Comparison of ATOVS, CHAMP and ground based humidity estimates on different spatiotemporal scales

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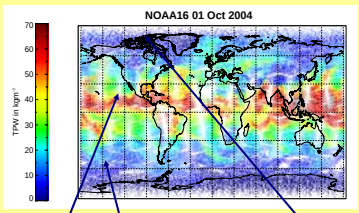
Introduction

Humidity products can be derived from a large range of different satellite sensors including infrared and microwave sounders and imagers, VIS spectrometer and radio occultation instruments.
Within the Satellite Application Facility (SAF) on Climate Monitoring (CM-SAF) data from the SEVIRI instrument on the geostationary Meteosat satellite, the ATOVS infrared and microwave instrument suite onboard the polar-orbiting NOAA and future MetOp platforms, the IASI instrument on MetOp and the microwave radiometer SSM/I onboard DMSP platforms are used to develop a water vapour climatology. From its system version 3 on (operational in March 2007) CM-SAF provides global estimates for individual instrument records.
The SAF on GRAS Meteorology (GRAS-SAF) is dedicated to radio occultation measurements from the EPS MetOp satellite, focussing on the Global Positioning System (GPS) Receiver for Atmospheric Sounding (GRAS) instrument. GRAS data is expected to improve on the traditional sounder products in the upper troposphere and lower stratosphere as well as under rainy conditions. Although the spatiotemporal sampling of the GRAS instrument is not as good as of other imagers or sounders GRAS data can be used to construct an alternative single source climate product.

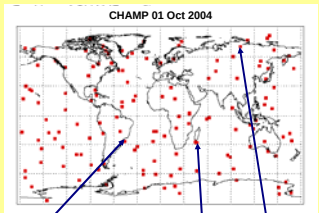
Objective

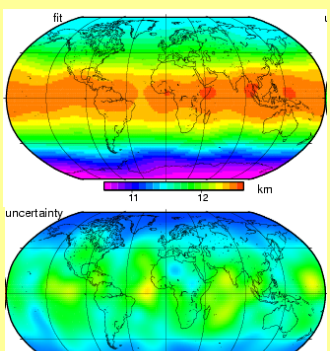
The main objective of the joint visiting scientist activity of the GRAS- and CM-SAF is the investigation of the potential role of GRAS data within the humidity product suite of the CM-SAF. Within this study a comprehensive intercomparison of CHAMP, ATOVS, and ground based temperature and mixing ratio profiles in order to better understand systematic differences between radio occultation and atmospheric sounder estimates will be performed. The understanding of the systematic differences between water vapour estimates based on totally different measurement principles is considered to be a prerequisite for the application of merging algorithms to data from different instruments into a so-called best climate data set. ATOVS and CHAMP data are used to construct daily, monthly, and seasonal maps of integrated water vapour that are analysed w.r.t. the different representation of spatial and temporal variability in the data sets. From this analysis it might be deduced on what spatiotemporal scales the individual estimates are best usable for the purpose of climate monitoring.
On this poster the two different data sources, exemplary SAF products and the in-situ data base that will be used for comparison to ground based measurements are shown for the example month of October 2004.
For the comparison data from 2004 and 2005 of ATOVS and CHAMP data will be processed in both SAFs.

Individual Soundings and Daily Sampling



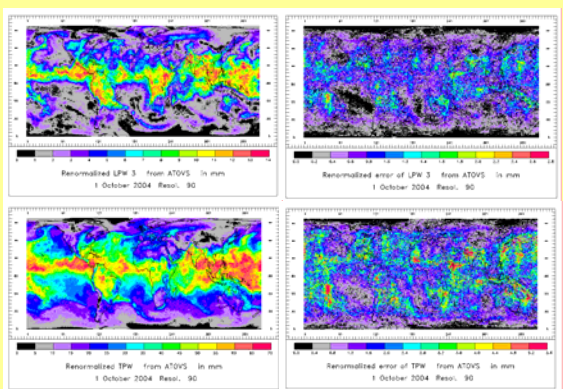
CM-SAF (ATOVS)	GRAS-SAF (GRAS)
Product Variables	
Total precipitable water; Temperature and mixing ratio profiles; Vertically integrated precipitable water, vertically averaged relative humidity and temperature in 5 layers.	Refractivity,"dry" variables; Temperature, geopotential height, humidity profiles, surface pressure; Vertically integrated variables.
Averaging Scales	
Daily, monthly, seasonal, and annual mean; Normal spatial resolution (60-90 km) gridded data; Global data set.	Monthly, seasonal, and annual mean; Low spatial resolution (e.g. 10° lat/lon gridded data); Global, hemispheric, and zonal data sets.





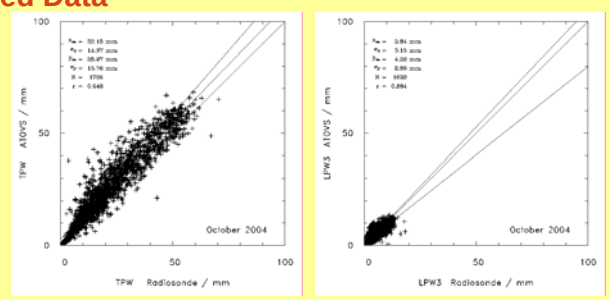
Development of climatology

Several alternative techniques can be applied to construct climatological gridded fields. Within the GRAS-SAF three alternative methods which are binning-and-averaging techniques, bayesian fitting of global spherical harmonics to the observed radio occultation data, and 3D variational assimilation of refractivities in ECMWF analysis, or other, model fields have been tested. Within the CM-SAF fields are constructed by applying a Kriging scheme that was adjusted for the use with satellite data to derive daily averages. Figures on the right show CM-SAF daily products for precipitable water in 2 layers the atmosphere together with the corresponding error estimates. Pictures to the left show a typical GRAS-SAF global map of monthly mean 200 hPa geopotential height and the corresponding error map obtained from CHAMP data employing the bayesian fitting of global spherical harmonics is shown. The four pictures to the right show middle layer 700-500 hPa (top right) and total (bottom right) vertically integrated precipitable water at 1 October 2004 derived from individual ATOVS soundings employing a Kriging algorithm. The basic temperature and moisture profiles are retrieved using the IAPP retrieval package. Figures in the left column show the daily mean value, figures in the right show the Kriging error that represents the sampling error as no retrieval error information is given for the IAPP retrieval.



Validation vs. Ground Based Data

Independent ground based temperature and water vapour measurements are needed to assess the quality of the retrieval schemes and derived products. Data from operational radiosonde networks, ground-based GPS measurements and dedicated reference sites will be used to assess the quality of the derived CM- and GRAS-SAF products. Reference site data are available from the three fixed ARM sites in Alaska (USA), Oklahoma (USA), and Nauru (Fidji) and the DWD site at Lindenberg (Germany). Additionally, a mobile ARM facility has been placed in North-West Africa during 2006. Those sites provide for instance lidar and microwave profiler measurements with high temporal resolution that enables direct matching of individual satellite retrievals. Radiosondes from the Global Upper Air Network (GUAN) can be used to assess the quality of spatiotemporal averaged products. For this radiosonde data within a given grid box are averaged. The figures to the right show a preliminary comparison of daily means of total column precipitable water (left) and a layer between 700 hPa and 500 hPa over land derived from ATOVS to GUAN radiosondes for October 2004. The comparisons have now been done for the period October 2004 to July 2005. The total precipitable water from ATOVS has a ~10% bias introduced in the near surface layer whereas for the middle tropospheric layer the bias is only around 1.5-5%. The near surface bias is most likely be introduced by NWP model information (German global model in this case) that is used as a first guess which is not much changed over land surfaces due to limited water vapour information from HIRS in the lower atmosphere.



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