Using MODIS to Assess AIRS Cloud Cleared Radiances and Quality Control

By

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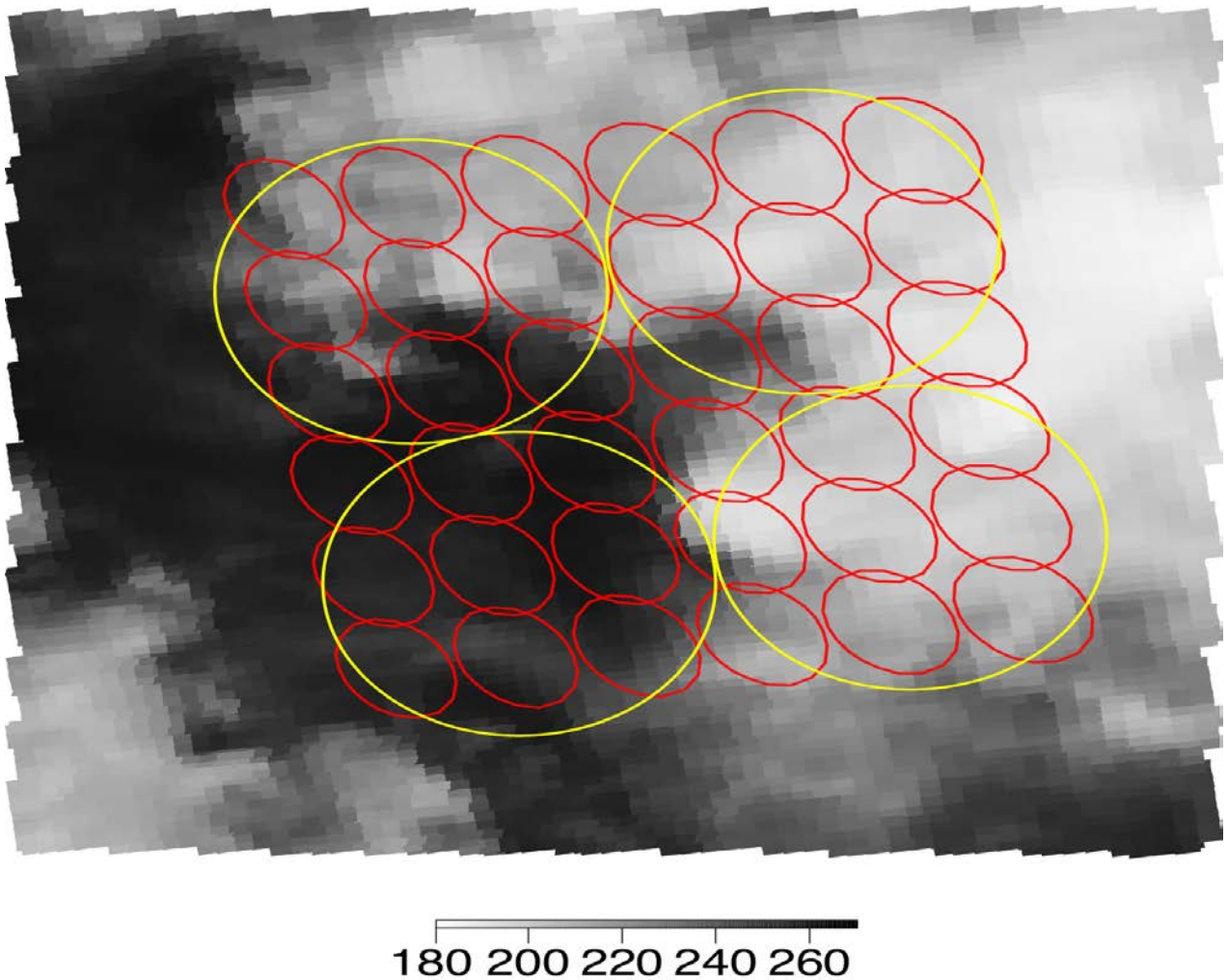
Outline

- Cover the methodology for our 20130203 case study
- Use convolved clear MODIS to examine AIRS cloud cleared radiances and their quality control
- Temperature errors as a function of radiance differences

AMSU, AIRS, and MODIS



η Determination for Operational Cloud Clearing

$$R^{s}_{CCR}(n) = \overline{R(n)} + \sum_{j=1}^{N_\eta} \left(\overline{R(n)} - R_{N_f+1-j}(n) \right) \eta^{s}_{j}$$

Find η's that minimize noise in the cloud cleared radiances

$$R^{s}_{n,est} - \overline{R}_n = S^{s}_{n,j} \eta^{s}_{j}$$

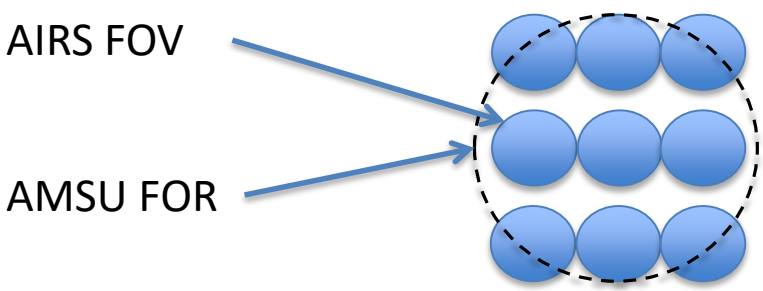
A first guess geophysical state is determined from a neural network which is forward modeled to determine R_{est}

$$S^{s}_{n,j} = \begin{pmatrix} \overline{R}_1 - R_{1,9} & \cdots & \overline{R}_1 - R_{1,1} \\ \cdots & \cdots & \cdots \\ \overline{R}_N - R_{N,9} & \cdots & \overline{R}_N - R_{N,1} \end{pmatrix}$$

Channels

AIRS Fields of view

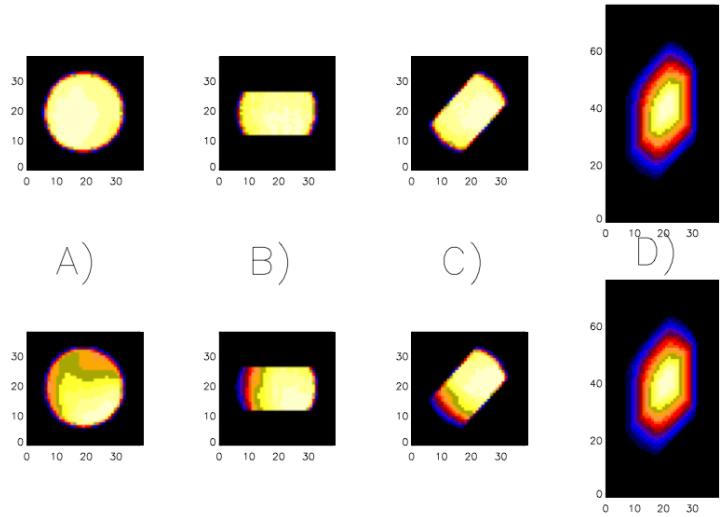
"AIRS Golfball"

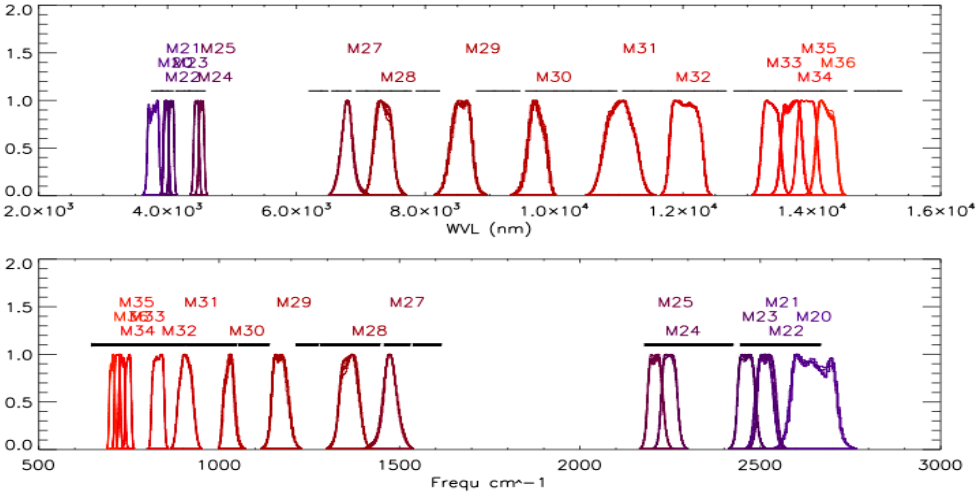


- Cloud cleared radiances are a level 2 product with their own QC
- Retrieval of T,q, and other products are based off the cloud cleared radiances

Comparing MODIS and AIRS

- Spectrally convolve AIRS to MODIS resolution for each MODIS channel
- Use the channel/scan angle specific weighted top hats from AIRS to spatially convolve MODIS to AIRS Resolution
- Spectrally convolve AIRS Cloud cleared radiances
- Clear MODIS Pixels are spatially convolved as well
- MODIS cloud flags are used to determine clear pixels.





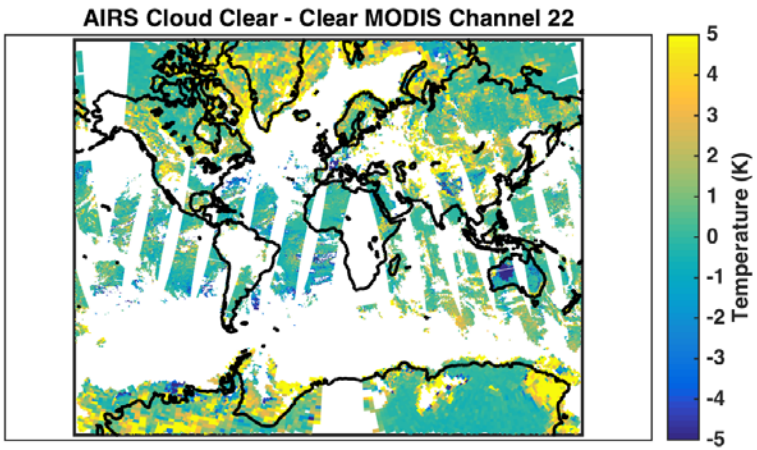
*From Schreier et. al.,2010

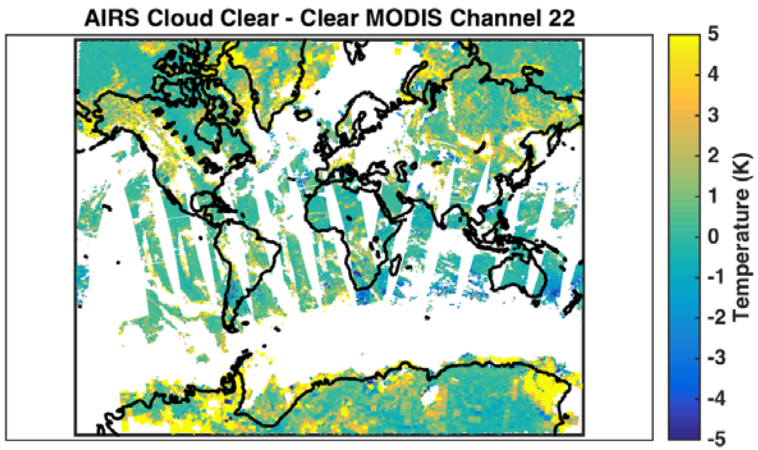
Checking the Convolution

- AIRS spectral gaps caused bad convolutions for channels 20, 23, 25, 27, 29, 30, 31
- Channel 36 had a poor matchup and is not used in this analysis

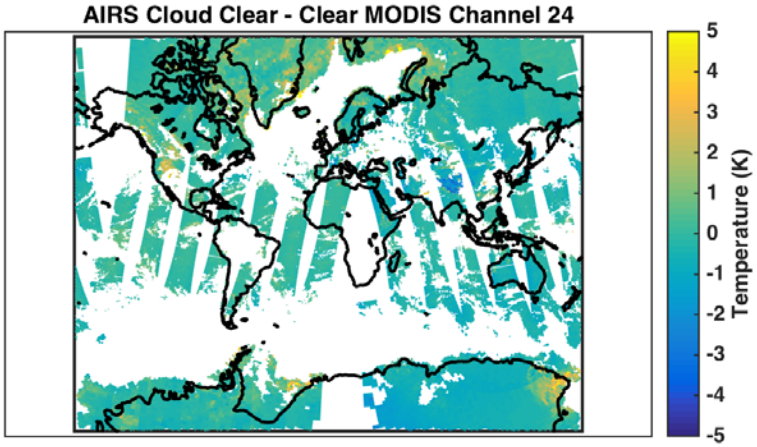
MOSIS Channel	Wavenumber (cm^{-1})	Main influence	Bias (K)	Std (K)	% diff between -.5K to.5K (%)
21	2525	Sfc/cld temp	-0.05	1.57	79
22	2465	Sfc/cld temp	-0.02	0.87	91
24	2236	CO_2/Atm temp	-0.09	0.65	91
28	1363	H_2O	-0.01	0.37	96
32	831	Sfc/cld temp	0.09	0.63	88
33	749	CO_2	-0.07	0.40	96
34	731	CO_2	-0.31	0.59	92
35	719	CO_2	-0.07	0.25	99

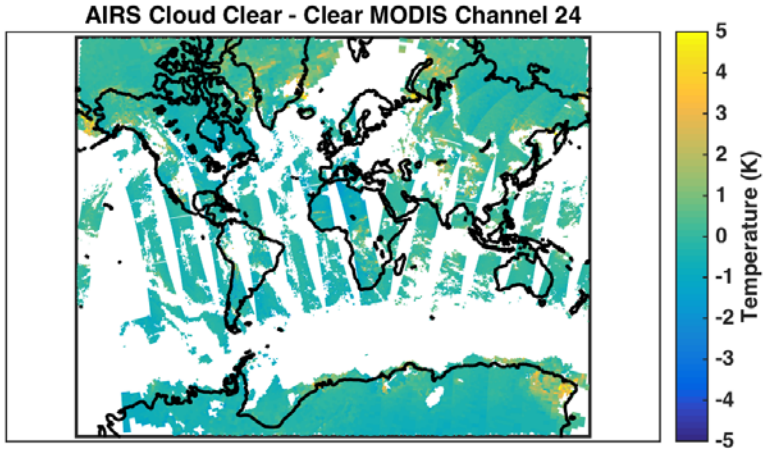
SFC

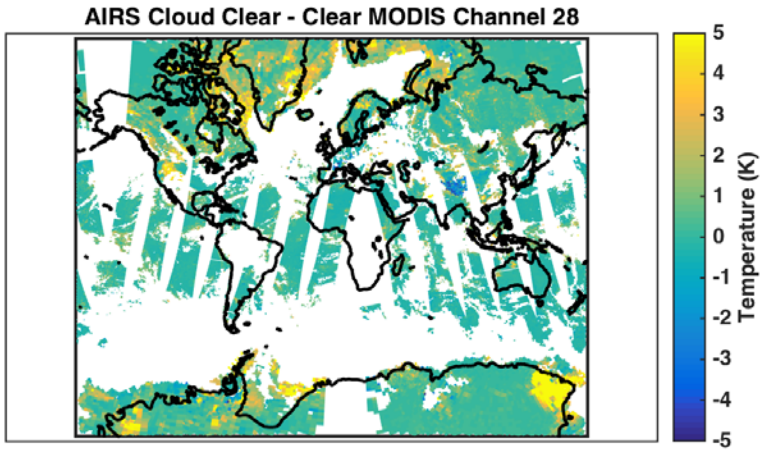

AIRS Cloud Clear - Clear MODIS Channel 22
5
4
3
2
1
0
-1
-2
-3
-4
-5
Temperature (K)


AIRS Cloud Clear - Clear MODIS Channel 22
5
4
3
2
1
0
-1
-2
-3
-4
-5
Temperature (K)

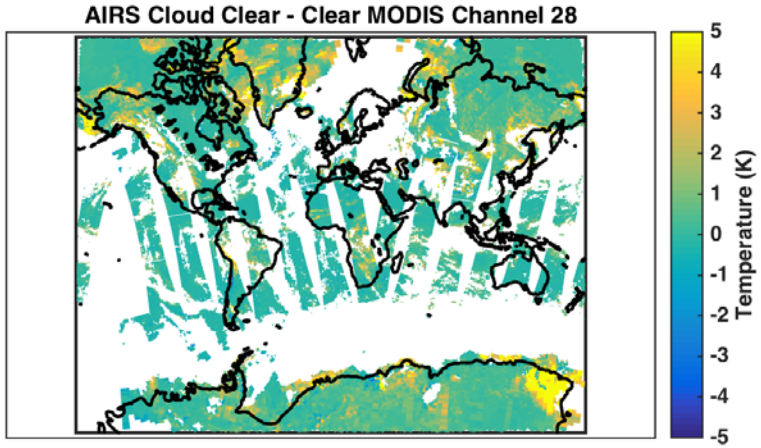
CO_2

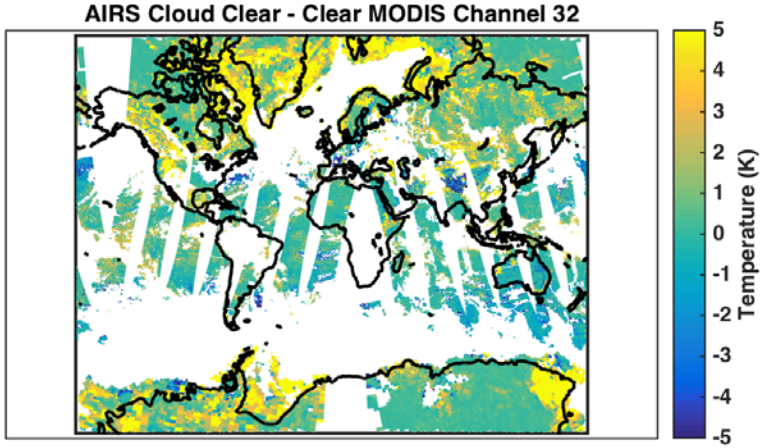

AIRS Cloud Clear - Clear MODIS Channel 24
5
4
3
2
1
0
-1
-2
-3
-4
-5
Temperature (K)


AIRS Cloud Clear - Clear MODIS Channel 24
5
4
3
2
1
0
-1
-2
-3
-4
-5
Temperature (K)

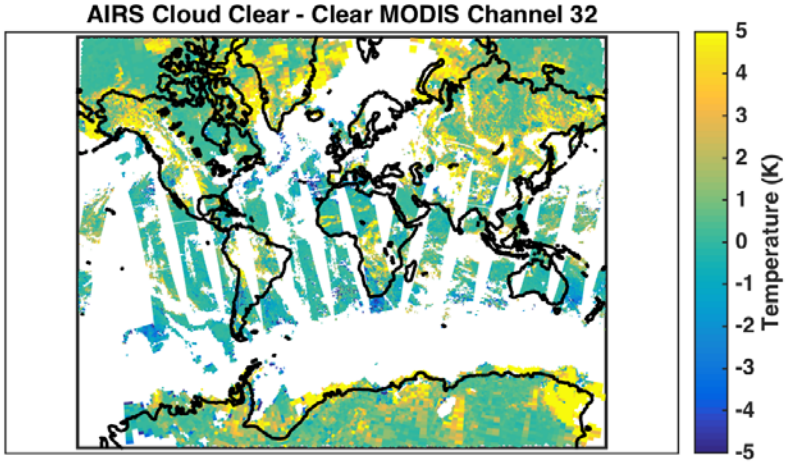

AIRS Cloud Clear - Clear MODIS Channel 28
5
4
3
2
1
0
-1
-2
-3
-4
-5
Temperature (K)

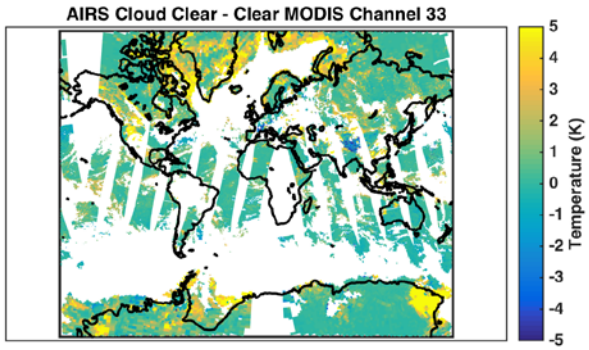
H_2O


AIRS Cloud Clear - Clear MODIS Channel 28
5
4
3
2
1
0
-1
-2
-3
-4
-5
Temperature (K)

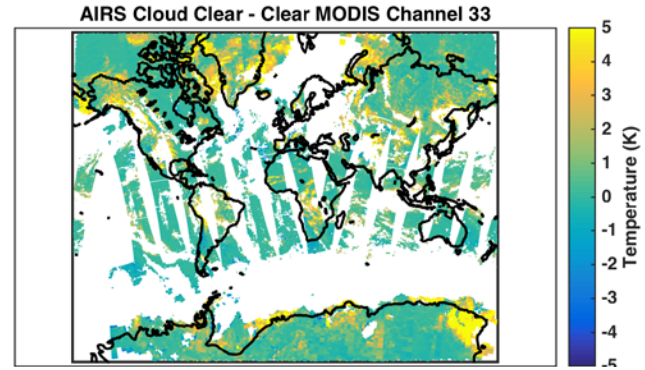

AIRS Cloud Clear - Clear MODIS Channel 32
5
4
3
2
1
0
-1
-2
-3
-4
-5
Temperature (K)

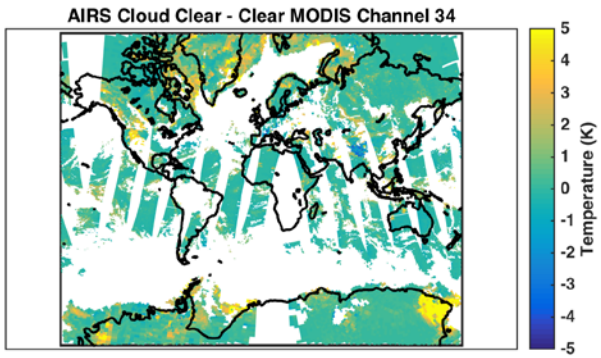
SFC


AIRS Cloud Clear - Clear MODIS Channel 32
5
4
3
2
1
0
-1
-2
-3
-4
-5
Temperature (K)

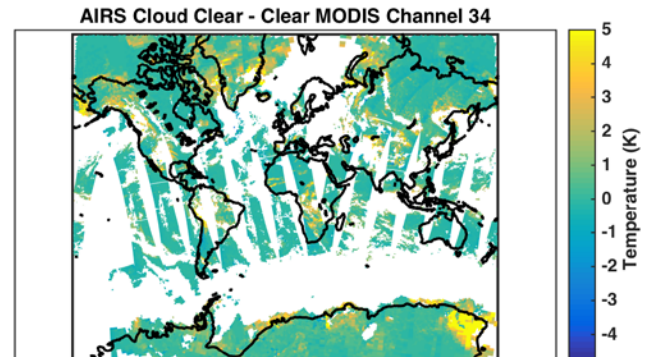

AIRS Cloud Clear - Clear MODIS Channel 33
Temperature (K)
5
4
3
2
1
0
-1
-2
-3
-4
-5

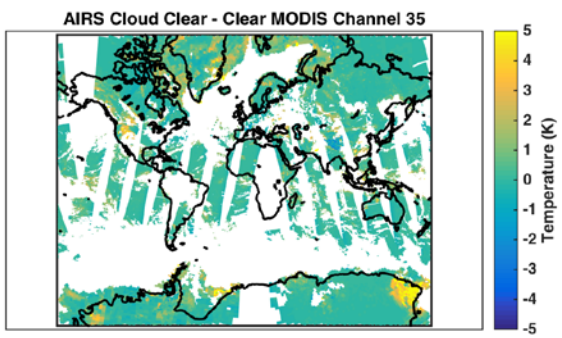
CO_2


AIRS Cloud Clear - Clear MODIS Channel 33
Temperature (K)
5
4
3
2
1
0
-1
-2
-3
-4

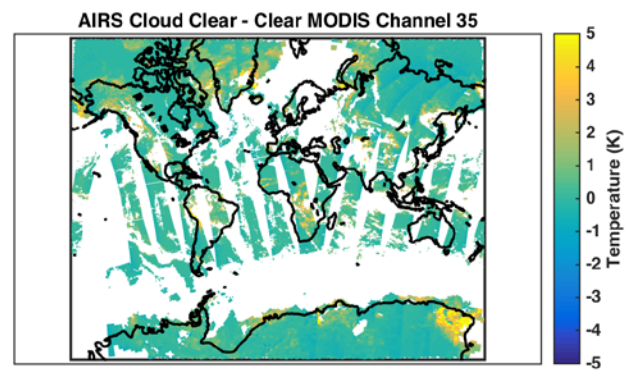

AIRS Cloud Clear - Clear MODIS Channel 34
Temperature (K)
5
4
3
2
1
0
-1
-2
-3
-4
-5

CO_2


AIRS Cloud Clear - Clear MODIS Channel 34
Temperature (K)
5
4
3
2
1
0
-1
-2
-3
-4


AIRS Cloud Clear - Clear MODIS Channel 35
Temperature (K)
5
4
3
2
1
0
-1
-2
-3
-4
-5

CO_2


AIRS Cloud Clear - Clear MODIS Channel 35
Temperature (K)
5
4
3
2
1
0
-1
-2
-3
-4
-5

AIRS Cloud Cleared QC

- Primarily designed to work for the 15 micron band
- Combination of extrapolation amplification and regressed predictor errors based on Temperature and total water burden
- QC 0 < 1K, QC 1 is 1-2.5K

AIRS Level 2 QC

QC 0 = “Best”: compares to in situ. Can be used in data assimilation and statistical climate studies

QC 1 = “Good”: Use of data in statistical climate studies when temporally or spatially averaged

QC2 = “D.N.U”: If needed check error estimates

From *AIRS/AMSUHSB Version 6 Level 2 Quality Control and Error Estimation*

AIRS Cloud Cleared vs. MODIS Clear

- Required at least 5 % of FOV to be cloud free as determined by MODIS
- Average radiance error was computed for each band in determination of “pseudo AIRS QC’
- Global QC 1 and 0 results both equate to their expected values
- May be some over estimating of error for QC 2; especially in MODIS bands 22 and 28
- QC 0 < 1K, QC 1 is 1-2.5K

Channel	Bias 0 (K)	STD 0 (K)	Bias 1	STD 1	Bias 2	STD 2
22	0.07	0.99	0.24	1.27	0.51	1.59
24	-0.09	0.33	0.32	0.60	0.51	
28	-0.05	0.35	0.12	0.59	0.31	1.55
32	0.20	0.80	0.29	1.20	0.08	2.27
33	0.28	0.57	0.58	1.10	1.07	2.19
34	0.08	0.50	1.15	1.22	3.67	3.4
35	0.23	0.42	1.34	0.97	4.71	

AIRS Cloud Cleared vs. MODIS Clear

- Frac 0 is the percentage of QC=0 cases with AIRS-MODIS greater than 1 K
- Frac 1 is the percentage of QC=1 cases with AIRS-MODIS greater than 2.5 K
- Frac 2_1 is the precentage of QC=2 cases with AIRS-MODIS less then 2.5 K
- MODIS may identify QC = 0 cases that contain too much error; especially for surface channels (22,32)
- MODIS may identify QC=2 cases that overestimated their error

Channel	Frac 0 (%)	Frac 1 (%)	Frac 2_1 (%)
22	10	4	13
24	<1	<1	
28	2	<1	6
32	12	4	7
33	8	3	19
34	5	7	14
35	5	5	

Air Temperature QC Meaning

QC = 0 (Best)

	Temp Error 70 mb	Temp Error surface/2	Temp Error surface
Ocean	3.0 K	0.6 K	1.0 K
Land	3.0 K	0.6 K	1.0 K
Frozen	3.0 K	0.6 K	1.25 K

QC = 1 (Good)

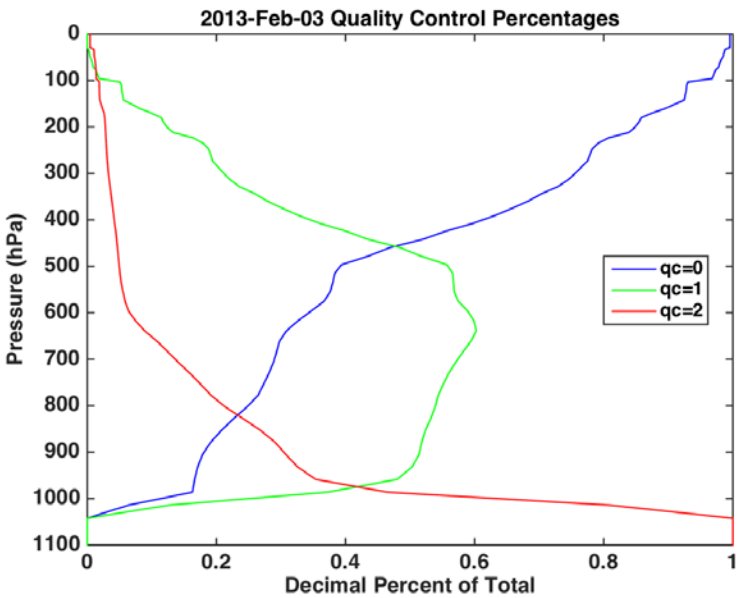
	Temp Error 70 mb	Temp Error surface/2	Temp Error surface
Ocean	3.0 K	3.0 K	3.0 K
Land	3.0 K	2.0 K	2.0 K
Frozen	3.0 K	2.5 K	2.5 K

Temp Error

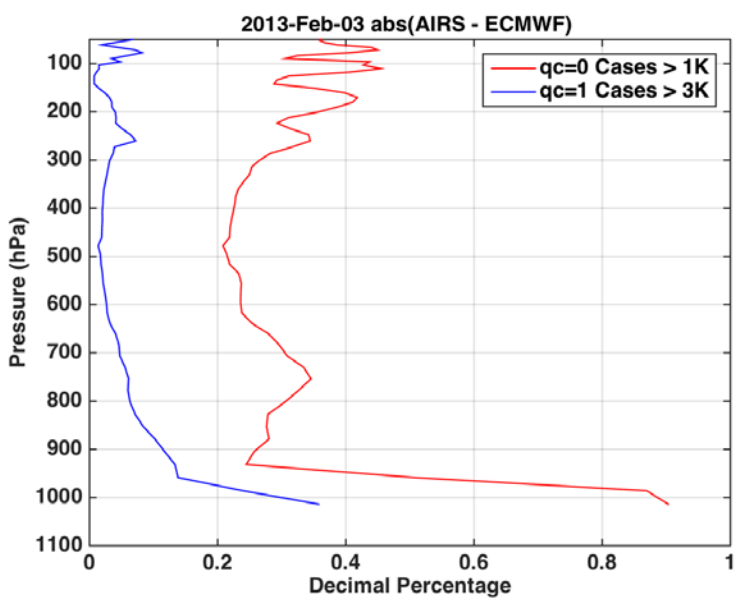
- Retrievals vs two Days of ECMWF 3 hour forecasts as truth
- 14 internal retrieval diagnostics used in regression

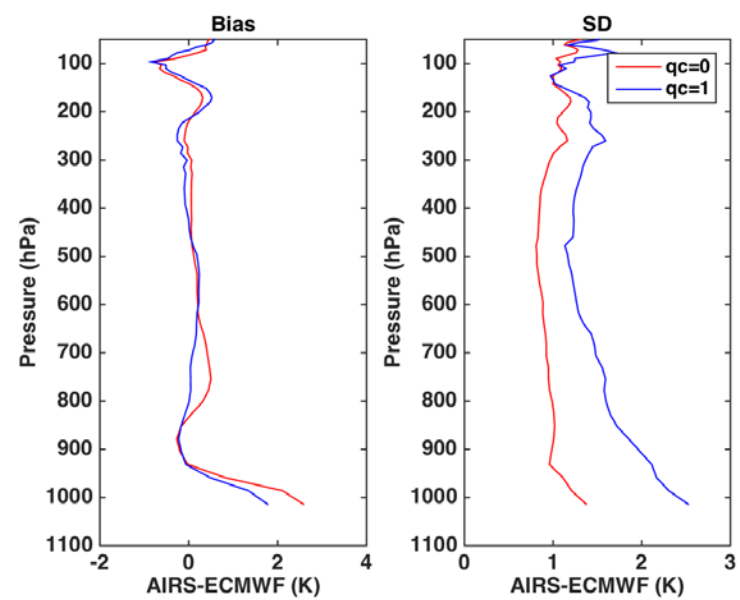
From *AIRS/AMSUHSB Version 6 Level 2 Quality Control and Error Estimation*

AIRS vs. ECMWF with quality control



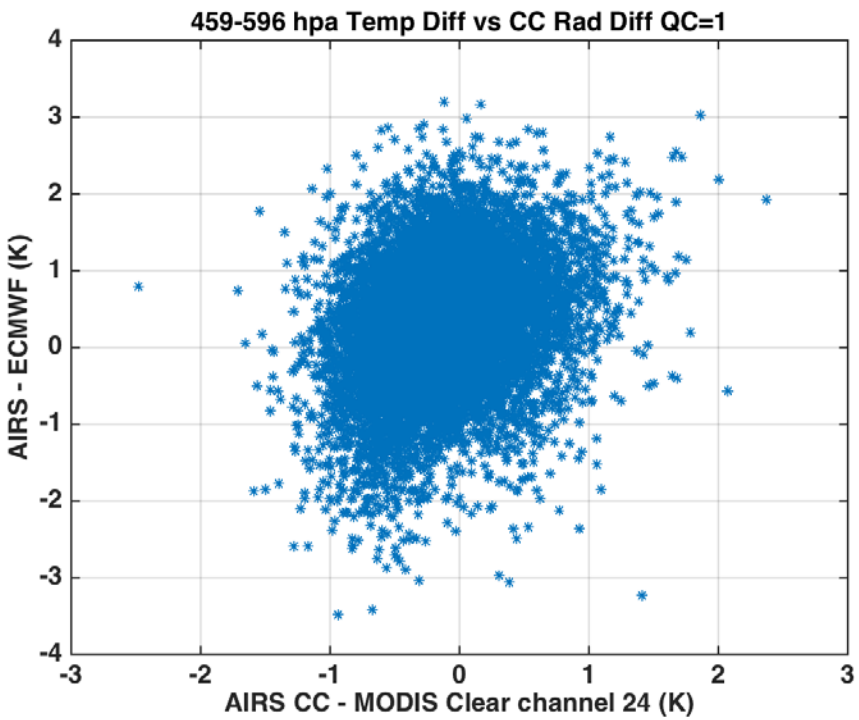
- AIRS quality control cases for 0 and 1 both equate to expected values globally
- 20% of QC = 0 cases are greater then 1K

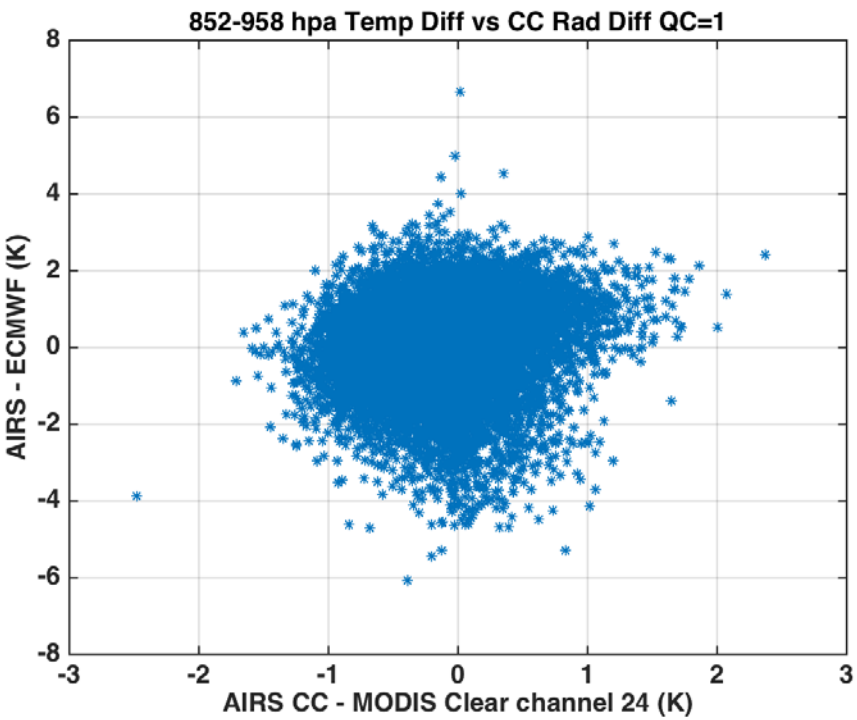




Temperature Error as a function of Cloud Cleared Radiance Error

- Compared average temperature difference at 3 heights to clear radiance differences for the 7 MODIS channels
- Looked only at non frozen ocean cases
- AIRS minus ECMWF values didn't show any dependence on radiance error

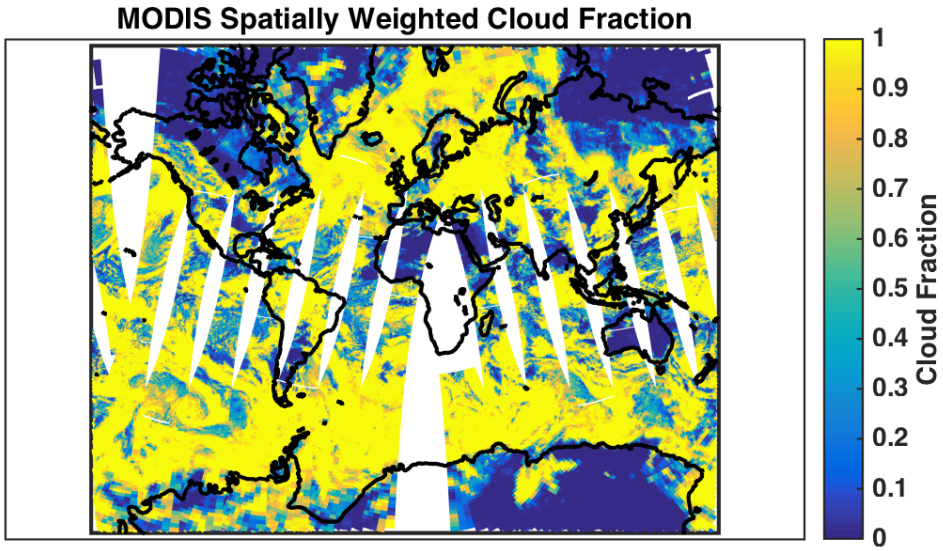


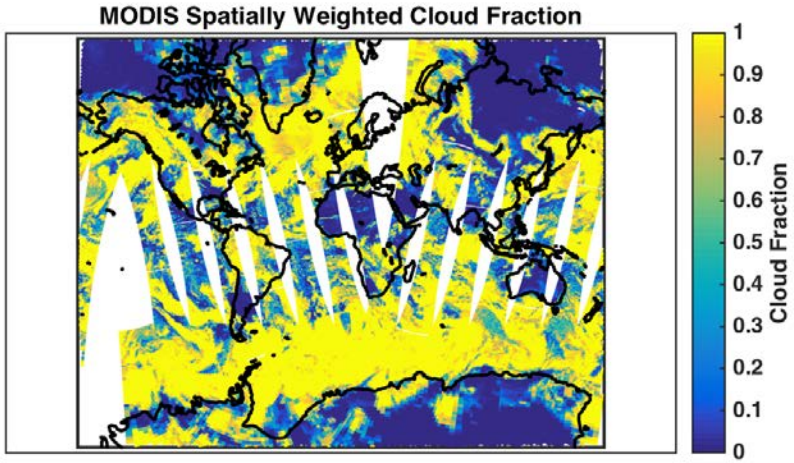


Conclusion

- Convolved MODIS Channels 22, 24, 28, 32, 33, 34, 35 matched with Convolved AIRS
- MODIS channels influenced by the surface showed the largest differences with AIRS for clear only cases
- AIRS CC RAD QC's worked for 0 and 1. QC = 2 cases may overestimate error in some instances
- Convolved clear MODIS channels may identify a small fraction of mischaracterized QC = 0, and QC = 2 cases
- No dependence on radiance differences was found for AIRS/ECMWF temperature differences
- More investigation is needed on the MODIS clear state to confirm these results

Extra Slides


MODIS Spatially Weighted Cloud Fraction
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Cloud Fraction


MODIS Spatially Weighted Cloud Fraction
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Cloud Fraction