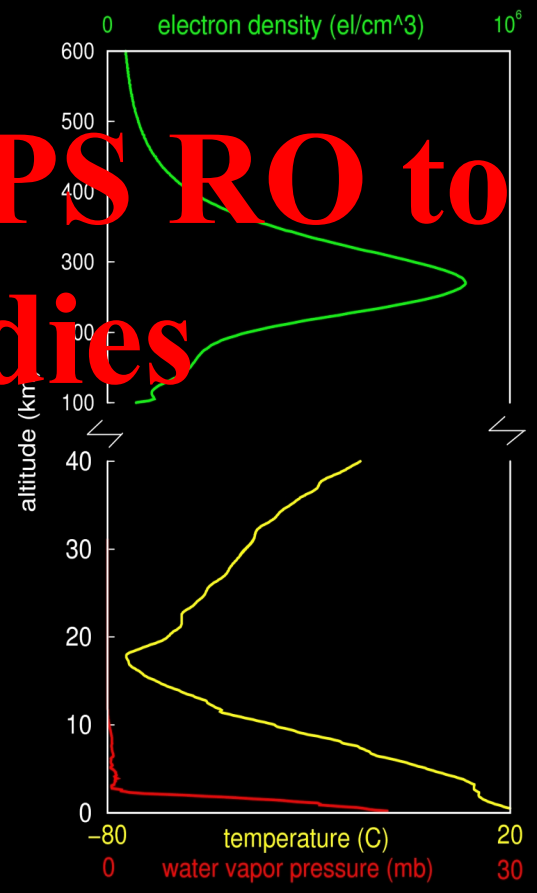
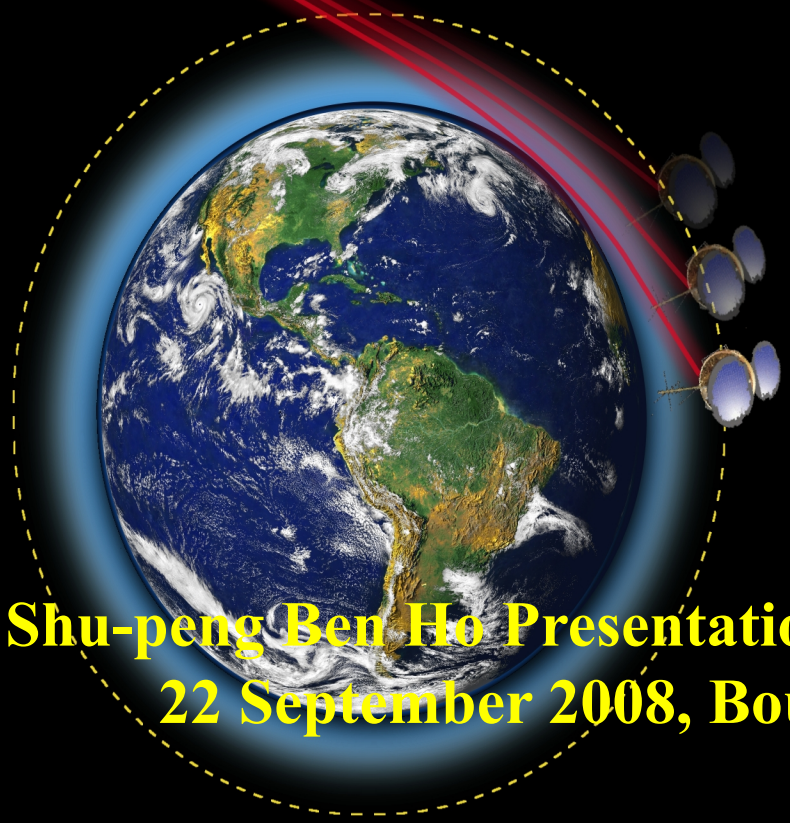
Applications of GPS RO to Climate Studies





Shu-peng Ben Ho Presentation for CES

22 September 2008, Boulder

Motivation:

- **Can GPS RO data be used as a climate benchmark dataset ?**
- **Can we use GPS RO data as benchmark measurements to inter-calibrate other instruments ?**
- **Using GPS RO data to fill up the gap of climate data for lacking of NPOESS data and other data types ?**

Outline of Presentation

- Challenges for defining Climate Trend using satellite data
- Characteristics of COSMIC GPS RO data for climate monitoring
- Applications of GPS RO for climate studies
- Conclusions and future researches

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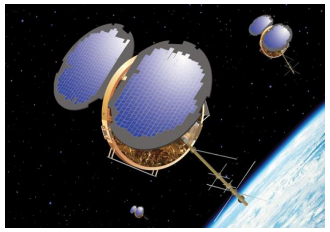
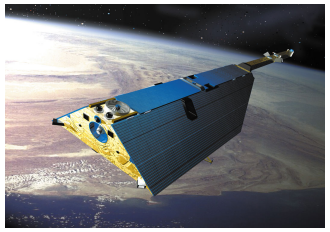


Challenges for defining Climate Trend using satellite data



Satellites: Comparability and Reproducibility ?

1) Not designed for climate monitoring

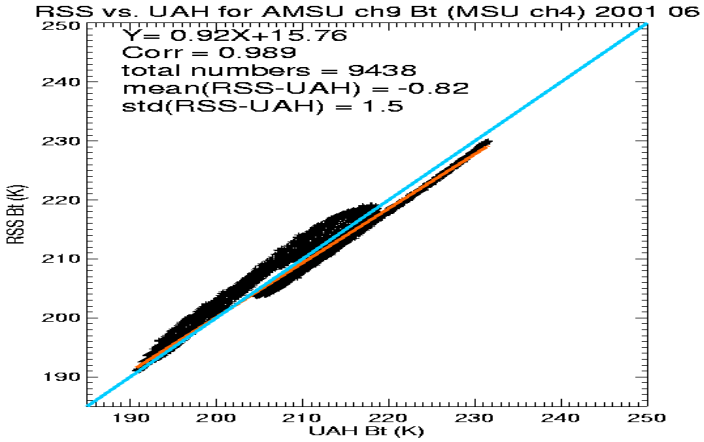
2) Changing platforms and instruments

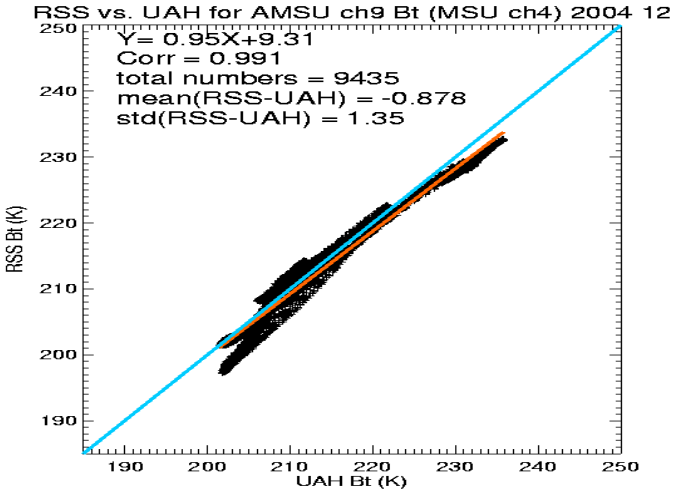
(No Comparability)

3) Different processing/merging method

lead to different trends: Due to the differing methods used to account for errors before merging the time series of eleven AMSU/ MSU satellites into a single, homogeneous time series, these derived trends are different from different groups (RSS vs. UAH).

(No Reproducibility)





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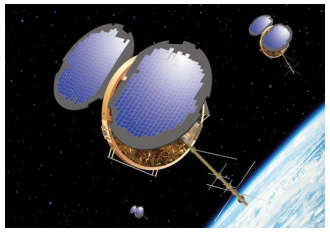
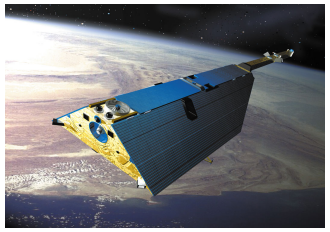
Characteristics of GPS RO Data

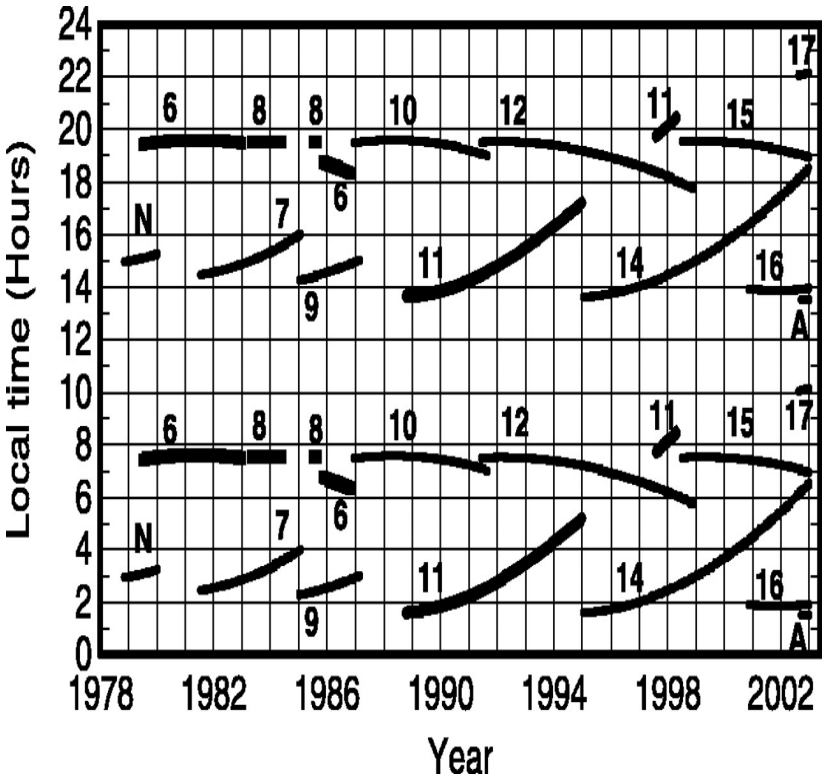
- **Measure of time delay: no calibration is needed**
- **Requires no first guess sounding**
- **Uniform spatial/temporal coverage**
- **High precision**
- **No satellite-to-satellite bias**
- **Independent of processing procedures**



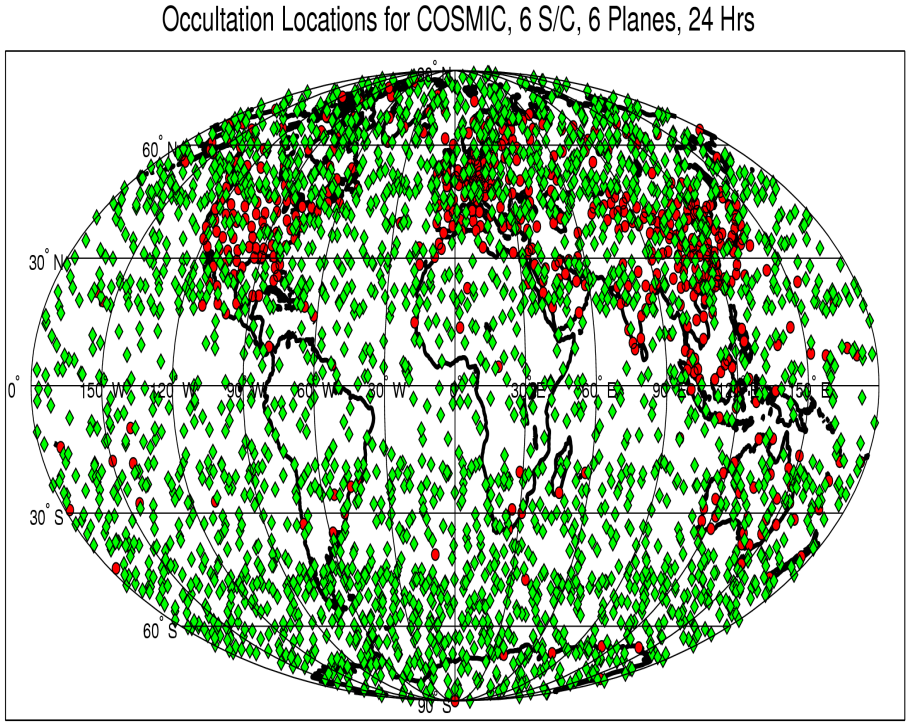
Difficulty I: to find observations with a good global and temporal coverage



AMSU/MSU local time



COSMIC has a more complete temporal and spatial global coverage



COSMIC

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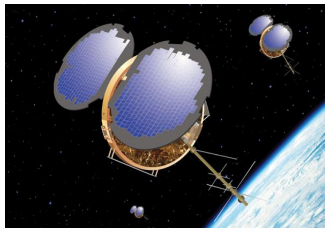
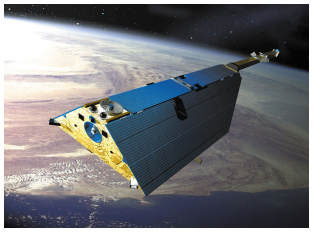
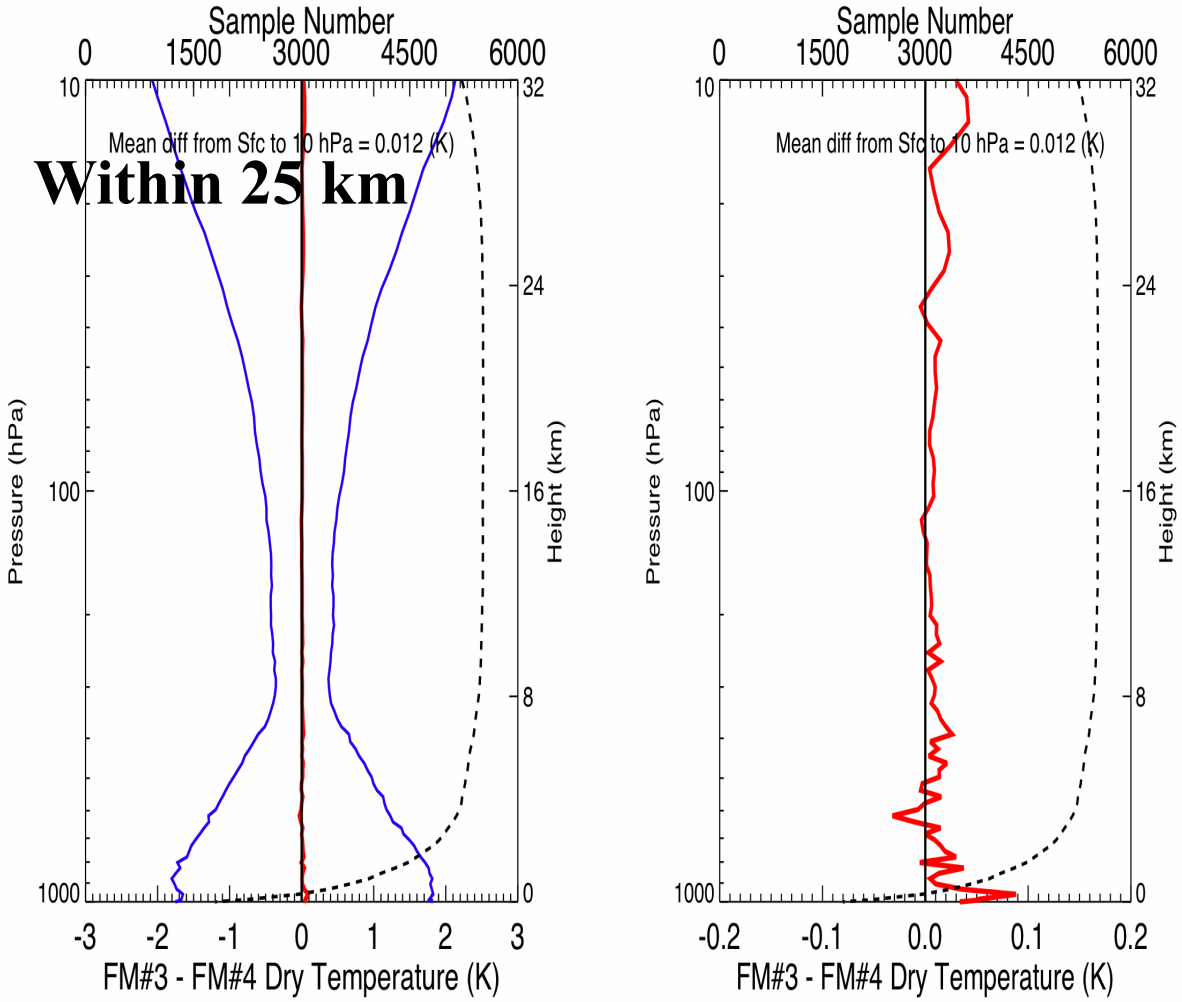


Difficulty II: Comparability of COSMIC data from different receivers





Using FM3-FM4 pairs in early mission

Need to quantify all COSMIC-COSMIC pairs

Precision < 0.05 K

Dry temperature difference between FM3-FM4 receivers

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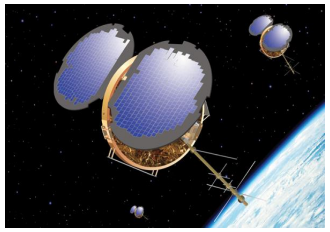
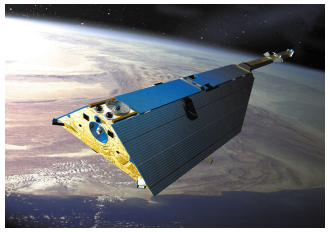
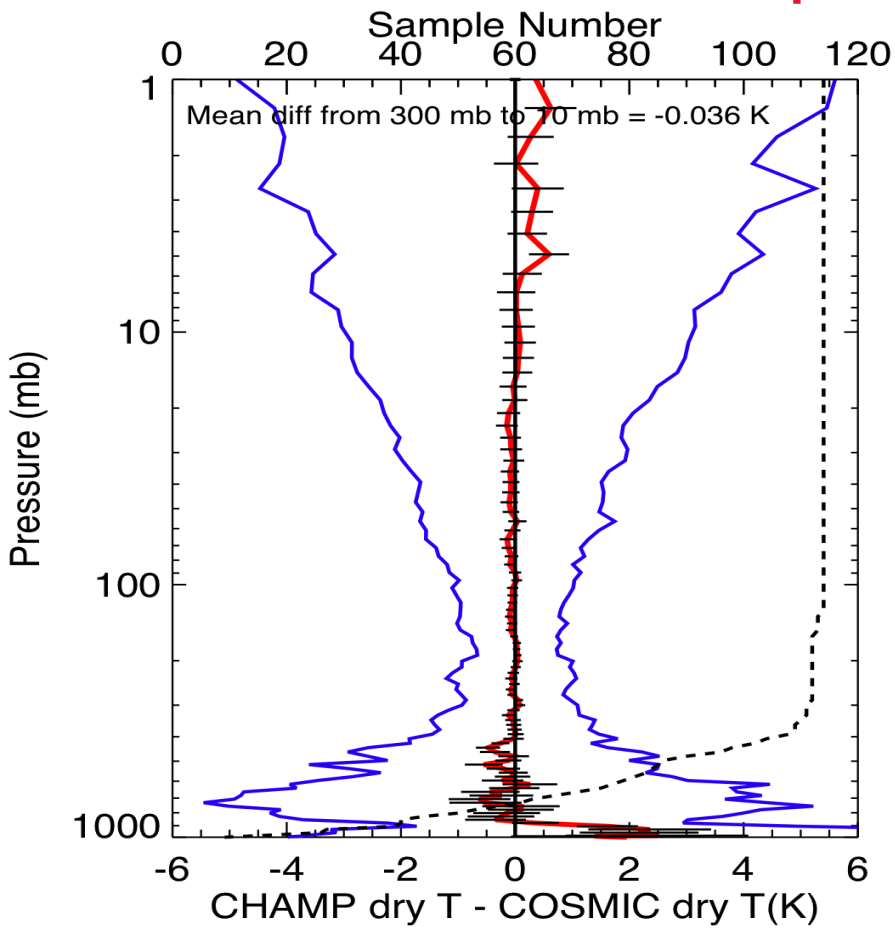


Difficulty III: Long-term stability



Global COSMIC-CHAMP Comparison from 200607-200707

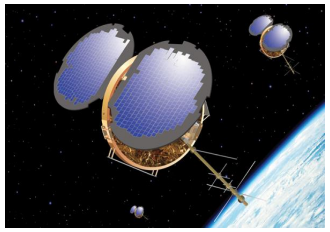


Within 60 Mins
and 50 Km

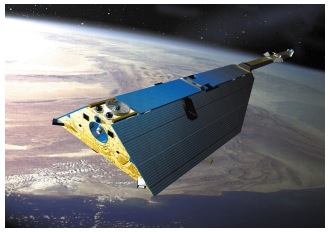
- Comparison of measurements between old and new instrument
- CHAMP launched in 2001
- COSMIC launched 2006

Don't need to have stable calibration reference

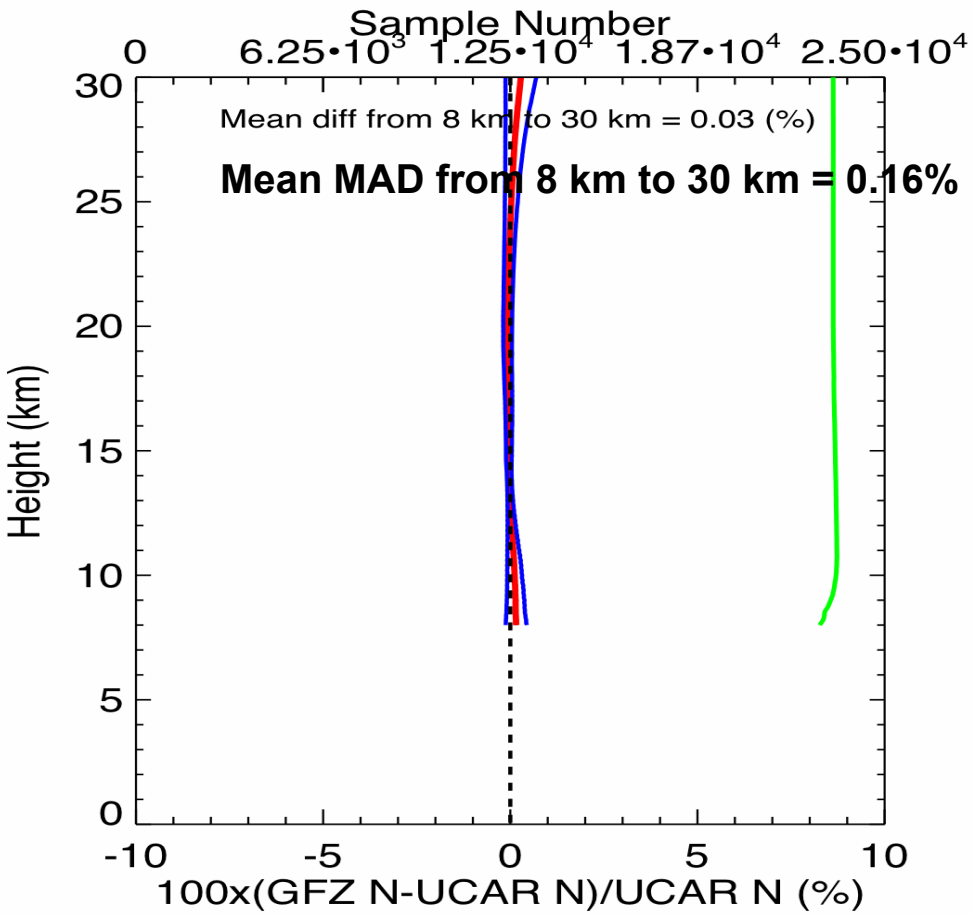
Mean bias < 0.05 K



Difficulty IV: Reproducibility of GPS RO data



200601-12

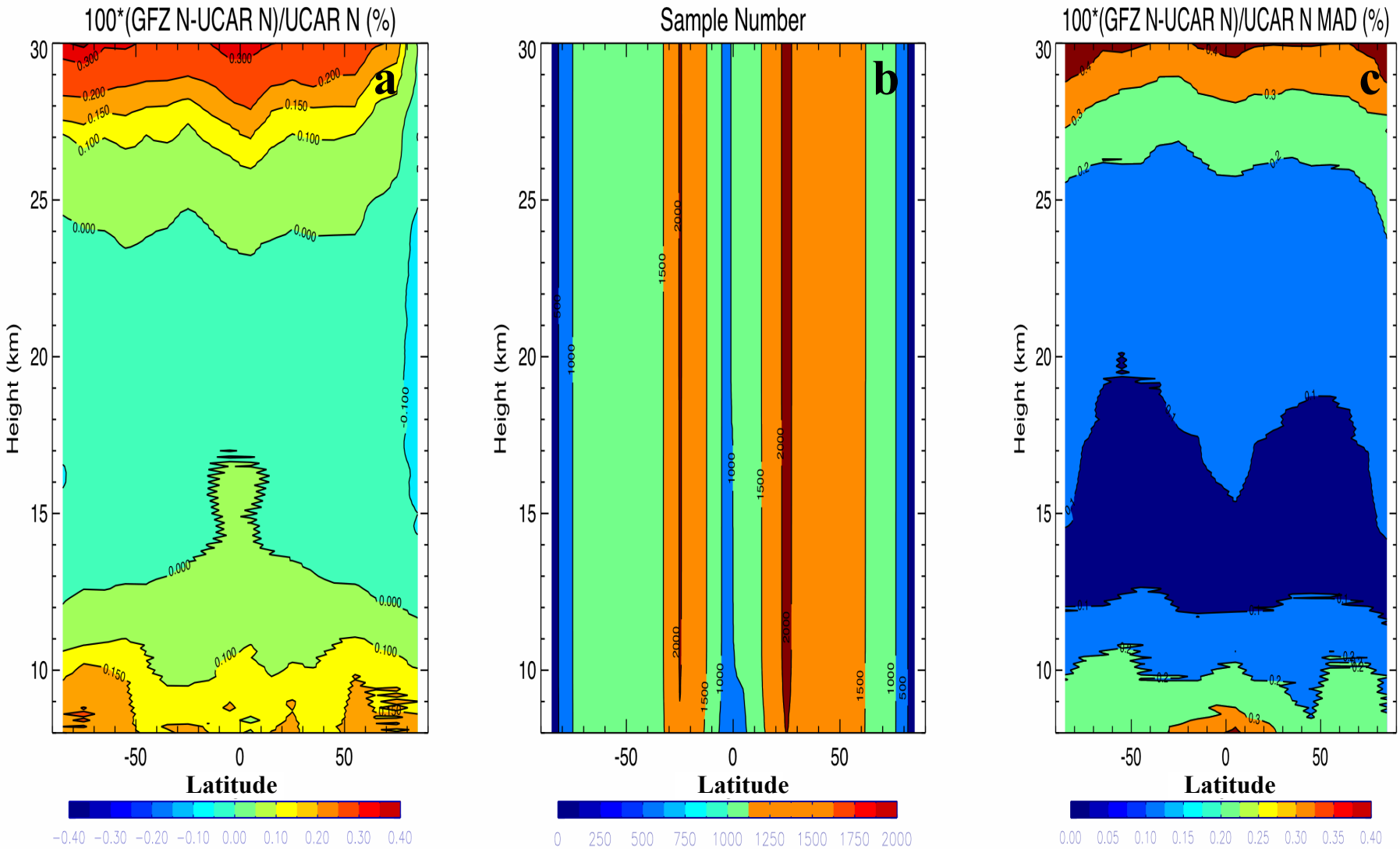


Mean bias < 0.03 %

Bias and MAD from 30km to 8 km

Fig. 8

Global mean 100*(GFZ N-UCAR N)/UCAR N (%)



Fractional N (%)

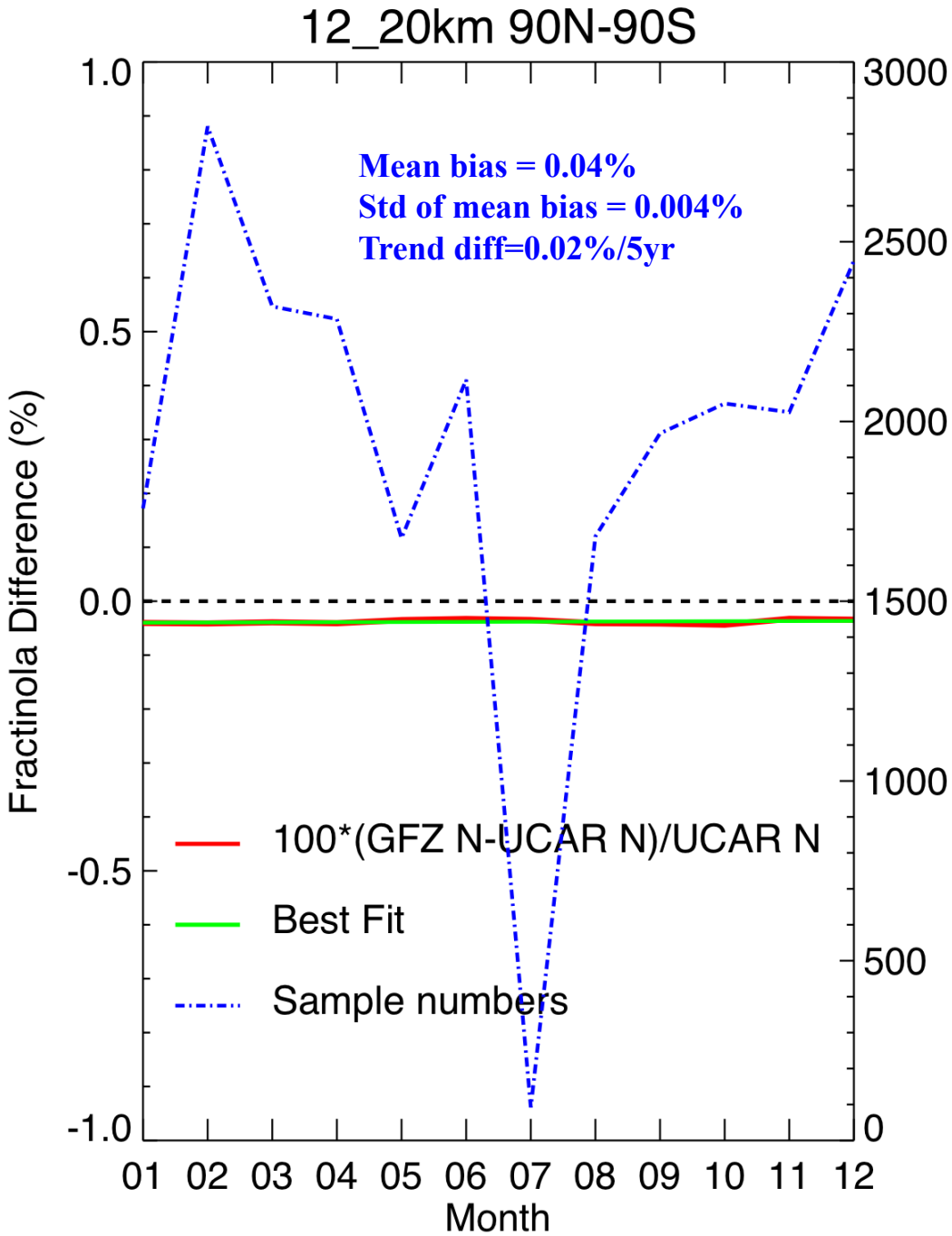
Sample Numbers

MAD (%)

Fig. 9

Although GFZ-UCAR bias is not negligible (=0.04%), yet the time variation of the bias is very small.

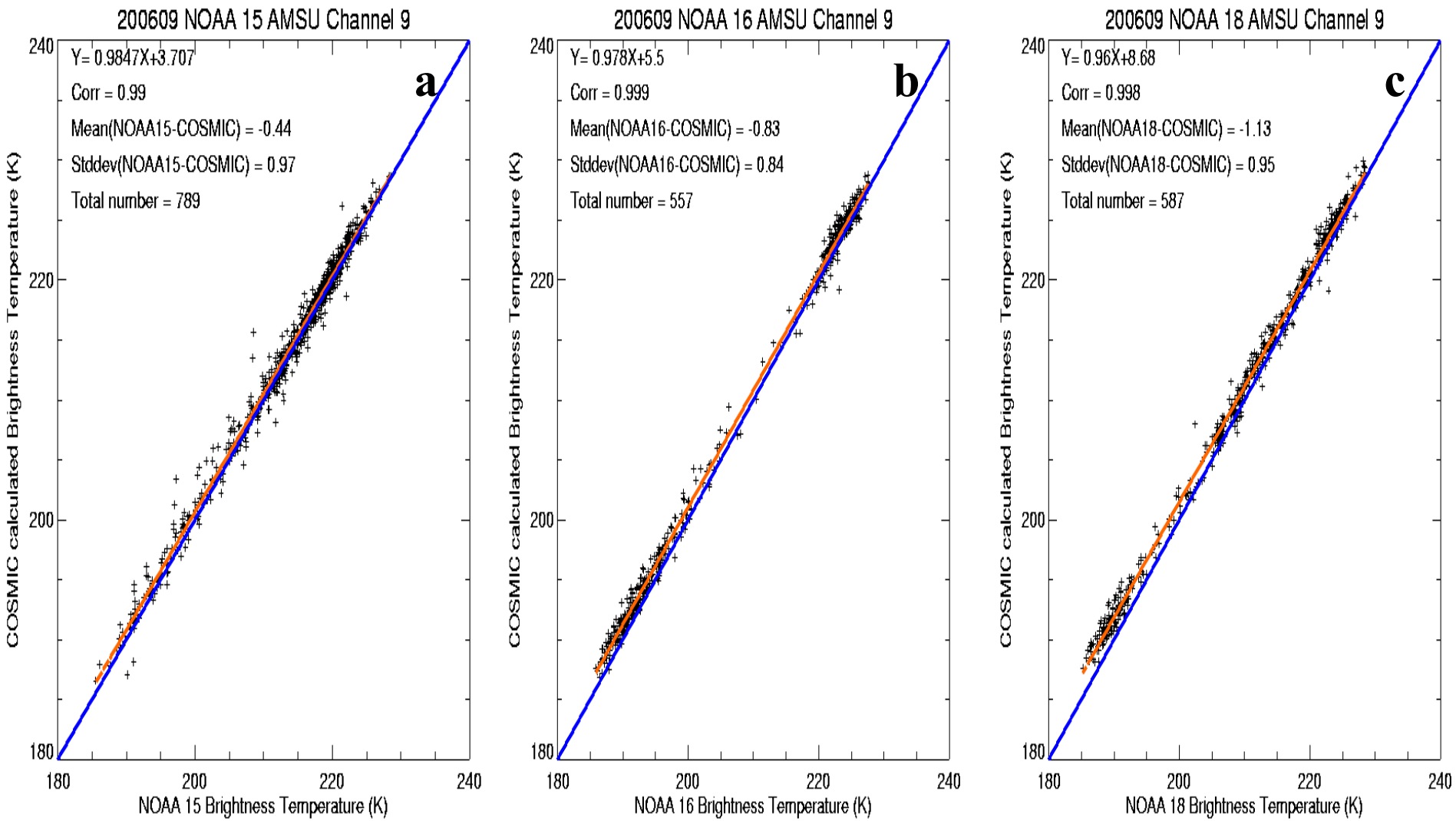
The fractional refractivity trend difference between GFZ and UCAR is around 0.02%/5yrs



Applications of GPS RO for climate studies

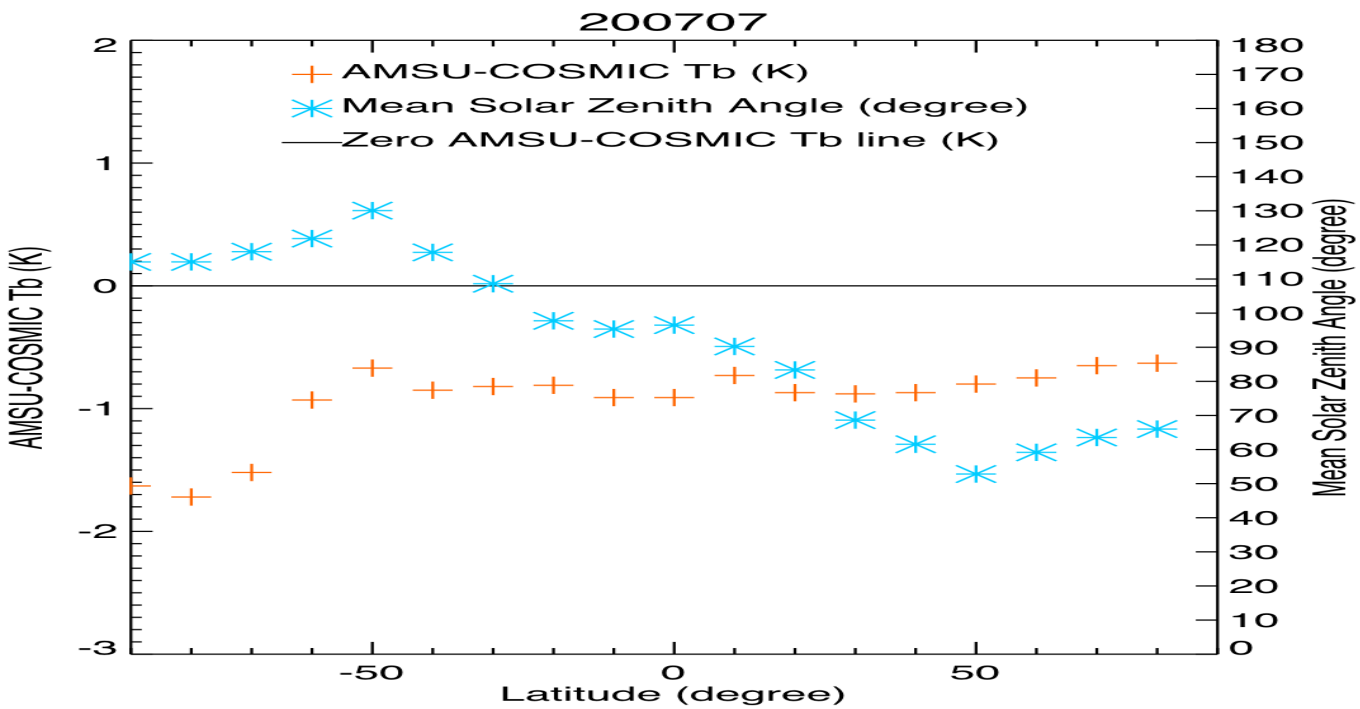
I. Can we use RO data to calibrate other instruments ?

200609



N15, N16 and N18 AMSU calibration against COSMIC

II. Use of RO Data to Identify the Location/local-time Dependent Brightness Temperature Biases for regional Climate Studies



Unbiased, good anchor for radiance assimilation

(Ho et al. OPAC special issue, 2007)

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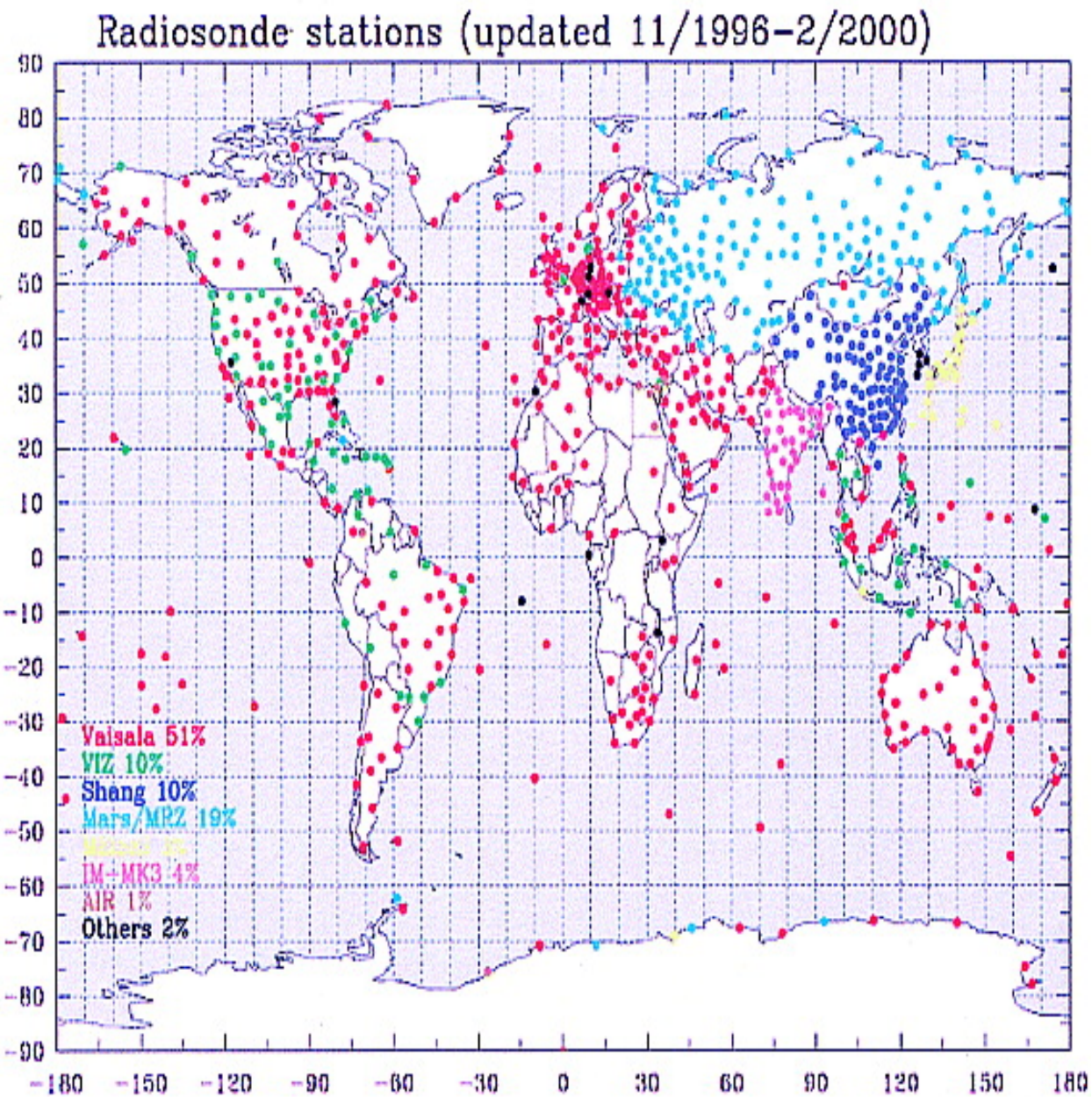
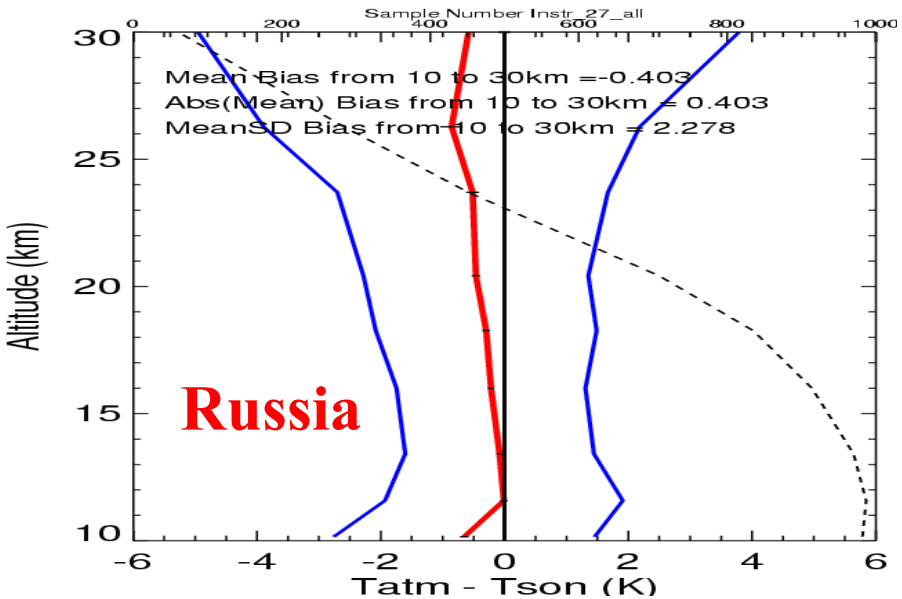
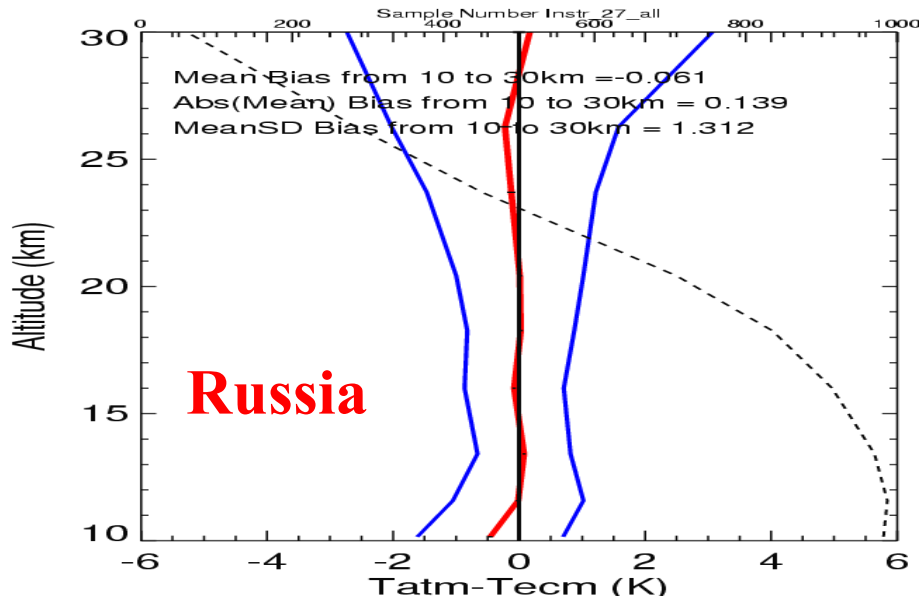
III. Using RO data to assess the quality of radiosonde data



Region	Sonde Type	Matched Sample
Russia	AVK-MRZ	2000 (20%)
China	Shang	650 (6.1%)
USA	VIZ-B2	600 (5.9%)
Others	Vaisala	3140 (30%)

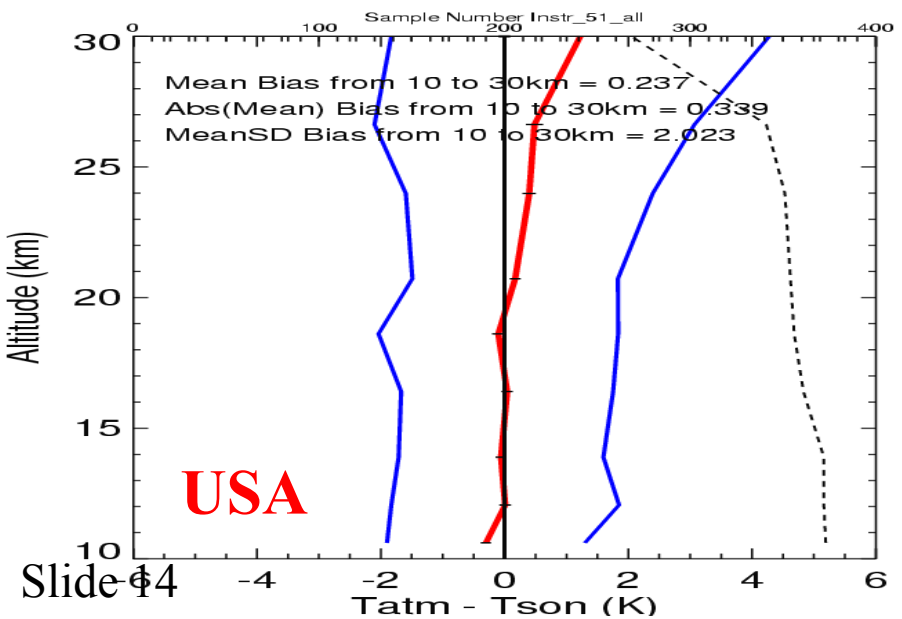
III. Using RO data to assess the quality of radiosonde data

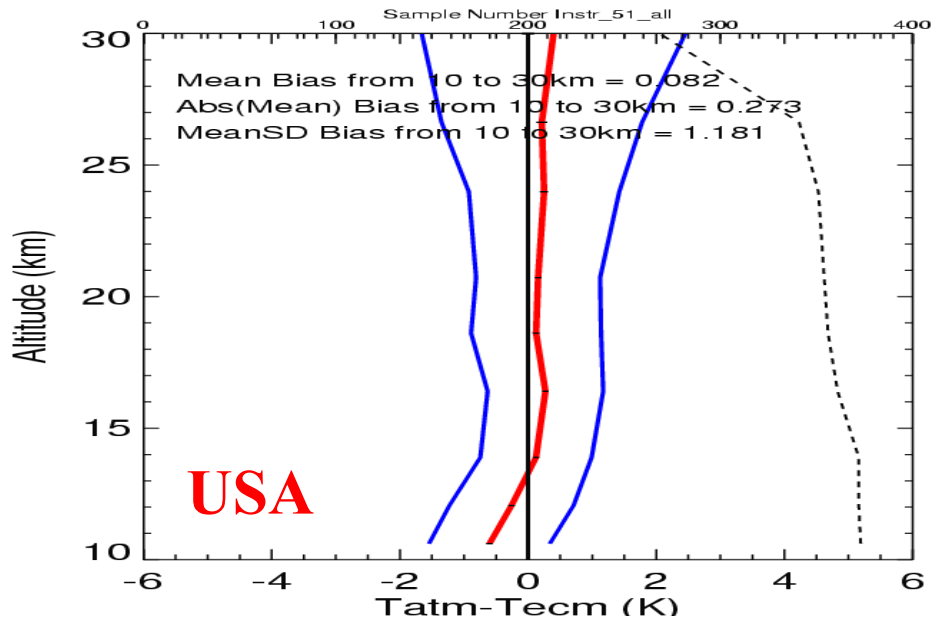


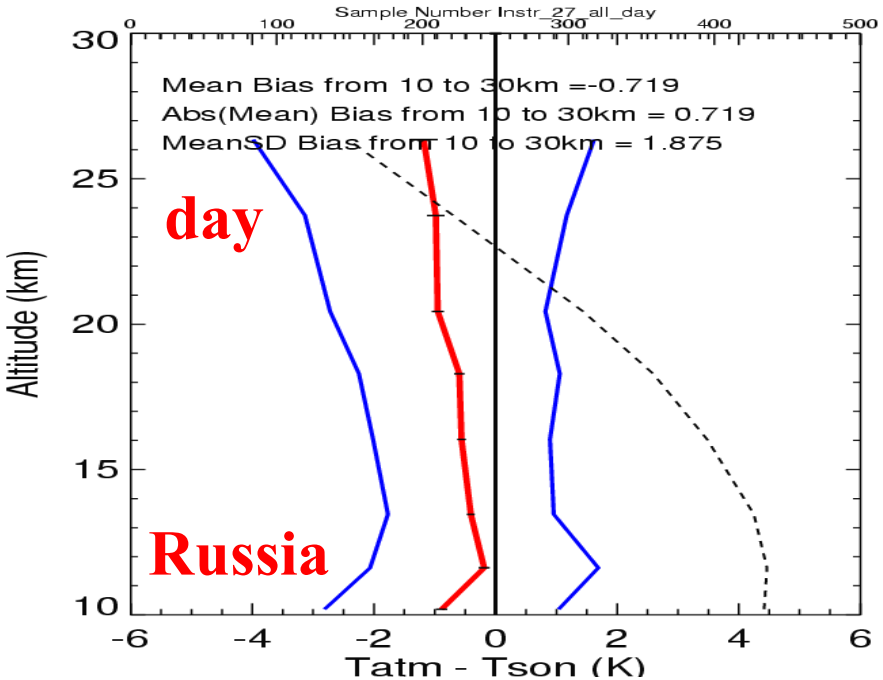


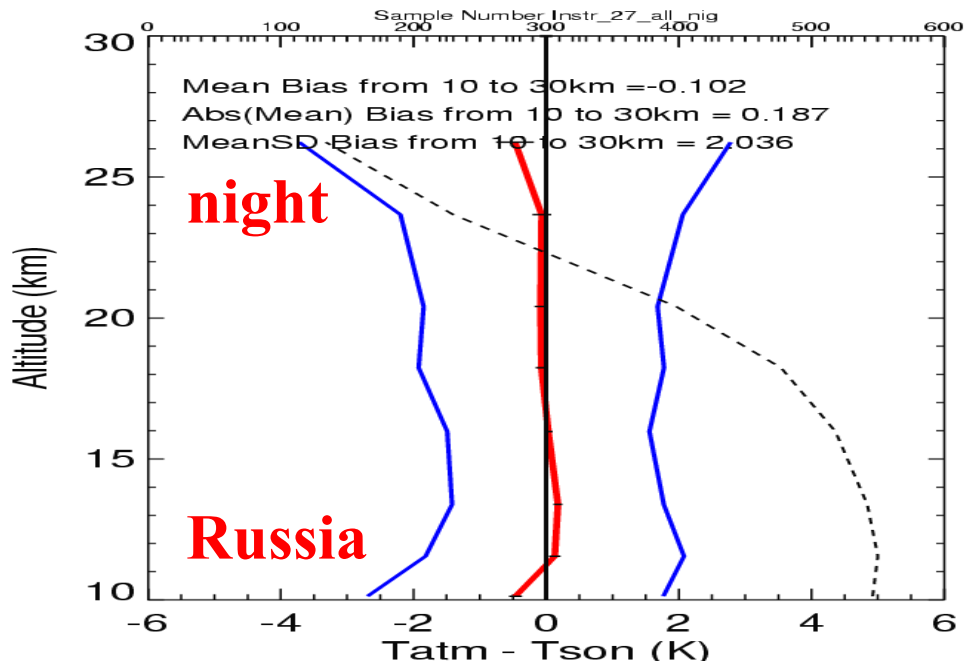
COSMIC-Radiosonde

COSMIC-ECMWF



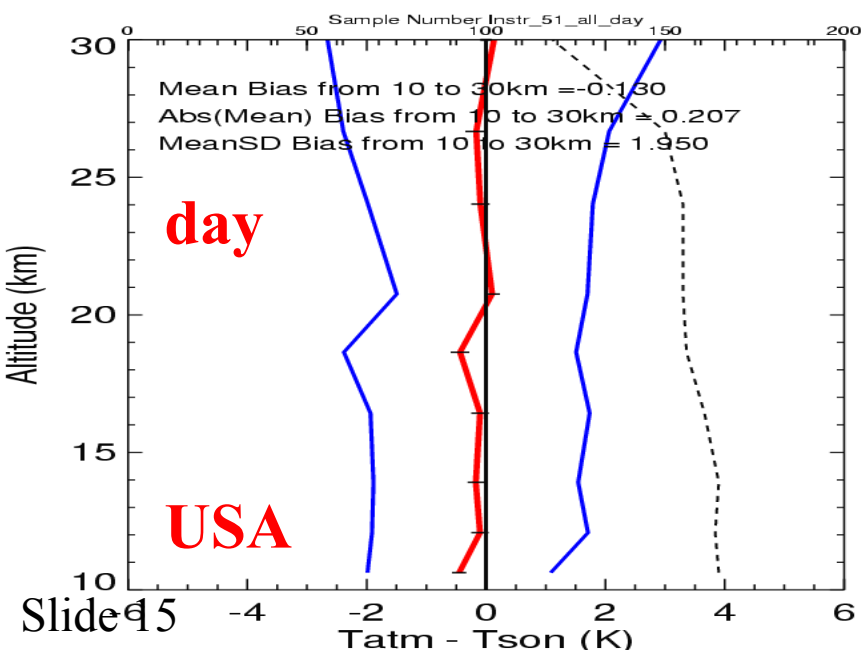


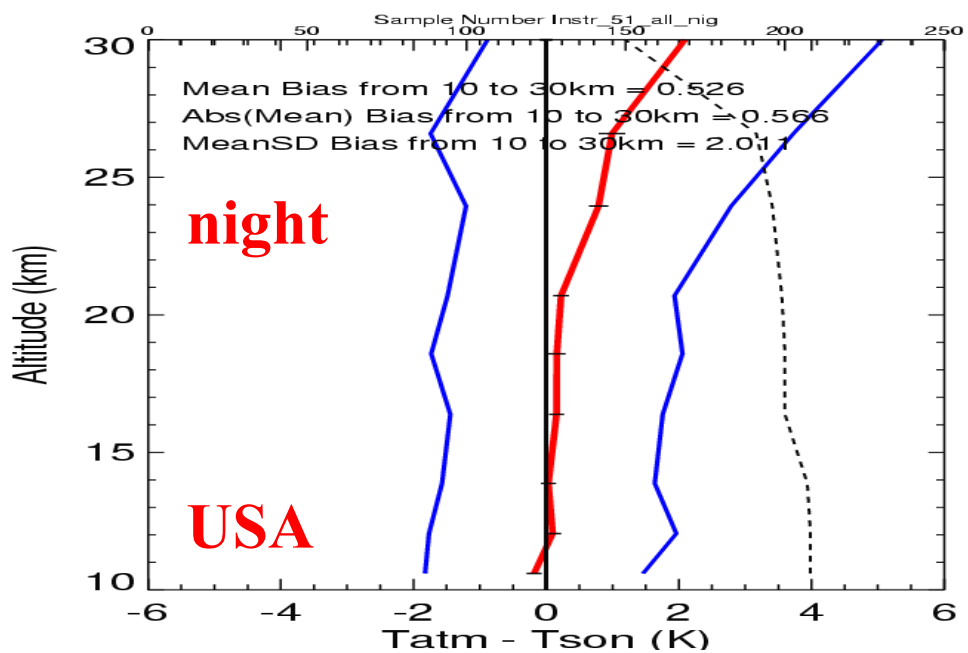


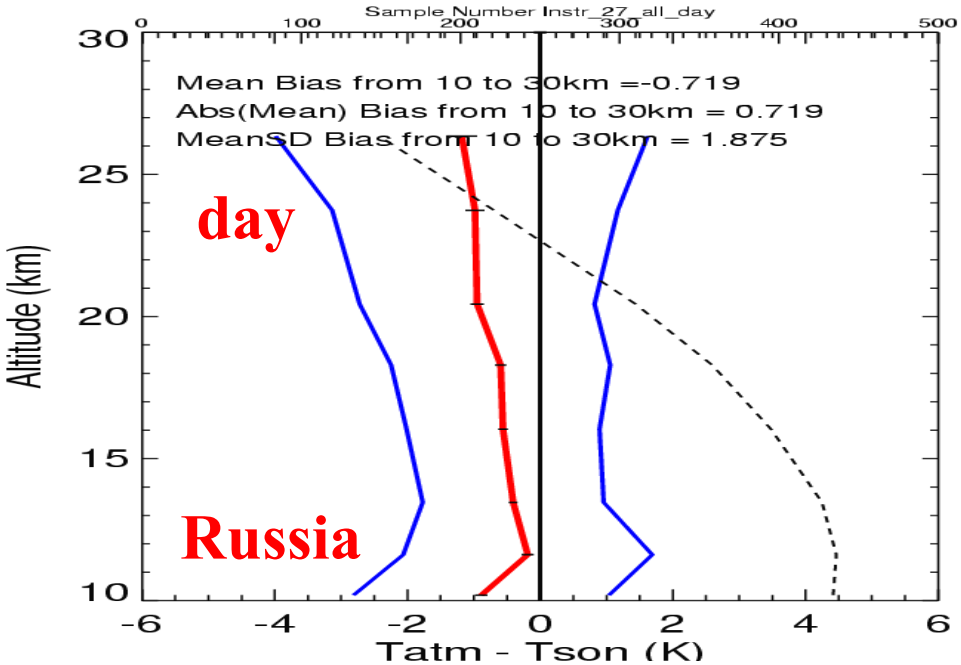


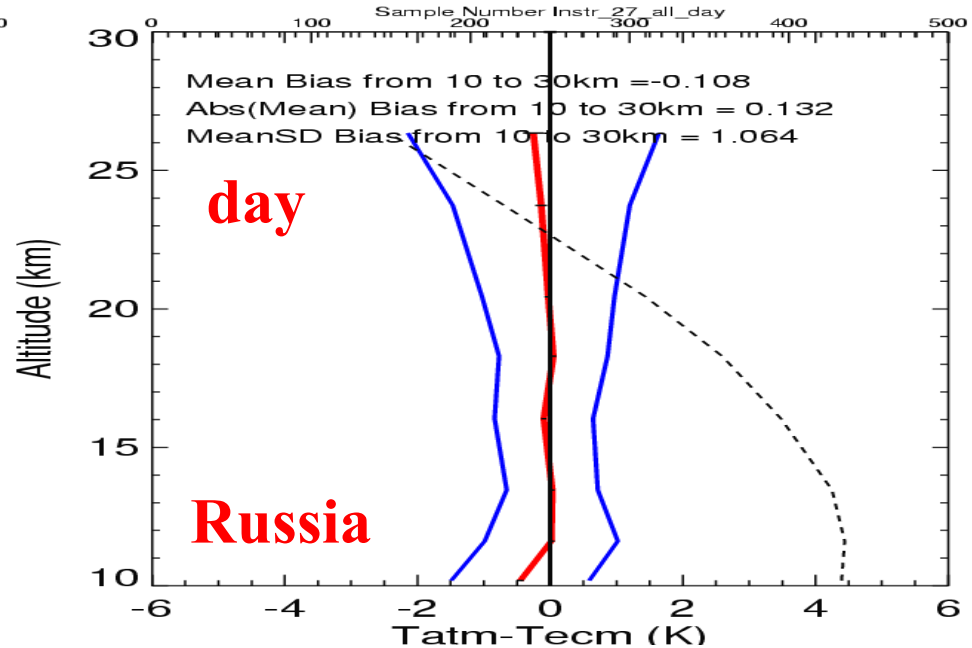
COSMIC-Radiosonde

COSMIC-Radiosonde



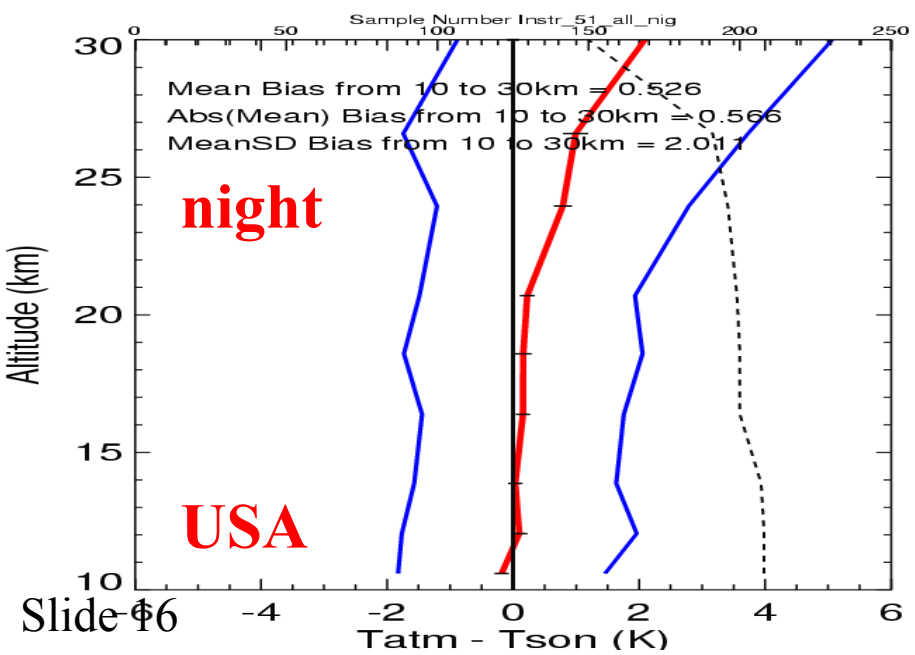


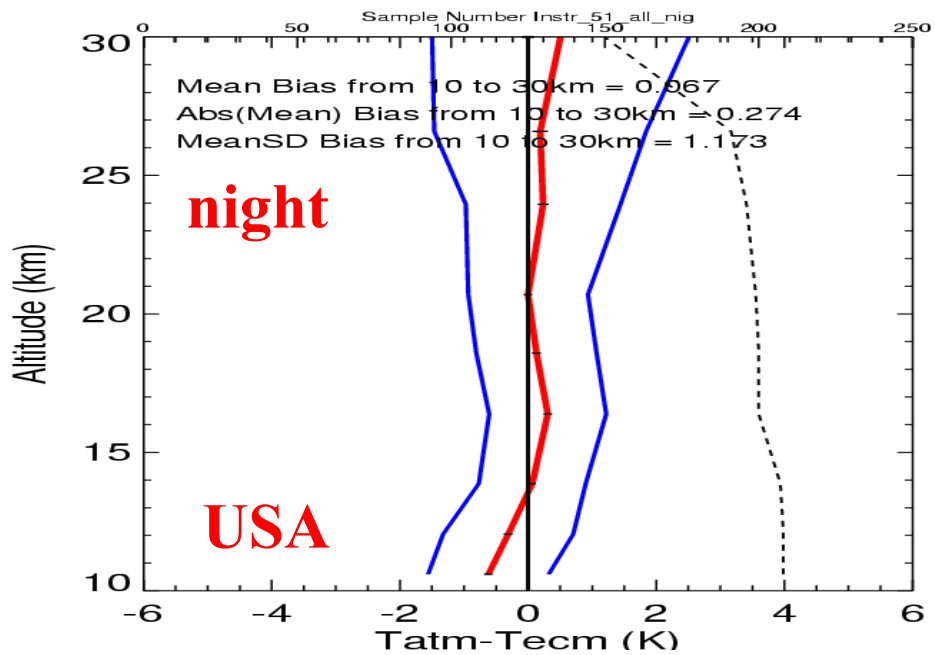


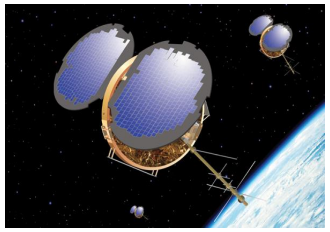


COSMIC-Radiosonde

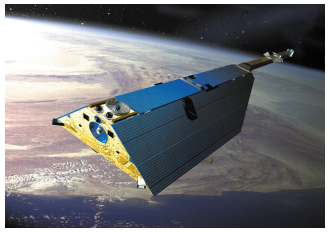
COSMIC-ECMWF







Conclusions and Future Work



- **Can GPS RO data be used as a climate benchmark dataset ?**

-GPS RO provide relatively uniform spatial/temporal coverage
-GPS RO precision < 0.05K
- Satellite-to-satellite bias < 0.05K
-Independent of processing procedures : the trend from GPS RO data processed by different centers < 0.02%/5yrs

- **Can we use GPS RO data as benchmark measurements to inter-calibrate other instruments ?**

-COSMIC data are useful to distinguish the differences among N15, 16 and 18 AMSU data, and are useful to calibrate NOAA AMSU data.
-COSMIC data are useful to indentify AMSU location dependent bias
-RO data are useful to assess the quality of radiosonde data (diurnal bias due to radiative effect)

- **Above results show the potential for using GPS RO data to fill up the gap of climate data for lacking of NPOESS data and other data types. More studies will be conducted in the future.**

 http://www.cosmic.ucar.edu/~spho/ ***Shu-peng Ben Ho, UCAR/COSMIC***