Validation of Sounder UTLS temperature using GPS RO: Experience with AIRS and COSMIC

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OUTLINE

- CrIS/ATMS EDR Cal/Val
- Characteristics of GPS RO
- Methodology of comparison
- AIRS/COSMIC results
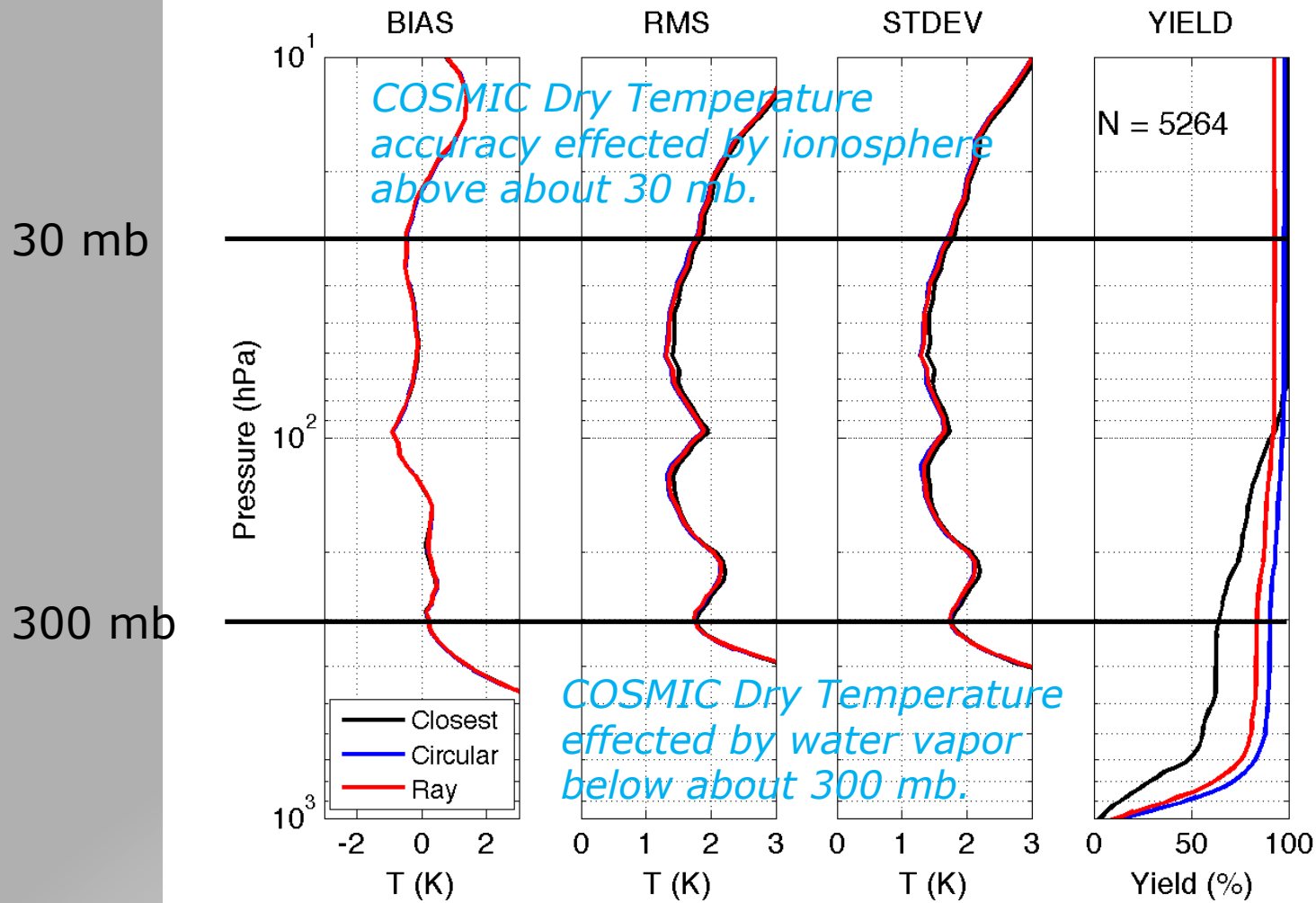- Preliminary Conclusions
- Future Directions

CrIMSS EDR Cal/Val

- NASA Suomi NPP -→ "gap" -→ JPSS J1 → JPSS J2

- JPSS jargon:
    - CrIS + ATMS = CrIMSS
    - EDR = NASA L2
    - AVTP = Atm. Vertical Temperature Profile

- CrIMSS EDR Requirements
  - Similar to AIRS.
  - See talk by Chris Barnet tomorrow for details.

- D. Tobin will lead UW analysis of dedicated sondes.

- The additional UW effort described here is to compare CrIMSS and AIRS UTLS temperature profiles using the GPS COSMIC network as a common reference.

UW Cal/Val Approach
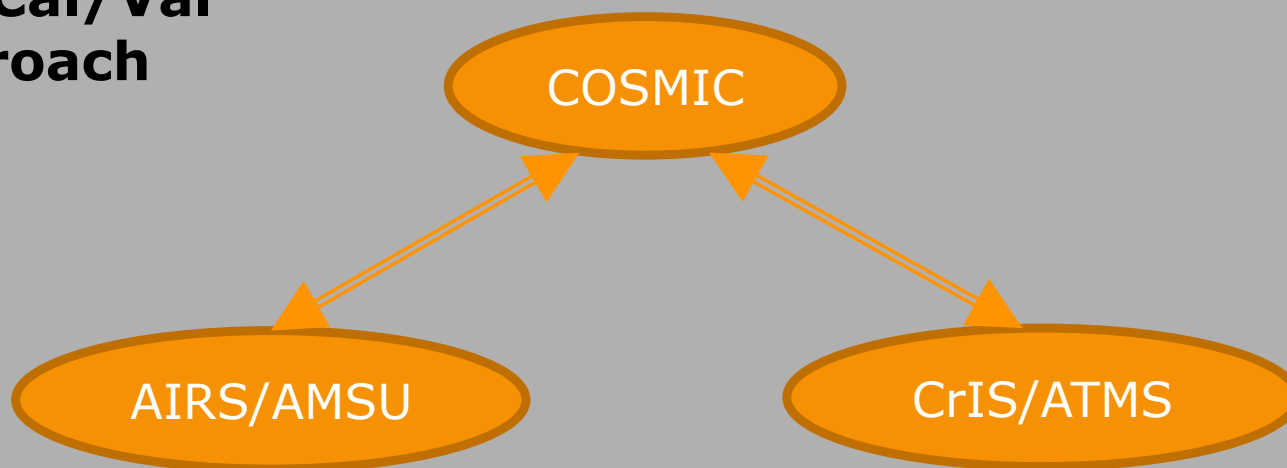
- Monthly statistics of AIRS-COSMIC and CrIMSS-COSMIC starting in May 2012 and continuing through the Cal/Val period.

- CrIMSS Cal/Val Product in NOAA CLASS:
  "Beta (2012)" → "Provisional (2013)" → "Validated (TBD)"

- COSMIC GPS RO is used for two purposes;
  1) as a common reference for comparing AIRS and CrIMSS
  2) as an absolute reference for each individually.
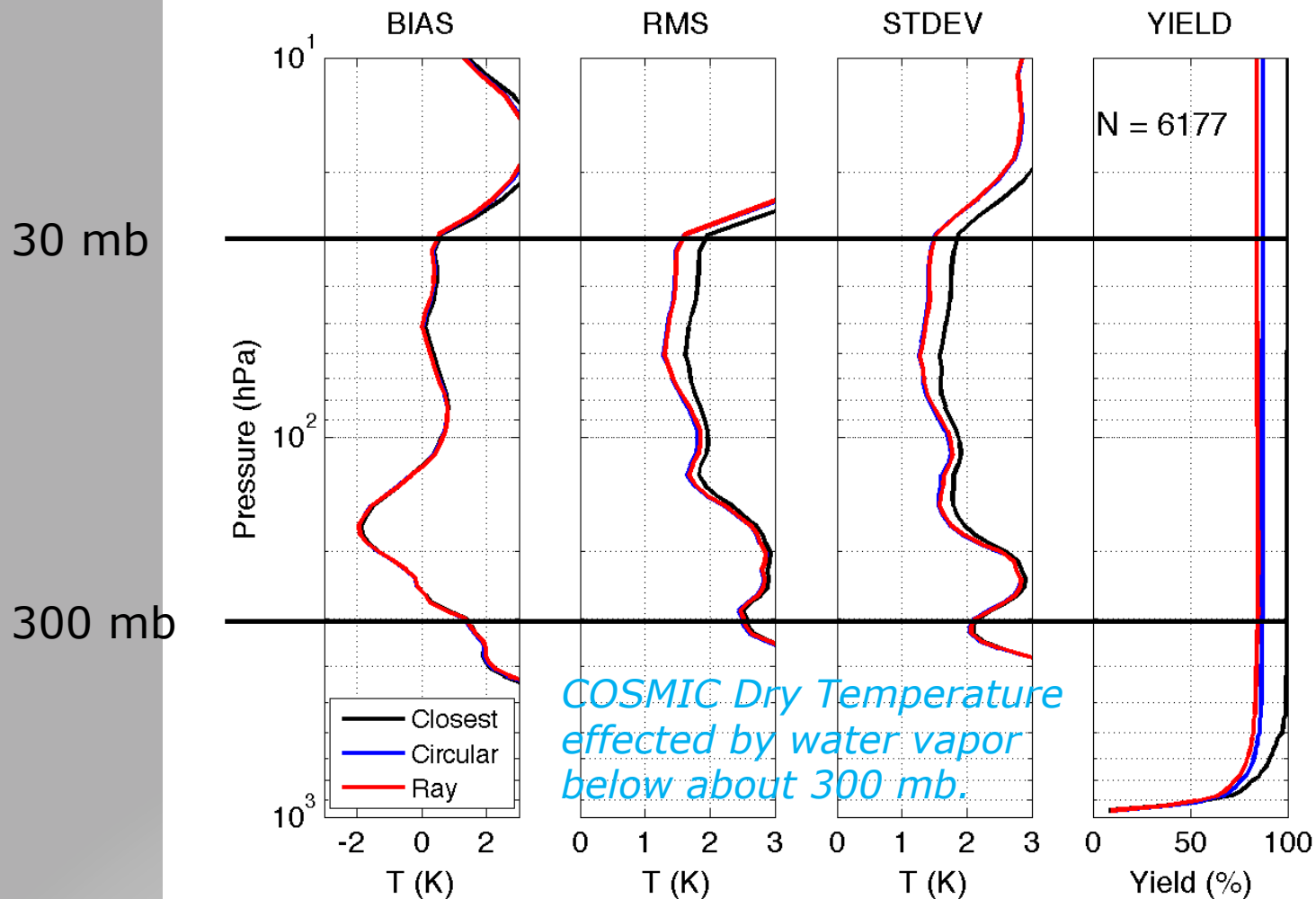
AIRS/AMSU–COSMIC: 2012 August GLOBAL

COSMIC Dry Temperature accuracy effected by ionosphere above about 30 mb.

COSMIC Dry Temperature effected by water vapor below about 300 mb.

N = 5264

30 mb

300 mb

AIRS v5 **BIAS** **RMS** **Std Dev.** **YIELD**

CrIS/ATMS−COSMIC: 2012 August GLOBAL

CrIMSS Beta

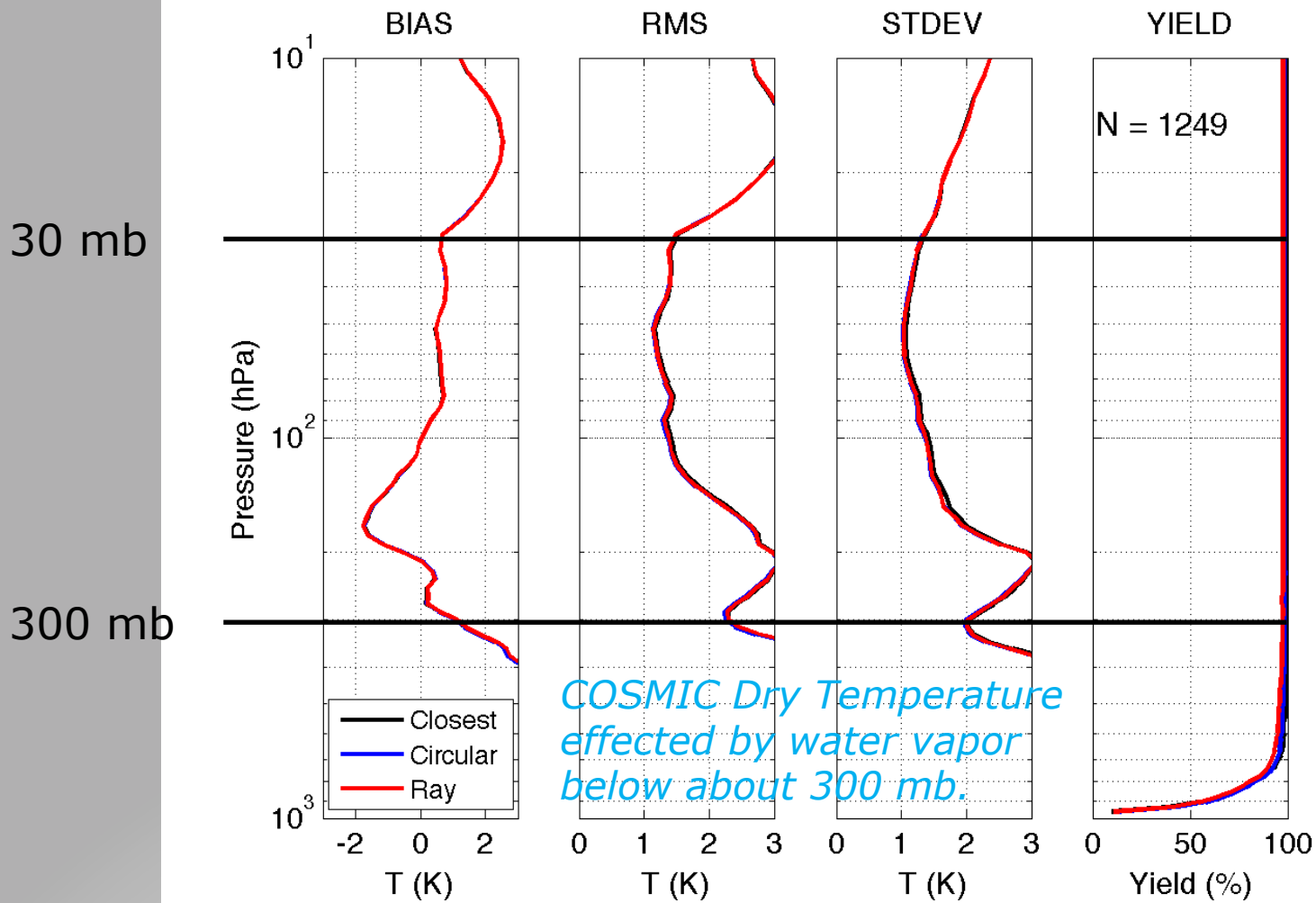| BIAS | RMS | Std Dev. | YIELD |

AIRS/AMSU–COSMIC: 2012 August 30N-60N

COSMIC Dry Temperature accuracy effected by ionosphere above about 30 mb.

COSMIC Dry Temperature effected by water vapor below about 300 mb.

N = 1177

Legend:
- Closest (black)
- Circular (blue)
- Ray (red)
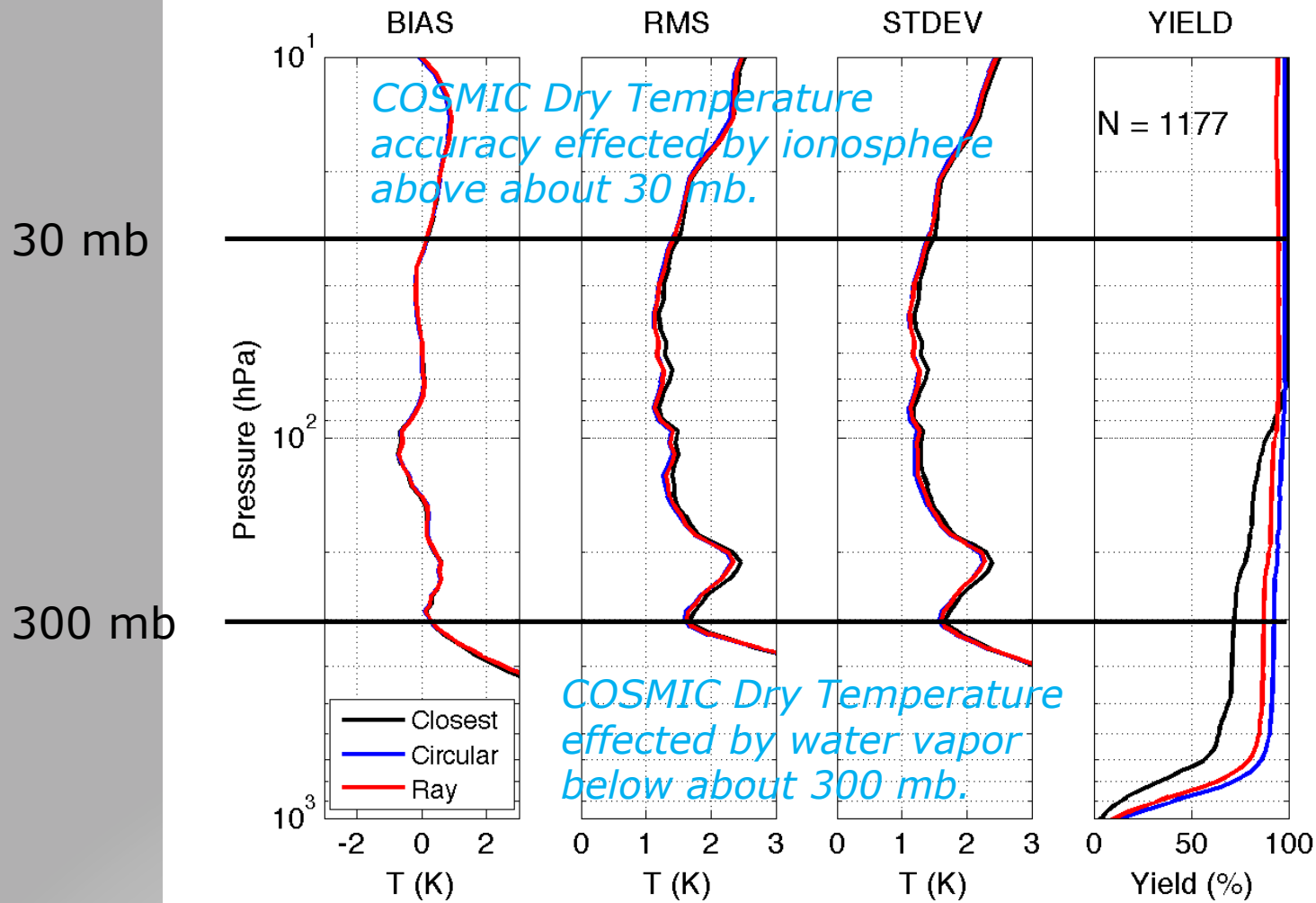
AIRS v5   **BIAS**   **RMS**   **Std Dev.**   **YIELD**

CrIS/ATMS–COSMIC: 2012 August 30N-60N

CrIMSS Beta **BIAS** **RMS** **Std Dev.** **YIELD**

CrIMSS "Beta" Conclusions

• CrIMSS Cal/Val Product in NOAA CLASS: "Beta (2012)" → "Provisional (2013)" → "Validated (TBD)"

• CrIMSS "beta" ATVP in the UTLS are only slightly degraded wrt AIRS L2 v5 using the COSMIC RO network as a common reference.

• Part of this degradation can be attributed to less sophisticated quality control in the CrIMSS "beta" product currently produced by IDPS and archived at NOAA CLASS.

See Chris Barnet (NOAA) talk on Thursday for details.

COSMIC GPS RO Network (U.S./Taiwan)

~ 1000 profiles per day
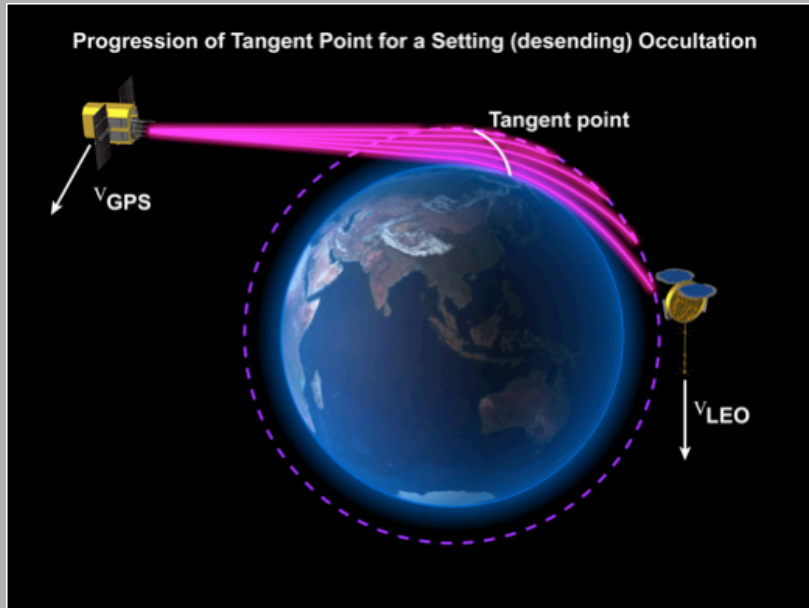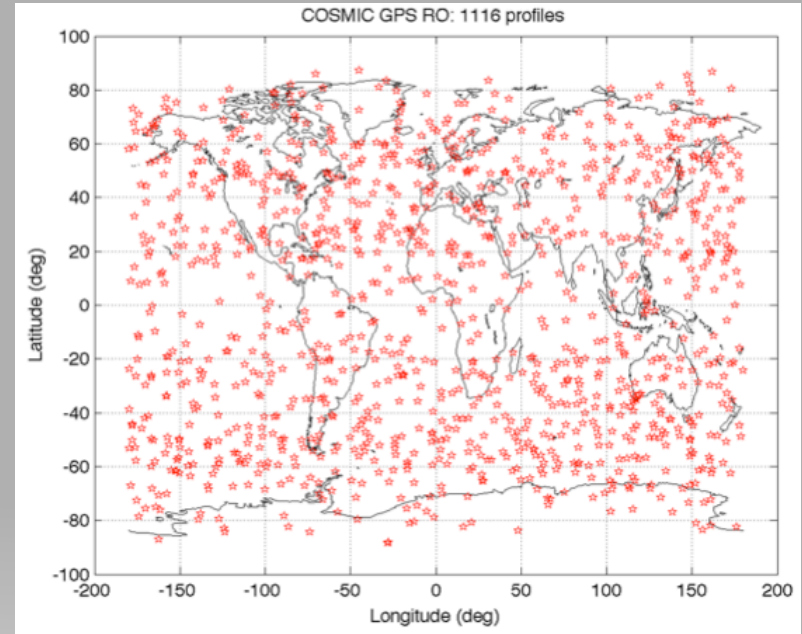
The product used is COSMIC version 2010.2640 named 'atmPrf', which contains the dry temperature profile. http://cosmic-io.cosmic.ucar.edu/cdaac/products.html
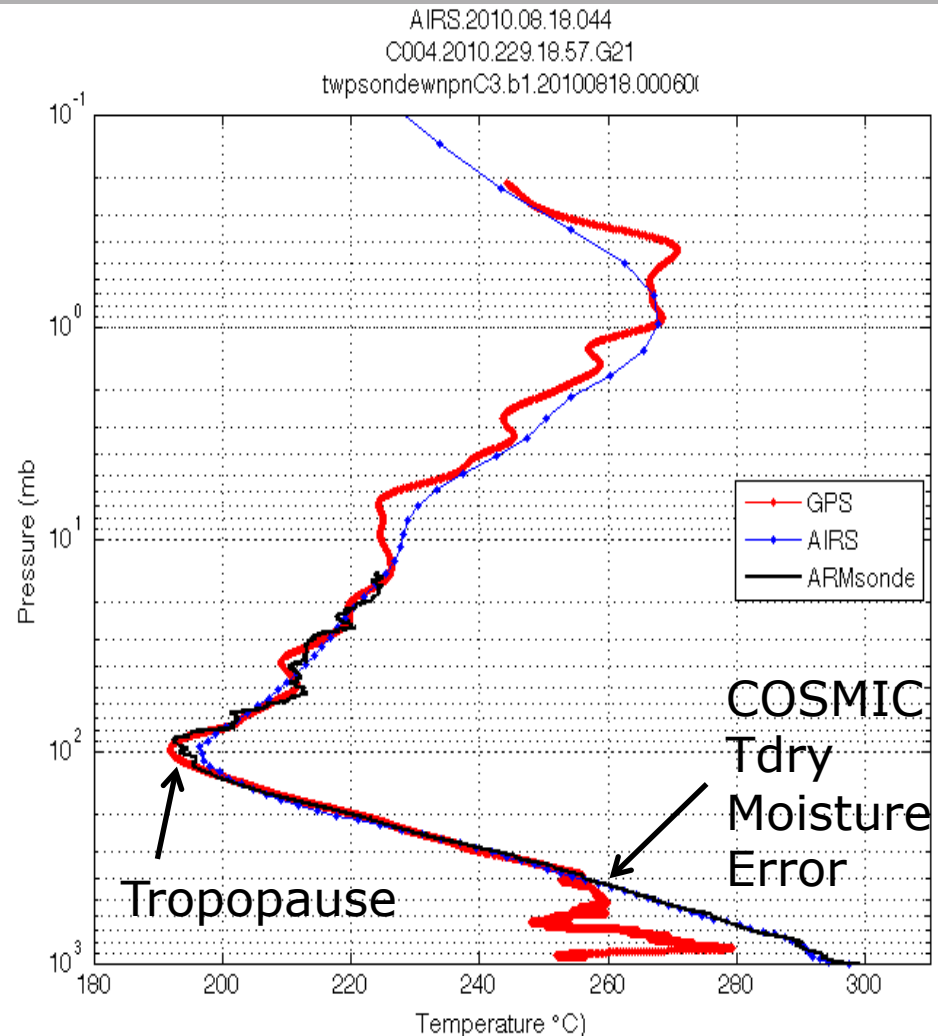
COSMIC AIRS Matchup Yield < 1 hour: 6.6%
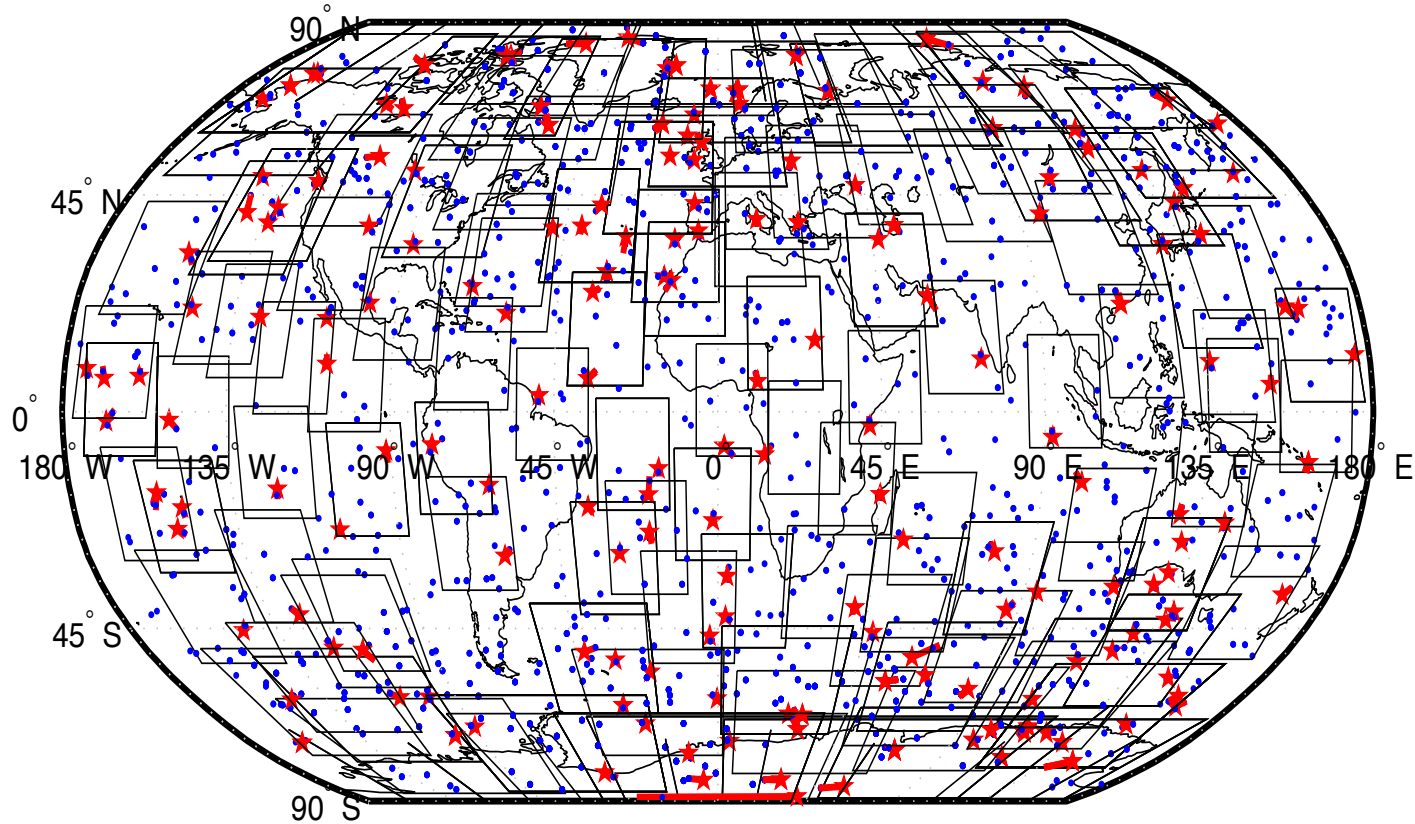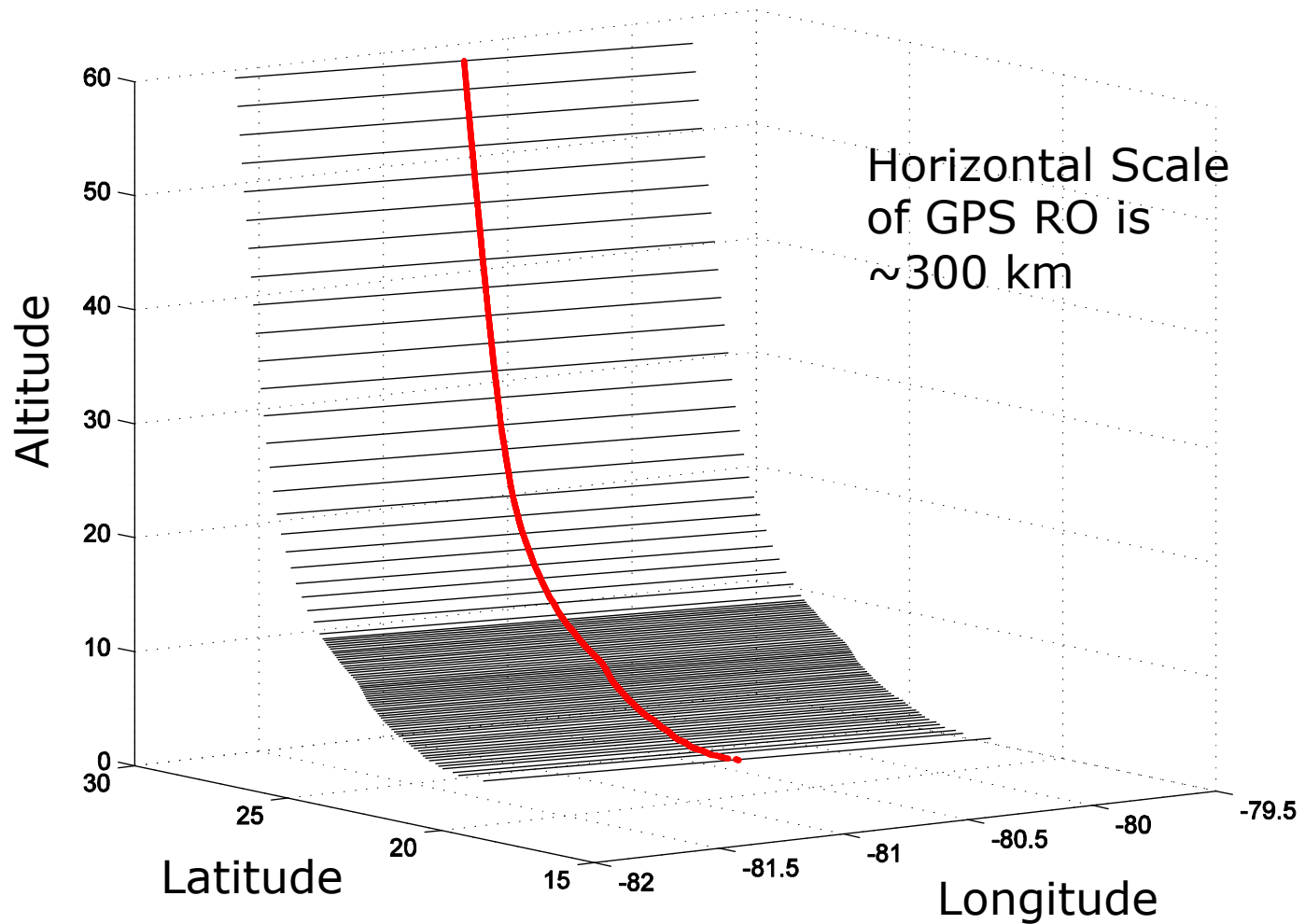
Red Star indicate matchups within 1 hour
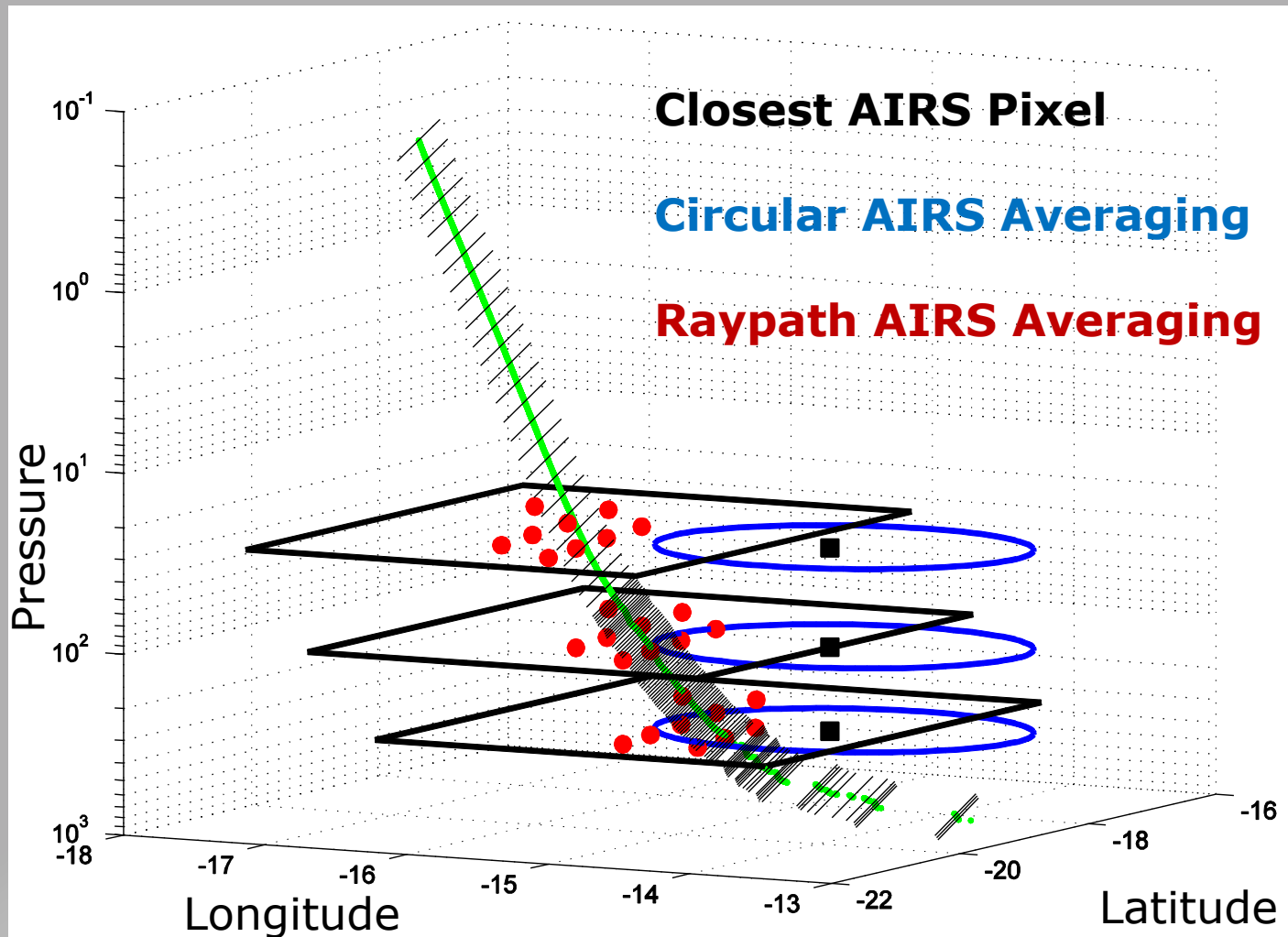
COSMIC/AIRS Daily Matchup
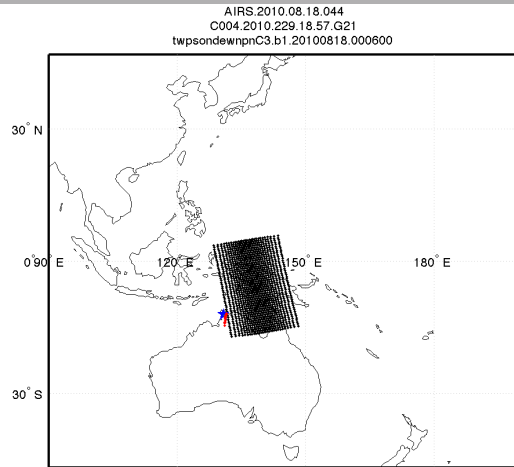
- *ARM sondes verify GPS RO vertical structure*

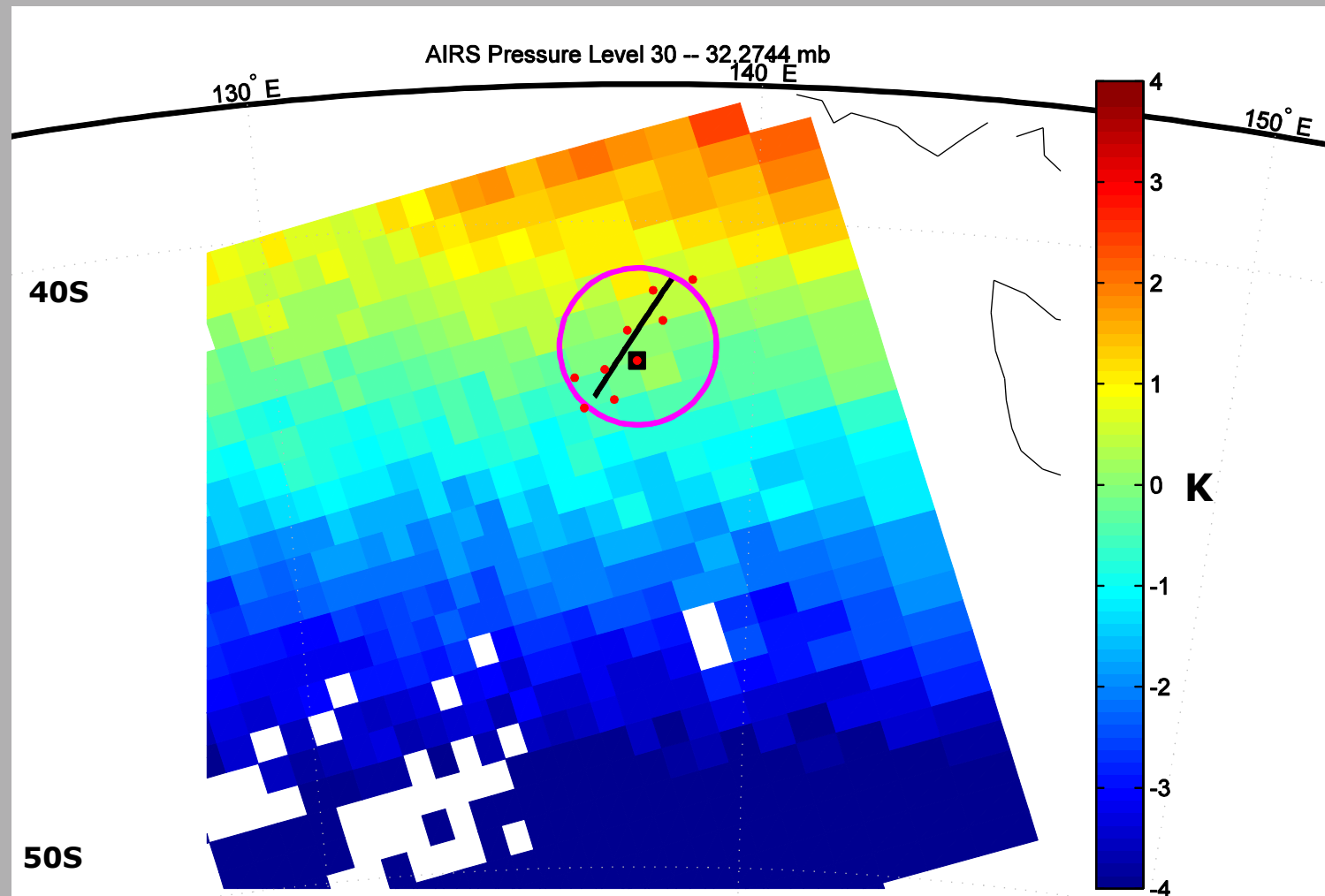- *AIRS vertical resolution limits ability to resolve fine structure.*
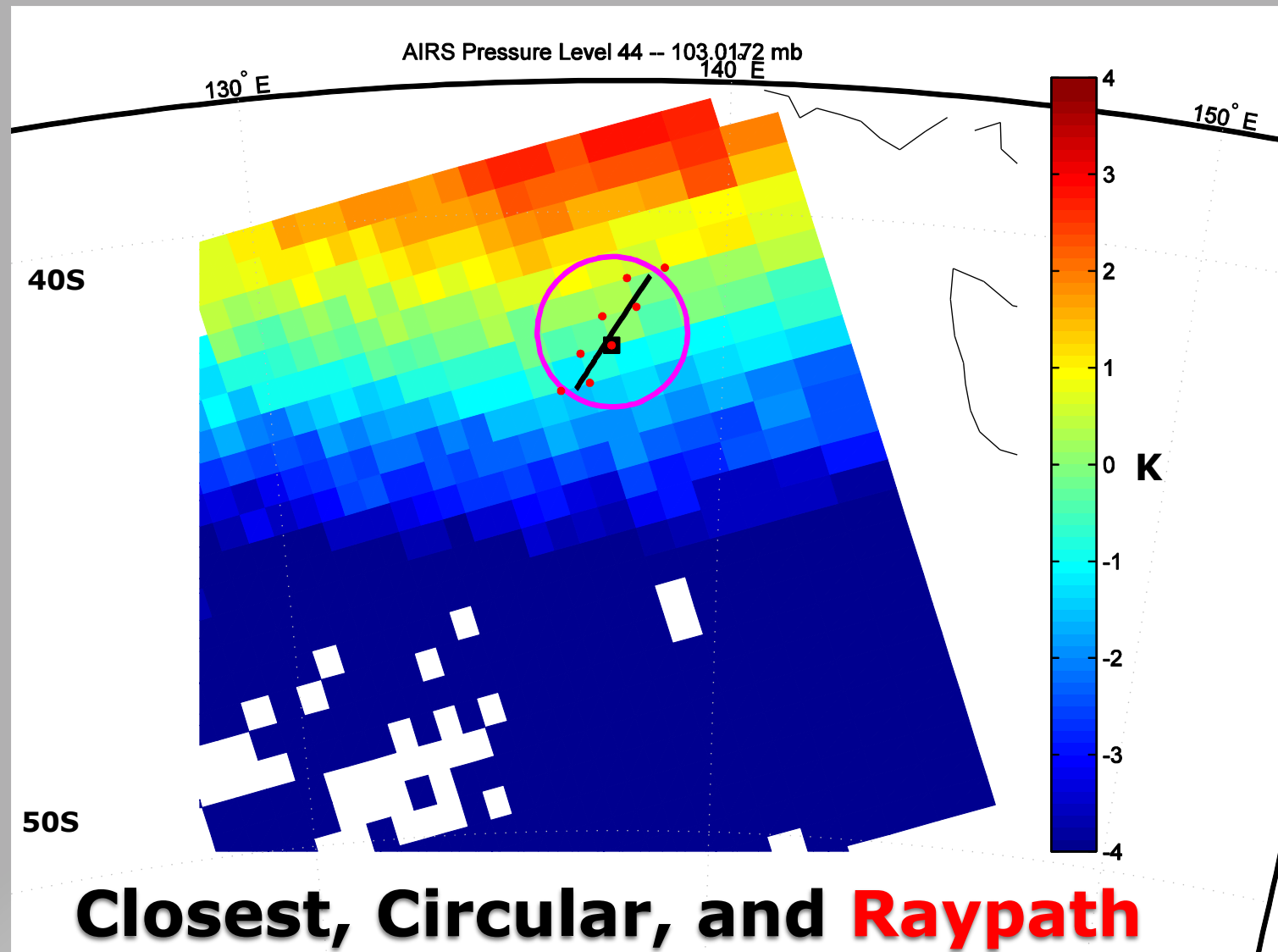
COSMIC/AIRS/ARM Sonde Profile

Horizontal Scale of GPS RO is ~300 km

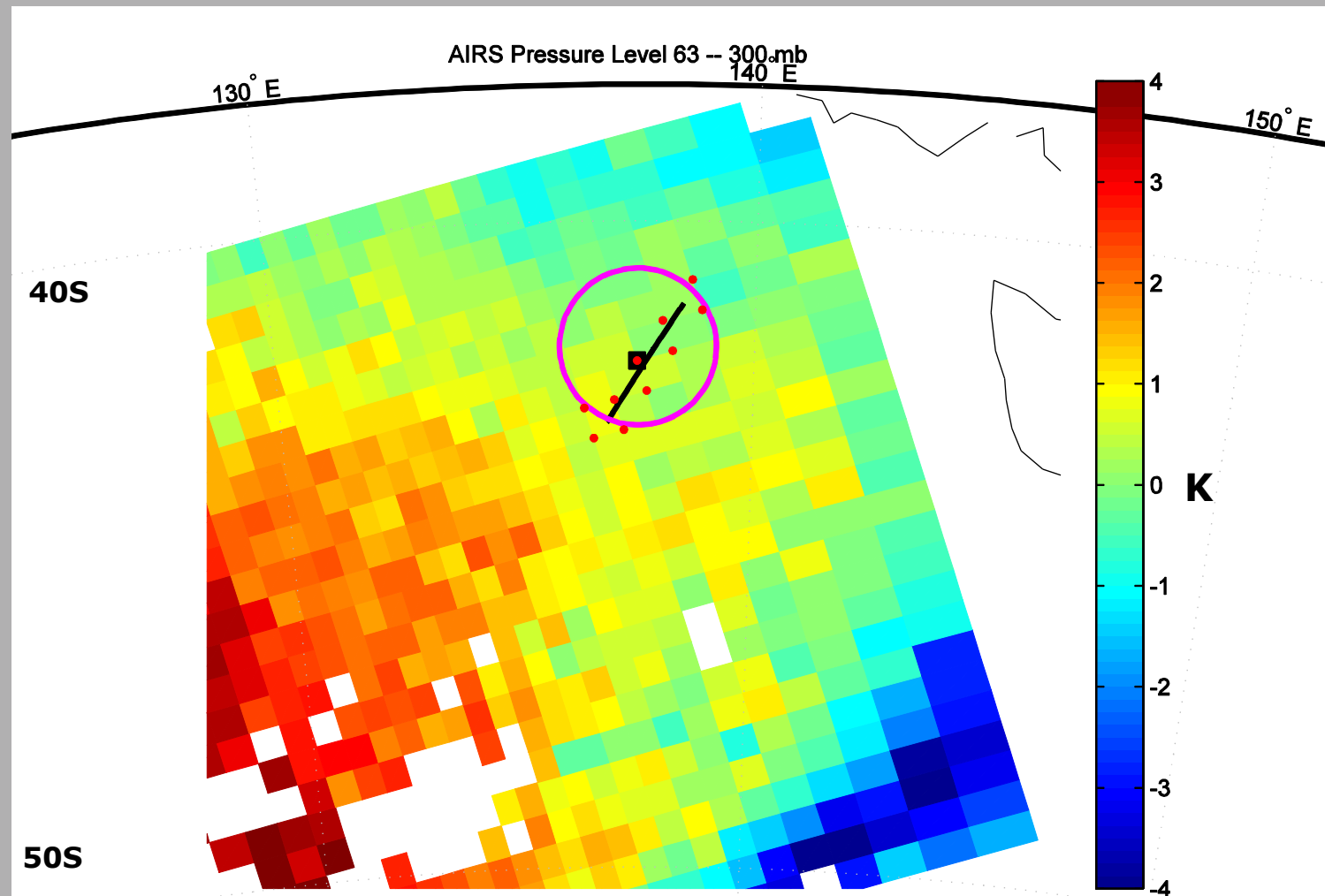**GPS RO Profile is like a "ribbon"**

Account for GPS RO Horizontal Scale

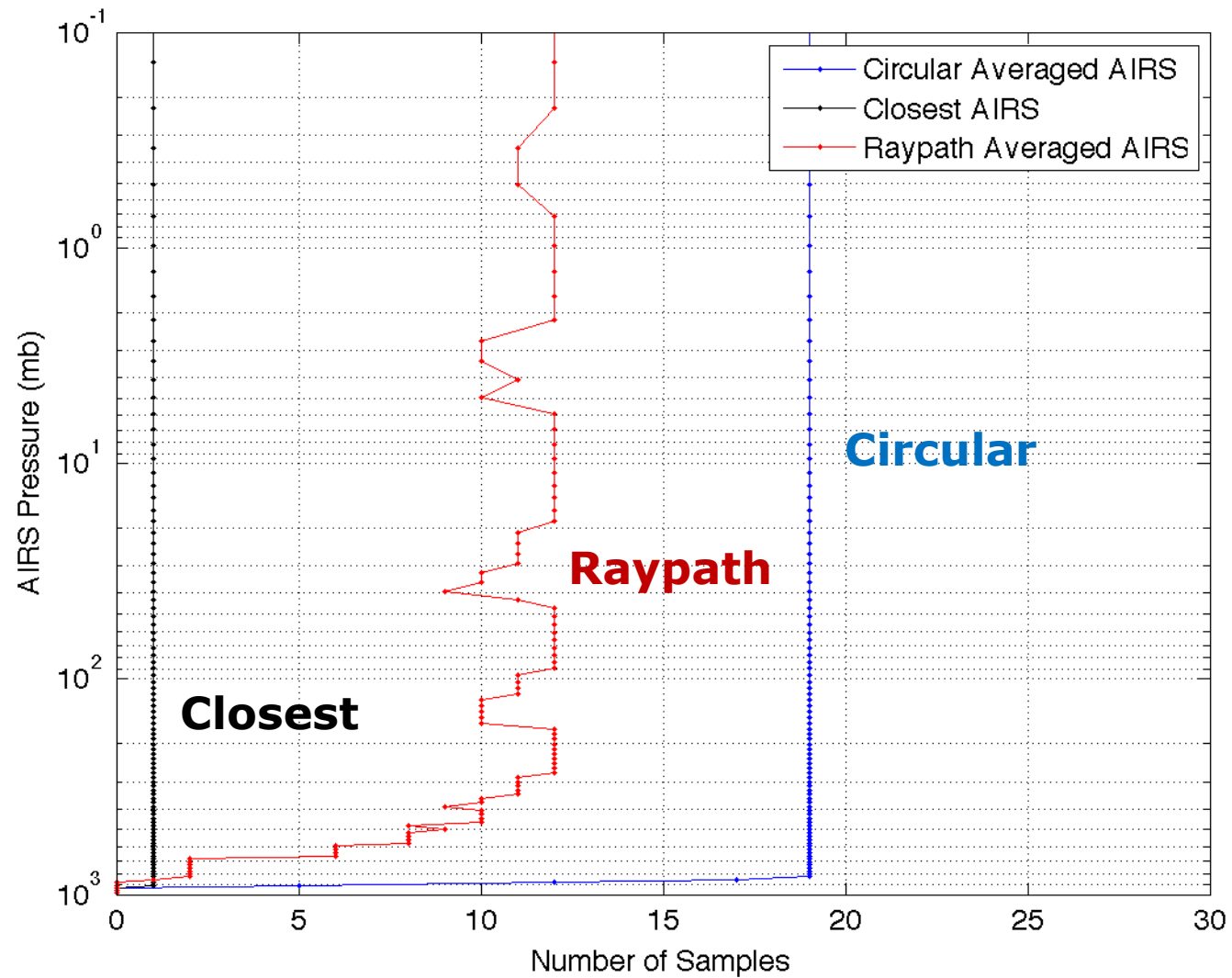**Closest, Circular, and Raypath matchups on the 30 mb AIRS level**

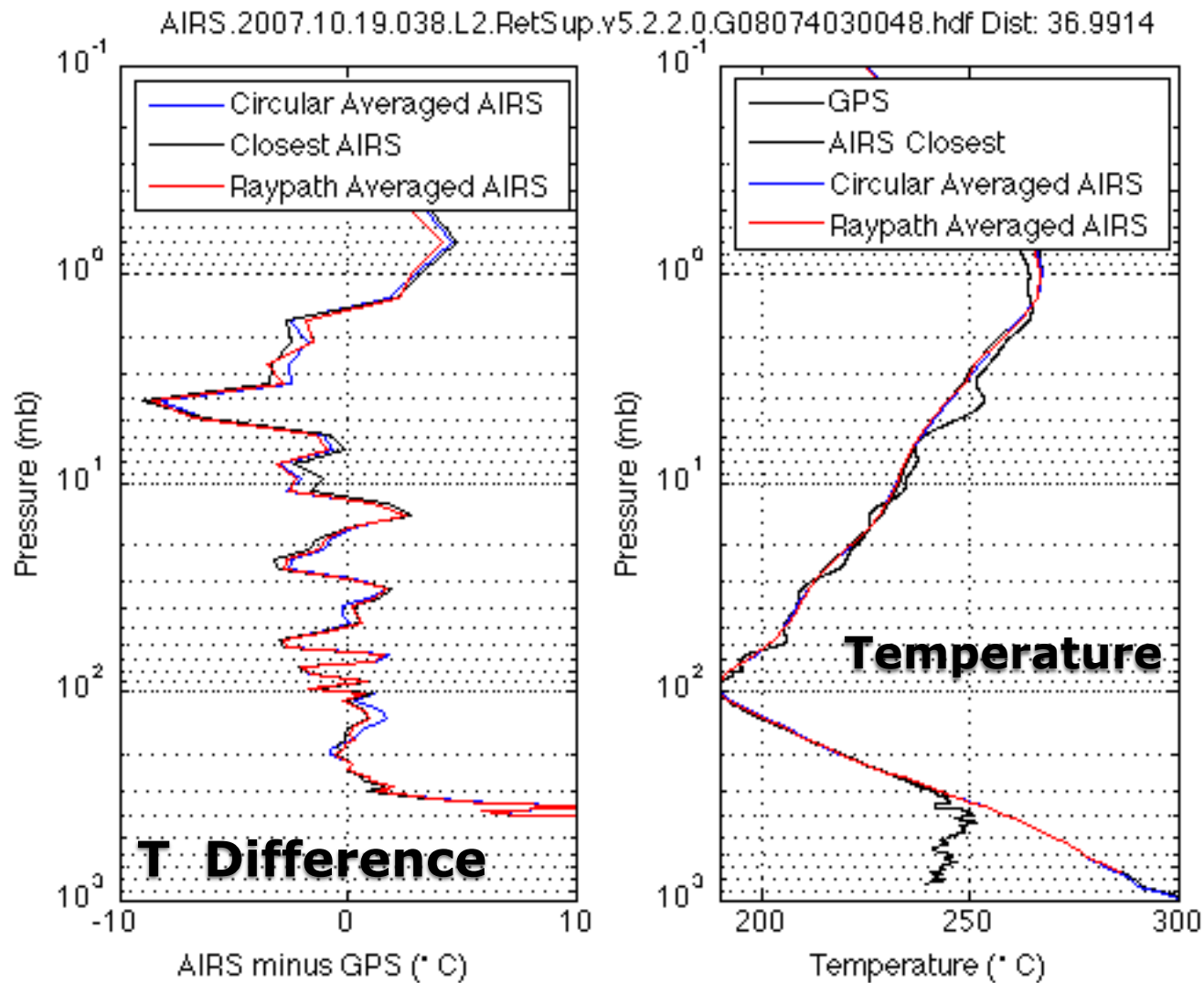**Closest, Circular, and Raypath matchups on the 100 mb AIRS level**

Closest, Circular, and **Raypath** matchups on the 300 mb AIRS level

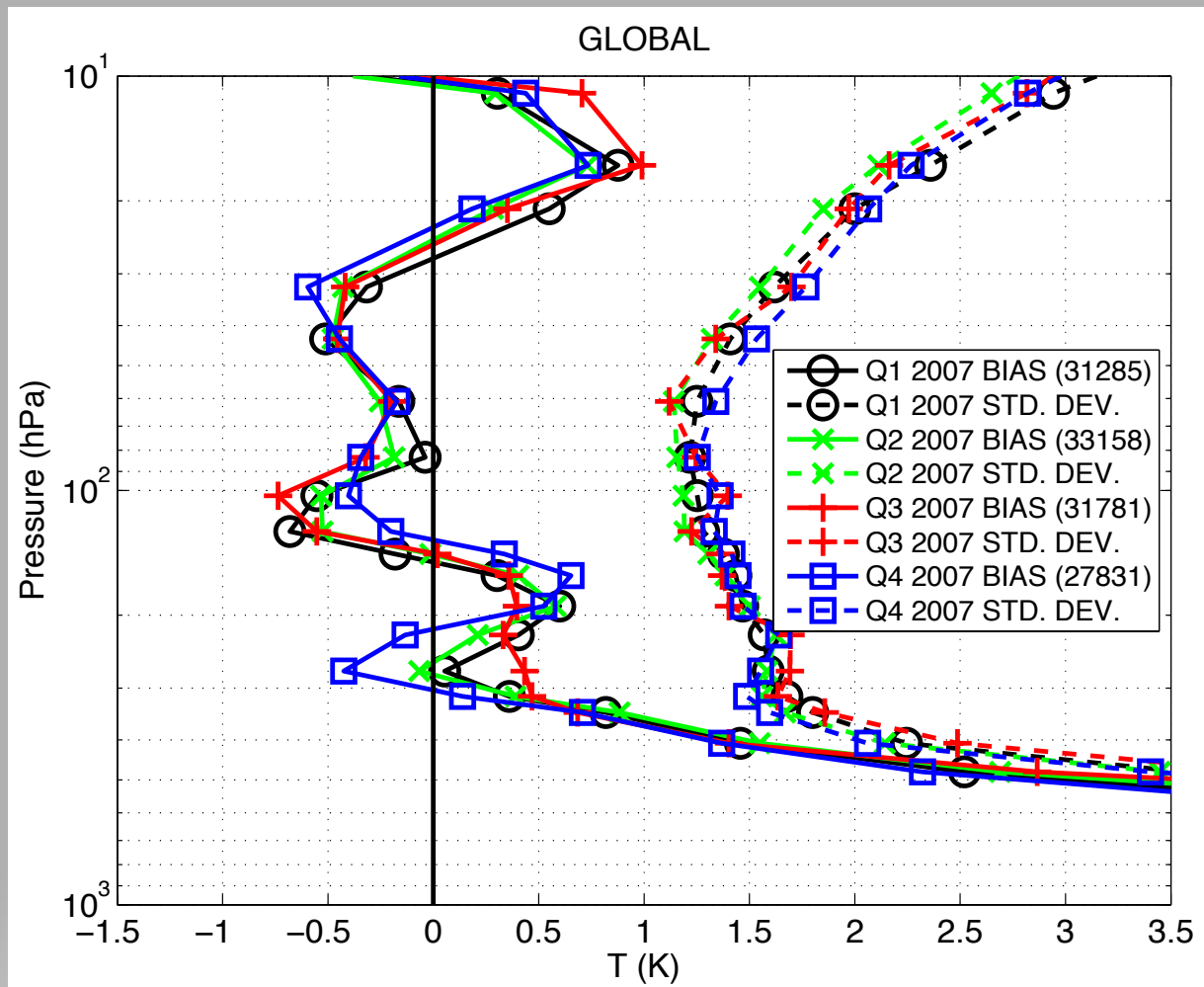- **Number of samples used (Closest, Circular, Raypath)**

AIRS.2007.10.19.038.L2.RetSup.v5.2.2.0.G08074030048.hdf Dist: 36.9914

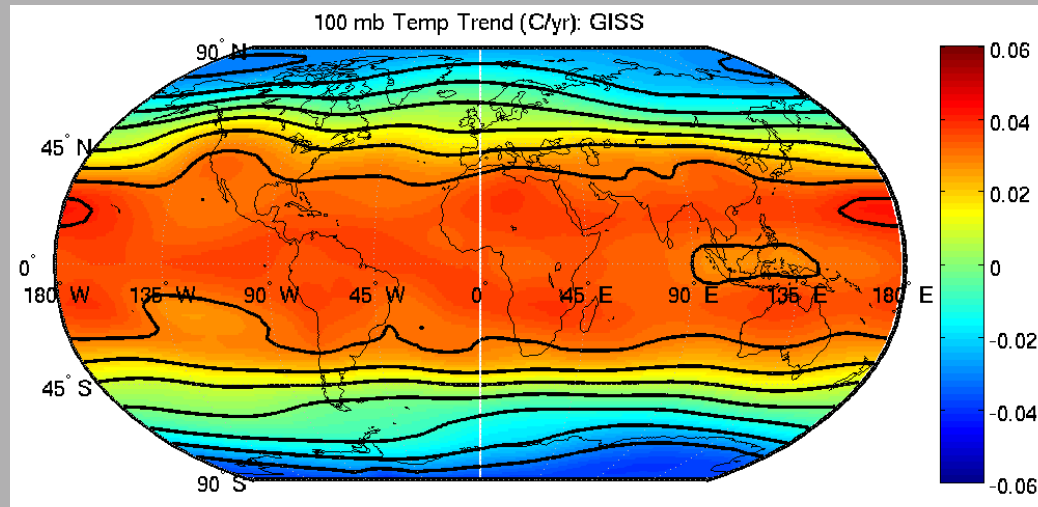- **Individual profile matchup (Closest, Circular, Raypath)**

AIRS-COSMIC Global Bias and Std. Dev.

Assess the Climate Quality of AIRS UTLS Temperature Products

- Look at CMIP3(A2) GCM predictions of temperature 2000-2100 to estimate TTD trends

- 2007-2012 provides a Five Year overlap of AIRS and COSMIC with calibration traceability to different SI standards.
  - COSMIC GPS RO products   (NCAR site)
  - AIRS L2 Version 5 products (NASA site)

- Assess the accuracy of AIRS in the UTLS region using GPS RO as a reference.

UTLS Temperature 100 mb Trends: 100 years (2000-2100)

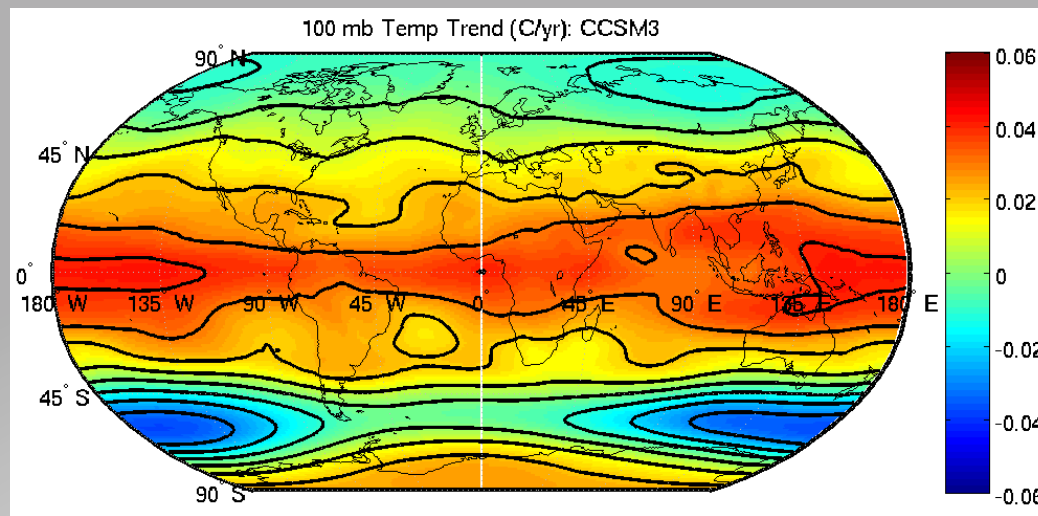100 mb Temp Trend (C/yr): GISS

GISS
AR4
A2

+0.06 K/yr

+0.00 K/yr

-0.06 K/yr

100 mb Temp Trend (C/yr): CCSM3
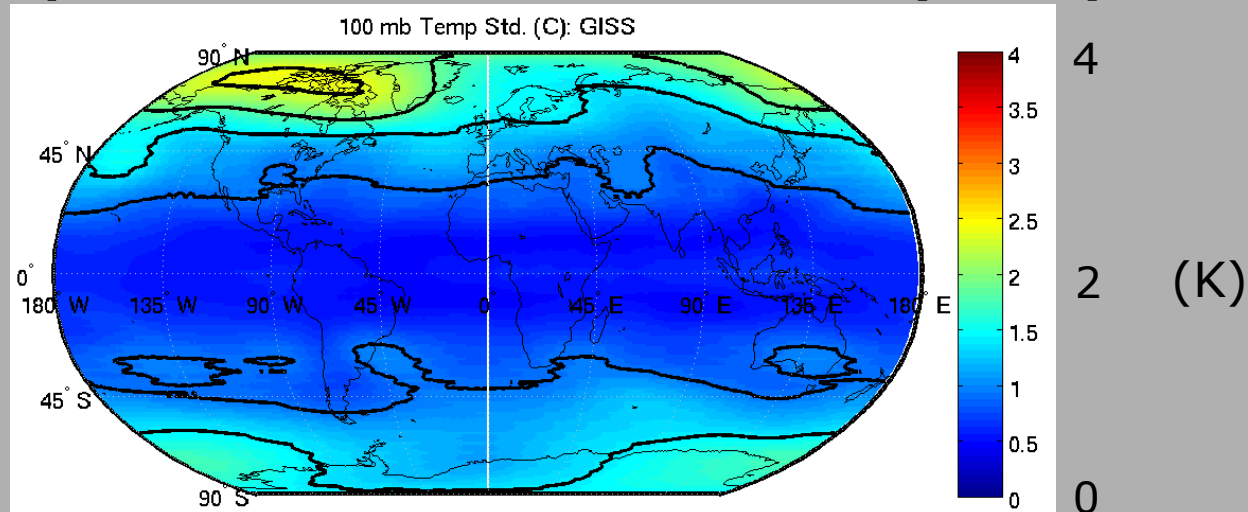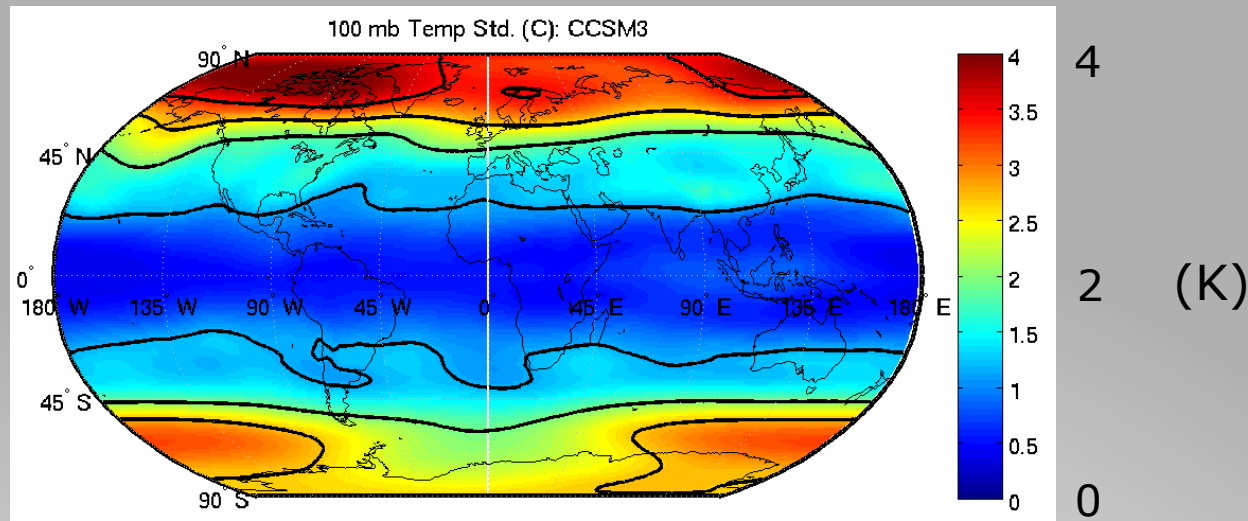
CCSM3
AR4
A2

+0.06 K/yr

+0.00 K/yr

-0.06 K/yr

- 100mb GCM trends positive in the equatorial regions, negative at the poles.

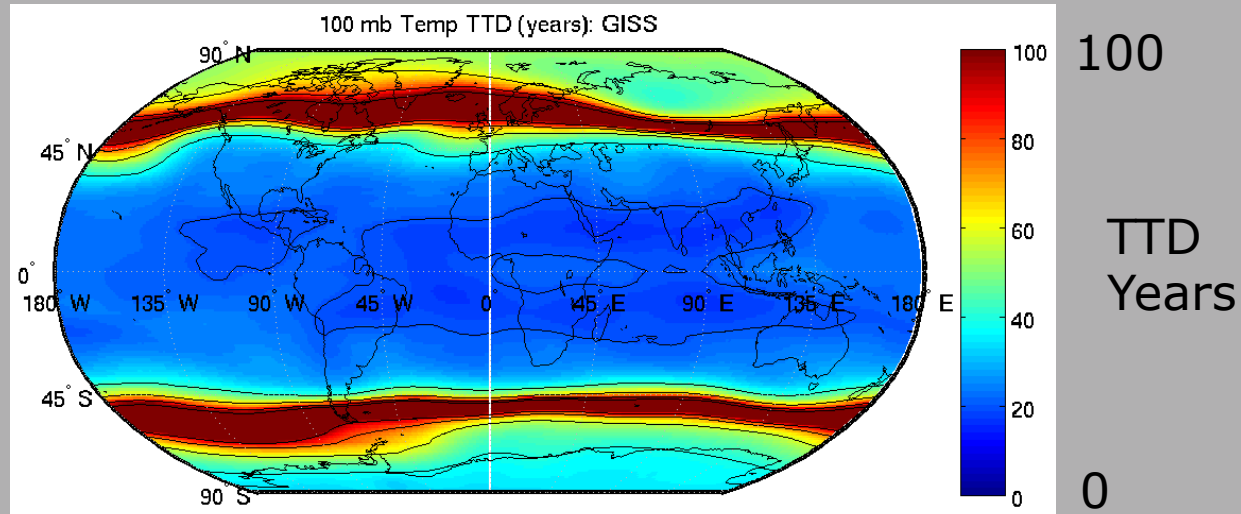# UTLS Temperature 100 mb Std. Dev.: 100 years (2000-2100)

GISS
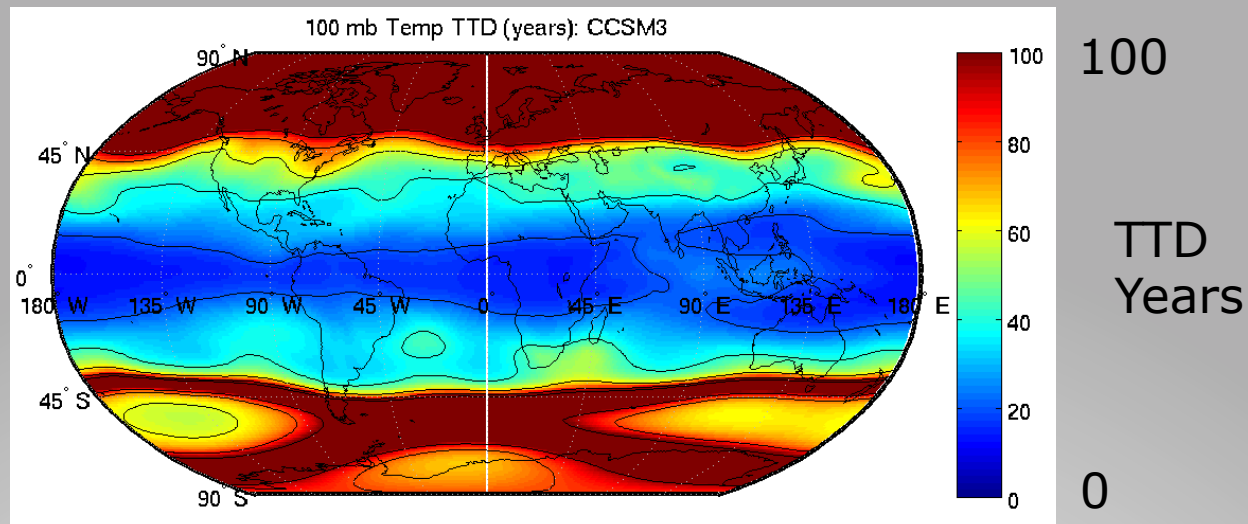

CCSM3

• The GCM natural variability is highest at the poles.

UTLS Temperature 100 mb TTD: 100 years (2000-2100)

100 mb Temp TTD (years): GISS

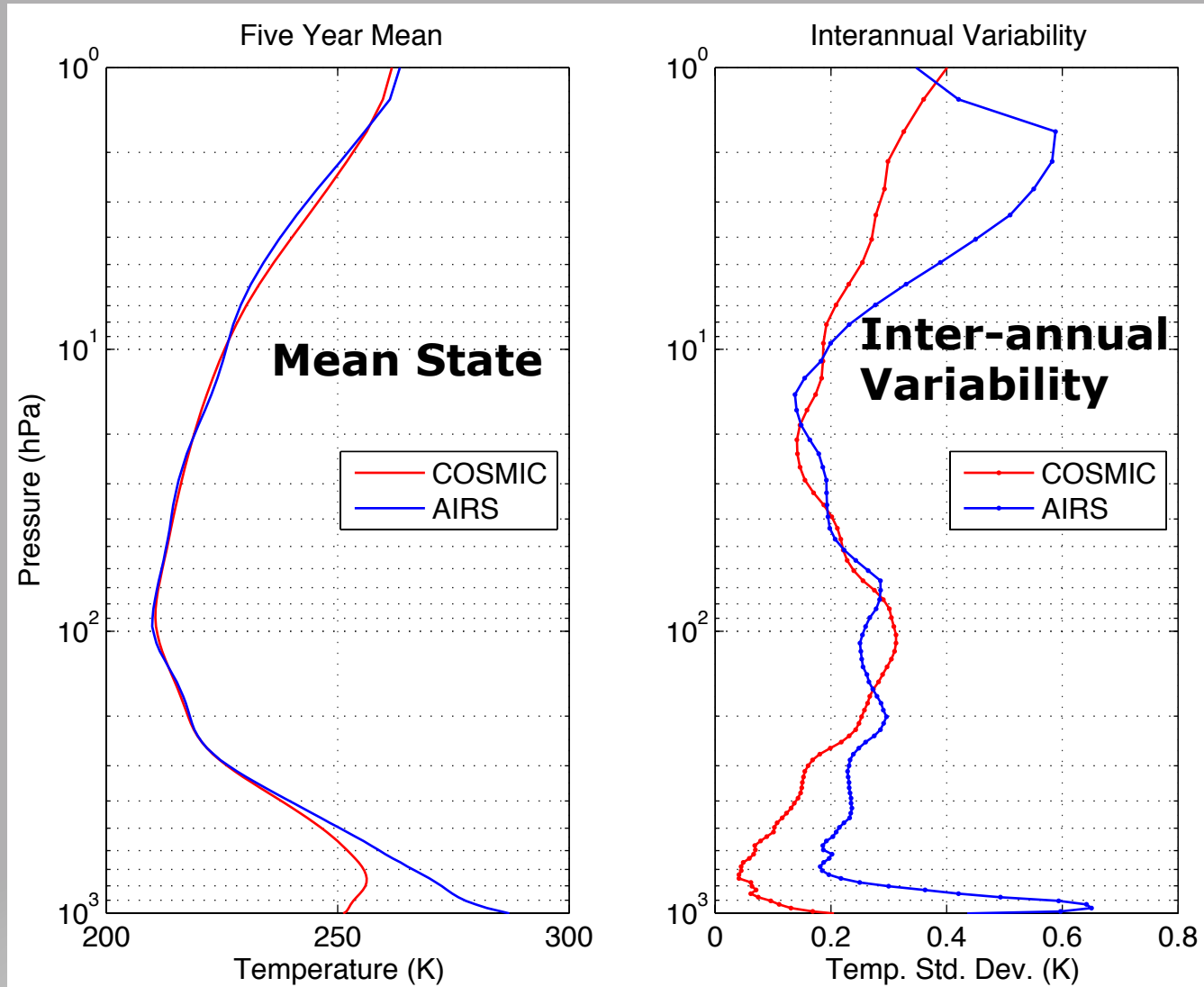GISS

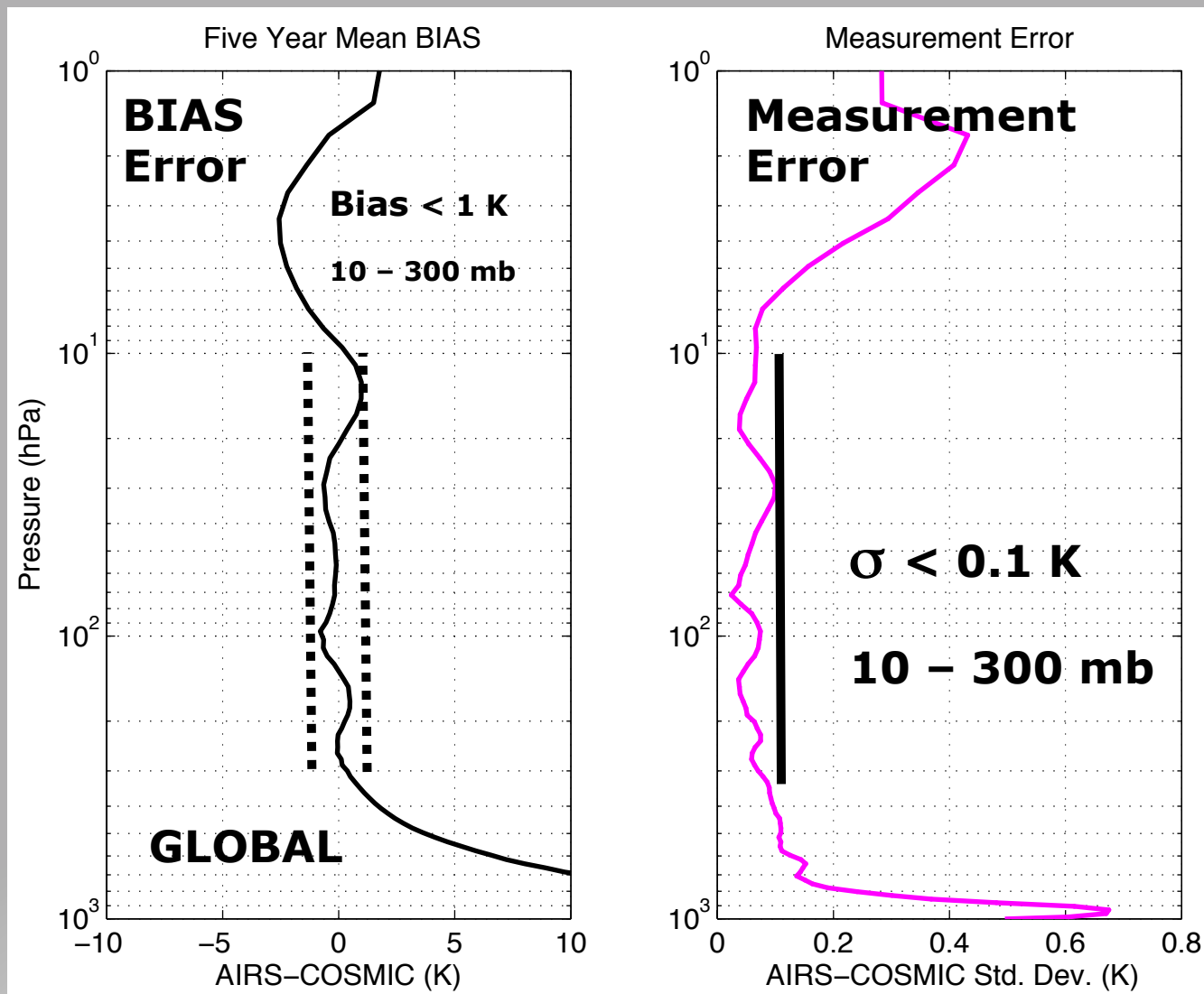TTD Years

100 mb Temp TTD (years): CCSM3

CCSM3

TTD Years

• The lowest detection times are near the equator. Poles are problematic.

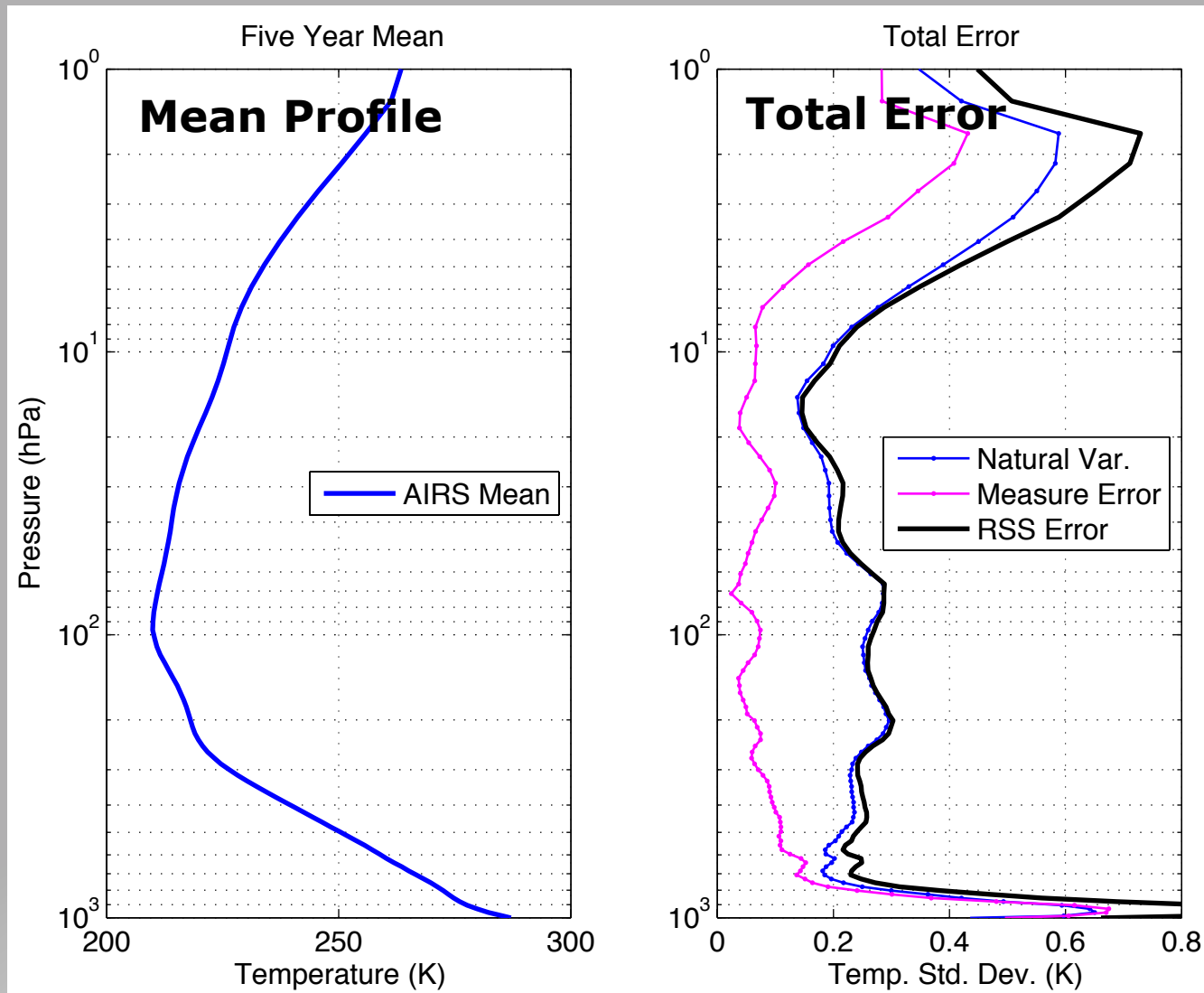• **These TTDs are for an "ideal" sensor with zero error.**

AIRS & COSMIC Annual Global

Inter-annual AIRS-COSMIC "error"

Natural variability + Measurement Error

CONCLUSIONS

- CrIMSS EDR Cal/Val benefits greatly from experience with AIRS products

- GPS RO is valuable for UTLS temperature validation.

- GPS RO and Hyperspectral IR Sounders can provide self-supporting evidence for climate trend detection especially important in the upper troposphere.

FUTURE WORK

- Publish methodology of GPS RO assessment.
- Support CrIMSS EDR Cal/Val through Validation Phase.
- Continue to explore climate assessment of AIRS record including sampling errors.