EUMETSAT
Monitoring weather and climate from space
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)
Number of Natural disasters set off by severe weather

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

Global average sea level rise (1994-2010)

Source: University of Colorado, LEGOS/CNES

GLOBAL AVERAGE SEA LEVEL (mm)

Altimetric mean sea level (MERG ED)

Rate = 3.2 ± 0.4 mm/yr

60-day smoothing

TOPEX/POSEIDON

JASON

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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).
Total Expenditure 2011: MEUR 306.5

* Budget pending entry into force of the programmes
Current Financial Planning 2011-2030...

Contributions at 2011 economic conditions (MEUR)

Satellite Launches

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

USER REQUIREMENTS

European National Meteorological Services

Private Enterprises, Value-Added Services, End-Users

Operating Agency

Interface with users and overall system design and development. Responsible for procurement of ground segment and launch services

European Space Industry

Satellite development and procurement agency

EUMETSAT
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.
EUMETSAT’s geostationary satellite coverage

Meteosat-9 (0° Longitude)
Meteosat-8 (9.5° E)
Meteosat-7 (57.5° E)
Meteosat-6 (67.5° E)
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.

- **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
Monitoring the oceans

Jason satellites

**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

Partners: cnes, NASA, NOAA

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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 ground segment overview

- **EUMETSAT geostationary systems**: Meteosat satellites
- **Jason-2**: Optional programme for ocean altimetry
- **EUMETSAT Polar System**: Metop satellites
- **NOAA satellites**: Data acquisition and control

**Data acquisition and control**
- Flight Operations
- Pre-processing
- EUMETSAT HQ

**Data Centre**
- EUMETSAT HQ Darmstadt

**Meteorological product extraction**
- Centralised processing and generation of products

**Satellite Application Facilities**
- Decentralised processing and generation of products

**Data dissemination**
- Via EUMETCast

**Users**

**Third-party data sources**
EUMETCast coverage

EUMETCAST AMERICAS
NSS-806, C-BAND

EUMETCAST EUROPE
EB-9, KU-BAND

EUMETCAST AFRICA
AB-3, C-BAND
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
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
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.
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.
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:
• 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.
• 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.
• 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.
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.
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)

<table>
<thead>
<tr>
<th>Mission</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-Resolution Infrared Sounding</td>
<td>Very high</td>
</tr>
<tr>
<td>Microwave Sounding</td>
<td></td>
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<tr>
<td>VIS/IR Imaging</td>
<td></td>
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<tr>
<td>Scatterometry</td>
<td></td>
</tr>
<tr>
<td>Radio Occultation Sounding</td>
<td>High</td>
</tr>
<tr>
<td>Nadir viewing UV/VIS/NIR/SWIR Sounding</td>
<td>Medium</td>
</tr>
<tr>
<td>Multi-viewing, -channel, -polarisation Imaging</td>
<td>Medium</td>
</tr>
<tr>
<td>Microwave Imaging</td>
<td></td>
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<tr>
<td>Radiant Energy Radiometry</td>
<td>Low</td>
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<tr>
<td>Ice Cloud Imaging</td>
<td></td>
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<tr>
<td>Low Light Imaging</td>
<td>(not ranked)</td>
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<tr>
<td>ARGOS</td>
<td></td>
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<tr>
<td>Search and Rescue</td>
<td></td>
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<tr>
<td>Space Environment Monitoring</td>
<td></td>
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## Payloads

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<tr>
<th>Payload</th>
<th>Sat “a”</th>
<th>Sat “b”</th>
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</thead>
<tbody>
<tr>
<td>High-Resolution Infrared Sounding</td>
<td></td>
<td>x</td>
</tr>
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<td>x</td>
</tr>
</tbody>
</table>

**EPS-SG Payload Accommodation on the Two-Satellite In-orbit Configuration**
<table>
<thead>
<tr>
<th>Instrument</th>
<th>EPS / Metop</th>
<th>EPS-SG / Metop-SG</th>
</tr>
</thead>
<tbody>
<tr>
<td>IASI → IAS</td>
<td>645 to 2760 cm(^{-1}) NE(\Delta T) 0.1 - 0.6 K (&lt;2400 cm(^{-1})) (\Delta \nu = 0.35 - 0.5) cm(^{-1}) pixel size 12 km</td>
<td>645 - 2760 cm(^{-1}) NE(\Delta T) (\leq 0.5) NE(\Delta T) (IASI) (\Delta \nu \leq 0.5) (\Delta \nu) (IASI) pixel size 12 km</td>
</tr>
<tr>
<td>AMSU / MHS → MWS</td>
<td>15 + 5 channels: 23 - 190 GHz</td>
<td>21 channels: 23.8 - 229 GHz</td>
</tr>
<tr>
<td>GRAS → RO</td>
<td>GPS tracked 650 occultations / day</td>
<td>GPS and Galileo tracked 1500 occultations / day / satellite</td>
</tr>
<tr>
<td>GOME-2 → Sentinel-5</td>
<td>0.29 – 0.74 µm 80x40 km(^2) resolution</td>
<td>14 bands: 0.27 – 2.385 µm 15 km resolution</td>
</tr>
<tr>
<td>AHVRR → VII</td>
<td>6 channels: 0.58 – 12.5 µm</td>
<td>(\geq 20) channels: 0.41 – 14.2 µm spatial sampling 500 m, 2 solar channels sampled at 250 m</td>
</tr>
<tr>
<td>ASCAT → SCA</td>
<td>spatial resolution 50 km dynamic range 4 - 25 m/s</td>
<td>spatial resolution 25 km dynamic range enhanced by VH</td>
</tr>
</tbody>
</table>

**Mission requirements evolution - EPS vs. EPS-SG**
### New Missions in EPS-SG

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

*Mission requirements evolution - new Missions in EPS-SG*