

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.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

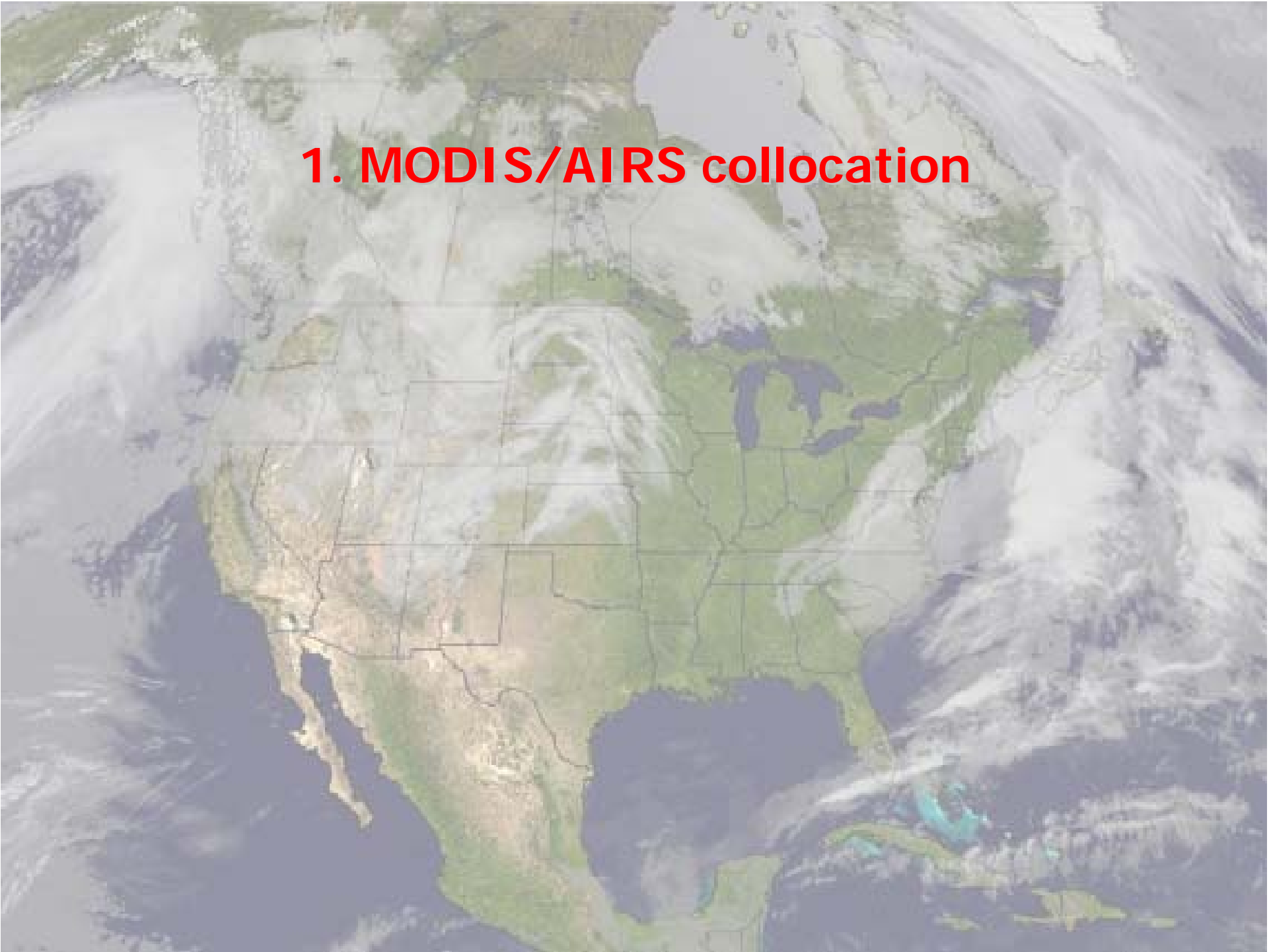
IMAPP DB AIRS L2 Collocation, Cloud Mask and SFOV UW All Sky Retrieval Software

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*)

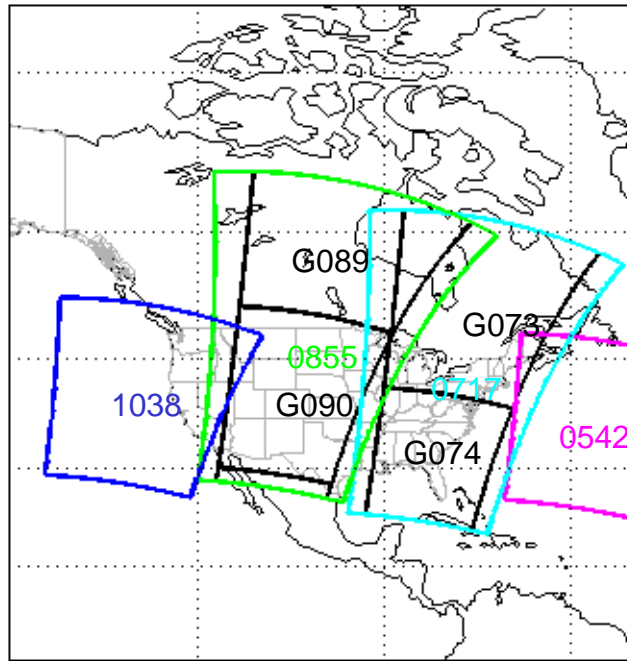
* ... surface pressure is provided by GDAS or GFS analysis or forecast file

1. MODIS/AIRS collocation

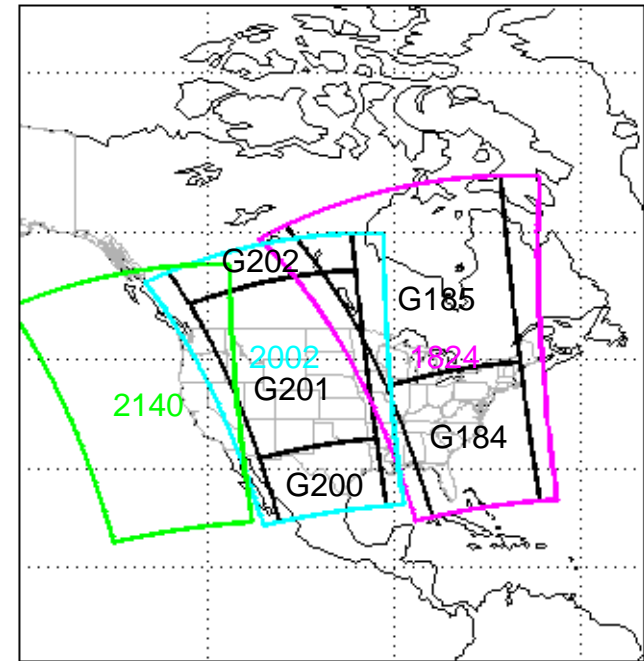


Direct Broadcast (DB) AIRS and MODIS data

2010-04-06 (D096), descending

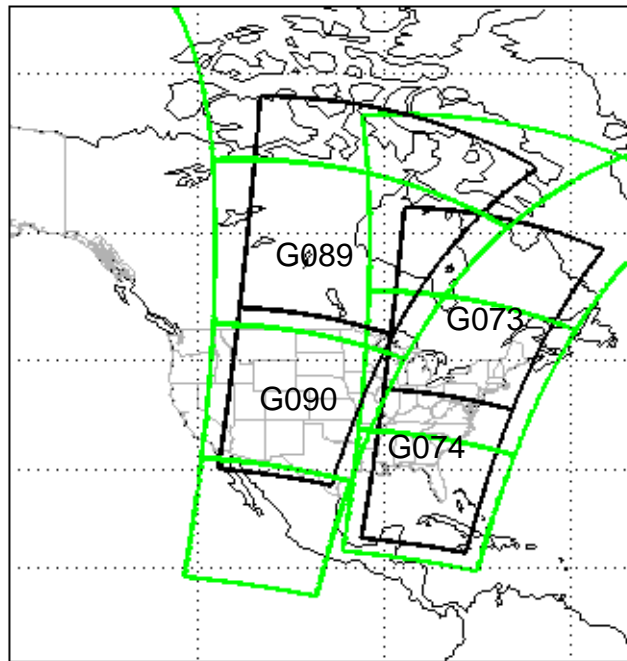


2010-04-06 (D096), ascending

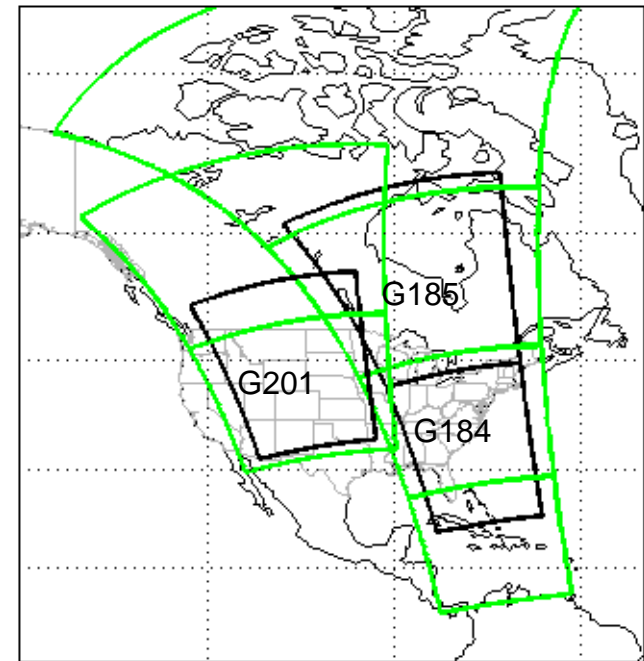


Direct Broadcast (DB) AIRS and MODIS data

2010-04-06 (D096), descending



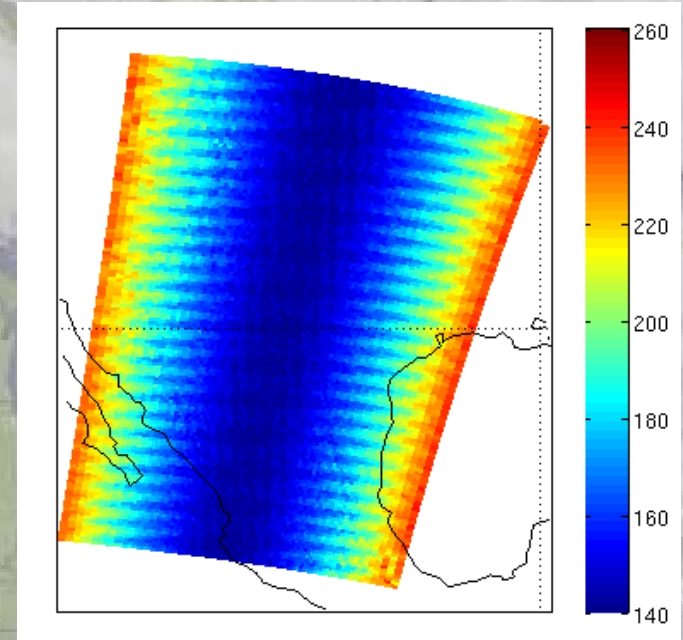
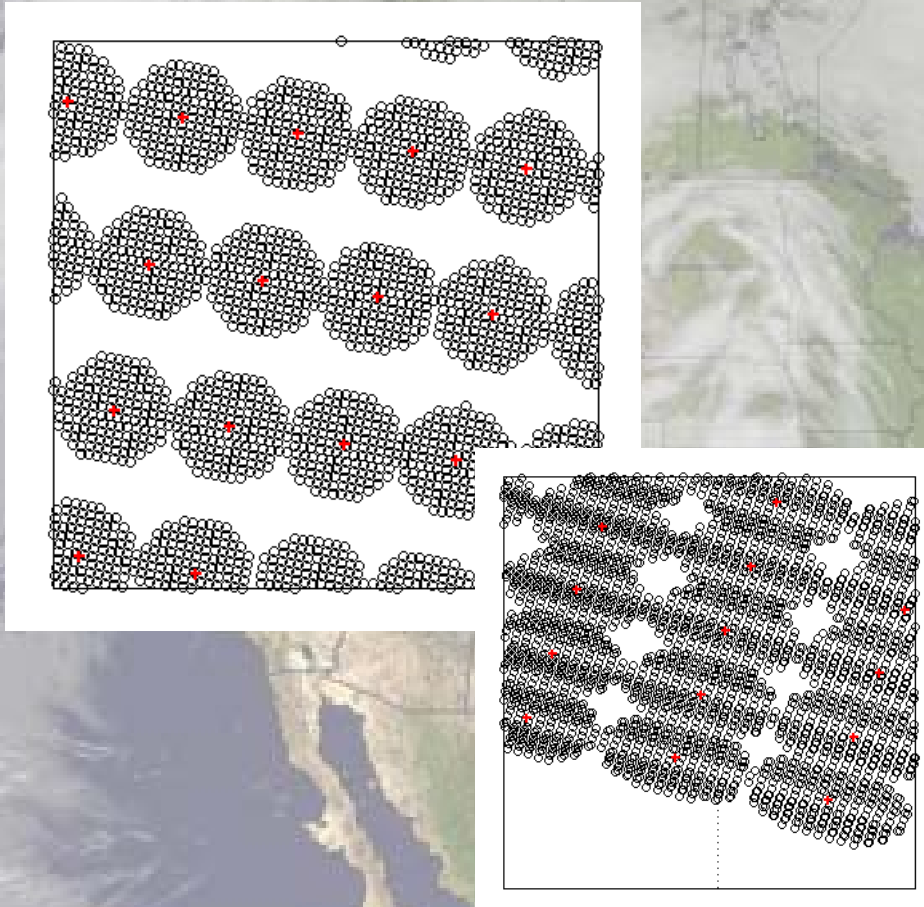
2010-04-06 (D096), ascending



Gran 073: 2010096.0715
2010096.0720
Gran 074: 2010096.0720
2010096.0725
Gran 089: 2010096.0850
2010096.0855
Gran 090: 2010096.0855
2010096.0900
2010096.0905

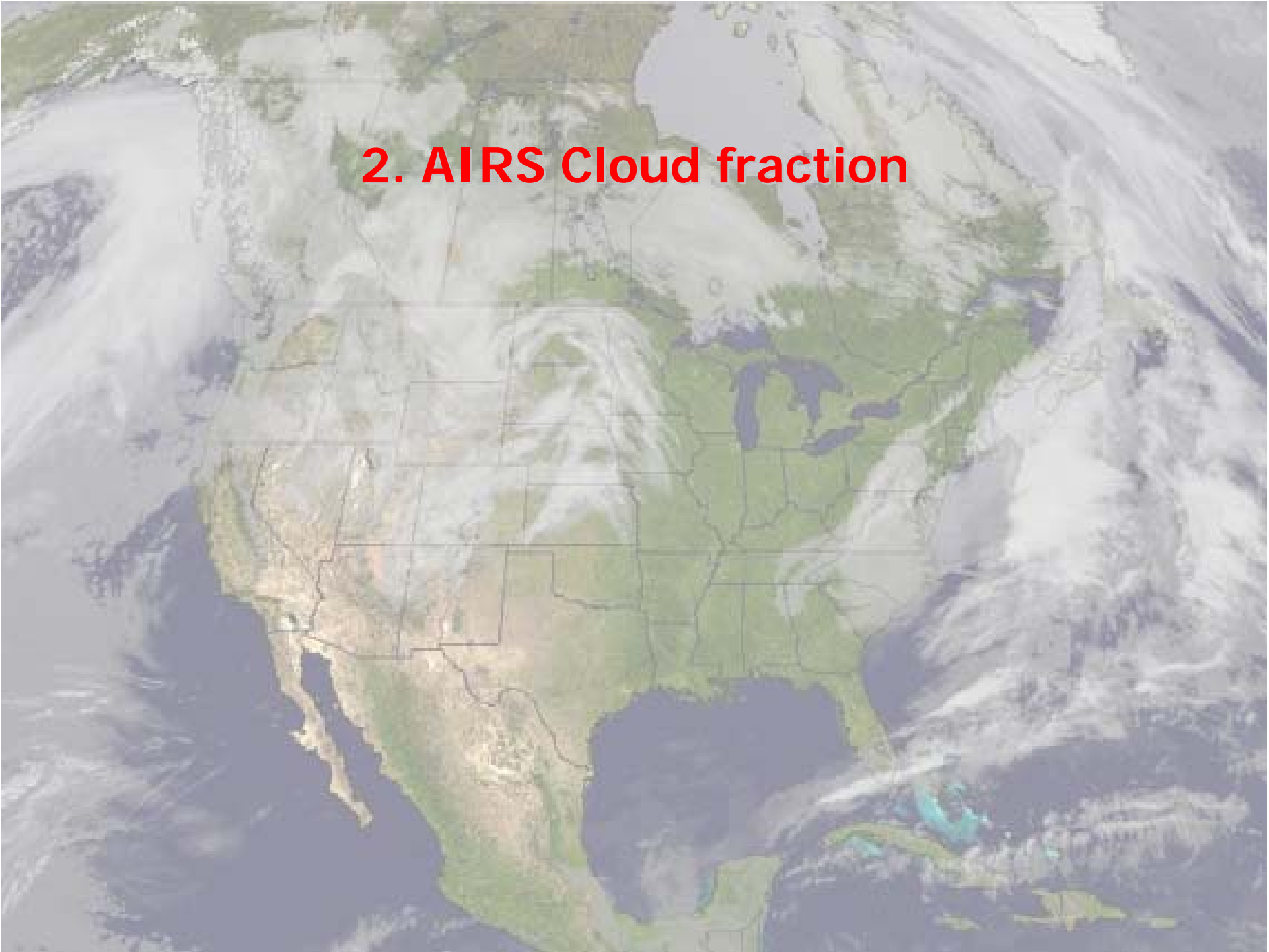
Gran 184: 2010096.1820
2010096.1825
Gran 185: 2010096.1825
2010096.1830
2010096.1835
Gran 201: 2010096.2005
2010096.2010

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.

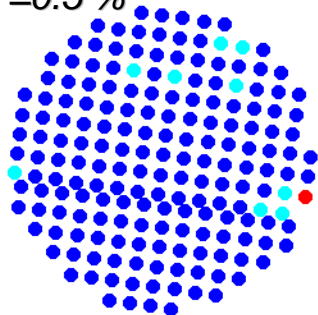
2. AIRS Cloud fraction



AIRS cloud fraction and mask from MYD35 product (1)

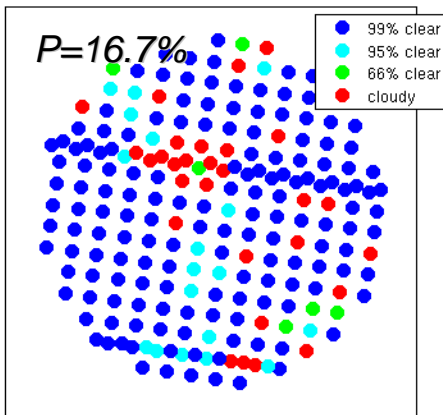
AIRS pixel 9660 (0.005 %)

$P=0.5\%$



AIRS pixel 12130 (0.167 %)

$P=16.7\%$

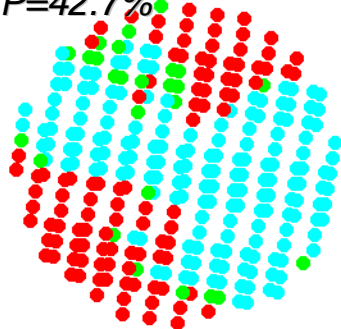


- 99% clear (confident clear)
- 95% clear (probably clear)
- 66% clear (probably cloudy)
- Cloudy

$$P=1-(n_{99}+n_{95})/n_{To}$$

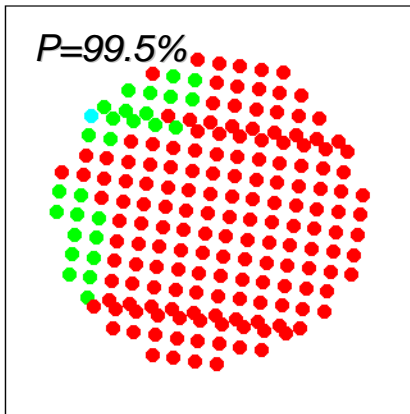
AIRS pixel 6571 (0.427 %)

$P=42.7\%$



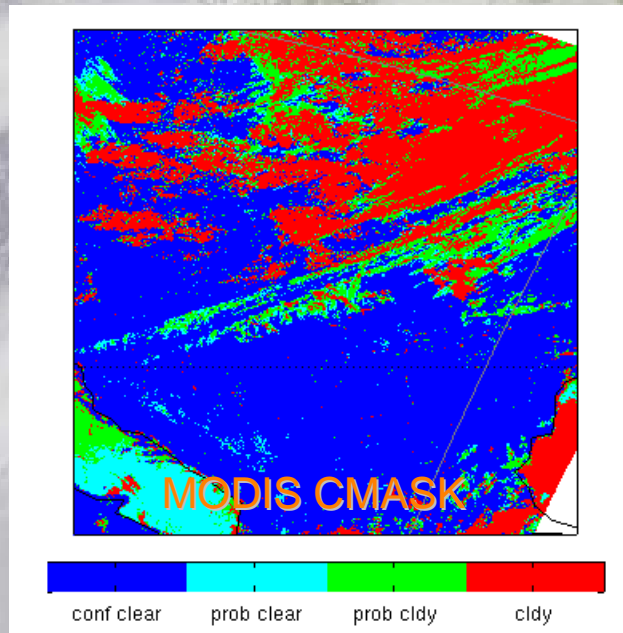
AIRS pixel 11188 (0.995 %)

$P=99.5\%$

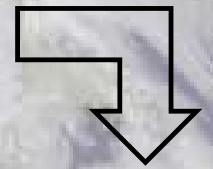
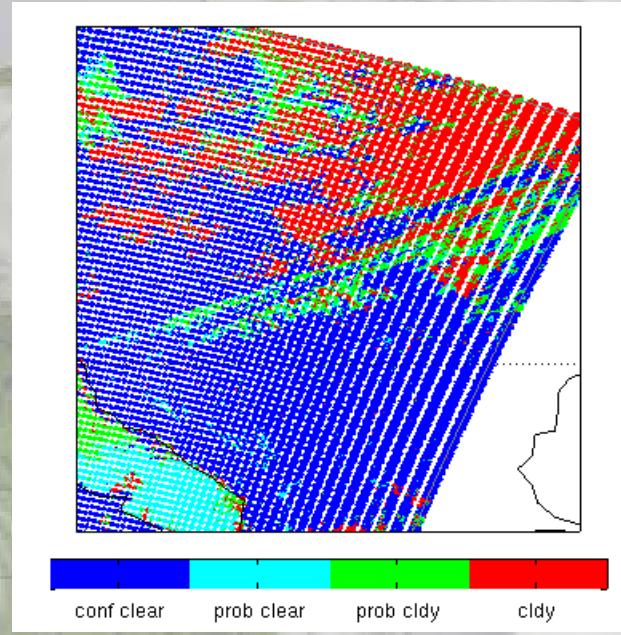


$P \leq 0.01$ AIRS FOV clear
 $P \geq 0.99$ AIRS FOV full cloudy

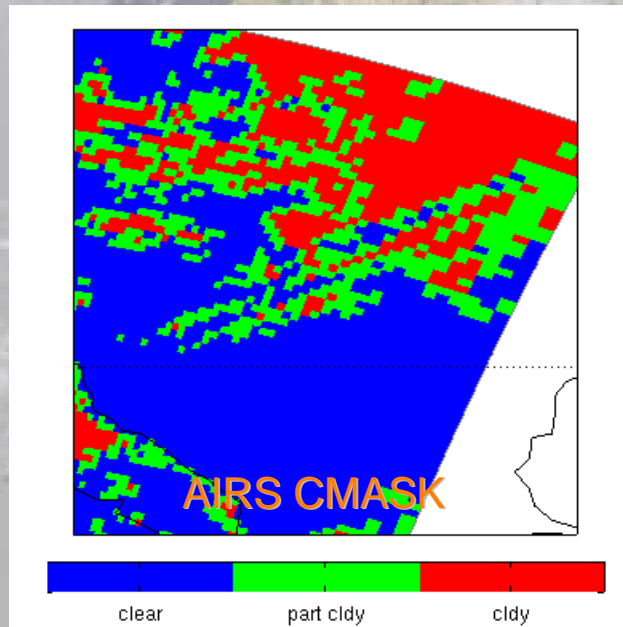
AIRS cloud fraction and mask from MYD35 product (2)



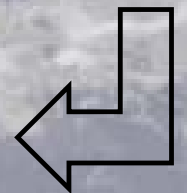
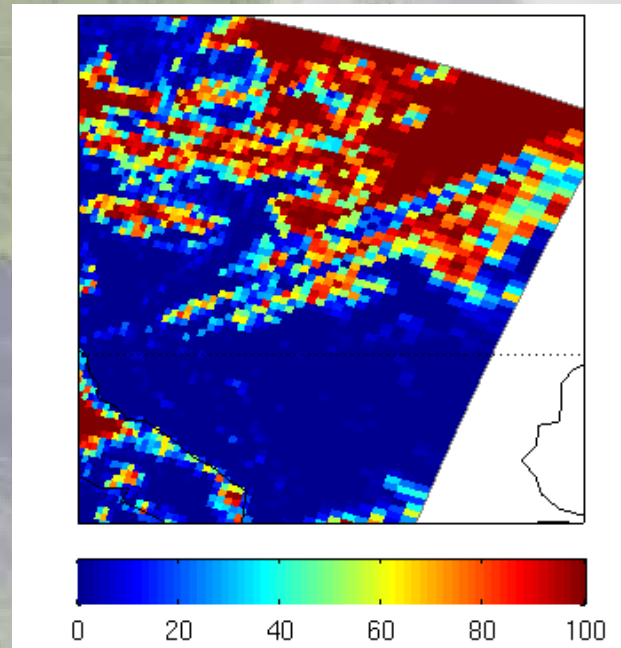
AIRS/MODIS collocation



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

Clear Regr Coeffs

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

CLOUDY

Cloudy Training data set
(ice, water)

Radiance calculations
Fast RT cloud model (Wei, Yang)

Scanang
Classification

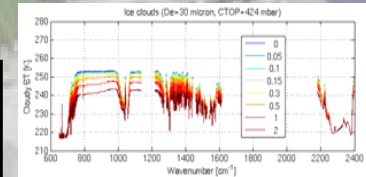
Ice Cloud Regr Coeffs
Water Cloud Regr Coeffs

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

Additional
Predictors
(spres, solzen)

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

Regression RTV
 $X = \overline{X}_{tr} + CA_{obs}$



To physical inversion

Retrieval parameters

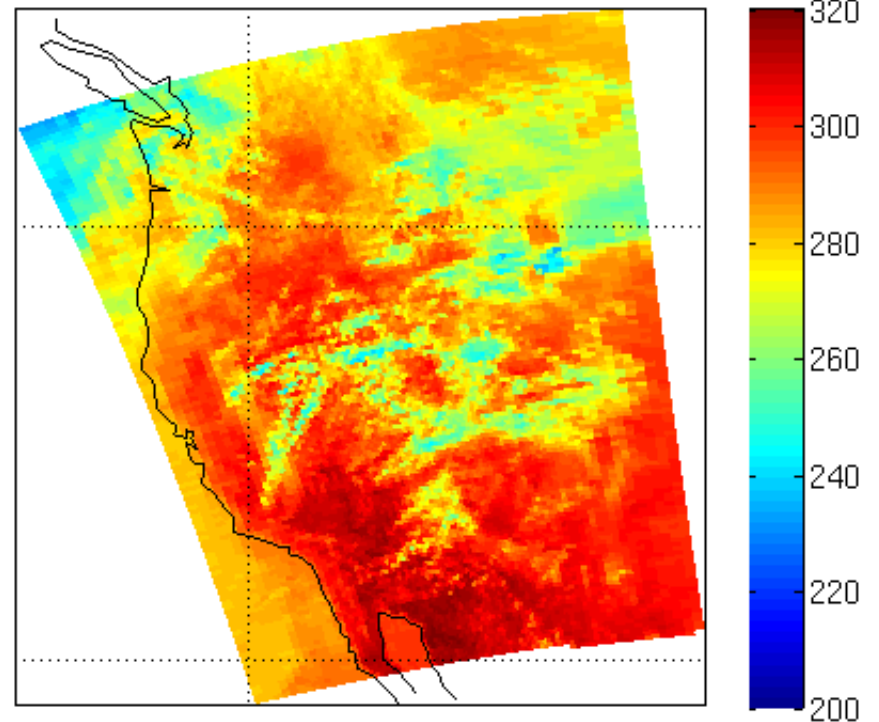
parameter	units	size	notes
Temperature	K	101x1	
Humidity	g/kg	101x1	
Ozone	ppmv	101x1	
TPW	cm	1x1	vertically integrated
TOA	DU	1x1	vertically integrated
Surface skin Temperature	K	1x1	
Surface Emissivity	--	2378x1	Retrieved as 6 eigenvector coefficients, then reconstructed to full spectrum
Cloud top 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

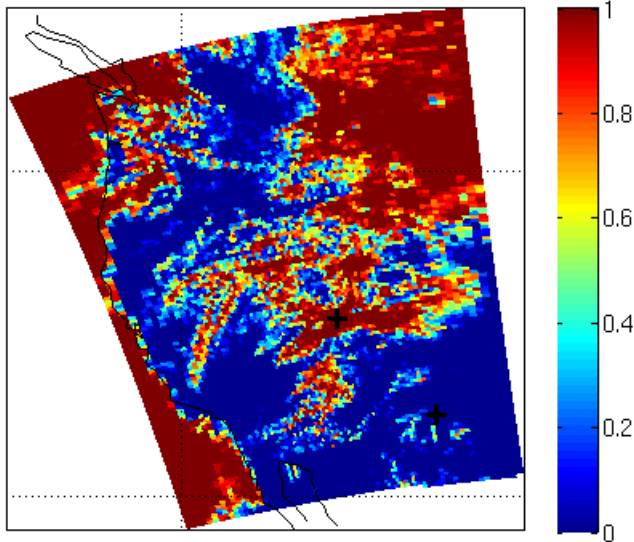


AIRS.2008.10.19.207.atm_prof_rtv.img
Brightness Temperature [K] at 911.2 cm^{-1}

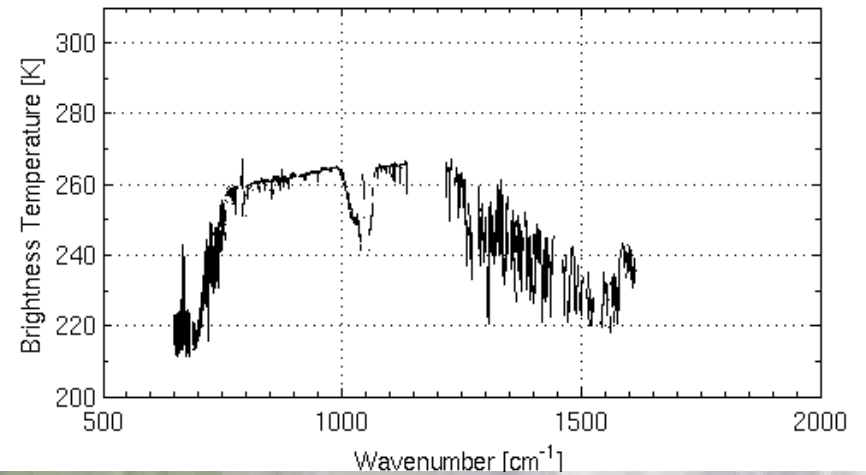


G207, 10-19-2008, BT at 911 cm⁻¹

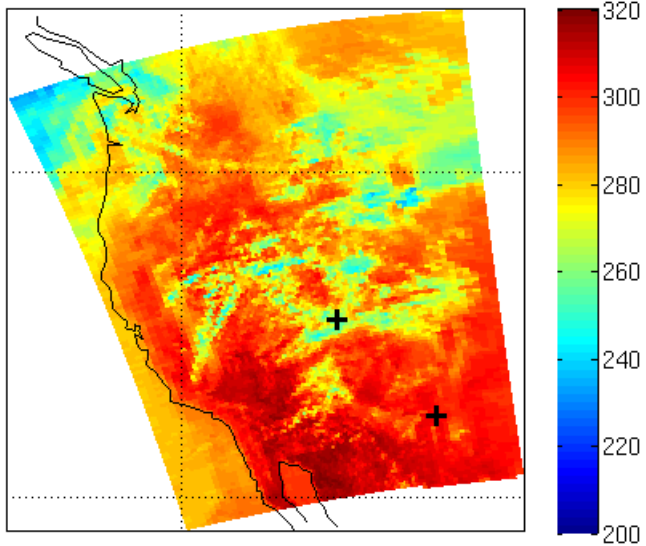
AIRS.2008.10.19.207.atm_prof_rtv.img
Cloud Fraction



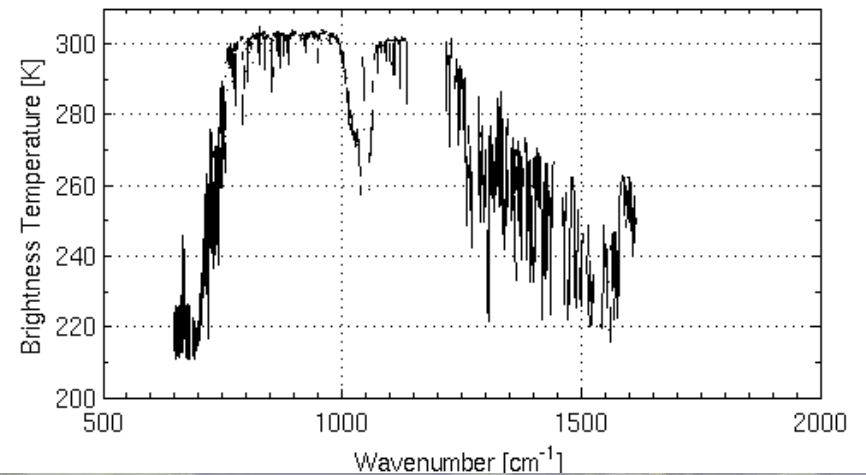
Pixel 55/57 (Lat/Lon: 38.4 / -111.7)



AIRS.2008.10.19.207.atm_prof_rtv.img
Brightness Temperature [K] at 911.2 cm⁻¹

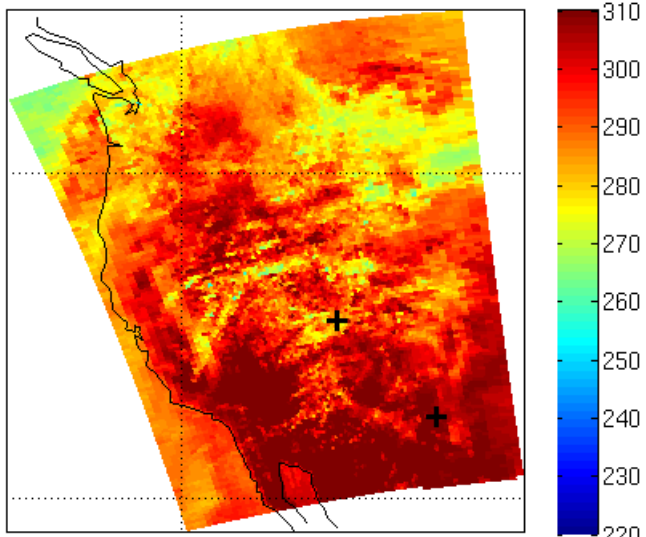


Pixel 77/26 (Lat/Lon: 33.9 / -106.4)



Surface Skin Temperature and Atmospheric Temperature at 700 mbar

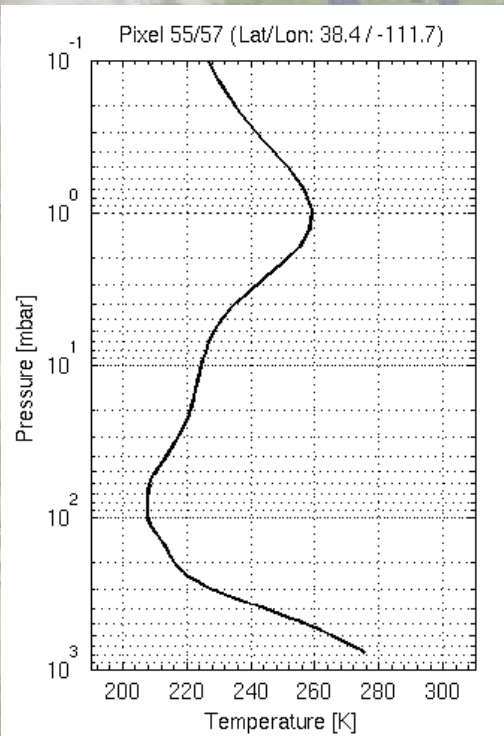
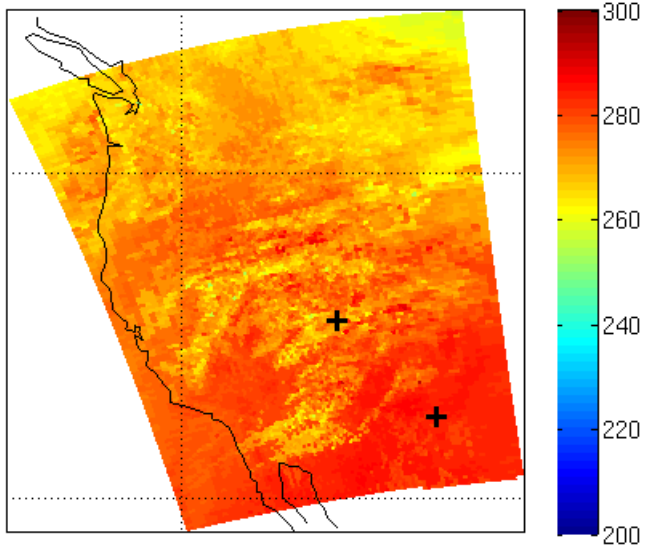
AIRS.2008.10.19.207.atm_prof_rtv.img
Surface Skin Temperature [K]



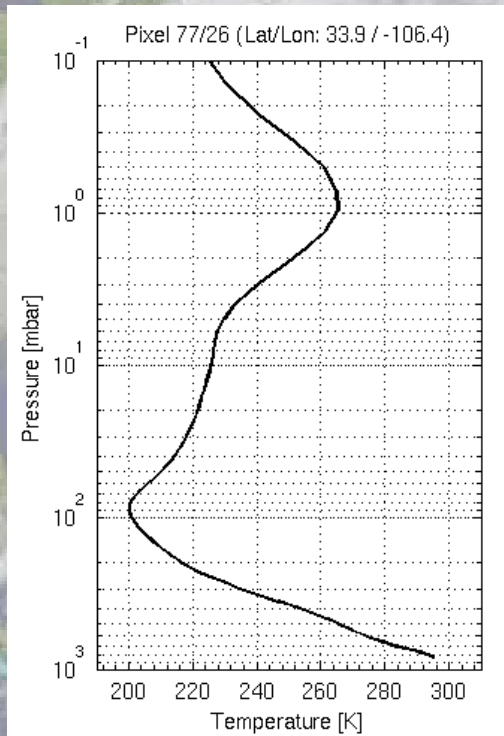
$Temp_s = 283.1$ K

$Temp_s = 308.2$ K

AIRS.2008.10.19.207.atm_prof_rtv.img
Temperature [K] at 706.565 mbar



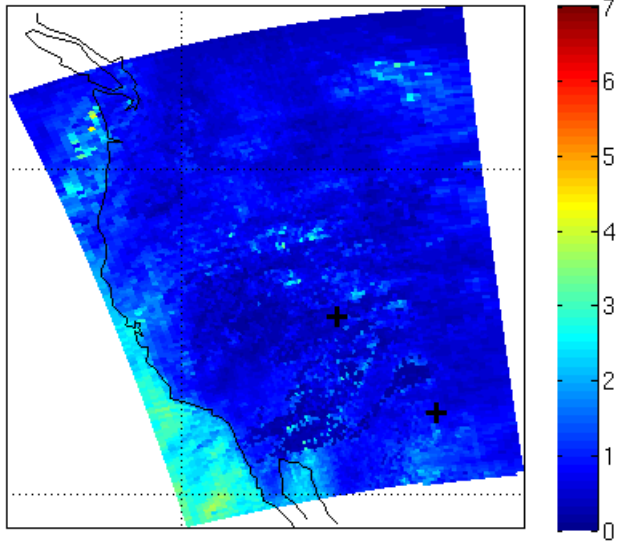
cloudy



clear

TPW and Atmospheric Humidity at 800 mbar

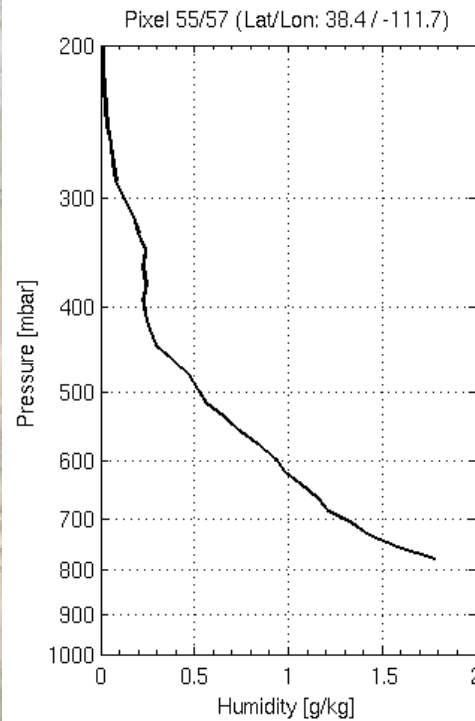
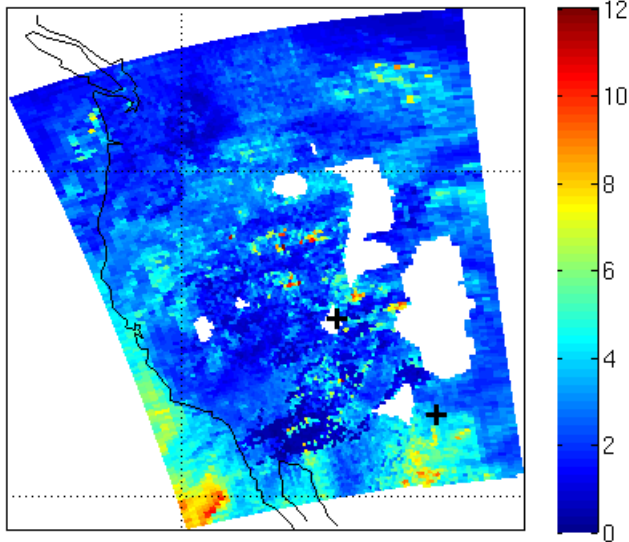
AIRS.2008.10.19.207.atm_prof_rtv.img
TPW [cm]



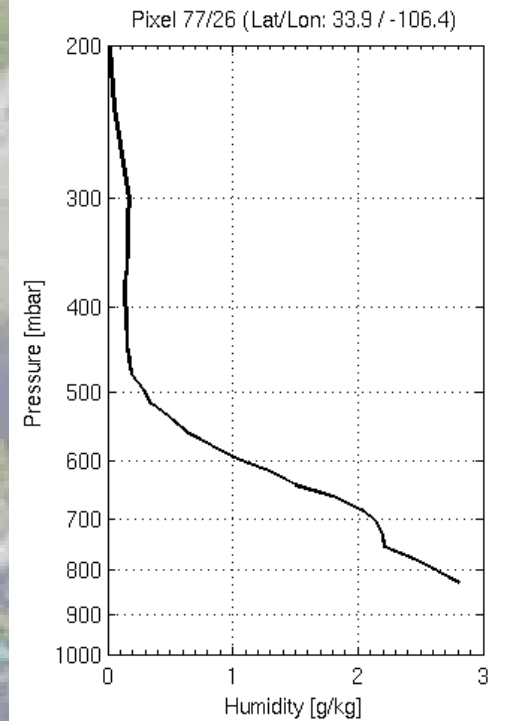
TPW=0.38 cm

TPW=0.58 cm

AIRS.2008.10.19.207.atm_prof_rtv.img
Humidity [g/kg] at 802.371 mbar



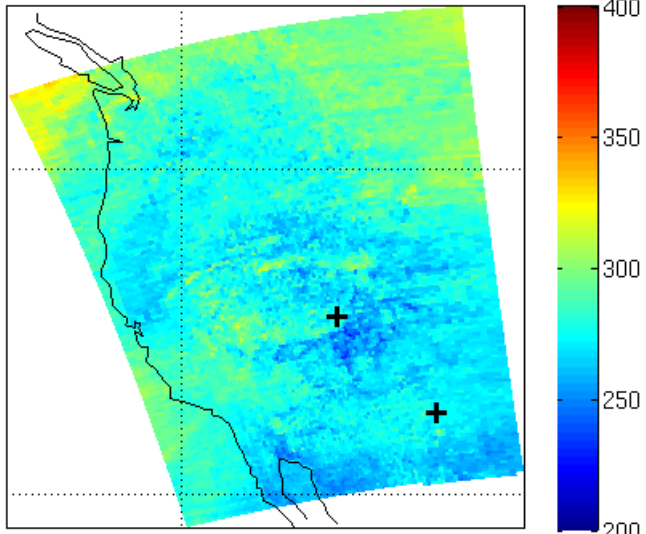
cloudy



clear

TOC and Atmospheric Ozone at 10 mbar

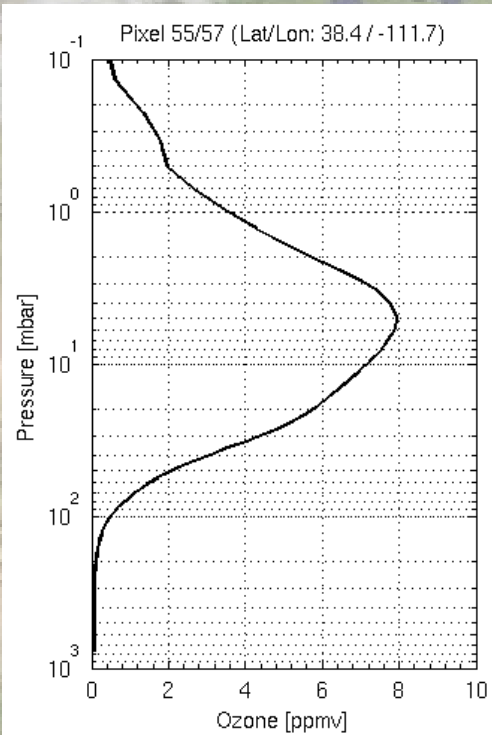
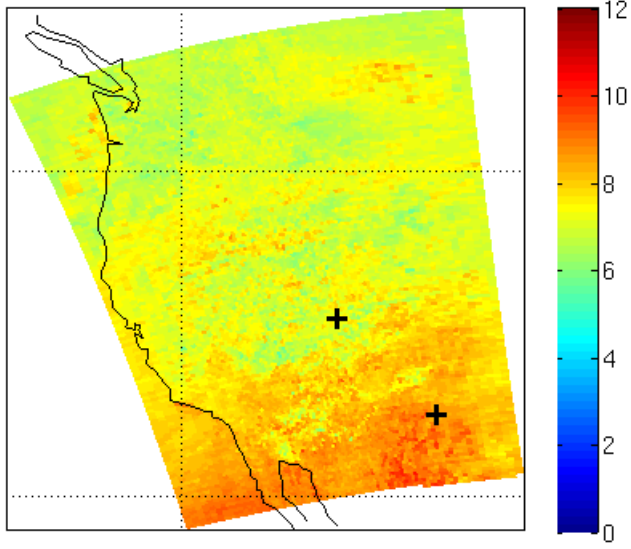
AIRS.2008.10.19.207.atm_prof_rtv.img
Total Ozone [dobsons]



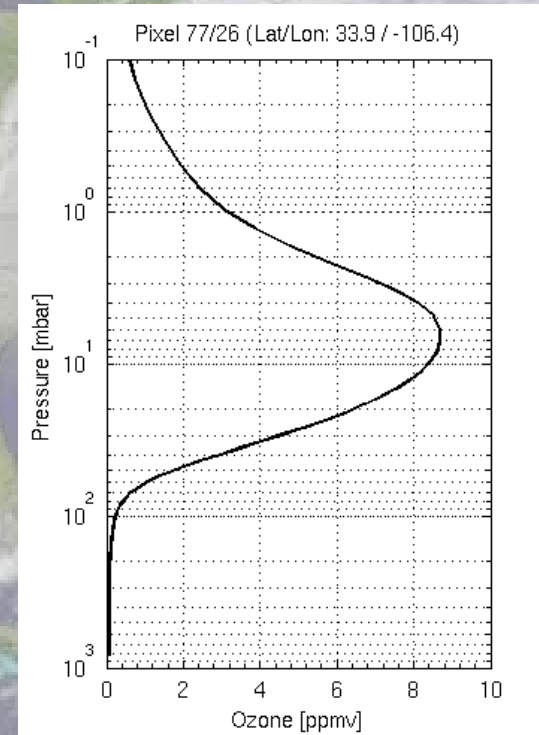
TOC=278.9 DU

TOC=270.4 DU

AIRS.2008.10.19.207.atm_prof_rtv.img
Ozone [ppmv] at 9.5119 mbar



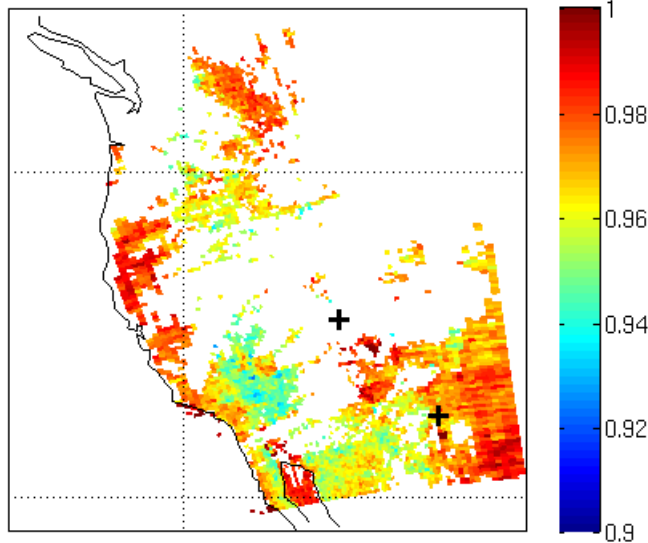
cloudy



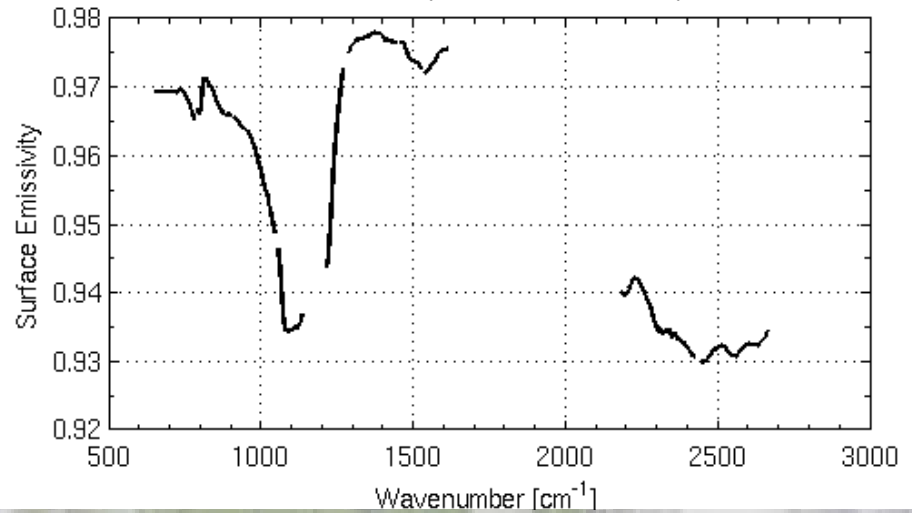
clear

Surface Emissivity and Cloud Top Pressure

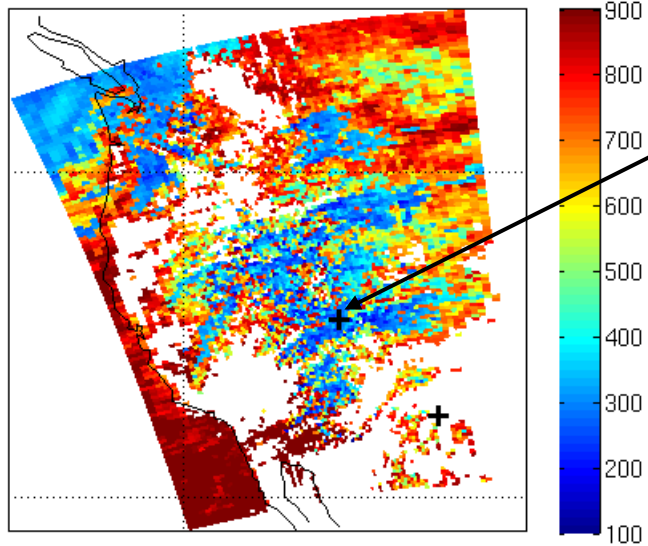
AIRS.2008.10.19.207.atm_prof_rtv.img
Surface Emissivity at 911.235 cm^{-1}



Pixel 77/26 (Lat/Lon: $33.9^\circ / -106.4^\circ$)



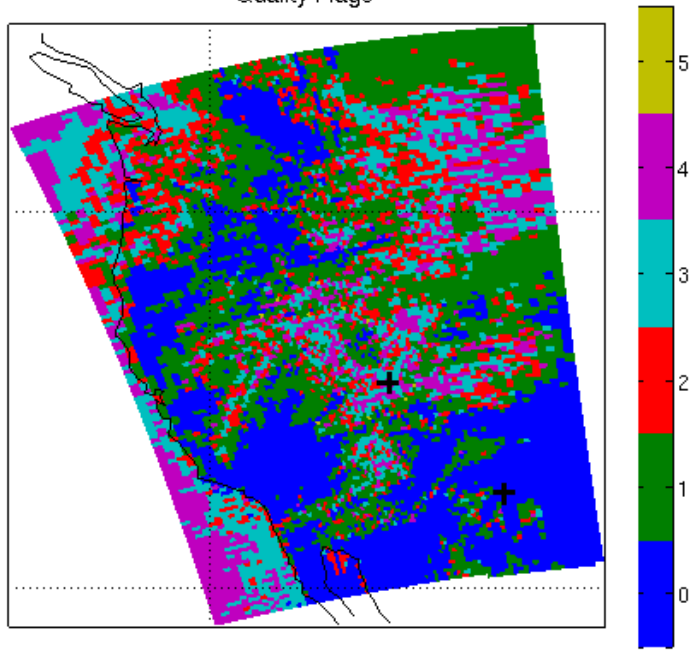
AIRS.2008.10.19.207.atm_prof_rtv.img
Cloud top pressure [mbar]



CTOP=265.7 mbar

Quality Flags

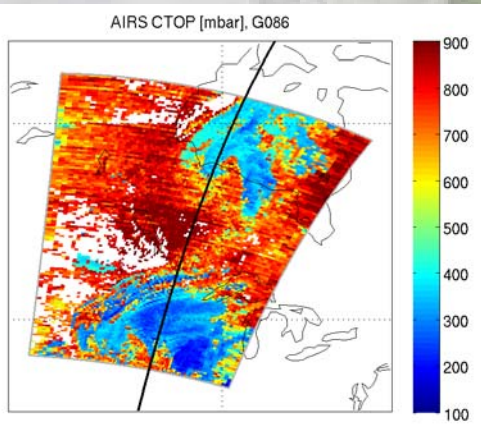
AIRS.2008.10.19.207.atrn_prof_rtv.img
Quality Flags



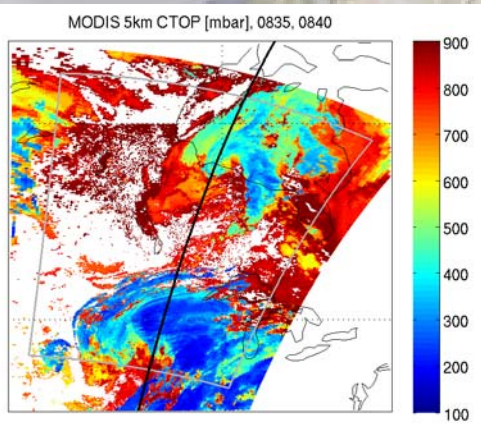
QF	COT	NOTES
0	0	clear
1	< 0.5	Thin clouds
2	$0.5 < \text{cot} < 1$	Medium thick clouds
3	$1 < \text{cot} < 1.5$	Thick clouds
4	> 1.5	opaque
5		Bad rtv

CTOP RTV evaluation, G086, 08-28-2006

AIRS

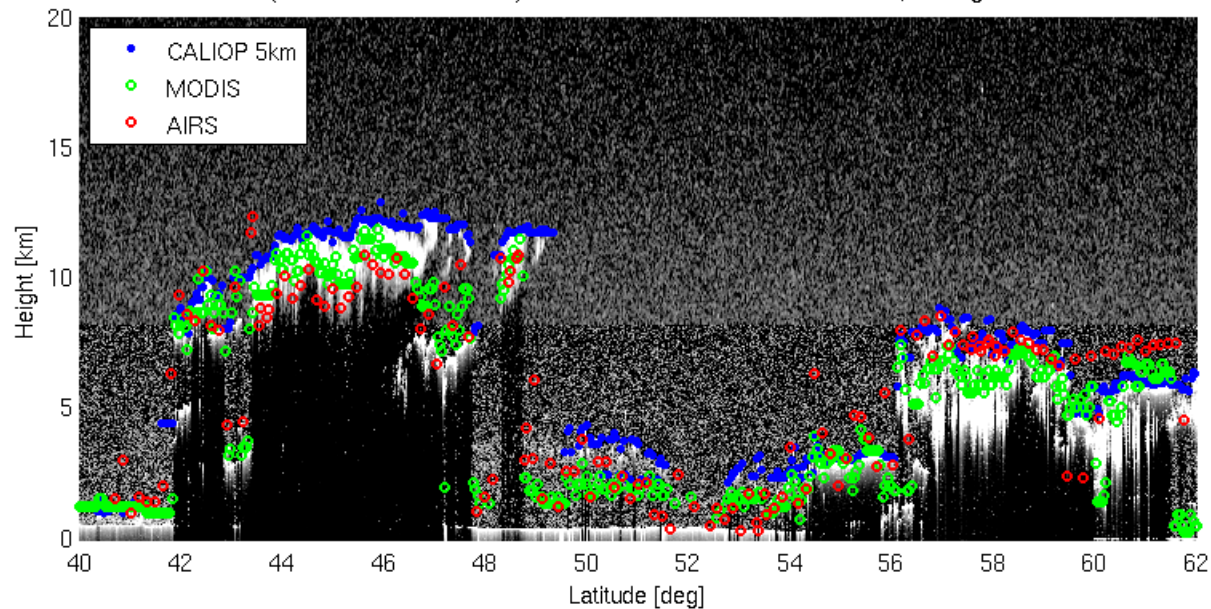


MODIS

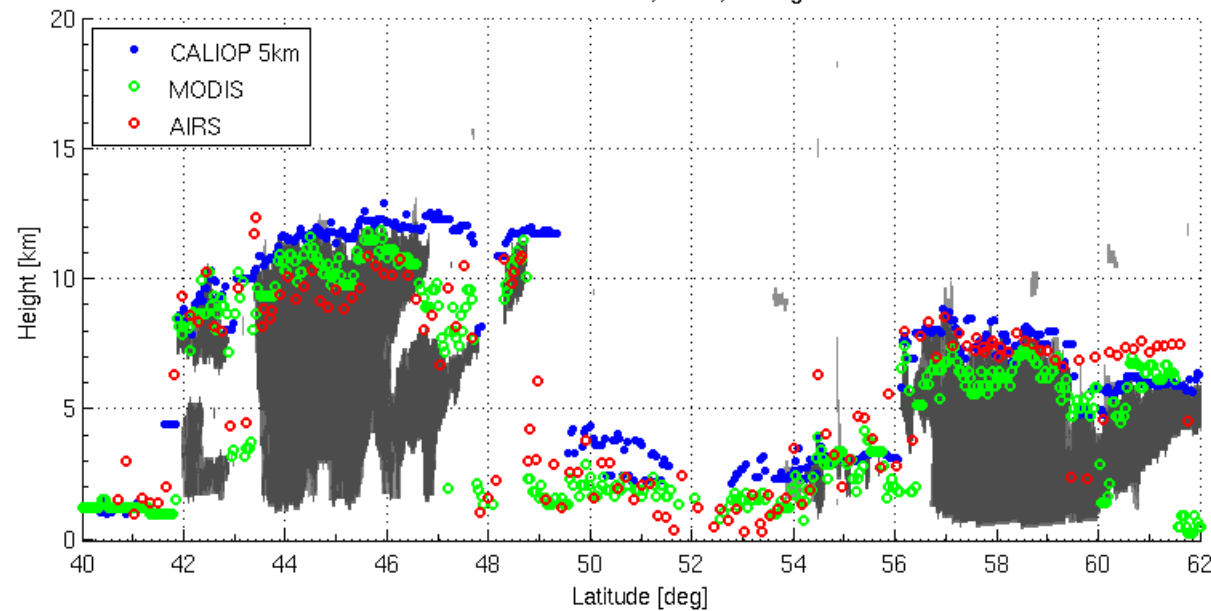


- CALIOP
- MODIS
- AIRS

CALIOP (3-01.2006-08-28T08-34) Total Attenuated Backscatter 532 nm, AIRS granule 086

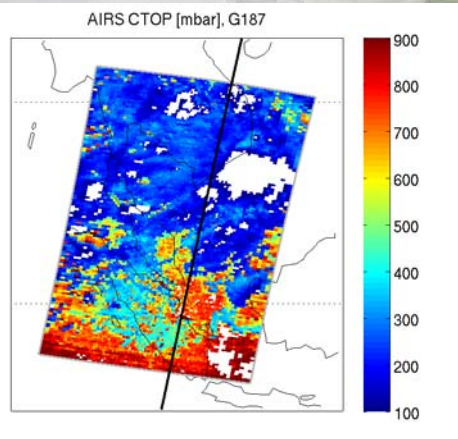


CPR Cloudmask orbit 01776,01776, AIRS granule 086

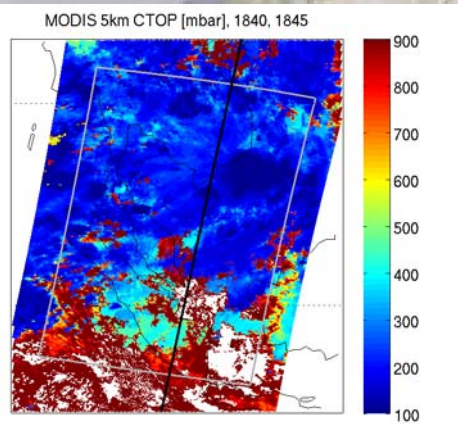


CTOP RTV evaluation, G187, 08-28-2006

AIRS

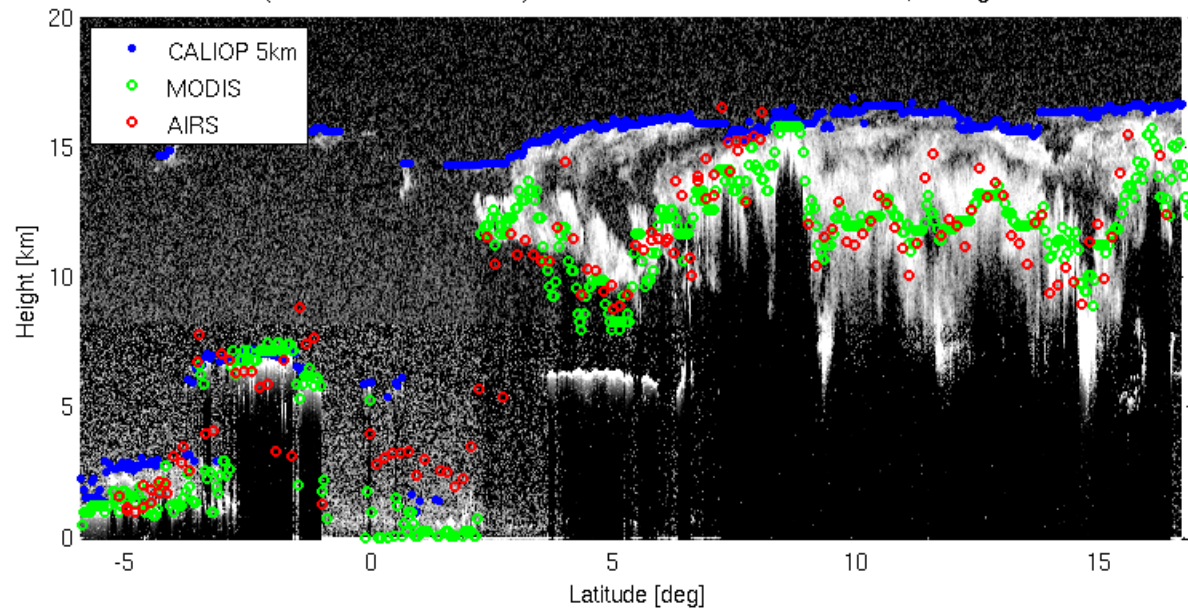


MODIS

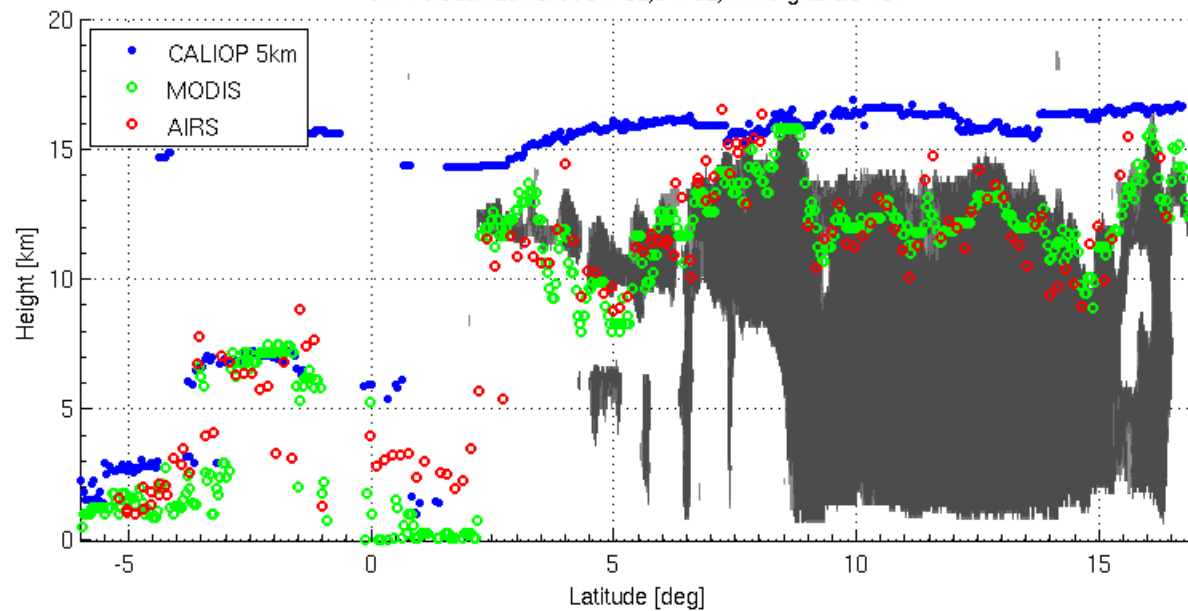


- CALIOP
- MODIS
- AIRS

CALIOP (2006-08-28T18-27-53Z) Total Attenuated Backscatter 532 nm, AIRS granule 187

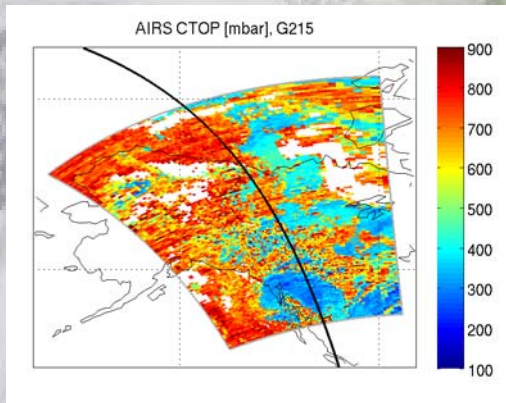


CPR Cloudmask orbit 01782,01782, AIRS granule 187

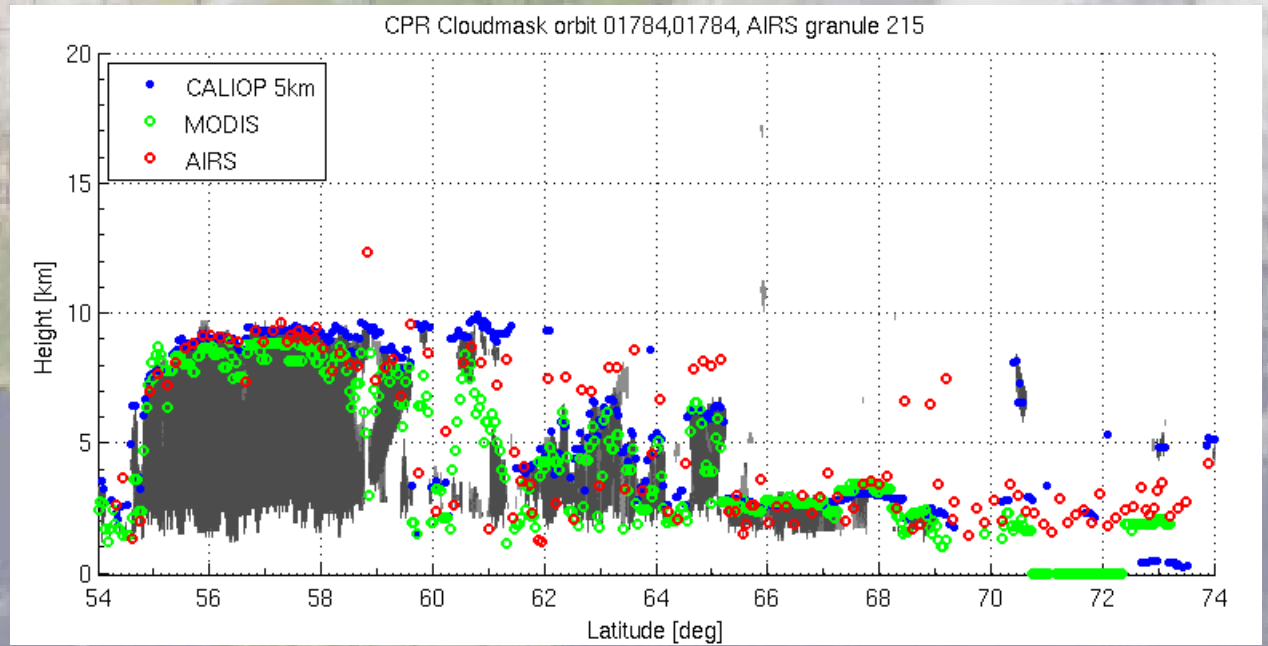
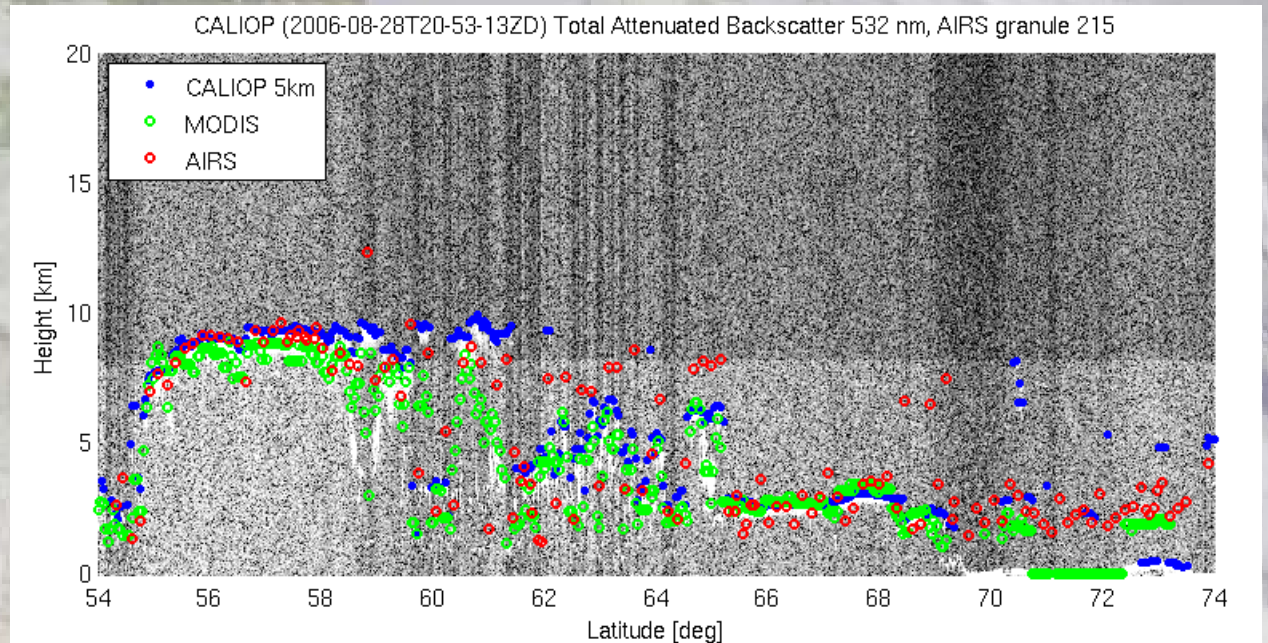
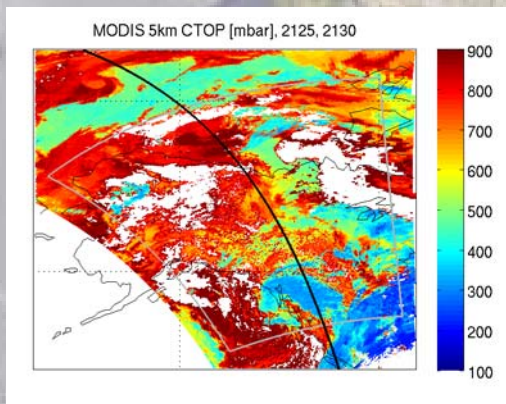


CTOP RTV evaluation, G215, 08-28-2006


AIRS



MODIS



Comparison of AIRS TPW with operational GOES products

 **CIMSS GOES Realtime Derived Products**
Precipitable Water (GOES 11/12)

View Single Image Java Animation (100 possible images)

1900 UTC

Home

Sounder DPI

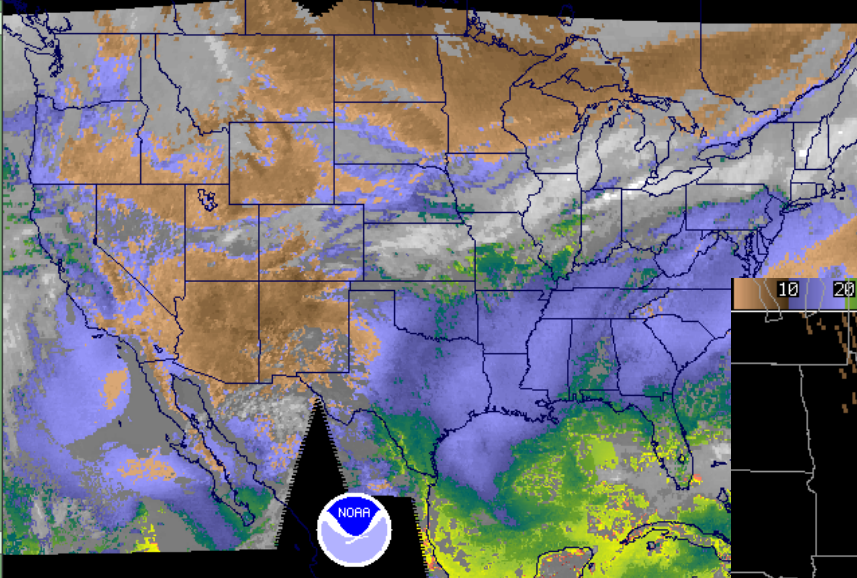
- Precipitable Water
 - Full GOES-EW
 - Cont. US (GWGE)>>
 - Cont. US (GC)
 - 3 layers partitioned
 - Cont. US w/ RAOB
 - Severe wx comparison
 - Sounder data (text)
- Lifted Index
 - Cont. US (GWGE)
 - Cont. US (GC)
 - Cont. US w/ RAOB
 - Severe wx comparison
- CAPE
 - Cont. US
- + Cloud Products
- + Total Column Ozone
- + DPI GIF Archive
- + All band display
- + GOES E/W Single Band
- + Wisconsin DPI

Imager DPI

- + Clear Sky Brightness Temp.
- + GOES Cloud DPI

GOES-10 @ 60W

- + Sounder - single sector
- + Sounder - all bands

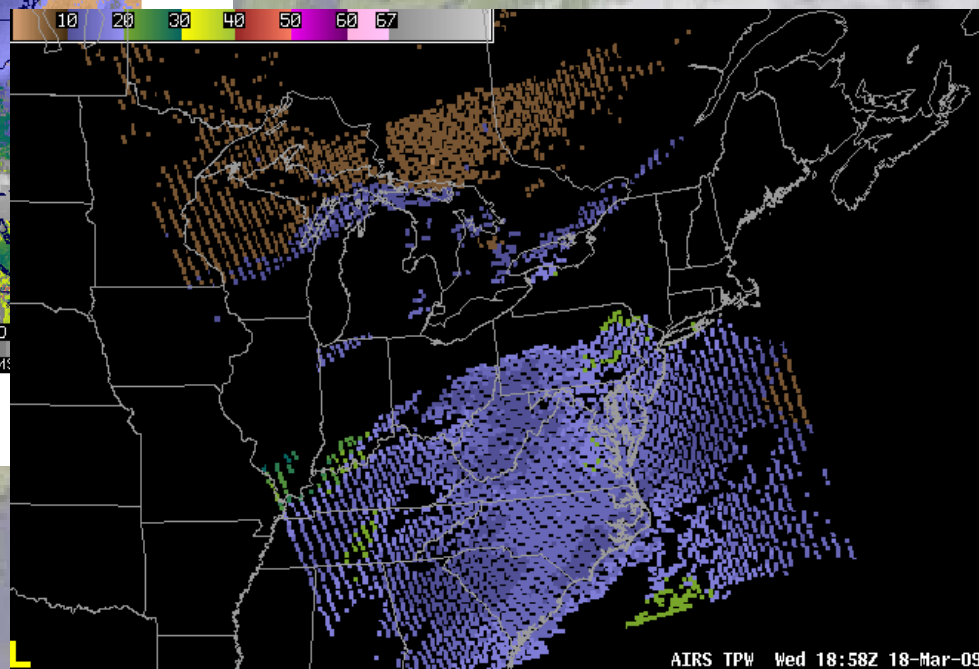


10 20 30 40 50 60 MM

GOES-W11/E12 SNDR(S) US TPW - 19:00UTC 18 MAR 09-CIMSS

GOES-East/West Precipitable Water composite, conterminous US only

[View description](#)



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, T_s, E_s, 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 forecasts.
- 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.