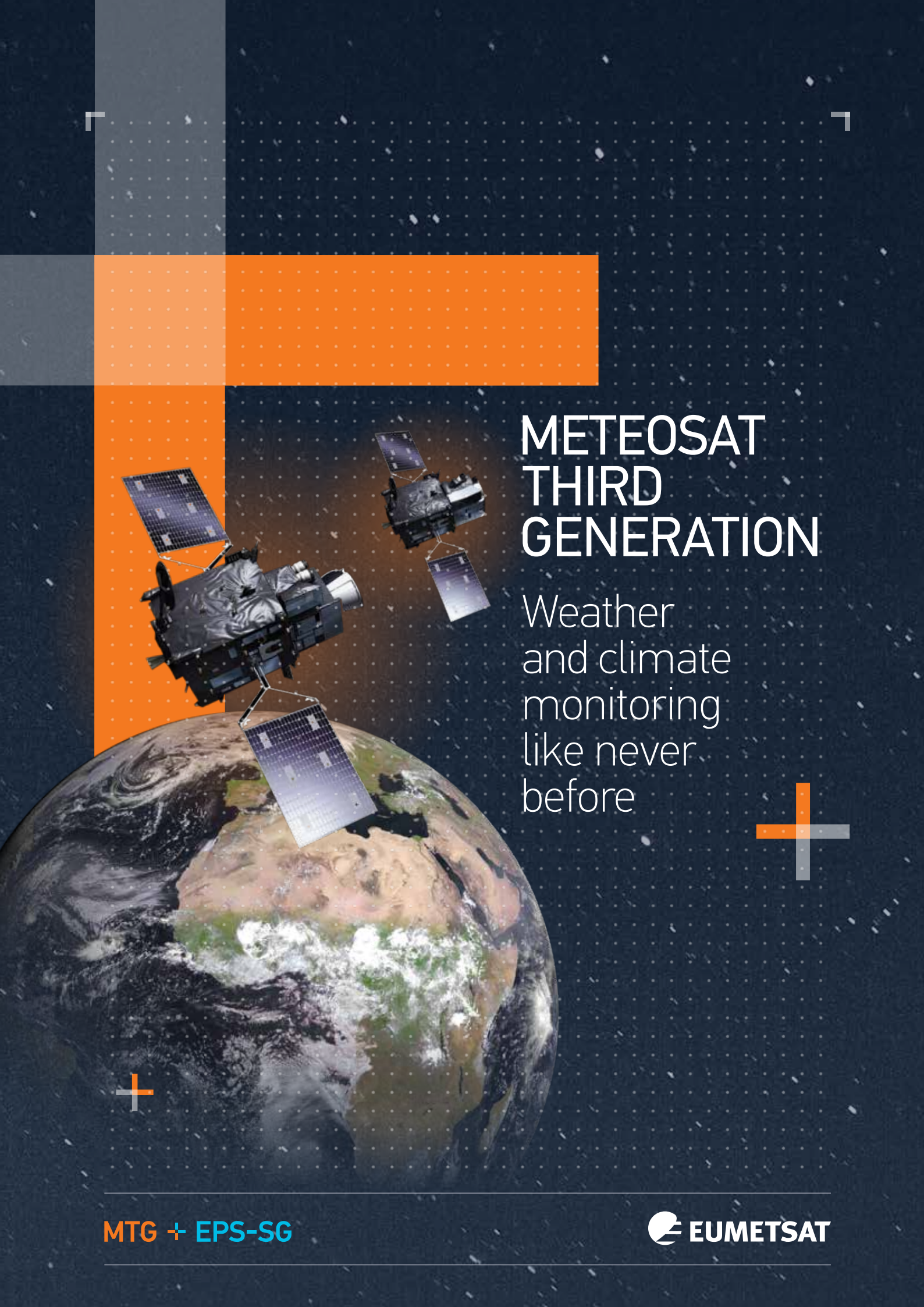


METEOSAT THIRD GENERATION

Weather and climate monitoring like never before

MTG + EPS-SG

EUMETSAT

Hail, high winds, extreme rainfall and related flash floods pose hazards to lives and property in Europe.

Statistics show the impact of severe storms on European economies has grown over the past decade.

The ability of national meteorological and hydrological services to forecast severe storms with lead times of minutes up to a few hours ahead is vital for economic sectors such as transport and tourism and for first responders to emergencies.

EUMETSAT's Meteosat Third Generation (MTG) is a highly innovative satellite system for Europe and Africa to support meteorological and related environmental services, especially for improving weather forecasts from several minutes to a few hours ahead (nowcasting). The data from these satellites will also aid complex computer modelling of the weather (numerical weather prediction), air quality monitoring and climate monitoring.

Continuity and innovation

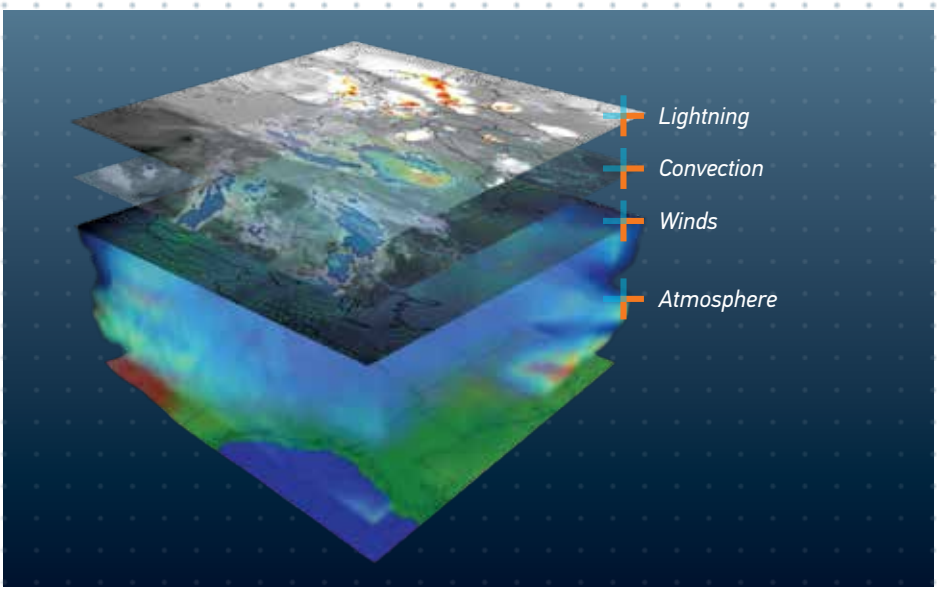
As the successor to EUMETSAT's existing fleet of Meteosat Second Generation (MSG) satellites, MTG will build on currently available data and imagery, as well as provide new – and novel – data types.

The MTG imager will be provided faster and in higher resolution than is possible from the MSG imager for better detecting and understanding clouds, for example. MTG will also allow for the continuation of the Meteosat climate data records. These records stretch back more than 40 years now and, through the MTG programme, are assured for another two decades or more.

The Lightning Imager and sounder instruments on the MTG satellites offer novel data types with high innovation potential to European data users.

Unprecedented information on the dynamic features of atmospheric moisture and temperature over Europe will be available every 30 minutes from the operational geostationary Infrared Sounder. By adding collocated spectral imagery and lightning data, national meteorological services are expecting a breakthrough in gaining precious prediction lead time through early detection of rapidly developing, high-impact weather events such as severe storms. In addition, lightning data will provide air traffic management with information on electrically active storms. Air quality monitoring over Europe will also be enhanced, such as the measuring of nitrogen dioxide, ozone and fine particles.

MTG will also accommodate the Copernicus Sentinel-4 sounding mission covering Europe every hour and taking measurements in three spectral bands.



Artist's illustration of the '4D Weather Cube', enabled by Meteosat Third Generation instruments which probe the atmosphere in three dimensions and with high repeat cycle, for the first time over Europe. Forecasters will be able to simultaneously track meteorological phenomena, such as convection, winds and lightning activity, and, thus, more accurately detect and forecast rapidly developing high-impact weather, like thunderstorms.

EUMETSAT

TACKLING MAJOR WEATHER-RELATED ECONOMIC RISKS

Extreme weather events and natural disasters are the top two most likely global risks identified by the World Economic Forum in its 2018 Global Risks Perception Survey. They are ranked second and third in terms of impact on economies. The risk of failure to mitigate or adapt to climate change ranks just below them.

Severe convective storms are some of the most dangerous weather-related events in Europe. From 2007 to 2017, the financial losses from convective storms in Western Europe alone amounted to about €35 billion.

National meteorological and hydrological services (NMHS) are key providers of information for reducing economic risks associated with extreme weather and natural disasters. The return on investment in national weather services has been estimated as at least 2:1 and often between 5:1 and 10:1, or more.

Using nowcasting techniques, weather prediction models, satellite and other data, NMHS monitor and predict weather-related extremes and provide authoritative advisories and warnings to the public.

Satellite data make a substantial contribution to improving weather and related services, i.e., in saving lives and property. The data from MTG is provided twice as fast as is now possible for imagery over Europe. This is particularly important for nowcasting and very short-range forecasting of severe weather events up to a few hours ahead.

In addition, MTG will enable a range of improvements to the use of satellite data in fire and fog monitoring, and will open new applications such as continuous monitoring of air quality from space.

Traditionally, the overall benefits accrued from investment made in the meteorological and hydrological infrastructures were estimated to be, in several countries, in [the] order of 10:1.

M. Jarraud
Former Secretary-General of WMO

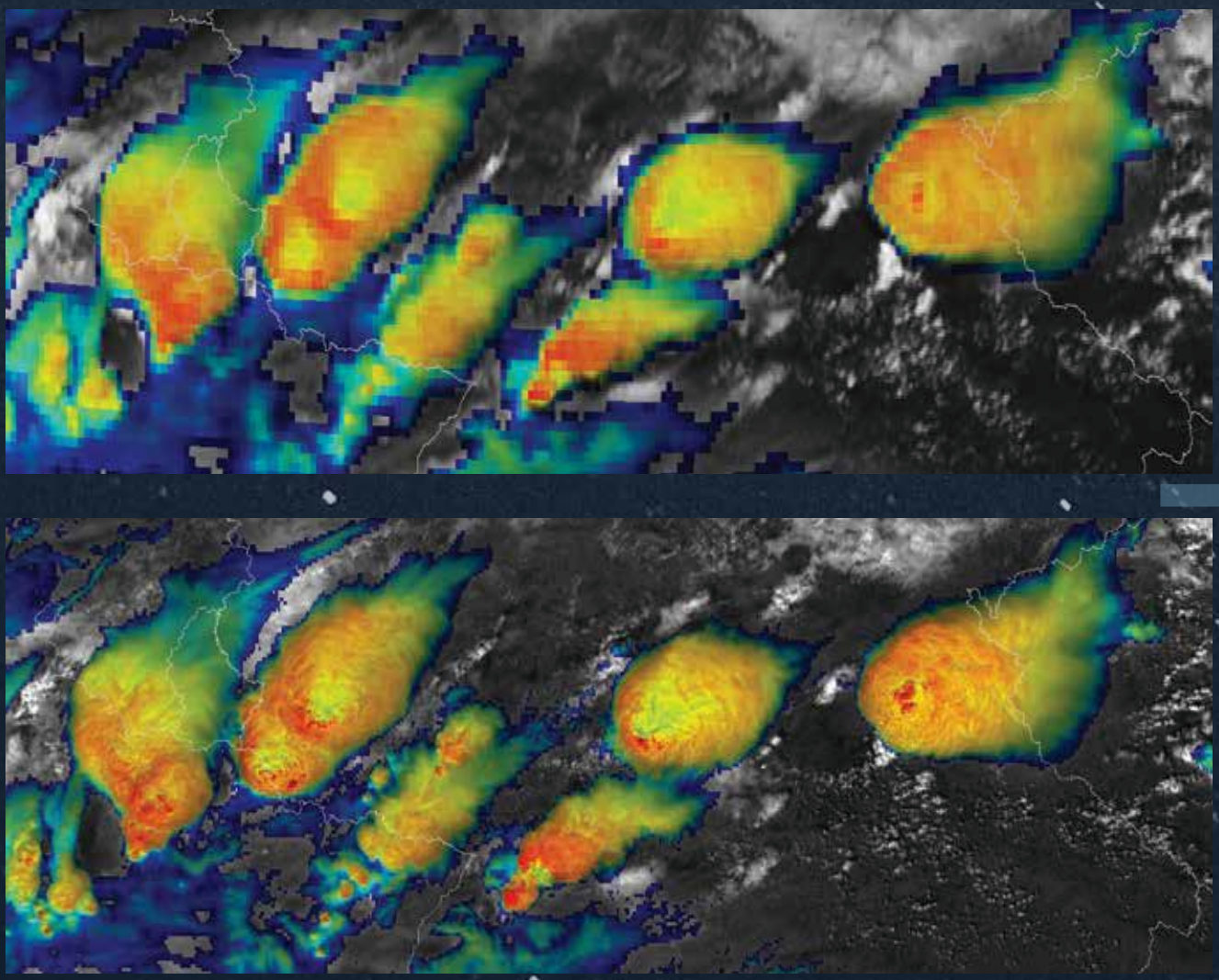
THE APPLICATIONS FOR MTG DATA

Monitoring and "nowcasting" severe convective storms

Monitoring, tracking and short-term prediction ("nowcasting") of potentially severe storms will benefit greatly from the data from the Flexible Combined Imager (FCI) on board MTG.

The FCI will provide imagery at a higher resolution (1km spatial sampling distance) than is currently available from the imager on board the Meteosat Second Generation satellites (3km spatial sampling distance). This, together with the greater frequency of imaging (2½ minutes for images of Europe compared to 5 minutes from MSG) will enable forecasters to better see cloud top details, thus more accurately assess storm intensity, and to make short-term predictions several minutes ahead.

Convective storm clouds over Central Europe, as seen from current Meteosat Second Generation imagery (top) compared to imagery simulating the higher-resolution future MTG imaging mission (bottom). The MTG imagery will enable a better view of cloud top details and, thus, more accurate assessments of storm intensity.



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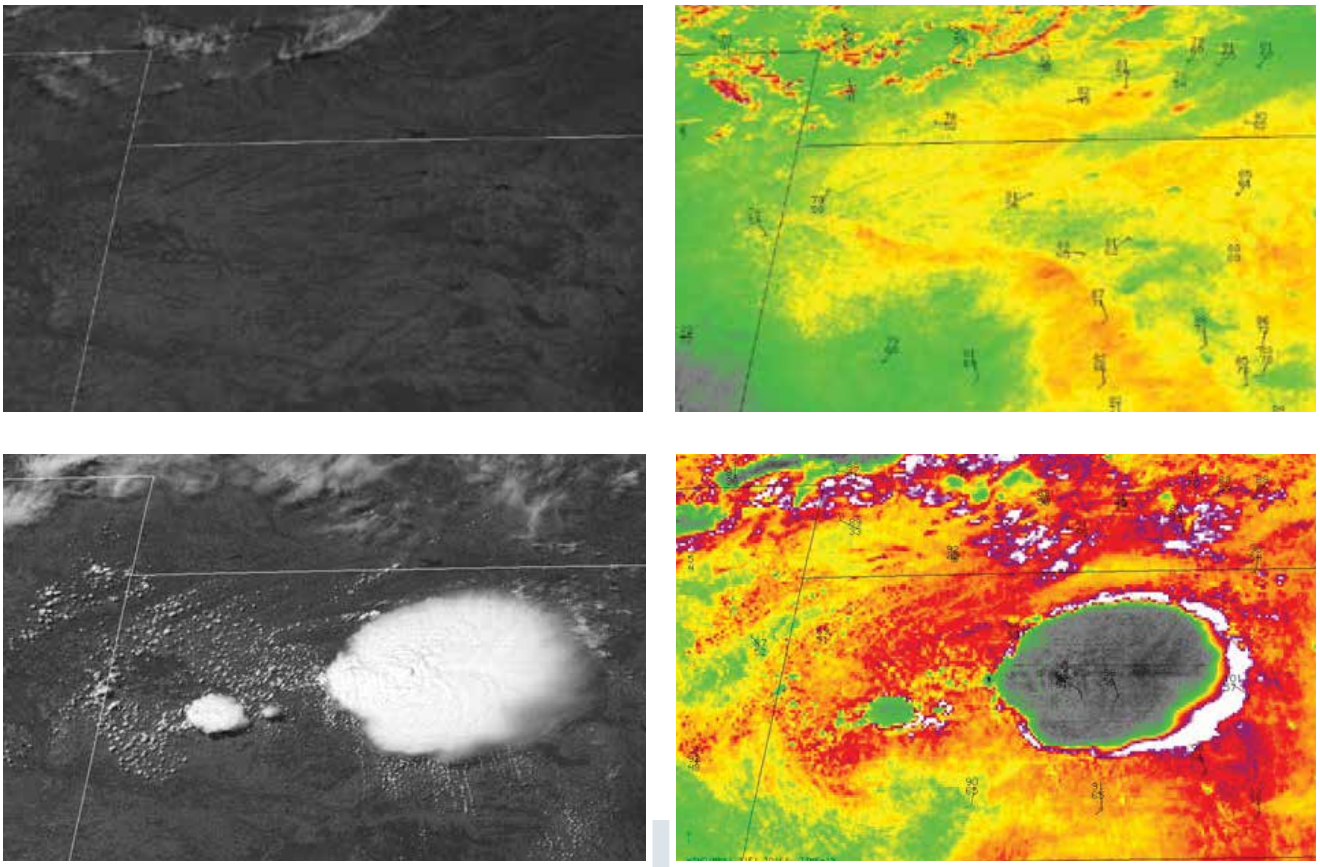
THE APPLICATIONS FOR MTG DATA

Detecting a precursor of potentially severe storms

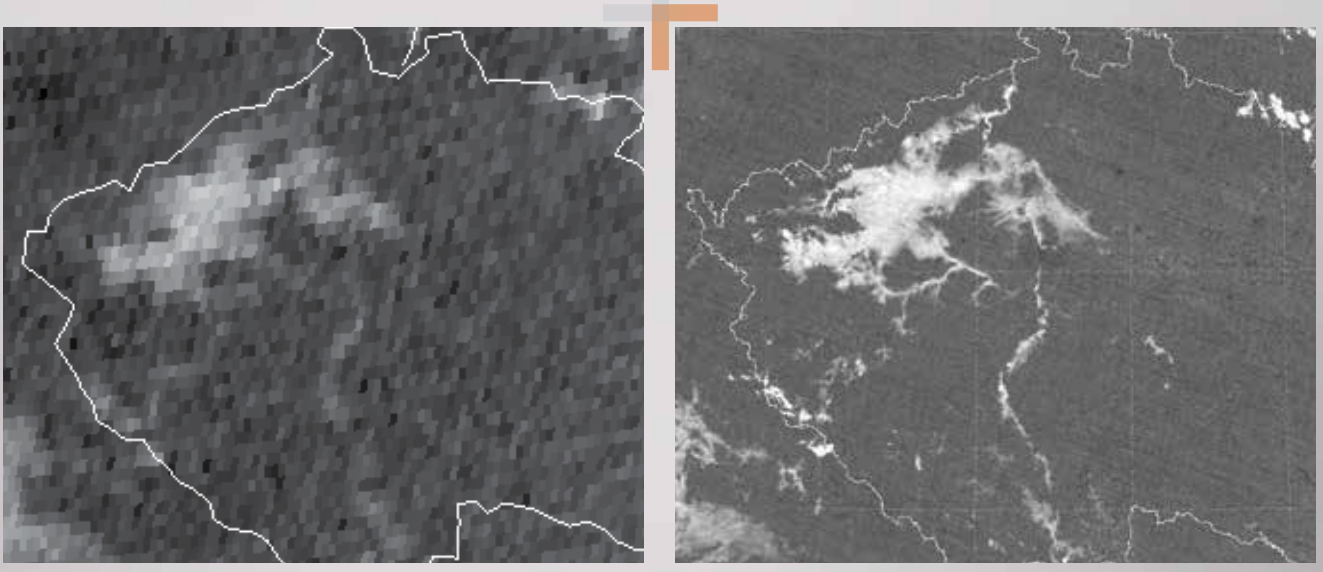
MTG's Flexible Combined Imager has the capability to provide early detection of a surface boundary – a precursor to a severe storm. Valuable situational awareness and potential nowcasting lead time can be gained from the imagery.



The US Geostationary Operational Environmental Satellite (GOES)-East satellite carries the Advanced Baseline Imager, an instrument similar to MTG's Flexible Combined Imager. The top-left image illustrates that conventional imagery and ground based radar detect no signal of low-level moisture – a precursor for potentially severe storms - over Kansas, while the ABI (top, right) detects this extending from below the centre to the bottom of the scene in orange-red colours. The bottom images, 3½ hours later, show a fully developed hail storm in the same area.

Fog detection for transport safety

Fog detection benefits greatly from frequent, high-resolution satellite imagery. Monitoring fog is very important for airport operations and air traffic control. Using imagery from the GOES-East Advanced Baseline Imager, which is similar to MTG's FCI, the US National Weather Service has experienced a reduction in lead times for warnings over San Francisco airport. Incoming or dissipating fog can be better monitored than with the old GOES imager, and alerts can be issued or lifted at shorter notice, leading to cost savings by airlines.



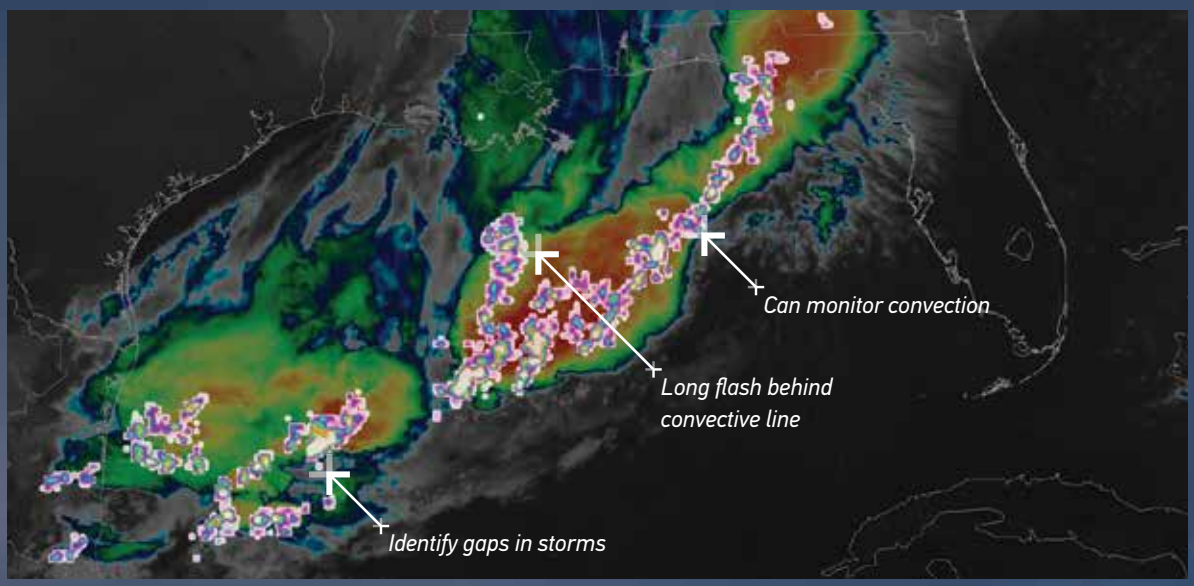
Detection of early morning fog over the Czech Republic based on current Meteosat Second Generation imagery (left) and with proxy data simulatin

THE APPLICATIONS FOR MTG DATA

Monitoring lightning for tracking storms

Severe convective storms are usually accompanied by large jumps in lightning activity. The MTG Lightning Imager will, for the first time over Europe and Africa, provide continuous observation of lightning activity from space. This includes cloud-to-cloud and cloud-to-ground flashes. The Lightning Imager provides particular value in detecting and monitoring convective storms in otherwise data-sparse areas, such as over the ocean and over parts of Africa.

Using satellite lightning data, weather forecasters have additional information to more precisely monitor convective development, identify gaps in storms and observe long flashes behind the convective line, all in an area which is outside the coverage of ground-based weather radars and most lightning detection networks. This is beneficial for issuing weather alerts and for providing information to weather-sensitive sectors of the economy, such as aviation.

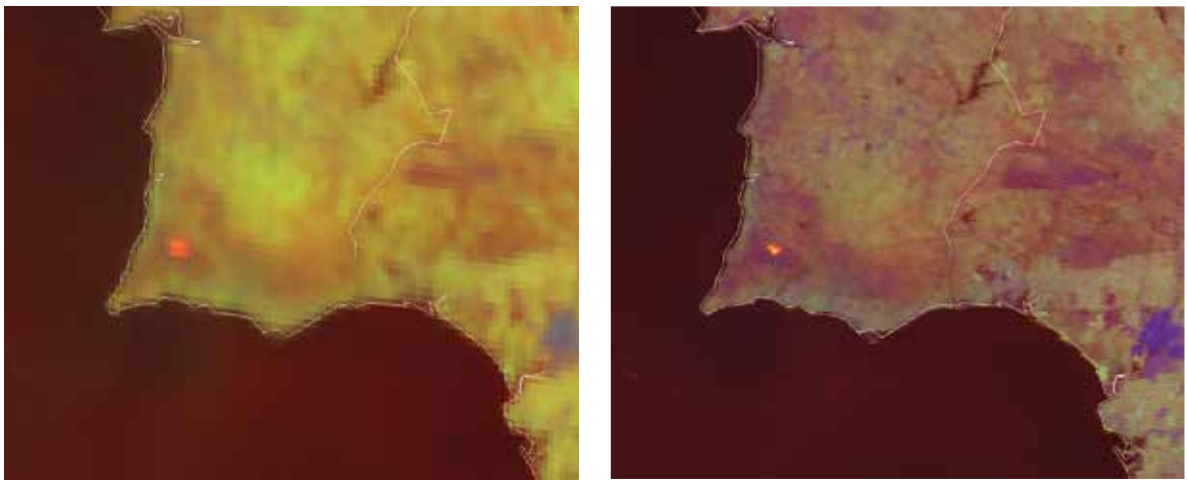


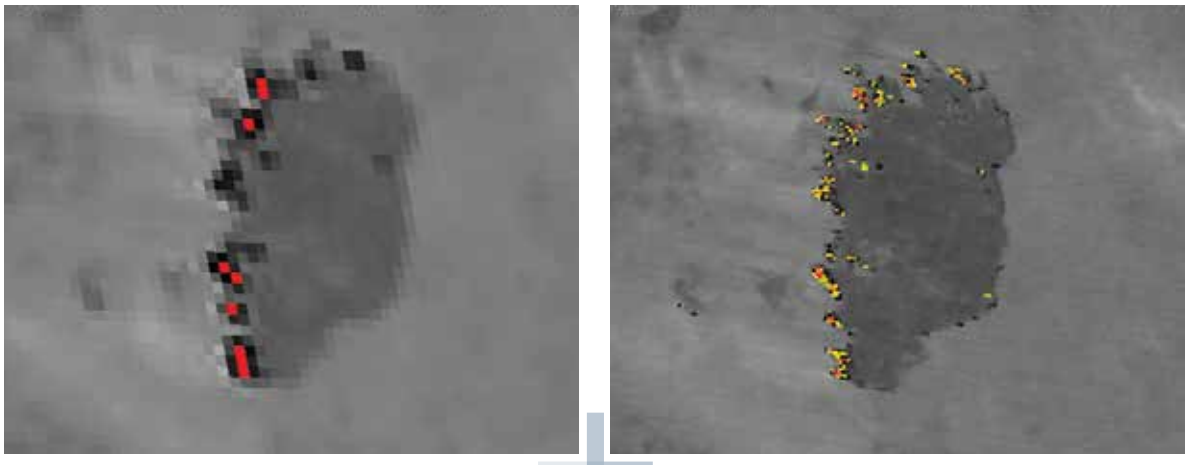
This image taken by the US GOES Geostationary Lightning Mapper (GLM) instrument shows lightning activity in white-blue-magenta colours along a convective storm line (yellow-orange-red shades in background infrared imagery) over the Gulf of Mexico. The GOES GLM is a precursor to the MTG Lightning Imager.

Fire detection and monitoring

Fires in Portugal and Greece during the 2018 European heatwave cost lives and property and burned vegetation. Fire detection and monitoring using data from the MTG Flexible Combined Imager (FCI) will be an important application area. Higher resolution and more frequent images will provide a powerful tool for detecting and fighting fires, detecting smoke and mapping burned areas. The American Forest Service has used the fire detection capability of the US GOES satellites to improve tactical planning.

August 2018 fires in Portugal mapped with current Meteosat Second Generation imagery (left panel) and with proxy data simulating imagery from the future MTG (right panel).





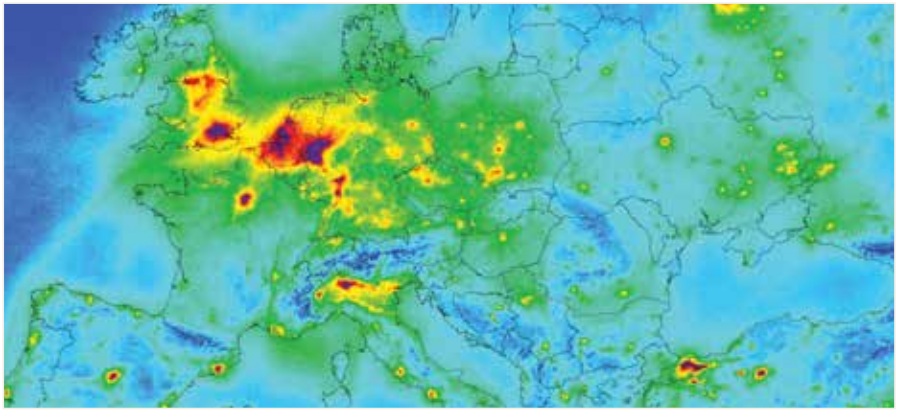
A bushfire line in Botswana as seen in imagery from MSG (left panel), compared to future MTG imagery simulated by proxy data (right panel). MTG imagery will enable more precise detection of fire location and estimates of fire intensity.

THE APPLICATIONS FOR MTG DATA

Air quality monitoring

Air quality monitoring and management is an important part of environmental regulation. The monitoring of air pollutants such as nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone, formaldehyde and fine particles is of increasing societal importance. The Copernicus Sentinel-4 Ultraviolet, Visible and Near-Infrared Sounder (UVN) instrument will provide hourly information on tropospheric NO_2 and many other air quality parameters over Europe. NO_2 is a key atmospheric pollutant caused by combustion processes (vehicles, industry, households) and is a major concern in many cities and industrial areas. UVN data will be used by the Copernicus Atmosphere Monitoring Service (CAMS) and many other users. MTG imagery and data from the Infrared Sounder are also expected to contribute to air quality monitoring.

Seasonal average NO2 tropospheric column map at horizontal resolution of 2km; TROPOMI instrument on Sentinel-5P © ESA/KNMI, Henk Eskes



The MTG mission has massive potential to improve our weather and climate services. We intend to leverage MTG data to improve our situational awareness, to enhance our numerical weather prediction capability and to extend into the future our ability to monitor changes to our environment.

Simon Keogh
Met Office (UK)

Enhancing weather prediction models

MTG's Infrared Sounder (IRS) instrument will be the first of its kind for Europe. Probing the atmospheric temperature and moisture every 30 minutes is expected to lead not just to enhancements in the "nowcasting" of rapidly developing severe weather events but also for short-range weather prediction, up to a few hours ahead. IRS data are expected to help advance the ability of complex weather models to correctly represent moisture-related processes, such as convective development.

"The Netherlands have significant economical interests related to transportation by air, water, and land. Transport capacity planning will benefit from improved observations and forecasts enabled by MTG, next to the enhanced safety by better and more timely warnings in a densely populated area."

Paul de Valk
KNMI, The Netherlands

THE MTG MISSION

The MTG system comprises two types of three-axis stabilised satellites: MTG-I (imaging) and MTG-S (sounding). When fully deployed, the constellation will include two MTG-I satellites and one MTG-S satellite.

The two imaging satellites will operate in tandem, with one scanning Europe and Africa (the full disc) every 10 minutes and the other scanning Europe only every 2½ minutes. The MTG programme encompasses the observation missions detailed below, for the benefit of enhanced weather and related environmental services.

Spectral imagery mission

The Flexible Combined Imager (FCI) will provide scans of Europe and Africa every 10 minutes and of Europe every 2½ minutes. By comparison, the imaging instruments on Meteosat Second Generation satellites provide scans of Europe and Africa every 15 minutes and of Europe every 5 minutes.

Lightning imagery mission

The Lightning Imager (LI) instrument will continuously detect lightning discharges taking place in clouds or between clouds and the ground over Europe and Africa.

Infrared sounding mission

The Infrared Sounder (IRS) instrument is a first for Europe. It will provide hyperspectral soundings of the atmosphere every 30 minutes over Europe.

Copernicus Sentinel-4 sounding mission

The MTG programme accommodates the Copernicus Sentinel-4 sounding mission through the Ultraviolet, Visible and Near-Infrared Sounder (UVN) instrument. This instrument provides data about trace gases and aerosols (fine particles) in the atmosphere.

MTG-I

Payload

1. **FCI** (Flexible Combined Imager)
2. **LI** (Lightning Imager)
3. **DCS** (Data Collection and Retransmission Service)

GEOSAR (Geostationary Search and Rescue Relay)

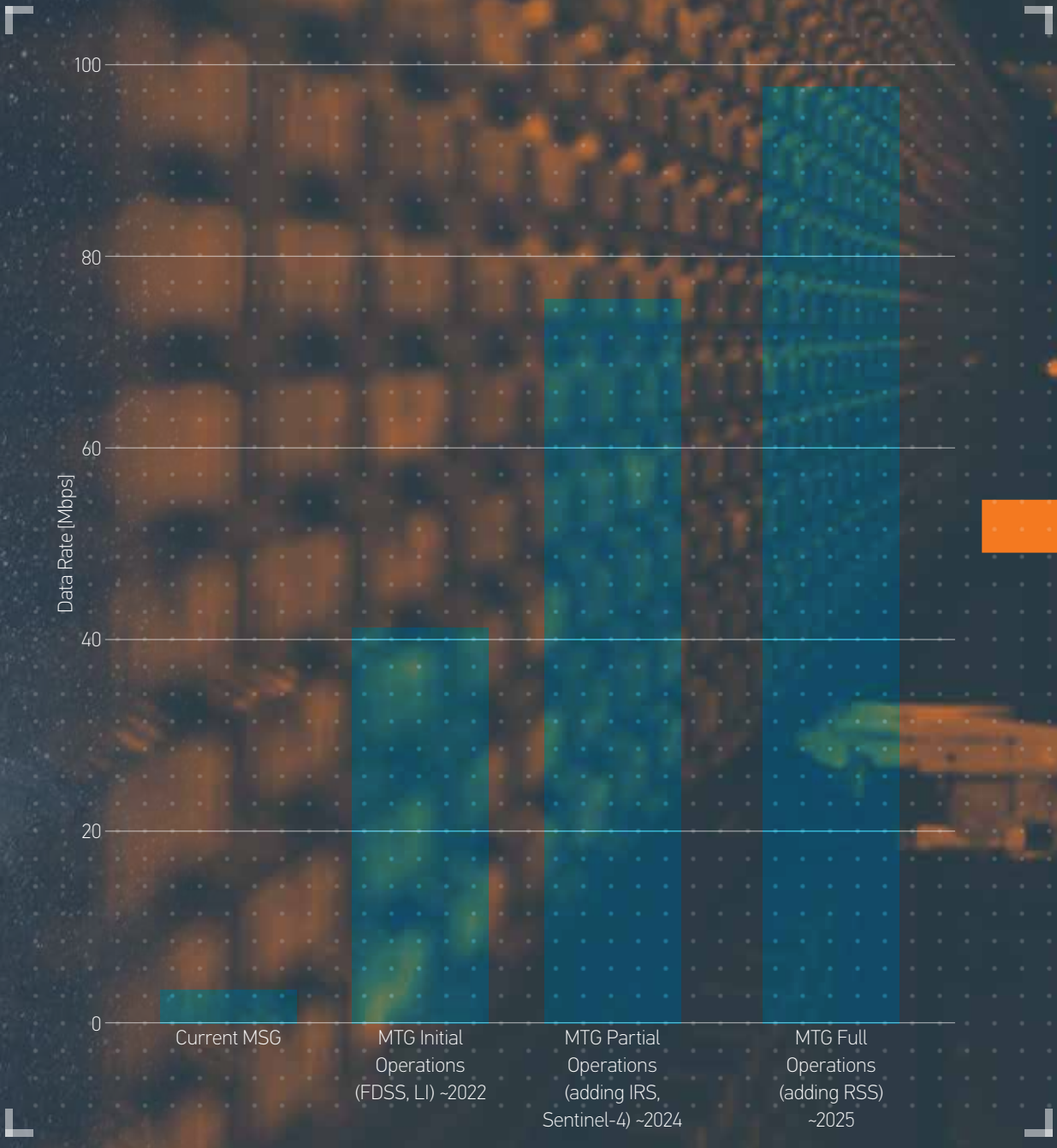
MTG-S

Payload

4. **IRS** (Hyperspectral InfraRed Sounder)
5. **COPERNICUS SENTINEL-4 UVN** (Ultra-violet, Visible and Near-Infrared Sounder)

MORE DATA

The fully deployed and operational configuration of Meteosat Third Generation (two imaging satellites and one sounding satellite) is expected to produce about 28 times as much data as the Meteosat Second Generation.



Evolution of data rates from current MSG to the full MTG operations

EUMETSAT

THE GROUND SEGMENT

In addition to the spacecraft, the other main component of the Meteosat Third Generation system is a comprehensive ground segment.

This is used to control the satellites, acquire and process the data and deliver the data and products to users worldwide.

The primary users of the data are the national meteorological and hydrological services in EUMETSAT's 30 Member States, the European Centre for Medium-Range Weather Forecasts based in the UK and the Copernicus services, particularly the Copernicus Atmosphere Monitoring Service.

From the Geostationary Mission Control Centre in Darmstadt, Germany (opposite page), EUMETSAT will operate the MTG satellites from Telemetry, Tracking and Control Stations in Fucino, Italy (top left) and Cheia, Romania (top right), and from Mission Data Acquisition Stations in Lario, Italy (bottom left) and Leuk, Switzerland (bottom right)


LG
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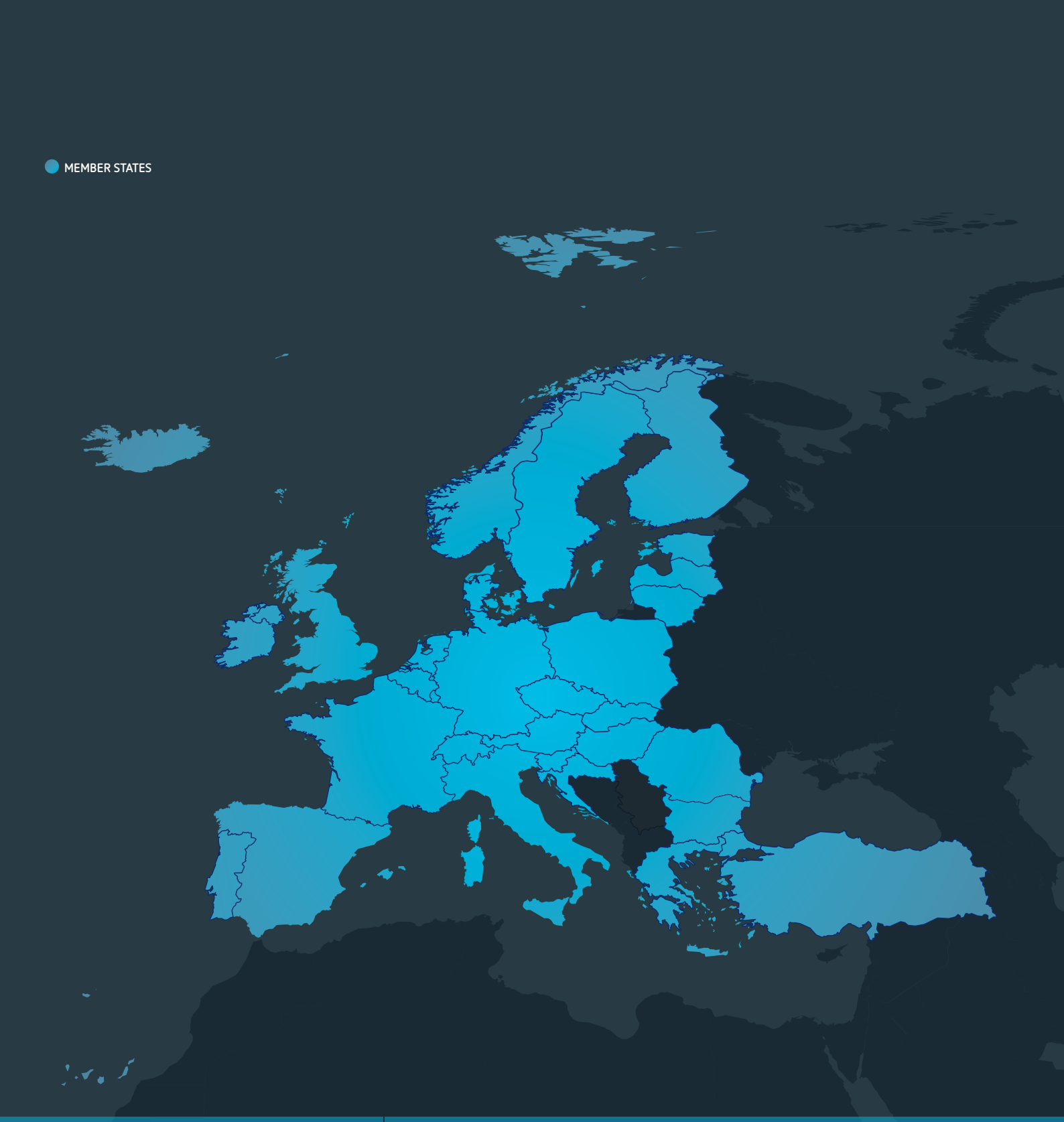

EUMETSAT

Eumetsat-Allee 1
64295 Darmstadt
Germany

Tel: +49 6151 807 3660/3770
Email: ops@eumetsat.int
www.eumetsat.int

@eumetsat
eumetsat
eumetsat
eumetsatmedia
eumetsat1
EUMETSAT

MEMBER STATES

EUMETSAT also has established cooperation agreements with organisations involved in meteorological satellite activities, including the National Meteorological Services of Canada, China, India, Japan, Russia, South Korea and USA

Brochure: PRG.04, V.1