EUMETSAT

Monitoring weather and climate from space

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Weather forecasting

Value of weather forecasting to economy is > 20 times budget of public weather service

Contribution from satellite data > 35%

(source: Case for Space Final Report, UK Space 2006)

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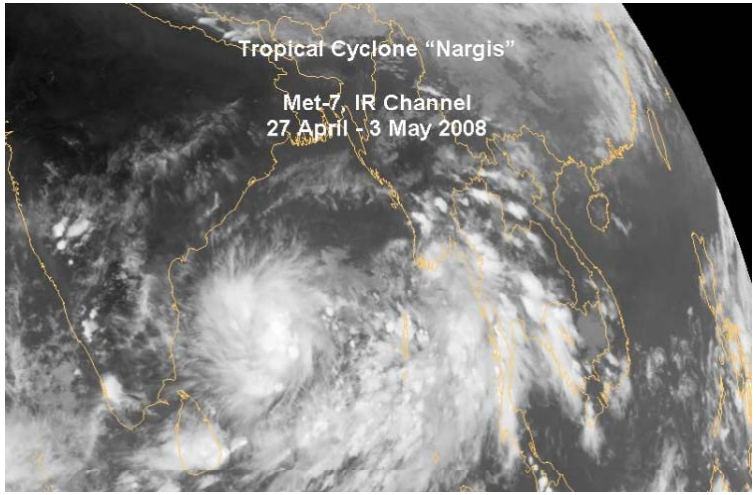
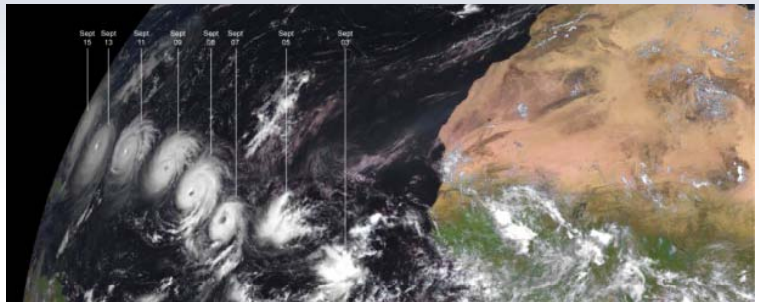
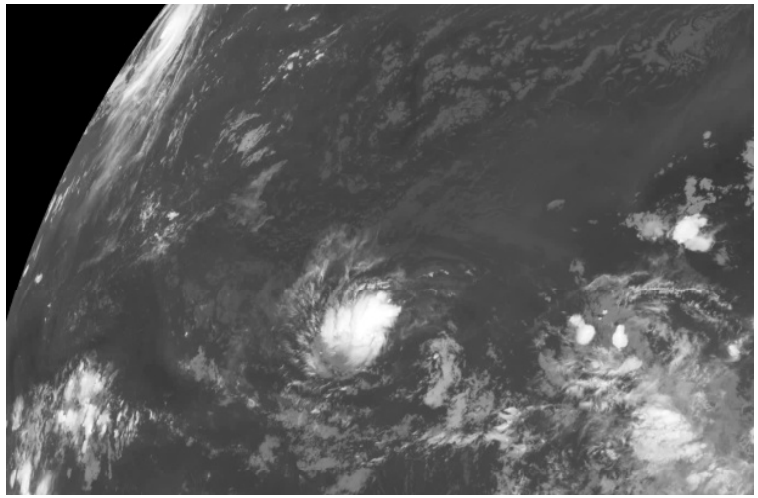
Hazardous weather

Tropical Cyclone Nargis
27 April – 3 May 2008



Hurricane Isabel
6 – 15 September 2003





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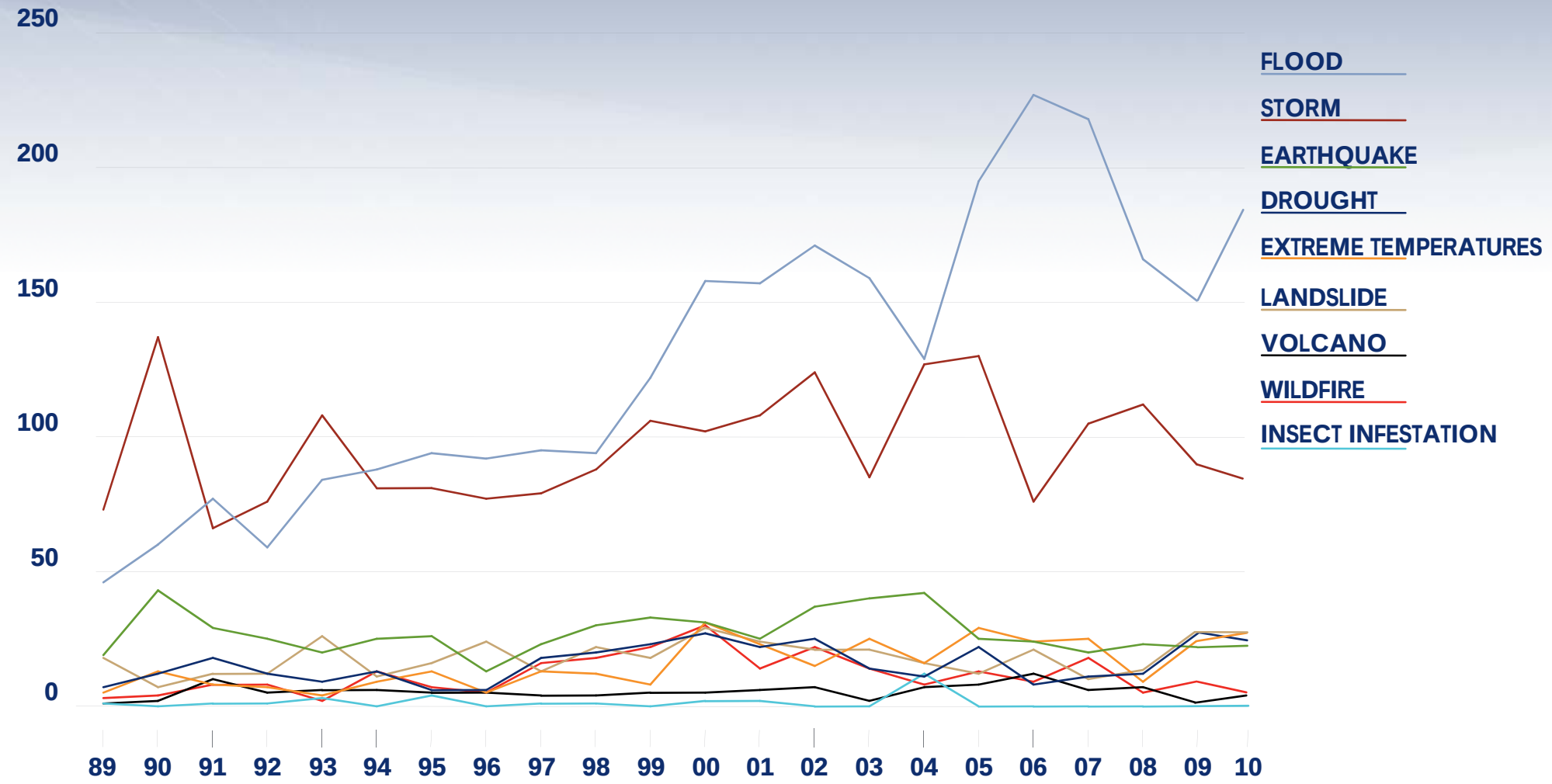
Number of Natural disasters set off by severe weather



Source: EM-DAT: The OFDA/CRED International Disaster Database

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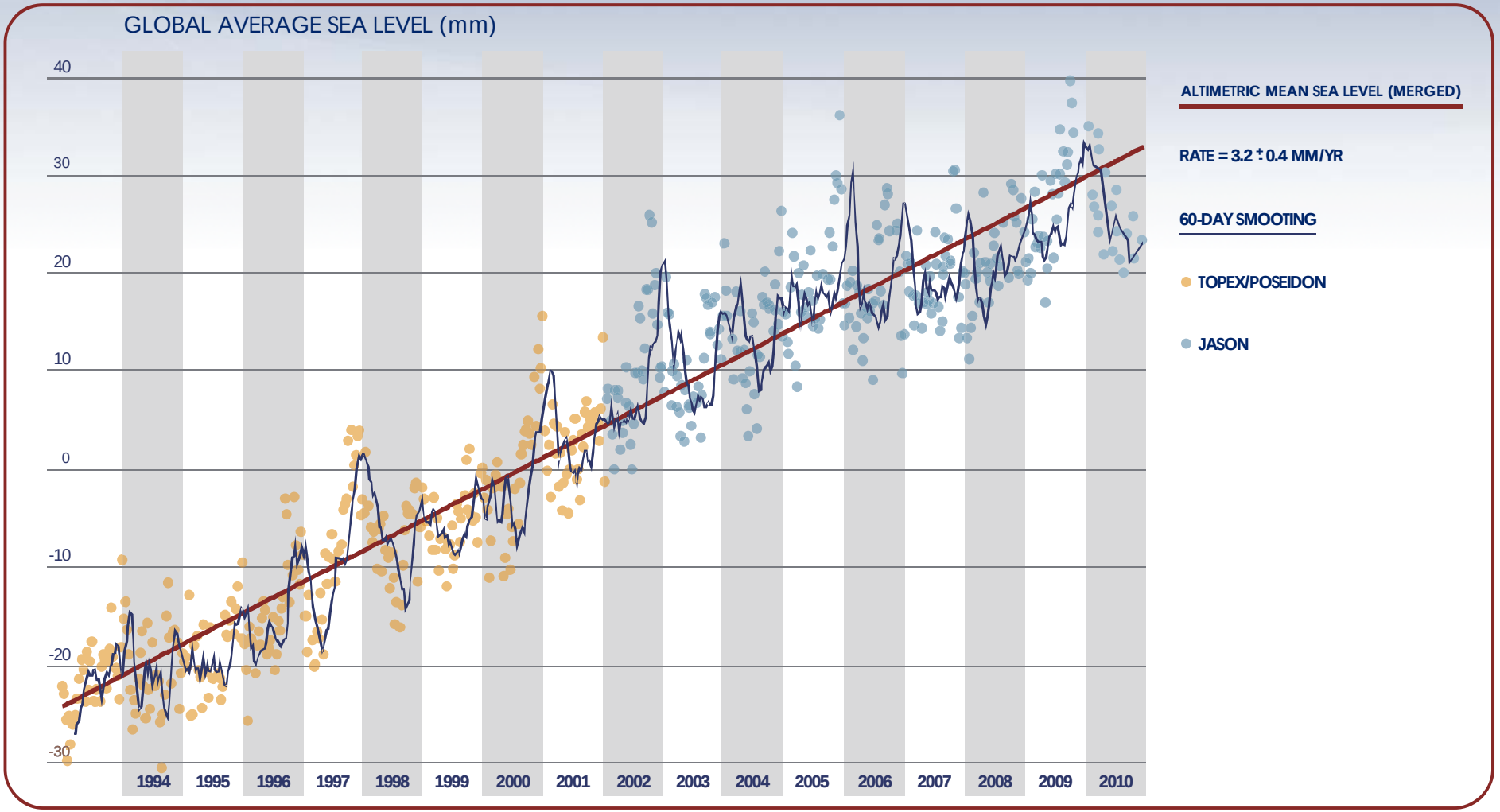
Climate change monitoring

Global average sea level rise (1994-2010)

Source: University of Colorado, LEGOS/CNES



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EUMETSAT objectives

- The primary objective is to establish, maintain and exploit European systems of operational meteorological satellites.
- A further objective is to contribute to the operational monitoring of the climate as well as the detection of global climatic changes.
- Furthermore, environmental issues which drive or are driven by meteorological conditions are considered.

EUMETSAT's mission is….

To deliver operational satellite data and products that meet the meteorological and climate data requirements of its Member States, 24 hours a day, 365 days a year, through decades.

This is carried out taking into account the recommendations of the World Meteorological Organization (WMO).

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Member States scale of contributions 2011

GERMANY	19.20 %
UNITED KINGDOM	15.62 %
FRANCE	14.70 %
ITALY	12.04 %
SPAIN	7.56 %
THE NETHERLANDS	4.38 %
SWITZERLAND	2.75 %
BELGIUM	2.57 %
SWEDEN	2.53 %
TURKEY	2.27 %
AUSTRIA	2.05 %
NORWAY	2.03 %
POLAND	1.95 %
DENMARK	1.78 %
GREECE	1.65 %
FINLAND	1.35 %
PORTUGAL	1.23 %
IRELAND	1.17 %
CZECH REPUBLIC	0.80 %
HUNGARY	0.69 %
ROMANIA	0.57 %
SLOVAK REPUBLIC	0.32 %
CROATIA	0.25 %
SLOVENIA	0.23 %
LUXEMBOURG	0.21 %
LATVIA	0.10 %

Cooperating States:

BULGARIA : 0.18 %
ESTONIA : 0.09 %
ICELAND : 0.10 %
LITHUANIA : 0.16 %
SERBIA : 0.18 %

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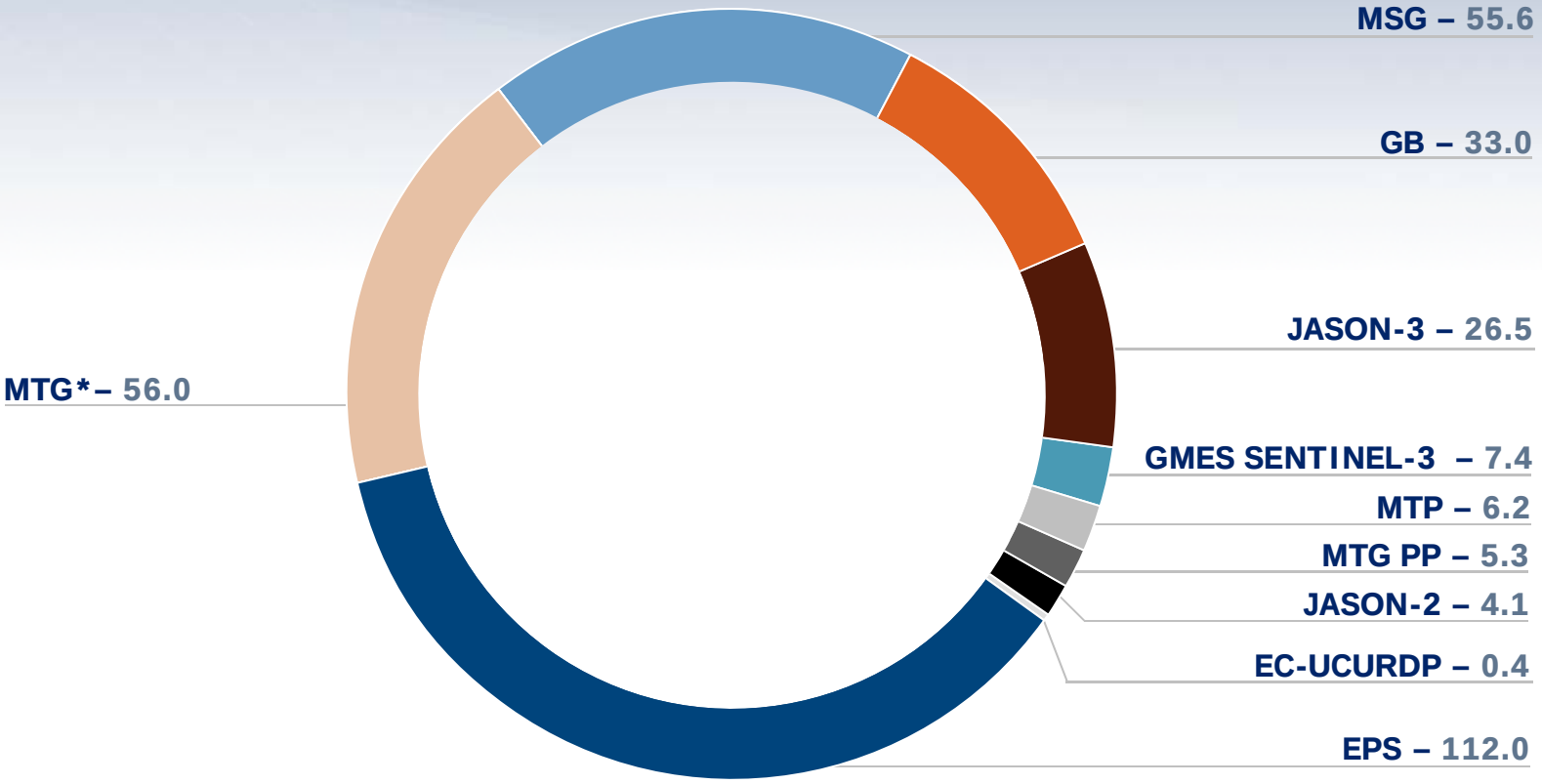
Expenditure 2011 (MEUR)



Total Expenditure 2011: MEUR 306.5

* Budget pending entry into force of the programmes

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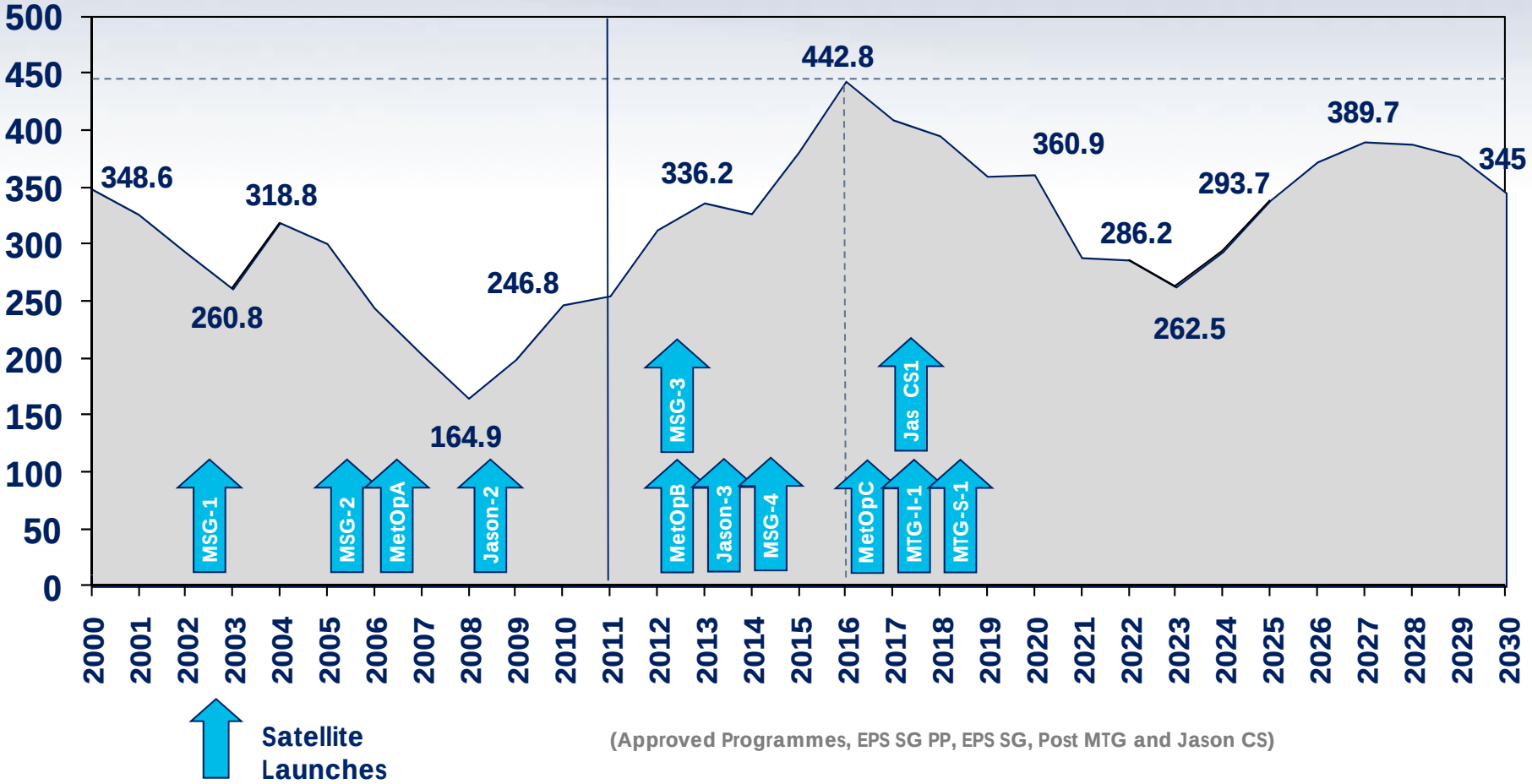
Current Financial Planning 2011-2030...

Budgets 2000-2010 & Financial Plan 2011-2030
Contributions at 2011 economic conditions (MEUR)



(Approved Programmes, EPS SG PP, EPS SG, Post MTG and Jason CS)

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What we do

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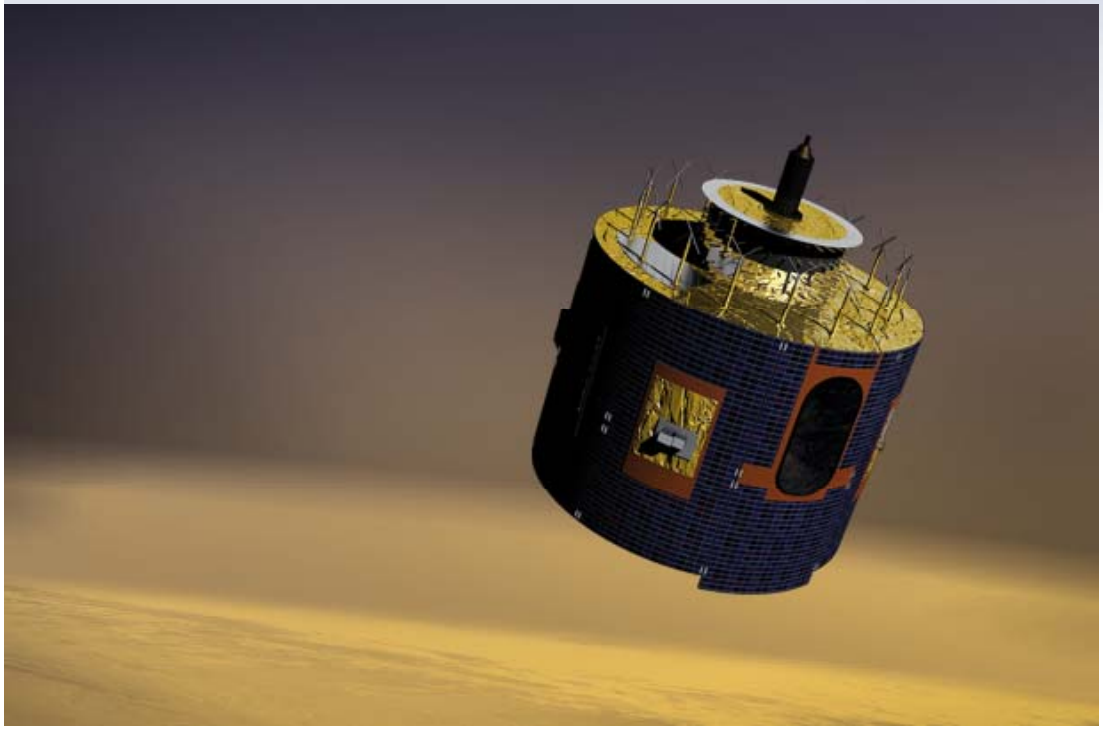
Geostationary satellites

Meteosat Second Generation (MSG)



- consists of a series of four geostationary weather satellites
- scheduled to operate consecutively until 2018
- provides important image data on European weather on a daily basis, every 15 minutes with 12 spectral bands
- Meteosat-9 (in operation since 2006) provides data collection and environmental monitoring data
- Meteosat-8 (in operation since 2004) provides Rapid Scan Service (RSS) images every five minutes
- RSS delivers image data and meteorological products for the detection of rapidly developing localised convective weather systems.

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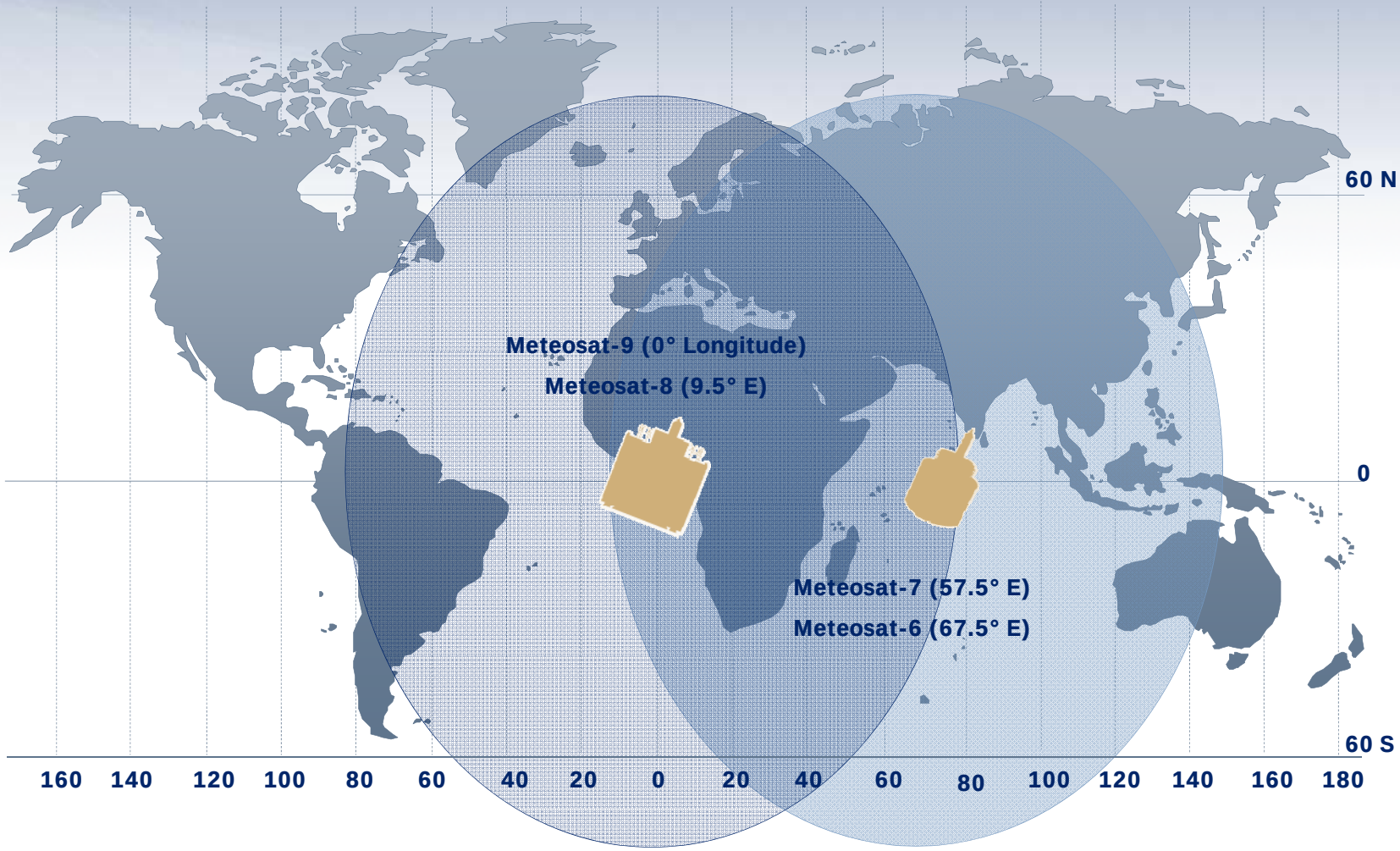
EUMETSAT's geostationary satellite coverage



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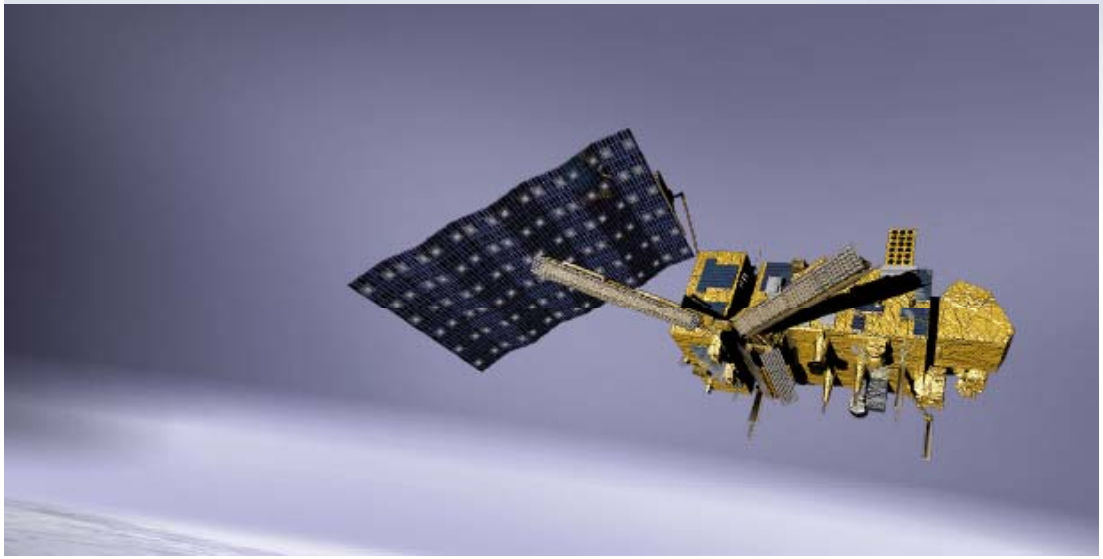
Polar-orbiting satellites

EUMETSAT Polar System (EPS)



Europe's first series of polar-orbiting satellites for operational meteorology consists of three Metop in low Earth orbit to operate over a period of at least 14 years.

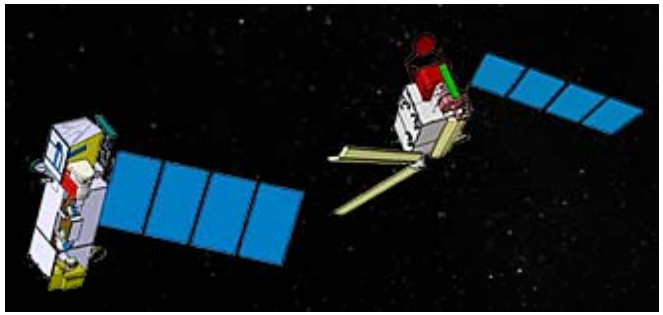
Metop-A (launched in 2006)

- carries imaging and sounding instruments
- direct broadcasting and data collection capabilities
- significant contribution to the Global Observing System and the monitoring of climate and atmospheric chemistry.

EPS data

- unprecedented accuracy; used in various applications such as Numerical Weather Prediction models, atmospheric composition, cloud detection analysis or radiation budget components.

Partners:



- **EPS –SG (in approval process)**
- Second Generation EPS ready in 2018
- two satellite configuration being studied with distributed payloads for the two satellites
- Payload to include GMES Sentinel-5

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Monitoring the oceans

Jason satellites

Partners: cnes NASA NOAA

Jason-2
- launched in June 2008 from Vandenberg, California
- EUMETSAT's first optional programme on ocean altimetry
- enabled EUMETSAT to extend its expertise in data and product dissemination for weather forecasting and climate monitoring
- inclusion of data in support of marine meteorology, operational oceanography, seasonal prediction and climate monitoring.

Jason-3
- programme under development
- will provide continuity after Jason-2
- satellite scheduled for launch in 2013

Jason-CS
- future programme under discussion
- to provide continuity after Jason-3

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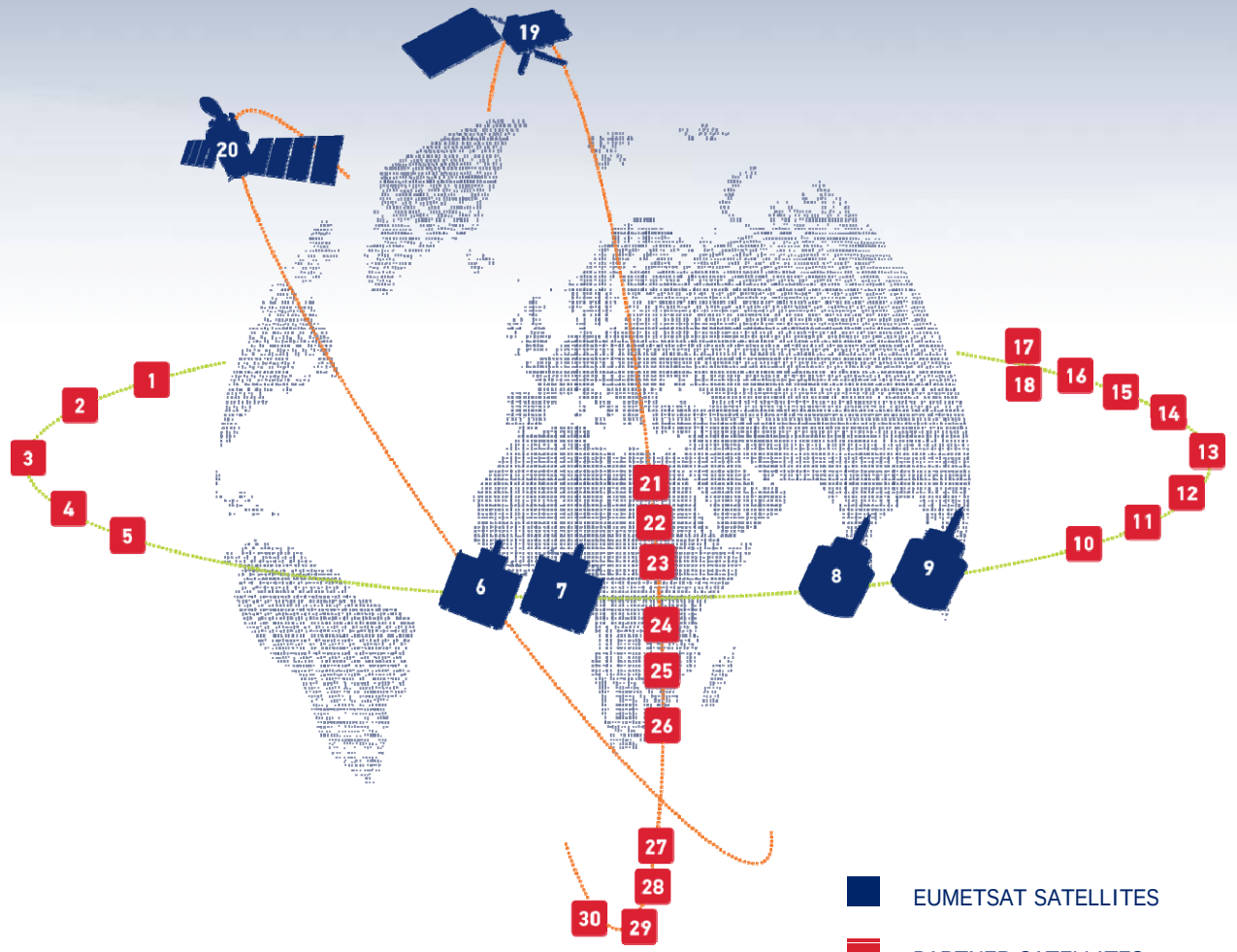
Global meteorological satellite system

GEOSTATIONARY

- 1-5 GOES-11, -12, -13, -14, -15 (USA)
- 6 METEOSAT-9 (EUMETSAT) 0°Longitude
- 7 METEOSAT-8 (EUMETSAT) 9.5°E
- 8 METEOSAT-7 (EUMETSAT) 57.5°E
- 9 METEOSAT-6 (EUMETSAT) 67.5°E
- 10 GOMS-2 (RUSSIA)
- 11 KALPANA-1 (INDIA)
- 12 FY-2D (CHINA)
- 13 INSAT-3A (INDIA)
- 14 FY-2E (CHINA)
- 15 FY-2C (CHINA)
- 16 COMS (SOUTH KOREA)
- 17 MTSAT-1R (JAPAN)
- 18 MTSAT-2 (JAPAN)

LOW EARTH ORBIT

- 19 METOP-A (EUMETSAT)
- 20 JASON-2 (USA, EUROPE)
- 21-25 NOAA-15, -16, -17, -18, -19 (USA)
- 26 FY-1D (CHINA)
- 27 FY-3A (CHINA)
- 28-29 OCEANSAT-1, -2 (INDIA)
- 30 METEOR-M N1 (RUSSIA)



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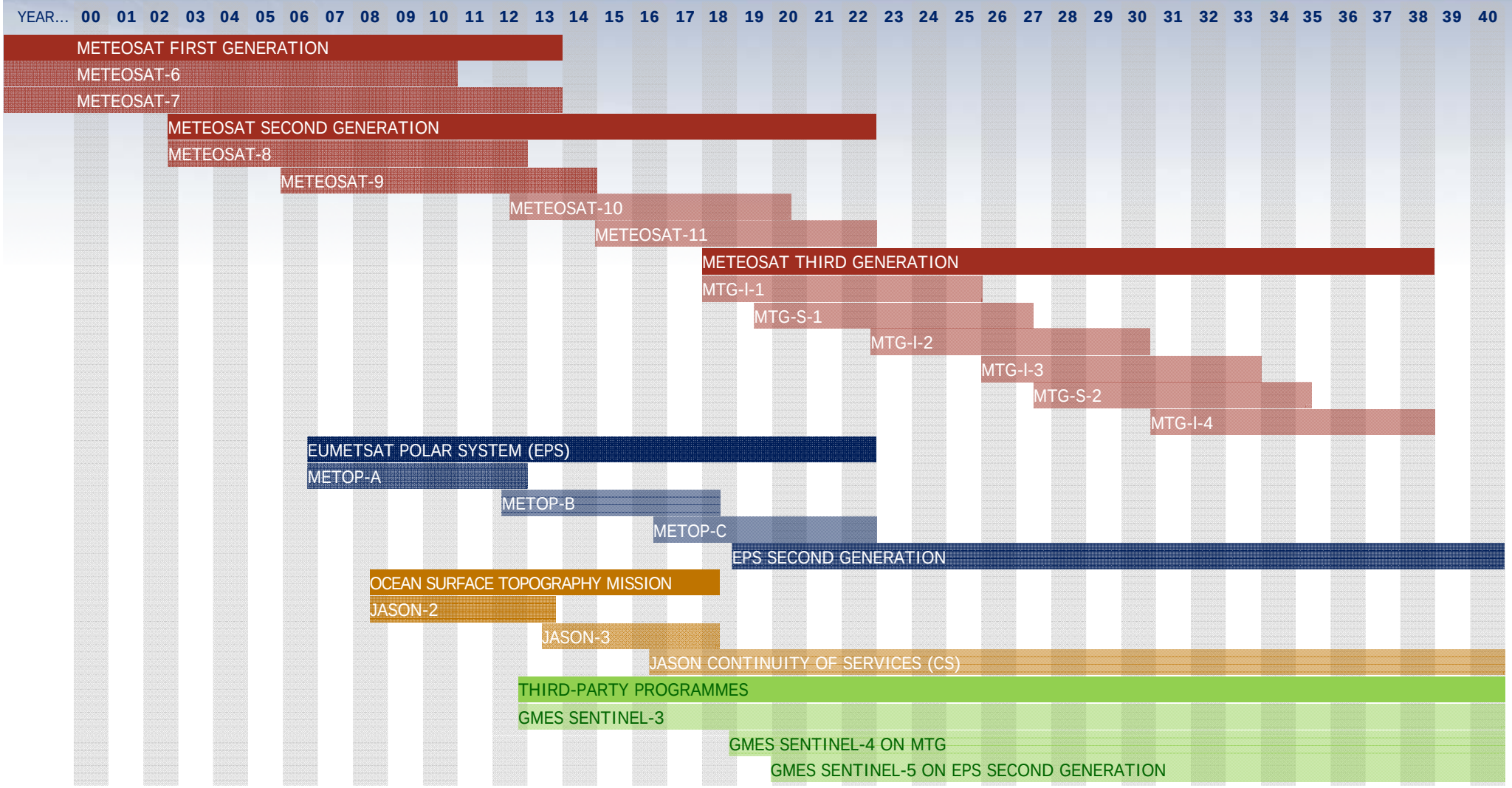
EUMETSAT space segment



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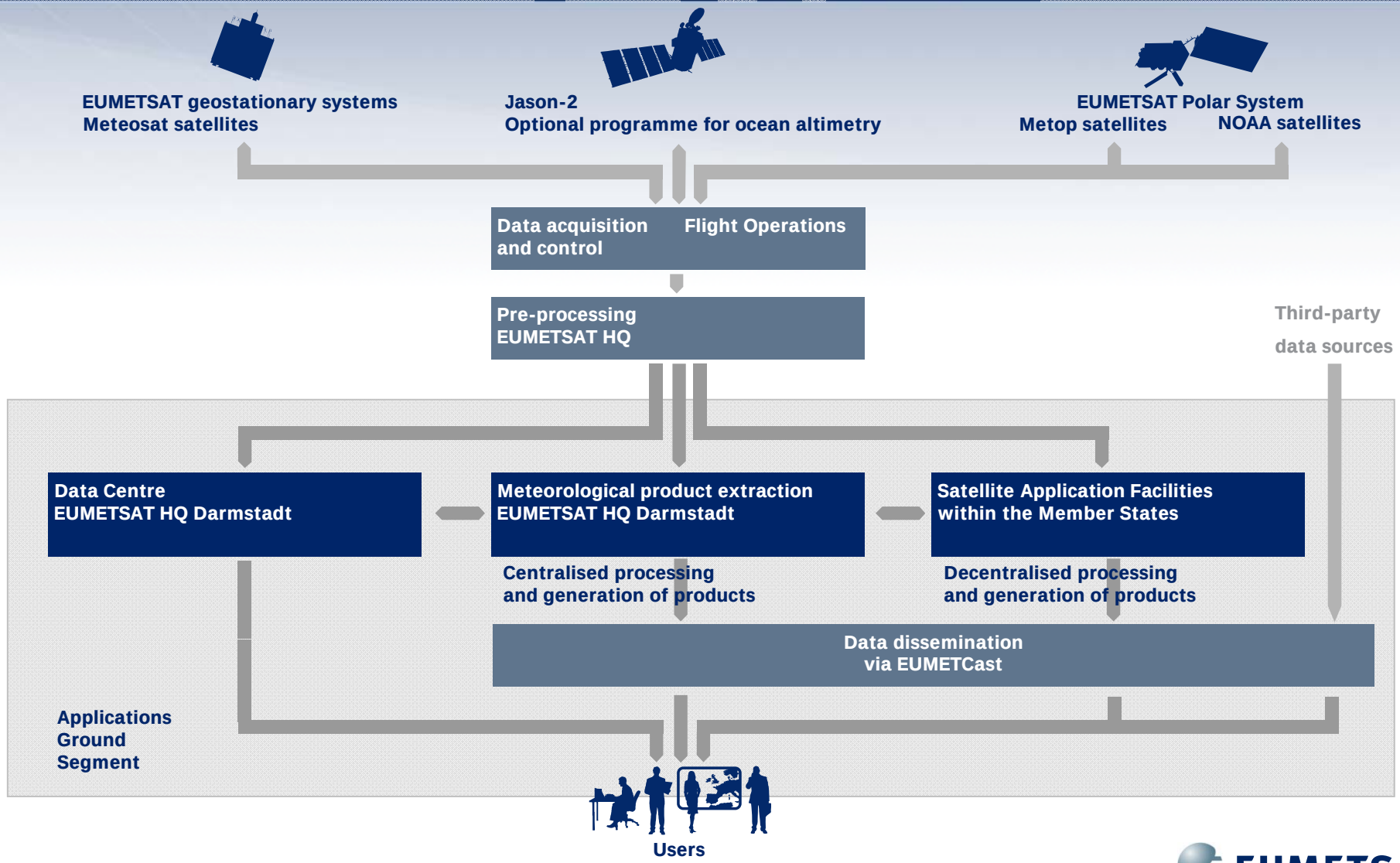
EUMETSAT ground segment overview



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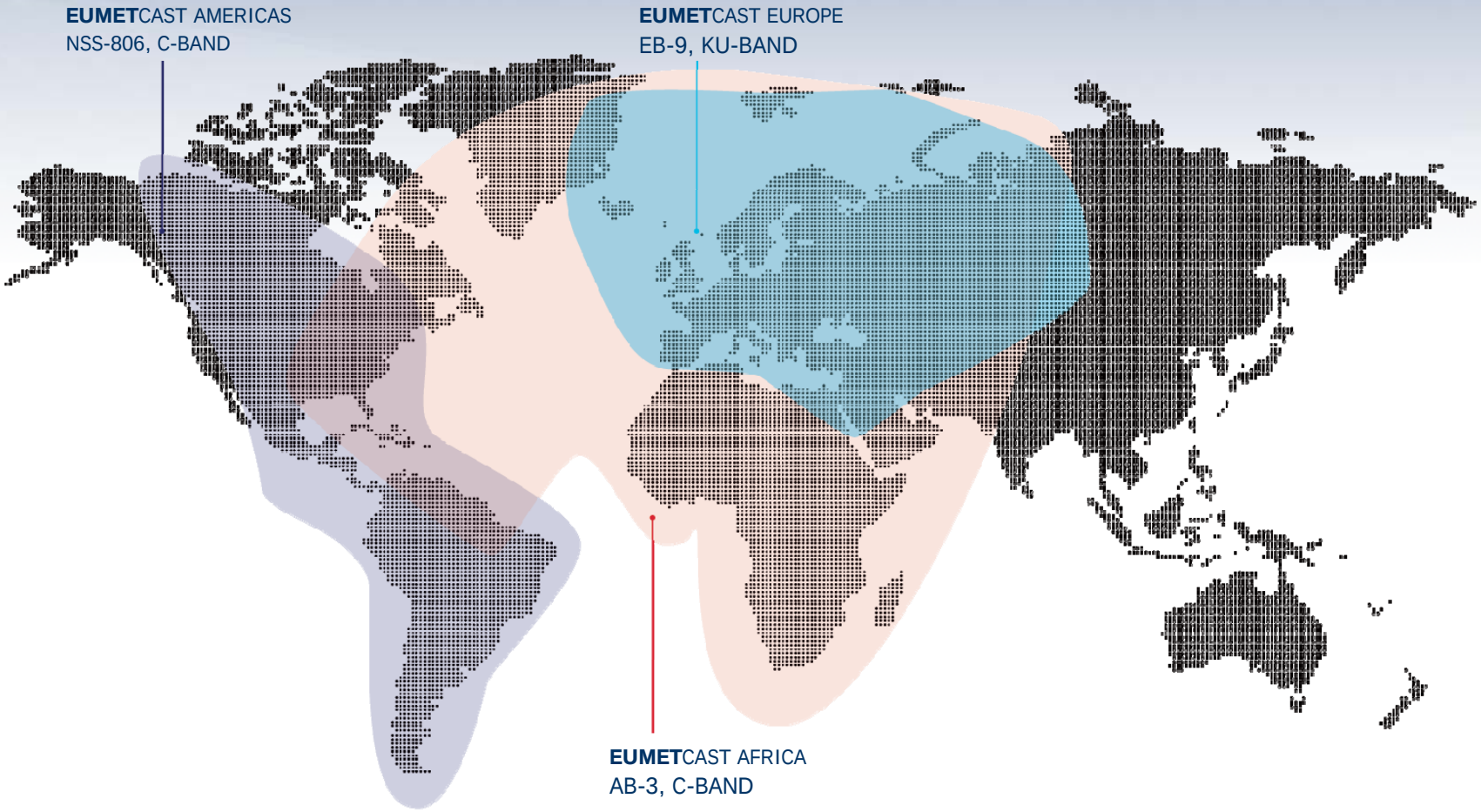
EUMETCast coverage



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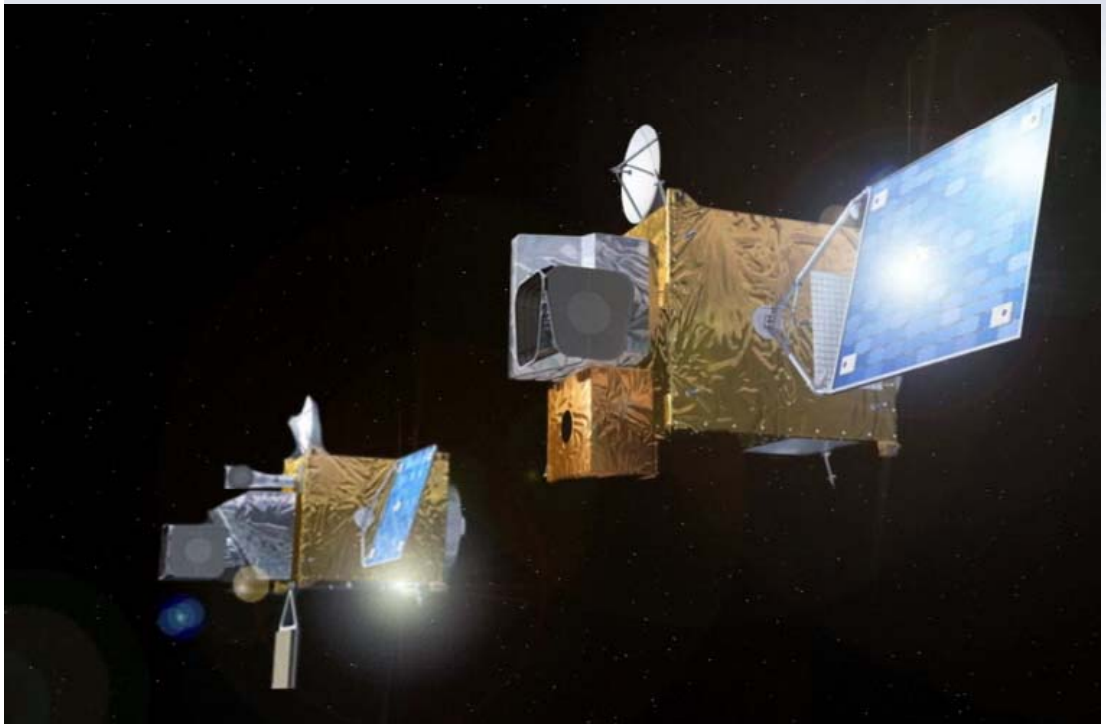
EUMETSAT Data Centre

- Archive dating back to 1981
- Over 530 Terabytes of data stored
- Over 1.3 Petabytes of data retrieved annually
- Raw and reprocessed data, centrally and decentrally produced
- Data retrieval for reprocessing for climate monitoring
- Seamless Data Centre Network with data from EUMETSAT Satellite Application Facilities (SAFs)
- Access online via Product Navigator

EUMETSAT

Geostationary satellites

Meteosat Third Generation (MTG)



- will consist of four imaging and two sounding satellites
- scheduled to start operations from 2019, taking over from MSG
- will provide important image data on European weather on a daily basis, every 10 minutes with 16 spectral bands
- the imaging satellites will carry the revolutionary new Lightning Imager providing better data for users such as civil aviation
- the sounding satellites will carry an infrared sounder for the first time ever providing four-dimensional (over time and space) high-resolution data on water vapour and temperature structures
- also on board the sounding satellites will be the Global Monitoring for Environment and Security Sentinel-4 Ultraviolet Visible Near-infrared spectrometer for atmospheric chemistry and air quality monitoring

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MTG Mission

The MTG mission capitalises on the continuation and enhancement of the Meteosat Second Generation (MSG) capabilities with respect to nowcasting, global and regional numerical weather prediction, climate and atmospheric chemistry monitoring. The MTG Program has been established as result of cooperation between EUMETSAT and ESA, where ESA is in charge of the Satellites development, and EUMETSAT is in charge of the procurement of the recurrent satellite.

MTG Mission

The MTG mission will provide Europe's National Meteorological Services and, by extension, the International Users and Science Community, with an advanced operational satellite system, providing improved imaging and new infrared sounding capabilities for both meteorological and climate applications. This system will facilitate enhanced capabilities for monitoring and prediction of meteorological phenomena and the monitoring of climate and air composition through operational applications for the period of time between 2016 and 2036.

MTG satellite payload complement

The objective of the MTG System is to provide continuous high resolution observations and geophysical parameters of the Earth System derived from direct measurements of its emitted and reflected radiation using satellite based sensors from the geo-stationary orbit.

The MTG space segment supports the following missions, services and associated payloads:

MTG satellite payload complement

- Flexible Combined Imager (FCI) mission; allowing to scan either the full disc in 16 channels every 10 minutes with a resolution in the range 1-2km, i.e. 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 resolution twice better (High spatial Resolution Fast Imagery (HRFI) in support of the Rapid Scanning Service (FCI-RSS).
- InfraRed Sounding (IRS) mission, covering the full disc, providing hyper-spectral 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 resolution around 4km.

MTG satellite payload complement

- Lightning Imagery (LI) mission, detecting continuously over almost the full Earth disc, the lightning discharges taking place in clouds or between cloud and ground with a resolution 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 resolution around 10km. The UVN mission is implemented with the GMES Sentinel-4/UVN payload accommodated in the MTG-S satellites.

MTG satellite payload complement

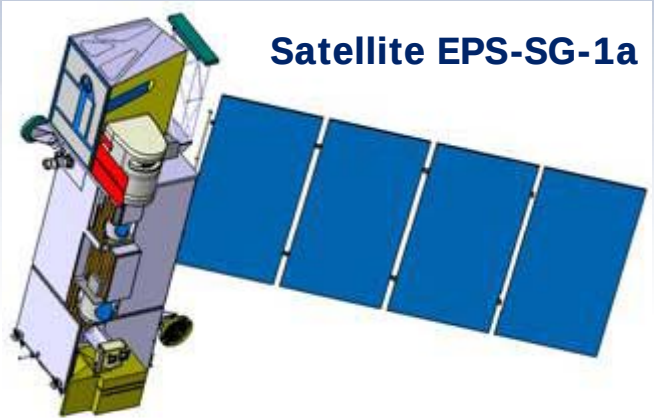
- Search and Rescue (S&R) Relay Service allowing the continuation of the MSG geostationary search and rescue (GEOSAR) service as part of the Cospas-Sarsat international system, whose aim is to provide distress alert and location information to appropriate rescue authorities for maritime, aviation and land users in distress.
- Data Collection System (DCS) mission which involves, as a continuity of the MSG mission, the collection and transmission of observations and data from surface, buoy, ship, balloon or airborne Data Collection Platforms (DCP).

Note: the Radiation Monitoring Unit (RMU), to be embarked on both MTG-I and MTG-S Satellites, is a not considered as a part of the payload.

EPS-SG In-orbit Configuration

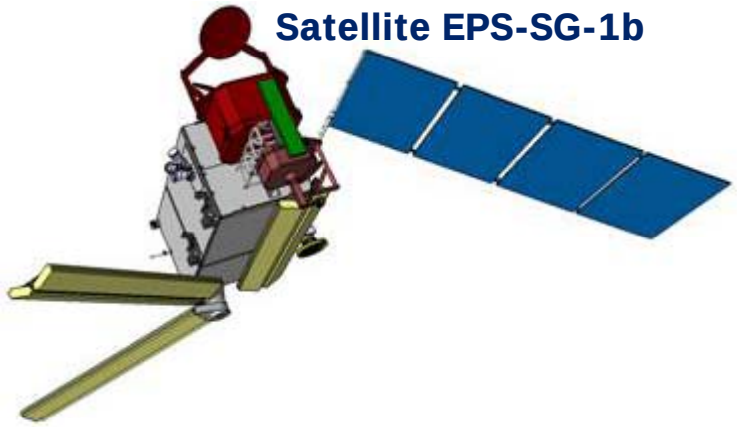
The EPS-SG Phase A System baseline has been agreed by Council in June 2010 and it is based on a Two-Satellite In-orbit Configuration.

The EPS-SG Instruments are accommodated taking into account missions co-registration requirements (*and continuity of Mid-morning observations*) within the JPS overall system.



Payload	METimage LLI IASI-NG ATMS (or MWS) 3MI Sentinel-5 CERES follow-on RO
Dry mass [kg]	~ 2500
Launch mass [kg]	~ 2900
Power [kW]	~ 2.2
P/L data rate [Mbit/s]	~ 60

Payload	SCA MWI-Precipitation MWI-Cloud ARGOS-4 S&R SEM RO
Dry mass [kg]	~ 2000
Launch mass [kg]	~ 2300
Power [kW]	~ 1.6
P/L data rate [Mbit/s]	~ 1.2



Metop Second Generation Satellites (Metop-SG)

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Candidate EPS-SG Missions

Candidate EPS-SG Missions and Priorities

Missions identified as part of Phase 0 (Pre-feasibility Studies) and retained in Phase A (Feasibility Studies)

High-Resolution Infrared Sounding	Very high
Microwave Sounding	
VIS/IR Imaging	
Scatterometrry	
Radio Occultation Sounding	High
Nadir viewing UV/VIS/NIR/SWIR Sounding	Medium
Multi-viewing, -channel, -polarisation Imaging	
Microwave Imaging	
Radiant Energy Radiometry	Low
Ice Cloud Imaging	
Low Light Imaging	(not ranked)
ARGOS	
Search and Rescue	
Space Environment Monitoring	

EPS-SG Satellites - Payload Complement

Payload	Sat "a"	Sat "b"
High-Resolution Infrared Sounding	x	
Microwave Sounding	x	
Radio Occultation Sounding	x	x
Nadir viewing UV/VIS/NIR/SWIR Sounding	x	
VIS/IR Imaging	x	
Multi-viewing, -channel, -polarisation Imaging	x	
Radiant Energy Radiometry	x	
Low Light Imaging	x	
Scatterometrry		x
Microwave Imaging		x
Ice Cloud Imaging		x
ARGOS		x
Search and Rescue		x
Space Environment Monitoring		x

EPS-SG Payload Accommodation on the Two-Satellite In-orbit Configuration

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EPS versus EPS-SG Missions

Instrument	EPS / Metop	EPS-SG / Metop-SG
IASI → IAS	645 to 2760 cm^{-1} NEΔT 0.1 - 0.6 K (<2400 cm^{-1}) $\Delta\nu$ = 0.35 - 0.5 cm^{-1} pixel size 12 km	645 - 2760 cm^{-1} NEΔT $\leq$ 0.5 NEΔT(IASI) $\Delta\nu \leq 0.5\ \Delta\nu$(IASI) pixel size 12 km
AMSU / MHS → MWS	15 + 5 channels: 23 - 190 GHz	21 channels: 23.8 - 229 GHz
GRAS → RO	GPS tracked 650 occultations / day	GPS and Galileo tracked 1500 occultations / day / satellite
GOME-2 → Sentinel-5	0.29 – 0.74 µm 80x40 km^2 resolution	14 bands: 0.27 – 2.385 µm 15 km resolution
AHVRR → VII	6 channels: 0.58 – 12.5 µm	≥ 20 channels: 0.41 – 14.2 µm spatial sampling 500 m, 2 solar channels sampled at 250 m
ASCAT → SCA	spatial resolution 50 km dynamic range 4 - 25 m/s	spatial resolution 25 km dynamic range enhanced by VH

Mission requirements evolution - EPS vs. EPS-SG

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New Missions in EPS-SG

Instrument	EPS-SG / Metop-SG
MWI	19 channels: 18.7 - 183 GHz footprint size 50 km at low frequencies to 10 km at high frequencies
ICI	11 channels: 183 – 664 GHz footprint size < 15 km
3MI	11 (+2) channels: 342 - 2130 nm multi-channel, multi-viewing, multi-polarization spatial sampling 4 km
RER	3 broad spectral bands angular sampling ≥ 3 views spatial resolution 20 km
LLI	one broad-band channel 0.4 - 1.1 µm spatial sampling 0.55 – 2.7 km

Mission requirements evolution - new Missions in EPS-SG