Monday, September 21, 2020 | 11:00 a.m.

Technical Session

Inter-Calibration and Validation of Operational Sensors

Performance comparison between sensors of differing scientific objectives, capabilities, and mission parameters to assess measurement bias and uncertainty.

- Post-launch calibration using onboard and/or vicarious techniques
- Retrievals through data assimilation with various data used for validation
- Results of particular approaches, validation campaigns, and experiments
- Techniques, platforms, and instruments for validation
- Application of calibration results to scientific measurements
- Requirements and potential approaches for the calibration of global satellite observing sensors

11:05

New Perspectives for Inter-Calibration using Sentinel-3 Tandem Data

Sebastien Clerc, Nicolas Lamquin, Ludovic Bourg – ACRI-ST; Dave Smith – RAL Space; Sam Hunt – The National Physical Laboratory (NPL); Jonathan Mittaz – University of Reading; Craig Donlon – The European Space Agency (ESA)

ABSTRACT: During the commissioning phase of Sentinel-3B, the satellite was placed in close formation with Sentinel-3A for several months. This configuration provides a unique opportunity to compare measurements from the two satellites, opening new perspectives for inter-calibration. We will briefly present an overview of activities performed using tandem data and describe in more details two applications for Sentinel-3 optical instruments.

A first application is the estimation of inter-satellite calibration biases. We describe the methodology used to intercompare the multispectral OLCI A and B instruments, using re-gridding, conversion to reflectance and spectral adjustment of the Rayleigh signal. Statistics are then computed for the different classes of scene. Clouds are particularly interesting targets because of their abundance and white reflectance spectrum. Thanks to this method, it has been possible to estimated inter-calibration biases with an uncertainty lower than 0.5% across the full instrument field-of-view. Biases have been shown to be temporally stable during the tandem period.

The efficiency of this inter-calibration has been assessed by aligning OLCI-A on OLCI-B with a custom reprocessing. We also demonstrate the positive impact on inter-comparison of Level 2 land and ocean products.

A second type of application concerns the validation of per-pixel uncertainties. For this goal, differences between SLSTR A and B measurements (L1 or L2) are compared to ex-ante uncertainties provided by models. More precisely, the independent components of the uncertainties are used to normalize the inter-satellite differences. This normalized difference is expected to behave like a normal distribution with a standard deviation of 1. Although the agreement is relatively satisfactory for data with the highest quality level, some significant variations have been observed for lower quality indices. This information can help improve processing algorithms and/or uncertainty estimates.

11:25

Deep Convective Clouds for Sentinel-3 OLCI Cross-Calibration Monitoring

Nicolas Lamquin, Sebastien Clerc, Ludovic Bourg – ACRI-ST; Craig Donlon – The European Space Agency (ESA)/ The European Space Research and Technology Centre (ESTEC)

ABSTRACT: Few weeks after its launch in April 2018, Sentinel-3B of the European Space Agency has been put in a tandem phase with its twin Sentinel-3A already in orbit. Both platforms were on the same track with the same geometrical conditions to gather acquisitions over the same targets only thirty seconds apart. This tandem phase lasted from early June to mid October 2018 to provide a unique opportunity for each S-3 sensors to increase knowledge of payload differences, reduce uncertainties when comparing data and to homogenise differences by defining appropriate adjustments. The inter-unit consistency is critical for the mission.

The outcome of the tandem phase analysis provides a strong reference for assessing other cross-calibration methodologies, one of those being based on the use of Deep Convective Clouds (DCCs). Whereas a physical model of DCC reflectance must be provided to compare Ocean and Land Colour Instrument (OLCI) measurements with an absolute reference, DCC observations are rather used for their whiteness, brightness, and large spatial extent, for interband monitoring. In this presentation, we present and validate a DCC-based radiometric validation methodology adapted to OLCI with a specific emphasis on its ability to accurately monitor the cross-calibration of the independent sensors. We base the analysis on a careful analysis of the OLCI DCC reflectance measurements with a sensitivity assessment of the data selection employed (use of SLSTR synergetic brightness temperature or reflectance in absorption bands, analysis and handling of saturated pixels) as well as a cautious analysis of the FOV-dependency of the results.

Performance is assessed by comparisons with the cross-calibration reference of the tandem analysis, in and out of the tandem phase acquisition period. The methodology covers the complete OLCI spectrum (to the exception of absorption bands) with precision less than about 1%.

11:45

Radiometric Comparison of OCO-2, OCO-3 and Aqua MODIS

Shanshan Yu, Robert Rosenberg, Carol Bruegge, Lars Chapsky, Dejian Fu, Graziela Rodrigues, David Crisp, Annmarie Eldering – Jet Propulsion Laboratory, California Institute of Technology; Tommy Taylor, Heather Cronk – Colorado State University, Amit Angal – Science Systems and Applications, Inc. (SSAI); Jack Xiong – NASA Goddard Space Flight Center

ABSTRACT: The Orbiting Carbon Observatory 2 (OCO-2) and the Orbiting Carbon Observatory 3 (OCO-3) are NASA Earth Science missions designed to measure carbon dioxide in Earth's atmosphere. OCO-2 was inserted at the front of the 705 km Afternoon Constellation (A-Train) in August 2014, and flies about 7 minutes ahead of the Aqua spacecraft. OCO-3 was mounted on the Japanese Experiment Module Exposed Facility onboard the International Space Station (ISS) in May 2019. OCO-2 and OCO-3 use three-channel grating spectrometers to measure reflected sunlight within the O2 band at 0.76 micron and two CO2 bands at 1.61 micron and 2.06 micron. The grating of each channel disperses light onto 1016 spectral channels of a focal plane array, yielding spectra with a resolution of ~ 0.04, 0.08, and 0.1 nm, respectively. OCO-2 uses onboard lamps, solar observations, and lunar measurements as well as surface targets for radiometric calibration/validation. OCO-3 is equipped with onboard lamps, and can also observe the Moon a few times each year, but cannot observe the Sun due to its configuration onboard ISS.

The OCO missions require a 5% accuracy on absolute radiometric calibration to meet their CO2 accuracy requirements. Here, we describe results from the radiometric comparisons of OCO-2 and Aqua MODIS using OCO-2 nadir observations over eight desert sites and nearly simultaneous MODIS observations with sensor viewing zenith angles of 15±0.5 degree. The MODIS data are collocated into the OCO-2 geolocation grid using a 1 km circular region around each OCO-2 footprint. Without correcting for viewing geometry differences and mismatched spectral response functions, the mean and standard OCO-2/MODIS radiance ratio over the eight sites are determined to be 1.103±0.010, 1.120±0.007, 1.233±0.016 for the OCO-2 three bands, respectively. Here, we report the OCO-2 absolute radiometric calibration obtained from ongoing efforts to develop bi-directional reflectance distribution function (BRDF) models to account for the viewing geometry

differences and to reduce the seasonal variations, and by correcting biases due to mismatched spectral response functions. We will also discuss the absolute radiometric comparison of OCO-2 and OCO-3 using simultaneous nadir overpasses of these desert sites.

12:05

Challenges in NOAA-20 Ozone Monitoring Profiler Suite (OMPS) Calibration and Validation

Xiaozhen Xiong – Science Systems and Applications, Inc. (SSAI); Chunhui Pan – University of Maryland; Trevor Beck, Banghua Yan, Larry Flynn – NOAA/NESDIS/STAR

ABSTRACT: The Ozone Mapping and Profiler Suite (OMPS) is the 2nd Ultraviolet (UV) Sensor Suite aboard NOAA-20 spacecraft following the 1st OMPS on S-NPP. They both carry two advanced nadir viewing hyper-spectral instruments, Nadir Profiler (NP) and Nadir Mapper (NM), but the OMPS on NOAA-20 is operated in a higher spatial resolution mode than on S-NPP. This enables better measurements of the total column and vertical profile of ozone in the atmosphere, as well as traces gases SO2 and NO2 for air quality applications. NOAA STAR has conducted intensive calibration and validation analyses of S-NPP and NOAA-20 OMPS NM and NP sensor data records (SDRs), and the SDRs, except for NOAA-20 NP, have reached validated maturity and are delivered to the user community in near-real-time. However, some challenges still remain within the calibration and validation, including the inter-comparison of NOAA-20 with SNPP due to their differences in bandpass and spatial resolution.

This presentation provides some insight into those remaining challenges through the radiative transfer simulations, cross-sensor comparisons and the analysis of EV360 (EV360 is a special once-a-week mode for OMPS observation using the standard Earth View science mode for one complete orbit including the nightside.) We found that radiative transfer simulations using each instrument's bandpasses explain some of the SDRs differences between S-NPP and NOAA-20. Model simulation data are used to assess the accuracy and consistence of OMPS data, and to better select the good data sets for comparison, VIIRS aerosol and cloud mask data are, for the first time, used to matchup with OMPS footprint to identify and select the best clear scene cases. The differences between the simulations with the observations are also used frequently to check the possible inaccuracies in the calibrations, including solar, wavelength and stray light corrections. Recently, we started to analyze EV360 data, and it is expected that additional analysis of the EV360 radiance and rawcounts will help us to improve the future dark current corrections and the quality of NOAA-20 OMPS SDRs.

12:25

Valuation of Calibration for Satellite Constellations

Afreen Siddiqi, Olivier de Weck – Massachusetts Institute of Technology (MIT); Brandon Russell, Will Arnold, Jeff Holt, Chris Durell – Labsphere Inc.

ABSTRACT: Earth observation systems, consisting of in-space and air borne platforms and sensors, are providing a growing number of high resolution spatial and temporal services including agricultural crop yield predictions, local weather forecasts, and traffic management. As the complexity of these systems increases with multi-platform elements and sophisticated processing and modeling, there are also increasing avenues for introduction of errors. It is important to characterize and quantify the uncertainties and errors. Here, it shown that a value-chain approach can be used for conceptualizing errors and modeling uncertainties relevant for final decisions. This approach can then be applied for improving system value assessments and obtaining an 'error-adjusted' value of the remote sensing system. The error-adjusted value can be used in optimization or trade-studies for system design. This value system is then applied, as an example, to the FLARE real world calibration/validation system to look at potential Return on Investment (ROI) of better calibration to satellite image prices and market penetration.