CHIRP Radiance Corrections/Offsets Connecting AIRS, SNPP, JPSS-1, and IASI

AIRS Virtual Science Team Meeting

C. L. Hepplewhite[2], L. Larrabee Strow[1,2], and Howard Motteler[2]

October 2020

[1] UMBC Physics Dept.

[2] UMBC JCET

Summary

- What is CHIRP
- What are radiance offsets for connecting AIRS, CrIS and IASI.
- Data and methods used to derive the radiance offsets.
- Results and Discussion.
- Integration of offsets into the CHIRP L1C.

What is CHIRP

- Climate Hyperspectral InfraRed Product creates a homogenous radiance record from the start of AIRS through the end of the JPSS CrIS mission. Later versions will include IASI.
- CHIRP data are available as level 1 calibrated, geolocated granules. (Details are provided in the accompanying presentation and on-line documentation).
- Current working version of CHIRP connects AIRS to CrIS from SNPP and JPSS1.
- CHIRP spectral resolution of CrIS is equivalent to 0.8/0.6/0.4 cm interferometric OPD (LW/MW/SW).
- CHIRP uses SNPP-CrIS as the radiometric standard.
- Here we present the radiance offsets between SNPP-CRIS and the other two sensors in the CHIRP record: AIRS and JPSS-1 CrIS.
- At this point we assume all instruments are stable in time.

What are the Radiance Offsets

- The radiance offset betwen two sensors is the radiometric calibration difference observed when they are both measuring the same scene at the same time.
- In principle, radiometric calibration offsets could be a function of time and brightness temperature and may be non-linear.
- Ideally the best result would be to cross-calibrate the sensors against a primary standard black body - instead must use data available during the missions.
- Fortunately there is a lot of mission overlap between AIRS, CrIS and IASI (more details to follow).
- CHIRP V1 derived from AIRS or J1-CrIS have BT bias offsets applied to convert them to the NPP-CrIS radiometric calibration.

Data and Methods

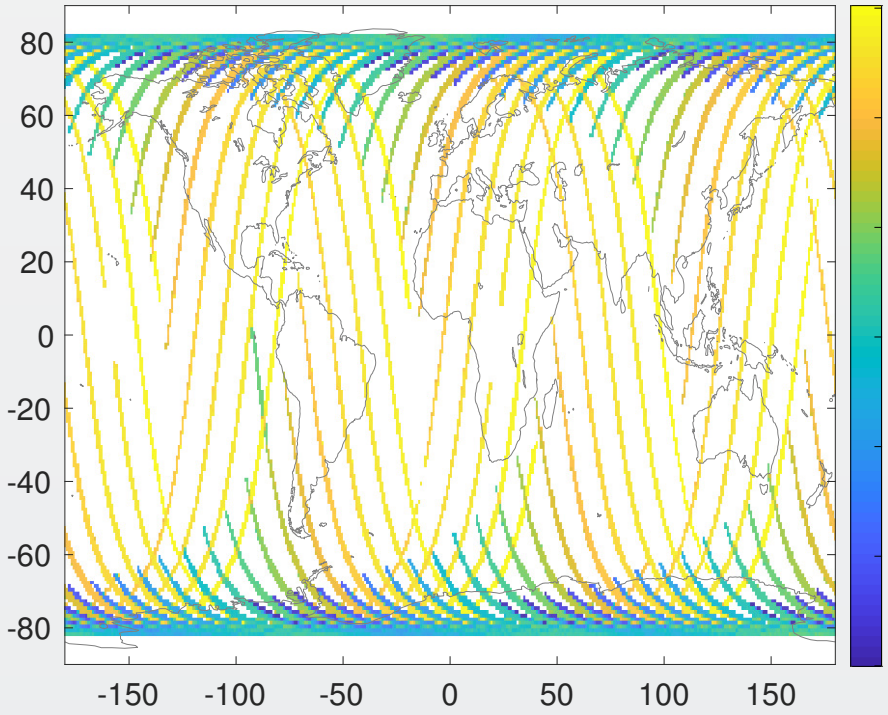
- Data used: SNOs and global random statistical samples.
- Periods analyzed include all available mission overlaps.
- Available mission overlaps for
  - AIRS:NPP from Apr 2012 to present (Dec 2015 at FSR).
  - AIRS:J1 from Jan 2018 to present.
  - NPP:J1 from Jan 2018 to present.
  - AIRS:IASI1 from May 2007 to present.
  - NPP and J1:IASI1. (Note: SNOs are not available for NPP:J1).
- The recommended transition date for parent AIRS to parent CrIS SNPP is 01-Sep-2016.
- The switch to JPSS1 is proposed 01-Sep-2018 to avoid the 2019 SNPP CrIS shutdown.
- BUT: CHIRP will be produced for all of SNPP-CrIS (after switch to hi-res mode) and for all of JPSS1 CrIS

Data and Methods 2

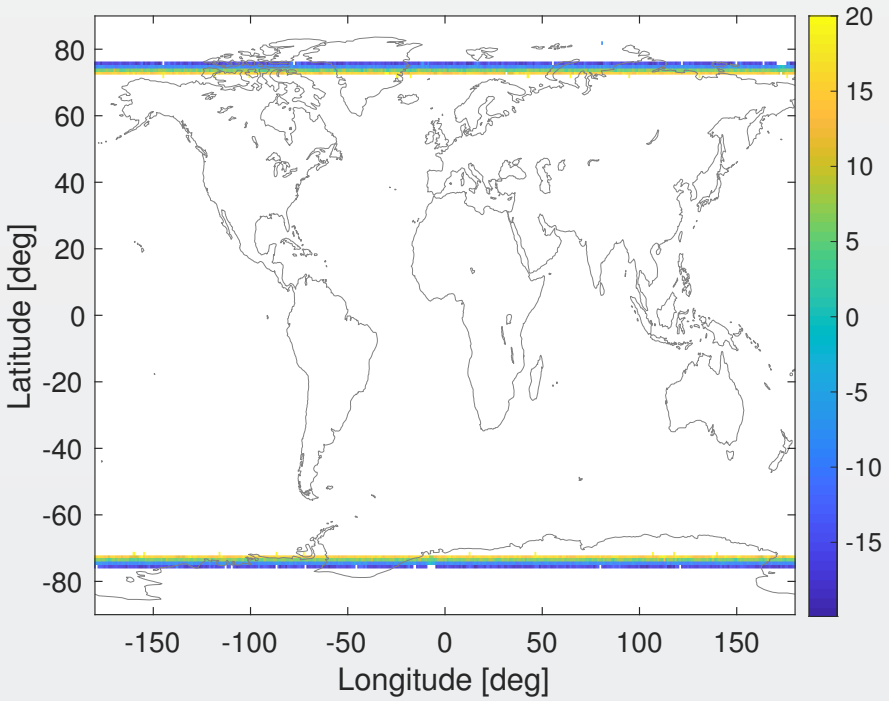
- Two Sources of intercalibration data are available: SNOs and global random samples.
- SNOs have the advantage of being matched pairs of observations, but are spatially less uniformly distributed than global random.
  - AIRS:CrIS SNOs are global but weighted to high latitudes,
  - IASI:CrIS SNOs are restricted to a very narrow latitude band near 70-deg.
- both SNOs and random samples can be used for trending and for scene dependencies.
- In the following bias plots the mission overlap period March.2018 to Feb.2019 (incl.) is used.

Data and Methods 3

AIRS - SNPP CrIS SNO Locations



AIRS - IASI SNO Locations (like CrIS:IASI)



Results 1. AIRS:NPP bias versus AIRS modules

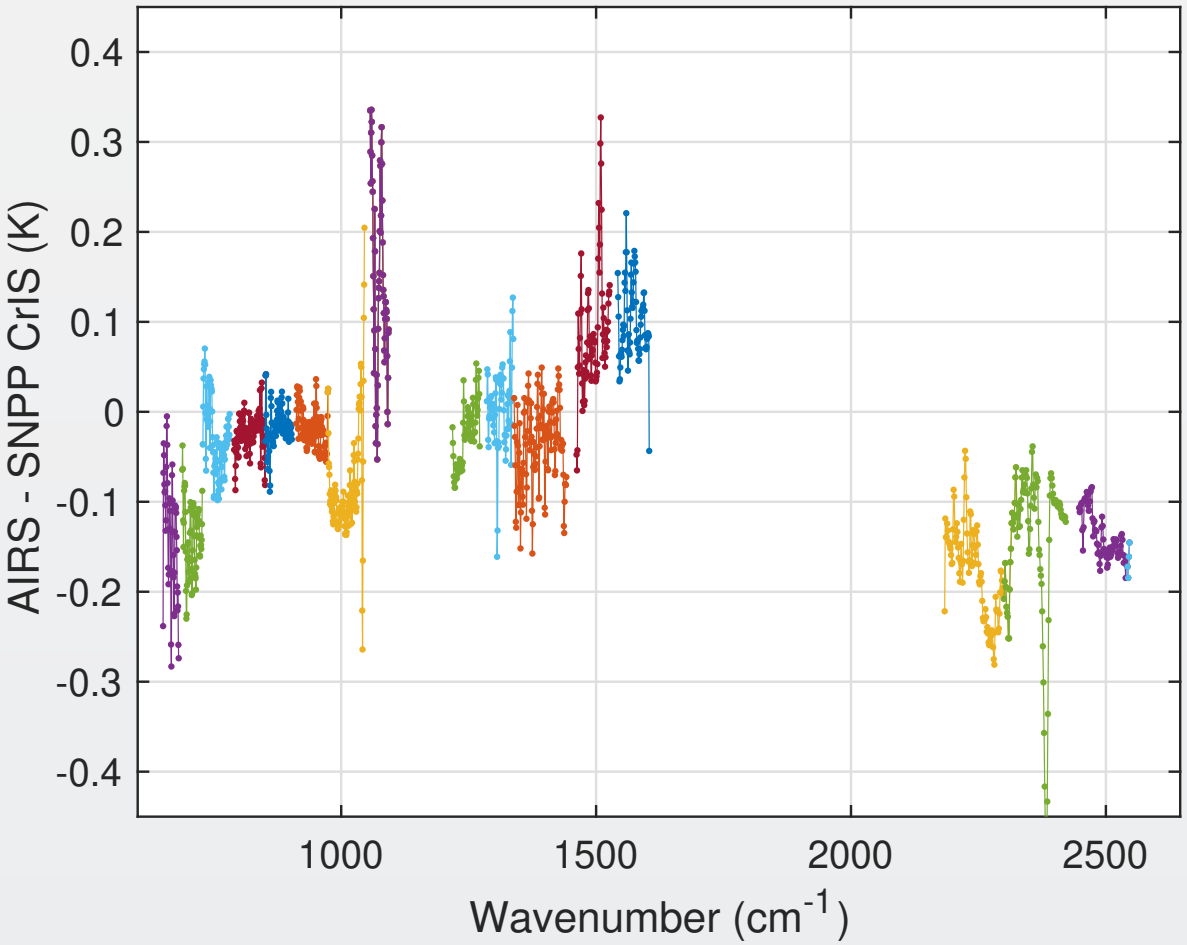


Figure 1: AIRS bias relative to SNPP from global statistics. Colors denote AIRS detector modules.

Results 2. AIRS:NPP bias with fill and bad channels

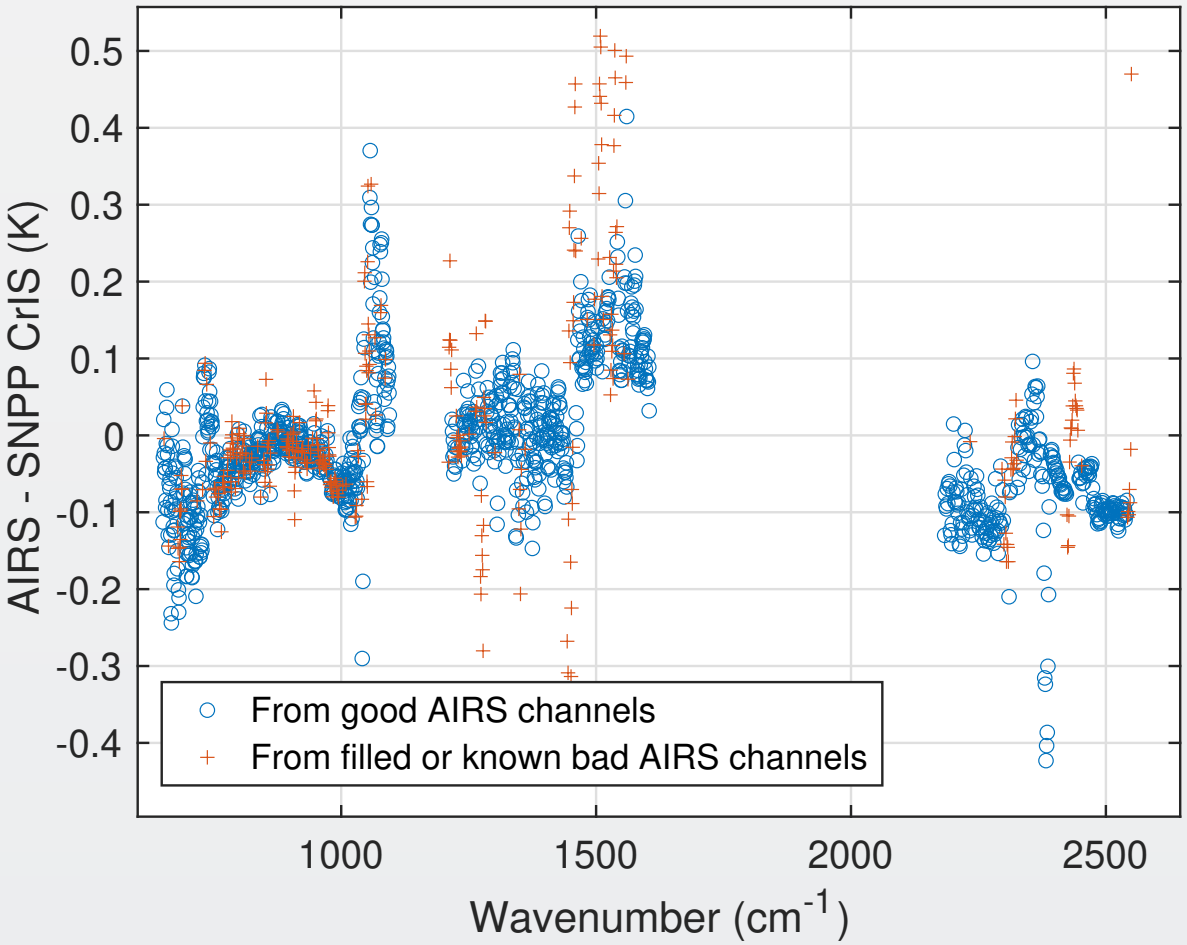


Figure 2: AIRS bias relative to SNPP from global statistics. Showing parent bad or fill channels (total of 356).

Results 3. AIRS:NPP and AIRS:J1 bias

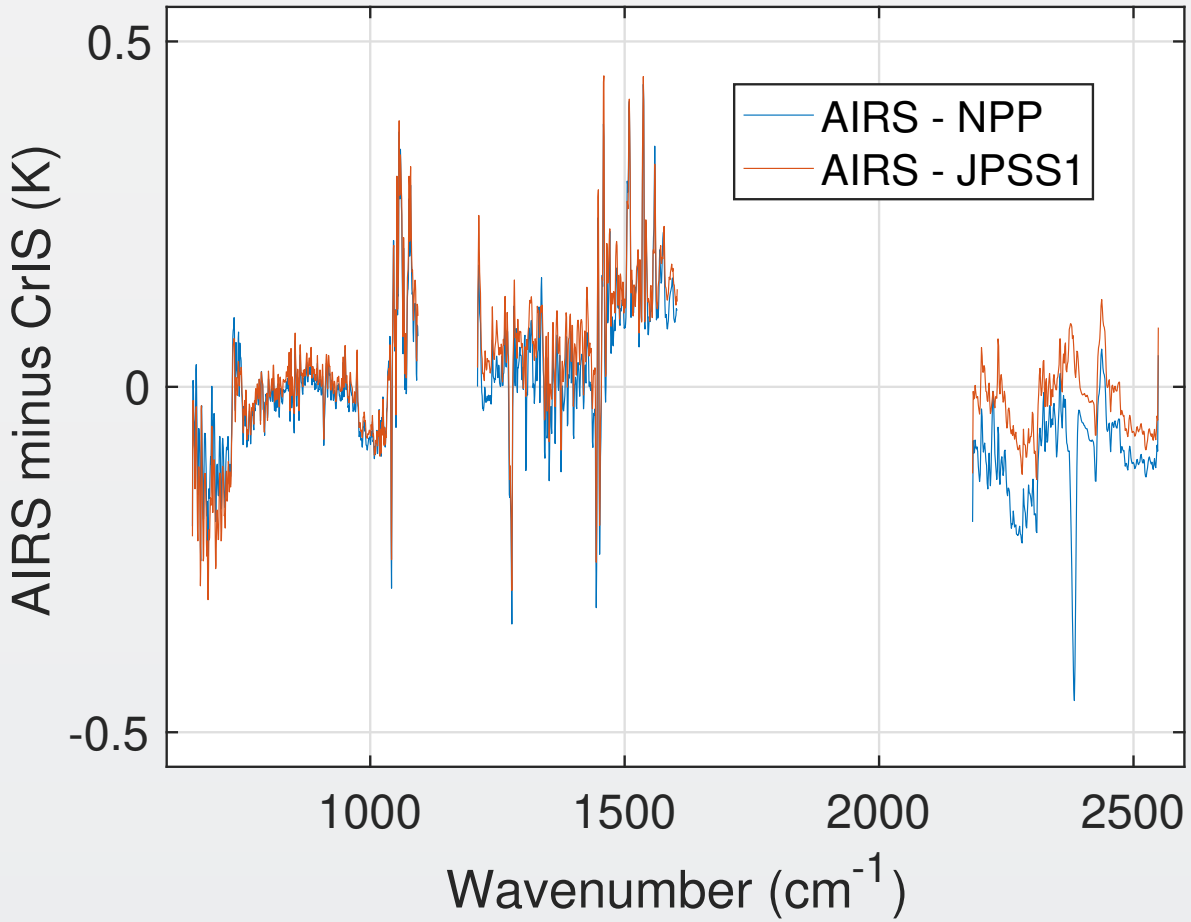


Figure 3: AIRS bias relative to SNPP and J1 from SNO. One year of data. Double difference can be used for NPP:J1 bias.

Results 4. AIRS:NPP bias From Stats and SNOs

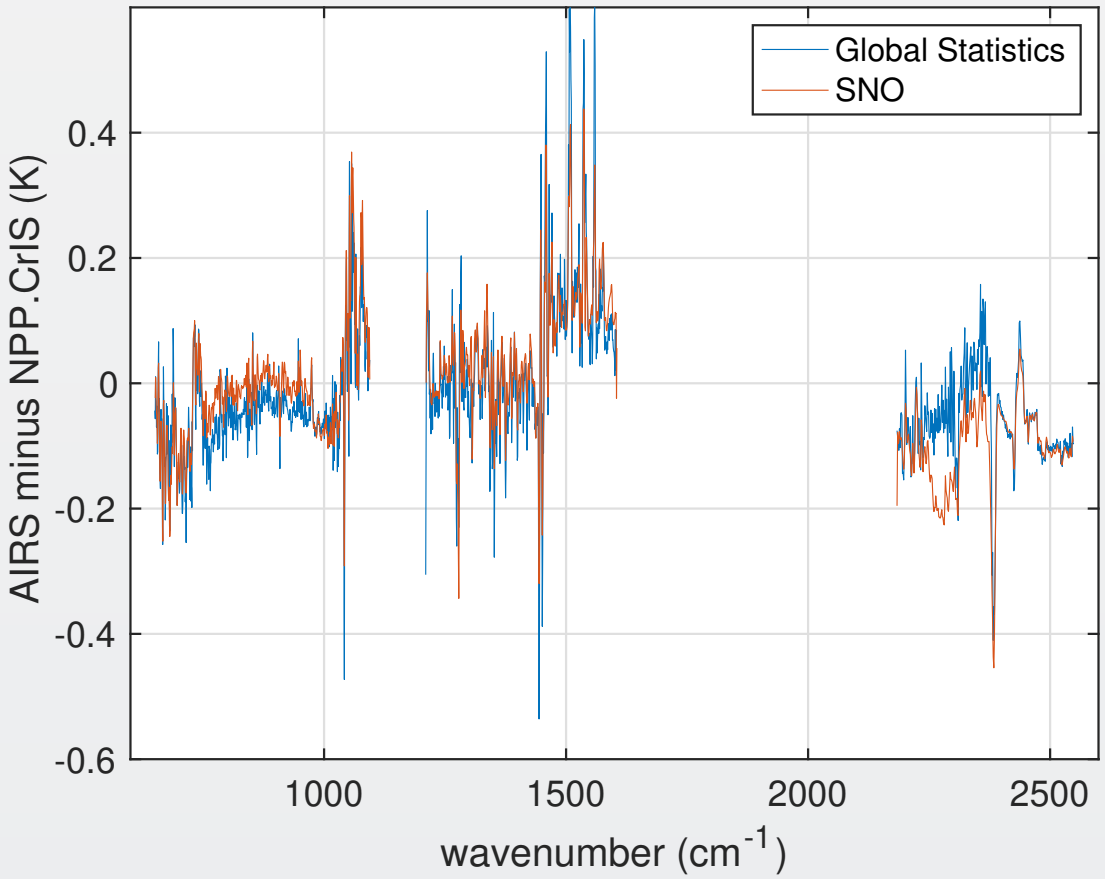


Figure 4: AIRS bias relative to SNPP from SNO and global stats. Good agreement, ~0.03K.

Results 5. J1:NPP bias

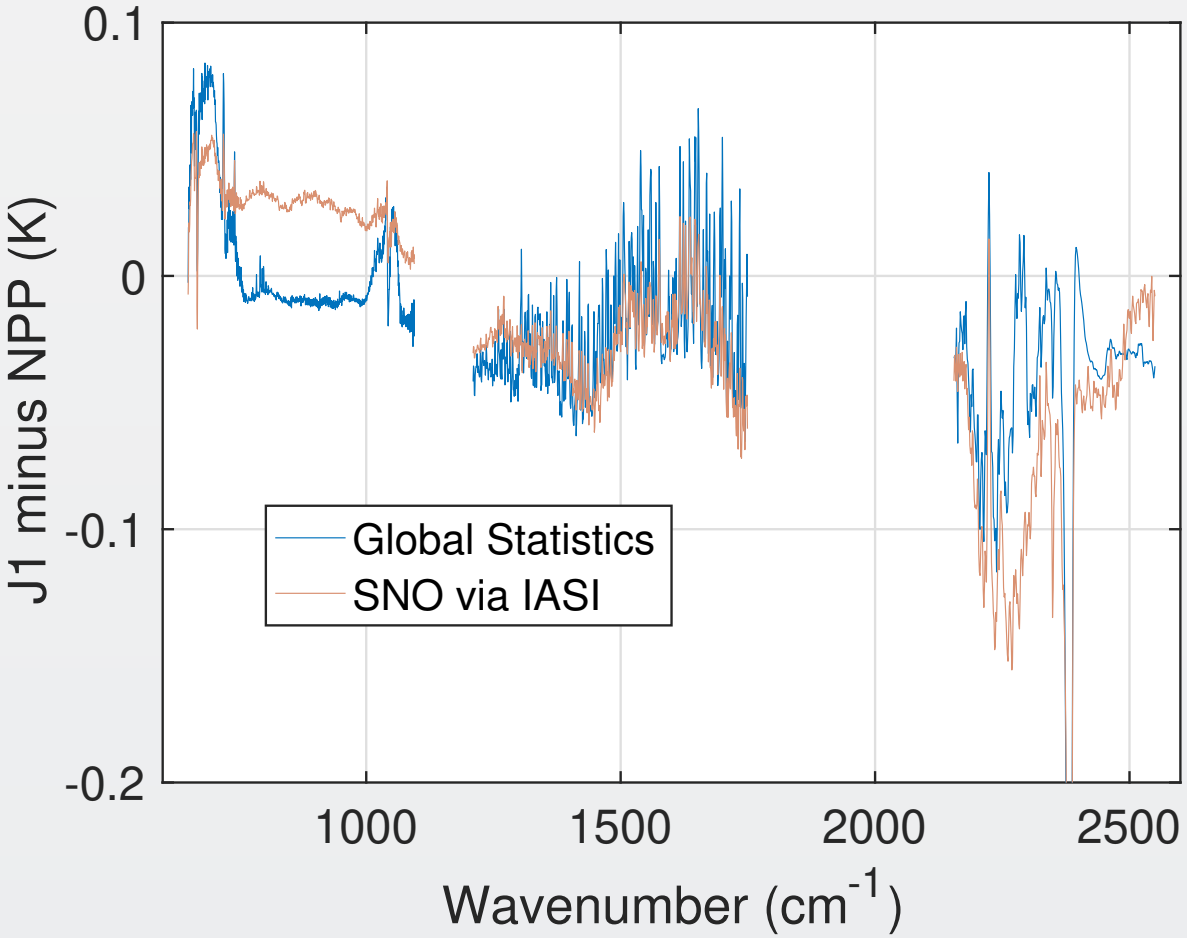


Figure 5: CHIRP channels. CrIS bias from JPSS-1 relative to SNPP from SNO using IASI.1 as cross reference and from global random stats.

Results 6. Bias variation with irradiance.

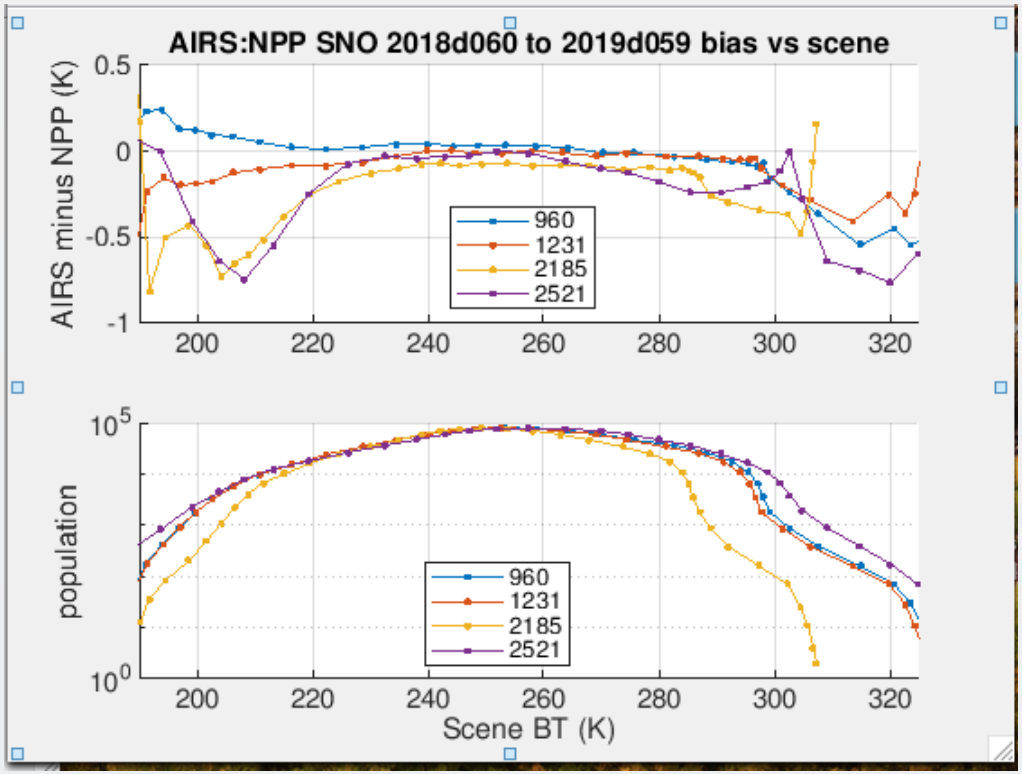


Figure 6: Four CHIRP channels. Bias variation with irradiance from SNO.

Summary, Conclusions and Future Work

- Radiometric offset vectors have been determined to tie CHIRP derived from AIRS to NPP:CrIS and J1:CrIS.
- The current CHIRP product includes a single valued vector for every channel.
- The bias has been found to be stable over the period of interest, which is 2016 to 2019.
- The dependency of bias on irradiance has been investigated, and some examples have been illustrated.
- Future work includes validation of the CHIRP product with particular attention to equivalence of trends of parents sensor.