Characterization of Infrared Imager/Sounder and Infrared/Microwave Sounder Synergistic Cloud-Cleared Infrared Radiances

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Office of Research and Applications, NOAA/NESDIS

CIMSS

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NOAA U.S. DEPARTMENT OF COMMERCE

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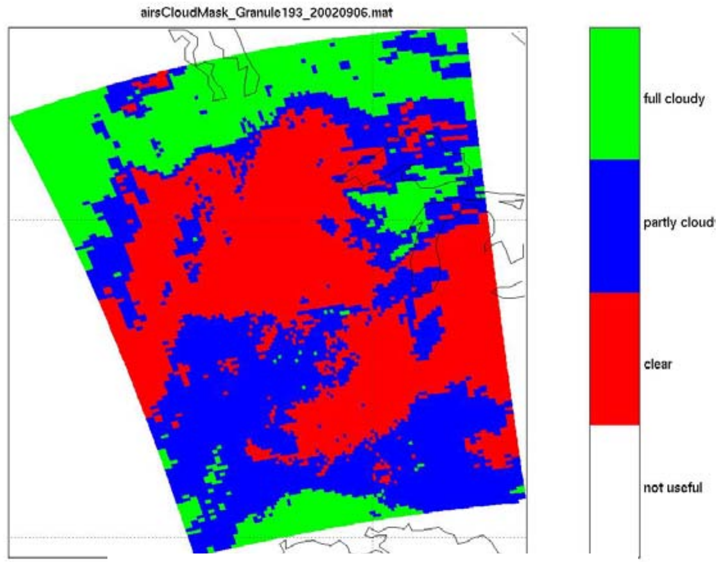
ABSTRACT

- **To evaluate the characteristics of these cloud-cleared radiances and their potential for improvements of numerical weather prediction and cloudy sounding applications.**
- **Preliminary results have shown that these two approaches, though quite different in character, and processing methodology, are both effective and have certain unique characteristics and deficiencies.**

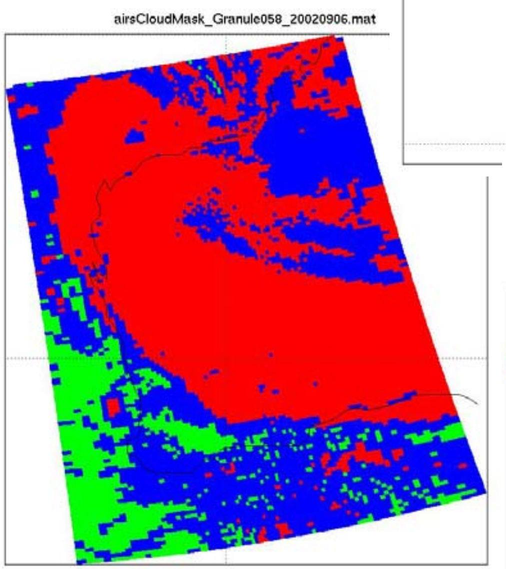
Case Granule Dataset Used

- 4 Granules of Collocated AIRS & MODIS Data
- MODIS 1-km Cloud Mask
- AIRS C.M. (from MODIS)
- No ancillary data used

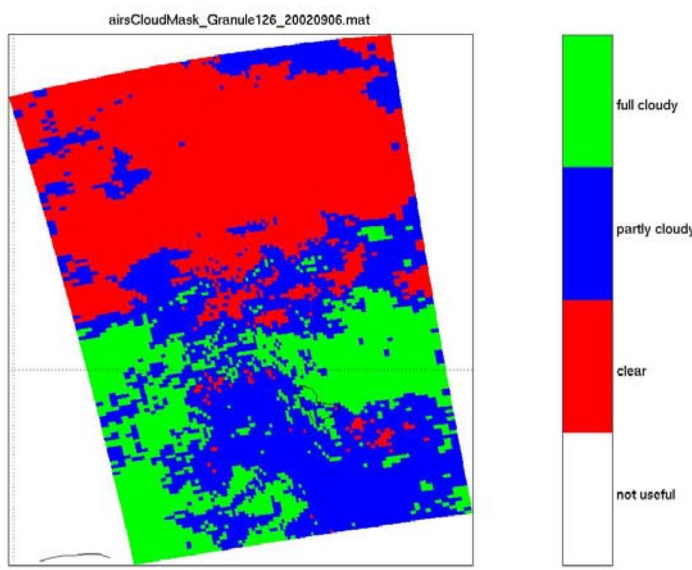
2 Sep. 2002
AIRS
Focus Day



Wisconsin Granule

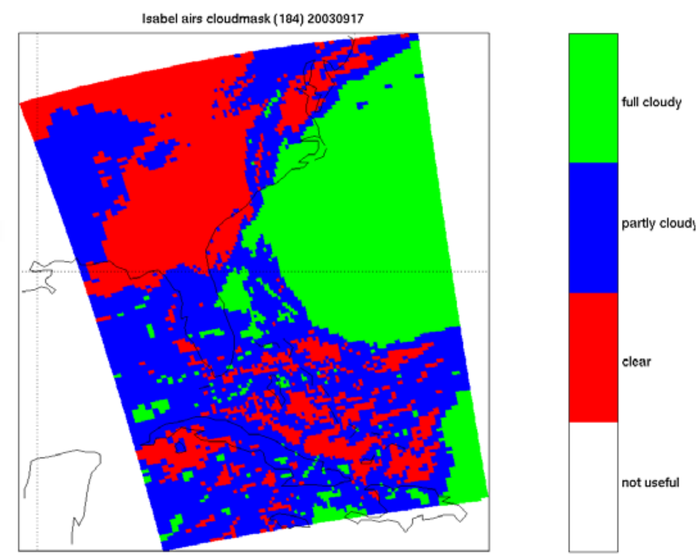


Australia Granule



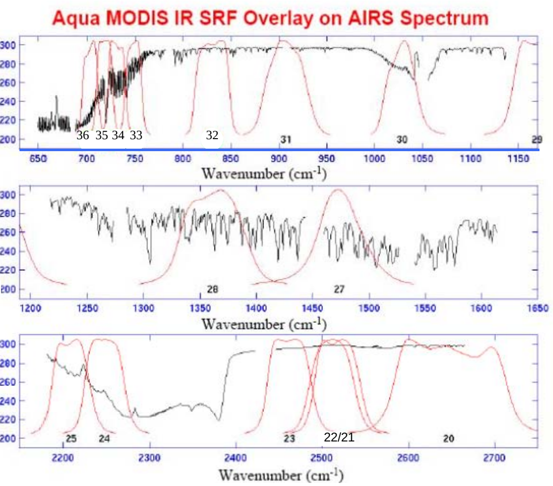
South Africa Granule

17 Sep. 2003



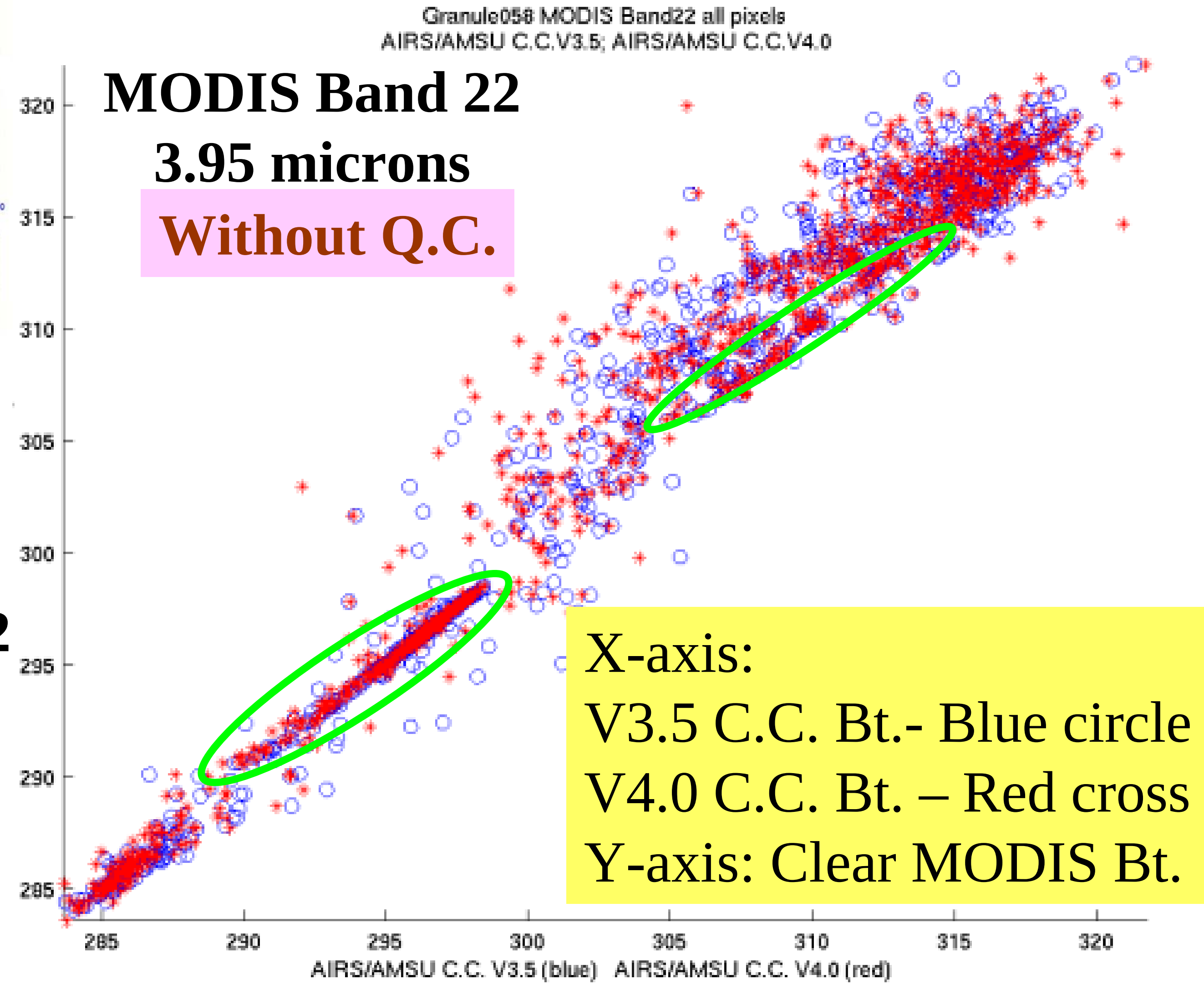
Hurricane Isabel Granule

AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison

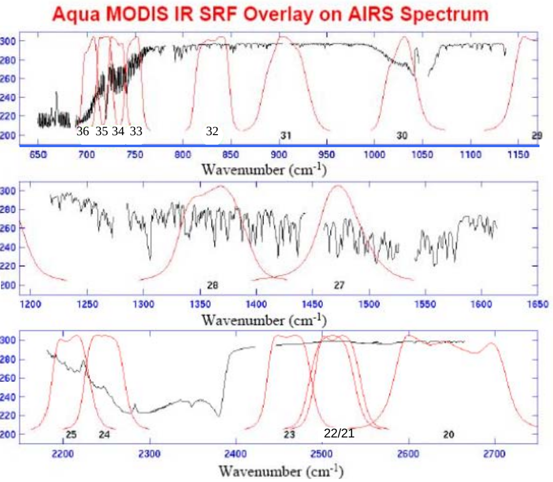


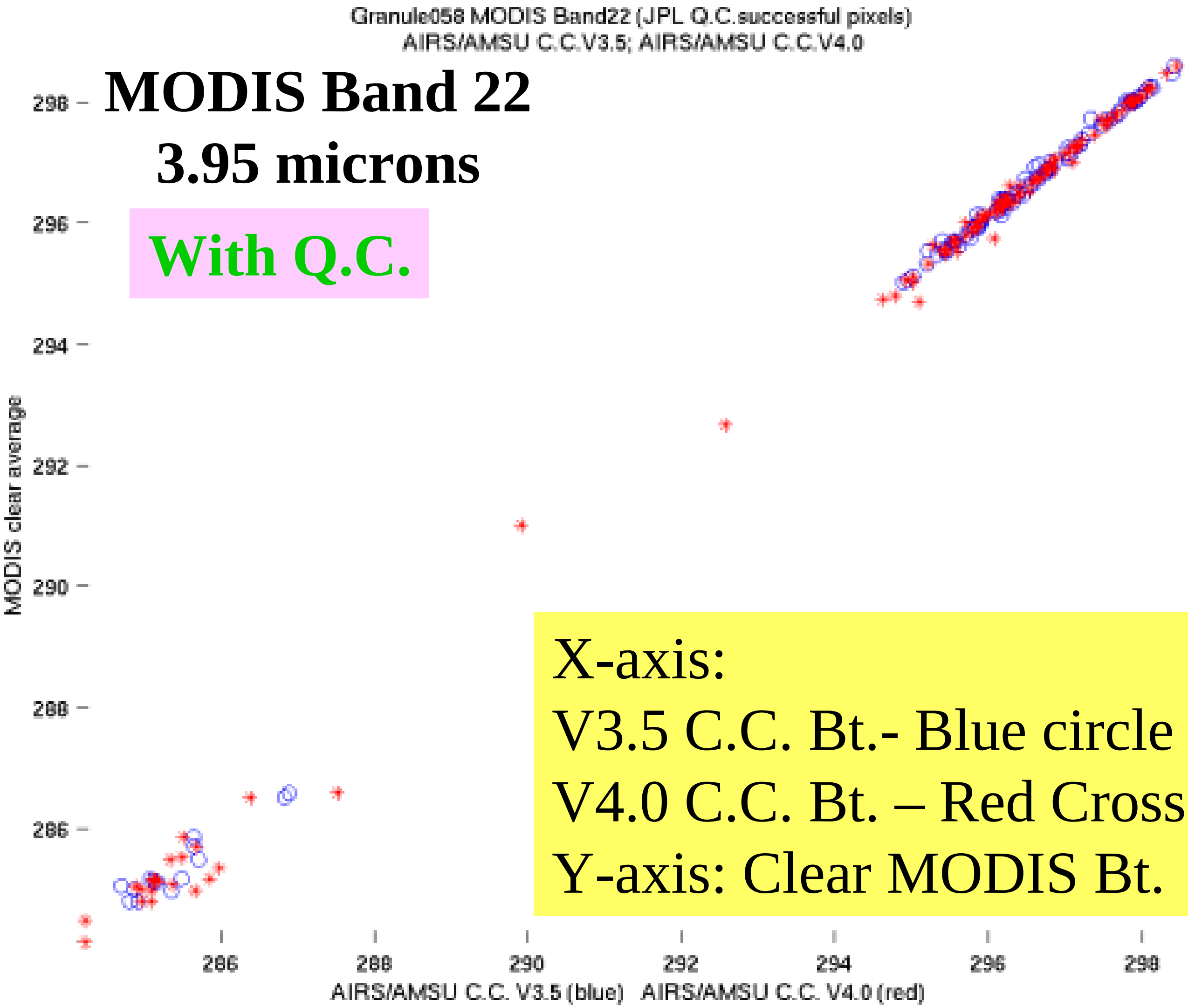
MODIS Band 22
3.95 microns

58_20020906 MODIS Band22 JPL C.C. V3.5-V4.0



AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison





MODIS Band 22
3.95 microns

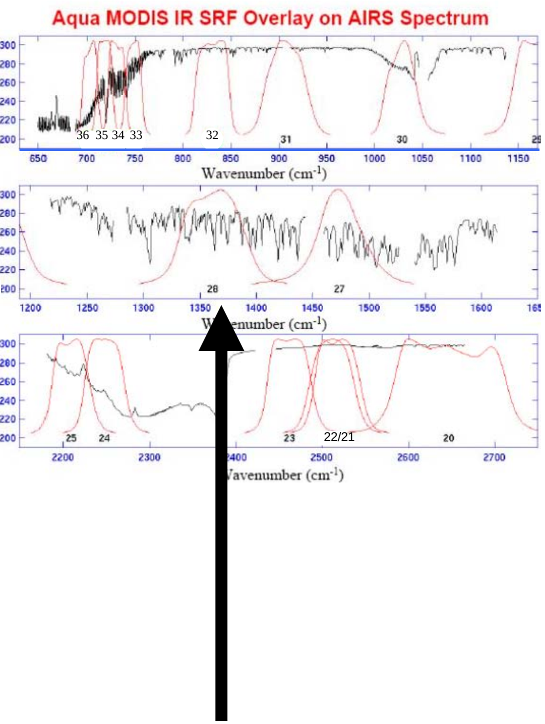
With Q.C.

Q.C. filtered most of the unreliable data as well as some good data.

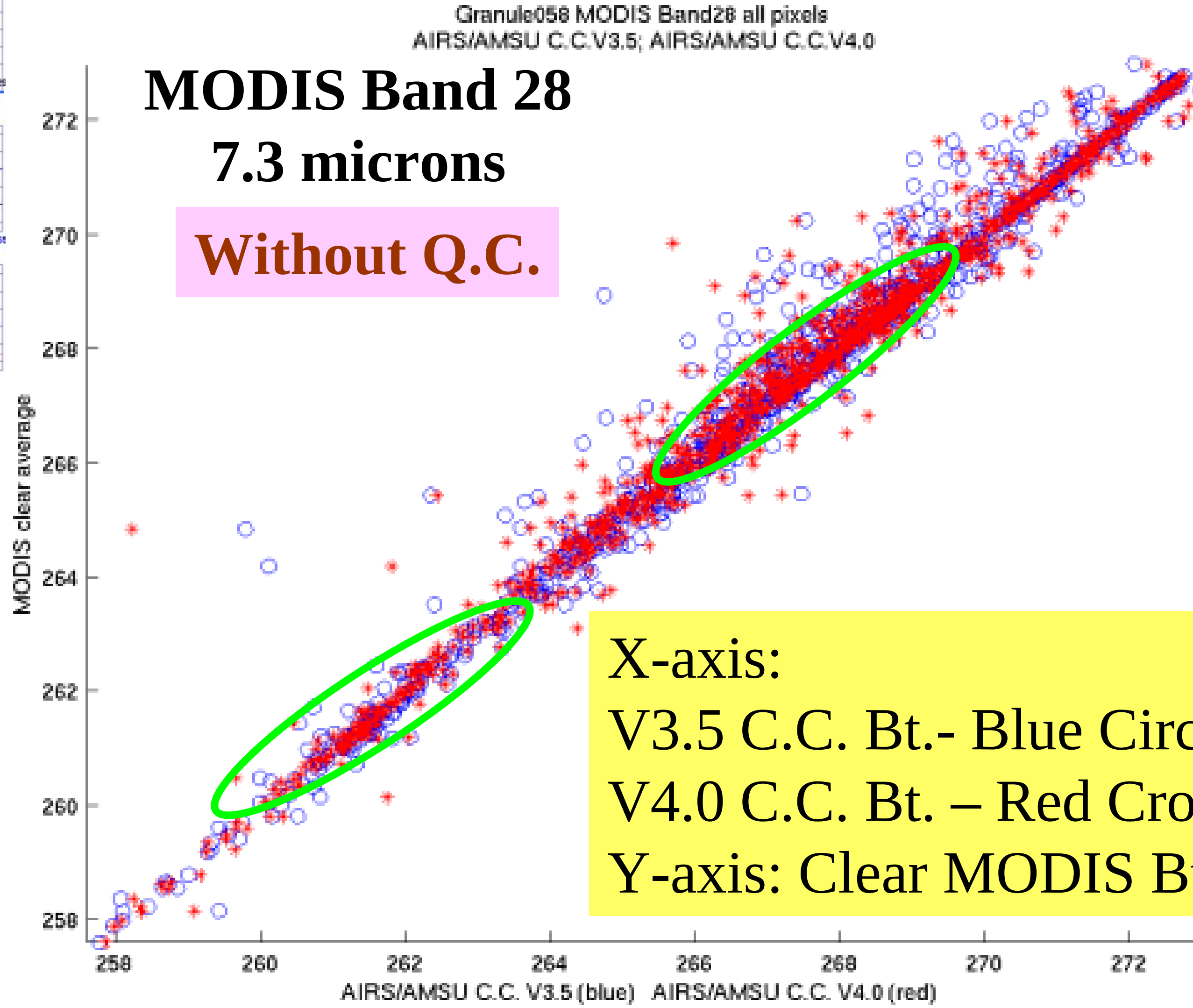
X-axis:
V3.5 C.C. Bt.- Blue circle
V4.0 C.C. Bt. – Red Cross
Y-axis: Clear MODIS Bt.

AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison

058_20020906 MODIS Band28 JPL C.C. V3.5-V4.0



MODIS Band 28
7.3 microns

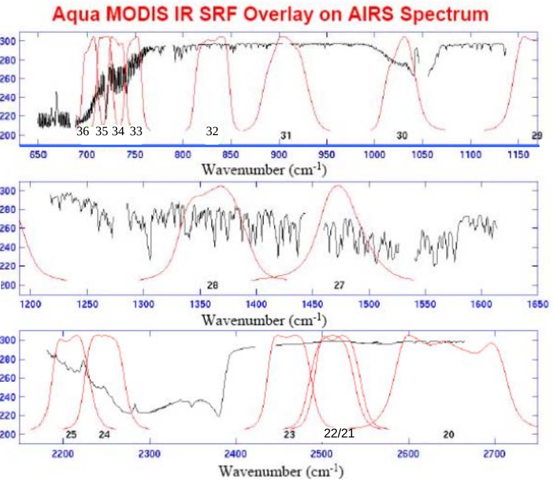


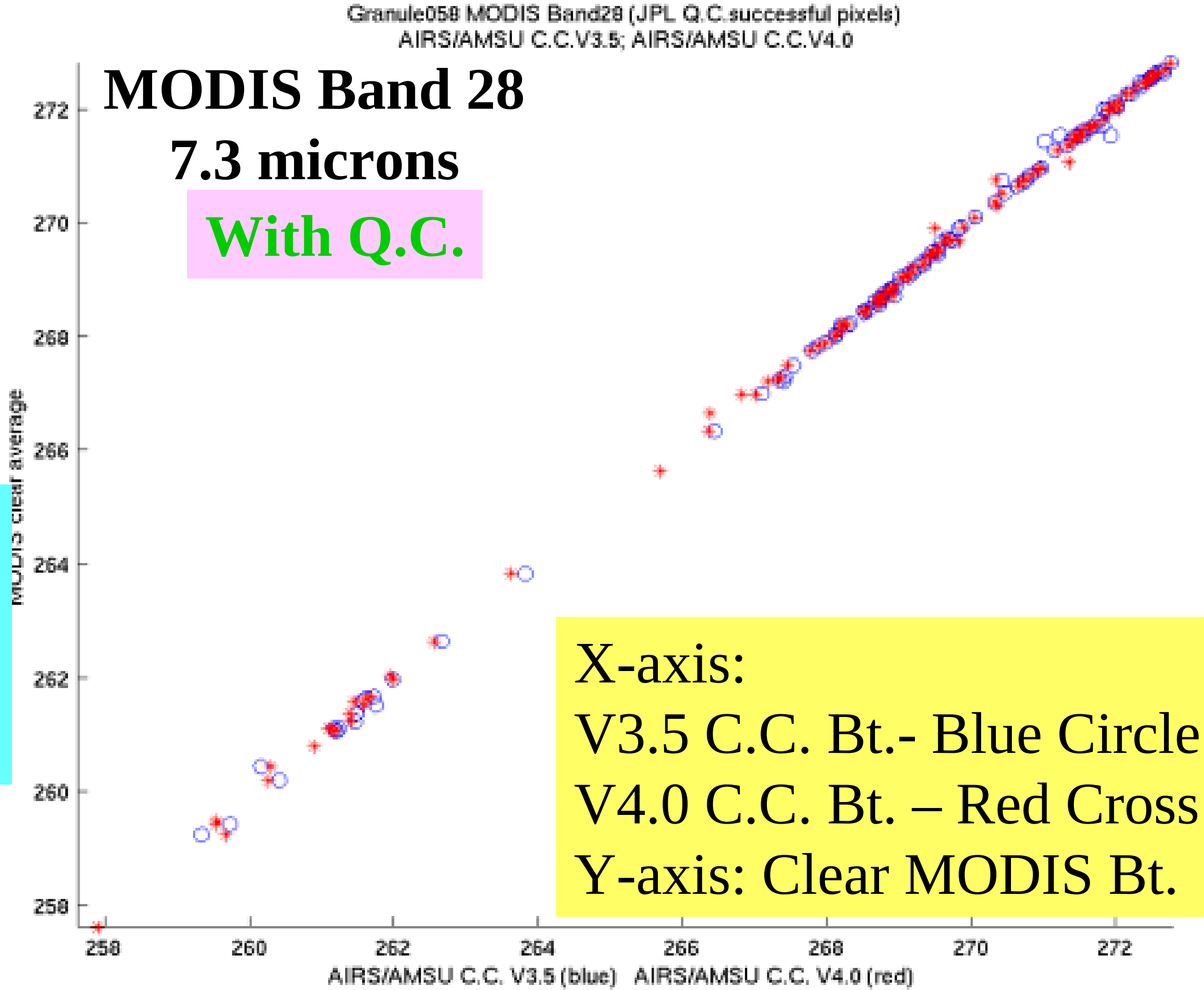
MODIS Band 28
7.3 microns

Without Q.C.

X-axis:
V3.5 C.C. Bt.- Blue Circle
V4.0 C.C. Bt. – Red Cross
Y-axis: Clear MODIS Bt.

AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison





MODIS Band 28

7.3 microns

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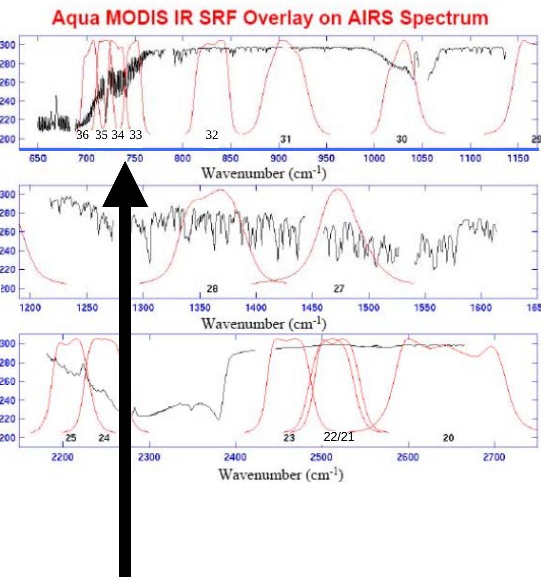
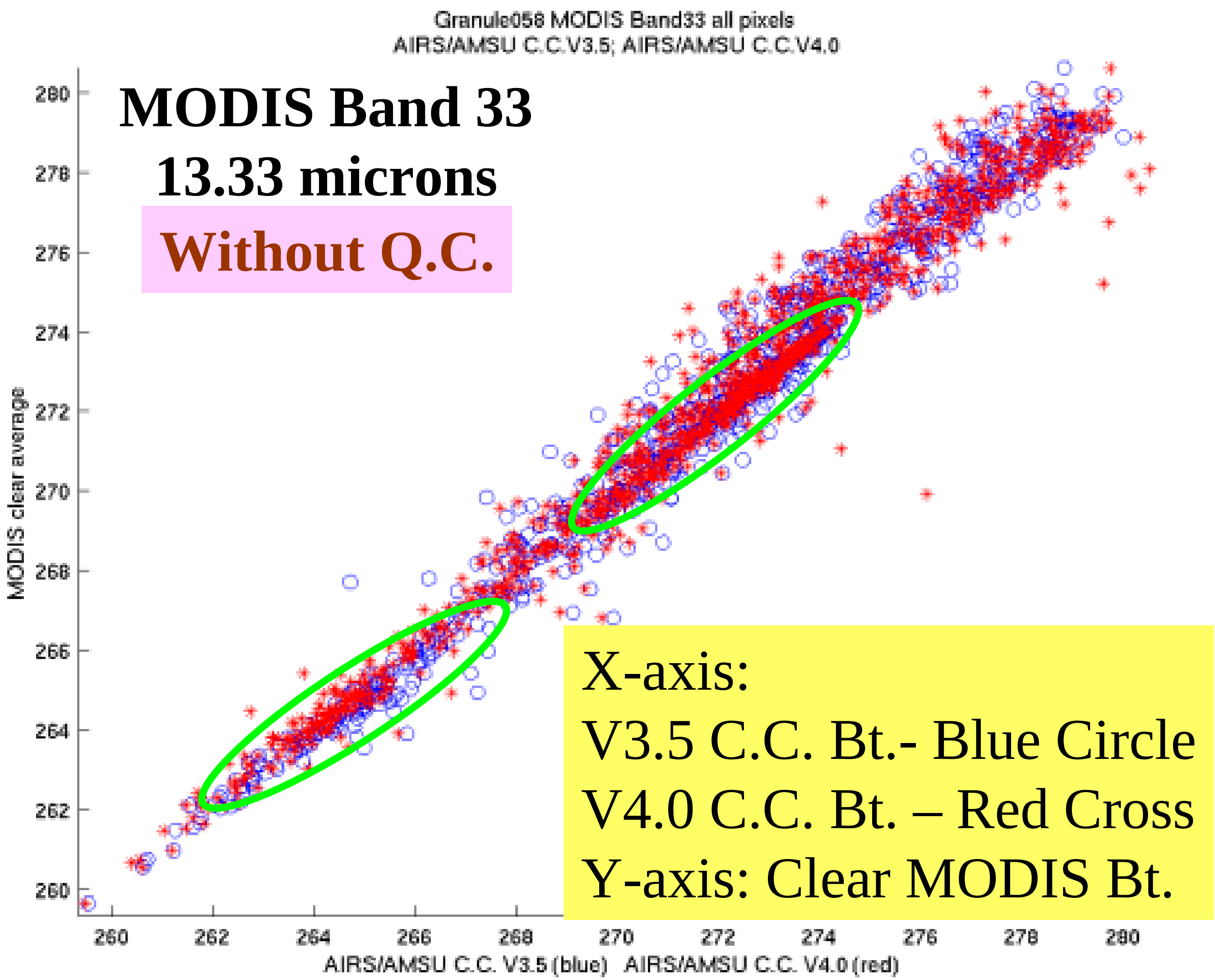
X-axis:
V3.5 C.C. Bt.- Blue Circle
V4.0 C.C. Bt. – Red Cross
Y-axis: Clear MODIS Bt.

AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison

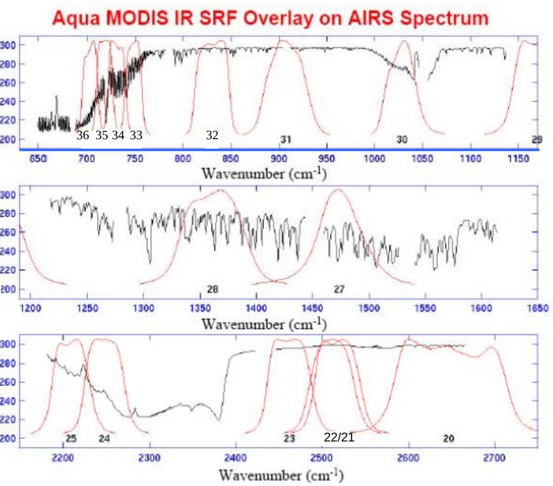
058_20020906 MODIS Band33 JPL C.C. V3.5-V4.0



MODIS Band 33
13.33 microns



AIRS/AMSU (3 by 3 AIRS FOV) V3.5 Vs V4.0 C.C. Comparison



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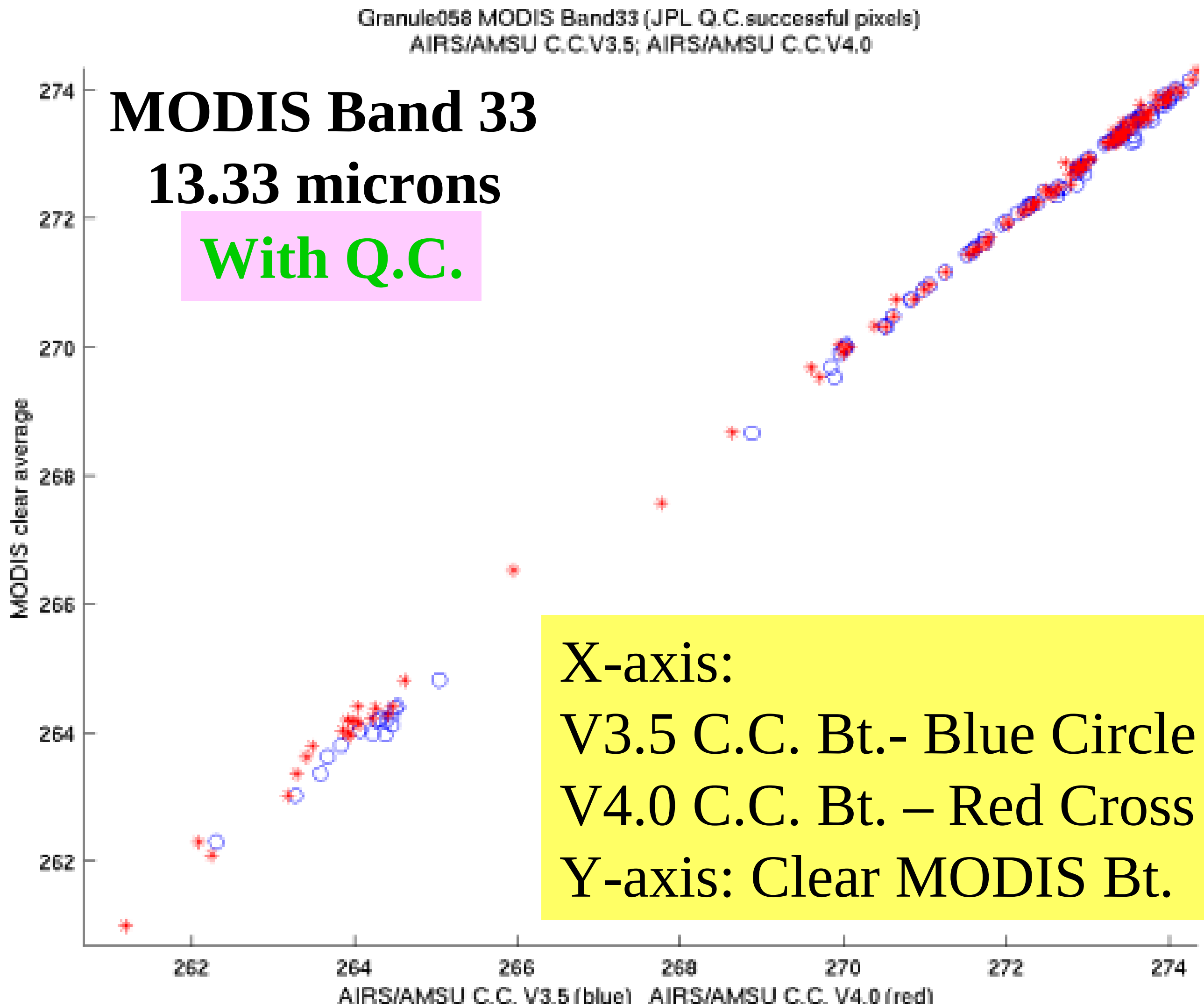
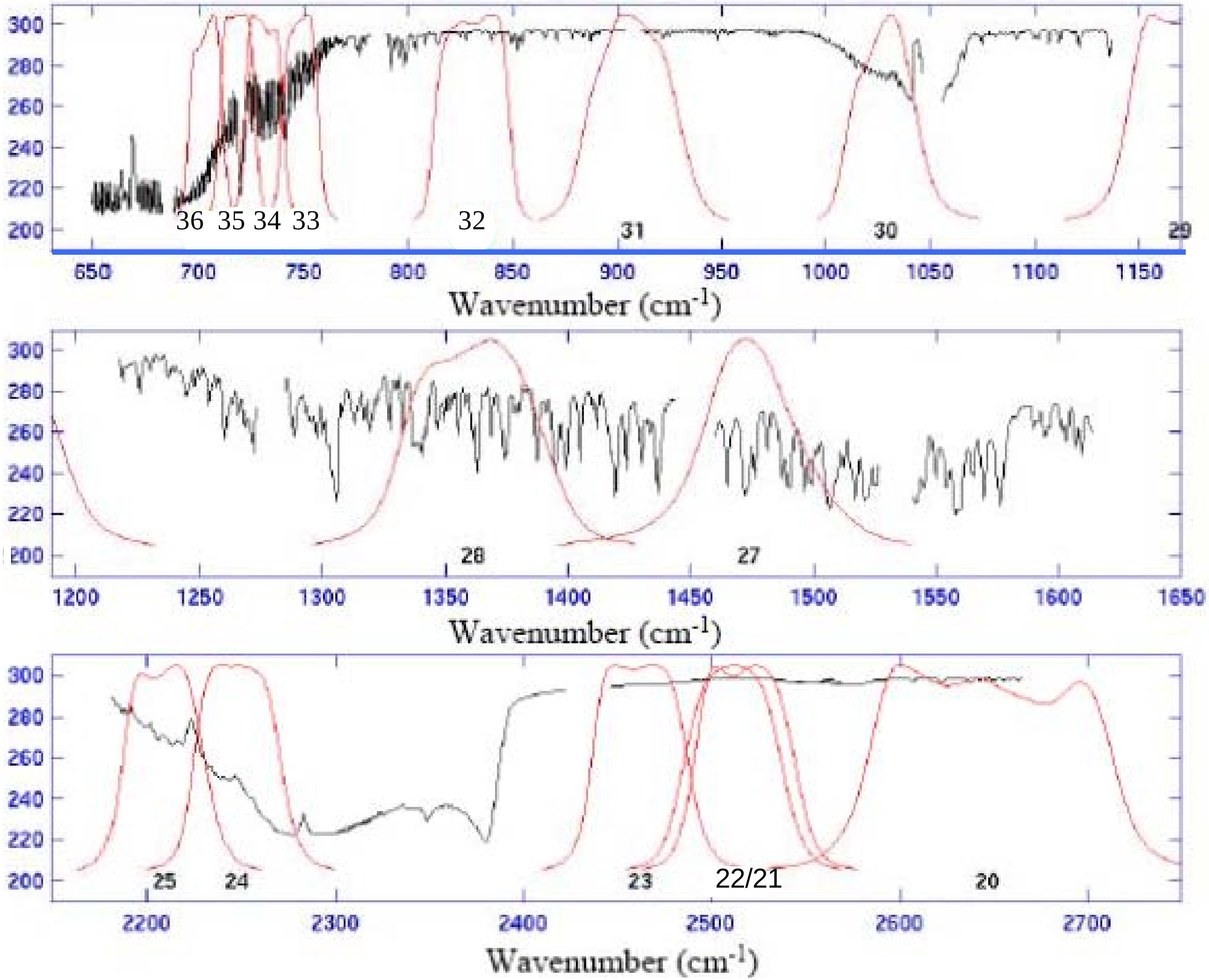


Aqua MODIS IR SRF Overlay on AIRS Spectrum



MODIS/AIRS Synergistic N* Cloud Clearing

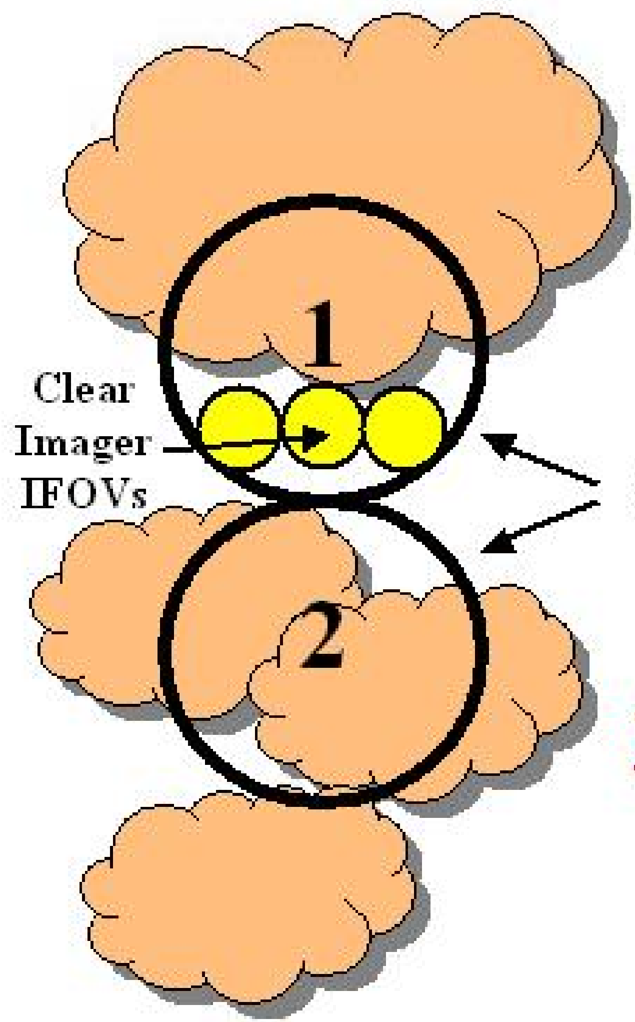
	MODIS Bands Used in C.C.	MODIS Bands Used in Q.C.
Multi-band N*	22 24 25 28 30 31 32 33 34	22 24 25 28 30 31 32 33 34
Single-band N*	31or 22	22 24 25 28 30 31 32 33 34

Threshold for AIRS Pair C.C. Retrieval:

Each AIRS footprint within the C.C. pair (2 by 1) must have at least 15 MODIS confident clear (P=99%) pixel (partly cloudy)

MODIS/AIRS Synergistic Single-Channel N* Cloud-Clearing

General Principal



$$R_c(\upsilon) = \frac{R_1(\upsilon) - N^* R_2(\upsilon)}{1 - N^*}$$

Where;

$N^* = N_1/N_2$.

$$N^* = \frac{srf[R_1(w)] - R_c(w)}{srf[R_2(w)] - R_c(w)}$$

$$srf[R_i(w)] = \int \theta(w, \upsilon) R_i(\upsilon) d\upsilon$$

Filter: **Or Q.C.**

$$\Sigma\{srf[R_c(\delta\nu_j)] - R_c(\delta\nu_j)\}^2 \le \varepsilon$$

After Smith

MODIS/AIRS Synergistic Multi-Channel N* Cloud Clearing

General Principal

$$J(N*) = \sum_i \frac{1}{\sigma_i}[(R_{M_i}^{clr} - f_i(R_\nu^{cc})]^2$$

$$J(N*) = \sum_i \frac{1}{\sigma_i}[(R_{M_i}^{clr} - f_i(\frac{R_\nu^1 - R_\nu^2 N^*}{1-N^*})]^2$$

$$\frac{\partial J(N^*)}{N^*} = 0$$

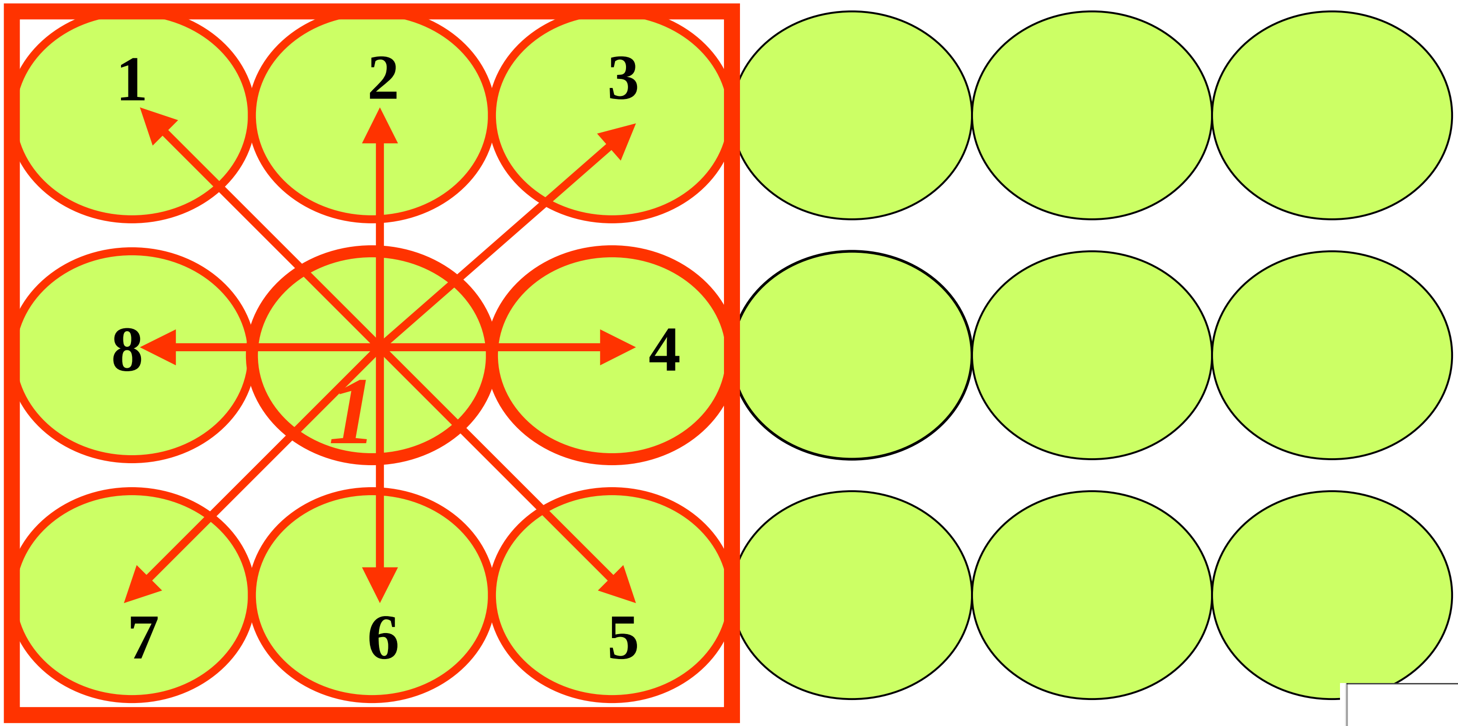
$$N^* = \frac{\sum_i \frac{1}{\sigma_i^2}[f_i(R_\nu^1) - R_{M_i}^{clr}][f_i(R_\nu^1) - f_i(R_\nu^2)]}{\sum_i \frac{1}{\sigma_i^2}[f_i(R_\nu^2) - R_{M_i}^{clr}][f_i(R_\nu^1) - f_i(R_\nu^2)]}$$

Li et al, 2005, IEEE-GRS

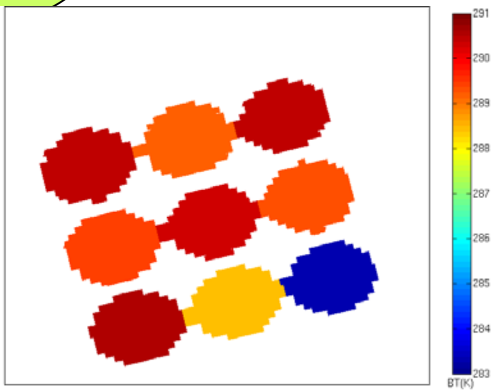
MODIS/AIRS Synergistic N* Cloud Clearing

Over Sampling Strategy

8 possible AIRS pairs (2 FOVs)



1

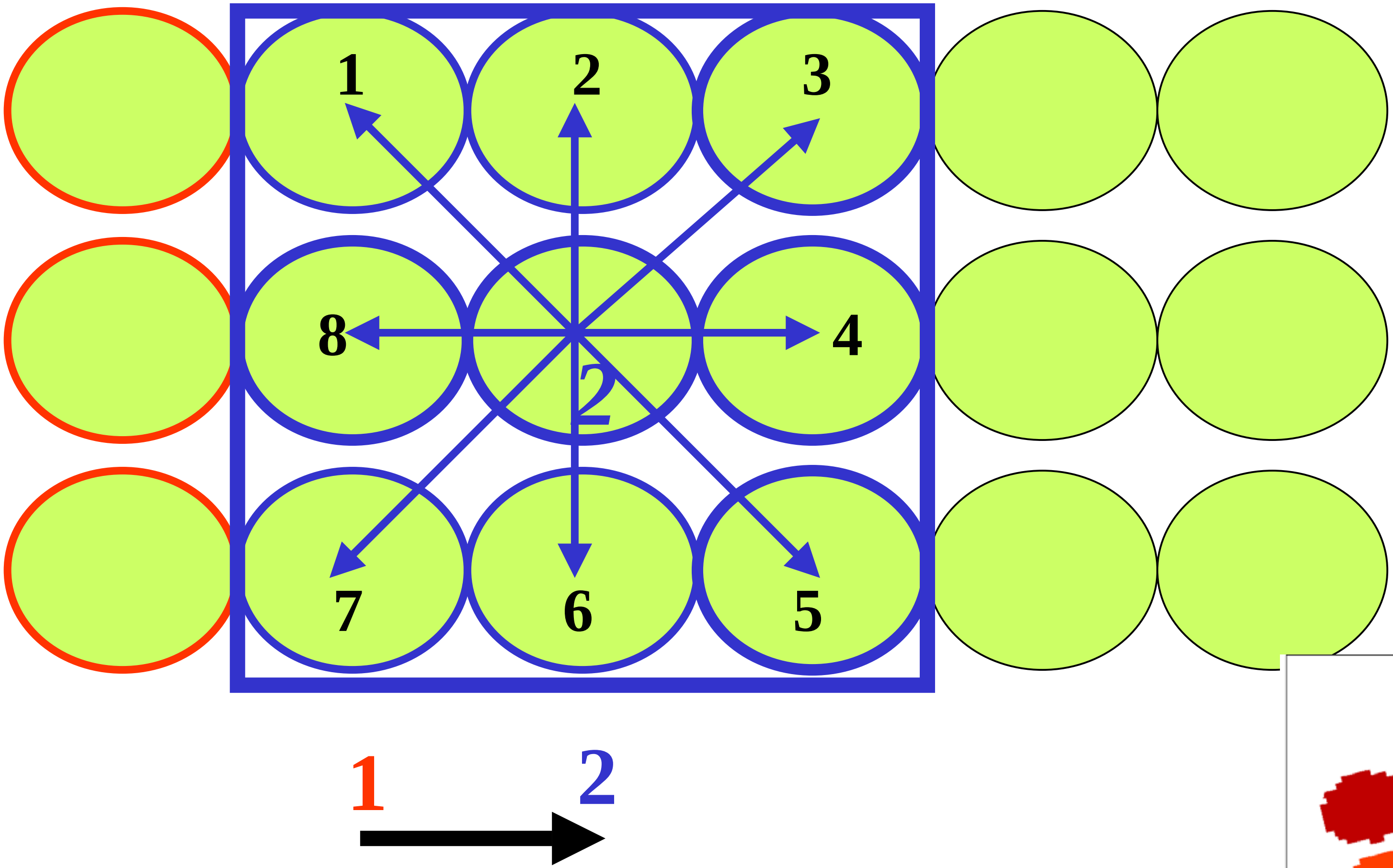


Pseudo Single AIRS FOV

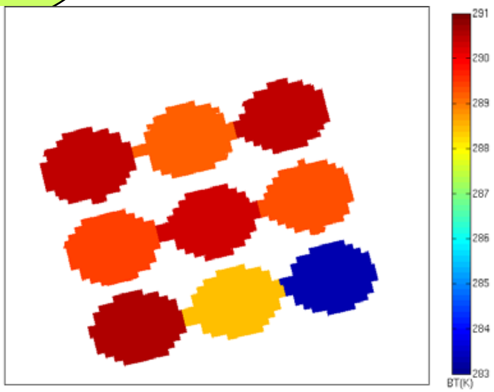
MODIS/AIRS Synergistic N* Cloud Clearing

Over Sampling Strategy

8 possible AIRS pairs (2 FOVs)



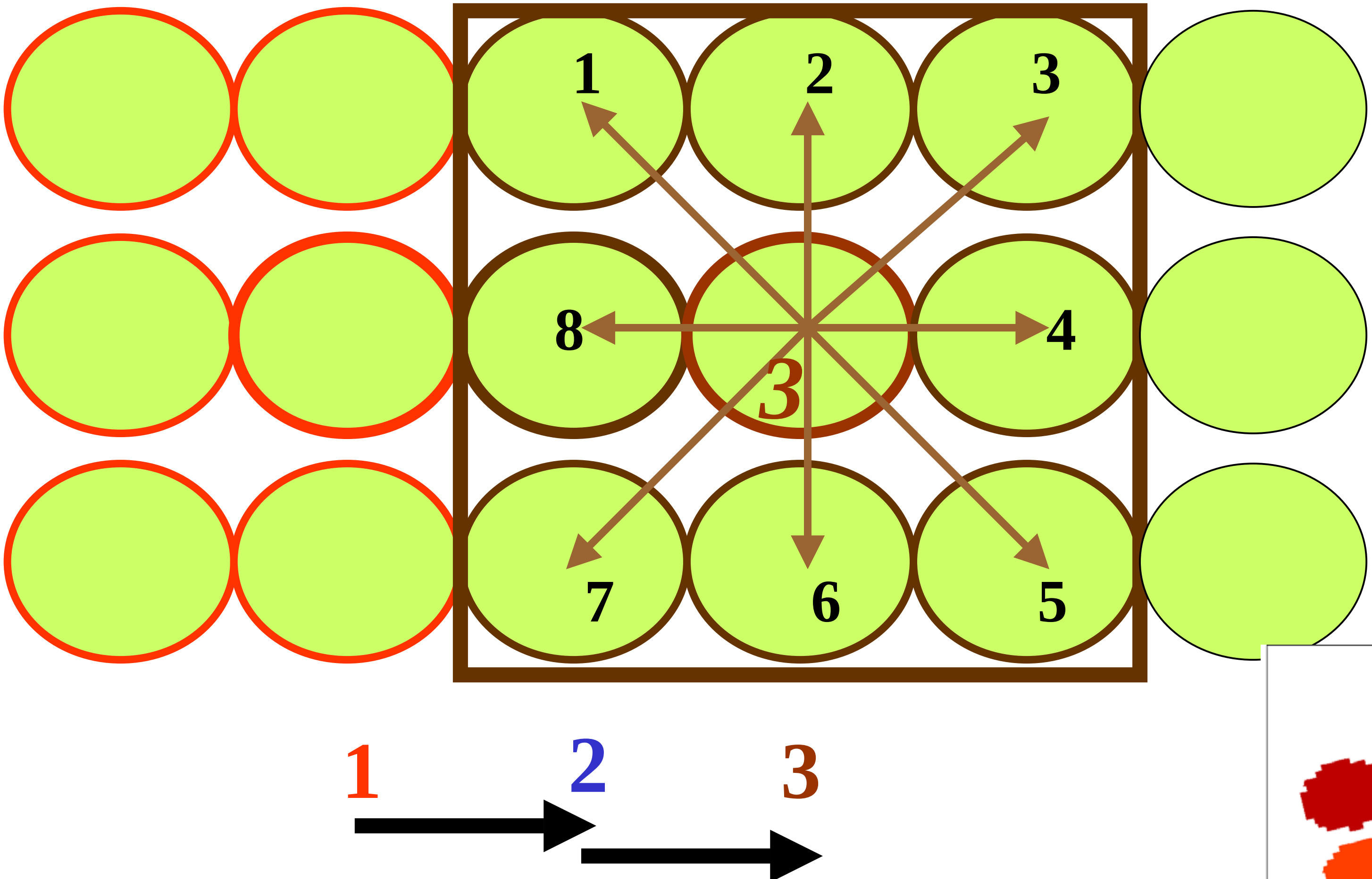
Pseudo Single AIRS FOV



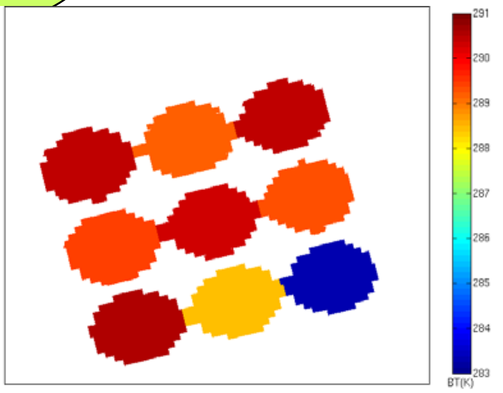
MODIS/AIRS Synergistic N* Cloud Clearing

Over Sampling Strategy

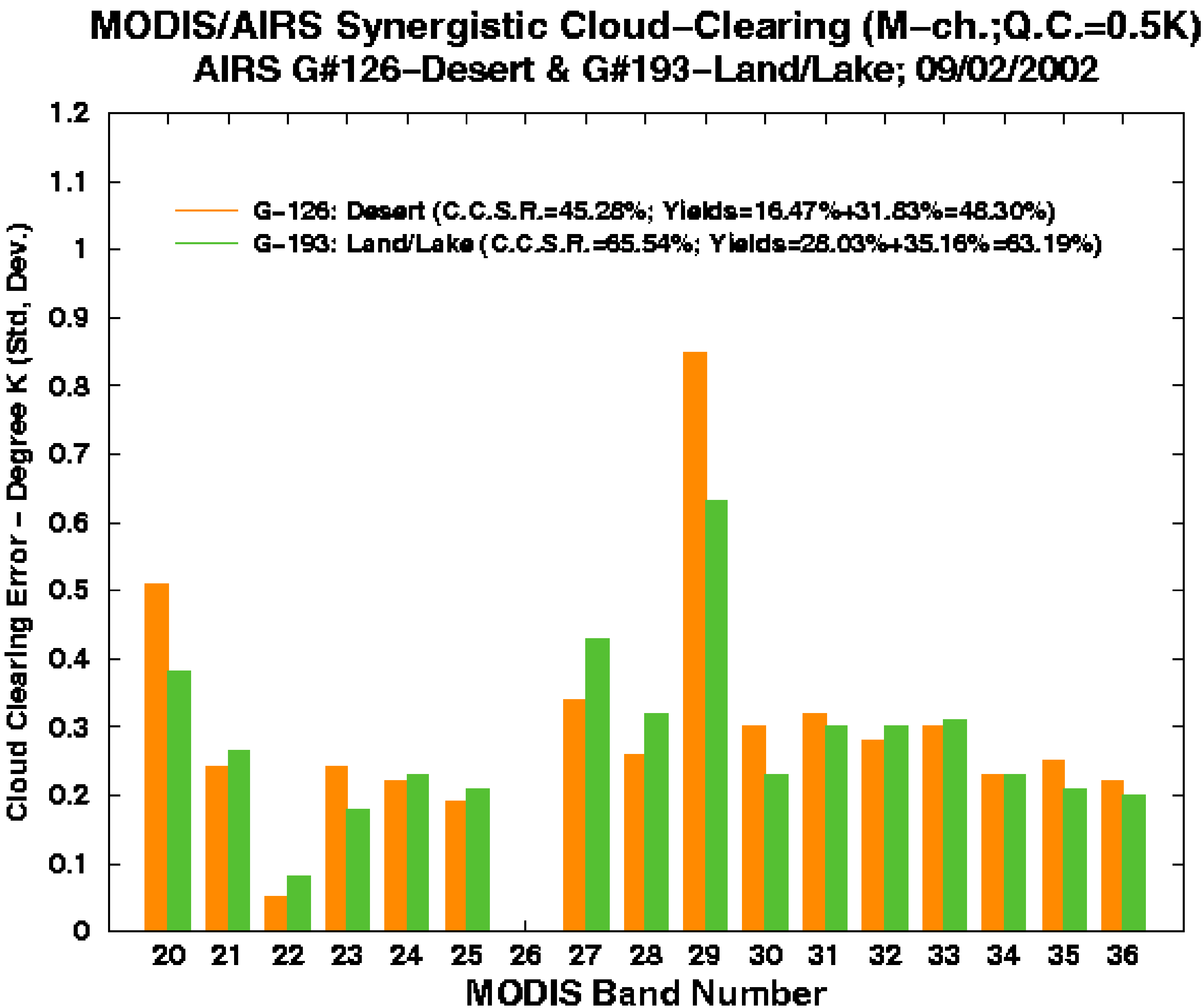
8 possible AIRS pairs (2 FOVs)

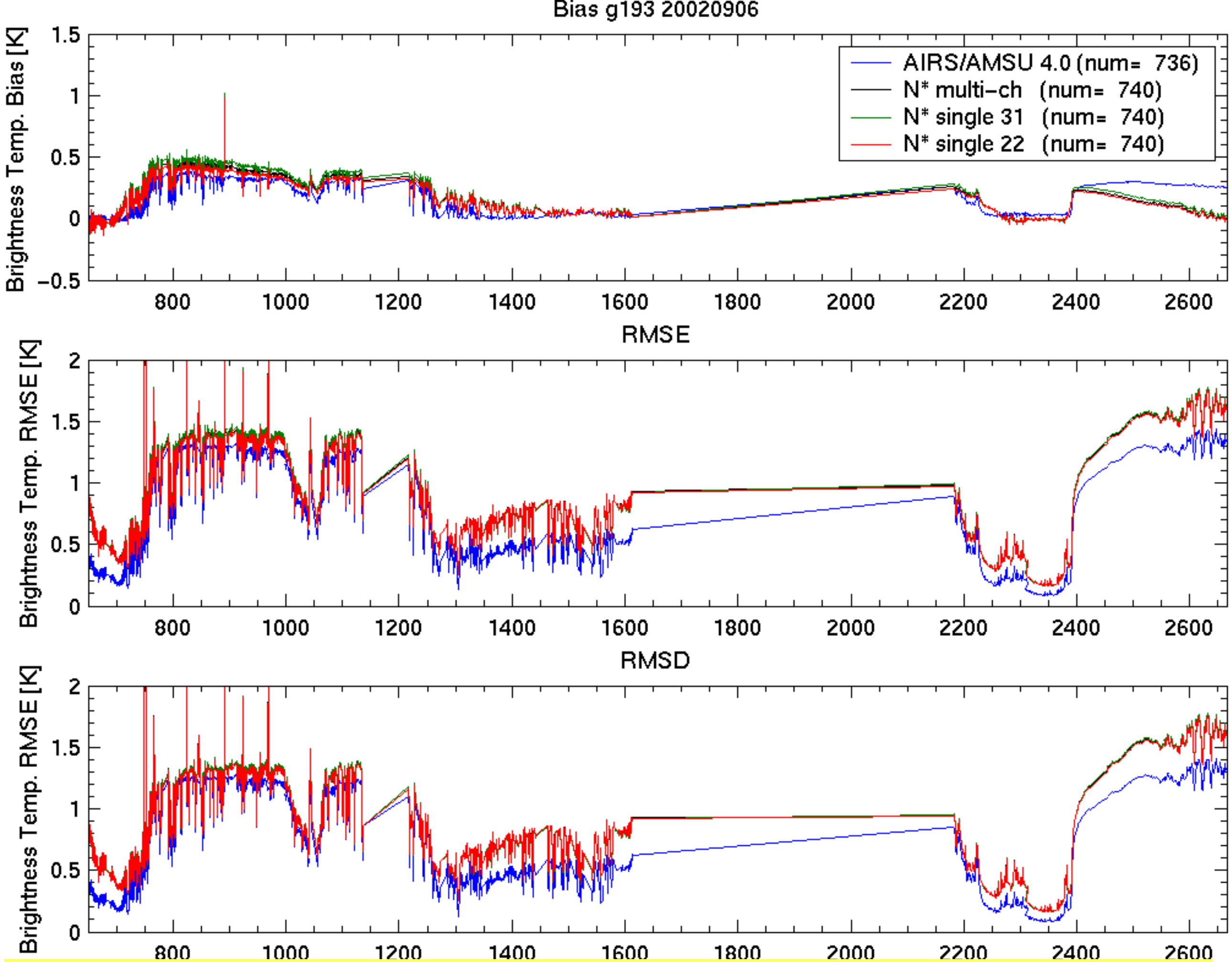


Pseudo Single AIRS FOV

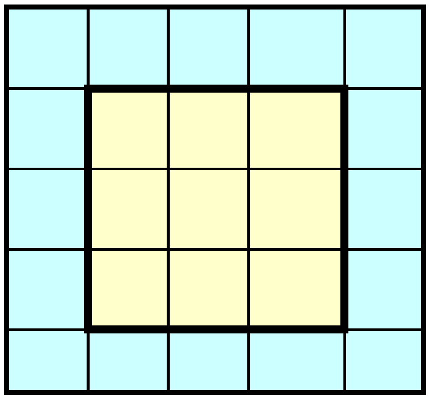


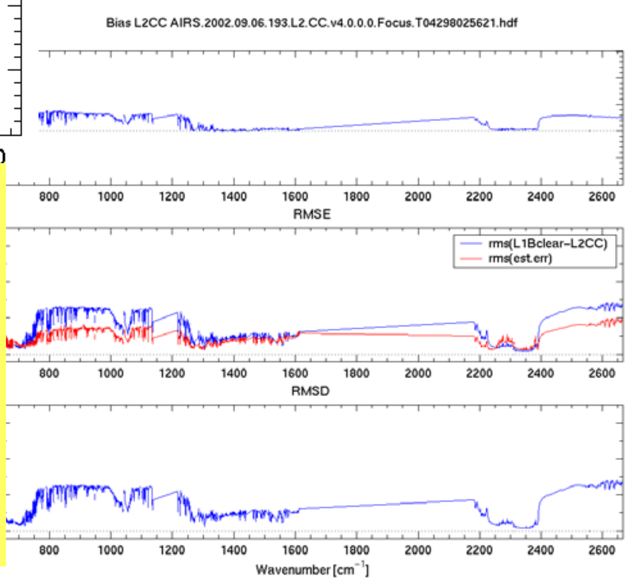
Multi-Channel N* Desert vs. Land C.C. Error Comparison





Wisconsin Granule



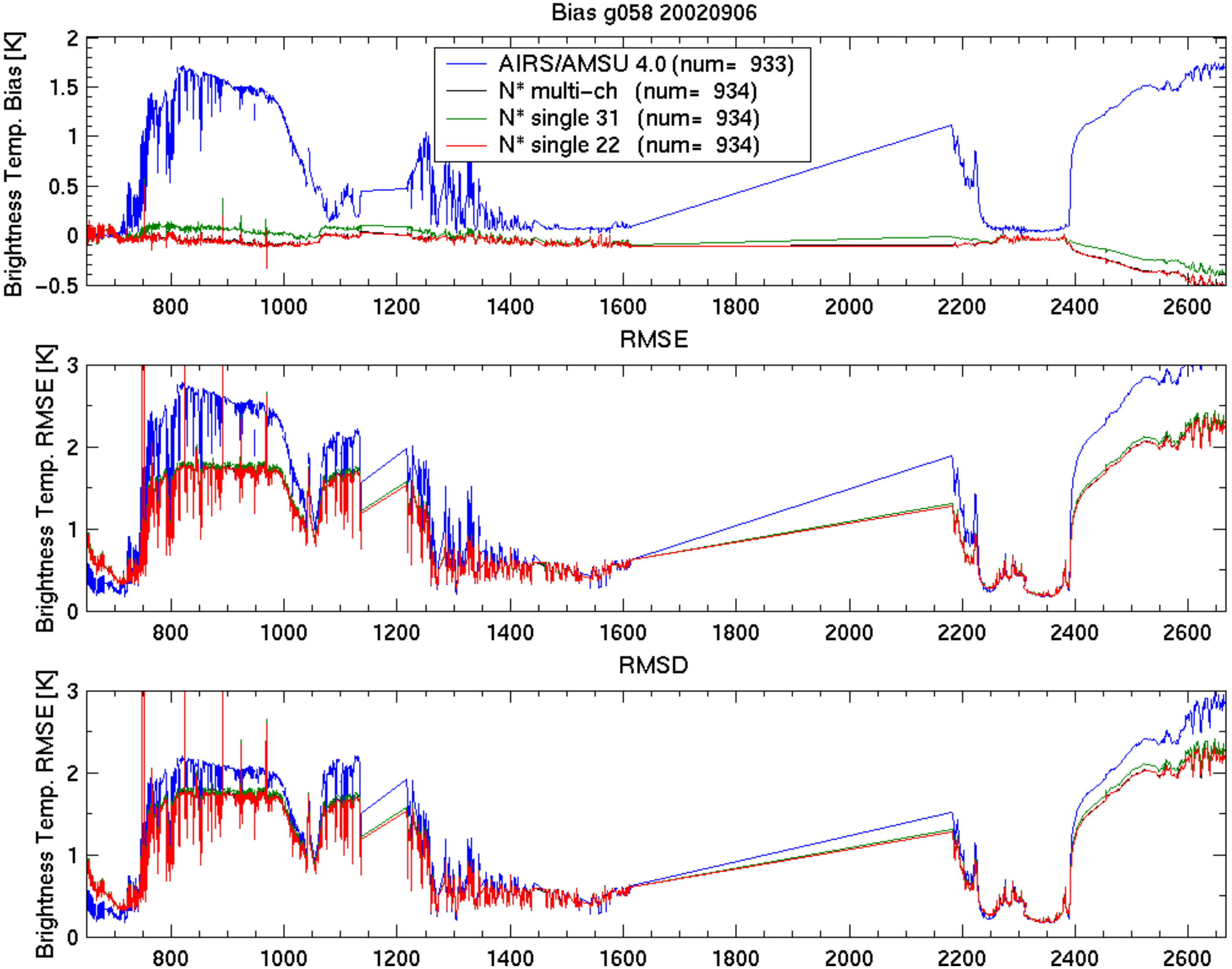


AIRS/AMSU C.C. (3 by 3 AIRS FOV) V4.0 - Blue
AIRS/MODIS C.C. (1 by 2 AIRS FOV)
Multi-Ch. - Black
Single-Ch.:Band 31 – Green; Band 22 - Red

AIRS/MODIS Synergistic C.C. can Supplement AIRS/AMSU C.C. Especially over Desert Region

AIRS/AMSU C.C.
(3 by 3 AIRS FOV)
V4.0 - Blue

AIRS/MODIS C.C.
(1 by 2 AIRS FOV)
Multi-Ch. - Black
Single-Ch.:
Band 31 – Green
Band 22 - Red

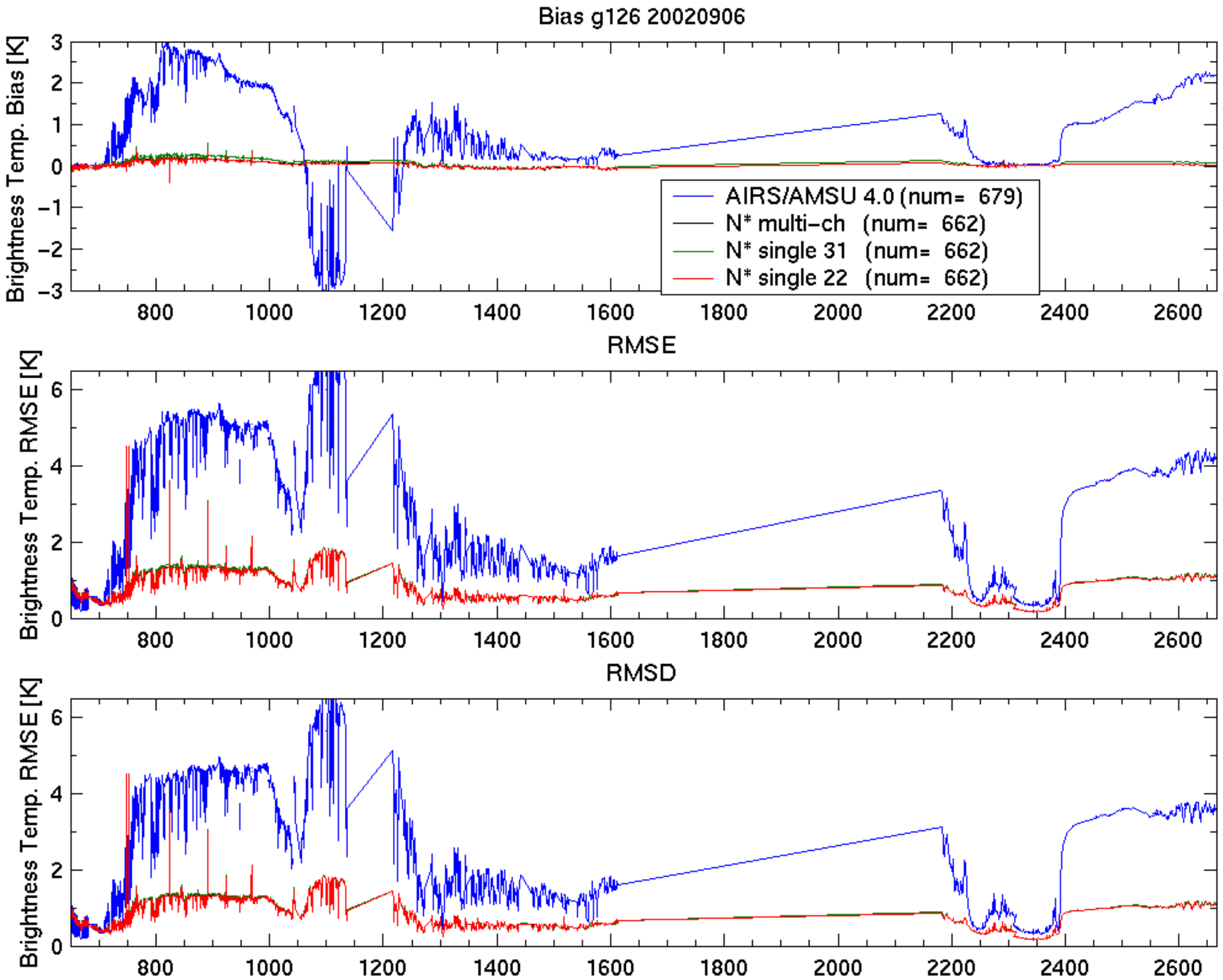


Australia Granule

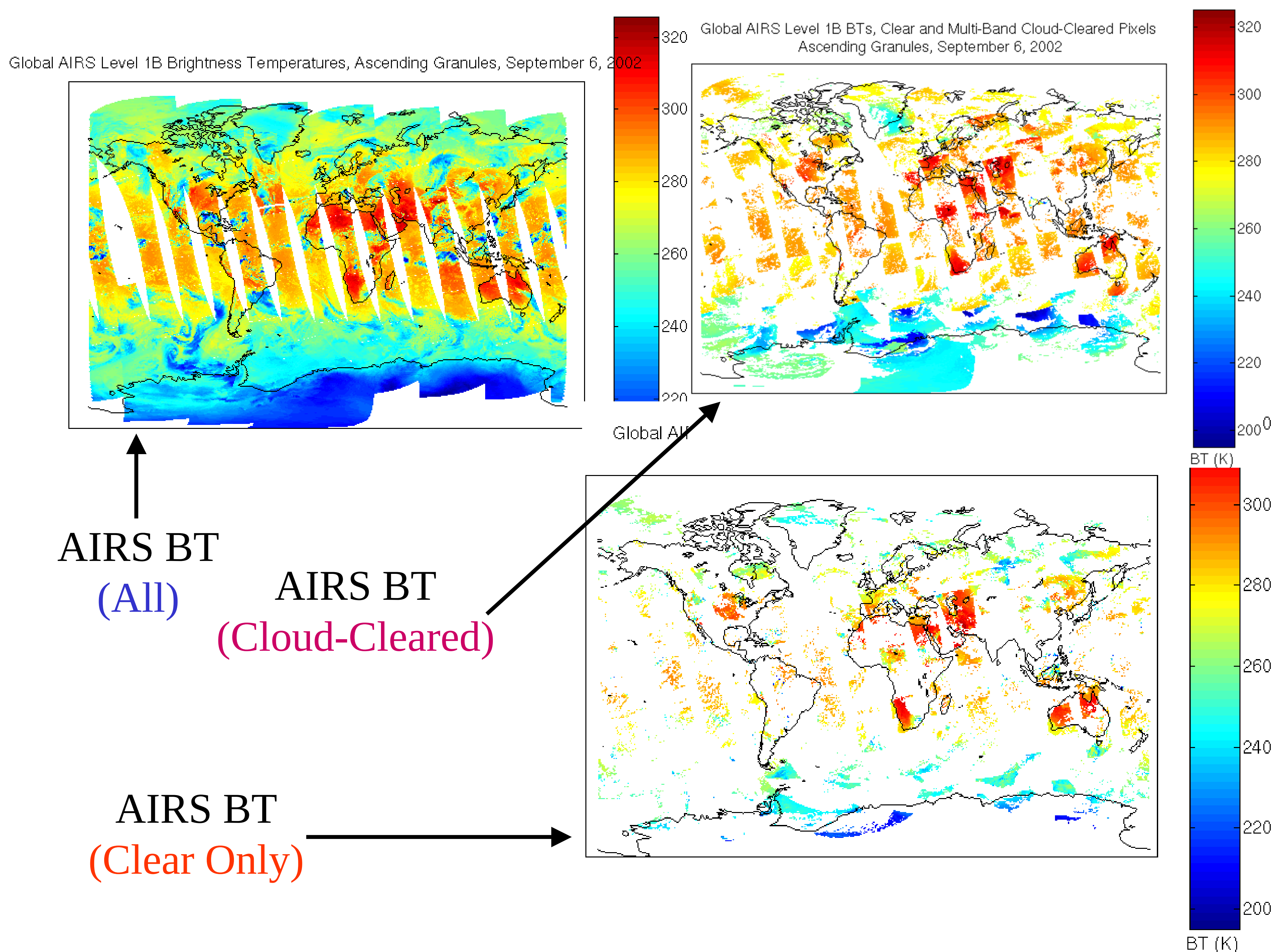
AIRS/MODIS Synergistic C.C. can Supplement AIRS/AMSU C.C. Especially over Desert Region

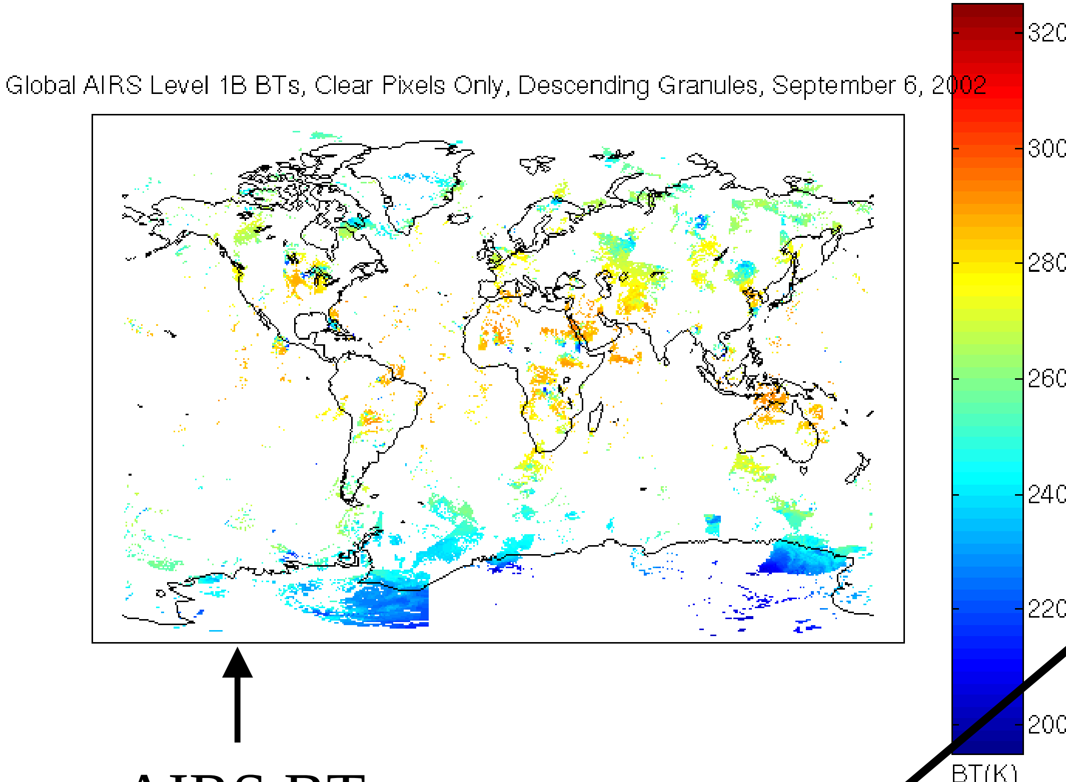
AIRS/AMSU C.C.
(3 by 3 AIRS FOV)
V4.0 - Blue

AIRS/MODIS C.C.
(1 by 2 AIRS FOV)
Multi-Ch. - Black
Single-Ch.:
Band 31 – Green
Band 22 - Red

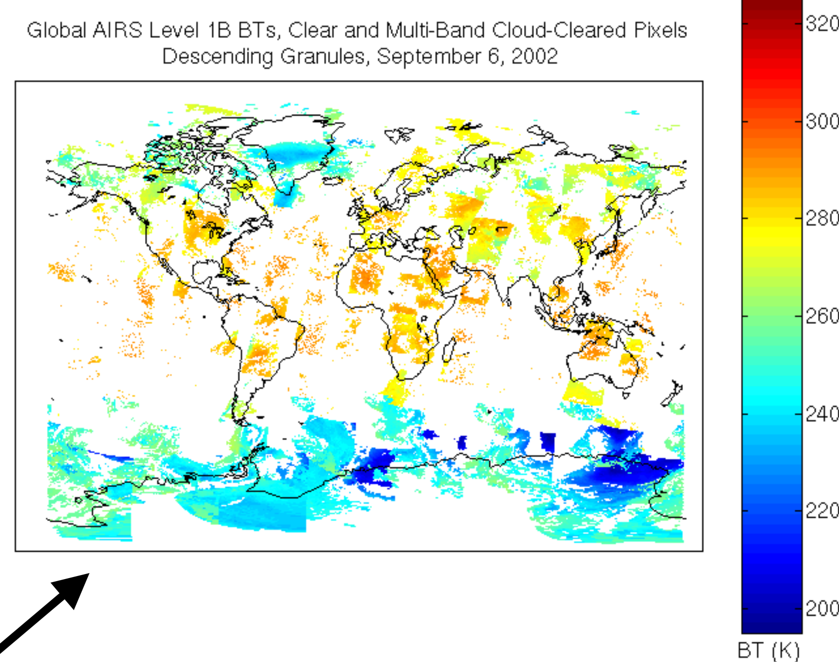


South Africa Granule

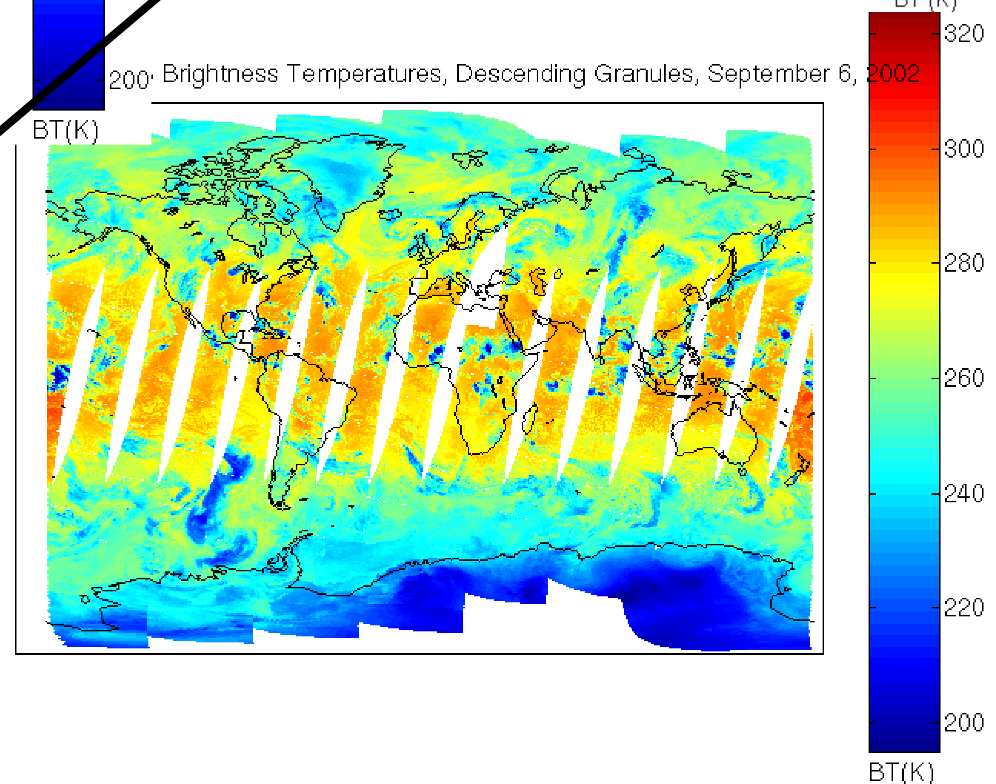

Global AIRS Level 1B Brightness Temperatures, Ascending Granules, September 6, 2002
320
300
280
260
240
220
Global AIRS Level 1B BTs, Clear and Multi-Band Cloud-Cleared Pixels
Ascending Granules, September 6, 2002
320
300
280
260
240
220
200
BT (K)
Global AI
300
280
260
240
220
200
BT (K)
AIRS BT
(All)
AIRS BT
(Cloud-Cleared)
AIRS BT
(Clear Only)



AIRS BT
(Clear Only)



AIRS BT
(Cloud-Cleared)



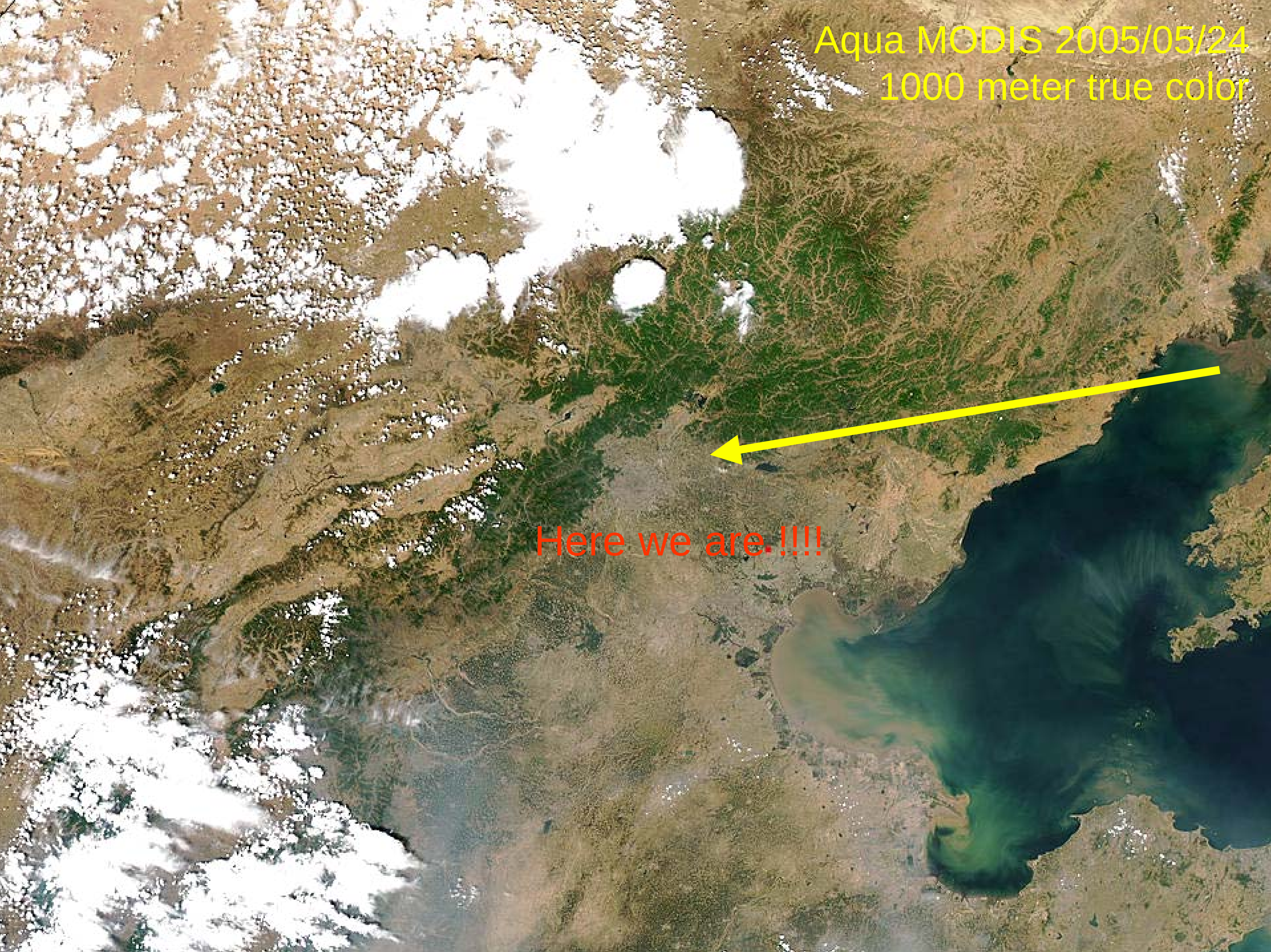
AIRS BT
(All)

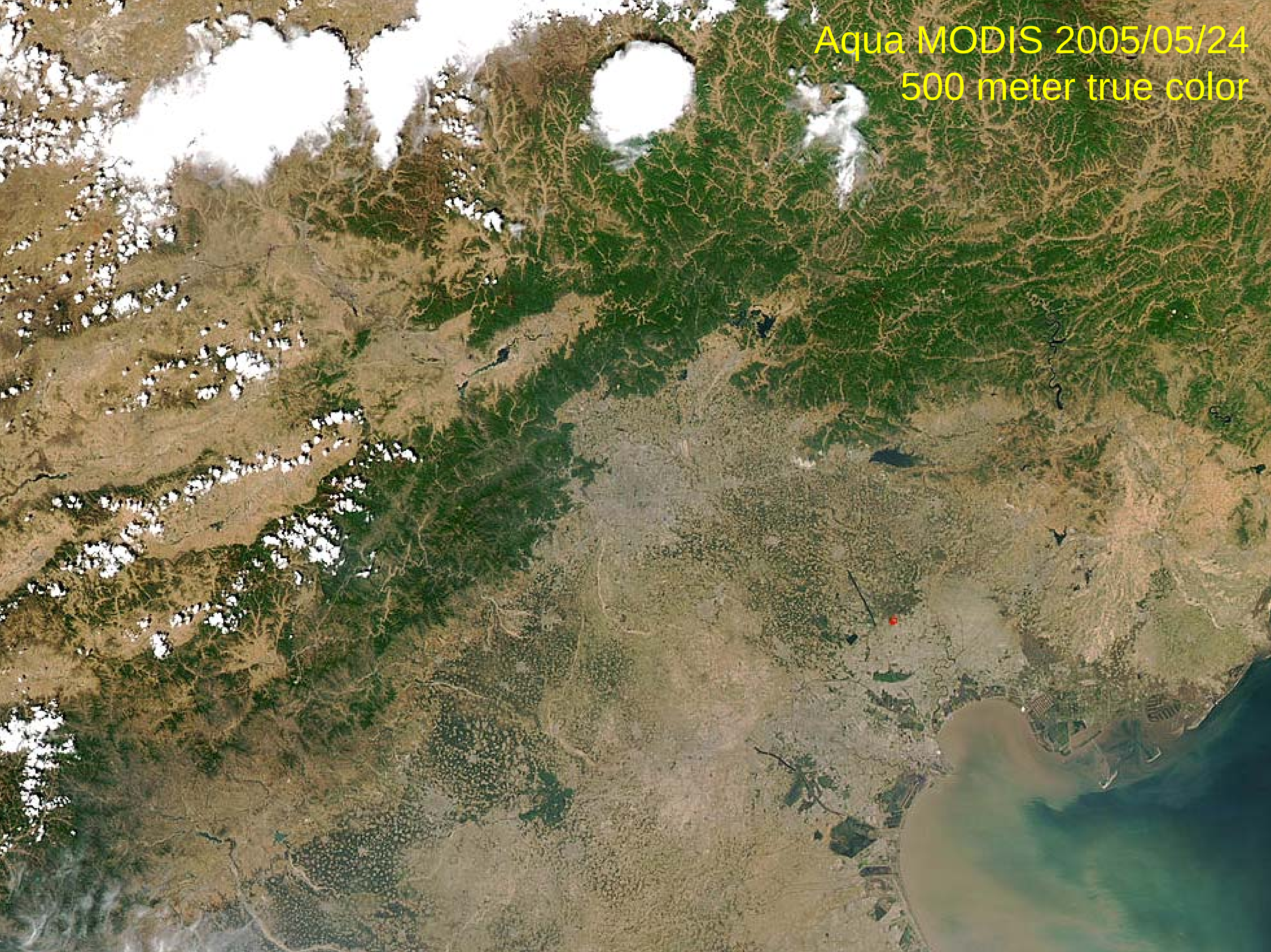
Synergistic AIRS/MODIS C.C. Summary

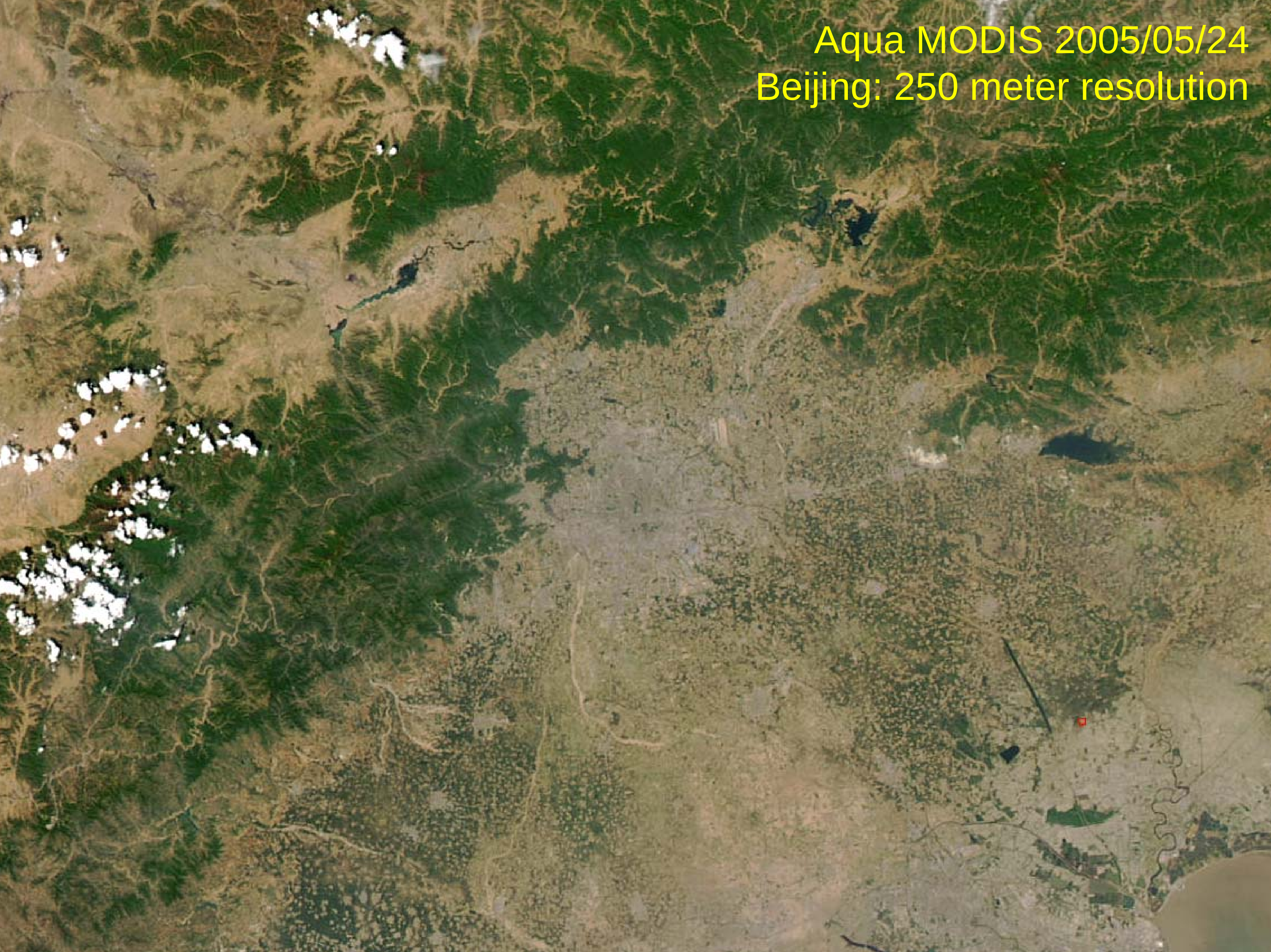
- **Synergistic AIRS/MODIS C.C. could provide cloud-cleared radiances over non-oceanic scenes with good yield and performance at high spatial resolution (pseudo single AIRS FOV)**

- **Synergistic AIRS/MODIS C.C. could also provide additional pseudo-clear AIRS single FOV radiances (without conducting actual C.C.) (not presented here)**

- **MODIS can provide additional Q.C. to refine/enhance AIRS/AMSU C.C. performance**


Aqua MODIS 2005/05/24
1000 meter true color
Here we are !!!!


Aqua MODIS 2005/05/24
500 meter true color


Aqua MODIS 2005/05/24
Beijing: 250 meter resolution

IMAPP Poster B44