Comparison of MODIS radiances and atmosphere products with AIRS, MISR and ground based measurements

Steve Ackerman
Jun Li, Paul Menzel, Dave Tobin,
and others at
CIMSS/UW-Madison

Combining Observations

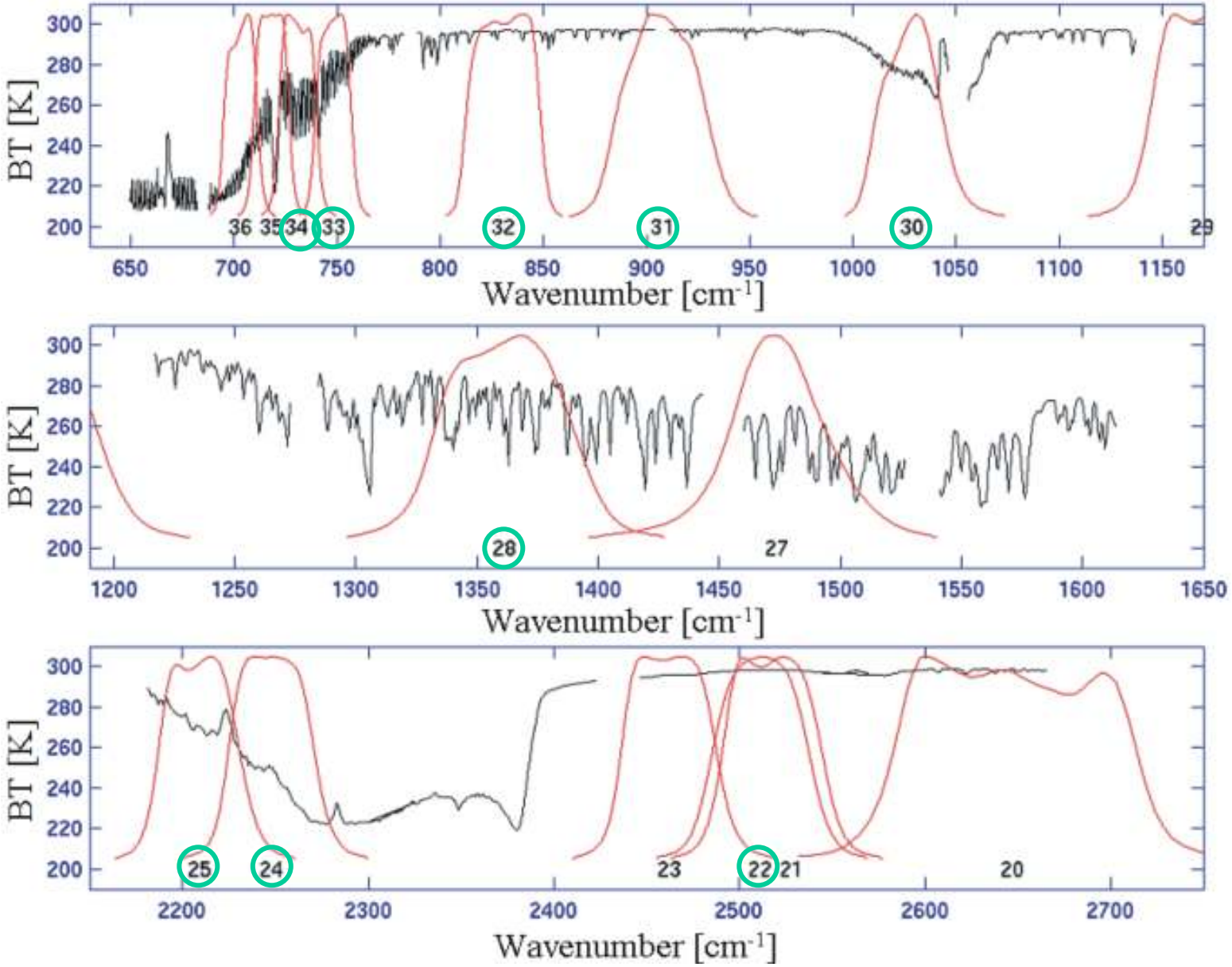
- Radiance Comparisons
- Product Comparisons
- Combined Retrievals
- Science Insights

WHY?

Combining Observations

- Radiance Comparisons
- Product Comparisons
- Combined Retrievals
- Science Insights

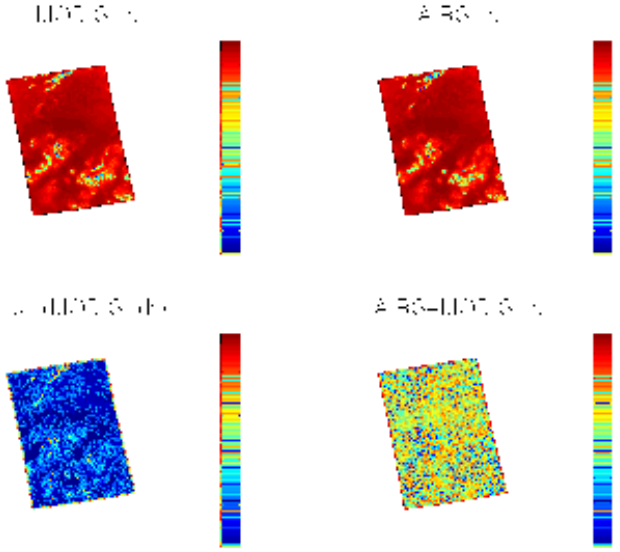
Aqua MODIS IR SRF Overlay on AIRS Spectrum

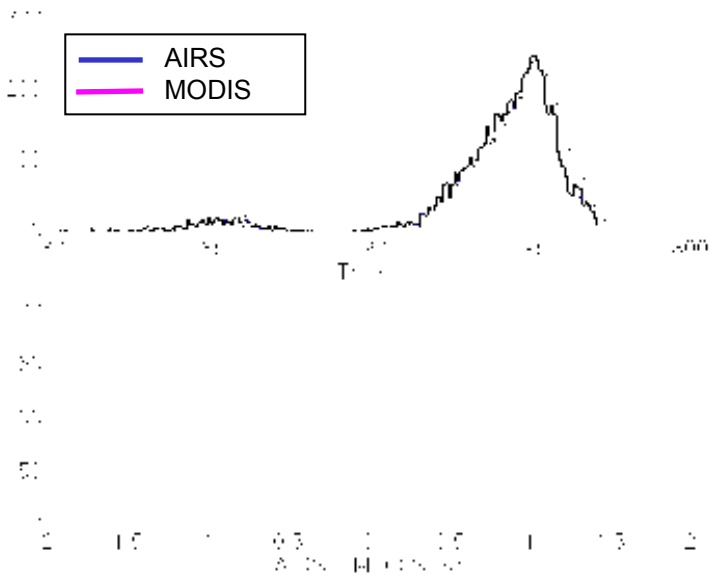


AIRS/MODIS Brightness Temperature Comparisons

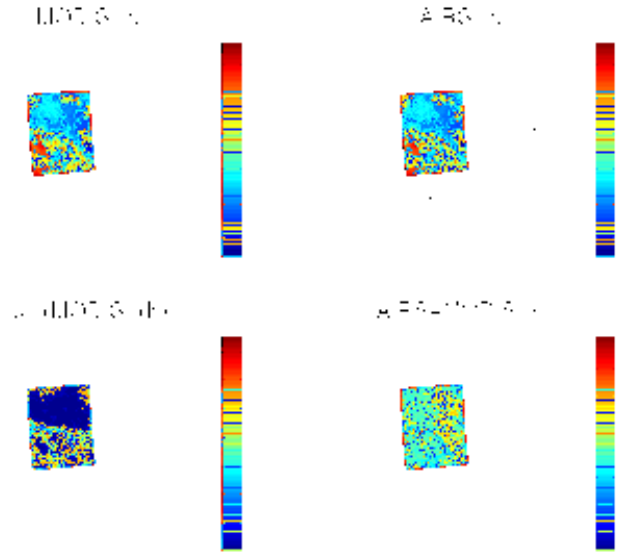
20-July-2002, Band 32 (~12.0μm)

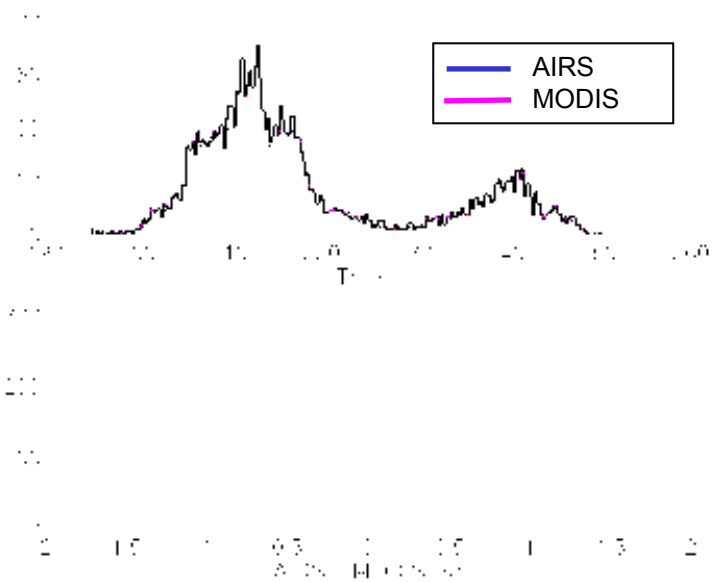
GOES-10 sub-satellite point





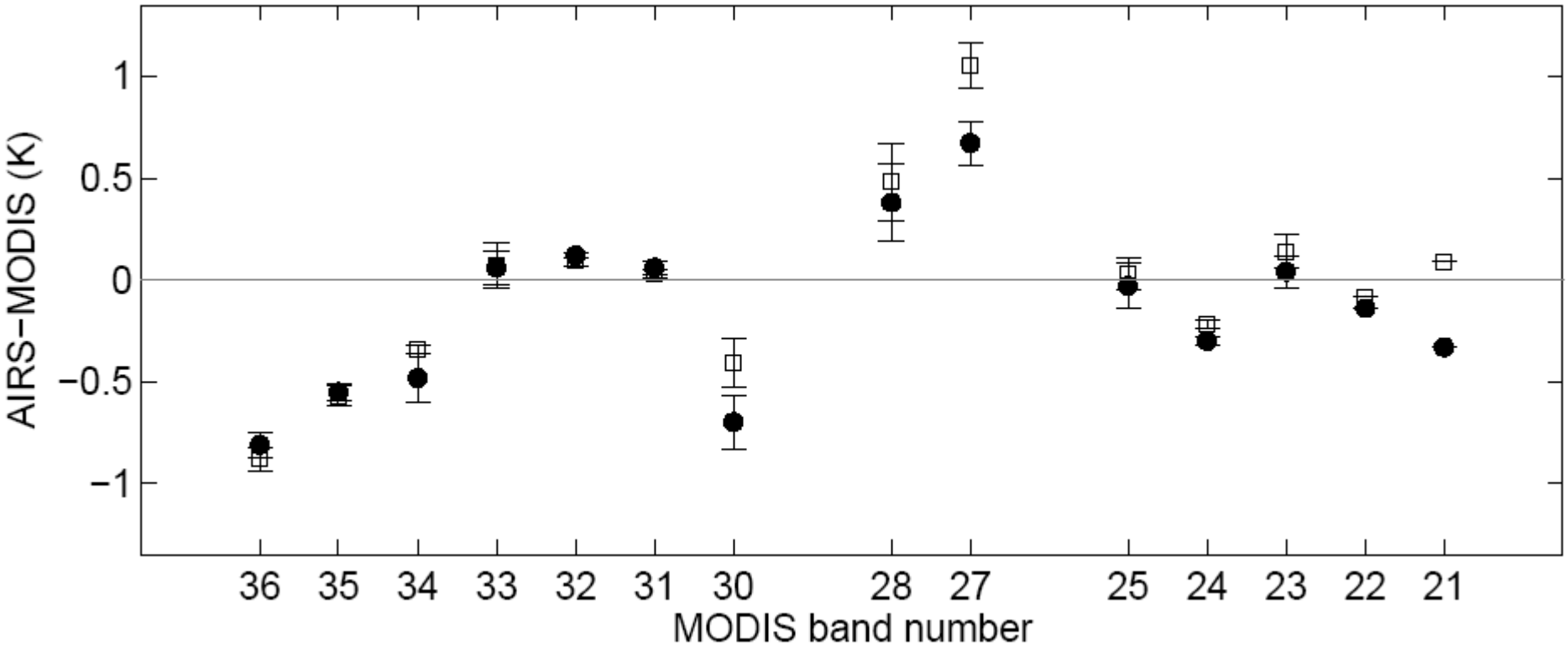
Dome Concordia, Antarctica





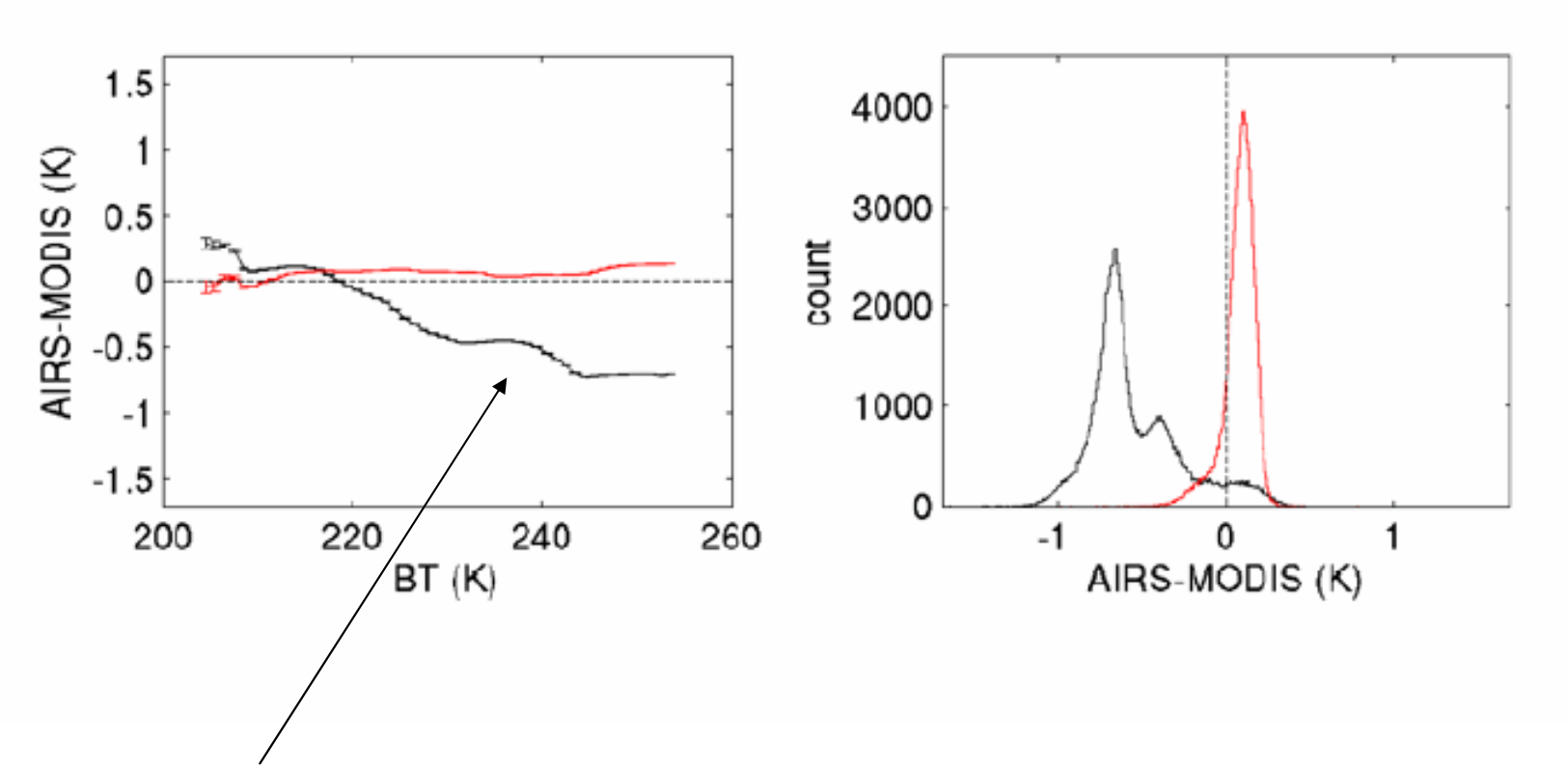
Climate

Brightness Temperature differences between AIRS and MODIS



Climate

Bias appears to be temperature dependent.



Impact on CO2 slicing?

Black – original, Red corrected by spectral shift

Combining Observations

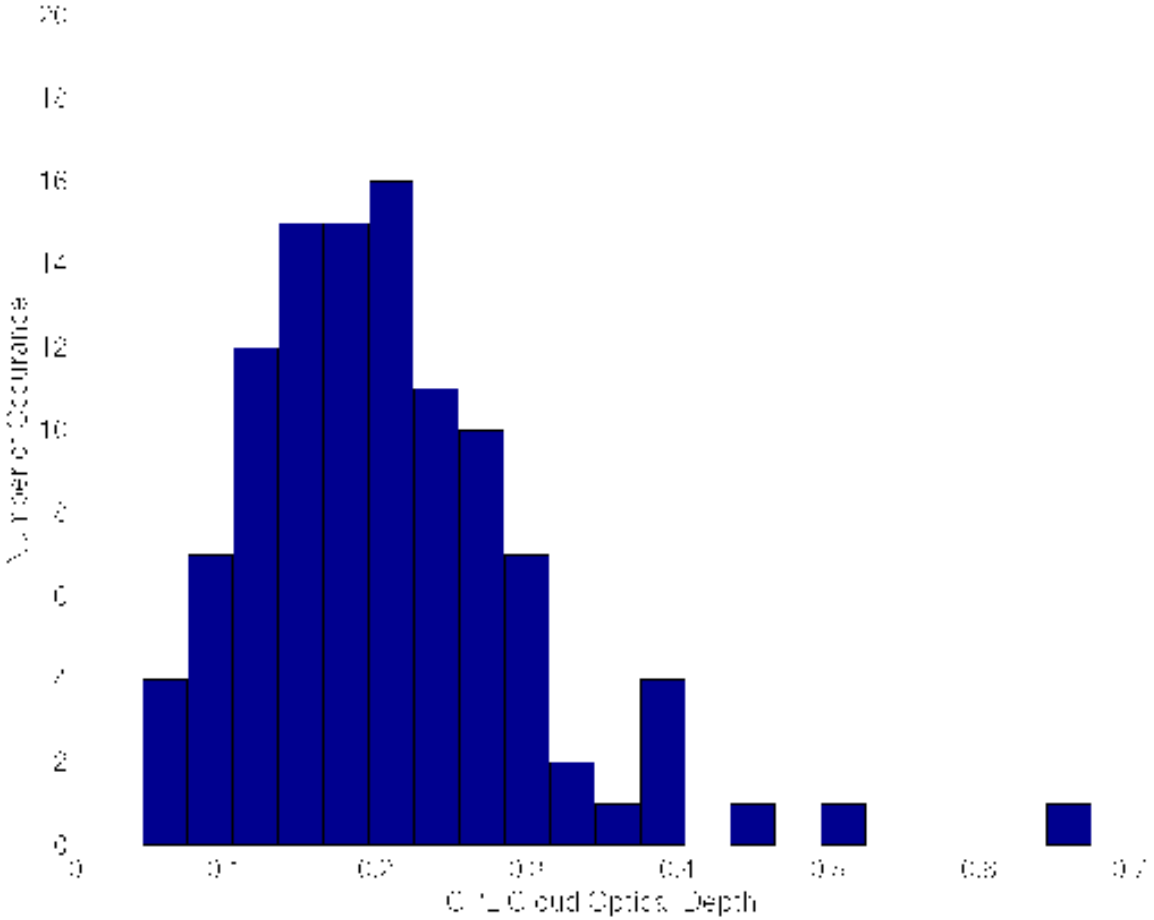
- Collocation
- Radiance Comparisons
- Product Comparisons
- Combined Retrievals
- Science Insights

Cloud detection
Cloud top pressure
Water vapor
Volcanic Ash cloud

What is a cloud?

"I know one when I see one."

Preparing for
CALIPSO and MODIS

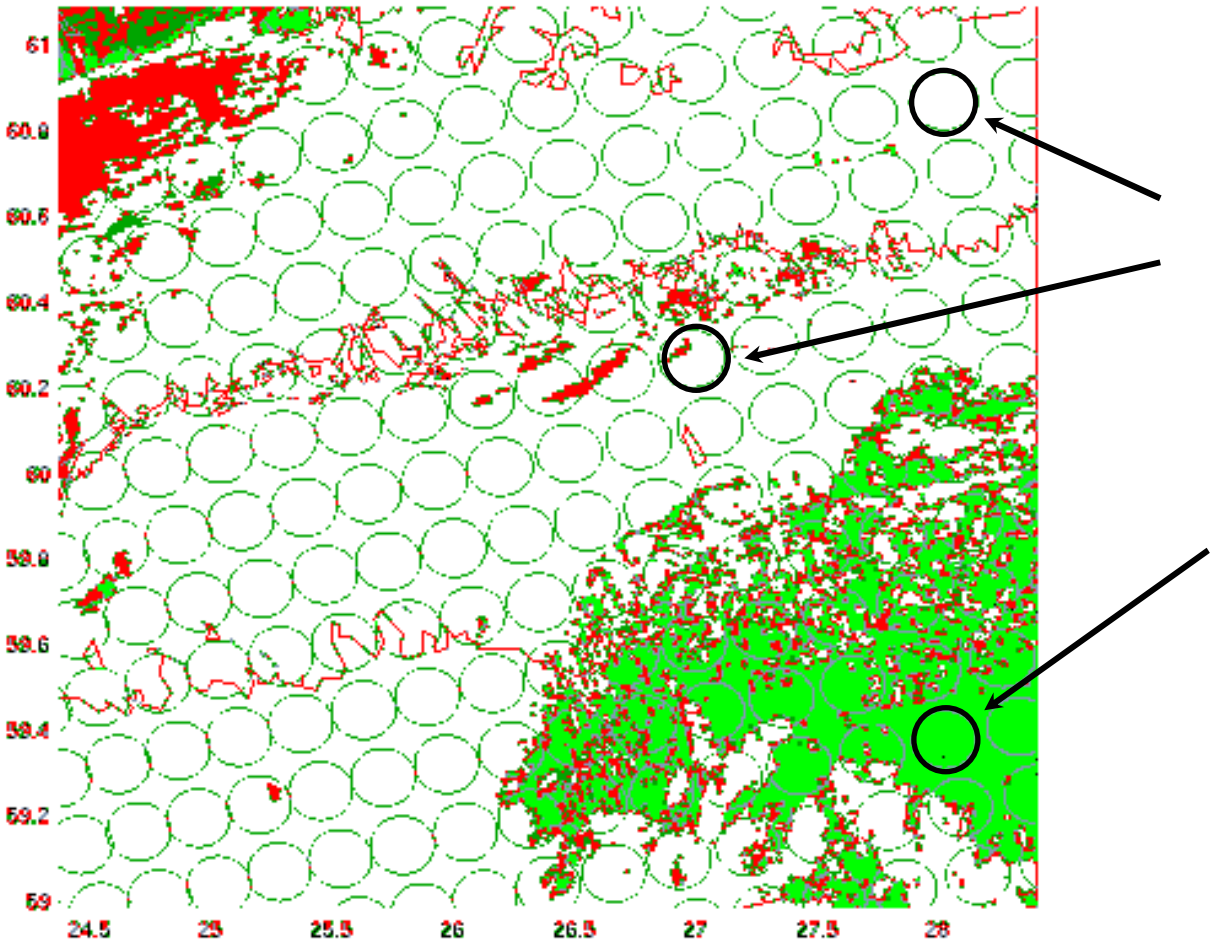


The number of occurrences that MAS scene was identified as clear and the cloud physics lidar (McGill, 2002) detected a cloud optical depths (visible wavelengths). This figure suggests that the cloud limit is approximately optical depth 0.3

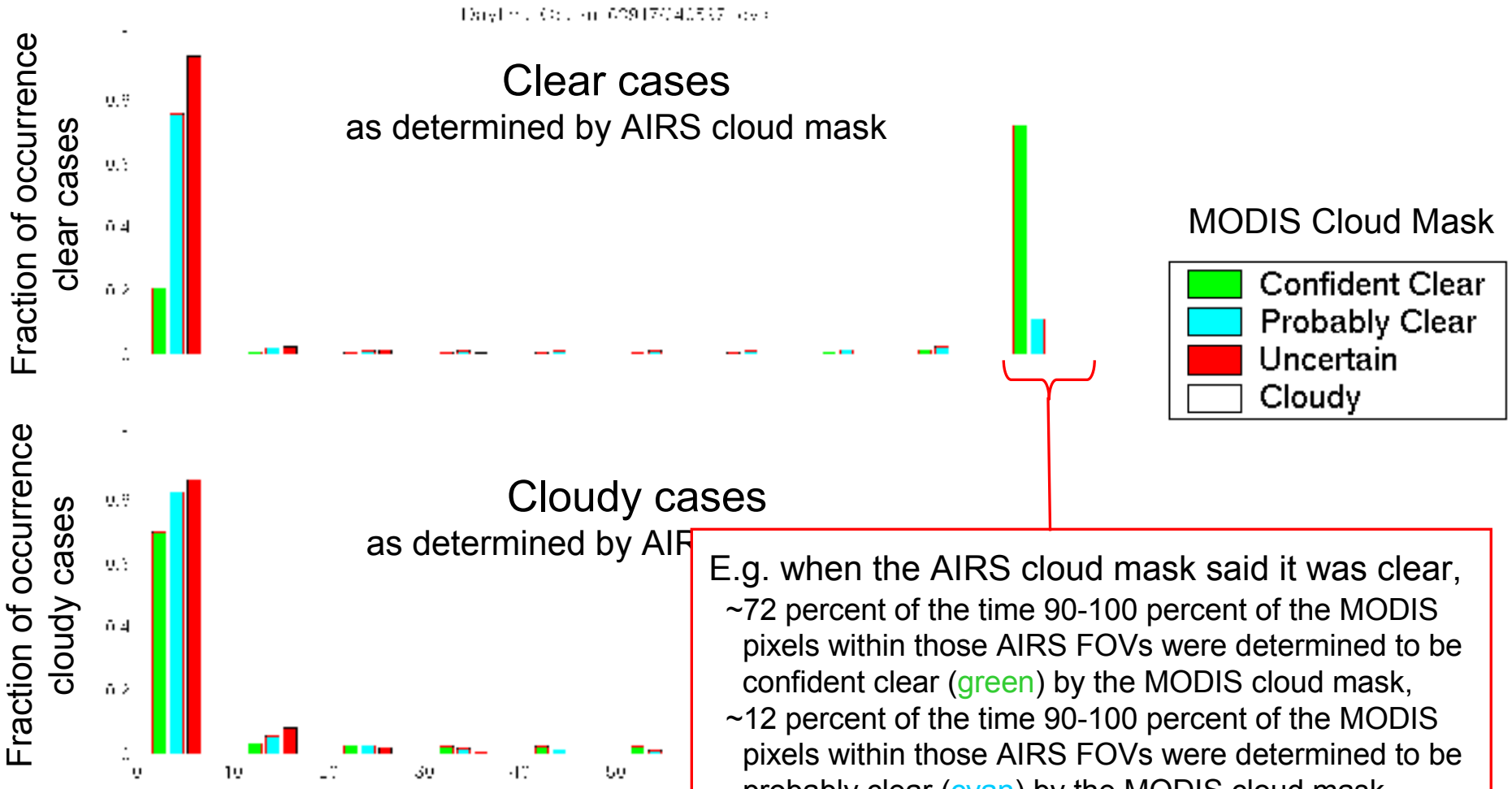
Water, Weather

AIRS Clear Flag from MODIS cloud mask

Not Determined	Cloudy	Uncertain	Probably Clear	Confident Clear



Sample AIRS/MODIS Cloud Mask Histogram



E.g. when the AIRS cloud mask said it was clear,

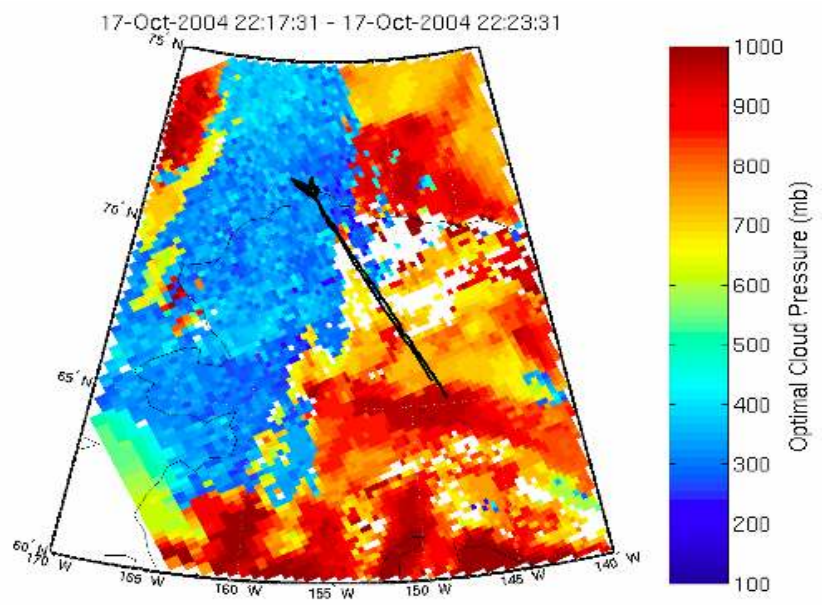
- ~72 percent of the time 90-100 percent of the MODIS pixels within those AIRS FOVs were determined to be confident clear (green) by the MODIS cloud mask,
- ~12 percent of the time 90-100 percent of the MODIS pixels within those AIRS FOVs were determined to be probably clear (cyan) by the MODIS cloud mask,
- ~0 percent of the time 90-100 percent of the MODIS pixels within those AIRS FOVs were determined to be uncertain (red) by the MODIS cloud mask, and
- ~3 percent of the time 90-100 percent of the MODIS pixels within those AIRS FOVs were determined to be cloudy (white) by the MODIS cloud mask.

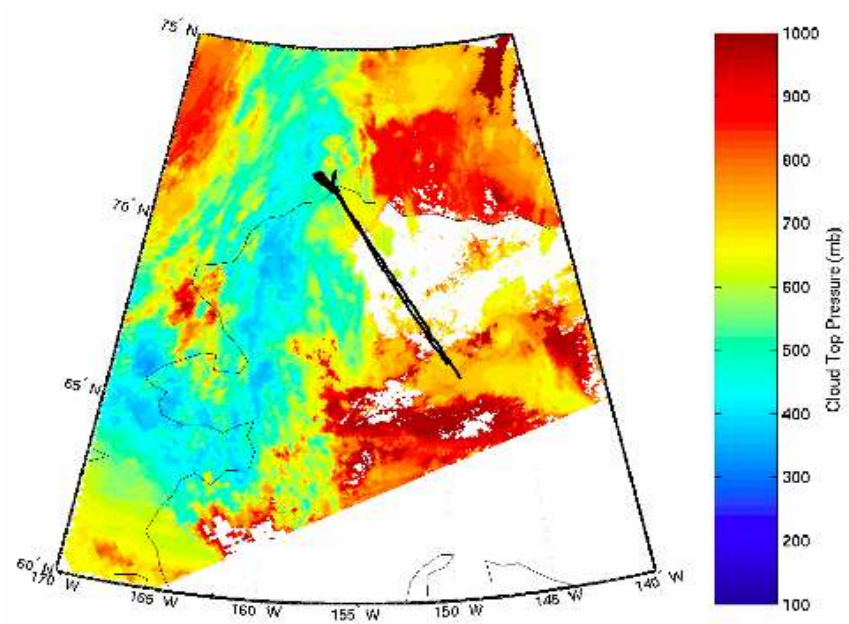
Water, Weather

Cloud Height Comparison over polar regions…

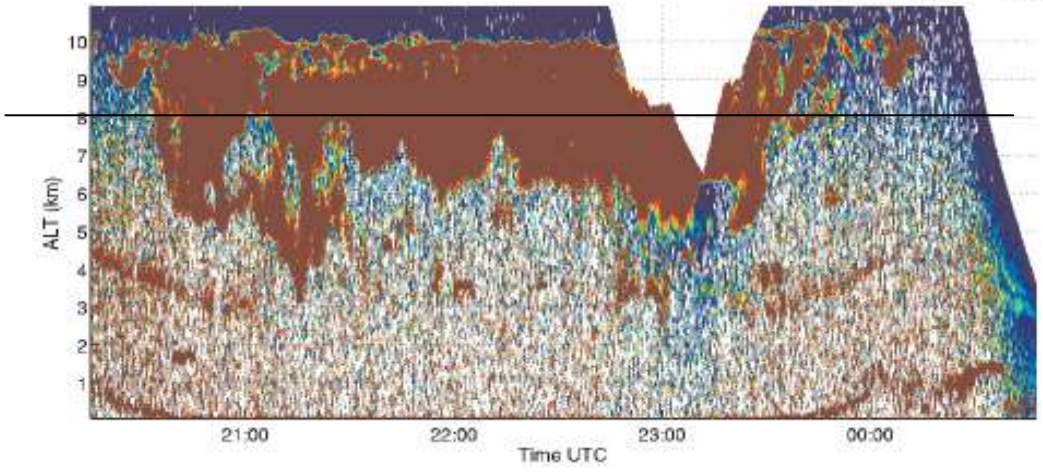
AIRS

MODIS





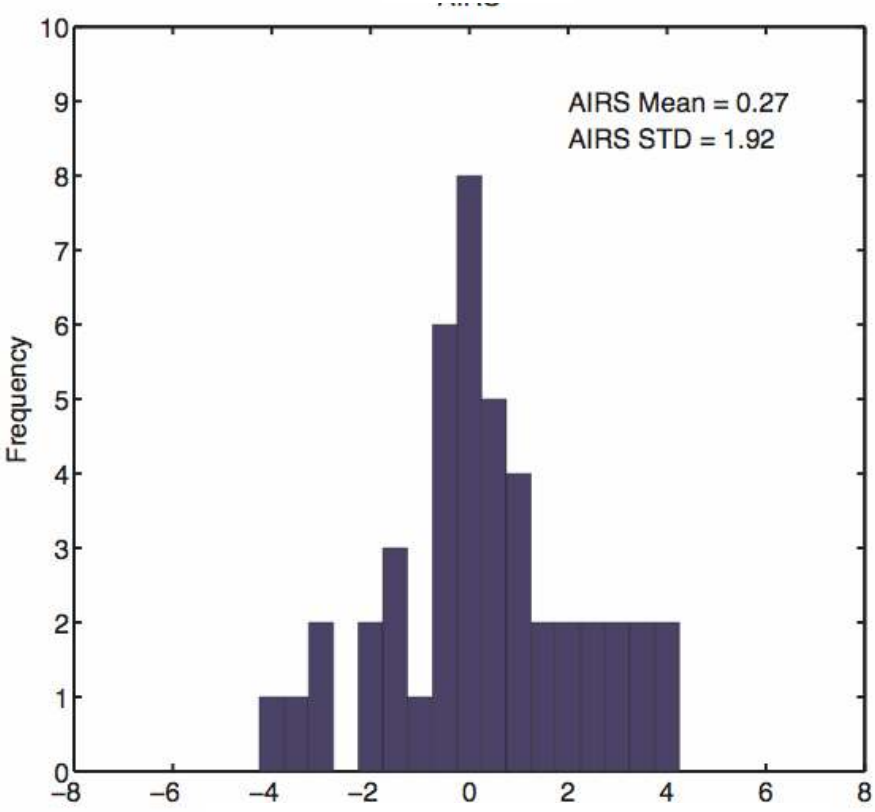
AIRS



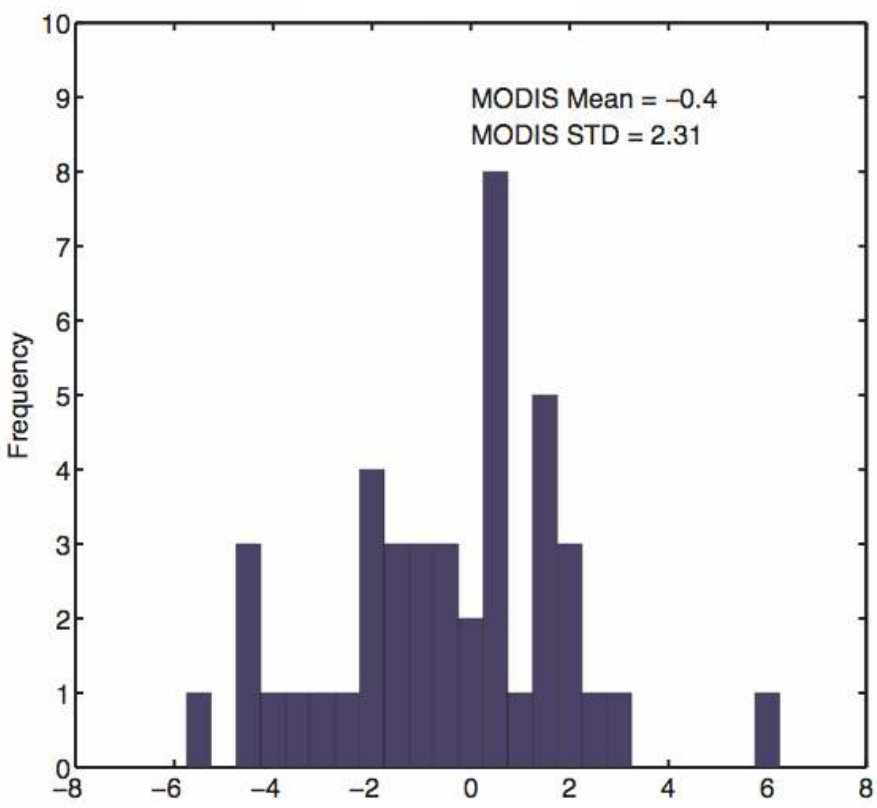
Water, Weather

ARM ARCL vs AIRS and MODIS

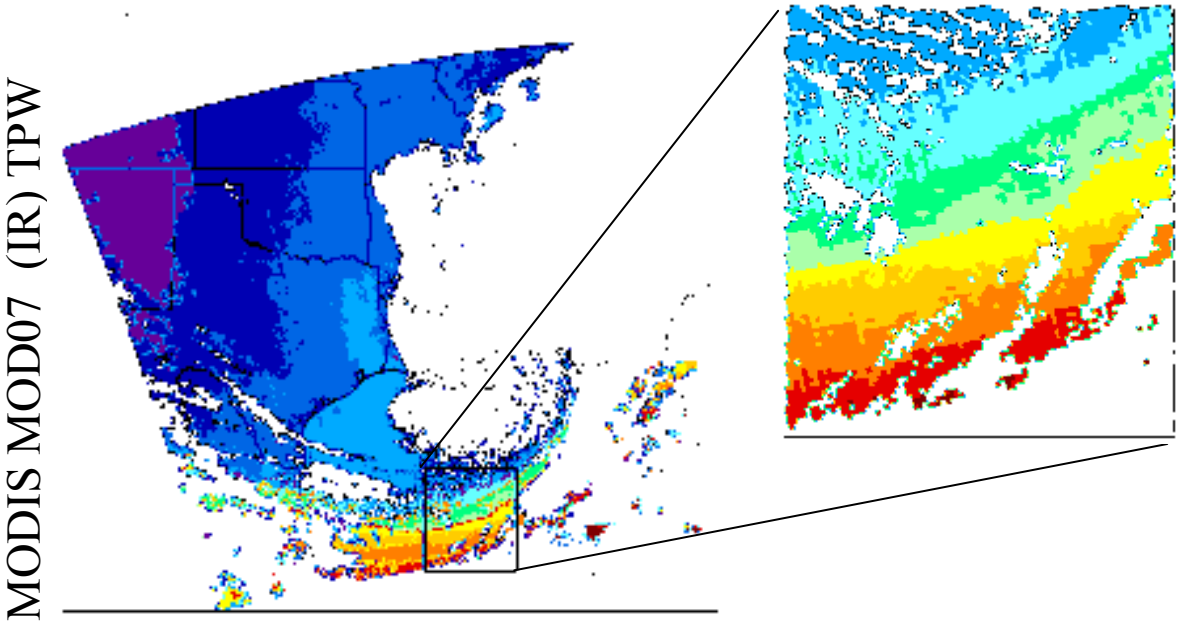
AIRS



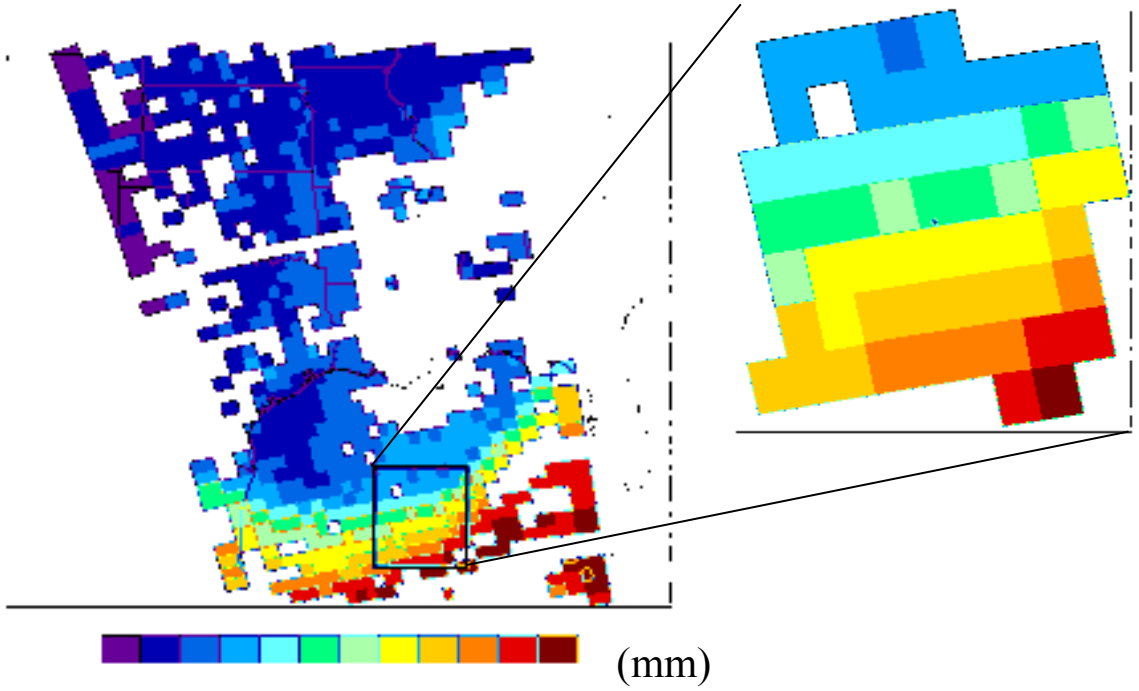
MODIS



High-spectral resolution helps with retrieval in inversions

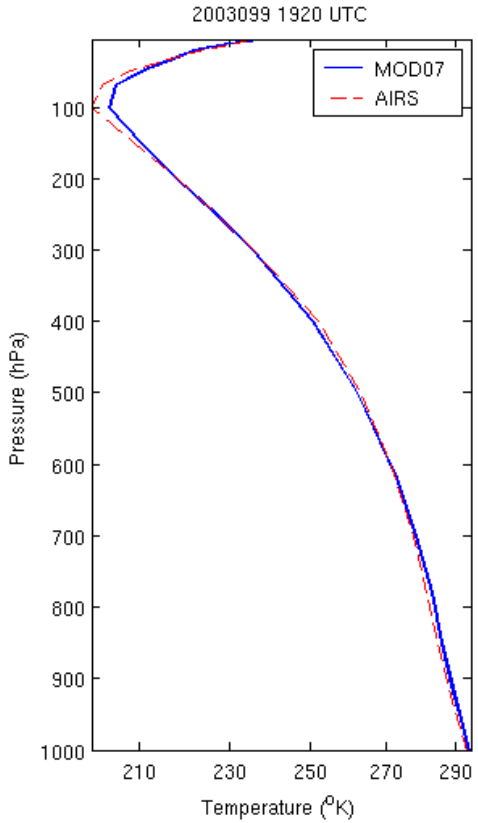


Aqua AIRS / MODIS Total Precipitable Water Comparison

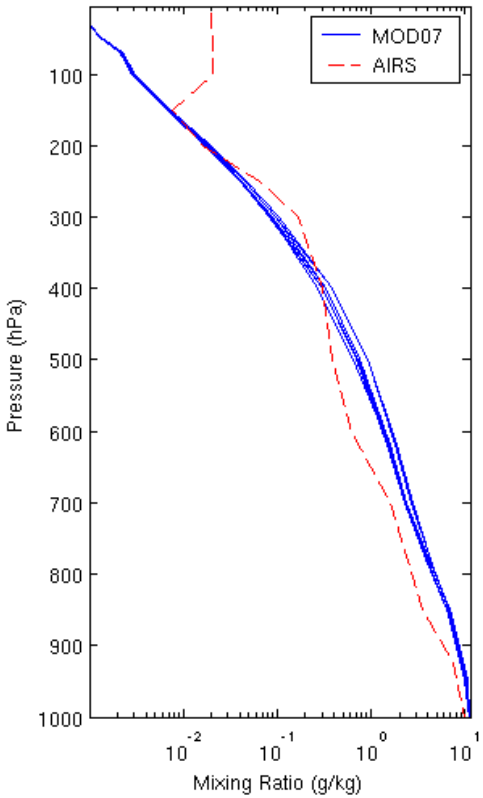


Water, Weather

Comparison of AIRS (red) and MODIS (blue) profiles



Temperature

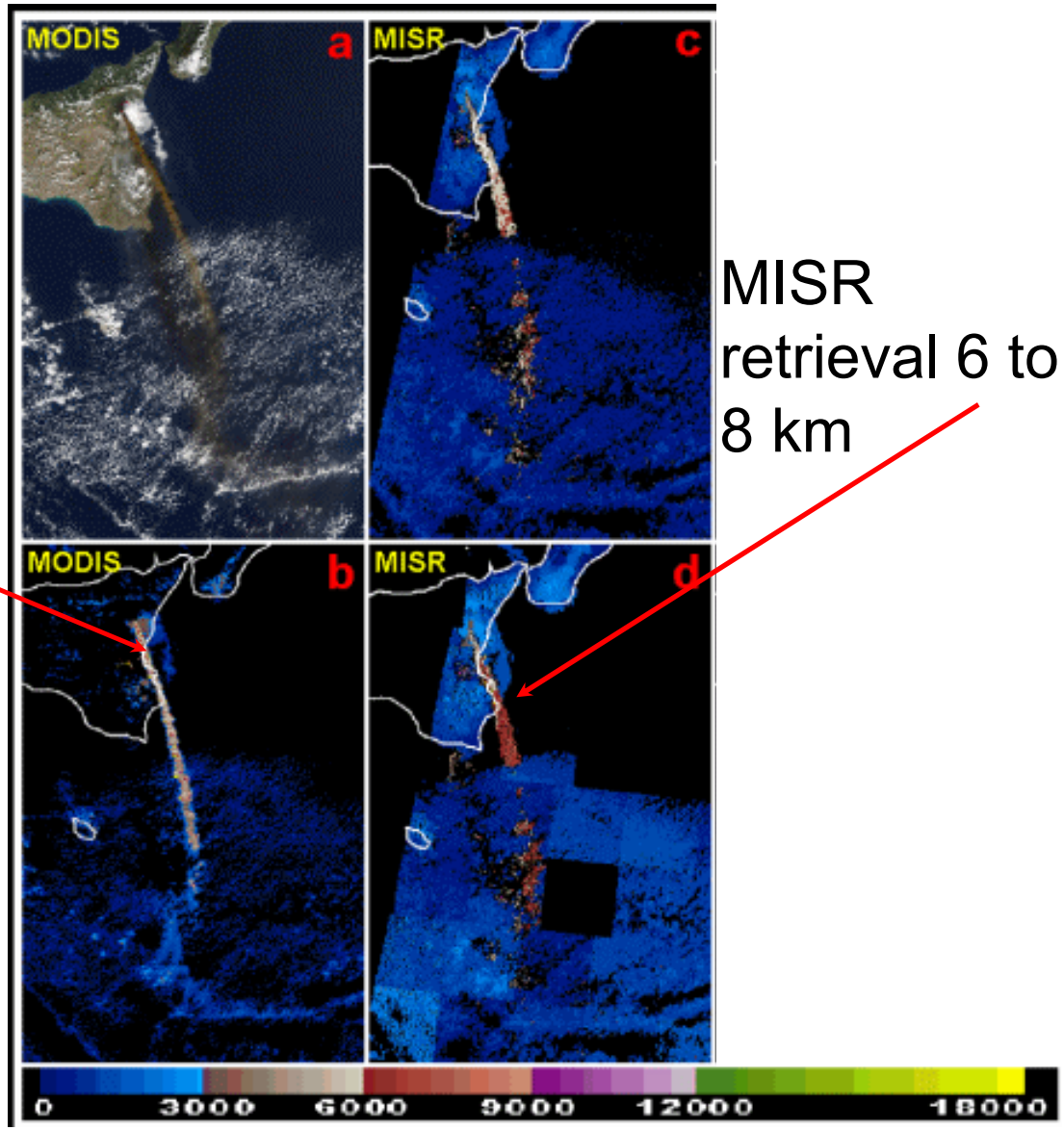


Mixing Ratio

All MOD07 profiles in a 3x3 FOV around the selected lat/lon are shown

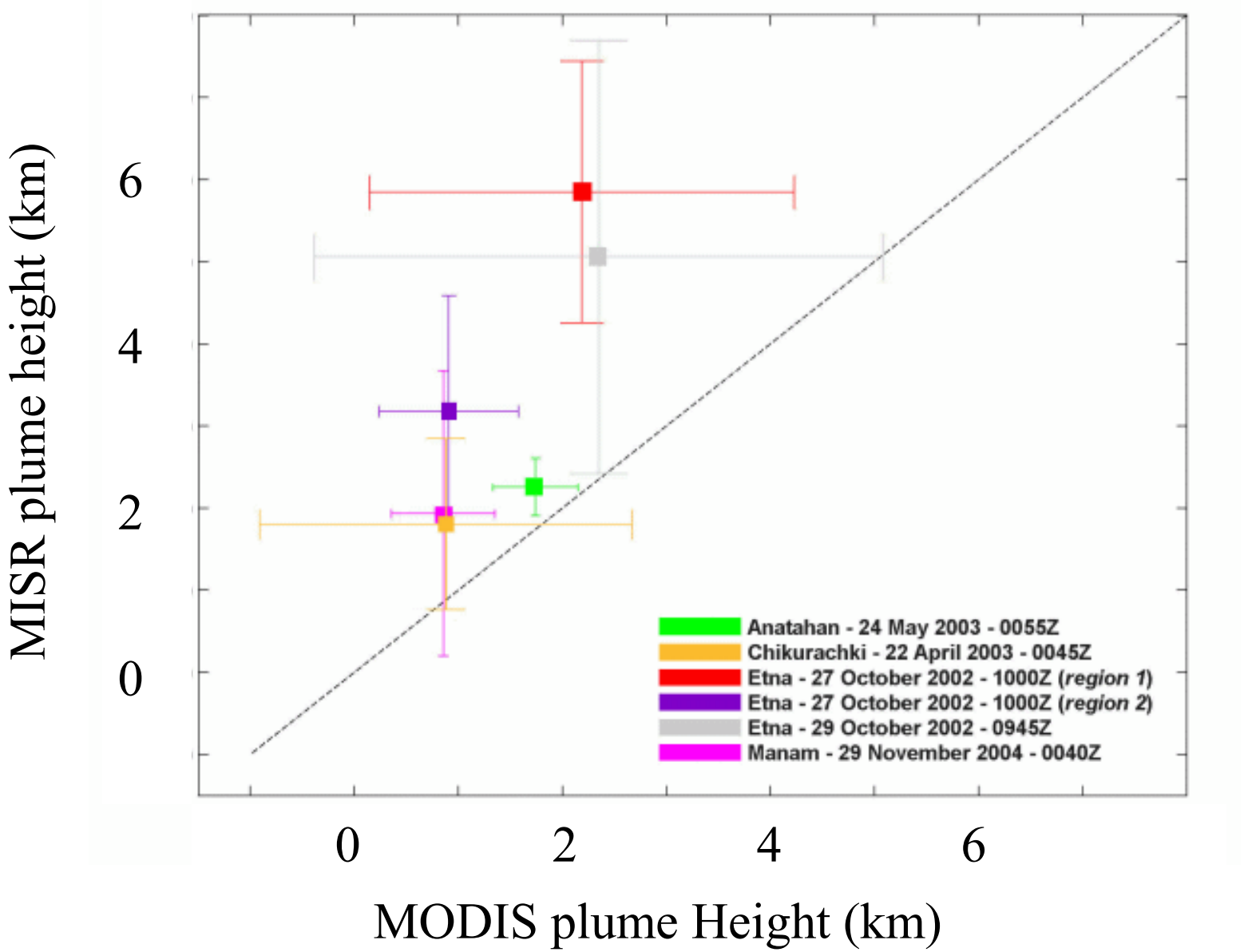
Estimating the height of volcanic plumes from the 15 micron CO2 band

MODIS CO_2 retrieval 6 km



MISR retrieval 6 to 8 km

MODIS CO2 heights lower, but similar variability

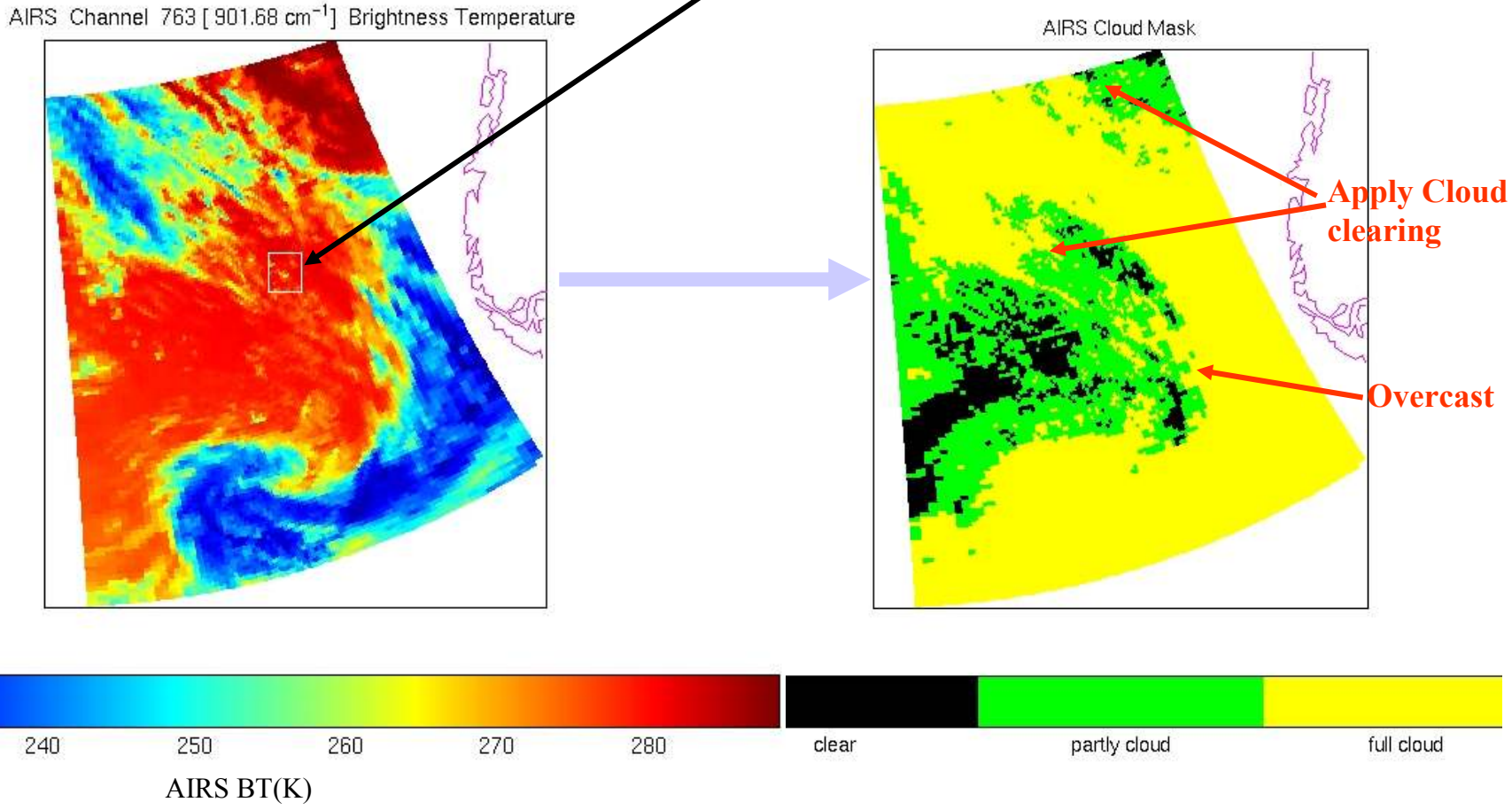


Combining Observations

- Radiance Comparisons
- Product Comparisons
- Combined Retrievals
  - Soundings with MODIS/AIRS – cloud clearing
  - Clouds with AIRS/MODIS
- Science Insights

Feb.18, 2004, G203, 20:17 – 20:23 UTC, MODIS 20:15; 20:20

Study area for cloud clearing

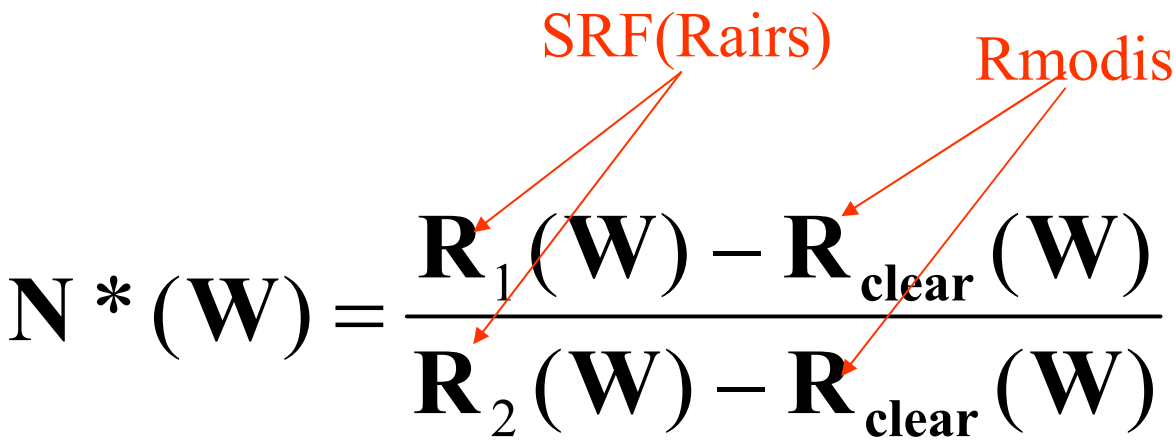


AIRS cloud detection from MODIS 1km cloud mask

Water, Weather

$$\mathbf{R}_{\mathbf{clear}}(\nu) = \frac{\mathbf{R}_1(\nu) - \mathbf{N}^*(\nu)\mathbf{R}_2(\nu)}{1 - \mathbf{N}^*(\nu)}$$

where $N^*(\nu)=\varepsilon_1(\nu)N_1/\varepsilon_2(\nu)N_2$. N* can be calculated in **MODIS spectral region** from **two adjacent AIRS cloudy footprints**



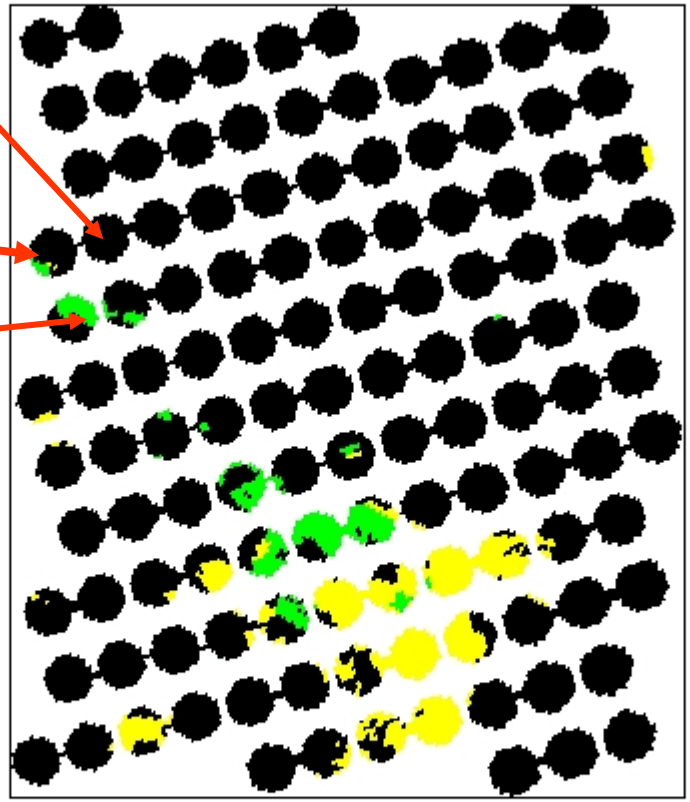
$$\mathbf{N}^*(\mathbf{W}) = \frac{\mathbf{R}_1(\mathbf{W}) - \mathbf{R}_{\mathbf{clear}}(\mathbf{W})}{\mathbf{R}_2(\mathbf{W}) - \mathbf{R}_{\mathbf{clear}}(\mathbf{W})}$$

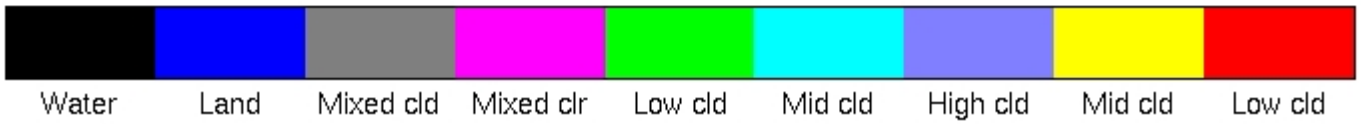
Clear neighbor
for reference

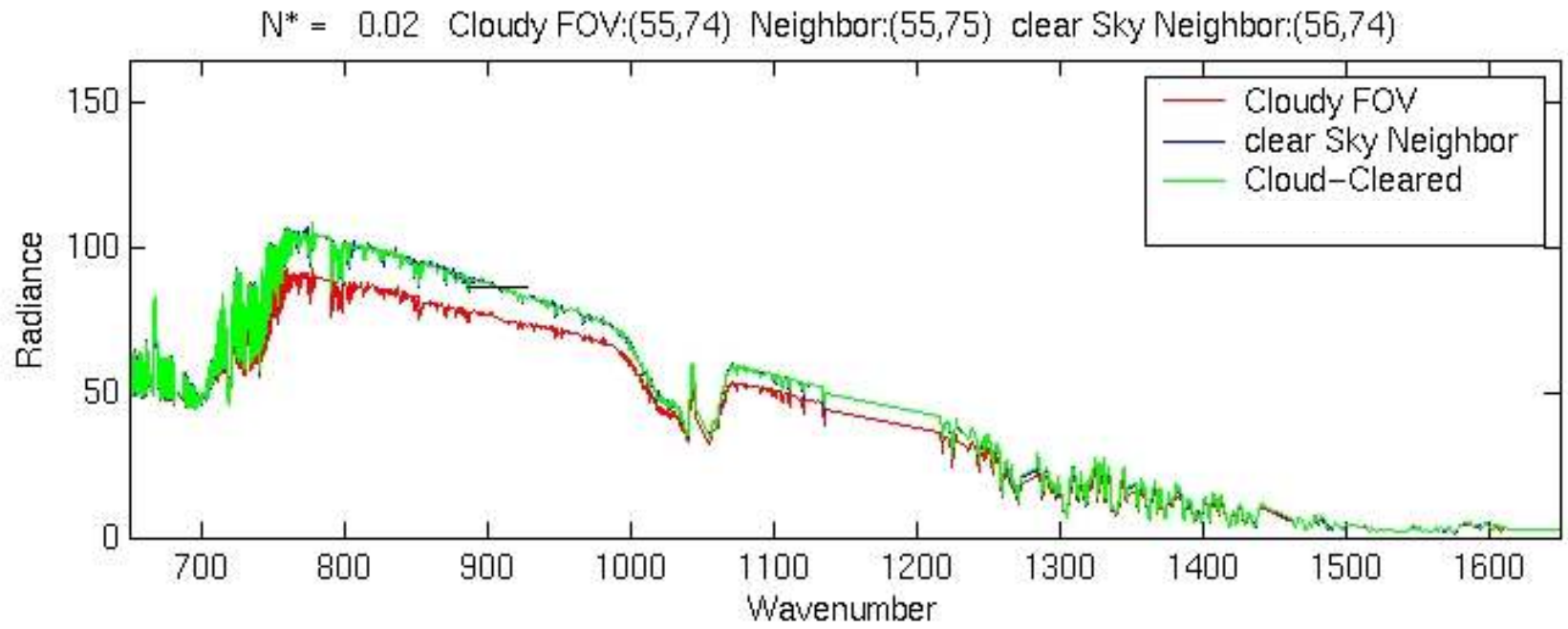
Cloudy FOV

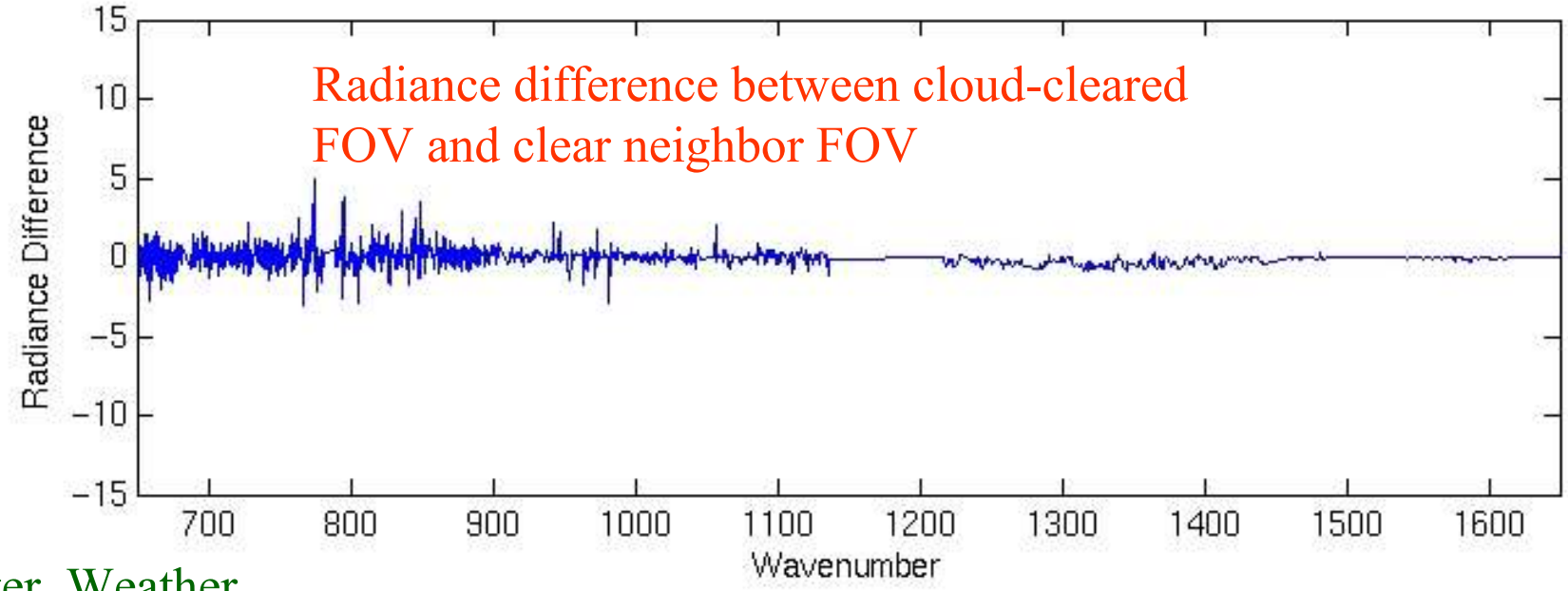
(Line 74, column 55)

Cloudy neighbor for N*



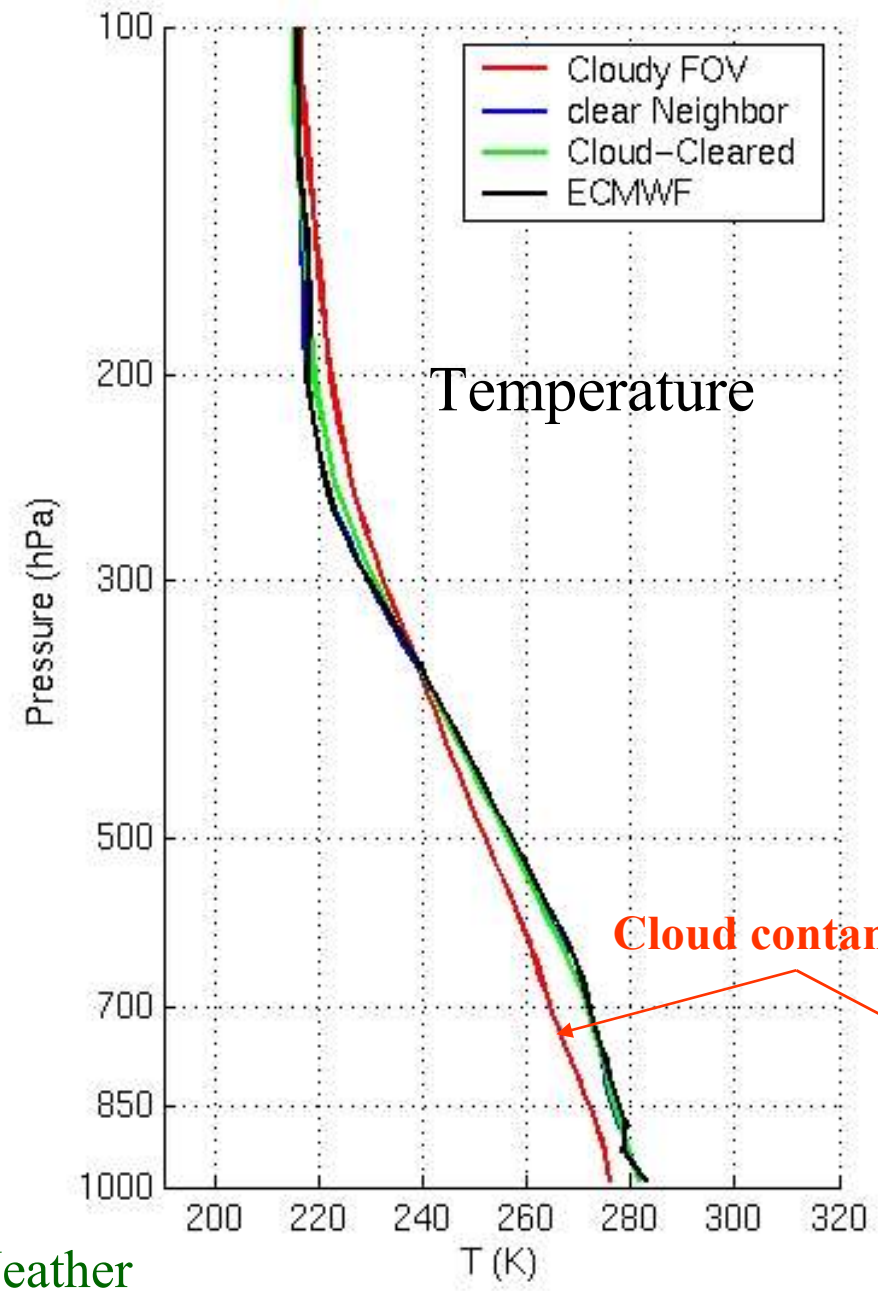




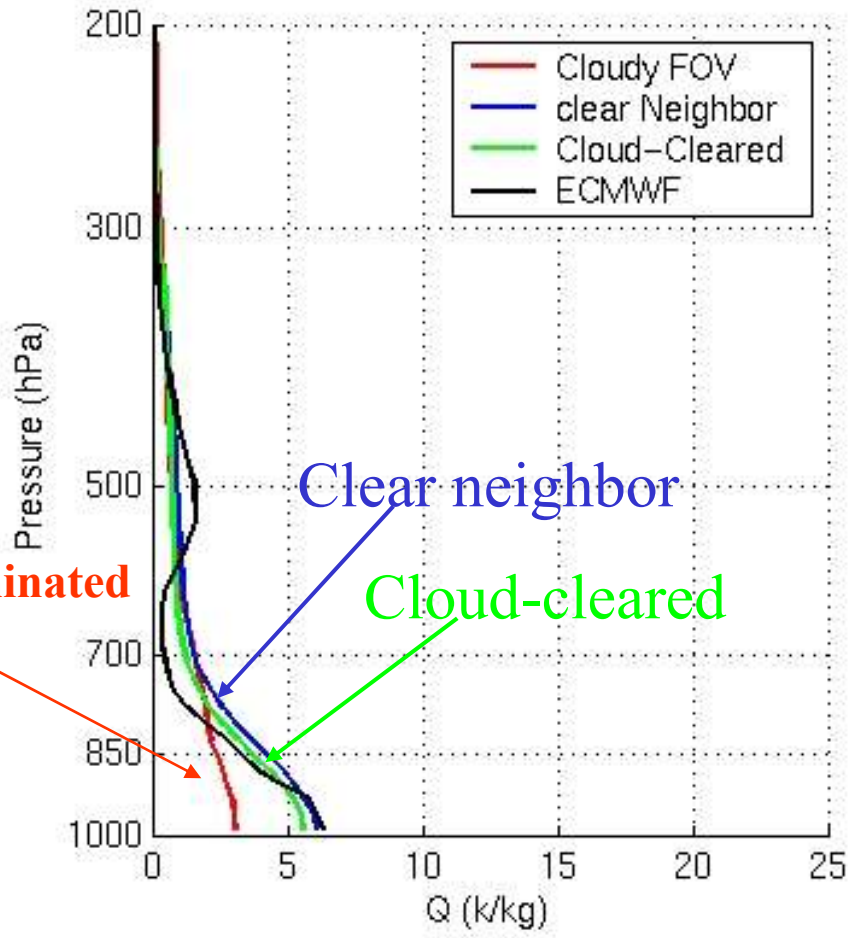


Water, Weather

AIRS single FOV profile retrieval versus ECMWF analysis



Water Vapor Mixing Ratio



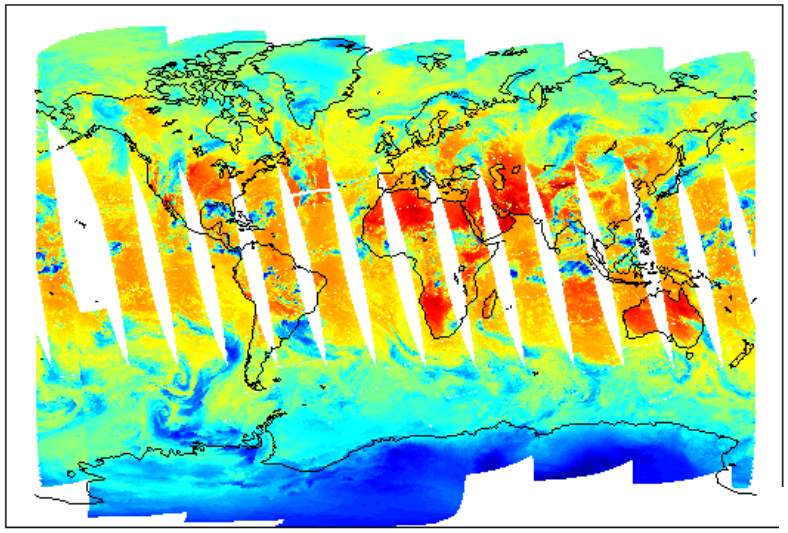
Cloud contaminated

Clear neighbor

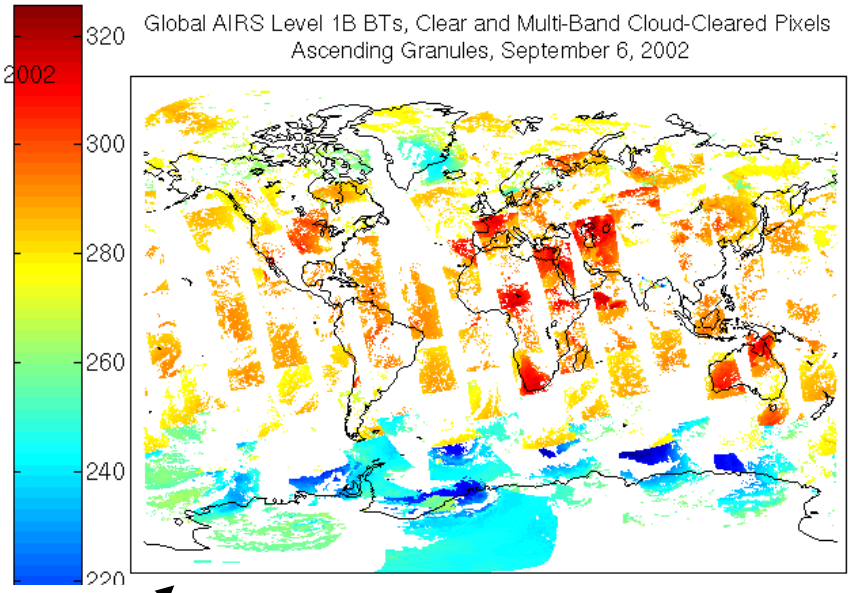
Cloud-cleared

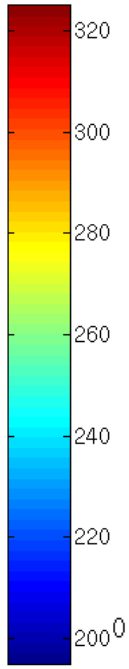
Weather

Global AIRS Level 1B Brightness Temperatures, Ascending Granules, September 6, 2002



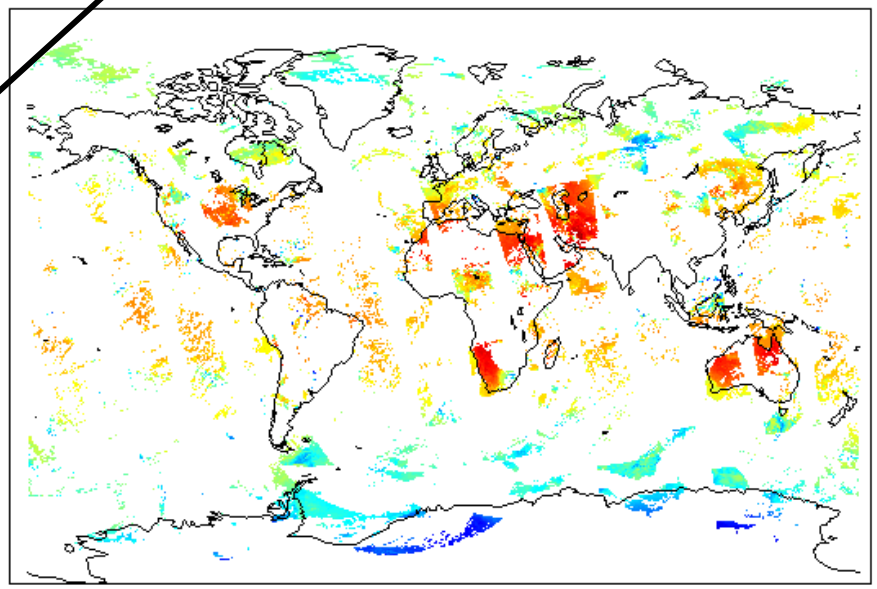
Global AIRS Level 1B BTs, Clear and Multi-Band Cloud-Cleared Pixels
Ascending Granules, September 6, 2002



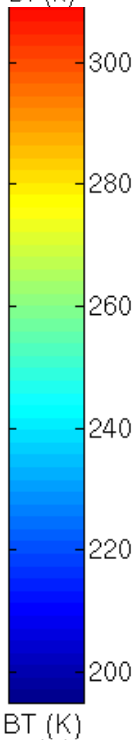


AIRS BT
(All)

AIRS BT
(Cloud-Cleared)



AIRS BT
(Clear Only)

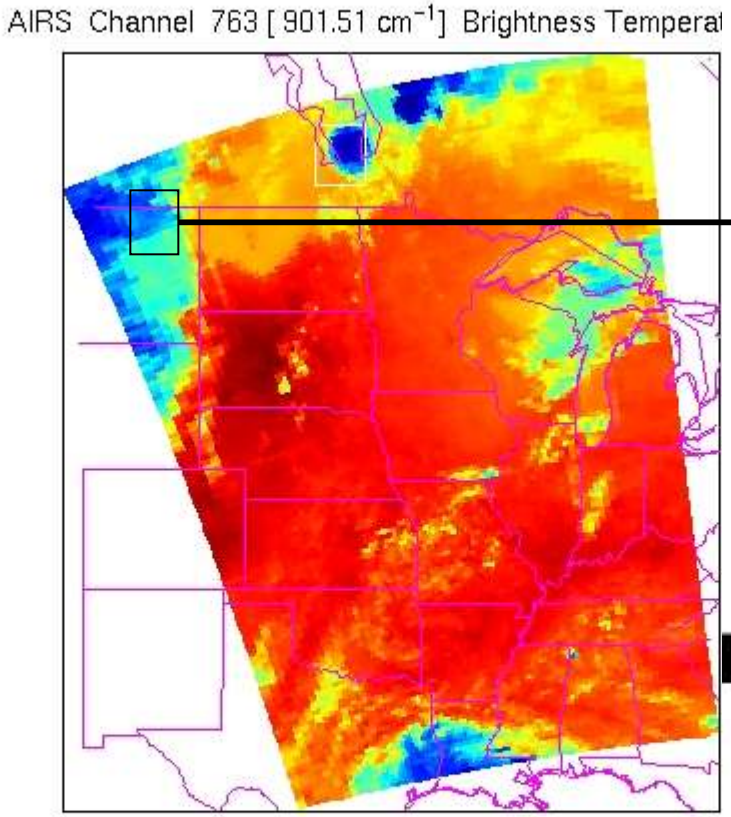


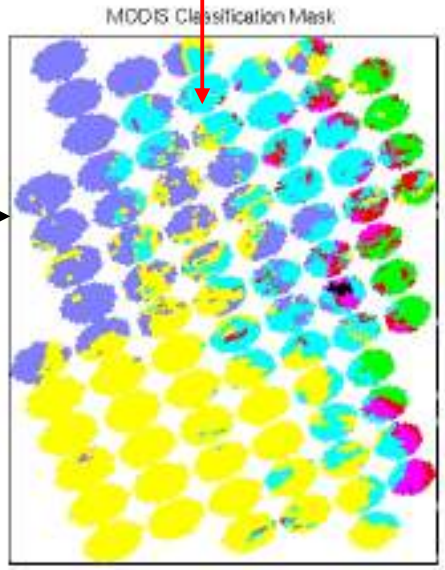
Weather

Improving Cloud Property Retrievals in IR

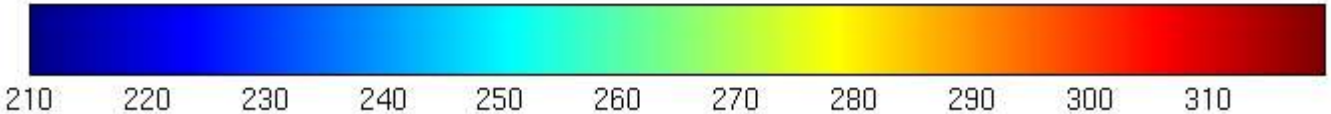
Thick ice clouds, see next slide

Sept.06, 2002 granule 193



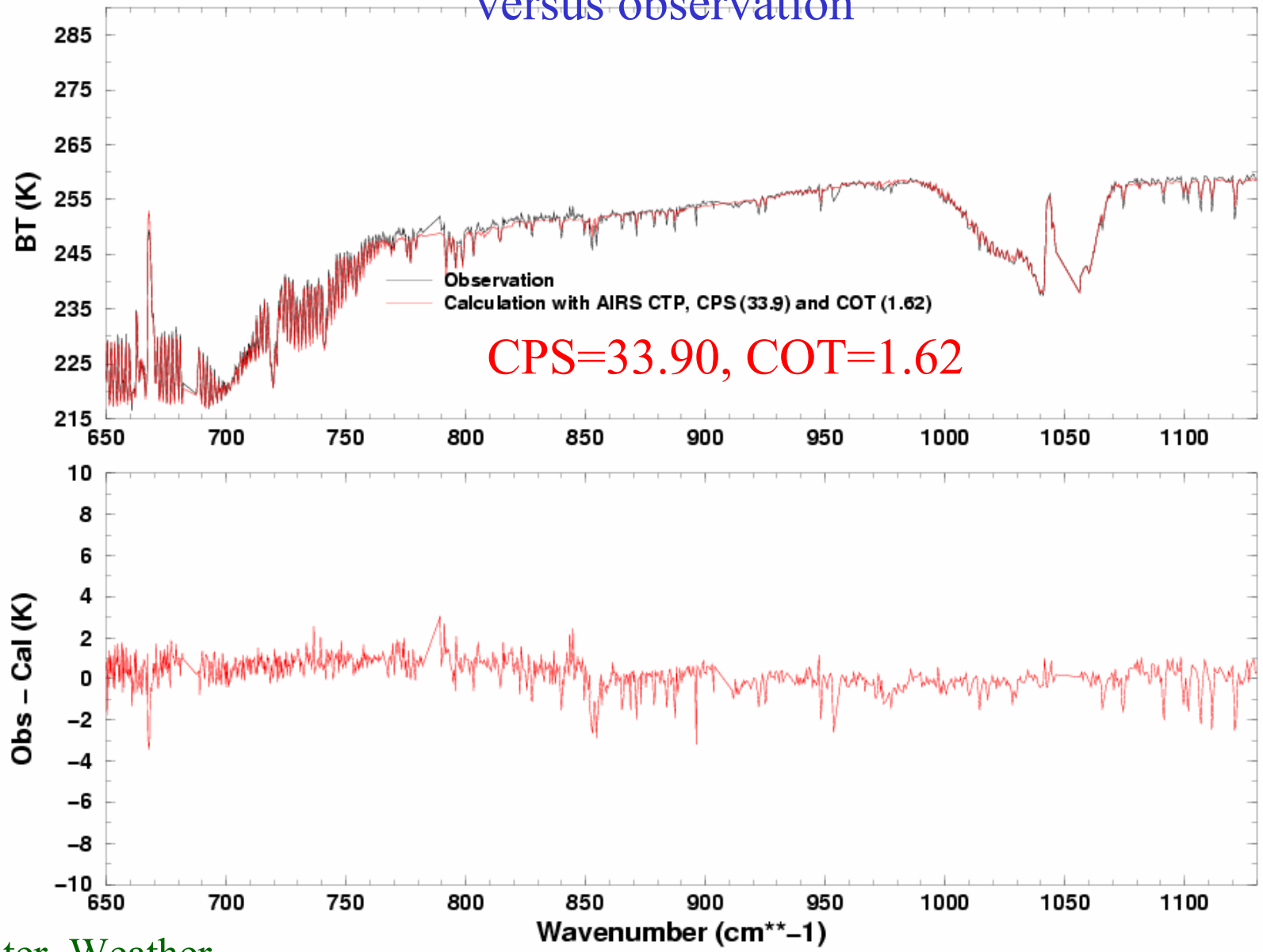


1km MODIS classification mask superimposed to AIRS footprints



BT(K)

AIRS calculation with ***MODIS/AIRS CTP, CPS, and COT*** versus observation



Water, Weather

Combining Observations

- Radiance Comparisons
- Product Comparisons
- Combined Retrievals
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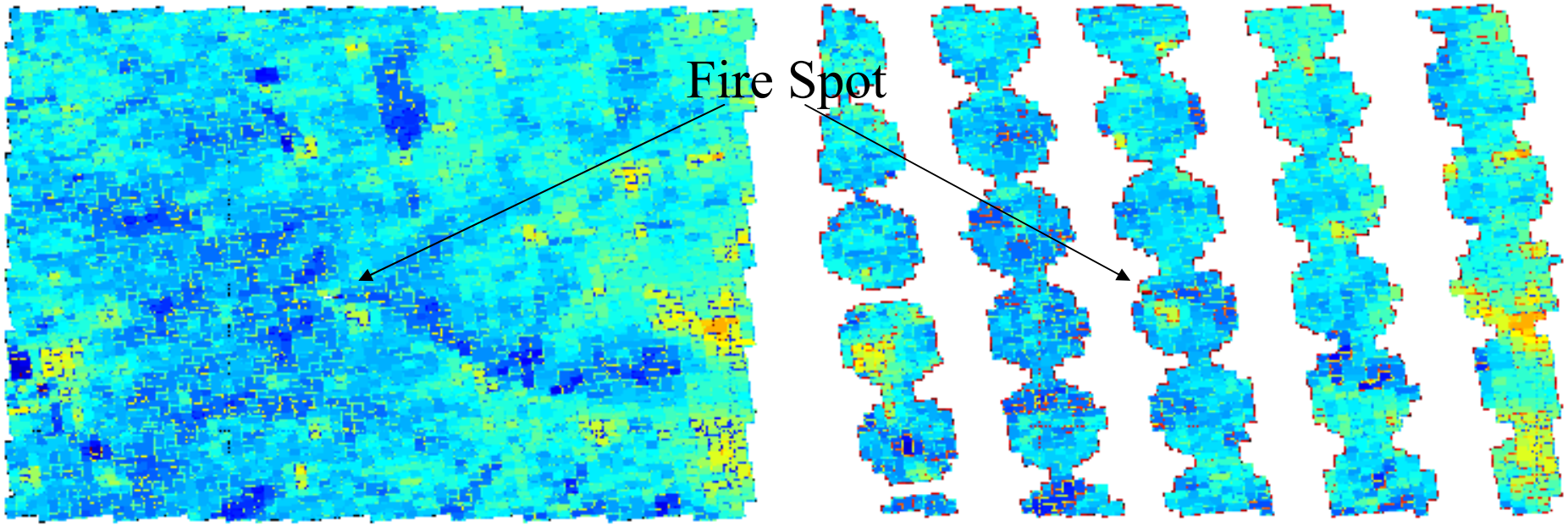
Student Project: Tire Fire



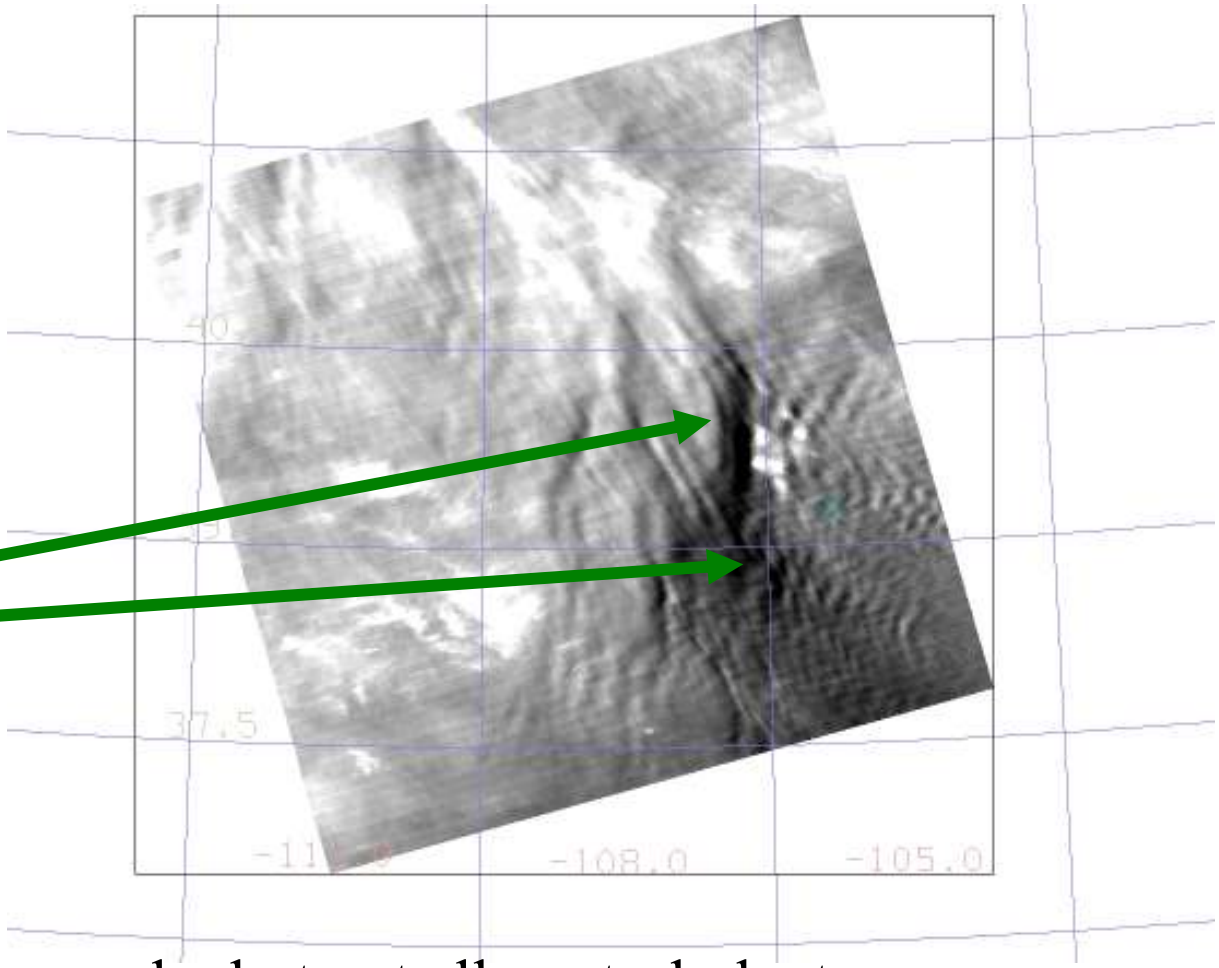
Composition

Mountain wave Turbulence from MODIS

MODIS 6.7 micron image over CO

March 6, 2004

Lee Waves



Waves frequently observed – but not all are turbulent.

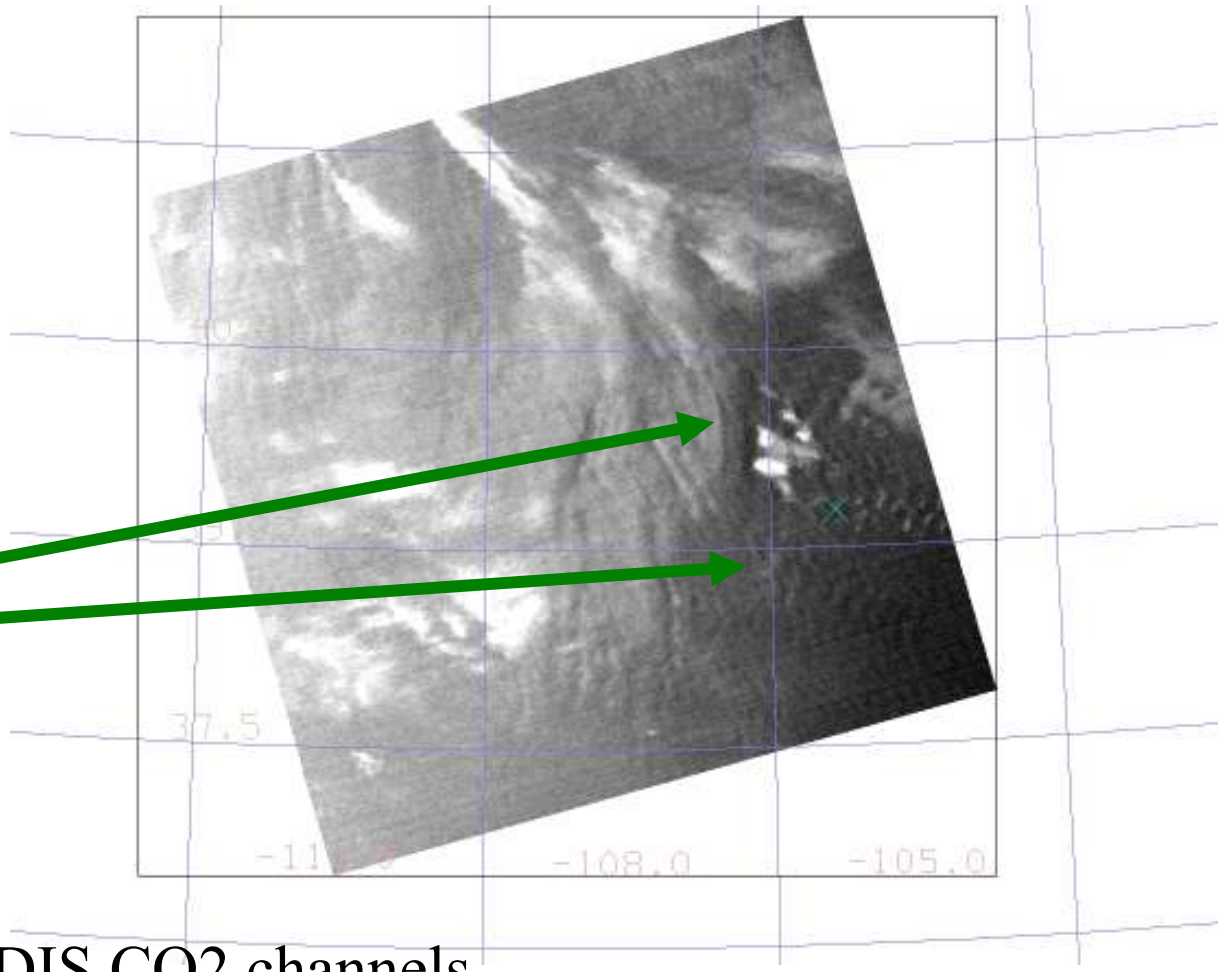
Mountain wave Turbulence from MODIS

Next Step: Validate Model Simulations

MODIS 14.2 micron image over CO

March 6, 2004

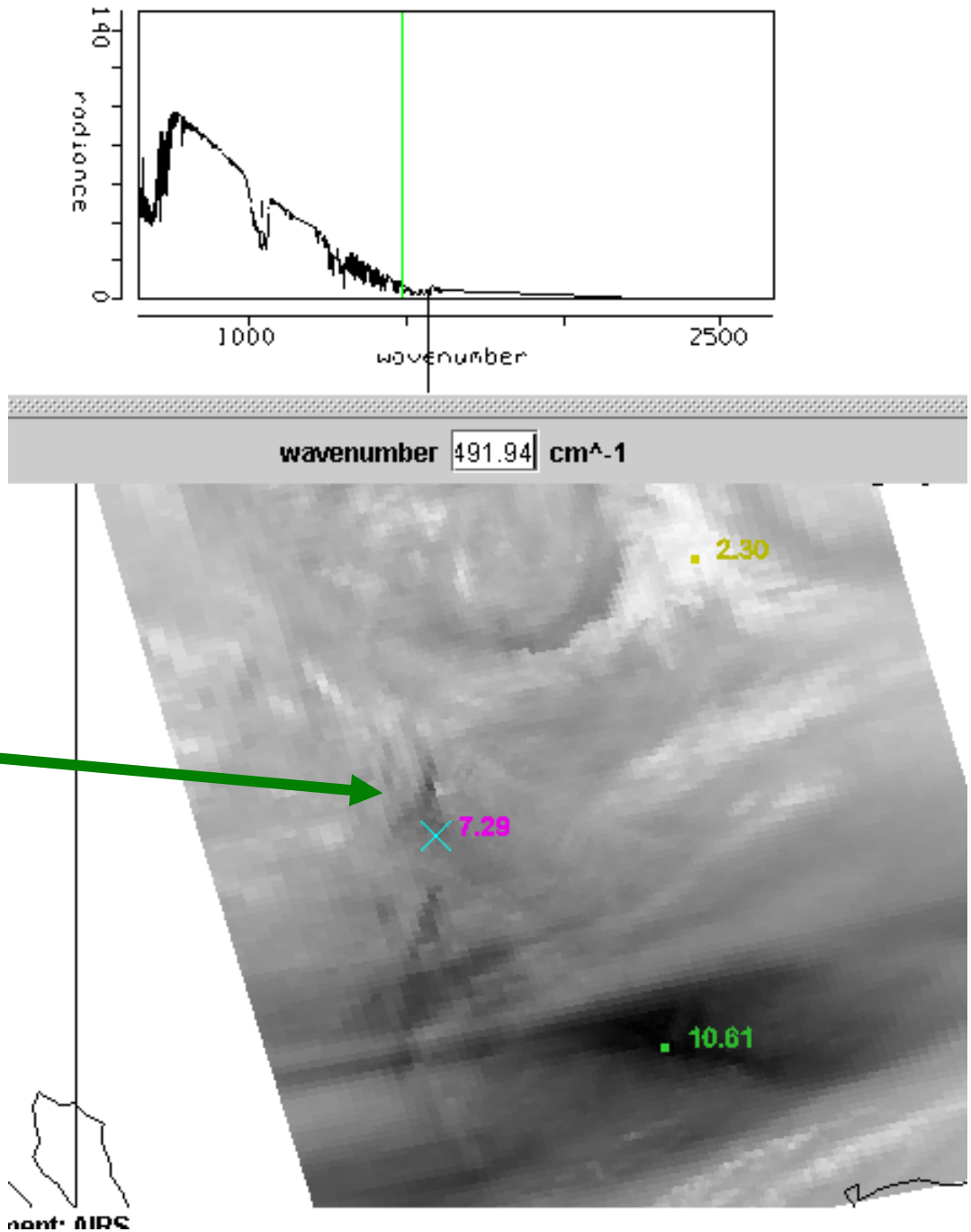
Lee Waves



Waves seen in MODIS CO2 channels

AIRS 6.7 micron:

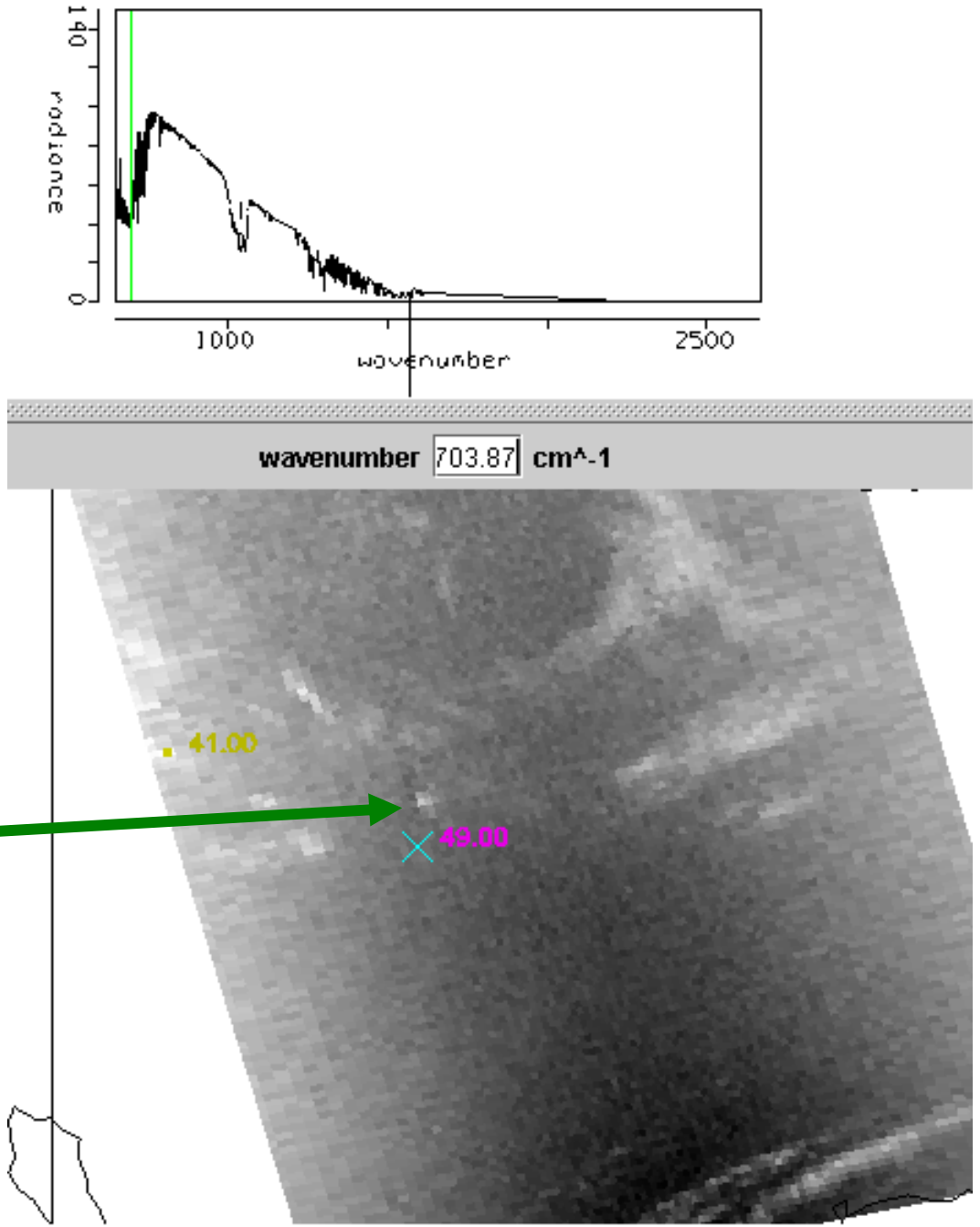
Large footprint, mountain waves still visible, but not detailed pattern.



AIRS 14.2 micron (stratospheric channel):

Large footprint, mountain waves still visible.

Vertically propagating waves



Summary

- AIRS/MODIS calibration/validation activities demonstrate MODIS IR capabilities
- Comparison of MODIS products with other instruments is promising.
- MODIS masks (cloud mask, cloud phase mask, cloud classification mask) and radiances with 1km spatial resolution can be use for the AIRS sub-pixel cloud characterization.
- MODIS data used for AIRS cloud-clearing for partly cloudy AIRS footprints.
- Combined observations provide insight into algorithm performance, but also atmospheric behavior/structure.