



# Comparisons of IR Sounder and COSMIC Radio Occultation Temperatures:

## Guidance for CrIS NUCAPS Validation

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# Roadmap

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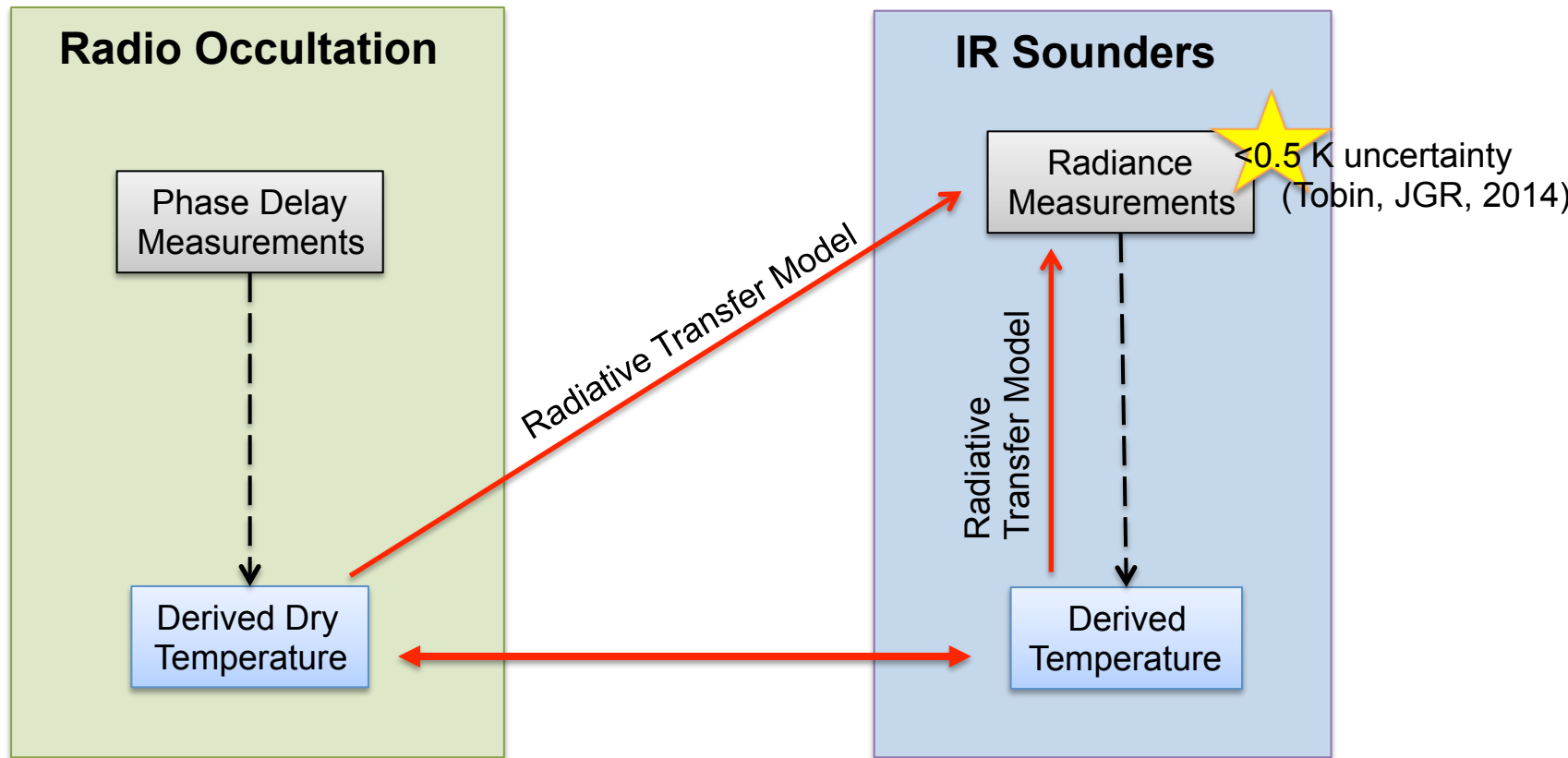
- Background
- Methods
- Results
  1. 6 year 'climatology' of COSMIC and AIRS comparisons
  2. Monthly operational sounder and COSMIC comparisons
- Conclusions

# Background

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- **Objective:** compare radio occultation (RO) and IR sounder temperatures
  - \*\*two independent measurements
- Continuation of work
  - Feltz et al., 2014, AMT, Application of GPS radio occultation to the assessment of temperature profile retrievals from microwave and infrared sounders*
- Previous datasets compared
  - IR : NASA AIRSv5, NOAA IASI, CrIMSS
  - RO: UCAR COSMIC, UCAR GRAS
- Datasets compared in this study
  - IR: NASA AIRSv6, EUMETSAT IASI A/Bv6, NOAA NUCAPS CrIS
  - RO: UCAR COSMIC, UCAR COSMIC2013

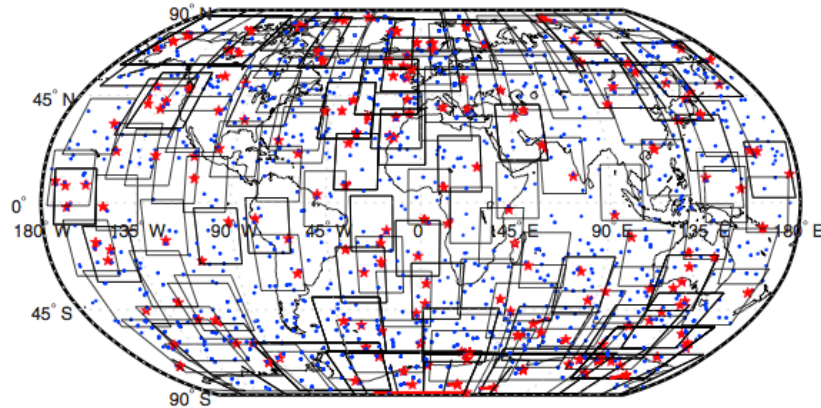
# Methods: Comparisons Overviews



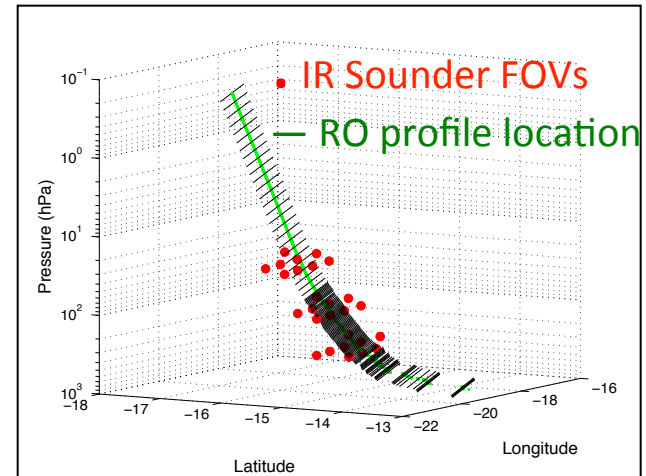


# Methods: Temperature Profile Matchup

Daily Matchup Map



Individual Matchup Case



- Use profile-to-profile methodology
  - Accounts for RO profile geometry and horizontal resolution
  - 1 hour time criterion
- Method is consistent across different RO/IR sounder pairs
  - create consistently sized 6-8 min sounder granules

Feltz, M. et al. (2014), A methodology for the validation of temperature profiles from hyperspectral infrared sounders using GPS radio occultation: Experience with AIRS and COSMIC, JGR, doi:10.1002/2013JD020853.

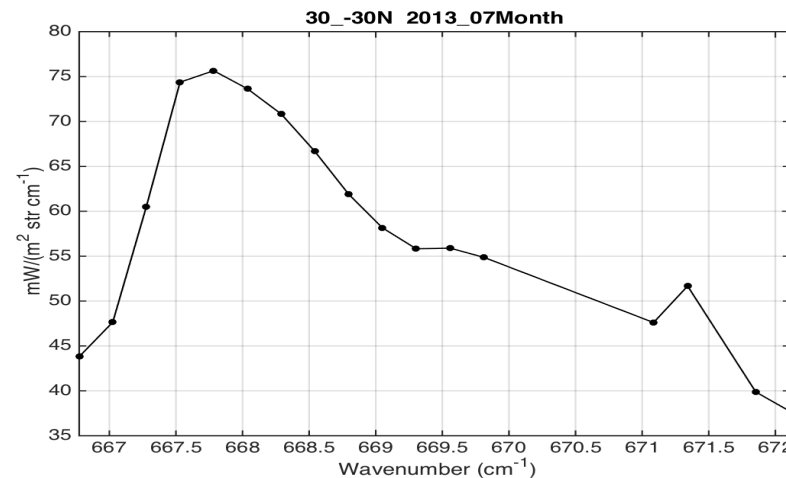
# Methods: Radiance Calculations

- Optimal Spectral Sampling RTM

- Input:

- *ERA-Interim 0.75°, 6-hrly:* *sfc pressure, skin temp, ozone profile*
    - *CDAAC ERA-interpolated:* *water vapor profile*
    - *Carbon Tracker 2° zonal:* *carbon dioxide profile*
    - *AIRS L1B sensor view ang.:* *slant view angle (L2's corresponding L1B 3x3 mean)*
    - *AIRS L2 and COSMIC:* *temperature profiles*

- Methodological uncertainty larger for channels w/ WFs peaking above ~10hPa

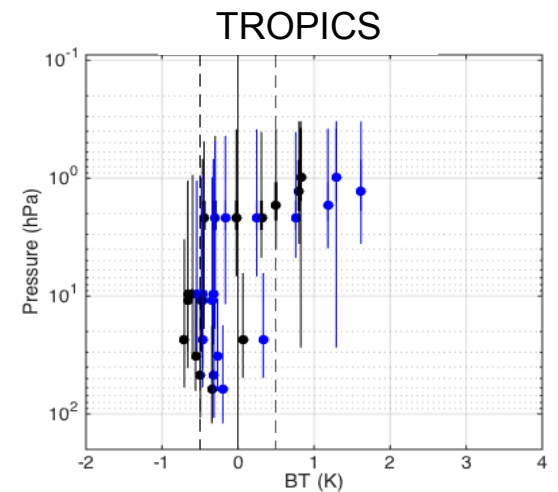
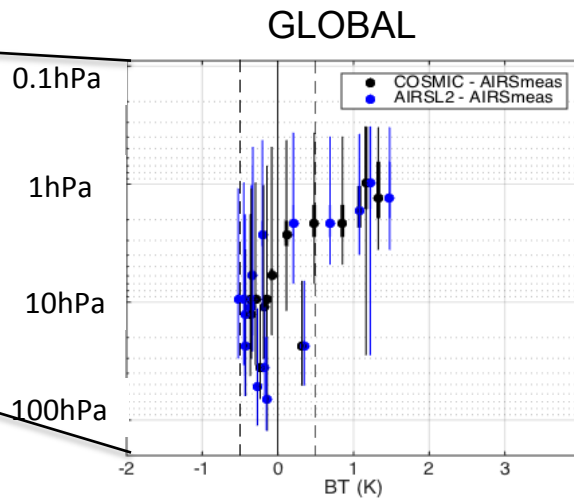
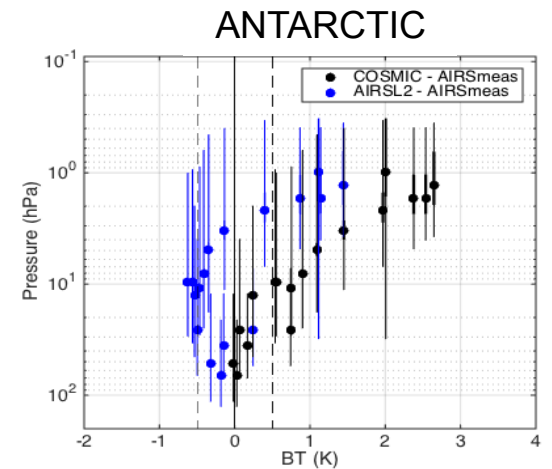
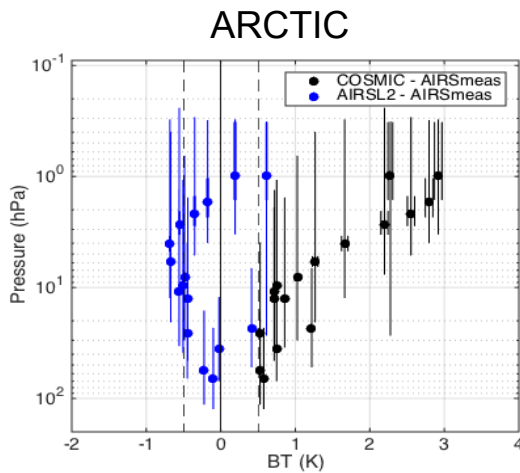
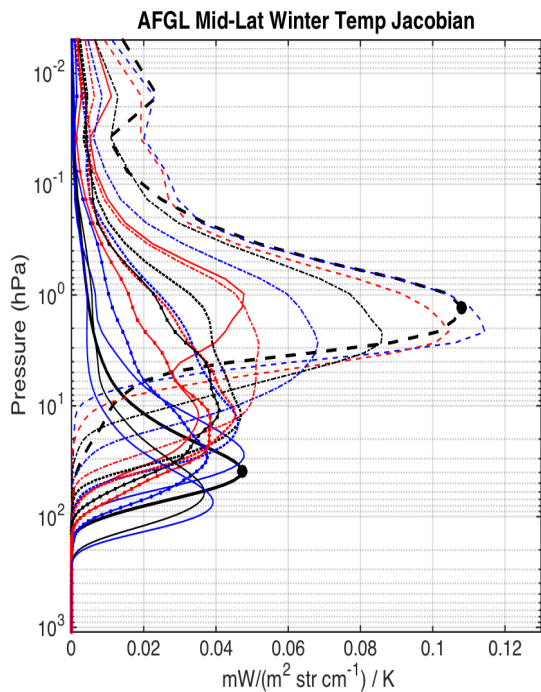


← Calculated AIRS spectrum showing channels of focus

# Results 1: COSMIC/AIRSV6 6 yr Comparison

## BT Bias: DJF 2007-2012

- COSMICcalc – AIRSmeas BT
- AIRScalc – AIRSmeas BT



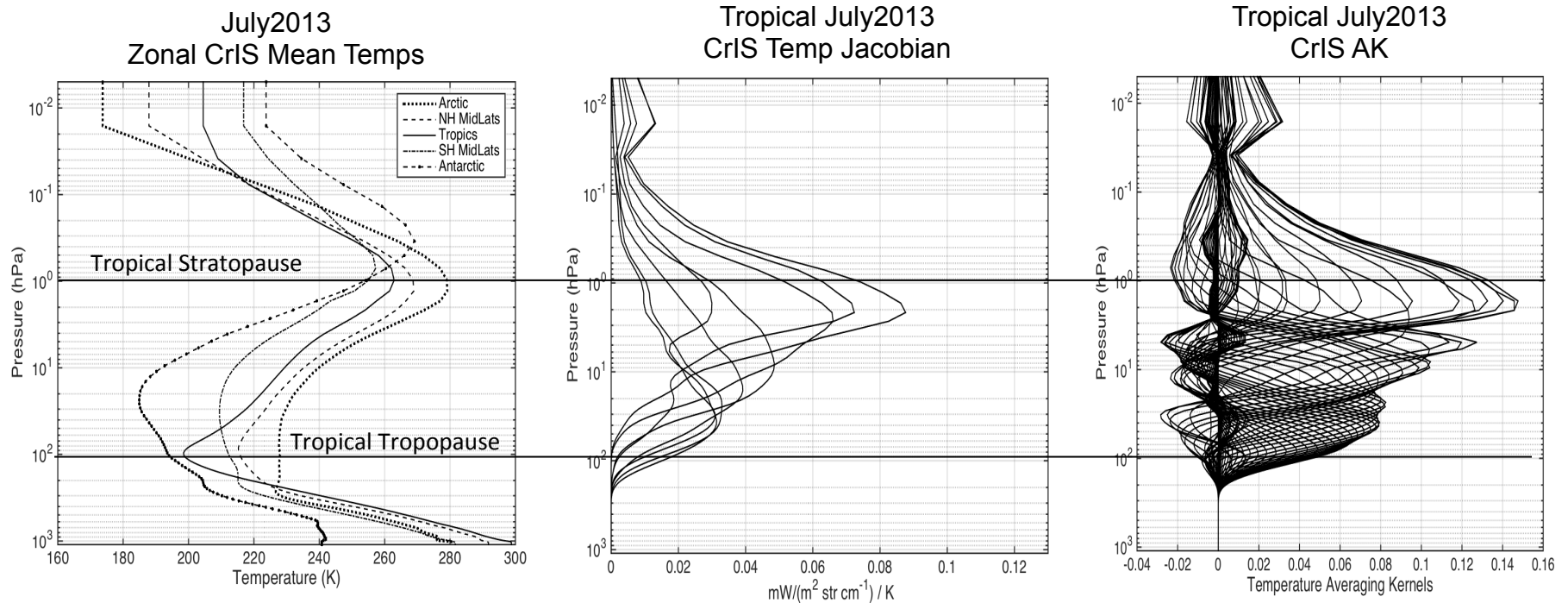
# Transition

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- **Previous:** 6 years of COSMIC vs. AIRSv6 BT comparisons
  
- **Next:** Monthly operational sounder / RO temperature profile comparisons

# Result 2: Operational Sounder Comparison

- Different vertical smoothings are applied to the temperature profile comparisons
- AKs calculated for 15 $\mu$ m CO<sub>2</sub> band for each instrument using mean zonal IR temp profiles merged with AFGL climatology





# Result 2: Operational Sounder Comparison

Bias (—) & RMS (- - -)

EUM IASIA/B v6 – COSMICv2013

CrIS NUCAPS – COSMIC2013

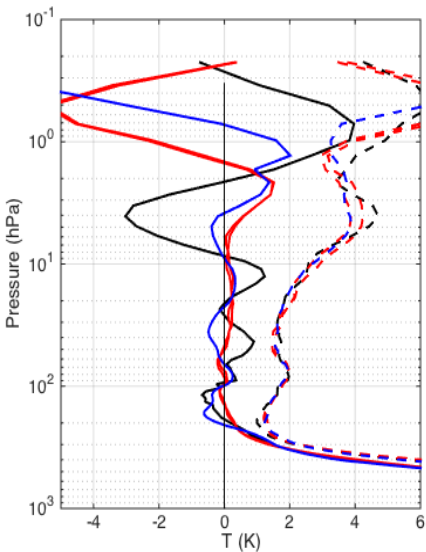
AIRS v6 – COSMIC2013

## IR Sounder – COSMICv2013 Bias and RMS

Tropics: 30N-30S

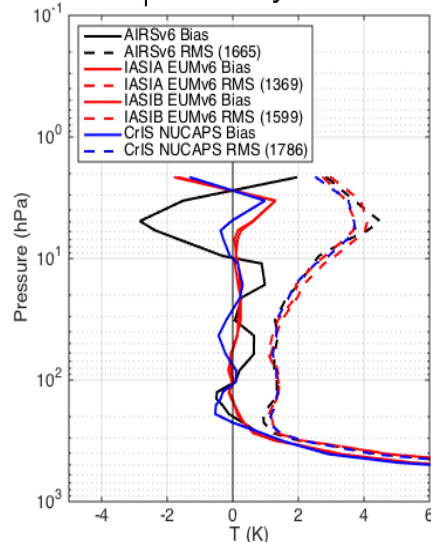
Oct 2013

101 Levels



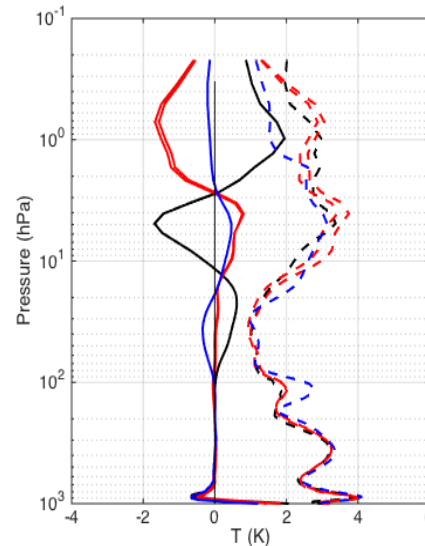
No vertical smoothing

1km Layers



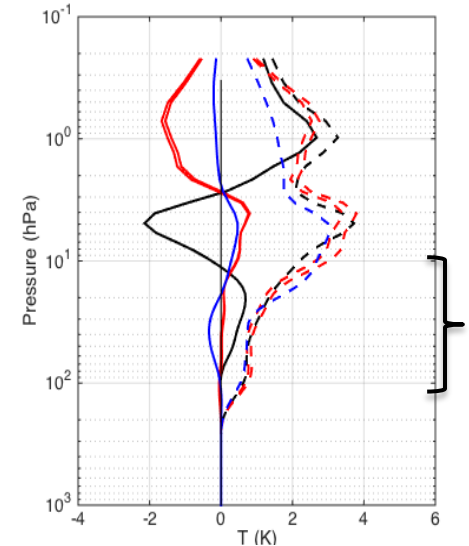
Degradation of profile into ~1km layers (~3km in strat)

IR-AK\*RO



AK applied to only RO profile

AK\*IR-AK\*RO



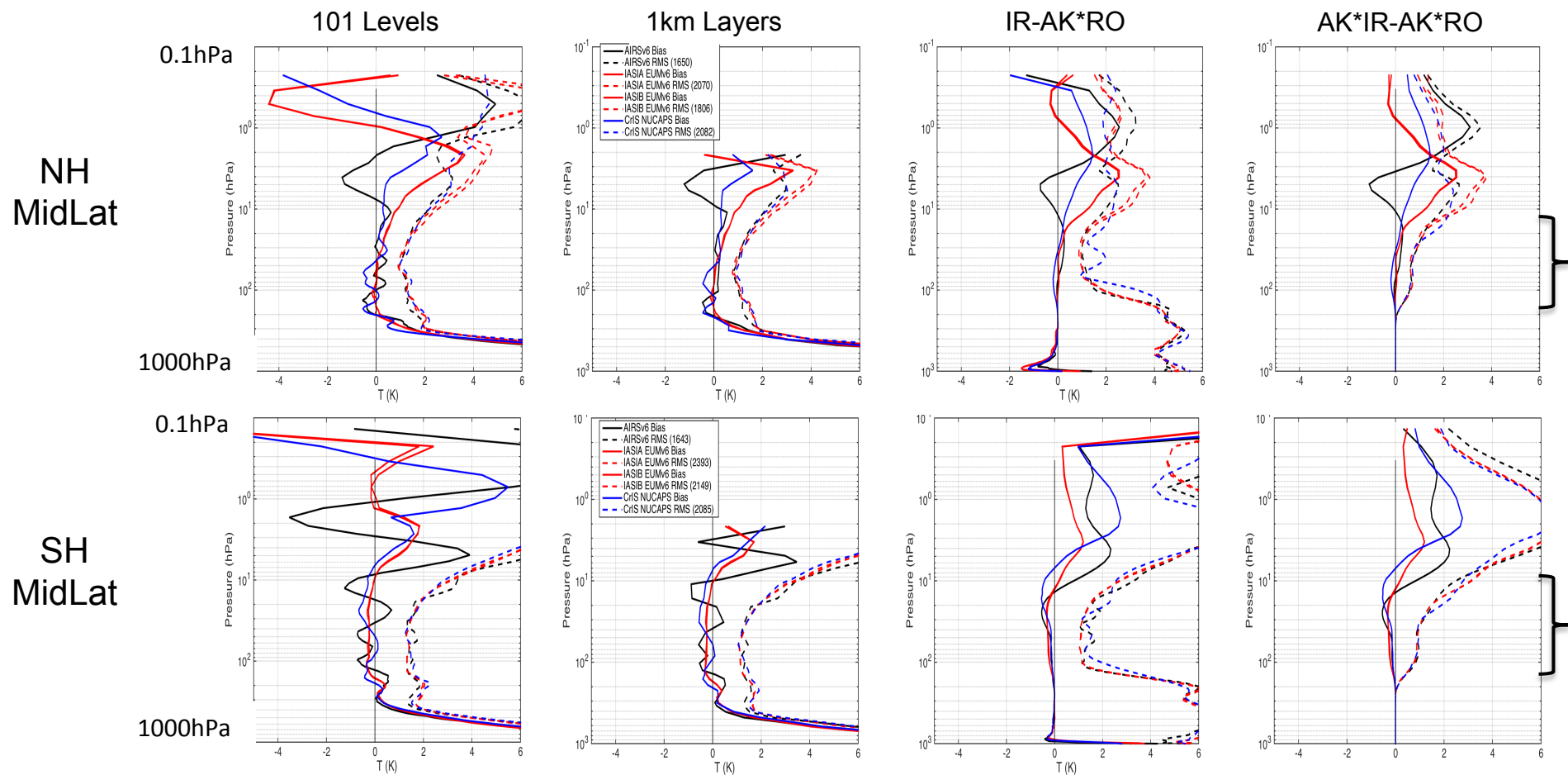
AK applied to both IR and RO profiles



# Result 2: Operational Sounder Comparison

Bias (—) & RMS (- - -)  
 EUM IASIA/B v6 – COSMICv2013  
 CrIS NUCAPS – COSMIC2013  
 AIRS v6 – COSMIC2013

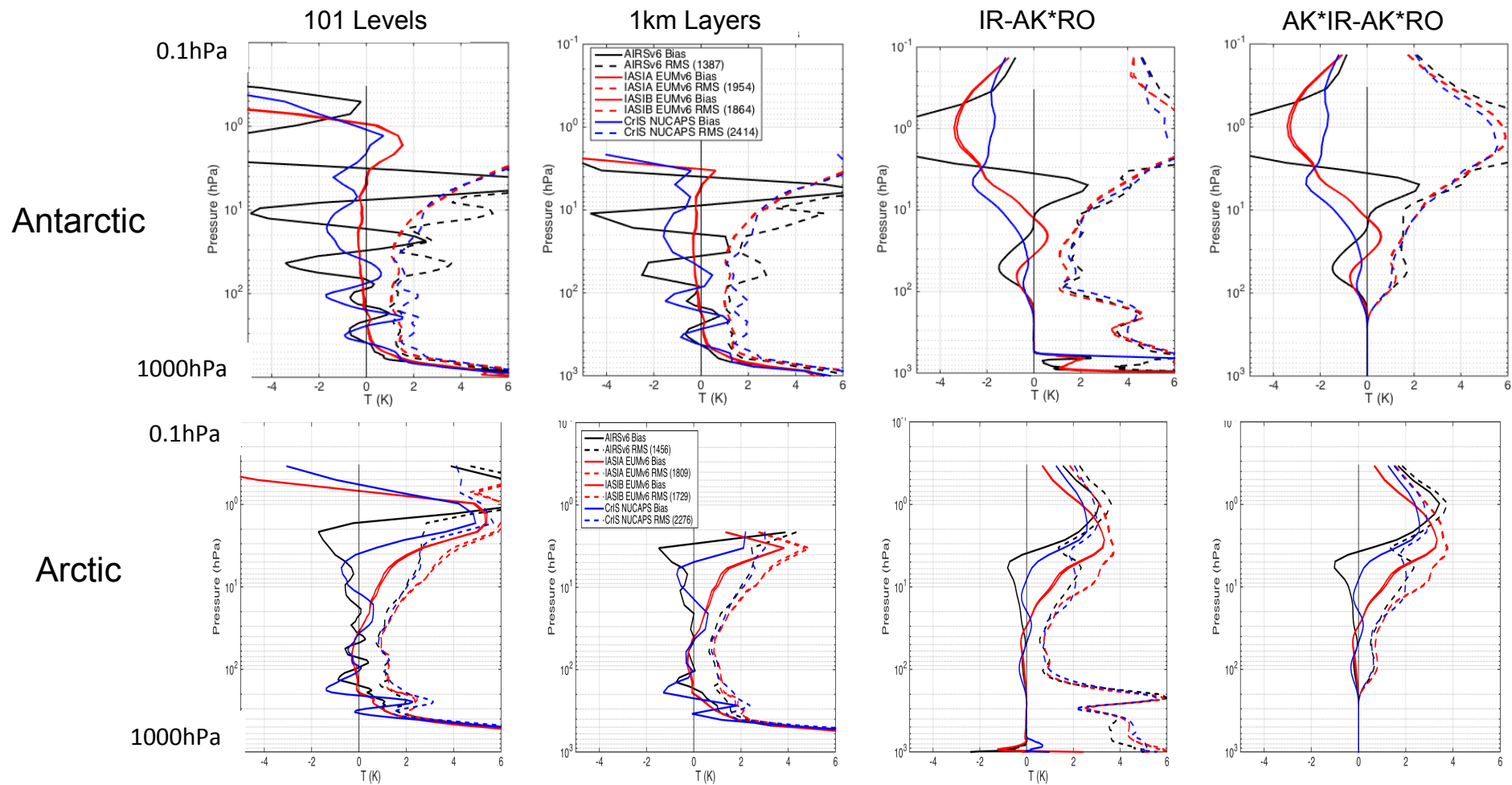
## IR Sounder – COSMICv2013 Bias and RMS July 2013



# Result 2: Operational Sounder Comparison

Bias (—) & RMS (---)  
 EUM IASIA/B v6 – COSMICv2013  
 CrIS NUCAPS – COSMIC2013  
 AIRS v6 – COSMIC2013

## IR Sounder – COSMICv2013 Bias and RMS July 2013



# Conclusions

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- Comparisons of calculated COSMIC and AIRS radiances to measured AIRS radiances were made over 6 year period
  - Globally and for the tropics, both COSMIC and AIRS calc radiances were within the 0.5K agreement with the AIRS measured radiances for channels whose K's peaked from 100 - ~5hPa
  - COSMIC temp has a seasonally dependent error that increases towards the poles and with height above ~10hPa
- Monthly comparisons of COSMIC2013 with AIRSv6, EUM IASI v6, & CrIS NUCAPS were made
  - NUCAPS, where RO is most accurate, has a bias of under 0.5K magnitude in the tropics and globally, while in polar zones, depending on the season, biases of up to 1K were seen
  - EUMETSAT IASI and AIRSv6 biases are under 1K btwn 100-10hPa in the tropics & mid-lats
  - In the polar winter seasons, AIRSv6 bias exhibits large vertical oscillations while NUCAPS has similar but smaller artifacts, and EUM IASI shows no artifact

Thank You