Thursday, September 24, 2020 | 8:00 a.m.

Technical Session

Space Station Instruments

Examine the unique challenges and advantages associated with International Space Station (ISS) payload design, calibration, and operation.

- Completing science objectives within the time allocated on the ISS
- Special materials and contamination considerations
- Unique ground test and calibration requirements
- Space station-specific concept of operations

8:05

Radiometric Cross-Comparison of DESIS with Landsat 8 OLI and Sentinel 2A MSI

Mahesh Shrestha, Jon Christopherson – U.S. Geological Survey Earth Resources Observation and Science (EROS) Center

ABSTRACT: The DLR Earth Sensing Imaging Spectrometer (DESIS) is a new hyperspectral instrument developed by the German Aerospace Agency (DLR) and operated under the collaboration of DLR and Teledyne Brown Engineering (TBE). It is mounted on International Space Station (ISS) and has a ground sample distance of 30 m and a swath of 30 km. It has 235 spectral channels that measure across the spectral range from 400 nm and 1000 nm with a spectral sampling of approximately 2.5 nm. This study performs the radiometric assessment of DESIS by cross comparing it with a well-calibrated sensor such as Landsat 8 Operational Land Imager (OLI) and Sentinel 2A Multispectral Instrument (MSI). The cross-comparison between DESIS and Landsat 8 OLI and Sentinel 2A is performed by using the three and two coincident collects between the sensor pairs respectively. From these three coincident collects between DESIS and Landsat 8 OLI, 17 regions of interest (ROI's) of different surface types and intensity levels are chosen for cross-comparison. Initial analysis shows that there is a very good agreement between DESIS with Landsat 8 OLI. The mean of reflectance difference between DESIS and Landsat 8 OLI is within 0.015 reflectance unit and approximately 7% (in relative scale) across all the bands. Similarly, for DESIS and Sentinel 2A cross-comparison, two coincident collects from Libya 4 CNES ROI are used. The difference between these two sensors is within the 0.015 reflectance unit across all the bands. These initial results show that DESIS has a very good agreement with both Landsat 8 OLI and Sentinel 2A MSI.

8:25

Atmospheric Waves Experiment Calibration

Joel Cardon, Harri Latvakoski, Greg Cantwell – USU/Space Dynamics Laboratory

ABSTRACT: The Atmospheric Waves Experiment (AWE) is the first dedicated NASA mission to investigate global gravity wave properties in the upper atmosphere and their impacts on the ionosphere-thermosphere-mesosphere (ITM). The AWE Advanced Mesospheric Temperature Mapper (AMTM) will fly on the ISS and measure temperature waves in the OH airglow layer. The OH temperature waves are produced by gravity waves that rise from the Troposphere into the Mesosphere and spread out horizontally in the OH airglow layer at ~87km altitude, carrying energy and momentum with them. The temperature waves are observed by measuring the background-subtracted ratio of OH P1(2) and P1(4) emission line radiances. The AWE calibration will be performed at SDL in the large THOR chamber using collimator and extended blackbody sources. The AMTM has a very large 90° field-of-view, and the ground calibration must be performed over this full range, requiring a 2-axis gimbal platform in the THOR chamber. This paper will summarize ISS-specific challenges and ground and on-orbit calibration plans.

8:45

Improved Radiometric Accuracies for Climate Science with HySICS

Greg Kopp, Paul Smith, Peter Pilewskie – Laboratory for Atmospheric and Space Physics (LASP), University of Colorado;
Gary Fleming, Bruce Wielicki – NASA Langley Research Center

ABSTRACT: The HyperSpectral Imager for Climate Science (HySICS), to be flown as the CLARREO Pathfinder payload in 2023, will acquire images of the Earth's ground and atmosphere with unprecedented radiometric accuracies of <0.3% (k=1) achieved via on-orbit calibrations using the spectral solar irradiance. These high radiometric accuracies enable benchmarking of Earth radiances for climate studies and provide reference calibrations for other on-orbit Earth-viewing sensors.

The 2007 U.S. Academy of Sciences Decadal Survey for Earth Science recommended the Tier 1 mission CLARREO (Climate Absolute Radiance and Refractivity Observatory) to acquire high-accuracy, climate-benchmarking spatial/spectral radiances of the Earth's surface and to provide reference calibrations for other on-orbit assets. The more recent 2018 Decadal Survey similarly prioritized reference radiance inter-calibrations as one of its "Most Important Targeted Observables," providing on-orbit SI traceability for other programs such as the Global Space Based Inter-Calibration System (GSICS). To achieve these climate-benchmarking and inter-calibration capabilities, the space-borne imaging spectrometer for the CLARREO requires radiometric-accuracies that are nearly 10x better than any currently-flying spectrometer provides, necessitating innovative new on-orbit measurement techniques.

The HySICS is currently in development for the NASA CLARREO Pathfinder, a mission planned for launch to the International Space Station (ISS) in 2023 to demonstrate both the CLARREO-needed on-orbit radiometric accuracies and inter-calibrations of other space-based sensors. The instrument has a radiometric-uncertainty goal of 0.3% (k=1), which is much better than any current spaceflight reference detector or calibration light source is capable of providing. Instead of incorporating either of these traditional detector- or source-based calibration approaches into the instrument, the HySICS relies on on-orbit calibrations provided by direct views of the spectral solar irradiance, which is known on an absolute scale to ~0.2% from other space-based instruments. As opposed to using diffusors or other scattering surfaces that can degrade on orbit, the HySICS is designed for improved radiometric accuracies by regularly acquiring direct solar-irradiance measurements, avoiding concerns with on-orbit degradation that plague Earth-sensing optical instruments. A prototype HySICS demonstrated this solar-irradiance cross-calibration approach during two high-altitude balloon flights (Kopp et al., 2017).

We describe the radiometric-accuracy details of this Offner-based imaging spectrometer that contiguously covers 350 to 2300 nm with 6-nm spectral resolution and has an instantaneous nadir-looking field-of-view of 500 m and a swath width of 70 km from the ISS's orbit altitude.