EUMETSAT SAF and EARS scatterometer wind services at KNMI

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Abstract

Scatterometer sea-surface wind observations are being successfully assimilated into Numerical Weather Prediction (NWP) models, and used for nowcasting. KNMI provides near-real time scatterometer wind products based on data from several satellites. Currently global data from SeaWinds on QuikSCAT and ASCAT on MetOp are available. Regional data, mainly in the North Atlantic and European seas, are still available from the scatterometer on ERS-2. Example wind fields are shown for hurricane Dean where all three scatterometers measure its eye within 4 hours.

INTRODUCTION

Scatterometer winds have proven to be very useful for the analysing and forecasting of dynamic weather (see Isaksen and Stoffelen, 2000). The Royal Netherlands Meteorological Institute (KNMI) is involved in the Level 2 wind processing of the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF, http://www.osi-saf.org/) and the EUMETSAT Advanced Retransmission Service (EARS, http://www.eumetsat.int/Home/Main/What_We_Do/Satellites/EARS_System/index.htm?l=en). In the OSI SAF, global scatterometer wind products are made with a timeliness of typically 2 to 3 hours, whereas in the EARS project regional products, mainly in the North Atlantic and European regions, are delivered with a target timeliness of 30 minutes. The products are available to registered users and can also be viewed on the KNMI website.

CURRENT PRODUCTS

At the moment of writing (autumn 2007), four different wind products are available in near-real time:

1. OSI SAF SeaWinds 100-km product (operational status).
2. OSI SAF SeaWinds 25-km product (currently experimental status, but expected to become operational soon).
3. OSI SAF ASCAT 25-km product (currently demonstration status, expected to become pre-operational soon).
4. EARS ERS-2 25-km regional product (demonstration status, will be supported for as long as ERS-2 will be available).

The timeliness of the QuikSCAT products is typically 2.5 hours after sensing time and the ASCAT data are normally available after 2 hours. The ERS-2 data are acquired by regional ground stations rather than orbit-by-orbit. With the loss of the on-board ERS-2 tape recorders, the European Space Agency (ESA) developed a new strategy for on-ground data acquisition. Rather than 14 ERS-2 data acquisitions per day, the acquisition rate has more than tripled, allowing data coverage in the North Atlantic and adjacent seas. At KNMI, a procedure has been developed to provide on-the-fly unique scatterometer winds, i.e., swath overlaps are taken out, and incomplete Wind Vector Cells are combined for completion. Generally, the ERS-2 winds are already available to the user after 1 hour, which makes them particularly useful for weather nowcasting. This product is provided as a predecessor for the EARS ASCAT winds.

In the context of the EUMETSAT Numerical Weather Prediction Satellite Application Facility (NWP SAF, http://www.metoffice.gov.uk/research/interproj/nwpsaf/), KNMI has developed generic software for scatterometer wind processing. This software features:

- Instrument-specific Quality Control procedures (see Portabella and Stoffelen, 2002).
- Generic wind inversion procedure for all kinds of scatterometer data.
- A 2D Variational Ambiguity Removal (2D-VAR) scheme providing meteorologically consistent scatterometer wind fields (see De Vries, Stoffelen and Beysens, 2005).

The scatterometer processing software is available through the NWP SAF and it is used for the scatterometer processing at KNMI.

All wind products are in Binary Universal Form for the Representation of meteorological data (BUFR) and made available to the users via a FTP server; access is granted on request. Most of the products are also available through EUMETSAT's Digital Video Broadcast Data Distribution System (EUMETCast). Service messages are distributed to all registered users. The products are archived at KNMI; data can be obtained by sending a request to scat@knmi.nl. The OSI SAF global wind products will also become available in the EUMETSAT Unified Meteorological Archive and Retrieval Facility (UMARF).

PRODUCT VISUALISATION

Each product is visualised in near-real time on the KNMI website: go to http://www.knmi.nl/scatterometer/ and look for the wind products links. For each product, an overview page is available showing the winds on a global map. The user can click anywhere on the coloured winds and a detailed wind vector plot will appear. One can choose between a view containing wind arrows or wind flags. In the detailed plots, also an infrared cloud image from a METEOSAT, GOES or GMS geostationary satellite is shown as background. Moreover, Numerical Weather Prediction (NWP) winds from the High Resolution Limited Area Model (HIRLAM) used at KNMI are shown in those regions where they are available.

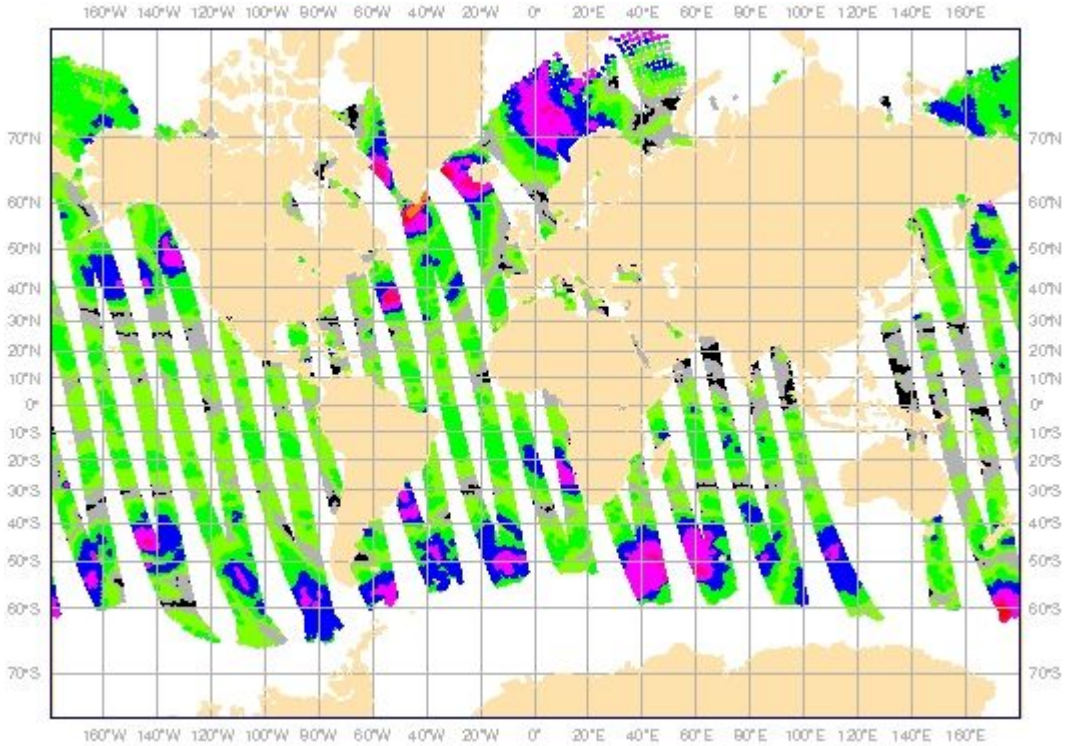

Figure 1: **Display of global ASCAT winds over the last 22 hours from the KNMI website. Colours indicate the wind speed. The plot shows the ascending tracks of 3 October 2007, descending tracks are available in a separate plot.**

Product monitoring information is also available on the web. Each product page contains a 'Monitoring information' link, leading to a page where mean values of selected parameters are plotted as a function of time. The monitoring results of different parts of the satellite swath, corresponding to different across-track locations or Wind Vector Cell (WVC) numbers, are plotted. The user may

choose to view the data of the last seven days or the information of the previous three month period (daily averages).

The Maximum Likelihood Estimator (MLE), which is shown on the monitoring pages, is a normalised measure of the minimum distance between the measurements and the Geophysical Model Function (GMF) surface (i.e., MLE of first-rank wind solution). It provides a good indication of the quality of the wind retrieval (see Portabella and Stoffelen, 2001) and therefore is suitable for monitoring purposes. Scatterometer winds are also compared with NWP model winds from the European Centre for Medium-Range Weather Forecasts (ECMWF), and information considering the timeliness of the wind production is provided.

The monitoring of relevant quality parameters as a function of time yields a sensitive method of detecting deviations from normal operation. However, one must be careful to regard the difference with reference background NWP model winds as the 'true' accuracy of the product, since both the NWP model winds and the scatterometer winds contain errors. Deviations in product quality usually appear as a step in one or more of the monitoring plots.

The incoming data at KNMI are processed into a wind product within 10 minutes. The end to end timeliness, shown on the monitoring pages, is measured from the end of satellite data acquisition until the availability of the wind product for the end user. As such, the timeliness is to a great extend out of the scope and control of KNMI. The timeliness information is however of interest to the end users and therefore included in the monitoring web page.

EXAMPLE: HURRICANE DEAN

On 21-22 August 2007, Hurricane Dean crossed Mexico's Yucatan Peninsula. Wind speeds as high as 260 km/h have been reported. All three scatterometers (i.e., SeaWinds, ASCAT, and ERS-2) crossed near the eye of the hurricane within a few hours. The pictures below are taken from the KNMI website and show the usability of the scatterometer winds, providing timely and precise information on the hurricane position and intensity.

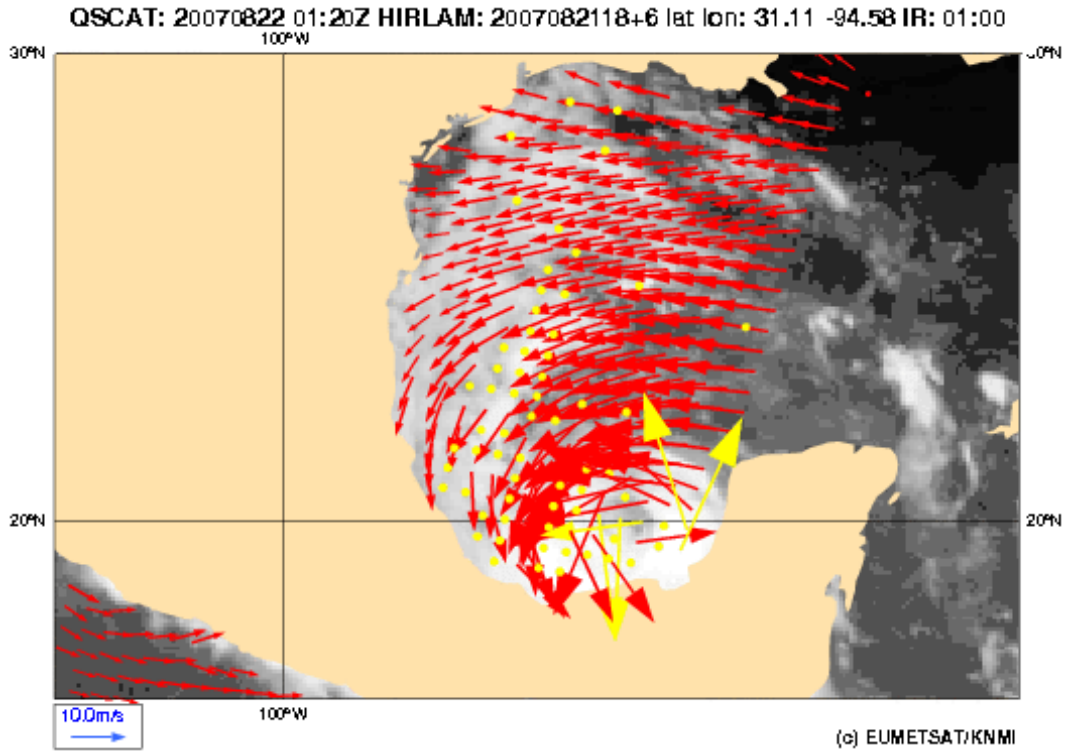

Figure 2: **Dean as observed by SeaWinds on QuikSCAT on 22 August 2007, 0:46Z. The product is on 25-km resolution, but it is displayed on 50-km resolution.**

The magenta markers on top of the wind arrows denote land presence. Yellow wind arrows indicate that the Variational Quality Control flag is set, i.e. the Wind Vector Cell is spatially inconsistent. A yellow dot means that the KNMI Quality Control Flag is set.

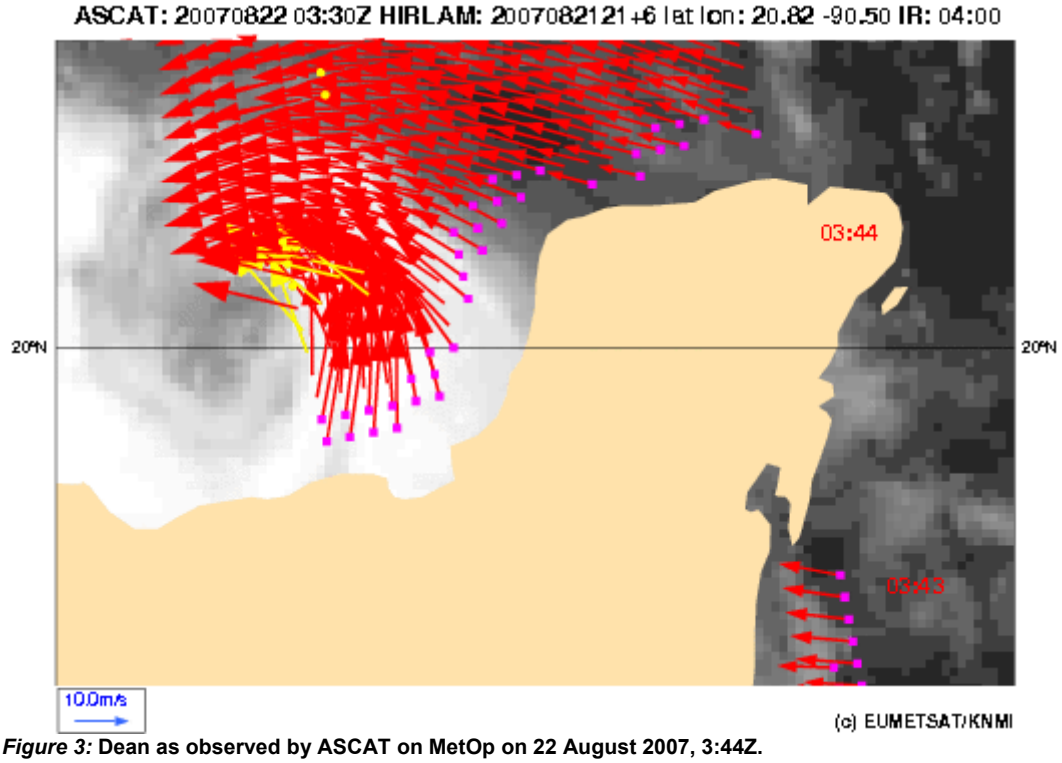

Figure 3: **Dean as observed by ASCAT on MetOp on 22 August 2007, 3:44Z.**

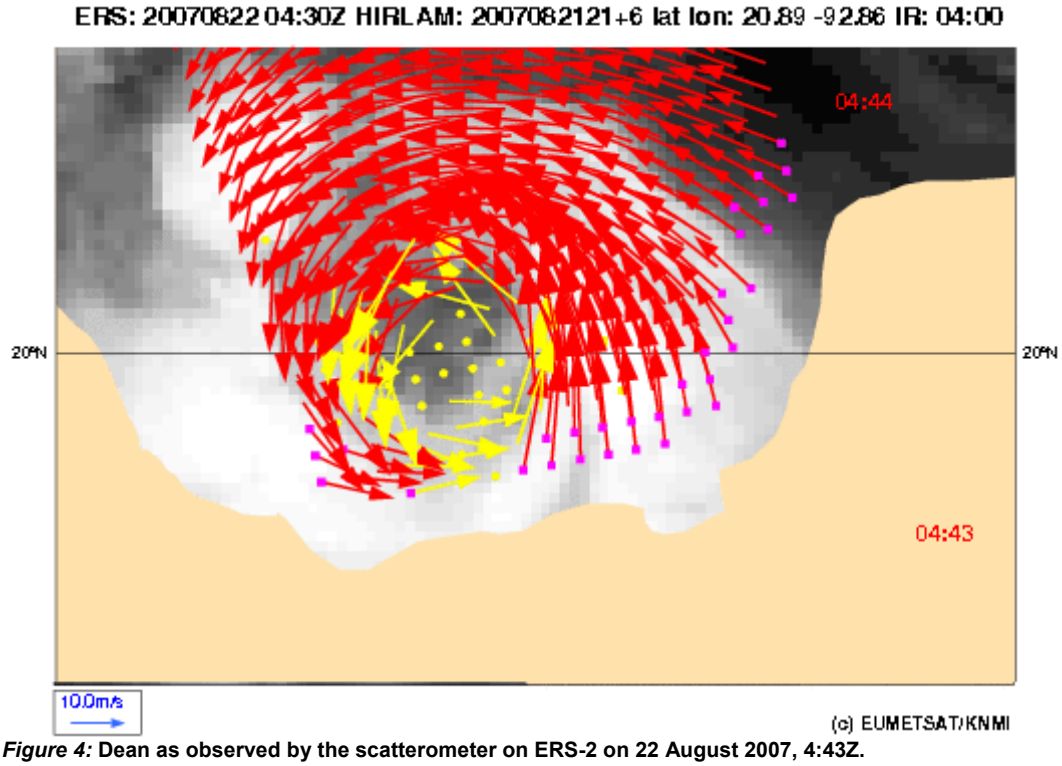

Figure 4: **Dean as observed by the scatterometer on ERS-2 on 22 August 2007, 4:43Z.**

The highest reported scatterometer winds are in the order of 25-30 m/s (90-110 km/h) near the eye of the hurricane, but these are average values over a 25-km wind vector cell. Locally, significantly higher wind speeds occur.

The ERS and ASCAT instruments operate in the C-band and are less sensitive to rain than the QuikSCAT instrument which operates in the Ku-band. Hence, less wind vectors are flagged by the quality control (yellow dots).

FUTURE PRODUCTS

For the near future, it is planned to provide regional ASCAT winds on 25-km and 12.5-km with a timeliness of 30 minutes in the EARS project. However, this depends on the availability of High Rate Picture Transmission (HRPT) data transmissions from MetOp-A, which are currently not available due to a satellite anomaly. Plans are developed currently for an alternative means of fast data delivery.

In the OSI SAF, ASCAT products on 12.5-km are planned to become available in 2008. An ASCAT 'coastal' wind product is planned for 2009.

ACKNOWLEDGEMENTS

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The KNMI website (http://www.knmi.nl/scatterometer/publications/) contains up-to-date documents and user manuals concerning the scatterometer wind products at KNMI.