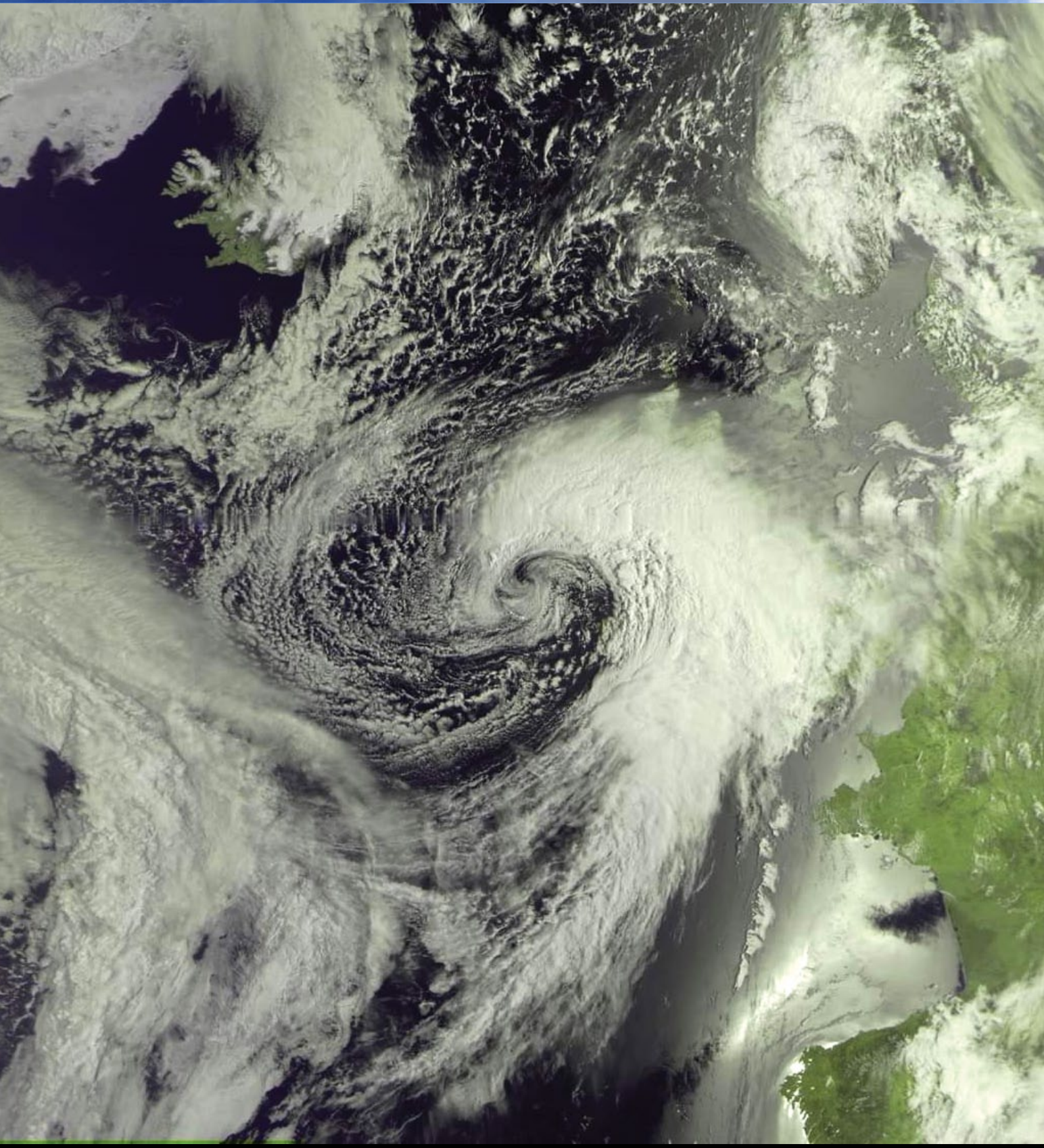
GEO Newsletter

Group for Earth Observation

No 70 - June 2021



Following a record-breaking dry month of April in the British Isles, conditions changed dramatically during May. This Meteor M2 image from Bob Bale shows a deep depression arriving on May 3 threatening heavy rainfall.

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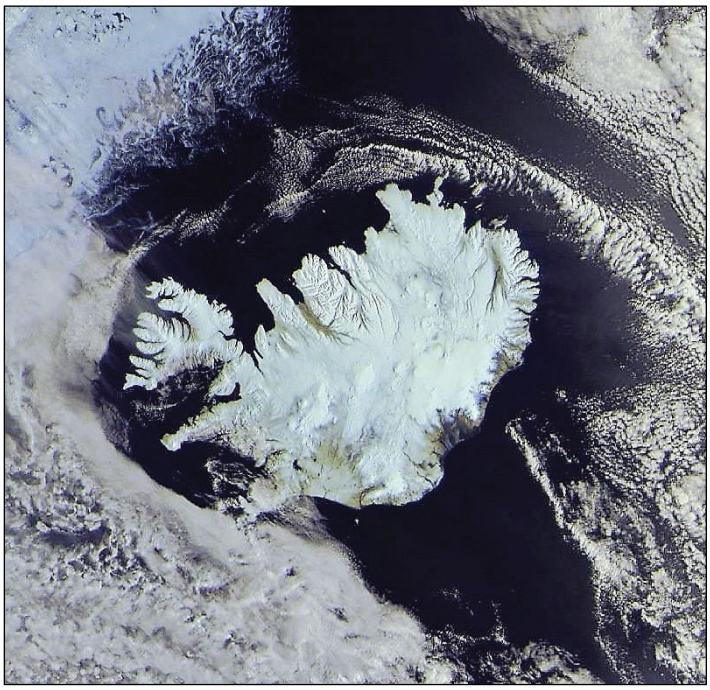

Rob Bale captured this Meteor M2 image on April 11, 2011, displaying Iceland, so often beset by cloud, completely cloud-free for once.

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

Readers will no doubt be pleased to learn that Russia's **Meteor M2-3** satellite looks likely to launch in August and could well be transmitting imagery by the time you receive the September edition of this Newsletter. News Agency *Tass* reported on February 21 this year that a speaker during the 11th international conference of the *Association of Aviation and Space Insurers Aviation and Space Insurance in Russia,* had stated that "The Russian meteorological satellite *Meteor-M No. 2-3* is planned to be launched in August 2021".

Those of you who take an interest in Meteor M2 may have noticed that this satellite is now making its equator crossings more than two hours earlier than when first launched. This means that evening passes in the northern hemisphere are now much better illuminated, and throughout June and July, could rival those acquired during daytime.

Since our articles relating to iceberg A68a in the previous issue, NASA has posted a four minute video on *YouTube* documenting the berg's entire journey. "*The Voyage of One of the Planet's Largest Icebergs*" can be viewed at the url below

https://youtu.be/JxdcBNp0cTE?t=2

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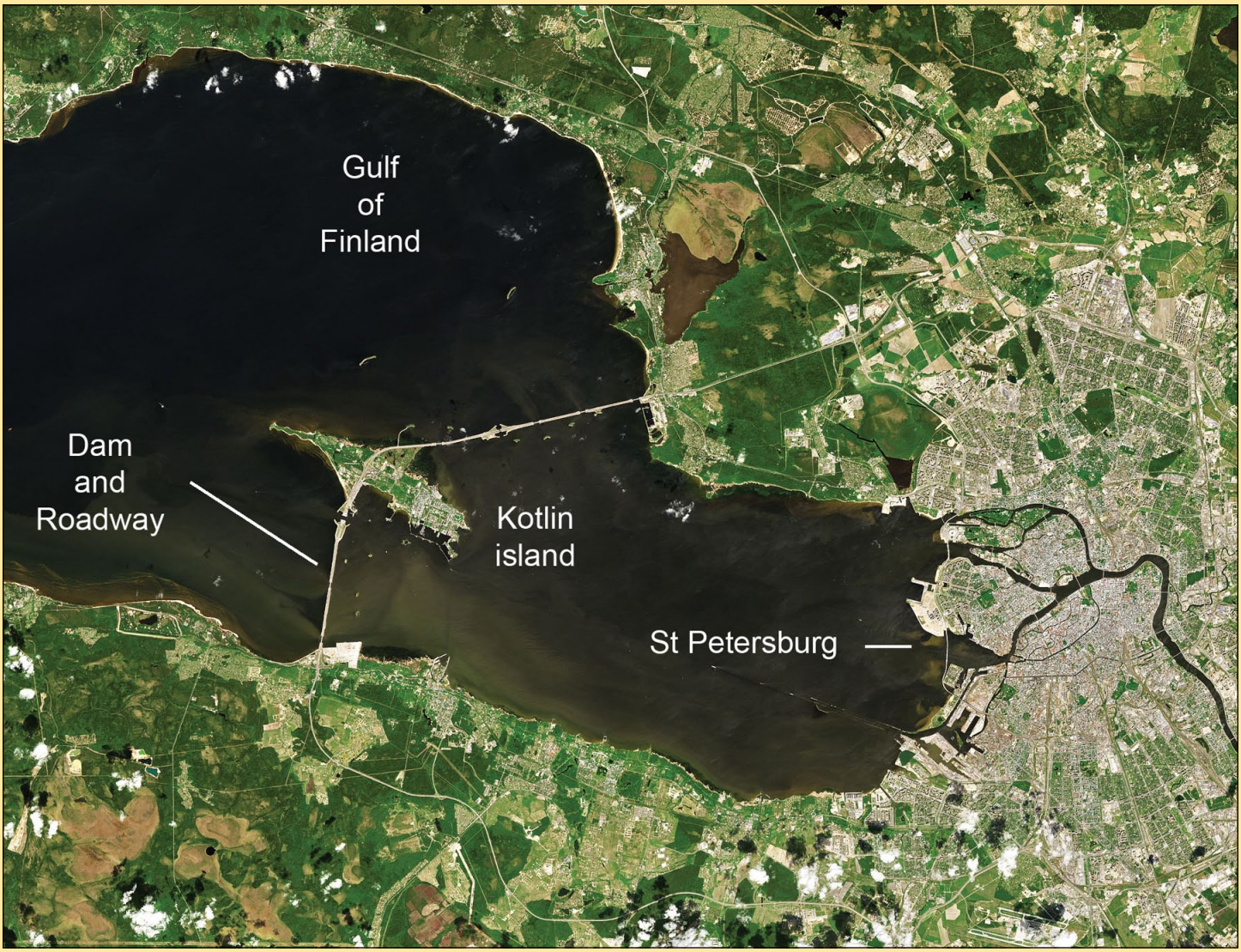
Saint Petersburg Keeps the Sea at Bay

NASA Earth Observatory

Story by Adam Voiland



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

Floods have long plagued Saint Petersburg, Russia's canal-filled 'Venice of the North.' Spread across 42 marshy islands of the Neva River Delta, the historical core of the city rises just one to two metres above sea level.

In 1703, construction had barely begun on Saint Petersburg's first building—the star-shaped Peter and Paul Fortress—when floodwaters washed away construction materials at the site. Since then, more than 300 floods have hit the city, including three catastrophic events where water levels rose more than three metres and swamped thousands of buildings.

The largest floods are typically triggered when cyclones in the Baltic Sea push water east into the Gulf of Finland and Neva Bay. The narrow, shallow gulf can set up powerful seiche waves (standing waves) that are especially dangerous if they coincide with high tides or seasonal floods on the Neva River.

Russia's answer to this flood-prone geography is the Saint Petersburg Flood Prevention Facility—a colossal complex that includes 11 dams, 6 locks, 30 water purification stations, and two navigation channels. As seen in this image from the Operational Land Imager (OLI) on Landsat 8, the structure spans 25 kilometres across the Gulf of Finland, from Lomonosov northward to Kotlin Island, then east toward Gorskaya. A six-lane highway runs across the structure's wide top.

Work on the project began in 1979, but it was not until 2011 that officials declared it operational. The $3.85 billion structure is designed to withstand storm surges of five metres. The floodgates are left open most of the time to allow water and marine life to pass. However, the flow can be cut within 45 minutes if a flood is imminent, as has been done more than a dozen times in the past decade. Vulnerable areas in the historic core of the city—which is a UNESCO World Heritage Site—have not experienced damaging flooding since the dam opened.

Galápagos Islands

European Space Agency

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

The Copernicus Sentinel-2 mission takes us over the Galápagos Islands—a volcanic archipelago situated some 1000 kilometres west of Ecuador in the Pacific Ocean. The archipelago consists of 13 major islands and a handful of smaller islands and islets scattered across approximately 60 000 square kilometres of ocean. Repeated volcanic eruptions and ongoing seismic activity have helped form the rugged

Continued overleaf ...

mountain landscape of the islands. In this image, captured on 23 September 2020, several circular volcanic cones can be seen atop the islands.

The largest island of the archipelago, Isabela (Albemarle), is visible in the centre. Around 132 km in length, the island's sea horse shape is the result of the merging of multiple large volcanoes into a single land mass. The five volcanoes seen on the island are (from north to south): Wolf Volcano, Darwin Volcano, Alcedo Volcano, Sierra Negra Volcano and Cerro Azul Volcano. Two of the island's volcanoes, Ecuador and Wolf, lie directly on the Equator.

At the southern end of the island, hills covered with forests can be seen in bright green, separating the Sierra Negra, the most active of the Galápagos volcanoes, from the sandy coastline (partially visible here owing to cloud cover). Tortuga Island, named for its distinct shape, can be seen southeast from Isabela. This tiny island is actually a collapsed volcano and is a nesting location for a variety of seabirds.

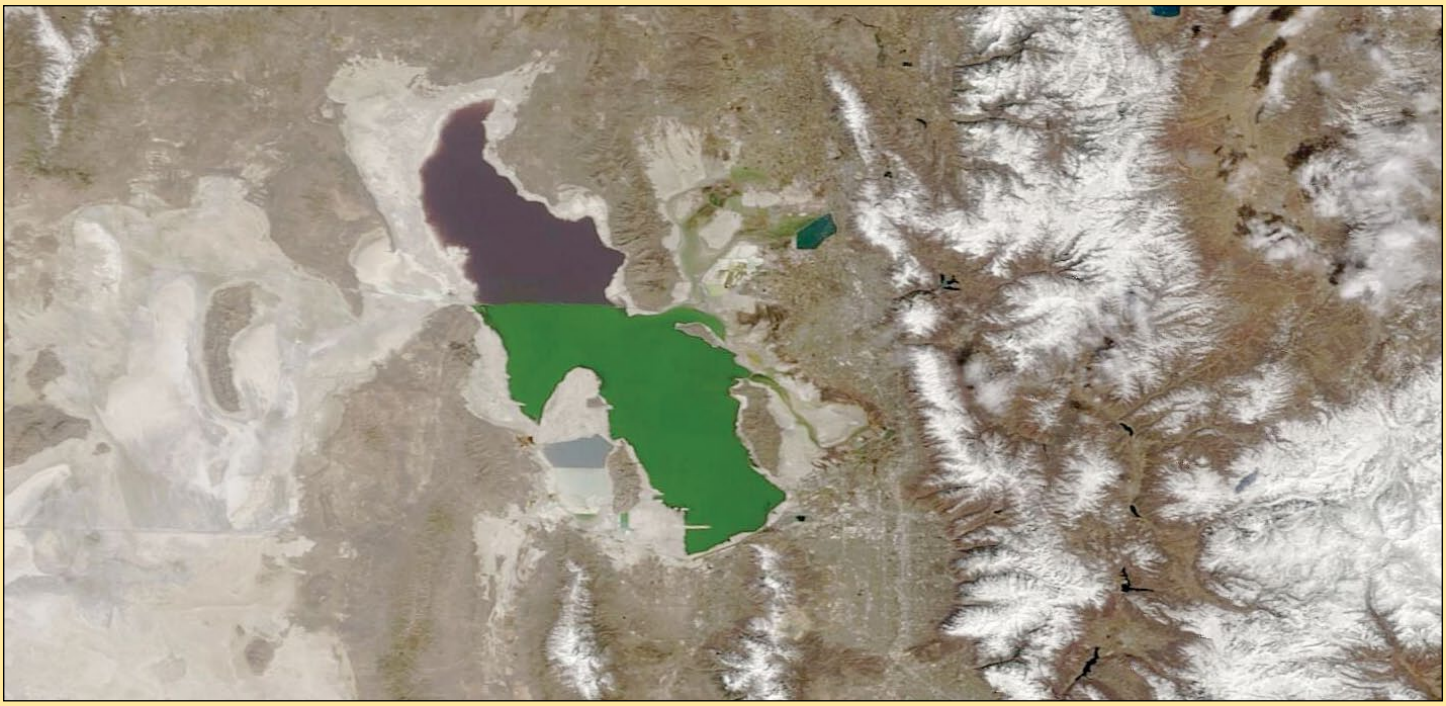
The second largest island of the archipelago, Santa Cruz, can be seen to the right of Isabela. Its capital, Puerto Ayora (not visible), is the most populated urban centre in the islands.

The Galápagos Islands are best known for their diverse array of plant and animal species, many of which are endemic. These include the giant Galápagos tortoise, the marine iguana, the flightless cormorant and the Galápagos penguin—the only species of penguin that lives north of the equator.

These species were observed by Charles Darwin during the voyage of the HMS Beagle in 1835 and inspired his theory of evolution by natural selection. To preserve the unique wildlife on the islands, the Ecuadorian government made the entire archipelago a national park in 1959.

Great Salt Lake

MODIS Web Image of the Day



Credit@ MODIS Land Rapid Response Team, NASA GSFC

On April 4, 2021, the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's Terra satellite acquired a stunning true-colour portrait of Utah's two-toned Great Salt Lake centred on a background of tans and white. The waters of the lake contrast not only with each other, but also stand out as a saline oasis in an otherwise arid basin housing scant vegetation and copious salt flats. Tall mountains surround the basin and are capped with snow—a truly precious commodity that holds precipitation fast until warm weather, when it is released as water. That water will be used by people for drinking, agriculture, and industry—and some will travel through rivers and streams to add water to the Great Salt Lake.

It is effectively split into two by a man-made causeway, which runs across the entire lake and stops the free-flow of water between the northern and southern arm. The plum-coloured northern arm, known as Gunnison Bay, contains roughly thirty percent salt. More freshwater rivers run into the southern portion (Gilbert Bay) so not only are the green waters less saline than the north, but the salinity can fluctuate between 6 and 27 percent.

Suez Canal Traffic Jam seen from Space

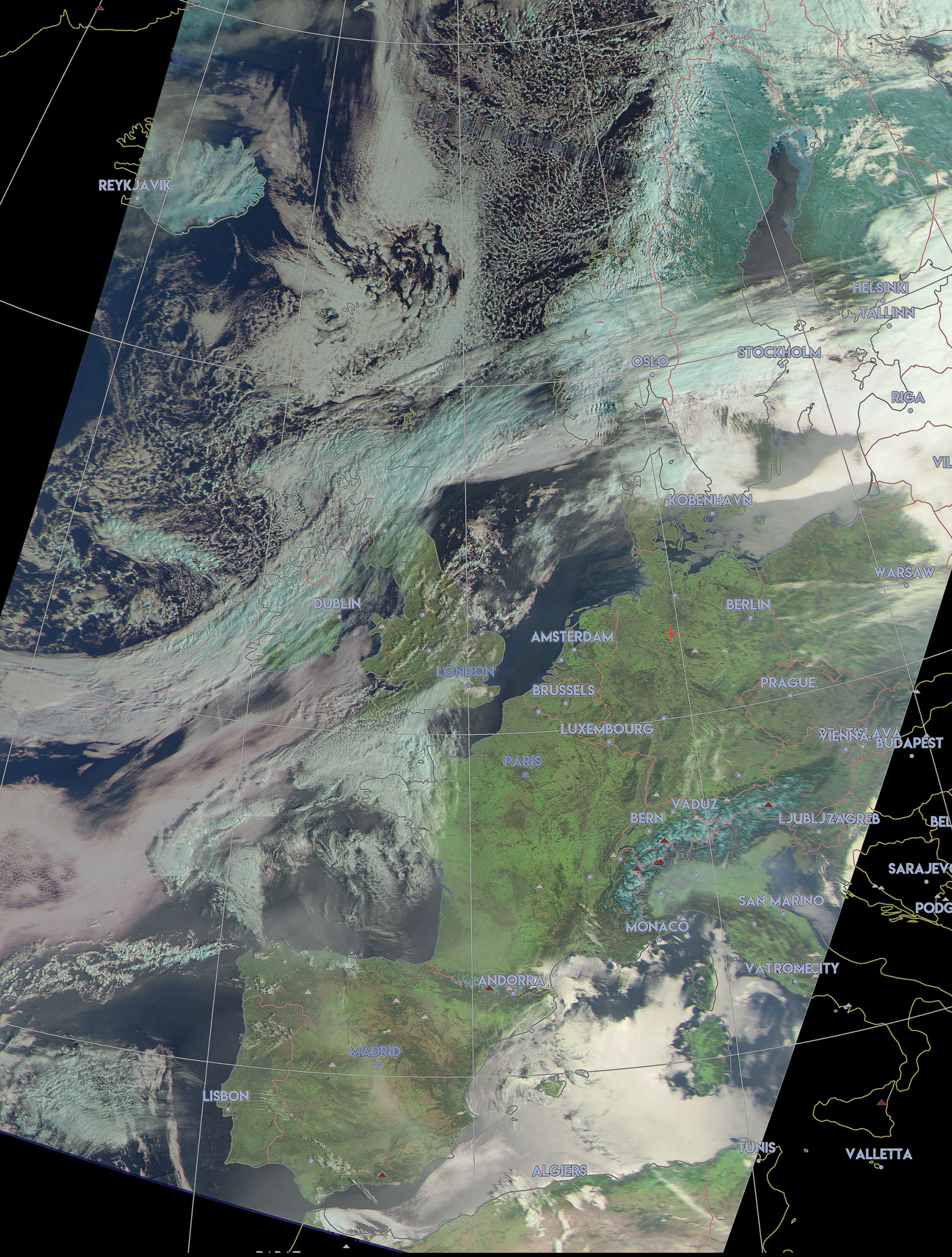
European Space Agency

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

The enormous *Ever Given* container ship, wedged in Egypt's Suez Canal, is visible in this image captured on March 25, by the Copernicus Sentinel-1 mission. The giant, 400 metre long container ship ran aground in the canal on March 23, on its journey from China to the Netherlands.

The canal connects Port Said on the Mediterranean Sea to the Indian Ocean via the Egyptian city of Suez on the Red Sea. The blockage delayed hundreds of tankers and vessels from reaching their destinations, and these can be seen accumulating in the Gulf of Suez.

The two identical Copernicus Sentinel-1 satellites carry radar instruments to provide an all-weather, day-and-night supply of imagery of Earth's surface, making it ideal to monitor shipping traffic. The sea surface reflects the radar signal away from the satellite and makes water appear dark in the image. This contrasts with metal objects, in this case the ships in the bay, which appear as bright dots in the dark waters.



Joachim Scharrer sent in this superb long Meteor M2 image of western Europe acquired on March 31, 2021, following the switch over to transmission of the three visible light channels three days earlier. A feature is the spectacular sunglint on the Mediterranean Sea.

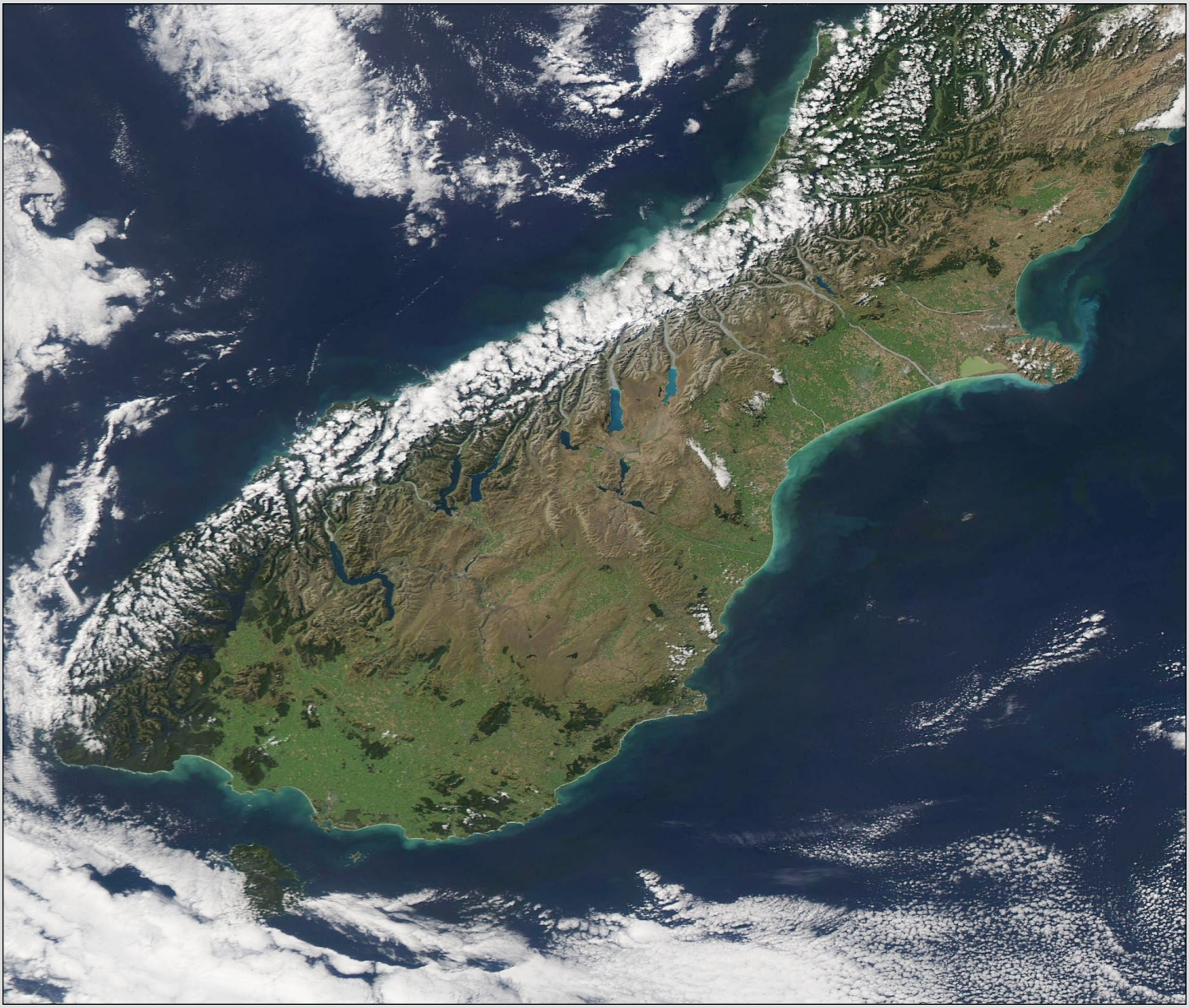
Sunny Summer Day in South Island, New Zealand

NASA Earth Observatory

The stunning colours of New Zealand's South Island shone on March 18, 2021, when the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's **Aqua** satellite acquired this true-colour image of a rare cloud-free late summer day.

The Southern Alps stretch down the length of South Island, capped with snow and glaciers year-round. On this day, clouds also covered much of the western slopes and the western coast, not unusual at any time of the year as the West Coast of South Island is the wettest region anywhere in New Zealand. Thanks to the tall mountains and the resultant rain shadow, the area just east of the mountains is one of the driest areas in New Zealand.

While most of South Island experiences copious sunshine, capturing satellite images of the island can be difficult due to frequent and shifting cloud patterns brought by the island's position in the *Roaring Forties*. This is a wide belt of gale-force westerly winds that circle the Southern Hemisphere, bringing storms and copious clouds. Clouds are so frequent—and so appreciated—that they are frequently used in common names. For example, the highest peak in the Southern Alps (and in New Zealand) is Aoraki/Mount Cook at 3,754 metres. The native name is said to translate to "The Cloud Piercer", a nod to the dramatic clouds that so frequently sit around the mountaintop.



NASA's Aqua satellite captured this superb MODIS image of South Island, New Zealand on March 18, 2021
Image Credit: MODIS Land Rapid Response Team, NASA GSFC

Eruption at Mount Etna

MODIS Image of the Day

This MODIS image, captured by NASA's Aqua satellite on March 12, shows an eruption plume from Mount Etna
Image Credit: MODIS Land Rapid Response Team, NASA GSFC

On March 12, 2021, Italy's Mount Etna erupted for the twelfth time in twenty-five days, sending a large plume of ash about 10 kilometres into the atmosphere along with dramatic lava fountaining. The Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's **Aqua** satellite acquired this true-colour image on that same day, which captured the large ash plume as it drifted eastward over the Ionian Sea.

There is nothing particularly unusual about Mount Etna flinging lava, volcanic ash, or molten rocks into the air. The Italian volcano ranks as one the most active in Europe and has been in a state of eruption since 2011. This most recent paroxysm, which started on February 16, has been particularly violent. In February, lava fountains rose as high as 1.5 kilometres, about 3 times the height of *One World Trade Center*, the tallest building in the United States. Columns of ash and small rock fragments (called lapilli) rose as high 11 kilometres in altitude. Long lava flows poured down Etna's eastern flank and lapilli (rock fragments) and ash landed in several cities and villages near the volcano.

Despite the extreme strombolian activity, the risk to people has been deemed as small. The *Global Disaster Alert and Coordination System* (GDACS) gave the eruption a 'green' (low risk) alert, stating that the event is likely to have a low humanitarian impact. About 2.75 million people live within 100 kilometres of the volcano and 940,000 within 30 kilometres.

Fending Off the Wind on the Steppe

NASA Earth Observatory

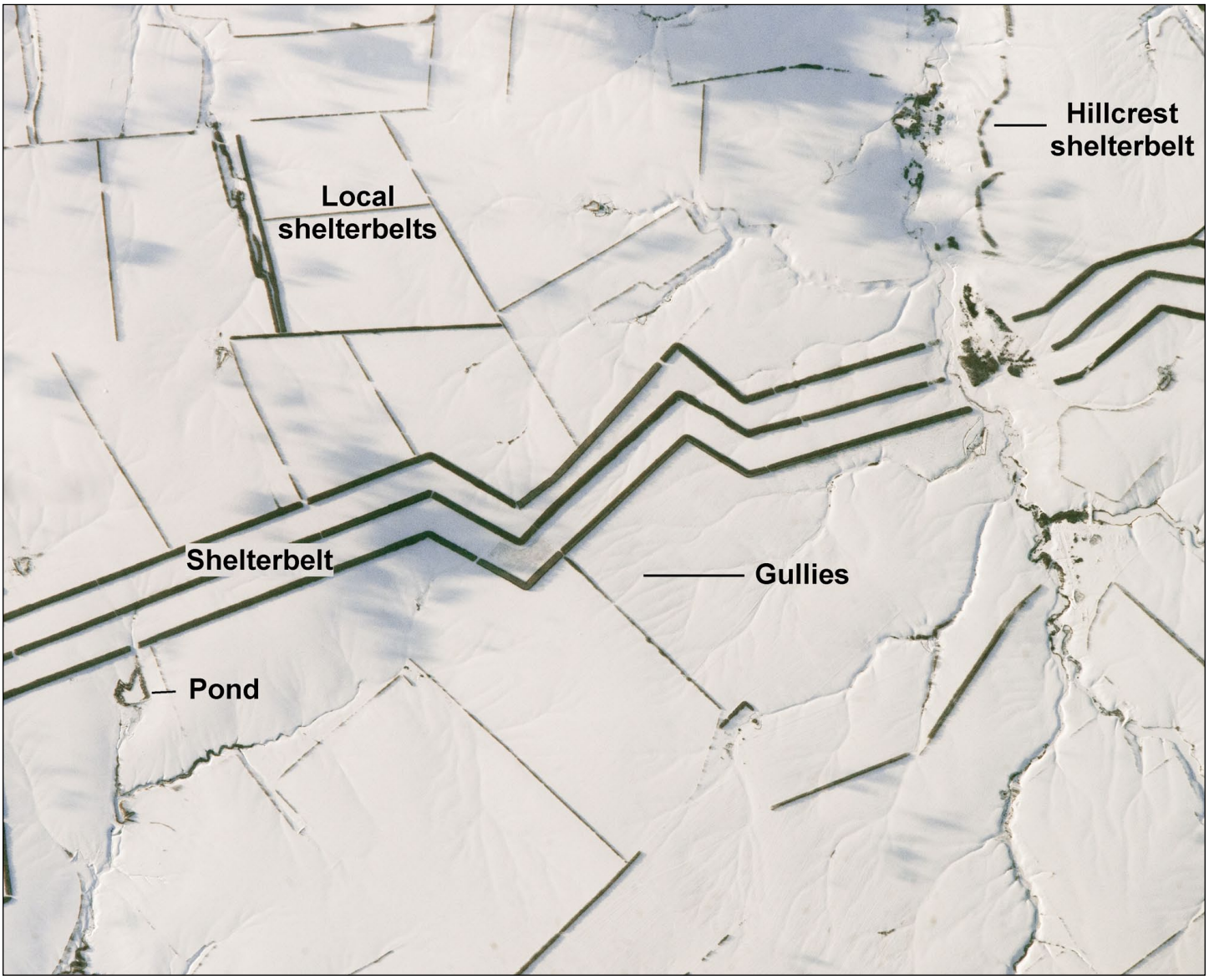
Caption by Andi Hollier, Hx5, JETS Contract at NASA-JSC.

The dark, angular lines crossing this snowy landscape attracted the attention of an astronaut looking down from the International Space Station. This photograph shows the parallel lines of a major shelterbelt—also known as a windbreak—crossing the steppes of southern Russia near the Volga River (Volgograd Oblast). The image shows a 14-kilometre section of an extensive system of shelter belts planted to protect crops and reduce the erosion of steppe soils by wind. The shelterbelt is broken where it meets a local stream.

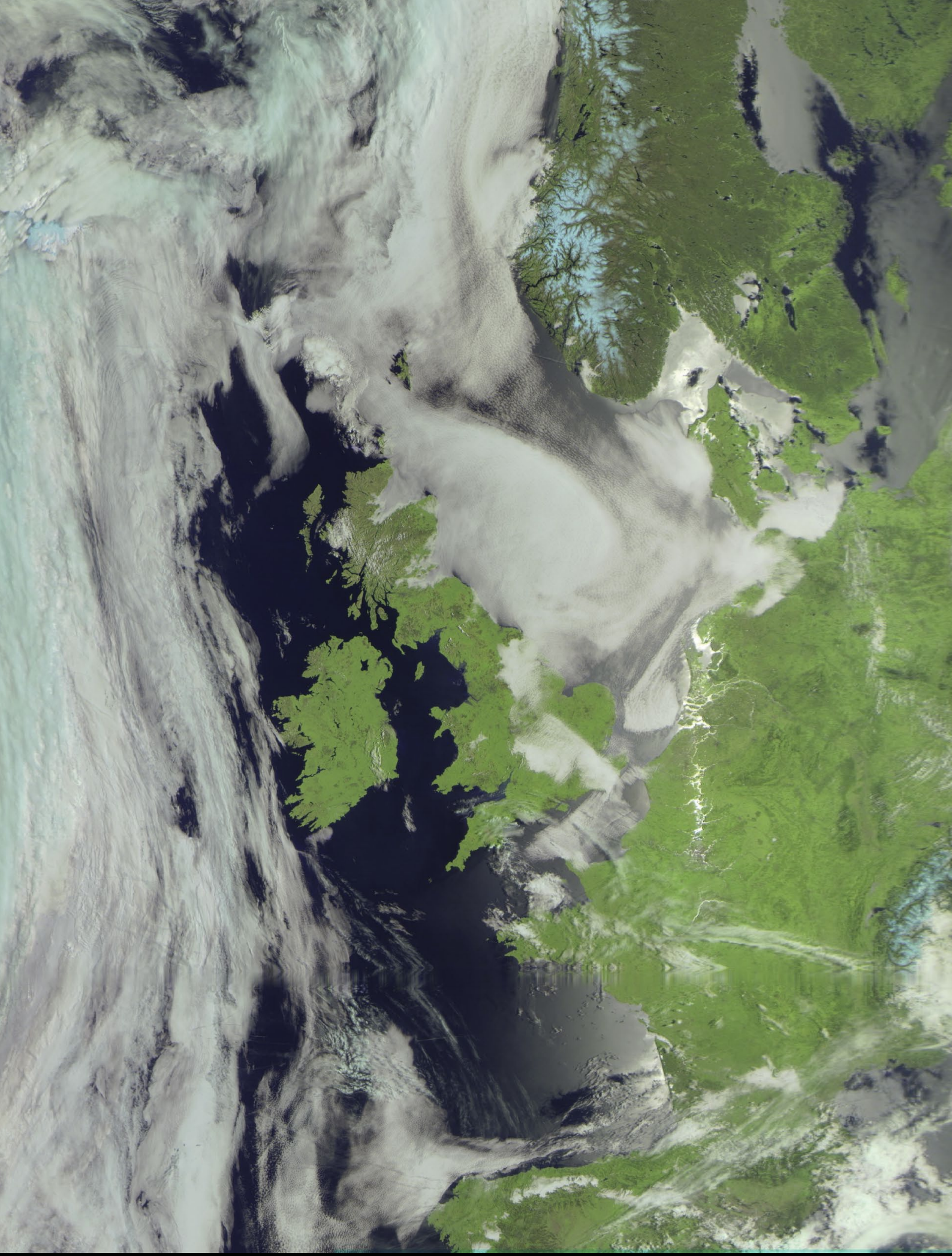
Each of the north-south trending lines is a dense mass of trees about 60 metres wide. The trees throw shadows to the east in this late afternoon view (north is to the right). Together the three lines span about 800 meters, and there is enough space between the rows of trees for narrow fields to be tilled.

Shelterbelt construction began when open steppe landscapes were first settled by Russian farmers in the early 1700s. At present, more than two million hectares of the steppes have been planted. The soils within the main shelter belts in this region have been shown to be significantly improved, becoming richer in organic carbon than virgin soils that have never been ploughed.

The photograph also shows narrower lines of trees along farm boundaries; these protect individual fields from winds and associated gully erosion. The trees also protect water bodies from evaporation by the steady winds, and they prevent ponds and streams from filling with blown sand and silt. Lines of trees at the crest of the creek bank protect the creek valley (top right).



Astronaut photograph ISS050-E-52312 © NASA



Following a desperately cold winter and wet and chilly spring, summer suddenly arrived on May 30, 2021.
This Meteor M2 image includes sparkling sunglint on the Skaggerak, the Dutch waterways
and the Bay of Biscay, with a massive fog bank over much of the North Sea

www.geo-web.org.uk

Preparing for Rising Seas in the Maldives

NASA Earth Observatory

Story by Adam Voiland.

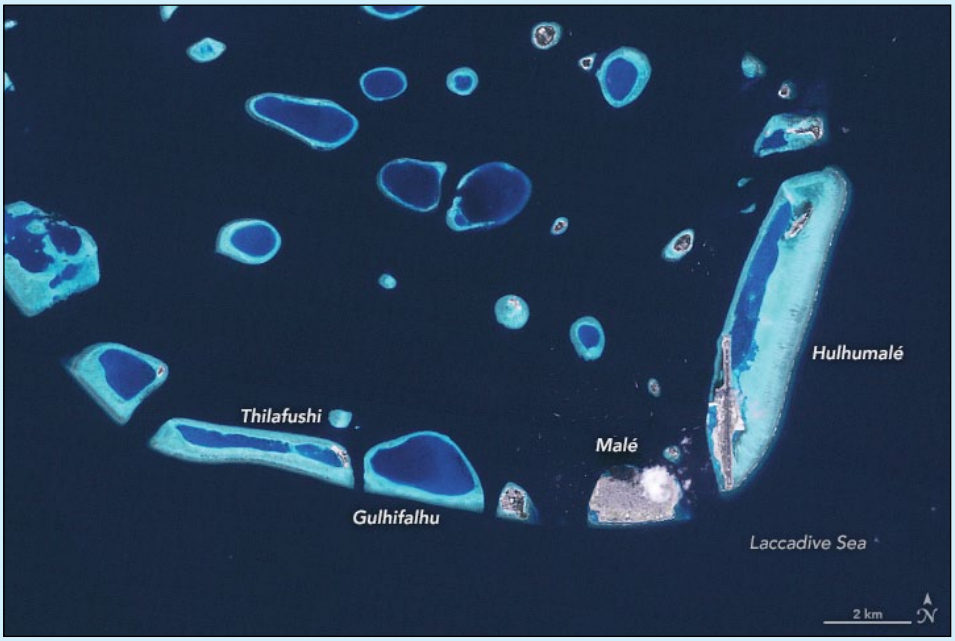
With more than 80 percent of its 1,190 coral islands standing less than one metre above sea level, the Maldives has the lowest terrain of any country in the world. This makes the archipelago in the Indian Ocean particularly vulnerable to sea level rise.

With global sea level rising 3 to 4 millimetres per year, and that rate expected to rise in coming decades, some analysts anticipate a grim future for the Maldives and other low-lying islands. One study concluded that low-lying islands could become uninhabitable by 2050 as wave-driven flooding becomes more common and freshwater becomes limited. The *Intergovernmental Panel on Climate Changes* anticipates sea level could rise by about half a metre by 2100 even if greenhouse gas emissions are sharply reduced, or rise up to one metre if greenhouse gas emissions continue to increase strongly.

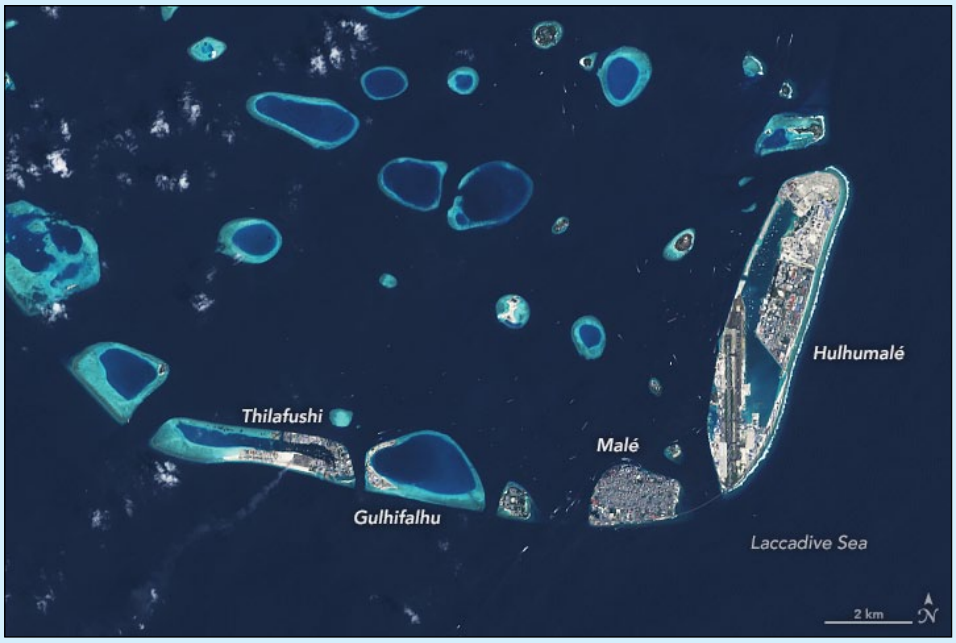
While government of the Maldives has explored plans to purchase land on higher ground in other countries as an insurance policy against sea level rise, planners are also working to enhance the resilience of the country's current islands. One example is Hulhumalé, a newly constructed artificial island northeast of the capital, Malé.

The two Landsat satellite images opposite show just how much the area has changed between 1997 and 2020. Construction of Hulhumalé, designed to relieve crowding in Malé, began in 1997 in a lagoon near the airport. Since then, the island has grown to cover 4 square kilometres, making it the fourth largest island in the Maldives. Hulhumalé's population has swollen to more than 50,000 people, and is expected to rise to 240,000 by the mid 2020s.

The new island, built by pumping sand from the sea floor on to a submerged coral platform, rises about two metres above sea level, about twice the elevation of Malé. The extra height could make the island a refuge for Maldivians who are eventually driven off lower-lying islands due to rising seas. It could also prove to be an option for evacuations during future typhoons and storm surges.



The artificial island of Hulhumalé, in the Maldives, imaged by Landsat in 1997
Image: NASA / USGS



The artificial island of Hulhumalé, in the Maldives, imaged by Landsat in 2020
Image: NASA / USGS

Hulhumalé is not the only island in the Maldives that has seen major changes since the 1990s. Reclamation projects have enlarged several other atolls in similar ways in recent decades. Among them is Thilafushi, a lagoon to the west that has became a fast-growing landfill and a common location for trash fires (note the smoke plume blowing to the southwest in the 2020 image). Gulhifalhuea is the site of another land reclamation project that is opening up new manufacturing and industrial space.

There is one piece of positive news: natural processes on coral reef atolls (like those in the Maldives) might make the islands more resistant to sea level rise than their low elevations might initially suggest. Multiple studies, many of which use Landsat observations, show that most coral atoll islands in the Maldives and elsewhere have remained stable or even grown larger in recent decades.

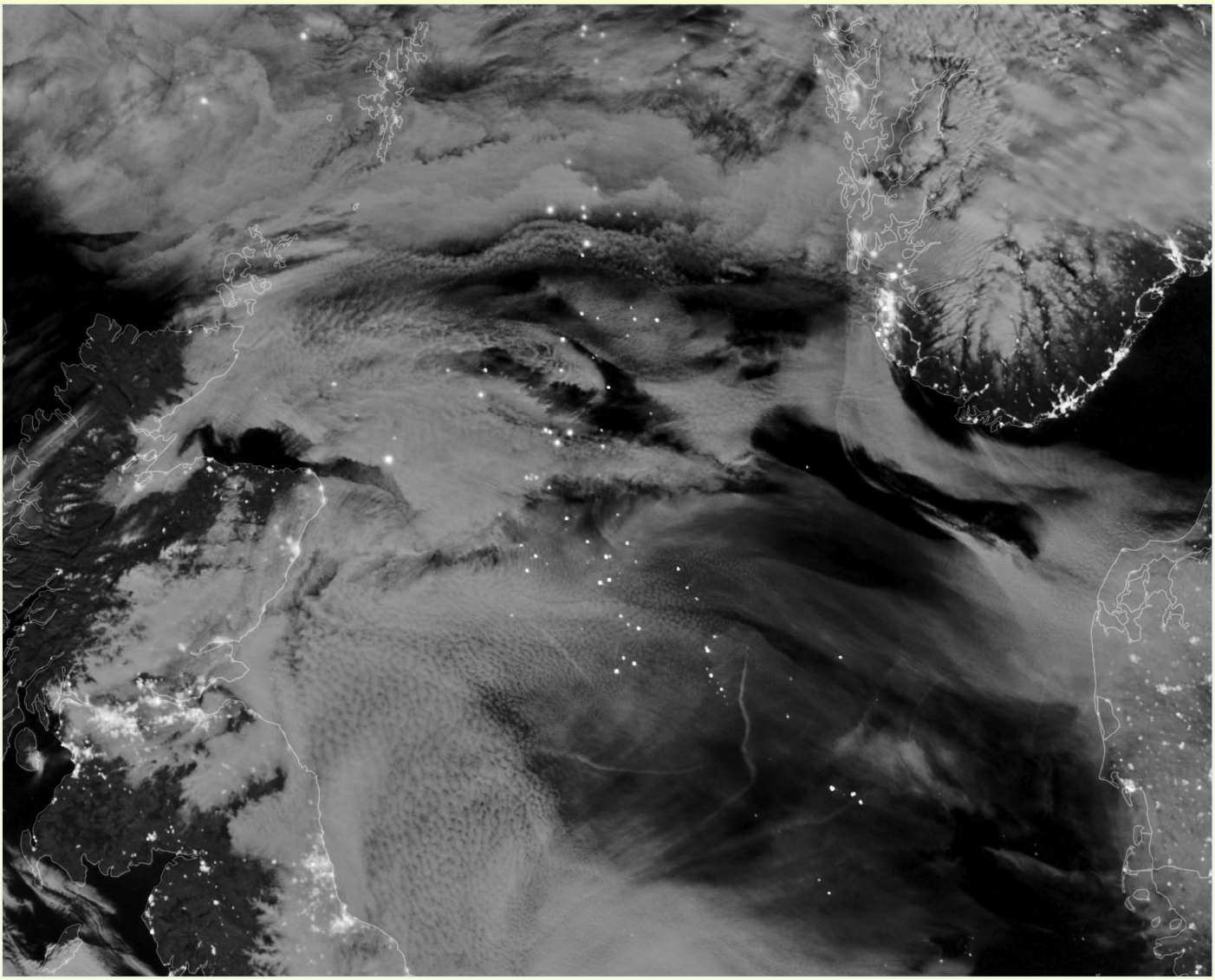
Scientists are still studying why, but some research indicates that storms and floods that wash over islands can move offshore sediment onto the island surface, building the island up in the process. Other research shows that healthy coral reefs can grow upward even when seas are rising by producing abundant sediment.

"*The key thing to understand is that these islands aren't static. They don't sit passively as if they were in a bathtub and slowly drowning,*" said Murray Ford, a geologist at the University of Auckland. "*They are constantly being reshaped by oceanographic and sedimentary processes.*"

These natural processes may offer only limited protection to highly developed islands, partly because the construction of sea walls can disrupt the movement of sediment, and human activity often degrades the health of coral reefs.

"*Once an island is on an engineered pathway, it can't easily get off it. Islands that are being built on reclaimed land must factor in sea level rise and build higher off the ground,*" said Murray. "*For islands that are unpopulated, or sparsely populated, care should be taken to not interfere with the natural ability of islands to adjust to changes in sea level.*"

Image: Lights in the North Sea



NASA Earth Observatory images by Joshua Stevens, using VIIRS day-night band data from the Suomi National Polar-orbiting Partnership and MODIS data from NASA EOSDIS LANCE and GIBS/Worldview.

This image, acquired by the day-night band (DNB) of the Visible Infrared Imaging Radiometer Suite (VIIRS) carried by the NOAA-NASA Suomi NPP satellite, shows lights from oil rigs and the pathways of ships navigating between the rigs in the North Sea on March 2, 2021.

The DNB detects light in a range of wavelengths from green to near-infrared and uses filtering techniques to observe signals such as city lights, auroras, and reflected moonlight.

Colour off the Coast of Australia

MODIS Image of the Day

A swirling halo of blue surrounded the coastline of northwestern and northern Australia in mid-May 2021. This gorgeous true-colour image was acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's *Aqua* satellite on May 13.

The rugged landscape of the northern section of Australia's Northern Territory makes up roughly the eastern two-thirds of this image, while the northern tip of Western Australia sits in the west. Both regions are coloured in bold rust tones, tans, and washed with green. In contrast to the rich Earth-tones found inland, stunning shades of blue, turquoise, greens, and tan hug the shoreline. These jewel-toned colours were swept into the deep blue waters of the Indian Ocean by strong currents found just offshore.

Some of the coastal colour comes from sediment, such as the muddy-brown stain in the King Sound, which is found along the southwestern coastline of Western Australia in this image. The dirt-coloured smudge in the water is caused by mud stirred up by the strong tides in the shallow Sound. It is also from sediment carried into the Sound by the Fitzroy, one of Australia's largest rivers.

When sediment is suspended near the surface, it appears mud-coloured; however, as it sinks the reflective properties change, so sunken sediment appears green or blue from space. This change in colour can be seen in King Sound, both at the edge of the sediment plume—where the colour changes from tan to green—and further from shore, where the water of the Sound takes on a turquoise tint.

While some of the colour surrounding the Australian coast may come from sediment, most of the shining stain probably comes from large blooms of phytoplankton. These floating, microscopic, plant-like organisms carry pigment that, when massed together in large 'blooms', can easily be seen from space. For the most part, phytoplankton float near the surface of the ocean and drift wherever currents take them. Because of this, phytoplankton can sometimes be used to reveal the flow of currents in the ocean.

Image Credit: MODIS Land Rapid Response Team, NASA GSFC

Breakup at the the Brunt Ice Shelf

NASA Earth Observatory

Story by Kathryn Hansen with information from Christopher Shuman (NASA GSFC/UMBC JCET).

Antarctica's Brunt Ice Shelf finally calved a large iceberg in February 2021, two years after rifts opened rapidly across the ice and raised concerns about the shelf's stability.

The break was first detected by GPS equipment on February 26, 2021, and confirmed the next day with radar images from the European Space Agency's Sentinel-1A satellite. On March 1, clouds were sparse enough for the Operational Land Imager (OLI) on Landsat 8 to acquire the natural-colour image of the new iceberg shown below.

Named A-74, the berg spans about 1270 square kilometres, roughly twice the size of Chicago. That's a large piece of ice for the Brunt Ice Shelf, but Antarctica is known for churning out some enormous bergs. For comparison, Iceberg A-68 was almost five times that size when it calved from the Larsen-C Ice Shelf in 2017.

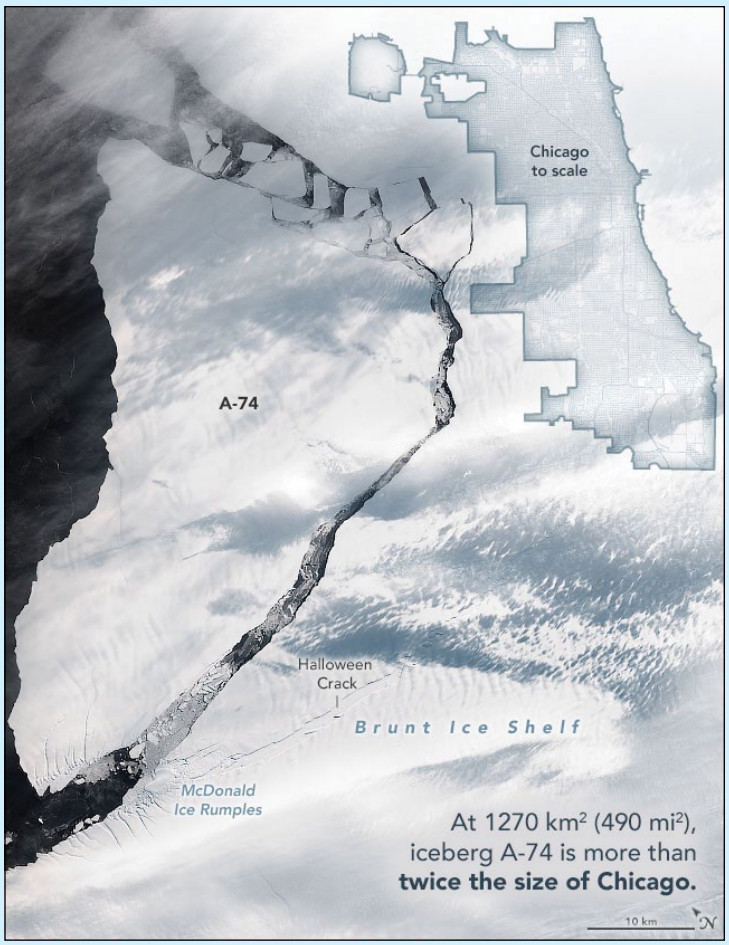
A-74 broke from the ice shelf northeast of the McDonald Ice Rumples—an area where the flow of ice is impeded by an underwater bedrock formation that causes pressure waves, crevasses, and rifts to form at the surface. The rift that spawned the new berg appeared near the rumples in satellite images in September 2019, and it advanced across the ice shelf with remarkable speed during the austral summer of 2020-2021.

> "*I would not have thought that this rift could go zipping across the northeast side of the Brunt Ice Shelf and cause a significant calving—all in a tiny fraction of the time it has taken Chasm 1 to extend toward the ice rumples from the south*," said Christopher Shuman, a University of Maryland, Baltimore County, glaciologist based at NASA's Goddard Space Flight Center.

Chasm 1 is a separate rift located south of the ice rumples and the Halloween Crack. After decades of growth—and then a rapid acceleration in 2019—that rift appeared poised to spawn its own iceberg, prompting safety concerns for researchers 'upstream' at the British Antarctic Survey's *Halley VI Research Station*. This section of the shelf is still holding on, but when it eventually breaks the berg will likely measure about 1700 square kilometres.

> Scientists are waiting to see how the complex structure responds to the recent calving. "*The Halloween Crack may or may not be the first to respond*," Shuman said. "*We'll be closely watching that pinning point for changes to the larger Brunt Ice Shelf remnant.*"

Map showing the location of the Brunt Ice Shelf
Image: Paleo nim / Wikipedia CC



NASA Earth Observatory image by Joshua Stevens, using Landsat data from the US Geological Survey and data © OpenStreetMap contributors via CC BY-SA 2.0.

It also remains to be seen what will become of the new iceberg. Most likely, it will eventually get caught up in the Weddell Gyre—similar to the fate of A-68. But first it needs to be pushed offshore, and to date it does not appear to have moved very far.

The Brunt Ice Shelf lies adjacent to Coats Land, on the eastern shore of the Weddel Sea, and was named after Welsh meteorologist David Brunt. It was he who initiated the Royal Society Expedition to this ice shelf in 1955 which set up Halley Bay Base, the precursor of the current British Antarctic Survey research station.

The Halley Research Station sits on the 130 metre thick ice shelf which is slowly flowing towards the Weddell Sea. The first four Halley stations, the earliest of which were simply wooden huts, are now long gone. They tended to become buried deep in the snow, which caused access and ventilation problems.

The current state-of-the-art base station, operational since 2013, is Halley VI, and comprises a number of interconnected pods on hydraulic legs fitted with retractable skis: this makes it possible to tow the entire facility across the ice. In 2015 a developing crack in the ice shelf threatened the base, and in March 2017, the Halley VI Station was successfully relocated 23 kilometres farther inland to a more secure location.

The British Antarctic Survey's Halley VI Base
Image: Hugh Broughton Architects / Wikipedia CC

Giant Iceberg breaks off Brunt Ice Shelf in Antarctica

European Space Agency

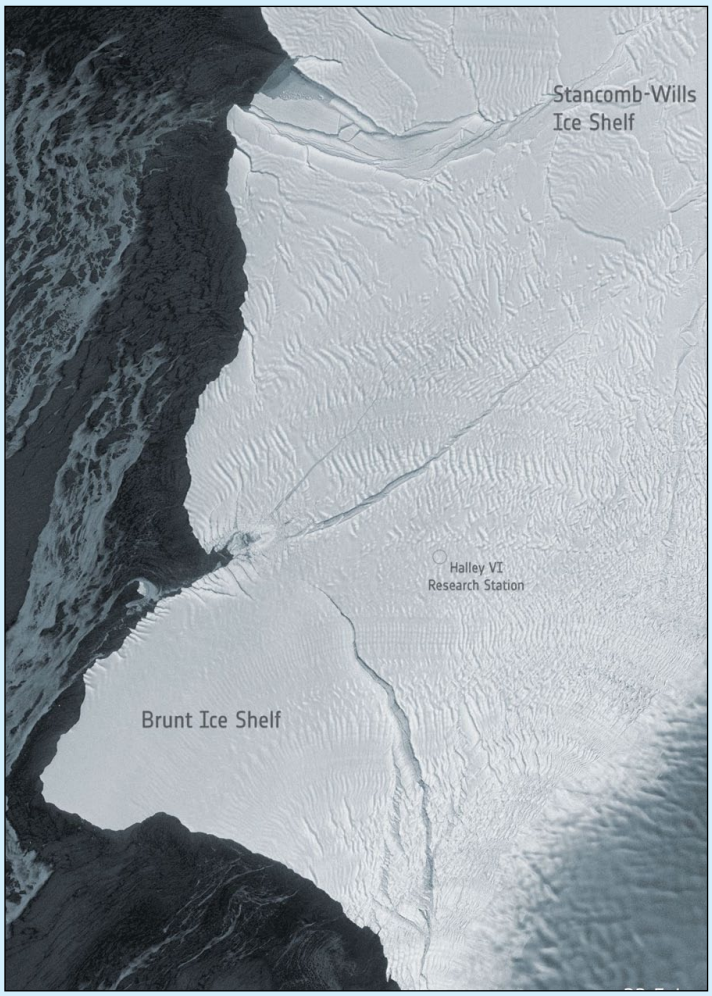
A giant iceberg, approximately 1.5 times the size of Greater Paris, broke off from the northern section of Antarctica's Brunt Ice Shelf on Friday, February 26, 2021. Radar images, captured by the Copernicus Sentinel-1 mission, show the 1270 square kilometre iceberg breaking free and moving away rapidly from the floating ice shelf.

Glaciologists have been closely monitoring the many cracks and chasms that have formed in the 150 metre thick Brunt Ice Shelf over the past years. In late 2019, a new crack was spotted in the portion of the ice shelf north of the McDonald Ice Rumples, heading towards another large crack near the Stancomb-Wills Glacier Tongue.

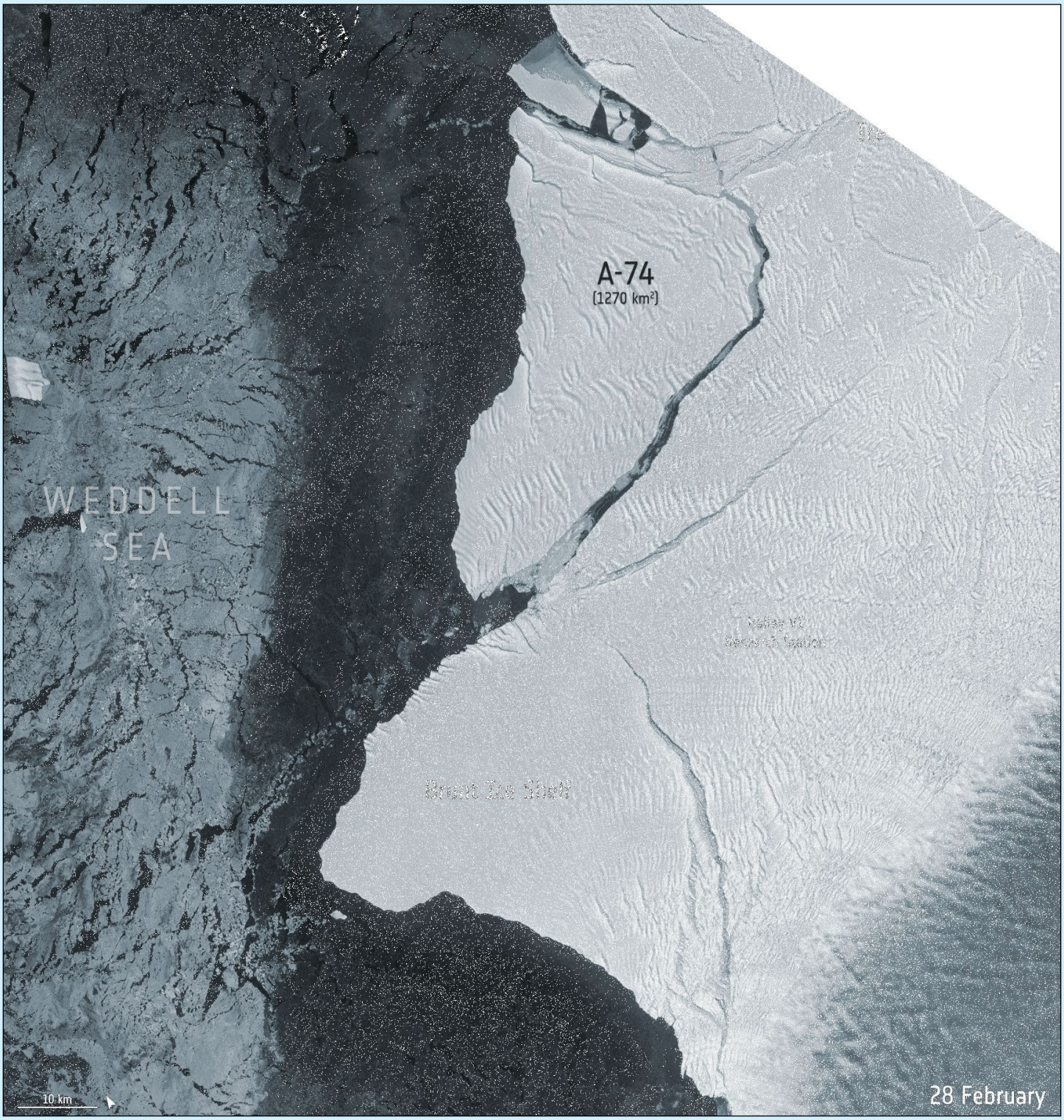
This latest rift was closely monitored by satellite imagery, as it was seen quickly cutting across the ice shelf. Recent ice surface velocity data derived from Sentinel-1 data indicated the region north of the new crack to be the most unstable—advancing at around five metres per day. Then, in the early hours of Friday 26th, the newer crack widened rapidly before finally breaking free from the rest of the floating ice shelf.

ESA's Mark Drinkwater said, *"Although the calving of the new berg was expected, watching such a remote event unfold is still captivating. Over the following weeks and months, the iceberg could be entrained in the swift south-westerly flowing coastal current, run aground or cause further*

Continued on page 18



The Brunt Ice Shelf on February 26, prior to breakup
Image contains modified Copernicus Sentinel data (2021) processed by ESA, CC BY-SA 3.0 IGO



The Brunt Ice Shelf, imaged by Sentinel-1 on February 28.
Image contains modified Copernicus Sentinel data (2021), processed by ESA, CC BY-SA 3.0 IGO

damage by bumping into the southern Brunt Ice Shelf. So we will be carefully monitoring the situation using data provided by the Copernicus Sentinel-1 mission."

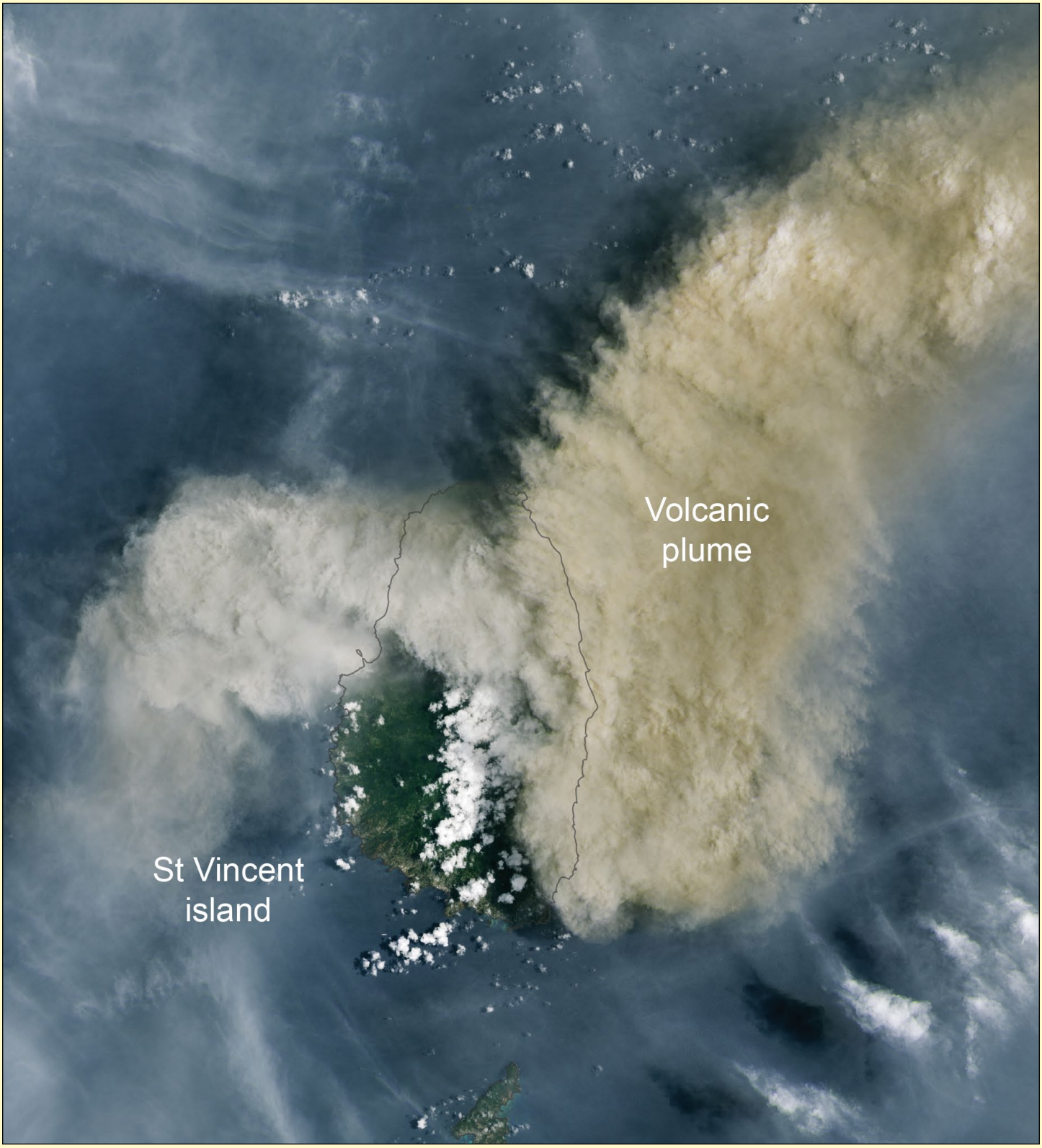
Antarctic icebergs are named from the Antarctic quadrant in which they were originally sighted, plus a sequential number: then, if the iceberg breaks, a sequential letter is added. This new iceberg was given the designation A-74. The calving does not pose a threat to the presently unmanned British Antarctic Survey's Halley VI Research Station, which was re-positioned in 2017 to a more secure location after the ice shelf was deemed unsafe.

Routine monitoring by satellites offers unprecedented views of events happening in remote regions like Antarctica, and how ice shelves manage to retain their structural integrity in response to changes in ice dynamics, air and ocean temperatures. The Copernicus Sentinel-1 mission carries radar, which can return images regardless of day or night (or cloud cover) and this allows us year-round viewing, which is especially important through the long, dark, austral winter months.

Eruption at La Soufrière

NASA Earth Observatory

Story by Kathryn Hansen



NASA Earth Observatory images by Lauren Dauphin, using Landsat data from the U.S. Geological Survey and MODIS data from NASA EOSDIS LANCE and GIBS/Worldview.

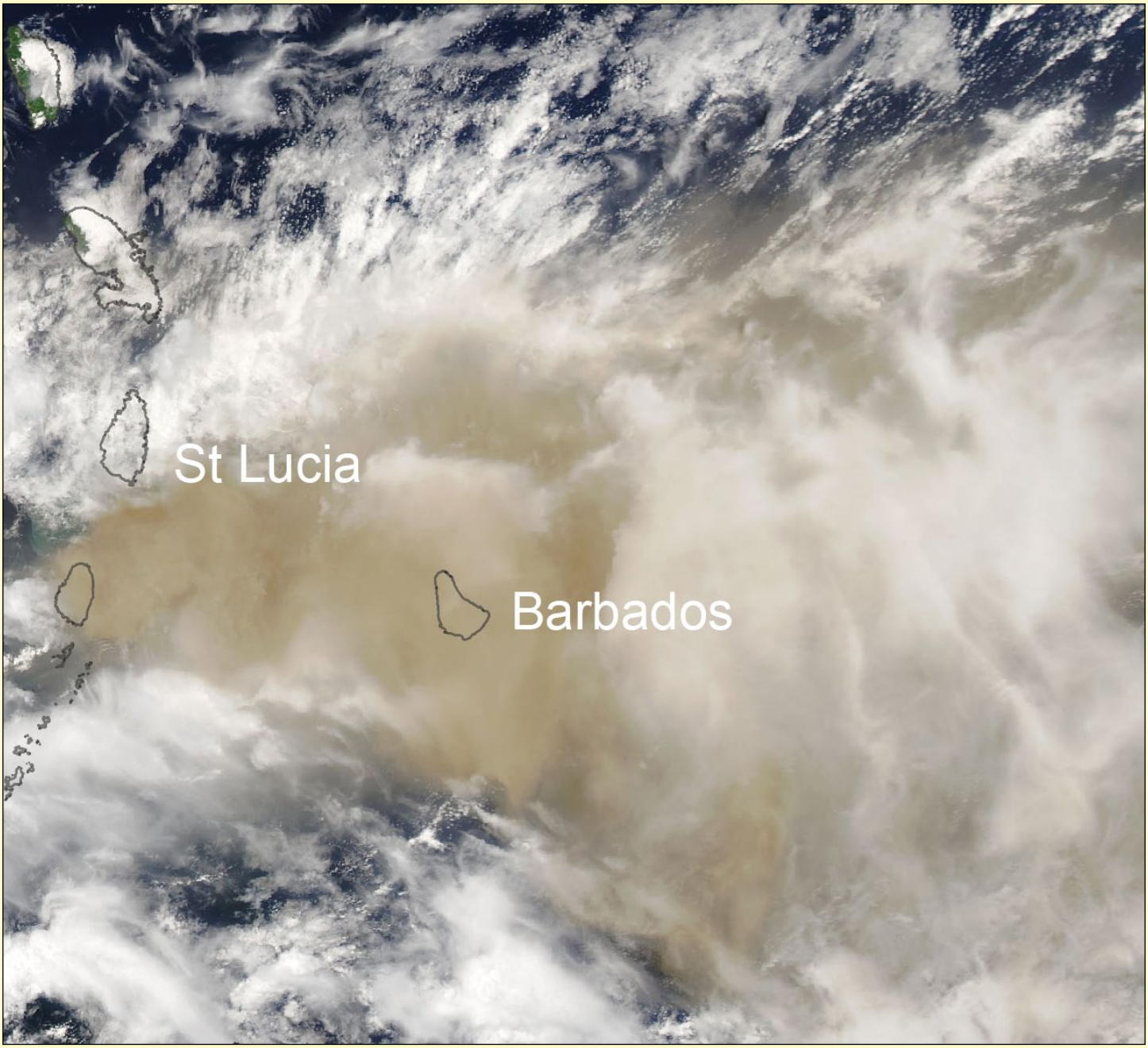
Eruptions at La Soufrière volcano have propelled ash and gas high into the air over the Caribbean islands of Saint Vincent and Barbados. The eruption—the volcano's first explosive event since 1979—prompted thousands of people to evacuate. The recent bout of explosive activity began on April 9, 2021. At about 10:30 am local time and the Operational Land Imager (OLI) on Landsat 8 acquired the above image of volcanic ash billowing from La Soufrière. The plume obscures the 1178 metre volcano beneath, which stands on the northern side of Saint Vincent. According to Jean-Paul Vernier, an atmospheric scientist with NASA's *Earth Applied*

Sciences Disasters Program, activity was apparent months before the explosive eruptions. It started with an effusive eruption in which magma that reached the surface slowly built up a lava dome. Then, in April, the dome finally turned out a massive explosion without many precursor signs. Explosive eruptions result from the rapid expansion of pressurised gasses trapped in the rock or magma: the pressure violently breaks rocks apart and produces a plume of rock, ash, and gas.

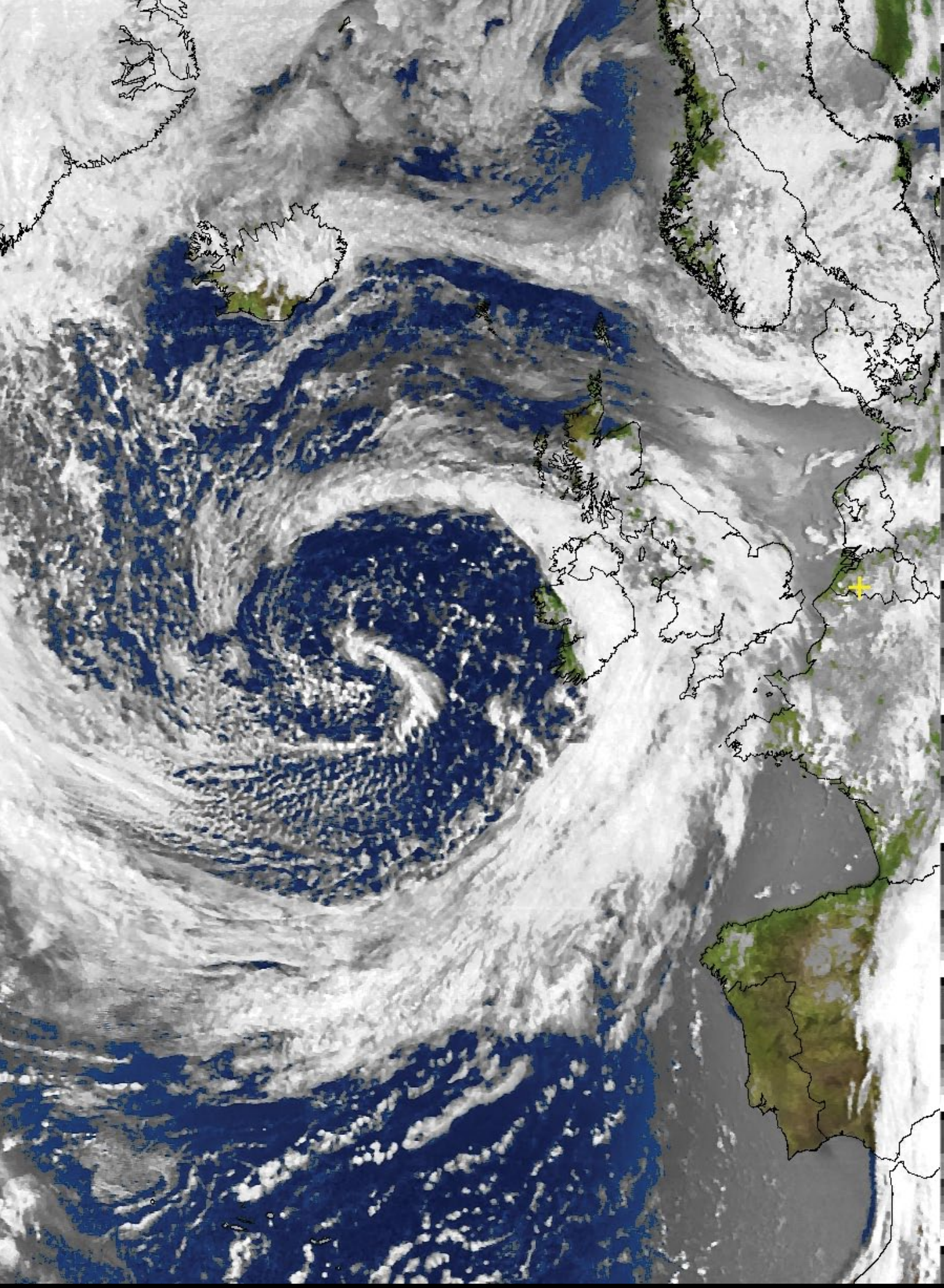
Winds carried much of the ash and gas east from Saint Vincent and, on the afternoon of April 10 the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite acquired the image below, showing ash reaching Barbados, 190 kilometres away. Clouds (white) are also abundant in this view.

These images show ash aloft in the atmosphere, but some of it fell back to the ground. According to news reports, ash fall blanketed parts of Saint Vincent and Barbados. It also has threatened food and water supplies on Saint Vincent and reduced visibility, which complicated evacuation efforts. People displaced to the island's southern side—away from the volcano and generally safer—still had to contend with falling ash and poor air quality.

Scientists are investigating the extent and height reached by the ash and gas plume. They think some ash had risen all the way into the stratosphere, where strong winds could potentially carry it great distances. Other satellite instruments detected sulphur dioxide reaching Cape Verde, an archipelago in the central Atlantic Ocean. Sulphur dioxide near ground level can irritate the human nose and throat: higher in the atmosphere it can make sulphuric acid aerosols which, in extreme cases, may lead to a cooling effect.



NASA Earth Observatory images by Lauren Dauphin, using Landsat data from the U.S. Geological Survey and MODIS data from NASA EOSDIS LANCE and GIBS/Worldview.



André T'Kindt submitted this NOAA 19 APT image dating from May 23, 2021, which illustrates one of the succession of Atlantic depressions that soaked the British Isles that month.

Phytoplankton Bloom off of the Eastern United States

MODIS Imge of the Day

Image Credit: MODIS Land Rapid Response Team, NASA GSFC

A spring bloom of phytoplankton coloured the shores of Virginia, Maryland, Delaware, and New Jersey in mid-May 2021. The Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's *Aqua* satellite acquired this image of the bloom in the Atlantic Ocean on May 13. The jewel-toned swirls stretch along the coast for about 320 km and measure about 55 km in width.

Phytoplankton are tiny, plant-like organisms that often float near the ocean surface and utilise sunlight to convert carbon dioxide into sugars and oxygen. In turn, they become food for the grazing zooplankton, shellfish, and finfish of the sea. They also play an important but not fully understood role in the global carbon cycle, taking carbon dioxide out of the atmosphere and sinking it to the bottom of the ocean. These microscopic organisms live in these waters year-round, but usually their numbers are so small that they aren't visible. It's only when conditions are right—warming waters, lengthening sunlight, and adequate nutrients—that they burst into the explosive reproduction which creates massive blooms easily seen from space.

On April 24, only three weeks before this image was acquired, a strong storm moved northeastward through the Mid-Atlantic states, carrying strong winds and torrential rains. By April 26, when the skies cleared, MODIS imagery revealed that the rivers as well as the waters of Delaware Bay (north) and the Chesapeake Bay (south) were mud-coloured, indicating that a large quantity of sediment had washed into the two bays and, most likely, continued into the waters of the near-shore Atlantic. Although most of the sediment rapidly cleared from satellite imagery, it is likely that this rush of soil-laden water provided a burst of nutrients that spurred the phytoplankton growth.

Overwintering Fires on the Rise

NASA Earth Observatory

Story by Kathryn Hansen.

Zombie fires, holdover fires, hibernating fires, or overwintering fires: Whatever you choose to call them, you're probably going to hear a lot more about them in the coming years. New research shows that this type of wildfire—which can survive the snow and rain of winter to re-emerge in spring—is becoming more common in high northern latitudes as the climate warms.

> "*Smouldering fires are flaming fires that have entered 'energy-saver mode,'*" said Rebecca Scholten of Vrije Universiteit Amsterdam. "*The fires start above ground, then continue to smolder in the soil or under tree roots through winter. These fires are only just surviving based on the resources they have—oxygen and fuel—and can transition back into flaming fires once conditions are more favourable.*"

In their research, Scholten and colleagues show that the boreal forests of Alaska and Canada's Northwest Territories are especially prone to overwintering fires, where fires can burn deep into the organic soil layer. Combining ground-based fire data with fire detection data from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on the **Terra** and **Aqua** satellites, the scientists found a way to identify overwintering fires based on their unique characteristics. These fires tend to emerge close to the original fire, and they flare up earlier in the year compared with fires caused by lightning and people.

The scientists found that between 2002 and 2018, overwintering fires generally accounted for a small amount of the total burned area in the region. But in individual years, following hot and severe fire seasons, that number could escalate. In 2008 in Alaska for example, overwintering fires accounted for 38% of the burned areas.

> "*For me, the sheer fact that these fires exist and happen every other year now was probably the most surprising finding*," stated Scholten.

She also noted that early detection could help with fire management and reduce the amount of carbon—stored in large amounts in the region's organic soils—that gets released to the atmosphere during fires.

The images in figures 1-4, acquired with the Operational Land Imager (OLI) on **Landsat 8**, highlight the progression of a particularly potent overwintering fire in Alaska during 2015-16. The images are false color (OLI bands 7-6-2), which emphasise hot spots and actively burning fires while distinguishing burned vegetation (brown) from unburned vegetation (green).

Figure 1, acquired in September 2015, shows the burn scar from the Soda Creek Fire, which scorched nearly 17,000 acres in southwest Alaska near the Kuskokwim River. The fire was never completely extinguished before winter set in. In April 2016 (figure 2), the fire continued to smoulder in the soil under a layer of snow.

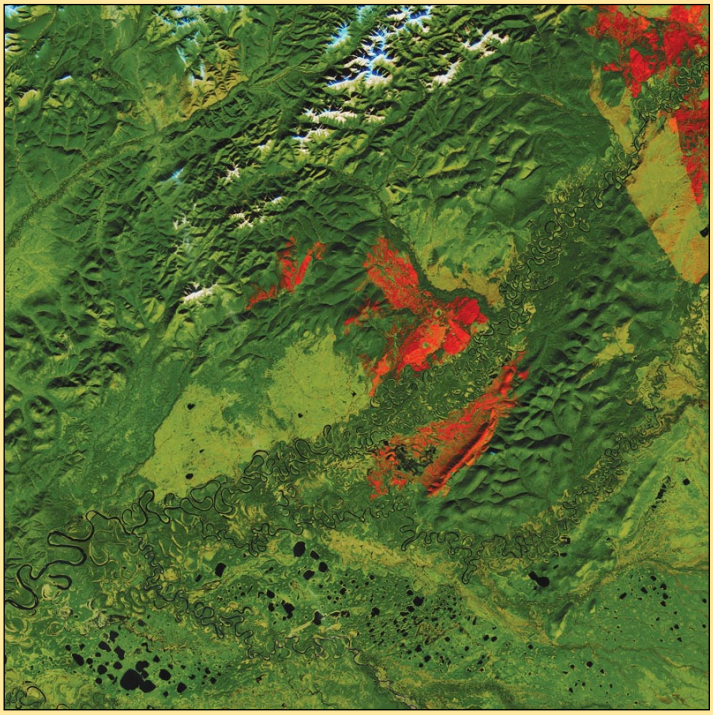


Figure 1 - September 24, 2015
A burn scar reveals the extent of
a seemingly extinguished fire.

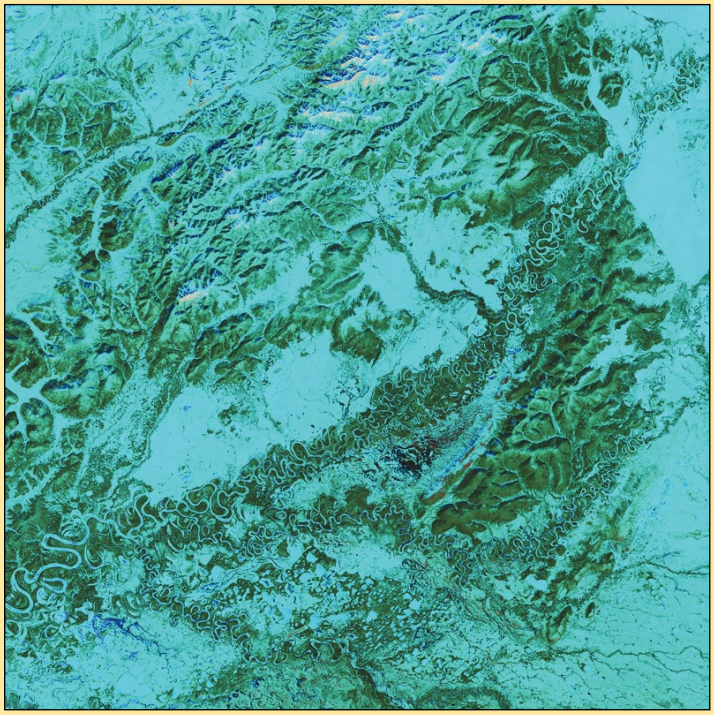


Figure 2 - April 12, 2016
Unseen from above, the fire continues
to smoulder beneath the snow.

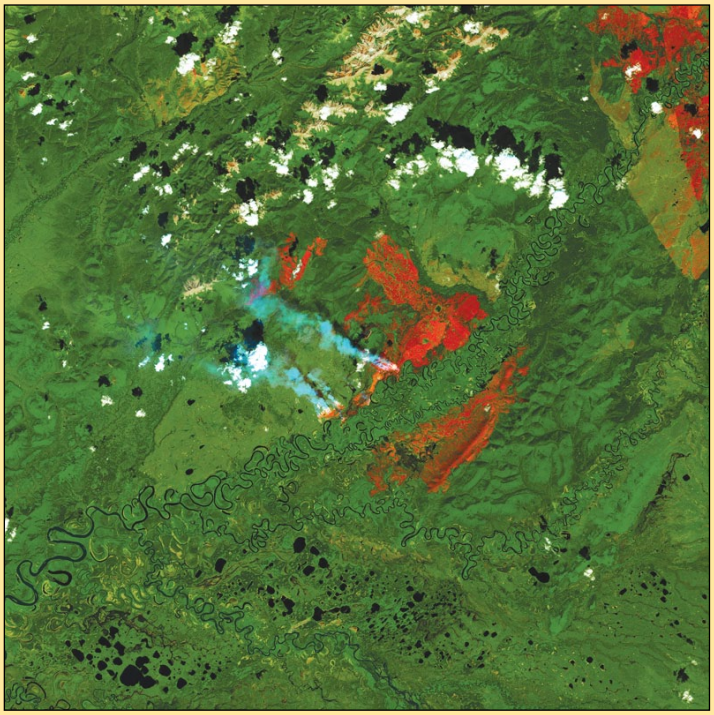


Figure 3 - May 30, 2016
The fire reemerges and even begins to spread.

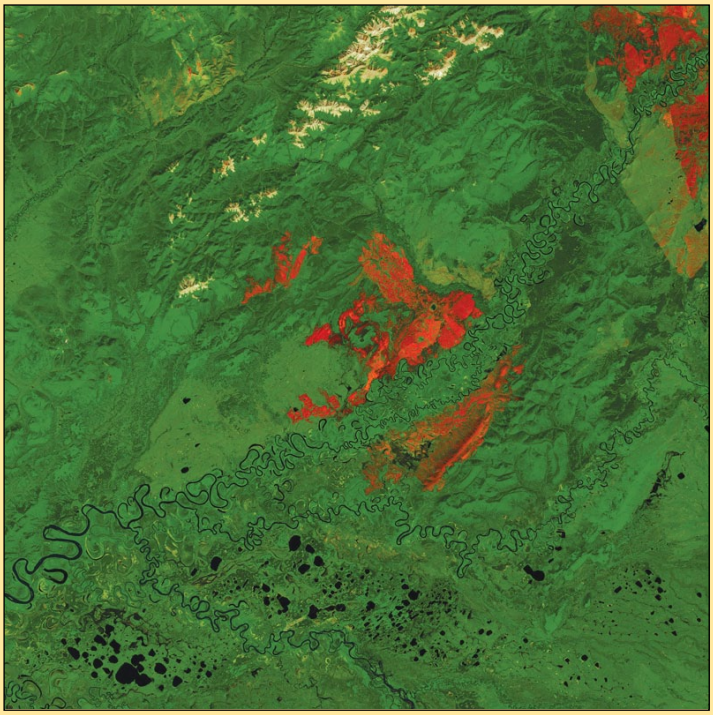


Figure 4 - June 5, 2016
The post-winter burned area increases by 57%.

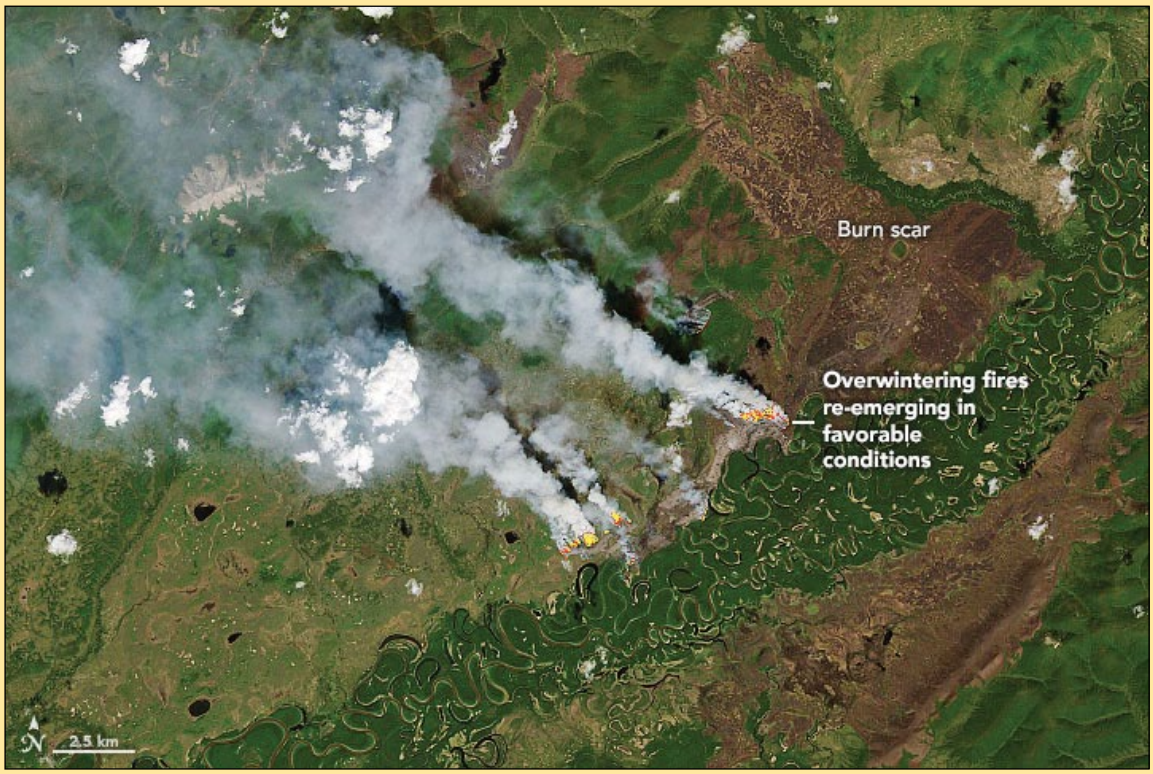


Figure 5 May 30, 2016 - This is a natural colour version of figure 3.

When the snow finally melted in late May (figure 3), the additional heat and oxygen caused flames to re-emerge and quickly spread. (figure 5 shows a natural-colour version of this image, overlaid with the shortwave-infrared signature of active fire fronts). The June 2016 image (figure 4) outlines new burned area from these overwintered fires (compare with figure 1), which added nearly 10,000 acres to the previously burned area.

The incident was not an isolated case. The study points to numerous fires that overwintered after Alaska's large fire years of 2009 and 2015, although they can happen after other hot and active fire years, too.

"*Although our satellite record of these fires in itself is too short to look at long-term trends, we found that the number of fires that overwinter is strongly linked to summer temperatures and large fire seasons,*" Scholten said. "*And for these we do see a pronounced upward trend—hotter summers and more burned area—with continued climate warming.*"

NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey and fire perimeter data from the Alaska Interagency Coordination Center (AICC).

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	Failed [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 A	1701.3 MHz	RHCP	AHRPT	Good
Metop B	1701.3 MHz	RHCP	AHRPT	Good
Metop C	1701.3 MHz	RHCP	AHRPT	Commissioning
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	System failure [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 all but failed and is no longer capable of powering the AHRPT/LRPT instrument.