

Synergistic use of high spatial resolution imager and high spectral resolution sounder for atmospheric and cloud retrievals

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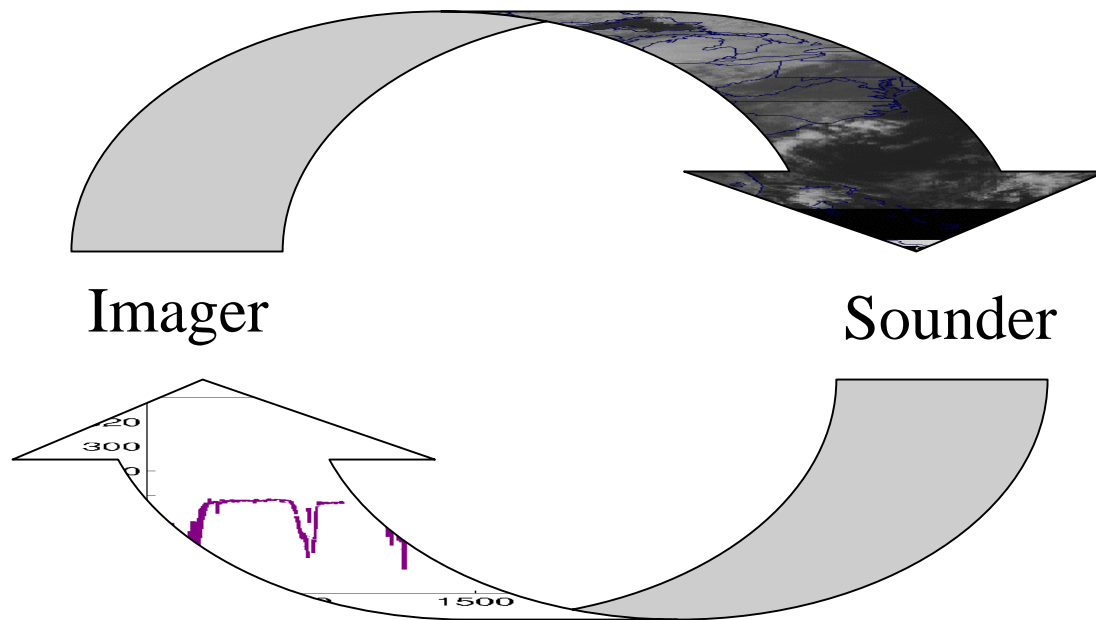
29 October 2003 - 4 November 2003



Best products will be realized from combinations of imager *and* sounder data!

Using MODIS/AIRS data to simulate ABI/HES system !

Better cloud detection and characterization, better spatial, etc



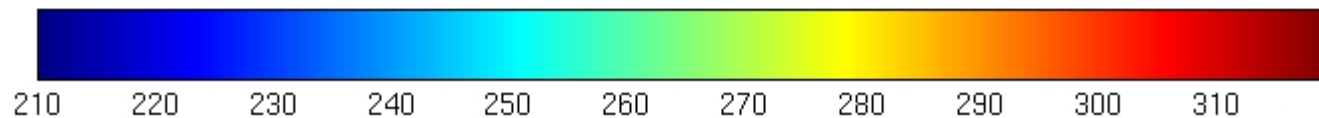
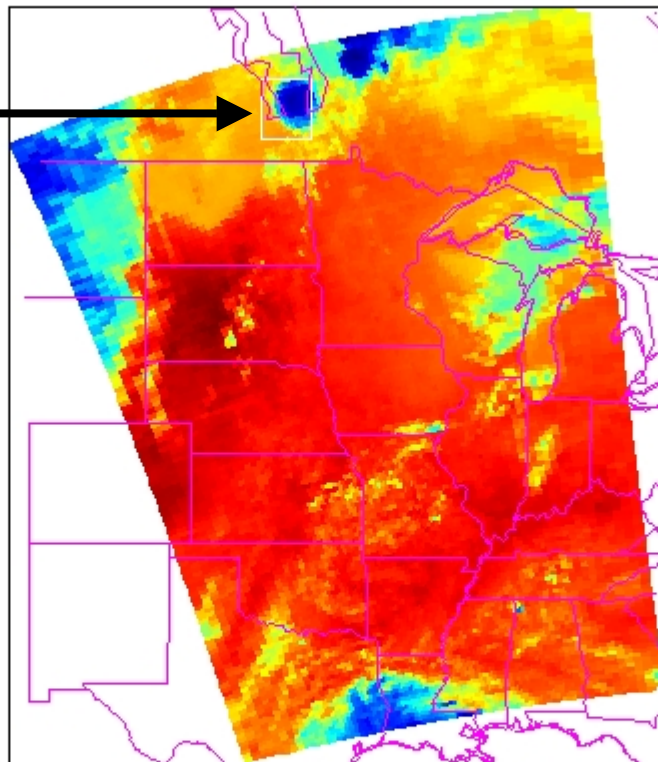
Better surface emissivity, better spectral, better accuracy, etc

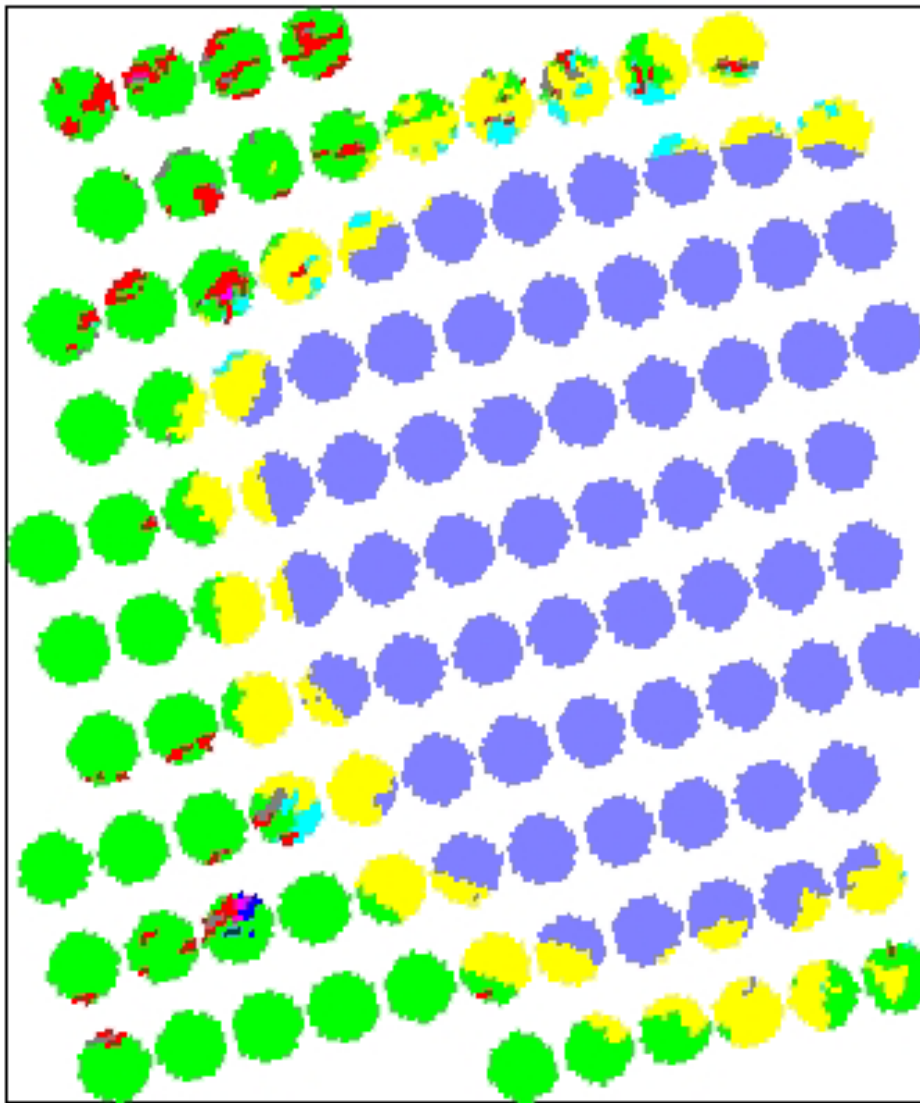
What can we do for MODIS/AIRS synergistic retrieval?

- AIRS sub-pixel cloud detection and characterization using MODIS data
- MODIS products serve as the background information for sounder retrieval

AIRS Channel 763 [901.51 cm⁻¹] Brightness Temperature

A1

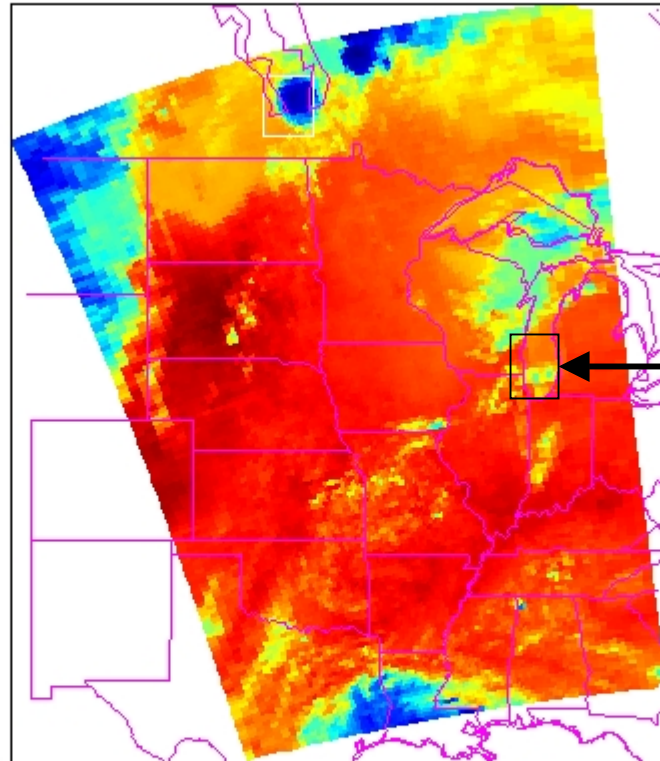




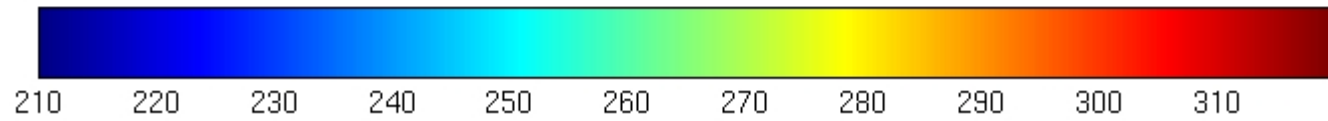
MODIS classification mask at 1km resolution



AIRS Channel 763 [901.51 cm⁻¹] Brightness Temperature



A2



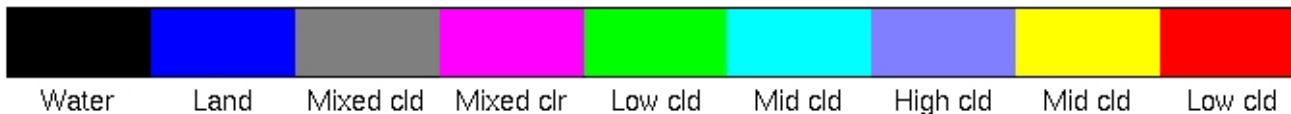
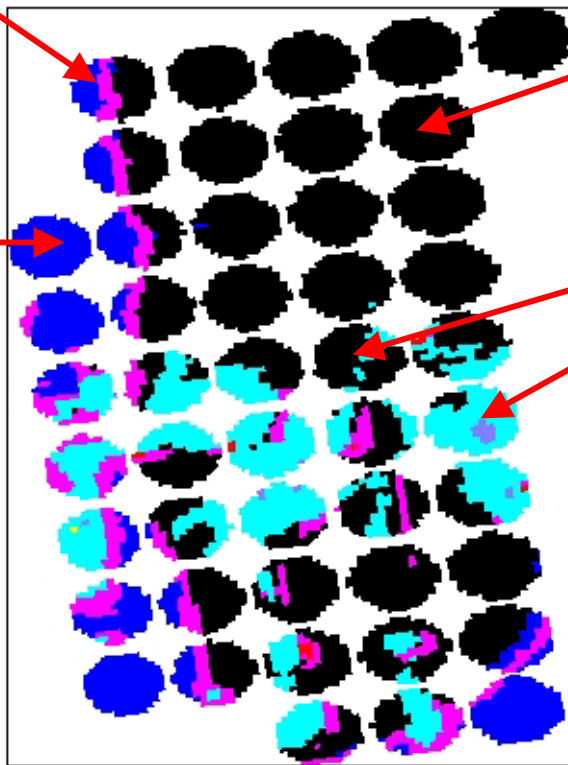
Clear mixed water/land (Milwaukee)

Clear Water

Clear Land

Cloudy FOV

MODIS Classification Mask



What can we do for MODIS/AIRS synergistic retrieval?

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1DVAR algorithm for cloud retrieval (Li, Menzel and Schreiner 2001)

Observed AIRS Radiance Measurements

Background Information from MODIS

$$J(X) = [R^m - R(X)]^T E^{-1} [R^m - R(X)] + [X - X_B]^T B^{-1} [X - X_B]$$

Fast Cloudy Radiative Transfer Model: coupled

- (1) Single - Scattering Cloud Model and
- (2) AIRS Clear Sky Radiance Model – SARTA.
- (3) Temperature/moisture profiles are from ECMWF.

$$X = (CTP, ECA_1, ECA_2, ECA_3, \dots, ECA_{10}, CPS, COT)$$

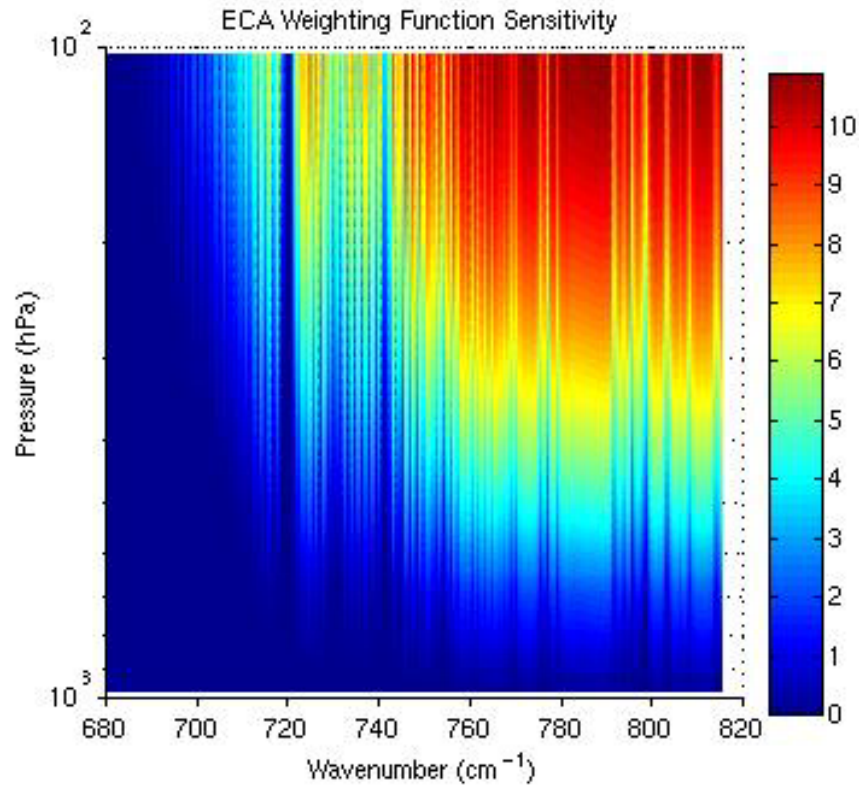
CTP: Cloud-Top Pressure

ECA: Effective Cloud Amount

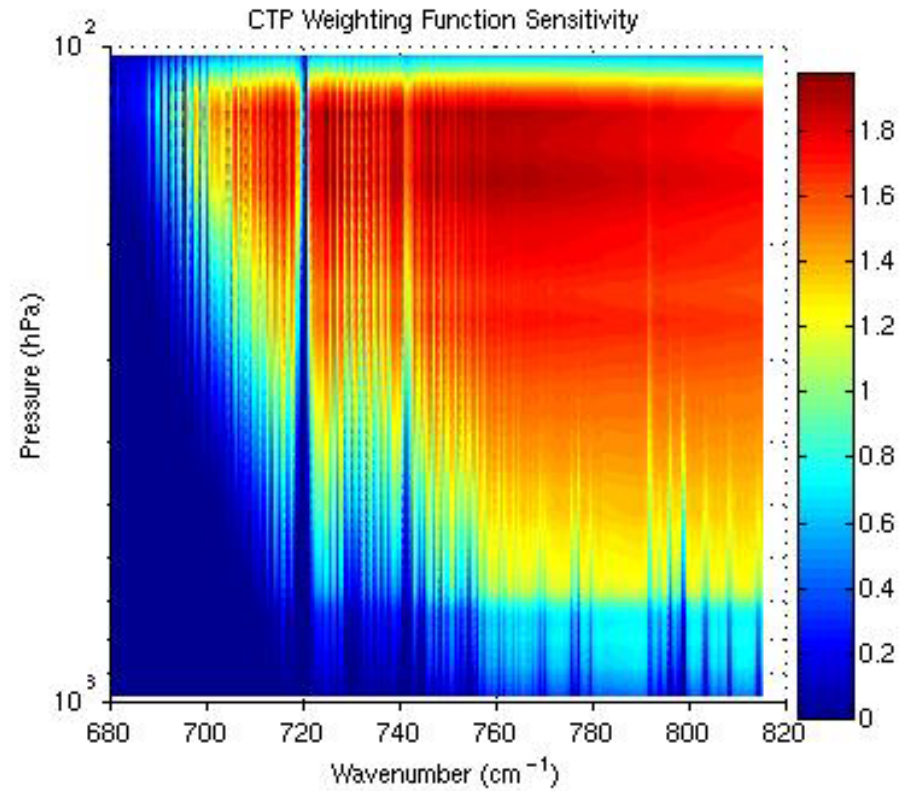
CPS: Cloud Particle Size

COT: Cloud Optical Thickness at $0.55\mu\text{m}$

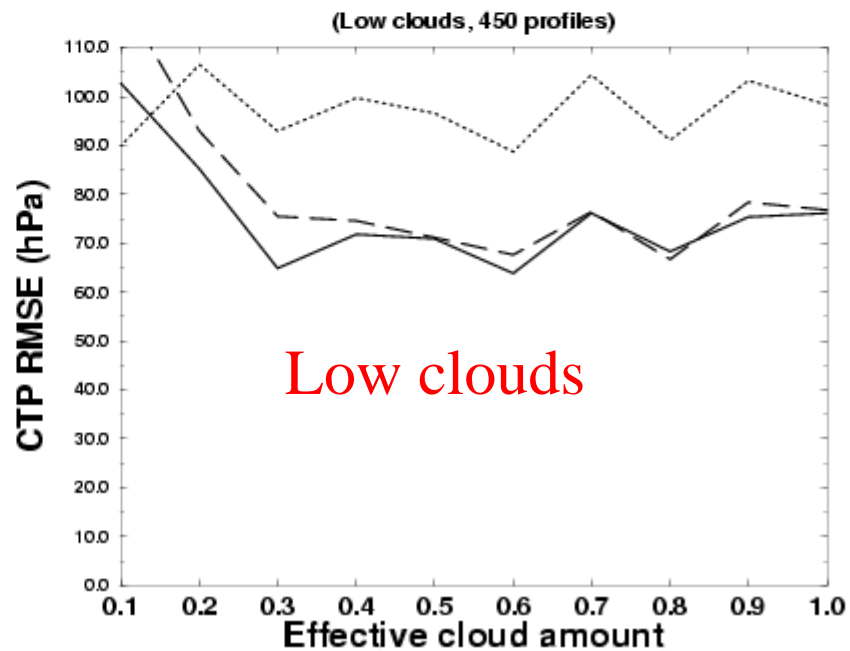
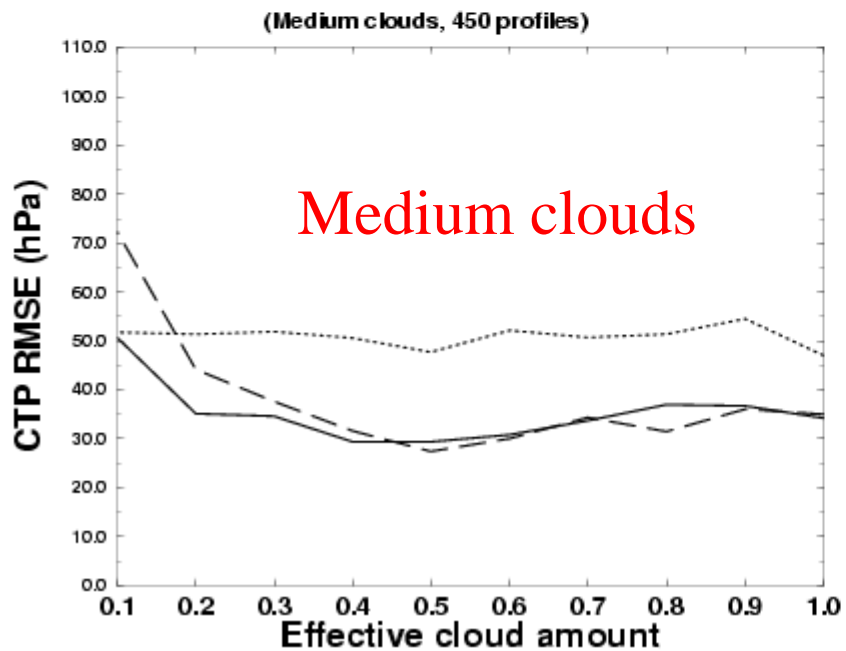
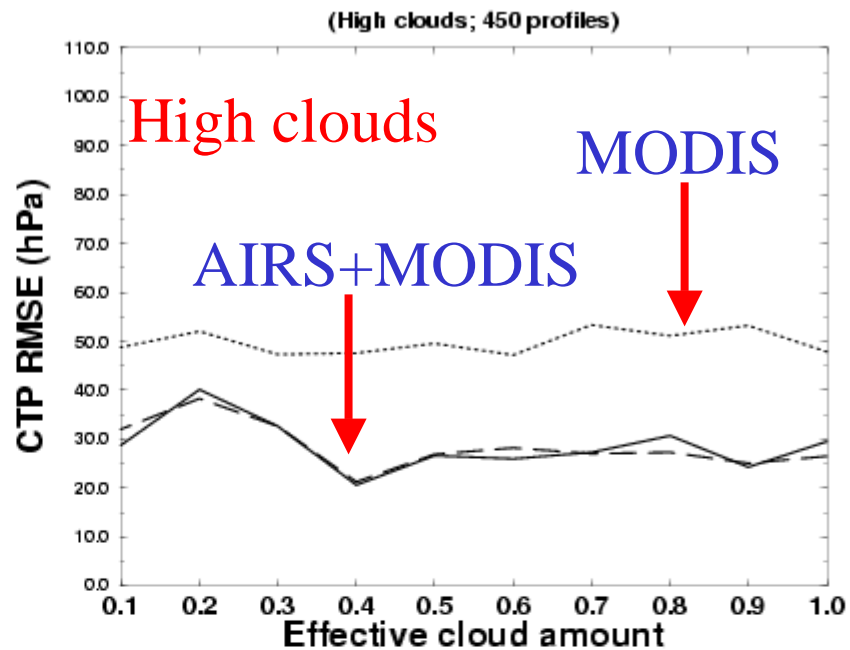
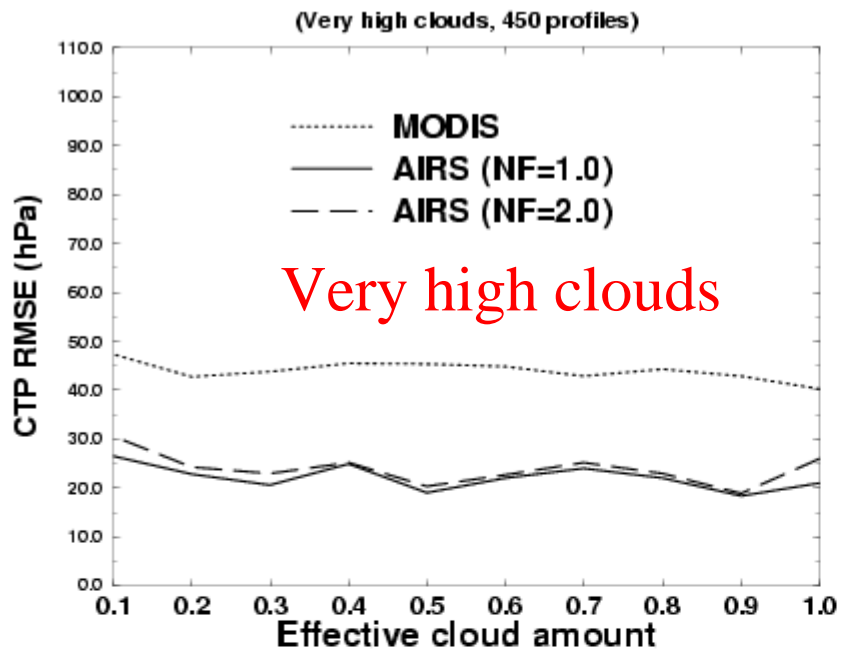
ECA Sensitivity

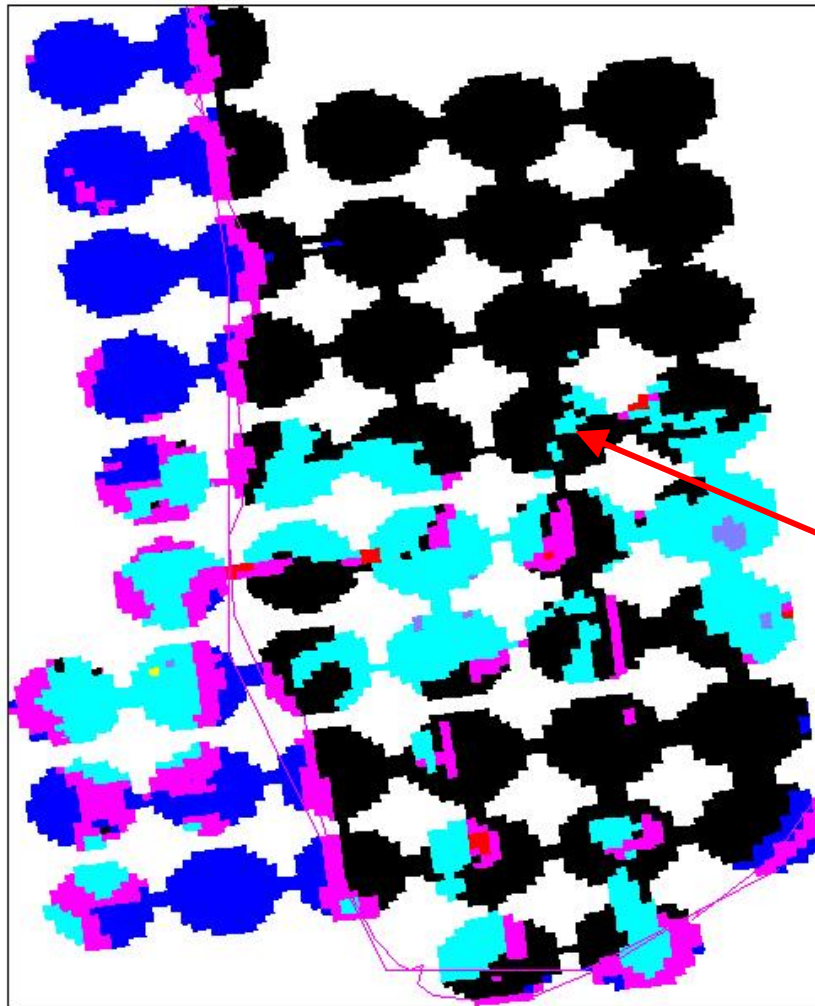


CTP Sensitivity



Tropical atmosphere



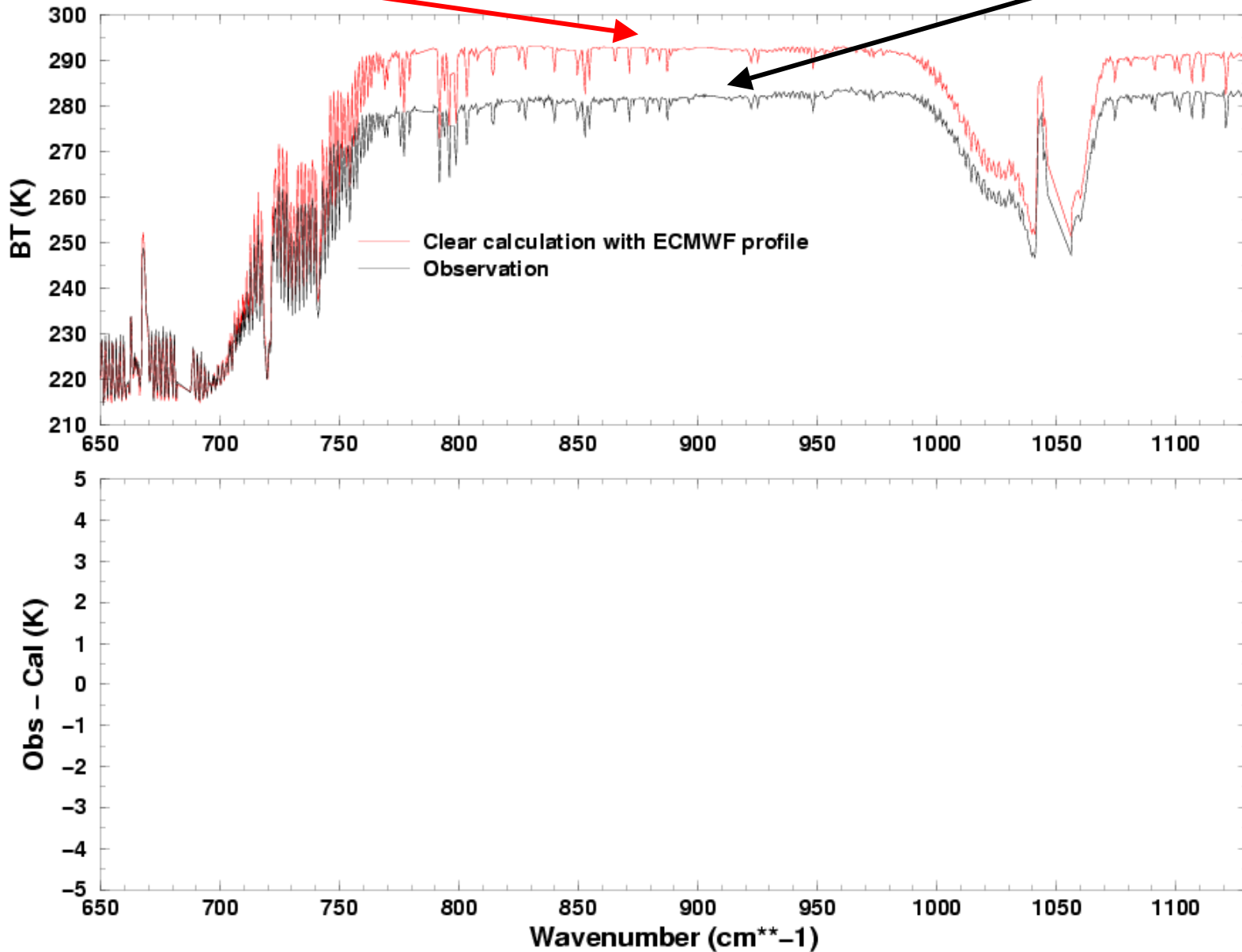


Thin ice clouds

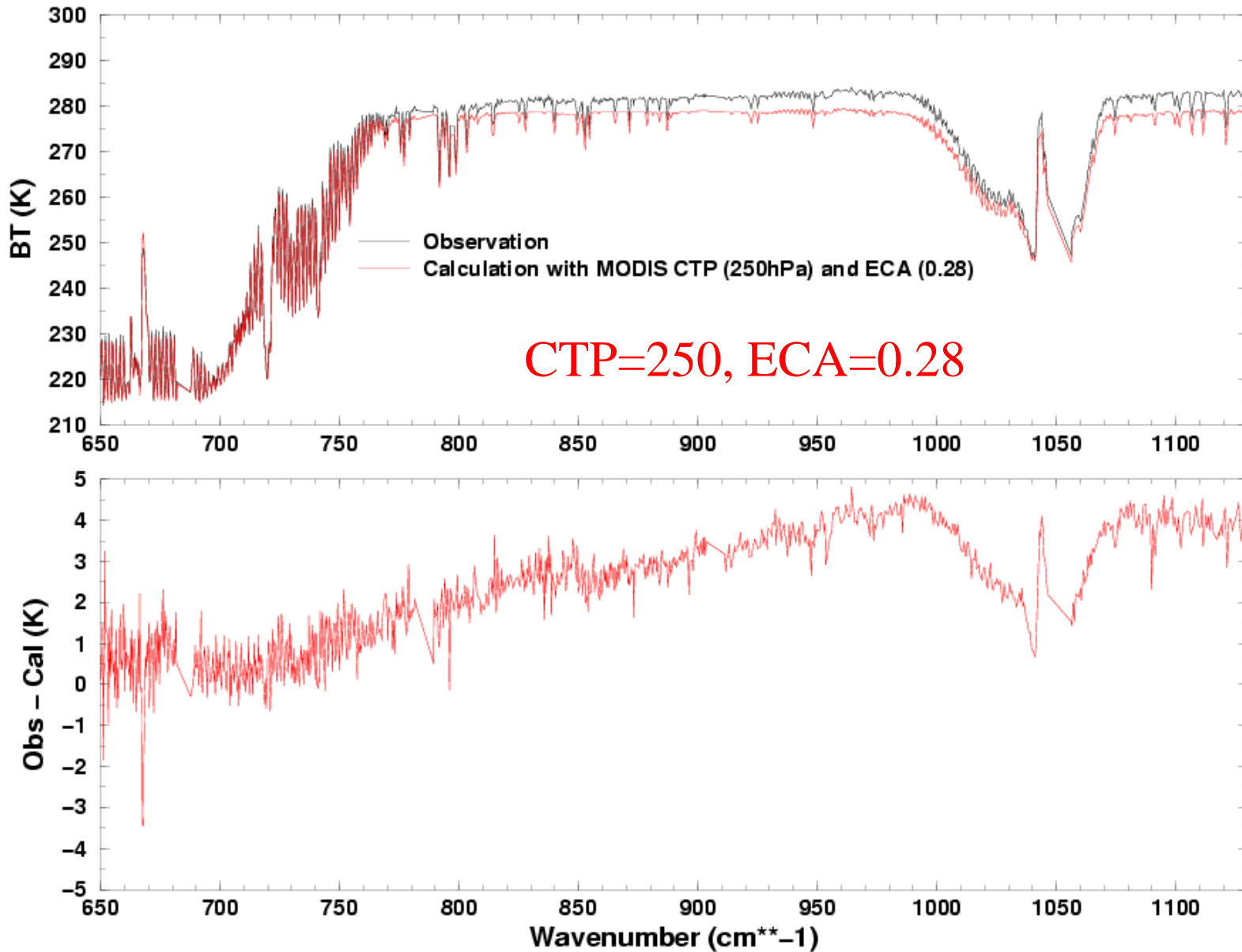


Water Land Mixed Cld Mixed Cld Low Cld Mid Cld High Cld M.L.Cld Low Cld

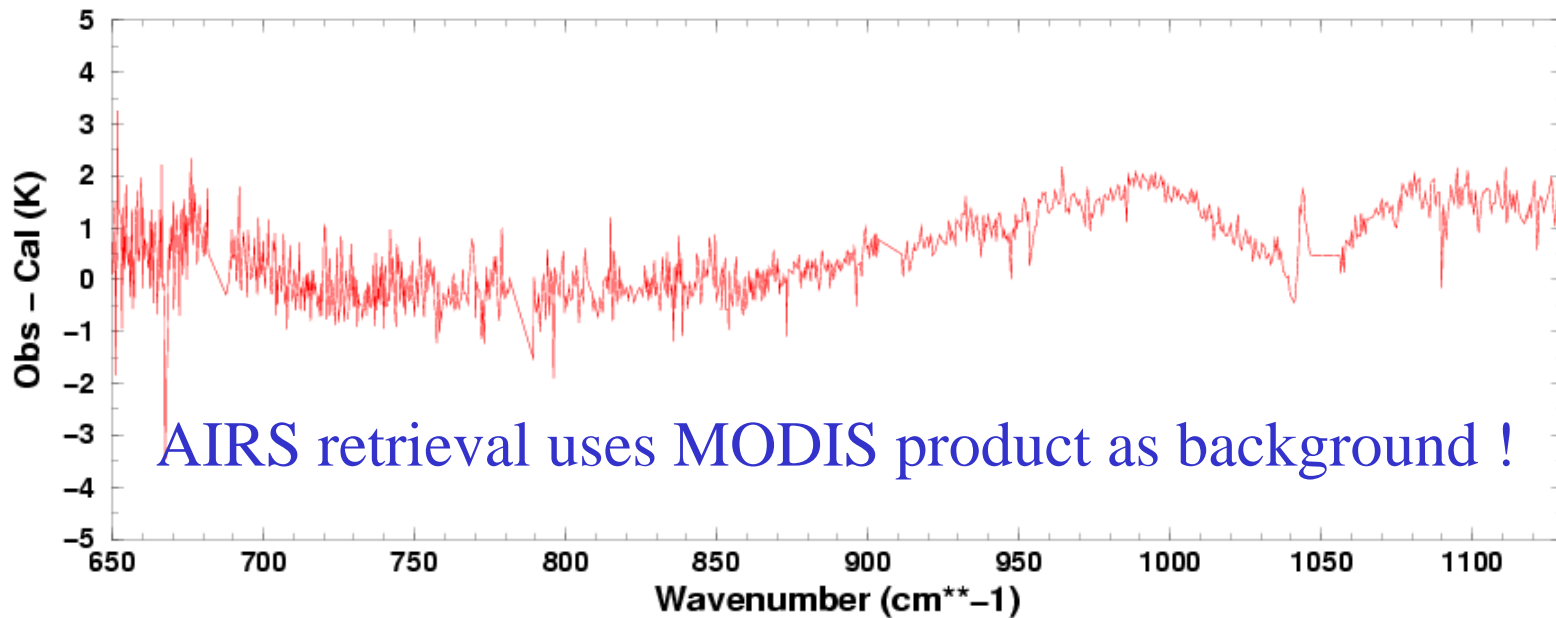
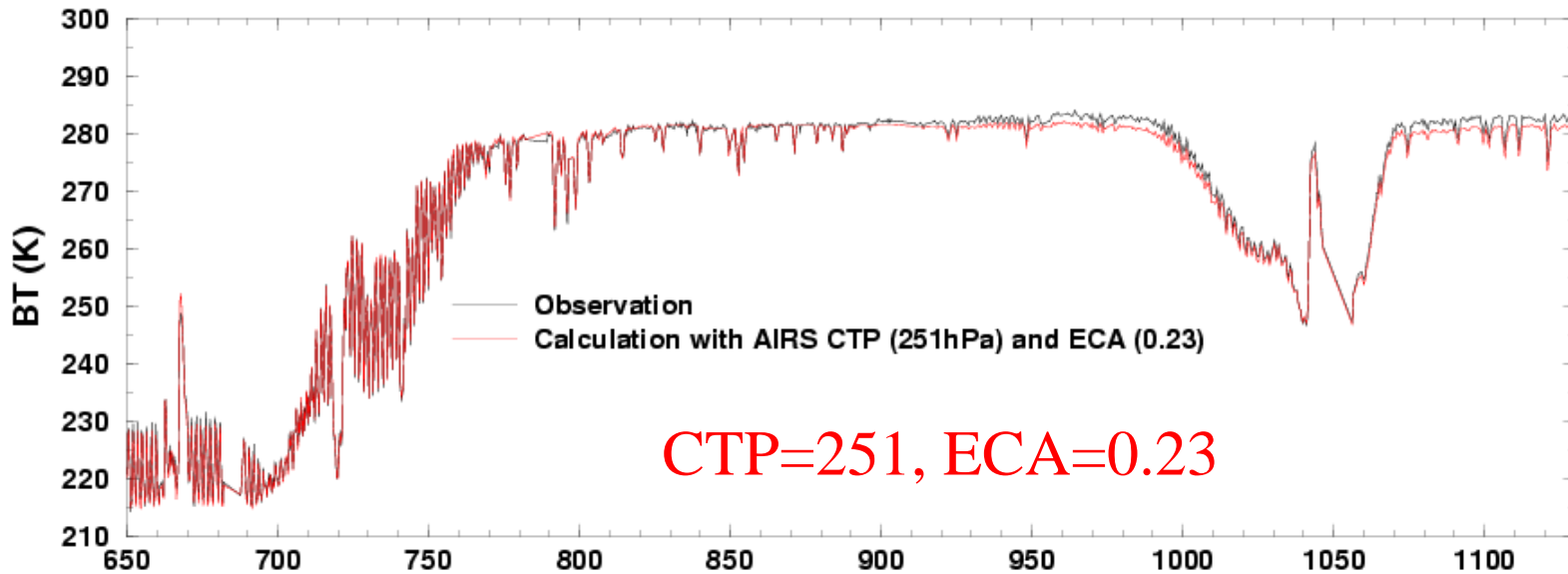
AIRS clear calculation with *ECMWF profile* versus cloudy observation



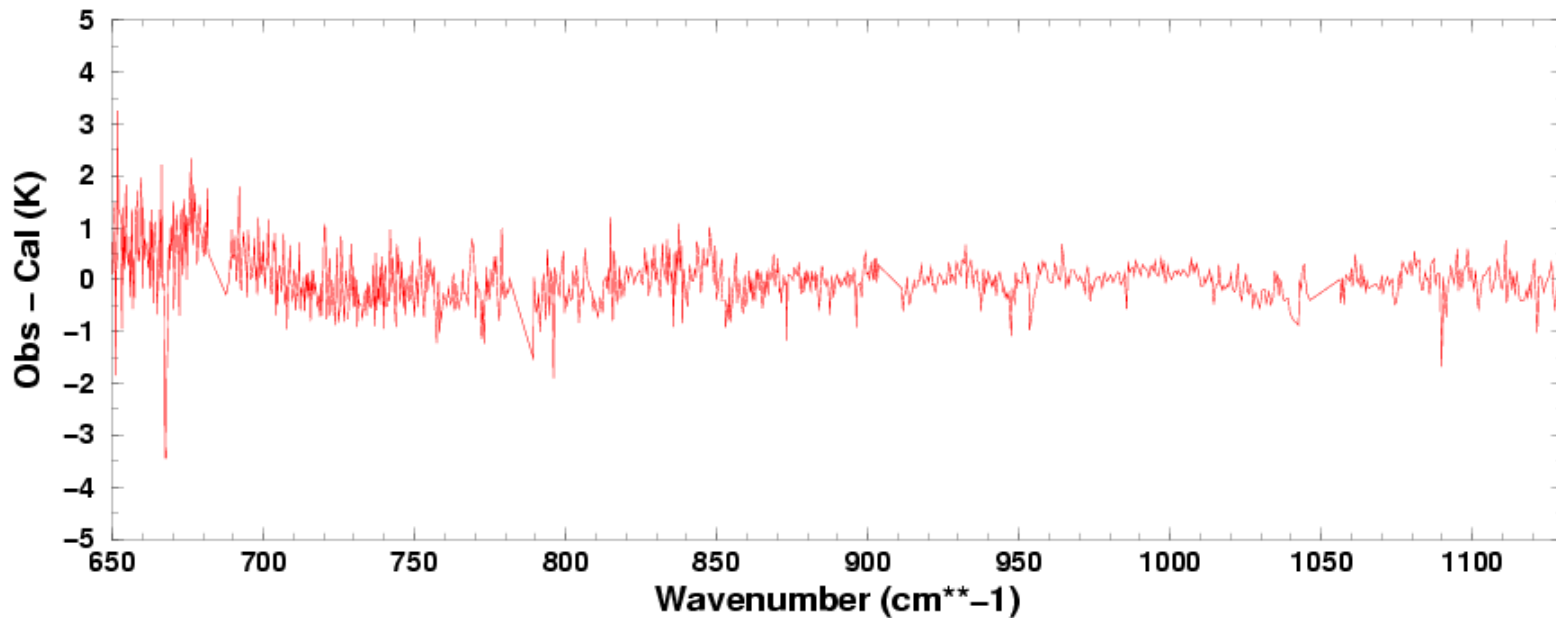
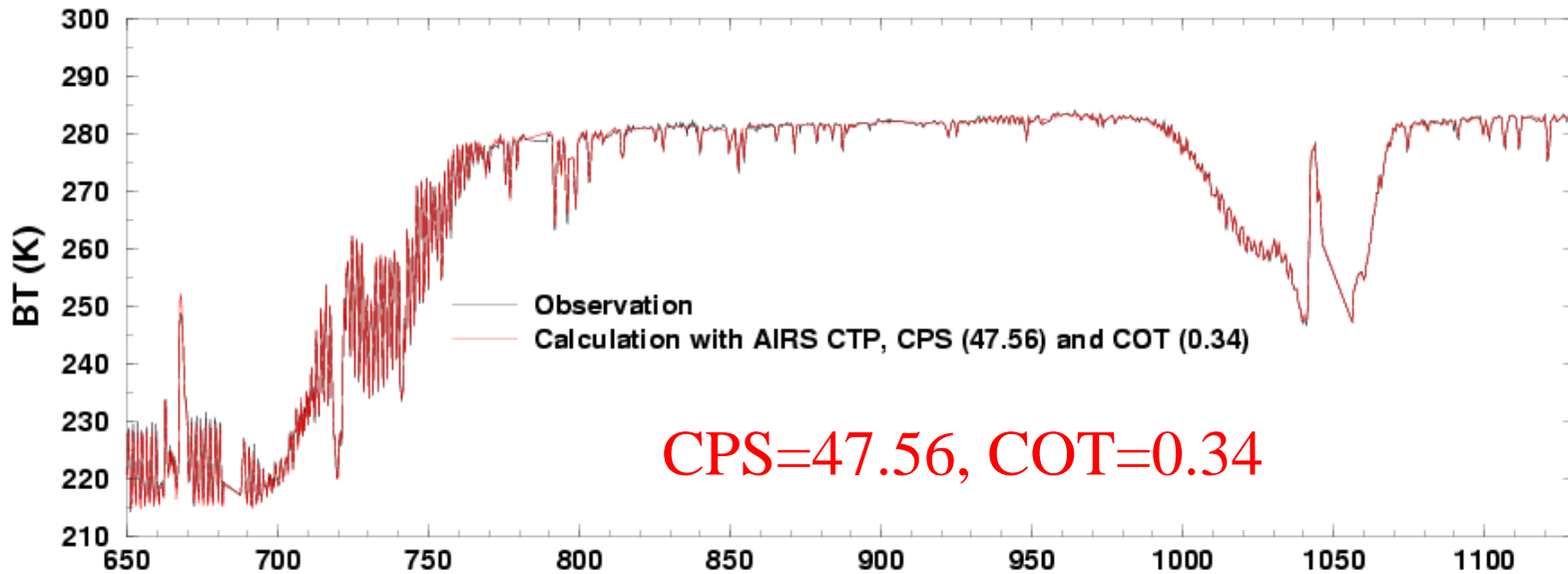
AIRS cloudy calculation with *MODIS CTP and ECA* versus cloudy observation



AIRS cloudy calculation with *AIRS CTP and ECA* versus cloudy observation

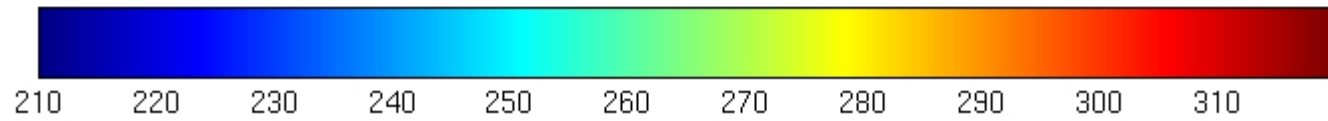
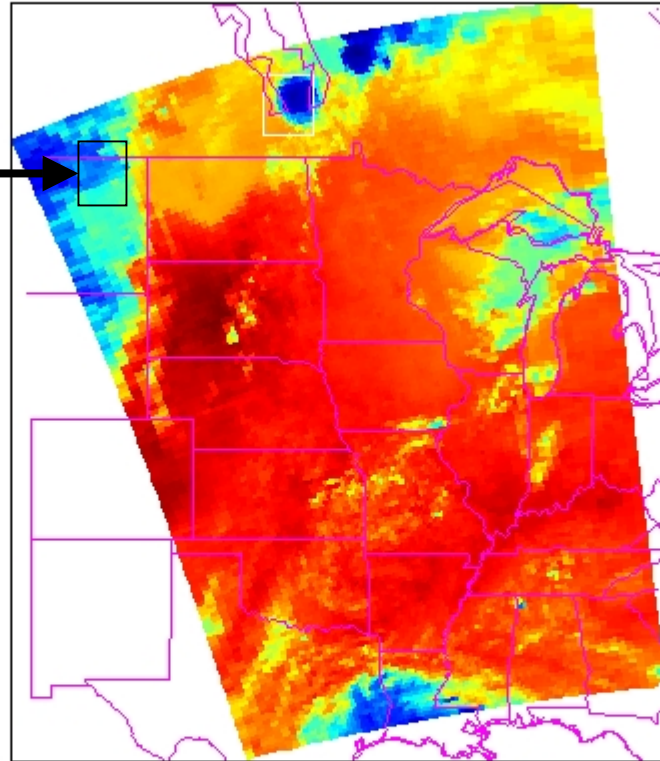


AIRS cloudy calculation with *AIRS CTP, CPS, and COT* versus cloudy observation



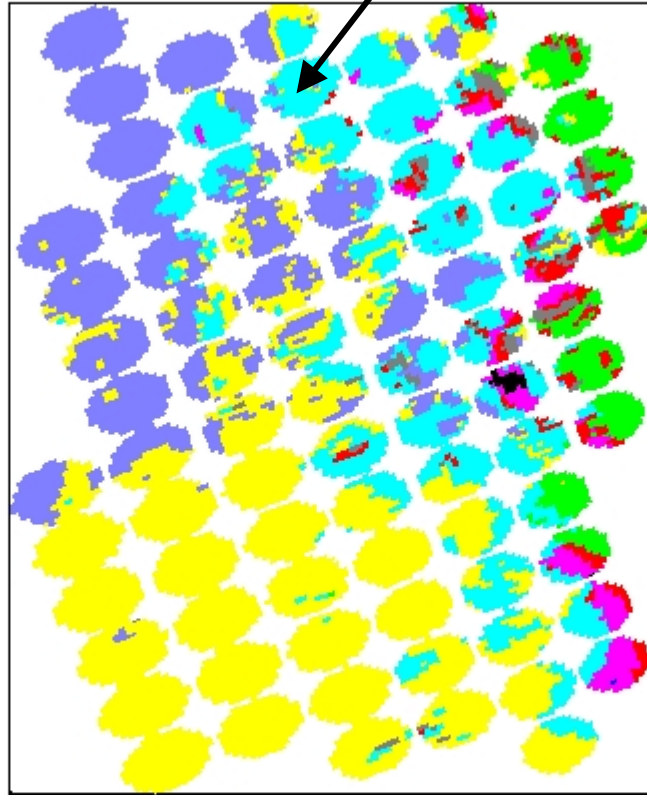
AIRS Channel 763 [901.51 cm⁻¹] Brightness Temperature

A3

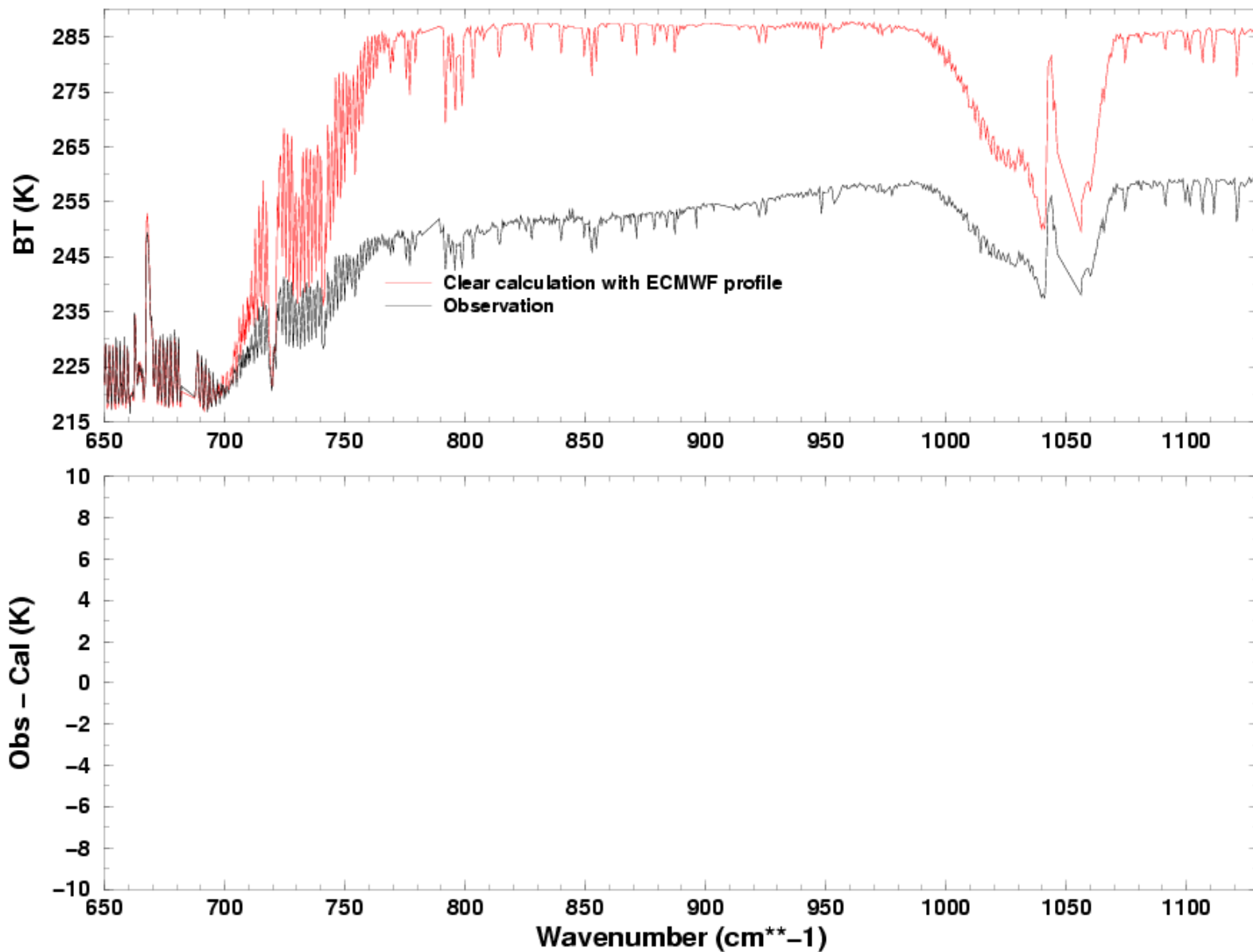


Thick ice clouds

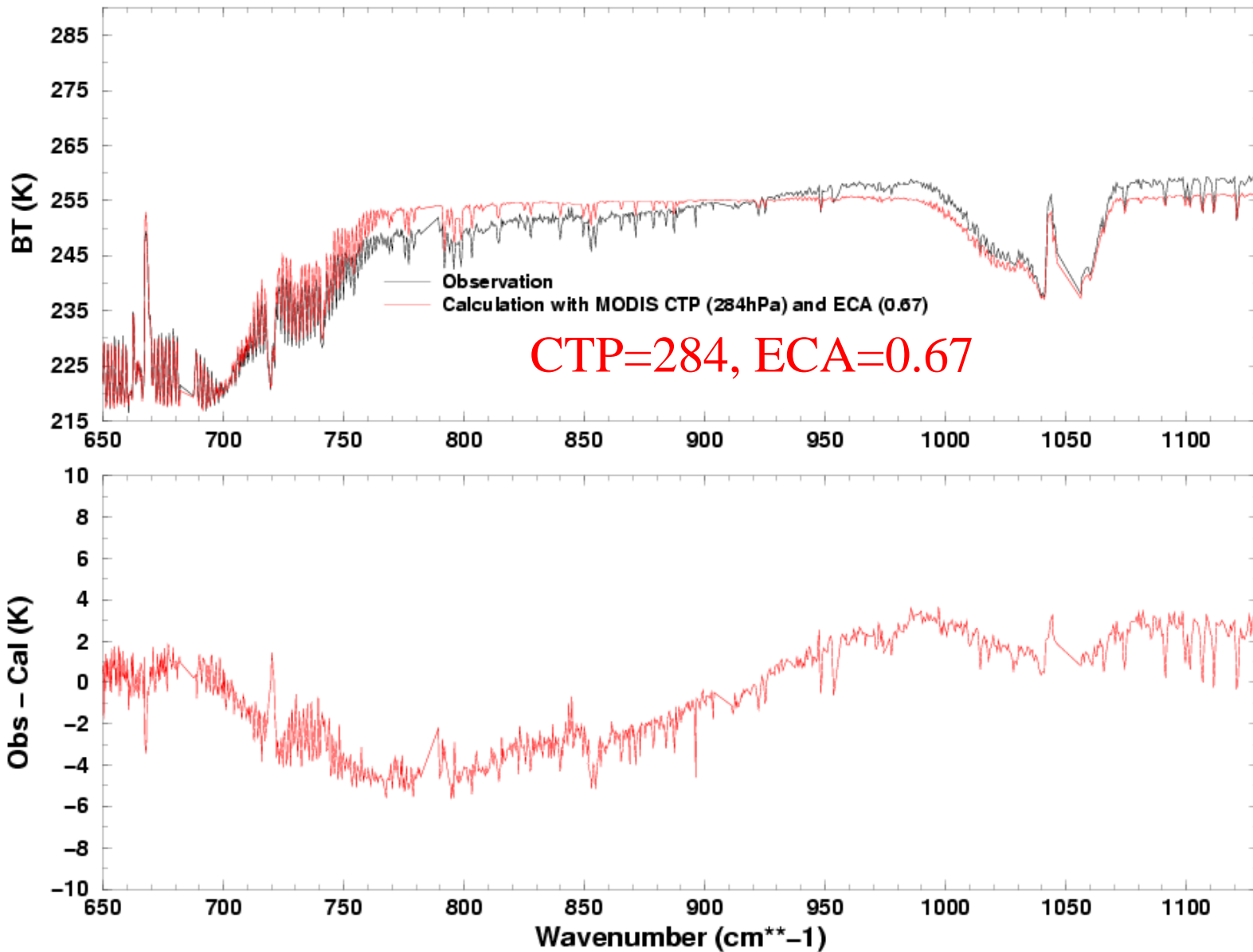
MODIS Classification Mask



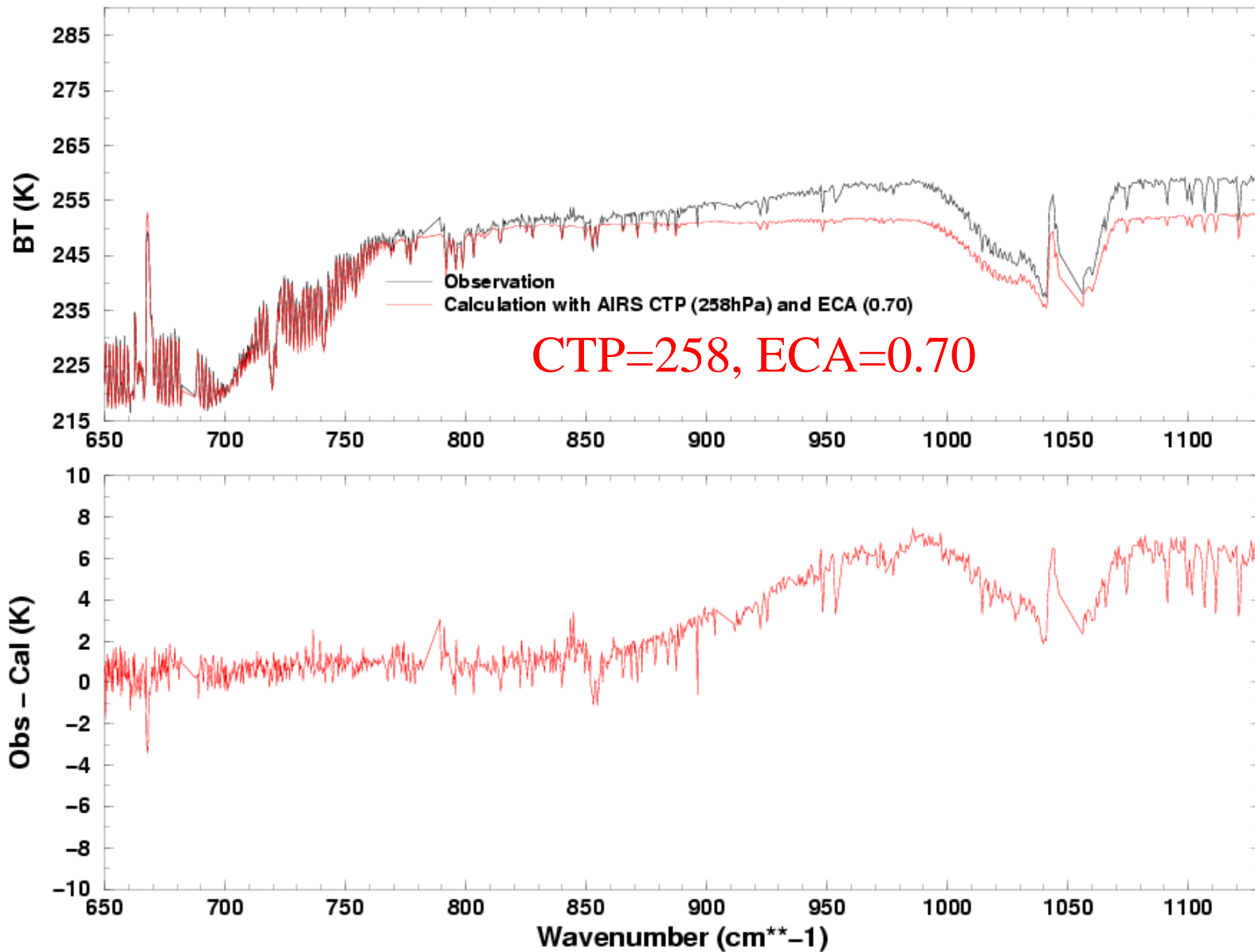
AIRS cloudy calculation with *ECMWF profile* versus cloudy observation



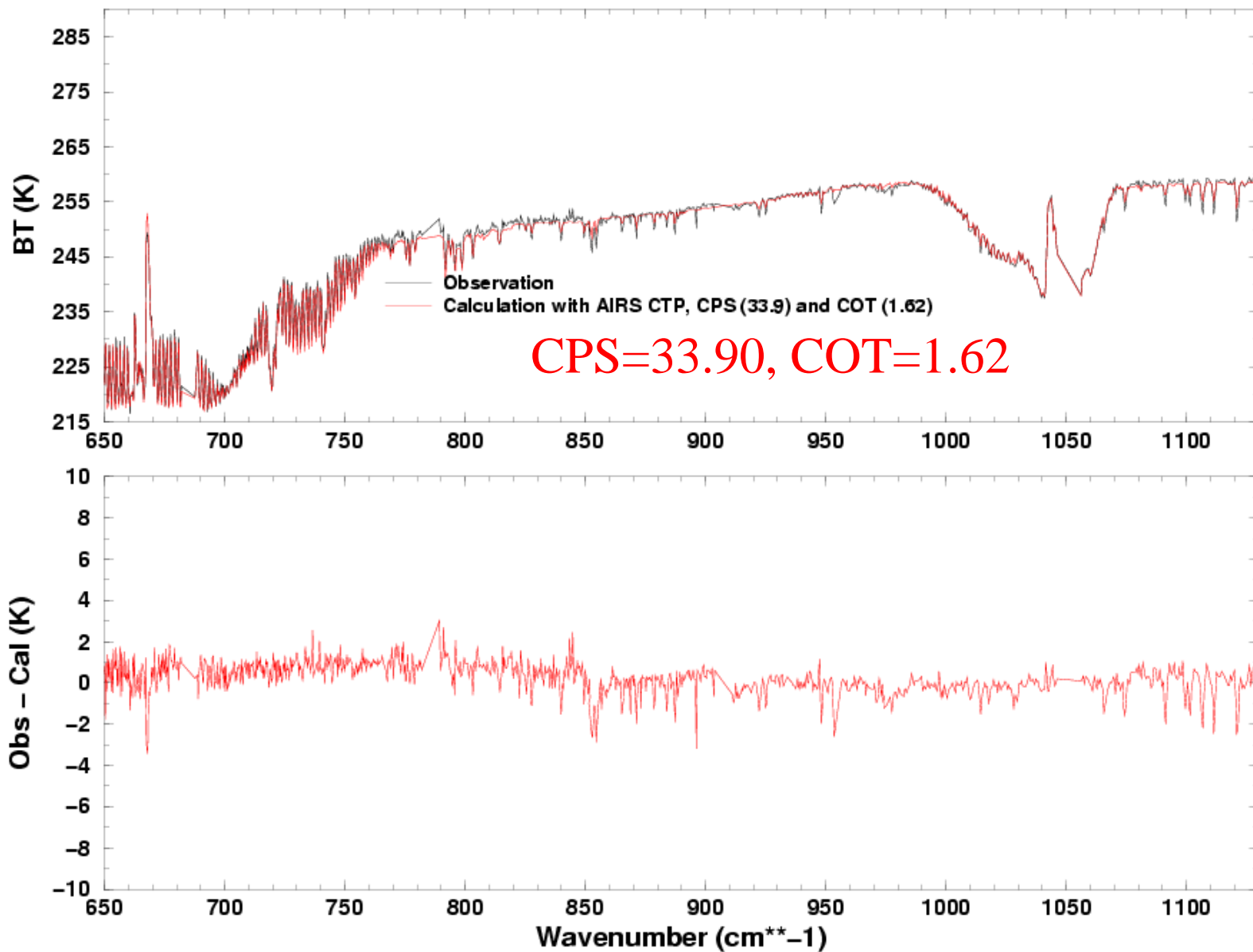
AIRS cloudy calculation with *MODIS CTP and ECA* versus cloudy observation



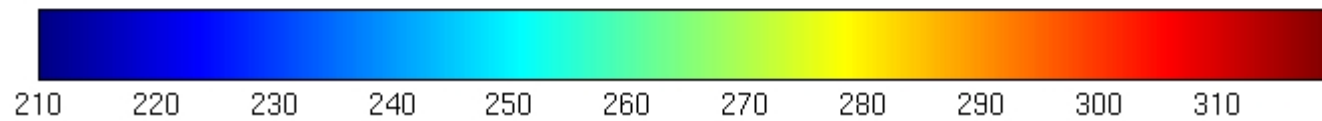
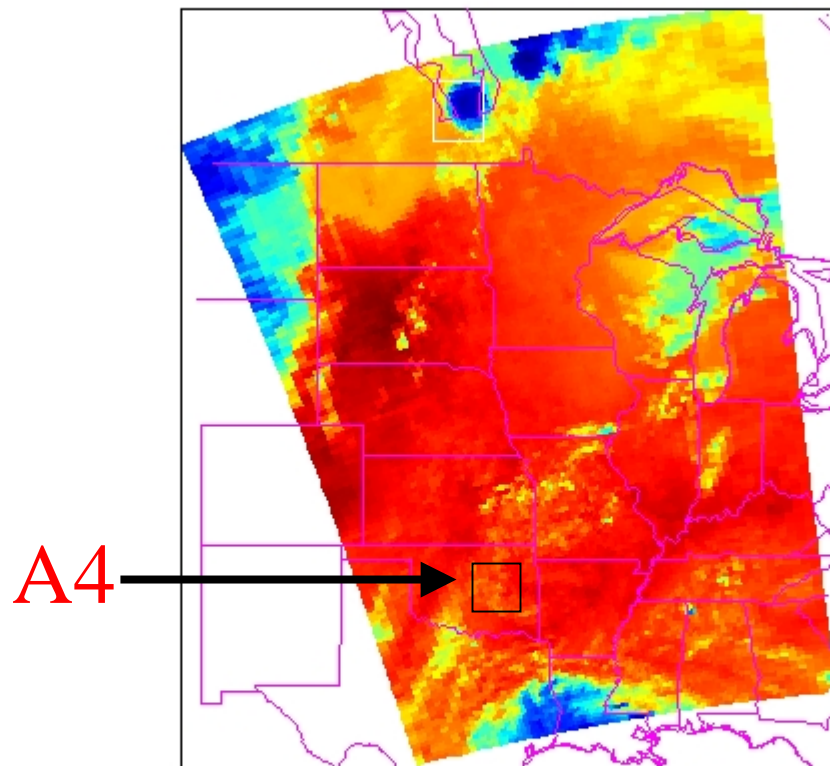
AIRS cloudy calculation with *AIRS CTP and ECA* versus cloudy observation



AIRS cloudy calculation with *AIRS CTP, CPS, and COT* versus cloudy observation

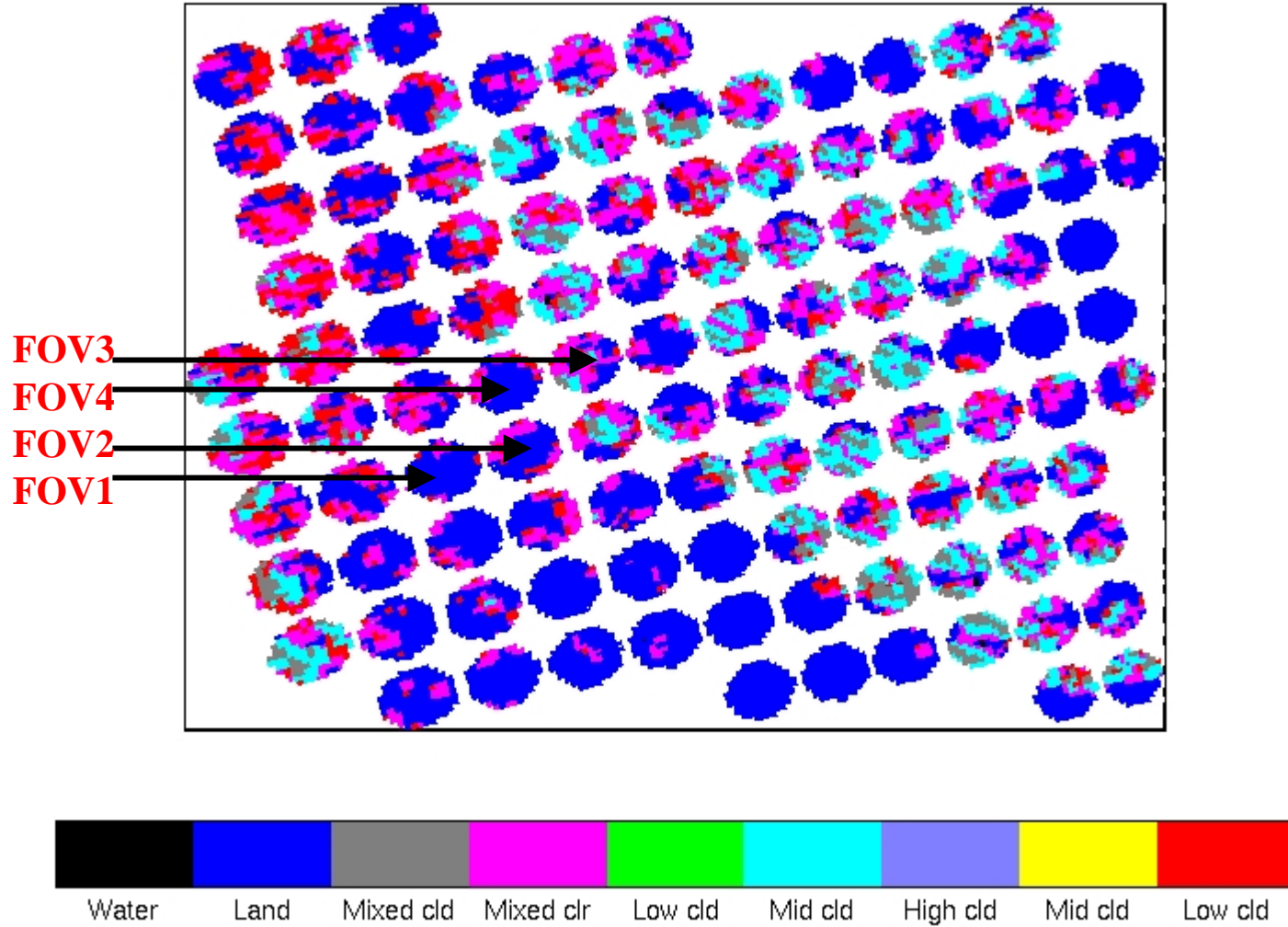


AIRS Channel 763 [901.51 cm⁻¹] Brightness Temperature

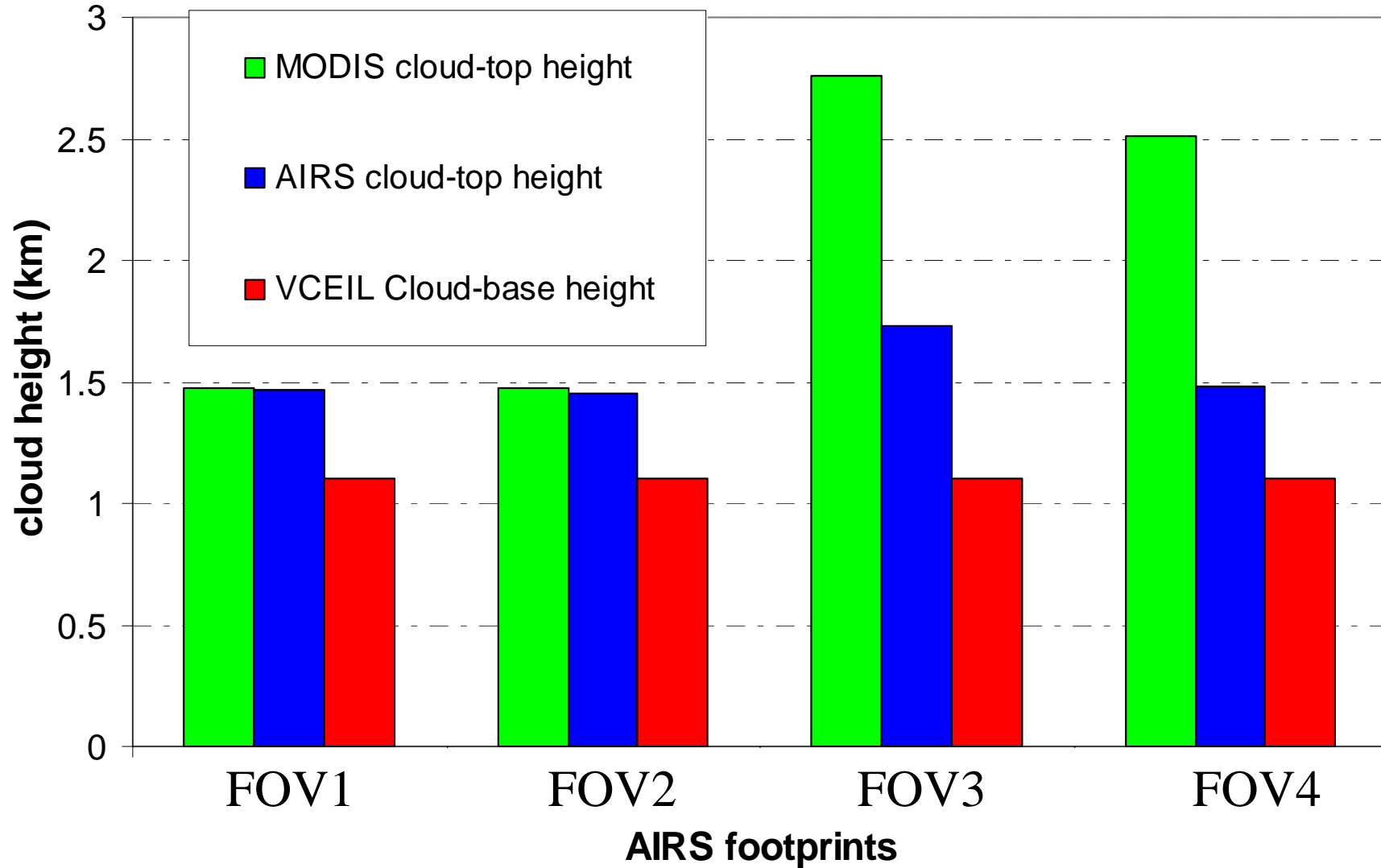


AIRS Four Footprints Near Purcell, OK

MODIS Classification Mask



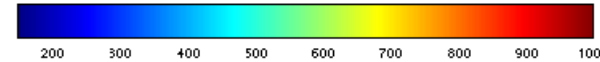
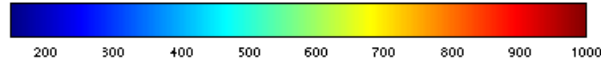
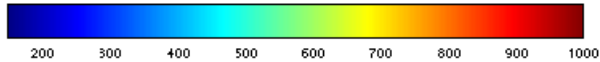
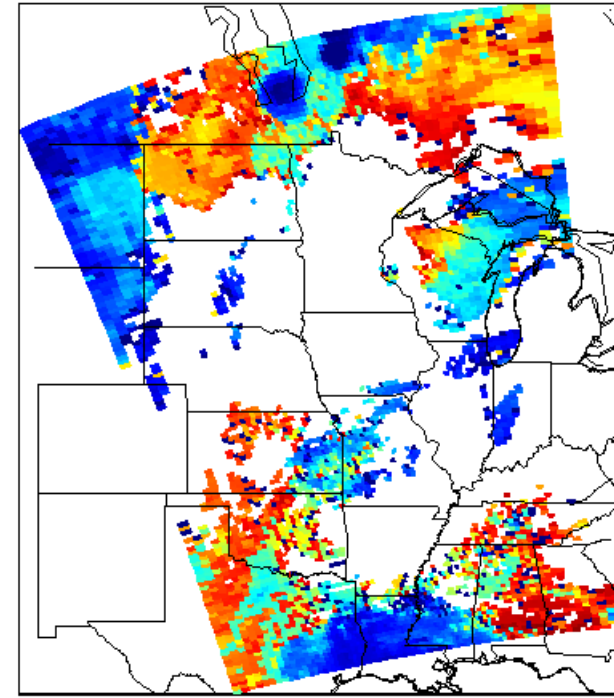
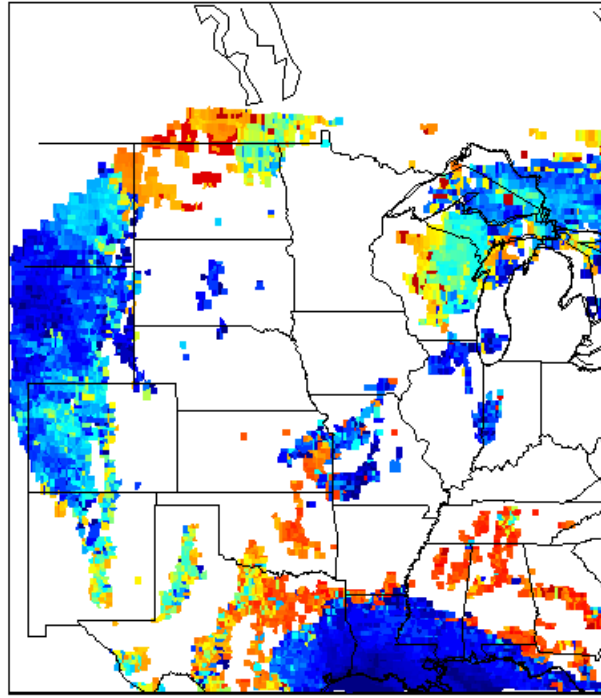
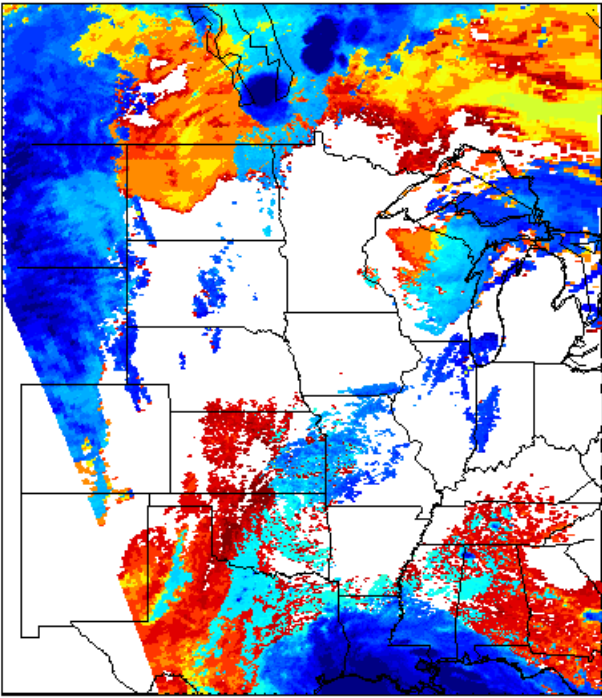
Cloud-top height retrievals



MODIS Cloud Top Pressure

GOES Cloud Top Pressure

AIRS Cloud Top Pressure



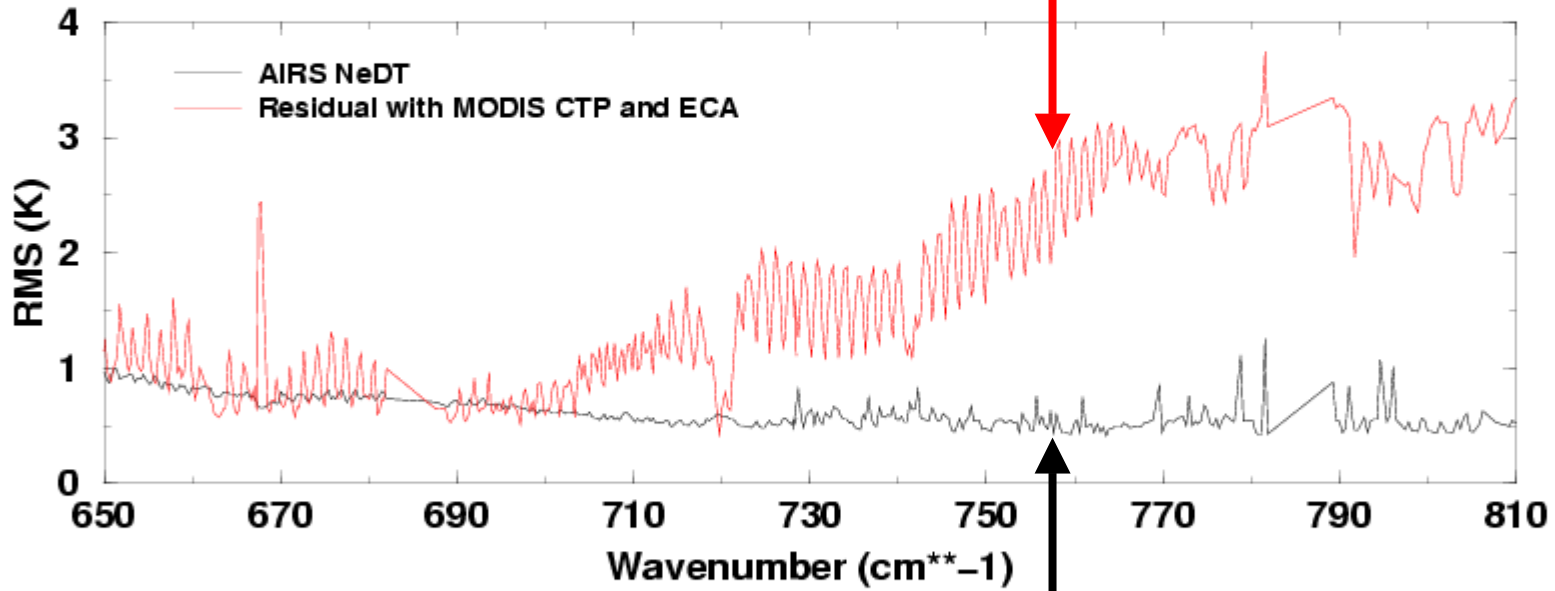
MODIS at 5km

GOES at 10km

AIRS at 14km

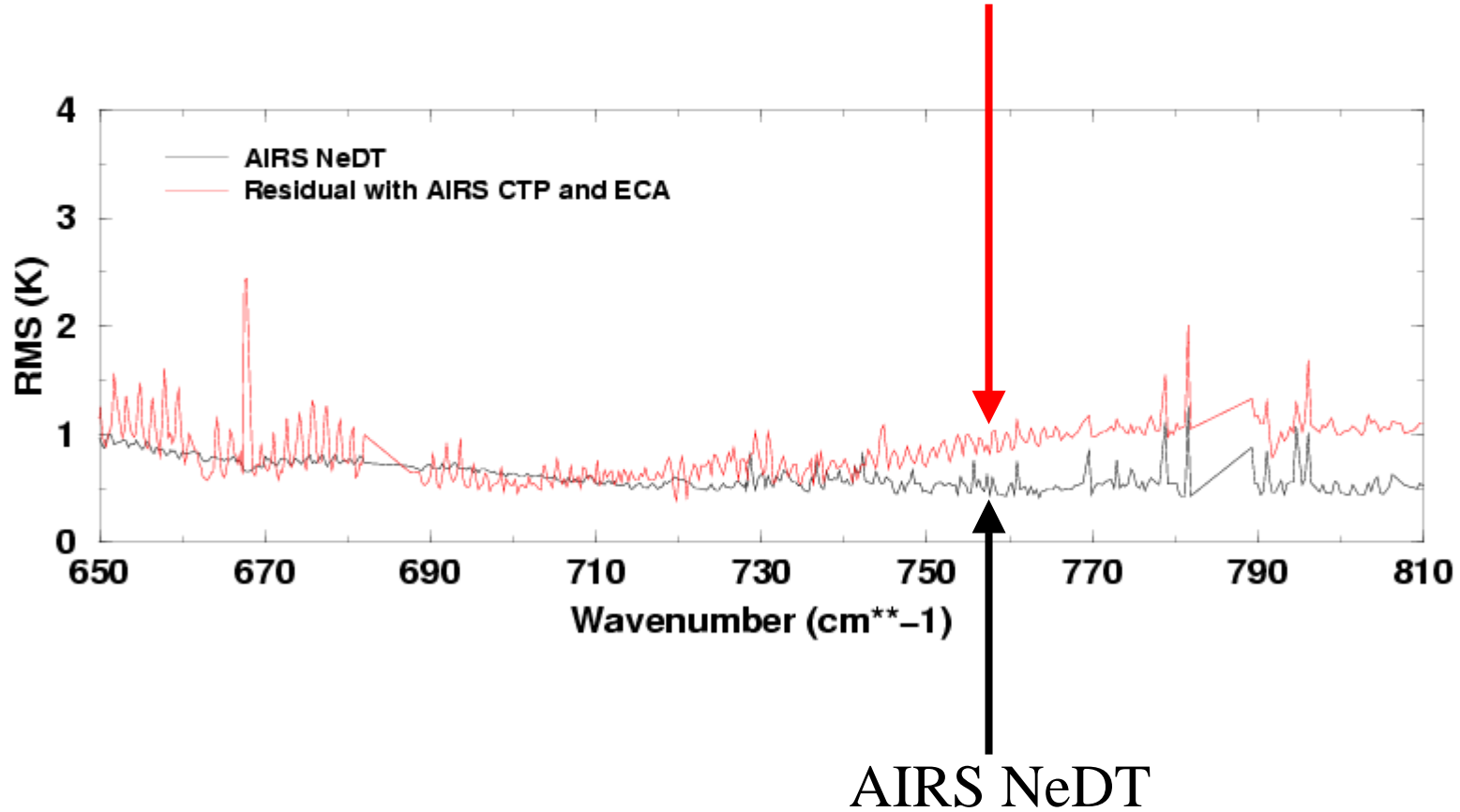
AIRS/MODIS/GOES CTP comparisons

RMS Residual with MODIS CTP and ECA



AIRS NeDT

RMS Residual with AIRS CTP and ECA



Summary

- **MODIS data help AIRS sub-pixel cloud detection and characterization**
- **With MODIS products as the background, improved atmospheric and cloud parameters can be obtained from sounder radiance measurements**
- **Other**
 - **Improved imager SST products with sounder emissivity retrieval**
 - **Image product + sounder product => better imager product**

Future work

- Synergistic use of MODIS/AIRS for retrieving the atmospheric profiles and cloud properties simultaneously
- Prepare ABI/HES retrieval system, MODIS/AIRS data will be used

International TOVS Study Conference, 13th, TOVS-13, Sainte Adele, Quebec, Canada, 29
October-4 November 2003. Madison, WI, University of Wisconsin-Madison, Space Science and
Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2003.