Radiometric Differences Between AIRS, CrIS and IASI Derived for the CHIRP

AIRS Science Team Meeting

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Overview

Overview of talk

- Definition of the CHIRP
- Establish the framework for determining radiometric records from the different sensors.
- Attribute quality and uncertainty for each channel.
- Utilization of large data sets of overlapping observations to quantify radiometric offsets between the sensors.
- Examples of results for single footprint observations.
- Issues concerning spatial & temporal sampling and gridded are not covered here.

CHIRP

The Climate Hyperspectral Infra-red Radiance Product

- Spectrally equivalent to CrIS in medium resolution - which for the CrIS sub-bands relates to 0.8/0.6/0.4cm OPD (LW/MW/SW resp.)
- The total number of channels available to use depends on the overlap of the parent sensor, for example AIRS L1C with 2645 channels to the CrIS MSR with 1683 with two guard channels per band edge.
- Covers the time period from AIRS L1C data availability (Sep 2002) to the present, with a transition from AIRS to CrIS proposed on Sep 2016.
- Operational overlap between sensors is now considerable: AIRS:CrIS Since 2012, AIRS:IASI from 2007 etc.
- The AIRS L1C currently includes cleaned and filled channels, the CHIRP will use drift corrected AIRS spectral radiance.

The CHIRP cont.

- CHIRP channels will carry the AIRS L1C noise, quality flag and L1C processing information (up to the transition date).
- CHIRP will have the same stability characteristucs as the parent sensor (AIRS before and CrIS after the transition date).
- Each CHIRP channel has information from close neighbor parent AIRS channels (through the deconvolution/translation algorithm) so quality information will be weighted accordingly.
- The AIRS fill channels are used and the corresponding CHIRP channels retained but will be flagged for the user. (See below for more details).
- After the transition date (Sep 2016) CrIS-NPP L1C data have been available in FSR (0.8/0.8/0.8cm LW/MW/SW OPD) resolution and therefore the translation to the MSR grid is straightforward and carrying quality data to CHIRP simpler.

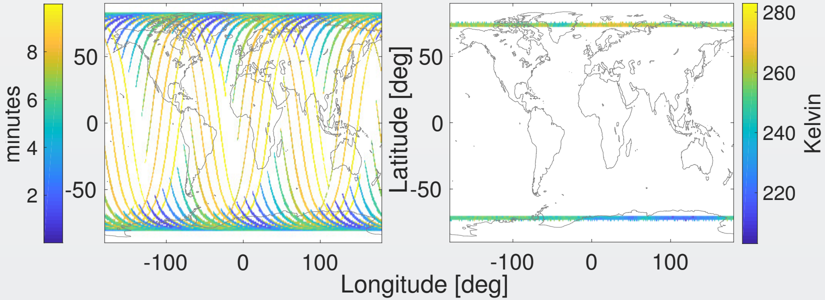
Data Sets

SNO and Global Random Data Sets

- Simultaneous nadir overpass (SNO) sets of observations have been accumulated for each pair of sensors: AIRS&CrIS (NPP and N20), AIRS&IASI (MetOp-A and B), CrIS&IASI (two sets).
- SNOs are best for precise intercomparison but are weighted to high latitudes.
- Global random observations are available for several years. Not restricted to field of view/regard, year long statistics (to capture all scene types) and corrected for mean view angle differences.
- Global random sets are sampled so that equal areas have equal numbers of observations (uniformly weighted with latitude).

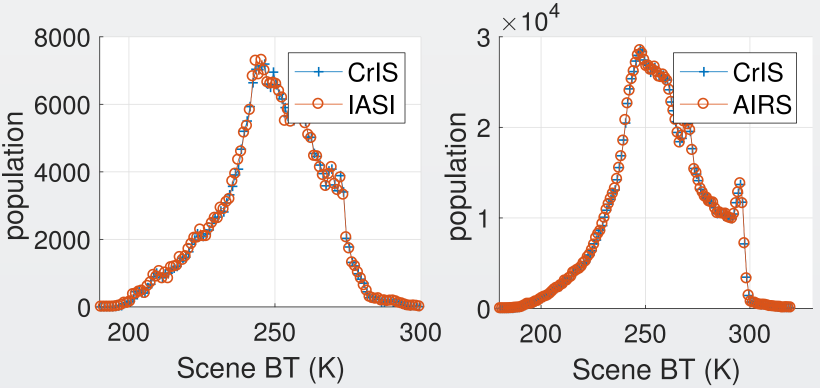
Recap SNOs

- SNOs availability is dependent upon the relationship between the orbits of the two spacecraft. AIRS&Cris SNOs and IASI&CrIS SNOs are distributed as shown here:



Recap SNOs 2

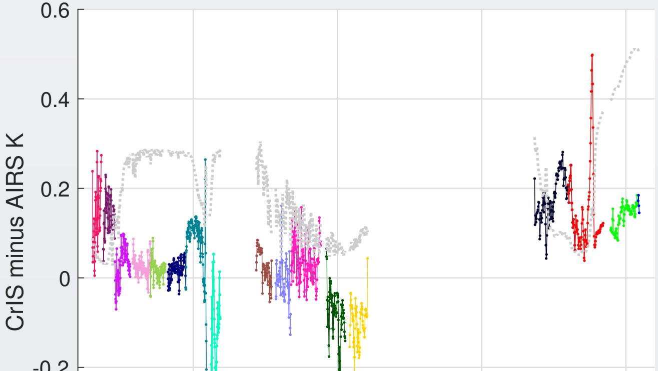
- The different data sets cover slightly different ranges of scenes: more evident in the window channels than optically think channels.



Results

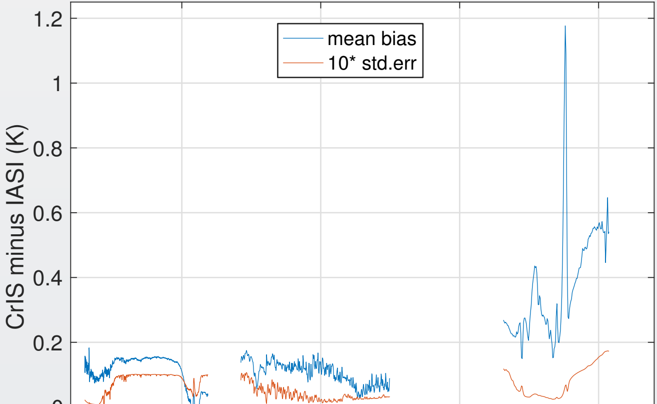
AIRS:CrIS SNOs

- A year of AIRS&CrIS SNOs are compared on the CHIRP grid. About $1.5x10^6$ samples are acquired.
- Results for 2018 are shown in the next figure. AIRS L1C fill channels, dead and band edge channels are ommitted. The standard error of the mean difference is shown in the gray line.



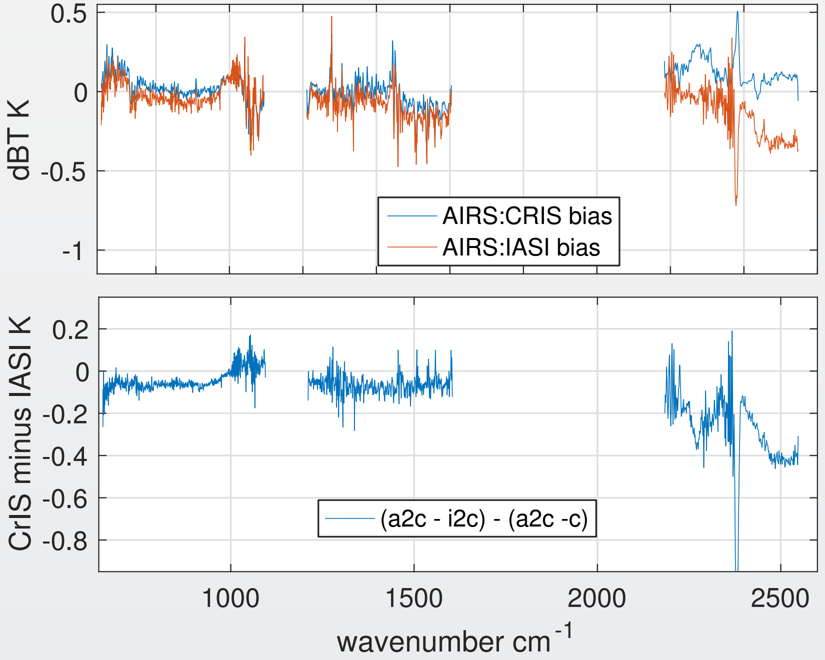
IASI:CrIS SNOs

- A year of IASI&CrIS SNOs consists of about $7x10^4$ samples.
- Results for 2017 are shown in the next figure. Since IASI includes all CrIS bands, the resultant mean bias is computed for all CrIS channels. The standard error of the mean difference is shown in the gray line.



SNOs AIRS&CrIS AIRS&IASI on CHIRP

- SNO pairs are collected for the complete period of operational overlap.
- Translation of AIRS L1C to CHIRP (CrIS MSR) and IASI to CHIRP permits both AIRS&CrIS and airs&IASI radiometric bias and then to use AIRS as the transfer when taking a double different to compute CrIS&IASI bias.
- Every AIRS and IASI observations are first translated to CHIRP, then analysed.
- In the following figure the mean differences are computed for one year of data.
- The standard error of the mean is very similar to the individual SNO bias values shown previously.

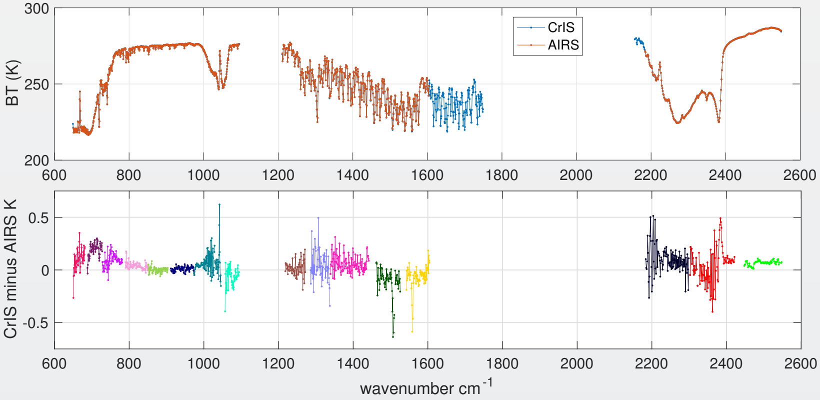


0.5
0
-0.5
-1
dBT K
AIRS:CRIS bias
AIRS:IASI bias
0.2
0
-0.2
-0.4
-0.6
-0.8
CrIS minus IASI K
(a2c - i2c) - (a2c -c)
1000
1500
2000
2500
wavenumber cm -1

Global Random

- 1% of global random equal area samples returns about $1x10^7$ observations.
- Each AIRS observation is translated to the CHIRP (CrIS MSR) grid and compared to CrIS on the same grid.
- The mean brightness temperature spectrum and mean difference is shown in the next figure. The standard error of the mean is negligible on this scale and is not shown.
- The small difference of the mean atmospheric view angle between the two sensors is corrected for each channel based on empirical correction derived from the data themselves.
- AIRS L1C fill channels, dead channels, and band-edge channels are not included.
- The different AIRS detector modules are distinguished by the different colors on the bias plot.

Gobal Random result



Discussion & Conclusions

- The translation algorithm of AIRS or IASI to the CHIRP (CrIS MSR) spectral grid has been demonstrated.
- The SNO intercomparison provides a reliable means to quantify the bias as a function of wavelength.
- Using global random equal area samples over a full year gives consistent bias estimates as the SNO.
- The mean bias between the sensors is small, of order tenth Kelvin, and consistent across the band pass.
- The multi-year period of overlap of the missions has been used to determine the stability of the bias estimates with values close to the known AIRS drifts.