Met Office
Hadley Centre

Upper Tropospheric Humidity data set from operational microwave sounders

Viju John, ITSC-16, 08 May 2008

Collaborators

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- Thanks to CLASS, NOAA for L1b data, NWP SAF for RTTOV and AAPP

Contents

This presentation covers the following topics:

- UTH from microwave radiances (T_B^{18})
- Cloud issues
- Climatology
- Inter-satellite differences
- IR – Microwave comparison

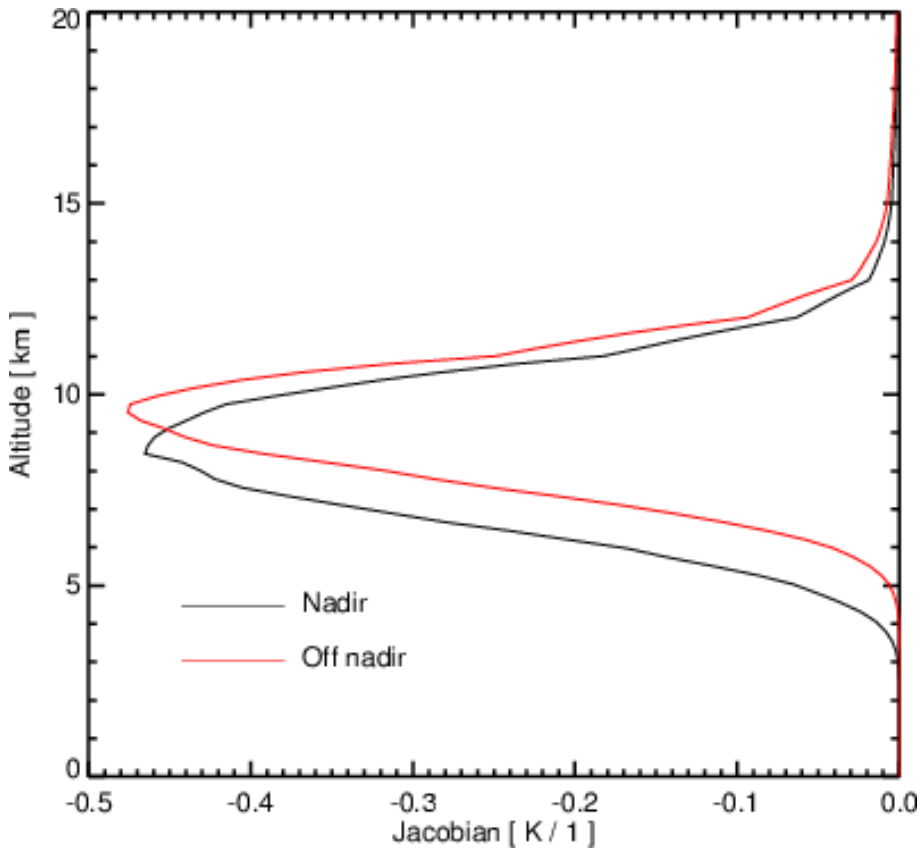
Motivation

- Water vapour in the upper troposphere (UT) is an important climate variable (***Held and Soden*, 2000**)
- Good quality measurements are lacking (***Foster and Collins*, 2004**)

  - radiosonde data quality is not good in UT (***lots, 19xx - 200x***)

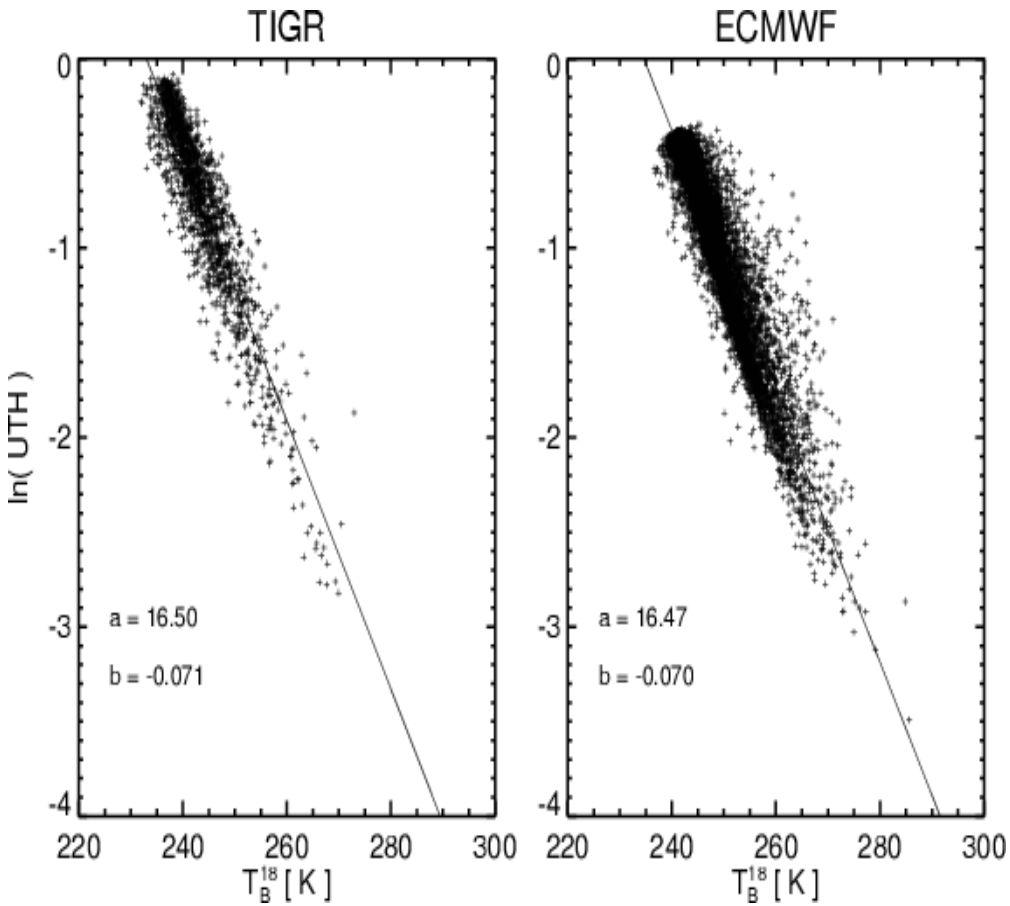
- IR (HIRS) measurements of UT water vapour available, but there is clear-sky bias in the data set (***Lanzante and Ghars*, 2000**)
- Microwave data (SSM/T2, AMSU-B, MHS) can be used except in the presence of precipitating clouds (***Greenwald and Cristopher*, 2002**)

UTH from T_B^{18}



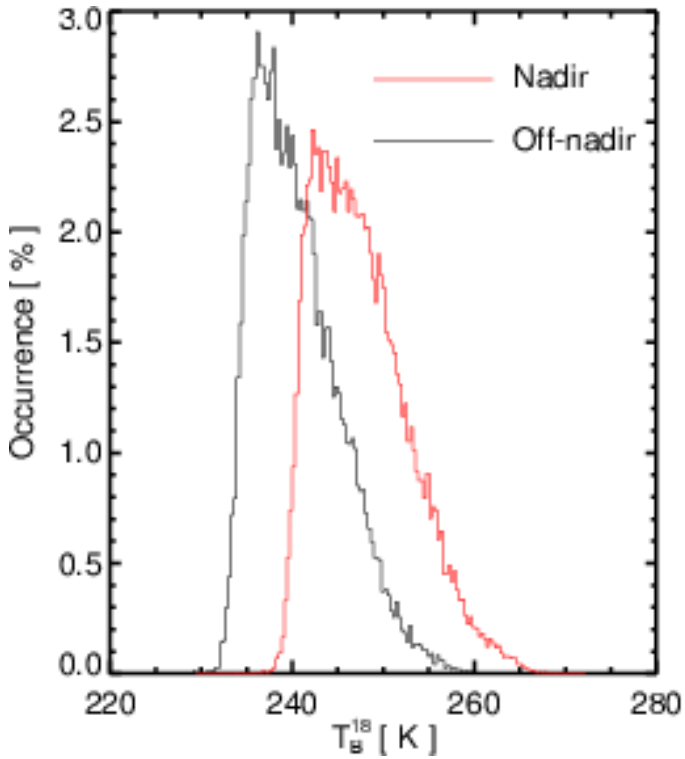
- 183.31 +/- 1.00 GHz
- UTH: Jacobian weighted relative humidity in the "upper troposphere"
- A simple relation between radiance and UTH exists for IR 6.7 T_Bs (***Soden and Bretherton,* 1993, 96**)
- This is also applicable to AMSU T_B^{18} (***Buehler and John*, 2005**)

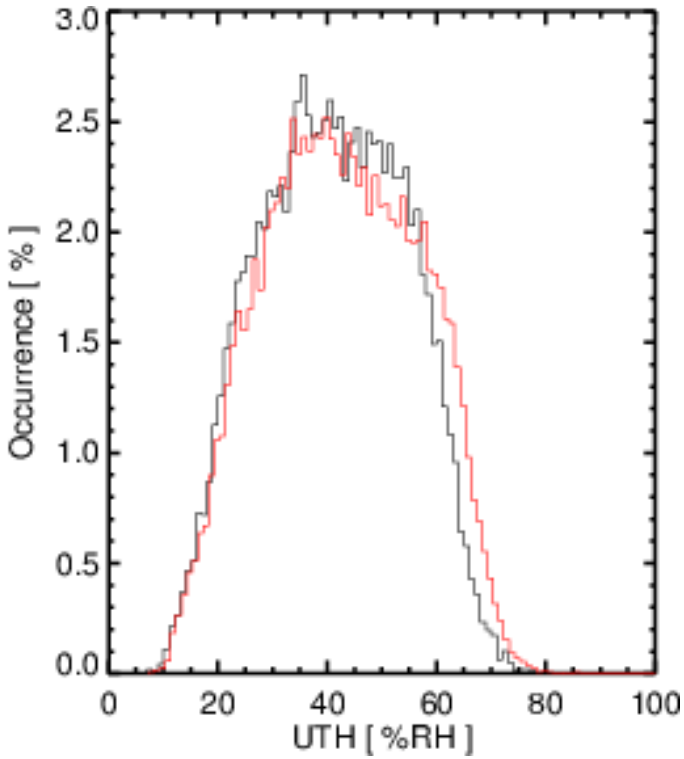
UTH from T_B^{18}



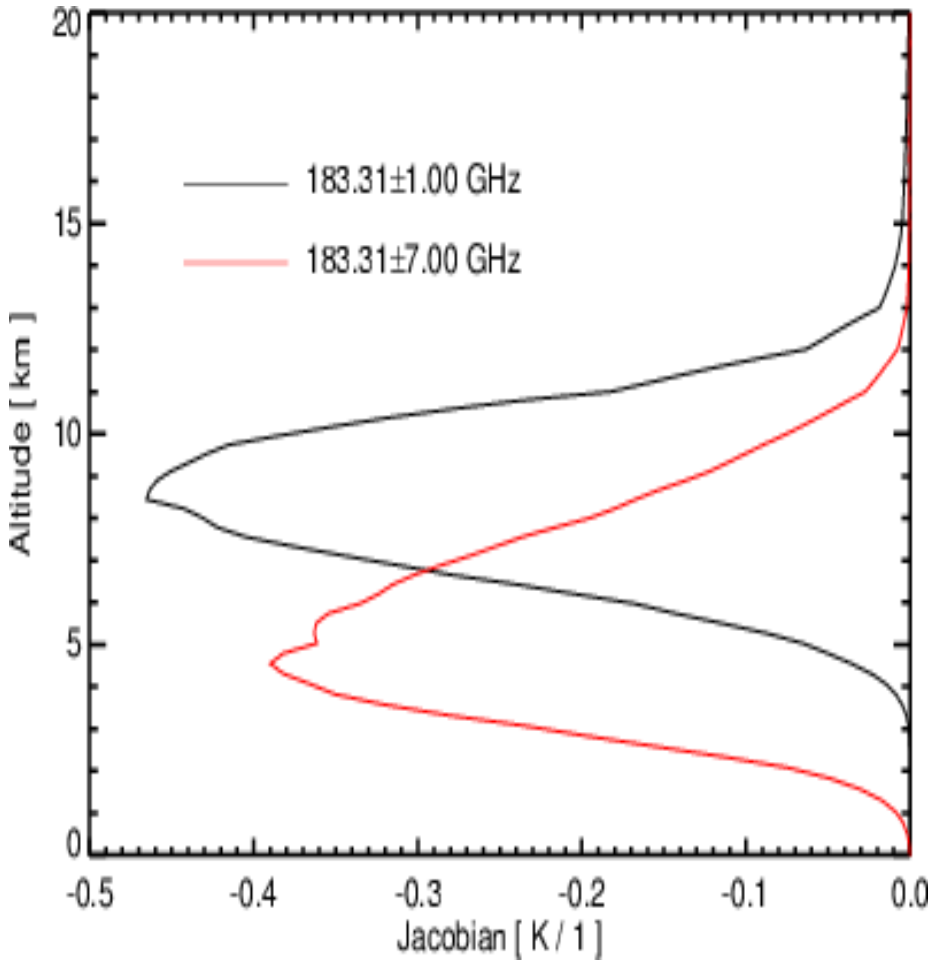
- $\ln(\mathrm{UTH}) = a + b\, T_B^{18}$
- Similar coefficients from independent data sets
- Retrieval precision is 2 %RH for low humidity and 7 %RH for high humidity
- Coefficients are calculated for all viewing angles

UTH is limb corrected



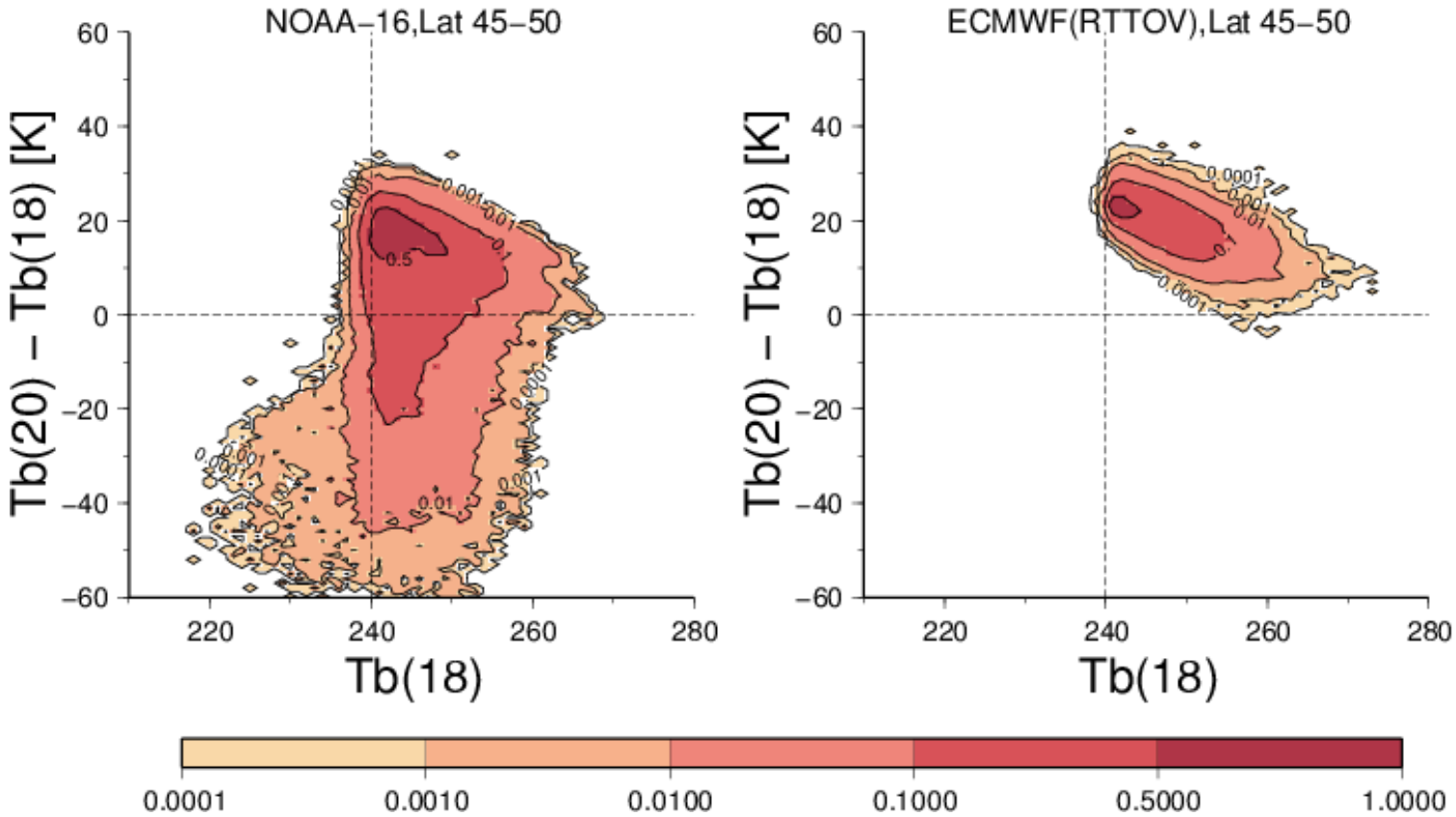


Cloud Filter

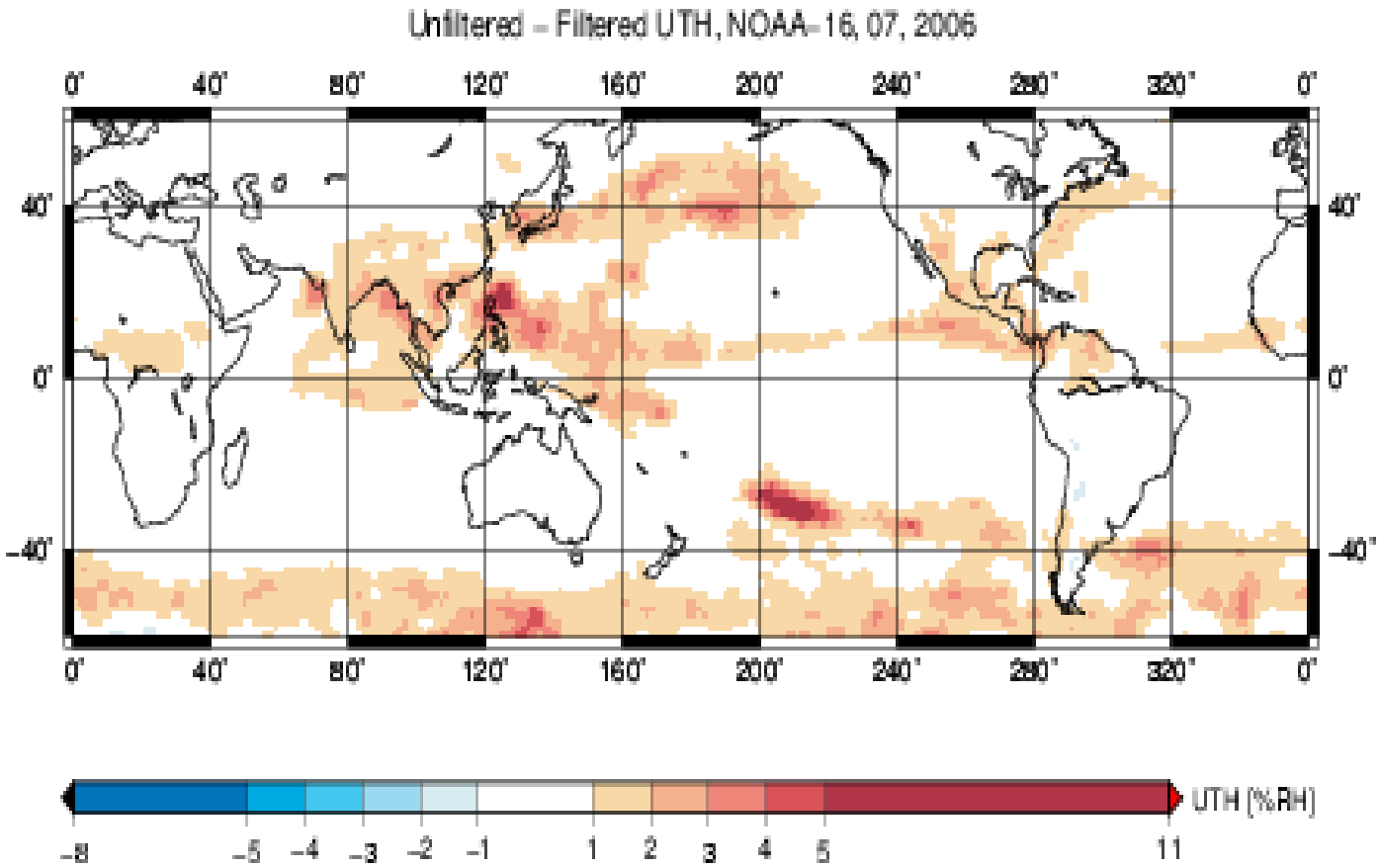


- Clear sky: $T_B^{20} > T_B^{18}$
- Cloudy: $T_B^{18} > T_B^{20}$
- T_B^{18} > Threshold

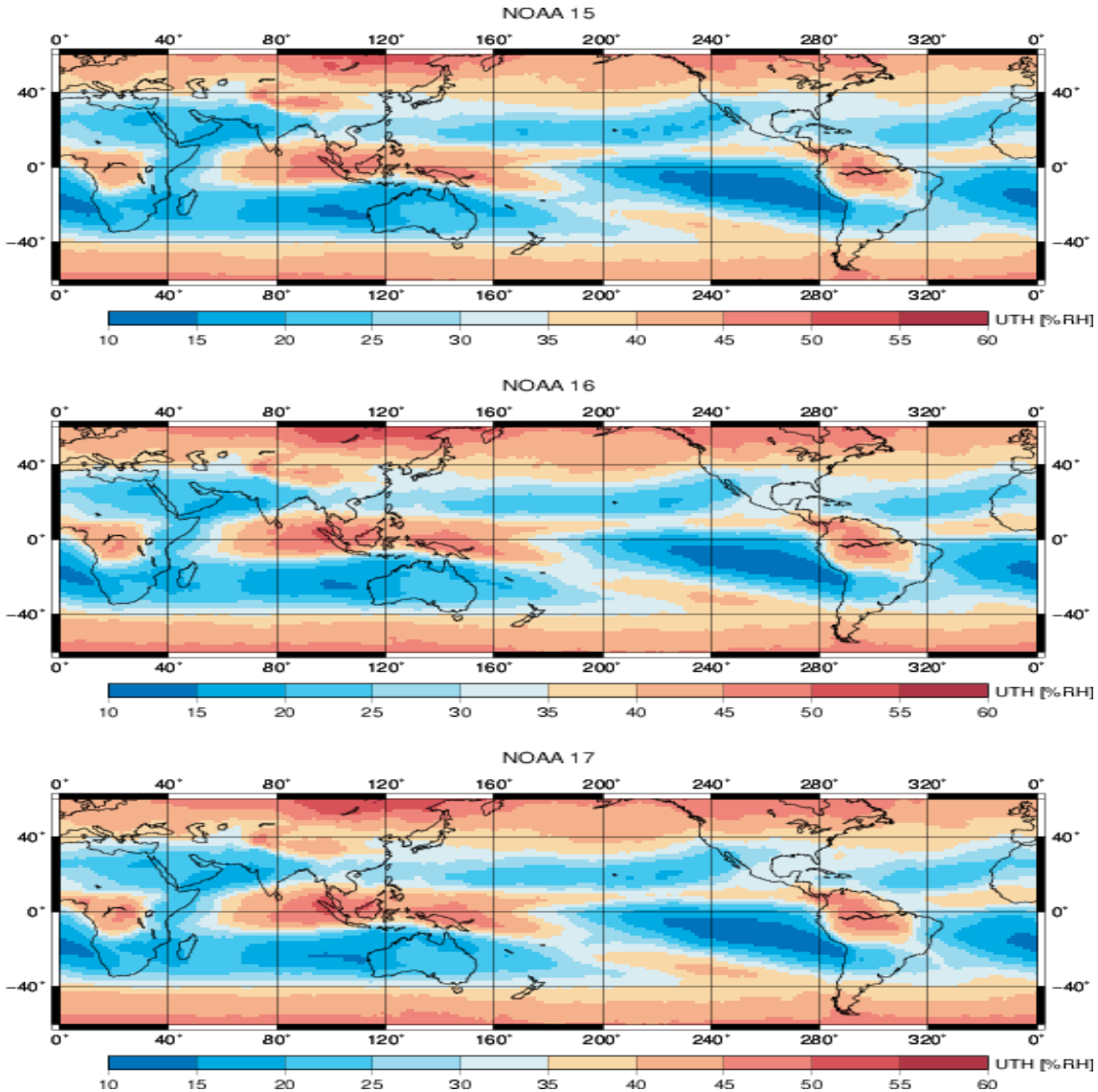
Cloud Filter



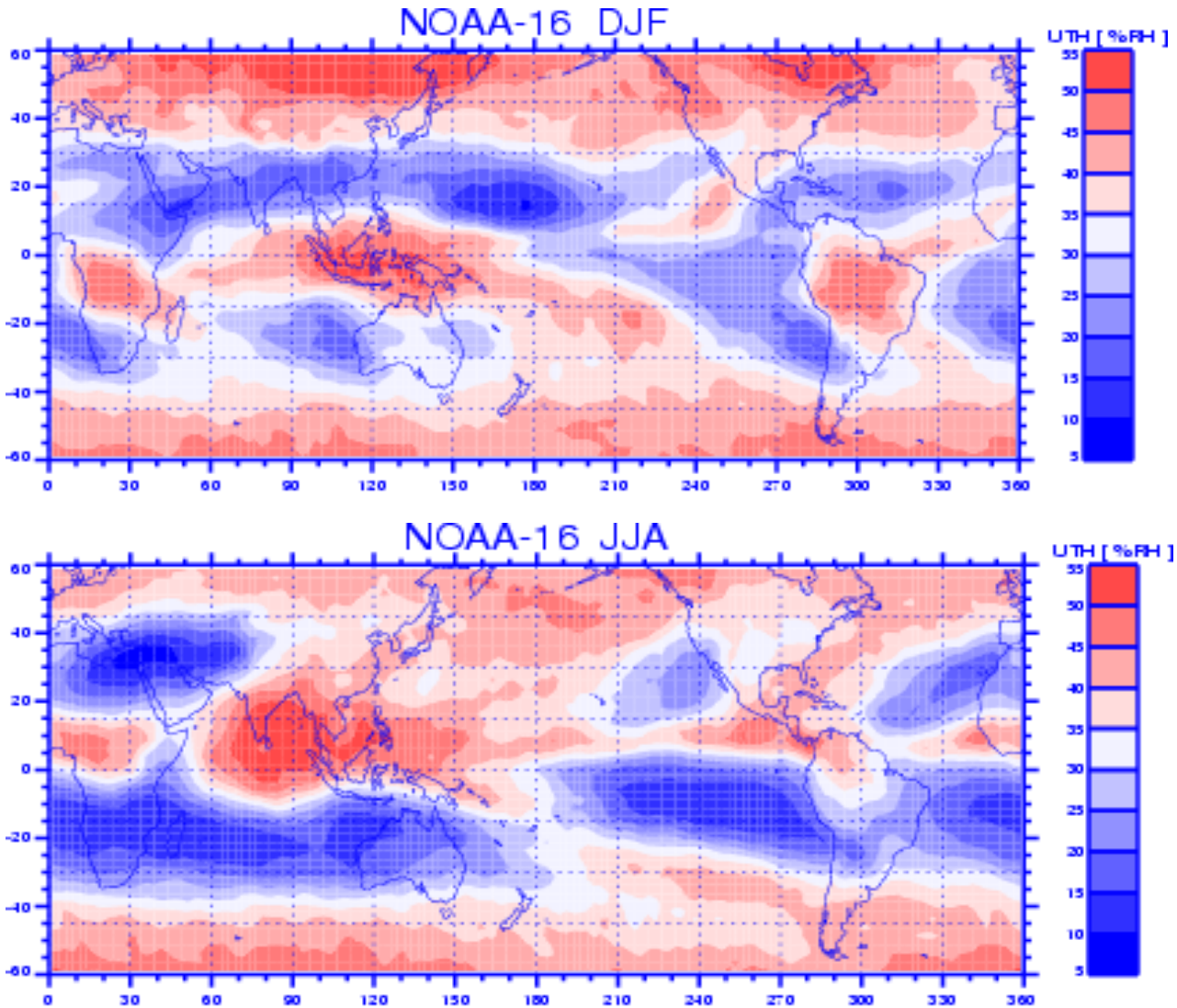
Cloud Impact



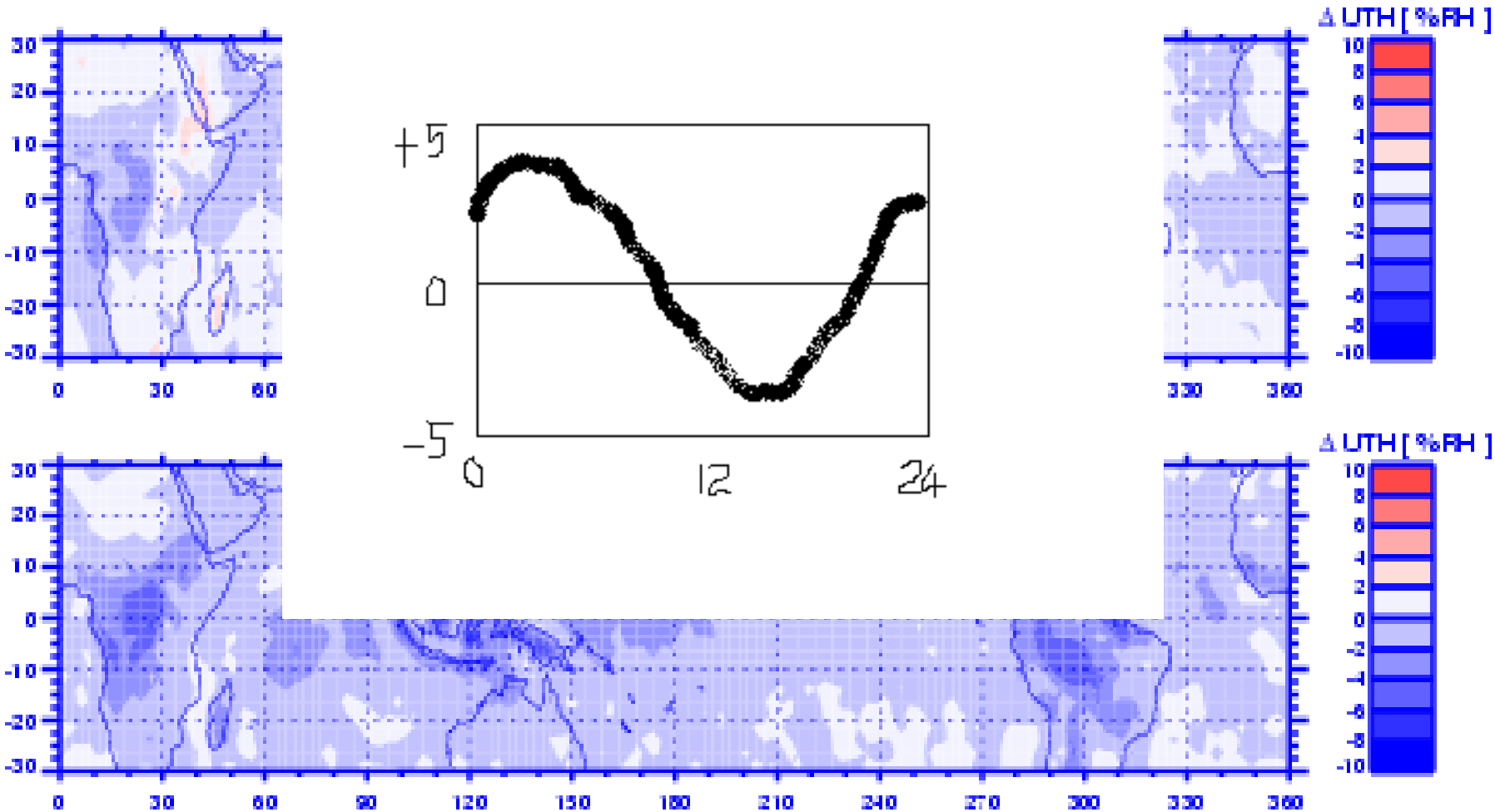
UTH Climatology



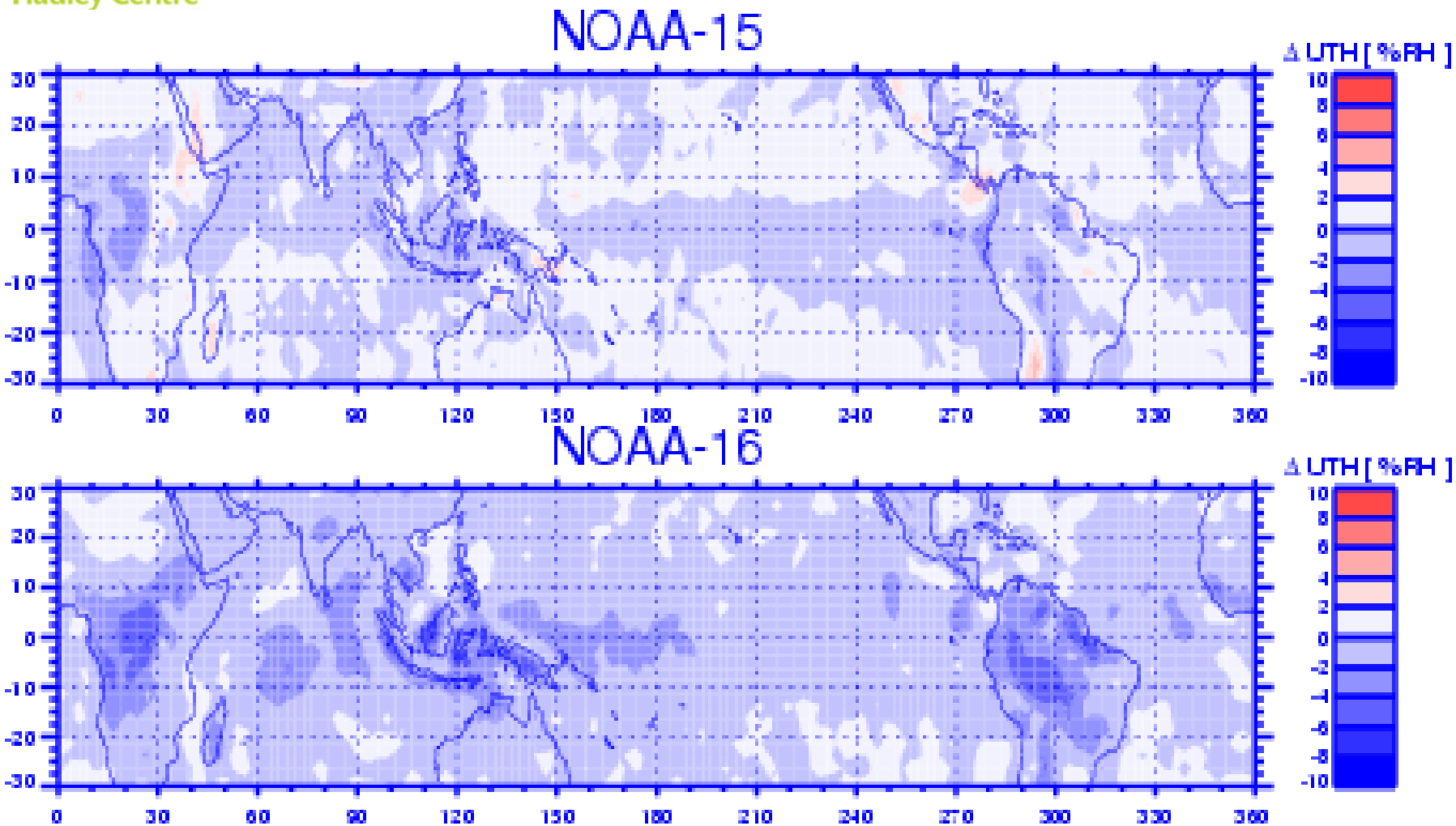
Seasonal Cycle



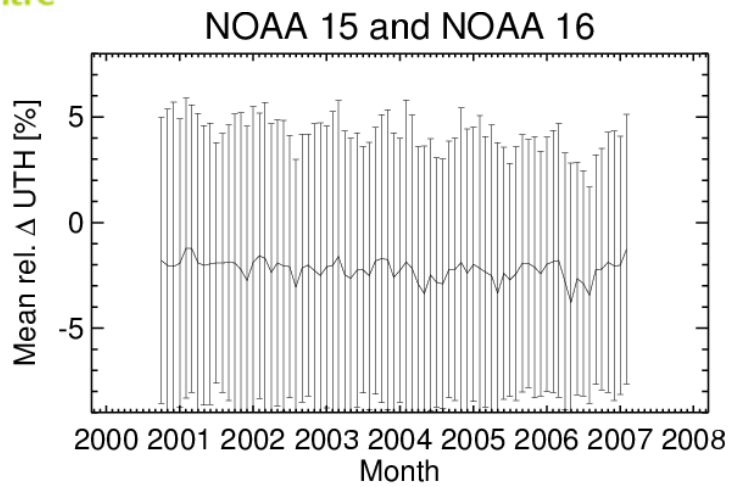
Diurnal Cycle

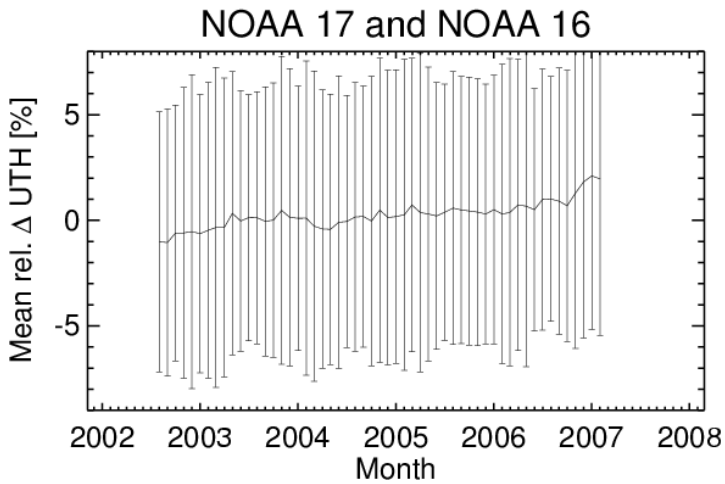


Diurnal Cycle



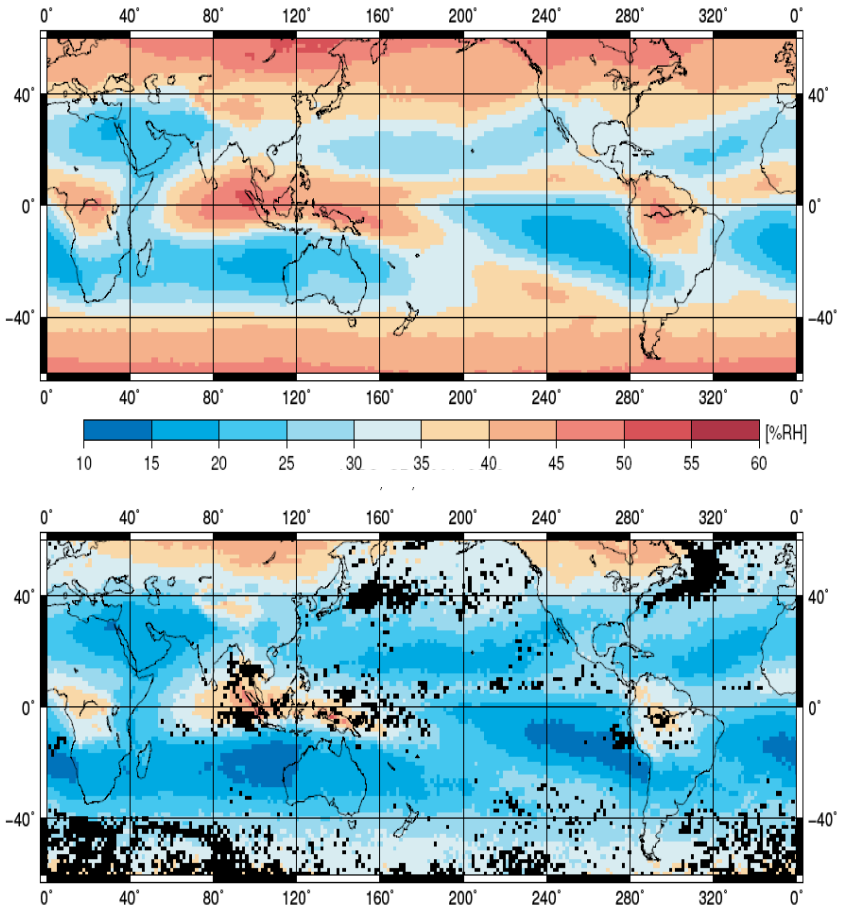
Inter-satellite difference

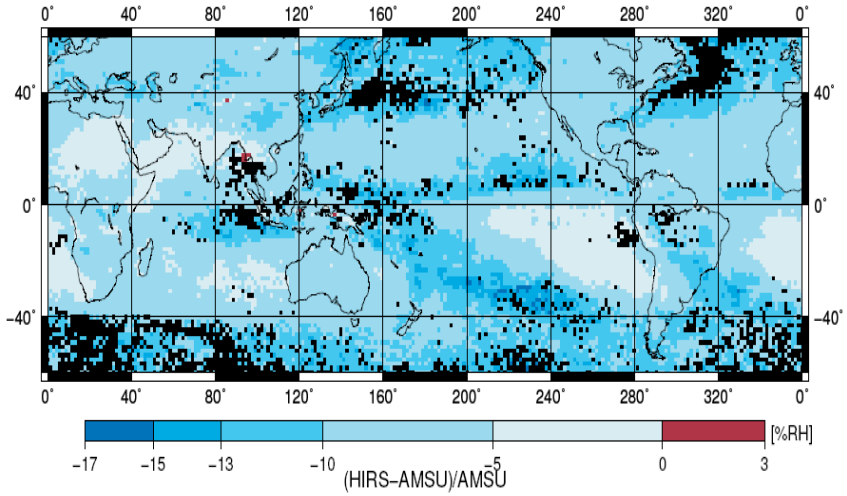




- NOAA-15 UTH is ~3% drier than NOAA-16 UTH, but no clear time evolution
- NOAA-17 UTH shows a time varying bias compared to NOAA-16 UTH

AMSU – HIRS comparison





- HIRS has 7-9%RH dry bias compared to AMSU
- More details in *Buehler et al*., An Upper Tropospheric Humidity Data Set From Operational Satellite Microwave Data, J. Geophys. Res., in press.

Data Set

- Available at: http://www.sat.ltu.se/projects/uth-clim/
- Contains:

  - mean, variance, # of pixels, median

  - ascending and descending separated

  - cloud filtered and unfiltered

  - daily and monthly (2.5 x 2.5 grid)

- Also contains deep convective cloud fraction (***Hong et al.*, 2005**)

Summary and outlook

- Gridded daily and monthly UTH data set available from operational microwave sounders
- Cloud impact is not significant
- Shows large-scale features of atmospheric general circulation
- Seasonal and diurnal cycles
- HIRS UTH is drier than AMSU UTH
- Plan to extend the data set by combining similar instruments (SSM/T2 and MHS)

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Questions and answers