Operational Processing of ATOVS data at the Satellite Application Facility on Climate Monitoring

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Introduction

The major objective of the Satellite Application Facility on Climate Monitoring (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). The products cover different cloud, radiation and humidity parameters, which are derived from different operational satellite and sensor types. Daily and monthly mean products of different humidity and temperature variables are derived operationally from ATOVS data at the CM-SAF

Product definition

HTW	Total precipitable water vapor (TPW), integrated from surface – 100 hPa,
HLW	Layered integrated water vapor, temperature and relative humidity at 5 layers (surface – 850 hPa, 850-700 hPa, 700–500 hPa. 500–300 hPa, 300–200 hPa)
HSH	Temperature and specific humidity at 6 pressure levels (1000 hPa, 850 hPa, 700 hPa. 500 hPa, 300 hPa, 200 hPa)

Daily and monthly mean products are available on a (90 km)² sinusoidal global grid. For each variable the mean value, error statistics and number of observations are given.

a) TPW / kg m^{-2}

b) extra daily standard deviation / kg m^{-2}

c) observations per grid
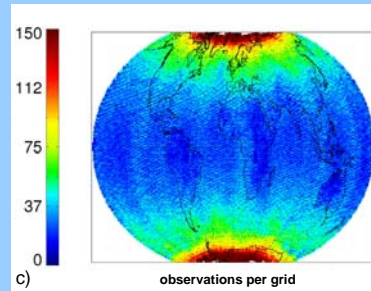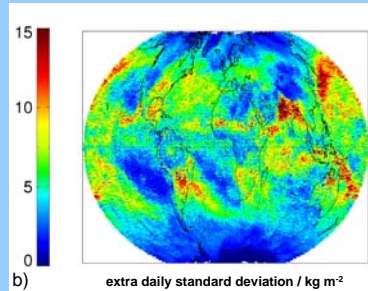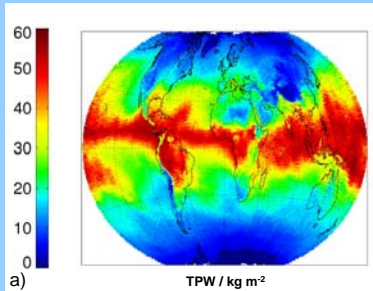
Example for October 2004:

a) Monthly average total precipitable water (TPW) from ATOVS in kg/m²

b) Extra daily standard deviation in kg/m²

c) Number of observations per grid.

Methods

The CM-SAF operationally applies the International ATOVS Processing Package (IAPP, Li et al., 2000), v2.1, to retrieve humidity and temperature profiles from ATOVS observations onboard NOAA-15, NOAA-16, and NOAA-18. The full information from HIRS 3/4, AMSU-A and AMSU-B/MHS is used for the retrieval. Furthermore, the profiles are vertically integrated and averaged to provide column integrated water vapor as well as humidity and temperature values for 5 layers and 6 levels. A Kriging routine (Lindau and Schulz, 2004) is applied to determine daily and monthly averages on a global grid from the swath based retrievals. Climate Data Records (CDRs) from 2004 to present (ongoing) are available for the different temperature and humidity variables.

Input data

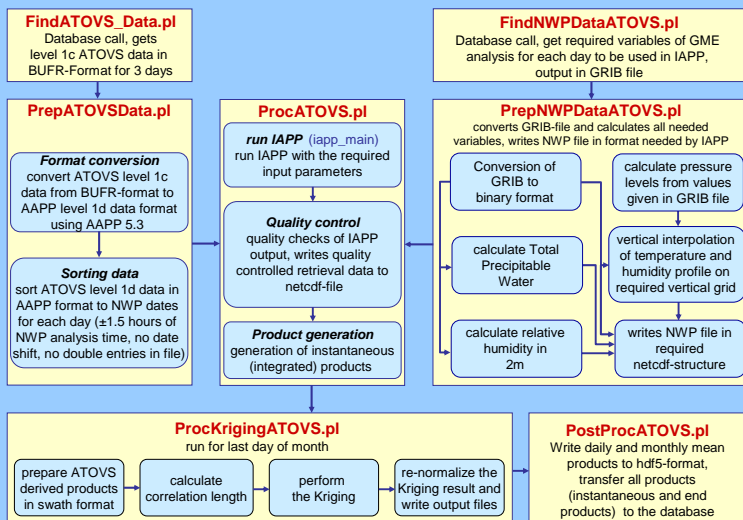The products are generated using the following input data:
➢ ATOVS Level 1c data from NOAA 15, NOAA16 and NOAA 18 (data from NOAA 17 cannot be used after a failure in AMSU-A)
➢ 3-hourly initialized analysis of the GME model on model levels (currently 40 levels, Majewski et al., 2002)
➢ Background data (e.g., topography) as provided in IAPP

Quality control tools

An IDL-based tool for operational quality monitoring of the routine processing of the ATOVS based products is available.

Schematic of operational processing

FindATOVS_Data.pl
Database call, gets level 1c ATOVS data in BUFR-Format for 3 days

PrepATOVSData.pl

Format conversion
convert ATOVS level 1c data from BUFR-format to AAPP level 1d data format using AAPP 5.3

Sorting data
sort ATOVS level 1d data in AAPP format to NWP dates for each day (±1.5 hours of NWP analysis time, no date shift, no double entries in file)

ProcATOVS.pl

run IAPP (iapp_main)
run IAPP with the required input parameters

Quality control
quality checks of IAPP output, writes quality controlled retrieval data to netcdf-file

Product generation
generation of instantaneous (integrated) products

FindNWPDataATOVS.pl
Database call, get required variables of GME analysis for each day to be used in IAPP, output in GRIB file

PrepNWPDataATOVS.pl
converts GRIB-file and calculates all needed variables, writes NWP file in format needed by IAPP

Conversion of GRIB to binary format

calculate pressure levels from values given in GRIB file

calculate Total Precipitable Water

vertical interpolation of temperature and humidity profile on required vertical grid

calculate relative humidity in 2m

writes NWP file in required netcdf-structure

ProcKrigingATOVS.pl
run for last day of month

prepare ATOVS derived products in swath format

calculate correlation length

perform the Kriging

re-normalize the Kriging result and write output files

PostProcATOVS.pl
Write daily and monthly mean products to hdf5-format, transfer all products (instantaneous and end products) to the database

Processing routine is run once per month on an IBM P5-575 system (8 processors) running AIX 5.3.

Known shortcomings of the CDRs

Discontinuities in time series have different reasons, e.g.:
➢ Data from different sensors are not inter-calibrated:
• Discontinuities in time series with change in satellite combination
• Retrievals used for mean product calculated from different sensors
➢ The retrieval is dependent on NWP data as first guess. Currently the operational NWP model GME from DWD is used, but CM-SAF has no influence on changes in model configuration
➢ ATOVS Level 1c data used as input; CM-SAF has no influence on changes in, e.g., calibration coefficients

Plans for future ATOVS processing at CM-SAF

Several changes and updates are planned for the (near) future:
➢ Implementation of IAPP V3 in operational processing environment at CM-SAF, a Beta-release of the software package is available.
➢ Inclusion of ATOVS data from Metop in the operational processing
➢ Re-processing of the time series and extension backwards using (inter-) calibrated satellite data (Generation of Environmental Data Records)

CM-SAF services

All products are available via our Web User Interface (www.cmsaf.eu)
Data are provided via different media (FTP, CD, DVD,…). Quick-looks of all products will be available on the CM-SAF webpage in the near future.

References:

Li, J., W. Wolf, W. P. Menzel, W. Zhang, H.-L. Huang, and T. H. Achtor, 2000: Global soundings of the atmosphere from ATOVS measurements: The algorithm and validation. J. Appl. Meteor., 39, 1248-1268.

Lindau, R., J. Schulz, 2004: Gridding/merging techniques for the humidity composite product of the CM-SAF. Proceedings of the 2004 EUMETSAT Satellite Conference, Prague, Czech Republic, EUM P41, 519-526.

Majewski, D., D. Liermann, P. Prohl, B. Ritter, M. Buchhold, T. Hanisch, G. Paul, W. Wergen and J. Baumgardner, 2002: The operational global icosahedral-hexagonal grid point model GME: Description and high resolution tests. Mon. Wea. Rev., 130, 319-338.