A Long-Term Homogeneous Hyperspectral Radiance Time Series: AIRS2CrIS

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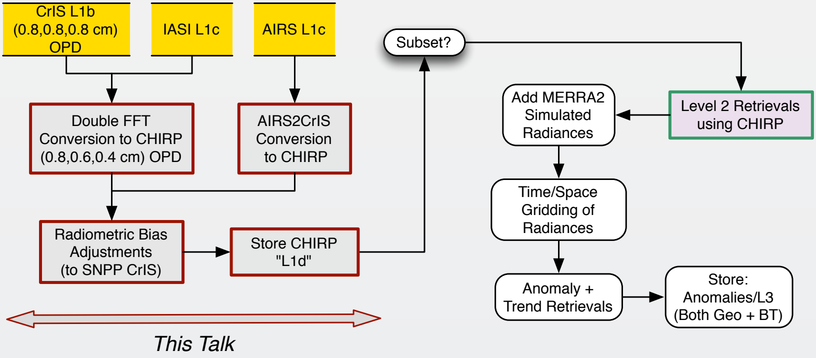
Introduction



CHIRP: (Common or Climate) Hyperspectral InfraRed Product

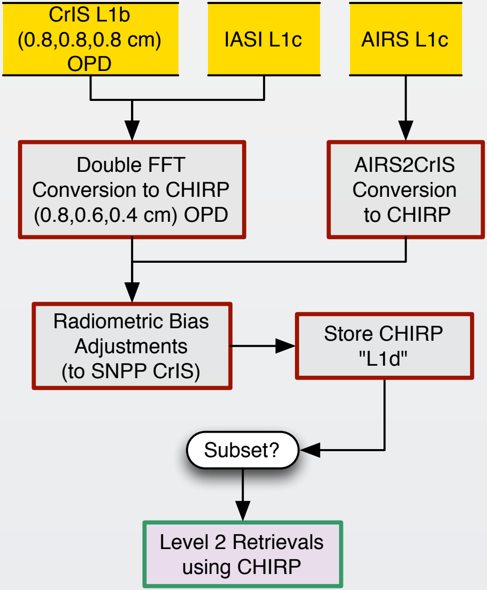
OPD: 0.8 / 0.6 /0.4 cm

Spectral Spacing: 0.0625 / 0.0833 / 0.1250 cm^{-1}

Why CHIRP

- Convert AIRS, CrIS, IASI to a common spectral spectral response function (SRF)
- Correct for instrumental radiance offsets
- Provides long-term radiance continuity over different instruments
- Allows use of a single forward model (Radiative Transfer Algorithm) for retrievals
- Common SRF for AIRS/CrIS and IASI (1:30 and 9:30 equator crossings)
- Applications
  - Gridded (time/space) radiance products ("L1G")
  - Geophysical retrievals (anomalies, trends) directly from all-sky radiance anomaly/trends. (See talk by L. Strow)
- OLR trends directly from radiance trend retrievals (See talk by Sergio DeSouza-Machado)
- Use for Level 2 retrievals? Only way to mitigate radiance calibration difference among instruments and to achieve common sensitivity (both for radiances and RTA)

CHIRP Data Flow



AIRS, CrIS Differences

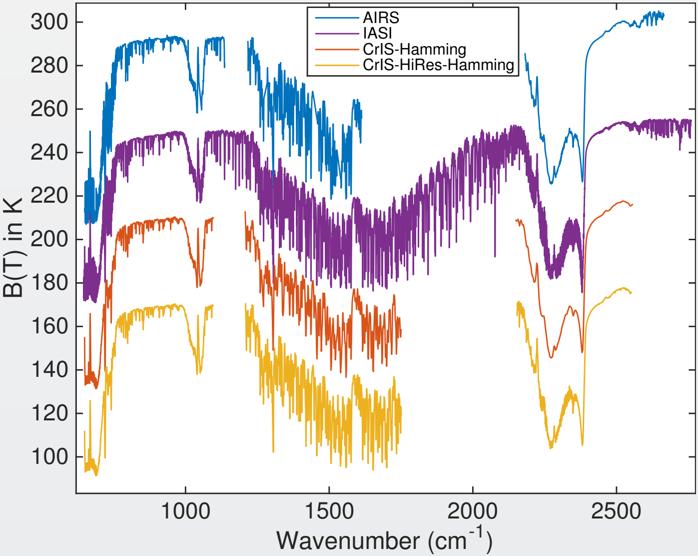
- Instrument Line Shape (ILS):
  - CrIS: sinc
  - AIRS: 2378 ILS's, about 75% in good shape
- Footprints: roughly similar, some small issues
- Orbits: sampling almost identical (later)
- Noise: nominally similar
- Calibration (later)

ILS Differences

- Large in B(T)
- Existing approach: Retrievals use different forward models
- Cannot inter-calibrate AIRS and CrIS with different ILS functions!
- A hyperspectral radiance climatology requires same ILS between instruments

Our approach: Convert AIRS to the CrIS ILS

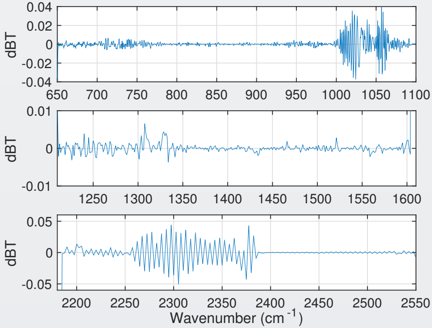
Spectral Differences Among AIRS, CrIS, IASI



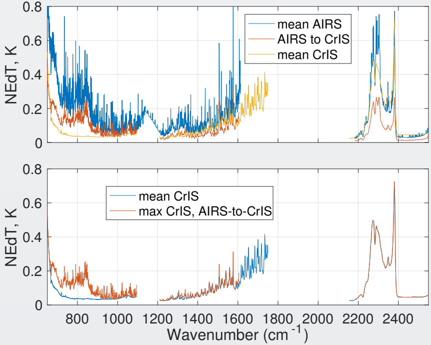
AIRS2CrIS Algorithm

- Simple deconvolution to 0.1 cm^{-1} grid
- $S_a r = r_A$, $r_o = S_a^{-1} r_A$ using Moore-Penrose pseudoinverse
- $r_{A2C} = S_c \circledast r_o$
- Small additional terms using linear regression (mostly bias)
- Errors below assume AIRS ILS functions are perfect

AIRS2CrIS Mean Error (std. similar)



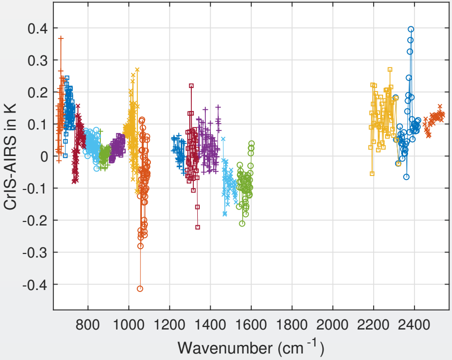
AIRS2CrIS Noise



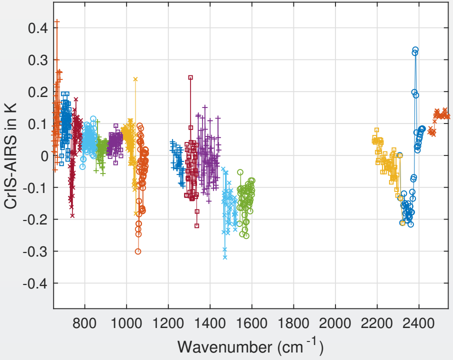
Shortwave sounding region max noise dominated by CrIS

SNPP versus AIRS

2016 SNOs



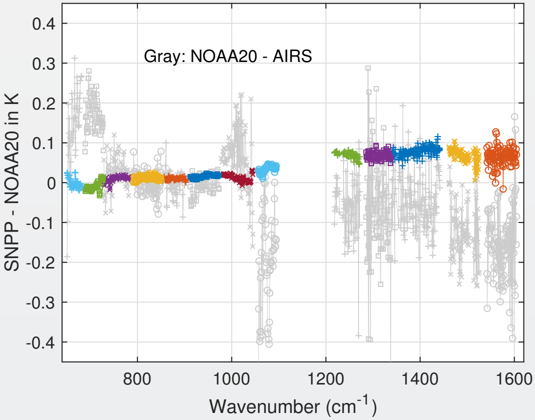
2016 Random Comparisons



Sources for Differences

- Differential calibration AIRS modules
- AIRS SRFs (widths and centroids)
- Non-linearity: CrIS, AIRS?
- etc.

SNPP vs NOAA20 CrIS (via AIRS Snos)



- *Preliminary*, NOAA20 CrIS non-linearity will be updated in July 2018
- Connecting CrIS instruments together will be easier!
- So far spatial, spectral, and sampling among CrIS instruments will be identical