

GLOBAL SPACE-BASED INTERCALIBRATION SYSTEM Update on GSICS

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Summary and Purpose of Document

This document informs ET-SAT-8 of the recent activities of GSICS Research Working Group (GRWG) and GSICS Data Working Group (GRWG)

The following activities are highlighted:

- GEO-LEO IR inter-calibration and correction product;
 - Visible Channel Calibration;
 - Transitioning GSICS to Operations
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1. BACKGROUND

1.1 Scope

The Global Space-based Inter-Calibration System (GSICS) is an international collaborative effort initiated in 2005 by WMO and the CGMS to monitor, improve and harmonize the quality of observations from operational weather and environmental satellites of the Global Observing System (GOS). GSICS aims at ensuring consistent accuracy among space-based observations worldwide for climate monitoring, weather forecasting, and environmental applications.

This is achieved through a comprehensive calibration strategy which involves:

- monitoring instrument performances,
- operational inter-calibration of satellite instruments,
- tying the measurements to absolute references and standards, and
- re-calibration of archived data.

1.2 GSICS' principles

GSICS systematically generates inter-calibration products for Level 1 data from satellite sensors to compare, monitor and correct their calibration to community references, by generating calibration corrections, with specified uncertainties, through well-documented, peer-reviewed procedures based on various techniques to ensure consistent and robust results. GSICS products are delivered to users with free and open access, adopting community standards.

GSICS promotes a greater understanding of instruments' absolute calibration, by analysing the root causes of biases, more accurate and more globally consistent retrieved L2 products and allows their inter-operability for more accurate environmental, climate and weather forecasting products.

2. STATUS OF GSICS PRODUCTS

GSICS' main products are GSICS Corrections, which are functions with which users can convert the calibration of monitored instruments to be consistent with community-defined references. These GSICS Corrections are available for both near real-time and re-analysis applications.

Analysis of these inter-calibration results also allows investigation of the causes of instrument biases, which are written up in the form of GSICS Reports and Guidelines –e.g. for changes to pre-launch characterisation and future operational practices.

The full interactive summary of GSICS Products is accessible from <http://gsics.wmo.int>. This also provides links to the products and their associated documentation.

2.1 Products developed within GSICS Research Working Group

2.1.1 GEO-LEO IR

Inter-calibration products for the infrared channels of current geostationary imagers have been developed within GSICS, using the Simultaneous Nadir Overpasses of the hyperspectral sounder, MetopA/IASI, as a reference. Several of these are now in *Pre-Operational* status, meaning they are regularly updated on the GSICS Data servers and have a complete set of documentation, as required by the GSICS Procedure for Product Acceptance, including Algorithm Theoretical Basis Documents, software documentation, user guides, uncertainty analysis, and they conform to GSICS file and variable naming conventions. Table 1 summarises the status of the GEO-LEO IR products, available from various GSICS Processing and Research Centers (GPRCs).

Further developments are underway to allow the migration of reference instrument – e.g. from MetopB/IASI to MetopA/IASI. This will be performed using a double-differencing method, comparing inter-calibration results derived using both references, and will be provided to users integrated into future GSICS Corrections to allow them to be transferred back to a common reference. Although the differences between the IASI instruments on Metop-A and Metop-B are negligible, this is important for traceability and to ensure consistency.

Table 1 – Status of GSICS inter-calibration products for infrared channels of geostationary imagers as of May 2013

GPRC	Monitored Instrument	Reference Instrument	GSICS NRT Correction	GSICS Re-Analysis Correction	GSICS Bias Monitoring
EUMETSAT	Meteosat-10 } Meteosat-9 } -- Meteosat-8 } Meteosat-7 }	IASI	Pre-operational Demonstration	Pre-operational Demonstration	Prototype
JMA	MTSAT-1R } MTSAT-2 }	IASI (+ AIRS)	Demonstration	Demonstration	Prototype
NOAA	GOES-13 & -15 Imager GOES-11 & -12 Imager	IASI (+ AIRS)	Pre-operational	Pre-operational Demonstration	Prototype
	GOES Sounder	IASI (+ AIRS)	In development	In development	In development
CMA	FY2C } FY2D } -- FY2E }	IASI (+ AIRS)	In development	In development	Prototype
KMA	COMS	IASI (+ AIRS)	In development	In development	In development

2.1.2 GEO-LEO VIS

The GSICS Research Working Group (GRWG) is continuing to investigate a number of different methods to inter-calibrate the visible and near infrared channels of geostationary imagers to reference instruments in Low Earth Orbit (GEO-LEO VIS), because direct comparison of collocated radiances is complicated by Spectral Response Function (SRF) and scene type differences, and the absence of a suitable hyperspectral reference instrument. These methods all use pseudo invariant reference targets to transfer the calibration of the reference instrument to the monitored instrument and require the definition of Spectral Band Adjustment Factors to account for their different SRFs, which may be derived from hyperspectral observations or radiative transfer models.

Deep Convective Clouds (DCCs) represent the prime candidate method, as these bright targets, whose reflectivity is almost Lambertian and independent of the clouds' microphysics, are observable from all geostationary imagers with no additional costs. A common algorithm is currently being developed, which should give the first Demonstration GSICS products for the visible channels of all geostationary imagers in early 2014.

Rayleigh scattering generates a very low reflectivity pseudo invariant reference over open ocean. An algorithm is currently in development to use these as targets to inter-calibrate GEO VIS channels, which will complement the bright DCC-based method. The GRWG aims to integrate these methods to better cover the full dynamic range of these channels during 2014.

The Moon provides a target with low reflectance, which because of its high stability can be used to transfer calibration from the best current reference instruments back in time using any available lunar observations. Members of the GRWG are currently working with USGS to apply their ROLO

lunar irradiance model to VIS/NIR channels of GEO imagers, and use it as an inter-calibration transfer.

2.2 Products developed by Third Parties

GSICS also encourages inter-calibration products developed by third parties to be submitted to the GSICS Procedure for Product Acceptance to be certified as compliant with GSICS principles and standards. This ensures potential users are provided with sufficient information to allow them to judge which inter-calibration products best suits the requirements of their application.

2.2.1 LEO-LEO VIS

The first example of such a product is the PATMOS-x inter-calibration of the visible channels of the Advanced Very High Resolution Radiometer (AVHRR) operated on multiple NOAA and Metop LEO satellites. PATMOS-x provides a demonstration GSICS inter-calibration of their data to Aqua/MODIS as a reference.

2.2.2 LEO-LEO Microwave

GSICS is also working with affiliated projects, such as the X-CAL group of the Global Precipitation Mission (GPM) to assess how inter-calibration methods for microwave imagers and sounders can meet requirements identified through GSICS Users' Workshops.

3. GSICS INFRASTRUCTURE

The GSICS Data management Working Group (GDWG) have defined a series of standards and conventions to ensure GSICS products are consistently structured and include sufficient metadata to ensure full traceability – in terms of both metrology and informatics. Wherever possible these are based on existing international conventions, such as adopting the WMO file naming, the Climate and Forecasting (CF) convention for netCDF file. The GDWG have also designed and set up a series of collaboration servers to allow users to easily access GSICS products. These GSICS Data servers are hosted by different GPRCs and are accessible through the WMO portal:

<http://gsics.wmo.int>.

The definition of these standards has allowed members of the GDWG to develop a prototype plotting tool to allow users to visualise the data from the GSICS Corrections available on the dataservers as GSICS Bias Monitoring. For the GEO-LEO IR products this is expressed as time series of brightness temperature biases evaluated for any user-selectable scene radiance.

The GDWG has also established the GSICS User Notification Service to allow communication with registered users, who can register using the [online registration form](#). The registration does not require any user name or password, users are only asked to supply basic contact information. Registering allows users to specify what kind of GSICS information they are interested in receiving, e.g.: quarterly newsletters, announcements of new products and services, operational GSICS product status notices, etc.

4. RECENT MEETINGS

4.1 GSICS Data and Research Working Groups' Meeting

The 2013 Annual Meeting of the GSICS Data management and Research Working Groups took place in Williamsburg, Virginia, USA, on 4-8 March. For the first time, a mini conference to present the latest updates on activities of interest to GSICS was held the day before the start of the Meeting. This was dominated by results from the cal/val of instruments on Suomi/NPP and the

host's (NASA) development of the CLARREO concept, which is particularly important to GSICS as it would provide a climate quality inter-calibration reference instrument, which is directly traceable to SI standards.

The Research Working Group initially focused on the steps necessary to advance to operational status the current GSICS products to inter-calibrate the IR channels of current geostationary imagers (GEO-LEO IR) to IASI. Ways to extend these products to more GEOs and transfer from one reference instrument to another were also discussed. The group then turned its attention to the inter-calibration of GEO channels in the reflected solar band. We planned a series of milestones to develop prototype GSICS products, initially using deep convective clouds to transfer the calibration from the MODIS reference. This method will then be extended to apply to LEO instruments and combined with results using clear ocean targets (Rayleigh scattering) and/or lunar observations to cover the monitored instruments' full dynamic range.

The Data Working Group discussed the underlying technologies that support current and future capabilities. The WG is planning to prepare a tutorial on data access.

4.2 GSICS Users' Workshop

The 2013 GSICS Users' Workshop was hosted by NOAA/NESDIS/STAR at NOAA's new National Center for Weather and Climate Prediction in College Park, Maryland, USA on 8 April, in conjunction with the first NOAA Satellite Conference. More than 60 people from about 15 agencies, universities, and private companies attended the workshop. A total of 14 oral talks, together with 10 posters, were presented, covering topics such as GSICS strategy, product development and data management, current and planned instrument inter-calibrations, and feedback on and requests for GSICS products. Users demonstrated successful applications of GSICS spectral response function corrections to increase the GOES Imager data quality and showed examples of GSICS correction products to improve GOES Sounder and MTSAT products. With the expected delivery of retro-processing data, users plan to continue the investigation of the impacts of the GSICS Correction on the Level 2 and Level 3 products. It is expected that the GSICS inter-calibrations will play an important role in the GOES-R on-orbit cal/val project.

Reacting to the GOES-15 Imager calibration anomaly event in March 2012, users expressed the need for a satellite operational anomaly alert system for the GOES-R series. It was also recommended that two new GSICS sub-groups, ultraviolet (UV) and synthetic observation, added to the restructured GRWG subgroups to better understand UV instrument calibration and radiative simulation performance.

5. SUMMARY

GSICS is progressing toward operational status, having developed an infrastructure to allow the generation, distribution and visualisation of inter-calibration products. The first GSICS Correction products for the inter-calibration of infrared channels of geostationary imagers are expected to achieve operational status later in 2013 and can be considered sufficiently mature to be included as part of operational processing chains generating Level 2 products and Fundamental Climate Data Records (FCDRs) from satellite data. These will be followed by inter-calibration products for other satellite instruments and other spectral bands.