

Status Report: UTH Project (2015)

The SCOPE-CM Upper Tropospheric Humidity (UTH) project uses data sources from multiple sensors on board both polar orbiting and geostationary satellites. The project aims at advancing maturity levels established by the SCOPE-CM Maturity Matrix Model with multi-agency cooperation. The following is a status report on accomplished activities in various areas of the maturity matrix.

Software Readiness:

The HIRS channel 12 brightness temperature dataset is processed in an operational environment. The processing is stable and reproducible. The time series of the HIRS channel 12 brightness temperature dataset is extended to the end of 2014.

Through a project funded by NOAA's Climate Data Record Program at NCEI, a beta data set of AMSU-B/MHS FCDR's for NOAA-15, -16, -17, -18 and MetOp-A for the period 2000-2010 has been completed by UMD/NOAA. The data set also includes AMSU-A for the same period. The generation of final AMSU-B/MHS FCDR has just been started. The AMSU-B/MHS data set contains geolocation corrections as well as intersatellite calibration. Further details are available at <http://cics.umd.edu/AMSU-CDR/home.html>.

A simple method was developed by Soden and Bretherton [1993] for transforming satellite radiances to UTH. This method has been updated by UMD/NOAA for recent sensors including Advanced Technology Microwave Sounder (ATMS) water vapor channels, channels 18-22. The method relates satellite Tb's with the natural logarithm of Jacobian weighted humidity. The coefficients have been updated for all ATMS water vapor channels that can also be applied to AMSU-B/MHS water vapor channels with the same frequency. Since because of surface emissivity issues, layer-averaged humidity (LAH) cannot be estimated, a filter is developed based on total precipitable water vapor to filter-out the observations that are affected by the surface emissivity.

The geo-ring FTH demomstrator record is available from CM SAF. However the format has not been adapted to the Meteosat FTH edition 1 format. The geo-ring software was installed at Noveltis. Feedback has been received but has not been implemented yet.

Metadata:

The netCDF attributes for HIRS channel 12 brightness temperature dataset are updated to CF convention.

Product Validation:

An independent evaluation of the UMD/NOAA LAH results showed a bias of less than 10% for retrievals. In addition to AMSU-B/MHS water vapor channels, UMD/NOAA has also validated and inter-calibrated ATMS and SAPHIR water vapor channels.

An assessment of the quality of the Meteosat FTH product as function of viewing angle has been carried out. Based on comparisons to ARSA and HIRS products no significant dependencies on the viewing angle or longitude was observed. The impact of weighting functions on FTH has been assessed. The impact can exceed 20% relative.

An inter-comparison of UTH data from three different sensors (HIRS, microwave, and geostationary) is conducted. Differences are explained.

Utility:

A study on "Characterization of SSM/T-2 radiances using ERA-Interim reanalyses" is carried out by a CMSAF visiting scientist to ECMWF.

Various studies are carried out based on UTH/FTH datasets. Many of these are published in journal papers.

Public Access:

All the UTH/FTH datasets are available to public either online or from principle investigators.

Documentation:

A Climate Algorithm Theoretical Basis Document (C-ATBD) is written for the inter-satellite calibrated HIRS channel 12 brightness temperature dataset. The document is submitted to NCEI's CDR program and is made available for public access.

UMD/NOAA has submitted the C-ATBD for the AMSU-B/MHS FCDR to NCEI for final review.

For the homogenised Meteosat FTH data record an ATBD has been drafted and reviewed and is available at www.cmsaf.eu/docs. Retrieval details are also summarised in an ACP paper.

Publications:

Chung, E. S., B. J. Soden, B. J. Sohn, and J. Schmetz, 2013: An assessment of the diurnal variation of upper tropospheric humidity in reanalysis data sets. *J Geophys Res-Atmos*, 118, 3425-3430.

Chung, E. S., B. Soden, B. J. Sohn, and L. Shi, 2014: Upper-tropospheric moistening in response to anthropogenic warming. *PNatl Acad Sci USA*, 111, 11636-11641.

Chung, E.-S., B. J. Soden, and V. O. John, 2013: Intercalibrating Microwave Satellite Observations for Monitoring Long-Term Variations in Upper- and Midtropospheric Water Vapor. *J Atmos Ocean Tech*, 30, 2303-2319.

Clain, G., H. Brogniez, V. H. Payne and, V. O. John, and M. Luo (2015), An assessment of SAPHIR calibration using quality tropical soundings, *J. Atmos. Oceanic Technol.*, 32, 61–78, doi:10.1175/JTECH-D-14-00054.1.

Gierens, K., Eleftheratos, K., and Shi, L.: Technical Note: 30 years of HIRS data of upper tropospheric humidity, *Atmos. Chem. Phys.*, 14, 7533-7541, doi:10.5194/acp-14-7533-2014, 2014.

John, V. O. and E.-S. Chung (2014), Creating a Microwave Based FCDR for Tropospheric Humidity: Initial Assessment of SSM/T-2 Radiances, *Global Space-based Inter- Calibration System (GSICS) Quarterly, Special Issue on Microwave, Vol 8*, doi: 10.7289/V55H7D64

Moradi, I., H. Meng, and R. Ferraro, Correcting geolocation errors for microwave instruments aboard NOAA satellites, *Geoscience and Remote Sensing, IEEE Transactions on*, 51(6), p. 3625 – 3637, 2013

Moradi, I., R. Ferraro, B. Soden, P. Eriksson, and Ph. Arkin, Retrieving layer averaged tropospheric humidity from Advanced Technology Microwave Sounder (ATMS) water vapor channels, *Geoscience and Remote Sensing, IEEE Transactions on*, revised, 2015

Moradi, I., R. Ferraro, P. Eriksson, and F. Weng, Inter-calibration and validation of observations from ATMS and SAPHIR microwave sounders, *Geoscience and Remote Sensing, IEEE Transactions on*, revised, 2015

Moradi, I., B. Soden, R. Ferraro, Ph. Arkin, and H. Vomel, Assessing the quality of humidity measurements from global operational radiosonde sensors, *Journal of Geophysical Research: Atmospheres*, 118(14), p. 8040–8053, 2013

Moradi, I. and R. Ferraro, 2014. Inter-calibration of microwave satellite data: an ongoing challenge, *Global Space-based Inter-Calibration System (GSICS) Quarterly, Special Issue on Microwave*, Vol 8, doi: 10.7289/V55H7D64 (leading paper of the special issue)

Moradi, I. and R. Ferraro, 2014. Inter-calibration of observations from SAPHIR and ATMS instruments, *Global Space-based Inter- Calibration System (GSICS) Quarterly, Special Issue on Microwave*, Vol 8, doi: 10.7289/V55H7D64

Moradi, I., S. Buehler, V. John, T. Reale, and R. Ferraro, 2013. Evaluating instrumental inhomogeneities in global radiosonde upper tropospheric humidity data using microwave satellite data, *Geoscience and Remote Sensing, IEEE Transactions on*, 51(6), pp. 3615–3624, doi: 10.1109/TGRS.2012.2220551

Schröder, M., R. Roca, L. Picon, A. Kniffka, H. Brogniez, 2014: Climatology of free tropospheric humidity: extension into the SEVIRI era, evaluation and exemplary analysis. *Atmos. Chem. Phys.*, 14, 11129-11148, doi:10.5194/acp-14-11129-2014.