

# COPERNICUS @EUMETSAT

COMBINING EUMETSAT AND  
COPERNICUS MISSIONS TO  
CREATE NEW OPPORTUNITIES



# COPERNICUS - A EUROPEAN RESPONSE TO THE CHALLENGE OF GLOBAL MONITORING FOR ENVIRONMENT AND SECURITY



Governments, commerce, industry, as well as citizens all around the world, are increasingly aware of the need for development without damaging our environment. The immense forces affecting the climate and environment of our planet are complex. Allowing for the definition of sustainable development policies, responsible decision-making and careful planning, requires comprehensive information on global, regional and local levels. This information is also relevant for the support to EU Security policies i.e. in the area of border and maritime surveillance.

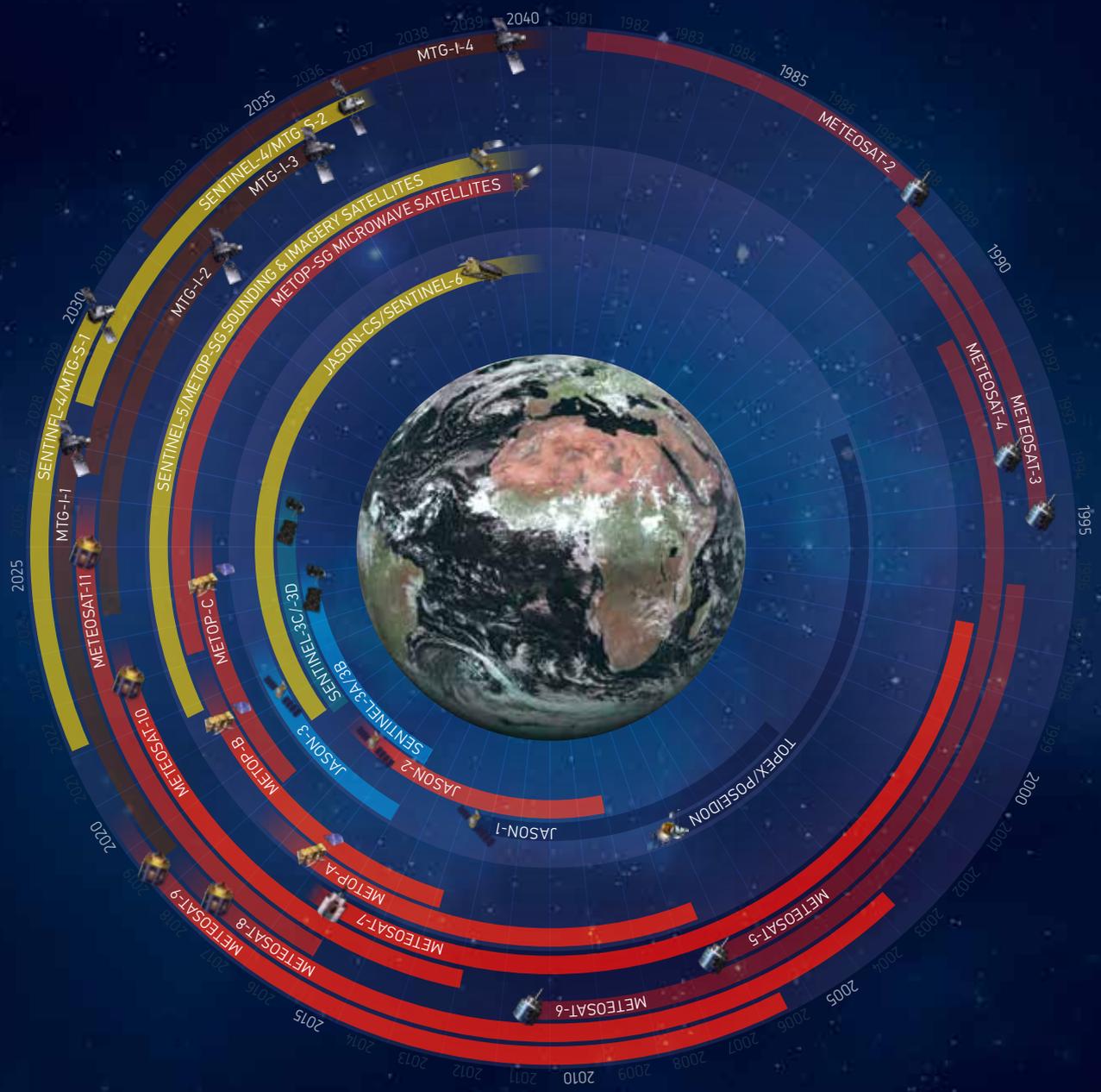
The Copernicus Programme, established in 2014 as the flagship Earth observation programme of the European Union, is the response to this challenge. Its objective is to “ensure an autonomous capacity for space-borne observations and provide operational services in the field of atmosphere, marine, land and climate change monitoring, emergency management and security.” The Copernicus programme places a world of insight about our planet at the disposal of citizens, public authorities and policy makers, scientists, entrepreneurs and businesses on a full, free and open basis.

The portfolio of Copernicus operational information services relies on the ingestion of space-based and *in-situ* observations provided by the Copernicus space and *in-situ* components into Earth system models or other information systems.

This portfolio consists of six information services, including the Copernicus Marine Environment Monitoring Service (CMEMS), provided by Mercator-Ocean International, the Copernicus Atmosphere Monitoring Service (CAMS) and the Copernicus Climate Change Service (C3S), both provided by the European Centre for Medium Range Weather Forecasts (ECMWF). Further services might be implemented in the future, in particular for the support to the reporting on Green House Gas anthropogenic emissions foreseen by the Paris Agreement.

Ultimately, Copernicus data and information services will support a wide range of applications including environment protection, management of urban areas, regional and local planning, agriculture, forestries, fisheries, health, transport, climate change, sustainable development, civil protection and tourism.





- EUMETSAT MISSIONS
- COPERNICUS MISSIONS
- COPERNICUS MISSIONS INTEGRATED ON EUMETSAT MISSIONS
- OTHER MISSIONS

# EUMETSAT – OPERATING THE COPERNICUS SENTINEL-3, -4, -5 AND -6 MISSIONS TO DELIVER INTEGRATED DATA SERVICES



**Philippe Brunet**  
Directorate General,  
Internal Market, Industry, Entrepreneurship  
and SMEs, European Commission

*"We really value the technical competence and experience of EUMETSAT to make Europe's flagship space programme on Earth observation a success story which will serve society in many ways, including by timely environmental monitoring as well as creating a thriving downstream sector."*

The Earth observation data and products required by the Copernicus information services need to be collected both by satellite systems and *in-situ* measurement networks. Europe has therefore developed Copernicus-dedicated operational Earth observation satellite missions, the so-called Sentinels. Copernicus also relies on existing contributing missions - in particular those of EUMETSAT - and coordinates the collection from *in-situ* networks through the European Environmental Agency (EEA).

EUMETSAT- Europe's agency for monitoring weather and climate from space - is uniquely equipped to support the EU Copernicus programme in the areas foreseen by its ruling Convention.

The European Union has therefore entrusted EUMETSAT with exploiting the five Copernicus missions (i.e. Jason-3, the Sentinel-3 marine mission as well as Sentinel-4, -5 and -6) of the Copernicus space component dedicated to the monitoring of atmosphere, ocean and climate on its behalf. EUMETSAT carries out these tasks in cooperation with the European Space Agency (ESA).

Under an agreement signed on 7 November 2014, EUMETSAT will provide, in the period 2014-2020, data, products and support services to the relevant Copernicus information services and user communities using its multi-mission infrastructure. Moreover, the organisation makes available to the European Union its unique expertise and successful experience of interactions with the user communities involved in the monitoring of the atmosphere, ocean and climate. This cooperation will continue and be further enhanced for the period 2021- 2027 with the deployment of Sentinel-4, -5 and -6.

EUMETSAT also provides operational observational products to three Copernicus information services from its fleet of environmental satellites as well as from third-party missions exploited by international cooperation partners. Those Copernicus services focus on the monitoring of the marine environment, the atmospheric composition and the climate. The products are devised at the organisation's headquarters in Darmstadt as well as by its distributed network of Satellite Application Facilities (SAF), including the SAF on Ocean and Sea Ice,

Alain Ratier, EUMETSAT Director-General and Philippe Brunet, Director of Aerospace, Maritime and Defence Industries, EC Directorate General Internal Market, Industry, Entrepreneurship and SMEs, sign the agreement between the European Union and EUMETSAT on the implementation of the Copernicus Programme





the SAF on Atmospheric Composition and the SAF on Climate Monitoring. For the Copernicus Climate Change Service, EUMETSAT delivers Climate Data Records resulting from the recalibration and reprocessing of datasets for its own satellites, spanning over three decades available in its archives.

Those Copernicus information services are closely related to weather information services, as they use similar numerical models for forecasting and reanalysis purposes and share a wealth of input observations. There is already a significant overlap of the respective end-user communities and EUMETSAT interacts on a day-to-day basis with both, in the understanding that many future applications will emerge from the combination of observations and information.

Therefore, EUMETSAT, through its involvement in Copernicus, wishes to create new and unique opportunities for users in the EU and EUMETSAT Member States, through the synergy between its own and the Copernicus Sentinel missions. The ultimate goal is to deliver to all users a single multi-mission data stream integrating observations of the weather, atmosphere and ocean.

To achieve this goal, the organisation will capitalise on:

- the cooperation with ESA on the development of the Sentinel-3,- 4,-5 and -6 missions;
- the implementation of the Sentinel-4 and Sentinel-5 missions as part of EUMETSAT Meteosat Third Generation and EPS-Second Generation satellite systems - also developed in cooperation with ESA;
- the use of EUMETSAT's multi-mission infrastructure and ground systems.

# SUPPORTING COPERNICUS MARINE, ATMOSPHERE AND CLIMATE SERVICES



**Pierre Bahurel**  
Director General,  
Mercator Ocean International

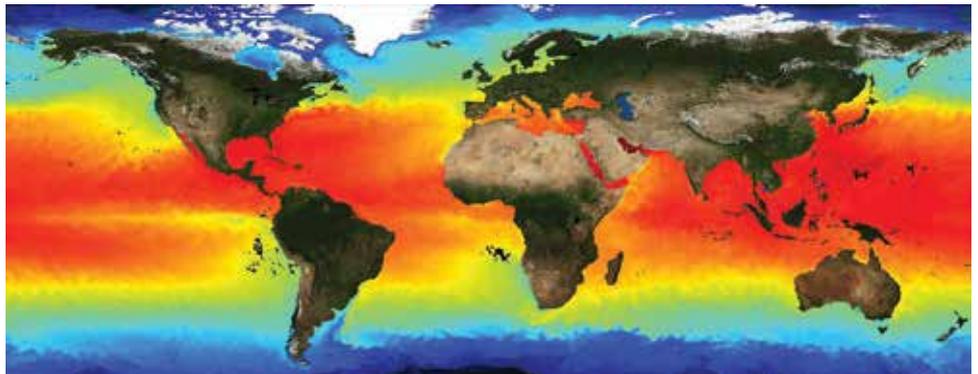
*"By providing real-time and reprocessed ocean observations, EUMETSAT is a major contributor to CMEMS. EUMETSAT data have a direct impact on service quality, as they are ingested into two thirds of Mercator Ocean International observation products and into all our models; from Jason-2, Metop, Meteosat, Jason-3, Sentinel-3, and soon Jason-CS."*

## COPERNICUS MARINE ENVIRONMENT MONITORING SERVICE (CMEMS)

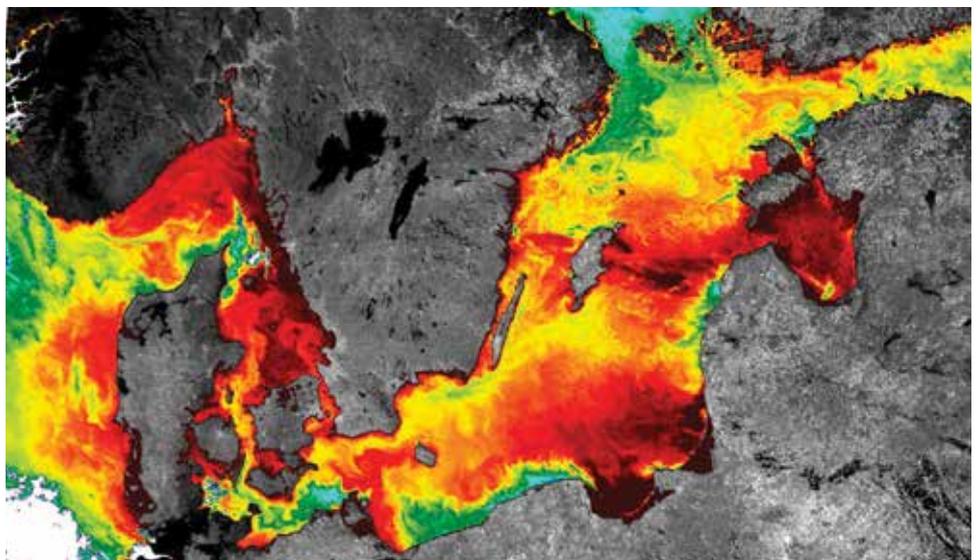
Marine data is an engine for "smart and sustainable growth" in the European Union, as stated in the recent Marine Knowledge 2020 EC Communication. The Copernicus Marine Environment Monitoring Service (CMEMS) has been designed to respond to issues emerging in the environmental, business and scientific sectors. Using both satellite and *in situ* observations as inputs, it provides state-of-the-art analyses and forecasts daily, which offer an unprecedented capability to monitor, understand and anticipate marine environment events.

CMEMS provides regular and systematic reference information on the state of the physical oceans and regional seas and leads the development of operational oceanography in Europe. The products and forecasts it delivers support four main application areas, Maritime Safety, Coastal and Marine Environment, Marine Resources, and Weather, Seasonal Forecasting and Climate activities.

The ability to monitor and forecast the state of the three-dimensional ocean and its interactions with the atmosphere and the climate system requires an integrated, operational satellite and *in-situ* observing system of the global oceans comparable to and integrated with the meteorological observing system.



Sentinel-3 SLSTR Sea Surface Temperature



*The Infrared channels of the SLSTR instrument aboard Sentinel-3B captures a generation of filaments and meanders in the Gulf of Finland, fully formed eddies in the Gotland Basin, coastal upwelling along the Polish and Latvian coasts and other mesoscale and sub mesoscale features in the basin of the Baltic Sea, 6 June 2018*



EUMETSAT's Meteosat and EPS/Metop satellite systems and the Jason-2 mission shared with CNES, NOAA and NASA are part of this integrated system.

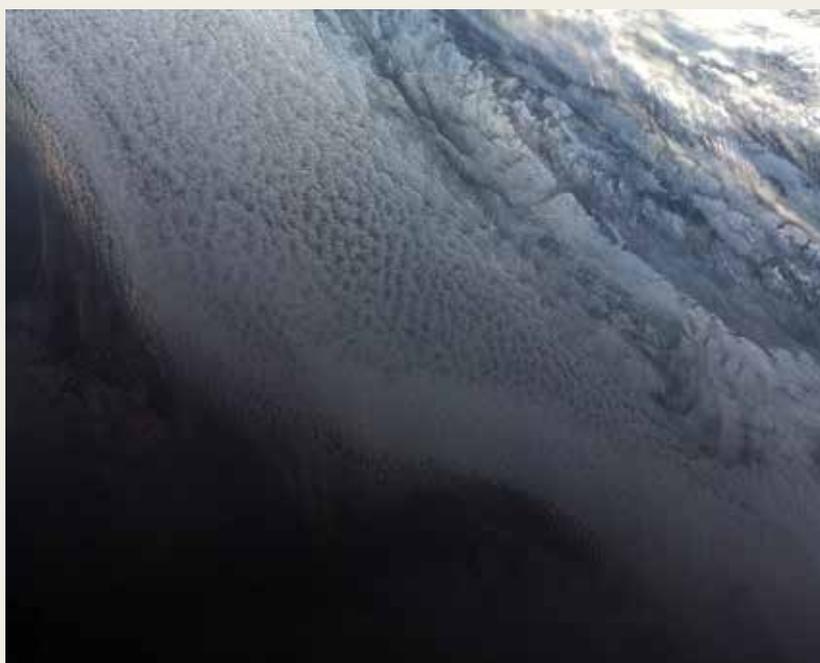
The role of EUMETSAT expanded in 2016, after the launch of Jason-3, carried out in cooperation with CNES, NOAA and NASA, and the launch of the first pair of Copernicus Sentinel-3A and -3B satellites developed by ESA.

EUMETSAT exploits the Jason-3 and Sentinel-3 marine missions on behalf of the European Union, in the closest possible synergy with its own missions. It thus delivers an integrated marine data stream to all users in the EU and EUMETSAT Member States through its EUMETCast real-time data broadcasting service and its Copernicus On-line Data Access (CODA) interface.

Using cross-calibrated information from Jason-3 and Sentinel-3, EUMETSAT generates a global bias-free multi-mission sea surface topography product that can be ingested into the ocean models operated by the CMEMS.

This service will be enhanced in 2021, when the Sentinel-6 mission complements and improves the capabilities of its Jason-3 precursor.

*Sentinel-3B first image, 7 May 2018 at 10:33 GMT, shows the sunset over the Weddell Sea off the coast of Antarctica.*



# SUPPORTING COPERNICUS MARINE, ATMOSPHERE AND CLIMATE SERVICES



**Vincent-Henri Peuch**  
Head of Copernicus Atmosphere  
Monitoring Service,  
ECMWF

*"The Copernicus Atmosphere Monitoring Service (CAMS), provides continuous data and information on atmospheric composition to support a number of applications ranging from air quality forecasting to international protocols and treaties monitoring."*

## COPERNICUS ATMOSPHERE MONITORING SERVICE (CAMS)

The Copernicus Atmosphere Monitoring Service (CAMS) combines advanced numerical prediction models of the atmosphere with satellite and *in-situ* observations to provide information on air quality, atmospheric composition, the ozone layer, ultraviolet radiation and solar energy as well as climate forcing by gases and aerosols. The service also supports studies of pollution incidents and possible response, annual assessments of air quality and the monitoring of greenhouse gases.

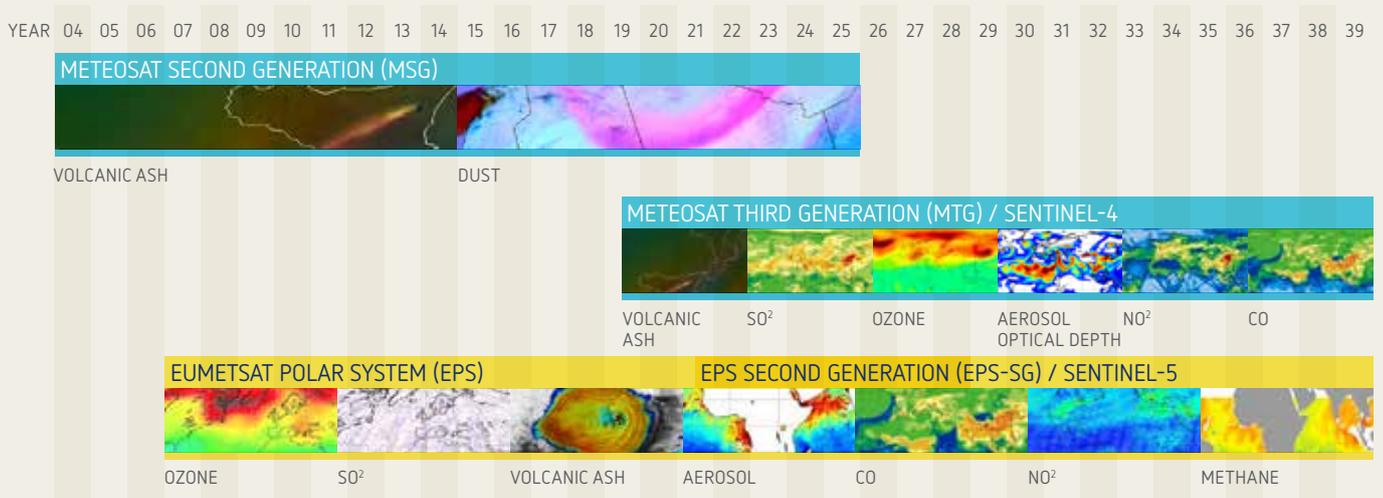
EUMETSAT supports CAMS through the provision of atmospheric composition products from its own Meteosat and

EPS/Metop satellite systems (e.g. ozone, carbon monoxide and other trace gases, aerosols) and of the US Suomi NPP and NOAA-20 satellites.

As of 2023, EUMETSAT will deliver the Copernicus Sentinel-4 and -5 sounding missions dedicated to the monitoring of atmospheric composition from the geostationary and polar orbits. For the sake of efficiency and synergy, these missions will be implemented as part of the EUMETSAT's future satellite systems, Meteosat Third Generation (MTG) and the EUMETSAT Polar System - Second Generation (EPS-SG).

*12-hour CAMS forecast of dust (orange), sea salt (blue), biomass burning (red) and sulphate aerosols (yellow), 12:00 UTC, 18 January 2017*



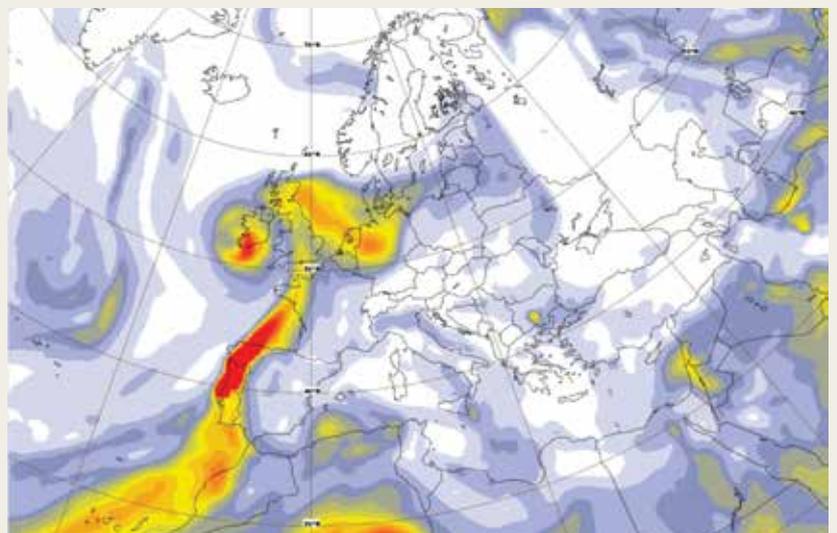
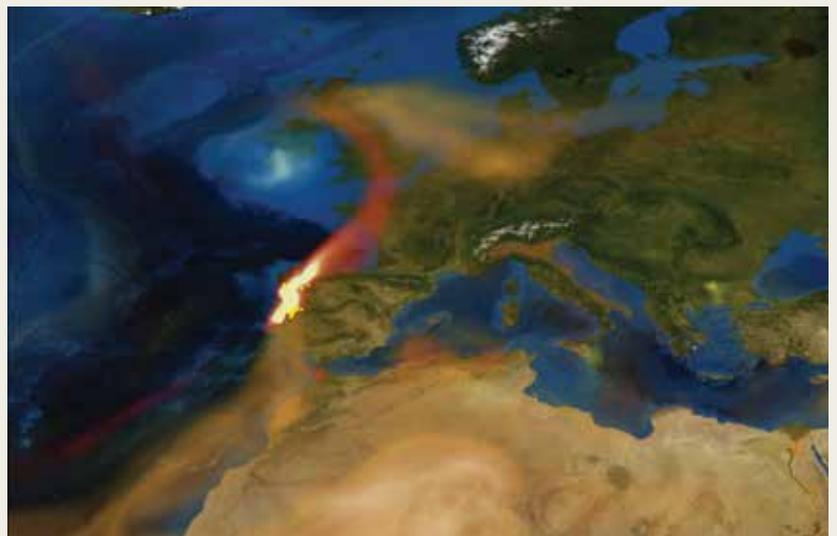


The missions will be based on additional instruments flown on the MTG-S and Metop-SG A satellites, respectively.

On each spacecraft, there will be a unique synergy between the soundings performed in the UV, near and shortwave infrared by the Sentinel instrument and in the thermal infrared by a EUMETSAT hyperspectral instrument (IRS on MTG-S, developed by ESA and IASI-NG on Metop-SG developed by CNES). This will provide access to the broadest possible range of trace gases through their signature across the spectrum.

Here again, EUMETSAT will deliver an integrated data stream combining Copernicus and its own atmospheric composition products, for the benefit of all users in the EU and EUMETSAT Member States.

*Using EUMETSAT Fire Radiative Power product, the Copernicus CAMS predicted the transport of large smoke plumes generated by fires as far as the Netherlands (top), and CAMS forecasts of aerosol optical depth (AOD) show enhanced AOD extending from the Iberian peninsula to the British Isles due to strong southerly winds (bottom), 16 October 2017*



# SUPPORTING COPERNICUS MARINE, ATMOSPHERE AND CLIMATE SERVICES



**Jean-Noël Thépaut**  
Head of Copernicus Climate Change Service,  
ECMWF

*"The service combines observations of the climate system with the latest science to deliver authoritative, quality-assured information about past, current and future states of the climate in Europe and worldwide. EUMETSAT plays a key role in the generation of high quality Climate Data Records, a must in the value chain of the Copernicus Climate Change Service"*

## COPERNICUS CLIMATE CHANGE SERVICE (C3S)

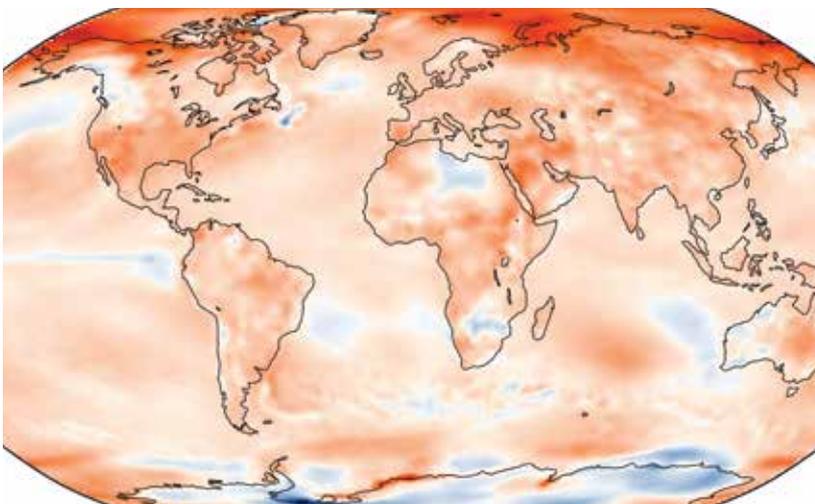
The Copernicus Climate Change Service (C3S) supports policy makers, businesses and scientists by providing authoritative, quality-assured information about the past, current and future climate. This knowledge base is needed to support adaptation and mitigation policies.

C3S in particular monitors and analyses more than 20 Essential Climate Variables (ECVs) to build a global picture of our climate, from the past to the future, as well as develops customisable climate indicators for relevant economic sectors, such as energy, water management, agriculture, insurance, health...

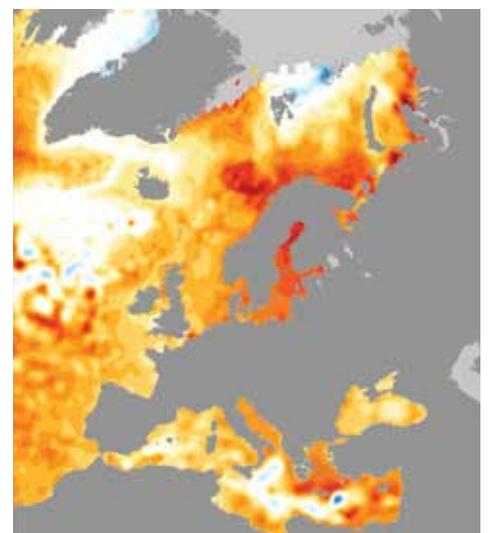
The relatively slow dynamics of climate change calls for observations that are accurate, well-calibrated and homogeneous, typically spanning decades.

EUMETSAT contributes to C3S through the re-calibration and cross calibration of long series of observations from meteorological satellites, which build the longest record of climate change from space. This is achieved through the reprocessing of physical and geophysical products based on the latest algorithms and, ultimately, through the delivery of homogeneous and well documented Climate Data Records for use in climate reanalyses. EUMETSAT also maintains an inventory of climate records of ECVs produced by space agency members of the Committee on Earth Observation Satellites (CEOS), and the Coordination Group on Meteorological Satellites (CGMS). EUMETSAT is also contributing with other European partners in dedicated research projects funded by the EU Horizon 2020 programme, to support the development of C3S. The EUMETSAT network of Satellite Application Facilities also delivers Climate Data Records for use in climate services, in particular via the C3S Climate Data Store.

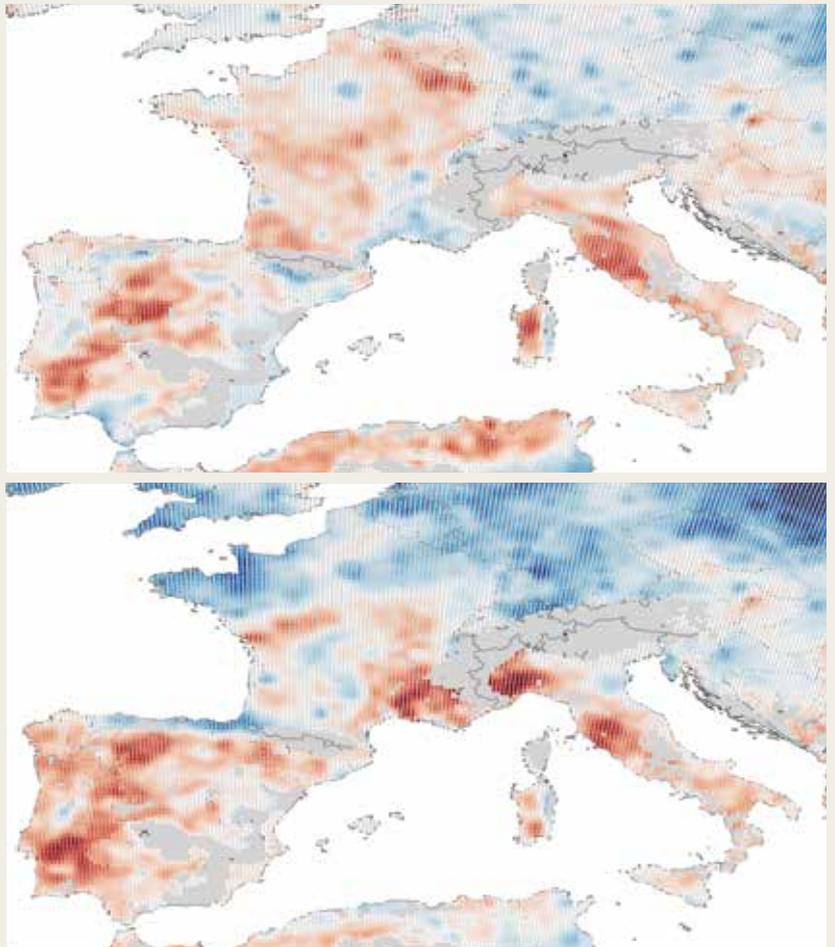
*Surface air temperature anomaly for 2017 relative to the annual average for the period 1981-2010.  
Data source: ERA-Interim*



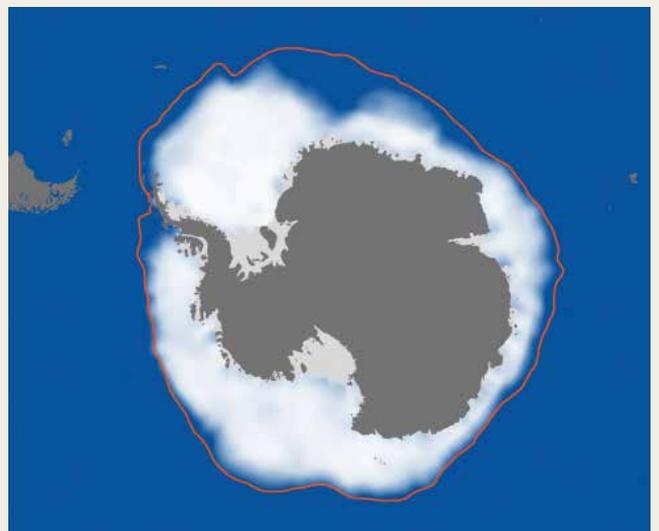
*Trends of mean sea level (mm/year) derived from altimeter observations during January 1993 to May 2017. The data has not been adjusted for glacial isostatic adjustment. Data source: CMEMS Ocean Monitoring Indicator based on the C3S sea level product.*



Right: Maps of soil moisture anomalies illustrate extremely dry conditions over southern Europe persisting from spring (top) into autumn (bottom) (source: H SAF)



Sea-ice cover for June 2018 over the Arctic (left) and Antarctic (right) regions. The pink lines denote the climatological ice edge for June for the period 1981-2010 (source: Copernicus Climate Change Service)



# SECURING DATA ACCESS FOR ALL USERS

EUMETSAT makes optimal use of its existing multi-mission infrastructure for the delivery of products from Copernicus missions operated by EUMETSAT

It includes the Earth observation portal and Product Navigator, the Data Centre holding all archives, and all systems established by EUMETSAT for real-time dissemination of environmental data to the worldwide user community.

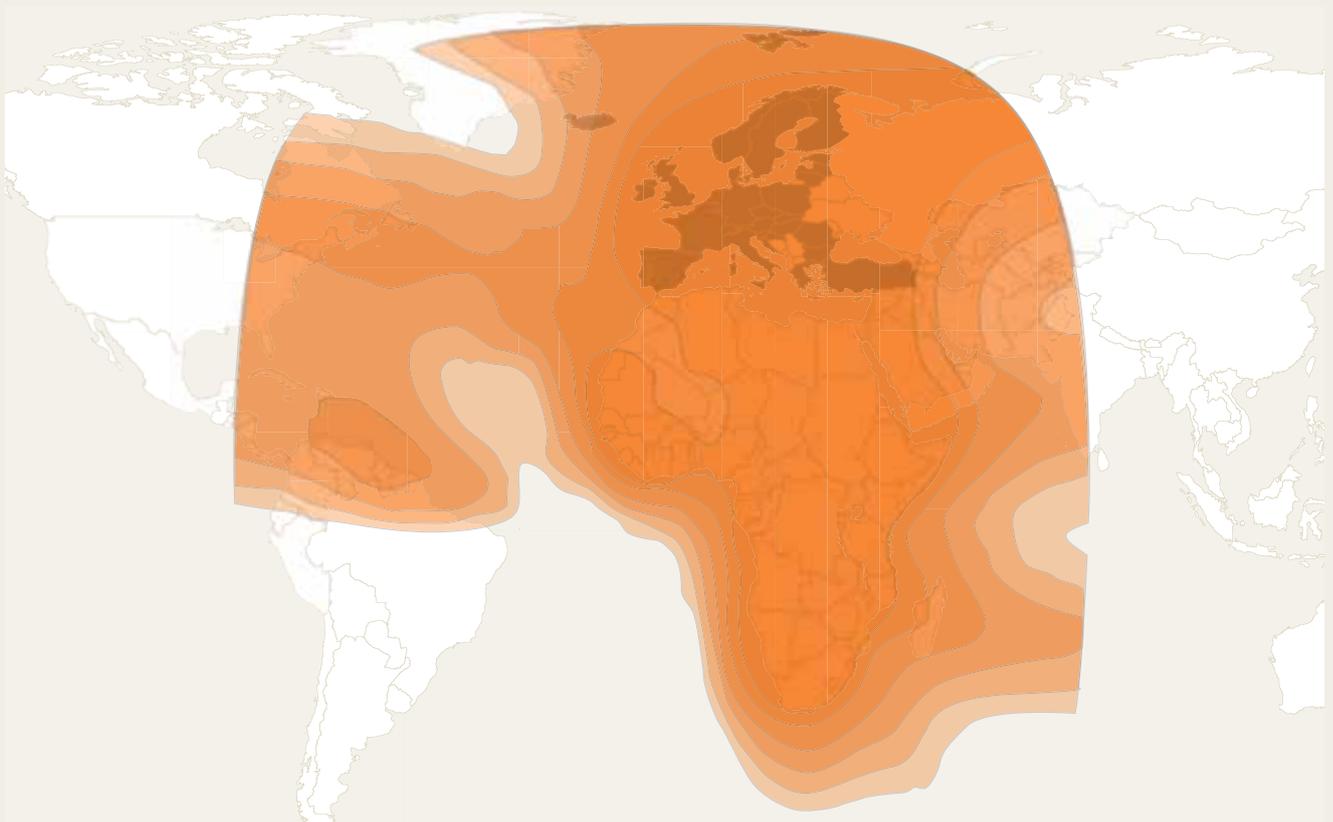
EUMETSAT delivers Copernicus data and products to all users in the EU, EUMETSAT Member States, and Africa. EUMETSAT relies primarily on its operational EUMETCast multicasting service (push system). This service is based on European commercial telecommunication satellites and uses Digital Video Broadcast (DVB-S2) technologies widely used for TV broadcasting.

EUMETCast delivers a wide range of meteorological and Copernicus satellite data to more than 4,000 users in Europe and Africa, with an average availability of 99.9%. At the request of the European Commission, near-real time dissemination of Sentinel-5P data and of Sentinel-3 land products to Africa has been implemented.

EUMETCast thus offers equal access opportunities to all Copernicus users in Europe and Africa for the development of a broader range of real-time applications and downstream services.

For Sentinel-3, EUMETSAT has also developed the Copernicus Online Data Access (CODA) interface, where users can pull the data from EUMETSAT.

*EUMETCast coverage over Europe and Africa*



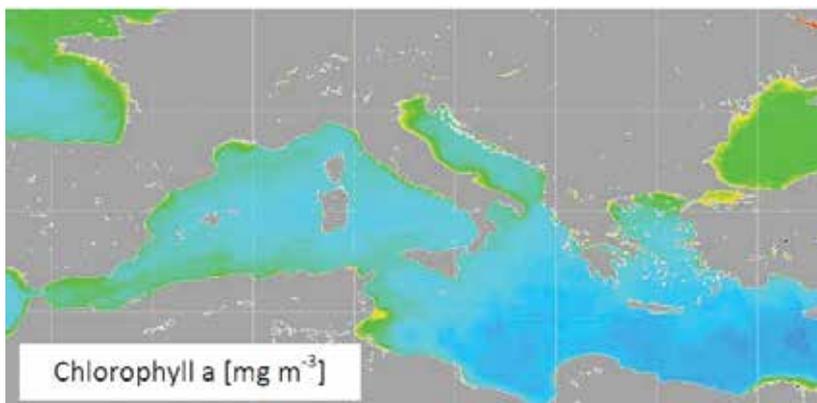
# DELIVERING THIRD PARTY MISSION DATA SERVICES TO COPERNICUS

The EUMETCast broadcasting system also redistributes to the Copernicus services and users relevant third party products acquired by EUMETSAT through the cooperation it has established with other satellite operators, in the United States, China, India and Japan

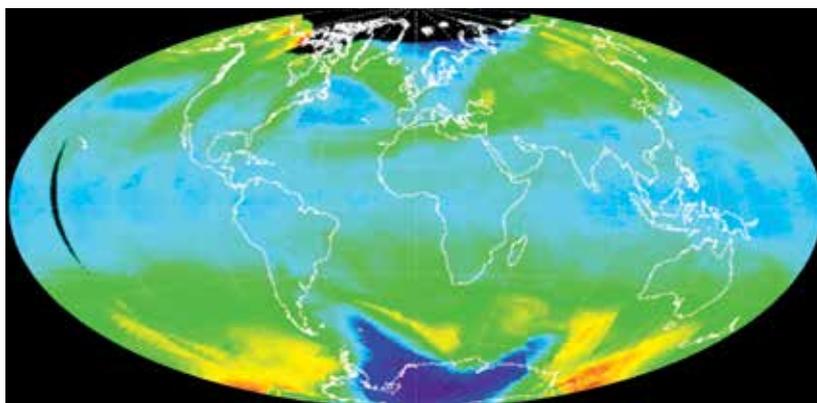
As in meteorology, this will fulfil requirements originating from the Copernicus information services as well as from users of observations acquired from different orbits than the Sentinel missions.

As part of its well-established cooperation with NOAA, EUMETSAT already delivers sea surface temperature and ocean colour products from the US Suomi NPP and NOAA-20 satellites. Together with Metop, Suomi NPP and NOAA-20 forms the Initial Joint Polar System shared by Europe and the United States. EUMETSAT also provides aerosol and ozone profiles from the same satellite.

At the request of the European Commission, EUMETSAT also provides access to data from its Indian and Chinese partners in support to Copernicus services.

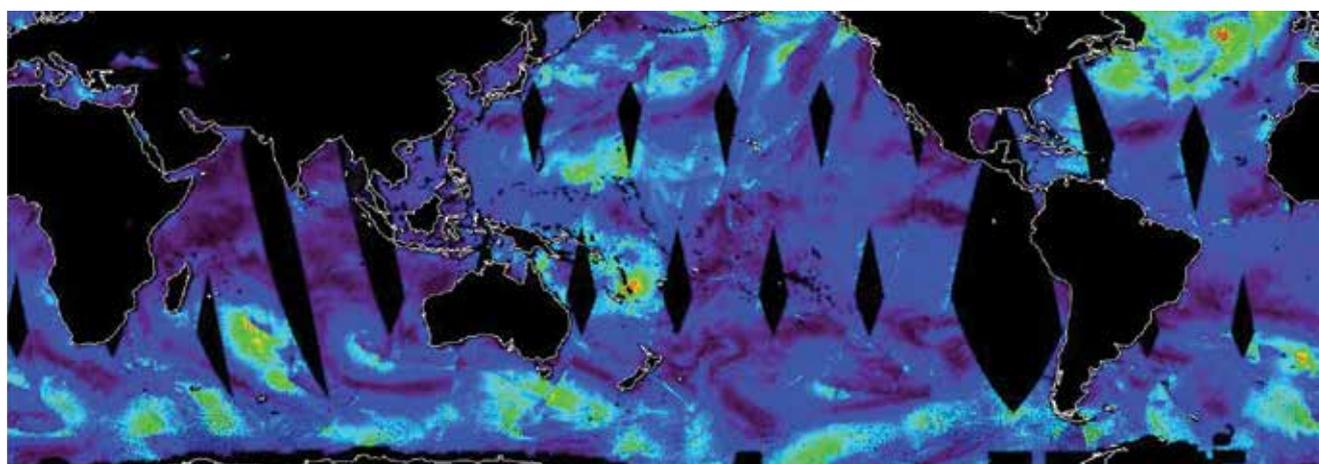


S-NPP VIIRS Ocean Colour products available on EUMETCast (source: NOAA)



Global coverage of total column ozone achieved by the OMPS instrument of NOAA's Suomi-NPP satellite

Ocean surface wind vector products available to EUMETSAT Member States since December from the Chinese State Ocean Administration's HY-2A satellite



# SUPPORTING THE EVOLUTION OF COPERNICUS

EUMETSAT, in cooperation with ESA, supports the European Commission in the planning of the future Copernicus space component

EUMETSAT has contributed with ESA to the discussions initiated by the European Commission on the evolution of the Copernicus programme in the period 2021 – 2027, in particular for its space component.

The extensive user consultation process undertaken by the European Commission in preparation for the future EU Multi-annual Financial Framework (MFF) has confirmed that the objectives of the current Copernicus programme remain valid. However, the process highlighted that new user requirements need to be addressed, including for the inventory of anthropogenic CO<sub>2</sub> emissions in support to the Paris Agreement and for the monitoring of the Arctic region.

In this period, EUMETSAT foresees to continue the operations of the missions it currently operates (Sentinel-3 Marine, -4, -5 and -6), including their potential new generations (Sentinel-3 and -6 NG).

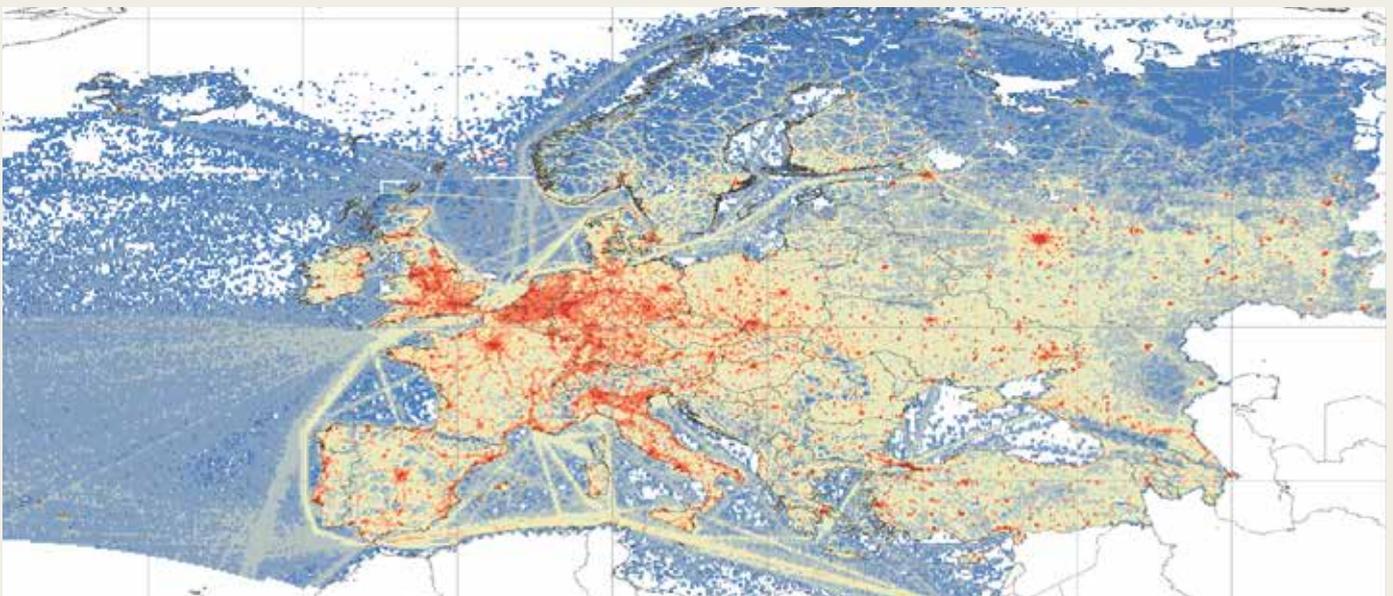
EUMETSAT also plans to be in charge of the deployment, operations and data services delivery of a possible CO<sub>2</sub> monitoring Sentinel mission, creating synergies with the atmospheric composition observations from EUMETSAT instruments and Sentinel-4 and -5 flown on EUMETSAT MTG and EPS-SG satellites.

A lower level contribution to possible Copernicus Imaging Microwave Radiometer (CMIR) and Polar Ice and Snow Topography (PIST) missions is also planned, focussed on the processing of their global ocean and atmospheric data for synergy with Sentinel-3/-6 and EPS-SG.

ESA and EUMETSAT have agreed on a cooperation scenario for these missions.

The implementation of these missions will however depend on the decisions on the evolution of the Copernicus programme to be taken by the EU Council and the European Parliament in 2020 timeframe, following the proposal made by the EC in June 2018.

*European total CO<sub>2</sub> emissions of the TNO-CAMS inventory of anthropogenic sources excluding the land use, land-use change and forestry sectors for 2014, gridded at a resolution of 0.125°x 0.0625° (source: Copernicus Operational Anthropogenic CO<sub>2</sub> Emissions Report 2017)*



# WEKEO - DISTRIBUTED COPERNICUS DATA AND INFORMATION ACCESS SERVICES (DIAS)

EUMETSAT has joined forces with ECMWF and Mercator Ocean International to deploy a Copernicus DIAS platform fulfilling the requirements of the European Commission

The European Commission (EC) has launched the development of Copernicus Data and Information Access Services (DIAS) to facilitate access to Copernicus data and information. By providing data and information access alongside processing resources, tools and other relevant data, the platform will boost user uptake, stimulate innovation and the creation of new business models based on Earth observation data and information.

In response to this initiative, EUMETSAT, together with Mercator Ocean International and ECMWF, the providers of the Copernicus Marine Environment Monitoring (CMEMS), Atmosphere Monitoring (CAMS) and Climate Change Services (C3S) have developed WEKEO, a distributed and federated DIAS platform building on the assets of the three entities.

WEKEO offers a single access point to all Copernicus data and information for download and also offers cloud-based hosted processing and tools allowing users to transform Copernicus data and information for their own specific business.

The deployment of WEKEO uses a stepwise approach minimizing the risks, capitalizing on user feedback. Industry is strongly involved in the development, deployment and operation of WEKEO through competitive procurements.



www.wekeo.eu



Implemented by





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**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



European  
Commission

