Wednesday, September 23, 2020 | 8:00 a.m.

Technical Session

Pre-launch Testing and Post-launch Performance

Assessment of pre- and post-launch calibration and performance characterization for operational remote sensing systems

- Pre-launch and on-orbit measurement techniques
- Instrument transition from the laboratory to space environments
- Application of ground calibration results to on-orbit measurements
- Operational sensor calibration lessons learned

8:05

Decoupling Flat-fielding and Non-linearity Correction of a Pushbroom Radiometer – Analysis of Landsat 9 Operational Land Imager-2 Prelaunch Test Data

Raviv Levy – Science Systems and Applications Inc. / NASA Goddard Space Flight Center; Brian Markham – NASA

ABSTRACT: One of the goals in any calibration effort for pushbroom imaging radiometers is to flat field the instrument data across the full dynamic range. A challenge when approaching levels of 1% and lower in a 14 bit system is that the non-uniformity and non-linearity become a coupled variable set. The Landsat-9 Operational Land Imager-2 (OLI2) prelaunch radiometric calibrations conducted at Ball Aerospace utilized spectral sources, large integrating spheres and rotation stages. These tools, combined with unique collects such as the integration time sweeps and yaw collects at multiple illumination levels provided the basis for improvements in the calibration of both the full field of view and the full dynamic range for all of spectral bands. In an integration time sweep, a constant source level is observed while varying the detectors' integration time; in a yaw collect the instrument is rotated so that each detector views the same part of the illumination source. While previously we reported on the characterization of the calibration source used, this presentation will focus on how the multiple datasets were utilized to arrive at flat fielding and the non-linearity corrections. The method used enables a reduction in the uncertainty of the uniformity correction throughout the dynamic range. The uncertainty in the source non-uniformity, the source stability and the instrument under test stability are the three limiting factors. The data sources, the types of non-linearities, the differences between integration time sweeps and radiance collects, the representations of the non-linearity and the validation of the relative gain corrections throughout the dynamic range will be presented.

8:25

Pre-launch Radiometric Calibration of the JPSS-2 OMPS Instrument

Tyler McCracken, Eileen Saiki, Thomas Rogers, Dan Soo – Ball Aerospace

ABSTRACT: Ball Aerospace and Technologies Corp. has built the third build of the Ozone Mapping and Profiler Suite (OMPS), which measures daily ozone using three spectrometers that cover a wavelength range from 250 nm to 1000 nm. The JPSS-2 OMPS instrument consists of a pair of nadir-viewing spectrometers that provide total column ozone measurements and a limb-viewing spectrometer that provides ozone vertical profiles. The ground radiometric calibration of the sensors is ultimately albedo-based and determined through a sequence of tests to determine both absolute calibration and a direct albedo calibration. This presentation discusses the results of the JPSS-2 OMPS ground calibration program including an overview of the test suite and calibration uncertainties.

8:45

Ground-to-Space Transmitter System for Extended Instrument Diagnostics of On-Orbit Operational Radiometric Sensors

Timothy Berkoff, Constantine Lukashin, Trevor Jackson, Carlos Roithmayr – NASA Langley Research Center; William Carrion – Science Systems and Applications, Inc. (SSAI) / NASA Langley Research Center; Steven Brown, Brian Alberding – National Institute of Standards and Technology (NIST); Tom Varghese – Cybioms, Brendan McAndrew, Jan Mcgarry, Evan Hoffman, Mark Shappirio, Joel McCorkel – NASA Goddard Space Flight Center; Vanderlie Martins – University of Maryland, Baltimore County

ABSTRACT: Satellite instrument change in orbit during a mission lifetime can result in significant error for absolute radiance sensor calibrations. Polarization (POL) response, out-of-band signal rejection (OOB), and relative spectral response (RSR) are important contributors to understanding calibration error, yet no existing systems can conduct all of these diagnostics while a sensor is in space. In this presentation, a system under development is described that enables new diagnostic analyses of radiometers while they are in orbit by propagating a laser beam from the ground. While the system is not expected to provide high accuracy (<7%) absolute radiance calibrations, it is anticipated to provide POL, OOB, and RSR characterization measurements at high precision and repeatability, as these are self-referenced measurements and do not require knowledge of absolute radiance arriving at the sensor. The approach we are investigating will propagate a specially conditioned multi-beam phase-scrambled continuous wave laser transmission designed to mitigate atmospheric and laser coherence effects. To conduct a measurement, the space-borne sensor would need to "point-and-stare" at a pre-determined ground-target location. The ability to evaluate POL, OOB, and RSR changes during a mission enables critically needed insights to the cause of calibration change of current and proposed mission sensors. To achieve the same diagnostic capabilities with on-board hardware would be inherently prohibitive due to expense, increase in complexity, power, size, and payload mass. Understanding calibration change is especially important for trend analyses of Earth observations, where continuity of data sets and time on orbit needed to reach a scientific conclusion is at a premium. In addition, this approach can potentially reduce the need for additional complex on-board calibration systems on future missions, resulting in long-term cost savings and risk reduction for satellite operations. For small-size satellite platforms, such as U-class CubeSat systems, the Ground-to-Space Laser approach could enable critical diagnostic capability in cases where on-board diagnostic systems are not possible.

9:05

GOES-17 ABI L1b Product Performance Mitigation Results

Jon Fulbright – ASRC Federal; Elizabeth Kline – NOAA/NESDIS/GOES-R; David Pogorzala – Centauri; Katherine Pitts – Science Technology Corp; Zhipeng Wang, Xiangqian Wu – NOAA/NESDIS/STAR

ABSTRACT: The ABI instrument on GOES-17 suffers from insufficient cooling, resulting in degradation in the L1b radiance products during times of excessive solar heating. The original calibration algorithm assumes only a slowly-varying thermal state, and the primary calibration parameters, the gain and offset values, become obsolete almost immediately during times of rapid thermal changes.

In July 2019 a modification of the calibration algorithm (named "Predictive Calibration") was introduced as part of the mitigation strategy. We described this algorithm last year at Calcon, and now we have on-orbit data quantifying the improvement. In this talk, we summarize the early evaluation of L1b products created with this modified algorithm. We also describe some of the imagery artifacts sometimes introduced into the GOES-17 ABI L1b data by the Predictive Calibration or other mitigation steps.

9:25

Focus Characterization and Performance of Planet's SuperDoves On-ground and On-orbit Performance Predictions

Juan Fernandez-Saldivar, Caroline Pritchett, Kenji Ozawa, Ignacio Zuleta – Planet

ABSTRACT: Consistent imaging performance of Planet's SuperDoves is a key feature as the main goal is for global daily revisits over Earth's landmass. For such small 3-U cubesat platforms, the thermal environment imposes unique challenges in ensuring the payload remains in focus over not only repeated orbital conditions but other varying operational conditions (downlinks and other pointing manoeuvres).

The modelling and testing on ground of representative space thermal environments is typically done using extensive tests. Whilst this is a common approach of larger platforms and fewer satellites, the variability of the large number of satellites, conditions and dynamics will be prohibitive to perform fully for each satellite in a typical Planet's constellation. In order to account for the satellite to satellite variability Planet has approached this challenge by reducing the set of on-orbit conditions to a relatively small subset of thermal tests that can be carried out not only on each full satellite but also at the telescope level in air. This is leveraged by quick iteration in production and including automation for test and analysis of results.

In this work, we compare some of the satellites on 2 flocks already on-orbit by relating them to their ground focus test results and to other telescopes which are currently being tested and that will be launched later on this year. Using this approach Planet quickly iterates in assessing and predicting the behaviour of the image performance and variance across flocks and ensure that satellites will be in focus for operational conditions.

9:45

Radiometric Calibration Performances of GOES-16/17 Advanced Baseline Imagers

Fangfang Yu, Hyelim Yoo, Zhipeng Wang, Haifeng Qian, Xi Shao – University of Maryland; Xiangqian Wu – NOAA/NESDIS/STAR

ABSTRACT: The Advanced Baseline Imager (ABI) is the primary instrument onboard NOAA's current Geostationary Operational Environmental Satellites (GOES), GOES-16 (GOES East) and GOES-17 (GOES West). These 16-band instruments are collecting imagery critical to the National Weather Service for accurate weather nowcasting and forecasting over the Earth's Western Hemisphere. While GOES-16 operates as designed, the partial failure of the GOES-17 ABI cooling system leads to a set of different operational configurations that optimizes the instrument performance under the circumstances. Since GOES-17 ABI became operational in February 2019, several major Ground System (GS) updates have been successfully implemented to improve the ABI radiance quality of the solar reflective and infrared (IR) bands. The impacts of the GS updates on radiance and image quality were intensively validated and carefully monitored using different methods. This study is to report the radiometric calibration performance after each major update. The update of the scan mode in April 2019 reduces the calibration difference between the swaths within the timeline for the GOES-17 IR bands. The predictive calibration (pCal) algorithm implemented in July 2019 significantly improves the calibration accuracy for the GOES-17 IR data when they are available during the period of unstable focal plane module (FPM) temperature, and thus greatly reduces the calibration error at night. After several solar calibration updates to both ABIs from April to June 2019, the overall difference is less than 5% for all the solar reflective bands as compared to the corresponding channels of S-NPP Visible Infrared Imaging Radiometer Suite (VIIRS). Details will be reported in the meeting.

10:05

NEON Imaging Spectrometer (NIS) Calibration Updates

Alok Shrestha, Tristan Goulden, Ian Crocker – Battelle; Joe Boardman – AIG LLC

ABSTRACT: The NIS (NEON Imaging Spectrometer) is an airborne pushbroom hyperspectral instrument developed by NASA Jet Propulsion Laboratory (JPL) for the National Ecological Observation Network (NEON) and is included in all three of NEON's Airborne Observation Platform (AOP) payloads. NEON, funded by the National Science Foundation (NSF), is a continental-scale observatory designed to collect long-term data to better understand and forecast impacts of climate change, land use change and invasive species (Kampe et al. 2010). NEON has recently completed the construction phase and is in the initial operational phase, which represents annual activities that will be repeated for the remaining 30-year lifetime of the project (Goulden et al. 2019). The AOP begun data collection in 2013, although only a small subset of NEON sites was collected. By 2018 and 2019, AOP was collecting data in 16 domains annually, representing the typical data collection scenario during the operational phase of the NEON project. NEON provides 28 data products from AOP, which are publicly available and can be freely accessed from NEON data portal: https://data.neonscience.org/home. In addition to the NIS, AOP payloads include a discrete and full-waveform lidar and a high resolution RGB camera.

The NIS design is based on AVIRIS (Airborne Visible/Infrared Imaging Spectrometer) NextGen Imaging Spectrometer and measures radiant energy both in VNIR (Visible-Near Infrared) and SWIR (Shortwave Infrared) spectral region (380-2510 nm) with ~5 nm sampling and 1 mRad instantaneous field of view (IFOV) (Kuester et al. 2010). This 1 mRad IFOV leads to a ground resolution of 1m at a typical flight altitude of ~1000m. In order to ensure the accuracy of the measurements, the NIS requires stable and consistent annual calibrations (Leisso et al. 2014). Assessment of NIS calibration datasets revealed anomalies that should be characterized and corrected to improve the accuracy of NIS datasets. This presentation will briefly discuss the current status of NEON project and provides detailed description of NIS calibration improvements including: 1) characterizing NIS stray light anomalies, 2) techniques implemented to correct such anomalies, and 3) NIS stability analysis.

Goulden T., B. Hass, J. Musinsky, and A. K. Shrestha, 2019, "Status of NEON's Airborne Observation Platform", AGU Fall Meeting, 9-13 December, 2019, San Francisco, CA, USA,

Kampe T. U., B. R. Johnson, M. Kuester, and M. Keller, 2010, "NEON: the first continental-scale ecological observatory with airborne remote sensing of vegetation canopy biochemistry and structure", Journal of Applied Remote Sensing 4(1), 043510 (1 March 2010). https://doi.org/10.1117/1.3361375

Kuester M. A., J.T. McCorkel, Johnson, B.R., and Kampe T.U., 2010, "Radiometric Calibration Concept of Imaging Spectrometers for a long-term Ecological Remote Sensing Project"

Leisso N., Kampe T., Karpowicz B., 2014, "Calibration of the National Ecological Observatory Network's airborne imaging spectrometers", 2014 IEEE Geoscience and Remote Sensing Symposium, Quebec City, QC, 2014, pp. 2625-2628. doi: 10.1109/IGARSS.2014.6947012