CGMS

CGMS-37 EUM-WP-03
v1, 28 September 2009
Prepared by EUMETSAT
Agenda Item: B.1

STATUS OF EUMETSAT POLAR SYSTEM (EPS)

This document presents the status of the EPS programme as of August 2009.

Status of EUMETSAT Polar System (EPS)

1 OVERVIEW

The operational status of the EPS low earth orbit polar system is stable and the Metop-A satellite continues to perform well over the reporting period, with the only unplanned outages occurring on IASI, GOME, A-DCS.

In-Plane Manoeuvres, GOME instrument throughput performance testing, GOME instrument software upload and other routine instrument maintenance led to some further, planned minor losses of operational data.

In particular, it can be noted that the Metop-A platform has continued to behave nominally without any major anomaly (e.g. Payload switch off).

The redundant A-HRPT has continued to be operated according to switching zones defined according to the trade-off between user needs and radiation risk. On 25 May 2009, the operations zones were extended to further low risk geographical areas outside of Europe, but of significant importance to the user community. The new switching zone is given section 2.2.

Dissemination of Metop-A products has continued nominally during the reporting period (except for the above mentioned outages). The operational level 1 product services: ATOVS, AVHRR, IASI, GOME, GRAS, ASCAT, and level 2 product services: ASCAT soil moisture, ATOVS and IASI retrievals, have continued nominally.

2 SPACE SEGMENT

2.1 Satellite Status and Configuration

The Metop-A Platform Service Module (SVM) has been performing well during the reporting period, with two In-Plane manoeuvres executed successfully on 22nd January and on the 18th June. The first manoeuvre has been performed in order to stop the orbit drifting which was due to over performance of the double burns in-plane manoeuvre on 30th October 08 which was the final operation of the out-of-plane manoeuvre performed on 23rd October 08. It shall be noted that the drifting of the orbit outside the normal maintenance window did not impact at all the mission data and that the satellite returned inside the window in March 2009. With the In-Plane manoeuvre executed on 18th June 09 the main objective was attained, namely taking the satellite to less than 1km from the dead-band centre for the upcoming OOP manoeuvre in second half of September 09 and keeping an eccentricity which is satisfactory for ASCAT calibration campaign operations.

The SVM EDR is currently using the redundant I/O board following the incident (number 31) from January 2008 as reported previously. The Metop-A platform behaved well over the reporting period without any configuration change to report.

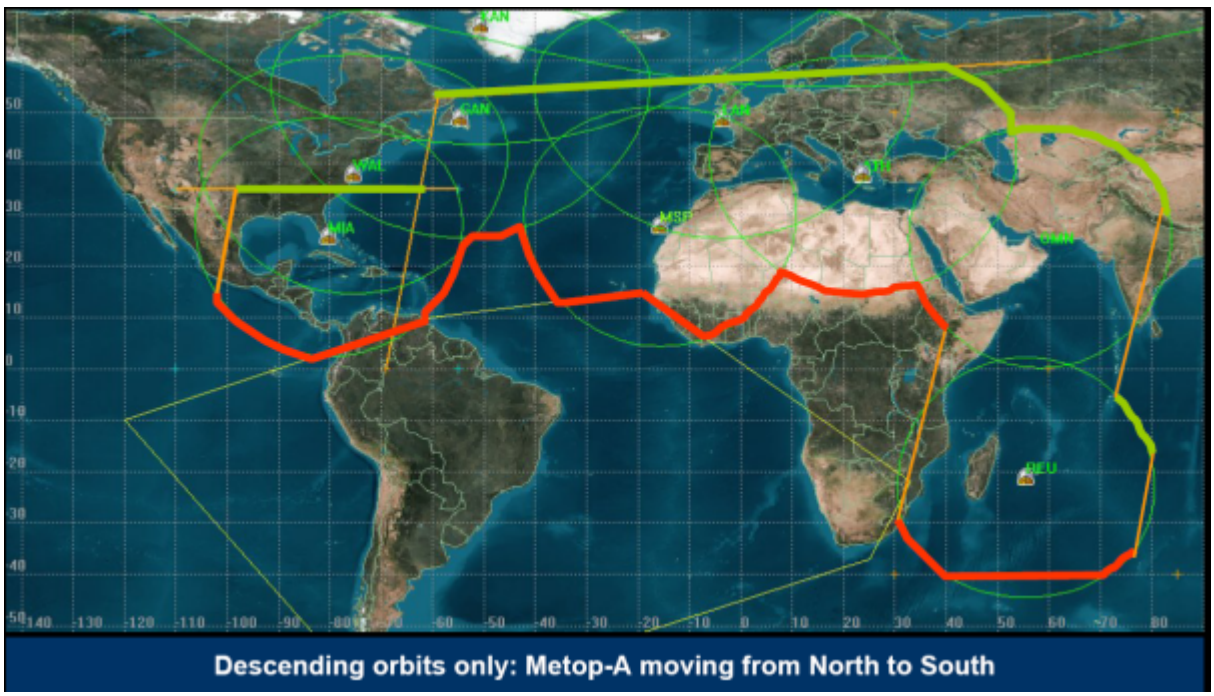
The nominal HRPT suffered a permanent failure on 4 July 2007 and the redundant HRPT entered in operation the 29 September 2008 following a specific scenario minimising the risk of failure by switching on the demodulator only for restricted geographic areas.

The A-DCS instrument is configured on the redundant, B-side since 22 March 2007 and is performing nominally in this configuration.

One GOME anomaly occurred on 16 February 2009. At 21:36:09 the Payload Module Computer detected a command transfer error with the GOME Instrument Control Unit (ICU) and autonomously triggered a GOME equipment switch-off (EQ-SOL) with ICU Suspend. Analysis showed that it was not a permanent failure and the root cause of the problem was due to a Single Event Upset (SEU). The instrument was put back in operations on 19th Feb 09 with a mission outage of 42h23min.

2.2 A-HRPT operations and switching zone coverage

A new scenario of the extended HRPT zone allowing a wider coverage has been implemented from 25th May 2009 onward (with a trial phase of two months). The switching zone has been extended westwards towards the Gulf of Mexico and eastwards to the Indian Ocean and south-west Asia to meet user needs while taking into account the constraints related to the safety of the instrument. The new extended zone coverage is given here after:



Since the implementation of the new extended zone, there were no problems reported related to the strategy with the new zone.

2.3 GOME Co-adding Patch

Saturation of GOME FPA channel 3 (400 and 600 nm) had previously been observed over bright surfaces such as deep convective tropical clouds, even with the shortest standard integration time of 187.5 ms. This had impacted approx 5% of all measurements. It was found that using the 93.75ms integration time with the co-adding function enabled solved the saturation problem, but resulted in a registration error of the ground pixel location when compared with the channels without co-adding. It was decided to operate GOME with occasionally saturated channel 3 data until a software patch could be developed to solve the co-adding problem.

The new software was successfully up linked on 3 Match 2009. During this maintenance activity, a small patch was also uploaded to cure the problem of the Scan Unit occasionally switching off while the ICU builds a Report Format.

Since the upload of this new software and the corresponding timelines to operate the instrument, the situation has significantly improved, although there are a few remaining cases of saturated spectra related to specular reflection by ice clouds under sun glint conditions.

2.4 GOME Throughput

In order to attempt to further investigate the loss of throughput, particularly in the UV, a test was run from 27-28th Jan 09 to incrementally run the FPA detectors warmer. The main conclusions and recommendations are the following:

The main sources of the observed dynamic throughput degradation are very likely associated with scan-mirror degradation and an additional contribution by an attenuating layer directly in front or on the detectors. (Possible sources could be an ice-layer)

The observed recovery of throughput during both instrument switch-offs and in a controlled manner during the instrument throughput test is linked to detector temperature. The recovery rate is approximately 1 to 2.5% per 5 degrees temperature increase, depending on wavelength.

The maximum recovery which can be achieved by increasing the temperature towards 270 K is currently unknown. However, it is expected that the scan mirror contribution will still be significant.

It is believed that the escape route for contaminants within the FPA housing is too convoluted for effective in-orbit decontamination.

2.5 IASI Single Event Upsets (SEU) Investigation

Susceptibility to SEU observed on IASI has been greater than expected. It was decided to better characterise this effect with respect to the solar activity cycle and ageing factor in order to define appropriate mitigation actions to minimise the mission outage for Metop A and also the follow-on satellites. A working group led by CNES released the final report in June 2008, indicating that a modification to the on-board data processing software (restart of DPS (= DMC + 4 DPC) in case IASI is switched to IASI in STBY-REFUSE mode) is the best trade-off between obtaining a sensible reduction of the outage times due to SEU and the complexity and cost of the solution to be implemented.

It is planned to apply the modification as a patch to the unit flying on Metop-A (FM2) and to be implemented in the baseline SW for the next units (PFM and FM3). This modification will be ready to take place in third quarter 2009. Furthermore, satellite operations procedures have been updated in agreement with CNES to identify the signatures of previously experienced SEUs and to avoid the necessity for the involvement of CNES experts in anomaly analysis to allow faster recovery (ca. 3 or 4 orbits of mission outage) before resuming the level 1 product generation and dissemination.

It has to be noted that the 2 anomalies in December 08 are falling outside the range of the "turbo procedure". Indeed, on the 9th December 08, a SEU affected a converter, resulting in IASI STBY-REFUSE mode.
On the 29th December 08, a request for switching off the IASI equipment has been sent by the PMC. This was the first occurrence of such an anomaly for IASI and for METOP. CNES with Thales Alenia Space advice, decided to switch OFF the IMS in order to recover through a full reactivation.

Similarly to the SEU mitigation procedure, action has been taken by EUMETSAT and CNES to mitigate the mission outage by optimising the mission recovery.

2.6 Summary of mission outages

A summary of instrument maintenance and unplanned outages follows:

A-DCS: SEU caused all high and low rate messages to be lost 08/01/2009 (Science data production interrupted for 29h 44min)

ASCAT: (Total outage during reporting period of 2h 26 min)

- Gain Compression monitoring was performed every 28 days in average. (7 gain compression activities for a total programmed outage time of 44 min)
- Monthly external calibrations (18 calibration activities for a total programmed outage time of 1hr 42 min)

GOME: (Total outage during reporting period of 128h)

- Throughput test and between 27 & 29/01/09. (outage of 52h 20 min)
- GOME EQ-SOL on 16/02/09. (outage of 42h 23 min)
- Software 2.6.3 uplink on 02/03/09. (outage of 30h 23min)
- In Plane Manoeuvre related outages 22/1 & 18/06/09. (outage of 03h 22 min)

IASI: (Total outage during reporting period of 72h)

- Routine External Calibration Every 412 Orbits / 29 Days (23h48min)
- External Calibration for Moon Intrusion***** on 14 Jan 2009. (12h04min)
- Data Processing Subsystem Table of Parameters (DPS-TOP) Upload (0h32min)
- IASI EQ-SOL on 29 Dec 2008 (49h50 min Dec 2008+ 35h23min Jan 2009)
- IASI SEU:

  Autonomous transition due to SEU on the protection circuitry of the main converter (CV1) supplying DPCs and FMU on 09/12/2008 (outage of 15h 23 min).

  Autonomous transition due to SEU in DPS subsystem (DPS_Status_Mode_Power_Acquisition and DPS_Pixel_Mode_Acquisition) on 26/08/2009 (outage of 03h 55 min)

  Autonomous transition to Heater Refuse mode due to OOL detected by IMS on parameter ENC0013 (CCM Status & Mode Acquisition) on 07/09/2009 (outage of 17h 07 min).

***** *It should be noted that automated implementation of External Calibration for Moon Intrusion will reduce the outage of future events by an order of magnitude.*

SEM: (Total outage during reporting period of 54h 49 min)

- TED and MEPED calibration performed regularly once per week. (26 calibration activities for a programmed outage time of 42h 16 min)
- Outages related to the two In Plane Manoeuvres (outage of 12h 33 min).

3 Ground Segment

The EPS Ground Segment has been used to support the routine operations of Metop. The stability of the Ground Segment remains at a very high level.

At the year transition 2008-2009 a leap day and a leap second were introduced into the system. Analyses of the problems encountered during the transition have identified permanent technical solutions that are now under development and will be implemented during the second half of 2009.

At the **EUMETSAT Polar Site facility in Svalbard**, both Command and Data Acquisition (CDA) stations have been available, CDA-1 mainly supporting Metop and CDA-2 supporting NOAA blind orbits.

There was one significant ground station anomaly during the period. On 30/07/09 (DOY 210), the CDA1 antenna started to exhibit a juddering non-smooth mechanical movement when observed in most control regimes, accompanied by a non-nominal noise associated with the judder. Although no impact was seen on spacecraft uplink or downlink, all Metop operations were transferred to CDA-2. NOAA support was provided on CDA1 for one more day, then cancelled until the investigation and repair were completed. A team of experts were sent to Svalbard, and problems were identified with a faulty PCB and a servo amp. Following repair and extensive testing,

CDA-1 returned to operational status on 10/08/09 (DOY 220). NOAA nominal operational support resumed in CW34, in line with their scheduling cycle.

In the **EPS Mission Control Centre**, all the Ground Segments have performed well, with Ground Segment 1 (GS-1) supporting Metop spacecraft control and data circulation. GS-3 has been used as the prime maintenance verification environment for new software releases and hardware upgrades and GS-2 has been used for operational validation. Several upgrades to all facilities have been made during the year, without any interruption to operations.

Re-processing of the ASCAT level 1b and soil moisture archive has been completed, and a complete validation of the reprocessed data set is under way.

The **Back-Up Control Centre** (BUCC) in Madrid is activated by the local INSA staff weekly and periodically staff from EUMETSAT travel to upgrade the systems to the latest version, perform a full maintenance and operations validation. This now occurs every three months.

The **Initial Joint Polar System** (IJPS) service continues to support NOAA for blind orbits and to process NOAA spacecraft dumps from NOAA via the Transatlantic Trunk (TAT) link on GS-1. The NOAA Fairbanks support for Metop Telemetry Tracking and Command (TT&C) is fully operational and the transfer of Metop data to NOAA has functioned without problems. Preparations of the Ground Segment and operational processes for NOAA-19 were completed in time for the switch to NOAA-19 for the prime NOAA spacecraft.

During the fourth quarter of 2008, procurement of a new generation of hardware for the operational ground segment facilities and development environment, based on the IBM Power 6 architecture, was concluded. The new generation facilities are planned to enter into operation progressively over the year 2009, with a precursor migration to an upgraded operating system version on the product processing facilities leading this effort. Migration of other facilities to the upgraded operating system, and the transition to the new hardware architecture, will continue in the second half of 2009.

4 EPS Service Performance

The monthly Metop end to end service performance (number of PDUs and Full Products vs. expected) was generally above 99%, apart from January. The IASI outage end of December 2008 was the main reason for the performance drop to 95% in January. GOME instrument operations and other instrument calibrations slightly reduced the availability of the related products.

The monthly NOAA-18 service performance stayed between 95% and 97%. These losses are mostly due to NOAA GS and NOAA TAT problems. The dissemination of NOAA-18 ATOVS Level 2 products remained at the trial stage due to the severe performance degradation of the HIRS instrument on NOAA-18. ATOVS Level 2 became operational with the transition to NOAA-19

Metop PDU dissemination via EUMETCast reflected the overall EUMETCast performance (as follows:

For the Ku-Band Europe service
During the reporting period the EUMETCast KU-Band service generally provided very good performance remaining always between 99.9% and 100%, except for 99.77% in March.

For C-band Africa,
The C-Band Africa turnaround continued to perform excellently in the 99.9 to 100% range. A DVB multiplexer fault in February caused an interruption of approximately 40 min.

For C-band Americas,
The C-Band Americas turnaround performance was generally above 99.8% except for April and May. Two outages of the C-Band Americas service of respectively 6 and 7 hours occurred on 20 April and on 5 May due to issues with the communication network at the service provider facilities. The service performance dropped below the SLA limit of 99.5% for both months.

PDU dissemination to NOAA and full product transfers to the Data Centre were generally 100% or close to 100%.

The dissemination of Metop products to GTS showed nominal behaviour.

5 Metop-B and C Preparations

The launch date for the Metop B satellite is now planned to take place in the second quarter of 2012. The in-orbit phasing between Metop-A and Metop-B will be close to 50 minutes, i.e. half an orbit, as approved by Council in Autumn 2008.

On the satellite, an upgrade of the A-HRPT is on-going to replace the transistor units which have proven on Metop-A to be at risk of failure due to heavy ion impact. The new transistors have successfully passed heavy ion radiation testing on-ground.

Simultaneous Metop-A and B Mission Control Functions (MCF) have been fully functionally tested on the Ground Segment development environment. This ensures that the ground segment will already be able to control two satellites, to cover an earlier Metop-B launch date in case of a critical failure on Metop-A. The MCF changes have also been rolled out to the operational environments. Certain aspects such as performance load testing are postponed until the IBM hardware and operating system versions have been upgraded in mid 2009 (part of planned maintenance activities), since a significant performance improvement is then expected.

In the data processing area, changes are being initiated to the related elements in the Ground Segment, in particular to the Product Generation Facility (PGF) to ensure full Metop-A and -B support is in place. A specific test of the capacity of the PGF to support the worst case scenario of 2 Metop + 2 NOAA satellites is foreseen in August

2009, and the final choice of the PGF upgraded architecture will be based on the results of this test.

A Ground Segment Key Point is taking place in September 2009 to review the ground segment design, followed by overall implementation tests in the Ground Segment development environment in early 2010.

The next formal milestone is the System Verification and Validation Readiness Review (SVVRR) at the end of 2010, which authorises the start of the D2 phase with the end-to-end testing of the system and operations.

Metop-C Launch is foreseen for Third Quarter 2016.