

Global Analysis and Characterization of AIRS/MOIDS Cloud-Clearing

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Maratea, Italy

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

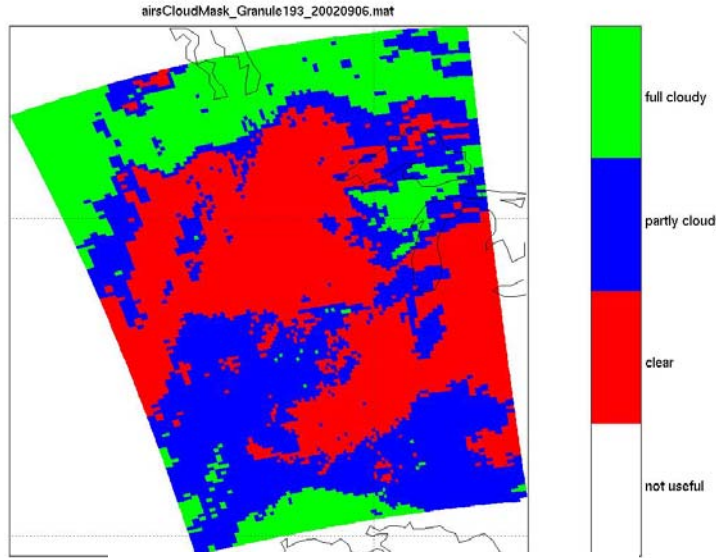
Summary

- **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.**

2005 ITSC 14 Beijing

Case Granule Dataset Used

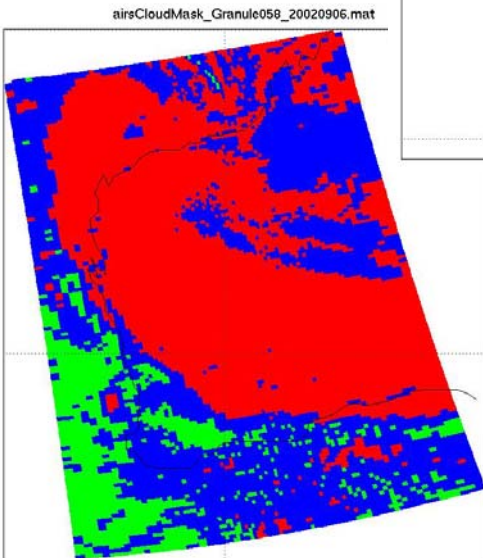
2 Sep. 2002
AIRS
Focus Day



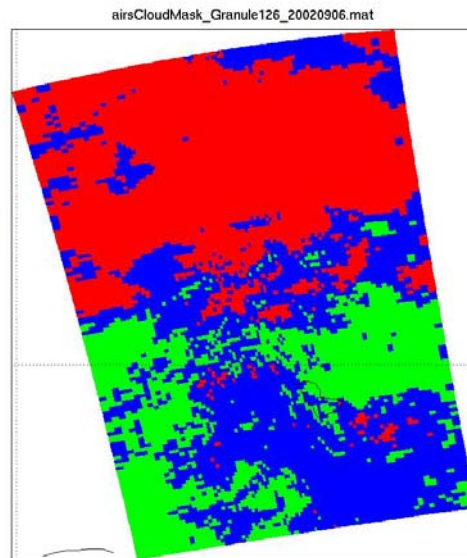
- 4 Granules of Collocated AIRS & MODIS Data
- MODIS 1-km Cloud Mask
- AIRS C.M. (from MODIS)
- No ancillary data used

Wisconsin Granule

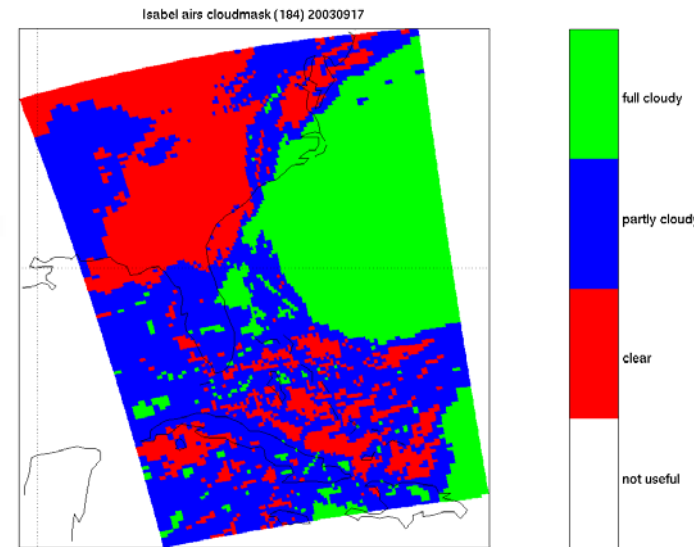
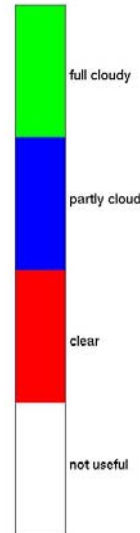
17 Sep. 2003



Australia Granule

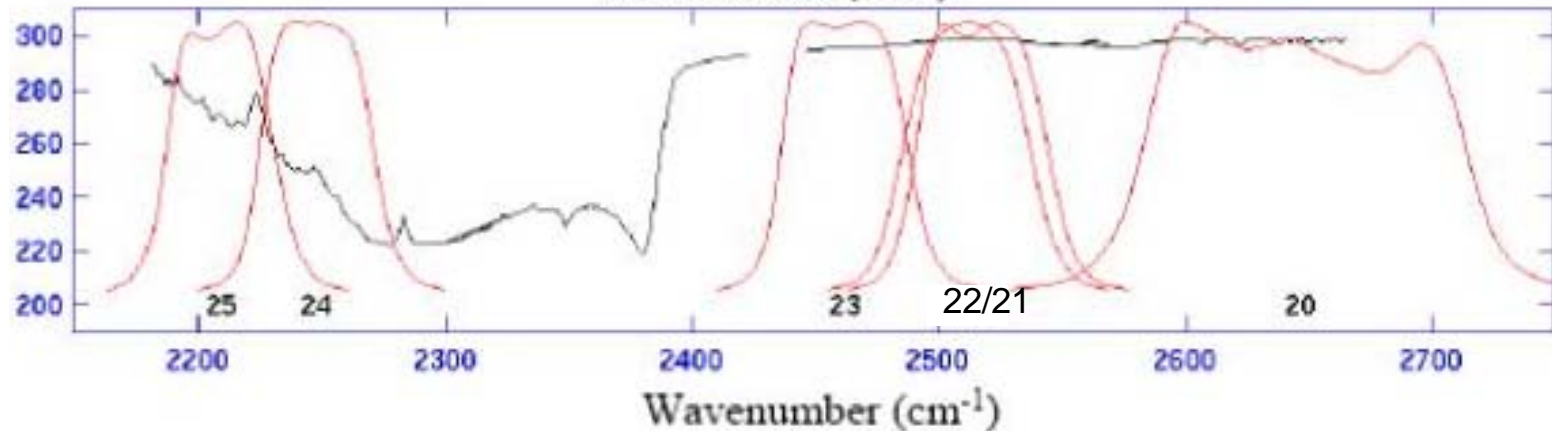
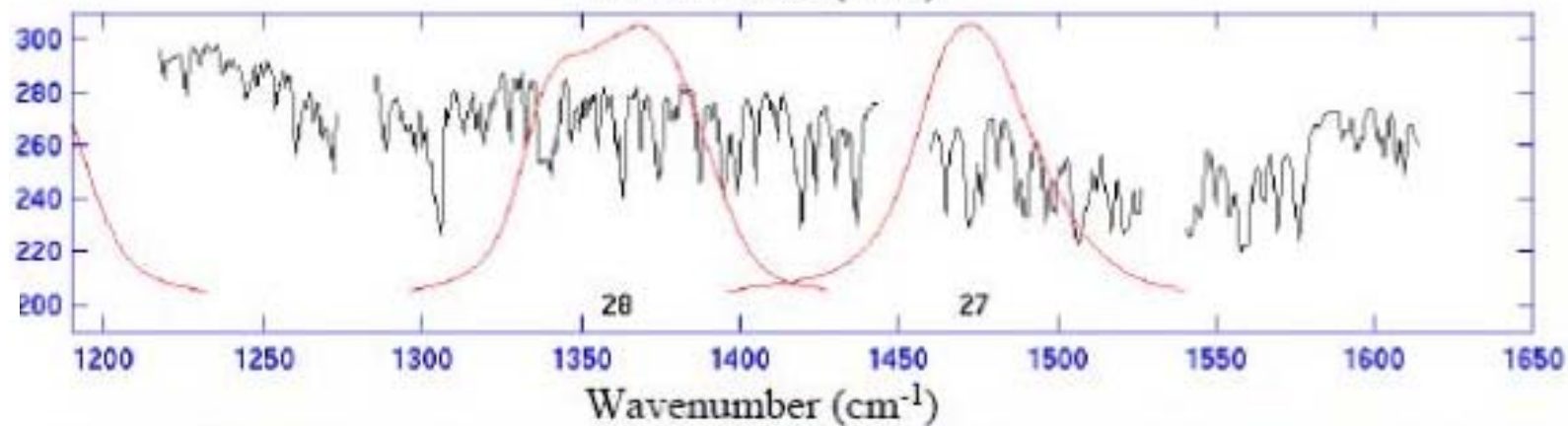
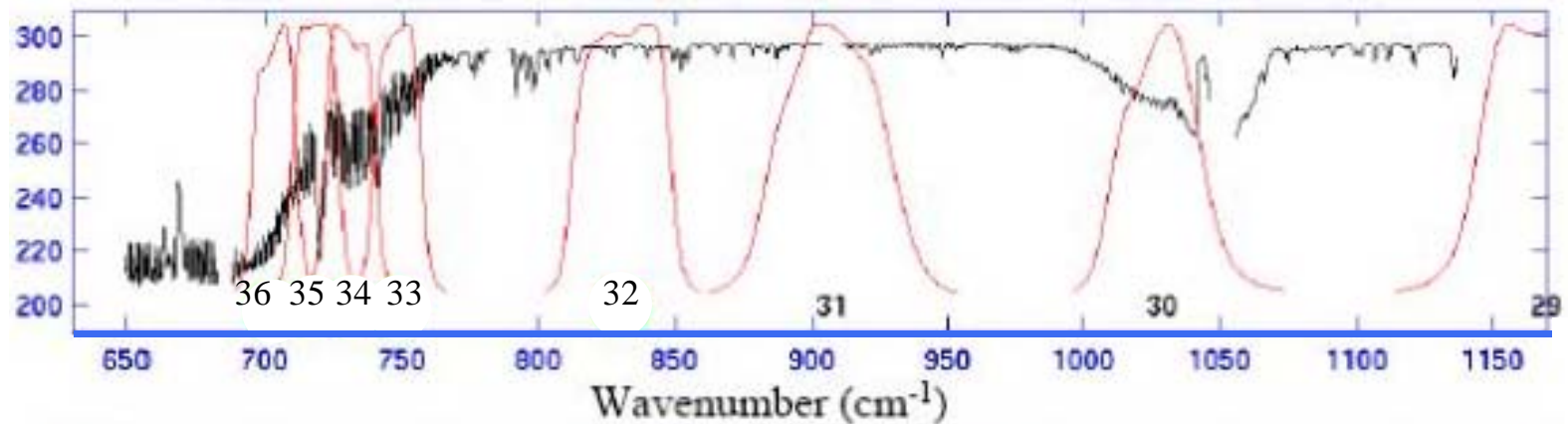


South Africa Granule

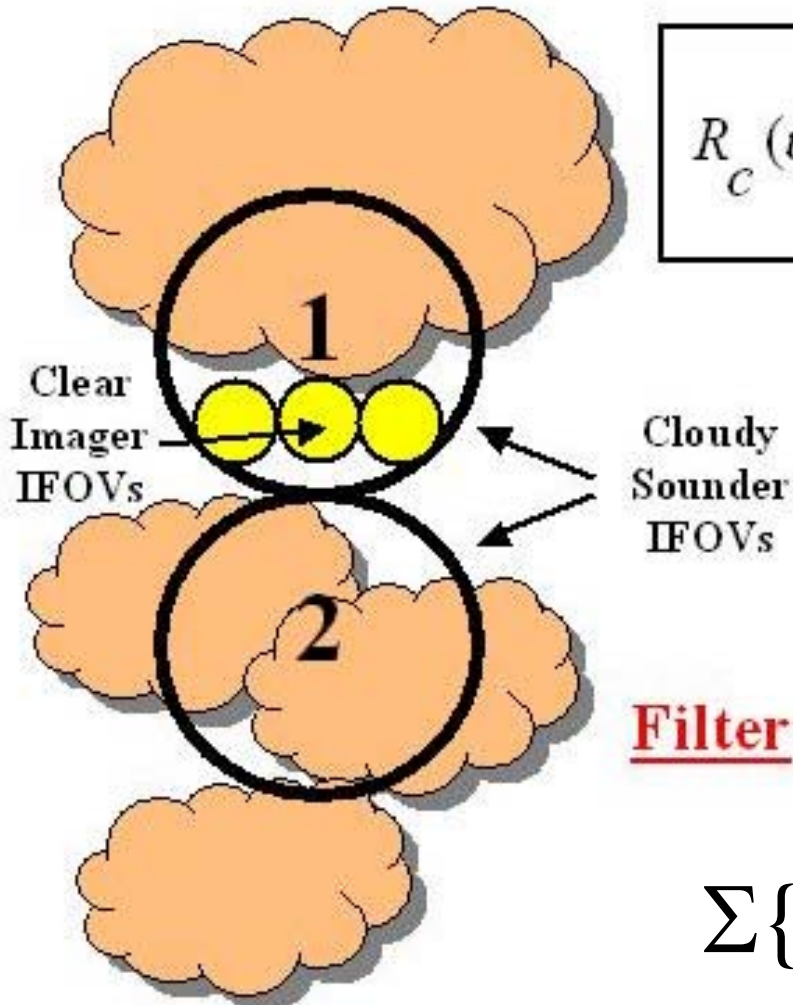


Hurricane Isabel Granule

Aqua MODIS IR SRF Overlay on AIRS Spectrum



MODIS/AIRS Synergistic Single-Channel N^* Cloud-Clearing General Principal



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

Where;
 $N^* = N_1/N_2$

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

$$\text{srf}[R_i(w)] = \int \theta(w, \nu) R_i(\nu) d\nu$$

Filter: Or Q.C.

$$\sum \{ \text{srf}[R_c(\delta\nu_j)] - R_c(\delta\nu_j) \}^2 \leq \epsilon$$

After Smith

MODIS/AIRS Synergistic Multi-Channel N* Cloud Clearing

General Principal

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

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

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

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

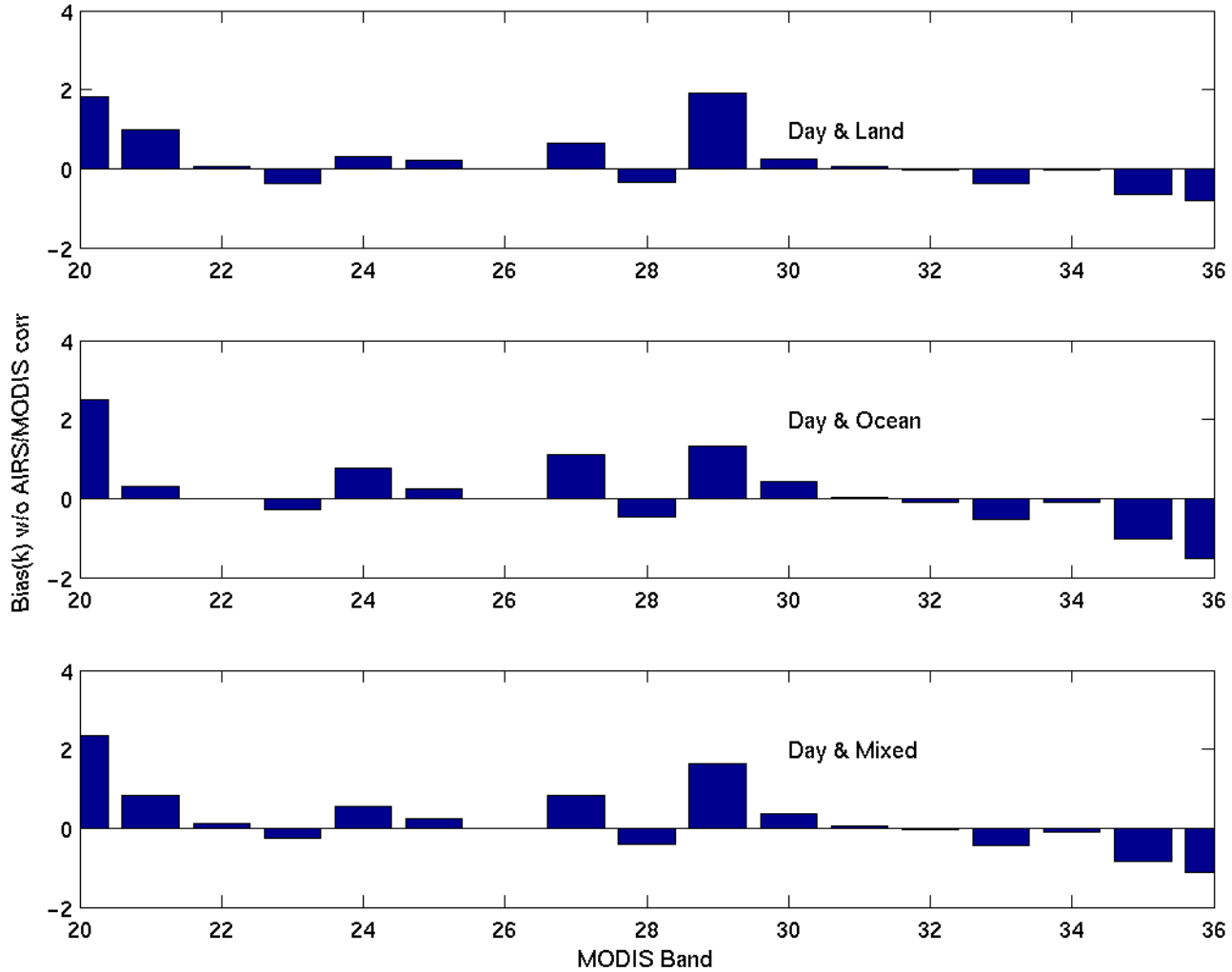
Global AIRS/MODIS Cloud Clearing Analysis

45 Days (1 Jan. to 15 Feb. 2004):

- Used by John Le Marshall in his AMS bulletin paper while only thinned and selected channels of “clear” only AIRS were assimilated
- Collocated MODIS and AIRS level 1 data
- Collocated MODIS cloud mask

Day Time

AIRS Cloud clearing Global Statistics on day 20040104



Land

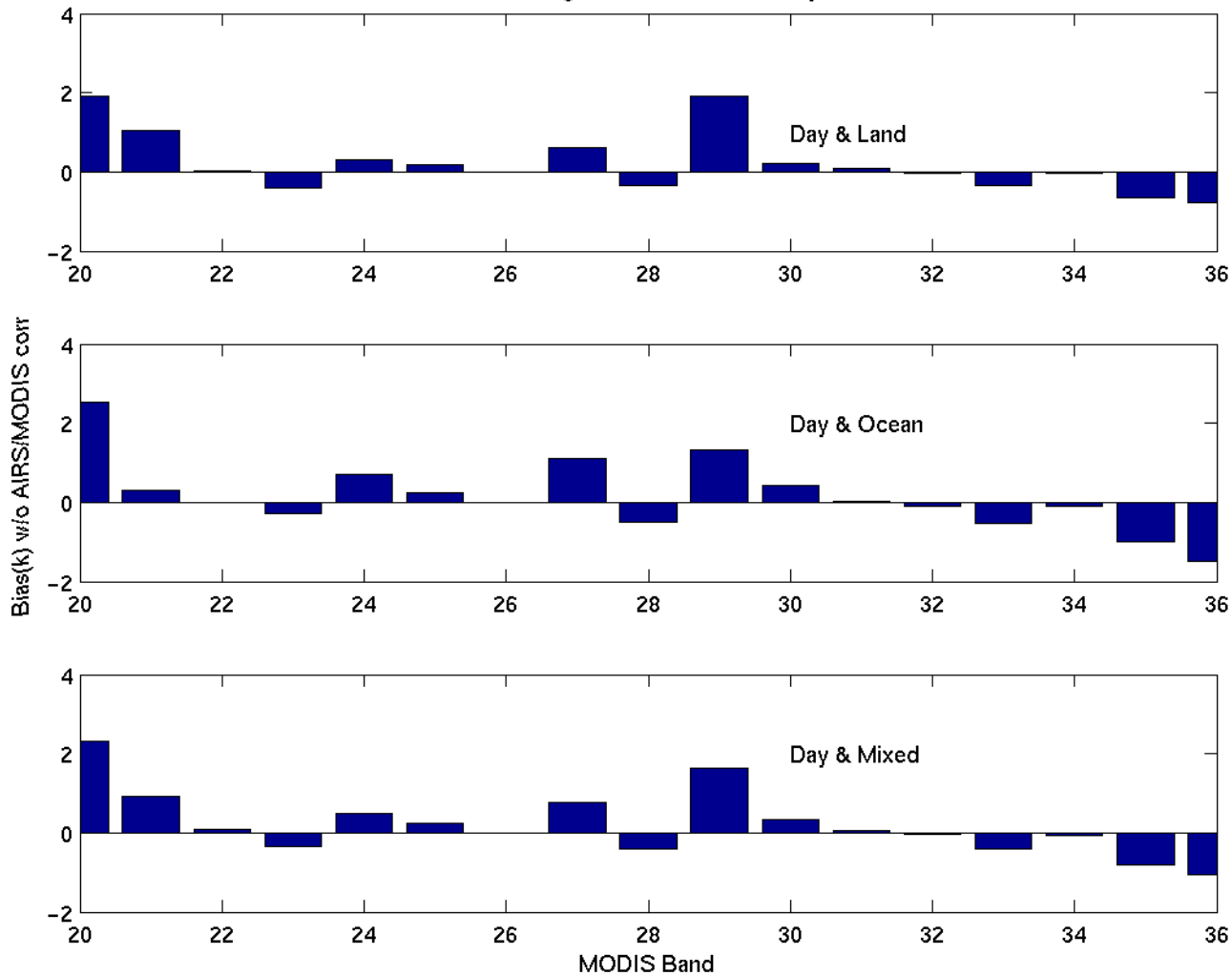
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Day Time

AIRS Cloud clearing Global Statistics on day 20040113



Land

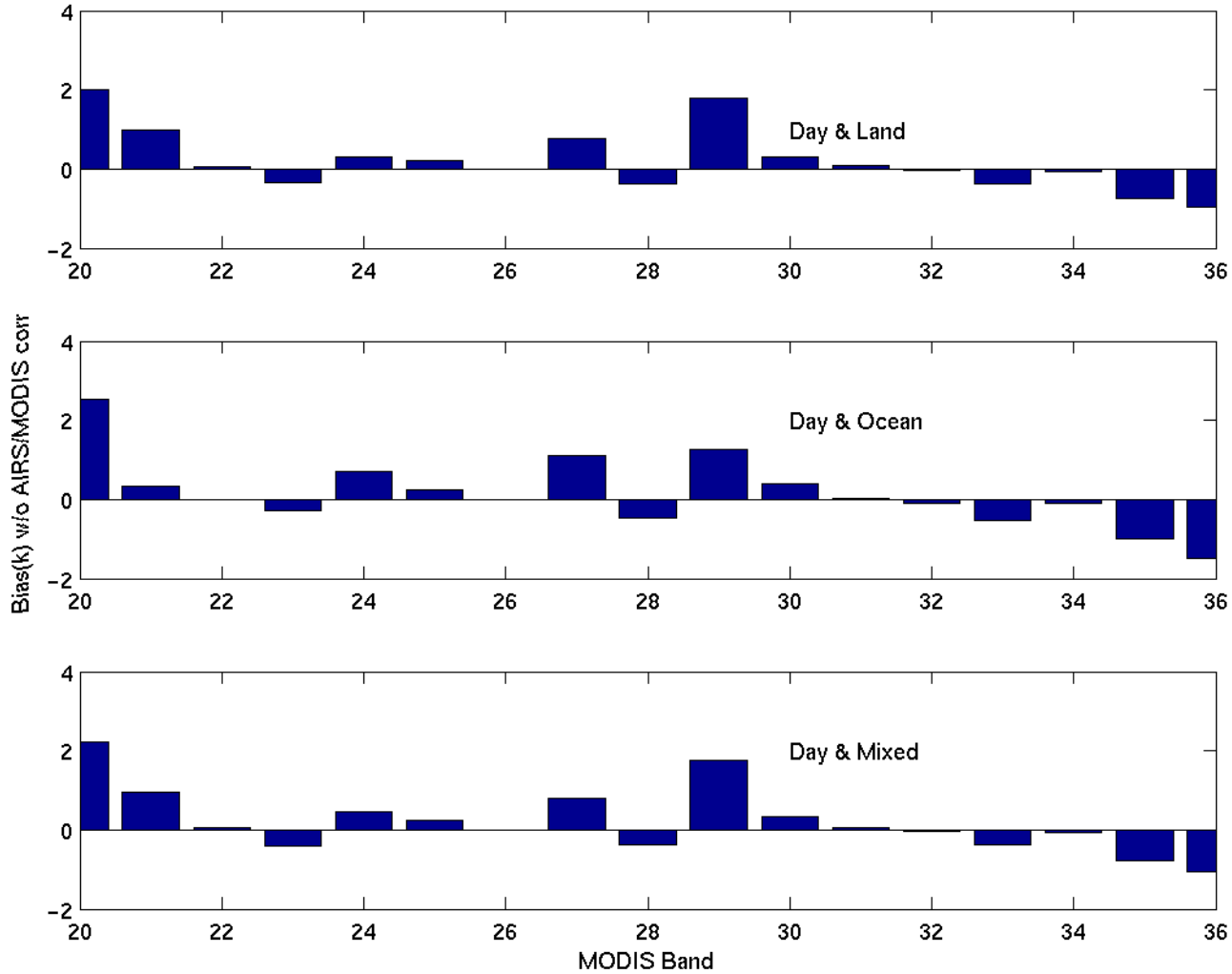
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Day Time

AIRS Cloud clearing Global Statistics on day 20040121



Land

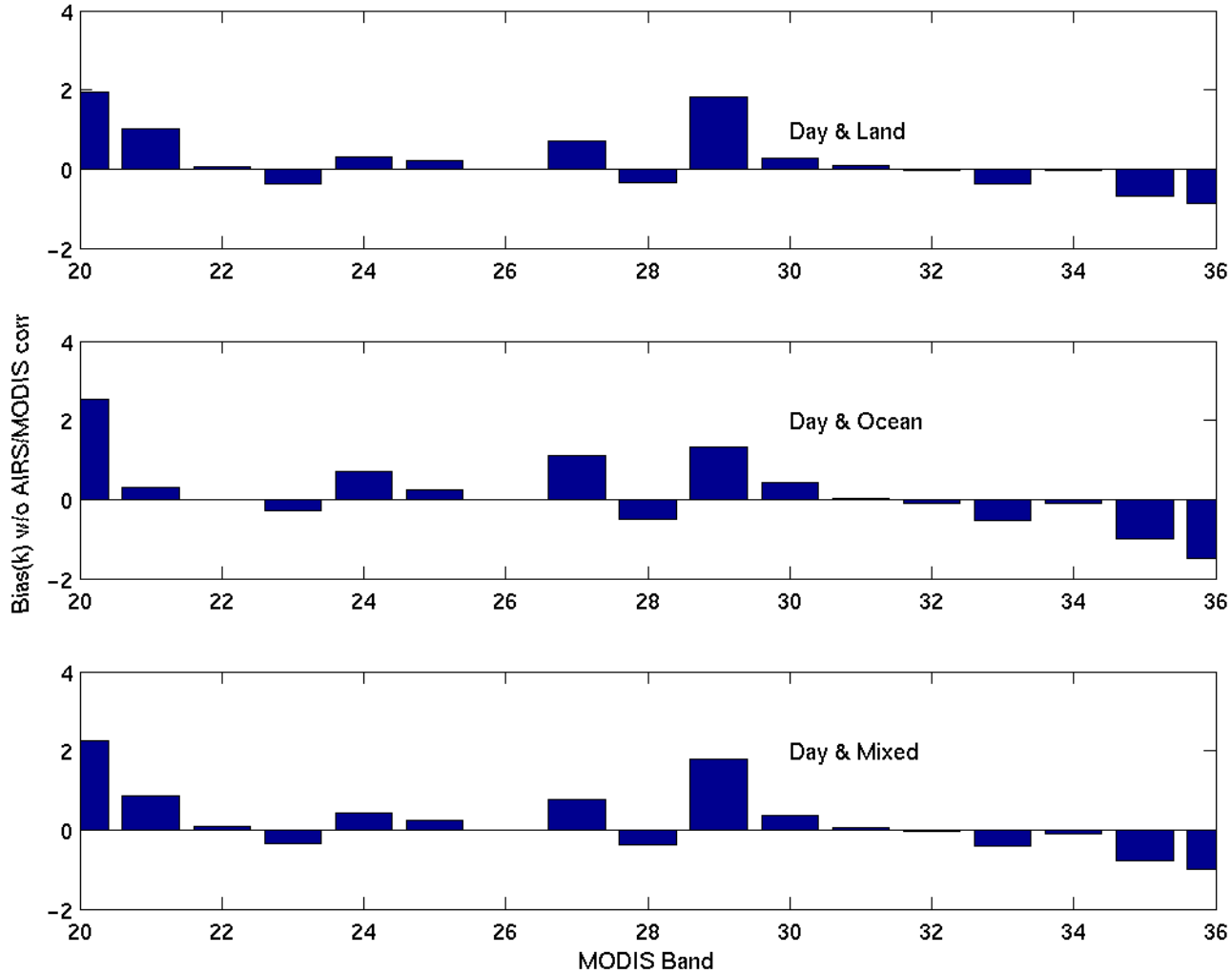
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Day Time

AIRS Cloud clearing Global Statistics on day 20040124



Land

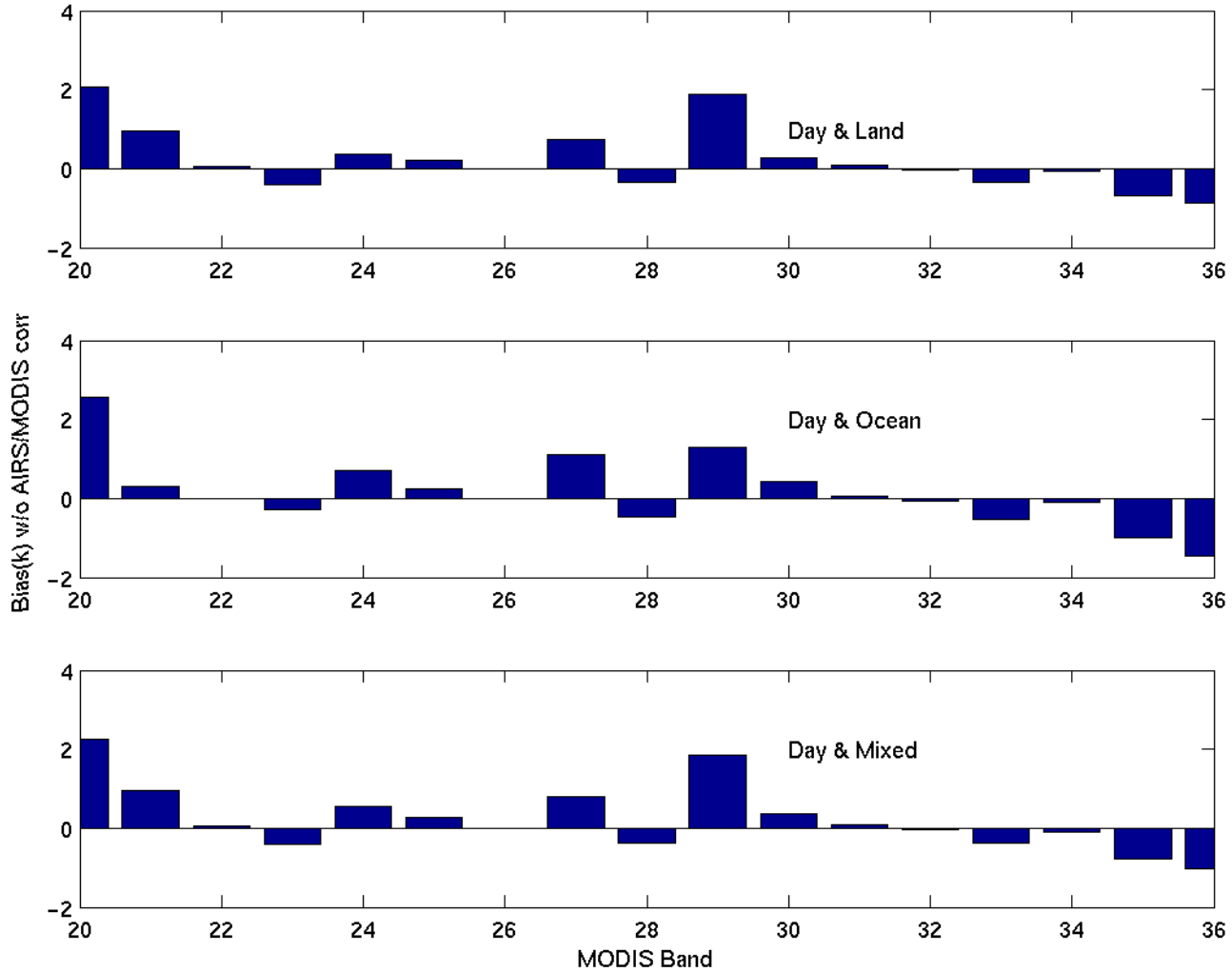
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Day Time

AIRS Cloud clearing Global Statistics on day 20040206



Land

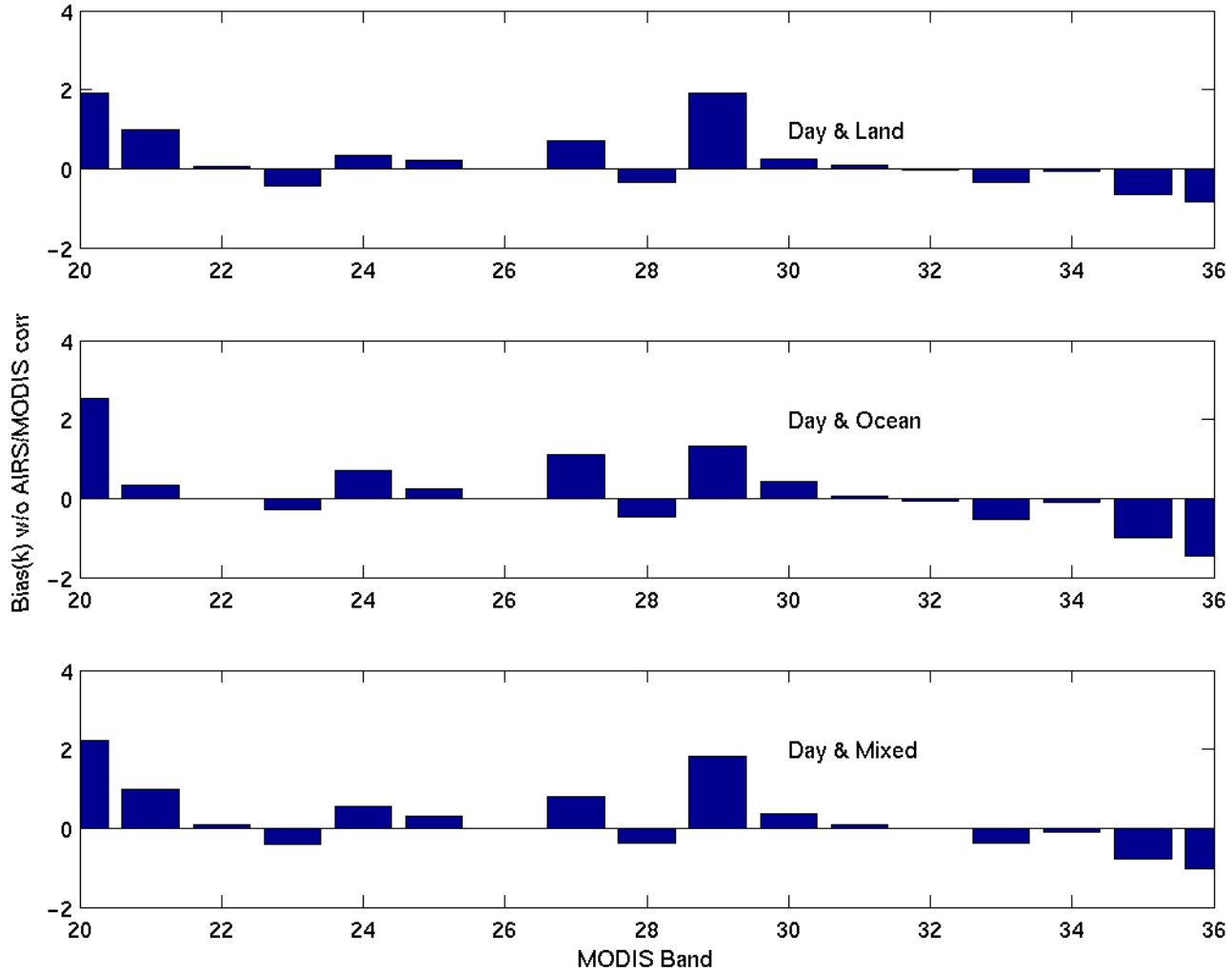
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Day Time

AIRS Cloud clearing Global Statistics on day 20040207



Land

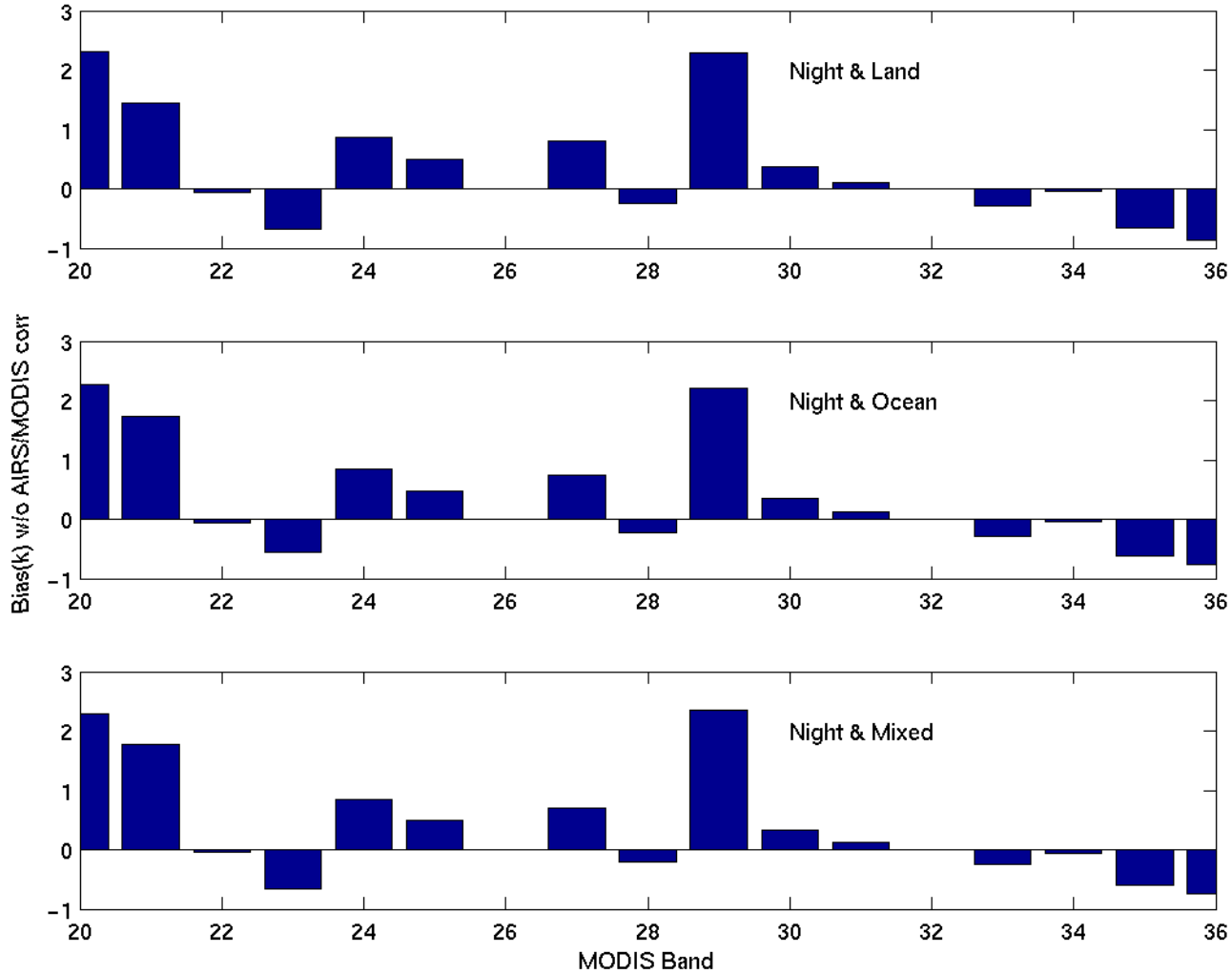
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Night Time

AIRS Cloud clearing Global Statistics on day 20040104



Land

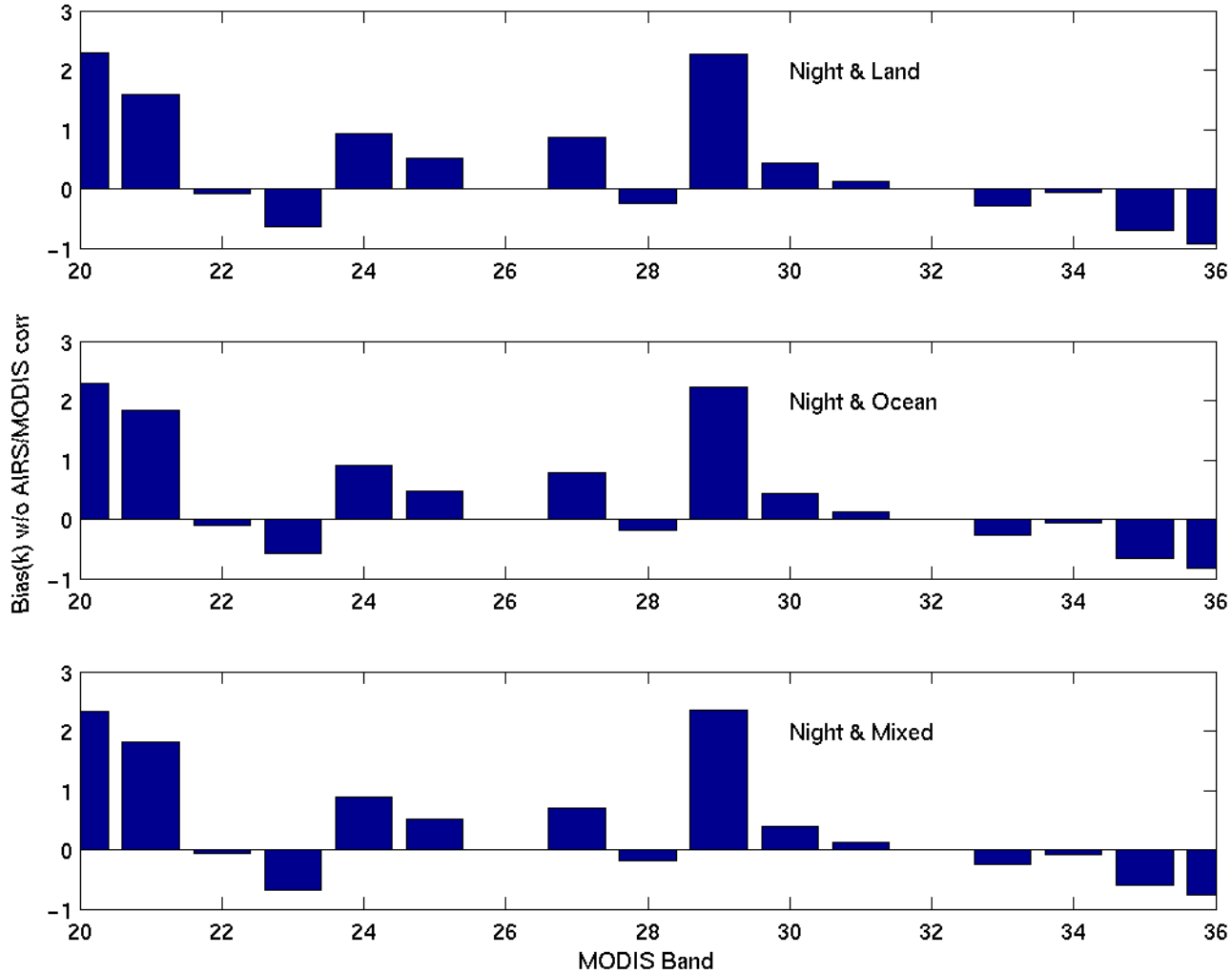
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Night Time

AIRS Cloud clearing Global Statistics on day 20040113



Land

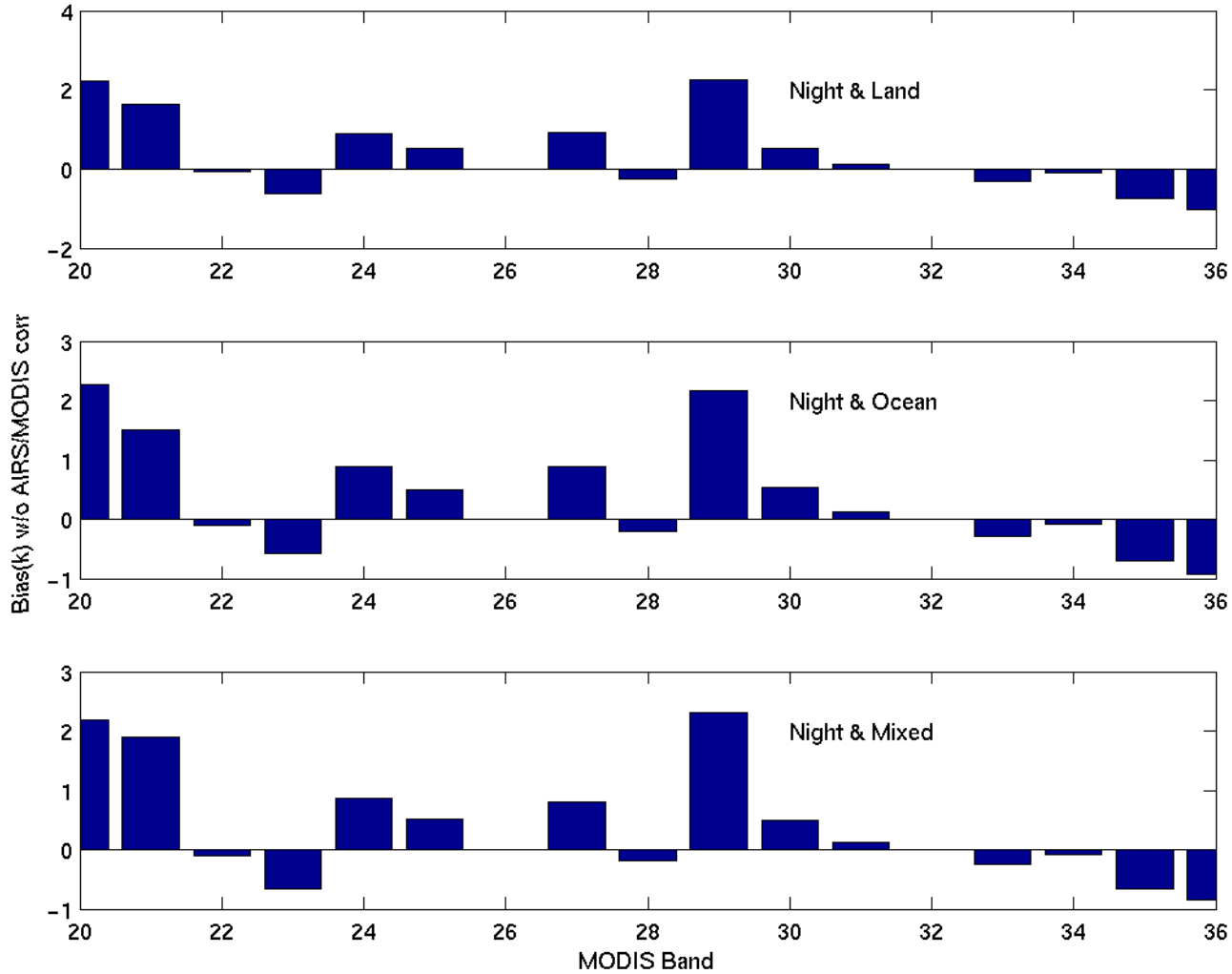
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Night Time

AIRS Cloud clearing Global Statistics on day 20040121



Land

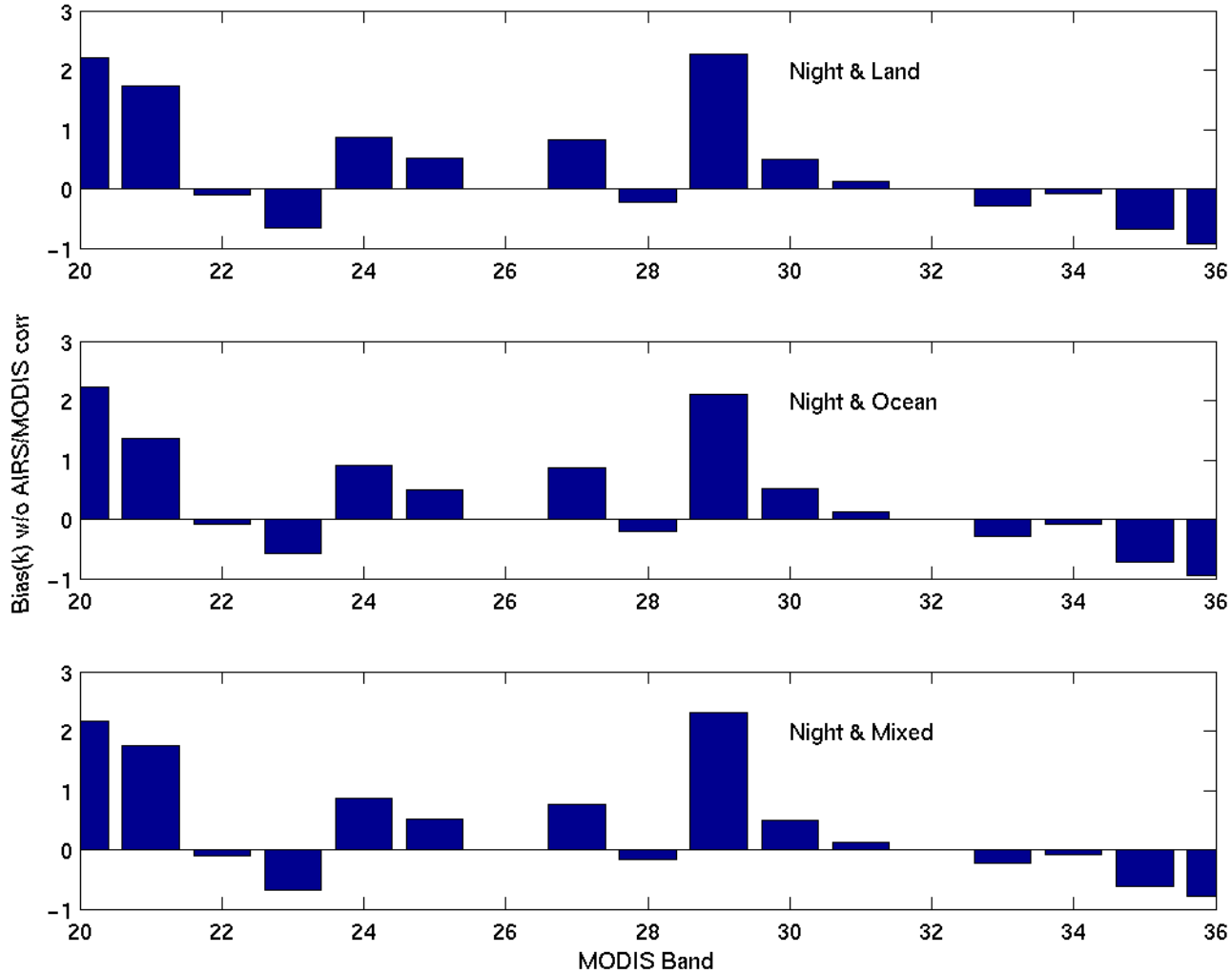
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Night Time

AIRS Cloud clearing Global Statistics on day 20040124



Land

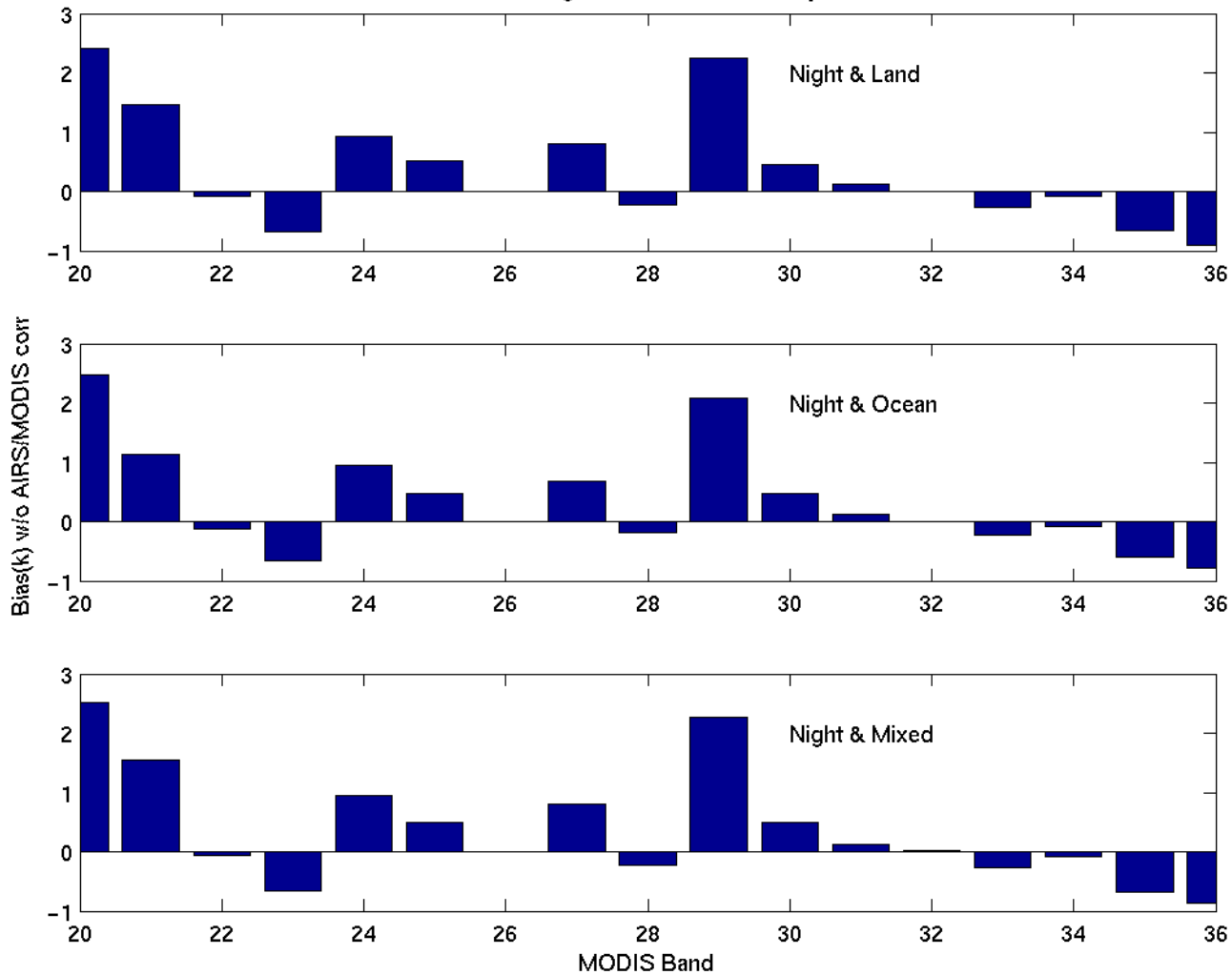
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Night Time

AIRS Cloud clearing Global Statistics on day 20040206



Land

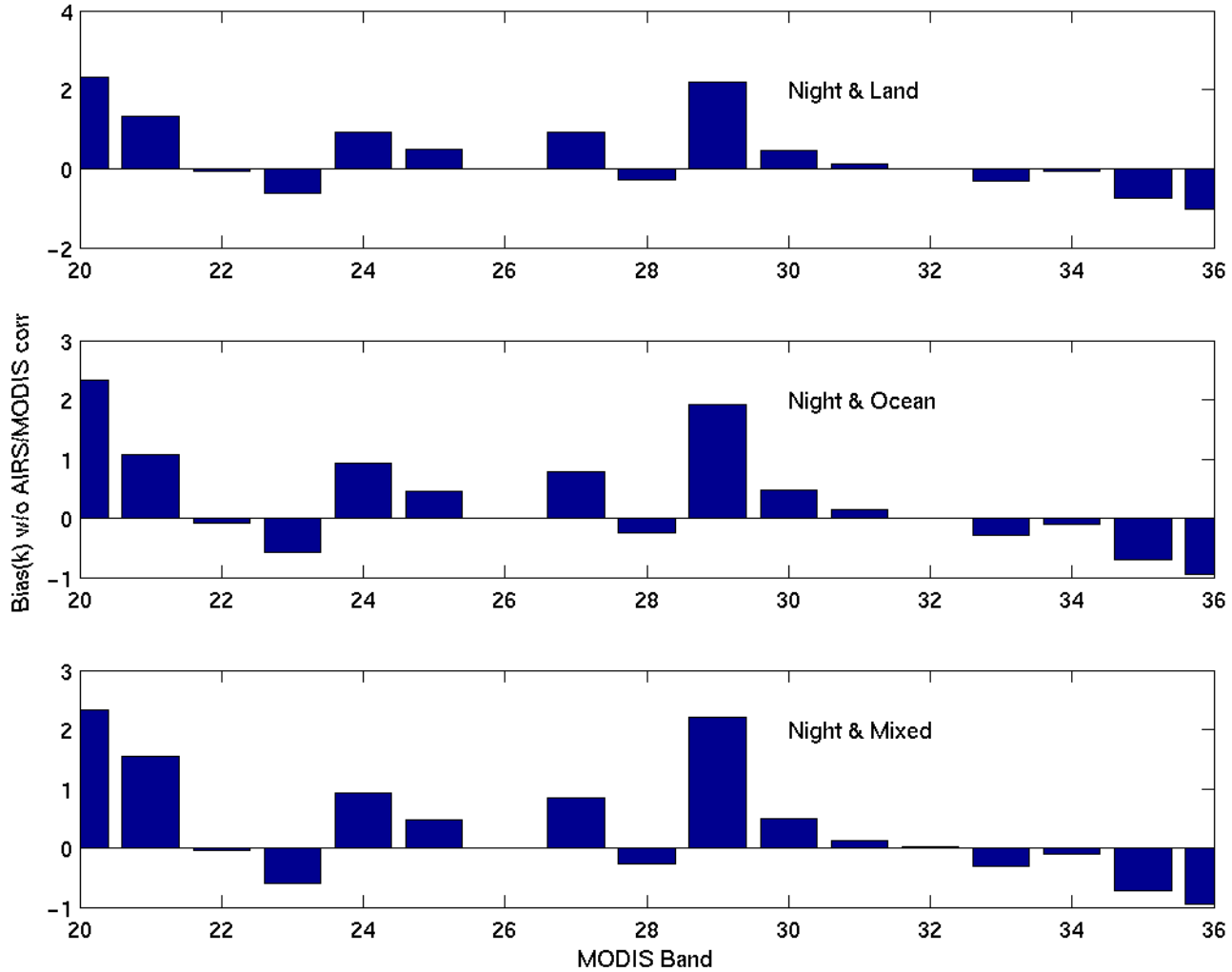
Ocean

Mixed

AIRS/MODIS C.C. BIAS

Night Time

AIRS Cloud clearing Global Statistics on day 20040207



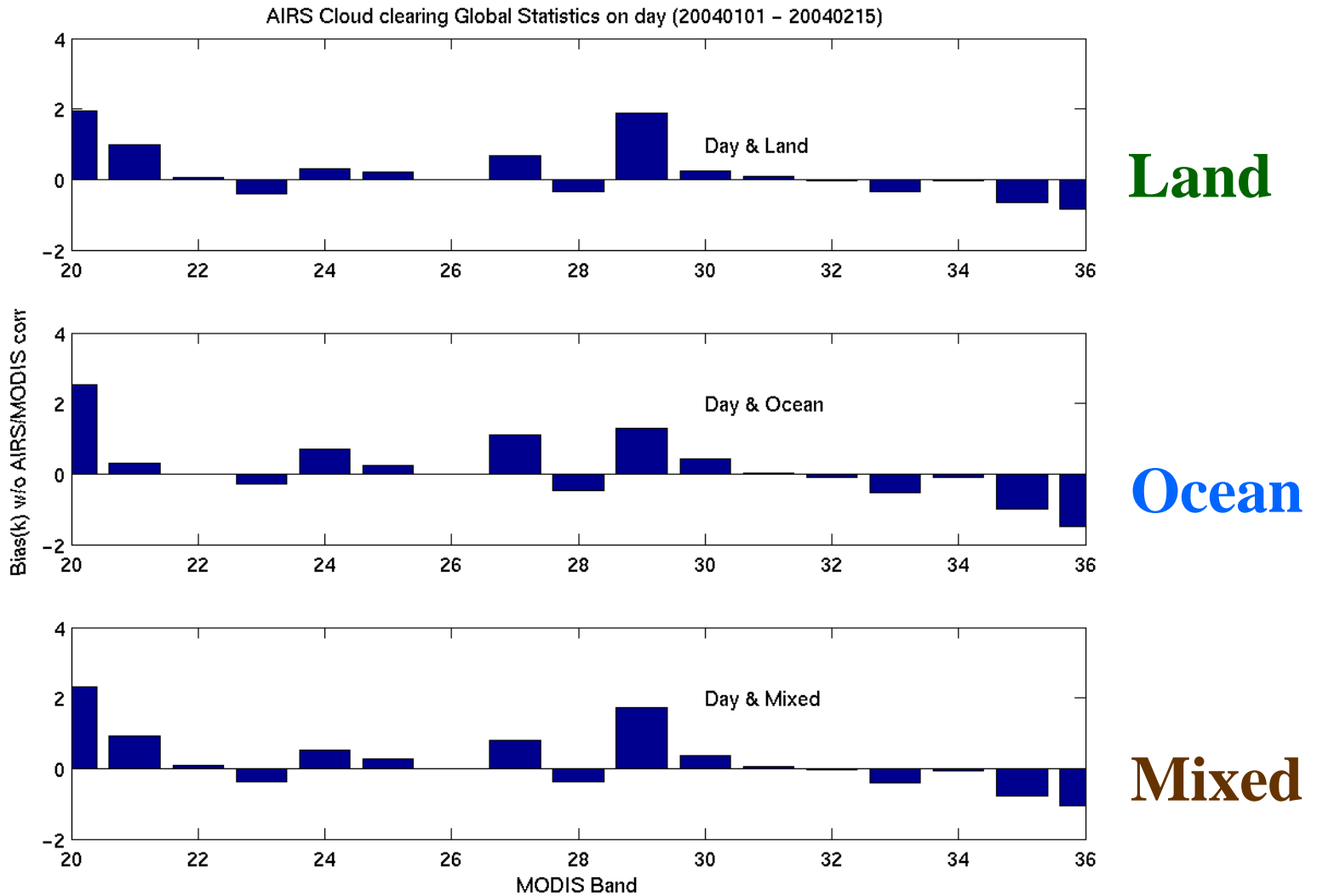
Land

Ocean

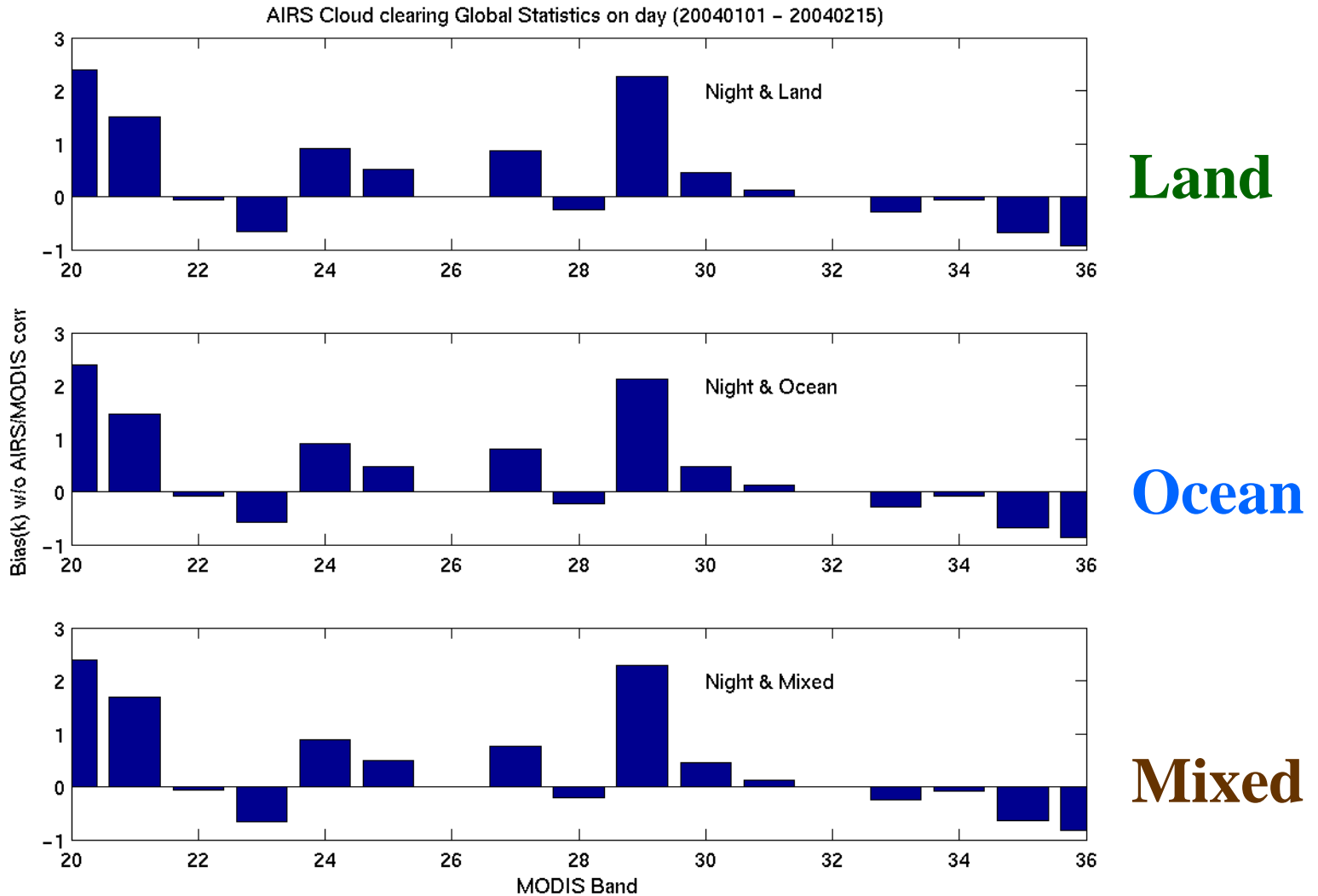
Mixed

AIRS/MODIS C.C. BIAS

Global AIRS FOV Processing Statistics (1-1-2004 to 2-15-2004) – Day Time



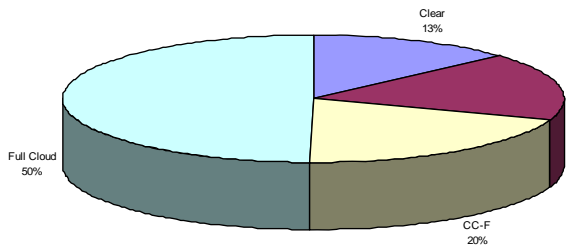
Global AIRS FOV Processing Statistics (1-1-2004 to 2-15-2004) – Night Time



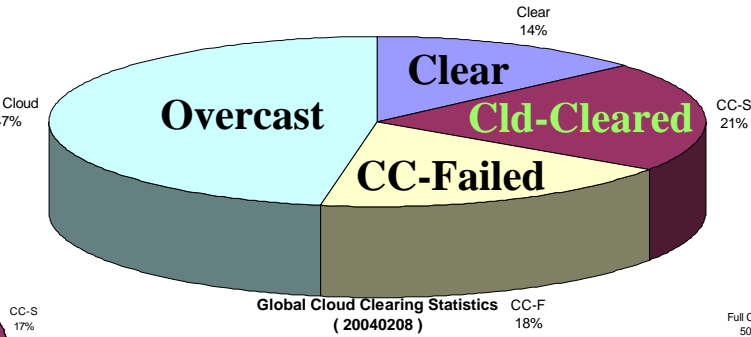
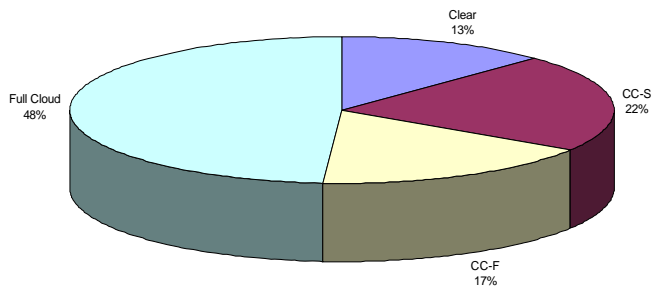
Global Cloud Clearing Statistics
(20040215)

Global AIRS FOV Processing Statistics (1-1-2004 to 2-15-2004) – Selected Day

Global Cloud Clearing Statistics
(20040101)

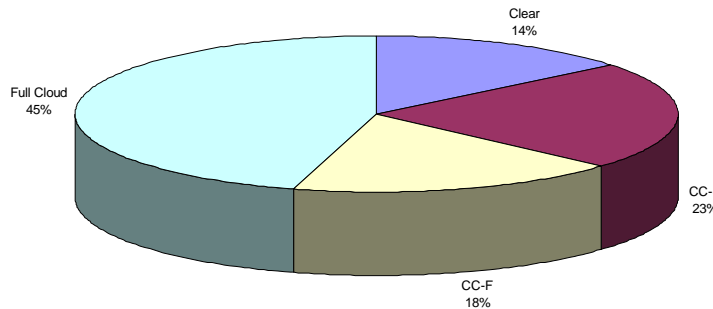
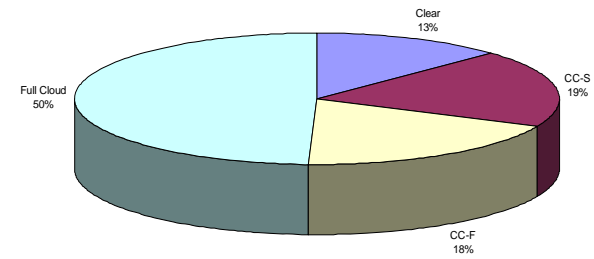


Global Cloud Clearing Statistics
(20040118)



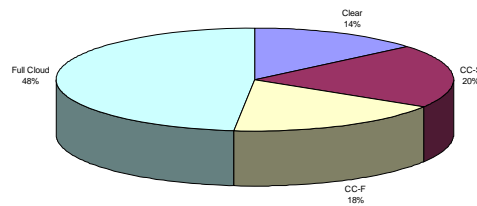
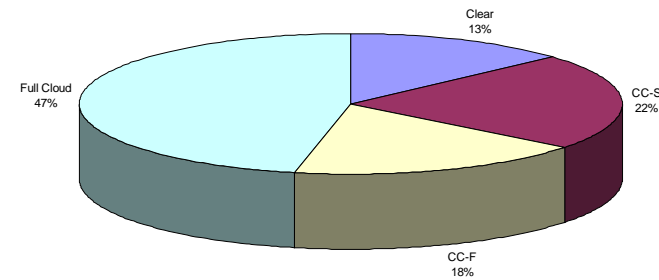
Global Cloud Clearing Statistics
(20040208)

Global Cloud Clearing Statistics
(20040106)

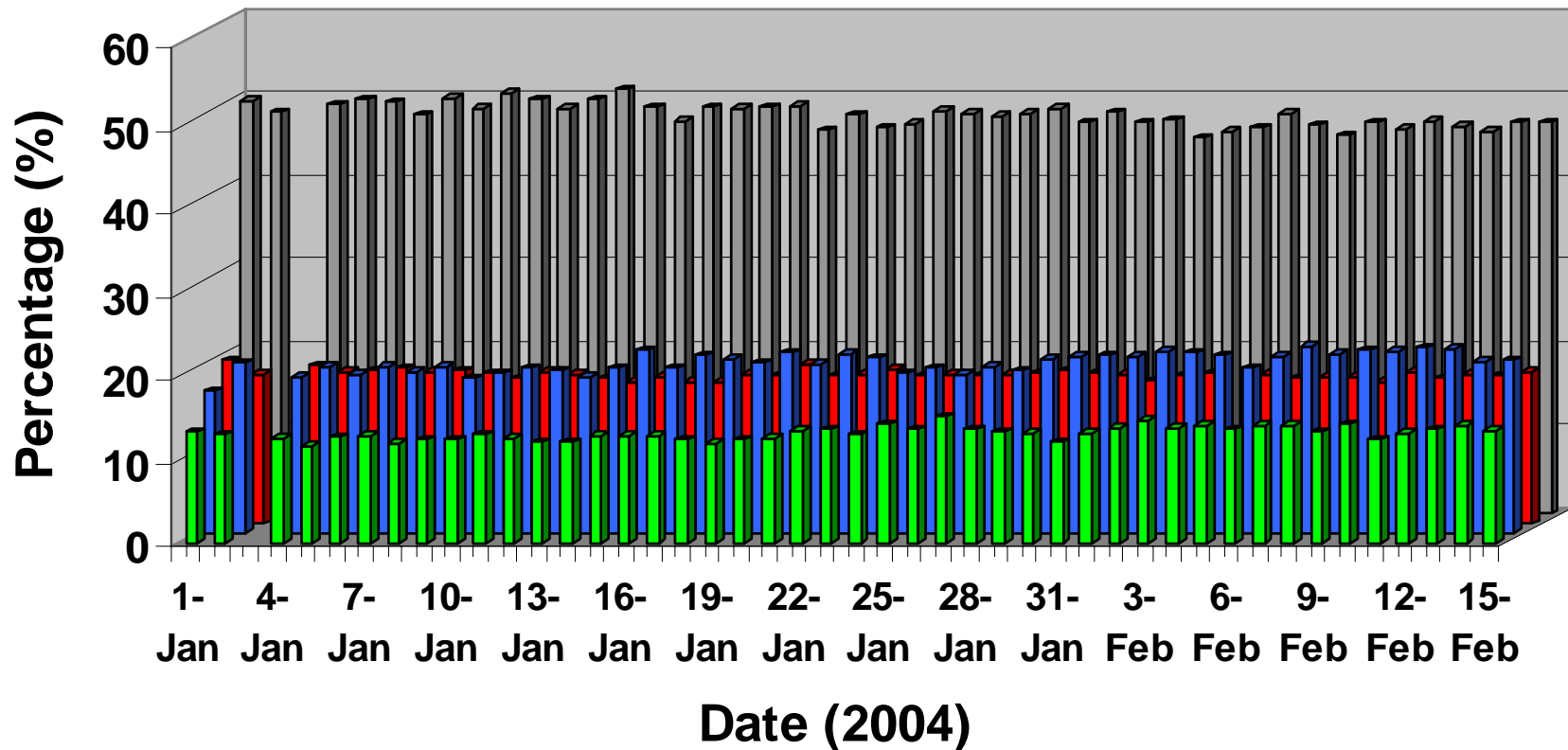


Global Cloud Clearing Statistics
(20040126)

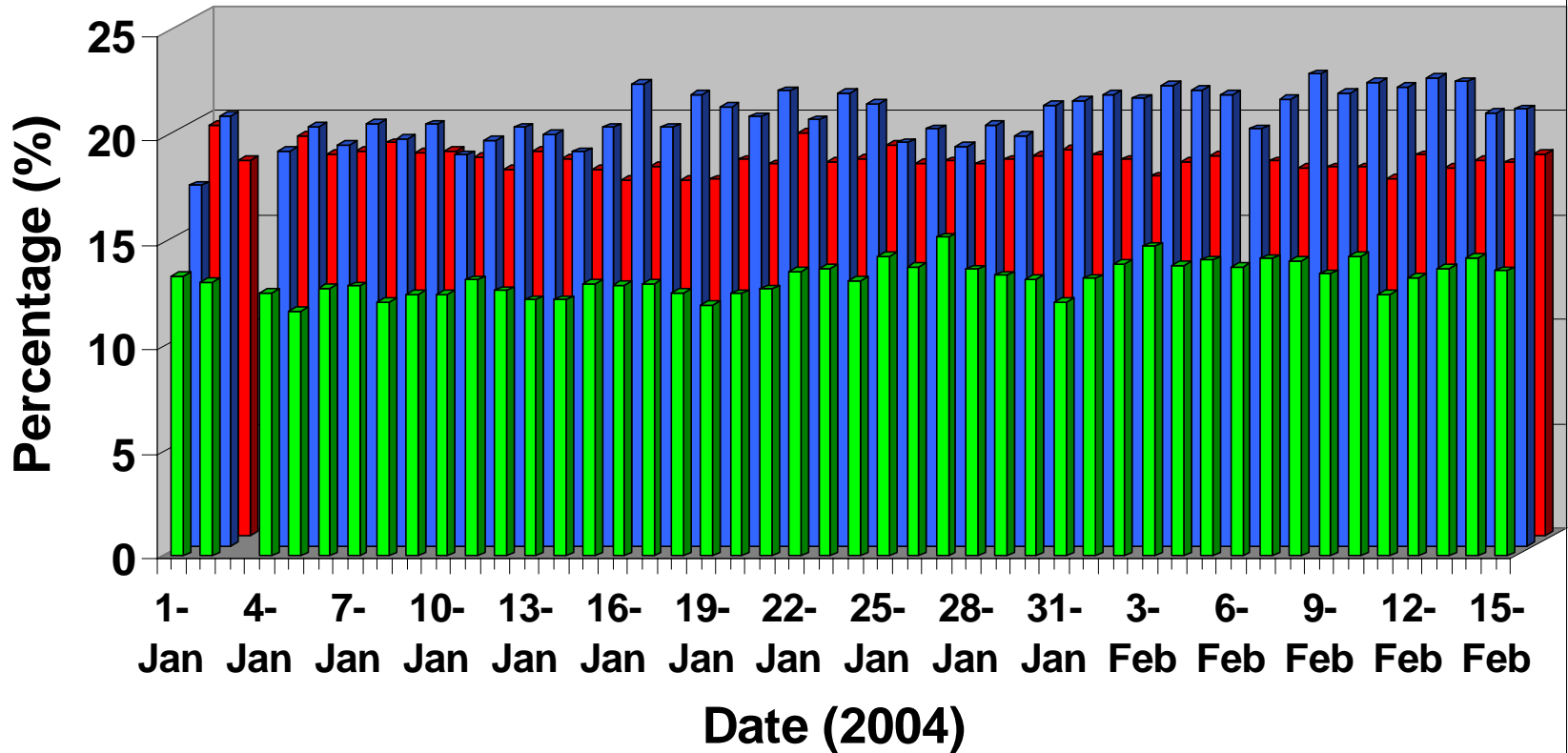
Global Cloud Clearing Statistics
(20040212)



Global AIRS FOV Processing Statistics (1-1-2004 to 2-15-2004)

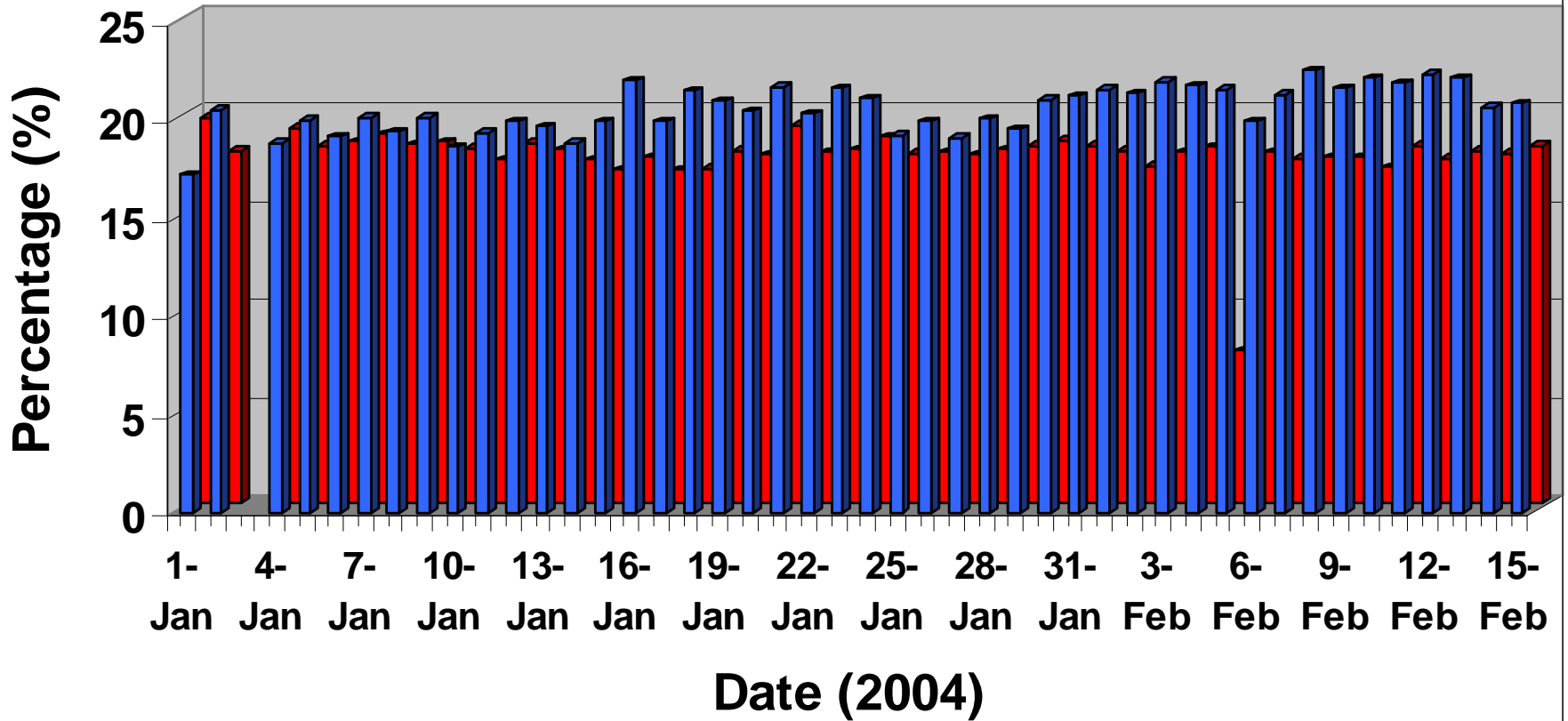


Global AIRS FOV Processing Statistics (1-1-2004 to 2-15-2004)



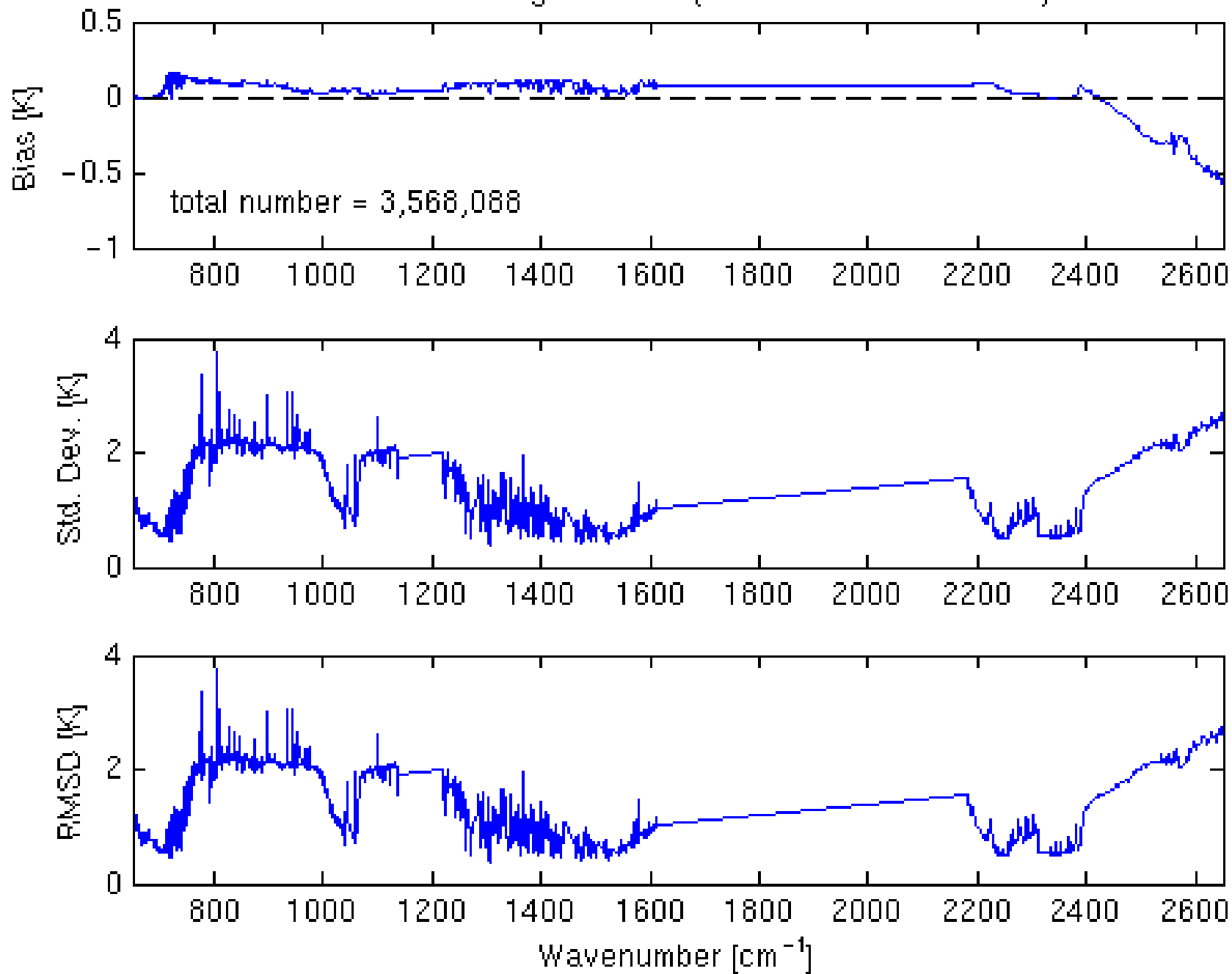
■ Clear (13.26%)
 ■ Cloud-Cleared (20.60%)
 ■ CC Failed (17.78%)

Global AIRS FOV Processing Statistics (1-1-2004 to 2-15-2004)

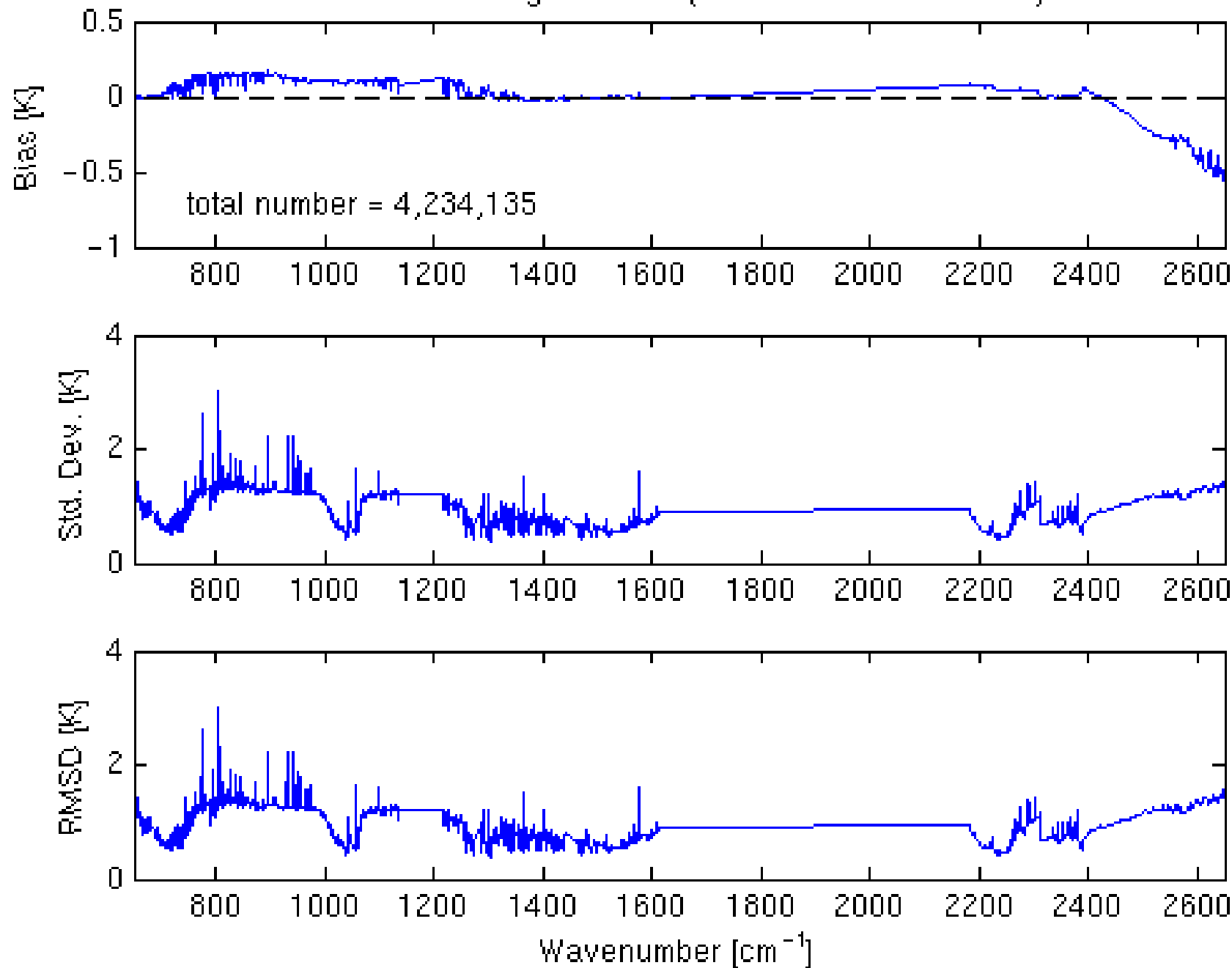


■ Cloud-Cleared (20.60%) ■ CC Failed (17.78%)

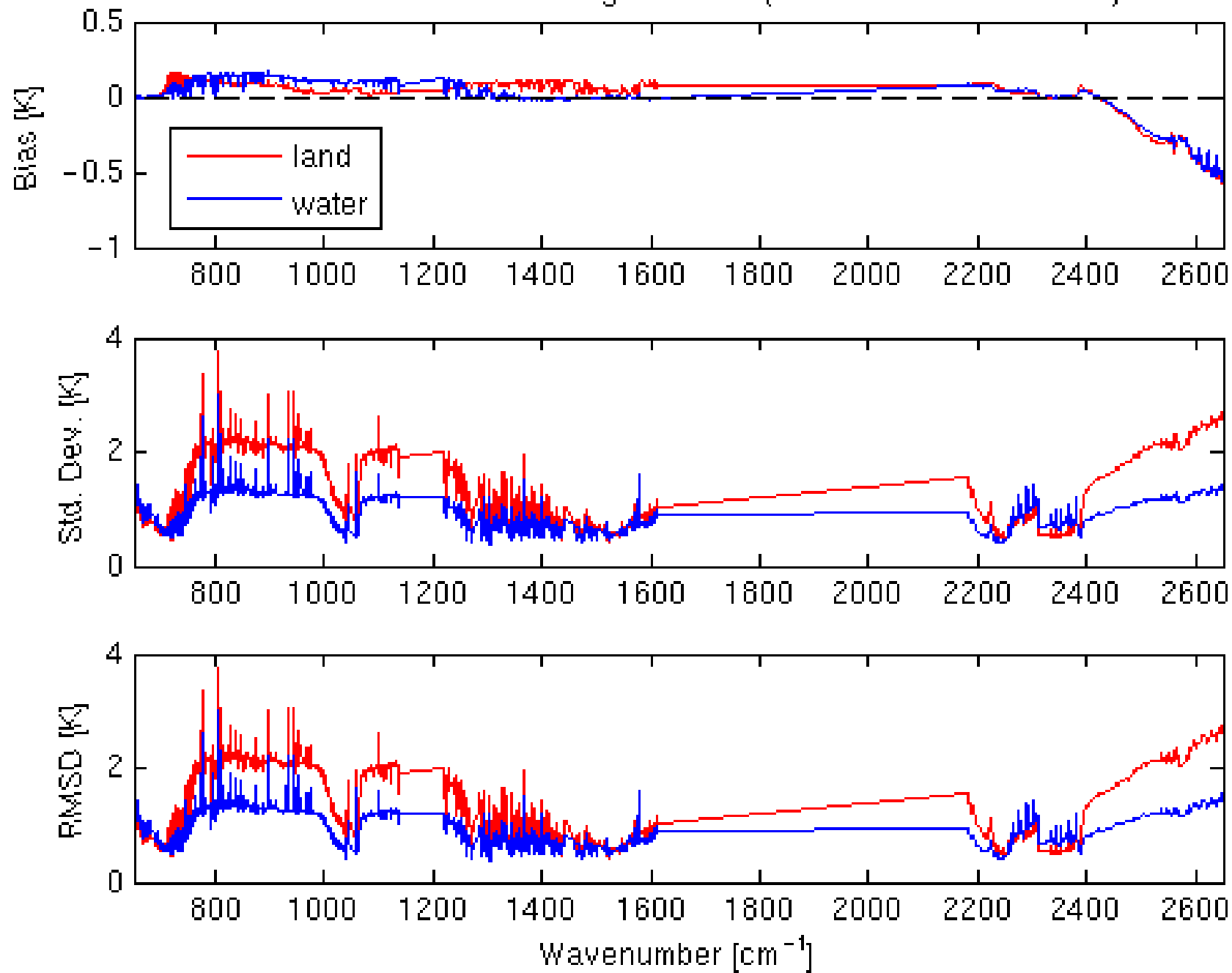
Global AIRS Cloud Clearing Statistics (20040101 -- 20040215) over land



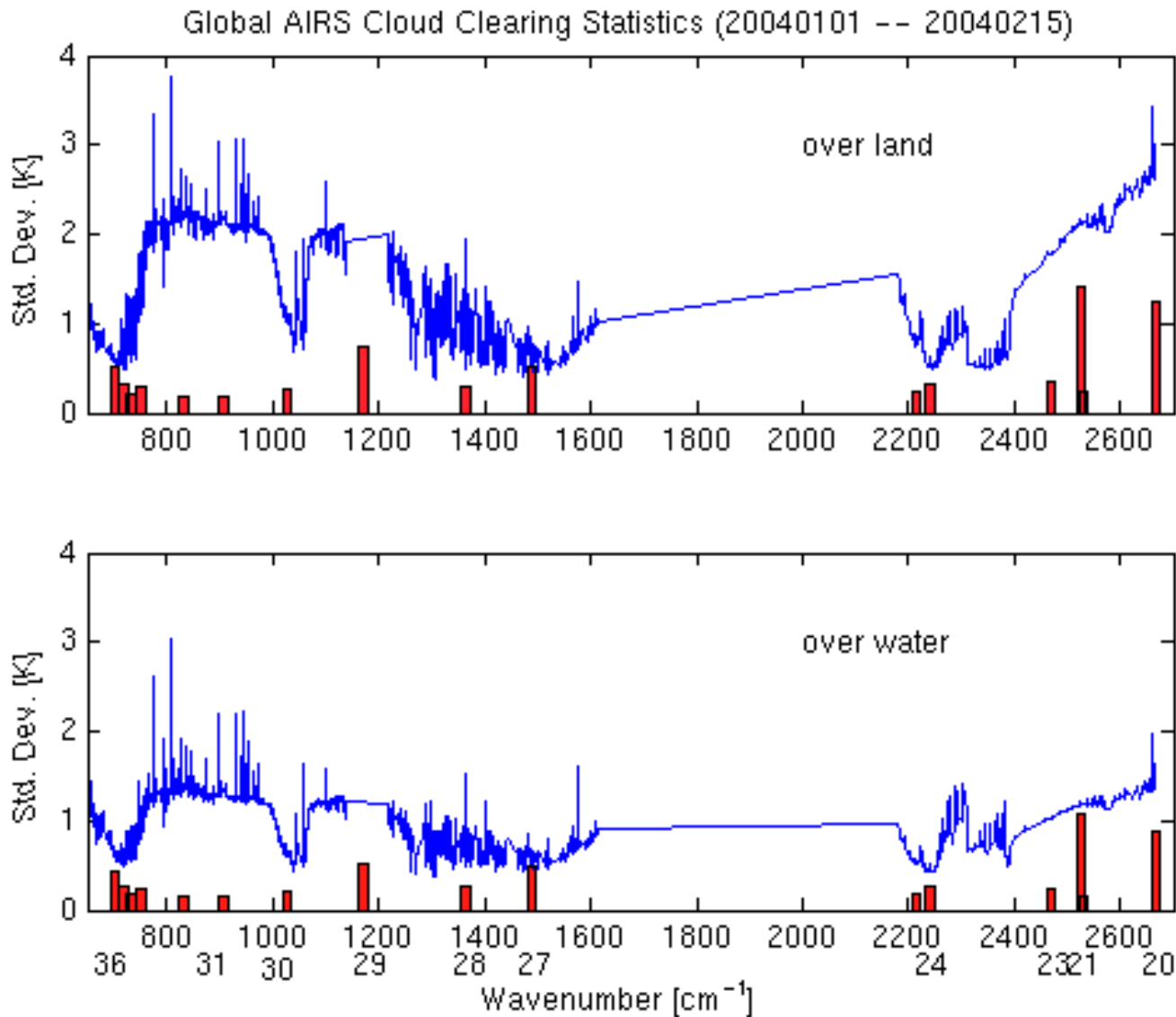
Global AIRS Cloud Clearing Statistics (20040101 -- 20040215) over water



Global AIRS Cloud Clearing Statistics (20040101 -- 20040215)



Global AIRS FOV Processing Statistics (1-1-2004 to 2-15-2004)



Global Analysis and Characterization of AIRS/MODIS Cloud-Clearing

Summary

45 days of collocated AIRS/MODIS global data are analyzed:

- To characterize the synergistic AIRS/MODIS cloud-clearing performance in terms of bias and RMS error using collocated MODIS clear and near by AIRS clear data
- The performance is consistent in terms of daily statistics of successful (~21%) and unsuccessful (~18%) cloud-clearing percentage
- The performance is consistent over land or water surface when FOV to FOV scene variation is taking into account.
- The performance is also consistent at day and night time when MODIS cloud mask characteristic is taking into account
- Quantitative cloud clearing errors (bias & RMS) are derived for assimilation and retrieval applications.

Global Analysis and Characterization of AIRS/MOIDS Cloud-Clearing

Future Work

- Deliver cloud-cleared datasets (including the associated bias & RMSE) to JCSDA and GMAO for potential assimilation of AIRS cloud-clearing radiances.
- Perform cloud-cleared radiance sounding retrievals.
- Continue to refine cloud-clearing error processing procedure to include the calculate clear radiances as the “reference truth” and to remove FOV to FOV scene in-homogeneity from the errors estimate when using near-by clear as the independent reference truth.
- Reanalyze cloud-clearing characteristic using Ver. 5 MODIS cloud mask and new AIRS/MOIDS collocation routine.
- Using Ver. 5 MOIDS cloud phase and height info to improve cloud-clearing Q.C..

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