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ANNUAL REPORT

Back cover photo: Meteosat Third Generation (MTG) teams from EUMETSAT, the European Space Agency, the French Space Agency (CNES), Thales Alenia Space, Arianespace and OHB pose in front of MTG-I1 before it is loaded into the launcher at Kourou, French Guiana (Credit: ESA/CNES)

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Director-General's foreword

"The mid-December 2022 launch of the first imaging satellite in the Meteosat Third Generation system, MTG-I1, capped a pivotal year for EUMETSAT."

It was a year in which, despite significant external challenges, the organisation made concrete progress and continued to deliver on its mission.

EUMETSAT took control of MTG-11 on 28 December, after its 13 December launch from Kourou, French Guiana, on an Ariane 5 rocket. The launch and early operations phase (LEOP), led by Telespazio, brought the spacecraft to its correct orbit. The satellite's commissioning phase has begun and it is expected to become operational at the end of 2023. This is an achievement to which the whole organisation contributed and of which everyone can be proud.

The launch of MTG-I1 marks the start of the deployment of the organisation's next-generation systems, MTG and EUMETSAT Polar System – Second Generation (EPS-SG). These systems will be the catalysts for major advances in weather forecasting and climate monitoring in our member states and beyond. The launch and end of the LEOP also represents the start of the next phase of work, following almost two decades' worth of planning and development, in which the investment of expertise and resources that has gone in to our new systems will bring tangible benefits to communities across Europe and Africa.

While much of our attention and effort was geared toward the launch of MTG-I1 in 2022, work continued on preparations for launching MTG-S1, the first sounder, and Metop Second Generation A1 and B1, a consecutive pair of satellites carrying complementary instruments. The first pair of satellites, is expected to be launched in 2025-2026. With several satellite launches planned for 2025 and 2026, this will be an exciting and challenging time for the organisation. In addition to core programmes, EUMETSAT continues to work on the most efficient ways to provide innovative data and products to meteorological and climate services, through satellite programmes and ground segment developments.

Throughout 2022, EUMETSAT held many bilateral discussions with member states on preparation of our new programmes. As a result, in December, the EUMETSAT Council approved a €26.8 million allocation for the preparatory phase of the EPS-Aeolus and EPS-Sterna missions, which are primarily designed to measure winds and atmospheric temperature and humidity respectively. Formal EPS-Aeolus and EPS-Sterna programme proposals will be presented to member states in mid-2024. Our teams also continued to collaborate with the European Space Agency and the European Commission on development of the Copernicus CO2M carbonmonitoring programme, the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) mission and the Copernicus Imaging Microwave Radiometer (CIMR) mission in 2022.

In the meantime, expert and efficient satellite operations ensured a high level of data availability throughout 2022. The very reliable delivery of EUMETSAT services and data, 24 hours a day, every day, is central to what we do and of critical importance to our member states.

All of these developments occurred in the context of post-pandemic strictures, the negative economic impact of the war in Ukraine and constraints on the availability of European launchers around the time of the planned launches of the MTG-Sounder and Metop-SG satellites. Those impacts will continue to be felt in 2023 and adaptations will need to be made across all areas of EUMETSAT to meet those challenges.

The difficult inflationary climate and pressures on the construction industry caused delays to the start of work on the EUMETSAT childcare centre. However, the organisation was delighted construction could proceed in 2022 and that the centre will open in late 2023. Contracts were also signed for the construction of the extension to the East Building at EUMETSAT headquarters and work will commence in early 2023.

staff, the council agreed to a proposal to reform the financial control regime at EUMETSAT and to strengthen the internal audit function. This is a fundamental change to the organisation's processes and culture.

I thank the staff of EUMETSAT for rising to the challenges of 2022 and know the difficulties that lie ahead will be met with the same commitment and determination. I also thank the EUMETSAT Council for its guidance and support throughout the year. In particular, I thank former Council Chairman Gerard van der Steenhoven, whose term ended in 2022, for his outstanding contribution to EUMETSAT. I welcome Eoin Moran to the role and look forward to working with him in the years ahead.

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Phil Evans Director-General

Council Chairman's foreword

The central importance of EUMETSAT's work – and the need to continue to innovate and improve – was again brought home in 2022, another year of extreme weather events. The World Economic Forum's Global Risks Report 2022 reinforces this need. The report identified the top three most severe risks on a global scale over the next 10 years as climate action failure, extreme weather and biodiversity loss. The Gallagher Re Natural Catastrophes Report of 2022 identified 11 natural disasters that resulted in multi-billion US dollar insured losses. These catastrophes caused about 50,000 fatalities and total economic losses of US\$360 billion. All but one of the disasters were weather or climate related.

Communities experiencing the record heat, drought, fires and floods of 2022 required accurate forecasts and climate analyses from their meteorological and hydrological services. Data from EUMETSAT's satellites are essential for ensuring forecast accuracy.

Over the past year, EUMETSAT has continued to deliver new and better products and services to member states, and to examine how to make best use of new technologies and approaches for the future. The organisation continues to respond to changes affecting the meteorological community, including the growth of artificial intelligence and machine learning, the development of cloud technologies and the growth of "new space". EUMETSAT's approach remains to deliver on its first priority, that is, to fulfil the essential requirements of its member states for operational weather and Earth system monitoring in the most effective manner.

With Europe poised for a new era of satellite meteorology, through the deployment of EUMETSAT's next-generation satellite systems and additional missions, the council in 2022 approved plans for making the best scientific use of the data produced. Three new or updated roadmaps for marine and meteorological pathfinders, of wind products and of aerosol products were adopted. A roadmap for the use of artificial intelligence and machine learning to improve the use of satellite observations for weather prediction also was approved. These roadmaps are an investment in the science behind the translation of data from satellite instruments into tangible benefits felt by member states' communities. At the same time, EUMETSAT continues to innovate in the area of how data are provided to member states and other data users.

The EUMETSAT Council approved changes to the organisation's data policy to reflect the vastly increased amount of observations that will be available from its new satellite systems. EUMETSAT is committed to making its data as widely available as possible. The World Meteorological Organization Unified Data Policy is the reference for EUMETSAT's data policy. The aim is to continue to offer full and non-discriminatory access to as much of EUMETSAT's data as possible under documented licensing conditions, while protecting the value of EUMETSAT membership.

In addition, a new training framework was approved by the council, focusing on supporting weather forecasters in member states to transition to the use of data from the new satellite missions.

On a personal note, I was delighted to attend the launch of the first satellite in EUMETSAT's next generation systems – Meteosat Third Generation-Imager 1 – in Kourou, French Guiana on 13 December. This was a huge achievement for the organisation and represents an exciting milestone in a project that began almost two decades ago and now enters an important new phase.

I take this opportunity, on behalf of EUMETSAT's member states, to congratulate staff and management for delivering on the organisation's mission and making important progress on our strategic objectives in 2022.

Finally, I am honoured to have been elected Chairman of the EUMETSAT Council and to take up that post from September 2022. I pay tribute to my predecessor, Gerard van der Steenhoven, for his expert stewardship of the organisation over the previous four years and look forward to the opportunities that lie ahead.

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Eoin Moran Council Chairman

"EUMETSAT continues to innovate in the area of how data are provided to member states and other data users."

2022 highlights

First MTG Imager successfully launches

At 21:30 (CET), on 13 December, Meteosat Third Generation – Imager 1 was successfully launched from Kourou, French Guiana, on an Ariane 5 rocket. EUMETSAT took control of the satellite on 28 December, after a 15-day launch and early operations phase, led by Telespazio. The satellite will undergo a 12-month commissioning phase, before becoming operational at the end of 2023.

Data users prepare for next-generation systems

About 200 users of EUMETSAT data – meteorologists, climate experts and researchers – met in Darmstadt on 31 May – 2 June, to prepare for the use of data from MTG and EUMETSAT Polar System – Second Generation. The event was designed to encourage research into, and development of, innovative uses of the systems' data. The event was part of EUMETSAT's ongoing work with national meteorological and hydrological services to prepare to make best use of the data once available. The full report from the event is available here – www.eumetsat.int/media/50569



Meteosat-9 moves to Indian Ocean

After moving to longitude 45.5°E in April, Meteosat-9 became EUMETSAT's reference satellite for the Indian Ocean region on 1 June, taking over from Meteosat-8. EUMETSAT provides the service on a best-effort basis, as its contribution to an international initiative to provide meteorological satellite coverage from the geostationary orbit over the region. The service particularly benefits Indian Ocean island nations, eastern Africa, Central and Eastern Europe and Central Asia.

Meteosat-8 moves to the "graveyard orbit"

After 20 years of life-saving service, more than any other meteorological satellite in geostationary orbit, Meteosat-8 was moved to the "graveyard orbit" in October. The first of the second generation of Meteosat satellites, Meteosat-8 was designed to last 7.5 years. Although guidelines for satellite disposal did not exist when the spacecraft was built, EUMETSAT was committed to moving Meteosat-8, in line with space debris mitigation standards.

Altimetry becomes a mandatory EUMETSAT programme

In December, the EUMETSAT Council agreed to recategorise the organisation's satellite altimetry programme from "optional" to "mandatory", consolidating involvement in ocean monitoring. The decision emphasises the importance of operational oceanography and satellite altimetry to weather forecasting and climate monitoring for all member states. The move also adds surety to EUMETSAT's involvement in the European Union Copernicus programme's ocean-monitoring missions, Copernicus Sentinel-3 and Sentinel-6.

European Commission launches Destination Earth

The European Commission held a public online event on 30 March for the launch of the Destination Earth initiative. As one of the implementing entities, EUMETSAT took part in the launch, along with the European Centre for Medium-Range Weather Forecasts and the European Space Agency. EUMETSAT has responsibility for a key part of the initiative which will create digital twins of the entire Earth system. EUMETSAT will have endto-end responsibility for the multi-cloud data lake underpinning the initiative and for an online inventory.

2022 highlights

Member states invest in innovation

The EUMETSAT Council in December authorised a three-year, €26.8 million investment in the preparatory phase of new satellite systems designed to significantly improve weather forecasting accuracy. The funding will allow engineering activities to continue on the EUMETSAT Polar System (EPS) – Aeolus and EPS-Sterna missions, which would measure winds and atmospheric temperature and humidity respectively. The work will pave the way for the council's decision, by mid-2025, whether to proceed with the two programmes.

AI MOOC passes 10,000 registrations

In late 2021, EUMETSAT, the European Centre for Medium-Range Weather Forecasts, Mercator Ocean International and the European Environment Agency developed a massive open online course (MOOC) covering artificial intelligence and Earth monitoring. The course remains available online and, by the end of 2022, had attracted more than 10,700 registrations. The MOOC provides an introduction to the use of machine learning techniques with Copernicus data, through a mix of video content and new Jupyter notebooks.

Annual conference draws large turnout

About 460 people attended the annual EUMETSAT Meteorological Satellite Conference in Brussels, Belgium, on 19-23 September. The conference was held in person, after last year's online event and the cancellation of the 2020 edition due to pandemic restrictions. The theme of the 2022 conference was "a digital ecosystem for Earth observation". A wellattended press conference was held in conjunction with the conference to promote awareness of the upcoming launch of MTG-I1.

Africa forum focuses on transition to MTG

Preparing Africa's meteorologists and scientists for use of data from MTG was a feature of the 15th EUMETSAT User Forum in Africa, held in Dar es Salaam, Tanzania, on 13-16 September. About 150 meteorologists and scientists from 50 African nations attended, to help ensure their communities get maximum benefit from the new capabilities of the MTG system.



The Coordination Group for Meteorological Satellites, consisting of satellite agencies from around the world, marked its 50th anniversary at a meeting at the World Meteorological Organization's headquarters in Switzerland on 17 June. The event showcased the benefits of coordinated space-based observations and looked at future challenges, including threats of disruption to services from "space weather" and growing pressure on radio frequencies.

Agreement strengthens commitment to Africa

The African Union Commission and EUMETSAT signed an agreement in May to formalise cooperation under the Intra-ACP Climate Services and Related Applications (ClimSA) programme. The agreement aims to significantly boost African nations' capacity to mitigate the impacts of climate change by sharing the benefits of Europe's nextgeneration meteorological satellites. It commits EUMETSAT to providing data, technical support and training in Africa.

EUMETSAT publishes climate action statement

At the Global Climate Observing System's Climate Observation Conference in Darmstadt, Germany, in October, EUMETSAT published its first statement on climate action. The statement commits EUMETSAT to contributing to the maintenance of essential climate variables records, implementation of the Paris agreement, provision of climate change information to the United Nations and provision of continuous, long-term climate data records.

Election of new EUMETSAT Council Chairman

Eoin Moran, Director of Ireland's national meteorological service, Met Éireann, was elected EUMETSAT Chairman for a twoyear term at the council's 101st meeting in Amsterdam on 30 June – 1 July. At the same meeting, Marianne Thyrring, Director-General of the Danish Meteorological Institute, was elected vice-chair, also for a two-year term. Moran formally took over the position in September from Gerard van der Steenhoven, of the Royal Netherlands Meteorological Institute, who held the post for four years.

Working groups tackle staff survey issues

Three corporate working groups, with representatives of staff, the management board and the Staff Association Committee, were established in March to tackle organisation-wide issues identified by the 2021 staff survey. The groups presented recommendations to the management board in October on workload, diversity and inclusion, people development and bureaucracy. Work is progressing on refining the groups' proposals.

Work begins on childcare centre

Work began on EUMETSAT's 44-place "LittleOrbiters" childcare centre in 2022 and was celebrated with a special cornerstone-laying ceremony on 4 October. The cornerstone was laid by Director-General Phil Evans, Referatsleiter DK22 for the Federal Ministry for Digital and Transport Prof Dr-Ing Hans Moser, and Stadtrat of the City of Darmstadt Wolfram von Rotberg. The centre is expected to open in late 2023.

Responding to disasters

EUMETSAT is one of 17 agencies from around the world that have committed to the International Charter on Space and Major Disasters.

Meteosat-8 IR10.8 image of Cyclone Batsirai over Madagascar, 5 February 2022. Cloud top temperatures are coloured, from -36°C (blue) to -80°C (dark red). The charter is a system for providing satellite data quickly and reliably to authorised users, for example, aid agencies, to respond to natural and human-induced disasters. The data is made available free of charge and the aim is to help mitigate impacts on lives and property by providing information that is not available to disaster management agencies on the ground.

EUMETSAT responded to activations of the charter in 2022 related to tropical storms and associated disasters in Africa and Asia. EUMETSAT supports the secretariat and management activities of the charter. It also provides access to its satellite imagery via its EUMETView data service and redistributes products from other charter members, in particular, post-disaster maps, via the EUMETCast data dissemination system.

Leadership of the charter rotates between members every six months. EUMETSAT and the Canadian Space Agency will take on the role of co-chairs in October 2023.





EUMETSAT climate statement

On 19 October 2022, the final day of the Global Climate Observing System conference in Darmstadt, Germany, EUMETSAT issued a statement on its commitment to climate monitoring. The statement highlighted four key ways EUMETSAT works with global partners to monitor climate change and its impacts.



statement on how the organisation contributes to climate action on the EUMETSAT website.

The Earth is facing a threat.

The concentration of greenhouse gases in the atmosphere is rising, fuelled by increased emissions. This is causing a substantial rise in temperature across the globe.

Take the Arctic, currently warming more than two times faster than the global average. Or consider Greenland where, since 2000, temperatures in certain regions have surged to more than 8°C above the monthly average, according to the Copernicus Climate Change Service. And looking back still further reveals that, over the past 40 years, marine heatwaves in the eastern Mediterranean Sea have become considerably more frequent.

The steps we take today matter.

As Europe's operational satellite agency, EUMETSAT is committed to taking the necessary steps to address climate change and its consequences through cooperative action. In fact, this commitment is built into EUMETSAT's core. Both its founding convention and mission statement put forth the operational monitoring of the climate and the detection of global climatic changes as one of the agency's fundamental objectives. The climate data EUMETSAT collects and processes enable experts to better understand climate change and policymakers to mitigate further damage to the planet.

Looking ahead

The full exploitation of EUMETSAT's new satellite fleets will require dedicated research activities and the strengthening of collaborative efforts between member states and with international initiatives, such as the European Union's (EU) Horizon Europe programme and World Meteorological Organization activities. EUMETSAT aims to remain at the forefront of a changing environment, anticipating and capitalising on technological advances and developments in the space industry.

Potential future EUMETSAT missions

EUMETSAT continuously plans to meet the future needs of its member states to fulfil their obligations to their communities. At the same time, EUMETSAT aims to ensure it provides a tangible return on member states' investments and that those investments are affordable.

EUMETSAT is examining the expansion of its low-Earth-orbiting fleet with the addition of new, complementary satellite systems. In December 2022, the EUMETSAT Council authorised a €26.8 million investment over three years in the preparatory phase of new satellite systems designed to significantly improve weather forecasting accuracy.

The funding will allow the continuation of engineering activities aimed at establishing a preliminary design for these missions, which would eventually enable the expansion of the EUMETSAT Polar System (EPS) with two new missions: EPS-Aeolus and EPS-Sterna. The work will pave the way for the council's decision, by mid-2025, whether to proceed with the two programmes. The EPS-Sterna mission would enable the provision of atmospheric temperature and humidity profiles. The mission would significantly benefit medium and short-range weather forecasting globally, as well as enhancing very-short-range forecasting regionally at high latitudes.

The EPS-Sterna mission would be a constellation of small satellites, based on the Arctic Weather Satellite (AWS) developed by the European Space Agency (ESA) and which is planned to be launched in 2024. This mission is developed following the so called "new space" approach, which has the objective of developing space systems in a more flexible, standardised and industrialised way at relatively lower cost. The EPS-Sterna constellation will be developed by EUMETSAT in cooperation with ESA, capitalising on the AWS experience, and it will be the first small satellite constellation to be operated by EUMETSAT.

EPS-Sterna system activities progressed well in 2022. System feasibility studies have concluded and the requirement consolidation and preliminary architecture definition is ongoing with the System Requirement Review (SRR) to be completed by the end of 2023. A study on the scientific and socio-



Credit: Adobe Stock

economic benefits of EPS-Sterna has started and results are expected in the second half of 2023. In parallel, the AWS, the precursor of the EPS-Sterna constellation, completed its Preliminary Design Review in February 2022. AWS is expected to be launched in 2024, providing one year of demonstration before the EPS-Sterna programme approval decision in mid-2025. If approved, the launch of the EPS-Sterna constellation is planned for 2029 and the mission lifetime would be 13 years.

The EPS-Aeolus mission would be the successor to ESA's Aeolus Earth Explorer. EUMETSAT would operate the Aeolus-2 satellite, whose development was approved by ESA's ministerial council in November, and plans to procure a recurrent satellite to ensure more than 10 years of observations. A draft cooperation agreement with ESA includes a clear division of roles for the implementation of EPS-Aeolus. It was validated by the ESA and EUMETSAT councils and is planned to be signed in 2025, when the EUMETSAT Council considers the programme proposal.

EPS-Aeolus would allow wind vectors from the ground to 30km altitude to be determined by measuring the Doppler shift of signal backscattered by the pulses from an ultraviolet laser.

Looking ahead



Number of scientific publications released per year investigating the short-range forecasting of five key environmental variables with the use of artificial intelligence (AI) and/or machine learning (ML) techniques. Several key milestone events in Al/ML research and development are marked along the x-axis. Credit: Chris Chung (TU Delft/EUMETSAT)

Artificial intelligence and machine learning

As the graph above shows, there is a growing interest in artificial intelligence (AI) and machine learning (ML) methods applied to nowcasting and short-range forecasting. Recent scientific publications have demonstrated the readiness of ML methods to be used in operational weather prediction. EUMETSAT needs to be ready to support member states in this new area. After council approval for EUMETSAT's AI and ML roadmap in 2021, work began to facilitate the uptake of AI and ML techniques in 2022. Four pathfinder domains have been agreed. They are: a joint nowcasting effort, preparing for future extremes, an incubator of processors and exploring new requirements and applications. These pathfinder domains will be explored in the first phase of the roadmap (2023-2025) through project proposals from member states and contributions from EUMETSAT's satellite application facility network.

A call for proposals for two joint fellowships was issued in August 2022. Two projects will start in 2023-24.

Space weather

Space weather refers to conditions on the Sun and in the solar wind - a flow of ionised solar plasma (charged particles) released from the upper atmosphere of the Sun - and the outer edge of the Earth's atmosphere. Space weather can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human health.

EUMETSAT has instruments on its Metop fleet and on Copernicus Sentinel-6 measuring energetic particles and ionosphere properties through radio occultation. These measurements are used for operational purposes and they are shared with other satellite agencies through the Coordination Group for Meteorological Satellites.

In addition, EUMETSAT is exploring with member states an increased role in operational space weather activities as a provider of operational data in this challenging sector. Member states have strategic assets in space and see a need for information on space weather.

A workshop on space weather was held with member states in March 2022. As a follow-on, a survey was carried out to assess member states' interest and level of expertise in the field. The results were presented to the EUMETSAT Policy Advisory Committee in Autumn 2022.





The survey showed overall positive responses on the importance of data access and a potential role for EUMETSAT in operational space weather data and product provision. Additionally, the member states would further explore a potential role for EUMETSAT in operational space weather data and product provision. A final roadmap will be developed in 2023 in close cooperation with ESA to manage respective responsibilities.

Making best use of scientific data

With Europe poised for a new era of satellite meteorology, through the deployment of nextgeneration satellite systems and new missions, EUMETSAT has mapped out its plans for making the best scientific use of the data produced. In July, the EUMETSAT Council approved three new, or updated, roadmaps for scientific development of marine and meteorological pathfinders, of wind products and of aerosol products derived by satellite instruments.

Investing in the science behind the translation of data into tangible benefits for member states is critical. The scientific roadmaps for marine and meteorological pathfinders, and the wind and aerosol products, will foster the development of new advanced satellite data products using data from EUMETSAT's existing and up-coming satellite systems, as well as existing and new satellite missions that are part of the European Union's Copernicus programme. EUMETSAT has also been working with the EU Directorate-General for Research and Innovation in Brussels to ensure the full exploitation of Meteosat Third Generation (MTG) and Metop – Second Generation (Metop-SG) satellite data. A call was issued in December 2022 under the Horizon Europe Work Programme 2023-2024. This call would enhance the development of new environmental information based on MTG and Metop-SG observations.

Specifically, the research activities under this call are expected to contribute to:

- uptake of the newly available environmental information and data at global and regional scale from Copernicus Sentinels and the EUMETSAT next-generation fleet
- preparation and implementation of high-quality, novel, satellite data products and applications using the next-generation EUMETSAT and Copernicus instruments to improve the implementation and operationalisation of new and advanced services and applications
- demonstrated use of these applications for Earth system predictions, long-term climate monitoring and disaster risk prediction and reduction
- exploitation of European cloud systems and a contribution to the Destination Earth initiative
- demonstrated use of satellite-derived environmental information to advance and improve seamless climate, weather and environmental services in Europe, and potentially beyond.

Space weather can influence the performance of space-borne and ground-based technological systems and can endanger human health. Elements of this image were furnished by NASA. Credit: Adobe Stock

Case study



Meteosat Third Generation: cutting-edge weather data

As devastating storms, floods, and other extreme weather events become more frequent, it is essential to monitor the Earth's complex systems.

Thousands of researchers and data users attended the European Space Agency's Living Planet Symposium in Bonn, Germany, in May, to tackle that formidable challenge. One of the world's largest Earth observation conferences, the symposium provided experts with an opportunity to exchange ideas on how satellites can best be used to collect information about the planet – from monitoring wetlands, forests, and biodiversity, to tracking the health of the oceans and keeping tabs on diminishing Arctic sea ice, to measuring greenhouse gases in the atmosphere.

A highlight of the event was presentations about EUMETSAT's Meteosat Third Generation (MTG) system. MTG-Imager 1, the first satellite in the system, was launched on 13 December.

"We are really excited about the new MTG satellites," Dr Tony McNally, Head of Earth System Assimilation at the European Centre for Medium-Range Weather Forecasts (ECMWF), said.

"The observations that we'll receive from these satellites will be critical for many applications, including accurate forecasts of severe weather. The MTG satellite could capture the genesis or rapid intensification of a tropical cyclone in the Atlantic – that's literally a life or death situation for the people of the Caribbean."

Game changers

McNally is looking forward to a few instruments in particular that will further improve weather forecasts by providing even better pictures of fastevolving meteorological systems. These include the Flexible Combined Imager on MTG-I1 and the Infrared Sounder on the second satellite, the sounder, expected to launch in 2024.

"The Flexible Combined Imager will be a really big step up," McNally said. "We will get 16 channels, which enable us to tune in to different features of the atmosphere, similar to how different radio stations play different types of music. More channels mean more information, and from each individual channel we will get better spatial detail. Importantly, we'll also receive more rapid updates.

"Then, the Infrared Sounder on the following MTG satellite is going to be an absolutely gamechanging instrument. With more than a thousand channels, as is the case with this instrument, we can build up a three-dimensional, timeevolving picture of the atmospheric state with unprecedented vertical detail."

McNally is also eagerly anticipating the data that will come from a brand new instrument on MTG imaging satellites, the Lightning Imager. The four cameras on board will collect continuous, near-real-time data about intracloud, cloud-to-cloud, and cloud-toground lightning flashes. This information can be used to identify highly unstable and dynamic regions of the atmosphere – again critical for accurate weather forecasts.





ECMWF Atos high-performance computing facility, Bologna, Italy (credit: S. Marzoli/ECMWF)

Unique collaboration

Although crucial, the instruments alone are only one piece of the puzzle. Another essential piece is how useful the data they generate are for the people who work with them.

"In order to make the best of a satellite, you have to invest in infrastructure and collaborate with users and I think EUMETSAT does that really well," McNally said.

"The close relationship between EUMETSAT and the ECMWF is really quite unique and highly productive – it ensures that these new satellite systems actually benefit the people who pay for them."



For more information, read the case study on the EUMETSAT website

www.eumetsat.int/features/meteosat-thirdgeneration-cutting-edge-weather-data "The close relationship between EUMETSAT and the ECMWF is really quite unique and highly productive – it ensures that these new satellite systems actually benefit the people who pay for them."

Dr Tony McNally Head of Earth System Assimilation European Centre for Medium-Range Weather Forecasts (ECMWF)



Satellite operations

The uninterrupted provision of data from EUMETSAT's satellites, 24 hours a day, every day, is essential for member states' meteorological and hydrological services to provide timely, accurate weather forecasting. Central to this objective is the efficient and expert operation of the organisation's satellite fleets.

EUMETSAT was able to meet that objective with a very high level of data availability in 2022, a transformative year for the fleet.

Geostationary satellites 36,000km altitude

Three collision avoidance manoeuvres were carried out in 2022. Two involved Sentinel-3A, on 10 January and 16 March, and one involved Metop-C, on 22 November.

Meteosat

Throughout 2022, operations preparation activities continued to ensure important milestones were met before the launch of Meteosat Third Generation – Imager 1. The last system verification test was successfully conducted in July, and the operational scenario validation concluded in September ahead of the launch and operational readiness review. In October and November, training and rehearsals were conducted to ensure the team and systems at EUMETSAT were ready to operate the new satellite.

The satellite was successfully launched on an Ariane 5 launcher from Kourou on 13 December. The launch and early operations phase, performed by Telespazio, prepared the satellite for its handover to EUMETSAT, and was successfully completed on 28 December. The satellite is now undergoing commissioning.

Meteosat-9

45.5°E

Indian Ocean data coverage (IODC) Delivers the EUMETSAT best-effort contribution to the multi-partner IODC services.



Meteosat-8

Graveyard orbit

Decommissioned

Moved to graveyard orbit from 41.5°E in October 2022 and decommissioned.

Meteosat-10

9.5°E

Rapid Scan Service (RSS) Delivers the Meteosat secondary RSS service over Europe and adjacent seas.

Meteosat-11

0° longitude

Full Earth Scan imagery

Provides the Meteosat primary full-disc imagery service over the European continent, Africa and parts of the Atlantic and Indian oceans.

MTG-I1

3.4°W

Commissioning phase MTG-I1 was successfully launched on 13 December 2022.

The Meteosat lifetime review, held in November, assessed the performance of the Meteosat Second Generation satellites and preparations for the launch of the first third-generation satellite.

After more than 20 years in orbit, having supported the Full Earth Scan and Rapid Scan Services over Europe, and providing Indian Ocean data coverage (IODC) at 41.5°E for its last six years, Meteosat-8 was successfully re-orbited and decommissioned in October 2022. In its final phases of operation, from April to June 2022, Meteosat-8 supported a smooth transition of IODC services to Meteosat-9. A technology test campaign was then performed to obtain valuable information on satellite and instrument operations prior to decommissioning. Having ended its role as the Rapid Scan Service backup satellite at 3.5°E, Meteosat-9 was moved to 45.5°E between February and April 2022. It then completed a two-month period of parallel operations with Meteosat-8 before taking over responsibility for IODC operational services in June.

Meteosat-10 and -11 continued operating reliably to provide the Rapid Scan Service and Full Earth Scan service, respectively, with excellent image quality performance and availability. In 2022, the two satellites achieved an overall availability of more than 99.7% for Meteosat-11 and 99.9% for Meteosat-10, surpassing service requirements and operational targets.

Satellite operations

Metop-B

SSO 98.7° inclination

EPS primary mission Delivers the primary operational EPS services from 817km altitude.

Metop-C

SSO 98.7° inclination

EPS secondary mission Delivers additional EPS services from 817km altitude.



Metop

Following the successful decommissioning of Metop-A at the end of 2021, the focus of the Metop Mission Lifetime Review, held in June, shifted to the remaining Metop satellites in orbit, Metop-B and -C.

Metop-B remains the prime satellite and this is likely to continue, despite predictions its orbit drift will bring it to exceed specification limits by the end of 2023. Metop-B performed well in 2022, with most of the remaining fuel being reserved to lower its orbit when it reaches the end of its operational life. In August 2022, rocking commands successfully spun the filter wheel on the High Resolution Infrared Radiation Sounder, which had been stalled for two years. At the end of 2022, the instrument was once again producing useful data.

Metop-C's mission performance remained good throughout 2022, although there is some continuing degradation in the Microwave Sounder's performance. The platform's performance is of greater interest, for both the attitude and orbital control system and the power subsystems. One of the satellite's gyroscopes was marked faulty at the end of the 2022, leaving one spare gyroscope. On the power sub-system, one of the satellite's five batteries has exhibited symptoms of cell leakage. Some heater power-saving options were implemented as a mitigation of any impact from disconnecting the battery, anticipated to be necessary before the end of 2023.

Copernicus Sentinels

The Sentinel-3A and -3B satellites continued to perform smoothly in orbit throughout 2022 with satellite and instrument availability generally above target. Both delivered mission data in line with performance requirements and completed a longterm lunar calibration campaign for the Ocean and Land Colour Instruments' cameras. The average yearly availability to data users of Sentinel-3 marine and near-real-time atmospheric products exceeded targets.

Jason-3

NSO 66° inclination

Interleaved orbit

Providings measurements of ocean surface topography and sea state from a non-synchronous, 10-day repeat orbit at 1,336km altitude (mission shared with CNES, NOAA, NASA and the European Commission).

Copernicus Sentinel-3A

SSO 98.7° inclination

Copernicus Sentinel-3 mission Delivers Copernicus marine and nearreal-time atmospheric data services from 814km altitude.

Copernicus Sentinel-3B

SSO 98.7° inclination

Copernicus Sentinel-3 mission Delivers Copernicus marine and nearreal-time atmospheric data services from 814km altitude. Copernicus Sentinel-6 Michael Freilich

NSO 66° inclination

Reference altimetry mission Delivers measurements of ocean surface topography and sea state from a non-synchronous, 10-day repeat orbit at 1,336km altitude (mission partners are EUMETSAT, the European Commission, ESA, NASA/JPL and NOAA, with support from CNES).

The next Sentinel-3 lifetime review, in January 2023, is expected to confirm both satellites have sufficient fuel to continue operating into the 2030s and do not currently have any lifetime-limiting issues. Satellite reliability calculations indicate any consideration of a deorbiting decision would not be necessary until 2032, when the 90% probability of a successful re-orbiting would be reached for both satellites.

Sentinel-6 Michael Freilich entered routine operations at the end of 2021 and mission performance in 2022 was good. The satellite flew in close tandem formation with Jason-3 for several months to complete crosscalibration of the Poseidon-4 instrument. In April, Sentinel-6 Michael Freilich became the reference mission for ocean altimetry and Jason-3 moved to adopt an interleaved orbit.

Steps were taken in 2022 to improve the availability of Sentinel-6 mission data, including modifications to the software for the onboard mass memory unit, in conjunction with updates to the Swedish Space Corporation Kiruna ground station service and the ground data processing systems at EUMETSAT. The first annual Sentinel-6 mission performance review, in November 2022, concluded that the Sentinel-6 system – comprising the satellite and ground systems – is meeting or exceeding performance targets. The satellite is expected to continue to deliver data within specification for its nominal lifetime until the transition to Sentinel-6B, which is planned for launch in 2025.

Jason-3

After Sentinel-6 Michael Freilich became the reference ocean altimetry mission on 7 April, Jason-3 began a series of manoeuvres to move it to an interleaved orbit. Jason-3 began its new mission on 25 April 2022.

The overall satellite status is nominal. The annual Jason-3 operations review identified nothing to prevent the mission from achieving a similar lifetime to that of Jason-1 or Jason-2, which completed more than 11 years of operations.

Case study

The eyes on a storm

On 24 December 1963, Météo-France's Satellite Meteorology Research Centre received a Christmas present forecasters had been dreaming of: the first weather satellite image ever processed by a European centre.



Fast-forward nearly six decades and meteorologists are eagerly awaiting the next big moment in European weather forecasting history, the first image from Meteosat Third Generation's inaugural imaging satellite, which was launched on 13 December 2022.

New ways of forecasting extreme events

"It's been a long time in the making, and it will be really exciting to see the first images beamed back to Earth," Sylvain Le Moal, Head of Satellite Applications, Imagery, and Innovation at Météo-France's Satellite Meteorology Centre (CMS), said.

"Meteosat Third Generation satellites will provide invaluable observations for users such as meteorologists, national weather centres, scientific researchers, and the media. Services and products making use of the data will provide new ways of tracking lightning and more effective means of pinpointing fire hotspots. It will also help scientists build long-term records that can guide responses to the global climate crisis."

Applications that will benefit in particular include nowcasting – very short-range forecasting that can project how fast developing and highly dangerous weather events such as storms will evolve in the coming minutes and hours. The satellite constellation will also provide a major boost to numerical weather prediction, helping to extend the accuracy of weather forecasts into the future.

"The first priority for numerical weather prediction models is to know what the state of the atmosphere is right now," Le Moal said.

"Meteosat Third Generation's sounder satellite, for instance, will provide regular measurements – up to every 30 minutes – on aspects such as humidity and temperature from the ground to the top of the atmosphere.

"These data will be invaluable for weather forecasting tools such as France's small-scale numerical prediction model, AROME. The AROME model has been designed to improve forecasts of severe events such as violent and localised storms, fog, and extreme urban heat. Meteosat Third Generation will greatly improve the data we feed into the model."



Météo-France's Satellite Meteorology Centre (CMS) (credit: Météo-France)

Preparing for the future

Preparing for Meteosat Third Generation began some 20 years ago.

"When I arrived at CMS two decades ago, Meteosat Second Generation's first satellite had just become operational, but planning for the third-generation satellites had already begun in earnest," Le Moal said.

"Since then, member states have taken part in a wide range of initiatives and workshops that have allowed us to account for the needs of end users. Meteorologists, forecasters, researchers, and other professionals who will benefit from these satellite data have been informing the design and development of Meteosat Third Generation every step of the way."

Meteosat Third Generation satellites will carry next-generation instrumentation, as well as new instruments, such as the Lightning Imager.

"To make sure we're ready, we've needed to enhance our telecommunications lines, build antennas, and process algorithms to account for new information types such as lightning data," Le Moal said. "Meteosat Third Generation satellites will provide invaluable observations for users such as meteorologists, national weather centres, scientific researchers, and the media."

Sylvain Le Moal Head of Satellite Applications, Imagery, and Innovation Météo-France

"We've also been developing specialised training courses so that end users are ready to hit the ground running as soon as Meteosat Third Generation goes live. All of this has been done in collaboration with EUMETSAT and its member states – it's a truly international endeavour."



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For more information, read the case study on the EUMETSAT website

www.eumetsat.int/features/eyes-storm

Services to data users

EUMETSAT makes considerable effort to ensure its data are provided to those who require it in a way that meets their needs, that is, quickly, reliably and efficiently. The aim is to ensure member states and other data users reap maximum benefit from EUMETSAT's satellite fleets.

Significant achievements in enhancing data access were realised in 2022.

EUMETSAT's online data access services

After becoming operational in 2021, the new online access services that enable people to search and download EUMETSAT data (EUMETSAT Data Store), customise the data (EUMETSAT Data Tailor) and view data (EUMETView), have gained in popularity. These services have gone through several releases, providing improved operational stability and implementing enhanced features based on user feedback.

One key enhancement was the introduction of the EUMETSAT data access application programming interface client (EUMDAC), which provides easy programmatic interfaces to the Data Store and the Data Tailor. EUMDAC simplifies the way data users can discover, search, download, and customise data contained in the Data Store. Instead of writing lengthy code to download a particular product type for a specific time range, the data user can do this with one, or a few, simple commands. Respondents to a 2022 survey of the online data access services rated the client "very helpful".

New releases of the Data Store included the addition of Copernicus Sentinel-3 data and other content enhancements. A fair use policy was introduced to ensure fair usage of the Data Store bandwidth and to protect the service in cases of unusual high-traffic peaks.

On EUMETView, the need for a user login to visualise all available layers was removed and a new "view description" feature was added to allow people to add their own text to a map. An "auto-update" feature now allows for the most recent images to be displayed and animated continuously. A selection of new layers was introduced, including new precipitation estimate products from EUMETSAT's Support to Operational Hydrology and Water Management Satellite Application Facility.

Access to the Data Store more than doubled in 2022 to an average of 600 unique users per month in the last quarter. For EUMETView, the number of unique IP addresses – linked to one or more users visualising imagery – rose to 3,000 per day on a regular basis.



WEkEO

The European Union's (EU) Copernicus programme aims to provide integrated access to its data and information. To achieve this, EUMETSAT, together with the European Centre for Medium-Range Weather Forecasts (ECMWF), the European Environment Agency and Mercator Ocean International, the entities entrusted with implementing the Copernicus Atmosphere, Climate, Land, and Marine Monitoring Services, have established the WEkEO Data and Information Access Service. WEkEO provides easy and transparent access to data from the Copernicus Sentinel satellites operated by EUMETSAT and the European Space Agency (ESA), and data from the Copernicus services, and offers hosted processing capabilities close to the data sources.

In 2022, EUMETSAT transitioned from its Copernicus Online Data Access tool to its new Data Store service. On 29 September, WEkEO access to EUMETSATprovided Copernicus data was successfully moved to the Data Store. This also allowed for the easy addition of reprocessed Sentinel-6 data to WEkEO.

A use cases section and a Jupyter catalogue have been added to the WEkEO portal, providing a user-friendly overview and access to example applications. All Jupyter notebooks are available to WEkEO data users for self-learning.

European Weather Cloud

The European Weather Cloud (EWC) is a joint initiative of EUMETSAT and the ECMWF. The EWC is set to become the cloud-based collaboration platform for the development of meteorological applications and operations in Europe and, as such, is supporting the digital transformation of Europe's meteorological infrastructure. The platform is dedicated to supporting the national meteorological and hydrological services in EUMETSAT's and the ECMWF's member states to fulfil their official duty to protect life and property from impending meteorological hazards. The EWC made strong progress in 2022 and agreement was reached with EUMETSAT's and the ECMWF's councils to commence the operational phase of the initiative after a joint readiness check in 2023.

In December 2022, the EUMETSAT Council approved a medium-term resource plan for the EWC for 2023-2026, including a features development roadmap. At the end of August 2022, EUMETSAT launched its first research and development call for the EWC. After evaluation of the submissions and approval by EUMETSAT's Science and Technology Group, the selected projects will begin in 2023. Credit: Met Office



Commercial radio occultation data

In 2021, EUMETSAT began a three-year pilot programme to purchase radio occultation data, process it and disseminate it for use in weather forecast modelling. A contract was signed with Spire Global Luxembourg Sarl. EUMETSAT already receives radio occultation data from its own fleet of low-Earth-orbiting Metop satellites but research showed that the use of more radio occultation data increased the accuracy of weather forecasting models. Member states reported that the additional data received had been useful and beneficial.

In December 2022, the EUMETSAT Council agreed to a proposal to develop a plan for a commercial data service, should it decide at the end of the pilot programme in 2024 to continue buying data. The council specified that planning for a recurrent commercial data service must be undertaken on the basis that the data are acquired with a global license, meaning they can be shared globally, in near-real time, in line with the trial programme.

The US National Oceanic and Atmospheric Administration has recently adopted a similar approach to EUMETSAT's when buying commercial radio occultation data. The two agencies share the data, making even more available for weather forecasting models.

Training

Last year, EUMETSAT delivered training to more than 2,750 participants at more than 80 events. At least half of the participants were from EUMETSAT member states.

The training covered marine, atmosphere, land, climate and severe weather applications of satellite data. The biggest innovation in EUMETSAT training was the use of Jupyter notebooks, so that participants could work with data from a range of sources in an integrated manner. The advantage of this approach is that participants could return to their workplace with working processing chains. This is particularly beneficial for fire, dust and marine training courses.

The Nordic Meteorological Competency Training (NOMEK) course brings together forecasters from Denmark, Finland, Iceland, Norway and Sweden to learn about better forecasting of severe weather and represents great cooperation between EUMETSAT and its member states. The 2022 NOMEK course was held in Oslo, Norway in April.







EUMETSAT Data Lake and Data Store facts and figures

Data policy

EUMETSAT is committed to making as much of its data available, as widely as possible, while protecting the value of EUMETSAT membership. The aim is to ensure the data disseminated can help to protect communities and boost economies. EUMETSAT uses the World Meteorological Organization's (WMO) Unified Data Policy as the reference for its own policy, which offers full and non-discriminatory access to as much EUMETSAT data as possible under documented licensing conditions.

In December 2022, the EUMETSAT Council approved changes to the data policy, to reflect the vastly increased amount of data that will be available from EUMETSAT's new satellite systems. All EUMETSAT "essential" and "non-essential" data and products, including from MTG and EPS-SG instruments, will be offered as the organisation's contribution to the WMO as "core data" and "recommended data", respectively. A proposal outlining the detailed implementation of the data policy will be submitted to the council in 2023 for approval.

Destination Earth

The EU's Destination Earth initiative (DestinE) will create digital twins of the planet, modelling the entire Earth system. EUMETSAT has responsibility for the multi-cloud data lake underpinning DestinE, including its design, establishment and testing, as well as its operations, and the provision of an online inventory. The ECMWF and ESA are the other two agencies selected by the European Commission for the first phase of DestinE. ESA is responsible for DestinE's core service platform and the ECMWF for the digital twins driving the weather and climate modelling.

A workshop attended by more than 140 participants was held at EUMETSAT headquarters in November 2022, as the first step in the organisation's contribution to joint activities in partnership. The workshop aimed to:

- foster understanding of Destination Earth and particularly the DestinE data lake services
- collect and explore a list of potential use cases
- collect and explore a list of potential partnerships.

In February 2022, EUMETSAT organised an event to brief industry about Destination Earth and, in particular, about the DestinE data lake and related upcoming procurements.

After an invitation to tender and evaluation process, EUMETSAT awarded a contract to a consortium of CloudFerro Sp Z.o.o. from Poland, CS Group – France and EODC Austria for the data lake service.

Services to data users

EUMETSAT satellite application facilities

EUMETSAT's satellite application facilities (SAFs) transitioned to a new five-year continuous development and operations phase (CDOP) in 2022. The new phase, CDOP4, covering 2022-2027, contains a commitment to the development and operations of hundreds of new and improved products based on satellite data and the continuation of existing data and software services. A particular emphasis of CDOP4 is the release of operational products based on EUMETSAT's next-generation systems, Meteosat Third Generation (MTG) and EUMETSAT Polar System – Second Generation (EPS-SG). All eight SAFs kicked off their CDOP4 phase between March and July 2022.

The SAF network marked its 25th anniversary in 2022. The first SAF, the Nowcasting and Very Short Range Forecasting SAF, came into being at the Spanish National Weather Service, Madrid, on 14 February 1997.

The Operational Hydrology and Water Management SAF released a multisensor precipitation rate (H68) product which provides better temporal and spatial coverage through a combination of several microwave missions (credit: H SAF) The SAF network's products featured in international climate reports again in 2022. The *European State of Climate 2021* report, by the Copernicus Climate Change Service, included data records from the Climate Monitoring (CM) and Ocean and Sea Ice SAFs and the World Meteorological Organization's *State of Climate Services – Energy* report included CM SAF data records.

Data users were provided with a large number of new and enhanced SAF products in 2022. They included releases of long-term data records and extensions, near-real-time products, products with lower latency and software packages, including packages able to process MTG and EPS-SG data.

The full list of new SAF products for 2022 can be found on page 70.

The Ocean and Sea Ice SAF's data records on sea ice concentration were improved and extended and the first on sea ice drift was released (credit: OSI SAF)





100 200 300 400 500 600 700 800 900



1 June 2010, 12:00 UTC AAS-3: r, years vations





The Climate Monitoring SAF released the CLAAS-3: climate relevant cloud properties (cloud cover, height, liquid water content) product from 18 years of Meteosat Second Generation SEVIRI observations (credit: CM SAF)

Radio Occultation Meteorology (ROM SAF) led by the Meteorologiske Institut, Denmark

EUMETSAT NWP SAF

Numerical Weather Prediction (NWP SAF) led by the Met Office, United Kingdom

Ocean and Sea Ice (OSI SAF) led by Météo-France, France

Nowcasting and Very Short-Range Forecasting (NWC SAF) led by Agencia Estatal de Meteorología, Spain



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Land Surface Analysis (LSA SAF) led by Instituto Portugues do Mar e da Atmosfera, Portugal



Atmospheric Composition Monitoring (AC SAF) led by the Ilmatieteen laitos, Finland



Climate Monitoring (CM SAF) led by Deutscher Wetterdienst, Germany

Operational Hydrology and Water Management (H SAF) led by Servizio Meteorologico Aeronautica Militare, Italy



Above: Composite of two night-time images from the Sea and Land Surface Temperature Radiometer sensors on board Sentinel-3A and -3B, captured an hour apart on 22 December 2021, over the Great Barrier Reef

Marine heatwave intensification threatens coral reef health

A dramatic increase in number and intensity of marine heatwave episodes has occurred over the past four decades.

Below: Sea surface temperature anomaly in the Mediterranean over the first 20 days of August 2022 as measured by the AVHRR instrument on board EUMETSAT's Metop-B satellite. These anomalies are calculated by subtracting the climatological mean of August over the period 1985-2007 from the mean over the first 20 days of August 2022. Credit: OSI SAF







Credit: Adobe Stock

These episodes of persistent, anomalously warm ocean temperatures pose a serious threat to the health of marine ecosystems around the globe. One particular ecosystem impacted by marine heatwaves is coral reefs. Heatwaves can cause coral bleaching, disease outbreaks, and algal blooms. In its 6th Assessment Report, the United Nations' Intergovernmental Panel on Climate Change (IPCC) found that ocean surface temperatures increased on average by almost 1°C globally since the start of the industrial era. Similarly, the frequency of marine heatwaves (high confidence) as well as their intensity and lifetime (medium confidence) have increased since the 1980s. The Sentinel-3 satellites, operated by EUMETSAT, are the Copernicus programme's contribution to monitoring of sea surface temperatures, with the Sea and Land Surface Temperature Radiometer (SLSTR) on Sentinel-3A and -3B. The SLSTR provides frequent, high-guality, and high-resolution sea surface temperature data, allowing for observations at event scale. Climate data records of satellite sea

Healthy coral Coral and algae live in symbiosis

Stressed coral Symbiosis is disturbed, algae leave the coral **Bleached** coral

Above: Schematic representation of coral bleaching occurring with increasing sea surface temperatures

surface temperatures can provide a good basis for verifying the IPCC's conclusions that global oceans have warmed strongly and marine heatwaves have increased significantly since the 1980s. Data on marine heatwaves can help characterise the stressors facing marine ecosystems and contribute to decision making to protect, manage and restore those affected.



For more information, read the case study on the EUMETSAT website

www.eumetsat.int/marine-heatwaveintensification-threatens-coral-reef-health

Climate services

The use of EUMETSAT data in climate services and science is expanding from year to year. EUMETSAT has enhanced its systematic approach to delivering high-quality climate data records utilising satellite observations that now span more than 40 years. New climate data records were created at EUMETSAT headquarters and by the satellite application facilities (SAF) network in 2022.



Illustration of the use of EUMETSAT data in the first part of the IPCC report (credit: : IPCC Climate Change 2021)

Determining the impact of EUMETSAT climate data

Early in 2022, EUMETSAT assessed the impact of its mission data and products on the first part of the United Nations' Intergovernmental Panel on Climate Change (IPCC) 2021 assessment and the Copernicus Climate Change Service's (C3S) report on the European State of Climate 2021. Both reports made heavy use of EUMETSAT data and products, including those of the SAFs. This use of EUMETSAT data will further increase for the next global European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis, called ERA6.

Strengthened engagement with climate data users

Recognising the need for more support to users of climate data, the EUMETSAT climate team established a user engagement team in 2022.

Serving member states with high-quality and easy-to-access climate products tailored to their applications requires close collaboration and regular communication. EUMETSAT's workshop, *Shaping the Future – EUMETSAT support to Climate Services*, in spring 2022, helped to enhance collaboration with climate data and service providers within member states and to assess their needs for climate products, data access, and data visualisation. The workshop significantly improved understanding of the needs for existing products and provided ideas for new products and joint activities. A salient outcome of the workshop was the recommendation



Brightness temperature [K] 155 181 207 233 258 284 310



FCDR MWI // SSMIS F18 // 22GHz // 2020-01-01, ascending orbits

to develop a "climate normals and climate anomalies" service for EUMETSAT's climate data records that will start in 2023.

A new agreement to support the Copernicus Climate Change Service (C3S) entered into force on 1 January 2022. The agreement covers and funds provision of satellite data used as inputs to ERA6 until the end of 2025.

Data record release and development in 2022

In 2022, EUMETSAT released several new, extended, or improved data records, of (re)calibrated and quality-controlled sensor data as well as of validated and quality-controlled geophysical variables. Besides releasing new versions of existing data records, there were several first-time releases.

A list of the climate data records released in 2022 can be found on page 69.

The update of the rolling, five-year Climate Services Development Plan for 2022-2026 was approved in June and contains new commitments that support the SAF network and the C3S. A quality-controlled, recalibrated and remapped radiation data record from satellites in geostationary orbit will be created in the next five years in cooperation with the US National Oceanic and Atmospheric Administration and the Japan Meteorological Agency, starting from the mid-1970s and continuing into the future. The Microwave Image Radiances: Climate Monitoring SAF fundamental climate data record 4th release is an extended and improved edition now covering 1978-2020 and is based on SSMR, SSM/I and SSMIS observations. It is the basis for the Ocean and Sea Ice SAF Sea Ice Concentration data record and was released 4 August 2022. Credit: CM SAF

Systematic activities to reprocess data from Copernicus missions to enhance their quality and temporal consistency as a step towards climate data records were further enhanced throughout 2022. A first altimeter and microwave radiometer data record from the first year of data from the Sentinel-6 Michael Freilich satellite was generated and jointly released to the public with NASA Jet Propulsion Laboratory in July. An ocean colour data record from the Ocean and Land Colour Instruments on Sentinel-3A and -3B was completed and delivered to the Copernicus Marine Environment Monitoring Service. All activities are captured in the new, five-year rolling Copernicus Reprocessing Plan, published in November, which details EUMETSAT's activities for the programme.

Case study

Climate change in the European context

The annual European State of the Climate Report was published on 22 April 2022. EUMETSAT data, products, and services made a significant contribution to the report.

Compiled by the Copernicus Climate Change Service, implemented by the European Centre for Medium-Range Weather Forecasts on behalf of the European Commission, the report detailed a year of contrasts. Spring was cooler than average but the summer was the hottest on record, with temperatures close to 1°C above the 1991-2020 average.

The report also detailed extreme events such as devastating floods in western Europe in July, which killed more than 200 people and caused about €15 billion damage, and summer wildfires that burned more than 800,000 hectares across southern Europe.

The report stated that extreme weather events experienced in Europe in 2021 are made more likely by climate change, and stressed the urgent need to act.

Sea ice extent

In the Arctic Ocean, the extent and thickness of sea ice has fallen dramatically over the past four decades. The melting ice is strongly connected to heating in the region over the same time. Average summer sea ice concentration decreased by 11.8% each decade relative to the 1981-2010 average. A smaller, yet equally pronounced, decline also occurred during winter. Arctic ice thickness is also reported to be plummeting by an average of around 13% per decade.



EUMETSAT's Ocean and Sea Ice Satellite Application Facility (OSI SAF) uses satellite imagery to track changes and movement of global sea ice on a daily basis.

The data analysed by the OSI SAF can be used to provide some of the most direct visualisations of climate change, with graphs mapping year-onyear variations.

"Satellite observations are the foundation for most of our knowledge about the evolution of the global sea ice cover," Dr Jörg Schulz, EUMETSAT's leading climate scientist, said. "OSI SAF products provide essential evidence for understanding how climate change is playing out in polar regions.

Sunshine duration

As solar radiation passes through the atmosphere, it is scattered, reflected, and absorbed by air molecules, small airborne particles, water droplets, and ice crystals.

Longer-term variations in surface solar radiation are likely a result of human activities, with aerosol pollutants very probably major drivers. In Europe, annual sunshine duration shows a clear upward trend over the past four decades.


Geostationary and polar-orbiting satellites provide essential data on aspects such as aerosols, cloudiness, precipitation, water vapour, and longterm changes in average radiation on the Earth's surface and at the top of the atmosphere. Meteosat measurements are used by EUMETSAT's Satellite Application Facility on Climate Monitoring to create products and maps that can be used to characterise cloud cover and estimate surface solar radiation and sunshine duration at specific locations in Europe and beyond.

"Climate services use these products to help to build up our understanding of climate change," Schulz said.

Climate data reanalysis

EUMETSAT's Meteosat geostationary satellites and Metop polar-orbiting satellites provide continuous, decades-long archives of space-based observations of the Earth's atmosphere, ocean, land, and cryosphere. Researchers can also make substantial enhancements to the global climate record by turning to past satellite observations.

"More than six decades after the launch of the first weather satellites, the datasets collected by past missions are again proving crucial," Schulz said. "Satellite observations are the foundation for most of our knowledge about the evolution of the global sea ice cover."

Dr Jörg Schulz Climate Service and Product Manager EUMETSAT



"Historical satellite data can help us to fill in the details of the past, with comprehensive records of surface temperatures, to polar ice, to essential trace gases in the atmosphere."

The outputs from climate data reanalyses contribute to almost all high-level climate documents, including the Copernicus and World Meteorological Organisation state of the climate reports.



For more information, read the case study on the EUMETSAT website

www.eumetsat.int/features/climate-changeeuropean-context

Programme development

The first strategic objective in EUMETSAT's strategy document, *Destination 2030*, is the deployment of the Meteosat Third Generation (MTG) and EUMETSAT Polar System – Second Generation (EPS-SG) systems.

The systems will bring about a new era of monitoring the weather and climate from space and offer huge potential for developing new products and applications. The development of these new systems benefits from EUMETSAT's effective cooperation with the European Space Agency (ESA). After EUMETSAT defines its member states' requirements from its satellite systems, ESA procures the spacecraft on EUMETSAT's behalf. This cooperation is central to the success of EUMETSAT's meteorological satellite systems.

A significant milestone was achieved in December 2022, with the launch of the first satellite in EUMETSAT's Meteosat Third Generation system. MTG-Imager 1 (MTG-I1) was successfully launched and brought to its correct orbit and is now undergoing a 12-month commissioning phase. Work continues toward the launch of the first MTG sounding satellite in 2024.

Progress was made toward the launch of the first satellites in EPS-SG in 2025. This system will enable more accurate weather forecasts up to 10 days in advance.

EUMETSAT also reached important milestones in the development of future Copernicus missions. Altogether, EUMETSAT made significant steps towards the deployment of major new satellite observation systems for member states and the users of EUMETSAT data worldwide.





'ntegration of the MTG-11 satellite with the Ariane 5 'auncher, in preparation for launch from Kourou, French Guiana (credit: ESA, CNES, Arianespace)

Meteosat Third Generation

The recurrent MTG satellite platforms have been finished and have been placed in storage. MTG-I2 has been delivered to Thales Alenia Space in Cannes for storage, ready to start the final integration with its instruments in 2024, for a launch in 2026.

MTG-I

EUMETSAT took over control of the newest addition to its fleet of geostationary meteorological satellites – MTG-I1 – on 28 December 2022. MTG-I1 was successfully launched on an Ariane 5 rocket from Kourou on 13 December. The launch and early operations phase (LEOP) lasted 15 days and was performed by Telespazio from the Fucino Space Centre in Italy.

During the LEOP, a series of critical operations successfully deployed the satellite's solar arrays, manoeuvred it into geostationary orbit and deployed its communications antennas from their stowed launch positions. MTG-I1 is currently undergoing a 12-month commissioning phase, during which its instruments will be calibrated and the data they produce validated. Operational service is expected to begin at the end of 2023. MTG-11 was built by Thales Alenia Space under contract by ESA. ESA is responsible for procuring the satellites from industry and fulfilling EUMETSAT's requirements. Thales Alenia Space Cannes is the prime industrial partner for the development of the MTG-I satellites and also integrated the Flexible Combined Imager instrument.

Other partners included:

- OHB-Bremen, which assembled, integrated and tested the platform
- LEONARDO in Italy, which provided the Lightning
 Imager instrument
- Thales Alenia Space Italy, which delivered the
- Data Collection and GEOSAR instruments.

MTG-S

The MTG-S1 spacecraft platform is fully ready and waiting for integration of the instruments.

The Infrared Sounder (IRS) instrument underwent repairs in 2022 after an incident with ground support facilities. The IRS will enter its calibration campaign in spring 2023.



EUMETSAT Polar System – Second Generation

The launches of the first satellites in the EUMETSAT Polar System – Second Generation, Metop-SGA1 and –SGB1, are planned for the first and fourth quarters of 2025 respectively, after the council approved the third schedule rebaselining of the Metop-SG satellites' development in December 2022. Ariane 6 has been selected as the de facto launcher for both satellites.

Satellite mechanical tests began on Metop-SGA1 in December, after the delivery of the final instrument, IASI-Next Generation proto flight model. Integration, verification and validation of the system progressed, with mission control and operations (MCO) and payload data acquisition and processing (PDAP) milestones reached. The launch version of the MCO was accepted in December 2022 and a new PDAP procurement approach was endorsed by the council, also in December, to secure ground segment readiness for Metop-SGA1's launch. Satellite system validation test milestones were achieved in July and November.

The IASI-NG instrument is installed on Metop-SG-A - Toulouse, 25 October 2022 (credit: Airbus)



Copernicus missions

Preparations for the launch of Copernicus Sentinel-3C, which has a launch window of December 2024 to November 2025, continued throughout 2022. The main focus remained on progressing the re-engineering of the Sentinel-3 ground segment to remove hardware and software obsolescence and to expand its capacity to process data from a third satellite. The test systems are already able to process in real time simulated Sentinel-3C data created by tuning Sentinel-3A data.

The first operations validation tests started in August for the new flight operations segment and in October for the new payload data processing system. The fully re-engineered ground segment for Sentinel-3A and -3B is expected to enter operations in summer 2023. The Sentinel-3C ground segment acceptance review will take place shortly afterwards.

The main activity relating to the spacecraft was the successful completion of the last pre-storage satellite verification test in January. Sentinel-3C and -3D have been placed in storage with de-storage activities planned to start in 2024 at the earliest. Sentinel-3D is expected to be launched no earlier than 2027.

Copernicus Sentinel-4 is an instrument to be carried on EUMETSAT's MTG-Sounder satellites. In December 2022, the Copernicus Sentinel-4 instrument finished its calibration campaign in the RAL Space facilities in the United Kingdom and was delivered to OHB in Bremen for integration into the MTG-S1 satellite.

The Copernicus Sentinel-5 instrument will be part of the Metop-SGA1 payload. Implementation of the temporary ground processing system at EUMETSAT was agreed with ESA to secure availability of level 1 products to calibration/ validation users and for commissioning.

The Copernicus Sentinel-6B satellite successfully passed its pre-storage and acceptance review in July 2022 and was placed into storage at Airbus

Defence and Space premises in Friedrichshafen, Germany, in October. The decision by NASA to award SpaceX the launch of the satellite was announced in December 2022. The launch is planned for November 2025, on a Falcon 9 rocket, from Vandenberg Air Force Base in California, the United States.

EUMETSAT will develop the ground segment for, operate, and process and disseminate the data from, the future Copernicus anthropogenic carbon dioxide emissions-monitoring mission, CO2M. Important milestones for this mission achieved in 2022 include:

- the project implementation plan was defined and signed with ESA
- the EUMETSAT management arrangements review was completed
- the system preliminary design review, cochaired by ESA and EUMETSAT, was completed and the ground segment preliminary design review was kicked off
- the space segment preliminary design reviews were completed.

EUMETSAT will contribute to the Copernicus Polar lce and Snow Topography Altimeter (CRISTAL) mission with the deployment and operations of global ocean altimetry product processing and data access services.

EUMETSAT will also contribute to Copernicus Imaging Microwave Radiometer mission with the deployment and operations of the data processing chains for the generation and the dissemination of global secondary level two products. It will do this to support weather applications in synergy with other relevant missions operated by EUMETSAT.

In 2022, the space segment preliminary design reviews were completed for both missions and the principles for the ESA and EUMETSAT implementing arrangements were defined. EUMETSAT operates Copernicus Sentinel satellites from its Low-Earth Orbit Control Centre in Darmstadt, Germany

European and international cooperation

The need for accurate weather forecasts, early warnings of severe weather events, and understanding of Earth's changing climate are global challenges that require global cooperation to address. Through a framework established by the World Meteorological Organization (WMO), EUMETSAT maintains global, multilateral, and bilateral cooperation agreements focusing on data and scientific exchange.

Relationships with partners in Europe

The Director-General took part in a series of meetings at ministerial level throughout 2022 in the lead-up to the European Space Agency (ESA) Ministerial Council in November, where decisions of central importance to EUMETSAT were made. Areas of particular significance for EUMETSAT were the continuation of the European Union's (EU) Copernicus programme, including funding for the preparation of future missions to be operated by EUMETSAT. This included the AEOLUS windmonitoring mission, cooperation on space weather and development of a way forward, studies for future meteorological missions, the Destination Earth digital twins initiative and climate monitoring.

"Family portrait" at the European Space Summit, Toulouse, France, 16 February 2022 (credit: Hamilton de Oliveira/MEFR)







Starting with the European Space Summit in Toulouse in February and continuing with 16 bilateral meetings with ministers in member states, the Director-General stressed the benefit from member states' continued investment and support. The meetings were an opportunity for the Director-General to highlight how EUMETSAT can and does contribute to these fields and the overlap with EU priorities, for example, EUMETSAT's role in the Copernicus programme, meteorology, and space weather. As a result of EUMETSAT inputs, the EU's Horizon Europe programme for the first time included funding for research into the use of Meteosat Third Generation (MTG) and EUMETSAT Polar System – Second Generation (EPS-SG) data.

The Director-General also spoke at the EU's Space Working Group council meeting and identified EUMETSAT support for the Space Strategy for Europe. The European Commission consulted EUMETSAT from the beginning of the process of developing a European space and defence strategy. The EU's plan was to be presented in March 2023.

Copernicus

EUMETSAT maintained continuous dialogue with the European Commission and ESA to prepare for the future of the Copernicus programme. All three entities are preparing for a decision on the future of the programme in 2024. EUMETSAT operates the Copernicus Sentinel-3, Jason-3 and Sentinel-6 satellites on behalf of the European Union and processes and disseminates their data. In addition, the Copernicus Sentinel-4 and Sentinel-5 instruments will be flown on board EUMETSAT's MTG and EPS-SG satellites. EUMETSAT will operate the carbon-monitoring CO2M mission on behalf of the EU. The decisions to be made on the future of the Copernicus programme in 2024 will be significant for EUMETSAT.

Destination Earth

The EU's Destination Earth (DestinE) initiative involves building virtual replicas of Earth systems, ultimately allowing greater insight into weather and climate phenomena and their impacts on society. EUMETSAT is one of the three agencies, along with ESA and the European Centre for Medium-Range Weather Forecasts, that the European Commission selected for the first stage of the initiative, and has end-to-end responsibility for creating and maintaining the data lake underpinning the project. EUMETSAT has begun dialogue with the commission about phase two of the initiative to ensure a long-term approach to planning.

European and international cooperation

Bilateral partnerships

US National Oceanic and Atmospheric Administration

EUMETSAT maintains a strong relationship with the US National Oceanic and Atmospheric Administration (NOAA). The Director General and NOAA's Administrator Dr Rick Spinrad had their first in-person meeting in 2022, one of several high-level meetings during the year.

During the EUMETSAT-NOAA high level working group meeting in March, both organisations agreed to set up a group to examine top priorities for the next 10 years. Both organisations face similar issues and challenges including the evolution of ground segments, new technology, artificial intelligence, machine learning and cloud technology, the future architecture of their low-Earth-orbiting and geostationary systems, miniaturisation and the role of the commercial space sector.

EUMETSAT has communicated regularly with NOAA on preparation of data users for next-generation satellite systems. EUMETSAT was able to learn from NOAA's experience preparing for its new geostationary and polar-orbiting satellites.

China

A world of weather, based on data from the meteorological satellites of EUMETSAT, NOAA, CMA and JMA. Cloud imagery provided by Météo-France.

A series of technical and scientific workshops with representatives from the China Meteorological Administration (CMA) was held in 2022, including some involving EUMETSAT's satellite application facilities. An online high-level bilateral meeting was held in December. The CMA is shifting its focus to improving the capability of meteorological satellite applications for data users and plans to establish a centre for remote sensing applications and services to fully apply FengYun satellite data. The CMA announced it intends to establish a global, regional and operational satellite application centre, similar to EUMETSAT's satellite application facilities, within the framework of the WMO integrated processing and prediction system. Discussions also covered the use of polar ground stations for downlinking of global data.

EUMETSAT participated in the first international forum on high-quality meteorological development hosted by the CMA on 15 September. The workshop was important for the CMA to show it coordinates with international partners when preparing long-term plans. EUMETSAT was the only space agency providing a presentation, together with the ECMWF and WMO. The CMA again demonstrated its impressive roadmap, and commitment to the fulfilment of the WIGOS Vision 2040.

Japan

EUMETSAT renewed its cooperation agreement with the Japan Meteorological Agency (JMA) on technical and scientific cooperation and exchange of data and products in support of Earth observation in July 2022.

The JMA plans to begin the manufacturing of its next-generation geostationary satellites in 2023 and to include a hyperspectral sounder. EUMETSAT has previously expressed its willingness to support the agency on the use of the data as far as possible in that regard.

The visiting scientist programme has restarted, after being impacted by Covid-19 pandemic travel restrictions. A scientist from the JMA is expected to arrive at EUMETSAT in March 2023 for a one-year stay. The purpose of the visit is to work on activities related to processing and calibrating data from EUMETSAT's Hyperspectral Infrared Sounder instruments.



Multilateral partnerships

Coordination Group for Meteorological Satellites

The Coordination Group for Meteorological Satellites celebrated its 50th anniversary in 2022. The 50th plenary agreed to look at refocusing the group's activities to suit the changing environment. A task team was established to identify priorities, which will be decided by the 51st plenary in 2023.

World Meteorological Organization

The WMO approved its new data policy, *The WMO Unified Policy for the International Exchange of Earth System Data (the "WMO Unified Data Policy", or "Resolution 1")*, in 2022. The WMO data policy is the reference for EUMETSAT's, as agreed by the EUMETSAT Council in December 2022.

Relationships with Africa

Africa produces the lowest proportion of greenhouse gases of all continents but is deeply impacted by climate change. EUMETSAT, in cooperation with the European Commission's Directorate-General for International Partnerships, has been working with African agencies for more than 20 years, providing meteorological and climate data, training, and technical assistance to enhance access to, and use of, satellite data for weather and climate forecasting. EUMETSAT's Meteosat Third Generation (MTG) system, with its satellites having a constant view of Africa and Europe, will provide imagery and data of unprecedented precision and resolution to meteorologists and climate experts on the African continent.

The first imaging satellite in the new system, MTG-11, was launched in December 2022. The satellite will provide significantly more and better weather and climate information for Africa. EUMETSAT is committed to making the data from the MTG system readily available to African weather and climate services, providing training for forecasters, and participating in capacity-building projects on the continent.

In September, the 15th EUMETSAT User Forum in Africa, held in Dar es Salaam, Tanzania, attracted 150 participants from 50 African countries, regional organisations and from EUMETSAT and its member states. The focus of the forum was on MTG and the use of satellite data in support of the blue economy, disaster resilience and climate services. On the eve of the forum, the African Union Commission (AUC), the African Ministerial Conference on Meteorology and the Tanzanian Government's minister for meteorology signed a joint statement on the transition to MTG data.

The statement calls on the European Union and EUMETSAT to support the strengthening of capacities for MTG, continue to provide Meteosat data free of charge, to provide regular training on the use of MTG data, and to establish a satellite application facility in Africa.

African nations' capacity to mitigate the impacts of climate change received a significant boost in May through an agreement designed to share the benefits of Europe's next-generation meteorological satellites, including MTG. The AUC and EUMETSAT signed an agreement to formalise their cooperation under the EU-funded Intra-ACP Climate Services and Related Applications (ClimSA) programme. The Organisation of African, Caribbean and Pacific States and the EU initiated ClimSA to improve climate services. The AUC coordinates its implementation in Africa.

ClimSA enables African meteorological and hydrological services to renew their EUMETCast stations – receiving stations for EUMETSAT data – to ensure that they are capable of receiving and processing MTG data.

In addition to these milestones, EUMETSAT contributed to EU-Africa events in 2022. A presentation on MTG was given at the Africa-Europe Week 2022, in the margin of the EU-African Union summit. EUMETSAT also contributed to the EU Global Action on Space event, *Current and future opportunities for EU-African cooperation in the space domain*, in September, and the *Copernicus data access and use in Africa* event in October.



African Space Art Project

The launch of Meteosat Third Generation – Imager 1 (MTG-I1) made history not just for European satellite meteorology but also for the world of contemporary art.

In recognition of the enormous contribution to African meteorology and climate services MTG will make, and of EUMETSAT's long-standing relationship with Africa, a unique project came into being.

The African Space Art Project was an initiative of EUMETSAT, Arianespace and the French nongovernmental organisation African Artists for Development. The aim was to adorn the Ariane 5 rocket launching MTG-I1 into space with a replica of a specially commissioned contemporary African artwork.

After a careful selection process, three artists – Géraldine Tobé and Michel Ekeba from the Democratic Republic of Congo and Jean David Nkot from Cameroon – were asked to create the art piece together.

Here, they explain their inspiration and approach.

"The artwork is not just a series of elements placed side by side: they are mixed in order to create a unified message about sustainability, but also about the importance of collaboration and harmony.

"The central character is a woman depicted three times in different positions by Géraldine Tobé. Her work represents the rural part of the African population that is extensive, continues to suffer, and will experience increasing hardships because



"Surrounding these three women, Jean-David Nkot painted a dotted cartography representing Africa using six colours to depict the six climatic regions in the continent.

"Lastly, Michel Ekeba created astronauts made of electronic waste, a reference to the 1960s Zambian Space Programme, in order to bring attention to the vast amount of non-recyclable electronic waste that pervades the environment in his country, the Democratic Republic of Congo.

"Our artistic universes are very different, partly because we come from different cultures but also because of the tools and techniques we are using.

"Michel Ekeba is a photographer and sculptor, while Jean-David Nkot and Géraldine Tobé are painters. Géraldine uses smoke to create stunning images in greyscale, while Jean-David uses mostly bright colours. It was crucial for us to first confront our differing ideas in order to find a common concept in order to create a cohesive, meaningful piece of art.



Jean David Nkot (Cameroon), Michel Ekeba (DRC) and Géraldine Tobé (DRC) in residency in Ouidah, Benin, as they work together to create the unique work of art, a fusion of their three creative universes, a copy of which was transferred on to the fairing of the rocket launching MTG-11 into space (far left) (credits: Frédérique Toulet Photographe, ESA/CNES/Arianespace)

"We built on the very ancient astronomical knowledge stemming from African people. For example, several thousand years BC, the Dogon, an ancient West African people, developed a very complex cosmogony based on the distant stars Sirius A and B that were "discovered" by Western astronomers only in the 19th Century. More generally, the tight interconnections between Earth and space are very present throughout many African cultures.

"In the 1970s, several projects aimed at giving Africans a more prominent role in the conquest of space were set up, but they did not succeed, which just adds to how meaningful it is for us to have the privilege of participating in this project." "The artwork is not just a series of elements placed side by side: they are mixed in order to create a unified message about sustainability, but also about the importance of collaboration and harmony."

Géraldine Tobé Artist Democratic Republic of Congo



Copernicus

The Copernicus component of the European Union's (EU) space programme makes its data available free of charge to everyone. In line with this principle, EUMETSAT has developed a suite of tools and tutorials in open source programming languages to support uptake of the data.

In 2022, EUMETSAT migrated the online data access to Copernicus data (previously delivered by CODA) to the EUMETSAT Data Store. For users of Copernicus data, the Data Store offers operational and reprocessed collections from the Copernicus Sentinel-3 and Sentinel-6 missions, which will progressively enable users to access a consistent, full mission archive online. A EUMETSAT data access client, EUMDAC, has also been developed, and allows data users simple programmatic access to the advanced features offered by the Data Store application programming interfaces. Supporting explanatory resources, including a knowledge base, videos, and Jupyter notebooks, as well as helpdesk support and training events, have facilitated data users' transition to the new service.



EUMETSAT also collaborates with other agencies to provide training on the use of Copernicus data. In 2022, EUMETSAT developed a new version of its annual introductory marine applications online training course. The Supporting Marine Applications course is designed to support potential users who wish to work with satellite data for a diverse range of marine applications. The 2022 iteration of the course brought marine products from Copernicus Sentinel-3 and Sentinel-6 missions together with the products available from the Ocean and Sea Ice Satellite Application Facility (OSI SAF), providing data users with a holistic view of the wide variety of products available through EUMETSAT. The 2022 external collaboration was with the University of Athens, which provided guest tutorials on monitoring marine ecosystems.

Towards the development of a marine applications curriculum of training, EUMETSAT is designing advanced courses suited to supporting data users in different marine user groups. The Supporting Marine Earth Observation Educators course offers an opportunity for those already familiar with satellite data and with teaching or training responsibilities, to co-develop resources for their own activities. The participants act as multipliers, delivering and further developing learning material about marine products distributed by EUMETSAT, including those from Copernicus missions and the OSI SAF, and the Copernicus marine service. About 1,400 participants took part in 15 training events on Copernicus atmosphere applications in 2022. A workshop dedicated to wildfires attracted about 200 participants in October, including about 100 from European organisations and services. The training included sessions on the use of data from MTG, EPS-SG, Modis, Copernicus Sentinel-2 and -5, GOES-R, and JPSS satellite instruments during fire events.

User engagement related to wildfire and dust monitoring also continued in 2022, with development of demonstrational tools, training material, courses and workshops. Higher-resolution imagery and a dedicated fire channel on MTG's Flexible Combined Imager, will allow for a much-improved capacity to detect and monitor fires even at smaller scales. The user preparation involves civil protection agencies, meteorological services, researchers, modellers and data providers from EUMETSAT, the European Centre for Medium-Range Weather Forecasts (ECMWF) and Copernicus Services.

A training session on dust monitoring was held, together with the World Meteorological Organization, the ECMWF and the Aerosol, Clouds and Trace Gases Research Infrastructure European infrastructure. More than 250 attendees took part, discovering 20 products from models, satellite data and in-situ data.

EUMETSAT ran a Jupyter Notebook competition in 2022 as an outreach initiative to build up learning resources for people wanting to work with Copernicus data. The aim was to start a communitydriven collection of notebooks on the Copernicus WEkEO online platform, which could help others to start their own journeys with Earth observation data.

First prize, from 36 notebooks submitted, went to a team that developed a notebook with the title Portrait of a Lake's Death. The notebook shows people how to use Copernicus Sentinel-2 data to document the disappearance of the Aculeo Lagoon in Chile, due to drought conditions and changes in land use.

Management and administration

EUMETSAT's strategic objectives include continuously improving management and risk management process and remaining an attractive employer for diverse, skilled, talented and engaged people.

In 2022, EUMETSAT reached important milestones towards these objectives. A reorganisation of the Technical and Scientific Support Department was undertaken, a new approach to financial control was adopted and digitalisation of administrative processes continued. Working groups developed proposals to address issues highlighted in the 2021 staff survey and a study into ways to reduce EUMETSAT's carbon footprint was undertaken.



Reorganisation of the Technical and Scientific Support Department

As EUMETSAT evolves, the Technical and Scientific Support Department (TSS) needs to enhance its capacity to support other departments to achieve the organisation's objectives, relying on EUMETSAT core values. The department was reorganised in 2022 to





achieve the aims listed below. TSS's people are its greatest asset and the new structure will improve the way they work together.

- Improving the management of increasing complexity for the benefit of the organisation.
- Supporting, within EUMETSAT, the development of downstream applications, day two data and big data services.
- Developing further the TSS project management culture, contributing to EUMETSAT's capability to deliver programmes according to our commitments to member states, including end user requirements, budget and deadlines.
- Offering clearer career development opportunities and paths, through technical expertise, team management and project management. This also addresses some of the outcomes from the TSS staff survey.
- Enhancing the capability to support programmes in development, developing a multi-mission ground segment approach, developing synergies between satellite application facilities and digital solutions, such as Destination Earth, WEkEO, the user portal, the European Weather Cloud, and relying on an IT Infrastructure based on a platform as a service model.

The department will retain the matrix logic regarding interfaces within the organisation and the existing "competence area" structure as much as possible.

In order to facilitate this departmental change, a change management cross-organisational team was established and has been holding open door sessions in TSS so that everybody in EUMETSAT is aware of their future role or the new way of interfacing with the department.

Response to the Covid-19 pandemic

Throughout 2022, EUMETSAT continued to carefully monitor the evolution of the Covid-19 pandemic and regulations adopted by member states, particularly Germany as the host state. Measures for increased hygiene at EUMETSAT headquarters were maintained, as were restrictions on visits to headquarters. EUMETSAT senior management continued to meet weekly within the Covid Coordination Group in order to review the situation and the implications for EUMETSAT and its employees.

From April, and in sync with German legislative developments, it was agreed to generalise onsite presence while maintaining a requirement for testing and mask wearing. The return to headquarters coincided with the start of a pilot teleworking policy and the publication of corresponding rules. The teleworking pilot arrangements required presence in the office at least three days per week and a maximum of two days of teleworking per week, business needs permitting.

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Management and administration

New policies, tools and work practices

For more than 20 years, document management tools have been the cornerstone of EUMETSAT's most critical processes, a trusted repository for decisions, technical documents, and other vital records ensuring business continuity. For this reason, EUMETSAT must ensure its information repositories are up to date. The current tool, based on Oracle WebCentre Content, served EUMETSAT well for some 10 years but will not be supported in the future, and needed to be replaced. Replacing the tool with a new, modern one is key to how EUMETSAT staff will continue to work together and evolve the organisation's institutional memory.

Following council approval of a procurement proposal in July, an efficient tender evaluation board process managed to issue an invitation to tender and to evaluate all proposals received in time to submit a contract proposal to the December council meeting. The council agreed to the proposed selection of M-files as the future EUMETSAT information management tool.

A proposal to establish a procurement review procedure for all open competitive procurements valued at or above €100,000 also was approved at the July council meeting. The procurement review procedure offers a formal avenue of redress to unsuccessful tenderers who claim a procedural breach in the implementation of a procurement action. It reinforces the principle of fair treatment by making available objective legal recourse, allowing tenderers to challenge the outcome of an open competitive procurement action on the grounds of procedural breach.

The practical implementation of the procedure involves the appointment of a EUMETSAT Ombudsperson and his or her alternate by the council in spring 2023. The new procedure will become operational as soon as the Ombudsperson has been nominated.

The December council meeting approved a proposal to discontinue the function of financial control. The proposal implements external auditors' recommendations regarding the EUMETSAT internal control framework made more than 10 years ago. The new system will end a priori financial control, replacing it with an audit only model.



Evolution of the EUMETSAT campus

EUMETSAT's 44-place childcare centre, LittleOrbiters, began to take shape in 2022. After a report to the council in July, site preparations and excavation work began. The initial works and installation of the wooden shell of the building progressed quickly. A cornerstone-laying ceremony was held on 4 October. The outside shell of the building was completed by the end of the year, ready for the interior finishing in 2023. LittleOrbiters will start admitting children of EUMETSAT staff in October 2023.

In July, the council approved the contract proposal for the construction of an extension of the East Building. The extension will provide an additional 120 workspaces, a series of meeting rooms and an extension of the canteen area, which has become tight since the canteen was established in the East Building in 2014. The contract with Leonhard Weiss was signed in July 2022 and all preparations for the start of works in January 2023 took place in December 2022. The extension of the East Building is expected to be completed by June 2024. Childcare centre cornerstone laying ceremony, 4 October 2022. Left to right: Prof. Dr.-Ing. Hans Moser, Referatsleiter DK22, Bundesministerium für Digitales und Verkehr, Phil Evans and Wolfram von Rotberg, Stadtrat der Stadt Darmstadt

Staff survey follow-up activities

EUMETSAT conducted a staff engagement survey in 2021 using Willis Towers Watson, which conducted the last survey in 2018. The primary objective of the staff survey initiative was to measure sustainable staff engagement, a broader indicator than employee satisfaction and motivation.

Survey results were presented to staff through presentations at organisational, divisional and departmental level.

To address the most pronounced corporate level issues, cross-organisational working groups were formed with members from the management board, Human Resources, the Staff Association Committee and staff members to analyse and propose tangible actions to improve 1) efficiency and bureaucracy, 2) people and career development, and 3) diversity and inclusion and workload issues.

In addition to actions raised at a corporate level, survey results are being analysed and actions established at departmental, divisional and team levels.

A report on the organisational actions identified and their implementation will be presented to EUMETSAT's delegate bodies in autumn 2023.

Management and administration



Reducing EUMETSAT's carbon footprint

In 2022, EUMETSAT contracted a study into its corporate carbon footprint. The study analysed the evolution of EUMETSAT's corporate carbon footprint using the year 2019 as base year, that is, the year prior to the Covid-19 pandemic.

The study calculated EUMETSAT's total carbon footprint within the project scope and the relative greenhouse gas emissions in 2019 and 2021. The study showed that EUMETSAT's emissions had reduced by 50% between 2019 and 2021. The main contributor to this reduction was lower "scope three" emissions, relating to purchased goods and services, generated waste, business travel and employee commuting. These emissions had radically reduced due to forced teleworking during the pandemic, which also prevented business travel.

Above: EUMETSAT's energy-efficient Technical Infrastructure Building

Further analysis of the organisation's carbon footprint is required and, when this is completed, EUMETSAT will establish a roadmap for further improvements to its carbon footprint. In order to keep scope three emissions as low as possible, EUMETSAT will continue applying significant reductions to mission travel and offering subsidised "job tickets" to encourage staff to commute to work using public transport, in combination with teleworking.

This builds on previous decisions aimed at reducing the organisation's carbon footprint and providing value for member states. EUMETSAT already receives 100% of its electricity supply from renewable sources. The Technical Infrastructure Building, the largest consumer of energy at EUMETSAT, has received official certification for its energy efficiency.

Communication and outreach

The launch of Meteosat Third Generation (MTG) – Imager 1 was the focus of much of EUMETSAT's external communication activity in 2022. The impact and benefits of the MTG system, for member states and Africa, in particular, were highlighted via the media and social media throughout the year, reaching a crescendo during the launch campaign itself from September to December.

The communication team's approach was to ensure all activities were as inclusive, dynamic and sustainable as possible.

Close collaboration with media offices in member states' national meteorological and hydrological services (NHMS) resulted in national media coverage in 25 of those countries. Half of the NMHS also published news about the MTG-I1 launch online. This successfully enabled member states to explain their involvement in the programme and the benefits it would bring their citizens. In addition, media briefings the week before launch were held in English, Italian, French and German and achieved widespread coverage of the expected benefits of MTG. The briefings included spokespeople from EUMETSAT, the European Space Agency, industry and NMHS.

A more structured approach to internal communication began at EUMETSAT in 2022. In order to connect a growing workforce, EUMETSAT launched an internal newsletter, a blog written by senior managers, and a quarterly newsletter focusing on innovation, held more internal briefing events and continued to publish articles on the intranet.

Other communication activities undertaken by EUMETSAT also promoted important achievements and projects. For example, the deorbiting of Meteosat-8 in October was covered by the media and showcased the expertise of EUMETSAT's operations teams and the organisation's commitment to preventing space debris. A competition was organised by EUMETSAT, the European Centre for Medium-Range Weather Forecasts, Mercator Ocean International and the European Environment Agency to promote the use of Copernicus data. The competition involved the development of Jupyter notebooks to help people work with the vast amount of data available, creating a community-driven resource. The competition attracted more than 450 registrations and resulted in 31 notebooks being submitted.

In September, EUMETSAT provided all staff members with a booklet outlining the organisation's core values. The core values are guidance on how staff do their daily work, and promote behaviours that foster a positive and productive work environment in alignment with EUMETSAT's mission and vision. The booklet also is provided to all new recruits.

Ethics Officer

The Ethics Officer's mandate was broadened in 2022 so that everybody working at EUMETSAT, staff member or contractor, may consult with her or share concerns or allegations of retaliation. The Ethics Officer also made significant progress in establishing a shared understanding of the definition of ethics in the organisational context and her role. She held multiple briefings, including with the Chairman of EUMETSAT's Administrative and Finance Group (AFG), the Director-General, the management board and heads of divisions.

Newcomers met with the Ethics Officer as part of their induction process to be briefed on the organisation's ethics framework and reporting of wrongdoing policy, how to raise issues and points of contact. The Ethics Officer also attended divisional and departmental assemblies to explain her role and activities.

Work began on an invitation to tender for a code of ethics, ethics training, and an awareness campaign and tools for a "speak-up" programme. The proposal will be completed in 2023.

Other milestones in 2022 included:

- A pilot training programme for senior staff on bullying and harassment and investigations was held and a new course is being developed with an option to include training on increasing general awareness of ethics.
- As part of the framework allowing EUMETSAT employees to report wrongdoing in a secure and streamlined manner, and to receive protection against retaliation, the policy and framework were extended to include employees of contracted service companies, as well as temporary workers, interns and visiting scientists. This included improvements to the mechanism for reporting wrongdoing, allowing contractors to escalate reports to the AFG Chairperson and allowing for allegations of retaliation from people who are not EUMETSAT employees on a case-bycase basis.



Credit: Adobe Stock

Record low precipitation leads to serious drought conditions

Depleted soil moisture and vegetation stress contributed to widespread strain on the water cycle, with EUMETSAT satellite data revealing that severe soil wetness deficits impacted nearly half of Europe in August.

"Already in the first half of 2022, data showed that rainfall over most parts of Europe was well below average," Dr David Fairbairn of the European Centre for Medium-Range Weather Forecasts (ECMWF) said. Fairbairn contributes to EUMETSAT's Support to Operational Hydrology and Water Management Satellite Application Facility (H SAF).

"With low levels of precipitation continuing into the summer and hot temperatures causing increased evapotranspiration, soil moisture became severely depleted in many parts of Europe."

Europe's rivers felt the heat as the Po, Danube, Rhine, Rhône, and many other waterways suffered alarmingly low water levels.

Dr Luca Brocca, of the Italian National Research Council, said conditions underlying the drought in the Po Valley – reported to be the region's worst in 70 years – were building long before summer.

In the heat of the moment

Summer 2022 was the hottest ever recorded in Europe. An intense series of heatwaves coincided with unusually dry conditions that led to record temperatures, droughts and fire activity in many parts of Europe.

"Winter 2021-2022 saw the driest conditions in a decade, and by February 2022, the Po's water levels resembled those typical of August," said Brocca, who also contributes to EUMETSAT'S H SAF.

"When the heatwaves hit, it was a recipe for disaster. The Po Valley, like many European regions, is experiencing a multi-year drought. To recover, we need a substantial amount of precipitation spread over several years.

"As drought impacts worsen, satellite data plays a crucial role in understanding and predicting such conditions."

A brutal wildfire season

The European Forest Fire Information System reported the highest burnt area ever recorded in 2022, exceeding 785,000 hectares in the European Union. This included areas in Portugal, Germany, Slovenia, Spain, and France, where the Gironde region experienced two major phases of fire activity in July and August, leading to widespread destruction and the evacuation of more than 40,000 people.

"During the summer, satellite data showed many countries in Europe had significantly elevated values of fire radiative power, which is a measure of the intensity of ongoing fires," Carla Barroso, Weather Applications and User Training Expert at EUMETSAT, said.



[-] -0.3 -0.2 -0.1 0 0.1 0.2 0.



SAF Soil Wetness Index (L3) Anomaly June 2022



H SAF Soil Wetness Index (L3) Anomaly July 2022 [-]



H SAF Soil Wetness Index (L3) Anomaly August 2022



fAPAR Anomaly June 2022



fAPAR Anomaly August 2022

Above top row: Anomaly of Monthly Soil Wetness Index (28-100cm below the surface), compared the period 2006-20. Product: Root Zone Soil Wetness Index provided by H SAF.

Bottom row: Anomaly of Fraction of Absorbed Photosynthetic Active Radiation (fAPAR) – the change or deviation in the amount of sunlight that plants use for photosynthesis – compared to the period 2006-2020. Product: fAPAR, provided by LSA SAF.

"The past decade has seen the likelihood of major fire and drought events increasing across Europe and other parts of the world. But even by recent standards, 2022 was a particularly shocking year for the number and intensity of wildfires and related emissions."

Preparing for the future

European temperatures have risen at over twice the global average in the past 30 years, Dr Christine Träger-Chatterjee, Climate Data Applications Expert at EUMETSAT, said.

"The quality and continuity of satellite data records over long time series provide significant opportunities, for instance for climate services to design ways to both help monitor situations in real time and to support studies of long-term trends "Because of global heating, the reality is that situations like extreme heat, drought, and wildfires we saw in 2022 will happen more frequently and potentially more intensely in future."

Dr Christine Träger-Chatterjee Climate Data Applications Expert EUMETSAT

that could help predict what might happen in future," she said.



"Because of global heating, the reality is that situations like extreme heat, drought, and wildfires we saw in 2022 will happen more frequently and potentially more intensely in future. The climate is changing rapidly, and we need to do everything we can to address that."



For more information, read the case study on the EUMETSAT website

www.eumetsat.int/features/heat-moment



Mission planning

Sentinel-6C Sentinel-6 NG

> CRISTAL (CO2M)

Manadatory programme	Satellite	2020	2025	2030
Meteosat Second Generation (MSG)	Meteosat-8 Meteosat-9 Meteosat-10 Meteosat-11			
Meteosat Third Generation (MTG)	MTG-I1 MTG-S1 MTG-I2 MTG-I3 MTG-S2 MTG-I4			
EUMETSAT Polar System (EPS)	Metop-A Metop-B Metop-C			
EUMETSAT Polar System - Second Generation (EPS-SG)	Metop-SGA1 Metop-SGB1 Metop-SGA2 Metop-SGB2 Metop-SGB3 Metop-SGB3			
Optional and Copernicus programme	<u>;</u>			
Jason	Jason-3			
Copernicus Sentinel-6 I	Sentinel-3A Sentinel-3B Sentinel-3C Sentinel-3D Michael Freilich			
	Sentinel-6B			

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2035	2040	2045





Operational performance

		2017	2018	2019
Satellite series	Service	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
Meteosat	Full Earth Scan (0°) Rapid Scan (9.5°E) IODC Image (41.5°E)			
Metop	AMSU Level 1B - Metop-A AMSU Level 1B - Metop-B AMSU Level 1B - Metop-C	•••••	•••••	
	ASCAT Level 1B - Metop-A ASCAT Level 1B - Metop-B ASCAT Level 1B - Metop-C	•••••	••••••	
	AVHRR Level 1B - Metop-A AVHRR Level 1B - Metop-B AVHRR Level 1B - Metop-C	••••••		
	GOME Level 1B - Metop-A GOME Level 1B - Metop-B GOME Level 1B - Metop-C			
	IASI Level 1C - Metop-A IASI Level 1C - Metop-B IASI Level 1C - Metop-C			
	MHS Level 1B - Metop-A MHS Level 1B - Metop-B MHS Level 1B - Metop-C			
Jason-3	Altimetry (NRT)	••••••	•••••	•••••
Sentinel-6	POSEIDON 4 Level 2 HR POSEIDON 4 Level 2 LR			
Sentinel-3	SRAL Level 1 - Sentinel-3A SRAL Level 1 - Sentinel-3B	••••••	••••••	•••••••••
	SRAL Level 2 - Sentinel-3A SRAL Level 2 - Sentinel-3B	•••••	••••••••	
OLC	CI Level 1 - Sentinel-3A & -3B	•••••••		$\bullet \bullet $
SLST	R Level 2 - Sentinel-3A & -3B	•••••	••••••••	••••••
EUMETCas	st Europe Africa	••••••	••••••	••••••

		Service availability Above target 100% availability Exceeded target	 / to users > Below target > Within 1% of reaching target > More than 1% below target
2020 1 2 3 4 5 6 7 8 9 10 11 12	2021 1 2 3 4 5 6 7 8 9 10 11 12	2022 1 2 3 4 5 6 7 8 9 10 11 12	Why were some services below target?
			May 2022, Full Earth Scan, due to thermal regulation tests Nov-Dec 2022, Rapid Scan, due to planned routine instrument maintenance
			Jan 2022, AMSU level 1B, Metop-C
			Jan 2022, AVHRR level 1B, Metop-C
			March 2022, IASI level 1C, Metop-B, September, Metop-C
			Apr 2022, POSEIDON instrument commanded to wait
			Sep 2022, ground segment issues
			Nov and Dec 2022, ground segment issues Jun, Aug, and Nov 2022, ground segment issues



EUMETSAT user base

Number of user enquiries in 2022

3,206 user enquiries were processed in 2022, with 66% from EUMETSAT member states.

Number of EUMETCast stations and users on 31 December 2022

At the end of December 2022, there were 4,913 registered EUMETCast stations exploited by 3,378 registered users.



4,913 stations 3,378 users

Data Centre and Data Store users and orders in 2022

Unique active users in 2022

😑 Data Centre 🛛 🔵 Data Store





Financial information

The 2022 EUMETSAT Financial Statement has been audited by the Tribunal De Contas. The following tables, in K€, are a summary of the information for 2022 included in those accounts.

Summary revenue and expenses 2022

TOTAL REVENUE	1,106,088
Asset impairments	
Other revenue	555,23 [°]
Sales revenue	1,345
Other contributions	63,255
Member state contributions	486,255
REVENUE	NLO1
	NEUF

EXPENSES

Costs for human resources	182,22
Services and works contracts	88,84
Other operating expenses	15,68
Satellite related costs	68,49
SAF, prospective activities, research fellows	14,04
Depreciation	162,16
Change of provisions	
TOTAL EXPENDITURES	531,45
Expenses from financial operations	531,45 28
Expenses from financial operations NET SURPLUS FOR THE PERIOD	531,45 28 574,34

<u>Surplus to</u>	<u>o be distribu</u>	<u>ted to mem</u>	<u>iber states</u>	<u> 33,746</u>
Result allo	ocated to re	serves		540,597

Expenditure budgets 2022

TOTAL	M€ 701.
 Destination Earth (DestinE) 	M€ 16.
• <u>Copernicus 2.0</u>	M€ 89.
<u>Copernicus</u>	M€ 6.'
● <u>Jason-CS</u>	M€ 1.:
EPS - Second Generation (EPS-SG)	M€ 25
EUMETSAT Polar System (EPS)	M€ 40.
Meteosat Third Generation (MTG)	M€ 192.
Meteosat Second Generation (MSG)	M€ 26.
General budget (GB)	M€ 76.

Summary balance sheet 2022

	KEUR
ASSETS	
Current assets	1,077,453
Non-current assets	3,907,662
TOTAL ASSETS	4,985,115
LIABILITIES	
Current liabilities	764,975

TOTAL LIABILITIES	1,349,09
Non-current liabilities	584,11
	/ 04,7/

TOTAL NET ASSETS/EQUITY 3,636,021

TOTAL LIABILITIES & 4,985,115 NET ASSETS/EQUITY

M€ 701.6 Total expenditure 2022

Member state contributions 2022

REVENUE	REUN
Austria	10,492
Belgium	12,737
Bulgaria	1,449
Croatia	1,378
Czechia	5,172
 Denmark	8,494
Estonia	661
Finland	6,426
France	66,612
Germany	94,426
Greece	5,108
Hungary	3,413
Iceland	524
Italy	49,498
Ireland	6,730
Latvia	759
Lithuania	1,152
Luxembourg	1,040
Netherlands	21,052
Norway	10,438
Poland	12,592
Portugal	5,418
Romania	5,197
<u>Slovakia</u>	2,361
<u>Slovenia</u>	1,196
<u>Spain</u>	32,923
Sweden	13,593
Switzerland	17,032
Türkiye	21,212
United Kingdom	67,172
TOTAL MEMBER	486,257
STATE CONTRIBUTIONS	





Human resources

Staff in post

At the end of December 2022, there were 593 staff in post. There were 43 starters and 17 leavers.

Staff nationalities



Engineering	340
● <u>Science</u>	9
Senior management	Į.

• Germany	22.09%
ltaly	17.03%
United Kingdom	14.00%
<u> Spain </u>	13.83%
France	12.14%
Portugal	2.70%
● <u>Türkiye</u>	2.36%
• <u>Romania</u>	1.85%
● <u>Belgium</u>	1.69%
● Other	12.31%

(Netherlands 1.52%, Ireland 1.52%, Poland 1.18%, Finland 1.01%, Greece 0.84%, Hungary 0.84%, Bulgaria 0.67%, Sweden 0.67%, Switzerland 0.67%, Austria 0.51%, Croatia 0.51%, Denmark 0.51%, Lithuania 0.51%, Norway 0.34%, Slovakia 0.34%, Czechia 0.17%, Estonia 0.17%, Slovenia 0.17%, United States 0.17%)

Recruitment and gender balance

6,000 applications were received for vacancies posted in 2022, of which 26.6% were from women.

71 applications were from EUMETSAT staff, with 11 successful internal appointments.

30.7% of staff in post are female

Recruitment 2022 % of female candidates 2022

Gender balance % of females in post at year end

╋	9.	6	%
	incr	reas	se

of female staff in A4-A5 posts (2006-2022)

B grade posts	Applications				2006
Female candidates	Shortlisted				2007
	Suitable				2008
	Appointed		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		2009
					2010
A1 grade posts	Applications				2011
Female candidates	Shortlisted				2012
	Suitable		-		2013
	Appointed		1/2		2014
					2015
A2-A4 grade posts	Applications				2016
Female candidates	Shortlisted				2017
	Suitable				2018
	Appointed				2019
					2020
A4-A5 grade posts	Applications				2021
Female candidates	Shortlisted				2022
	Suitable			 Eurospace ave	rage 2022
	Appointed			22% female	
		Benchmark	based on 🏅		

weighted market data

Bojan Bojkov



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Organisation chart

1 January 2023



EUMETSAT delegate body chairs 2022



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EUMETSAT Council delegates and advisors

Austria	=	France	
Mr A. Schaffhauser	Zentralanstalt für Meteorologie und Geodynamik	Ms V. Schwarz	Météo France
Mr L. Berset	Österreichische Forschungsförderungsgesellschaft	Mr A. Soulan	Météo France
		Ms A. Debar	Météo France
Belgium		Ms L. Frachon	Météo France
Dr D. Gellens	Koninklijk Meteorologisch Instituut	Ms A. Magnoulous	Météo France
Mr P. Rottiers	Belgian Science Policy Office (BELSPO)	Germany	-
Bulgaria	_	Prof G. Adrian	Deutscher Wetterdienst
Prof Dr L Gospodinov	National Institute of Meteorology and Hydrology	Mr M. Rohn	Deutscher Wetterdienst
Prof Dr H. Branzov	National Institute of Meteorology and Hydrology	Dr M. Uphoff	Bundesministerium für Verkehr und digitale Infrastruktur
	National Institute of Meteorology and Hydrology	Dr G. Seuffert	Bundesministerium für Verkehr und digitale Infrastruktur
Prof Dr P. Ninov	National Institute of Meteorology and Hydrology	Mr T. Ruwwe	Deutsches Zentrum für Luft-und Raumfahrt
Croatia		Greece	
		Maj. Gen. D. Sideridis	Hellenic National Meteorological Service
Dr B. Ivancan-Picek	Državni hidrometeorološki zavod	Brg. Gen. A. Gatopoulos	Hellenic National Meteorological Service
Mr I. Guettler	Državni hidrometeorološki zavod	Lt. Col I. Matsangouras	Hellenic National Meteorological Service
Czechia		Hungary	
Mag. M. Rieder	Český hydrometeorologický ústav	Mal Hanna	Owner (ware Matter well (wini Constant)
Mr M. Setvák	Český hydrometeorologický ústav	Mr L. Hanyecz	Orszagos Meteorologiai Szolgalat
Dr J. Stastka	Český hydrometeorologický ústav	Dr K. Radics	Orszagos Meteorologiai Szolgalal
Ms D. Bachmanová	Ministerstvo životního prostředí	Iceland	
Denmark	:=	Dr A. Snorrason	Veðurstofa Íslands
Ms M. Thyrring	Danmarks Meteorologiske Institut	Iroland	-
Mr T. Kjellberg Christensen	Danmarks Meteorologiske Institut	Ireland	
Mr A. H. Müller	Danmarks Meteorologiske Institut	Mr E. Moran	Met Éireann
		Ms J. Prendergast	Met Éireann
Estonia	_	Ms S. O'Reilly	Met Éireann
Mr T. Ala	Estonian Environment Agency	Italy	
Ms K. Rosin	Estonian Environment Agency		
		Brig. Gen. L. Baione	Aeronautica Militare
Fintand	+	Mr A. Raspanti	Aeronautica Militare
Prof Jussi Kaurola	Finnisches Meteorologisches Institut	Mr A. Bartolini	Ministero dell'Economia e delle Finanze
Mr J. Pulliainen	Finnisches Meteorologisches Institut	Dr F. Battazza	Agenzia Spaziale Italiana
		Ms P. Sacco	Agenzia Spaziale Italiana
		Latvia	

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Ar E. Zarins	Latvijas Vides ģeoloģijas un meteoroloģijas centrs
Ir A. Viksna	Latvijas Vides ģeoloģijas un meteoroloģijas centrs

Lithuania

Mr K. Šetkus

Lietuvos hidrometeorologijos tarnyba Ms 0. Snieskaite Lietuvos hidrometeorologijos tarnyba

Luxembourg

Ms M. Reckwerth

Netherlands

Prof. G. Van der Steenhoven	Koninklijk Nederlands Meteorologisch Instituut
Mr H. Roozekrans	Koninklijk Nederlands Meteorologisch Instituut
Mr G. Verver	Koninklijk Nederlands Meteorologisch Instituut

MeteoLux, Administration de la navigation aérienne

Norway

Mr R. Skålin	Meteorologisk institutt
Mr L. A. Breivik	Meteorologisk institutt
Mr S. Rasmussen	Meteorologisk institutt

Poland

Dr J. Karp	Instytut Meteorologii i Gospodarki Wodnej Państwow
	Instytut Badawczy (IMGW)
Mr P. Ligenza	IMGW
Dr A. Rutkowski	IMGW
Mr J. Trzosowski	IMGW

Portugal

Mr J. M. A. de Miranda	Insituto Portugues do Mar e da Atmosfera
Ms I. M. Martins	Insituto Portugues do Mar e da Atmosfera
Mr N. Lopes	Insituto Portugues do Mar e da Atmosfera
Ms I. Trigo	Insituto Portugues do Mar e da Atmosfera

Romania

Ms E. Mateescu	Administrația Națională de Meteorologie
Dr G. Stancalie	Administrația Națională de Meteorologie

Slovakia

Dr M. Benko	Slovenský hydrometeorologický ústav
Mr V. Rak	Slovenský hydrometeorologický ústav

Slovenia

Agencija Republika Slovenija za okolje
Agencija Republika Slovenija za okolje
Agencija Republika Slovenija za okolje

Spain	
Mr MÁ. López González	Agencia Estatal de Meteorologia
Mr M. Manso Rejon	Agencia Estatal de Meteorologia
Ms A. Grande Royo-Villanova	Agencia Estatal de Meteorologia
Mr J. P. Ortiz-de-Galisteo Marin	Agencia Estatal de Meteorologia
Ms M. Lopez	Centro para el Desarrollo Tecnologico Industrial
Sweden	
Mr H. Wirtén	Sveriges meteorologiska och hydrologiska instit
Ms B. Aarhus Andrae	Sveriges meteorologiska och hydrologiska instit
Mr S. Nilsson	Sveriges meteorologiska och hydrologiska instit
Ms E. Strandberg	Sveriges meteorologiska och hydrologiska instit
Switzerland	
Mr P. Binder	Federal Office of Meteorology and Climatology Meteo
Mr B. Calpini	Meteo Swiss
Mr F. Fontana	Meteo Swiss
Türkiye	
Mr V. Mutlu Coskun	Devlet Meteoroloji İşleri Genel Müdürlüğü
Mr Y. Yagan	Devlet Meteoroloji İşleri Genel Müdürlüğü
Mr C. Akin	Devlet Meteoroloji İşleri Genel Müdürlüğü
Mr M. Çelik	Devlet Meteoroloji İşleri Genel Müdürlüğü
Mr M. Altinyollar (Interpreter)	Devlet Meteoroloji İşleri Genel Müdürlüğü
Mr S. Karayususufoglu Uysal	Devlet Meteoroloji İşleri Genel Müdürlüğü
Dr K. Öztürk	Devlet Meteoroloji İşleri Genel Müdürlüğü
United Kingdom	
Mr S. Brown	Met Office
Mr S. Green	Met Office
Ms I. Harrison-Roberts	Met Office
Ms S. Hewitt	Met Office
Ms S. Jackson	Met Office
Mr S. Turner	Met Office
Observers	
European Centre for Mediur	n-Range Weather Forecasts
European Space Agency	
EUMETNET	
European Commission	

National Oceanic and Atmospheric Administration

World Meteorological Organization



EUMETSAT participation in major events in 2022

14th Space Policy Conference	Brussels	25-26 January
102 nd AMS Annual Meeting	hybrid	23-27 January
NOAA High Level Working Group	virtual	11 and 14 March
EUMETSAT Space Weather Workshop	virtual	29 March
Committee on Earth Observation Satellites Strategic Implementation Team meeting	virtual	29-31 March
32 nd ESA - EUMETSAT bilateral meeting	virtual	5 April
Inauguration of the MTG ground segment	Leuk	6 May
CGMS-50, WGIII and WGII meetings	virtual	17-21 May
Living Planet Symposium	Bonn	23-27 May
MTG and EPS-SG User Days	Darmstadt	30 May - 2 June
Coordination Group for Meteorological Satellites-50 (CGMS) plenary session, and CGMS-World Meteorological Organization Space Day	Geneva and h	ybrid 15-17 June
European Union Council Space Working Group	Brussels	21 June
Meteo et Climat	Paris	21 June
15 th EUMETSAT User Forum in Africa	Dar-es-Salan	n 13-16 September
Committee on Earth Observation Satellites Strategic Implementation Team meeting	Frascati	13-16 September
EUMETSAT Meteorological Satellite Conference	Brussels	19-23 September
Meteorological Technology World Expo	Paris	11-13 October
Global Climate Observing System Climate Observation Conference	Darmstadt	17-19 October
Switch to Space 3	Brussels	19 October
Ocean Surface Topography Science Team Conference	Venice	30 October - 3 November
Group on Earth Observations Week 2022	Accra	31 October - 4 November
Hessian Space Event	Frankfurt	4 November
Committee on Earth Observation Satellites plenary	Biarritz 2	9 November - 1 December



Data records released in 2022

In 2022, EUMETSAT released several new, extended, or improved data records, of (re)calibrated and quality-controlled sensor data as well as of validated and quality-controlled geophysical variables. Besides releasing new versions of existing data records, there were several first-time releases.

(2022) First-time release of SEVIRI on MSG Optimal Cloud And (OCA) data record released	alysis (doi: 10.15770/EUM_SEC_CLM_0049)
(2022) First-time release of Metop Multi-sensor aerosol data record released	(doi: 10.15770/EUM_SEC_CLM_0053)
(2022) First-time release of GOME-2 on Metop ozone profiles of the AC SAF	(doi: 10.15770/EUM_SAF_AC_0037)
(2022) First-time release of IASI on Metop atmospheric temperand humidity profiles data records	erature (doi 10.15770/EUM_SEC_CLM_0063)
(2022) First-time releases of third party radio occultation (Cosmic/Champ/Grace) bending angle data records	(doi: 10.15770/EUM_SEC_CLM_0030, 10.15770/EUM_SEC_CLM_0031, 10.15770/EUM_SEC_CLM_0032)
(2022) Release of new version of GRAS on Metop bending and data record	gle (doi: 10.15770/EUM_SEC_CLM_0051)
(2022) Release of new version of sensor data record of HIRS atmospheric temperatures	(doi: 10.15770/EUM_SEC_CLM_0026)
(2022) Release of new version of global ocean and sea ice data records of the OSI SAF	(doi: 10.15770/EUM_SAF_OSI_0013, 10.15770/EUM_SAF_OSI_0015)
(2022) Release of new version of sensor data record microwave imager radiances of the CM SAF	(doi: 10.5676/EUM_SAF_CM/FCDR_MWI/V004)
(2022) First-time release of tropospheric bromine monoxide data record from Metop GOME-2 released	(doi: 10.15770/EUM_SAF_03M_0012)
(2022) Updated/extended release of soil moisture data record v.7 12.5km sampling	(doi: 10.15770/EUM_SAF_H_0009)
(2022) Updated/extended Meteosat cloud data record CLAAS-3 released	(doi: 10.5676/EUM_SAF_CM/CLAAS/V003)



New products released in 2022

ROM SAF: Radio Occultation Processing Package version 11	Released 26 January 2022
AC SAF: SO2 and CO from IASI Metop-C	Released 27 January 2022
NWP SAF: AAP v.8.9 and IASI L1 processor 8.4	Released 22 February 2022
NWP SAF: Pre-processor for MTG IRS (IRSPP version 1.0)	Released 9 March 2022
ROM SAF: Gridded Radio Occultation Sentinel-6 Products	Released 14 March 2022
NWP SAF: Microwave Imager Pre-processor (MWIPP 1.1)	Released 16 March 2022
NWC SAF: GEO Software Package GEO version 2021	Released 12 April 2022
AC SAF: Ozone Profile Data Record from GOME-2	Released 14 April 2022
AC SAF: Ultra-violet Radiation products from Metop-C	Released 20 April 2022
AC SAF: Tropospheric Bromine monoxide (BrO) data record from Metop GOME-2	Released 2 May 2022
AC SAF: Ozone and Nitric acid (HNO3) from IASI	Released 18 May 2022
H SAF: Accumulated rain from passive microwave and scatterometer observation	n Released 9 June 2022
H SAF: Multi-sensor Microwave Precipitation Rate	Released 9 June 2022
H SAF: SEVIRI Accumulated rain: Indian Ocean Coverage	Released 9 June 2022
CM SAF: Microwave Imager Radiance: Fundamental Data Record release 4	Released 4 August 2022
NWP SAF: AAPP version 8.10	Released 9 August 2022
H SAF: ASCAT Soil Moisture Data Record version 7	Released 15 September 2022
NWP SAF: Pre-processor for MTG IRS	Released 12 October 2022
OSI SAF: Pencil beam scatterometer Wind Processor	Released 14 October 2022
NWC SAF: GEO software package GEO version 2021.1	Released 27 October 2022
ROM SAF: Demonstrational NRT RO products from Spire	Released 27 October 2022
OSI SAF: Sea Ice Concentration Data Record version 3	Released 18 November 2022
OSI SAF: Sea Ice Drift Data Record version 1	Released 18 November 2022
NWP SAF: Radiative Transfer Model RTTOV version 13.2	Released 1 December 2022
CM SAF: Meteosat Cloud Data Record CLAAS-3	Released 6 December 2022
Scientific and technical publications 2022

Aguilar Taboada, D. 'Use of All Perturbing Forces in Repeat-Ground-Track Computation'. *28th Int. Symposium on Space Flight Dynamics*. Beihang, China, 2022.

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