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STATUS OF EUMETSAT POLAR SYSTEM (EPS)

Working Paper Abstract

This paper provides a summary of the status of the EUMETSAT Polar System (EPS) and its performance over the past year. This covers Metop-A, the EPS ground segment and the EPS service performance (global and regional services).

The paper also includes the status and progress reports of on-going projects, covering the Metop-B preparations, the completion of the global timeliness improvement implementation, the extension of EARS, as well as regional and global NPP service implementation evolutions.

Status of EUMETSAT Polar System (EPS)

1 OVERVIEW

The EUMETSAT polar system is performing well and is meeting its service specification.

The Metop-A satellite continues to perform with high availability, although outages have occurred on MHS in October 2010 and three times in 2011 on ASCAT due to Single Event Upsets (SEU). It should however be noted that MHS channels 3 and 4 are exhibiting a rapid degradation such that the data may no longer be usable in the coming months. Further information is provided in Section 2.2 below.

The software designed to make an auto-recovery following detection of an SEU, which had previously been uplinked to IASI post-launch, triggered on detection of SEU events for the first time in January 2011 and again in June 2011. This prevented several hours of outage on each occasion which would have otherwise occurred.

IASI product services had a planned outage of just less than 4 days at the end of August 2010 as decontamination operations were performed, restoring throughput back to the values seen after the initial post-launch decontamination and after the last one performed in 2008.

The A-HRPT activation zone was extended in January 2011 to provide around the globe coverage.

The first collision avoidance in-plane manoeuvre had to be made by Metop-A on 1 May 2011.

Dissemination of Metop-A products continued nominally during the reporting period (except during the above mentioned events).

Following an extensive validation campaign, including user trial disseminations, the Demonstration Phase of the Antarctic Data Acquisition (ADA) improved product delivery timeliness service was declared operational on 10 June 2011. This means that products from an average of 9 orbits per day are sent with a worst-case timeliness (time from data sensing to delivery of Level-1 product) of about 70 minutes. The reduction in time is due to the earlier dump of raw data from the satellite's data recorder to the McMurdo station as shown in the Figure 1 below. This has been achieved through cooperation with NOAA and the Station and McMurdo site owners, NASA and National Science Foundation (NSF) respectively.

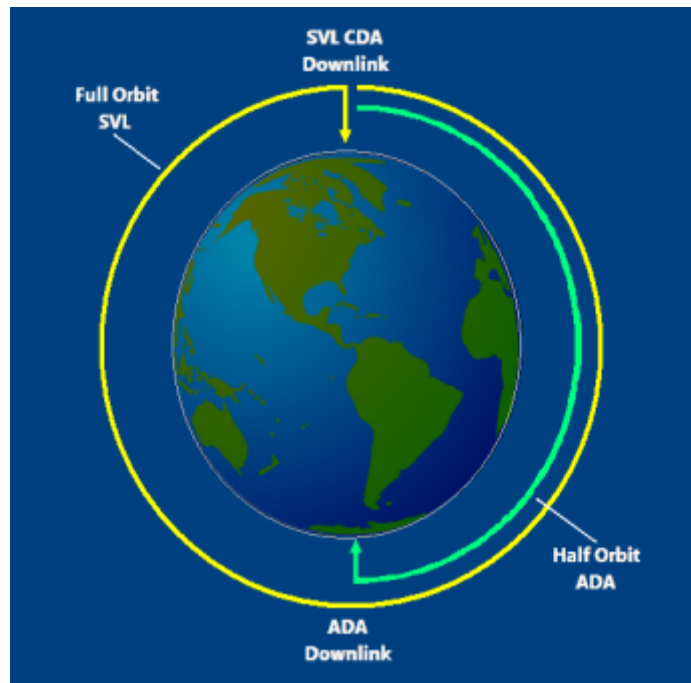


Figure 1: Metop Data dumps over McMurdo in Antarctica.

2 SPACE SEGMENT

2.1 A-HRPT Zone Extension

The A-HRPT activation zone was extended on 18 January 2011 to provide around the globe coverage of “all longitudes”, whilst continuing to avoid operations in regions of high risk heavy ion or proton impact (the polar regions and South Atlantic).

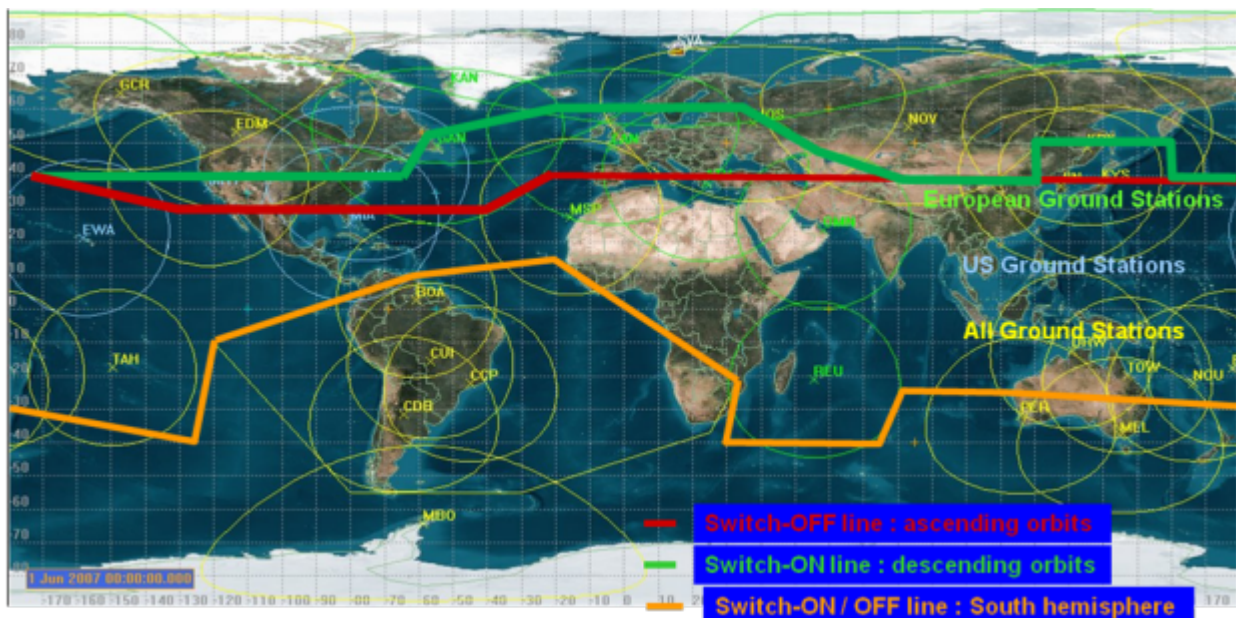


Figure 2 : Extended A-HRPT zone coverage.

2.2 MHS gain degradation. (Channels 3 & 4)

The MHS channels 3 & 4 have been significantly degrading leading to the necessity to increase the amplifier gain by 1dB, performed on the 19 May 2011. There is no margin to perform further gain adjustments following this final adjustment.

MHS Channel performance is measured by looking at the Noise Equivalent Delta Temperature (NEDT), an indicator of the Signal to Noise Ratio. The NEDT specification limit is 1K and is used by ECMWF as a threshold for assimilation into its models. An NEDT of around 5K is the point at which the ATOVS L2 processor will no longer be able to use the channels at all.

Two extrapolation models have been applied to the data to help predict when these limits may be reached. In the worst case we may imminently start to see Channel 3 NEDT exceeding 1 K at hot points in the satellite orbit, with a permanent out of specification performance before the end of the year.

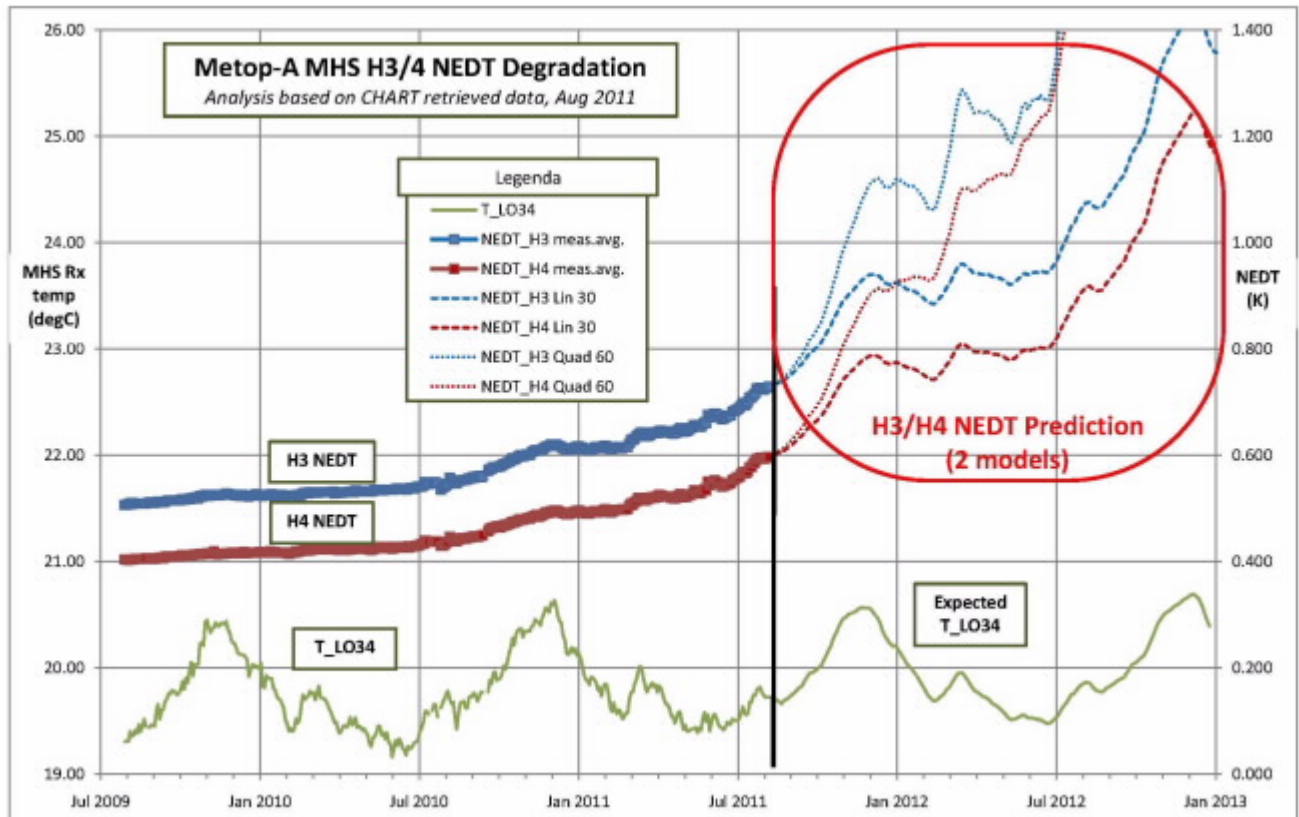


Figure 3 MHS NEDT Evolution and Extrapolation to NEDT Specified Limit of 1 Kelvin

2.3 Collision Avoidance Manoeuvre. (01/05/11)

During calendar week 17 (late April 2011), the satellite collision warning process that EUMETSAT established with the US Air Force Joint Space Operations Center, identified a high risk debris conjunction event concerning METOP-A. After the analysis performed by EPS Flight Dynamics Team, it was decided that the manoeuvre will be performed, as the risk of collision was significantly higher than the acceptable threshold. The burn took place on 1 May 2011 at 03:28 UTC, according to the dedicated manual procedure for unplanned manoeuvres. As usual for an in-plane manoeuvre, this required an outage of both SEM & GOME (as they both had to be in safe modes before the firing), and a general degradation of all the other products during the manoeuvre mode. This is the first time that EUMETSAT has had to manoeuvre Metop-A due to collision risk.

2.4 Main Metop-A Events September 2010 – August 2011

All instruments are operational on their nominal configuration, although several outages have occurred as a result of autonomous on-board events following detection of anomalies.

All the anomalies have been identified and recovered (see following table for more details). Mission outages due to foreseen maintenance activities (gain compression, calibrations and manoeuvres) are not shown. The main Metop-A events over the reported period are given below:

Metop-A Major Events 1st September 2010 – 31st August 2011	
Sub-Sys.	Event
SVM	<ul style="list-style-type: none"> • 05th & 06th October 2010: Double burn OOP manoeuvre. • Jan 2011 till present : continuous degradation of the TM transmitter output power (under investigation -monitored closely) • 31st March 2011: Planned IP manoeuvre. • 1st May 2011: Collision Avoidance IP manoeuvre (first time for EUMETSAT!) • 9th June 2011: Planned IP manoeuvre. (to compensate the effect of the collision avoidance manoeuvre on 1st of May)
PLM	<ul style="list-style-type: none"> • Start of ADA dumps & dissemination. (May 2011) • HRPT zone extension 18th Jan 2011. • Routine Operations.
ADCS	<ul style="list-style-type: none"> • 4th December 2010 ADCS Message corruption. Degraded/interrupted data for 2 days and 00:48:02 h, plus mission outage of 03:26:48 • Routine Ops

AVHRR	Routine Ops
AMSU-A1-A2	<ul style="list-style-type: none"> • 5th-6th Oct 2010 AMSUA1 Calibration Mode. OOP outage 22:14:10 h • 5th-6th Oct AMSUA2 Calibration Mode. OOP outage 22:18:30 h • Routine Ops
HIRS	<ul style="list-style-type: none"> • 5th -6th Oct 2010 HIRS Commanded Position Mode. OOP outage 23:46:17 h • Routine Ops
SEM	<ul style="list-style-type: none"> • 5th- 6th Oct 2010 SEM Manoeuvre Mode. OOP outage 22:07:46 h • 31st March 2011 : Planned IP manoeuvre. Data production interrupted. Outage: 05:47 h:m, • 31st March 2011 : Post-manoevre calibration. Outage: 01:41 h:m (TED+MEPED IFC) • 1st May 2011 : Collision Avoidance IP manoeuvre. Outage 03:26 h:m • 1st May: Post-manoevre calibration. Outage: 01:41 h:m. (TED+MEPED IFC) • 9th June SEM Manoeuvre mode IP outage: 05:45 h. • 9th June post-manoevre calibration outage: 01:41 h. (TED+MEPED IFC)
ASCAT	<ul style="list-style-type: none"> • 3rd of Jan 2011 ASCAT 80% drop of transmitted RF power. Then Measurement Signals degraded from 2011-004-09:41:15 for 1d 06:14:02, plus outage of 04:57:46 h • 14th May ASCAT Autonomous transition to Heater/Refuse mode due to OOL crossings for parameter BND0143 (Integrated Transmitted Power Slot 2). Outage of 1d 23:59:28 h • 23rd May: ASCAT HRS in wrong position (switching anomaly). 80% drop of transmitted RF power associated with an increase of redundant HPA temperature. Signals degraded for 01:47:37 h
GRAS	<ul style="list-style-type: none"> • 5th May 2011: GRAS GOBS v1.9 patching. Outage 04:40 h:m
GOME	<ul style="list-style-type: none"> • 5th- 6th Oct 2010 GOME Dark Mode. OOP outage 21:57:47 h • 31st March 2011: Planned IP manoeuvre; Data production interrupted. Outage 1 orbit • 5th April 2011 : Upload of new timelines • 18th April 2011: timeline not executed for 1 orbit due to commanding error. • 1st May 2011: Collision Avoidance IP manoeuvre. Outage 1 orbit

	9th June 2011: IP Manoeuvre Outage 1 orbit, 01:41 h
MHS	<ul style="list-style-type: none"> • 3rd-4th Oct 2010 MHS Entered Fault Mode Mission outage 22:57:56. • 5th-6th MHS was already in Fault Mode then was configured for OOP in standby mission outage as already stopped for OOP outage 25:19:43 h. • 19th May MHS Receiver Gain of Channels H3 & H4 increased from 2dB to 3dB (Max Gain reached). Outage 3 mins
IASI	<ul style="list-style-type: none"> • 30th August till 4th September 2010: IASI Decontamination, Total mission outage 5 days and 05:55:41 h, (125:55:41 h). • 05th-06th October 2010: IASI OOP outage 24:04:46 h • 24th -25th December IASI External calibration (moon avoidance) Mission outage 16:38:09 h • 30th Jan 2011 IASI autonomous recovery of a SEU. 1 occurrence, total mission outage 00:02: 04 h, 2 PDUs lost • 11th Feb 2011: IASI Resetting of on-board monitoring routine following the above mentioned SEU. Total outage 00:02: 25 h, 2 PDUs lost. • 5th- 18th April 2011: Updated Verification Data Selection, Vortex Collapse tracking request from CNES. • 20th April 2011 : IASI DPS TOP upload and transition to Auxiliary mode 1 occurrence, total outage 00:25: 18 h • 22nd June: IASI, On-board SEU Auto recovery mechanism triggered @ 2011-173-11:53:38, which resulted in a short outage of approximately three minutes. 25th July: IASI outage due to SEU. "Turbo recovery" authorised: Outage 03:25 h:m • 25th July: IASI went into heater refuse mode at 09:16:31 UTC went back to Normop at 12:41:55z. • 18th August: IASI outage due to commanding conflict: Outage 10:15 h:m

Table 1: Significant Metop-A Events 1 Sept. 10 to 31 Aug. 11

3 GROUND SEGMENT

3.1 Overview

The EPS Ground Segment has performed very well over the last five years supporting both EPS and NOAA operations.

Several major upgrades were performed during this reporting period:

- The completion of the EPS Ground Segment Hardware and Operating System for obsolescence reasons and in readiness for Metop-B;
- The ongoing upgrades to all aspects of the EPS system, and subsequent verification and validation activities, to support Metop-B operations;
- The Ground Segment changes required to implement the ADA demonstration phase and the start of the ADA operations on 10 June 2011 (some small data gaps experienced as reported below). 202 improved timeliness passes due to ADA were successfully disseminated before the end of June 2011 (excluding the previous 1 day user trials).

The new Multi-Mission Administration Message (MMAM) is under testing.

3.2 Polar Site Facility

Some data losses occurred in January 2011 due to problems with the CDA-1 tracking, which resulted from an issue with the tilt mechanism. Corrections to this mechanism have been made and no further losses have been reported.

The GEANT link between Svalbard and EUMETSAT has now become the primary back-up to the Fibre link in September 2011, the satellite link remaining only at a lower capacity for satellite TTC. Some outages occurred in February and May 2011 due to related communications work.

3.3 Products

No major anomalies or limitations have affected the EPS operational products during the reporting period. The main outages were directly related to the satellite operations and outages described above, or to the EUMETCast dissemination.

Improvements and expansion of products continued and became available on EUMETCast:

- AVHRR Polar winds, derived above the polar caps from Metop-A AVHRR, became operational at the start of 2011 (also disseminated on GTS-RMDCN)

- A major upgrade of the IASI Level 2 processor was implemented on 15/09/2010, bringing improvement of the quality of temperature profiles, land surface temperatures, carbon monoxide and ozone total column.
- IASI Principal Component Scores, became operational at the start of 2011 (also disseminated on GTS-RMDCN)
- The dissemination of the IASI surface emissivity products started on EUMETCast on 23/11/10.
- An upgrade of the IASI Level 1 processor was introduced on 7 February 2011, correcting a minor but long-standing issue in inter-pixel uniformity of the IASI spectra. The IASI reduced spectra were increased from 300 to 366 channels, (also disseminated on GTS-RMDCN)
- An ASCAT multi-level, multi-parameter product in BUFR format has been implemented. Operational dissemination on EUMETCast and GTS/RMDCN started in December 2010. This is a EUMETSAT and OSI SAF joint product, containing ASCAT backscatter and soil moisture generated at EUMETSAT, and winds generated by the OSI SAF.
- A major upgrade of the GOME-2 Level 1 processor was implemented on 5 January 2011, improving the quality of cloud detection and the clarity of the data structure, as well as providing additional information on PMD measurements aiming to improve aerosol products.
- A new IASI Level 2 Sea Surface Temperature (SST) product, specified to fulfil the requirements of the Group for High Resolution Sea Surface Temperature (GHRSSST), was introduced in March 2011. This is the first step in collaboration with the OSI SAF to provide the GHRSSST community with IASI SST. The dissemination is based on Internet ftp.

A re-processing of the GOME-2 archive is scheduled to start in August 2011 on the new EPS re-processing facility.

4 SERVICES PERFORMANCE

4.1 EPS Service Performance

The monthly Metop end to end service performance (number of PDUs and Full Products vs. expected) was generally above 99% over the year. IASI and ASCAT instrument operations slightly reduced the availability of the related products, as did scheduled instrument calibration and gain activities for other instruments.

The monthly NOAA-19 service performance was generally above 98% with losses mostly due to NOAA GS and NOAA TAT problems.

PDU dissemination via EUMETCast reflected the overall EUMETCast performance of better than 99.8%. PDU dissemination to NOAA and full product transfers to the Data Centre were generally close to 100%.

The dissemination of Metop products to GTS showed nominal behaviour.

4.2 EARS Status and Service Performance

During this period EARS-ATOVS, EARS-AVHRR and EARS-ASCAT provided good operational service with high availability. There were a number of significant changes to the EARS service during the reporting period.

18 January 2011	Metop-A HRPT zone extension
13 April 2011	EARS-ASCAT products disseminated on EUMETCast Africa
16 June 2011	Addition of Metop-A data from NOAA Ewa Beach, Miami and Monterey.

The operational performance of the IP VPN was very good during this period with >99.8% availability per month. In addition to the IP VPN, secure internet links were used to communicate with Moscow and Muscat. The communications to Moscow operate well with >99.93% availability per month. However, communications to Muscat suffered problems starting on 10 February 2011. The openvpn tunnel connection frequency suffered packet drop by OmanTel firewall/gateway. This required reengineering of the transfer mechanism from Muscat to EUMETSAT.

The EARS service utilised EUMETCast for the dissemination of data to users, and this continues to perform well.

EARS-ATOVS products were also distributed by the GTS/RMDCN and are retrievable at the DWD (Offenbach, Germany) RTH. No issues were identified during this period.

EARS-ASCAT products were also distributed by KNMI to the GTS/RMDCN and are retrievable at the Exeter RTH. No issues were identified during this period.

The NWP SAF performed quality monitoring of the EARS-ATOVS products and no issues were identified during this period. NWP SAF identified an issue with the EARS-AVHRR Metop product header and this was quickly resolved.

The following anomalies/limitations are ongoing:

NOAA-17 AVHRR instrument scan motor has failed resulting in degraded product quality and NOAA's classification of the data as unusable. The majority of EARS stations are no longer acquiring the satellite data.

NOAA-15 Has low power transmissions, which results in difficulty acquiring these data. Furthermore, the AMSU-B scan motor has failed and the HIRS instrument has an anomaly, which resulted in the HIRS data not being usable in EARS-ATOVS. As a consequence, only level 1a data are currently distributed to the users from that satellite. The data from this satellite remains important to users due to complimentary time of data compared to NOAA-19/Metop, but the EARS service NOAA-15 is given on a low priority/best effort basis.

5 PROJECTS

5.1 EPS Global Data Timeliness Project

On 10 June 2011, the Antarctic Data Acquisition (ADA) Service for the improved timeliness delivery of Metop global products commenced its Demonstration Phase. This followed the confirmation by NOAA that they and their user community were able to successfully process and assimilate the raw data and products sent from EUMETSAT under the IJPS agreement.

Daily operational reporting shows that the system performed well, some limited anomalies in the McMurdo ground station were successfully diagnosed and recovered, thanks to the NASA remote expert support combined with the winter-over crews at the McMurdo site. Initial indications are that the user community has already been able to benefit from the improved timeliness of product delivery.

Operations are continuing as planned and await the transition to full-orbit McMurdo capability in 2014.

5.2 Metop-B Project

The launch date for the Metop-B satellite is planned for the second quarter of 2012, with a target date of 9 April. 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.

The changes to the EPS Ground Segment and the associated procedures to support parallel operations of the Metop-A and Metop-B satellites are near completion. The closely related project to upgrade the hardware and operating system platforms for the core EPS systems has also been completed successfully.

Similarly, the system verification and operational validation activities for Metop-B are now mostly complete, the SIVVR having been brought forward to September 2011. The Satellite System Validation Test (SSVT), which will operate the Metop-B satellite in its test facility in Toulouse from the upgraded ground segment at EUMETSAT, will take place in the latter part of October 2011.

The results of the SIVVR, the SSVT, along with the results of final validation activities, will be key inputs to the Launch and Operations Readiness Review (LORR) in December 2011. This will be followed by the rehearsals campaign in the first quarter of 2012.

5.3 EARS Extension and NPP Regional Data Service Projects

In July 2008, the EUMETSAT Council decided to establish a new pilot EARS-IASI service in addition to the EARS-ATOVS, EARS-AVHRR and EARS-ASCAT services. The new EARS-IASI service was intended to provide L1C products including 366 selected IASI channels as well as a set of Principal Component scores covering the full IASI spectra.

As the IASI processing requires high CPU and memory availability, the EUMETSAT servers located at the EARS remote stations will be upgraded to support the service. The new servers have been procured and preparation of the servers and applications is under way.

Dissemination of EARS-SCAT value-added Wind Product via EUMETCast continues to operate normally.

Due to the limited availability of Metop-A HRPT the EARS system has been configured to use the Fast Dump Extract System (FDES) at Svalbard with the objective of establishing a Metop-A European regional data service with timeliness similar to that originally planned for the EARS services. This system is used to support the EARS-ATOVS, EARS-AVHRR and EARS-ASCAT services. Extending the use of the FDES data for IASI will follow in due course.

In December 2010, Council approved EARS options for supporting NPP. Preparation of new contracts for the involved set of HRPT station partners have started and negotiations are ongoing.

5.4 NPP Global Data Service Project

The NPP satellite is scheduled for launch in October 2011. It will be the first of the next generation of polar spacecraft to be operated by NOAA, and will be followed by JPSS-1. The baseline NPP/JPSS-1 services are defined to be equivalent to the current and approved operational services for data from the US satellites in the Afternoon Orbit. They will ensure continuity, once NPP takes the role as the primary operational satellite in this orbit.

EUMETSAT will provide global data from NPP to its user community via EUMETCast and the GTS/RMDCN. This will allow them to fulfil any Cal/Val commitments and to access the data for routine operational use.

EUMETSAT's NPP related activities will encompass:

- the acquisition of global data from the CrIS, ATMS and VIIRS instruments from NDE;
- the tailoring of these data according to the requirements of the users community; and
- the dissemination of the tailored products to the user community.