GSICS Global Space-based Inter-Calibration System

Quarterly

Newsletter Fall 2022 Issue

doi: 10.25923/yd9k-8370
Vol. 16 No 3, 2022
Editor: Manik Bali, ESSIC UMD

CMA • CNES • ESA • EUMETSAT •IMD• ISRO • JAXA • JMA • KMA • NASA • NIST • NOAA •ROSCOSMOS . ROSHYDROMET • SITP • USGS • WMO

JPSS-2, NOAA's third satellite in the Joint Polar Satellite System, successfully lifted off from Vandenberg Space Force Base on Nov. 10, 2022

Meteosat third Generation successfully launched on 13 Dec 2022 by an Ariane 5 rocket from French Guyana: Curtsey ESA. See Page 12

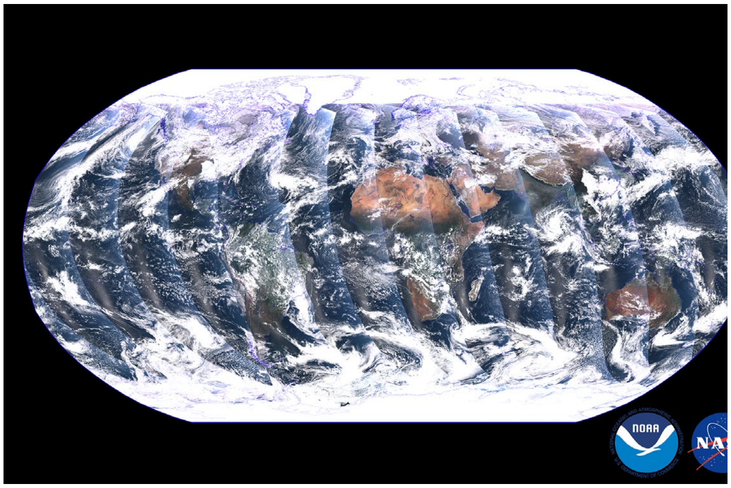
Successful Launch of JPSS-2 Ushers in another Decade of Dedicated Earth Observations with NOAA-21

By Changyong Cao (NOAA/NESDIS/STAR) and Ivan Csiszar (NOAA/NESDIS/STAR)

The Joint Polar Satellite System (JPSS-2) or NOAA-21 satellite was successfully launched on November 10, 2022, from the Vandenburg Space Force Base (VSFB) in California on an ATLAS 401 rocket, carrying the four major Earth observing instruments including the Advanced Technology Microwave Sounder (ATMS), Cross-track Infrared Sounder (CrIS), Visible Infrared Imaging Radiometer Suite (VIIRS), and the Ozone Mapping and Profiler Suite (OMPS). One day before the launch, a JPSS-2 launch algorithm and cal/val readiness workshop was held near the launch site. Presenters at the workshop included several NOAA NESDIS Center for Satellite Applications and Research (STAR) instrument scientists, STAR environmental product calibration/validation leads, representatives from the NOAA National Weather Service, NOAA Fisheries and the ocean product user community, and the JPSS program.

Although the four satellite instruments are almost identical in the JPSS series on different satellites (Suomi NPP, NOAA-20, NOAA-21, JPSS-3, and JPSS-4), there are several notable improvements for NOAA-21. For ATMS, the improvements include reduced noise correlation across channels especially for the water vapor bands, and reduced striping in some of the channels, as a result of a hardware upgrade; for VIIRS, there is significant straylight reduction in the Day/Night Band

doi: 10.25923/yd9k-8370



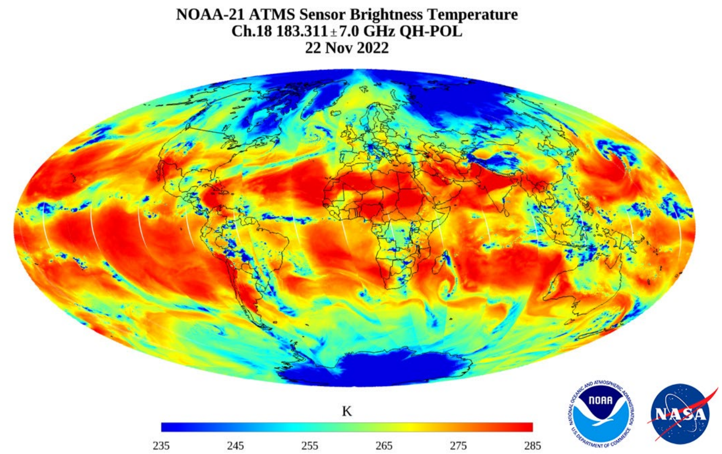


Figure 1: First images from NOAA-21 VIIRS (L, true color M3, M4, M5, 12/05/2022); and ATMS (R, CH18, 11/22/2022). The high resolution VIIRS image is available at: https://ncc.nesdis.noaa.gov/NOAA-21/N21FirstVIIRSGlobalTrueColor.png (Courtesy of Bin Zhang)

(DNB), reduced polarization sensitivity in the visible bands, and a shift in the spectral placement of the fire/hot spot band towards wavelengths with less atmospheric absorption; the OMPS suite on NOAA-21 now includes the limb profiler sounder (as it did on Suomi NPP but not NOAA-20), and the spatial resolution of OMPS nadir mapper has been significantly increased with increased data rate. Finally, NOAA-21 CrIS is expected to perform equally well as it does on NOAA-20.

The first light image from ATMS was released on November 22, 2022, by NOAA, showing that the instrument is working very well, with high quality data produced (Right image in Figure 1). The NOAA-21 VIIRS nadir door was opened on December 5, 2022 and the first light image shows high quality as expected (Left image in Figure 1, released on December 8, 2022). The CrIS and OMPS nadir doors are scheduled to be opened in late December 2022. Post-launch intensive calibration/validation led by STAR instrument scientists has already begun. The cal/val teams are working diligently towards achieving established milestones that consists of three phases of data maturity – beta, provisional, and validated – for each instrument's data records.

NOAA-21 joins Suomi NPP and NOAA-20 in this important NOAA JPSS mission. With dedicated work by the NOAA scientists, engineers, and support staff, NOAA 21 satellite data products are expected to reach fully operational status within 90 days after launch. The three satellites will work in tandem providing global twice/daily observations for atmospheric temperature and moisture sounding, atmospheric chemistry, and moderate spatial resolution visible and infrared imagery and day/night bands. These observations provide critical information for numerical weather prediction, hurricane tracking, fire, aerosol, ocean color, vegetation, and other environmental monitoring and intelligence that may save lives and protect property. The high-quality sensors on NOAA-21 are expected to provide significant contributions to the WMO GSICS program in the coming decade.

doi: 10.25923/yd9k-8370

ESA Calibration/Validation Strategy for Optical Land-Imaging Satellites and Pathway towards Interoperability

By Fabrizio Niro (Serco/ESA), Philippe Goryl (ESA), Steffen Dransfeld (ESA), Valentina Boccia (ESA), Ferran Gascon (ESA), Silvia Scifoni (Serco/ESA) and Georgia Doxani (Serco/ESA)

Background and Motivations

Land remote sensing capabilities in the optical domain have dramatically increased in the past decade, owing to the unprecedented growth of space-borne Earth Observation (EO) sensors providing a wealth of measurements at enhanced spatial, temporal, and spectral resolution. Notwithstanding the potential of this growing amount of satellite systems, their synergistic exploitation is still hampered by the lack of interoperability across them.

Interoperability can be addressed at different levels of complexity, ranging from format definition, products content and metadata, processing algorithms and quality assurance approaches. Yet, in general terms, two systems can be considered interoperable when their derived EO products come with all the necessary metadata and quality information, including a detailed uncertainty analysis, allowing to fully characterise, and eventually correct for, the systematic differences between them.

Generic Framework

To facilitate the path towards interoperability, ESA has elaborated a generic Calibration/Validation (Cal/Val) strategy [1], which stems from the principles formulated within the Quality Assurance Framework for Earth Observation (https://qa4eo.org/). It consists of a set of basic elements (Figure 1), which shall be verified for each satellite product to ensure that the interoperability conditions are met, namely:

- *Metrology*—It is the basic pillar underpinning the Cal/Val approach, by providing the guidelines, best practices, and standards, to tie EO data acquired by a variety of sensors to a common reference, ideally SI traceable.

- *Radiative Transfer Models (RTM) and Inter-comparison*—The use of RTM simulations allows advancing our understanding of the uncertainty budget associated to the validation. Inter-comparison exercises are key to characterize the discrepancies between algorithms and models, so that to converge to a community-agreed solution.

- *Fiducial Reference Measurements (FRM) and supersites*—These are well-characterised sites, in terms of environmental conditions, and in-situ measurements are carried out within these sites in a continuous and sustained manner following rigorous metrological best practices.

- *Protocols*—The availability of standardized protocols is the essential element for establishing a common approach to validation. When protocols are agreed and widely adhered to, Cal/Val data from a variety of networks and campaigns can be reliably combined, enhancing spatiotemporal sampling.

- *Networks*—Once the protocols are consolidated, they shall be replicated in a network of representative sites to enable operational validation of satellite EO data at global scale.

- *Ad-hoc campaigns*—While the networks ensure operational validation using mature and consolidated protocols, dedicated campaigns shall be continued to experiment advanced methods, which could potentially be considered for operational use, after reaching the suitable maturity level.

- *Database and tools*—The final stage of an operational Cal/Val system consists of providing the users with a centralised repository of reference data and collocated satellite subsets with associated tools for running a validation exercise using community endorsed practices and standardized reporting procedures.

Readiness Status and Way Forward

This generic Cal/Val framework was applied to operational land products at different processing stages and the readiness level of each element was assessed after consultation with the science community (Figure 2). Overall, we observe that we reached a good level of readiness for Level 1 Top-Of-Atmosphere (TOA) products, owing to the efforts spent in the past decades in developing and consolidating the protocols for calibration and intercalibration, as well as the availability of an operational ground-based network, such as RadCalNet [2]. Despite this good maturity level, protocols are still being improved in the frame of the Committee on EO

doi: 10.25923/yd9k-8370

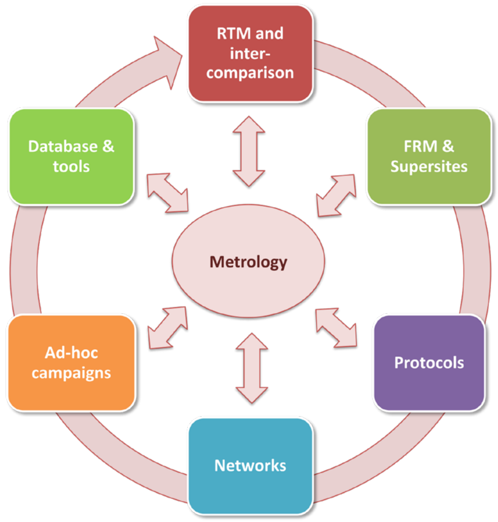


Figure 1. ESA generic Cal/Val framework.

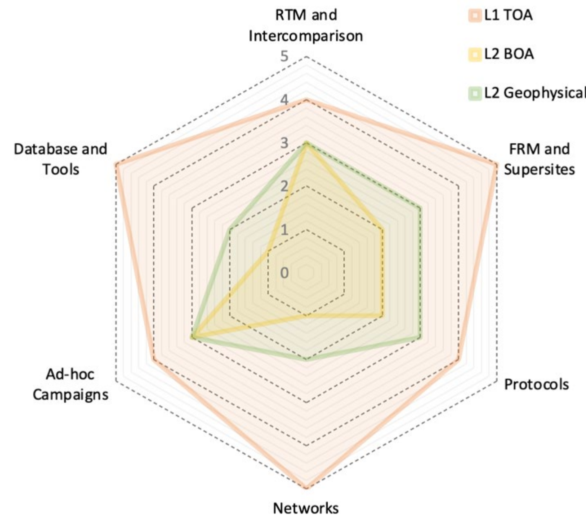


Figure 2. Readiness level for Level 1 TOA, Level 2 BOA, and Level 2 geophysical products.

Satellites Working Group on Cal/Val (CEOS-WGCV) and GSICS, while the final step toward traceability in-space is planned and undergoing with the upcoming launch of the SI-Traceable Satellite Instruments (SITSATs).

Conversely to TOA products, significant gaps remain in the ability to assess radiometric quality at Bottom-Of-Atmosphere (BOA) level. Our capability in validating Surface Reflectance (SR) products is remarkably the weakest point in terms of readiness level over the whole processing chain. The major gaps in this respect are the lack of a network of SR measurements and of community agreed validation protocols. Concerns also remain with respect the accuracy of RTM-based simulations since significant discrepancies (up to 4%) still persist when intercomparing commonly used models [3]. Finally, crucial data gaps were identified for cloud mask validation, which is an essential preprocessing step for the generation of SR products. ESA is currently tackling these gaps with the highest priority, notably with the establishment of the HYPERNETS network (https://www.hypernets.eu/) and the development of community-agreed protocols, such as those prototyped in the frame of the Atmospheric Correction and Cloud Mask Inter-comparison Exercises (ACIX and CMIX) [4, 5] or within the FRM for Vegetation project (FRM4VEG) [6].

When we consider Level 2 bio-geophysical products, the situation is slightly improved, thanks to the effort spent in the past years for developing common protocols and procedures, in particular in the frame of the CEOS-WGCV Land Product Validation (LPV) sub-group (https://lpvs.gsfc.nasa.gov/). Despite these on-going efforts, several challenges remain, owing to the disparity of the used practices across existing networks, the lack of community-agreed protocols for some variables, the scarcity of reference data over some geographical areas (Africa, South America), and the difficulty in discovering and accessing Cal/Val data.

As a result of this assessment, a set of recommendations were derived on how to enhance the readiness level of the Cal/Val solution. These recommendations will be pursued by ESA in coordination with other Space Agencies in the frame of the CEOS-WGCV. The objective for the coming years is to contribute to harmonising best practices and fill the gaps, paving the way for enhanced interoperability across current and future optical sensors.

References

1. Niro, Fabrizio, et al., Remote Sensing (2021), https://doi.org/10.3390/rs13153003
2. Bouvet, Marc, et al., Remote Sensing (2019), https://doi.org/10.3390/rs11202401
3. Govaerts, Yves, et al., Atmosphere (2022), https://doi.org/10.3390/atmos13111759
4. Doxani, Georgia, et al., Remote Sensing (2018), https://doi.org/10.3390/rs10020352
5. Skakun, Sergii, et al., Remote Sensing of Environment (2022), https://doi.org/10.1016/j.rse.2022.112990
6. Origo, Niall, et al., Remote Sensing of Environment (2020), https://doi.org/10.1016/j.rse.2020.111690

doi: 10.25923/yd9k-8370

GSICS Quarterly: Fall Issue 2022 Volume 16, No. 3, 2022

The Value of Spaceborne Radars to Monitor Operational Ground-Based Weather Radar Networks

By Alain Protat, Australian Bureau of Meteorology, Melbourne, Australia

1 Introduction

A critical role of operational weather radar networks is to provide situational awareness and nowcasting in severe weather situations. In this operational context, it is critical to closely monitor the calibration of the radars of the network. At the Australian Bureau of Meteorology (BoM), a combination of three well-established techniques is used to ensure that the calibration of all operational radars remains within the 1 dB accuracy requirement (Louf et al. 2019, Protat, A., et al 2022). The main technique to derive an absolute calibration error is the Volume Matching Method (VMM, Schwaller and Morris, 2011; Warren et al., 2018), leveraging from intersections between individual ground-based radar beams and NASA Tropical Rainfall Measurement Mission (TRMM, Simpson et al. 1996) or Global Precipitation Mission (GPM, Hou et al. 2014) scanning Ku-band radar beams.

A major advantage of this spaceborne radar approach is that it provides a single calibration reference for all radars of an operational network. However, there are multiple possible sources of errors contributing to the VMM calibration error estimate, such as temporal mismatch, imperfect attenuation corrections, gridding and range effects, and differences in radar minimum detectable signal and operating frequency, as discussed in P22. The main objective of this study is to quantitatively evaluate this concept of calibrating a whole radar network with a spaceborne radar.

2 Concept of the study

To quantitatively evaluate the VMM technique, we use another independent

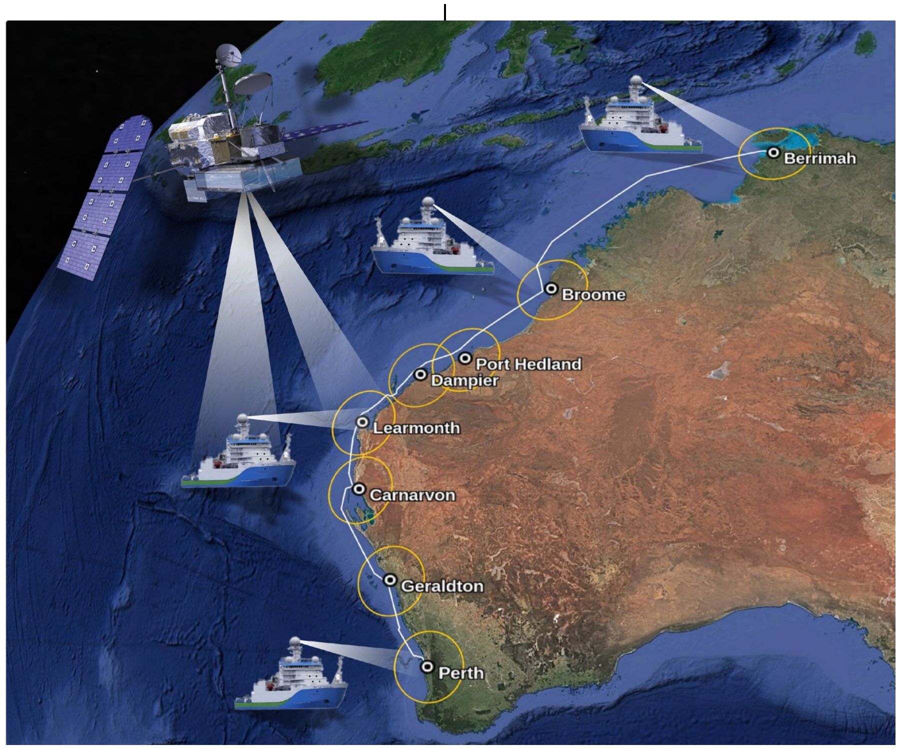


Figure 1: The concept of this study. Ship-based OceanPOL radar and ground-based radars are calibrated independently using the GPM Ku-band spaceborne radar, then all ground radars are compared with OceanPOL during the ORCA voyage as RV Investigator sails south. The 150 km radius of each radar is shown by a yellow circle and the ship track is shown using a white line. © 2021 Google Earth; Map Data: SIO, NOAA, U.S. Navy, NGA, GEBCO; Map Image: Landsat/Copernicus

source of reference from the dual-polarization C-band weather radar (OceanPOL) observations collected on board the Marine National Facility (MNF) Research Vessel (RV) Investigator between Darwin and Perth, Australia, as part of the *Years of the Maritime Continent – Australia* (YMCA, Protat et al. 2020) and the *Optimizing Radar Calibration and Attenuation corrections* (ORCA, P22) experiments.

The concept of this study is presented in Fig. 1. GPM observations are first used to calibrate both the ship-based radar and all the operational C-band ground-based radars along the western coast of Australia independently, using the VMM technique outlined in Warren et al. (2018). In short, ground-based and spaceborne radar data are averaged over an optimally defined common sampling volume, the Ku-band reflectivities are converted to C-band, and some filters are applied to mitigate differences in partial volume filling, minimum detectable signal, and possible attenuation effects (Warren et al. 2018).

The calibrated ship-based C-band radar observations are then individually compared with those from each

doi: 10.25923/yd9k-8370

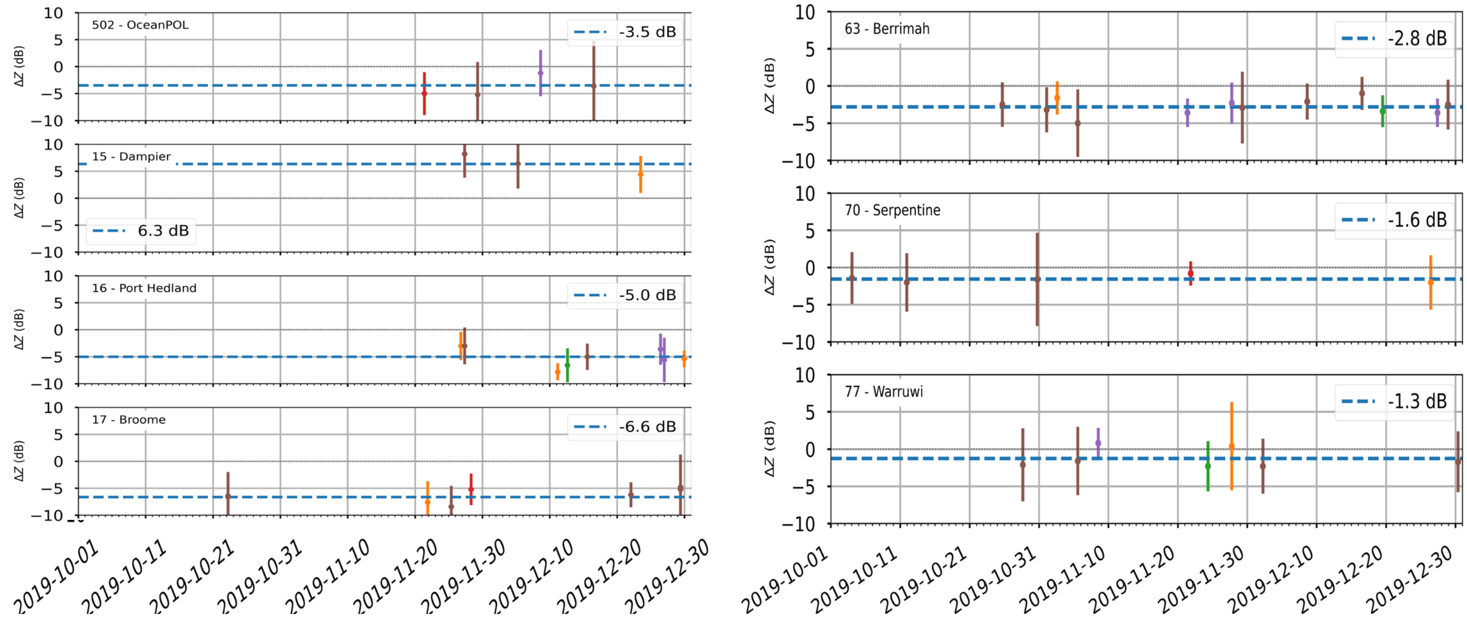


Figure 2: Individual calibration error estimates from the GPM comparisons. The standard deviation of the PDF of reflectivity difference is also shown for each estimate as an error bar. The mean value over the whole period is displayed as a dashed line for each radar, and the value is reported on the upper-right of each panel. A negative value mean that the radar is under-calibrated (radar – GPM). The colour of each overpass point is the number of matched volumes: less than 20 (blue), 20 to 60 (orange), 60 to 100 (green), 100 to 150 (red), 150 to 200 (purple) or more than 250 (brown).

ground-based C-band radar as the ship sails close to them. By using a ship-based radar instead of a spaceborne radar, most of the error sources in ground-based / satellite radar comparisons discussed in section 1 are reduced to a minimum. Since all radars have also been calibrated using GPM, the differences between ship-based and ground-based observations are interpreted in this work as an error estimate of the VMM technique (P22).

3 Results

Seven ground-based C-band radars along the western coast of Australia and the ship-based OceanPOL radar are first calibrated independently using GPM radar overpasses over a 3-month period. Calibration results are shown in Fig. 2. Assuming a typical error of 2 dB for individual GPM overpasses (Warren et al. 2018), it is reasonable to assume from Fig. 2 that the calibration of the OceanPOL, Warruwi (77), Dampier (15), Broome (17), and Serpentine (70) radars has not changed over the observational period, with fluctuations around the mean calibration error estimate less than ~1.5 dB. The Port Hedland (16) radar time series shows calibration error estimates ranging from -8 dB to -2.5 dB over that period, but the three points closest to the date when collocated observations with OceanPOL were collected also agree reasonably well (around the mean value of -5 dB) so this value has been retained for this radar. The next step of this calibration consistency check study consists in using the OceanPOL radar (previously calibrated using GPM, Fig. 2) as a second independent reference to compare with the ground-based radars. The calibration difference between the OceanPOL radar and the 7 operational radars is estimated using collocated gridded radar observations. The ship – ground radar comparisons are

Date	Time Span (UTC)	Radar	Calibration Error (Radar – OceanPOL)
Multiple	Multiple times	77	-0.3
Multiple dates	Multiple times	63	+0.4
20191225	12:00 – 21:00	17	+0.4
20191226	18:00 – 24:00	16	+0.1 (noAP)
20191227	08:00 – 11:00	15	+0.3 (noAP)
20191228	08:00 – 11:00	29	+0.1 (noAP)
20200102	03:00 – 05:00	70	-0.4

Table 1: Ground radar – OceanPOL calibration difference estimates for all comparisons of this study. Only the mean calibration difference for radars 63 and 77 that includes all dates and time spans in P22 is provided. For radars 15, 16, and 29, a minimum height of 2 km is used for the comparisons to remove residual anomalous propagation artefacts observed for these radars (noAP).

doi: 10.25923/yd9k-8370

summarized in Table 1. For all seven radars the calibration difference with the ship radar lies within ± 0.5 dB, therefore fulfilling the 1 dB calibration requirement. This result validates the concept of using the GPM spaceborne radar observations to calibrate national weather radar networks, provided that the spaceborne radar maintains a high calibration accuracy.

References

Hou, A. Y., and Coauthors: The Global Precipitation Measurement mission. Bull. Amer. Meteor. Soc., 95, 701–722, 2014.

Louf, V., A. Protat, C. Jakob, R. A. Warren, S. Rauniyar, W. A. Petersen, D. B. Wolff, and S. Collis: An integrated approach to weather radar calibration and monitoring using ground clutter and satellite comparisons. J. Atmos. Oceanic Tech., 36, 17-39, 2019.

Protat, A., V. Louf, J. Soderholm, J. Brook, and W. Ponsonby: Three-way radar calibration consistency check using ground-based and spaceborne radars. Atmos. Meas. Tech., 15, 915–926, 2022. (P22)

Protat, A. and I. McRobert: Three-dimensional wind profiles using a stabilized shipborne cloud radar in wind profiler mode. Atmos. Meas. Tech., 13, 3609–3620, 2020.

Schwaller, M. R., and K. R. Morris: A ground validation network for the Global Precipitation Measurement mission. J. Atmos. Oceanic Technol., 28, 301–319, 2011.

Simpson, J., C. Kummerow, W.-K. Tao, and R. F. Adler: On the Tropical Rainfall Measuring Mission (TRMM). Meteor. Atmos. Phys., 60, 19–36, 1996.

Warren, R. A., A. Protat, V. Louf, S. T. Siems, M. J. Manton, H. A. Ramsay, and T. Kane: Calibrating ground-based radars against TRMM and GPM. J. Atmos. Oceanic Tech., 35, 323-346, 2018.

JPSS-2 VIIRS Pre-Launch Polarization Sensitivity Assessment

By David Moyer (The Aerospace Corporation), Jeff McIntire (SSAI) and Xiaoxiong Xiong (NASA)

Introduction

The Visible Infrared Imaging Radiometer Suite (VIIRS) is a cross-track scanning instrument in a low Earth orbit aboard the Suomi National Polar-orbiting Partnership (S-NPP), National Oceanic and Atmospheric Administration 20 (NOAA-20) or Joint Polar Satellite System (JPSS-1), and JPSS-2 spacecraft with launch dates of October 2011, November 2017 and November 2022, respectively [1]. VIIRS provides calibrated top-of-atmosphere (TOA) reflectance, brightness temperature and radiance products for weather and climate applications. The VIIRS Sensor Data Records (SDRs) radiance and reflectance are key inputs into the Environmental Data Record (EDR) algorithms for ocean, land and atmospheric products and their calibration is based on unpolarized at-aperture radiance [2]. However, VIIRS scenes can have significant polarization in their at-aperture radiance from Rayleigh scatter in the atmosphere or specular reflection off the ocean. This requires not only the VIIRS polarization sensitivity to be minimized but also well characterized for EDR product performance purposes. Therefore, the VIIRS instrument polarization sensitivity is characterized and is required to be a small fraction (2-3%) of the total at-aperture radiance. The JPSS-2 VIIRS polarization sensitivity results and a brief comparison with S-NPP and NOAA-20 (JPSS-1) is discussed below [3].

Methodology

The pre-launch JPSS-2 VIIRS polarization testing data was collected at Raytheon Intelligence and Space in El Segundo, California and used the Polarization Test Source Assembly (PTSA) is the Ground Support Equipment (GSE) used as the external source. The PTSA contains a 100 cm Spherical Integration Source (SIS) that provides wide field-of-view unpolarized illumination with adjustable intensity combined with a polarization sheet between it and the VIIRS sensor. A rotation stage rotates the polarization sheets 360° in 15° increments for a total of 25 separate VIIRS measurements to allow the VIIRS polarization sensitivity modulation to be characterized using:

$$dn(b,d,ms,\theta) = \frac{1}{2}\,a_0 + a_2\cos 2\varphi + b_2\sin 2\varphi \;\ldots\ldots (1)$$

where the dn is the offset corrected

doi: 10.25923/yd9k-8370

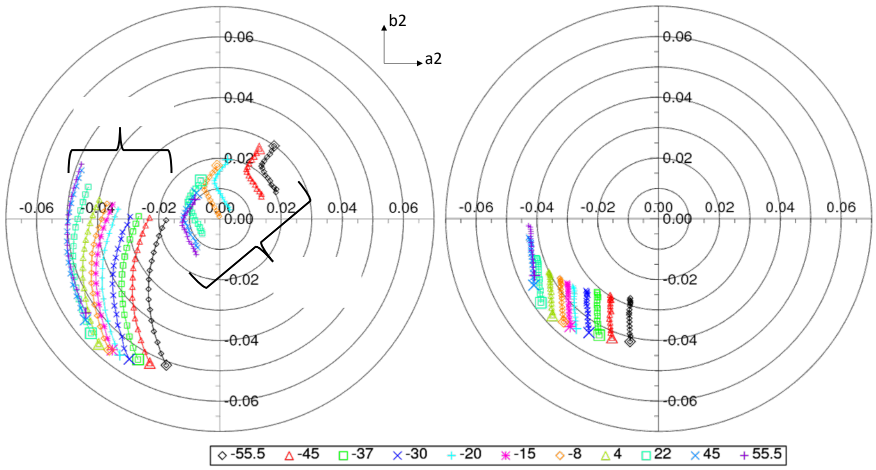


Figure 1. Band M1 polarization sensitivity polar plots for each scan angle (colors), detectors (symbols), and sensor builds (S-NPP and NOAA-20 on the left and JPSS-2 on the right).

VIIRS response to the PTSA for each band (*b*), detector (*d*), half-angle mirror side (*ms*) and VIIRS scan angle (θ). The $\frac{1}{2}\, a_0$ represents the average VIIRS signal during the PTSA sheet rotation (or DC offset of the measurements), the a_2 and b_2 are amplitudes of the cosine and sine terms of the VIIRS signal modulation as a function of φ which corresponds to the PTSA sheet polarization angle. The VIIRS polarization amplitude (PA), with requirements between 2-3%, and phase (β) are computed using:

$$PA = \frac{2\sqrt{a_2^2 + b_2^2}}{a_0} \quad \ldots\ldots(2)$$

$$\beta = \frac{atan2\,\frac{b_2}{a_2}}{2} \quad \ldots\ldots(3)$$

Results

The PA and β can be visualized using polar plots to compare the polarization sensitivity behavior between detector, scan angles and different VIIRS builds. Figure 1 is an example of a polar plot for band M1 with the x- and y-axis corresponding to the a_2 and b_2 terms in equation (1), respectively. From the origin of the polar plot, a vector can be used to evaluate the PA (magnitude of this vector) and β (half of the angle of the vector with respect to the positive x-axis). There are multiple colors on the polar plot that correspond to each unique scan angle. There are 16-line connected symbols within each color corresponding to each detector of the band of interest. Detector 1 (in instrument order) has a larger symbol to identify the detector order of the points on a connected line. The three VIIRS sensor builds are shown for band M1 with S-NPP having the smallest and NOAA-20 the largest PA and JPSS-2 (on the right) having improved but large PA values.

The reason for the largest differences in PA and β between the sensor builds is due to changes in the optical design and dichroic beam splitter #1 performance variation. S-NPP VIIRS had optical crosstalk and out-of-band spectral response in the VNIR bands that was not related to its polarization sensitivity performance that met requirements [4]. A modification to the VNIR bandpass filters was performed to remove the optical crosstalk and reduce the out-of-band response for NOAA-20 VIIRS. Unfortunately, an unexpected result of the VNIR bandpass changes caused the polarization sensitivity of NOAA-20 VIIRS to exceed requirements. Further changes to the bandpass filters for bands M1-M4 was done for the JPSS-2 VIIRS build to remove these polarization effects. The JPSS-2 VIIRS polarization sensitivity was reduced below the requirements for bands M2-M4, but the band M1 polarization remained high (as seen in figure 1).

This was found to be the result of high polarization sensitivity in dichroic beam splitter #1 driving the high PA values. This high dichroic polarization has been corrected for JPSS-3 and -4 sensor builds and will improve the polarization sensitivity to be like the S-NPP build. Table 1 lists the JPSS-2 VIIRS polarization sensitivity for all VNIR bands, scan angles, and half-angle mirror sides A and B. All the bands are below their 2-3% requirements except band M1

doi: 10.25923/yd9k-8370

Conclusions

The polarization sensitivities for JPSS-2 were smaller than the JPSS-1 VIIRS, but band M1's amplitude value of 4.8% still exceeds the sensor's maximum amplitude requirement of 3%. The cause of the band M1 polarization amplitude failure is due to a large polarization contribution from dichroic #1. The scan angle dependence is consistent between JPSS-1 and -2, but the amplitude and phase consistently decreased in detector-to-detector spread, for most bands, on the JPSS-2 VIIRS sensor compared to JPSS-1. The polarization sensitivity characterization was below the 0.5% requirement for all bands with the spectral effects being the largest contributor to the uncertainty. This indicates that the polarization sensitivity values will accurately remove polarization effects on the TOA radiance for JPSS-2 VIIRS. The pre-launch sensor characterization of the polarization sensitivity plays a major role in the performance of these EDRs. The low polarization amplitude and measurement uncertainties (< 0.5%) in JPSS-2 VIIRS reduces the striping and radiometric biases that would be present due to the top-of-atmosphere partially polarized radiance. With S-NPP, NOAA-20, and JPSS-2 VIIRS all having different polarization sensitivities, intercomparison of ocean color EDRs will be more consistent with each sensor applying unique polarization sensitivity corrections based on pre-launch measurements.

		Band								
	Scan Angle	M1	M2	M3	M4	M5	M6	M7	I1	I2
HAM A	-55	4.224	1.730	1.138	0.886	1.601	1.447	1.077	0.801	1.140
	-45	4.252	1.518	1.008	0.943	1.596	1.201	0.964	0.798	1.032
	-37	4.325	1.440	0.968	0.950	1.578	1.053	0.882	0.813	0.967
	-30	4.419	1.383	0.933	1.030	1.598	0.961	0.850	0.835	1.022
	-20	4.591	1.307	0.883	1.083	1.565	0.898	0.900	0.842	1.101
	-15	4.640	1.333	0.900	1.114	1.576	0.879	0.936	0.858	1.140
	-8	4.728	1.304	0.911	1.134	1.529	0.847	0.974	0.855	1.178
	4	4.815	1.329	1.026	1.149	1.525	0.845	1.036	0.862	1.255
	22	4.845	1.503	1.144	1.149	1.542	0.855	1.112	0.868	1.332
	45	4.723	1.701	1.274	1.123	1.520	0.860	1.196	0.875	1.408
	55	4.530	1.774	1.326	1.068	1.493	0.856	1.233	0.866	1.445
HAM B	-55	4.152	1.635	1.079	0.848	1.588	1.492	0.998	0.811	1.052
	-45	4.204	1.455	0.971	0.922	1.573	1.239	0.911	0.794	0.978
	-37	4.301	1.387	0.942	0.937	1.544	1.080	0.848	0.801	0.928
	-30	4.394	1.347	0.912	1.019	1.573	0.985	0.833	0.822	1.004
	-20	4.521	1.286	0.871	1.067	1.546	0.908	0.900	0.830	1.098
	-15	4.590	1.305	0.889	1.118	1.550	0.885	0.938	0.846	1.141
	-8	4.645	1.286	0.902	1.124	1.509	0.850	0.982	0.841	1.185
	4	4.727	1.305	1.012	1.144	1.511	0.838	1.050	0.850	1.269
	22	4.758	1.461	1.122	1.150	1.521	0.838	1.128	0.855	1.350
	45	4.649	1.649	1.247	1.114	1.508	0.849	1.210	0.859	1.427
	55	4.481	1.712	1.296	1.064	1.481	0.841	1.248	0.853	1.459
	-55	1.730	1.138	0.886	1.601	1.447	1.077	0.000	1.140	4.224

Table 1. JPSS-2 VIIRS polarization amplitude (*PA*) values for each VNIR band, scan angle and half-angle mirror side.

References

1 Welsch, C.; Swenson, H.; Cota, S. A.; DeLuccia, F.; Haas, J. M.; Schueler, C.; Durham, R. M.; Clement, J. E.; Ardanuy, P. E. VIIRS (Visible Infrared Imager Radiometer Suite): A Next-Generation Operational Environmental Sensor for NPOESS. Intl. Geoscience and Remote Sensing Symposium (IGARSS) 2001, doi: 10.1109/IGARSS.2001.976733

2 Cao, C.; Xiong, J.; Blonski, S.; Liu, Q.; Uprety, S.; Shao, X.; Bai, Y.; Weng, F. Suomi NPP VIIRS sensor data record verification, validation, and long-term performance monitoring, J. Geophys. Res. At-mos. 2013, 118, 11,664– 11,678, doi:10.1002/2013JD020418.

3 Moyer, D.; McIntire, J.; Oudrari, H.; De Luccia, F. JPSS-2 VIIRS polarization sensitivity comparison with Heritage VIIRS sensors. Proc. SPIE 10781, Earth Observing Missions and Sensors: Development, Implementation, and Characterization V. 2018, 107811B, https://doi.org/10.1117/12.2324801

4 Moeller, C.; McIntire, J.; Schwarting, T.; Moyer, D.; Costa, J. Suomi NPP VIIRS spectral characterization: understanding multiple RSR releases. Proc. SPIE 8510, Earth Observing Systems XVII, 85101S (15 October 2012); https://doi.org/10.1117/12.980437

doi: 10.25923/yd9k-8370

NEWS IN THIS QUARTER

Highlights of the 51st Meeting of the CEOS Working Group on Calibration and Validation

By Philippe Goryl, ESA

The 51[st] CEOS Working Group on Calibration and Validation (CEOS-WGCV) plenary took place in Tokyo Japan from 3-to-6 October 2022. It was the first face-to-face meeting (hybrid) since the COVID crisis; all participants highlighted the benefit, efficiency, and pleasure of having a face-to-face meeting that facilitate the exchange of information.

On top of the subgroup reports, the agenda addressed topics relevant to GSICS, such as Quality and Cal/Val Maturity Matrix; support to "New Space"; Fiducial Reference Measurement readiness, and the potential for an assessment framework and FRM network for top of atmosphere brightness temperature; Cal/Val for hyperspectral imaging missions; and increased coordination around SITSAT (SI Traceable Satellites) missions. An update of the recently endorsed CEOS/GSICS solar spectrum reference TSIS-1 HSRS [R1] was also presented and discussed.

A dedicated session was organised jointly with WGISS (the CEOS Working Group on Information Systems and Services) where the discussion focussed on the way of representing quality information within products or their metadata, Other key topics, in this session were the status of CEOS-ARD activities, the CEOS Interoperability Framework initiative, and CEOS common terminology.

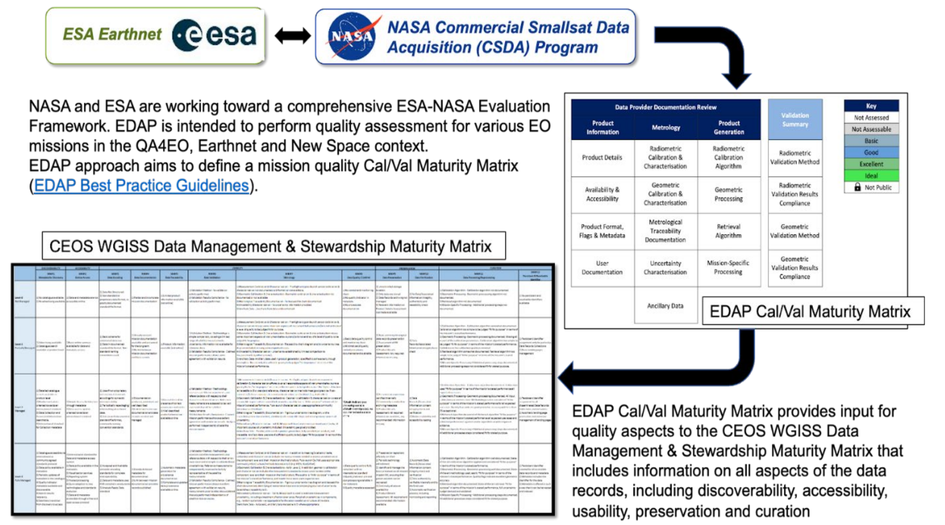


Figure 1: Roadmap for an ESA-NASA evaluation framework, EDAP Cal/Val Maturity Matrix towards the CEOS WGISS Data Management and Stewardship Maturity Matrix.

There is a clear need, expressed by various end-users including the climate community and modellers, to provide uncertainties associated with measurements – following the guidelines and recommendations from QA4EO (Quality Assurance For Earth Observation) [R2]. [R1]QA4EO's internationally agreed principles contain a suite of guidelines that provide a consistent approach across disciplines, including for fundamental data records (FDRs), thematic data products (TDPs), and fiducial reference measurements (FRMs). Recently, following the example of FIDUCEO [R3] (among others), GSICS and the CEOS WGCV progressed approaches to retrieve, calculate and derive uncertainties, using rigorous metrological processes. However, the way these uncertainties are reported per pixel remains an issue in operational environments, mainly due to the resultant product sizes. Expertise in data management from GSICS, together with CEOS WGCV/WGISS, should aim to address this issue in the very near future.

The WGCV-WGISS meeting discussed high level and synthesized representation of quality and Cal/Val information through a Cal/Val Maturity Matrix. NASA and ESA, through the NASA Commercial Smallsat Data Acquisition (CSDA) program and the ESA Earthnet Data Assessment Project (EDAP) respectively, are working toward a comprehensive evaluation framework for quality assessment for various EO missions in the New Space/smallsat context. A Cal/Val Maturity Matrix was defined to facilitate harmonisation of the assesment and reporting of QA and performance.

doi: 10.25923/yd9k-8370

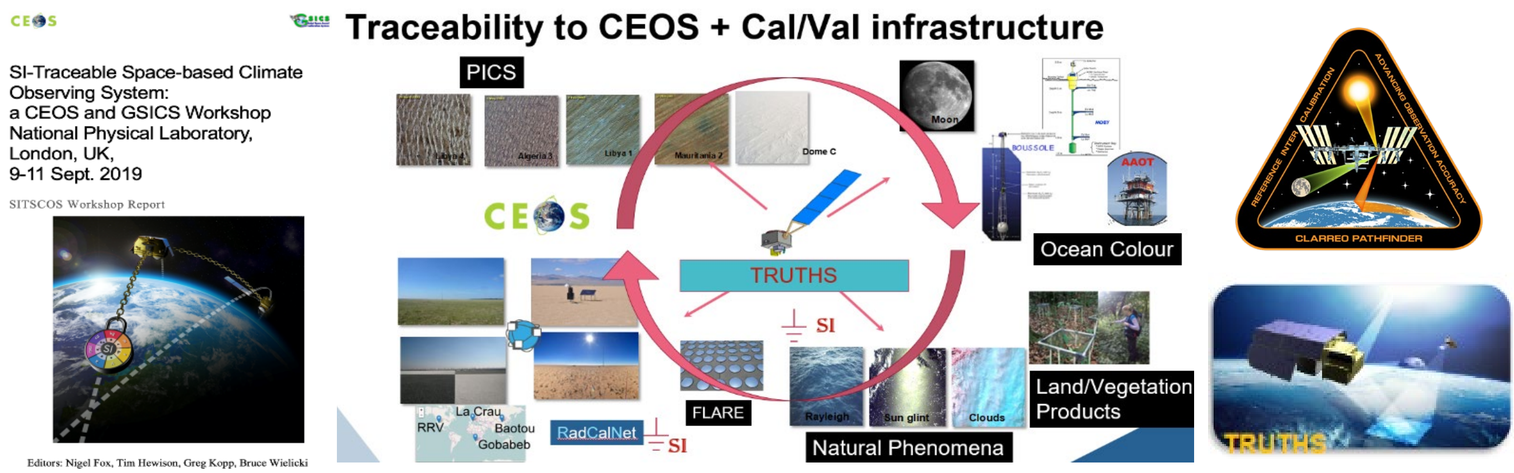


Figure 2: Traceability to CEOS, Cal/Val Infrastructure and SITSAT (courtesy Nigel Fox (NPL))

This Cal/Val Maturity Matrix then provides input for the quality aspects to the CEOS WGISS Data Management & Stewardship Maturity Matrix that includes information on all aspects of the data record, including discoverability, accessibility, usability, preservation, and curation. This approach could also be relevant for GSICS-WGCV coordination. WGCV shares with GSICS the objective of providing references on which missions, products, and measurements can be compared to inform possible calibration adjustments. It is in this respect that WGCV put into operation the RadCalNet [R4] network service to provide satellite operators with SI-traceable Top-of-Atmosphere (TOA) spectrally-resolved reflectance for post-launch radiometric calibration and validation of optical imaging sensor data. This free and open access service provides a continuously updated archive of TOA reflectance derived over a network of sites, with associated uncertainties, at a 10 nm spectral sampling interval, in the spectral range from 380 nm to 2500 nm and at 30-minute intervals. Similarly, WGCV is putting in place a reference calibration network for SAR (multi-frequency) – SARCalNet, which is an established network of calibration sites that would facilitate collaboration between sensors by using the same calibration references. SARCalNet will comprise three types of external targets used by SAR - Natural, Artificial passive and Artificial active. In addition, recently, responding to the current CEOS chair (CNES) priority, WGCV is aiming to establish a reference calibration network for thermal infrared (TIRCALNET), providing brightness temperature (BT) at the top of atmosphere for TIR calibration. The largest uncertainties and challenges are from site heterogeneity and emissivity estimates, with the instrument radiometric uncertainty being less significant. The network requirement is to provide a spectrally sampled BT at top of atmosphere to 0.5K (or top of atmosphere radiance). These reference networks are of course relevant also for GSICS, offering references for validation or (inter)calibration.

Most relevant for both groups, providing ultimate references from space, are SITSATs (SI-traceable Satellites). Highlighted during the CEOS and GSICS workshop at National Physical Laboratory, London, UK, on 9-11 Sept. 2019 [R5], there is a need to build a SI-Traceable Space-based Climate Observing System or a SITSAT virtual constellation. Relevant updates in this field was provided by the Chinese Space Based Radiometric Benchmark (CSRB) project, which was initiated after realising the importance of reference-type missions for improving climate science and harmonising global satellite observations; TRUTHS – the ESA mission with the aim of establishing a benchmark of ToA and BoA surface reflectance for climate action and mitigation, adaptation and sustainability, climate sensitivity and response; as well as the Australian initiative: the Satellite Cross-Calibration Radiometer (SCR) – a series of satellites designed to collect hyperspectral data for calibrating other remote sensing systems.WGCV is now proposing to establish a new dedicated group aimed at coordinating activities related to SITSATs and the use of SITSATs as references for (inter)calibration. Coordination with GSICS will be fundamental. In terms of WGCV communication, updates on the CEOS Cal/Val portal [R6] were presented. It was noted that In the context of GSICS Group Data –

Return to Page One

doi: 10.25923/yd9k-8370

relevant links to GSICS scripts and notebooks have been included in the Tools section, as well as the link to the RAPID tool [R7] (produced by the Satellite Application Centre (SAC), ISRO in collaboration with the India Meteorological Department (IMD)). Cooperation between the CEOS Cal/Val portal and GSICS is continuing satisfactorily.

Finally, the Joint Organisation CEOS/GSICS for the Workshop on Pre-Flight Calibration / Characterisation should resume shortly (it was on hold due to COVID travel restrictions). The workshop, which is raising increasing interest will be organised towards the end of 2023 in Europe.

References

[R1] TSIS-1 Hybrid Solar Reference Spectrum (HSRS): https://lasp.colorado.edu/lisird/data/tsis1_hsrs

[R2] QA4EO website: https://qa4eo.org/

[R3] Fiduceo website: https://research.reading.ac.uk/fiduceo/

[R4] RadCalNet website: https://www.radcalnet.org/

[R5] SITCOS Workshop: https://calvalportal.ceos.org/sitscos-ws

[R6] CEOS Cal/Val portal: https://calvalportal.ceos.org/

[R7] RAPID Tool: https://rapid.imd.gov.in/r2v/

STOP PRESS! Meteosat Third Generation-Imager 1 (MTG-I1) launched from European Space Centre in Kourou

By Tim Hewison, EUMETSAT

EUMETSAT is pleased to announce the successful launch of the geostationary satellite, MTG-I1, on one of the last Ariane-5 rockets at 21:30 CET on 13 December 2023. MTG-I1 – full name Meteosat Third Generation – Imager 1 – is the first of a new generation of meteorological satellites carrying the Flexible Combined Imager and Lightning Imager, which will greatly enhance monitoring and forecasting severe weather events over Europe and Africa such as storms, lightning, fog and wildfires. As soon as data is received in early 2023, a 12-month commissioning phase will begin, in which its instruments will be calibrated and the data they produce validated, before becoming operational as Meteosat-12.

Announcements

GSICS Annual Meeting to be held 27 Feb 2023 – 3 March 2023 in hybrid mode

By Lawrence E Flynn, NOAA

The GSICS Annual Meeting 2023 will be held in a hybrid mode via the web and in-person at the NCWCP in College Park, MD, USA from 27 Feb to 3 March 2023. Details (e.g., subgroup agendas) on the meeting will be placed at http://gsics.atmos.umd.edu/bin/view/Development/Gsicsannualmeeting2023.

The meeting will have the following sessions.

1. Mini-Conference: A session on upcoming topics on Satellite Calibration and Inter-calibration (Contact: fangfang.yu (AT) noaa.gov)
2. Plenary: A session on Agency Reports. (Contact: fangfang.yu (AT) noaa.gov)
3. Breakout Session contacts for each subgroup:
   - Infrared: Likun Wang (Chair/Contact: likun.wang (AT) noaa.gov)
   - UVN Spetrometer: Larry Flynn (Vice-Chair/Contact: lawrence.e.flynn (AT) noaa.gov)
   - Microwave: Quanhua Liu/ Qifeng Lu (Co-Chair/Contact: quanhua.liu (AT) noaa.gov)
   - Visible and Near Infrared: General -- Dave Doelling (Chair/Contact: David.R.Doelling (AT) nasa.gov), Lunar -- Tom Stone (tstone (AT) usgs.gov)
   - Space Weather Subgroup: TBD but contact the GCC to be in on the planning.
4. GSICS Data Working Group Breakout Session: Kamaljit Ray (Chair/Contact: kamal.ray (AT) imd.gov.in)
5. Cross-cutting: A session on Interdisciplinary topics (Contact: lawrence.e.flynn (AT) noaa.gov)

Please indicate to the GRWG Chair (Fangfang Yu), GCC (Larry Flynn/Manik Bali) or GDWG (Kamaljit Ray/Manik), if you want to propose a topic for the opening or closing sessions or mini conference.

Contact the GCC (Lawrence.e.flynn (AT) noaa.gov) if you want an invitation letter to attend the meeting in person.

GSICS-Related Publications

Chen, Hongtao, and Li Guan. 2022. 'Assessing FY-3E HIRAS-II Radiance Accuracy Using AHI and MERSI-LL'. *REMOTE SENSING* 14 (17). https://doi.org/10.3390/rs14174309..

Chen, Jun, Na Xu, Xianqiang He, Wenting Quan, Qingyin He, Qijin Han, and Delu Pan. 2022. 'Determining Pseudo-Invariant Calibration Sites for Comparing Inter-Mission Ocean Color Data'. *ISPRS JOURNAL OF PHOTOGRAMMETRY AND REMOTE SENSING* 192 (October): 377–94. https://doi.org/10.1016/j.isprsjprs.2022.08.004..

Guo, Biyun, Yingchun Fu, Deyong Hu, Guo Zhang, and Xinyu Wang. 2022. 'Intercalibration of Luojia1-01 and Suomi-NPP-VIIRS Monthly Nighttime Light Composite Using a Spatial-Temporal Residuals Correction Random Forest Model'. *IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING* 15: 7712–23. https://doi.org/10.1109/JSTARS.2022.3204545.

Mears, Carl, Tong Lee, Lucrezia Ricciardulli, Xiaochun Wang, and Frank Wentz. 2022. 'Improving the Accuracy of the Cross-Calibrated Multi-Platform (CCMP) Ocean Vector Winds'. *REMOTE SENSING* 14 (17). https://doi.org/10.3390/rs14174230.

Miyoshi, Y., I. Shinohara, S. Ukhorskiy, S. G. Claudepierre, T. Mitani, T. Takashima, T. Hori, et al. 2022. 'Collaborative Research Activities of the Arase and Van Allen Probes'. *Space Science Reviews* 218 (5): 38. https://doi.org/10.1007/s11214-022-00885-4.

Pignalberi, Alessio, Michael Pezzopane, Igino Coco, Mirko Piersanti, Fabio Giannattasio, Paola De Michelis, Roberta Tozzi, and Giuseppe Consolini. 2022. 'Inter-Calibration and Statistical Validation of Topside Ionosphere Electron Density Observations Made by CSES-01 Mission'. *REMOTE SENSING* 14 (18). https://doi.org/10.3390/rs14184679.

Saunier, Sebastien, Bringfried Pflug, Italo Moletto Lobos, Belen Franch, Jerome Louis, Raquel De Los Reyes, Vincent Debaecker, et al. 2022. 'Sen2Like: Paving the Way towards Harmonization and Fusion of Optical Data'. *REMOTE SENSING* 14 (16). https://doi.org/10.3390/rs14163855

Yamamoto, Munehisa K., and Takuji Kubota. 2022. 'Implementation of a Rainfall Normalization Module for GSMaP Microwave Imagers and Sounders'. *REMOTE SENSING* 14 (18). https://doi.org/10.3390/rs14184445.

Submitting Articles to the 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 / validation capabilities and how they have been used to positively impact weather and climate products. Unsolicited articles may be submitted for consideration anytime, and if accepted, will be published in the next available newsletter issue after approval / editing. Please send articles to manik.bali@noaa.gov.

With Help from our friends:

The GSICS Quarterly Editor would like to thank Sri Harsha Madhavan (SSAI), Ingrid Guch (The Aerospace Corporation), Manik Bali (UMD), Tim Hewison (EUMETSAT), Quanhua (Mark) Liu and Lawrence E. Flynn (NOAA) for reviewing articles in this issue.

doi: 10.25923/yd9k-8370

GSICS Newsletter Editorial Board

Manik Bali, Editor
Lawrence E. Flynn, Reviewer
Lori K. Brown, Tech Support
Fangfang Yu, US Correspondent.
Tim Hewison, European Correspondent
Yuan Li, Asian Correspondent

Published By

GSICS Coordination Center
NOAA/NESDIS/STAR NOAA
Center for Weather and Climate Prediction,
5830 University Research Court
College Park, MD 20740, USA

Disclaimer: The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the authors and do not necessarily reflect the views of NOAA or the Department of Commerce or other GSICS member agencies.