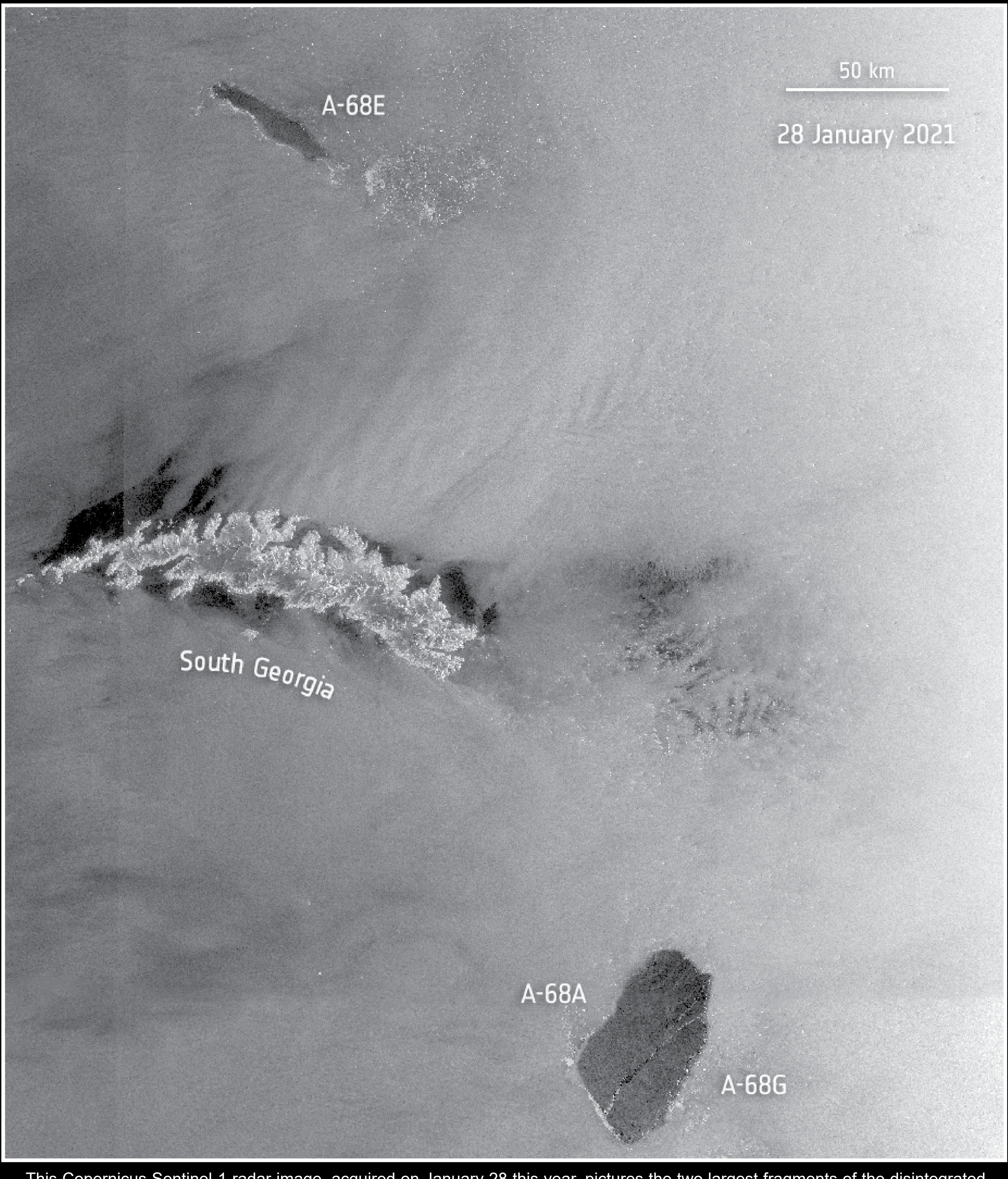
GEO Newsletter

Group for Earth Observation

Group for Earth Observation

No 69 - March 2021



This Copernicus Sentinel-1 radar image, acquired on January 28 this year, pictures the two largest fragments of the disintegrated A68 iceberg. The berg had at one point threatened South Georgia, but in the event, ocean currents carried it safely out of range.

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

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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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http://www.facebook.com/groupforearthobservation

From the Editor

Les Hamilton

It is with deep sorrow that I have to record that Francis Bell, the founder of Group for Earth Observation, passed away in early January. For decades, Francis had liaised with agencies, in particular NOAA and EUMETSAT, to promote free access to weather satellite imagery for the amateur community. He organised numerous GEO Symposia and three members' visits to EUMETSAT headquarters in Darmstadt. Francis was also a well-known face at rallies, manning the GEO Stand and always ready to give advice to anyone who required it. You can read much more in John Tellick's illustrated tribute to Francis on page 13.

Since the previous issue, enthusiasts the world over have been following a unique event through satellite images: the final breakup of iceberg A68a during its close encounter with South Georgia. John Tellick followed the event daily via EUMETcast's Metop imagery, and has documented his experience, using pictures to describe what took place far better than any words could. And as one iceberg ends its journey, another begins after the Brunt Ice Shelf calved A74, a 1270 square kilometre tabular 'berg. We'll follow this up and report in the June issue.

With the restrictions of lockdown, time has permitted more pages to been compiled than usual. We hope you enjoy reading them.

We also have expectations of three articles offered by readers, which haven't made our publication deadline. Hopefully these will be offered in the June Newsletter. Any reader wishing to make a contribution should ensure that it reaches the editor by May 30 at the latest, preferably by email to:

geoeditor@geo-web.org.uk

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Quarterly ? Question

Quarterly Question 67

The question posed last December concerned a body of water surrounded by snow-capped mountain ranges. The lake in question is **Issyk-Kul** (pictured opposite), which lies amidst the Northern Tian Shan mountains in Eastern Kyrgyzstan.

A saline endorheic lake with no riverine outlets, Issyk-Kul is notable as being the seventh deepest lake in the world, with an average depth of 278 metres and plunging to a maximum depth of 668 metres. Not surprisingly, Issyk-Kul contains a vast quantity of water, over 1700 cubic kilometres of it, making it the tenth largest lake in the world by volume.

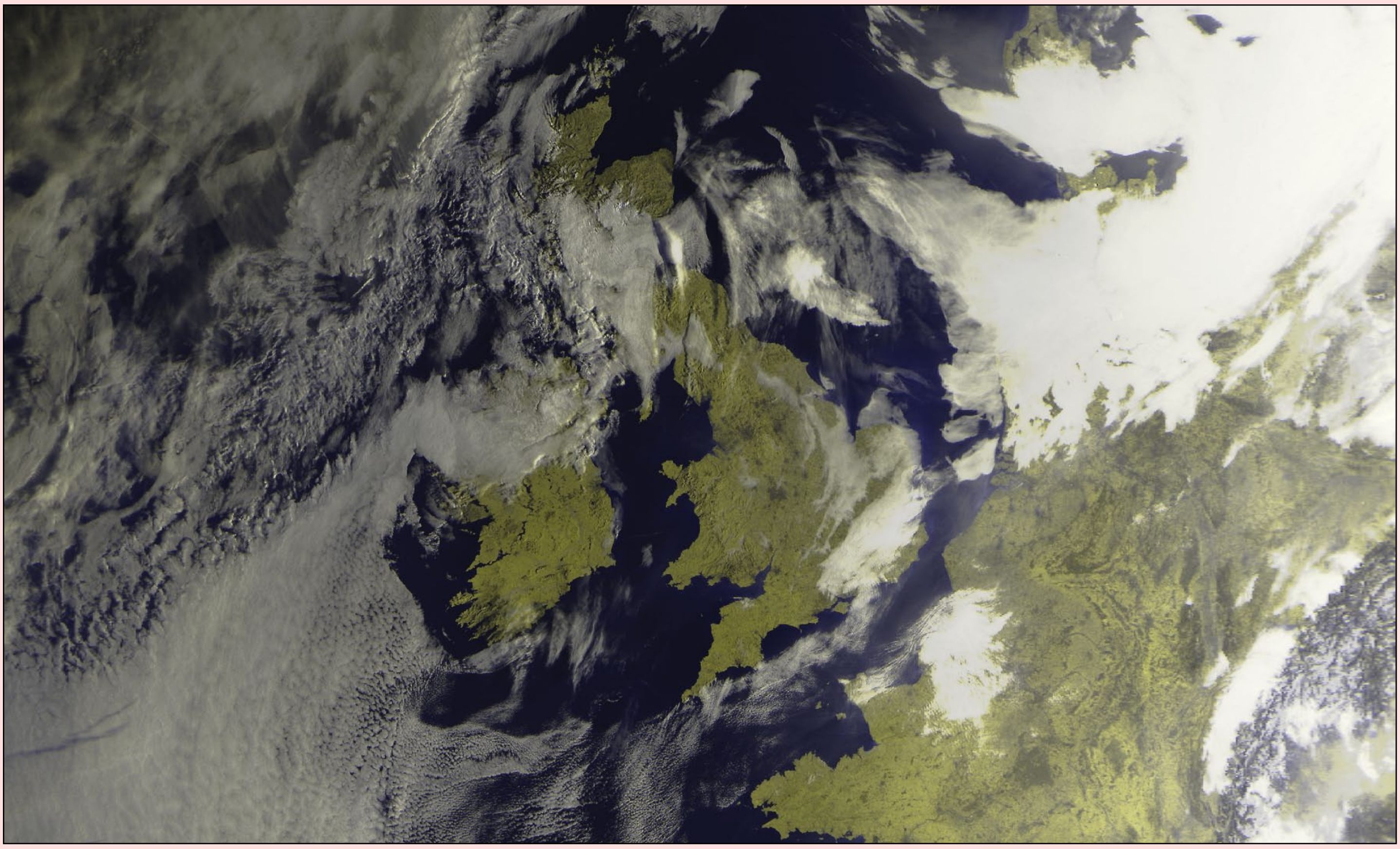
The name Issyk-Kul means 'warm lake' in the Kyrgyz language because, despite being surrounded by snow-capped peaks, it apparently never freezes over, probably because the lake is fed by a number of hot springs. The lake is a Ramsar site of globally significant biodiversity and forms part of the Issyk-Kul Biosphere Reserve.

Future Quarterly Questions?

The Quarterly Question was devised by Francis Bell as a—generally straightforward—puzzle for GEO Quarterly readers, and frequently based on his experiences when visiting over 100 countries worldwide. If any reader feels inclined to continue the tradition, please feel free to send materials to the editor at

geoeditor@geo-web.org.uk

at least one week prior to the month of publication.



Two weeks after a spell of sub-zero temperatures, and one week following a thaw and devastating flooding, summer arrived early in the British Isles, as seen in this LRPT image from Meteor M2 on the last day of February.

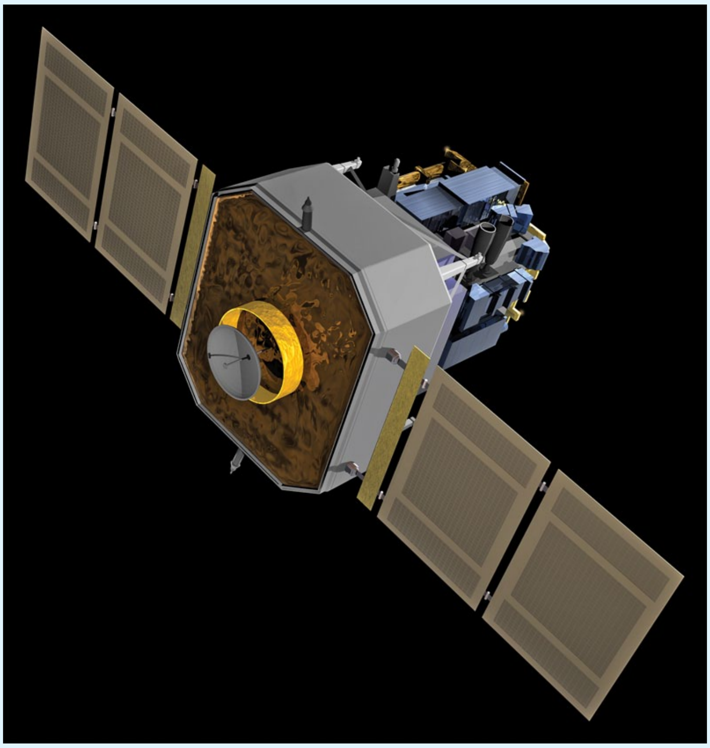
Solar Observatory SOHO: 25 Years in Space

Fritz Zajicek OE3FZB

GEO Newsletter readers, mostly amateur enthusiasts and educational users, usually focus on receiving and observing weather from Earth imaging satellites. But what would our mother Earth be without the sun. So, let's take a look to our central celestial body and the SOHO spacecraft that has been observing it for a quarter century now.

The Solar and Heliospheric Observatory (SOHO) was built as a joint project between the European Space Agency (ESA) and the US National Aeronautics and Space Administration (NASA), by a European industrial consortium led by Matra Marconi Space. Other sources mention the lead management by Astrium, an EADS Company, later Airbus Defence and Space, now Airbus SE). It was first proposed 13 years before its actual launch.

SOHO was launched 25 years ago on a Lockheed Martin Atlas II-AS launch vehicle on December 2, 1995 and began normal operations in May 1996. It occupies a halo orbit around L1 (Lagrangian Point 1), 1.5 million kilometres



Artist's concept of the NASA SOHO spacecraft
Image credit: Cgruda, Public domain, via Wikimedia Commons

closer to the Sun than the Earth, from where it enjoys uninterrupted views of our star.

The spacecraft dimensions are 4.3 x 2.7 x 3.65 metres, with a launch mass of 1850 kg and a scientific payload mass of 610 kg. The electrical power of 1500 W is provided by a solar array with 9.5 metre span and 950 W from two 20 Ah Ni Cd batteries.

SOHO - folded for Transport
Credit: SOHO (ESA & NASA) / Wikimedia Commons

Mission Details

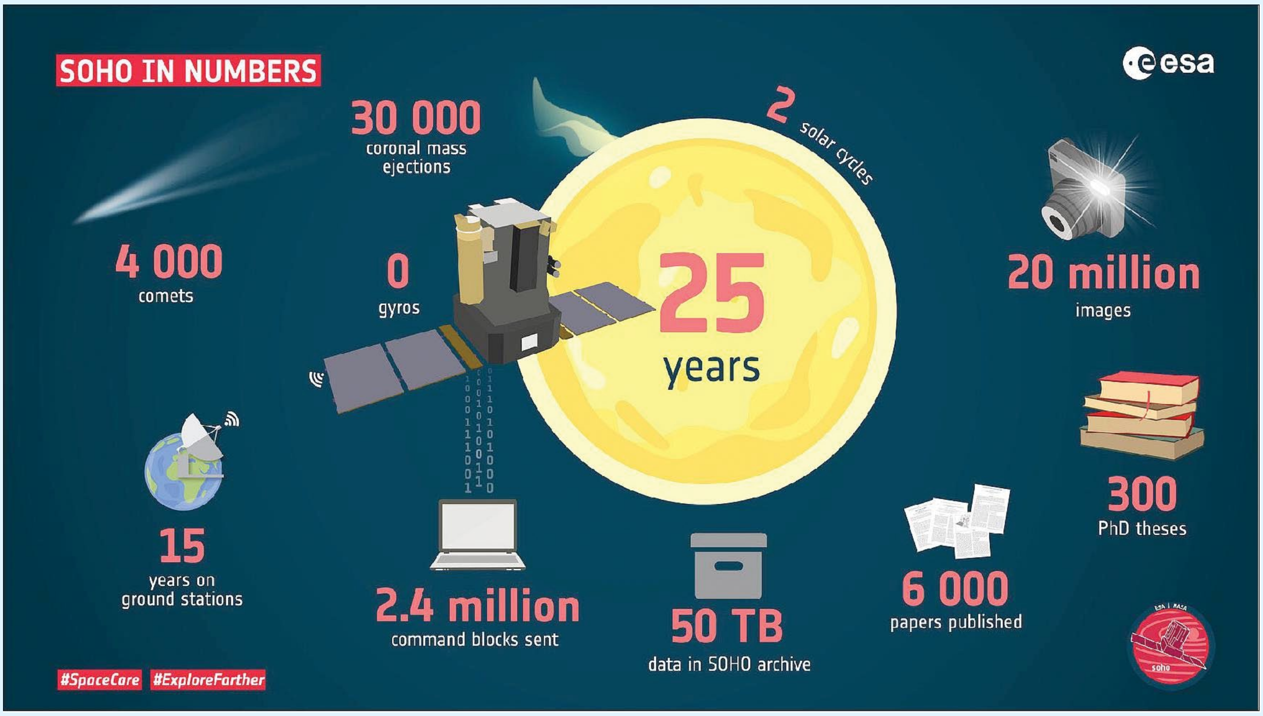
Originally planned to study the Sun as a two-year mission (with a constructive nominal lifetime of 3 years), SOHO continues to operate after over 25 years in space. The mission has now been extended till December 2020, with indicative extensions for an additional two years, up to 2022. This decision was taken during the ESA's Science Programme Committee (SPC) meeting in November 2018.

Payload

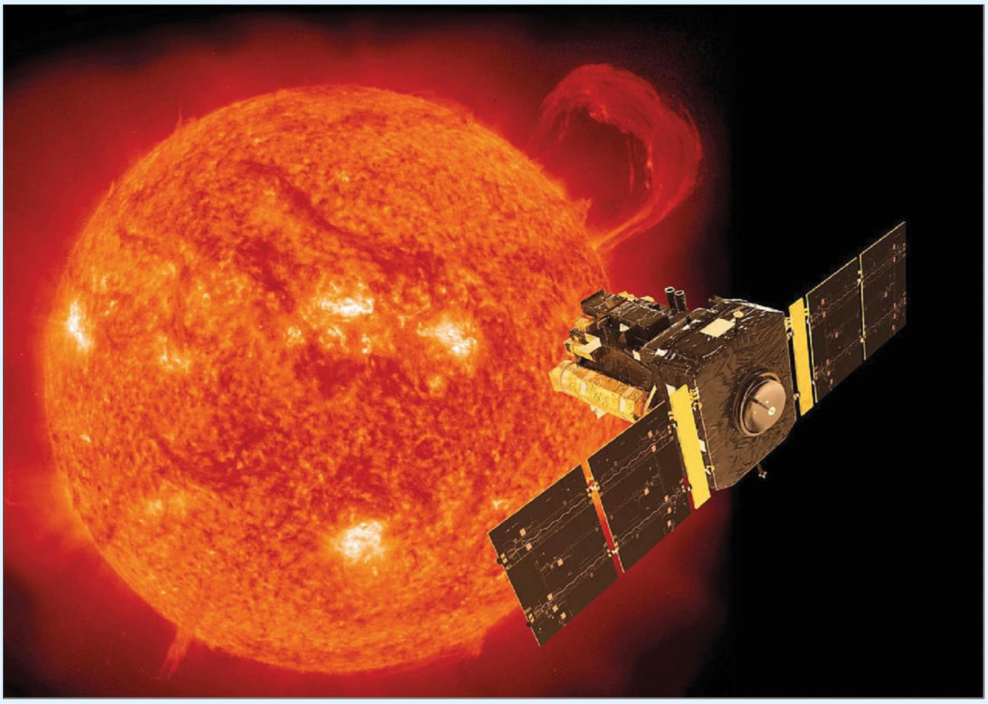
The SOHO Payload Module (PLM) consists of twelve instruments, each capable of independent or coordinated observation of the Sun or parts of the Sun. Nine instruments came from multinational teams led by European scientists, and three from US-led teams. Some instruments are no longer fully functional or have been deliberately retired due to symptoms of old age.

Objectives

The mission was launched with three scientific objectives in mind. The first was to study the dynamics and structure of the solar interior. The second was to study why the Sun's outer atmosphere, the corona, is so much hotter than its surface, and the third was to study where and how the solar wind particles are accelerated. But perhaps the most important aspect of SOHO's work has been something that was only just coming to prominence at the time of its launch: the study of space weather.



This graphic highlights some of the SOHO mission's impressive numbers to date
Image credit: ESA, via eoPortal.



The image at left is an artist's impression of the ESA/NASA SOHO spacecraft, backed by an image of the Sun acquired by the satellite's extreme-ultraviolet imaging telescope on September 14, 1999.

Image credit: Spacecraft: ESA/ATG medialab; Sun: ESA/NASA SOHO, CC BY-SA 3.0 IGO, via eoPortal

In the last 25 years SOHO could thus observe more than two of the eleven-year solar cycles, collected around 50 TB of data and sent 20 million images to the scientists on Earth.

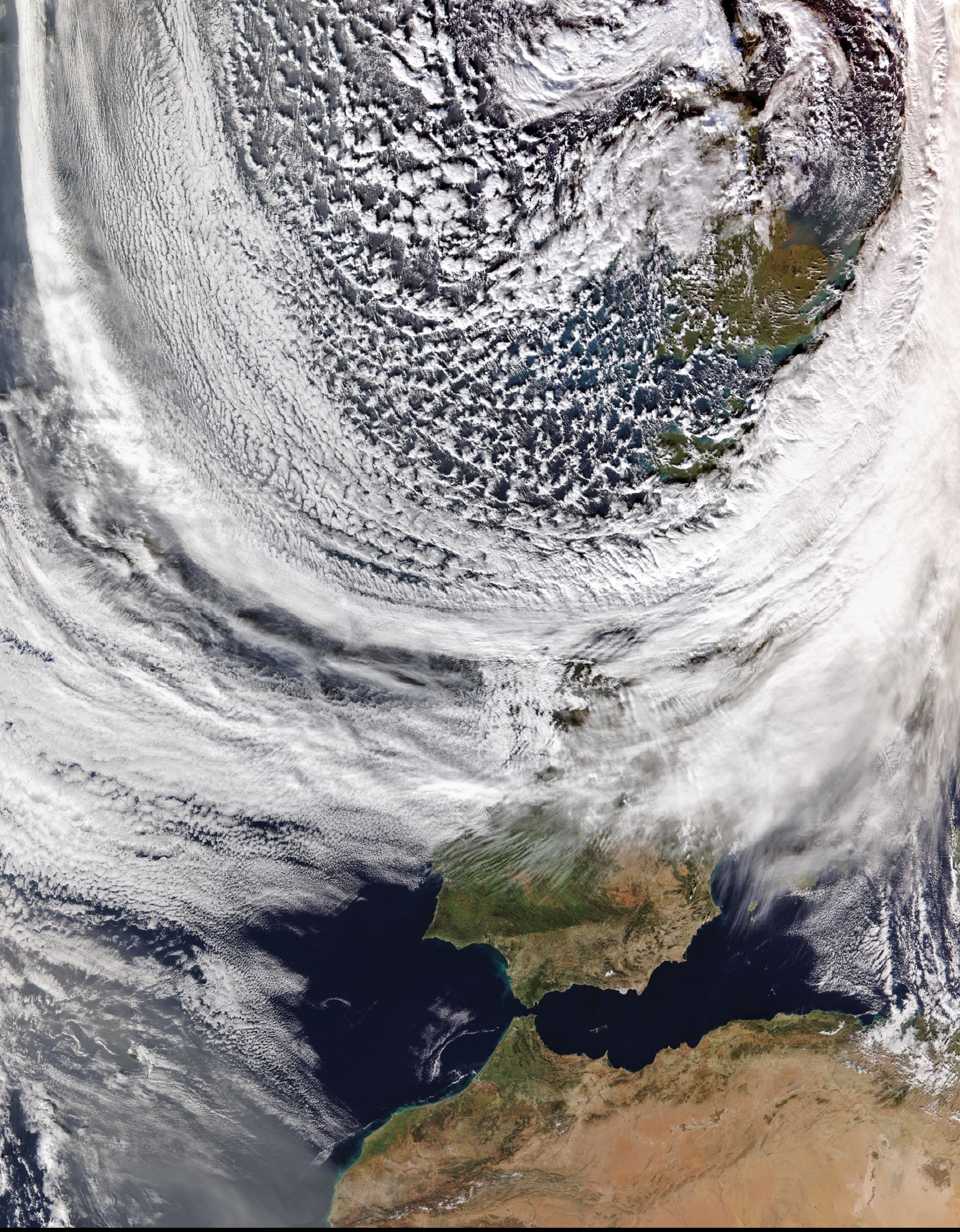
In addition to investigating how the Sun works, SOHO is the most prolific discoverer of comets in astronomical history, having spotted more than 4000 of these icy bodies during the sunward leg of their journeys.

Almost 6000 papers have now appeared in refereed journals based on SOHO data as an outcome of the spacecraft mission. Many of these represent significant progress in our understanding of the original objectives, the better understanding of solar processes and their influence on our Earth.

SOHO remains the flagship of solar research probes.

References:

- Max Planck Institute for Solar System Research (MPS) https://www.mps.mpg.de/en
- MPS News - Solar Observatory SOHO: 25 years in space https://www.mps.mpg.de/solar-observatory-soho-25-years-in-space
- ESA Earth Observation Portal (eoPortal) https://directory.eoportal.org/web/eoportal/home
- eoPortal - SOHO (Solar and Heliospheric Observatory) https://directory.eoportal.org/web/eoportal/satellite-missions/s/soho
- Wikipedia (in different languages with slightly different content) - https://en.wikipedia.org/wiki/Solar_and_Heliospheric_Observatory



NOAA 20 captured this image of Storm Bella at 13.30 UT on December 20, 2020 as the enormous depression engulfed the UK, France, Belgium and The Netherlands. Responsible for serious flooding across southern England, the storm produced winds of 160 kph over the Needles near Penzance, and caused disruption at Schiphol Airport as pilots struggled to land aircraft in 90 kph winds.
Image: NASA Worldview Snapshots (https://wvs.earthdata.nasa.gov/)

A Swirl of Old Supercontinent Silt

NASA Earth Observatory

Story by Adam Voiland.

The Svalbard archipelago between mainland Norway and the North Pole, is known as a mecca for geologists. It is one of the few places in the world that has easily accessible rocks from nearly every geological time period. There is little soil or vegetation to cover up the remarkable geologic diversity. Despite the Arctic location, ocean currents moderate the weather enough to keep much of the land clear of snow in the summer.

Among the more striking geologic attractions, at least when viewed from above, are glaciers on the archipelago's northwestern island of Spitsbergen. The ice there seems to 'bleed' meltwater of an intense shade of red. The Operational Land Imager (OLI) on Landsat 8 acquired figure 1 showing red water pooling in a shallow meltwater lake near the terminus of Holmström glacier. The image was captured on August 23, 2020, shortly after an unusual heatwave brought record-breaking temperatures to Svalbard. Figure 2 shows a wider view. Note that the image has been rotated to combat relief inversion, an optical illusion that can make valleys look like mountains.

The red colour is due to an abundance of sediment that has sloughed off from a particularly iron-rich layer of rock that formed roughly 400 million years ago (during the Devonian Period). Sometimes called the Old Red Sandstone, the rock layer formed on land when sand and other sediments were trapped in a basin enclosed by series of mountain ranges. The mountain ranges emerged when several of the world's land masses were smashed together in a supercontinent called Laurussia, sometimes called the Old Red Continent.

"The red Devonian rock is fairly soft and erodes easily," explained University of Edinburgh geologist Geoffrey Boulton. *"Glacial grinding produces a great deal of silt. These very small—and in this case red—particles are easily suspended in flowing meltwater and take a long time to settle in still water."*

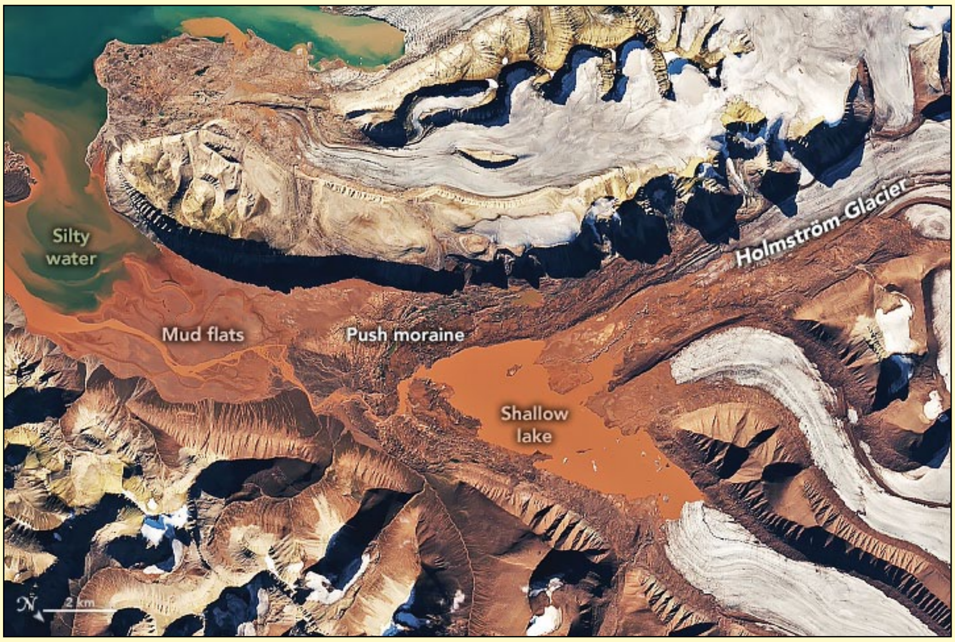


Figure 1 - Landsat-8 captured this image on August 23, 2020.

The silty meltwater pooled first in a shallow lake that had formed behind Holmström's push moraine—a dam-like pile of sediment bulldozed by the front of the glacier when it surged about a century ago. Since then, a drainage stream has carved a narrow channel through the folded sediments of the moraine. The stream eventually widens and meanders some as it moves through mud flats as it approaches the sea.

"When the silty water reaches seawater in Ekmanfjorden, it stays at the surface because the freshwater has a lower density than saltwater," explained Boulton.

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

Figure 2 - A wider Landsat view over the area.

Iceberg A-68a's Last Dance

John Tellick

Les Hamilton has written an article describing the giant iceberg's travel from the Southern Ocean and its drift towards South Georgia (page 31).

Thanks to Metop's world AVHRR imaging coverage via EUMETCast meteorological data dissemination, we have been able to witness—cloud cover permitting—the gyrations of its final journey, fragmentation and break-up.

The iceberg started life as a very large 'chunk of ice' which broke away from the Larsen Ice Shelf of Antarctica (see aerial photos on page 12). By the time it arrived in the neighbourhood of South Georgia it had lost much of its mass, yet was still larger than the island of South Georgia and had an estimated draft of 200 metres. It was predicted that it would 'beach' on the island shore and cause an environmental catastrophe to local wild life.

However as Les Hamilton explains, thankfully, due to the effects of local undersea terrain and ocean currents, it drifted (was nudged?) past and avoided the island. From December 2020 to February 2021 it gyrated on its journey as the following sequence of Metop images shows.

All images © EUMETSAT 2020/2021

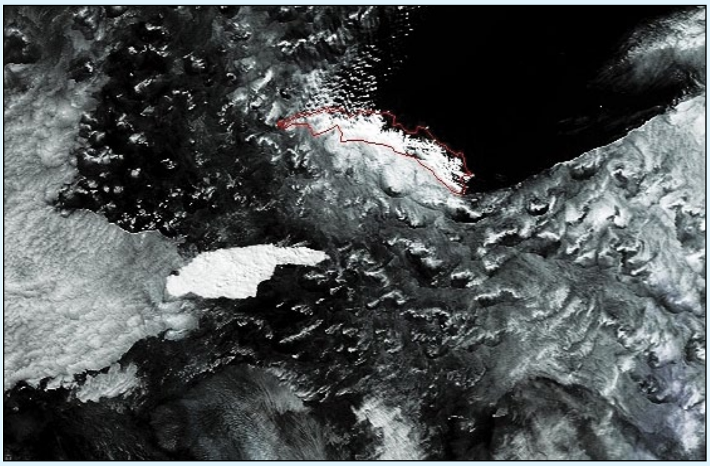


Figure 1 - What was left of the original iceberg as it drifted towards South Georgia on December 9, 2020.

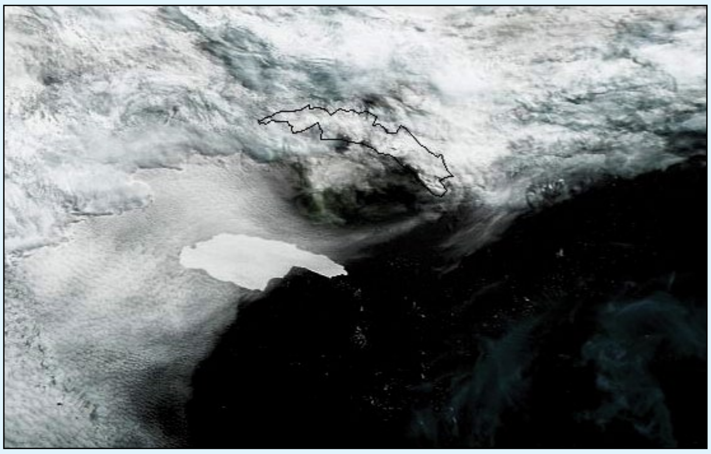


Figure 2 - December 11: Possibly the closest approach of the iceberg to South Georgia.

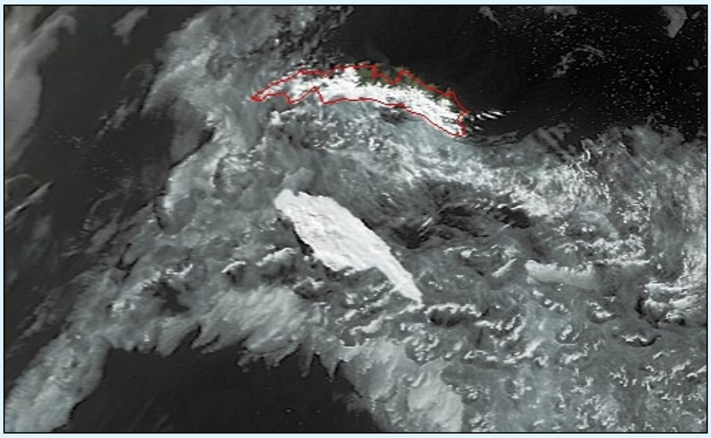


Figure 3 - December 14: the iceberg, still intact, starts to turn away from South Georgia.

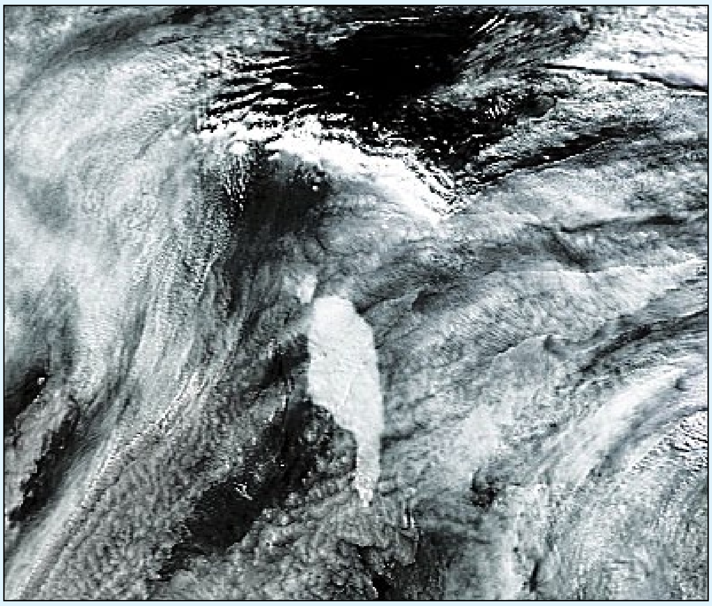


Figure 4 - December 17: The top left hand corner fractures.

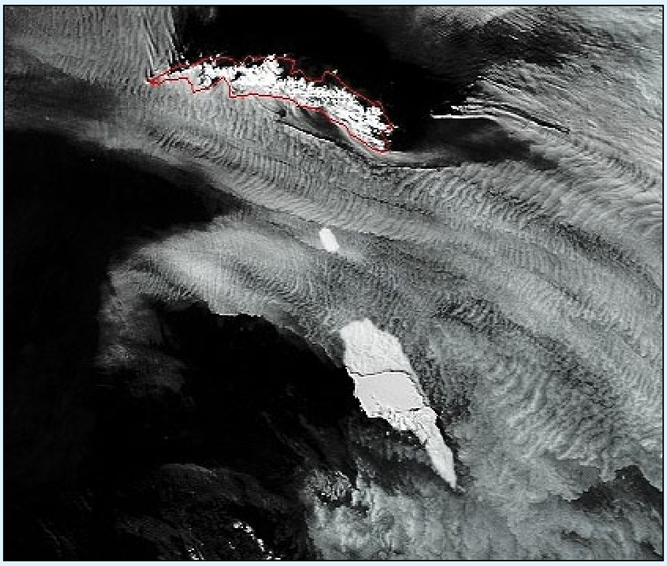


Figure 5 - December 22: The base of the finger is fracturing as the iceberg moves further away from the island. The dark horizontal line across the main area is due to cloud shadow and is not a fracture.

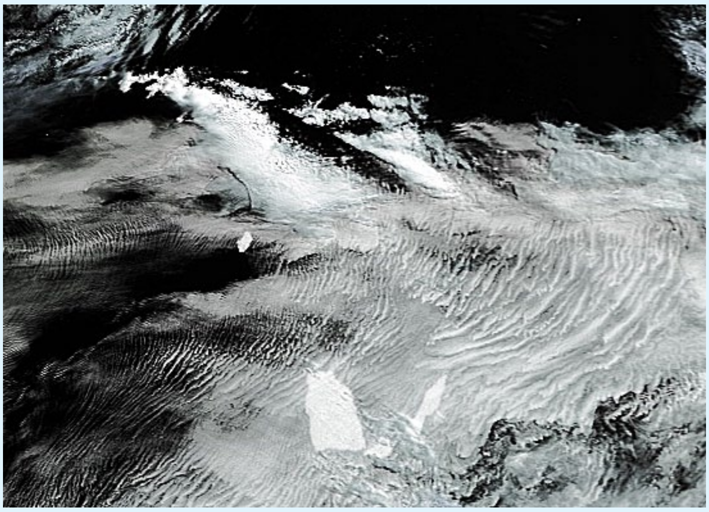


Figure 6 - December 25: The finger moves off and another lower right fracture develops.

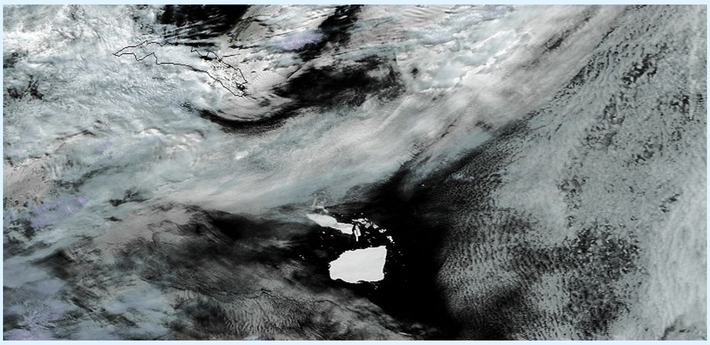


Figure 7 - December 29: The finger moves around the main surviving fragment of A68a.

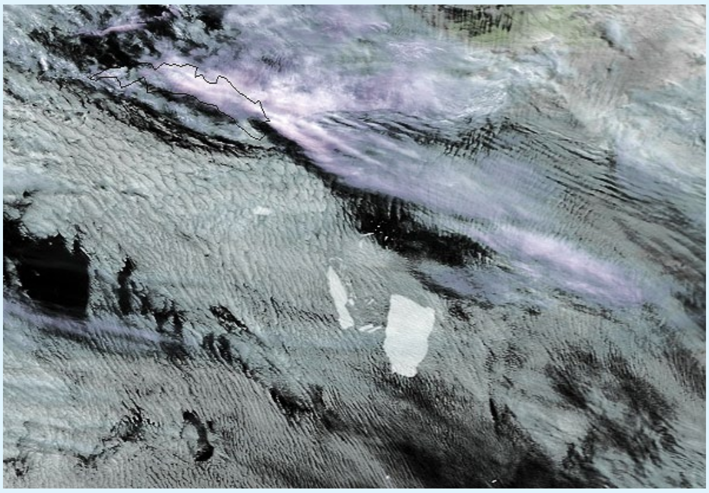


Figure 8 - December 31: The main block turns with the finger.

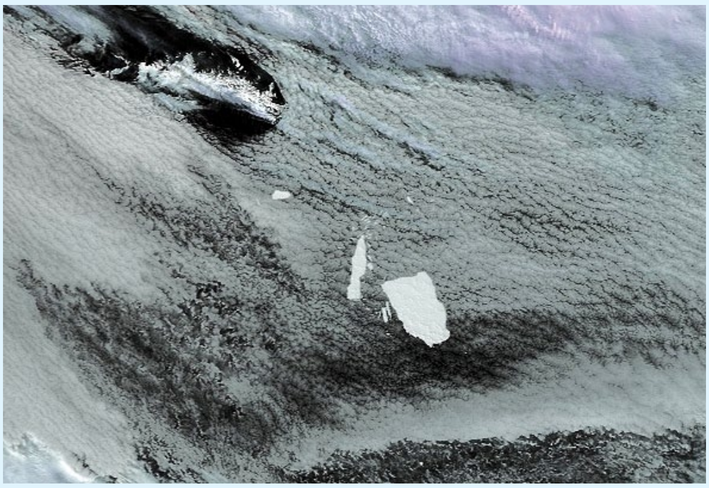


Figure 9 - January 1, 2021: The main block is still turning.

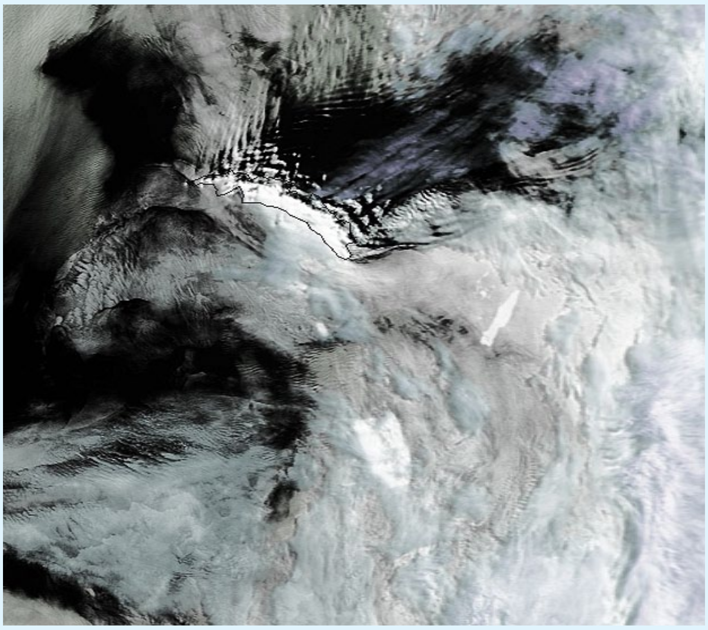


Figure 10 - January 6: The finger is now drifting further away from the main block.

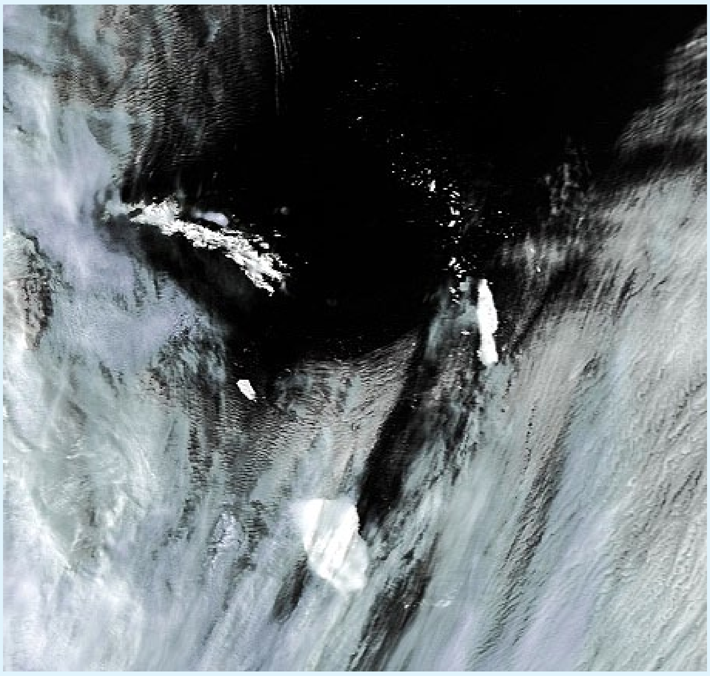


Figure 11 - January 7: The finger drifts further north.

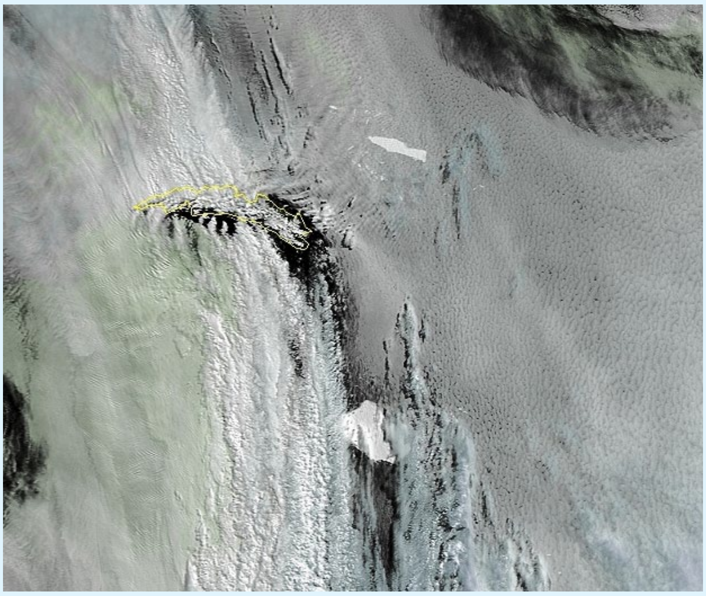


Figure 12 - January 11: The finger turns on a path that goes around the north of South Georgia.

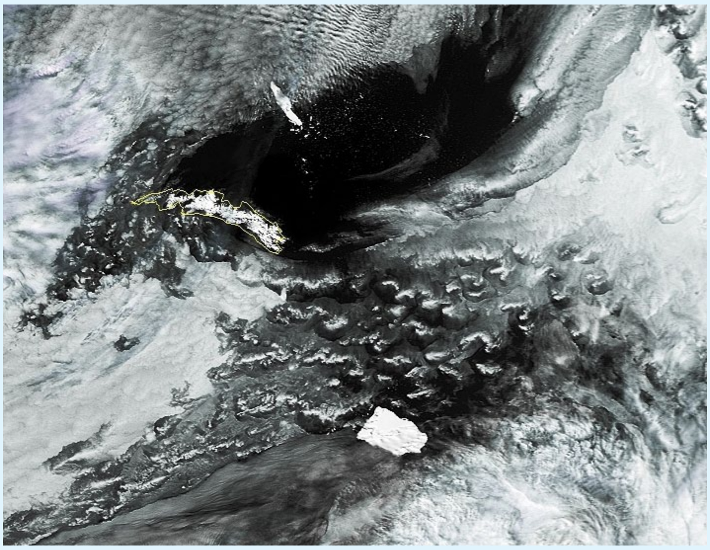


Figure 13 - January 17: The finger turning again as the main block rotates and moves away from South Georgia.

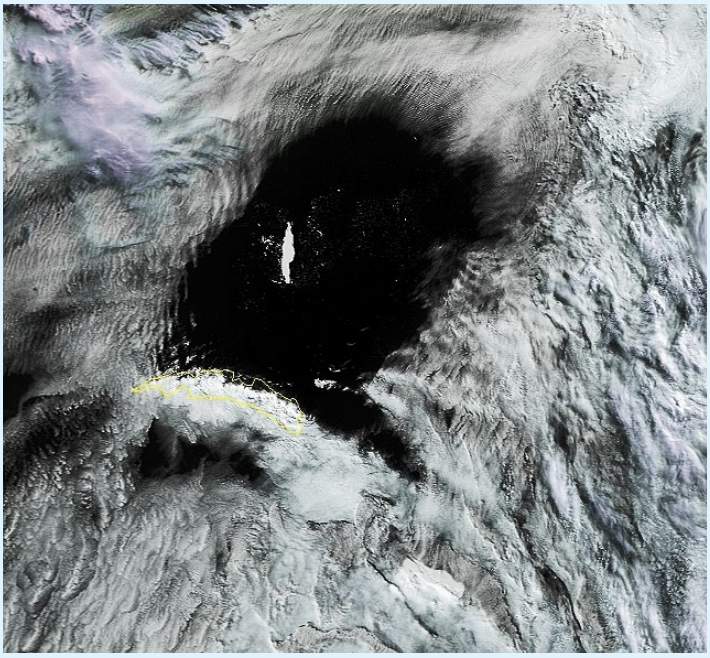


Figure 14 - January 23: The finger turns slightly again.

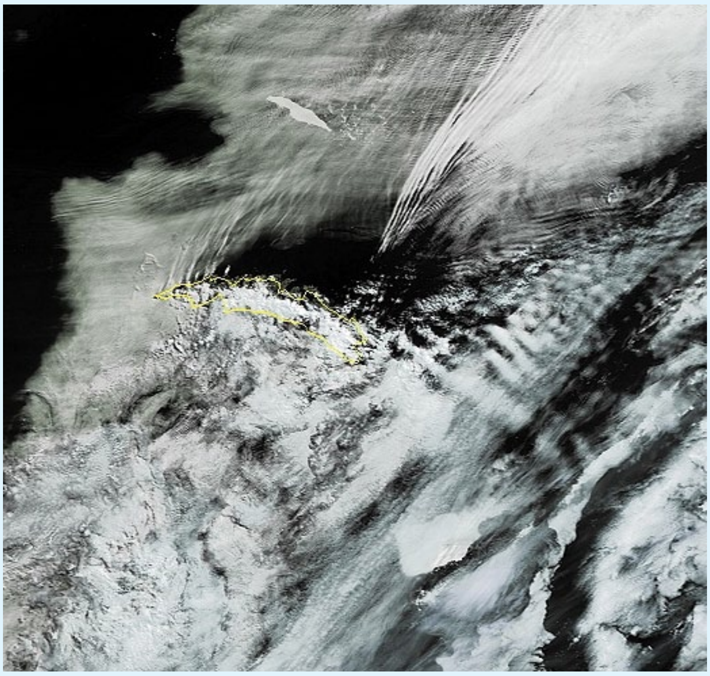


Figure 15 - January 27: The finger turns again as does the main block of A68a.

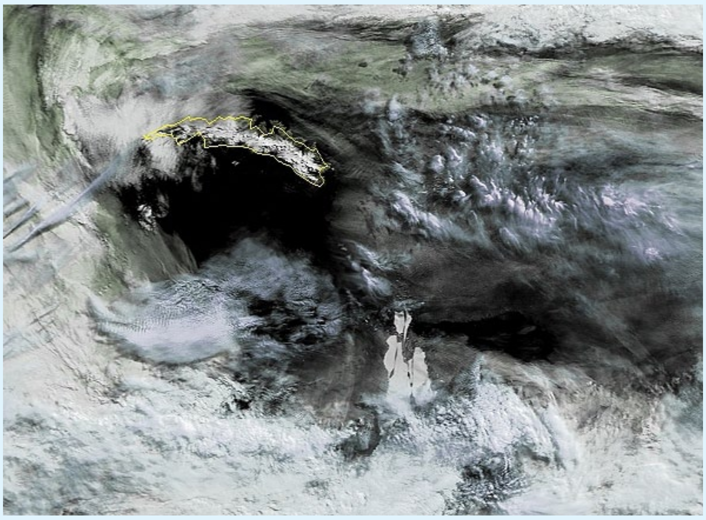


Figure 16 - January 30: The main block, having turned again, now starts breaking up.

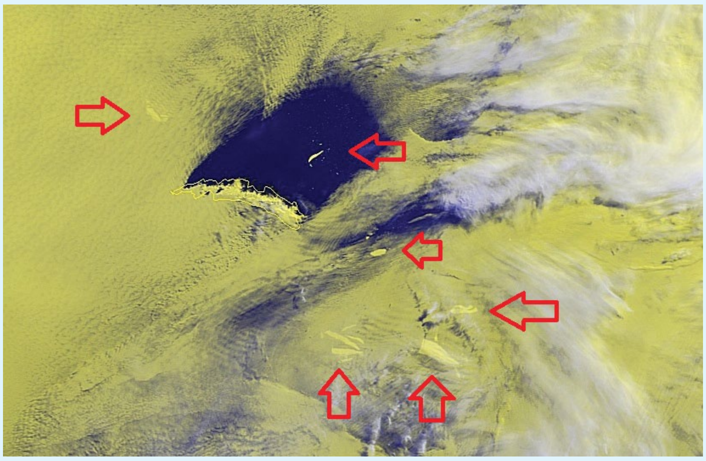


Figure 17 - February 11: After a week of cloud, the fractured pieces of A68 A appear under the clouds.

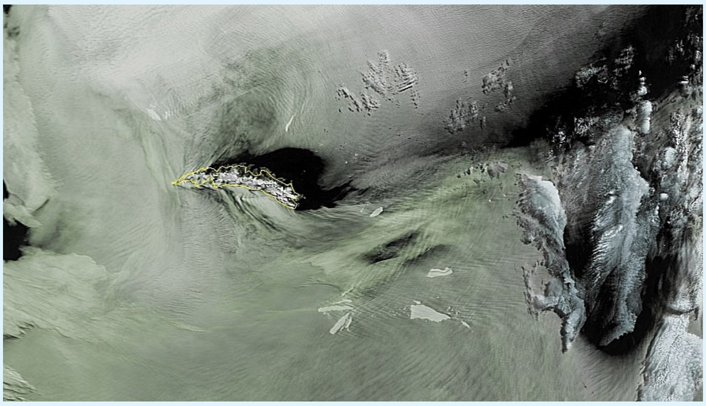


Figure 18 - February 12: Another view of the break-up.

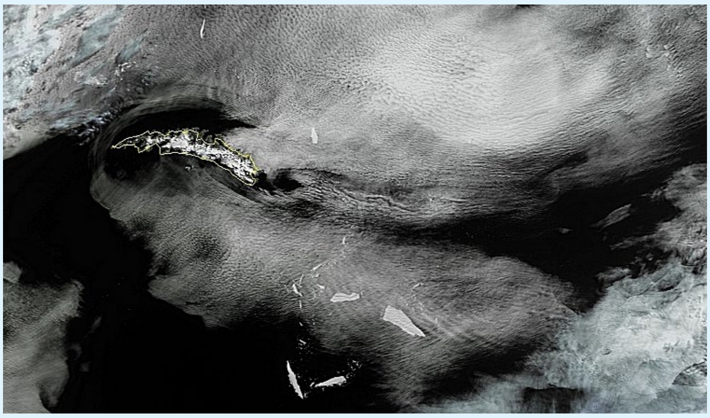


Figure 19 - February 16: The fractured pieces disperse.

On November 12, 2017, NASA's Operation IceBridge—the airborne mission flown annually over both polar regions to map the ice—photographed the recently calved A68a tabular iceberg. John Sonntag, IceBridge mission scientist, shot this photo from a window of the P-3 research plane.
NASA photograph courtesy of NASA/John Sonntag

The edge of A-68, the iceberg the calved from the Larsen C ice shelf.
NASA photograph courtesy of NASA//Nathan Kurtz.

In Memorium: Francis Bell

John Tellick

Francis Bell, photographed in his 'shack' during a GEO Management Meeting in 2004
Photo: David Taylor

GEO members will have been saddened to hear of the death of our Director and Chairman, Francis Bell, who was the inspiration behind the formation of GEO. The GEO management team and the many GEO members who met Francis over the years at Rallies and Symposia will miss him greatly.

Francis had perhaps a bit of a father figure persona about him—I guess this was a throwback from his days as a master at The Royal Grammar School in Guildford.

My friendship with Francis goes back very many years: to the days of RIG in fact. Francis was a long time member of the committee, and served two spells as Chairman of the Group. We both enjoyed attending radio rallies and demonstrating live WEFAX and APT images on the RIG stand.

Francis organised two great and very well attended AGM/activity days at the Royal Grammar School for RIG.

Around 2002, Francis was at the forefront of a move to create a more amateur -run and independent organisation dedicated to Earth Observation, and the Group for Earth Observation (GEO) was formally created in 2003, with the Launch Edition of GEO Quarterly following in March 2004.

This coincided closely with the failure, early in its test phase, of a Solid State Power Amplifier (SSPA) aboard the newly launched MSG-1: the first of the Second Generation 'all digital' Meteosat satellites. This resulted in the decision that it would not be able to transmit 'direct dissemination' from this satellite to users as had been the system for the First Generation Meteosats. This forced EUMETSAT to adapt a new transmission system that they had been using for NOAA sounding data, that was to prove particularly beneficial to amateur enthusiasts. MSG-1 data would be rebroadcast from a commercial TV satellite, and I'm pleased to say that several members of both GEO and

Francis Bell (front row left) poses with the GEO party during the inaugural Darmstadt visit in 2007.
Photo: EUMETSAT

our Dutch friends in Werkgroep Kunstmanen took part and worked with EUMETSAT in extensive testing: reporting problems and 'fixes' and proving the robustness of the new DVB-S data service which became EUMETCast. Francis, David Simmons and myself then spent several happy and fun years demonstrating live EUMETCast reception at radio rallies with an 80 cm dish and 'off the shelf' domestic satellite TV receiving equipment.

Francis was very keen to maintain the close relationship that GEO had built up with EUMETSAT during these tests and exchanges, and worked tirelessly to bring to fruition a project close to his heart. This was an organised two-day visit by a party of GEO members to EUMETSAT's Darmstadt HQ in 2007. This was hosted by EUMETSAT, in their large conference centre, with many technical presentations given, plus a guided tour of all the EUMETSAT technical and operational areas. Some of GEO and Werkgroep Kunstmanen's 'technical experts' also had a very useful meeting with EUMETCast engineers.

On the second day of the trip we enjoyed a guided tour of the large Usingen ground station near Frankfurt where the massive Meteosat reception and control dishes were installed, and where the new EUMETCast service was uplinked to the commercial satellite. Francis had also organised a conducted tour of the ESA main Control Centre (ESOC) in Darmstadt, including the satellite control room. Evenings during the trip were spent enjoying a great social get-together with some of EUMETSAT's staff over dinner. So successful was this venture, that it was repeated in 2011 and 2015.

Francis also organised eight GEO Symposium's between 2002 and 2014, most of them held at the National Space Centre in Leicester, where he was ably assisted by his wife, Nadine, who looked after our welcome, registration and refreshments of coffee and biscuits during the day. In 2012, in place of a symposium, Francis organised a visit to Surrey

Francis and friends enjoying a convivial dinner at the conclusion of the 2011 Darmstadt visit.

Francis (2nd from right) with the GEO party just prior to their visit to Surrey Satellite Technology Ltd in 2012.
Photo: Baz Omidi

Satellite Technology Limited (SSTL) where the GEO party were taken on a guided tour of the premises.

GEO management team meetings were often hosted by Francis at his house in Surrey—where the sun always seemed to shine and where we spent happy breaks in the garden 'away from the table'. These meetings always culminated in the most wonderful dinner, cooked by Nadine, always with second helpings of 'main' and pudding. It was generally very late in the evenings before we finally broke up, and those who had travelled from far afield were admirably accommodated overnight by Nadine and Francis.

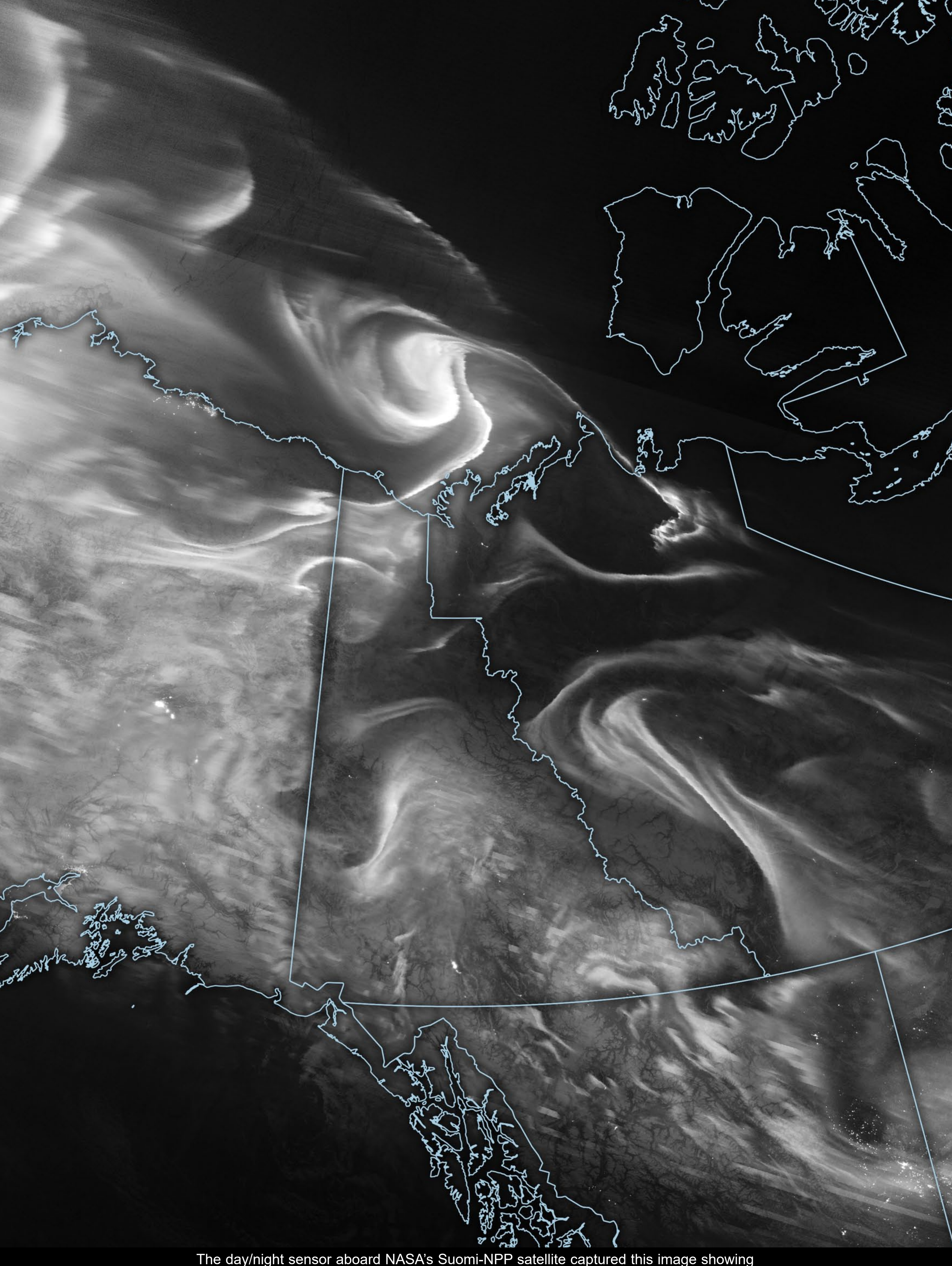
These were very happy days and remembrances of Francis, and he will be hugely missed. The photographs on the following pages reflect Francis' activities during his time with GEO, and will undoubtedly stir many fond memories for many readers.

Almost everywhere he travelled, Francis delighted in taking his minimalist, portable APT kit with him, sometimes even resorting to the use of a simple antenna fashioned from a metal coat hanger. Here he is pictured on location with a turnstile antenna.

Francis congratulating Arne van Belle on his presentation at the 2009 GEO Symposium held in the Royal Grammar School.
Photo: David Taylor

Francis Bell, with wife Nadine (left) and Minh van den Bosch, pictured following the Symposium in the Royal Grammar School.
Photo: David Taylor

Francis, pictured centre, with members of the GEO party at Usingen next to the T-Systems EUMETCast DVB-S uplink dish (at right) during the 2011 Darmstadt visit.
Photo - Arne van Belle



The day/night sensor aboard NASA's Suomi-NPP satellite captured this image showing auroras over Alaska and western Canada on February 7, 2021.
Image: NASA

The Grand Bahama Bank

Modis-Web Image of the Day

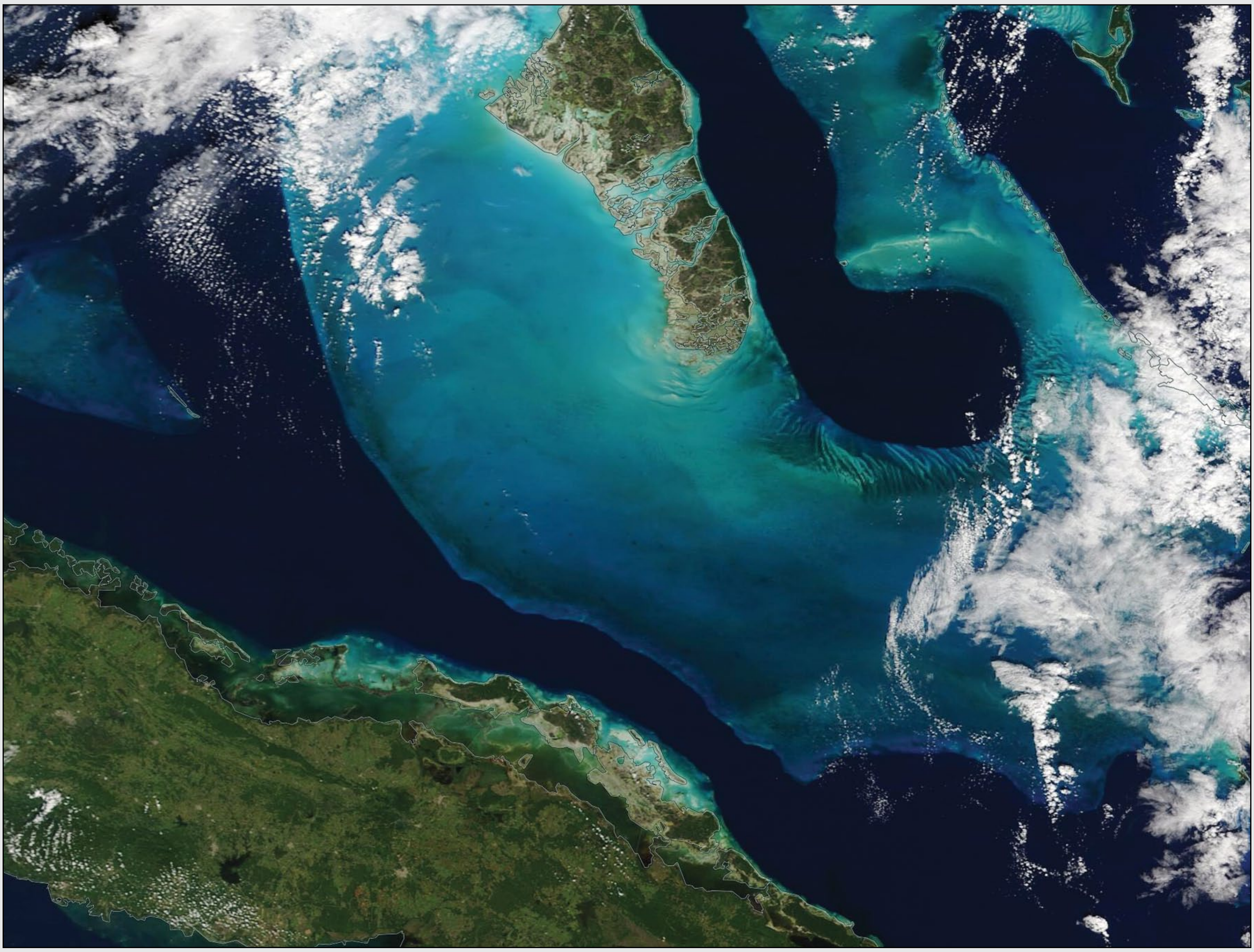
https://modis.gsfc.nasa.gov/gallery/showall.php

Peacock blue and gem-like greens colour the waters off the Bahamas. While the variation of colours and sweeping curves are reminiscent of gentle brush strokes laid down by a master painter, they are the result of a combination of shallow depth, uneven contours of the ocean floor, sea grass banks, and the light-coloured sands that form the Great Bahama Bank.

The Great Bahama Bank is a massive underwater hill underlying Andros Island in the west, Eleuthera Island in the east and multiple islands in between. It reaches almost to northeastern Cuba, which can be seen near the bottom of the image.

In past ice ages, the Great Bahama Bank was dry land, but as ice melted and sea levels rose, the tall hill slowly submerged under the ocean. Today, the bank is covered by water, though it can be as shallow as two metres deep in places, while the surrounding basin drops to depths as low as 4,000 metres. The bank itself is composed of white carbonate sand and limestone, mainly from the skeletal fragments of corals. Where the depth plunges, the ocean appears deep blue.

Between Andros Island and Eleuthera Island, a long deep, dark region that is known as the *Tongue of the Ocean*, where the depth drops to 2,000 metres. An important area rich in sea life, it is home to more than 160 fish and coral species. At the southern edge of the *Tongue of the Ocean*, colourful wave-shaped ripples can easily be seen from space. These are underwater dunes on the Great Bahama Bank, sculpted by currents over time. Sand and sea grass found in the dunes add to the striking colours of this area. The dunes are partially covered by cloud in this image.



The Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's Terra satellite acquired a true-colour image of the Great Bahama Bank on November 30, 2020.
Image: NASA

An Inland Delta Flooded

NASA Earth Observatory

Story by Adam Voiland

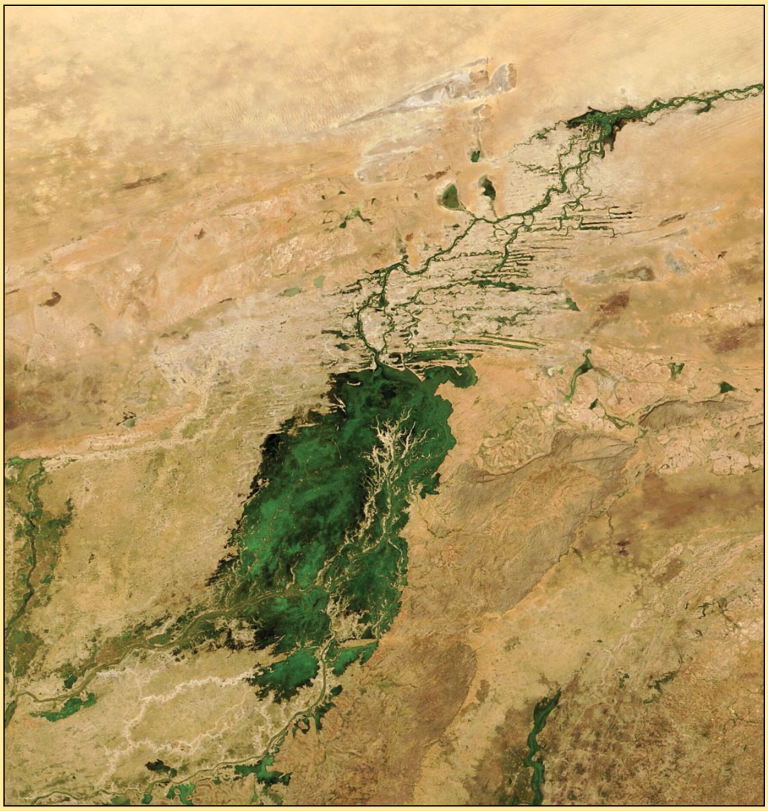
Drought is a perennial problem in the semi-arid Sahel region of Africa. But in 2020, in Mali and other countries in West Africa, excessive rainfall has been the problem at times. Exceptionally heavy summer rains pushed seasonal floods on the Niger River and the Macina (the Inland Niger Delta) to destructive levels.

After intense rains fell in July and August in the Guinea Highlands and overloaded many streams and rivers, it took several weeks for flood waters to work their way through the vast inland delta in central Mali. When the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's *Terra* satellite captured a natural-colour image on October 29, 2020, water had spread widely across the nearly flat delta, which was once a lake bottom. Standing water appears black. Many flooded areas appear green because bourgou grass, rice, and other plants grow in the shallow flood waters. For comparison, the other image shows the dry landscape in May 2020, before the rains.

The dried out Macina, imaged during May 2000.
NASA Earth Observatory images by Lauren Dauphin, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview.

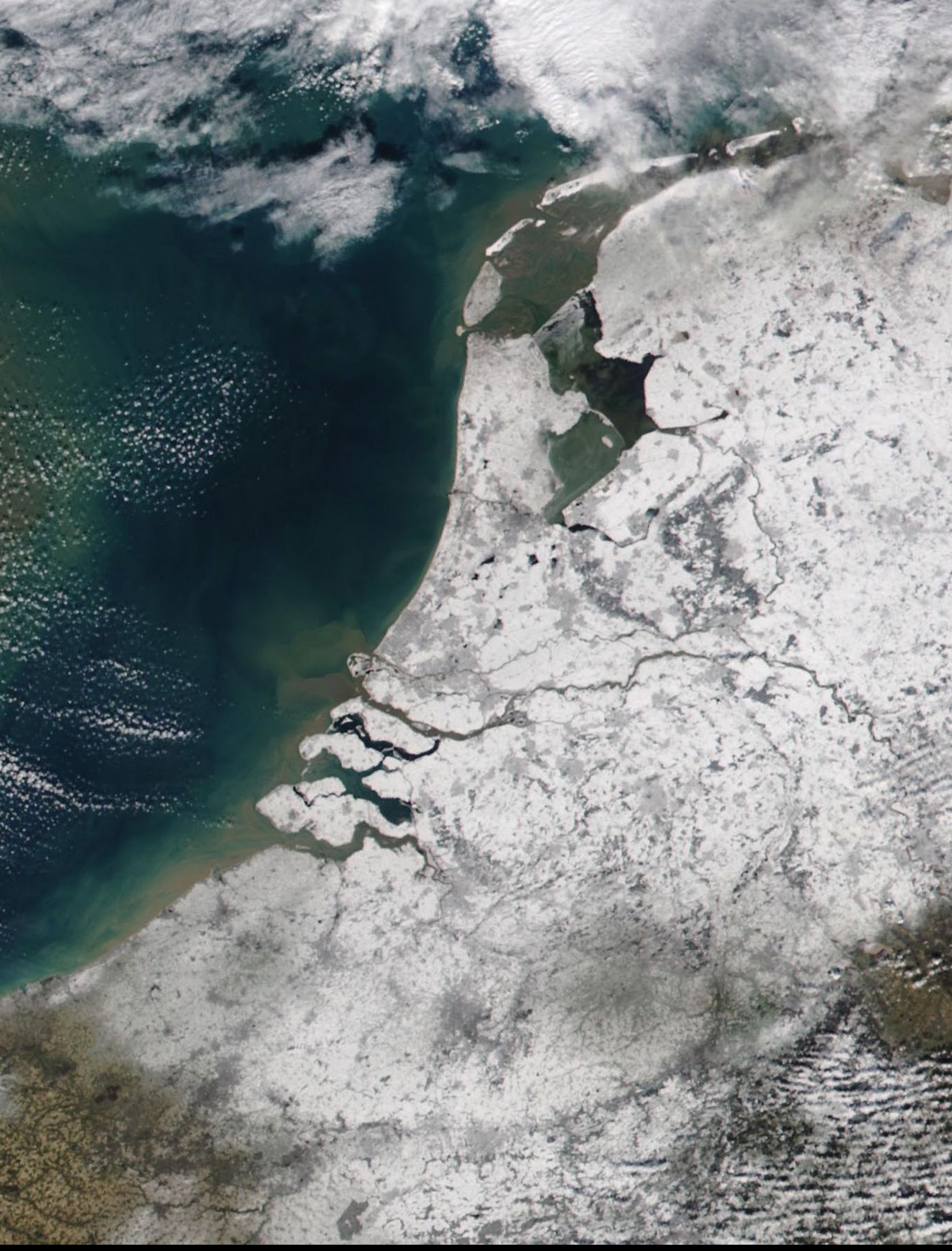
In late October, floodwaters reached their peak height at Mopti, a town at the confluence of the Niger and Bani Rivers. Water levels in the delta were recorded at 670 centimetres on October 26 and remained at that level until November 2, according to Mali's National Directorate of Water Resources. That tied the peak water levels from 2018, the highest since 1969.

After November 2, waters receded at Mopti even as they continued to rise at points downstream such as Akka and Diré. It typically takes water a full six months between falling in the Guinea Highlands and reaching the ocean at the Niger Delta in Nigeria. People watch the timing of flooding closely because it affects when rice can be grown, when fish will be available to catch, and when pastures can be ready for grazing. Water levels were expected to be low enough in mid-December 2020 for the annual cattle crossing on the Niger River at Diafarabé. In the much anticipated event, nomadic herders drive cattle across the river toward rich grazing lands in the inland delta and are reunited with their families after months apart.



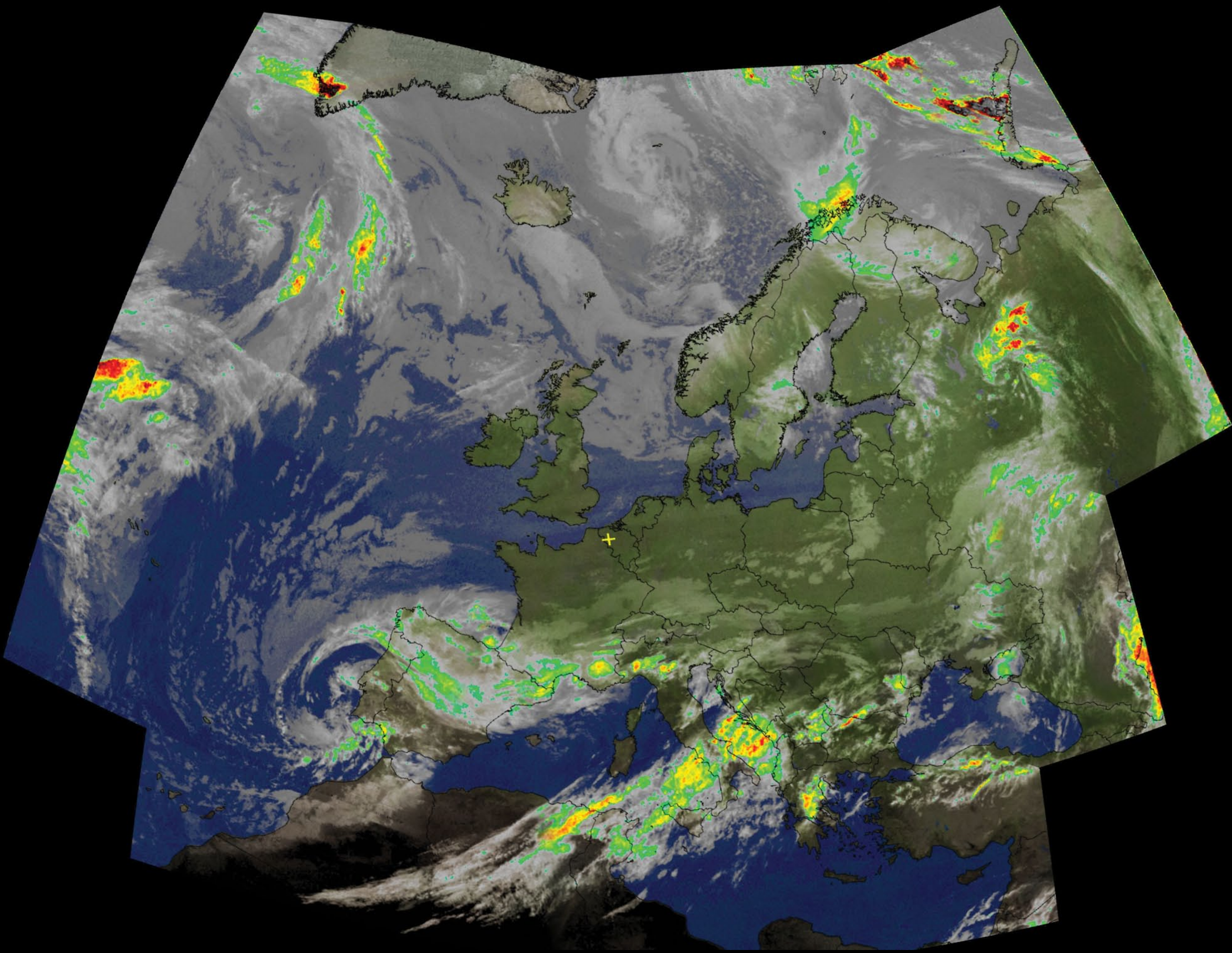
The Macina following Niger floods, imaged on October 29, 2000.
NASA Earth Observatory images by Lauren Dauphin, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview.

While seasonal floods are common in Mali, the severity of the floods this year caused widespread damage. The United Nations Office for the Coordination of Humanitarian Affairs estimates that 1,160 homes were destroyed by flooding.

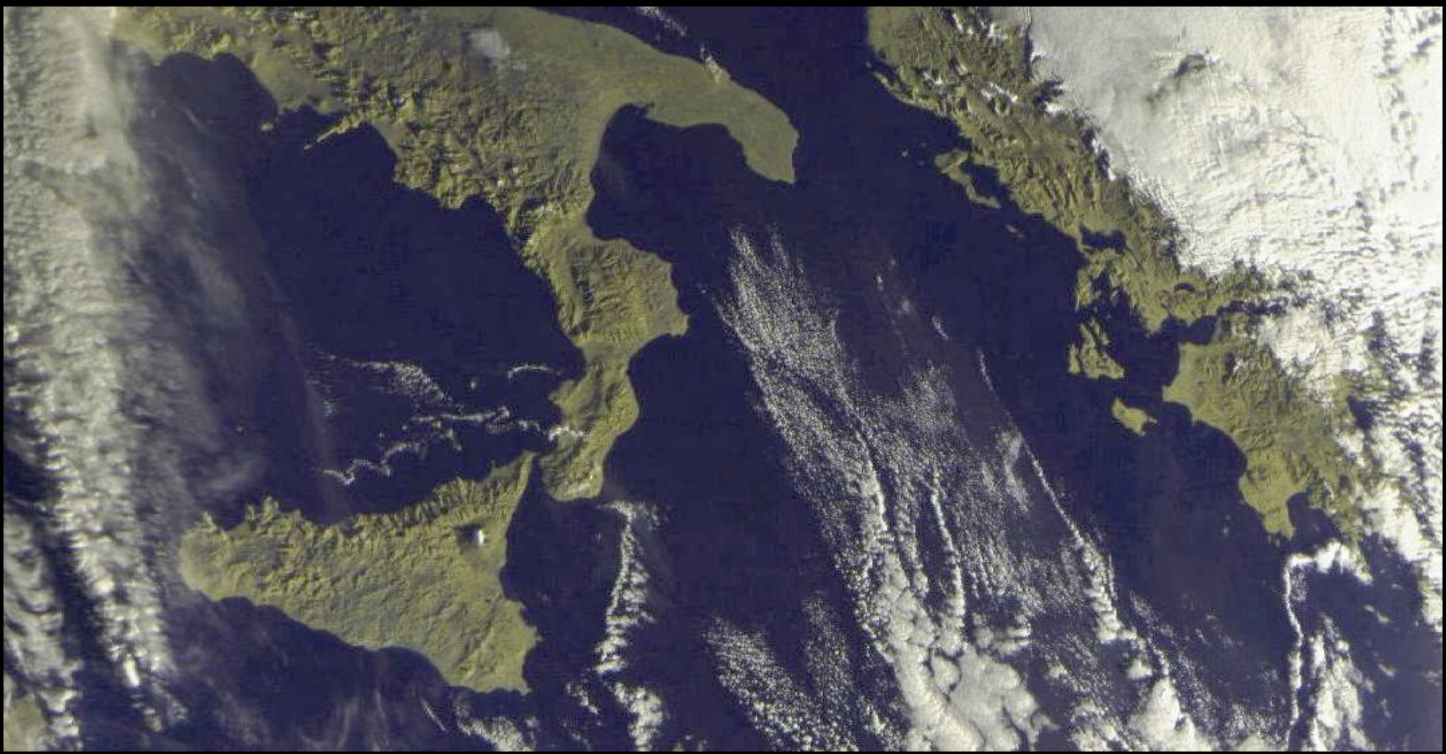


Storm Darcy brought The Netherlands its first major snowstorm for a decade, encasing the country in snow and ice and prompting thousands of skaters to take to the ice. NOAA 20 imaged the deep-freeze on February 11, 2021.
Image: NASA Worldview Snapshots (https://wvs.earthdata.nasa.gov/)

Readers' Images



André T'Kindt created this composite image from passes of NOAAs 15, 18 and 19 on December 13, 2020.
Created in WXtoImg, using the MCIR precipitation option.



Joachim Scharrer sent in this Meteor M2 image showing a plume above mount Etna on December 15, 2020.

Ice on the Caspian Sea

Modis-Web Image of the Day

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

Sitting at the crossroads between Europe and Asia, the Caspian Sea claims the title of Earth's largest land-locked inland water body. It covers roughly 371,00 square kilometres) and borders five countries. Russia sits along the northwestern shore, and moving clockwise come Kazakhstan, Turkmenistan, Iran, and Azerbaijan.

Although it is often called a lake and receives fresh water from roughly 130 rivers, including the mighty Volga, the waters of the Caspian Sea are saline. While the overall saltiness is about one third as much as the ocean, the salinity is not uniform. In the north, where the rivers enter, the water is freshest, and the southern waters are saltiest. The depth of the lake changes dramatically between north and south as well. Most of the north area sits over a shelf, leaving a depth of only 10 metres or less, but the depth drops to hundreds of metres in the south, reaching as much as 1,000 metres in some places.

As winter comes to the Caspian Sea, frigid temperatures embrace the northern regions first, bringing frost to the land and encouraging ice formation. But more than air temperature affects freeze-up of the Caspian Sea. Salinity and depth also are important factors. Fresh water freezes at 0°C, but when salt is present the freezing point drops. For every five parts per thousand salt content (salinity), the freezing point drops by 0.28 °C. Additionally, shallower water cools more readily throughout the water column than deeper water, and the rapid cooling of the water column facilitates freezing. These factors explain why the northern Caspian Sea reliably freezes in the wintertime, while the southern section usually remains ice-free.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's *Aqua* satellite acquired this true-colour image of the Caspian Sea on December 3, 2020. Bright, white fast-ice clings to the shore of Kazakhstan while open water can be seen near the Volga River Delta and southward. Tan sediment pours into the Caspian Sea from the Volga River and changes colour to green as it sinks into the blue waters of the Sea.

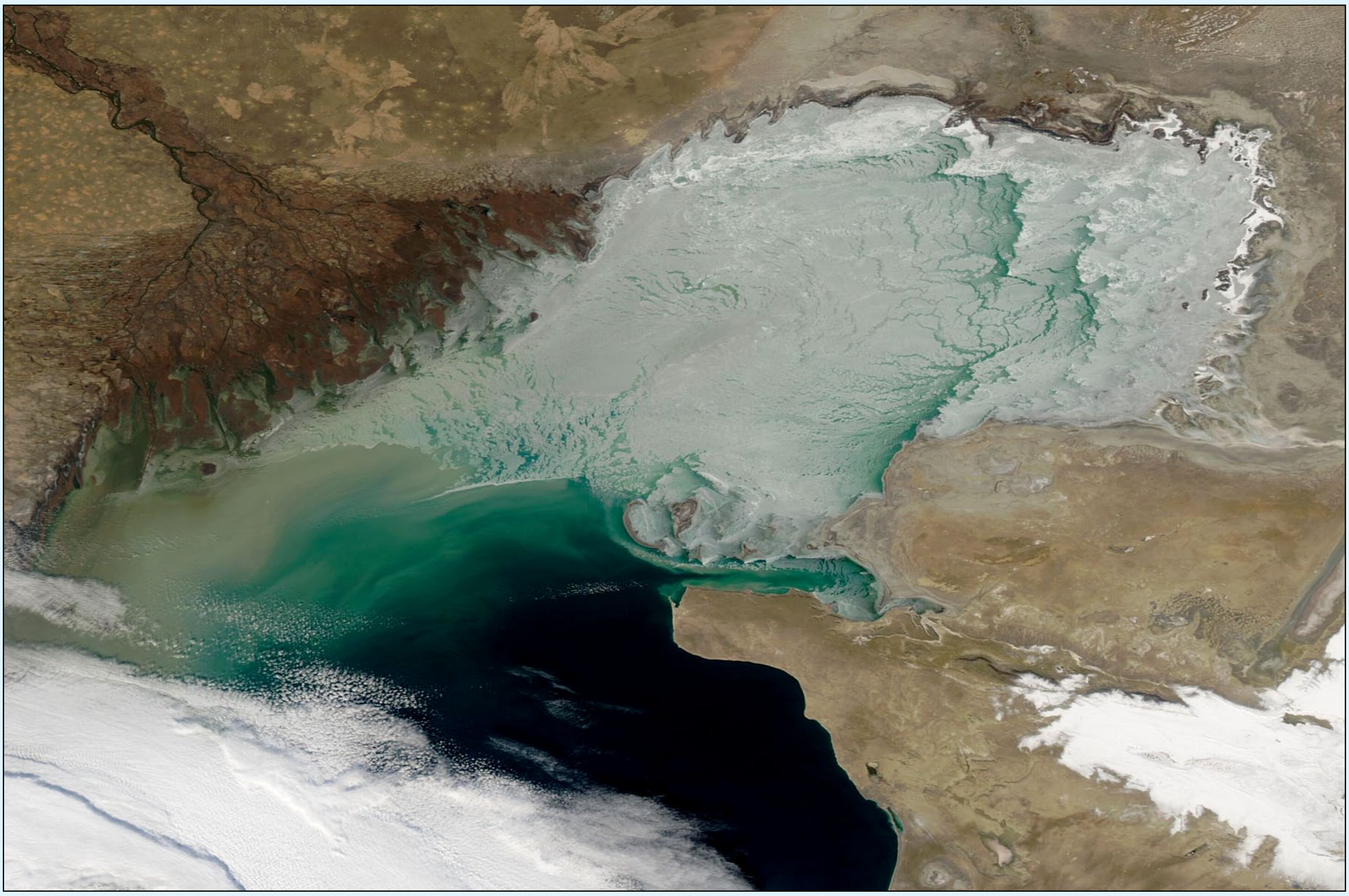
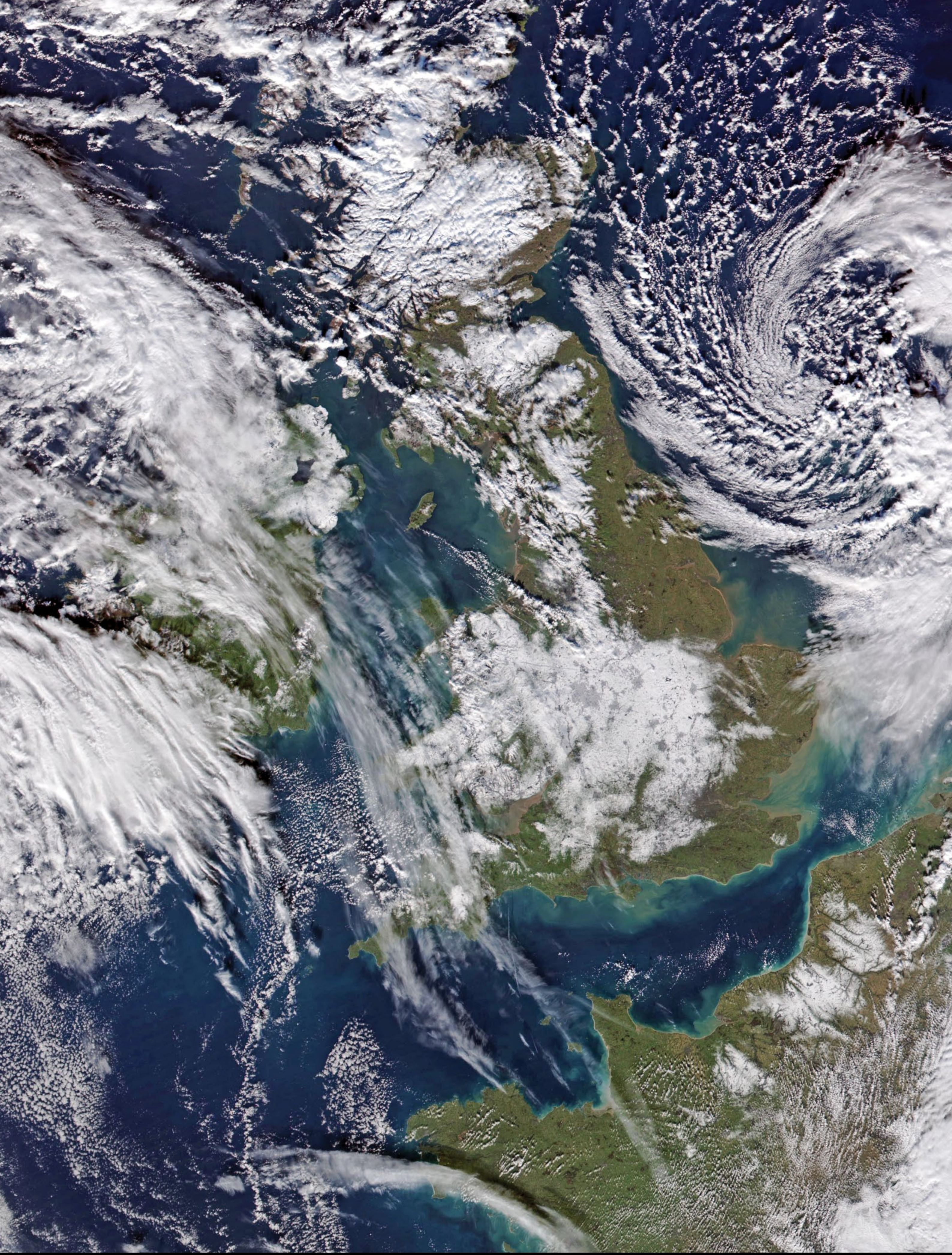


Image Credit: MODIS Land Rapid Response Team, NASA / GSFC.



Late January 2021 brought heavy snowfalls to much of Great Britain, particularly western areas. NOAA 20 captured this almost cloud-free image of the island on January 25, with urban areas standing out as grey spots in the blanket of white.
Image: NASA Worldview Snapshots (https://wvs.earthdata.nasa.gov/)

Introducing NASA Worldview Snapshots

Les Hamilton

For many years, high resolution Level-1 image segments from NASA's **Terra** and **Aqua** satellites were regularly available for download, in near real-time, via the LANCE-MODIS website: many of the images that have appeared on the pages of GEO Quarterly over the years had been sourced from here. But this web page is now gone, replaced by the *NASA Worldview Snapshots* web page.

The *NASA Worldview Snapshots* interface is pretty straightforward to use and comes with a number of new features. It provides imagery that is already rectified (free from the 'bow-tie' effect that users previously had to correct themselves), offers options to add '*Coastlines*', '*Coastlines, Borders & Roads*' and '*Fires*', and includes imagery from both the **Suomi-NPP** and **NOAA 20** satellites in addition to **Terra** and **Aqua**.

The scope is wide ranging. In addition to making near real-time imagery available approximately three hours after acquisition, *NASA Worldview Snapshots* also includes a huge library of historic satellite imagery dating back to the date each satellite became fully commissioned. For example, the **Terra** satellite was launched on December 18, 1999 and, by using the 'Calendar' feature**,** images can be recovered from as long ago as February 2000.

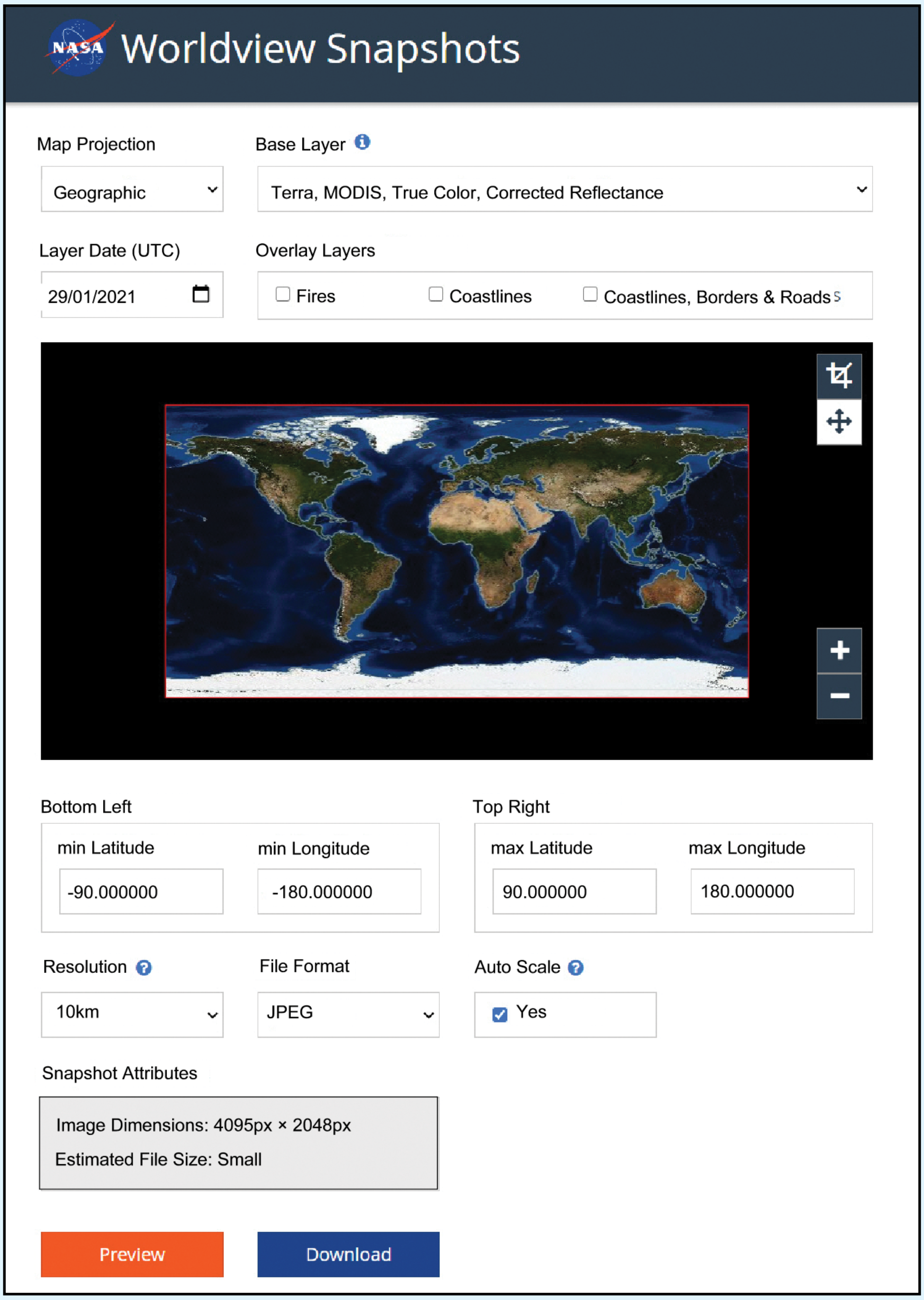


Figure 1 - The main Worldview Snapshots Page

Getting Started

You can access *Worldview Snapshots* at the following URL

https://wvs.earthdata.nasa.gov/

which displays the page shown in figure 1. *Worldview Snapshots* provides you with access to imagery from the ModerateResolution Imaging Spectroradiometer (MODIS) carried by NASA's **Aqua** and **Terra** satellites as well as the Visible Infrared ImagingRadiometer (VIIRS) aboard both the **Suomi-NPP** and **NOAA 20** satellites.

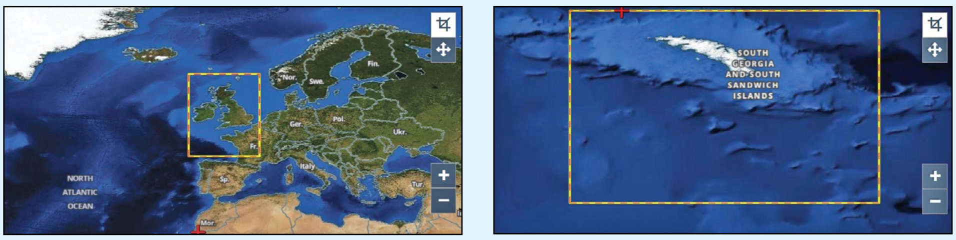


Figure 2 - Selections from zoomed map: British Isles (left) and South Georgia.

Selecting a Date and Region

Start by using the 'Calendar' to select an appropriate date, then outline the region required on the map. For ease of use, the map may be zoomed and dragged around using the controls to its right. Hovering the mouse over each control reveals a pop-up window defining its function. The area required is then defined by drawing a rectangle around it with the selection tool. Figure 2 provides two illustrations of this.

Satellite Selection

Clicking the drop-down menu beneath '*Base Layer*' (figure 1) displays the options shown in figure 3. For most purposes you will select the *True Color* option which combines frequencies that provide natural-looking images of land surface, oceanic and atmospheric features. Other frequency combinations produce false colour images designed to highlight specific features such as snow, ice and burn scars. If you are interested, do visit the Frequently Asked Questions (FAQ) link in the **How to Use** section of the main *Worldview* page to learn more.

Image Resolution

Clicking the '*Resolution*' option reveals a drop-down menu offering image resolutions between 250 metres and 10 kilometres per pixel. The highest resolution possible for the area you select will be denoted with an asterix as shown in figure 4.

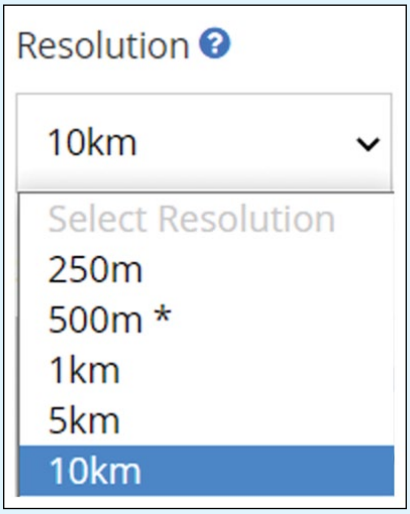


Figure 4 - Resolution options

Generating an Image

With these basics completed, click the orange **Preview Button** at the foot of figure 1 (you can alternatively, click the **Download Button** if you are confident of the final rendition). This reveals the *Preview Screen* (figure 5), where, if all is well, you again have the option to download the image.

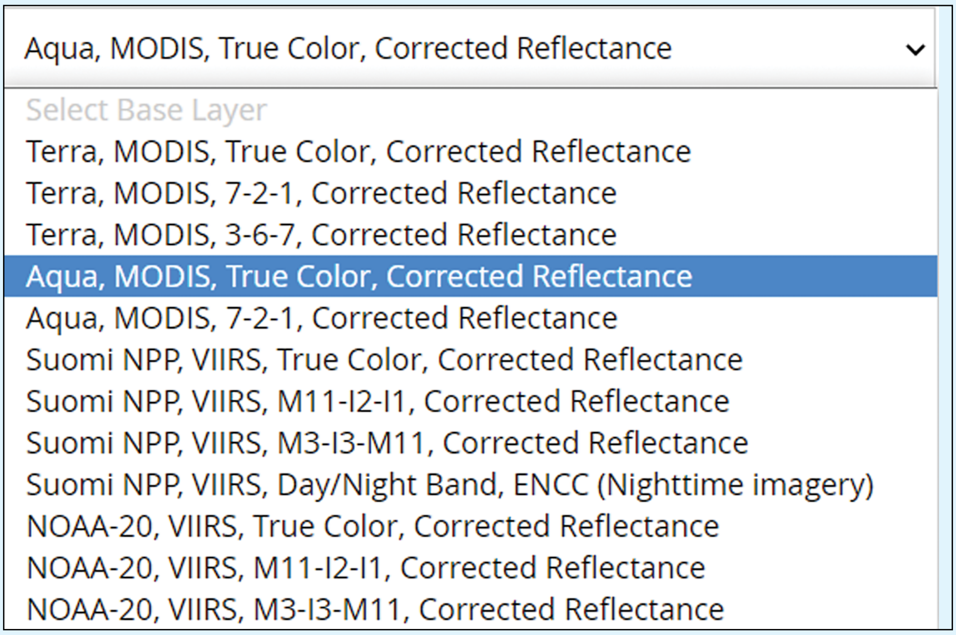


Figure 3 - Bare Layer Options.

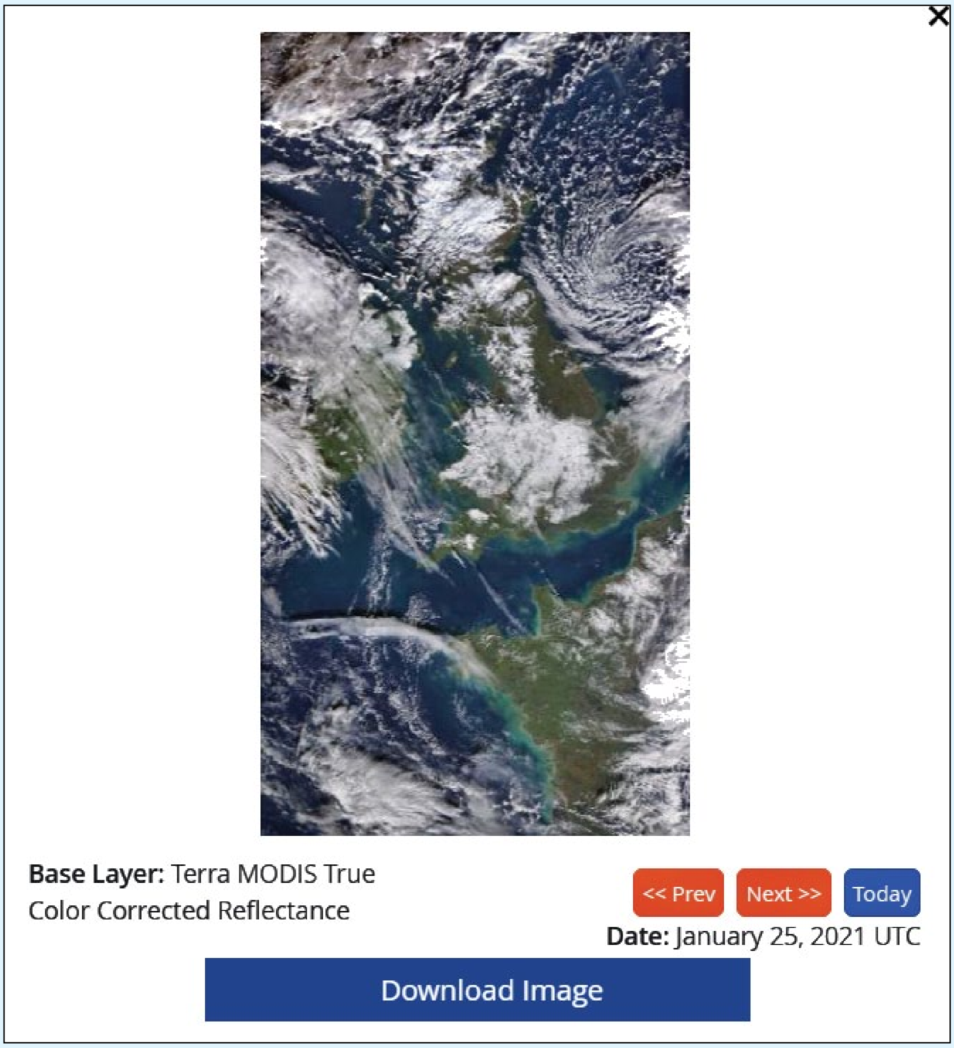


Figure 5 - The Preview Screen

The advantage of using the *Preview Screen* is that it allows you to check the image of the area from each satellite in turn and select the one that suits your needs best: for example, which one is least obscured by clouds.

The *Worldview* image archive consists of spliced satellite passes and, if you are unlucky in your choices, there may be an obtrusive line of discontinuity slanting across an image where cloud features do not match precisely,

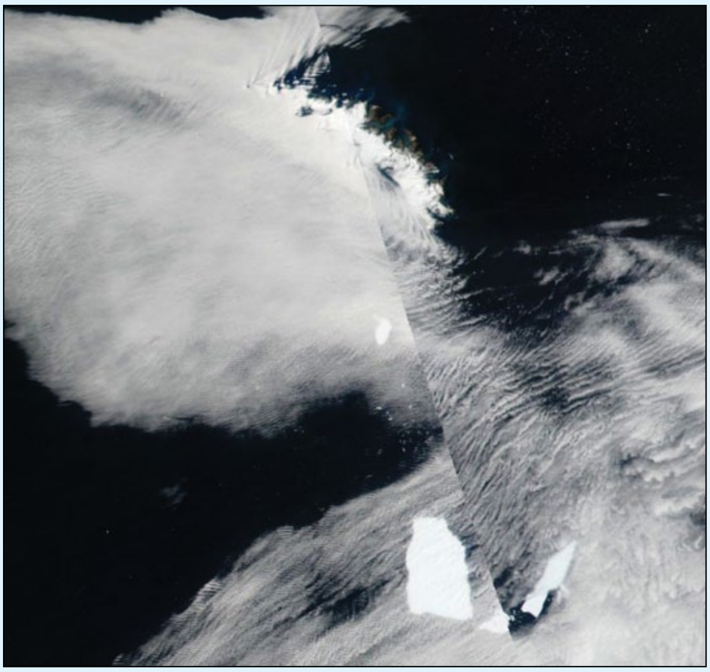


Figure 6
This December 26, 2020 Suomi-NPP image of South Georgia and the disintegrating A68 tabular ice slab clearly illustrates the discontinuity where adjacent satellite passes have been integrated together.

as illustrated in figure 6, which shows the A68a iceberg and South Georgia. By temporarily closing the *Preview Screen* (click the 'x' at the top right corner) you return to the main screen where you can select a different satellite and click the preview button again. You can repeat this for all/any of the four satellites and would be unfortunate indeed if none of the preview images was acceptable. Now you can download your selected image with confidence.

Autoscale

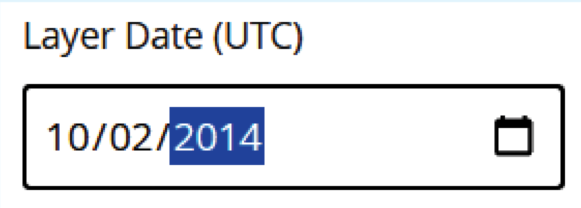
The '*Auto Scale*' feature scales the width of images, particularly at higher latitudes, to create a better looking, more psuedo-equal-area image. '*Auto Scale*' is selected by default. Figure 7 illustrates the use of this feature.

Fires

Checking the '*Fires*' option on the interface places a small orange dot at the source of wildfires. Figure 8 illustrates this for the spate of wildfires near Los Angeles on August 2, 2020.

Rolling Back Time

If you wish to view historic images from long ago, opening the '*Calendar*' and scrolling back month by month is time consuming. Instead, click on the year below '*Layer Date*' to select it, and use the keyboard down-arrow key to scroll, one year at a time as in the illustration below.



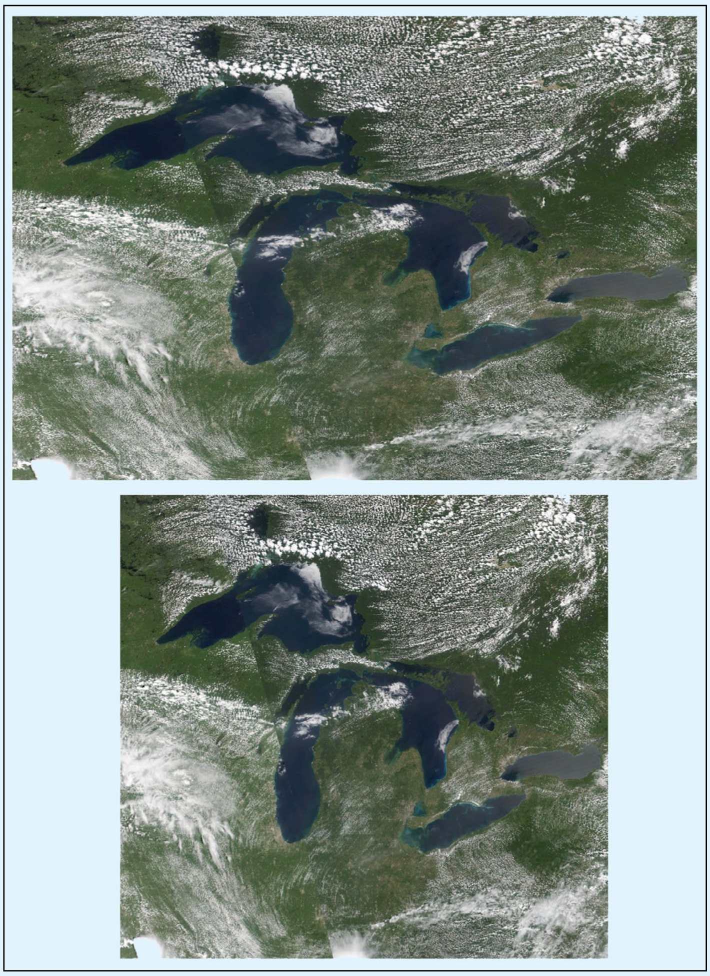


Figure 7
This Worldview Snapshot of the Great Lakes, acquired on July 17, 2020, illustrates the Autoscale feature. The upper image was downloaded with Autoscale deselected, whereas, for the more 'normal looking' lower image, Autoscale was selected.

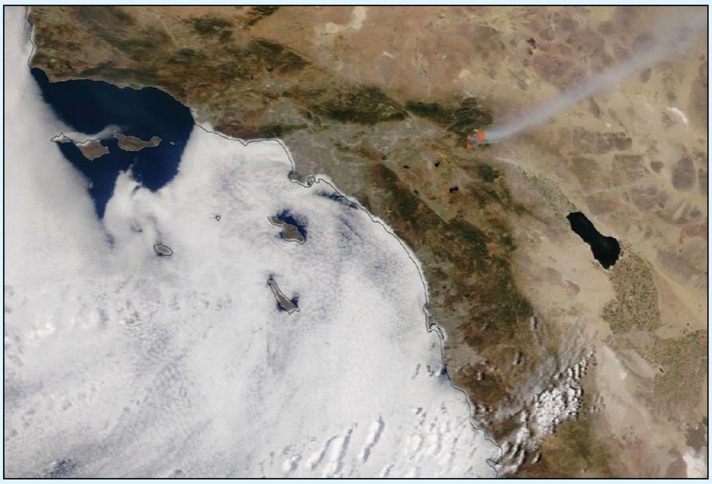
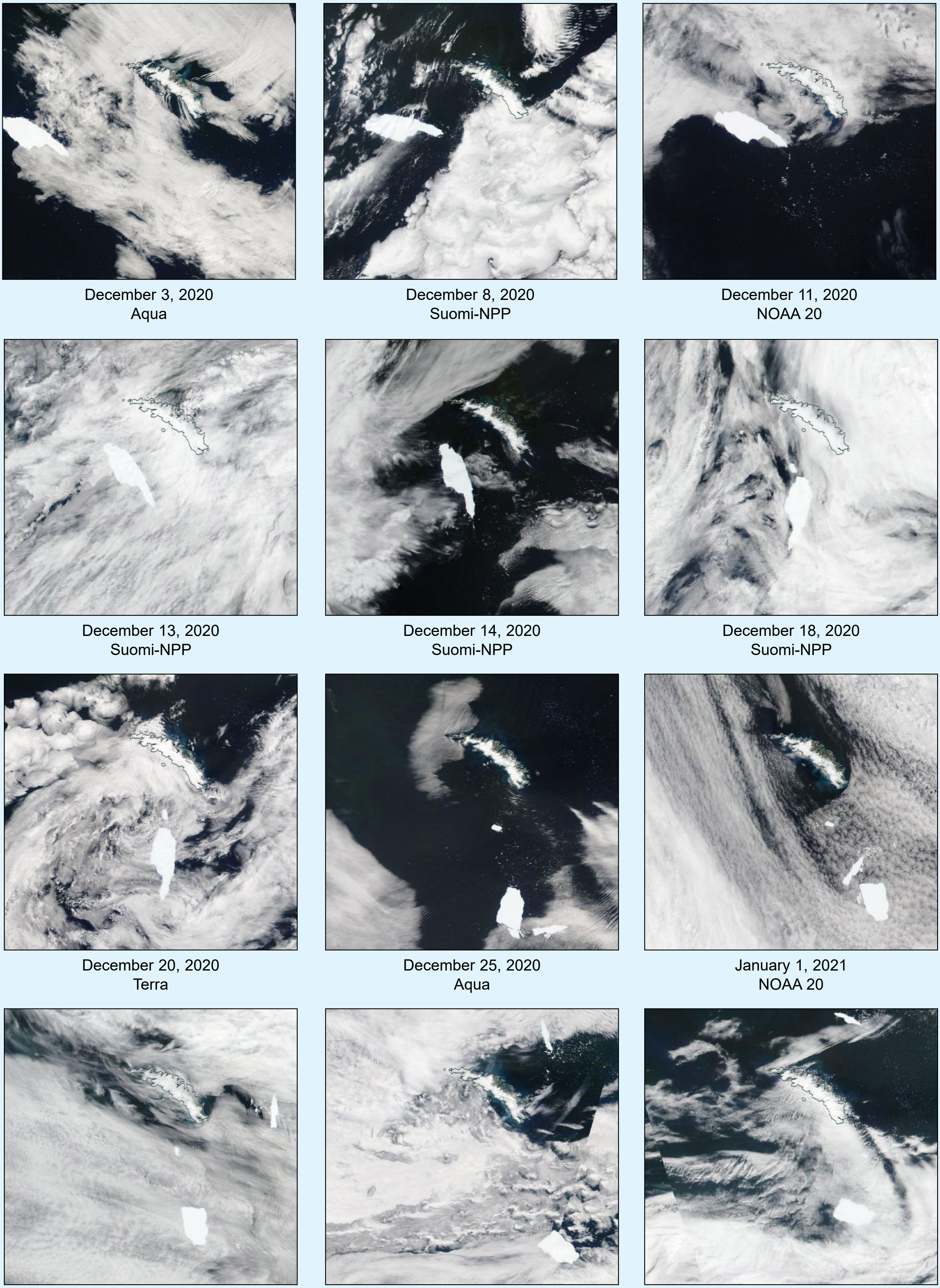


Figure 8
Wildfire hotspots near Los Angeles on August 2, 2020.

Following a Trend

Useful features at the foot of the *Preview Screen* are two buttons labelled 'Prev' and 'Next'. These allow you to view precisely the same area daily over a period of time, useful for following the progress of an extended event. I followed the breakup of iceberg A68A throughout December and January in this manner, saving the clearest images from the satellites to create the montage in figure 9 overleaf.



December 3, 2020
Aqua

December 8, 2020
Suomi-NPP

December 11, 2020
NOAA 20

December 13, 2020
Suomi-NPP

December 14, 2020
Suomi-NPP

December 18, 2020
Suomi-NPP

December 20, 2020
Terra

December 25, 2020
Aqua

January 1, 2021
NOAA 20

January 9, 2021
Suomi-NPP

January 17, 2021
Terra

January 26, 2021
Suomi-NPP

Figure 9
This sequence of images illustrates the breakup of tabular iceberg A68a between early December 2020 and late January 2021.
Credit: NASA Worldwide Snapshots (all images)

The Strait of Hormuz

Modis-Web Image of the Day

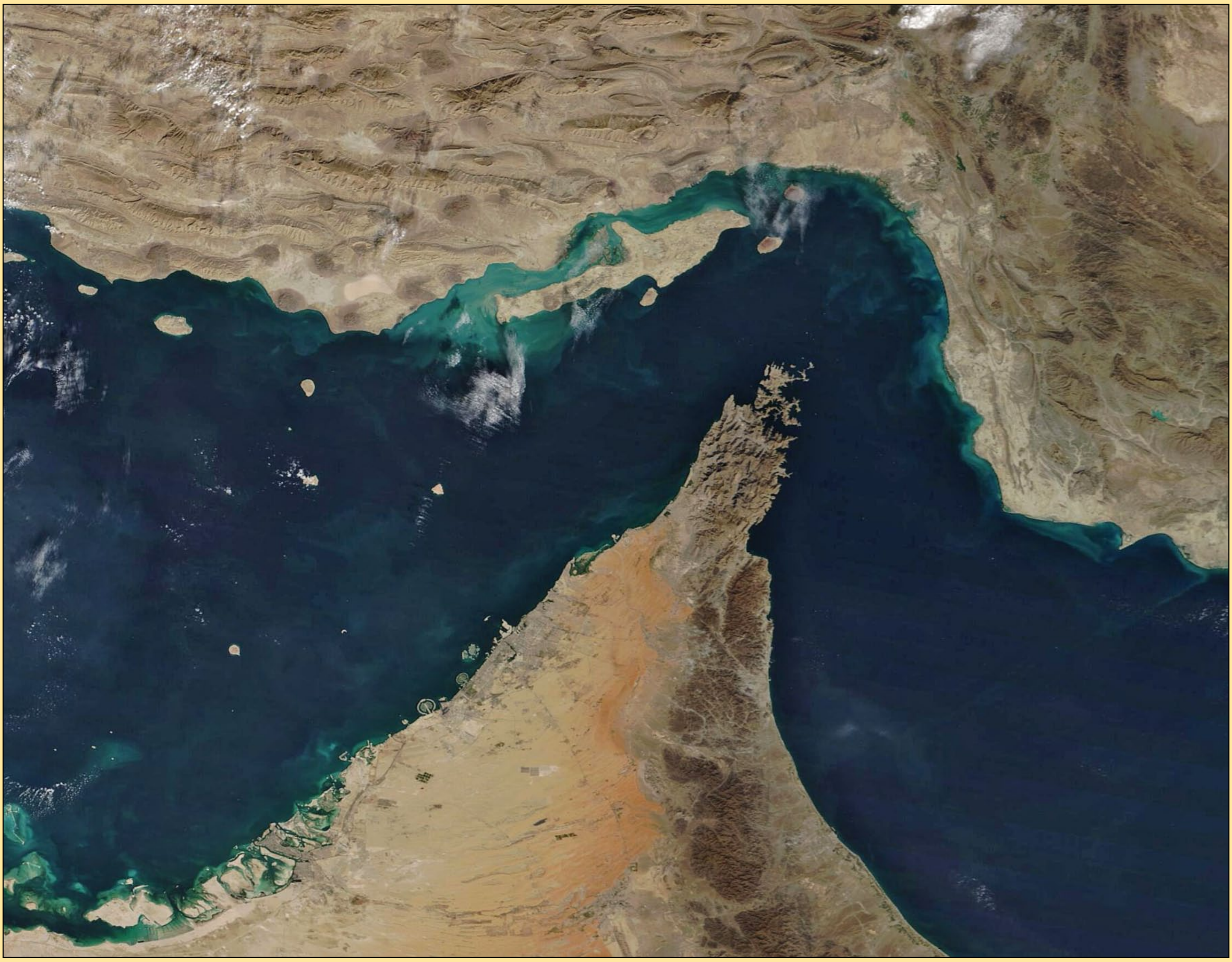
https://modis.gsfc.nasa.gov/gallery/showall.php

The narrow Strait of Hormuz lies between the Persian Gulf and the Gulf of Oman, separating Iran to the north from the Arabian Peninsula on its south. Only about 34 kilometres wide at the narrowest point and roughly 155 kilometres long, about thirty percent of the world's seaborne oil and nearly one-quarter of the liquefied natural gas (LNG) supply passes through this strait—all on shipping lanes only three kilometres wide. It has been estimated that 21 million barrels of oil, with a value of 1.2 billion US dollars (USD), pass through the strait every day.

The arid landscape of Iran sits in the north, with Qeshm Island, the largest in the Persian Gulf, just off the Iranian coast. The tiny Strait of Khuran separates the island and the mainland and bounds a wetland of international importance, recognised by Ramsar [1]. These wetlands provide critical habitat to two globally threatened species: the Dalmatian Pelican and the Green Sea Turtle. In the south, the rocky and rugged Musandam Peninsula juts into the Strait of Hormuz. The tip of the peninsula is filled by the Musandam Governate, and exclave of Oman. To the south, the land on the peninsula belongs to the United Arab Emirates.

Reference

1 The Ramsar Convention on Wetlands of International Importance is an international treaty for the conservation and sustainable use of wetlands. It is also known as the Convention on Wetlands. It is named after the city of Ramsar in Iran, where the convention was signed in 1971.



On December 2, 2020, the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's Terra satellite acquired this true-colour image of the Strait of Hormuz.
Image: NASA

Lake Turkana

Modis-Web Image of the Day

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

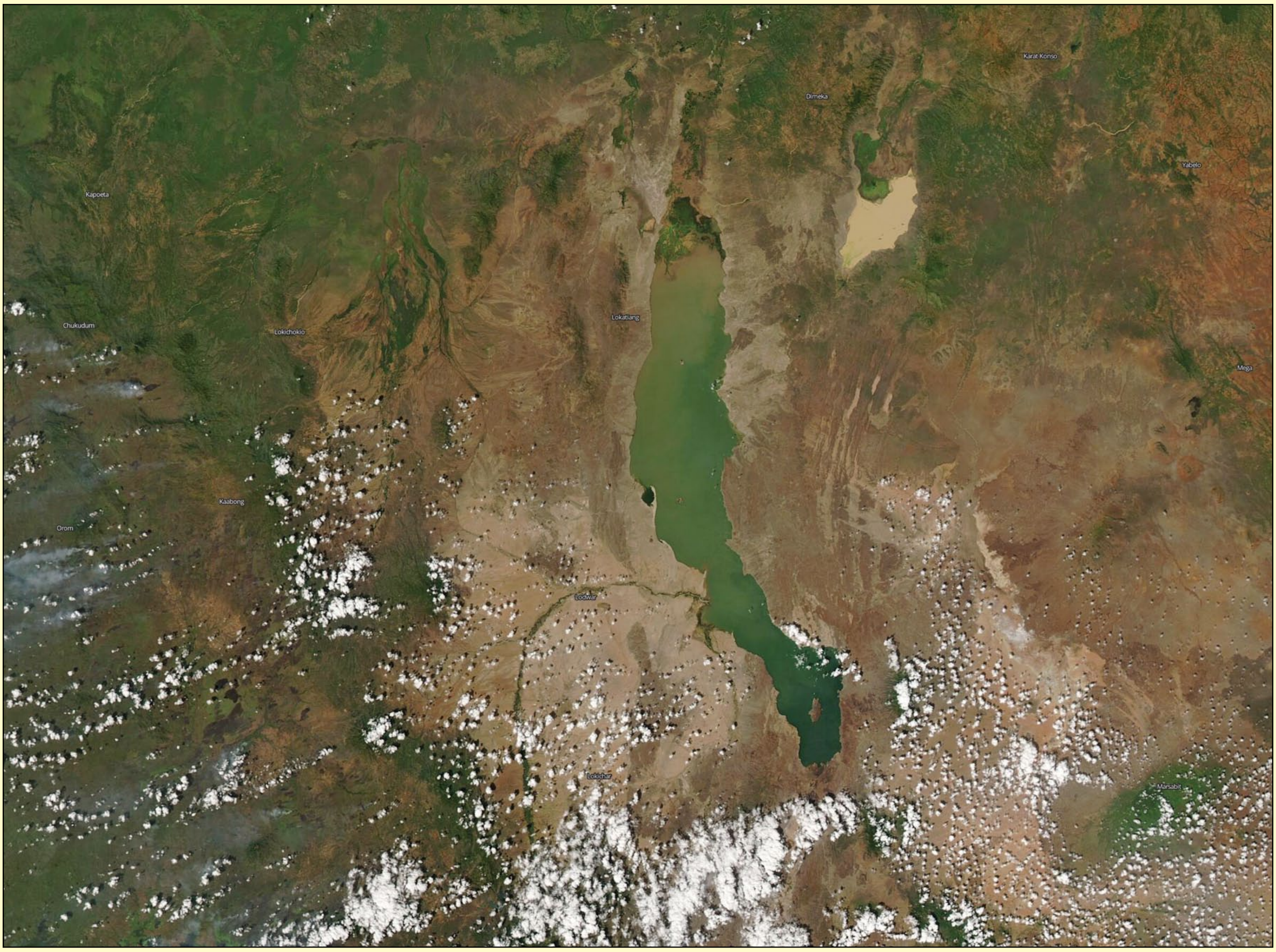
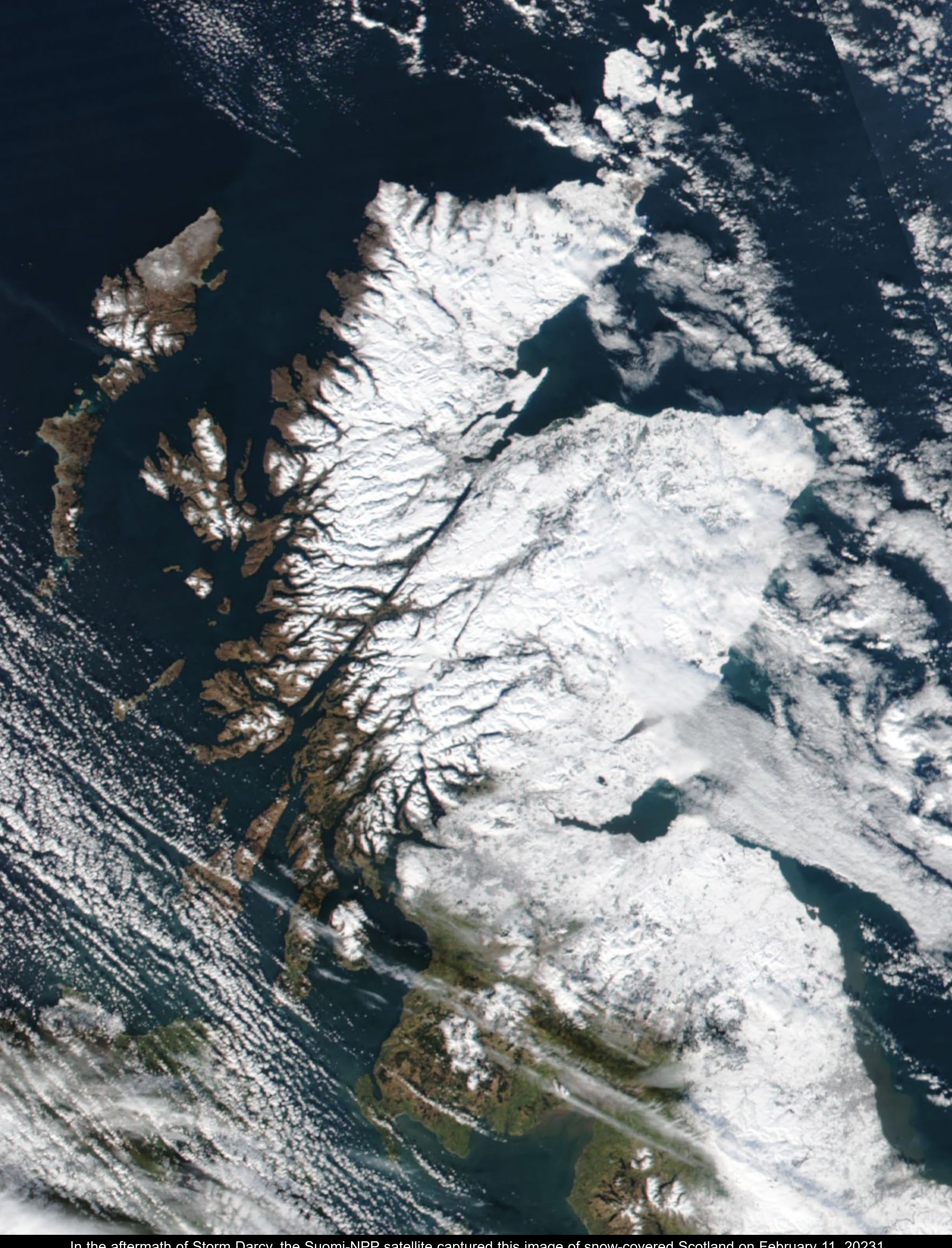


Image Credit: MODIS Land Rapid Response Team, NASA GSFC

Lake Turkana has been called '*The lake that tells the story of humanity's birth*'. Seated in East Africa's Rift Valley, this saline lake stretches for more than 249 kilometres) and measures only 44 km in width, providing scarce water resources in a very dry landscape. More than two million years ago, however, the lake was larger and the surrounding countryside more hospitable. Palaeontologists have discovered fossils dated as early as 3.4 – 4.2 million years in the Turkana basin on the west side of today's lake boundaries, which include ancient fish, turtles, rodents, horses, elephant and primates, evidence of the abundant life found in this region in times past.

In the 1960s, scientists began to work the fossil beds on the east side of the lake. Tools that showed the handiwork of humanity were found in sediment dated at 3.3 million years old. In 1972, a team lead by Richard Leakey discovered a skull and some bones that were subsequently dated back 1.9 million years. This early hominid, *Homo rudolfensis*, was just one of three hominid species that coexisted in this region between 1.78 and 1.98 million years ago. In 1984, the nearly complete skeleton of a boy who lived between 1.5 and 1.6 million years ago was found near Lake Turkana. Known as Turkana Boy, he is one of the earliest examples of *Homo erectus* known. The ancient sediments and sandstone of Lake Turkana have truly revealed much about our planet's ancient history, and the dawning of our species.

On December 10, 2020, the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's **Aqua** satellite acquired this true-colour image of Lake Turkana. Sediment stains the waters, especially in the muddy-coloured northern end. Lake Chew Bahir, the small lake northeast of Lake Turkana, is also stained with sediment. Lake Chew Bahir and the northern tip of Lake Turkana lie in Ethiopia while the southern section of Lake Turkana belongs to Kenya.



In the aftermath of Storm Darcy, the Suomi-NPP satellite captured this image of snow-covered Scotland on February 11, 20231. With the winds coming from the east, the west coast and islands largely escaped the snow. Indeed, just two date later, conditions on Skye were so tinder-dry that wildfires broke out.

Image: NASA Worldview Snapshots (https://wvs.earthdata.nasa.gov/)

The Ocean Odyssey of Iceberg A68a

Les Hamilton

Regular readers may recall one of our articles in 2017 which detailed the calving of the A68 tabular iceberg from the Larsen-C ice shelf in Antarctica on July 12 that year [1]. Considerable interest was expressed at the time owing to its size: measuring 175 × 75 kilometres, with a surface area of 5800 square kilometres, it was the fourth largest tabular iceberg recorded during the satellite era. As a guide, its area was approximately twice the area of Luxembourg.

A68a became virtually becalmed for several months, and by November that year had drifted a mere five kilometres from the Larsen-C ice shelf. Although A68 was largely to remain intact during the following three years, it did lose a 65 square kilometre chunk shortly after calving, which was designated iceberg A68b, the parent 'berg being renamed A68a.

But interest waned over the following two years as A68a made extremely slow progress north across the Weddel Sea. It was not until February 2020 that the iceberg finally cleared the Antarctic Peninsula and moved into the open waters of the Southern Ocean, where winds and currents hastened its drift northwest in the general direction of South Georgia.

By early November 2020 it had become clear that it was highly possible that A68a, which figure 1 shows to be considerably larger than South Georgia, might actually ground on the shallower continental shelf near the island, posing a serious threat to its colonies of seals and penguins. The iceberg's close position to the remote island prompted fears that it might anchor itself to the coast and impact the fragile ecosystem that thrives around the island, through the scraping of the seabed or the release of cold freshwater into the surrounding ocean. The map in figure 2 shows the continental shelf around South Georgia.

During December 2020, A68a started changing its direction as ocean surface currents, steered by sea floor bathymetry, diverted it in a southeasterly direction away from the island. On December 17, a glancing collision with the shelf broke off a corner off A68a as shown in figure 3.

ESA's Sentinel-1 satellites followed the subsequent demise of A68a through their radar sensors, which are able to image through cloud. An image acquired on January 31, 2021 appears on the front cover of this issue. Figure 4, acquired the following day (reproduced overleaf) shows all the major units of the now disintegrated A68a [2].

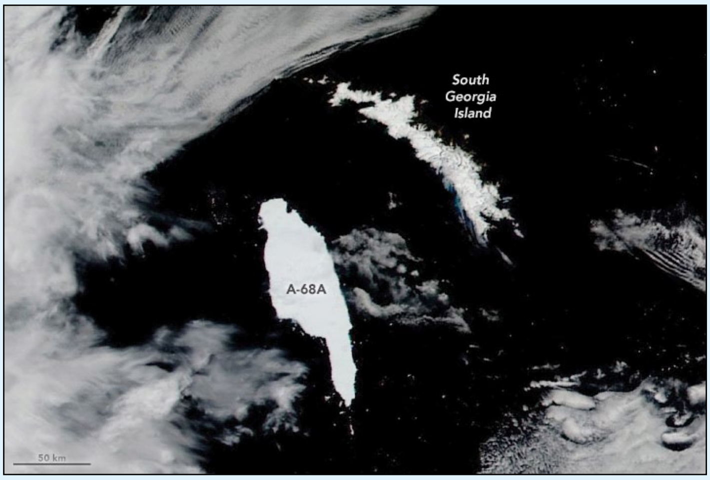


Figure 1
A68a and South Georgia Imaged by NASA's Suomi-NPP satellite on December 14, 2020
Image: NASA

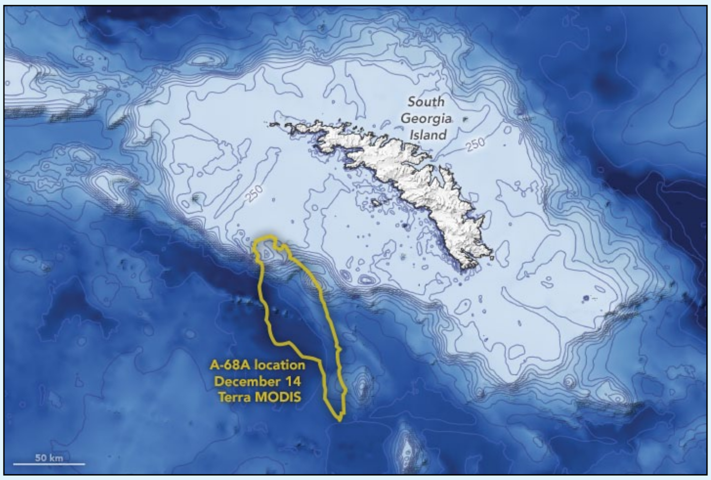


Figure 2
Credit: NASA, with data from the British Oceanographic Data Center's General Bathymetric Chart of the Oceans

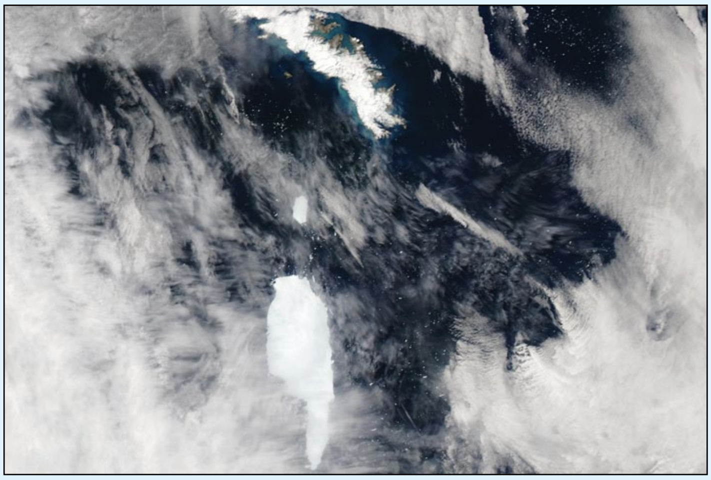


Figure 3
NASA's Aqua satellite captured this scene on December 22 with A68a and the tiny A68d moving away from South Georgia.
Credit: NASA Worldwide Snapshots

References

1 Breakup of the Larsen Ice Shelves, GEOQ 56, p 9.

2 The A-68a story
http://www.esa.int/Applications/Observing_the_Earth/The_A-68_story

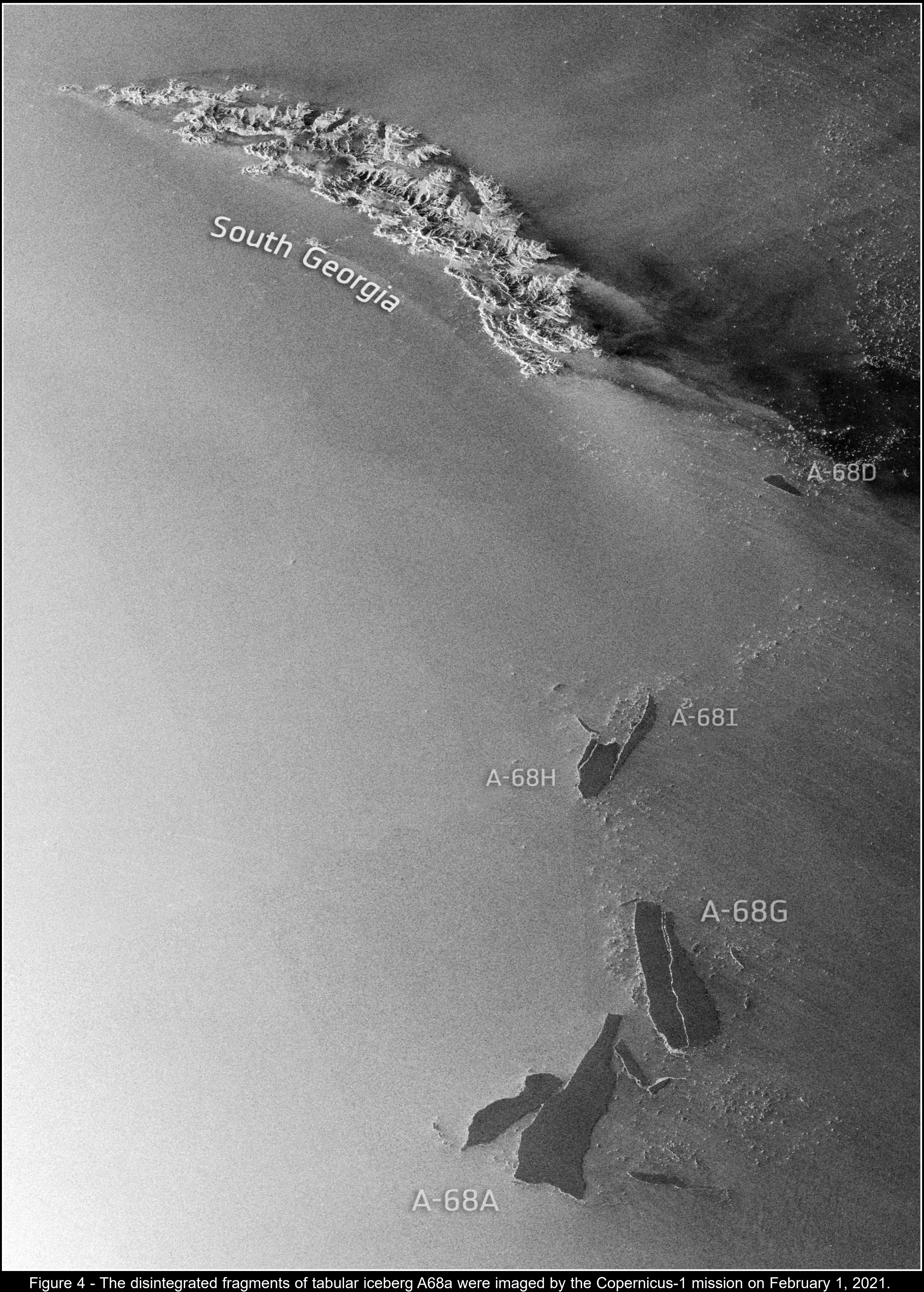
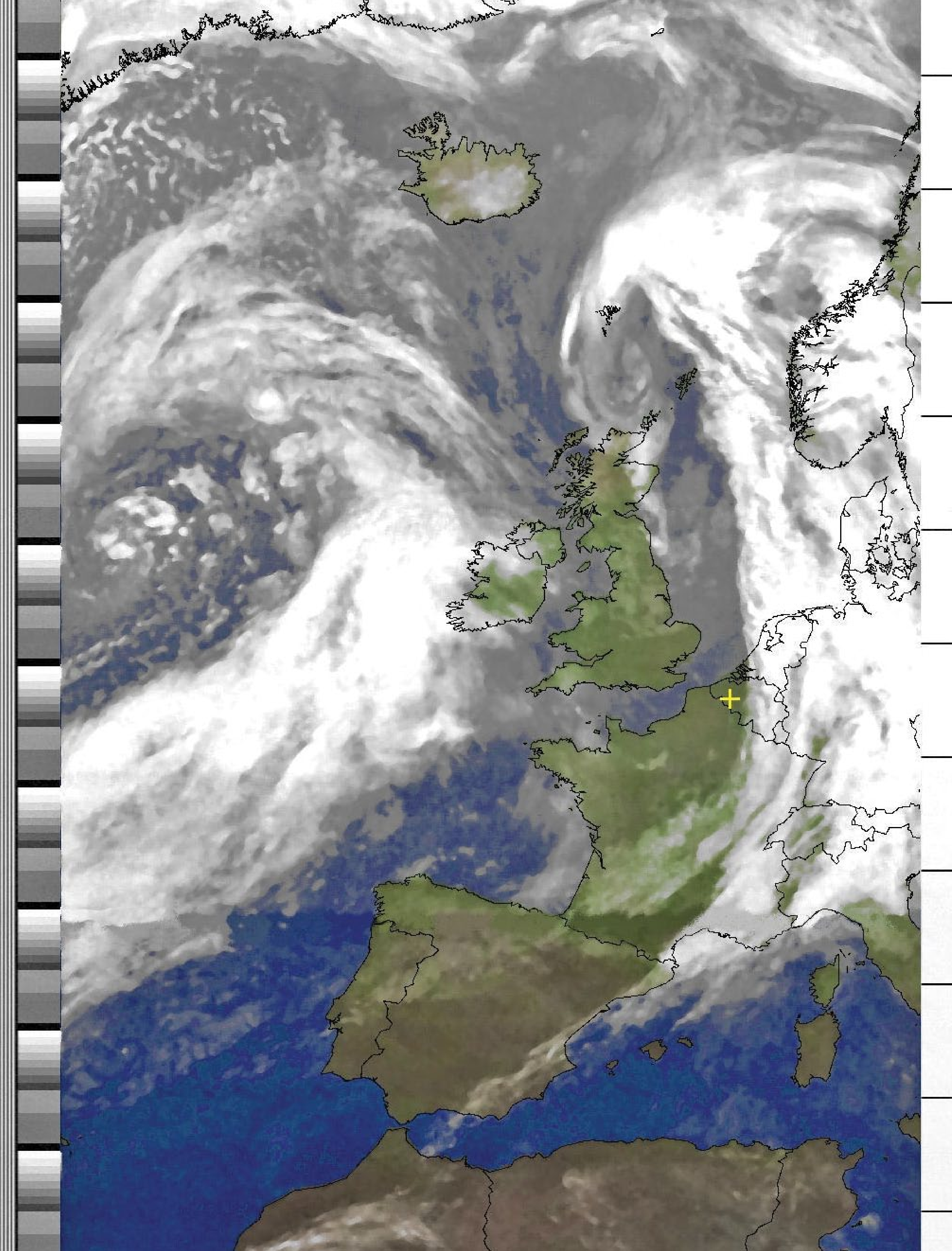


Figure 4 - The disintegrated fragments of tabular iceberg A68a were imaged by the Copernicus-1 mission on February 1, 2021.
Image contains modified Copernicus Sentinel data (2021), processed by ESA, CC BY-SA 3.0 IGO



This NOAA 18 APT image captured by André T'Kindt at 20:02 UT on February 18 this year shows the two Atlantic depressions that brought an end to the prolonged spell of freezing weather in nations bordering the North Sea.

Cloud-free Iceland

European Space Agency

On August 14, 2020, the Copernicus Sentinel-3 mission showed us a rare, cloud-free view of Iceland.

The large, white area visible on the island is a national park that encompasses the Vatnajökull Glacier. Covering an area of around 8400 square kilometres, and with an average ice thickness of more than 900 metres, Vatnajökull is not only classified as the biggest glacier in Iceland, but the biggest in Europe.

The white, circular patch in the centre of the country is Hofsjökull, the country's third largest glacier and its largest active volcano. The elongated white area west of Hofsjökull is Langjökull, Iceland's second largest ice cap.

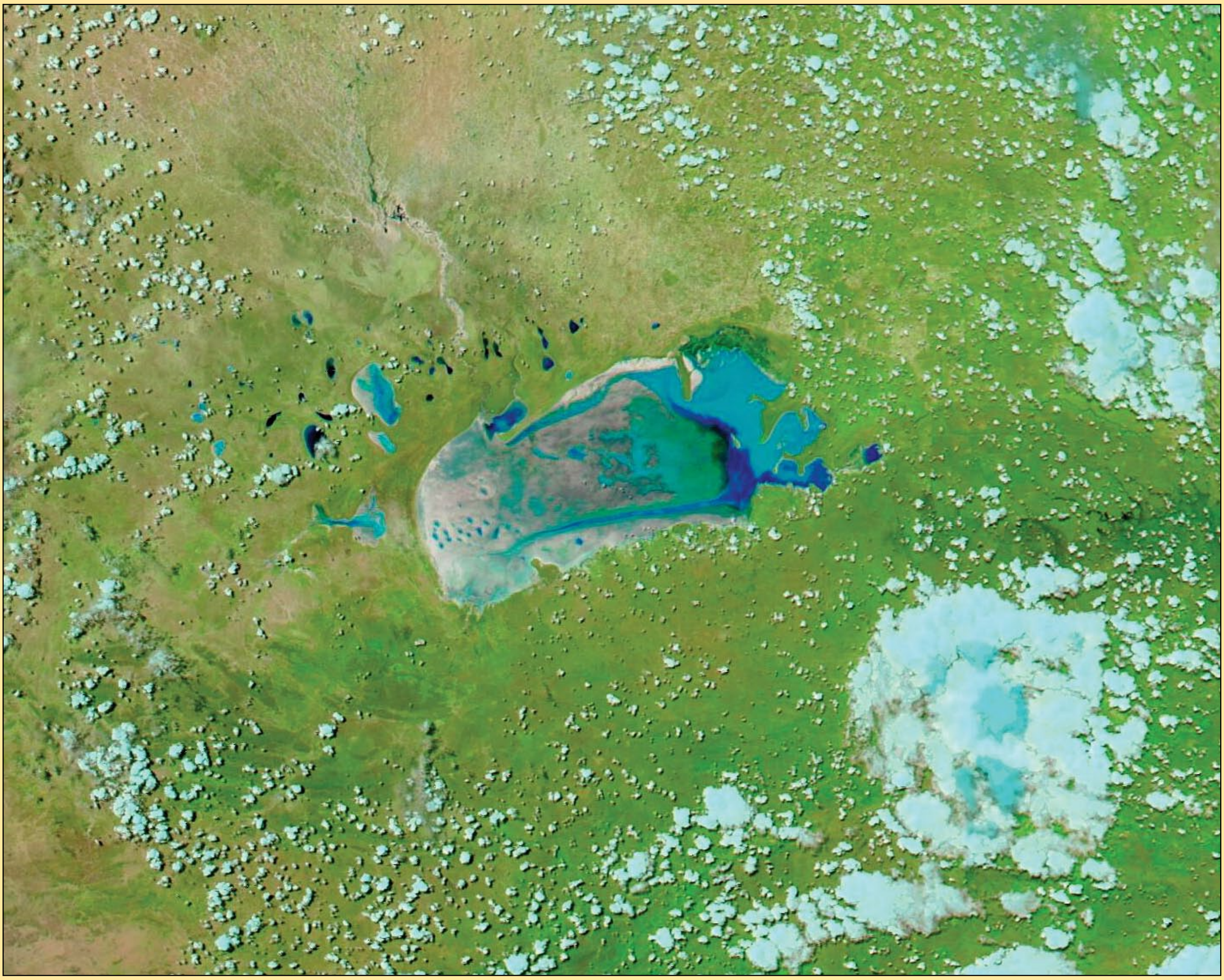
Reykjavík, the capital and largest city of Iceland, is located on the Seltjarnarnes Peninsula, in southwest Iceland. In the top-left of the image, several sea ice swirls can be seen off the coast of Greenland.

Sentinel-3 is a two-satellite mission to supply the coverage and data delivery needed for Europe's Copernicus environmental monitoring programme. Each satellite's instrument package includes an optical sensor to monitor changes in the colour of Earth's surfaces.

The Sentinel-3 missing acquired this image of Iceland on August 14 last year
Credit: image contains modified Copernicus Sentinel data (2020),
Processed by ESA, CC BY-SA 3.0 IGO

Water in the Etosha Pan

MODIS Image of the Day



This false colour MODIS image of the Etosha Pan, was acquired on February 19 by NASA's Terra satellite.
Credit: MODIS Land Rapid Response Team, NASA GSFC

The Etosha Pan in northern Namibia has been called an 'ephemeral wonder'. For much of the year the large salt pan is bone dry, and winds pick up its dust and salt and spread it across the arid landscape. But in years when the wet season brings abundant rains, the large, shallow basin stands out as a temporary oasis.

After an extended dry season, rains came to the region in early 2021, filling streams and rivers with enough water to reach the inland salt pan. According to news reports, parts of northeastern, central, and southern parts of Namibia saw rainfall double or triple the norm in January 2021. This followed a wet December, which brought about 25% more rain than normal. As of February 7, the wet season rainfall total was the highest since 2010 and 2011.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** satellite acquired this false-colour image of the Etosha pan on February 19. 2021. The image combines visible and near-infrared light (bands1,4,3) such that vegetation appears bright green and water is teal. Mineral salts appear white, except where they are moistened with water and may thus appear gray or light teal. Unvegetated land appears tan and high cloud, which contains ice or moisture, may be tinted with teal.

The Etosha Pan measures roughly 130 by 50 kilometres, though it is quite shallow. The basin is connected to hundreds of small streams and channels that start in Angola, but it takes a substantial amount of rain for water to move far enough through the system (seeping into the riverbeds along the way) to fill the pan. The most prominent tributary is the Ekuma River. Once that water arrives, the area becomes a haven for flamingos, pelicans, and other birds, as well as rhinos and impala.

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 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	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..