Updates to the IMAPP AIRS Utility Software

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Acknowledgements

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Special thanks to Fred Nagle, Greg Quinn and Robert Holz (CIMSS) for the AIRS/MODIS collocation code.

Thanks to Daniel Zhou (NASA Langley) and William Smith (Hampton University) for discussion on cloudy sounding algorithm development.

The cloudy fast radiative transfer model was developed in collaboration with Ping Yang and Heli Wei (Texas A&M University).

Image and Data credits:

NASA DAAC: AIRS L1B, AIRS L2
NASA LAADS: MODIS MYD, NCEP gdas
NASA LaRC ASDC: CALIPSO data
NASA CloudSat Project, DPC CIRA, CSU: 2B-GEOPROF
ECMWF: ECMWF model analysis
UMBC: SARTA forward model

IMAPP and IMAPP AIRS L2 software package

• IMAPP is a NASA funded, freely distributed software package to receive and process DB data from MODIS and AIRS onboard Aqua.

• Currently used by ~75 ground stations around the world

• The first IMAPP software was released in 2000, the first version of AIRS L2 software in 2006.

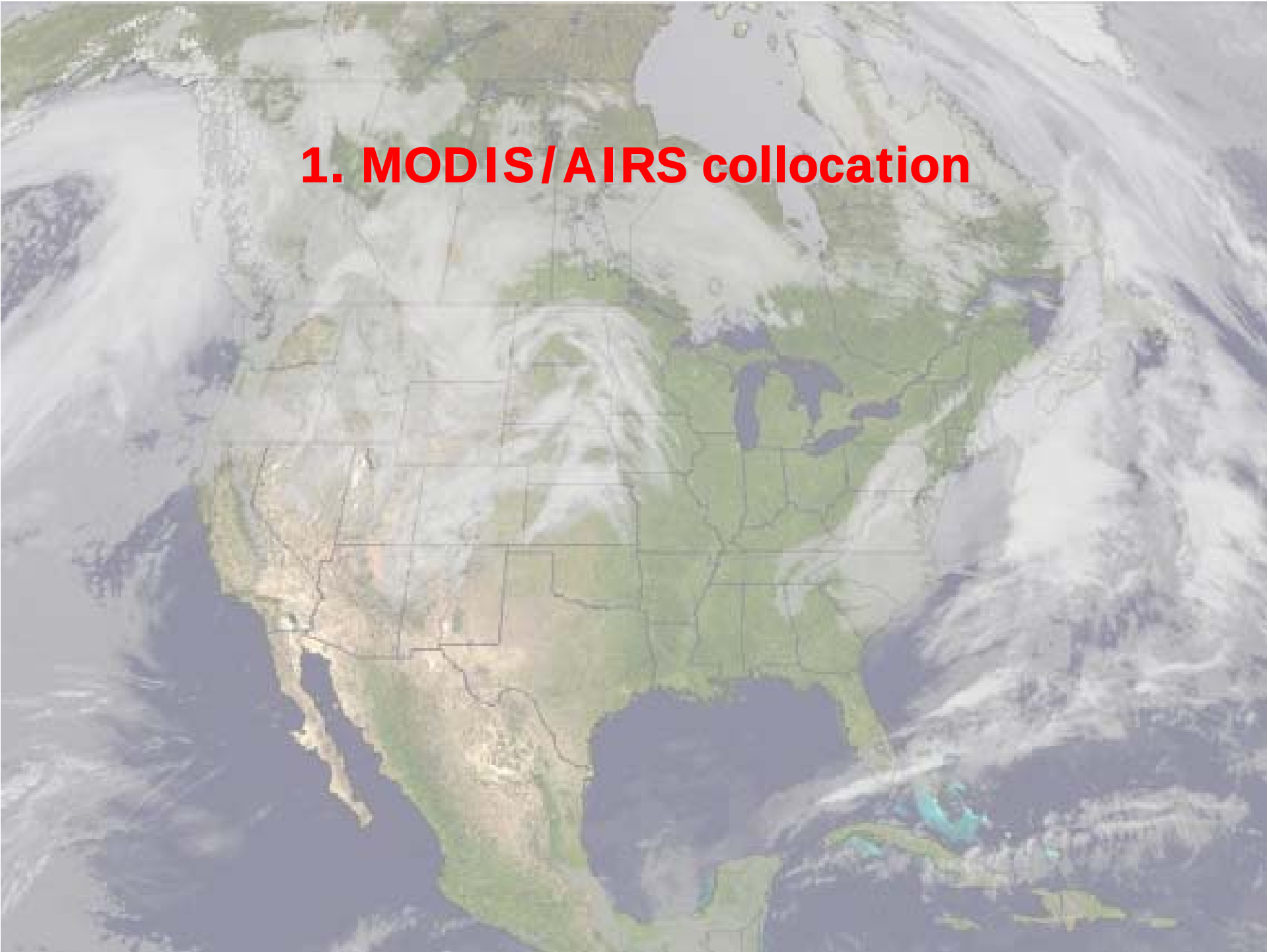
• The latest version of the UW AIRS software package has been released in December 2009.

IMAPP DB AIRS L2 Collocation, Cloud Mask and SFOV UW All Sky Retrieval Software

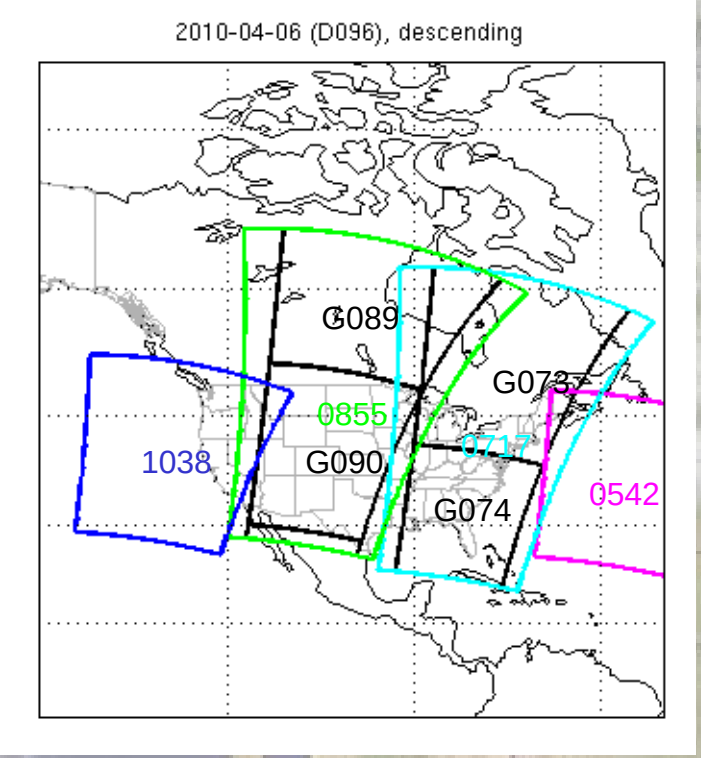
Code/Script	Input	Output
AIRS/MODIS Collocation v1.1	AIRS L1B MODIS geolocation	Collocation File (hdf)
AIRS Cloud Fraction v1.1	Collocation File MODIS cloudmask	Cloud Fraction File (binary)
UW Retrieval v2.0	AIRS L1B Cloud Fraction File Ancillary data*	Retrieval output (binary, hdf)

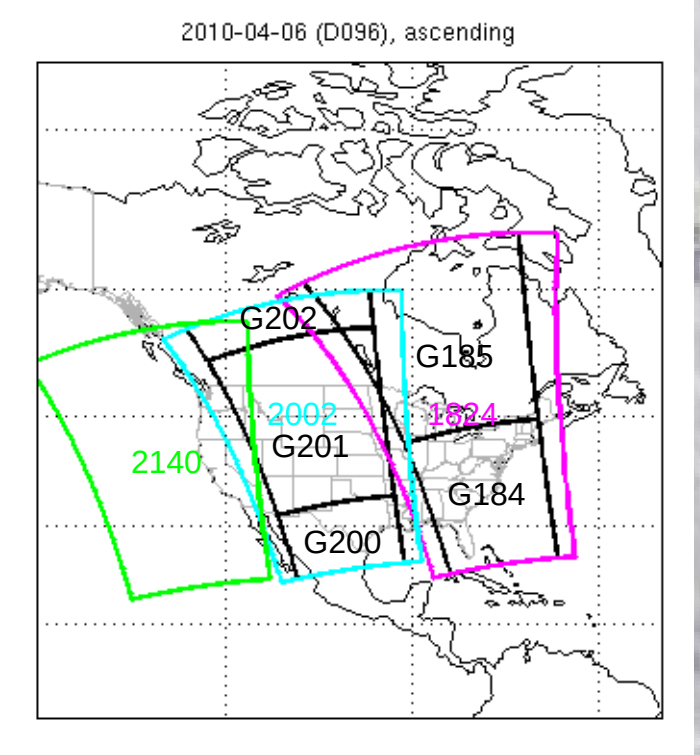
+ … either DB MODIS files (a1*geo.hdf, a1*mod35.hdf) or standard DAAC 5minute granules (MYD03*, MYD35*)

* … surface pressure is provided by GDAS or GFS analysis or forecast file

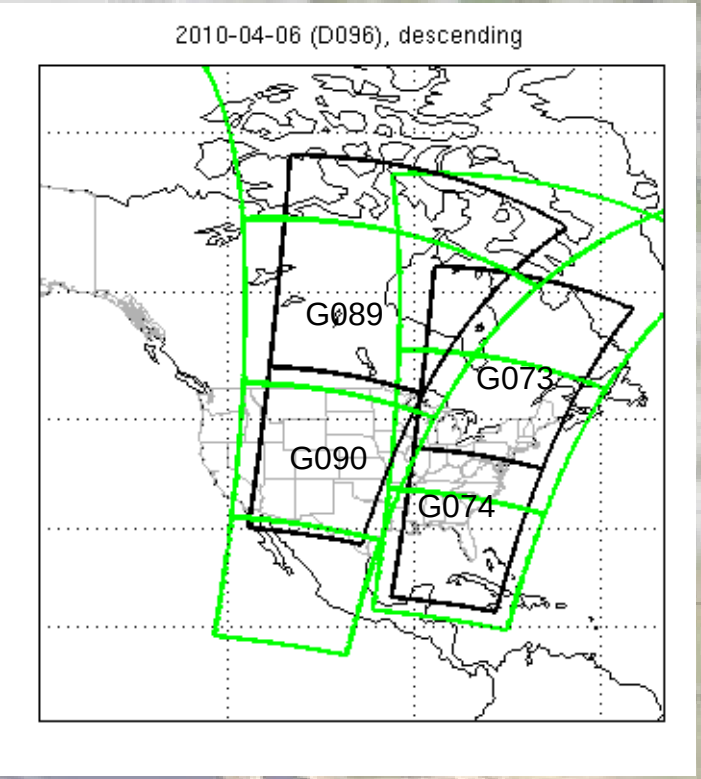

1. MODIS/AIRS collocation

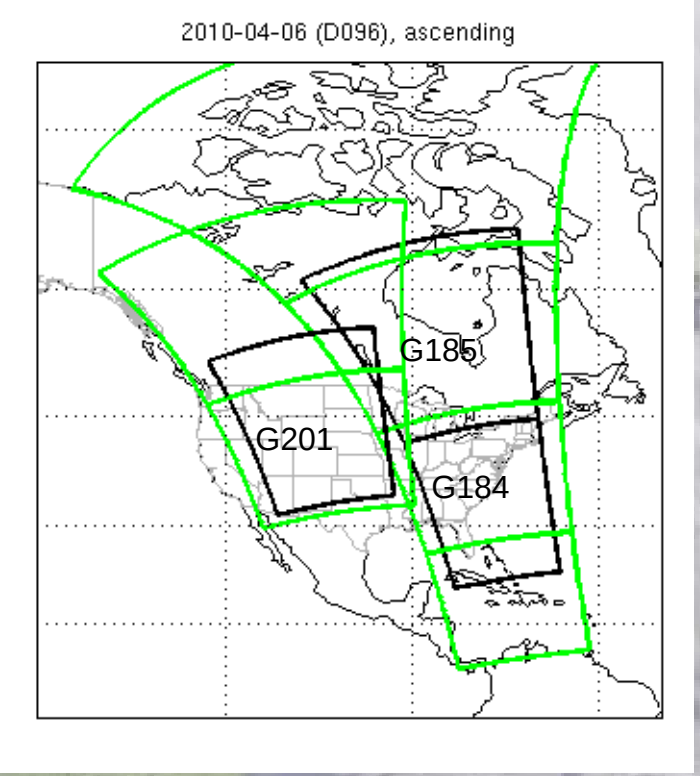
Direct Broadcast (DB) AIRS and MODIS data





Direct Broadcast (DB) AIRS and MODIS data





Gran 073: 2010096.0715
2010096.0720
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Gran 090: 2010096.0855
2010096.0900
2010096.0905

Gran 184: 2010096.1820
2010096.1825
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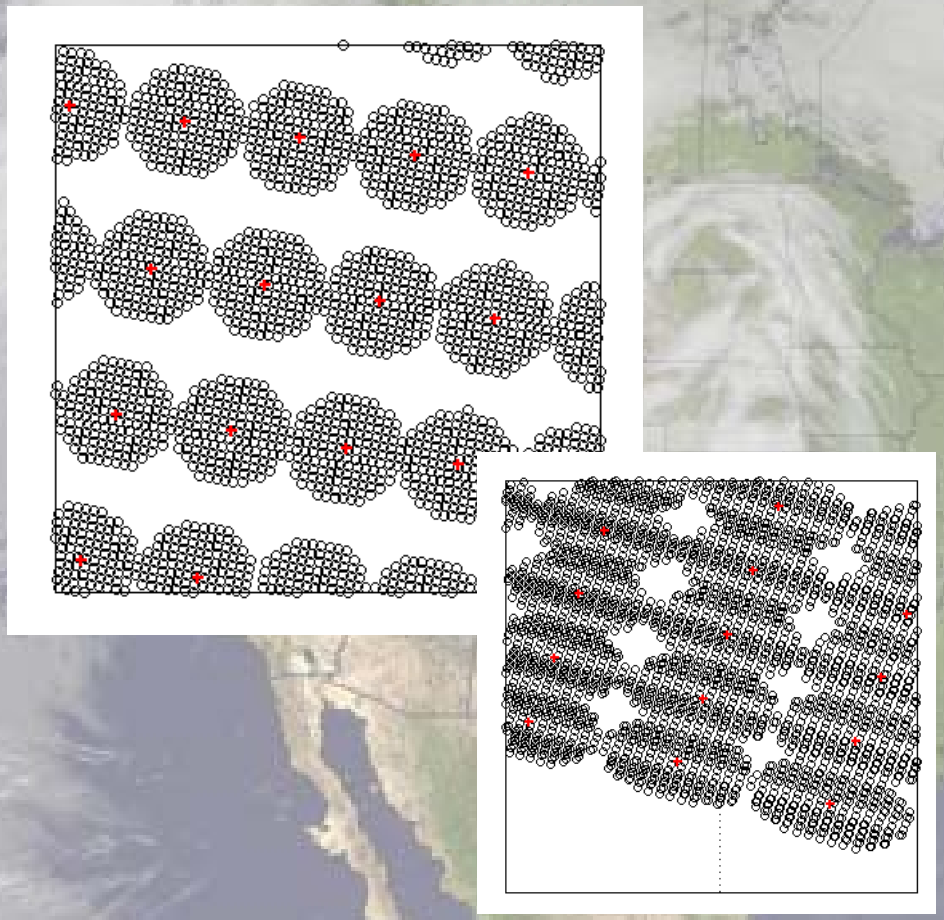
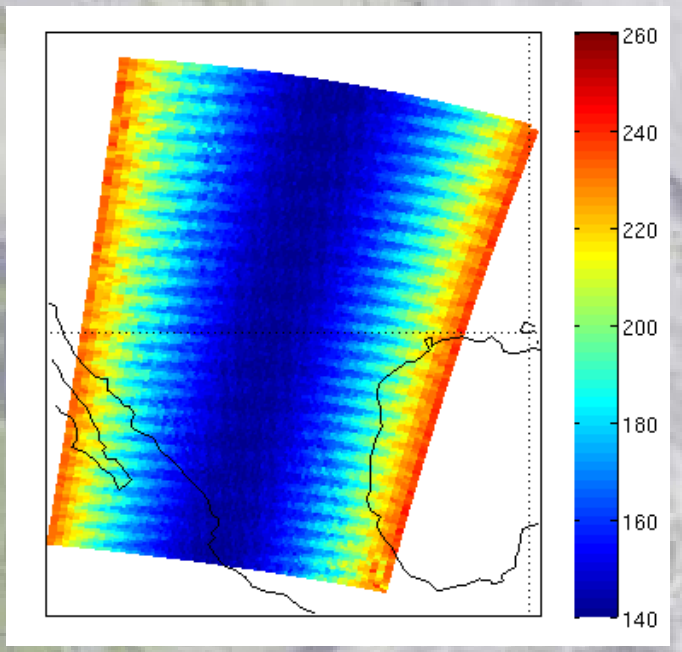
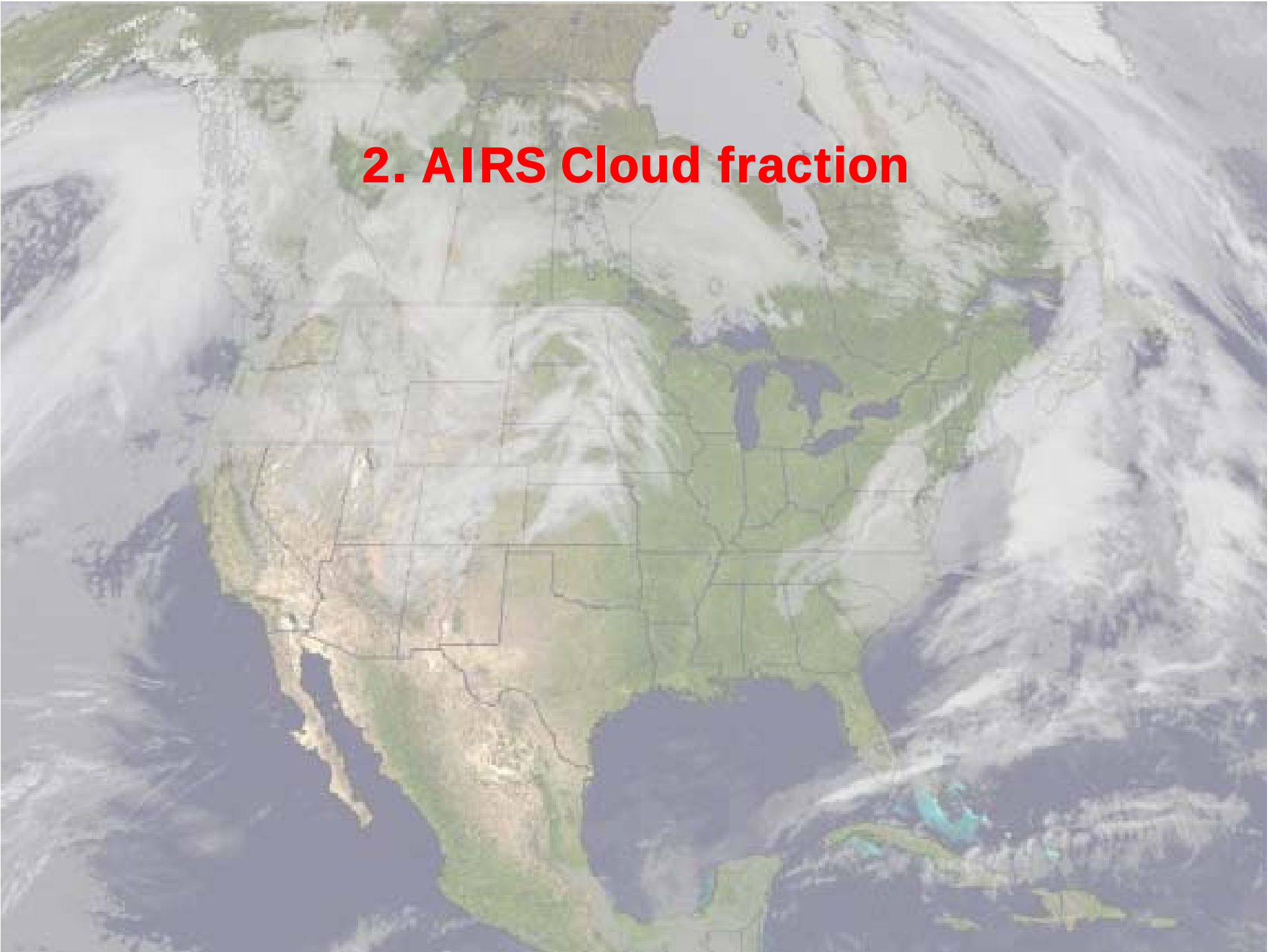
2010096.1835
Gran 201: 2010096.2005
2010096.2010

AIRS/MODIS collocation

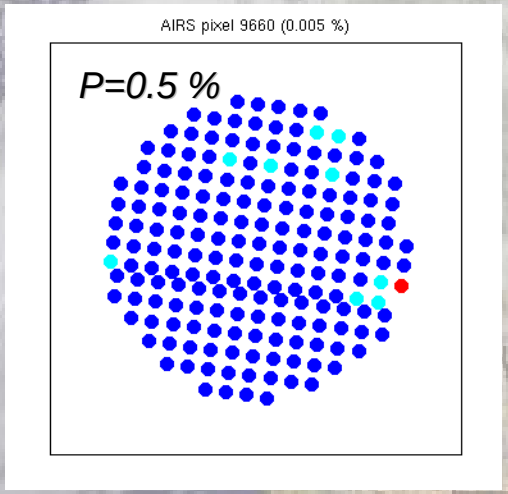


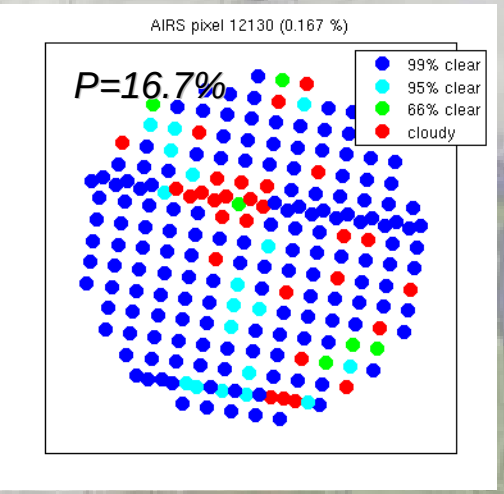


Nagle, Frederick W., and Robert E. Holz, 2009: Computationally Efficient Methods of Collocating Satellite, Aircraft, and Ground Observations. J. of Atmos. and Ocean Techn., Volume 26, Issue 8, pp1585-1595.


2. AIRS Cloud fraction

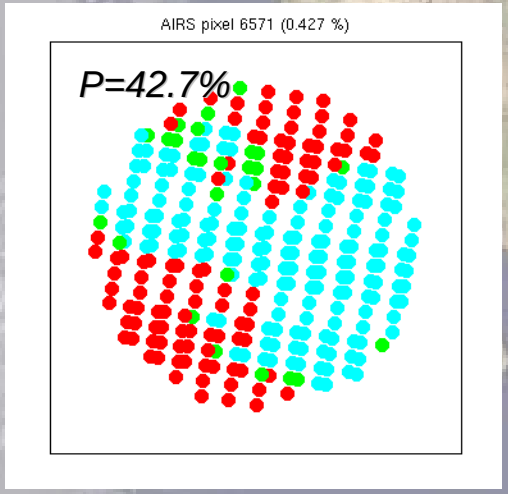
AIRS cloud fraction and mask from MYD35 product (1)

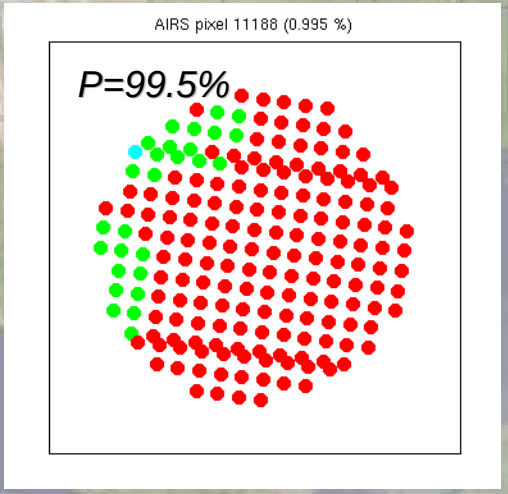




- 99% clear (confident clear)
- 95% clear (probably clear)
- 66% clear (probably cloudy)
- Cloudy

$$P = 1 - (n99 + n95)/nTo$$

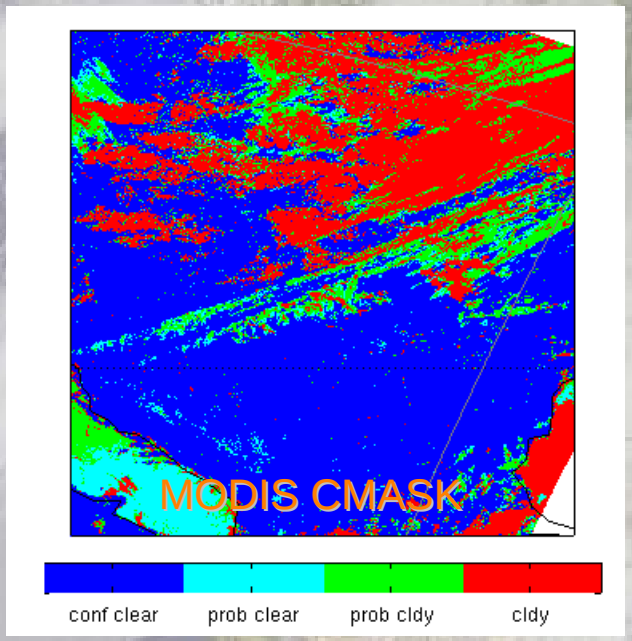




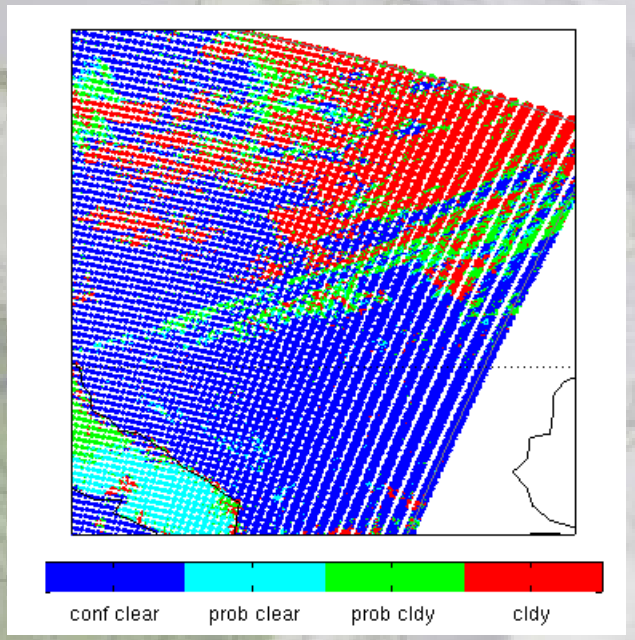
$P \leq 0.01$ AIRS FOV clear

$P \geq 0.99$ AIRS FOV full cloudy

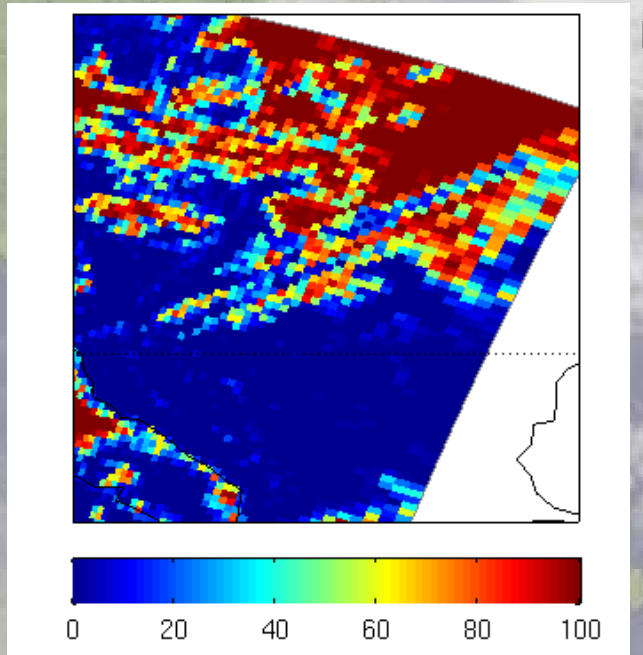
AIRS cloud fraction and mask from MYD35 product (2)



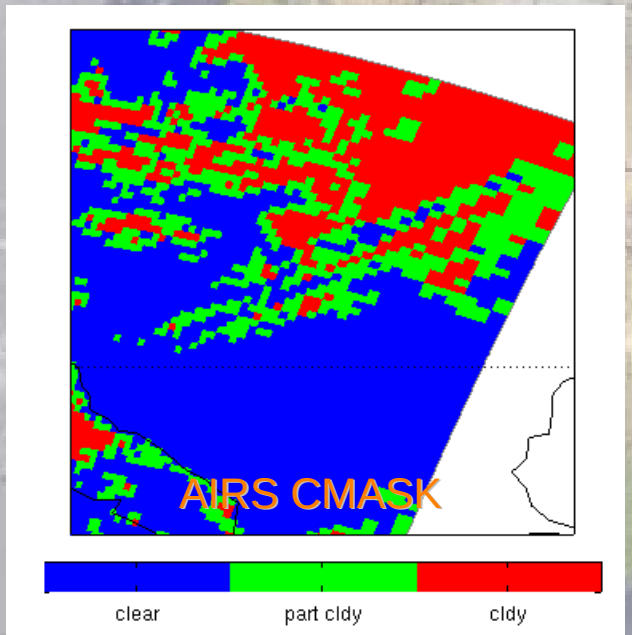
AIRS/MODIS collocation



Compute percentage *P*



clear: $P < 0.2$
cloudy: $P > 0.8$



3. AIRS SFOV Retrieval

Regression

CLEAR

Training data set
(SeeBor V5)

Radiance calculations
SARTA v1.7 (UMBC)

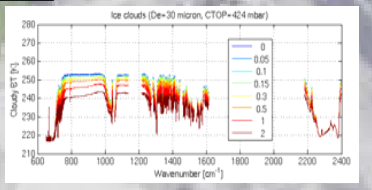
BT and Scanang
Classification

CLOUDY

Cloudy Training data set
(ice, water)

Radiance calculations
Fast RT cloud model (Wei, Yang)

Scanang
Classification



Additional
Predictors
(spres, solzen)

PC regression

$$C = dXA^T(AA^T)^{-1}$$

Clear Regr Coeffs

Ice Cloud Regr Coeffs
Water Cloud Regr Coeffs

Regression RTV

$$X = \overline{X_{tr}} + CA_{obs}$$

T, Q, O3, STemp, Emissivity
at single FOV

T, Q, O3, STemp, CTOP, COT
at single FOV

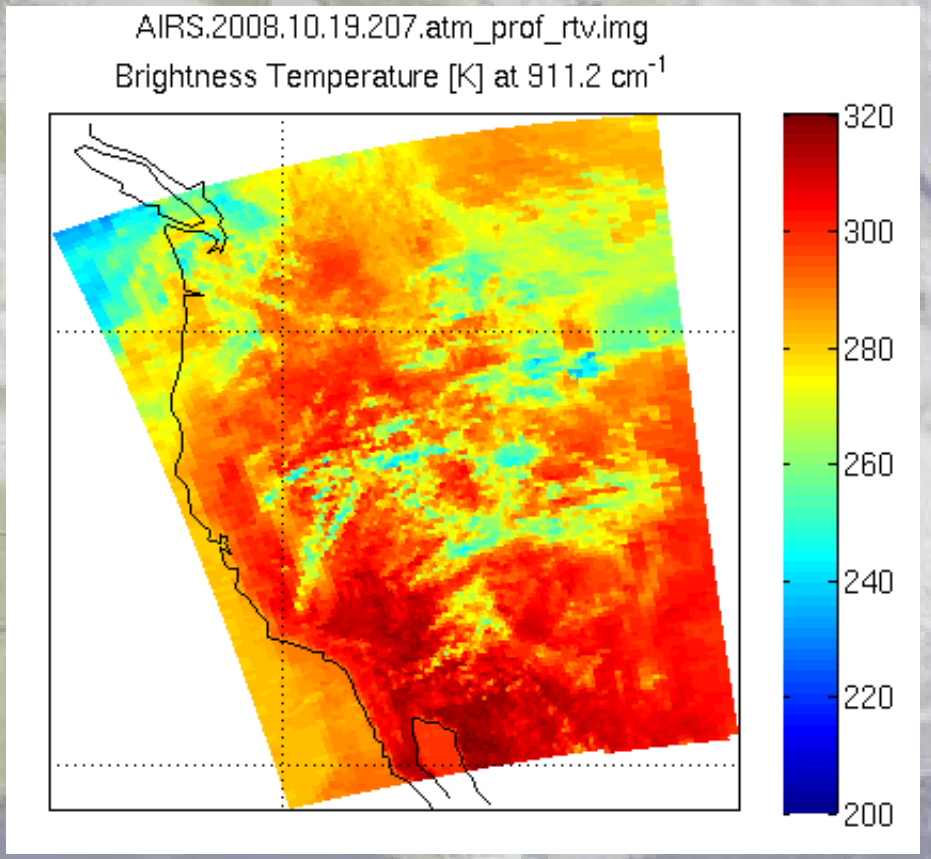
To physical inversion

Retrieval parameters

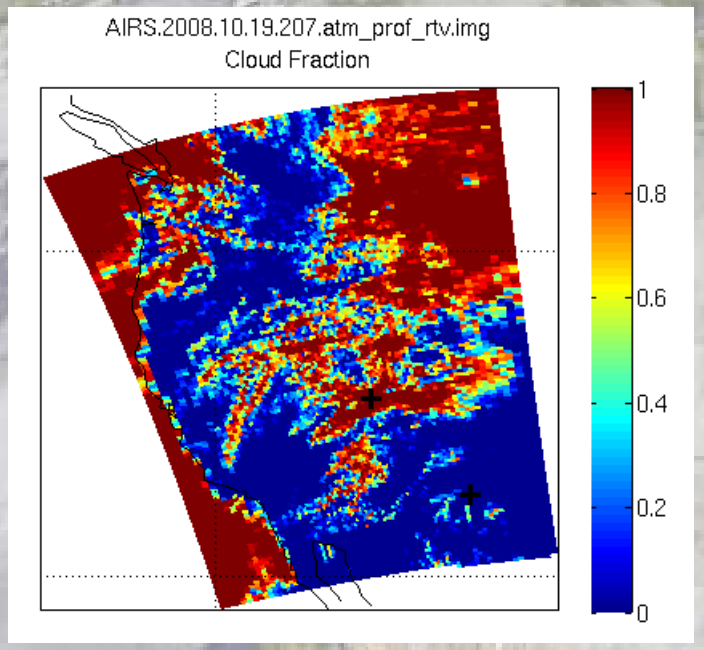
parameter	units	size	notes
Temperature	K	101x1	
Humidity	g/kg	101x1	
Ozone	ppmv	101x1	
TPW	cm	1x1	vertically integrated
TOA	DU	1x1	vertically integrated
Surface skin Temperature	K	1x1	
Surface Emissivity	--	2378x1	Retrieved as 6 eigenvector coefficients, then reconstructed to full spectrum
Cloud top Pressure	mbar	1x1	
Cloud Optical Thickness	--	1x1	Not in output file, values are used internally to derive quality flag

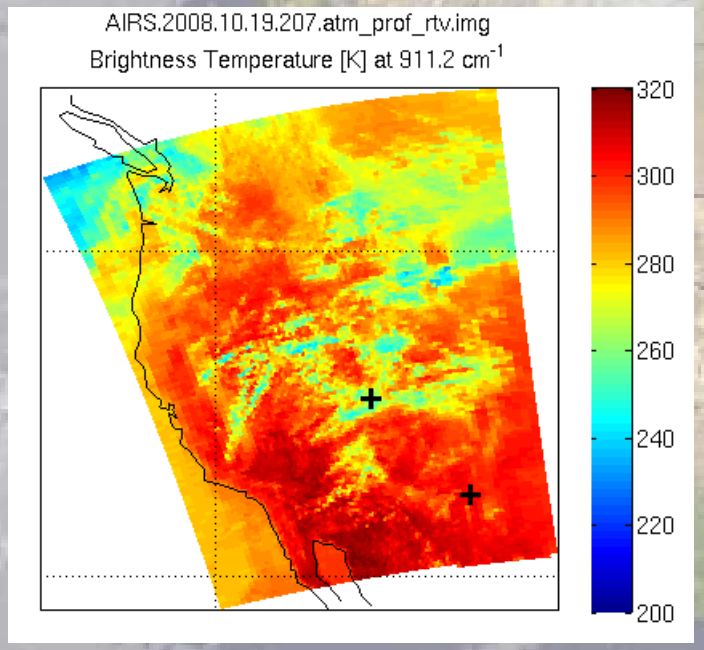
G207, 10-19-2008

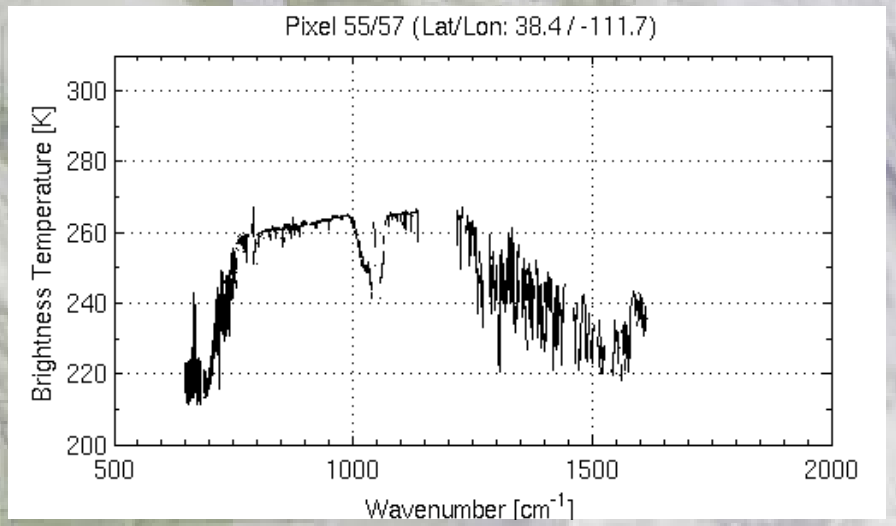
Aqua MODIS 2008293 2041 UTC / Band 31 RAW / SSEC DB

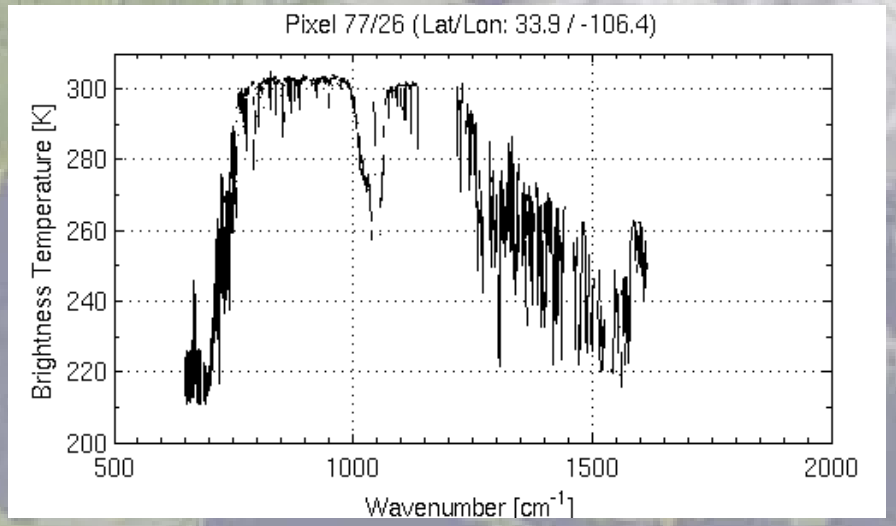


G207, 10-19-2008, BT at 911 cm-1

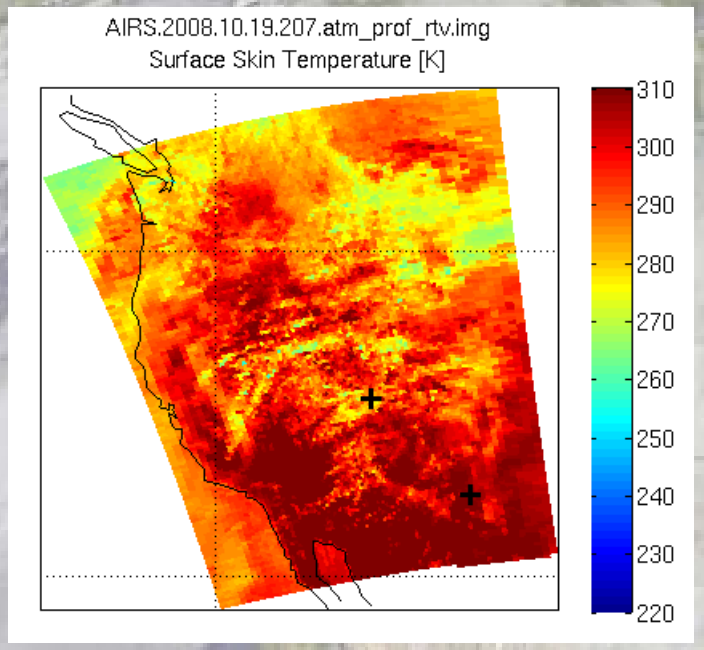


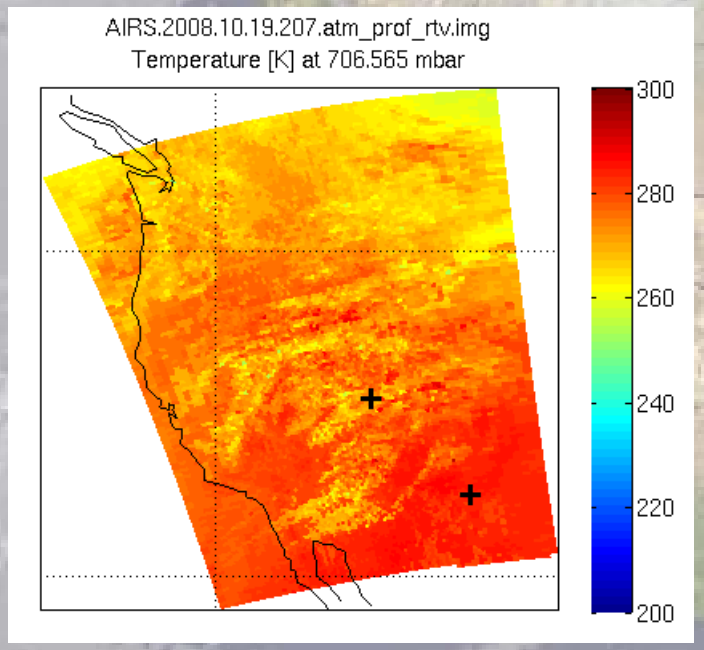




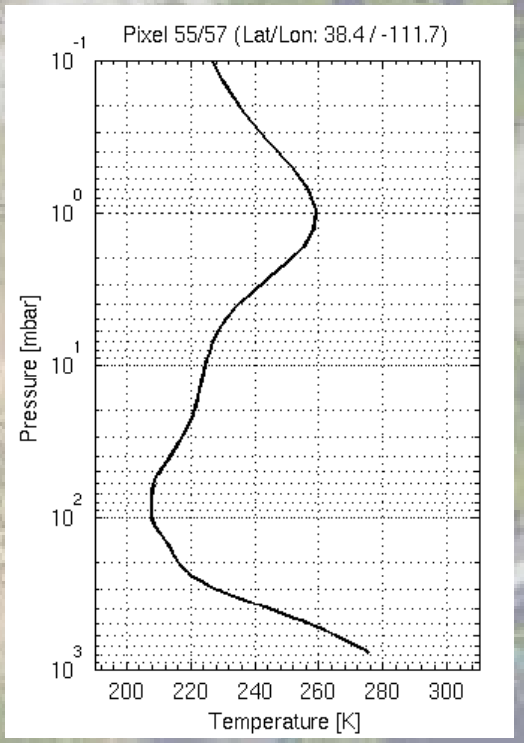


Surface Skin Temperature and Atmospheric Temperature at 700 mbar



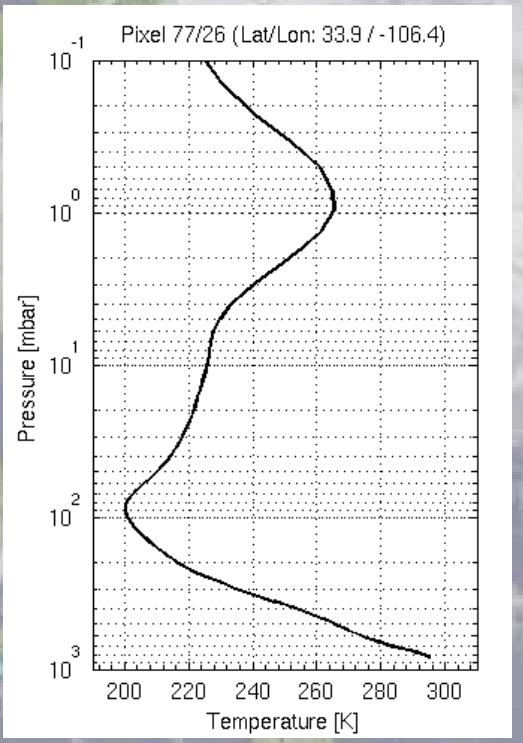


$Temp_s$=283.1 K



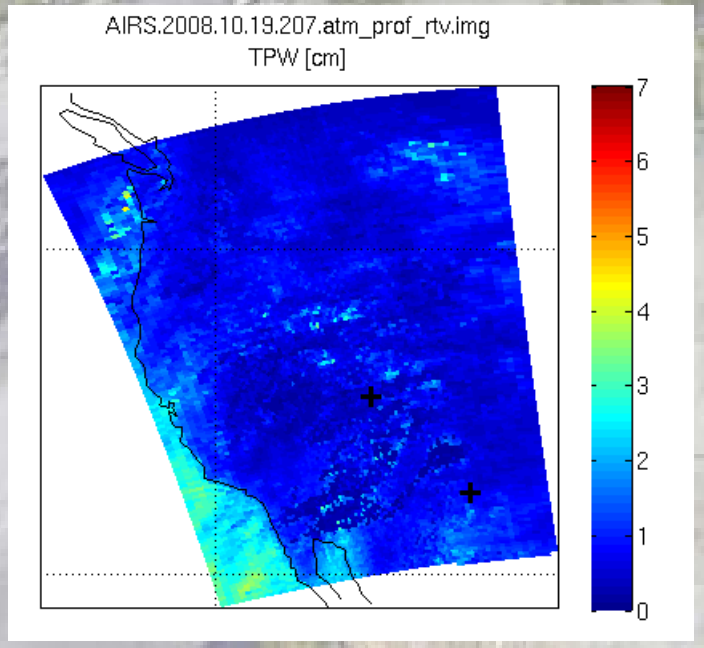
cloudy

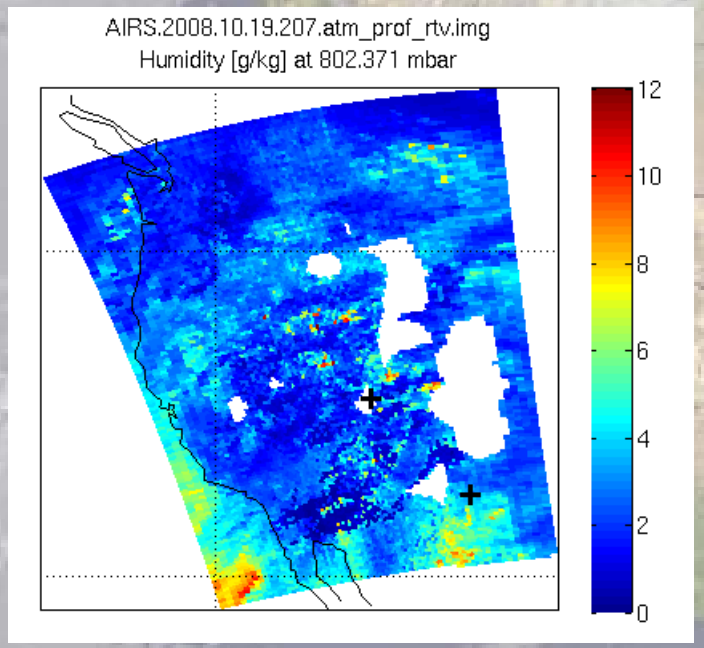
$Temp_s$=308.2 K



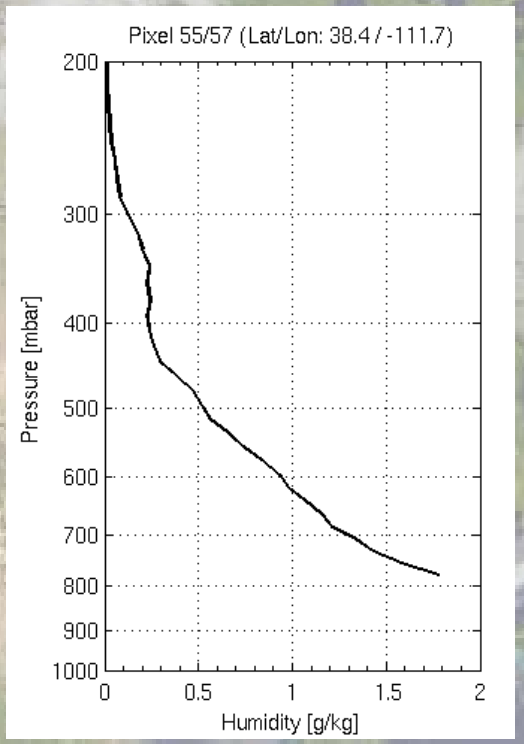
clear

TPW and Atmospheric Humidity at 800 mbar



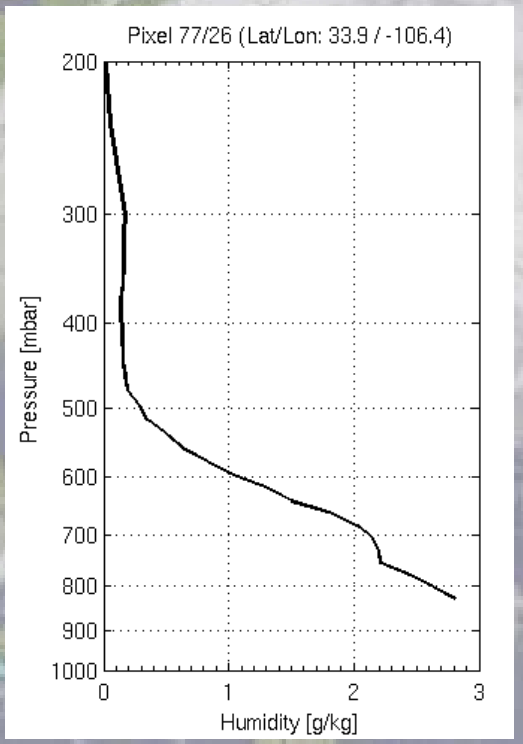


TPW=0.38 cm



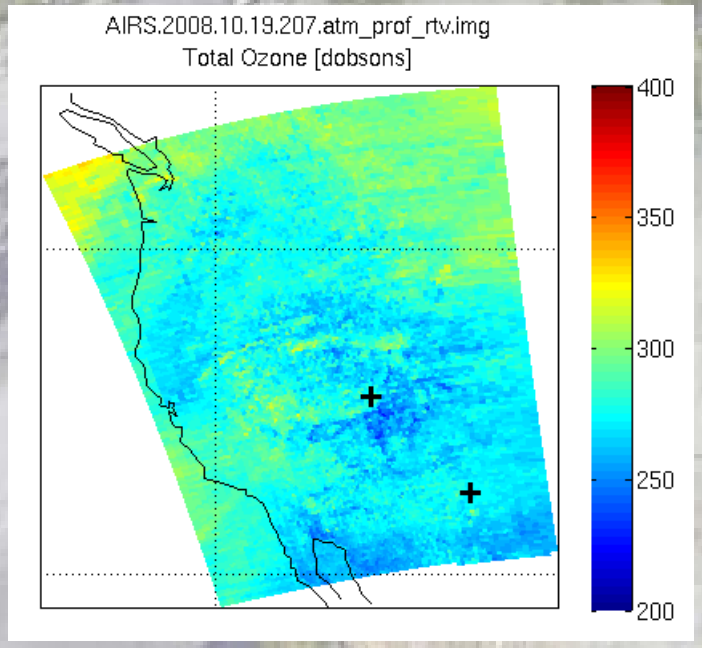
cloudy

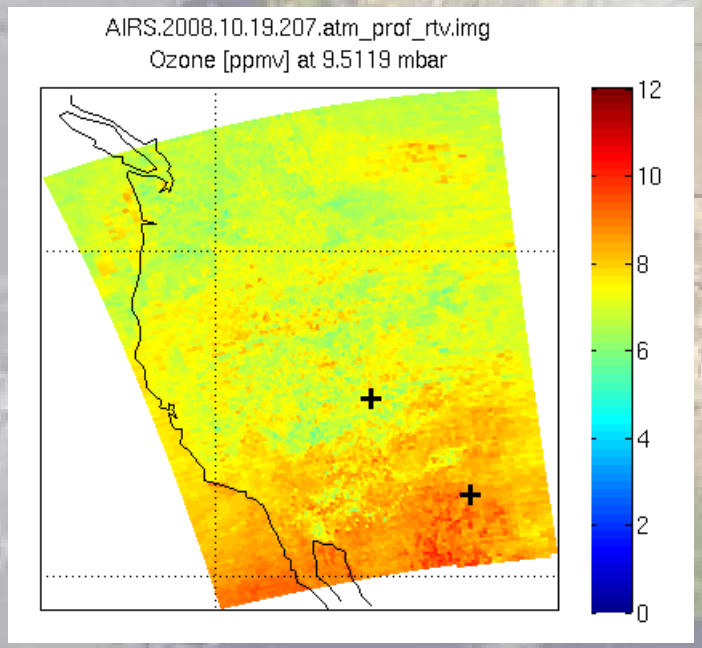
TPW=0.58 cm



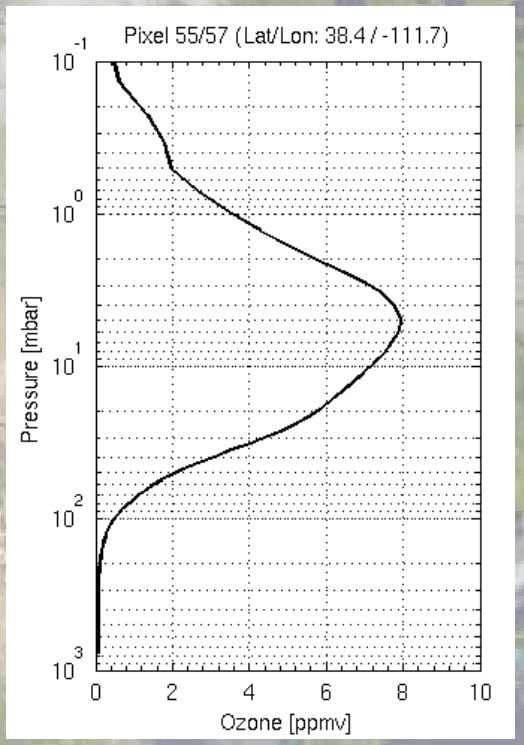
clear

TOC and Atmospheric Ozone at 10 mbar



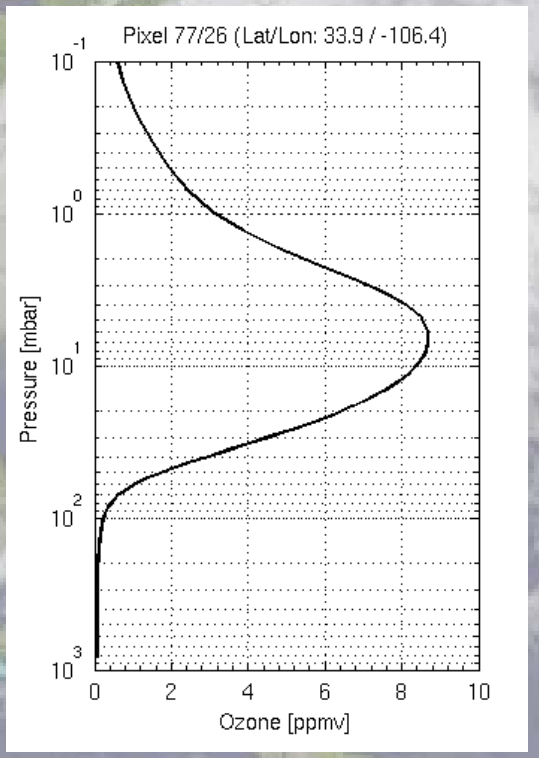


TOC=278.9 DU



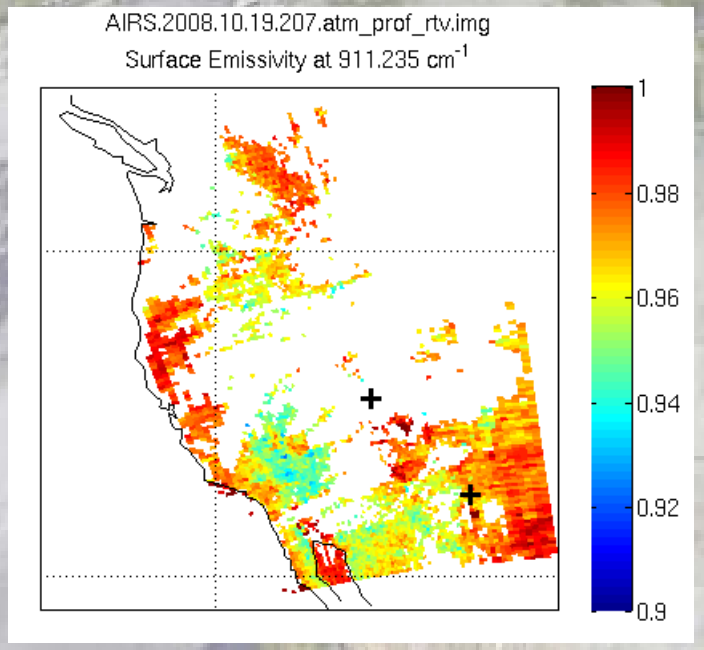
cloudy

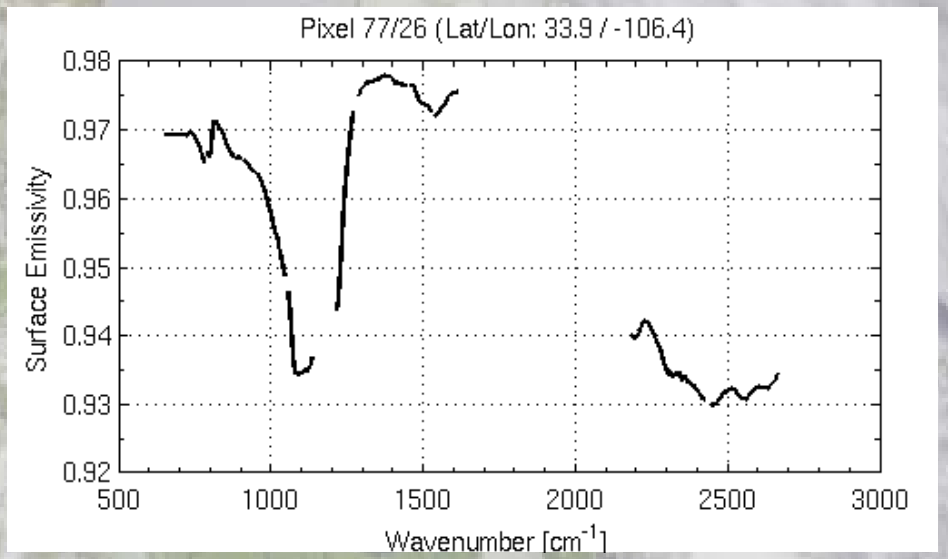
TOC=270.4 DU

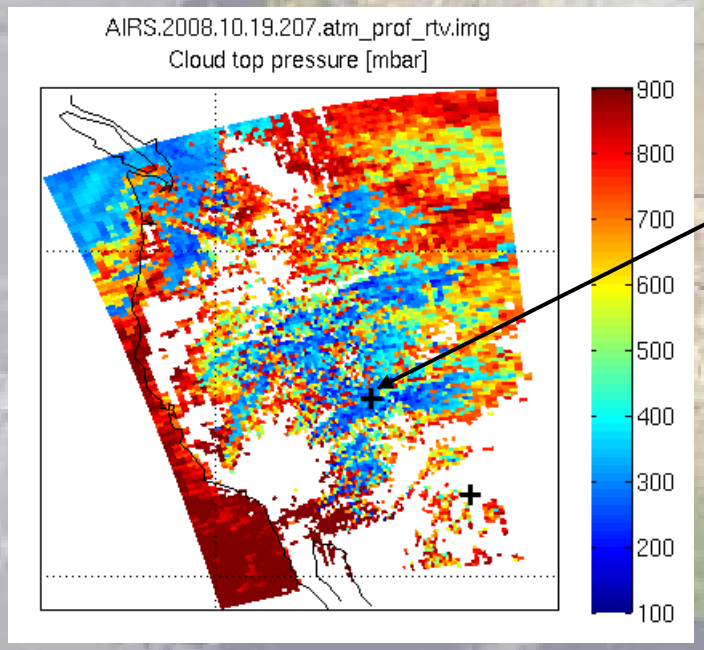


clear

Surface Emissivity and Cloud Top Pressure

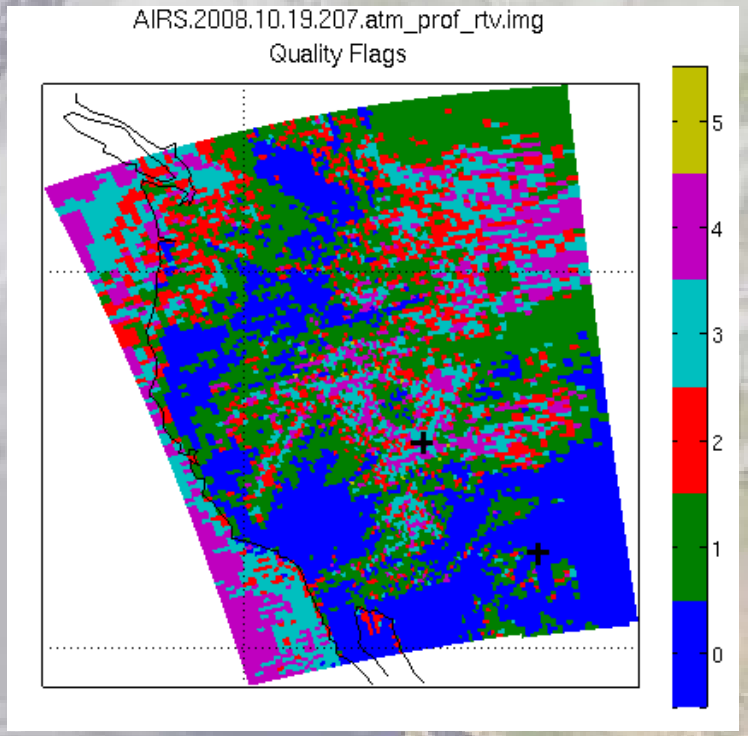






CTOP=265.7 mbar

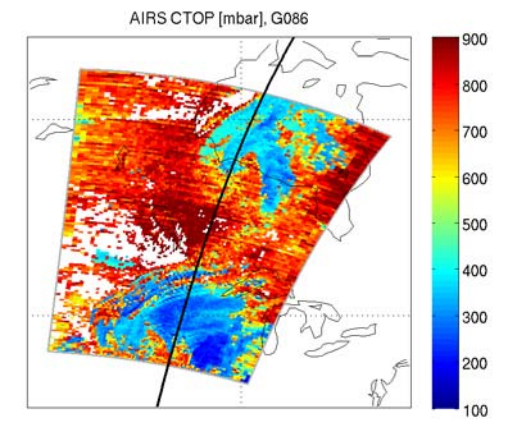
Quality Flags



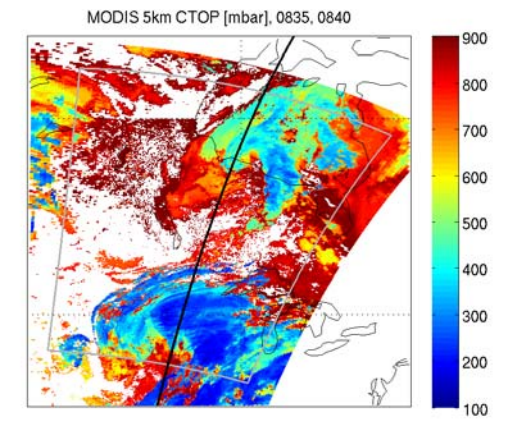
QF	COT	NOTES
0	0	clear
1	< 0.5	Thin clouds
2	0.5 < cot <1	Medium thick clouds
3	1 < cot < 1.5	Thick clouds
4	> 1.5	opaque
5		Bad rtv

CTOP RTV evaluation, G086, 08-28-2006

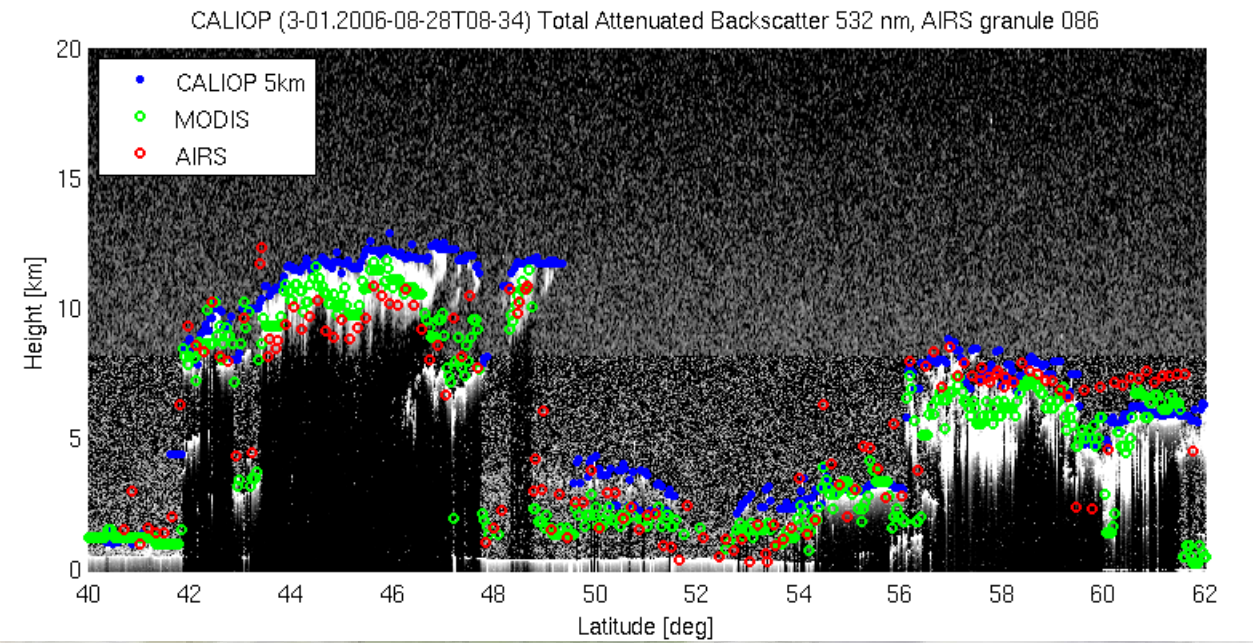
AIRS

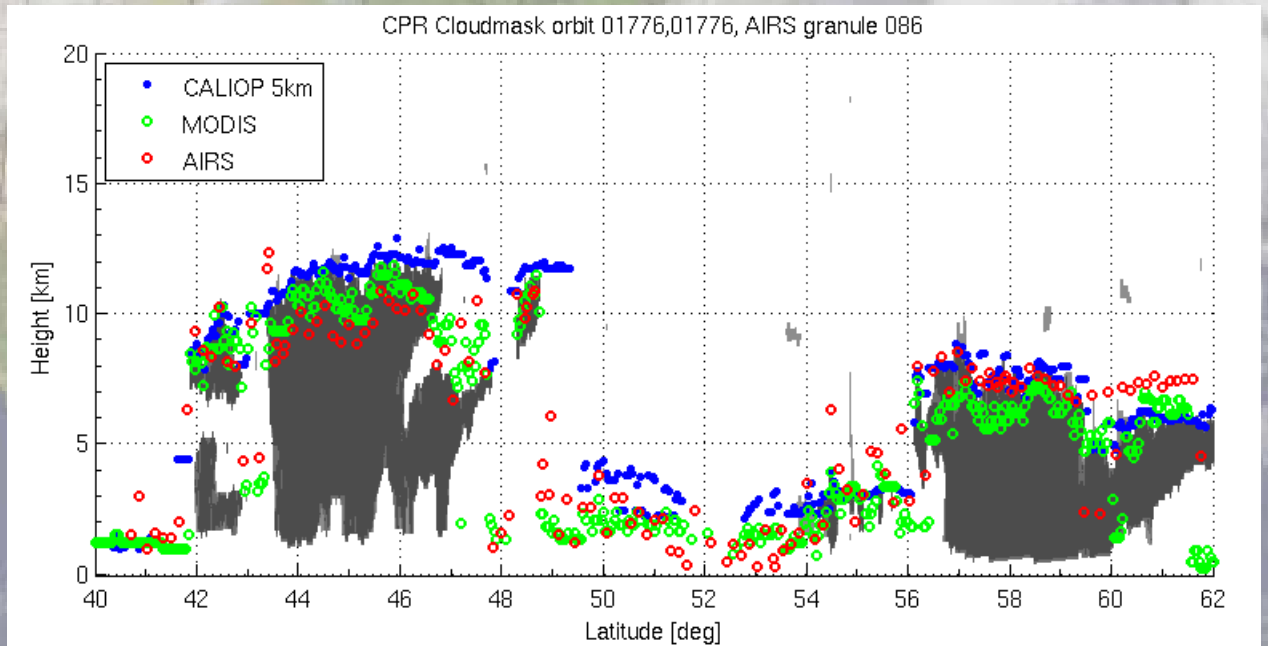


MODIS



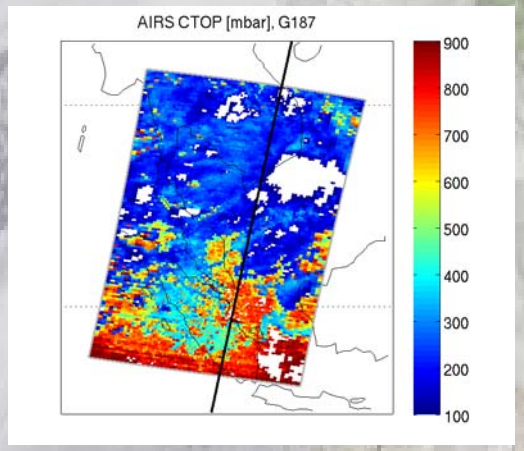
CALIOP
MODIS
AIRS



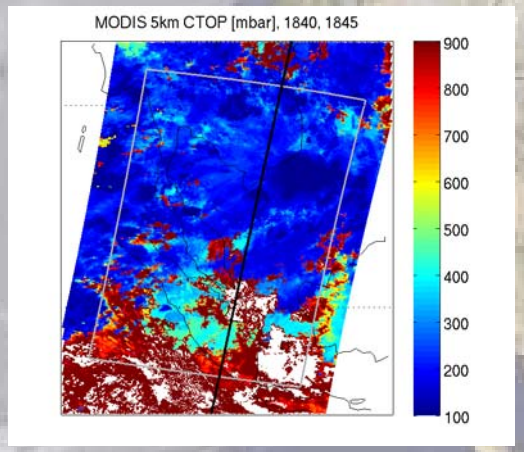


CTOP RTV evaluation, G187, 08-28-2006

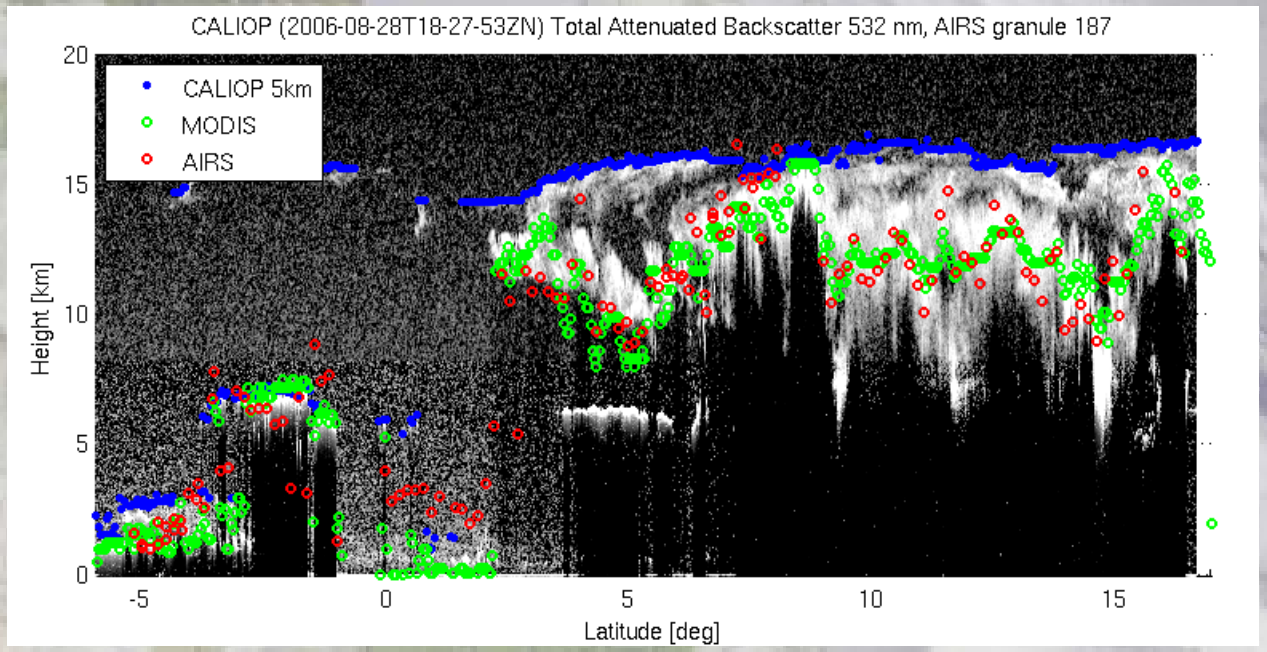
AIRS

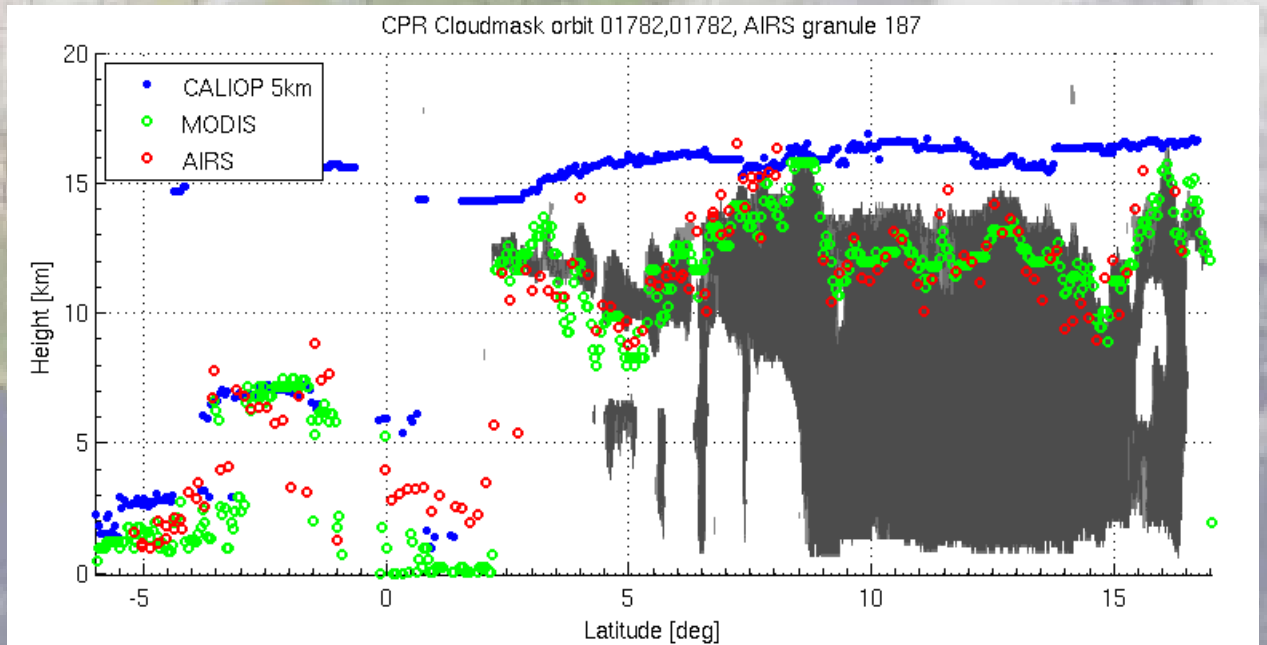


MODIS



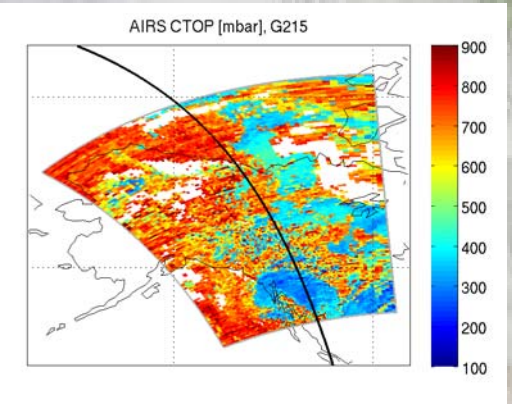
CALIOP
MODIS
AIRS



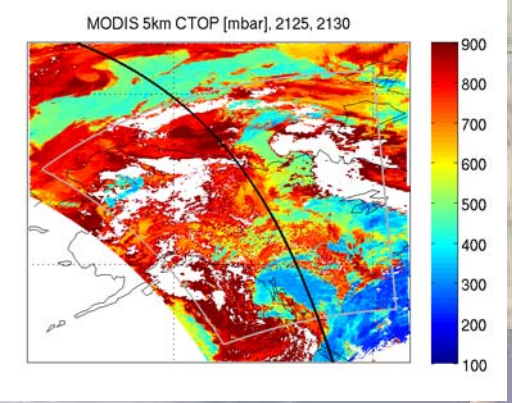


CTOP RTV evaluation, G215, 08-28-2006

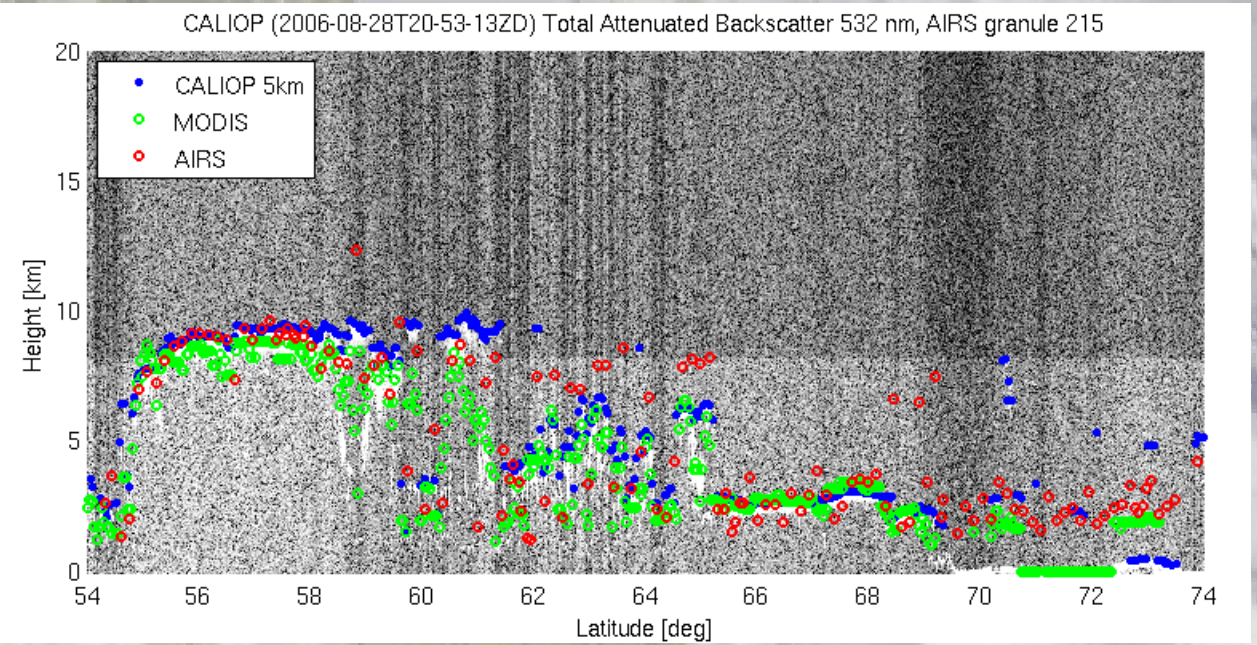
AIRS

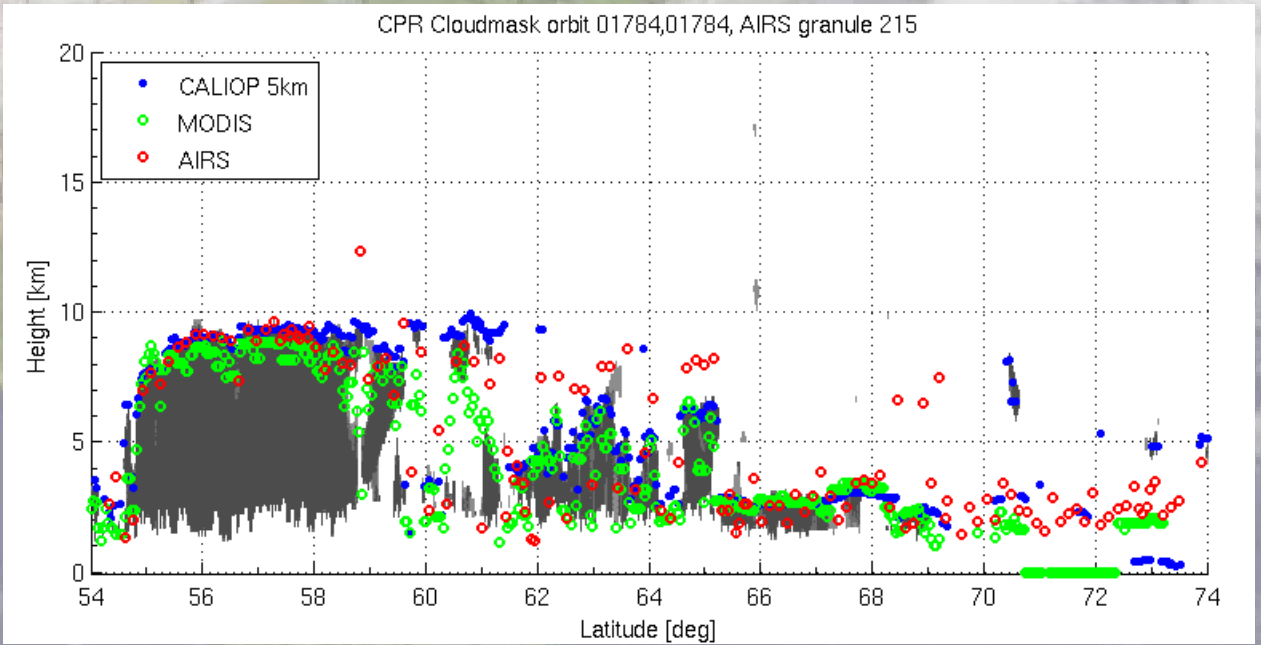


MODIS

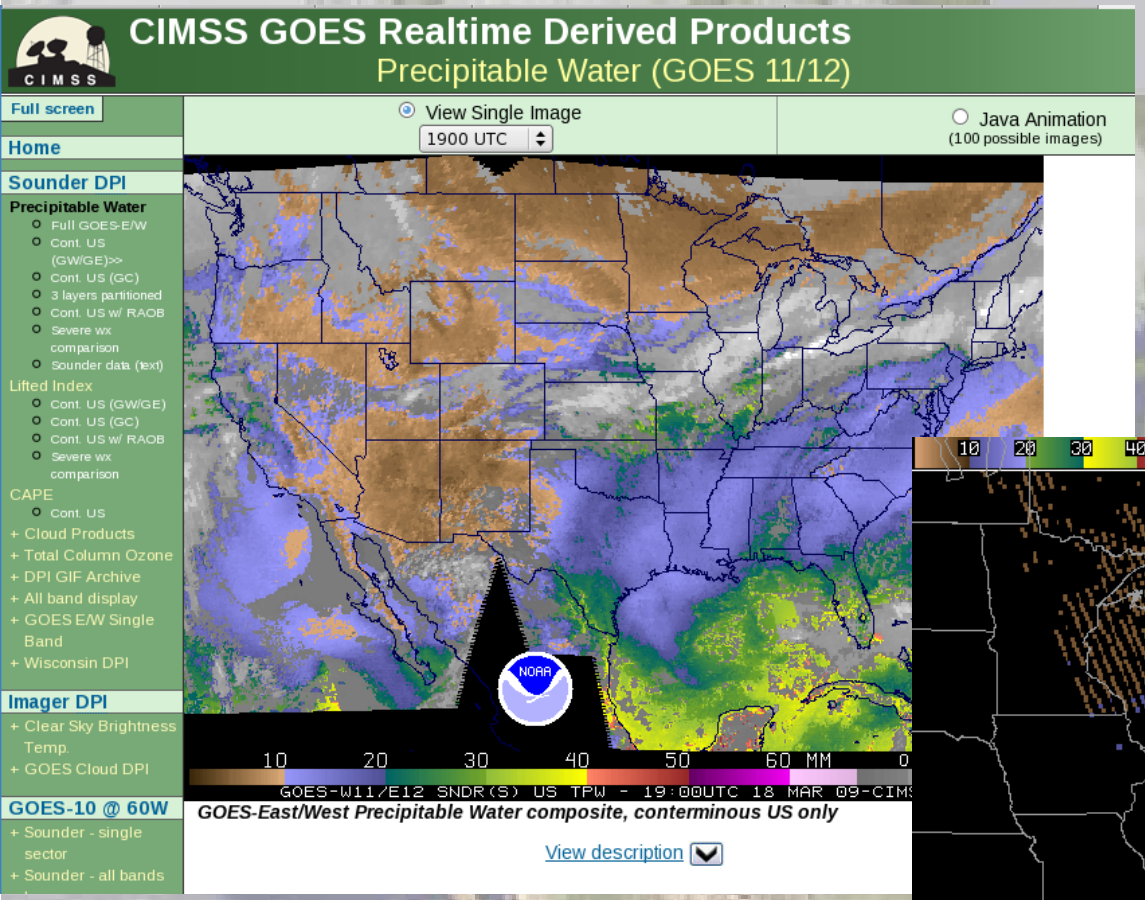


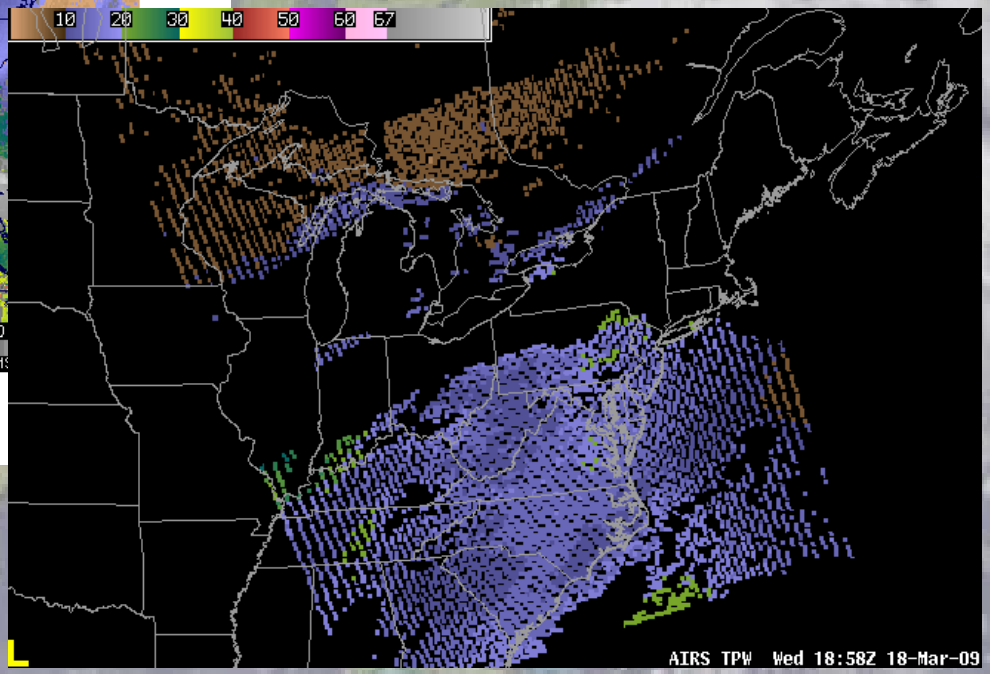
CALIOP
MODIS
AIRS





Comparison of AIRS TPW with operational GOES products





AIRS TPW Wed 18:58Z 18-Mar-09

Summary

- Latest version of the software package includes AIRS/MODIS collocation, AIRS cloud mask, and retrievals of T, Q, O3, Ts, Es, CTOP at SFOV.
- This version can be used on MODIS DB (of any size) or on 5 minute granules.
- CTHs retrieved from AIRS have been compared with CloudSat, and CALIOP CTHs. Good agreements with CloudSat and optically thick clouds, some problems for non-uniform cloud cover.
- Current applications include hurricane studies, AIRS/MODIS combined CTOP retrieval, real-time comparisons with the operational GOES product and plans of implementing AIRS derived products into NWS's forcasts.
- Current efforts include improvement of the cloudy retrieval and physical algorithm development.
- For more information and software go to

http://cimss.ssec.wisc.edu/imapp/uwairs_utils_v1.1.shtml

International TOVS Study Conference, 17th, ITSC-17, Monterey, CA, 14-20 April 2010. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2011.