Recent activities of the GOES-R Calibration Working Group

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Pre-Launch Analysis

Support of the GOES-R Flight Segment has been primarily in the form of analysis of data from pre-launch testing of the Advanced Baseline Imager (ABI) Prototype Model (PTM). The CWG reviewed much of this data and issued reports highlighting the agreements and disparities between the CWG's and vendor's analyses. Completed reports include the Irradiance Calibration, Reflective Channel Calibration, Emissive Channel Calibration (Figure 1) and Coherent Noise tests. Analysis of the remaining PTM test data is currently underway.

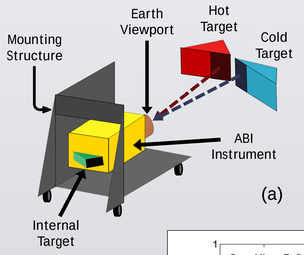
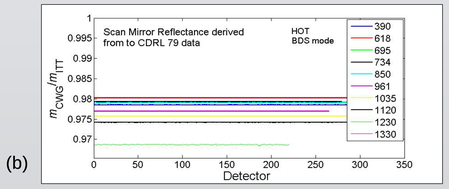
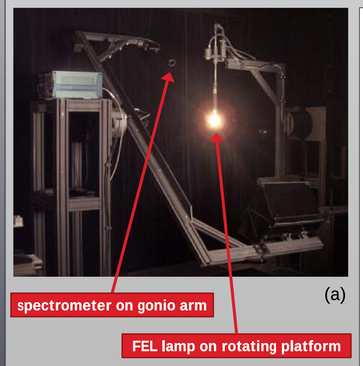


Figure 1: Experimental setup used during the Emissive Channel Calibration of ABI (a). Example result depicting relative agreement between CWG and the instrument vendor on the slope of the calibration curve as a function of detector row (b).



NIST Support

Working with NIST the CWG completed several analyses pertaining to pre-launch validation of the ABI instrument. The spatial uniformity of the output from the FEL lamp, used to establish the ABI solar diffuser irradiance-to-radiance transfer function, was characterized as seen in Figure 2. In addition select ABI channels underwent end-to-end testing of their spectral response with the Spectral Irradiance and Radiance Responsivity Calibrations Using Uniform Sources (SIRCUS) facility.



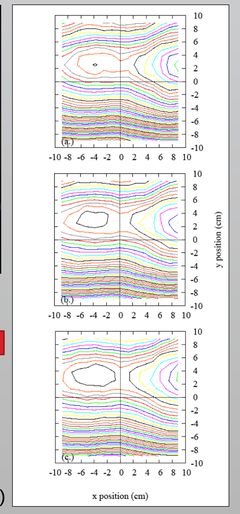


Figure 2: Experimental setup used during portion of the FEL uniformity test (a). Example result depicting the geometry-corrected percent deviation of the signal from the origin (b). Contour intervals are 0.1%.

Simulated ABI Imagery

With the recent launch of the Visible Infrared Imaging Radiometer Suite (VIIRS) it is possible to construct mesoscale, CONUS and full-disk mosaics to simulate ABI imagery. This is due to the fact that the large swath width of VIIRS allows for complete, gap-free coverage of the Earth. In addition many of the ABI channels have a similar spectral response to VIIRS bands (Figure 3). This ability allows the CWG to simulate phenomenology captured by VIIRS as it would be seen by ABI (Figure 4), as well as provide for the ability to conduct post-launch cross-validation analyses of radiance imagery between ABI and VIIRS. The CWG is currently developing these simulation tools to make full use of the opportunities VIIRS imagery provides.

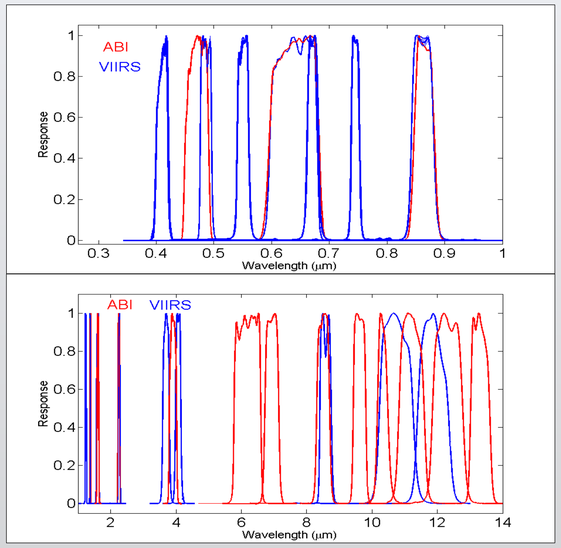


Figure 3: Spectral response functions for the reflective (top) and emissive (bottom) channels of ABI and VIIRS. Note that only the VIIRS "M" Bands are depicted here.

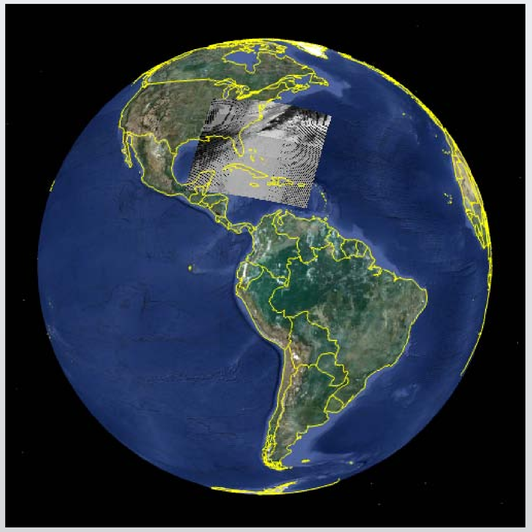


Figure 4: Preliminary simulated Channel 11 (8.5 μm) ABI imagery produced from VIIRS Band 14 data. Image boundary approximates an ABI mesoscale product.

Lunar Irradiance Analysis

Post-launch calibration activities for the past year have focused on vicarious calibration of ABI using lunar irradiance. One of these studies focused on comparing the predicted lunar irradiance values from the USGS Robotic Lunar Observatory (ROLO) Model with those given by the Miller-Turner (MT2009) Model. This comparison is shown in Figure 5 below, where the output irradiances from ROLO for the six ABI reflective channels are plotted against the spectral output from the MT2009 model.

The second effort in this area was an attempt at predicting the number of lunar observation opportunities available to ABI during a given calendar year. Satellite positions for GOES-13, predicted using the Simplified General Perturbation Model (SGP4), were used in conjunction with known orbits of the sun, Earth and moon to calculate the lunar phase angle as seen by the satellite. Figures 6 and 7 show that by constraining the phase angle to < ±25 degrees and projecting the ABI field of regard (FOR) of 23.1 degrees, with an exclusion zone of 0.5 degrees near the Earth edge, 36 lunar imaging opportunities were predicted for the year 2016.

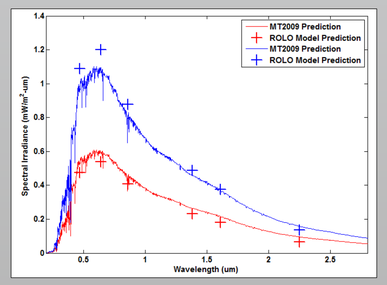


Figure 5: Comparison of the MT2009 and ROLO lunar irradiance models for the six ABI reflective channels.

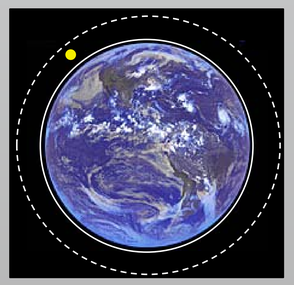


Figure 6: Moon's appearance within the annular ring between Earth's limb margin and the ABI's FOR.

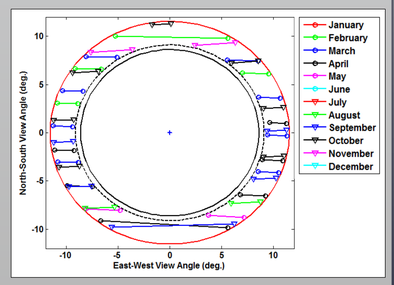


Figure 7: Lunar imaging opportunities for GOES-13 in 2016, lunar phase < ±25 degrees

Simplified 3D ABI Model

A simplified, three-dimensional model of ABI (Figure 8), with an emphasis on the calibration components and optical path, was created using Blender. The goal of this model is to aid the CWG in visualizing the positions and relative orientations between the various components from any perspective, which is useful for validating predicted angles and potential anomaly resolution.

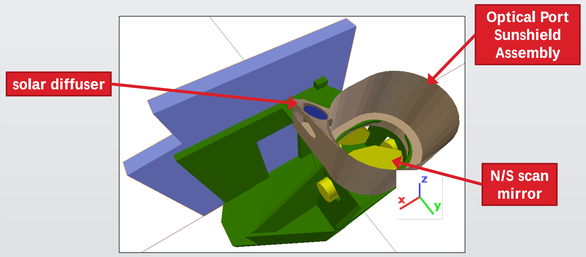


Figure 8: View of the ABI model within Blender. From this perspective several of the main optical components can be seen.

SNO Predictions

The CWG completed a web-based interface for computing Simultaneous Nadir Overpass (SNO) predictions between any two selected satellites using SGP4. This allows analysts to identify data that can be used for cross-calibration studies. Predicted SNO opportunities between GOES-15 and NPP are shown in Figure 9.

Table of predicted SNOs for the next 14.0 days since TLE Epoch: 4/24/2012

Index	Date	Time (GOES-15)	GOES-15 Lat,Lon	NPP Lat,Lon	Distance(km)	Time Diff (sec)
1	04/25/2012	22:33:01	-0.03,-135.01	-0.62,-137.56	291.28	80
2	04/26/2012	22:16:56	-0.04,-135.04	0.43,-133.04	229.00	80
3	04/28/2012	10:36:02	0.03,-135.07	0.78,-138.30	367.91	80
4	04/29/2012	10:19:58	0.04,-135.10	-0.28,-133.77	152.00	80
5	04/30/2012	22:39:13	-0.03,-135.16	-0.92,-139.07	446.93	80
6	05/01/2012	22:23:09	-0.03,-135.18	0.14,-134.55	72.72	80
7	05/04/2012	10:26:11	0.02,-135.23	0.00,-135.29	7.04	80
8	05/06/2012	22:26:41	-0.01,-135.29	-0.20,-136.06	88.43	80
9	05/07/2012	22:10:35	-0.01,-135.30	0.80,-131.52	430.01	80

Figure of GOES-15 and NPP satellite orbits during SNOs since TLE Epoch: 4/24/2012

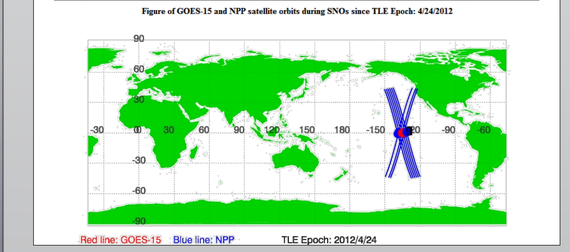


Figure 9: Outputs from the online SNO prediction tool for GOES-15 and NPP in both tabular and graphical form.

Acknowledgements

The CWG would like to acknowledge the contributions from the following groups:

- The GOES-R Program, Flight and Ground Segments
- NIST
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- Marshall Space Flight Center
- University of Maryland