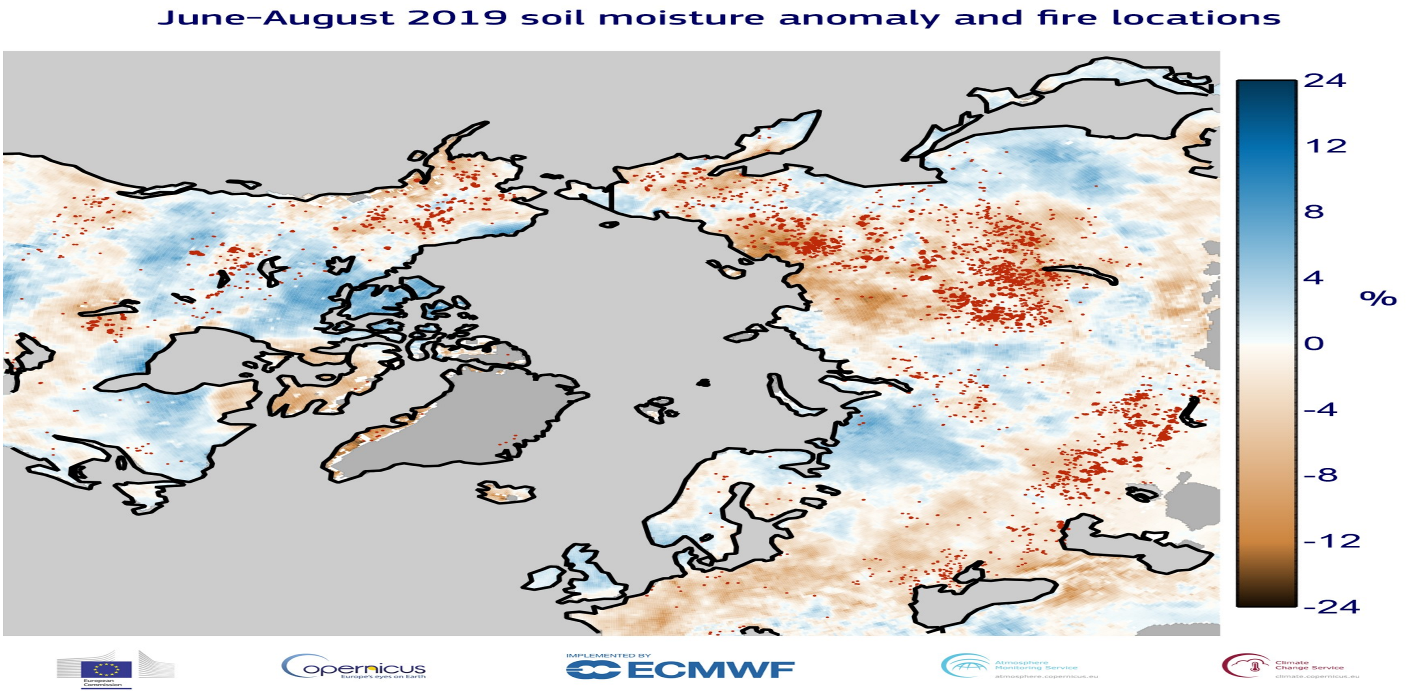
OBSERVER: Copernicus services enable civil authorities to anticipate the spread of wildfires and to assess air pollution from forest blazes

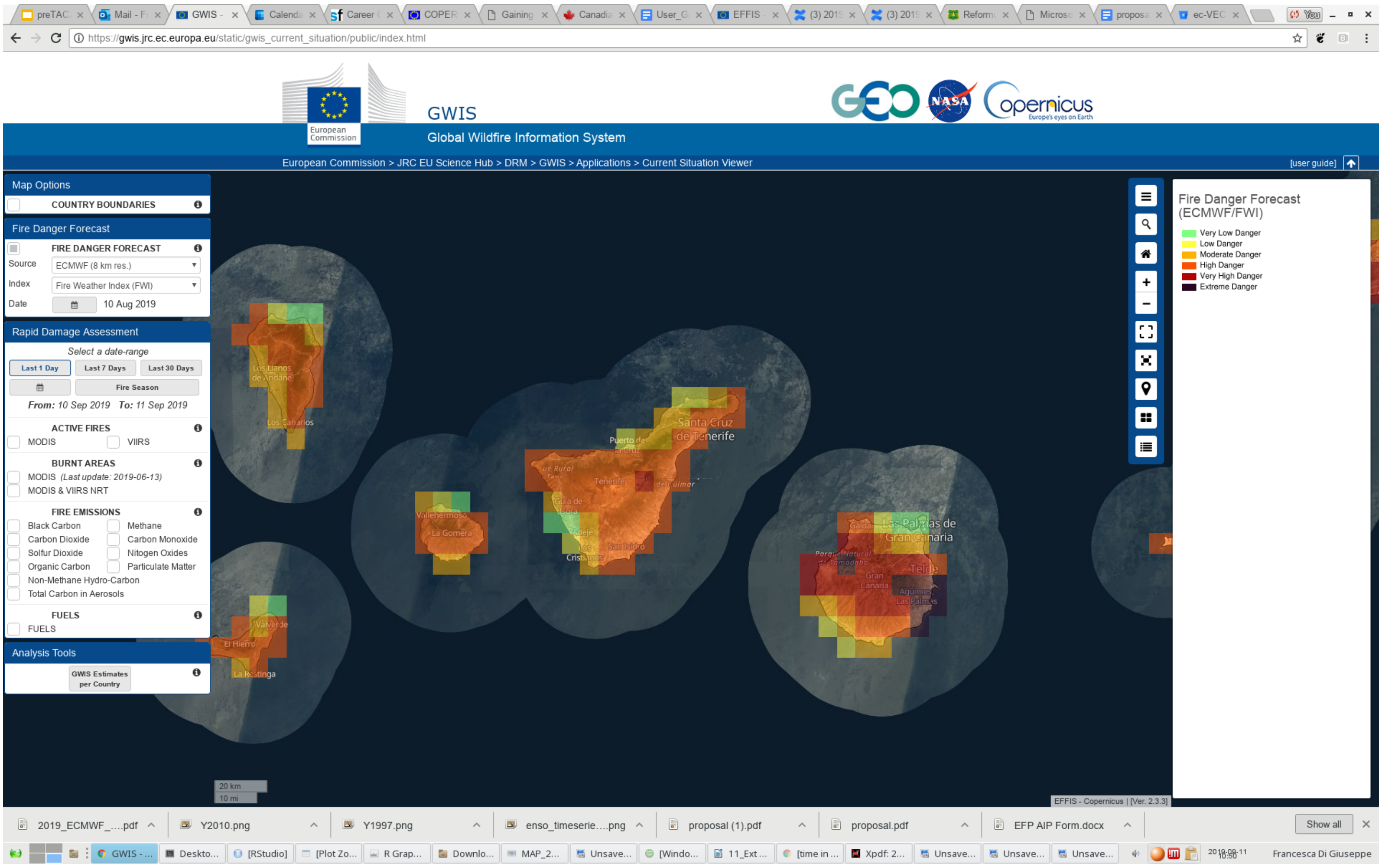


Wildfires are a natural part of the Earth's ecology as they return nutrients from dead wood and dense undergrowth to the soil. They can, however, also lead to the loss of human and animal life, damage to property and the emission of atmospheric pollutants that can travel thousands of kilometres. Rising summer temperatures and the increased frequency of droughts due to climate change compound the risk by providing ideal conditions for fires to spread. Observations and forecasts are therefore vital to identifying potential hotspots and to managing the effects of these mostly human-induced events.

In this Copernicus Observer edition, you can learn how the Copernicus Atmosphere Monitoring Service (CAMS), the Copernicus Climate Change Service (C3S) and the Copernicus Emergency Management Service (Copernicus EMS) play an essential role in helping local authorities and other actors to anticipate wildfire risk across multiple timescales while mitigating the effects on public health via air-quality monitoring.

Fires pose a major threat in parts of Europe and the rest of the world. Unusual blazes in the Arctic Circle, southern Europe and Sweden are just a few examples of the damage that record-high air temperatures and a lack of rainfall can bring during the summer season. In 2017, wildfires in Europe killed 127 people, burnt about 1.2 million hectares of forest and land, and incurred an economic cost of almost 10 billion euros. Such emergencies are a global phenomenon and frequently threaten parts of Australia, Brazil, Canada, South Africa and the United States.

Copernicus, the European Union's Earth observation programme, uses the information from a network of dedicated 'Sentinel' satellites along with that from other satellites, sensors on the ground, in the air and at sea to monitor the planet's environment. These vast amounts of data are compiled into six operational services, including CAMS and C3S, which are both implemented by the European Centre for Medium-Range Weather Forecasts (ECMWF) on behalf of the EU. By making information openly accessible and available free of charge, CAMS and C3S help civil authorities to assess the effects and risk of wildfires on different time scales in cooperation with a third service, [Copernicus EMS](), which is administered by the EU's Joint Research Centre and includes the European Forest Fire Information System ([EFFIS]()).



A wildfire in Gran Canaria on Saturday 10 August 2019 burnt an area of about 1200 ha with a fire perimeter of about 15 km. This forecast from EFFIS/GWIS shows the extreme fire danger around that date. (Credit: Global Wildfire Information System, Copernicus Emergency Management System; EU Joint Research Centre.)

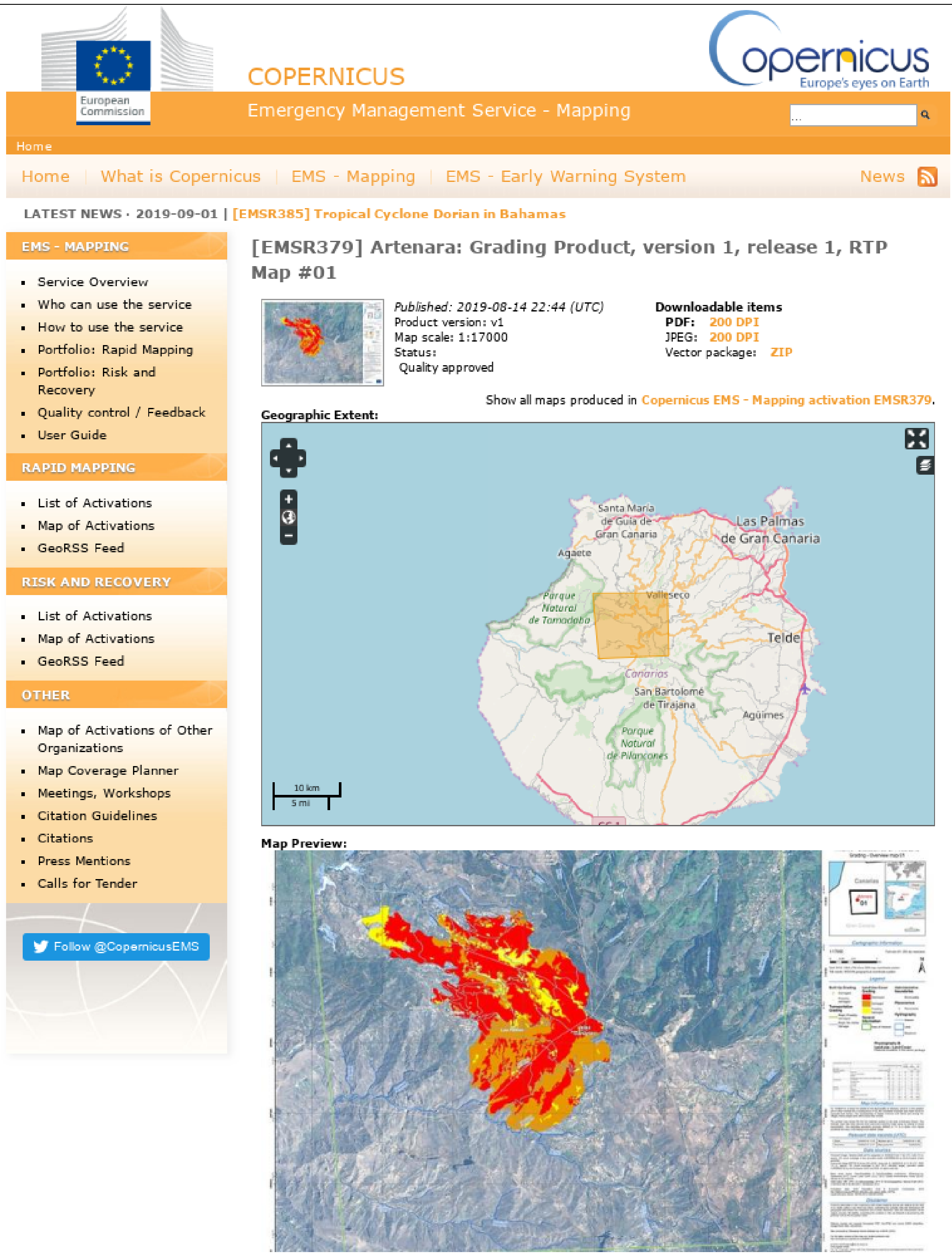
The Copernicus programme provides a range of services over various timescales to limit the risks and effects of wildfires. CAMS carries out real-time monitoring of active fires and their emissions, while C3S makes long-term observations and projections based on various climate-change scenarios. Copernicus EMS offers fire-danger forecasts for up to 10 days ahead as well as a rapid mapping service that tracks the spread of active blazes, which are identified by thermal anomalies in satellite images.

Fires need fuel, oxygen and heat in order to be ignited and sustained. Dry vegetation, low soil moisture and high air temperatures are all contributing factors, but they do not provide a direct cause of ignition. About 85 percent of wildfires in the United States are triggered by humans who have left campfires unattended, burnt debris, operated faulty equipment, discarded lit cigarettes negligently or committed an act of arson, according to the US National Park Service. Fires are sometimes lit for other reasons: in Brazil, for example, farmers burn vegetation in the dry season to clear land for cattle or crops. Forest fires can also have natural causes, such as lightning or volcanic eruptions.

"*In populated areas, most fire ignitions are caused by humans*. *But an ecosystem needs to regenerate vegetation, so fires would occur even if humans didn't exist. Self-ignition happens in remote areas of Australia and Siberia, for example. There are also secondary ignitions when strong fires emit sparks that are transported by the movement of air masses, often for many kilometres*," says **Francesca Di Giuseppe**, the principal scientist in charge of the Fire Forecast system at ECMWF, which provides operational predictions to EFFIS for Copernicus EMS.

Copernicus EMS relies on EFFIS for near-real-time and historical data on forest fires in Europe, Africa and the Middle East. Established by the European Commission in collaboration with national fire administrations, EFFIS is part of a broader effort to coordinate a joint response to disasters through the EU Civil Protection Mechanism, which is supported by the fire-mapping services of Copernicus EMS through the network of Sentinel satellites.

Set up as an operational service in 2000, EFFIS provides information on pre-fire conditions and assesses post-fire damage. It predicts fire danger, detects active blazes, assesses their severity and land-cover impact, and estimates potential soil loss as well as vegetation regeneration. The Global Wildfire Information System (GWIS) is a larger twin service that is backed by the Copernicus and NASA programmes, among others, and covers all regions of the world.



Post-fire analysis of the fire blazing on Gran Canaria on 10 August 2019. (Credit: Copernicus Emergency Management System; EU Joint Research Centre.)

"*To support EFFIS, we identify potential hotspots and forecast weather conditions that would allow a fire to be sustained or to spread*," **Di Giuseppe** says. "*The idea is to highlight regions that could produce an uncontrollable fire if ignition takes place. With this information, the fire emergency services in each nation can focus more on localised regions rather than having to monitor the whole country*."

At the end of each fire season, EFFIS provides a report for the member states in Europe, with an assessment of the damage for that period. This is produced as part of the Copernicus service, but it is not yet available globally. A fire-danger reanalysis product also allows scientists to see how extreme the fire season was compared with other years. These data will soon be included in the C3S Climate Data Store, a one-stop shop for information about the Earth's past, present and future climate.

Land devastation is not the only effect of wildfires, whose emissions impact air quality; increasing atmospheric concentrations of gases such as carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3) and other toxic pollutants can also be damaging to human health. While short-term exposure is unlikely to cause any long-term illness, it can lead to premature death in individuals with respiratory or cardiovascular diseases, according to the US Environmental Protection Agency.

"Wildfires are a significant source of chemical species that influence global atmospheric composition and air pollution, so reliable and accurate CAMS forecasts require up-to-date information on emissions," says CAMS Senior Scientist **Mark Parrington**. *"As a consequence of this, we provide very timely data on the location and intensity of wildfires globally and can use this to monitor how fires are changing over time."*

CAMS monitors forest fires and their associated pollutants through observations from the MODIS instrument on NASA's Terra and Aqua satellites, with plans to add data from Copernicus Sentinel-3 soon. CAMS incorporates 'fire radiative power' data into its Global Fire Assimilation System (GFAS) to produce daily estimates of biomass burning emissions. Information about injection heights is also derived from fire observations and meteorological data from ECMWF's operational weather forecasts. Determining the altitude at which emissions are injected into the air helps scientists predict a fire's environmental impact.

CAMS forecasts successfully show how smoke aerosols and pollutants are transported from fires worldwide every day. Among others, smoke transport from fires across central Siberia and the outflow of smoke from fires in southern tropical Africa out over the Atlantic Ocean were demonstrated. Last month, CAMS forecasted how biomass burning aerosols from fires in the Amazon rainforest spread as far as the Atlantic coast, causing skies to darken over São Paulo, a city of more than 12 million people in eastern Brazil.

"The CAMS data made it possible to place the beginning of this year's fire season in the Amazon within the context of the previous 16 years. The CAMS forecasts of aerosol, carbon monoxide and other species also showed just how far the smoke was transported. Both of these factors contributed to the media storm surrounding the fires," **Parrington** says.

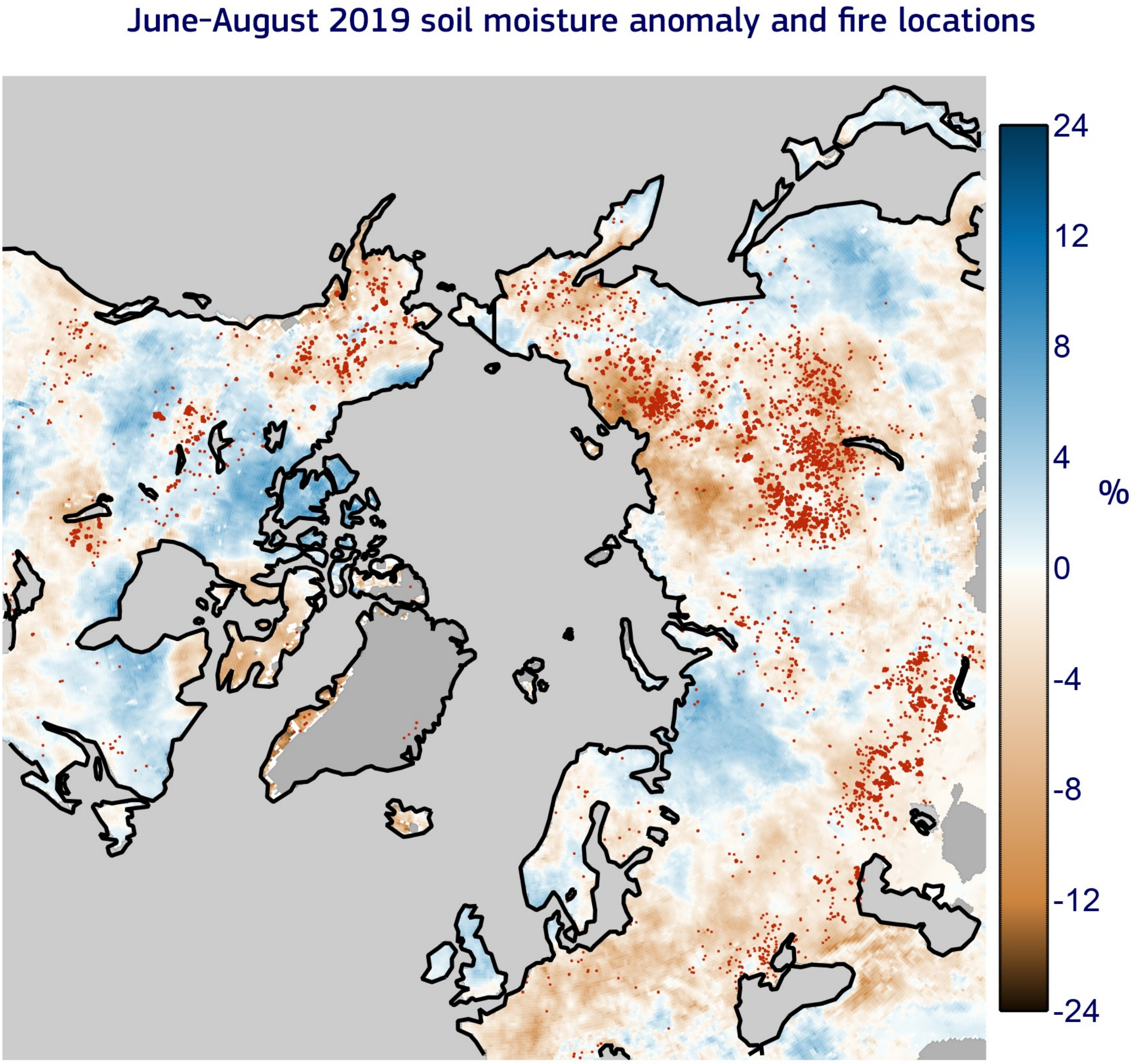
The GFAS is being upgraded to include observations from other instruments and satellites covering the globe. Its data archive on individual wildfire activity stretches back to 2003 and is available online and free of charge. CAMS helps policymakers and civil authorities address the issue of atmospheric pollution, while keeping the general public informed about potential health risks. Smartphone apps such as airText and the Plume Air Report include CAMS forecasts to help users limit their exposure to airborne toxins and allergens. Daily air-quality information is also broadcast on Euronews.

Over the longer term, C3S helps to manage wildfire risk by monitoring a range of variables – including air temperature, precipitation and soil moisture – that have an impact on the level of fire danger and help scientists to ascertain why a particular blaze broke out. In order to identify droughts, like the one in northern and central Europe in 2018, the service provides soil-moisture products based on satellite data and on reanalysis, a description of the recent climate based on observations and computer models. C3S includes such information in its annual European State of the Climate with retrospective assessments of wildfire risk compared with an average year.

"*High temperatures and dry conditions tend to go hand in hand with higher-than-average wildfire danger*," says C3S Senior Scientist **Freja Vamborg**. "*Outbreaks are much more likely when these factors coincide, providing there are enough ignition sources. The risk varies each year across regions: in 2018, it was higher than average in northern Europe during the severe drought, but southwestern Europe was at greater risk in 2017, when it was particularly warm and dry there.*"

In a changing climate, the factors that contribute to wildfires are changing too, many of which could lead to increased fire risk, such as rising temperatures and more frequent droughts in certain parts of the world. One way of looking at wildfire risk within this context has been shown by a demonstrator project within the C3S Sectoral Information System over the past two years. This initiative uses the Fire Weather Index (FWI) – developed in Canada and widely regarded as the most reliable indicator of fire danger – to assess such risk to the tourism sector in Europe. The FWI factors in the moisture content of potential fuel as well as indices that reflect the spread rate, fuel consumption and intensity of a fire if it were to start. This autumn, web users will be able to access two related products through the Climate Data Store: an FWI for the coming season and a wildfire dataset based on climate projections for the period up to 2100. Both products focus on Europe.

The Copernicus programme's collaborative monitoring of wildfire risk provides authorities on the ground with a head start in their efforts to limit the damage from such events. Human lives are saved, businesses are able to adapt and the environmental consequences are better understood when reliable data are available to the people who track nature's rage each summer.



June-August 2019 soil moisture anomaly compared to the 1981-2010 reference period, based on the ERA5 dataset. Fire locations (red dots) during June-August 2019 based on the Global Fire Assimilation System (GFAS) dataset. (Credit: Copernicus Climate Change and Atmosphere Monitoring Services; European Centre for Medium Range Weather Forecasts)