THE VALUE OF PERFORMANCE.

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NGAS Support to CrIS SDR CalVal

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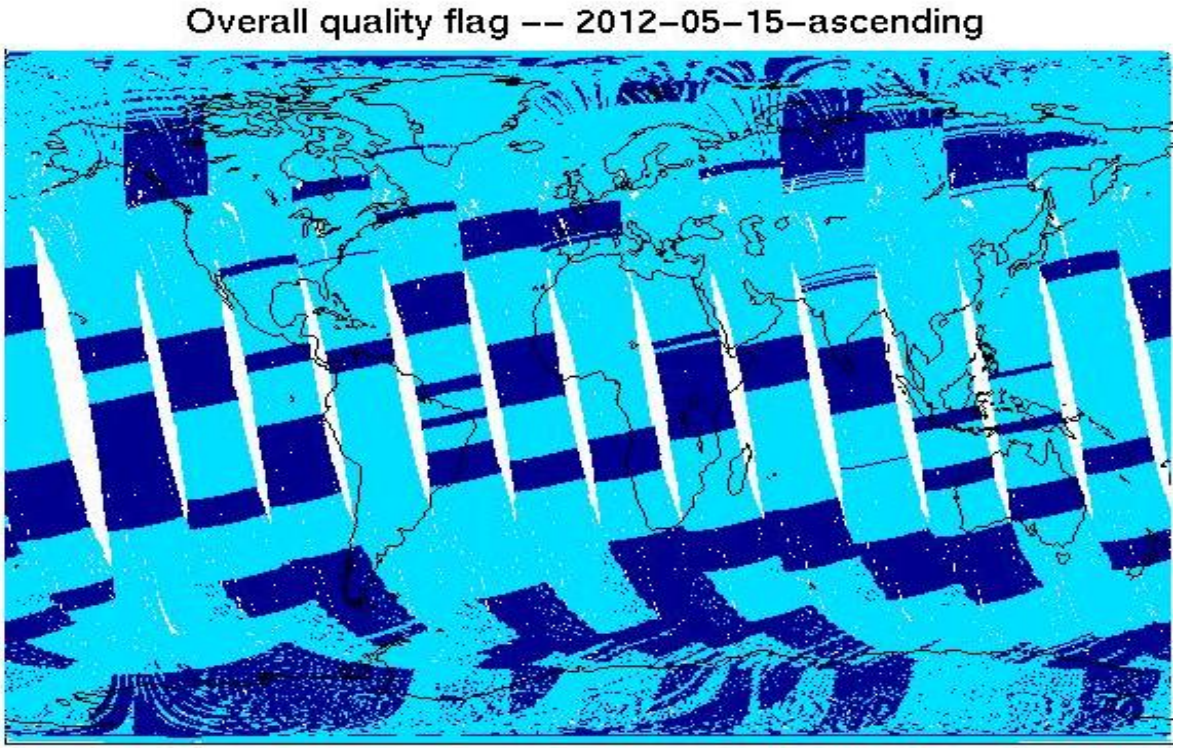
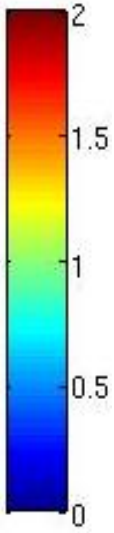
May 14, 2014

NGAS Activities in Supporting CrIS SDR CalVal

- Supported CrIS SDR algorithm/data product DR investigations
  - 27 DRs formally assigned to NG team to investigate since Launch
- Developed, verified and implemented CrIS SDR algorithm code updates using G-ADA
  - 8 CrIS SDR code update packages delivered to DPES since Launch
  - All major algorithm modules are affected and significantly improved by the CrIS CalVal team (ILS correction, Radiometric calibration, Quality flags, Robust error handling)
- Supported SDR performance assessment and characterization
- J-1 SDR algorithm development
  - Science improvement
  - Software development

CrIS SDR Data Product at Mission Start





Quality flag
2 – invalid
1 – degraded
0 -- valid

Distribution of overall quality flag for CrIS Golden Day May 15, 2012. Note CrIS SDR data were incorrectly labeled as degraded extensively

Significantly Improved CrIS SDR Algorithm to Produce Quality SDR Data Products

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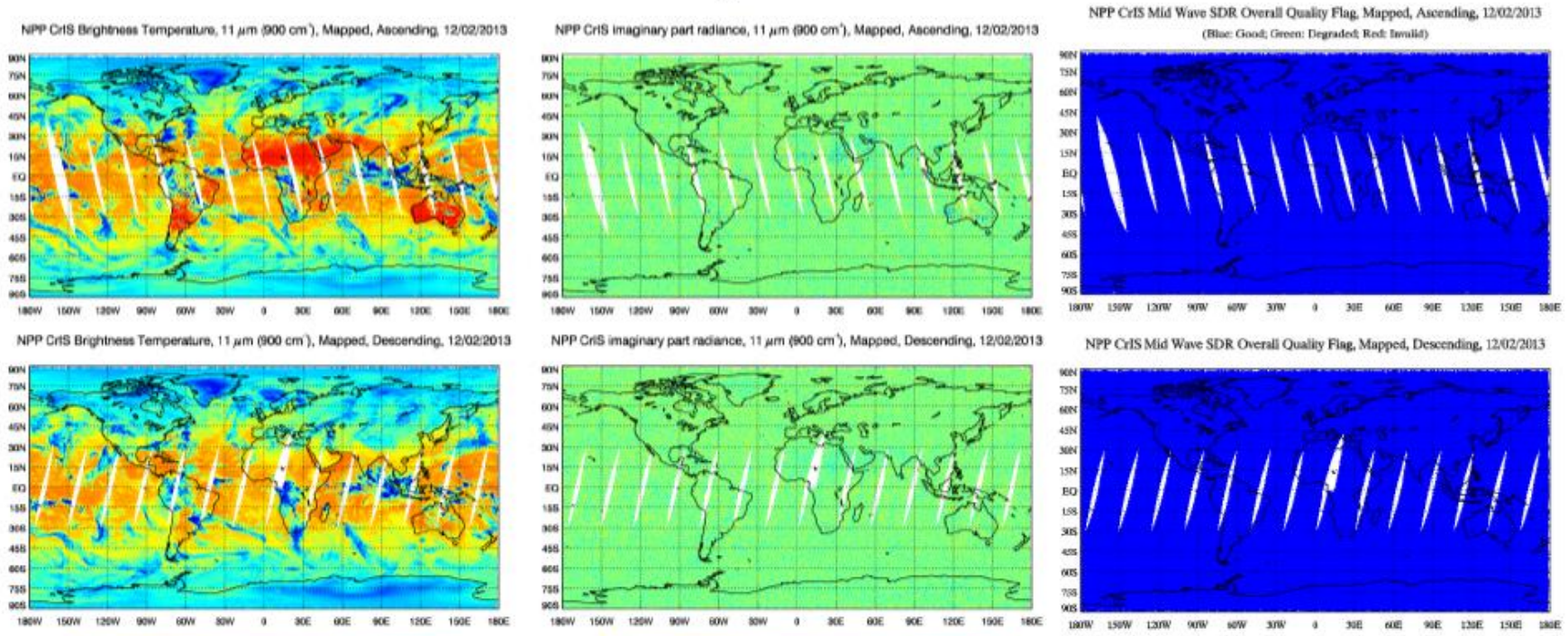
Example of data quality after Mx8.0

Real radiance

Near zero Imaginary radiance indicates good real radiance

Overall SDR quality flag
Blue - good



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(Courtesy of Yong Han, STAR)

CrIS SDR Algorithm Code Updates to Resolve DR7542

- DR 7542: CrIS SDR NEdN with zero values
  - Zero NEdN values were found in operational CrIS SDR valid data products
- Root cause
  - The code internally uses the binSize of ICT spectrum of the 1st scan in the sliding window to compute NEdN values
  - When this ICT spectrum is determined by the algorithm to be invalid, its binSize is set to zero and therefore NEdN is never computed. Later the algorithm writes out the default value of zeros for NEdN in the CrIS SDR data product
- Code updates
  - Update 1: In the extreme case when all ICT spectra in the sliding window are invalid, NEdN values can not be computed. In this case, the code should output fill values for NEdN instead of zero. Modified code to replace zero NEdNs with fill values (-999.8)
  - Update 2: Fix the identified code bug to compute and output valid NEdN values. Rather than using the binSize of the first ICT spectrum in the sliding window (not guaranteed to be always valid), the code is modified to search through the sliding window for a valid spectrum and use its binSize to compute NEdN values

CrIS SDR Algorithm Code Updates to Resolve DR7466

- DR 7466: Occurrence of extended SDR anomaly due to time stamp error
  - A corrupted time stamp of a reference spectrum should only affect SDR radiances that are calibrated using the specific reference spectrum. But extended anomaly is observed and persists for a longer period of time
- Root cause:
  - Algorithm checks for invalid reference (Deep/ICT) spectra to exclude them from being saved in a buffer. They are flagged using the SDR_Invalid flag. But later the code uses the RDR Missing flag to determine whether to remove invalid reference data from the calibration window buffer, causing misalignment
- Code updates
  - Modify the code to check SDR Invalid flag instead of RDR Missing flag to determine whether an invalid SDR reference spectrum should be removed from the buffer
  - Update other part of the code to be consistent with the above code change

Proposed a new Approach for CrIS Spectral Calibration

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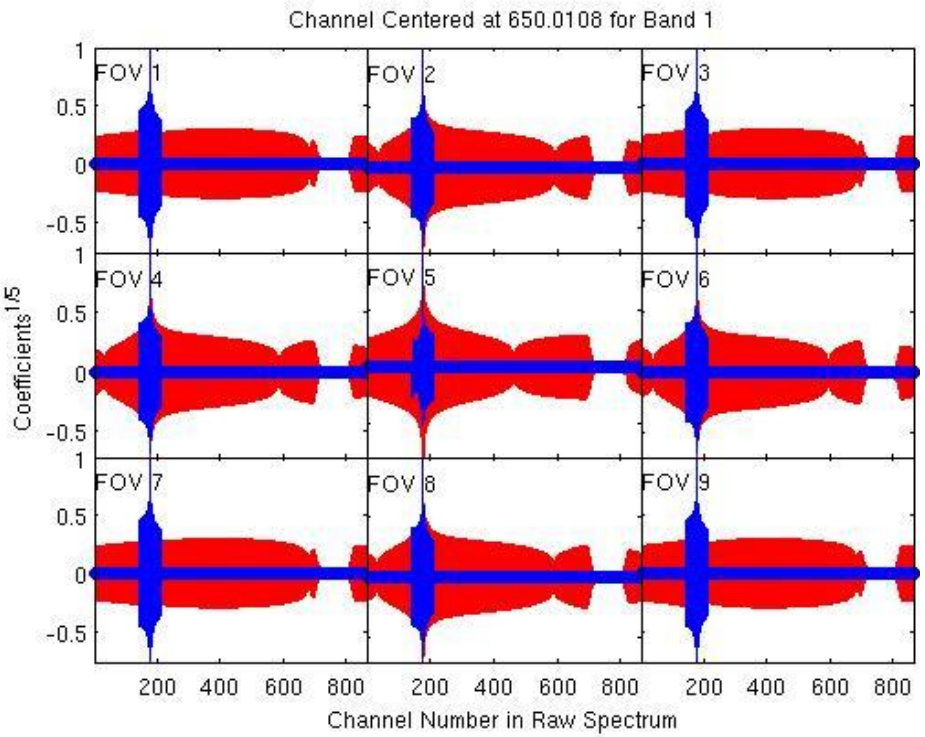
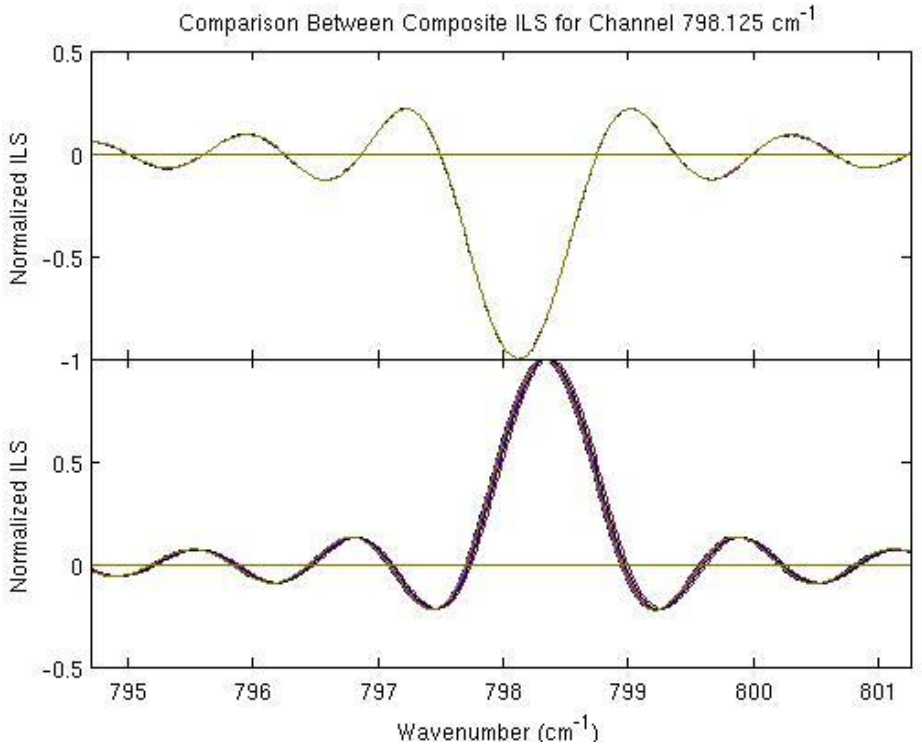
- Least square approximation of the user required ILS by combining native sensor ILS based on detailed modeling of sensor effects
  - Ideal point detector, finite size detector, Finite Impulse Filter, decimation
  - Current SDR algorithm does it in two steps, also by combining native sensor ILS of all bins in each band, but the coefficients are computed based on physical/mathematical models
- The new approach performs frequency resampling and self-apodization correction in one simple step
- The new approach is intended to ensure consistency between CrIS SDR data products and the presumed ILS used by the user community in developing their forward models (e.g., CRTM, OSS RTM in CrIMSS EDR algorithm)

Comparison of ILS Generated by CrIS SDR Algorithm and the new Approach





The new approach provided an objective criterion for evaluating different calibration approaches, assuming that instrument ILS can be accurately modeled

Verification of CrIS SDR Performance Using TVAC Data

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- Issue: significant errors observed in TVAC data after processing using the CrIS SDR algorithm
  - Wavelength dependent and up to ~0.3% in the SW band
- Root cause: most of the errors are due to the instrument operator being removed from the calibration equation
  - Should be

$$L^S = F_{INT}^{-1}\left[\frac{\tilde{S}^S - \langle\tilde{S}^{DS}\rangle}{\langle\tilde{S}^{ICT}\rangle - \langle\tilde{S}^{DS}\rangle}\right] \cdot F_{INT} L^{ICT}$$

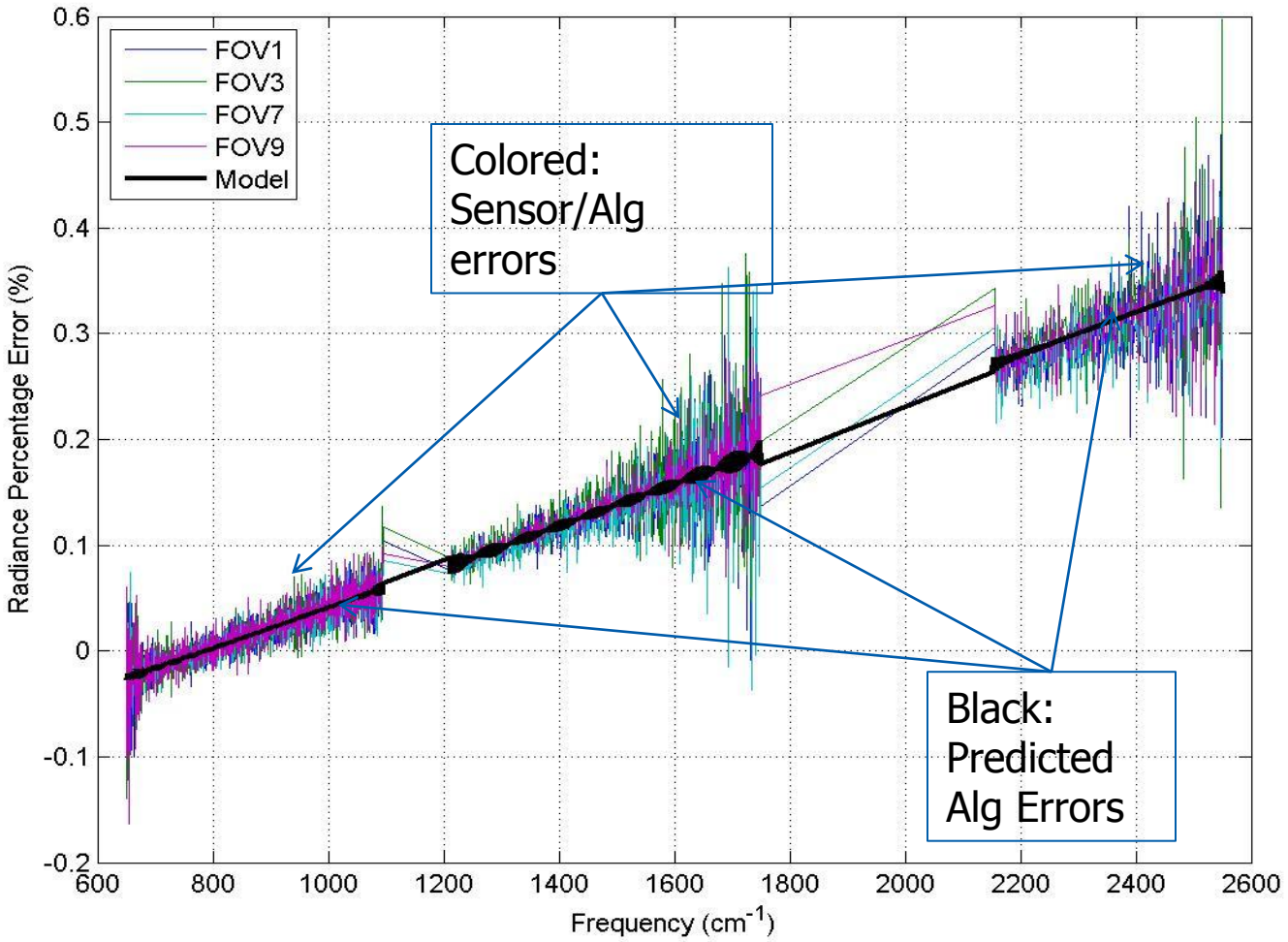
  - Implemented in the code

$$L^S = F_{INT}^{-1}\left[\frac{\tilde{S}^S - \langle\tilde{S}^{DS}\rangle}{\langle\tilde{S}^{ICT}\rangle - \langle\tilde{S}^{DS}\rangle}\right] \cdot L^{ICT}$$

F_{INT} is the instrument operator that represents the ILS effects, including all effects that the instrument might introduce such as self-apodization, IGM modulation, etc. The notation implies that the radiance has been affected by the instrument

F_{INT} Effect on Radiometric Calibration

The observed radiance errors in TVAC data are consistent with the predicted algorithm errors due to dropping the F_{INT} term in the calibration equation



Improved Radiometric Calibration After SDR Algorithm Update

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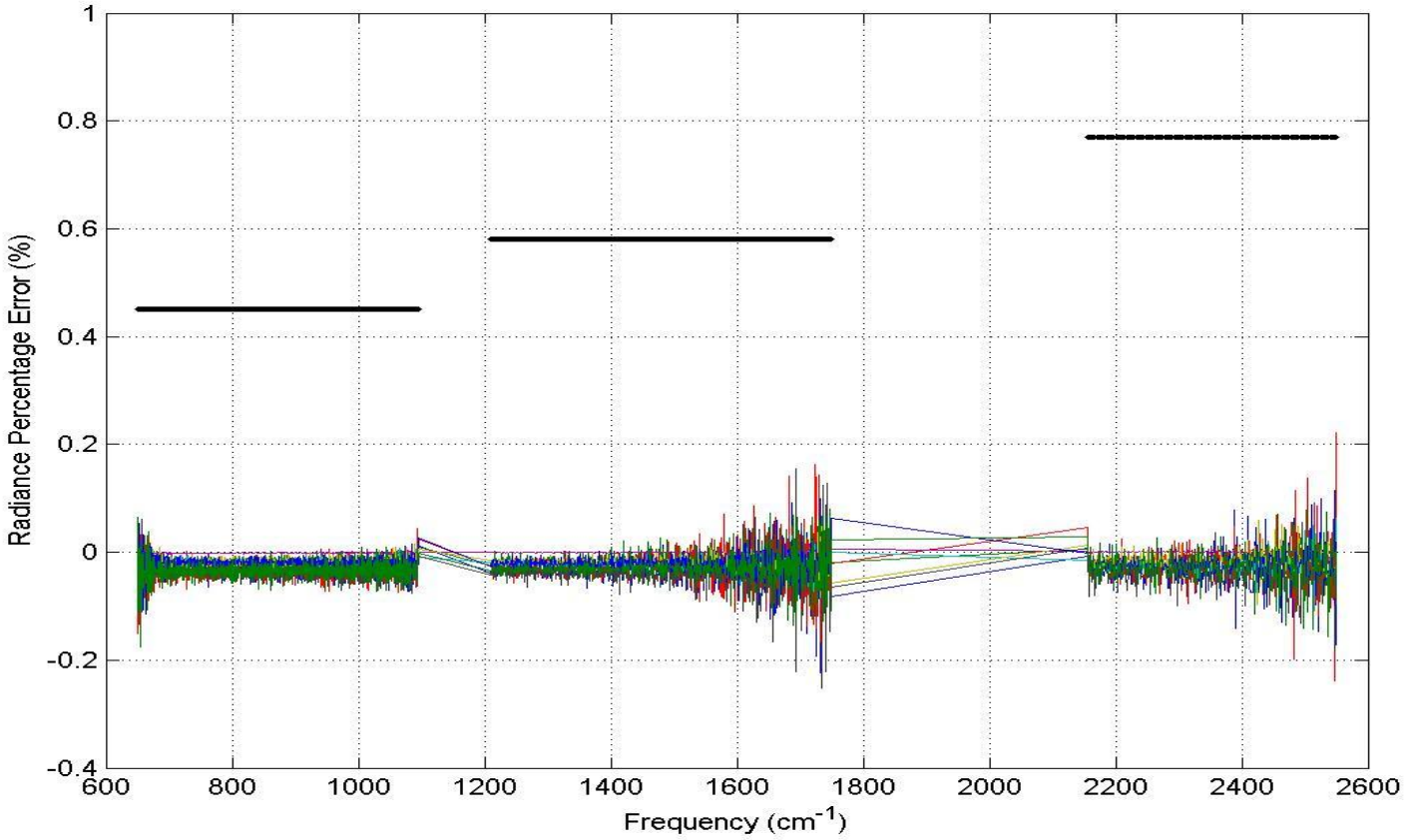
- Small residual errors suspected to be caused by SA correction matrix not properly normalized

Difference between new baseline results and "ILS-Off" results ("Truth")



Next Steps

- Continue to Support S-NPP CrIS SDR Cal/Val
- Support J-1 SDR algorithm development
- Support to CrIS sensor TVAC test data analysis
  - Verification of both sensor performance and algorithm performance using TVAC data