WMO/GSICS and SCOPE-CM

Global Space-based Inter-Calibration System
Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring

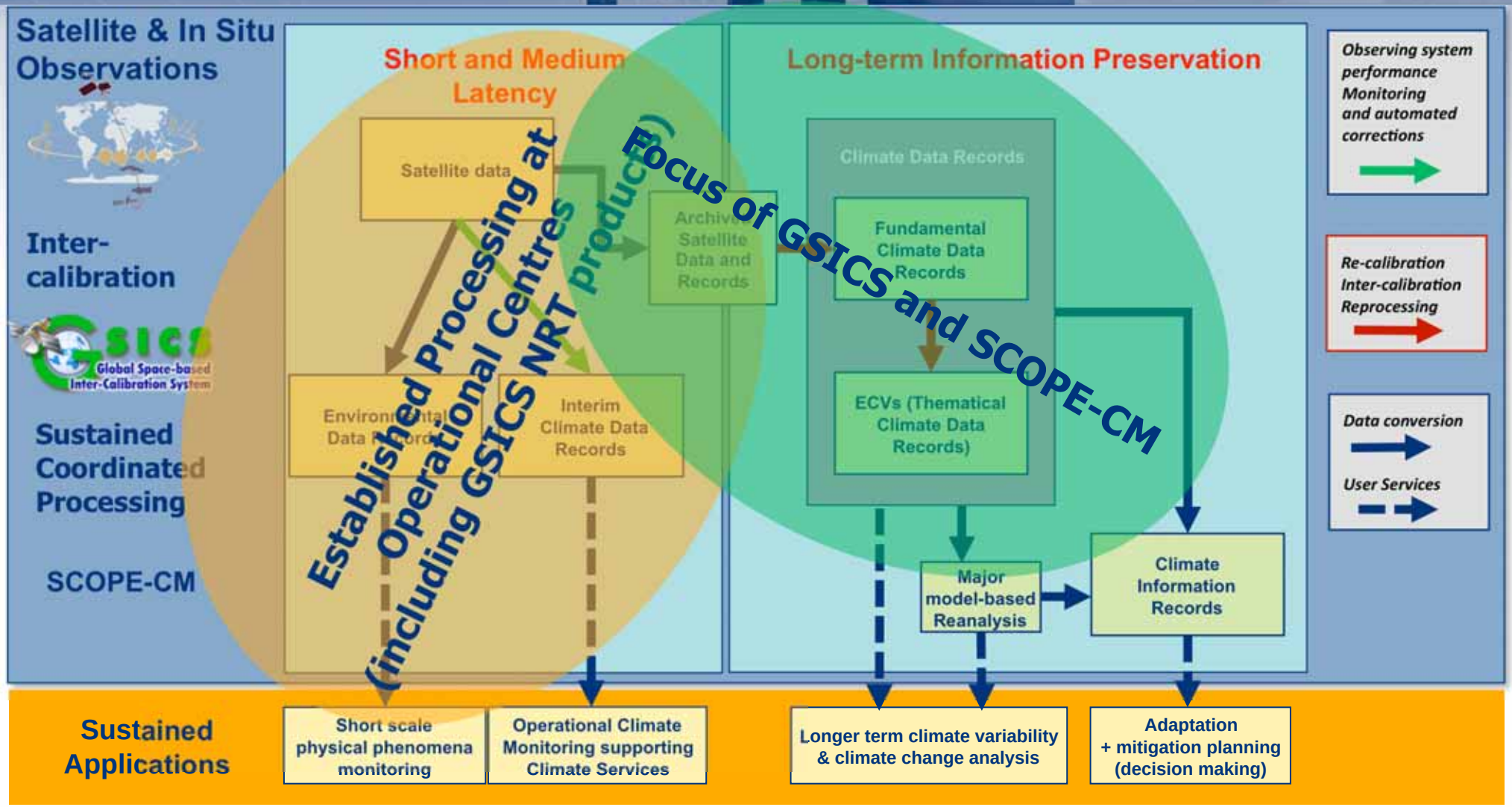
Jörg Schulz and Lothar Schüller, EUMETSAT

Using a lot of material from Mitch Goldberg (NOAA), Tim Hewison (EUMETSAT) and Rémy Roca (LMD)

Overview

- Introduction: Satellite data supporting climate applications
- GSICS
  - Objectives
  - Building Blocks
  - Products
- SCOPE-CM
  - Objectives
  - Structures
  - Current Projects
- Summary and Conclusion

Sustained Climate Information Flow



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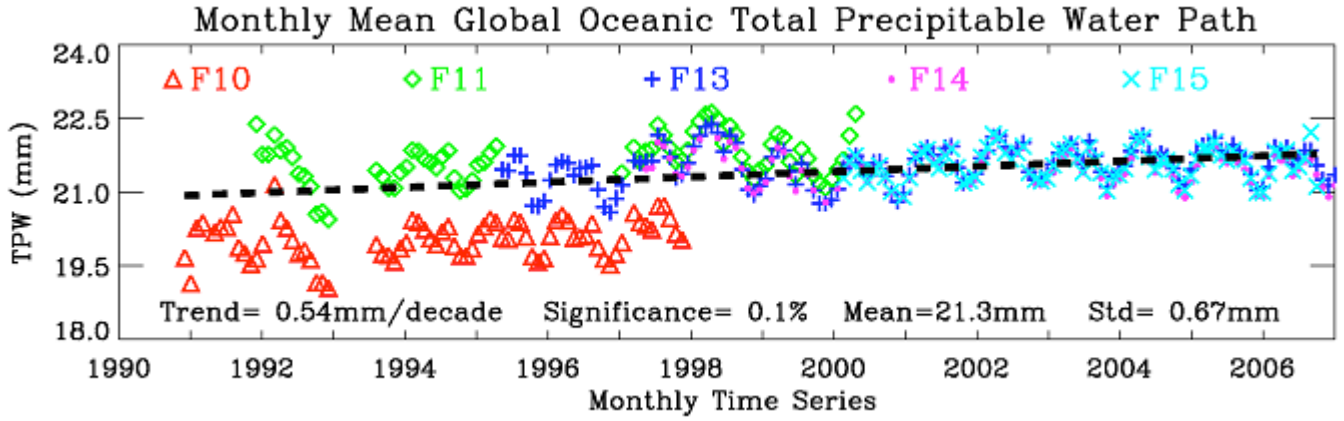
What is the Global Space-based Inter-Calibration System (GSICS)?

- Goal - Enhance calibration and validation of satellite observations and to inter-calibrate critical components global observing system.
- Part of WMO Space Programme
  - GSICS Implementation Plan and Program formally endorsed at CGMS 34 (11/06).
  - In technical terms GSICS is:
  - Quantify the differences – magnitude and uncertainty
  - Correct the differences – physical basis and empirical removal
  - Diagnose the differences – root cause analysis

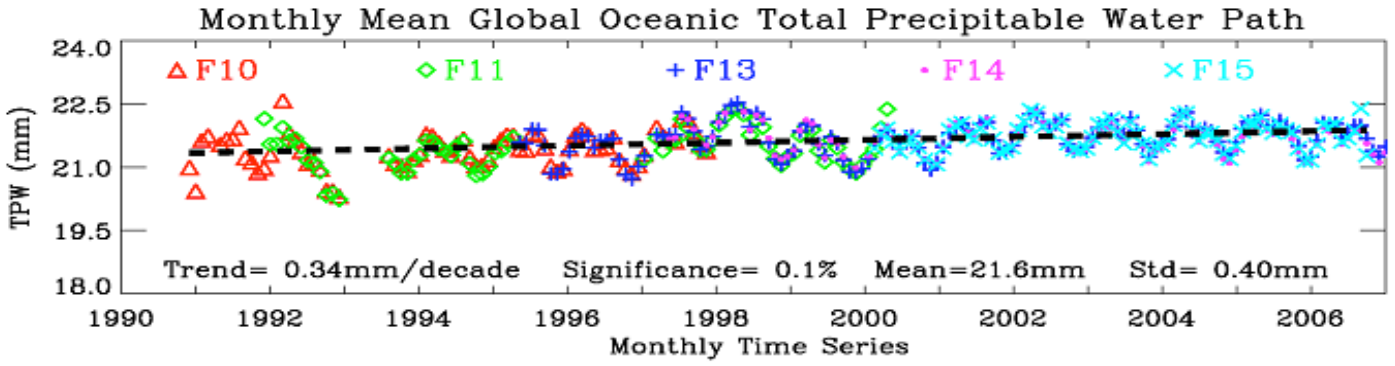
Motivation

- Demanding applications require well calibrated and intercalibrated measurements
  - Climate Data Records
  - Radiance Assimilation in Numerical Weather Prediction
  - Data Fusion
- Growing Global Observing System (GOS)

Calibration is Critical for Climate Change Detection



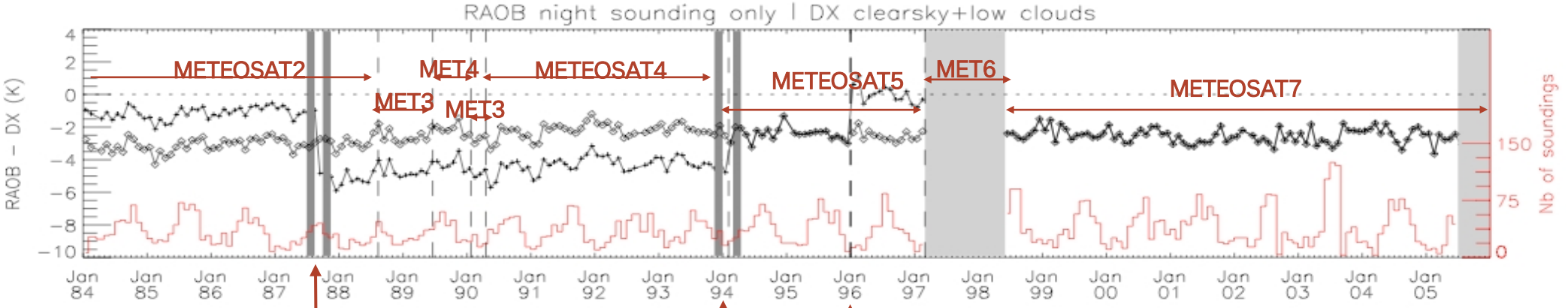
Before intercalibraion



After intercalibration

Trend of global oceanic total precipitable water decreases from 0.54 mm/decade to 0.34 mm/decade after intercalibrations! Calibration uncertainties translate to uncertainties in climate change detection.

METEOSAT FG 1984-2005 Archive Evaluation Using Radiosondes



Upgrade of calibration technique (Schmetz, 1989)

Upgrade of calibration technique (van de Berg, et al., 95)

ISCCP DX Normalized Instead of nominal

Comparisons between the METEOSAT BTs and the simulated BTs from radoisoundings: (+) represent the raw data, (◇) represent the homogeneised data. The histogram shows the nb of soundings used for comparison.

Can we do better than that and extend to SEVIRI?

Courtesy of Héléne Brogniez and Rémy Roca, LMD

Building Blocks for Satellite Inter-calibration

- Collocation
  - Determination and distribution of locations for simultaneous observations by different sensors (space-based and in-situ)
  - Collocation with benchmark measurements
- Data collection
  - Archive, metadata - easily accessible
- Coordinated operational data analyses
  - Processing centers for assembling collocated data
  - Expert teams
- Assessments
  - Communication including recommendations
  - Vicarious coefficient updates for “drifting” sensors

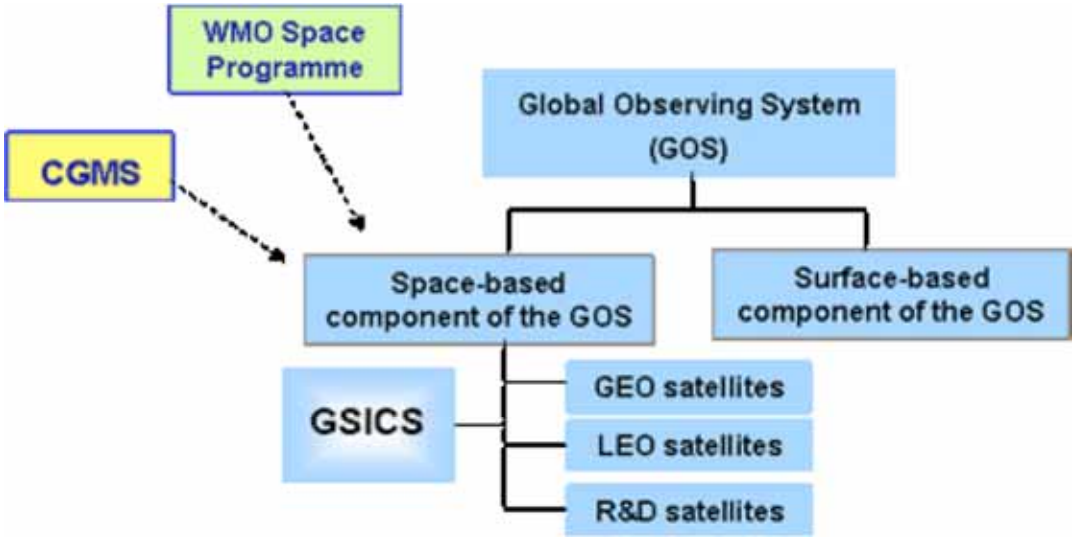
Other key building blocks for accurate measurements and inter-calibration

- Extensive pre-launch characterization of all instruments traceable to SI standards
- Benchmark instruments in space with appropriate accuracy, spectral coverage and resolution to act as a standard for inter-calibration
- Independent observations (calibration/validation sites – ground based, aircraft)

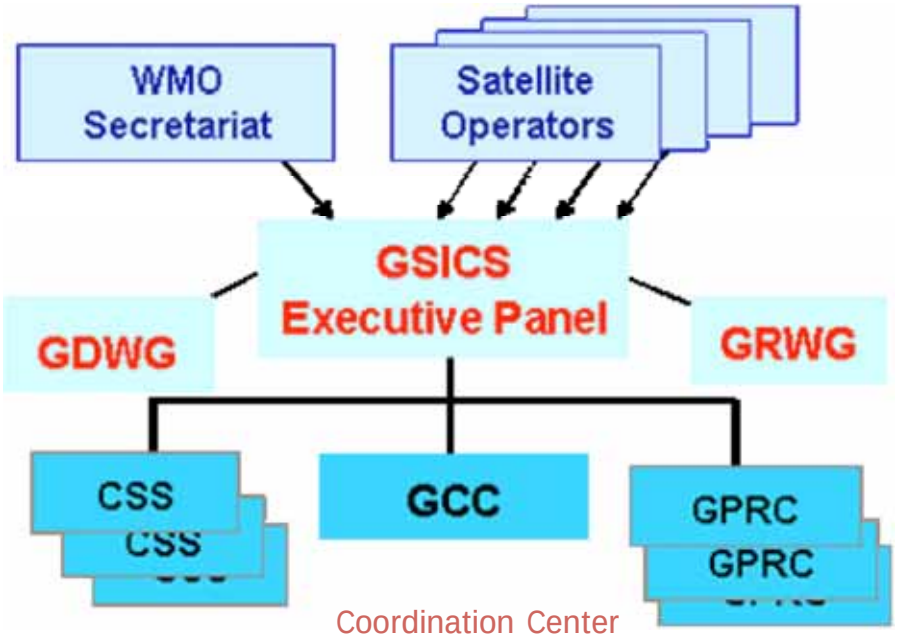
GSICS Product Portfolio

- For Operational Meteorological Satellites
  - Geostationary – IR & Solar
  - LEO – IR, Solar and Microwave – Conical & Cross-track Scanners
  - Current Operational & Historic Instruments
  - In near real-time and re-analysis modes
- 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

GSICS organization



GSICS as an element of the space-based component of the Global Observing System



- Organizations contributing to GSICS: CMA, CNES, EUMETSAT, ISRO, IMD, JAXA, JMA, KMA, NASA, NIST, NOAA, ROSHYDROMET, USGS, WMO, ESA
  - Overseen by GSICS Executive Panel
  - Assisted by Research Working Group and Data management Working Group

- GSICS activities rely on:
  - GSICS Coordination Centre (GCC)
    - operated by NOAA/NESDIS
  - Processing & Research Centres (GPRC)
    - operated by each satellite operator
  - Calibration Support Segments (CSS)
    - including field sites and laboratories

Example of GSICS Bias Monitoring

From CMA: Time Series of FY2D-IASI Standard Biases [K]

风云卫星遥感器定标与检验
Calibration and Validation for FY Sensors

Home | Calibration | Sensors | GSICS | IPM

You Are Here： Introduction > FY_2X > GSICS

中文 | English

GEO: FY-2D
LEO: IASI
Channel: ALL
Date: 2010 05 17
Time: day ○ night ◉ all ○
Display: Serials TbBias

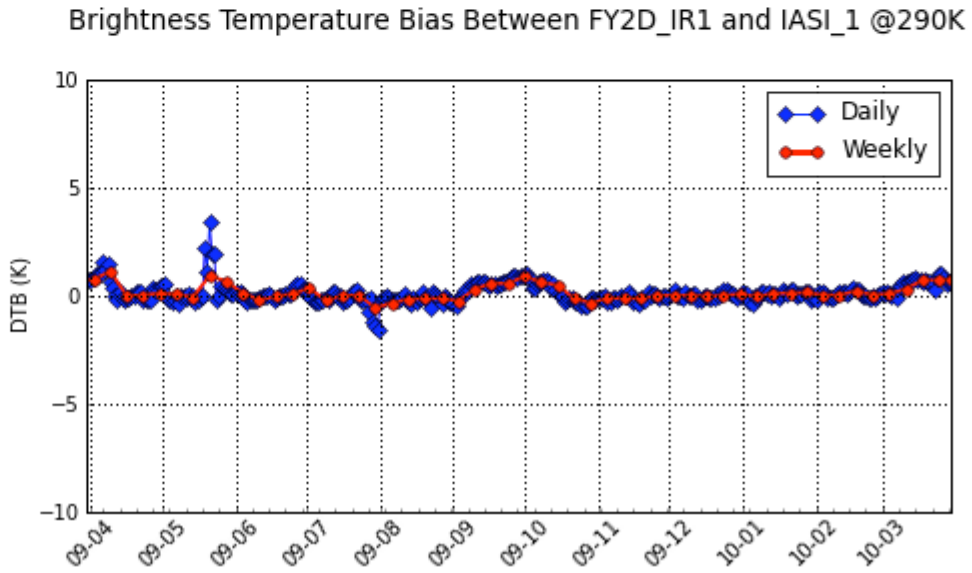
Push the button to get GSICS Correction NetCDF file with IASI

Download: Download

GSICS FY-2X IR Inter-calibration

For technical information on FY-2X infrared intercalibration in terms of comparison examination methods and how to read the charts on this page, please see the GSICS FY-2X Infrared Intercalibration Guide.

Terms: Bias@290K



Example of GSICS Bias Monitoring

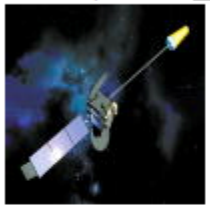
From JMA: Time Series of MTSAT-1R-IASI/AIRS Standard Biases [K]

Meteorological Satellite Center (MSC) of JMA

Home | Calibration | Products | Operations | Supports

Current position: Home > GSICS MTSAT Calibration Monitoring > MTSAT-1R IR Intercalibration with AIRS/IASI

Back



GSICS MTSAT Infrared Intercalibration

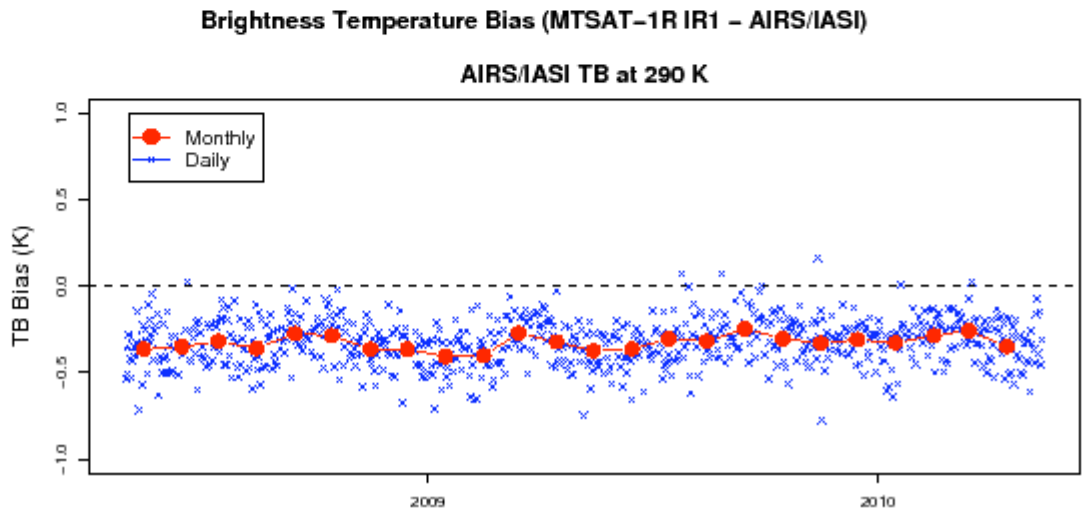
MTSAT-1R IR Intercalibration with AIRS/AQUA and IASI/METOP-A

MTSAT-1R Infrared Channel

- (•) IR1 (10.8 μm)
- ( ) IR2 (12.0 μm)
- ( ) IR3 (6.8 μm)
- ( ) IR4 (3.8 μm)

LEO Data

- (•) AIRS & IASI (all)
- ( ) IASI (des,9:30am)
- ( ) AIRS (asc,1:30pm)
- ( ) IASI (asc,9:30pm)
- ( ) AIRS (des,1:30am)



Example of GSICS Bias Monitoring

From EUMETSAT: Time Series of Meteosat9-IASI Standard Biases [K]

EUMETSAT — Monitoring weather and climate from space

SEARCH GO

ABOUT EUMETSAT | WHAT WE DO | ACCESS TO DATA | IMAGE GALLERY | DOCUMENTATION | NEWS

Home > Access to Data > Inter-calibration Services > GSICS Meteosat IR Inter-calibration

ACCESS TO DATA

- Product Navigator
- Delivery Mechanisms
- Meteosat Image Services
- Meteosat Meteorological Products
- Data Collection and Retransmission
- Environmental Data Services
- Other Geostationary Services
- Metop & NOAA Services
- **Inter-calibration Services**
  - Meteosat - NOAA HIRS
  - **GSICS Meteosat IR Inter-calibration**
- EUMETSAT Data Centre
- User Support

GSICS Meteosat IR Inter-calibration

This page demonstrates prototype results of the inter-comparison of equivalent infrared channels of geostationary **Meteosat imagers** and the polar-orbiting **IASI** sounder from collocated observations. The data will be updated twice every 5 days, around 0700UTC. The activity is an important milestone toward an operational GSICS. Similar activities are currently pursued by other GSICS participants. The results, using the **inter-calibration algorithm**, can also be downloaded as **Statistical Data**, in **NETCDF Format**, from **EUMETSAT's GSICS Data and Product Server**. The results for 2007 were analysed by Hewison and König, 2008 (See **Inter-Calibration of Meteosat Imagers and IASI** from the Proceedings of the EUMETSAT Satellite Conference, Darmstadt, Germany, September 2008).

Satellite: Meteosat-9 SEVIRI

Channel: IR13.4

Date: Year 2009 Month 05 Day 27

Time: 2130

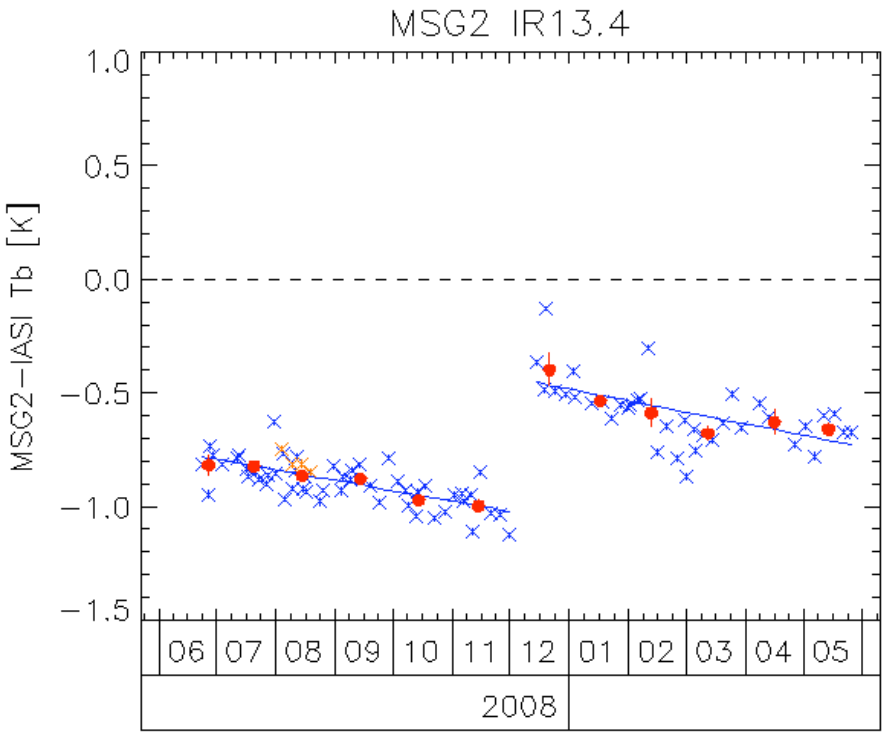
Display: Time Series Plot

Download: Statistical Data

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



Example of GSICS Bias Monitoring

From NOAA: Time Series of GOES12-AIRS Standard Biases [K]

STAR Center for Satellite Applications and Research
formerly ORA — Office of Research and Applications

NOAA Satellites and Information
National Environmental Satellite, Data, and Information Service

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    - > GOES15 vs. AIRS/IASI
    - > FY-2C vs. AIRS/IASI
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  - > LEO-LEO Inter-calibration
  - > GCC GSICS Homepage
  - > GSICS wiki
  - > GSICS Partners Webpage
    - > CMA
    - > EUMETSATthis link opens in a new window
    - > KMA

GOES-12 Imager vs. Aqua AIRS and Metop-A IASI

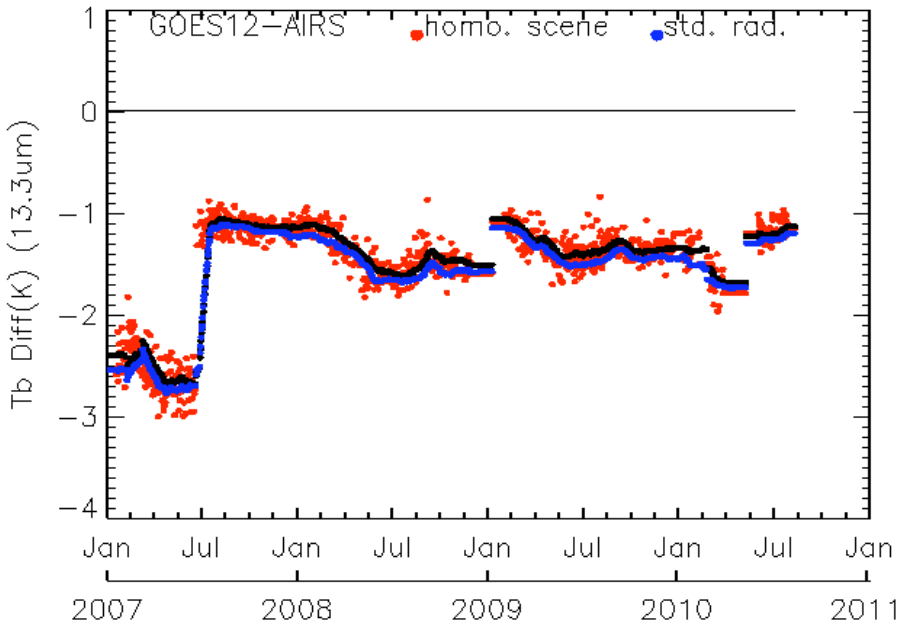
Please select a channel, then press 'Display' button

GOES-AIRS Tb bias (Daytime at Std. Rad.)
GOES vs. AIRS Ch6 (13.3µm) Display

Tb Double Diff. (daytime at homo. scenes)
Ch2 (3.9µm) Display

Evaluation of the MBCC Calibration
Ch2 (3.9µm) Display

GOES12 vs. AIRS/IASI Spectra
GOES12 vs. AIRS/IASI Spectra Display



Future GSICS Products

- GEO-LEO Solar Channels
  - Strategy: Combine various invariant targets (DCCs, deserts, etc) and direct comparison of ray-matched collocated observations
  - Currently conducting error analysis of each method
  - Aim for demonstration products in 2011
- HIRS-IASI
  - Direct comparisons to allow use of HIRS as reference
- Conical scanning microwave imagers:
  - SSM/I, SSMIS, GMI through GPM X-cal
- Cross-track scanning microwave sounders:
  - MSU/AMSU through NOAA/NESDIS
- LEO-LEO imagers:
  - AVHRR through NOAA/CIMSS

These products will contribute to the SCOPE-CM pilots

GSICS Outcome

- Coordinated international inter-satellite calibration program
- Exchange of critical datasets for cal/val
- Best practices/requirements for monitoring observing system performance
- Best practices/requirements for prelaunch characterisation (with CEOS WGCV)
- Establish requirements for cal/val (with CEOS WGCV)
- Advocate for benchmark systems
- Quarterly reports of observing system performance and recommended solutions
- Improved sensor characterisation
- High quality radiances for NWP & Climate

Sustained & Coordinated Processing of Environmental satellite data for Climate Monitoring (SCOPE-CM)

- WMO Initiative based on activities of existing initiatives (GOS, GCOS and GSICS). An implementation plan was endorsed by GCOS and WMO Executive in 2008.
- Aiming at the sustained generation of multi-mission and global Climate Data Records from satellites addressing observational needs for climate variability and trend analysis following the GCOS guidelines (it is directly answering to GCOS needs).
- Serving users and other organisations (e.g. WMO Regional Climate Centres RCC, National Weather Services, Climate Science Institutions, etc.)
- SCOPE-CM has established close contacts with WCRP major projects to serve the sustainable generation of satellite-derived CDRs. In particular close collaboration with WCRP GEWEX-RP and WOAP is envisioned, e.g., the current GEWEX Imperatives Paper sees SCOPE-CM and GSICS as primary partners for its data set generation.

WMO's SCOPE-CM initiative: Goals and Structure

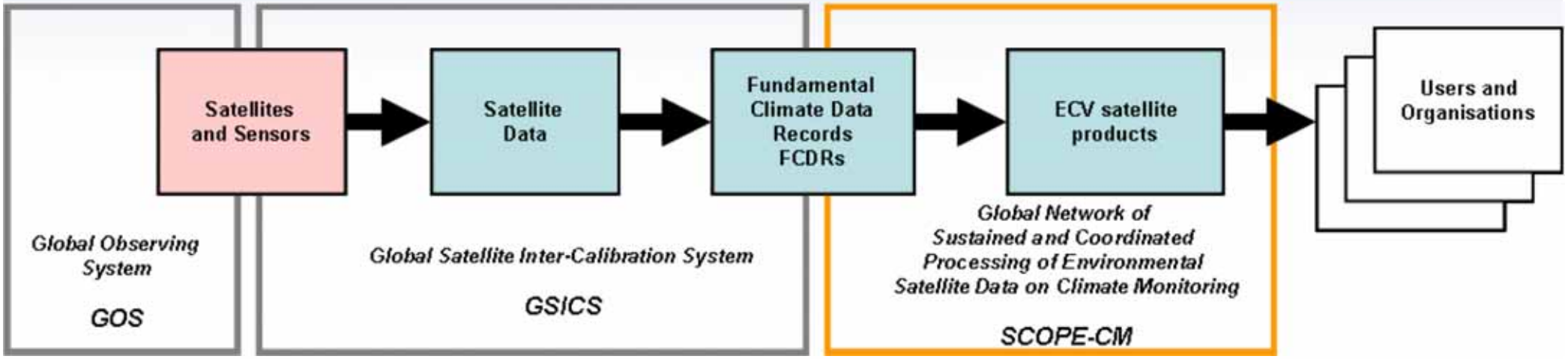
Initial Participants of the SCOPE-CM Network

- Operational Satellite operators:
  - NOAA
  - JMA
  - CMA
  - EUMETSAT (Central Application Facilities and CM SAF)

- Stakeholder
  - WMO Space Programme
  - GCOS
  - CEOS
  - CGMS/GSICS
  - WCRP/GEWEX

GOS/GSICS/SCOPE-CM/User Interfaces

GSICS and SCOPE-CM pave the way towards operational production of high quality ECVs on a global scale.



There are plenty of mutual benefits among this and CEOS activities that should lead to a close collaboration rather than competition.

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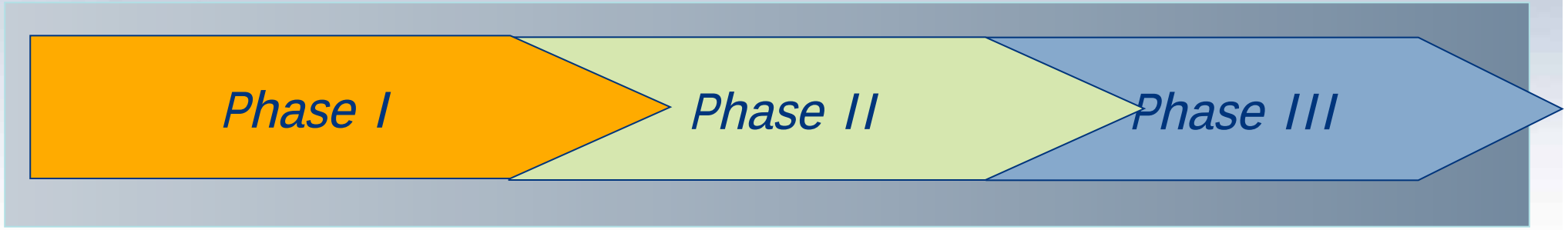
Development Phases



- establish initial network and structure
- agreement on principles and standards
- first pilot projects on selected subjects
- assessment of the current capabilities
- establishment of feedback mechanisms

- establishment of structures for sustainable generation of FCDRs and TCDRs
- generation of first SCOPE-CM products
- increased coverage of products in terms of ECVs, time and spatial dimension
- fostering extension of the network

- full deployment of the sustained system of product generation
- products review and quality control
- continuous product improvement

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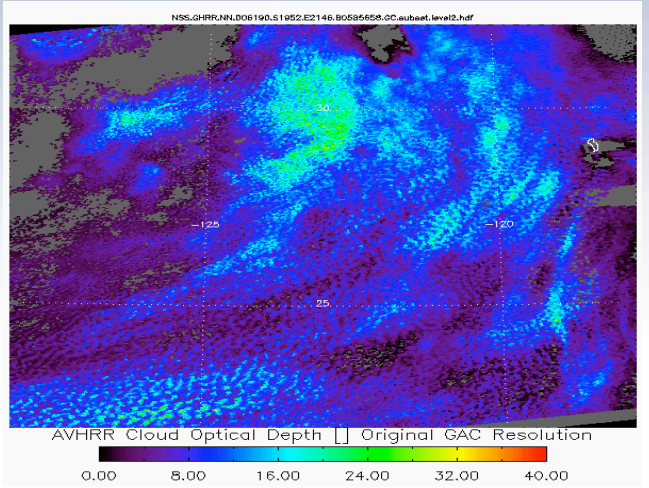
SCOPE-CM Pilot Projects

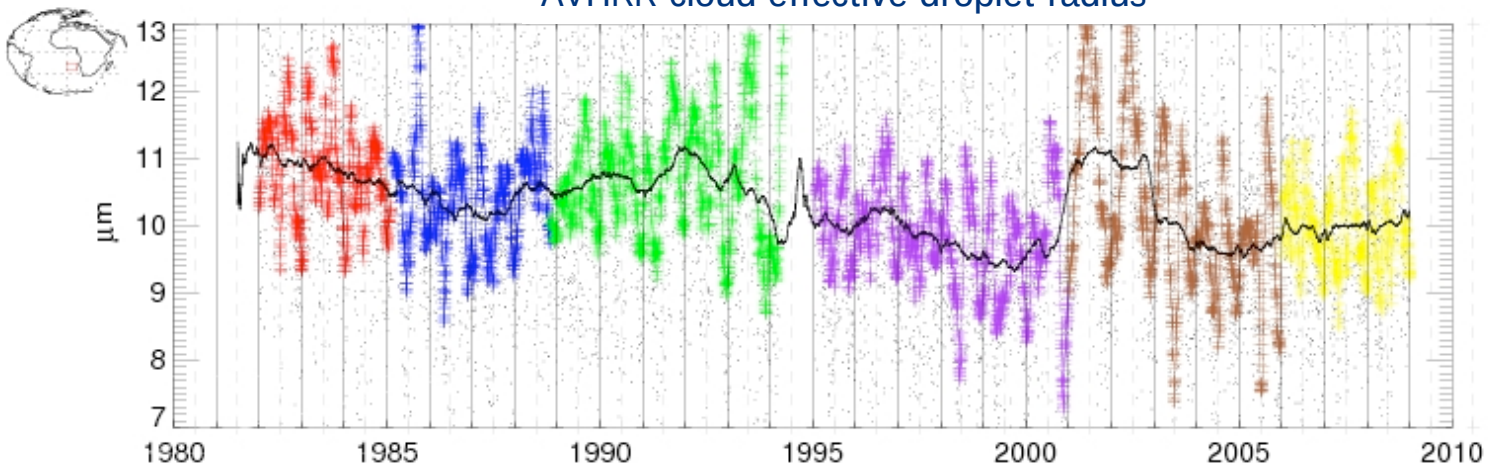
	Sensors	*Parameters and topics*	*Lead*	*Contributors*
1	AVHRR	Clouds and Aerosols	NOAA	CM SAF
2	SSM/I	Water vapour, clouds, precipitation	CM SAF	NOAA
3	GEO Ring	Surface albedo, clouds and aerosols	EUMETSAT	EUMETSAT, NOAA
4	GEO Ring	Upper Air Winds and clear sky radiances	EUMETSAT	EUMETSAT
5	GEO Ring	Upper tropospheric humidity	NOAA	EUMETSAT, EUMETSAT, CM SAF

Pilot project examples: Project 1

- 30 year of AVHRR data after re-calibration (PATMOS-X from NOAA) FCDR
- Cloud product generation at NOAA and EUMETSAT CM SAF based on the same FCDR
- Project strives for consensus cloud property algorithm for AVHRR, i.e., join and strengthen development capabilities.

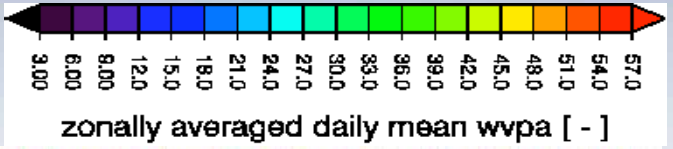


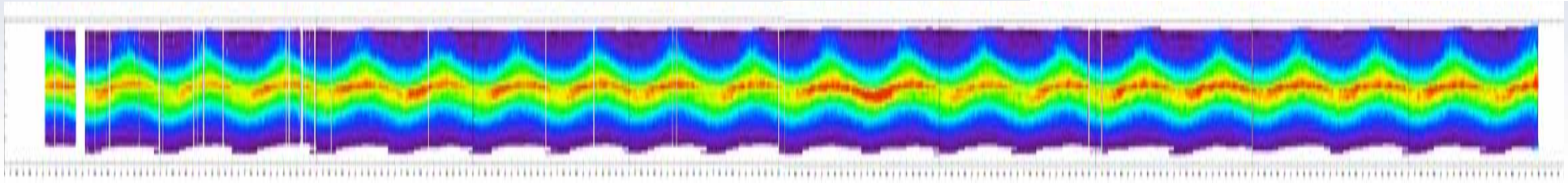
AVHRR cloud effective droplet radius



Pilot project examples: Project 2

SSM/I 20 years data set water vapour over ocean:





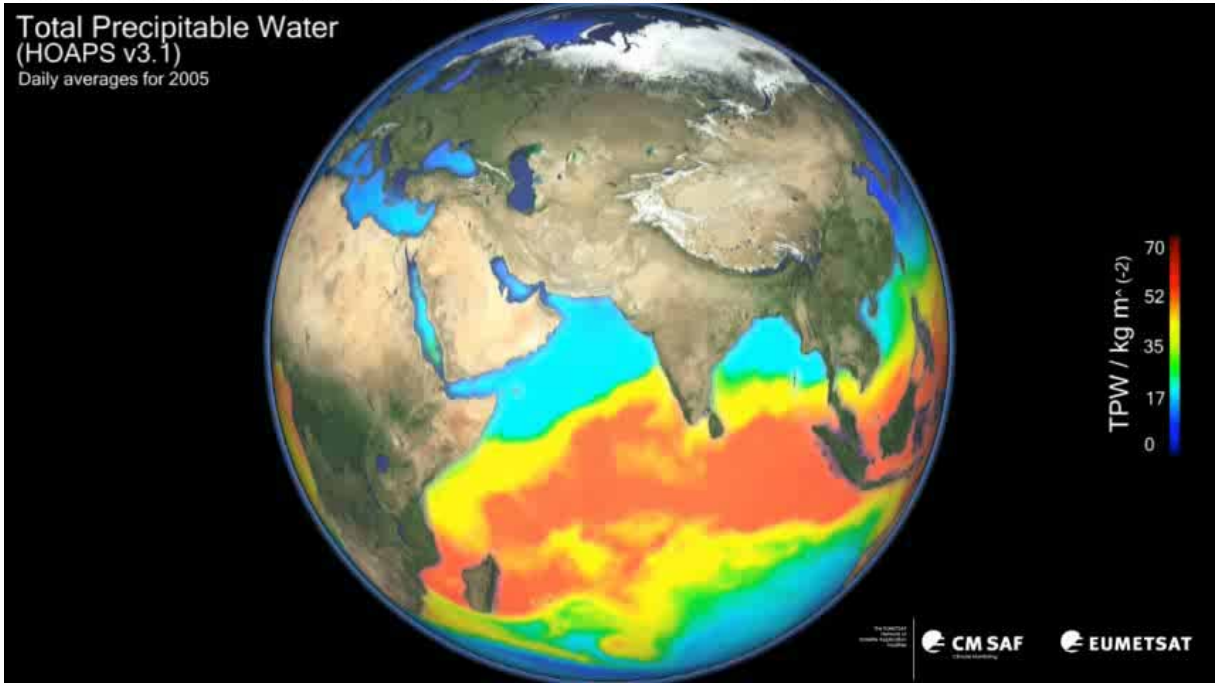
HOAPS

MPI-Meteorology
University Hamburg

Research
To
Operations

EUMETSAT

CM SAF



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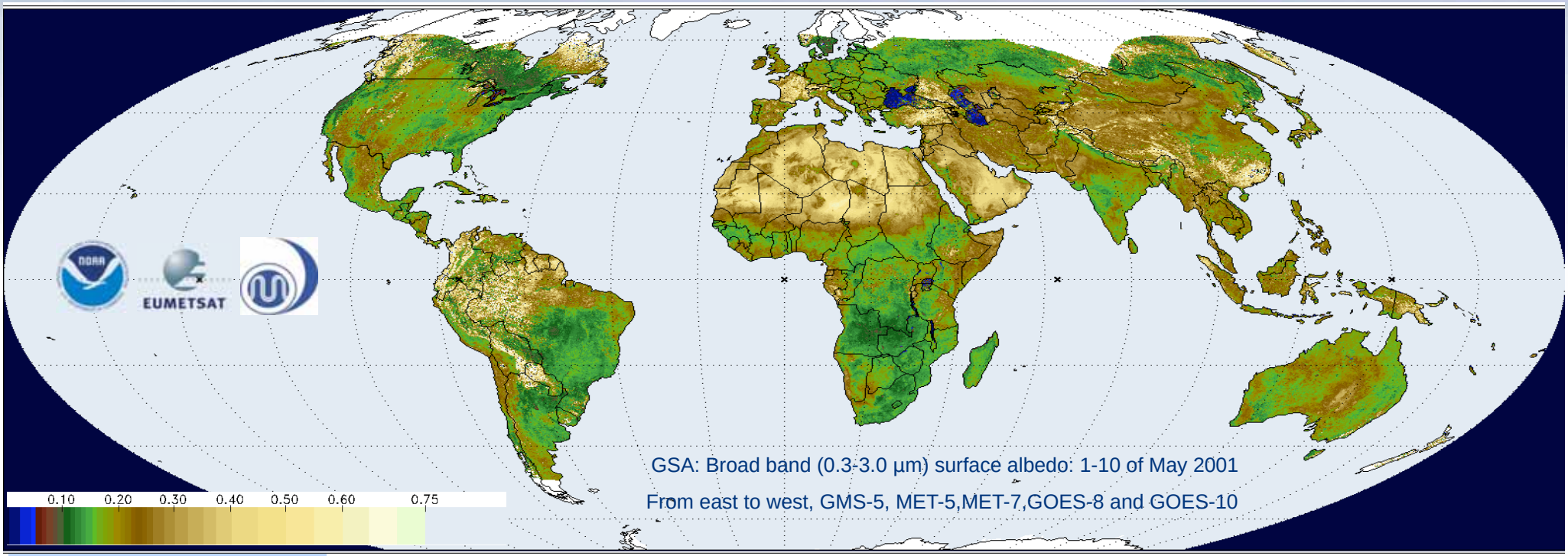
Surface Albedo from GEO Orbit



SMS **Series (GOES 1-3)**

GOES First Generation (4-7)

GOES Second Generation (8-12)

GOES Third Generation (13-15)

GOES Fourth Generation (R-U)

Meteosat First Generation

Meteosat Second Generation

Meteosat Third Generation

GMS 1-5

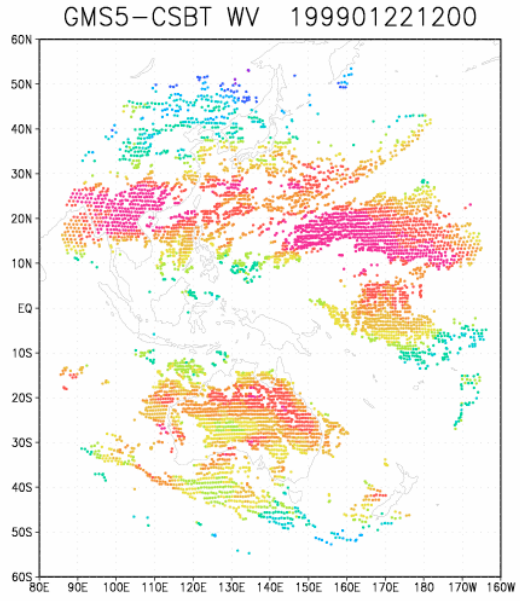
MTSAT 1R, 2

1975 2003 2040

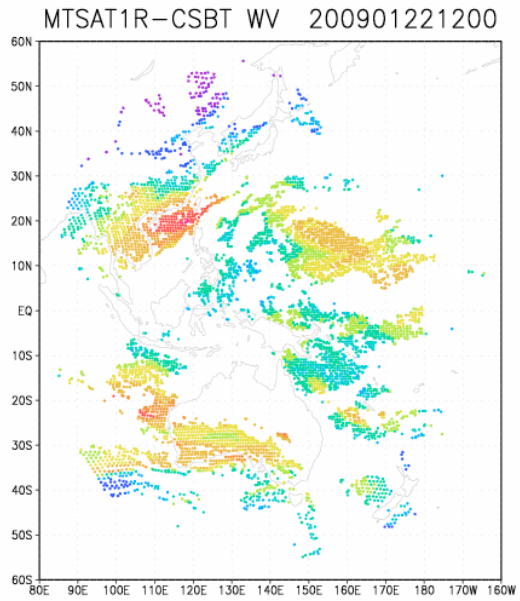
Pilot project examples: Project 4

- Clear Sky Radiance from JMA Geostationary satellites currently processing

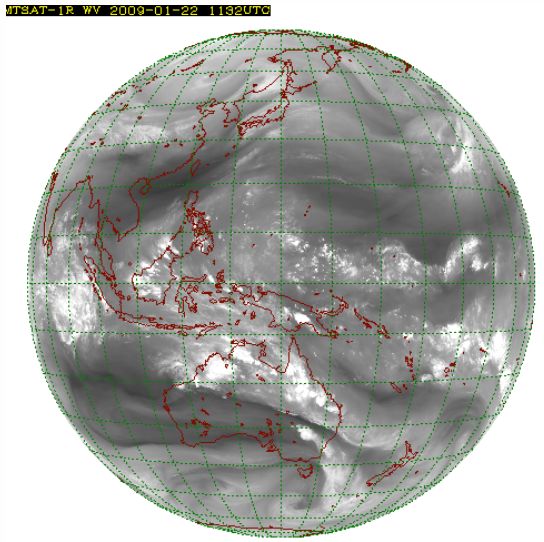
15-year Clear Sky Radiance data set from 1995 to 2009



CSR from *GMS-5* on 22 Jan *1999*



CSR from *MTSAT-1R* on 22 Jan *2009*



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SCOPE-CM Outcome

- Coordinated international network to produce high quality CDRs from multi-agency mission data in operational environment.
- Exchange of information on historical satellite missions.
- Best practices in deriving and utilising consensus algorithms for GCOS ECVs.
- Best practices /requirements for transitions of data sets produced in research environment to operational environments (HOAPS → CM-SAF, ISCCP → NOAA, etc. provides first experiences).
- Establishment of user needs for sensor inter-calibration (towards GSICS and CEOS WGCV).
- Further information: www.wmo.int/pages/prog/sat/SCOPE-CM.html.

Facts and Outreach

- GSICSs offers a great framework that can very well support many CDR creation activities, e.g. for SST employing IR and MW the operational inter-calibration could be of high value.
- SCOPE-CM directly facilitates the production of CDRs currently using sensors from operational missions.
- Shall establish feedback mechanism between GSICS/SCOPE-CM and the WG Climate to exchange experiences made in SCOPE-CM and to make results of the WG Climate useful for GSICS and SCOPE-CM.
- We need to discuss the respective roles of SCOPE-CM and WGC/VCs, in particular, how they may benefit from each other.