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# **New & Future Systems 1 Session**

**Shallow Water Bathymetry Using the High-Resolution Dragonette Satellite Constellation. Presenter(s): Ellie Jones, Wyvern Inc.**

Accurate bathymetric mapping in shallow environments is critical for understanding coastal dynamics, managing marine ecosystems, and supporting navigation safety. Visible to near-infrared (VNIR) imaging spectroscopy is uniquely suited to understanding shallow water ecosystems and water properties. High-resolution imaging spectroscopy from space presents a cost-effective and efficient method for large-scale collection of shallow water bathymetry data compared to traditional vessel-based collection methods.

Bathymetry using VNIR imaging spectroscopy leverages the interaction of sunlight with the water column and underlying substrate. Incident sunlight enters the water column, where it undergoes absorption and scattering processes. As the light reaches the seafloor, it is partially reflected back through the water column and exits the surface as upwelling radiance; carrying information about water depth and benthic cover. VNIR light wavelengths, especially shorter wavelengths, are particularly sensitive to these interactions due to their penetrating capabilities in optically clear waters.

This study explores the use of high-resolution VNIR hyperspectral imagery produced from Wyvern’s Dragonette constellation to derive benthic properties and depth in optically shallow water. Ground truth bathymetric data, acquired by the University of Hawai’i Undersea Research Laboratory in 2016 with a spatial resolution of 5 meters, serves as the training dataset. The processing chain is explored, including the application of radiative transformation models and glint correction. Machine learning methods are applied to processed hyperspectral imagery to predict depth and benthic cover. Performance is compared to ground truth and other multispectral & hyperspectral satellites (including Sentinel-2, and PRISMA).

**Case Study on the Influence of Pavement Areas and Riverside Walkaways on Heat.**

**Presenter(s): Srini Dharmapuri, Sanborn**

SatVu, a start-up company based in London (UK), is developing a constellation of ten satellites (“HotSats”) flying a Medium-Wave Infrared camera. The mission is to capture the thermal information of any target on Earth. SatVu’s MWIR sensor offers a unique perspective of the world, imaging at an unprecedented resolution of 3.5 m, and is a significant improvement over any commercially available space-based thermal sensor.

SatVu is planning two data products: Visual and Night-Only Bottom-of-Atmosphere (BOA) Radiance Products. Visual Product is optimized for photo interpretation and is therefore suitable for activity monitoring, anomaly detection, and other use cases.

The Night-Only Bottom-of-Atmosphere (BOA) Product Prototype is developed explicitly for analytical purposes, which require temporal and spatial consistency. This product undergoes additional radiometric processing to deliver values such as radiance and brightness temperature at a surface level. This product will support time-series analysis, continuously assessing thermal signal fluctuations within and between the scenes.

 The Sanborn and SatVu have attempted to perform ortho rectification of the temp imagery using high-resolution DEM data. Subsequently, Sanborn tried to create a relationship between the night-only Bottom-of-atmosphere data and the other derivative layers made from the optical imagery. The spatial correlation has enabled us to study the relationship between landscape (trees, concrete buildings, riverside walkways) and the heat in that area. A preliminary analysis was attempted on Dallas using thermal data collected in 2023 and Austin using the thermal data collected in 2020. The higher-resolution thermal data enables us to visualize the issues more granularly**.**

**Hyperspectral OSK GHOSt Sensor Calibration Methodology and Refinements Using RadCalNet Data.**

**Presenter(s): Lee Sanders, Orbital Sidekick Inc.**

To fully exploit the vast information content in hyperspectral imaging (HSI) and avoid mis-interpretation or errors in HSI analysis and the resulting actionable information, robust calibration procedures based in known truth to anchor the spectral measurements are essential. Spectral calibration is required to ensure the characterized wavelength bandcenters and bandwidths are highly accurate. Radiometric calibration is required for proportionate generation of spectral features as well as enabling the usage of HSI data across temporal image site studies which can even include spectral data from other calibrated sensors. This presentation provides a deeper review as to the developed methodology, adaptation, and challenges addressed in the vicarious calibration of hyperspectral sensors, in particular with the in-orbit OSK GHOSt hyperspectral payloads. Key to OSK achieving these calibration goals include obtaining ground and atmospheric truth data coincident with the dates and times of image collection from the Gobabeb, Namibia and Railroad Valley, USA RadCalNet sites. The goal for spectral calibration accuracy is 0.2 nanometers and radiometric calibration to be 6.5% or better.

**Developments in the Umbra SAR constellation**

**Presenter(s): Paul Woodford, Umbra**

Umbra is a 100% American-owned space technology company that is creating the US's highest-resolution shareable SAR constellation. Through November 2024, Umbra has launched ten satellites, and is set to launch more satellites in 2025. With low costs and easy licensing, Umbra is enabling new applications in areas such as environmental monitoring, in addition to defense and intelligence applications. We show examples from some of these applications and provide insight into new and emerging capabilities of the constellation. In addition, we discuss the processes used to continually monitor the performance of the satellites.

**AI & Automation Session**

**Accuracy Testing of High-Resolution Orthoimagery using 3D Surface Models and Open-Source Software**

**Presenter(s): Mark Abrams, Exquisite Geolocation Systems**

Global accuracy testing of satellite imagery requires a global network of highly accurate test sites, precise, accurate, and current 3D imagery, and geodetic control. Historically, these control sites and networks are not photo-recognizable and require survey teams to establish and maintain them. As an alternative strategy, we have demonstrated DGNSS-enabled drone surveying to establish absolute local control tied to the South African geodetic framework in Bloemfontein, South Africa. The aerial survey provides high-resolution (1.5 cm) geocoded imagery suitable for property mapping (local requirement) and suitable for geodetic tests and evaluation of satellite imagery with an estimated horizontal accuracy of less than 5 cm (CE90) and vertical accuracy of better than 10 cm (LE90). We are exploring using periodic cadastral surveys to establish a self-consistent network of high-resolution sites that can be used for satellite accuracy testing dockand image control for long-term change detection. Using 76 ground control points at Vista Park, Bloemfontein, we demonstrated a CE90 of 4.2 cm and an LE90 of 9.2 cm between the 3D imagery and DGNSS control measurements. Initial testing of 2D and 3D satellite imagery validates the utility of the approach, in particular by providing easily identified photo-recognizable control points, manhole covers, in this case, which significantly simplify the alignment between the satellite imagery and the control imagery.

**Understanding the Challenges of 3D Mesh Generation from Satellite**

**Presenter(s): Stephanie Dockstader, ESRI & Brian Connolly, ESRI**

This presentation will discuss the user challenges discovered when using existing commercial data catalogs for 3D product generation. Many community users that want to create reality mapping products from satellite imagery are working from a pre-existing data catalog covering a specific area of interest. Although the software may successfully complete the generation of 3D products, the quality of the results is heavily dependent on how the data was originally collected and processed. Often its it not easy to understand how to properly select the best images available to avoid inadequate results and expensive re-processing. This cross-industry team has been working together to identify a variety of existing commercial data sources and process them with the automation workflow in mind. Results will be shared, and discussions on challenges with image overlap, temporal variations, and collection geometry are presented.

**From Pixels to Marine Mammals: Enhancing animal detection by applying open source processes to basic satellite imagery:**

**Presenter(s): John Wall, NOAA**

The Geospatial Artificial Intelligence for Animals (GAIA) initiative seeks to scale beyond manual review of images by developing a human-in-the-loop workflow for detecting marine animals invery high-resolution satellite imagery (< 0.5m). We are focusing on imagery from Maxar Technologies. Maxar offers level 2A and 3D ortho products, which require less preprocessing than level 1B, the pre-processing steps are not well defined or consistent through time, making reproducibility at a large spatial-temporal scale and across organizations challenging. Therefore, to enhance marine mammal detection and species identification, as well as to facilitate reproducibility across studies, GAIA is applying transparent, consistent, and reproducible methods for correcting radiometric, geometric, and atmospheric distortions while also orthorectifying and pansharpening level 1B imagery. Here, we detail GAIA's workflow for transforming satellite imagery into a format ideal for human-visual detection and species identification of three different size classes of marine mammals: (1) large baleen whales (12 - 33 m), (2) small toothed whales (1.5 - 8 m), and (3) pinnipeds (1 - 5 m) building on lessons learned since our last presentation at JACIE. This pipeline integrates into our high-throughput, cloud-based system to facilitate satellite imagery review by subject matter experts; these results will impact mission planning and field operations.

**Analysis of African Elephants Using Commercial Remote Sensing Data:**

**Presenter(s): Thomas Schill, MITRE**

Several recent studies report on the application of machine learning methods to detect, identify, and count large animals in the wild. These studies offer the promise of automated, scalable methods for assessing and monitoring wildlife population under a range of conditions. However, the approach is not without its challenges and limitations. The current study focuses on elephants in Kenya using Worldview2 imagery from MAXARâ„¢. We discuss specific issues that make the problem challenging, including limitations of spatial and spectral resolution, object occlusion, lighting conditions, object pose and articulation, object adjacency, and the presence of possible confuser objects (i.e., other large animals). Comparisons to other object detection problems, such as vehicle counting, provide an informative contrast. This paper presents our methodology for object labeling and model training, including differences across several deep learning models. We present our initial performance findings and offer recommendations for improvement.

**High Density Remote Sensing Data for People and Artificial Intelligence:**

**Presenter(s): Thomas Chrien, Matter Intelligence, Inc**

The vision of Matter Intelligence is to capture and amass a global encyclopedia of the highest resolution data set of the Earth's material composition and temperature. People and Artificial Intelligence need data that captures our surroundings beyond the visible with high spatial and spectral fidelity to discern critical information about materials and how they change. The density of information content is driven by spatial resolution, swath, spectral resolution, spectral range, radiometric resolution and change over time. Well calibrated sensor radiance also contains information content about the observed surface as well as the intervening atmosphere and reflected/emitted spectral components. We employ rigorous physical models to separate these components to derive accurate surface reflectance/emissivity spectra and temperature measurements. Critical sensor design attributes and rigorous sensor characterization enable the separation of instrument artifacts from remotely sensed surface information.

Matter Intelligence goes beyond what other companies have done by constructing an advanced observation platform that far exceeds the competition in terms of usable information content. Our system simultaneously determines object shape, composition, and temperature at a global scale, unlocking transformative commercial and defense applications. We will detail our system objectives while highlighting the application of techniques to further improve information retrieval.

**Automation Advancements for Ground Control Points through Multimodal Collection Methods**

**Presenter(s): Shawana Johnson, Global Marketing Insights, Inc. & Hayden Howard, CompassData, Inc.**

In the rapidly evolving field of geospatial analytics and on-bard processing in space and airborne assets, integrating emerging technologies with traditional survey methods offers unprecedented opportunities for innovation and efficiency. Calibration and validation are increasingly important for not only combining multiple spaceborne, drone/aerial imagery, LiDAR scanning, and terrestrial-based surveys for assets but for Position, Navigation and Timing (PNT) for all space assets. There are multiple technologies driving the industry forward by creating new workflows that enhance data accuracy and usability. These new workflows assist in reducing the risk of high capital expenditures in the capital-intensive nature of developing these assets. This presentation will demonstrate multimodal collection methods, survey control and topology to ensure high-quality geospatial data providing time savings and cost reductions to the client stakeholder base demonstrating that while the detail of spatial accuracy within survey and mapping can be overwhelming for a downstream user there are highly reliable technologies that when employed simplify the data into accurate and digestible formats. In addition, an automation enabling on-board access to these capabilities will be highlighted.

# **Standards, Formats, and Specifications Session**

**Enabling USGS System Characterization and EDAP+ Validation Interoperability**

**Presenter(s): Jeff Clauson, USGS**

The ESA-NASA "Earth Observation Mission Quality Assessment Framework - Optical Guidelines“ establishes a standardized approach to evaluate the quality of commercial Earth Observation (EO) data. The framework consists of a two-part assessment: 1) Documentation Review: Examines mission documents to assess data quality. and 2) Detailed Validation: Quantitatively assesses data products against stated performance metrics. The results are compiled into a Quality Assessment Report and a color-coded Cal/Val maturity matrix, which visually summarizes the assessment results. The USGS ECCOE Project system characterization process aligns with the ESA-NASA EDAP+ framework in several ways, especially in the areas of geometric and radiometric validation. However, there are also differences. This talk will present the steps being taken to align the USGS system characterization processes to enable a data provider to use a USGS System Characterization Report in the fulfillment of the independent system evaluation for the EDAP+ validation component.

**Satellite Data Quality Initiatives Coordinated by the Committee on Earth Observation Satellites**

**Presenter(s): Medhavy Thankappan, Geoscience Australia**

Small satellite Earth observation (EO) missions developed and launched by New Space companies is rapidly changing the EO landscape. Many of these smaller missions are limited in their capacity to carry on-board calibration equipment for ongoing characterisation of sensor performance in support of data quality monitoring. Variable data quality across EO satellites often limits the potential for combined use of data in applications that need time-series observations from multiple sources.

Space agencies operating larger EO satellites with onboard calibrating equipment, have recognised the need for routine calibration and validation of the smaller commercial missions, in order to achieve consistency in the quality of data streams becoming available from these platforms. The development of future SI-Traceable Satellites (SITSats) such as the Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder, and the Traceable Radiometry Underpinning Terrestrial and Helio Studies (TRUTHS), will be benchmarks for optical data quality due to their traceability to international standards while delivering highly accurate measurement of climate variables.

The Committee on Earth Observation Satellites (CEOS) through its member organisations, coordinates several initiatives focussed on improving quality of EO data to realise the full potential of the global investments in EO and achieve impactful outcomes that benefit the whole EO community. The presentation will highlight the collaborative effort on enhancing EO data quality through a range of initiatives coordinated by CEOS, to deliver whole-of-community benefits across the public and private sector EO missions. Community discussions at JACIE 2025 are expected to strengthen the CEOS coordination effort.

**Future Advances in Commercial Imagery Products**

**Presenter(s): Barbara Eckstein, L3Harris and Jeff Snyder, NGA**

The scope of NGA's National System for Geospatial Intelligence (NSG) Electro-Optical Ground-Commercial (NEOG-C) Program Office is rapidly evolving, with commercial SAR and Non-Earth Imagery (NEI) products added to its original panchromatic (pan) and multispectral imagery (MSI) scope. The NEOG-C program provides the requirements for and tests the commercial imagery integrated into the NSG. In the near future, NEOG-C will transition its workload into a more broadly scoped program, which will include commercial hyperspectral imagery (COMHSI) products and other sensor types.

Commercial imagery products delivered to the NSG are primarily encoded using the National Imagery Transmission Format (NITF), which is both a format and a standard that provides the richest possible data and metadata and is interoperable with NSG segments, including the libraries and analysts' exploitation tools.

The data and metadata requirements for commercial NITF products are defined in the “NGA Compendium of Commercial Requirements Documents (NCCRD), document ID STDI-0006. Volume2 sets the requirements for pan and MSI NITF datasets. Volume 3, once completed, will set the requirements for commercial SAR (COMSAR) imagery products.

Improvements to commercial pan, MSI, and SAR products are in work. These improvements are necessary to improve the quality and utility of pan and MSI, and to flesh out COMSAR NITF requirements.

This talk will discuss the evolution of the NEOG-C Program as well as NEOG-C's near- and long-term initiatives for commercial data providers, dataset requirements, and verification and validation of commercial imagery products.

**A holistic approach to ensuring quality and consistency in CEOS-ARD surface reflectance products**

**Presenter(s): Medhavy Thankappan, Geoscience Australia**

The CEOS-ARD Surface Reflectance Product Family Specification (PFS) establishes a solid foundation for interoperability. However, its non-prescriptive nature allows various approaches to deriving surface reflectance products. The effort by CEOS member organisations such as NASA and ESA, to generate the Harmonized Landsat Sentinel-2 (HLS) and Sen2Like products respectively, require the reprocessing of surface reflectance data. This additional reprocessing requirement highlights the need to improve the consistencyof surface reflectance data products from different providers.

In 2024 an expert panel was convened to develop a conceptual approach for harmonised surface reflectance data products to enable better interoperability across products from different sensors. The development of a guidance document that outlines the essential steps, model parameters, and tolerances required to achieve consistent surface reflectance data products from different satellite sensors is a key outcome from the panel discussions. The concept emphasises the critical role of radiometric calibration, atmospheric correction, cloud and shadow masking, adjacency correction, topographic correction, and validation against reference data. Harmonisation steps include geometric correction, bidirectional reflectance distribution function (BRDF) correction, and ensuring accurate geolocation and image co-registration. The guidance document attempts to describe an ideal target surface reflectance measurand that, if achieved, enables better interoperability at the measurement level.

The proposed surface reflectance interoperability concept has the potential to serve as a reference for organisations reprocessing Earth observation data collections and contribute to a virtual constellation of interoperable surface reflectance measurements. This will offer users interoperable surface reflectance datasets, enabling more accurate time-series analysis and better insights across diverse applications.

# **Thermal Session**

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| **Advances in Thermal Infrared Earth Observation: The FOREST-2 and OTC-P1 Missions' Contributions to Wildfire Detection and Surface Temperature Monitoring****Presenter(s): Julia Gottfriedsen, OroraTech GmbH**The FOREST-2 satellite mission by OroraTech delivers advanced thermal infrared (TIR) Earth observation data, primarily designed for low-latency wildfire monitoring. Launched in June 2023, FOREST-2 features a 410 km swath with a 200m ground sampling distance (GSD) with MWIR and LWIR sensing capabilities. The derived Level 2 Active Fire product offers near-real-time wildfire detection, aiming for URT latency below 5 minutes and sensitivity to fires as small as 4x4 meters. Data Quality is validated in collaboration with ESA under the EDAP framework, including validation against VIIRS data for radiometric accuracy and thermal anomaly detection.The upcoming OTC-P1 mission, set to launch in early 2025, will build on these advancements by addressing the “afternoon data gap” and further enhancing temporal resolution. FOREST-2 and OTC-P1 are the first contributors to the development of a larger thermal Earth observation constellation, supporting wildfire management, environmental monitoring, and emergency response with the aim to deliver high-frequency thermal intelligence with a revisit rate of 30 minutes. |
| **HotSat radiance estimates using cross calibration with VIIRS and atmospheric forecasts from GEOS****Presenter(s): James O'Connor, SatVu**The HotSat imager has a single mid-wave infrared (MWIR) band, the first iteration of which was launched as HotSat-1 in June 2023. The satellite captured 6 months of imagery that we have used to construct and evaluate a radiometric model of the instrument during nighttime operation.To derive the radiometric model, we use data from the satellite's onboard heated high-emissivity paddles, alongside HotSat-1 imagery of the open ocean. The ocean images are thermally homogeneous scenes for which we know the emissivity and have obtained estimates of the surface temperature from the Operational Sea Surface Temperature and Ice Analysis (OSTIA) system, produced by the UK Met Office. We assess the performance of this radiometric calibration on a dataset of HotSat-1 images captured over land. For this we make use of level 1B radiance products from VIIRS. The Suomi-NPP, NOAA-20, and NOAA-21 satellites with VIIRS instruments have similar overpass times to HotSat-1 so we assume that the surface emission and the state of the atmosphere have not changed. We formulate radiative transfer equations in a way which aims to minimize the dependency on the unknown surface emissivity over each instrument's wavebands and generate an equation describing the relationship between VIIRS and HotSat observations. We plan to utilise Goddard Earth Observing System (GEOS) climate forecasts to calculate calibration parameters ahead of imaging as part of SatVu's image processing workflow. This research forms a basis for vicarious calibration and drift analysis for future HotSat imagers planned as part of SatVu's imaging constellation. |
| **The constellr HiVE constellation: Commissioning and planned CAL/VAL activities towards a 2 Kelvin accuracy Surface Temperature (ST) Product****Presenter(s): Andreas Brunn, Constellr**constellr is a new space company at the forefront of delivering daily, global surface temperature (ST) data, with the ambition of supporting the agriculture sector by boosting efficiency and sustainability. Besides supporting this general ecosystem monitoring ambitions, HiVE (High-precision Versatile Ecosphere monitoring mission) data also provides crucial information for many other applications including the monitoring of urban heat islands and infrastructure or the location of wildfires.In early 2025, constellr will begin deploying its HiVE constellation, a cutting-edge system of 100 kg class microsatellites. Each satellite will be equipped with a cryocooled, 4-band thermal camera and a visible/near-infrared camera that replicates the Sentinel-2 bands below 1Âµm, supporting atmospheric correction, on-the-fly emissivity estimation and precise geolocation. After the full deployment of the 1st gen constellation, it will be capable of accessing any place on earth on a daily basis. Achieving the required 2K accuracy without on-board calibration equipment calls for robust characterization, calibration and validation (CAL/VAL) procedures, both pre-launch on the ground and in-orbit during commissioning and regular operations of the system. The proposed presentation will, besides a brief introduction into the HiVE system and planned schedules, present the results of the ground calibration campaign, the planned commissioning activities for the initial in-orbit characterization and calibration and the activities planned to keep the system accurate during the operational lifetime. Finally, we will present initial results from the commissioning phase.  |
| **RIT's open-source platform to provide near real-time validation of the Thermal Infrared Sensors (TIRS) onboard Landsat-8 and Landsat-9:****Presenter(s): Rehman Eon, Rochester Institute of Technology (RIT)**Landsat-9 (L9), launched on September 27, 2021, continues a five-decade tradition of uninterrupted Earth observation from space. With the addition of the Thermal Infrared Sensor-2 (TIRS-2), L9 extends a legacy of thermal data collection spanning more than 40 years. Since 1999, the Rochester Institute of Technology (RIT) has provided thermal infrared (TIR) reference data for Landsat sensor calibration and has progressively supported the evaluation of higher-level surface temperature products. The thermal sensors on Landsat are calibrated through a vicarious approach, using reference data from the National Oceanic and Atmospheric Administration (NOAA) buoy network, which operates at various near-shore and inland water locations across the continental United States. Water is a preferred target for monitoring TIRS performance over time due to its stable spectral properties and well-characterized emissivity. RIT's calibration process employs a forward-modeling approach designed by the Landsat Calibration and Validation Team, which predicts at-sensor spectral radiance for each TIRS band based on reference water surface measurements. In this presentation, we introduce an open-source platform developed at RIT for near real-time validation of the TIRS instruments on Landsat-8 (L8) and L9. The platform's main objective is to compile a comprehensive calibration and validation dataset for the Landsat thermal sensors since their launches and make this data openly available to the scientific community. The talk will showcase the platform's capabilities, highlighting its role in supporting the accurate and reliable calibration of Landsat thermal sensors.**constellr HiVE high resolution thermal data for urban and agricultural monitoring****Presenter(s): Daniel Spengler, constellr GmbH**Thermal remote sensing satellite data is essential for monitoring environmental challenges, especially urban heat and agriculture. constellr's innovative productsâ€” LSTfusion, LSTprecision, and LSTzoomâ€”are designed to offer high-resolution insights, contributing to climate resilience and sustainable development. These products utilize data from constellr's HiVE (High-precision Versatile Ecosphere monitoring) satellite constellation, launching in 2025. HiVE satellites will provide daily global revisit, 30m spatial resolution, and temperature accuracy up to 2K (LSTprecision), ideal for monitoring urban heat and agricultural landscapes at high resolution. LSTprecision delivers accurate, high-temporal resolution LST data with up to daily revisit (2-day 2025, daily in 2027), which is vital for tracking changes in both urban environments and agricultural fields over time. LSTzoom is based on leveraging the optical bands of the HiVE satellites to offer a sharpened ultra-high-resolution thermal imagery with up to 10m spatial resolution. This enables detailed analysis of small-scale areas, crucial for precision farming and targeted urban heat mitigation. LSTfusion harmonizes and integrates multiple public thermal mission datasets, using constellr's proprietary algorithms to deliver precise Land Surface Temperature (LST) data with high spatial sharpness. Incorporating HIVE data this product will offer more continuous data streams in time and space than any single constellation while using quality and high-resolution information from proprietary data and processes. Especially for agriculture management LSTfusion provides useful information at large scales to monitor crop stress, soil moisture, and irrigation needs, improving yield predictions and resource efficiency. All products provide valuable support for upcoming public missions like TRISHNA, LSTM, and SBG. |

# **Resources for Data Quality Session**

**Leveraging the DIRSIG model to simulate proxy data for LandIS instrument and science studies**

**Presenter(s): Aaron Gerace, Rochester Institute of Technology**

The Landsat Next Instrument Suite (LandIS) has a nominal launch date of 2030/2031 and will contribute to over fifty years of continuous Landsat Earth observations once it begins operations. To address the needs of science users, LandIS will be a deviation from previous Landsat sensors as it will be comprised of three identical instruments that acquire image data across twenty-six spectral bands at varying resolutions, (10/20/60)[m]. In addition to these improvements, each sensor will be placed on its own platform and separated in-orbit to increase revisit rate. This presentation describes how the DIRSIG model is used to simulate LandIS proxy data for full WRS-3 path/rows to support instrument and science studies posed by NASA. The DIRSIG (Digital Imaging and Remote Sensing Imaging Generation) tool was designed over forty years ago to simulate spaceborne image data to enable an assessment of system requirements and environmental conditions on image quality. DIRSIG was used for Landsat 8 to evaluate a new georeferencing algorithm for OLI, assess the impact of potential jitter on OLI image quality, and to support a requirement waiver for TIRS. An overview of the DIRSIG model is presented, along with a workflow developed to enable large-scale synthetic landscapes to support LandIS studies. LandIS requirements were used to develop a preliminary sensor model necessary to image the synthetic environment. Results of various studies are presented including a discussion of how DIRSIG was used to simulate LandIS proxy data to support an assessment of LandIS per-band compressibility to address data volume concerns.

**Design and Development of a National Calibration Site in Turkiye**

**Presenter(s): Design and Development of a National Calibration Site in Turkiye: Kaan Kalkan, TUBITAK Space Technologies Research Institute**

Calibration sites are fundamental to ensuring the accuracy and reliability of remote sensing data, which is critical for high-quality geospatial information. With TÃ¼rkiye's increasing reliance on Earth observation technologies, this study explores the design principles for a national calibration site tailored to its unique geographic and operational needs. The research focuses on developing a comprehensive calibration facility that can support radiometric and geometric calibration as well as the validation of remote sensing products. Drawing inspiration from international examples, the proposed design incorporates permanent and portable artificial targets to facilitate precise, repeatable calibration processes for both optical and SAR sensors. Considerations include selecting an appropriate location with favorable atmospheric conditions and diverse surface types, and employing advanced methodologies to reduce uncertainties in data acquisition. While serving national requirements, the site is also planned to contribute to the global Earth observation community by offering high-quality calibration resources. By addressing both the technical and environmental challenges, the study provides a roadmap for designing a calibration site that meets international standards while addressing TÃ¼rkiye's priorities.

**Optimal Estimation for Retrievals and Uncertainty Quantification in Remote Sensing**

**Presenter(s): Nimrod Carmon, JPL**

Optimal Estimation (OE) is a robust, physics-based framework for retrieving geophysical parameters from remote sensing measurements while simultaneously quantifying uncertainties. By combining observational data with prior information, OE delivers accurate results with formal error estimates, improving the reliability of remote sensing products. Despite its widespread use in research, OE remains underutilized in commercial and operational workflows.

This presentation introduces the OE approach, explaining its mathematical foundations and advantages for parameter retrieval. We demonstrate its application to hyperspectral Visible Shortwave Infrared (VSWIR) and multispectral Thermal Infrared (TIR) data, showcasing retrievals of key parameters such as surface reflectance, surface temperature, and atmospheric properties. Results from airborne and orbital missions illustrate the precision and robustness of OE, emphasizing its ability to quantify uncertainty rigorously, an essential capability for decision-making in Earth observation.

Additionally, we highlight how formal uncertainty estimates enhance the interpretation of retrieved parameters, specifically for mineral composition and plant traits. These examples demonstrate the improved confidence and accuracy OE brings to mapping and quantifying surface properties, which are critical for applications in natural resource management, agriculture, and environmental monitoring.

By providing an overview of the methodology, practical examples, and outcomes, this work aims to inform industry professionals and commercial operators about the significant value OE brings to remote sensing. Broader adoption of OE can enhance data quality, foster confidence in derived products, and unlock new opportunities for operational applications.

**Updated Absolute Radiometric Calibration for the Maxar Earth-Observing Fleet**

**Presenter(s): Tina Ochoa, Maxar**

Maxar Intelligence, USA, uses reflectance-based calibration as its primary approach. Surface reflectance data of tarps laid out in Colorado, USA, are the main measurements along with atmospheric data. These data are used to push a radiative transfer model to calculate top-of-atmosphere radiances. Radiometric Transfer Calibration Sites (RadTraCS) is a method that transfers the primary calibration derived by the reflectance-based method to various pseudo-invariant sites around the world and can be used to perform ongoing radiometric assessments and calibration in the Colorado winter months or when sensor access to the vicarious sites is limited. Radiometric Calibration Network (RadCalNet) sites are used to perform an independent validation of calibration results.

In the past, customers wanting current absolute radiometric calibration had to obtain reports containing additional gains and offsets. With this new calibration, only abscalfactors and effective bandwidth are required to convert digital numbers to at-sensor radiance. These abscalfactors are retroactive and relevant to the entire archive. We will show that the Maxar sensors are stable to allow for this all-time all-image update. We present an updated absolute radiometric calibration for WorldView-3, WorldView-2, and GeoEye-1, WorldView-4, WorldView-1 and CAVIS. Comparisons to RadCalNet sites are within Â±3% percent difference. A complete set of abscalfactors and other radiometric parameters in the form of a JSON file will be made available at the conference. At the writing of this abstract, the abscalfactors update in the Maxar Factory is TBD and users that would like to utilize the new calibration will need to have this JSON file.

**Radiometric Calibration and Surface Reflectance Validation using RadCaTS**

**Presenter(s): Jeffrey Czapla-Myers, University of Arizona**

The Radiometric Calibration Test Site (RadCaTS), developed by the Remote Sensing Group of the Wyant College of Optical Sciences at the University of Arizona, provides satellite operators and the scientific community with daily ground-based data for the calibration and validation of Earth-observation sensors and their surface reflectance products. Located in Railroad Valley, Nevada, USA, RadCaTS has been in operation since 2012. It is currently used with low-Earth orbit sensors such as Terra and Aqua MODIS, Landsat-8 and -9 OLI, Sentinel-2A and -B MSI, and the VIIRS instruments on the SNPP, NOAA-20, and NOAA-21 platforms.

The primary goal of RadCaTS is to offer the scientific community independent, accurate, and timely analyses of radiometric calibration and surface reflectance validation. RadCaTS is one of the original four automated test sites in the CEOS WGCV Radiometric Calibration Network (RadCalNet), which aims to harmonize ground-based calibration and validation measurements from international organizations. The data portal became operational in July 2018, and the results presented in this work include those obtained using both RadCaTS and RadCalNet.

# **New & Future Systems 2 Session**

**The Dragonette Constellation: Calibration and Validation**

**Presenter(s): Chad Bryant, Wyvern Inc**

The satellite Earth observation (EO) sector is rapidly expanding generating vast volumes of data with impacts on societal and scientific challenges. However, the effectiveness of this data is hindered by inconsistency in quality due to variability in calibration methods, sensor designs, mission objectives, and operational budgets. These inconsistencies limit the seamless integration of data and impede the ability to create long-term, multi-source datasets critical for scientific and operational applications.

Cross-calibration techniques internal and external to the constellation have become essential for addressing inconsistencies where data reliability impacts user outcomes. By aligning data from multiple sensors under similar observation conditions, these methods ensure uniformity across datasets. Nevertheless, challenges such as orbit dynamics and operational constraints complicate achieving synchronous observations, reducing the frequency and effectiveness of cross-calibration.

The Dragonette satellite constellation tackles these challenges through meticulous radiometric and geometric calibration of its satellites. Internal cross-calibration ensures uniformity across the constellation, fostering confidence among users in the system's data quality. Additionally, external calibration with established references, such as Committee on Earth Observation Satellites (CEOS) sites and Sentinel-2 data, further validates data accuracy. This robust calibration framework enables the Dragonette constellation to meet the high precision demands of its customers and ensure consistent, reliable data products for diverse remote sensing applications.

**Onboard Computing to Enable Orbital Detection of Hazards**

**Presenter(s): Douglas Franz, MyRadar**

The increasing availability of commercial space launches has expanded the potential for innovative, new & future small satellite missions. Small satellites, exemplified by the MyRadar Hyperspectral Orbital Remote Imaging Spectrometer (HORIS) constellation currently under development, are significantly limited by Size, Weight, and Power (SWaP) constraints. To address these challenges, HORIS uses a hierarchical edge computing approach that employs a combination of computing architectures to optimize SWaP utilization. This approach employs deep learning inference at various stages of the processing pipeline to address bottlenecks for edge data processing, significantly reducing the need for downlink bandwidth and power for data transmission from Low Earth Orbit (LEO). Specifically, low-power deep learning inference on visible wavelength imagery is utilized for scene and context discrimination and constraining atmospheric properties, which is crucial for accurate environmental monitoring. For scenes of interest, an always-on AI subsystem initiates multi-sensor data capture and processing, facilitating sensor duty cycling and subsequent target detection, classification, and semantic segmentation deep learning inference tasks. Overall, this hierarchical edge computing strategy optimizes satellite resource utilization and allows for miniaturization and proliferation of real-time orbital environmental monitoring capabilities.

**SpaceEye-T 1: Launch of Satrec Initiative's 30 cm Native Resolution Optical Satellite**

**Presenter(s): Byung Joon (Bryan) Ahn, Satrec Initiative**

Ever since crossing the sub-meter resolution threshold, the commercial satellite industry has rapidly advanced to deliver finer spatial resolution imagery for diverse government and public applications. For optical satellites operating at orbital altitudes of ~600 km, the highest commercially available resolution is currently 30 cm, commonly classified as Very Very High Resolution (VVHR).

Building upon over 30 years of innovation since developing South Korea's first satellite, KITSAT-1, Satrec Initiative (SI) has reached a new milestone with the development of SpaceEye-T, a next generation high-performance Earth observation satellite with 30 cm native resolution. With a constellation of four SpaceEye-T satellites planned, Sl is currently on-track to launch the first satellite of its series, SpaceEye-T 1, by March 2025. This presentation will highlight the launch and early operations of SpaceEye-T 1, along with Sl's plans for its VVHR constellation.

**Commercial Remote Sensing Global Rankings - a study**

**Presenter(s): Nadine Alameh, Taylor Geospatial Institute**

The Taylor Geospatial Institute (TGI), in collaboration with the Center for Strategic and International Studies (CSIS), Taylor Geospatial Engine, and the United States Geospatial Intelligence Foundation (USGIF) have issued “The 2024 Commercial Remote Sensing Global Rankings," an assessment of the world's leading commercial space-based remote sensing systems.

Drawing inspiration from the US National Geospatial-Intelligence Agency's (NGA) 2021 product comparing the performance of commercial satellite imaging systems, “The 2024 Commercial Remote Sensing Global Rankings," provides an independent assessment of worldwide commercial space-based remote sensing systems. Channeling the Olympics, the project produces a “Top 3" ranking of systems across several categories of performance. The 2024 assessment centers largely on advances in US and Chinese remote sensing systems. Of 11 performance categories, Chinese systems garner the gold medal in five areas and US systems in four areas, with Finland and South Korea each securing a gold medal.

The presentation provides a detailed discussion of the trends in each category, the stakes involved should any one country dominate the commercial remote sensing market, and recommended actions for the US government to keep US companies at the leading-edge of technology and globally competitive.

**Lunar calibration of Earth observation thermal infrared imagers using cross-calibration and thermo-physical models**

**Presenter(s): Christian Mollière, OroraTech**

OroraTech is launching a series of cost-effective thermal infrared (TIR) imagers designed to deliver high-quality earth observation data, which aids in mitigating climate change effects, such as providing timely wildfire detection. To keep the design simple while maintaining high accuracy, OroraTech's TIR imagers use the Moon for radiometric in-flight calibration instead of internal calibrators such as blackbodies. While Lunar calibration is routinely performed in the visible domain using, for example, the Robotic Lunar Observatory (ROLO) model or the Lunar Irradiance Model of ESA (LIME), the methodology in the thermal domain lags behind.

Here, we present the Lunar calibration results for our current mission, FOREST-2, using quasi-simultaneous Lunar observations together with Sentinel-3 SLSTR. A comprehensive uncertainty analysis indicates our ability to calibrate the gains of our mid and long-wave channels to within a few percent through a cross-calibration approach. Additionally, we validate the suitability of two thermo-physical models of the Moon for the automated in-flight calibration of our TIR imager constellation by comparing them with the Lunar acquisitions of FOREST-2. Our findings confirm the feasibility of utilizing Lunar calibration in the TIR domain and provide a methodology for the inter-calibration and harmonization of various TIR missions.

# **Lightning Talks Session**

**Advancing GEOINT with the EarthDaily Constellation**

**Presenter(s): KC Kroll, Descartes Labs Government**

The Joint Agency Commercial Imagery Evaluation (JACIE) Workshop offers a premier platform to explore next-generation electro-optical (EO) capabilities. We proudly introduce the EarthDaily Constellation, an EO platform redefining standards in data fidelity, global coverage, and revisit cadence, delivering transformative GEOINT capabilities.

The EarthDaily constellation will provide near-global daily coverage of landmasses and coastal zones through its "string of pearls" design, ensuring consistent, accurate data without tasking or ad-hoc imaging. Its advanced sensors span 22 calibrated spectral bands across visible, near-infrared, short-wave infrared, and thermal infrared, enabling enhanced change detection, time series analysis, and predictive modeling.

Unlike traditional EO systems, EarthDaily offers scalable Analysis Ready Data (ARD) optimized for accuracy and consistency. Its automated, cloud-native processing pipeline minimizes operational overhead, allowing analysts to focus on insights. Rigorous pre- and post-launch calibration ensures radiometric and geolocation accuracy, optimizing data for AI-powered geospatial applications.

Key applications include change monitoring, climate monitoring, disaster assessment, and resource management. EarthDaily surpasses industry benchmarks with its spectral diversity, temporal consistency, and scientific-grade quality, offering a more comprehensive operational picture. This approach reduces latency, enhances precision, and supports mission success in dynamic environments.

We invite JACIE participants to discover how EarthDaily advances geospatial intelligence priorities, delivering actionable insights to address today's global challenges.

**A technical dive into India's first commercial edge computing mission**

**Presenter(s): Arya Pratap Singh, Kaleideo Space Systems**

With the recent advancements in compute hardwares, devices are getting smaller, yet powerful. Edge computing in space is a growing topic of research. Edge computing brings various advantages to the overall satellite mission, be it bringing down cost and increasing the data downlink speed by compressing data and then downlinking it, to generate near real time insights at the time of catastrophes, provide timely feedback for defense to counter terrorist activities etc. To demonstrate such capabilities in a real time environment, we at Kaleideo Space Systems developed a highly optimized deep learning road network identification algorithm optimizing 3 hours of compute complexity to less than 3 minutes. The result is a clearly defined road network over the Ohio, Toledo region of USA. The original file size as compared to the useful insights, i.e. the road networks was 99% smaller making the downlinking much faster which in turn made an 8 hour actionable item to less than 15 minutes. The testing was done in collaboration with Spiral Blue, who was responsible for integration of software/OS modules onboard on Satellogic satellites, the satellite collaborator which had 1 metre spatial resolution.

The high performance computing framework takes into account available processors, working threads, tracking non daemon threads, and serializes them in a way to optimize the data streamlining. Primarily a combination of multithreading, multiprocessing and highly optimized frameworks like NUMBA (Just in time compiler), and Cython was used in order to optimize each of the modules, including preprocessing of data, inference and post-processing.

**CSDA Analysis for Characterizing Canopy Chlorophyll and Photosynthetic Productivity for Agricultural and Forest Monitoring**

**Presenter(s): Petya Campbell, GSFC & UMBC**

Canopy chlorophyll (CCab) is among the most important drivers of photosynthesis and canopy gross primary productivity (GPP). There is a critical need for temporally dense time series of canopy traits (e.g., CCab and GPP) provided on demand, to enable monitoring of vegetation function at temporal scales relevant to the dynamics in photosynthetic function to detect transient stress and seasonal changes, and at a spatial scale enabling practical assessments.

We will present our initial results that demonstrate for forests and crops that linking CSD (i.e., hyperspectral and VHR with red-edge bands) to field measurements of photosynthetic pigments and productivity, enables the generation of robust algorithms for processing on demand and consistent VHR CCab and GPP products, that offer a bridge to reliably upscale field measured canopy traits to local and regional levels, and across seasons.

The project leverages on the close collaborations within the team, to utilize existing field collections of canopy traits (e.g., CCab, LAI, GPP) and Commercial Satellite Data (CSD), including very high resolution (VHR, â‰¤5 m) WorldView and PlanetScope, and hyperspectral DESIS (400-900 nm, 30 m) data, at select sites representing key regionally important agricultural crops and forest species. The developed at VHR algorithms and traits will be upscaled to the Harmonized Landsat and Sentinel (HLS, 30 m) dataset, for a large-scale monitoring of vegetation function. The project will generate robust algorithms characterizing the relationships between CCab, GPP, canopy reflectance and VIs and multi-temporal estimates of CCab and GPP, which are consistent at very high and moderate resolution.

**DEM Creation from Enhanced Resolution Sentinel 1 SLC Products**

**Presenter(s): Jeff Pennings, Wolverine Radar**

This presentation will demonstrate how Wolverine Radar's Full Aperture Sentinel 1 SLC products can produce higher resolution DEM products than traditionally processed SLC files. The presentation will discuss the basic differences between Full-Aperture SLC products and Standard SLC products and provide some potential InSAR applications where this computationally intensive resolution enhancement can be leveraged to benefit society.

**Advancement in Field UV-VIS-NIR Spectroscopy of Soil and Clay Minerals**

**Presenter(s): McKenzie Woodman, Spectral Evolution**

Soil mineral detection is a critical metric in environmental, geological, and soil research today. Most soils are a mixture of organic material, clay, sand, and silt. Due to their large surface area and negative charge clays play a critical role in nutrient availability. Common plant nutrients are positively charged, such as CA++, Mg++, K+ and Na+. The ability to hold and store positively charged ions is called cation exchange capacity (CEC). Clay also acts as a binder for soil particles, helping soil hold moisture and reduce nutrient loss due to leaching. The most common clay minerals in soil include kaolinite, illite, and montmorillonite. We also compared Kaolinite to Halloysite due to their chemical and spectral similarities. Typical soil sampling necessitates expensive or tedious lab analysis. Most commonly this is done with an XRD that involves grinding the sample down to a powder significantly manipulating it. Another challenge is that typical soils are dark decreasing the reflectance signal when conducting field spectroscopy. To address this problem, we deployed Spectral Evolutions NaturaSpec series to maximize signal to noise ratio and spectral resolution as well as demonstrate added utility in field soil spectroscopy. Spectral Evolutions field spectroradiometers combined with the contact probe, benchtop probe, and EZ ID software allows unmixing of signal and identification of clay minerals with nondestructive in-situ measurements. In this study we present novel methods of spectrally unmixing soil reflectance to identify clay minerals in their natural conditions as well as explore different resolution spectrometers' ability to identify these minerals.

**AI-Powered Global-Scale Monitoring**

**Presenter(s): Sandy Brusiloff, Impact Observatory**

Impact Observatory (IO), a US-based small business, develops AI-powered geospatial monitoring tools to assess risks and anticipate change at unparalleled speed and scale. Leveraging imagery from public and commercial Earth observation satellites, IO enables near-real-time global coverage and long-term trend analysis using sources like Landsat.

Under an NGA SBIR Phase II project, “Seeing the World in Real-Time with Automated Land Use Mapping," IO created the world's first fully automated, 20+ class land cover maps using deep learning from Sentinel-2, and has been extended to Landsat and PlanetScope. This innovation produces a dynamic, “living" map of the world, highlighting key trends and events for human analysts to review.

We now report on recent efforts to build a prototype geospatial "Sidekick" powered by large language models (LLMs). Agentic, tool-using systems using LLMs can provide a natural language interface to this living map, and enable non-geospatial expert users to benefit from the acceleration of automated, near-real-time scene analysis. This system integrates IO's land cover monitoring capabilities, combining remote sensing science with LLM-powered tools to deliver near-real-time insights from open and commercial sources. By generating plain-language narratives in multiple languages, the Sidekick improves and accelerates information sharing with state, local, and international partners.

We demonstrate a humanitarian assistance and disaster relief scenario, where the system provides timely, accessible, and scalable geospatial insights, leveraging validated data and custom tools to support critical decision-making.

# **Active Sensors (SAR, LiDAR) Session**

**ICESat-2 Mission Status and Overview**

**Presenter(s): Nathan Kurtz, NASA**

NASA's Ice, Cloud and Land Elevation Satellite-2 (ICESat-2) has provided global elevation laser altimetry data at unmatched accuracy since October 2018, supporting a broad range of scientific studies. ICSEat-2 has enabled time series analyses on seasonal scales for ice sheets, glaciers, and sea ice. ICESat-2 also provides the terrestrial ecology community with global canopy heights that have improved local and regional biomass estimates. The high spatial resolution of ICESat-2 is well suited to oceanographic, bathymetric and hydrologic applications, and the data are incorporated into dynamic models and other remote sensing products. In the atmosphere, ICESat-2 data highlight cloud layer detection and blowing snow. ICESat-2 has now completed its 3-year prime mission objectives and is now continuing under nominal operations during an extended mission phase. In this presentation we will present the current status of the mission, discuss expected mission lifetime and new science capabilities, as well as highlighting the evolution of the latest release (rel007) data products expected in May 2025.

**Capella Space 2025**

**Presenter(s): Tom Repetti, Capella Space**

Capella Space is at the forefront of satellite imaging technology with its Synthetic Aperture Radar (SAR) systems, providing advanced Earth observation capabilities. This briefing explores the functionalities and benefits of Capella Space's SAR technology, which utilizes very high-resolution radar to capture all-weather, and day-and-night imagery of the Earth's surface. Unlike optical imaging systems, SAR is impervious to weather conditions and varying light levels, making it invaluable for consistent and reliable monitoring.

Capella Space's SAR constellation offers detailed insights into terrestrial changes, facilitating applications in environmental monitoring, disaster response, and defense and intelligence. This briefing will cover the technical specifications of Capella Space's SAR satellites, their operational advantages, and potential use cases across various sectors. Emphasis will be placed on the integration of SAR data into decision-making processes and the transformative impact of this technology on global surveillance and data analytics.

**ICEYE's Ground Track Repeat (GTR) Orbits for Coherent Change Detection (CCD)**

**Presenter(s): Alvah Bickner, ICEYE**

Coherent Change Detection, or CCD, is a process that compares two time-lapsed satellite radar images to detect & measure changes to that area. CCD is able to detect millimeter level changes due to changes in the images. The images used to generate CCD must be coherently collected, meaning little to no difference in collection geometry. ICEYE has one asset in a ground track repeat (GTR) that allows the asset to maintain a 24 hour repeat ground track, revisiting the same location on the earth every 24 hours with the same collection geometry, and plans to achieve global GTR coverage sometime in 2026. CCD can be used to detect environmental changes, military movements, and even vehicle ground tracks. CCD can be run on Spot/Dwell and Stripmap imagery. ICEYE has upcoming capability and product releases and scheduled satellite launches into 2025.

**Accuracy Testing and Application Suitability Testing of Open Sources DEMs for Urban Planning and Route Alignment Selection in Ethiopia**

**Presenter(s):** **Zenabu Sisay, Bahir Dar University, Institute of Land Administration**

This study assessed the accuracy and application suitability of four open-source DEMs (SRTM30, ASTER V003, ALOS W3D30, ALOS-PALSAR 12.5m) for urban planning and infrastructure development in Bahir Dar, Ethiopia, using 179 GCPs and 378 RTK points, and a photogrammetry DEM for reference ground in-situ measurement. The research aimed to evaluate vertical accuracy (RMSE, 95% confidence intervals) and application appropriateness for various urban planning applications against established national and international standards using point based and derivative statistical analysis. Considering the strong correlation between DEMs and GCPs (RÂ² > 0.9, p<0.005). ALOS W3D30 exhibited the strongest correlation (RÂ² = 0.99). ALOS W3D30 demonstrated the highest accuracy using GCPs (RMSE 2.72m, 95%CI 5.34m), while ALOS-PALSAR performed best against the photogrammetry DEM (RMSE 3.08m). RTK-based GPS RMSE ranged from 4.57m to 4.99m. Accuracy varied across land use types, performing better in open and built-up areas slope analysis showed ALOS W3D30 and SRTM generated slopes similar to the reference DEM. The study concludes that ALOS W3D30, ALOS-PALSAR, and SRTM30 are suitable for moderate-accuracy (1-5m) urban planning applications, particularly in flatter terrains, offering a cost-effective alternative to high-resolution data acquisition. These open-sources DEMs offer a cost-effective solution for various urban planning tasks such as environmental assessments and flood vulnerability mapping, minimizing the need for expensive, high-resolution data acquisition. ASTER V003 consistently showed lower accuracy across all assessment methods. Further research could explore the impact of varying urban densities and topographic complexities on DEM performance.

**Airbus Space Reference Points (SRPs) - Precise 3D information over any location on Earth**

**Presenter(s): Michael Tonon, Airbus & Mathilde Jaussaud, IGN**

High location accuracy, whatever the location, is a major requirement for satellite image users. Target performance is usually achieved by either specific on-board satellite equipment or by an auxiliary registration reference dataset. Both methods may be expensive with certain limitations in terms of performance. The Institut National de l'information GÃographique et ForestiÃ¨re (IGN) and Airbus Defence and Space (ADS) have worked together for almost 20 years, to build reference data for improving image location using multi-satellite observations. IGN and ADS have created a worldwide geometric foundation called Space Reference Points (SRP). It is a worldwide 3D GCP database, built from an abundant SPOT 6/7 multi-view archive with a large automatic process. SRP aims to provide a systematic and reliable solution for image location (Unmanned Aerial Vehicle, VHR satellite imagery, High Altitudes Pseudo-Satellite.) and similar topics thanks to a high-density point distribution with a 3m CE90 accuracy allowing massive radiometric matching with images to be corrected. A new generation of this database is under construction with improved performance (targeted accuracy 1 m CE90) transmitted from radar images. This innovative radar-to-optical geometric automated geolocation is called SAROptic (ADS patent). This presentation describes the principle of SRP generation and its improvement with SAROptic and cloud technologies and presents the first validation results for the improved version.

**Methods for evaluating the utility of 3D data from satellite images**

**Presenter(s): Christina Selby, Johns Hopkins University Applied Physics Laboratory**

Three-dimensional (3D) data derived from satellite imagery is crucial for large-scale scene modeling applications, particularly in regions where airborne-lidar or camera access is restricted. Accurately measuring the resolution and accuracy of this data is essential for assessing mission feasibility. In this work, we evaluate methods for assessing the quality of 3D point clouds and digital surface models (DSMs). We outline tools and workflows for automated evaluation, using high-resolution airborne lidar as a reference, and present our analysis of datasets of varying quality.

Our approach automates the derivation of several products from airborne lidar data that are used as reference inputs into metrics calculations. We trained a classification model for airborne lidar point clouds, leveraging a wide variety of labeled 3D datasets to produce point classifications. We then developed a method to estimate the aggregate nominal pulse spacing of the reference lidar point cloud and used this to generate gridded DSMs, ground masks, and building footprint polygons. Additionally, we implemented methods to resample all datasets to a common raster format, transform them to a unified coordinate frame, and align them using a robust and efficient phase correlation method. The evaluation pipeline includes metrics for assessing 3D surface position fidelity and surface slope accuracy. We also estimate the resolution of the 3D data using a contrast transfer function, which evaluates contrast between adjacent building features.

# **Environmental Commercial Data and Atmospherics Session**

**The GHGSat constellation: Land and offshore methane detection and quantification**

**Presenter(s): Jean-Philippe MacLean, GHGSat**

GHGSat operates a constellation of small satellites designed and optimized to detect and quantify industrial emissions from individual facilities with a resolution down to ~25m. As of 2024, the constellation comprises of 10 methane satellites in a sun-synchronous orbit with a detection limit down to ~100kg/h, in addition to one CO2 specific satellite based on the same technology. Here, we provide an overview of the technology, present the different Earth observation products for methane, and report on our latest efforts to characterize system performance.

For end users, detection limit and quantification accuracy are key figures of merit of an observing system. They can be assessed through controlled releases, where plumes are generated intentionally with a steady, metered flow rate. GHGSat has built up a world leading sample size of 49 controlled release events on land, including self-organized and third-party single-blind studies. From this data, we infer a detection limit on land of 100.4 kg/hr, at 50% probability of detection and wind speed of 3 m/s. Offshore, controlled releases are challenging due to operational and regulatory reasons. Therefore, to estimate the detection limit of the constellation in an offshore environment, we employ a combination of analytical modelling and orbital simulations and find that it varies between 160 kg/h and 600 kg/h depending on the latitude and season.

Finally, we provide an update on the status of the constellation's commercial operations, recent developments to automate the processing of emission measurements, and discuss global emission insights enabled by our satellite constellation.

**Leveraging NASA's Imaging Spectrometer Optimal FITting (ISOFIT) framework for Advanced Atmospheric Correction in Commercial Hyperspectral Smallsats: The Pixxel Case Study**

**Presenter(s): Jeremy Kravitz, Pixxel Space Technologies**

Atmospheric correction is essential for processing hyperspectral imagery, ensuring accurate surface reflectance retrieval. NASA's Imaging Spectrometer Optimal FITting (ISOFIT) framework has set a benchmark for advanced atmospheric correction, particularly for missions like AVIRIS-NG and EMIT. However, its application to commercial small satellite platforms remains underexplored. This study details Pixxel's adaptation of ISOFIT for its spaceborne hyperspectral satellites, addressing the unique demands of the commercial sector.

Pixxel, a leader in commercial hyperspectral imaging, operates high-performance satellites designed to capture precise spectral data. To enable robust atmospheric correction, ISOFIT's framework was adapted to account for the spectral, radiometric, and orbital characteristics of Pixxel's satellites. Key updates included sensor-specific calibration, parameter optimization, and integration of auxiliary datasets aligned with operational conditions of commercial missions.

Performance validation was conducted using global RadCalNet sites and cross-calibration with NASA's EMIT mission for near-coincident overpasses. Results demonstrated improved atmospheric correction precision, achieving accuracy comparable to NASA's hyperspectral missions. The integration of posterior error estimates provided robust uncertainty quantification, ensuring reliable data for applications like precision agriculture, environmental monitoring, and natural resource management.

This work underscores the transformative potential of adapting state-of-the-art public sector tools like ISOFIT for commercial use, bridging the gap between public research institutions and private enterprises. By advancing hyperspectral imaging capabilities, these innovations enable higher-quality commercial data products and foster the growth of hyperspectral analytics in industry.

**Simulating hyperspectral radiometric calibration reference over bright desert targets**

**Presenter(s): Yves Govaerts, Rayference**

Rayference has developed a radiometric calibration reference based on simulated radiance over pseudo-invariant bright desert calibration sites in the 350 â€“ 2500 nm spectral range. This calibration reference is generated with the Eradiate 3D radiative transfer model, our open-source software developed to support the upcoming missions able to deliver SI-traceable satellite observations with an anticipated radiometric accuracy of 1%. Input data assembly practices were adapted to comply with these accuracy requirements. Data from the Copernicus Atmospheric Monitoring Service (CAMS) are used to reconstruct accurate atmospheric vertical profiles at place and time of data acquisition for which the calibration reference needs to be generated. The accuracy of this simulated calibration reference has been assessed against well-calibrated multi-spectral radiometers. Its accuracy has proven to be better than Â±3%. This calibration reference been used to compare EMIT, PRISMA and EnMAP observations acquired over bright desert PICS with simulations performed with the Eradiate model based on CAMS vertical profiles. Results show that observations agree with the simulated calibration reference within Â±3% across most of the spectral domain. The generation of this simulated calibration reference can therefore be used for the harmonization of hyperspectral observations. Examples of the harmonization of different hyperspectral missions will be presented. These examples demonstrate that the simulated calibration reference offers a cost-effective solution for the radiometric calibration of Earth Observation satellite constellations.

# **ARD & Interoperability Session**

**Potential improvements on sensor geometric performance by image processing**

**Presenter(s): Guoqing (Gary) Lin, NASA Goddard Space Flight Center**

In remote sensing, sensor geometric performance includes: 1) sensor (detector) spatial response that may be parameterized by full width half maximum (FWHM) and modulation transfer function (MTF); 2) band-to-band registration (BBR) for a multi-spectral sensor; and 3) geolocation accuracy. For a sensor generating very high resolution (pixel size is =< 5 m) images, it is challenging to achieve high performance in all these three areas.

An image may over-sample an earth surface scene when the ratio of FWHM of a sensor spatial response to the image's pixel size exceeds 1. When the ratio is >= 2.0, which happens to a few sets of commercial images we assessed, we recommend reprocessing the image by either sub-sampling or aggregating so that the ratio is < 2.0.

The reprocessing to reduce the over-sampling factor closer to 1 will improve image quality (as indicated by MTF). When reprocessing by aggregation, image signal-to-noise ratio (SNR) will also improve (e.g. 3 times with a 3x3 aggregation). It will also improve BBR and geolocation accuracy 3 times relative to aggregated pixel size.

We will show an example from VIIRS sensor that performs native sample aggregation on-board spacecraft for single gain bands, and on the ground for dual-gain bands. MTF, BBR, geolocation accuracy and SNR improve after aggregation.

We will discuss over-sampling factors in images from WorldView, Planet, BlackSky, GHGSat. We will show how they can improve their image quality in terms of MTF, BBR, geolocation accuracy and SNR through reprocessing.

**Spatio-Temporal Validation of Analysis-Ready PlanetScope Surface Reflectance Data**

**Presenter(s): Jessica Bobeck, Planet Labs PBC**

Analysis-Ready PlanetScope (ARPS) is a 4 band (VIS+NIR) geometrically and radiometrically calibrated surface reflectance product that is derived from the hundreds of Dove sensors currently in operation, as well as Planet's historic catalog. Leveraging advanced methodologies, such as the CubeSat-Enabled Spatio-Temporal Enhancement Method (CESTEM) [1], to radiometrically and geometrically harmonize data from PlanetScope's constellation with rigorously calibrated reference datasets, results in a data product that is pre-processed, harmonized, and spatially consistent near-daily stacks of images that enable time-series analysis and machine learning applications.

The calibration and harmonization of PlanetScope scenes into ARPS is essential for ensuring image interoperability across sensor platforms, facilitating robust broad area monitoring remote sensing analysis. This presentation focuses on the validation of surface reflectance derived from Analysis-Ready PlanetScope (ARPS) imagery against benchmark datasets including Sentinel-2, Landsat 8/9, and RadCalNet sites, as well as the the effort to conform to CEOS-ARD [2] specifications for surface reluctance products. The results demonstrate the capability of ARPS to deliver harmonized 3-meter pixel-size surface reflectance data, supporting cross-sensor analysis and offering new avenues for high-resolution environmental monitoring.

**Automated routines for the validation of CEOS ARD compliance**

**Presenter(s): Wolfgang Lueck, EOIntelligence**

The adoption of CEOS Analysis Ready Data (ARD) standards has streamlined the integration of satellite imagery into diverse applications by ensuring consistent and reliable data quality. To facilitate widespread adoption, robust and automated validation routines are essential for assessing compliance with CEOS ARD standards. This study presents a suite of open-source automated routines designed to validate the packaging, geometric accuracy, and radiometric integrity of CEOS ARD-compliant satellite imagery, with a particular focus on small satellites and CubeSats.

The proposed workflows evaluate the packaging of metadata and ancillary information to confirm adherence to CEOS ARD specifications. Geometric accuracy is assessed through advanced algorithms for band alignment and co-registration, ensuring the spatial fidelity of multi-band data. Additionally, the routines incorporate tools for measuring the Modulation Transfer Function (MTF) to quantify image sharpness, validate radiometric calibration integrity, and assess spectral response functions for consistency across sensors. These methodologies leverage open-source tools and libraries, enabling broad accessibility and reproducibility.

Preliminary results demonstrate the effectiveness of these routines in validating the CEOS ARD compliance of CubeSat and small satellite data, highlighting areas for sensor improvement and data optimization. By automating validation processes, this work aims to enhance the reliability of small satellite data, bridging the gap between emerging technologies and standardized Earth observation practices. This presentation will detail the methodologies, tools, and results, showcasing their potential to advance the operational readiness of CubeSat and small satellite platforms within the CEOS ARD framework.

# **Hyperspectral Session**

**Cal/Val and Early Results from Planet's Tanager-1 Hyperspectral Mission**

**Presenter(s): Geert Barentsen, Planet**

Planet successfully launched its first hyperspectral satellite, Tanager-1, in August, 2024. Tanager-1 is a high-performance VSWIR (Visible to Shortwave Infrared) imaging spectrometer, capturing data across approximately 420 spectral bands from ~400-2500 nm, covering an 18 km wide swath at 30 m resolution. Developed through a public-private partnership with the NASA Jet Propulsion Laboratory (JPL) as part of the Carbon Mapper Coalition, Tanager-1 is designed to pinpoint methane emissions globally, with myriad additional applications in areas such as biodiversity, agriculture, and water quality. The payload features a compact Dyson pushbroom spectrometer -- similar to the technology used in NASA's EMIT mission -- enabling a fast optical system to fly on Planet's new SmallSat platform.

Accurate spectral and radiometric calibration is critical for high-resolution imaging spectrometers like Tanager. Tanager-1's commissioning includes rigorous pre- and post-launch calibration and validation activities. Pre-launch lab measurements included mapping the spectral response functions of all bands, using a scanning monochromator to sweep a spectrally-narrow stimulus across all wavelengths. Band centers and spectral uniformity were measured by observing laser sources of known wavelengths, and radiometric calibration was performed using a NIST-traceable standard lamp and panel. On-orbit, these calibrations are being refined through vicarious calibration, utilizing atmospheric features and well-characterized Earth targets to verify and adjust the calibrations.

This talk will provide an overview of Tanager-1's design, its early applications, and the comprehensive CalVal activities. As we move into an era of hyperspectral remote sensing, Tanager-1 exemplifies the cutting-edge spectral and radiometric precision achievable by modern imaging spectrometers.

**Data Fusion of VSWIR Hyperspectral (EMIT) and TIR (ECOSTRESS) for Enhanced TES (Temperature Emissivity Separation)**

**Presenter(s): Nimrod Carmon, JPL**

This work presents a novel data fusion approach combining Visible Shortwave Infrared (VSWIR) hyperspectral data from the EMIT mission with Thermal Infrared (TIR) observations from ECOSTRESS. We develop fusion algorithms that utilize EMIT's spectral data to infer water vapor, providing essential inputs to improve the Temperature Emissivity Separation (TES) algorithm in ECOSTRESS. Furthermore, we estimate solar energy absorption from EMIT data to constrain potential surface temperatures. This fusion enhances the integration of VSWIR and TIR data, enabling more accurate atmospheric and surface energy balance assessments for environmental modeling and monitoring applications.

**Comparing Night Imaging Capabilities: Moderate-Resolution VNIR Hyperspectral Data, Landsat 8/9, and Landsat Next for Global Systematic Nighttime Observations**

**Presenter(s): Bob Ryan, I2R**

Nighttime satellite imaging plays a vital role in urban monitoring, environmental research, and disaster response. This study compares the capabilities of the DLR Earth Sensing Imaging Spectrometer (DESIS) and the Landsat 8/9 Operational Land Imager (OLI), along with simulated data from the upcoming Landsat Next mission, for observing nighttime lights (NTL).

DESIS is a hyperspectral sensor located on the International Space Station's MUSES platform. It captures 235 spectral channels within the visible-near infrared (VNIR) range and provides a spatial resolution of 30 meters, which matches that of Landsat OLI's multispectral bands (VNIR and shortwave infrared (SWIR)). While DESIS exhibits higher sensitivity for detecting and selectively identifying NTL sources, Landsat OLI's SWIR bands enhance fire and flare observations, something DESIS is unable to detect due to its lack of SWIR channels. Additionally, Landsat's Thermal Infrared Sensor (TIRS) bands facilitate the detection of clouds, which are not as easily identified by DESIS or by OLI alone.

To simulate the future capabilities of Landsat Next, expected to launch in the early 2030s, we utilize high spatial resolution four-band aerial imagery to model 10- and 30-meter data. Landsat Next will offer improved spatial, spectral, and temporal resolutions compared to Landsat OLI, thereby enhancing global NTL imaging.

This study emphasizes the complementary strengths of DESIS and Landsat OLI, as well as the anticipated advancements of Landsat Next, highlighting their significant potential for comprehensive global nighttime Earth observation.

**Characterizing Hyperspectral Sensors for SI Calibration and Cross-Calibration of Satellites**

**Presenter(s): Bob Ryan, I2R**

**Hyperspectral sensors are vital for performing satellite cross-calibrations and for bottom-of-**atmosphere (BOA) ground truth calibration/validation measurements. Imaging hyperspectral sensors deployed on satellites or high-altitude platforms, such as Satellite Cross-Calibration Radiometers (SCRs), facilitate SI-traceable radiometric calibration and robust radiometric consistency across global Earth observation missions. Radiometric consistency is essential for harmonizing increasingly diverse Earth observation data and performing multi-sensor-based time series assessments. Complementing these efforts, non-imaging hyperspectral sensors on surface-based autonomous platforms are used for bottom-of-atmosphere (BOA) radiometric validation. This data is primarily used for validating satellite-derived products and atmospheric correction.

We discuss the laboratory characterization/calibration of both imaging and non-imaging hyperspectral sensors required to achieve high radiometric accuracies. Laboratory characterizations are similar for cross-calibration and surface-based sensors and include wavelength calibration, spectral bandpass characterization, dark spectra evaluation, radiometric linearity, absolute radiometric calibration, polarization, and stray light analysis. We show examples from laboratory characterizations recently performed on non-imaging hyperspectral sensors fielded on autonomous watercraft to validate satellite-derived ocean color products. In this case, the laboratory characterizations provided radiometric accuracy within 10% (k=2) uncertainty for ocean color measurements. We also show examples of characterizations performed on commercial off-the-shelf (COTS) imaging hyperspectral sensors, which are potential radiometrically accurate lower-cost SCRs.

**Validation and initial processing results for Surface Reflectance Products from Planet's Tanager-1 Hyperspectral Mission**

**Presenter(s): Christina Henze, Planet Labs**

This past summer, Planet successfully launched its first hyperspectral satellite, Tanager-1. Tanager-1, developed through a public-private partnership with the NASA Jet Propulsion Laboratory (JPL) as part of the Carbon Mapper Coalition [1], is a full VSWIR imaging spectrometer with approximately 420 bands from 400-2500 nm with an 18 km swath width, 30 m spatial resolution and a Signal-to-Noise ratio of 300-600 in the methane absorption feature found near ~2350 nm under reference conditions [2].

Besides the core Top of Atmosphere Radiance products, Planet will also offer Surface Reflectance products. The atmospherically-corrected reflectance data will be processed using the open source Imaging Spectrometer Optimal FITting [3] (ISOFIT) model that uses an optimal estimation method for simultaneously solving for both the atmospheric composition and surface reflectance values using Tanager's hyperspectral radiance imagery and observation geometries as the input [4].

Based on the successful spectral and radiometric on-orbit calibration, we will show initial results of our Surface Reflectance Retrieval pipeline and review the influences of different ISOFIT versions on our Surface Reflectance products. Additionally, this talk will present results for the validation of Surface Reflectance based on crossover analysis with other hyperspectral satellite and airborne missions as well as based on ground truth data.

# **Topography, Geolocation, & DEMs Session**

**An open-source radargrammetry pipeline for 3D terrain reconstruction using commercial SAR images**

**Presenter(s): David Shean, University of Washington**

Commercial satellites offer affordable, on-demand, <0.5 m X-band SAR images, with untapped potential for 3D terrain mapping. InSAR DEMs require precise orbit control and short baselines for coherent phase, while radargrammetry applies photogrammetric principles to extract 3D information from SAR images with longer baselines. Many suitable SAR image pairs exist in modern commercial archives.

We developed a radargrammetry workflow for the Ames Stereo Pipeline involving bundle adjustment, dense image correlation, triangulation, point cloud filtering, and alignment. We processed a set of 0.25 m spotlight GEC images from the Umbra Open Data Catalog acquired Feb-Aug 2024 over the Panama Canal, which includes dense vegetation, exposed ground, urban areas, and variable terrain slope and roughness. We identified candidate pairs based on acquisition geometry, and obtained 9 viable DEMs. We adjusted the initial RPC models, and used the ASP MGM correlator for dense feature matching of backscatter amplitude.

We corrected residual geolocation errors in each DEM using 3D ICP co-registration over static control surfaces in the COP30 reference DEM, and created a composite DEM. Initial evaluation shows <1-3 m per-pixel std for the 9 DEMs in the composite, and limited bias compared to ICESat-2, a WV-2 stereo DEM from May 2024, and a Precision3D DSM.

Our workflow can be applied to other SAR images with suitable acquisition geometry. Future work will support rigorous SICD sensor models and improved corrections. Commercial SAR DEMs can be used for radar-stereo-lidar fusion in support of the NASA Surface Topography and Vegetation targeted observable.

**Learning-based Terrain Modeling from Multiple Space Lidar Measurements**

**Presenter(s): Jie Shan, Purdue University**

Spaceborne lidar provides direct 3D measurements, offering an efficient approach to modeling terrain in a timely manner. However, the large gaps between orbital tracks pose a significant challenge for generating continuous, high-resolution digital elevation models (DEMs). To address this issue, we propose an advanced learning-based approach using a vision transformer architecture. The model is trained with the 3D Elevation Program DEM, incorporating the sparse sampling patterns of orbital lidar data.

We evaluate our trained interpolation model across four counties in the United States, demonstrating its ability to generate 30-meter DEMs for unseen regions using only GEDI and ICESat-2 measurements. The results highlight the potential of our method to overcome the limitations of sparse lidar sampling and achieve accurate, high-resolution terrain mapping. This presentation will detail our approach, results, and key findings.

**The Future of Urban Cadastral Systems: Integrated Surveying Approaches for Modern Land Management**

**Presenter(s): Tirsit Lisanework Alemu, Bahir Dar**

Urban cadastral systems in Ethiopia are critical for securing land tenure and supporting sustainable urban development. Traditionally, surveying relies on discrete use of Total Stations (TS) and Differential GPS (DGPS), which are limited by inter-visibility constraints and overhead obstructions, respectively. This study evaluates the performance of an integrated SmartStation approachâ€”a high-performance Total Station combined with a GNSS receiverâ€”compared to standalone TS and DGPS methods in terms of accuracy, precision, time efficiency, and cost. A reference network of nine control points was established, leveraging Total Station measurements as the baseline. Using SmartStation, TS, and DGPS, multiple measurements were conducted and evaluated. Results indicate that SmartStation achieves a precision of 9 mm, comparable to TS (5 mm) and superior to DGPS (21 mm). While TS and DGPS methods together required 350 minutes for measurements, the integrated SmartStation approach reduced the total time to 225 minutes. Additionally, cost analysis reveals that SmartStation provides a more affordable solution compared to the combined expense of TS and DGPS equipment. The findings demonstrate that SmartStation eliminates the need for extensive control points, lengthy traverses, and complex setups while maintaining high accuracy. These advantages make it particularly suitable for urban cadastral applications, where efficiency and precision are paramount. The study highlights the potential of integrated surveying technologies to revolutionize land governance by improving data accuracy, reducing operational costs, and enhancing time efficiency. Policymakers should support training programs and infrastructure development to enable widespread adoption and effective utilization.

**Reconstructing Pushbroom Metadata Via Registration To A Truth Ortho**

**Presenter(s): Byron Smiley, Pixxel**

Pixxel processes data from hyperspectral satellites (TD1, TD2, TDL) that use a pushframe sensor combined with a continuous bandpass filter. This arrangement creates a spectral band every fifth row of the pushframe sensor, becoming a collection of pushbroom sensors. These satellite buses do not generate accurate metadata during their imaging events. Knowledge of the first line time, satellite pointing, and even satellite position were observed to fall short of that needed for accurate orthorectification, easily demonstrable by comparison to public data from Landsat-9, Sentinel-2. Techniques have been invented to reconstruct the first line time, attitude/quaternion list, and position list of pushbroom collections using registration to truth orthos from Sentinelâ€“2. Experimental results show that TD1 and TD2 require an adjustment to first line time and attitude, while TDL requires adjustments to position and attitude. The adjusted metadata creates alignment with the supplied Sentinel-2 truth ortho for all spectral bands upon orthorectification. Furthermore, adjusted metadata provides a very straightforward way to compute the improvements in geolocation, simply by differencing projected coordinates before and after adjustment. Geolocation statistics will be presented for TD1, TD2, and TDL.

**National Agriculture Imagery Program (NAIP) Geolocation Accuracy Assessment Over Arizona**

**Presenter(s): Paul Bresnahan, USGS-EROS KBR**

Orthoimages are commonly used as a reference layer for geo-registration and geolocation accuracy assessments. The Landsat program has relied on Digital Ortho Quarter Quad (DOQQ) orthoimages generated predominately in the 1990's and early 2000's for geo-registration over the United States. Since then, US Department of Agriculture National Agriculture Imagery Program (NAIP) orthoimages have become available and have evolved to an impressive level of accuracy. This assessment quantifies the geolocation accuracy of NAIP imagery over an entire Landsat Worldwide Reference System (WRS)-2 path/row in Arizona and demonstrates its potential use for the geo-registration and evaluation of Landsat and other imagery sources. In addition to using ground-surveyed check points that are directly measurable, a technique is demonstrated using check points along painted highway edges in areas that lack distinct image-identifiable points.

**Emerging 3D Terrain Awareness Techniques Using UAV and Satellite Data in Polar Regions**

**Presenter(s): Nancy K. O'Hare, University of Georgia**

Bridging the performance gap in 3D terrain reconstruction between traditional photogrammetric and computer vision techniques is challenging. The gap can be unpredictably large when scaling these techniques generated using UAVs to satellites and vice versa. To this is added the complexity of doing so in polar environs. Satellite data have limited view angles in higher latitudes and UAV data have limited operational ability due to daylight and temperature constraints for more than six months per year. Â Neural Radiance Fields (NeRFs), a computer vision technique, has shown promise when applied to satellite data for a sub-tropical environment (urban Jacksonville, FL) but are relatively untested across a broader latitudinal range as well as across more diverse landscapes (natural areas with few anthropogenic features). Initial results from two polar sites (urban scenes from Anchorage, AK and natural scenes from Mount Doran, AK) suggest that current NeRF models need significant refinement to work in polar landscapes (in terms of PSNR, SSIM) and are consequently untestable for geographic metrics of X,Y,Z accuracy. Moreover, UAV data present challenges with high spatial resolution that can be problematic when attuned to NeRF or other algorithms designed for broader scale methods for DSM or DEM generation without loss of fine-scale landscape topography. Up-to-date research on melding both computer vision techniques and applying photogrammetric techniques to fine scale UAV data will be presented.

**Advancing Planet's High-Resolution Satellite Imagery: Recent Progress and Future Directions**

**Presenter(s): Duy Nguyen, Planet**

Planet's SkySat constellation consists of approximately 15 high-resolution satellites which have a sub-daily revisit frequency. This work will provide a detailed overview of the advancements made in high-resolution satellite imagery over the past year, with a particular focus on SkySat product improvements and a preview of Planet's Pelican constellation - which will provide our next generation of high-resolution imagery. These developments are the result of collaborative efforts with our pipeline team, aimed at addressing the evolving needs of users and enhancing the technical capabilities of satellite imagery. Key topics will include significant improvements in rectification accuracy and the integration of Digital Elevation Models (DEM). For example, rectification improvements have led to a 65% reduction in Scene-2-Scene (S2S) misalignment in our CE90s, dropping the average from 3.03m to 1.05m week-over-week. The integration of AirbusDEM has been particularly effective in mitigating severe cases of S2S misalignment, enhancing the overall alignment quality. Additionally, spot checks have shown that the AirbusDEM reduces image warping artifacts, resulting in more accurate, visually consistent imagery.

These technical upgrades have led to enhanced usability and precision in high-resolution imagery, supporting a broad range of applications that require accurate geospatial data. This talk will explore Pelican's anticipated capabilities, such as faster revisit times, higher resolution, and greater operational flexibility, which build upon the foundation set by SkySat.

**Qualification of 3D Drone Imagery for Satellite Geolocation Testing**

**Presenter(s): Mark Abrams, Exquisite Geolocation Systems**

Global accuracy testing of satellite imagery requires a global network of highly accurate test sites, precise, accurate, and current 3D imagery, and geodetic control. Historically, these control sites and networks are not photo-recognizable and require survey teams to establish and maintain them. As an alternative strategy, we have demonstrated DGNSS-enabled drone surveying to establish absolute local control tied to the South African geodetic framework in Bloemfontein, South Africa. The aerial survey provides high-resolution (1.5 cm) geocoded imagery suitable for property mapping (local requirement) and suitable for geodetic tests and evaluation of satellite imagery with an estimated horizontal accuracy of less than 5 cm (CE90) and vertical accuracy of better than 10 cm (LE90). We are exploring using periodic cadastral surveys to establish a self-consistent network of high-resolution sites that can be used for satellite accuracy testing and image control for long-term change detection. Using 76 ground control points at Vista Park, Bloemfontein, we demonstrated a CE90 of 4.2 cm and an LE90 of 9.2 cm between the 3D imagery and DGNSS control measurements. Initial testing of 2D and 3D satellite imagery validates the utility of the approach, in particular by providing easily identified photo-recognizable control points, manhole covers, in this case, which significantly simplify the alignment between the satellite imagery and the control imagery.

# **Techniques & Tools Software to Measure Quality 1 Session**

**EarthDaily Mission and Thermal Imager Pre-Launch Cal/Val Progress**

**Presenter(s): Keith Beckett, EarthDaily Analytics**

The EarthDaily Analytics team is actively building a constellation of highly innovative satellites, capable of covering the earth's landmass every day with a novel set of spectral channels selected to serve a wide range of applications. This new data will flow through our EarthPipeline, a completely automated Ground Segment-as-a-Service offering, capable of processing, calibrating and validating not only the data from EarthDaily Analytics' constellation but data from multiple partners' constellations as well.

We know that nearly every application targeted by EarthDaily Analytics, agriculture, forestry, water and many more, will all benefit greatly from the science-grade imagery and analytics that the EarthPipeline will deliver. With novel spectral channels, ranging from visible through to thermal, combined with the objective to deliver high-value imagery and analytics, comes several calibration and validation challenges.

With a focus on our thermal imaging capabilities, we will discuss the EarthDaily constellation and the EarthPipeline, will delve into our rigorous pre-launch cal/val processes and present our progress to date, and discuss how we will ultimately address these various challenges in order to achieve the radiometric, geometric and retrieval accuracy requirements necessary to achieve the science-grade data products.

**Planet's cross-sensor sharpness assessment tool**

**Presenter(s): Venkataraman Krishnaswami, Planet Labs**

Planet operates diverse satellite constellations capturing vast volumes of imagery daily across a wide range of Ground Sampling Distances (GSDs). Developing a unified sharpness assessment framework that works consistently across different sensor types and resolution scales presents a significant challenge. This study explores a simulation-based sharpness evaluation methodology designed for cross-constellation application. While similar techniques have been applied to large GSD satellites (e.g., 30m GSD or more, for which large scale calibration and validation sites on ground are unavailable), we extend this approach to constellations with low and mid-range GSDs (for e.g., 30cm to 3m). The method involves simulating calibration targets, such as bridges for large GSDs or checkerboard patterns for low and mid GSDs, using real-world physical dimensions and the satellite's GSD derived from imaging altitude. The simulated target is convolved with a predefined Point Spread Function (PSF) model to generate blurred templates under varying settings. These templates are then compared to real-world images using correlation techniques, enabling precise sharpness quantification. This framework's scalability across resolutions offers a standardized and robust approach to sharpness assessment. Furthermore, we present a detailed analysis of its correlation with existing calibration methodologies, highlighting its strengths, limitations, and practical advantages. Examples demonstrating the approach's effectiveness and insights for improving cross-constellation imaging quality will be showcased.

**Monitoring Natural Capital from Space: A Framework for Determining Remote Sensing Capabilities and Uncertainties for ecosystem services valuation**

**Presenter(s): Afreen Siddiqi, Massachusetts Institute of Technology**

This research investigates the remote sensing technologies needed to effectively monitor natural capital for quantifying ecosystem services. Ecosystem services are the many benefits humans receive from the natural environment, such as clean water, pollination, and climate regulation. Measuring these services is important to understand the value of nature and make informed decisions about how to manage natural resources. Remote sensing is seen as a key technology for monitoring ecosystem services at scale.

 In this research, an analytical framework is developed to systematically identify limitations in current remote sensing capabilities and directly inform the design of future systems by establishing traceability to societal benefits. This framework first identifies the value/benefits of the ecosystem services provided by the natural capital, employs a physics-based approach to identify parameters that are crucial to the value, and determine the necessary measurements for their quantification. We investigate the available remote sensing sensors and future capabilities needed to monitor the value of ecosystem services, including an analysis of sources of uncertainty impacting value estimation. A value function is then formulated to assess the performance of existing and proposed remote sensing systems in monitoring and quantifying specific ecosystem services.

The framework is applied to a case study focused on wetlands flood mitigation function. Hydrological models are utilized to identify essential parameters for monitoring flood water storage by wetlands. Using a study area encompassing the Fall Lake Creek reservoir in Oregon, water storage capacity is measured and monitored by integrating USGS digital elevation models with Sentinel-1 synthetic aperture radar, Sentinel-2 optical data, and Planet Scope optical data. Results are validated against USGS published ground truth measurements. An uncertainty analysis is conducted by introducing synthetic spatially autocorrelated errors into input datasets to assess their impact on estimated water elevation and storage volumes. Based on these findings, the research proposes new sensor requirements, including advancements in resolution, spectral bands, and data acquisition techniques, aimed at maximizing the value function. Overall, this work contributes a framework for determining observation capabilities for future remote sensing systems for effective assessments of natural capital and value of ecosystem services.

**ROCX 2025: An Open Community Remote Sensing Collection**

**Presenter(s): John Kerekes, Rochester Institute of Technology**

Remote sensing research can be advanced through the use of high-quality, multi-modal remote sensing data sets coupled with good experiment design and ground truth collection. There is a continual need for new editions of such data sets. This is the aim of ROCX 2025: RIT Open Community eXperiment 2025. Satellite, airborne, and UAV remote sensing data collections coordinated with ground experiments are planned for mid-September 2025 at the RIT Tait Preserve located 20 minutes from RIT's campus in Rochester, New York. An open call for participation was distributed in spring 2024 with responses of interest from over 40 organizations. Since summer 2024 a Working Group with over 40 individuals has been meeting bi-weekly to discuss plans and to provide a framework for the experiment. A call for proposals released during October 2024 yielded 12 specific proposals to collect data from satellites and UAVs and to deploy ground experiments for modalities ranging from visible, multispectral, hyperspectral imagery to lidar and magnetometer data. A second call is planned for February 2025.

This presentation will describe the ROCX 2025 planning to date including the Tait Preserve primary ground test site, the proposed satellite and UAV remote sensing instrumentation, and the planned ground experiments. A highlight includes plans for ground based calibration sources and targets to assist with characterization of satellite imagers. Plans for open access data distribution will also be highlighted. Feedback from the audience will be solicited on the experiment plans.

**Bridge Modeling and Application for Determining In-Flight Sensor Spatial Resolution**

**Presenter(s): Alana Semple, NASA/SSAI**

In-fight estimation of sensor spatial performance can be assessed at various ground targets. When assessing sensors of pixel sizes ~10 m - 100m, bridges over water are a common target site. The bridge acts as a linear impulse signal, and a line spread function (LSF) can be directly extrapolated from the image over a bridge. One point of interference in this extracted LSF is artificial widening caused by the bridge width. Even though it is treated as an impulse, if the bridge is too wide for the pixel size it can smear the LSF. This would make the imagery appear to be of lower quality than it really is. To remove the impacts of bridge width, we run a series of simulations where a modeled perfect bridge has a known gaussian LSF applied, outputting a simulated image of the bridge. The LSF is estimated from the output image as it would be in practice with a real image, and the apparent widened Full Width at Half Maximum (FWHM) recorded. This is performed on various combinations of bridge width relative to pixel size, to build a non-dimensional empirical relationship between apparent FWHM and true FWHM. We find that if the bridge width is 0.2 times the pixel size or less, the apparent FWHM is equal to the true FWHM. For larger ratios, this empirical relationship can be applied to any imaged bridge, allowing for easy removal of the impacts of bridge width. Proof of concept is performed with Landsat-8/9 and Sentinel-2.

# **Characterization 1 Session**

**Geometric & Registration Accuracy Assessment of Multi-Date Deep Stacks of Maxar Imagery**

**Presenter(s): Andrew Bower, Maxar Intelligence**

High-quality mosaics and deep stacks of high-resolution satellite imagery require orthorectified imagery to be properly aligned. Orthorectification must enable proper edge matching of adjacent images and correlation of overlapping images. The alignment of orthophotos is enabled by scale appropriate absolute accuracy, relative accuracy, and precision. Orthophotos that do not align make imagery correlation and analysis challenging and inconsistent and very difficult to scale. Orthophoto alignment requires highly automated satellite image geo-positioning and orthorectification production methods. This presentation describes Maxar's approach for building aligned orthorectified image products with sufficient alignment to enable effective edge matching and image to image correlation. We briefly summarize Maxar's approach to terrain model production, single image geolocation (SIG), and orthorectification. We then provide detailed case studies that report the precision, relative accuracy and absolute accuracy for a collection of Maxar high-resolution satellite imagery (broad and deep collections of imagery). We demonstrate edge matching and image correlation proof points from the case study. We report absolute accuracy, relative accuracy and precision statistics leveraging industry standard accuracy statistics implemented in a spreadsheet. We conclude with examples that illustrate the value of the resulting orthophoto alignment to mapping and map maintenance use cases.

**System Characterization and Evaluation of Remote Sensing Imagery**

**Presenter(s): Ajit Sampath, USGS-EROS KBR**

The U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center has developed a robust system characterization [8, 9] process to rigorously evaluate the quality of remote sensing imagery. This process encompasses a comprehensive assessment of geometric, radiometric, and spatial characteristics, ensuring the data's suitability for scientific applications. Geometric characterization involves evaluating geodetic accuracy and inter-band coalignment. Radiometric characterization employs pseudo-invariant calibration sites and cross-calibration with Landsat data to establish radiometric accuracy. Spatial characterization utilizes edge response analysis to quantify image sharpness and resolution [9].

This research introduces enhanced methodologies, including:

* Spectral Band Adjustment Factor (SBAF) [3]: A technique to account for spectral band differences across sensors, improving cross-sensor compatibility and analysis.
* RadCalNet Integration [2]: Leveraging RadCalNet sites for precise characterization of hyperspectral and multispectral datasets, enabling more accurate calibration and atmospheric correction.

The efficacy of these methods is demonstrated through three case studies:

* NASA's EMIT Hyperspectral Instrument [4]: Evaluating the performance of this advanced instrument for mineral mapping and environmental monitoring.
* ISRO's Resourcesat-2A Sensors [5]: Illustrating the application of SBAF to improve data consistency and interoperability.
* Airbus's Vision-1 Sensor [1,6]: Assessing the quality of commercial imagery for a range of applications.

**Landsat 8/9 L1T Product Radiometric Pixel Uncertainty**

**Presenter(s): Bob Ryan, I2R**

Scientists from USGS, KBR, and I2R are collaborating to develop algorithms that can quantify the radiometric uncertainty of every pixel in Landsat L1 and L2 image products, starting with orthorectified L1T products from the Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS). Having knowledge of radiometric pixel uncertainty in space and time is crucial for detecting changes, analyzing time series, and creating machine learning algorithms for remote sensing applications. The team is building on a similar framework used for the Sentinel-2 Radiometric Uncertainty Tool (RUT), with an additional focus on the uncertainties related to interpolation. Uncertainties due to sensor noise propagation through interpolation, intrinsic interpolation uncertainties, and the radiometric uncertainty due to geometric uncertainty are investigated. The SI uncertainty included is based on vendor-provided L1R per-pixel radiometric uncertainty values, rather than device physics.

The paper provides an update to the algorithms with an emphasis on advancements in estimating intrinsic interpolation uncertainty. It includes examples of OLI uncertainty results for each uncertainty component and an overview of the algorithms being developed.

**Generating decimeter precision DEMs from commercial VHR stereo imagery using a novel jitter correction framework**

**Presenter(s): Shashank Bhushan, NASA Goddard Space Flight Center, University of Maryland**

Very high resolution (VHR) stereo imagery acquired by commercial satellites with TDI linescan cameras has been widely used to obtain detailed digital elevation models (DEMs) and measure precise surface elevation change. Even with decades of advancements in satellite photogrammetry, artifacts from unmodeled pointing errors (“jitter") remain a major source of residual error. Jitter artifacts are induced by the limited precision of onboard attitude determination and control systems to accurately record high-frequency (~1”10 Hz) satellite vibrations during linescan image acquisition, leading to systematic subpixel image offsets and vertical errors (>0.5â€“1.0 m) in the output stereo point clouds and gridded DEMs.

We present a new, generalized open-source workflow using the Ames Stereo Pipeline to jointly refine the Level-1B sensor model orientation parameters along the satellite track using an improved, piecewise bundle adjustment framework. Our method relies on a dense network of match points between the two images and high-precision 3D control data prepared by fusing sparse satellite laser altimetry (e.g., NASA ICESat-2) with a coarse global DEM (e.g., GLO-30). The high-precision 3D control data ensures that the refined orientation parameters not only reduce relative Level-1B pixel reprojection errors but also improve the precision and accuracy of triangulated 3D point clouds.

Initial results show corrected vertical and horizontal accuracy of <15 cm for WorldView-3 stereo DEMs prepared from over planar surfaces. With continued improvements and testing, our novel refinement workflow and resulting data products will enable the community to address new scientific questions that require decimeter precision and accuracy.

**Radiometric Performance of Maxar Legion Earth-Observing Sensors**

**Presenter(s): Michele Kuester, Maxar**

Absolute radiometric calibration provides an on-orbit check and any necessary adjustments to the preflight sensor calibration performed in a laboratory. On-orbit calibration accounts for radiometric characteristics of the focal plane and filters that may change during the rigors of launch and in the space environment. An accurate calibration is the baseline for the successful integration and fusion of data from multiple sensors on multiple platforms. For example, a time-lapse series of images requires an accurate calibration to ensure that phenomena observed are due to actual changes on the ground versus changes in the sensor. Using calibration sites around the globe, Maxar has created an industry-leading absolute radiometric calibration process to ensure the quality of every remote sensing product we provide to our customers.

Maxar's WorldView Legion is a much anticipated next-generation constellation providing high-resolution multispectral imagery at rapid revisit times to its customers. At the writing of this abstract, Legion 1 and Legion 2 initial abscalfactors derived from vicarious calibration efforts in Watkins, CO, USA, are within Â± 3% percent difference of the Radiometric Calibration Network (RadCalNet) site in Gobabeb, Namibia. A complete set of abscalfactors and other radiometric parameters in the form of a JSON file for the Legion sensors that have past the initial operational capacity (IOC) milestone by this presentation will be made available at the conference.

# **Techniques & Tools Software to Measure Quality 2 Session**

**CIDR Tool Update**

**Presenter(s): Peter Rinkleff, USGS**

The CIDR Tool is utilized by many government entities to task acquisitions of commercial remotely-sensed data through government contracts. As these contracts continue to evolve, the acquisition tool also needs to evolve. A series of upgrades have been planned which are based on both contractual and user-needs. These changes are designed to promote new capabilities, increase system efficiency, and provide a more positive experience to the end-user. We will present proposed changes to CIDR which are expected to occur in phases over the next few years and solicit comments and input from JACIE meeting participants.

**Physics-Based Satellite Derived Bathymetry (PBSDB) using Landsat OLI coastal images**

**Presenter(s): Minsu Kim, USGS-EROS KBR**

Satellite imagery has a great advantage over the active sensors if high precision and accuracy of the satellite derived bathymetry (SDB) can be achieved. This research proposes a fully physics-based bathymetry algorithm by combining atmospheric and ocean optics. The amount of correction is determined using estimated aerosol optical depth, ozone, water vapor, and surface pressure to extract the radiative transfer look up table value, along with solar and sensor angles. The optically deep water is solved using optical modeling of the water based on chlorophyll, dissolved organic matter and suspended particulate. Ocean optics theory forms a foundation for SDB and it consists of the water volume backscattering component and bottom reflected component. The magnitude of the bottom reflected component follows the exponential function of the optical depth. The optical depth is computed from diffuse attenuation spectrum and the depth. We estimate the water attenuation spectrum from optically deep water. The bottom reflectance is modeled as a mixture of typical sand-like and grass-like bottom reflectance spectra. Thus, two bottom coefficients and the depth are three unknowns, and it is solved from nonlinear optimization. This physics-based approach does not require known depths if proper bottom spectra are used based on an educated guess. Fast, low-cost, and vast areal bathymetry coverage using SDB is a powerful complementary technique to active sensors. Landsat OLI images are suitable for SDB because of the very high signal to noise ratio despite the relatively low resolution.

**Empirical Approach to Normalize Landsat Reflectance to Nadir BRDF Adjusted Reflectance (NBAR)**

**Presenter(s**): **Mahesh Shrestha, USGS-EROS KBR**

The Landsat satellite program has been providing high quality remote sensing data for more than fifty years. It originally provided a top-of-atmosphere (TOA) reflectance/radiance product as its standard product. To better serve remote sensing community, the program later generated a surface reflectance product, which removes atmospheric effect of aerosol, water vapor, and other gases. However, bidirectional distribution reflectance function (BRDF) due to view zenith angle was not addressed, primarily because of its smaller magnitude for narrow field of view (±7.5⁰) sensors like Landsat. The view zenith angle discrepancy at the overlapping region between the adjacent Landsat imagery can reach up to 15⁰, and since most terrestrial surfaces are anisotropic, reflectance discrepancies due to view zenith angle become an issue when using these overlapping regions for building long time series, vegetation monitoring, landcover land change, and studying subtle change on the Earth surface. This work proposes an empirical approach to provide consistent view angle normalization across Landsat image. It normalizes Landsat surface reflectance to nadir BRDF adjusted reflectance (NBAR), however, doesn’t perform solar illumination angle normalization.

The Landsat NBAR is derived by multiplying Landsat reflectance by BRDF model coefficients. BRDF model coefficients are generated for difference landcover type using Landsat 8 and 9 underfly data. In this research, 1-day apart Landsat 8 and 9 OLI scenes from the 836 paths/rows imaged during 2023 are selected to quantify average surface reflectance difference between forward and backward scattering pixels at Landsat scan edge. The view zenith BRDF effect in Landsat was approximately 0.02 reflectance for the visible bands and 0.03 NIR and SWIR2 bands, and upto 0.05 for infrared bands. Landsat 8 and 9 underfly data was used to developed BRDF model, as it provides simultaneous nadir and off-nadir observations over millions of pixels on the Earth’s surface. The model was generated for different landcover types. Landsat pixels which have less than 1⁰ view zenith angle is considered as nadir observation and the corresponding observation from other sensor is considered as off-nadir observation. Landsat NBAR is generated using the BRDF model developed using the underly data. The view zenith BRDF effect using NBAR is within 0.005 for all bands, except SWIR1 bands, which is within 0.01. This work minimizes reflectance difference due to view zenith BRDF in Landsat imagery helping users to understand real changes on the Earth surface.

**Quantifying Scene Complexity for ML Models**

**Presenter(s): Samuel Vilt, MITRE**

Recent parametric studies have demonstrated that various scene complexity factors have a major effect on performance of Artificial Intelligence/Machine Learning (AI/ML) algorithms for object detection. Complex images provide more opportunities to mislead the ML model, thus producing inaccurate results. A combination of measures of scene complexity could determine the strongest training imagery to best train a robust model able to deal with complex imagery. We hypothesize that by exposing the model in training to the imagery with the highest complexity, as determined by a curated combination of metrics, the resulting model will produce more reliable results.

When it comes to determining what can be detected in imagery by the analyst, there are methods such as NIIRS. However, studies have shown that resolvability rating scales like NIIRS do not carry over to making training decisions for a ML model. We have developed a combination of metrics that shows promise to solve this problem by providing the information needed to make informed decisions for those training and using ML models. Using open-source imagery and deep learning models, we demonstrate our methods and present the findings from recent experimentation.

**The Role of Advanced Surveying Techniques in Modern Geospatial Analysis**

**Presenter(s): Solomon Dargie Chekole, Bahir Dar University**

This study evaluates and compares the precision, accuracy, and time efficiency of three surveying techniques: Global Positioning System (GPS), Total Station (TS), and Terrestrial Laser Scanning (TLS). The research addresses the limitations of individual methods and explores their complementary strengths for modern surveying applications. A reference network of 14 control points was established using a Leica 1201 Total Station, providing a baseline for accuracy comparison with GPS-RTK and TLS methods. The study also included detailed facade measurements of a campus building using TS and TLS. Each method was evaluated five times to ensure statistical reliability. Key findings reveal that TS achieved the highest precision (1 mm) for horizontal and vertical coordinates, while GPS-RTK exhibited a horizontal accuracy of 9 mm and a vertical accuracy of 1.5 cm. TLS demonstrated superior efficiency in capturing dense spatial data with a precision of 2 mm but required significant computational resources. Time analysis showed that TS was more time-intensive than GPS-RTK but comparable to TLS. These results highlight the trade-offs between accuracy, precision, and time efficiency across methods. While TS excels in precision for small-scale projects, GPS and TLS offer advantages in larger or obstructed areas. The study underscores the importance of selecting appropriate surveying techniques based on project requirements and provides practical insights for improving accuracy in multi-method applications.

The research suggests that policy-makers should promote hybrid surveying policies, establish clear usage guidelines, invest in training and CORS infrastructure, prioritize sustainability, and balance cost-efficiency with accuracy to enhance land administration and surveying practices.

**Hyperspectral imaging is the future, yet surface reflectance and validation lag behind**

**Presenter(s): Edward (Ned) Bair, Leidos**

Current and planned hyper- and super-spectral missions from government and commercial vendors offer tremendous advances in imaging spectroscopy, e.g.,: improvement in signal-to-noise, spectral, spatial, and temporal resolution. Yet, most of these sensors use five RadCalNet sites worldwide for calibration and validation. These sites have simple geography and ground cover. Measurements are taken with multiband instruments, then interpolated spectrally by matching field measurements. We can and need to do better. For bright targets such as new snow, many of the hyperspectral surface reflectance products fail, with a noted hooking artifact that we showed at 2024 JACIE meeting. Recommended solutions are careful atmospheric correction accounting for: 1) reflection from areas adjacent to the target and 2) terrain correction. Other approaches currently being pursued are to solve for the terrain using spectra or to skip the surface reflectance altogether, going from top-of-atmosphere radiance to surface properties, such as snow grain size and light absorbing particle concentration. For in situ validation, a number of automated hyperspectral options exist, each having unique trade-offs. Cosine and azimuth response, durability, and mounting configuration need to be addressed. These issues are especially important in cold regions, such as midlatitude mountains or high latitudes. We are currently pursuing options to build an automated hyperspectral validation system that will work at The Cold Regions Research and Engineering Laboratory and University of California-Santa Barbara Energy Site (CUES, snow.ucsb.edu) on Mammoth Mountain, CA at 2940 m altitude.

Thanks!

**Optimizing Electro-Optical Camera Focusing Under Temperature Variations: A Lunar Imaging Approach**

**Presenter(s): Mustafa Teke, TUBITAK UZAY Space Tech. Research Institute**

Image quality is a critical parameter for Earth observation satellites, directly influencing their ability to deliver reliable and precise data. Electro-optical system designs prioritize achieving optimal image sharpness under varying operational conditions. In this study, we investigate the effect of temperature variations on the focusing performance of an electro-optical camera by capturing and analyzing lunar images under similar thermal conditions.

The focusing accuracy is evaluated by acquiring Moon images at different internal camera temperatures and comparing their sharpness. The comparison involves aligning the images to a consistent viewpoint and cropping the illuminated areas of the lunar surface for precise analysis. Image quality is quantitatively assessed using sharpness metrics.

Our results indicate the system achieves optimal focusing at a minimum internal temperature of 25Â°C. These findings provide valuable insights for designing and operating electro-optical systems, ensuring robust performance across varying environmental conditions. This work contributes to advancing image quality standards in Earth observation satellite systems.