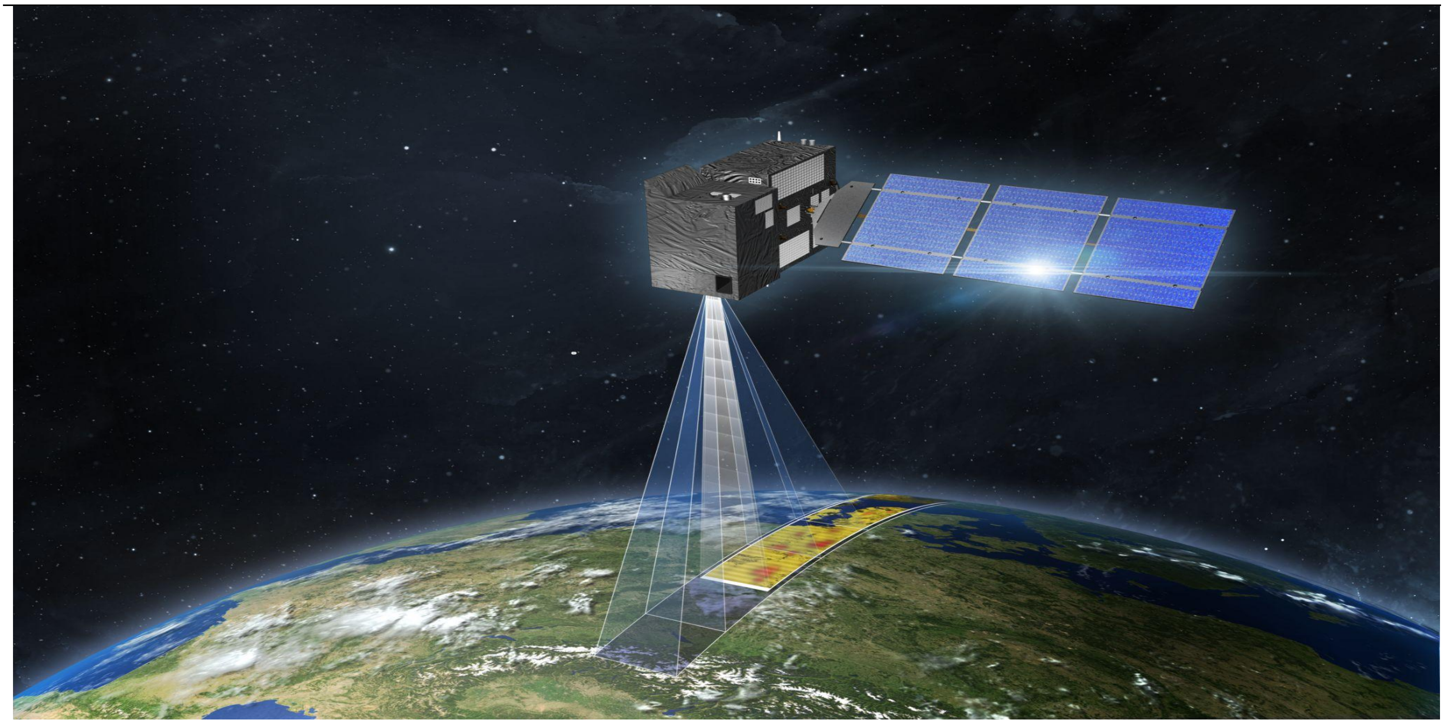
OBSERVER: Advancing Earth Observation with the Copernicus Sentinel Expansion Missions



The Copernicus satellite missions currently in orbit provide invaluable data that feed a vibrant ecosystem of Earth Observation products and services across diverse application areas. Copernicus is served by a set of six dedicated satellite families, the Sentinels, which are specifically designed to meet the needs of the Copernicus services and their users. The Copernicus Sentinel Expansion Missions will further bolster these efforts, providing even deeper insights into the dynamics of our planet. In this week's Observer, we explore each of the Copernicus Sentinel Expansion Missions and how they'll take Earth Observation to new heights.

What are the Copernicus Sentinel Expansion Missions?

The Copernicus Sentinel Expansion Missions are six satellite missions being developed to address gaps in the coverage of Copernicus user requirements and to extend the current capabilities of the Copernicus Space Component. They're being developed by several European partners, including the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

The Copernicus Sentinel Expansion Missions will represent a major leap forward in Europe's Earth Observation capabilities. With missions such as CO2M tracking greenhouse gas emissions, CIMR providing detailed insights into sea ice and the polar environment, CHIME gathering hyperspectral observations from the earth surface, CRISTAL monitoring ice thickness and change, LSTM mapping land surface temperature variations, and ROSE-L improving radar observations, users will be equipped with more precise data on the state of our planet.

With the first new satellite mission expected to launch as early as 2026, and others to follow over the next decade, here's a rundown of what we can expect from them.

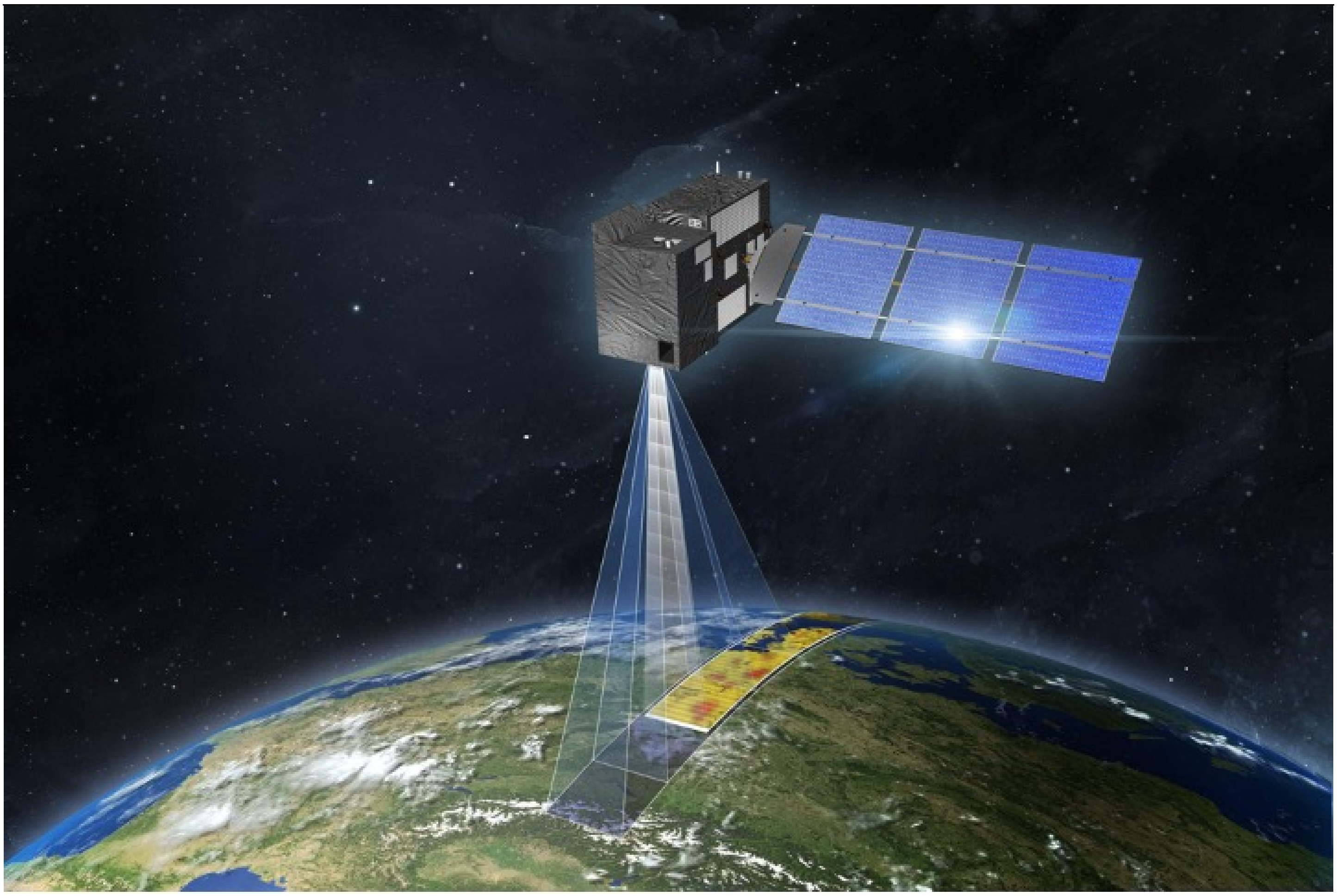
CO2M

The Copernicus Anthropogenic Carbon Dioxide Monitoring (CO2M) mission will be the first to be launched in the series. It will involve two satellites, CO2M-A and CO2M-B, which are currently being developed and are expected to be launched in 2026. There is the possibility of a third unit, subject to the availability of funding, which would improve the probability of detection of large CO2 emitters, such as power plants. The CO2M satellites are expected to operate for seven and a half years in orbit and will orbit the Earth in sun-synchronous orbits at an altitude of 735 km.

These satellites will look at three important metrics in the fight against climate change: carbon dioxide (CO2) methane (CH4), and Nitrous oxide (NO2) emissions from human sources.

CO2M will be equipped with three instruments including the Integrated CO2 and NO2 Imaging Spectrometer (CO2I), the 3-band Cloud Imager (CLIM), and the Multi-Angular Multi-band Polarimeter (MAP). But the CO2M satellites won't work alone. While the satellites operate high in the sky, far above the Earth's atmosphere, a new global system will help track emissions on a regional and national scale. This system is the CO2 Monitoring and Verification Service (CO2MVS), which will be implemented within the Copernicus Atmosphere Monitoring Service (CAMS). Satellite observations will be combined with ground-based measurements and modelling in the CO2MVS to distinguish human-made emissions from natural sources such as plants and animals.

CO2M's main goal is to help us track greenhouse gas emitters and transparently assess which nations are on track to meet the emissions targets set by the Paris Climate Change Agreement.


Artist's impression of a CO2M satellite. Credit: OHB, ©ESA

CIMR

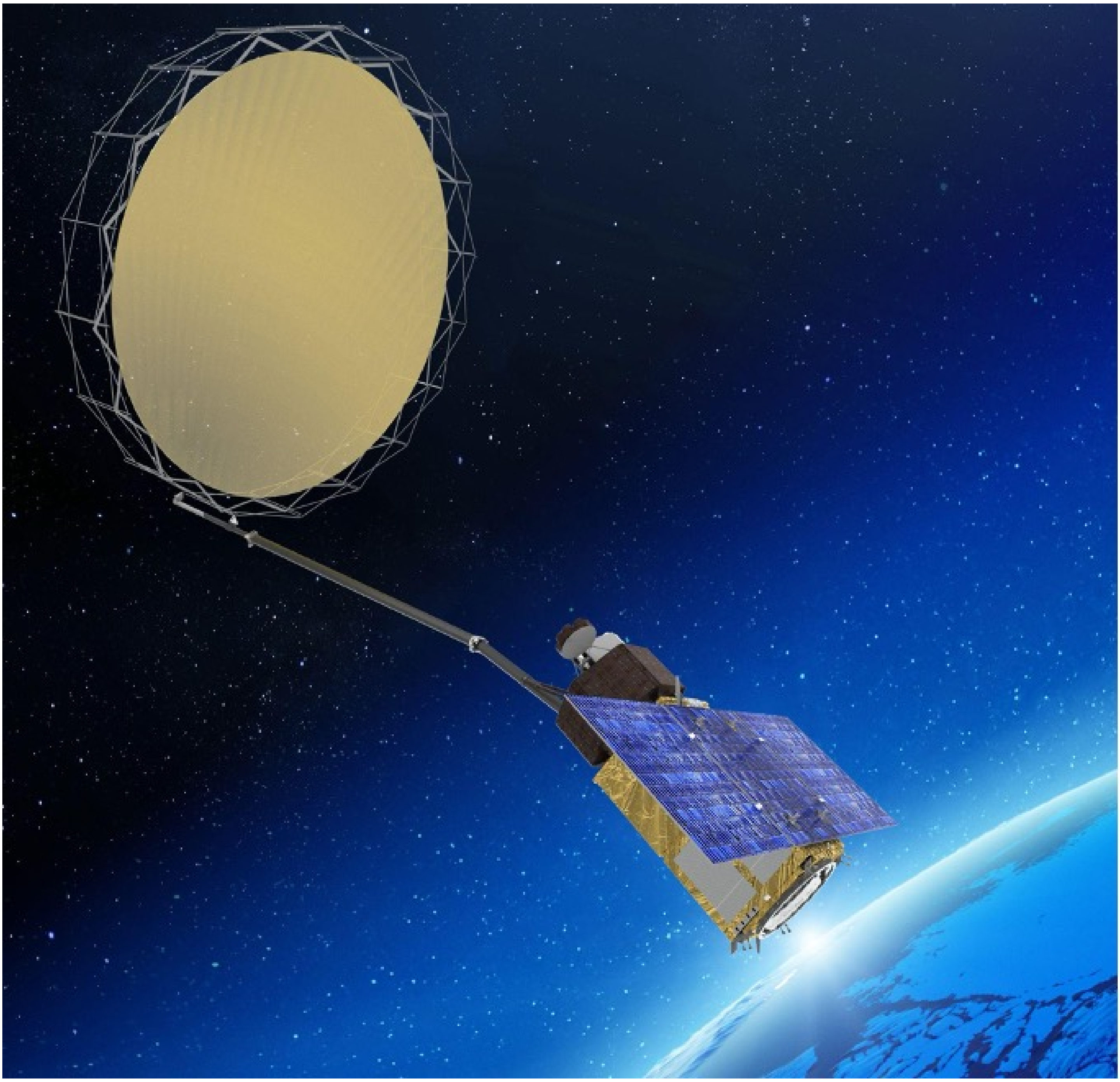
The Copernicus Imaging Microwave Radiometer (CIMR) mission consists of up to three satellites with the first two, CIMR-A and CIMR-B scheduled for launch in 2029 and 2031 respectively. The satellites have a planned lifespan of seven years. Positioned in quasi-polar orbits, these satellites will follow near-circular, sun-synchronous orbits, allowing scientists to closely observe changes over time in ice- and sea-covered regions.

CIMR will be equipped with radiometer imagers and support the EU Arctic Policy by measuring:

- Sea Ice Concentration/Extension (SIC/SIE) for sea ice thickness, drift and type;
- Sea Surface Temperature (SST) and Sea Surface Salinity (SSS);
- Other variables important for environmental monitoring such as soil moisture, wind speed, snow extent, etc.

The imagers will record SST frequently (sub-daily) with a spatial resolution of 15 km. Surface salinity will be recorded more precisely at a resolution of 5 km, also sub-daily, and sea ice concentration at a resolution of 5 km, will be observed once a month.

CIMR will improve coverage of sea ice and of the Arctic environment and support European researchers in analysing and addressing the impacts of climate change in these regions, and also to extend the capabilities previously provided by earlier L-band satellite missions such as SMOS, Aquarius, and SMAP.



Artist's impression of CIMR. Credit: Thales Alenia Space

CHIME

The Copernicus Hyperspectral Imaging Mission (CHIME) will consist of two satellites, CHIME-A and CHIME-B, to be launched in 2028 and 2030 respectively. The satellites have an expected operational lifespan of seven years but will be launched with sufficient consumables to allow them to remain operational for up to 12 years. They will orbit Earth in a sun-synchronous manner at an average altitude of 632 km, covering land areas globally. This wide coverage is important because CHIME is intended to assist in land monitoring and complement the work of the Copernicus Sentinel-2 satellites.

CHIME will be equipped with a HyperSpectral Imager (HSI). With this instrument, the two satellites will acquire data each 11 days with a ground resolution of 30 metres and a swath width of 130 km, providing precise measurements in over 200 bands across the visible, near-infrared and short-wave infrared spectra.

CHIME will cover a range of areas, from small islands to open shallow waters. By providing systematic hyperspectral imagery, CHIME will help us map changes in land cover, which in turn will allow us to assess and monitor different ecosystems. These detailed and routine hyperspectral measurements from CHIME will provide crucial support to EU and related policies for the management of natural resources and assets.


Artist’s impression of CHIME. Credit: Thales Alenia Space

CRISTAL

Successor to the ESA CryoSat-2 satellite mission, the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) mission will be our eyes on Earth’s ice. It will be launched in 2027 and will consist of two identical altimetry satellites.

Operating in a drifting polar orbit at an altitude of approximately 699 km, CRISTAL will carry an Interferometric Radar altimeter for Ice and Snow (IRIS) and a Microwave Radiometer (MWR). IRIS will be used to measure the thickness of sea ice and of the snow covering it, as well as the height of the world's ice sheets and glaciers. Its dual-frequency operation will provide more accurate measurements than previous ice-monitoring altimeters. As the first high-resolution operational radar altimeter mission for the cryosphere and the only radar altimeter mission reaching high latitudes greater than 82°, CRISTAL is uniquely positioned to monitor small changes in sea ice thickness and changes in the height of the ice sheets and glaciers located in polar regions. These measurements will not only provide valuable data for understanding polar ice dynamics but will also assist in the planning of activities in the polar regions. With a planned lifetime of seven and a half years, CRISTAL will provide important insights into the Earth's changing cryosphere, responding to the needs for safeguarding the Arctic and monitoring climate change in the EU Arctic Policy.

Artist’s impression of a CRISTAL satellite. Credit: Airbus, ©ESA

LSTM

The Land Surface Temperature Monitoring (LSTM) mission is scheduled to join the Copernicus Sentinel system in 2028 to provide actionable information to improve sustainable agricultural productivity and adapt to climate variability. The mission has an expected lifetime of seven and a half years and will consist of two satellites, LSTM-A and LSTM-B. The satellites will operate in a low Earth polar orbit with a combined two-day revisit period at the equator and will each be equipped with radiometers covering the thermal and visible spectral range.

These instruments will provide high-resolution observations of land and coastal areas and will map the Earth's land surface temperature (LST), emissivity, and evapotranspiration rates every 1-2 days, depending on the latitude and cloud coverage. LSTM will provide LST observations at field scale with a 50 m resolution, covering a wide temperature range with an accuracy of 1 K. The mission will thus complement the global land surface temperature climate records provided by Sentinel-3 and eventually Sentinel-3 Next Generation at 1 km and 500 m respectively, by providing LST at high resolution.

With LSTM, we'll improve the way we monitor evapotranspiration rates, map soil composition and make detailed observations of land surface temperature variability. The resulting data and products will help with applications as diverse as coastal zone management, monitoring of extreme temperature events, and support urban planning as part of climate adaptation measures to avoid urban head island effects. Data from LSTM will also be useful for policy making and monitoring of policy goals including the UN Sustainable Development Goals, the UN Convention for Combating Desertification and Land Degradation, the UN Water Strategy, the EU Common Agricultural Policy (CAP), the EU Policy Framework on Food Security, the EU Water Framework Directive, and the EU 2030 agenda for Sustainable Development.

Artist’s impression of an LSTM satellite. Credit: Airbus

ROSE-L

The [Radar Observing System for Europe in L-band] (ROSE-L) mission, scheduled for launch in 2028, is Copernicus’ next step in radar observations. The two-satellite mission will operate in [a sun-synchronous orbit] at an altitude of 693 km and carry one instrument: the ROSE-L Synthetic Aperture

Radar (SAR), designed to provide high-resolution, all-weather imaging with a spatial resolution of 5-10 m.

This new radar system can work in synergy with other Copernicus SAR-based space elements operating at a different frequency, namely Sentinel-1, which operates in C-band. While Sentinel-1's C-band capabilities have been very useful for monitoring global land masses, coastal zones and shipping lanes, ROSE-L will take them to the next level. Unlike Sentinel-1's C-band, L-band SAR can penetrate the ground to different depths depending on the soil condition. This means that ROSE-L will improve our ability to monitor geohazards and observe and track land use, while providing high-resolution soil moisture data. ROSE-L will also support maritime monitoring, including iceberg detection, oil spills, and vessel detection and mapping.

In addition, ROSE-L will play an important role in monitoring the Arctic and cryosphere by producing geospatial maps of sea ice at a resolution of 20 m. During its seven-and-a-half-year lifetime, the ROSE-L mission will serve the needs of many users, including those involved with the Copernicus Land Monitoring (CLMS) and Emergency Management services (CEMS).

Artist’s impression of a ROSE-L satellite. Credit: Thales Alenia Space