Introducing GSICS and interactions with SCOPE-CM

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Global Space-based Inter-Calibration System

- **What is GSICS?**
  - Global Space-based Inter-Calibration System
  - Initiative of CGMS and WMO
  - Effort to produce consistent, well-calibrated data from the international constellation of Earth Observing satellites
- **What are the basic strategies of GSICS?**
  - Improve on-orbit calibration by developing an integrated inter-comparison system
    - Initially for GEO-LEO Inter-satellite calibration
    - Being extended to LEO-LEO
    - Using external references as necessary
  - Best practices for prelaunch characterisation (with CEOS WGCV)
- **This will allow us to:**
  - Improve consistency between instruments
  - Reduce bias in Level 1 and 2 products
  - Provide traceability of measurements
  - Retrospectively re-calibrate archive data
  - Better specify future instruments

EUMETSAT CNES JMA

NOAA CMA KMA

ISRO NASA WMO

USGS NIST JAXA

ROSHYDROMET IMD ESA

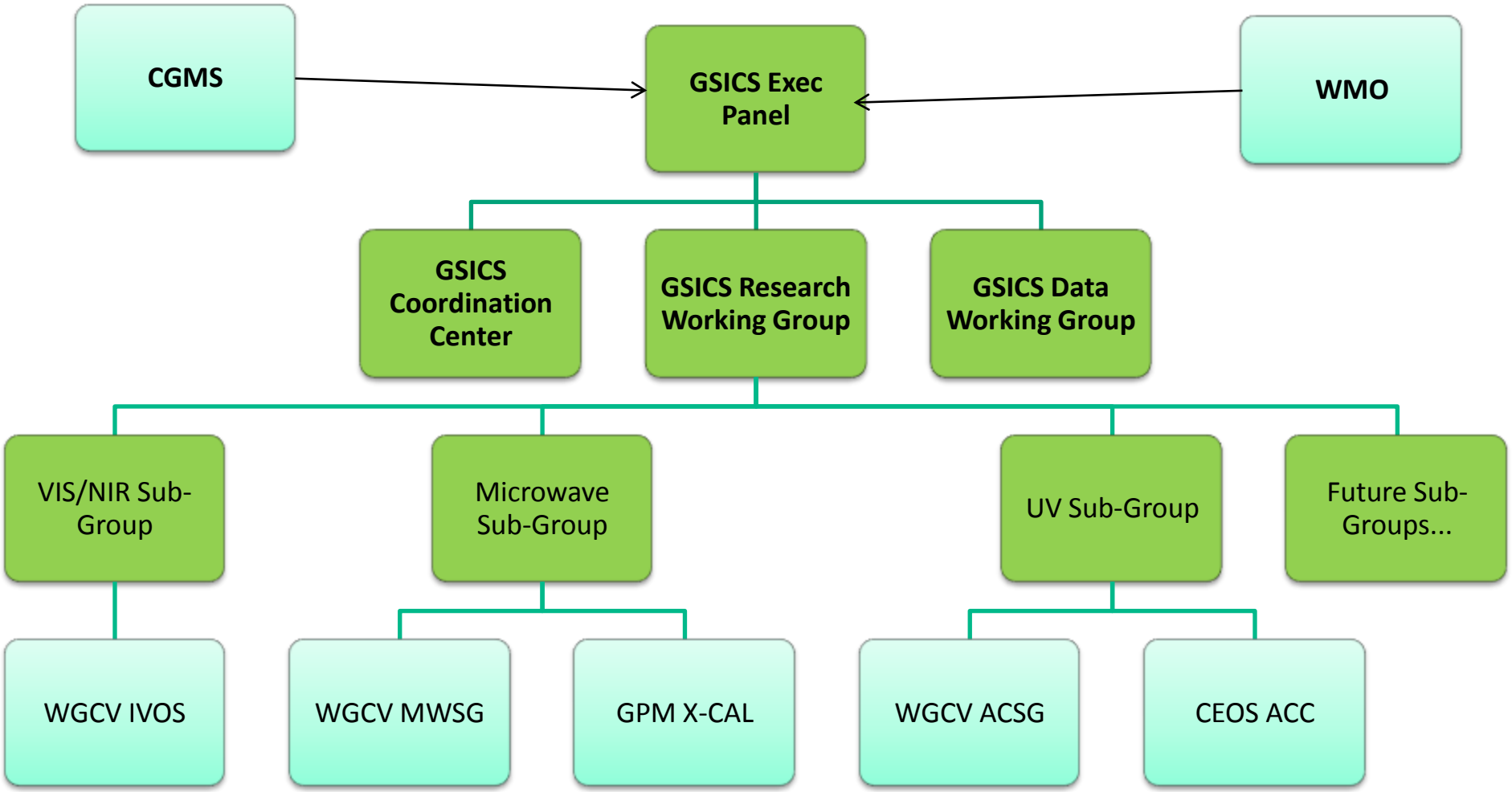
GSICS Principles

- Systematic **generation of** inter-calibration **products**
  - **for Level 1 data from** satellite sensors
  - **to** compare**,** *monitor* **and** correct **the calibration of** ***monitored*** **instruments to community references**
  - **by generating calibration corrections on a routine operational basis**
  - **with specified uncertainties**
  - **through well-documented, peer-reviewed procedures**
  - **based on various techniques to ensure consistent and robust results**
- **Delivery to users**
  - **Free and open access**
  - **Adopting community standards**
- **To promote**
  - **Greater understanding of instruments' absolute calibration, by analysing the root causes of biases**
  - **More accurate and more globally consistent retrieved L2 products**
  - **Inter-operability for more accurate environmental, climate and weather forecasting products**

TRACEABILITY / UNBROKEN CHAINS OF COMPARISONS

GSICS Global Space-based Inter-Calibration System

GSICS Organisation



Who are the targeted users?

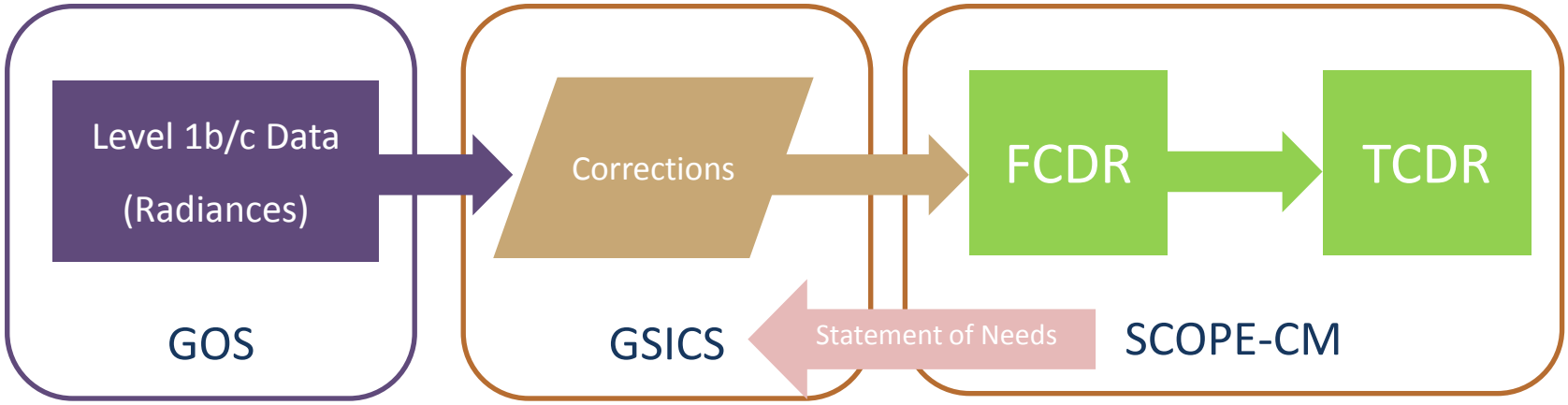
Any activity requiring well calibrated Level 1 data acquired by the satellites covered by GSICS

-Level 2 products (geophysical parameters)

-Climate applications

Example of user = the SCOPE-CM initiative (Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring)

Scope ➔ generate multi-mission and global satellite climate data records (Fundamental CDRs & Thematic CDRs)



➔ The way toward operational production of high quality ECVs on a global scale

GSICS User Community

- **Satellite Application Community**
  - **CDR generation for climate monitoring**
    "SCOPE-CM" framework, national/international programs
    WCRP/GEWEX/ISCCP - (Planned beta-testing of GEO GSICS Corrections)
  - **Reanalysis community for climate modelling (ECMWF reanalysis – 2012/15)**
  - **Operational NWP: direct radiance assimilation**
  - **Other users interested in accurate/consistent calibration**
    to generate stable (composite) L2 quantitative products or imagery
- **Satellite Operators**
  - **Prelaunch instrument characterization guidelines**
  - **Cal/Val Plans**
  - **Best practices for instrument monitoring and improved calibration**

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GSICS Products

- GSICS Bias Monitoring
  - **Routine comparisons of satellite radiances against reference**
- GSICS Correction
  - **Function to correct issued radiances**
  - **For consistent calibration with reference**
- GSICS Reports & Guidelines
  - **Recommendations to modify practices**
  - **Design and Operation of future satellite instruments**
- For Operational Environmental Satellites
  - ✓ **Infra-red recalibration (GEO and LEO) (current operational satellites)**
  - ✓ **Visible and near-infrared recalibration (GEO and LEO)**
  - ✓ **Microwave – Conical & Cross-track Scanners (LEO)**
  - ✓ **Historic Instruments**
  - ✓ **Pre-Operational & Demo status**
  - ✓ **Near real-time and re-analysis**
  - ✓ **In development within GSICS**
  - ✓ **In development with GPM XCAL**
  - ✓ **In development at EUMETSAT…**

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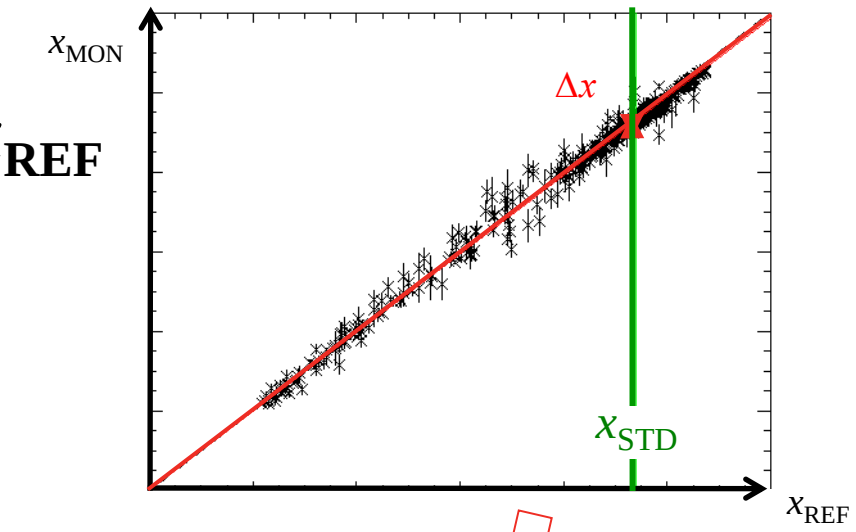
GSICS Products: (1/3) Bias Monitoring

- **Comparing samples of x_{MON} , x_{REF}**
  - Over fixed domain
  - Period (e.g. 1 orbit/1 day)
  - Typically ~ 1000 comparable samples/day
- **Regression**
- **Calc bias, $\Delta x = x_{MON} - x_{REF}$**
  - Δx at standard scene, x_{STD}
  - with uncertainty
- **Plot time series of bias Δx**
  - Compare recent results with long-term trend
  - Valuable for instrument monitoring



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Example of GSICS Bias Monitoring

From EUMETSAT: Time Series of Meteosat10-IASI Standard Biases [K]

This page shows prototype GSICS Bias Monitoring resulting of the inter-comparison of infrared channels of geostationary ▸ **Meteosat imagers** and the polar-orbiting ▸ **IASI** sounder from collocated observations. The plots show the relative biases between these instruments for standard radiances, corresponding to clear sky scenes over the ocean, in a standard atmosphere. The results from the ▸ **inter-calibration algorithm (PDF, 980 KB)** can also be downloaded as ▸ **GSICS Correction Coefficients (PDF, 79 KB)** in ▸ **netCDF format (PDF, 66 KB)** from ▸ **EUMETSAT's GSICS and Product Server**.

See the ▸ **GSICS Product Status Summary** for further details or visit our ▸ **GSICS page** for a comprehensive list of resources.

Satellite: Meteosat-10 SEVIRI

Channel: IR13.4

Date: Year 2013 Month 03 Day 17

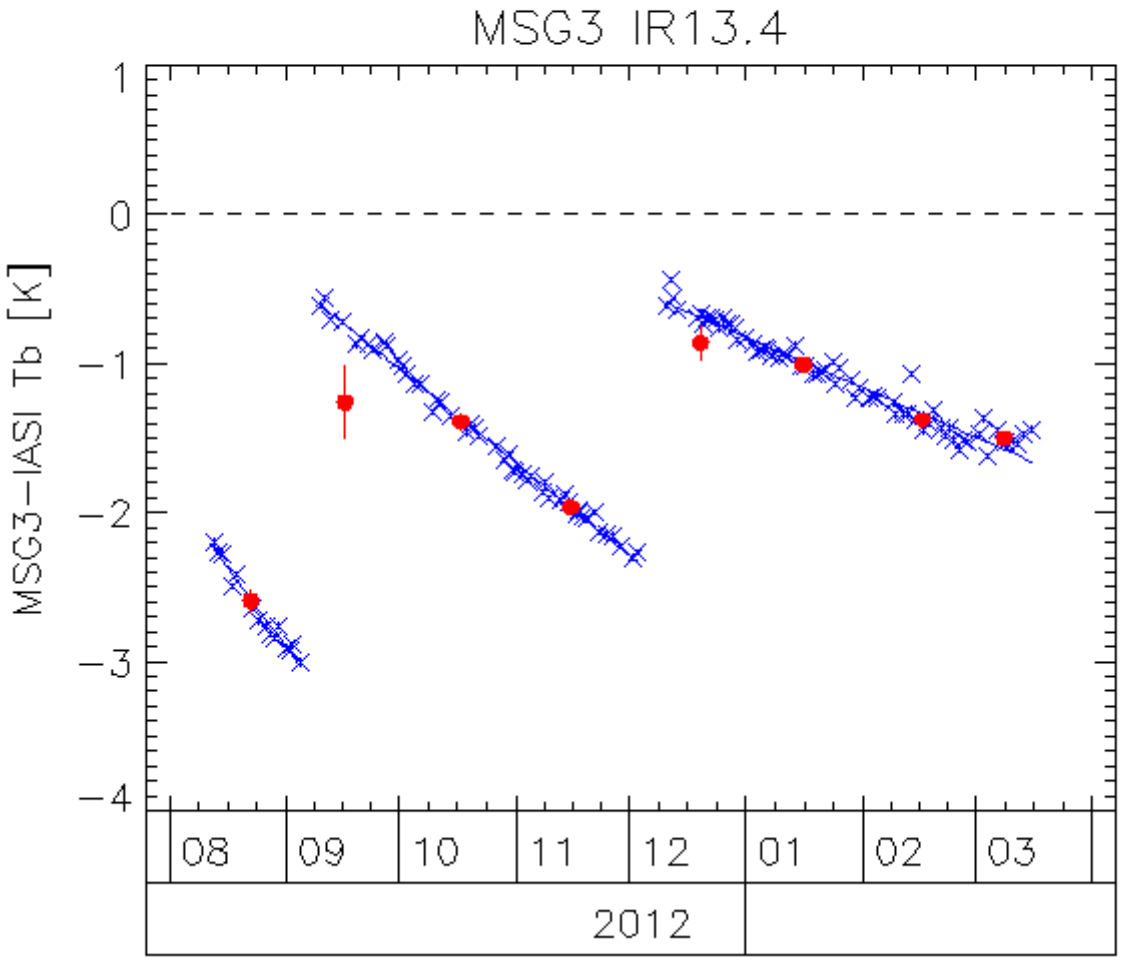
Time: 2215

Display: Time Series Plot

Legend

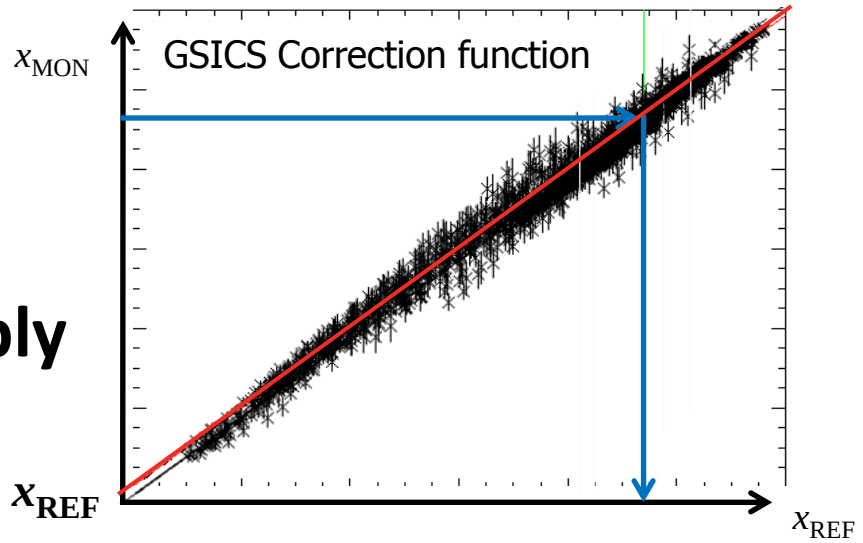
- Bias fitted at T_{bref} from 1 night-time overpass
- Bias fitted at T_{bref} from 1 day-time overpass
- Monthly mean Bias from all night-time data
- Trend in night-time data

Error bars: 1-σ uncertainty



GSICS Products: (2/3) GSICS Correction

- **Compare all x_{REF}, x_{MON} samples**
  - **– over smoothing period (e.g. 2 weeks)**
- **Regression coefficients**
  - **with uncertainty (covariance)**
- **Provide a *function* users can apply**
  - **to convert level 1 data, x_{MON}**
  - **to be consistent with calibration of reference, x_{REF}**
- **Two versions:**
  - **Near Real-Time (asymmetric time window)**
  - **Re-Analysis (symmetric time window)**



GSICS Products: (3/3) Guidelines

- Underlying assumption of GSICS Correction:
  - Small errors (e.g. SRF errors, blackbody temperature, ...) introduce small departures from 'true' calibration
  - If these are linearly related to a predictor (radiance, time, ...) we can apply empirical correction based on inter-calibration
- Guidelines can analyse GSICS products
  - to diagnose root causes of calibration errors
- Can derive recommendations to modify
  - operating practices (e.g. adopt new SRF definition),
  - pre-launch characterisation, etc.
- These GSICS Guidelines are distributed as written reports

GSICS Global Space-based Inter-Calibration System

GSICS Procedure for Product Acceptance

- Based on QA4EO
- Products progress from
  - Demonstration Mode
- Through
  - Pre-Operational Mode
- To
  - Operational Mode
- By a series of reviews
- Over period of ~1.5yr
- Subject to meeting acceptance criteria

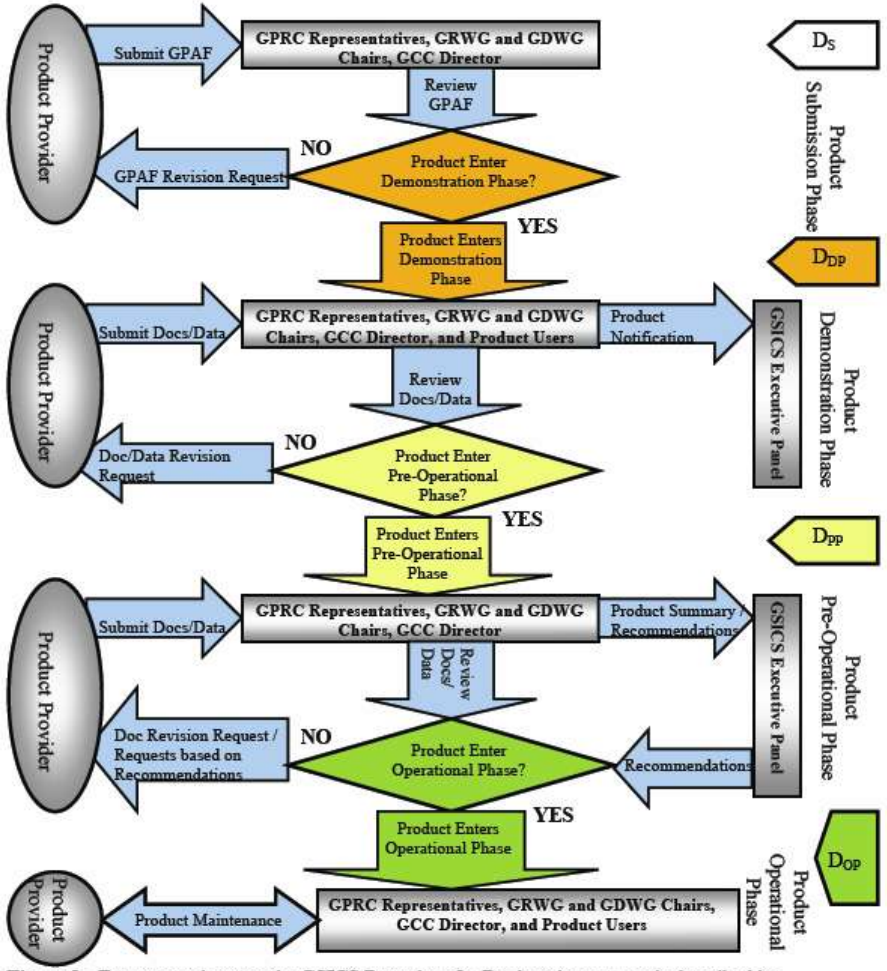


Figure 1: From top to bottom, the GSICS Procedure for Product Acceptance is described by four phases - Product Submission Phase, Demonstration Phase (DP), Pre-operational Phase (PP), and Operational Phase (OP) – and their review and revision cycles. The time markers at the far right, and their defined limits, are: date of submission (D_S); and the number of days from D_S to fulfill requirements to enter DP ($D_{DP} \leq D_S$+90days), PP ($D_{PP} \leq D_{DP}$+365days), and OP ($D_{OP} \leq D_{PP}$+180days).

GSICS Product Status 2014-02

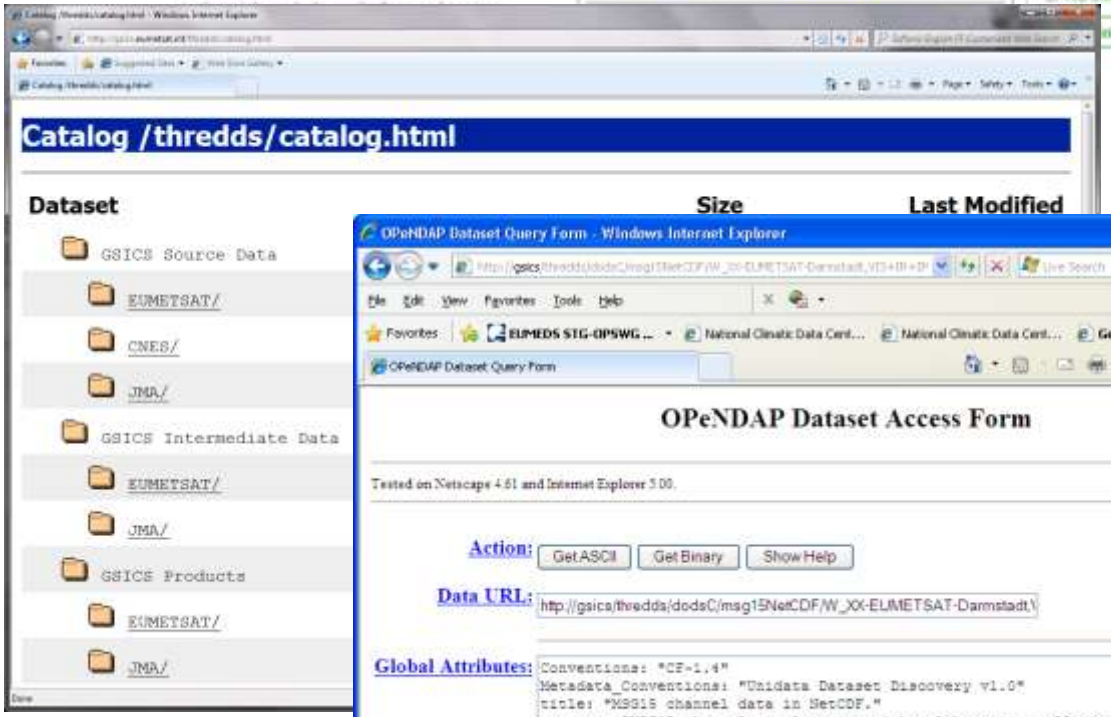
GPRC	Monitored Instrument	Reference Instrument	GSICS NRT Correction	GSICS Re-Analysis Correction	GSICS Bias Monitoring
EUMETSAT	Meteosat-8 – 10 } Meteosat-7	Metop-A/IASI	Pre-operational	Pre-operational	Prototype
JMA	MTSAT-1R } MTSAT-2 }	IASI (+ AIRS)	Demonstration	Demonstration	Prototype
NOAA	GOES-13 & -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 – E	IASI (+ AIRS)	In development	In development	Prototype
NOAA	AMSU/MSU	NOAA14/AMSU	In development	Pre-Operational	In development
NOAA Patmos-X	TIROS-N – NOAA – Metop /AVHRR	Aqua/MODIS	-	Demonstration	-

Full GSICS Product Catalog available at http://www.star.nesdis.noaa.gov/smcd/GCC/ProductCatalog.php

GSICS Global Space-based Inter-Calibration System

Where to get the data?

- **GSICS Bias Monitoring (prototype)**
  - –Hosted on websites of GSICS Processing & Research Centres (GPRCs)
- **GSICS Corrections**
  - –GSICS Data & Products Servers
  - –THREDDS-based system
  - – NetCDF format
  - – WMO GTS standard file names
  - –– Unidata & CF conventions
  - –See gsics.wmo.int for links



GTS = Global Telecommunication System
CF = Climate and Forecast

Other GSICS Activities

- Development of Best Practice Guidelines to :
  - Select Reference Instrument
  - Define Spectral Band Adjustment Factors

- Instrument Event Logs
  - Coordinate a common vocabulary and interface definition
  - To log events affecting instrument calibration

GSICS Web Meeting

https://gsics.nesdis.noaa.gov/wiki/Development/20130924

Marie highlighted that there are 4 SCOPE-CM activities that involve inter-calibration of satellite radiances:

05: Advancing the status of the AVHRR FCDR,

06: Inter-calibration of passive imager observations from time-series of geo stationary satellites (IOGEO),

03: Land surface albedo from geostationary satellites (LAGS), and

09: Sustained production of the International Satellite Cloud Climatology Project (ISCCP) cloud products.

- **Discussion identified specific follow-up areas, summarised in the following slides...**

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SCM-05 Advancing the status of the AVHRR FCDR

Within the CM-SAF the FCDR of AVHRR-GAC data from the PATMOS-X project has been used for reprocessing of their cloud retrievals (CLARA-A1). The first reprocessing revealed several issues with the input FCDR (quality of reference satellite calibration, infra-red calibration, navigation, and data housekeeping). This SCOPE-CM project aims to resolve these issues and to improve the quality of the AVHRR-GAC FCDR.

This project has several links to GSICS:

- **Firstly, GISCS is interested to follow the approaches adopted to perform the VIS and NIR recalibration and to propagate these calibrations back in time.**
- **Second, this SCOPE-CM project is interested in the approaches used by GSICS using IASI observations for the recalibration of the IR channels, as well as the approach GSICS is developing that uses HIRS observations to recalibrate the time-series of MFG and MSG observations of the IR and WV channels. The link is related to the work outlined in the SCOPE-CM IOGEO project.**

Further to this presentation the following actions were defined:

- **Action EUMETSAT: Keep SMHI informed about the progress on preparing a reference HIRS data record. When this dataset is ready it can be made available to the SCOPE-CM AVHRR-FCDR project.**
- **Action SMHI: Keep GSICS informed on the methods adopted by the CM-SAF for calibrating the VIS and NIR channels of the AVHRR-GAC time-series.**

SCM-06: Inter-calibration of passive imager observations from time-series of geostationary satellites (IOGEO)

This project aims to generate FCDR from all GEO VIS, IR and WV channels, using re-calibration methods based on work done within GSICS. However, since the aim is to go back in time till ~1982, GSICS methods cannot be taken over one-to-one. The main challenges are on the selected re-calibration method, i.e., a reference instrument needs to be available over the complete time-series, the method(s) should be applicable to all GEOs with accuracy <3%.

Some anticipated involvements of GSICS in this SCOPE-CM activity are:

- **Sharing of knowledge;**
- **Exchange of inter-calibration approaches;**
- **Contribute to the definition of an inter-calibration approach for the IR and WV heritage channels (2014-2015);**
- **Contribute to the definition of a combined inter-calibration approach for the VIS/NIR heritage channels (2015-2016);**
- **Participate in the verification and validation of the FCDRs (2015-2016).**

The IOGEO SCOPE-CM is open to additional participants from space agencies such as CMS and KMA. CMA indicated that they will recalibrate their FY1 historic data records against AIRS and IASI. In order to cover the entire time-series of the data records and additional reference is needed. EUMETSAT indicated that using the HIRS data record might be an option of completing the entire record, and thus can be useful to check temporal stability. Further to this discussion two actions were defined:

- **Action EUMETSAT: Invite KMA and CMA to participate in SCOPE-CM IOGEO**
- **Action EUMETSAT: Share HIRS data record with CMA**

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SCM-03: Land surface albedo from geostationary satellites (LAGS)

This project aims to generate a Thematic Climate Data Record (TCDR) of surface albedo from all GEOs, which requires the generation of a FCDR of visible reflectance observations.

One of the first tasks foreseen within the LAGS project is the re-calibration of VIS observations from all geostationary satellites during the cause of 2014. Although this task is related to the objectives of IOGEO SCOPE-CM, its timing is out of phase with IOGEO that aims at providing such a FCDR in 2017 at the earliest. Therefore, within LAGS an intermediate solution needs to be adopted for the re-calibration methods re-calibration of the VIS channels.

At the meeting it was discussed that the Deep Convective Clouds (DCC) method of GSICS could serve as baseline for the re-calibration in LAGS. Reasons are that most participants (JMA, NOAA, and EUMETSAT) are already using this method, or are familiar with the basic principles, and the method can be applied to all heritage geostationary satellite observations. For this phase of LAGS using DCC may be the most pragmatic solution. For future re-processings, LAGS may use the FCDR provided by IOGEO. The actions were:

- **Action JMA and EUMETSAT: To collaborate with EUMETSAT on transferring EUMETSAT's DCC method to JMA through the EUMETSAT VS activity with JMA.**
- **Action NOAA: Fangfang to establish contacts with the NOAA representative in SCOPE-CM GSA and inform them on using NOAA's DCC for the recalibration of the time-series of GOES visible channel observations.**

SCM-09: Sustained production of the ISCCP cloud products

The aim of this SCOPE-CM project is to repeat the recalibration of the ISCCP level-1 data, comprising all AVHRR and GEO radiances of common VIS and IR channels, and generate a homogeneously calibrated dataset of their radiances.

- **What are the plans for recalibration of historic data records?**

This question is basically answered in the above presentations on SCOPE-CM projects. There is overlap between these projects, although they either cover different datasets of have a different planning. GSICS or the SCOPE-CM secretariat may need to consider setting up a mechanism to coordinate the exchange of knowledge and methods between these projects.

- **Can GSICS share their DCC code for this activity?**

This can be done by sharing the code or by sharing the ATBD. This needs to be discussed further within NOAA and with EUMETSAT and JMA.

- **Concerns:- Where to find the resources for SCOPE-CM activities?**

There is no funding associated with SCOPE-CM. However, SCOPE-CM may be used as argument to find 3rd party funding within national or inter-national research funding programs. The commitments made to SCOPE-CM are not-binding, and their timely completion depends on the funding situation.

- **How to reconcile different approaches?**

At the meeting it was suggested that we should inter- compare the re-calibrated datasets generated within different SCOPE-CM projects and within GSICS so as to reconcile different approaches.

The actions defined are:

- **Action NOAA: Provide information on the ISCCP method to GSICS.**
- **Action EUMETSAT: Share and/or keep NOAA informed on the progress made in setting up the DCC method.**

Possible Future GSICS/SCOPE-CM Interaction

	GSICS Products	Other I/P from GSICS	O/P to GSICS
SCM-01 Tropospheric Humidity	**GEO-LEO IR**	**ATBD, SBAF Definition, Reference Selection**	**Common Reference Channels**
SCM-02 Albedo Polar Orbiters	**PATMOS-X**		
SCM-03 Albedo Geostationary	**1yr Test dataset for GEO Vis (DCC)**	**ATBD for DCC calibration**	
SCM-04 Monsoon/Cyclone studies			
SCM-05 AVHRR FCDR	**HIRS-IASI**	**Collocations** **Lunar Calibration ATBD?**	**Vis calibration Workshop**
SCM-06 IOGEO	**GEO-LEO IR + VIS**		
SCM-07 LWP & RWP in the GPM era		**GPM X-cal**	
SCM-08 RO-based gridded data sets		**GRUAN-GSICS-GPSRO I/C**	
SCM-09 ISCCP cloud products	**GEO-LEO IR**		
SCM-10 AMV, C/ASR from GEO/LEO	**GEO-LEO IR**		

Thank You