Technical Session
 Calibration Challenges in Remote Sensing for Environmental and Climate Change Studies

Understanding radiometric calibration and characterization of remote sensing instruments for environmental and climate change studies

- Implications of remote sensing strategy (wide-area coverage, indirect sampling, time trending) for radiometric calibration
- Comparison of radiometrically-calibrated measurements to direct sampling and in situ measurements
- Validation and maintenance of calibration accuracy across measurement data gaps
- Assimilation of radiometric calibration knowledge, information, and data products into models of complex systems
- Plans to achieve climate-quality calibration for present and future operational sensors
- Uncertainty budgeting for climate-quality calibration of environmental remote sensors

3:45
 Calibration of the National Ecological Observatory Network’s Airborne Observation Platforms
 Nathan Leisso, Tristan Goulden, Ian Crocker – Battelle Ecology - National Ecological Observatory Network; Joe Boardman – Analytical Imaging and Geophysics

ABSTRACT: The National Ecological Observatory Network (NEON) is a continental-scale ecological observation facility funded by the National Science Foundation (NSF). NEON's mission is to enable understanding and forecasting of the impacts of land-use change and invasive species by providing the infrastructure and consistent methodologies for the collection of continental-scale ecological data. The Airborne Observation Platform (AOP) will play a unique role by collecting regional scale remote sensing data surrounding the NEON sites. This is expected to enable scaling of individual in-situ measurements collected by NEON or others to those collected by external satellite-based remote sensing systems.

The airborne payload consists of the NEON Imaging Spectrometer (NIS), a full waveform and discrete LIDAR, and a high-resolution digital camera integrated into a Twin Otter aircraft. Three payloads on separate aircraft will provide coverage of 80 plus sites located in the 20 NEON Domains as well as targets of opportunity and PI-driven science. A key component of the NEON design is the consistent calibration of the airborne instruments to provide reliable and accurate scientific data over the full lifetime of the NEON observatory. The NEON Sensor Test Facility provides the facilities for the laboratory calibration of the AOP instrumentation.

This work examines the spectral and radiometric calibration of the NIS in the NEON Sensor Test Facility. Recent work has focused on the traceability and uncertainty of the radiometric and spectral calibration and stability of the calibration from lab to operations. To verify the operational stability during acquisitions, a quality check algorithm has been developed to assess the raw NIS data prior to ingestion into the NEON processing framework. In addition, routine vicarious calibration flights are scheduled to independently verify the lab-based calibration. The work presented here also examines implemented improvements in characterizing the level of stray light in the NIS data. These corrections have significantly improved the fidelity of the spectroscopic data as well as improving the overall radiometric and spectral accuracy across the typical heterogeneous scenes included in the NEON collections.

4:10
 Pre-Launch Calibration of the Sea and Land Surface Temperature Radiometer
 Dave Smith, Mireya Etxaluze, Ed Polehampton, Arrow Lee, Dan Peters, Tim Nightingale, Elliot Newman, Brian Maddison – Science and Technology Facilities Council (STFC); Jens Nieke – European Space Agency (ESA)

ABSTRACT: The Sea and Land Surface Temperature Radiometer (SLSTR) on the Copernicus Sentinel-3 mission is a dual-view, multi-channel scanning radiometer specifically designed to measure global sea-surface temperatures SST to an uncertainty < 0.3K for climate monitoring and continue the 21 year datasets of the Along Track Scanning Radiometer (ATSR) series. Two instruments were originally planned with the first being launched in February 2016 and the second launch schedule for spring 2018 to provide daily global coverage of SST and LST data. A further two instruments are being developed as replacements when the first two reach the end their operational lifetime.
Thorough pre-launch calibration using accurate sources and agreed procedures is a fundamental prerequisite for ensuring traceability and consistency of the data generated by the two instruments. This is particularly important at thermal infrared wavelengths where verification of the calibration against traceable reference standards becomes very difficult once on orbit.

The SLSTR-A and B instruments underwent extensive pre-flight calibration campaigns to ensure that all the necessary calibration parameters are measured before launch, but more importantly that the end-to-end system performance and calibration model is fully verified against traceable calibration sources before launch. As an infrared sensor, this is essential for understanding all sources of uncertainty that affect the instrument calibration which cannot be directly measured once on-orbit.

The pre-launch calibration activities included the spectral response characterisation, instrument line-of-sight for verification of the geometric pointing model, solar channel radiometric and thermal infrared radiometric calibration. A purpose built calibration rig was developed to provide a controlled thermal environment necessary for thermal infrared wavelengths and to allow the blackbody calibration sources around the field of view of the instrument. In the paper, the authors describe the test methods and measurement results and compare the results between the two models. Results from the model A instrument were used to improve methods used for the model-B instrument. In particular, additional tests and improvements to the test setup for the visible and short-wave infrared calibration activities have shed light on results from the model-A instrument.

4:35
Testing, Verification and Calibration of the TANSO-FTS-2 Sensor
Lawrence Suwinski, Ronald Glumb, Christopher Ellsworth, Eric Beaubien, John Holder – Harris Corporation; Hiroshi Suto, Yukie Yajima, Masakatsu Nakajima – Japan Aerospace Exploration Agency (JAXA)

ABSTRACT: TANSO-FTS-2 is the primary instrument aboard the Greenhouse gases Observation Satellite-2 (GOSAT-2). It measures high-resolution spectra of upwelling earth radiance in five spectral bands to extract concentrations of greenhouse gases (CO2, CH4) and artificial emission sources. The development, testing and ground calibration of TANSO-FTS-2 was performed by Harris Corporation under a subcontract to Mitsubishi Electric Corporation, the GOSAT-2 prime contractor of the Japan Aerospace Exploration Agency (JAXA) GOSAT-2 project. This paper will summarize the functionality, test methodology, test results and calibration performance of the TANSO-FTS-2. This includes details of the system signal to noise ratio (SNR), instrument line shape (ILS), linearity, polarization, field-of-view (FOV) and scanner performance testing. Also included are expected calibration error and line of sight (LOS) performance. A summary of the TANSO-FTS-2 modules and nominal on-orbit operational scenario will also be discussed, including a description of intelligent pointing functionality and expected performance.

5:00
Creating a single radiance climate record from AIRS, IASI and CrIS
Christopher Hepplewhite – The University of Maryland, Baltimore County (UMBC); Lawrence Strow, Howard Motteler, Steven Buczkowski – UMBC/ Joint Center for Earth Systems Technology (JCET)

ABSTRACT: We investigate three key aspects for creating a climate record from multiple hyperspectral infra-red sensors. The motivation is to produce a multi-decade continuous record of global radiance measured leaving the atmosphere. Current global observation mission scenarios aim to supply multiple follow-on missions for the JPSS CrIS and MetOp IASI sensors which, in addition to the current Aqua AIRS sensor, could in principle provide a continuous radiance record from 2002 to 2025 and beyond. We aim to apply this record to studies of climate trends directly from the radiance and also to a common set of geophysical quantities using retrieval methods that share a common radiative transfer model.

The three sensors being used in this study; Aqua AIRS, NOAA CrIS and MetOp IASI share some similar characteristics; they are all low-earth, high inclination sun-synchronous polar orbiters and hyperspectral infra-red mapping missions. Deriving a common radiance record requires methods to relate their spectral capabilities, their radiometric calibration and their spatial-temporal mapping characteristics. We detail
(i) a method to translate the spectral radiance measurements onto a common graduated scale, or line-shape, (ii) how to calibrate their radiometric scale and (iii) how to deal with spatial and temporal coherence differences of their global sampling.

Considerable mission overlaps of these sensors are used to make direct inter-comparisons between sensors using simultaneous nadir observations and large sample statistical methods. One of the key goals is to be able to maintain relative stability to about 10 mK per year over the long term, and in this paper we will show how this might be possible.

We demonstrate the performance of this approach by comparing top-of-atmosphere radiance trends from simulations using the ECMWF ERA reanalysis, which is presently the most popular measurement-based climate data set used by the scientific community.