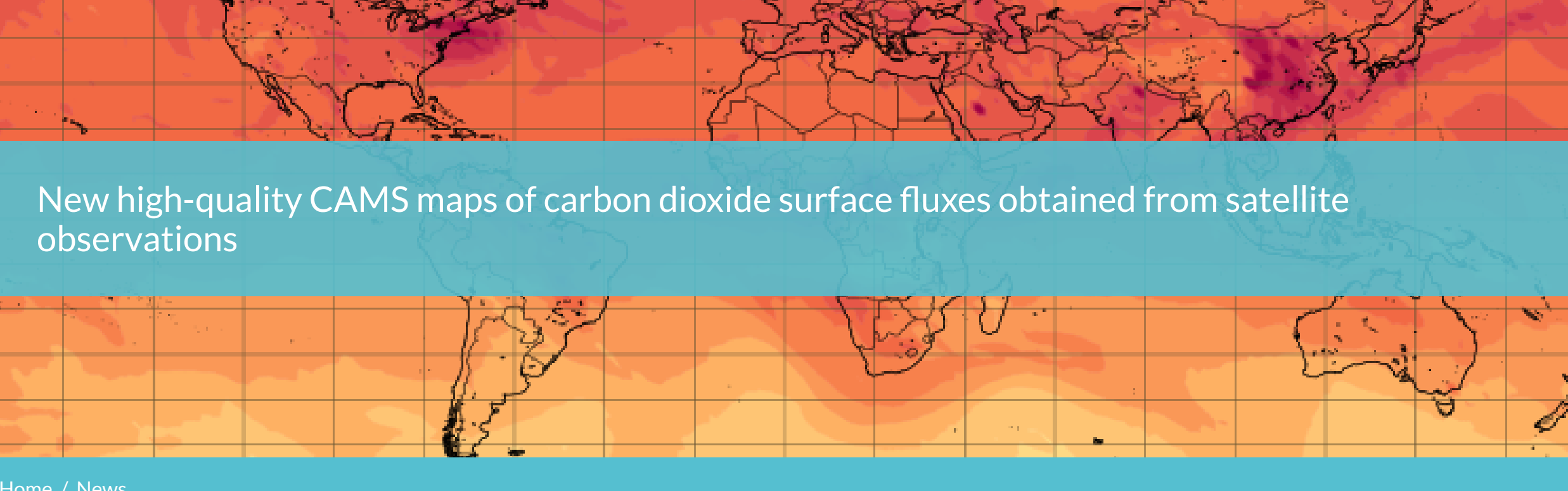




New high-quality CAMS maps of carbon dioxide surface fluxes obtained from satellite observations

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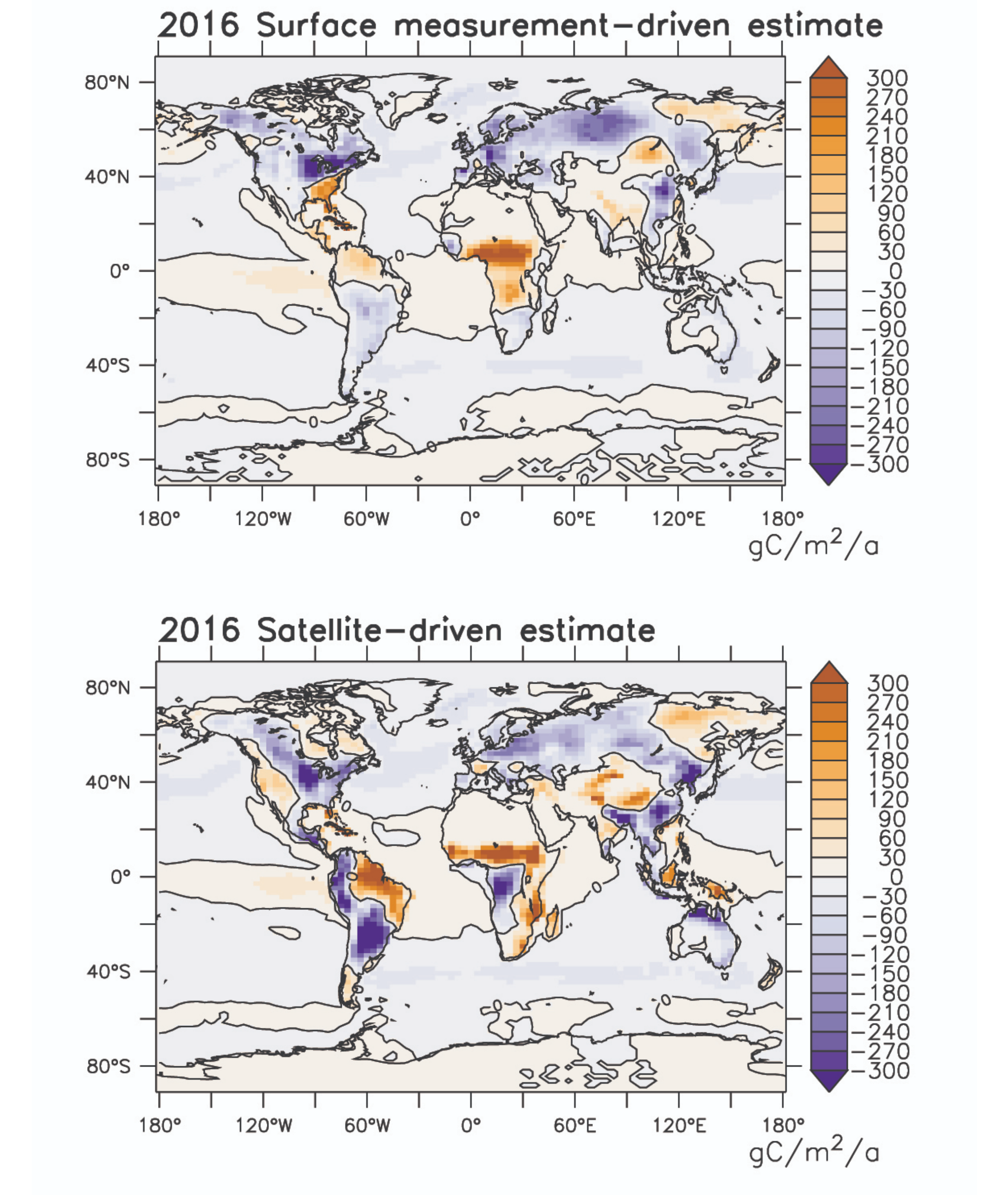
10th December 2019



Carbon dioxide (CO₂) is the main greenhouse gas produced as a result of human activities. In 2018, more than 10 billion tonnes of carbon were released into Earth's atmosphere by the combustion of fossil fuels. As a primary driver for climate change, it is more vital than ever that we have access to accurate information about the levels of CO₂ in our atmosphere and about its sources and sinks.

Ambitious research using data from the Copernicus Atmosphere Monitoring Service (CAMS) will allow the quality of CO₂ surface flux estimates inferred from satellite observations to be as good as the quality of estimates obtained via ground-based monitoring, and will introduce benefits only made possible by using space-based instruments.

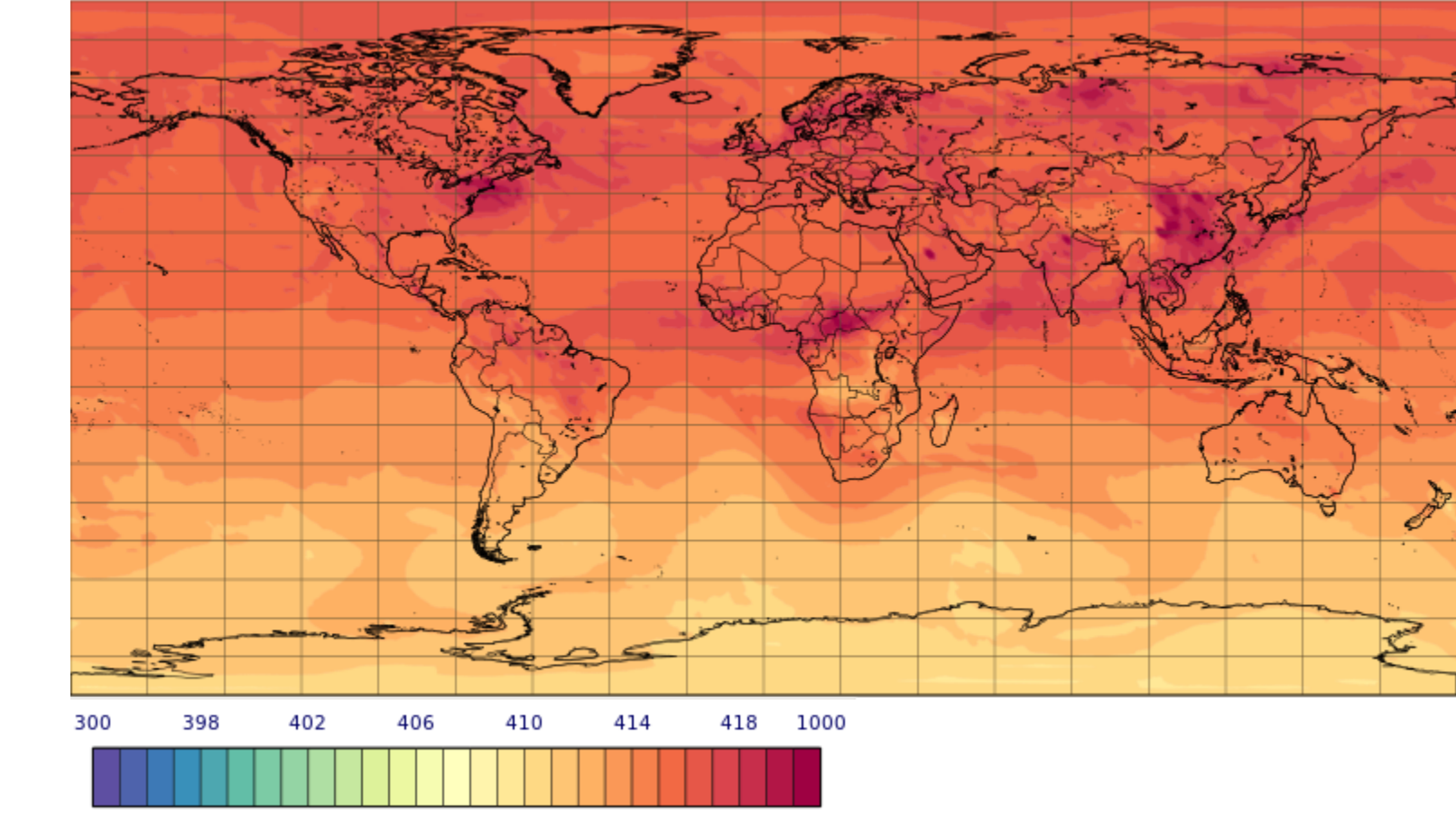
For decades, scientists have been measuring CO₂ concentrations. CAMS, which is implemented by the European Centre for Medium-Range Weather Forecasts (ECMWF) on behalf of the EU, and its precursor projects have used data from more than 100 sites around the world to map the 'surface net fluxes'. These fluxes result from the sum of CO₂ sinks, such as oceans and photosynthesis by plants, and of CO₂ sources, including the respiration of vegetation. Complementing this has been an effort to greatly increase the amount of data available by using dedicated satellites, such as the Japanese Greenhouse Gases Observing Satellite (GOSAT) and NASA's second Orbiting Carbon Observatory (OCO-2).



Estimated natural fluxes for 2016, in grams of carbon per square meter per annum, with sources shown in orange and sinks in blue. The top map uses surface measurements, while the bottom one uses satellite observations. There are some differences where surface measurements are sparse (e.g. in the Tropics), but consistent patterns in Eurasia and Northern America. (Credit: Copernicus Atmosphere Monitoring Service, ECMWF)

The observation of CO₂ concentrations in the atmosphere requires exceptionally fine detection capabilities and processing quality. Satellites generate huge quantities of raw data, but rely upon complex numerical modelling to create reliable observations of CO₂. Maps of CO₂ sources and sinks deduced from these observations depend on exactly how raw data are processed, and had been of limited accuracy.

Combating this challenge is Frédéric **Chevallier** from the Laboratory for Sciences of Climate and Environment (LSCE) in France, which coordinates the greenhouse-gas fluxes aspect of CAMS. LSCE has been leading on **new research**, in partnership with colleagues from the OCO-2 science team. Chevallier explains: "Surface measurements of CO₂ tend to sample the lowest part of the atmosphere with high accuracy. However, these measurements are mostly taken from easily accessible regions of developed countries. Satellite observations of CO₂ are much less accurate but they cover most parts of the globe. They also represent the whole vertical column of CO₂ rather than a specific altitude. Both types of observations are therefore complementary, but the processing chains from these observations up to the maps of CO₂ surface fluxes are so complex that consistent results between the two types of models had not been seen before, to our knowledge."



Thanks to the increasing quality of the processing of satellite observations from OCO-2, and improved numerical models of atmospheric transport, CAMS is now able to use satellite data to map CO₂ sources and sinks to a quality that matches those obtained with ground-based measurements, but with wider global coverage.

"This achievement is a key stepping stone for the efforts we lead at ECMWF on behalf of the European Commission to support the development of a global monitoring and verification support capacity of the carbon cycle and carbon emissions using the complementarity of surface and satellite observations," says Jean-Noël Thépaut, Director of the ECMWF Copernicus Services.

Higher quality maps of surface sources and sinks of atmospheric CO₂ will allow for greater understanding of biogeochemical cycles – the mechanisms underlying carbon sources and sinks – to help anticipate climate change. In addition, they will allow for better monitoring of regulatory policies, such as identifying CO₂ sinks to preserve and strengthen them, measuring sources to aid regulation, and monitoring reductions that have been promised by governments, for example in the **Nationally Determined Contributions** of the 2015 Paris climate agreement.

Buoyed by success, Frédéric and his team are planning their next steps. "Satellite observations are available faster than most surface measurements so we plan to update and extend the satellite-based model faster and more often than the model created from ground-based observations. We are also studying the combination of satellite and surface observations: we hope to provide robust carbon flux estimates for large countries to help them monitor their impact on climate. Lastly, we will continue to monitor the quality of other satellite products like those of GOSAT and help prepare future satellite missions, like the French-UK MicroCarb (planned for 2021) or the Copernicus CO₂ Monitoring mission (planned for 2025-2026)."

The CO₂ data are now available publicly on the **CAMS server**.^[1]

[1] The data set is FT18r1

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