CGMS

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Global Space-based Inter-Calibration System (GSICS): Report from the Executive Panel

Summary of the Working Paper

There has been documented progress this year regarding the Global Space-based Inter-Calibration System (GSICS). The main highlights of the year include extensive inter-comparisons of the *Metop-A* Infrared Atmospheric Sounding Interferometer and the Earth Observing System *Aqua* Atmospheric InfraRed Sounder instruments. These comparisons show that the two instruments typically have small (~ 0.2 K) biases, except over very cold Earth scenes (T<230 K) where biases can increase. In regards to inter-calibration analysis between geostationary and low-earth-orbiting satellites, some results have been released by EUMETSAT, JMA, and NOAA. These results are available on the local GSICS web pages being developed by the GSICS Processing and Research Centers. Communication amongst GSICS members has been fostered through meetings of the GSICS Research and Data Working Groups and the GSICS Executive Panel, as well as through the GSICS Quarterly newsletter. Also, the central GSICS web site, currently hosted by NOAA, is being overhauled to make the site more user-friendly, maintainable, and extendable. Finally, progress has been made on setting priorities for GSICS information services and products, as well as developing a procedure for product acceptance within GSICS.

1 INTRODUCTION

There have been several developments in the Global Space-based Inter-Calibration System (GSICS) since the CGMS 35 meeting held in Cocoa Beach, FL in November 2007. The main highlights of the year include extensive inter-comparison of *Metop-A* Infrared Atmospheric Sounding Interferometer (IASI) and the Earth Observing System (EOS) *Aqua* Atmospheric InfraRed Sounder (AIRS) instruments. In regards to inter-calibration analysis between geostationary and low-earth-orbiting satellites, some results have been released by EUMETSAT, JMA, and NOAA. These results are available on the local GSICS web pages being developed by the GSICS Processing and Research Centers. Communication amongst GSICS members has been fostered through meetings of the GSICS Research and Data Working Groups and the GSICS Executive Panel, as well as through the GSICS Quarterly newsletter. Also, the central GSICS web site, currently hosted by NOAA, is being overhauled to make the site more user-friendly, maintainable, and extendable. Finally, progress has been made on setting priorities for GSICS information services and products, as well as developing a procedure for product acceptance within GSICS. In this manuscript, these updates to the GSICS program are discussed.

2 *Aqua* AIRS and *Metop-A* IASI Data Inter-Comparisons

Within GSICS, there are several groups - CNES, EUMETSAT, JMA, NOAA, and University of Wisconsin - that are currently performing inter-comparisons between LEO *Aqua* AIRS and *Metop-A* IASI instruments. The reason for such extensive inter-comparison analysis is that the data from each of these hyperspectral instruments are capable of being convolved with the spectral response function (SRF) of any given LEO and/or GEO (LEO/GEO) broadband imager infrared channel, and then inter-compared with the data from that broadband imager channel. Also, since AIRS and IASI are LEO instruments, they can be inter-compared with data from the global constellation of LEO/GEO broadband infrared imagers, and then used as a calibration transfer radiometer to inter-calibrate the data between these instruments. In addition, the radiance biases between similar LEO/GEO imager infrared channels due to SRF differences can be estimated using the hyperspectral instruments, and then removed from the inter-satellite radiance biases. Thus, the central role that AIRS and IASI is being given in LEO/GEO intersatellite bias estimation translates to the necessity of knowing the accuracy, reliability and stability of these two instruments.

Several inter-comparison have been performed in the past year using *Aqua* AIRS and *Metop-A* IASI instruments. Groups from CNES, NOAA, and University of Wisconsin have performed direct AIRS to IASI inter-comparisons. From these inter-comparisons, it is found that the two instruments typically have small (~ 0.2 K) biases, except over very cold Earth scenes (T<230 K) at channels near 4 m, where biases can increase. In additions, the group from University of Wisconsin was able to find that biases between AIRS and IASI can vary as a function of AIRS focal plane. Some bias results are shown in Figure 1, which is taken from the Southern Hemisphere Simultaneous Nadir Overpass (SNO) analysis performed between AIRS and IASI performed Tobin et al. (2008).

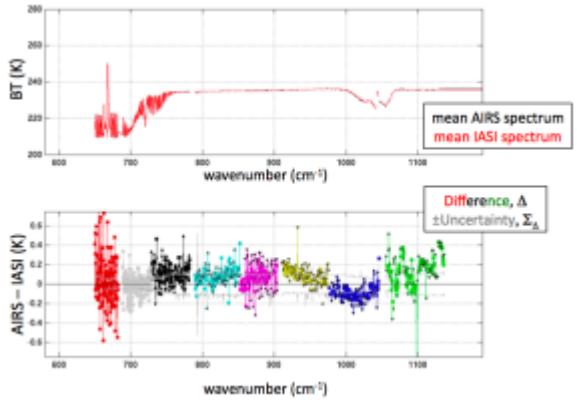

Figure 1a: Mean spectra and differences for southern hemisphere SNOs. Longwave spectral region.

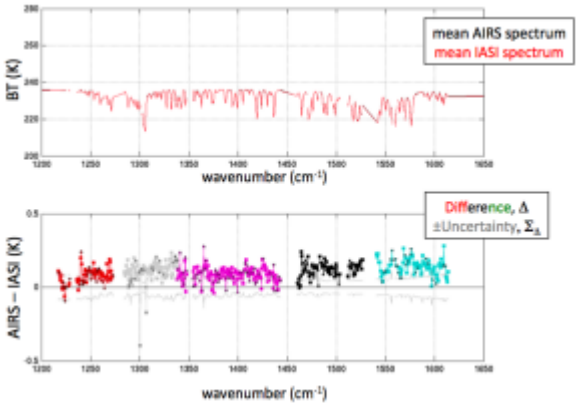

Figure 1b: Mean spectral and differences for southern hemisphere SNOs. Midwave spectral region.

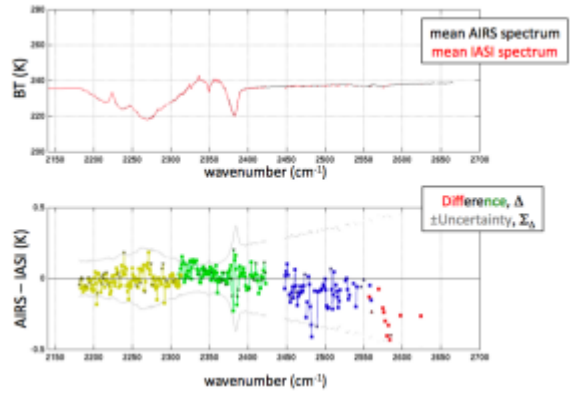

Figure 1c: Mean spectral and differences for southern hemisphere SNOs. Shortwave spectral region.

Several other studies have been performed using *Metop-A* IASI to perform inter-comparison with *Metop-A* HIRS. These studies, performed at EUMETSAT and NOAA, feature the ability to inter-compare IASI with any *Metop-A* HIRS infrared sounder channel. These IASI/HIRS inter-comparisons show that the two instruments agree to within 1 K for all channels, but most channels agree to within 0.25 K. Another study that has been done using *Metop-A* IASI to estimate SRF-related biases between similar HIRS channels of different HIRS radiometer models. In Figure 2, the radiance ratio versus scan line plot for one selected orbit of IASI data convolved with HIRS Channel 4 (14.22 m) SRFs from all HIRS instrument models are given. Each curve represents a radiance ratio between subsequent HIRS operational instruments – e.g. rad(N7)/rad(N6), rad(N8)/rad(N7), etc.

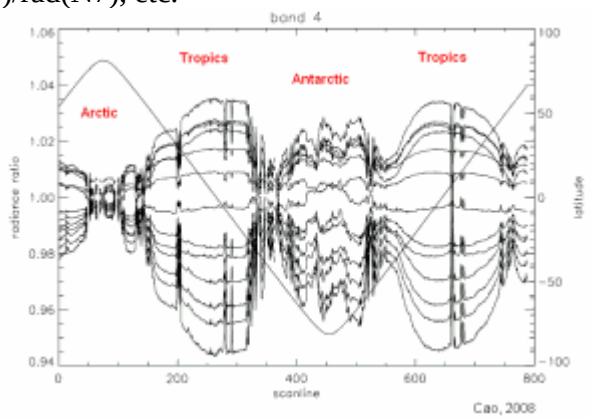

Figure 2: Radiance ratio versus scan line plot for one selected orbit of IASI data convolved with HIRS Channel 4 (14.22 m) SRFs from all HIRS models. Note that the latitude of each scan line is also given in the plot.

Such estimation of radiance ratios can be used to remove SRF-related radiance biases between instruments.

3 GEO to LEO Operational Satellite Instrument Inter-Comparisons

A great deal of progress has been made regarding GEO to LEO satellite instrument inter-comparisons. Although there are regional "flavors" of the GEO to LEO inter-comparison techniques between GSICS members, a robust consensus exists between members regarding the fundamental steps that need to be taken to perform the inter-comparisons. Also, at the July GSICS Executive Panel IV meeting held in Geneva, the GEO to LEO inter-comparison software written by JMA was isolated to be used to perform a baseline inter-comparison of all GEO imaging instruments with *Aqua* AIRS and *Metop-A* IASI. This baseline can be used as a means of comparison with the official GEO to LEO inter-comparison results provided from each GPRC.

Another development that shows the progress being made with the GEO to LEO inter-comparison algorithms is the manifestation of the results on the individual GPRC GSICS web sites, which are also a new development this past year. In Figure 3a and 3b, example web images of GEO to LEO inter-comparison results respectively between *GOES-12* Imager and *Aqua* AIRS, and *MTSAT* Imager and *Aqua* AIRS and *Metop-A* IASI, are shown (by NOAA and JMA, respectively). JMA is the first GPRC to implement the GEO to LEO intercalibration operationally. In addition to these two web sites, EUMETSAT has also launched their local GSICS web site, giving links to the *MSG* SEVERI and *Metop-A* IASI inter-comparison results (not shown).

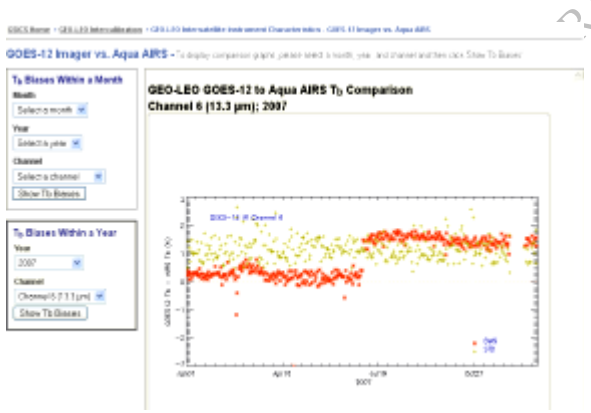

Figure 3a: NOAA/NESDIS on-line results for *GOES-12* Imager Channel 6 to *Aqua* AIRS comparisons.

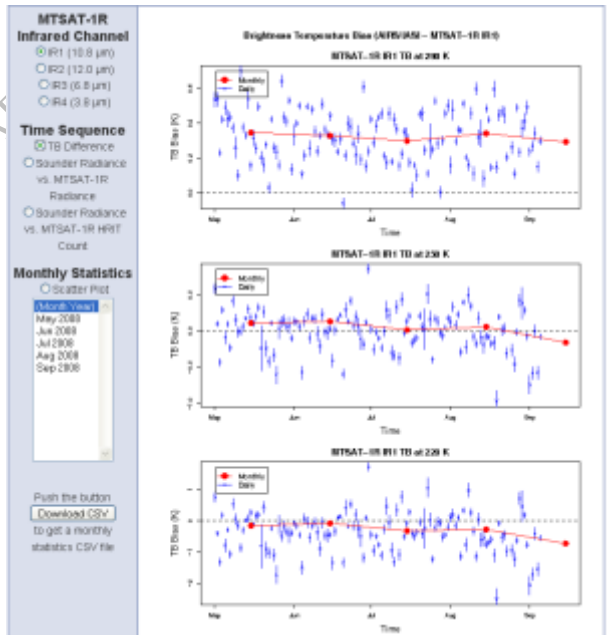

Figure 3b: JMA on-line results for *MTSAT* Imager 10.8 micron channel compared to AIRS and IASI.

4 Central GSICS Web Site Updates

The web site hosted by the GSICS Coordination Center (GCC) has recently undergone a very significant transformation using the NOAA/NESDIS Center for Satellite Applications and Research (StAR) web site kit. This web site kit offers:

Web page templates that do not require design work, and are edited with a simple text editor;

Web pages without frames;

Accessibility to persons with disabilities as dictated by Section 508 of the U.S. Rehabilitation Act; and

Instant approval by StAR for use on StAR web servers.

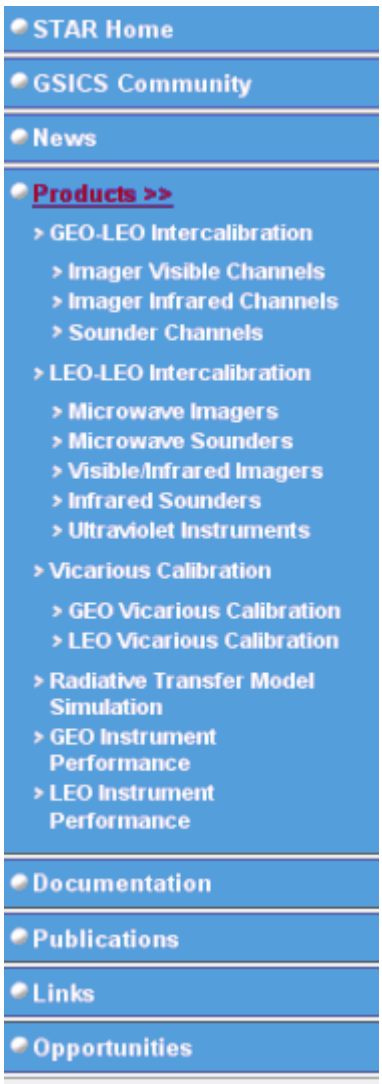

Figure 4: The left panel menu of the updated GSICS web site.

The updated GSICS web site offers attractive, well-organized, and easily-navigable web pages. It includes much expanded product pages and new pages dedicated solely to documentation of algorithms and processes. An example of the expanded product menu can be visualized in Figure 4. This picture shows links to web pages that contain results of geostationary (GEO) to low-earth-orbiting (LEO), as well as LEO to LEO, inter-calibration; vicarious calibration, radiative transfer model simulations; and GEO and LEO instrument performance monitoring. Many of the web links that have been established in the updated web site are not currently populated, but they have been designed to accommodate data and information produced as GSICS goals and milestones are met.

Although the GSICS web site update represents significant improvements to GSICS information technology, further developments of the web site are currently in progress. In particular, a new infrastructure and design of web pages that ultimately serve the plethora of GSICS data tables and graphs is currently being implemented. At GCC, new techniques are being implemented to serve GEO to LEO instrument inter-comparison products. These techniques feature menu-driven table and plot selection driven by java/php scripts that can parse filename strings. The strings then can be used to create information about the tables and plots that will help users to understand what they are seeing. These scripts also are capable of creating comment blocks that can help persons with disabilities navigate the site. In addition, the tables and plots are served in “inline Frames” or “iFrames.” According to Wikipedia, an iFrame is an HTML element which makes it possible to embed a HTML document inside another HTML document. This method is a very efficient way to serve information and data. In the future, we hope to apply this technology in serving LEO-LEO inter-calibration results and instrument performance monitoring plots and data tables.

As a coordination center, the GCC is responsible for maintaining pathways of information and data storage and transfer. At GCC,

the continual development of the GSICS web site is taking place to meet current and future web demands of GSICS members and data users. In addition, an integrated communication system that includes collaborative servers also requires a fast and easy to use web interface, as the one being developed at the GCC.

5 GSICS Services Definition and Product Acceptance Procedure

This GSICS Information, Services, and Product Roster is a list of potential and current GSICS products and services. Currently, this document is meant for internal use within GSICS to help define current GSICS assets, and to prioritize future GSICS activities. The plan for this document is to split it into two documents: 1) GSICS Information, Services, and Product Brochure and 2) GSICS Information, Services, and Product Survey. The GSICS Information, Services, and Product Brochure is to be a web-based guide of currently offered GSICS products. Meanwhile, the GSICS Information, Services, and Product Survey is to be a list all of products and services that the GSICS data user community *would like* GSICS to offer. This Survey is to be sent around to GSICS data users for comments and suggestions regarding their GSICS data needs.

Meanwhile, the formal acceptance procedure of distribution-ready products into the GSICS product portfolio answers the following four questions:

What is the product?

What is its scope and purpose within the GSICS product portfolio (does it fill a need within GSICS)?

What is the product theoretical basis and how is the product implemented operationally?

What is the product quality (uncertainty, quality indicators, etc)?

This proposed "acceptance" procedure of distribution-ready products is not designed to be limiting to GSICS, and is put into place mainly as a system of documentation and product quality assurance. The procedure is not developed to judge products as “good” and/or “bad”, or even to discriminate them based on the type of method. The acceptance procedure is put into place only to determine whether the product is within the scope of GSICS, and whether its methods and uncertainties have been properly documented. This way, the GSICS data user can decide whether or not a given product will suit their needs.

6 Meetings and Publications

In the past year, the GSICS Research Working Group (GRWG) held their third meeting (GRWG-III) in conjunction with the second meeting of the GSICS Data Working Group (GDWG-II). This joint meeting was hosted by NOAA at the NOAA Science Center, Camp Springs, MD, USA, on 19-21 February 2008. The first day was devoted to a joint session to address implementation and operational issues. On the second day, parallel sessions were held to discuss issues of interest only to the respective working groups. The meeting concluded on the third day with a half-day joint session comprised of a summary and recommendations. Meanwhile, the GSICS Executive Panel IV meeting was held during 10-11 July 2008, to discuss GSICS progress and direction.

The GSICS Quarterly newsletter has had three releases since the beginning of the year. These newsletters continue to be successful in helping GSICS members communicate their progress, and keep abreast of the latest GSICS developments.

7 GSICS Future Plans

There are several key GSICS Milestones that are planned for the next year. These milestones can be broken down by those spearheaded by the GSICS Research Working Group (GRWG), GSICS Data Working Group (GDWG), and the GSICS Coordination Center (GCC). A list of the primary milestones for 2009 is given in Table 1.

Table 1: A list of 2009 GSICS-related Milestones, separated by responsible GSICS organizational branch.

MS #	GRWG Milestones	GDWG Milestones	GCC Milestones
1	Finish software developments required for all GPRCs to implement GEO-LEO algorithm	Resolve file and parameter naming conventions	Implement GEO-LEO "baseline" algorithm at NOAA for all data sources
2	Develop GEO-LEO solar channel inter-calibration algorithm	Get collaborative servers up and running with THREDDS/OPNDAP software	Coordinate and compile Quarterly Instrument Anomaly Reports from all GPRCs
3	Develop instrument performance monitoring tools	Link or upload routine output of GEO-LEO algorithms at all GPRCs to GSICS central web site	Continue coordinating and compiling Quarterly Newsletter
4	Add new satellite instruments to LEO-LEO and GEO-LEO inter-calibration analysis	Perform review within GSICS of LEO-LEO inter-comparison software and documentation to facilitate acceptance as a GSICS Product	Coordinate effort to define GSICS Information, Services and Product Roster - complete internal GSICS review and then create a version to be sent to potential customers.
5	Perform historic LEO-LEO and GEO-LEO inter-calibration analysis	Link current instrument performance monitoring results to web site	Finalize GSICS Procedure for Product Acceptance with a final review from the Executive Panel
6	Microwave Cross-calibration Efforts **1.** Microwave baseline intersensor calibration algorithm - operational mission (SSM/I, SSMIS) **2.** Microwave baseline intersensor calibration algorithm - research mission (TMI, Windsat, AMSR-E, GPM) **3.** SSMI demonstration of Climate Data Records after intersensor calibration	Get TWiki up and running for the purpose of interactive documentation development	Coordinate joint GRWG-IV-GDWG-III meeting

8 Summary

In summary, there has been documented progress this year regarding the Global Space-based Inter-Calibration System (GSICS). The main highlights of the year include extensive inter-comparisons of the *Metop-A* Infrared Atmospheric Sounding Interferometer and the Earth Observing System *Aqua* Atmospheric InfraRed Sounder instruments. These comparisons show that the two instruments typically have small (~ 0.2 K) biases, except over very cold Earth scenes (T<230 K) where biases can increase. In regards to inter-calibration analysis between geostationary and low-earth-orbiting satellites, some results have been released by EUMETSAT, JMA, and NOAA. These results are available on the local GSICS web pages being developed by the GSICS Processing and Research Centers. Communication amongst GSICS members has been fostered through meetings of the GSICS Research and Data Working Groups and the GSICS Executive Panel, as well as through the GSICS Quarterly newsletter. Also, the central GSICS web site, currently hosted by NOAA, is being overhauled to make the site more user-friendly, maintainable, and extendable. Finally, progress has been made on setting priorities for GSICS information services and products, as well as developing a procedure for product acceptance within GSICS.