Sounder Overview

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Summary

- Other talks will provide:
  - GeoXO mission overview
  - Sounder applications
  - Data access and distribution
  - GXS performance
  - Sounder value assessment
- This talk will briefly cover:
  - What is a hyperspectral sounder
  - What are the primary data products
  - How are the data used
  - What aspects of data quality affect the ability to use the data, and how does this drive instrument design and calibration

What is a Hyperspectral Sounder?

- Provides moderate to high resolution spatial (x,y) sampling
- Provides moderate to high resolution spectral (z) sampling
- Results in high to very high data rates

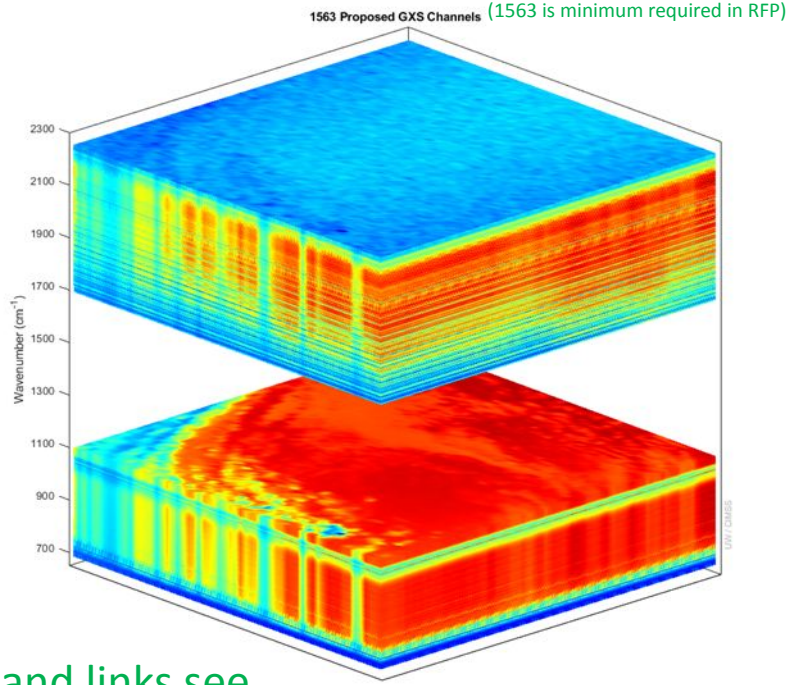
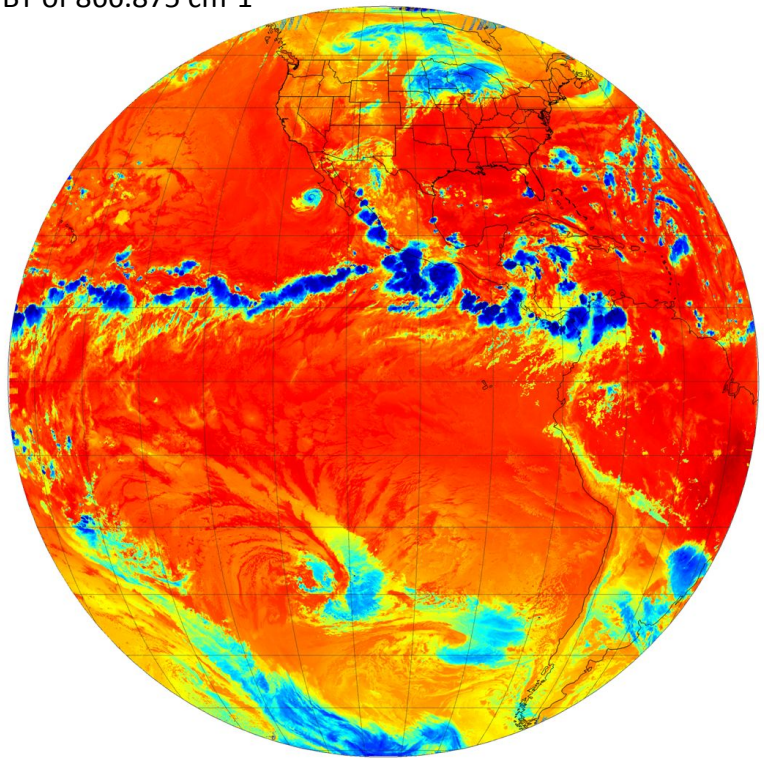


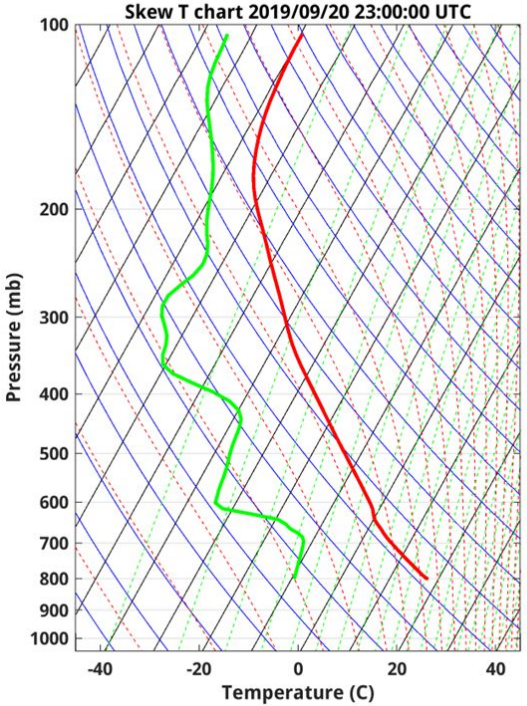
Image provided by SSEC/UW; for more information and links see https://www.ssec.wisc.edu/geo-ir-sounder/

Sample Data Products

BT of 866.875 cm-1



Single channel (wavelength) imagery



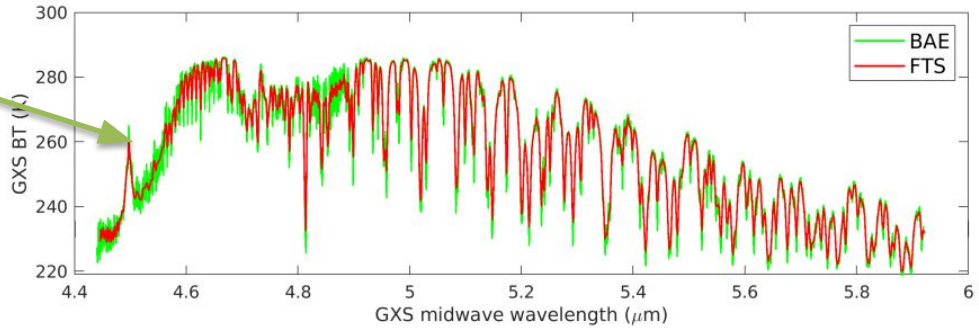
Profile retrievals; Temperature (red) and moisture (dewpoint; green) shown

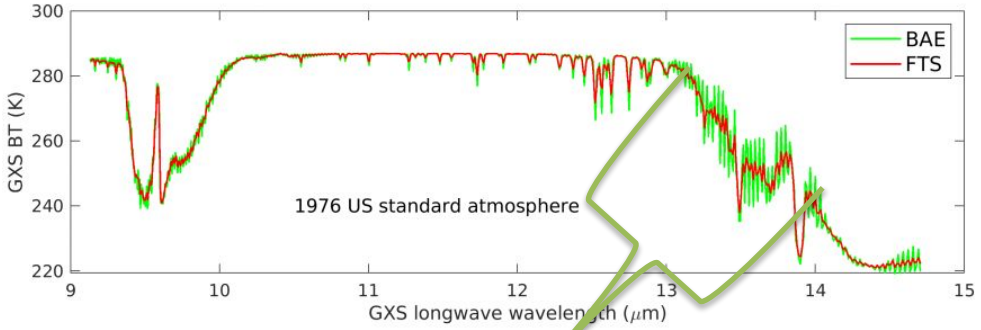
From UW/SSEC/Zhenglong Li and Tim Schmidt

Spectral Radiance is Observed at Each Pixel

Imagery produced by plotting radiance at a single channel for all spatial pixels

BAE=GXS, FTS is similar to JPSS CrIS



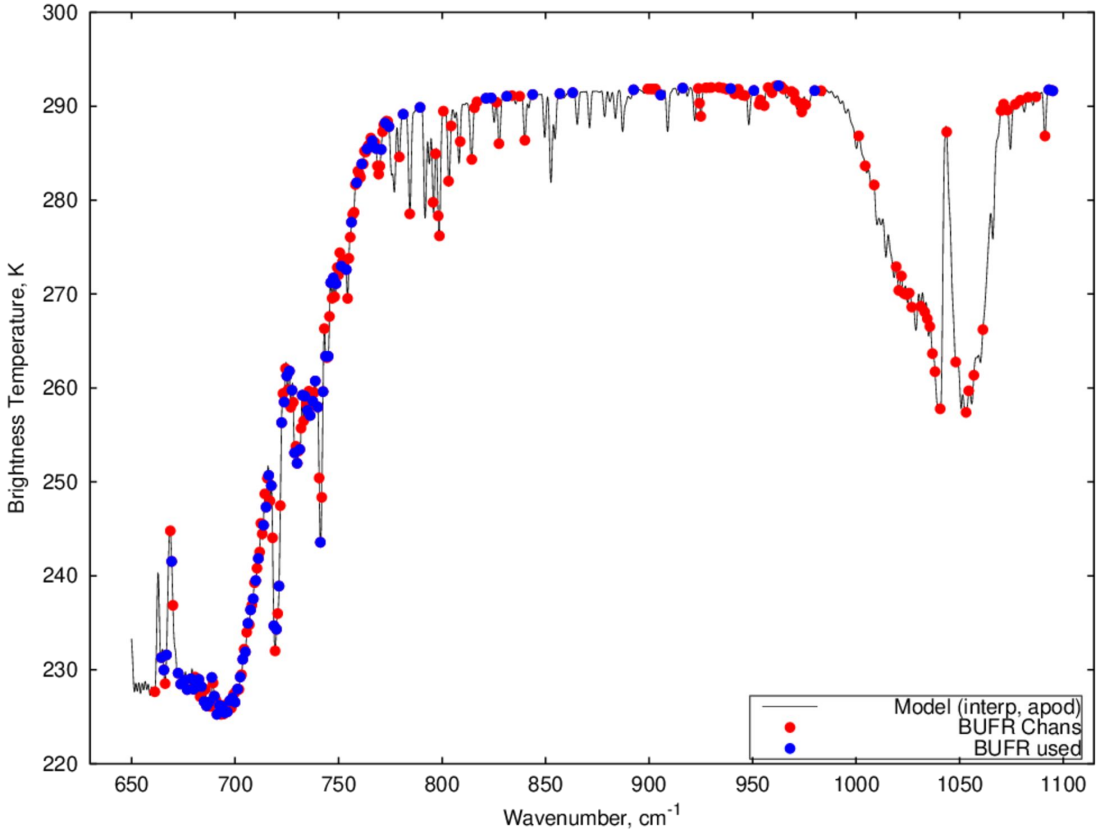


Profiles are produced by analyzing multiple channels for each pixel

From UW/SSEC/Zhenglong Li and Tim Schmidt

Spectral Radiance is also used directly

- Example from JPSS CrIS LW band
- Red and Blue channels are distributed to users
- Blue channels are assimilated by this particular NWP user
- Low latency from observation to assimilation is important



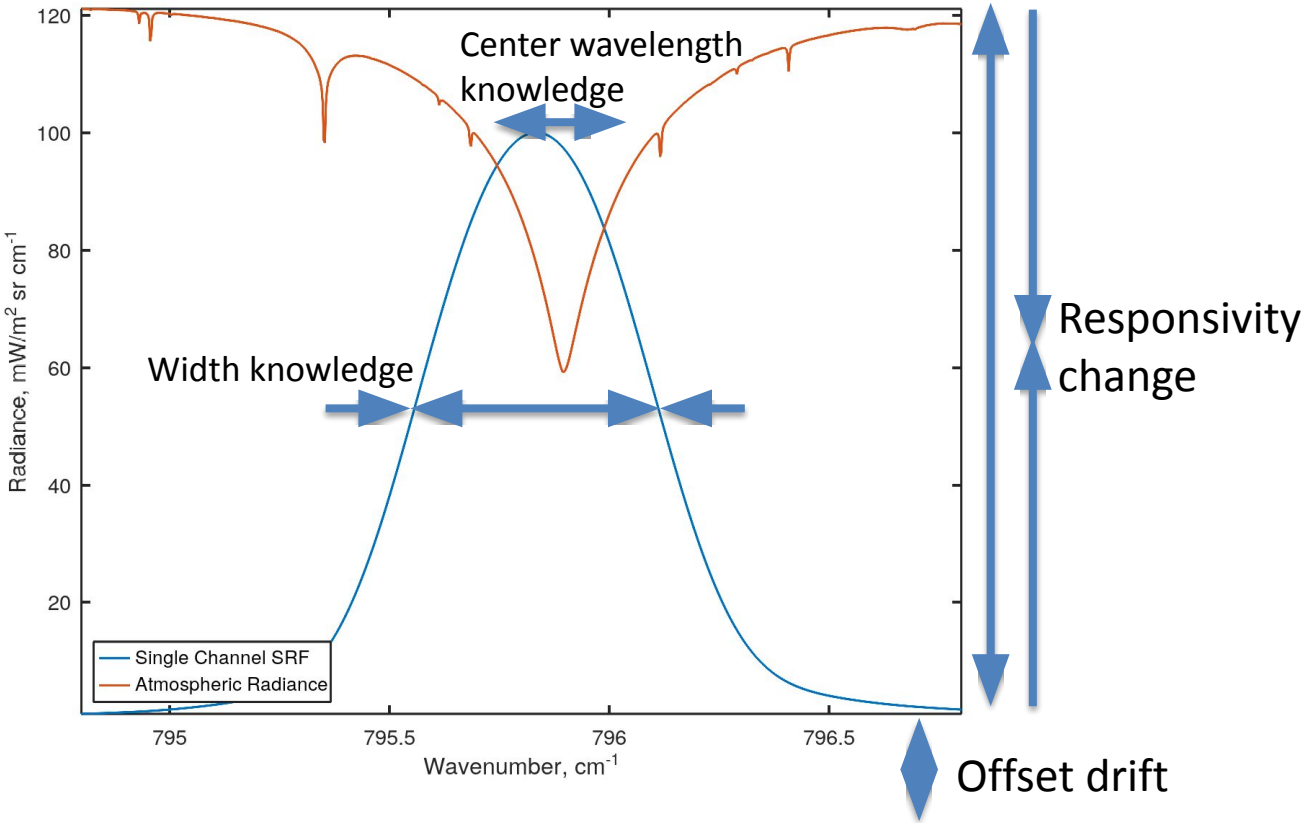
Key Performance Categories

- Radiometric, including:
  - NEdN, or radiometric precision
  - Absolute accuracy, sometimes specified as the bias remaining after extensive averaging
  - Relative accuracy, or differences in bias from pixel to pixel, frame to frame, scan to scan, channel to channel, etc, that produce artifacts in images and spectra and are difficult to distinguish from true features in the atmosphere
- Spectral, including:
  - Spectral calibration (channel center wavelength) knowledge and stability
  - Spectral response function (SRF) knowledge and stability
  - Spectral response uniformity across pixels (may be after correction, for image products)
- Spatial, including:
  - Ensquared energy (does most of the energy collected by the pixel come from the desired footprint?)
  - Spectral coregistration (do all spectral channels view the same spot on the ground?)

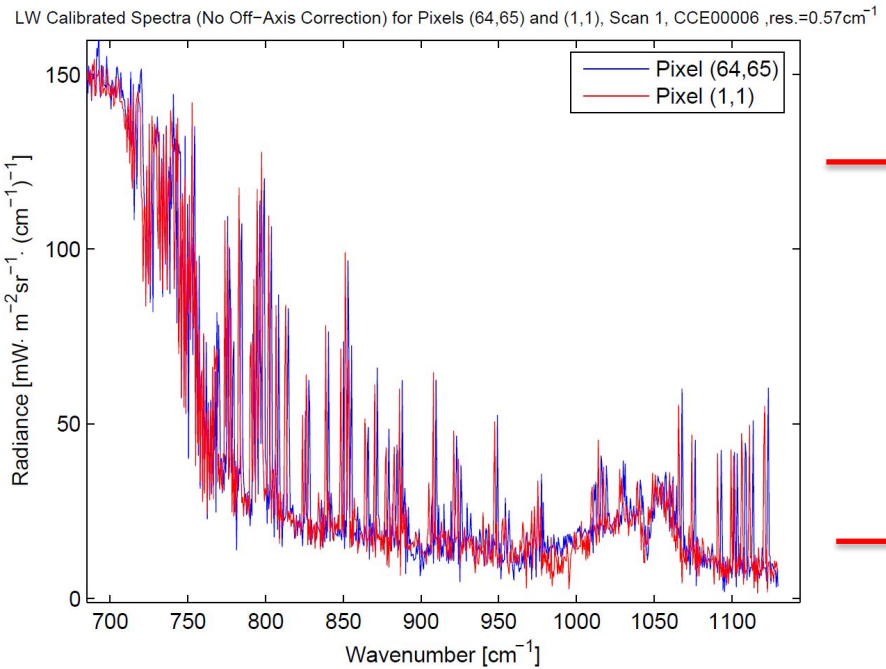
All contribute to differences between observed and modeled radiance for each spectral channel

Radiance Error Contributions

- The single channel output is atmospheric radiance convolved with the instrument spectral response function (SRF)
- The result is affected by:
  - Offset drift
  - Responsivity change
  - Center wavelength knowledge
  - SRF (width) knowledge



Example: FTS Off-Axis Spectral Shift



Uncorrected spectra for on-axis (64,65) and off-axis (1,1) pixels
(Example of atmospheric radiance viewed at zenith from the ground)

Image at 1066 cm-1 uncorrected for spectral shift

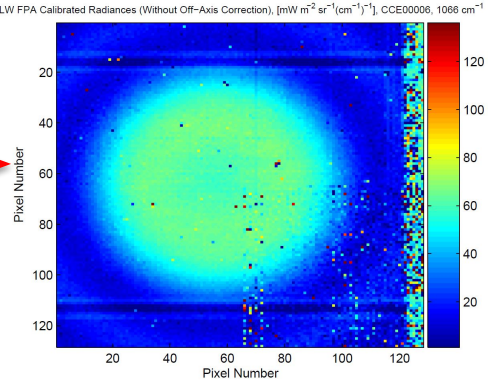
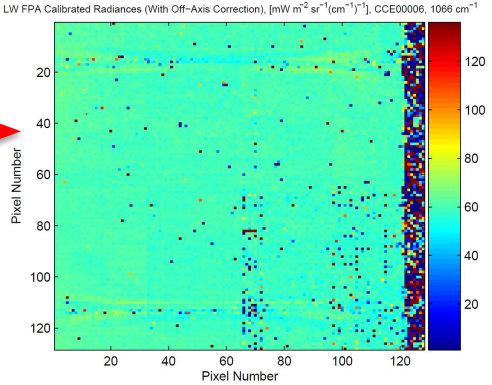


Image at 1066 cm-1 corrected for spectral shift



Analysis performed for imaging FTS system (GIFTS) by Jialin Tian in 2007

Key GXS Requirements

- Spectral range and resolution (GXSPORD108 and GXSPORD110)
  - 680 – 1095 cm^{-1} (14.7 um – 9.13 um); 0.625 cm^{-1} res
  - 1689 – 2250 cm^{-1} (5.92 um – 4.44 um); 0.625 cm^{-1} res
- Spatial Resolution: 4 km at nadir (112 urad) (GXSPORD144)
- NEdN: See table on the right (GXSPORD162)
- SD refresh rate (GXSPORD122)
  - 30 min SD, or equivalent coverage rate for other areas (0.9 NHSD with 2 Mesos, CONUS in ~15 min, etc.)
- Spectral response similarity: (GXSPORD114)
  - Difference between corrected spectral response functions and nominal on-axis reference spectral response < NEdN the over lifetime
- Spectral center knowledge / stability: (GXSPORD116)
  - For 50% of detectors, GXS channel center stability shall be ≤ 5 ppm of channel λ over any hrs
- Spectral center uniformity: Spectral channels same for all pixels. (GXSPORD679)
- Co-registration: (GXSPORD153, 154)
  - 95% within band and 80% across bands
- Data latency: 180 sec for L1b (GXSPORD138)
- Dynamic Ensquared Energy: ≥ 70% (GXSPORD149)

NEdN

Spectral Range	NEdN mW/(m² sr cm^{-1})
680-718 cm^{-1} 13.9-14.7 µm	2.5 at 680 cm^{-1} and 0.352 at 718 cm^{-1} interpolated in wavenumber for 224K scene
718-800 cm^{-1} 12.5-13.9 µm	0.352 for 224K scene
800-881 cm^{-1} 11.34-12.5 µm	0.2 for 234 K scene
881-1095 cm^{-1} 9.13-11.34 µm	0.2 for 218 K scene
1689-2150 cm^{-1} 4.65-5.92 µm	0.06 for 234 K scene
2150 - 2250 cm^{-1} 4.44-4.65 µm	0.06 for 228 K scene

The BAE Sounder Performance presentation that follows will provide GXS implementation-specific details regarding performance

Questions:

- What data products are you interested in?
- How will you use the data?
- What data qualities are important to you?