EUMETSAT AGENCY REPORT

2014/15 INSTRUMENT CAL/VAL ACTIVITIES

Overview

• Satellite Status

• Instrument Calibration Event Logs & Information

• Development of GSICS Products at EUMETSAT
  • GEO-LEO IR Products for current Meteosats using IASI
  • GEO Solar-band Channels for current Meteosat – DCC & Lunar
  • Re-calibration of Meteosat archive data
Operational services call for long term commitments.

Mandatory Programmes

- **METEOSAT FIRST GENERATION**
  - METEOSAT-7
  - METEOSAT-8
  - METEOSAT-9
  - METEOSAT-10
  - MSG-4/METEOSAT-11*

- **METEOSAT SECOND GENERATION**
  - METEOSAT-10

- **METEOSAT THIRD GENERATION**
  - MTG-I-1: IMAGERY
  - MTG-S-1: SOUNDING
  - MTG-I-2: IMAGERY
  - MTG-I-3: IMAGERY
  - MTG-S-2: SOUNDING
  - MTG-I-4: IMAGERY

Optional Programmes

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

- **EPS-SECOND GENERATION (EPS-SG)**
  - METOP-SG A: SOUNDING AND IMAGERY
  - METOP-SG B: MICROWAVE IMAGERY

- **JASON**
  - JASON-2
  - JASON-3

- **JASON-CS/SENTINEL-6**

- **SENTINEL-3 A/B/C/D**

YEAR... 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
Current EUMETSAT satellites

METOP A-B
(LOW-EARTH, SUN – SYNCHRONOUS ORBIT)
EUMETSAT POLAR SYSTEM/INITIAL JOINT POLAR SYSTEM

JASON-2
(LOW-EARTH, 63° INCL. NON SYNCHRONOUS ORBIT)
OCEAN SURFACE TOPOGRAPHY MISSION

METEOSAT 8-9-10-11 (2nd GENERATION)
(GEOSTATIONARY ORBIT)
TWO-SATELLITE SYSTEM:
• METEOSAT - 10: FULL DISK IMAGERY MISSION AT 0° (15 MN)
• METEOSAT - 9: RAPID SCAN SERVICE OVER EUROPE AT 9.5°E (5 MN)
• METEOSAT - 8: BACK UP AT 3.5°E
• METEOSAT - 11: Launch Planned 2015-07-02 => STORAGE

METEOSAT – 7 (1st GENERATION)
(GEOSTATIONARY ORBIT)
INDIAN OCEAN DATA COVERAGE MISSION AT 57°5 E
(UNTIL END 2016)
NEAR FUTURE - GEO AND LEO SATELLITES

- MSG-4 launch 2 July 2015 (for in orbit storage)
- Jason-3 launch (with NOAA, CNES, NASA) on 22 July 2015
- EUMETSAT will operate Copernicus Sentinel-3 (Marine Mission) after commissioning by ESA, in 2016
- Metop-C launch planned in October 2018
MTG: Approved, under development
Sentinel-4 onboard MTG-I satellite

Jason-CS/Sentinel-6:
Proposed, for approval in 2015
Phase B2 approved at ESA CMIN12
Recurrent satellite co-funded by EU/Copernicus

EPS-SG: Approval process started in July 2014
Metop-SG programme approved at ESA CMIN12
Sentinel-5 development approved at CMIN14
Recurrent Sentinel-5 instruments funded by EU/Copernicus
**WMO OSCAR**


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**OSCAR**

Observing Systems Capability Analysis and Review Tool

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**Instrument: SEVIRI**

**Instrument details**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>SEVIRI</th>
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<tbody>
<tr>
<td>Full name</td>
<td>Spinning Enhanced Visible Infra-Red Imager</td>
</tr>
<tr>
<td>Type of Instrument</td>
<td>01. Moderate-resolution optical imager</td>
</tr>
<tr>
<td>Purpose</td>
<td>Multi-purpose imagery and wind derivation by tracking clouds and water vapour features</td>
</tr>
<tr>
<td>Short description</td>
<td>12 channels (11 narrow-bandwidth, 1 high-resolution broad-bandwidth VIS) [see detailed characteristics below]</td>
</tr>
<tr>
<td>Background</td>
<td>New development</td>
</tr>
<tr>
<td>Scanning Technique</td>
<td>Mechanical, spinning satellite, E-W continuous, S-N stepping</td>
</tr>
<tr>
<td>Resolution</td>
<td>4.8 km FOV, 3 km sampling for narrow channels, 1.6 km FOV, 1 km sampling for broad VIS channel</td>
</tr>
<tr>
<td>Coverage / Cycle</td>
<td>Full disk every 15 min. Limited areas in correspondingly shorter time intervals</td>
</tr>
<tr>
<td>Mass</td>
<td>260 kg</td>
</tr>
<tr>
<td>Power</td>
<td>150 W</td>
</tr>
<tr>
<td>Data Rate</td>
<td>3.2 Mbps</td>
</tr>
</tbody>
</table>

**Satellites this instrument is flying on**

Note: a red tag indicates satellites no longer operational, a green tag indicates operational satellites, a blue tag indicates future satellites

- **Meteosat Second Generation (MSG) (EUMETSAT)**
  - Meteosat-4 (2002 - 2016)
  - Meteosat-10 (2012 - 2019)
  - Meteosat-11 (2015 - 2022)

**Contribution to Space Capabilities**

The instrument contributes to the following Capabilities, as identified in the "Vision for the GOS in 2025" and the Implementation Plan for the Evolution of Global Observing Systems:

- *Multi-purpose VIIRSR imagery from GEO*

**Tentative Evaluation of Measurements**

The following list indicates which measurements can typically be retrieved from this category of instrument. To see a full Gap Analysis by Variable, click on the respective variable.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Relevance for measuring this Variable</th>
<th>Operational Limitations</th>
<th>Processing maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud top height</td>
<td><strong>2014</strong></td>
<td>No specific</td>
<td>Consolidated methodology</td>
</tr>
</tbody>
</table>
Instrument Specifications
General information on the platform, instruments, and sensors operated in the mission that is relevant to all users of the satellite data (see OSCAR website).

Calibration Events
Database (and graphical interface) of events at satellite and processing level that are not occurring systematically and that impact the radiometric or geometric quality of the observations due to instruments calibrations, manoeuvres or miscellaneous.

Data Outages
Events that triggered the temporary or definitive end of the data collection.

Instrument Monitoring
Database (and graphical interface) of quasi continues information on the present state of the instruments and sensors operated on the platform;
Stable Landing Page – Example EUMETSAT

[http://wwwc.eumetsat.int/website/home/Data/Products/Calibration/MSGCalibrationNEW/index.html]
EUMETSAT achievements – GSICS IR subgroup

• Status of Current products
  • Meteosat/SEVIRI-Metop/IASI Pre-Op
    • Expected to promote to Operational in 2015
  • Meteosat-7/MVIRI-Metop/IASI Demo
    • Algorithm implemented for Reprocessing

• Development of New products
  • Prime GSICS Corrections
    • Combines results from IASI/Metop-A & -B
    • Ready to submit as Demo GSICS product
  • AVHRR-IASI to prepare for Sentinel-3/SLSTR
    • Support for EU Horizon2020 FIDUCEO project
    • Maybe future GSICS product?

• For past instruments:
  • Recalibration of MFG archive for IR/WV channels (FCDR available by end 2015)
  • Generation of FCDRs with HIRS and AVHRR to serve as references (FIDUCEO project)
EUMETSAT achievements – GSICS VIS/NIR subgroup

- Deep Convective Clouds
  - Accounting for seasonal variations
  - Support to visiting scientists from JMA and CMA with MTSAT2 & FY2E
  - EUMETSAT’s ATBD ready
  - Preparing the demo product (expected in 2015)

- Lunar Calibration Workshop
  - Development of GSICS Implementation of ROLO
  - First iteration on the GSICS Lunar Observation Dataset
  - Support to visiting scientists from JMA and CMA with MTSAT2, Himawari-8/AHI & FY2E

- Implementing GIRO in Operations to monitor Meteosat-7, -8, -9, -10, -11 (soon)

- Incrementation of our monitoring capabilities (integrated multi-mission approach)
Planned activity for past instruments:

- FCDR of microwave humidity sounders L1 data (SSM/T2, AMSU-B, MHS) (FIDUCEO project)
EUMETSAT achievements – GSICS UV subgroup

- Formation of UV Sub-Group
  ➔ New Chair: Rosemary Munro

Within the framework of Atmospheric Composition Group activities:

- CEOS WGCV: Support to the preparation of a workshop on sensor on-ground and in-orbit (no-vicarious) calibration. Proposal for joint meeting presented to WGCV in May

- Contribution to the inter-comparison between the OMPS and GOME-2 Sensor Data Record/L1b by Wu et al. (presented at the 2014 EUM User Conference)

- Prototyping inter-calibration procedure GOME-2/MSG (VIS06) and GOME-2/AVHRR channel 1.

- Preparing for routine AVHRR-GOME-2 and IASI sensor inter-calibration within operational PMAp EPS multi-mission sensor colocation and co-registration framework
  ➔ Potential for producing time series of AVHRR Ch1(2)/GOME-2 and AVHRR T4/5/IASI inter-calibration coefficients.
EUMETSAT achievements – Data Working Group

- Improvement of the GSICS plotting tool performances.

- Support to NOAA to ensure compatibility of their pre-operational GSICS RAC products with the GSICS plotting tool.

- CMA technical expert hosted for 3 months at EUMETSAT HQ. Main activities:
  - Configuration of CMA GSICS collaboration server
  - Support to the validation of a GSICS product development framework developed by EUMETSAT
  - Familiarisation with on-going GSICS tasks
  - Event logging
  - Product notification and distribution
  - Data product contents wrt guidelines + conventions + standards
  - Familiarisation with Data Centre operational environment + archiving of data
GSICS Products Development – Lunar calibration

• ACHIEVEMENTS
  ✓ Flexible and robust extraction tool in place for the GEOs imagers
  ✓ Unique archive of lunar observations from GEOs available
  ✓ Applications: instrument monitoring + characterization
  ✓ To secure operations, implemented independent version of the ROLO model
  ✓ Extremely accurate drift estimate (uncertainty: ~0.02% yr\(^{-1}\) for LRES, ~0.05% yr\(^{-1}\) for HRVIS)
  ✓ All SEVIRI well within specification for long-term drift
  ✓ Lunar calibration can be used to monitor the vicarious calibration

• OPEN ISSUES:
  ✓ Phase-angle dependence of the ROLO model
  ✓ Original ROLO spectral sampling

• FUTURE:
  ✓ Keep consolidating in-house expertise and provide support to present and future programs and to climate activities.
  ✓ More GSICS related ➔ Initiate a project for transferring MODIS calibration to the GEOs using the Moon as transfer target
ACHIEVEMENTS

- Implementation **COMPLETED**
- Decoupled processing of MODIS and SEVIRI to derive gains **COMPLETED**
- Uncertainty analysis to associate an uncertainty estimate to the derived gain **ONGOING**
- Definition of a GSICS product content+ Formatting to GSICS standards in NetCDF **ONGOING**
- Implementation of the DCC algorithm for Met-07 **ONGOING**

PLANNED WORK FOR 2015

- Establish a reference value for MODIS radiance
- Uncertainty analysis to be continued
- Operational implementation of the DCC extraction for MSGs
- Generation of a GSICS product (demo) for Met-9
- Support to SCOPE-CM ➔ corrections for Met-7,8,9 and 10
- Integration of the DCC results in a VIS/NIR calibration monitoring tool (➔ towards consolidated GSICS corrections)

![Graph showing Drift = 0.516 ± 0.063 % yr⁻¹ for METEOSAT 9 - Band VIS06 from 2008 to 2012]
Enhancing monitoring capabilities
Towards consolidated GSICS corrections?

Example of the VI S06 band on MSG2/SEVIRI.

Development of Multi-Mission Integrated Calibration Monitoring System
Re-calibration of Meteosat archive data

- Aim is to re-calibrate the IR and WV channels on MFG and MSG and produce a 30+ years (1982 – present) FCDR;
- We have identified reference instruments (HIRS-2, AIRS, and IASI);
- We collected METEOSAT images and reference datasets;
- We generated collocations between MFG (and MSG) and reference measurements;
- We analysed Meteosat-5 and -7 time-series and confirmed need for recalibration;
- We plan to apply DCC-based algorithm to visible channel

**Fig:** Time-series of infra-red biases of the MET-7 IR channel relative to HIRS/2/AIRS/IASI radiances adjusted for spectral band differences.
Calibration is key to ensuring EUMETSAT achieves its 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 continues to develop new calibration capabilities
1. For real-time operations
2. Support of climate reanalysis
3. Support to future programs (MTG + EPS/SG) + third party programs (S3)
4. In international cooperation, including:
   - Global Space-based Inter-Calibration System
   - CEOS WGCV