Climatology of free tropospheric humidity (FTH)

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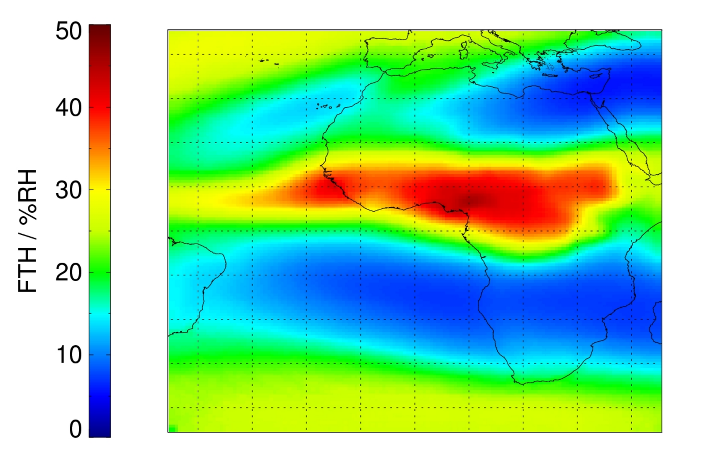
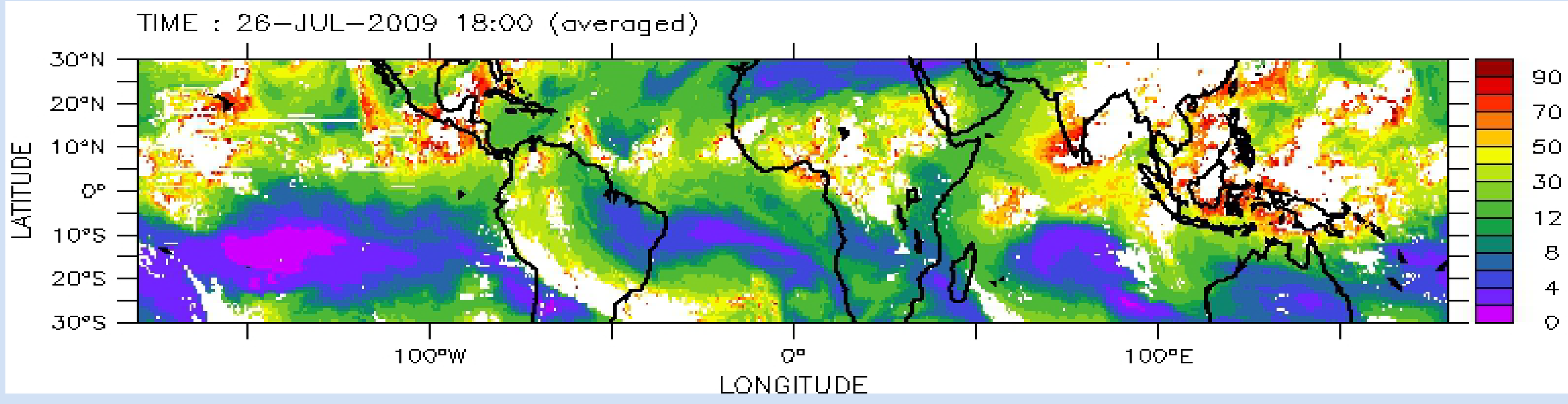


Meteosat FTH:
- ±45°N/S/E/W; 0.625°; 3h+monthly averages
- 1983 – 2009
- Example on left: JJA climatology

Outlook: Geo-ring FTH
- ±45°N/S, all longitudes; 0.625°; 3h+monthly averages
- July 2009
- Example on right: "image" at 18:00 on 26 July 2009



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We present a free tropospheric humidity (FTH) data record which is based on observations of Meteosat-2 - 5 and Meteosat-7 - 9 Meteosat Visible and Infrared Imager (MVIRI) and Spinning Enhanced Visible and Infrared Imager (SEVIRI) at the water absorption band at 6.3 µm. With the extension to SEVIRI observations the data record now covers the period 1983 – 2009 with a spatial and temporal resolution of 0.625° and 3 hours, respectively. The data record is referenced under digital object identifier (doi): 10.5676/EUM_SAF_CM/FTH_METEOSAT/V001 and is freely available from http://www.cmsaf.eu/wui. Within a Research and Operation activity between CNRS and DWD the retrieval and homogenisation developments were transferred in order to sustain and increase the availability of long temporal records related to atmospheric humidity.

Conclusions

The FTH time series has been extended into the SEVIRI era and exhibits good quality and stability relative to ARSA data. The experience gained during homogenisation is potentially valuable for FCDR developments within SCOPE-CM. The extension of this analysis to other UTH data records and their inter-comparison is part of the GEWEX water vapor assessment (G-VAP, http://www.gewex-vap.org).
The FTH record is highly valuable for climate analysis and model evaluation: FTH is strongly related to dynamical processes in the atmosphere and has a large impact on OLR. The analysis of FTH is important to further assess the observed small changes in value and area and the associated large variability.
The work presented on this poster is largely based on Schröder et al. (2014).

Retrieval of FTH

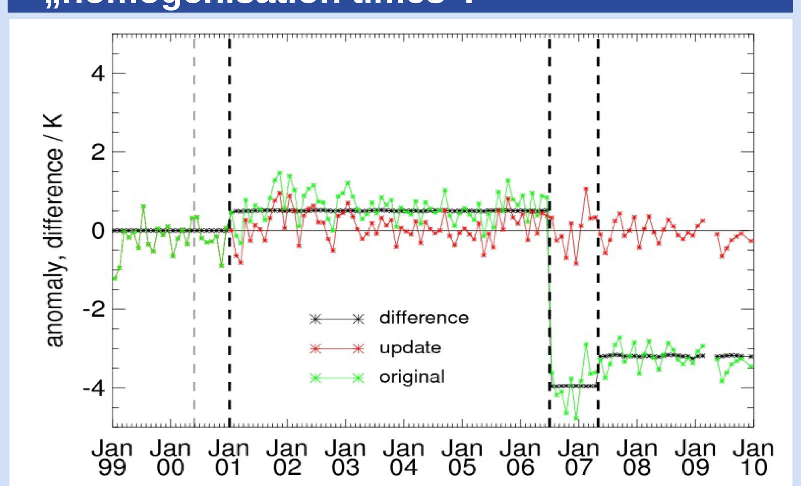
The following processing steps were conducted to generate the FTH data record:
1) Spectral calibration to the Meteosat-5 water vapour channel.
2) Homogenisation following Picon et al. (2003).
3) Intercalibration to HIRS (Breon et al., 2000).
4) Identification of cloud free pixels and pixels with cloud top pressure > 700 hPa.
5) Inversion using:

$$\ln\left(\frac{\langle RH\rangle p_0}{\cos\theta}\right) = a \times BT_{6.3\mu m} + b \qquad FTH(RH) = \frac{\sum_{p=700hPa}^{150hPa} RH(p) \times J_{RH}(p)}{\sum_{p=700hPa}^{150hPa} J_{RH}(p)}$$

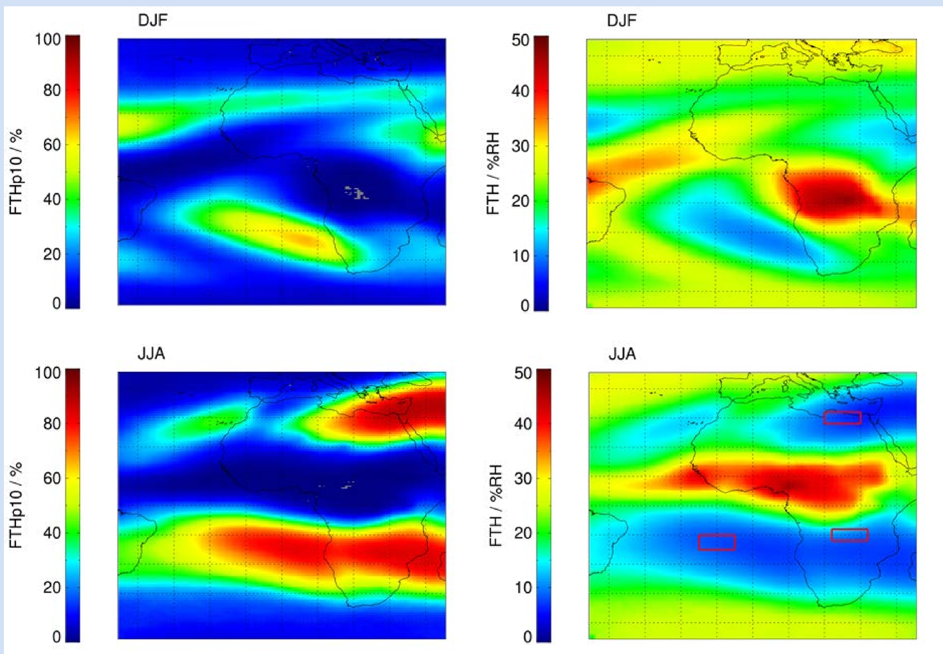
with J_{RH}: relative humidity Jacobians, θ: viewing angle, p: pressure, p_0: pressure ratio.

6) FTHp10: frequency of occurrence of FTH<10%.

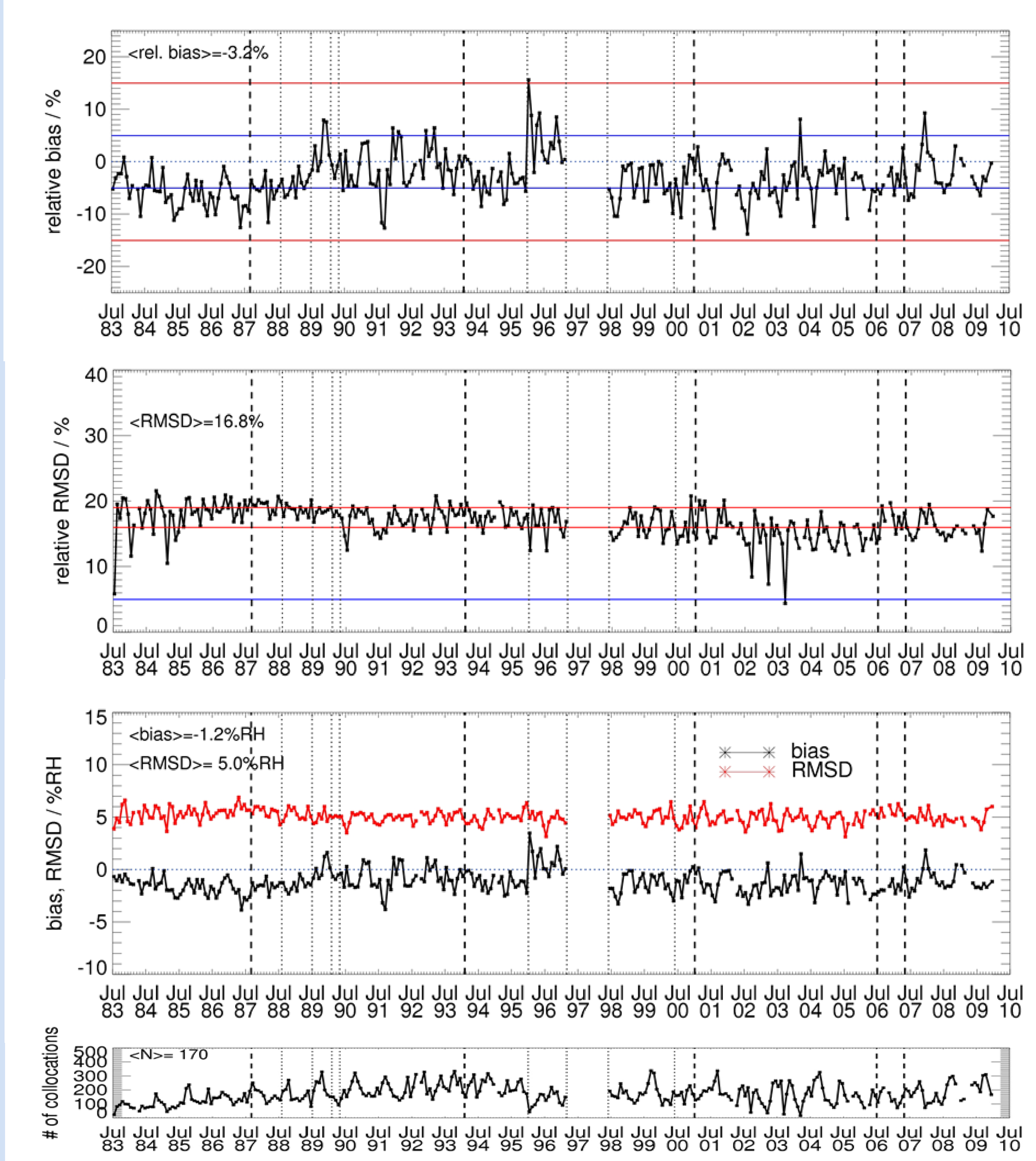
Monthly deseasonalised BT anomaly and the difference original and homogenised BT anomaly. Thick vertical mark the „homogenisation times".



Seasonal averages: FTHp10 (left) and FTH (right). Annual cycles in boxes are strongly different.



Evaluation



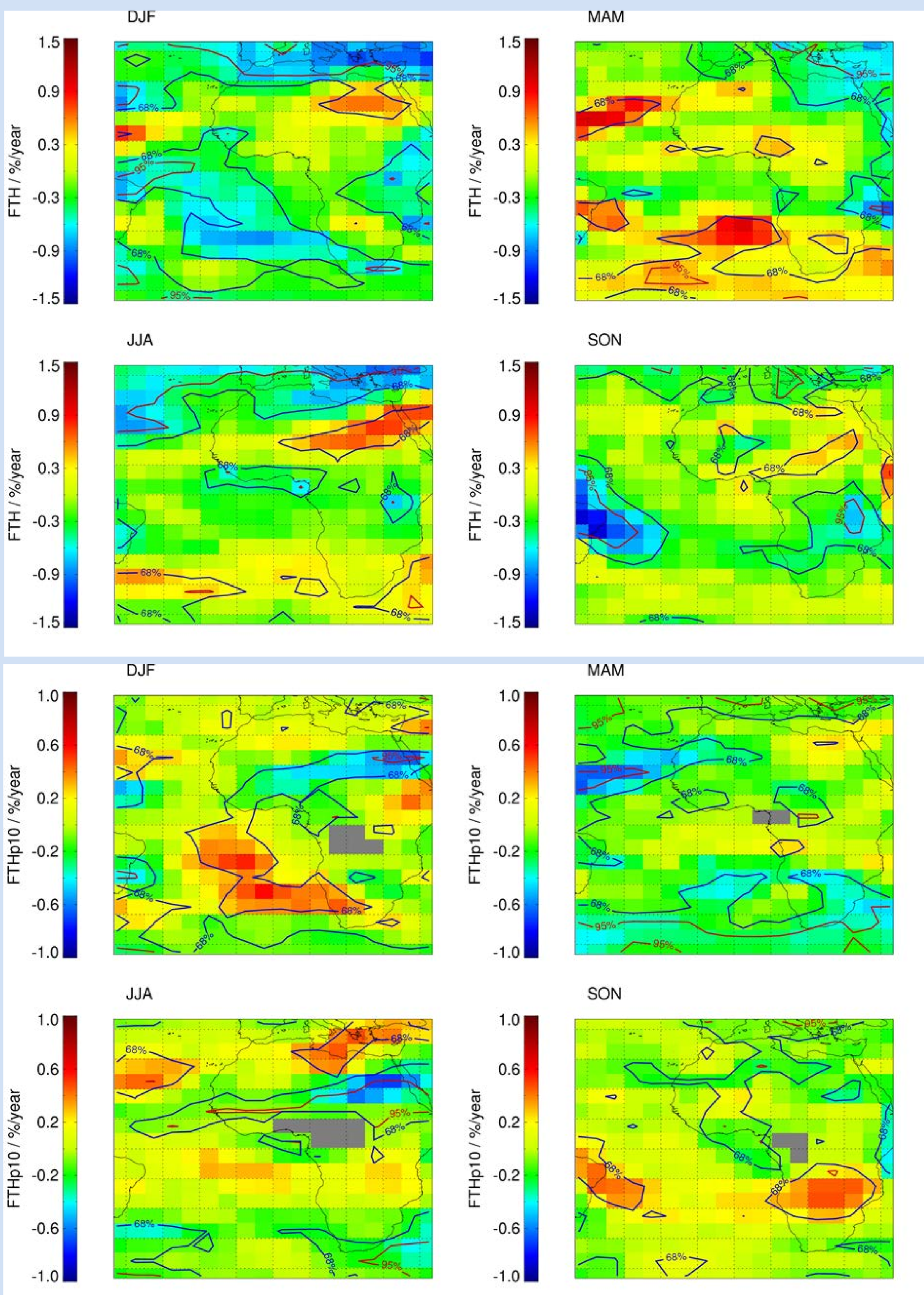
Absolute and relative bias and RMSD between Meteosat FTH and FTH(ARSA). RTTOV was applied to data from the radiosonde archive ARSA. Using the Jacobians FTH(ARSA) was computed. The stability is 0.5 ± 0.45 %/decade and has been computed using results shown in the top panel. Thin and thick dashed vertical lines mark the time of radiometric and homogenisation events. The number of valid observations is also given. The coloured lines in the first two panels highlight the FTH requirements from GCOS-154, an error budget estimate and a line at 15%, which is close to the peak values in maximum relative bias.

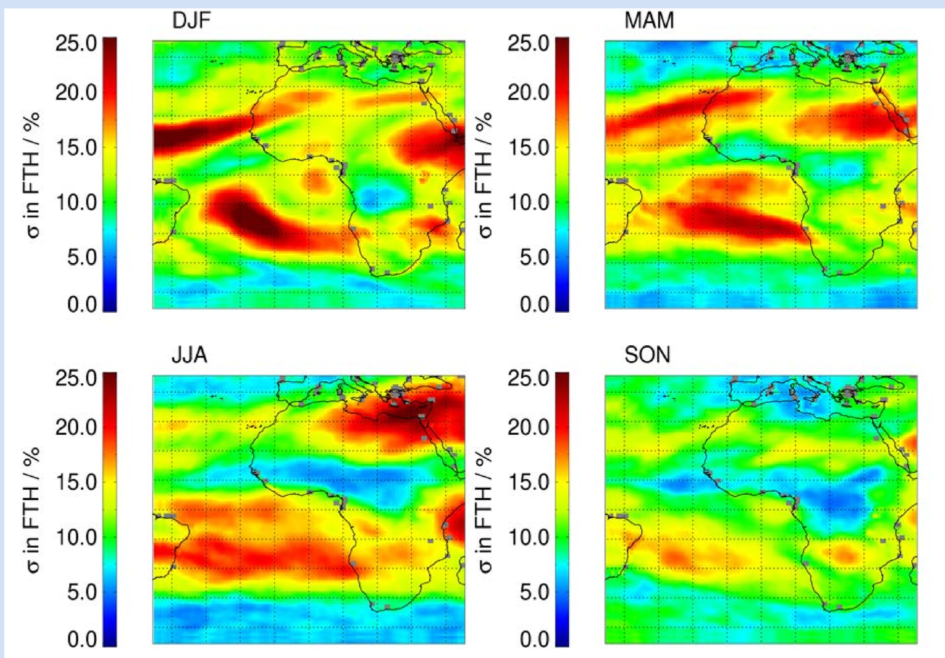
Analysis

Seasonal trend in %/year for FTHp10.

Seasonal trend in %/year for relative FTH.

Black and red contour lines mark confidence probabilities of 68% and 95% (from two-sided t-test).

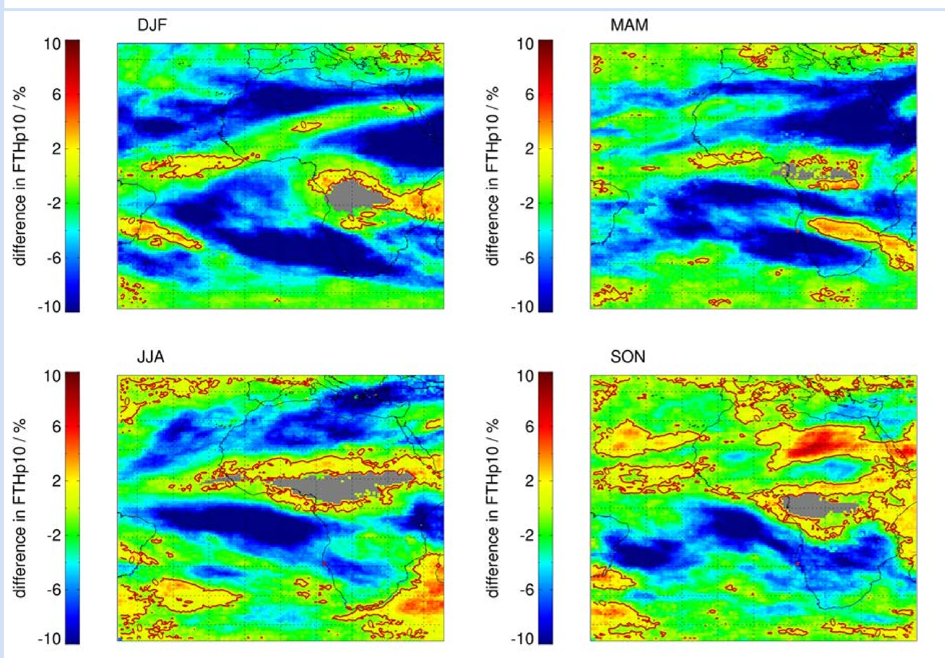




Relative standard deviation in FTH for each season (top four panels) over the period 1984-2009. Areas where only a small number of observations are valid are shown in grey.

Maxima in inter-annual standard deviations generally coincide with minima in FTH and maxima in FTHp10. Maxima in absolute estimates of the trends in seasonal FTH and FTHp10 are associated with maxima in standard deviation. As a result, the estimated trends are hardly significant. However, the maxima in trend estimate of FTHp10 coincide with maximum absolute differences in FTHp10 averaged over the 2000s and over the 1990s. The linear analysis performed in the dry free tropospheric subtropical regions leads to results that are not significant but that are consistent with theoretical considerations. The combination of trend estimates, coverage probability and estimated uncertainty provides valuable information to further analyse changes in the climate system.

***References**: Breon et al., 2000, JGR; Picon et al., 2003, JGR; Schröder et al., 2014, ACP.*



Difference between decadal averages of FTHp10 in the period 1990-1999 and in the period 2000-2009. The difference was computed per season. Red contour lines indicate a 0% difference. Areas where only a small number of observations are valid are shown in grey.

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