# Using Sounders and Imagers For Improved Cloud-Clearing and Soundings

Eric S. Maddy[1,3], Haibing Sun[2,3], Chris Barnet[1], W. Wolf[3]

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[1]Science and Technology Corporation, [2]IMSG, [3]NOAA/NESDIS/STAR

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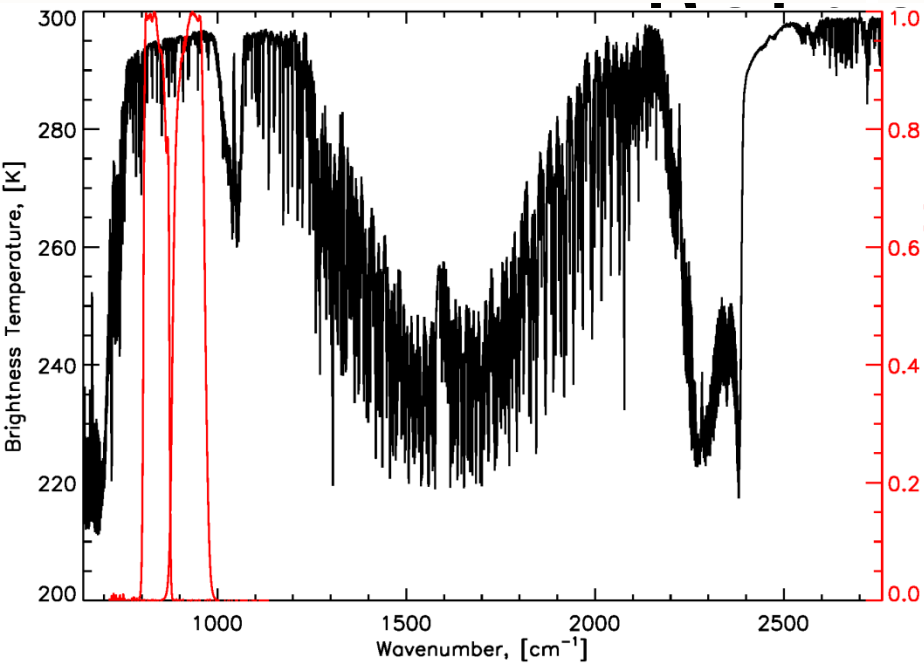
# Background and Motivation

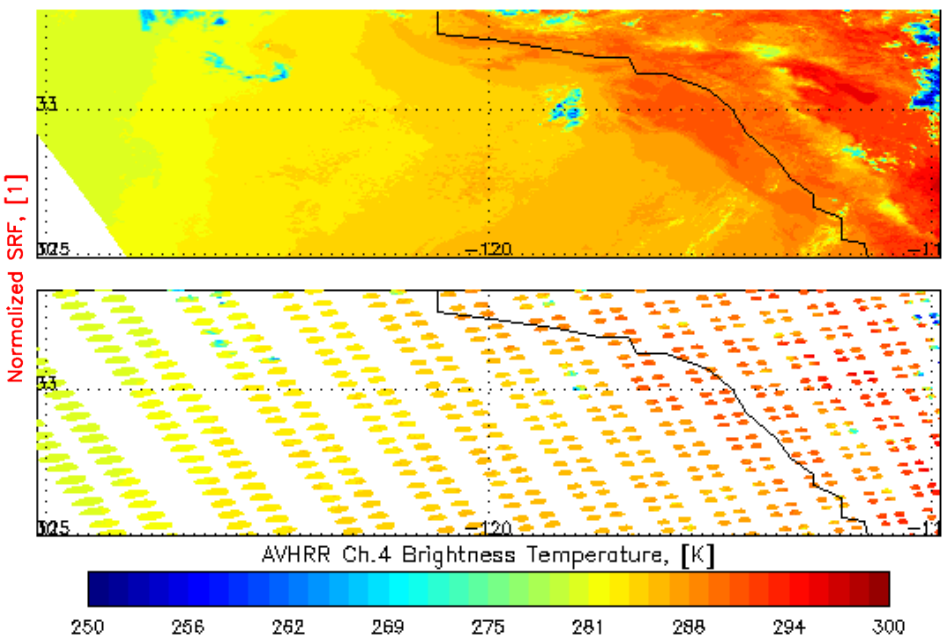
- We've shown at previous meetings that sub-pixel cloudy-sky and clear-sky masked AVHRR measurements improve cloud-clearing and cloud classification and L2 in our NOAA IASI systems.
- We apply similar procedures to collocated Aqua MODIS and AIRS L2 algorithms. Specifically, we run AIRS/MODIS cloud-cleared radiances through the offline NOAAv6 algorithm and show some preliminary results using the official v6.0.7 algorithm.
- The results presented are a first crack at using MODIS and AIRS together, no optimization in the use of MODIS, noise estimation and QC is probably sub-optimal, …

Typical IASI spectrum and
AVHRR Spectral Response Functions




Spectral convolution of IASI to AVHRR resolution

Top: CLAVR-X AVHRR cloud mask (courtesy: A. Heidinger),
Bottom: AVHRR collocated to IASI footprints (H. Sun)

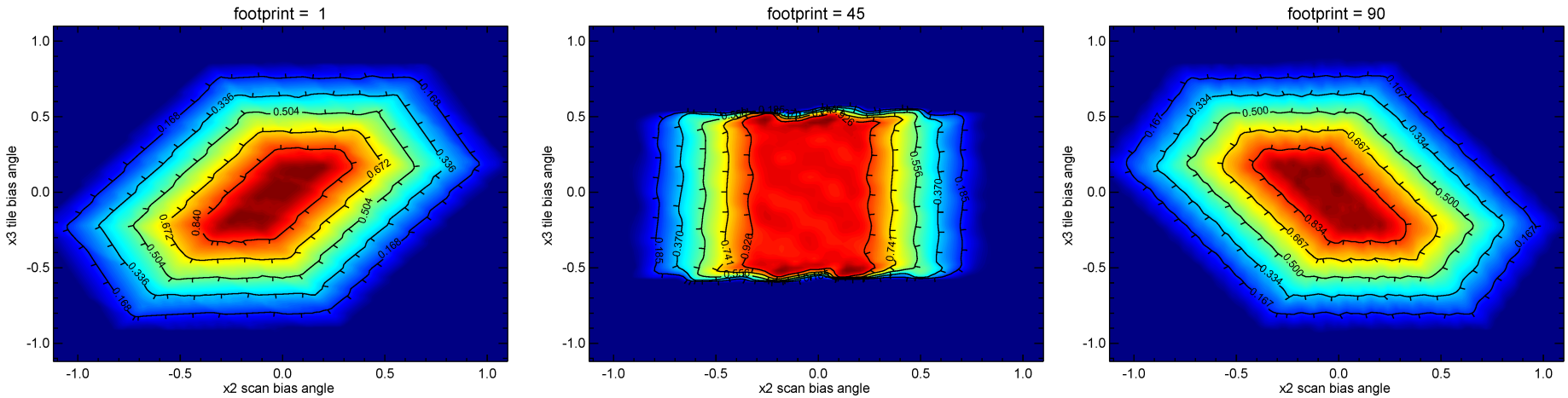



Spatial collocation and convolution of AVHRR to IASI footprints

We want to exploit the high spatial resolution of the multispectral AVHRR data to improve IASI retrievals:

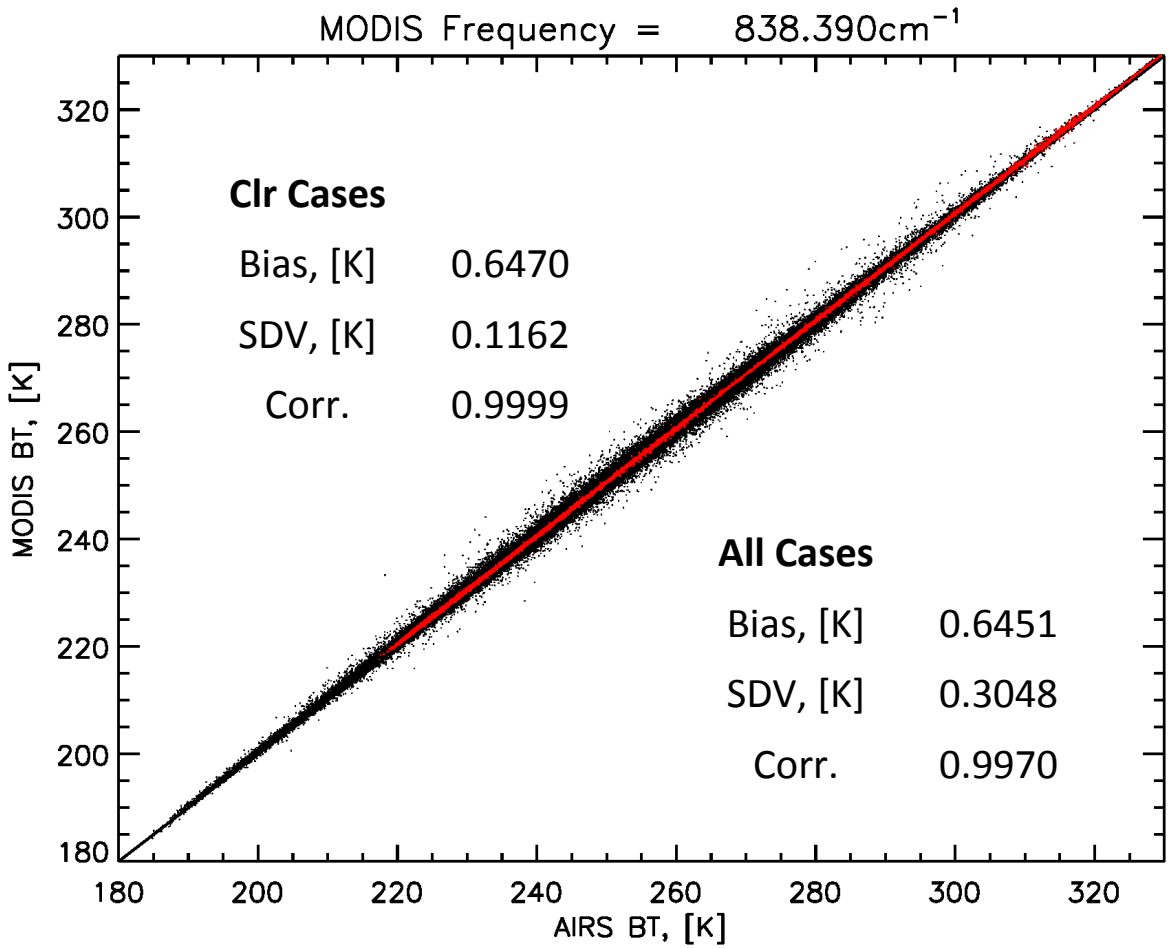
1. QA cloud cleared radiances using spectrally convolved IASI – spatially convolved AVHRR to compare apples to apples.
2. Utilize subpixel (1km AVHRR vs. 12km IASI resolution)/multispectral (visible/NIR) information about clouds from AVHRR to improve/validate cloud-clearing, improve the 'clear estimate' required for cloud clearing, and/or other retrievals (cloud retrieval).

# MODIS/AIRS Collocations

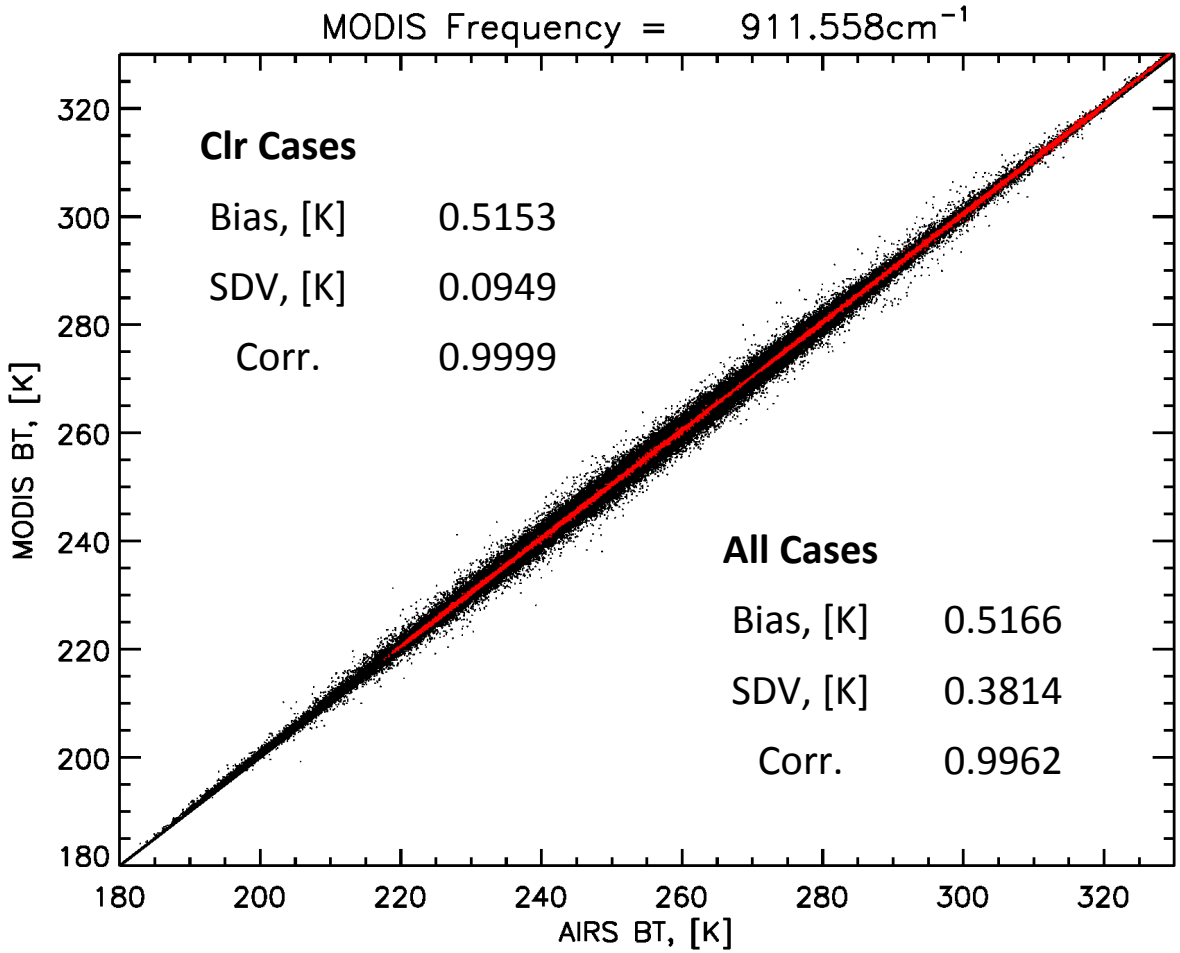



- Single non-channel dependent ideal FOV, truncated, rotated and smeared(integrated) [see for instance, Schreier, et al., *JTECH*, 2011.]
- Collocation methodology is based on work by F. Nagle (Univ. of Wisconsin), and optimized for AIRS by Haibing Sun.
- The number of clear, probably clear and cloudy-sky masked pixels are saved along with all-sky, clear-sky masked, probably clear-sky masked MODIS radiances and reflectances.

# MODIS (838.4cm$^{-1}$)



# MODIS (911.56cm$^{-1}$)

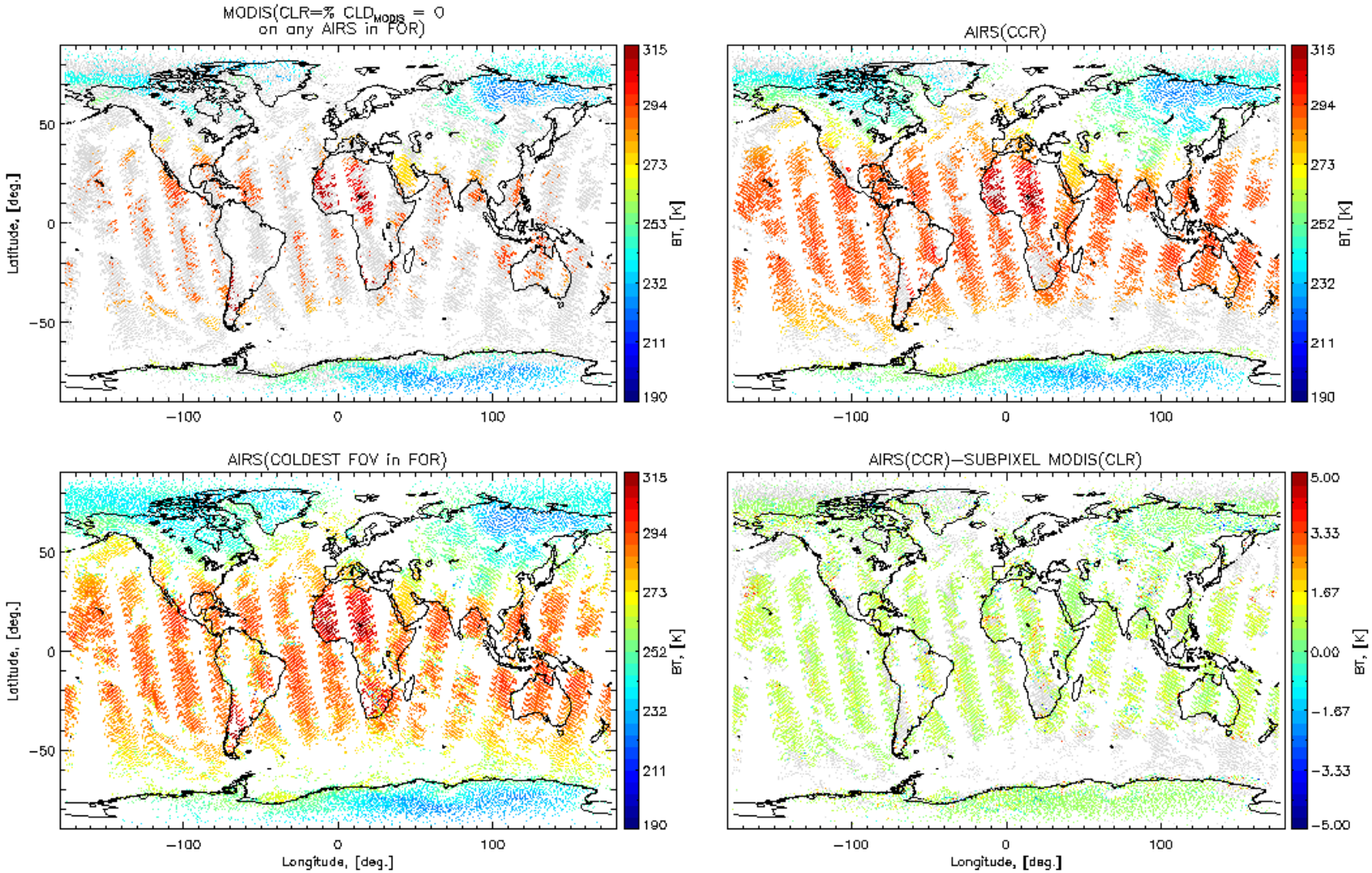


# So we have accurate MODIS/AIRS collocations…How good are cloud-cleared radiances?

- Compare AIRS cloud-cleared radiances using split window MODIS channels to sub-pixel clear-sky MODIS radiances – how good is out fit to MODIS?
- Compare NOAA AIRS v6 versus NOAA AIRS v6 (MODIS) all orbits February 03, 2013.
- Algorithm startup are the AIRS v6 principle component regressions (not used in AIRSv6.0.7).
- Radiance computations using ECMWF for nighttime all-sky and clear-sky masked AIRS footprints. We show cloud-cleared radiances minus calculations.

Colored pixels indicate locations of AIRS clear scenes on FOV

Cloud-cleared radiances using MODIS



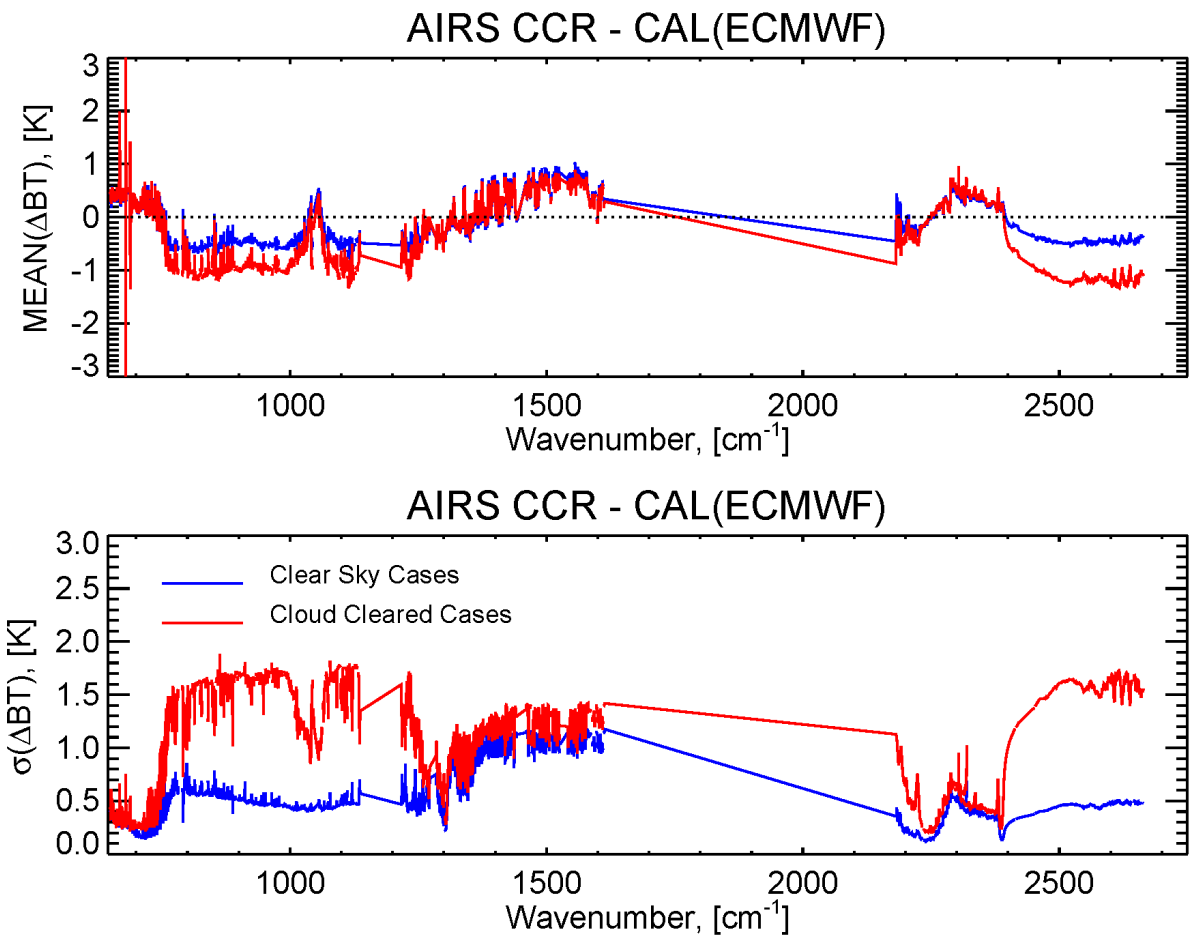

Coldest AIRS FOV on FOR

AIRS Cloud-cleared radiances using MODIS minus subpixel clear-sky MODIS

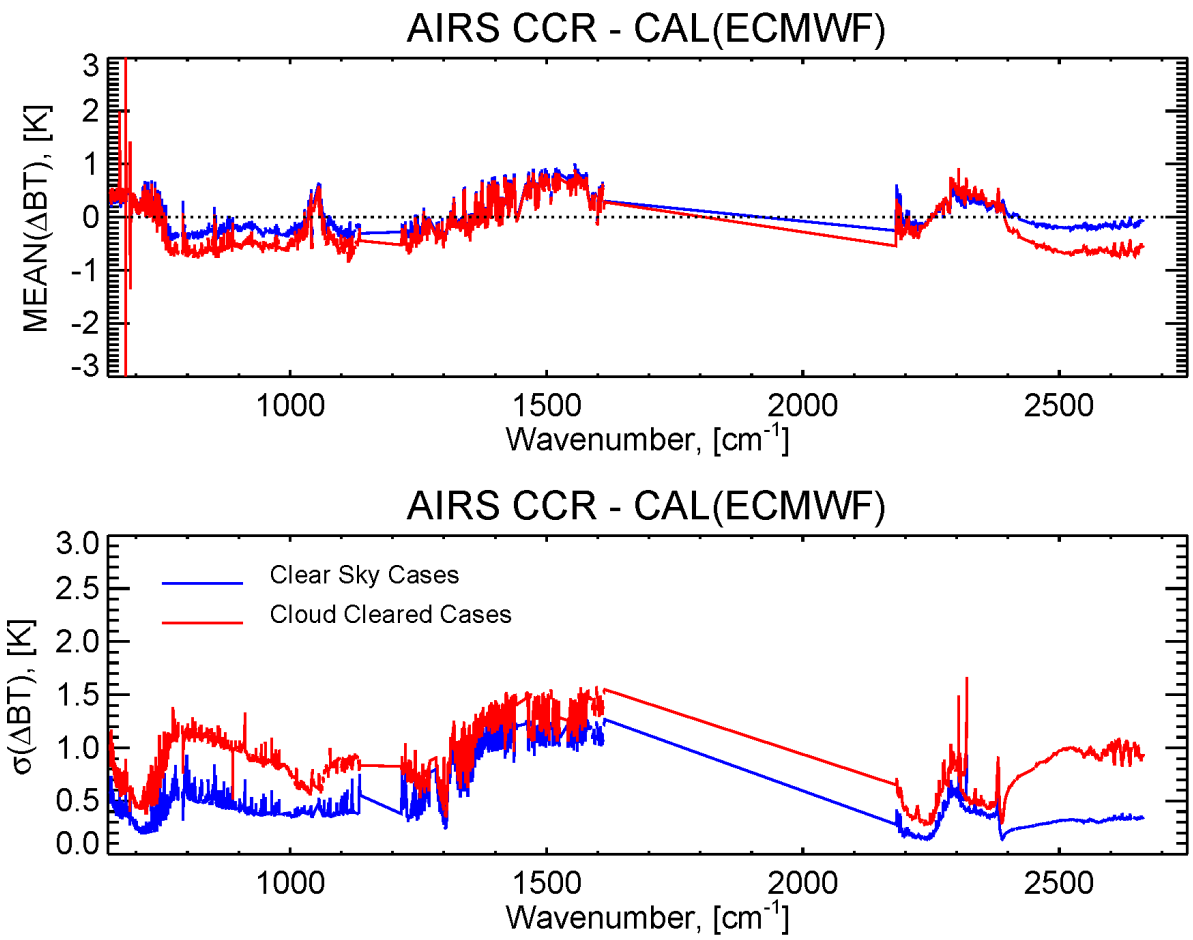
# Collocations are good and cloud-cleared radiances agree with the sub-pixel clear MODIS.

- How do they stack up against clear-sky calculations using ECMWF over ocean?
- Is there any improvement using MODIS clear states relative to using v6 regressions (not SCCNN)?

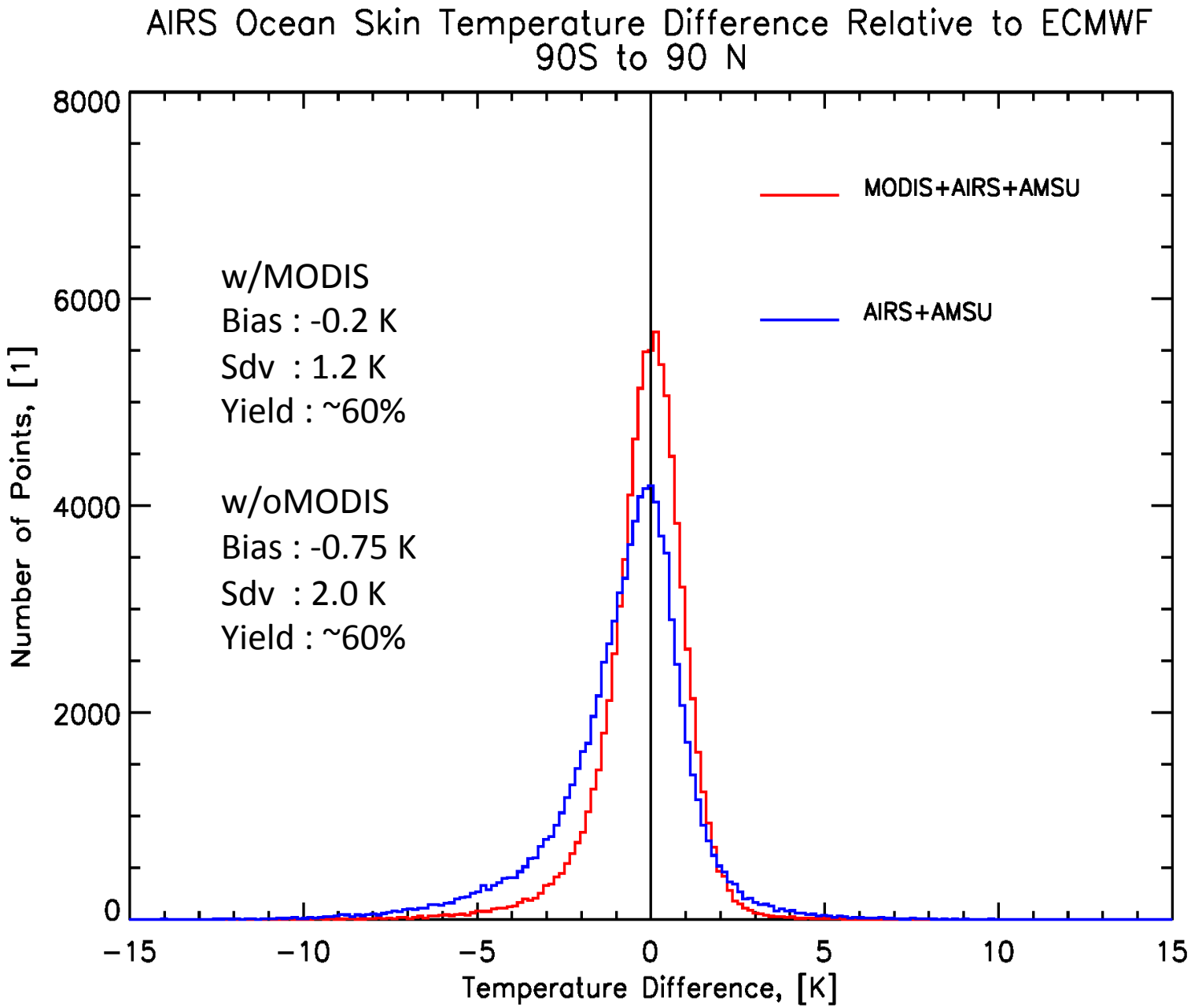
# AIRS NOAAv6 Ocean cloud-cleared minus ECMWF calculations



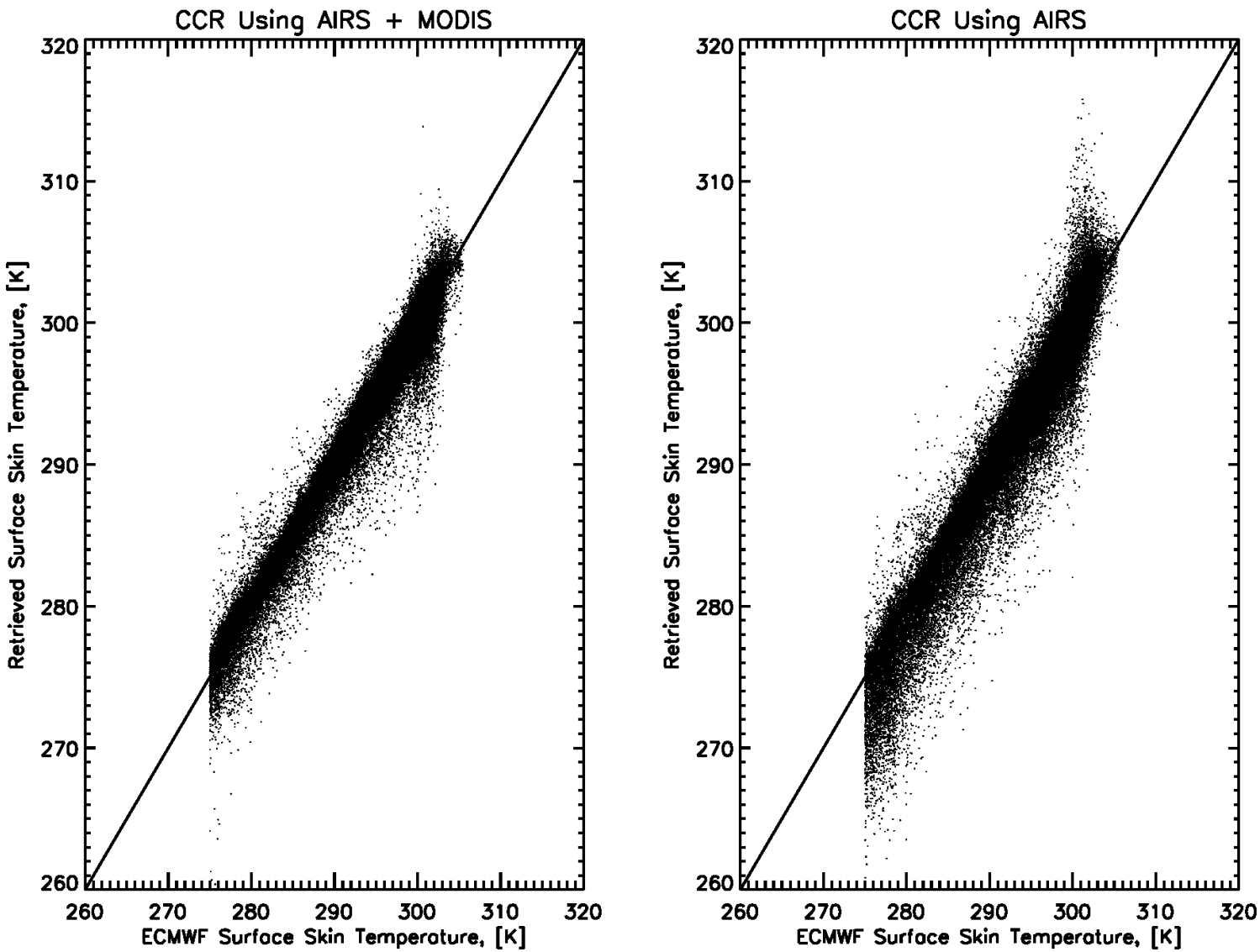
# AIRS NOAAv6(MODIS) Ocean cloud-cleared minus ECMWF calculations



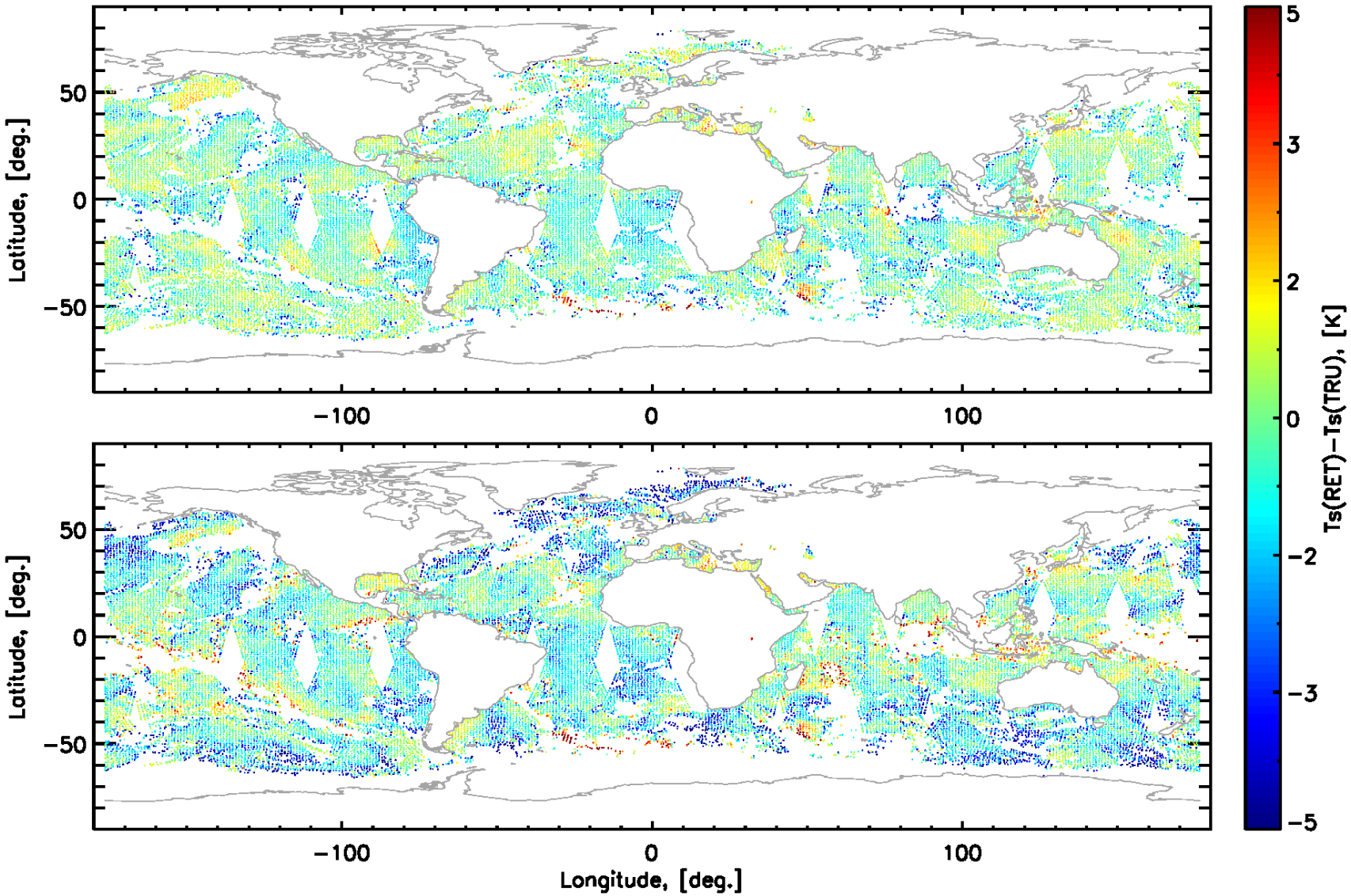

Same cases as previous slide


AIRS Ocean Skin Temperature Difference Relative to ECMWF
90S to 90 N
MODIS+AIRS+AMSU
AIRS+AMSU
w/MODIS
Bias : -0.2 K
Sdv : 1.2 K
Yield : ~60%
w/oMODIS
Bias : -0.75 K
Sdv : 2.0 K
Yield : ~60%
Number of Points, [1]
Temperature Difference, [K]
8000
6000
4000
2000
0
−15
−10
−5
0
5
10
15

# Scatterplot of SST versus ECWMF (Global, NFO)



Top: SST – ECMWF using a v5 like setup with MODIS




Bottom: SST – ECMWF using a version 5/6 like setup without MODIS

# Summary

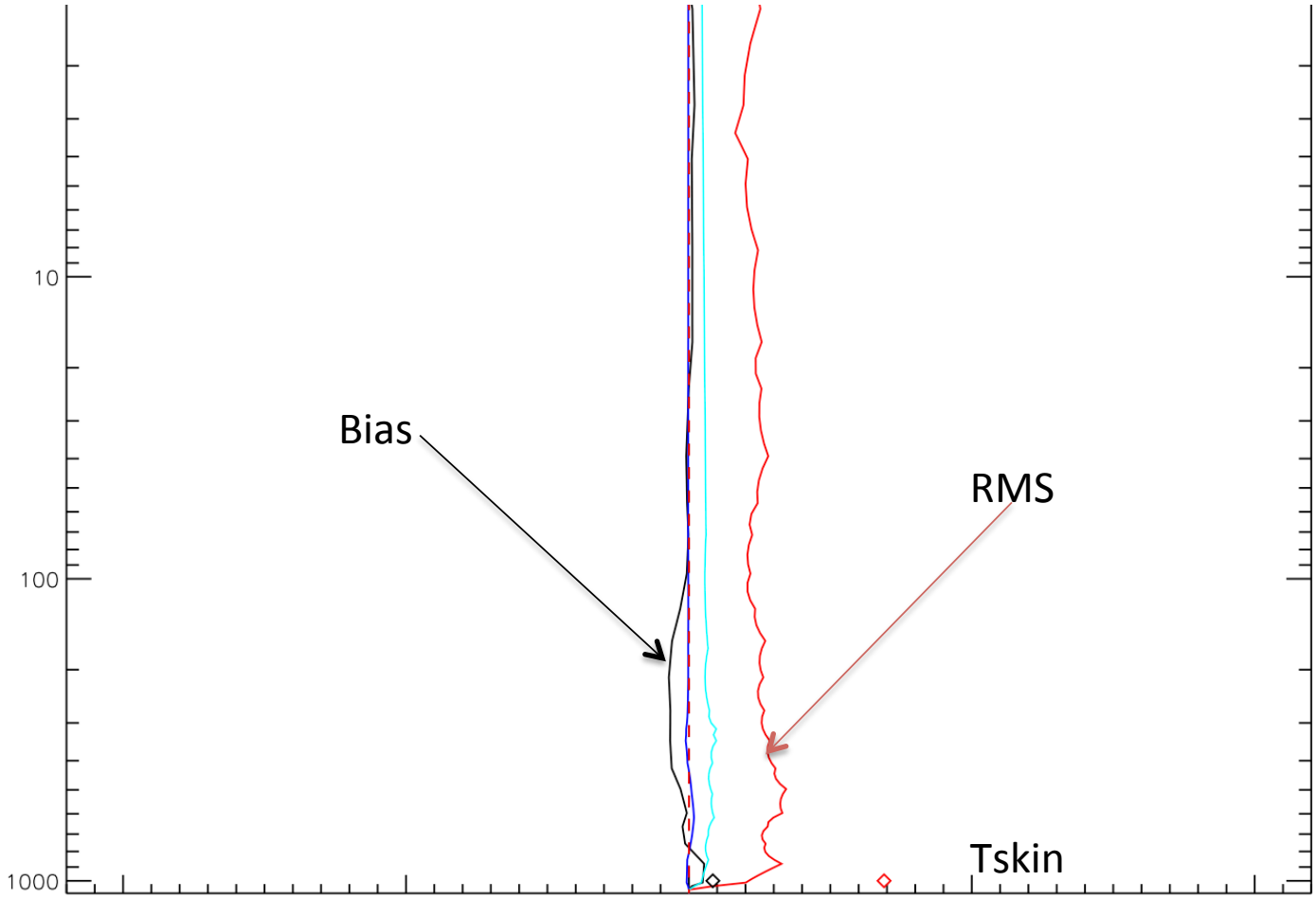
- We've developed collocation software for AIRS and MODIS that results in highly accurate matchups of clear-sky and all-sky subpixel MODIS radiances, reflectances and products (not shown but can be added).
- We show that using MODIS to cloud-clear AIRS radiances results in an improved agreement with calculations using ECMWF as inputs for surface sensitive channels and also in our L2 retrievals of SST.
- Future work would include optimizing the selection of MODIS channels for use in cloud-clearing and possibly using a hybrid MODIS clear-sky + AIRS clear-sky cloud-clearing algorithm, using MODIS products as a background for AIRS, and optimizing the error estimates within the AIRS retrieval software (optimize a priori constraints and error propagation).

# An interesting (unexpected) result

- Compared v6.0.7 AIRS (official version) with v6.0.7 AIRS where the cloud-clearing module was bypassed and cloud-cleared radiances were replaced using MODIS CCRs produced at NOAA.

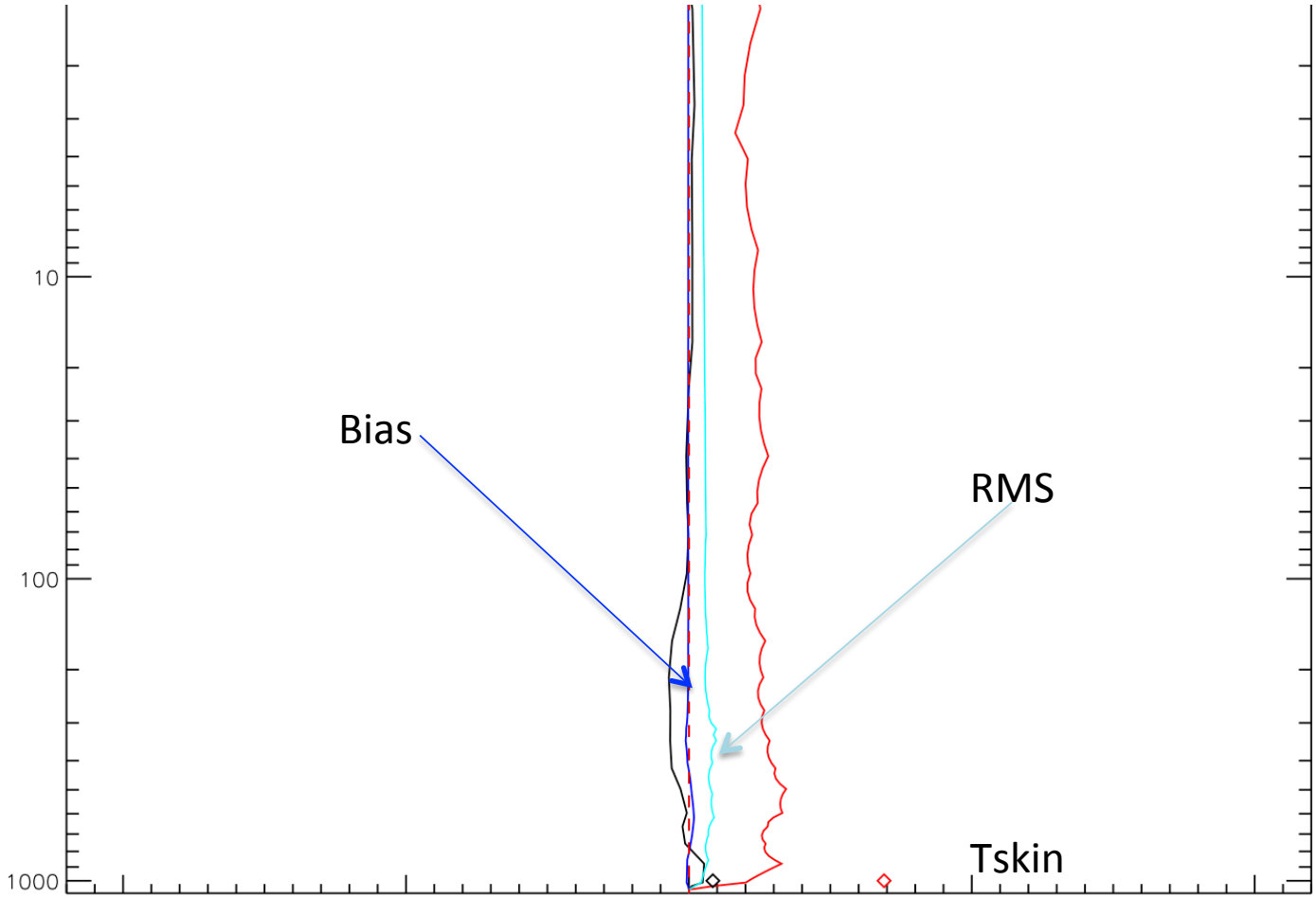
- SCCNN, and all other modules were identical.

# 02/03/13 Ocean
# MODIS(CCR) – AIRSv6(CCR): Qual = 0



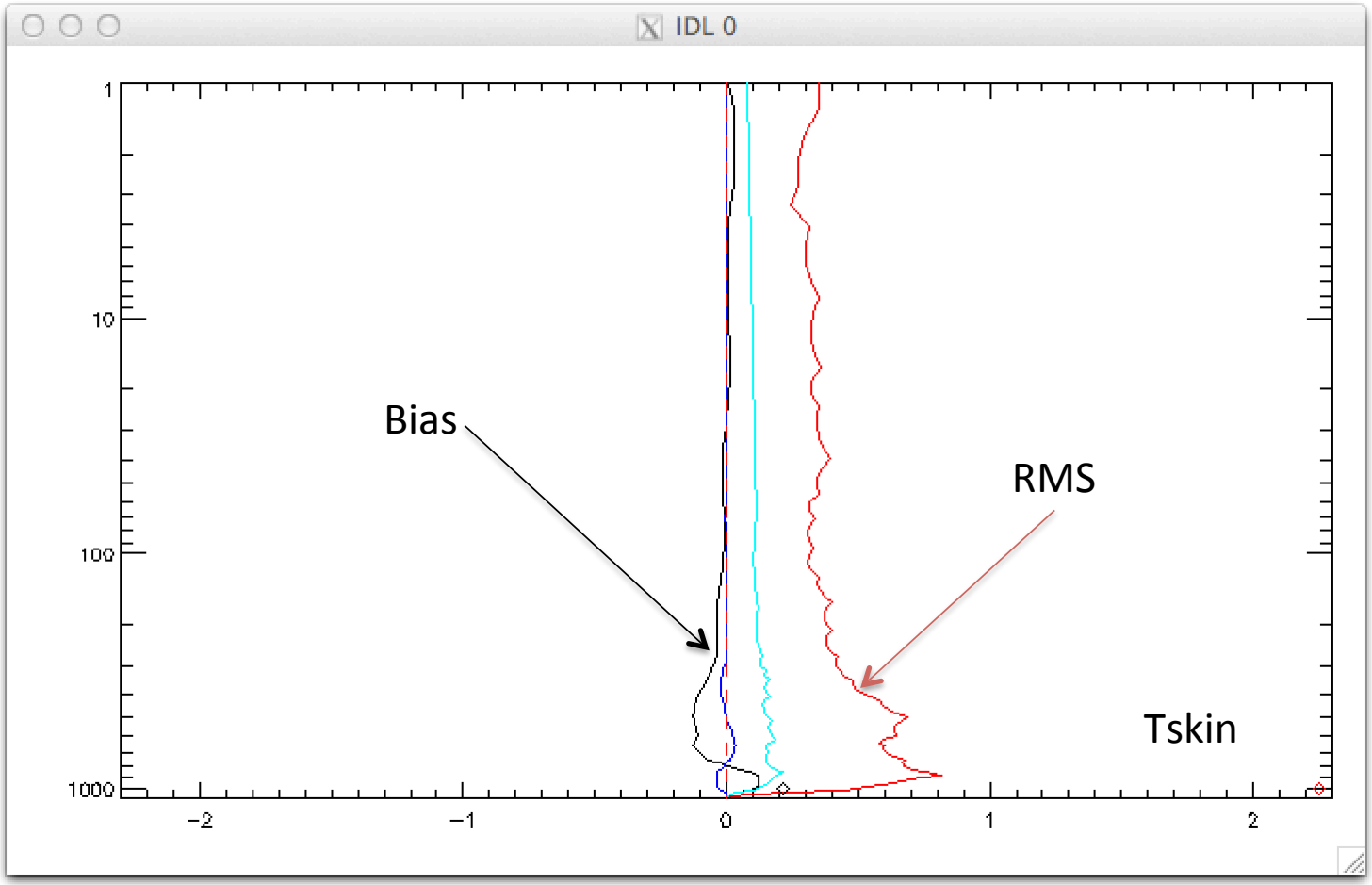

RMS and Bias, T(p), Tsurf, and fractional difference water

# 02/03/13 Ocean
# MODIS(CCR) – AIRSv6(CCR): Qual = 0



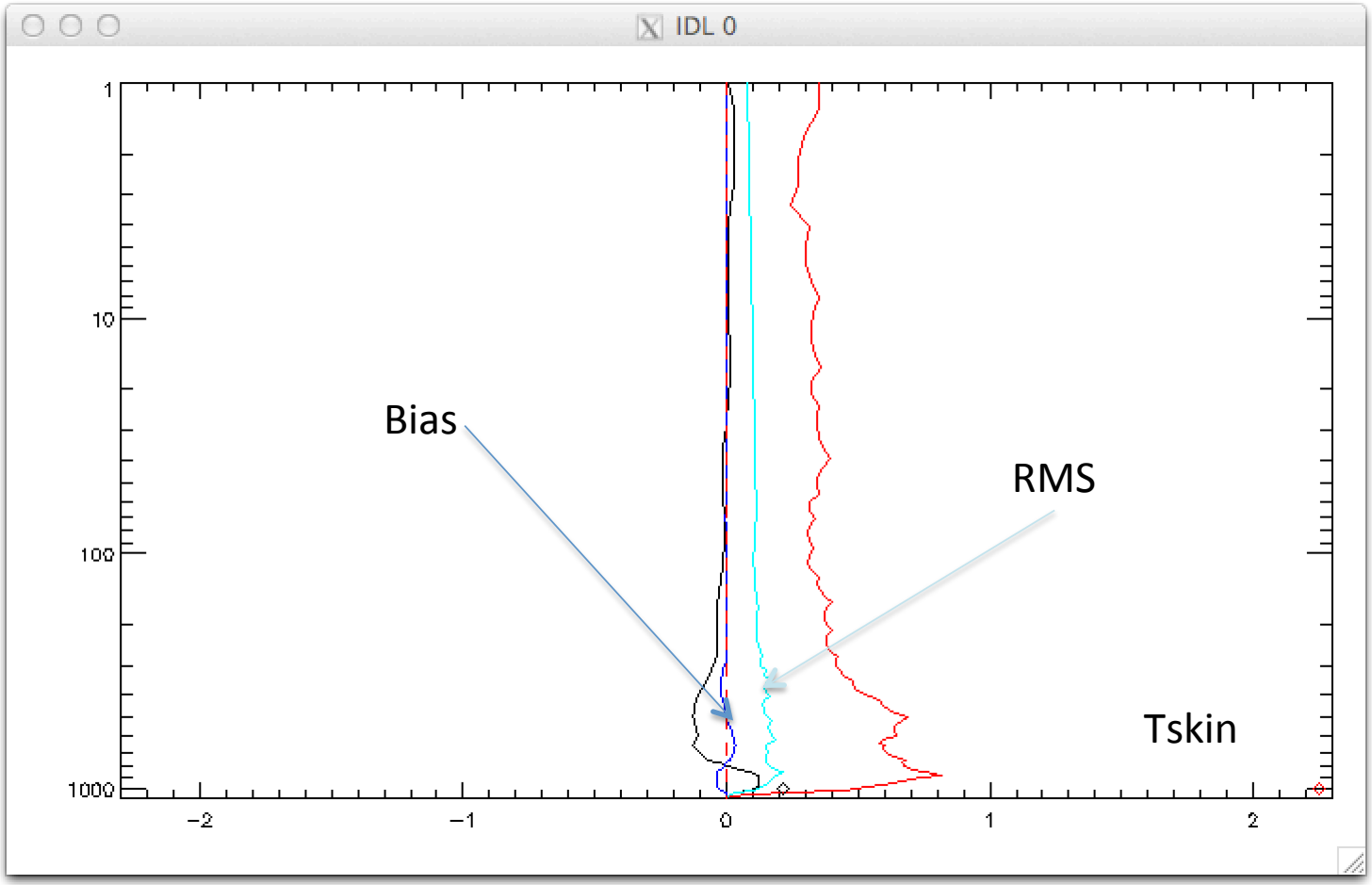

RMS and Bias, T(p), Tsurf, and fractional difference water

# 02/03/13 Ocean
# MODIS(CCR) – AIRSv6(CCR): Qual = 0,1




RMS and Bias, T(p), Tsurf, and fractional difference water

# 02/03/13 Ocean
# MODIS(CCR) – AIRSv6(CCR): Qual = 0,1




RMS and Bias, T(p), Tsurf, and fractional difference water

# Bias (solid) and Standard Deviation (dashed) versus ECMWF (ocean only)