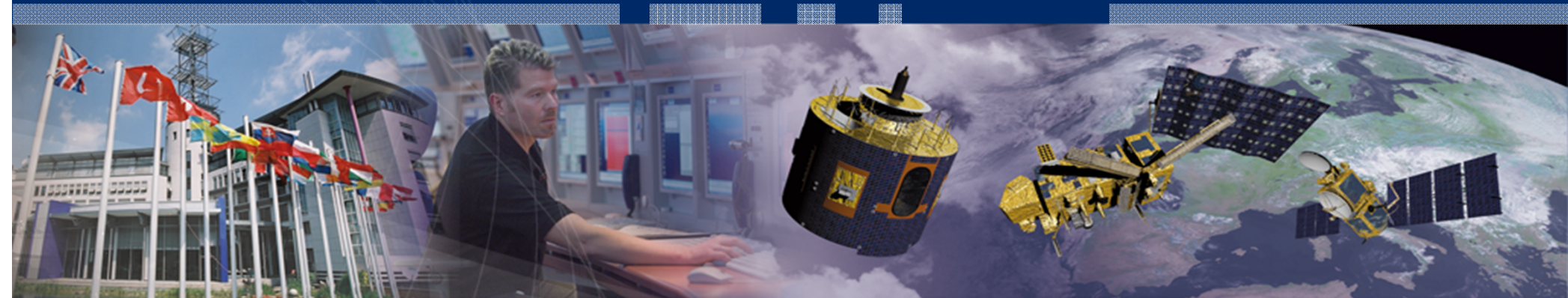# EUMETSAT
Current and future missions, and calibration activities

Sébastien Wagner
sebastien.wagner@eumetsat.int

CEOS IVOS Meeting – Frascati, 19-21 March 2013

EUMETSAT

1. **EUMETSAT objectives**

2. **EUMETSAT missions and programs (present and future)**

3. **EUMETSAT calibration activities**

4. **EUMETSAT and GSICS**

EUMETSAT

EUMETSAT's Objectives and Vision

EUMETSAT's objectives:

1. To establish, maintain and exploit European systems of operational meteorological satellites
2. To contribute to the operational monitoring of the climate & the detection of global climatic changes
3. Furthermore, other environment monitoring issues are considered when interactions with the atmosphere or the ocean are involved

EUMETSAT's vision:

- Be the leading user-governed operational agency for European Earth Observation satellite programmes that are consistent with the objectives of the EUMETSAT Convention and,
- Be a trusted global partner for the provision of satellite data from GEO and LEO orbits.
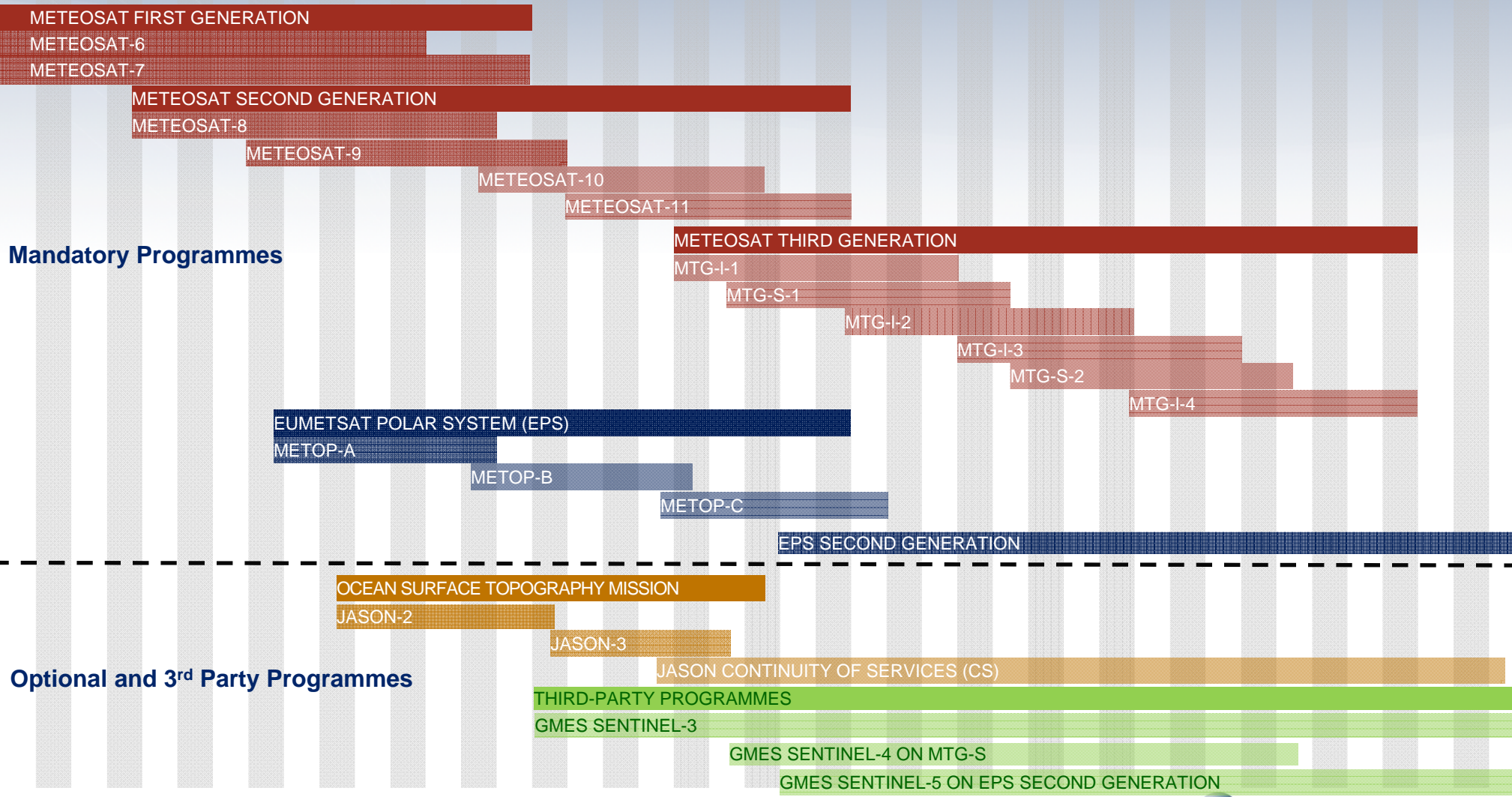
EUMETSAT's strategy – Eight objectives

1. Deliver satellite programmes which meet the needs of EUMETSAT Member States;

2. Provide services based on cost-effective ground and space segment infrastructures which respond to evolving user requirements;

3. Meet additional needs of EUMETSAT Member States for global space-based observations through international cooperation;

4. Secure new opportunities in areas that are complementary to EUMETSAT's programmes and meet Member States' requirements;

5. Extend the user base for EUMETSAT data, products and service in EUMETSAT Member/ Cooperating States and for WMO Members;

6. Be an active partner in European and Global initiatives of relevance to space-based weather, climate and environmental monitoring;

7. Deliver continuously improved management processes;

8. Recruit and maintain a core resource of talented and engaged people with relevant skills.

EUMETSAT

EUMETSAT commitment to long term continuity...

YEAR... 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Mandatory Programmes

METEOSAT FIRST GENERATION
METEOSAT-6
METEOSAT-7

METEOSAT SECOND GENERATION
METEOSAT-8
METEOSAT-9
METEOSAT-10
METEOSAT-11

METEOSAT THIRD GENERATION
MTG-I-1
MTG-S-1
MTG-I-2
MTG-I-3
MTG-S-2
MTG-I-4

EUMETSAT POLAR SYSTEM (EPS)
METOP-A
METOP-B
METOP-C

EPS SECOND GENERATION

Optional and 3rd Party Programmes

OCEAN SURFACE TOPOGRAPHY MISSION
JASON-2
JASON-3
JASON CONTINUITY OF SERVICES (CS)

THIRD-PARTY PROGRAMMES
GMES SENTINEL-3
GMES SENTINEL-4 ON MTG-S
GMES SENTINEL-5 ON EPS SECOND GENERATION

CEOS IVOS Meeting – Frascati, 19-21 March 2013

EUMETSAT

Operations – Satellites Status – March 2013

Operational status of the geostationary and LEO systems is stable:

– <u>Meteosat-7</u> provides Indian Ocean Data Coverage at 57.5° E

– <u>Meteosat-8</u> (MSG-1) is hot backup, located to 3.4° East

– <u>Meteosat-9</u> (MSG-2) provides Rapid Scanning Service at 9.5°E

– <u>Meteosat-10</u> (MSG-3) is Operational Prime, located at 0.0° East

– <u>Metop-A</u> sun-synchronous at 09:30 - all instruments operational

– <u>Metop-B</u> sun-synchronous at 09:30 (0:50 later) –commissioning

  – all instruments operational – although HIRS noisy

– <u>Jason 2</u> Low Earth Inclined Orbit System service for Near Real Time products has confirmed to be stable.
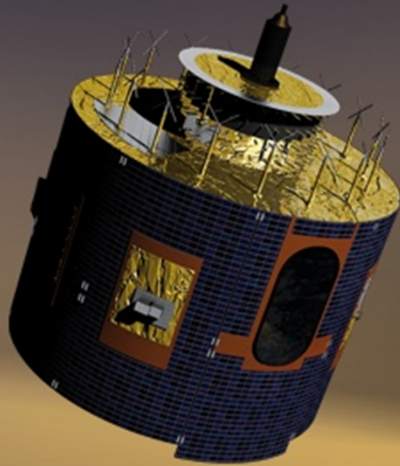
EUMETSAT

Meteosat Long-Term Planning Perspective

CEOS IVOS Meeting – Frascati, 19-21 March 2013

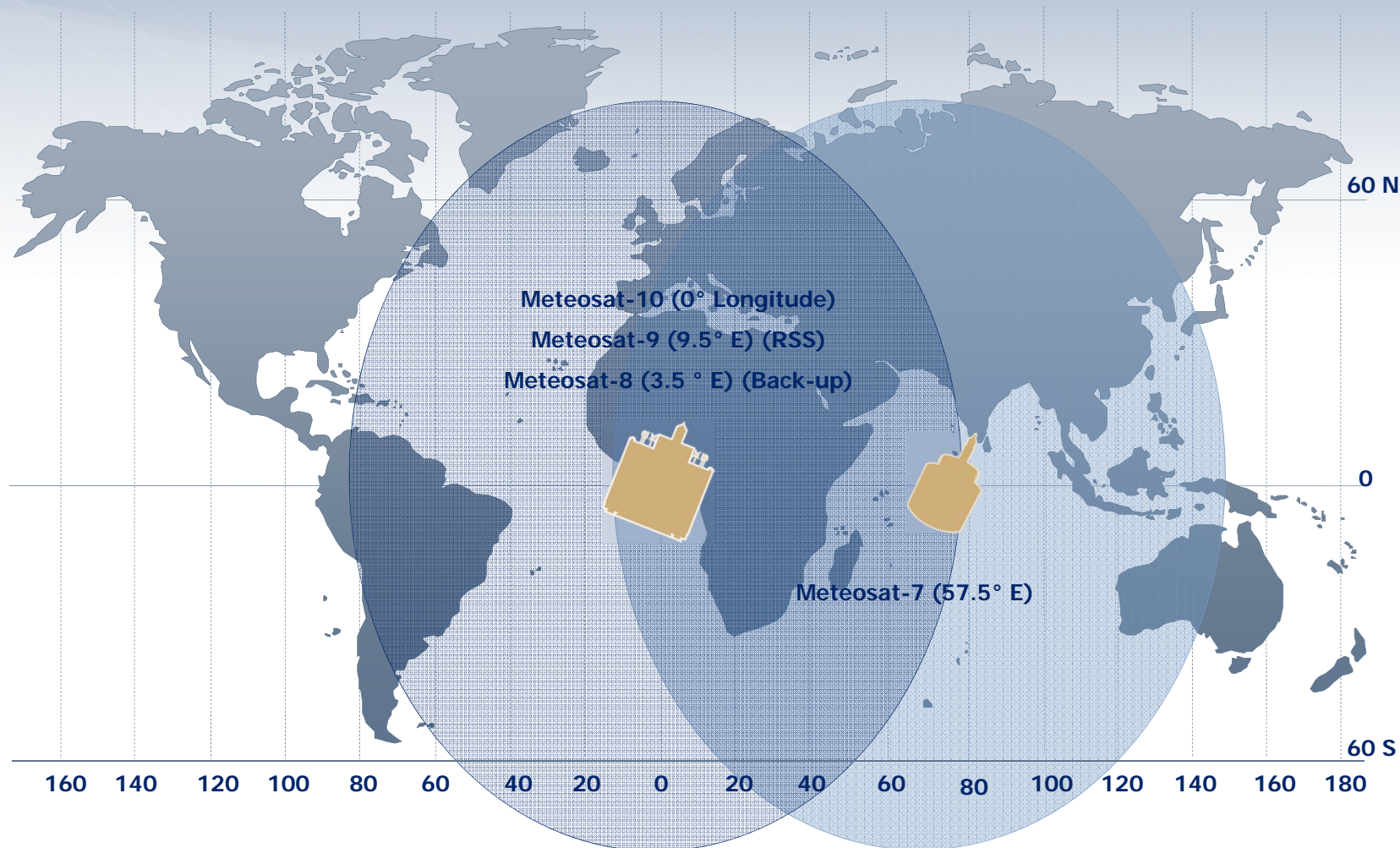EUMETSAT
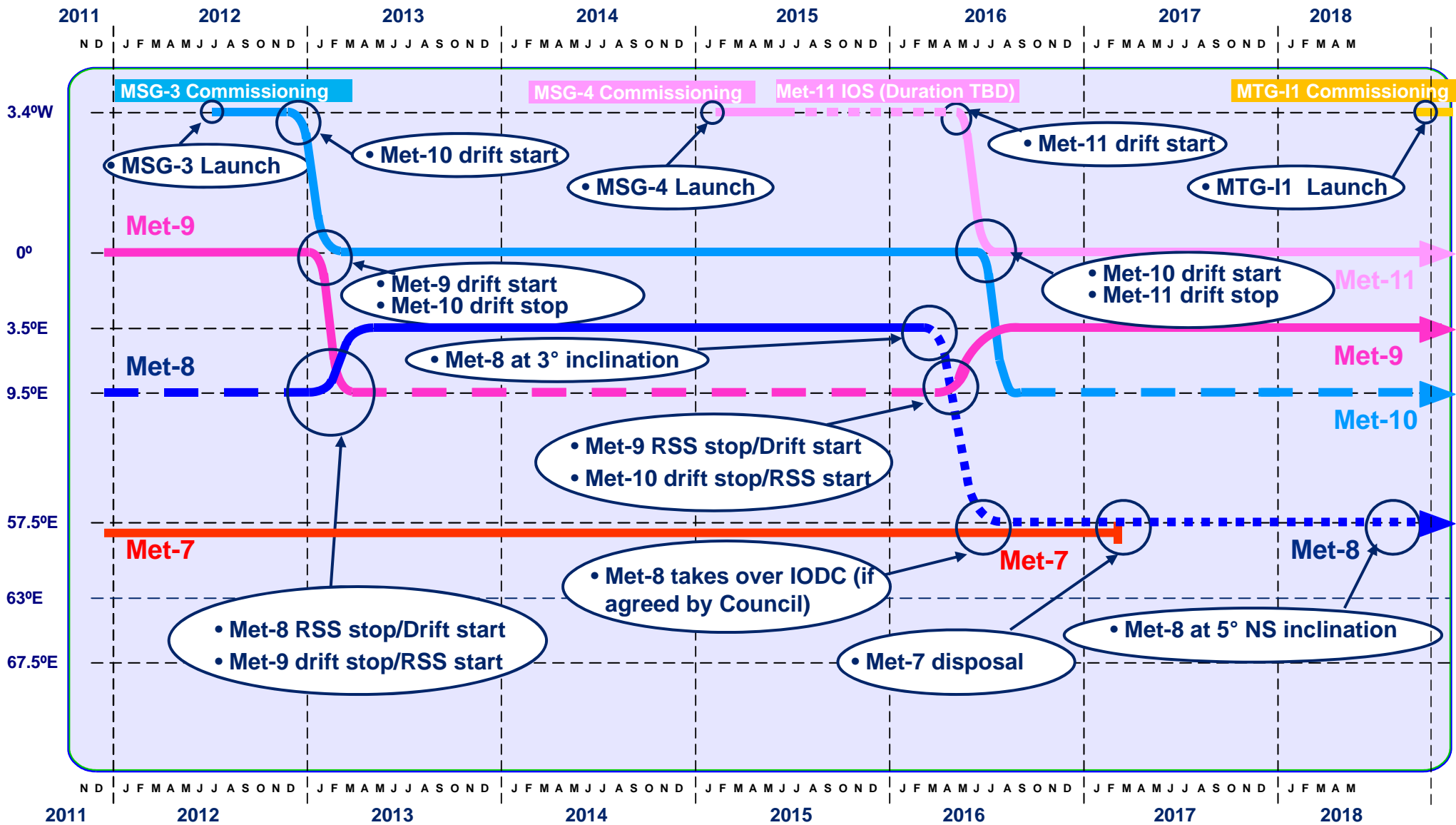
Geostationary satellites

Meteosat Second Generation (MSG)

- 4 geostationary weather satellites, operations at least until 2018 (MTG)

- Full disk imagery: Imaging European weather, every 15 minutes with 12 spectral bands (currently Meteosat-9)

- Rapid Scan Service (RSS) every 5 minutes (currently Meteosat 8): detection of rapid, local development of convective systems

- Data collection for environmental monitoring

EUMETSAT

EUMETSAT's geostationary satellite coverage

Meteosat-10 (0° Longitude)

Meteosat-9 (9.5° E) (RSS)

Meteosat-8 (3.5 ° E) (Back-up)

Meteosat-7 (57.5° E)

60 N

0

60 S

160 140 120 100 80 60 40 20 0 20 40 60 80 100 120 140 160 180

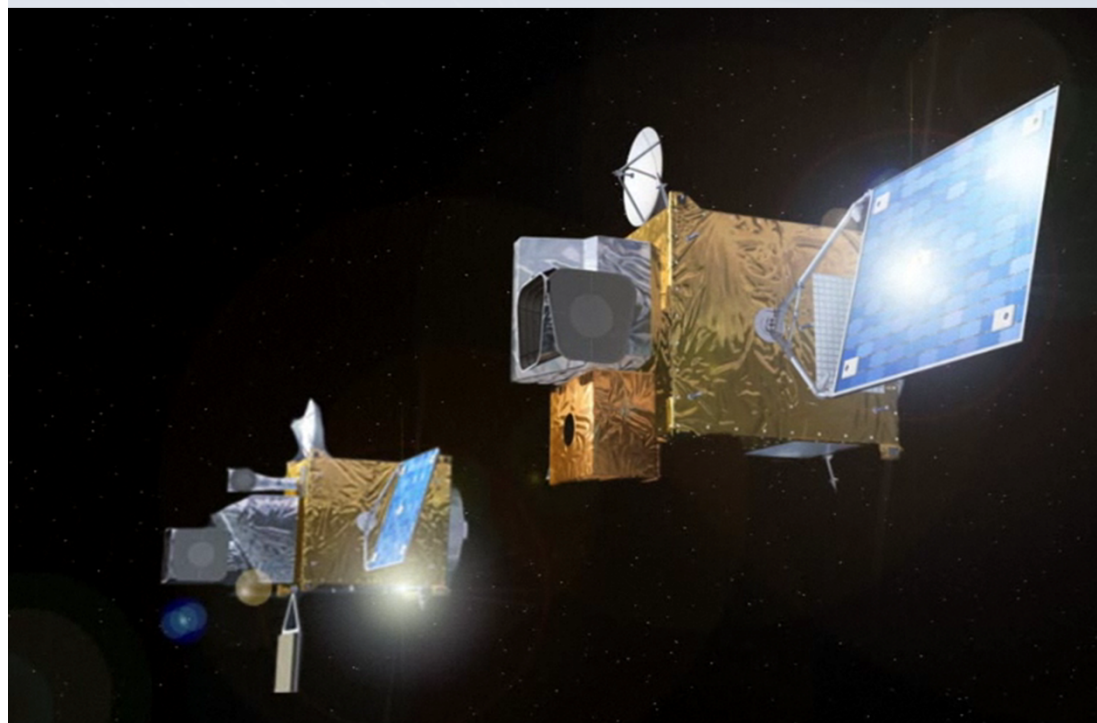CEOS IVOS Meeting – Frascati, 19-21 March 2013

EUMETSAT

Future Geostationary satellites : MTG-I and MTG-S

Meteosat Third Generation (MTG)

- 4 MTG-I imaging and 2 MTG-S sounding satellites – both 3-axis stabilised

- Start of operations in 2018 and 2019, for 15-20 years

- Imaging mission
  - Imaging European weather every 10 minutes with 16 spectral bands
  - new Lightning Imager

- Sounding mission (IR and UV)
  - Hyperspectral infrared sounder providing high-resolution soundings of water vapour, temperature, O3 in 4D
  - Synergy with Global Monitoring for Environment and Security Sentinel-4 Ultraviolet Visible Near-infrared spectrometer: atmospheric chemistry and air quality monitoring

EUMETSAT

Current Polar-orbiting satellites: EUMETSAT Polar System

Europe's first series of polar-orbiting meteorological satellites

3 Metop satellites for at least 14 years of operations (mid morning orbit)

Metop-A and B currently in orbit

Part of Initial Joint Polar System shared with NOAA

Missions and Payload
- Imagery (VIS, IR), sounding (IR, MW, UV, GPS occultation), radar (Ascat)
- direct broadcasting and data collection capabilities

Applications
- Numerical Weather Prediction and Nowcasting at high latitudes
- Marine meteorology and oceanography
- Air quality, atmospheric chemistry

EUMETSAT

Future polar-orbiting satellites: EPS Second Generation

Second generation ready by 2020

Part of future Joint Polar System shared with NOAA

Preparatory programme in approval process

Twin satellite configuration under study (phase A)

Payload to include GMES Sentinel-5

Mission Priorities

High-Resolution Infrared Sounding	IAS
Microwave Sounding	MWS
VIS/IR Imaging	VII
Scatterometry	SCA
Radio Occultation Sounding	RO
Nadir-viewing UV/VIS/NIR/SWIR Sounding	UVNS
Multi-viewing, -channel, -polarisation Imaging	3MI
Microwave Imaging	MWI
Radiant Energy Radiometry	RER
Ice Cloud Imaging	ICI
Low Light Imaging	LLI
ARGOS	DCS
Search and Rescue	S&R
Space Environment Monitoring	SEM

EUMETSAT

Monitoring the oceans and climate in partnership

High precision altimetry

Jason-2
- launched in June 2008
- EUMETSAT's first optional programme (new convention)
- Applications: marine meteorology, operational oceanography, seasonal prediction and climate monitoring

Jason-3
- under development, to provide continuity with Jason-2
- launch scheduled in April 2014

Jason-CS
- future programme under discussion with ESA, EC, NOAA in the context of GMES
- to provide continuity after Jason-3

Partners:

EUMETSAT

Monitoring the oceans within GMES: Sentinel 3

EUMETSAT will operate the Sentinel-3 satellite for the European GMES programme (Global Monitoring for Environment and Security)

Further response to the operational needs of the European marine (and climate) community,

Data provision with near-real-time and off-line products includes:

- sea-surface topography (radar altimetry);
- sea-surface temperature (advanced visible/thermal radiometer)
- ocean-surface colour (visible spectrometer).

*ultimately under ESA responsibility

EUMETSAT

Calibration Support for Recent & Forthcoming Launches

- Supported commissioning of Meteosat-10 (MSG3, launched in July 2013)
  - by running prototype inter-calibration wrt Metop-A/IASI
  - Validated potential variations to official SRF
  - Performed SEVIRI Solar Channel Calibration & analyzed

- Monitor Metop-A/IASI and Metop-B/IASI
  - Direct monitoring in collaboration with CNES
  - by double-differencing against Meteosat/SEVIRI
  - also applicable to Metop-A/HIRS and Metop-B/HIRS – but not started

- Starting planning inter-calibration activities for Sentinel-3
  - SLSTR – Sea and Land Surface Temperature Radiometer
  - OLCI - Ocean and Land Colour Instrument

EUMETSAT

EUMETSAT and inter-calibration activities:
The GSICS context...

GSICS = Global Space-based Inter-Calibration System
WMO and CGMS initiative

EUMETSAT

GSICS Activities at EUMETSAT

As a GSICS Processing and Research Centre → dedicated activities such as:

- **GEO-LEO IR Products for current Meteosats using IASI (on Metop) as a reference :**
  - **GSICS Corrections**
  - **GSICS Bias Monitoring**
  - **Uncertainty Analysis**
  - **Ice Contamination**
  - **Under development: Delta Correction to migrate MetopB/IASI → MetopA/IASI**

- **GEO Solar-band Channels for current Meteosats:**
  - **Review of SEVIRI Solar Channel Calibration System**
  - **Implementation of GSICS DCC inter-calibration v MODIS**
  - **Development of Lunar Calibration method**

- **Re-calibration of Meteosat archive data:**
  - **Using multiple NOAA/Metop/HIRS as reference**

CEOS IVOS Meeting – Frascati, 19-21 March 2013

EUMETSAT

GSICS Products Development – Lunar Calibration

Since last meeting, further developments on the extraction procedure for the SEVIRI instruments

Achievements:
1. **Development of an automatic extraction tool for lunar observations for LRES + HRVIS channels in both FD and RSS modes**
2. **Consolidation of the existing lunar observations database for MSG1, MSG2 and MSG3:**
   - **MSG1: end 2003 – 2009 (Full Disk + RSS) complete (part of the commissioning + all the operational data). Validation data still missing (1 year of data between May 2007 and May 2008).**
   - **MSG2: 2006- June 2012 complete.**
   - **MSG3: after 01/01/2013 complete.**
   - **Automatic saving of lunar observations after 01/01/2013 by the Image Processing Facility.**
3. **Full range of phase angles covered**
4. **Collaboration with USGS ➔ inter-band calibration using the ROLO model as a reference (~1% relative error)**
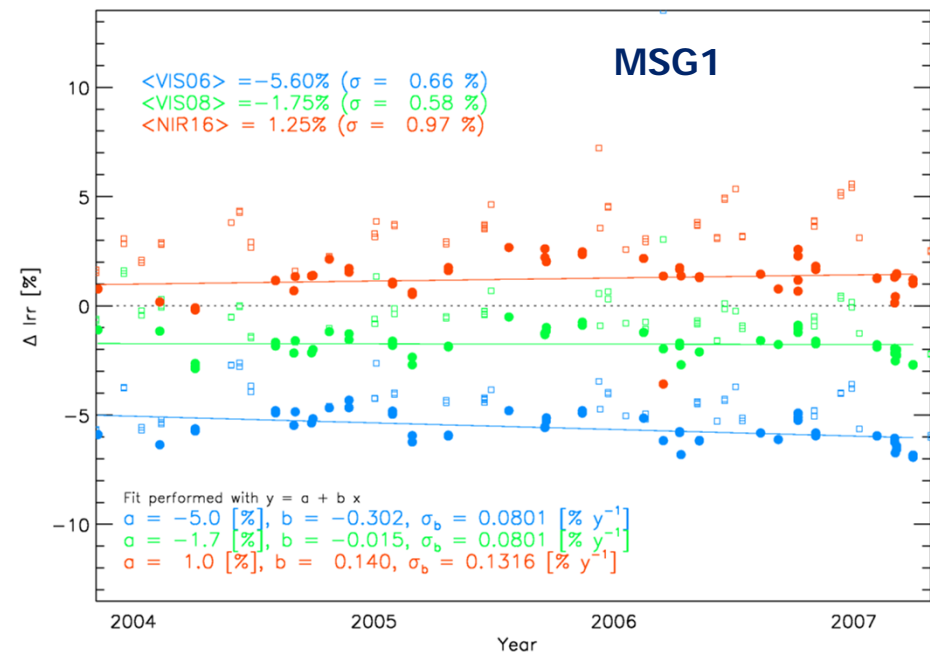
Results to be used only for inter-band calibration and drift monitoring

Lunar calibration method and instrument are stable.
SD <1% - consistent with expected performance of ROLO
⇒ BUT is it affected by seasonality?

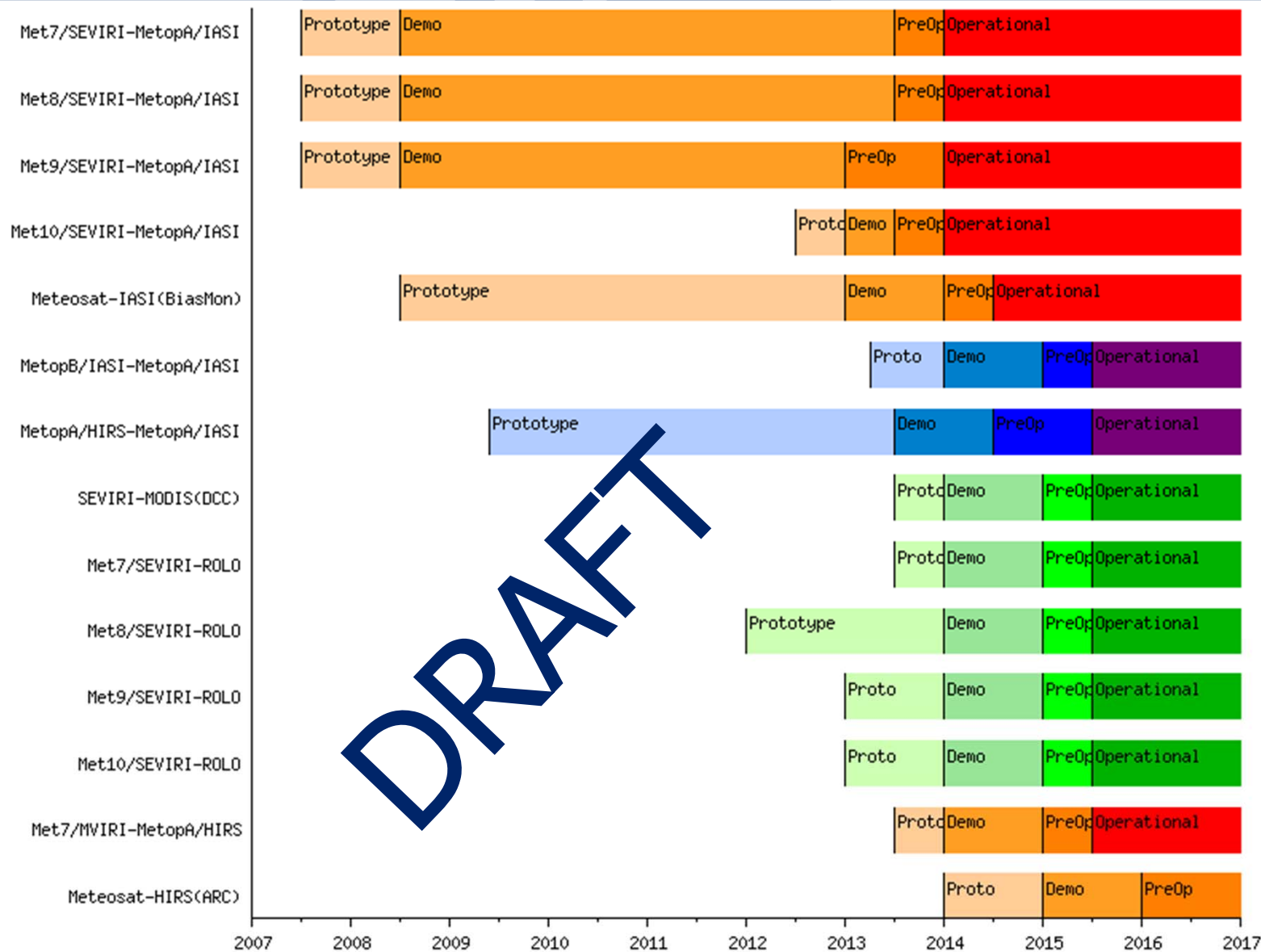**Relative difference between channels = consistent with current findings in terms of absolute calibration.**

Future work:

- **Assessment of lunar calibration capacities with HRV & MFG/MVIRI sensor**
- **Understanding of the observed biases between ROLO and MSG/SEVIRI**

MSG1

<VIS06> =−5.60% (σ = 0.66 %)
<VIS08> =−1.75% (σ = 0.58 %)
<NIR16> = 1.25% (σ = 0.97 %)

Fit performed with y = a + b x
a = −5.0 [%], b = −0.302, σ_b = 0.0801 [% y^{-1}]
a = −1.7 [%], b = −0.015, σ_b = 0.0801 [% y^{-1}]
a = 1.0 [%], b = 0.140, σ_b = 0.1316 [% y^{-1}]

EUMETSAT's GSICS Product Development Plan

Calibration Event Logging System

Action:

Recommendation CGMS (39.12): CGMS Satellite Operators to provide regular information on satellite/ instruments events affecting calibration and establish corresponding websites. (minutes CGMS-39).

Recommendation GSCIS: Satellite operators to provide "a log of satellite / instrument events" to support the identification of "spurious" events/trends in calibrated data sets.

Concept:

- log all events impacting radiometric and geometric data quality:
  - ❶ *Platform level*
  - ❷ *Satellite level*
  - ❸ *Data processing level*

- use common Standards and Procedures across missions and instruments;

- allow for portability across space agencies;

- comprise a database historic events;

- allow users to assess and visualize the events database.

EUMETSAT

Summary

In order to continuously improve data quality and accuracy, EUMETSAT needs to keep up to date with latest developments in terms of calibration and inter-calibration:

➔ **Global Space-based Inter-Calibration System**

➔ **Closer interactions with CEOS-IVOS**

EUMETSAT

Thank you

CEOS IVOS Meeting – Frascati, 19-21 March 2013

EUMETSAT

Meteosat Long-Term Planning Perspective

CEOS IVOS Meeting – Frascati, 19-21 March 2013