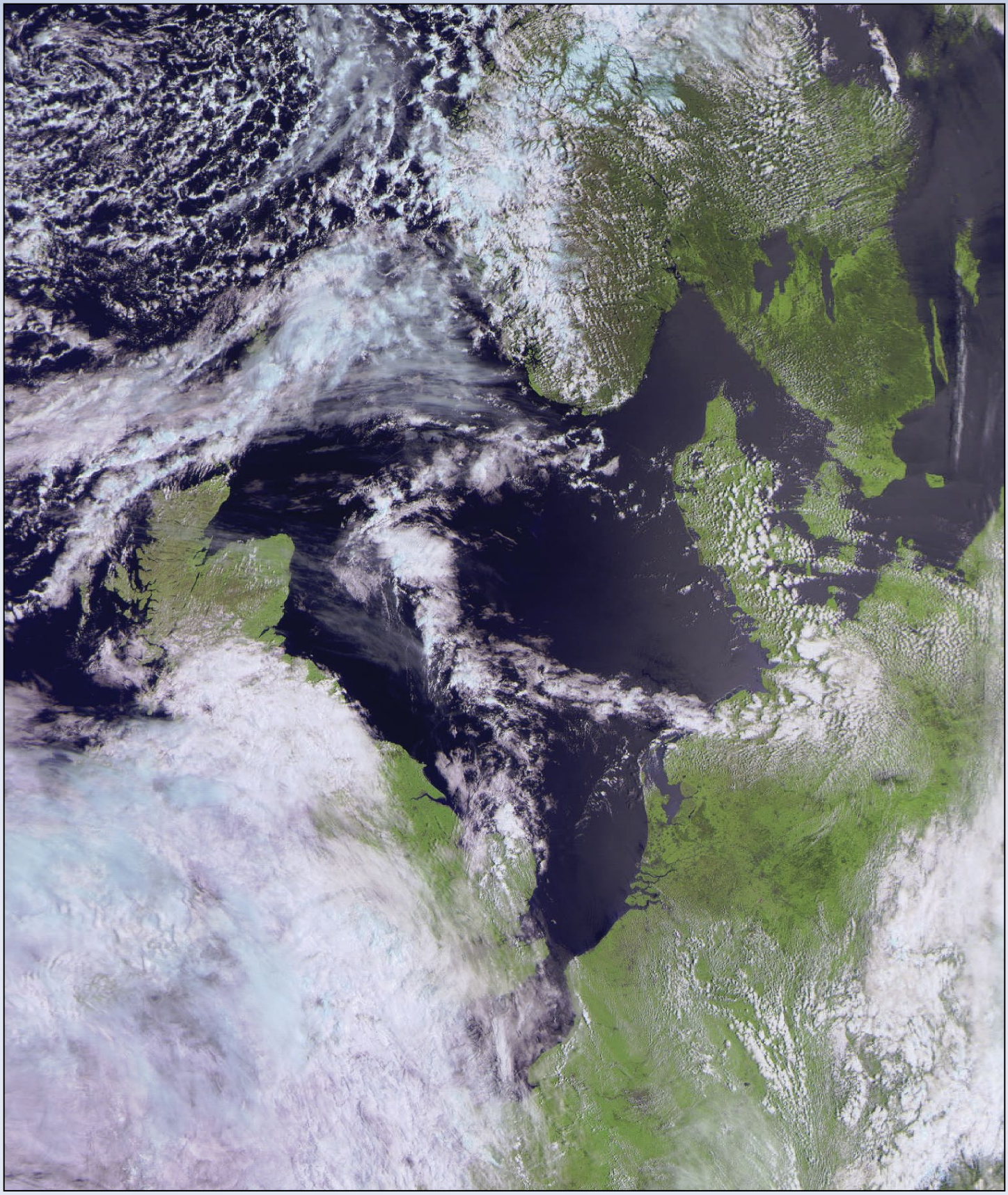
GEO Newsletter

Group for Earth Observation

Group for Earth Observation

No 62 - June 2019



A feature of this Meteor M2 image acquired on May 29, 2019 is a ring of cloud over the North Sea stretching from the south of Denmark, crossing the Dutch provinces of Groningen and Friesland, then looping round the North Sea before finally turning east, almost back to Jutland.

GEO MANAGEMENT TEAM

Director and Public Relations

Francis Bell,

Coturnix House, Rake Lane,

Milford, Godalming, Surrey GU8 5AB,

England.

Tel: 01483 416 897

email: francis@geo-web.org.uk

General Information

John Tellick,

email: information@geo-web.org.uk

GEO Newsletter Editor

Les Hamilton,

email: geoeditor@geo-web.org.uk

Technical Consultant (Hardware)

David Simmons

email: tech@geo-web.org.uk

Webmaster and Website Matters

Alan Banks,

e-mail: webmaster@geo-web.org.uk

Management Team

David Anderson

Rob Denton

Nigel Evans

Clive Finnis

Carol Finnis

Peter Green

David Simmons

David Taylor

The upper stage of the Fregat launcher, which will carry Meteor M 2-2 into orbit, arriving at the Vostochny Space Centre for testing prior to the July 5 launch.
Image: Roscosmos

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.yahoo.com/neo/groups/GEO-Subscribers/info

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GEO
Group for Earth Observation

and follow the dozens of links to NOAA, NASA, ESA, EUMETSAT and much more ...

Meteor M 2-2 launch on July 5

Following postponements, the launch of Russia's Meteor-M2-2 weather satellite is scheduled for July 5.

As with the ill-fated Meteor M 2-1, it will blast off aboard a Soyuz-2.1b carrier rocket with Fregat upper stage, from the Vostochny space center.

Let's hope lessons have been learned from the failure of the previous launch.

From the Editor

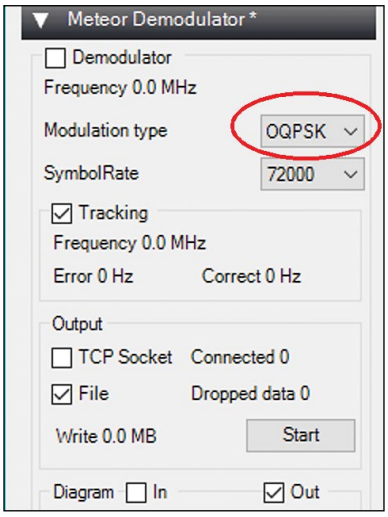
Les Hamilton

As this edition of the GEO Newsletter reaches you, expectations are high that we will soon have a new Earth orbiting weather satellite to monitor.

Roscosmos, Russia's State Corporation for Space Activities, is currently testing and assembling the satellite and its launcher at their far eastern Vostochny Space centre, located on the 51st parallel north in the Amur Oblast.

Regular readers will recall that Meteor M2-1, the intended successor to the current Meteor 2M—which continues to operate well almost five years following its successful launch in July 2014—was destroyed following a bungled launch operation in November 2017 (GEOQ No 57, page 8). If all goes well, this new satellite **Meteor M2-2** will be lifted into orbit on July 5 this year.

In almost all respects, the new satellite is a twin of the current Meteor M2, and offers identical LRPT image transmissions for the amateur community to capture and enjoy—**with one crucial exception**.



The modulation used by Meteor M2 in its LRPT transmissions is QPSK (quadrature phase-shift keying). The new Meteor will, however, use OQPSK (Offset QPSK) in its transmissions), and you will have to adjust your software accordingly.

Those of you using the *Meteor plugin* for S*DR Sharp* must change the **modulation type** to OQPSK, as illustrated in this diagram. Otherwise, you will be unable to decode the satellite's LRPT data stream into imagery.

Although there have been no reader contributions for articles in this issue, please remember that these are always welcome, by email, to the editor at

geoeditor@geo-web.org.uk

Contents

The GEO Report

Francis Bell

Dundee Satellite Receiving Station

Because I have a background of amateur radio interests, and a dedication to live signal reception, I have tended to focus my home satellite activities towards direct signal reception with appropriate dishes plus other antenna and dedicated receivers. However, I increasingly recognise that obtaining the same data and images can be achieved via Internet sites.

Occasionally in the past I have downloaded satellite images from Dundee University's Satellite Receiving Station, recognising the quality of their work and its availability to the public. Perhaps, being a little innocent, I never considered how the University financed this Earth observation program until recently, when I received, together with others, emails from the University indicating the financial uncertainty of continuing with their project. This news triggered a reaction from me.

My first email from Dundee indicated their need to generate finances to continue their project and it gave broad outlines of their future programme (details below). Also included in the email was a request for financial support to help them achieve a target of £65,000 of which an encouraging £7,200 had already been achieved as I compiled this report.

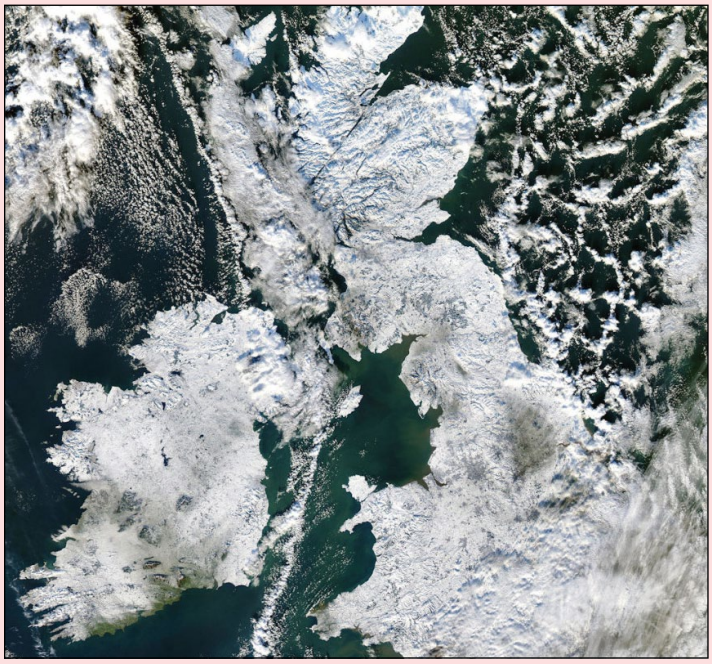
Personally, I was supportive of Dundee's initiative, and in the background recognised that GEO has reserve funds in the bank which could contribute to the Dundee project.

Most of the money that GEO has in the bank has been generated by the profits made over the years by the GEO 'Shop'. Our other income from annual membership subscriptions has almost exactly covered the cost of running the group with the major costs being the printing and distribution of our Quarterly publication.

I though it would be to everyone's benefit if GEO made a substantial donation to the Dundee fund, enabling them to continue with their Earth observation and climate programme.

I contacted the three past managers of our GEO Shop and they agreed with my idea of making a substantial donation to the Dundee project—with the qualification that the money would go towards the satellite project rather that just disappearing into the University's general funds.

From our previous *GEO Newsletter* you can see our accounts which show that our 'Shop' account has a balance of about £14,000. The amount of our donation to



Winter 2010-11 in the UK
Image: Dundee Satellite Receiving Station

Dundee is £5,000 and at the time of writing arrangements are being made to pay this money into an appropriate Dundee account: Scottish Charity Number SC015096.

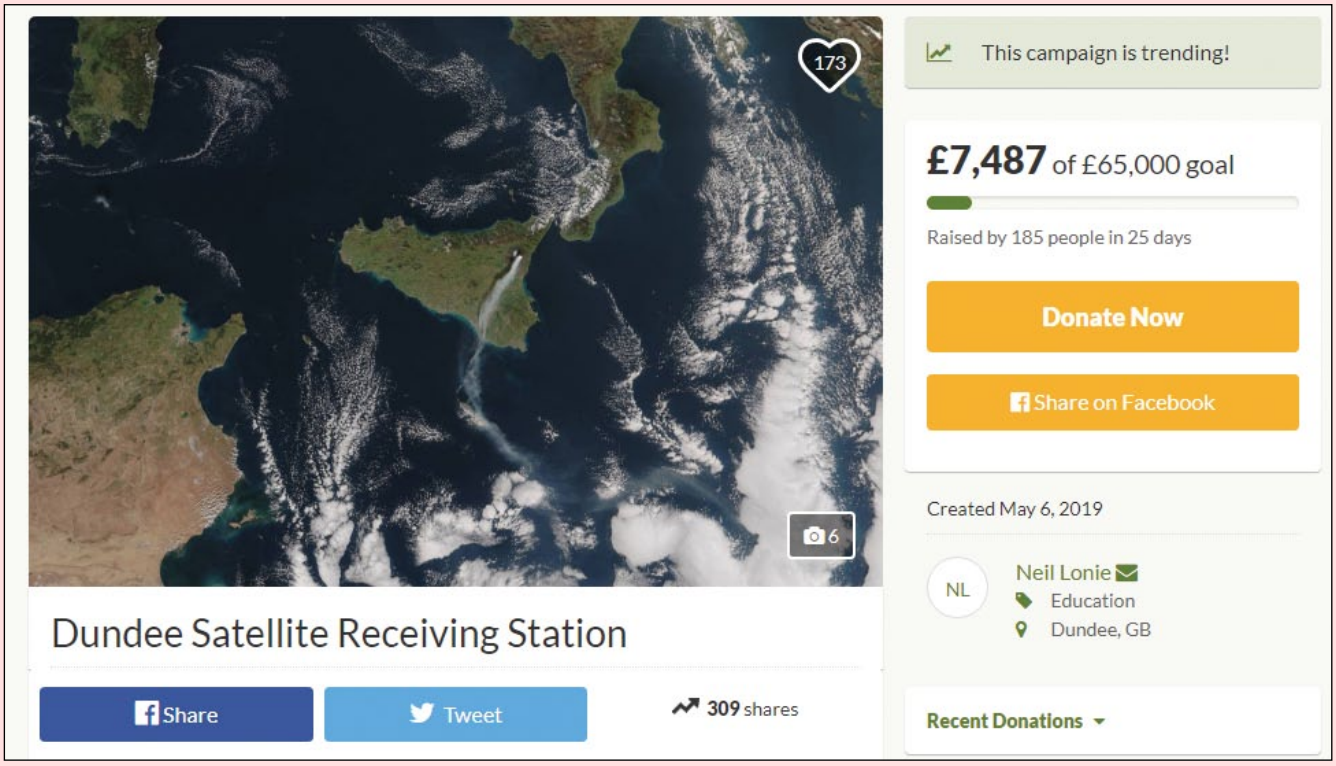
I offer my congratulations to GEO for agreeing to this donation and my best wishes go to Dundee for their satellite, Earth observation and climate projects.

Below are some notes from Dundee University explaining their programme.

From its inception in the late 1960s until 1978, the University students and faculty funded the station. From 1978 to date, the DSRS has received public funding to provide this invaluable service. However, on 1st April 2019, this funding was stopped and there is no plan for an equivalent service. We are now seeking alternative financial backing to not only continue the operations, but to launch the next weather-climate 'mission'. We see this as an opportunity to "reboot" the Station and engage yet more with the public, while we continue to work with, and support, the efforts of climate change scientists in the UK and worldwide. We are now seeking funding to:

1. Continue collection operations using the experienced staff to extend the 40+ year unbroken record of environmental data.
2. Upgrade existing infrastructure and extend capability to acquire data from new and more sophisticated satellites, thus launching the DSRS onto its next

Visit: http://www.sat.dundee.ac.uk/ or http://www.sat.dundee.ac.uk/future.php



Dundee Satellite Receiving Station's crowdfunding web page (imaged prior to the GEO donation)

mission, "The Mission to Planet Earth II", honouring the original NASA mission of the late 1990s.

3 Improve the website and enhance public ease of access and use, strengthen the our international educational and outreach focus, and become mobile-friendly with equivalent facilities available "on the move" to make our data even more accessible.

4 Guarantee the existence of a civilian facility that has a philosophy of free information, if at all possible, for everyone around the world when it comes to weather.

5 All funds raised will be specifically for the DSRS operating fund and used to pay for the objectives listed above.

6 Any funds raised will be withdrawn and presented to a specific DSRS account maintained by the Univ. of Dundee, Scotland, a Scottish Registered Charity, No. SC015096.

You can learn more about Dunde Satellite Receiving Station by visiting the following links:

http://www.sat.dundee.ac.uk/
http://www.sat.dundee.ac.uk/future.php

Crowdfunding Initiative

New fund raising efforts are under way, including a crowd-funding opportunity through which donations towards Dundee Satellite Receiving Station are very welcome. For more information please visit

https://www.gofundme.com/
dundee-satellite-receiving-station

GEO Visit to Darmstadt

I was very disappointed having to cancel our proposed visit to Darmstadt this summer but with only eight people having registered I thought this was the only realistic option. I believe some of the EUMETSAT staff were also disappointed with our cancellation. However, subsequent feedback from some of our members has revealed that many more were planning to join the Darmstadt visit but had not registered in time. I particularly express my disappointment to those members who did actually register for our visit and I hope the cancellation has not excessively disrupted their plans for this summer.

With appropriate support, perhaps it will be possible to have the visit to EUMETSAT, ESOC and Usingen next year. Perhaps with improved internal communications within GEO we will be able to keep in touch with each other more easily hence avoiding the recent cancellation. I know we have the YAHOO GEO-Subscribers group but something more personal may sometimes be appropriate.

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http://www.facebook.com/groupforearthobservation

Visit: http://www.sat.dundee.ac.uk/ or http://www.sat.dundee.ac.uk/future.php

Quarterly Question

Francis Bell

My thanks to those readers who emailed me with the answer to the last Quarterly Question which related to a satellite image of a group of islands in the Atlantic Ocean. I think the question was straightforward because several towns were mentioned in the accompanying text, so although the islands did not have particularly special outlines, the towns should have led to the identification of the island group which was: The Azores.

Figure 1 - A remote Pacific island

Quarterly Question 62

This Quarterly Question relates to the island image shown in figure 1. The previous Quarterly Question also related to an island group and seemed to generate readers' interest, so it seemed appropriate to have a further island question this issue.

The Descriptive Text below, which I have edited a little, accompanied the image which I downloaded from ESA, and should help to identify the island in question. The reference to a volcano—which is named—should also help to identify the island: the scale can be judged from the long runway of the airport which can be seen enlarged in figure 2 overleaf.

The question is straightforward: name the island shown in the satellite image and quote its latitude/longitude to the nearest whole degree. Also, state which country currently claims sovereignty over this island. Answers by email to Francis Bell at this address:

francis@francisbell.com

by August 25, 2019.

Also mention if you have ever visited this island. I believe I know of one GEO member who has been there!

Descriptive Text

This Copernicus Sentinel-2 image was taken over one of the most remote islands in the world. The island is located in the Pacific Ocean, over 3500 kilometres from any mainland. The island was given its current name by the Europeans who arrived there in the 1700s.

The island is famous for its monolithic stone statues, called Moai, said to honour the memory of the original inhabitants' ancestors. There are nearly 1000 scattered

around the island, usually positioned near fresh water. Many are located near the Rano Raraku volcano, on the southeast coast. The white edges along the southern coast show the harsh waves colliding with the shore.

An interesting feature of the image is the ochre-orange colour of the Poike—the peninsula on the eastern end of the island. In ancient times, it is said that there was a lot of vegetation on the island. However, land clearing for cultivation and rats played a role in deforestation, leading to the erosion of the soil, particularly in the east.

Several reforestation projects have been attempted, including a eucalyptus plantation in the middle of the island, visible in dark green. The brown patch to the right of the plantation is likely to be a burn scar from a wildfire.

The majority of the island's inhabitants live in the main town with its harbour on the west coast, clearly visible in the image. Interestingly, the long runway of the island's only airport, located on the south west of the island with an approach over the sea, was once designated as an emergency landing site for the US Space Shuttle.

At the very edge of the southwest tip of the island lies Ranu Kao, the largest volcano on the island. Its shape is distinctive owing to its crater lake, one of the island's only three natural bodies of water.

Figure 2 - A close-up image of the airport

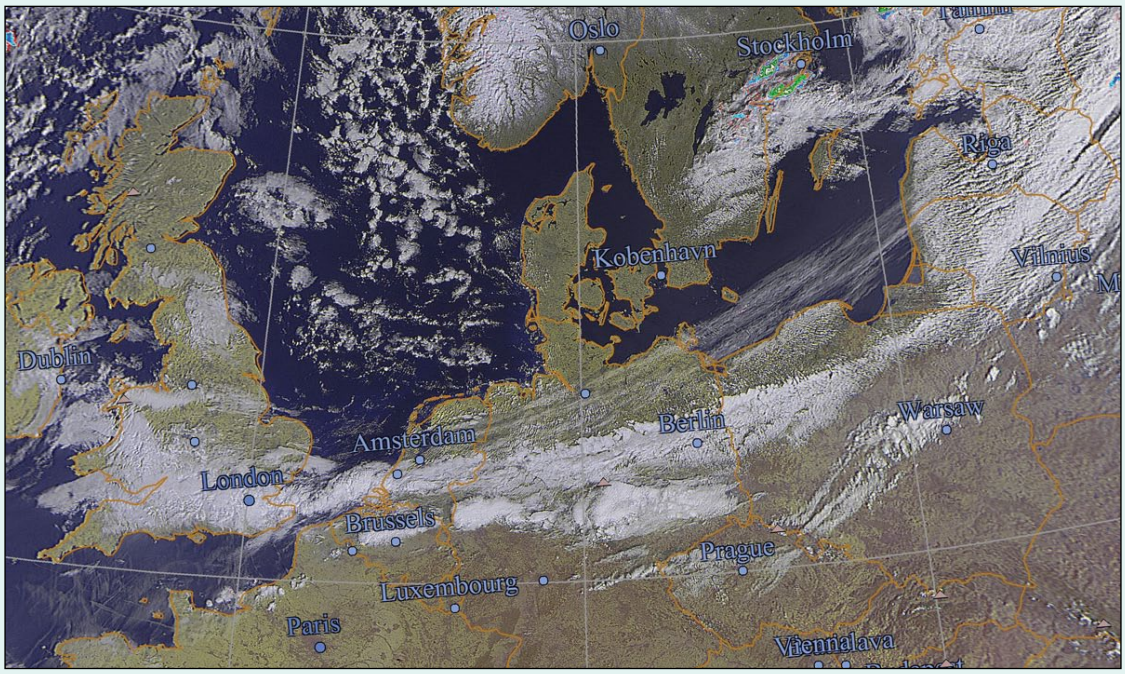
Many tourists are drawn to the island for its mysterious history and isolated position. What is relatively unknown is the existence of two small beaches on the northeast coast. Anakena beach has white, coral sand, while the smaller Ovahe beach, surrounded by cliffs, has pink sand.

A New QFH Antenna Design

Joachim Scharrer was in touch recently to say that he had just constructed a new QFH-Antenna following a design by a Norwegian, Børre Ludvigsen. The design is an adaptation of the 135 MHz QFH described in 'Taming the QFH' by Bill Sykes and Bob Cobey' in the March 1997 RIG Journal. Børre's detailed construction guide can be visited at

http://abdallah.hiof.no/QFH/

The illustrations show Joachim's new QFH antenna, and part of the first Meteor M2 image he received using it on March 31 this year.



Savage South Georgia

NASA Earth Observatory

More than two centuries ago, Captain James Cook sailed around the Antarctic circle searching for the Southern Continent. Instead, he landed on an isolated island about 1,300 kilometres southeast of the Falkland Islands in the Southern Ocean. He became the first recorded explorer on the remote island, which he claimed for Great Britain and named the 'Isle of Georgia' for King George III.

But the island was 'savage', according to Cook. As he described in a manuscript,

> *'Pieces were continually breaking off, and floating out to sea; and a great fall happened while we were in the bay, which made a noise like a cannon. The inner parts of the country were not less savage and horrible.'*

Cook began mapping the coastline, but did not bring the ship into the island due to the dangerous conditions.

South Georgia is still known for its rugged terrain and inhospitable environment. The island has eleven peaks rising more than 2,000 metres above sea level. The mountains shield the north and east coasts from prevailing winds blowing from the Southern Ocean and Antarctica. The island also supports 161 glaciers, several of which are in retreat.

All of the images on this page were acquired by the Operational Land Imager (OLI) on *Landsat 8* on December 25, 2018. Figure 1 shows a clear view of South Georgia and the South Sandwich Islands.

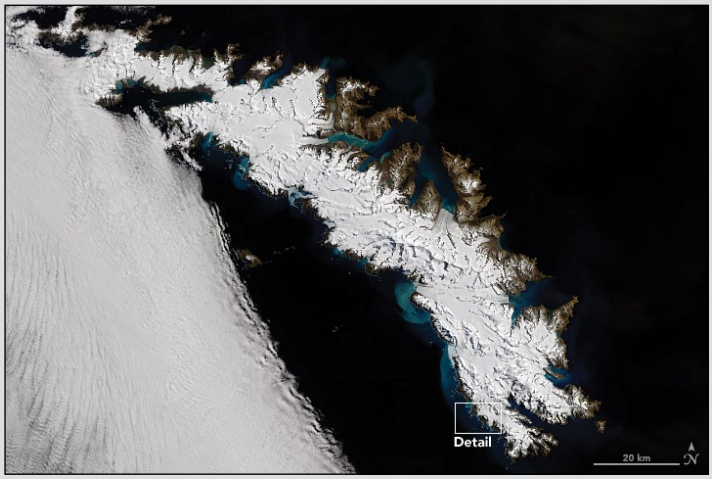


Figure 1 - South Georgia Island

Figure 2 gives a sense of the topography by overlaying the Landsat data over a digital elevation model from the Shuttle Radar Topography Mission (SRTM). The Novosilski and Brøgger Glacier are approximately 13 km and 11 km long, respectively.

Figure 2 - South Georgia Island

South Georgia provides a unique ecosystem for wildlife: its waters are highly productive, supporting large populations of krill, which feed on phytoplankton and provide food for many marine predators. The steep terrain above and below the water line includes deep bays that shelter substantial populations of penguins, seals, and the globally threatened wandering albatross. Scientists have collected more than 30 years of population data on seabirds and marine mammals at South Georgia—one of the longest and most detailed scientific datasets in the Southern Ocean.

Figure 3 shows the southern tip of the island (detail box on figure 1). The discoloured water near the shore is possibly due to phytoplankton blooms or sediments from the island mixing into the sea. The southernmost point has the quirky name 'Cape Disappointment', a label given by Cook when he realised he had not reached a southern continent.

NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey, and topographic data from the Shuttle Radar Topography Mission (SRTM). Story by Kasha Patel.

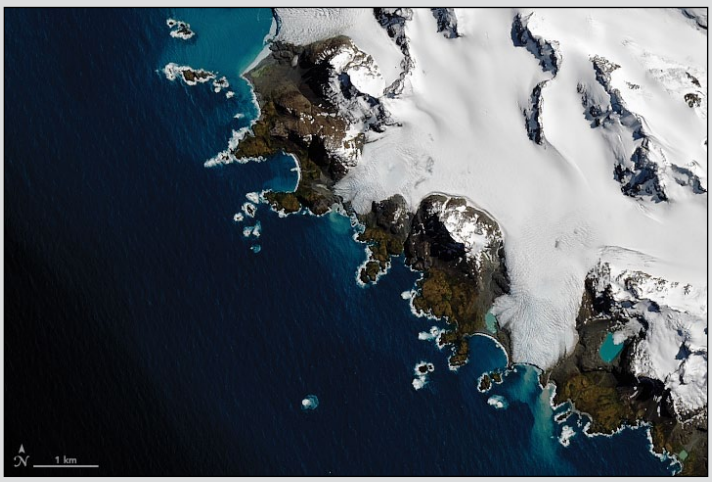


Figure 3 - Detail from the southern tip of South Georgia Island

GEO Outreach

Visit to the South London Amateur Radio and Computer Group

Francis Bell G7CND

The GEO stand preparing to receive visitors. On the left is David Simmons G1MAL tuning in his SDR dongle and on the right Robert Coombes G4ZEJ connecting the coax cable from his dish positioned in the car park to the radio receiver and computer on the stand.

GEO recently attended its first rally of the year. This rally was organised by the South London Amateur Radio and Computer Group with the venue being Kempton Park West London.

We have attended this rally for many years and always found it worthwhile because of the opportunity it provides to keep in touch with local GEO members and to meet interested members of the general public with our demonstrations of weather satellite reception which can be achieved at home or in interested schools.

Our stand, see the photographs, had four computers demonstrating libraries of pre-recorded images as well as live reception of radio signals in the aircraft band using the same SDR dongle which is used for 137 MHz reception of polar orbiting satellites. A bonus at this rally was the live reception of EUMETCast images. Robert Coombes had brought his tripod mounted 85 cm dish and placed it in the car park just outside the exhibition area with a coax cable running directly to our stand. The resulting displayed live images suitably impressed visitors to our stand.

Robert Coombs' s 85 cm. dish photographed in his garden but used at the Kempton rally for live reception of EUMETCast images. Correct focus and direction are essential but the modest size and portability of the dish should encourage anyone considering their own home reception of EUMETCast.

Literature explaining weather satellite reception was available on the stand together with some of our remaining past copies of the GEO Quarterly. As usual, our literature was well received by those visiting our stand.

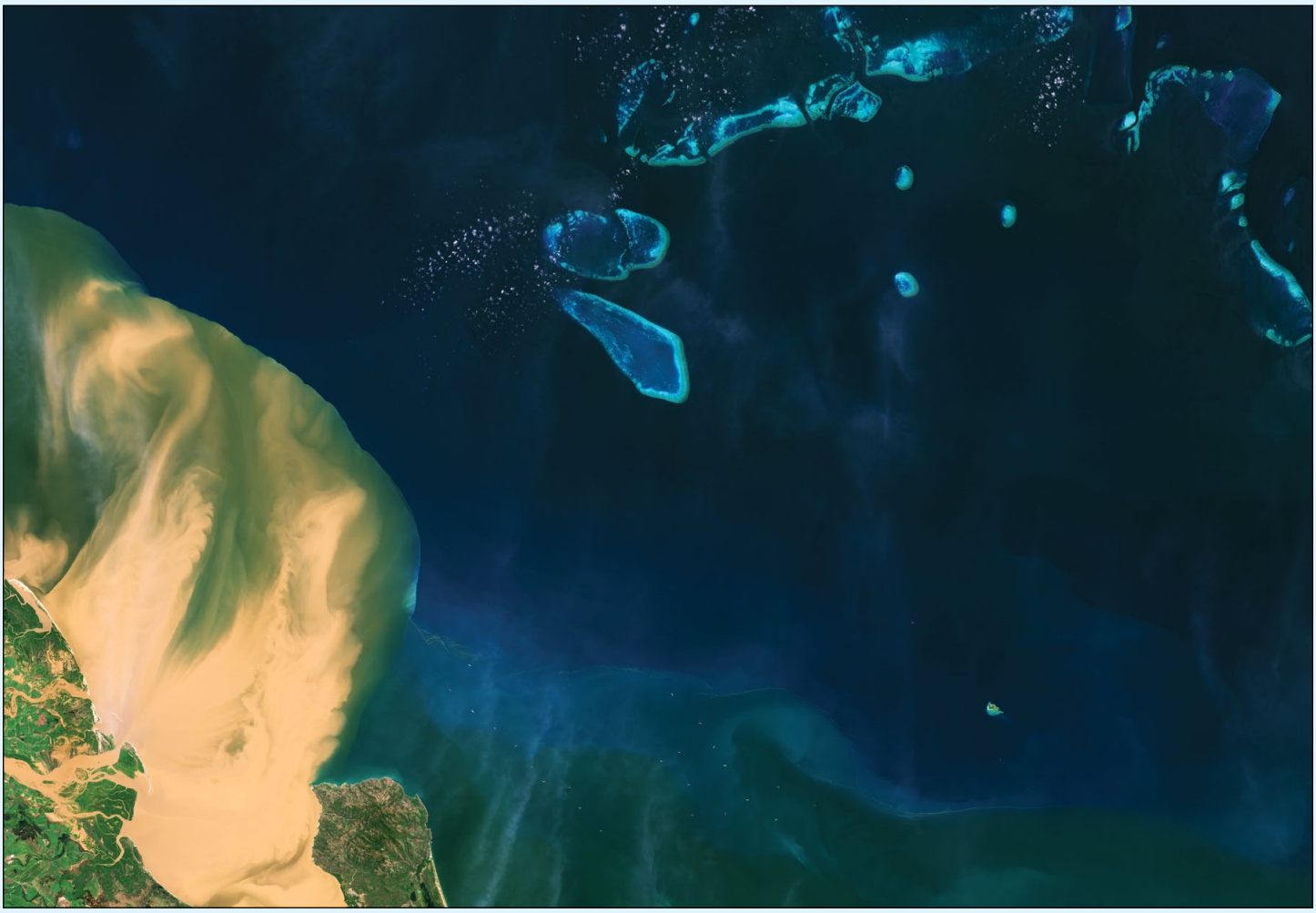
Further planned events for this year include the 'Spacelink' school conference at Farncombe, Surrey and the amateur radio rally at Newbury on 23rd June 2019.

If any member has a local event where they think it may be appropriate to have a GEO stand, then please get in touch with me for possible help.

This photograph shows some visitors to our stand examining literature and enjoying watching live EUMETCast images.

Queensland Floods

European Space Agency



The Burdekin River pouring sediment into the Coral Sea following torrential rains.
Copyright contains modified Copernicus Sentinel data (2019), processed by ESA, CC BY-SA 3.0 IGO

The Copernicus Sentinel-2 mission takes us over Queensland, Australia's northeast state, where a large amount of sediment is visible gushing into the Coral Sea, close to the Great Barrier Reef lagoon. In early 2019, many areas in Queensland received more than their annual rainfall in less than a week. The downpour led to millions of dollars' worth of damage, including homes being destroyed and the loss of almost 500 000 cattle.

This image was captured a few days after the torrential rain, and shows the muddy waters flowing from the Burdekin River into the Coral Sea. The Burdekin River rises on the northern slopes of Boulder Mountain and flows close to 900 kilometres before emptying into the Coral Sea. Burdekin River is one of Australia's larger rivers by discharge volume, and is a major contributor of sediment and freshwater to the Great Barrier Reef lagoon.

The Great Barrier Reef, the world's largest coral reef, extends for 2000 kilometres along the northeast coast of Australia and covers almost 350 000 square kilometres. The reef is an interlinked system of about 3000 reefs and 900 coral islands, divided by narrow passages. An important area of biodiversity, the reef became a UNESCO World Heritage Site in 1981.

The sand-coloured sediment plume can be seen stretching over 35 km from the coast, dangerously close to the vivid turquoise reef. The blues of the coral contrast with the dark-coloured waters of the Coral Sea.

The reef suffers regular damage, more than half of it having disappeared over the past 30 years owing to climate change, coral bleaching and pollution. Large quantities of sediment that flow out from rivers carry chemicals and fertilisers from inland farms. The sediment blankets the coral, and reduces the amount of light, as well as potentially causing harmful algal blooms.

Data from Copernicus Sentinel-2 plays a key role in providing information on pollution in lakes and coastal waters. Frequent coverage is also fundamental to monitoring floods. Copernicus Sentinel-2 is a two-satellite mission, each satellite carrying a high-resolution camera that images Earth's surface in 13 spectral bands.

A Break in the Clouds for Europe

NASA Earth Observatory

If you look at global maps of cloudiness or sun duration, you will notice that Europe stands out as being one of the cloudiest continents. Aside from relatively sunny Spain and Portugal, clouds regularly darken skies across the rest of the continent, particularly in the winter when the jet stream often steers storm systems directly toward western Europe.

So the bout of unusually clear days and nights in late February 2019 most likely came as a welcome change in atmospheric scenery. With a strong high pressure system hanging over Europe, skies were remarkably clear between February 23 - 27, a period when temperatures soared. Weather stations in England, Scotland, the Netherlands, and Sweden have all measured record-breaking temperatures for this time of year.

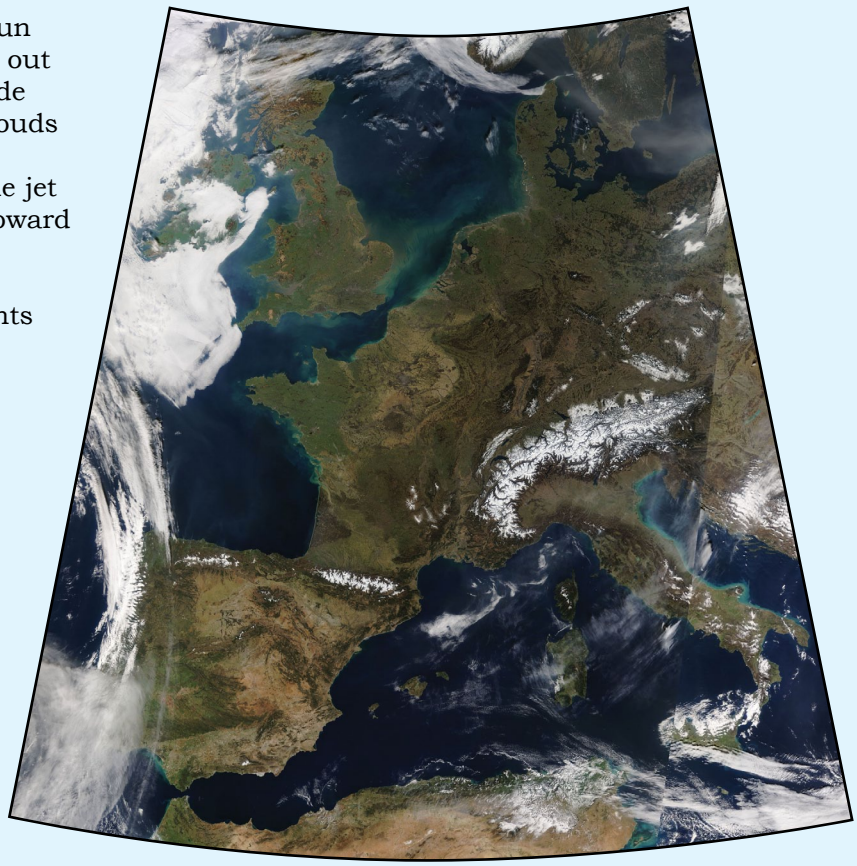


Figure 1 - Daytime image

The daytime and nighttime satellite images opposite highlight the many contrasting features of the land surface, features that are often obscured by clouds. In the daytime image (figure 1), acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's *Terra* satellite, some of the most prominent patterns relate to farming. Areas with high concentrations of croplands and few forests, most notably in France and Spain, have a light brown colour for winter; more densely forested areas appear darker green.

The warmth and moisture of the oceanic climate of the United Kingdom, northern France, Belgium, and the Netherlands means vegetation in those countries maintains a healthy green colour throughout the winter. In the colder, drier continental climate of central and eastern Europe, vegetation—aside from evergreen forests—withers and browns during winter. Aside from the snow-covered heights of the Alps and Pyrenees mountains, the warm weather this winter kept most of the continent free of snow.

Figure 2 - Night image

By revealing the locations of cities, the nighttime image (figure 2) underscores the human footprint on the landscape. Madrid, London, Paris, and Berlin—all capital cities—also stand out as the brightest ones in their respective countries. Note that thin cloud cover has diffused some of the light from cities in central Europe, making several appear

abnormally bright. The image was acquired by the Visible Infrared Imaging Radiometer Suite (VIIRS) on the *Suomi NPP* satellite.

As shown in the cloud probability map (right), it is usually quite cloudy in western and central Europe during late February. The map shows average cloudiness since 1999 as observed by MODIS for seven days before and after February 27 each year since 1999.

Credit

NASA Earth Observatory images by Joshua Stevens, using data from the Level 1 and Atmospheres Active Distribution System (LAADS), the Land Atmosphere Near real-time Capability for EOS (LANCE), NASA EOSDIS/LANCE and GIBS/ Worldview, and VIIRS day-night band data from the Suomi National Polar-orbiting Partnership.

Story by Adam Voiland.

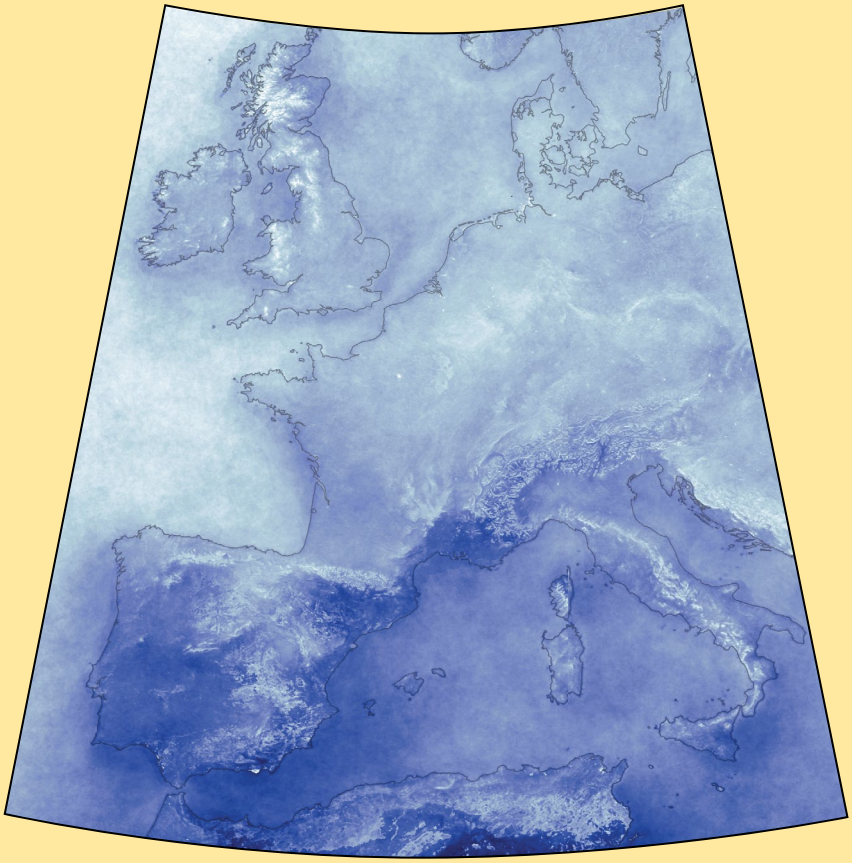
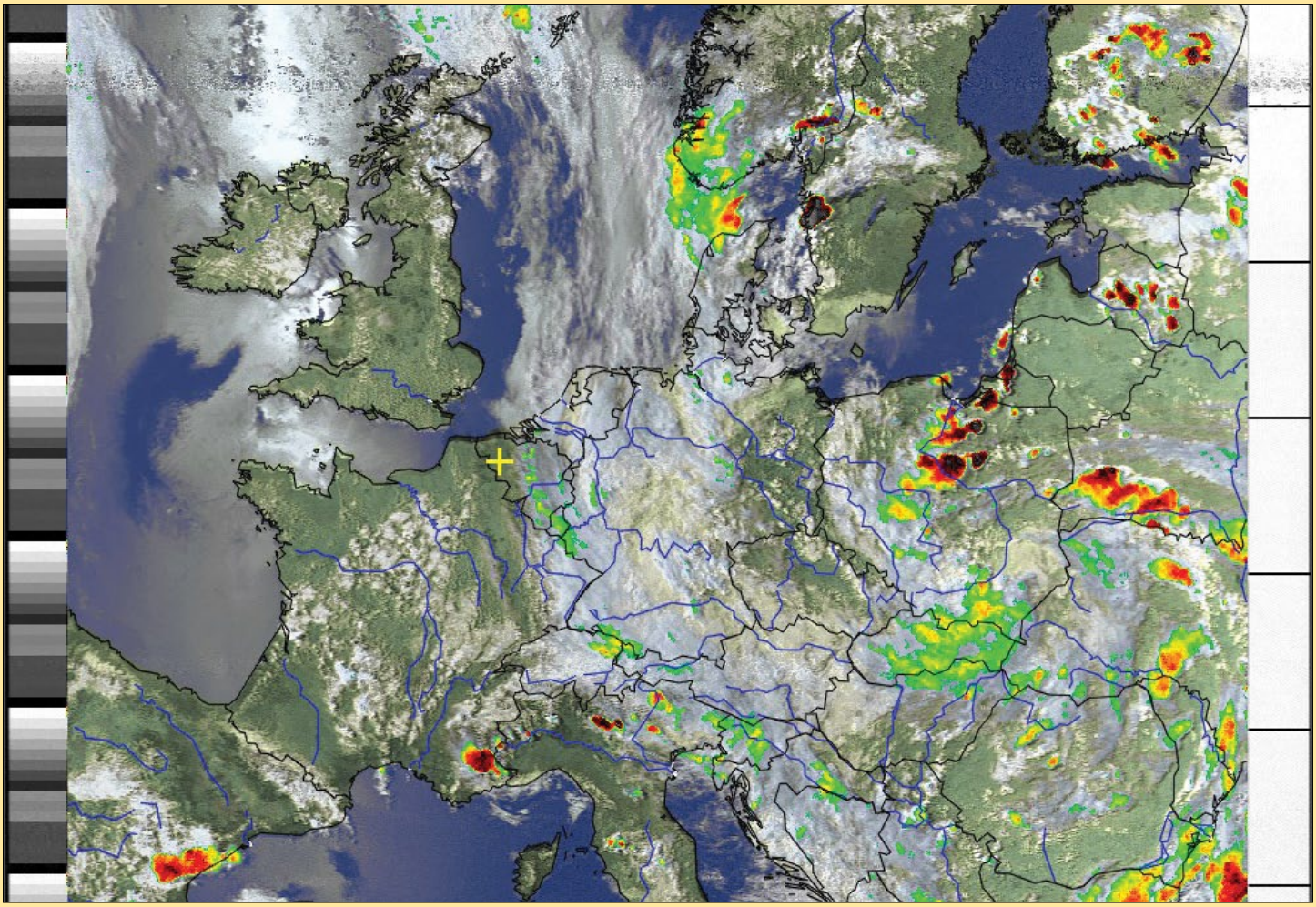


Figure 3 - Cumulative cloudiness map, 1999-2019



André T'Kindt J010TR submitted this NOAA 19 APT image acquired at 17:24 UT on May 21, 2019. It was captured using a turnstile antenna and preamp and processed in WXtoImg using its *HVCT with precipitation* mode.

Ash and Snow at Shiveluch

NASA Earth Observatory

For about 30 minutes on April 10, 2019, the ever-restless Shiveluch volcano on the Kamchatka Peninsula lofted a plume of volcanic gas and ash some 8 kilometres into the chilly Siberian air. For about thirteen hours the plume drifted south - enough time for scientists using satellites like Japan's Himawari 8 and the European Space Agency's Sentinels-2 and -3 to get a good look at it.

Though the airborne plume was short-lived, the eruption left an unmistakable signature on the snow below. The day after the eruption, several satellites captured natural-colour images of a trail of ash extending south for 220 kilometres. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's *Aqua* satellite acquired figure 1 on April 19, 2019, ten days after the eruption.

In the winter months, ash-coloured snow is a common sight on the Kamchatka Peninsula, one of the most volcanically active parcels of land in the world with 29 active volcanoes. As recently as March 2019, ash tracks from the simultaneous eruptions of two volcanoes attracted some media attention. In that case, fresh snow covered up the ash within a few days.

On April 19, 2019, the Operational Land Imager (OLI) on Landsat 8 acquired a detailed view of the volcano (figure 2). What appears to be a small plume of steam and other volcanic gases is rising from the summit.

The volcanoes of Kamchatka are defined by their inaccessibility. Fewer than 350,000 people live on the peninsula, mostly in Petropavlovsk-Kamchatsky. There are few roads, and helicopters are the only way to get around in many areas. As a result, the logistical challenges associated with installing and maintaining ground-based sensors make satellites a necessity for monitoring Kamchatka's volcanoes.

Story by Adam Voiland, with fact checking by Janine Krippner (Smithsonian Institution Global Volcanism Program).

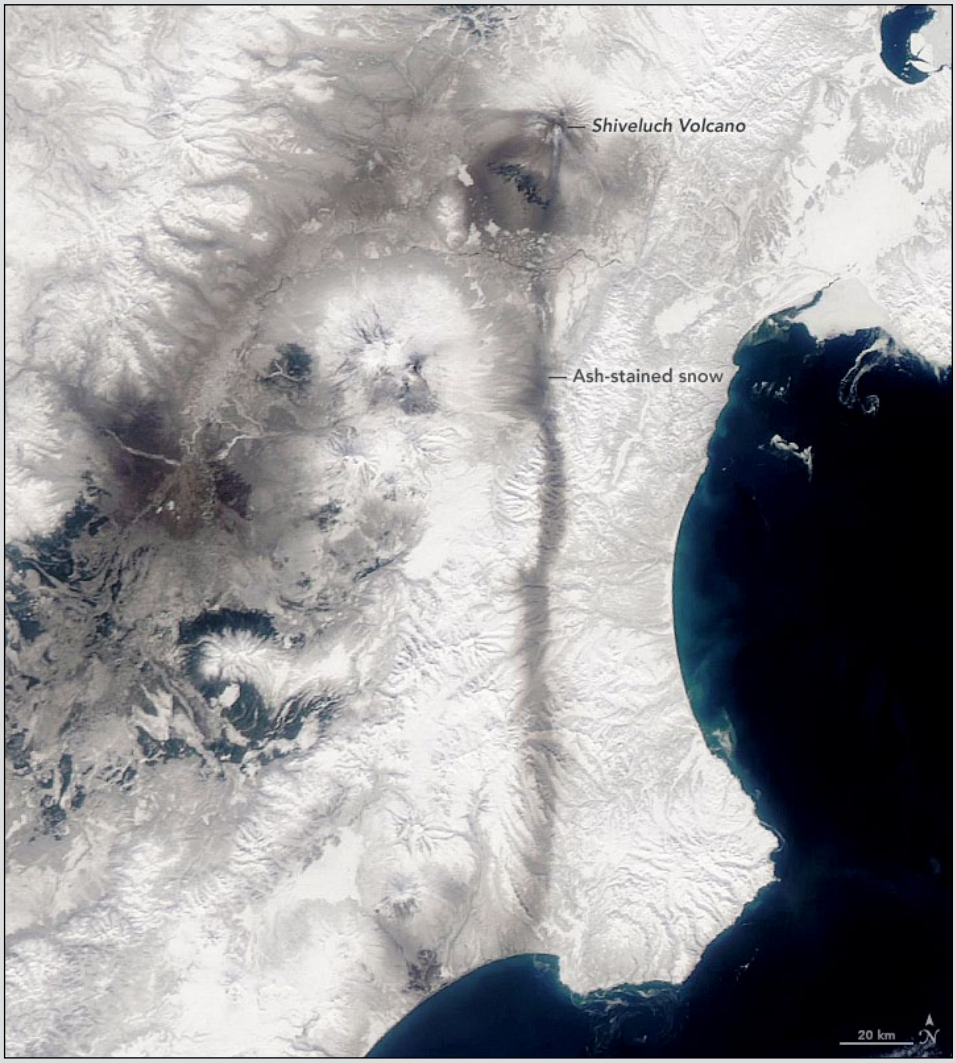


Figure 1 - Shiveluch smoke plume captured by NASA's Aqua satellite
NASA Earth Observatory image by Lauren Dauphin, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview.

Figure 2 - Shiveluch steam plume captured by Landsat-8 on April 19, 2019
NASA Earth Observatory image by Lauren Dauphin, using Landsat data from the USGS

Lithium Harvesting at Salar de Uyuni

NASA Earth Observatory

Forty thousand years ago, a large lake spread across southwestern Bolivia. When it eventually dried up, the salt-encrusted landscape of **Salar de Uyuni** remained. Covering more than 10,000 square kilometres, it is the largest salt pan in the world.

The spectacularly flat surface and mirror-like qualities during the wet season have turned Salar de Uyuni into a big draw for tourists and, periodically, racing enthusiasts. Meanwhile, geologists think the mineral-rich, blue-green brine beneath the salt crust contains the world's second-largest deposit of lithium, a valuable metal used to make rechargeable batteries. The US Geological Survey estimates that Bolivia holds about 15% of the world's reserves of lithium.

And yet just a small fraction of it gets mined and used. Unlike neighbouring Chile and Argentina, Bolivia is not among the world's top lithium producers. Yet with global demand for lithium rising, Bolivian leaders are trying hard to change this. The government began investing in a lithium mining operation at Salar de Uyuni about a decade ago.

Landsat satellites began to detect evidence of buildings and evaporation ponds in the southern end of the salt flat in 2011. The Operational Land Imager (OLI) on Landsat 8 acquired figure 2 on April 12, 2013. Now, nearly six years later, the size of the facility has grown significantly, as illustrated in figure 3, acquired earlier this year.

Wells tap into lithium-rich brine beneath the surface and pump it into rectangular evaporation pools fitted with plastic liners, where sunshine and wind separate out lithium, salt, and other substances through evaporation. Brine usually remains in the pools for about six months. The lithium bearing minerals are eventually transported for processing at a facility in nearby Rio Grande.

There are some big challenges associated with harvesting Salar de Uyuni's lithium. Relatively rainy and cool weather means it takes longer for brine to evaporate there than at other lithium mining operations in the region. Also, Uyuni's brine has unusually high concentrations of magnesium and potassium that have to be removed, making the process more expensive.

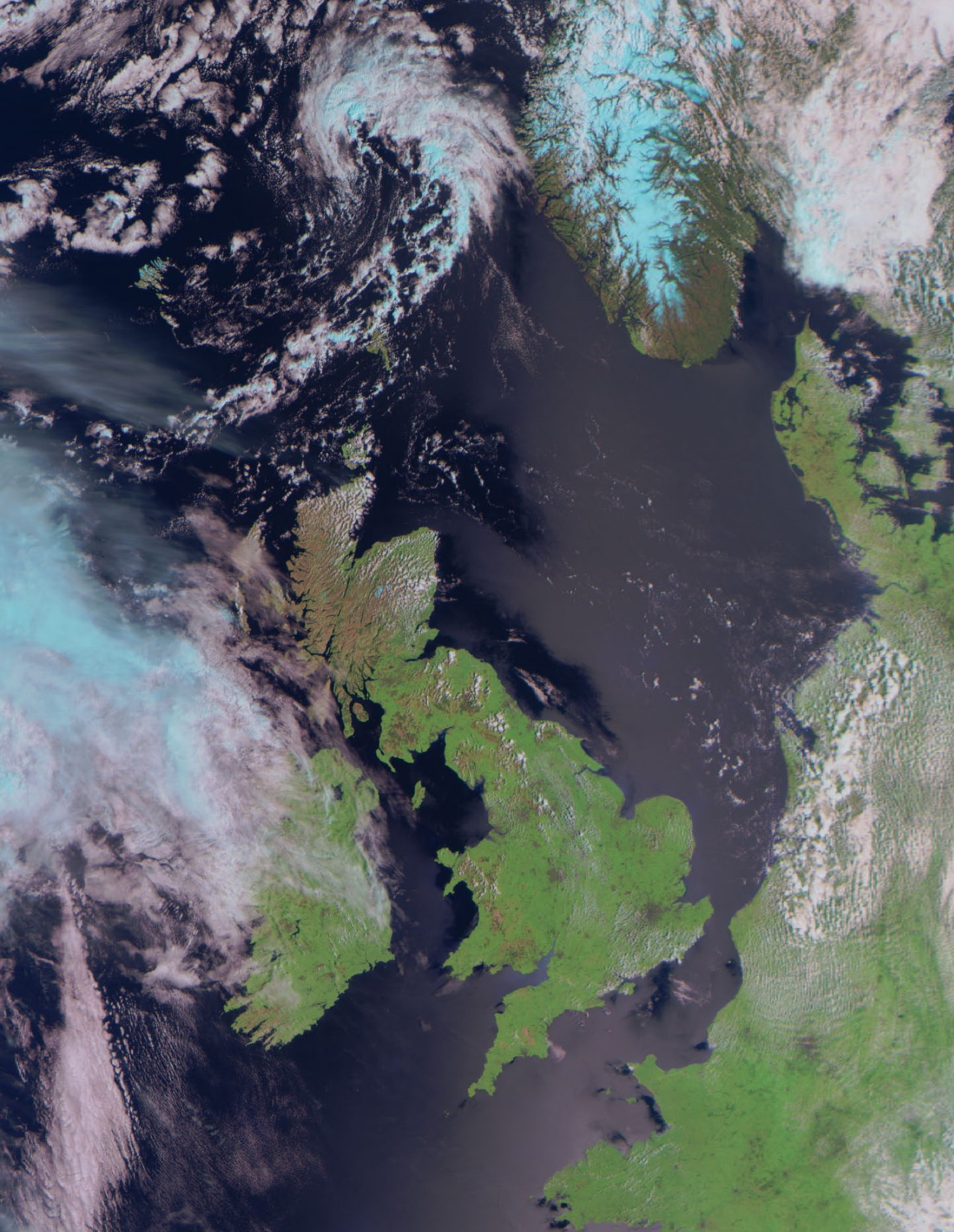
In addition to tourists and lithium miners, Salar de Uyuni attracts Earth scientists. Though the surface looks perfectly flat, it has just enough of a grade in certain areas that scientists consider it to be one of the best places in the world for calibrating satellite altimeters, instruments designed to measure the elevation of land surfaces.

NASA Earth Observatory images by Lauren Dauphin, using Landsat data from the US Geological Survey. Story by Adam Voiland.

Figure 1 - This Landsat-8 image shows the location of the lithium extraction operations near the south of Salar de Uyuni

Figure 2 - This Landsat-8 image was acquired on April 12, 2013

Figure 3 - This Landsat-8 image was acquired on January 7, 2019



After a depressing spring, with cold Arctic winds keeping the temperature down for weeks on end, came the first signs of summer.
This Meteor M2 image, in RGB123 mode, acquired on May 12, shows the British Isles at last shaking off winter and heading for warmer times.

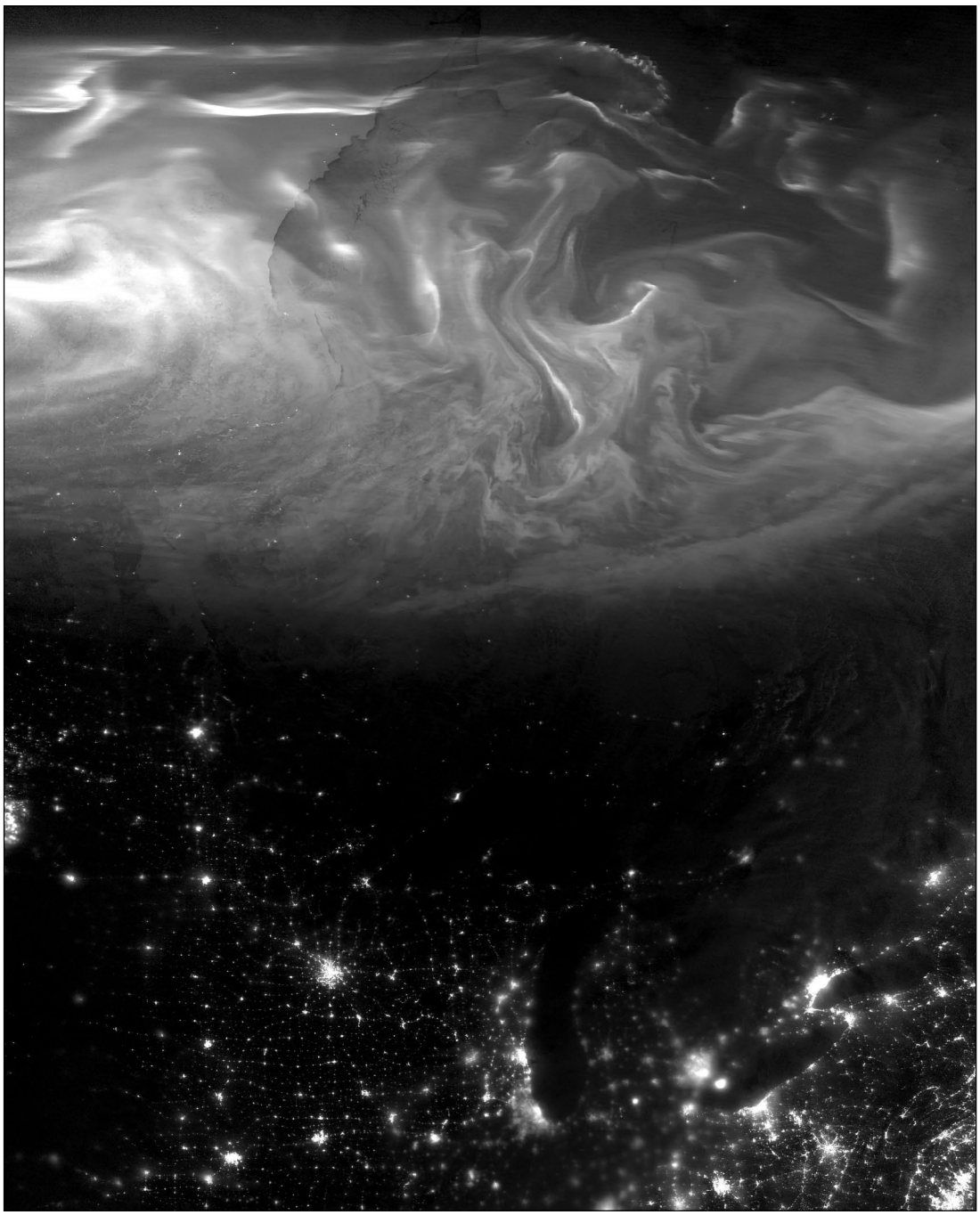
Dazzling Spring Aurora over Hudson Bay

NASA Earth Observatory

On March 28, 2019, a stunning aurora borealis developed over the Hudson Bay region of Canada, and the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite acquired this night time image of the dancing lights.

VIIRS has 'day-night band' that detects city lights and other night time signals such as auroras, airglow, and reflected moonlight. In this image, the sensor detected the visible light emissions that occurred when energetic particles raining down from Earth's magnetosphere interacted with the gases of the upper atmosphere.

The creation of an aurora typically starts when the Sun sends a surge of charged particles—through solar flares, coronal mass ejections, or an active solar wind—towards Earth. This surge disturbs Earth's magnetosphere, the surrounding region of space protected by the planet's magnetic field. The solar particles collide with the magnetosphere and compress it, changing the configuration of Earth's magnetic field lines (such as their shape and direction). Some particles trapped along the magnetic field lines are accelerated into Earth's upper atmosphere where they excite nitrogen and oxygen molecules, causing the release photons of light photons, which are observed as the aurora.



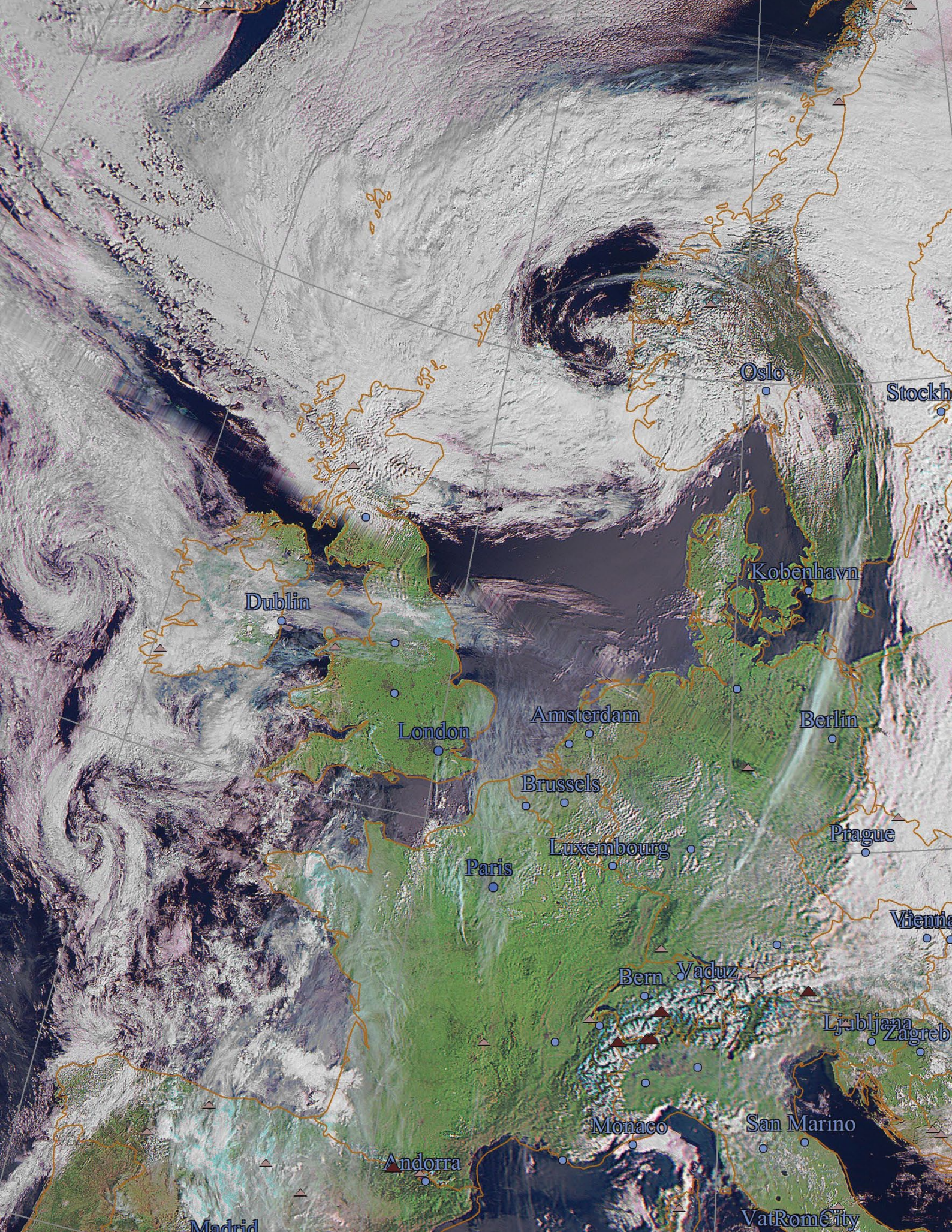
This aurora was imaged by NASA's Suomi-NPP satellite on March 28, 2019.
NASA Earth Observatory image by Joshua Stevens, using VIIRS day-night band data from the Suomi National Polar-orbiting Partnership.

'This aurora stemmed from minor coronal holes that provided just enough activity to produce some aurora at high latitudes', stated Mike Cook, space weather forecaster lead at Apogee Engineering and a team member of the citizen science project *Aurorasaurus*.

'It didn't take much to spark some auroral activity at high latitudes, as we are near the Spring Equinox which, because of Earth's axial tilt, aligns us for better geomagnetic activity,' added Cook.

March is historically the most geomagnetically active month.

Caption by Kasha Patel.



This is a segment from a MeteorGIS composite image sent in by Joachim Scharrer, created from the two morning passes of Meteor M2 on May 23, 2019.
It shows a depression that produced unseasonable cold and wet conditions over the North Sea region.

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	137.9000 MHz	On	Good

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
Meteor M N1	1700.00 MHz	RHCP	AHRPT	Dead? [8]
Meteor M N2	1700.0 MHz	RHCP	AHRPT	Good

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.