GEO Newsletter

Group for Earth Observation

Group for Earth Observation No 63 - September 2019

Pictured a few seconds after leaving its launchpad, Russia's new Meteor M2-2 Earth observing satellite heads for orbit aboard its Soyuz-2-1b/Fregat-M launcher.

Image: Roscosmos

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

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http://www.facebook.com/groupforearthobservation

From the Editor

Les Hamilton

Many readers will by now have been receiving LRPT images from Russia's Meteor M2-2 satellite, which was successfully launched on July 5. Following four weeks or so transmitting the three visible channels, the satellite's commissioning phase switched to displaying the three infrared channels in early August before reverting back to the visible channels on August 19. A frustrating factor has been the numerous changes in frequency between 137.9 MHz and 137.1 MHz and Symbol Rates of 72,000 and 80,000 baud. This behaviour also occurred during the commissioning phase of Meteor M2 in 2014, so it is probable that by the end of the year, if not before, the final values for both frequency and symbol rate for Meteor M2-2 will have been finalised.

There are also ongoing developments in both the Meteor Plugin for SDRsharp and the LRPT Decoder software, perhaps the most significant being the ability to automatically detect the Symbol Rate of the transmission. Details are regularly updated in Alex's excellent tutorial to be found at

_http://happysat.nl/Setup_Meteor/Setup.html_

Alex also regularly updates a status page showing the current frequency, Symbol Rate and Channels in use by both the Meteor satellites, at

_http://happysat.nl/Meteor/html/Meteor_Status.html_

Another excellent resource for keeping up with developments—providing you are a *Facebook* subscriber—is the *APT Group* (which covers both APT and LRPT satellite transmission modes. This is an open group, which means that anyone can read their posts: if you wish to contribute, though, you must register as a member. Their website is

https://www.facebook.com/groups/Satellite.apt.group/

If you haven't started receiving this new satellite yet, there are a number of fine images in this issue, sent in by readers, to whet your appetite.

Please remember that contributions from readers detailing their activities are always welcome, by email, to the editor at

geoeditor@geo-web.org.uk

Contents

The GEO Report

Francis Bell

I would like to start this brief report by offering my congratulations to those members I know of who are receiving the latest Russian polar orbiting satellite Meteor M2-2. I have been reading the correspondence published via our GEO Subscribers *YAHOO* group and admire the way individuals have shared their experiences and advice relating to the reception of this new satellite. Sometimes, when possible, I have downloaded some of the images which have been referred to in correspondence, and these have included excellent images of Australia and North America. I believe I have at home the equipment necessary to receive this new satellite. I just need to overcome the personal inertia of getting started with it.

Often in my reports I include comments about rallies and shows which GEO has recently attended. Unfortunately my attendance at the two events which I had hoped to support on GEO's behalf this summer both had to be abandoned.

The school 'Space-Link' one day event, which GEO has attended for a number of years, was frustratingly cancelled at the last minute and I'm not sure about further contacts with this group.

GEO did book a stand at the large Newbury radio rally but unfortunately I was unable to attend because a few days before this event I had to go to hospital and have my leg put in plaster. Unfortunately I had sustained an injury to my foot —medically known as Charcot-Foot—which needed immobilising for immediate rest, hence the plaster cast. The demand for rest and my lack of mobility ruled out my attendance at the Newbury rally hence there was no GEO stand there even though it had been booked. At the time of writing my foot is much better and I am walking almost normally again.

I am still in touch with Dundee University and their programme of satellite reception and I hope to give an up-to-date report about GEO's support for them in the next Quarterly Report.

Quarterly ? Question

My thanks to those readers who responded to Quarterly Question 62, which related to an isolated island in the mid Pacific Ocean. In addition to the satellite image shown there were clues to the island's identity in the text. The name of the island and other details can been read, below, in a correct answer I received from David Rennolds (G0BXS).

Answers as follows:
Name: EASTER ISLAND
Lat/Long: 109º WEST 27º SOUTH
Country claiming sovereignty: CHILE

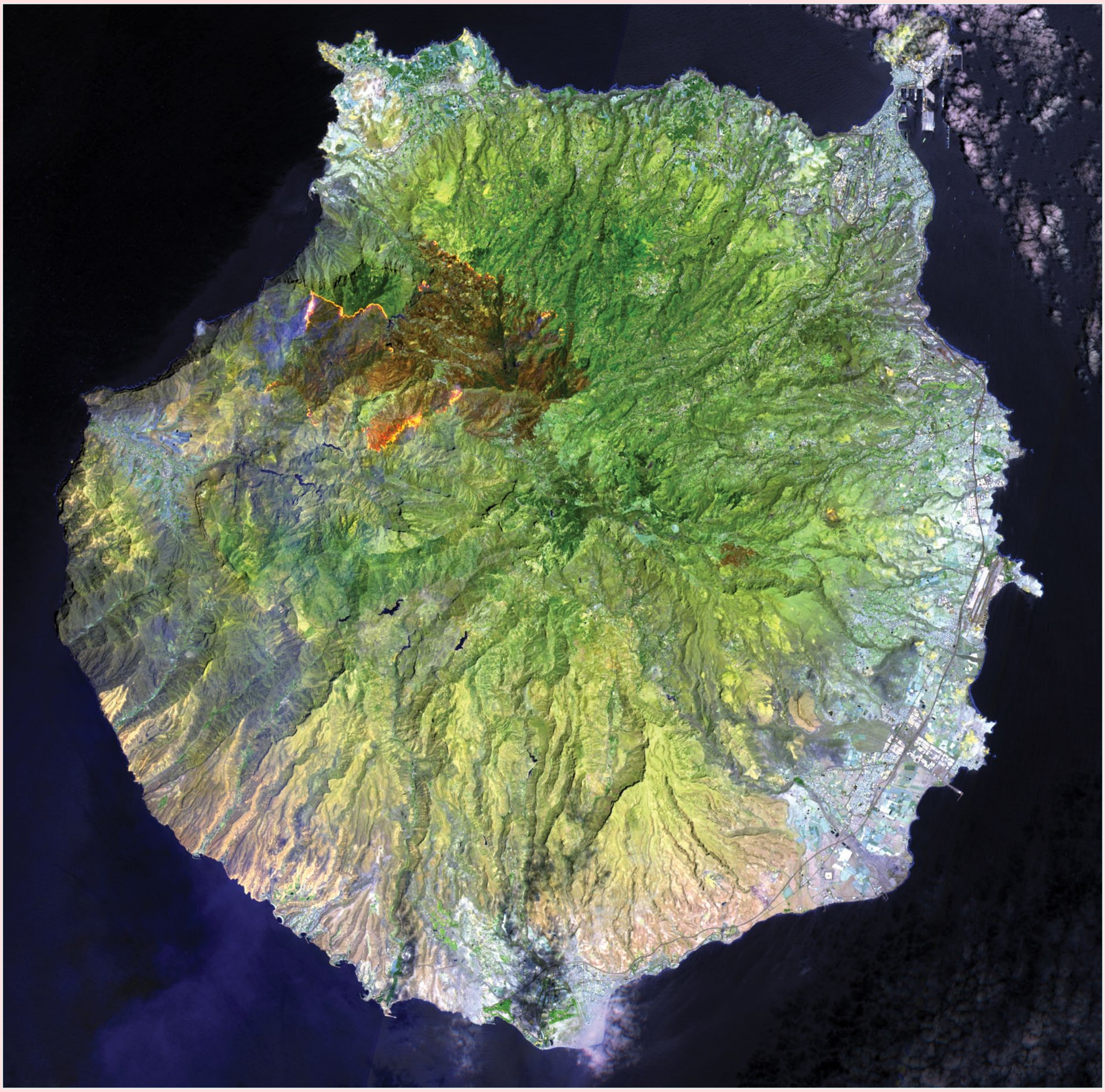
Question 63

The question this quarter has been prompted by the news in August 2919 relating to the many wildfires in Brazil. In addition to Brazil there have been wildfires on one of the islands in the Canary Island Group. I was particularly distressed to learn of the fires in the Canary Islands because the particular island in question has been a holiday destination for my wife and myself on a number of occasions and it's unfortunate to think of the natural landscape being damaged by fire. However, it must be recognised that in this case it is a volcanic island so many devastating events must have happened there in the past.

The question this quarter is quite straightforward: "**Name the individual island shown in the satellite image on page 5**".

(see page 5)

A secondary question—perhaps more difficult—is why we call this group of islands the 'Canary Islands'. This is a more difficult question than asking about the origin of the name for 'Easter Island' which, I understand, was discovered by European explorers on 5th April 1722 which happened to be Easter Sunday.



Copyright contains modified Copernicus Sentinel data (2019), processed by ESA

The recent satellite image of the island in question is shown above and notes which were published with the image follow. I have edited these notes a little to remove the name of the island in question.

Satellite Image Information

An unprecedented wildfire has ripped through one of Spain's Canary Islands off the northwest coast of Africa. The wildfire, which started on Saturday August 17, 2019, has now started to subside after engulfing around 10 000 hectares of land, leading to the evacuation of over 9000 people.

This false colour image, captured on August 19, was created using the shortwave infrared bands from instruments aboard the Copernicus Sentinel-2 satellite, and allows us to clearly see the fires on the ground in bright orange. Burn scars are visible in dark brown. These bands also allow us to see through smoke—but not clouds.

The Copernicus Emergency Mapping Service was activated to help respond to the fire. The service uses satellite observations to help civil protection authorities and, in cases of disaster, the international humanitarian community, respond to emergencies.

The fire started near the town of Tejeda and spread to Tamadaba Natural Park, driven by a combination of high temperatures, strong winds and low humidity. According to authorities, over 700 firefighters on the ground and 16 aircraft helped tackle the blaze, with some flames reaching over 50 metres in height.

Answers, please, to Francis Bell via email at

francis@francisbell.com

or

francis@geo-web.org.uk

by November 30, 2019.

Successful Meteor M2-2 Launch

Les Hamilton

Following a wait of almost eighteen months following the unfortunate demise of the Meteor M2-1 weather and climate-monitoring satellite, its twin, Meteor M2-2 was successfully launched atop a Soyuz-2-1b/Fregat-M rocket along with a cluster of 32 secondary payloads. The launch was from Russia's far eastern Vostochny Cosmodrome at 05:41 UT on July 5.

As readers may recall, Meteor M2-1 did launch as expected but, due to a programming error—the rocket's take-off coordinates were mistakenly entered for the Baikonur Cosmodrome in Kazakhstan, over 4000 kilometres to the west—the rocket's upper stage fired facing the wrong orientation, and as a result the launcher and its payloads plunged into the North Atlantic ocean.

Meteor M2-2 satellite
Image: Roscosmos

Following lift-off, the Soyuz flew under power from both its first and second stages for a total of 118 seconds, after which the exhausted strap-on first stage boosters were jettisoned. The second stage then continued to burn for another 170 seconds, with separation of the rocket's payload fairing taking place about a minute before the end of this burn.

The Meteor M2-2 satellite undergoing final checks prior to its integration with the Fregat-M launcher upper stage.
Image: Roscosmos

Personnel look on as the Meteor M2-2 payload is integrated with the Fregat-M upper stage of the launcher.
Image: Roscosmos

Moments before the second stage completed its firing 4 minutes and 47 seconds into the flight, the third stage engine started firing through the inter-stage lattice structure, which itself separated along with the second stage a second or so later.

The third stage then burned for four and a half minutes before shutting down, releasing the Fregat upper stage and its passengers into a ballistic trajectory just short of orbital velocity. This set the third stage into free fall back to Earth on a path designed to bring its debris crashing safely into the Atlantic Ocean. Almost immediately, the Fregat fired its engines for just over a minute to enter its initial parking orbit, and about three-quarters of an hour later fired again to establish the near circular 98.6° orbit of 790 by 830 km from where it released Meteor-M No.2-2 (Meteor M2-2 for short).

Following the successful release of its primary payload, the Fregat's task continued with a complex preprogrammed sequence, including multiple firings of its main engine, designed to deliver its secondary payloads into two different orbits. Payloads in the micro-sat range were released at an altitude of 580 km and inclination of 97.7°, while the cubesats were to be released at around 530 km and 97.5°. The total release programme was completed in just 4½ hours following lift-off.

Its task completed, the Fregat was placed in a suicide trajectory through the atmosphere and disintegrated over the equatorial east Pacific Ocean.

Meteor-M2-2 is identical with its lost predecessor, and several more spacecraft of this configuration are planned to fly in the next few years. Built by the VNIIEM Corporation, the 2,750 kilogram satellite is designed for at least five years of service.

Instrumentation

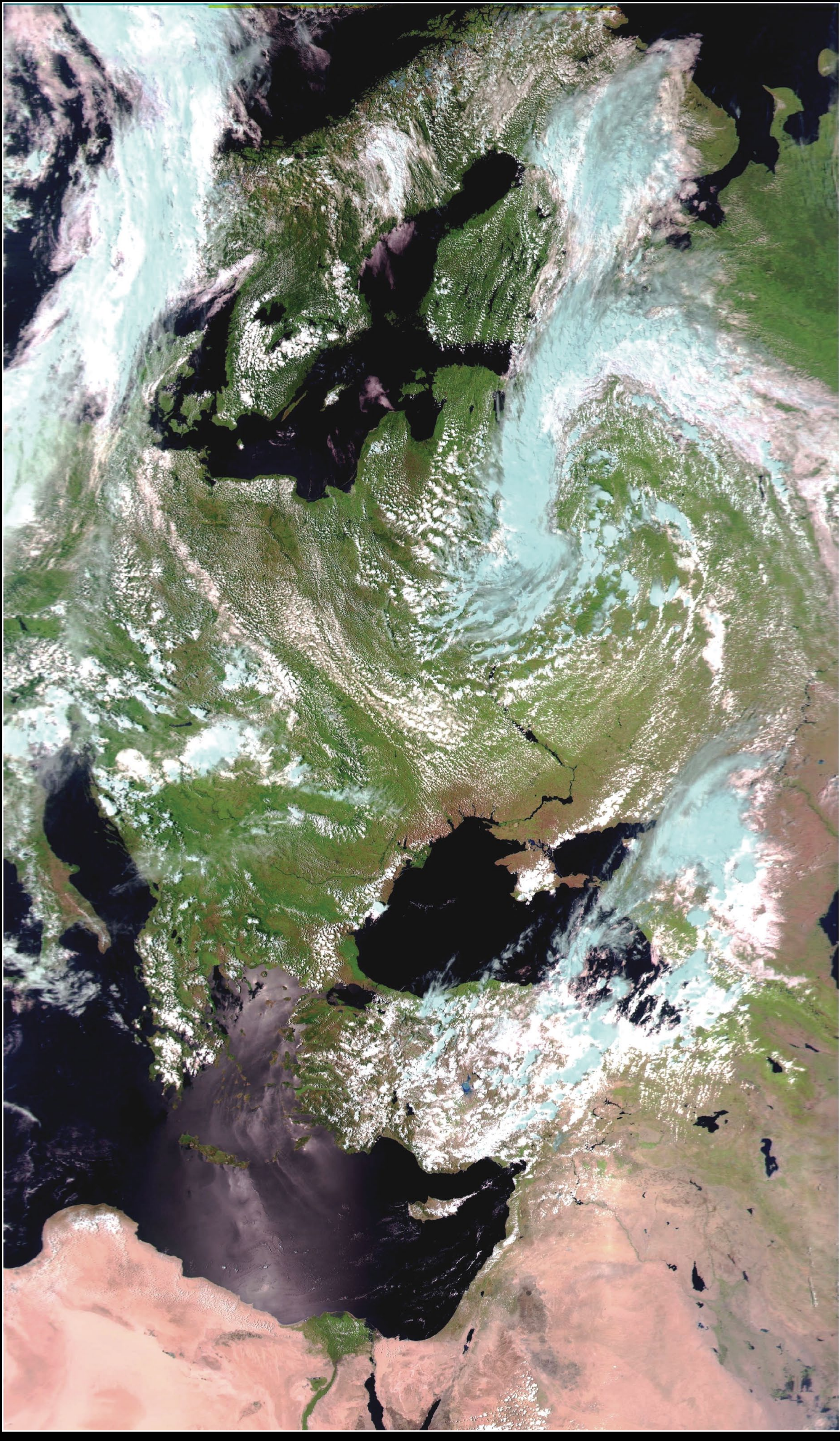
Meteor-M2-2 is equipped with two imaging payloads. MSU-MR is a low-resolution instrument operating in visible-light and near-infrared wavelengths which will take wide-swath images of Earth to help monitor cloud cover and the icecaps. The second imager, KMSS-2, provides complimentary high-resolution visible-light images of more specific areas.

The satellite also carries two sounding instruments: the MTVZA-GYa microwave radiometer and IKFS-2 infrared spectrometer, which will build profiles of temperatures, humidity and wind conditions within the atmosphere.

The Soyuz-2-1b/Fregat-M rocket being transported to its launchpad at the Vostochny Cosmodrome.
Image: Roscosmos

The Soyuz-2-1b/Fregat-M rocket on its launchpad the day before lift-off
Image: Roscosmos

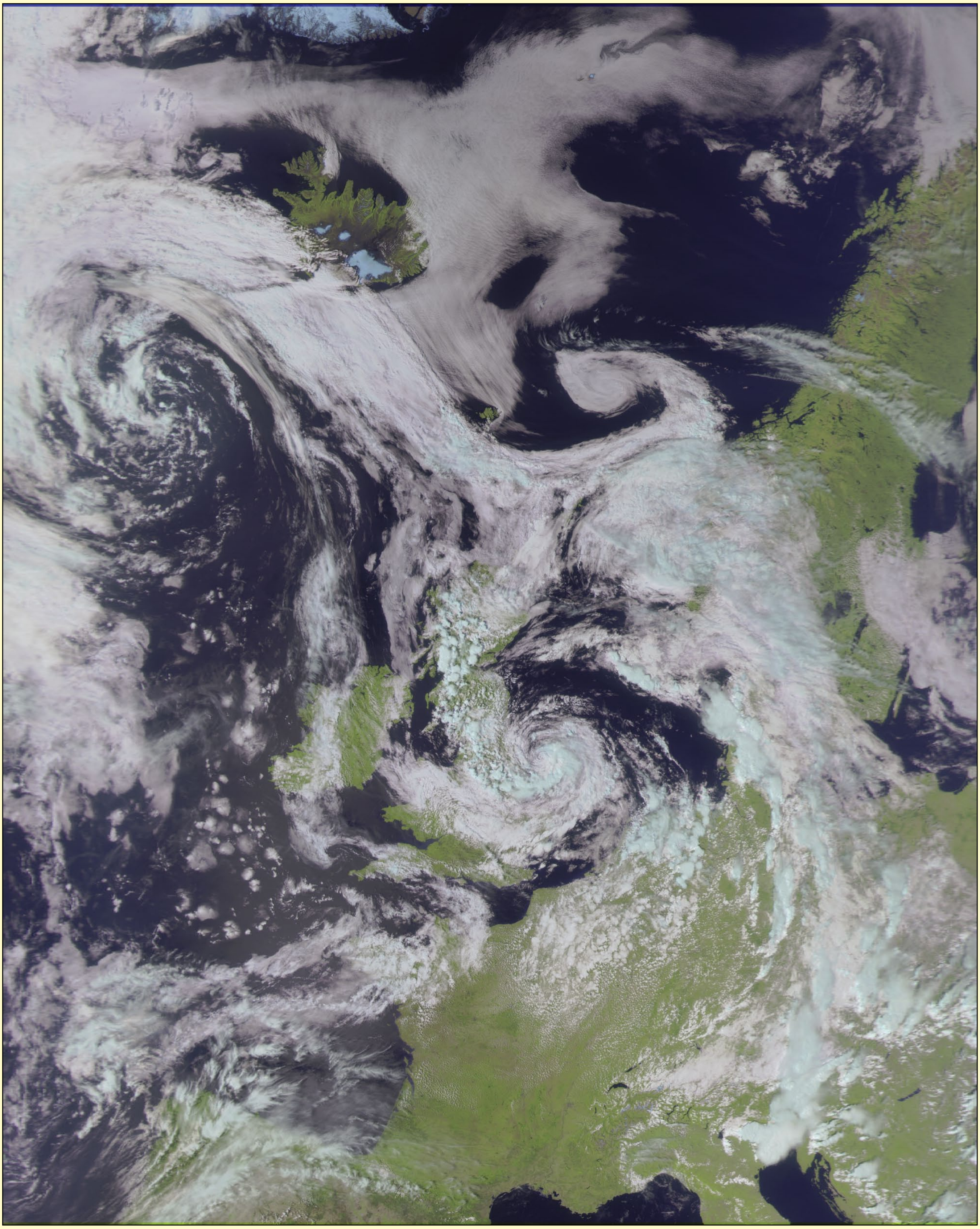
The Soyuz-2-1b fires its motors at the instant of lift-off
Image: Roscosmos



Enrico Gobbetti received his first Meteor M2-2 image (above) acquired from the 12.27 UT pass on July 18, 2019

Combatting severe 'pager' interference to Receive Meteor M2-2 Imagery

John Cooper G8GKU



The Meteor M2-2 Image above was captured by G8GKU at 15:25 UT on July 31 2019, and processed to give RGB123 false colour. Orbit No 375, at 137.9 MHz OQPSK with 72000 symbol rate.

Read article on following page ...

Along with the new Meteor M2-2 satellite came the challenge of OQPSK in place of the QPSK utilised by Meteor M2. The immediate situation was to leave me with no working demodulation or decoding system for OQPSK.

Discussion with Les Hamilton revealed the option of using tools as found in Les's pre-packaged archive tool sets. Please see

http://leshamilton.co.uk/MeteorLRPTSuite.htm

A 'thank you' has to go to Les for assembling the various sets of tools.

As always, things were not so simple as might have been thought. The tools chain as above is centred around using the LRPT Demodulation within SDR# as to be found in the archive.

The Pager Situation

Due to the quantity and strength of 137.x MHz data and 'pager' signals in Oxford, it is not workable to use the well tried and tested SDR-RTL Dongle receiver. As I am located close to Oxford, a hybrid system had to be devised to facilitate the reception and decoding of M2-2 images.

Beating the Pagers

The three key components which allow me to receive (mostly) unbroken images from Meteor M2-2 are as follows. Other methods of course exist, and the use of the following products is merely descriptive as opposed to an endorsement to purchase.

First, after the crossed dipole RHCP aerial, is the use of a specific signal preamplifier, the **Mini-Circuits PGA-103+** device. A data sheet may be found on the Mini-Circuits web pages. There are other devices by other manufacturers but the **PGA-103+** is excellent for the task. It has a very low noise figure and an impressive degree of strong signal handling, resulting in low (if any) cross-modulation of the weak M2-2 signal by the local heavyweight data transmitters.

The device has to be embedded in circuit to be actually used: the device is not 'plug and play', unless one has the evaluation module version. There is a useful article detailing the building of a amplifier with the **PGA-103+** at the following URL,

http://www.g4ddk.com/PGA103+2.pdf

To ensure maximum signal is obtained, the aerial is real-time tracked in azimuth and elevation with data obtained from Alex's DDEtoSerial driver, to be found at the following URL,

***http://tripsintech.com/
orbitron-dde-azimuth-elevation-to-serial/***

Secondly is the use of twin screened 50 Ohm coax between the preamplifier and the receiver position. Silver plated coax screen is highly recommended.

Thirdly is the use of the **SDR-Play Duo receiver**. This receiver has a front end design which allows repetition of weak signals in the presence of strong close in-band signals at an offset of only a few kilohertz. This is exactly the situation when I am receiving 137.x MHz images.

The complete signal chain for Meteor M2-2 uses the above for reception of the satellite signal and the received data is stored as a 16 bit I.Q. WAV file.

At this stage the tools within Les's archive come into play. The SDR# application is fired up and the recorded dot.wav file selected as the signal source. The LRPT demodulator plug-in within SDR# is used to demodulate the OQPSK, resulting in an 's' file, which is then decoded by the LRPT decoder within the tools set archive. There are options to be set in SDR#, the demodulator and the decoder, all of which are self descriptive.

By using this hybrid system, the break-up and loss of many images due to strong local close in-band interference has been very much reduced. Acknowledgement is made of all software names and such items.

NOAA 15 on the Brink

Enthusiasts monitoring NOAA 15, a weather satellite sent into orbit over 21 years ago (in May, 1998), experienced problems receiving images from July 23 this year. The problem manifested itself in distorted images, and sometimes no images at all, and was attributed to instability of the scan motor.

Several days later, the problem appeared to have been overcome only for it to reappear a few days thereafter.

By August, NOAA 15 was once again transmitting good imagery, but the end of life for this satellite can surely not now be long delayed, considering its age.

Atmospheric River Swells Terrestrial Rivers

NASA Earth Observatory

In late June 2019, a potent atmospheric river event carried soaking rain into southern Chile, dropping nearly a month's worth of precipitation in just 48 hours. According to atmospheric scientist René Garreaud of *Universidad de Chile*, between 100 to 200 millimetres of rain fell over a wide area near Concepcion, leading to landslides and severe flooding in the Biobio and Araucania regions.

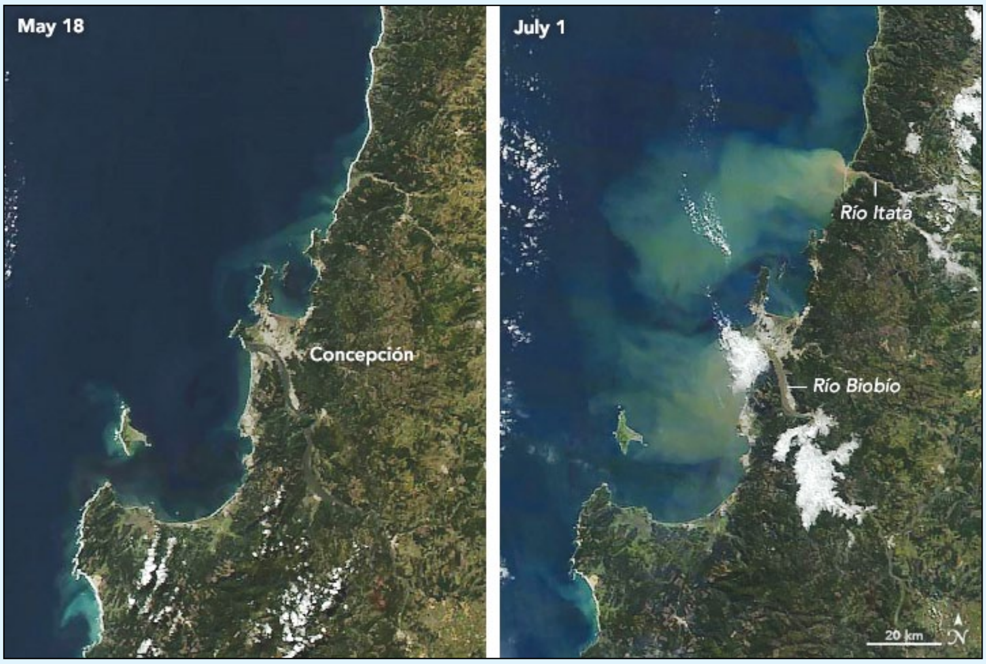
The images above capture some of the signs of that deluge. The top natural-colour pair was acquired by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on May 18 by the *Aqua* satellite and on July 1 by *Terra* a few days after the storm.

The third image was acquired on July 1 by the Enhanced Thematic Imager+ on *Landsat 7*.

The discoloured water offshore, which extends more than 50 kilometres in some areas, is sediment that ran off the hillsides and downriver.

Atmospheric rivers can stretch tens to hundreds of kilometres in width, and can carry an amount of water vapour equivalent to 7.5 to 15 times the flow at the mouth of the Mississippi River.

These weather systems are essentially jet streams of moist air. They often occur off the west coast of North America, sending soaking rain into California, Oregon, and Washington. In subtropical Chile, atmospheric rivers contribute 45 to 60 percent of the annual precipitation, most of it in the winter rainy season (June to September), according to a 2018 research paper.



The Pacific Ocean near Conception in Chile before and after the atmospheric river event.
MODIS images © NASA

Sediment flowing from the Rio Itata as imaged by Landsat 7 on July 1.
Image: USGS / NASA

According to Garreaud, the early winter rainfall increased discharge on some rivers by ten-fold, carrying nutrient-rich sediments into the coastal zone. Garreaud and colleagues study how such outflows of nutrients promote and sustain phytoplankton blooms in the southern winter.

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

Northern Italy at Night

European Space Agency

Everyone is used to living with smarter devices. But imagine living in a smart city where everything from public transport to city lamps is efficient and sustainable. This night time image of northern Italy from Earth orbit is one of the ways space is paving the way for cities to get smarter.

Doorbells, refrigerators and toothbrushes are everyday devices that are now controllable, customisable and designed to make your life run more efficiently by collecting and relaying data using telecommunications satellites.

Other space technology is helping to collect valuable data that can result in larger scale changes for cities. Take one of humankind's greatest achievement in space so far, the International Space Station. Astronauts routinely snap photos of Earth from this orbital outpost, like this one of northern Italy, taken by ESA astronaut Luca Parmitano during his 2013 mission, provide vital data about city efficiency and sustainability.

Researchers have devised a method to assess the environmental impact of artificial light on humans, animals, and the surrounding environment using one of the few sources of publicly-accessible night images of Earth in colour: pictures taken by the astronauts aboard the International Space Station.

City lights are disruptive not only for the lives of nocturnal animals, who suffer from disorientation and behavioural and physiological changes, but also for people. An excess of artificial light before bedtime reduces melatonin production, a hormone linked to sleep. This suppression can lead to negative effects on our health, including breast and prostate cancer.

In addition, street lights account for a large chunk of a country's energy consumption. As the world grapples with climate change and cleaner sources of energy, how that energy is put to use is a bright topic.

Cities at Night

http://citiesatnight.org/

is an online platform that invites citizens to flip through the half a million photographs of Earth at night taken so far by astronauts from the Space Station to identify cities. The end result of *Cities at Night* will be a map of Earth that is accessible to anyone.

Researchers want to use the map to locate energy inefficiencies in urban cities to urge dimming of the lights. A case in point is the city of Milan, which replaced its orange sodium lamps with white LEDs. Comparisons of Milan from night as seen from space before and after this change has shown that the white light is worse for the local environment.

The data retrieved from these images is vital for the drawing up of risk maps for artificial lighting that can help to guide city officials in these types of decisions. And that's just smart.

Apollo 11 Launchpad

European Space Agency

Celebrating 50 years since Apollo 11 blasted off with the first humans that would walk on the Moon, Copernicus Sentinel-2 captures the historic launch site at *Kennedy Space Center*, Cape Canaveral, Florida, US.

On 16 July 1969, the Saturn-V rocket carrying Apollo 11 began its momentous voyage to the Moon. It lifted off from launch pad 39A—which can be seen in this image acquired on January 29, 2019. Launch pad 39A is the second pad down from the top (the launch pad at the far top is 39B).

The crew—Neil Armstrong, mission commander, Michael Collins, command module pilot and Edwin 'Buzz' Aldrin, lunar module pilot—were embarking on a milestone in human history.

Just four days later, the lunar module, *Eagle*, touched down. Watched on television by millions around the world, Neil Armstrong was the first to set foot on the Moon, famously saying, 'That's one small step for man, one giant leap for mankind.'

A few minutes later he was joined by Buzz Aldrin. They took photographs, planted the US flag, spoke to President Richard Nixon via radio transmission and spent a couple of hours walking and collecting dust and rocks. The two men returned to the lunar module, slept that night on the surface of the moon: then *Eagle* began its ascent back to rejoin the command module, which had been orbiting the Moon with Michael Collins. Apollo splashed back down safely in the Pacific Ocean on July 24.

The Moon has again captured the attention of space agencies. ESA and international partners are now looking forward to the next era of human exploration, and to understand better the resources available on the Moon to support human missions longer-term. While Apollo 1 touched down for the first time on the near side of the Moon 50 years ago, it is time to explore the far side, examine different types of lunar rocks there, to probe deeper into the Moon's geological history and to find resources like water-ice that are thought to be locked up in permanently shadowed craters near the Moon's south pole.

Raikoke Erupts

NASA Earth Observatory

Story by Adam Voiland, with information from Erik Klemetti (Denison University), Simon Carn (Michigan Tech), and Andrew Prata (Barcelona Supercomputing Center).

Unlike some of its perpetually active neighbours on the Kamchatka Peninsula, Raikoke Volcano on the Kuril Islands rarely erupts. The small, oval-shaped island most recently exploded in 1924 and in 1778. The dormant period ended around 4 am local time on June 22, 2019, when a vast plume of ash and volcanic gases shot up from its 700-metre-wide crater. Several satellites—as well as astronauts on the International Space Station—observed as a thick plume rose and then streamed east as it was pulled into the circulation of a storm in the North Pacific.

On the morning of June 22, astronauts shot figure 1, showing the volcanic plume rising in a narrow column and then spreading out in an the umbrella region; the area where the density of the plume and the surrounding air equalise and the plume stops rising. The ring of clouds at the base of the column appears to be water vapour.

'*What a spectacular image. It reminds me of the classic Sarychev Peak astronaut photograph of an eruption in the Kuriles from about ten years ago*,' stated Simon Carn, a volcanologist at Michigan Tech. '*The ring of white puffy clouds at the base of the column might be a sign of ambient air being drawn into the column and the condensation of water vapour. Or it could be a rising plume from interaction between magma and seawater because Raikoke is a small island and flows likely entered the water*.'

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's *Terra* satellite acquired the image in figure 2 on the morning of June 22. At that time, the most concentrated ash was on the western edge of the plume, above Raikoke. Figure 3, an oblique, composite view based on data from the Visible Infrared Imaging Radiometer Suite (VIIRS) on Suomi NPP, shows the plume a few hours later. After an initial surge of activity that included several distinct explosive pulses, activity subsided and strong winds spread the ash across the Pacific. By the next day, just a faint remnant of the ash remained visible to MODIS.

Since ash contains sharp fragments of rock and volcanic glass, it poses a serious hazard to aircraft. The *Tokyo and Anchorage Volcanic Ash Advisory Centers* tracked the plume closely and issued several notes to aviators indicating that ash had reached an altitude of 13 kilometres. Meanwhile, data from the CALIPSO satellite indicated that parts of the plume might have reached as high as 17 kilometres.

In addition to tracking ash, satellite sensors can also track the movements of volcanic gases. In this case,

Figure 1 - Raikoke erupts, viewed from the ISS
Astronaut photograph ISS059-E-119250 is provided by the ISS Crew Earth Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center. The image was taken by a member of the Expedition 59 crew.

Raikoke produced a concentrated plume of sulphur dioxide (SO_2) that separated from the ash and swirled throughout the North Pacific as the plume interacted with the storm.

'*Radiosonde data from the region indicate a tropopause altitude of about 11 kilometres, so altitudes of 13 to 17 kilometres suggest that the eruption cloud is mostly in the stratosphere*,' said Carn. '*The persistence of large SO_2 amounts over the last two days also indicates stratospheric injection*.'

Volcanologists watch closely for plumes that reach the stratosphere because they tend to stay aloft for longer than those that remain within the troposphere. That is why plumes that reach the stratosphere typically have the greatest effects on aviation and climate.

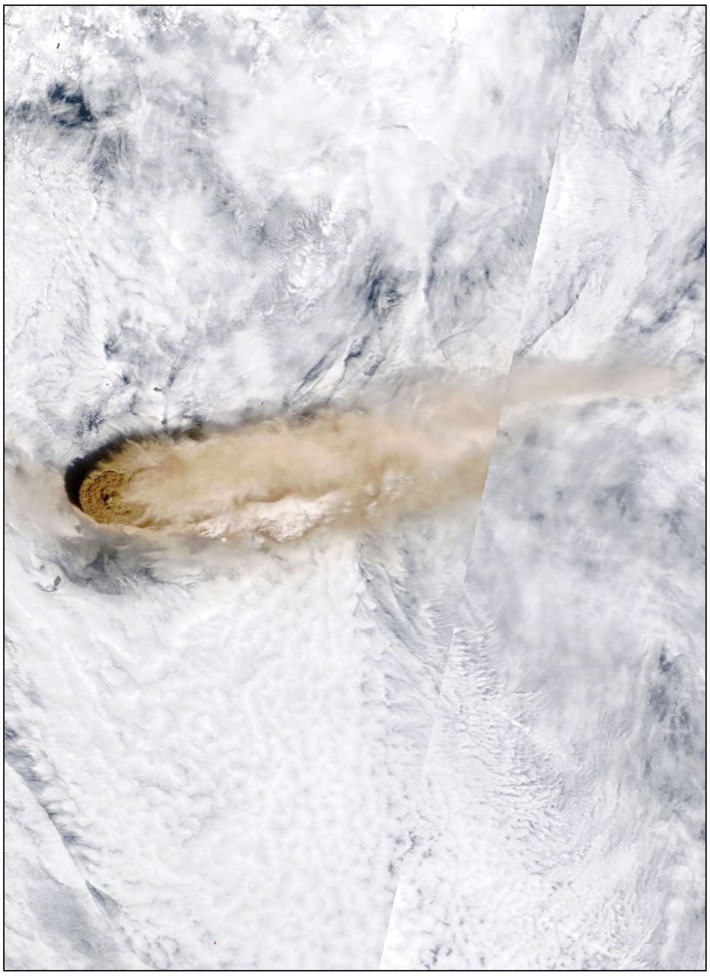


Figure 2
NASA Earth Observatory image by Joshua Stevens, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview

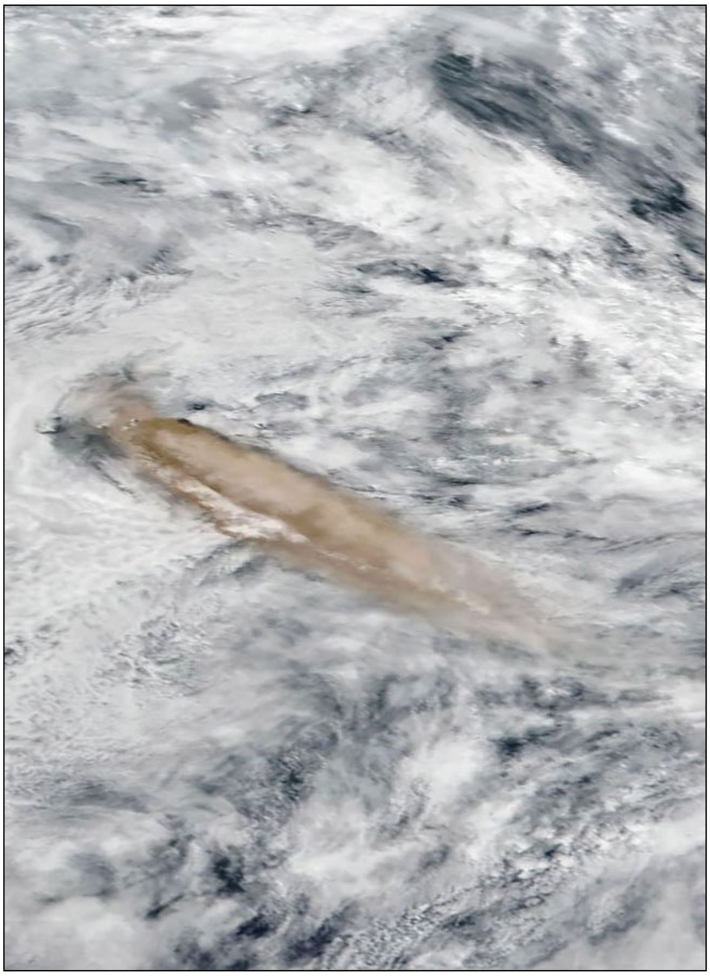


Figure 3
NASA Earth Observatory image by Joshua Stevens, using VIIRS data from the Suomi National Polar-orbiting Partnership

Deciphering the Maud Rise Polynya

NASA Earth Observatory

Story by Kathryn Hansen

By the end of austral winter, the seas around Antarctica are blanketed with up to 18 million square kilometres of ice—an area about twice the size of the continental United States. But that vast span of ice is not always continuous. Cracks can open up and expose the seawater below.

Sometimes, state-sized areas of ice go missing from the middle of the ice pack. This phenomenon is known as a **polynya**, and scientists have been investigating these features for decades. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's *Terra* satellite acquired these images of the **Maud Rise polynya** in the eastern Weddell Sea on September 25, 2017. Figure 1 is natural colour and Figure 2 is in false colour to afford better differentiation between areas of ice (blue) and clouds (white).

Coastal polynyas form when strong offshore winds move sea ice away from the continent. In contrast, **open-ocean polynyas** like the one near Maud Rise grow amid the ice far from shore. This type of polynya is somewhat more complex, with circulation in the atmosphere and ocean both playing a role in creating and sustaining them. These openings can be large and long-lived.

The Maud Rise polynya—named for the submerged mountain-like feature over which it grows—routinely occurs in early spring and occasionally in winter. According to Joey Comiso, an emeritus scientist at NASA's Goddard Space Flight Center, the shape of the sea floor '*causes the ocean current driven by the Weddell Gyre to bring warm water up to the upper layer of the ocean and causes the sea ice to melt.*'

In winter 2017, the Maud Rise polynya was especially large, growing from 9,500 km^2 in mid-September to about 80,000 km^2 by late October (nearly the same size as South Carolina). The

continued overleaf

polynya was among largest in this area since the famous Weddell polynyas that formed in 1974, 1975, and 1976, which reached areas larger than the size of California.

How polynyas can form, grow, and persist during Antarctica's cold winter has long been a topic of investigation. Recent research points toward strong cyclonic winds—some as strong as hurricanes—as the trigger for open-ocean polynyas. Diana Francis, a scientist at New York University Abu Dhabi and leader of that study, explained that cyclonic winds '*drag the floating sea ice in opposite directions around the cyclone centre, creating the opening.*'

In some winters, atmospheric circulation moves a significant amount of heat and moisture from mid-latitudes to Antarctica, allowing large cyclones to develop over the sea ice. For example, a cyclone passed over the sea ice in winter 2016 before a small, short-lived polynya formed.

Compared to 2016, the movement of heat was stronger and more consistent in 2017, according to Francis. 'The result was more frequent and intense cyclones, making the 2017 event bigger and keeping the polynya open for a longer period.'

Comiso agrees that the atmosphere plays an important role, especially in initiating polynyas. '*But the oceanographic contribution is just as important in sustaining the polynya,*' he said.

Indeed, conditions in the ocean and atmosphere most likely work together. '*I think the atmospheric conditions play the role of the trigger for the initial opening,*' stated Francis. '*Once the area is free of ice, ocean dynamics bring warmer water near the surface and prevent the formation of new ice and sustain the polynya over longer period of time. Satellite images are a powerful tool to help us understand such a complex system where interactions between atmosphere-ice-ocean take on full meaning.*'

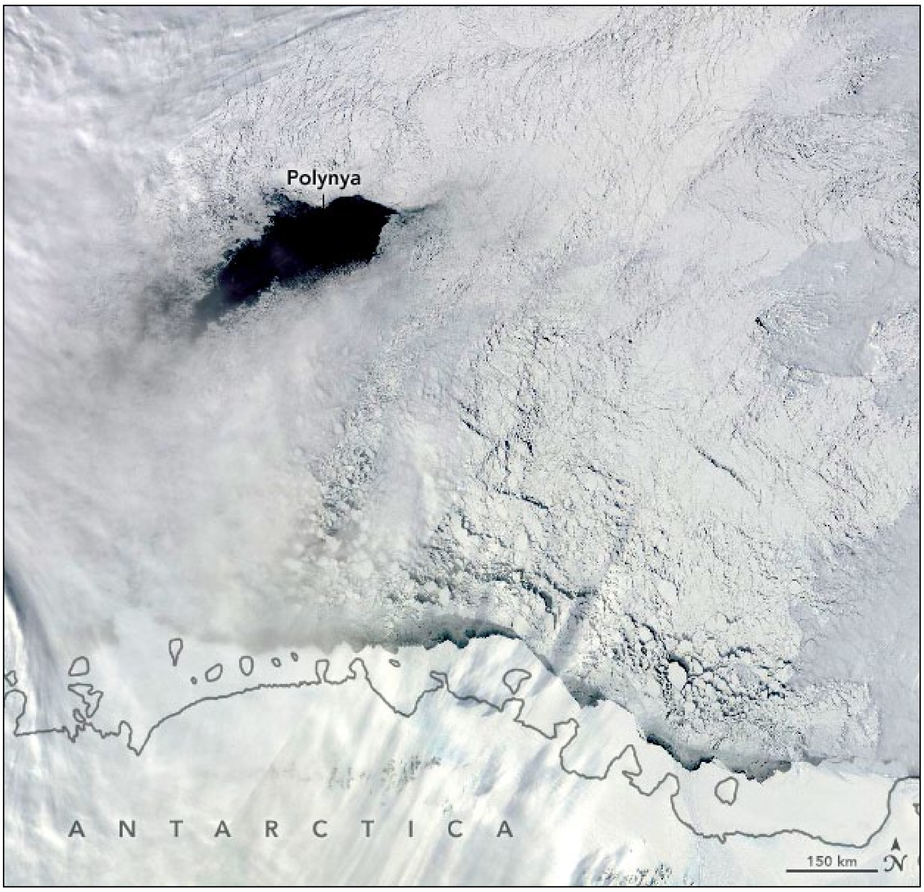


Figure 1 - The Maude Rise polynya, imaged on September 25, 2017 by NASA's Terra satellite
NASA Earth Observatory images by Lauren Dauphin, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview

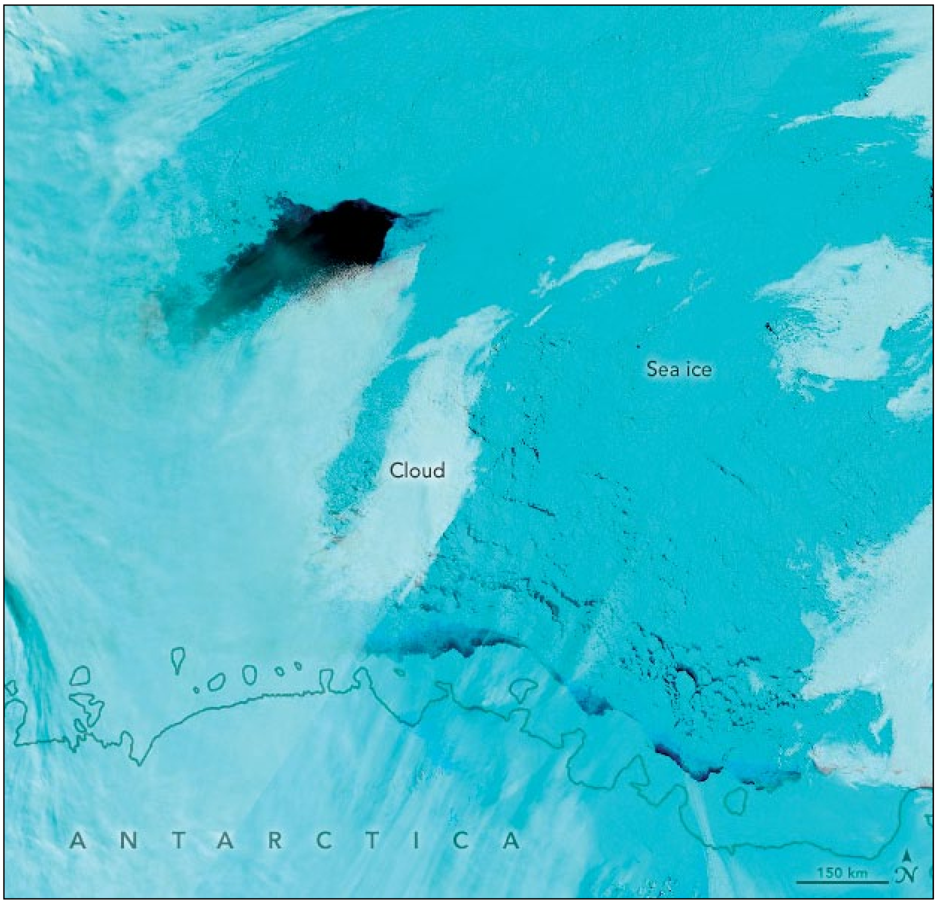
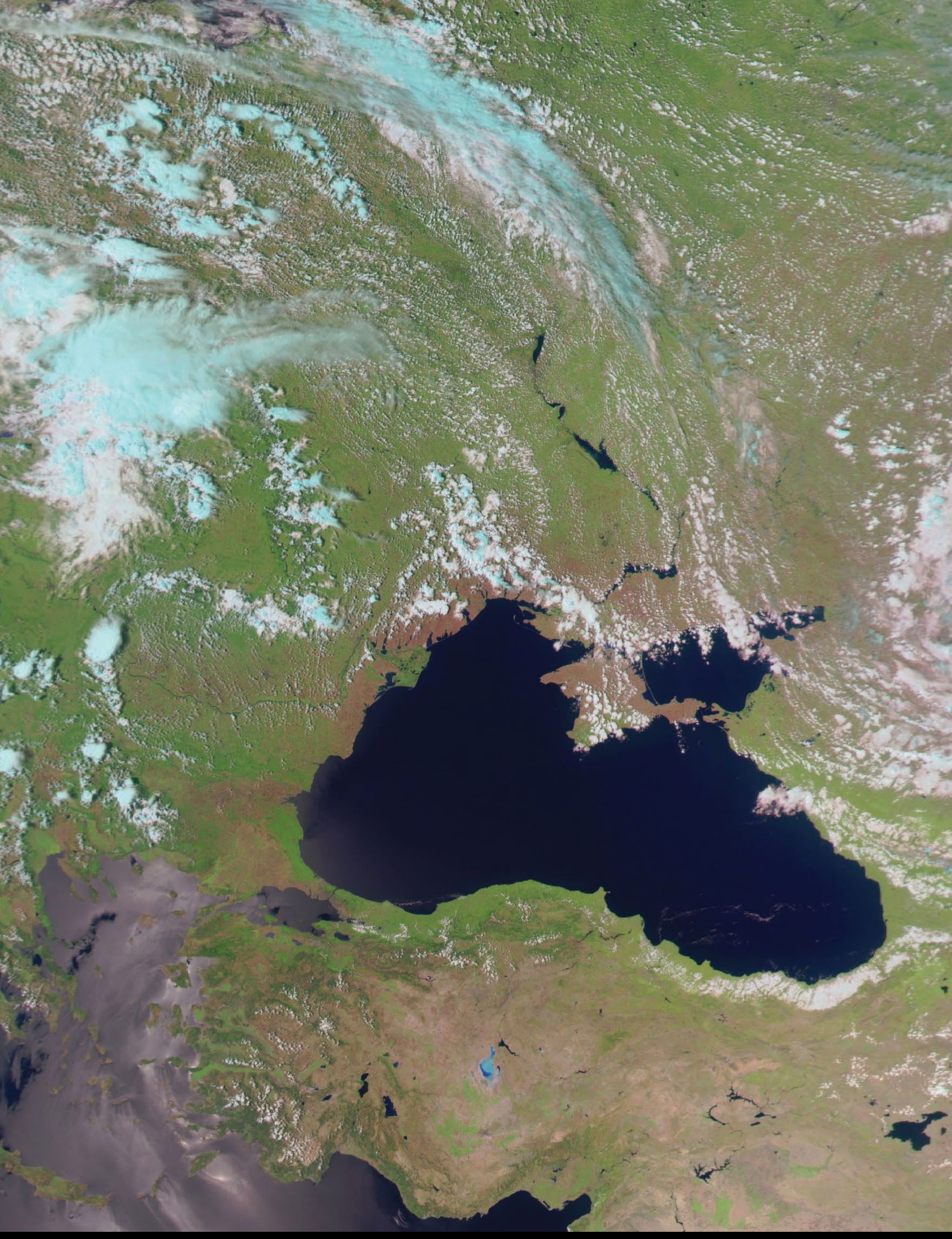
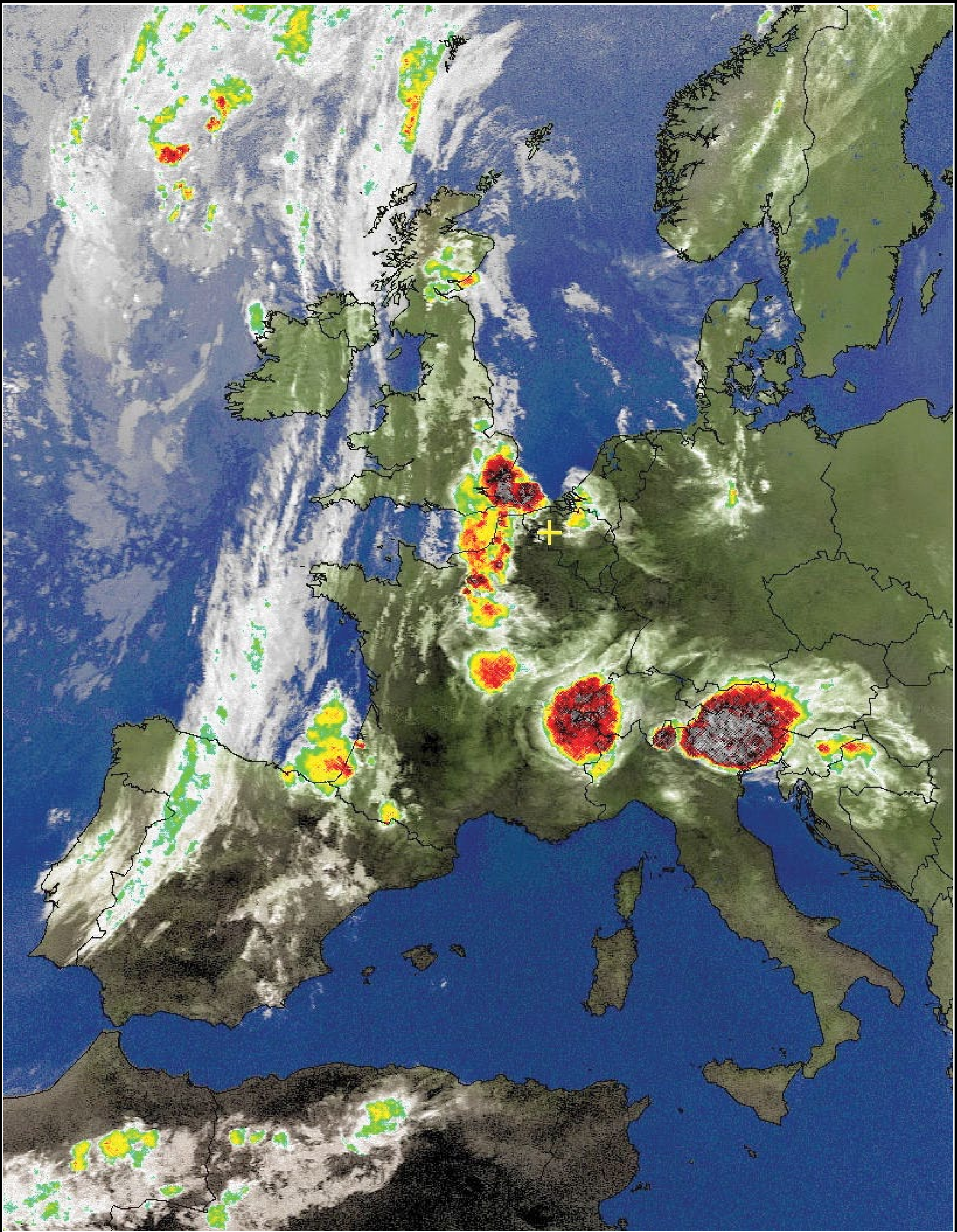


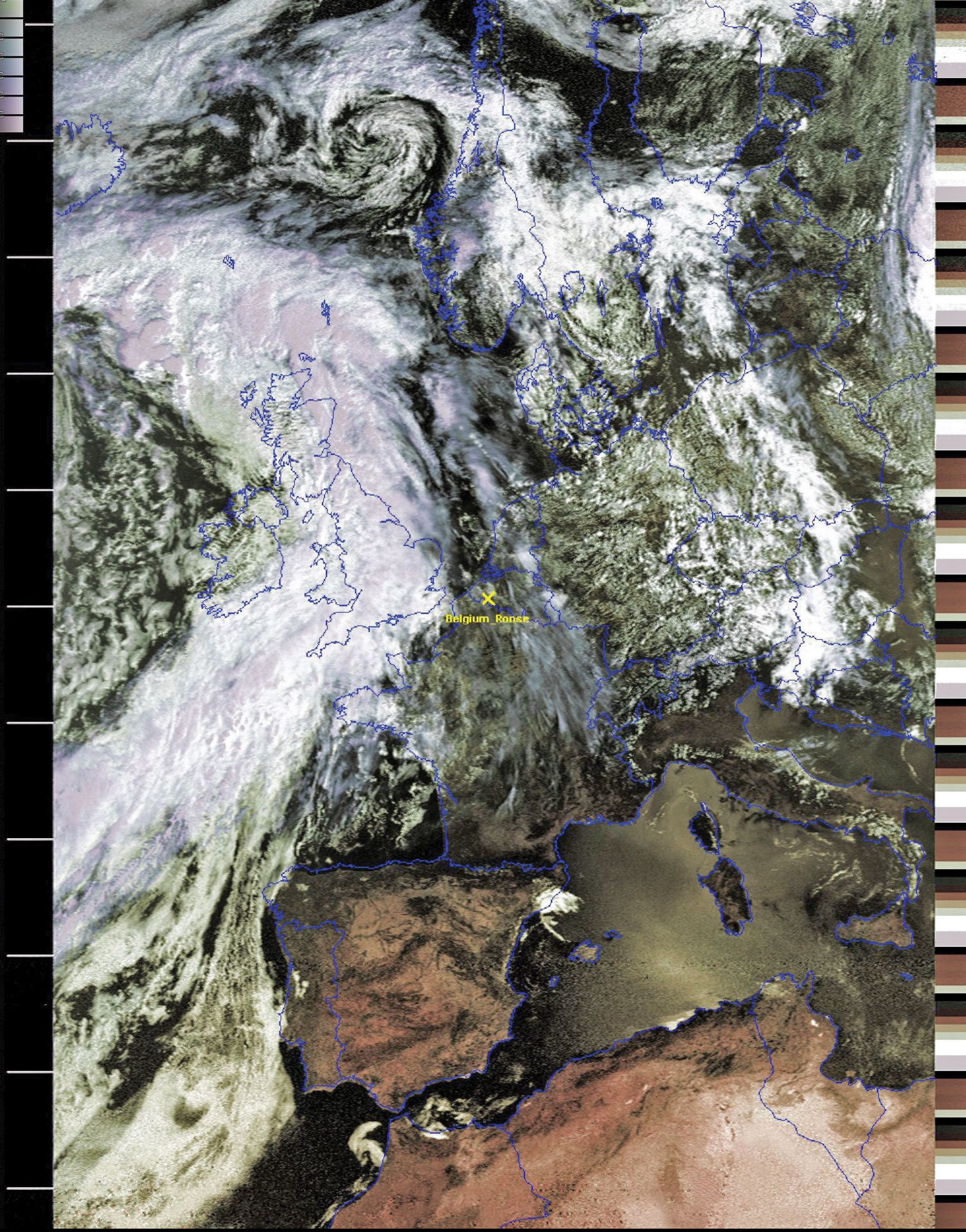
Figure 2 - The Maude Rise polynya, imaged on September 25, 2017 by NASA's Terra satellite
NASA Earth Observatory images by Lauren Dauphin, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview



Norbert Pütz acquired this splendid Meteor M2-2 image of the Black Sea at 13.57 Ut on July 27, 2019



André T'Kindt captured this evening APT image from NOAA 18 at 21:59 UT on July 25, 2019. It graphically illustrates the rash of powerful thunderstorms that erupted over Europe in the wake of record-breaking heatwave temperatures.

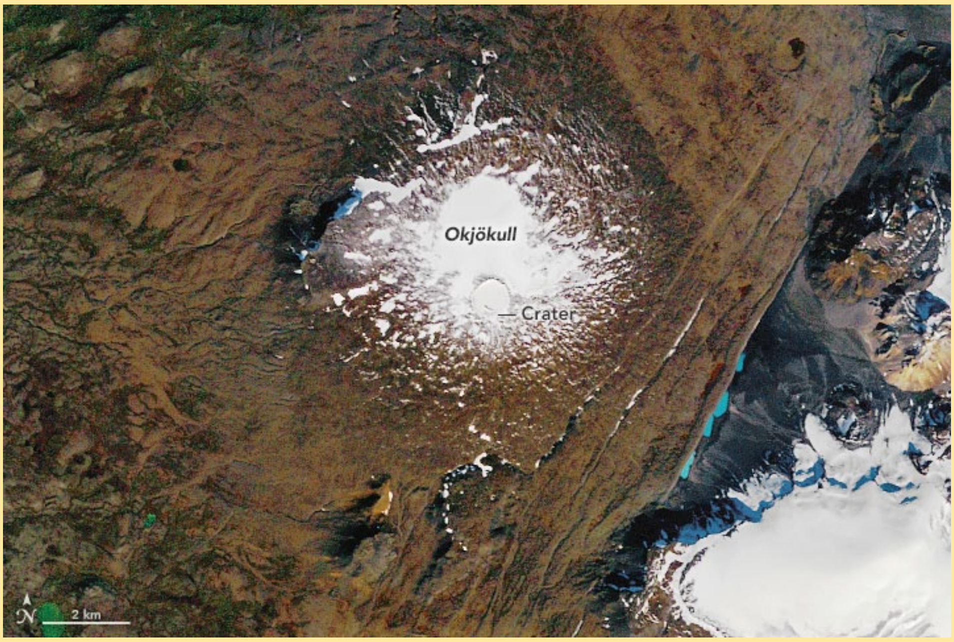


This is another NOAA 18 APT image sent in by André T'Kindt. Acquired on August 16, 2019, it depicts a weather front that brought intensive rainfall over most of the British Isles.

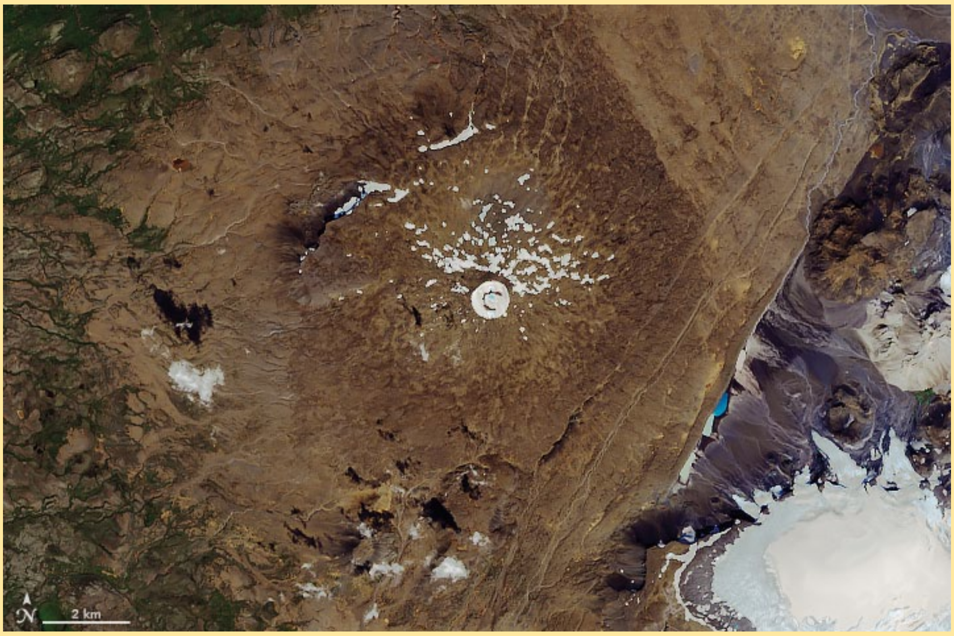
Okjökull Remembered

NASA Earth Observatory

The glacier atop Iceland's Okjökull volcano was declared dead in 2014. Satellite images show the latter stages of its decline.



Okjökull glacier, pictured during the latter part of its decline, on September 14, 1986 by Landsat 5's Thematic Mapper.



Okjökull glacier, pictured during the latter part of its decline, on August 1, 2019 by Landsat 8's Operational Land Imager

On August 18, 2019, scientists will be among those who gather for a memorial atop Okjökull volcano in west-central Iceland. The deceased being remembered is Okjökull—a once-iconic glacier that has melted away throughout the 20th century and was declared dead in 2014.

A geological map from 1901 estimated Okjökull spanned an area of about 38 square kilometres (15 square miles). In 1978, aerial photography showed the glacier was 3 square kilometres. Today, less than 1 square kilometre remains. The satellite images above show the glacier during the latter part of its decline, on September 7, 1986, (top) and August 1, 2019 (bottom). The images were acquired with the Thematic Mapper (TM) on Landsat 5, and the Operational Land Imager (OLI) on Landsat 8, respectively.

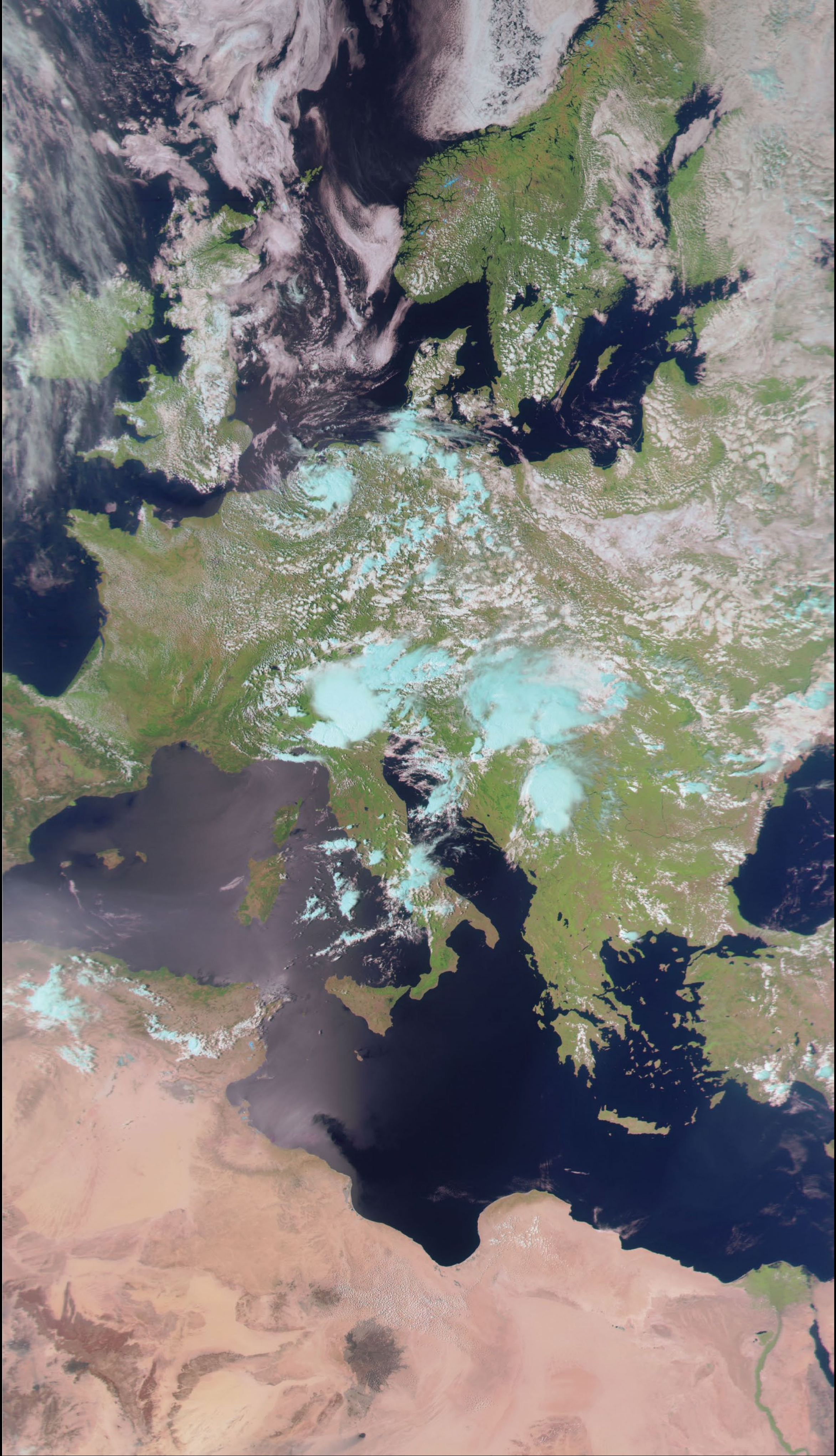
The dome-shaped glacier appears in the 1986 image as a solid-white patch, just north of the snow-filled crater. Snow is also visible around the glacier's edges. In the August 2019 image, only a spattering of thin ice patches remain. Notice the areas of blue meltwater, which are likely associated with the mass of warm air that hit Iceland as it moved from mainland Europe to Greenland in late July.

The glacier's demise is not just a matter of shrinking area. Glaciers form from snow that becomes compacted into ice over time. The ice then creeps downslope under its own weight, helped along by gravity. Okjökull has thinned so much, however, that it no longer has enough mass to flow. According to some definitions, a stagnant glacier is a dead glacier.

Okjökull, also called Ok (jökull is Icelandic for "glacier"), was part of the Langjökull group—one of Iceland's eight regional groupings of glaciers. Ice covers about 10 percent of the island, making it an integral part of the landscape. Loss of glacial ice has wide-ranging effects, with the potential to impact water resources, infrastructure, and even the rising of the land as it rebounds under a lighter load of ice.

Scientists have noted that glaciers have disappeared from Iceland before, although perhaps none as ceremoniously as Okjökull. Anthropologists from Rice University produced a film about the glacier's demise, and a plaque is set to be installed on the site of the former glacier.

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



This is another Meteor M2-2 image sent in by Norbert Pütz, one that he described as his best ever.
It was received on August 2 this year using a Russian style inverted V-antenna, pre amp and FUN Cube Pro+ dongle.

Currently Active Satellites and Frequencies

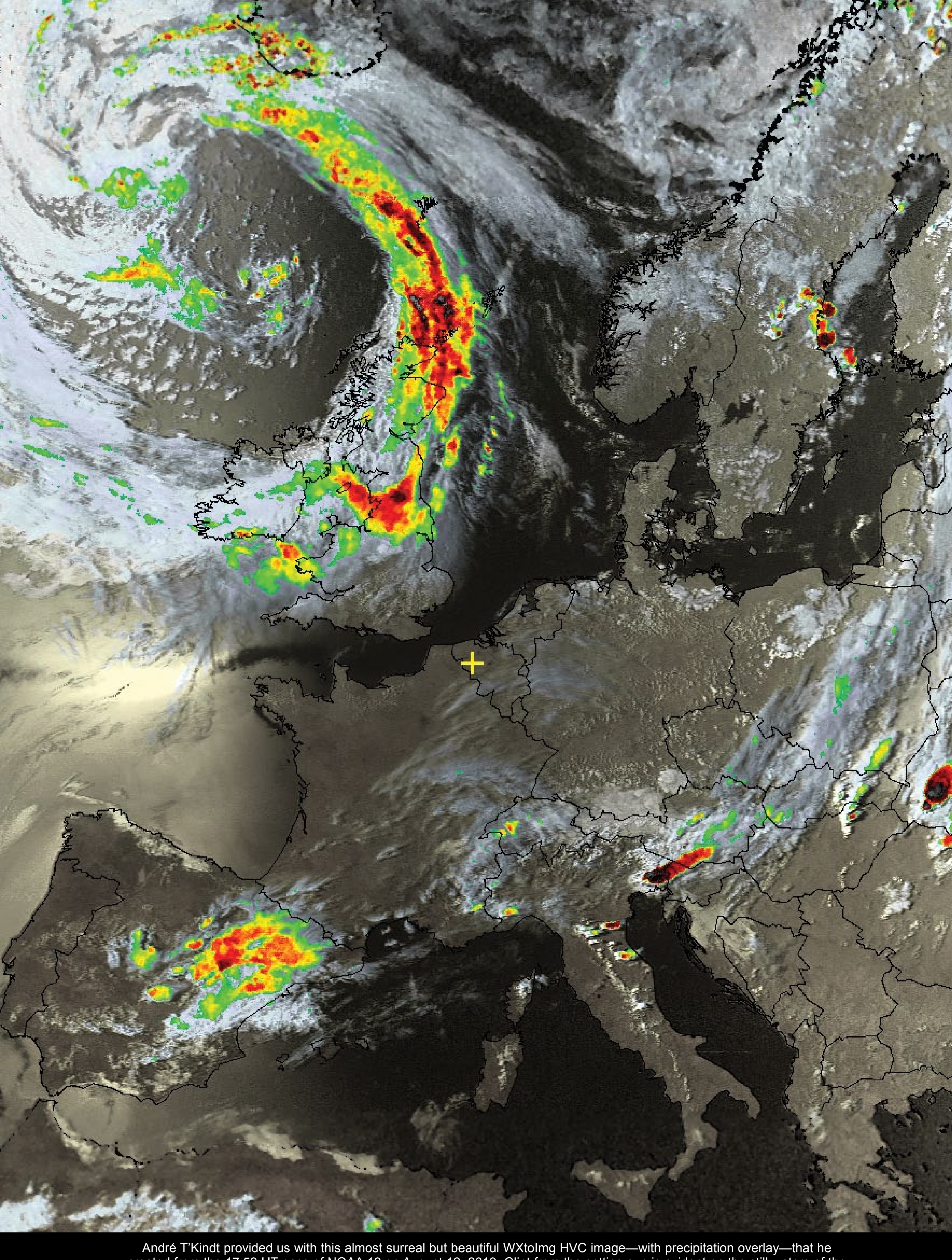
Polar APT/LRPT Satellites			
Satellite	Frequency	Status	Image Quality
NOAA 15	137.6200 MHz	On	Good
NOAA 18	137.9125 MHz	On	Good
NOAA 19	137.1000 MHz	On	Good [1]
Meteor M N1	137.0968 MHz	Off	Dead [8]
Meteor M N2	137.1000 MHz	On	Good
Meteor M N2-2	137.9000 MHz	On	Good

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
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	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.



André T'Kindt provided us with this almost surreal but beautiful WXtoImg HVC image—with precipitation overlay—that he created from the 17.59 UT pass of NOAA 19 on August 12, 2019. Glint from the setting sun is evident on the still waters of the Bay of Biscay while a band of intense rainfall, with thunderstorms, crosses the British Isles.