



Characterizing Noise Trends of the Cross-Track Infrared Sounder (CrIS)

Bryce Walker, Mark Esplin, Ben Esplin, Deron Scott

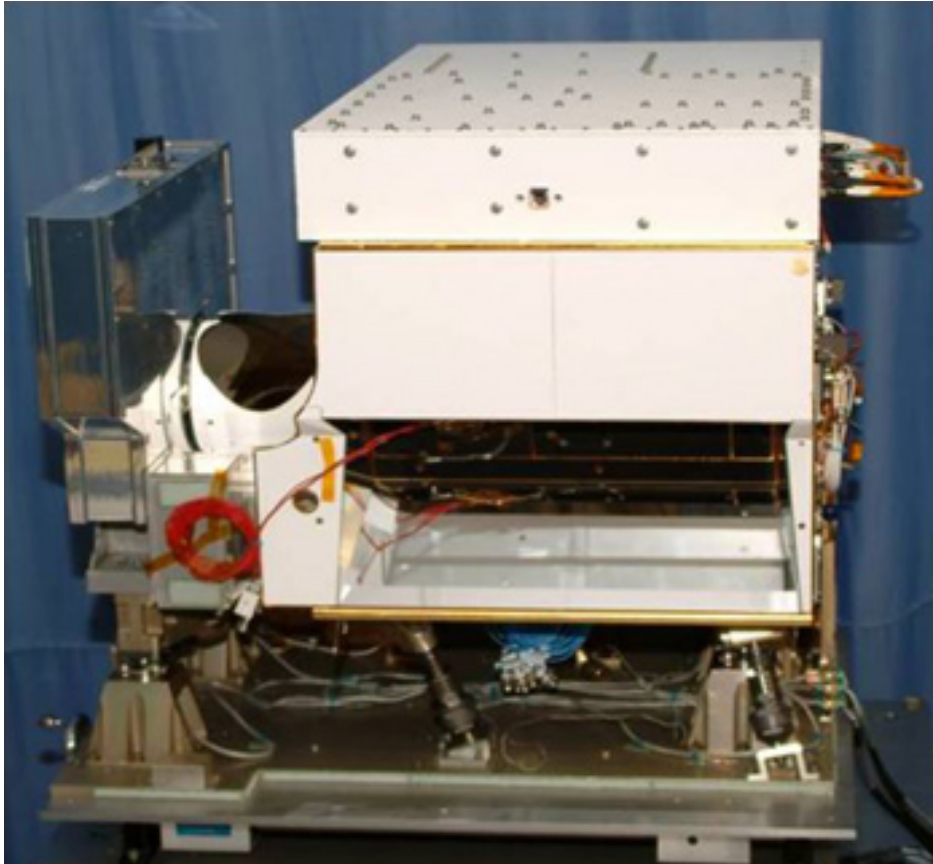
Outline

- CrIS Summary
- Noise characterization process
- Noise trending results
- Recent Changes
- Conclusions



http://www.jpss.noaa.gov/images/media-gallery/gallery-jpss1_1.jpg

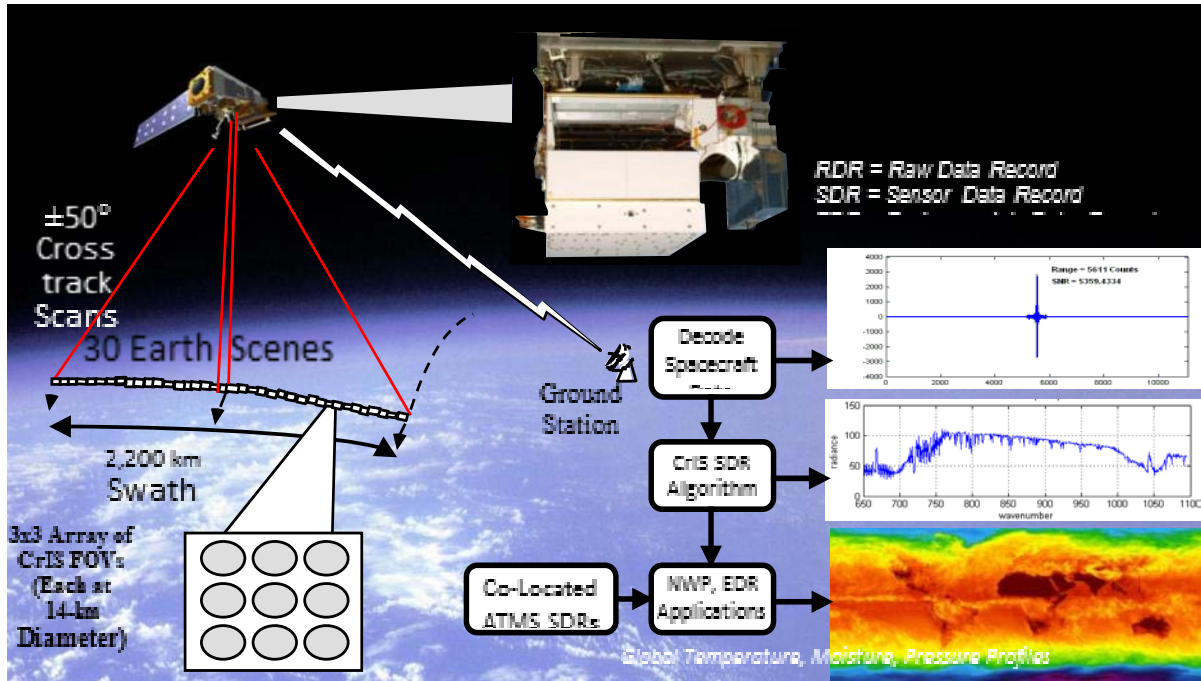
Cross-Track Infrared Sounder (CrIS)



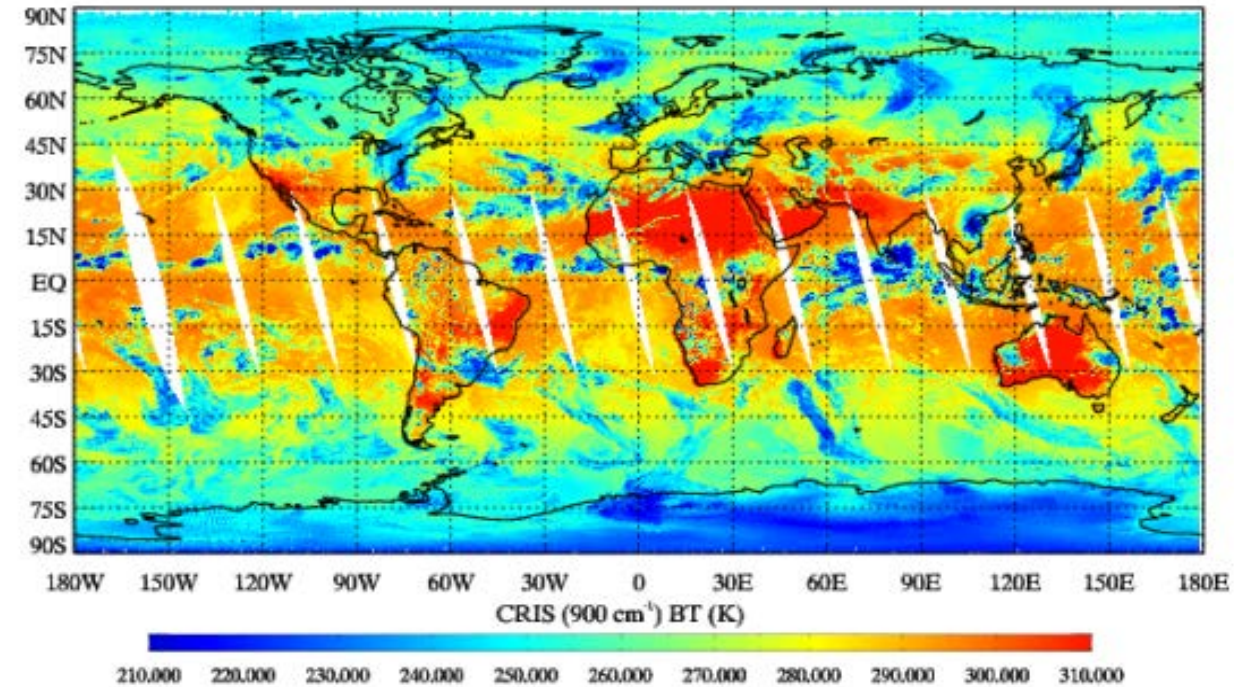
<http://www.jpss.noaa.gov/images/instruments-cris.jpg>

- The CrIS sensor is an infrared Fourier transform spectrometer
- One CrIS instrument is currently flying on the Suomi National Polar-orbiting Partnership (NPP) spacecraft
- Another CrIS (J1) is preparing for launch in 2017

What it does

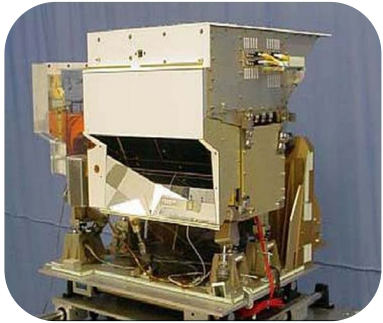


Ascending_orbits: CRIS (900 cm⁻¹) BT (K) Date: 2012-10-28

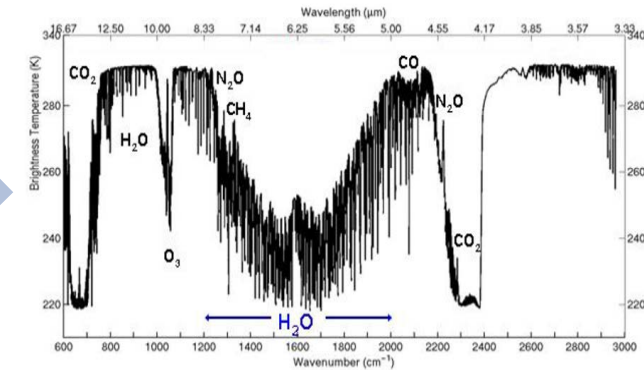
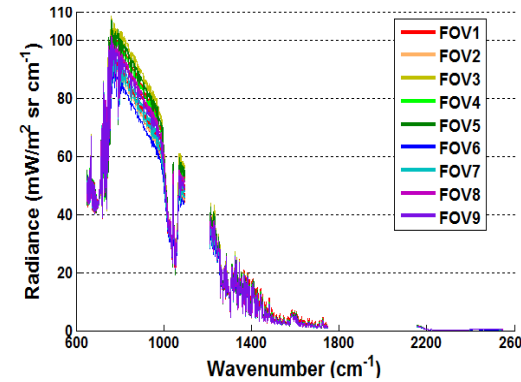
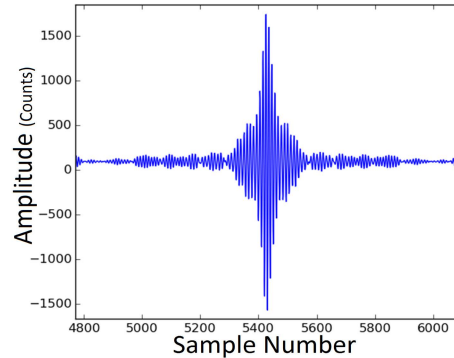


- CrIS takes optical readings of the atmosphere

How it works



<https://directory.eoportal.org/web/eoportal/satellite-missions/n/npoess>



Interferometer

- CrIS is an infrared Michelson Interferometer
- Its adjustable mirror arrangement causes interference, and the sensor detects varying light intensities

Interferogram

- The magnitude of light intensity is recorded several times as the mirror moves either forward or backward
- Data is sent to earth in packets

Spectra

- From the calibrated Fourier transform, the wavelengths of light that interfered with each other to make the interferogram can be determined

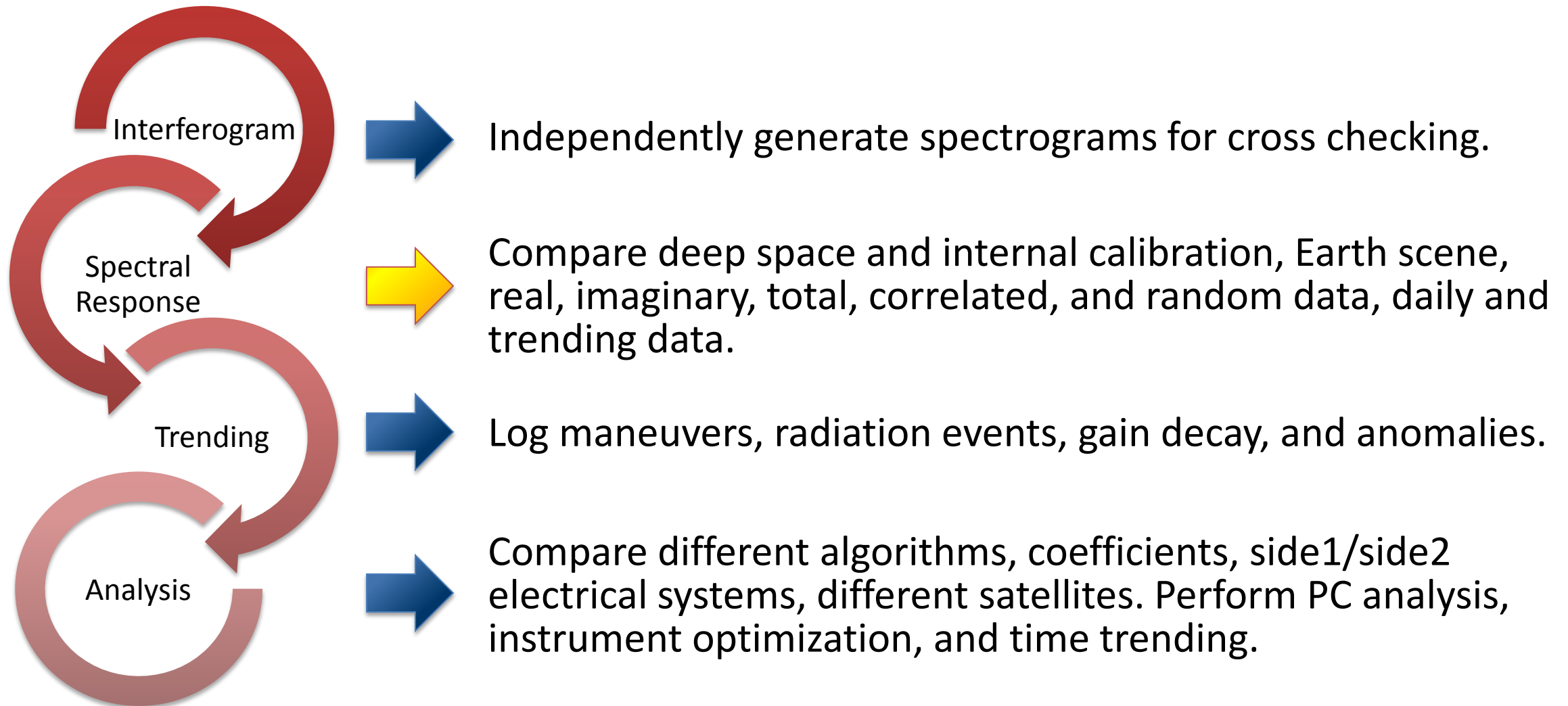
Use

- Data is converted into atmospheric profiles of temperature, pressure, and water vapor
- Information helps predict the weather, document trace gasses, protect sea wildlife*, and monitor climate change

- CrIS data helps determine how the atmosphere behaves

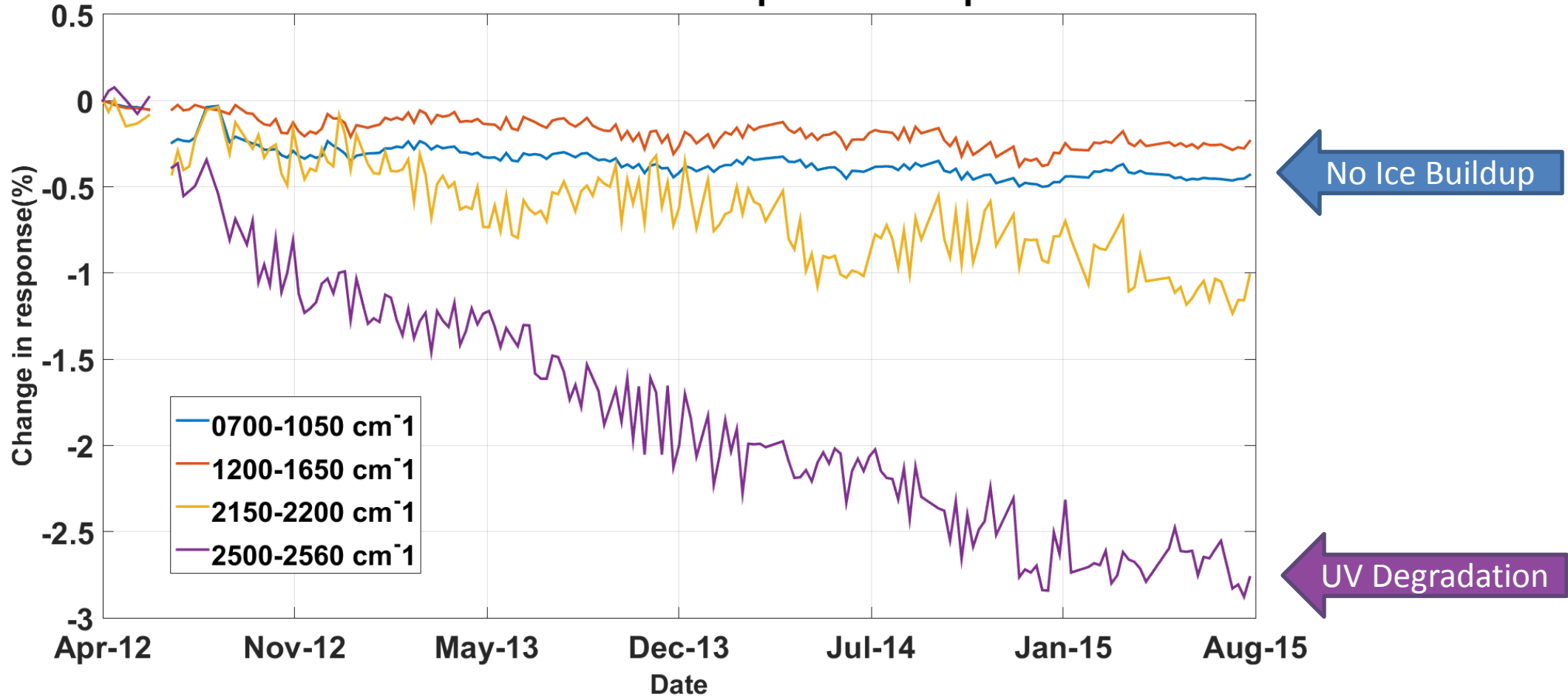
*<http://www.jpss.noaa.gov/media.html?story=news-62>

What SDL Does



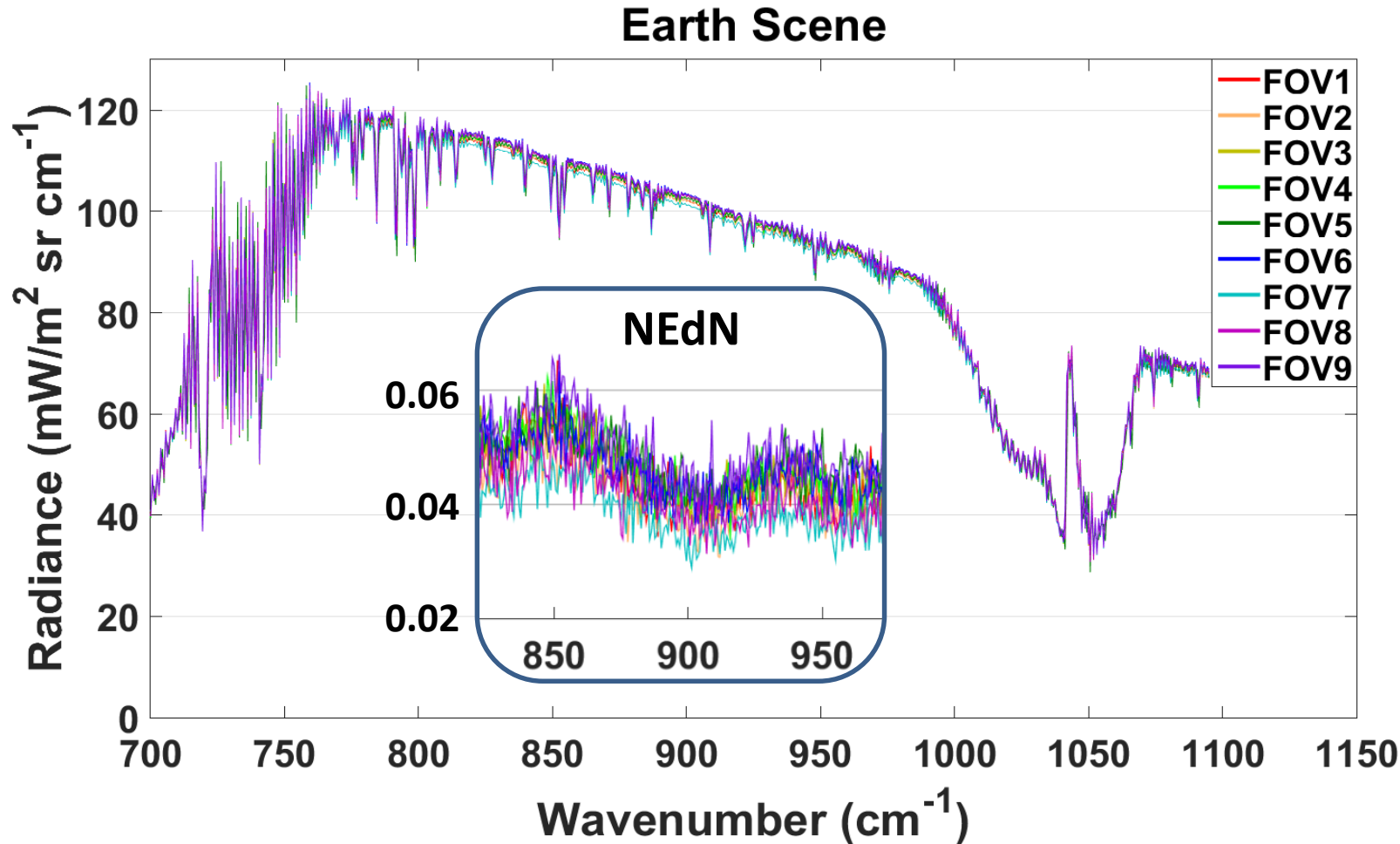
CrIS Relative Response over Time

CrIS Nominal Relative Response At Equator



- CrIS response has only dropped 3 percent in 3 years

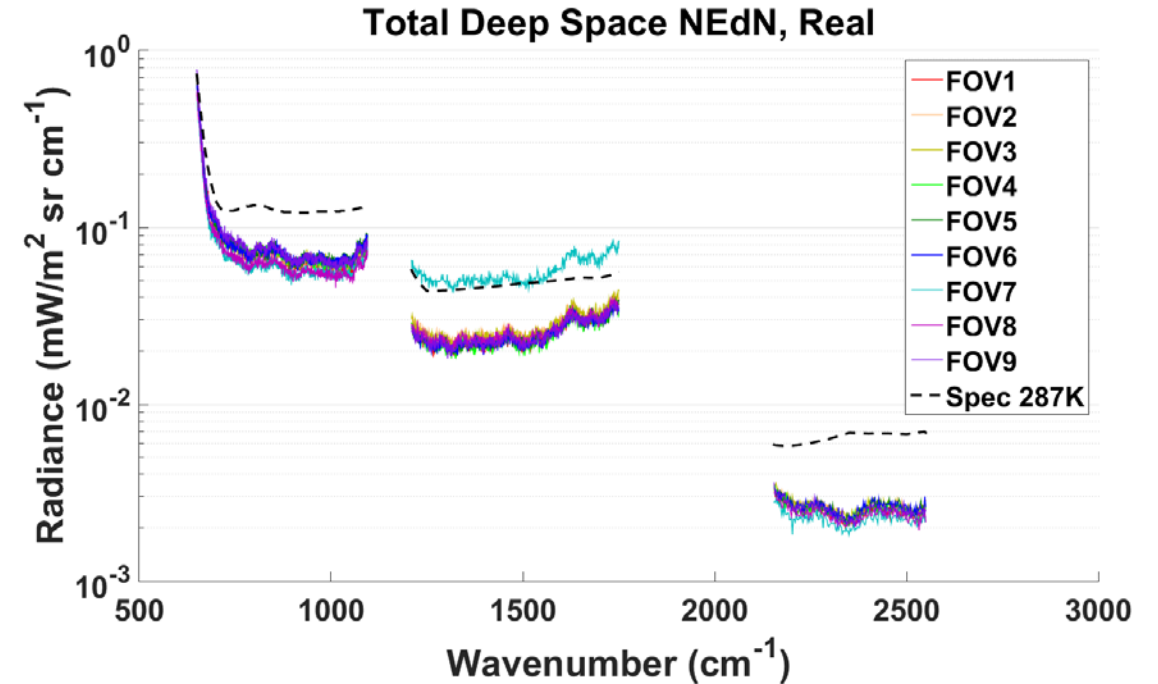
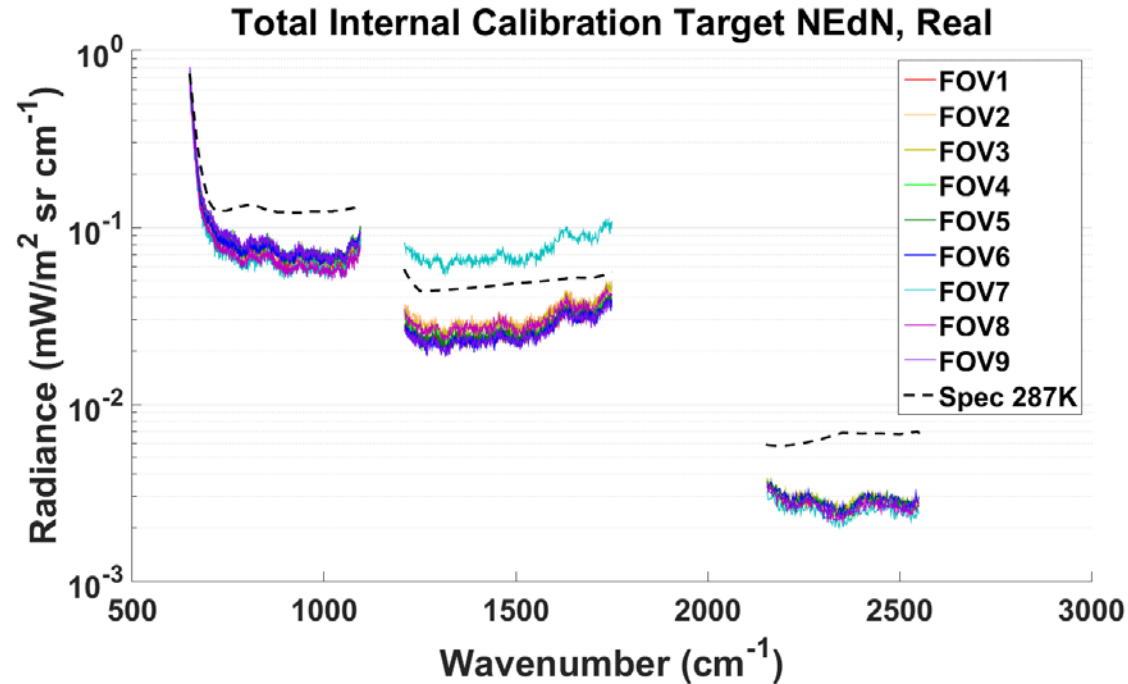
Noise



- SDL monitors the instrument's noise trending
- A higher signal-to-noise ratio (small NEdN) means more useful information can be pulled from the data
- Noise results reported for Earth scene, internal calibration target, and deep space scenes

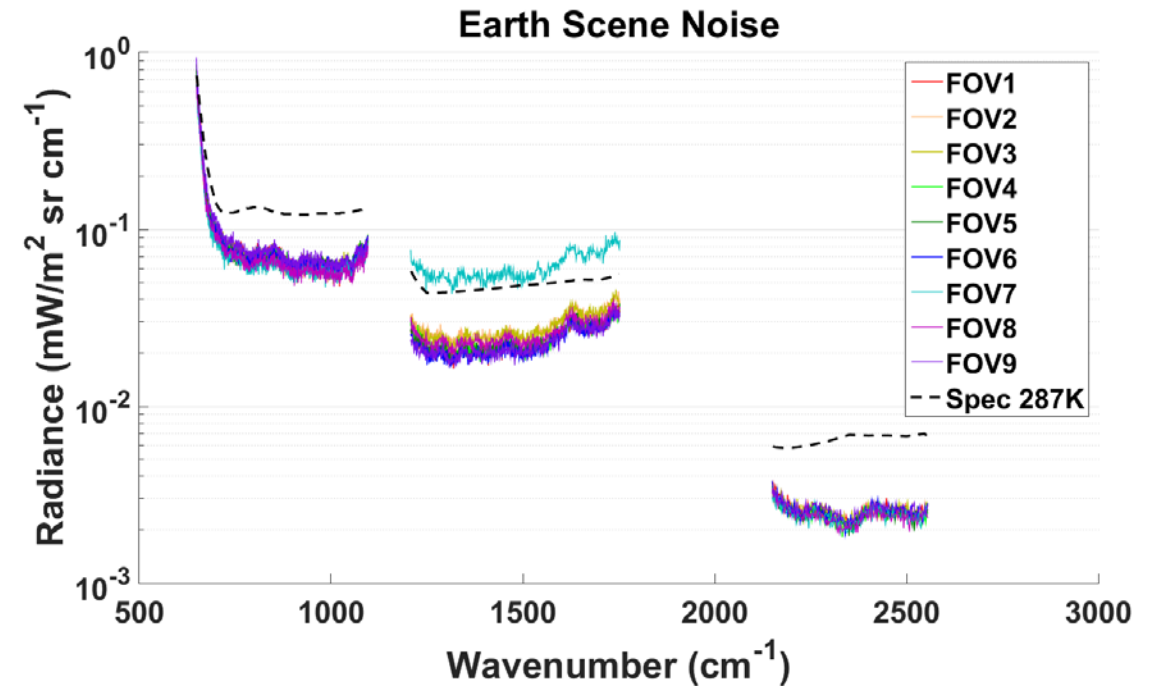
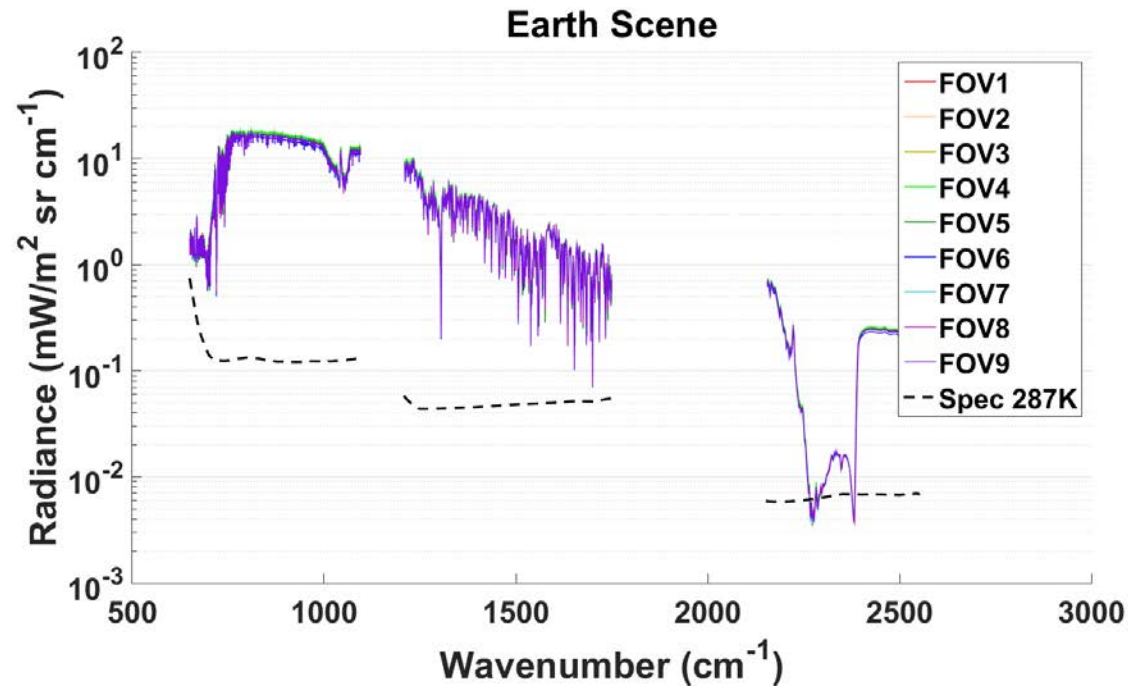
- The NEdN is very low for the CrIS instrument

Deep Space and Internal Calibration Target Noise Profiles



- Noise results broken into total noise, correlated noise, uncorrelated components
- Total noise derived directly from measurement (std-dev of multiple scenes)
- CrIS meets specification in all fields of view (FOV) except FOV 7

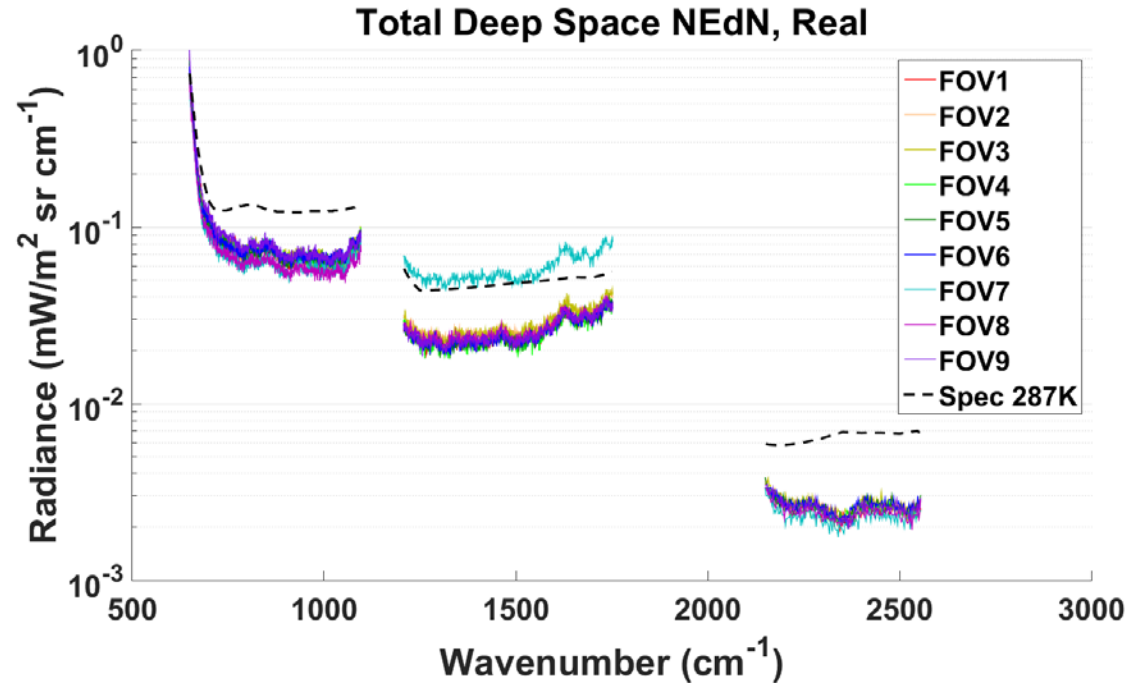
Noise Correction for Earth Scene



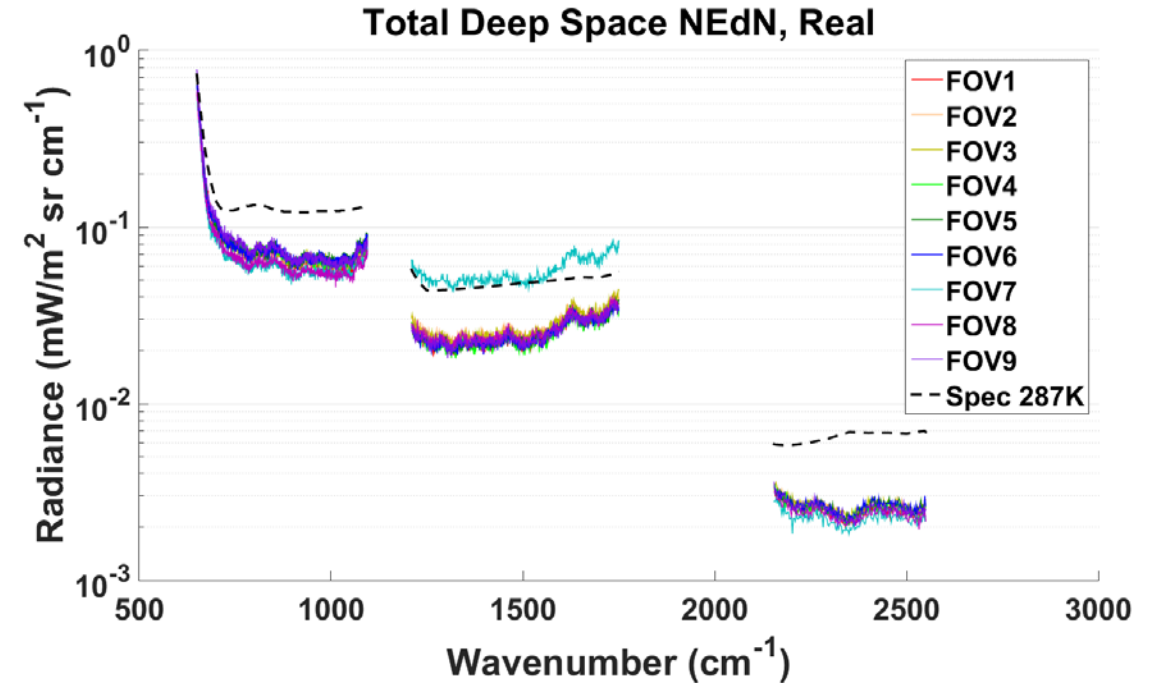
- Uncorrelated (random) and correlated noise derived from principle component analysis (PCA)
- With PCA, we can see NEdN in Earth scenes

NEdN not Significantly Different between Algorithms

Processed by ADL

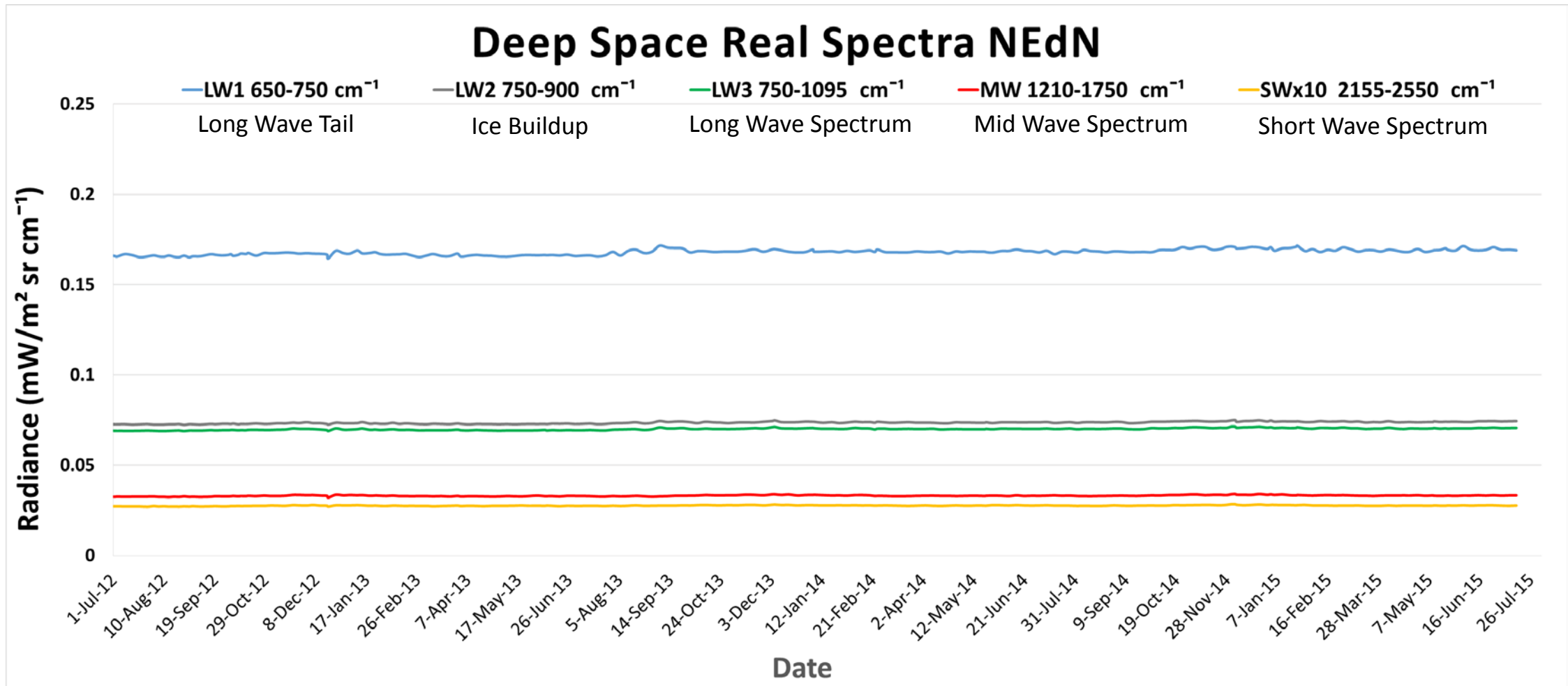


Processed by SDR Generator



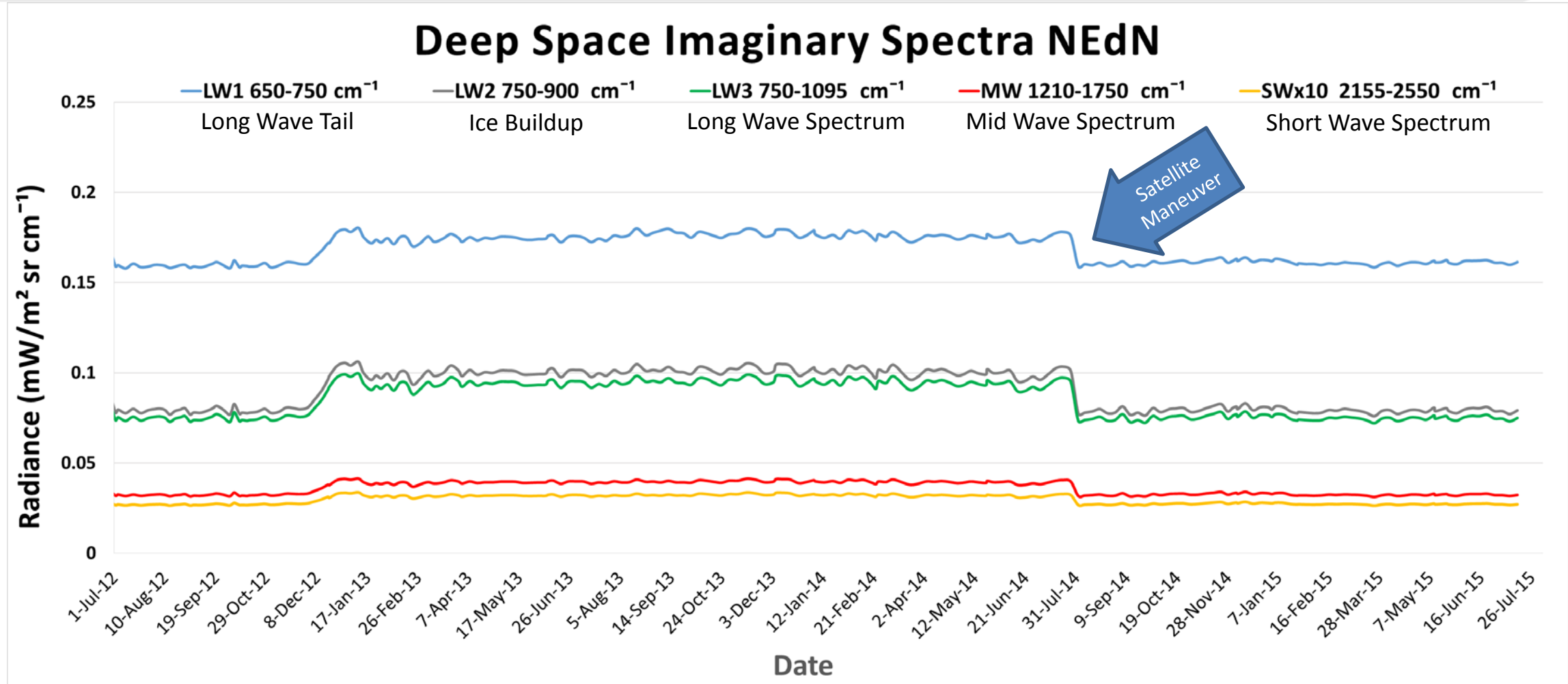
- NEdN is processing independent

Real Trending



- Worst case, NEdN has increased only 0.4%

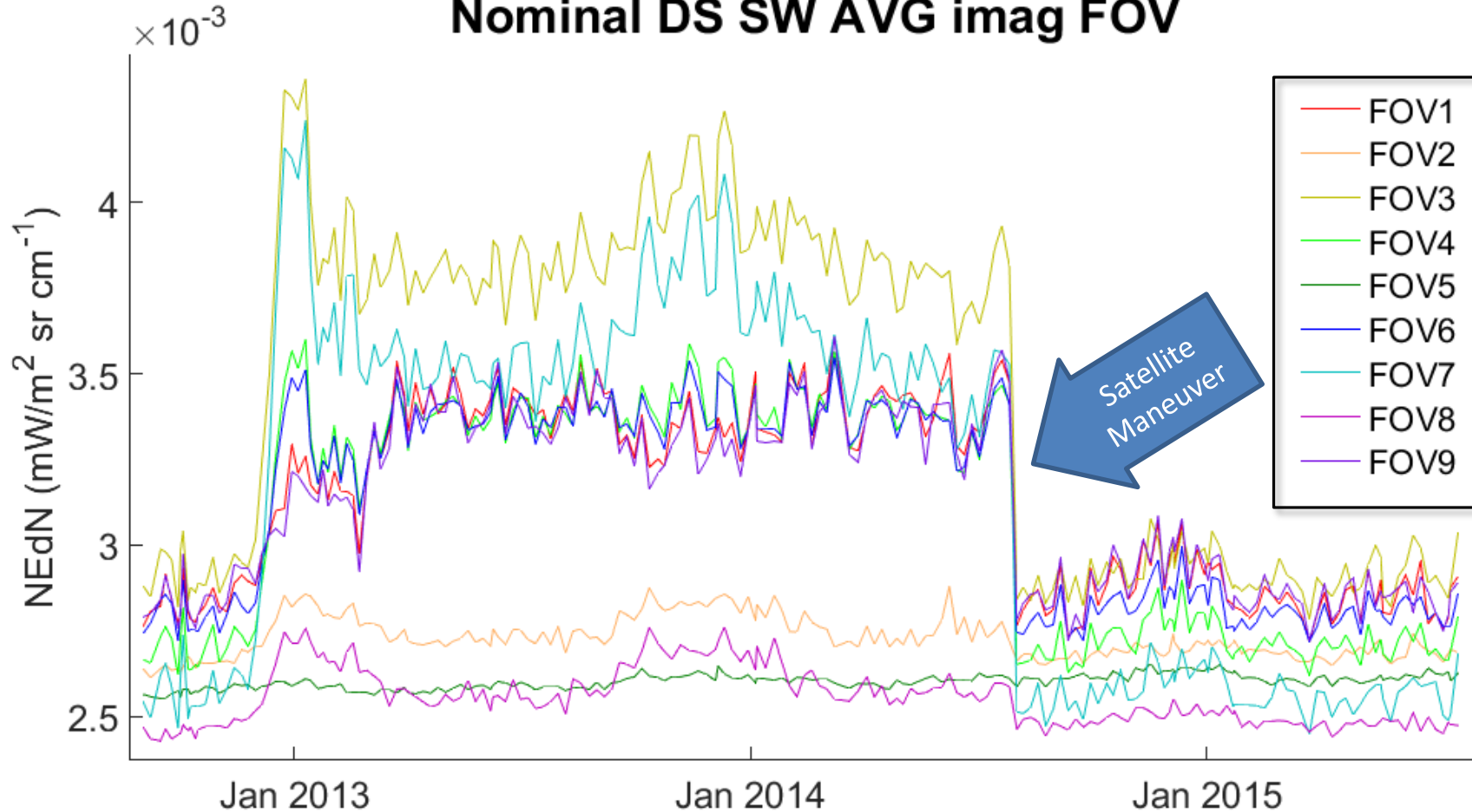
Imaginary Trending



- More variation in imaginary spectra

Independent FOV Trending

Nominal DS SW AVG imag FOV

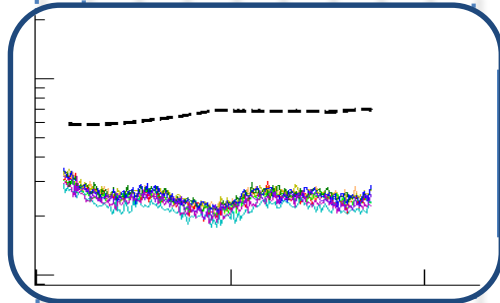


FOV Placement

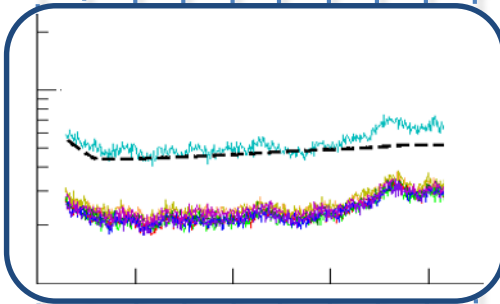
1	2	3
4	5	6
7	8	9

- FOVs not affected equally by satellite jitter/maneuvers

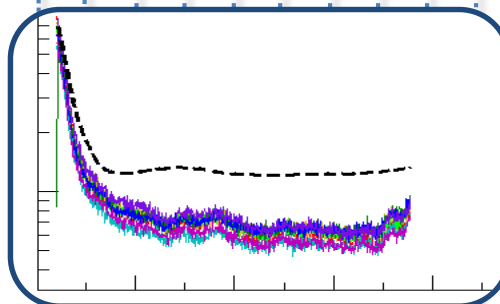
New Developments



Short Wave Band
2.500 cm⁻¹ **4** → 0.625 cm⁻¹



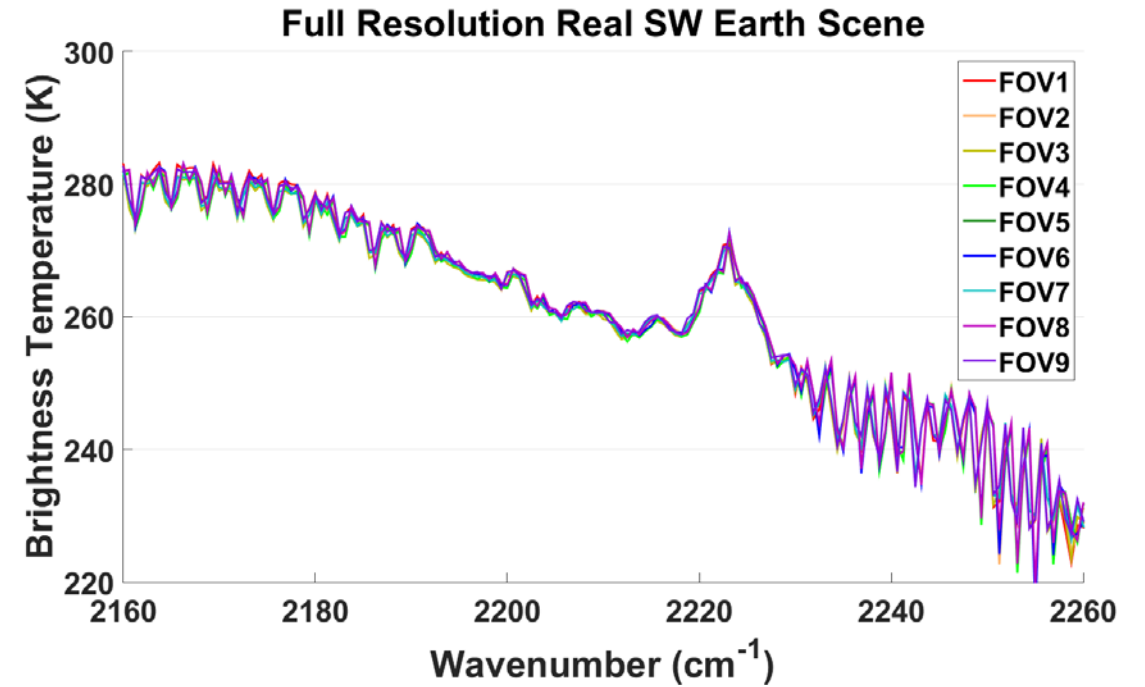
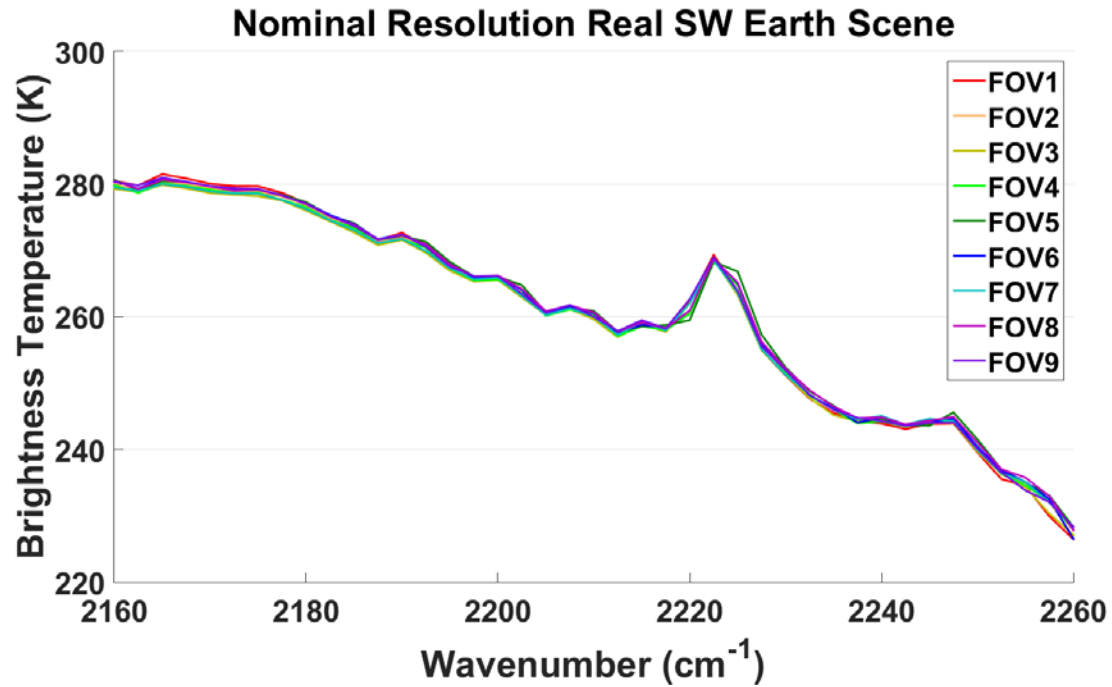
Mid Wave Band
1.250 cm⁻¹ **2** → 0.625 cm⁻¹



Long Wave Band
0.625 cm⁻¹ **1** → 0.625 cm⁻¹

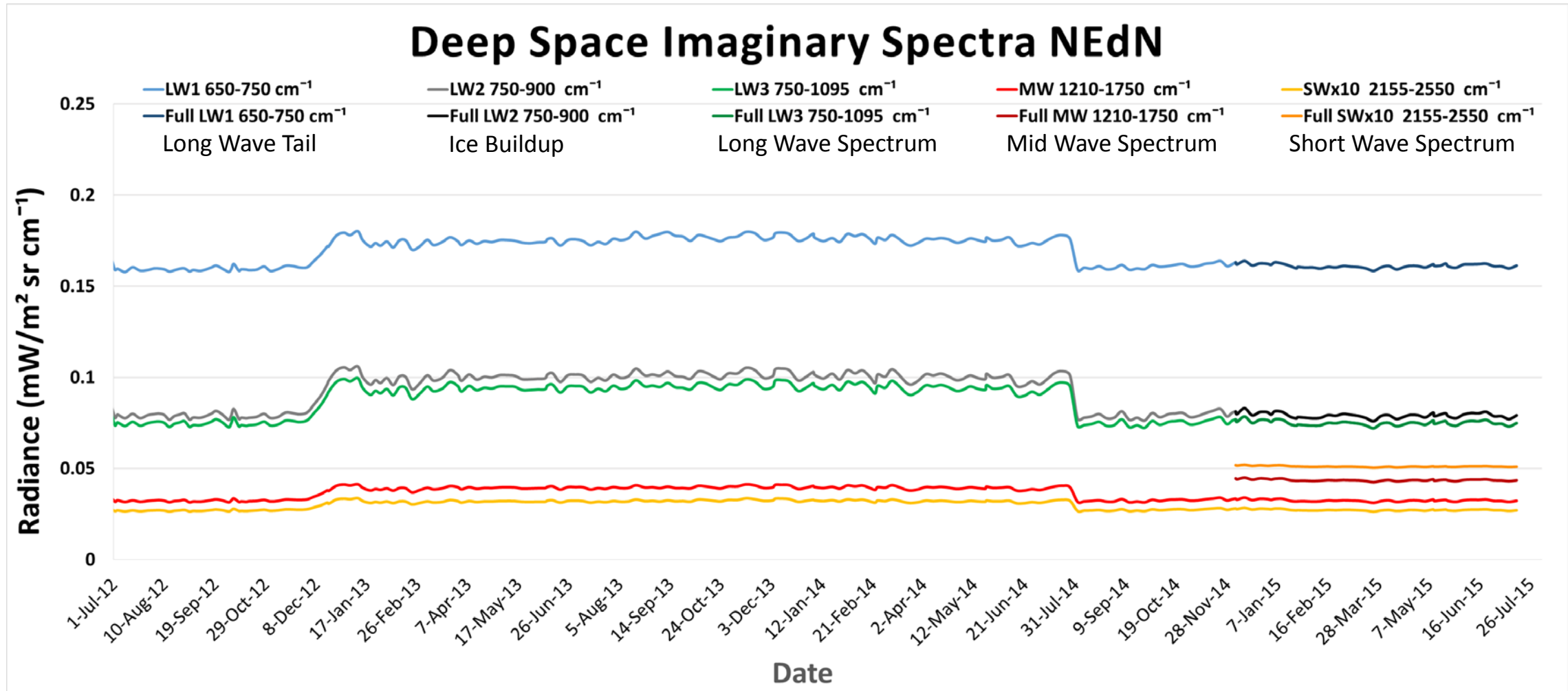
- During the past year, CrIS was reconfigured to enhance its spectral resolution
- Now all three spectral bands CrIS analyzes are sampled at 0.625 cm⁻¹
- CrIS now sends more data

Improvements – More Information



- Full resolution provides more data

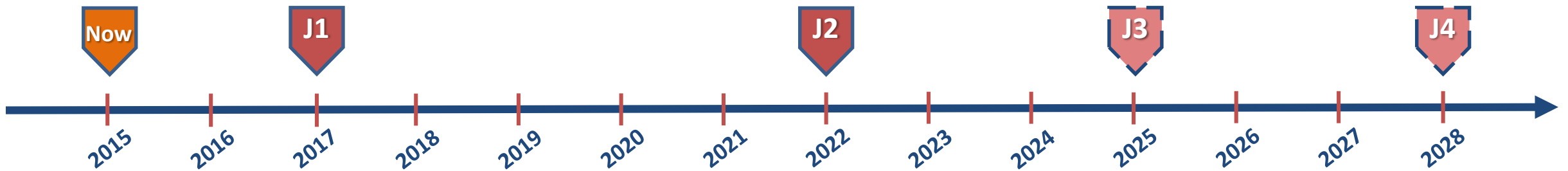
Challenges – Increased Noise



- Noise increases with more samples

A Look Ahead

- Assess J1 noise on orbit
- Compare with ground measurements to ensure consistency
- Compare NPP and J1 noise
- 2 CrIS instruments in space by 2017

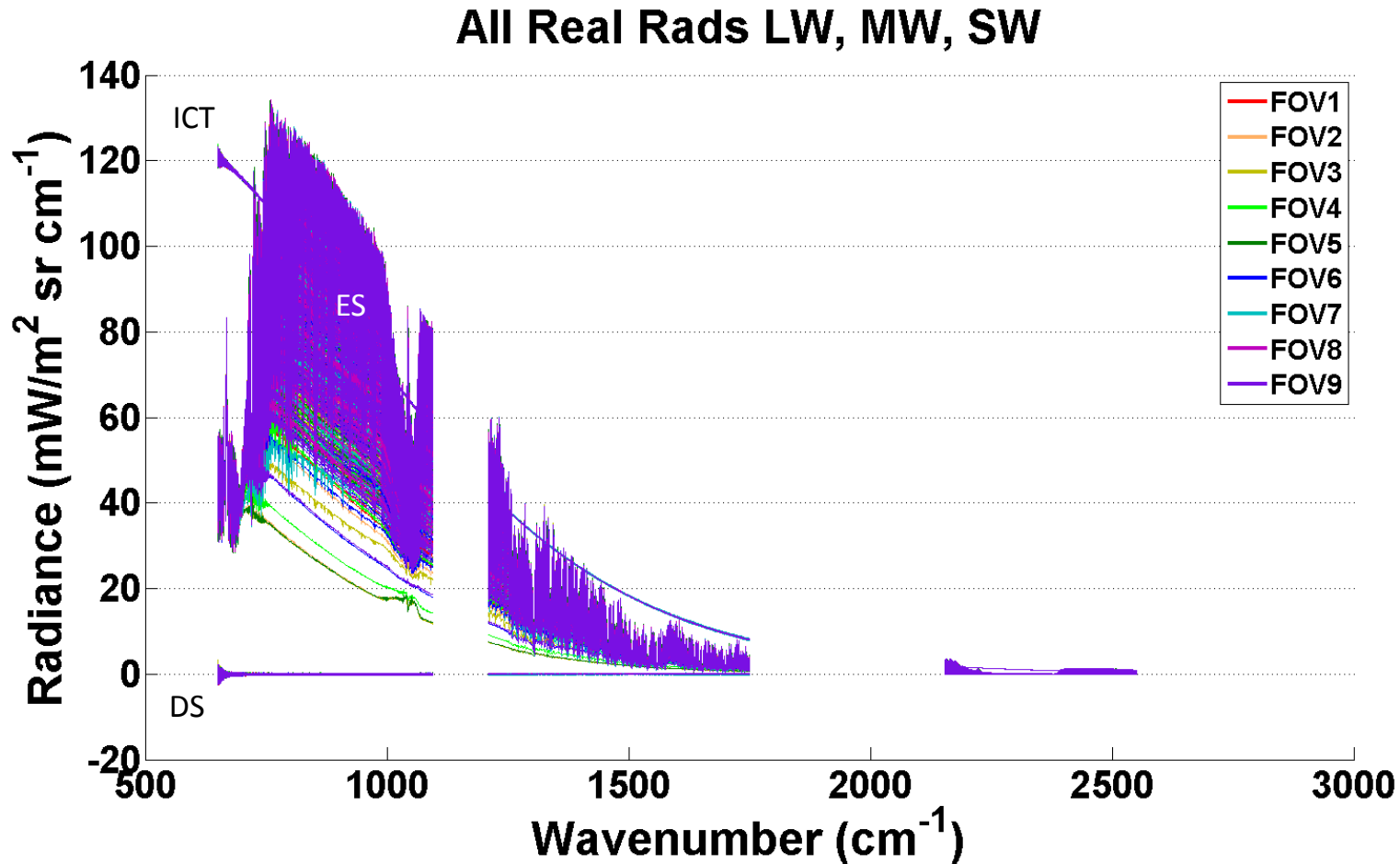


Conclusion

- Response degrades slowly
 - Spectral response will last the life of the instrument.
- NEdN is very low
 - Over the life of the instrument, it has increase by only 0.4%
- Noise is algorithm Independent
- Imaginary NEdN helps characterize payload
- Improved resolution provides more data

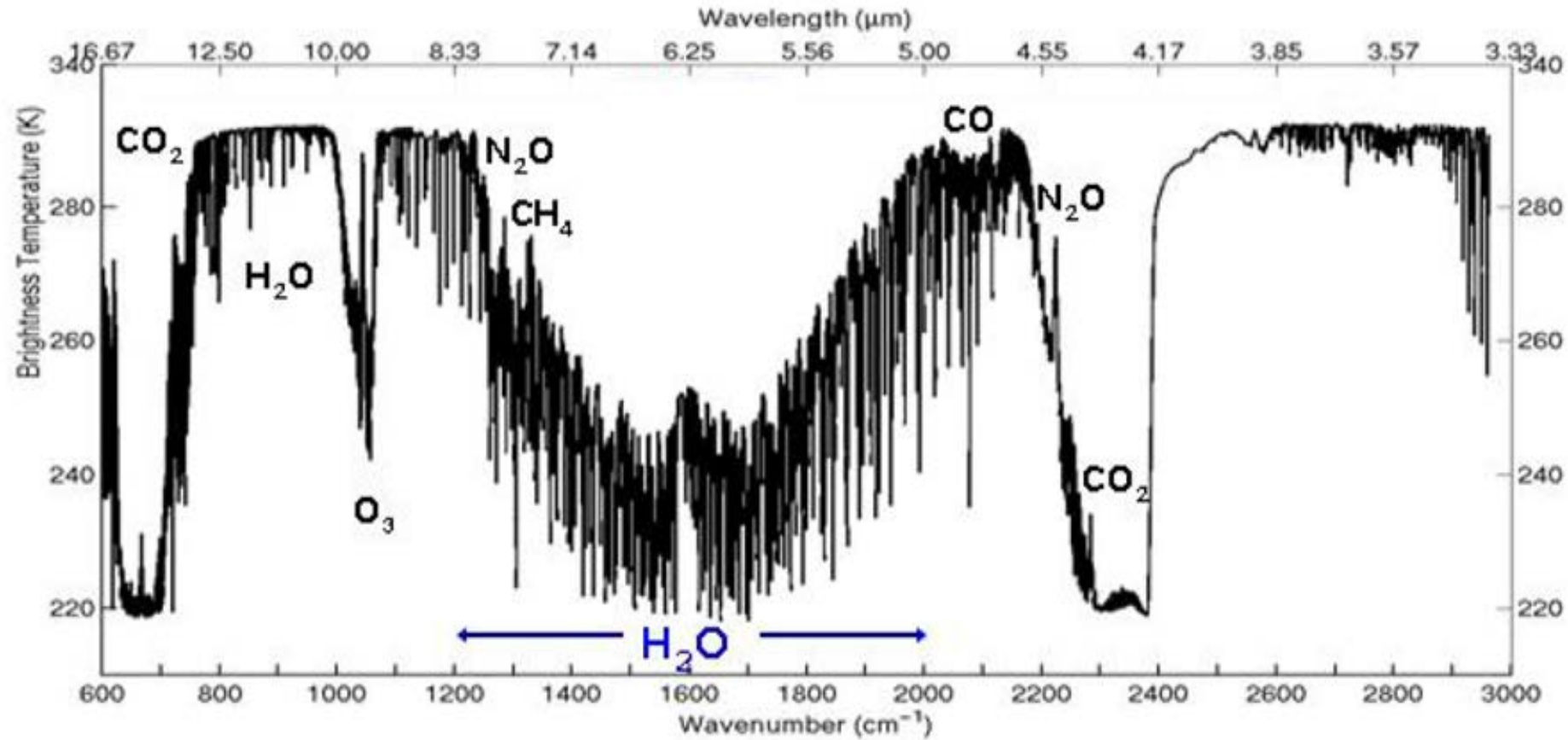
ADDITIONAL SLIDES

Deep Space, Earth Scene and Internal Calibration Target



- Earth Scenes are much noisier

Spectral Signatures of Atmospheric Gasses



- Different gasses absorb different wavelengths