Validation of Temperature Profile Environmental Data Records (EDRs) from the Cross-Track Infrared Sounding Suite (CrIMSS) Using COSMIC Dry Temperature Profiles

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Abstract

In this temperature profile matchup methodology, spatially and temporally coincident GPS RO profiles and IR granules were found. For each case, three matchup techniques were used for comparison and analyzed with the same statistical techniques. The closest profile, the circular averaged profile of a radius half the GPS RO horizontal resolution, and the ray-path averaged profile of AIRS data were compared. In order to investigate the effect of the horizontal resolution of the GPS RO, these three different approaches to creating an IR matchup were evaluated. The azimuth angle of the radio occultation for each COSMIC RO profile altitude was used to compute the horizontal extent of the nominal GPS RO horizontal resolution at each reported altitude level (Kursinski et al. 1997). Figure 1 below shows the spatial extent of a 135 km radius averaging circle on selected AIRS retrieval levels. Figure 2 to the right illustrates the closest, circular, and raypath methods as a 3D profile.

Methodology

Onboard the NASA Aqua satellite, AIRS looks toward the ground through a cross-track rotary scan mirror which provides 14-45.5 degrees (from nadir) ground coverage along with views to cold space and on-board spectral and radiometric calibration sources every scan cycle. For each of the ninety ground footprints observed each scan, one spectrum with all 238 spectral samples is obtained. The AIRS IR spatial resolution is 13.5 km at nadir from the 705.3 km orbit. The AIRS Level 2 products contain atmospheric temperature and moisture profiles from about 1 m down to the surface with a horizontal resolution of about 45 km and provide nearly complete daily global coverage in ascending and descending modes. The version 5 support product AIRRSUP was used in this analysis.

Satellite Data

The COSMIC Data Analysis and Archival Center-CDAIC (http://cosmic.arc.nasa.gov/products.html) was used to obtain COSMIC data. The product used for the results shown was the real-time atmospheric ‘dry temperature’. A typical COSMIC profile is obtained in about 100 seconds with over 3,000 vertical samples. 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.

Assessment of CrIMSS Version Change (Mx5.3 → Mx6.3) on October 15th, 2012

Prior to CrIMSS update: Mx5.3

IDPS 42/22

After CrIMSS update: Mx6.3

IDPS 42/22

Both CrIMSS and COSMIC temperature profiles are computed at the AIRS 101 levels using nearest neighbor linear interpolation prior to statistical analysis.

AIRS v5 minus COSMIC after CrIMSS update

Not: The COSMIC GPS RO dry temperature is contaminated by water vapor below about 300mb.

Case Study: November 4th 2012, Madison, WI

The figures below contain an overlay of the GPS RO profile (red), the radiosonde launched from UW-SSEC (green), the circular weighted AIRS profile (black), and the circular weighted CrIMSS profile (blue). The right hand figure illustrates the 300 to 30 mb pressure range for which the COSMIC dry temperature profile is most accurate. Note that both the radiosonde and COSMIC profiles have higher vertical resolution than AIRS or CrIMSS.

Conclusions

- A methodology has been developed for the validation of CrIMSS AVTP in the upper troposphere and lower stratosphere using GPS radio occultation.
- GPS RO dry temperature from the COSMIC network is matched to CrIMSS profiles within one hour.
- The GPS RO horizontal resolution of 300 km is accounted for using a raypath method.
- This methodology has been used to evaluate a CrIMSS software version update that occurred on 15 October 2012.
- The overall quality control percentage of combined (IR+MW) to combined + IR only + MW only before the update was 6% and after the update was over 20%.
- The same methodology has been applied to AIRS v5 retrievals to provide a relative comparison.

Coincident RS92 sondes launches from UW-Madison are being used in detailed case study analyses.

References

Acknowledgments

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