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Newsletter– Summer 2016 Issue

Manik Bali, Editor

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In This Issue

Harmonization and Recalibration: A FIDUCEO perspective

By Emma Woolliams (National Physical Laboratory (NPL), UK), Jon Mittaz (NPL and University of Reading (UOR)), Chris Merchant (UOR) and Arta Dilo (NPL)

Obtaining information about long-term environmental and climate trends requires the analysis of decadal-scale time series of observations made by different sensors. To ensure that such comparisons are meaningful, it is essential to quantify the stability of satellite sensors and to determine the radiometric differences between sensors and the uncertainties associated with those differences.

This paper describes the principles adopted within the Fidelity and uncertainty in climate data records from Earth Observations (FIDUCEO) project for harmonising satellite data series to obtain long-term stability. The FIDUCEO project aims to develop metrologically-robust Fundamental Climate Data Records (FCDR), i.e. long-term records of satellite L1 products (top-of-atmosphere radiance, reflectance and brightness temperature). These FCDRs will have not only uncertainty information at the pixel level, but also information about the correlation structure of the associated errors. In the second half of the FIDUCEO project we will demonstrate how to propagate this information to derived geophysical datasets, i.e. Climate Data Records (CDRs) for four ECVs. One important aspect of the work of FIDUCEO is to harmonise the data series. The aim of harmonisation is to establish long-term stability in the data record.
Most sensors are calibrated prelaunch, where *calibration* means establishing the basic model (measurement equation) for translating a measured signal (e.g. in counts) into the required measurand (e.g. radiance). However, this model may also make allowance for in-orbit factors; for example, it may account for gain changes of the instrument throughout the orbit due to variations in self emission by using

parameters that estimate the gain from an in-orbit calibration process (e.g. measuring an internal calibration target). The calibration model therefore typically contains several parameters or corrections (calibration coefficients), some of which are determined pre-launch, others determined in-orbit.

For most of the satellite instruments that are considered in FIDUCEO there are potential problems with using pre-launch coefficients when analysing in-orbit measurements. The pre-launch testing generally had the aim of confirming that the instrument met its design specifications rather than that of determining the optimum set of calibration parameters. The FIDUCEO targets are long-standing historic sensor series. For such sensors, the sensor behaviour in-orbit can be very different from its behaviour during pre-launch testing and more scientific value can be derived from considering the series as a whole, for both the FCDR and the derived CDRs.

Therefore, some level of adjustment to the initial calibration parameters is required to allow for in-orbit behaviour. Within FIDUCEO we define *recalibration* as obtaining new calibration coefficients and/or a new calibration model for the sensor from some external information. This may be done by comparing the output of one satellite to a more radiometrically accurate sensor using appropriate match ups, such as simultaneous nadir overpasses (SNOs). Recalibration goes beyond the common approach of *bias correction*, which has the same aim but performs the correction differently. Recalibration adjusts the calibration coefficients, leading to new measured values, whereas, in bias correction, an offset or factor is applied to the existing measured values. Bias correction is more common for an operational update of a sensor providing near real-time data, and is the approach adopted for the current GSICS corrections. In FIDUCEO, we consider that recalibration is more appropriate and effective for reprocessing historical satellite missions to create improved FCDRs.

When we perform a comparison of two sensors using match-ups we must take into account the fact that those two sensors are not observing exactly the same thing. This is in part due to uncertainties in the collocation process itself, which must be allowed for as part of any sensor-to-sensor comparison. However, a more significant difference is due to differences in the spectral response functions (SRFs) of the two instruments, even when nominally observing the same 'band'. In FIDUCEO, we do not aim to 'correct for' SRF differences by translating the measured values of the test sensor as though they were taken by the reference sensor ('*homogenisation*'). Instead, we aim to reconcile the calibration of different sensors given their estimated SRF differences. After recalibration, the sensor series is then '*harmonised*'. We therefore have four different concepts, as summarised in Table 1.

Within the FIDUCEO project our aim is to perform harmonisation. We will obtain new recalibrated L1 products from raw counts, such that the spectral characteristics of each instrument are preserved. The harmonisation process itself will involve refitting the calibration parameters (recalibration) using match-ups, taking into account all error covariances both in the instrument and in the match-up process.

Discuss the article

Aim \ Method	Bias correction	Recalibration
Respecting satellite SRF differences while reconciling calibration	GSICS definition for 'Sensor equivalent calibration'	FIDUCEO definition for 'harmonisation'
Adjusting for SRF differences and calibration differences	GSICS definition for 'Reference sensor normalised calibration'	FIDUCEO definition for 'homogenisation'

*This work was funded under the FIDUCEO project, which has received funding from the European Union's Horizon 2020 Program for Research and Innovation under Grant Aareement no. 638822

How good are GSICS references, IASI-A and AIRS?

By Manik Bali (NOAA), Jonathan Mittaz (NPL) and Mitch Goldberg (NOAA)

Introduction

The Atmospheric Infrared Sounder (AIRS) launched in 2002 and the Infrared Atmospheric Sounding Interferometer–A (IASI-A) launched in 2006 are hyperspectral instruments that take measurements of the Top of Atmosphere radiances in the NIR and IR wavelengths. Originally designed to take sounding measurements with accuracy better than 1K, these instruments have also been used as in-orbit references for monitoring the Geostationary satellites by the GSICS community. Currently AHI, SEVIRI, GOES and COMS instruments use IASI –A, AIRS and CrIS measurements simultaneously to estimate biases of the GEO in morning / evening as well as afternoon / night These inter-comparisons have revealed not only the temporal biases in the GEO instruments but also diurnal biases. However, one big question is how trustworthy are these instruments and under what observing conditions do these instrument provide the most accurate measurements? Using inter-comparison of IASI-A with AATSR spanning 39 months and AIRS with ATSR-2 (spanning three months) the complete range of IASI- A and AIRS biases are revealed.

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Method

The IASI-A and AIRS have stated accuracies of 0.5 K and 0.2 K respectively. The idea is to inter-compare these instruments with broad band instruments of better stated accuracy, these are the Along Track Scanning Radiometer (ATSR-2) and the Advanced Along Track Scanning Radiometer (AATSR). The ATSR-2 and AATSR overlap in time with AIRS and IASI-A respectively and are designed for climate applications (accuracy better than 0.1K and stability better than 0.01 K/decade). To achieve this high accuracy and stability standards these instruments are equipped with robust onboard calibration systems consisting of two blackbodies (one at ambient temperature ~245 K and another heated to ~300 K) which help in pinning down the detector non-linearity across this temperature range. In order to inter-compare AIRS with ATSR-2 and IASI-A with AATSR, locations observed by the two comparing instruments under similar viewing conditions were identified. These are collocated pixels. Within a given IASI or AIRS pixel (size ~ 13-15 KM radius at Nadir), several ATSR-2 and AATSR pixels (1KM at nadir) are collocated. Out of these, only those IASI-AATSR pairs (AIRS –ATSR-2) pairs where the distributions of AATSR and ATSR-2 pixels were homogenous (Standard Deviation less than 0.1K) were selected for analysis. Table 1 shows a summary of the qualifying pixels.

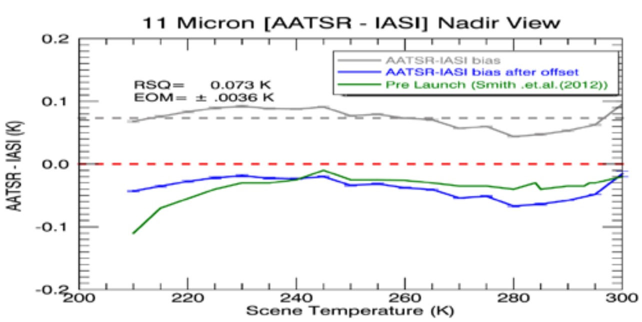
Table 1: Number of collocations produced by the collocation algorithm for AATSR vs. IASI-A inter-comparison and ATSR-2 vs. AIRS inter-comparison (second last column). The last column displays the number of collocations obtained after applying threshold stated in Table 1 that are eventually used in this study

Collocation	*Period of collocation*	*Number of Collocations*	*Number of qualifying Collocations used in this study*
AATSR Vs IASI –A	*1Jan2008- 31 Mar2011*	*10,047,594*	*1,447,030*
ATSR-2 Vs AIRS	*1Sep2002 – 30Nov2002*	*767, 354*	*23, 305*

Inter-comparison Results

The IASI and AIRS are used as in-orbit references. It is important to examine the IASI and AIRS biases with respect to the entire range of viewing scan angles, times of observation and measure any spectral biases of IASI-A and AIRS. Inter-comparisons of the IASI-A with AATSR and AIRS with ATSR-2 for the 11 Micron channel show that the IASI–A and AIRS are nearly as good as pre-launch references. This is because in-orbit inter-comparisons with AATSR and ATSR-2 (Shown in Figure 1) reveal a temperature dependence that was documented at the time of pre-launch testing of the AATSR and ATSR-2. The IASI-A most likely has a positive bias of +0.07K (w.r.t AATSR) while the AIRS has a negative bias of 0.01K (w.r.t ATSR-2).

Figure 2 on the right shows the scan angle dependence of IASI-A minus AATSR. As shown in the figure, the nadir view of the AATSR does not show any scan angle dependence bias w.r.t to IASI-A.



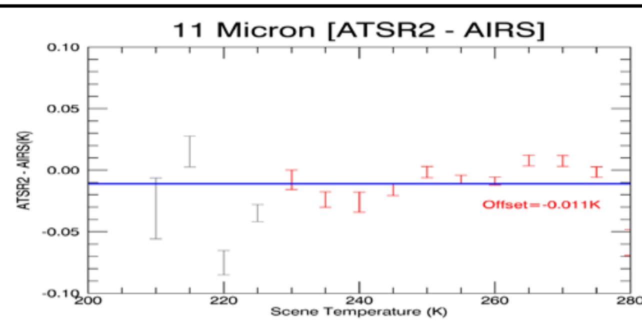


Fig 1: Temperature dependence of AATSR–IASI-A (in grey) bias over the period of 39 months. Blue curve is the same temperature dependence with an offset of 0.11 K (i.e. post launch) subtracted from it. This blue curve is similar to pre-launch (Smith et al., 2012) characteristics of AATSR to within hundredths of a Kelvin. Figure on the right shows the ATSR-AIRS bias. The offset is nearly Zero (thousandths of a Kelvin for temperatures above 210K.

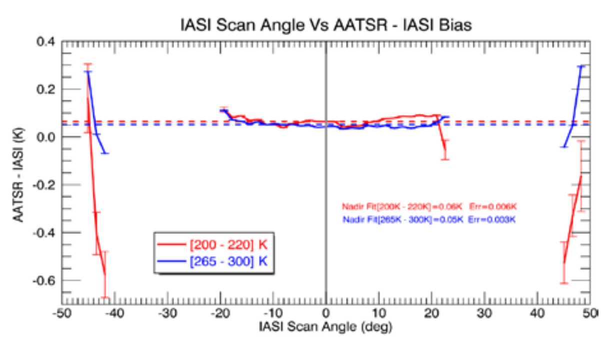


Fig 2(left): Scan angle dependence of the AATSR–IASI bias for cold (200–220 K) and SST (265–300 K) temperature ranges. Neither AATSR nor IASI show any scan angle dependence in the −20 to +20◦ scan

Conclusion

IASI-A and AIRS are extremely trustworthy references for GSICS as they provide nearly pre-launch level of reference radiances. IASI-A also has nearly no scan angle dependence in the -20 to +20 scan angle range which gives further opportunity to use it as a reference at off nadir points as well.

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Discuss the article

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The Moon as a diagnostic tool for microwave sensors

By Martin Burgdorf , T. Lang, S. Michel, S. A. Buehler and I. Hans (Universität Hamburg)

The upper tropospheric humidity (UTH) is an essential climate variable that is required to monitor the global water vapor climate feedback and hence to understand changes in atmospheric dynamics associated with global warming. It is best measured at mm wavelengths from space, where the presence of clouds is less of a problem than in the infrared. Such observations with microwave humidity sounders began in the early 1990s with instruments that were optimized for the 183-GHz line in combination with two window channels at lower frequencies.

The UTH can vary considerably within a few hours, but the trends caused by climate change manifest themselves as small changes over decades. Detecting them with microwave sensors in space makes high demands on the long-term stability of their flux calibration, which are difficult to meet with their on-board calibration targets, whose own temperature calibrations might slightly drift over the duration of the mission. It is therefore desirable to employ a second invariable reference in order to check the stability of the flux calibration: the Moon.

Weather satellites in polar orbits observe the Moon automatically from time to time, because every scan of a sounding instrument does not only sweep over the Earth but also over reference sources with high and low flux. The latter is usually provided by cold space, i.e., the cosmic microwave background.

Its flux is always measured far from Earth and Sun, but this means that occasionally the Moon moves through the field of view (see Fig. 1). A model of its disk-integrated brightness temperature has been developed by Mo and Kagawa (2007) in order to subtract its contribution to the overall flux received so that the standard calibration routine remained valid. This is particularly important for AMSU-A, where up to a third of the scans in one orbit can be contaminated by the Moon. With MHS (Microwave Humidity Sounder, Goodrum et al., 2014), however, because of the smaller beam width and the deep space view (DSV) being closer to nadir, the intrusions of the Moon last only of the order three minutes (see Fig. 2).

The model for the Moon's brightness temperature is based on the data from the microwave sounders themselves; therefore this natural satellite cannot serve as an absolute reference for these instruments. As the properties of its surface do not change with time, however, it can be used for inter-calibration and checks of the photometric stability. By considering only intrusion events where the Moon moves through the center of the deep space view, and by correcting for changes in its phase angle and distance from the Earth, it becomes possible to reduce the errors in its calculated flux due to periodic variations to about 2%. Dedicated maneuvers enabling observations far apart in time but at the same phase and ideally similar libration of the Moon can be expected to improve this value considerably. The maximum signal of the Moon is best determined by fitting a Gaussian to its light curve. This fit does not only provide information about the gain and the beam pattern, but its exact position in time gives also some idea of the pointing accuracy. It follows from the time difference Δ between the maximum of the light curve and the minimum of the angular distance between the DSV and the Moon, as calculated with the ATOVS and AVHRR Pre-processing Package, by simple multiplication with ω, the angular velocity of the deep space view in the sky:

$$\omega = 360^\circ \cdot sin(90^\circ - \alpha)/P$$

where α is the distance of the DSV direction from nadir, and P is the orbital period. The following table gives an example some missing value for MetOp-A MHS:

Year	$\bar{\Delta}$	$\sigma(\Delta)$	$\sigma m(\Delta)$	Intrusions considered
Jan/Feb	0.11	0.14	0.023◦	36
Jan/Feb	0.00	0.12	0.018◦	43

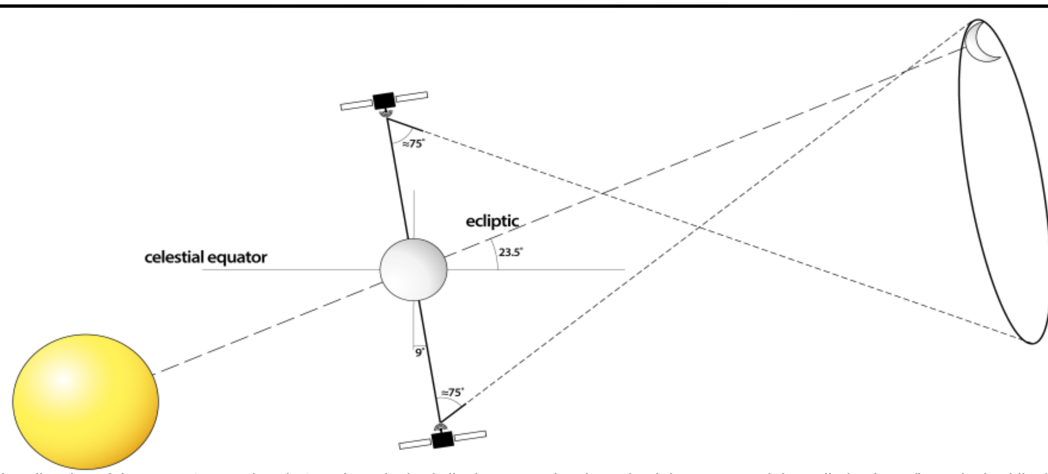

Figure 1: Viewing direction of the Deep Space View (DSV, short dashed line) compared to the celestial equator and the ecliptic plane (long dashed line). For simplicity, the slight tilt of the Moon's orbit against the ecliptic is not displayed. The DSV direction has a typical angle α ≈ 75◦ against nadir and describes a circle in the sky during one orbit.

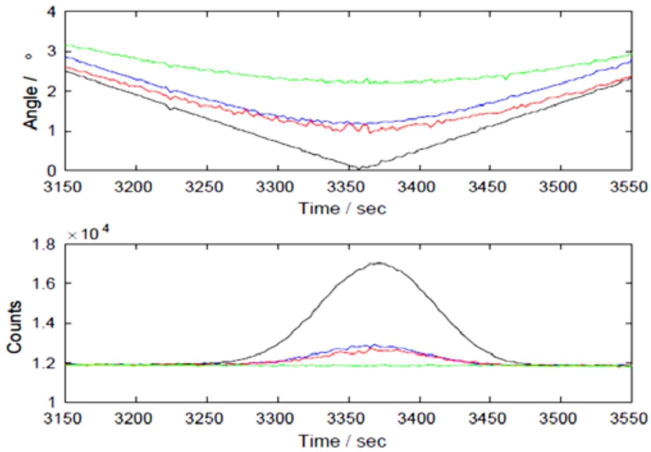

Figure 2: Moon intrusion event with MHS on MetOp-A on Sep 19, 2008 around 22:32 (UT); blue: DSV 1, black: DSV 2, red: DSV 3, green: DSV 4. Top: angle between Moon and space view. Bottom: space view count. In this example, the calculated minimum angle and the measured maximum signal in DSV 2 occur five scans apart, and DSV 1 gives more signal than DSV 3, although its approach to the Moon was calculated to be less close.

Both the mean and the scatter of the differences between the calculated DSV position and the actual pointing along the scan direction are smaller than the uncertainty of **0.3°** claimed in the MHS Level 1 Product Generation Specification. The stronger the signal of the Moon is compared to the one from the internal black body, the tighter are the constraints it can put on the stability of flux calibration and pointing accuracy.

This makes it particularly interesting for the Ice Cloud Imager and the Microwave Imager (Alberti et al., 2012) on MetOp-SG, where it will almost fill the FWHM of the beam.

More details on the appearances of the Moon in the deep space views and the limiting factors of the measurement accuracy can be found in Burgdorf et al. (2016).

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Discuss the article

GRUAN in the service of GSICS: Using reference ground-based profile measurements to provide traceable radiance calibration for space-based radiometers

By Jordis Tradowsky (Bodeker Scientific), Greg Bodeker (Bodeker Scientific), Peter Thorne (Maynooth University), Fabien Carminati (UK Met Office), William Bell (UK Met Office)

The Global Climate Observing System (GCOS) Reference Upper-Air Network (GRUAN) comprises 24 sites that measure vertical profiles of essential climate variables (ECVs) such as temperature, pressure, and water vapour. These measurements are reference quality measurements in that all systematic biases having been accounted for and measurement uncertainties are traceable to internationally recognized measurement standards (Immler et al., 2010). The resultant long-term homogeneity of the measurement series, as well as their network-wide uniformity and coherence, makes them ideally suited for providing a reference standard for space-based radiometric measurements. Reference measurements of the atmospheric state variables influencing radiative transfer through the column, together with, for example, surface emissivity and surface temperature, can be used as input to a state-of-the-art radiative transfer model to simulate top-of-the-atmosphere (TOA) radiances. Propagating the SI traceable uncertainties in the measured vertical profiles of the state variables through to uncertainties in the TOA radiances provides a degree of SI traceability for the simulated radiances. Bootstrapping methods, that also account for vertical autocorrelation in the profiles, can be used to propagate uncertainties from measured variables to the modelled radiances. The modelled radiances, with their robustly determined uncertainty estimates, are also suitable for comparison with space-based radiometric measurements. If satellite

measurements are provided with their associated uncertainty estimates, a quantitative comparison between those measurements and the modelled radiances can be performed. Such a radiance-space validation supports the creation of seamless, stable, and long-term measurement series from many satellite-based instruments that are then suitable for detecting trends and variability in a wide range of atmospheric variables describing the state of Earth's atmosphere and surface.
At present, a GRUAN data product for Vaisala RS92 radiosondes is available. Data products for other radiosonde types, Global Navigation Satellite System Precipitable Water vapour (GNSS-PW), ozonesondes, lidars, and microwave radiometers are currently under development. GRUAN is working towards providing a set of ECV profile measurements, suitable for describing the clear-sky radiative transfer in the column, above many of the GRUAN sites. Reale et al. (2016) gives a summary of activities within the GRUAN community.

Currently under development at the UK Met Office is a software package, referred to as the GRUAN processor (Carminati et al., 2016), which is designed to simulate TOA spectra (L1B radiance or brightness temperatures), including uncertainties propagated to observation (radiance) space, from GRUAN measurements. The processor will also simulate TOA radiances from numerical weather prediction (NWP) model fields interpolated to the GRUAN locations. The GRUAN processor will therefore provide statistics on the differences between NWP fields and GRUAN observations in terms of temperature and water vapour, but also in terms of simulated TOA radiances/brightness temperatures.
The co-location algorithm of the GRUAN processor uses a trilinear interpolation of latitude, longitude, and time that accounts for the radiosonde drift and ascent time. Co-located GRUAN and model profiles are converted into radiances (or brightness temperatures) using the RTTOV (Radiative Transfer for TOVS, http://nwpsaf.eu/site/software/rttov/) fast radiative transfer model. Measurements by various past, present and future satellite instruments, which are supported by RTTOV, can be simulated. The GRUAN processor will be used to characterize the uncertainties in Met Office and ECMWF NWP models, and simulations based on them. Its development is part of the Gap Analysis for Integrated Atmospheric ECV CLImate Monitoring (GAIA-CLIM, http://www.gaia-clim.eu/) project, which is funded by the European Union's Horizon 2020 research and innovation programme. The GRUAN processor will be integrated into the GAIA-CLIM Virtual Observatory, a freely accessible portal that will enable users to access and work with the data.

To promote the use of GRUAN measurements for the calibration and validation of space-based measurements, further activities are underway within the GRUAN community, including:

- The construction of Site Atmospheric State Best Estimates (SASBEs): Redundant measurements of ECVs from different instruments (e.g., lidar, sonde, microwave radiometer) can be combined into a SASBE to provide a best estimate of the spatial and temporal variability of that ECV above the site of interest, together with traceable uncertainty estimates. GRUAN sites seek to make redundant measurements of various ECVs and therefore are well equipped to deliver observations suitable for the construction of SASBEs.
- The establishment of GRUAN operating protocols to encourage sites to time measurements with satellite overpass times. The extent to which satellite overpass times for GRUAN sites can be calculated in advance and provided to GRUAN sites will determine, in part, the ability of those sites to provide targeted measurements for the calibration of space-based instruments. If these targeted measurements are subsequently used in a SASBE, the uncertainty in the SASBE can be reduced at the overpass time of the satellite.

Currently SASBEs for temperature, water vapour and ozone concentration profiles above the GRUAN site in Lauder, New Zealand (45.038°S, 169.684°E) are under development within a project funded by the German Academic Exchange Service. When finalized, these SASBEs can be used as input for radiative transfer calculations.
An interactive version of the temperature SASBE above Lauder is available at http://sasbe.bodekerscientific.com/ where further information about the data product can also be found. Viewers can subscribe to be informed when the SASBEs become available to the scientific community.

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Discuss the article

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A Drawback of Solar Diffusers in RSB Calibration

By Junqiang Sun and Mike Chu (NOAA)

The solar diffuser (SD) panel is the key component in the on-orbit calibration of the reflective solar bands (RSBs) that functions as a source of quantifiable illumination. However, the RSB calibration methodology faces a complication stemming from "SD degradation non-uniformity effects" recently discovered from investigations into the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership (SNPP) satellite and the twin MODerate-resolution Imaging Spectro-radiometer (MODIS) onboard the Terra and Aqua satellites (Sun et al., 2015-2016). In the standard procedure, the degrading SD reflectance as measured by the accompanying SD stability monitor (SDSM) serves as the reference for RSB performance characterization. Because the SDSM and the RSBs are at different outgoing angles with respect to the SD, the use of the SDSM-measured SD degradation to characterize the RSBs dictates that the relative reflectance performance with respect to these two outgoing angles remains constant. The non-uniformity effects create growing differences of this relative SD reflectance between the two views, and consequently all associated calibration and science results are affected by the inherent long-term drift. In this newsletter article, the findings from the investigations into SNPP VIIRS and Terra/Aqua MODIS are summarized.

The investigations exploit the angular dependence in the SDSM and the RSB responses, to the illumination coming through the SD port reflecting off the SD panel, in each calibration event. The shaping of the responses curve within the fully illuminated interval can be shown to evolve from event to event, thus demonstrating changing angular dependence of the detector response, specifically, with respect to the incident angle. The SNPP VIIRS results for SDSM and RSBs are displayed in Figure 1, with each point representing the best-fit slope value for one event of the response result (scan-based SD degradation or RSB calibration coefficient) in a sub-interval within full illumination, the "sweet spot", versus solar declination angle in the instrument coordinate. The evolution of the slopes and the wavelength dependence are clear, and the largest effect of about 0.1% occurs at the shortest wavelength (SDSM D1: 412 nm, RSB M1: 410 nm). The evolution also shows sudden stops or changes, dubbed the "turning" or "turn-off" phenomenon. The oscillatory pattern will be demonstrated by the later Aqua result to be a manifestation of the residual error of the vignetting function (VF), which characterizes the transmission function of the attenuation screen in front of the SD port, and is not an SD degradation effect.

The results for Terra and Aqua MODIS RSB are shown in Figure 2. The Terra MODIS result after mid 2003 is remarkably similar to that of SNPP VIIRS, although several times stronger at 0.3% (Band 8: 412 nm). Although Terra MODIS comes with an SD door, ever since the anomaly of the SD door operation in mid 2003, it has been operating with the SD door in permanently fixed open position and the attenuation screen in closed position. Therefore Terra MODIS has become exposed to the constant impact of solar radiation and the harsh space environment the same as SNPP VIIRS which has a fixed screen but no SD door. Aqua MODIS, on the other hand, with a fully operational SD door for protection, shows a weak effect of less than 0.1% in Figure 2b. The turn-off changes also do not appear. In addition, its calibration operations with both open- and closed-screen mode can be used to examine the VF effect.

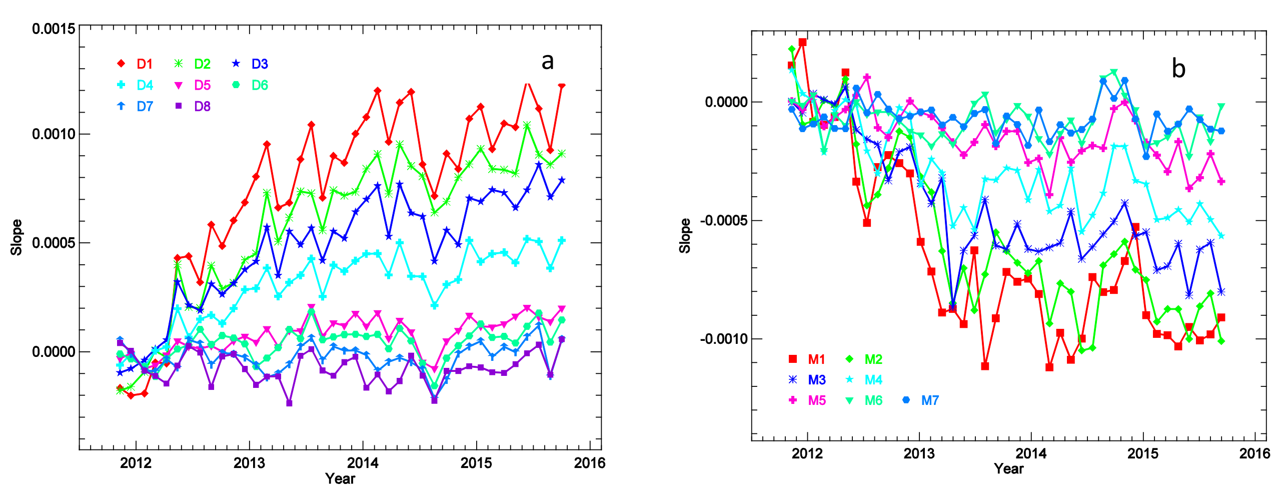

Figure 1. SD degradation non-uniformity effect in SNPP VIIRS: a. SDSM; b. RSB M1-M7 detector 8.

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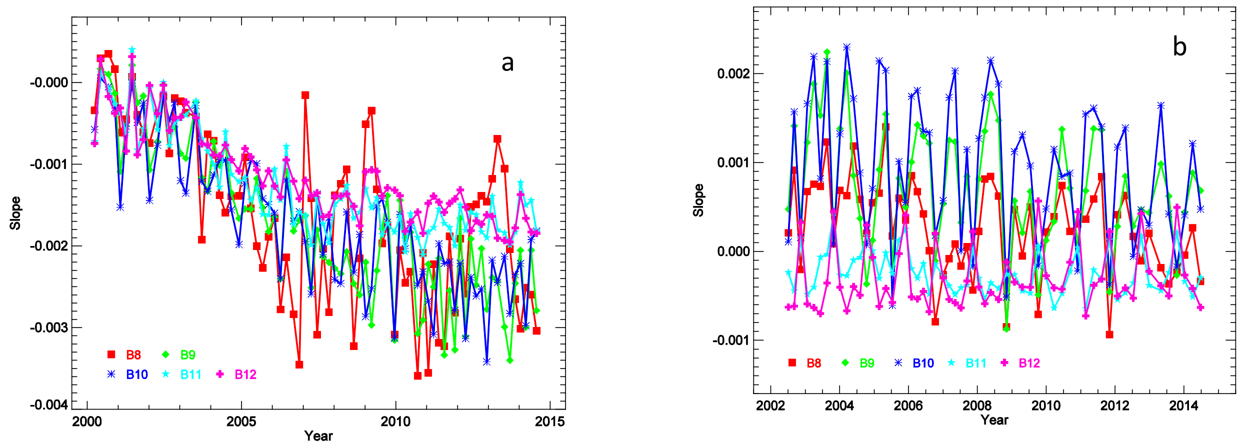

Figure 2. SD degradation non-uniformity effect in MODIS 1: a. Terra MODIS Bands 8-12 detector 6; b. Aqua MODIS Bands 8-12 detector 6.

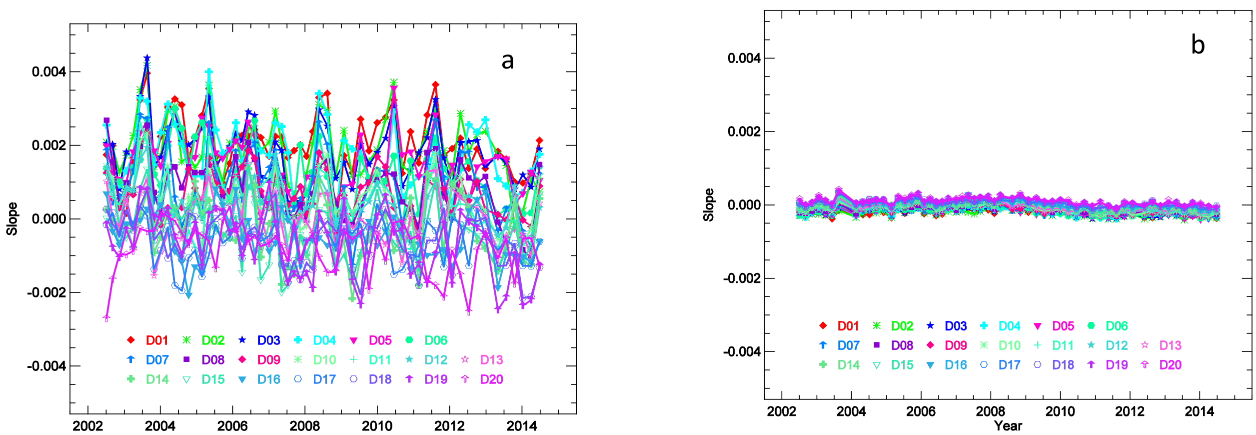

Figure 3. SD degradation non-uniformity effect for Aqua band 3 mirror side 1: a. with SD screen close; b. with SD screen open

In Figure 3, the open-screen result without oscillation proves that the residual of the vignetting effect of screen pinholes leaks through due to imperfect VF characterization, and is thus not an effect related to the SD. The SD degradation non-uniformity effect with respect to the incident angle has been shown, but it necessarily generalizes to the outgoing angle via optical reciprocity. This changing SD property establishes that the reflectance in the SDSM view direction is not interchangeable with the one in the RSB view direction and therefore a built-in error infects RSB calibration. Mitigations do exist to help restore calibration accuracy, such as the “hybrid method” for SNPP VIIRS (Sun et al., 2015) or the earth targets-based method for MODIS (Sun et al., 2014), but this SD effect in RSB calibration is an important mismatch to be addressed and reconciled. One possibility is to include an SD door for future VIIRS missions, or of similar protective measure for any instrument employing an SD, to minimize all associated SD effects, as the benefits are already demonstrated by Aqua MODIS. Finally, a thoroughly tantalizing suggestion is to perform late-mission yaw-maneuver measurements of the SD reflectance and the screen VF to yield insights on the on-orbit change of the SD and the screen. The information can well-serve calibration scientists, instrument builders and optical designers alike. With Terra/Aqua MODIS and SNPP VIIRS in orbit, and four more follow-on VIIRS missions to come, opportunities exist aplenty to improve SD design and RSB calibration.

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News in this Quarter

Highlights on 2016 GSICS Executive Panel Meeting

By Kenneth Holmlund (EUMETSAT)

The GSICS Executive Panel (EP) held its seventeenth meeting on 2-3 June in Biot, France. In the absence of Peng Zhang the meeting was chaired by GSICS EP Vice-Chair Kenneth Holmlund.

This two day meeting was attended by GSICS Executive Panel representatives of CMA, EUMETSAT, ROSHYDRO, ISRO-IMD (Remotely), JMA, KMA, NASA, NOAA, USGS and WMO. Albrecht Von Bargen, Chair CEOS WGCV represented CEOS in the GSICS EP and gave an overview of the GSICS-CEOS partnership.

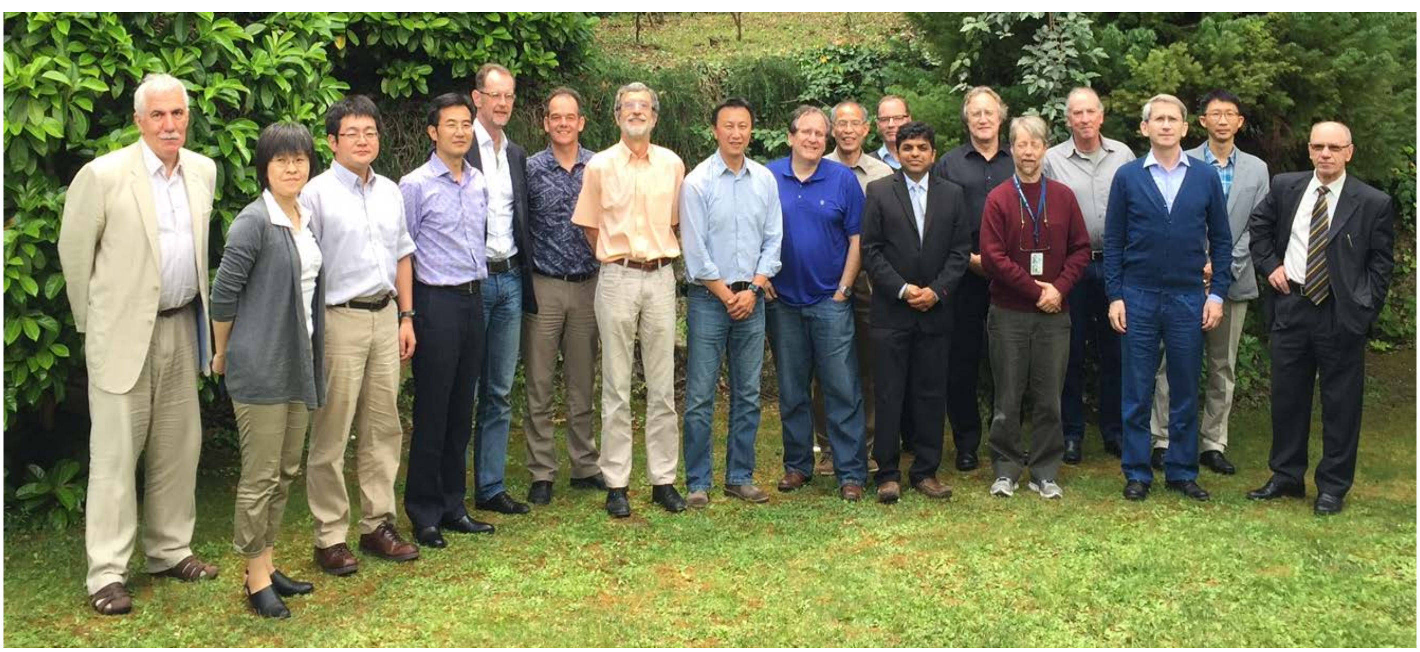
The Executive Panel noted the overall progress achieved by GSICS, which is having its eleventh year of existence.

The panel announced officially ***that MSG 2/3-SEVIRI-IASI-A Cross Calibration product produced by EUMETSAT have now attained the highest possible maturity in GSICS and are upgraded from pre-operational to operational***. The EP thanked EUMETSAT and GCC for the effort that was put in to make these products operational.

On the research side, good progress is being made in developing new algorithms and products. Specifically, the importance of lunar calibration in order to achieve high accuracy SI-traceable calibration required for climate monitoring and other applications was discussed. This item was also discussed in a dedicated paper presented also to the CGMS Working Group II (WGII) on Satellite Data and Products with associate recommendations on how to proceed towards a higher accuracy lunar calibration approach. Also the processes for promoting product status to pre-operational and operational as well as the promotion of products from instrument families that are already in pre-operational or operational phase were discussed. This latter item was reflected in a specific CGMS WGII paper on transfer of reference instruments. The main outcome is that in general several instruments can be considered as reference instruments as long as they meet the associated criteria in terms of quality and availability. In addition, the notion of an anchor instrument was agreed, which allows the use of specific a specific reference instrument to be denoted as anchor for a certain application

An important aspect was raised related to outreach. GSICS has recently performed a user survey, with feedback that is now integrated into the normal work of the various working groups. Furthermore, GSICS is reaching out to user communities and a proposal to engage in a dedicated project with ISCCP through SCOPE-CM was discussed. The participation in SCOPE-CM IOGEO also was endorsed. There were convincing results presented on the utility of estimates using GSICS corrections to provide improved SST.

Part of the outreach has also been the provision of a clear, structured set of documents.



Participants in the GSICS Executive Panel 2016 meeting in Biot, France.

These include a GSICS overview, vision, terms of reference and a guide to products or services. The vision and terms of reference are already finalized and the others are under development.
The plans for the next GSICS Users' Workshop part of the JPSS Annual Science Team Meeting 8-12 August 2016, with a side event on the use of ICVS (Integrated Calibration / Validation System) were announced
A specific concern on the workload of the data management side was raised and discussed. The current activities go in some cases beyond the originally foreseen scope of the GDWG since the activities originally foreseen for the GSICS Coordination Centre can only be performed by the GDWG members.
During the meeting an active engagement in the GDWG was called for. This does not only benefit GSICS itself, but is also beneficial for the agency activities requiring such attention nevertheless.
E.g., this was demonstrated by the use of GSICS by JMA to identify calibration issues during Himawari-8 commissioning and by KMA to readjust SRFs for Kompsat-2.
The highlights of the recent work by GSICS include:

- first GSICS products are declared operational;
- very good user feedback, particularly from satellite operators;
- members to strengthen their engagement in GSICS and, in particular in GDWG;
- all CGMS members invited to join GSICS;
- members to analyze their requirements for calibration;
- support inclusion of calibration references in the Vision 2040;
- support GSICS engagement with CEOS/WGCV in the Architecture for Climate Monitoring from Space;
- support GSICS efforts for outreach to further document GSICS and communicate to ensure visibility and full benefit.

By adding a few small parameters as ancillary data, all users of geostationary imager data can apply an adjustment, which will provide bias consistency of all GEO imagers enabling improved applications.
Again, it should be noted that the GSICS activities were also presented to the CGMS Working Group II that applauded GSICS for its good progress and high quality work. This was also further reported to CGMS Plenary.
Finally, the GSICS EP expressed its thanks to Jerome Lafeuille (WMO) for his many years of support to GSICS

Discuss the article

Summary Report on the CEOS/WGCV-GSICS microwave subgroups joint meeting held at Beijing, China from July 06-07, 2016

By Xiaolong Dong (Chinese Academy of Sciences) and Cheng-Zhi Zou (NOAA)

The first CEOS/WGCV-GSICS microwave subgroups joint meeting was held at Beijing, China from July 06-07, 2016. The purpose of the meeting was to foster exchanges between the two subgroups on currently available calibration and cross-calibration algorithms and defining microwave reference/standard and calibration procedure. Fifteen satellite microwave calibration experts from NOAA and Chinese satellite meteorological and oceanic agencies participated in the meeting. Presentations from the participants covered areas of microwave instrument performance, inter-comparison and inter-calibration, pre-launch calibration, and development of standard instruments. The meeting highlighted inter-calibration activities within the two subgroups for several different types of satellite microwave sensors, including microwave sounders, microwave imagers, radar scatterometer, and radar altimeters. The meeting also discussed procedures to define

Participants in the CEOS/WGCV -GSICS meeting in Beijing, China.

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microwave references, which is a key step for satellite inter-calibration. Looking forward, the meeting recognized the challenges in the development and use of the environmental observing satellites in a rapid changing environment. These challenges include 1) the number of Earth-observing satellites has vastly increased; 2) onboard instruments are more complex and are capable of collecting new types of data in ever-growing volumes; 3) the user community has expanded and become more diverse as different data types become available and new applications for Earth observations are developed; 4) users have become more organized, forming several international bodies that coordinate and levy Earth observation requirements. To meet these challenges, participants suggested: 1) to develop focusing areas in the two subgroups to avoid overlap effort and to optimize resources available in satellite calibration and inter-calibration; 2) to initiate the development of guidelines for the calibration of microwave radiometers. Finally, the participants encouraged further coordination between the two microwave subgroups for scientific exchanges.

Discuss the article

Microwave Inter-calibration activities reported at MicroRad 2016

By Vinia Mattioli (EUMETSAT)

The 14th edition of the Specialist Meeting on Microwave Radiometry and Remote Sensing of the Environment (MicroRad'16) was held this in year in Espoo, Finland, on April 11-14, hosted by Aalto University.

Microrad is a unique venue, where the microwave radiometry community has the opportunity to meet and present research results, instrument designs and applications in the field of microwave remote sensing, to an audience that comprises academia/industry and meteorological operational agencies.

The social program included an opening reception, a reception sponsored by the city of Espoo and an exquisite conference social banquet, providing additional opportunities for the participants to convene.

Participants of the MicroRad 2016 at, Espoo, Finland

The technical program of MicroRad'16 included sessions on surface parameter monitoring and retrieval, atmosphere sounding, cloud and precipitation, current and future microwave missions, instruments design, sensor calibration techniques, Radio Frequency Interference (RFI) detection. This year, four presentations were devoted to microwave inter-calibration.

In the framework of the NASA's Precipitation Measurement Missions (PMM), the PMM Intercalibration Working Group (XCal) investigates issues impacting the calibration of individual microwave radiometers and methods to shift the measurements of the constellation to a common reference before deriving precipitation products. The Global Precipitation Mission (GPM) Microwave Imager (GMI), launched in February 2014, is the current XCal reference satellite to which other satellites are intercalibrated. A poster presentation [1] was given showing the latest calibration and intercalibration results. Intercalibration offsets between GMI and the rest of the constellation are typically in the 0.5-1.5 K range, but can in some cases be as large as 4 K. XCal-developed

updates to the calibration of TRMM TMI and GPM GMI were also discussed.
A specific oral presentation [2] was given by Rachel Kroodsma within XCal proposing a current investigation for the vicarious calibration of high frequency channel between 150 and 183 GHz. Indeed, the theory of vicarious cold calibration breaks down at these channels and cannot be used to derive a calibration reference. The proposed approach considered the use of the warm end of the TB histograms, which is found comparatively to be very stable. A theoretical analysis of this was presented. Finally, the new high frequency calibration method was used to identify and correct calibration issues with current radiometers and derive inter-calibration offsets.
The satellite based HOAPS (Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data) climatology Fundamental Climate Data Record (FCDR) is a long-term inter-calibrated dataset that includes all available data from the six SSM/I radiometers. In order to further extend the HOAPS dataset in time, the SSM/I successor instruments SSMIS (Special Sensor Microwave Imager Sounder) have now being reprocessed. A poster presentation [3] focused on the main calibration issues identified for the SSMIS instruments and compares the different inter-calibration procedures implemented to homogenize the time series of all SSMIS instruments.
Between April and June 2015, three L-band radiometers have been operating simultaneously: ESA's Soil Moisture and ocean Salinity (SMOS), NASA Soil Moisture Active Passive (SMAP) and Acquarius. The objective of the presented poster was to demonstrate a set of methods for their inter-comparison, using SMOS as a transfer radiometer, along with a full record of results over the lifetimes of SMOS, SMAP and Aquarius. A more general conclusion on common use of these data sets was also given.

References

1 http://microrad2016.org/Papers/viewpapers.asp?papernum=1217.

2 http://microrad2016.org/Papers/viewpapers.asp?papernum=1138.

3 http://microrad2016.org/Papers/viewpapers.asp?papernum=1035.

4 http://microrad2016.org/Papers/viewpapers.asp?papernum=1181.

Discuss the article

Announcements

Toshiyuki Kurino replaces Jérôme Lafeuille as WMO representative in GSICS Executive Panel

By Lawrence E. Flynn(GCC Director), NOAA

On 18 July 2016, Mr. Toshiyuki Kurino joined WMO as chief of the Space-based Observing System Division. In this capacity, Mr. Kurino replaces Jerome Lafeuille as the WMO Secretariat's representative to the GSICS Executive Panel.
Mr. Kurino is one of the founding members of GSICS. Well known to the international community as "Toshi", Kurino-san has played a vital role in the growth of GSICS to advance to what it is today. He has also co-chaired the Coordination Group for Meteorological Satellites (CGMS) Working Group II (Satellite Data and Products).

Mr. Kurnio began his career in 1981 at the Meteorological Satellite Center (MSC) of JMA when he joined as a scientist for meteorological satellite data processing and analysis. Over the past 31 years, he has contributed to and led vital departments of JMA with responsibility for satellite meteorology, disaster risk reduction, climate monitoring, and space weather.

For the last ten years, Mr. Kurino has been supervising Japan's meteorological satellite program, including: 1) coordination to enhance satellite data utilization by domestic and international users, 2) promotion of cross-cutting cooperation with the National Meteorological and Hydrological Services (NMHSs) and/or other satellite operators, including the Japan Aerospace Exploration Agency (JAXA), for the development of innovative meteorological products that will maximize the potential of advanced observation data from Himawari-8/9,

and 3) development of relevant services and activities including international coordination and cooperation.

The GSICS Coordination Center would like to join all the GSICS member agencies and the GSICS Executive Panel in welcoming Mr. Kurino and hope to continue to work closely with WMO to achieve the future goals of GSICS.

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Meteosat/SEVIRI-IASI products declared operational

By Manik Bali (GCC Deputy Director), NOAA

In the GSICS Executive Panel meeting of June 2-3, 2016, Biot France the MSG 2/3-SEVIRI-IASI-A Near Real-Time and Re-Analysis Corrections developed by EUMETSAT were formally declared operational. These products have completed the required documentation including the Algorithm Theoretical Basis Document (ATBD), uncertainty analysis, user guide and other ancillary reports required by the GSICS Procedure for Product Acceptance. EUMETSAT has confirmed that the software for the products is running stably and reproducibly with minimal code changes expected. We have received some positive feedback from product users and continue to encourage user comments.

GCC has established a wiki page that details the review of this product since its submission in Demo phase and the progress in its maturity to the Operations phase. This page can be accessed here.

Users can access to the products and the associated documents freely at the GSICS product catalog, which is also linked to the WMO GSICS portal website. Users can contact the EUMETSAT User Desk (ops@eumetsat.int) for any help in using these products.

Discuss the article

OSCAR/Space v2.0 launched

By Stephen Bojinski, WMO

A new version of the WMO Space-based Observing System Capability Analysis and Review tool (OSCAR/Space v2.0) is now available (http://oscar.wmo.int/space). It provides a wide range of information on satellite programmes, instruments, and the variables they can observe in the areas of weather, water, climate, the Earth's environment, and space weather.

OSCAR/Space v2.0 features powerful search functions and gap analyses, by variables and mission types, for users in meteorological and other services, satellite agencies, academia, and supporting the WMO Rolling Review of Requirements. Through GSICS, satellite operators are establishing calibration event landing pages that are linked to OSCAR/Space. OSCAR/Space continues to serve as a community reference tool. WMO encourages users to engage in maintaining the content of the database. Feedback can be provided through sat-help-desk@wmo.int

GSICS-Related Publications

Bali, M., Mittaz, J. P., Maturi, E., and Goldberg, M. D., 2016, "Comparisons of IASI-A and AATSR measurements of top-of-atmosphere radiance over an extended period," Atmos. Meas. Tech., 9, 3325-3336, doi:10.5194/amt-9-3325-2016.

Pinto, C.T., F.J. Ponzoni, R.M. Castro, L. Leigh, M. Kaewmanee, D. Aaron, and D. Helder, 2016, "Evaluation of the Uncertainty in the Spectral Band Adjustment Factor (SBAF) for Cross-Calibration Using Monte Carlo Simulation," *Remote Sensing Letters* 7 (9): 837–46. doi:10.1080/2150704X.2016.11904.

Wu, Aisheng, Xiaoxiong Xiong, Changyong Cao, and Kwo-Fu Chiang, 2016, "Assessment of SNPP VIIRS VIS/NIR Radiometric Calibration Stability Using Aqua MODIS and Invariant Surface Targets." *Ieee Transactions on Geoscience and Remote Sensing* 54 (5): 2918–24. doi:10.1109/TGRS.2015.2508379.

Submitting Articles to GSICS Quarterly Newsletter:

The GSICS Quarterly Press Crew is looking for short articles (~800 to 900 words with one or two key, simple illustrations), especially related to calibration and validation capabilities and how they have been used to positively impact weather and climate products. Unsolicited articles are received for consideration anytime, and if accepted, will be published in the next available newsletter issue after approval/editing. Note the upcoming spring issue will be a general issue. Please send articles to manik.bali@noaa.gov.

With help from our friends:

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