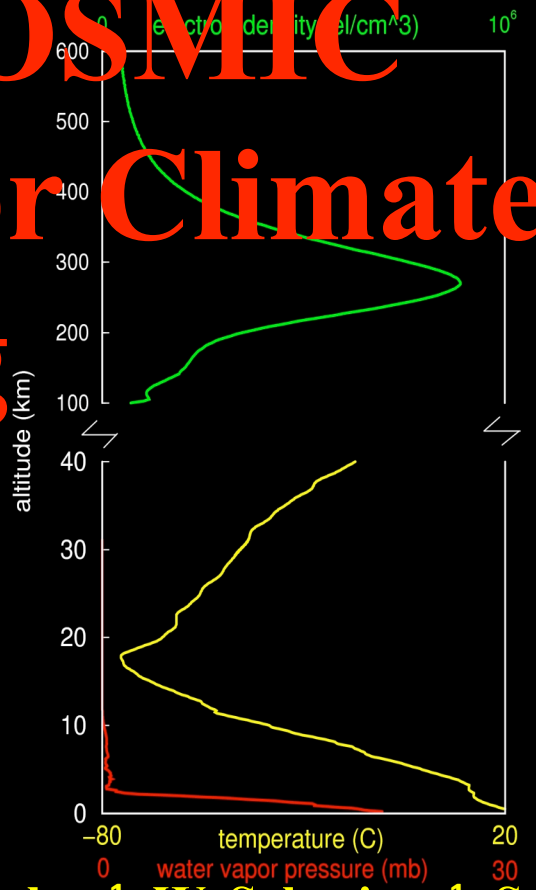
Applications of COSMIC Radio Occultation for Climate Monitoring



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Global Monitoring Annual Conference

May 14 2009, 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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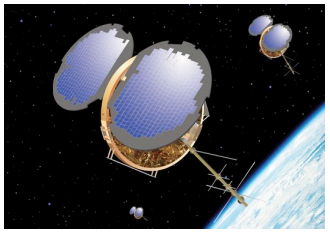
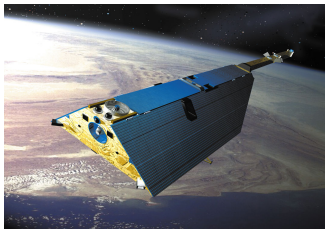
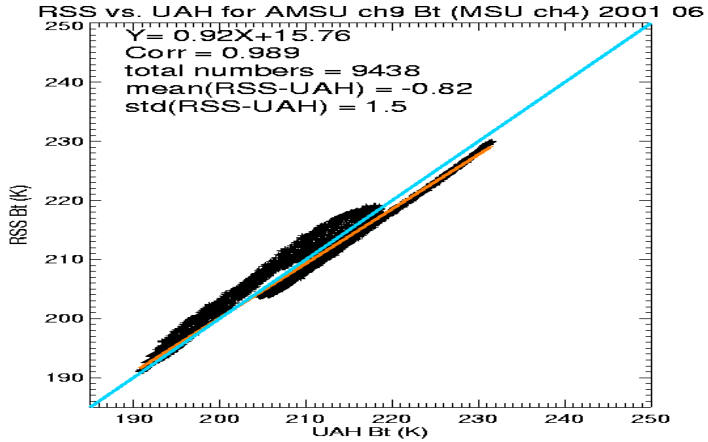


Challenges for defining Climate Trend using satellite data



Satellites: Comparability and Reproducibility ?

- **High precision**
- **No satellite-to-satellite bias**
- **Independent of processing procedures**
- **Uniform spatial/temporal coverage**



1) Not designed for climate monitoring

2) Changing platforms and instruments

(No Comparability)

3) Different processing/merging method lead to different trends:

(RSS vs. UAH). (No Reproducibility)

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

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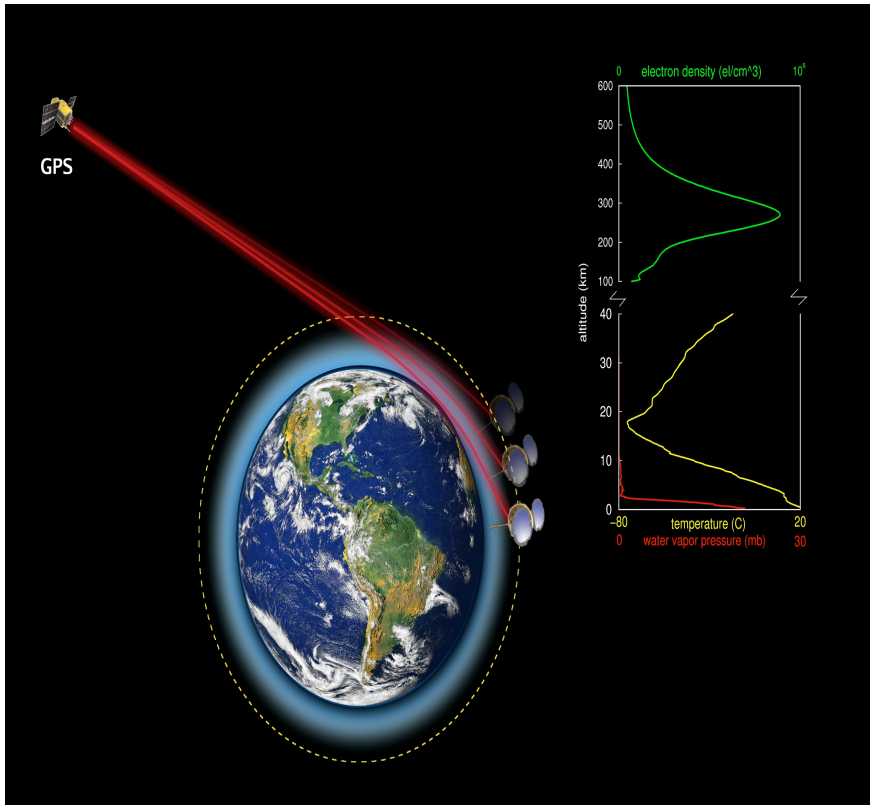
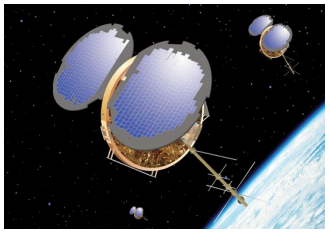
Characteristics of GPS RO Data

Climate Benchmark dataset ?

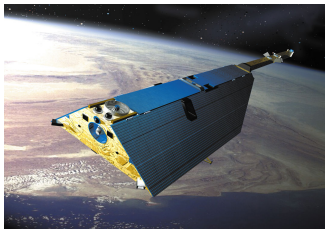
- **Measure of time delay: no calibration is needed**
- **Requires no first guess sounding**
- **Uniform spatial/temporal coverage**
- **High precision**
- **No satellite-to-satellite bias**
- **Independent of processing procedures**



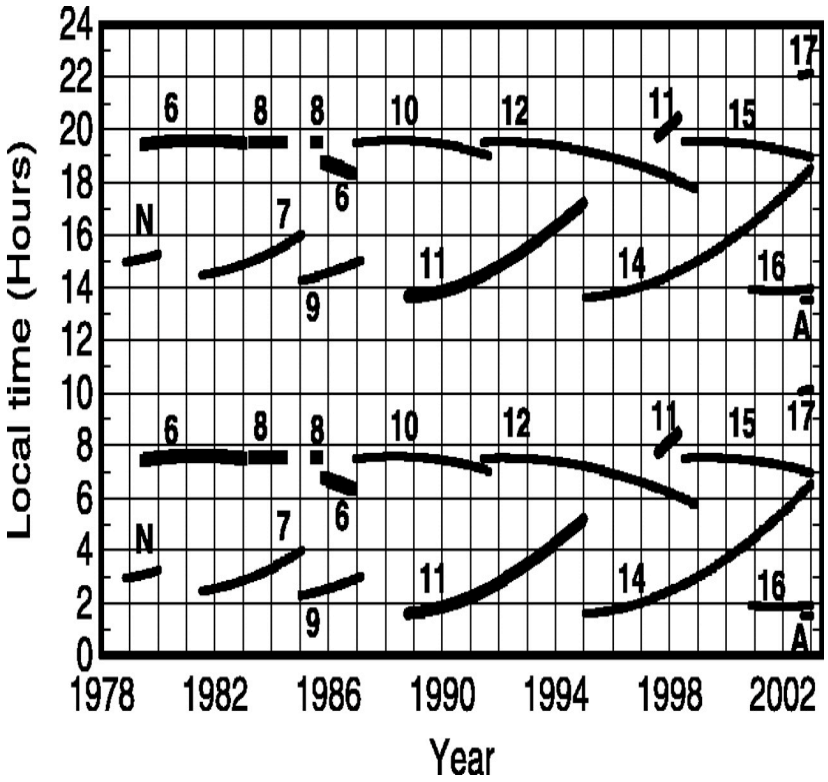
COSMIC launched in April 2006



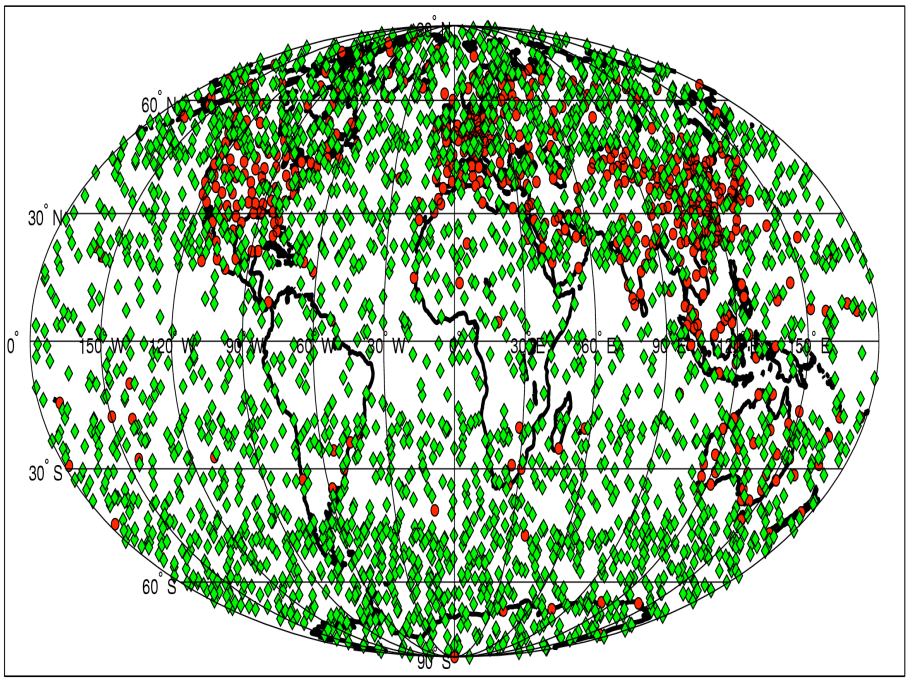
Difficulty I: to find observations with a good global and temporal coverage



AMSU/MSU local time



COSMIC has a more complete temporal and spatial global coverage



COSMIC launched in April 2006

COSMIC

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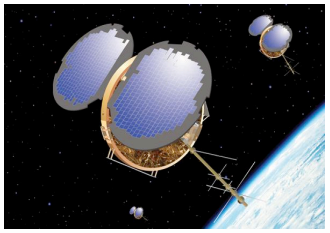
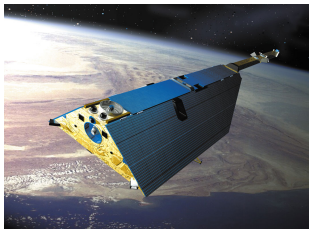
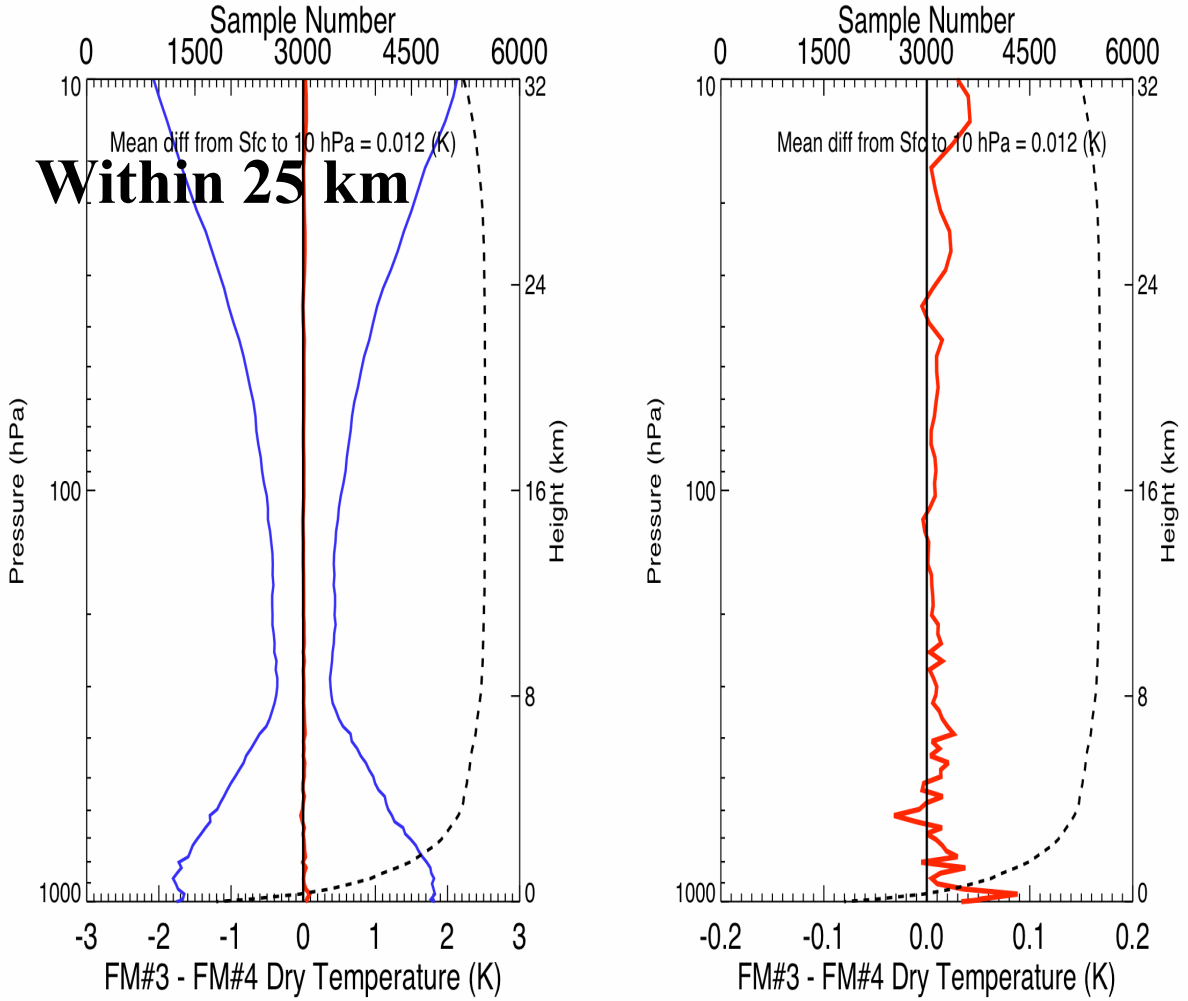


Difficulty II: Comparability of COSMIC data from different receivers





Using FM3-FM4 pairs in early mission

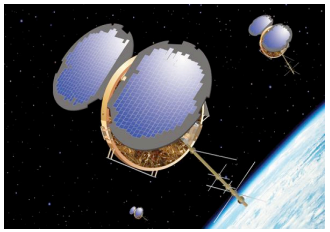
Need to quantify all COSMIC-COSMIC pairs

Precision < 0.05 K

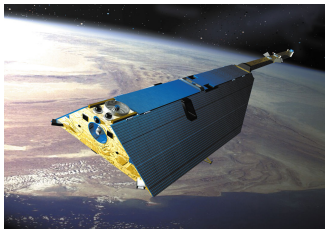
(Ho et al., TAO, 2009)

(Anthes et al., BAMS, 2008)

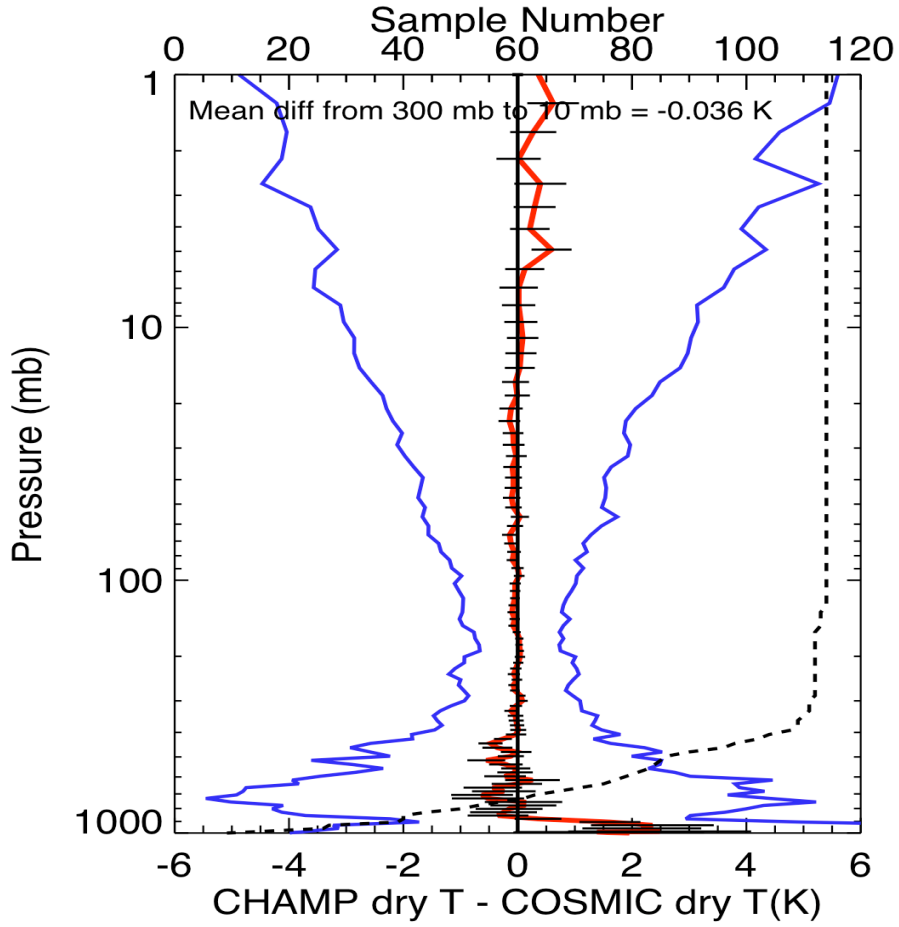
Dry temperature difference between FM3-FM4 receivers



Difficulty III: Long-term stability



Global COSMIC-CHAMP Comparison from 200607-200707



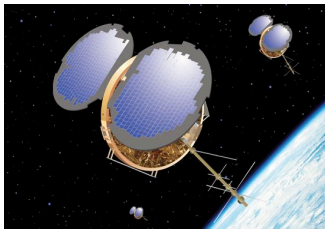
Within 60 Mins
and 50 Km

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

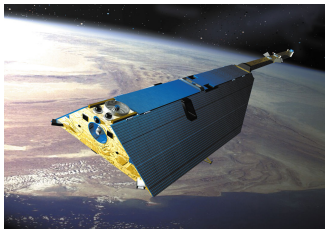
Don't need to have stable calibration reference

Mean bias < 0.05 K

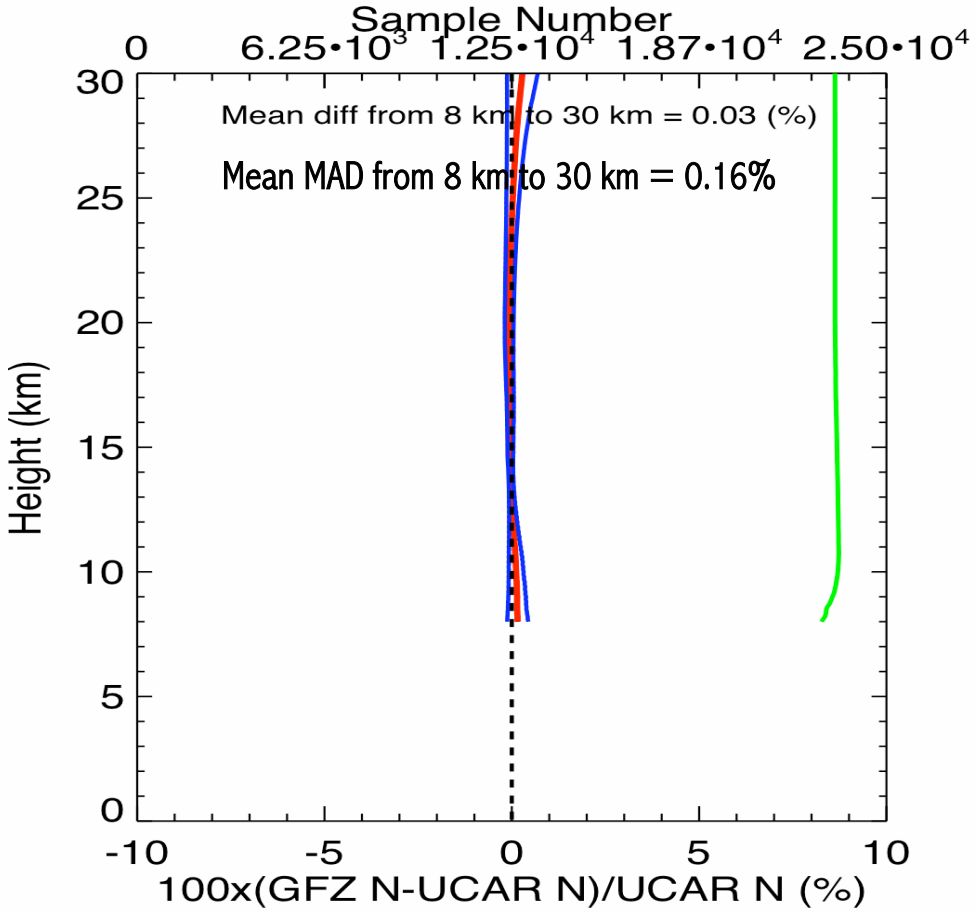
(Ho et al., TAO, 2009)



Difficulty IV: Reproducibility of GPS RO data



200601-12

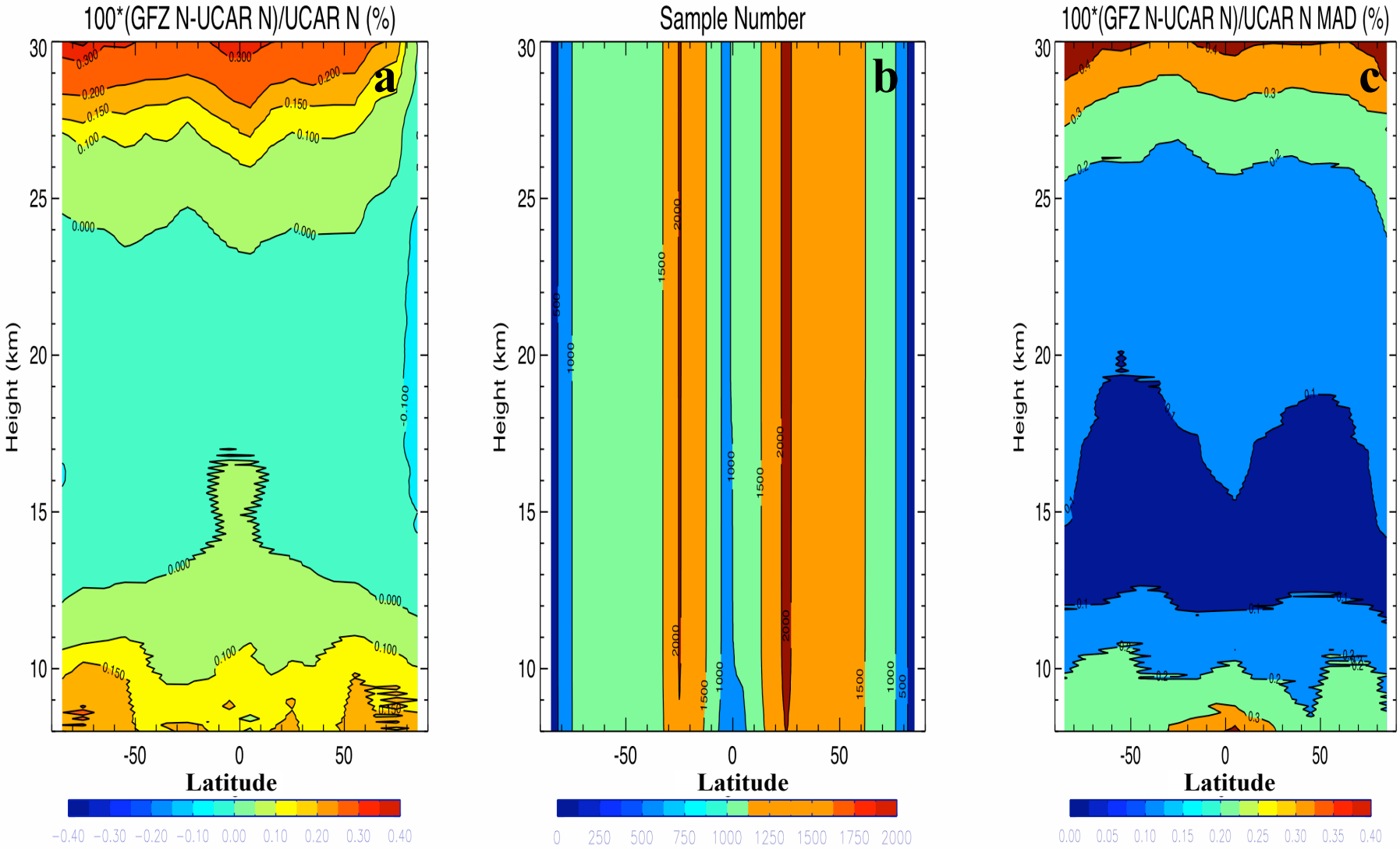


Bias and MAD from 30km to 8 km

Mean bias < 0.03 %

Fig. 8

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



Fractional N (%)

Sample Numbers

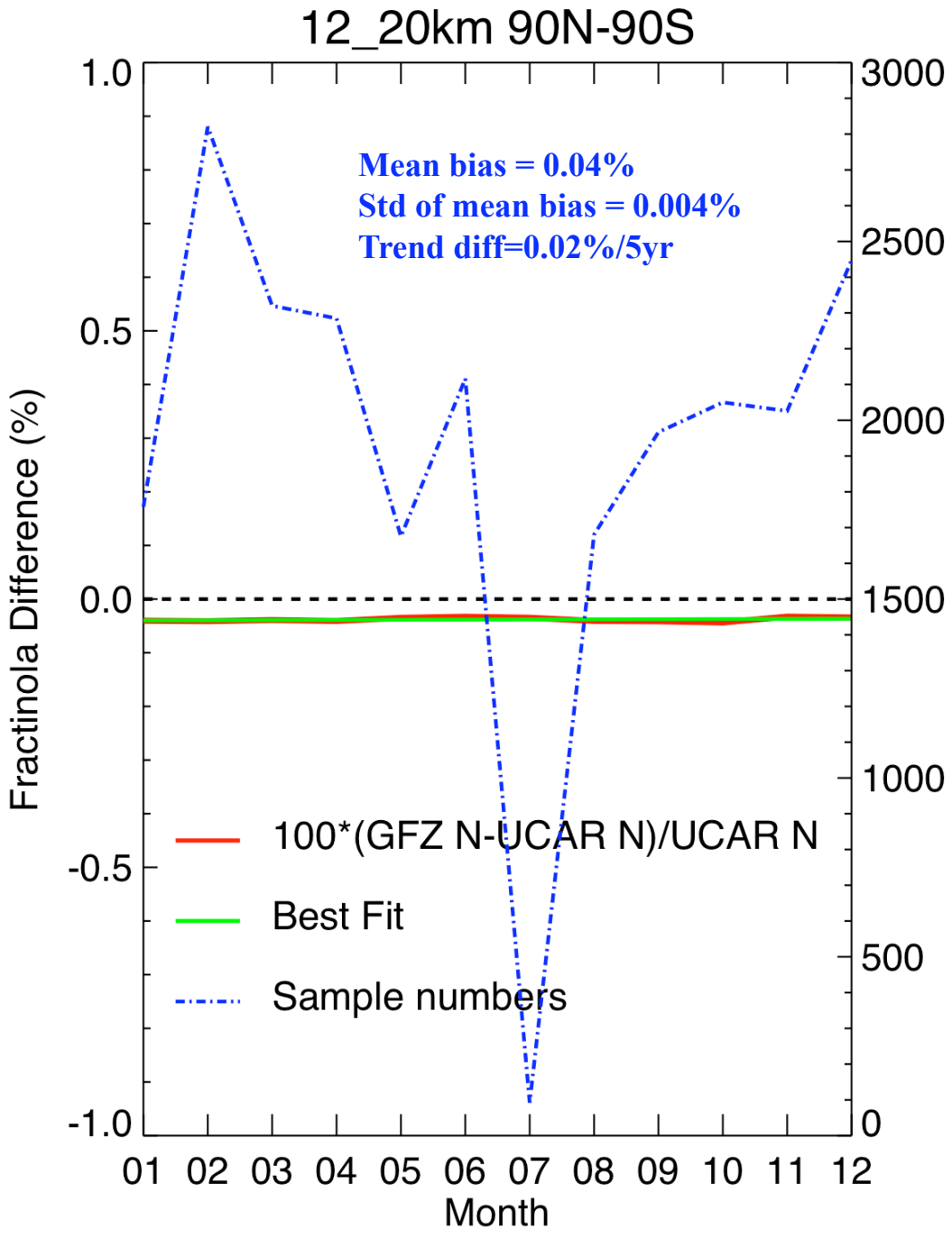
MAD (%)

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

(Ho et al., JGR, 2009)



Applications of GPS RO for climate studies

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

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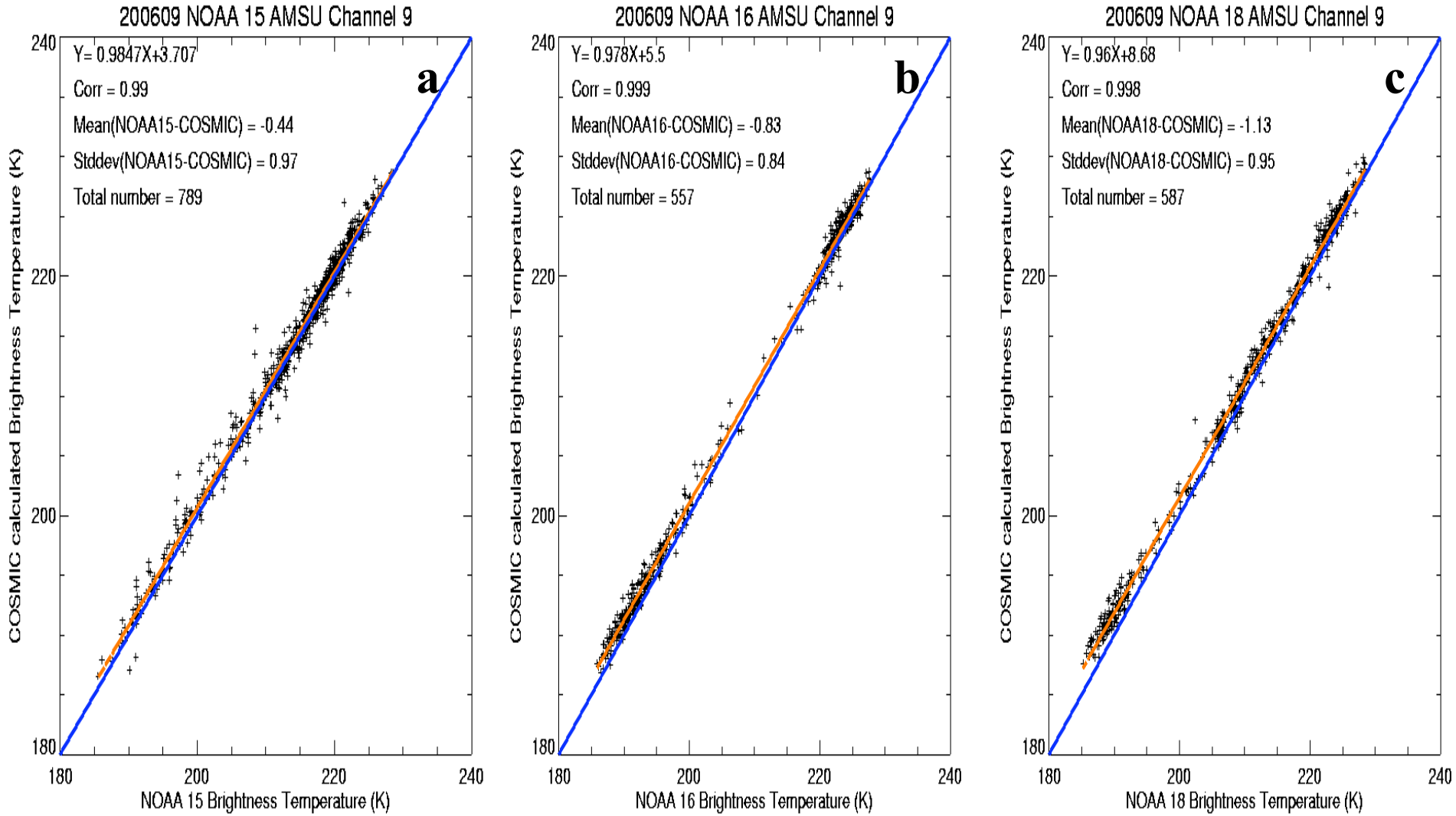
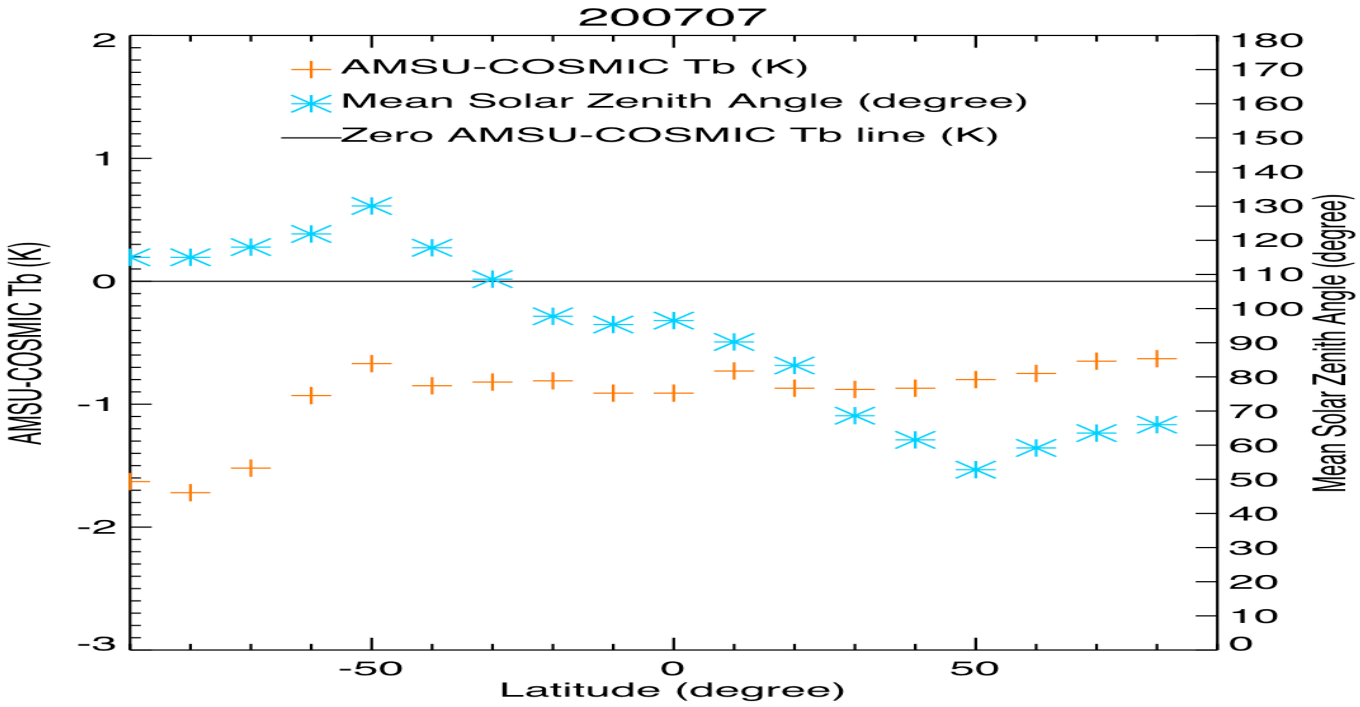


N15, N16 and N18 AMSU calibration against COSMIC

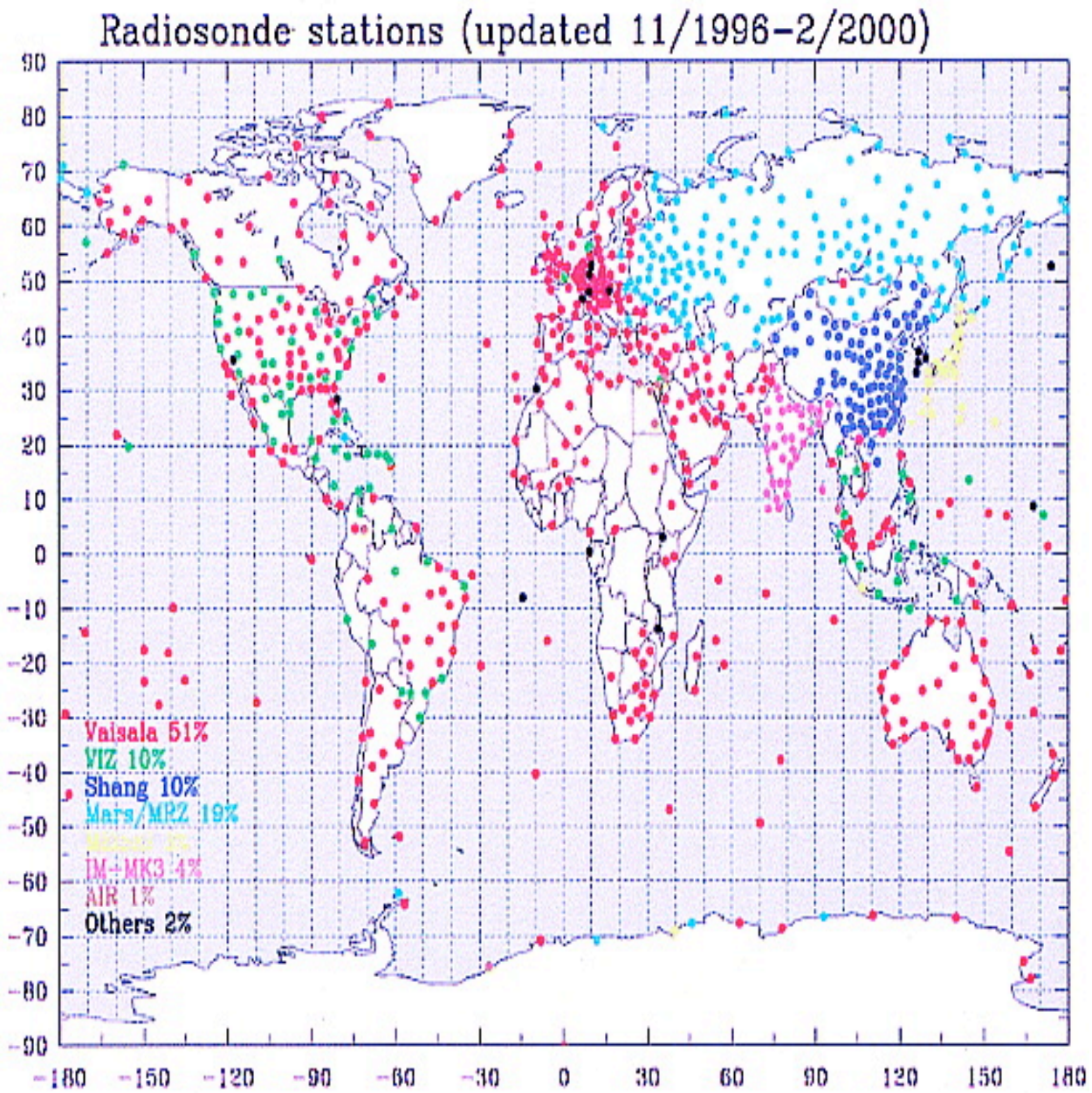
II. Use of RO Data to Identify the Location/local-time Dependent Brightness Temperature Biases for regional Climate Studies



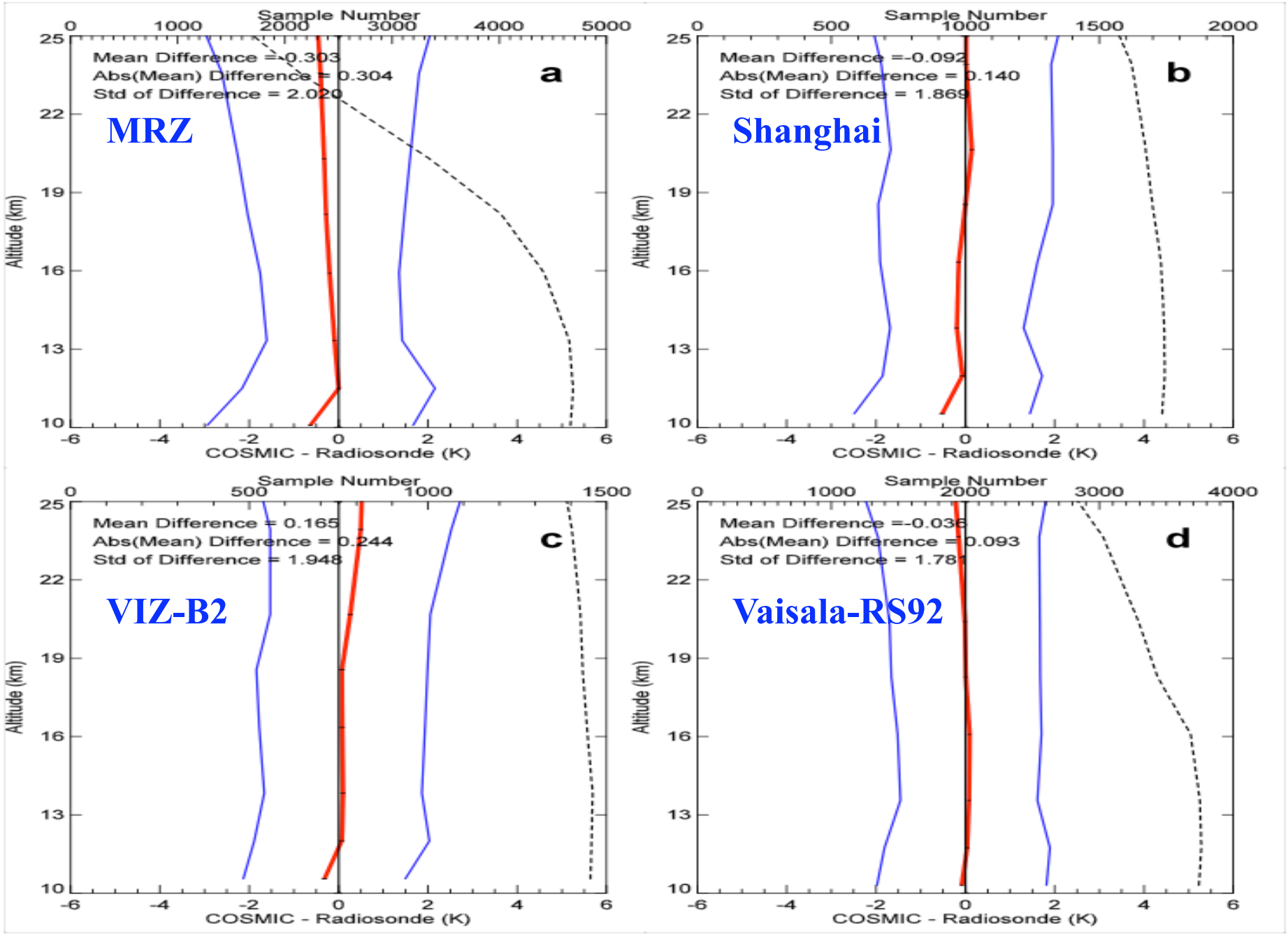
Unbiased, good anchor for radiance assimilation

(Ho et al. OPAC special issue, 2009)

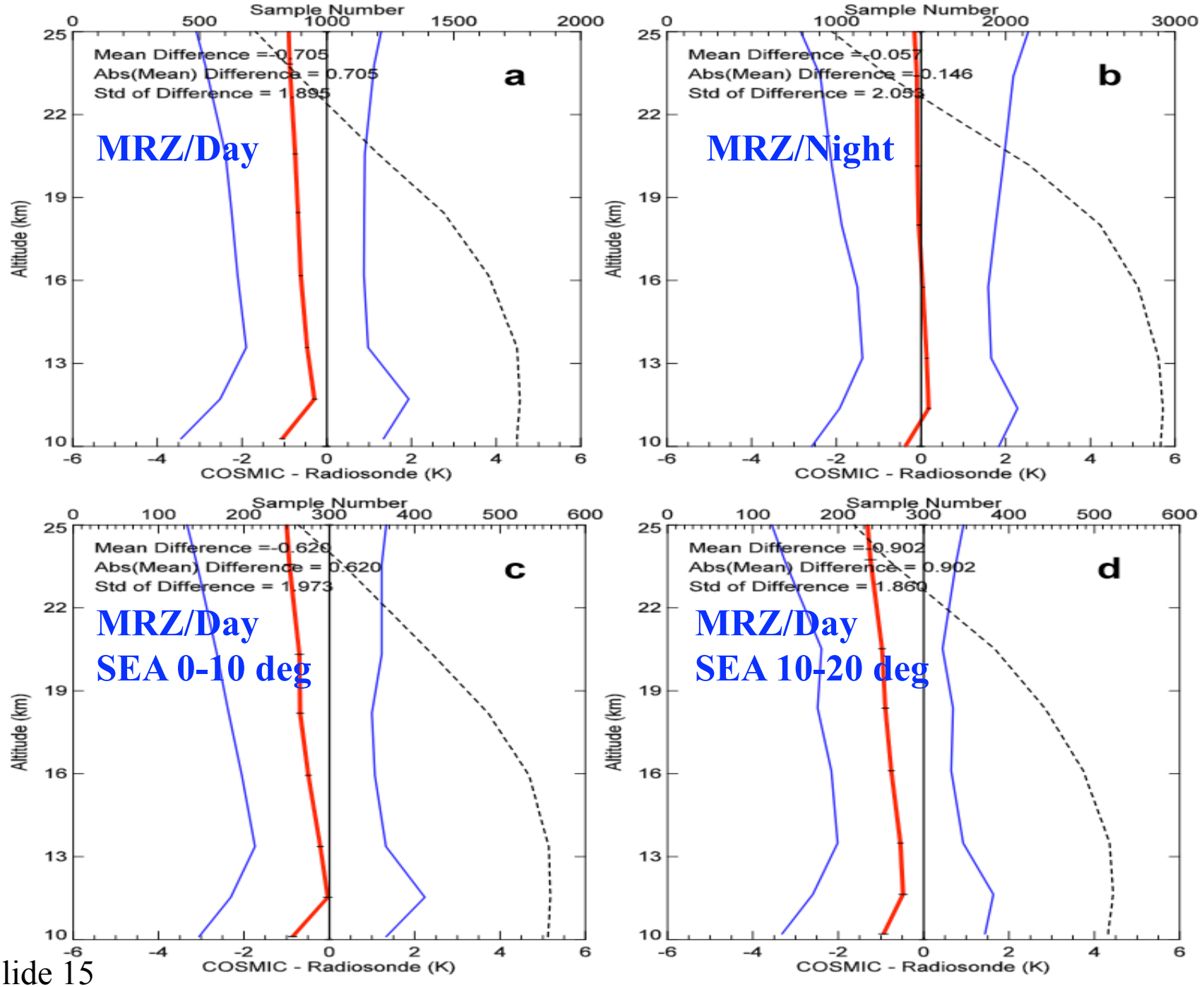
III. Using RO data to assess the quality of radiosonde data

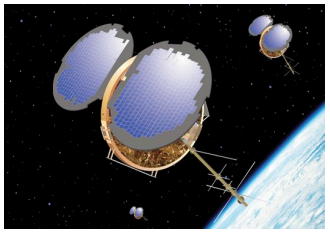


Region	Sonde Type	Matched Sample
Russia	AVK-MRZ	2000 (20%)
China	Shang	650 (6.1%)
USA	VIZ-B2	600 (5.9%)
Others	Vaisala	3140 (30%)

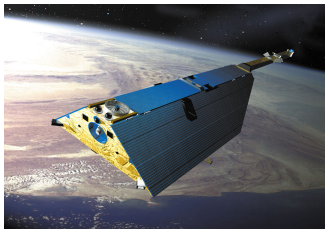


(He et al., GRL, 2009)


Sample Number
Mean Difference =-0.705
Abs(Mean) Difference = 0.705
Std of Difference = 1.895
a
MRZ/Day
Sample Number
Mean Difference =-0.057
Abs(Mean) Difference =0.146
Std of Difference = 2.053
b
MRZ/Night
Sample Number
Mean Difference =-0.620
Abs(Mean) Difference = 0.620
Std of Difference = 1.973
c
MRZ/Day
SEA 0-10 deg
Sample Number
Mean Difference =-0.902
Abs(Mean) Difference = 0.902
Std of Difference = 1.869
d
MRZ/Day
SEA 10-20 deg
Altitude (km)
COSMIC - Radiosonde (K)



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/

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