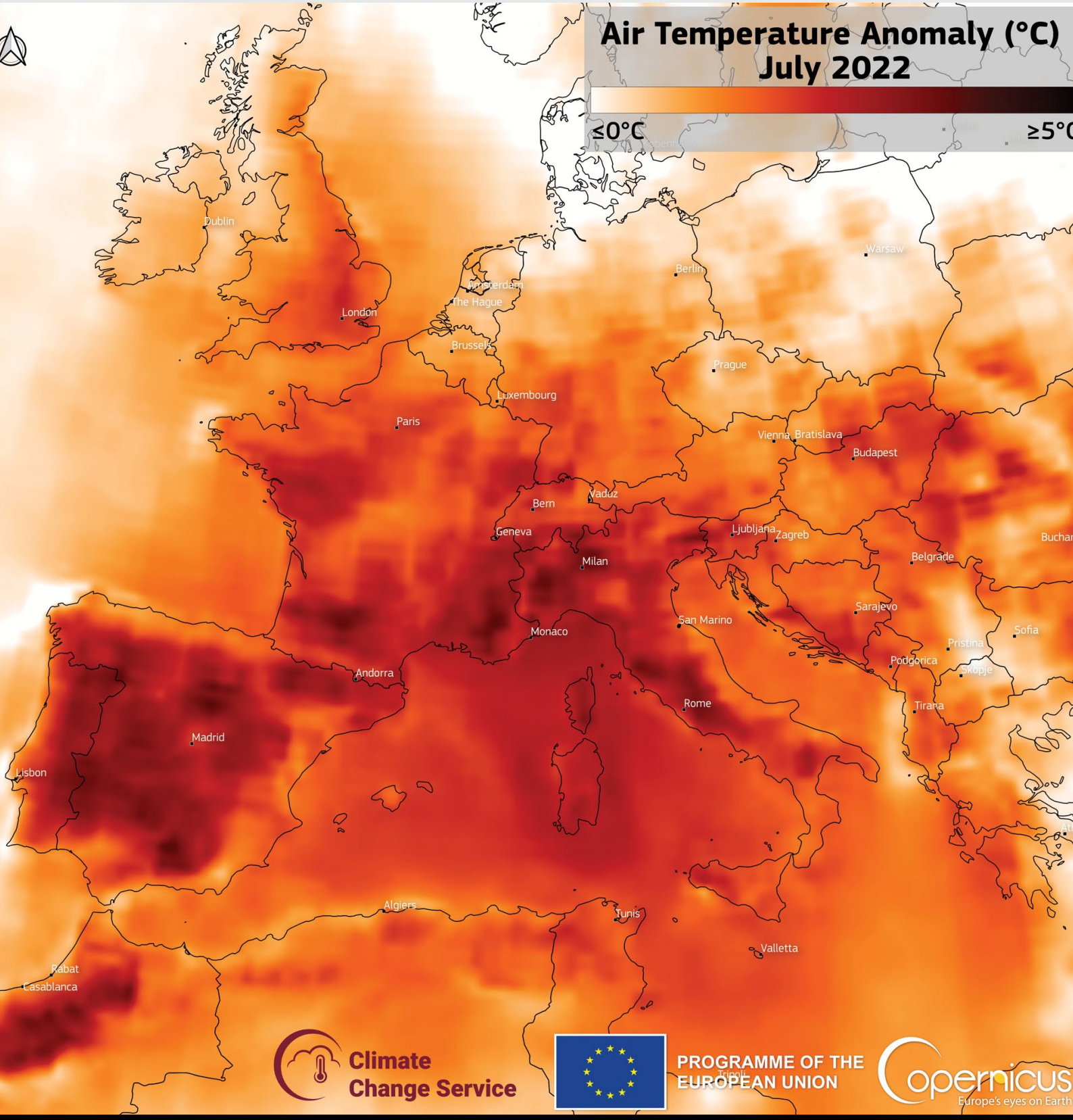
GEO Newsletter

Group for Earth Observation

Group for Earth Observation

No 75 - September 2022



July 2022 was characterised by intense, and in some parts prolonged, heatwaves which affected Europe and the rest of the world, breaking several air temperature records. As reported in the latest Climate Bulletin published by the *Copernicus Climate Change Service* (C3S), July 2022 was one of the three warmest Julys on record globally and the sixth warmest July for Europe. This image, created using data retrieved from C3S, shows the Surface Air Temperature Anomaly for June 2022. As highlighted by the darkest shaded red colour, temperature anomalies reached peaks of +4ºC in Italy, France, and Spain.

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Useful User Groups

Weather Satellite Reports

This group provided weekly reports, updates and news on the operational aspects of weather satellites.

https://groups.io/g/weather-satellite-reports

SatSignal

This end-user self help group is for users of David Taylor's Satellite Software Tools, including the orbit predictor WXtrack, the file decoders GeoSatSignal and SatSignal, the HRPT Reader program, the remapper GroundMap, and the manager programs - MSG Data Manager, GOES-ABI Manager, AVHRR Manager etc.

https://groups.io/g/SatSignal

MSG-1

This forum provides a dedicated area for sharing information about hardware and software for receiving and processing EUMETCast data.

https://groups.io/g/MSG-1

GEO-Subscribers

This is the official group is for subscribers of the Group for Earth Observation (GEO), aimed at enthusiasts wishing to exchange information relating to either GEO or Earth Observation satellites.

https://groups.io/g/GEO-Subscribers/

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From the Editor

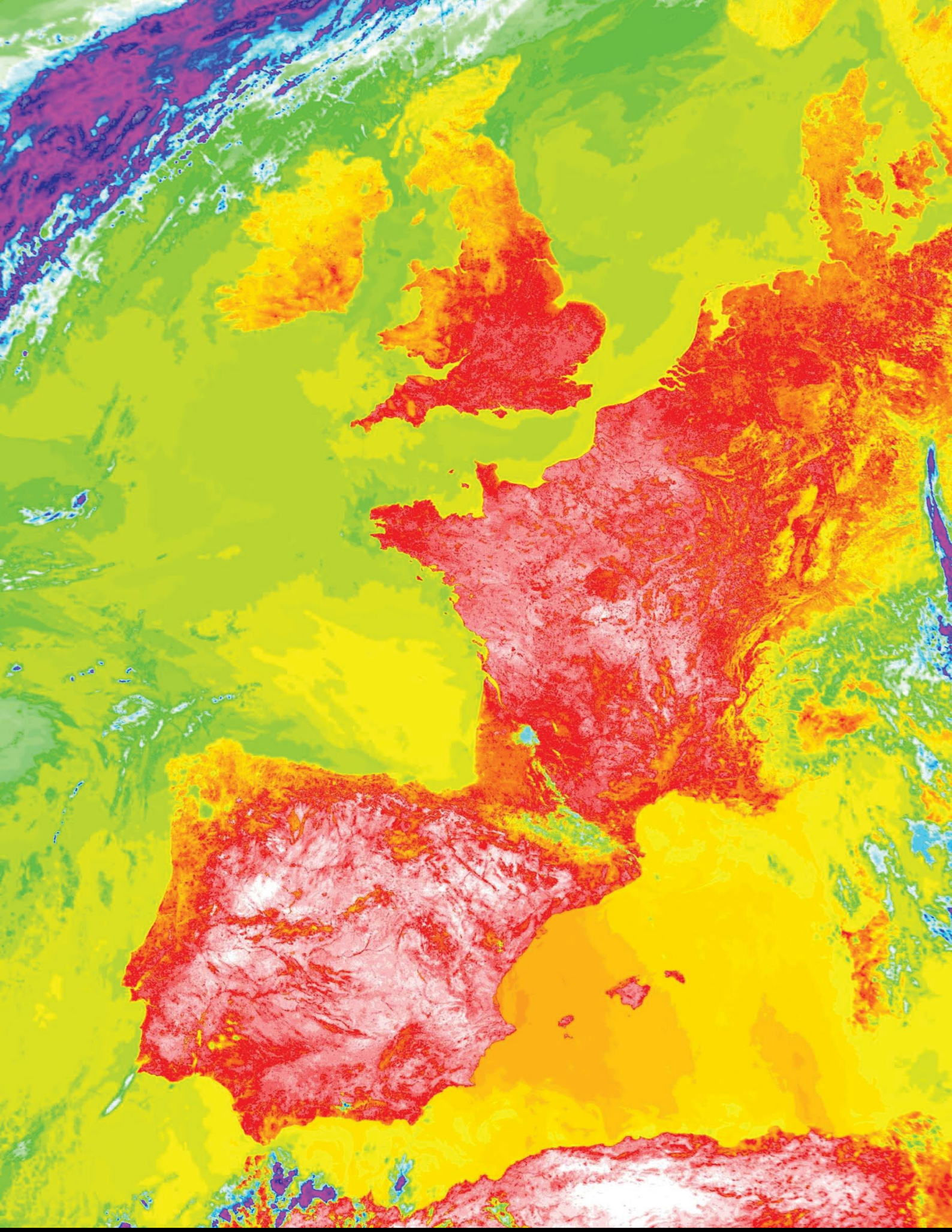
Les Hamilton

What a summer it's been in the Northern Hemisphere this year, with heatwaves, droughts, record high temperatures and forest fires galore! A temperature of 40.3°C recorded at Coningsby, Lincolnshire on July 19 broke the UK all-time record, the first occasion the 40-degree mark had been topped there, and another record was set in Spain, with 47.6°C at La Rambla meteorological station near Cordoba. Indeed, on that day, the only European nations that failed to record a temperature in excess of 35°C were Iceland (30.5 °C) and Ireland (33.3 °C).

All this emphasises, if ever the need were required, for mankind to address the problems of Climate Change with the utmost urgency. And by way of contrast, with much of Europe and North America facing severe drought, Australia was experiencing record flooding rainfall in the east of the country. The front page image from the *Copernicus Climate Change Service* illustrates the temperature anomalies over Europe this July.

According to the latest report '*Drought in Europe - August 2022*' recently published by the European Drought Observatory (EDO) of the Copernicus Emergency Management Service (CEMS), Europe is experiencing its worst drought in centuries, which is causing a severe impact on the energy sector and on summer crop yields. Reports on pages 33 and 34 show starkly just how badly the Rhine and Yangtze rivers have been affected this summer.

Contents



This thermal false-colour image from Metop-C, submitted by John Tellick, was acquired at 09:56 UT on August 12, 2022 illustrates heat across Europe and the UK on the hottest day of the 2nd UK heatwave on August 12th.

Young, Active Bagana Volcano

NASA Earth Observatory

Story by Sara E Pratt

NASA Earth Observatory image by Joshua Stevens, using Landsat data from the U.S. Geological Survey. .

Bougainville Island in Papua New Guinea hosts three large volcanoes along its mountainous middle: Mount Balbi, Mount Bagana, and the Mount Takuan volcanic complex. Of these, only Mount Bagana is currently active.

Since Bagana was first viewed by scientists in the 1840s, it has been erupting nearly nonstop. The remote volcano extrudes thick, blocky, slow-moving andesitic lavas. These have built the stratovolcano to a height of 1,850 metres above sea level. The large, symmetrical cone formed over 300 to 500 years, making it one of the youngest and most active volcanoes in the South Pacific. Lava descends the flanks on all sides of the volcano, forming lobes up to 50 metres thick. A small lava dome is sometimes observed near the summit.

Since February 2000, Bagana has been in an eruptive period, according to the *Smithsonian Global Volcanism Program*. Recent lava flows are visible in this image acquired on May 28, 2022, by the Operational Land Imager-2 (OLI-2) on Landsat 9. The fresh lava is dark brown, while lighter brown areas were probably stripped of vegetation by volcanic debris or acidic gases. Older lava flows are covered in light green vegetation, and the surrounding forests are dark green. The volcanic plume, as well as some nearby clouds, are white.

Bagana is also a ‘remarkable emitter of sulphur dioxide’, according to recent research. The volcano belches out several thousand tons of the air pollutant per day, the most of any volcano in the world without a lava lake.

Such robust volcanic activity is due to the geologic setting. In the southwest Pacific, the Australian and Pacific plates are converging at a rate of about 11 centimetres per year, a slow-motion collision with big consequences. As one plate dives down below the other in a process called subduction, a deep-sea trench forms at the leading edge of the lower plate, and volcanoes form on the overlying plate. But these forces are ever shifting. The island of Bougainville formed mainly in two geologic stages. About 45 million years ago, the Pacific Plate was subducting beneath the Australian Plate. Volcanoes began to build up on the sea floor. Then, around 10 million years ago, the direction of subduction changed and the Australian Plate began to subduct beneath the Pacific Plate. This activity produced the more recent volcanic rocks of Bougainville Island, and later led to the formation of Bagana Volcano.

Sea Ice in the Barents Sea, Kolguyev Island, Novaya Zemlya

MODIS Web Image of the Day

https://modis.gsfc.nasa.gov/gallery/showall.php

As days lengthen and air temperatures increase in late spring, the wintery covering of sea ice worn by the Barents Sea begins to melt. With daytime temperatures in Murmansk, Russia reaching 10°C since May 6, and night time lows above freezing since May 10, regional melting has become more rapid in late May 2022. Murmansk is located to the west of the area captured in this image.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's Terra satellite acquired this true-colour image of the Barents Sea on May 31. At that time, although most of the Barents Sea was open water, thin filigrees of floating sea ice remained visible between the round Kolguyev Island, in the west, and the Novaya Zemlya group of islands in the northeast. The landmass sitting in the southeast belongs to the Zapolyarny District of Nenets Autonomous Okrug, Russia. Fast ice (ice clinging to a landmass) remains along Novaya Zemlya, the edges and bays of the Zapolyarny District, and in a very few locations along the northeastern and southwestern edges of Kolguyev Island. In the far northeast, behind Novaya Zemlya, abundant sea ice remains in the Kara Sea, although it is cracked and thinning.

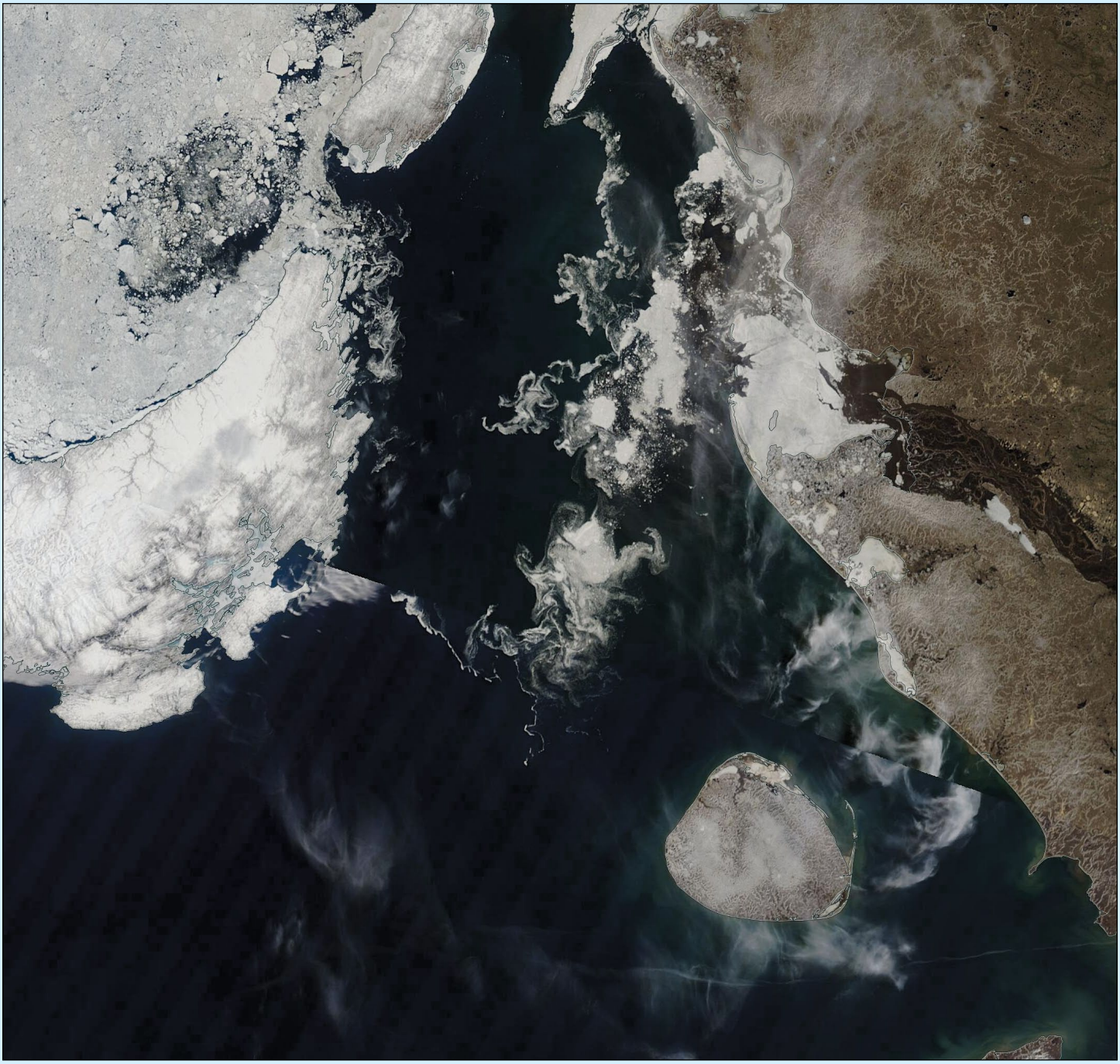


Image Credit: MODIS Land Rapid Response Team, NASA GSFC

Tenoumer Crater, Mauritania

Les Hamilton

Figure 1 - Tenoumer Crater, Mauritania
Image: Wikimedia / Credit: Michael Dennig

Earlier this year, I was intrigued by a NASA internet article relating to Tenoumer Crater [1]. I had never previously heard of this feature but once I saw the image above I was sufficiently impressed to learn all I could about it.

When the term 'Meteor Crater' crops up, everyone automatically thinks of the famous Barringer Crater in Arizona. Barringer is often dubbed the "Best preserved crater on Earth", but the secluded and largely unknown Tenoumer Crater certainly gives it a run for its money. A statistical comparison between the two craters is shown in the table directly below.

	Tenoumer Crater	**Barringer Crater**
Width	1900 metres	1200 metres
Depth	200 - 300 metres	170 metres
Rim	110 metres	45 metres
Age	21,400 ± 9,700 years	50,000 years

As this data clearly shows, the much younger Tenoumer Crater, located at latitude N22°55′ and longitude W10°24′ in the western Sahara Desert in Mauritania, scores in every category. The crater is exposed at the surface and is nearly circular with its edges rising as high as 110 metres above the surrounding terrain. The depth of the crater is difficult to ascertain precisely as it is buried by between 200 and 300 metres of unconsolidated sediments: as you

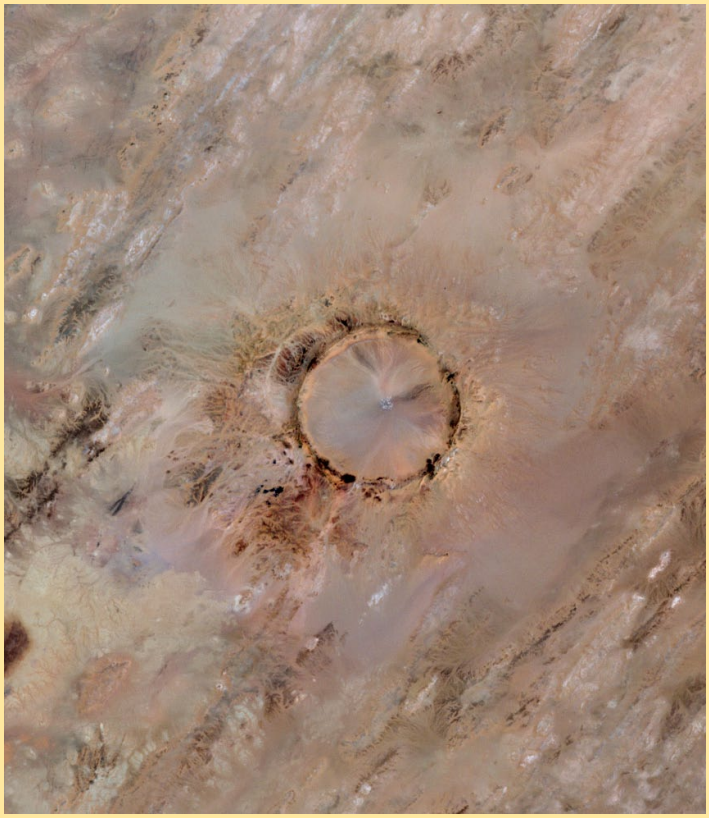


Figure 2 - Tenoumer Crater imaged by ESA's Sentinel-2 mission on May 16, 2022.
Image: modified Copernicus Sentinel data (2022), processed by ESA, CC BY-SA 3.0 IGO

might expect from its location in the Sahara, this sediment is most probably largely windblown material accumulated during the aeons since the crater formed.

Prior to 1970 there was much debate concerning the origin of Tenoumer Crater: was it the product of vulcanism or the result of a meteorite strike? Scattered rocks in the immediate vicinity of the crater were very similar to basalt and rhyodacite, both of which are characteristic of vulcanism and were formerly attributed to be evidence of an outpouring of lava. However, the crater lies in the Reguibat Shield, a stable peneplain consisting of Precambrian granite and gneiss at least two billion years old, surfaced by a thin layer of Pliocene sediments which were deposited no more than a mere 2.5 million years ago. In 1970, the crater, which is located on top of these recent deposits was confirmed to be of meteoritic origin.

The rocks and outcrops surrounding the feature, formerly attributed to a volcanic event, were found to contain inclusions of the two billion year old granitic basement rocks. These inclusions exhibited distinctive features considered to be indicative of shock-wave action and thus diagnostic for a meteorite impact, such as small fractured glass inclusions, quartz grains exhibiting planar deformation and partial fusion and decomposition of biotite grains inter alia.

Figure 3 is the original image that sparked my interest in Tenoumer Crater. It was acquired by the *Advanced Spaceborne Thermal Emission and Reflection Radiometer* (ASTER) instrument carried by NASA's Terra satellite on January 24, 2008. In this simulated true colour image, the arid landscape appears in varying shades of brick red, brown, and tan. The crater's outline is unmistakable, yet doesn't necessarily look like a crater; the light and shadows make it look more as if someone has pressed a giant cookie cutter into the rock. In this image, the sunlight shines from the southeast (lower right), and the bright arc along the northwestern part of the crater is where the crater walls slope up to the rim. Elsewhere around the perimeter, the relatively steep walls cast dark shadows.

Figure 3 - Tenoumer Crater imaged by the ASTER instrument aboard NASA's Terra satellite
NASA image created by Jesse Allen, using data provided courtesy of NASA/GSFC/METI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team.

Figure 4 - A view over the sediment-filled crater
Credit: unknown

References

1 https://www.earthobservatory.nasa.gov/images/8536/tenoumer-crater-mauritania
2 https://www.esa.int/ESA_Multimedia/Images/2022/06/Tenoumer_Crater_Mauritania
3 https://en.wikipedia.org/wiki/Tenoumer_crater
4 https://www.anews.com.tr/life/2022/07/03/incredible-image-of-tenoumer-one-of-the-best-preserved-craters-in-the-world
5 https://www.wondermondo.com/tenoumer-crater/

Hurricane Agatha over Mexico

MODIS Web Image of the Day

https://modis.gsfc.nasa.gov/gallery/showall.php

Hurricane season in the eastern Pacific arrived to an early and potent start. Though May storms are rare there, Hurricane Agatha struck western Mexico, near Puerto Escondido, bearing maximum sustained winds of 169 kilometres per hour on May 30, 2022. That made the Category 2 storm the strongest May hurricane to make landfall along the Pacific coast of Mexico since modern record keeping began in 1949, according to the National Hurricane Center (NHC). Agatha was only the third hurricane to make landfall in Mexico during the month of May.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's Aqua satellite acquired a true-colour image of Hurricane Agatha on May 30, 2022, as the storm was making landfall over Mexico. Agatha brought intense downpours and howling winds to several tourist beaches and fishing towns in an otherwise sparsely-populated region before weakening rapidly as it moved northward over the mountainous terrain of southern Mexico. The strong winds and drenching rain triggered landslides and, as of the evening of May 31, ten people had been reported killed in Oaxaca, Mexico with another 20 people missing.

At 11:00 am EDT on May 31, the NHC issued its final advisory on Agatha, stating that the storm had dissipated over the rugged terrain of southeastern Mexico. At that time, they forecast that heavy rains from the remnants of Agatha could precipitate up to 40 cm on parts of Mexico.

The eastern Pacific hurricane season officially runs from May 15 through November 30 with the peak months of the season from July through September. NOAA's seasonal outlook for the eastern Pacific hurricane season in 2022 indicates that a below-normal season is likely. The Atlantic hurricane season begins on June 1 and ends November 30, and the seasonal outlook there predicts a more active season than normal.

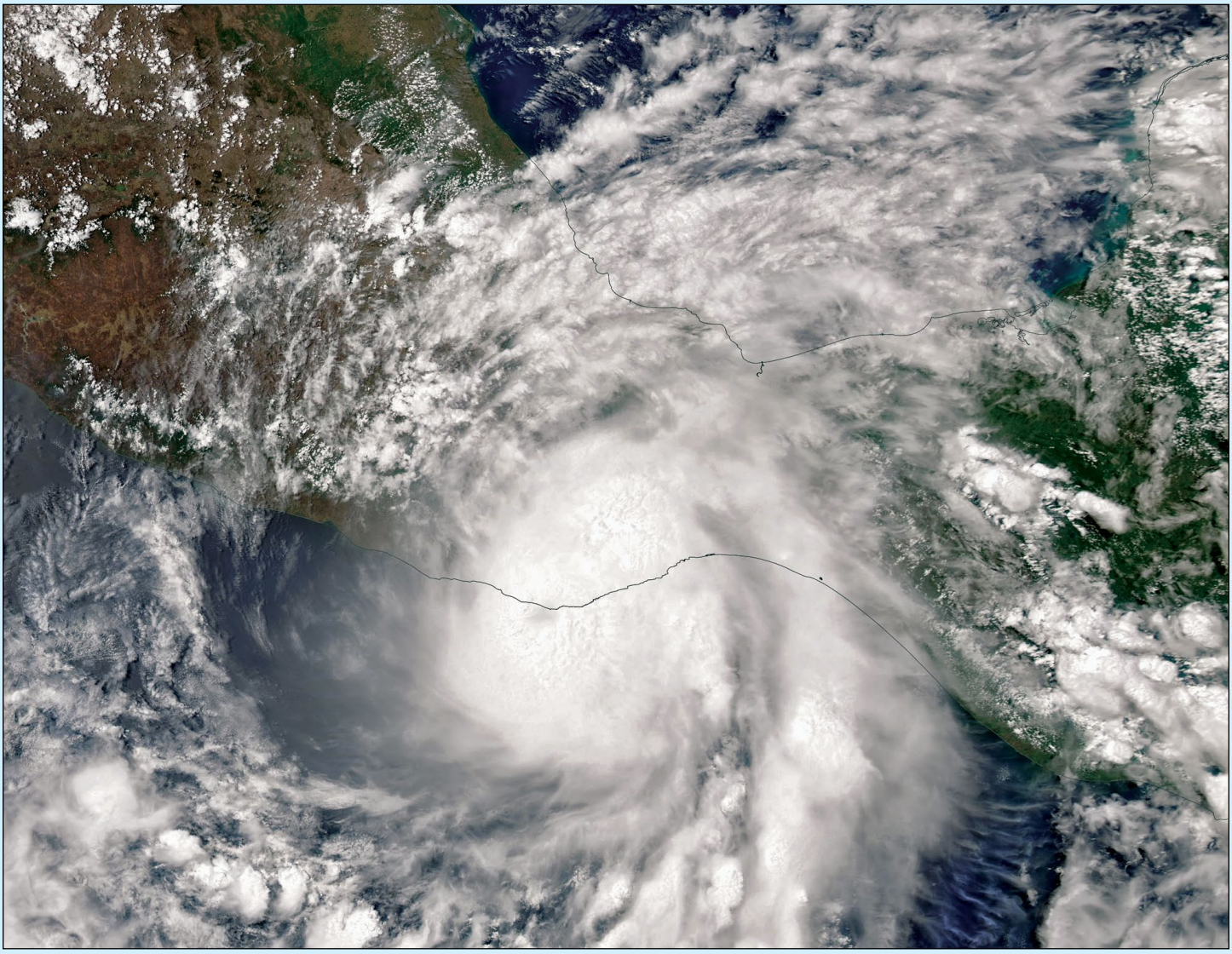


Image Credit: MODIS Land Rapid Response Team, NASA GSFC

Europa Island

NASA Earth Observatory

Story by Kathryn Hansen

NASA Earth Observatory images by Lauren Dauphin, using Landsat data from the U.S. Geological Survey.

Several volcanic seamounts and hundreds of volcanic cones rise above the floor of the southern Mozambique Channel. A few of the larger volcanic features are capped with flat expanses of carbonate that breach the water's surface, forming low-lying coralline islands. Europa is one such island.

Europa Island is the focus of this image, acquired on April 3, 2022, with the Operational Land Imager-2 (OLI-2) on Landsat 9. It is part of an overseas French territory that includes the Îles Éparses, or 'scattered islands,' dispersed around Madagascar. Mozambique on the African mainland lies about 500 kilometres to the west, and Madagascar sits about 300 kilometres to the east.

Europa Island spans about 28 square kilometres, making it the largest of the Îles Éparses. It was initially an atoll that became exposed at the sea surface around 90,000 years ago. The atoll progressively filled in, and it slowly transformed into the island we know today. A belt of nearly pristine coral reefs now hugs the coastline. These 'fringing' reefs span about 18 square kilometres, with a healthy 80% coverage of live corals. An abundance of fish, including sharks, cruise the reefs.

Another important habitat—the Grand Lagoon—cuts far into the island. Saltwater mangroves dominate the lagoon's shoreline, while a sandy beach covers its western side. This beach, the lagoon, and the island's shore all support each life stage of the island's numerous sea turtles. Europa has been called the largest nesting site for green turtles in the Western Indian Ocean.

Vegetation across much of the island has probably not changed much since naturalists started visiting in the early 20th century. Dry forests still grow along the oldest and highest parts of the island, where the ground is rocky. Herbaceous plants and grasses spring from the newer surfaces that rise just a few centimetres above sea level, and bushes prefer the coastal areas. The native vegetation provides critical breeding habitat for seabirds, including the red-tailed tropicbird, the red-footed booby, and the great and lesser frigatebird.

The most obvious evidence of human activity in these images are an airstrip, built in 1973 when a military camp was established, and the nearby sisal plantation planted by a family that attempted to settle on the island in the early 1900s. Several attempts to settle on the island since 1860 have failed, possibly because of the lack of fresh water. Today the only human presence is the French military and the occasional visiting scientist.

Heatwaves and Fires Scorch Europe, Africa, and Asia

NASA Earth Observatory

Story by Sara E. Pratt

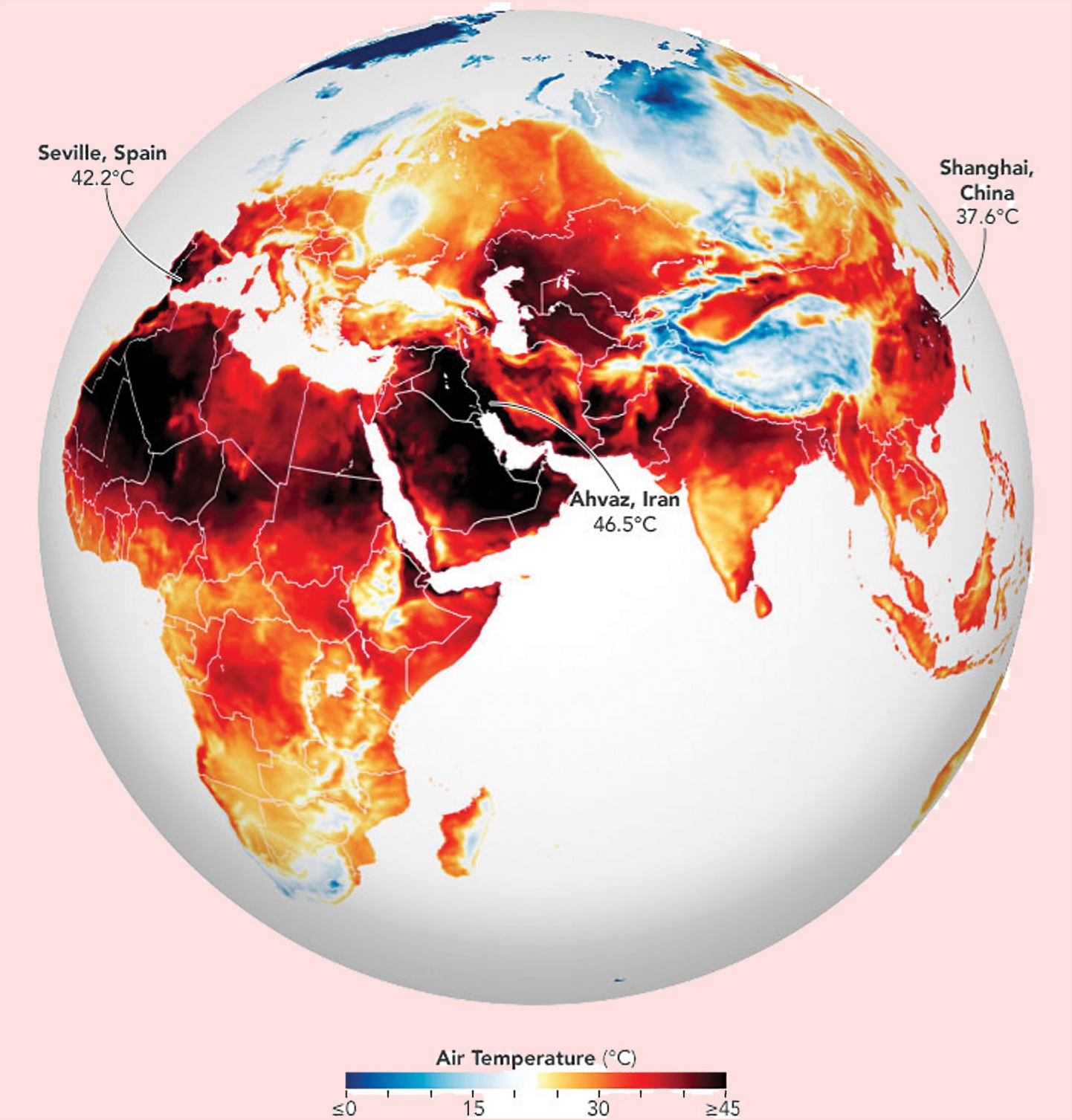


Figure 1 -Temperature map for July 13, 2022
NASA Earth Observatory image by Joshua Stevens, using GEOS-5 data from the Global Modeling and Assimilation Office at NASA GSFC.

In June and July 2022, heatwaves struck Europe, North Africa, the Middle East, and Asia, as temperatures climbed above 40°C in places and broke many long-standing records.

Figure 1 shows a model of air temperatures across most of the Eastern Hemisphere on July 13. The data come from the *Goddard Earth Observing System Model*, Version 5 (GEOS-5), a global atmospheric model that uses

continued overleaf

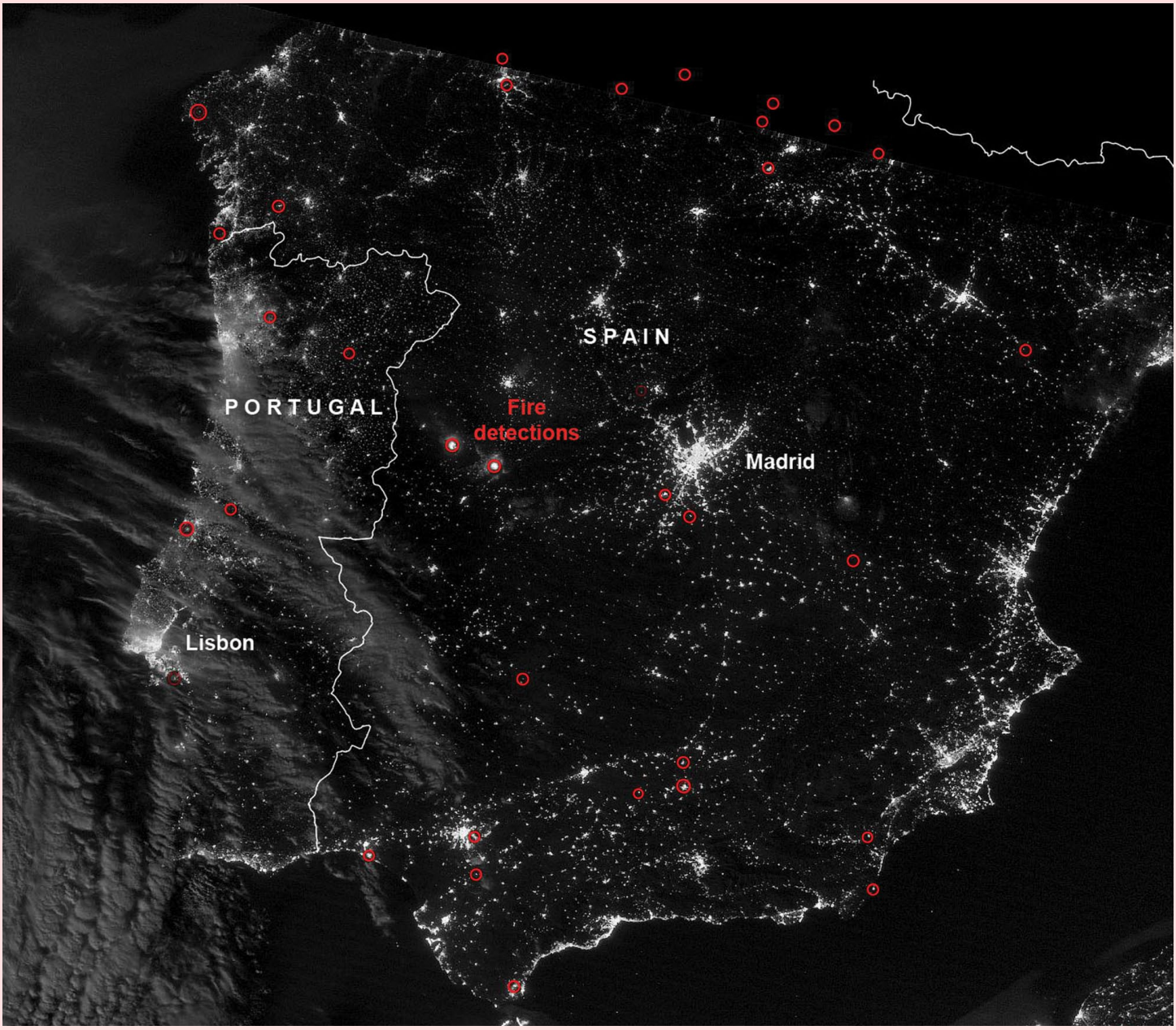


Figure 2 -Fire detections in the Iberian peninsula on July 12, 2022.
NASA Earth Observatory image by Joshua Stevens, using VIIRS day-night band data from the Suomi National Polar-orbiting Partnership.

mathematical equations to represent physical processes near the surface and in the atmosphere.

In Western Europe, which was already experiencing severe drought, the heatwave fuelled fires that raged across Portugal, Spain, and parts of France. In Portugal, temperatures reached 45°C in the town of Leiria, where more than 3,000 hectares had burned. More than half of the country was on red alert as firefighters battled 14 active fires.

Figure 2 shows the locations of fire detections in Portugal and Spain as observed by the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite on July 12. The prominent fire detections west of Madrid include the town of Las Hurdes where more than 1,500 hectares were burned.

In Italy, the record heat contributed to the July 3 collapse of a portion of the Marmolada Glacier in the Dolomites. The avalanche of snow, ice, and rock killed 11 hikers.

In the U.K., the Met Office issued extreme heat or amber warnings as temperatures were expected to continue to climb, possibly breaking all-time highs.

In North Africa, Tunisia endured a heatwave and fires that damaged the country's grain crop. On July 13, in the capital city of Tunis, the temperature reached 48°C, breaking a 40-year record. In Iran, temperatures remained high in July after reaching a scorching 52°C in late June.

In China, the summer has brought three heatwaves that have buckled roads, melted tar, and popped off roof tiles. The Shanghai Xujiahui Observatory, where records have been kept since 1873, recorded its highest temperature ever: 40.9°C on July 13. High humidity and dewpoints, along with warm overnight temperatures, created potentially deadly conditions.

Sunglint in Satellite Images

John Tellick

One thing that Earth Observation Satellites—particularly polar orbiting ones—suffer from at certain times of the year is sun glint. This has been particularly in evidence in recent NOAA-19 images.

Sunglint occurs when the suns' rays are reflected into the satellite's radiometer from a still watery surface: seas, lakes, rivers etc. on the Earth below.

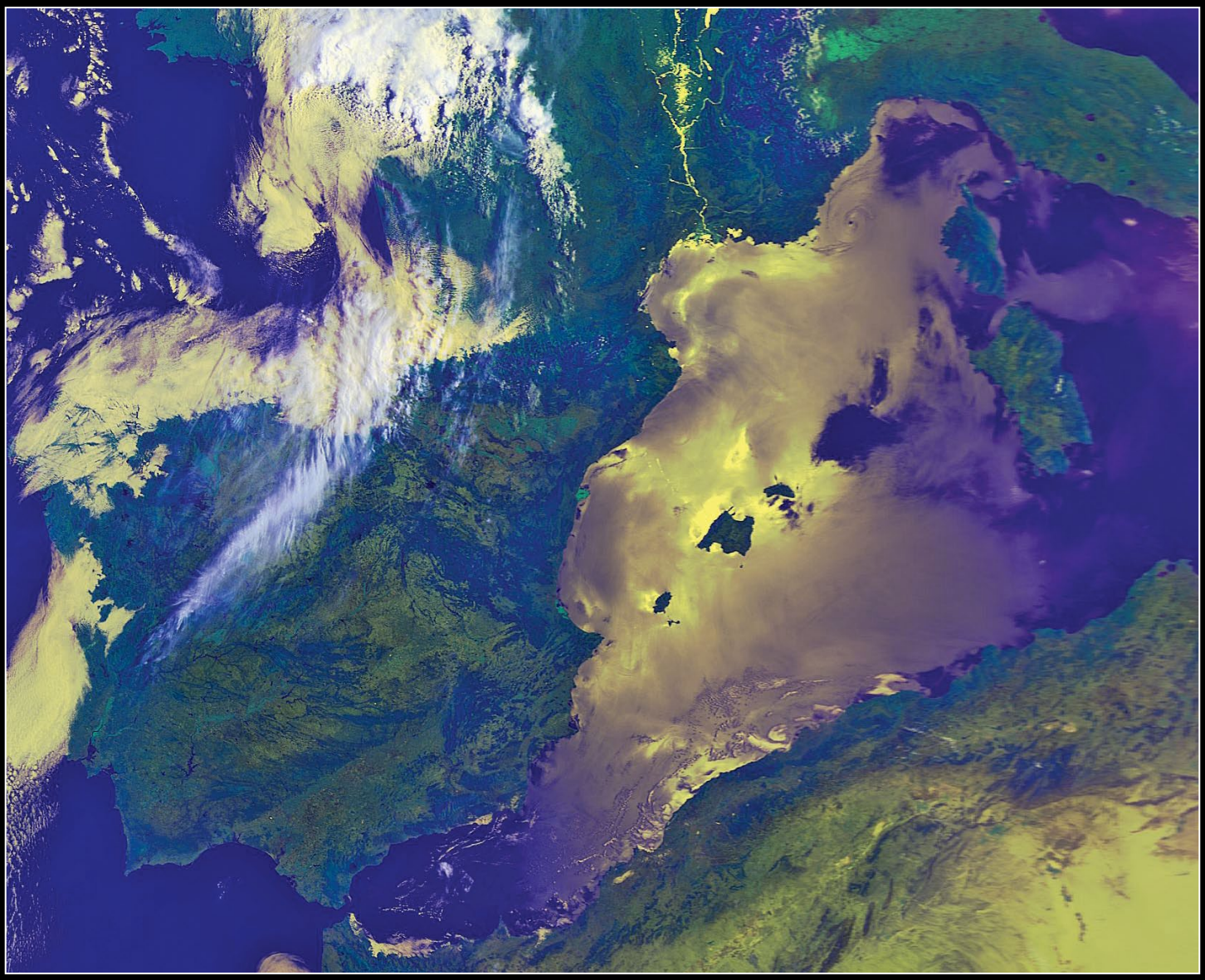
Still water in the ocean acts as a mirror, and when the sun, 'water mirror' and satellite are at a particular angle to one another, sunglint occurs. When a ray of light hits a mirror at an angle, it always reflects away from the mirror at an identical angle: it is this self-same process that produces the sunglint observed in satellite images.

The sun glint area will look silvery and bright but where areas of water in the same image are rough, they do not reflect sunlight evenly and the area will appear dark.

I have used RGB [Red, Green, Blue] processing of three wavelengths to produce the accompanying images from NOAA-19. This tends to make them rather colourful but does show up sun glint really well compared to a normal false colour image.

As the sun glint area on NOAA-19 descending images is over to the east side of the satellite pass (looking north) it is in the area of the satellite scan which suffers from distortion resulting from the curvature of the Earth, so the image has been geographically corrected—to look right. This results in stretching of that area of the image, and thus results in a lower resolution of that specific geographical area.

This sun glint phenomenon is common on polar orbiting satellites but can also sometimes be seen over the world's oceans on geostationary satellite images, especially when the Sun is directly above—or close to—the Equator.



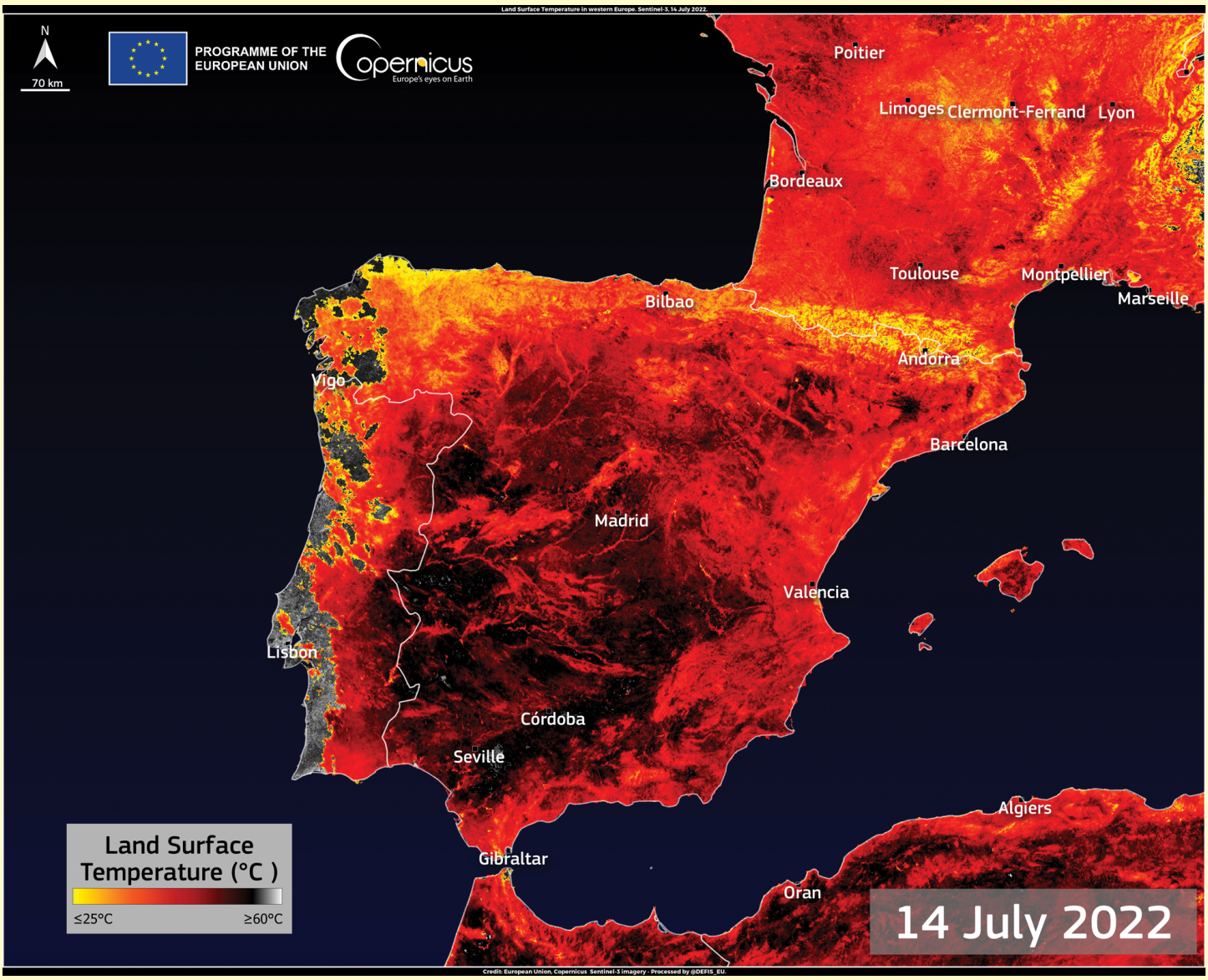
This NOAA 19 image captured on July 22, 2022 shows spectacular sunglint over the Mediterranean Sea and on the waters of the River Rhône flowing into it from the north.
Image received via EUMETCast and processed with David Taylor's EARS AVHRR Manager and HRPT Reader.

This NOAA 19 image was captured on July 17, 2022. With the sun to the east of the satellite's scan, this RGB image displays spectacular sun glint over the Adriatic and Tyrrhenian seas. NOAA-19 used to be the operational local midday ascending pass satellite but its orbit has drifted considerably since its launch in 2009 and it now descends in the early morning, around 07:00 UT.
Image © EUMETSAT 2022

Heatwave over Western Europe

Copernicus image of the day

https://www.copernicus.eu/en/media/image-day



Credit: European Union, Copernicus Sentinel-3 imagery

An extreme heatwave occurred over western Europe during mid July 2022, with many temperature records being broken in Portugal and Spain. According to the national meteorological organisation of Portugal (IPMA), the Pinhão weather station recorded an air temperature of 47.0°C on July 14, setting a new July record for the country. The previous maximum value for the month was 46.5°C, reached in Amareleja, Alentejo, in 1995. On July 12, the city of Ourense in northwestern Spain set its all-time temperature record with 43.2°C.

The Land Surface Temperature (LST) in some areas of Spain exceeded 59°C and reached 48°C in southern France on July 142, as highlighted in this data visualisation of measurements from the Copernicus **Sentinel-3 Sea and Land Surface Temperature Radiometer** (SLSTR) instrument.

Note

The LST is the temperature of the soil and should not be confused with air temperature. However, the high air temperatures are reflected in land surface temperature values.

The Copernicus Sentinel-3 mission is composed of two twin satellites (Sentinel-3A and Sentinel-3B) both equipped with the SLSTR, an instrument whose main objective is to provide Sea and Land Surface Temperature (SST, LST).

Floodwaters Reach Australia's Channel Country

MODIS Web Image of the Day

https://modis.gsfc.nasa.gov/gallery/showall.php

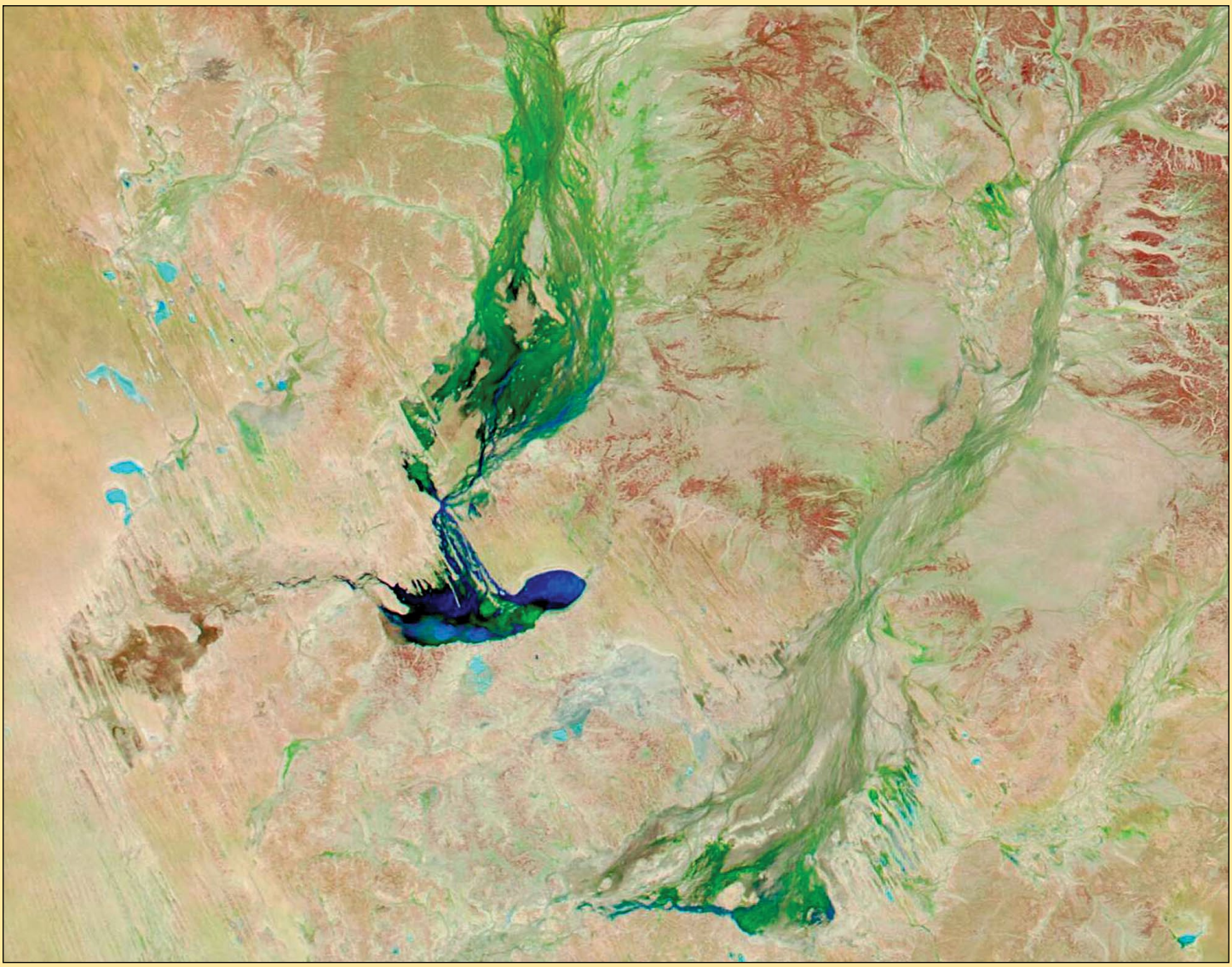


Image Credit: MODIS Land Rapid Response Team, NASA GSFC

Torrential rains over eastern Australia brought severe flooding to parts of Queensland and New South Wales in early March 2022. Media reported that tens of thousands of residents along the southeastern Australia coast had been evacuated, with about 1,000 rescues in New South Wales by March 1. According to *AccuWeather*, the city of Brisbane received more than 600 mm of rain in the three-day period February 24-27, setting the record for its wettest three-day period since weather data tracking begin in 1840. According to the *Center for Disaster Philanthropy*, the *Insurance Council of Australia* extended the area declared an insurance catastrophe from south-east Queensland into northern New South Wales in order to help prioritise handling more than 15,000 claims that had already been lodged by March 1.

While the floods were nothing short of catastrophic across the coastal regions, the flooding brought water trickling inland, even to Australia's Channel Country—an area so named because of the dry riverbeds (channels) that mark the arid interior area. The region is also known for its ephemeral lakes, which are dry (or nearly so) most of the year. Channel Country flooding is a fairly common occurrence at the end of summer, but this year's massive flooding has brought large amounts of water to the region.

On March 3, the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's Aqua satellite acquired this false colour image of flooding in the Channel Country of southwestern Queensland. This type of image is particularly useful to separate out deep water (deep blue) and shallow water or moist salt flats (light blue) from dry land (brown) and vegetation (bright green). This image shows water in Lakes Machattie, Mipia and Koolivoo. The floodplains of the Georgina River and Eyre Creek are flushed with green vegetation far northward, heading into the Northern Territory.

Lake Mead Keeps Dropping

NASA Earth Observatory

Story by Michael Carlowicz

Continuing a 22-year downward trend, water levels in Lake Mead stand at their lowest since April 1937, when the reservoir was still being filled for the first time. As of July 18, 2022, Lake Mead was filled to just 27% capacity.

This largest reservoir in the United States supplies water to millions of people across seven states, tribal lands, and northern Mexico. It now also provides a stark illustration of climate change and a long-term drought that may be the worst in the US West in 12 centuries.

The low water level comes at time when 74% of nine Western states face some level of drought; 35% of the area is in extreme or exceptional drought. In Colorado, location of the headwaters of the Colorado River, 83% of the state is now in drought, and the snow pack from last winter was below average in many places.

The natural-colour images in figures 1 and 2 were acquired on July 6, 2000, and July 3, 2022, by Landsat 7 and Landsat 8.

The detailed images in figure 3 (overleaf) also include a view from Landsat 8 on July 8, 2021 (middle). The light-coloured fringes along the shorelines in 2021 and 2022 are mineralised areas of the lake shore that were formerly underwater when the reservoir was filled closer to capacity. The phenomenon is often referred to as a 'bathtub ring.'

The lake elevation data (figure 4) come from the US Bureau of Reclamation (USBR), which manages Lake Mead, Lake Powell, and other portions of the Colorado River watershed.

As of July 18, 2022, the water elevation at the Hoover Dam was 317.4 metres above sea level,

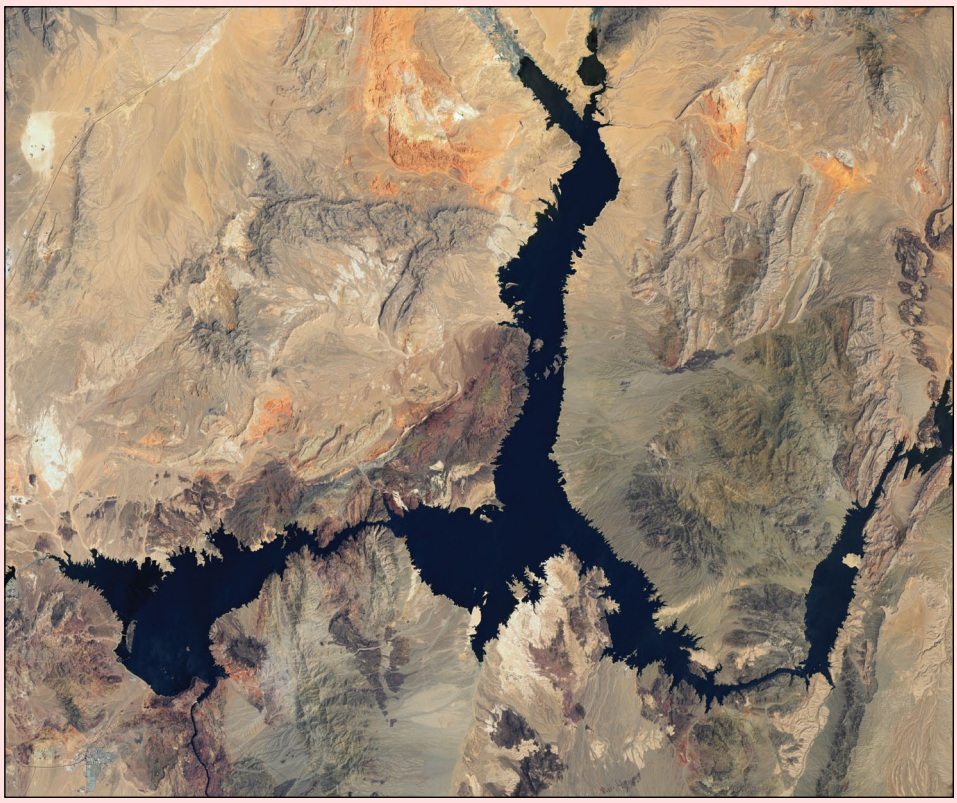


Figure 1
Lake Mead imaged by Landsat-7 in July 2000
NASA Earth Observatory images by Lauren Dauphin, using Landsat data from the U.S. Geological Survey

Figure 2
Lake Mead imaged by Landsat-8 in July 2022
NASA Earth Observatory images by Lauren Dauphin, using Landsat data from the U.S. Geological Survey

whereas the water elevation twenty years earlier at the end of July 2000 (around the time of the Landsat 7 image above) was 341 metres. Lake levels at the dam should stay above 305 metres to continue operating hydropower turbines at normal levels.

At maximum capacity, Lake Mead would reach an elevation 372 metres near the dam and would hold 36 trillion litres of water. The lake last approached full capacity in the summers of 1983 and 1999.

About 10% of the water in Lake Mead comes from local precipitation and groundwater each year, with the rest coming from snow melt in the Rocky Mountains that flows down the Colorado River watershed through Lake Powell, Glen Canyon, and the Grand Canyon.

The Colorado River basin is managed by USBR and other agencies to provide electric power and water to roughly forty million people—most notably the cities of San Diego, Las Vegas, Phoenix, Los Angeles—and four to five million acres of farmland in the Southwest.

The river water is allotted to states (including tribal lands) and Mexico through laws like the 1922 Colorado River Compact.

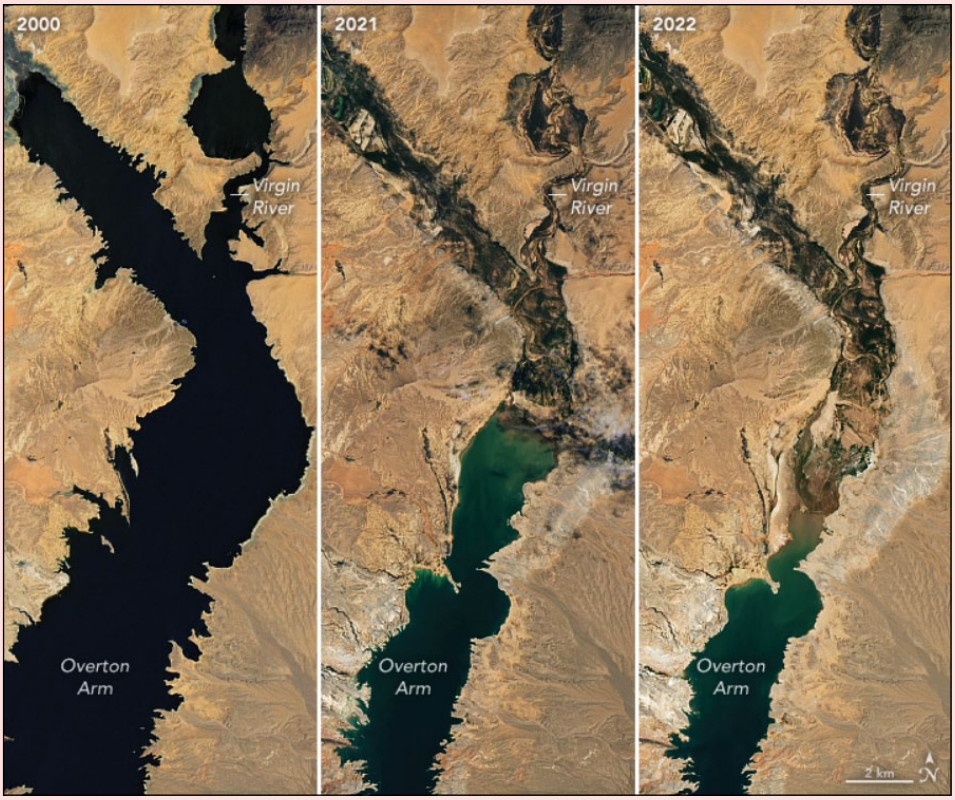
Above Lake Mead, Lake Powell is currently filled to just 27% of capacity, and the entire Colorado river system stands at 35%. USBR announced in August 2021 that state water allocations would be cut in 2022; further modelling and negotiation is underway for 2023 allocations.

In June 2022, USBR issued an emergency request to the Colorado River basin states to reduce water usage by 2 million to 4 million acre-feet over the next 18 months.

In addition to serving as a major drinking and irrigation source for the Southwest, Lake Mead is a national recreation area that is particularly popular with boaters. According to the National Park Service, five of six boating ramps/launches are now closed.

"Declining water levels due to climate change and 20 years of ongoing drought have reshaped the park's shorelines," stated the Park Service on its website.

"As Lake Mead continues to recede, extending launch ramps becomes more difficult and more expensive due to the topography and projected decline in water levels."



July 6, 2000 **July 8, 2021** **July 3, 2022**

Figure 3 - Comparison images: Lake Mead imaged by Landsat-8 in July 2022
NASA Earth Observatory images by Lauren Dauphin, using Landsat data from the U.S. Geological Survey

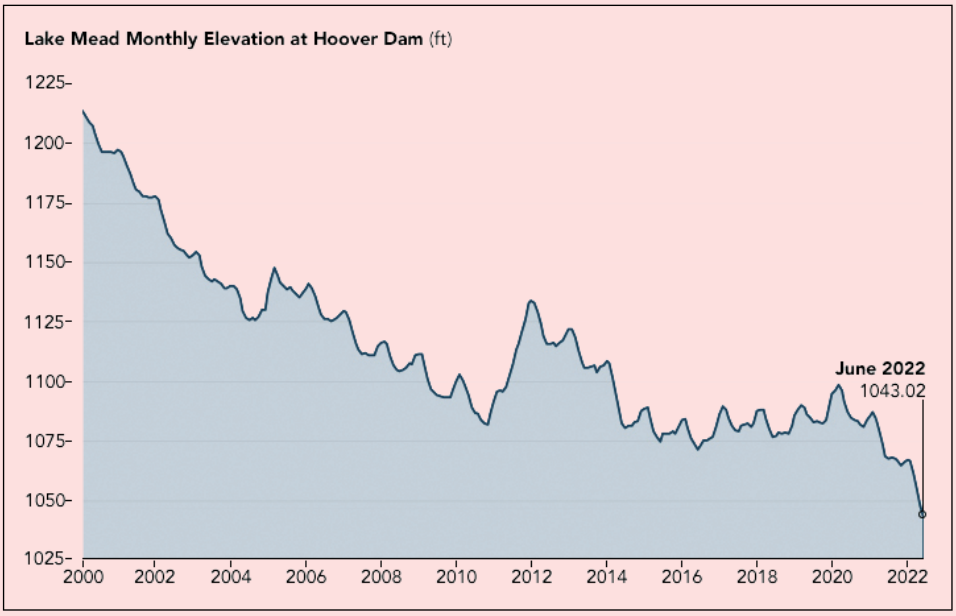
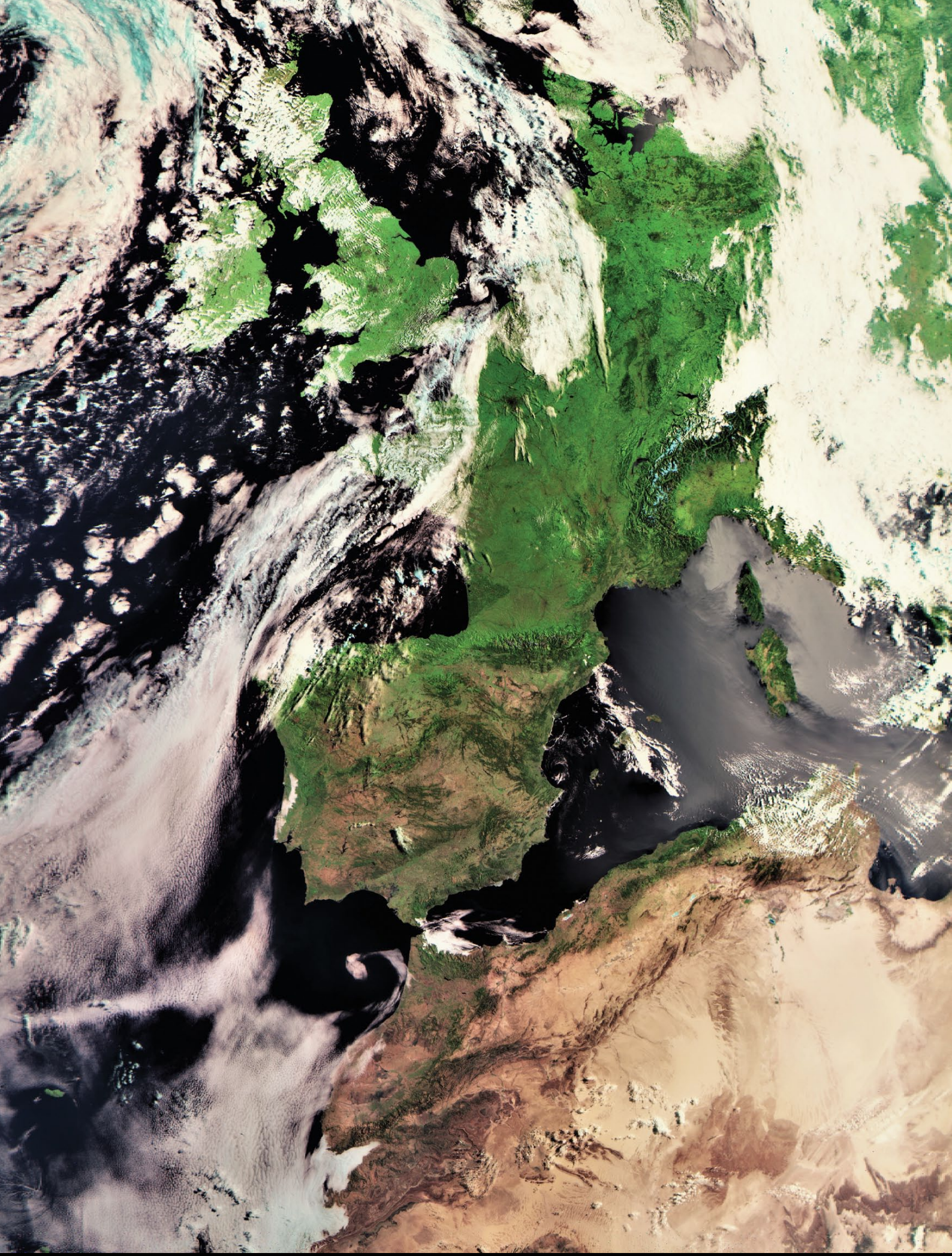


Figure 4
Lake elevation data at the Hoover Dam for Lake Mead for 2000-2022
Lake elevation data from the Bureau of Reclamation



This high-resolution image acquired from Meteor M2 on June 10, 2022, was provided by Enrico Gobbetti

Sahara's Amazing Richat Structure

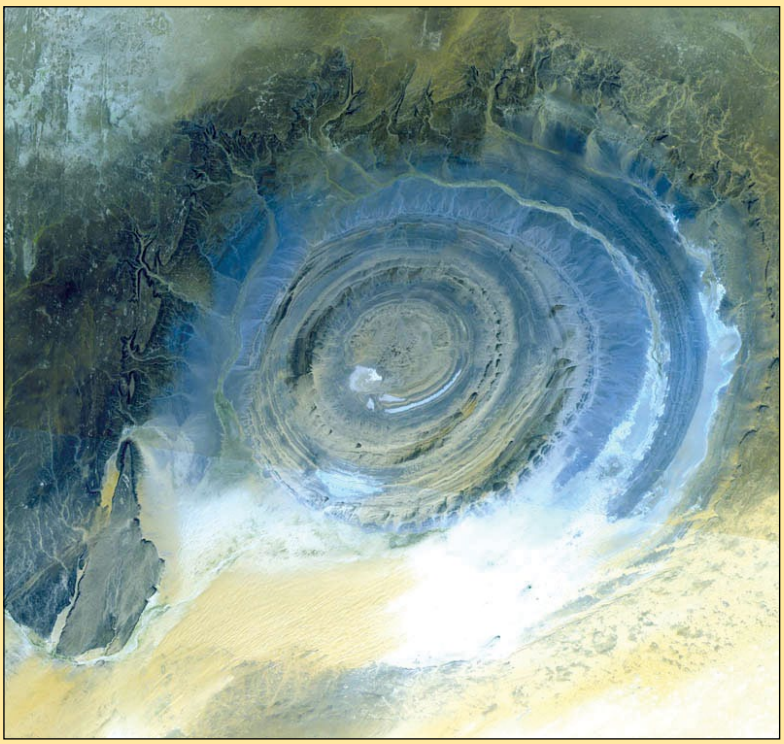
Les Hamilton

While researching the Tenoumer Crater article (page 7), I was reminded of having seen in the past articles relating to yet another circular feature in Saharan Mauritania: the Richat Structure, often dubbed '*The Eye of the Sahara*' on account of its almost perfectly circular outline. But whereas Tenoumer crater is a mere 1.9 kilometres across, Richat is a much larger feature, with a diameter of some 48 kilometres.

Richat attracted the attention of astronauts James McDivitt and Edward White aboard the Gemini IV mission that spent four days in orbit following lift-off on June 3, 1965, who became the first astronauts to photograph the structure from space. The image opposite, a more recent, better quality one, illustrates the unusual blue colouration of the Structure which somewhat resembles the appearance of a giant ammonite fossil.

In actual fact the Richat Structure had originally been identified through ground-based exploration as early as the 1930s when it was initially considered to have been the result of a meteorite impact. But from the late 1940s onward, once it had been established that there was no evidence whatever on the ground of the shock metamorphism and deformations that result from an extraterrestrial impact, geologic investigations established that the structure was in fact a heavily eroded, slightly elliptical dome of predominately sedimentary rocks, uplifted between approximately 500 and 400 million years ago as a result of pressure by molten magma from below.

After the layers of sedimentary rock were elevated, millennia of constant weathering gradually levelled them to expose the structure's distinctive concentric rings. These near circular ridges and valleys are known as cuestas (unsymmetrical ridges featuring a strong slope or escarpment on one side and a gentle slope on the other, and resulted from differential erosion of alternating hard and soft rock layers within the uplifted dome. Tellingly, the rocks in the centre of the Richat structure are the oldest, trending to younger material towards its rim, precisely what is to be expected following the erosion to a near-level plain of a domed anticline. There are more photographs of the Richat Structure overleaf.



This image of the 'Eye of the Sahara' was acquired on October 7, 2000 by the advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on NASA's Terra satellite.
Credit: NASA/GSFC/MITI/ERSDAC/JAROS, and U.S./Japan ASTER Science Team

This Astronaut photograph ISS030-E-12516 dating from December 17, 2011, shows fine detail of the Richat Structure.
Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center.

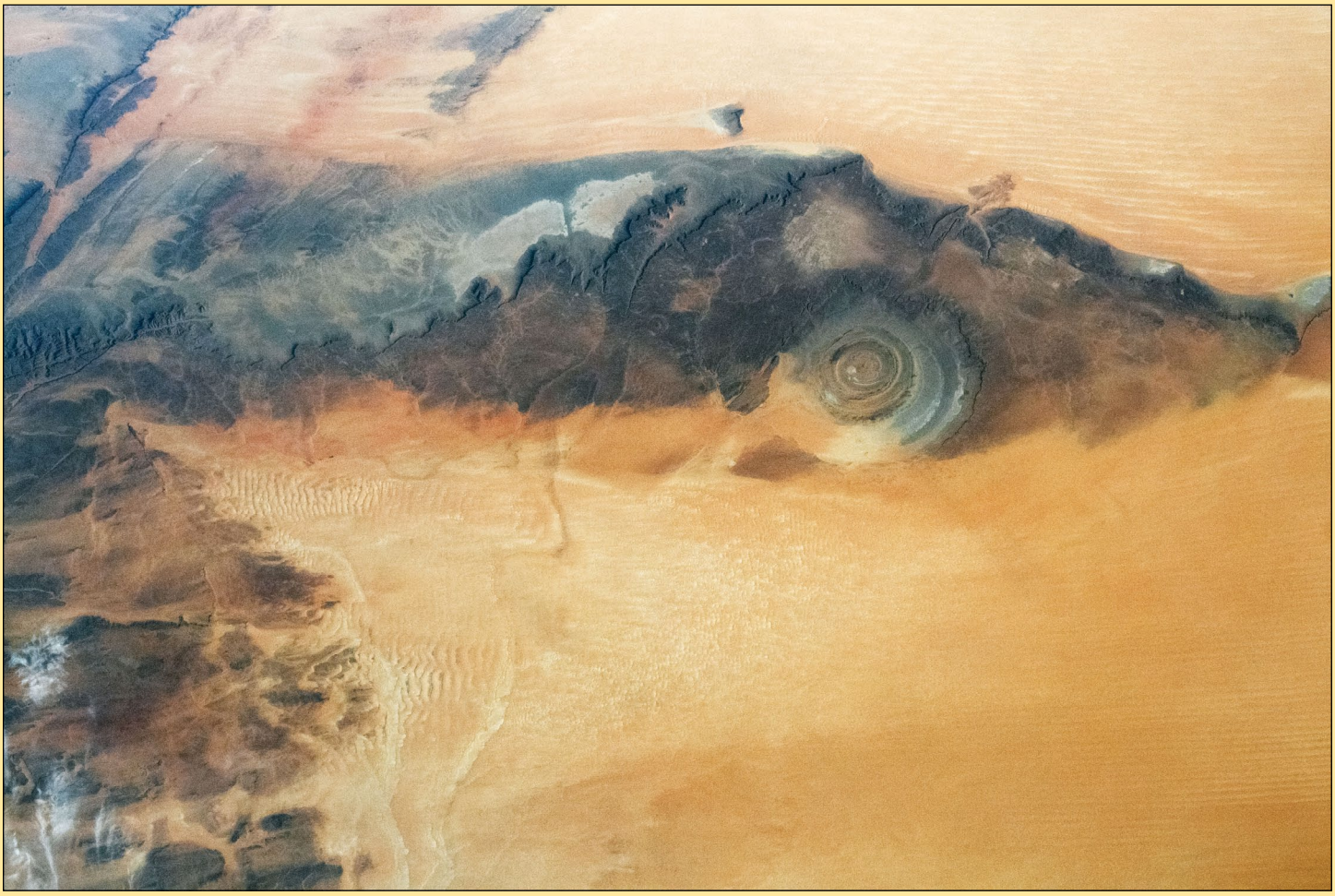
Source References

1 The Eye of Sahara
https://earthobservatory.nasa.gov/images/150060/the-eye-of-sahara

2 Richat Structure
https://earthobservatory.nasa.gov/images/92071/richat-structure

3 Richat Structure
https://en.wikipedia.org/wiki/Richat_Structure

4 Strange Marvels
https://thedebrief.org/the-mysterious-eye-of-the-sahara-is-one-of-earths-strangest-marvels/



This Astronaut photograph (ISS063-E-43607) was acquired on July 10, 2020 and shows the Richat Structure against brightly coloured Saharan dune fields.
Credit: Earth Science and Remote Sensing Unit, Johnson Space Center.

This photograph shows terrain within the Richat Structure's inner ring.
Credit: Clemens Schmillen / Wikimedia

Ice Springs Lava Flow

NASA Earth Observatory

Story by Sara E. Pratt

The Ice Springs lava flow lies about 16 kilometres west of the town of Fillmore, Utah, in the Black Rock Desert. It was named for the icehouse conditions found within its natural cavities, where year-round ice provided natural cold storage for farmers in the days before refrigeration.

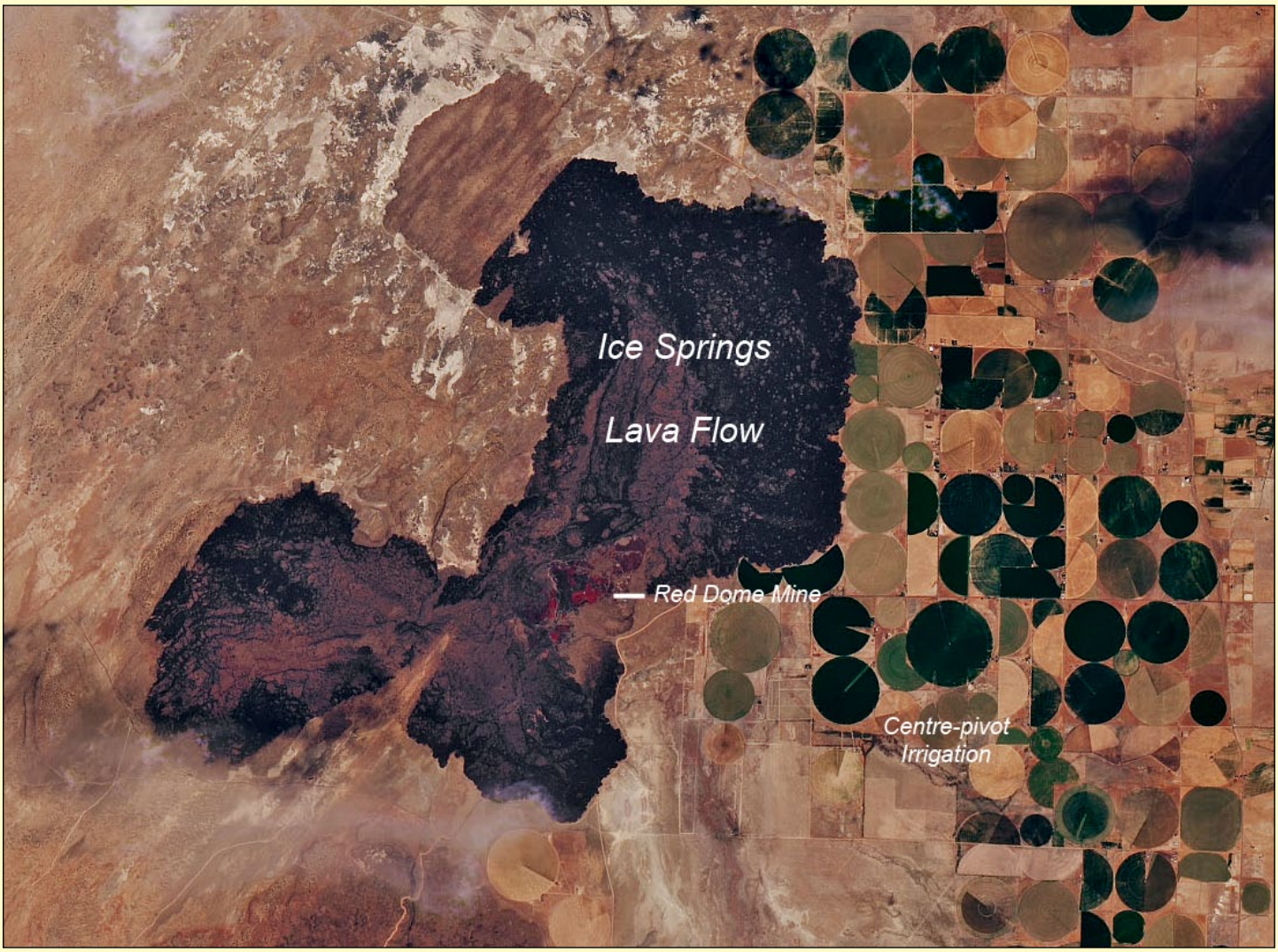
The black basalt of the Ice Springs lava flow is visible in the image below, acquired on July 12, 2022, by the Operational Land Imager-2 (OLI-2) on Landsat 9. Soil and vegetation have not yet taken hold on these young rocks. The last lava flowed from the Ice Springs vent about 700 years ago, making the jagged basaltic aa lava the newest rock in Utah.

A total of about 540 million cubic metres of lava have erupted here from four cinder cone volcanoes, for which the area is also known as *The Cinders*.

The 45-square-kilometre Ice Springs lava flow erupted on to older lava flows, which erupted on the shores and under the surface of ancient Lake Bonneville. A precursor to the Great Salt Lake, Lake Bonneville occupied basins in northeastern Nevada, western Utah, and southeastern Idaho in the late Pleistocene Epoch, from 25,000 to 10,000 years ago. At its greatest extent, the lake was up to 300 metres deep and covered about 52,000 square kilometres.

The darker brown areas in the image are older lava flows, along with the sediments deposited atop them when they sat at the bottom of Lake Bonneville. In some places, the contact between the younger and older lava flows appears almost linear; this is where the lava flowed up against a fault scarp. The lightest brown areas are more recent sand dunes.

One of the cinder cones, Red Dome, is the site of Utah's largest open-pit lava-rock mine. Lava, cinder, pumice, and scoria rock have been mined here since the 1930s for use in landscaping, road construction, the manufacture of cinder blocks and cement, and to line BBQ grills and fish tanks.



NASA Earth Observatory image by Joshua Stevens, using Landsat data from the U.S. Geological Survey.

Wildfire near Salamanca, Spain

European Space Aency

This Copernicus Sentinel-2 image shows Las Batuecas—Sierra de Francia Nature Reserve near Salamanca in western Spain. The image was acquired on 13 July 2022 and shows the wildfire affecting the area. The satellite's shortwave infrared channel was used to highlight heat from the wildfire. According to regional authorities, more than 4000 hectares of land had been burned and 600 people had to be evacuated. In response to the emergency, the Copernicus Emergency Mapping Service was activated. This service uses satellite observations to help civil protection authorities and, in cases of disaster, the international humanitarian community, respond to emergencies.

Recent Updates to Metop Manager's GAC Processing

John Tellick

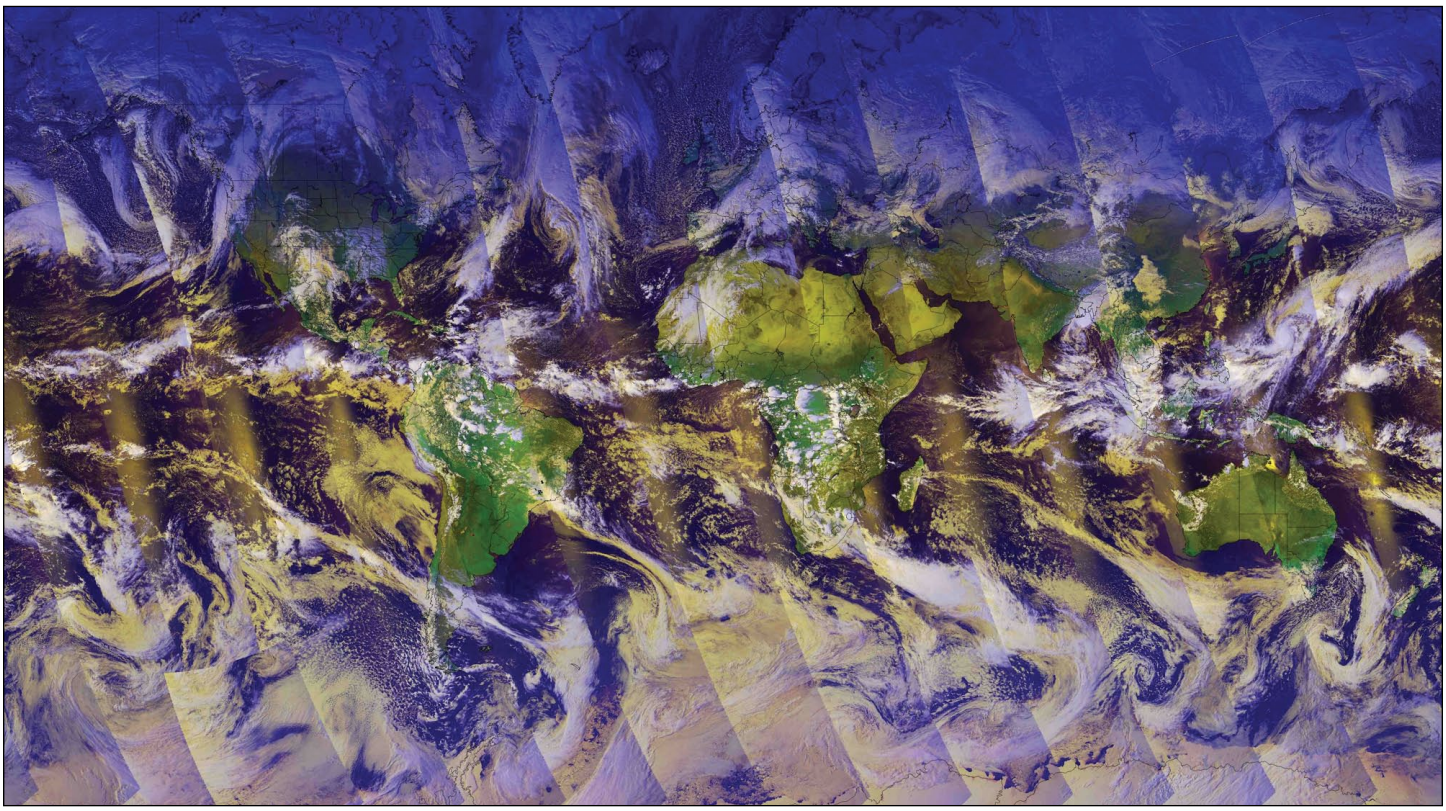


Figure 1 - This full Earth GAC composite image was created from NOAA-19 data acquired on November 5, 2016.

Many years ago now, NOAA-19 used to be a 'local midday' ascending satellite, allowing users to obtain well lit APT images from it, and in addition excellent GAC RGB image composites. The example above, acquired in November 2016 was typical, albeit with some inevitable loss of illumination over the Arctic at that time of year.

Somehow, unnoticed by many it seems, NOAA-19's orbit started drifting out of its midday ascending mode: its 'daylight image' became less well lit and the GAC composites began to suffer problems.

David Taylor addressed this problem by reconfiguring the GAC processing in Metop Manager to process the ascending orbit IR channel only. This did work well, but the monochrome images didn't have the same appeal as the coloured composites.

However, several months ago this year I noticed that, as NOAA-19's orbit continued its onward drift, the satellite's current morning descending visible imagery was becoming better illuminated, although there was a considerable difference in image levels across the images from east to west. Being an 'early morning' pass, the Sun was to the east of the satellite's scan.

But as spring advanced into summer, with the Sun heading northwards, this disparity reduced as the westerly illumination improved. I got in touch with David Taylor to ask if he would consider reconfiguring the current version of Metop Manager to once again run RGB GAC—however this would mean altering the processing from ascending to descending orbits. Despite being busy with other projects, David kindly not only made the change but sent me a beta version to test. This new version now offered the choice of creating either RGB descending or IR-only ascending pass GAC composite images.

Both options proved to work well but the last few image chunks in the Southern Hemisphere RGB image were missing— there was no daylight in that region at this time of year. Again, David considered this problem and ascertained that the software had a 'no daylight level cut-off point' which prevented it from adding these 'dark chunks.'

This was soon rectified and full RGB and single channel IR processing options became available in the following program version update. The result can be seen in figure 2 (overleaf) on a NOAA-19 RGB GAC composite image created from data acquired on July 22 this year.

My thanks to David Taylor for his help during that busy period with EUMETCast channel reconfigurations and as usual, his willingness to offer advice on other technical problems.

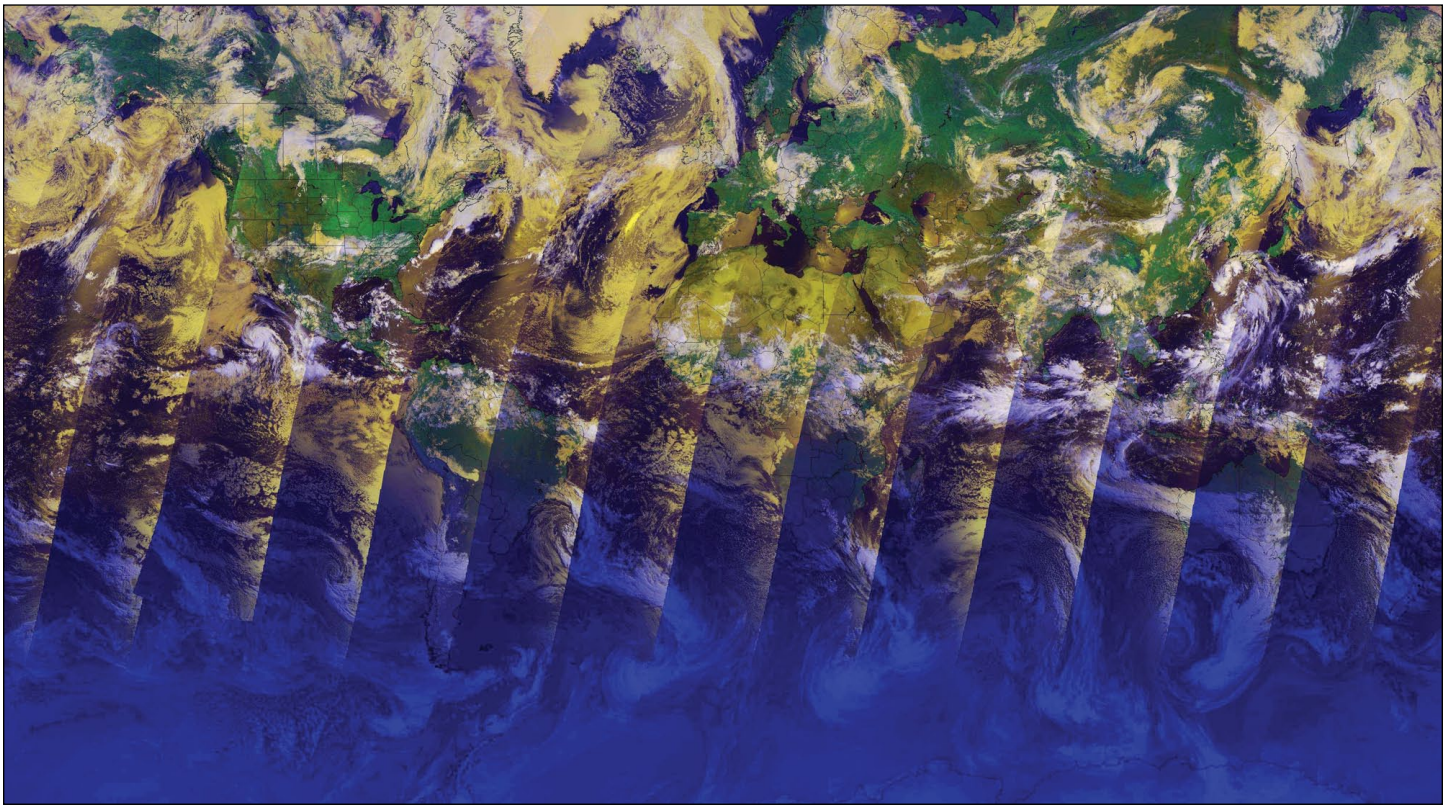
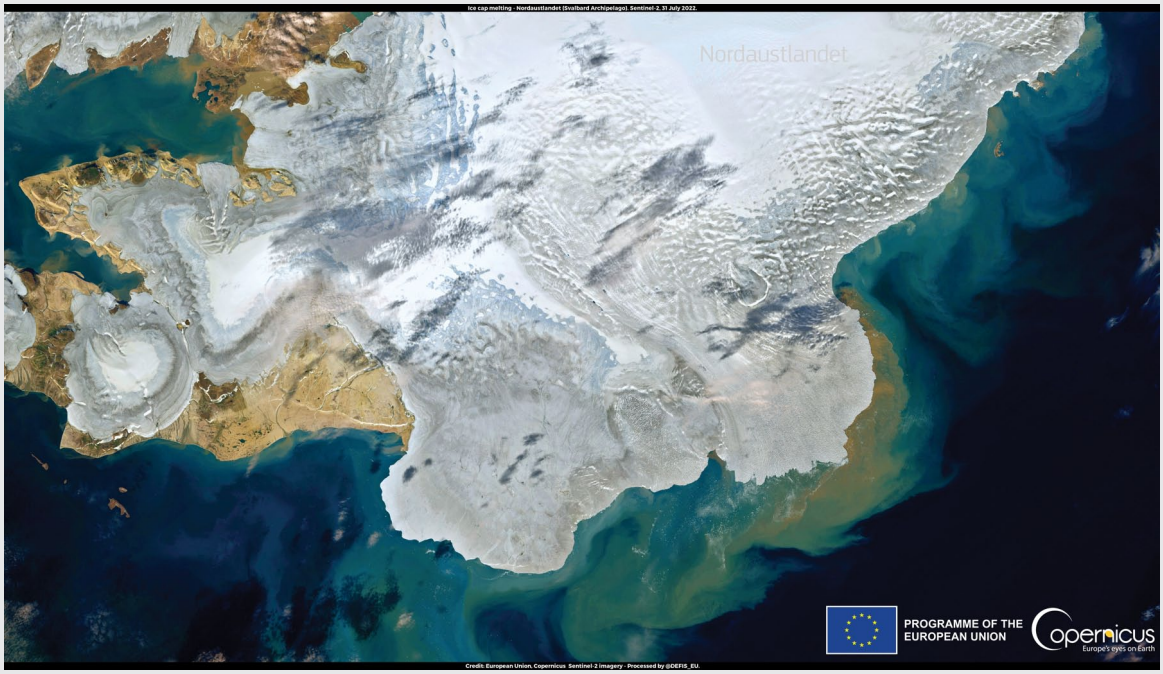


Figure 2 - This full Earth GAC composite image was created from NOAA-19 data acquired on July 22, 2022.

Heatwave in the Arctic causes intense ice cap melting in Svalbard

Copernicus Image of the Day



Credit: European Union, Copernicus Sentinel-2 imagery

The extremely high temperatures recorded in this summer of 2022 are also affecting the Arctic. As of August 1, 2022, in Norway's Svalbard archipelago, situated north of mainland Europe, the recorded temperatures are about 5°C higher than the reference values (the 1981-2010 average for the same day). This heatwave is causing exceptional levels of ice cap melting, thus contributing to sea level rise.

This image, acquired by one of the Copernicus Sentinel-2 satellites on 31 July 2022, shows a large sediment discharge in the Arctic Ocean, off the coast of Svalbard, caused by the rapid melting of snow and ice.

Data acquired by the Copernicus Sentinel satellites are used to detect changes in the Earth's surface with great detail and monitor the effects of climate change on remote environments such as the Arctic region.

Muruntau Gold Mine

NASA Earth Observatory

Story by Adam Voiland

In satellite images of central Uzbekistan, a large circular cavity stands out amidst fields of sand and dusty plains. It is Muruntau gold mine, one of the world's largest sources of gold.

On July 22, 2022, the Operational Land Imager (OLI) on Landsat 8 acquired this natural-colour image of the mine. Hundreds of trucks and a conveyer system are used to transport ore to nearby processing facilities. Workers then use a process called heap leaching to extract gold and other precious metals.

The mine taps into the Muruntau gold deposit, thought to be one of the largest single gold deposits on Earth. The deposit was discovered in 1958, and mining began in 1967. The pit is now 3.5 kilometres wide and 600 meters deep. In 2021, the mine produced as much as 3 million ounces (85,000 kilograms) of gold.

According to geologists, gold is near the surface in this area due to a chain of events that spanned many millions of years. Among them the closure of an ancient ocean; a period of mountain building; intrusions of granite and water into key rock formations; and the onset of movement along nearby faults.

Astronomers are investigating how gold ended up on our planet in the first place. While nuclear fusion within the Sun can synthesise many elements, the process does not produce enough energy to create heavy elements like gold. Some astronomers think that collisions between neutron stars and supernova explosions may have provided that energy.

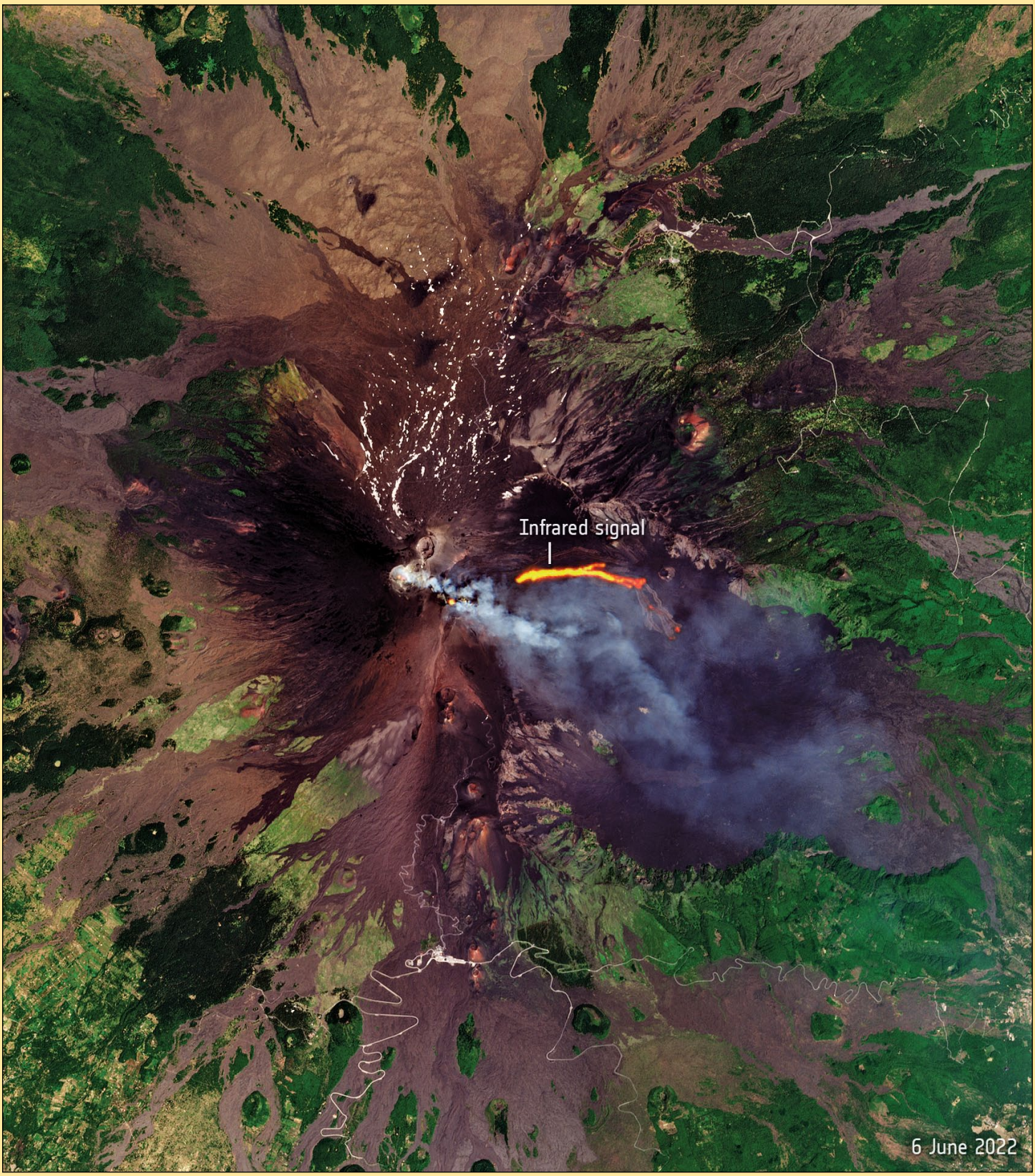
Any gold on the planet early in Earth's history would have sunk toward the core, but intense bombardment by meteorites about four billion years ago probably stirred things up and pushed small amounts of the metal into the mantle and toward the surface. By one estimate, gold makes up only 0.000004 percent of Earth's crust. About 80% of known gold reserves have already been mined.

NASA Earth Observatory image by Joshua Stevens, using Landsat data from the U.S. Geological Survey.

Mount Etna Eruption

Copernicus image of the day

https://www.copernicus.eu/en/media/image-day



This image was captured by the Copernicus Sentinel-2 mission on 6 June 2022 and shows the latest activity in Italy's Mount Etna—one of the world's most active volcano. The image has been processed using the mission's shortwave-infrared band to show the ongoing activity in the crater.

Credit: European Union, Copernicus Sentinel-2 imagery

Summer in Iceland

MODIS WEB Image of the Day

On August 5, 2022, the cloud layer that frequently covers Iceland parted, allowing the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's **Aqua** satellite to acquire this gorgeous true-colour image of a sunny Icelandic summer day.

Image Credit: MODIS Land Rapid Response Team, NASA GSFC

True to its name, Iceland's winters are long and snow-laden. However, the island's location and relatively gentle maritime climate produce summers warm enough to melt all except about 10% of the country's winter coat of white. This 10% of the country remains covered with year-round glaciers and ice caps.

The largest ice cap Vatnajökull, is located near the southeast coast and is truly spectacular. It stretches across an area of 8,100 square kilometres, which is slightly larger than the area of the U.S. states of Delaware and Rhode Island combined. About thirty outlet glaciers flow from Vatnajökull's ice cap. One of these long glaciers is Breidamerkurjokull, which ends in Jokulsarlon glacial lagoon which can be seen off the southeast section of Vatnajökull.

Two smaller ice caps Langjökull and Hofsjökull can be seen in the central highlands. Snow and glaciers also sit in the highlands of northwest Iceland. The cold currents flowing off the shores tend to keep the northwestern section of Iceland colder than the rest of the island.

A gray area in the southwest section of Vatnajökull is atypical and appears to be caused by recently-deposited dust and sand. In July 2022, the white cap was suddenly stained with gray and brown. How the colour got there is not quite what you would expect on a damp, icy island.

Ash from volcanic eruptions has darkened Vatnajökull periodically in the past. But in July 2022, the volcanoes of Iceland were all quiet. Instead, windstorms probably lofted sand and mineral dust from the ground on to the ice cap. Scientists have estimated that about 4.5 million tonnes of dust comes to rest atop Iceland's glaciers every year.

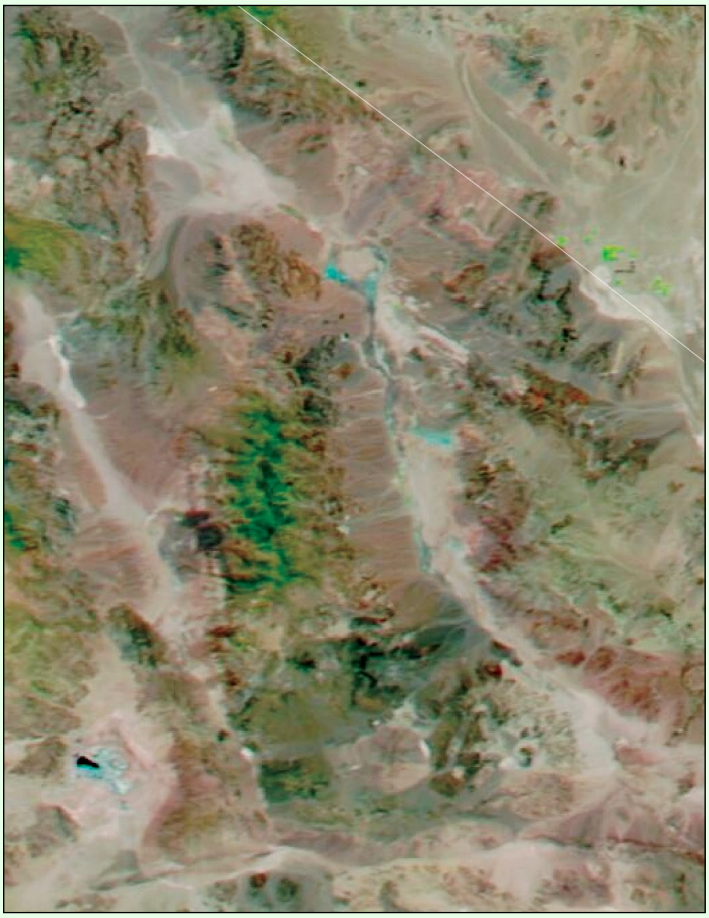
Iceland's climate is neither hot nor dry, but it can still be a dusty place. On average, the country sees 135 'dust days' in which at least one weather station on the island detects dust. Much of it comes from heavily eroded areas at the fronts of glaciers, but also from sandy deserts. Together these dusty surfaces cover nearly a quarter of the country.

The abundant dust and frequent strong winds result in several significant dust storms each year. Some of the particles are lofted all the way to Greenland and its ice sheet but much of it stays local to Iceland. Thin layers of dust can reduce the amount of light that the ice cap reflects back to space—leading to a cascade of effects, including melting. In contrast, thicker layers of ash can actually insulate the ice from melting.

Death Valley Flash Flooding

NASA Earth Observatory

Story by Sara E. Pratt



Death Valley before the rainfall on July 11, 2022

Death Valley after the deluge on September 7, 2022

NASA Earth Observatory image by Lauren Dauphin, using MODIS data from NASA EOSDIS LANCE and GIBS/Worldview.

In early August 2022, flash floods soaked Furnace Creek in Death Valley, the driest place in North America. In just three hours on August 5, a thousand-year rainfall event dropped 75% of the local average annual rainfall (5 centimetres). Flood water washed debris over roads, swept away and buried cars, knocked a water facility offline, damaged buildings, and stranded about a thousand visitors and staff in Death Valley National Park.

The deluge dropped 3.71 centimetres, which came close to breaking the single-day record for highest rainfall ever received in the park; 3.73 cm in April 1988. It did, however, break the record for the most rain recorded in August, which averages just 0.25 centimetre for the whole month.

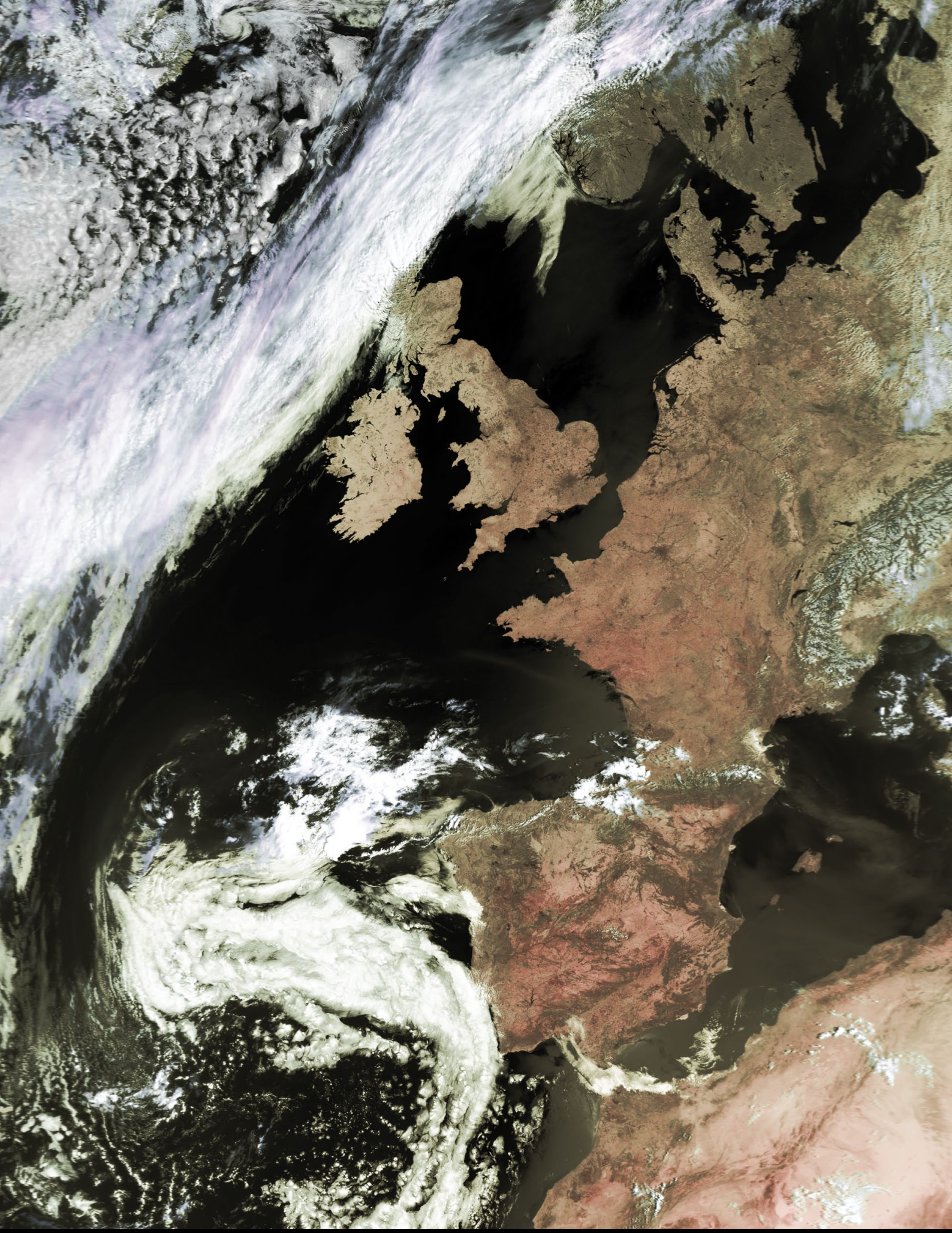
By August 6, the flood water had mostly receded, and the stranded visitors were able to exit the park escorted by National Park Service personnel. But extensive mud and gravel deposits still remained, leaving some roads impassable; they were expected to remain closed into mid-August, according to a statement by the Park Service.

Some of the flood water is visible in the latter of this pair of false-colour images acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra and Aqua satellites on July 11 and August 7, 2022. The false-colour images were composed from a combination of infrared and visible light (MODIS bands 7-2-1), to make it easier to distinguish the water. Flood water appears dark blue; saturated soil is light blue; vegetation is bright green; and bare ground is brown.

At 86 metres below sea level, you might expect Death Valley to be filled with water. But the desert is subject to a rain shadow effect, as humid air masses travelling east from the Pacific Ocean must cross four mountain ranges before they reach the desert valley. As the air masses are forced up and over the mountains, the moisture they carry condenses, falling as rain on the western slopes, leaving a dry area—a rain shadow—on the eastern side. By the time most air masses reach Death Valley, they are bone dry.

On rare occasions, the lowest spot in the valley fills with a wide, shallow lake, dubbed Lake Badwater. Extreme heat and aridity usually evaporate the ephemeral lake quickly, returning the valley floor to a salt-caked playa.

Summer temperatures in Death Valley National Park can soar to 49°C. The highest air temperature in world history, 57°C, was recorded at Furnace Creek on July 10, 1913. The second-hottest temperature ever recorded in the park, 54°C, occurred on August 16, 2020.



This August 11, 2022 image from Metop-C depicts the British Isles and western Europe in the grip of the second summer heatwave of the year. Almost everywhere, temperatures range from the mid 30s Celsius up into the mid 40s as wildfires proliferate and drought conditions are declared.

Image: NOAA CLASS Archive.

Tracking 30 Years of Sea Level Rise

NASA Earth Oservatory

Story by Michael Carlowicz

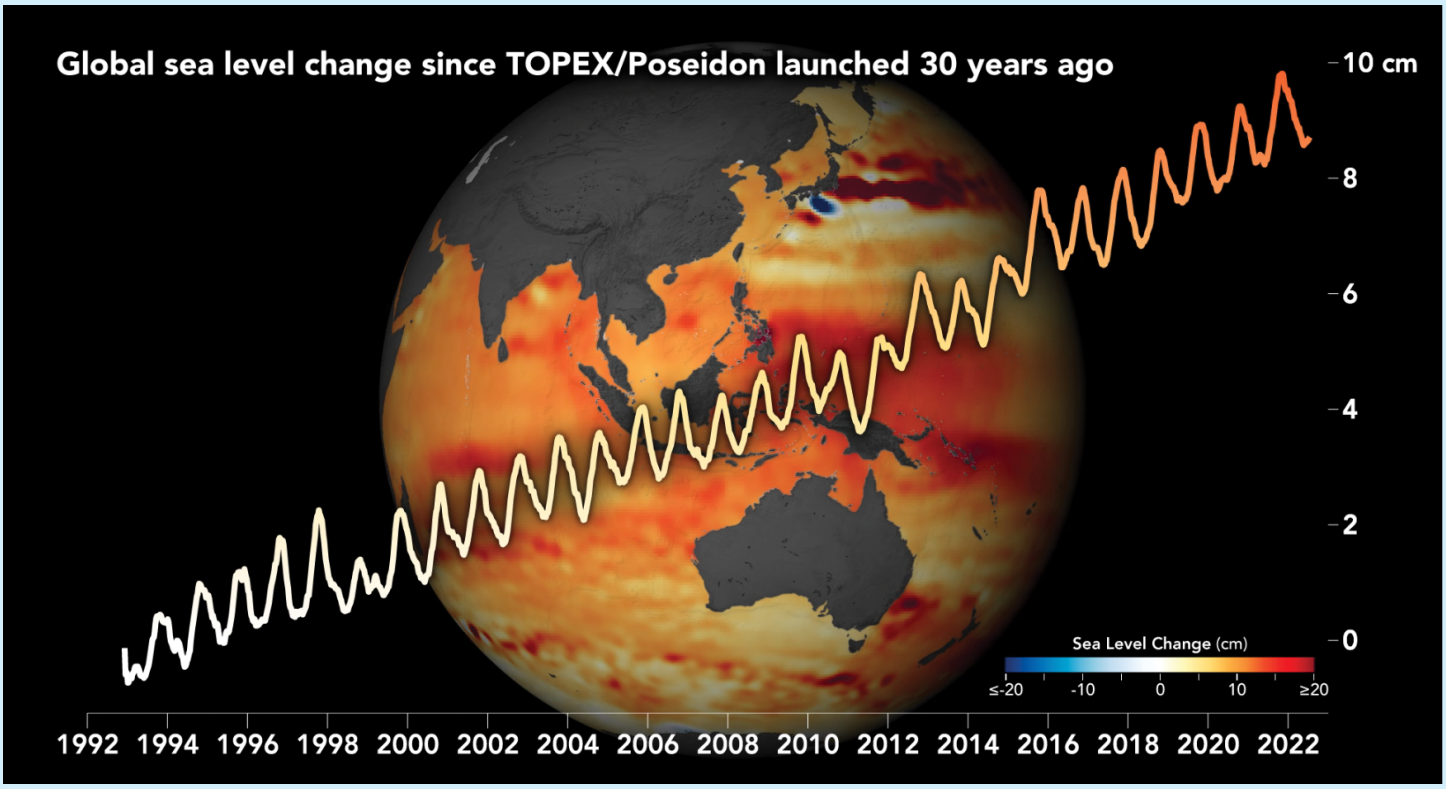


Figure 1
A graph of sea-level rise is shown superimposed on a globe of Earth where shades of red over the oceans indicate where ocean level rise has been confirmed.

Earth Observatory image by Joshua Stevens, using TOPEX/Poseidon data courtesy of Josh Willis/JPL-Caltech.

Thirty years ago, scientists and engineers launched a new satellite to study the rising and falling of seas over time, a task that once could only be done from the coast.

TOPEX/Poseidon rocketed into space on August 10, 1992, and started a 30-year record of ocean surface height around the world. The observations have confirmed on a global scale what scientists previously saw from the shoreline: the seas are rising, and the pace is quickening.

Scientists have found that global mean sea level—shown in the line plot above—has risen 10.1 centimetres since 1992. Over the past 140 years, satellites and tide gauges together show that global sea level has risen between 21 and 24 centimetres.

Starting with TOPEX/Poseidon, NASA and partner space agencies have flown a continuous series of satellites that use radar altimeters to monitor ocean surface topography—essentially, the vertical shape and height of the ocean. Radar altimeters continually send out pulses of radio waves (microwaves) that reflect off the ocean surface back toward the satellite. The instruments calculate the time it takes for the signal to return, while also tracking the precise location of the satellite in space. From this, scientists derive the height of the sea surface directly underneath the satellite.

Since 1992, five missions with similar altimeters have repeated the same orbit every 10 days: **TOPEX/Poseidon** (1992 to 2006), **Jason-1** (2001 to 2013), the **Ocean Surface Topography Mission/Jason-2** (2008 to 2019), **Jason-3** (2016 to present), and **Sentinel-6 Michael Freilich** (2020 to present). The missions were built through various partnerships between NASA, France's Centre National d'Etudes Spatiales (CNES), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Space Agency (ESA), and the U.S. National Oceanic and Atmospheric Administration (NOAA).

Together, the mission teams have assembled a unified, standardised ocean topography record that is equivalent to the work of a half-million tide gauges. The scientists accumulated and corroborated a data record that is now long enough and sensitive enough to detect global and regional sea level changes beyond the seasonal, yearly, and decadal cycles that naturally occur.

"With 30 years of data, we can finally see what a huge impact we have on the Earth's climate," said Josh Willis, an oceanographer at the Jet Propulsion Laboratory and NASA's project scientist for Sentinel-6 Michael Freilich. *"The rise of sea level caused by human interference with the climate now dwarfs the*

natural cycles. And it is happening faster and faster every decade."

The map in figure1 shows global trends in sea level as observed from 1993 to 2022 by TOPEX/Poseidon, the three Jason missions, and Sentinel-6 Michael Freilich. Note the spatial variations in the rate of sea level rise, with some parts of the ocean rising faster (depicted in red and deep orange) than the global rate. Many of the anomalies reflect long-term shifts in ocean currents and heat distribution.

The altimetry data also show that the rate of sea level rise is accelerating. Over the course of the 20th century, global mean sea level rose at about 1.5 millimetres per year. By the early 1990s, it was about 2.5 mm per year. Over the past decade, the rate has increased to 3.9 mm per year.

In the line plot, the highs and lows each year are caused by the exchange of water between the land and sea. *"Winter rain and snowfall in the northern hemisphere shifts water from ocean to land, and it takes some time for this to runoff back into the oceans,"* Willis noted. *"This effect usually causes about 1 centimetre of rise and fall each year, with a bit more or less during El Niño and La Niña years. It's literally like the heartbeat of the planet."*

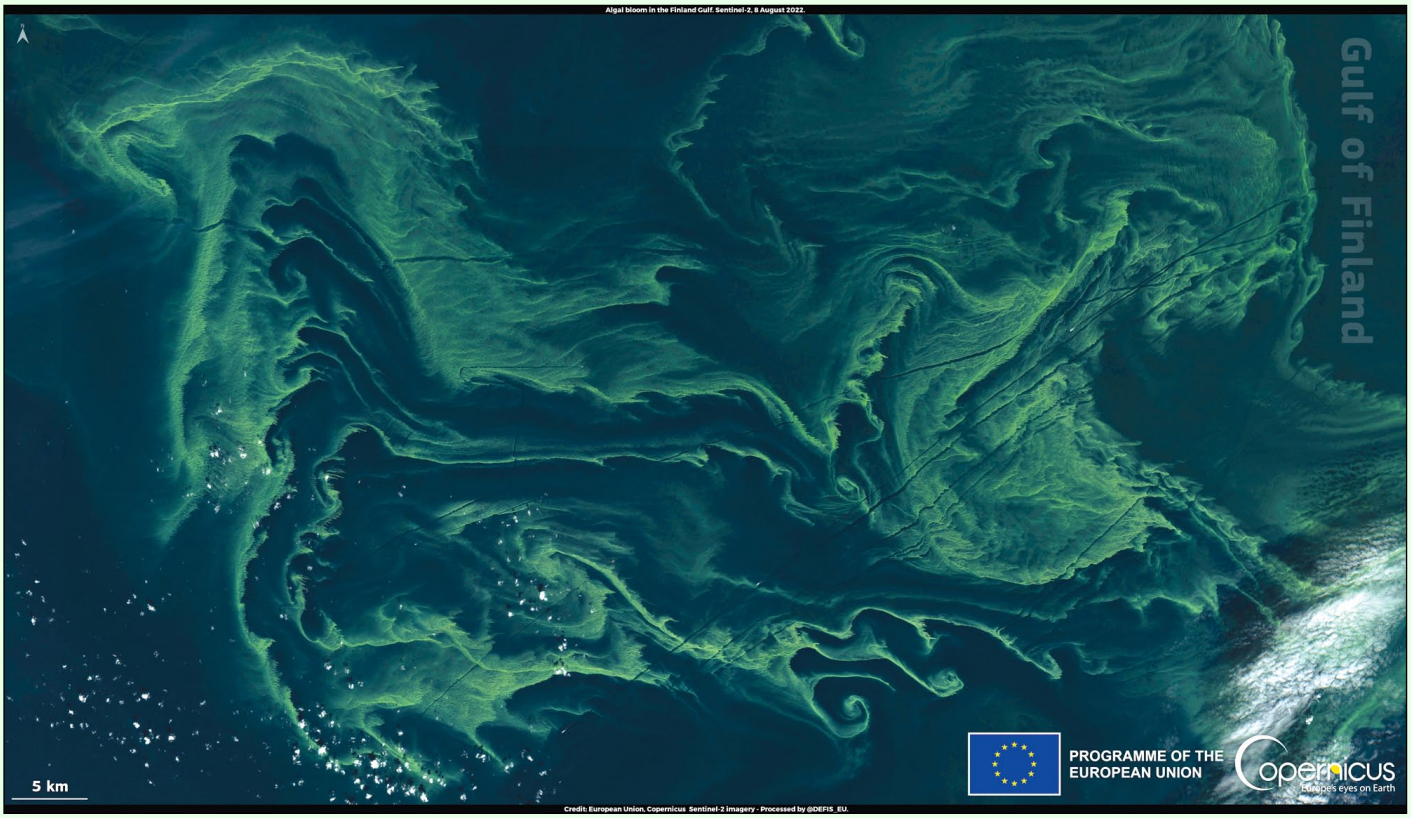
While a few millimetres of sea level rise per year may seem small, scientists estimate that every 2.5 centimetres of sea level rise translates into 2.5 meters of beachfront lost along the average coast. It also means that high tides and storm surges can rise even higher, bringing more coastal flooding, even on sunny days. In a report issued in February 2022, U.S. scientists concluded that by 2050 sea level along U.S. coastlines could rise between 25 to 30 centimetres above today's levels.

"What stands out from the satellite altimetry record is that the rise over 30 years is about ten times bigger than the natural exchange of water between ocean and land in a year," stated Willis. *"In other words, the human-caused rise in global sea level is now ten times bigger than the natural cycles."*

Massive Algal Blooms in the Gulf of Finland

Copernicus image of the day

https://www.copernicus.eu/en/media/image-day



Credit: European Union, Copernicus Sentinel-2 imagery

Every summer, colourful algal blooms can be observed in the shallow waters of the Baltic Sea. This image, acquired by one of the Copernicus Sentinel-2 satellites on August 8, 2022, shows a massive algal bloom ongoing in the central-eastern part of the Baltic Sea, known as the Gulf of Finland. This bloom was probably triggered by heat waves in the area during June and July 2022. According to Copernicus Marine Environment Monitoring Service data, the sea surface temperature anomaly at the time in this area was approximately +2ºC.

The resolution of the Copernicus Sentinel-2 satellites allows Copernicus services to monitor marine biological activity and water quality worldwide.

River Rhine Runs Dry

European Space Agency

The River Rhine, near Cologne, in Auguet 2021

The River Rhine, near Cologne, in Auguet 2022

Images contains modified Copernicus Sentinel data (2021-22), processed by ESA, CC BY-SA 3.0 IGO

Water levels on the River Rhine, Europe's second-largest river, have continued to drop owing to soaring temperatures and lack of rainfall, preventing many vessels from navigating through the waters at full capacity. The Copernicus Sentinel-2 mission captured part of the Rhine near Cologne, showing the stark difference between August 2021 and August 2022.

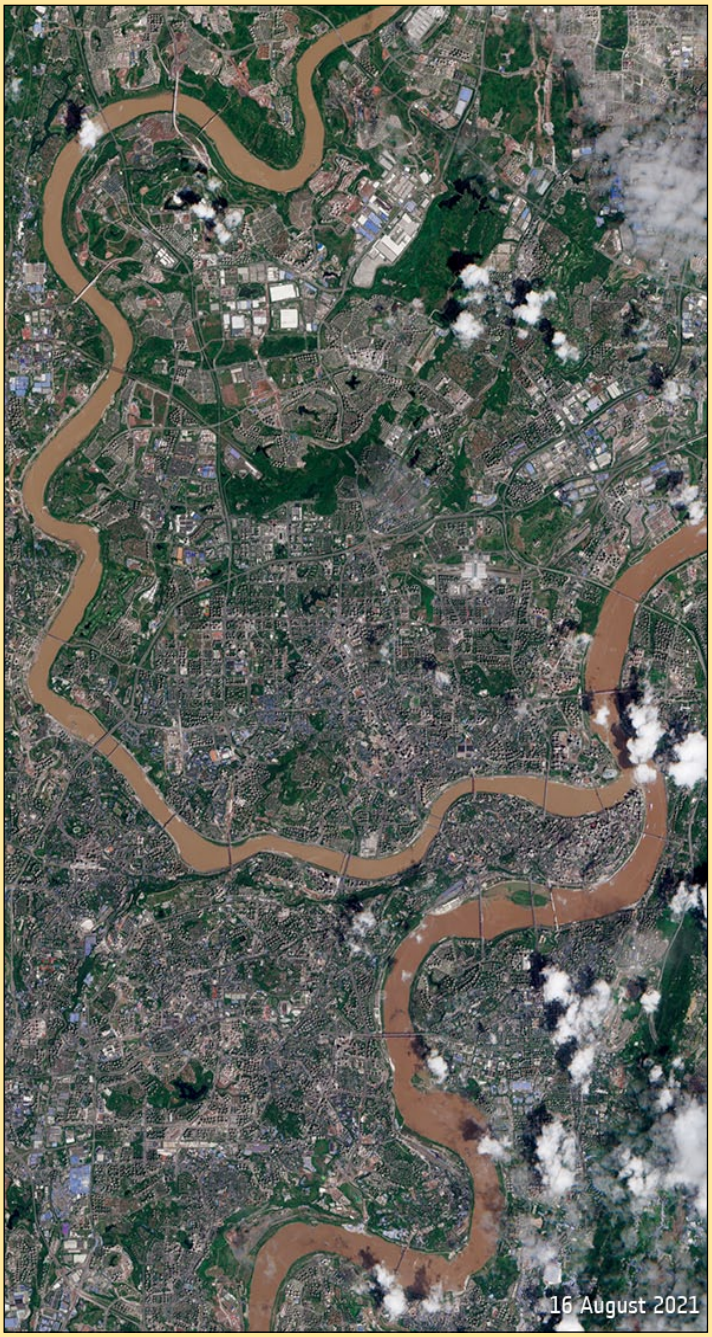
Flowing from the Swiss Alps to the North Sea, the Rhine is an important shipping route for many products from grains to chemicals to coal. When water levels drop, cargo vessels need to sail with reduced loads, so they don't run aground.

Water levels at the chokepoint of Kaub, near Frankfurt, fell to 32 cm in depth on July 15, down from 42 cm from a week earlier. Ships, however, need around 1.5 metres to be able to sail fully loaded, making it difficult for larger vessels to navigate through the waters. Freight ships continue to sail, but only with around 25% to 35% of their capacity.

These low water levels are emerging earlier than usual; the lowest annual water levels are typically recorded during September or October. However, reduced temperatures and predicted rainfall may offer relief to the Rhine.

Drought Causes Yangtze to Shrink

European Space Agency



The Yangtze and Jialing rivers, near Chongqing on August 15, 2021

The Yangtze and Jialing rivers, near Chongqing on August 21, 2022

Images contains modified Copernicus Sentinel data (2020-22), processed by ESA, CC BY-SA 3.0 IGO

A record-breaking drought has caused parts of the Yangtze River to dry up—affecting hydropower, shipping routes, limiting drinking water supplies and even revealing previously submerged Buddhist statues.

The Yangtze is China's most important river, providing water to more than 400 million people. This summer, it has reached record low water levels, with rainfall in the Yangtze basin around 45% lower than normal with entire sections and dozens of tributaries drying up. The loss of water flow to China's extensive hydropower system has created problems in Sichuan, which receives more than 80% of its energy from hydropower.

Images captured by the Copernicus Sentinel-2 mission show a comparison of the Yangtze and Jialing rivers, near Chongqing between this year and last. Higher than normal temperatures increase the evapotranspiration of the river waters and, together with missing precipitation, result in lower water levels and sediment transportation downstream. This explains the significant colour difference of the Yangtze in the 21 August 2022 acquisition. Several areas of dry and exposed riverbed can also be seen west of Chongqing.

Franz Josef Land

MODIS WEB Image of the Day

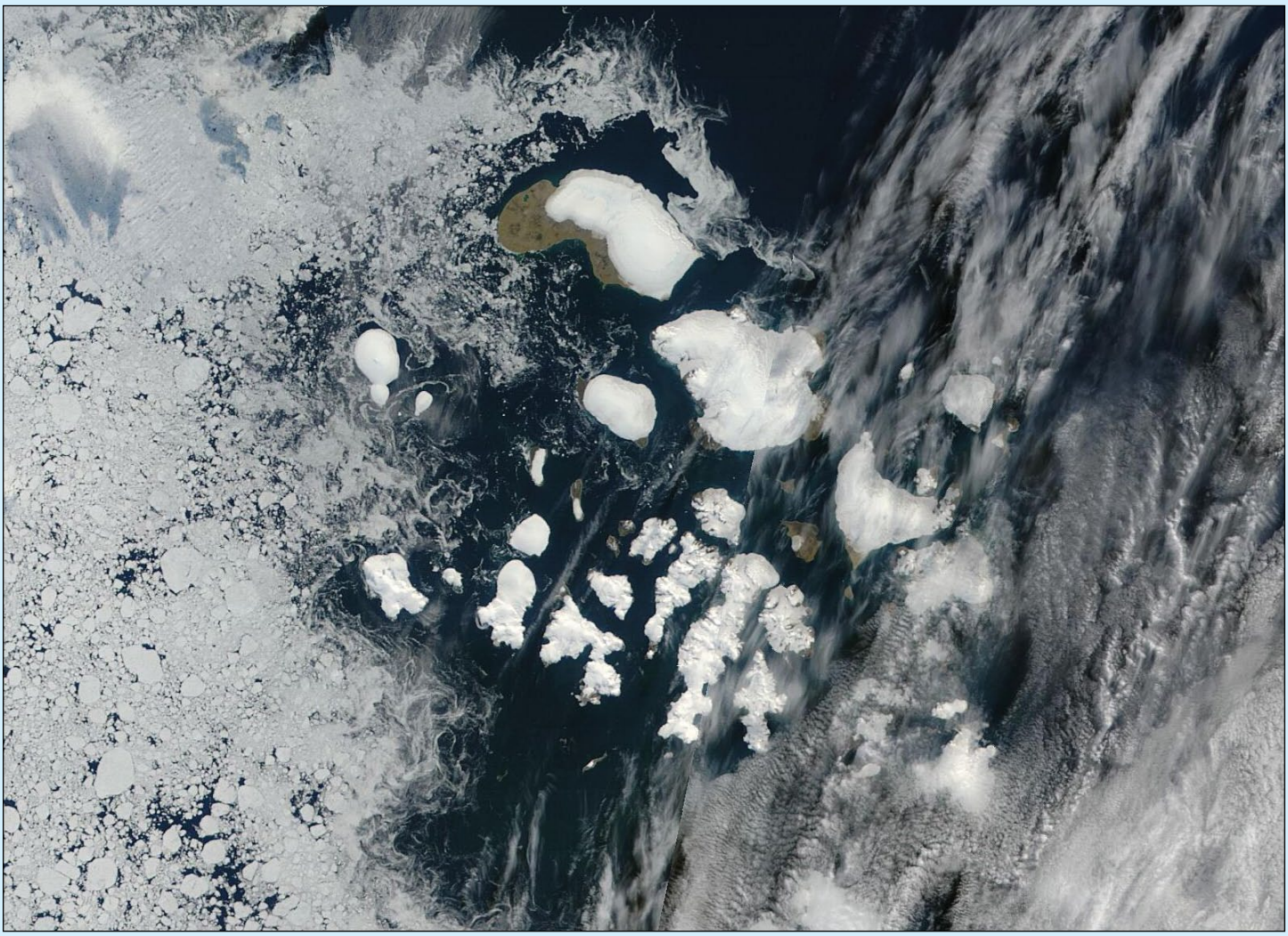


Image Credit: MODIS Land Rapid Response Team, NASA GSFC

Sitting at the northern-most tip of Russia and only 970 kilometres away from the North Pole, the archipelago known as Franz Josef Land remains coated in ice year-round. With such a northerly location, frigid temperatures are the norm. In summer, the average high is just 2°C and it plummets to about -22°C in winter. The steady freeze helps to maintain the presence of glaciers, which cover roughly 85% of the islands.

Despite the harsh climate, life finds a way to flourish. Vegetation includes lichens, mosses, and Arctic flowering plants. Polar bears thrive on land, while sea birds such as guillemots, kittiwakes, and little auks breed in abundance on the cliffs. Atlantic walrus, bowhead whales, shark, seals, and even tiny copepods and phytoplankton live in the waters around and between the islands.

Franz Josef Land was included in the Russian Arctic National Park in 2016, due to its pristine nature and biodiversity. Given that the ice on and around Franz Josef Land depends on frigid temperatures year-round, and island life depends on ice, the nature of these islands is at particular risk in a warming climate, despite preservation provided by classification as a park. A study published in June 2022 in the journal *Scientific Reports* found the Northern Barents Sea to be an exceptional warming hot-spot, with warming rates up to twice as high as previously estimated. The study states:

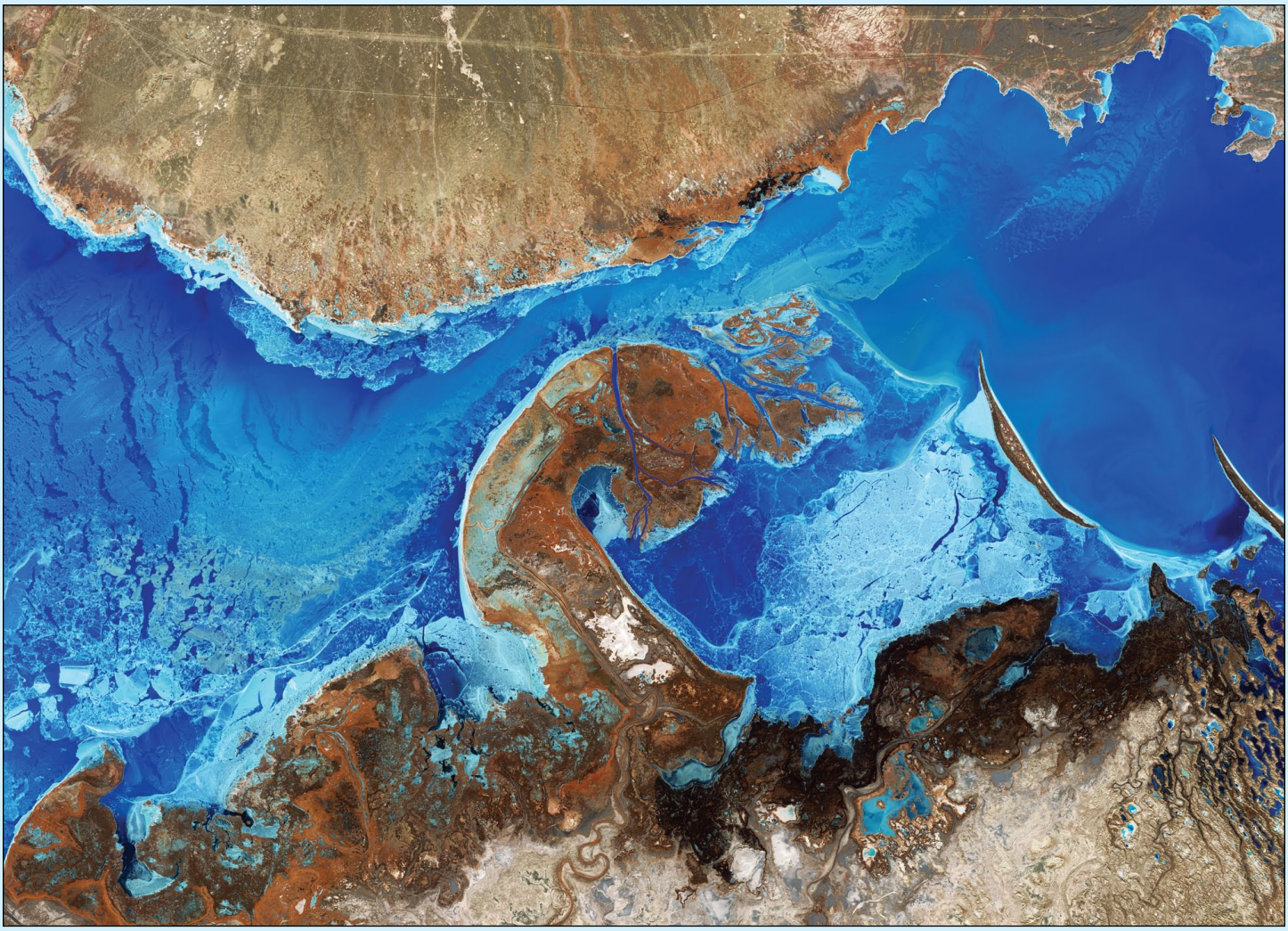
> *'The regional warming rate for the Northern Barents Sea region is exceptional and corresponds to 2 to 2.5 times the Arctic warming averages and 5 to 7 times the global warming averages.'*

On August 17, 2022, the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's Aqua satellite acquired this true-colour image of the northern section of Franz Josef Land. The islands remain covered with glaciers, but sea ice is scarce around and between most of the islands. Scant ice floats to the east of the islands while copious broken ice covers the Barents Sea north the of the archipelago.

Lake Balkhash, Kazakhastan

NASA Earth Observatory

Caption by Adam Voiland



Lake Balkhash, imaged by the Copernicus Sentinel-2 mission on November 29, 2021.

Image contains modified Copernicus Sentinel data (2021), processed by ESA, CC BY-SA 3.0 IGO

Lake Balkhash, the largest lake in Central Asia, is featured in this false-colour image captured by the Copernicus Sentinel-2 mission. The lake, which is situated in east-central Kazakhastan, is around 605 km in length from east to west, with a maximum depth of around 25 m. The lake's size varies depending on water balance, with its area fluctuating between 15 000 and 19 000 square kilometres.

Jutting out into the lake is the Sarymsek Peninsula which divides Balkhash into two separate hydraulic parts. The west part is wide and shallow with its water on this side particularly fresh and suitable for drinking. The east part, on the other hand, is narrow and relatively deep, with its waters on this side of the basin brackish and salty. The two parts of the lake are united by a narrow strait, the Uzynaral visible in the centre of the image, with a depth of around 6 m.

The sediment plume passing through the Uzynaral Strait is most likely due to waves stirring up sediments from the bottom of the lake. This has led to a higher reflection and thus a brighter water colour in this part of the lake.

The north banks of Lake Balkhash are high and rocky while the south banks are low and sandy, with wide belts covered with thickets of reeds and numerous small lakes. These low-lying banks are periodically flooded by the waters of the lake.

A high presence of sea ice can be seen in bright blue-greenish colours especially near the southern shoreline. This colour is due to ice having a higher reflectance in the visible parts of the spectrum than in the near-infrared. Balkhash usually remains frozen from the end of November to the beginning of April, with this image captured on 29 November 2021.

South of Balkhash lies the Saryesik-Atyrau Desert, which stretches for around 400 km in east Kazakhastan. There are a great number of small lakes, ponds and wetlands in the desert (visible in brown), as well as occasional grasslands, that support a varied animal and bird population.

Currently Active Satellites and Frequencies

Polar APT/LRPT Satellites			
Satellite	Frequency	Status	Image Quality
NOAA 15	137.6200 MHz	On	Good
NOAA 18	137.9125 MHz	On	Good
NOAA 19	137.1000 MHz	On	Good [1]
Meteor M N1	137.0968 MHz	Off	Dead [8]
Meteor M N2	137.1000 MHz	On	Good
Meteor M N2-2	137.9000 MHz	Off	System failure [12]

Polar HRPT/AHRPT Satellites				
Satellite	Frequency	Mode	Format	Image Quality
NOAA 15	1702.5 MHz	Omni	HRPT	Weak
NOAA 18	1707.0 MHz	RHCP	HRPT	Good
NOAA 19	1698.0 MHz	RHCP	HRPT	Good
Feng Yun 1D	1700.4 MHz	RHCP	CHRPT	None: Device failure
Feng Yun 3A	1704.5 MHz	RHCP	AHRPT	Inactive [2,10]
Feng Yun 3B	1704.5 MHz	RHCP	AHRPT	Active [2]
Feng Yun 3C	1701.4 MHz	RHCP	AHRPT	Active [2]
Metop B	1701.3 MHz	RHCP	AHRPT	Good
Metop C	1701.3 MHz	RHCP	AHRPT	Good
Meteor M N1	1700.00 MHz	RHCP	AHRPT	Dead [8]
Meteor M N2	1700.0 MHz	RHCP	AHRPT	Good
Meteor M N2-2	1700.0 MHz	RHCP	AHRPT	Active [12]

Geostationary Satellites				
Satellite	Transmission Mode(s)		Position	Status
Meteosat 8	HRIT (digital)	LRIT (digital)	41.5°E	IODC
Meteosat 9	HRIT (digital)	LRIT (digital)	3.5°E	On [5]
Meteosat 10	HRIT (digital)	LRIT (digital)	9.5°E	Off [4]
Meteosat 11	HRIT (digital)	LRIT (digital)	0°W	On [3]
GOES-13	GVAR 1685.7 MHz	LRIT 1691.0 MHz	60°W	Off
GOES-14	GVAR 1685.7 MHz	LRIT 1691.0 MHz	105°W	Standby
GOES-15 (W)	GVAR 1685.7 MHz	LRIT 1691.0 MHz	128°W	On [6]
GOES-16 (E)	GRB 1686.6 MHz	HRIT 1694.1 MHz	75.2°W	On[6,9]
GOES-17	GRB 1686.6 MHz	HRIT 1694.1 MHz	137.2°W	[11]
MTSAT-1R	HRIT 1687.1 MHz	LRIT 1691.0 MHz	140°E	Standby
MTSAT-2	HRIT 1687.1 MHz	LRIT 1691.0 MHz	145°E	On
Feng Yun 2D	SVISSR	LRIT	123.5°E	Backup/Off [7]
Feng Yun 2E	SVISSR	LRIT	86.5°E	On
Feng Yun 2F	SVISSR	LRIT	112.5°E	Standby
Feng Yun 2G	SVISSR	LRIT	99.5°E	On
Feng Yun 2H	SVISSR	LRIT	86.5²E	
Feng Yun 4A	HRIT (digital)	LRIT (digital)	99.5°E	On

Notes

1 LRPT Signals from Meteor M N2 may cause interference to NOAA 19 transmissions when the two footprints overlap.
2 These satellites employ a non-standard AHRPT format and cannot be received with conventional receiving equipment.
3. Meteosat prime Full Earth Scan (FES) satellite
4 Meteosat backup Full Earth Scan (FES) satellite
5 Meteosat prime Rapid Scanning Service (RSS) satellite.
6 GOES 15 also transmits EMWIN on 1692.700 MHz
GOES 16 also transmits EMWIN on 1694.100 MHz
GOES 17 also transmits EMWIN
7 There has been no imagery from Feng Yun 2D since June 30, 2015. Since Feng Yun 2G is operating from the same position (86.5°E), it is likely that FY-2D is now in standby as a backup satellite.
8 On March 20, 2016, Meteor M1 suffered a catastrophic attitude loss, frequently pointing its sensors towards the sun. The following day all signals ceased and it seems highly probable that this satellite is now incapable of imaging the Earth.
9 GOES Rebroadcast (GRB) provides the primary relay of full resolution, calibrated, near-real-time direct broadcast space relay of Level 1b data from each instrument and Level 2 data from the Geostationary Lightning Mapper (GLM). GRB replaces the GOES VARiable (GVAR) service.
10 Although Feng Yun 3A's status is recorded on the wmo-sat website as 'inactive (end of operation)', it continues (as of June 2018) to transmit imagery.
11 GOES 17 is expected to start operations during January 2019.
12 Following a collision with a micrometeorite, the power system aboard Meteor M2-2 has been compromised. AHRPT is still being transmitted when the solar panels are sunlit, but there is insufficient battery power to enable the LRPT stream..