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RADCALNET

Determining the Minimum RadCalNet Observation Requirements for Radiometric Accuracy Assessment of Earth-Observation Sensors: Mehran Yarahmadi, SSAI

Reliable assessment of radiometric accuracy is essential for ensuring the long-term quality and interoperability of Earth-observing sensors. The emergence of automated, globally distributed RadCalNet sites has increased opportunities for consistent, traceable vicarious calibration without the need for resource-intensive field campaigns. However, the number of observations required to achieve a statistically robust evaluation of sensor performance remains insufficiently understood. This study investigates the minimum number of RadCalNet datapoints needed to rapidly and reliably characterize the radiometric accuracy of widely used satellite sensors, including Landsat 8/9 OLI, Sentinel 2 MSI, and the Terra and Aqua MODIS instruments. Using multi-year measurements from the RVUS, GONA, LCFR, and BSCN sites, we apply statistical analyses across spectral bands to quantify the sensitivity of calibration stability to sample size and to identify key influencing factors such as atmospheric variability, spectral response differences, viewing geometry, and seasonal effects. The results provide guidance on the optimal temporal sampling required for efficient sensor evaluation and outline conditions under which a network-based approach offers clear advantages over single-site assessments. These findings support the development of streamlined calibration strategies for operational and next-generation Earth-imaging missions by establishing practical thresholds for rapid radiometric performance verification.

RadCalNet and Beyond: The Future of Automated Vicarious Calibration Sites: Brian Wenny, SSAI / NASA GSFC

The release of the initial RadCalNet data set in 2018 provided a means of SI-traceable vicarious calibration for both agency and commercial remote sensors. Under the auspices of the Committee on Earth Observing Satellites (CEOS) Working Group on Calibration and Validation (WGCV) Infrared Visible Optical Sensors (IVOS) subgroup, ongoing efforts by the RadCalNet working group have continually reviewed, evaluated and updated the processing methodology and quality control procedures resulting in periodic updated versions of the dataset. Presented here are some of the recent and future developments of RadCalNet. The most recent update in late 2025 included a full reprocessing of the Railroad Valley site data archive. Four new sites are in various stages of joining RadCalNet. A re-evaluation of the TOA product uncertainty is underway to assess the feasibility of replacing the current Look Up Table with an â€˜on-the-flyâ€™ calculation of the uncertainty for each BOA spectra individually during data processing using a Monte Carlo approach. Challenges and lessons learned from the 10+ years of development and operation of the network are discussed, with the primary issue mentioned by users being data availability and latency. The continued support from both agency and commercial users is necessary to maintain and grow RadCalNet.

Products and Services Beyond RadCalNet: Custom RadCaTS Results and Emerging Upgrades: Jeffrey Czapla-Myers, University of Arizona

The Radiometric Calibration Test Site (RadCaTS) was developed by the Remote Sensing Group at the University of Arizona (UArizona). RadCaTS, located in Nevada, USA, provides ground-based data for the radiometric calibration and surface reflectance validation of Earth-observation sensors that operate in the solar-reflective regime (350 nm to 2500 nm). RadCaTS has been in operation since 2012 and is currently used with a variety of spaceborne and airborne sensors.

The goal of RadCaTS is to provide accurate, timely, SI-traceable TOA and surface reflectance data. RadCaTS is one of the original automated test sites in the CEOS WGCV Radiometric Calibration Network (RadCalNet), which aims to harmonize ground-based calibration and validation measurements from international organizations. RadCalNet provides TOA reflectance (nadir view) and surface reflectance data in 30 minute intervals, 09:00–15:00 local time. The spectral range of the data is from 400 nm to 2500 nm, in 10 nm intervals.

In contrast, RadCaTS can produce temporal, spectral, and sensor view angle-specific data tailored to any sensor under test. TOA spectral radiance, TOA reflectance, and surface reflectance results are provided as either band-averaged or hyperspectral (1 nm) and use the exact time, viewing, and illumination geometry as the overpass of interest, thereby minimizing uncertainties due to temporal and spectral interpolation.

Work is underway at UArizona to improve RadCaTS data in the spectral and geometric domains. This includes developing a field radiometer in the SWIR spectral region (1000 nm to 2400 nm), hyperspectral VNIR measurement integration (400 nm to 800 nm), and directional reflectance measurements.

RadCalNet: Past and Present: Norvik Voskanian, NASA

Vicarious calibration is a key component of assessing the quality of Earth imaging sensors. The growing number of ground sites with automated systems allows increased calibration opportunities without the need for labor-intensive dedicated field campaigns. In 2018, the Committee on Earth Observing Satellites (CEOS) Working Group on Calibration and Validation (WGCV) Infrared Visible Optical Sensors (IVOS) subgroup released the initial Radiometric Calibration Network (RadCalNet) dataset to the public. This was a culmination of two decades of effort within WGCV and IVOS. NASA is one of the founding members of the RadCalNet working group and via support from the Terra Project has played a critical role in the success of RadCalNet including defining and developing its data requirements, data processing approach, SI-traceable absolute uncertainties, and generation of the TOA reflectance products. RadCalNet provides the science community with SI-traceable surface (BOA) and top-of-atmosphere (TOA) spectral reflectance from voluntary participating vicarious calibration sites. Currently, there are 5 sites located in Railroad Valley, Nevada, USA, La Crau, France, Gobabeb, Namibia and two sites in Baotou, China. Key elements of the provided datasets are the demonstration of SI-traceability for the in-situ based vicarious results and documented uncertainty budgets for the BOA and TOA reflectance products. Since the initial release RadCalNet data has been used by the worldwide science community as a vicarious calibration tool for on-orbit VSWIR instruments. One advantage of the SI-traceability of RadCalNet is that the multiple sites can be used interchangeably which increases the number of potential matchups available.

ROCX

Airborne Hyperspectral, LiDAR, and Photographic Baseline Characterization of the ROCX 2025 Experiment site by the National Ecological Observatory Network Airborne Observation Platform: Mark Helmlinger, National Ecological Observatory Network

Funded by the U.S. National Science Foundation (NSF) and proudly operated by Battelle, the National Ecological Observatory Network (NEON) program provides continental-scale data across the United States that characterize and quantify complex, rapidly changing ecological processes. The NEON observatory design spans the breadth of ecological conditions across the Continental United States, Alaska, Hawaii and Puerto Rico, and will collect data for up to 30 years. Within NEON, the Airborne Observation Platform (AOP) program supports the scientific objectives of the NEON observatory by collecting annual airborne remote sensing observations at the NEON sites. After over 10 years of operations consisting of over 1000 individual flights, NEON has built a robust archive of high-quality calibrated remote sensing data. To support NEON objectives, the AOP program operates, calibrates, and maintains three combined payloads which each contain a full-waveform LIDAR, science-class imaging spectrometers, and high resolution RGB camera. In a typical year, only two payloads are required for the NEON collections, leaving one payload available to acquire Research Support Services (RSS) collections, which allow collection requests by external PIs. As a case study, we highlight a recent RSS flight that supported the community-lead calibration and validation efforts at the ROCX experiment site prior to additional collections by other sensors. The collection of the ROCX site occurred on September 5th, 2025 and data are currently publicly available. This presentation will showcase the RSS request process, data collected, details on data quality, and offer insight into how NEON supported the ROCX mission.

Expanding the SPARC/FLARE Methodology: Toward a Unified Point Source Irradiance-Based Calibration Metric for Earth Remote Sensing Systems: Stephen Schiller, Self/CalVal Research

Accurate radiometric calibration remains a central challenge for achieving quantitative consistency across Earth-observation systems spanning drones, UAVs, aircraft, and satellites. The Ground-to-Space Calibration Experiment (G-SCALE; Russell et al., 2023) demonstrated a unified cross-platform approach using specular mirror targets, including the SPecular Array Radiometric Calibration (SPARC) method and its commercial implementation, FLARE. Traditionally, sensors calibrated with mirror targets express pixel digital numbers in terms of equivalent radiance within their own operational domains, limiting cross-platform comparison and traceability. This work revisits and generalizes the calibration framework by defining calibration fundamentally in terms of irradiance at the sensor aperture -- the radiometric quantity that directly drives detector response.

When SPARC/FLARE mirrors are treated as controlled irradiance sources, calibration becomes physically complete and naturally scalable to any geometry, altitude, or spatial resolution, enabling deployment through global or on-orbit networks (e.g., NIST CANDLE, NASA Landolt). Sensor-received irradiance is computed from the mirror intensity spectrum via the inverse-square law, including mirror configuration, reflectance, distance, and atmospheric transmittance. This maintains full SI-traceability through daily Top-of-Atmosphere solar irradiance from the NIST-calibrated TSIS-1 spectroradiometer aboard the ISS, establishing a consistent reference chain across all platforms. An irradiance-based form of the Zero Airmass Response Constant (ZARC) is introduced to normalize sensor response as if imaged under zero-airmass conditions, providing a common calibration metric from drones to satellites. This formulation extends G-SCALE toward a unified, SI-traceable calibration framework. Application of this inter-sensor calibration method (iSPARC) will be presented using data that includes the ROCX 2025 field campaign.

Coastal Hyperspectral Reflectance Object Material Analysis (CHROMA): Generating Multi-Modal Datasets for Advancing AI-Driven Hyperspectral Unmixing in Complex Environments: Katarina Doctor, US Naval Research Laboratory

The Coastal Hyperspectral Reflectance Object Material Analysis (CHROMA) experiment, spearheaded by the U.S. Naval Research Laboratory (NRL) and conducted within the Rochester Institute of Technology's (RIT) Open Community eXperiment (ROCX), provides a critical data-centric foundation for advancing Artificial Intelligence (AI) in remote sensing. The primary objective of CHROMA is to accelerate AI application in hyperspectral imaging, particularly strengthening capabilities in environmental intelligence and resource management.

CHROMA focuses on addressing the persistent challenge of hyperspectral unmixing, which involves separating mixed spectral signatures within a single pixel to improve confidence in object detection and identification. The experiment utilized a Domain-Centric AI paradigm, integrating expert knowledge with a comprehensive, multi-modal, and multi-scale data collection from airborne, UAV, and satellite platforms over a coastal and aquatic-adjacent environment.

The data acquisition focused on spectrally rich targets, including naturally occurring rock and mineral samples alongside fabricated metal panels with engineered coatings (simulating naval assets), which serve as fiducial references. By observing these targets across diverse sensor modalities, the experiment seeks to elucidate the interplay between material properties and sensor phenomenology, enhancing the efficacy of AI models in resolving sub-pixel material compositions. This capability is decisive for applications like infrastructure assessment, environmental monitoring, and improving the survivability of naval platforms in complex coastal interfaces.

The resulting high-quality dataset, characterized by its comprehensive ground truth and multi-platform coherence, will be openly shared to advance defense and civilian research, moving AI-enhanced sensing toward higher Technology Readiness Levels.

Early Results from NGA's Evaluation of ROCX 2025 Collection Campaign: Gen Ito, NGA

NGA participated in the ROCX 2025 Collection Campaign, hosted by Rochester Institute of Technology in fall 2025. NGA set up two ground experiments: one with static materials, including tarps, aluminum and copper with various igneous and metamorphic rocks supplied by the Naval Research Laboratory, and minerals and synthetic grass supplied by the Defense Research Development Canada; and one NITE (NIght Time Experiment) with lights. The goal was to deploy materials of interest, including those related to critical materials. NGA also provided a meteorological station that captured weather data for the calibration of all participating instruments. Various NGA personnel participated during the field test to deploy targets and take ground truth data.

This talk will provide an overview of NGA's experimental setup and a preliminary evaluation of the ground target data and their cross-correlation with commercial satellite data. The evaluation will include spatial and spectral aspects, if applicable. Additional analysis will include hyperspectral/multispectral imagery, thermal imagery, and lidar. Our goal is to better understand the variations that arise from differences in scales that each dataset operates in.