Met Office
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Climate data records from operational microwave humidity sounders

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Thanks to R. P. Allan, S. A. Buehler, M. Milz, B. J. Soden

Outline

This presentation covers the following topics:

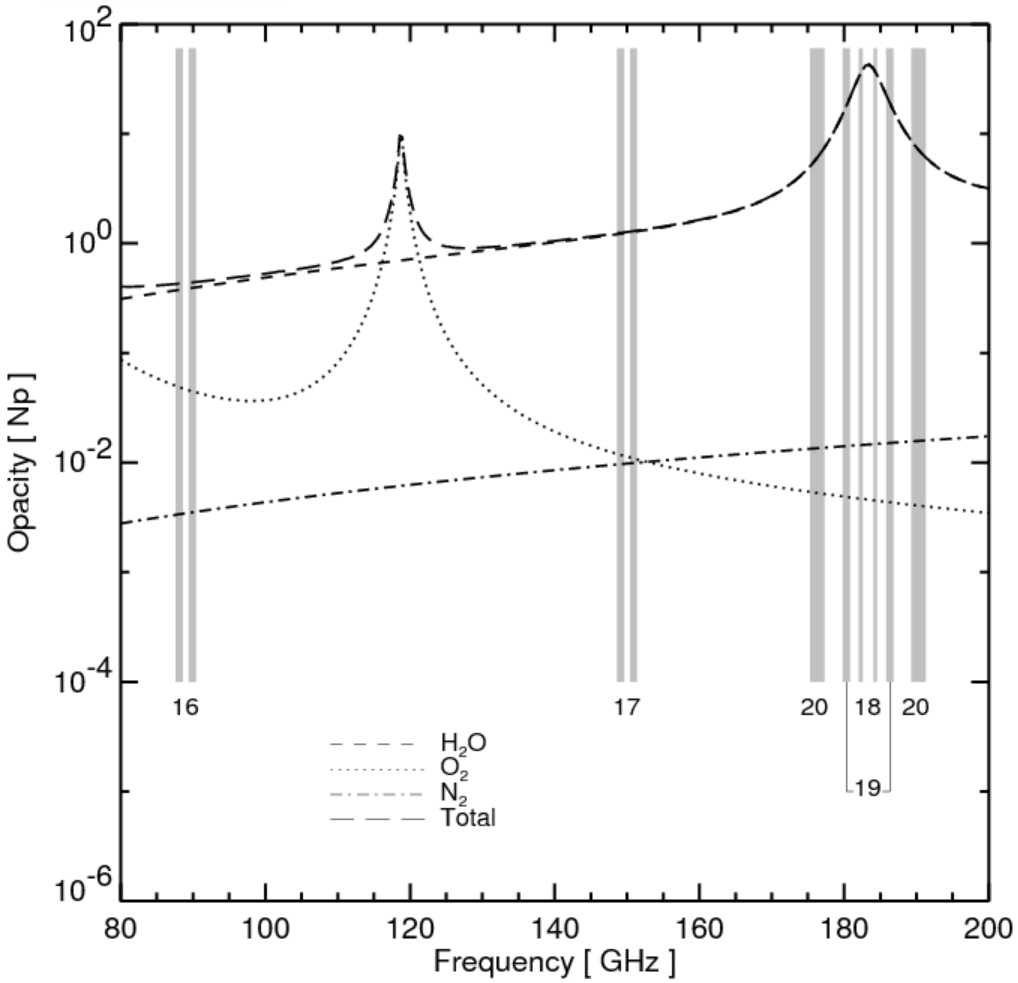
- Motivation
- Operational humidity sounders
- Upper tropospheric Humidity
- Initial steps of homogenization
- Evaluation of radiosonde data

Motivation

- Water vapour in the upper troposphere (UT) is an important climate variable (***Held and Soden*, 2000, Bates and Jackson, 2001**)
- Good quality measurements are lacking (***Foster and Collins*, 2004**)

  - radiosonde data quality are 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 Gahrs*, 2000**)
- Microwave data (SSM/T2, AMSU-B, MHS) can be used except in the presence of precipitating clouds (***Greenwald and Christopher*, 2002**)

Channel characteristics

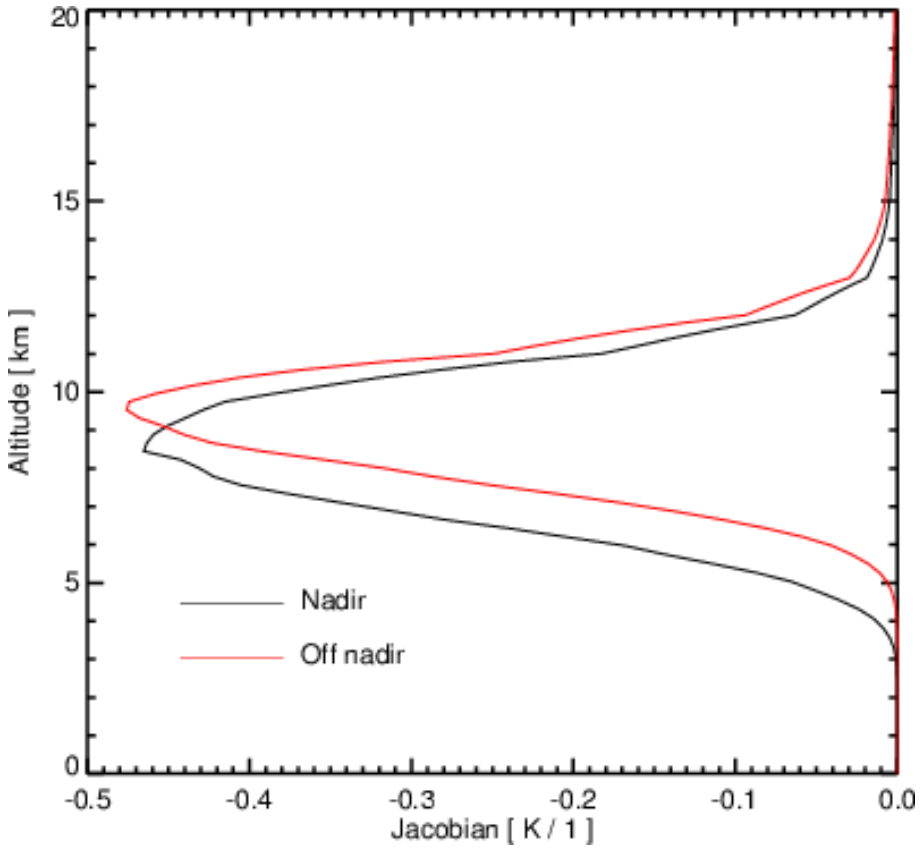


5 channel radiometers

AMSU-B and MHS - starting from 1999

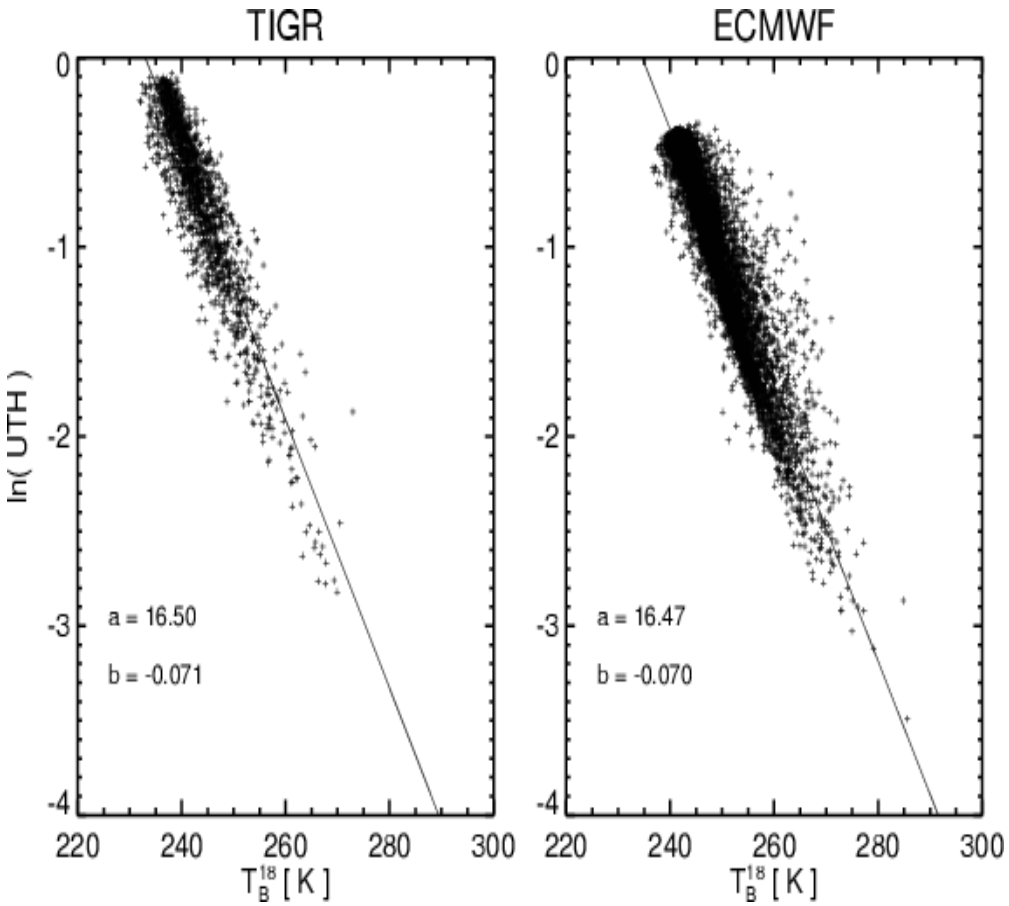
SSM-T/2 from 1994

UTH Channel



- 183.31 +/- 1.00 GHz (Channel 18)
- UTH: Jacobian weighted relative humidity in the “upper troposphere” (500-200 hPa)
- A simple relation between radiance (brightness temperature) and UTH exists for IR 6.7μ T_B (***Soden and Bretherton,* 1993, 96**) and AMSU T_B^{18} (***Buehler and John*, 2005**)

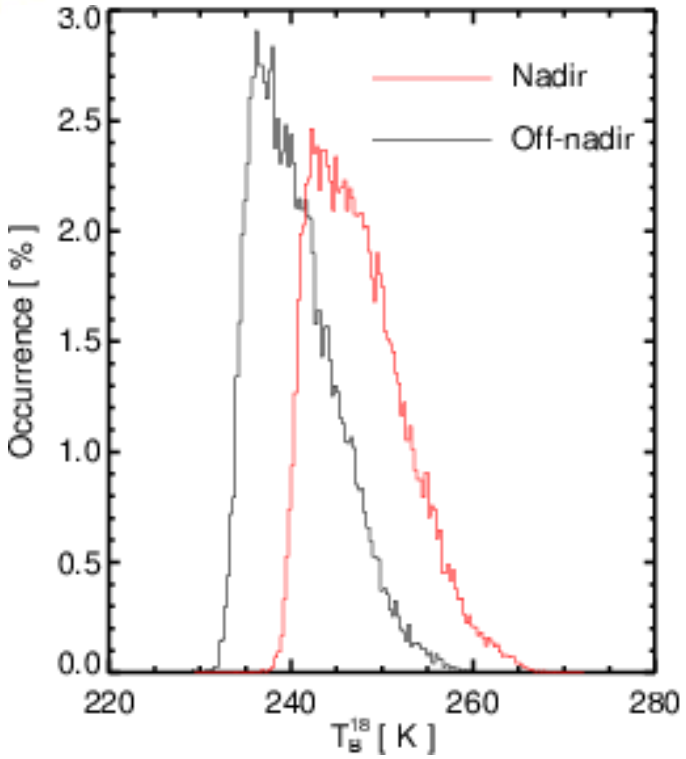
UTH from T_B^{18}

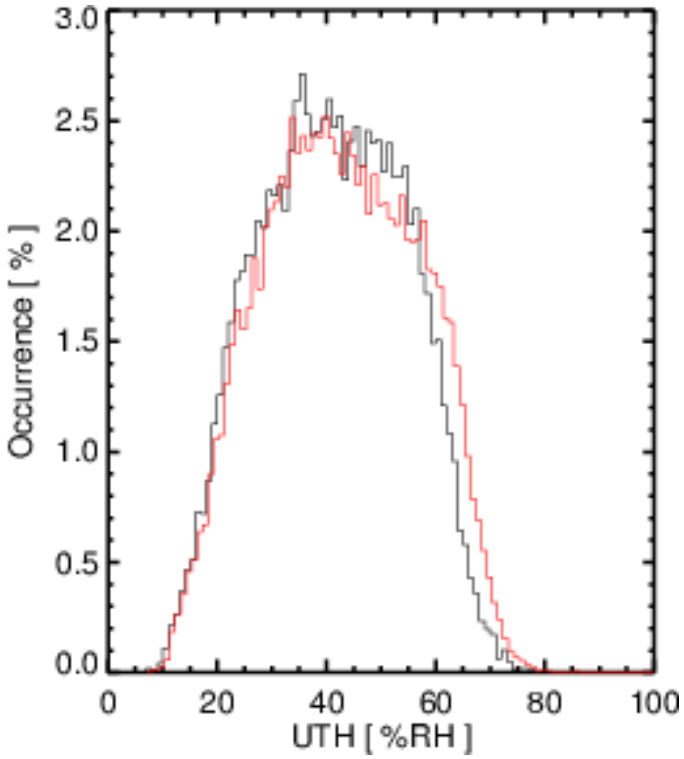


- $\ln(\mathrm{UTH}) = a + b\, T_B^{18}$
- Similar coefficients from independent data sets
- Retrieval precision is 2 %RH for low humidity and 7 %RH for high humidity
- Coefficients are calculated for all viewing angles

A similar relation is possible for MTH and T_B^{19}

UTH is limb corrected

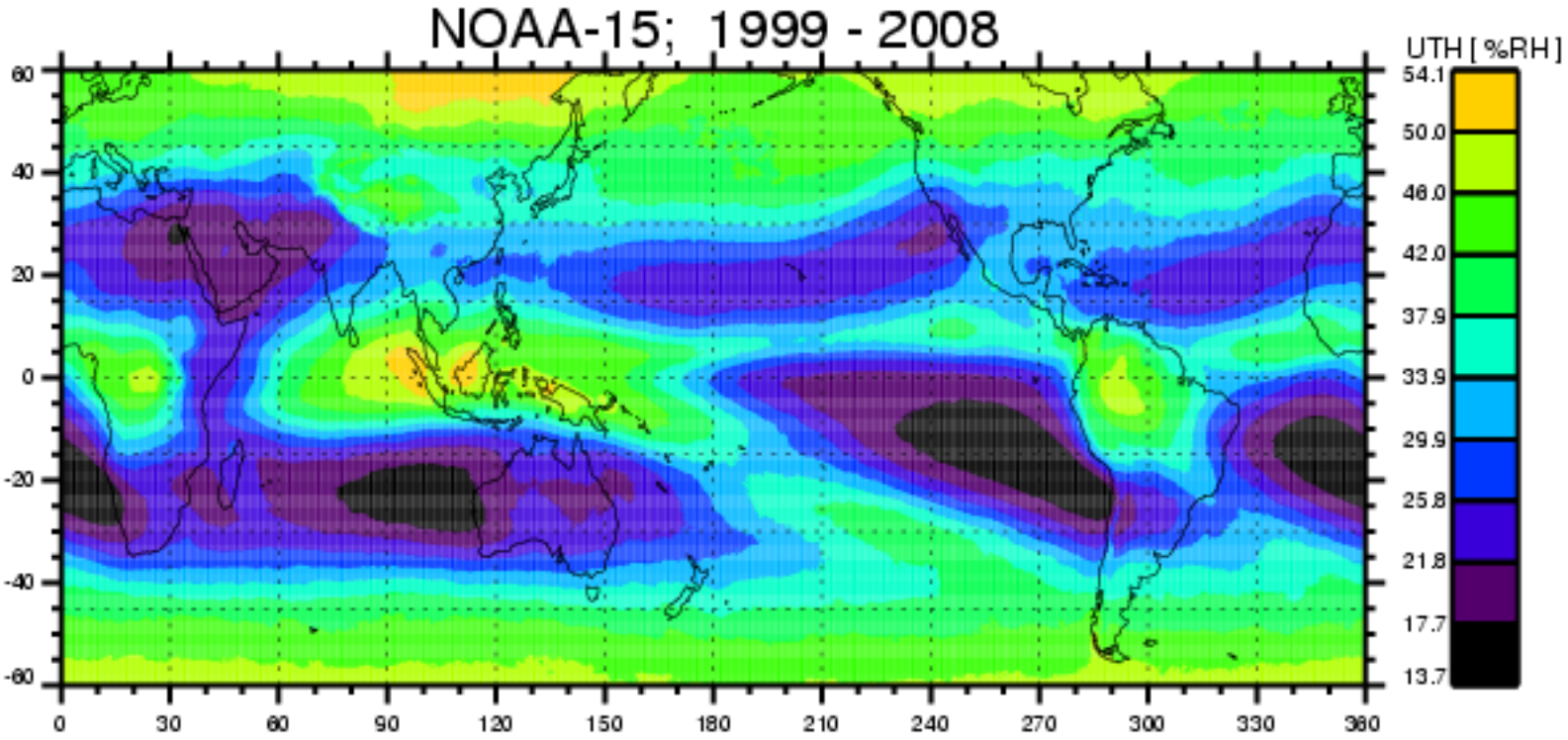




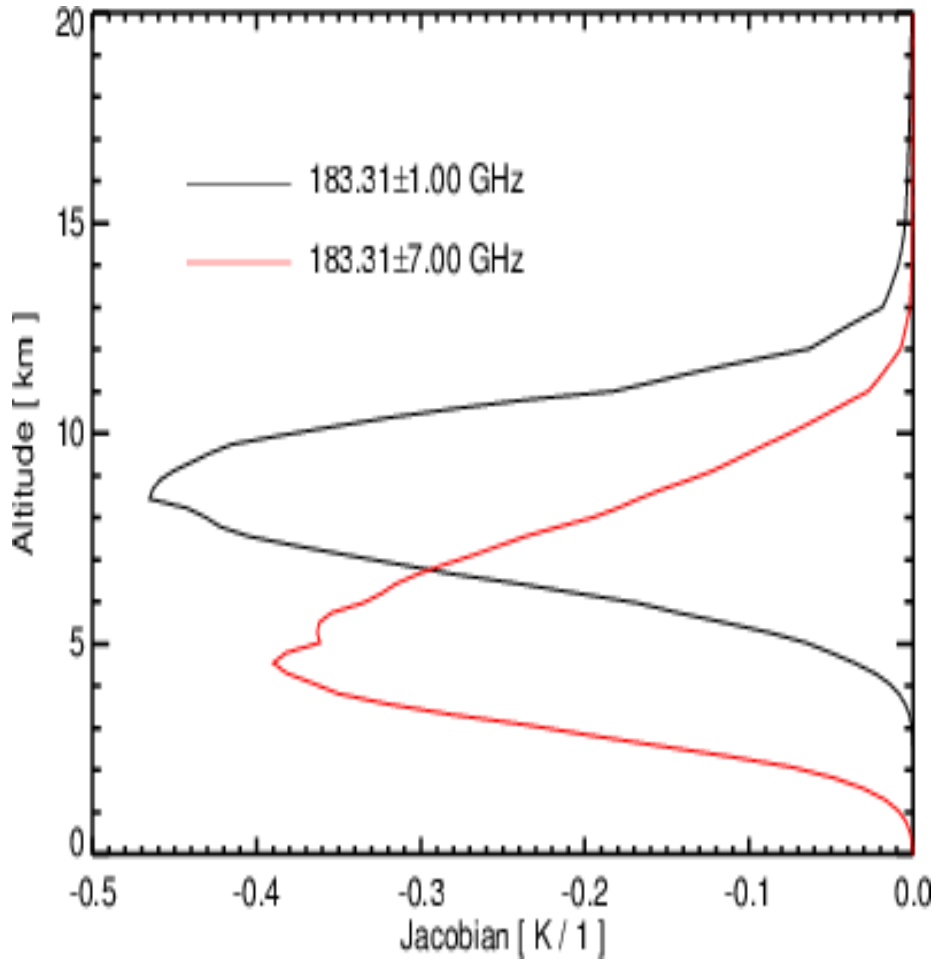
Regression coefficients are calculated for each viewing angle

Limb correction of radiances not needed

UTH Spatial Distribution

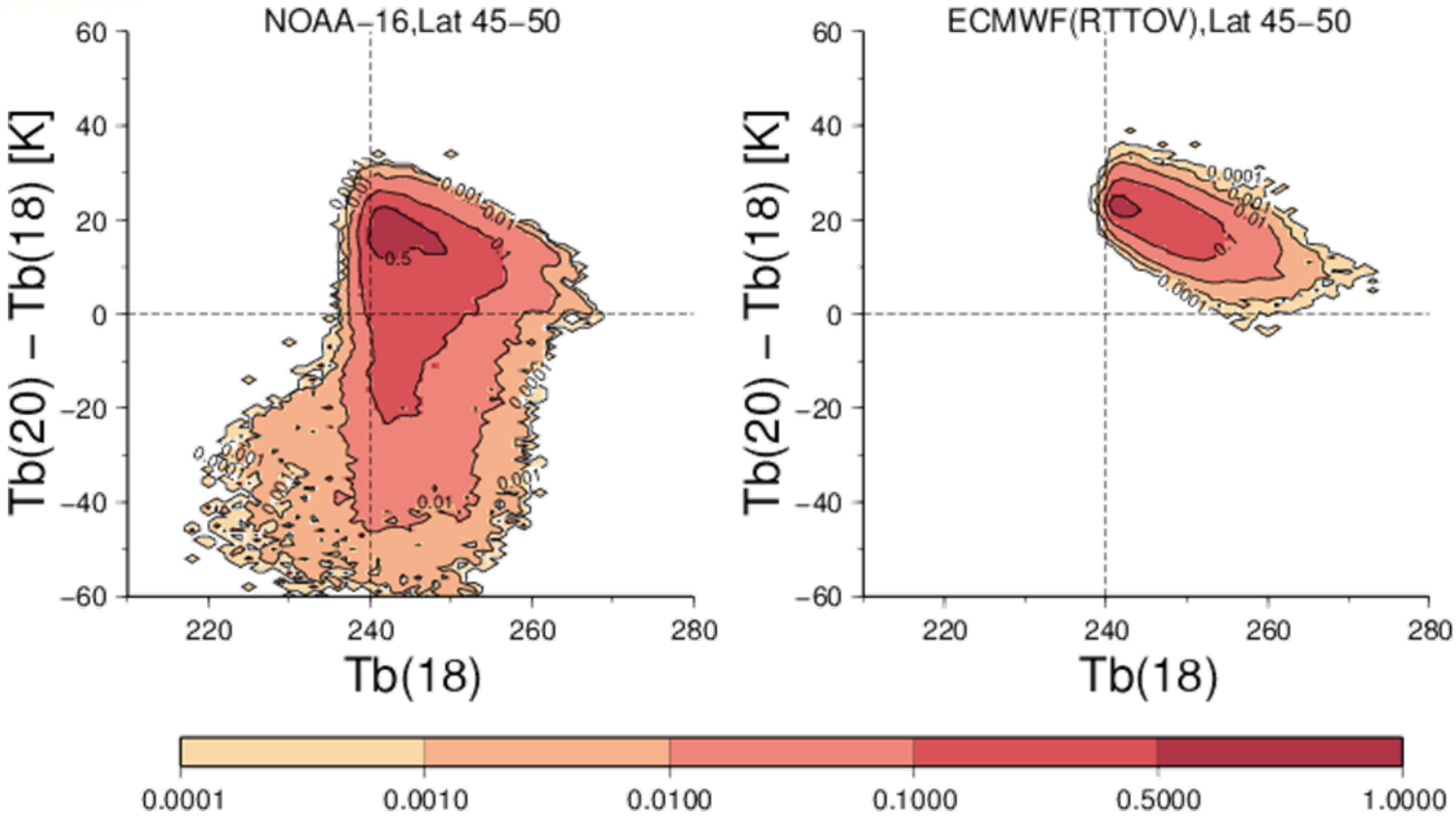


Cloud Filter

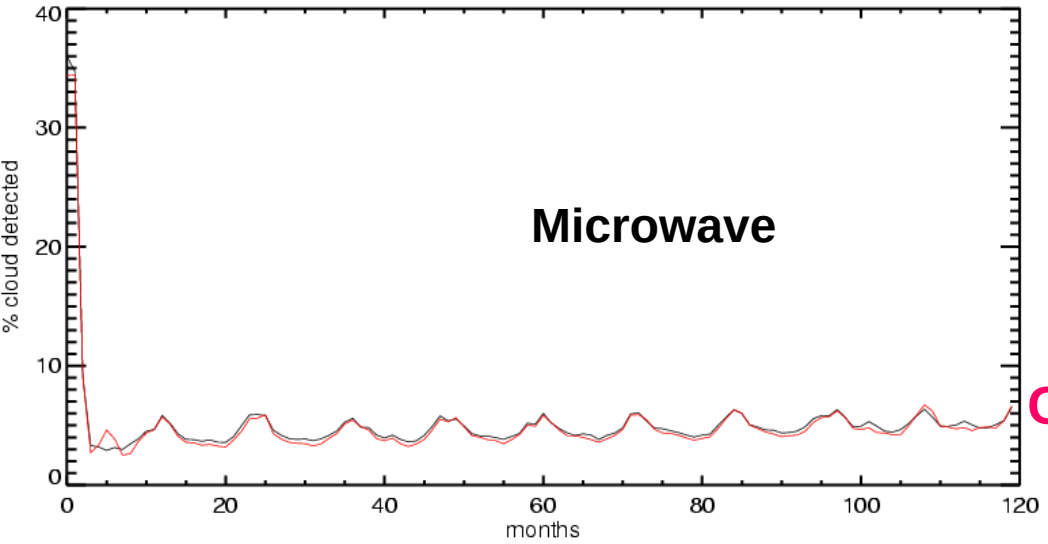


- Clear sky: $T_B^{20} > T_B^{18}$
- Cloudy: $T_B^{18} > T_B^{20}$
- $T_B^{18} >$ Threshold

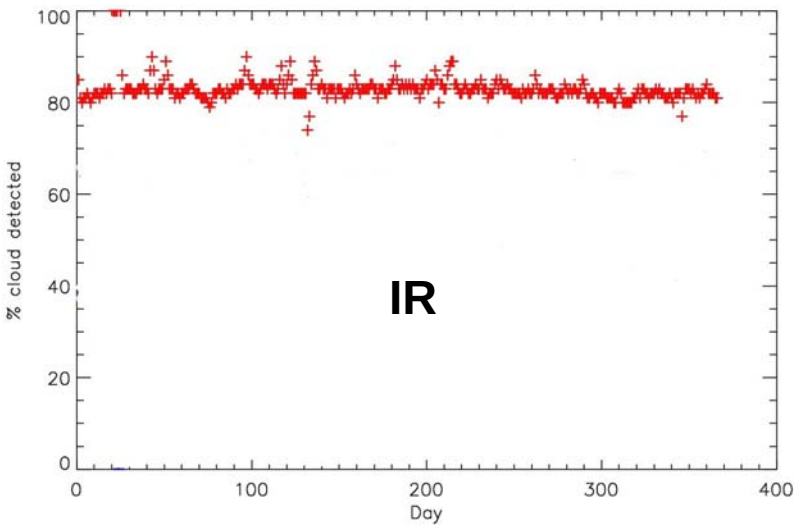
Cloud Filter



% cloud contamination in IR and MW data



Cloudiness is correlated with RH

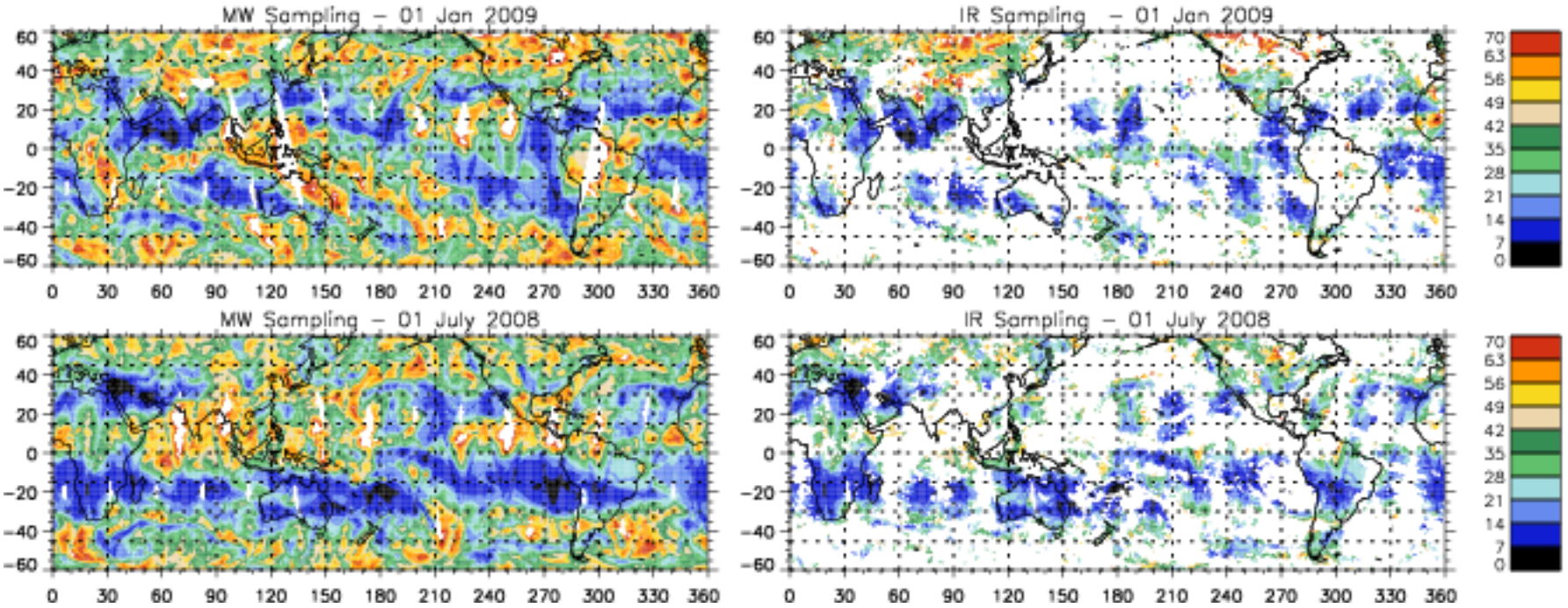


Clear-sky sampling issues

- Lanzante and Gahrs (2000) used radiosonde UTH data to estimate the impact
- They found 5-10% dry bias in IR data set
- Due to poor data quality in the UT and insufficient spatial coverage radiosondes may not be the best data to use for this
- HIRS and AMSU-B/MHS are flying on same satellites with similar viewing geometries - this gives a unique opportunity to estimate the clear-sky sampling bias
- 2008 data from MHS and HIRS on MetOp are used; MHS pixels are mapped to HIRS grid and then sub-sampled for clear HIRS pixels

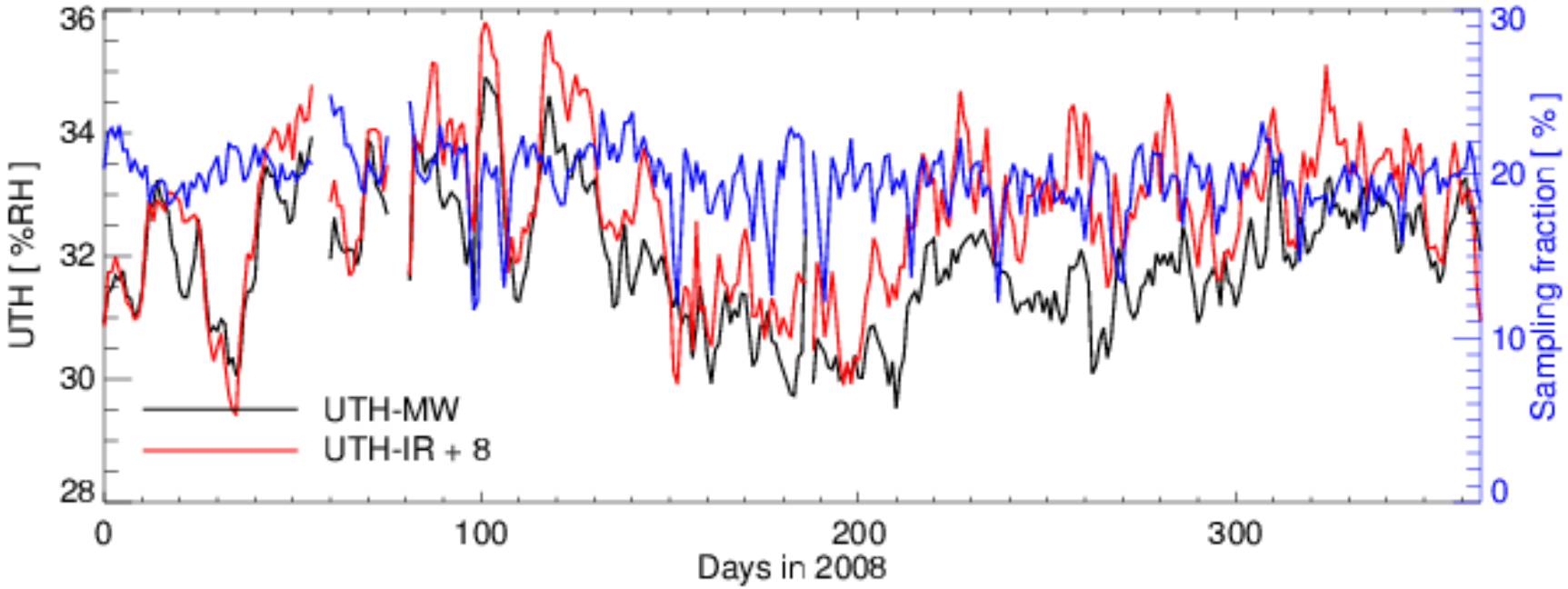
MW and IR sampling - Daily mean

Grid resolution = 1 x 1 degree



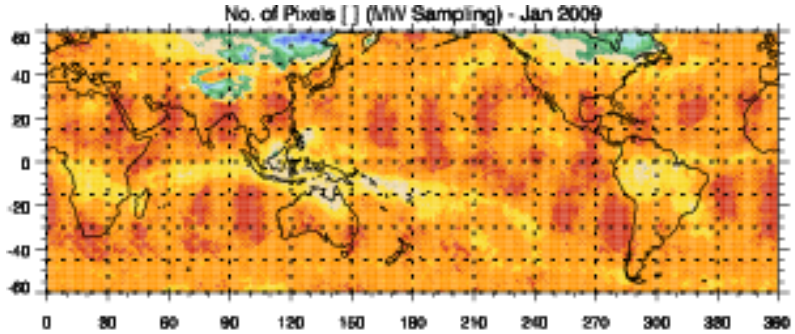
Daily mean time series

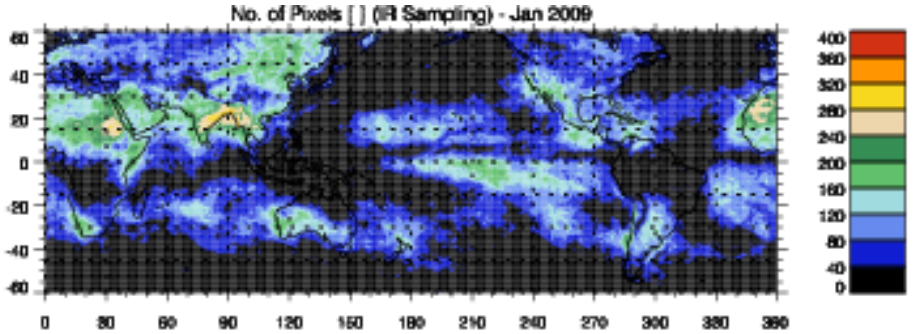
Area weighted tropical average time series

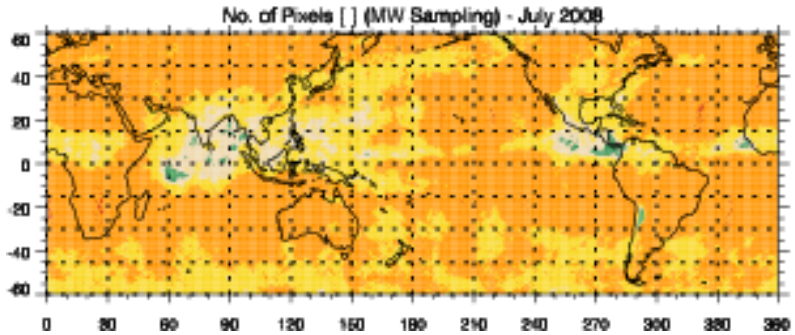


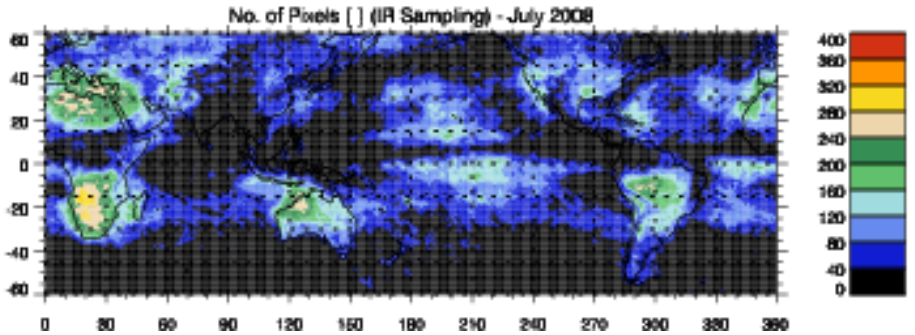
MW and IR sampling - # of pixels

Monthly, 1 x 1 degree grids

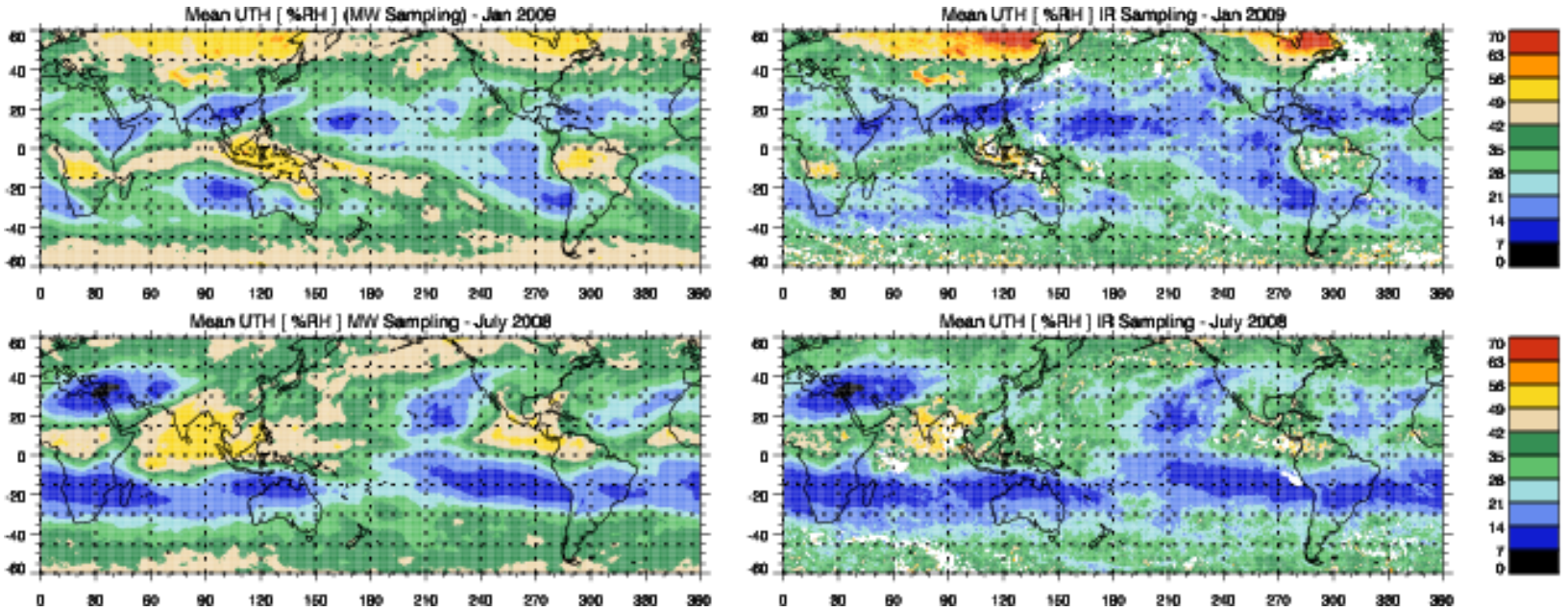




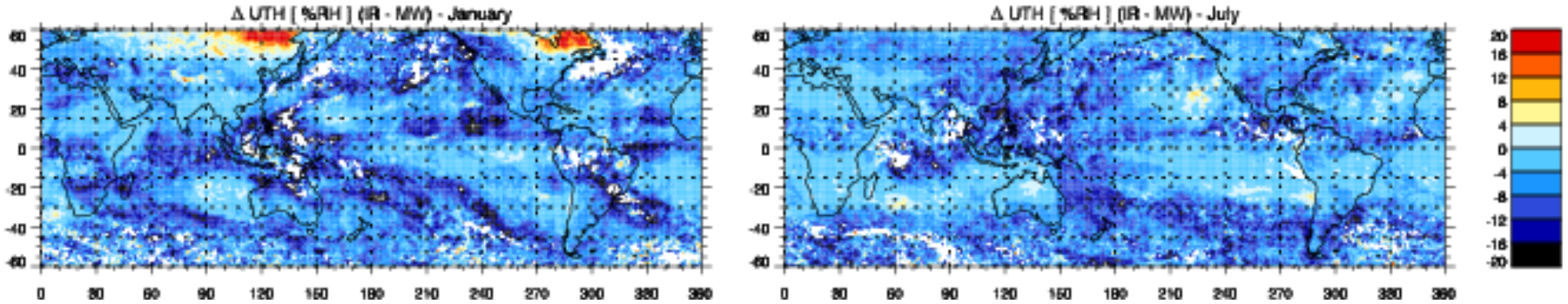




MW and IR sampling – monthly mean

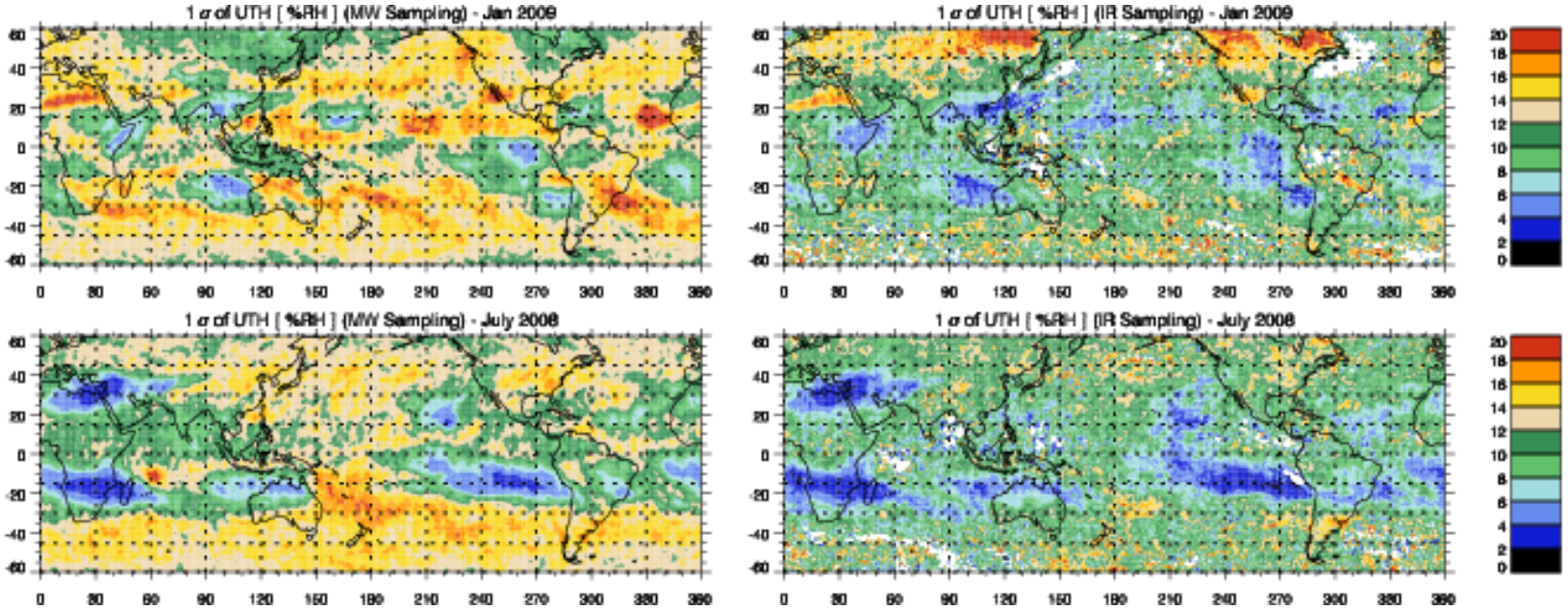


MW and IR sampling – clear-sky bias



There are larger values - up to -35 %

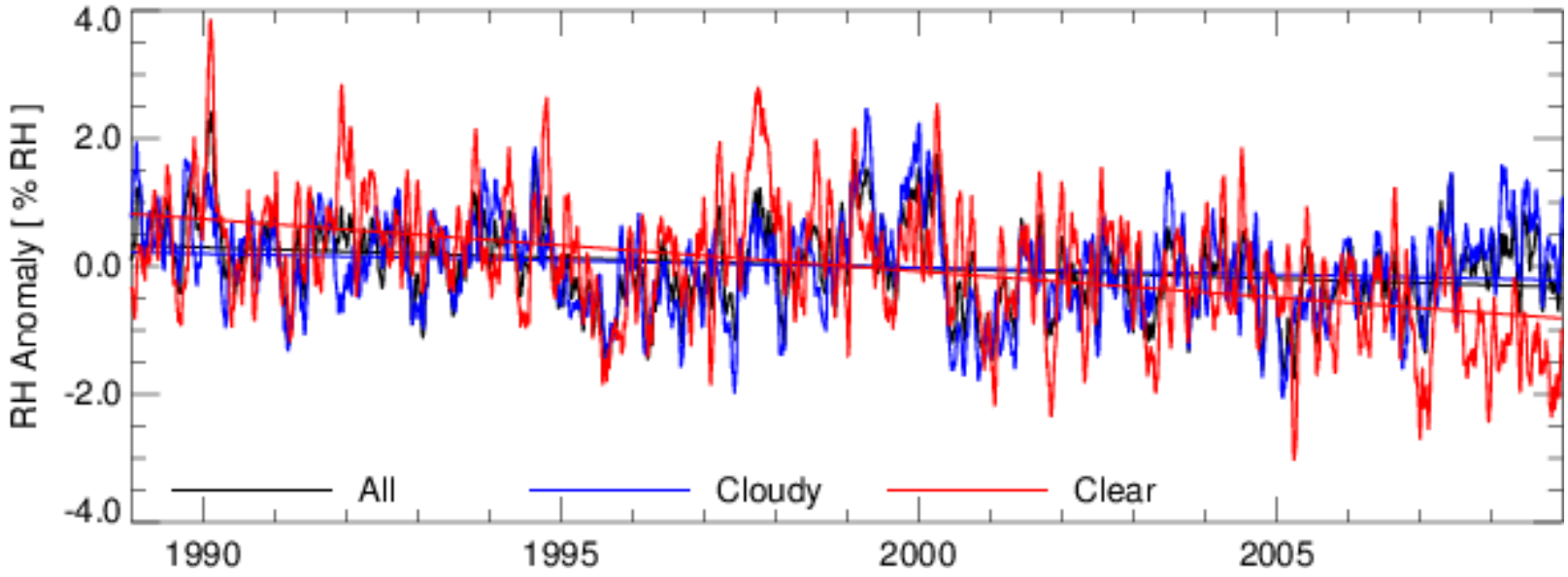
MW and IR sampling - variability



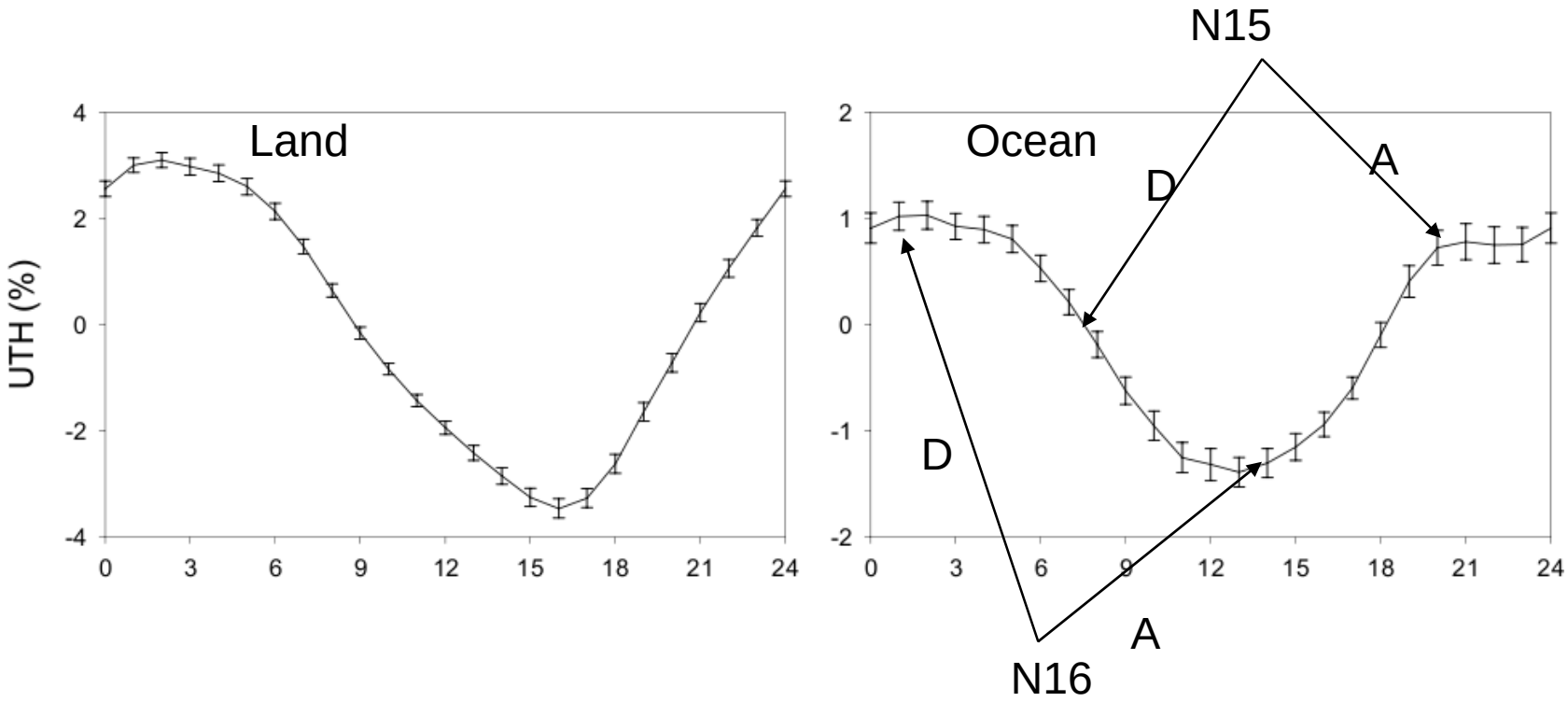
MW and IR sampling - Trend?

ERA-Interim 500 hPa RH and cloud cover

Clear = cloud cover < 30%



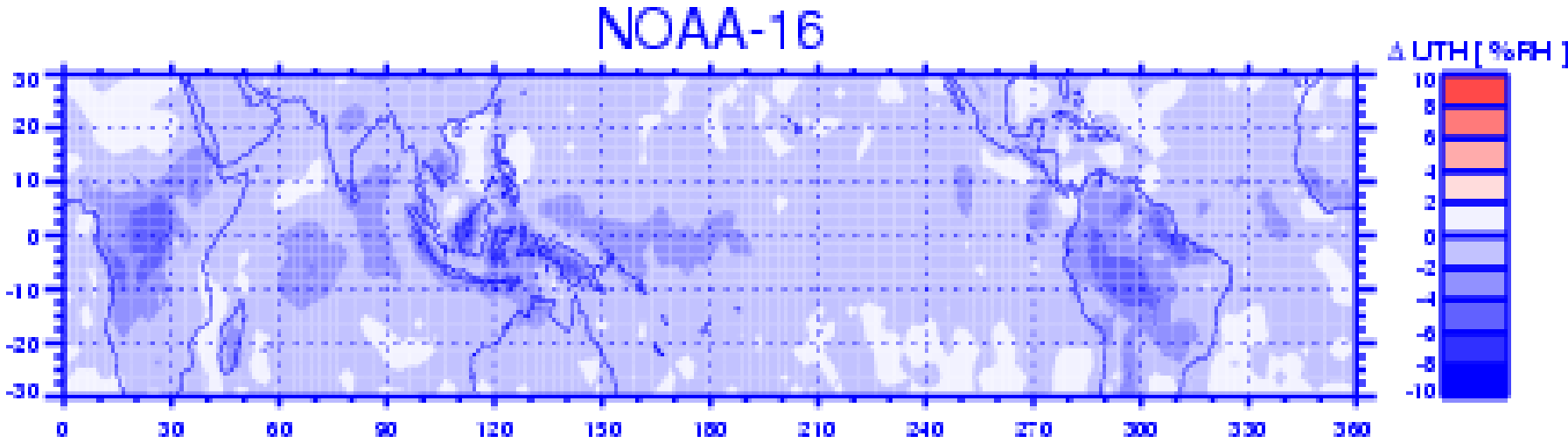
Diurnal Cycle



Chung et al., 2007

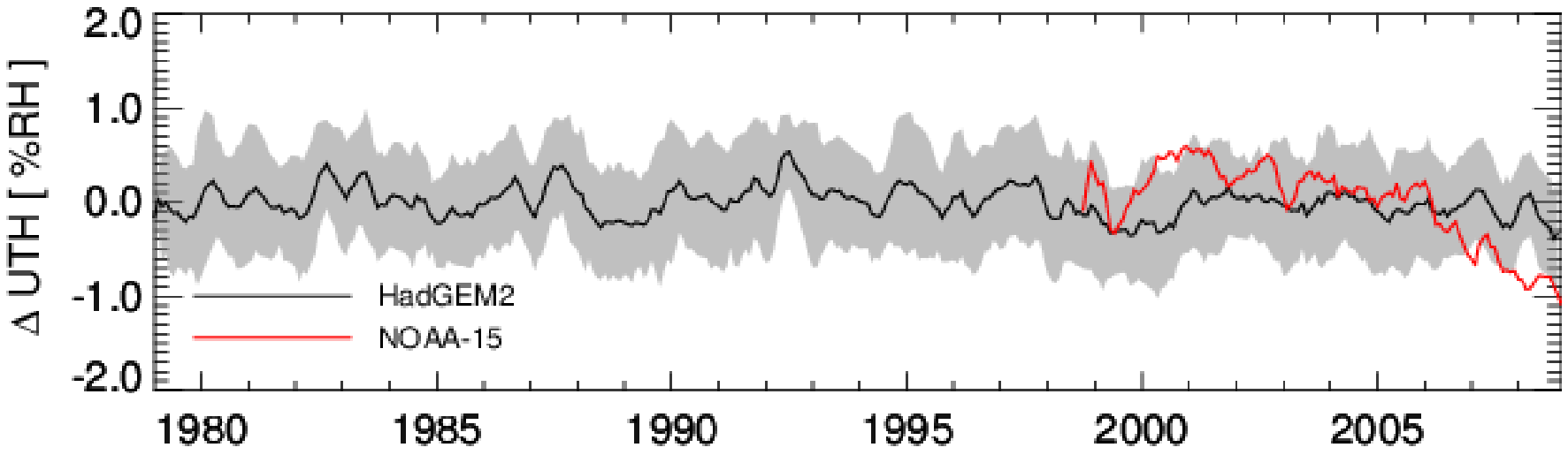
Diurnal Cycle

Difference between ascending and descending passes



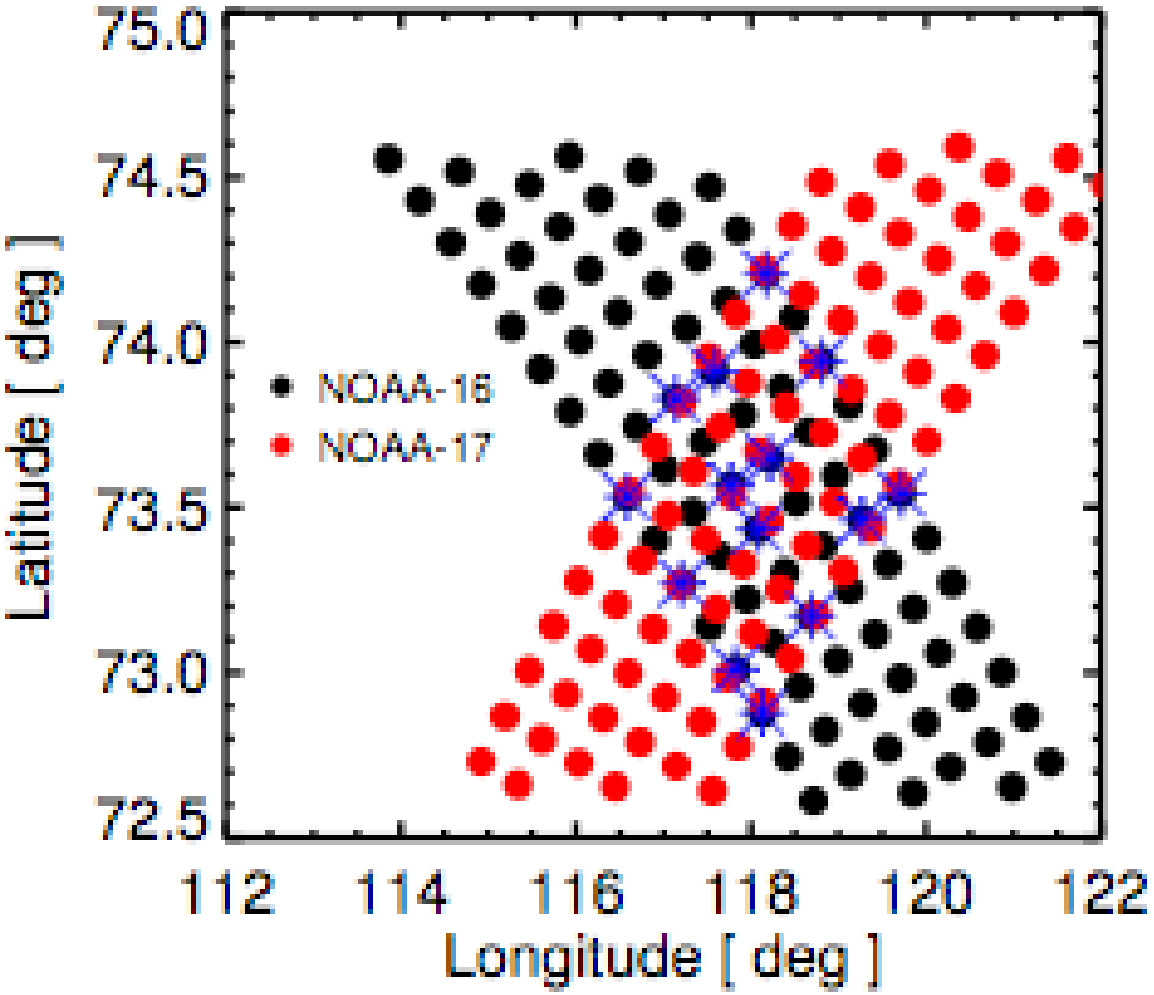
Strongly associated with convection

Orbital drift?

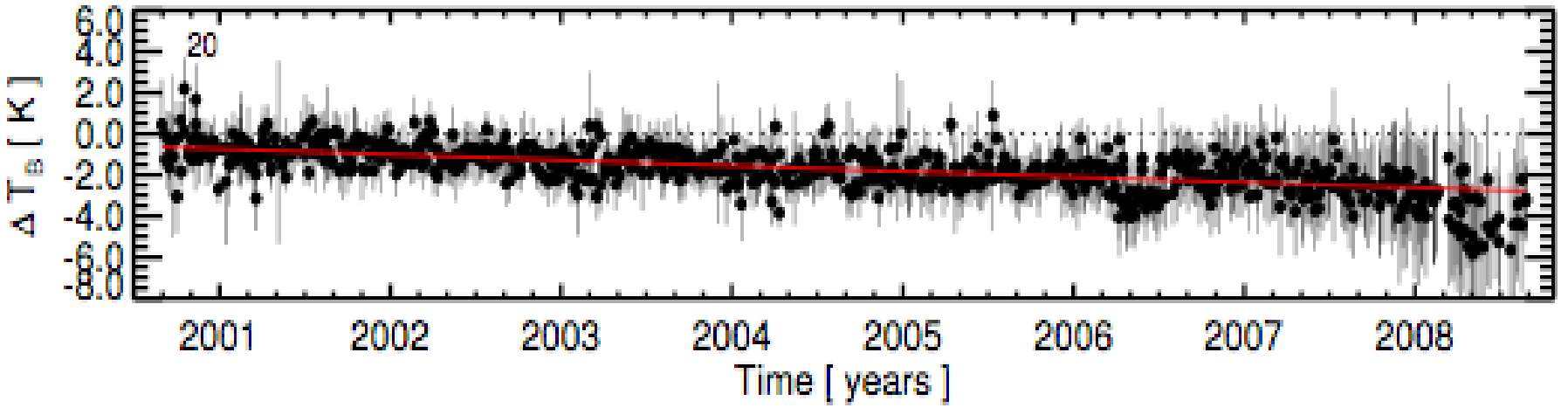


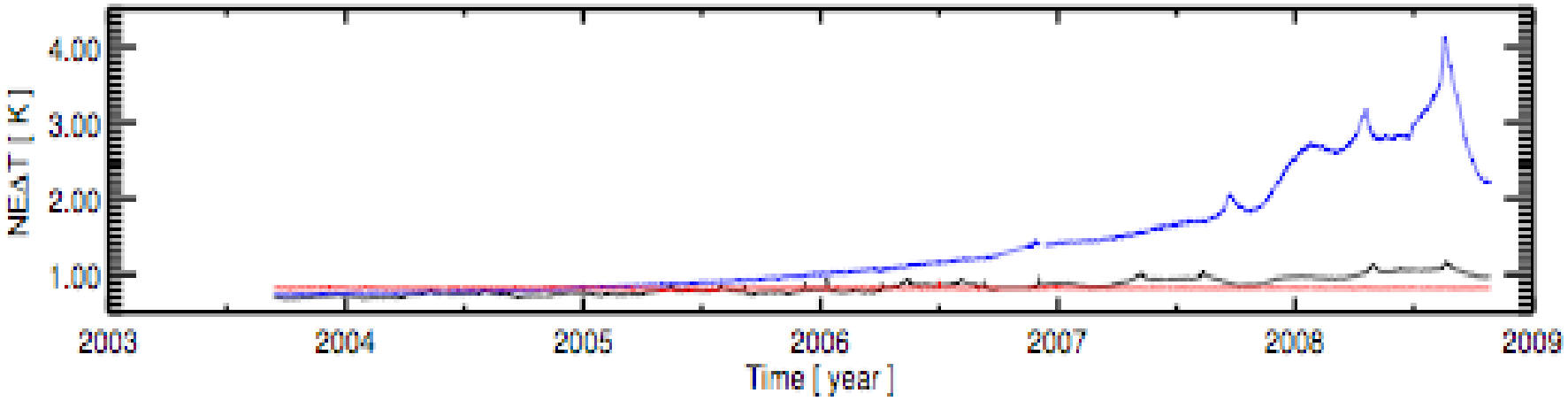
Drift in NOAA-15 may be due to orbital drift.

SNO Example



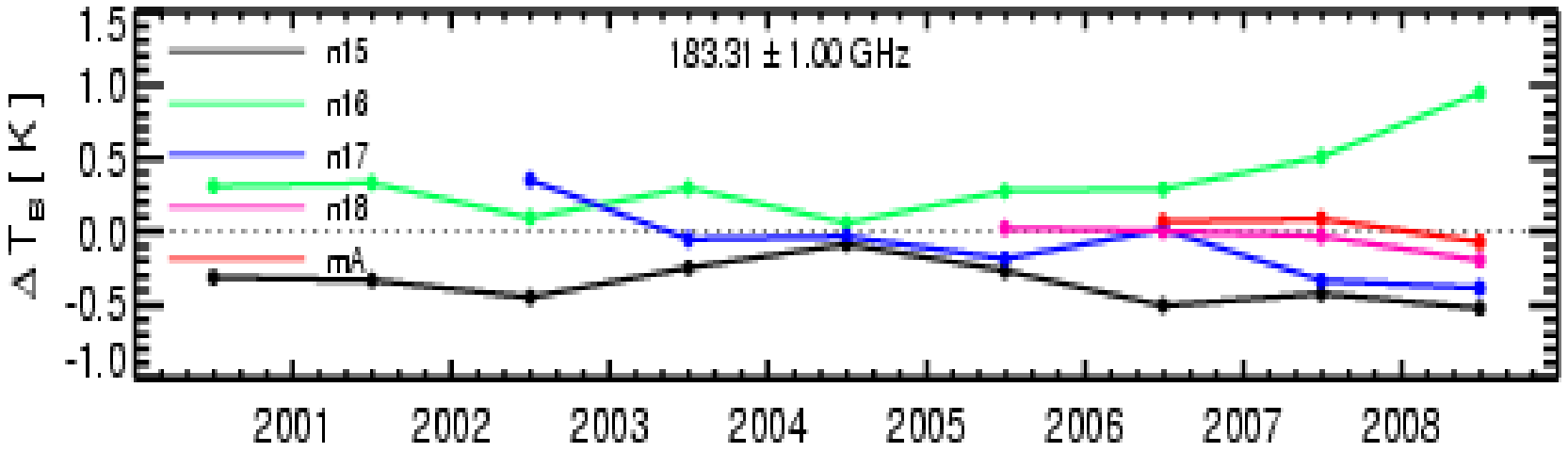
Drift in brightness temperature





Inter Satellite Differences

Using simultaneous nadir overpasses



Large inter-satellite biases

Bias is not constant over time

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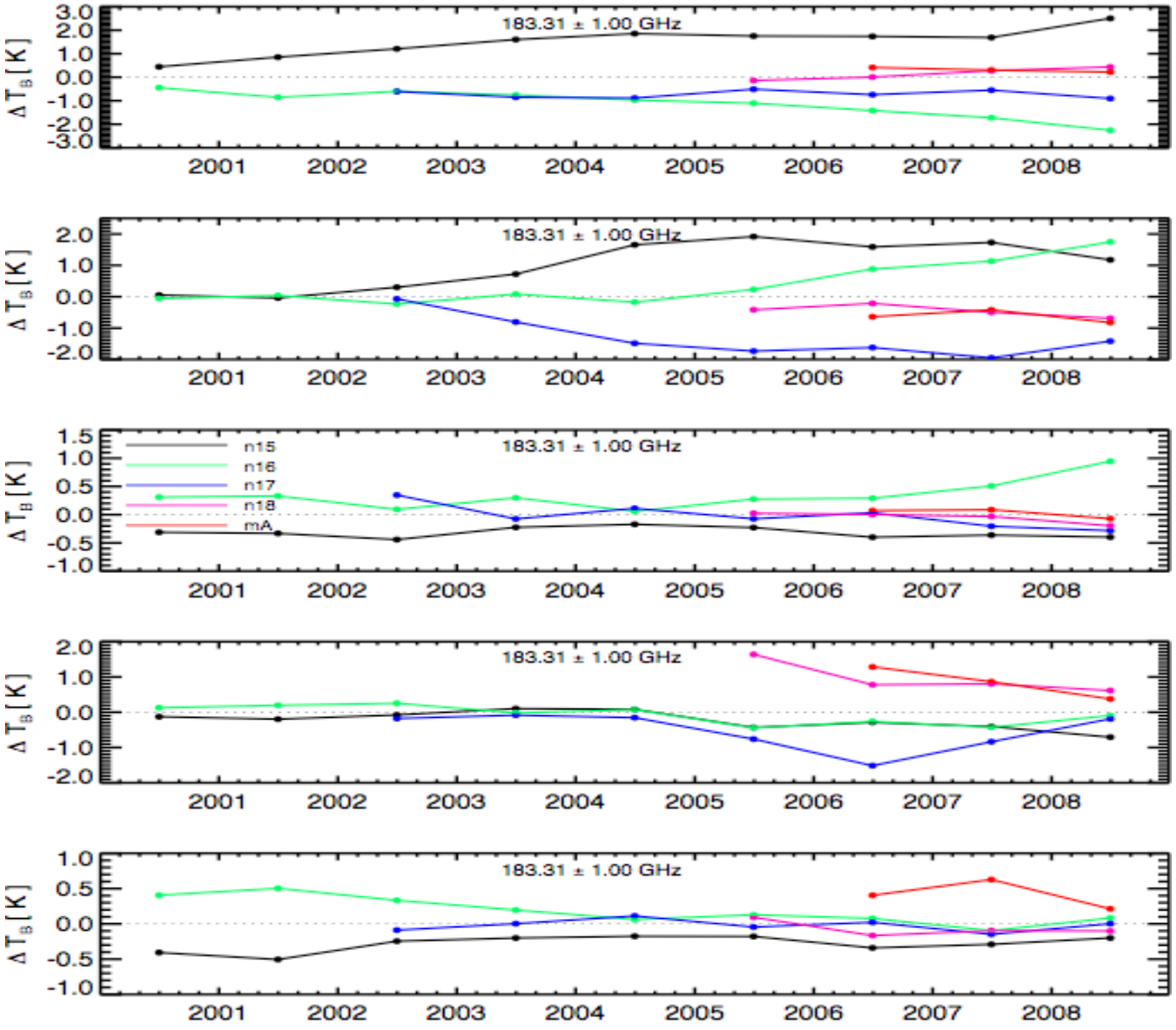
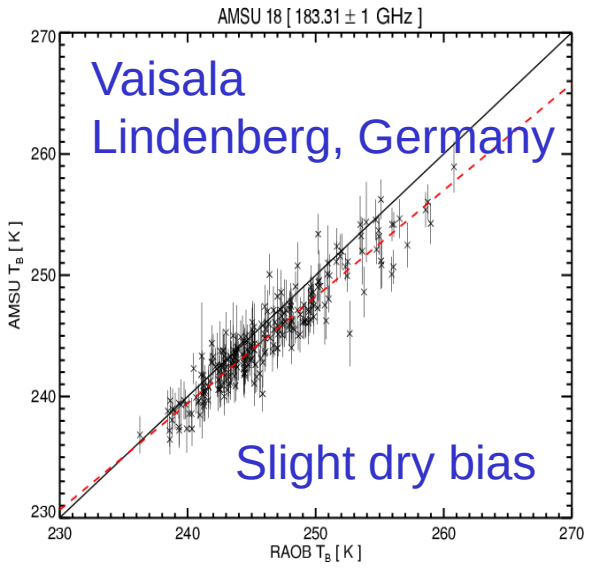
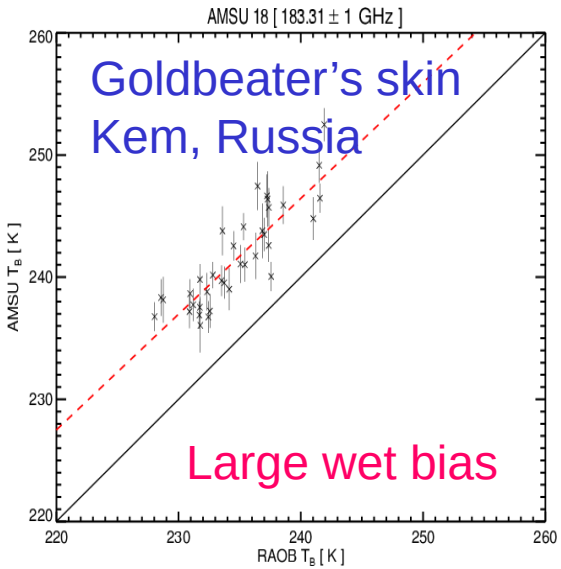
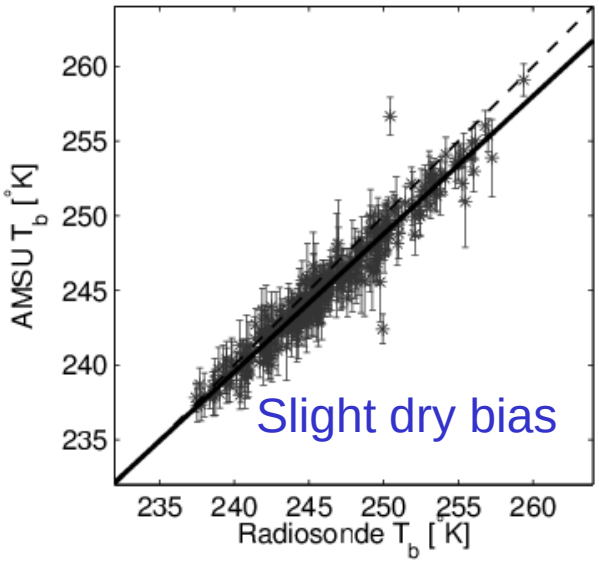
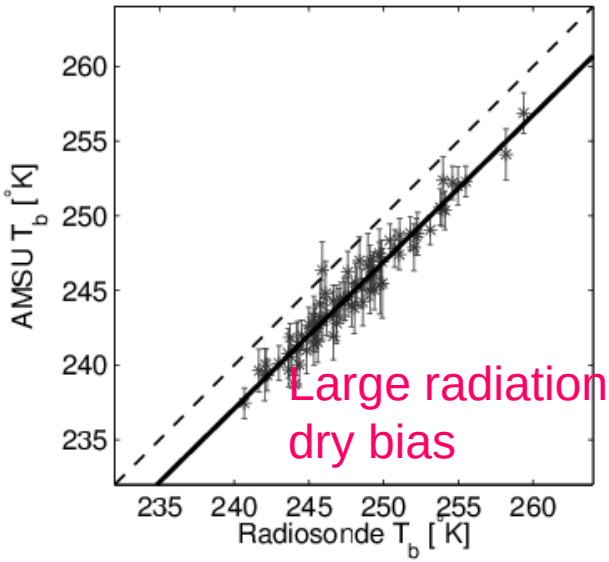


Radiosonde quality issues





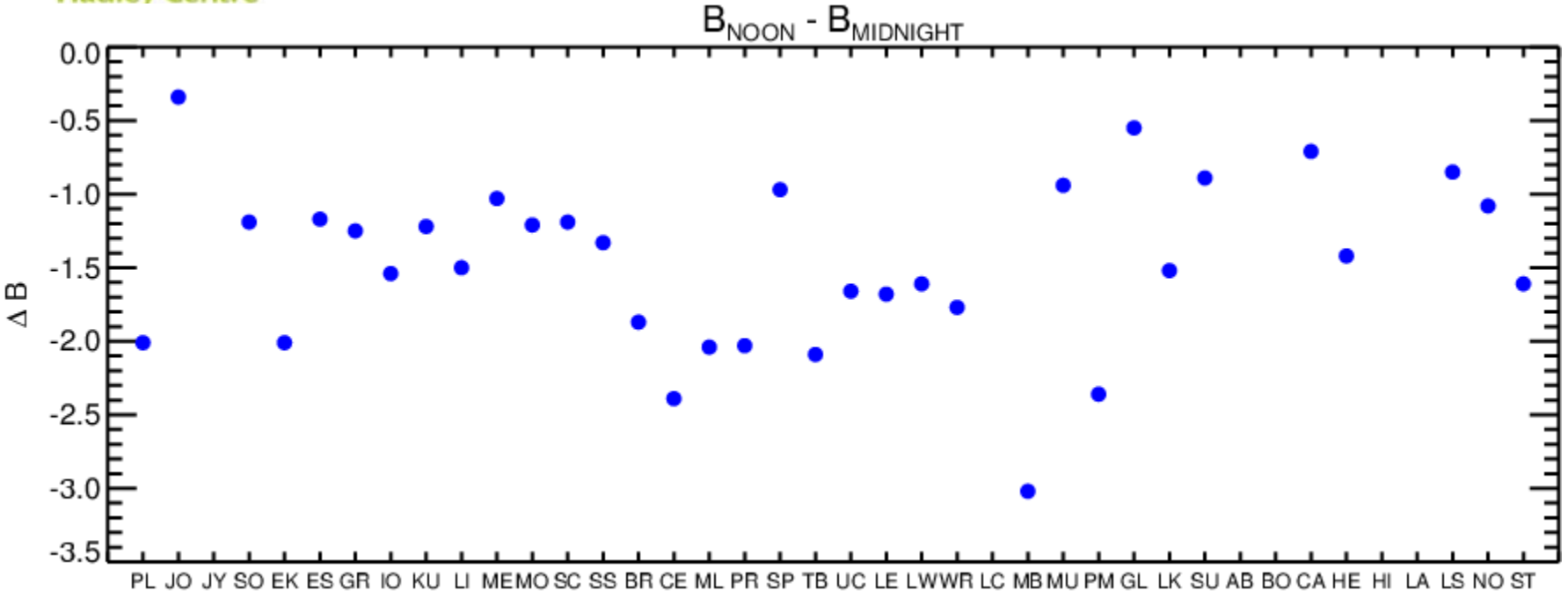




Results using ARM Data (TWP-C1)

Moradi et al., 2010
Submitted to JGR

Day/night biases



European stations; data from 2001 to 2003

Summary and future plans

- Gridded daily and monthly UTH data set available from operational microwave sounders
- As cloud impact is insignificant, MW UTH data can be used to estimate CSB in IR UTH
- Significant diurnal cycle□in UTH
- Working on inter-satellite calibration, orbital drift correction, MTH retrieval, SSM-T/2, ...

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Questions??