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Newsletter– Fall 2015 Issue

Manik Bali Editor

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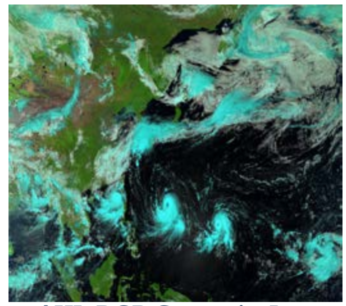
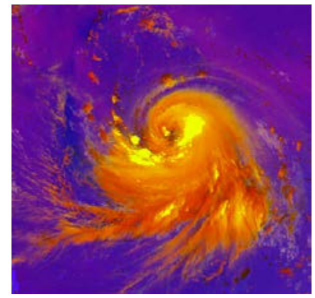
Himawari-8



AHI- RGB Composite Image



AHI- Day convective storm

Post-launch calibration of Himawari-8/AHI

By Arata Okuyama and Masaya Takahashi, JMA

The next-generation geostationary meteorological satellite of the Japan Meteorological Agency (JMA), Himawari-8, started operations on 7 July 2015. Himawari-8 features the new Advanced Himawari Imager (AHI), whose observation capability is better than that of its predecessor MTSAT-series satellites. The hardware configuration of the AHI is similar to that of the Advanced Baseline Imager (ABI) planned for the GOES-R satellite (Schmit et. al, 2005 and Schmit, 2008).

The AHI carries 16 observation bands covering visible, near- and short-wave infrared and thermal infrared spectra. The AHI produces full-disk imagery every 10 minutes, and rapid scanning at 2.5-minute intervals is also conducted. The AHI can observe specific regions every 30 seconds for landmark analysis. By utilizing this function, the AHI can receive the moon imagery twenty times in the 10 minutes observing cycle, which is expected to support more precise calibration and validation. This study reports on the current data quality, especially concerning the radiometric calibration for the AHI. This report is based on data from the commissioning period. There is room for data quality improvement in the future.

For calibration of observation data, AHI has a blackbody as an internal calibration target and a solar diffuser as a solar calibration target. Using these targets, calibration coefficients, slope and offset, are derived to enable conversion of raw data counts from detector samples into radiances.

An infrared on-orbit calibration approach developed under the GSICS project involves the use of hyper-spectral infrared sounders such as the Infrared Atmospheric Sounding Interferometer (IASI) on board EUMETSAT's Metop

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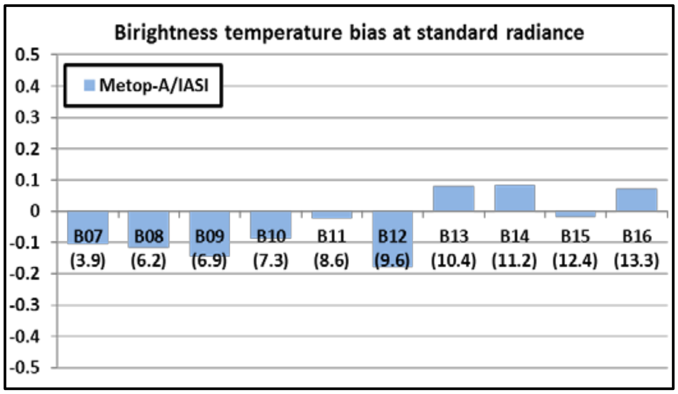

Figure 1. Brightness temperature biases at the standard radiance for 16 May to 15 June 2015.

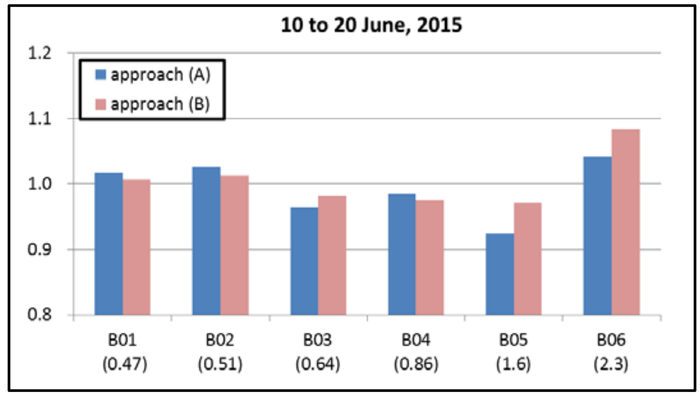

Figure 2. Estimated calibration coefficients (slopes) of bands 1 to 6 based on validation approaches A) and B) for 11 to 20 June 2015. The slopes are defined as Reference radiance / Observed radiance. A value of greater than 1 means that the reference is lower than the observation, and vice versa.

Satellites and the Atmospheric InfraRed Sounder (AIRS) on board NASA's Aqua satellite (Gunshor et al 2006, Tobin et al., 2009, Hewison et al, 2013). Figure 1 shows the brightness temperature (Tb) biases for each band at a standard radiance, which is defined as the Tb of a typical observation scene and computed using the RTTOV 11.2 radiative transfer model with conditions of clear-sky ocean at nighttime and at nadir with the US standard atmosphere 1976. With the Metop-A/IASI, both ascending- and descending-orbit data are utilized. Only ascending night-time orbit data are utilized for band 7 to avoid the effect from solar reflection. The biases are within 0.2 K for all the infrared bands. This approach is also effective in investigating the time dependency of the Tb bias. Some of the MTSAT-2 infrared bands, especially the 12.0 µm band, tend to experience increased bias at nighttime around the eclipse season. By way of example, the estimated bias of the MTSAT-2 12.0 µm band at the standard radiance during the eclipse season is up to 0.5 K at night and less than 0.05 K during the day. Apart from this, there is no significant diurnal variation for Himawari-8/AHI.

A calibration method for visible bands is under investigation within the GSICS framework. JMA has also developed the following approaches for visible and near-infrared vicarious calibration in addition to the solar diffuser:

A) Ray-matching with reference to S-NPP/VIIRS;
B) Comparison with simulated radiance based on a radiative transfer model;
C) Comparison with deep convective cloud measurement by Aqua/MODIS, and;
D) Comparison with the simulated lunar irradiance.

In approach A), S-NPP/VIIRS measurements are utilized for reference. VIIRS SRFs are similar to AHI SRFs, especially for near-infrared bands. Collocation datasets of VIIRS and AHI with similar geometric conditions and observation times are created, and both sets of measurements are compared. SRF differences are considered on the basis of radiative transfer computation results and information from Spectral Band Adjustment Factors (SBAF) database developed by NASA, which is available on the web page (see here). Approaches B), C) and D) were introduced in the past GSICS Quarterly (Takahashi and Okuyama, 2014). Figure 2 shows estimated correction coefficients (slopes) for visible and near-infrared bands based on approaches A) and B). The slope represents the ratio between observation and the reference (reference / observation); with a value of 1 indicating that the observation radiance is equal to the reference value. A value less than 1 means that the reference is lower than the observation, and vice versa. The coefficients estimated by using both approaches are consistent for bands 1 to 4, but there is a discrepancy of approximately 5% for bands 5 and 6. Additional study is needed to investigate the cause of this. Further investigations are described in (Okuyama et. al., 2015), e.g. image navigation accuracy is estimated less than 1km. Stripe and coherent noise still remain in images. Efforts to improve image quality are ongoing. The imager's enhanced observation capability is expected to provide a greater wealth of information, including spatially finer images, temporally rich content such as animation of developing weather conditions and physical products. This is expected to contribute to advanced nowcasting services and short-range weather forecasting systems.

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Discuss the Article

Improved FY-2D SVISSR onboard IR calibration models using GSICS inter-calibrated radiances

By Yong Zhang, Zhiguo Ron and, Xiuqing Hu, NSMC/CMA

Introduction

FY-2D is the fourth satellite of the FY-2 satellite series. With the launch of FY-2D, the Chinese geostationary meteorological satellite observing system has new capabilities for re-programming during the flood season to provide 15-minute full disc images in tandem with FY-2C. This greatly improves the timeliness of satellite generated cloud images. FY-2D carries the 5-channel Stretched Visible Infrared Spin Scanning Radiometer (SVSSR) imager initially providing either nominal half-hourly full disc images during flood season or hourly full disc images. The SVISSR consists of one visible channel with a 1 km nominal field of view (FOV) and four infrared (IR) channels (two split window channels, one water vapor channel and one mid-infrared channel) with 5 km FOVs at nadir.

Prelaunch calibration of FY-2D

Extensive prelaunch calibration and characterization measurements were made using a ground-based black body calibration source (BCS) of FY-2D IR channels. It was performed at various temperature intervals, which were referred to as cold, nominal, and hot plateaus, and at different CFPA temperatures. Nine different temperature measurements of the key optics were made at the CFPA temperature set at 93.5 K and 100.3 K. During thermal vacuum chamber radiometric sensor calibration, the BCS temperatures were varied from 180 to 340 K to measure detector noise, dynamic range, and nonlinearity characterization of the IR channels. The onboard blackbody was maintained at 288K and inserted into the main optics twice during each calibration cycle to obtain the environmental calibration coefficients

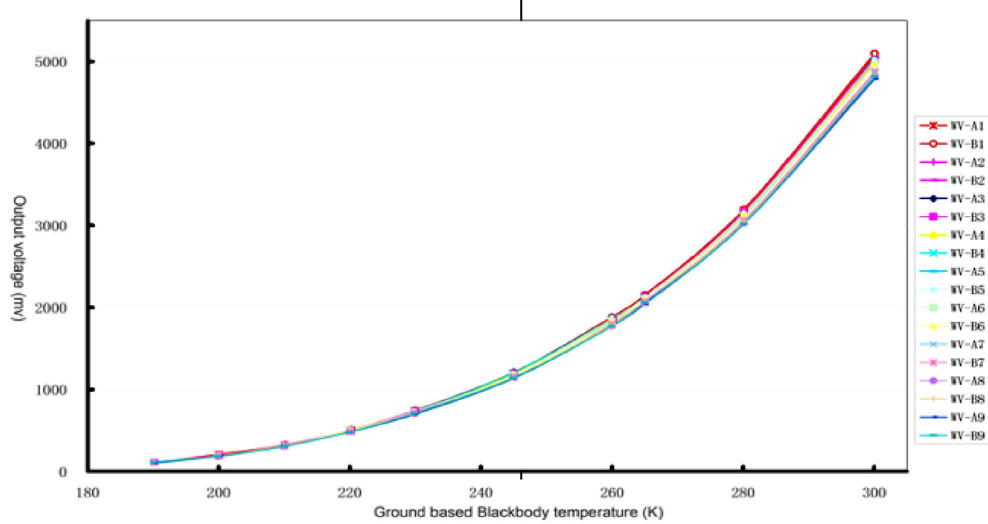

Figure 1. Prelaunch calibration curves of FY-2D water vapor channel. The colored lines represent different calibration cycles, totally 9 temperature groups.

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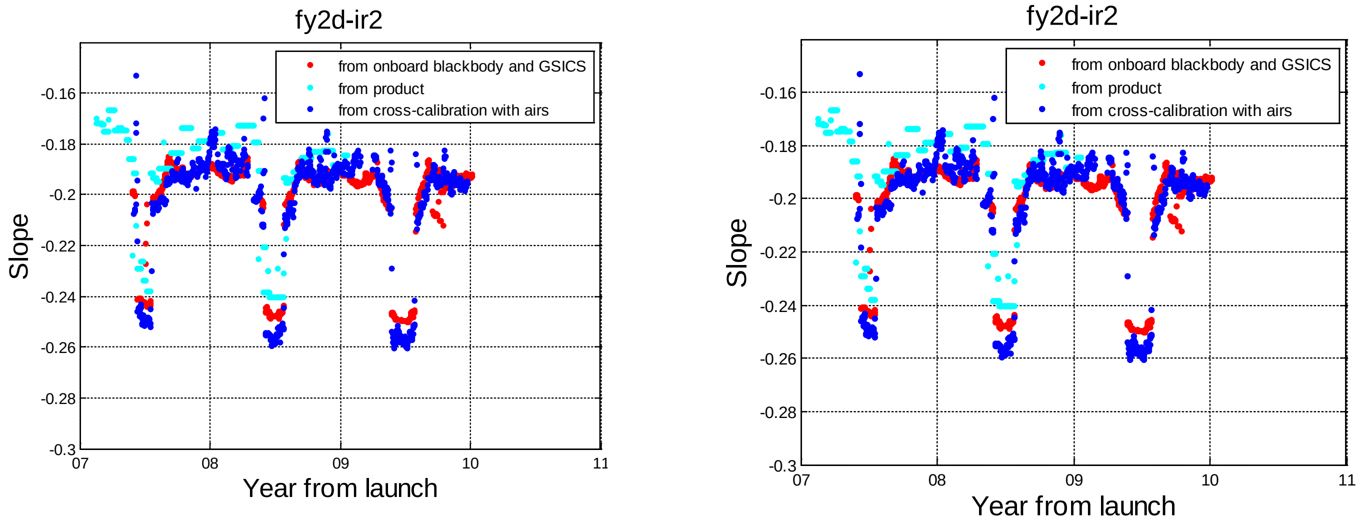

Figure 2. Comparisons of the calibration SLOPE between the onboard calibration models (red dots), cross calibration with AIRS (blue dots) and operational calibration coefficient in product (cyan dots)

during vacuum chamber calibrations. The prelaunch calibrations were mainly focused to quantify the ground based BCS temperature with the sensor output voltage. 2nd order polynomial regression was used to compute the prelaunch calibration coefficients for FY-2D. Figure 1 shows the water vapor channel regressions as a function of different calibration cycles.

Onboard blackbody calibration models

FY-2D SVISSR doesn't have onboard blackbody calibration covering the full optics, which include the fore, aft and calibration-optics. During the earth and space views, the optical path consists of the fore and aft-optics to reach the sensor. During the blackbody view, the optical path is comprised of the calibration and aft-optics. This optical path difference may cause a calibration bias. The calibration bias is dependent on fore optics radiance contribution. During FY2D and AIRS/IASI coincident inter-calibration events, the GSICS predicted FY2D at sensor radiance can be used to estimate the fore optics radiance contribution

The key optic components in the fore- and calibration-optics, include the primary mirror, secondary mirror, transition mirror and calibration plane mirror. All of the mirrors contribute to the total radiance signal in the main optics. From telemetry data, the real-time measured temperatures of these mirrors in the fore and calibration optics can be characterized by size, solid angle, transmittance, reflectance, emissivity and other factors related to the fabricants. So, the radiance contribution of each of the mirrors in the fore-optics can be calculated from these characterization factors and temperatures based on telemetry. Then the fore-optics radiation can be simulated from the contributions of the mirrors and the background radiation of the instrument. According to the temperature data obtained from telemetry, the channel radiances of each mirror can be calculated by the Planck function and the spectral response function.

Table 1. Onboard blackbody calibration models coefficients of FY-2D SVISSR IR1 & IR2

Coefficients	Primary mirror		Secondary mirror		Transition mirror		Constants	
	IR1	IR2	IR1	IR2	IR1	IR2	IR1	IR2
93.5K stable period	-185.75	-317.40	110.62	109.95	13.69	19.29	-161.36	-192.64
100.3K stable period	49.04	-113.76	36.70	41.45	0.74	3.41	-73.09	-89.63
Transition period	-31.34	-13.14	50.23	44.42	-11.28	-11.77	-39.96	-45.84

An onboard blackbody calibration fore-optics correction model was calculated using the GSICS-predicted at-sensor radiance and the radiance contributions from the mirrors by multiple linear regressions. The calibration model can be expressed as:

$$R_f(j) = \sum_{i=1}^{n} a_j(i) R_j(i) + c$$

Where $R_j(i)$ and R_f are the radiance of each mirror calculated to the end of fore optics and the fore optics radiation contribution, respectively, a_i are coefficients of each mirror, and c is a constant. R_f can be obtained from the GSICS inter-calibration events, i, and j denotes different channels and mirrors separately.

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According to the seasonal variability of the FY-2D SVISSR CFPA temperatures, the onboard blackbody calibration models are divided into three phases: CFPA temperature stable at 93.5K, 100.3K and transition periods. Table 1 lists the primary mirror, secondary mirror and transition mirror model coefficients. The historical FY-2D SVISSR satellite data from the early 2007 to the end of 2009 were recalibrated using these models. Figure 2 shows the calibration slope comparison between the onboard calibration models using Table 1, cross-calibration with AIRS and the operational calibration used in the product. From figure 2, we can find that the calibration results from the models and cross calibration with AIRS were better than operational calibration results in product and the calibration models were similar to the cross calibration with AIRS, but the frequency of calibrations with blackbody models were much higher than cross calibration with AIRS.

Summary and Discussions

In this paper, we focused on the operational calibration of the satellite FY-2D IR channels. The FY-2D prelaunch calibration methodology was introduced and the results were analyzed. FY-2D SVISSR does not have onboard blackbody calibration for the full optics. Therefore an onboard blackbody calibration methodology was outlined step by step to determine an onboard calibration model. The model coefficients were determined from the GSCIS inter-calibration results. The historical FY-2D satellite data were also recalibrated with these models.

The onboard blackbody calibration models of FY-2D SVISSR based on GSICS can be used to calibrate the satellite infrared data operationally. The blackbody calibration models can be improved by including model sensitive analysis, piecewise regression analysis, modeling as a function of historical data time range, model assumptions, and model validations. All in all, for FY-2D and other FengYun satellites, the on-orbit radiometric calibration after launch is a challenging task. Well-calibrated infrared data are significant for expanding the applied areas of FengYun series satellites data.

Acknowledgment

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Discuss the Article

Fast Radiative Transfer Model for hyperspectral Meteor-M data simulation

By E. Rusin, V. Pyatkin (Siberian Branch of Russian Academy of Sciences), A. Kozlov, A. Rublev, A.Uspensky, (Roshydromet), A. Polyakov, Ya. Virolainen, Yu. Timofeyev (Saint Petersburg State University)

The development of a fast and accurate radiative transfer model is required for simulating and analysis of the high-resolution radiances measured by the hyperspectral IR sounder IRFS-2 (Infrared Fourier Spectrometer-2) onboard Russian meteorological satellite Meteor-M №2. This model is designed for satellite data “inversion” and retrieval of various atmospheric parameters (Rodgers, 2000) as well as for assimilation of the radiance data into a numerical weather prediction (NWP) system (Saunders et al., 1999).

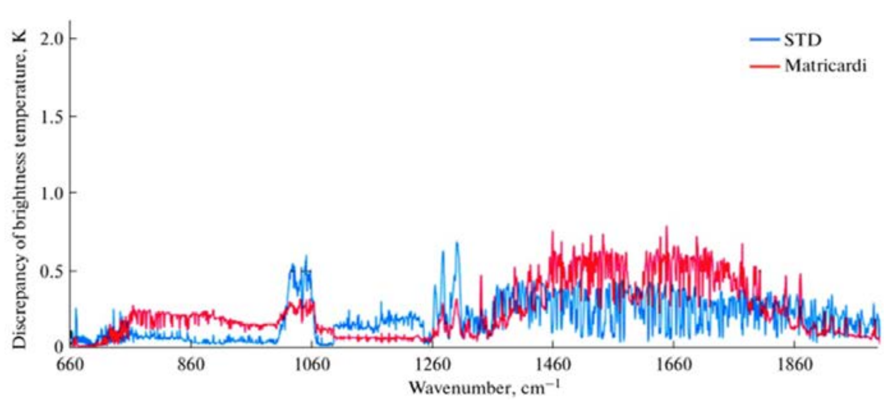

Figure 1. Comparison of the IRFS-2 spectra modeling results using FRTM/IRFS and LBLRTM 2015

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There are many well-known software packages focused on the IR sounders, for example, for IASI, AIRS and CrIS instruments (Uspensky et al., 2014). Such packages, called FRTM in general (RTTOV, RTIASI, SARTA), are based on the parameterization of line-by-line (LBL) radiative transfer (RT) calculations for the flat parallel and cloudless atmosphere. Spectroscopic database HITRAN is used in LBL calculations.

The hyperspectral IR-sounder IRFS-2/Meteor-M measures the IR radiance spectra (2701 channels in the range 667–2000 cm^{-1} or 5.0–15.0 μm). One spectrum is measured in 0.7 s (Golovin et al., 2014). This value poses a strong limitation to the FRTM performance: the measured signal in one channel should be calculated in a few milliseconds. In order to keep up with this requirement there should be either simple analytical approximations or interpolation schemes used.

The main objective of FRTMs like RTTOV, RTIASI, SARTA is to perform fast and accurate calculations of outgoing radiance spectra, R, measured at the top of the atmosphere given atmospheric state vector x: R = H(x), where H is the radiative transfer equation operator. The components of the vector x are temperature profiles, T(p), water vapor and ozone mixture ratio profiles, q(p) and Q(p), as well as surface temperature and emissivity, Ts and ε, together with near-surface temperature and humidity, T_a and q_a. The T(p), q(p) and Q(p) values should be specified at the fixed pressure grid, $\{p_i\}$.

The RTTOV software package provides simulation of measurements for various types of satellite instruments, such as IR sounders AIRS, IASI and CrIS. Along with this the RTTOV can be used to calculate various parameters like optical depth, transmittances, Jacobians etc. In order to adapt the FRTM RTTOV to the IRFS-2 data simulation, we need to use the predefined set of atmospheric models, to perform off-line LBL RT computations and in the end to generate internal RTTOV regression coefficients to reconstruct synthetic IRFS-2 radiances for any input atmospheric model. The objective of such FRTM adaptation is to provide fast and accurate modeling of IRFS-2 measured spectra with errors less or equal to the instrumental noise. The FRTM RTTOV – 9.1 was used as a basis for this FRTM development. With LBL RT calculations (LBLRTM 11.7, January 2010) an ensemble of synthetic spectra to be measured by IRFS-2 has been generated for the representative set of diverse atmospheric models.

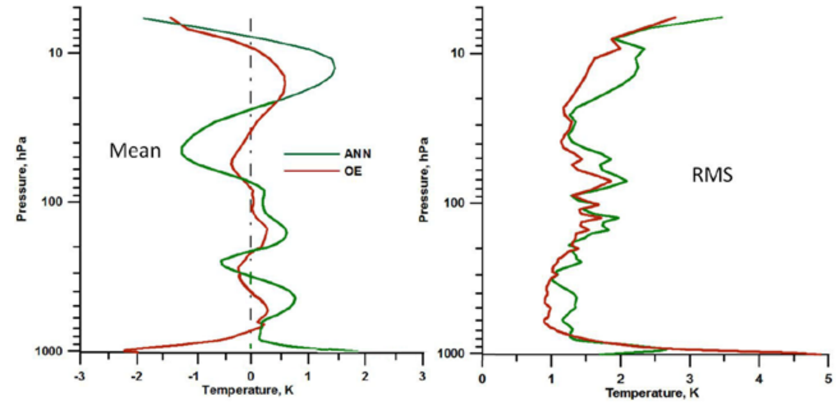

Figure 2. Comparison of retrieved temperature profiles from IRFS-2 and NCEP GFS data, August 20-22, 2015

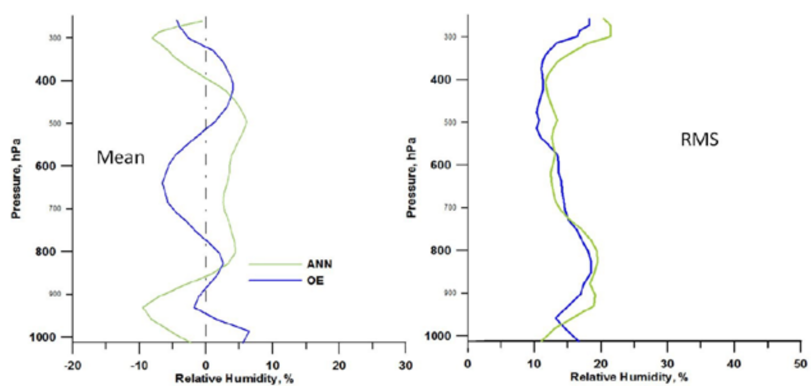

Figure 3. Comparison of retrieved humidity profiles from IRFS-2 and NCEP GFS data, August 20-22, 2015

Water vapor, carbon dioxide, ozone, nitrogen oxide, carbon monoxide, and methane were included as profile variables. A representative global set of 83 atmospheric models was applied to find regression coefficients (Matricardi, 2008). The vertical temperature profiles and the concentrations of all the absorbing gases were specified at the fixed pressure grid (101 levels). The developed FRTM/IRFS presents itself as a set of regressions for each IRFS-2 channel with profile dependent predictors similar to those of RTTOV-9. It provides a significant (30- to 200-fold) acceleration compared with the LBLRTM. For the validation and estimation of the accuracy, the spectra, calculated using the FRTM/IRFS and LBLRTM in the entire operational spectral range of IRFS-2instrument (660–2000 cm^{-1}), were compared with each other (see Figure 1).

The comparison is presented for the independent set (STD) of the standard models WCP-112, 1986, and for the aforementioned set of atmospheric models of Matricardi, 2008. As shown in Fig.1 the root-mean-square deviation mainly does not exceed 0.3 K and is always less than 0.75 K. It is important that a good coincidence of the results is observed in the CO_2 absorption band (660–750 cm^{-1}), which is the main spectral range to retrieve vertical temperature profiles. The developed FRTM/IRFS provides the opportunities to retrieve vertical profiles of atmospheric temperature and water vapour concentration. The FRTM/IRFS is built into a single executable that provides the solution of an inverse problem using the iteration procedure.

Each iteration incorporates forward model calculations of radiances and Jacobians for the corresponding guess retrieval profiles as well as a convergence criteria check. Algorithms for retrieval of the atmospheric parameters from IRFS-2 measurements can use two methods for solving inverse problem: ANN - Artificial Neural Network approach, and OE - Optimal Estimation. Bias and RMS of differences between retrieved profiles and Global Forecast System (GFS) data produced by the National Centers for Environmental Prediction (NCEP) are shown in Figure 2 in the 60° S to 60° N latitude band over the ocean. The results of comparison for relative humidity under the same conditions are presented in Figure 3 According to the preliminary estimates, the RMS of temperature difference between retrieved and NCEP GFS vertical profiles lie in range 1-3 K. For humidity profiles, it is approximately 10-15%.

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Discuss the Article

Updates to the calibration of the visible channel of the ISCCP B1U data in the production of the H-series ISCCP cloud products

By Anand K. Inamdar and Kenneth R. Knapp, NOAA

The International Satellite Cloud Climatology Project (ISCCP) B1 data, which was rescued at the National Atmospheric and Oceanic Administration's National Climatic Data Center (NOAA/NCDC) (Knapp, 2008a) has provided climate researchers with a dataset rich in climate information for the period 1978 through the present. The ISCCP B1 data represents geostationary satellite imagery for all channels including the infrared (IR), visible and IR water vapor sensors. These are global three-hourly snapshots from satellites around the world covering the time period from 1979 to present at approximately 10 km spatial resolution.

ISCCP B1 data is currently being used in the ISCCP reprocessing effort at the NOAA National Centers for Environmental Information, NCEI (formerly NCDC), Asheville, leading to the next generation (so-called H-series) of the ISCCP cloud products. The reprocessed product will result in a higher resolution ISCCP cloud climatology, improved cloud detection, cloud optical depth, precipitation, surface albedo, and surface radiation budget, etc. Among other applications, the B1 data has been successfully employed in hurricane research and precipitation monitoring in data-sparse regions. The primary common channels among the earlier GEOs were the visible (0.67 µm) and the Infrared (IR) Window (11 µm). The IR water vapor channel at 6.7 µm became available on later satellites. The IR channels have already been calibrated by ISCCP (Desormeaux et al 1993) and by Knapp (2008b), and the focus of this study is assessment of the calibration of the visible channel.

In order to retrieve accurate ISCCP cloud properties and radiative budget parameters, it is essential that all meteorological geostationary satellites be calibrated to a consistent standard. The visible sensors of all meteorological satellites are calibrated at pre-launch in the laboratory and they do not have on-board visible calibration, thus showing a decrease of sensitivity during the post-launch period. The ISCCP performs calibration of the GEO visible sensors every month by normalizing to the concurrent Advanced Very High Resolution Radiometer (AVHRR) on the afternoon NOAA polar-orbiting weather satellite at the same viewing geometry and anchored on multiple ER-2 calibration under-flights. Recently an improved and Moderate Resolution Imaging Spectroradiometer (MODIS) – compatible AVHRR visible channel calibrated Climate Data Record (CDR), in the form of the AVHRR Pathfinder Atmospheres-Extended (PATMOS-x), product (Heidinger et al. 2010) has become available at NCEI. This is one of the most inter-sensor consistent AVHRR data record similar in quality to the one used by ISCCP in its calibration and is regularly updated. The present study reports results of cross-calibration with the CDR product and comparison with the ISCCP calibration (Inamdar and Knapp, 2015), and further extends the calibration beyond the ISCCP base period (1983-2009).

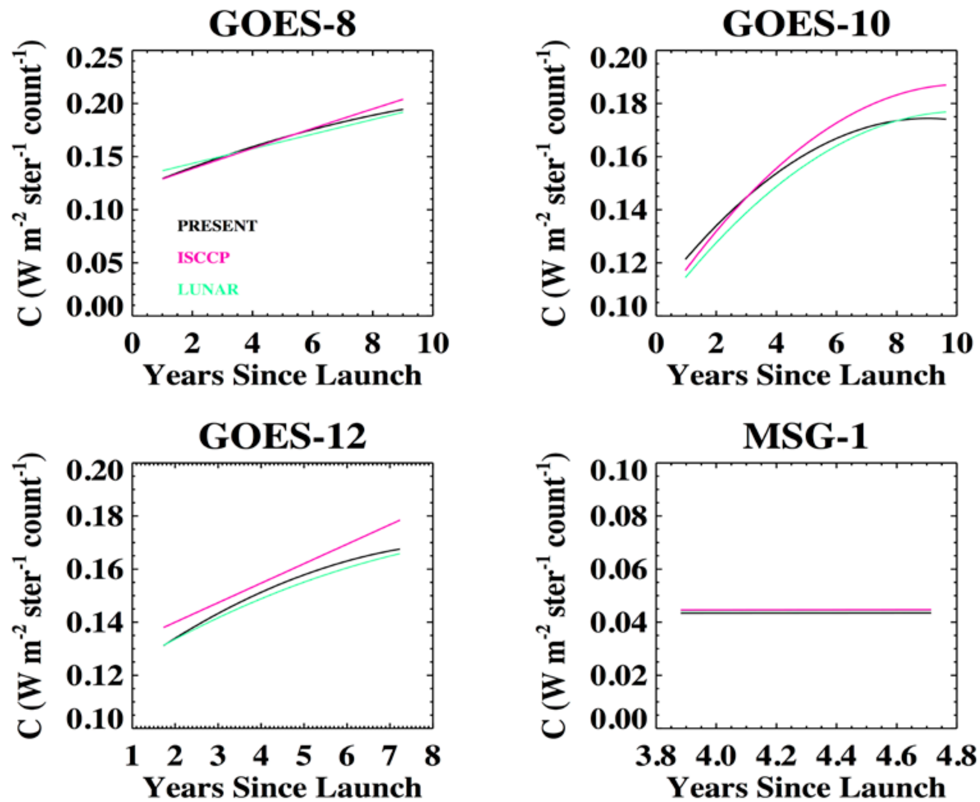

Figure. 1. Time variation of the calibration coefficient derived from ISCCP and present scheme for a sampling of satellites, with additional results from the lunar calibration overlaid for comparison.

The integrated radiance, L (W m^{-2} ster^{-1}), over the visible spectral channel is conventionally expressed in terms of the detector-measured raw counts, X, and a calibration intercept (a_0) and calibration slope (a_1) as, $L = a_0 + a_1 X$, or in terms of counts to space, X_0, as, $L = C(X - X_0)$, with C being the calibration coefficient at pre-launch.

The coefficients, a_0, and a_1 are derived for every month through spatial and temporal matching of GEO and AVHRR imagery and regression analysis (details in Inamdar & Knapp, 2015). While in orbit, the sensor degrades in time resulting in an increase in the calibration coefficient, C, with time which can be considered to vary in a quadratic form in terms of Y, the number of years lapsed since launch. Thus, if $C(0)$ is the calibration coefficient at launch, then

$C(Y) = C(0)(1 + g_1 Y + g_2 Y^2)$, with g_1 and g_2 being constants.

The time series of radiance data derived from the monthly sets of slope and intercept coefficients have been processed into the quadratic formulation as described above through employing a fixed space offset value, X_0, for a sampling of satellites shown in Fig. 1. Thus the radiance L (W m^{-2} ster^{-1}) can be formulated as,

$$L = C(Y)(X - X_0)$$

The space offset 10-bit count values determined from midnight images for the GOES series and MSG-1 (presented in Fig. 1) have been found to be exceptionally stable at 29.2 and 47.85 respectively within 5% standard deviation for the entire time span.

It is to be noted that, while the ISCCP processing allows, by design, differing time variations of the calibration intercept and slope values listed for each month, the statistical fitting described here has been applied to both sets of monthly coefficients (ISCCP and present scheme) to facilitate an overall comparison. An independent assessment of the radiometric calibration through comparison of observations against the exceptionally stable lunar reference (Stone et al. 2013) is also provided in the results presented here. The fixed space constraint formulation presented here contrasts from the generalized approach shown earlier (Inamdar & Knapp, 2015). Yet the results reveal that the calibration derived from match-up with the two independent data sets (AVHRR Global Area Coverage (GAC) and PATMOS-x) agree to within their mutual uncertainties, and also consistent with lunar-based reference observations.

Acknowledgments: This work was supported by NOAA through the Cooperative Institute for Climate and Satellites - North Carolina under Cooperative Agreement NA14NES432003.

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Discuss the Article

News in this Quarter

2015 GSICS User's Workshop

By Manik Bali and Lawrence E Flynn (NOAA)

The 2015 GSICS User's workshop (GUW) was held in the afternoon of 24th Sept 2015 as a half-day session of the 2015 EUMETSAT satellite Conference in Toulouse, France.

The GUW was structured to be an interactive workshop with four main sessions. Each presentation was followed by a 5 min Q & A period.

Wenjian Zhang, Director of the WMO Observing and Information Systems Department kick started the workshop with a welcome note in which he outlined the important role GSICS is playing within the GCOS (Global Climate Observing Systems).

The welcome note was followed by a presentation from Jerome Lafeuille, (WMO Rep to the GSICS Executive Panel). Jerome started the first session of the Workshop on 'Current GSICS Products and Announcements'. After giving an overview of GSICS and its classical products briefly, Jerome introduced the concept of GSICS Deliverables. He mentioned that in the near future users will have access to a range of entities named GSICS deliverables which include Calibration Corrections, ATBD's, Reference data sets and Tools.

Product developers Tim Hewison (EUMETSAT) and Dave Doelling (NASA) reviewed GSICS satellite inter-comparison methods for IR and Visible instrument measurements and led discussions on reference instrument criteria, lunar calibration, product update frequencies, diurnal variations (especially for GEO ring inter-calibration), instrument acquisition and orbital stability and other product

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creation issues.

Manik Bali (UMD/ESSIC) introduced the GSICS Product catalogue and its content, and solicited feedback on its format and on product metadata needs. The second session was a continuation of the discussion of the topics introduced in the first session in an interactive session, allowing attendees to request more information. The third part was presentations by product users on their experiences and expectations.

The third session titled 'Feedback from beta testers/users - presentations on external users' focused users of GSICS products, providing their experiences, warnings, plans and preferences for product applications. Roger Saunders (UK Met Office) demonstrated the capability of Numerical Weather Prediction (NWP) models to help to understand and evaluate spectral and radiometric calibration products and provided recommendations for relative frequency of the updates for different measurement characteristics. Lei Yang (CMA) gave a condensed but comprehensive presentation on the GSICS activities for CMA's GEO (FY-2) and LEO (FY-3) instruments and measurements including plans for lunar calibration work. Chang-Suk Lee (Pukyong National University) showed the good improvement in Communication, Ocean, and Meteorological Satellite (COMS)/Meteorological Imager (MI) Sea-Surface temperature records after applying GSICS-derived bias corrections. Regis Borde (EUMETSAT) identified issues faced in implementing GSICS corrections for Meteosat-7 and evaluating their impact on products.

The session continued with Karsten Fennig (DWD) covering a variety of issues present regarding requirements for generating Fundamental CDRs including differentiating between corrections and offset adjustment to a reference, traceability to original records, and the importance of reviewed documentation, such as ATBDs and validation reports. It concluded with Sante Laviola's (ISAC –CNR) talk on factors affecting inter-calibration of the 183 GHz microwave channels and a discussion of the criteria for selection of a microwave reference instruments.

Prior to the GUW, GCC had circulated a survey. GSICS Working groups (GRWG and UV, VIS, IR, MW subgroups and the GDWG) added survey questions targeted at users of products in their domain. The survey was sent out to a large community involved in Inter-calibration and the idea was to obtain feedback from them and learn about their expectations from GSICS and how GSICS could best help them in the coming future.

The fourth session was a series of reports, summaries and discussions on responses to the survey consisting of Users' Feedback Questions. Reports on the submissions were provided by the GDWG Co-Chair, GRWG Subgroup Chairs, the GCC Deputy Director, and the GRWG Vice-Chair. Among the high interest topics in this final session were the following:

- The content, format and traceability involved in providing intermediate products.
- The need and sources for Spectral Band Adjustment Factors (SBAFs) and tools to work with the bandpasses.
- The selection and evaluation of reference sensors for visible, microwave and ultraviolet sensor.
- The identification of reference solar spectra (in coordination with CEOS) and their uncertainties and their representation of solar activity (especially below 400 nm).
- The dual applications of GSICS adjustments for operational and climate purposes and interactions with the frequency and uncertainty of the products.
- Identification of best practices and shared resource development for ground-based calibration.

The web-based Survey will remain open for additional responses until at least 31 December 2015.

The success of GSICS can be observed in the broad array of participation around the globe by representatives of meteorological and research institutes from China, Japan, Korea, US, India, and the European Union, and the coverage of their activities over measurements from instruments across the spectrum from microwaves to the ultraviolet. Presentations and meeting outcomes can be accessed at 2015 GSICS Users Workshop on the GSICS wiki.

Actions from the GSICS Users Workshop

The GCC identified three actions from the meeting and feedback as follows:

- GCC is to develop and propose a model to help reduce the complexity involved in creating, distributing and using GSICS products. Provide users with a beta version of the GSICS data distribution model designed to help users navigate through the GSICS products and download the required variables more easily.(GCC could begin by taking feedback members on their requirements).
- GCC is to draft a straw man User Requirements' document and send it out for review.
- GSICS users are requested to develop lists of the type of information that they think should be acquired during pre-launch characterization and made available to the users to support user preparation, and communicate this information to the GCC.

Discuss the Article

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GSICS-related highlights of the 2015 EUMETSAT Meteorological Satellite Conference

By Tim Hewison, EUMETSAT

In recent years there has been a tradition of hosting the EUMETSAT Meteorological Satellite Conference in different member states of the organization. In 2015, MétéoFrance generously hosted it at the International Conference Centre of their Météopole campus in Toulouse on 21-25 September.

This year the "Instrument calibration and validation campaigns" session spanned three days, and was divided into sub-sessions, focusing on the visible, near-infrared, ultraviolet, thermal infrared and microwave parts of the spectrum. These were complemented by a short session on general calibration facilities and a joint session on calibration/validation of marine observations, focusing on the recent and upcoming launches of Jason-3 and Sentinel-3, respectively. In addition to the 38 oral presentations, there were 15 posters providing in-depth details of a diverse selection of calibration-related topics. Both oral and poster sessions received a high level of audience feedback - perhaps encouraged by the delicious refreshments provided in the poster area and absence of Wi-Fi in the presentation room.

This conference has grown to become one of the highlights of the GSICS calendar - not only for the dedicated session on instrument calibration, but also other sessions gathering experts from several of the application areas, which could benefit from GSICS' activities - in particular the marine and climate-related sessions. This has made the conference the natural choice for GSICS Users Workshops (see below). It was particularly rewarding to see many GSICS developers among the attendees and presenters. These included keynote presentations from Masaya Takahashi (JMA) on Himawari-8/AHI, Changyong Cao (NOAA) on VIIRS, which they extended into excellent session introductions.
The presentations and posters given at the conference are now available online at http://www.eumetsat.int/website/home/News/ConferencesandEvents/DAT_2305526.html. The proceedings will also be published there.

Attendees of the 2015 EUMETSAT Meteorological Satellite Conference at MétéoFrance, Toulouse

Joint GSICS GRWG-UVSG and CEOS WGCV-ACSG Meeting

By Lawrence E. Flynn, NOAA

A joint GSICS Research Working Group UV Sub-Group (GRWG-UVSG) and Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation - Atmospheric Composition Sub-Group (CEOS WGCVACSG) meeting was held at NOAA National Center for Weather and Climate Prediction (NCWCP) in College Park, MD, on the 8th and 9th October 2015. The meeting was organised around a set of questions which formed the basis of a user survey designed to assess the most appropriate focus for the GSICS UV sub-group's activities. The questions are listed below.

- What ground-based measurement characterizations are most important?
- What internal measurements do you make to maintain your instrument's calibration in orbit?
- What internal consistency methods do you use to check the calibration?
- What external methods and measurements do you use to maintain your instrument's calibration in orbit?
- Does your sensor use vicarious calibration methods? If so, what adjustments are derived?
- What external resources, if any, are regarded as reference measurements?
- Are there solar spectra that your community regards as references?

The presenters addressed one or more of the questions using examples from their own experiences. Instruments covered included GOME, GOME-2, SBUV/2, TEMPO, OMPS and EPIC. The Agenda with presentations are available at https://gsics.nesdis.noaa.gov/wiki/Development/20151008

Following the presentations there was an extended discussion session focusing on the selection of useful projects based on the techniques and analysis methods presented. The following four baseline projects were selected:

1. **Reference Solar Spectrum:**

The aim of this activity is to evaluate the available reference solar spectra and make a recommendation for a reference solar spectrum for community use. The studies will examine complexities from solar activity, spectral resolution and wavelength shifts as they impact comparisons of UV solar measurements from satellite instruments. Lead – Larry Flynn (NOAA).

2. **White Paper on Ground-based Characterization of UV/Vis/NIR/SWIR spectrometers:**

The aim of this activity is to prepare a white paper documenting best-practises for the onground calibration of UV/Vis/NIR/SWIR spectrometers based on in-orbit experience from relevant missions. Lead – Rüdiger Lang (EUMETSAT)

3. **Match-Ups and Target Sites:**

The aim is to produce over-pass comparisons of UV sensors for specific target sites in use by the community. As a first step summaries of methods and results for target sites currently in use will be collected. Lead – TBD (GSICS members are invited to provide articles for a special issue of the GSICS Quarterly on this topic –current use of Match-Ups and Target Sites for UV instrument calibration and trending – or articles related to the other three projects)

4. **Cross-calibration below 300 nm**

Devise new methods for comparison of wavelength pairs for different viewing geometries taking into account contribution function equivalence to allow radiometric performance comparisons for ozone profile wavelengths from 240 nm to 300 nm. Lead Larry Flynn (NOAA).

Co-operation between the GRWG-UVSG and the CEOS WGCV-ACSG will be actively pursued during these projects as appropriate. An obvious first area of common interest is the Reference Solar Spectrum activity. The next GRWG-UVSG is being considered as part of the GSCIS Joint Annual Meeting of the Research and Data Working Groups, which will be held from 29th February to 4th March 2016 at JAXA Tsukuba Space Center, Japan.

Discuss the Article

Announcements

2016 GRWG/GDWG Meeting to be held from Feb 29 to March 4, in Tsukuba, Japan

By Masaya Takahashi (JMA) and Misako Kachi (JAXA)

The 2016 GSICS Joint Meeting on Research and Data Working Groups co-hosted by the Japan Aerospace Exploration Agency (JAXA)

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and the Japan Meteorological Agency (JMA) will take place at the Tsukuba Space Center of JAXA, Tsukuba, Japan, from February 29 to March 4, 2016.

The meeting will begin with a Mini Conference on February 29, 2016. The Mini Conference is a session to discuss items to introduce GSICS products and items that are not yet directly linked to GSICS Products. This will be followed by a Plenary on March 1. The plenary is a member session and will cover topics related to the UV-VIS/NIR-IR-MW subgroups of GRWG, GDWG and GCC. Reports from GSICS Processing and Research Centers (GPRCs) and discussion on cross-cutting issues will also be planned. Following this, the GSICS Data Working Group (GDWG) and the GSICS Research Working Group (GRWG) will break out into parallel sessions while converging on important topics. During the plenary meeting, participants will also get the opportunity for a guided tour of JAXA. The meeting will finish with a wrap up session where summary of meeting and status of action items will be discussed. Details of the meeting will be announced at GSICS Wiki

SPIE Asia Pacific Remote Sensing Symposium 2016 to be held in New Delhi, India, 4-7 April, 2016

By Jack Xiong (NASA), Saji Abraham Kuriakose (SAC) and Toshiyoshi Kimura (JAXA)

The SPIE Asia Pacific Remote Sensing Conference on Earth Observing Missions and Sensors would be held in Delhi, India from 4-7 April, 2016. The Venue is Pride Plaza Hotel. This conference would cover a range of topics that focus on topics related to radiometer and imager systems and include:

- Existing missions and sensors, including their status, performance assessment, and lessons learned
- Pre-launch and on-board calibration and characterization methodologies and results
- Sensor performance validation and vicarious calibration
- Calibration inter-comparison and consistency among sensors
- Sensor calibration accuracy and traceability
- New research, operational, and commercial missions and sensors, including their mission studies, design
- requirements, applications, and system implementation
- NASA-ISRO SAR (NISAR) mission status, performance prediction, development, implementation and characterization
- Enabling technologies for sensor development and innovative techniques for sensor radiometric, spectral, spatial, and polarization calibration and characterization
- New sensor test concept and test equipment design
- Improved test data analysis methodologies and techniques
- Characterization and applications of CEOS recommended reference standard test sites.

Additional information can be found from http://spie.org/AE/conferencedetails/earth-observing-missions-and-sensors

GSICS-Related Publications

Ahn, M.-H. et al., 2015: Estimation of uncertainties in the spectral response function of the water vapor channel of a meteorological imager SPIE CONFERENCE PROCEEDINGS Vol. 9535 95351V.

Chen, H., 2015: Biases in Satellite-Derived Temperature Trends Due to Orbital Drift, Orbital Differences and Their Corrections *THESIS FLORIDA STATE UNIVERSITY* *http://diginole.lib.fsu.edu/cgi/viewcontent.cgi?article=8524&context=etd*

Gao, H. et al., 2015: Cross-Calibration of the HSI Sensor Reflective Solar Bands Using Hyperion Data *IEEE TGRS.* Vol.53 No.**7** 6, 4127-4137.

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Gerace, A. et al., 2015: The development of a DIRSIG simulation environment to support instrument trade studies for the SOLARIS sensor SPIE PROCEEDINGS. Vol. 9472 947214

Lukashin, C. et al., 2015: CLARREO Reflected Solar Spectrometer: Restrictions for Instrument Sensitivity to Polarization *IEEE TGRS*. Vol. 53 No. 12 pp. 6703-6709.

Moradi, I. et al., 2015: Intercalibration and Validation of Observations from ATMS and SAPHIR Microwave Sounders *IEEE TGRS*. Vol. 53 No. 11 pp. 5915-5925.

Okuyama, A. et al., 2015: Preliminary validation of Himawari-8/AHI navigation and calibration *SPIE PROCEEDINGS*. Vol. 9607 96072E

Sun, W. et al., 2015: Deriving polarization properties of desert-reflected solar spectra with PARASOL data *ACP*. Vol. 15 No. 13. pp. 7725-7734

Uprety, S. and C. CAO, 2015: Suomi NPP VIIRS reflective solar band on-orbit radiometric stability and accuracy assessment using desert and Antarctica Dome C sites *REMOTE SENSING OF ENVIRONMENT* Vol. 166 pp. 106-115.

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 cal/val 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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