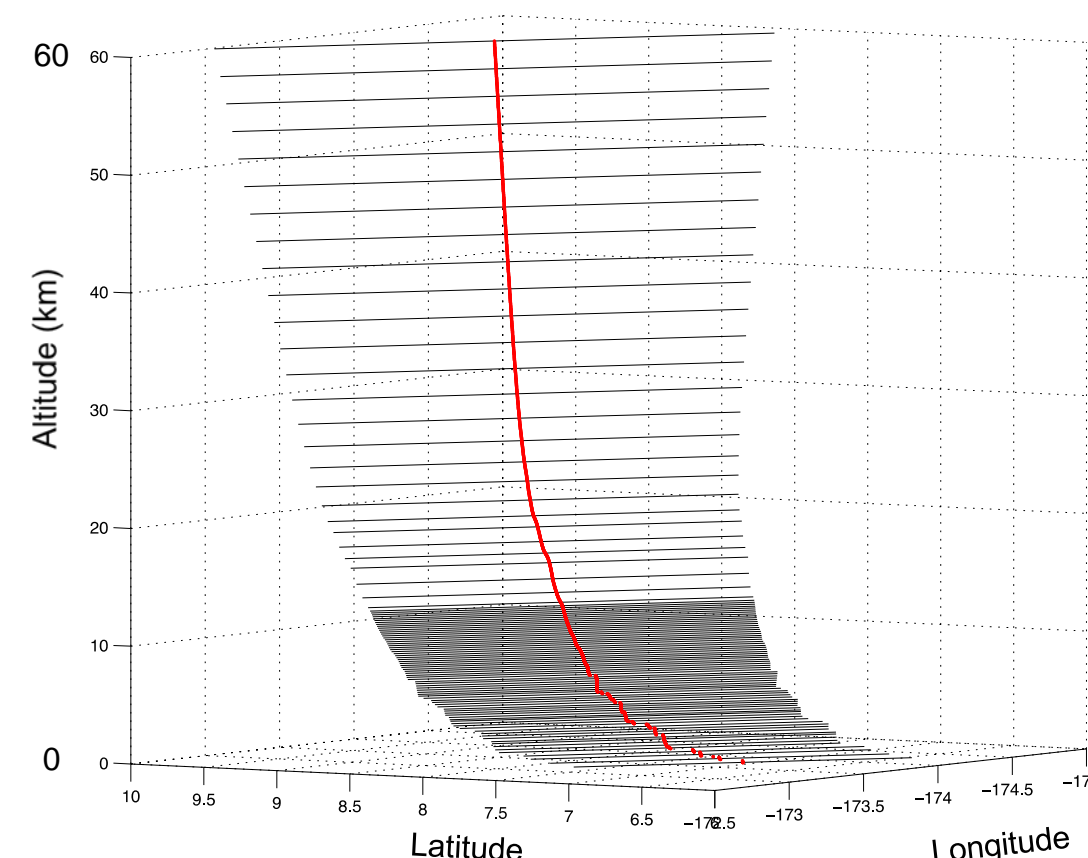
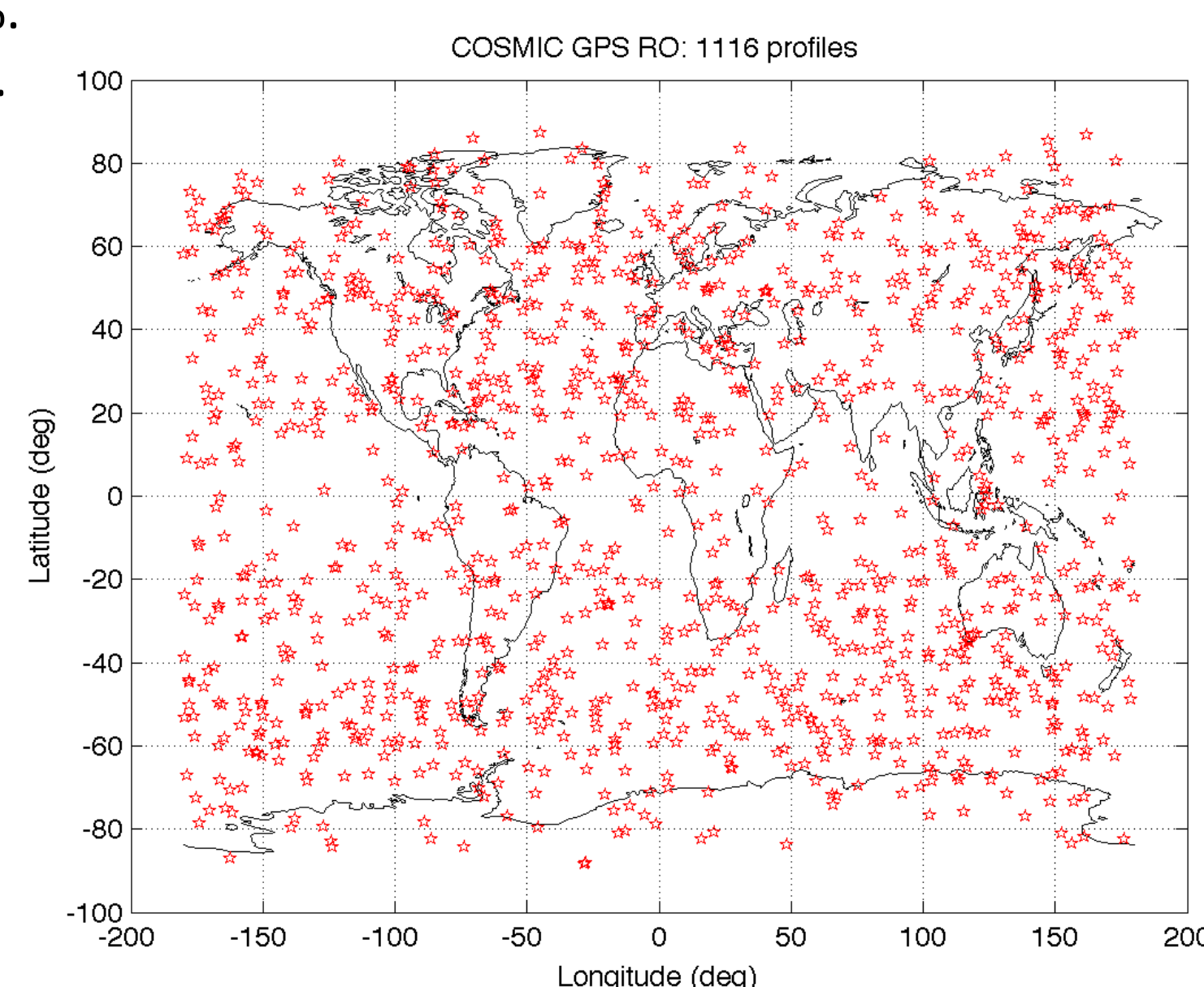
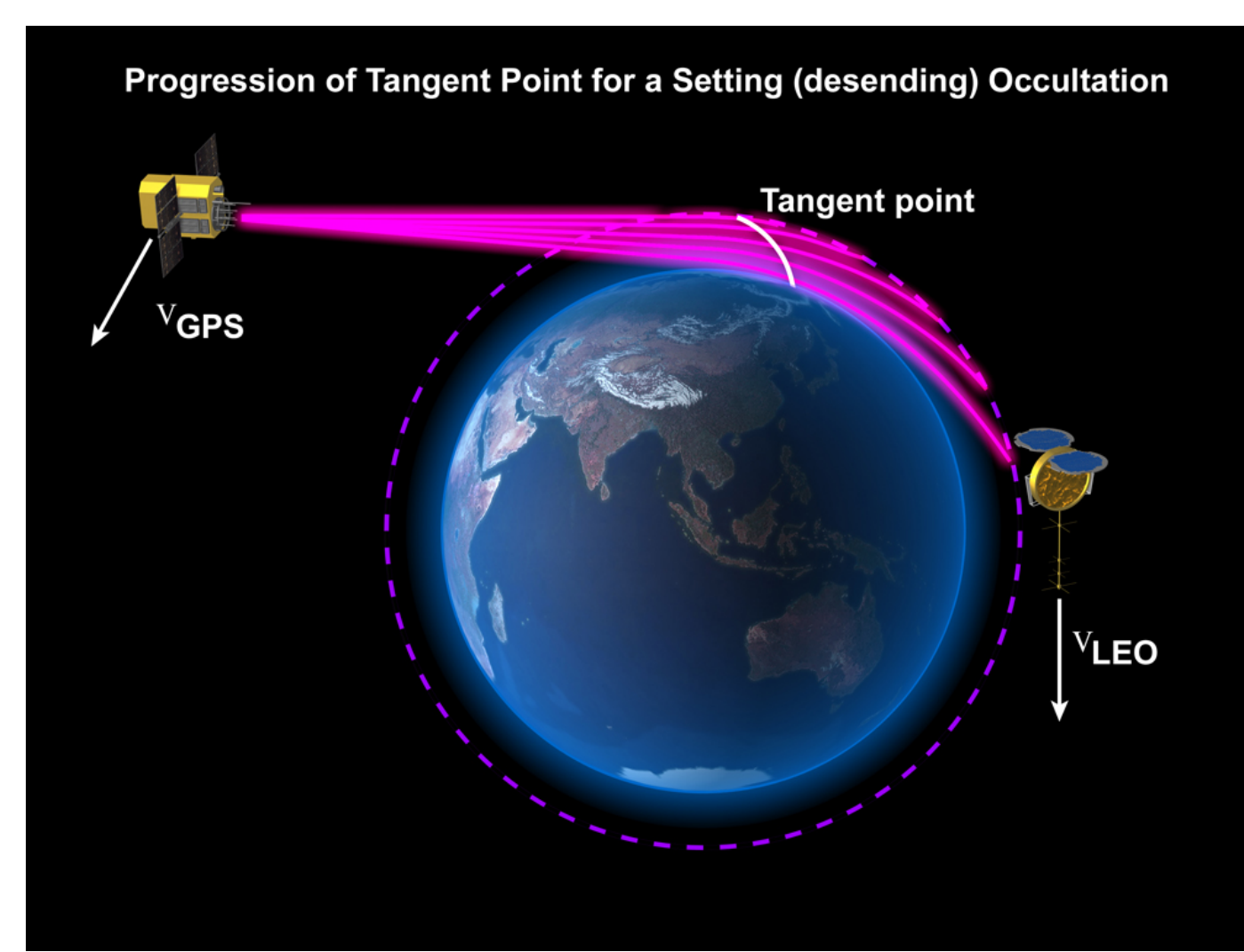


Abstract

This paper presents a validation of the temperature profile retrievals from the advanced infrared and microwave sounders through inter-comparison with GPS RO profiles matched in time and space. We will discuss the unique issues related to matchups in time and space between GPS RO and polar orbiting satellites. In particular we show the impact of including the horizontal averaging inherent in the radio occultation measurements on the statistical validation. In particular, an analysis of the NASA AIRS Level 2 products (v5) will be presented compared to measurements made by the COSMIC program. Systematic bias and RMS vertical profiles have been created for 1 km vertical layers in several latitude zones (Arctic, NH Mid-Lat, Tropical, SH Mid-Lat, and Antarctic). Application of this method to JPSS CrIMSS data is in progress.

Satellite Data

The COSMIC Data Analysis and Archival Center-CDAAC was used to obtain COSMIC data. <http://cosmic.io.cosmic.ucar.edu/cdaac/products.html> The product used was COSMIC version 2010.2640. A typical COSMIC profile is obtained in about 100 seconds with over 3,000 vertical samples. The netcdf files contain time in units of GPS seconds, which are 15 seconds ahead of UTC. The netcdf files also contain azimuth angle of the occultation plane at tangent point with respect North direction, positive to the East from the North direction. The angle is measured between North and the GPS direction of the ray path. A quality control flag is included in the GPS RO netcdf files. For an example day, 19 October 2007, the percentage of GPS profiles marked bad was 2.5%. These bad profiles are excluded from the analysis.



COSMIC RO profile showing horizontal ray path extent of 150-300 km

AIRS looks toward the ground through a cross-track rotary scan mirror which provides +/- 49.5 degrees (from nadir) ground coverage along with views to cold space and to on-board spectral and radiometric calibration sources every scan cycle. The scan cycle repeats every 8/3 seconds. Ninety ground footprints are observed each scan. One spectrum with all 2378 spectral samples is obtained for each footprint. A ground footprint every 22.4 ms. The AIRS IR spatial resolution is 13.5 km at nadir from the 705.3 km orbit. The AIRS Level 2 sounding products contain atmospheric temperature and moisture profiles from about 1 mb down to the surface with a horizontal resolution of about 45 km.

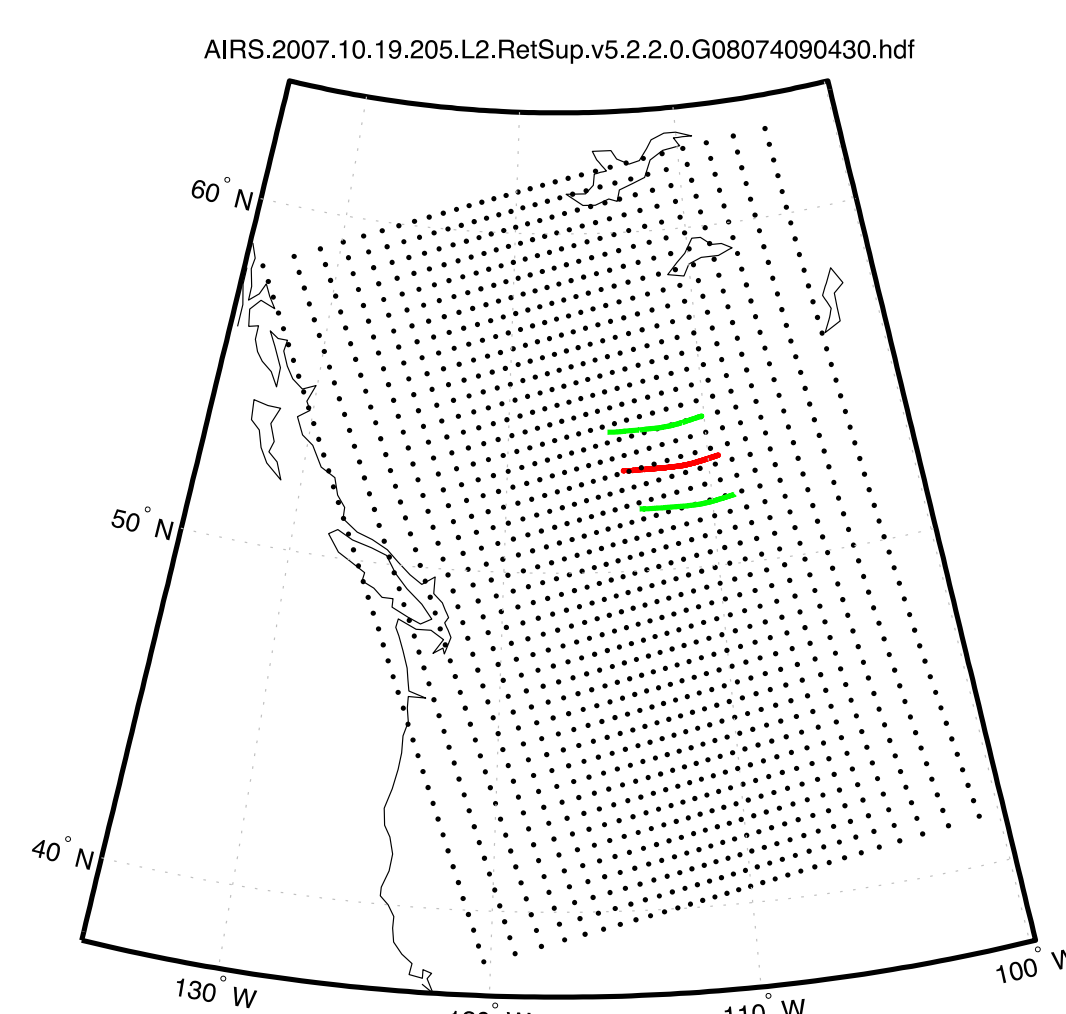


Figure. COSMIC RO profile (red line) with horizontal resolution (green lines) overlaid on AIRS fields of view (black dots).

As a preliminary approach in our matchup analysis, the AIRS fields of view within a circle of radius 150 km centered at the latitude/longitude of the perigee of the COSMIC RO profile were found. To investigate the effect of the horizontal resolution of the COSMIC RO profiles, the average AIRS profile within 150 km was compared with the closest AIRS profile. Figure 6 shows a comparison of the closest AIRS profile to the area average AIRS profile and to a coincident COSMIC RO profile.

Time Difference Cutoff (Hours)	Matchup Number	Percent Yield (%)
0.5	147	4.5
1.0	271	6.6
1.5	316	9.7
2.0	437	13
2.5	530	16
3.0	644	20

Table 1. COSMIC/AIRS Matchup Yield

Conclusions

We developed the matchup tools for the comparison of COSMIC RO and AIRS IR temperature profiles. We found that one hour time difference between GPS RO and the IR profile measurement provides adequate yield with sufficient accuracy to characterize bias and RMS errors for 20 degree latitude zones. When GPS RO horizontal averaging was applied to the AIRS Level 2 granule matchups, improved agreement was obtained compared to using the closest AIRS IR profile. Daily zonal statistics were found to provide a useful measure of AIRS retrieval performance. We anticipate that monthly time series for latitude zones can be used to monitor CrIMSS retrieval performance.

This study shows RMS error is between 1.5 K and about 2 K for the 300 mb to 30 mb altitude range for all latitude zones. Above this range, the COSMIC RO profiles appear to have higher vertical resolution than the AIRS IR profiles. Below this range, the COSMIC RO profiles become strongly contaminated by water vapor in the occultation ray path. The height of this effect is latitude dependent. These results are in qualitative agreement with results of Yunck et al. 2009.

Future work includes the application of the AIRS temperature averaging kernel to the COSMIC minus AIRS profile differences to remove vertical structure higher than the theoretical AIRS resolution. Application of this method to CrIMSS EDR products is in progress and will be reported in a future paper.

COSMIC AIRS Matchup Methodology

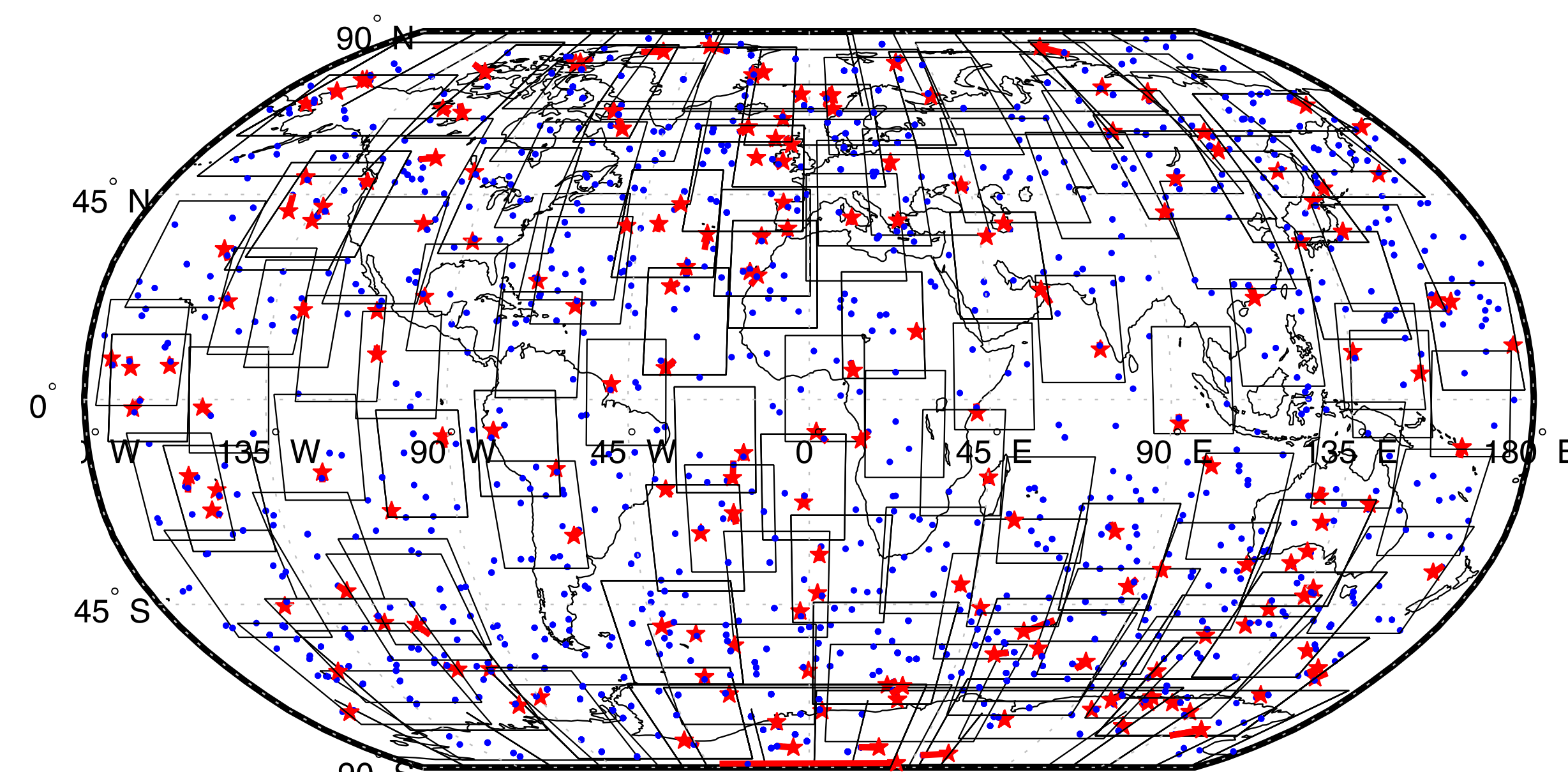


Figure. Locations of COSMIC RO profiles (blue dots) and AIRS granule bounding boxes (black squares) with COSMIC RO matchups within one hour (red stars) for 19 October 2007.

Following Yunck et al. 2009, we computed the bias and RMS statistics for Arctic, Northern Mid-Latitude, Tropical, Southern Mid-Latitude, and Antarctic zones. Figures 1 and 2 show the results for these latitude zones on the CrIMSS Focus Day 19 October 2007 along with global statistics. Figure 1 illustrates the bias and RMS profiles on the AIRS 100 pressure levels while Figure 2 contain the same matchup cases degraded to 1 km vertical resolution. Shown on each figure are both the statistics of the closest profile to AIRS (solid line) and the spatially weighted average AIRS profile (dashed line).

Focus Day Bias and RMS

19 October 2007

AIRS 100 Levels 1 - km Layers

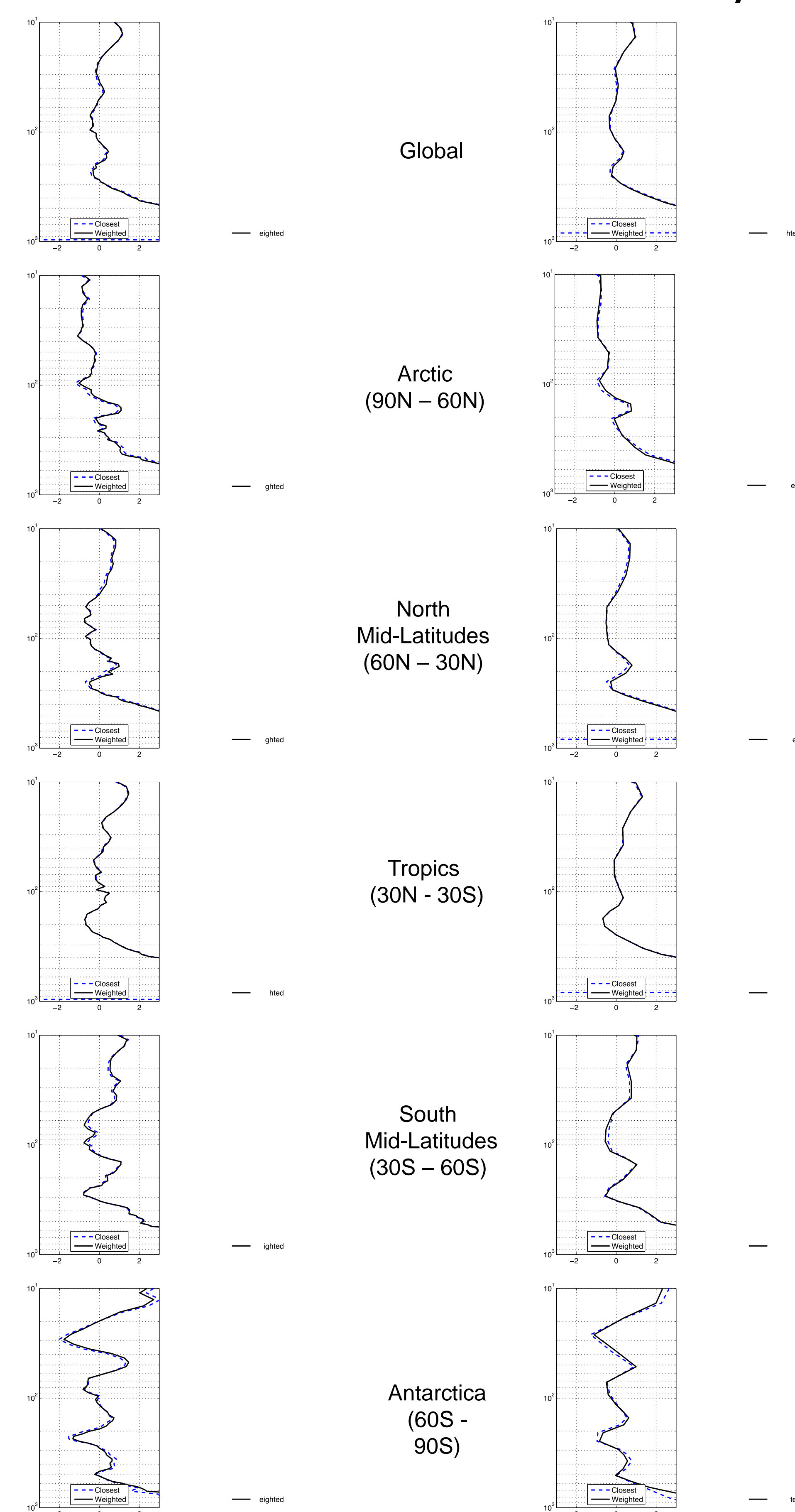


Figure 1. AIRS 100 pressure levels

Figure 2. 1 km layers

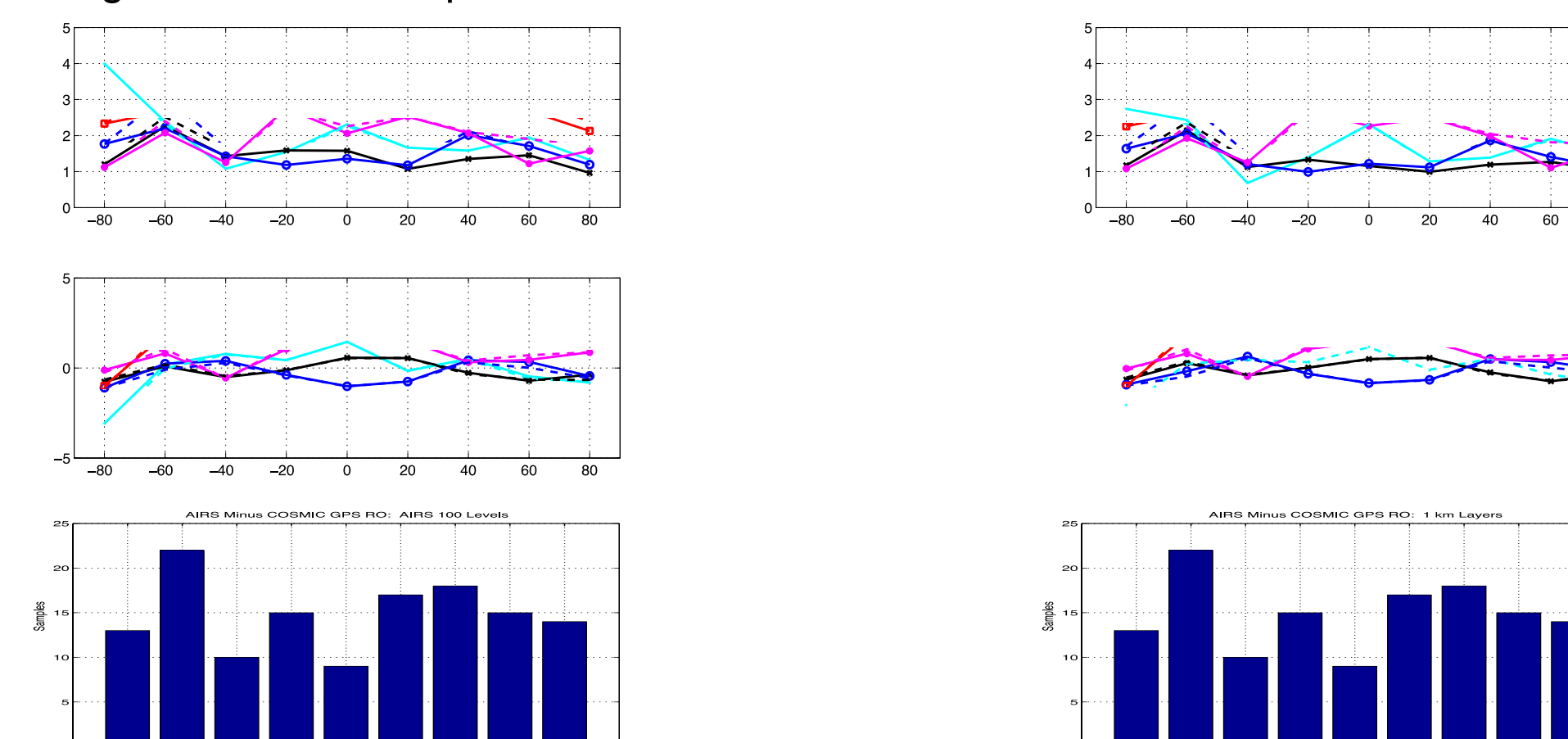


Figure. AIRS minus COSMIC RMS statistics versus latitude for 20 degree latitude zones.

Acknowledgments

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