Current GSICS Activities

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GSICS Research Working Group

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CEOS WGCV Plenary 41

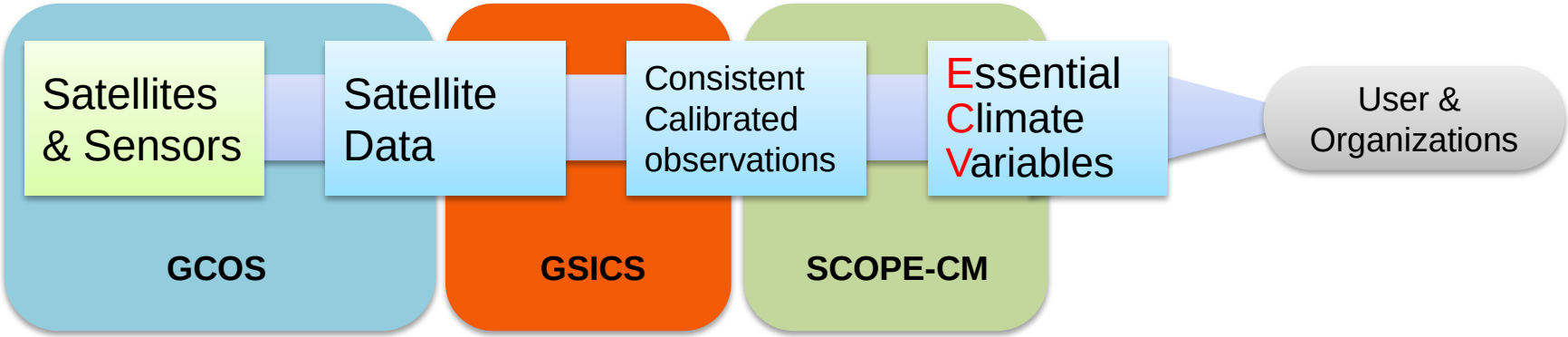
Outline

1. Overview
   - ✓Introduction
   - ✓Organization status
2. Recent GSICS activities
3. Collaboration

Background of GSICS

The Global Space-based Inter-Calibration System (GSICS) :

- initiated in 2005 by the WMO and the CGMS
- was recognized in 2009-2011 as a Pilot Project in the Demonstration Phase of the WMO Integrated Global Observing System(WIGOS)



GSICS?

Why GSICS?

- Space-based observations from various satellite missions must be precisely calibrated with similar methods against common references
- Poor or inhomogeneous calibration results in degraded performance and lower benefits
- **CGMS members are collaborating within GSICS to develop and apply "best practices" for homogeneous calibration**

What is GSICS?

- ensures consistent calibration of satellite measurements and tie the measurements to SI reference standards
- defines and implements procedures for operational, in-orbit satellite inter-calibration;
- relates the measurements of one instrument to those of a reference instrument with a stated uncertainty.
- The overlapping records of two satellite instruments can be compared once a number of effects, such as diurnal cycle, are taken into account.
- GSICS inter-calibration allows biases to be removed among satellite measurements.

Scope of GSICS?

- coordinates the systematic generation to correct the individual calibration(Level 1)
- a range of activities related to:
  - Instrument Level 1 data monitoring
  - comparison with references
  - routine generation of corrections in near real-time
  - provision of algorithms enabling recalibration of archived data
  - traceability to absolute calibration standards
  - prelaunch instrument characterization
  - post-launch instrument validation
  - documentation on state-of-the-art calibration techniques

Who benefits from GSICS ?

- **Satellite operators**
  - Sharing development effort and resources (calibration references, datasets, software tools)
  - Capacity building (best practices for instrument monitoring, traceability, sensor comparison and correction)
  - Improved instrument assessment, faster identification and correction of anomalies, facilitating commissioning and operation
  - Interoperability within the CGMS constellation

- **Satellite data users**
  - Improved calibration
  - Interoperability through inter-calibration
  - Assessments, reports, for better understanding
  - Algorithms enabling to reprocess data records
  - GSICS leverages the value of individual missions

GSICS Services and Tools

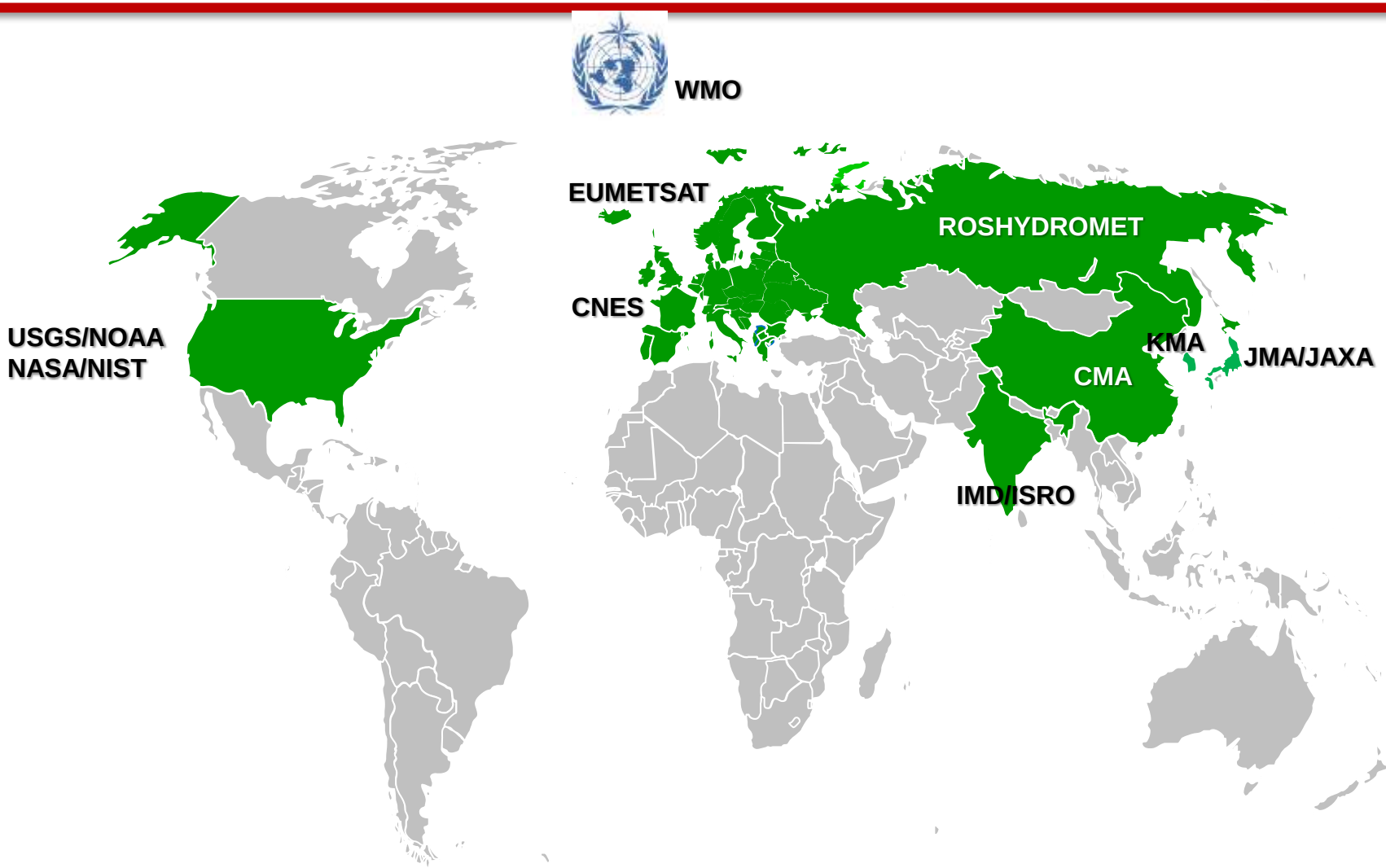
General information services

- GSICS portal maintained by WMO (http://gsics.wmo.int)
- GCC website maintained by the GSICS Coordination Center
- GSICS related websites maintained by each member agency
- GSICS User Messaging Service managed by the GCC
- GSICS Product Catalogue
- GSICS Quarterly newsletter
- GSICS User Workshop
- GSICS Wiki providing access to technical documentation (ATDB of each product and recording presentations from the GRWG and GDWG meetings)

Specific tools

- GSICS Data and Products Servers (at EUMETSAT, NOAA, CMA)
- GSICS product generation framework and products format checker
- GSICS Implementation of the ROLO Model (GIRO) lunar calibration software and associated GSICS Lunar Observation Dataset
- Various software tools(Bias plotting tool)

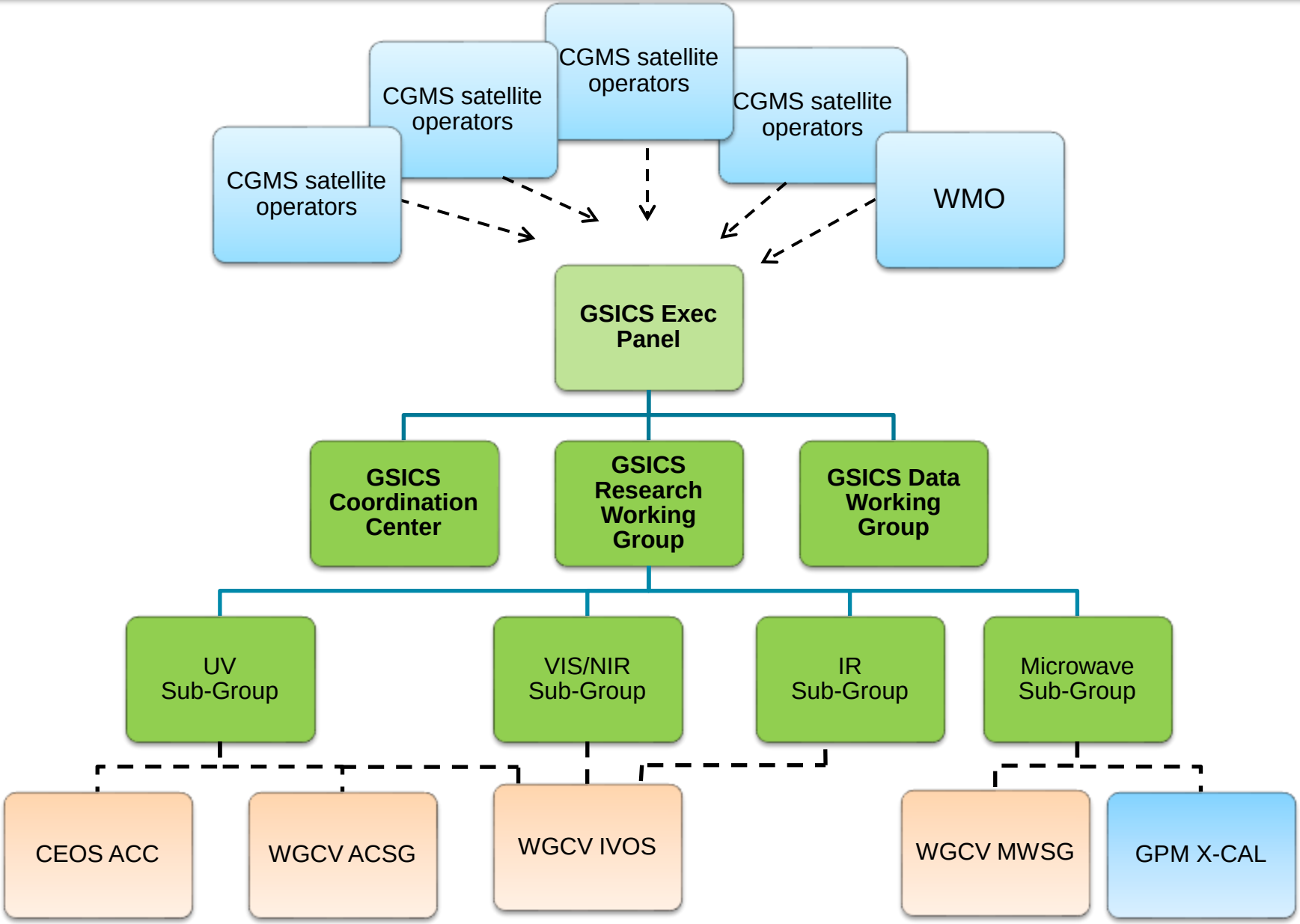
GSICS Members



Obs. ESA + CEOS/WGCV
Assoc. GPM X-Cal

14 Members Worldwide

GSICS Structure



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Operational coordination

GSICS Procedure for Product Acceptance

Submission Phase

ISRO (INSAT/IASI)	KMA (COMS/IASI)	EUM (DCC, Prime)	CMA (FY-2/IASI)

Demonstration Phase

4 EUMETSAT	17 NOAA	6 JMA

Pre-operational Phase

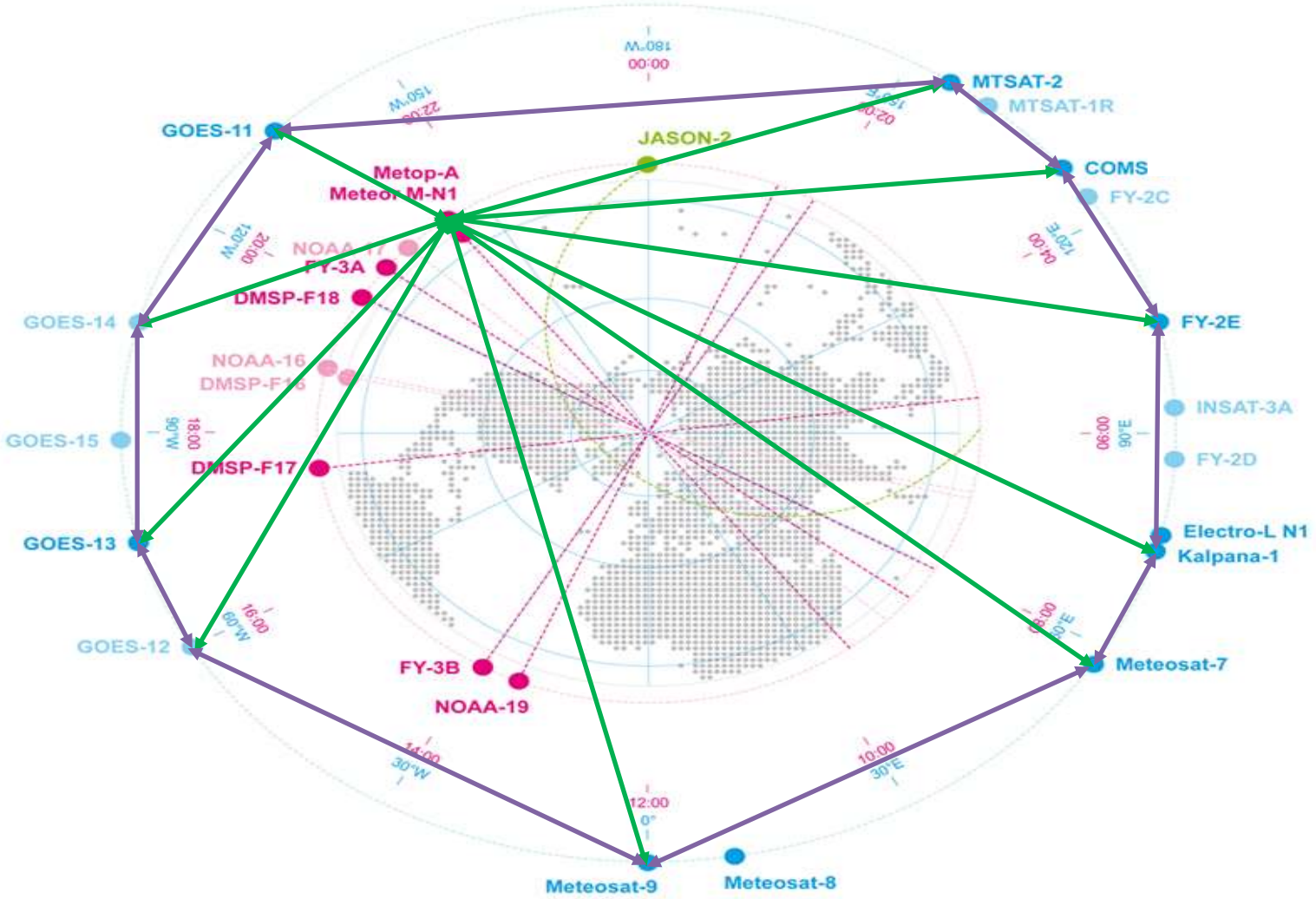
4 NOAA products (GOES-11,12,13,15 / IASI, AIRS)

Operational Phase

4 EUMETSAT products (Meteosat 9-10/IASI)

IR Product Development within GSICS (IR)

- GEO-LEO IR hyperspectral
  - Progress existing products to Operational Status
  - Promote new products to Demonstration Status
  - Application of Prime GSICS Correction concept
    - To merge multiple reference instruments
    - To allow corrections to cover diurnal cycle
- Scope potential new GSICS products/deliverables
  - Alternative inter-calibration algorithms
  - Retrieved SRFs
  - GEO-GEO inter-calibration
    (part of GEO-ring)
  - LEO-LEO inter-calibration
- Traceability of Reference Instruments
  - Plans for TANSO-FTS/2 & CLARREO
  - GSICS IR Reference Sensor Traceability and Uncertainty Report



IR Inter-calibration available through the whole GEO ring

Comparing GEO-LEO and GEO-GEO Differences

- To validate uncertainty estimates and ensure L1 data consistency
- To generate globally consistent L2 products

DCC calibration Status (VIS/NIR)

- Started in 2014
  - NASA Langley provided all GPRCs verification data to validate the proper implementation according to ATBD submitted in 2011

- The DCC method has been implemented by all GPRCs by 2015 and reported on their status and issues of the implementation

- The DCC methodology provides excellent estimate of the relative degradation of the monitored instrument, however the GEO domain specific DCC methodology noise can be reduced by adjusting DCC methodology components as needed

1) DCC BRDF
   - KMA has evaluated model developed by Seoul National Univ.
   - CNES has defined the more Lambertian part of the BRDF

2) DCC deseasonalization
   - NOAA, EUMETSAT, CMA have developed methods

3) DCC statistics and identification (to provide sufficient sampling)

Improving the lunar reference

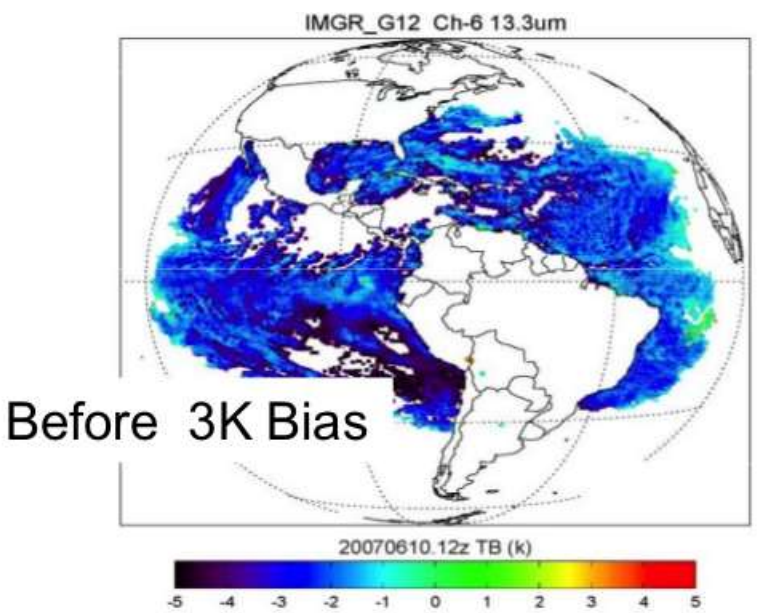
- The reference irradiance is generated for each observation of the Moon taken by an instrument by computing the lunar model(ROLO, GIRO)

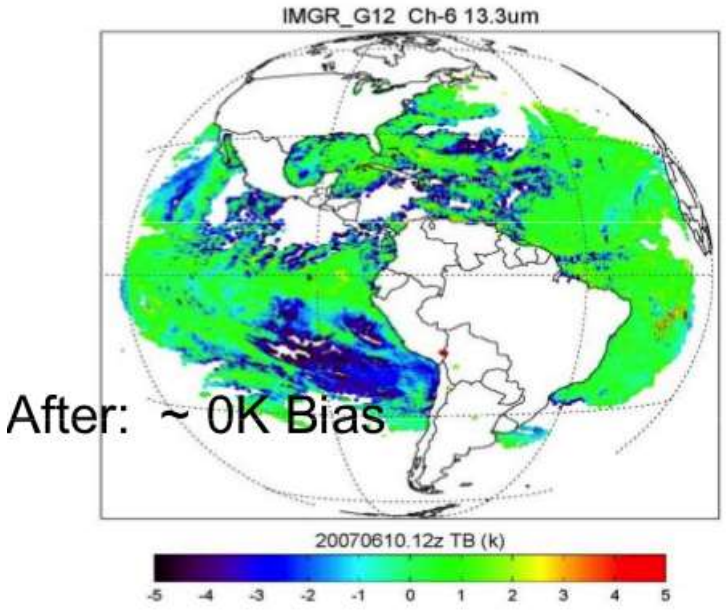
- Improvement of the reference standard for lunar calibration
  - to improve absolute accuracy
  - to reduce residual geometry dependencies (phase, librations)

- **Requirements for and <u>Absolute Lunar Calibration Reference</u>**
  - reprocessing the ROLO telescope dataset using new algorithms
  - incorporating reliable new observational data e.g. PLEIADES
  - lunar radiometry e.g. SNPP VIIRS
  - collecting new radiometric measurements of the Moon
  - requirements:
    - high-accuracy, with traceability to SI
    - full spectral coverage at moderate spectral resolution
    - photometric geometry coverage (phase and librations) sufficient for high-precision modeling

Achievement (NOAA)

GSICS Correction Algorithm for Geostationary Infrared Imagers

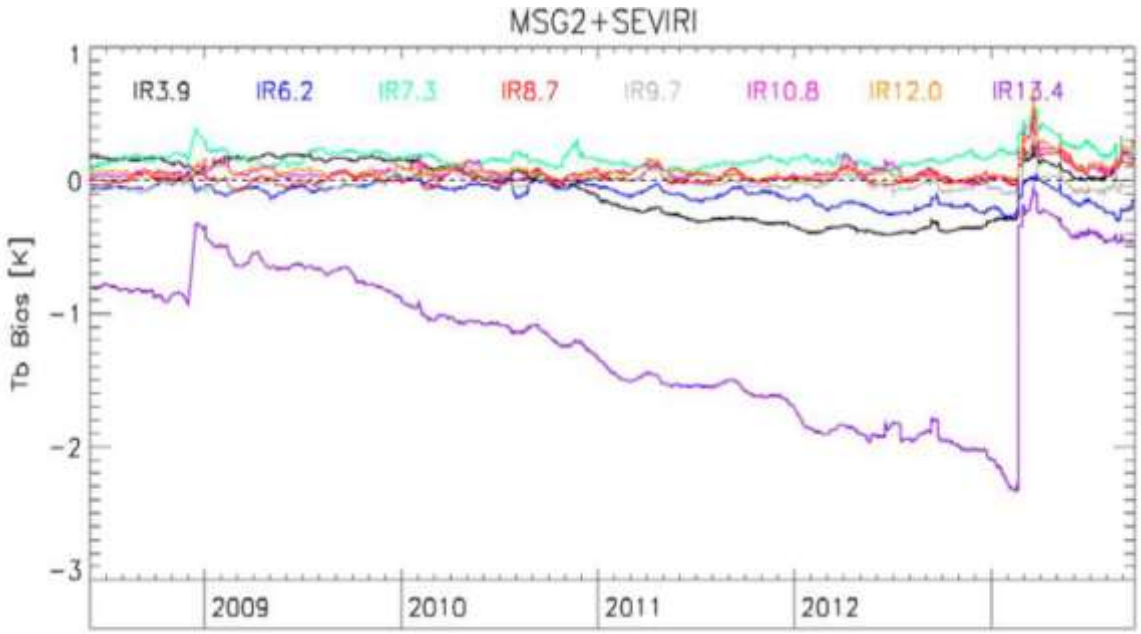




- The GSICS correction adjusts the GOES data to be consistent with IASI and AIRS.
- The figures show the difference between observed and calculated brightness temperatures (from NCEP analysis) before and after correction
- The bias is reduced from 3K to nearly zero.

Achievement (EUMETSAT)

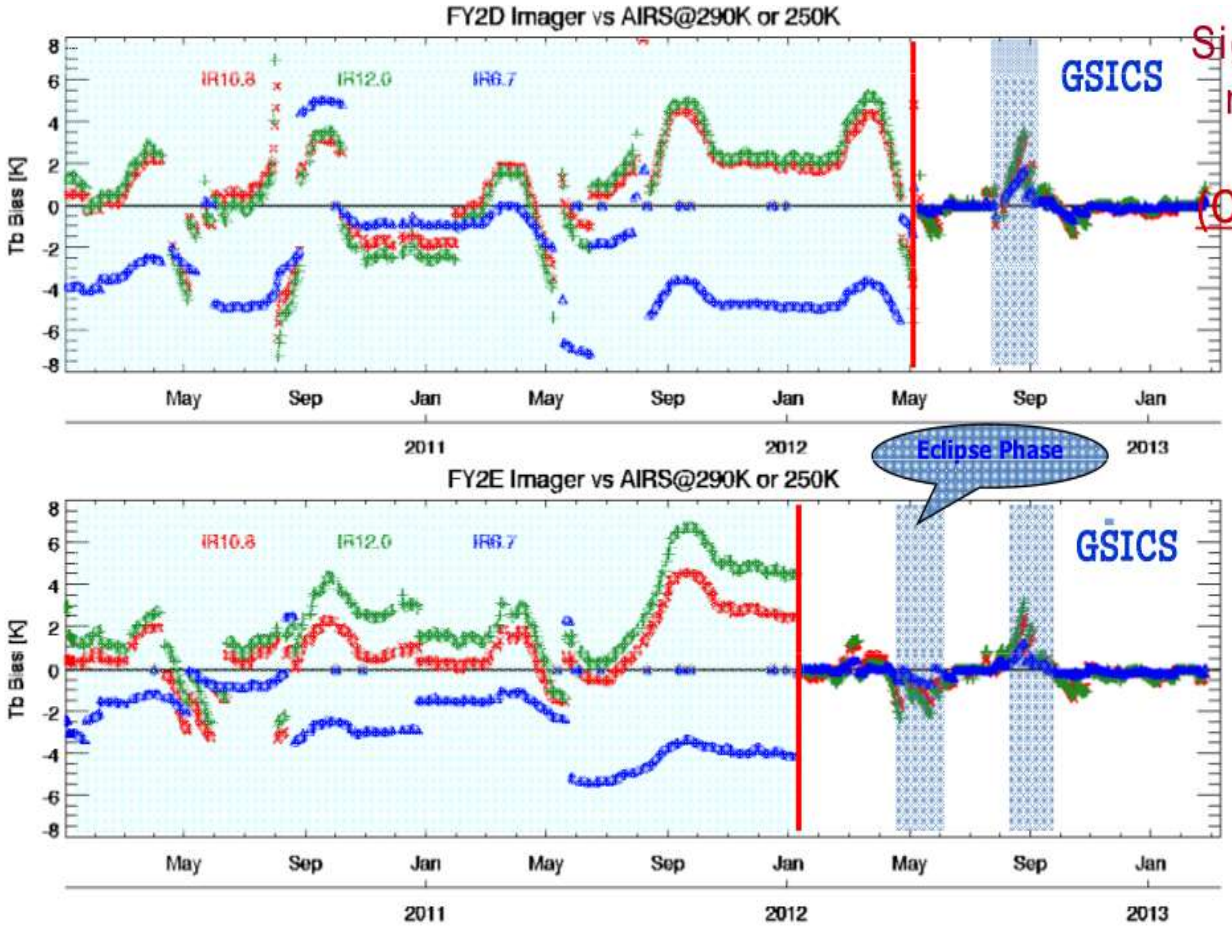
Meteosat-9/SEVIRI 13.4µm channel



- Ice buildup on 13.4µm channel (Hewison & Müller 2013)
- Based on GSICS analysis
  - Compared to IASI
- Clearly see decontamination events
- Correction available for GSICS period
  - for climate may need to correct for earlier sensors

Achievement (CMA)

IR Calibration Bias of FY-2 VISSR



Significant progresses were made in FY-2 operational calibration (Changed to GSICS in 2012)

Operational calibration of FY-2D/2E was upgraded using GSICS inter-calibration algorithm in 2012-04 and 2012-01 separately.

The calibration biases were sharply decreased, and reduced to about 0.5~1K @ 290K (@ 250K) without eclipse period.

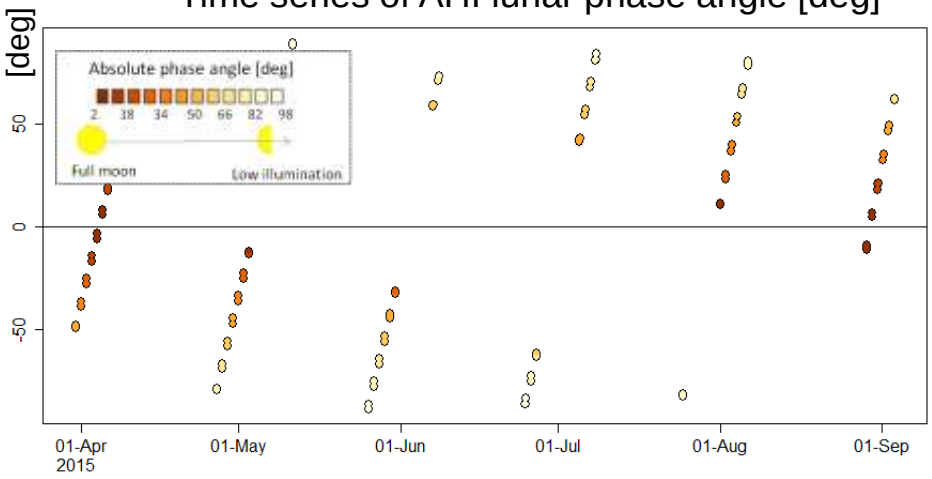
Time series of TBB biases for IR1~3 channels vs. AQUA/AIRS reference scenes (290 K for IR1 and IR2, 250 K for IR3).

Achievement (JMA)

AHI Lunar Observation for GIRO

- **2979** useful lunar observations for the GIRO within the applicable phase angle:
  2 deg ≤ |phase angle| ≤ **92** deg
- 47 days data
  → 60-70 lunar observation / day on average

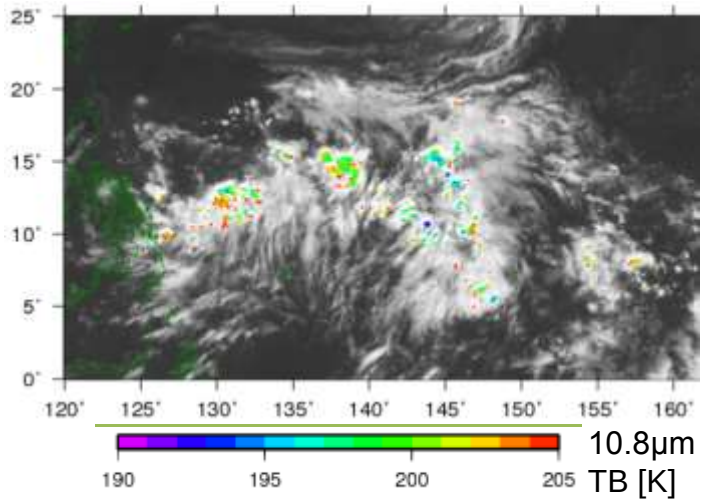
Time series of AHI lunar phase angle [deg]



GEO-LEO VIS/NIR

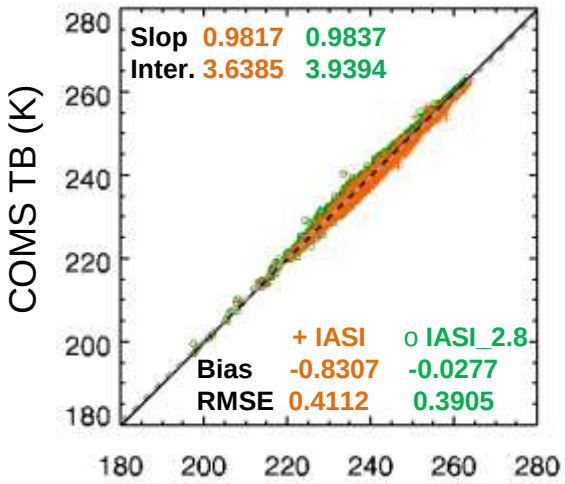
- Currently two main activities on-going:
  - Inter-calibration of GEO imagers with MODIS using Deep Convective Clouds as transfer target
  - Lunar calibration : and using the Moon for inter-calibration

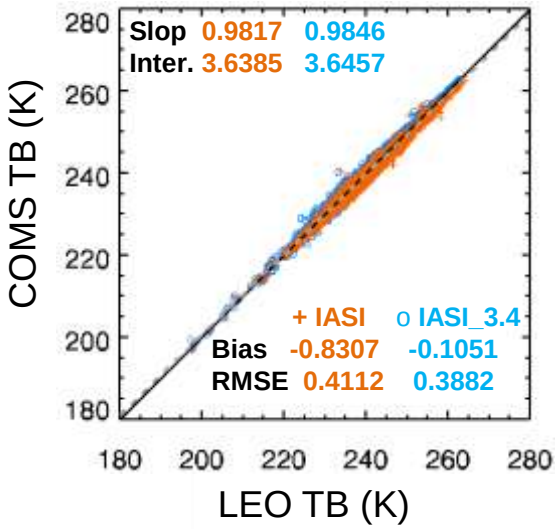
MTSAT-2 DCC detection 2012-07-01T04



Achievement (KMA)

- **Result** of IASI SRF shift and check the **TB bias and trend of TB bias for WVIR**
- Period: Jan. 01.2014 - Dec.12.2014

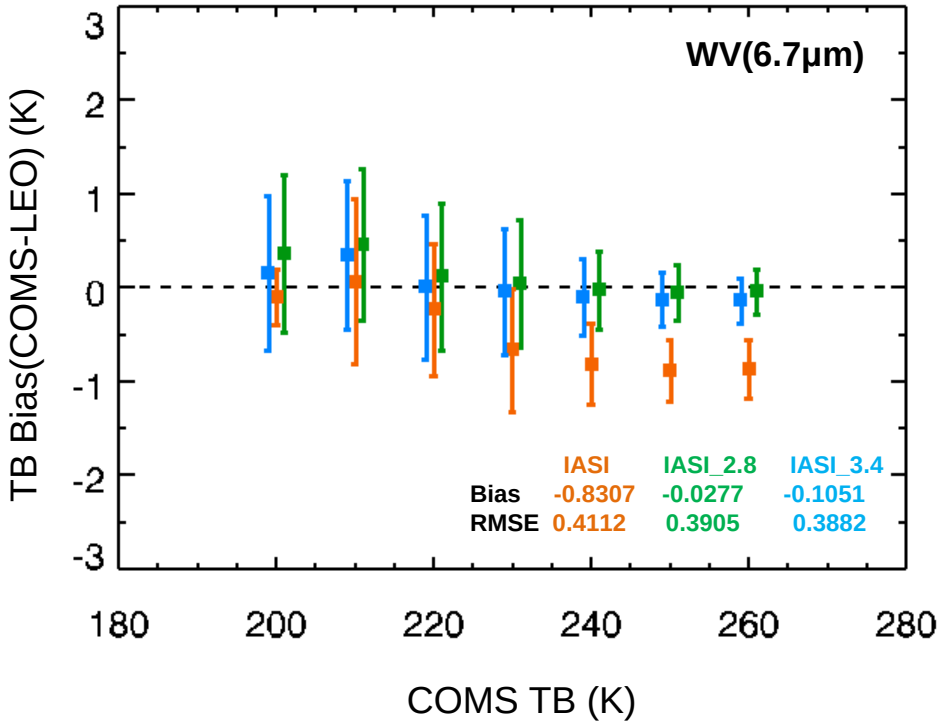




IASI : Original MI + Original IASI

IASI_2.8 : Original MI + IASI SRF shifted by +2.8cm^{-1}

IASI_3.4 : MI corrected + IASI SRF shifted by +3.4cm^{-1}



GRWG Work plan 2016-2017

- Further development of GEO-LEO IR and DCC products
  - To progress existing products to Operational Status
  - To promote new products to Demonstration Status
- Development of lunar inter-calibration & merging with DCC
  - To finalize implementation and monitor the GSICS VIS/NIR product
  - To put in place an algorithm using the Moon as a transfer target
- GEO-ring demonstrator
  - to recalibrate IR and WV radiances for multiple GEO satellites
  - to support the generation of SCOPE-CM FCDRs
  - to analyse GEO-ring test dataset and SBAF tool
- Application of “Prime GSICS Correction” concept
  - to merge multiple reference instruments and multiple methods
  - to allow corrections to cover diurnal cycle

GDWG Activities

- GSICS Website Review; identification of minimum requirement / updates
- Roll out of the GSICS Wiki on a new server (gsicswiki.net)
- Collaboration software development to preserve GSICS products
- Finalising the Instrument information landing page for the WMO OSCAR
- New Meta-data, conventions and template for existing and new GSICS Products; GEO-LEO-IR (existing), GEO-LEO-VNIR (new)
- **GDWG Work Plan 2016/2017**
  - Updating collaboration server products' structure.
  - Updating current GSICS product plotting tool to support new GSICS products
  - Test exchange of GSICS products between collaboration servers
  - New GSICS product templates
  - GSICS products checker tool (if resources allow)

GCC Activities

- **GSICS Coordination Center** continues to support and coordinate exchanges of ideas within GSICS
- Four new Issues of GSICS Newsletter were published
- Meeting Support : Web-meetings + GSICS Users Workshop
  - Supported CEOS WGCV-ACSG and GSICS UV Meeting at NCWCP
  - Supported GSICS GRWG + GDWG Annual Meeting, Tokyo
- GPPA → Fine Tuned the GPPA and proposed review paths to producer

  GPPA: GSICS Procedure for Product Acceptance
- Review the GSICS versioning paradigm
- Updated the Instrument Info Kiosk with the SRF netCDF files and Hyperlinks to the SRF data
- Selection of Reference Instrument
  - GCC evaluated the criterion and a process to select reference (by Tim Hewison)
  - Presented the work in JPSS Science meeting (With contribution from JMA, KMA, EUMETSAT and NOAA)
- GCC reviewed FCDR inter-calibration requirements, in the framework of the GSICS User Product Guidance
  - IR, Reviewed FIDUCEO project report.
  - MW, User feedback on the MW FCDR received

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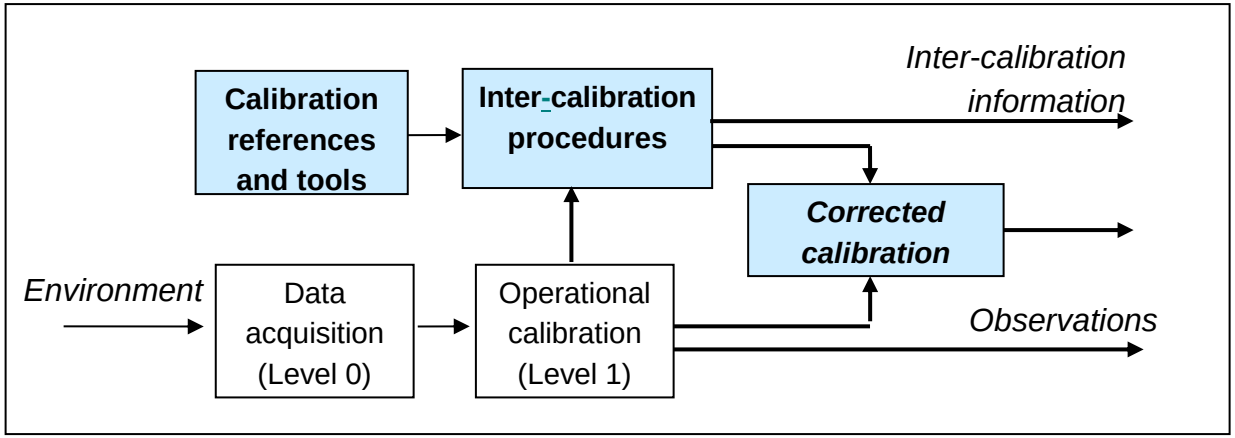
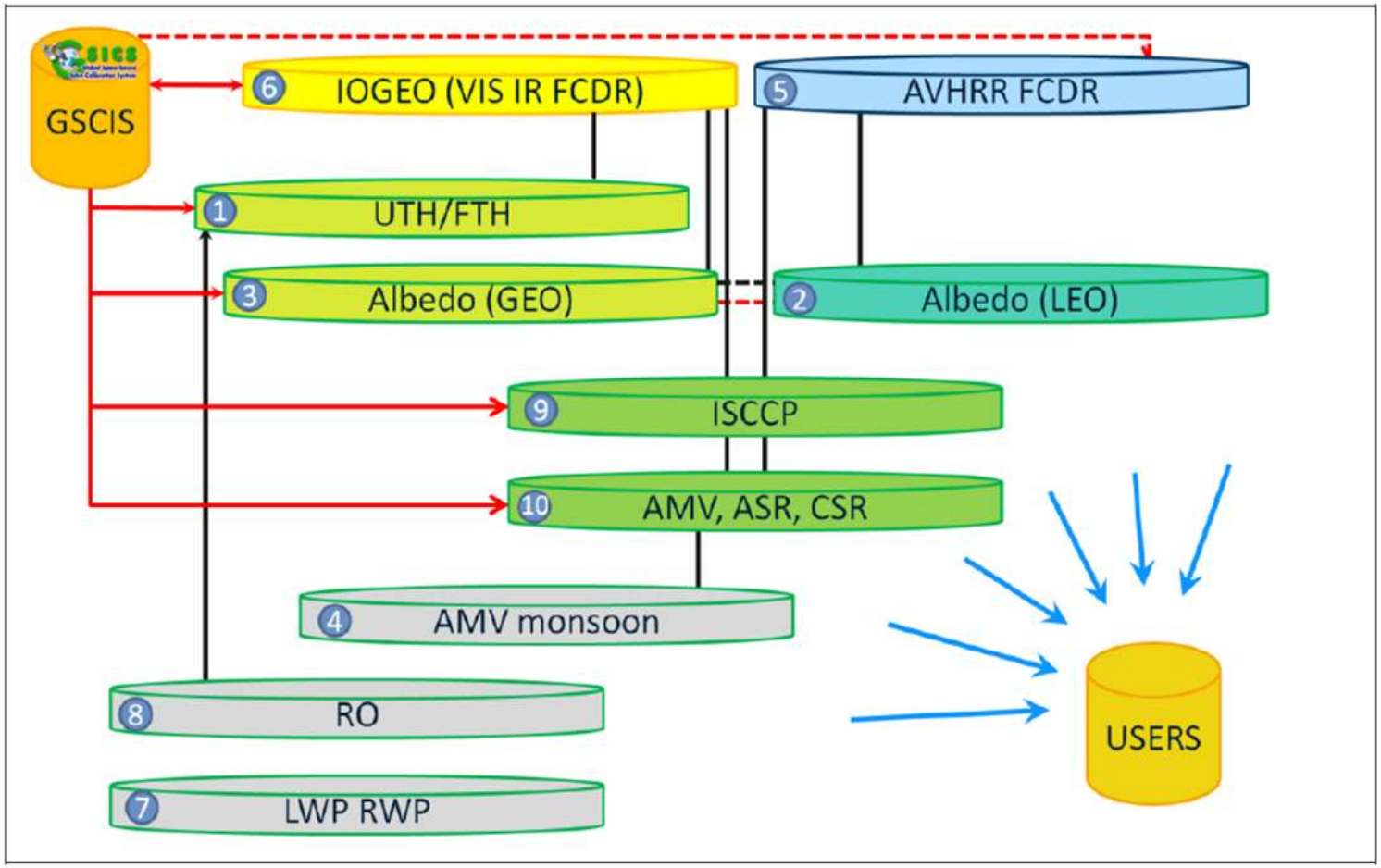
Contribution for Climate Monitoring from Space

- **Role of GSICS in the architecture for Climate Monitoring from Space**
  - Need to find a clear plan to communicate with users, collect and document the user requirements
  - Procedures ensuring the consistency of data records through accurate and harmonized calibration should be part of the Architecture
  - These belong to the «sensing pillar» (space segment design, pre-launch characterization, maintaining references, instrument monitoring and calibration) and to the «CDR creation and preservation pillar» (intercalibration, re-calibration)



GSICS/SCOPE-CM Collaboration

Excellent collaboration concept between GSICS and SCOPE-CM incl. ISCCP!



Partnership with WGCV

GSICS, in partnership with the CEOS WGCV, contributes to the Architecture for Climate Monitoring from Space in multiple ways:

- GSICS provides a calibration infrastructure
  - In orbit references providing traceability
  - Ground-based calibration sites (CEOS WGCV lead)
  - Databases and software tools
- GSICS develops processes to be implemented by satellite operators
  - Best practice for pre-launch characterization (Joint GSICS/WGCV Workshop)
  - Procedures for in-orbit calibration and validation with uncertainty estimation
  - Procedures for in-orbit comparison and inter-calibration
  - Procedures for vicarious calibration with ground targets (CEOS WGCV lead)
  - Algorithms for re-calibration of archive data
  - Communication and capacity building

CEOS WGCV IVOS discussion:

- Each satellite operator would at all times remain responsible for
  - the calibration,
  - any updates,
  - re-processing and
  - assessment of the uncertainty of their own satellites data products.
- However there could be a 'CEOS agreed harmonisation/correction coefficient'
  - that can be applied (by a user) to allow interoperability (potentially more than one for differing scene types)
  - building on but potentially generalising further,
  - what GSICS has been progressing and exploiting all methods (test-sites, PICS, Rayleigh) & infrastructure (databases)
  - that we as CEOS have been pursuing over the years.
  - In essence bias removal

**Infrared Visible Optical Sensors (IVOS)*
**reference : GSICS-EP-17_Doc_16_Hewison-GSICS-IVOS.pdf*

Thank you!

GSICS deliverables

Monitored instrument

Core GSICS inter-calibration products

Instrument behaviour assessment

Instrument correction algorithms

Near Real Time corrections

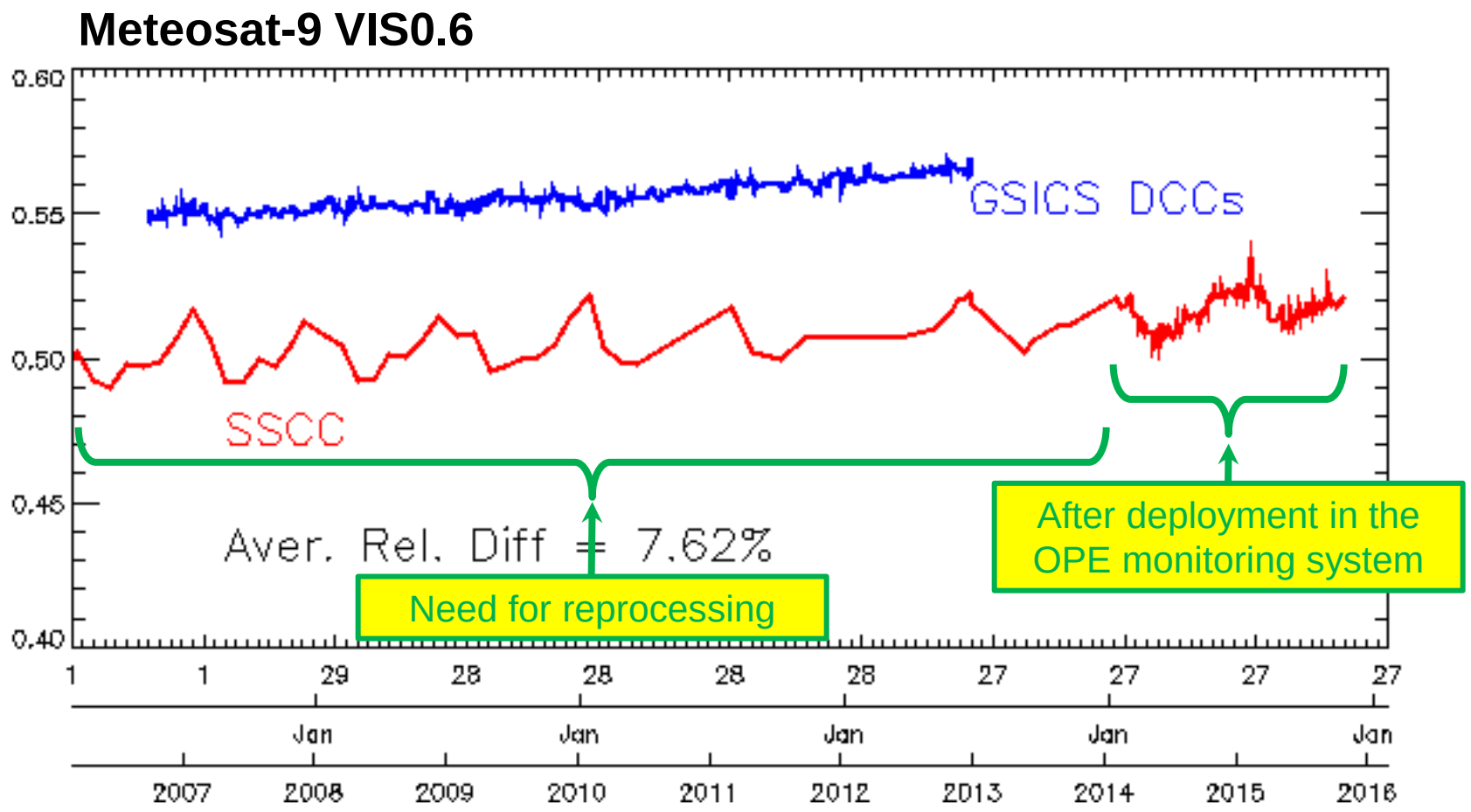
Time–centered corrections

Bias adjustment sequences(archive)

Users

Science resources	Solar & lunar spectra	Target characteristics	Calibration datasets	etc.	Spectroscopy database, RTM
Standards & procedures	References (benchmarks)	Metadata & Data Formats	Standard vocabulary	Procedures	etc.
GSICS tools	SNO matchup	Bias monitoring	Ray matching	Plotting, readers	etc.
User services	Registration, messaging	Product catalogue	Data servers	wiki, website	Documentation info, etc.

Achievement (EUMETSAT)

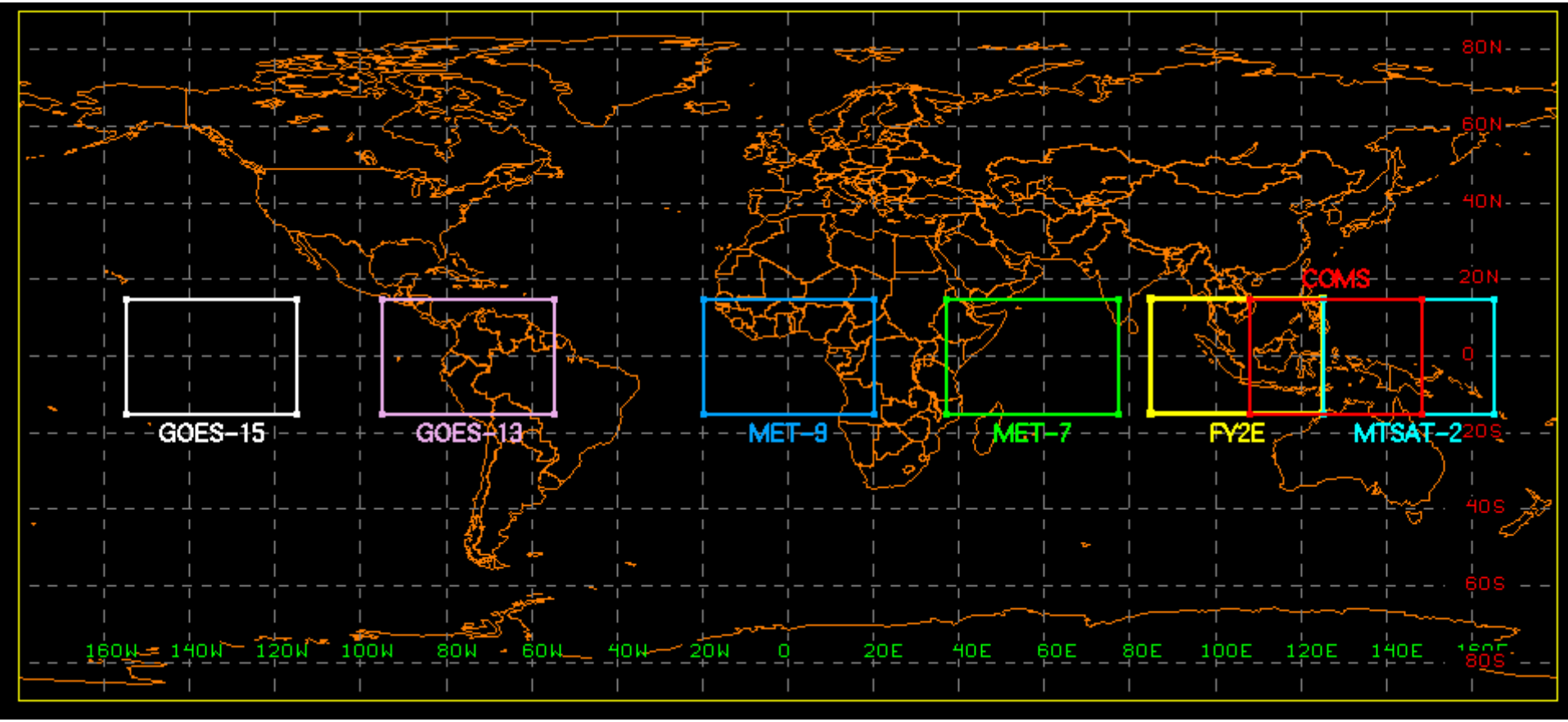


- VIS0.6 Calibration Coefficient from inter-calibration w.r.t. Aqua MODIS using Deep Convective Clouds shows good agreement with user feedback

Achievement (NASA)

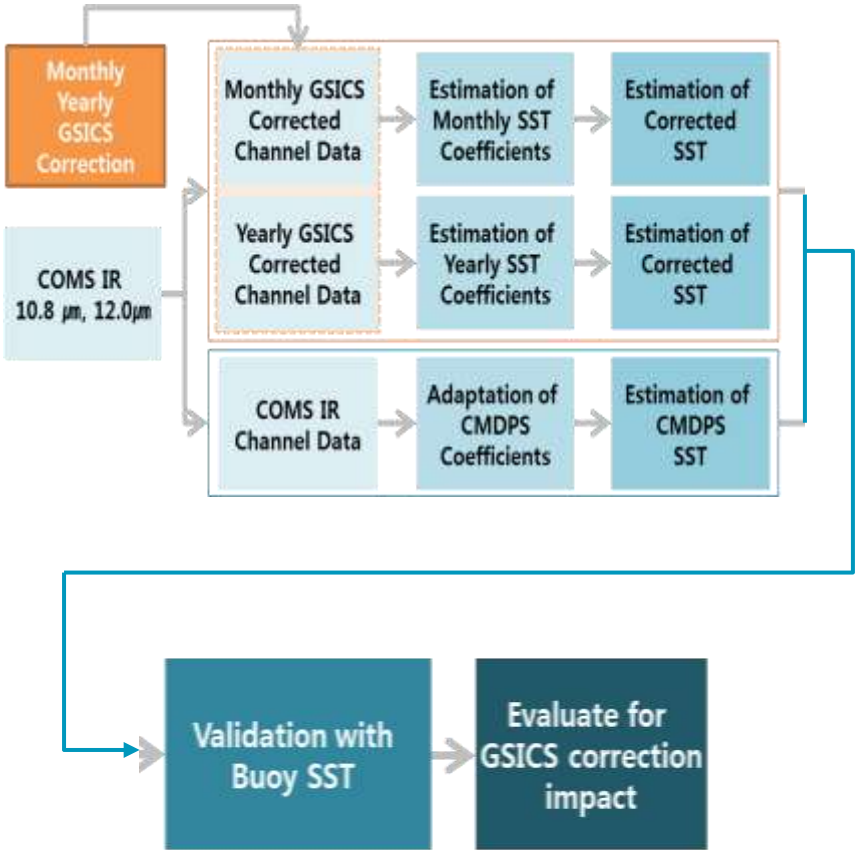
VIS-NIR intercalibration of GEO to LEO (MODIS) using DCC as transfer standard

- Soon in demonstration phase

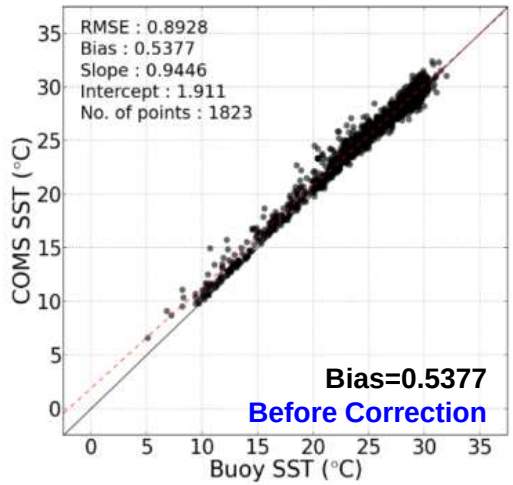


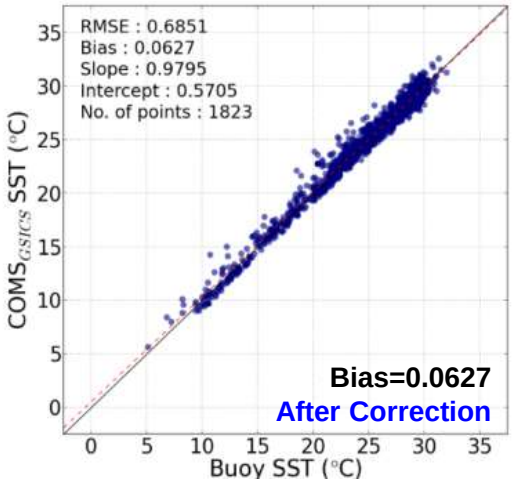
Achievement (KMA)

Application of GSICS correction to SST (Sea Surface Temperature)

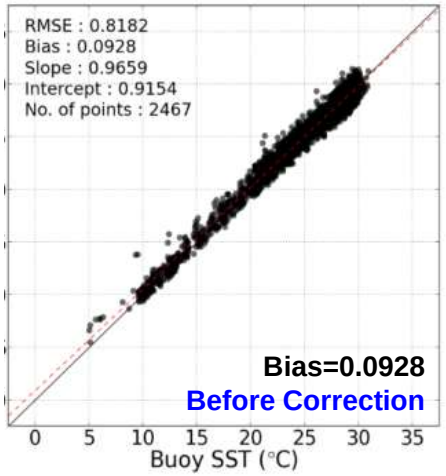


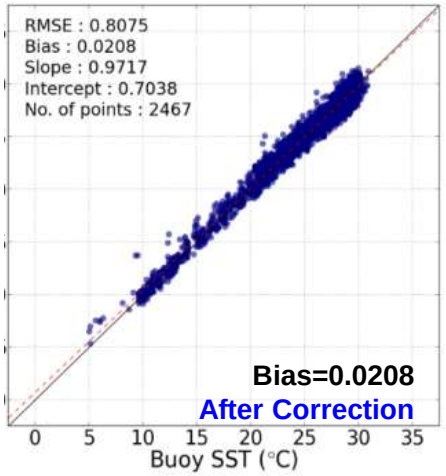
Daytime SST





Nighttime SST





SCOPE-CM IOGEO (Annual meeting 2016)

- **Planning**
  - 2016-2017: to generate of IR and WV radiance FCDRs for the GEO satellites
  - 2017-2018: to inter-compare the FCDRs of VIS reflected radiances in overlapping regions
  - 2018-2020: Gridded FCDR (GEO ring) of inter-calibrated radiances

- **Geo-Ring dataset analysis**
  - **Decision:** The best full disk coverage within 30 min time difference should be provided for the GEO-ring demonstration dataset.
  - Rob to consider including an analysis of GEO-ring bias monitoring statistics provided by ECMWF as part of IOGEO.
  - EUMETSAT to coordinate input for GEO-ring test dataset from all geostationary satellite operators by 2016-09-01**.**

- **NASA SBAF Tool (including hyperspectral deserts)**
  - SBAFs remove the variability that comes from combining more instruments even from a same series such as AVHRR. (e.g. the comparison between MTSAT-2 and Himawari-8 (6micron band) : strong non-linearities in the SBAF results)