METEOSAT THIRD GENERATION: PROGRESS ON SPACE SEGMENT SYSTEM FEASIBILITY STUDIES: PAYLOAD ASPECTS

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ABSTRACT

ESA and EUMETSAT have initiated joint preparatory activities for the formulation and definition of the Meteosat Third Generation (MTG) geostationary system to ensure the continuity and improvement of the Meteosat Second Generation (MSG) system. The MTG will become the new system to be the backbone of the European operational meteorological services from 2015, in particular, will ensure the continuation of the imagery missions. The first phases were devoted to the definition and consolidation of end user requirements and priorities in the field of Nowcasting and Very Short Term Weather Forecasting (NWC), Medium/Short Range global and regional Numerical Weather Prediction (NWP), Climate and Air Composition Monitoring and to the definition of the relevant observation techniques. The following missions have been analysed and preliminary concepts studied:

- High Resolution Fast Imagery Mission (successor to MSG SEVIRI HRV mission)
- Full Disk High Spectral Resolution Imagery Mission (successor to the mission of other MSG SEVIRI channels)
- Lightning Imagery Mission
- IR Sounding Mission
- UV-VIS-NIR Sounding Mission

After pre-phase A mission studies (2003-2006), where preliminary instrument concepts were investigated allowing in the same time to consolidate the technical requirements for the overall system study, a phase A study on MTG has been launched at the beginning of February 2007 for the space segment system feasibility and programmatic aspects to be accomplished during 2007-2008 time frame. The space segment phase A study will cover all elements to the level of details allowing to conclude on the feasibility of the system and to produce cost estimates with a good level of confidence.
This paper provides an overview of the outcome of the MTG space segment at the end of phase A, addressing the progress accomplished for the various payloads in terms of achievable performances including Radiometry and Image Navigation and Registration aspects. It namely focuses onto the Imaging and IR Sounding, Lightning Missions, introduces the UV-VIS-NIR Sounding mission concept status, establishes the critical technologies and introduces the way forward to the implementation of the MTG development programme.

GOES-R INSTRUMENT OVERVIEW AND ANTICIPATED USER BENEFITS

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ABSTRACT

The first step to improving forecasts of environmental hazards including severe weather and space weather events, is to improve detection of both the phenomena and the antecedent conditions leading to the event. The baseline instruments for the GOES-R series, including the Advanced Baseline Imager (ABI), the Geostationary Lightning Mapper (GLM), the Space Environment in-situ Suite (SEISS), the Solar Ultra-Violet Imager (SUVI) and the Extreme Ultraviolet and X-Ray Irradiance Sensor (EXIS) are designed to provide dramatic improvements to that first critical step.

The ABI will improve upon the current GOES Imager with more spectral bands, faster imaging, higher spatial resolution, better navigation, and more accurate calibration. The ABI expands from five spectral bands on the current GOES imagers to a total of 16 spectral bands in the visible, near-infrared and infrared spectral regions. There will be an increase of the coverage rate leading to full disk scans at least every 15 minutes. ABI spatial resolution will be 2 km for the infrared (IR) bands and 0.5 km for the 0.64 um visible band. The ABI will improve every product from the current GOES Imager and will introduce a host of new products.

The new GOES-R Geostationary Lightning Mapper (GLM) is a single channel, near-IR transient detector that will continuously measure total lightning activity with near-uniform spatial resolution of 8-12 km over the full-disk. The GLM will detect total lightning flash rate and changes in flash rate over both land and water. Total lightning activity is related to the updraft strength and the amount of ice in the mixed phase region of thunderstorms. By monitoring lightning frequency, one can infer storm kinematics and microphysical structure and, therefore, changes in storm severity.

The solar instruments and the SEISS, to monitor the highly-variable solar and near-Earth space environment continue a long history of space weather observations from the GOES. These observations are used to protect life and property of those sensitive to solar and space weather fluctuations. The expanded services from GOES-R will improve support to forecasters at NOAA's Space Weather Prediction Center (SWPC), customers in other government agencies, such as the Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA); commercial users of space weather services and international space environment services.

The ABI together with GLM will offer the promise of improving the observation and forecasting of virtually every type of hazardous weather event. The anticipated improvements in water vapor and cloud drift winds alone should provide significant improvements to Numerical Weather Prediction performance thereby improving the forecasts of all types of weather events. The ABI, with its additional channels, improved spatial resolution and temporal refresh, together with the GLM will be an especially powerful team for improving aviation forecasts. Substantial improvements in detection and forecasting of volcanic ash plumes, low clouds and fog, convection and hazardous winds can be expected.

This presentation will describe the expected new capabilities of GOES-R and how these will translate to improved weather forecasts and service to the user communities.

AN OVERVIEW OF FY-3A INSTRUMENTS AND CALIBRATION

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ABSTRACT

FY-3A, the first satellite in the second generation polar-orbiting meteorological satellites in China, will be launched in May, 2008. It will carry 11 payloads including seven optical sensors (VIRR, MERSI, IRAS, ERM, SIM, SBUS, TOU), three microwave sensors (MWTS, MWHS,MWRI) and one space environment monitor (SEM). These instruments can provide global observations and scientific understanding of clouds, radiation, atmosphere, land and ocean. The FY-3 Proto-Flight Model (PFM) was completed and transferred into the manufacture of their Flight Models (FM) in 2005. The three PFM sensors (MERSI, MWTS, MWHS) were conducted the airborne flight experiment at the China Radiometric Calibration Sites (CRCS) including Dunhuang, Qinhai Lake and Simao in 2007 and obtained the ideal airborne observation data. Their FM sensors are all finished the preflight calibrations and characterizations in 2007 and ready to be launched. The NSMC and the manufacturers of these instruments make full analysis and evaluation of these sensors before launch and also make the plan of Activation and Evaluation (A&E) phase during post-launch. We are planning to use the similar sensors such as AVHRR, MODIS, MERIS, TMI, AMSR-E, SSMIS, AMSU-A, AMSU-B, HSB, MHS, ATMS from international satellites to be conducted cross calibration and comparison. At the same time, a large ground-based synchronous experiment in CRCS sites will be conducted for vicarious calibration and validation for these new sensors during the A&E phase. The paper gives the characteristics of FY-3A instruments , briefly introduces the instruments' laboratory calibration and airborne flight test, the latest results for vicarious calibration and inter-calibration of the instruments in operation, as well as products' validation with ground truth, along with some ideas for the international cooperation in CAL/VAL.

THE NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS): IMPROVING WEATHER FORECASTING AND ENVIRONMENTAL MONITORING FROM SPACE

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ABSTRACT

The National Oceanic and Atmospheric Administration (NOAA), Department of Defense (DoD), and National Aeronautics and Space Administration (NASA) are working with industry partners to jointly develop the next-generation operational weather and environmental satellite system - the National Polar-orbiting Operational Environmental Satellite System (NPOESS). NPOESS will enable high-quality, space-based, remotely-sensed data to be used faster and more frequently in numerical weather prediction models for improved environmental forecasts and warnings.

NPOESS will consist of four spacecraft (C1 – C4) and associated sensors in two orbits (1330 local time ascending node – LTAN and 1730 LTAN) to meet the operational needs of NOAA and DoD. NOAA depends on data from the afternoon orbit (1330 LTAN) for input into global numerical weather prediction (NWP) models. The afternoon NPOESS spacecraft will carry the following primary instruments: Visible/Infrared Imager Radiometer Suite (VIIRS); Cross-track Infrared Sounder (CrIS); Advanced Technology Microwave Sounder (ATMS), Ozone Mapping and Profiler Suite (OMPS); as well as the Microwave Imager Sounder (MIS – C3 only), Space Environment Monitor (SEM), and Clouds and the Earth's Radiant Energy System (CERES). These advanced imagers and sounders will deliver higher spatial, spectral, and temporal resolution data enabling more accurate weather forecasts and warnings. The early morning orbit (1730 LTAN) will provide visible and microwave imagery for global cloud forecast models to support DoD's tactical decisions for air, sea, and ground operations. Currently, the early-morning spacecraft will fly with a reduced complement of instruments: VIIRS and MIS (C2 and C4). The first NPOESS spacecraft is scheduled for launch in 2013. The last satellites in the two-orbit NPOESS constellation are expected to continue operations until about 2023-2025. NPOESS is on track to deliver essential measurements for operational weather and ocean nowcasting and forecasting, land use, and space weather while providing continuity of data for 14 of 26 essential climate variables.

A mid-morning orbit (2130 LTAN) will be occupied by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Meteorological Operational (MetOp) spacecraft that carries advanced instruments similar to those that will fly on NPOESS. EUMETSAT's MetOp-A, that was launched in October 2006, permanently replaced NOAA's Polar-orbiting Operational Environmental Satellite (POES) in the mid-morning orbit as part of the NOAA/EUMETSAT Initial Joint Polar-orbiting Operational Satellite System (IJPS). The joint constellation of NPOESS and MetOp satellites will allow the international community to realize global coverage from advanced atmospheric sounding instruments with a data refresh rate of approximately four hours.

As a precursor to NPOESS, the NPOESS Preparatory Project (NPP) that is jointly managed by the NPOESS Integrated Program Office and NASA is scheduled to be launched at the turn of the decade. NPP will carry the primary NPOESS sensors (VIIRS, CrIS, ATMS, and OMPS) to provide on-orbit testing and validation of sensors, algorithms, ground-based operations, and data processing systems prior to the launch of the first operational NPOESS satellite. Flight units for the primary instruments are nearing completion for integration onto the NPP spacecraft. The NPP satellite will be launched into the 1330 LTAN orbit to reduce the risk of a data gap between the last POES and the first NPOESS satellite.

NPOESS will acquire, process, and deliver meteorological, oceanographic, terrestrial, climatological, and solar-geophysical observations of the Earth, atmosphere, and space to central processing facilities through an innovative global communications network of 15 unmanned ground stations that will provide significantly improved data latency over current systems. The NPOESS ground system architecture is expected to deliver 95% of the data within 28 minutes from the time of collection. NPOESS spacecraft will also simultaneously broadcast real-time data at X-band and L-band frequencies to suitably equipped ground stations. Key components of the NPP and NPOESS command, control, and communications system have already been installed and have passed preliminary tests at the Svalbard Satellite station (SvalSat) and at NOAA's Satellite Operations Facility. Communications capabilities from Antarctica are being upgraded to support NPOESS. NOAA and EUMETSAT are currently exploring opportunities to receive MetOp data from an Antarctic ground station, thereby substantially improving data latency in the mid-morning orbit. Installation and testing of the NPOESS Integrated Data Processing system at NOAA and DoD facilities will continue throughout 2008. In the future, NPOESS and MetOp will provide essential real-time data to the international community to support weather forecasting, as well as continuity of critical

SATELLITE DATA VALIDATION IN SODANKYLÄ, NORTHERN FINLAND; EPS VALIDATION CAMPAIGN IN 2007

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ABSTRACT

The Finnish Meteorological Institute's (FMI) Arctic Research Centre (ARC) is located at Sodankylä in Northern Finland. Sodankylä area is usually classified to boreal region. However, with regard to the stratospheric meteorology, Sodankylä can be considered to be an Arctic site, often lying beneath the middle or the edge of the stratospheric polar vortex and in the zone of polar stratospheric ozone depletion. The Sodankylä site has a long history extending back to 19th century as a boreal- sub arctic meteorological and magnetic observatory. Continuous, homogenized time series of the key Sodankylä weather parameters start from the year 1908 and the radiosonde record, also homogenized to the extent possible, goes back to 1949. In the present time FMI-ARC executes ground based observation program serving operational weather forecasting and atmospheric research, internationally competitive arctic global change research program, competent technical development and support functions and satellite data receiving, processing and archiving functions.

FMI-ARC's own research has two focuses. In the past two decades the main focus has been polar stratosphere research. Satellite validation and satellite operations in general are an emerging topic, which have gradually expanded over the last 10 years. The research group has participated in all major European polar ozone campaigns: EASOE, SESAME, THESEO and VINTERSOL, numerous smaller field campaigns and EU research projects, in the three of them in the coordinator position. FMI-ARC has submitted Sodankylä data for the validation of almost all polar orbiting ozone satellites and has been an active partner in the validation of e.g. ENVISAT mission of ESA and recently hosted a total ozone intercomparison and validation campaign SAUNA for Ozone Monitoring Instrument onboard the EOS AURA satellite of NASA. FMI-ARC hosted an intercomparison campaign for the balloon humidity sensors which included both the most commonly used radiosonde RH sensors and research grade frost point or alpha-lyman sensors.

In June – September 2007 FMI-ARC hosted the EPS Validation Campaign for Eumetsat. During the campaign altogether 360 PTU sondes, 40 ozone sondes and 7 frost-point hygrometers were flown. These 360 PTU sondes correspond to two Metop passes on each calendar day, assuming 2 soundings per each overpass during three months of operation. Ozone sondes were launched 3 times per week, CFH sondes in average two times per month. Each CFH sonde payload included also an ozonesonde and one or more PTU sondes. The measurements were made with the purpose to provide validation data for T, Q and O3 parameters at given levels for the EPS IASI L2 and ATOVS L2 products at the location of the campaign site. All sonde launches were performed in synchronization with Metop satellite overpasses. Thus, the first PTU launch took place 1 hour and the second PTU launch 5 minutes before each Metop overpass. Thus FMI performed in total 4 overpass launches each day, first during the morning overpass and the second one during the evening overpass. In addition, regular PTU sondes were launched at 23:30 and 11:30 UT. Ozonesonde and the CFH sonde were launched during the morning overpass and as the first sonde (one hour before the satellite overpass). When the CFH sonde was launched, the CFH sonde and the ozonesonde were flown in the same payload. Several surface measurements were also operated continuously. A new Microwave Radiometer was developed in cooperation with a private Finnish company for atmospheric water vapor profiles.

Examples of the measured data are shown. Some further use of the huge validation data set is also discussed in the presentation.

SIMULATION OF METEOSAT THIRD GENERATION - LIGHTNING IMAGER THROUGH TROPICAL RAINFALL MEASURING MISSION LIGHTNING IMAGING SENSOR DATA.

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ABSTRACT

The Centro Nazionale di Meteorologia e Climatologia Aeronautica recently hosted a fellowship sponsored by Galileo Avionica, with the intent to study and perform a simulation of Meteosat Third Generation - Lightning Imager (MTG-LI) sensor behavior through Tropical Rainfall Measuring Mission - Lightning Imaging Sensor data (TRMM-LIS).

For the next generation of earth observation geostationary satellite, major operating agencies are planning to insert an optical imaging mission, that continuously observes lightning pulses in the atmosphere; EUMETSAT has decided in recent years that on of the three candidate mission to be flown on MTG is LI, a Lightning Imager.

MTG-LI mission has no Meteosat Second Generation heritage, but users need to evaluate the possible real time data output of the instrument to agree in inserting it on MTG payload. Authors took the expected LI design from MTG Mission Requirement Document, and reprocess real lightning dataset, acquired from space by TRMM-LIS instrument, to produce a simulated MTG-LI lightning dataset. The simulation is performed in several run, varying Minimum Detectable Energy, taking into account processing steps from event detection to final lightning information.

A definition of the specific meteorological requirements is given from the potential use in meteorology of lightning final information for convection estimation and numerical cloud modeling.

Study results show the range of instrument requirements relaxation which lead to minimal reduction in the final lightning information.

THE METEOSAT VISIBLE CHANNEL CALIBRATION METHODOLOGY USED IN THE CERES GEOSTATIONARY CLOUD AND RADIATION PRODUCTS.

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ABSTRACT

Five years of Clouds and the Earth's Radiant Energy System (CERES) cloud and radiation products are now available for the climate community. The CERES products provide the user community with a consistent cloud and radiation dataset of climate quality, with an instantaneous broadband calibration stability of 0.1% per year. In order to take into account the diurnal flux variation between CERES measurements, 3-hourly geostationary derived broadband measurements are used to estimate the monthly mean flux. Accurate geostationary visible channel calibration is crucial in order to derive cloud and radiation parameters consistent across geostationary satellites. To assure that the geostationary fluxes do not alter the CERES calibration, they are normalized to the CERES flux measurements. The CERES geostationary calibration algorithm cross-calibrates the Terra- Moderate Resolution Imaging Spectrometer (MODIS) with each of the 5 geostationary satellites using a ray-match technique. The calibration algorithm also uses deep convective cloud radiances as a stable bright target to monitor the geostationary degradation. Trends in cloud amount and optical depth are a direct result of the geostationary calibration and are analyzed to detect calibration drifts.

The CERES geostationary calibration algorithm will be discussed as it relates to the METEOSAT 5,7,8,9 visible channels during the years of 200-2006. The derived METEOSAT calibration will be compared against the official EUMETSAT calibration.

TOWARDS A CONSENSUS CALIBRATION OF THE AVHRR REFLECTANCE CHANNELS FOR CLIMATE STUDIES

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ABSTRACT

With the launch of METOP, EUMETSAT has joined force with NOAA to extend the AVHRR data record to over three decades. The Advanced Very High Resolution Radiometer (AVHRR) is therefore a potentially critical satellite data source for climate studies. One limitation of the AVHRR is the lack of onboard calibration of the solar reflectance channels. Because many of the climate parameters derived from the AVHRR rely on the solar reflectance channels, accurate calibration is a must. Over the years, several vicarious techniques have been put forth to calibrate the AVHRR reflectance channels. This work describes a project involving several groups working to achieve a consensus calibration for climate studies. This project will finish in 2009 and this presentation will highlight the comparison of the existing calibration methodologies using derived product and radiometric time series.

INTER-CALIBRATION OF METEOSAT IMAGERS AND IASI

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ABSTRACT

EUMETSAT has embarked on a programme of inter-calibrating its satellite instruments as a contribution to the international Global Space-based Inter-Calibration System (GSICS). This aims to produce more consistent, better characterised data with less bias in the radiances and the products derived from them.

Initially, hyper-spectral observations from the well-characterised Infrared Atmospheric Sounding Interferometer (IASI) on the polar-orbiting Metop spacecraft have been used to synthesise the radiances expected in the infrared channels of the geostationary Meteosat satellites. The differences between these collocated observations from these instruments will be presented, showing trends in their relative biases during 2007.

Future plans include the assessment the measurements' absolute accuracy through references traceable to SI standards, comparison with the bias monitoring performed when assimilating data into Numerical Weather Prediction (NWP) models and the application of these techniques to past satellite data to construct a re-analysis time-series for suitable for climate monitoring applications.

NPOESS 1ST & 2ND GENERATION SYSTEMS: MOVING TOWARDS OPERATIONAL MONITORING OF THE ATMOSPHERE IN A GEOSS ENVIRONMENT

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ABSTRACT

NPOESS, the National Polar-orbiting Operational Environmental Satellite System, managed by the Integrated Program Office, will represent the U.S. next generation, polar-orbiting, low-earth orbit [LEO] operational, satellite constellation. This NPOESS 1st Generation will span the period of ~2009 through 2029. An NPOESS 2nd Generation --- namely, *NexGen*, is already under consideration for the Post-2026 generation. Since NPOESS is structured as an operational, long-term, environmental, satellite monitoring system for weather, climate, land, ice, and oceans, both the 1st and 2nd Generation NPOESS will be very well positioned to establish and sustain operational monitoring of the Earth's atmosphere. This NPOESS capability will be realized during the emergence and evolution of any Global Earth Observation System of Systems [GEOSS] with nearly world-wide participation of the Earth's nations.

Both generations of NPOESS will employ sounders and imagers which will enable the long term monitoring of the thermodynamics and some of the critical chemistry of the Earth's atmosphere. This presentation will discuss the atmospheric temperature and moisture profiles, aerosol effects/properties and some of the most critical, atmospheric trace/greenhouse gases such as H_2O, O_3, CO, CH_4, CO_2, N_2O and other oxides of sulfur and nitrogen which will be monitored over much of the globe with varying degrees of accuracy. It will be indicated how these measurements will be important in helping to contribute to some of the Societal Benefit Areas that the Group on Earth Observations [GEO] has and will be focusing on in GEOSS – especially weather forecasting, climate variability, human health and well-being and air quality. Results of analyses, field demonstrations/campaigns, and simulations will be presented to demonstrate the role of the NPOESS sensors and products to a comprehensive atmospheric monitoring. Some of the critical spectral, spatial and radiometric requirements necessary to achieve such monitoring will be discussed.

The environmental products derived from these NPOESS atmospheric monitoring measurements will be shown to be key inputs for numerical weather prediction/weather forecasting and climate monitoring, determination of climate change and potentially climate prediction and important chemistry affecting air quality and human health. For example, radiatively active gases such as O_3 and long lived gases such as CO will be demonstrated to be important in critical areas such the monitoring of air quality and the initialization of improved climate processes models. The 2nd Generation NPOESS will, in addition, try to formalize monitoring observations of the atmospheric dynamics (winds, moisture flux and stability tendency) even though the 1st Generation NPOESS will begin some of the measurement indicators of these crucial atmospheric characteristics.

IR-BASED SOLAR CHANNEL CALIBRATION USING DEEP CONVECTIVE CLOUDS

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ABSTRACT

Over the tropical latitudes, there are abundant clouds overshooting the Tropical Tropopause Layer (TTL). These deep convective clouds (DCCs) were used for testing if solar channel calibration is possible purely based on IR channel measurements. The proposed method was tested first using MODIS measurements. DCCs were determined from MODIS 10.8 μm brightness temperature (TB) measurements by applying the criteria of TB < 190 K, and then MODIS-derived cloud optical thickness (τ) and effective radius (R_e) of determined DCCs were examined to find representing optical properties. It was found that most of τ of those selected DCCs are close to 100 or appear to be larger than 100. In addition, R_e distributions show a sharp peak centered at around 22 μm. MODIS visible channel radiances were then simulated using a modified SBDART radiative transfer model with Baum's scattering data base for homogeneous overcast ice clouds of τ = 100 and R_e = 22 μm, based on the assumption that reflected visible radiances are in the near maximum when τ = 100. The comparison of simulated radiances with MODIS-observed radiances for one year of 2006 demonstrates that visible channel measurements can be calibrated within a ±5% uncertainty range on a daily basis. Furthermore, considering that DCCs are abundant over the tropical latitudes and that the algorithm only requires DCC determination, the method can be easily adopted for the calibration of visible sensors aboard both geostationary and low-orbiting satellites.

COMBINING GROUND-BASED REMOTE SENSING AND BALLOON-BORNE PROFILE MEASUREMENTS IN LINDENBERG (RICHARD-AßMANN-OBSERVATORY) FOR IASI-VALIDATION: METHODS, AVAILABILITY, AND ACCURACY

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ABSTRACT

A total of 290 radiosondes (Vaisala RS92) were launched from June to August 2007 at times given by the Metop overpasses in addition to 368 routine radiosonde ascents at standard times (00, 06, 12, 18 UT) to provide temperature and humidity profiles for the validation of the Infrared Atmospheric Sounding Interferometer (IASI) on board the Metop satellite.

These soundings were supplemented by a variety of ground-based remote sensing. Water vapour and temperature profiles as well as precipitable water were measured continuously by microwave profiler and GPS. A Raman lidar provided profiles of water vapour with high vertical and temporal resolution. Cloud parameters, e.g. cloud top height, pressure and temperature, were derived by a Ka-band radar and a ceilometer. Cloud cover was determined by human observations and a whole sky imager. A Brewer spectrometer and a precision filter radiometer were used for measurements of total ozone and aerosol optical depth, respectively. In-situ measurements of surface meteorological parameters and long-wave radiation completed the validation data set of summer 2007.

A lot of efforts have been made in the field of the Integrated Profiling Technique (IPT). The IPT combines radiosounding data and data of microwave profiler, lidar, ceilometer, and Ka-band radar to an optimal estimate of the current atmospheric state characterized by profiles of temperature, humidity and cloud liquid water content. The IPT was adapted to provide profiles from 60 min before until 60 min after the Metop overpass.

On the strength of past experience, however, the combination of several measurements did not overcome all disadvantages of the individual measurement systems.

The vertical resolution of radiosonde measurements is high, but there is a relatively quick passage of the radiosonde through the atmosphere compared to the characteristic time scales of the turbulence, thus the representativeness of radiosondes measurements is limited. Furthermore, we should take into account the fact that the radiosonde is drifting away from the location of launch during the ascent. It is also to keep in mind that humidity measurements of the RS-92 standard radiosonde have a bias for lower humidity. Therefore, the quality of humidity measurements was evaluated during the summer campaign by 39 reference soundings (RS90-FN), which have been used to derive a correction function (elimination of the dry bias) for standard humidity soundings.

On the other hand the advantage of remote sensing techniques to provide information of the column above the observatory site is foiled by the low vertical resolution and smoothing effects, respectively (microwave profiler), or by insufficient weather conditions (lidar).

We will present:

- an overview of the balloon-borne and remote sensing systems at the observatory site and their capabilities,
- results describing the spatiotemporal variability of temperature and humidity in the boundary layer, the free troposphere and the stratosphere,
- estimations of the accuracy of balloon-borne profile measurements,
- principles and results of the Integrated Profiling Technique (IPT),
- a comparison between several profile retrievals suitable for satellite validation.

CORRECTIONS TO GAINS AND SPECTRAL RESPONSE OF CERES BASED ON IN-FLIGHT MEASUREMENTS

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ABSTRACT

A CERES (Clouds and the Earth's Radiant Energy System) scanning radiometer is designed to measure accurately the solar radiation reflected by the Earth and thermal radiation emitted by the Earth suitable in the climate research. There are two CERES instruments aboard the Terra spacecraft (launched 2000), and two aboard the Aqua spacecraft (launched 2002). There is then almost a decade long radiation budget dataset indispensable in the climate research, particularly if we include data from a CERES aboard TRMM satellite having operated in 1998.

There are several CERES science data products available. The most basic, instantaneous data product is referred to as the ERBE-like for the continuity with Earth budget missions before CERES instruments. Since this product lays foundation for other products, it is very important to maintain its high accuracy of 1% as specified in the mission objectives. In order to meet this requirement, instruments' performance is constantly monitored using not only internal calibration sources but also analyzing all in-flight data, and comparisons to other instruments. As a result of such a comprehensive approach to the stability and consistency of CERES data, the CERES radiation budget dataset is often used as a benchmark. However, recent analyses have shown some small change in instruments' optical throughput attributable to gain and spectral response changes. It is therefore the Instrument Working Group's top priority to devise corrections for the observed changes to be included in the Edition-3 of the ERBE-like data product.

The main focus of this paper is to show how the CERES in-flight measurements are used to derive corrections to the gain and spectral response. It is demonstrated that the mission long measurements of deep convective clouds (DCC) can be used as a stability metric. This metric is used in conjunction with the internal calibration sources to quantifying the gain and spectral response changes for both modes of operations: the FAPS mode (a fixed relative azimuth is orthogonal to the spacecraft velocity vector), and a RAPS mode (a relative azimuth is changing at a constant rate.) In the paper, results of applying derived corrections to all four CERES instruments are also included. The processing of the Edition-3 data is to commence in the spring of 2008.

IMPACT OF CHANGES TO SEVIRI LEVEL 1.5 RADIANCES ON THE LAND-SAF LAND SURFACE TEMPERATURE

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ABSTRACT

The Satellite Application Facility on Land Surface Analysis, Land-SAF, generates fields of Land Surface Temperature, LST, for the Meteosat-disk. LST is estimated operationally every 15-min, and made available to users in near real time or off-line, since July 2005. The LST algorithm consists of a generalised split-window algorithm, applied to clear-sky SEVIRI brightness temperatures, for channels 10.8 [micro]m and 12.0 [micro]m, hereafter Tb108 and Tb120, respectively. The latter are estimated from level 1.5 radiances of the relevant channel, assuming that these are effective radiances representing the integral over the channel spectral band. However, until early 2008, the actually level 1.5 data distributed via EUMETCast were defined in terms of spectral blackbody radiance. Here we analyse the impact of the transition of level 1.5 window channel radiances, from spectral to effective values, on the Land-SAF LST product.

The LST algorithm performs an atmospheric correction of window channel brightness temperatures, Tb108 and Tb120, taking into account geometric effects (i.e., the dependence of the total optical path on satellite viewing angle), the total amount of water vapour in the atmosphere and surface emissivity. Thus LST is particularly sensitive to Tb108 and Tb120 and also to the respective difference, since this is largely associated to the differential atmospheric absorption in the two neighbouring window channels. A first attempt to simulate the correct Tb108 and Tb120 suggests these may become 0.2 to 0.5 K cooler, while the difference [Tb108 - Tb120] is also likely to decrease by up to 0.5K. Sensitivity studies indicate that a reduction of 0.2K in both Tb108 and [Tb108 - Tb120] translates into a decrease of 0.5 to over 1K in LST. The analysis of level 1.5 data with corrected effective radiances (made available for testing in January 2008) suggests that the discrepancies of Tb108 and Tb120 estimated from spectral and effective radiances, may be higher than those obtained with simulated data. Preliminary results point towards a decrease in LST by up to 2K over Europe and up to 3K over Northern Africa. The correction seems to be higher for warmer temperatures, which is in line with LST validation results indicating a tendency for overestimation of daily amplitudes.

Generation of homogeneous and continuous time-series of LST is a request from several Land-SAF users to begin and maintain a climate record of SEVIRI-based LST, for applications that rely on anomalies and for those requiring data for calibration/training of algorithms. The importance of re-processing the entire database can be quantified based on the impact of changes of the main input to LST.

This work has been carried out within the scope of Land-SAF, co-funded by EUMETSAT.

CALIBRATION EXPERIENCE WITH 3-AXIS STABILIZED GEOSTATIONARY METEOROLOGICAL SATELLITE

Xiangqian Wu[1], **Michael Weinreb**[2]

(1) NOAA/NESDIS, (2) RTI

ABSTRACT

The attitude of a geostationary meteorological satellite can be maintained on orbit in two ways. Earlier generation of Geostationary Operational Environmental Satellites (GOES), as well as the Geostationary Meteorological Satellite (GMS), Feng Yun (FY-2), and METEOSAT, are stabilized in space by spinning rapidly around its axis that is parallel to the earth's rotation axis (South-North poles), hence the name "spin-stabilization". Current GOES (starting with GOES-8 launched in 1994) and the Multiple-functional Transport Satellite (MTSAT) since 2005 are stabilized in all three dimensions, or "3-axis stabilization", such that the spacecraft appears truly stationary relative to the earth. Future geostationary meteorological satellites, including the METEORSAT Third Generation (MTG) of Europe, FY-4 of China, and Communication, Ocean, and Meteorological Satellite (COMS) of Korea, have all planned to be 3-axis stabilized. The stabilization of a spacecraft has profound impact on every aspect of its mission, including the calibration of instrument onboard the spacecraft. This talk reviews calibration experience at NESDIS during the transition of this major configuration change, including the expectation and preparation before the change and lessons learned after. It is hoped that the experience would help the preparation for MTG, FY-4, and COMS.

CALIBRATION AND VALIDATION OF ASCAT BACKSCATTER

Craig Anderson, Hans Bonekamp, Julia Figa, Julian J Wilson, Arthur de Smet, Colin Duff

EUMETSAT

ABSTRACT

The Advanced Scatterometer (ASCAT) on Metop A is real aperture, vertical polarisation, C band radar whose primary objective is to allow the wind field at the ocean surface to bedetermined from the normalized radar cross section (sigma0) output. Data is provided at nominal resolutions of 25 and 50 km in two swaths, each 550 km wide on either side of the nadir track.

A set of three transponders enable the ASCAT antenna gain patterns to be determined and an absolute calibration to be achieved. This paper describes the calibration process, the accuracy levels achieved and the stability of the instrument.

ASCAT is a successor instrument to the Active Microwave Instruments on ERS-1 and 2 and shares the same beam geometry, polarisation and almost the same radar frequency. Research using data from ERS-1 and 2 has resulted in a number of accurate backscatter models for ocean, sea ice and rainforest regions of the Earth. We describe how these models are used with ASCAT data to confirm the calibration levels and to monitor the instrument stability in between transponder calibration campaigns

THE IMPACT OF THE CUT-OFF IN THE ASSIMILATION OF ASAR WAVE SPECTRA AND JASON-1 ALTIMETER DATA IN THE WAVE MODEL

Lotfi Aouf[1], Jean-Michel Lefèvre[1], Fabrice Ardhuin[2], Bertrand Chapron[3], Daièle Hauser[4]

(1) Meteo France, (2) SHOM, (3) Ifremer, (4) CETP/IPSL

ABSTRACT

A new 3G wave model has been implemented at Météo France. The dissipation of the swell is well improved by using a new term described by Bidlot et al. (2005). Our assimilation system uses both the ASAR wave spectra and altimeter wave data. In previous study we showed that the use of the altimeter data and ASAR wave spectra has significantly improved the wave prediction in both analysis and forecast. This work focuses on the impact of the azimuthal cut-off of SAR wave spectra in the assimilation system. As known the ASAR wave spectra has a limitation in the azimuth direction. Instead of using an average value (around 240 m) for the azimuthal cut-off retrieved from the algorithms, a new technique has been implemented in order to get more information from the ASAR in the range direction. Such technique can include shorter waves (150 m) in the assimilation procedure.A test run of the assimilation of ASAR wave spectra with variable cut-off and Jason-1 altimeter data has been performed for a long period of 6 months. The optimal interpolation for the ASAR spectra uses two different correlation models for the wave energy and the components of wave numbers of dominant wave trains.
The results shows a significant impact on the mean wave parameters. The outputs of integrated waves parameters from the runs have been validated with indpendent wave observations such altimeters GFO-NOAA, Envisat Ra-2 and NDBC buoys data. Conclusions and discussions will be commented in the final paper.

SALP/AVISO AND MYOCEAN INFORMATION SYSTEMS

Frederique Blanc

CLS / Space Oceanography Division

ABSTRACT

We will present here the SALP/AVISO information system to present or search, discover and understand, access, visualise and analyse ocean products, satellite altimetry.

An overview of the products handled by the system will first be presented. We will then review the various services activities depending on the user profile to finish with presentation of auxiliary services like the BRAT educational toolbox.

The talk will end with the presentation of the MyOcean GMES information system, the interoperability requirements to be met, the products to be managed, the services to access and monitor them..

SEA ICE ANALYSIS USING VARIATIONAL ASSIMILATION OF SATELLITE-DERIVED SEA ICE CONCENTRATION.

Alain Caya, Alain Buehner, Tom Carrieres, Mingrui Dai

Environment Canada

ABSTRACT

In preparation for data assimilation in coupled atmosphere-ice-ocean models, a three-dimensional variational (3D-Var) data assimilation system and an ensemble Kalman filter (EnKF) are developed. The EnKF is used to estimate background-error covariances for the 3D-Var data assimilation system. Specification of the background-error covariance between the sea ice and ocean variables is particularly important because of the lack of direct measurements of the three-dimensional ocean state under sea ice. A diffusion operator for modeling the background-error horizontal correlations in the 3D-Var is well suited for regions with complex lateral boundary conditions like in the Canadian Arctic Archipelago. Results from assimilating sea-ice concentrations derived from satellite data are shown.

Work is also under way for direct assimilation with 3D-Var of passive microwave data using a radiative transfer model. Projects planned, together with O&SI-SAF collaborators, to examine the direct assimilation of high-resolution satellite data (AVHRR and SAR) are also discussed.

STATUS OF GLOBAL SEA ICE, SNOW AND ICEBERG MONITORING AT THE U.S. NATIONAL ICE CENTER

Pablo Clemente-Colón, John Woods, Sean Helfrich, Todd Arbetter, James Brinkley, Wanshu Huang, Brian Melchior, John Peña

U.S. National Ice Center

ABSTRACT

The U.S. National Ice Center (NIC) brings together Navy, NOAA, and U.S. Coast Guard (USCG) assets in support of coastal and marine sea ice operations and research. The NIC provides specialized strategic and tactical ice products to support operational needs of the U.S. government. In partnership with the Canadian Ice Service (CIS) and the International Ice Patrol (IIP), the NIC also participates in the North American Ice Service (NAIS) seeking to harmonize operations and conduct collaborative research in support of their combined requirements. As the only national operational ice service with global monitoring responsibilities, the NIC closely collaborates with many other ice and meteorological services offices throughout the world. The NIC utilizes multiple sources of satellite and in-situ observations in conjunction with as NWP and ocean-sea ice model output to produce sea ice analyses. Parameters of interest to the NIC include sea and lake ice extent, concentration, thickness and the calving/tracking of icebergs. Operational responsibility for the production of the NOAA Snow and Ice mapping system (IMS), which provide global snow cover for the NWP community, has been transferred to the NIC in 2008. Recent changes in data access, processing, and operational products as well as support for users in the meteorological and oceanographic community will be discussed.

SSALTO/DUACS: FASTER DATA DELIVERY FOR OPERATIONAL OCEANOGRAPHY AND GMES

Joel Dorandeu[1], Gerald Dibarboure[2], Gilles Larnicol[2], Nicolas Picot[3]

(1) CLS, (2) CLS (Collecte Localisation Satellite), (3) CNES

ABSTRACT

This paper describes the DUACS multi-mission system, and its most relevant improvements and changes. Initiated 10 years ago with an EC project, DUACS is now a part of the CNES multi-mission ground segment SSALTO, and the backbone of the Sea Level Thematic Assembly Centre (SL-TAC) of the GMES Marine Core Service.

Near Real Time (NRT): Daily Operational Products

DUACS-NRT provides GODAE, climate forecasting centres, the MyOcean EU FP7 project, and real time oceanographic research (e.g.: in-situ campaigns) with directly useable, high quality near real time altimeter data. Regional products (European Shelves, Mediterranean Sea, and Black Sea) are delivered to operational projects. Commercial applications are also developed for the fishery and offshore drilling industries. All DUACS near real time products are generated and distributed on a daily basis to reduce the NRT delay, and to smooth the operational procedures of NRT users.

DUACS features a systematic quality control of the input data, the system itself, and its products with detailed reports put online twice per week. The system also carries out on-the-fly editing and reprocessing of erroneous datasets, as well as a long term monitoring of NRT data it has used, to quickly detect anomalies, drifts and discontinuities in incoming altimeter data.

Delayed Time (DT): A consistent data set from built upon all altimeters

The second generation of DUACS-DT products is composed of global data sets of along track and gridded Sea Level Anomaly, Absolute Dynamic Topography, and geostrophic currents, but also of regional-specific products (higher resolution, optimized parameters). DUACS reprocessed all past altimeter data: Jason-1, T/P, ENVISAT, GFO, ERS1/2 and GEOSAT. These delayed time products are regularly updated when new Level2 data are released and fully validated.

The system operationally integrates the state-of-the-art corrections, models and references recommended by the altimeter community, as well as the best Cal/Val and cross-calibration and merging algorithms.

Ongoing Improvements to secure multi-mission products

Adding Jason-2 to the system is arguably the most important improvement on DUACS in 2008. Additionally, the effort to improve the quality of DUACS combined data and the robustness of the NRT system are ongoing with the release of Key Performance Indicators on the system, and Ocean Indicators for a near real time ocean monitoring.

Last year, preliminary studies were carried out to merge into the high-accuracy NRT system, innovative information of lower quality altimeter data flows such as OSDR / FDGDR / OGDR (real time data delivered in a few hours as opposed to 2 or 3 days for classical NRT data), as well as CryoSat data. These offline studies and experimental NRT productions will be integrated to the system in order to guarantee sustainability and quality in the operational DUACS framework.

MEAN SEA LEVEL MONITORING FROM SATELLITE ALTIMETRY

Joel Dorandeu[1], Anny Cazenave[2], Alix Lombard[3], Michael Ablain[1], Stephanie Guinehut[1]

(1) CLS, (2) LEGOS, (3) CNES

ABSTRACT

Observing, understanding and forecasting climate changes are of prime importance at short, medium and long term. Indeed, global climate changes are likely to directly impact the life of billions of human beings all over the world. It is also crucial to precisely estimate the part of the change that is due to direct anthropogenic forcing factors, if we want to push solutions forward.

The present-day Mean Sea Level (MSL) rise is one of the main characteristics of the suspected global warming. Indeed, MSL variations result from thermal expansion due to ocean heat content change, density (salinity) change and global ocean mass change due to ice melting or variations in land water storage. Only space measurements can give access to precise, global and continuous observation of the Mean Sea Level. Satellite Altimetry provides such measurements: it uses radar measurements to estimate the distance between the sea surface and the satellite. From the knowledge of the satellite height by precise orbit determination, one can compute the Sea Surface Height (SSH) and derive MSL variations at global or regional scales. Satellite altimetry from the Topex/Poseidon (T/P) and Jason-1 missions, complemented by EnviSat, have provided precise sea level measurements since the early 1990s with quasi global coverage and have revealed that the sea level is not rising uniformly. The MSL rise estimated from altimetry is about 3 mm/year at global scale, but local trends show high discrepancies from one region to another: in some regions, rates are several times the global mean rise, while in other regions the sea level is falling. Other space observation systems also help in the interpretation of the global MSL change: ice measurement (thickness, extension) and characterization are performed from space, gravimetry missions (GRACE) allow promising estimation of water mass variations.

From the experience of this 15 year old space measurement series, several insights can be highlighted for the future: continuity of high precision space altimetry measurement is needed in the long term to ensure a sustainable MSL monitoring as a key element in the global climate change survey. It is also crucial that several altimetry missions are combined to improve space/time coverage. Other altimetry missions also provide independent measurements which are, besides in-situ measurements, mandatory to calibrate and validate at the level of accuracy required by such applications.
Space observations, in particular altimetry, have become the core observation system for MSL monitoring. They have to be maintained into integrated multi-disciplinary observation systems, with high complementarity between space and in-situ measurements in order to provide relevant measurements for studies, analyses and forecasting systems.

THE GOCI INSTRUMENT ON COMS MISSION THE FIRST GEOSTATIONARY OCEAN COLOUR IMAGER

François Faure

ASTRIUM SAS Satellite

ABSTRACT

François FAURE, Pierre COSTE, Astrium SAS Satellite, Toulouse, France
Dr Gm Sil KANG, KARI, Daejeon, South-Korea

Abstract

GeostationaryOcean Color Imager (GOCI) is under development to provide a monitoring of Ocean Colour around the KoreanPeninsula from geostationary platforms. Currently under manufacture by Astrium SAS, it is planned to be launched onboard Communication, Ocean, and Meteorological Satellite (COMS) of Korea in 2009.

GOCI will be the first Ocean Colour Imager to operate from Geostationary Orbit. The instrument is developed for use in South Korea under the KARI contract. The GOCI instrument will complete its production and delivery to Korea mid 2008 for integration onto the COMS satellite aside the COMS Meteo Imager (MI).

The mission is designed to significantly improve ocean observation from low orbit service by providing a high frequency coverage. The GOCI is designed to provide multi-spectral data to detect, monitor, quantify, and predict short term changes of coastal ocean environment for marine science research and application purpose. Target area for the GOCI observation in the COMS satellite will cover a large 2500 x 2500 km2 sea area around the KoreanPeninsula, with an average resolution of 500m.

The presentation will give an overview of the mission objectives and major system requirements. The GOCI FM instrument is presently in final phase of production and an overall description of the instrument design and main characteristics will be given in the final paper. Several innovative features will be highlighted like the use a dedicated advanced CMOS detector matrix coupled with a pointing mechanism and of the use of solar calibration to provide an accurate absolute radiance.

THIRTY YEARS AFTER SEASAT: THE PRESENT STATUS AND FUTURE OUTLOOK OF SATELLITE ALTIMETRY FOR STUDYING OCEAN CIRCULATION AND SEA LEVEL CHANGE

Lee-Lueng Fu

Jet Propulsion Laboratory

ABSTRACT

The first space-borne radar altimeter for studying the ocean was launched onboard Seasat in 1978. The 3-month long mission demonstrated the potential of the technique of radar altimetry for oceanography. However, it took more than a decade to launch the Joint U.S./French TOPEX/Poseidon Mission (T/P) in 1992, which marked the beginning of precision altimetry with sufficient accuracy for studying the large-scale patterns of ocean circulation and global sea level change. The data record established by T/P was continued by its follow-on US/French Jason Mission in 2002. This combined 15 plus year record of sea surface height (SSH) has provided the first global view of the change of ocean circulation and sea level on decadal scales. Ocean circulation is found to be tied to major modes of climate variability such as the Pacific Decadal Oscillation. Basin-scale patterns of decadal variability are determined in all ocean basins.

Such variability is not only interesting in its own right; it must also be taken into account in the determination of longer-term trends in global sea level change. The combination of the observations from Jason and GRACE, a satellite measuring Earth's gravity field, allows the separation of sea level change into contributions from mass and density change of the ocean. The density change of the ocean from heating/cooling provides information on the ocean's heat storage. With the approach of modeling and data assimilation, the vertical distribution of the heat storage can be determined. In addition to T/P and Jason, the European Remote Sensing (ERS) Satellites and their replacement, ENVISAT, have provided complementary data leading to enhanced spatial and temporal resolution of SSH observations. Significant advances have also been made in the understanding of the mesoscale variability of the ocean that contains most of the kinetic energy of the ocean. Preliminary results from the Ocean Surface Topography Mission (OSTM)/Jason-2 will be presented. Planning of the next-generation wide-swath altimeter will also be addressed.

DIURNAL VARIABILITY IN THE UPPER OCEAN

Chelle Gentemann[1], **Peter Minnett**[2]

(1) Remote Sensing Systems, (2) University of Miami - RSMAS

ABSTRACT

Several recent studies have concluded that coupled climate models should utilize a diurnally varying sea surface temperature (SST) to examine the details of the boundary layer response and ensuing air-sea interactions. This requires a model of diurnal warming and estimates of model error. A new diurnal model has been developed, specifically developed to determine the diurnal warming at the ocean surface and its vertical structure. The global distribution of diurnal warming is clearly linked to wind speed and will therefore respond to the climatic distributions and seasonal or anomalous changes in wind speed, as shown by the response to ENSO wind speed anomalies. The Subtropical High regions in each ocean basin, and the Tropical Indian and Western Pacific Oceans have the largest averages of diurnal warming. The intra-day variability of surface warming has been related to the stability of the boundary layer and atmospheric convection. Since the tropical convection is an important driver of global atmospheric circulation, this example of ocean-atmospheric feedback underscores how diurnal warming of the ocean surface may influence larger scale weather patterns and climate.

THE EUMETSAT OCEAN AND SEA ICE SAF (OSI SAF) : A CONTRIBUTION TO OPERATIONAL OCEANOGRAPHY

Guenole Guevel

Météo-France

ABSTRACT

The EUMETSAT OSI SAF (**www.osi-saf.org**) was created in 1997 as an answer to requirements from the meteorological and oceanographic communities of EUMETSAT Member States and Co-operating States for a comprehensive information derived from meteorological satellites at the ocean-atmosphere interface.

The two previous phases, the Development phase (1997-2002) and the IOP (initial Operations Phase, 2002-2007) met the main target which was to develop, validate and then produce operationally quality controlled satellite-derived products related to four key parameters (Sea Surface Temperature, Radiative Fluxes, Sea Ice, Wind) over various geographical coverage from regional to global.

These products are currently available in near real time both through EUMETCAST and local FTP servers, and offline from local archive and some of them from UMARF.

The current phase of the OSI SAF, the CDOP (Continuous Development and Operations Phase) has taken into account new requirement sources, in particular from GODAE, GHRSST and GCOS at international level, and GMES (through MyOcean) at European level, with a strong need for increasing the temporal and geographical resolution of the products and for extending the coverage range from coastal to global. In September 2008 the OSI SAF will offer as operational products at global coverage the SST, Sea Ice and Wind.

In terms of access to the products a new approach has been defined that can be summarized as following : The products are (or will be soon) accessible both :

- via EUMETCAST and UMARF, in particular at the intention of meteorological institutional users, in GRIB (ed 2) or BUFR, over predefined areas and projections,
- via flexible INTERNET FTP servers, in particular at the intention of the oceanographic community,
- in NETCDF, at full resolution and satellite projection, and with specific interface allowing geographical extraction, re-projection and re-gridding.

The objective of this paper is to offer an overview on the OSI SAF project, the target production at the end of the CDOP, the (pre-)operational production status, the preparation for future satellites, the user support and users interactions, as well as involvement in relevant projects, such as GMES.

MONITORING OF SEA-ICE DRIFT IN THE ARCTIC OCEAN -TESTING BEFORE IMPLEMENTATION IN THE OCEAN AND SEA ICE SATELLITE APPLICATION FACILITY

Thomas Lavergne[1], Gorm Dybkjær[2], Leif Toudal Pedersen[2]

(1) The Norwegian Meteorological Institute, (2) Danmarks Meteorologiske Institut

ABSTRACT

Sea-Ice products are routinely processed at EUMETSAT Ocean and Sea-Ice Satellite Application Facility (OSI SAF). At present new ice drift products in Near Real Time are being tested for later implementation in the OSI SAF processing chain. Drift information is derived both at low resolution (from active radar instruments like the ASCAT or passive microwave imagers like the SSM/I) and at medium resolution (from AVHRR visible and infrared channels on board the METOP satellite). The algorithm and characteristics of each product, such as spatial and temporal resolutions are presented. A strong aspect of the research and development work has been to identify methods to characterize uncertainties in the retrieved vectors, those being of the uttermost importance to any subsequent assimilation attempt. Validation results against buoys and other drifting platforms related to the International Polar Year are also presented.

MODEL AND OBSERVATION BIAS CORRECTION IN ALTIMETER OCEAN DATA ASSIMILATION IN FOAM

Daniel Lea[1], **Keith Haines**[2], **Martin Matthew**[1]

(1) Met Office, (2) Reading University

ABSTRACT

We implement a combined online model and observation bias correction system in the UK Met Office FOAM OI ocean data assimilation system. The observation bias scheme is designed to estimate the error in the mean dynamic topography that must be used for altimeter data assimilation. The mean dynamic topography field is added to the altimeter data supplied as sea-level anomalies giving the absolute sea surface height. The bias scheme separately estimates the remaining model bias in the model sea surface height field. The final unbiased estimate of the absolute dynamic topography is assimilated into the FOAM model by adjusting the subsurface density field using the Cooper and Haines scheme. Various diagnostics including the observation minus background statistics show that both model and observation bias correction schemes improve the assimilation results. Combining the schemes provides better results than either alone.

The FOAM system is now transitioning from the Unified Model ocean to a 0.25 degree global NEMO system using the same OI assimilation scheme. Preliminary results will be presented using the bias correction scheme with this new system.

ASSESMENT OF WIND/WAVE PREDICTION MODEL PERFORMANCES IN HURRICANE CONDITIONS

Jean-Michel Levevre[1], Lotfi Aouf[1], Abderrahim Bentamy[2], Pierre Queffeulou[2]

(1) Meteo-France, (2) Ifremer

ABSTRACT

Forecasting sea-state for severe conditions is crucial for the safety of people and goods. However, in situ data are too sparse to assess the performances of operational Numerical Weather Prediction (NWP) and Numerical Sea-Sate Prediction (NSSP) models in most of such situations. Remote sensing data from altimeters, Synthetic Aperture Radars and scatterometers offer the opportunity to sample the whole ocean surface with a high accuracy and coverage. The purpose of this study is to assess the performances of some operational wind and wave models, in hurricane situations. Blended winds based on model wind fields and scatterometer winds will be used to provide the best forcing to the wave models. Several drag formulations for the wind stress will be used in the wave models because most of them have not been fully validated for hurricane winds. The case of GAMEDE, a tropical cyclone of the Indian ocean in February 2006 will be carefully documented.

IMPROVED JASON-2 ALTIMETRY PRODUCTS FOR COASTAL ZONES AND CONTINENTAL WATERS (PISTACH PROJECT)

Franck Mercier[1], Nicolas Picot[2], Gérald Dibarboure[1], Claire Dufau[1], Loren Carrere[1], Pierre Thibaut[1], Estelle Obligis[1], Sylvie Labroue[1], Michael Ablain[1], Philippe Sicard[1], Anny Cazenave[3], Jérôme Bouffard[3], Frédérique Seyler[4], Pascal Kosuth[5]

(1) CLS, (2) CNES, (3) LEGOS, (4) IRD/LMTG, (5) CEMAGREF/TETIS

ABSTRACT

As part of Jason-2 project, CNES is currently conducting a dedicated study to ir

The PISTACH (Prototype Innovant de Systeme de Traitement pour les Apllications (

Level 2 (I)GDR altimeter products, is organized around 3 phases:

- Phase 1: user needs and structure of coastal products
- Phase 2: analysis and selection of fields to be taken into account in this product (retracking of the wa

  tropospheric correction, local models for correction of tides and atmospheric forcing, sea state bias, d
- Phase 3: prototype implementation, validation and operations during Jason-2 CalVal phases

The prototype will be implemented during summer 2008 and the first products sho

The project, the prototype and the products will be presented at the meeting.

CLIMATE DATA RECORDS OF SEA-SURFACE TEMPERATURES.

Peter Minnett

University of Miami

ABSTRACT

The retrieval of sea-surface temperatures (SSTs) from satellite radiometers is a singularly successful achievement in the field of satellite oceanography. Starting with the Advanced Very High Resolution Radiometers on the operational NOAA polar-orbiting series, and continuing through to the current sensors on MetOp and the research satellites Terra, Aqua and Envisat, a time series of consistent global SSTs spanning more than two decades is now available. The key to the accurate SST retrieval is not so much in the accurate on-board calibration of the radiance measurements, although that is a necessary prerequisite, but lies in the successful correction for the effects of the intervening atmosphere. The determination of the residual error characteristics of the SST retrievals is a vital aspect of establishing the utility of these fields in a wide range of applications including weather and ocean forecasting, and in climate research. The requirements of a “Climate Data Record” (CDR) include well characterized error estimates and traceability to a National Standard, if feasible. This presentation will cover the generation of CDRs of SSTs using comparisons between the satellite retrievals and ship-based measurements of the skin SST derived from well-calibrated infrared spectroradiometers, with calibration traceable to NIST (National Institute of Standards and Technology) temperature standards.

SEA-ICE DRIFT VELOCITY FOR THE SEA OF OKHOTSK DERIVED FROM MTSAT-1R IMAGERY

Takuya Miyakawa

Japan Meteorological Agency

ABSTRACT

The Japan Meteorological Agency's MTSAT-1R is in operation covering East Asia and the western Pacific. The Meteorological Satellite Center (MSC) of the Japan Meteorological Agency (JMA) produces, on an operational basis, various satellite-derived products from MTSAT-1R, including atmospheric motion vectors (wind) and sea-surface temperatures. In addition, MSC is currently developing a new product, sea-ice drift velocity for the Sea of Okhotsk.

The Sea of Okhotsk is known as the southernmost seasonal sea-ice zone in the Northern Hemisphere. In this area, the sea ice extends widely in winter affecting maritime transportation and the fishery industry, and information on sea ice is important for such users. In winter, JMA operationally provides sea-ice concentration charts derived from MTSAT-1R's imagery. As MTSAT-1R is stationed at a longitude of 140 degrees east over the Sea of Okhotsk and the latitude of the sea-ice area is not very high, the satellite's imagery is suitable for producing sea-ice products for the area. MSC is developing a new sea-ice drift velocity product by tracking the sea-ice coverage from MTSAT-1R's visible channel imagery. Although sea ice cannot be observed in cloudy conditions, the new product can depict small-scale features in the marginal ice zone. Using sea-ice drift velocity together with existing sea-ice concentration charts is expected to provide detailed clarification of the characteristics of sea-ice distribution.

NEW GENERATION OF WET TROPOSPHERIC CORRECTION ALGORITHMS FOR ALTIMETRY MISSIONS

Estelle Obligis[1], **Abdelaziz Rahmani**[1], **Laurence Eymard**[2]

(1) CLS, (2) CNRS/LOCEAN

ABSTRACT

The Envisat microwave radiometer is designed to correct the satellite altimeter data for the excess path delay resulting from tropospheric humidity. Parametric models have been widely used to retrieve the wet tropospheric correction from the measured brightness temperatures at 23,8 GHz and 36,5 GHz and the altimeter wind speed or backscattering coefficient. The learning database has been built with European Centre for Medium-Range Weather Forecasts (ECMWF) analyses and simulated brightness temperatures by a radiative transfer model. It is composed of 12 daily global fields with an half a degree resolution, distibuted over the year 2005.

Although linear models provide a good average estimation of such quantity, it appears, when mapping the bias between the reference and the retrieved wet tropospheric correction, that locally there are great areas of over and under estimation of the order of 1 cm of the variable. This mismatch leads to critical issues concerning altimetry missions due to geographical distortion in the sea level map.

The use of neural networks to formulate the inversion algorithm (Labroue et al, 2001, Obligis et al, 2004) to retrieve the wet tropospheric correction from the measured brightness temperatures and the backscattering coefficient has proven itself worthy. In fact the neural network outclasses the parametric model, but still, the areas of over and under estimation are in place covering a large part of the oceanic surface. Such regularity in the localisation of the errors proves that the model is missing at least one fundamental physical parameter. It is a necessity to determine which parameter leads to those errors. Here the use of neural networks fits perfectly because of their flexibility: adding a parameter to the model does not pre request any knowledge of the physical equation linking the parameter to the variable anymore.

To scout for the missing element of our model, we used a peculiar method based upon a classification method. After dividing the database in three classes representing cases of good, over and under estimation, we used a binary classification tree to determine which parameter is the most responsible for such a division. This process enlightened the sea surface temperature (SST) parameter. In fact it appears that when added to the model, most of the errors on the wet tropospheric correction no longer exist. Only remains areas of over estimations in the up-welling zones. A characteristic of those zones is the inversion of the temperature gradient in the low layers of the atmosphere. Adding as a new parameter the value of this gradient calculated between 1000 and 800mb (Gamma800), the network definitely erases almost all of the under and overestimation areas. As those two parameters can not be provided by the radiometer, assuming the annual variability of the SST and the stability of the up-welling zones, we computed 4 seasonal tables of SST and single table of Gamma800 for each point of the ECMWF grid.

To test the validity of those assumptions, we used the network onto a 2003 database, using the ECMWF analyses. The SST and Gamma800 values are both estimated from the 2005 database. The results are really great: the areas of over and under estimation are widely erased, even if the network is much more efficient when using 2003 data for the determination of SST and Gamma800.
These results have been obtained with the Envisat/MWR radiometer, but the proposed improvements are fully applicable to other radiometers (Jason2/AMR for example).

FUTURE PERSPECTIVE FOR OCEAN SURFACE TOPOGRAPHY

Francois Parisot[1], Hans Bonekamp[1], Stan Wilson[2]

(1) EUMETSAT, (2) NOAA

ABSTRACT

The *Symposium on 15 Years of Progress in Altimetry* developed consensus recommendations concerning the transition of satellite altimetry into a sustainable global system capable of supporting the emerging capabilities in, and growing importance of, operational oceanography and climate monitoring. The *Ocean Surface Topography Constellation Strategic Workshop* seek to formulate a consensus response to these recommendations to guide international efforts toward achieving a robust, systematic, and sustained satellite altimetry over *the next 15 years*. Such an *operational* system will require a series of coordinated missions to ensure continuity of observations, as well as the future transition of new technical capabilities into that system.

The Committee on Earth Observing Satellites (CEOS) uses the word *Constellation* as an organizing construct to facilitate planning, implementation, and utilization of space-based observations in the context of the Global Earth Observing System of Systems (GEOSS). The Ocean Surface Topography Constellation provides an opportunity for implementing agencies to mobilize collective capabilities in a coordinated way for greater efficacy – establishing consensus standard data products and formats, sharing data and experience in the use of that data, and coordinating orbits to optimize spatial/temporal coverage (i.e., the capability to monitor/measure a given signal if interest (meso-scale, large-scale, fast planetary waves, etc.).

This paper presents the status of the work done by the implementing agencies in order to build a constellation that would ensure continuity of high accuracy altimetry as well as complementary high inclination satellites, ensure a smooth transition to new technologies, maintain an open data policy through a broad international collaboration between engineering and science, research and operations.

HIGH-RESOLUTION ASCAT SCATTEROMETER WINDS NEAR THE COAST

Marcos Portabella, Ad Stoffelen, Anton Verhoef, Jeroen Verspeek, Jur Vogelzang

Royal Netherlands Meteorological Institute (KNMI)

ABSTRACT

KNMI is involved in the Level 2 scatterometer wind processing of the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF), the EUMETSAT Numerical Weather Prediction SAF and the EUMETSAT Advanced Retransmission Service (EARS). In the NWP SAF, scatterometer wind processing portable software packages are being made available freely. In the OSI SAF, currently four different wind products are available: OSI SAF SeaWinds 100-km product (operational status), OSI SAF SeaWinds 25-km product (under operational review), OSI SAF ASCAT 25-km product (pre-operational), and EARS ERS-2 25-km regional product (demonstration) that may be viewed at www.knmi.nl/scatterometer. The latter product is available within one hour and may be used for weather nowcasting. In such application, as well as other applications, winds near the coast and at high resolution are required. Therefore, KNMI attempts the development of ASCAT scatterometer wind products at higher resolution and nearer to the coast, which effort will be presented at the conference.

EUMETSAT develops an ASCAT radar backscatter product (L1) on a 25-km swath grid, a 12.5-km grid, and at full measurement resolution. The two former products are achieved by applying spatial averaging kernels to the latter product, i.e., respectively of 50-km and 25-km resolution. These averaging kernels are used to suppress noise in the measurements, but, on the other hand, prevent wind retrieval in coastal regions due to their spatial extent. Currently, the swath grids are applied rigorously and no ASCAT scat terometer winds are available in the first 80 km off the coast. Applying box averaging rather than kernel averaging results in scatterometer winds at closer proximity to the coastline. By replacing the Hamming filter kernels (i.e., cosine weighting function) with a simple box (i.e., constant weighting function over a limited radial distance), we can produce 25-km sampled winds, which, in contrast to the 25-km sampled (nominal-resolution) level 2, will provide sea-surface wind information up to 25 km off the coastline, at 35- to 40-km resolution. Moreover, these boxes may be optimally chosen such that they are located close to the coast, but still not contaminated by land. In particular, by using a non-regular swath grid near the coast, we can maximize the number of wind observations at shorter distance off the coast. Later on, these different swath gridding and spatial averaging strategies will be applied to the 12.5-km product and processing may be sustained at even shorter distances to the coast. We expect high resolution ASCAT coastal winds may be produced down to 15 km off the coast.

Different spatial averaging strategies may allow more noise in the L1 data and thus in the L2 retrieved winds. To suppress this random noise KNMI has developed spatial filtering techniques, which maintain small-scale meteorologically-relevant spatially-coherent structures in the resulting scatterometer wind fields. This filter, by the so-called Multiple Solution Scheme (MSS) and 2-Dimensional Variational Ambiguity Removal (2D-VAR), will be illustrated. The MSS collects additional information from the scatterometer wind inversion step, i.e., information on the probability of all possible winds, as retrieved from the input local backscatter measurements. This wind vector probability distribution at the swath grid is subsequently used as input to the 2DVAR, which provides a meteorologically balanced and spatially coherent wind field.

THE SEAWINDS DATA PROCESSOR

Jur Vogelzang, Ad Stoffelen, Marcos Portabella, Anton Verhoef, Jeroen Verspeek

KNMI

ABSTRACT

SeaWinds on board QuikSCAT is a scatterometer operated by the National Aeronautics and Space Administration (NASA) from 1999 onwards. It is a rotating beam scatterometer operated at Ku-band, so both its observation geometry and its operating frequency differ greatly from that of the Advanced Scatterometer (ASCAT) carried by Metop-A. The advantage of SeaWinds over ASCAT is its large swath width of 1900 km, but its disadvantages are an unfavorable observation geometry in the nadir part of the swath and increased sensitivity to rain.

The SeaWinds Data Processor (SDP) reprocesses NASA's level 2 BUFR product. SDP has been made at KNMI in the framework of the Satellite Application Facility for Numerical Weather Prediction (NWPSAF) sponsored by EUMETSAT. SDP has a number of advanced features. The Multi Solution Scheme (MSS) takes 144 solutions with their probability into account rather than a maximum of 4 in a traditional scheme. The Two Dimensional Variational Ambiguity Removal (2DVAR) method selects the most likely solution that satisfies basic physical laws and takes the probability information into account.

Recently version 2.0 of SDP has been released. It features processing of the outer swath and improved tuning of the error model underlying 2DVAR as well as the quality control procedure. At this conference we will show examples of SDP wind products and assess their quality.

HOAPS-3: AN 18 YEAR CLIMATOLOGY OF GLOBAL OCEAN WATER CYCLE PARAMETERS DERIVED FROM SSM/I SATELLITE DATA.

Axel Andersson[1], Christian Klepp[1], Hartmut Graßl[1], Stephan Bakan[2], Jörg Schulz[3]

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ABSTRACT

Proper knowledge of the global water cycle is a vital requirement for the successful modeling and understanding of the global climate system. High resolution global data sets of such information are required for various applications. The compilation of the satellite-based relevant quantities remains however a challenging task.

The HOAPS-3 climatology (Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data) contains fields of precipitation, surface fluxes and atmospheric parameters over the global ice-free ocean between 1987 and 2005. Except for the NOAA Pathfinder SST, all basic state variables needed for the derivation of the fluxes are calculated from SSM/I passive microwave radiometer measurements. Multi-satellite averages, inter-sensor calibration, and an efficient sea ice detection procedure make HOAPS a suitable data set for climatological applications as well as for case studies. Gridded 0.5 degree monthly, pentad and twice daily data products are freely available from www.hoaps.org.

The presentation will focus on the climatology of HOAPS-3 global ocean water cycle parameters. Additionally, North Atlantic intra-decadal variability of precipitation is investigated over the ocean and land in combination with GPCC rain gauge data.

FREQUENCY OF SEVERE STORMS IN THE TROPICAL OCEANS AND GLOBAL WARMING.

Hartmut Aumann

California Institute of Technology

ABSTRACT

Data from the Atmospheric Infrared Sounder (AIRS) show that the frequency of Deep Convective Clouds (DCC) in the tropical ocean zone increases by about 3% per 0.1 K of warming of the zonal mean surface temperature. We define DCC by cloud top temperatures colder than 210 K in a 13 km footprint and emissivity gradient across the 10 micron window characteristic of cirrus ice. With global warming at the 0.1 K/decade rate, this corresponds to an increase of 3% per decade. DCC have long been associated with severe storms, including extreme precipitation and hail. A 3% per decade increase of DCC is consistent with the increase in precipitation deduced from SSMI data with the assumption that 30% of the total precipitation over tropical oceans is associated with severe storms. The AIRS 1:30 overpass results are compared with equivalent measurements from the IASI 9:30 overpasses to evaluate difference in seasonal and diurnal effects.

CLIMATOLOGICAL EVALUATION OF FOG/LOW STRATUS DISTRIBUTION BASED ON METEOSAT 8/9 SEVIRI DATA

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ABSTRACT

Low stratiform clouds play an important role in the global climate system. Fog more specifically also has a direct impact on human safety and quality of life. The spatially accurate mapping of low stratus and fog distribution has posed problems in the past, not to speak of climatological aggregation. Newest generation geostationary satellite data for the first time provide the potential for automated high-resolution fog and low stratus detection and thus climatological evaluation. This is exploited here for the generation of climatologies. The retrieval methodology used is based on SEVIRI (Spinning-Enhanced Visible and Infra-Red Imager) data from Meteosat 8 and 9. A combination of spectral and spatial tests serves to identify low stratus clouds; a microphysics-based analysis of cloud vertical extent further allows for the delineation of (ground) fog areas.

This paper presents some initial satellite-based "climatologies" of low stratus and fog for Europe, based on SEVIRI data, which has been available since 2004. The climatologies have a nominal spatial resolution of 3km; the high temporal resolution of the data (15min) allows for the computation of parameters such as average fog/low stratus hours per day and average fog dissipation time. In this way, the temporal aggregation of the SEVIRI-based fog/low stratus products can contribute to the understanding of inter- and intra-annual variability of fog and low stratus distribution at various spatial scales, and set a sound basis for long-term climate change monitoring.

The transition from Meteosat 8 to Meteosat 9 is discussed. Also, the computed fog/low stratus distribution is contrasted with ground-based climatological assessments.

VALIDATION OF CLOUD PROPERTY RETRIEVALS FROM MTSAT-1R IMAGERY USING MODIS OBSERVATIONS

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ABSTRACT

To create a weather service with a higher temporal resolution using the Communication, Ocean and Meteorological Satellite (COMS) imager scheduled to be launched in 2009 in Korea, a new cloud analysis algorithm (CLA) was explored on the basis of five channels (centered at 0.6, 3.7, 6.7, 10.8, and 12.0 micron m) from weather imagers in geosynchronous earth orbit (Choi *et al*. 2007 IJRS). The algorithm introduces the following retrieval methods: (i) the cloud phase (CP) based on spectral absorptivity in the 6.7-micron m band in addition to the 10.8- and 12.0-micron m bands; (ii) the cloud optical thickness (COT) and effective particle radius (ER) using a combination of cloud-reflected radiances in the 0.6- and 3.7-micron m bands through thermal correction; and (iii) the cloud top pressure (CTP) using the brightness temperature in the 10.8-micron m band for optically thick clouds (COT > ~10), and the radiance ratio in the 6.7- and 10.8-micron m bands for optically thin high clouds (CTP <= 400 hPa).

The retrieval methods have been previously validated by comparing the MODIS cloud data and the collocated cloud properties from the CLA by using the MODIS level-2 calibrated radiances (Choi *et al*. 2007); however, these validation results may indicate only the uncertainty induced by RT modeling and remains to be established. Here, we present validation results for the cloud properties retrieved by the developed algorithm from the full-disk imagery of the Multi-functional Transport Satellite (MTSAT-1R) for August 2006. The considered cloud properties include CP, COT, ER, and CTP. Their one-month averages, daily variations, and respective collocated values are compared with the Moderate Resolution Imaging Spectroradiometer cloud data. Our validation results show that an additional 6.7-micron m brightness temperature test in CP retrieval identifies water and ice phases that may be overlooked in the 10.8- and 12.0-micron m bands. Our method to extract cloud-reflected radiances at the 0.6- and 3.7-micron m bands contributes to the accuracy of the COT for values between 5 and 60, and the ER for values less than 40 micron m. Estimating high-cloud top pressure from the radiance ratio in the 6.7- and 10.8-micron m bands remarkably reduces (by up to 70%) large uncertainties in the CTP, which may be found in the presence of high thin cirrus clouds.

MOISTENING PROCESSES IN THE TROPICAL UPPER TROPOSPHERE OBSERVED FROM METEOSAT MEASUREMENTS

Eui-Seok Chung[1], **Johannes Schmetz**[2], **Byung-Ju Sohn**[1]

(1) Seoul National University, (2) EUMETSAT

ABSTRACT

In order to investigate processes of moistening the upper troposphere (UT), we examined Lagrangian evolutions of deep convection index, cloudiness, UTH tendency, and condensation/evaporation rate of the convective cloud system observed by Meteosat-8 infrared measurements over tropical Africa and the Atlantic Ocean. Condensation/evaporation rates were inferred from the imbalance between cloud expansion rate and wind divergence which were directly determined from the Meteosat-8 measurements.

It was found that wind divergence corresponds much more with UTH tendency, in comparison to the poor correlation found between evaporation rate of cloud condensates and UTH tendency. Because water vapor concentrations in the UT are nearly an order of magnitude larger than ice water concentrations, the transport of moist air associated with the formation and vertical growth of clouds and the subsequent upper-tropospheric divergence should be primarily responsible for moistening the UT. On the other hand, the role of evaporation of detrained hydrometeors from the convection center appears to be secondary, as indicated by less coherent relationship between UTH tendency and evaporation rate, and in a much smaller amount of ice water. Results strongly support the notion that the UT is predominantly moistened by water vapor advected to drier surroundings from the diverging cloud top areas.

ON THE SENSITIVITY OF SATELLITE-DERIVED CLOUD PROPERTIES TO SENSOR RESOLUTION AND BROKEN CLOUDS

Hartwig Deneke[1], **Robert Roebeling**[1], **Erwin Wolters**[1], **Arnout Feijt**[1], **Clemens Simmer**[2]

(1) KNMI, (2) MIUB

ABSTRACT

Current operational cloud property retrievals from meteorological satellite imagers assume the presence of a plane-parallel cloud covering individual satellite pixels. Thereby, variability at spatial scales smaller than the sensor resolution is neglected. Due to the high spatial variability of clouds, and due to the non-linear response of radiances to cloud properties, satellite-inferred cloud climatologies are known to be sensitive to the spatial resolution of the instrument.

We compare retrieval results obtained at typical nadir resolutions for polar-orbiting and geostationary satellite platforms of 1x1 and 3x3 km^2, respectively. The resulting distributions of cloud optical thickness, effective radius, and water path exhibit significant systematic differences as a consequence of the difference in sensor resolution. The relation of these differences to the variability of clouds is further investigated, with the aim of finding a correction for the resolution dependence.

Based on the higher-resolution images, coarse-resolution pixels containing clouds are classified as either overcast or broken. For overcast clouds, it is demonstrated that information on the amplitude of unresolved variability can be used to reduce the systematic biases. A simple statistical scheme is presented that is able to estimate the amplitude of unresolved variability, based on features calculated at the resolved scale of the coarse-resolution images.

Broken clouds are identified to cause particularly large differences, and are found to occur frequently for the satellite scenes considered (about a third of all cloudy pixels). Previous studies have proposed to treat radiances for partly cloud-filled pixels as a linear combination of clear-sky and cloudy radiances weighted by fractional cloud coverage. We quantify the accuracy of this approach. Different spectral and spatial features are investigated, which seem promising candidates to provide an estimate of pixel-level fractional cloud coverage.

MSG-BASED SURFACE INCOMING SHORTWAVE RADIATION CLIMATOLOGY OVER COMPLEX TERRAIN

Bruno Duerr[1], **Reto Stoeckli**[1], **Richard Mueller**[2], **Rainer Hollmann**[2]

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ABSTRACT

In the framework of the Satellite Application Facility for Climate Monitoring (CM-SAF) an independent HELIOSAT-based processing chain for surface incoming shortwave (SIS) radiation was developed at MeteoSwiss to investigate the usability of METEOSAT data over complex terrain such as the Alps. The MeteoSwiss contribution aims to validate and improve the standard SIS product of CM-SAF.

A complete 4-years dataset of SIS based on METEOSAT8 and METEOSAT9 data is presented with special focus on monthly SIS anomalies compared to observed temperature anomalies at the surface, and on the influence of the MSG-HRV channel georeferencing uncertainty. Furthermore the MeteoSwiss SIS product is validated with surface measurements and compared to the standard CM-SAF SIS product. Finally the differences between the two products are discussed regarding the effects of the complex terrain and snow-cover.

CLIMATE DATA RECORDS FOR METOP HIRS AND IASI.

Karsten Fennig, Viju John, Roger Saunders

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ABSTRACT

Infrared sounding instruments have been observing the global atmosphere routinely since 1972 with a commitment to continue until at least 2018. The infrared radiances are sensitive to changes in atmospheric temperature, humidity, clouds and other atmospheric constituents and therefore provide an invaluable resource not only for climate monitoring but also for model validation and reanalyses.

However, changes in spectral response functions of individual instruments, along with satellite orbit drift and other factors introduce systematic biases into these data records. The focus of the HadIR project is on generating a longterm (>30 years) homogenised record of all-sky and clear-sky infrared radiances in order to:

- Quantify and reduce uncertainty in temperature and humidity changes aloft.
- Assess model simulations of recent climate accounting for both model and observational uncertainty.
- Estimate all-sky (and clear-sky) long-wave feedbacks.
- Contribute to the next generation reanalysis projects (e.g. ERA-70).

In this presentation we will outline the current status of the HadIR dataset. First processed instruments are HIRS and IASI on the METOP platform. Data from these instruments is processed in near-real time, converted to a common data format (NetCDF, CF-1.0) and then continuously archived. The HIRS data product is the full global dataset including AMSU-A and MHS observations mapped onto the HIRS grid. Additionally a cloud test based on Stubenrauch et. al (1999) is included. The IASI data product has all available channels included. It is spatially sub-sampled in order to reduce the data file size. The spatial sampling strategy is to use 1 in 4 FOV with a different detector each scan line. It is planned to provide a cloud flag for the IASI data.

Our aim is to continue to extend this dataset and to go back in time and reprocess the historical HIRS data to the same data format throughout the whole time period.

MULTI-SATELLITE, MULTI-SENSOR SEA SURFACE TEMPERATURES FROM INFRARED AND MICROWAVE RADIOMETERS

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ABSTRACT

Current global sea surface temperature (SST) datasets do not take full advantage of the numerous satellites and different sensors now retrieving SST. Existing operational SST products depend on a single sensor to produce global datasets. This results in a lower spatial and temporal resolution than what is possible with a multi satellite, multi sensor SST analysis. Initial efforts indicate that blending data from different sensors requires much more rigorous bias and error characterization than is necessary when only including data from a single sensor type. Therefore, creating a climate-quality multi-sensor SST requires careful inter-calibration of different satellite sensors, calculation of sensor-specific observation errors that consider environmental variables, location of observation, and sensor calibration problems; and development of techniques for relating and combining measurements at different spatial resolutions and times of the day. Initial methodology, validation results, and future work will be discussed.

VALIDATION OF SATELLITE-DERIVED CLOUD LIQUID WATER PATH: IMPROVEMENTS TO THE METHOD

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ABSTRACT

We compared cloud liquid water path (CLWP) values derived from satellite data with values derived from a ground- based microwave radiometer (MWR). We studied the effect of two modifications to the validation method, namely 1) correction for the parallax effect and 2) variation of the time interval for averaging the ground measurements according to the wind speed and direction. These two issues are also of interest for the validation of other satellite-derived parameters, e.g. transmission.

Differences between the two types of CLWP-values are not only caused by errors in the underlying radiation measurements and in the retrieval methods, but also by the different character of the satellite and the ground data. Firstly, differences between satellite and ground-based cloud data are due to parallax effects when satellites view the Earth under an oblique angle. Secondly, a satellite-derived value represents a spatial mean over the area of the satellite pixel whereas a single ground-derived value represents a tiny fraction of the pixel (order of magnitude: 0.1%) only. By taking a temporal average of the ground-based data, their spatial scale is extended to, typically, a few percent of the satellite pixel.

We compared CLWP derived from SEVIRI data (pixels: 3*6 km; view zenith angle: 59º) with CLWP computed from MWR data collected in Chilbolton, UK (one sample per 30 s). Taking all appropriate samples (1895), average values were almost equal (37 vs. 39 g/m2) and two-third of all differences are within the range from -21 to +16 g/m2. The explained variance (vare) is 58%. We then showed that statistics improved considerably when 1) we corrected for parallax, with cloud heights determined from either ground or satellite data (vare = 64%), 2) the time interval, over which the ground data were averaged, was adapted according to the wind speed and direction at cloud top height (from ECMWF data) (vare = 64%) and 3) both improvements were made (vare = 70%). Using higher resolution satellite data (HRV), we finally made an estimate of the homogeneity of the cloud fields. As expected, the proposed improvements to the validation method have a larger effect for inhomogeneous cloud fields than for homogeneous cloud fields.

For studying these and other issues related to validation of cloud properties, we also computed artificial high-resolution (100 m) CLWP fields from 1 km MODIS CLWP data. Experiments performed with these cloud fields corroborate the conclusions obtained with the data.

MULTI ANNUAL CLOUD ANALYSIS FROM METEOSAT DATA USING IMAGE SEGMENTATION

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ABSTRACT

The satellites of the METEOSAT series have continuously measured the state of the atmosphere as well as the land and sea surfaces over the past 30 years. With MSG in operation and MTG in planning another 30 years of consistent measurements can be expected.

This unique data set has a big potential for climate analysis. One prominent aspect of climate changes is forcing of the water cycle. The analysis of cloud cover, structure and statistics on cloud types can give an indication for a change in atmospheric conditions.

The “classical” approach identifying clouds is based on their spectral signature on a pixel by pixel basis. The spatial strucutre, context and neighbourhood were used in visual interpretation of satellite images and will now be implemented in automatic computer based objective analysis.

Advanced image analysis algorithms enable the segmentation of satellite data on various scales. Segments are built up as homogeneous areas in terms of spectral and/or spatial properties. Big segments are created from smaller by “region merging”; thus a small scale segment belongs explicitly only to one bigger segment. An area of cumulus clouds is a large scale segment which contains coastal cumuli and non cloudy patches, each of them forming small scale segments.

Various analyis can be performed on the segement hirarchy. Every segment has a spectral signature that allows a classification similar to the “classical” pixel by pixel approach. In addition segments are described by the spatial properties like size, shape (round, long, bow) or smothness of the edges. The analysis of neighbourhood and the relationship between “children” and “parents” (i.e. the embedding of small segments in big ones) is used as a powerful tool for advanced classification. With this additional information segments with a similar spectral signature are assigned to different classes. A cirrus cloud for example can be identified as isolated cirrus, a condensation trail (slim and straight) or the edge of a thunder storm (sickle form and neighbourhood to cumulus).

An automated detection of clouds using spectral signatures as well as segment based information for MSG will be presented. The satellite data will be compared to data from a regional climate model.

The use of this technique enables the statistical analysis of cloud cover and cloud types over large areas and long time series. Change in a climate context in cloud cover and type can be detected.

UPPER TROPOSPHERIC HUMIDITY DATA SET FROM OPERATIONAL MICROWAVE SOUNDERS

Viju John[1], Stefan Buehler[2], Mathias Milz[2], Mashrab Kuvatov [3], Brian Soden[4], Darren Jackson[5]

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ABSTRACT

Microwave radiation measured around 183.31 GHz by operational weather satellites can be used to derive Upper Tropospheric Humidity (UTH). This presentation gives details of a new UTH data set derived from Advanced Microwave Sounding Unit - B (AMSU-B) instruments on board NOAA (15, 16, and 17) satellites for 8 years (2000-2007). In contrast to UTH data sets derived from infrared measurements, the new data set is less affected by clouds. The maximum uncertainty due to clouds is estimated as 10 %RH in deep convective areas. We also show that the data from the three satellites are consistent with mean relative differences less than 4 +/-7%. Comparisons with Radiosonde measurements and infrared UTH measurements show consistent results with previous studies.

THE FIRST LONG-TERM SATELLITE-DERIVED TOTAL WATER VAPOUR COLUMN CLIMATOLOGY FROM CM-SAF: FEATURES, INTERCOMPARISON RESULTS AND TREND ESTIMATION.

Markus Jonas[1], **Jörg Schulz**[1], **Rainer Hollmann** [1], **Marc Schröder**[1], **Ralf Lindau**[2]

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ABSTRACT

The production of climate data records (CDRs) for variability and trend monitoring is one of the major objectives within the Continuous Development and Operations Phase (CDOP) of the Satellite Application Facility on Climate Monitoring (CM-SAF). In this study, the first such CDR from CM-SAF, a total water vapour column climatology, is presented and compared to various data sources to increase confidence in consistency and accuracy of such a climatology.

Based on intercalibrated brightness temperatures from the SSM/I sensors on board the DMSP satellite platforms, a climatology of total water vapour column content over global ice-free oceans has been compiled within the Hamburg Ocean-Atmosphere Fluxes and Parameters from Satellite (HOAPS) framework. The climatology covers the period 1987 - 2006. A recently developed geostatistical interpolation technique using the Kriging approach has been applied to the swath-based total column water vapour retrievals from the HOAPS data set. The resulting climatology consists of daily and monthly mean fields of the column water vapour itself and an uncertainty estimate from the Kriging technique.

The climatology has been compared to different types of meteorological analyses from the ECMWF (ERA40, ERA INTERIM and operational analyses) and other centers (JRA, NCEP). This comparison shows an overall good agreement of the climatology and the analyses fields. Regarding the biases to the ECMWF data sets, one finds that ERA INTERIM performs significantly better than ERA40 and the operational analyses over time. Only from 2003 on, the operational analysis reaches comparably low biases as ERA INTERIM.

In order to show the robustness of the SSM/I-based climatology it has also been compared to other independent data sets (as SSM/I channels are assimilated in all ECMWF analyses used): (a) a second CM-SAF total water vapour climatology based on ATOVS from the NOAA polar orbiting satellites for one selected year and (b) time series of instantaneous column water vapour values as obtained from the integration of radiosonde profiles. The latter mentioned data sources agree reasonably well with the climatology. Existing distinctions may be traced back e.g. to the different spectral channels of the SSM/I and AMSU instruments used.

Finally, as an application of the produced CDR, interannual variability patterns and trends have been calculated and compared to various recently published other trend estimates.

CM-SAF ARCTIC CLOUD STUDIES DURING THE 2007 POLAR SUMMER EXTREME SEA ICE ANOMALY EVENT

Karl-Göran Karlsson, Anke Tetzlaff

SMHI

ABSTRACT

The Arctic sea ice reached a new record in minimum ice extent during the polar summer of 2007. The new record of 4.13 million square kilometres was almost 23 % lower than the previous record from 2005. This has surprised the scientific community. For example, most IPPC4 climate scenarios have not anticipated that such a low ice extent should happen within several decades. It is suggested that the 2007 anomaly was caused by several factors enhancing the decrease of the ice extent in an extreme way.

This study has looked at the potential role of extreme Arctic cloud conditions during the polar summer of 2007. Normally, the Arctic ice-covered region is predominately covered by low-level (stratus) clouds during the melting period. This drastically reduces the incoming shortwave radiation at the ice surface which otherwise would be high (because of the sun being above horizon all day long). During the 2007 Arctic summer, a strong positive anomaly in surface pressure (i.e., an anticyclonic anomaly) was noticed in the area north of Canada and Greenland. The question is if the associated subsidence patterns and the anticyclonic circulation also lead to a substantial negative anomaly in cloud amounts in this region. In that case, extremely high incoming shortwave radiation fluxes at the ice surface could have contributed to the ice melting anomaly.

Arctic cloud conditions in the period April-September 2007 have been studied from NOAA AVHRR data using the cloud algorithms of the Climate Monitoring SAF (CM-SAF) project. Arctic AVHRR datasets were collected from the EUMETSAT EARS-AVHRR retransmission service where the Arctic region was mainly covered by data received by the HRPT station in Svalbard. Results will be shown together with comparisons to available ground measurements and other satellite-derived datasets (e.g. from MODIS and CloudSat/CALIPSO).

BI-TEMPORAL MINERAL DUST DETECTION OVER LAND FROM MSG INFRARED CHANNELS

Lars Klüser, Thomas Holzer-Popp

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ABSTRACT

Many processes have been suggested by which transported mineral dust interacts with different components of the climate system (e.g. radiation balance, atmospheric stability, convective clouds, wind direction and speed). Thus satellite monitoring of mineral dust activation and transport is needed to observe and quantify the impact of mineral dust on several components of the climate system.

Remote sensing of mineral dust in the atmosphere mostly relies on measurements of reflected solar radiation and thus is often limited to regions with dark surfaces. Over vegetated or generally dark surfaces many methods are available to derive mineral dust optical depth from remote sensing data of polar orbiting or geostationary satellites. But in most cases these methods fail over bright surfaces as they are common in the desert regions, e.g. in the Sahara. Thus infrared measurements have to be used to derive dust information also over desert surfaces.

The presented new method for the detection and analysis of mineral dust over (cloud free) land combines day- and night-time data from two infrared channels of Meteosat Second Generation (MSG).

The Bi-temporal Mineral Dust Index (BMDI) uses brightness temperature differences between the 10.8[micro]m and 12.0[micro]m channels at day- and at night-time (03 UTC and 12 UTC respectively) together with the difference in 10.8[micro]m brightness temperature between day and night. As mineral dust is quite absorptive in the 10.8[micro]m region and less in the 12.0[micro]m region, the use of brightness temperature differences between those bands is rather common to detect mineral dust from infrared measurements.

As MSG offers measurements in both wavelength bands from a geostationary orbit, the combination of day- and night-time observations to a bi-temporal dust index becomes possible. Thus a dust mask over land for further applications can be derived together with the dust index by applying additional threshold tests.

Test cases of BMDI for several periods of enhanced dustiness (for all seasons) of the years 2004, 2006 and 2007 show good results in detecting the dust plumes and estimating the atmospheric dust load. Some of those dust events are already analysed in the literature, so this can be considered as a first validation step. In general the results of those cases highlight the ability of automatically detecting mineral dust plumes with BMDI.

Thus BMDI allows for operational daily dust detection and monitoring of activated dust plumes on the MSG pixel scale (3x3km² at nadir).

EUMETSAT GEOSTATIONARY AND LOW EARTH PROGRAMMES: STATUS AND PLANS

Ernst Koenemann

EUMETSAT

ABSTRACT

The talk will give an overview of the current state of the MSG programme and show the first results from the new Rapid Scanning Service from MSG 8 relocated to 9.2 deg east. This is followed by the current state of the EUMETSAT Polar System after the successful transition into operational phase of MetOp-A. The progress achieved on the definition and the start of the development programme for the Meteosat Third Generation (MTG) programme will be presented followed by the status of the Post EPS Phase 0 activities. EUMETSATŽs participation in the GMES programme and planned activities for a continuation of the Jason follow on programme will be presented.

CLIMATIC ANALYSIS AND CATEGORIZATION OF THE MESOSCALE CONVECTIVE SYSTEMS IN THE MEDITERRANEAN BASIN DURING THE WARM SEASON WITH THE USE OF METEOSAT SATELLITE IMAGERY

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ABSTRACT

The Mesoscale Convective Systems have a crucial role in many extreme weather phenomena in the Mediterranean region during warm season. The main object of the present study is the construction of a climatic database with the characteristics of the MCS's (Mesoscale Convective Systems) in the whole Mediterranean region during the warm seasons of the years 2005, 2006 and 2007, using a tracking algorithm on Meteosat-8 and Meteosat-9 images. Several parameters related to geographical (position and time of the MCS first detection, life span, velocity and direction), geometric (size, ellipticity etc) and spectral (mean and minimum brightness temperatures, temperature gradients etc) features were calculated for each MCS. An extensive analysis conducted in a large number of MCSs reveals that the majority of the MCSs were first detected over land between 10:00 UTC and 17:00 UTC with a mean life span at about eight hours, propagating mainly to Northeastern and Northwestern directions. The mean speed of the whole MCSs dataset was found at approximately 50 km/hr. In general, the growing phase lasts less than the dissipitation phase, while the majority of MCSs suffer from splits and mergings with other cloud systems during their life cycle. Less than 20% of the dataset were isolated MCS without splittings and mergings with other systems. Moreover, water vapor and split window channels of SEVIRI were used as additional information for detecting the active convective core of MCSs. Finally, a first classification of the MCSs dataset was performed by means of its basic parameters (e.g. area extent and duration) in order to examine the characteristics of each MCS class, separately.

FOSTERING THE BENEFITS OF WEATHER AND CLIMATE OBSERVATION FROM SPACE

Jerome Lafeuille, Richard Francis

WMO

ABSTRACT

The World Meteorological Organization (WMO) Space Programme involves activities of WMO Members and WMO Secretariat to ensure the enhancement of the space-based observing system supporting programmes undertaken or co-sponsored by WMO, as well as the development of user awareness and preparedness to benefit from these space-based capabilities. Weather and climate monitoring and forecasting heavily rely on operational meteorological satellites complemented by R&D satellites.
An update will be provided on these activities with particular focus on critical issues related to:

- The user requirements collection and updating process
- The evolution of the Global Observing System (GOS) towards an integrated interdisciplinary system serving weather and climate monitoring, its actual planning and implementation
- Accessibility of satellite data and products
- Provision of user information and capacity building in partnership with space agencies.

LONG TERM SURFACE ALBEDO DATASETS GENERATED WITH METEOSAT IMAGES

Alessio Lattanzio[1], **Yves Govaerts**[2], **Bertrand Theodore**[3]

(1) Makalumedia, (2) EUMETSAT, (3) Moltek-SAS

ABSTRACT

The Global Climate Observing System (GCOS) has recognized the importance and the key-role of the surface albedo in the study of the climate change. This and the other climate variables, called Essential Climate Variables (ECVs), must satisfy the following requirements: (i) a global coverage over long-term periods with adequate spatial and temporal resolution, (ii) reliability and accuracy as well as a (iii) quality control.

The Coordination Group for Meteorological Satellites (CGMS) assigned to EUMETSAT an action (T18 (TF7)) in order to prototype and test a new algorithm able to retrieve surface albedo using geostationary satellites as described in the "Implementation plan for the global observing system for climate in support of the UNFCCC" document (WMO/TD No. 1219).

In this frame EUMETSAT decided to develop a new specific algorithm, named Meteosat Surface Albedo (MSA), based on a method proposed by Pinty et al. The MSA algorithm is currently running in the operational reprocessing facility of EUMETSAT in order to generate reliable albedo data set starting from 1982. These data have been acquired by six different radiometers. As Meteosat first generation satellites have not been designed for climate monitoring, before proceeding with the interpretation of the complete archive (~ 25 years of data), a detailed temporal consistency analysis of the albedo data set generated with the MSA algorithm has been performed in order to check the compliance with points (ii) and (iii). Specific efforts have been put on the estimation of the measurement error accounting for the observation uncertainties and retrieval method assumptions.

Currently almost 65% of the archive has been processed and the albedo data set can be requested from the EUMETSAT archive facility. This paper will present the method elaborated for the evaluation of the temporal consistency of the MSA data set and illustrate typical problems raising from the processing of old data and the differences between the various radiometers of Meteosat first generation. Finally, the paper will establish the minimum surface albedo change that can be significantly detected from the analysis of this data set.

ATMOSPHERIC EFFECT ON VALIDATION OF BROADBAND SURFACE ALBEDO (SAL) PRODUCT OF CM SAF USING MAST MEASUREMENTS

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ABSTRACT

Satellite Application Facilities (SAFs) are specialised development and processing centres within the EUMETSAT Applications Ground Segment. The Satellite Application Facility on Climate Monitoring (CM SAF) was initiated in order to generate and archive high quality data sets on a continuous basis for the climate monitoring and modelling. One of the CM-SAF products is the surface albedo product (SAL).

The broad band short wave surface albedo is derived from satellite reflectance data of red and near infrared channels using published BRDF formulas for four main land categories: forest, grass, crop and barren. Snow is considered as a separate class. First the atmospheric correction is carried out to calculate the surface reflectance from the top of the atmosphere reflectance. Then the spectral albedo values are derived and the broadband conversion made. The validation of the satellite based products has two main strategies: large areas are compared with airborne measurements instantaneously or individual pixels are compared with continuous mast measurement results during long periods, preferably covering seasonal variation.

The satellite based albedo values are atmospherically corrected, but the mast measurements typically not. Since the atmosphere optical thickness depends strongly on the wavelength, the spectrum of the incoming surface radiation is not identical to that of the incoming top of atmosphere radiation. For vegetation, especially, the near infrared band reflectance is much higher than the visible band reflectance. Therefore the total reflected radiation is systematically higher, when the visible band radiation is more attenuated than the near infrared band radiation. This tends to increase the measured albedo value systematically.

The problem in taking into account the atmospheric effects in continuous broadband measurements is that the atmosphere optical thickness is strongly wavelength dependent. Spectrometers can measure relatively quickly the whole bandwidth to which the pyranometers are sensitive. However, the amount of data is so large for one spectrum that continuous measurements are not normally carried out all year round. Thus and ideal atmospheric correction of the mast data is often not possible.

A new simple and robust method for carrying out the atmospheric correction for mast measurements is presented here. The method was tested using Cabauw mast measurements of February – June 2006. Since the atmosphere optical thickness values were not measured extensively, the atmospheric correction for each month (or week) was derived for average atmosphere and 0.1 and 0.9 quantiles. The overestimation of the broadband surface albedo due to the atmosphere contribution was on the average 1 – 4 % in absolute albedo units for the Cabauw test site in February – June 2007. The effect is largest at low sun elevation angles. In February the monthly mean albedo value without atmospheric correction was 20.7%. The corrected value was 16.8%, 17.9% and 16.2% for mean, 0.1 quantile and 0.9 quantile values of the atmospheric correction.

The weekly mean CM-SAF surface albedo product (SAL) values derived using MSG/SEVIRI were compared to the weekly mean values of the mast measurements. Practically all SAL values were within the 0.1 and 0.9 quantiles of the atmospherically corrected mast measurements. This study indicates, how important it is to take into account the atmospheric effects, when using broadband mast measurements for satellite based product validation.

IDENTIFICATION OF AIR TRAFFIC INDUCED CIRRUS USING A NEW DAY- AND NIGHT-TIME MSG CIRRUS DETECTION ALGORITHM

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ABSTRACT

A new cirrus detection algorithm for the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI) aboard the geostationary Meteosat Second Generation (MSG), MeCiDA , is presented. The algorithm uses the seven infrared channels of SEVIRI and thus provides a consistent scheme for cirrus detection at day and night. MeCiDA combines morphological and multi-spectral threshold tests and detects optically thick and thin ice clouds. The thresholds were determined by a comprehensive theoretical study using radiative transfer simulations for various atmospheric situations as well as by manually evaluating actual satellite observations.

The cirrus detection has been optimized for mid and high latitudes but it could be adapted to other regions as well. The retrieved cirrus masks have been validated by comparison with the Moderate Resolution Imaging Spectroradiometer (MODIS) Cirrus Reflection Flag. To study possible seasonal variations in the performance of the algorithm, one scene per month of the year 2004 was randomly selected and compared with the MODIS flag. 81% of the pixels were classified identically by both algorithms. In a comparison of monthly mean values for Europe and the North-Atlantic MeCiDA detected 29.3% cirrus coverage, while the MODIS SWIR cirrus coverage was 38.1%. A lower detection efficiency is to be expected for MeCiDA, as the spatial resolution of MODIS is considerably better and as we used only the thermal infrared channels in contrast to the MODIS algorithm which uses infrared and visible radiances.
The advantage of MeCiDA compared to retrievals for polar orbitinginstruments or previous geostationary satellites is that it permits the derivation of quantitative data every 15 min, 24 h a day. This high temporal resolution allows the study of diurnal variations and life cycle aspects. We use these new features to study the impact of air traffic on cirrus coverageand life cycle aspects. MeCiDA is fast enough for near real-time applications.

USING CO2 SLICING TO INFER GLOBAL CLOUD COVER (IMPROVING ALGORITHM APPLICATIONS AND OVERCOMING INSTRUMENT IDIOSYNCRASIES)

Paul Menzel[1], Bryan Baum[1], Darren Jackson[2], Richard Frey[1], Elisabeth Weisz[1], Erik Olson[1], John Bates[3]

(1) University of Wisconsin, (2) CIRES, (3) NOAA/NCDC

ABSTRACT

The frequency of occurrence of upper tropospheric clouds has been extracted from NOAA/HIRS polar orbiting satellite data from 1979 onwards using CO2 slicing to infer cloud amount and height. More recently this has been continued with the MODIS data on the Terra and Aqua platforms. Algorithm adjustments for instrument noise, sensor to sensor differences, viewing angle, spectral response shifts, calculated versus measured radiance biases, changing CO2 and O3 amounts, and investigator error have been studied. CALIPSO measurements are being used to verify the improvements in the CO2 slicing algorithm. Some lessons learned are being documented and the HIRS/MODIS trend analyses are being compared with ISCCP. This presentation will touch on all of these topics.

COMPARISON OF GLOBAL WATER VAPOUR COLUMN TRENDS FROM GOME/SCIAMACHY WITH INDEPENDENT DATA SETS

Sebastian Mieruch, Stefan Noël, Heinrich Bovensmann, John P. Burrows

University Bremen

ABSTRACT

An analysis and intercomparison of trends from column integrated water vapour data, retrieved by satellite observations, radiosonde measurements and model calculations has been performed.

The global satellite water vapour time series are provided by the Global Ozone Monitoring Experiment (GOME) on ERS-2 (European Remote-Sensing satellite) from January 1996 to December 2002 and are extended by measurements of the SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) onboard ENVISAT (ENVironmental SATellite) up to December 2007. The combination of the two sets of data results in a long-term time series of currently 12 years on the basis of monthly means covering the Earth on a 0.5 x 0.5 degree grid. In the future this time series can be extended with further SCIAMACHY data and measurements of GOME-2 onboard MetOp.

Additional sets of data, covering also the time span from January 1996 to December 2007, have been investigated such as radiosonde measurements, model data (ECMWF) and water vapour data from the Special Sensor Microwave Imagers (SSM/I) onboard several satellites.

For the detection of trends or changes in the water vapour column over the time period of 12 years we use the same linear least square regression algorithm for all sets of data. Special emphasis is placed on the estimation of the errors and therefore the significance of the trends, which also includes the consideration of autocorrelations in the data.

RADIATION CLIMATE DATA RECORD BASED ON THE CLIMATE VERSION OF HELIOSAT.

Richard Mueller[1], **Bruno Dürr**[2], **Rainer Hollmann**[1], **Christine Träger-Chatterjee**[1]

(1) Deutscher Wetterdienst, (2) MeteoSwiss

ABSTRACT

The Heliosat method is the most established method within the Solar Energy community in Europe. Several successful EU projects and commercial applications are based on the Heliosat method or on solar irradiance data, retrieved with the Heliosat method. Beside the robust and accurate nature of the Heliosat method, the great benefit of the Heliosat method is its applicability to the first generation of Meteosat satellites. However in order to fulfill the requirements for the retrieval of climate data records the Heliosat method has to be modified and improved. In this terms a self calibration method has been developed and implemented, which takes care of instrument changes and aging. More over, a snow detection method has been applied, based on a fuzzy logic algorithm, developed by A. Zelenka et al. Finally, a new method has been implemented into the Heliosat method in order to be able to use the thermal channels for the retrieval of the thermal radiation at the surface.
The presentation will discuss the climate version of the Heliosat method, including short outlines of the new methods and modules. The accuracy of the retrieved solar and thermal irradiance at the earth surface will be compared to other satellite based data sets, especially to MSG based data sets. The results will be discussed in terms of benefits and drawbacks of Heliosat relative to other methods, including a reflection of the the underlying satellite capabilites.

GLOBAL WETLAND DYNAMIC DERIVED FROM MULTI-SATELLITE ESTIMATES: A 12-YEAR RECORD WITH APPLICATIONS TO HYDROLOGY STUDIES AND METHANE EMISSION MODELING

Catherine Prigent[1], Fabrice Papa[2], Bill Rossow[3], Elaine Matthews[4]

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ABSTRACT

Wetlands cover only 5% of the Earth's ice-free land but exert major impacts on global biogeochemistry, hydrology, and wildlife diversity. Until now, quantitative, global time-series of spatial and temporal dynamics of inundation have been unavailable. A globally-applicable remote-sensing technique employing a suite of complementary satellite observations has been developed: it uses passive microwave land-surface microwave emissivities calculated from SSM/I, ERS scatterometer responses, and AVHRR visible and near infrared reflectances. Combining observations from different instruments makes it possible to capitalize on their complementary strengths, to extract maximum information about inundation characteristics, and to minimize problems related to one instrument only. The technique is globally applicable without any tuning for particular environments. The satellite data are used to calculate inundated fractions of equal-area grid cells (0.25°x0.25° at the equator), taking into account the contribution of vegetation to the passive microwave signal. Global estimates of monthly-inundated areas for 1993-2004 will be presented.

Global inundated area varies from a maximum of 5.8 x 10^6 km^2 to a mean minimum of 2.1.10^6 km^2. These values are consistent with existing independent, static inventories. The multi-satellite estimates also show good agreement with regional high-resolution SAR observations over the Amazon basin. The seasonal and inter-annual variations in inundation have been evaluated against rain-rate estimates from the Global Precipitation Climatology Project (GPCP) and water levels in wetlands, lakes and rivers measured with satellite altimeters. The inundation database is now being used for hydrology modeling: a promising synergy with radar altimetry can provide crucial information about hydrological parameters such as water storage and river discharge and is now under investigation. The 12-year record dataset shows a declining inundation extent, especially in the tropical region, that will be discussed and compared to other hydrological variables. In addition, wetland being the major source of atmospheric methane and the only one dominated by climate, simple parameterizations of methane emission have been developed from complex process models for wetlands and introduced into climate models. Realistic inundation dynamics derived from the satellite observations provide the opportunity to develop and calibrate simulations of methane emissions associated with surface hydrology and initial efforts are already underway.

THE EFFECT OF ANCILLARY DATA ON COMPONENTS OF THE EARTH'S RADIATION BUDGET AS COMPUTED FROM SATELLITE MEASUREMENTS

Ehrhard Raschke[1], Stefan Kinne[2], William B. Rossow[3], Yuan-C, Zhang[4]

(1) University of Hamburg, (2) MPI-MET Hamburg, (3) City College New York, (4) Columbia University New York

ABSTRACT

Various ancillary data, describing the radiative transfer properties of the atmosphere and of the Earth's surface, are required to determine the cloud field properties within the atmosphere and the radiation budget components at its boundaries from related satellite measurements. These is in particular. information on the surface reflectance and skin temperature to identify clouds and aerosols in the troposphere. Vertical profiles of atmospheric gas concentrations and of the aerosols as well are often proscribed from direct sampling over a small ensemble of areas. Most quantities undergoe in particular over continents strong diurnal variations.

Such information on quantities, which often vary stronlgy in space and time, needs also be derived from satellite measurements. Thus it is expected that it contains systematic errors and also artifacts which are expected to propagate into the final results on the Earth's cloud fields and radiation budget components.

With examples from the International Satellite Cloud Climatology Project (ISCCP), from the GEWEX Surface Radiation Budget Project (SRB) and the Cloud and Radiation Experiments (CERES), which all aim for global fields and long time series, we were able to identify error sources, which if not corrected already lead to erronous conclusions in the interpretation of time series.

During the presentation several examples aill be discussed including also methodological errors (e.g. computation of the insolation at the Top of the Atmosphere and of the Pinatubo aerosol clouds). We conclude, that at least all data of these three projects need to be re-analysed preceded by a reanalysis of all acillary data. This conclusion hold also for all other project making use of the results of all three projects including the retrieval of aerosols from satellite measurements. The presently available data sets of all three projects should not yet be used for analyses of longer time series.

Our efforts are part of a complete assessment of all GEWEX cloud and radiation products.

ON THE DISTRIBUTION OF THE FREE TROPOSPHERIC HUMIDITY FROM METEOSAT

Rémy Roca, Hélène Brogniez, Julien Lémond, Laurence Picon

LMD

ABSTRACT

Free tropospheric humidity over the subtropics is known to play a strong role in the earth radiation budget by providing efficient way for longwave radiation to escape to space. Non linearity in the radiative transfer yields to higher sensitivity of the OLR to perturbations in these dry environments than in the moist deep tropics. METEOSAT offers a unique observational dataset to study the variability of the water vapor distribution in the region. Joint research efforts between LMD and CMSAF are currently permitting the building of a long term data base (~30 years). The talk will discuss the status of development of the database as well as preliminary analysis of multiyear variability analysis. In particular, time will be devoted to discuss the homogeneity of the dataset over the period by comparison to NOAA satellite similar data field as well as with comparison with radiosondes archive and reanalysis products. The results of recent investigation on the dynamics of water vapor in this region using back-trajectories techniques highlight the importance of using the Probability of Distribution Function of instantaneous estimates rather than typical monthly averages of the quantity for a good understanding of the processes at play. The strong adequation of the METEOSAT archive towards this kind of approach will be demonstrated.

LONG-TERM APPLICATION AND EVALUATION OF IAPP USING GLOBAL RADIOSONDE AND CHAMP MEASUREMENTS

Marc Schroeder[1], **Jörg Schulz**[1], **Markus Jonas**[1], **Ralf Lindau**[2]

(1) Deutscher Wetterdienst, (2) Universität Bonn

ABSTRACT

The major objective of the Satellite Application Facility on Climate Montoring (CM-SAF) is the exploitation of satellite observations to derive information on key climate variables of the Earth system. The CM-SAF focuses on the atmospheric part of the Essential Climate Variables defined within the framework of the Global Climate Observing System (GCOS). Among other methods the CM-SAF operationally applies the International ATOVS Processing Package (IAPP) to retrieve humidity and temperature profiles from ATOVS observations onboard NOAA-15, -16, and -18. A kriging routine is applied to the swath based retrievals in order to determine daily and monthly averages on a global grid. Furthermore, the profiles are vertically integrated and averaged to provide column integrated water vapour as well as humidity and temperature values for 5 layers and at 6 layer boundaries. Currently the years 2004-2007 had been processed, and a reprocessing event will go back to 1998 in the near future.

The evaluation of temperature and humidity Climate Data Records (CDRs) for the period 2004-2007 is carried out using global radiosonde observations that meet the quality standards of the GCOS Upper Air Network (GUAN). The evaluation is extended by utilising CHAllenging Minisatellite Payload (CHAMP) observations for the years 2004 and 2005. The evaluation considers biases, RMSE, and mean absolute deviations and separates between global and zonal values. The maximum average bias of column integrated and layer integrated water vapour between ATOVS and GUAN radiosondes is 0.5 kg/m^2 and 0.8 kg/m^2 (850-700 hPa), respectively. For the layer averaged temperatures we find a maximum bias of -1.1 K (300-200 hPa). The RMSE of water vapour exhibits an annual cycle with a maximum in summer months and a maximum of zonal RMSE around the equator with some variation depending on the month. The exemplary comparison of ATOVS and CHAMP data confirms above findings. When future progress in inter-calibration efforts leads to improved homogenised radiances, reprocessing of ATOVS observations can be carried out easily and will lead to CDRs with at least the accuracy as presented above. Currently CM-SAF is working on an automated evaluation of temperature and humidity products with radiosonde profiles from reference stations.

BIAS MONITORING OF SATELLITE INFRARED RADIANCES UTILISING GROUND BASED REFERENCE OBSERVATIONS AND RADIATIVE TRANSFER SIMULATIONS

Jörg Schulz, Marc Schröder

Deutscher Wetterdienst

ABSTRACT

The establishment of high quality long-time series of atmospheric parameters for climate monitoring requires known error characteristics and temporal stability. The provision of homogeneous, inter-calibrated radiances from satellites is the primary mission of the Global Space-based Inter-Calibration System (GSICS) and is a challenging task in view of various aspects like technical improvements, calibration issues and different spatial coverage of present and upcoming satellites.

We present a conceptual framwork for the evaluation of GSICS type inter-calibrated satellite radiances demonstrated on the example of the SEVIRI instrument onboard Meteosat. Ground-based observations from GCOS Reference Upper-Air Network (GRUAN) sites perform long-term measurements of the atmospheric state with high accuracy employing different instruments, e.g., lidars, microwave radiometers and research quality radiosondes. Utilising a fast radiative transfer model (RTTOV) these measurements can be operationally used to infer residual biases after applying the GSICS inter-calibration by comparing simulated and observed radiances of all channels of SEVIRI. Additionally, a line-by-line radiative transfer model is utilised in an off-line mode to estimate uncertainties of RTTOV and to extend the evaluation to high-spectral observations of IASI on a regular basis. In this way the efforts of the (inter-)calibration of satellites, in particular of SEVIRI, carried out within the GSICS framework, are tested independently.

THE USE OF SATELLITE DATA FOR REANALYSIS AND CLIMATE MONITORING

Jean-Noël Thépaut, Dick Dee, Sakari Uppala

ECMWF

ABSTRACT

Reanalysis of past observations using a state-of-the-art data assimilation system produces a coherent, dynamically consistent, long-term record of atmospheric parameters which accurately represents the available observations. Reanalysis products are widely used for many different purposes, including climate monitoring and research. It is important to occasionally repeat the reanalysis process in order to take advantage of developments in modeling and data assimilation, of newly available observations, of re-calibrated and/or re-processed existing observations and other input data sets. In this way the quality of the reanalysis products can be continuously improved, and new applications become possible.

ECMWF has completed several global atmospheric reanalysis projects, beginning with FGGE (1979), followed by ERA-15 (1979-1993) and ERA-40 (1957-2002). At the moment the ECMWF is producing a new reanalysis for the period after 1989, which is expected to reach real-time later in 2008 and will then be continued as a climate data assimilation system. This latest-generation reanalysis is referred to as ERA-Interim, since it partly serves to prepare for the planned production of a more extensive high-resolution replacement of ERA-40 which will cover at least 75 years.

The post-1989 period is characterized by the availability of increasing numbers and types of satellite observations. ERA-Interim makes use of radiance data from various sensors on polar orbiting satellites (including rainy radiances from SSM/I), atmospheric motion vector products derived from geostationary satellites, surface wind products from scatterometer data, bending angle data from GPS radio-occultations, and ozone column and profile data from various sensors. Handling large volumes of data from such a variety of sources requires intelligent quality control and bias correction schemes. In this presentation we will highlight some of the innovative features that have been developed to deal with this challenge.

SATELLITE BASED ANALYSIS OF SURFACE SOLAR RADIATION ANOMALIES

Christine Traeger-Chatterjee, Richard W. Mueller, Rainer Hollmann

Deutscher Wetterdienst

ABSTRACT

It seems that in recent years the surface radiation conditions in Europe are changing its characteristics. There also arises the question if and how the patterns and anomalies of solar radiation have been changed over the last decades. Satellite derived geophysical data sets are very well suited to investigate the questions related to changes of patterns due to their spatial coverage and homogeneity.

Within the framework of deriving surface radiation budget data from satellite and in preparation of the planned reprocessing activities of METEOSAT first generation, the Satellite Application Facility on Climate Monitoring (CM-SAF, www.cmsaf.eu) is using the Heliosat method to derive solar radiation data. To start this activity, a 10 year Heliosat based homogeneous time-series has been calculated giving the opportunity to investigate seasonal and inter-annual changes and anomalies of solar radiation within the field of view of METEOSAT (study area: 25° N to 60° N; 7.5° W to 25° E).

From previous studies it is known, that the Heliosat data show a very good accuracy compared to in-situ measurements, thus giving confidence to be used as a reference data set for inter-comparisons. The overlap period between 1995 and 2002 of Heliosat data with the 40 year reanalysis data of the European Centre for Medium-range Forecasts ERA-40 is used to examine the capability of ERA-40 to reproduce the observed characteristics of surface radiation patterns and anomalies in Europe. A positive result of this examination would justify the use of ERA-40 to investigate a longer-term change of anomaly patterns. More recent changes in surface radiation in Europe since 2002 are investigated using Heliosat derived surface radiation data. First results of this study and the inter-comparison with ERA-40 are presented.

SATELLITE CLOUD RETRIEVALS FROM COMBINED ANALYSIS OF THE RING EFFECT AND THE ABSORPTIONS OF O2 AND O4

Thomas Wagner[1], **Steffen Beirle**[1], **Marloes Penning de Vries**[1], **Tim Deutschmann**[2], **Michael Grzegorski**[2], **Ulrich Platt**[2]

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ABSTRACT

Spectrally resolving satellite instruments in the UV and visible spectral range (like GOME and SCIAMACHY) yield information on various cloud properties like cloud coverage, cloud fraction and cloud optical thickness. In this study we present cloud retrievals based on the analysis of absorptions of the oxygen molecule and dimmer and different spectral regions. In addition, also the strength of the Ring effect is analysed. We present results from GOME and SCIAMACHY observations and discuss the information content of the method. In selected case studies the influence of broken clouds and high surface albedo are presented and discussed.

INTERCOMPARISON OF DAYTIME CLOUD OPTICAL AND MICROPHYSICAL PARAMETERS

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ABSTRACT

The Advanced Baseline Imager (ABI), slated for launch on the future GOES-R satellite platform, is a multispectral imager that is similar to SEVIRI in spectral coverage. The anticipated launch date is September 2012. The ABI is designed to measure emitted and solar reflected radiance simultaneously in 16 spectral channels at a high spatial resolution (0.5 ~ 2km). These data will be used to provide a suite of products including cloud and aerosol properties. Since SEVIRI, now onboard the European satellite METEOSAT-8 (METEOSAT-Second-Generation), has similar spectral channels, it is ideally suited for use as a testbed for the development of ABI algorithms. The goal of this study is to investigate several different approaches for inferring cloud optical thickness and effective particle size. Towards this goal, we apply several different algorithms using a 1D-var approach to SEVIRI measurements. For example, one approach is to use simultaneous measurements from a visible channel (ABI:0.64 µm) and a near-infrared channel (e.g., ABI: 1.6 µm) or 3.9 (ABI: 3.75 µm). Another approach is to use IR window channels at 8.7, 10.8 and 12.0 µm. The benefit here is that the products would be consistent regardless of solar illumination. The algorithms differ basically in the applied radiative transfer model, inversion method, ice particle scattering property models, and use of ancillary data sets. The algorithms use precalculated look-up-tables (LUT) with a fast forward model for inversion. The design of the LUT and the interpolation procedures adopted for operational use of the LUTs are crucial points of any retrieval algorithm. We will present the sensitivity of the LUTs and associated retrievals to the assumed microphysical parameters. Our presentation will point to the differences and the strengths of the selected retrieval methods. Finally, we will present results from comparison of cloud optical and microphysical products derived by both SEVIRI and MODIS measurements provided by the Climate-SAF consortium and Freie Universität Berlin.

INTERCOMPARISON CLOUD PRODUCTS FROM GOME-2 L1 AND SCIAMACHY

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ABSTRACT

The second Global Ozone Monitoring Experiment (GOME-2) was launched onboard the first European meteorological polar satellite, MetOp-A, on 19 October 2006 in a sun-synchronous orbit, with an overpass time at about 9:30 local time. GOME-2 has a pixel size of 40x80 km^2 and a swath of 1920 km, so it has almost daily global coverage. The aim of GOME-2 is to monitor ozone, NO_2, and other stratospheric and tropospheric trace gases and aerosols. Since clouds strongly affect the detection of trace gases and aerosols, the FRESCO cloud algorithm is implemented in the operational L0-1 processor of GOME-2 to provide users with a first cloud estimation. The FRESCO algorithm uses the O_2 A-band at about 760 nm, and has been applied to GOME and SCIAMACHY measurements for several years. The FRESCO cloud products (effective cloud fraction and cloud pressure) have been validated with products from other algorithms (e.g. from PMDs) and other sensors namely, satellite IR and groundbased Lidar/Radar instruments.

The GOME-2 L1 cloud product has been compared with SCIAMACHY FRESCO cloud data (sc-v4) for one day of global data on 6 November 2007. Because of the 30 minutes of difference in measurement time and different viewing geometries, we could not expect that exactly the same cloud information was measured by GOME-2 and SCIAMACHY. The GOME-2 and SCIAMACHY effective cloud fractions have very good agreement; the mean effective cloud fraction difference is 0.0008+/- 0.0977. The cloud pressures also have a very good linear correlation, the mean cloud pressure difference is about -20 hPa for almost fully cloudy scenes and about 2.7 hPa if the cloud fractions are larger than 0.05. In the FRESCO algorithm the sun glint is retrieved as a low cloud. For the sun glint pixels the GOME-2 and SCIAMACHY effective cloud fraction difference is about 0.007, which is comparable to the effective cloud fraction difference.

FY-3A SATELLITE AND ITS POTENTIAL APPLICATION

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ABSTRACT

Fengyun 3 series is the second generation polar orbiting system of Chinese meteorological satellite. The launch date of the first mission (FY-3A) has been fixed at the end of this May. FY-3A performs integrated observations to the Earth by the combination of the ultraviolet, visible, infrared and microwave spectrum. It improves the remote sensing capacity to monitor the Earth's weather, climate and environment with its 11 payloads.

Among the 11 payloads onboard, the Visible and InfraRed Radiometer (VIRR) is the only successive instrument inherited from Fengyun 1 series. The others including InfraRed Atmospheric Sounder (IRAS), MicroWave Temperature Sounder (MWTS), MicroWave Humidity Sounder (MWHS), MEdium Resolution Spectral Imager (MERSI), Solar Backscatter Ultraviolet Sounder (SBUS), Total Ozone Unit (TOU), Microwave Radiation Imager (MWRI), Solar Irradiation Monitor (SIM), Earth Radiation Measurement (ERM), and Space Environment Monitor (SEM) works on the orbit in the first time.

The complex ground segment has been developed to control the satellite and retrieve, process and archive data for FY-3A. The products covered the atmosphere, ocean, land, cryosphere and biosphere have be generated through this segment operationally. The details of the FY-3A payloads, ground segment design and the related potential application will be introduced in this presentation.

IMPACT OF DRIZZLE AND 3D CLOUD STRUCTURE ON REMOTE SENSING OF EFFECTIVE RADIUS

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ABSTRACT

Remote sensing of cloud particle size with passive sensors like MODIS is an important tool for cloud microphysical studies. As a measure of the radiatively relevant droplet size, effective radius can be retrieved with different combinations of visible through shortwave infrared channels. The resulting effective radii are often quite different, indicative of different penetration depths for the spectral radiances used. Operational liquid water cloud retrievals are based on the assumption of a relatively narrow distribution of droplet sizes; the potential impact of precipitation on these distributions is neglected. MODIS observations sometimes show significantly larger effective radii in marine boundary layer fields derived from the 1.6 and 2.1 µm channel observations than for 3.7 µm retrievals. Possible explanations range from 3D radiative transport effects and sub-pixel cloud inhomogeneity aspects to the impact of drizzle formation.

To investigate possible factors of influence, we use LES simulated boundary layer cloud situations in combination with 3D Monte Carlo simulations of MODIS observations. LES simulations of warm cloud spectral microphysics for cases of marine stratus and broken stratocumulus, each for two different values of cloud condensation nuclei density, produce cloud structures comprising droplet size distributions with and without drizzle size drops. From 3D radiative transport simulations considering the full individual droplet size distributions synthetic MODIS observations are obtained. On these scenes the operational MODIS effective radius retrievals are applied and the results are compared to the given LES microphysics.

COMBINING METOP-A AND MSG NOWCASTING RELATED PRODUCTS TO DERIVE AND MONITOR ATMOSPHERIC INSTABILITY AND CONVECTION DEVELOPMENT.

Paolo Antonelli[1], **Wayne Feltz**[1], **Kris Bedka**[1], **Ralf Bennartz**[1], **Silvia Puca**[2], **Luigi De Leonibus**[3], **Francesco Zauli**[3], **Davide Melfi**[3], **Daniele Biron** [3]

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ABSTRACT

The combination of METOP-A and MSG observations provides a valuable asset in deriving and monitoring atmospheric instability. The high vertical resolution of IASI soundings provides an ideal input to identify regions of possible convective activity before the development of the convective system. The high spatial and temporal resolution of SEVIRI data allows for early convection detection, and for monitoring the evolution of convective systems. In addition the contribution of AMSU data allows for the estimation of rain rate classes associated to the identified convective systems. The work presented, describes an approach to combine existing and new products obtained from infrared and microwave observations to derive and merge information about atmospheric instability, convection detection, convection monitoring and precipitation estimation associated to convective systems.

THE USE OF SATELLITE PRODUCTS FOR MONITORING FOG OVER ROMANIA

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ABSTRACT

The last cold season (2007-2008) was, most of the time, particularly foggy for the Romanianterritory and neighborhoods also. The main cause for the persistence of this phenomenon was the long time presence of high pressure surface fields over our country, sustained by structures of ridge at the upper levels.

This evolution of the atmospheric pressure generated:

- persistent fog that results in problems concerning the flight and highway traffic
- white frost affecting the trees branches, electric cables etc.

The purposes of the present study were to highlight the synoptic configuration during foggy intervals, to establish the origin and stratification of involved air masses and to investigate the different fog types of interest in the analyzed periods. To reach these goals were used satellite imagery, the available soundings and the ECMWF numerical model analyses.

The EUMETSAT (Meteosat 9) satellite products also proved to be very useful in issuing very short range forecasts and in identification and monitoring this phenomenon (fog - day and night) using particularly the HRV – channel 12, RGB Composite NIR 1.6, VIS 0.8, VIS 0.6, RGB Composite IR 12.0 – IR10.8, IR 10.8 – IR 3.9, IR 10.8; RGB Composite VIS 0.8, NIR1.6, IR 3.9r and RGB Composite IR 12.0 – IR10.8, IR 10.8 – IR 8.7, IR 10.8.

USE OF GEOSTATIONARY RAPID SCAN IMAGERY IN THE OBSERVATION, DETECTION, AND NOWCASTING OF CONVECTIVE STORMS

Kristopher Bedka[1], **Wayne Feltz**[1], **John Mecikalski**[2], **Marianne Koenig**[3]

(1) UW-CIMSS, (2) University of Alabama in Huntsville, (3) EUMETSAT

ABSTRACT

Current and future geostationary satellite programs are moving toward higher temporal resolution scan strategies (i.e. "rapid-scan" ,~ 5 mins or less) to better observe rapidly evolving weather phenomena. Of significant interest to the community is the monitoring of convection, where a transition from immature cumulus to a severe thunderstorm can occur within a ~1 hour period. UW-CIMSS, in collaboration with the University of Alabama in Huntsville, has begun to study the potential benefits of rapid scan imagery toward diagnosing and nowcasting convective storms. The goal of this effort is to develop a product suite that can encompass the convective development cycle from "end-to-end" to provide guidance for severe convective storm and aviation weather forecasting. This presentation will demonstrate observation, detection, and nowcasting of storm initiation and convectively-induced turbulence signatures in rapid-scan GOES-12, MSG SEVIRI, and synthetic GOES-R ABI proxy dataset imagery, in addition to a description of future work toward this end-to-end system.

UNDERSTANDING SATELLITE-OBSERVED MOUNTAIN WAVE SIGNATURES USING HIGH-RESOLUTION NUMERICAL MODEL OUTPUT

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ABSTRACT

Prior work using satellite water vapor imagery has shown that pilot reports of severe turbulence over Colorado often occur when complex interference or crossing wave patterns develop downstream of the Rocky Mountains. To gain new insight into the underlying structure of such patterns, a high-resolution (1-km) Weather Research and Forecasting (WRF) model simulation was performed for an intense mountain wave event that occurred on 06 March 2004. A sophisticated forward radiative transfer model was used to generate synthetic satellite water vapor imagery for this simulation. Overall, the synthetic imagery realistically captured many of the mesoscale features observed within concurrent MODIS water vapor imagery, including a mountain wave train extending far downstream of the Colorado Front Range, the deformation of this wave train by an approaching cold front, and the substantially warmer brightness temperatures in the lee of the major mountain ranges comprising the Colorado Rockies. Inspection of the model data revealed that the mountain waves redistributed the water vapor within the entire atmospheric column, with the maximum column-integrated water vapor content occurring one-quarter wavelength downstream of the maximum ascent within each mountain wave. Due to this phase shift, the strongest vertical motions occur halfway between the locally warm and cool brightness temperature couplets on the water vapor imagery. Interference patterns seen in the water vapor imagery appear to be associated with mesoscale variability in the ambient wind field at or near mountain top due to flow interaction with the complex topography. It is also demonstrated that the synergistic use of multiple water vapor channels provides a more thorough depiction of the vertical extent of the mountain waves since the weighting function for each channel peaks at a different height in the atmosphere. A comparison of current GOES-12 to synthetic future GOES-R Advanced Baseline Imager (ABI) water vapor channel imagery is also provided to demonstrate the improved capability of ABI for observing mountain waves and may lead to objective nowcasting of turbulence interest fields.

GROUND-TRUTH FROM THE LIGHTNING DETECTION NETWORK LINET IN EUROPE FOR THE INTERPRETATION OF THUNDERSTORM-RELATED DATA COLLECTED BY SPACE-BORN SENSORS

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ABSTRACT

The lightning location network LINET has started continuous operation early in 2006 and covers large parts of Europe, approximately the area from longitude 10°W - 26°E to latitude 35°N - 66°N. It has been developed by the atmospheric research group in the Physics Department of the University of Munich, and undergoes permanent evaluation, partly in co-operation with scientific partners and national weather services. nowcast Inc. organizes the network operation as exclusive provider of continuous real-time lightning data for the German Weather Service, and continues to expand the covered area; as of Jan. 01, 2008, a total of 85 sensors are utilized.

Since the network is able to report total lightning (cloud-to-ground and cloud strokes), electrical activity of thunderstorms can be investigated in great detail. Tests in Brazil have shown that LINET detects and locates cloud lightning better than the Tropical Rainfall Measuring Mission (TRMM) Lightning Imaging Sensor (LIS). Due to high detection efficiency and the ability to monitor cloud activity, LINET allows recognition of severe weather conditions. Moreover, nowcasting becomes possible even with relatively simple algorithms.

At present, the combination of lightning with other meteorological data sources is examined. Especially satellite data from the different Meteosat Second Generation (MSG), TRMM and A-train sensors are utilized to examine correlations between lightning observations and microwave brightness temperature, IR radiance, cloud top temperatures, vertical structure of the clouds, and precipitation fields. It is investigated to what extent various satellite data can be utilized to derive thunderstorm features in areas where no high-quality ground-based lightning detection network is available. Finally, special attention is given to the comparison between lightning data from LIS and LINET, with the aim to contribute to the planning basis for future space-born lightning sensors.

A LOCAL VERSION OF THE GII IN SOUTH AFRICA COMPARISONS TO VERIFY THE VALUE OF THIS PRODUCT AS AN OPERATIONAL NOWCASTING TOOL

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ABSTRACT

A local version of the EUMETSAT MPEF GII product was installed in South Africa in September 2007. This Regional Instability Indices (RII) product is based on the same MSG channels as the MPEF products, but relies on the South African Unified Model (UM) instead of ECMWF. This implies that the RII's horizontal resolution has improved from 1 degree to 0.1 degrees and the local product – running on local servers – can do the calculations in 3X3 pixels in stead of 15X15 pixels. The computation of the Lifted Index has also been adjusted to local conditions and thus differs in magnitude from the GII's Lifted Index.

Specific case studies have been selected in order to demonstrate the usefulness of the RII product as an operational nowcasting tool in South Africa. Experimental results from statistical comparisons between RII and sounding data over South Africa, as well as RII and lightning activity during convection, will be shown. It will also be shown how the additional benefits of the RII product adds value to the UM's instability indices.

APPLICATION OF THE EUROPEAN SEVERE WEATHER DATABASE (ESWD) TO THE VERIFICATION OF SATELLITE-BASED NOWCASTING

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ABSTRACT

The main goal of the European Severe Weather Database, ESWD, is to gather detailed and quality-controlled in situ reports of severe weather events (e.g. flash floods, hail, straight-line winds, tornadoes) all over Europe in a uniform data format and a web-based user-interface (www.eswd.eu) where both the public and collaborating national weather services (NMHS) can contribute and retrieve observations. Involving the public helps to raise completeness of the ESWD data significantly.

ESWD development was based on the fact that severe convective weather events strongly depend on micro- and mesoscale atmospheric conditions, and in spite of the threat they pose to people and property, they usually escape the meshes of existing operational monitoring networks. Besides, such events are often embedded in systems acting on a larger scale, and even if damage is local, severe weather can continue for hours or days and affect more than one European country during its lifespan.

The database is maintained and developed by the non-profit research organisation European Severe Storms Laboratory, ESSL (www.essl.org). Operational ESWD service started in 2006, after a two-year test phase. By now, three NMHS are collaborating: DWD, INM and ZAMG. Aside from climatology, also verification is one major application of the ESWD.

Here, we focus on verification case studies of the satellite nowcasting algorithm Cb-TRAM (Tracking and monitoring severe convection from onset over rapid development to mature phase using multi-channel Meteosat-8 SEVIRI data) recently developed at DLR. These studies aim at demonstrating the potential benefits of coupling satellite nowcasting to ESWD ground reports of actual events.

Our presentation will first review the ESWD design and the quality-control experiences gained during its first years of operational availability, and then compare case study examples of Cb-TRAM from 2005-2008 to the ESWD reports. In this context, the ESWD database also contributes to ongoing severe weather research projects, like RegioExAKT (www.regioexakt.de) in Germany, and the talk will briefly present results from these activities.

VALIDATION OF SEVERE WEATHER FORECASTS BASED ON SYNTHETIC SATELLITE DATA AS PART OF AN INTEGRATED THUNDERSTORM FORECAST SYSTEM

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ABSTRACT

A new tool is presented that validates severe weather forecasts based on synthetic satellite data against satellite observations. The algorithm Cb-TRAM is used for tracking and monitoring objects of severe convection both in observed satellite imagery from METEOSAT SEVIRI and in synthetic satellite images forecasted by the COSMO-DE from the German Weather Service (DWD). Here, objects are defined by the area where convection is detected based on certain thresholds in Cb-TRAM, together with the vertical extent of the cloud cell. The tool compares size, displacement, overlap, intensity distribution, and history of the observed and forecasted objects and thereby assesses the quality of the forecast. The functioning of the method will be demonstrated in case studies of severe thunderstorms. If several forecasts for one object are available (e.g. from an ensemble forecast), this method enables the selection of the forecast that agrees best with the observation and that could then be used to estimate the future thunderstorm evolution. In particular, this method has the potential to close the gap between nowcasting and forecasting. It is part of an integrated thunderstorm forecast system for air traffic named WxFUSION (Weather Forecast User Oriented System Including Object Nowcasting) which is currently under development within the framework of the DLR project “Wetter & Fliegen” in close collaboration with the DWD.

A SEVERE WEATHER EVENT IN ROMANIA DUE TO MEDITERRANEAN CYCLONIC ACTIVITY

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ABSTRACT

The Mediterranean cyclones are responsible for the occurrence of most episodes of severe weather (heavy rains, wind gusts) in the south and south-eastern part of Romania. The maximum intensity of this type of phenomena is reached when the initial trajectory of a cyclone is blocked by an anticyclonic field, often generated above the Russian Plain and extended until Central Europe. The low layer cyclogenesis is sometimes re-enhanced by the upper half of the troposphere, the tropopause level and the low stratosphere activity.

The severe weather event from 17th-19th of November was selected to illustrate the above, with special focus on the interpretation of water vapor satellite imagery (WV 6.2 - channel 5). The presence of the jet stream and jet streak, the advection of positive upper level PV anomaly downward to the mid-troposphere and the tropopause dynamic anomaly were also investigated using the ECMWF numerical model analyses.

The pointing out of the opposite features of the air masses in contact (maritime tropical origin mass from south and continental polar mass from north and east) represents the most important element in monitoring this type of weather episode using the satellite products.

Different satellite products were used in nowcasting activity to determine the aggravation degree in weather evolution: HRV – channel 12, IR 10.8 - channel 9 - enhanced, RGB Composite (Airmass RGB) WV 6.2 – WV 7.3, IR 9.7 – IR 10.8, WV 6.2; RGB Composite IR 12.0 – IR10.8, IR 10.8 – IR 3.9, IR 10.8; and RGB Composite NIR 1.6, VIS 0.8, VIS 0.6.

IMPROVED IDENTIFICATION OF CONVECTIVE CLOUDS FOR THE RDT PRODUCT

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Meteo France

ABSTRACT

The Rapid Developing Thunderstorm (RDT) product was developed by Météo-France in the framework of the SAF Nowcasting (EUMETSAT). It is based mainly on geostationary satellite data, and its objectives are :

- the identification, monitoring and tracking of intense convective systems
- the detection of rapidly developing convective cells.

The current scheme for convective clouds identification is based on a segmentation of cloud trajectories after some of their attributes (duration, minimum cloud top temperature …) followed by a learning step which correlates their radiance attributes with their lightning activity. It shows some weaknesses : it over discriminates the learning database, and the statistical method used doesn't allow to easily add new discrimination parameters (while using multiple MSG channels is definitely desirable). This lead to a re-design.

A first study allowed to choose a statistical decision method, among a number of linear and non-linear models; the simple logistic regression was considered adequate. Next, in order to include some physical guidance in the statistical decision, the discrimination scheme has been adapted to the cloud development stage, with a different decision model tuning for the following three stages :

- Development (before lightning occurrence for low cloud; early stage of convection)
- Intermediate (triggering of flashes and quick vertical development)
- Mature (anvil spread, and overshoot).

Most aspects of the discrimination are separately tuned for each phase: the choice of input parameters and whether they are time-averaged of instantaneous, their respective weights. For instance, the top temperature instantaneous change rate is a discriminating parameter for development stage but not for mature stage, and inversely for the GCD index (WV 6.2 - IR 10.8).
The way time is considered in the intermediate stage is to tune logistic regressions with respect to attributes time series by reference to the time where a cloud top temperature threshold is crossed. While for the two other stages (development and mature), the attributes time series are defined in a moving time frame.
In the intermediate stage, the temperature thresholds used are -5°C, -15°C, -25°C, -40°C, and the discrimination skill increases with colder temperature threshold. The threat score expected is 43% for the lowest cloud to 78% for the highest ones. The logistic regression for the development stage has a weak threat score (around 20%). This regression is based on instantaneous parameters on past historic. The regression defined on mature systems provides a very good score with a 90% detection rate for less 10% of false detection. This regression uses parameters averaged on past historic. The improvement provided over IR data only by the use of the two water vapour channels on the threat score is 20% for the mature stage and part of the intermediate stage.

This re-design allowed to eliminate over-discrimination and to easily assess the improvement brought by new discriminating parameters, like the two water vapour channels. Moreover, the new discrimination scheme takes care of cloud phase defined on cloud top temperature and can be separately assess (and tuned) for each phase. This is particularly useful for the early provision of a global discrimination scheme which is much reliable for phases which are easy (like the intermediate and mature ones) while still developing and improving for the difficult early development phase.

GLOBAL INSTABILITY INDEX DERIVED FROM METEOSAT-9 DATA USING TEMPERATURE AND HUMIDITY INFORMATION FROM IASI ON METOP-A

Dieter Klaes, Marianne König, Thomas August

EUMETSAT

ABSTRACT

One operational product derived from Meteosat Second Generation (MSG) satellites is the Global Instability Index (GII). The GII is an airmass parameter indicating the stability of the clear atmosphere. The usefulness of this product has been demonstrated in many nowcasting applications in particular to identify regions of potential severe thunderstorms and related hazardous weather. GII is an NRT product from MSG provided by EUMETSAT via EUMETCast.

The MSG based GII retrieval currently uses forecast profiles from the European centre of Medium Range Weather Forecasts (ECMWF) as first guess or background profiles.

This paper investigates the possibility to obtain initial temperature and humidity information from collocated measurements from the hyperspectral Infrared Atmospheric Sounding Interferometer (IASI) instrument on EUMETSAT's polar orbiting Metop-A satellite. Temperature and moisture profiles derived from the IASI soundings are used as initial input to the GII retrieval, where the temporal evolution of the air mass properties can then be recorded by the geostationary MSG observations. The algorithm used is EUMETSAT IASI Level 2 Product Processing facility (PPF) version 4.1. A specific case study is presented for a situation over Europe, which is investigated in the frame of the Convection Workshop (21 June 2007).

USING MULTI-SPECTRAL SATELLITE REMOTE SENSING TECHNIQUES TO NOWCAST NOCTURNAL CONVECTION INITIATION

Wayne Mackenzie, John Mecikalski

University of Alabama in Huntsville

ABSTRACT

Accurately forecasting convection initiation (CI) is an ongoing problem within meteorology. Mecikalski and Bedka (2005) have demonstrated with good success a process which nowcasts (0-1 hour) convection initiation during the daytime using GOES real-time satellite processing. Using 1 km visible imagery, temporal temperature trends using multiple wavelengths and band differencing, an algorithm was developed to select regions where cumulus clouds have ~60% or greater chance of precipitating within the next hour. An ongoing extension of this work is to advance daytime CI nowcasting to nighttime conditions. Since 1 km visible satellite is not available during the nighttime hours, one must rely on infrared channels with a spatial resolution of 4 km to monitor clouds. This can be challenging because 4 km is typically less than the cumulus horizontal spatial scale initially, and tracking cumulus at night is more difficult. As a corollary, during nighttime conditions the 3.9 micron near-infrared channel becomes available as an additional resource to use from the GOES instrument. Several nocturnal cases have shown longer lead times in the convective interest fields outlined by Mecikalski and Bedka (2006). A hypothesis will be presented along with a case study showing the increased lead-time. Recent research has shown that the 3.9 micron channel temporal temperature trends and difference fields will aid in the nowcasting of convection and provide additional information into cloud top microphysics. A data set of several cases has been analyzed and used to determine a critical value for using the 3.9 micron channel as a CI interest field. Thus, examples of cases with CI will be reviewed; statistics will be shown and MSG data will be used when available to take advantage of improved spatial resolution and more available channels. The addition of MSG data will aid in reducing false alarms and improving the probability of detection because of several channels, which can monitor the microphysical evolution of the cloud with time.

PHYSICAL RETRIEVAL ALGORITHM DEVELOPMENT FOR OPERATIONAL SEVIRI CLEAR SKY NOWCASTING PRODUCTS

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ABSTRACT

The physical retrieval algorithm is recommended through the SAFNWC (Satellite Application Facility for NoWCasting) Visiting Scientist Activity (VSA). Initial evaluation with radiosondes over land and AMSR-E (Advanced Microwave Advanced Microwave Scanning Radiometer - Earth Observing System) product over ocean shows that the recommended physical retrieval algorithm is promising for SEVIRI nowcasting product (PGE13). The selected algorithm has been be optimized for purpose of operational implementation for PGE13 version 1.0, the version 1.0 algorithm targets on the region where atmosphere is more unstable and will potentially cause the convective storm development. The PGE13 physical retrieval algorithm and its improvement on the current legacy approach will be evaluated and presented; initial applications of the improved products on nowcasting will be evaluated.

INNOVATIONS IN CONVECTIVE AND LIGHTNING INITIATION NOWCASTING USING GEOSTATIONARY SATELLITE AT THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

John Mecikalski, John Mecikalski

University of Alabama in Huntsville

ABSTRACT

This presentation highlights the ongoing research in the 0-1 h nowcasting of convective initiation (CI). The goal for accurate high-temporal CI forecasting has resulted in improvements to the Mecikalski and Bedka (2006) GOES-based CI nowcasting methodology, which has subsequently broadened our understanding of how geostationary satellites (GOES, MSG) sense growing cumulus clouds. Here, CI is defined here as the first occurrence of a 35 dBZ echo at the surface. The goals of this presentation include to: 1) demonstrate and describe the skill in our nowcasting procedures in terms of POD and FAR skill scores, 2) present an overview of the relative importance of each possible GOES/MSG infrared field to nowcasting CI and lightning initiation (LI), and 3) present an overall update to the CI forecasting procedure based on new research at UAH. At the present time, research involves processing co-located GOES visible/infrared, and comparing these data to WSR-88D level radar data, for several CI and LI events across North Alabama/South Tennessee. For six events, 1 km GOES-NEXRAD data are processed, which involves parallax correcting GOES observations, and interpolated both into the same coordinate system. High-resolution satellite-derived wind information is used to track moving clouds (Bedka and Mecikalski 2005; Bedka et al. 2007), with the monitoring of cloud-top infrared temperature trends possible (e.g., Roberts and Rutledge 2003) juxtaposed with WSR-88D data. Within all events, approximately 55,000 1 km pixels of CI/LI become available for statistical analysis. Using principal component analysis, we are able to evaluate the relative importance of eight infrared CI indicators, which are combinations of the 6.7, 10.7 and 13.3 um channels from GOES-12. Channel differencing and time trends of channel (differences) are specifically evaluated. Results show that the 13.3 um channel is particularly important given its ability to detect particularly large updraft development. Fields from MSG are being evaluated, and include the 8.5 um channel, as well as the 8.5-10.8 um difference. Through research involving the National Weather Service and convective weather forecasting tools of MIT Lincoln Labs (Wolfson et al. 2004) we are fortunate to be able to test these improvements within a methodology to nowcast CI. Work already completed shows that GOES information from moving convection has value above that previously used within this system. This presentation will report on our progress and most recent findings. New research is also extending the 0-1 hour CI nowcasting capabilities by examining trends in IR fields as well as CI climatologies across the U.S., and new ways of nowcasting CI based on land-surface heat and moisture gradients, as well as soil moisture. These aspects extend the satellite-based approaches into the 1-6 hour timeframe. Another topic to be discussed is the new aspect of GOES-R and the Meteosat Third Generation (MTG) that will benefit short-term thunderstorm prediction.

EXTREME CONVECTIVE CASES - THE USE OF SATELLITE PRODUCTS FOR STORM NOWCASTING AND MONITORING

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ABSTRACT

A detailed storm nowcasting is still a very demanding activity for operational activities of forecasting offices. Proper prediction of exact location and intensity of the initial convection, estimation of storm intensity based on its development and storm trajectory monitoring and forecasting are very important for warning purposes. Use of dedicated satellite products may improve operational storm prediction and monitoring. Early detection of the unstable air and assessment of the potential of deep convection were already presented on EUMETSAT Conferences in 2006 and 2007. In the frame of co-operation between EUMETSAT and IMWM, further works on storm nowcasting were done.

This paper focuses on selected case studies, where extreme convective cases were used to demonstrate usefulness of satellite products for analysis of pre-storm conditions, convection detection, characterisation of convective cells and nowcasting future storm behaviour. The area of Poland used for this analysis suffers from many severe storms between April and September with highest storm activity in the May to August period. Selected cases were connected with tornado, heavy lightning activity (including stratospheric sprite registered in Poland) and heavy wind and rainfall damages.

Possibilities and weaknesses of used satellite products for storm nowcasting and monitoring were discussed.

NEARCASTING CONVECTIVE DESTABILIZATION PRIOR TO ISOLATED CONVECTIVE EVENTS USING OBJECTIVE TOOLS WHICH OPTIMIZE THE IMPACT OF SEQUENCES OF GOES MOISTURE PRODUCTS

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ABSTRACT

Future instruments (e.g., multi-channel geostationary imagers, Wind Profilers, automated aircraft reports, etc.) will resolve atmospheric features with resolutions far beyond today's capabilities in both time and space. Although these data are expected to improve NWP guidance at 6-12 hours and beyond, a greater benefit from detailed time/space-frequency data (i.e., from GOES and MeteoSat) may come through objective NearCasting systems that assist forecasters in identifying rapidly developing, extreme weather events by helping to fill the 1-6 hour information gap which exists between nowcasts (based primarily on extrapolation of radar data) and longer-range NWP guidance.

NearCasting systems must detect and retain extreme variations in the atmosphere (especially moisture fields) and incorporate large volumes of high-resolution asynoptic data, while also be extremely computationally efficient. This requires numerical approaches that are notably different from those used in numerical weather prediction, where the forecast objectives cover longer time periods.

A new approach to objective NearCasting is presented that uses Lagrangian techniques (instead of Eulerean methods used in conventional NWP) to optimize the impact and retention of information provided by satellites. It is designed to detect and preserve intense vertical and horizontal variations observed in the various data fields observed over time. Analytical tests have confirmed this, as well as the computational advantages of this approach.

Real data tests have been conducted with the goals of detecting the development of atmospheric details several hours prior the onset of significant weather events. Tests using full resolution (10 km) moisture products from current GOES sounders to update and enhance current operational RUC forecasts show that the Lagrangian system captures and retains details (maxima, minima and extreme gradients) critical to the development of convective instability several hours in advance, even when subsequent IR satellite data are no longer available due to cloud development. Results from case studies of hard-to-forecast isolated convective events show substantial skill in being able to define areas of convective destabilization 3-6 hours in advance when using combinations of NearCast products that are displayed similar to current GOES Derived Product Image (DPI) observations.

The results provide examples of NearCast products that can be available at even higher resolution using GOES-R ABI data, as well as showing the potential value of the system in Europe and Africa using existing and future Meteosat products. This presentation will expand upon earlier work and include discussions of ongoing assessments of the NearCasting products being conducted within several US-NWS Weather Forecast Offices.

PHYSICAL, STATISTICAL AND TEMPORAL ANALYSIS APPROACHES FOR CLOUD IDENTIFICATION USING MSG-SEVIRI DATA

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ABSTRACT

Most current algorithms for the retrieval of geophysical and atmospheric parameters - such as temperature, humidity and gas profiles, sea and land surface temperature - are developed to work with cloud free data.

In this study a cloud detection algorithm applied to the MSG-SEVIRI data is proposed. In order to obtain a good performance in cloud detection, physical, statistical and temporal approaches have been used. In the statistical algorithm, the spectral and textural features of the MSG-SEVIRI images have been used as input, while in the physical tests, a set of dynamic thresholds has been used. The physical algorithm does not use real time ancillary data - such as sea surface temperature map and NWP temperature and humidity profiles. A further test is applied to the pixels having low confidence to be cloud free or cloudy. This test takes advantage of the best MSG-SEVIRI temporal resolution and it applies the K-Nearest Neighbour (K-NN) classifier to the spectral and textural features calculated in “temporal” boxes 3x3 pixels, defined “temporal” because their elements belong to three subsequent MSG-SEVIRI images. The MACSP (cloud MAsk Coupling of Statistical and Physical methods) algorithm has been validated against the MODIS and compared with the CLOUDSAT-CPR and SAFNWC cloud masks. The outcomes show that the MACSP detects 91.8% of the total number of the pixels used for validation against MODIS cloud mask correctly, while the SAFNWC cloud mask detects 89.2% of them correctly. The MACSP detects 91.2% of the cloudy CPR pixels and 90.8% of the cloud free CPR pixels, considered for comparison, correctly. On the other hand, SAFNWC and CPR cloud masks agree in the detection of 90.7% of the cloudy pixels and of 90.2% of the cloud free pixels.

Finally, the analysis of the MODIS cloud mask granules used for validation, pointed up the pixels classified as “uncertain” by the MODIS cloud mask algorithm. Taking advantage of the best MSG temporal resolution, two distinct temporal analysis tests have been applied to a set of subsequent MSG-SEVIRI images in order to verify the pixels classified as “uncertain” by the "$BT_{3.9}$-BT_{11}" MODIS cloud mask test over land. Both the temporal analysis tests are K-NN classifiers. The first one uses as input the spectral and textural features of five subsequent infrared images and it is applied over land during day/night time. The second one uses as input the spectral an textural features of five subsequent HRV images.

GOES DERIVED PRODUCT IMAGES: PAST, PRESENT AND FUTURE

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(1) NOAA/NESDIS, (2) CIMSS

ABSTRACT

The development of atmospheric profiling products from geostationary orbit has a long and continuing history. It began at both the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin Space Science and Engineering Center (SSEC) and the NASA Goddard Space Flight Center (GSFC), following the launch of GOES-4 on September 9, 1980. GOES-4 carried VAS, the Visible and Infrared Spin Scan Radiometer (VISSR) Atmospheric Sounder. Evolving from imaging work done at GSFC and development of a physical retrieval algorithm at CIMSS, the concept of a Derived Product Image (DPI) was born. For more complete monitoring of the weather situation, DPIs emphasize: display at full horizontal resolution, animation for exploitation of the frequent geo observations, and compositing of the mutually exclusive clear and cloudy portions. Trends and gradients in moisture and stability DPI were studied during the VAS Demonstration period as well as following provision of near real-time DPI to the National Severe Storms Forecast Center (NSSFC) in Kansas City.

On April 13, 1994, the GOES-8 launch ushered in the era of 3-axis stabilized geo satellites, with separate sounders (no longer time-share the optics with Imager operations) which had more spectral channels (from 12 to 18) and an improved radiometric signal. DPI included Total Precipitable Water (TPW), Lifted Index (LI), and Cloud-Top Pressure (CTP). The DPI images built from the soundings were originally averaged over a 5x5 Field-of-View (FOV) area. With improved signal-to-noise ratio on subsequent GOES Sounders, along with development of a new GOES Sounder Merged Product System (MSPS) processing package, products are now provided to the NWS. This suite of full resolution GOES Sounder products are for use in Numerical Weather Prediction (NWP) and the National Weather Service (NWS) Advanced Weather Interactive Processing System (AWIPS). Clear-sky radiances and derived products are retrieved at every GOES Sounder pixel and delivered in the form of point retrievals in Binary Universal Form of Representation of meteorological data (BUFR) format and Derived Product Imagery (DPI). DPI improvements continue with the current GOES, for example with improved cloud masking and additional parameters.

Continued sensor improvements will lead to corresponding improvements to the DPI. While the GOES-R/S Advanced Baseline Imager (ABI) is not a sounder, it can continue current sounder-like products. This is due to the fact that both the GOES Sounder and the ABI have three broad spectral bands that are sensitive to mid-level moisture. Sample ABI-like DPI can be shown by using EUropean Organization for the Exploitation of METeorological SATellites (EUMETSAT) Spinning Environmental Visible and InfraRed Instrument (SEVIRI) data as a pre-cursor. The advent of high-spectral resolution data from the geostationary perspective will allow further improvements in the various DPIs. For example, cloud heights will be more accurate, especially for high/thin clouds, and the atmospheric stability products will be more precise. These DPI images will be demonstrated with current polar-orbiting high spectral resolution data from Infrared Atmospheric Sounding Interferometer (IASI) onboard METOP-A.

NOWCASTING OF 2M - AIR TEMPERATURE BASED ON MSG-SEVIRI AND TERRA-MODIS MEASUREMENTS

Marion Schroedter-Homscheidt[1], **Klemen Zaksek**[2]

(1) DLR, (2) University of Hamburg

ABSTRACT

Air temperature at 2 metres height above ground is measured by meteorological stations in order to understand its spatial and temporal distribution. Especially in the case of heterogeneous areas, the density of the meteorological network is often too sparse to determine an air temperature field of sufficient quality at any time for the whole area of interest. Some applications e.g. from traffic management or energy meteorology require air temperature in a high spatio-temporal resolution, partly even in near-real-time.

Thus a parameterization, which determines air temperature from remote sensing data, was developed. Since air temperature is not driven directly by the Sun but indirectly by the under-laying ground, land surface temperature was used as a proxy in many past studies. All these studies dealt with the same problem – the transfer function between the 2 metres air temperature and the land surface temperature.

The present study shows results based on SEVIRI (Spinning Enhanced Visible and InfraRed Imager) data on board the Meteosat Second Generation satellites using a parameterization based on boundary layer physical principles. Land surface temperature, albedo, downwelling surface short- and long-wave fluxes used as input parameters were processed by Land Surface Analysis Satellite Applications Facility, while wind speed information is taken from ground measurements.

As the land surface temperature varies significantly over time and space, a downscaling procedure from the SEVIRI pixel resolution to a 1000 m spatial resolution was performed using a regression analysis between the land surface temperature and normalized differential vegetation index acquired by the MODIS (Moderate Resolution Imaging Spectroradiometer) instrument.

The method was tested for central Europe for the period June to December 2005. The resulting RMSE equals 2.0 K during daytime, which is a promising result especially considering the high temporal (30 min) and spatial resolution (1000 m).

COLD-RING SHAPED STORMS IN CENTRAL EUROPE

Martin Setvak[1], Daniel T. Lindsey[2], Petr Novák[1], Michaela Radová[1], Jindrich Stástka[1], Robert M. Rabin[3], Pao K. Wang[4]

(1) Czech Hydrometeorological Institute, (2) NOAA/NESDIS/RAMMB, CIRA/CSU, (3) NOAA/NSSL, and SSEC, (4) University of Wisconsin-Madison

ABSTRACT

This presentation addresses MSG observations of Central European convective storms, which exhibit a cloud-top feature resembling a cold ring in the IR-window bands, surrounding a distinct central warm spot (CWS). The storms from 25 June 2006 above the Czech Republic and Austria are unique examples of storms with such features – not only by the magnitude and duration of the cold ring / CWS couplets, but also by storm heights as determined from radar observations. While cold-ring shaped storms are not rare, their duration is typically much shorter, and the magnitude of the cold ring is typically significantly smaller. This presentation focuses on MSG/SEVIRI observations combined with radar data.

It appears that the cold-ring shaped storms are similar to those exhibiting a cold-U or cold-V shape (also known as “enhanced-V” shape); the formation mechanism for each is similar – wake effects or a gravity wave breaking mechanism. The actual shape of the feature seems to be related to the wind shear – while cold-ring shaped storms seem to be typical for low shear environments, cold-U (V) shapes are known to be related to strong shear. Presently, we are aware of only one case which transformed from a storm with a cold ring into a storm with a distinct cold-U shape.

We also discuss the potential of the cold-ring feature as one of the indicators of storm severity. Finally, we briefly note the possible impacts of this feature on some of the cloud products of SAFNWC.

APPLICATION OF METEOSAT SEVIRI CHANNEL DIFFERENCE 0.6 - 1.6 µM IN CONVECTIVE CELLS DETECTION

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Meteorological and Hydrological Service

ABSTRACT

One of the most challenging tasks in the operational nowcasting is the early detection of potentially dangerous convective clouds. Convective cells detecting algorithms, used in the operational weather services, are frequently based on single infra-red channel data. The main advantage of such methods is their applicability during both day-time and night-time. However, due to the fact that the criteria in these methods are only cloud-top temperatures and the shape of the clouds, they have proven to be unsuccessful in many cases.

Due to the properties of visible channels, enabling the differentiation of cloud phase and particle size and giving insight into the optical depth of clouds, an attempt has been made to reinforce the automatic convection detection method by introducing data from Meteosat SEVIRI channels 0.6 and 1.6 µ m. In order to utilize properties of both channels at the same time, and to rule out the clouds which are not of the interest, difference of reflectivity in 0.6 and 1.6 µm channel is used. The properties of this difference are often used in composite images, especially in “Convective storms” RGB composite where it enables better identification of young, severe storms. High value of the difference means that reflectivity in 0.6 µm channel is very high, signalising the clouds are dense and thick, whereas the reflectivity in 1.6 µm channel is very low because of the ice particles on top of the clouds. Therefore, very high values of difference are found only at thick clouds with ice on the top, i. e. convective clouds.

On the other hand, the areas which have low reflectivity in 1.6 µm channel due to small vertical depth have also low values in 0.6 µm channel and can therefore be easily discriminated in the difference image, because the resulting difference value is small. If the threshold is set properly the difference of reflectivity in 0.6 and 1.6 µm channels can be used in automatic convective cells detection.

The differences of reflectances of the two channels were calculated for numerous cases and the results were compared to the radar reflectivity data. This comparison shows that the method suggested here enables the recognition of small developing cells almost at the same time they are seen by the radar, provided that a proper threshold is set for the difference values. This enables the early detection of convective cells in the areas not covered by radar measurements. It is also shown that the detection provided by the channel difference method is much more precise and detailed than the detection based on IR channel data. The main disadvantage of the method is the fact that it can be used only during daytime, so the night-time convection needs to be treated separately. The results of the difference method will be combined with the IR detection method into an operational product.

A CLOUD MODEL INTERPRETATION OF SATELLITE OBSERVED FEATURES ATOP SEVERE STORMS

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(1) University of Wisconsin-Madison, (2) Czech Hydrometeorological Institute, (3) NOAA/National Severe Storms Laboratory

ABSTRACT

Satellite visible and IR images of severe thunderstorms contain many special features that are potentially very useful for the nowcasting and forecasting of storm development if we can understand thoroughly the physics that cause these features. One effective way to achieve such understanding is to perform simulations of storms by numerical storm models. If the model results match the observation, then one can use model physics to interpret the physical mechanisms responsible for the observed features.

This paper will use a 3-dimensional cloud resolving model with parameterized cloud microphysics to simulate some severe storms. We will show that the model reproduced the satellite observed major visible and IR features atop severe storms fairly closely. These features include the cold-V, cold point, warm-cold couplet, distant warm area, gravity wave patterns, plumes and jumping cirrus. Both visible and infrared features will be discussed. We will show animations to demonstrate that these features can be explained satisfactorily by the model physics.

Possible applications of the findings will also be presented.

USING THE FIFTH GENERATION OF MCIDAS FOR ANALYSIS AND DISPLAY OF EARTH OBSERVATION DATA

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ABSTRACT

The next generation of the Man-computer Interactive Data Analysis System (McIDAS-V) is now freely available for use with a wide variety of Earth data analysis and visualization. Built upon the VisAD and IDV libraries, this application emphasizes the integration of disparate data types. In this presentation, I shall describe the evolution of this project and present many examples of the analysis and visualization capabilities of McIDAS-V. The capabilities, coupled with many configuration options, makes the McIDAS-V application ideally suited to both research and applications in Earth sciences, including algorithm development, case-studies, and nowcasting.

THE METEOSAT DATA COLLECTION SYSTEM, PAST, PRESENT AND FUTURE

Sean Burns

EUMETSAT

ABSTRACT

The collection and distribution of environmental data from Data Collection Platforms is one of the core services operated by EUMETSAT in support of Meteorology and Weather Prediction. It is achieved via the Data Collection and Retransmission System (DCS), which provides a relay mechanism for data transmitted from sensors located on the surface of the earth and within its atmosphere. The DCS was initially established with the first generation of Meteosat satellites, and is continued and expanded with Meteosat Second Generation.

The DCS is particularly useful for the collection of data from remote and inhospitable locations where it may provide the only possibility for data relay. Even so, the system has very many uses in regions with a highly developed infrastructure. The installations required for relay of the data tend to be inexpensive, unobtrusive and normally blend easily into the local environment.

Similar Data Collection Systems are operated by NOAA, JMA and CMA.

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Most recently the Meteosat DCS has been operated in support of Tsunami Warning Systems in the Indian Ocean using Meteosat-6.

This paper will present a brief history of the Meteosat DCS, the major operational programmes supported by the system, the future plans for DCS including Meteosat Third Generation and High Bit Rate DCPs.

STANDARDIZED DATA ACCESS SERVICES FOR GOME-2/METOP ATMOSPHERIC TRACE GAS PRODUCTS

Torsten Heinen[1], **Bernhard Buckl**[1], **Thilo Erbertseder**[1], **Stephan Kiemle**[1], **Diego Loyola**[2]

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ABSTRACT

Within the distributed EUMETSAT EPS ground segment, DLR acts as an integral part of the Ozone and Atmospheric Chemistry Monitoring Satellite Application Facility (O3M-SAF) for the processing, archiving and delivery of GOME-2 atmospheric products providing the total column density of different trace gases such as O3, NO2, BrO, SO2, OClO and HCHO, as well as cloud properties. Based on the continuous reception of GOME-2 level 1B data, different processing chains are triggered for the generation and dissemination of level 2 and value added products in near-real-time and off-line.

Recognizing the importance of interoperability and harmonized access to geospatial information, the German Remote Sensing Data Center (DFD) introduces standardized service-oriented data access to GOME-2 atmospheric products within DLR's multi-mission earth observation ground segment facility. These new user services extend the already established data services provided by DLR in the O3M-SAF and the World Data Center for Remote Sensing of the Atmosphere (WDC/RSAT) in order to support the concept of Spatial Data Infrastructures (SDI) on different levels and contribute to European initiatives such as 'Heterogeneous Mission Accessibility' (HMA/ESA) and 'Global Monitoring for Environment and Security' (GMES/EU).

Concerning GOME-2-based air quality products the requirements for individual and customized applications are increasing. Users ask for defining and displaying their own area of interest from regional to urban scales and analysing the data by combining it with information on population density, land use, administrative boundaries and traffic density to name a few. These requirements are crucial when e.g. exceedance levels of air pollutants are quantified and statistically analysed.

This paper shows how these requirements can be addressed using service-oriented data access and presents the extension of DLR's existing multi-mission web gateway EOWEB® with OGC Web Map Service (WMS) and Web Coverage Service (WCS) compliant interfaces. In this way the GOME-2 trace gas products are easily accessible not only for scientific applications, but they can be seamless integrated into processing systems, GIS environments widely used in applications areas like aviation control and air quality monitoring as well as popular virtual globe software such as NASA World Wind, Google Earth and Microsoft Virtual Earth.

PLANS FOR EVOLUTION OF EUMETSAT OPERATIONAL SERVICES FROM METEOSAT, METOP AND JASON-2.

Mikael Rattenborg

EUMETSAT

ABSTRACT

Within the last 18 months, EUMETSAT has completed the migration to the second generation Meteosat system and started operations of the advanced polar-orbiting Metop-A satellite and will at the end of 2008 start operations of the Jason-2 ocean monitoring satellite together with its partners. The enhanced capabilities of these satellites have opened up new areas of application and new possibilities for enhanced services. The paper will present the plans for the evolution of the EUMETSAT operational products and services over the coming years to meet the needs of users in existing and emerging application areas.

EVOLUTION OF THE EUMETSAT ADVANCED RETRANSMISSION SERVICE (EARS)

Anders Meier Soerensen[1], **David Lee**[2], **Christelle Ponsard**[2]

(1) EUMETSAT, (2) MOLTEK

ABSTRACT

The EUMETSAT Advanced Retransmission Service (EARS) is providing data from polar orbiting meteorological satellites to more than a 1000 users with a data timeliness of 10 to 30 minutes. EUMETSAT is currently in the process of defining the future specification and evolution of the EARS services including additional instruments, satellites and geographical coverage. At the same time EUMETSAT is investigating ways to mitigate the current unavailability of the Metop-A HRPT data stream.

This paper presents the proposed evolution of the EARS services as well as the status of the measures taken to minimise the impact on the EARS services of the Metop-A HRPT unavailability.

The currently defined services consist of EARS-ATOVS, EARS-AVHRR and EARS-ASCAT. The new services being considered for the future evolution include EARS-IASI and selected instruments from the FY-3 polar orbiting satellites.

METOP DATA RECOVERY FROM ANTARCTICA AN UPDATE ON EUMETSAT AND NPOESS COOPERATION TO REDUCE METOP DATA LATENCY

Peter Wilczynski

NOAA/NPOESS PEO

ABSTRACT

In June 2006, NPOESS completed a U.S. Government mandated certification process known as the "Nunn-McCurdy" process. This process restructured NPOESS in many key ways. The government document generated from that process, which solidified the new NPOESS program, is known as an Acquisition Decision Memorandum (ADM). The ADM formally provides NPOESS new guidance to continue the program with fewer satellites, maintaining the original requirements and providing operational and scientific data continuity. The ADM cites that NPOESS is a "two-orbit rather than a three-orbit program that uses data from Europe's METOP satellites for the mid-morning orbit…" The ADM requested that the NPOESS Program Executive Office (PEO) develop a plan to use METOP from the third orbit and develop a plan to achieve the originally planned NPOESS capability in that orbital plane. The PEO determined that a reduction in METOP data latency would be the most significant step forward in an "NPOESSS-like" capability for METOP in that orbital plane. The PEO and NOAA NESDIS met with the Eumetsat Director General (DG) in March 2006 to determine if METOP operations would support data collection in Antarctica. The Eumetsat DG indicated he would support METOP data collection in Antarctica. NOAA NESDIS wrote a formal letter of intent in October 2007. In December 2007, Eumetsat wrote NOAA NESDIS that the Eumetsat Council approved going forward with METOP data collection in Antarctica in support of U.S. and European weather data users.

A joint PEO (NOAA)-Eumetsat Working Group was formed in June 2007 to develop a comprehensive plan based on requirements, to implement METOP data collection in Antarctica by 2010-11. This group has met monthly since August 2007. A draft plan has been developed to install a new data recovery capability for METOP at the U.S. McMurdo Station in Antarctica. This paper will discuss the key elements of this plan, a status update and an overview of the implementation schedule.

ATMOSPHERIC SOUNDING WITH IMAGING FTS: DESIGN AND PERFORMANCE OF AN AIRBORNE PRECURSOR

Felix Friedl-Vallon

Forschungszentrum Karlsruhe

ABSTRACT

Limb and nadir sounding with imaging Fourier transform spectrometers is a scientifically promising advancement of current techniques applied to atmospheric science. With the advent of fast and sensitive large focal plane arrays in the thermal infrared region it is also a technically feasible option for the next generation of atmospheric sounders (e.g. MTG).
An airborne precursor for future satellite instruments of this class is currently developed by the research centres Karlsruhe and Jülich. The first deployment of the instrument will be on the new German research aircraft HALO. First scientific missions are planned for the second half of the year 2009.
The presentation will summarise theoretical and experimental work done in the context of the development of the GLORIA-AB (GLObal Radiance Imager for the Atmosphere - AirBorne version) sensor. It will discuss design considerations and challenges for such an instrument, describe the solutions found and present laboratory figures of merit for the prototype instrument.
These results will be reviewed in the context of the requirements for satellite sensors.

AN IMPROVED ASSESSMENT OF THE TROPICAL HUMIDITY-TEMPERATURE RELATIONSHIP FROM COMBINED AIRS AND IASI DATA

Antonia Gambacorta[1], Christopher Barnet[2], Walter Wolf[2], Mitchell Goldberg[2], Brian Soden[3], Larrabee Strow[4]

(1) UMBC/NOAA, (2) NOAA, (3) University of Miami , (4) UMBC

ABSTRACT

The relationship between water vapor and temperature has been the focus of several studies in the past. These efforts have focused on tropical averages of monthly anomalies of water vapor and temperature measurements and have led to an overall disagreement on the strength of the water vapor dependence on local temperature variations, particularly in the middle and upper troposphere. They have also highlighted the inadequacy of sparse and inhomogeneous radiosonde datasets or low vertical resolution satellite retrievals, to accurately characterize this correlation.

A recent study, by Gambacorta et al., (paper in submission) has exploited the high resolution and uniform spatial coverage of the Atmospheric InfraRed Sounder (AIRS) data to reveal large spatial gradients in the horizontal and vertical structure of the covariance between water vapor and temperature in the tropical troposphere. These results emphasize the importance of relative humidity changes when considering regional responses of water vapor to surface warming and illustrate the value of satellite observations for accurately quantifying this behavior. In this paper, we present a more detailed analysis which combines retrieval profiles from both AIRS and the Infrared Advanced Sounder Instrument (IASI).

Launched into orbit on May 4, 2002 and October 19, 2006 respectively, AIRS and IASI are on board of two polar-orbiting satellite systems, (1:30 am orbit for AIRS; 9:30 am orbit for IASI). By employing the same inversion algorithm for both AIRS and IASI, and by exploiting the combined scanning geometry of the two instruments, an unprecedented temporal and spatial resolution in the global monitoring of temperature and water vapor distributions is possible. This will enable a closer investigation of the rapidly variable tropical water vapor and temperature distributions, and a more comprehensive understanding of the mechanisms regulating the strength and spatial patterns of the temperature-water vapor co-variance in the tropical region.

Updated results will be shown at the conference.

RAW SAMPLING DATA FROM GRAS

Christian Marquardt, Yago Andres, Axel von Engeln, Francisco Sancho

EUMETSAT

ABSTRACT

Eumetsat's Metop-A satellite is the first of a series of three polar-orbiting, meteorological satellites that are planned to provide 14 years of advanced meteorological and climate observations. Among other instruments, Metop carries the "GNSS Receiver for Atmospheric Sounding" (GRAS) exploiting radio occultation soundings of the atmosphere. GRAS is the first GPS receiver custom build for radio occultation soundings from space; it currently provides about 600 rising and setting occultations per day.
GRAS exhibits a "raw sampling" (or open loop) measurement mode dedicated to lower tropospheric observations. Here, radio occultation signals undergo strong amplitude fluctuations caused by atmospheric multipath, which cannot be tracked correctly by the the phase-locked tracking loops usually implemented in GPS receivers. In order to nevertheless exploit measurements from this part of the atmosphere, GRAS switches into a measurement mode in which the raw electromagnetic GPS signal is sampled at a high frequency (1 kHz). This happens towards the end of setting occultations as well as at the beginning of rising occultations.

We will discuss the basic characteristics of the raw sampling mode of GRAS and present initial results from the analysis and processing of this type of data.

USING AEROSE-DOMAIN SEVIRI AND IASI DATA FOR SOUNDING PRODUCTS FROM THE GOES-R ADVANCED BASELINE IMAGER

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ABSTRACT

The Advanced Baseline Imager (ABI) to be flown on the GOES-R series (Schmit et al., 2005) will have a set of 10 narrowband infrared channels suitable for continuing GOES legacy sounding products, namely vertical temperature and moisture profiles, total precipitable water (TPW), surface skin temperature, and atmospheric stability indices. Retrieval algorithms for these products are currently under development by the GOES-R Algorithm Working Group (AWG) Soundings Application Team (SAT). To facilitate the development, validation and demonstration of the proposed ABI sounding products, we have built a large, ocean-based, empirical proxy-dataset, that is, one based upon actual satellite measurements taken over the tropical Atlantic, as opposed to radiative transfer model simulations. Our proxy dataset is unique in that the satellite measurements will be supplemented by ship-based measurements acquired at sea during several trans-Atlantic Aerosol and Ocean Science Expeditions (AEROSE) (Morris et al., 2006). The AEROSE campaigns include the most comprehensive collection of *in situ* measurements of the Saharan air layer (SAL) and associated dust outflows over the tropical Atlantic. The AEROSE shipboard data complement includes Vaisala rawinsonde observations (RAOBs) (Nalli et al., 2005), ozonesondes, calibrated IR spectra and high accuracy sea surface skin temperature (skin SST) from Marine Atmospheric Emitted Radiance Interferometers (M-AERI) (Minnett et al., 2001), Microtops sunphotometers, micropulse lidar (MPL) and ceilometer. We have collected satellite data within the AEROSE space-time domains [10S, 35N; 80W, 10W], rather than merely at the ship locations/times, so that dynamical features over the tropical Atlantic (e.g., SAL, dust outflows, tropical convection, etc.) can be observed and studied. These include data from the Spinning Enhanced Visible and Infrared Imager (SEVIRI) onboard Meteosat in GEO orbit (Schmetz et al., 2002), and the Infrared Atmospheric Sounding Interferometer (IASI) (e.g., Cayla, 1993) onboard MetOp-A and Atmospheric Infrared Sounder (AIRS) onboard Aqua (e.g., Aumann et al., 2003), both in LEO orbit. The multi-year AEROSE datasets will be extremely useful for studying the impact of GOES-R for observing these and other interesting mesoscale and synoptic scale phenomena over the Atlantic Ocean. In this preliminary work, we present some initial SEVIRI, IASI and AIRS retrieval validation results based upon radiosonde matchup locations obtained during the AEROSE campaigns.

DETERMINATION OF ATMOSPHERIC DYNAMIC CHARACTERISTICS FROM SATELLITE SOUNDING DATA

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ABSTRACT

A method of determining atmospheric dynamic characteristics based on multi-wave passive satellite sounding data has been developed. The method makes it possible to simultaneously determine not only the vector of horizontal wind speed (**V)** but also the effective coefficient of horizontal mesoscale diffusivity (K_d) and vorticity (rot **V**). The diffusivity coefficient has not been determined earlier on the basis of satellite data. The values of K_d calculated with the use of satellite data for different atmospheric situations were compared with the theoretical ones. It is shown that for the turbulence scales of 20 km ≤ r ≤ 300 km mean values of K_d calculated from the data of water vapor channels of the radiometer SEVIRI (6.2 and 7.3 μm) agree well with the Richardson-Obuhov and Golitsyn classical theoretical dependencies $K_d(r)$.

With the use of numerical data of atmospheric soundings made by the radiometer SEVIRI from geostationary European meteorological satellites Meteosat-8 and Meteosat-9 the characteristics of atmospheric motions in the middle and upper troposphere in the zones of hazardous atmospheric phenomena – tropical cyclones (TC) and jet fluxes were studied in detail. The calculation results obtained with the data of water vapor channel of the radiometer SEVIRI have shown that the spatial distribution of K_d has distinctly seen peculiarities relatively to the trajectory of a tropical cyclone: local maxima of K_d are located to the right and to the left of the trajectory, and the minima – along the trajectory. The minimal and maximal values of K_d differ by 5 – 7 times. The connection of peculiarities of the spatial distribution of K_d with the structural parameters of tropical cyclones was analyzed.

A comparison of the calculated fields of **V** and K_d with the data of baric topography maps was made. A good agreement for both the location of jet flux zones in the troposphere (the layer of 200 – 400 hPa) and the wind speeds in them was obtained. The locations of calculated regions of maximal K_d values coincide with the zones of enhanced turbulence indicated on the maps. The calculated maximal values of K_d are by 7 – 10 times higher than the background values of K_d. This makes one think that the method used by us gives a possibility to reveal from satellite data zones of enhanced turbidity hazardous for aviation and to obtain for them quantitative horizontal diffusivity factors.

The work was made under the financial support of the Russian Foundation for Basic Research (Project No. 06-05-64317 and No. 06-05-64275).

ERROR ASSESSMENT AND VALIDATION OF THE IASI TEMPERATURE AND WATER VAPOR PROFILE RETRIEVALS

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ABSTRACT

The Infrared Atmospheric Sounding Interferometer (IASI) Level 2 products comprise retrievals of vertical profiles of temperature and water vapor. The L2 data were validated through assessment of their error covariances and biases using radiosonde data for the reference. The reference radiosonde data set includes dedicated launches as well as the ones performed at regular synoptic times.

For optimal error estimate the linear statistical Validation Assessment Model (VAM) was used. The model establishes relation between the compared satellite and reference measurements based on their relations to the true atmospheric state. The VAM utilizes IASI averaging kernels and statistical characteristics of the ensembles of the reference data to allow for finite vertical resolution of the retrievals and temporal non-coincidence.

The paper presents the validation results for different geographical locations and discusses potential use of the estimated error covariances for applications such as NWP, satellite intercalibration, and Earth System studies.

FIRE DETECTION AND MONITORING OVER AFRICA

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ABSTRACT

Biomass burning is a significant global source of greenhouse gases (e.g. carbon dioxide and methane) as well as of nitric and carbon monoxides, methyl bromide and hydrocarbons that lead to acid rain and the photochemical production of tropospheric ozone and destruction of stratospheric ozone which impact global climate. Other impacts of biomass burning relate to the biogeochemical cycling of nitrogen and carbon compounds, the hydrological cycle, the reflectivity and emissivity of the land, the stability of ecosystems and ecosystem biodiversity.

The potential of the SEVIRI instrument on-board the MSG series for applications related to fire detection and monitoring has long been recognized. We present an operational procedure for active fire detection based on information from Meteosat-8/SEVIRI, which is currently being developed within the framework of the Satellite Application Facility on Land Surface Analysis (LSA SAF). The procedure primarily relies on information from MSG channels (namely the 0.6 μm, 0.8 μm, 3.9 μm, 10.8 μm and 12.0 μm) together with information on illumination and viewing angles. The method is based on contextual algorithms that have been successfully developed for different sensors, namely GOES, NOAA-AVHRR and MODIS. A potential fire pixel is compared with the neighbouring ones and the decision is made based on relative thresholds as derived from the pixels in the neighbourhood. The algorithm is self-adaptive and has shown consistency over large areas and throughout the seasons.

We will present an overview of results obtained for 2007 and the first half of 2008, paying special attention to the duration of wildfires as well as to daily cycles of wildfire activity over different regions and for different types of land cover. Quality of results will be assessed by means of a set of tests applied under various conditions and to different ecosystems and by comparing obtained results with those from other sources, namely; i)the GOFC/GOLD (Global Observations of Forest Cover and Land Cover Dynamics) Fire Program project, ii) the MODIS fire and thermal anomalies products, iii) the AFIS (Advanced Fire Information Service) from the CSIR-Meraka Institute (South Africa) and iv) the Active Fire Monitoring (FIR) product from EUMETSAT. Finally, we will discuss potential applications of the developed product, paying special attention to aspects that relate to fire radiative power and carbon emissions.

MAPPING THE DAILY RISK OF FIRE IN CONTINENTAL PORTUGAL

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ABSTRACT

Wildfires are a major concern in Europe, especially in Mediterranean countries, where warm and dry spring and summer conditions may lead to high levels of vegetation stress. During summer months, Mediterranean countries suffer frequent large-scale fire episodes with dramatic consequences for the ecosystems and population but late winter and spring fires should not be disregarded in some southern European areas. This is particularly true in Continental Portugal where time series of burnt area show a positive trend since the early 80's together with a large inter-annual variability. Whereas the observed increase in burnt area is partially attributable to changes in farming and land use, inter-annual variability is partly due to temperature and precipitation conditions in the preceding late spring season and partly to the occurrence of atmospheric circulation patterns of short-duration that induce extremely hot and dry spells over western Iberia.

We describe an operational procedure for assessing fire risk in Continental Portugal on a daily basis and at the local level. The procedure is currently being developed within the framework of the Satellite Application Facility on Land Surface Analysis (LSA SAF) and consists of the following three main steps; i) characterising the background conditions associated to the heat and water stress of vegetation according to the late spring hydro-meteorological regime, ii) characterising on a daily basis the meteorological conditions that favour the onset and propagation of wildfires during the fire season, and iii) evaluating the spatial distribution of fire risk taking into account both background and meteorological conditions together with the structural risk at the local level.

Heat and water stress of vegetation is evaluated by means of statistical models that relate the amount of burnt area during the fire season with averages of relevant meteorological parameters (e.g. temperature and precipitation) over late spring. The impact on vegetation of meteorological conditions is evaluated based on information provided by the Canadian Fire Weather Index (FWI). Structural risk is finally assessed by means of a set of variables related to long-term fire hazard that range from fuel structure and terrain characteristics to human activities and climate variability.

We will present and discuss results that were obtained on an experimental basis during the fire season of 2007, which was characterised by an extremely low level of fire activity. Results for the fire season of 2008 will also be presented and discussed. We conclude by showing how this new line of research within the LSA SAF may be viewed as an adequate response to more general demands on environment monitoring and risk management (in particular, to GMES requirements).

LAND SURFACE EMISSIVITY RATIONALE FOR A VALIDATION PROGRAMME

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ABSTRACT

The last years have seen a growing interest for reliable estimates of land surface emissivity (LSE), which is partly attributable to the fact that LSE is a key parameter both for the correct assessment of surface energy budget (e.g., in NWP, climate and SVAT models), and for an accurate retrieval of surface and low-troposphere variables from remote-sensed information over land. For instance, the impact of uncertainties in LSE on the quality of land surface temperature (LST) as retrieved from satellite data is especially strong in the case of dry atmospheres, a feature of the atmospheric column that is commonly observed over arid and semi-arid zones where LSE is poorly known, when based on information about soils and vegetation cover.

LSE maps for SEVIRI on-board METEOSAT are currently being derived on an operational basis within the framework of the Satellite Application Facility on Land Surface Analysis (LSA-SAF). The procedure is based on the so-called Vegetation Cover Method (VCM), using Fraction of Vegetation Cover (FVC), as main input. VCM makes use of a look-up-table developed for spectral emissivities, taking into account the response function of each of the SEVIRI channels considered, together with laboratory reflectance spectra of different types of surface objects such as vegetation, water, soil, rocks and manmade materials. A quality control is performed taking into account variability of LSE within each surface type and channel, and relative error values in the FVC parameter.

Validation and quality control of LSE is however a particularly difficult task. There is no network of ground-based measurements of LSE and taking into account the spatial variability in LSE within a given pixel, validation of LSE at the scale of the pixel may not be feasible if solely based on a direct comparison with in-situ point measurements, due to the scale mismatch between ground point measurements (3 to 50 cm) and the SEVIRI resolution (about 5 km). Other approaches to validation may be envisaged, namely those involving an inter-comparison of obtained retrievals with estimates that rely on the so-called “physical methods”, which allow a simultaneous retrieval of LSE and LST. This is the case of the Two Temperature Method that is currently applied on a non-operational basis to retrieve LSE-LST pairs from SEVIRI data over selected regions. However other estimates of LSE-LST pairs based on different physical methods are currently available, e.g. those from MODIS data by means of the Day/Night Method and ASTER data by means of the Temperature-Emissivity Separation (TES) algorithm. We will show how a synergic usage of different estimates of LSE may contribute i) to improving the validation of the LSE product of the LSA SAF, ii) identifying regions where estimates are less reliable, iii) getting better LSE maps based on VCM.

This work was performed within the framework of the LSA-SAF, co-funded by EUMETSAT.

GLOBAL MONITORING OF ANNUAL VEGETATION CYCLES USING DOAS UV/VIS SATELLITE OBSERVATIONS

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ABSTRACT

Vegetation-cycles are of general interest for many applications. Be it for harvest-predictions, global monitoring of climate-change or as input to atmospheric models. From novel spectrally resolving UV/vis satellite instruments (like GOME of SCIAMACHY) the spectral signatures of different types of vegetation can be identified and analysed using the DOAS technique. Although the spatial resolution of GOME and SCIAMACHY observations is much coarser than those of conventional satellite instruments for vegetation monitoring, our data sets on different vegetation types add new and useful information, not obtainable from other sources. We present the seasonal variation of vegetation for the time period 1996-2003 on a global scale and compare our results to other satellite data sets. We discuss the average seasonal variations as well as specific anomalies found in different years. Our data set will be extended using measurements of the GOME-2 series; this will allow retrieval of continuous time series for vegetation and land-use applications of more than 12 years.

ESTIMATION OF ONSET, CESSATION AND LENGTH OF GROWING SEASON IN THE GUINEA SAVANNAH ZONE OF NIGERIA USING RAINFALL AND NDVI SATELLITE DERIVED DATA

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ABSTRACT

This study examines the onset and cessation of rainfall and normalized difference vegetation index (NDVI) otherwise known as greenness, and also the time lag between the onset of rainfall and that of greenness and their respective cessations. The onset and cessation of greenness were determined from the mean dekadal analyses of NDVI using Advance Very High Resolution Radiometer (AVHRR) data for some meteorological stations across Nigeria.

The analyses were carried out for seven (7) stations in the Guinea Savannah zone of Nigeria for a period of twenty-one (21)years (1981 – 2001) from which the time lag between the onsets of rainfall and NDVI was revealed and there respective cessations. It also derived the growing days, growing seasons, rates of green-up and senescence. It also showed a good relationship between the values of NDVI and that of rainfall.

This study has shown how applicable the satellite-derived NDVI can be used in the estimation of onset and cessation of greenness, rate of green-up and senescence thereby making it an important tool in vegetation study.

A number of recommendations are made that would help to upgrade the methodology as an effective tool for vegetation study. These include integrating NDVI with other socio-economic and bio-physical indicators like GIS and complementing satellite data with other parameters in specific climatic zones, for each season and vegetation type.

THE OPERATIONAL MSG/SEVIRI FIRE RADIATIVE POWER PRODUCTS GENERATED AT THE LAND SAF

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ABSTRACT

Biomass burning is globally significant source of trace gases and aerosols and a major mechanism controlling both land-cover change and exchanges of carbon between the land and atmosphere. Quantitative estimates of biomass burning emissions are required for many earth science applications, including for operational forecasting of atmospheric state, where such data are required in close to real-time. This is possible only via a satellite remote sensing approach, ideally utilising the high temporal frequency available from geostationary orbit. This work describes new European Fire Radiative Power products that has been developed to meet these requirements, and which includes both repetitive detection of actively burning fires at 15 minute intervals (thus allowing analysis of the complete biomass burning diurnal cycle) and quantification of the fires radiative power output (which has been shown to relate closely to the rate of fuel consumption and thus trace gas, carbon and aerosol emission). The FRP products are derived from multi-spectral observations provided by the Meteosat SEVIRI imaging radiometer, including all fire-affected regions of Africa, Europe and part of eastern South America. Two product versions are delivered operationally to users by the Land Surface Analysis Satellite Applications Facility (http://landsaf.meteo.pt/), a pixel-level product made available at the full spatio-temporal resolution of the original SEVIRI observations, and a gridded “integrated” product available at hourly time-steps at a reduced spatial scale. This latter product includes corrections due to the presence of clouds and undetected small fires. This work details examples of the information content, performance characteristics and accuracy of both product types, and provides examples of their use in delineating major biomass burning events and patterns in the main fire-affected areas covered. It is anticipated that these products will provide valuable input to a variety of earth science applications, including real-time forecast models linking pollutant emissions from fires to models of atmospheric chemistry and transport.

VALIDATION ACTIVITIES PREPARATION FOR SMOS (SOIL MOISTURE AND OCEAN SALINITY) LAND PRODUCTS AT THE VALENCIA ANCHOR STATION

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ABSTRACT

Since 2001, the *Valencia Anchor Station* is being used for validation activities in the context of low spatial resolution Earth Observation Missions such as CERES (*Clouds and the Earth's Radiant Energy System*) and GERB (*Geostationary Earth Radiation Budget*), and is also being prepared for the SMOS (*Soil Moisture and Ocean Salinity*) Mission. All these missions have in common the low spatial resolution of their respective footprints (roughly of the order of 40 x 40 km^2) and the necessity to count on a well characterised and instrumented large scale area (http://www.uv.es/elopez).

The *Valencia Anchor Station* has been selected as a primary validation site by the SMOS Mission. The reasonable homogeneous characteristics of the area make this site appropriate to undertake the validation of SMOS Level 2 land products (soil moisture content and vegetation water content) during the *Mission Commissioning Phase*, before attempting more complex areas.

A control area of 10 x 10 km^2 has been chosen where a network of ground soil moisture measuring stations is being set up based on the definition of homogeneous physio-hydrological units attending to climatic, soil type, lithology, geology, elevation, slope and vegetation cover conditions. These stations are linked via a wireless communication system to a central post accessible via internet. They are also being used to study the correlation between soil moisture and the *Temperature-Vegetation Dryness Index* (TVDI) obtained from remote sensing data, which will allow us to produce soil moisture maps for the whole control area. These area soil moisture estimations will also be compared to modeling products both from ISBA – SURFEX and from HIRLAM.
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OPERATIONAL LAND SURFACE ALBEDO DERIVED FROM METEOSAT SECOND GENERATION AND METOP OBSERVATIONS

Jean-Louis Roujean, Olivier Hautecoeur, Dominique Carrer, Bernhard Geiger, Laurent Franchistéguy, Catherine Meurey

Météo-France

ABSTRACT

The European Meteorological Satellite Organization (EUMETSAT) maintains a number of decentralized processing centers dedicated to different scientific themes. The Institute of Meteorology (IM) of Portugal is the host of the Satellite Application Facility on Land Surface Analysis (Land-SAF). The LSA SAF program provides a mean to constrain the model representation of the climate trend as a consistent production of data sets guaranteed until at least 2019 with the forthcoming MSG-3 mission. Its objective is to provide added-value products for the meteorological and environmental science communities with main applications in the fields of climate modeling, environmental management, natural hazards management, and climate change detection. Since 2005 data from Meteosat Second Generation satellite are routinely processed in near real time by the Land-SAF operational system, which is located on the premises of IM. Presently, the delivered operational products comprise land surface albedo and temperature, short-wave and long-wave downwelling radiation fluxes, and snow cover. Within the project consortium Météo-France is responsible for the development of several products, of which one is the daily surface albedo product. After about seven years (1999-2007) of research, development, and progressive operational activities, a summary of the validated MSG surface albedo product characteristics and performances is presented after one year of the Continuous Development and Operational Phase that will end in 2012. It is worth mentioning that MSG albedo is now produced for the whole disk, with most recent maps generated for Africa and South America. In particular, we will show first results of an advanced albedo product resulting from merging data between the polar satellite MetOp and the MSG-2 geostationary satellite data. In addition to the presentation of the SAF-Land project, it is discussed that the retrieval of the surface albedo cannot be dissociated from the retrieval of the Aerosol Optical Thickness (AOT). An experimental method of simultaneous albedo and AOT daily retrieval is presented.

ACTIVE FIRE MONITORING OVER BULGARIA: VALIDATION OF SEVIRI FIR PRODUCT

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ABSTRACT

Wild fires burned several hundred thousand hectares in South-Eastern Europe during 2007 that caused substantial economic losses and ecological damages in Bulgaria. Regarding fire prevention at a national level, Meteosat SEVIRI Active Fire Monitoring (FIR) product, available since February 2007, is considered as potentially useful in providing early warning and high frequency monitoring. Concerning with this, the current study is aimed to evaluate the performance of SEVIRI FIR product during the fire situation over Bulgaria in July and August 2007 when the wild fires developed in cloud-free scenes, helping to follow their evolution by satellites.

Thermal anomalies reported by Meteosat FIR product were validated by using ground-based fire monitoring data provided by State Forest Agency of Bulgaria that include information for approximate location of fires and their evolution, area affected (total, under/at the forest canopy), fire rescue operations, etc. This dataset is used in assessing the ability of SEVIRI FIR algorithm to detect signals from actual fires. The results show that FIR threshold algorithm is not efficient in detecting small fires up-to 10 ha at forest canopy, as well as in using during the night.

Another approach was applied with the aim to verify SEVIRI FIR product's ability to identify the exact fire location by comparison with another satellite system with higher resolution as well as of known level of accuracy. For that purpose, data for Fire and Thermal Anomalies Product based on MODIS instrument on board of Aqua and Terra polar orbiting platforms kindly provided by NASA are used. The comparison between the two systems is performed for the month of higher fire activity. Only MSG slots for which there are corresponding in time MODIS satellites overpasses are considered. SEVIRI detected 1139 fire pixels over Bulgaria with 4.8 % of them during the night, while MODIS reported 14.1% cases of thermal anomalies in night Meteosat slots. Some of the MODIS thermal anomalies, related to actual fires are detected by SEVIRI in previous/next MSG slots, but there is no SEVIRI signal in the specific slots, corresponding to the MODIS overpasses. A systematic displacement between the fire locations is seen in 86 % of the cases of matching between MODIS and SEVIRI fire pixels: Pixel classified as fires by SEVIRI algorithm are located 5-10 km to the north-west of the fire location detected by MODIS. This result was reported and after a detailed investigation, an Anomaly Report has been raised at EUMETSAT to deal with this problem.

It is concluded that incorporation of refine contextual and threshold fire detection algorithms, which accounts the variable Meteosat pixel size could offer increased sensibility to smaller, cooler fires for South-Eastern Europe and for the night period. Considering the need of a balance between improving and validating FIR product, NIMH Bulgaria intends to further evaluate in 2008 the performance of the FIR algorithm, which is under revision by EUMETSAT especially for the Mediterranean area and aiming to be used in the Meteosat-8 Rapid Scanning Service.

APPLICATIONS OF THE 8,7 ÌM SEVIRI SENSOR

Henk Verschuur

EUMETSAT

ABSTRACT

The 8,7 µ m channel has very specific emissivity properties. Especially for sandy surfaces and for sulphur dioxide the difference is remarkable from other surfaces. Also the difference in emissivity of the water phase allows distinguishing between water and ice clouds. Cloud studies can also profit from the emmissivity properties of the size of water and ice particles. This applies also for research on volcano activities as emissivity of volcanic ash depends on the particle size of volcanic ash.

It is interesting to notice that the IPCC considers the current level of scientific understanding of organic and black carbon burning, biomass burning, mineral dust, aerosol indirect effect, and aviation contrails as relatively low. It is remarkable that the 8,7 µ m channels can play a major role in research in these areas if combined with other channels.

A summary of the most important applications which can profit from the 8,7 µ m channel is: desert monitoring, dust studies, volcanic ash and SO2 activities, coal and gas burning, industrial accidents, cloud phase detection including fog and low stratus detection.

The MSG SEVIRI instrument is unique as it senses in the1,6 µ m, 3,9 µ m and the 8,7 µ m, additional to the other, more traditional, channels. It is recommended to include the 8,7 µ m in future satellite instruments.

THE GLOBALISATION OF TRAINING IN THE APPLICATION OF METEOROLOGICAL SATELLITE DATA

Gordon Bridge, Volker Gaertner

EUMETSAT

ABSTRACT

With the regular use of the Internet and Teleconferencing systems for the delivery of training resources to student groups, there is an opportunity for a more globalised approach to both the preparation and delivery of such resources. This presentation will summarise current practice employed by EUMETSAT, based upon collaboration with various training partnerships in Europe, Africa and South and North America and will then, based upon an updated, long term EUMETSAT Strategy for training in the application meteorological satellite data, summarise proposals for a more global extension of this collaboration to partners operating similar satellites in other regions of the world, with the key objective of pooling and making more cost effective use of resources as they are developed.

USE OF WEATHER EVENT SIMULATION IN TRAINING

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ABSTRACT

Training by doing has always been recognized as one of the most effective educational techniques available, and has been employed in various ways for many years in the training of meteorologists. Modern workstations offer enormous potential for employment of this training technique, and for blending it with other training methods and approaches. A Weather Event Simulator is under development for use with the Ninjo workstation which, when complete, will deliver state-of-the-art ability to capture and replay weather event information. The Meteorological Service of Canada (MSC) is presently developing methodologies for integrating this capability into its training framework, and combining its use with other successful training initiatives. The results are expected to be very effective in meeting the challenges of replacing lost experience due to retirements, guiding the changing role of the operational forecaster, validating emerging scientific techniques, and of course, delivering very effective training. This talk will discuss some of the uses under development of the Weather Event Simulator and its integration into other training initiatives and methodologies in the MSC.

THE ROLE OF BLENDED LEARNING METHODS FOR EUMETSAT□S TRAINING ACTIVITIES

Volker Gaertner

EUMETSAT

ABSTRACT

At the latest since the launch of Metop in October 2006 EUMETSAT is faced with the challenge to reach users in all parts of the world. This goal can only be achieved in cooperation with relevant training partner organisations at the national and international levels. To be successful in this endeavour the use of efficient combination of distant learning tools together with a minimum number of classroom courses has to be further promoted and coordinated amongst the involved partners. The talk will outline the benefit of blended learning courses for the efficient implementation of EUMETSAT's training strategy.

COMPREHENSIVE TRAINING WORKSHOPS FOR INTERNATIONAL DIRECT BROADCAST USERS

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ABSTRACT

Since 2004 SSEC/CIMSS has conducted international direct broadcast (DB) training workshops centered around the DB receiving countries/sites. So far six (6) DB workshops have been conducted at Perth/Australia, Nanjing/China, Beijing/China, Chung-Li/Taiwan, Andoya/Norway and Pretoria/South Africa. One additional workshop under the GEOSS initiative was conducted at Cachoeira Paulista/Brazil. These workshops focus on the complete end-to-end processing of the data into geophysical products. Basic remote sensing principals, algorithm theory, and limitations and applications of the products are taught in lectures followed by hands-on computer laboratory exercises. The user friendly visualization software tool HYDRA is freely distributed for students in the class room and allows examination of data and products at the pixel level for the purpose of manipulating and interrogating DB measurements, imagery, and products.
SSEC/CIMSS is devoted to continue this kind of training workshop tailored for the international DB community as part of an ongoing effort to maintain and expand the use of the International MODIS/AIRS Processing Package (IMAPP), and in preparation for the development of the future International Polar Orbit Processing Package (IPOPP) for the National Polar-orbiting Operational Environmental Satellite System (NPOESS).

MODERNISATION OF FORECASTER'S TRAINING AT BTZ LANGEN

Wilfried Jacobs, Hans Bauer

Deutscher Wetterdienst

ABSTRACT

The Meteorological Training and Conference Centre (BTZ) in Langen is the main venue for the training of DWD's staff and also for special national and international seminars. All training seminars are now based on the new visualization software NinJo (New integrated JAVA application).

BTZ is going to intensify its use of self-learning in basic and further training to make repetition of content more attractive and to improve retaining facts in memory. Self learning modules will enable all participants to have a similar level of background knowledge at the beginning of training courses. So during the training we can concentrate on the most relevant aspects and the seminar length can be shortened.

National Meteorological Services are participating in national and international projects to share resources. Together with DFS, the Deutsche Flugsicherung GmbH, we develop self-learning modules for weather encoding based on FLASH. In EUMETCAL we concentrate on the inventory of existing training material, the exchange of material and knowledge as well as the co-ordinated preparation of new learning material. Material from EUMeTrain is used to complement our training seminars with case studies, CAL-modules, interpretation guides etc. We are active in the blended EUMETCAL courses about NWP, Satellite meteorology and Radar meteorology.

In our presentation we will mainly consider the future plans for our national and international training.

CONTINUOUS METOEROLOGICAL TRAINING IN SOUTHERN AFRICA AND THE USE OF VISIT VIEW

Winifred Jordaan

South African Weather Service

ABSTRACT

The South African Weather Service appoints scientific personnel as weather observers or meteorologists (researchers, climatologists or forecasters) depending on the training received.

Weather Observers:
Weather Observers are trained by Weather Service Personnel. Bursaries are allocated to matriculants that have passed their mathematics and physical sciences. They are then trained for one year in all aspects of weather observations as needed by the South African Weather Service.

These personnel are located in 18 office right through South Africa. We are in a process of refreshing their meteorological knowledge and to bring them the latest information on observation. The only way to give a lecture to all the offices simultaneously and to save time is to use visit view.

Meteorologists:
A post graduate qualification is a requirement for employment as a meteorologist within the South African Weather Service and to address these needs, training is provided to students in collaboration with various Universities within South Africa (Cape Town, Wits and Pretoria universities) This is done on a partnership basis because of the low student numbers required by the industry.

The specialties that are addressed are Weather Forecasting, Climatology and Research fields like Numerical Weather Prediction, Seasonal Modeling and Physical Meteorology.

As most of these specialties have a large practical aspect, most of the courses are given through the University of Pretoria with the majority of the lecturers being employed by the South African Weather Service itself.

After graduation these personnel is posted to their positions. Most of the personnel is in Pretoria, but there are big forecasting offices in OR Tambo International airport, Bloemfontein, Port Elizabeth, Durban and Cape Town. Visit View is installed at all these offices and they can register individually for the courses (international) as well. This will encourage them to register for the EUMETSAT visit view international courses as well. These personnel are also encouraged to develop their own visit view presentation for the other stations.

Neighboring countries:
The visit view software has been given to visiting scientists in 2007. They were encouraged to load the software and messages were sent to them trying to incorporate them into our schedule. If this can be achieved, weather discussions can become a reality between the neighbours.

RECENT DEVELOPMENTS IN PROFESSIONAL TRAINING AND ACADEMIC STUDIES PROGRAMS AT ENM

François Lalaurette

ENM/ Météo-France

ABSTRACT

ENM, the French College of Meteorology, is part of Météo-France, the French National Meteorological Service. It has however a unique position being at the same time a training institute with access to the best facilities in operational Meteorology and an academic college having close links with universities and research laboratories.
In this talk, examples will be given of recent developments at ENM that should open the door to more active European colloborations with other universities and meteorological services:
- distance learning, including an active involvement in the Eumetcal program
- the involvement in the ToulouseTech network of colleges of technology and management
- new programs in the area of Climate Change and Sustainable Development

PREPARING FOR GOES-R+ USER TRAINING AND EDUCATION

Anthony Mostek[1], **James Gurka**[2], **Mark DeMaria**[2]

(1) NOAA/NWS, (2) NOAA/NESDIS

ABSTRACT

User training for NOAA staff and outreach to NOAA's many customers are critical to the success of current and future satellite programs. The needs for training and education activities are captured in NOAA's Strategic Plan as part of establishing a “World Class Workforce”. The challenge to NOAA and its partners is clear from the Strategic and other planning documents: Keep pace with the rapid pace of technological change and keep users informed and trained on these changes. Otherwise,
NOAA and its partners face the clear possibility of being unprepared for the next Environmental Emergency!

The GOES program is developing a new series of satellites that will help keep NOAA at the forefront of environmental analysis, warning and prediction. There are many changes underway as part of NOAA's evolving programs. Some of these changes include:

- NOAA provides support from the Earth's surface (including sub-surface, water/land) through the atmosphere to space weather
- Major new approaches and products are provided for users to support the evolving needs of the U.S. and other countries for environmental information.
- The ability for users to interface with and manipulate data and products evolves rapidly. This rapid change is seen in the increase in gridded digital products produced by NOAA Offices.
- New innovations in decision aid/image processing software are developed. Examples are available with advanced radar products and in other disciplines (military image processing, medical imagery, etc.) - Merging of multiple products from multiple sensors (surface, air, space based) into a seamless system (GEOSS concept).
- Seamless merging of data/products/services already underway with systems such as Google Earth. Keys to success are common formats and reference systems that are available across a wide spectrum of applications and platforms. This capability is especially critical to
decision makers at all levels during crisis situations.

EXPERIENCES ON RUNNING A BLENDED LEARNING COURSE FOR OPERATIONAL FORECASTERS

Vesa Nietosvaara, Jaakko Karppanen

Finnish Meteorological Institute

ABSTRACT

Finnish Meteorological Institute was responsible for organising a blended course on Numerical Weather Prediction for forecasters October-December 2007. The course consisted of nine online collaboration sessions and a 4-day-classroom course at DWD training centre in Langen, Germany. The course was financially supported by Eumetsat, thus enabling a wide European participation at the course. All in all 17 countries were involved with the course.

This NWP course was the second pilot course organised for Eumetcal, and the first one in which organisers, teachers and students were all located randomly across Europe and Canada. The focus of the presentation is to describe the special challenges that a fully de-centralised organisation causes for the organisers, and how we could overcome these challenges.

The course in general was very successful. The participant feedback was very positive - particularly online sessions and online collaboration phases were appreciated. It was also mentioned several times that the longer duration of the course helped people to learn and apply the topics much better than is possible on a usual one-week course. Longer duration and online lessons before the classroom phase also enabled people to get to know each other and to create a warm and supportive atmosphere for working together.

The presentation will give suggestions for how to deal with technical aspects in online learning events, and give some recommendations on how to make learning rewarding and even fun.

COMPUTER AIDED LEARNING IN WEATHER FORECAST VERIFICATION TRAINING

Pertti Nurmi[1], **Laurence Wilson**[2]

(1) Finnish Meteorological Institute, (2) Environment Canada, Montreal

ABSTRACT

One important objective of the WMO/WWRP/WGNE Joint Working Group on Verification (JWGV) is to foster, promote and organize various forms of training activities on forecast verification. The JWGV has arranged successful forecast verification training workshops (e.g. at ECMWF in early 2007) which have included comprehensive tutorial sessions providing pedagogical coverage on common as well as new verification techniques of deterministic and probabilistic forecasts. The background data of the tutorials form an extensive set of training material which can be effectively used even for self-learning purposes. One way to accommodate this material (by two members of the JWGV) was the development and realization of a set of training modules under the EUMETCAL umbrella. These training modules, produced in 2006-08, cover verification methods for (i) continuous, (ii) categorical, and (iii) probabilistic forecasts. All modules provide information on the common and most popular verification techniques, including hands-on tools which are applicable either by trainers or any individual user. The CAL modules are designed to help in understanding the behavior of existing verification methods and to apply relevant techniques for given forecast situations. Completion of the CAL modules should provide the user with sufficient knowledge to be able to choose among the verification methods a suitable one for a given type of weather forecast and/or weather parameter.

THE INTEGRATED DATA VIEWER (IDV): DISPLAY OF EUMETSAT DATA AND PRODUCTS FOR TRAINING IN SATELLITE METEOROLOGY AND METEOROLOGICAL PUBLICATIONS

HansPeter Roesli

EUMETSAT

ABSTRACT

A large number of commercial and non-commercial software products are in use to process and display meteorological data. Many of them address in particular also image(-like) data. All have their merits and drawbacks. It is posited here that the Integrated Data Viewer (IDV) can be counted among the top of the list when it comes to versatility, extensibility, platform independence and, not the least, price.

IDV is developed at the Unidata Program Center (UPC), part of the University Corporation for Atmospheric Research in USA. Development is ongoing at fast pace driven by an active competent user community. The software is freely available under the terms of the GNU Lesser General Public License. IDV is a Java™-based software framework for analysing and visualising geoscience data. IDV release includes a software library and a reference application made from that software. It uses the VisAD library (http://www.ssec.wisc.edu/~billh/visad.html) and other Java-based utility packages.

The IDV "reference application" is a geoscience display and analysis software system with many of the standard data displays that other Unidata software (e.g. McIDAS) provide. It brings together the ability to display and work with various data sources like satellite imagery, NWP model output, surface observations, radio soundings, all within a unified interface. It also provides 3-D views of the earth system and allows users to interactively slice, dice, and probe the data, creating cross-sections, profiles, animations and value read-outs of multi-dimensional data sets. The IDV can display any Earth-located data if it is provided in a known format.

At EUMETSAT IDV is used to produce imagery from EUMETSAT data and products for training in satellite meteorology and meteorological publications. Its ability to access real-time data (through ADDE servers or the HRIT interface) makes it also suitable for direct use in training courses e.g. to investigate current weather.

Using the Jython language (http://www.jython.org/Project/index.html) the software library of IDV can be easily extended to create custom applications. At EUMETSAT a suite of library modules for SEVIRI RGB composites has been written that allow the application of a specific RGB scheme on the fly over a chosen SEVIRI data set. The possibility to save a state of the current display in so-called bundles makes it easy to re-play past weather or re-create a particular display with current data. Through the plug-in mechanism library modules, bundles and other locally developed facilities can easily be exchanged with other IDV installations.

The presentation will demonstrate various advantages of using of IDV focussing on the training environment.

SATREP ONLINE - A NEW CONCEPT TO TRAIN SATELLITE METEOROLOGY IN COMBINATION WITH NWP

Jarno Schipper[1], **Vesa Nietosvaara**[2]

(1) ZAMG, (2) FMI

ABSTRACT

In SATREP, Meteorologists try to recognise cloud patterns in satellite images by using the technique of conceptual models. Cloud tops and cloud patterns seen by satellites, are the fingerprints of physical processes in the troposphere. Conceptual models describe the physical processes through cloud phenomena, physical parameters, life cycles and weather events. Analysing a satellite image in terms of conceptual models is the initial step to retrieve a 3D- or even 4D-mental weather picture. Discrepancies between NWP model output and the Satellite image can also act as a trigger that the model is in error and so model modification will be required.

The analysis of a satellite image by these conceptual models has proven not only to be useful to weather forecasts but it also serves as a great training tool. In SATREP Online this training aspect is addressed.

SATREP online is a product of the international training project EUMeTrain. It consists of a web based platform (http://www.satreponline.org) in which operationally every day the 0600UTC Meteosat satellite images (individual channels and RGB combinations) are presented in combination with a corresponding set of basic and derived ECMWF model parameters.
The easy interface of SATREP Online allows a user to overlay the NWP on top of the various satellite images. With mouse over the user gets additional information and guidance on the use of NWP in combination with satellite. On a monthly basis a SATREP producer takes the lead in a weatherbriefing in which the actual SATREP is discussed for a large group of people.

These briefings are in turn being led by either Jarno Schipper (ZAMG) or Vesa Nietosvaara (FMI). The sessions normally take about 45 minutes. Because there is also a number of returning participants every month, the threshold for discussion or asking questions from trainer to trainee is relatively low. Every session tries to have a central point for special investigation. During the summer months more attention for that reason was paid to convection in which more RGBs and Nowcasting products such as GII were introduced. During the winter months the weight of the sessions was more on recognition of Fog and Snow etc.

The SATREP Online is a unique attempt in Europe to collect people from different countries together talking about the current weather situation. During the conference there will be a live demonstration of a weatherbriefing using the SATREP Online method.

THE COMET PROGRAM: EXTENDING SATELLITE METEOROLOGY TRAINING RESOURCES TO THE INTERNATIONAL ATMOSPHERIC SCIENCE COMMUNITY

Timothy Spangler, Patrick Dills

UCAR/COMET

ABSTRACT

The COMET® Program (http://www.comet.ucar.edu) receives funding from NOAA-NESDIS and the NPOESS Integrated Program Office (IPO) with additional contributions from the GOES-R Program Office and EUMETSAT to support education and training efforts in the area of satellite meteorology. This partnership enables COMET to create training materials of broad global interest on geostationary and polar-orbiting remote sensing platforms and their data, products, and operational applications.

Over the last few years, COMET's satellite training has focused on the capabilities, applications, and relevance of the upcoming NPP/NPOESS system to operational forecasters and other user communities. By partnering with experts from the Naval Research Laboratory and NOAA-NESDIS and working closely with various user communities, COMET strives to stimulate greater utilization of current and future satellite data observations and products. In addition, COMET has broadened the scope of its online training to include materials on the EUMETSAT Polar-orbiting System (EPS) and Meteosat geostationary satellites. EPS represents an important contribution to the Initial Joint Polar System (IJPS) between NOAA and EUMETSAT, while Meteosat imaging capabilities provide an important proving ground for the next generation GOES-R+ imager and support COMET's efforts to prepare users for the GOES-R+ spacecraft series. In 2007, COMET along with the support of its training partners initiated the Environmental Satellite Resource Center (ESRC). The ESRC consists of an Internet accessible and searchable database that houses learning and information resources for the international environmental satellite user community from multiple sources, including Meted (http://meted.ucar.edu). In addition to being able to locate information and multimedia of interest, users will have the opportunity to help expand the ESRC by contributing and sharing resources.

This presentation will provide a brief overview of COMET's satellite distance learning efforts, with a more in-depth review of ongoing initiatives. The presentation will also preview the new community Environmental Satellite Resource Center (ESRC), planned for initial implementation in 2008.

THE WEATHER ENTERPRISE IN THE UNITED STATES: A PUBLIC-PRIVATE PARTNERSHIP

Timothy Spangler

UCAR/COMET

ABSTRACT

The United States has a large government funded meteorological service, and a vibrant private sector. The American Meteorological Society has created **The Commission on the Weather and Climate Enterprise** to support and sustain this public-private partnership through improved collaboration and planning. A brief overview of the U.S. system will be presented including an overview of NOAA, the U.S. weather broadcasting industry, and the U.S. private weather forecasting industry. The role of the American Meteorological Society (AMS) Commission will be discussed along with specific examples of activities that the commission sponsors which support the public-private partnership.

CONNECTING RESEARCH AND EDUCATION THROUGH INTERNATIONAL EUMETCAL WORKING GROUPS

Carola Sundius, Jaakko Karppanen

Finnish Meteorological Institute

ABSTRACT

One of the arguments for research activities in National Meteorological and Hydrological Services (NHMS) is the advances in remote sensing technology and eventual positive impact on meteorological products. Advances in our knowledge of remote sensing technology has lead to improvement in weather forecasts through both more advanced visual imaging and integration to numerical models.

To reach the wider meteorological audience and the general public, the products have to be adopted by meteorological staff from observers to senior forecasters. The refinement of remote sensing research into weather products involves a key component of training. Training of meteorological staff is facing challenges with decreasing human resources, increasing multitude of tasks and growing demand from all levels of the society.

To tackle the challenges faced by the European meteorological training community, the Eumetcal programme coordinates a network of themed resource working groups and supports the delivery of blended learning courses. The working groups draw together experts from both the research and training communities to develop “standard” syllabi for the continuous professional development of meteorological and hydrological staff. The working groups are open communities welcome to researchers willing to share their expertise into training activities and material.

The Eumetcal programme is supported by EUMETSAT and thus strongly linked to Satellite Application Facilities. The Themed Resource Working Groups are open to ideas and input from the SAF researchers and can help fulfil SAF training responsibilities. Eumetcal is actively seeking new participants to its working groups to increase the quality and decrease the level to access training in European NHMSs.

THE ASMET5 TRAINING MODULE FOR THE AFRICAN USERS ON DUST STORMS, CONVECTION AND DEVELOPMENT OF SECONDARY LOWS

Henk Verschuur

EUMETSAT

ABSTRACT

The fifth module in the series of ASMET training modules is based on MSG imagery. Combinations of the MSG SEVIRI channels give a unique insight in the development of specific nowcasting applications such as dust storms, convective developments and the development of secondary lows over the southern part of the Atlantic. RGB images in combination with NWP data will be used to explain to students the development of these phenomena.

ASMET5 is the first full scale module developed for and by the African experts. Experts from the IMTR (KMD, Nairobi), EAMAC (Niamey), SAWS (Pretoria) assisted by experts from COMET (Boulder, USA) and EUMETSAT produced this product which will be made free available on the Internet.

DISTANCE LEARNING IN SATELLITE METEOROLOGY USING VISITVIEW

Tom Whittaker

University of Wisconsin-Madison

ABSTRACT

The VISITview software was developed for the United States' National Weather Service to facilitate the remote training of field meteorologists in using satellite data as part of their analysis and forecasting process. The freely available tools emphasize animation, color enhancements, overlays and zooming during the presentations. In addition, the instructors' interactions of pointing and drawing are easily accomplished. The low bandwidth requirements of VISITview for most sessions makes it ideal for distance learning and remote training situations where network connections are variable. In addition to providing a short history and overview of the tools available, I will give a demonstration of the ease of building a lesson and making it available for participants.

EVALUATING E-LEARNING MATERIAL: POSSIBILITIES AND PITFALLS. EXPERIENCES FROM THE EUMETRAIN USER SURVEY

Christian Zwatz, Veronika Zwatz-Meise, Jarno Schipper

ZAMG

ABSTRACT

In Meteorology, e-Learning is a more and more important part of training. As is the case with other forms of training, also this new type of material has to be evaluated. However, evaluations of e-Learning are often difficult, because the trainees can usually not be reached directly, face-to-face. This means that evaluations are usually done by questionnaires.
While surveys are a powerful method for getting accurate information about any social situation, they are also more difficult to implement than is immediately apparent. There is an acute danger of getting incorrect data, which might be inconclusive or even misleading. On the other hand, there are often possibilities for evaluations which in practice are not realised. More elaborate methods of analysing the data can also provide more accurate and in-depth information about training material and programs.
The presentation tries to give an overview about what dangers to avoid to get accurate data, and what possibilities there are for data analysis.
Regarding the gathering of the data, special consideration will be given to identifying various biases, which can lead to non-representative and skewed data. Some possibilities for avoiding these biases will be discussed.
Regarding the analysis of the data, three steps for analysis will be identified, each with its own strengths and weaknesses: Qualitative analyses, quantitative descriptive analyses, and finally analyses for detecting structures in the data.
For all the topics, the 2007 EUMeTrain User Survey is used to illustrate their practical application.

"MINI COURSES" - A NEW ELEMENT FOR DISTANT LEARNING

Veronika Zwatz-Meise, Jarno Schipper, Christian Zwatz

ZAMG

ABSTRACT

The most common methods in distant learning are online sessions and blended learning courses. Both fulfil special tasks: online courses last usually between 1 and 2 œ hour; they give possibility to learn new tasks, to ask questions to the teachers and to hear the comments from the other participants. Blended learning courses are related to a bigger topic, they last usually 6 to 8 weeks and comprise online sessions, discussions, face-to face courses and exercises.

Within the project EUMeTrain the discussions with partners and participants clearly showed that there is a demand for something in between. Meteorologists especially forecasters want to practise alone or together with 1 or 2 colleagues and they want to use some free time they can organise within there shift structure. This leads to the following characteristics of Mini Courses:

1. The topics should be already basically known; the main tasks is to apply knowledge and to get practise;
2. The courses should be so short that they can be done in 2 – 3 days with the possibility to divide them in smaller pieces;
3. There must be a continuous, permanent contact to a trainer from the institute that has developed the Mini Course; this contact will usually be classically by mail or phone. The trainee can ask questions and can get help if he got stuck.

So the Mini Courses consist of the following elements:

- The explanation what the subjects treats; what can be learned; why it has been chosen;
- Literature (manual, case studies, CALs) that treat the subject;
- The main course which contains questions and problems to be answered.

The expected outcome can be a paper, a text, containing the answers on the questions and problems. It will be discussed again between trainer and trainee until the result is satisfactory. A certificate signed by the EUMeTrain project manager and the involved trainer will confirm the successful finalisation of the Mini Course.

One example of a EUMeTrain Mini Course will be presented in more detail.

EVALUATION OF GPM-ERA SATELLITE PRECIPITATION ESTIMATES FOR HYDROLOGICAL APPLICATIONS

Valentine Anantharaj[1], F. Joseph Turk[2], Paul R. Houser[3], QiQi Lu[1], Jiale Xu[1], Yangrong Ling[1]

(1) Mississippi State University, (2) Naval Research Laboratories, (3) George Mason University

ABSTRACT

The planned NASA/JAXA Global Precipitation Measurement (GPM) mission is expected to enhance existing satellite-based rain fall estimates via improved spatial and temporal coverage of the GPM constellation of satellites. Precipitation is one of the primary forcing in hydrological and land surface models. Precipitation events often evolve over short space and time scales, where properly instrumented surface networks may not be available. Satellite data often provides the only source of timely precipitation data over many of the world's remote watersheds. Hydrological modeling is one of the key focus areas of the GPM Mission. Hence, the GPM-era rainfall products offer the potential to address the routine decision making needs for water resources management applications, especially in otherwise data sparse regions. The planned GPM-constellation is likely to include a number of satellites and instruments in dynamic configurations. The members of the GPM constellation will change owing to launch schedules before and during the mission. Hence, it is essential to understand the sensitivity of the precipitation estimation algorithms to the availability of types of sensors over a given period of time during the day.

Our research project is focused on leveraging today's existing environmental satellite constellation to examine the impact of satellites and orbits on land surface and hydrological models. We are evaluating the potential effectiveness of GPM-era satellite precipitation products by conducting *satellite omission experiments*. We have adopted the *NRL-blend* algorithm to generate and ensemble of precipitation products by systematically omitting categories of satellites and/or instruments on board while estimating the rainfall rate. A few other existing precipitation products, derived from both satellite data and ground observation, are also being evaluated at spatial and temporal scales that are relevant for water management applications. Since June 2007, we have been generating an ensemble of GPM *proxy* data, using data from existing satellites and based on the *NRL-blend* algorithm, over the continental United States and surrounding areas (0N-50N, 130W-50W). The set of ensemble members are configured (a) to omit the morning or afternoon and/or all cross-track sounders; (b) to omit the TRMM TMI and/or precipitation radar; and (c) to omit all morning or afternoon satellites. The different satellite configurations (ensembles) are compared against ground truth data. Our preliminary analyses indicate that compared to the "all satellites" configuration, the elimination of the morning satellites (specifically the across-track sounders) showed the largest impact.

Our other validation efforts include the use of land surface models and other types of hydrological observations, such as streamflow, discharge, and run-off measurements. We are employing the *Noah* land surface model (LSM), incorporated with the NASA Land Information System (LIS), to simulate land surface and hydrological states and partition the energy and moisture fluxes that are relevant for water resources management applications. Besides the routine evaluation techniques and metrics, such as root mean squared error, false alarm ratio and other skill scores, used in the research community, we are also adopting novel fuzzy-based methodologies to characterize the uncertainties in the satellite derived rainfall data and predictions.

SATELLITE-DERIVED PRECIPITATION VERIFICATION ACTIVITIES OF THE INTERNATIONAL PRECIPITATION WORKING GROUP (IPWG)

Phillip Arkin[1], Joe Turk[2], Beth Ebert[3], Ralph Ferraro[4], John Janowiak[1], Matt Sapiano[1], Daniel Vila[1], Chris Kidd[5]

(1) University of Maryland, (2) US NRL, (3) Australia BMRC, (4) US NESDIS, (5) University of Birmingham

ABSTRACT

Beginning in 2004, the International Precipitation Working Group (IPWG) began a satellite precipitation algorithm validation/intercomparison project over three domains (continental United States, Australia, and northern Europe) covered by quality-controlled surface networks. Its aim is to provide information to users on the daily-scale performance metrics (bias, RMSE, skill score, etc) relative to ground networks, and give algorithm developers a better understanding of the strengths and weaknesses of different algorithmic approaches and satellite data blends. A secondary aim is to investigate when and where satellite rainfall estimates generally perform better or worse than short-term rainfall predictions from NWP models. These validation activities were motivated by expanding requirements in climate modeling, data assimilation, nowcasting, and hydrological applications.

The development of high resolution precipitation products (HRPP; typically blends of low Earth orbiting passive microwave radiometric (PMW) and geostationary-based imagers) has also proceeded to the point where a more thorough analysis of their performance is required. The goal of the expanded Program to Evaluate High Resolution Precipitation Products (PEHRPP) is to characterize as clearly as possible the errors in various HRPP on many spatial and temporal scales, over variable background surfaces, and across seasons and climate regimes. Furthermore, errors of and differences between HRPP are meaningful in that they can be systematically related to precipitation characteristics and/or algorithm methodology, thereby potentially improving HRPPs by combining products or methods based on the observed errors and differences. In this presentation we will provide an overview of the validation strategies and summarize validation results to date.

REAL-TIME MONITORING OF RAINFALL OVER THE ARABIAN PENINSULA USING THE OBSERVATIONS OF METEOSAT SECOND GENERATION (MSG).

Mazen Assiri, Daivid I. F. Grimes

Reading University

ABSTRACT

Water is essential for life. In the Arabian Peninsula, rainfall is irregular, infrequent and low. Climate studies show that the Arabian Peninsula receives between less than 50mm per year and more than 250mm per year depending on location. Therefore rainfall monitoring is very important to optimise use of this scarce resource. Up till now, all rainfall monitoring has made use of raingauge observations, but the raingauge distribution is irregular and the number of raingauges is inadequate for reliable results. Consequently, there is a need for an approach which can deliver improved areal coverage in a timely manner. Recent studies have shown that rainfall monitoring based entirely on Meteosat imagery provides adequate and reliable monitoring in semi-arid regions of Africa such as Ethiopia and the West African Sahel and the aim of this study is to investigate whether a similar approach will work for the Arabian Peninsula.

Two basic approaches have been tried. The first is the TAMSAT method which depends on estimating rainfall using cold cloud duration based only on Meteosat thermal infra red imagery; the second is the UK Met Office algorithm which uses four channels from MSG in the visible, infra red and near infra red bands to produce rainfall estimates. A rigorous geostatistical approach has been used to validate the results of the estimation against available raingauge data. This work will present the results of the comparison between the estimates and the areal rainfall averages and discuss the feasibility of a real time operational system for the Arabian Peninsula.

THE VALIDATION OF THE SNOW COVER MAPPING DERIVED FROM NOAA AVHRR/3 OVER TURKEY

Aydin Ertürk, Ibrahim SONMEZ

Turkish State Meteorological Servis

ABSTRACT

The determination of the spatial and temporal distribution of the snow is essential for various reasons. On the one hand, the information of the snow cover is crucial since the water amount originated from snowmelt is the backbone of the hydrological models. On the other hand, snow cover is one of the important components in the radiative transfer models and climate studies. For this reason, various satellite sensors such as, MERIS, MODIS, AVHRR, SEVIRI and ASTER, are employed to get snow-cover information.

Clouds representing the similar spectral characteristics with snow have been the challenging point for the snow cover mapping algorithms. Since 1.6 microns is useful in separating snow and clouds, The NOAA AVHRR/3 (Advanced Very High Resolution Radiometer) instrument containing 3A (1.6 microns) with time-share 3B (3.7 microns) channel provides promising opportunities. In the frame of EUMETSAT H-SAF (Satellite Application Facilities on Support to Operational Hydrology and Water Management) project, the developed snow cover products algorithm derived from NOAA AVHRR/3 data is introduced. The daily snow cover product is validated over Turkey by using 125 synoptic stations for the time period of December 2007. The performance of the algorithm is analyzed for each day by using probability of detection (POD), hit rate (HR) and critical success index (CSI) statistics. Higher success rates such as, HR varying from 77.78% to 98.04% with the overall amount of 91.88% is obtained.

EVAPOTRANSPIRATION ASSESSMENT BY LSA-SAF: METHODOLOGY, STATUS OF VALIDATION AND PLANS FOR THE NEAR FUTURE.

Françoise Gellens-Meulenberghs, Alirio Arboleda, Nicolas Ghilain

Royal Meteorological Institute

ABSTRACT

EUMETSAT promotes several SAFs, among them the SAF on Land Surface Analysis (LSA-SAF), dedicated to the development and operational retrieval of products based on MSG and EPS over continental areas. Initially, the meteorological community was the first targeted users group of the LSA-SAF, but more recently the potential users community has been broaden to encompass several important areas including agriculture and forestry applications, hydrology, land use and general topics like climate and environment monitoring.

Evapotranspiration (ET) is included in the panel of biogeophysical parameters proposed by the LSA-SAF. The Royal Meteorological Institute (RMI) of Belgium is in charge of its methodological development, coding and scientific validation. This contribution describes at first the methodology used by the current version of the ET model running in near real time at the LSA-SAF institute since the end of 2006. Products generated each 30 minutes over Europe are already accessible to registered beta users. An extensive validation has been started at different spatial and temporal scales. Examples of results obtained for the year 2007 and for previous field campaigns are presented and illustrate the good quality of the current results. At local scale, comparisons are done at flux stations and at regional scale with data from the ECMWF model and the GLDAS system.

In a second step, some insight is given to on-going research. The extension of the current model to the full MSG disc is ready and should be implemented soon at the LSA-SAF Host institute. One of the practical implications is the need to enlarge in the near future the validation to the global scale. In parallel, research is pursued to still improve the model and increase forcing from satellite origin. An important topic is the development of a new version of the ET model including the modelling of soil moisture evolution. Recent results and plans for the near future are presented.

IMPROVEMENT OF A SURFACE ENERGY BALANCE MODEL BY THE USE OF MSG-SEVIRI DERIVED VEGETATION PARAMETERS

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ABSTRACT

In the framework of the EUMETSAT Land Surface Analysis (LSA) - Satellite Application Facility (SAF), models have been developed to retrieve from the MSG SEVIRI imager, surface variables like albedo, short- and long-wave radiation fluxes and vegetation parameters (Leaf Area Index, LAI, and Fraction of Vegetation Cover, FVC). An energy balance model is also being elaborated to produce actual evapotranspiration (ET) estimates as one of the end products of the LSA-SAF. The model is a simplified Soil-Vegetation-Atmosphere (SVAT) scheme adopting the tile approach, i.e. a sub-pixel computation of surface fluxes. The atmospheric forcings are 30 minutes full spatial resolution MSG derived surface radiative fluxes complemented by the ECMWF screen-level meteorological variables (air temperature and humidity, wind speed, …).

Important factors that strongly influence ET estimates are the time-dependent vegetation characteristics. In SVAT schemes, the influence of vegetation on energy partition is parametrized using key phenological factors, such as FVC and LAI. While some models use fixed vegetation characteristics during the whole year, others take advantage of a finer temporal sampling of vegetation evolution up to a couple of days. This contribution will first present the chosen way to use remote sensed daily vegetation parameters derived from SEVIRI in the LSA-SAF ET model. Secondly, we will show how the partitioning of surface heat fluxes is improved when using a finer characterization of vegetation both spatially and temporally. At last, we will present the impact of remotely sensed vegetation parameters uncertainty on the LSA-SAF ET model outputs.

DETERMINATION OF LAKE TANA EVAPORATION BY THE COMBINED USE OF SEVIRI, AVHRR AND IASI

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ABSTRACT

Lake evaporation is traditionally estimated by land-based hydrometeorological networks, using empirical relations to infer evaporative conditions over large water surfaces. Common theoretical frameworks include energy balance approaches, Penman approximations and complementary relationship models. This study explores the possibility of using a novel array of Earth Observation sensors to make an independent check of the traditional approaches and assumptions.

The AVHRR and IASI sensors on board of the polar orbiting METOP-A satellite, coupled with the SEVIRI observations from the geostationary MSG satellite provide high accuracy data on the surface and atmosphere of the Earth. Moreover, all these data are transmitted through the EUMETCAST system through transmission by the geostationary HOTBIRD satellite and can therefore be obtained routinely.

Fourier inversion of the IASI interferograms produces high resolution atmospheric spectra in the range from 3 to 15 μm. Inverse radiative transfer modeling of these spectra then yields (among many other parameters) temperature, humidity, ozone and aerosol profiles of the atmosphere from which the longwave energy balance components above lake surfaces can in principle be determined. Because AVHRR visible imagery is determined simultaneously from the same METOP platform, the visible spectra may be corrected for atmospheric effects with unprecedented accuracy, yielding independent values for albedos and shortwave energy balance components. Diurnal patterns can be analyzed by assimilating the IASI/AVHRR data with the VNIR, SWIR and TIR channels of SEVIRI, producing images every 15 minutes.

The new approach to the determination of lake evaporation was tested on Lake Tana (Ethiopia) which is a high altitude lake in the source area of the Blue Nile (altitude 1784 m, average area 3156 sq km). A ground survey in the Lake Tana catchment area was carried out in August 2007 in co-operation with the Ethiopian Ministry of Water Resources, Bahrdar University and Lake Tana Research Center. Additional information with regard to lake temperatures and synoptic meteorological data was collected since the start of 2008. This paper presents the first findings of the study which is expected to continue for several years.

INTERNATIONAL PRECIPITATION WORKING GROUP (IPWG): INTER-COMPARISON OF REGIONAL PRECIPITATION PRODUCTS

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ABSTRACT

The International Precipitation Working Group (IPWG) supports the inter-comparison of precipitation products, with the verification/validation of products over selected regions with quality controlled surface radar and gauge networks. Results of comparisons between satellite, model and surface data sets are provided at daily time scales and spatial scales of 0.25 degrees. These results aim to provide both the algorithm/product developers and the user community with information on the performance of the techniques and their suitability for certain applications, such as hydrological modelling.

This paper will present the results of inter-comparisons between different satellite and model rainfall estimates, particularly focusing on the region covered by the Meteosat satellite sensors. A range of techniques, ranging from single sensor infrared or microwave algorithms through to multi-sensor/multi-satellite algorithms will be compared. In particular, the usefulness of the infrared/microwave blended techniques will be evaluated: these include the NOAA/CPC CMORPH technique, the EUEMESAT Multi-sensor Precipitation Estimate (MPE) and the NRL IR-Microwave blended technique. Results of the inter-comparisons performed at different spatial and temporal scales will be presented to highlight characteristics of the different algorithms.

RAIN RATE RETRIEVAL USING 183-WSL ALGORITHM

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ABSTRACT

A new technique to detect precipitating clouds is proposed. The algorithm is based on the features of microwave radiation interactions with large rain drops, particularly at the opaque frequencies where the extinction effect due to the absorption of rainy clouds along the radiation path is more evident. This new passive microwave rain retrieval algorithm is developed using the water vapour strong lines at 183 GHz (183-WSL).

Since the 183 GHz bands are mainly dedicated to the sounding of the atmospheric water vapour amount, the behaviour of these frequencies in cloud-free regions with different temperature and water vapour profiles is explored. It is found that the perturbation on the radiation field induced by precipitation is much larger than that due to the water vapour absorption signals as measured in cloud-free regions. Moreover, since at mid-latitudes the peak of the weighting functions at 183 GHz ranges from 2 km up to the top of the troposphere, these frequencies are less affected by the surface emissivity and the precipitating signature is not masked by the surface-generated effects.

Multi-seasonal tests, carried out using AMSU-B water vapour channels on board the NOAA satellite series, have shown the sensitivity of the algorithm to correctly infer the structure of different precipitating events both over land and sea surfaces. Nevertheless, the application of the method on light and very light precipitation, particularly located at high latitudes, leads to a generally large underestimation of the rainfall rates. Further studies are thus planned to improve rain delineation in the winter season and at latitudes higher than 60 degrees.

A SCALABLE POINT PROCESS MODEL FOR TROPICAL RAIN RATE

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ABSTRACT

A new set of high resolution tipping bucket rain gauges has been deployed at various Pacific Island Meteorological Services. From two years of tip data we have developed a point process model of rainfall intensity which is down scalable to various resolutions. The model fits well to hourly data and we have shown that reliable statistics on minute rate rates can be obtained from this model. We've have also developed an expression for the third moment of the rain rate distribution for which we can now use to estimate rain rate extremes in the Pacific. The model should be useful for comparing rain rate statistics from rain gauges with satellite observations in attempting to assess the accuracy of satellite estimates.
Also described will the new network of tipping bucket gauges within the Pacific. Data from these gauges should be very useful researchers as rainfall data throughout the Pacific at these resolutions have previous been almost non-existent.

AN OPERATIONAL 24/7 TECHNIQUE FOR THE DELINEATION OF RAINING FROM NON-RAINING CLOUDS BASED ON CLOUD WATER PATH RETRIEVALS FROM MULTISPECTRAL SATELLITE DATA

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ABSTRACT

A new operational algorithm for the delineation of raining from non-raining clouds during day- and night-time using multispectral satellite data (e. g. Meteosat-8) is proposed. This approach is not only sufficient for the detection of mainly convective driven precipitation by means of the commonly used connection between infrared cloud-top temperature and rainfall probability but enables the detection of stratifom precipitating regions (e. g. in connection with mid-latitude frontal systems).

The scheme presented is based on the conceptual model, that precipitating clouds are characterized by a large enough combination of the droplet size and the vertical extension i. e. a large enough liquid water path. During day-time, this parameter is retrieved based on the well-known relation between the reflectance in a visible and slightly absorbing near-infrared wavelength using the semi-analytical cloud retrieval algorithm SACURA. During night-time, infrared channel temperature differences between 3.9µm, 8.7µm, 12.1µm, and 13.4µm are used since radiative transfer computations have shown that these differences are a function of the cloud water path. An extensive validation study over central Europe shows a good agreement to data from the ground based radar station network of the German weather service. Therefore, the new technique can be used as valuable information source with respect to e. g. the analysis of cloud-aerosol-precipitation interactions, within hybrid rainfall retrievals, or – along with a rain rate retrieval which is solely based on the effective cloud droplet radius and the optical thickness – as stand alone retrieval in areas with coarse ground station data networks.

THE EFFECT OF STORM TYPE ON SATELLITE PRECIPITATION ESTIMATION ERROR: RESULTS FROM AN EXPERIMENT IN EASTERN ITALIAN ALPS.

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ABSTRACT

Research has shown that lack of knowledge on vertical structure of precipitation and the hydrometeor's phase and size distribution introduces errors in satellite rain estimates. The models that are currently used in retrieval algorithms do not adequately represent the microphysical characteristics of precipitation. As a consequence, the uncertainty of satellite precipitation estimates depends on the variations of storm type (e.g. convective vs stratiform). This study seeks to investigate i) the significance of this dependence and ii) the link between satellite error characteristics and microphysical properties.

An X-band dual-polarization (XPOL) radar, located at the Veneto region Northeastern Italy, is devised to provide high resolution observations of precipitation along with in situ measurements from a dense gauge network. High resolution precipitation products from different satellite algorithm are evaluated against the XPOL/gauge estimate for storm events of varying type (convective, widespread, frontal, mixed phase/snow). The satellite error statistics are evaluated for the different storm types and for varying bulk hydrometeor size characteristics (e.g. mean drop diameter).

ERROR STRUCTURE CHARACTERISATION OF GEOSTATIONARY AND POLAR SATELLITE PRECIPITATION PRODUCTS DEVELOPED WITHIN THE HYDROLOGY SAF PROJECT

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ABSTRACT

The precipitation retrieval methods developed into the H-SAF project make use of geostationary and polar satellite data with different instruments as AMSU-MHS, SSM/I-SSMIS and SEVIRI. Rain rate and cumulated rain are produced with different time and spatial resolution. Several European institutes are involved in the H-SAF Precipitation Products (PP) validation activity. The studies on the PP performances are based on precipitation classes defined in order to characterise the products for hydrological applications. The validation work is based on *continuous* and *multi-category* statistics evaluated on the H-SAF area. The statistics are performed on the base of month/season, background (sea, coast, land) and precipitation classes defined by the hydrologists experiences. The results obtained comparing the PP with both radar and rain gauges data of seven European countries for two years long time series are presented. The radar and raingauge data have been up-scaled taking into account the satellite native grid of the PP. In addition to the statistical verification, case studies on the H-SAF area are presented for several meteorological situations and precipitation classes.

COMBINING GEOSTATIONARY OBSERVATIONS AND THE MEGHA-TROPIQUES DATA FOR UNDERSTANDING THE ENERGY AND WATER CYCLE IN THE TROPICS

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ABSTRACT

Megha-Tropiques is an indo-french satellite mission due to launch in Spring 2009. It carries on board a suite of instruments dedicated to the energy and water cycle analysis. The payload in composed of a multispectral microwave imager mainly for rainfall estimates, a microwave sounder for water vapor profiling and a broad band radiometer for the earth radiation budget measurements. The orbit is low on the Equator (~20°) and the satellite altitude is 865km providing a very frequent observations of the same region. After a short presentation and status of the development of the Mission, the talk will focus on the expected combination of the Megha-Tropiques measurements with the geostationary IR imagery. Two main fields will be presented. The first one concerns surface rain estimates for which the multispectral geo imagery is used to build a rainfall product. Experiment using TRMM data and a given approach will be shown with emphasis on the use of MSG and of the AMMA data for evaluation. Second, the geo-imagery is expected to be used to characterize the morphology of the organized convective systems (life cycle, size,.). Then the low orbiter data will be projected onto this life cycle to form a composite of the evolution of the radiation and rainfall features of the convective systems. Examples from the use of TRMM TMI and CERES data together will be shown in conjunction with METEOSAT first generation data. If time permits similar analysis using MSG and GERB will also be shown.

VALIDATION OF RAIN RATE ESTIMATES FROM SEVIRI USING WEATHER RADAR OBSERVATIONS

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ABSTRACT

We present a method to detect rainfall and estimate rain rates from SEVIRI onboard MSG using the cloud physical properties retrieval algorithm of the Climate Monitoring SAF. The rainfall detection and rain rate retrieval method uses information on cloud liquid water path, particle effective radius, cloud thermodynamic phase and cloud top height retrievals. The unprecedented sampling frequency of 15 minutes from SEVIRI allows for a statistically significant validation of rain rate retrievals from SEVIRI against weather radar observations.

For a two month period rain rate retrievals from SEVIRI are compared against weather radar observations for an area over Northern Europe. The weather radar observations are used to validate instantaneous, daily and decal rain rate retrievals, as well as rainfall accumulations across the entire study area and period. In addition, we evaluate the ability of SEVIRI to estimate the rainfall frequency, the probability of detection and false alarm rate. The rain rate retrievals from SEVIRI are analysed with respect to their frequency distributions and their residuals against weather radar observations.

The results show very high agreement (corr. ~0.9) between rainfall frequency estimates from SEVIRI and observations from weather radar. Although weaker correlations (corr. ~0.5) are found between the rain rates retrievals from SEVIRI and weather radar, the SEVIRI retrievals have an accuracy of about 0.2 mm hr-1 and a precision of about 0.8 mm hr-1. Part of the differences between SEVIRI and weather radar are explained by parallax shifts in the SEVIRI data, and irregularities in the weather radar data due to residual clutter. After removing days with problematic levels of residual clutter the correlation increases significantly to about 0.7. In a preliminary evaluation of rain rates predicted by a NWP model we show that the model predicted rain rates are nearly twice as high as the rates retrieved from SEVIRI over Europe.

In conclusion, SEVIRI is very well capable to estimate rainfall frequencies and reproduce realistic distributions of rain rate. The comparisons to model data shows that rain rates retrievals from SEVIRI provide a valuable tool to evaluation precipitation schemes in NWP models. In future studies we intend to exploit the observations of the European weather radar network (OPERA) and repeat this study to entire Europe.

EXPLAINING SYSTEMATIC BIASES IN RAINFALL ESTIMATES BY LIGHTNING MEASUREMENTS

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ABSTRACT

The potential benefits of adding lightning to the other satellite measurements is examined. It is shown that synergy between lightning observations and rainfall estimates obtained from combinations of the imager, passive MW and/or radar can explain large variability (over a factor of 2) in systematic biases of rainfall estimates.
The following situation shed some light on the causes: Lightning frequency is greater over land by more than an order of magnitude than over ocean. At the same time, rainfall amount over ocean is not less than over land, and convection amount and depth over ocean similarly is not less than over land. The fundamental difference between land and ocean electrical activity is caused by difference in the cloud microstructure and the related precipitation forming processes. It is noted that the imager retrieved cloud composition could serve as the context for the interpretation of the significance of the lightning properties as indicators for severe convective storms, intensity of the convection and possible flash floods. For example, the satellite imager could identify the cloud microstructure and precipitation forming processes, which in turn determine the ratio between rainfall amounts per a lightning flash. This represents a considerable yet unrealized potential for synergy between the MTG imager and the Lightning Imager (LI), which puts the consideration for an LI mission on a much more attractive ground.
Examples for the way it can work will be shown from both revisiting published studies with these new insights, and some new analyzed examples.

SYNERGISTIC USE OF SCATTEROMETER AND SCANSAR DATA FOR EXTRACTION OF SURFACE SOIL MOISTURE INFORMATION IN AFRICA

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ABSTRACT

The potential of the ERS-1/2 scatterometer global soil moisture product has been shown in several studies. The ASCAT sensor on-board the METOP satellite is extending the 16 year time series of the ERS-1/2 scatterometer as a source for extracting information for ocean and land applications. Calibrated ASCAT data will continue the scatterometer global soil moisture archive while improving both the spatial and temporal resolution.

A disaggregation scheme for spatial downscaling of the ASCAT soil moisture product, using a temporal stability analysis of medium resolution ScanSAR data from the ENVISAT ASAR sensor, has been developed.

Furthermore, by transferring the change detection algorithm from the scatterometer to the ScanSAR data, also a 1 km Surface Soil Moisture product is derived. The disaggregated scatterometer soil moisture product is evaluated in conjunction with the 1 km Surface Soil Moisture product in the region of the Southern African Development Community. The influence of land cover on the performance of the products is considered.

Both high resolution products performs best in areas with less dense vegetation, such as agricultural lands and crop land. In areas with a dense vegetation canopy, the uncertainties in the extracted soil moisture values are large. The disaggregated product, while implicitly taking into account effects of land cover and surface roughness at different scales, provide a statistical approach to downscale regional soil moisture measurements to a finer spatial scale.

USES OF NDVI FOR DROUGHT MONITORING

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ABSTRACT

Keywords:,
Belg season, Kiremt season, Bega season, Seasonal variability, Drought monitoring

In Ethiopia the surface based meteorological observation net work is sparse. Only few of the stations report on regular basis. It could take months to collect clamatological data from the meteorological stations network. As a result of their utility for operational purposes, drought monitoring, pest control, flood forecasting, food security purposes and fire control, and so on limited. Hence, the use of remote sensing techniques for rainfall estimation and vegetation monitoring is vital in a country like Ethiopia, where the meteorological stations are in adequate and not evenly distributed.

The National Meteorological Services Agency (NMSA) had been receiving and processing digital Satellite data from METEOSAT and NOAA 1991. The NOAA data is used among other things for vegetation and fire monitoring while the METEOSAT data is used for rainfall estimation. In this study the data set used are monthly GAC NDVI for the period 1984 to 1995 and mean monthly rainfall over Ethiopia. An attempt is made through statistical analysis to investigate the importance of NDVI in drought monitoring.

The analysis indicate that in the short rainy season (Belg) the vegetation shows a significant increases over south-western part in the month of May, for the long rainy season (Kiremt) the maximum vegetation is over western parts in the month of September, while October is the peak for the southern parts in the dry season (Bega). Time series analysis was done for some selected areas to see the relationship between NDVI values and rainfall

The seasonal variability and correlation coefficient has been done for the two seasons namely MAM the months are March, April and May and JJASO the months are June, July, August, September and October. Most of the areas are affected by drought in the years 84,91,90,92 and 94 respectively. Vegetation depends on several factors, however rainfall is one of the most important factor for vegetation activity. In general results of the analysis agree with other studies, which had been done earlier.

generally, which shows a one moth lagged response of vegetation to rainfall.

A NEW TECHNIQUE FOR DETECTING PRECIPITATION AT MID-LATITUDES DURING DAYTIME USING METEOSAT SECOND GENERATION SEVIRI

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ABSTRACT

A new method for the detection of precipitation during daytime using MSG SEVIRI data is proposed. The approach is not only applicable for the detection of mainly convectively induced precipitation by means of the commonly used relation between infrared cloud top temperature and rainfall intensity but enables also the detection of stratiform precipitation (e.g. in connection with mid-latitude frontal systems).
The new technique is based on the conceptual model that precipitating cloud areas are characterized by a combination of particles large enough to fall, an adequate vertical extension (both represented by the cloud water path (cwp)), and the existence of ice particles in the upper part of the cloud. The technique considers the VIS0.6 and the NIR1.6 channel to gain information about the cloud water path. Additionally, the channel differences ΔT8.7-10.8 and ΔT10.8-12.1 are considered to supply information about the cloud phase.
The information about the cloud water path and the cloud phase of the four variables is merged and incorporated into the new developed precipitation detection algorithm. The detection of the precipitating cloud areas is realized by using a minimum threshold for the pixel based rainfall confidence as a function of the respective value combination of the four variables VIS0.6, NIR1.6, ΔT8.7-10.8 and ΔT10.8-12.1. The calculation of the rainfall confidence is based on a comparison of the value combinations of these four variables with ground based radar data.
The results of the algorithm were compared with corresponding ground based radar data not used for deriving the transfer function. The proposed technique performs better than existing optical retrieval techniques using only IR thresholds for cloud top temperature.
The new developed algorithm shows encouraging performance concerning the detection of precipitation during daytime in the mid-latitudes using MSG SEVIRI data. Together with the existing precipitation detection algorithm during nighttime for MSG SEVIRI (Thies et al., 2008) the new algorithm offers the great potential for a 24 h technique for precipitation detection with a high spatial and temporal resolution.

References

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APPLICATION OF WATER AND ENERGY CYCLE SCIENCE AND OBSERVATIONS WITHIN THE FRAMEWORK OF GEWEX

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ABSTRACT

This talk will describe the activities of the Global Energy and Water cycle EXperiment,(GEWEX), a project within the World Climate Research Programme (WCRP) that focuses on the closure of the energy and water budgets at global and regional scales. Functionally, GEWEX achieve its goals through data set development and analysis, process studies and model improvement. This presentation will discuss GEWEX research priorities, products and achievements with an emphasis on GEWEX research related to clouds, precipitation and land surface processes. In particular, the use of earth observation techniques and the global data sets that have been developed within the GEWEX Framework will be shown. Scientific issues such as downscaling, model sensitivity studies and hydrologic applications related to the water sector will be highlighted.

CALIBRATING C/X-BAND MICROWAVE OBSERVATIONS AND A SOIL MOISTURE RETRIEVAL ALGORITHM TOWARD A CONSISTENT GLOBAL SOIL MOISTURE DATA PRODUCT

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ABSTRACT

Passive microwave satellite remote sensing has been documented as probably the most reliable global soil moisture observation approach. Currently there are several C/X band microwave sensors (the TRMM Microwave Imager-TMI; Aqua Advanced Microwave Scanning Radiometer-AMSR-E, and NRL's WindSat) flying in space and several global soil moisture research products have been generated from these sensors. However, none of these soil moisture retrievals have been used in the operational predictions because they are not either consistently available or proven to be reliable. This paper demonstrates the inconsistency between the currently available soil moisture data products. After the X-band brightness temperature observations from TMI, AMSR-E, and WindSat, a single-channel algorithm (SCA) for soil moisture retrieval is used to generate a consistent soil moisture data record from these satellite sensors. All soil moisture retrievals are blended into one product and evaluated with in situ field measurements. The blended product is expected to be a consistent global soil moisture data record started from 1997 when TMI observations became available.

DEVELOPMENT OF A GLOBAL FIRE/AEROSOL OPERATIONAL PRODUCT AS PART OF THE CEOS ATMOSPHERIC COMPOSITION CONSTELLATION

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ABSTRACT

The Atmospheric Composition Constellation (ACC) is one of four virtual constellations proposed by the Committee on Earth Observations from Space (CEOS) in support of the overall goals of the Group on Earth Observations (GEO) to provide prototype space-based Earth-observation systems for GEOSS, the Global Earth Observation System of Systems. The goal of this prototype is to demonstrate that a constellation can be developed using several satellites synergistically to characterize the global distribution of fire occurrences and aerosol. The fire and aerosol observations, in conjunction with air parcel trajectory models, are combined to produce a view of current aerosol distributions along with a forecast product related to large-scale aerosol events. The integrated product provides forecast guidance for users to develop warnings on instances of potential degradation of air quality due to long-range transport of aerosols from events such as widespread burning, regional-scale pollution episodes, and dust storms.

For initial demonstration purposes, we have combined measurements from the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO). MODIS provides Aerosol Optical Depth (AOD) measurements while CALIPSO provides retrievals of attenuated aerosol backscatter accurately defining the altitude at which these aerosols are present. The combination of the two products uniquely provides a three-dimensional depiction and significantly enhances the reliability of the subsequent ensemble of forward trajectory calculations. The first use of this product was to provide a retrospective study of biomass burning in southern Africa in September 2006, primarily in Botswana and Zambia, and show how emissions from these fires likely impacted air quality in Cape Town, South Africa, several days later. During 2008 we plan to use these two data products in near-real time to study the evolution of aerosol events during the International Polar Year (IPY) NASA Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) and NOAA Aerosol, Radiation, and Cloud Processes affecting Arctic Climate (ARCPAC) field campaigns. The results from this system will be used both for planning purposes, to provide information to help formulate mission flight plans, and in a retrospective mode to interpret in situ aircraft observations.

This ACC prototype demonstrates a system to provide relevant information on aerosols and particle pollution movement within the societal benefit area of human health and air quality. The ultimate goal of this project is to expand these capabilities through the incorporation of additional satellite measurements from other operational satellites such as Meteosat Second Generation (MSG) Spinning Enhanced Visible Infrared Imager (SEVIRI). A fire detection product developed for the U.S. GOES satellites, the Wild Fire Automated Biomass Burning Algorithm (WF-ABBA), can likewise be used to provide the basis of such algorithms for other geostationary platforms, including those currently operated by ESA and other operational agencies around the globe.

GREENHOUSE GASES FROM SCIAMACHY/ENVISAT NADIR OBSERVATIONS: CO2 AND CH4 DURING 2003-2005

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ABSTRACT

Carbon dioxide (CO2) and methane (CH4) are the two most important anthropogenic greenhouse gases. SCIAMACHY on ENVISAT is the first and currently only satellite instrument whose measurements are sensitive to CO2 and CH4 concentration changes at all atmospheric altitude levels down to the Earth's surface where their source/sink signals are largest. At the University of Bremen a scientific retrieval algorithm has been developed (WFM-DOAS version 1.0) and applied to the SCIAMACHY near-infrared nadir spectra to retrieve total columns and dry air column-averaged mole fractions of both gases. Until now (beginning of 2008) three years of data covering the first three years of ENVISAT (2003-2005) have been processed. The SCIAMACHY greenhouse gas data sets are available via the ESA GMES Service Element (GSE) project PROMOTE (they are core data products of PROMOTE's Climate Study Support Service) and are, for example, assessed within EU FP6 GEMS especially concerning their information content about greenhouse gas surface fluxes. An overview about these data sets will be given including detailed comparisons with global models optimized versus highly accurate but sparse greenhouse gas surface observations such as NOAA's CarbonTracker and EC-JRC's TM5 model.

LONG-TERM MONITORING OF TROPOSPHERIC NO2 WITH GOME-2

Heinrich Bovensmann, John P. Burrows, Andreas Heckel, Joana Leitao, Andreas Richter

University of Bremen

ABSTRACT

Nitrogen oxides (NO_x = NO_2 + NO) are important players in tropospheric chemistry. Together with hydrocarbons, they are precursors of ozone and also contribute to acid rain. The sources of nitrogen oxides are both natural and anthropogenic, the latter dominating in the industrialised part of the world.

Using space-borne UV/visible measurements of the scattered solar light, the atmospheric content in nitrogen dioxide (NO_2) can be derived with the differential optical absorption spectroscopy (DOAS) method. After removal of the stratospheric component, the tropospheric column of NO_2 can be determined. This has been successfully demonstrated using measurements from the GOME, SCIAMACHY, and OMI instruments. Data from the GOME-2 instruments on MetOp have the potential to continue the existing time series for 15 years, providing a total record of 25 years of near-global observations of tropospheric pollution.

For any long-term record of atmospheric measurements, data consistency is one of the key issues. This is true for data from a single instrument where ageing and drifts are a concern but even more if data from several sensors is to be combined. Therefore, prior to using such data in scientific applications, their quality and consistency needs to be established.

In this presentation, we present tropospheric NO_2 columns from GOME, SCIAMACHY, and GOME-2. The data is analysed with respect to consistency in the overlapping time periods, and aspects such as temporal and spatial sampling, spatial resolution and viewing angle are discussed. In addition, the excellent coverage of GOME-2 is used in several case studies to investigate the evolution of pollution plumes over time.

MONITORING OF ATMOSPHERIC COMPOSITION USING THE THERMAL INFRARED IASI/METOP SOUNDER

Cathy Clerbaux[1], P Coheur[2], D. Hurtmans[2], C. Wespes[2], A. Razavi[2], H. Herbin[2], L. Clarisse[2], J. Hadji-Lazaro[3], M. George[3], S. Turquety[3], A. Boynard[3], M. Pommier[3]

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ABSTRACT

The IASI instrument was launched onboard the METOP platform in October 2006. It is a nadir looking Fourier transform spectrometer that probes the Earth's atmosphere in the thermal infrared spectral range, with a spectral resolution of 0.5 cm-1 (apodized). IASI is monitoring the atmospheric composition at any location two times per day, and is measuring some of the chemical components playing a key role in the climate system and pollution issues.

This talk will summarize the early results we have obtained from the analysis of the Eumetsat L1 products (nadir radiance spectra) since May 2007. We operationally retrieve CO, CH_4, O_3, as well as partial columns for O_3. We also generate research products such as HNO_3, H_2O isotopes, and other atmospheric species. A special emphasis will be put on the study of recent pollution events.

IASI MEASUREMENTS OF BIOMASS BURNING AND VOLCANIC PLUMES

Pierre-François Coheur[1], **Solène Turquety**[2], **Juliette Hadji-Lazaro**[2], **Cathy Clerbaux**[2], **Lieven Clarisse**[1], **Daniel Hurtmans**[1]

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ABSTRACT

IASI, the infrared sounder onboard the MetOp series of platforms, measures the Earth's outgoing radiation over a large spectral interval (645-2760 cm^{-1}) with a spectral resolution of 0.5 cm^{-1} (apodized). Its in-flight radiometric performances are above the expectations, providing level1C radiance spectra with high signal-to-noise ratio. IASI also samples the atmosphere with unprecedented spatial resolution (12 km on-ground pixel size at nadir) and a revisit time of 12 hours. These specificities of IASI, associated with a good sensitivity to the lowest layers of atmosphere, makes it an extremely valuable sounder for identifying and tracking local pollution sources, and for monitoring the chemistry of the troposphere, including some the fast occurring processes.

This work focuses on the IASI observations of biomass burning and volcanic plumes, giving emphasis onto the measurements of several short-lived species, previously undetected from space. The wildfires episodes that happened in the Mediterranean basin in the summer of 2007 are taken as a case study for biomass burning events. The IASI observations are complemented with other satellite observations as well as with simulations from the LMDz-INCA 3-D global chemistry and transport model to assess the impact of these extreme fires on regional atmospheric chemistry and air quality. For volcanoes, the most significant events that occurred since the IASI launch are described, focusing on the measurement of the SO_2 spatial distribution (both horizontal and vertical) and its evolution in time after the eruption. The potential of using IASI for the early detection and for tracking volcanic plumes are also discussed in the perspective of operational applications in support to aviation control.

FIRST METOP/GOME-2 CHEMICAL ANALYSIS OF THE 2007 ANTARCTIC OZONE HOLE

Thilo Erbertseder, Julian Meyer-Arnek, Diego Loyola, Frank Baier

DLR (German Aerospace Center)

ABSTRACT

First results of the Antarctic ozone hole 2007 derived from MetOp/GOME-2 (Global Ozone Monitoring Experiment 2) data are presented. Total ozone column observations are routinely and continuously assimilated into the chemistry-transport model (CTM) ROSE/DLR at the German Remote Sensing Center (DFD) to obtain chemical analyses of ozone and related species in the stratosphere. A sequential assimilation scheme which follows optimum interpolation of first-guess minus observation residuals with Kalman-Filter-like covariance diagnostics is used. All relevant chemical gas-phase processes as well as heterogeneous processes on sulphuric acid and polar stratospheric clouds (PSCs) are considered by the scheme. Besides the GOME-2 ozone analysis the evolution of this year's ozone hole is augmented by chemical analyses of ozone change rates and chlorine activation in the polar stratosphere. The results are compared to ground-based observations. The work is carried out in the frame of the EUMETSAT AO project AGORA and the Ozone Monitoring SAF.

The assimilated GOME-2 data indicate no evidence of a significant recovery of the ozone layer over Antarctica. In mid-September 2007, the size of the ozone hole started a strong reversal which was caused by unusual meteorological conditions in the south polar stratosphere. An unusually high planetary wave activity resulted in extremely ozone-deficient air masses being transported from polar to middle latitudes from 10 to 15 September. There, they contributed to the thinning of the ozone layer, especially over the South Atlantic and South America. During this period of dynamical movements, the area for ozone hole conditions continued to shrink, and the ozone hole reached its minimum size on 20 September. Analyses for the last days in September indicate a return to the "normal", symmetrical shape of the polar vortex. Chlorine activation and ozone loss, however, had already come to a halt.

The size of the ozone hole in 2007 was slightly below average, thanks largely to this unusual dynamical circumstance. The 2007 ozone hole is somewhat weaker than the ones of 2000, 2005 and 2006, but stronger than those of 2002 and 2004. Due to the high inter-annual variability, a clear trend of ozone-hole recovery cannot clearly be identified at this stage. The continued ozone analysis based on MetOp/GOME-2 for the next 14 years is therefore a crucial task

MONITORING SYSTEM PERFORMANCE BY USING OPERATIONAL PRODUCTS, RESIDUALS, AND SENSITIVITIES

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(1) NOAA, (2) SSAI, (3) IMSG

ABSTRACT

Users want validated data products with well-defined accuracy, quality, and error contributions. For operational products, this poses a problem because of the short time between creation and use. There are three main strategies to solve this problem; construct algorithms with little sensitivity to expected measurement and instrument changes, compute quantities which will provide checks on the internal consistency of the process, and provide quality flags and sensitivities to users so they can evaluate the products. This presentation examines methods to provide information on instrument calibration and characterization, and to provide validation for measurements and products from the NOAA POES SBUV/2 and EuMetSat MetOP GOME-2 series of instruments by using products and residuals from NOAA operational algorithms. In the first section, we discuss tradeoffs between reducing sensitivity to instrument changes and increasing sensitivity to atmospheric changes. In the second section, we review a variety of "soft" calibration approaches that are used to check the consistency of Backscatter Ultraviolet and Visible (BUVV) measurements including ozone pair comparisons, and reflectivity and retrieval residual statistics. The third section looks at the generation of data quality parameters and the use of retrieval information such as averaging kernels in evaluating products.

AEROSOL RETRIEVAL FROM GOME-2 POLARIZATION MEASUREMENTS

Otto Hasekamp[1], **Jochen Landgraf**[1], **Piet Stammes**[2], **Olaf Tuinder**[2]

(1) SRON, (2) KNMI

ABSTRACT

Aerosols directly affect the Earth's climate by scattering and absorbtion of solar radiation and indirectly by changing the microphysical properties of clouds. The measurements of the Polarization Measuring Devices (PMDs) of GOME-2, onboard METOP-A, provide an interesting opportunity for aerosol retrieval, because polarization measurements are highly sensitive to aerosols. We will present first results of an aerosol retrieval algorithm making use of the PMD measurements. The algorithm retrieves aerosol optical thickness for a number of standard aerosol models (a combination of size distribution and refractive index), where the model that fits best to the measurement is selected. This lookup table based algorithm will be applied to all cloud free GOME-2 pixels. For selected scenes, it is intended to perform a full retrieval of aerosol micropysical properties.

THE CEOS ATMOSPHERIC COMPOSITION CONSTELLATION (ACC): AN EXAMPLE OF AN INTEGRATED EARTH OBSERVING SYSTEM FOR GEOSS AND OPERATIONAL MONITORING

Ernest Hilsenrath

NASA Headquarters

ABSTRACT

The Atmospheric Composition (AC) Constellation is one of four pilot projects initiated by CEOS to bring about technical/scientific cooperation among space agencies that meet the goals of GEO and comply with the CEOS member agencies national programs. The Constellation concept has been endorsed in the GEO Work Plan, 2007-2009. The AC Constellation goal is to collect and deliver data to develop and improve monitoring, assessment and predictive capabilities for changes in the ozone layer, air quality and climate forcing associated with changes in the environment. These data will support five of the nine GEO SBAs: Health, Energy, Climate, Hazards, and Ecosystems. At the present time ESA, EC, CSA, CNES, JAXA, DLR, NIVR, NASA, NOAA and Eumetsat are participating in the Constellation study, and have major assets in orbit including 17 instruments on seven platforms. One goal of the Constellation study is to identify missing capabilities that will result when the present orbiting research satellites missions end and those not included in the next generation operational missions. Missing observations include very accurate and high spatial resolution measurements needed to be to track trends in atmospheric composition and understand their relationship to climate change. The following are the top level objectives for the AC Constellation Concept Study:

- Develop a virtual constellation of existing and upcoming missions using synergies among the instruments and identify missing capabilities.
- Study advanced architecture with new space assets and varying orbits with expectations that new technology could also be brought forward to best meet user requirements
- Data system interoperability to insure that data are useful, properly targeted, and easily accessible.

To demonstrate that the Constellation concept can provide value added data products, the ACC has initiated the following three projects that are being supported by the participating space agencies.
1. Time of day changes in NO_2 using Aura/OMI and Metop/GOME-2. This project is being led by NOAA who will be ingesting both OMI and GOME-2 near-real-time and applying a common algorithm to avoid biases and reveal true time of day (09:30, 13:45) changes. This project is being led by NOAA.

2. Near-real-time fire detection and smoke forecasts using multiple satellites (A-Train, GOES, GOME-2, MSG, etc) and trajectory model. The model calculation will be enhanced by smoke altitude information provided by CALIPSO. This project is being led by NASA

3. Improved volcanic ash alerts for aviation hazard avoidance from satellite SO_2 and ash data from SCIAMACHY, OMI, GOME-2, AIRS and SEVIRI. This service will build upon existing services provided to the VAACs within Europe, the US, and Australia. This project is being led by ESA

Each of the three projects will address the GEO SBAs with consideration to discovery and interoperability of their data products. The status of the ACC studies will be reviewed with a progress report on the above three projects.

GMES SENTINELS 4 AND 5 - ATMOSPHERIC COMPOSITION MONITORING FROM SPACE

Paul Ingmann, Joerg Langen, Yasjka Meijer, Grégory Bazalgette Courrèges-Lacoste, Marco Arcioni

ESA/ESTEC

ABSTRACT

Atmospheric chemistry observations from space have been made for nearly 30 years. They have been motivated by the concern about a number of environmental issues. However, most of the space instruments have been designed for scientific research, improving the understanding of processes that govern stratospheric ozone depletion, climate change and the transport of pollutants. Long-term continuous time series of atmospheric trace gas data have been limited to stratospheric ozone and a few related species. According to current planning, meteorological satellites will maintain the latter observations over the next decade. They will also add some measurements of tropospheric climate gases. As their measurements are motivated by meeting operational meteorology needs, they fall short in meeting requirements for atmospheric chemistry applications.

Reliable long-term space-based monitoring of atmospheric constituents with quality attributes sufficient to serve atmospheric chemistry applications still need to be established. The general framework for this kind of measurements in synergy with ground-based and airborne measurements and integration with atmospheric models and data assimilation schemes has been outlined in IGOS-IGACO Theme Report in 2004. Several other efforts have been made to identify the needs of long-term atmospheric composition data, such as

- the GMES-GATO report,
- the Eumetsat position paper on observation requirements for nowcasting and very short range forecasting in the 2015-2025 time-frame in the context of the Post-EPS preparation, and
- studies commissioned by Eumetsat to identify requirements for geostationary platforms in the context of Meteosat Third Generation (MTG).

An ESA study on 'Operational Atmospheric Chemistry Monitoring Missions (CAPACITY)' had gathered all the various inputs and generated comprehensive observational requirements by environmental theme, by user group, and by observational system (ground / satellite). The study also assessed the contributions of existing missions to the fulfilment of these requirements, and identified priorities of observational techniques for future atmospheric composition missions. Requirements are getting consolidated in the context of the CAMELOT study.

Implementation of atmospheric composition missions is foreseen in the context of the Global Monitoring for Environment and Security (GMES) initiative. This is an activity which was confirmed as the European Union's priority at the 2001 Summit in Gothenburg, where the Heads of States and Governments requested that "the Community contribute to establishing by 2008 a European capacity for Global Monitoring for Environment and Security".

Atmospheric composition monitoring needs should be met by GMES Sentinels 4 and 5 where Sentinel 4 addresses the geostationary and Sentinel 5 the low Earth orbiting part.

The presentation will provide an overview over ways of meeting the objectives of Sentinels-4 and -5.

OZONE PROFILE CLIMATOLOGY PRODUCTS FROM 8 YEARS NNORSY-GOME DATA SET

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ABSTRACT

A neural network based retrieval scheme for the retrieval of total ozone and ozone profiles was developed at ZSW. The Neural Network Ozone Retrieval System (NNORSY) was successfully applied to TOVS and GOME Level 1 spectra. For NNORSY-GOME the training data set consists of ozone profiles from sondes (WOUDC, SHADOZ) as well as ozone profiles from satellite instruments (SAGE, HALOE, POAM). The retrieval of full 8 years of GOME spectra gives a consistent global high resolution ozone profile data set for July 1995 to June 2003, when a failure in the tape recorder of ERS-2 occurred. This NNORSY-GOME V3 data set includes about 43.000 NNORSY-GOME orbits at full spatial and temporal resolution of the GOME instrument. The ozone profiles reach from ground up to 61 km with a sampling rate of 1 km. NNORSY-GOME V3 was validated by the Belgisch Institut Voor Ruimte-Aeromonie (BIRA) in the frame of the ESA funded project CHEOPS-GOME (Climatology of Height-resolved Earth Ozone Profiling Systems for GOME). Here the NNORSY-GOME ozone profiles were proven to be of “a high and stable quality of the NNORSY profiles all along the data record”.

NNORSY-GOME V3 data set was used to derive several ozone profile climatology products. Two look-up-table climatologies (LUTI and LUTII) were done giving global ozone profiles on a 2.5° latitude and 10° longitude grid. Also a look-up-table climatology analogous to the TOMS V8.0 ozone climatology is available, depending on total ozone classes.

Furthermore a second and new approach based on neural network technique (NN) was followed to retrieve a fully dynamic ozone profile climatology. This NNORSY-CLIMATOLOGY is offered as a software package comprising several neural networks together with software tools for data conversion and interpolation. Depending on which user input information is available, the NNORSY-CLIMATOLOGY does not only consider standard input information such as date, time and geographical position but it also can derive improved climatological ozone profiles by taking optional dynamic input parameters like total ozone column and/or temperature profile into account. Due to this option of respecting dynamic parameters this new approach exploits the growing start information content to lead to a significant gain of accuracy in the climatological ozone profile.

If no input temperature profile is provided the NNORSY-CLIMATOLOGY delivers a climatological temperature profile as well. The dynamic NNORSY-CLIMATOLOGY can be used for accelerating classical retrieval schemes based on optimal estimation towards operational monitoring of atmospheric compositions from space, since neural networks are very fast and one climatological ozone profile can be processed typically in less than 1ms. Another decrease in computing time can be gained by the advanced accuracy of the climatological ozone profile if it is used as a priori for retrievals or first guess information in data assimilation.

Comparisons of the different NNORSY-CLIMATOLOGIES with other widely-used ozone profile climatologies are presented. Measured ozone profiles are opposed to the NNORSY-CLIMATOLOGY profiles. The improvements of the dynamic climatology are shown by looking at situations where short time effects take place, such as (mini) ozone hole conditions.

DEVELOPMENT OF OPERATIONAL TROPOSPHERIC NO2 PRODUCT FROM METOP-A GOME-2 FOR AIR QUALITY APPLICATIONS

Shobha Kondragunta, Trevor Beck, Lawrence Flynn

NOAA/NESDIS

ABSTRACT

NOAA is developing an operational tropospheric NO2 product from Metop-A GOME-2 instrument, flying in the morning orbit, to meet air quality monitoring and forecasting requirements in the United States (U.S.). Initial focus is on the development and characterization of GOME-2 NO2 product with the end goal being assimilation of the data into the National Weather Service (NWS) air quality model to constrain NOx emissions and improve forecasting. Algorithm development work will be consistent with Aura/Ozone Mapping Instrument (OMI) flying in the afternoon orbit. Methodologies to convert slant column amounts to vertical column densities and to extract tropospheric amount from total column amount are similar to those used by OMI, so diurnal changes in NO2 can be tracked. NO2 product status and preliminary comparisons between GOME-2 and OMI NO2 and NWS operational Community Multiscale Air Quality (CMAQ) predictions of NO2 on different spatial and temporal scales will be presented.

DETECTION AND MONITORING OF SULFUR DIOXIDE FROM SATELLITE-BASED UV SENSORS

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(1) UMBC, (2) NOAA/NEDIS

ABSTRACT

Sulfur dioxide column amounts are retrieved from Aura/OMI near-UV spectral radiance data with exceptional precision. The high sensitivity coupled with daily global coverage with unprecedented spatial resolution has provided a wealth of new information. Sulfur dioxide is a short-lived constituent of the atmosphere that is produced by volcanoes and from combustion of sulfur-containing fossil fuels. It is oxidized to sulfate aerosols at a rate that depends on altitude. Sulfate aerosols change the reflectance of the atmosphere, making sulfur dioxide an important climate constituent. While fossil fuel burning constitutes a large, broadly distributed source of sulfur dioxide, volcanic eruptions can inject very large sulfur dioxide clouds into the upper atmosphere in a few hours. Explosive eruptions also produce volcanic ash as frothy liquid magma freezes in the atmosphere. Ash clouds are a hazard to aviation but are sometimes difficult to discriminate from other clouds while sulfur dioxide is a unique marker. Volcanic clouds can drift global distances at aircraft cruise altitudes as they are carried by the upper air winds. Thus, satellite observations of sulfur dioxide are invaluable for locating fresh volcanic clouds. A near real-time data production capability has been developed for operational use at NOAA NESDIS where the data are distributed via internet to the Decision Support Systems. The UV algorithms are designed to operate with data from OMI and GOME-2 and future instruments like OMPS. The sensitivity is adequate to monitor pre-eruptive emissions from volcanoes for detection of new activity. In addition, large sources of sulfur dioxide from fossil fuel burning and from smelting of ores are being monitored.

O3M-SAF PRE-OPERATIONAL PRODUCTS: GOME-2 TOTAL COLUMN OZONE AND NO2

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ABSTRACT

The GOME-2 sensor is EUMETSAT's first operational ozone monitoring instrument: three identical instruments have been built, with the first sensor launched in October 2006 aboard the first of three MetOp satellites.
DLR provides the operational GOME-2 total column ozone, minor trace gas, and cloud products in the framework of EUMETSATŽs Satellite Application Facility on Ozone and Atmospheric Chemistry Monitoring (O3M-SAF),
Beginning of March 2007 EUMETSAT initiated the regular delivery of GOME-2 level 1 products via EUMETCast. Only two weeks later DLR was able to start the operations test-phase and by end of March 2007 DLR started the dissemination of demonstrational GOME-2 near-real-time (2:30 hours after sensing) total ozone and NO_2 products via EUMETCast and off-line products via FTP. In October 2007 these products were declared pre-operational shortly after the validation teams from the University of Thessaloniki and the BIRA institute in Brussels confirmed the high quality reached by the total ozone and NO_2 products.

In this paper, we present the pre-operational GOME-2 total ozone and NO_2 products, derived with the state-of-the-art GOME Data Processor (GDP) algorithm version 4.2 The GDP is embedded in the Universal Processor for Atmospheric Spectrometers (UPAS) system. UPAS is integrated into DLR's multi-mission ground segment DIMS system, used for the near-real-time and off-line trace gas product generation, archive and delivery. Details on the GDP algorithm are given, including new developments like the detection of clouds under sun-glint conditions and the effects of polarization on the total ozone retrieval.
Additionally, we present validation results of the GOME-2 total ozone and NO_2 products with ground-based measurements, and comparisons with satellite-based observations from GOME, SCIAMACHY, and OMI. The average agreement of GOME-2 total ozone columns with ground-based and other satellite ozone column measurements is at the "percent level"; GOME-2 generally underestimates the total ozone column by 0.5-2% and the total ozone columns show a scan angle dependency. GOME-2 total NO_2 columns are in excellent qualitative agreement with ground-based and other satellite observations of the NO_2 field, and of its temporal variations at scales from day to months; the overall accuracy is estimated to fall within the 10% to 20% range over unpolluted areas.

GOME-2 MISSION AND PRODUCT VALIDATION STATUS

Rosemary Munro[1], Ruediger Lang[1], Yakov Livschitz[1], Jukka Kujanpää [2], Diego Loyola [3], Olaf Tuinder [4]

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ABSTRACT

The Second Global Ozone Monitoring Experiment (GOME-2) performs operational global monitoring of ozone column densities and ozone profiles, and column densities of other atmospheric trace gases such as NO_2, BrO, OClO, HCHO, and SO_2. GOME-2 is an improved version of the Global Ozone Monitoring Experiment (GOME-1) launched 1995 onboard the second European Remote Sensing Satellite (ERS-2). It was launched on the first of the METOP series of polar-orbiting operational meteorological satellites on 19th October 2006. The remaining two satellites in the series will be launched in 2010 and 2014.

GOME-2 Level 1b products are produced centrally at EUMETSAT in the Core Ground Segment and were declared operational in March 2008. GOME-2 Level 2 products are produced by the Ozone Monitoring and Atmospheric Chemistry Satellite Application Facility, part of the EUMETSAT Distributed Ground Segment, hosted by the Finnish Meteorological Institute. Ozone profile, total column ozone and total column NO2 products have been declared “pre-operational” at the time of writing.

An overview of the GOME-2 mission and the product validation status will be presented.

RETRIEVAL OF WATER VAPOUR COLUMNS FROM GOME-2

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University of Bremen

ABSTRACT

The Air Mass Corrected (AMC-)DOAS method uses the spectral region from 688 to 700 nm to derive water vapour total columns on the global scale. The method has already been successfully applied to measurements of GOME and SCIAMACHY. A main feature of the AMC-DOAS method is that it does not rely on external calibration sources (like radio sondes); thus the GOME-type instruments can provide a completely new and independent water vapour data set.
In October 2006 the MetOp satellite has been successfully launched, carrying on it the GOME-2 instrument, a successor of GOME. The main improvement of GOME-2 is the increased swath width of 1920 km (compared to 960 km for GOME and SCIAMACHY) while the spatial resolution of 40 km x 80 km is still almost as good as for SCIAMACHY (typically 30 km x 60 km) and much better than for GOME (40 km x 320 km). The AMC-DOAS method could be easily adapted to GOME-2 such that now also GOME-2 data are regularly processed at IUP Bremen.
Here first (very promising) GOME-2 water vapour results are presented, with some emphasis on applications in polar regions.

RETRIEVAL OF AEROSOL OPTICAL PARAMETERS AND VERTICAL PROFILE FROM SATELLITE DATA: COMBINING SCIAMACHY MEASUREMENTS OF REFLECTANCE AND OF ABSORPTION BY O2 AND O2-O2

Marloes Penning de Vries[1], Tim Deutschmann[2], Michael Grzegorski[2], Ulrich Platt[2], Thomas Wagner[3]

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ABSTRACT

Aerosols cause a substantial amount of radiative forcing, but quantifying the amount of radiative forcing caused by aerosols is difficult: determining aerosol concentrations in the atmosphere and, especially, characterizing their (optical) properties, has proven to be quite a challenge.

A good way to monitor aerosol characteristics on a global scale is to apply satellite remote sensing. Most satellite aerosol retrieval algorithms are based on aerosol-induced changes in earth reflectance, which are usually subtle and have a smooth wavelength dependence. To simplify the under-defined problem, such algorithms need to assume certain aerosol models, where optical parameters such as single scattering albedo, asymmetry parameter and size parameter (or Angstrom exponent) are defined.

We combine measurements of the sun-normalized radiance and of absorption features, as well as Monte Carlo radiative transfer modeling (RTM). From the measured radiance we can obtain aerosol optical parameters (optical thickness, single scattering albedo, asymmetry parameter, Angstrom exponent); the absorption by atmospheric gases with known concentrations (O_2 and O_2-O_2) can provide us with the height profile of the aerosol layer.

For the measurements we make use of the large, continuous spectral range of the SCIAMACHY instrument (214-1773 nm). Modeling is performed with the RTM Tracy-II and its successor McArtim.

A complication to aerosol retrieval is the presence of clouds, which can be easily mistaken for aerosols and vice versa. We therefore studied the influence of clouds on aerosol retrieval for several representative cases (ocean, desert, highlands, and urban environments).

Results from SCIAMACHY measurements and calculations using our RTM will be presented.

ATMOSPHERIC CO2 DISTRIBUTIONS USING OPERATIONAL SATELLITE MEASUREMENTS: THE GEMS PERSPECTIVE.

Peter Rayner, Frederic Chevalier

CEA

ABSTRACT

The Global Environmental Monitoring with Satellite and in-Situ Data (GEMS) project has embedded the estimation of various trace species within the atmospheric assimilation system of ECMWF. In parallel, standalone analyses of CO2 and CH4 using a neural network retrieval provide an independent estimate. Both distributions can be used to determine surface net sources via inverse methods. We validate the assimilated concentration fields directly against in-situ data. We also compare simulated concentrations (with the fluxes as boundary conditions) against in-situ data. In this talk we present results for CO2 using measurements from the AIRS and IASI instruments. Vertical profiles constrained by AIRS data are frequently drawn towards in-situ measurements in the upper troposphere but the constraint in the lower troposphere is weak. Similarly, the derived surface fluxes do not provide consistent improvement in their simulation of in-situ concentrations compared to the prior fluxes. Preliminary results from the IASI instrument and neural network seem more promising. they show less spatial variability than the AIRS retrievals, closer to in-situ aircraft measurements. The IASI measurements are also sensitive to CO2 lower in the atmosphere, improving the chance of a good surface constraint.

MONITORING ABSORBING AEROSOLS WITH GOME-2

Piet Stammes[1], **Olaf Tuinder**[1], **Otto Hasekamp**[2]

(1) KNMI, (2) SRON

ABSTRACT

Monitoring of absorbing aerosols from space is important for detecting the occurrence of biomass burning and desert dust storms. Long term changes in these occurrences are an important aspect of climate change. GOME-2 on board of Metop-A, launched in October 2006, has the capability of detecting biomass burning and desert dust aerosols using the so-called absorbing aerosol index (AAI). This index uses the reflectance at two UV wavelengths, 340 and 380 nm. The spectral contrast at these wavelengths as compared to that of a Rayleigh scattering atmosphere indicates aerosol absorption. In this presentation we will show the AAI results from the first year of data from GOME-2.

THE IMPACT OF GEOSTATIONARY SATELLITE AEROSOL OPTICAL DEPTH OBSERVATIONS ON AIR QUALITY FORECASTS

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ABSTRACT

The objective of this study is to test the impact of Aerosol Optical Depth (AOD) observations from geostationary satellites on air quality forecasts. To this end several Observing System Simulation Experiments (OSSE's) were performed. The main objective of these experiments was to test the hypothesis that air quality forecasts benefit from frequent observations of AOD.

OSSE's are commonly used to quantify the impact of meteorological observations from future observation systems such as satellite instruments or groundbased networks on e.g. weather forecasts.
In this study OSSE's are applied to total column AOD measurements from the Flexible Combined Imager (FCI) and vertical AOD profiles from an Oxygen A-band sounder using the LOTOS-EUROS chemistry transport model and the ensemble Kalman filter data assimilation method.

Experiments were the AOD observations were sampled at four hour resolution were compared to results obtained when the AOD observations were sampled every half-hour. Experiments suggest that the performance depends critically on the error in the observations, which for the FCI instrument has a strong diurnal variation and large values in the middle of the day. Large errors cause the assimilation system to stay closer to the modelled values than to the observed values. Although in some cases the impact is clearly visible, on average the level of improvement when assimilating total AOD columns from the FCI instrument is small. Obviously the level of improvement also depends on the vicinity of simultaneously assimilated groundbased measurements.
In the next step experiments were AOD profile observations from an Oxygen A-band sounder are assimilated will be compared to the results using the FCI total column AOD observations.
The impact of the AOD profile measurements is expected to be larger because of lower errors and the vertical information (which is an advantage in case of dust or fires, i.e. high altitude aerosols). But the coarser horizontal resolution of the sounder might give a lower impact in broken cloud cases, when the FCI with its finer horizontal resolution can look in between the clouds.

NEW CALIPSO QUICKLOOK PRODUCTS IN SUPPORT OF WEATHER AND AIR QUALITY FORECASTING APPLICATIONS

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ABSTRACT

The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite (CALIPSO) mission provides new insight into the role that clouds, and atmospheric aerosols play in regulating Earth?s weather, climate, and air quality. CALIPSO is a joint mission between NASA and CNES and orbits in formation with four other Earth observing satellite missions in the Afternoon satellite constellation (A-Train). The payload includes a two-wavelength polarization-sensitive lidar (CALIOP), a three-channel passive Infrared Imaging Radiometer (IIR), and a visible Wide Field Camera (WFC). Together, this suite of active and passive sensors probes the vertical structure, spatial distribution and optical properties of thin clouds and aerosols over the globe. The payload has been operational since June 2006 and the science data products are available either at the Atmospheric Science Data Center (ASDC) at NASA Langley Research Center or at the ICARE Data Center at the University of Lille, France. Typical data latency for science products is usually 3-5 days. The CALIOP Vertical Feature Mask (VFM) product identifies aerosol and cloud layers with a vertical resolution of 30 meters in the lower and mid troposphere. Observations of aerosol layers collected over a several day period can be used with back-trajectories from assimilated wind fields to track the movement of elevated plumes of dust, smoke, and volcanic debris. When the VFM is combined with Aerosol Optical Depth (AOD) measurements from other instruments such as the Moderate Resolution Imaging Spectroradiometer (MODIS) or the Meteosat Second Generation (MSG) Spinning Enhanced Visible Infrared Imager (SEVIRI), 3-dimensional aerosol fields can be constructed and used with ensemble trajectory packages for air quality forecasts. CALIPSO's information on cloud occurrence also provides a valuable tool for retrospective skill analysis of Numerical Weather Prediction (NWP) model forecasts or cloud-tracked winds on a near real-time basis. To respond to the operational weather and air quality forecasting interests, a new Quicklook data set has been developed that seeks to improve data availability for a subset of the CALIPSO data set. Because CALIPSO data are downlinked once per day, data latency is reduced by processing the lidar measurements with climatological density profiles to normalize the attenuated backscatter signal in the mid stratosphere and with slightly coarser satellite ephemeris data. The resulting quicklook products are generated ~ 12 hours after they are received and are of sufficient of quality for identifying significant cloud and aerosol features relevant for forecasting applications.

AOD WITHIN THE EMEP AEROSOL MODEL: COMPARISON OF THE OBSERVATION OPERATOR WITH MODIS DATA

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ABSTRACT

The EMEP aerosol model is a 3-D Eulerian regional model. The model describes the emissions, chemical transformation, transport, dry and wet deposition of atmospheric aerosols and their gaseous precursors. It includes 7 aerosol components – sulphate (SO_4^{2-}), nitrate (NO_3^-) ammonium (NH_4^+), anthropogenic primary organic carbon (APOC), elemental carbon (EC), mineral dust, and sea salt, and the aerosol water content is calculated based on the chemical composition of aerosols and ambient relative humidity. The aerosol size distribution is described with four size fractions: nucleation (d < 0.02μ m), Aitken (0.02μ m < d< 0.1μ m), accumulation (0.1μ m < d < 2.5μ m), and coarse (2.5μ m d < 10.0μ m). The aerosols are assumed to be internally mixed and monodisperse within each of the four size fractions. The aerosol dynamics processes, including nucleation, condensation and coagulation, are calculated with the MONO32 module, (Pirjola et al., 2002). The EMEP aerosol was extensively evaluated with respect to aerosol concentrations ($PM_{2.5}$ and PM_{10}) and chemical composition, and to a lesser extent for number concentrations using surface measurements.

We have developed an observation operator for simulations of AOD. Two AOD schemes have been tested: (1) a simplified one, based on aerosol mass concentrations, and (2) the one, based on particle number size distribution and employing the Mie scattering mathematical formalism for spherical and internally mixed particles. The EMEP aerosol model has been used to calculate AOD at 0.55 μ m wavelength over Europe for the years 2003 and 2004. The results obtained with both schemes will be presented and discussed.
Model calculated AOD will be presented and compared with MODIS AOD retrievals for the years 2003 and 2004. On average, the model underestimates MODIS AOD by about 50% for warm seasons and by about 20% for cold seasons. The spatial correlation is below 0.35 for the whole EMEP grid (being poorer over ocean compared to land areas), while the temporal correlation mostly lies between 0.4 and 0.6 for different regions. The differences between the simulated and observed AOD, as well as the uncertainties in model and MODIS AOD have been discussed.

A joint analysis of $PM_{2.5}$ and AOD, calculated and observed, will also be presented for EMEP stations. Rather mixed correlations between observed surface $PM_{2.5}$ and MODIS AOD are found for 18 stations. In general, the correlation between measured $PM_{2.5}$ and AOD is better for sites in Southern Europe, lying mostly between 0.45 and 0.7, while it is lower in Central and Northern Europe (between 0.2 and 0.5). It is interesting to note that for many sites, the correlation between calculated and MODIS retrieved AOD is higher than the correlation between calculated and measured $PM_{2.5}$. For instance, the respective correlations are 0.53 and 0.19 for Swiss site Chaumont, 0.51 and 0.22 for Italian site Ispra, 0.55 and 0.17 for Spanish site Visnar. The differences between the modelled and MODIS AOD, as well as the uncertainties in calculated and MODIS retrieved AOD will be discussed.

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VERTICAL OZONE PROFILES FROM GOME-2 ON METOP-A

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ABSTRACT

The Global Ozone Monitoring Instrument 2 (GOME-2) on board EPS/Metop-A is the first instrument on a European operational meteorological platform aimed at sensing ozone and other trace gases in the Earth's atmosphere. GOME-2 is a nadir looking scanning instrument that measures UV-VIS back scattered solar light with a relatively high spectral resolution and an almost global coverage.

Within the framework of the Ozone and Atmospheric Chemistry Monitoring SAF (O3MSAF), KNMI runs the Ozone Profile Retrieval Algorithm (OPERA) to to calculate a vertical profile of partial ozone columns in 40 layers. The algorithm uses measurements in the range from 260 to 330 nm and tries to find the ozone profile best matching the original radiance measurements. This is done by iteratively adjusting the knowledge of the state of the model atmosphere via a forward model and the optimal estimation inversion technique.

We present and analyse results of the vertical ozone profiles calculated from GOME-2 data on Metop-A. With over one year of data, GOME-2 has proven to work well. The O_3 profile accuracy is, on average, above the threshold accuracy limits in the troposphere and the lower stratosphere compared to ground based measurements such as Lidar and Mwave. The vertical ozone profiles are produced on a (pre-)operational basis and are freely available to users in NRT and offline fashion from the O3MSAF.

TROPOSPHERIC CARBON DIOXIDE AND METHANE CONCENTRATIONS IN THE BOREAL ZONE RETRIEVED FROM SATELLITE HYPER-SPECTRAL INFRARED SOUNDERS DATA

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ABSTRACT

The development of space-borne hyper-spectral IR sounders (AIRS/EOS-Aqua, IASI/MetOp) opens new opportunities for detecting the variations of atmospheric carbon dioxide (CO2) and methane (CH4) concentrations. The capabilities to retrieve atmospheric column-average CO2 mixing ratio QCO2 and similar average mixing ratio QCH4 for CH4 from satellite measurements is of significant importance in the context of global carbon cycle research, climate change studies and due to sparse network of ground-based CO2&CH4 observations This paper presents an updated status of QCO2 and QCH4 retrieval schemes based on the clear-sky AIRS and IASI data inversion algorithms. The presentation first describes the approach developed for clear-sky or cloud-cleared AIRS data inversion and retrieval of the QCO2. The sensitivity studies (using FRTM SARTA simulations) enabled to select a set of CO2-dedicated channels in both SW an LW regions with strong signal responses to CO2 concentration changes and weak signal responses to variations of interfering factors, i.e. surface temperature Ts, water vapor(QH2O(p)) and ozone (QO3(p)) profiles. To retrieve the QCO2, the original method has been proposed based on the iterative least squares physical inversion algorithm. Its important features are as follows: clear-sky or cloud-cleared AIRS spectra and AIRS-based Level 2 retrievals (Ts, QH2O(p), QO3(p)) together with AMSU-based and "AIRS-independent" temperature (T(p)) profile retrievals are utilized as input data; a radiative tuning is applied to the AIRS data in CO2-dedicated channels to account for biases between actual and synthetic spectra; initialization of the iterative inversion algorithm is carried out through a correct choice of the QCO2 first guess; the inter-consistency check between AIRS LW-and SW-based QCO2 retrievals as well as the spatial and temporal filtering of the results are performed for the cluster of AIRS sounding points. The validation effort carried out with real AIRS data for two areas in the boreal zone of Western Siberia (Novosibirsk and Surgut regions) and for 10 months of year 2003 demonstrates that the retrieved monthly-averaged QCO2 values reproduce seasonal variations of CO2 column amounts (in a layer between ~3,5 km and about 7-8 km) with a precision about 3.0 ppmv comparing to in-situ airborne observations. We discuss also how the above methodology can be applied to IASI data inversion and provide some examples of QCO2 retrievals. The sensitivity studies (using FRTM simulations) enabled to specify the preliminary list of LW CO2-dedicated channels (some channels have central wave numbers close to those for AIRS CO2-channels). The adjustment of AIRS data inversion technique to IASI data requires accurate knowledge of Ts, T(p), QH2O(p), QO3(p) in sounding points. One possible option is to utilize the IASI-based Level 2 retrievals (Ts, QH2O(p), QO3(p)) together with collocated ATOVS-based T(p) retrievals; another one is to use NWP output products as ancillary information. Now both options are under consideration. With respect to the QCH4 retrieval from AIRS and IASI data the approach is being developed based upon the application of iterative physical inversion algorithm to clear-sky AIRS or IASI data in three CH4 – dedicated super- channels. The measurements in super-channels, that are generated as linear combinations of data in T- and CH4-dedicated channels with wave numbers 706.5&1332.5, 715.25&1341.75, and 714.0&1346.75 cm-1 respectively, have reduced sensitivity to T(p) uncertainties. It should reduce the effect of inaccurate profile T(p) knowledge in sounding points on accuracy of QCH4 retrievals. The performance of the described retrieval algorithms is currently being evaluated in a case study experiment involving datasets of IASI/MetOp and IASI-balloon together with ground based and radio-sonde observations for Esrange (Kiruna, Sweden) on 22 Feb 2007. This dataset was produced by the LPMAA team and was complemented with quasi-synchronous and collocated AIRS data as well as with AIRS-based L2 retrievals. The first experimental retrievals of QCH4 and QCO2 from AIRS and IASI data are consistent within their corresponding error bars. This research was carried out partially under INTAS project, Ref. Nr. 06-1000025-9145.

UPCOMING O3M-SAF TRACE-GAS COLUMN PRODUCTS: GOME-2 TROPOSPHERIC NO2, TOTAL BRO AND SO2

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ABSTRACT

This contribution focuses on the demonstrational GOME-2 trace-gas column products developed at the German Aerospace Centre, in the framework of EUMETSAT's Satellite Application Facility on Ozone and Atmospheric Chemistry Monitoring (O3M-SAF). We present the algorithms and initial results of tropospheric NO_2, total BrO and SO_2. These trace-gas column products are retrieved from GOME-2 solar backscattered measurements in the UV/VIS wavelength region, using the Differential Optical Absorption Spectroscopy (DOAS) method.

Total NO_2 is routinely retrieved with the GOME Data Processor (GDP) version 4.2 using the 425-450 nm wavelength region, and is already a pre-operational O3M-SAF product. An additional algorithm is now applied to derive the tropospheric NO_2 column for polluted conditions. After subtracting the estimated stratospheric component from the total column, the tropospheric NO_2 column is determined using an air mass factor based on monthly climatological NO_2 profiles from the MOZART-2 model. SO_2 emissions from volcanic and anthropogenic sources can be measured by GOME-2 using the UV wavelength region around 320 nm. With GOME-2, it is possible to detect and track volcanic SO_2 in near-real time and on a global scale, which is of particular importance for volcanic early warning services. For the GOME-2 retrieval of the total BrO column, current research focuses on the optimisation of the DOAS fitting window in the UV wavelength region. BrO columns retrieved from the baseline GOME fitting window (344.6-359 nm) show relatively large noise levels. Therefore, the use of a larger or alternative fitting window is being analysed.

More than one year of tropospheric NO_2, total BrO and SO_2 measurements are now available from GOME-2. We present initial validation results of tropospheric NO_2 and total BrO using ground-based measurements, as well as comparisons with other satellite products, such as those from SCIAMACHY and OMI. The use of tropospheric NO_2 columns for air quality applications will be presented and examples for BrO under polar winter conditions will be given. Finally, exemplary GOME-2 measurements of SO_2 from volcanic eruptions and degassing will be shown.

MONITORING OF VOLCANIC SO2 AND ASH EMISSIONS FROM SATELLITE

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ABSTRACT

Volcanic eruptions may eject large amounts of ash (aerosols) and trace gases such as sulphur dioxide (SO2) into the atmosphere. These ejecta can have considerable impact on the safety of air traffic and on human health. Ground-based monitoring is carried out at only a limited number of volcanoes: most volcanoes are not monitored on a regular basis, in particular the remotely located volcanoes. Global observations of SO2 and aerosols derived from satellite measurements in near-real time may therefore provide useful complementary information to assess possible impacts of volcanic eruptions on air traffic control and public safety.

The *Support to Aviation Control Service* (SACS) of Stage II of GSE-PROMOTE focuses on the timely delivery of SO2 data derived from different satellite instruments, such as SCIAMACHY, OMI and GOME-2, as well as a volcanic ash indicator based on SEVIRI data. This will allow for monitoring the occurrence and extension of volcanic eruptions and plumes. Extention of the Service with IR data, from instruments such as IASI and AIRS, and an aerosol indicator will increase the potential of the Service.

On the basis of selection criteria of exceptional SO2 emissions, the Service sends notifications by e-mail to interested parties, with a reference to a dedicated webpage. In the event of an "SO2 event", the location of the SO2 peak value is used to start backward and foreward trajectories on the basis of meteorological data (wind, temperature, pressure, etc.), to facilitate the interpretation of the satellite observations and to provide an indication of the source and of the plume height.

The service is primarily designed to support the Volcanic Ash Advisory Centres (VAACs) in their official task to gather information on volcanic clouds. On the basis of this, the VAACs issue advices and alerts to airline and air traffic control organisations on the possible danger of volcanic clouds. Other users interested in the data are local Volcanic Observatories.

Website for NRT service and data archive: http://www.temis.nl/aviation/so2.php

OPTIMAL ESTIMATION AND JOINT RETRIEVAL OF AEROSOL LOAD AND SURFACE REFLECTANCE USING MSG/SEVIRI OBSERVATIONS: COMPARISON WITH AERONET AND MODIS AEROSOL PRODUCTS

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ABSTRACT

The new Land Daily Aerosol Algorithm has been recently developed at EUMETSAT to derive the mean daily tropospheric aerosol load and surface reflectance from observations acquired by the SEVIRI radiometer on-board the Meteosat Second Generation satellites. Based on the Optimal Estimation method, this algorithm infers the aerosol optical depth from a forward radiative transfer model against daily accumulated observations in the 0.6, 0.8 and 1.6 SEVIRI bands. These daily time series provide the angular sampling used to discriminate the radiative effects that result from the surface anisotropy, from those caused by the aerosol scattering. The inverted forward model explicitly accounts for the surface anisotropy and the multiple scattering for the coupled surface-atmosphere system. The aerosol classes used for the inference are defined by their single scattering albedo and their phase function. These classes are the result of an original analysis of ground-based observations provided by AERONET, accounting for the sphericity and the non-sphericity of the aerosol particles. In this context, the Optimal Estimation method provides a rigorous mathematical framework to combine satellite data, prior information on the observed system, and the modelling representation of that system. The retrieval error resulting from the measurement and forward model uncertainties can be explicitly calculated. A detailed comparison with AERONET and MODIS aerosol products is presented, together with an analysis of the error covariance matrix of the retrievals.

SATELLITE OZONE OBSERVATIONS: STRATOSPHERIC OZONE TRENDS IN A CHANGING CLIMATE

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ABSTRACT

Regular and global ozone observations from space started in the late 1970s with the TOMS and SBUV series. The European contribution started with GOME1 aboard ERS1 (launched 1995) and has been continued wíth SCIAMACHY/ENVISAT (launch in 2002) and GOME2/METOP (launch in 2006) since then. With two more GOME2' planned for launch in 2011 and 2015, global ozone observations from space using the UV spectral range will cover more than three decades. Since the 1970s a steady decline in total ozone at middle latitudes has been observed and were confirmed by satellite observations. In addition dramatic ozone depletion occurs during spring at polar latitudes ("ozone hole"). While the ozone hole is a recurring phenomena in the southern hemisphere, ozone depletion above the Arctic have been more sporadic, nevertheless in some cold polar winters dramatic ozone losses were observed as well. Since the middle 1990s, we observe a modest increase in stratospheric ozone. With the success of the Montreal Protocol banning cfcs and related ozone depleting compounds, stratospheric chlorine has peaked by the end of the 1990s and started a modest decline, so that ozone recovery may be expected. However, ozone at middle to high latitudes show large inter-annual variability. Natural processes, such as solar activity, major volcanic eruptions, and dynamical processes that change global circulation patterns (Brewer-Dobson circulation) regulating ozone transport into high latitudes contribute to this variability. Currently, it is not clear if a changing climate will accelerate ("super-recovery") or delay ozone recovery in coming decades.

THE CHARACTERISTICS OF SPATIAL AND TEMPORAL DISTRIBUTION OF TROPOSPHERIC NO2 OVER CHINA DURING 1996~2007 BASED ON SATELLITE MEASUREMENT

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ABSTRACT

The characteristics of spatial and temporal distribution of tropospheric NO_2 column density concentration over China are presented, on the basis of measurements from the satellite instruments GOME and SCIAMACHY. From these observations, monthly averaged tropospheric NO_2 variations are determined for the period 1997 to 2006. The trend and seasonal cycle are also investigated. The possible source of tropospheric NO_2 over megacity area is discussed in this text. The results show a large growth of tropospheric NO_2 over eastern China, especially above the industrial areas with a fast economical growth, such as, Yangtze delta region and Pearl River Delta region because of the prominent anthropogenic activity. There is a rapid increase of tropospheric NO_2 over megacities in China. For instance, Shanghai had a linear significant increase in NO_2 columns of ~20% per year (reference year 1997) in the period 1997–2006, which is the rapidest increase among all the selected cities. The seasonal pattern of the NO_2 concentration shows a difference between east and west China. In the eastern part of China, an expected winter maximum in seasonal cycle is found because the prominent anthropogenic activity and meteorological conditions. In the western part this cycle shows a NO_2 maximum in summer time, which is attributed to natural emissions, especially soil emissions and lightning. A Quickly increasing vehicle population may contribute to the increase of tropospheric NO_2 over megacity in China for the remarkable correlation for vehicle population with tropospheric NO_2.

SATELLITE OBSERVATIONS OF TROPOSPHERIC NO2 COLUMNS OVER SOUTH EASTERN EUROPE

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ABSTRACT

Satellite observations of nitrogen dioxide (NO_2) tropospheric columns over SE Europe are analyzed to study the characteristics of the spatial and temporal variability of pollution in this region which is considered a crossroad of different pollution sources. Analysis of the interannual variability of the tropospheric NO_2 columns is presented, on the basis of measurements from four satellite instruments GOME/ERS-2, SCIAMACHY/Envisat, OMI/Aura and GOME-2/MetOp. Two different operational algorithms for the retrieval of tropospheric NO_2 are considered, the one developed jointly by KNMI and BIRA and the other developed by the University of Bremen. The aim of this work is to assess the ability of the satellite tropospheric NO_2 observations, based on different sensor and/or algorithms, to differentiate between known locally polluted and unpolluted sites, between local and regional sources of NO_2 and to detect potential transboundary transport of the pollutant in the area under study. In addition the consistency of the different satellite instruments/algorithms is investigated when compiling long-term data sets for the purposes of pollution monitoring. Tropospheric NO_2 amounts are simulated for the domain under study with a regional photochemical air quality model (CAMx) and are compared with the satellite data. It is found that in most of the cases the model reveals similar spatial patterns with the satellite observations, while over certain areas (for e.g. Istanbul) large discrepancies are found, which again appear different from sensor to sensor.

RECENT DEVELOPMENTS IN THE ASSIMILATION OF SATELLITE OBSERVATIONS AT ECMWF

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ABSTRACT

Over the past few years, the importance of satellite data has progressively increased, to the extent that satellite systems now provide the main sources of information for NWP data assimilation systems. Its contribution to forecast skill in the Northern Hemisphere is now more important than that of radiosondes. In the Southern Hemisphere forecast skill has dramatically improved over the last five years, and is now at a similar level to that of the Northern Hemisphere. This is due to a combination of NWP model improvements and an enhanced use of satellite observations at large in data assimilation schemes. In particular, a robust and sustained positive impact of satellite data in modern data assimilation systems has been obtained from the direct use of radiance observations.

This presentation will focus on the most recent research and developments undertaken at ECMWF towards further improvements in the use of satellite data in our 4D-VAR assimilation system.

We will report on our consolidated experience with METOP, the first operational European polar-orbiting satellite, after more than a year of use in operations for most of the instruments. A special focus will be dedicated to the progress made in the exploitation of the advanced infrared sounder IASI.

Another area of active research at ECMWF concerns the assimilation of satellite radiances in all-weather conditions (rain-affected microwave radiances, cloud-affected infrared radiances,…). The latest status of this activity will be highlighted, together with our long term strategy to unify the treatment of satellite observations across different weather regimes.

In support to a better use of infrared sounding data and in coordination with the development of an atmospheric composition monitoring capability, the ECMWF ozone analysis is being enhanced, making active use of the ENVISAT Sciamachy and AURA OMI data, and the latest developments in this area will also be emphasised.

Last but not least, and after more than one year of routine operations, this talk will relate the ECMWF experience on the assimilation of GPS radio-occultation measurements (in particular from the COSMIC constellation).

USE OF SATELLITE OBSERVATION FOR CONSTRAINING CLOUD PARAMETERIZATION IN A NUMERICAL WEATHER PREDICTION MODEL

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ABSTRACT

Mesoscale models offer an ideal framework for performing detailed and explicit simulations of cloud and aerosols. First these models are able to follow the time evolution of different moments of the cloud and aerosol distributions in the context of real meteorological conditions. Second the gridmesh of a mesoscale model is of the same size than a satellite pixel facilitating a comparison without it being necessary to resort to additional assumptions on size. Here we adopt a model-to-satellite approach, in which satellite brightness temperature (BT) images are directly compared to BTs computed from predicted model fields. The approach is especially powerful in identifying discrepancies of cloud cover forecasts with BTs at 10.8 μm. The model-to-satellite approach associated with the BT difference (BTD) technique can also verify specific forecasts such as cirrus cover, dust occurrence, and convective overshoots. Recent applications of the approach to the MSG observations will be shown. In particular, the BTD technique leads us to improve the cloud scheme of the Meso-NH model by tuning a critical parameter in a cirrus parameterization. This improvement yields a better predicted diurnal cycle of upper-tropospheric humidity in the Tropics. The BTD technique highlights the diurnal cycle of Saharan dust that is correctly predicted by Meso-NH. The model-to-satellite approach is further combined with the calculation of meteorological scores for an objective and long-term evaluation of the model forecasts. These recent applications of the approach to the MSG observations and the Meso-NH forecasts will be shown in the context of AMMA and TROCCINOX field campaigns over West Africa and Brazil, respectively.

TOWARDS IMPROVED FORECASTS OF ATMOSPHERIC AND OCEANIC CIRCULATIONS OVER THE COMPLEX TERRAIN OF THE EASTERN MEDITERRANEAN

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ABSTRACT

Forecasting atmospheric and oceanic circulations accurately over the Eastern Mediterranean has proved to be an exceptional challenge. The existence of fine-scale topographic variability (land/sea coverage) and seasonal dynamics variations can create strong spatial gradients in temperature, wind and other state variables, which numerical models may have difficulty capturing. The Hellenic Center for Marine Research (HCMR) is one of the main operational centers for wave forecasting in the eastern Mediterranean. Currently, HCMR's operational numerical weather/ocean prediction model is based on the coupled ETA/Princeton Ocean Model (POM). Since 1999, HCMR has also operated the POSEIDON floating buoys as a means of state-of-the-art, real-time observations of several oceanic and surface atmospheric variables. This study attempts a first assessment for improving both atmospheric and oceanic circulation by initializing a regional Numerical Weather Prediction (NWP) model with high-resolution sea surface temperatures (SST) from remotely sensed platforms in order to capture the small scale dynamical characteristics.

Results from case studies show that hi-resolution SST highlight areas over the eastern Mediterranean where phenomena such as Deep Water Formation, Ekman upwelling, and "heat" island and shadowing effects are taking place. The direct income on the short-term forecast is underscored in terms of radiation budget, precipitation and front-tracking.

ASSIMILATION OF SEVIRI CLOUD TOP PARAMETERS IN THE MET OFFICE REGIONAL FORECAST MODEL

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Met Office

ABSTRACT

For regional numerical weather prediction models one of the critical variables to correctly forecast is the cloud field in terms of coverage and the vertical distribution of cloud. Forecast variables such as surface temperature, visibility and precipitation are strongly influenced by the analysed cloud field. The SEVIRI imager on the Meteosat Second Generation satellites provides 15 minute imagery of the cloud field over the N. Atlantic and European areas at a resolution of about 5km. The Met Office Autosat processor routinely generates many products from the SEVIRI imagery including cloud amount and cloud top pressure. These parameters have been provided indirectly to the regional model assimilation for several years using the Nimrod nowcasting system where they are analysed along with radar and surface observations. However experiments have now been carried out to assimilate the SEVIRI cloud products directly into the 4D-Var regional model assimilation system by allowing the cloud top pressure and amount information to influence the model humidity field. The impact of the SEVIRI cloud products on the regional model analyses and forecasts will be described and the plans for operational implementation outlined.

ASSIMILATION OF FREQUENT SATELLITE PRECIPITATION OBSERVATIONS INTO A NUMERICAL WEATHER PREDICTION MODEL. APPLICATION TO FLASH FLOOD FORECASTING

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ABSTRACT

In this study, we investigate two methodologies to assimilate satellite precipitation observations into a numerical weather prediction (NWP) model. These include moisture nudging and Ensemble Kalman Filter assimilation. The Ensemble Kalman Filter assimilation, although theoretically superior to moisture nudging, is a computational intensive procedure. Therefore, simpler formulations such as moisture nudging are still viable alternatives allowing finer spatial resolutions and more accurate treatment of physical processes. The motivation behind the study is the improvement of short term quantitative precipitation forecasting in flash flood forecasting. The numerical model used in the study is the Weather Research and Forecasting (WRF) Model. The moisture nudging strategy consists of continuously adjusting the model relative humidity as a function of the differences between model and satellite precipitation, while the Ensemble Kalman filter is based on a local formulation. That is the WRF domain is divided into smaller sub-domains and the ensemble assimilation procedure is applied sequentially to these sub-domains. The two methodologies are tested using real data collected during flash floods that occurred in Central and Eastern Europe. Both ground-radar and satellite observations are considered in the analysis. First the radar data are continuously assimilated into the model initialized from a larger scale analysis to determine the reference state variables. Then, the model is reinitialized and the satellite precipitation estimates are assimilated using the two methodologies. The assimilation methodologies are evaluated in terms of both state variables and precipitation forecasting skills.

PROGRESS TOWARD THE ASSIMILATION OF AIRS CLOUDY INFRARED RADIANCES AT CMC

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Environnement Canada

ABSTRACT

Numerical Weather Prediction centers routinely assimilate infrared radiances identified as free from cloud contamination.
This condition represents an important limitation. Indeed, the field of view (FOV) of a typical infrared sounder (~14-17 km diameter) is cloudy approximately 75% of the time (Wylie and Menzel 1999). To limit the probability of cloud contamination, the selection criteria have to be restrictive.
Consequently, there is a substantial loss of available information in regions thought to be of highest meteorological interest (McNally 2002).
The assimilation of cloudy infrared radiances represents a major scientific challenge, and even a partial solution, i.e. applicable to specific cloud conditions, could yield important benefits in terms of impact on forecasts.
In the proposed approach, the impact of clouds on infrared radiances is modelled via a cloud emissivity model. This simplified method allows to account for the impact of clouds on infrared radiances using only 4 effective cloud parameters : the cloud top pressure, the cloud effective emissivity at 15µm, the effective radius for liquid phase clouds and the effective diameter for ice phase clouds.
The potential usefulness of this approach was already demonstrated using monte-carlo experiments in a 1Dvar context. The approach was therefore introduced in the 3D/4DVAR assimilation code of CMC to allow for testing in more realistic conditions. At this conference, we will present various assimilations experiments using this new approach, focusing in particular on the impact on the quality of the resulting forecasts.

USE OF CLEAR SEVIRI RADIANCES IN THE METOFFICE MESO-SCALE ASSIMILATION SYSTEM

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ABSTRACT

A series of short assimilation experiments, using recent JCMM test cases, were run using the 4/1 km data assimilation/forecast system to study the impact of the SEVIRI MSGRAD radiances. The lateral boundary condition are obtained from the operational NAE. The low-level SEVIRI channels required some tuning of observation errors and quality control. A simple land/sea emissivity model was used for the SEVIRI radiances in the 4 km assimilation and it was necessary to develop a lat/long mask at SEVIRI pixel resolution for blacklisting regions of complex surface terrain including regions of mixed land and water.

THE ASSIMILATION OF DATA FROM THE METOP SATELLITE AT THE MET OFFICE

Simon Keogh, Fiona Hilton, Nigel Atkinson, Brett Candy, Steve English, John Eyre

Met Office

ABSTRACT

EUMETSAT's first MetOp satellite was launched in October 2006 to provide polar-orbiting data for meteorological applications. Data from the AMSU- A, MHS and HIRS instruments have been assimilated at the Met Office since January 2007. These instruments, combined with ATOVS data from the NOAA satellites, form the backbone of our satellite data assimilation system, consistently demonstrating significant forecast impact.

MetOp also carries new instrumentation: IASI, an infrared interferometer, provides detailed information for temperature and moisture sounding complementary to ATOVS. ASCAT, the advanced scatterometer, is capable of measuring ocean surface wind vectors without significant rain contamination. These two new data types have been assimilated operationally at the Met Office since November 2007.

Results from impact trials will be given in this paper.

RECENT DEVELOPMENTS IN ASSIMILATION OF SATELLITE DATA IN THE MSC 4D-VAR ANALYSIS AND FORECAST SYSTEM

Stephen Macpherson, Louis Garand, Michel Roch, Cecilien Charette, Josep Aparicio, Godelieve Deblonde, Mark Buehner, Alain Beaulne, Nicolas Wagneur, Chantal Cote

Environment Canada

ABSTRACT

A new version of the global Meteorological Service of Canada (MSC) operational forecast model is being evaluated with model top at 0.1 hPa as opposed to the current version with top at 10 hPa. This allows for assimilation of radiances from higher-peaking channels from AMSU-A (4 new channels) and AIRS (~35 new channels in addition to the current 87 channels). In addition GPS radio-occultation data are assimilated up to 40 km (~3 hPa). The assimilation of METOP-A AMSU-A and MHS data and DMSP16 SSMIS radiances will also be tested in both the 10 hPa and 0.1 hPa top versions of the global model. The impacts of these additional satellite data on analyses and forecasts are presented.

GRAS LEVEL 1B PRODUCT VALIDATION WITH 1DVAR RETRIEVALS

Christian Marquardt, Yago Andres, Leonid Butenko, Axel von Engeln, Eoin O'Clerigh, Francisco Sancho

EUMETSAT

ABSTRACT

With the "GNSS Receiver for Atmospheric Sounding" (GRAS), Eumetsat's Metop satellite carries the first operational instrument performing radio occultation soundings of the atmosphere. Radio occultations exploit variations in signals emitted by the satellites of the Global Positioning System (GPS) as they travel through the limb of the Earth's atmosphere. They provide highly accurate information on temperature in the lower and mid stratosphere as well as (with somewhat lower accuracy) moisture in the troposphere. Due to their unique combination of measurement characteristics (weather independence, high vertical resolution, high accuracy, no calibration, no instrument drifts), radio occultations have been proven to be highly useful in both Numerical Weather Prediction (NWP) and climate monitoring.

The primary GRAS products Eumetsat provide to its users are vertical profiles of bending angles. A major difficulty encountered in the validation of this data is that other instruments, with the exception of other co-located radio occultation observations, do not measure the same quantity. An often used approach to validate them anyway is to either forward model geophysical parameters (e.g., temperature and humidity) into bending angles, or to retrieve geophysical parameters from the measurements. Statistical comparisons with other data sources - in situ measurements, satellite retrievals, or NWP data - can then be carried out.

The problem with this approach is that producing accurate error estimates and establishing a clear traceability for each of the individual measurements and/or retrieval results is often difficult. Since retrieval (or "inverse") problems are often under-determined and ill-conditioned, their solution requires the use a priori data, which contributes to the retrieval error. In regions with low information content of satellite measurements, retrieved geophysical parameters will actually be dominated by a priori rather than represent a true measurement.

In order to overcome these difficulties, Eumetsat has adopted a validation strategy using a variational retrieval methodology (1DVar) as one of its core components. Being based on Bayesian statistics, 1DVar retrievals offer a plethora of diagnostics which are also useful in the validation context. We present the application and results of this strategy during the commissioning of GRAS data.

NWP AND SATELLITE OBSERVATIONS IN 'THE YEAR OF TROPICAL CONVECTION'

Martin J. Miller

E C M W F

ABSTRACT

The period from May 2008 to September 2009 has been designated by the World Climate Research Programme and the World Weather Research Programme (THORPEX) as 'The Year of Tropical Convection'. This talk will discuss why such a focus is needed, and how the advances in NWP with its high resolution data sets together with the vast amounts of satellite data from many instruments provide a powerful combination to further our understanding of tropical convection and in turn to improve our abilities to predict weather and climate.

LATEST RESULTS ON THE ASSIMILATION OF GPS RO DATA AT THE MET OFFICE

Michael Rennie

Met Office

ABSTRACT

The presentation is on the Met Office's latest results regarding the data assimilation of radio occultation data. Radio occultation data provides high vertical resolution information on temperature, pressure and water vapour pressure and the data can be assimilated without bias correction. Current RO missions provide a global coverage with a good sampling of local solar time, providing information to regions of global models were radiosonde data is sparse. The Met Office began the operational use of GPS RO with CHAMP data from GFZ in September 2006 and in May 2007 became operational with FORMOSAT-3/COMSIC data after trials showed the data provided a significant impact. We currently use a 1D refractivity observation operator in a 4D-Var data assimilation system using RO data between from the surface up to 40 km. The presentation will include the latest results from monitoring of RO data, including GRAS data, the effect of an increase in the vertical resolution of the Met Office global model and some discussion of the use of RO in the bias monitoring of other data types, in particular satellite radiance measurements. Recent forecast impact experiments investigating the tuning of the assimilation of RO and experiments into the impact of GRAS data will be discussed.

ASSIMILATION OF LOWER TROPOSPHERIC SOUNDING AMSU CHANNELS OVER LAND AT THE MET OFFICE

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Met Office, UK

ABSTRACT

Advanced Microwave Sounding Unit (AMSU) A and B sensors onboard polar orbiting satellites (NOAA series and MetOp) are providing valuable temperature and humidity information for operational weather forecasting systems. So far, the lower tropopheric temperature sounding channels of AMSU-A are used only over sea because these channels are sensitive to surface and accurate surface modelling capabilities are limited to only over sea surfaces. For example, AMSU channels 4 and 5 have comparable sensitivity to surface and atmosphere and these channels can be assimilated over land only if we can model the surface accurately. The operational Met Office 4Dvar scheme currently uses only AMSU-A channels 6-14 over land with a fixed emissivity of 0.95. Recently, Karbou et al have developed an atlas that can derive surface emissivity from AMSU surface channels, channels 1,2,3,15 and 17 and their assimilation experiments using the atlast show improved first guess fit to observations. In the current work, monthly mean emissivity atlases are used for providing background emissivity information for the 4D Var assimilation scheme used in the Met Office. An accurate prior knowledge of skin temperature is a prime requirement to be able to use the lower tropospheric souding channels to extract useful temperature and humidity information. It is hoped that the background knowledge of emissivity from the use of atlas will help to analyse the skin temperature with the required accuracy. Emissivity and skin temperature are simultaneously retrieved in a 1Dvar pre-processing stage. The error covariance matrix is calculated assuming that the error correlation matrix is identical to the full correlation matrix. The pre-processing stage thus retrieves skin temperature and emissivities at five frequencies and performs quality control checks, thinning of observations and bias corrections. Emissivities retrieved at 50.3 GHz (AMSU channel3) was used for all channels 6-14. The chosen observations along with retrieved emissivity and skin temperature are used in the 4Dvar assimilation scheme, where temperature and humidity will be analysed.

THE ASSIMILATION OF INFRARED RADIANCES IN CLEAR-SKY AND CLOUDY CONDITIONS IN THE HIRLAM MODEL

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ABSTRACT

The limited area numerical weather prediction model HIRLAM has been adjusted to make use of the infrared (IR) radiances measured by SEVIRI on-board the MSG satellites. Therefore, the HIRLAM variational data assimilation system has been modified to take advantage of this additional observation type. Especially 4D-Var frameworks, which is one option in HIRLAM's assimilation system, are assumed to be capable of utilizing the information content provided by SEVIRI with its high spatial and temporal resolution.

First comprehensive impact studies are currently carried out to investigate the impact of SEVIRI's clear sky IR data on HIRLAM's 3D-Var and 4D-Var analysis and forecast fields. The two water vapour channels were selected within these experiments. In all studies, the system seems to be able to use SEVIRI observations to decrease an upper-tropospheric humidity bias in the NWP model, which is found when comparing model fields and collocated radiosondes. This impact is visible up to 48 hours integration time with a decreasing magnitude. In addition, we find a slight positive impact on geopotential height and mean sea level pressure forecasts. This impact is a bit more distinct for 4D-Var and during summer.

Furthermore, we examine the utilisation of SEVIRI observations in the presence of low level clouds. Here we consider clouds, whose effect on the measured radiance (water vapour channels) is negligible or small enough to be parametrized properly in the radiative transfer model by using derived cloud information such as cloud fraction and cloud top pressure.

Additionally, we investigate the feasibility to extend the observation operator to include a simplified moist physics scheme. Statistics of these modelled clouds in NWP model space and in observation space will be discussed. This framework can also be used to determine the sensitivity of modelled clouds (and subsequent simulated cloudy radiances) to NWP model variables. Under certain contidions, this could then be used to assimilate cloud-affected radiances.

GRAS RADIO OCCULTATION MEASUREMENTS ONBOARD METOP

Axel von Engeln, Christian Marquardt, Yago Andres, Leonid Butenko, Eoin O'Clerigh, Francisco Sancho, Dieter Klaes

EUMETSAT

ABSTRACT

GRAS is the first operational radio occultation instrument in space. It measures phase delays of GPS satellite signals as observed from Metop in Low Earth Orbit (LEO) when viewed through the atmospheric limb. These phase delay measurements can be converted into a so-called bending angle profiles if the position of the involved 2 satellites is accurately known. Hence 2 steps are required in the operational processing of radio occultation data: 1. a precise orbit determination; 2. the derivation of bending angle profiles. Precise GPS orbits are provided by a dedicated ESA/ESOC service while the Metop orbit is calculated in Near Real Time (NRT) at EUMETSAT's ground facility.

Radio occultation data from several research missions are already operationally assimilated into Numerical Weather Prediction Models either by using bending angle profiles directly, or by using refractivity profiles which can easily be derived from bending angles. These measurements are complementary to other nadir sounding instruments and provide valuable information on the atmospheric temperature in the altitude range from near the ground to about 35 km.

The presentation will first give an overview of the GRAS instrument and the data processing and will then focus on recent results of the operational processing chain. Offline validation of GRAS profiles with forward propagated ECMWF fields and with COSMIC radio occultation measurements will be covered.