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.**

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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

Bottom Figure: Measurement consistency between AVHRR and MODIS

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

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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)
- Relying on IASI as on-orbit standard (good and bad)
• 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