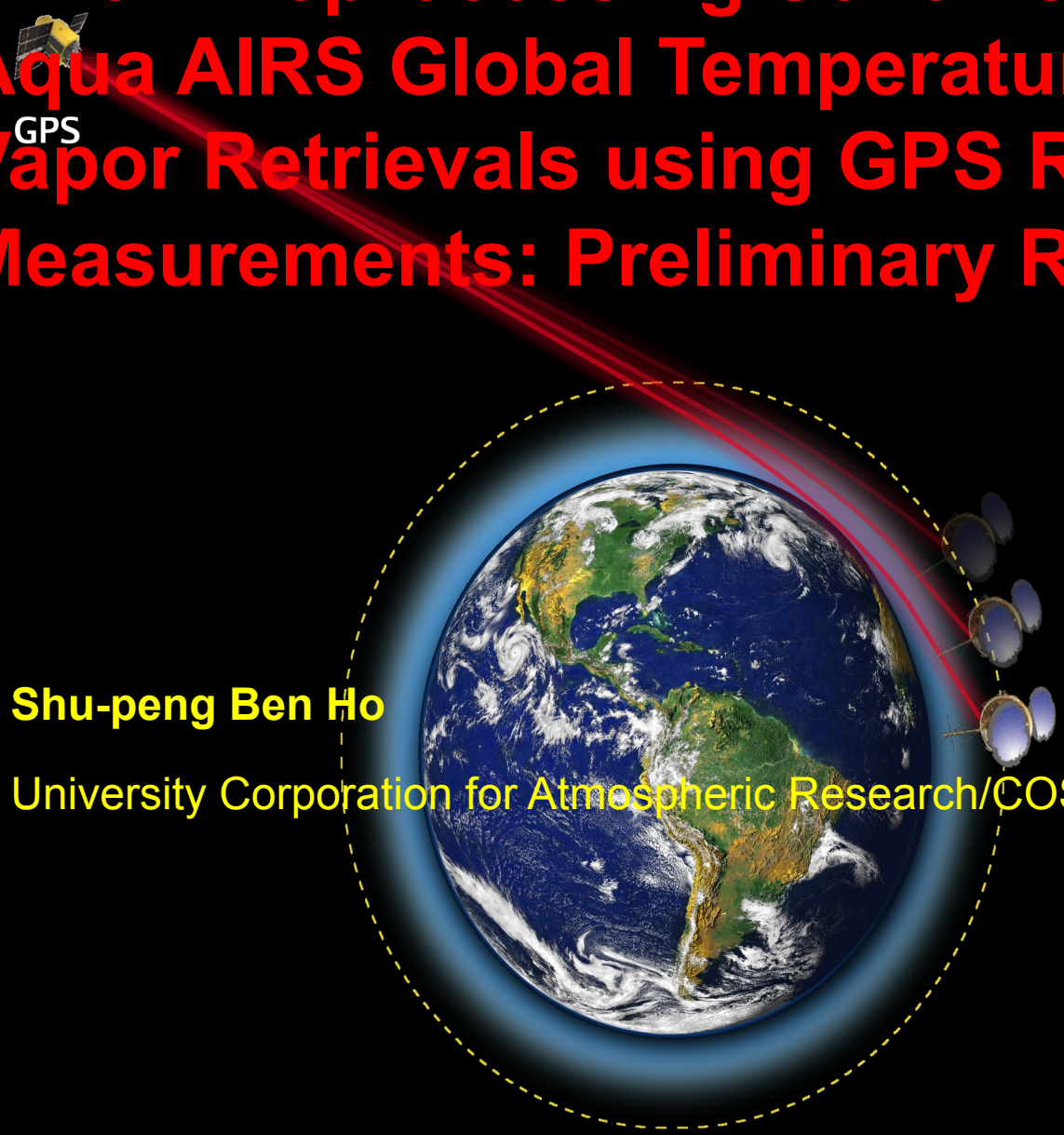
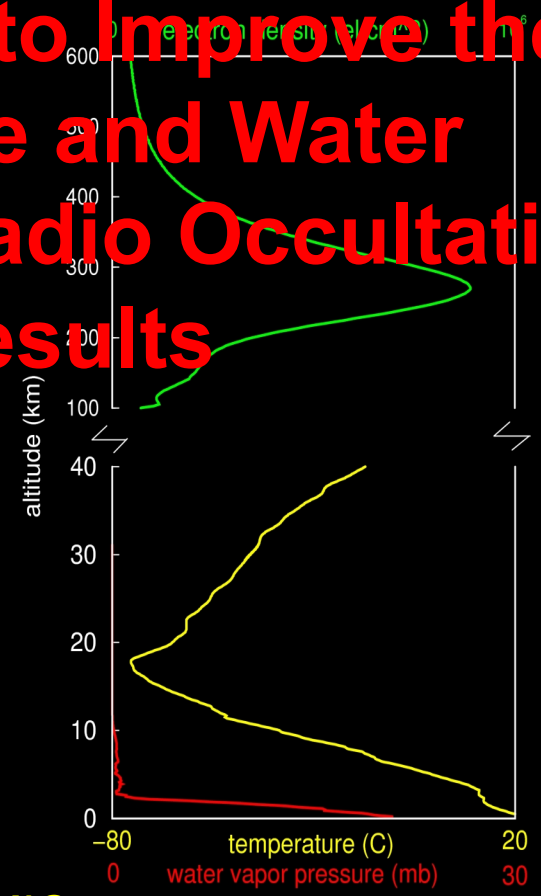
A New Reprocessing Scheme to Improve the Aqua AIRS Global Temperature and Water Vapor Retrievals using GPS Radio Occultation Measurements: Preliminary Results





Shu-peng Ben Ho

University Corporation for Atmospheric Research/COSMIC

Motivation:

-A new proposal entitled "**A New Reprocessing Scheme to Improve the Aqua AIRS Global Temperature and Water Vapor Retrievals in the Lower Troposphere and Stratosphere using GPS Radio Occultation Measurements**" **: a new approach for combined active + passive data**

- **Monitoring the long term stability of AIRS retrievals/measurements**

- **Improving AIRS Temperature and Moisture Retrievals in Lower Troposphere, and Upper Troposphere and Lower Stratosphere using GPS RO data**

Outlines:

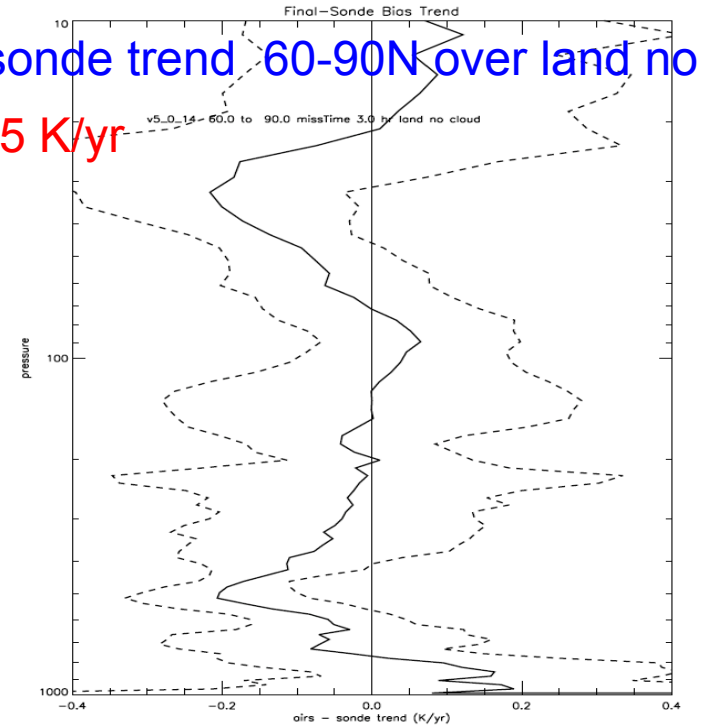
1.Characteristics of RO data

2.Monitoring the long term stability of AIRS retrievals/measurements

3.Improving AIRS Temperature and Moisture Retrievals in Lower Troposphere, and Upper Troposphere and Lower Stratosphere using GPS RO data

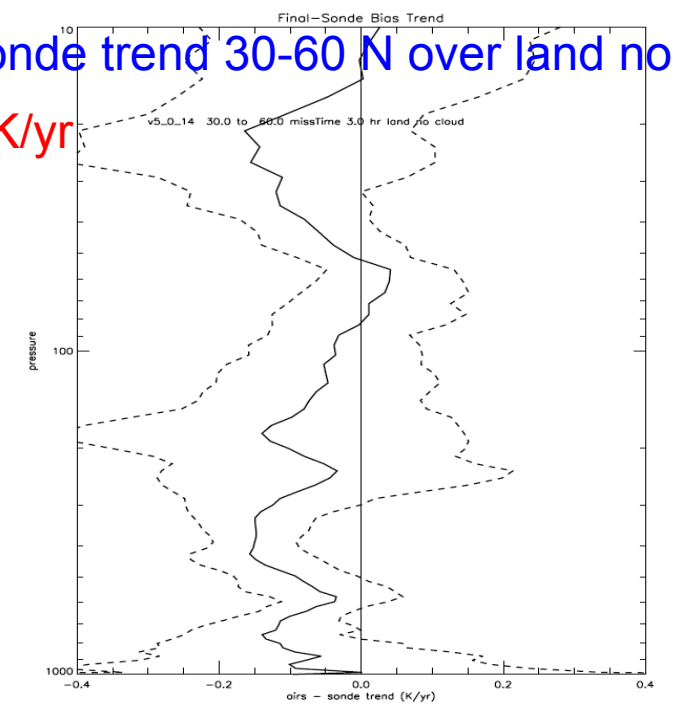
AIRS-sonde trend 60-90N over land no Cloud

-0.05 K/yr



AIRS-sonde trend 30-60 N over land no Cloud

-0.1 K/yr



I : Characteristics of GPS RO Data

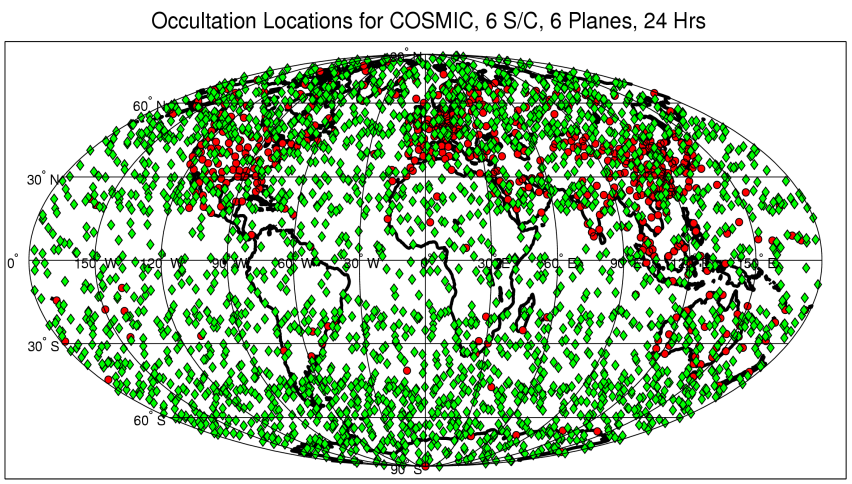
- **Measure of time delay: no calibration is needed**
- **Requires no first guess sounding**
- **Not affect by clouds**
- **Uniform spatial/temporal coverage**
- **High precision (<0.05K)**
- **No mission dependent bias**
- **Insensitive to clouds and precipitation**

Precision < 0.05 K

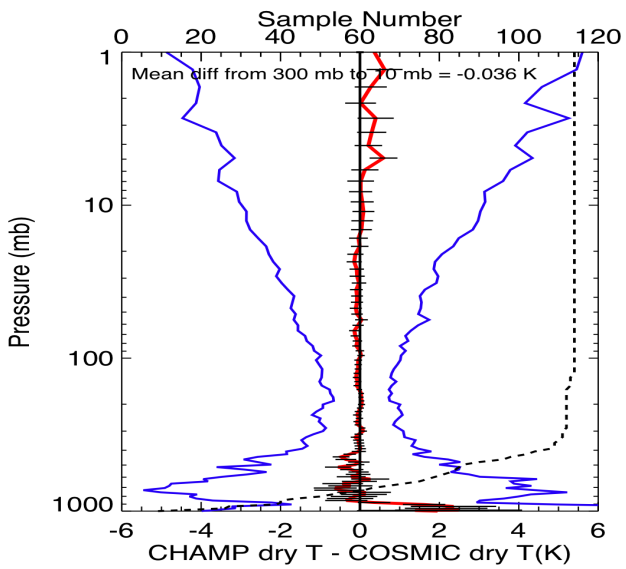
Using FM3-FM4 pairs in early mission

(Ho et al., TAO, 2009,
Ho et al., JGR, 2009
Anthes et al., BAMS, 2008)

CHAMP (launched in 2001) –COSMIC (launched in 2006)

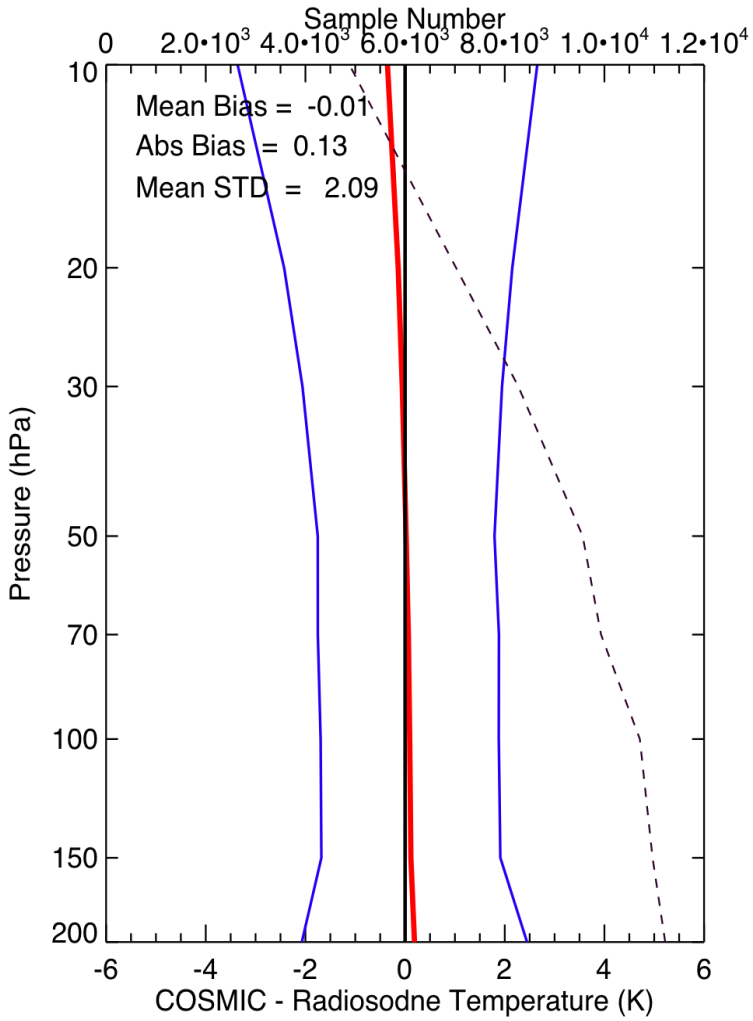


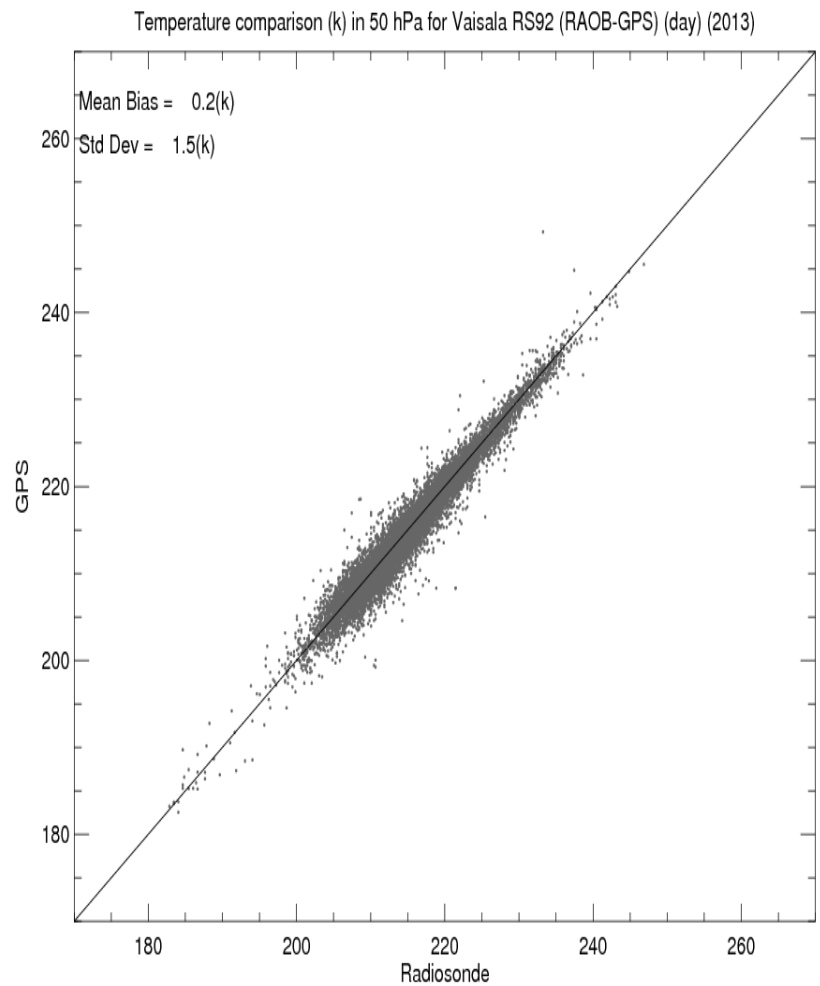
COSMIC



Within 60 Mins and 50 Km

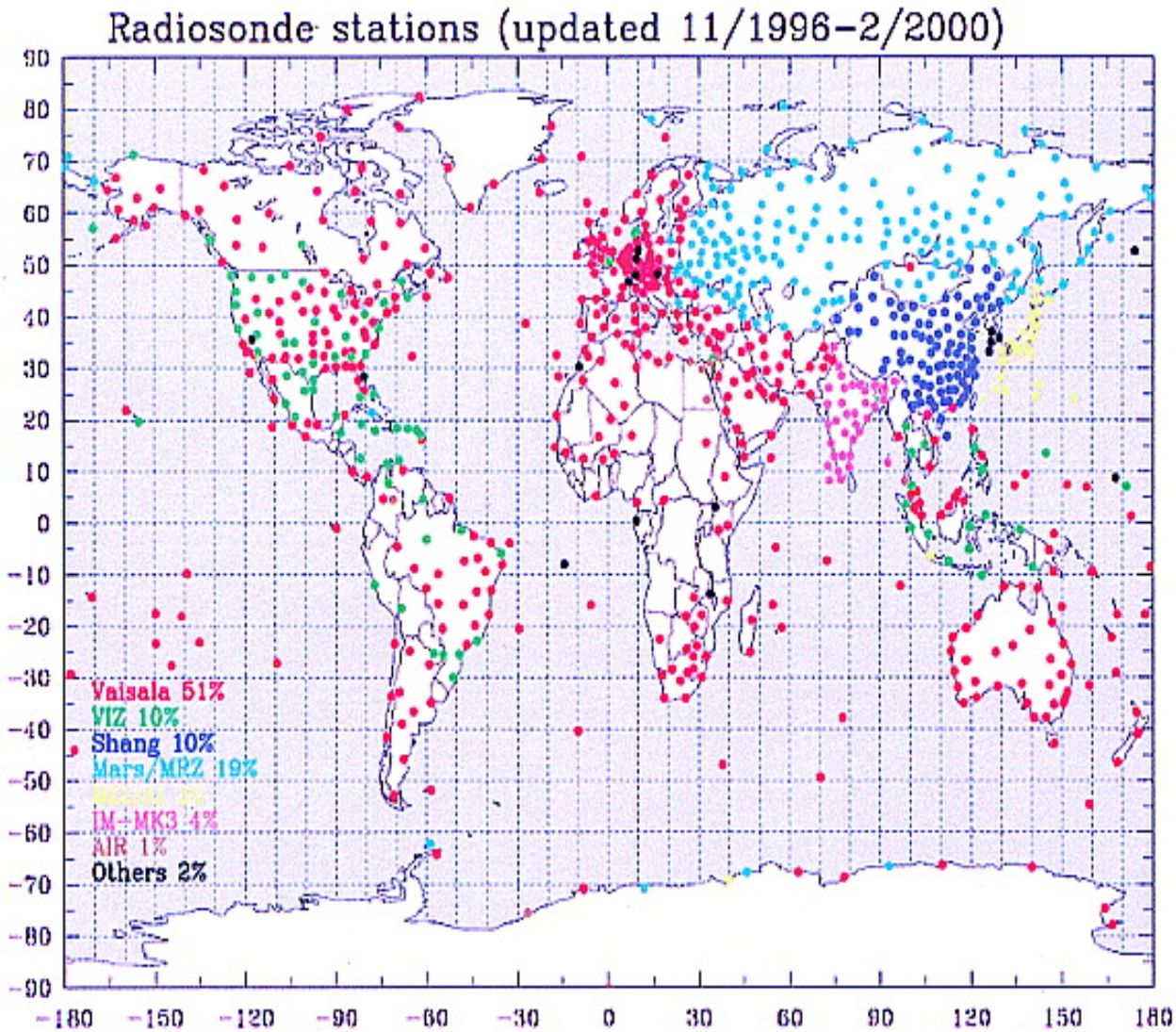
The accuracy of the RO temperature



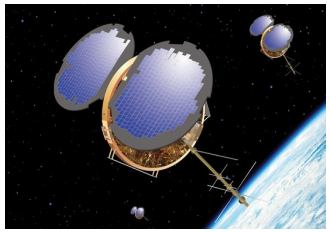


Ho, S.-P., Ying-Hwa Kuo ,William Schreiner, Xinjia Zhou, 2010: Using SI-traceable Global Positioning System Radio Occultation Measurements for Climate Monitoring [In "States of the Climate in 2009]. *Bul. Amer. Meteor. Sci.*, **91** (7), S36-S37.

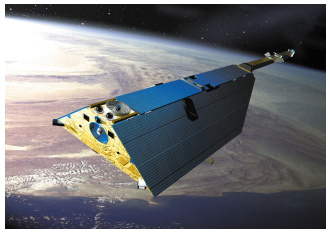
Using RO data to assess the quality of radiosonde data



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%)



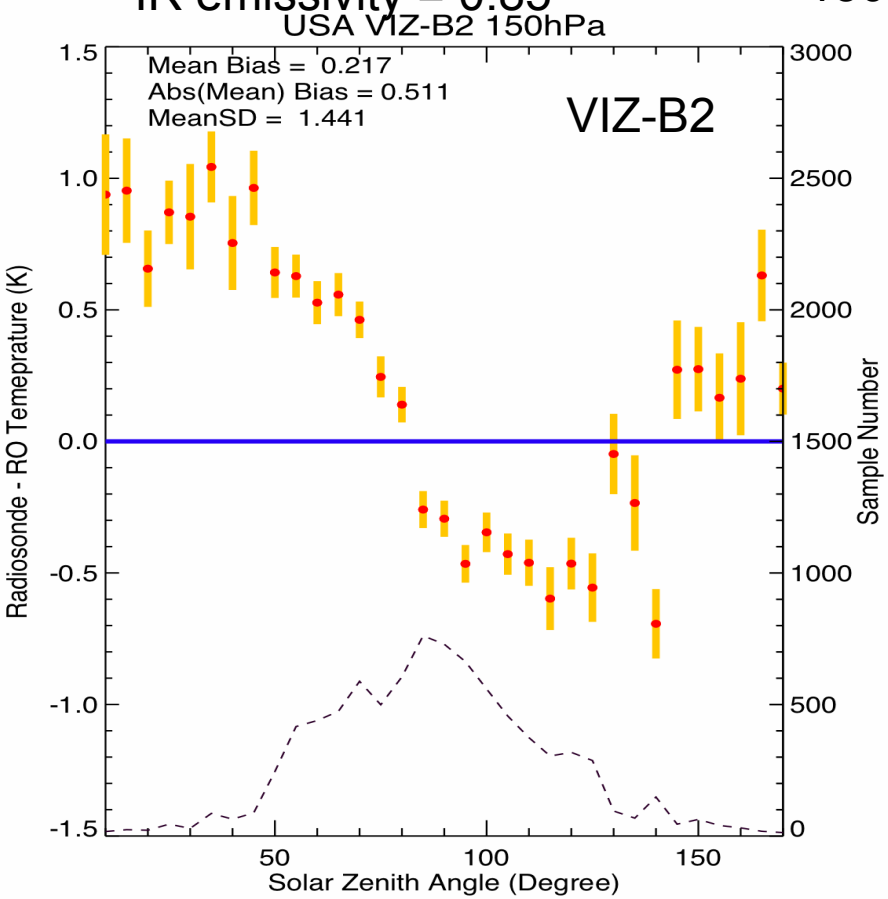
Using RO data to Identify Diurnal variation of Radiosonde Temperature Anomalies

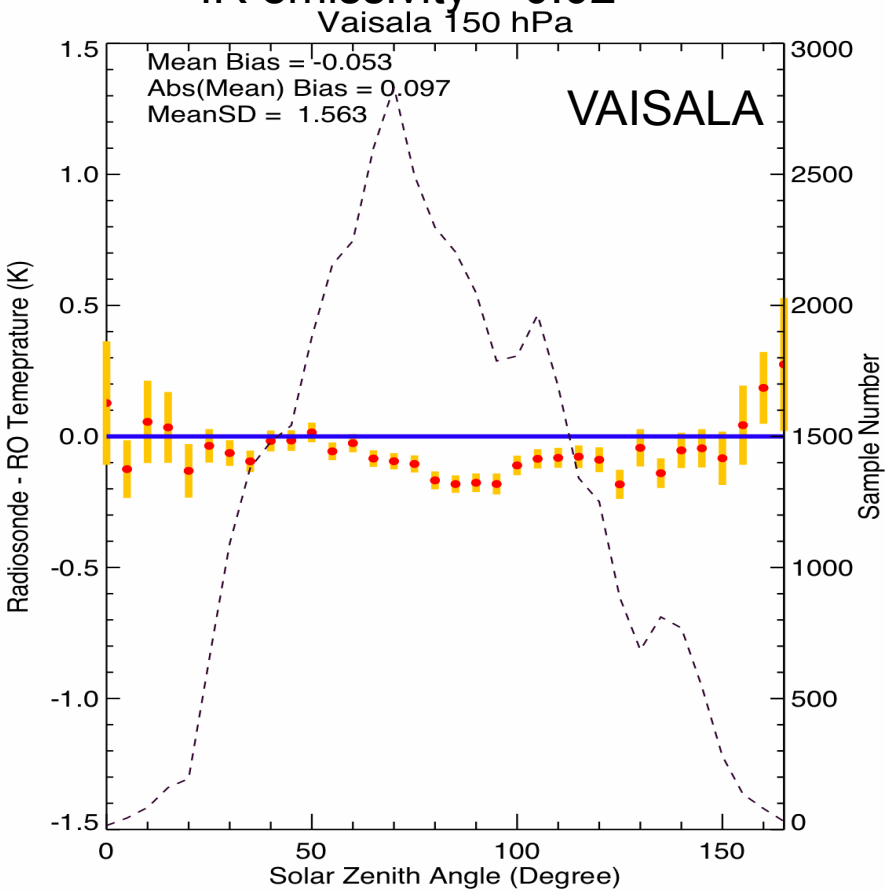


Solar absorptivity = 0.15
IR emissivity = 0.85

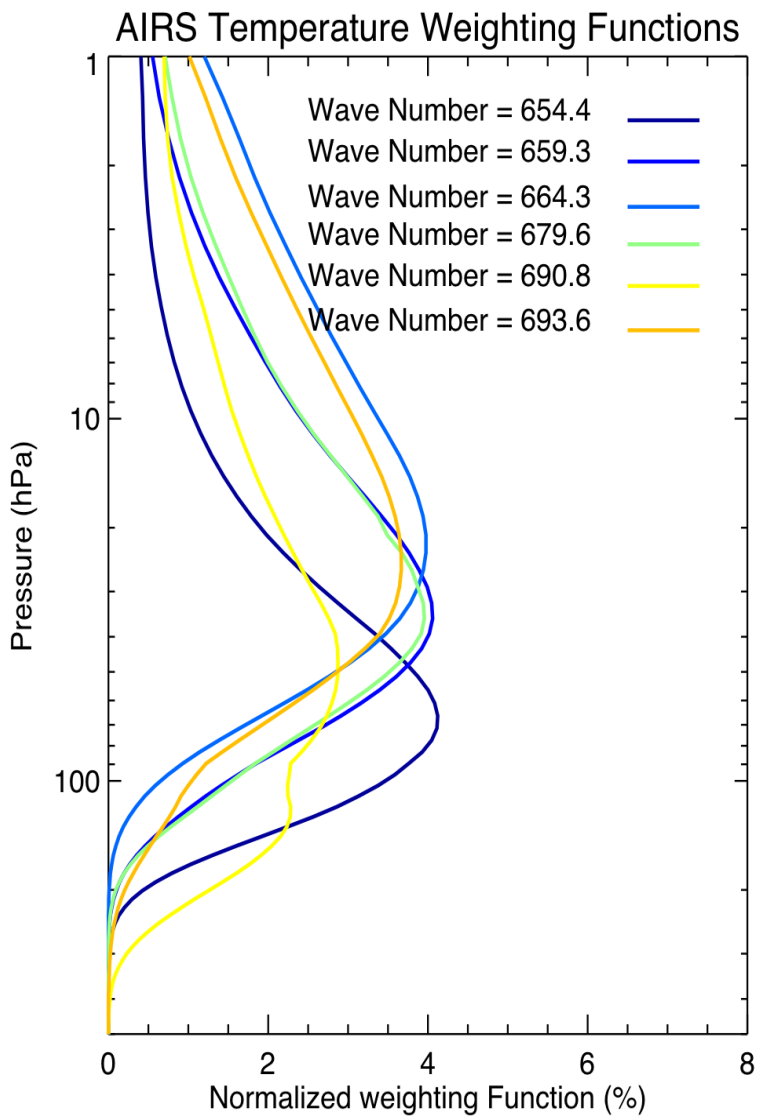
150 hPa

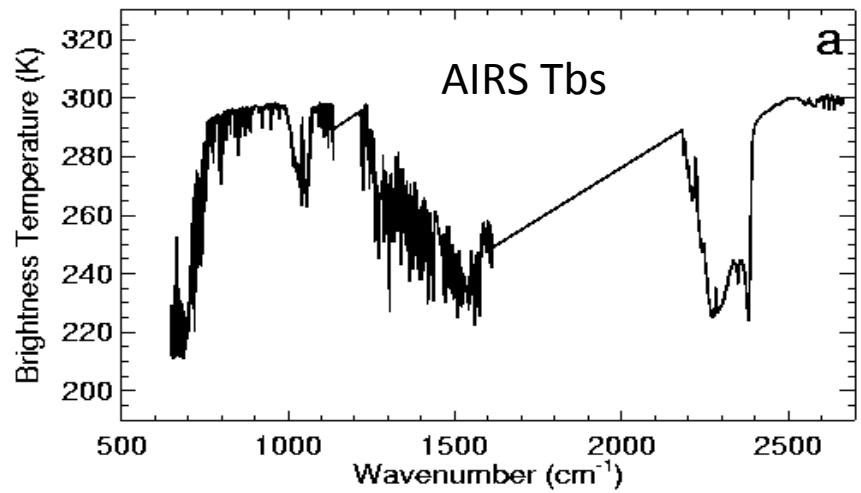
Solar absorptivity = 0.15
IR emissivity = 0.02

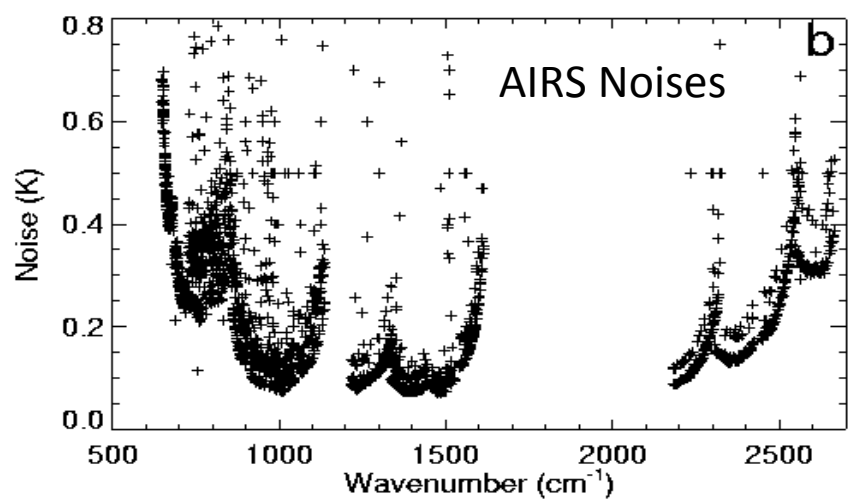




2.a Using RO data to monitoring quality of AIRS Measurements







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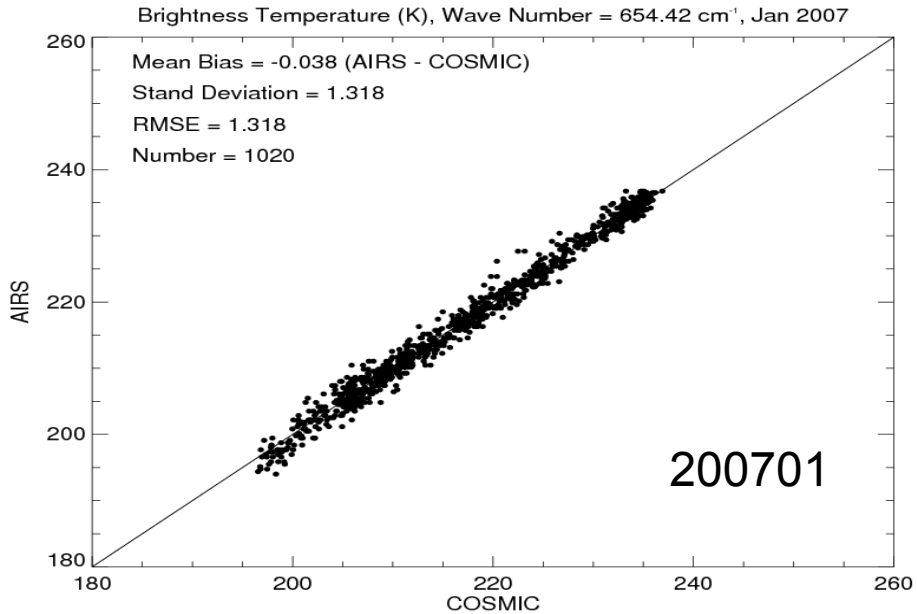
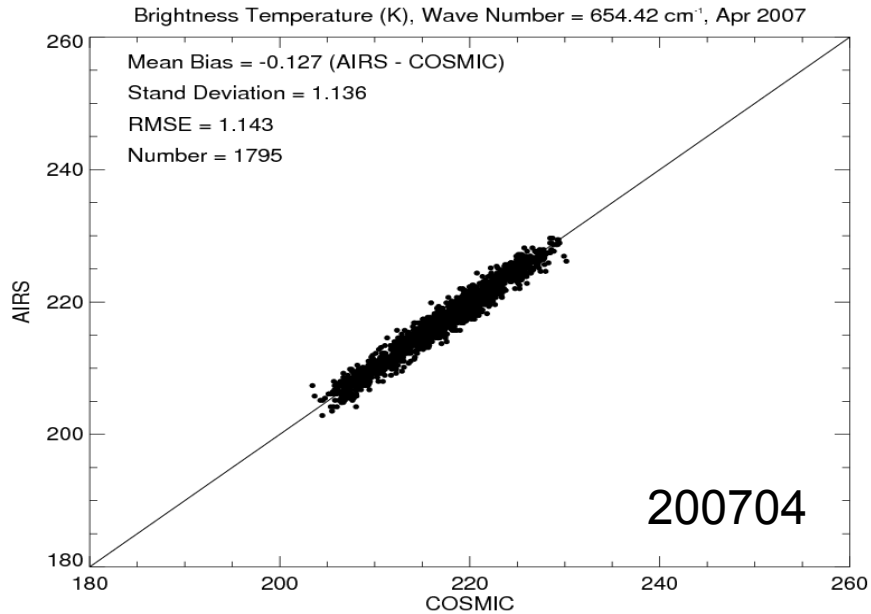
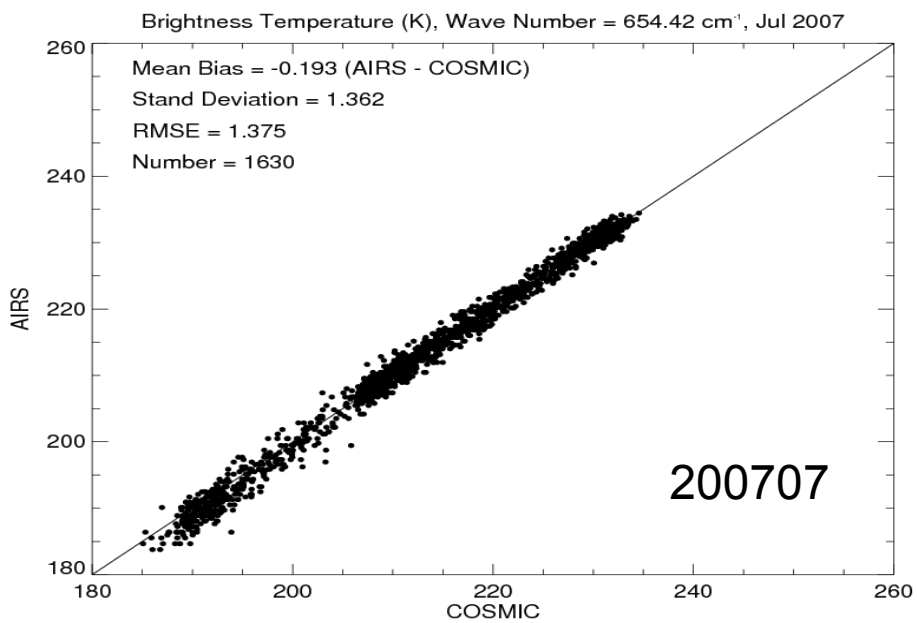
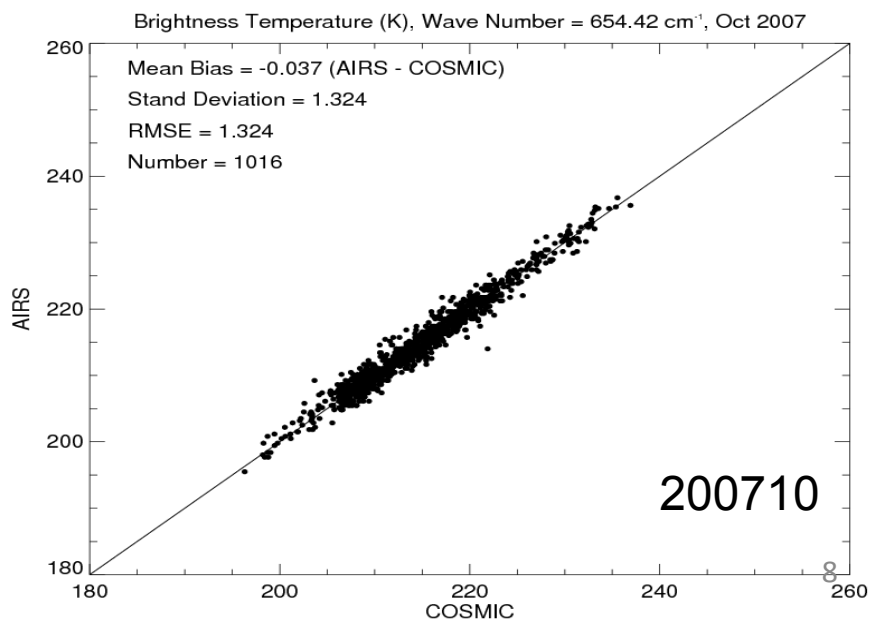
2.a Using RO data to monitoring quality of AIRS Measurements



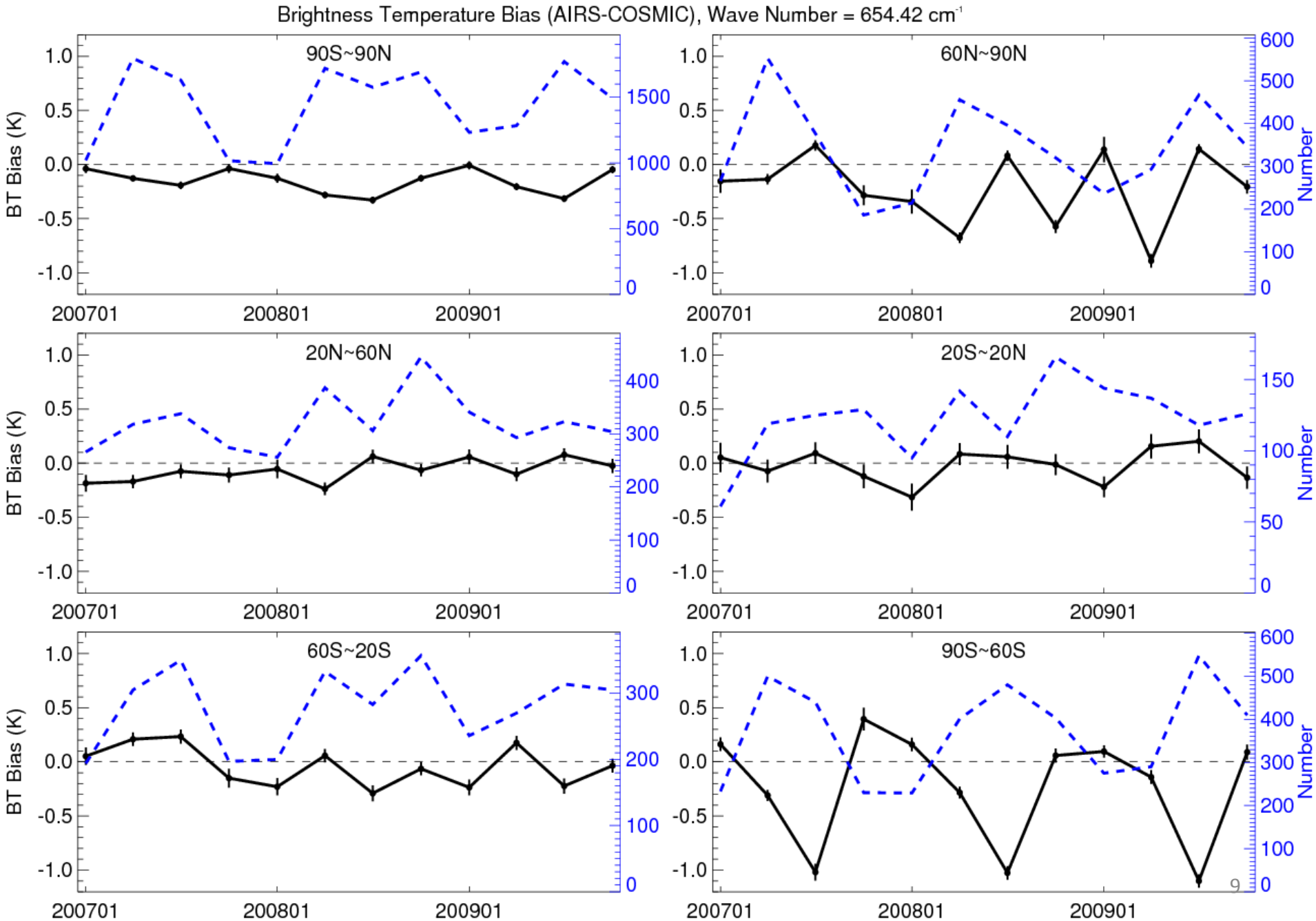


Distance difference = 100km, Time Difference = 30 minutes

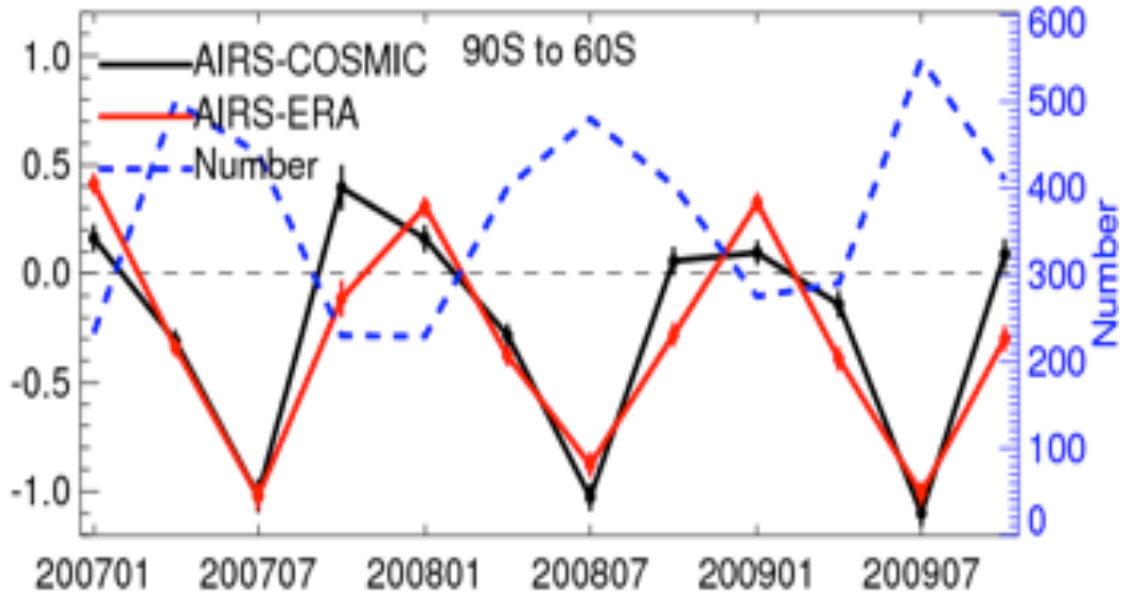




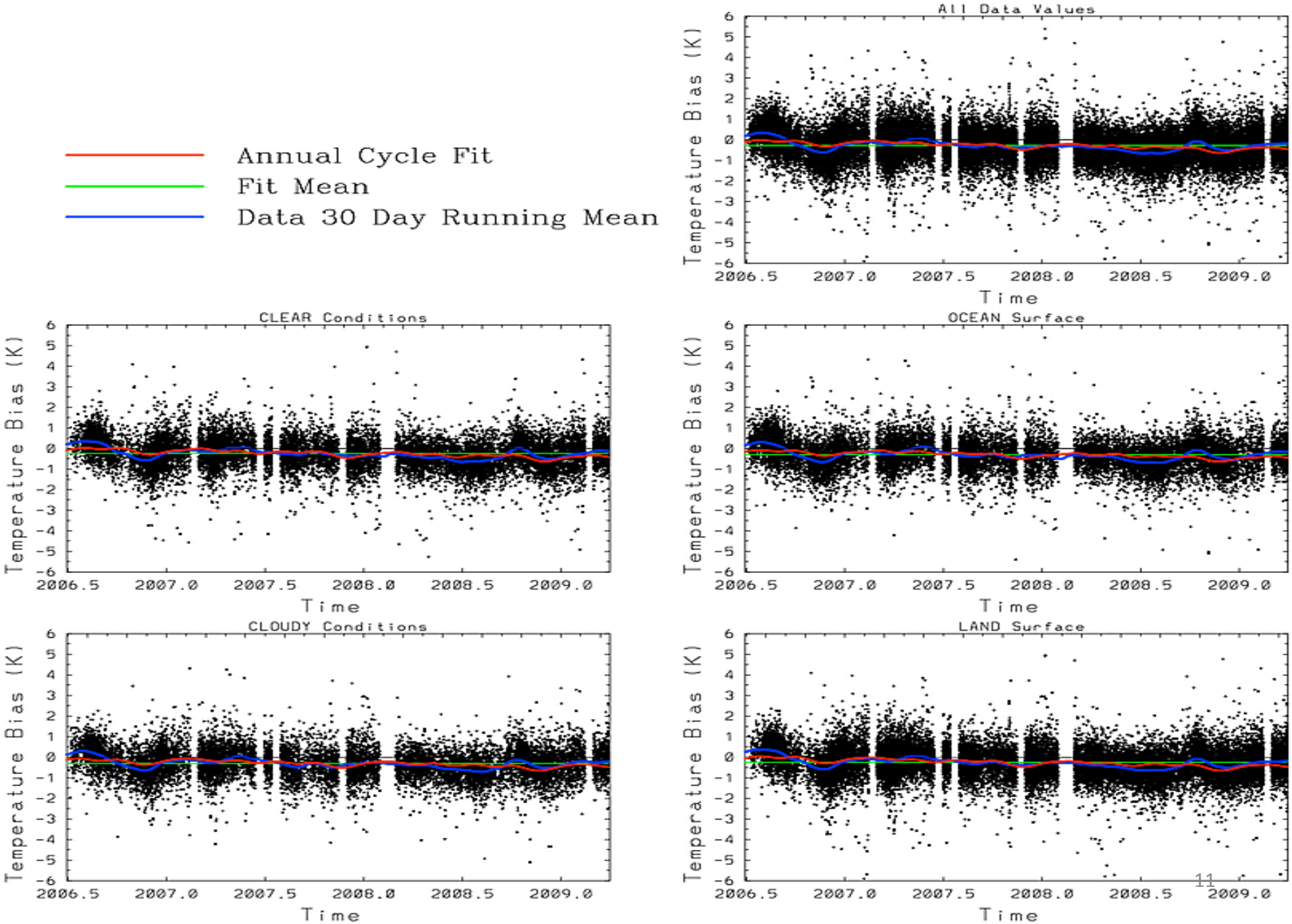
2.a Using RO data to monitoring quality of AIRS Measurements



2.a Using RO data to monitoring quality of AIRS Measurements



50 mb [ECMWF−RO] Temperature Difference (90S−60S)

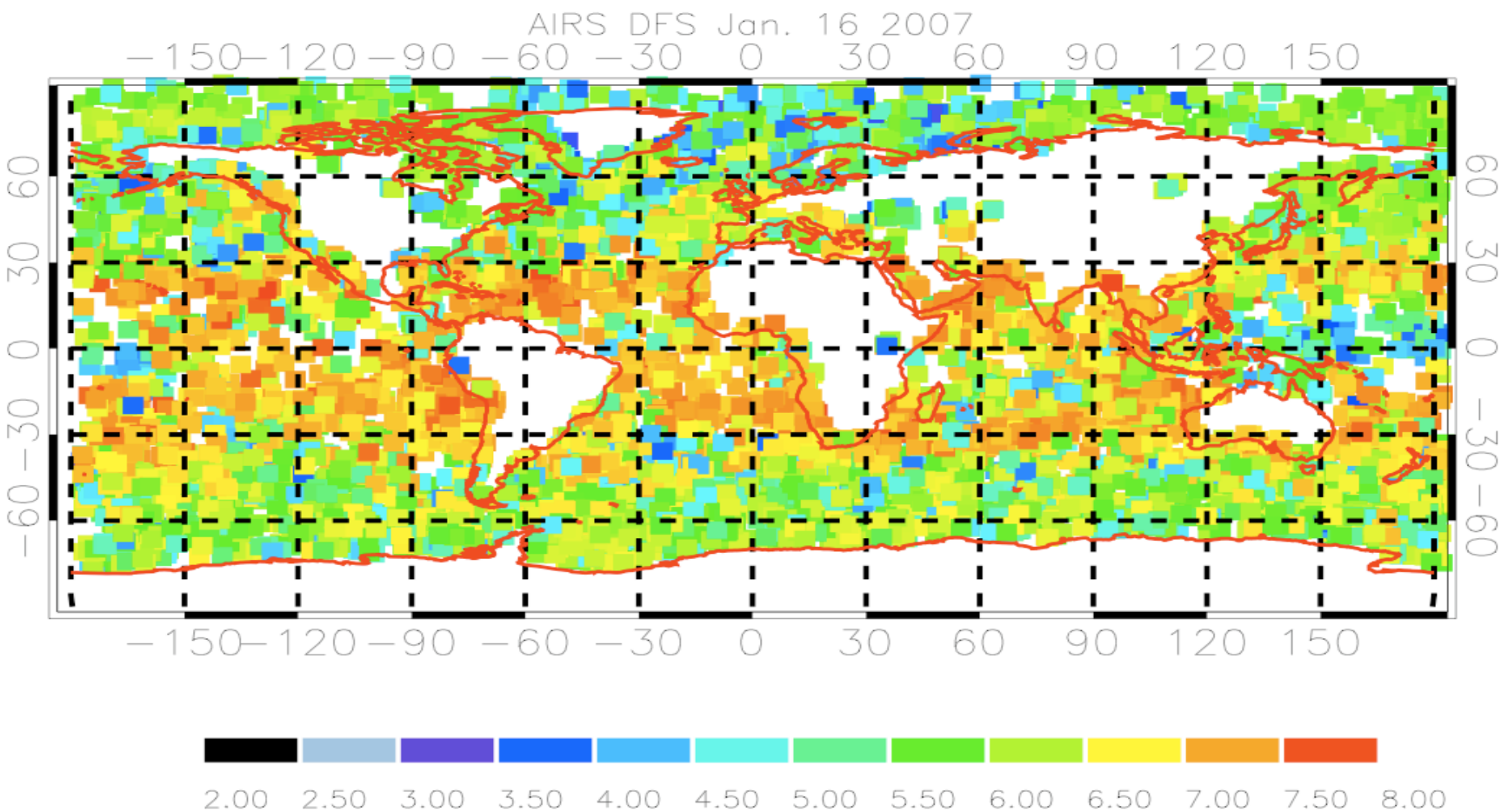


2.b Using RO data to validate AIRS data and retrievals

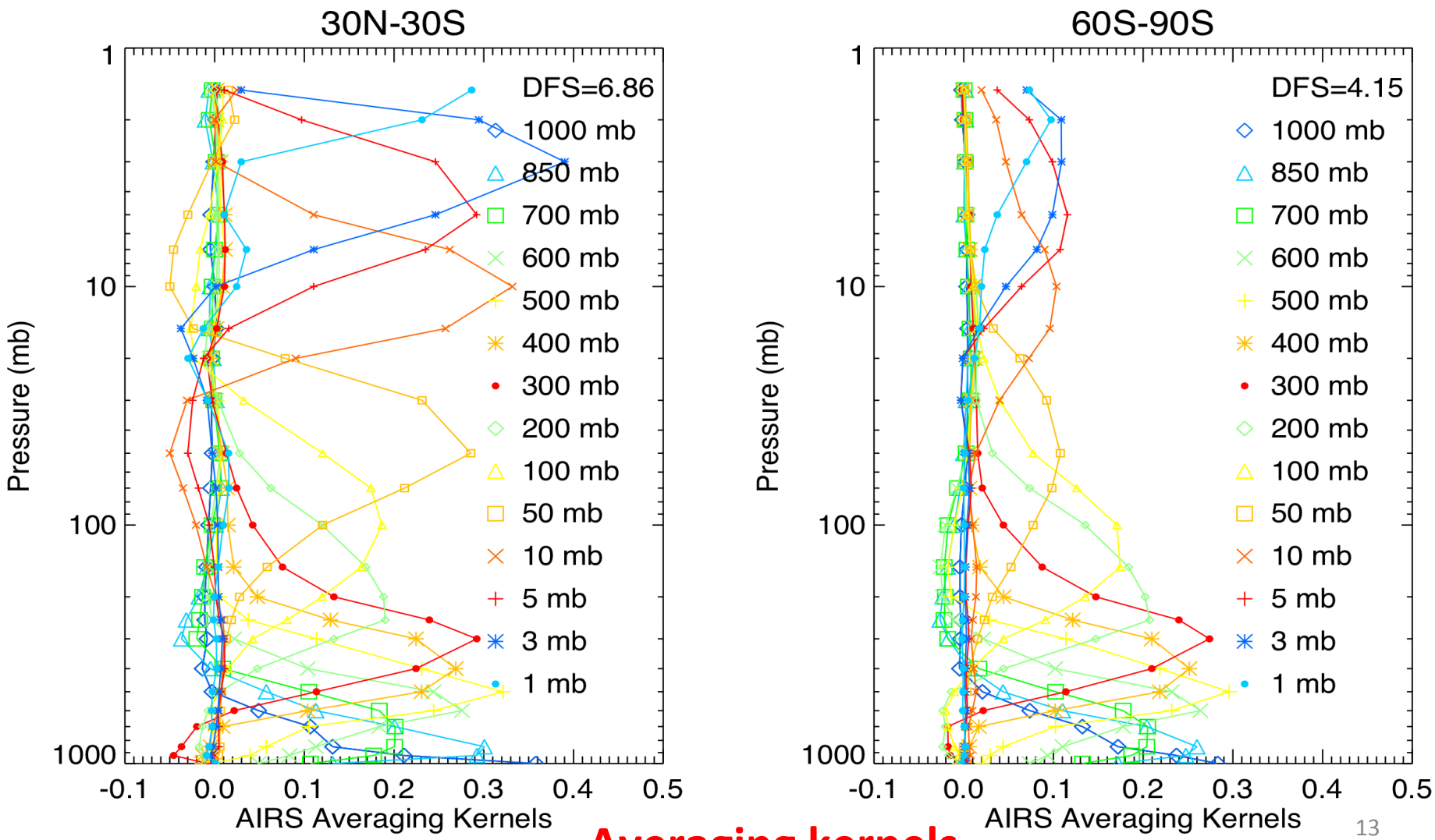
DFS is a function of atmospheric and surface conditions.

So AIRS temperature retrievals depend on the a priori profile and atmospheric/surface conditions, and also the retrieval methods.

$$T_{AIRS}^{\mathrm{Re}t} = A_{AIRS} T_{True} + (I - A_{AIRS}) T_{AIRS}^{Apr}$$



2.b Approach: Smooth RO temperature to eliminate effects of AIRS priori profiles and vertical resolution mismatch defined by averaging kernels -- examine the AIRS temperature



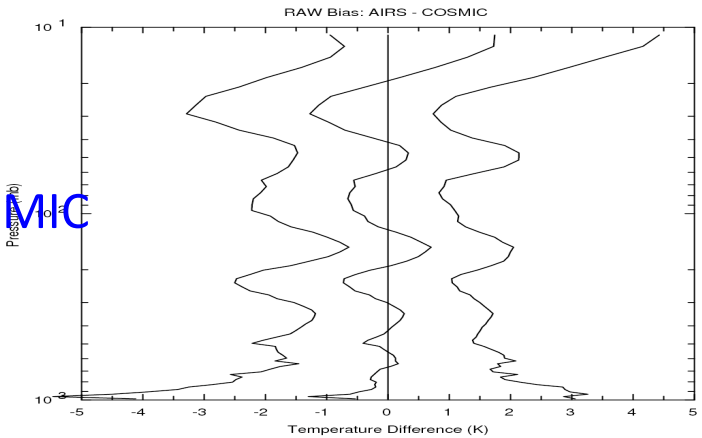
Averaging kernels

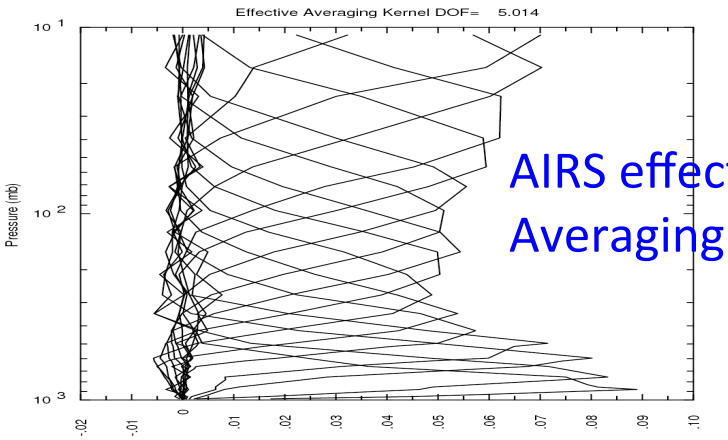
2.b

Results: eliminate effects of AIRS priori profiles and vertical resolution mismatch defined by averaging kernels (Eric Maddy' method)

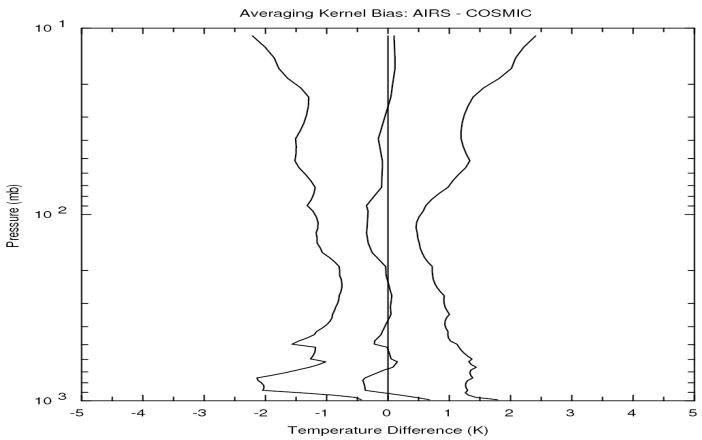
$$T_{AIRS}^{New} = A_{AIRS}^{Effective} T_{COSMIC} + (I - A_{AIRS}^{Effective}) T_{AIRS}^{Apr} \qquad A_{AIRS}^{Effective} = F A_{AIRS} F^{*}$$

AIRS-COSMIC



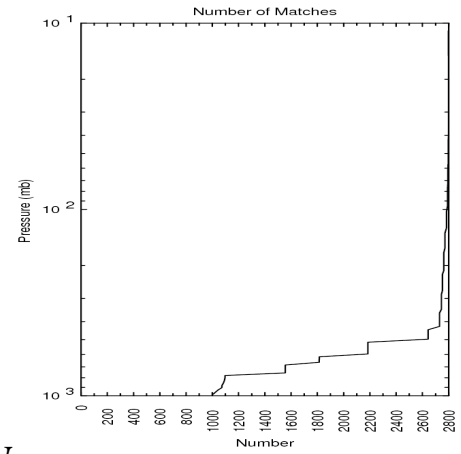


AIRS effective Averaging kernels



Average Dates:
Begin: 9 / 2006
End: 11 / 2006

ALL Latitudes
Land & Ocean
No Clouds
Day & Night



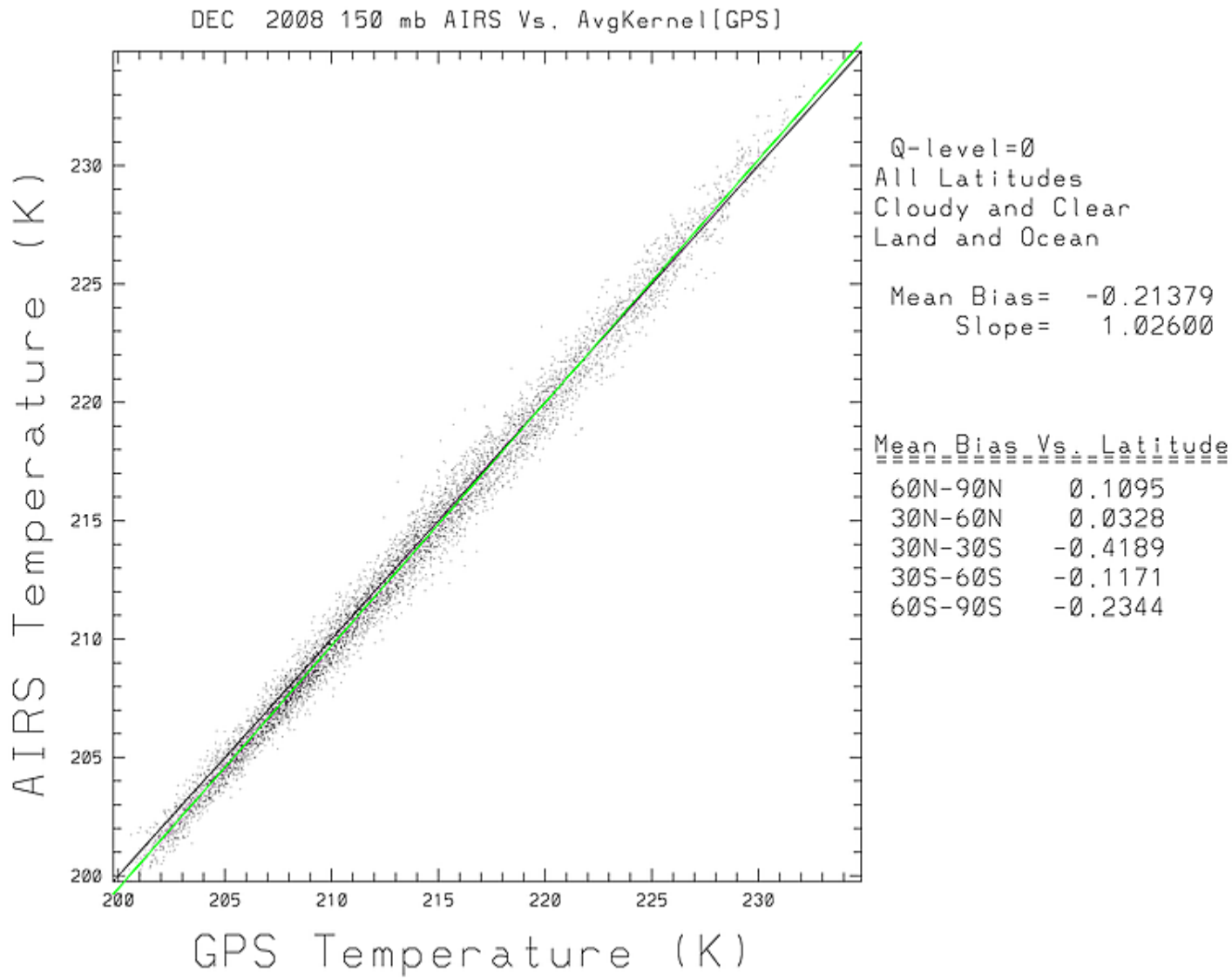
AIRS-Smoothed COSMIC

$$\Delta T_{AIRS} = T_{AIRS} - T_{AIRS}^{New}$$

150 mb AIRS vs. smoothed COSMIC Temperature (K)

Corr ~ 1.0

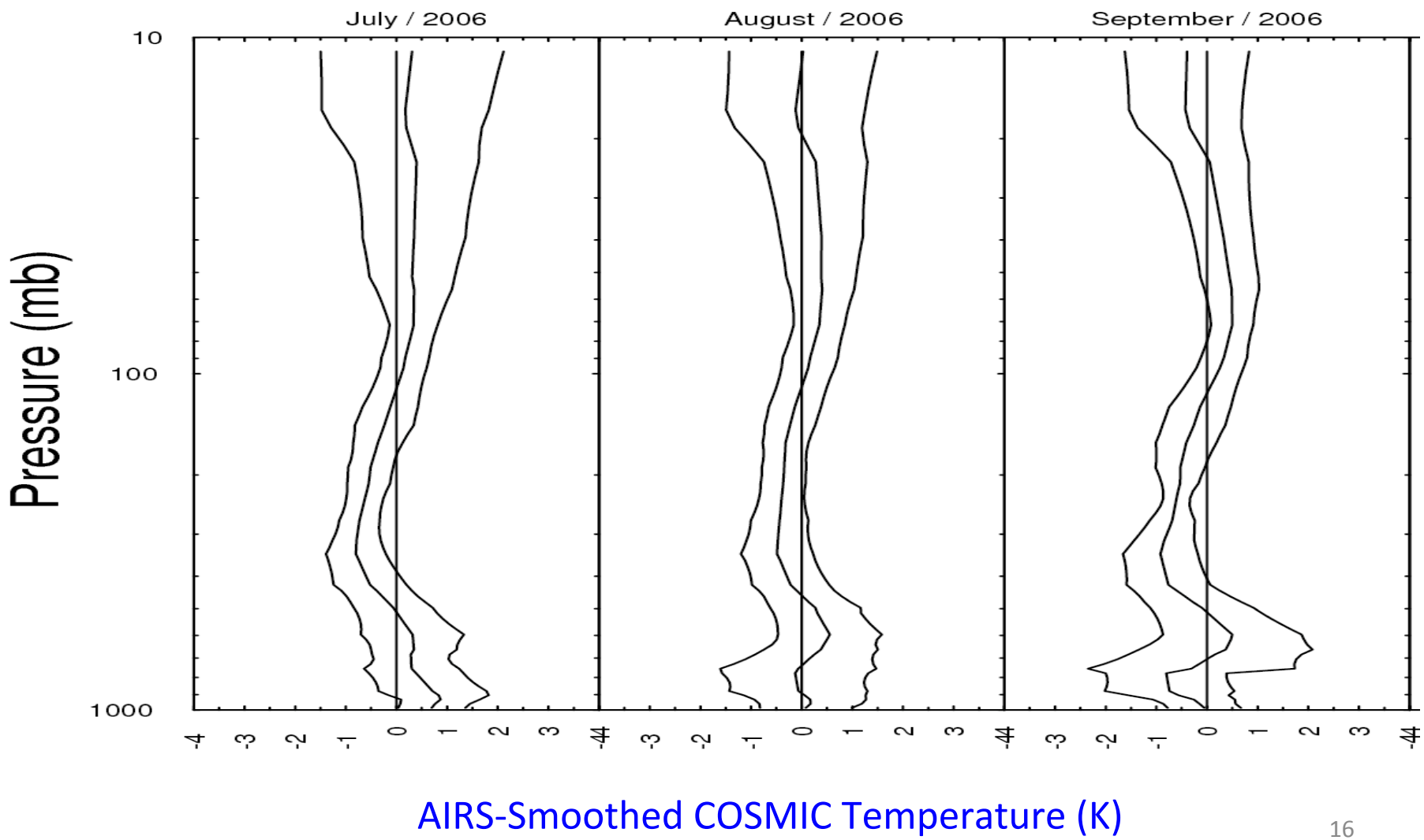
We can use the defined slope and offset to calibrate AIRS temperatures



2.b

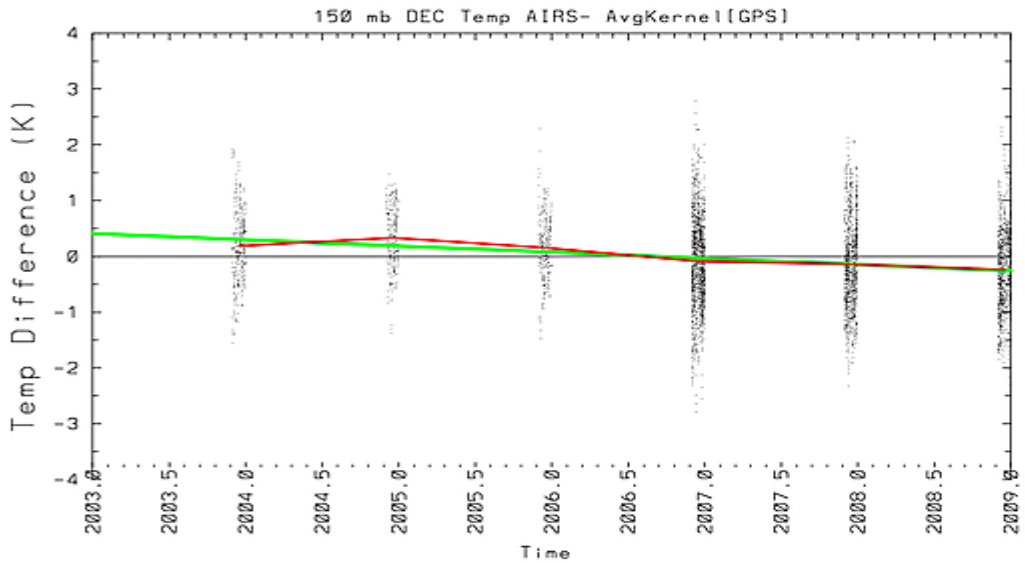
Biases are dependent on geo-location and and season ?

July, August and September, 2006, 30N-30S



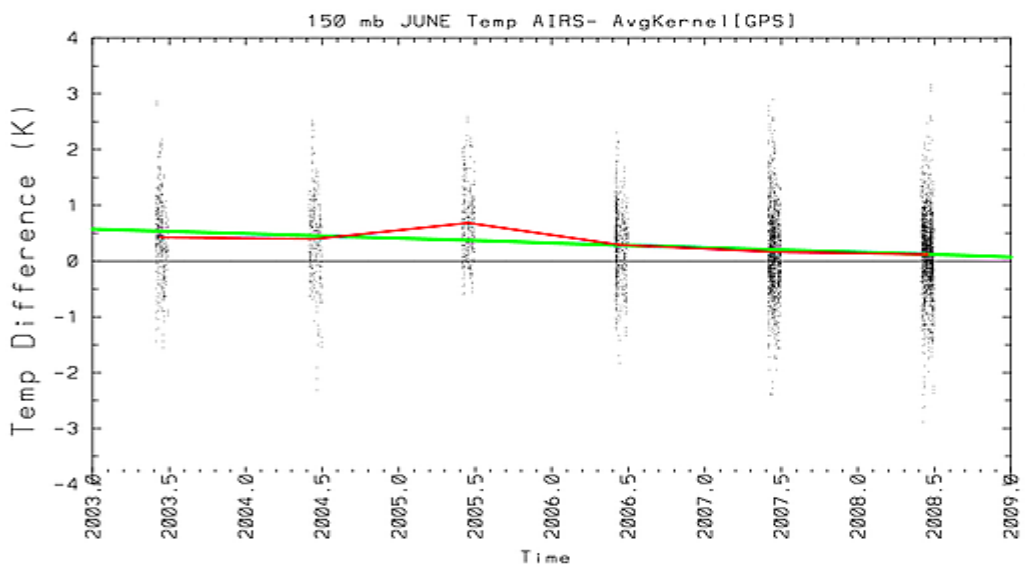
2.b Biases drift with years ?

60S - 90 S



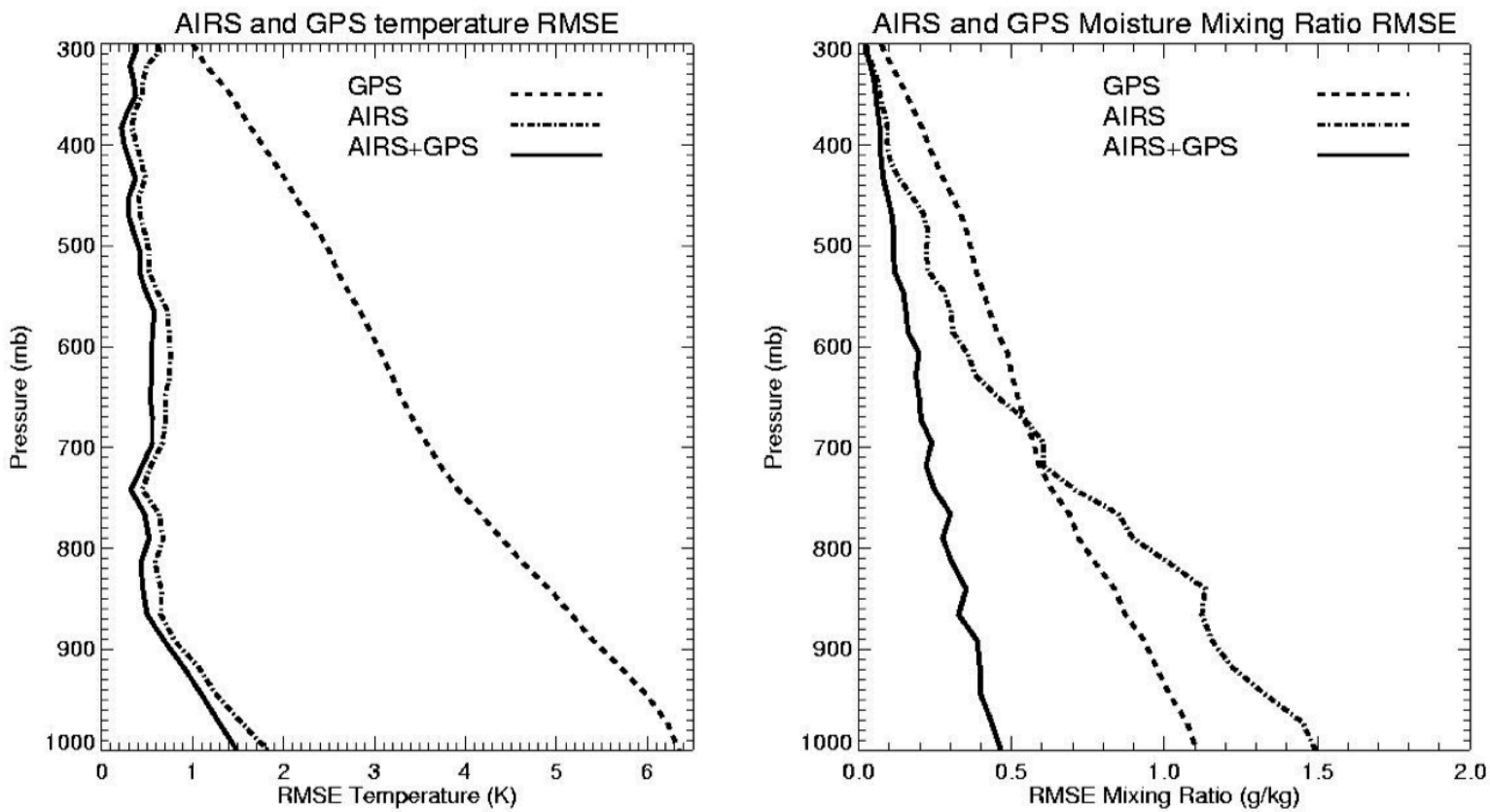
Q-level=0
Latitudes 60S-90S
Cloudy and Clear
Land and Ocean

DEC Means
==========
Bias=-0.03246+/-0.01197
Trend=-0.11110+/-0.00654



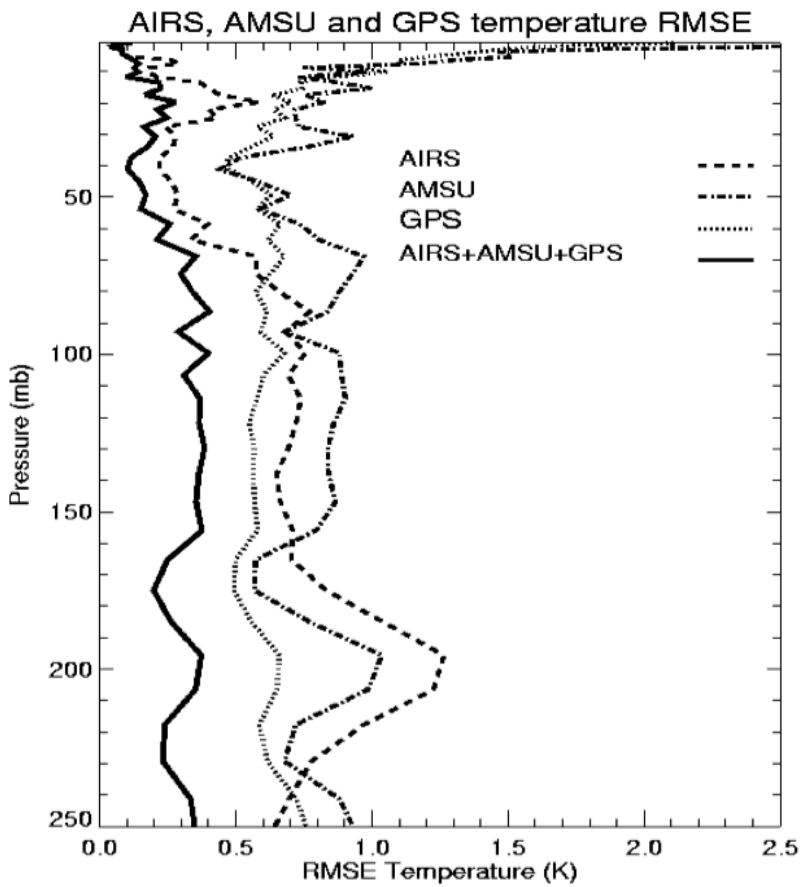
JUNE Means
==========
Bias= 0.24247+/-0.01044
Trend=-0.08374+/-0.00556

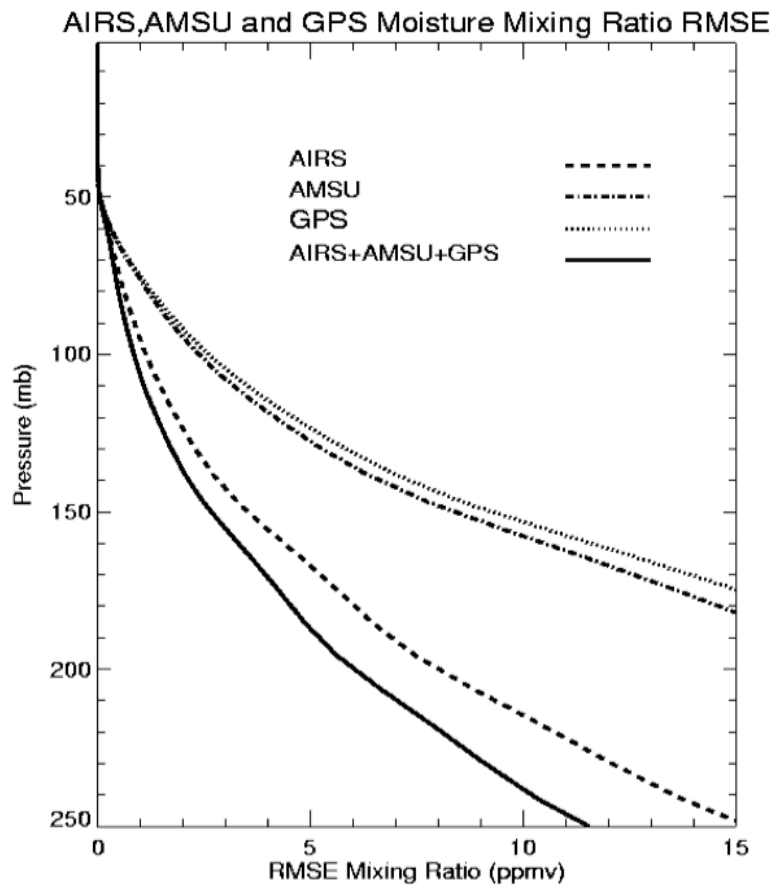
3a: Improving AIRS Temperature and Moisture Retrievals in Lower Troposphere, and Upper Troposphere and Lower Stratosphere using GPS RO data



From surface to 300 hPa

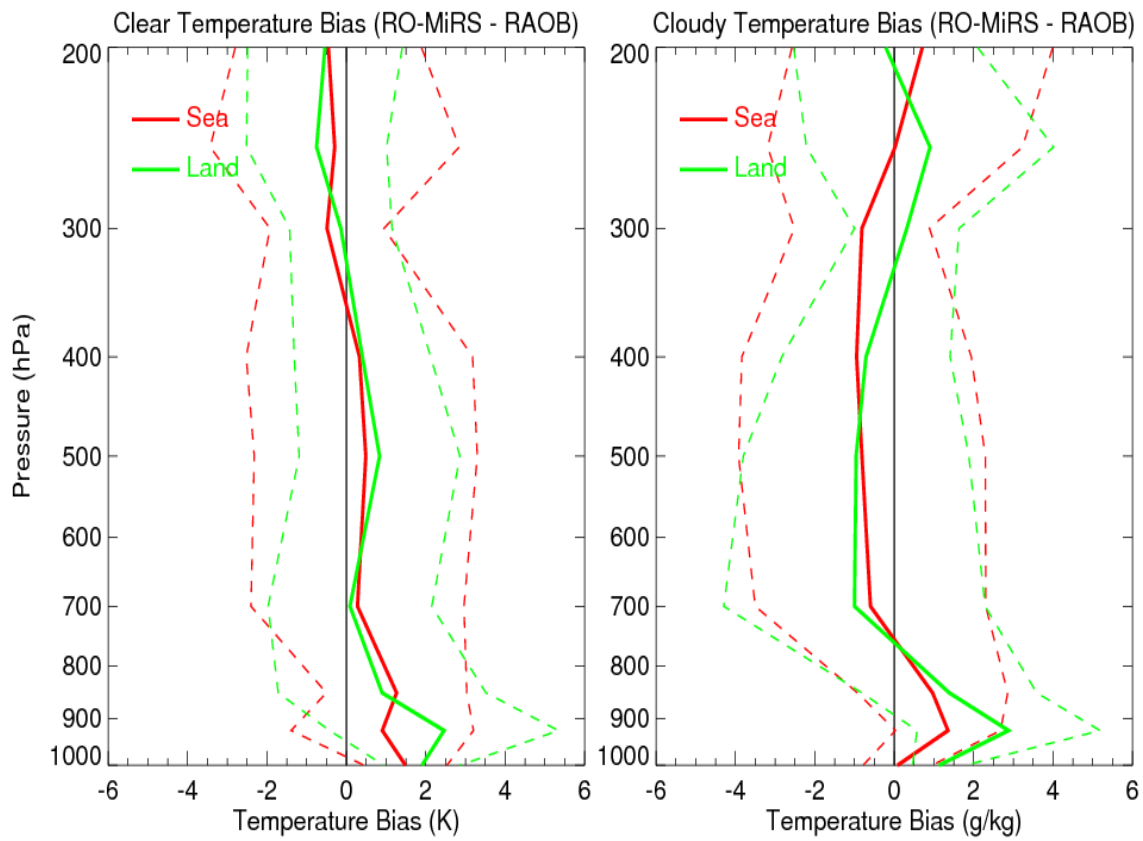
3a: Improving AIRS Temperature and Moisture Retrievals in Lower Troposphere, and Upper Troposphere and Lower Stratosphere using GPS RO data





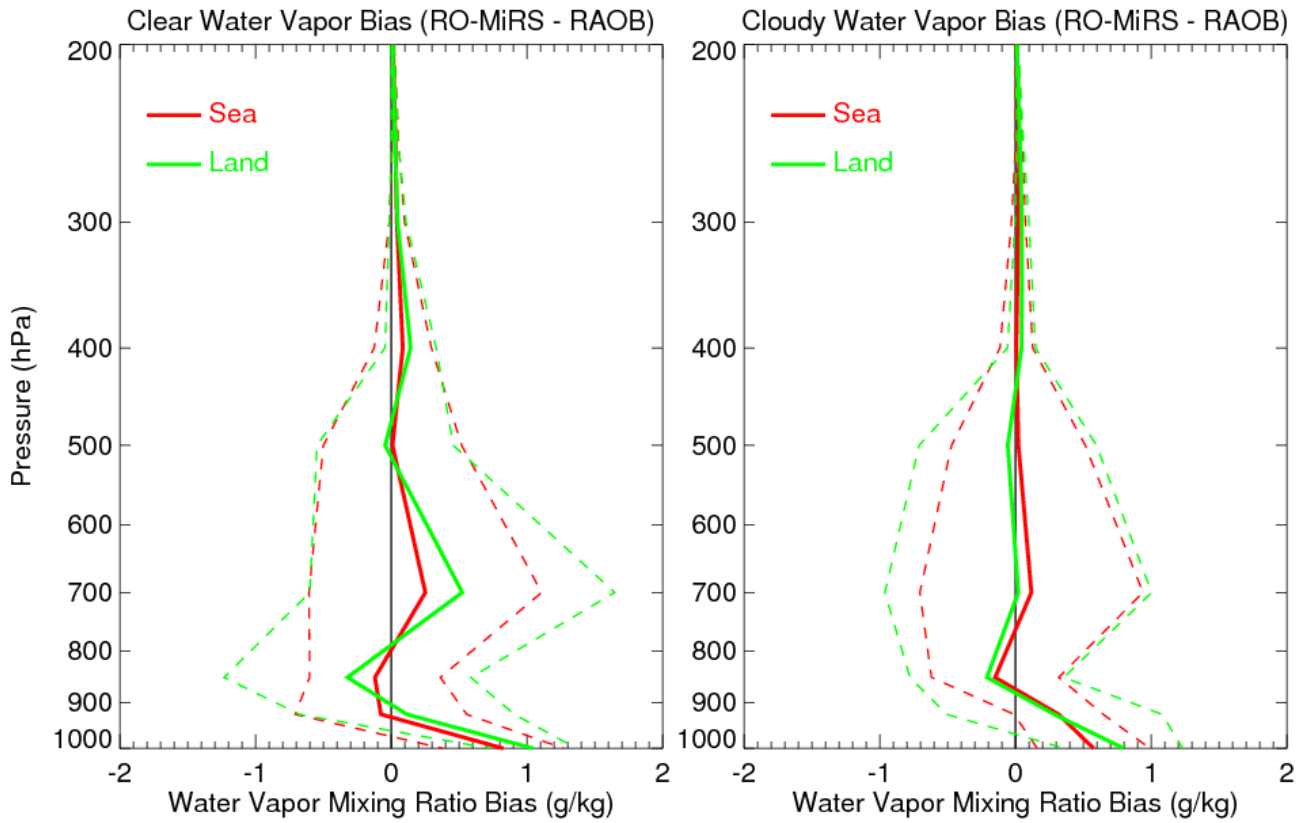
From 250 hPa to above

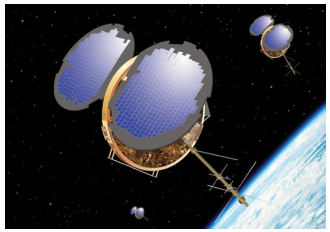
3b: A Fusion Approach to Simultaneously Retrieving Global Temperature and Water Vapor Profiles and Hydrological Data Products using MiRS from the Combined COSMIC and SNPP/ATMS



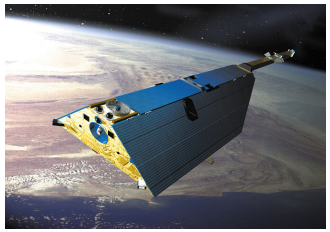
MiRS: Microwave Integrated Retrieval System

3b: A Fusion Approach to Simultaneously Retrieving Global Temperature and Water Vapor Profiles and Hydrological Data Products using MiRS from the Combined COSMIC and SNPP/ATMS





Conclusions and Future Work



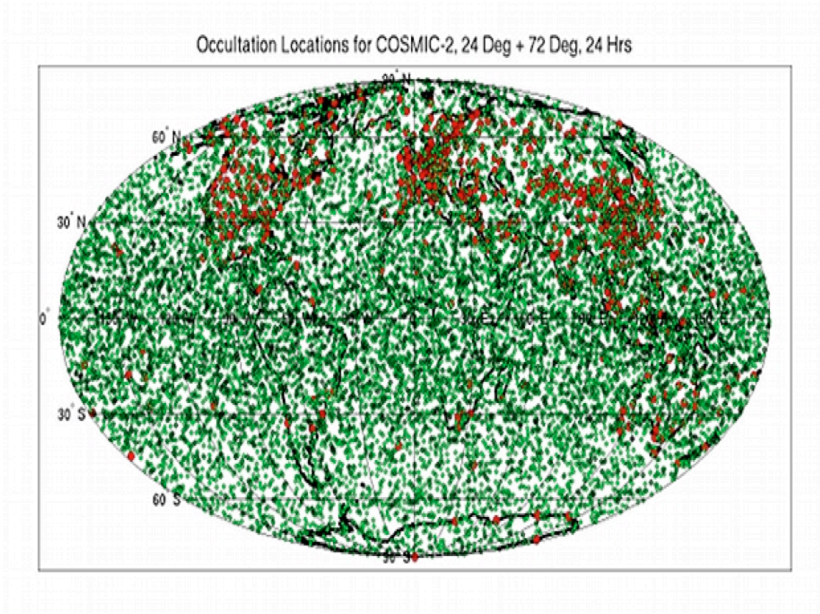
- In UCAR CDAAC a consistent inversion Algorithm is used to process SAC-C, GRACE, CHAMP, COSMIC, and GRAS

- Uniformly distribution RO profiles + coincident measurements from polar orbiting Satellites

- Improved inversion from coincident Active + passive measurements

- COSMIC II

COSMIC-II will be launched on 2016
12,000 uniformly distributed RO profiles per day



Ho et al., (BAMS 2013)

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