UTH measurements from satellite-borne nadir looking IR and MW sensors: Possible long time series with complementary instruments

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Motivation

- Several operational satellites measured water vapour in the upper troposphere over long periods (starting 1979).
- Different instruments and spectral regions lead to instrument specific differences in observed upper tropospheric humidity (UTH).
- Large differences in UTH between climate models used for the IPCC AR4 (John and Soden, 2007).
- A continuous, consistent time series of global UTH distributions would be beneficial for comparison and improvements of UTH in climate models.

Instruments

- **Humidity Sounder for Brazil (HSB)**
  - On EOS-Aqua (May 2002-jan 2003).
  - Microwave (183 GHz).
  - Nadir (viewing angle +/- 49°).
- **Advanced infrared Sounder (AIRS)**
  - On EOS-Aqua (May 2002 – now).
  - Infrared.
  - Identical footprints as HSB.
- **AMSU-B**
  - On NOAA-15/16/17 (1999 – now).
  - Similar intrument to HSB.
  - Long time series.

Unique opportunity:

1. Comparison of simultaneous measurements at identical footprint spots (AIRS vs. HSB).
2. Comparison between similar instruments on different satellites (HSB and AMSU-B).
3. Comparison of two operational instruments with long timeseries with defined biases (AIRS vs. AMSU-B).

Method

- HSB and AMSU-B provide measured brightness temperatures Tb18 for identical channel 2 (HSB) and channel 18 (AMSU-B) used to get UTH.
- AIRS vertical profiles are used to simulate Tb18 with AMSU-B/HSB characteristics using the radiative transfer code ARTS.
- UTH is calculated from Tb18 using the method by Buehler and John (2005).
- UTH products are compared.
  - Similar weighting functions
  - Similar instrumental properties

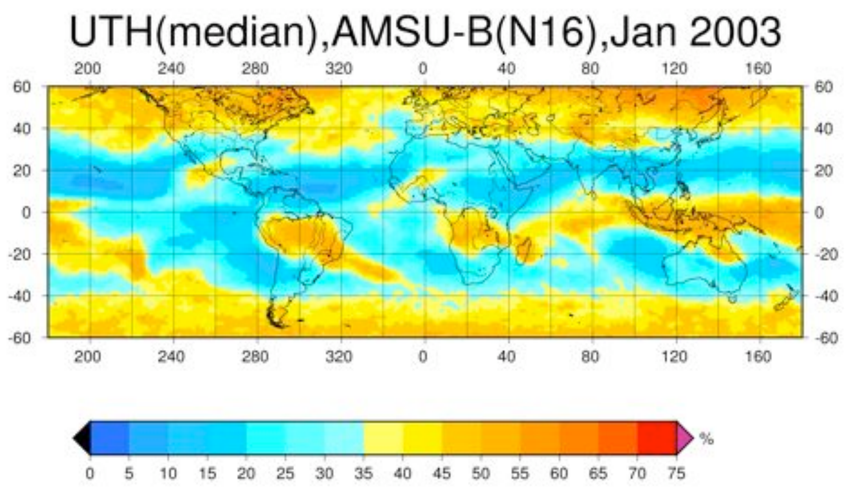


Figure 1: Median of monthly binned UTH from AMSU-B on board NOAA 16 for January 2003. Data are gridded to a 1.5°x1.5°grid.

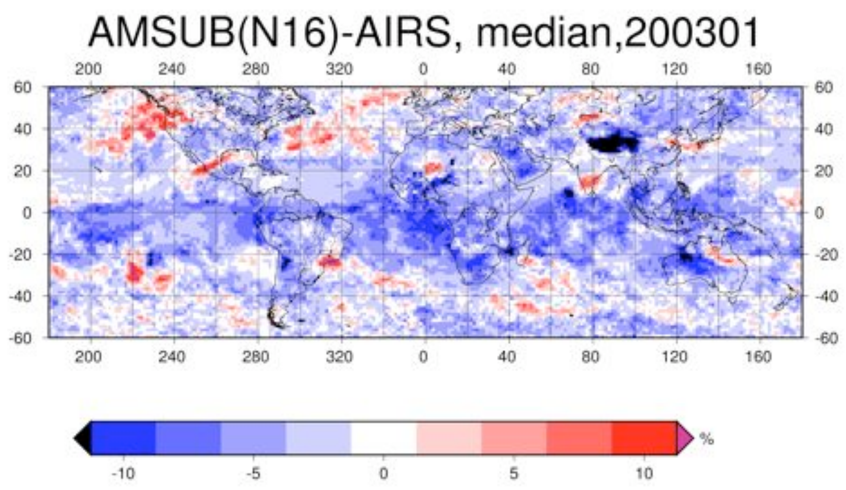


Figure 2: Difference of the median binned UTH between AMSU-B and AIRS for January 2003.

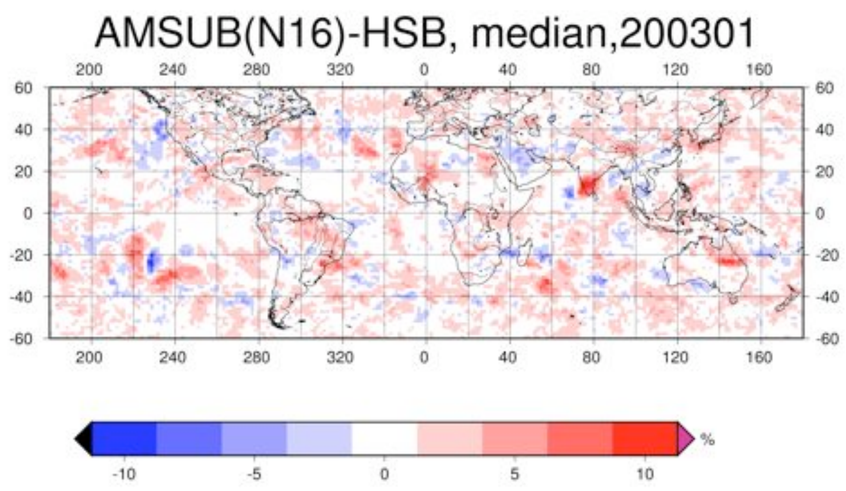
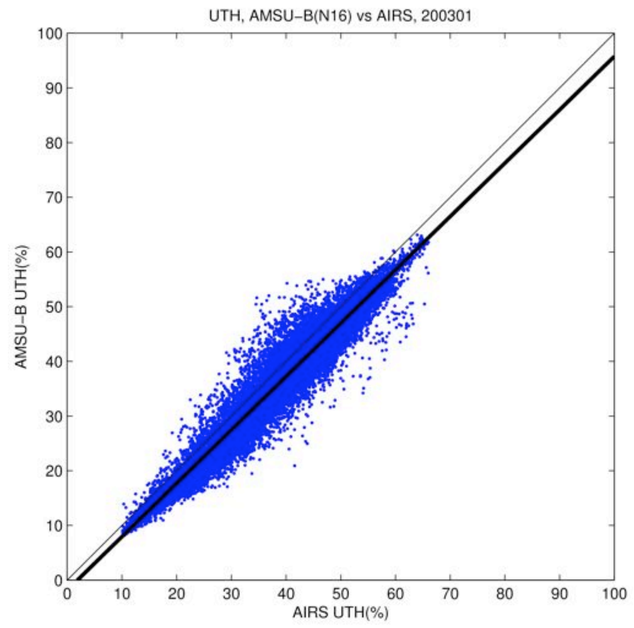


Figure 3: Difference of the median binned UTH between AMSU-B and HSB for January 2003.

Binned data (#1 vs #2)	mean bias (#1-#2)	std dev	Slope
HSB vs AIRS	-3.5 %RH	2.97 %RH	0.96
HSB vs AMSU B (N16)	-0.8 %RH	1.6 %RH	1.001
AIRS vs AMSU B (N15)	+3.57 %RH	3.14 %RH	0.98
AIRS vs AMSU B (N16)	+2.71 %RH	3.23 %RH	0.95
AIRS vs AMSU B (N17)	+2.97 %RH	3.22 %RH	0.98

Table 1: Bias, standard deviation and slope for the comparisons of the different instruments for binned datasets for January 2003.



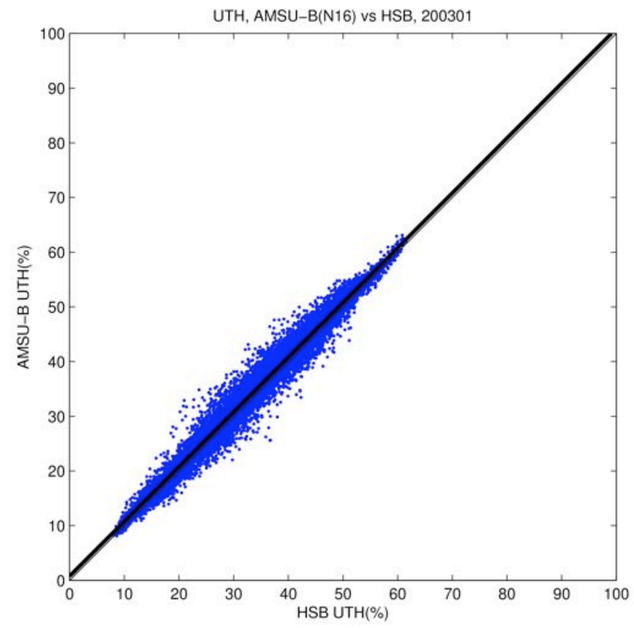


Figure 4: Scatterplots of binned median data: AIRS vs AMSU-B(N16) (top) and HSB vs. AMSU-B(N16) for January 2003.

Conclusions

- General distribution caught by all instruments.
- AMSU-B.and HSB agree very well.
- Bias between AMSU-B and HSB due to calibration differences (differences in the channel characteristics (position, width) can be excluded).
- AIRS and AMSU-B agree within 2σ limits (σ: standard deviation of the differences).
- Slight wet bias of AIRS of 2.7 to 3. 6 %RH compared to MW sensors, which is not significant within 2σ.

References: Buehler and John(2005), J. Geophys. Res., 110, D02110, doi:10.1029/2004JD005111.

John and Soden(2007), Geophys. Res. Lett., 34, L18704, doi:10.1029/2007GL030429.

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