Using Infrared Radiances in the Comparison of COSMIC and GRAS Dry Temperature

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Intro

Comparisons of GPS RO and radiometric sounder retrieval products, being independent from each other, can yield beneficial insight into data characteristics. By spatiotemporally matching GPS RO and sounder profiles from different instruments, various comparisons can be made. Monthly temperature profile comparisons involving NASA AIRSv6, NOAA IASI, CDAAC COSMIC, and CDAAC GRAS for a global and 5 latitude zones have been made.
Previous work from Feltz et al. AMT 2014 suggested a climatological bias in dry temperature between UCAR processed GRAS and COSMIC as a function of latitude zone and altitude. Motivations for this comparison were to determine whether the presented methodology could actually detect the differences between two GPS RO products as well as attempt to quantify the error in using either GPS RO product as a reference for sounder evaluation.
Since then, a UCAR version update (cosmic2013 and metopa2011) included a change in the use of background climatology intended to reduce this relative bias. This work evaluates the reprocessed data to assess the relative agreement between GRAS and COSMIC. The infrared radiance observations are believed to have an absolute accuracy of better than 0.5 K brightness temperatures. This relatively high accuracy is used to make an assessment COSMIC profile uncertainty for selected spectral channels that peak at several heights spanning the stratosphere. The stability of the IR radiances over time makes hyperspectral IR observations from AIRS, IASI, and CrIS a useful reference for comparisons of RO temperatures.

Conclusions

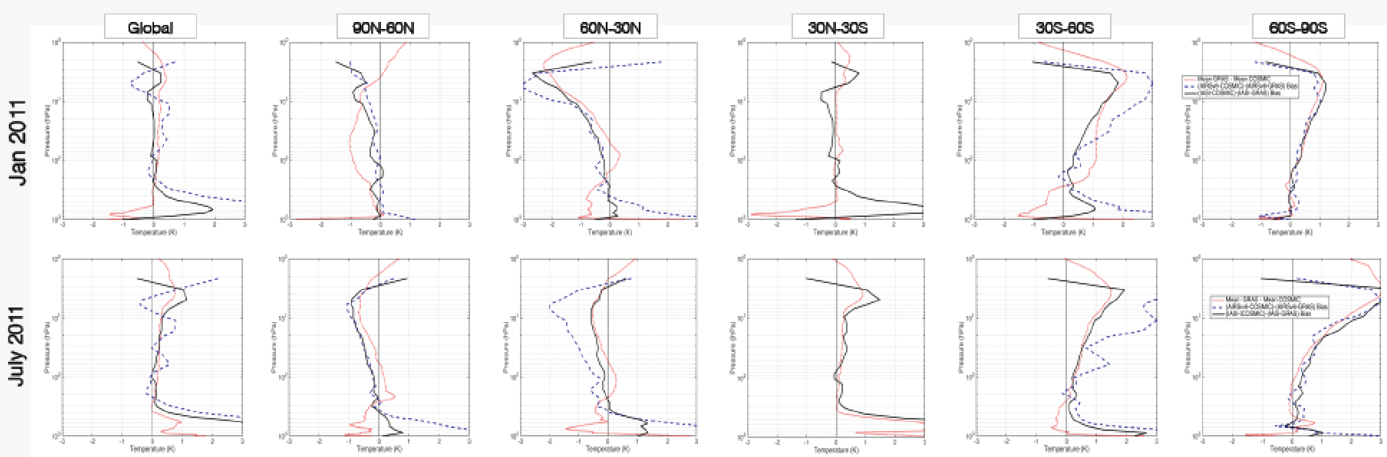
- A methodology for comparison of data from two independent, climate quality sources, GPS RO and infrared sounders, is presented. Though results here do not represent the characteristics of any entire dataset, they show useful information obtained from such comparisons.
- A hemispheric bias that was seen between previous versions of UCAR COSMIC and GRAS products (Feltz et al., AMT, 2014) appears to still be present in the same magnitude. Further investigation of possible systematic biases is justified by these results.
- The UCAR reprocessing of COSMIC brings the dry temperature into better agreement with AIRS L1B radiances in the 10 hPa to 50 hPa range
- For some zones and months analyzed, COSMIC dry temperature in the 5 to 0.5 hPa pressure range are warm relative to AIRS L1B by more than 3 degrees which is outside the uncertainty of the AIRS radiances
- Further quantification of the seasonal and latitude dependence of these biases is in progress

Results

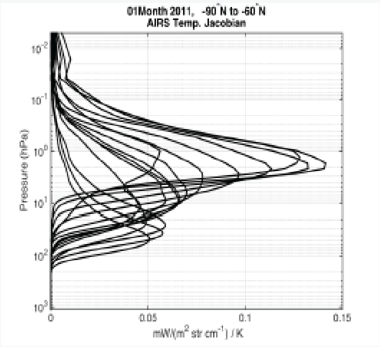
****Hemispheric bias appears to still be present in the same magnitude**

Below: Monthly, zonal **GRAS** (metopa2011) **minus COSMIC** (cosmic2013) **temperature bias**
- mean GRAS minus mean COSMIC using all profiles (red)
- using NOAA IASI (solid black) and AIRSv6 (dashed blue) as a common reference by way of a double difference

Notes on analysis:
- GRAS/AIRS matchups are fewer than GRAS/IASI (w/ no matchups in tropics)
- For quality control of the RO data, all profiles marked 'bad' were excluded
- For forward calculations, COSMIC temperature was merged with Air Force Geophysics Laboratory standard atm. For this reason computed COSMIC radiances for channels whose weighting function have significant weight above where COSMIC dry temperature is available should be noted. (COSMIC dry temp. usually available up to 0.5 hPa)



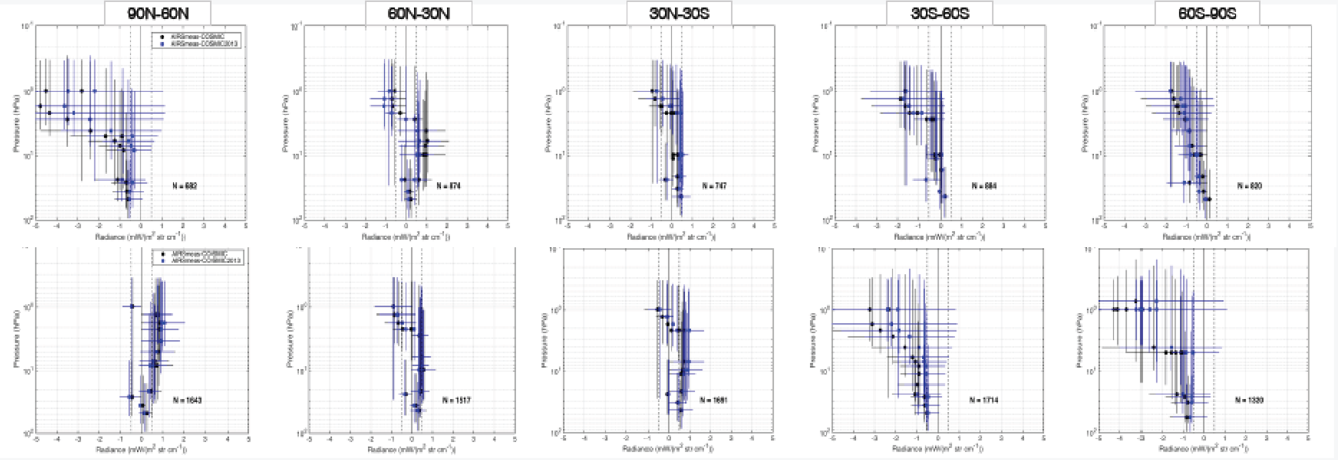
Below: COSMIC calculated AIRS temperature Jacobian for Jan 2011 Antarctic zone. Note the vertical scales of this figure and the right panels are different.



Reprocessing brings COSMIC dry temperature into better agreement with AIRS L1B radiances

Below: Monthly, zonal **AIRS measured minus COSMIC calculated radiance bias**

- cosmic (previous version) in black dots and cosmic 2013 (update) in blue squares
- AIRS measured radiance uncertainty (black dashed lines at 0.5K)
- horizontal error bars represent uncertainty in the bias
- vertical error bars represent full width at half max of the computed AIRS temperature Jacobian



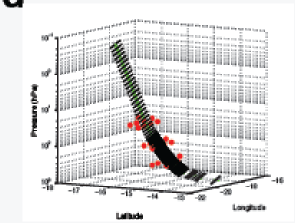
Method

Temperature Matchup

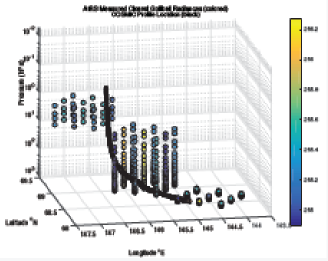
- Profile to profile matchup method minimizes spatiotemporal mismatch errors with 1 hr. time criterion
- Ray-path sounder profile technique used to account for unique geometry and theoretical spatial resolution of GPS RO profiles
- Matchup method further described and sensitivity discussed in Feltz et al. (2014)
- GPS RO profiles interpolated to AIRS 101 pressure levels
- Vertical resolution differences between RO and sounder addressed by degrading sounder minus GPS RO differences to ~1km slab layers as is done in current practice (RO has greater vertical resolution than sounders)
- Monthly zonally averaged bias statistics calculated

Measured Radiance Matchup

- Corresponding AIRS measured radiance golf balls (L1B 3x3 corresponding to one L2 field of view for which temperature is retrieved) matched to GPS profile shape



Left: COSMIC profile location (green with black lines showing computed ray-paths every 50 levels) overlaid with ray path sounder temperature profile method (red dots) on 3 pressure levels.



Left: COSMIC profile location (black) overlaid with matched AIRS measured brightness temperature profile (dots colored by Kelvin)

Data

GPS RO

- UCAR post-processed dry temperature products from COSMIC Data Analysis and Archive Center at http://cdaac-www.cosmic.ucar.edu/cdaac/products.html
  - cosmic v2010.2640 and cosmic2013
  - metopa v2011.2980 and metopa2011

IR/MW Sounder

- AIRS Level 2 Support Product, AIRX2SUP.006, from the GESDISC: http://disc.sci.gsfc.nasa.gov/AIRSdataholdings/by-access-method
- NOAA IASI Granule Data (L2) from the NOAA CLASS site: http://www.nsof.class.noaa.gov/saa/products/search?datatype_family=IASI

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