CGMS

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For information to Plenary

STATUS OF EUMETSAT CURRENT AND FUTURE SATELLITE PROGRAMMES - REPORT TO CGMS-44

This document summarises the status of EUMETSAT current and future LEO and GEO satellite systems. The reporting period for current satellite operations is 1 April 2015 to 31 March 2016. For future satellites, progress to date at the time of writing is included.

Current satellite programmes cover status of the spacecraft, ground segment, data transmission, projects and services, user statistics.

Future satellite programmes cover the mission objectives (spacecraft, payload, instruments, products) and programme status (space, system and ground segments).

CGMS is invited to take note.

Status of EUMETSAT current and future satellite programmes - report to CGMS-44

1 INTRODUCTION

This paper reports on the status of EUMETSAT current and future satellite systems. The reporting period for current satellite operations is 1 April 2015 to 31 March 2016. For future satellites, progress to date at the time of writing is included.

2 CURRENT SATELLITE SYSTEMS

EUMETSAT Current GEO satellites

Sector	Satellites in orbit P=pre-operational Op=operational B=back-up L=limited availability	Location	Launch date	Details on near real time access to L0/L1 data (links)	Environmental payload and status
East Atlantic (36°W-36°E)	Meteosat-9 (Op)	9.5°E	21/12/2005	Service Status Data access Level 1 data info	Rapid Scanning Service, Prime GERB Service
	Meteosat-10 (Op)	0°W	05/07/2012		12-channel SEVIRI imager, DCS, GERB not operational Data disseminated via EUMETCAST and LRIT
	Meteosat-8 (backup)	3.5°E	28/08/2002		Back-up of Meteosat-9 and Meteosat-10. GERB and DCS not operational
	Meteosat-11 (in-orbit storage)	3.4^{0}W	15/07/2015		Spacecraft configured for In-Orbit-Storage

Indian Ocean (36°E-108°E)	Meteosat-7 (Op)	57.5°E	02/09/1997		3-channel imager. Dissemination via EUMETCast Indian Ocean Data Coverage (IODC), currently approved until end of 2016

EUMETSAT Current LEO satellites

Orbit type ECT=Equator Crossing Time (for sun-synchronous orbits)	Satellites in orbit P=pre-operational Op=operational B=back-up, secondary L=limited availability	Equator Crossing Time (ECT) Ascending Node	Mean Altitude	Launch date	Details on near real time access to L0/L1 data (links)	Instrument payload and status
Sun-synchronous "Morning" orbit ECT between 19:00-24:00 and between 07:00-12:00	Metop-A (B)	21:30	837 km	19/10/2006	Data access L1 data info	AVHRR/3, HIRS/4, AMSU-A, MHS, IASI, GRAS, ASCAT, GOME-2, SEM, A-DCS (prime ARGOS-3 service) , SARSAT, (HRPT partly functional) Dissemination via EUMETCast
Sun-synchronous "Morning" orbit ECT between 19:00-24:00 and between 07:00-12:00	Metop-B (Op)	21:30	837 km	17/09/2012	Data access L1 data info	AVHRR/3, HIRS/4, AMSU-A, MHS, IASI, GRAS, ASCAT, GOME-2, SEM, DCS (ARGOS-2 service only), SARSAT, (HRPT fully functional). Dissemination via EUMETCast

2.1 Status of current GEO satellite systems

2.1.1 Mission objectives, payload/instruments, products

The Meteosat system is designed to support nowcasting, short-range forecasting, numerical weather forecasting and climate applications. The system currently comprises two operational satellites of the Meteosat Second Generation (MSG) (Meteosat 10 and 9) providing the core services over Europe and Africa and one satellite of the first generation (Meteosat 7) which is providing Indian Ocean Data Collection services. The Meteosat-10 satellite is currently providing the core service from 0-deg, Meteosat-9 is providing a rapid scan service over Europe from 9.5-deg East, while Meteosat-8 located at 3.5-deg East provides a backup function to Meteosat-10 and Meteosat-9. Meteosat-11 launched in July-2015 is in an In-Orbit-Storage configuration.

Meteosat Second Generation (MSG) consists of a series of four geostationary meteorological satellites, along with ground-based infrastructure, that will operate consecutively beyond 2020. The core mission of the MSG satellites is provided by the Spinning Enhanced Visible and InfraRed Imager (SEVIRI), which has the capacity to observe the Earth in 12 spectral channels and provide impressive high quality image data which is at the heart of the operational forecasting needs, and the Geostationary Earth Radiation Budget (GERB) instrument supporting long term climate studies.

Each Meteosat satellite is designed to remain in orbit, in an operable condition for at least seven years, but the actual performance of the satellites in orbit has exceeded this limit. The current policy is to keep two operable satellites in orbit and to launch a new satellite based upon a service availability analysis. In the case of MSG-4, the last satellite of the series, in view of the on-ground storage limitation being reached, an approach was selected to store the satellite in-obit, following launch and an initial commissioning phase, as long as the in orbit status will allow. Towards the end of the MSG lifetime, there will be a follow-on series in geostationary orbit - Meteosat Third Generation.

2.1.2 Status of spacecraft

During the period from 1 April 2015 to 31 March 2016, the Meteosat Transition Programme (MTP) and Meteosat Second Generation (MSG) space segments have performed well.

The MSG system has been stable.

Meteosat-8

Meteosat-8, launched on 28 August 2002, has been on station at 3.5°E since 11 February 2013. The satellite is available for use as a hot backup for the Meteosat-10 prime service and for the Meteosat-9 RSS service.

Meteosat-8 is nominally configured in Full Earth Scan (FES) imaging mode with the images being archived, not disseminated, GERB is in safe mode, Search and Rescue is switched-off and the Data Collection Platform (DCP) transponder is switched-off.

Meteosat-8 was used to provide the Full Earth Scan service during the Meteosat-10 safe mode (from 15-to-18-November) and also during the decontamination of the SEVIRI instrument on Meteosat-10 (08-14 December 2015). Meteosat-8 was rapidly re-tasked to conduct Rapid Scanning covering for the 31-March-to-04-April Meteosat-9 safe mode outage. This re-tasking was performed by dynamically moving up a scheduled Meteosat-8 gap filling rapid scanning for Meteosat-9 by one week.

Meteosat-8 SEVIRI was used for a 2-hour duration 10-minute Rapid Scan test in support of Meteosat Third Generation (MTG) data collection on 4-November, followed by a 30-hour test on 10/11-November-2015.
The number of life cycles for Meteosat-8 SEVIRI to conduct 5-minute RSS are limited and hence the 12-January-to-9-February-2016 one month of Meteosat-9 SEVIRI RSS outage was not covered by Meteosat-8 (as a Meteosat-8 SEVIRI RSS lifesaving measure).

Meteosat-9

Meteosat-9, launched on 21 December 2005, is on station at 9.5°E since 5 February 2013 and supports the Rapid Scanning Service (RSS) since 9 April 2013.

The spacecraft is in RSS imaging mode. The Search and Rescue transponder is switched-on (as requested by COSPAS-SARSAT) and the DCP transponder is switched-off.

From 12-January-to-9-February the Meteosat-9 Rapid Scanning Service stopped per schedule, in order to perform SEVIRI health and safety activity (to prolong SEVIRI life).

The spacecraft experienced a safe mode on 31-March-2016 due to deep space radiation and was restored to service on 4-April-2016.

The GERB instrument currently is switched OFF due to degraded performance. Previous GERB was operated as prime GERB instrument from April 2013 until end-April-2015 (due to the GERB-3 anomaly on Meteosat-10).

Meteosat-10

Meteosat-10, launched on 5 July 2012, following January 2013 relocations, has been the prime Meteosat satellite for the 0° service since 21 January 2013.

The spacecraft is currently in imaging mode, fully configured including DCP and Search and Rescue transponders. The spacecraft experienced a safe mode on 15-

November-2015 due to deep space radiation and was restored to service on 18-November.

The GERB instrument was successfully recovered on 11-February-2015, after being non-operational since an Auto-Safe mode on 27 April 2013. Since end-April-2015 it has been the prime GERB instrument.

Meteosat-11

Meteosat-11, launched on 15-July-2015, is configured in an In-Orbit-Storage configuration at 3.4^0W.

Following launch was a successful LEOP and Commissioning, lasting until 7 December 2015 when the satellite started its in-orbit storage phase. Similar to the Meteosat-10 commissioning, the Meteosat-11 commissioning included towards its end 2.5 months of SEVIRI data dissemination to National Meteorological Services (NMS) and ECMWF, allowing an expert feedback on the Meteosat-11 products. It is planned to store Meteosat-11 in orbit for about 2.5 years from the completion of the successful commissioning.

2.1.3 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

1. Date and Universal Time of the anomaly	**2. Fully specified location of the anomaly** (spacecraft location)	**3. Velocity or orbital elements at time of the anomaly**	4. Eclipse state of the vehicle (full, penumbra, partial, none)	5. Vector to Sun in spacecraft coordinates	6. Velocity vector of spacecraft in spacecraft coordinates	7. Initial guess at type of anomaly (See taxonomy below)	8. Estimated confidence of that guess	9. Anomaly category (e.g., affected system or kind of disruption)	10. Vehicle identity	11. Notes (e.g. unusual operational states or recent changes to operations (recent commands, attitude scheme, etc.)
15 Nov 2015	Geo (3.5 deg East)	Geo	No eclipse			Galactic Cosmic Rays	High	Satellite Safe Mode	Meteosat-8	
31 Mar 2015	Geo (9.5 deg East)	Geo	No eclipse			Galactic Cosmic Rays	High	CACE mode change	Meteosat-9	

Taxonomy of Satellite Anomalies Caused by In Situ Charged Particle Environment (to be used for column 7):

1. Electrostatic discharge (charging)
    - 1.1 Surface charging
        - 1.1.1 Plasma sheet (subauroral)
        - 1.1.2 Auroral
    - 1.2 Internal charging
        - 1.2.1 Subsurface charging (e.g., beneath blanket)
        - 1.2.2 Deep charging (e.g., inside a box)
2. Single-Event Effects
    - 2.1 Protons
        - 2.1.1 Solar proton event
        - 2.1.2 Geomagnetically trapped protons
    - 2.2 Heavy ions
        - 2.2.1 Galactic Cosmic Rays
        - 2.2.2 Solar energetic particles
        - 2.2.3 Geomagnetically trapped heavy ions
3. Total Dose
    - 3.1 Long-term dose accumulation (multiple causes combined)
    - 3.2 Short-term (days or less) dose accumulation
        - 3.2.1 Solar protons
        - 3.2.2 Geomagnetically trapped protons
        - 3.2.3 Geomagnetically trapped electrons

2.1.4 Ground segment matters

The availability of the Meteosat (first and second generation) ground segments was nominal in the reporting period.

A significant activity on the MSG ground segment is the migration of whole MSG Ground Segment to the Technical Infrastructure Building (TIB) which is part of the MSG Ground Segment Computer Infrastructure Upgrade Project (MCIUP). The mission data chain (IMPF, MPEF and DADF) is operational. The Operations Readiness Review took place on 12 April, and the transition for the Central Facility will take place in CW 18.

2.1.5 Data transmission

GEO satellite product dissemination is made via EUMETCast. EUMETCast is EUMETSAT's primary dissemination mechanism for the near real-time delivery of satellite data and products generated by the EUMETSAT Application Ground Segment. Third party data and products from partner organisations are also delivered by the system, which is based on Digital Video Broadcast (DVB) technology. EUMETCast comprises three services:

- Ku-band Europe service (DVB-S2)
- C-band Africa service (DVB-S)
- C-band Americas service (DVB-S)

The EUMETCast-Terrestrial Demonstration Service went live in March to complement the existing EUMETCast Satellite service. One purpose of the new service is to provide data to bilateral partners – mainly outside the footprints of EUMETCast satellites. EUMETCast-Terrestrial therefore offers an alternative solution for data provision to international partners such as NOAA, KMA and others. Also, EUMETCast-Terrestrial can deliver high volume data to small user communities in Europe whenever dissemination by satellite is less appropriate due to the limited number of users.

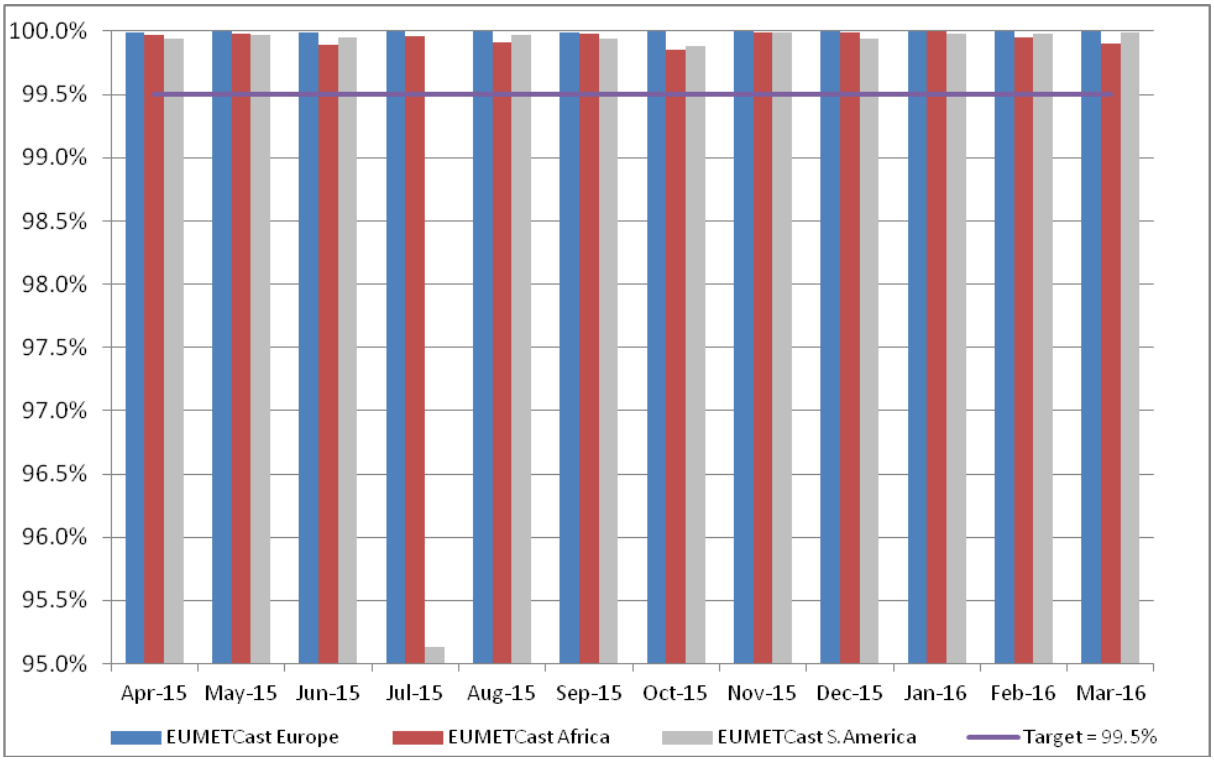

Figure 1: EUMETCast Availability

In July the South America turnaround Service was impacted by local interference and the Ku-band reception antenna had to be relocated to resolve problem. Apart from this event, as can be seen in Figure 1, all services provided very good availability over the reporting period.

2.1.6 Third Party Data Services

Service	Date and Event during reporting period
Third-Party GEO Data Services	
GOES and MTSAT Data	Nominal service. MTSAT data stopped in October 2015, a service from Himawari-8 started in September 2015.
FY-2G, F, D & E Data	Nominal service.
Third-Party LEO Data Services	
MODIS Data	Nominal service
FY-3A, B & C Global Data	FY-3A: mission discontinued for all instruments. FY-3B: available data from MWHS and IRAS. FY-3C: available data from MWHS-2, IRAS, MWRI. MWTS-2 on FY-3C failed in February 2015.
SSMI/S	Nominal service
SARAL	Nominal service
Megha-Tropiques Data	Nominal service, but with some outages since July 2015 (due to issues with the ISRO downlink station in Bangalore). Service became nominal again in December 2015.
GCOM-W1	Nominal service
NOAA 15, (16) and 18	Nominal service
Third-Party Data and Products	
DWDSAT and RETIM	Nominal service
BMD and MDD Service	Nominal service
SMOS Data	Nominal service
EU Copernicus/FP7 Projects	Nominal service
MESA	Nominal service

Service	Date and Event during reporting period
Other Projects	In the GEONETCast context the dissemination of products from NOAA NESDIS, US-EPA ongoing with nominal status, with SERVIR and RANET currently being unavailable. Vegetation data for Africa, provided by VITO, and Rainfall Estimates, provided by Tamsat / University of Reading, were nominal.

2.1.7 User statistics

EUMETCast

The status of EUMETCast registrations up to 31 December 2014 is provided in Figure 2~~Figure 2~~. Note that Total number of registered Users on 31 March 2015 was 3418 (users may have more than one station).

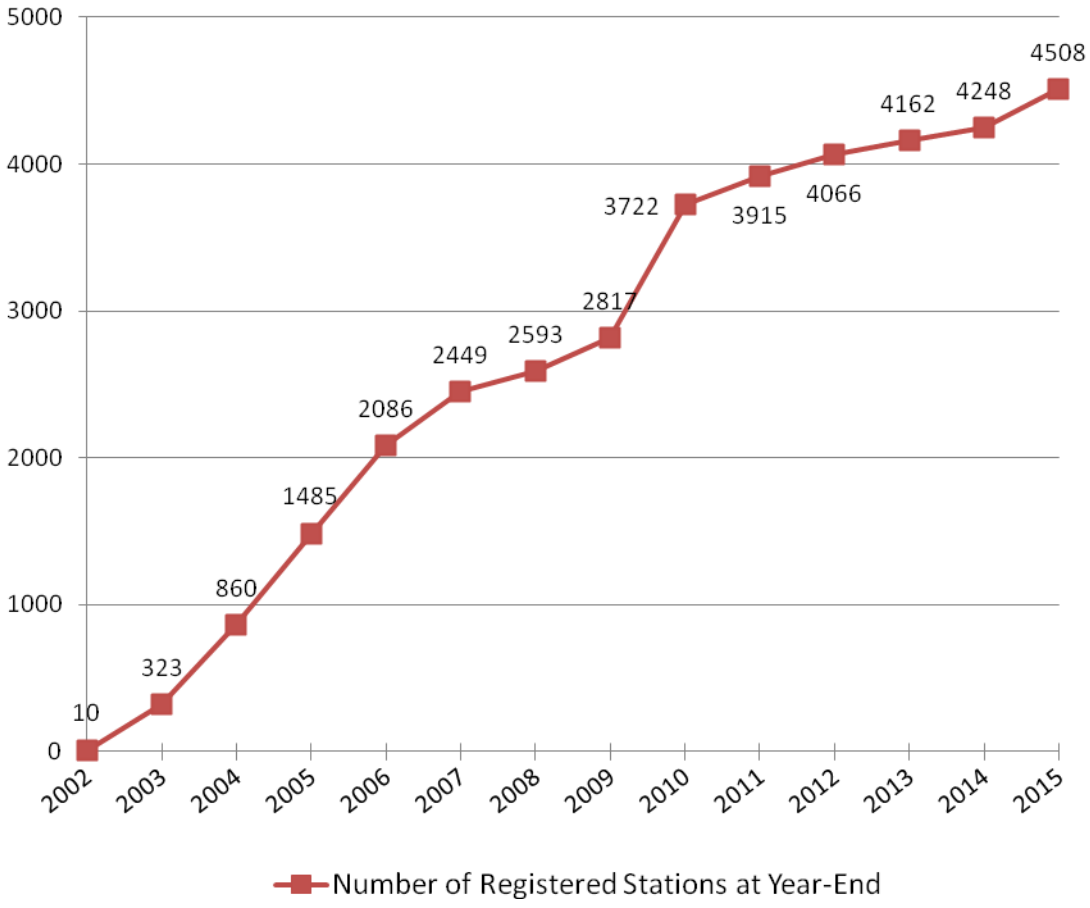

Figure 2: EUMETCast Registrations

The availability of the EUMETCast dissemination system has already been provided in Section 2.1.5.

The EUMETSAT Data Centre

EUMETSAT's Data Centre archives all payload data acquired from EUMETSAT's operational satellites and most of the products derived from that data. The Data Centre allows registered users to request data and products from the archive by use of its online 'self-service' ordering mechanism and supplies the requested items via physical media and the Internet.

The development of orders and deliveries from Jan 2015 up to and including April 2015 is provided in Fig. 3 below. 2015 saw a peak in the volume of ordering in the history of the Data Centre. Over 1.7 TB of data was processed to deliver over 430 TB of data in 11 Mio files to users, an increase of ca. 15% to the previous high.

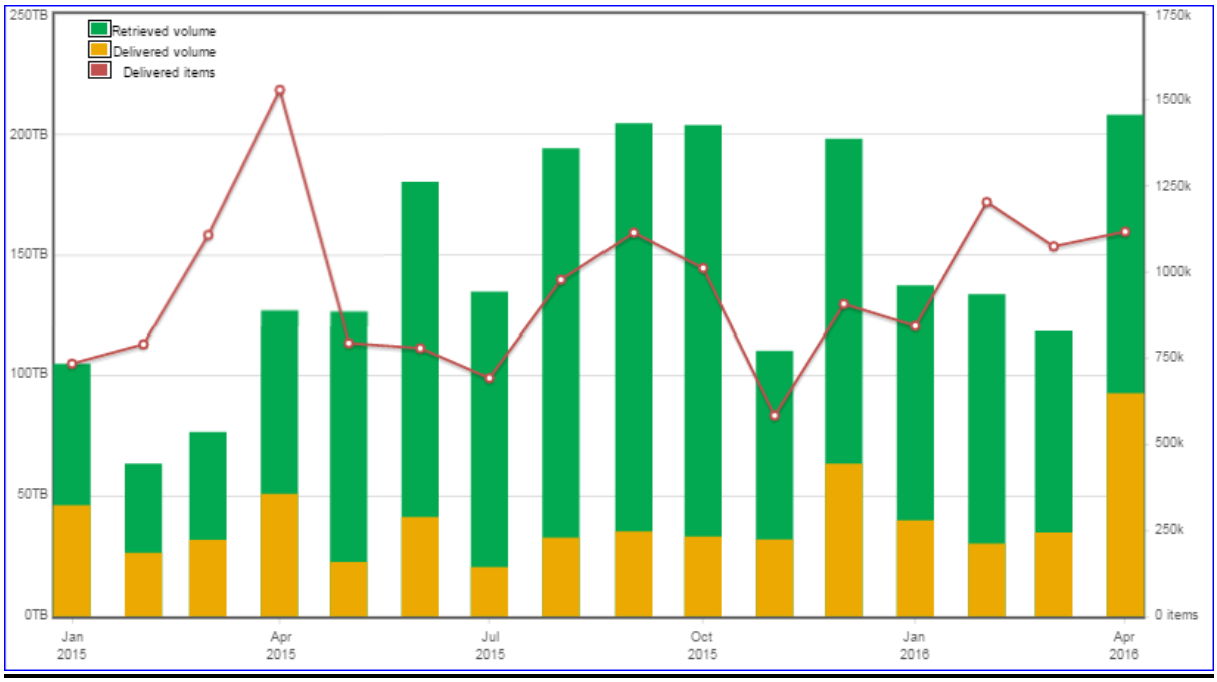

Figure 3: Data Centre Retrieval and Delivery of User Ordering

A new web-based and more intuitive Data Centre Online Ordering Application which is needed for Sentinel-3 data ordering was released to the public user community at the beginning of December 2015.

A contract was signed in June 2015 with the Technische Informationsbibliothek Braunschweig to support the introduction of Digital Object Identifiers (DOI) in the

EUMETSAT Data Centre mainly enabling the digital identification of Climate Data Records and for their referencing in scientific publications and the coordination of DOIs for all EUMETSAT Climate Data Records. The first DOI's have now been released for Climate Data Records and Operational GSICS Inter-Calibration products. Following a DOI link will take the user to the corresponding Product Navigator landing page, which has been upgraded to hold the DOI information (example: http://dx.doi.org/10.15770/EUM_SEC_CLM_0001).

2.2 Status of current LEO satellite systems

2.2.1 Mission objectives, payload/instruments, products

The prime objective of the EUMETSAT Polar System (EPS) Metop mission series is to provide continuous, long-term datasets, in support of operational meteorological and environmental forecasting and global climate monitoring.

The EPS programme baseline consists of a series of three polar orbiting Metop satellites, to be flown successively for more than 14 years, from 2006, supported by the relevant ground facilities. However, with the continuing good health of Metop-A and following the successful entry into operations of Metop-B, it has been decided to continue a dual-Metop operational service as long as this provides added user value and is compatible with the Metop-A end-of-life constraints due to the space debris mitigation guidelines.

Metop-A was launched on 19 October 2006 and Metop-B was launched on 17 September 2012.

Metop carries a set of 'heritage' instruments provided by the United States and a new generation of European instruments that offer improved remote sensing capabilities to both meteorologists and climatologists. The new instruments augment the accuracy of temperature humidity measurements, readings of wind speed and direction, and atmospheric ozone profiles.

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Under the Initial Joint Polar System (IJPS) and Joint Transition Activities (JTA) agreement, EUMETSAT and NOAA have agreed to provide instruments for each other's satellites; exchange all data in real time, and assist each other with backup services. NOAA, with the support of NASA and the US National Science Foundation also provide an Antarctica Data Acquisition (ADA) service providing global data acquisition and real-time transmission to the EUMETSAT processing facilities in order to reduce data dissemination latency. This service is currently providing Metop-B data from most orbits.

Full details of the satellite, its instruments and access to the related data and products can be found on www.eumetsat.int .

2.2.2 Status of spacecraft

The Metop-B satellite took over from Metop-A as the primary operational Metop satellite on 24 April 2013. Metop-A continues full service provision in parallel, as the secondary Metop satellite.

The Metop-A satellite continued to perform well over the reporting period, although signs of ageing are present on some instruments.

2.2.3 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

1. Date and Universal Time of the anomaly	2. Fully specified location of the anomaly (spacecraft location)	3. Velocity or orbital elements at time of the anomaly	4. Eclipse state of the vehicle (full, penumbra, partial, none)	5. Vector to Sun in S/C coordinates	6. Velocity vector of spacecraft in spacecraft coordinate	7. Initial guess at type of anomaly (See taxonomy below)	8. Estimated confidence of that guess	9. Anomaly category (e.g., affected system or kind of disruption)	10. Vehicle identity	11. Notes (e.g. unusual operational states or recent changes to operations (recent commands, attitude scheme, etc.)
01:40:14 14 Apr 2015	Lat 14.45S Lon 59.81W (SAA)	a[km] = 7203.451 e[-] = 0.00097 i[deg] = 98.719 RAAN[deg] = 164.732 PSO[deg] = 345.541 PSO[rad] = 6.03084 LON[deg] = 59.814W LAT[deg] = 14.454S	full		VY [km/s] = -7.423 VZ [km/s] = -0.494	Geo-magnet-ically trapped proton	high	IASI	Metop-B	
01:54:07 18 Apr 2015	Lat 27.10S Lon 61.06W (SAA)	a[km] = 7200.817 e[-] = 0.00086 i[deg] = 98.714 RAAN[deg] = 168.688 PSO[deg] = 332.779 PSO[rad] = 5.80809 LON[deg] = 61.063W LAT[deg] = 27.104S	full		VY [km/s] = -7.423 VZ [km/s] = -0.454	Geo-magnet-ically trapped proton	high	FMU	Metop-B	

06:10:41 19 Apr 2015	Lat 69.64N Lon 154.27W (North Pole)	a[km] = 7188.415 e[-] = 0.00063 i[deg] = 98.697 RAAN[deg] = 169.402 PSO[deg] = 71.477 PSO[rad] = 1.24751 LON[deg] = 154.268W LAT[deg] = 69.642N	none		VY [km/s] = -7.442 VZ [km/s] = -0.163	Galactic Cosmic Ray	medium/ high	ASCAT	Metop-A	
00:55:56 23 Apr 2015	Lat 28.22S Lon 46.76W (SAA)	a[km] = 7200.420 e[-] = 0.00083 i[deg] = 98.684 RAAN[deg] = 173.128 PSO[deg] = 331.655 PSO[rad] = 5.78848 LON[deg] = 46.761W LAT[deg] = 28.218S	full		VY [km/s] = -7.423 VZ [km/s] = -0.449	Geo-magnet-ically trapped proton	high	IASI	Metop-A	
10:47:22 7 Jun 2015	Lat 12.28S Lon 20.74W (SAA)	a[km] = 7203.748 e[-] = 0.00091 i[deg] = 98.638 RAAN[deg] = 218.331 PSO[deg] = 192.424 PSO[rad] = 3.35843 LON[deg] = 20.737W LAT[deg] = 12.284S	none		VY [km/s] = -7.423 VZ [km/s] = 0.499	Geo-magnet-ically trapped proton	high	IASI	Metop-B	
02:02:53 12 Jun 2015	Lat 24.63S Lon 64.3W (SAA)	a[km] = 7201.392 e[-] = 0.00085 i[deg] = 98.612 RAAN[deg] = 222.331 PSO[deg] = 335.261 PSO[rad] = 5.85140 LON[deg] = 64.302W LAT[deg] = 24.628S	full		VY [km/s] = -7.422 VZ [km/s] = -0.464	Geo-magnet-ically trapped proton	high	IASI	Metop-A	
20:55:58 22 Jun 2015	Lat 50.28S Lon 178.45E (South Pole)	a[km] = 7193.726 e[-] = 0.00168 i[deg] = 98.627 RAAN[deg] = 233.522 PSO[deg] = 230.971 PSO[rad] = 4.03121 LON[deg] = 178.453E LAT[deg] = 50.284S	none		VY [km/s] = -7.425 VZ [km/s] = 0.322	Solar proton event	medium/ high	MHS	Metop-B	

00:55:00 28 Jun 2015	Lat 11.99N Lon 52.60W (SAA)	a[km] = 7203.725 e[-] = 0.00143 i[deg] = 98.617 RAAN[deg] = 238.614 PSO[deg] = 12.110 PSO[rad] = 0.21135 LON[deg] = 52.605W LAT[deg] = 11.995N	full		VY [km/s] = -7.425 VZ [km/s] = -0.499	Geo-magnet-ically trapped proton	high	IASI	Metop-B	
14:24:02 28 Jun 2015	Lat 20.41S Lon 76.86W (SAA)	a[km] = 7202.328 e[-] = 0.00091 i[deg] = 98.594 RAAN[deg] = 238.553 PSO[deg] = 200.590 PSO[rad] = 3.50095 LON[deg] = 76.860W LAT[deg] = 20.412S	none		VY [km/s] = -7.423 VZ [km/s] = 0.478	Geo-magnet-ically trapped proton	high	FMU	Metop-A	
01:00:00 9 Jul 2015	Lat 35.00S Lon 46.55W (SAA)	a[km] = 7198.491 e[-] = 0.00117 i[deg] = 98.590 RAAN[deg] = 248.822 PSO[deg] = 324.726 PSO[rad] = 5.66754 LON[deg] = 46.549W LAT[deg] = 35.000S	full		VY [km/s] = -7.422 VZ [km/s] = -0.417	Geo-magnet-ically trapped proton	high	FMU	Metop-A	
01:42:52 3 Aug 2015	Lat 16.07S Lon 60.23W (SAA)	a[km] = 7203.168 e[-] = 0.00097 i[deg] = 98.601 RAAN[deg] = 274.108 PSO[deg] = 343.818 PSO[rad] = 6.00076 LON[deg] = 60.229W LAT[deg] = 16.072S	full		VY [km/s] = -7.422 VZ [km/s] = -0.490	Geo-magnet-ically trapped proton	high	IASI	Metop-B	
07:39:44 19 Aug 2015	Lat 74.26S Lon 119.32W (South Pole)	a[km] = 7187.592 e[-] = 0.00265 i[deg] = 98.615 RAAN[deg] = 290.106 PSO[deg] = 283.244 PSO[rad] = 4.94355 LON[deg] = 119.318W LAT[deg] = 74.260S	full		VY [km/s] = -7.426 VZ [km/s] = -0.117	Galactic Cosmic Ray	medium/ high	IASI	Metop-B	

00:48:06 18 Sept 2015	Lat 24.13S Lon 45.19W (SAA)	a[km] = 7201.497 e[-] = 0.00075 i[deg] = 98.629 RAAN[deg] = 319.353 PSO[deg] = 335.629 PSO[rad] = 5.85782 LON[deg] = 45.192W LAT[deg] = 24.133S	full		VY [km/s] = -7.423 VZ [km/s] = -0.465	Geo-magnet-ically trapped proton	medium	MHS	Metop-B	
01:41:07 29 Oct 2015	Lat 21.23S Lon 59.04W (SAA)	a[km] = 7202.162 e[-] = 0.00083 i[deg] = 98.679 RAAN[deg] = 359.721 PSO[deg] = 338.544 PSO[rad] = 5.90870 LON[deg] = 59.044W LAT[deg] = 21.226S	full		VY [km/s] = -7.422 VZ [km/s] = -0.475	Geo-magnet-ically trapped proton	high	MHS	Metop-B	
00:32:18 9 Nov 2015	Lat 32.03N Lon 51.53W	a[km] = 7199.474 e[-] = 0.00151 i[deg] = 98.746 RAAN[deg] = 9.679 PSO[deg] = 32.210 PSO[rad] = 0.56218 LON[deg] = 51.533W LAT[deg] = 32.032N	full		VY [km/s] = -7.432 VZ [km/s] = -0.432	Geo-magnet-ically trapped proton	high	ADCS	Metop-A	
20:22:37 11 Nov 2015	Lat 69.21S Lon 173.59E (South Pole)	a[km] = 7188.455 e[-] = 0.00253 i[deg] = 98.708 RAAN[deg] = 13.263 PSO[deg] = 250.824 PSO[rad] = 4.37771 LON[deg] = 173.591E LAT[deg] = 69.208S	none		VY [km/s] = -7.426 VZ [km/s] = 0.168	Galactic Cosmic Ray	medium/ high	IASI	Metop-B	
02:11:30 16 Nov 2015	Lat 11.92S Lon 68.23W (SAA)	a[km] = 7203.777 e[-] = 0.00100 i[deg] = 98.701 RAAN[deg] = 17.439 PSO[deg] = 347.926 PSO[rad] = 6.07245 LON[deg] = 68.228W LAT[deg] = 11.919S	full		VY [km/s] = -7.422 VZ [km/s] = -0.499	Geo-magnet-ically trapped proton	high	SSR	Metop-B	

20:42:01 22 Dec 2015	Lat 43.56N Lon 159.5W	a[km] = 7195.815 e[-] = 0.00129 i[deg] = 98.748 RAAN[deg] = 53.586 PSO[deg] = 135.871 PSO[rad] = 2.37139 LON[deg] = 159.477W LAT[deg] = 43.617N	none		VY [km/s] = -7.435 VZ [km/s] = 0.367	Galactic Cosmic Ray	medium/ high	SARP	Metop-B	
13:50:21 8 Jan 2016	Lat 46.05N Lon 56.28W	a[km] = 7195.123 e[-] = 0.00108 i[deg] = 98.804 RAAN[deg] = 69.539 PSO[deg] = 133.392 PSO[rad] = 2.32813 LON[deg] = 56.297W LAT[deg] = 46.054N	none		VY [km/s] = -7.436 VZ [km/s] = 0.351	Galactic Cosmic Ray	medium/ high	IASI	Metop-A	
23:16:56 18 Feb 2016	Lat 30.81S Lon 21.55W (SAA)	a[km] = 7199.726 e[-] = 0.00095 i[deg] = 98.746 RAAN[deg] = 110.660 PSO[deg] = 328.981 PSO[rad] = 5.74181 LON[deg] = 21.548W LAT[deg] = 30.810S	full		VY [km/s] = -7.422 VZ [km/s] = -0.437	Geo-magnet-ically trapped proton	high	IASI	Metop-B	

Taxonomy of Satellite Anomalies Caused by In Situ Charged Particle Environment (to be used for column 7):

1. Electrostatic discharge (charging)
    - 1.1 Surface charging
        - 1.1.1 Plasma sheet (subauroral)
        - 1.1.2 Auroral
    - 1.2 Internal charging
        - 1.2.1 Subsurface charging (e.g., beneath blanket)
        - 1.2.2 Deep charging (e.g., inside a box)
2. Single-Event Effects
    - 2.1 Protons
        - 2.1.1 Solar proton event
        - 2.1.2 Geomagnetically trapped protons
    - 2.2 Heavy ions
        - 2.2.1 Galactic Cosmic Rays
        - 2.2.2 Solar energetic particles
        - 2.2.3 Geomagnetically trapped heavy ions
3. Total Dose
    - 3.1 Long-term dose accumulation (multiple causes combined)
    - 3.2 Short-term (days or less) dose accumulation
        - 3.2.1 Solar protons
        - 3.2.2 Geomagnetically trapped protons
        - 3.2.3 Geomagnetically trapped electrons

2.2.4 Ground segment matters

The EPS Ground Segment has generally performed very well, supporting both EPS (dual-Metop) and NOAA operations.

EUMETSAT is providing global data from Suomi NPP to its user community via EUMETCast and the GTS/RMDCN for routine operational use..

The EUMETSAT Advanced Retransmission Service (EARS) acquires regional data at a network of European ground stations and retransmits the data for processing and dissemination from the EUMETSAT Central Site, thereby providing regional data timeliness in the order of 30 minutes from sensing. All the Metop services (EARS-ATOVS, EARS-AVHRR, EARS-ASCAT,EARS-IASI and EARS-NWC), as well as the Suomi NPP services (EARS-ATMS, EARS-CrIS and EARS-VIIRS), performed well over the reporting period.

2.2.5 Data transmission

LEO satellite product dissemination is made via EUMETCast. This applies to the global data and the regional data acquired by EARS stations. Please refer to Section 2.1.5 for a report on EUMETCast availability.

Metop satellites also provide a direct broadcast service through the Advanced High Resolution Picture Transmission (A-HRPT) subsystem. Following the failure of the prime A-HRPT on Metop-A in 2007 due to heavy-ion impact, the redundant A-HRPT unit operation is providing a restricted, zone-based operations service, avoiding regions of high cosmic ray and proton activity such as the polar regions and the South Atlantic Anomaly. The extent of the operational zones can be found on:

http://www.eumetsat.int/Home/Main/DataAccess/DirectDissemination/index.htm?l=en

Since the A-HRPT on Metop-B was re-engineered as a result of the lessons learned from the Metop-A A-HRPT failure, users around the globe are receiving operational instrument raw data, without restriction.

2.2.6 Projects, Services

Suomi NPP Global and Regional Service Projects

The Suomi NPP (S-NPP) satellite was successfully launched on 28 October 2011 and is now operated under NOAA responsibility. It is the first of the next generation of polar spacecraft and ensures continuity of Afternoon Orbit operational data services within the IJPS. S-NPP has taken over the role as the primary operational satellite in this orbit. NOAA-19 will continue as the NOAA Prime Services Mission for the afternoon orbits.

Global Data

EUMETSAT is providing global data from Suomi NPP to its user community via EUMETCast and the GTS/RMDCN for routine operational use since 31 July 2012.

EUMETSAT's Suomi NPP related activities encompass:

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

It is recalled that EUMETSAT has no direct support to operations of Suomi-NPP operations. EUMETSAT is however supporting global and regional Suomi-NPP data services within the scope of IJPS and in the framework of Copernicus (SNPP4C).

Regional Data

The core European EARS stations are being upgraded to support Suomi NPP and to establish operational regional services for ATMS, CrIS and VIIRS instrument data.

All core EARS stations now have the new X/L-band reception systems operational and are receiving Suomi NPP data on a routine basis. The product processing for the ATMS, CrIS and VIIRS instrument data is based on the CSPP processing package provided by University of Wisconsin-Madison.

The EARS-ATMS and EARS-CrIS services were declared operational on 15 May 2013 from the first core stations to be ready (Svalbard, Lannion, Maspalomas and Athens). Data acquired in Kangerlussuaq was added in January 2014. Data acquired at Moscow is now also part of this service, since 6 April 2016.

The EARS-VIIRS service became operational on the 29 October 2014, first with data acquired from Lannion, Kangerlussuaq, Svalbard and Athens. Data from the Maspalomas station was added to the service in November 2014.

Jason-2 Data Processing and Dissemination Service

This service delivers the 'Operation Geophysical Data Record' (OGDR) products, derived from the altimetry data acquired from the Jason-2 satellite. Jason-2 is operated in cooperation between EUMETSAT, NOAA, CNES and NASA in the frame of the Ocean Surface Topography Mission (OSTM). EUMETSAT and NOAA process the data from the Jason-2 satellite in near real-time and archive and disseminate the products.

The Jason-2 Service for Near Real Time (NRT) products became operational on 15 December 2008. Overall, for the reporting period, the Jason-2 System provided a

satisfactory operational service with availability around 99.6%, and 95% of data meeting the 3 hours timeliness target.

MODIS Data Dissemination Service

EUMETSAT receives the following MODIS data from NASA for redistribution via EUMETCast:

- Level 1 calibrated radiances (MOD02, MYD02);
- Fire product (MOD14, MYD14);
- MODIS chlorophyll Alpha.

EUMETSAT also receives MODIS direct broadcast polar winds from the Cooperative Institute for Meteorological Satellite Studies (CIMSS) for redistribution via EUMETCast.

The level 1 calibrated radiances and geo-location data are processed at EUMETSAT in order to retain only those data over the geographical region north of 25° North between 60° West and 45° East, and north of 65° North elsewhere. Furthermore, the level 1 radiance data are further reduced by retaining only measurements from 18 spectral channels (1, 2, 5, 6, 8, 9, 10, 12, 15, 20, 23, 26, 27, 28, 29, 31, 32 and 33).

Agreed MODIS products are disseminated unchanged on EUMETCast. Level 1 Calibrated Radiances products (MOD02) are processed before dissemination, comprising a spatially thinned sub-set of channels. MODIS precipitable water products (MOD05 and MYD05) are processed by EUMETSAT in order to retain only near infrared measurements over land during daytime. The worst-case dissemination delay generally stays below 30 min.

FY-3A&B Data Dissemination Service

Level 1 products from FY-3A, FY-3B and FY-3C are provided by CMA, and are made available to EUMETSAT Member States via EUMETCast. MWRI from FY-3B are also redistributed via EUMETCast.

Due to instrument failures, all sounding data from FY-3A and MWTS from FY-3B are no longer available. The FY-3B MWRI and MWHS services remain available.

On 10 September, the full dissemination of Level 1 data from the IRAS instrument onboard FY-3B started. The full dissemination of FY-3C Level 1 data in original HDF format from Micro-Wave Temperature Sounder-2 (MWTS-2), Micro-Wave Humidity Sounder-2 (MWHS-2), Micro-Wave Radiation Imager (MWRI), InfraRed Atmospheric Sounder (IRAS) started on the 18 September. On 25 November, the full dissemination of BUFR products for FY-3B MWHS and IRAS data, and FY-3C MWTS-2, MWHS-2 and IRAS started.

SSMIS Data Dissemination Service

ENV, IMA, LAS and UAS products are disseminated on EUMETCast in BUFR format.

SARAL Data Processing and Dissemination Service

SARAL (Satellite with ARgos and ALtika) is a joint CNES/ISRO programme. The role of EUMETSAT is analogous to the support provided for Jason-2:

- NRT processing of AltiKa payload instrument data;
- Encoding the SARAL products in BUFR;
- NRT dissemination of the SARAL products via EUMETCast and GTS/RMDCN;
- Archiving of the SARAL products in the Data Centre; and
- Coordination with CNES for the set-up, validation and operations of the SARAL ground segment at EUMETSAT.

The SARAL NRT altimetry products are distributed via EUMETCast since 16 September 2013 and via the GTS since 10 October 2013.
The provided service is above specification.

Megha-Tropiques Data Dissemination Service

Based on the requirements for Level 1A2 data from the SAPHIR, MADRAS, ScaRaB and ROSA instruments and the tripartite cooperation agreement between ISRO, EUMETSAT, and CNES, a data transfer mechanism was agreed which uses a procured data line directly from ISRO to EUMETSAT.
The initial service started on 27 May 2014 with data from the SAPHIR instrument reformatted to BUFR. The ROSA data is not available, and the MADRAS instrument has failed and so no products from MADRAS will be available for forwarding.

SMOS Data Dissemination Service

A BUFR version of the SMOS Level 1c near real time light product received from ESA via the Met Office (UK), is being distributed by EUMETSAT since February 2013.

GCOM-W1

GCOM-W1 AMSR2 data is redistributed to EUMETSAT Member State NMHSs and ECMWF via EUMETCast.

NOAA 15 and 18

Operational dissemination of NRT data from the ATOVS instruments onboard the non-IJPS NOAA satellites (since the loss of NOAA-16, now limited to NOAA-15 and NOAA-18) began on 25 November 2014. More precisely, L1B data from HIRS, AMSU-A, AMSU-B and MHS, received from NOAA DDS, are processed to L1C and reformatted to BUFR using the AAPP software.

2.2.7 User statistics

Overall user statistics are provided in Section 2.1.7.

3 FUTURE SATELLITE SYSTEMS

EUMETSAT Future GEO Satellites

Sector	Satellites in orbit P=pre-operational Op=operational B=back-up L=limited availability	Location	Launch date	Details on near real time access to L0/L1 data (Links)	Environmental payload and status
East Atlantic (36°W -36°E)	MTG I1[1]	9.5°E	Q3 2020		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG S1	0°	Q1 2022		Meteosat Third Generation/ Sounding (IRS, UVN)
	MTG I2	9.5°E	Q3 2024		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG I3	9.5°E	Q3 2028		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG S2	0°	Q3 2030		Meteosat Third Generation/ Sounding (IRS, UVN)
	MTG I4	9.5°E	Q3 2031		Meteosat Third Generation/ Imaging (FCI, LI)

[1] Operational Scenario for the MTG Imaging Mission will be provided by one satellite at 0 deg and one satellite at 9,5 deg East, providing the Full Disc (FD) imaging service and the Rapid Scan Service (RSS)

EUMETSAT Future LEO Satellites

Orbit type ECT=Equator Crossing Time (for sun-synchronous orbits)	Satellites in orbit P=pre-operational Op=operational B=back-up, secondary L=limited availability	Equator Crossing Time (ECT) Ascending Node	Mean Altitude	Launch date	Details on near real time access to L0/L1 data (links)	Instrument payload and status
Sun-synchronous "Morning" orbit ECT between 19:00-24:00 and between 07:00-12:00	Metop-C (Metop-3)	21:30	837 km	October 2018		AVHRR, MHS,AMSU-A, IASI, ASCAT,GRAS GOME, SEM, A-DCS
	Metop-SG 1A	21:30	837	June 2021		METimage, IASI-NG, MWS, Sentinel-5, 3MI, RO
	Metop-SG-1B	21:30	837	December 2022		SCA, MWI, ICI, RO, ARGOS-4
	Metop-SG 2A	21:30	837	2028		METimage, IASI-NG, MWS, Sentinel-5, 3MI, RO
	Metop-SG-2B	21:30	837	2029		SCA, MWI, ICI, RO, ARGOS-4
	Metop-SG 3A	21:30	837	2035		METimage, IASI-NG, MWS, Sentinel-5, 3MI, RO
	Metop-SG-3B	21:30	837	2036		SCA, MWI, ICI, RO

3.1 Status of future GEO satellite systems

3.1.1 MTG

3.1.1.1 Mission objectives, spacecraft, payload/instruments, products

The MTG mission encompasses the following observation missions:

- Flexible Combined Imager (FCI) mission, allows scanning of either the full disc in 16 channels every 10 minutes with a spatial sampling distance in the range 1-2km (Full Disc High Spectral resolution Imagery (FDHSI) in support of the Full Disc Scanning Service (FCI-FDSS)) or a quarter of the Earth in 4 channels every 2.5 minutes with a improvement in resolution by a factor of two High spatial Resolution Fast Imagery (HRFI) in support of the Rapid Scanning Service (FCI-RSS)).

- InfraRed Sounding (IRS) mission, covering the full disc in 60 minutes, providing hyperspectral sounding information in two bands, a Long Wave InfraRed (LWIR: 700 - 1210 cm-1) and Mid Wave InfraRed (MWIR: 1600 - 2175 cm-1) band with a spatial sampling distance around 4km.

- Lightning Imagery (LI) mission, detecting continuously over almost the full disc, the lightning discharges taking place in clouds or between cloud and ground with a spatial sampling distance around 10km.

- Ultraviolet, Visible & Near-infrared (UVN) sounding mission, covering Europe every hour taking measurements in three spectral bands (UV: 290 - 400 nm; VIS: 400 - 500 nm, NIR: 755 - 775 nm) with a spatial sampling distance better than 10km. This mission will be implemented with the Copernicus (formerly GMES) Sentinel-4 instrument which will be accommodated on two of the MTG Satellites, the so called MTG -S satellites.

Complementary to the direct observation missions summarised above and essential to satisfy key user needs, the following mission objectives also need to be fulfilled by MTG:

- Level 2 product extraction;
- Data Collection System (DCS), for collecting and transmitting observations and data from surface, buoy, ship, balloon or airborne Data Collection Platforms (DCP);
- Search And Rescue (SAR) relay service. Similarly to MSG, the MTG System will accommodate a Geostationary Search and Rescue (GEOSAR) transponder, enabling the operations of the mission under the aegis of the COSPAS-SARSAT System.

- Near Real Time Data Dissemination & Relay services to users, including Foreign Satellite Data (FSD) collection and distribution (data from other EUMETSAT and Third Party satellite systems for calibration and global applications):

  - EUMETCast & High Rate dissemination services (including relay of FSD);
  - Regional Meteorological Data Communication Network (RMDCN) dissemination service. (RMDCN provides a computer network infrastructure for the meteorological community in World Meteorological Organization (WMO) Region VI (Europe) and has expanded to sites in WMO Region II (Asia)). It is integrated with the Global Telecommunication System (GTS) established by the WMO.
  - Internet dissemination services;
  - Data stewardship and reprocessing support;
  - Off-line data delivery; on-line services to the Users; Data exploitation support, reach-out, training and help desk.

Archived dataset retrieval services will continue to be provided as part of the multi-mission EUMETSAT Data Centre services, and User support services will be enhanced to address the additional needs with MTG.

3.1.1.2 Programme status

3.1.1.2.1 Overall status, and space segment

From September 2015 to March 2016 the anticipated delay in Space Segment development has matured. Therefore at Programme Management and System level, the period was characterised by the re-base lining of EUMETSAT system and Ground Segment activities in order to mitigate this delay. A roadmap to revise the overall system development plan was defined, specifying also close interactions with ESA and Industry. The aim is to have the necessary contractual changes finalized by mid 2016 and to confirm the revised logic at the System Implementation Review (SIR) in Q4 2016. The Space Segment development has a major system keypoint this year, on the way to the Satellite CDR, for the Imager mission end of 2018 and of the Sounder mission in 2019.

Combined Imager (FCI) algorithms have been fed into the EUMETSAT internal prototyping activities with the objective of supporting the development of supplementary algorithms and generating test data. For the Lighting Imager (LI), the updates of the LI Level 1 ATBDs were received at the end of 2015 and are currently under review to assess on their maturity. Concerning the InfraRed Sounder (IRS), an update of the Level 1 algorithms has been received and considered mature enough to support the ITT for the Instrument Data Processing Facility for the sounder satellite (IDPF-S). For the UVN, EUMETSAT and ESA are working together to derive the algorithms needed for an operational processor, based on UVN Industry documentation to support this ITT.

The launch service contract, signed early July 2015, has been kicked off. Its implementation is covered by a shared overall schedule identifying the numerous interactions between Industry, ESA, EUMETSAT and Arianespace. The development

of the specific adapter is progressing well with its delivery date slightly postponed due to a test facility prioritisation in favour of the satellite central tube testing.

The LEOP service contract was signed in November 2015. Kick-off will be decided later in 2016 for a date in 2017.

3.1.1.2.2 Ground Segment and scientific activities

At ground segment level, the Mission Operations Facility (MOF) design is proceeding. The Critical Design Review (CDR) was performed and a close out is expected in April 2016. Various subsystems are under development and will be tested from Q2 2016. The first delivery of the MOF, primarily a mission control system based on SCOS-2000, will be delivered to EUMETSAT in September 2016.

The MTG-I Instrument Data Processing Facility (IDPF-I) development is also progressing and the first major delivery is upcoming in July 2016. This first delivery is a first delivery of the processing infrastructure and is primarily for familiarisation and first integration testing purposes.
The Level 2 processing facility is now approaching its Preliminary Design Review (PDR) in September 2016.

The two Ground Stations contracts for both the Telemetry Tracking and Control (TT&C) and Mission Data Acquisition (MDA) Ground Station Facilities are progressing. The MDA completed its CDR and the antennas are being erected on site in Lario, Italy. The TTC station is undergoing its CDR in April 2016.

Moreover, the Multi Mission Elements, including the infrastructure and the network are being prepared for upcoming deliveries.

3.2 Status of future LEO satellite systems

This section covers Metop-C, EPS-SG; Jason 3 and CS; and Sentinel 3.

3.2.1 Metop-C

The Metop-C satellite main components are presently in storage, the Payload Module in Airbus DS Friedrichshafen (D), The Service Module in Airbus DS Toulouse (F) and the Solar Array in Dutch Space Leiden (NL).

Each of these elements is re-activated on a yearly basis to verify that they function properly.

The MHS and IASI instruments went through their repair programme and are now fit for flight.

In September 2016 the final integration and test programme will re-start in order to ensure the readiness for launch on the 1st October 2018.

3.2.2 EPS-SG

3.2.2.1 Mission objectives, spacecraft, payload/instruments, products

The EPS-SG encompasses the following observation missions:

- The Infra-red Atmospheric Sounding mission (IAS), to provide temperature and humidity profiles, as well as observations of ozone and various trace gases, through a wide swath of hyper-spectral infra-red soundings in four bands from 3.62 to 15.5 µm, with radiometric and spectral resolutions improved by factor 2 vs. IASI and consistent spatial sampling of about 25 km.

- The Microwave Sounding mission (MWS), to provide all-weather atmospheric temperature and humidity profiles, as well as cloud liquid water columns, over a wide swath in the spectral region between 23.4 and 229 GHz, with footprints from 40 down to 17 km at the highest frequencies.

- The Scatterometry mission (SCA), to provide ocean surface wind vectors and land surface soil moisture by measurement of back-scattered signals at 5.3 GHz with spatial resolution of 25 km.

- The Visible/Infra-red Imaging mission (VII), for providing information on clouds, cloud cover, land surface properties, sea, ice and land surface temperatures, among other observations, by moderate-resolution optical imaging, in 20 spectral channels ranging from 0.443 to 13.345 µm, with a spatial sampling of 500 m (250 m in two channels).

- The Microwave Imaging mission (MWI), for precipitation and cloud imaging through measurements in the spectral range from 18.7 to 183 GHz with footprints from 10 to 50 km (for the highest to lowest frequency respectively).

- The Ice Cloud Imaging mission (ICI), to provide ice-cloud and water-vapour imaging in 11 channels (2 of which being dual-polarisation)by exploiting sub-millimetre-wave observations from 183 to 664 GHz with footprints of 15 km.

- The Radio Occultation mission (RO), for atmospheric all-weather soundings of temperature and humidity at high vertical resolution, and additionally ionospheric electron content in support of space weather, by tracking signals from global navigation satellites, GPS and Galileo at least.

- The Nadir-viewing Ultraviolet, Visible, Near-infra-red, Short-wave-infra-red Sounding mission (UVNS), to provide ozone profiles, monitor various trace gases, monitor air quality and support climate monitoring by means of hyper-spectral

soundings with a spectral resolution from 0.05 to 1 nm in the wavelength range from 0.27 to 2.385 µm, at a spatial sampling of 7 km for channels above 0.3 µm.

- The Multi-viewing, Multi-channel, Multi-polarisation Imaging mission (3MI), for aerosol observations by moderate resolution optical imaging in 12 spectral channels from the ultra-violet (0.410 µm) to the short-wave infra-red (2.13 µm), at a spatial sampling of 4 km.

- The IAS, MWS, SCA, VII, RO and UVNS missions provide continuity and improvements to missions currently provided with the Metop satellites. The MWI, ICI and 3MI are new missions with respect to Metop first generation, drawing from the experience with other experimental or operational missions.

- In addition to the above observation missions, EPS-SG satellites will embark payload to provide the following service in the frame of a relevant cooperation and in continuity to EPS:

  - ARGOS Advanced Data Collection Service (A-DCS), for the worldwide collection from in-situ platforms of oceanographic and meteorological data and their transmission to the user community.

There will be a series of three spacecraft of type Metop-SG A and B, with a 7.5-year design lifetime of each satellite covering at least 21 years of operations for each series of satellites.

3.2.1.2 Programme status

3.2.1.2.1 Overall status, and space segment

The EPS-SG Programme was approved in summer 2015 and formally entered into force on 1 January 2016. Cooperation Agreements with ESA on Metop-SG, with CNES on IASI-NG and with NOAA on the Joint Polar System were signed at end of 2015 as well as the Sentinel-5 Implementing Arrangements with the European Union. The cooperation agreements with DLR on METimage and with CNES on ARGOS are expected to be signed in summer 2016.

Space and Ground Segment level Preliminary Design Reviews (PDR) were all completed at the end of 2015. Completion of Phase B and readiness for Phase C/D was confirmed in April 2016.

Regarding the space segment, following the Metop-SG PDR in November 2015 which included the satellites and the six CPI (Contractor Provided Item) instruments MWS, 3MI, RO, SCA, MWI, ICI the work is proceeding at subsystem and unit supplier levels as they are being selected and kicked off. The results of the satellite and instrument level PDRs are being propagated into these lower levels where the design is progressing towards PDRs to be held during 2016.

The space segment is complemented by a set of CFI (Customer Furnished Item) instruments METimage, IASI-NG, ARGOS4 provided by DLR and CNES, respectively and Sentinel-5 provided by the European Union. PDR's at CFI instrument level were also conducted and completed in 2015 with the exception of the ARGOS4 instrument which was developed already in advance of Metop-SG activities and hence requires only some adaptations to Metop-SG.

The last major industrial contract to be concluded is related to the development of the METimage instrument. The industrial proposal for Phase C/D is currently being evaluated by DLR and contract signature is expected for summer 2016. Major delays announced in the industrial proposal required a change to the satellite integration and test approach. To mitigate the delay, an Enhanced Engineering Model (E-EM) of this instrument will be delivered. This approach will result in some additional activities on the critical path of satellite activities which are currently being identified.

Regarding the development of the IASI-NG instrument, work is progressing with PDRs at unit and sub-system levels. One key issue is the qualification of the optical material KBr. Due to difficulties in pre-qualification of this material CNES has initiated back up activities with an alternative material (ZnSE). In parallel the mechanical interface to the satellite is being further consolidated. As a consequence, the instrument Critical Design Review (CDR) has been shifted from June to September 2017.

The planned launch date for the first satellite Metop-SG A1 remains June 2021, followed 18 months later by the launch of the Metop-SG B1 satellite end of 2022. The launch date for the Metop-SG A1 satellite may be impacted by the difficulties encountered in the development of the METimage instrument. Recurrent satellites are planned to be launch in 2028 and 2030 (Metop-SG A2 and B2) and in 2035 and 2036 timeframe (Metop-SG A3 and B3).

Launch feasibility studies with Arianespace were concluded confirming the principle feasibility and mechanical compatibility of a launch by Soyuz from Kourou for Metop-SG. The studies confirmed that Ariane 5 cannot accommodate two Metop-SG satellites as co-passengers in a dual launch configuration. Similar studies were contracted to SpaceX for the Falcon 9 launcher. The results have not identified any technical incompatibilities. EUMETSAT is currently in the process of initiating the launcher procurement.

Further interactions with NOAA are conducted in the framework of the Joint Working Group (JWG) focusing on the future Joint Polar System (JPS). Discussions are progressing with NOAA towards a detailed joint development plan which is now being elaborated in detail to implement the agreed sharing of ground infrastructures in Svalbard and Mc Murdo.

3.2.2.1.2 Ground Segment and scientific activities

At Ground Segment level, the work focused on preparing the procurements for the Mission Control and Operations (MCO) and Payload Data Acquisition and Processing (PDAP) sub-segments and starting the Svalbard Site Infrastructure Service (SSIS) contract. The SSIS contract was signed and kicked off with KSAT in January 2016 as the first major contract of the EPS-SG Ground Segment.

The MCO Invitation to Tender (ITT) was published in December 2015 Following the bidding period, the proposals from industry were subsequently evaluated and the Contract Proposal is submitted to EUMETSAT Council in summer 2016 for approval and subsequent kick-off.

The PDAP ITT was released in March 2016. Proposals from industry are expected in June 2016. Following the evaluation of the offers a Contract proposal is planned to be submitted to EUMETSAT Council in December 2016 for approval and subsequent kick-off.

Instrument Functional Chain Teams (IFCTs) are established for all EPS-SG instruments. The objective of the IFCT’s is to ensure that the definition and development of instrument chains are addressed end-to-end in a consistent interdisciplinary way. One of the key tasks of the IFCTs is to review all available design information on the instrument chain performance and compare them with the expected end to end performances.

Work at EPS-SG System level progressed on updating the Product Generation Specifications, Product Format Specification and Auxiliary Data Specifications for the instrument chains that were generated for the EPS-SG System PDR. These were provided as baseline documents for PDAP and have been included in the PDAP procurement package.

3.2.3 Jason-3 and follow-on

The Jason-3 mission is a joint effort among four organizations: NOAA (National Oceanic and Atmospheric Administration), EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites), CNES (Centre National d'Etudes Spatiales), and NASA (National Aeronautic and Space Administration), to measure sea surface height by using a radar altimeter mounted on a low-earth orbiting satellite. The collection of precise measurements of sea surface height is essential for ocean climatology and ocean weather applications. Ocean climatology includes global sea-level rise, a key indicator of climate change, decadal variability in the ocean, seasonal/inter-annual variability, and coastal variability and its impact on ecosystems. Ocean weather involves operational oceanography, surface wave forecasting and evaluation, and hurricane intensity forecasting.

The Jason-3 mission will ensure the continuity of the 20 plus year data record started with TOPEX/Poseidon in 1992 and continued with Jason-1 and 2.
After a number of postponements due to launcher issues, the Jason-3 satellite was successfully launched by a Falcon 9 Space X rocket on 17 January at 18H42 UTC time with a very precise injection.

The LEOP activities started immediately and all instruments and equipment were successfully turned on. The first altimeter waveforms and related operational products were generated, first at CNES for a check but very quickly this activity was transferred to both NOAA and EUMETSAT with corresponding product generation through the Near Real Time processors.

Since then the NRT products are routinely produced and made available to the PI's for evaluation. The trial dissemination on EUMETCast has also started on 8 March 2016.

The operational orbit was reached on 12 February, with Jason-3 being about 550 Km, equivalent to 80 seconds, behind Jason-2 for the so called tandem phase which will allow a very accurate cross calibration of both systems. This tandem phase will last approximately 6 month.

A first 10 days cycle Sea Level Anomaly map covering 12 to 22 February has been released also including a comparison with Jason-2, and showing a very good matching of both measurement system.

A satellite in flight qualification meeting has been held in TAS premises on 23 March and has confirmed the excellent behaviour of all satellite subsystems.
It has been followed by the In Flight Acceptance Review (IFAR) from 12 to 14 April where the status of the full system was reviewed by the 4 partners. The Review Board report confirmed the excellent status of all elements, both on flight and ground segments

The next milestones are:

- The handover to NOAA of satellite routine operation on June 1st
- The start of release of the NRT product to all users by end of June
- The start of release of all offline products in November following the Ocean Surface Topography Science team meeting.

3.2.4 Jason CS

The Sentinel-6/Jason-CS primary mission objective is to provide continuity of ocean topography measurements beyond the TOPEX/Poseidon, Jason, OSTM/Jason-2, and Jason-3 cooperative missions, for determining sea surface height, ocean circulation, and sea level. Accordingly, the Sentinel-6/Jason-CS Mission will utilize the legacy TOPEX/Poseidon precision altimetry orbit.

As a secondary mission objective, it will collect high-resolution vertical profiles of atmospheric temperature, using the GNSS-RO sounding technique, to assess temperature changes in the troposphere and the stratosphere and to support numerical weather prediction. The secondary mission objective will not become a driver of or in any way impede the development and implementation of the Sentinel-6/Jason-CS Mission, or delay the launches.

The Sentinel-6/Jason-CS cooperative mission will be implemented by two identical Sentinel-6/Jason-CS Satellites launched in sequence, each with a nominal 5.5 year lifetime. In order to provide continuity, the launch of the Sentinel-6/Jason-CS A satellite is planned for 2020 and the launch of the Sentinel-6/Jason-CS B satellite is planned for 2025.

The Jason-CS Programme Proposal, Draft Programme Definition and Draft Enabling Resolution were submitted to the 82nd Council in November 2014. The potential participating states unanimously adopted the draft Declaration and associated Programme Definition. The full Council adopted the Enabling Resolution.

The Programme entered into force at EUMETSAT on 9 September 2015 with 12 Participating States. Since then two more countries have joined the programme.

In the US, the Jason-CS budget has been transferred from NOAA to NASA and the full FY 2016 budget has been approved. NOAA will still keep a role in the programme through data acquisition and science support.

A concept paper detailing the sharing of responsibility among the 4 partners (EUMETSAT, ESA, NASA, and NOAA) and establishing the partnership framework and rules has been discussed and will evolve toward a Memorandum of Understanding.

The user and system requirements have been developed and agreed with the partners and reviewed during a two steps System Requirements Review. Performance requirements and overall products definition and content, ensuring continuity with the past Jason missions, but also ensuring synergy with Sentinel 3 for the high resolution products have also been defined.

The satellite Phase C activities conducted by ESA are now well advanced, with most

of the satellite equipment under procurement for a Critical Design Review planned in April 2017.

At EUMETSAT, workshops have been organized on the Ground Segment development to ensure a maximum reuse of existing assets allowing containing development and operational cost within the agreed envelope.

The next milestones are the system Preliminary Design Review (PDR) end of 2016 followed by the ground segment PDR in Q1 2017.

3.2.5 Sentinel-3

Overall Status and Background

The Sentinel-3A spacecraft was successfully launched from the Plesetsk Cosmodrome with a ROCKOT launcher on 16th February 2016 and is now undergoing a 5 months commissioning phase which will complete in mid July with the In-Orbit Commissioning Review (IOCR).

EUMETSAT plays a key role providing data for the oceanographic and atmospheric user communities; providing marine data both in near real time (sensing + 3h) and off-line (sensing + 48h, sensing + 1m) and later atmospheric data in near real time NRT (sensing + 3h) products.

Following the handover, after the IOCR, of the responsibility for the spacecraft operations and the Marine Payload Data Ground Segment from ESA, EUMETSAT will:

- Monitor and control the S3 spacecraft and flight operations segment;
- Perform product generation, archiving and dissemination of all Sentinel-3 products routinely required by the marine user community and the related downstream services and later the atmospheric community;
- Serve the offline requests of the marine and later atmospheric user community for Sentinel-3 products.

Complementing the Marine part of the mission, ESA will similarly serve the Land Services Community and offline atmospheric needs.

The role of EUMETSAT for the provision of the Sentinel-3 Services over the mission lifetime takes benefit from, and builds upon, the significant infrastructure investments that have already been made, and will continue to be made, by EUMETSAT in the areas of:

- Multi-mission operations within a unified Operational centre (MTP, MSG, EPS and Jason);
- A common gateway to enable users to have straightforward access to all EUMETSAT's data and products (via the EUMETSAT unified archive and

retrieval facility and its interface to the future ESA Heterogeneous Mission Accessibility (HMA);
- Ground segment infrastructure, which allows the addition of further missions/services.

The Copernicus Agreement with the European Union authorising EUMETSAT to conduct the relevant Copernicus Space Segment operations, including the S-3 operations and build up phase, was signed on 7 November 2014.

Ground Segment Status

The EUMETSAT Flight Operations Segment (FOS) is receiving and processing the S- and X-Band housekeeping telemetry. It is shadowing the commissioning operations which are performed by ESA/ESOC during this phase. All FOS facilities are operating as expected with no significant anomalies detected. The first commanding of the S3A spacecraft by EUMETSAT has been successfully performed with EUMETSAT routinely commanding 2 passes per day, and these activities are now ramping up, as per the agreed hand-over plan, towards the formal handover of the spacecraft operations to EUMETSAT for the routine operations phase.

The Marine Payload Data Ground Segment (PDGS) has been operationally generating Level 0 products since the activation of the X-Band downlinks. Some issues have been encountered including with some level 0 data gaps and with the pre-processing of the data at the Core Ground Station but these have mostly been corrected. Level 0 data are being successfully archived and disseminated to members of the ESA led commissioning team. Level 1 and Level 2 production is now being incrementally activated and data released to members of the Sentinel-3 Validation Team and other selected expert users. The OLCI level 1 data was the first to be released and the SLSTR level 1 and Surface Topography level 1/2 data expected to be released in the coming days. Data for the wider user community are expected to be released formally at the IOCR if not earlier.

The Mission Planning facility in EUMETSAT has successfully supported the early System In-Orbit Verification activities providing ad-hoc special and individual instrument operations plans as well as the first nominal 27-day planning cycle which is now operational.

The EUMETSAT multi-mission elements are successfully supporting the ongoing FOS and PDGS operations.

Initial images from the OLCI, SRAL and SLSTR instruments have been released during early March and April showing a first demonstration of the potential of the Sentinel-3 mission.

4 CONCLUSIONS

This document summarises the status of EUMETSAT current and future satellite

systems.

CGMS is invited to take note.