Calibration Challenges in Developing FCDRs from HIRS

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Calibration and Validation

- ***Calibration:***
  - ***The process of quantitatively defining the system responses to known, controlled signal inputs (adopted by CEOS/WGCV)***
  - ***Convert satellite raw instrument output signals to geophysical quantities (radiance, temperature) that are traceable to established reference standards.***

- ***Validation: independent comparison and intercomparison to assess the accuracy and precision of retrieved physical quantities***

Calibrated radiances are the fundamental building blocks for all satellite products, including the radiances for data assimilation for NWP and fundamental climate data records for climate change detection.

SNO doesn't solve all the problems for HIRS

- SNO was first introduced with HIRS NOAA-15/-16 intercomparison in 2001-2002 (but the first journal paper submission was rejected because "SNOs don't happen often enough to be useful", according to one reviewer).

- Today SNO is supporting major programs and initiative. The bottom line is that it is useful for checking the consistency between satellites, for which it does well.

- There are many more calibration issues than what SNO can address (Cao, SPIE, 2006)

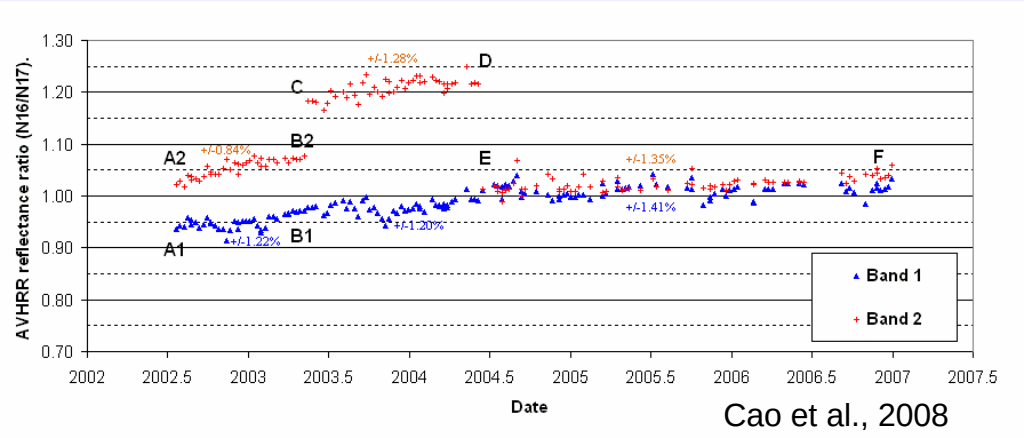
- We really need to focus on the fundamental measurement issues. What is the measurement? What do we know about the measurement?

- For HIRS, this is especially true. As discussed here.

SNO works well for some tasks

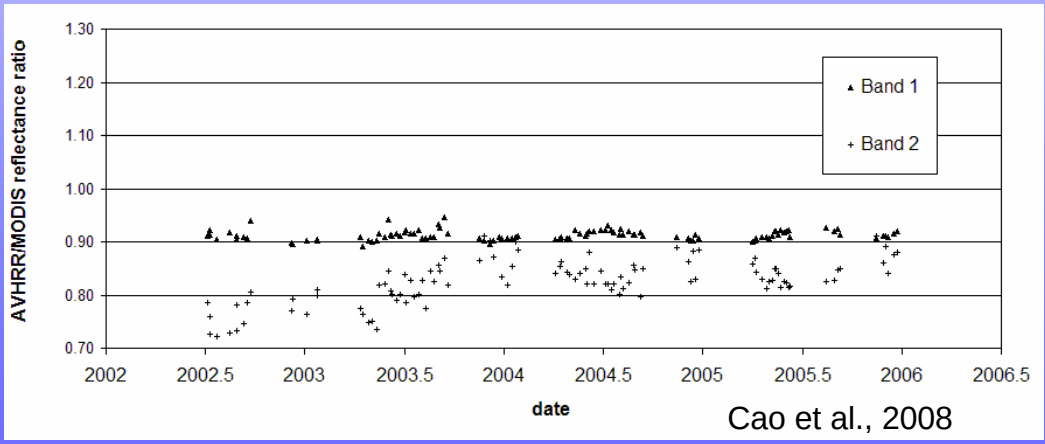
- The case of AVHRR and MODIS

Top Figure: Measurement consistency between two AVHRRs



Cao et al., 2008

Bottom Figure: Measurement consistency between AVHRR and MODIS



Cao et al., 2008

Each feature on the figures corresponds to a calibration event that can be explained

Despite progress in recent years, there are still many challenges

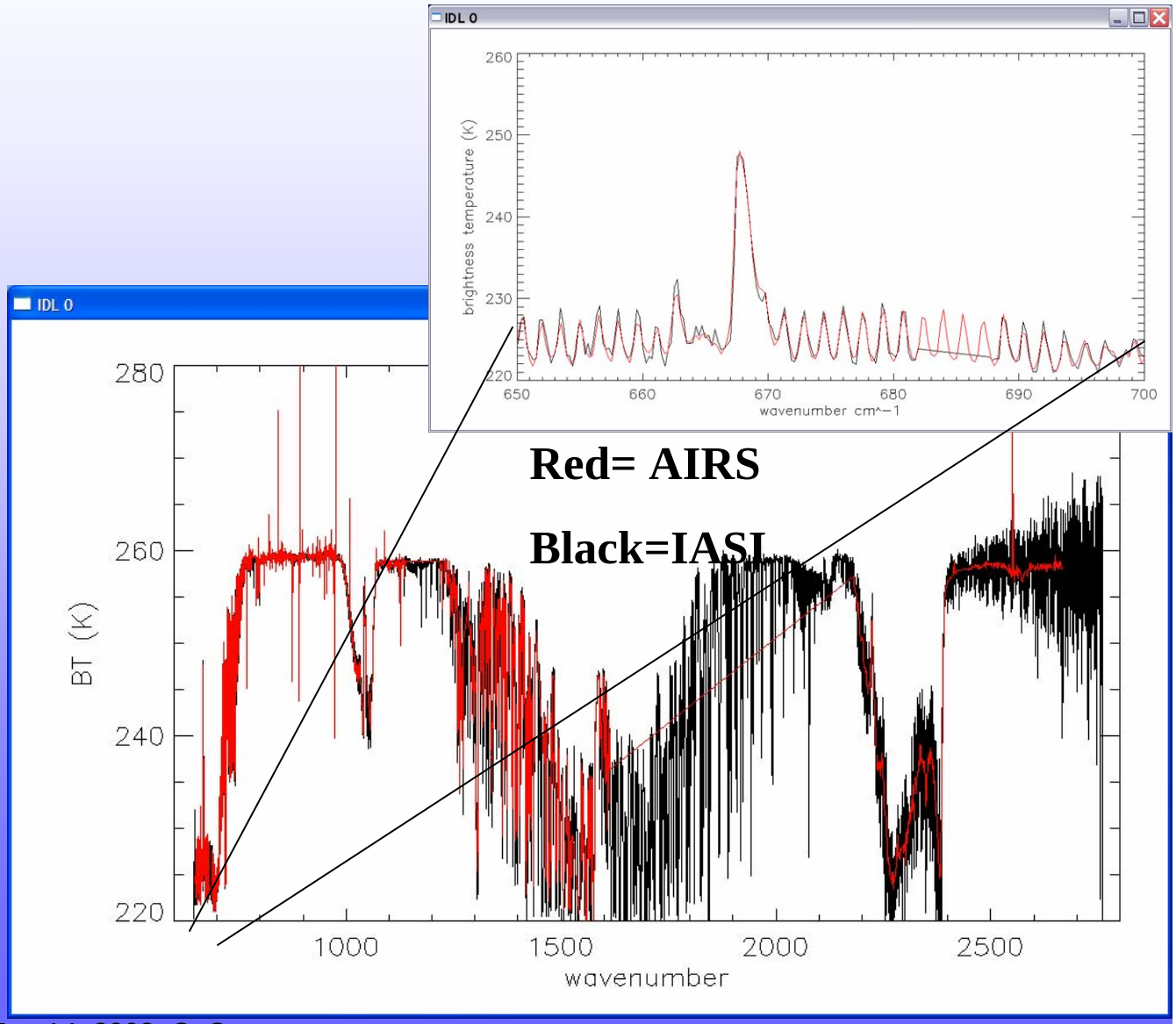
- Spectral response differences (even though measured perfectly) lead to observations of different layers of the atmosphere (observing different phenomena)
- Diurnal cycle effects due to orbital drift
- Instrument calibration biases can be overshadowed by other effects for some channels
- Blackbody problems difficult to analyze due to infrequent calibration
- Filter measurement uncertainties (evidences as well as speculations, Cao & Weinreb, 2004)
- Complications in nonlinearity (Cao, et al, JTECH,2005, 2007, Wang, et al., 2007)
- Relying on IASI as on-orbit standard (good and bad)

IASI and AIRS at the SNO

• IASI and AIRS are atmospheric sounding instruments for weather applications (with good potential for climate).

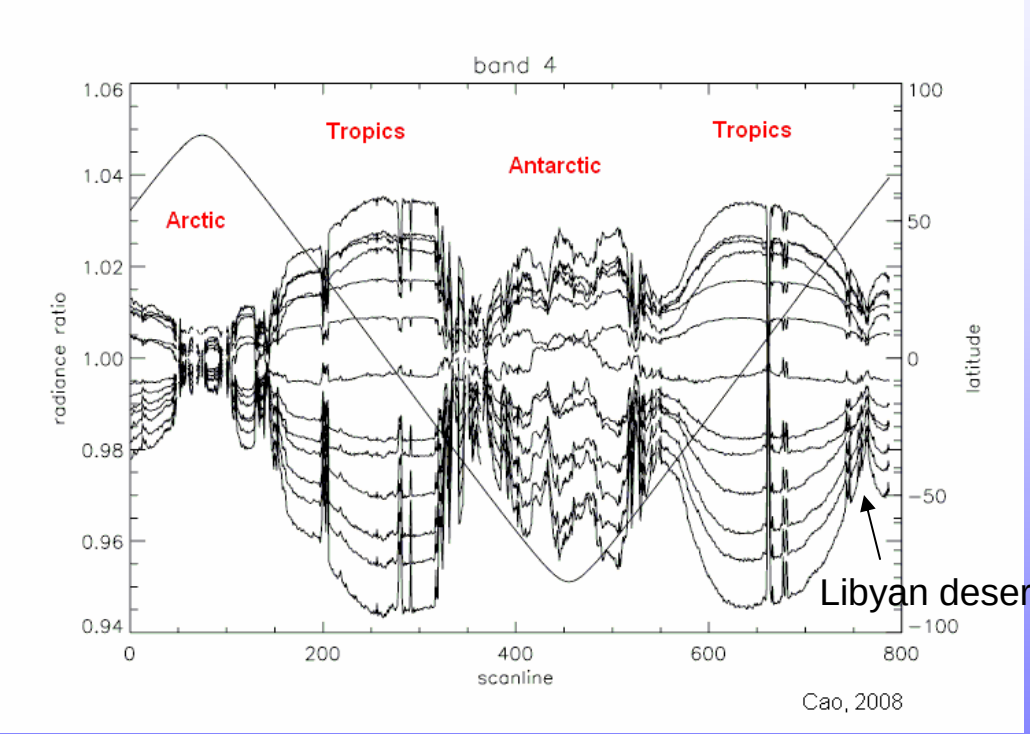
• IASI (8461 channels) and AIRS (2378 channels) provide spectrally resolved radiances in the 3.6-15.5 um spectral range.

• Excellent agreement between them provides a quasi on-orbit **standard**



HIRS Climate Zone and Spectral Dependent differential biases

- While IASI is helpful, it also reveals more problems
- Resolving SRF induced biases from NOAA-6 to MetOP HIRS using IASI orbital observations
- Intersatellite bias is a function of climate zone for many HIRS channels, which plays a dominate role.
- SNO analysis only quantifies the instrument biases in the polar regions.
- Understanding these Bell shaped curves is essential for developing longterm time series from HIRS



The HIRS Bell curves show observational variations by satellite (NOAA-6 to MetOP-A) and climate zone at summer solstice

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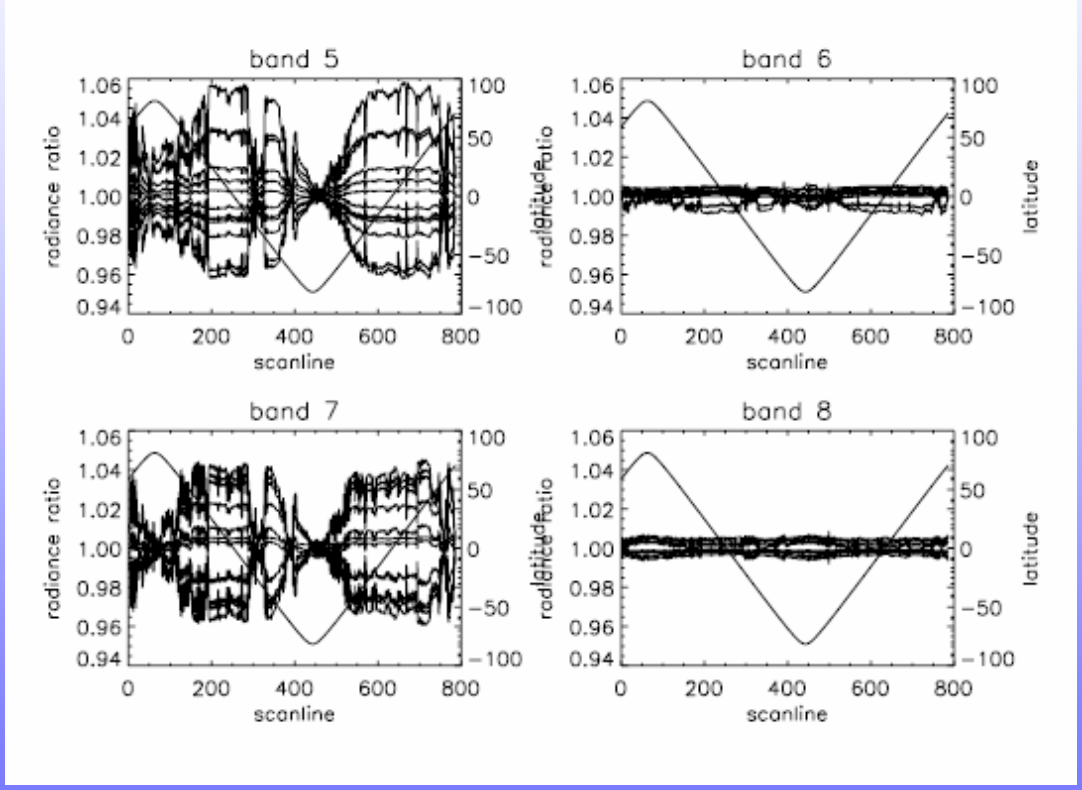
HIRS Climate Zone and Spectral Dependent differential biases

- The dominant intersatellite biases for some channels are due to observations of different layers of the atmosphere from the same channel on different satellites
- Different pattern for each channel
- Changes with season



Intersatellite bias due to calibration
– it's only part of the problem

- Mixed with all other effects.
- SNO analysis from NOAA-6 to NOAA-17 is completed but it doesn't solve all the problems.
- Issues need to be addressed from both sounding and calibration aspects (small user base is part of the problem).
- Focus on certain channels to minimize the unknown effects.

Next Presentation

- HIRS intersatellite biases by Wang