Remote Sensing of vertical integrated water vapor using SEVIRI infrared measurements

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1. Background

A methodology for the retrieval of atmospheric water vapor is presented which utilizes the infrared-channels of the Spinning Enhanced Visible and Infrared Imager (SEVIRI) on board the geostationary satellite METEOSAT8. The measured SEVIRI brightness temperatures depend on the amount of integrated water vapor (IWV) and thus allow its estimation.
The developed algorithms are based on different data sets, which relate SEVIRIs measured brightness temperatures to the corresponding IWV. Considering the different datasets, two algorithms were developed: Simulation Based Algorithm (SBA) and Measurement Based Algorithm (MBA). In both cases the SEVIRI infrared channels 6.2µm, 7.3µm, 8.7µm, 10.8µm, 12.0µm and 13.4µm are utilized. The inversion was made by means of multiple non-linear regressions. Therefore, an artificial neural network (multilayer perceptron type) was used. The developed algorithms allow the retrieval of the integrated water vapor above land and ocean regions during the day and at night. The product can be realized every 15 minutes for the full disk.

2. Data Used

a. Radiative Transfer Simulations using SOI-Model

First, we performed a huge number of radiative transfer simulations for a wide range of atmospheric and surface conditions using the Successive Order of Interaction (SOI) model. The calculation of the surface emissivities and the optical depths for the atmospheric model layers was taken from RTTOV-8.
To set up the atmospheric condition we used NCEP's Global Forecast Model (GFS) 12-hour forecast fields. Afterwards the simulated SEVIRI brightness temperatures were bias corrected.

b. Direct Data Allocation of foreign IWV Products

Second, we utilized the IWV products from NASAs Moderate Resolution Imaging Spectroradiometer (MODIS) on TERRA for land pixels and Advanced Microwave Scanning Radiometer (AMSR) on AQUA for sea pixels. The used MODIS IWV products consist of retrievals from near-infrared and infrared measurements.
After correction of the differential spatial resolution, the above products were assigned to the corresponding SEVIRI measurements.

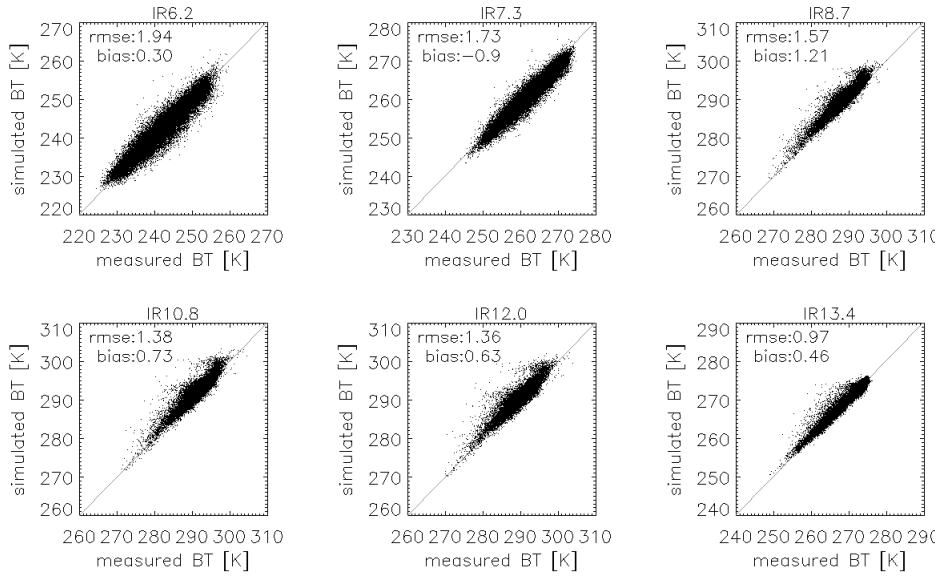

Figure 1: Comparison of simulated and measured SEVIRI radiances.

3. First Results

First results of the algorithms show an accuracy between 0.3 and 0.5 g/cm² for the MBA and between 0.3 and 0.6 g/cm² for the SBA. One reason for the lower accuracy of the SBA water vapor might be related to an emphasis on certain atmospheric and surface conditions used to set up the radiative transfer simulations. Generally the highest agreement is found above water surfaces, whereas comparisons above deserts show lower accuracy. Furthermore, the quality of the algorithms show a slight dependency on the satellite zenith angles, which decreases with increasing angle. Comparisons with the derived integrated water vapor from MODIS and AMSR are presented for one hemispheric scene above water and one European scene above land surfaces.

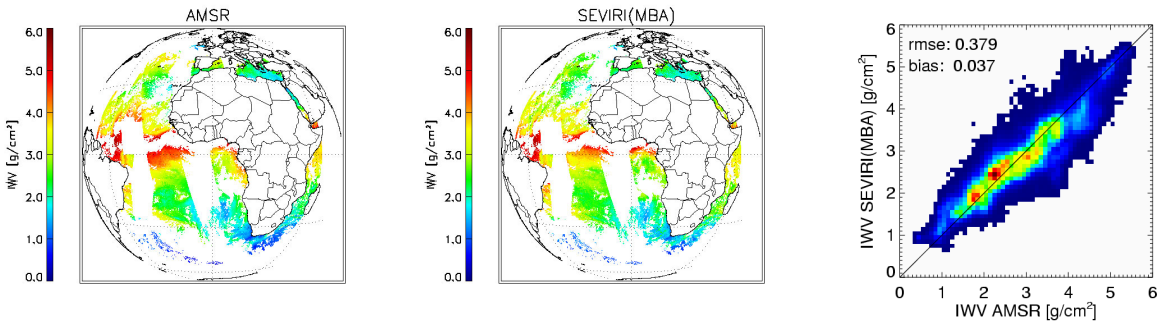

Figure 2: Comparison between the derived water vapor from SEVIRI (Measurement Based Algorithm) and AMSR measurements.

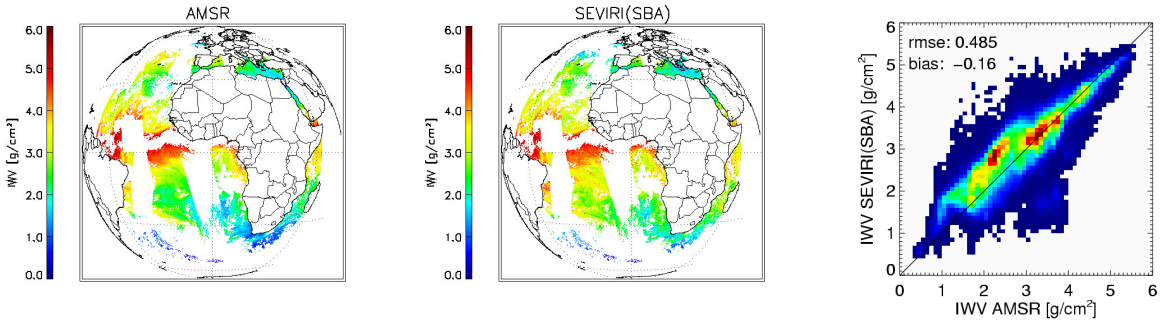

Figure 3: Comparison between the derived water vapor from SEVIRI (Simulation Based Algorithm) and AMSR measurements.

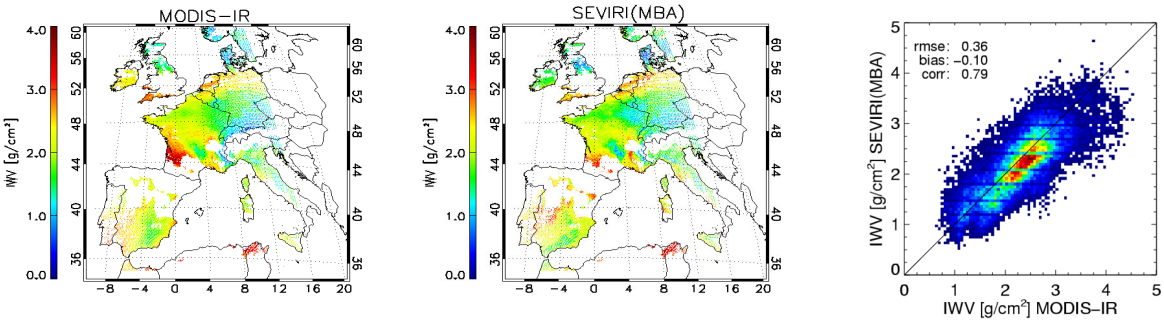

Figure 4: Comparison between the derived water vapor from SEVIRI (Measurement Based Algorithm) and MODIS infrared measurements.

REFERENCES

Heidinger, A., O'Dell, C., Greenwald, T., Bennartz, R., 2005: The Successive Order of Interaction Radiative Transfer Model Part I - Theoretical Basis, submitted to Journal of Applied Meteorology

Heidinger, A., O'Dell, C., Greenwald, T., Bennartz, R., 2005: The Successive Order of Interaction Radiative Transfer Model Part II - Model Perfomance and Applications, submitted to Journal of Applied Meteorology