Inside this issue . .

For readers who enjoy experimenting with live APT reception, Devendra Kulkarni explains how to receive NOAA APT imagery via an RTL-SDR dongle and WxToImg, with the aid of Virtual Audio Cable software.

Francis Bell has spent a busy summer, spreading the word about the Group in his GEO Outreach Programme. He provides illustrated reports on his visits to the annual AMSAT Colloquium, and a Spacelink Event at Broadwater school.

It's rather unlikely that any reader has heard of Lake Tengiz, Kazakhstan's first UNESCO World Heritage Site. Now a major wetland, it lies six hundred kilometres northwest of the more familiar Lake Balkhash, the 15th largest lake in the world

And there is a host of articles from NASA's Earth Observatory website dealing with such varied topics as the Northwest Passage, Cloud Gravity Waves, the Taklimakan Desert, a volcanic eruption on Bristol Island and Ice in the Labrador Sea.

There are also articles from the ESA website relating to the Malaspina Glacier, Antarctic Peninsula Ice Flow and the Zachariae Isstrom glacier

Editorial

Les Hamilton

geoeditor@geo-web.org.uk

Our striking cover image this issue is an Astronaut Photograph shot from the International Space Station. You can read more about this scene in a NASA report on page 17.

During the past couple of years, we have featured a number of articles relating to reception of Russian Meteor satellites by means of an RTL-SDR dongle. Now, Devendra Kulkarni takes the technique a stage further by explaining how images from the NOAA satellites may also be obtained in similar fashion, making use, additionally, of *Virtual Audio Cable* software. A cautionary note is in order here for readers based in Great Britain, as pager interference is likely to be a problem in many locations.

Can I remind readers that GEO Quarterly No 52, due in December, will be our regular printed copy. All subscribers will receive a printed, paper version in addition to their electronic copy.

Finally, can I appeal to everyone's common sense and ask that material for publication be sent in **as early as possible**. I was extremely disappointed when, in the week following copy deadline for this issue, I was sent a large quantity of material for processing, much of which could have been submitted many weeks earlier. The copy deadline is intended as the final date for last minute submissions of important, up-to-date news. Do please send in your contributions as early as possible - don't wait till the copy deadline to do so. Thanks.

Copy deadline for the December issue of GEO Quarterly is Sunday, November 20, 2016.

Contents

The GEO Report

Francis Bell

The general membership of GEO may not realise how widely dispersed is our management team. We have a management team (MT) rather than a committee because of our formal structure which is a 'Limited Company', but effectively we have a typical committee with responsibilities divided into predictable areas.

This electronic age of the Internet and Skype allows our dispersed MT to keep in touch with each other without always physically meeting: instead, we engage in regular Skype meetings. At our last MT Skype meeting we all recognised the need to widen the scope of our MT with additional people with appropriate skills and commitment to our group.

Expansion of the GEO Management Team

If you think you can play a constructive rôle in our team, please recognise this is an invitation for you to offer your services to GEO. Almost any long term contribution would be appreciated but specific rôles which come to mind are:-

1 Public relations and promoting GEO membership
2 Educational matters, for example contact with schools and other educational institutions
3 Administrative skills
4 Book keeping and accounts
5 Technical skills dealing with RF, satellites and/or the use of computers
6 Any other relevant skills needed to run a dynamic world-respected group

If you can, please respond to this invitation, thus making your personal contribution to the success of GEO. For a positive response please contact any member of the existing GEO management team.

GEO Outreach

The past three months have been a busy time for me with GEO activities. I have recently represented our group at two significant space related events, reports about which appear shown elsewhere in this Quarterly [page 8 and page 40]. I'm sure there must be other similar space related events around the country so, if any GEO member wants help representing our group or displaying materials at such events, please contact the GEO management team and we will be as supportive as possible. A copy of *Spacelink's* information leaflet explaining what they offer to the community is reproduced on the following page.

I think, as a result of Tim Peake's time on the ISS and the Principia project, there will be new interest in space science within schools, with the potential for individual schools to run their own receiving stations. If you know of any such school please let GEO know the details.

Reception Formats

Because of other matters occupying my time, I think I may be lagging behind with the latest reception formats of the polar orbiting *Meteor* satellite and the *EUMETCast* HVS. Hence, in the coming weeks, I will be concentrating my efforts towards the personal reception of these data streams. Please let the editor know of your own experiences in these areas, thus helping us all to be as up-to-date as possible. I know the editor is always receptive for worthwhile copy material for the Quarterly, so here is a specific invitation for readers to provide their experiences in receiving the latest satellite signals.

Possible Members' Meeting in 2017

I would be interested in receiving feedback from members about the potential for a GEO annual meeting in 2017. Since our formation in 2003, with just a few gaps, we have held our annual meeting at the NSC Leicester; the gaps have been filled by a meeting at SSTL Guildford and three visits to EUMESCAT's HQ in Darmstadt, Germany. However, I need feedback from members for a preference venue for any 2017 meeting.

The attraction of a meeting in Darmstdat would be information about the latest developments relating the EUMETCast's HVS, but of course this venue would mean foreign travel and expense for many of us. Surrey Satellite Technology Limited (SSTL) based in Guildford is a dynamic and important international company, and a visit to their HQ together with our own meeting is a possibility. A repeat venue at the NSC Leicester would of course be straightforward if that's what members prefer. Please let me know your views in good time to complete the necessary administration and advertise the event to our members.

I can be contacted concerning any GEO matter at

francis@geo-web.org.uk

Future Events

GEO will be represented at the London Radio and Computer Rally, Kempton Park on the 6th November 2016. For details about this rally visit: www.radiofairs.co.uk

Visit GEO on Facebook

http://www.facebook.com/groupforearthobservation

Group for Earth Observation

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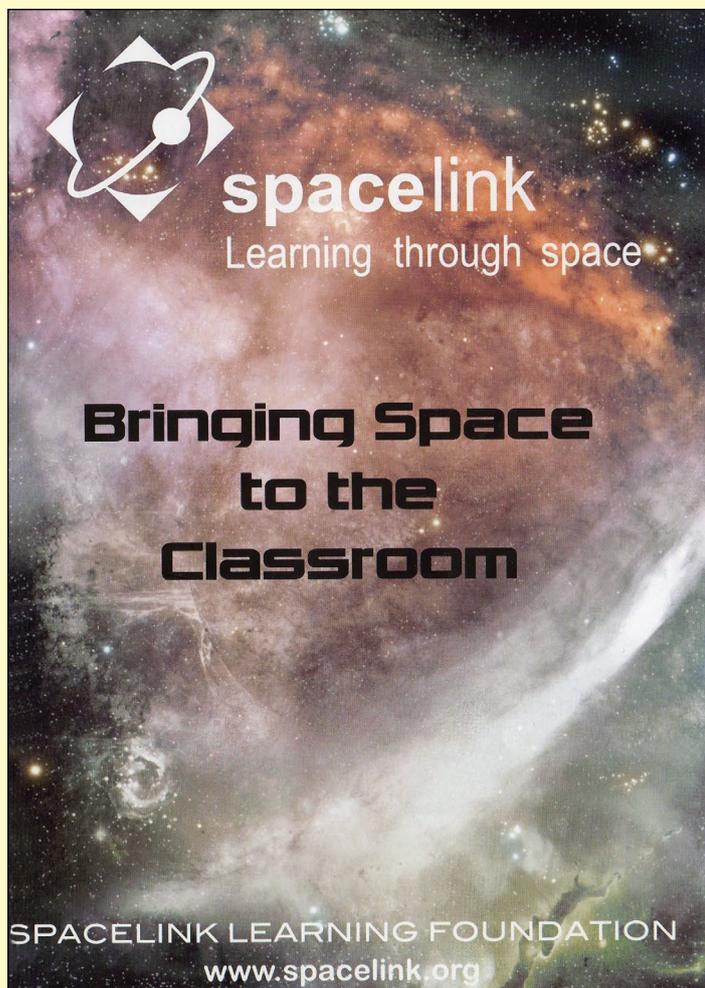
WHAT WE OFFER

- Nine specially-commissioned curriculum-related learning resources aimed at KS3 and KS4 but some are suitable for use at KS2. Two lessons, one from each KS are available free of charge for teachers to try. The full set of resources is available to Members of the Spacelink Club.

- The Helen Sharman Space Club Programme – designed for extra-curricular activities. Free access. Dr Helen Sharman, the first British woman astronaut, has been a Patron of SLF since the project started.

- To provide an inclusive E-customer Support Service to members of the Spacelink Club.

- Teacher Support

- Teachers' Forum

- Regular Newsletters

- Where possible in-school, support will also be available.

- Membership Fee – just £50 per annum. Promotional offer of £30 for a limited period.

How to become a Full Member

Just go to http://spacelink.org/become-full-member

As a full member, you will have access to all resources and support, as above.

A fun day at Polegate Primary School in East Sussex

Spacelink's Information Leaflet

Cover Image Details

Front Cover

This remarkable photograph was taken from the International Space Station, and shows a powerful Aurora in progress over Canada. You can read more about thyis event on page 17.

Inside Front Cover

The Sentinel-3A satellite imaged the United Kingdom, in this false-colour image acquired on May 9, 2016. In the southern North Sea/English Channel, an algal bloom is distinguishable in shades of light blue and green. Closer to the coast are brown sediments where rivers and streams run into the sea.

The Scottish Highlands appear light brown, representing bare soil and rock with some vegetation but otherwise, bright green represents vegetation.

© Contains modified Copernicus Sentinel data [2016]/ processed by ESA

Inside Back Cover

This **NOAA-18** HRPT image from Enrico Gobbetti was captured on July 18, 2016. Note the strong sunglint on the Mediterranean Sea between France and Tunisia.

Back Cover

The MODIS instrument aboard NASA's Terra satellite captured this image of an extra-tropical cyclone over Northeastern Canada at 16.50 UT on August 10, 2016. You can read more about this event on page 6.

Image: LANCE Rapid Response/NASA/GSFC

Copy Deadline

The copy deadline for GEO Quarterly No 52, our end-of year issue, is Sunday, November 20, 2016.

As this is our 'special' end-of-year issue, provided to members as a printed paper magazine in addition to the customary electronic copy, we are hoping for a great response from everyone for submissions of articles, news and satellite images.

The editor welcomes original contributions relating to any aspect of Earth Imaging, satellite monitoring/reception, and weather phenomena, which can be submitted to the editor in any convenient format.

Please note that **major articles** which contain numerous illustrations are time-consuming to prepare, and should be submitted **as early as possible** prior to the copy deadline.
Materials on media such as CDs may be sent to the editor,

> **Les Hamilton**
> **8 Deeside Place**
> **Aberdeen AB15 7PW**
> **Scotland**

Generally, the most efficient way to make submissions is by **email attachments** to

geoeditor@geo-web.org.uk

Particularly large attachments can be provided via a *DropBox* link.

Quarterly ? Question

Francis Bell

I often find myself frustrated when listening to so called scientific predictions relating to global warming and sea level changes broadcast on radio and TV programmes. There is no doubt that the Earth is experiencing superficial atmospheric, ocean and land surface warming but the causation of this is far from clear. I will submit my thoughts on this subject to the GEO editor at a later date but for the moment, offer a question about which the public media seems to be in total ignorance. The question relates to the melting of Earth's extensive sea ice surrounding the poles. If all this sea ice were to melt, by how much will the sea level rise?

For the purposes of calculation assume that 5% of the Earth's sea surface is covered with floating ice which has an average thickness of 2.0 m: this means that about 0.2 m of the ice is above sea level with 1.80 m of its thickness being below

sea level. These figures may only be approximate but are quite realistic for the calculation, By how much will the Earth's sea level rise if all this ice melts into liquid water?

There could be fine tuning of the calculations by taking into consideration the salinity of the ice and its volume at zero degrees as it melts into slightly warmed seas, but do not try to include these factors in your main analysis. Importantly do not consider the ice caps on Greenland and the land continent of Antarctica just consider the floating ice covering 5% of the sea surface with a thickness of 100 m.

As usual I offer a clue about the answer which is that you do not need a sophisticated calculator to come up with a correct answer.

Please email your answers to me,
francis@geo-web.org.uk
by Sunday, November 20, 2016.
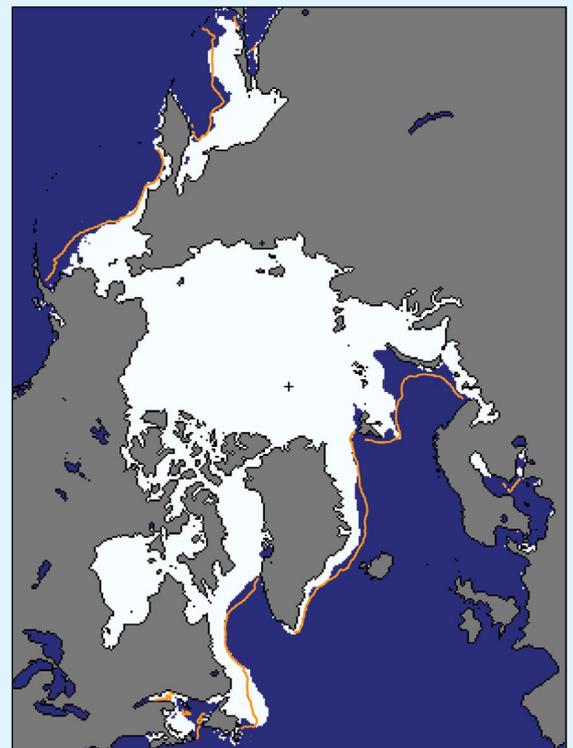
Arctic ice maximum in March 2016
Image: NSIDC

Quarterly Question 50 related to a satellite image of a circular structure on the surface of the Earth about 100 km in diameter. My thanks to those members who were sufficiently interested in the question to provide me with the correct answer: which was the Manicouagan crater located in Canada.

Coincidently, with out planning, a second image of this impact crater was shown on Page 23 as part of an image of NE USA and eastern Canada. The Manicouagan crater is clearly seen on the very top right hand third of this image and in this context the scale of the crater can be judged.

Below are some notes I have copied from the Internet relating to the Manicouagan crater together with a photograph of the largest dam retaining the lake's high water level for hydroelectric purposes.

The Manicouagan Crater is one of Earth's oldest known impact craters: it is sixth-largest confirmed impact crater on the planet

as measured by diameter, and the largest 'visible' one. It is located primarily in Manicouagan Regional County of Québec, Canada, about 300 km north of the city of Baie-Comeau. Created by the impact of a 5 km diameter asteroid or comet, research on the impact melt within the crater gives it an age of 214±1 million years. The crater is a multiple-ring structure, originally about 100 km across, although erosion and deposition of sediments have since reduced the visible diameter to about 72 km.

The most prominent feature is the crater's inner ring containing a 70 km diameter annular lake with a surface area of 1942 km²—the Manicouagan Reservoir—its waters contained by dams, the largest of which is shown in the accompanying photograph. In the centre of the reservoir stands René-Levasseur Island, and its highest point is Mount Babel. The lake and island are clearly seen from space and are sometimes called the 'eye of Quebec'. With a volume of 139.8 km³, this reservoir itself is the fifth largest in the world by volume.


The 214 m tall, 1314 m long Daniel Johnson multiple-arch buttress hydro-electric dam on the Manicouagan River
Inage: Dan Fleet at English Wikipedia

Franz Josef Land Revealed

NASA MODIS Web
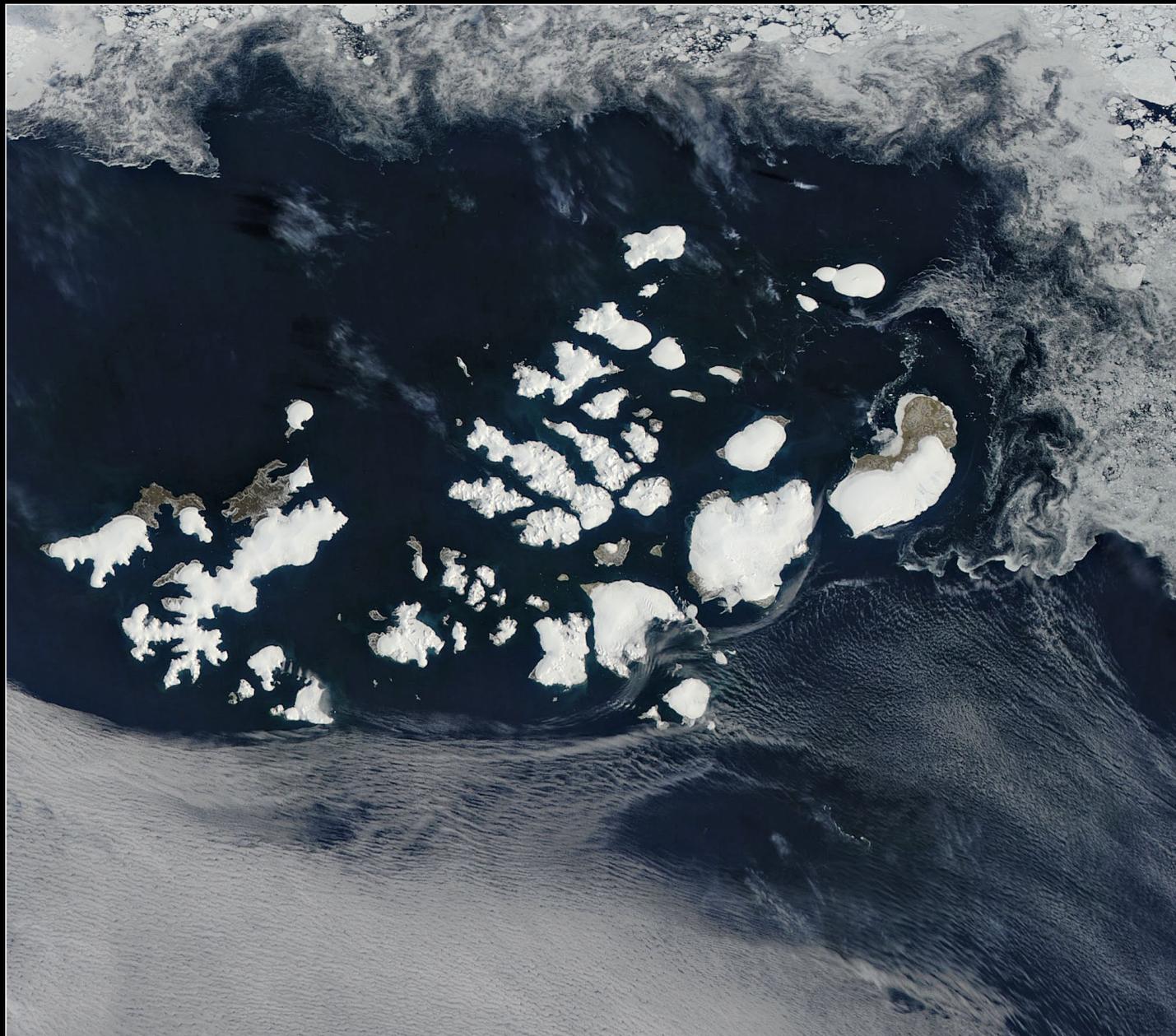
Franz Josef Land in the Arctic Ocean, imaged by NASA's Aqua satellite on July 13, 2016
Image: Jeff Schmaltz, MODIS Land Rapid Response Team, NASA GSFC

A beautiful nearly cloud-free summer morning in mid-July, 2016 allowed the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's **Aqua** satellite to capture a true-colour image of the still-frigid Franz Josef Land as it passed over the Arctic Ocean. This image was acquired on July 13, and shows snow and ice covering much of the archipelago, while filigrees of sea ice spin north of the islands and clouds cover the ocean to the south.

Franz Josef Land is Russia's northernmost territory, and the archipelago is made up of 191 islands. Glaciers cap many of the islands, and appears bright white in this image. In snow and ice-free areas the tundra appears pale brown.

The climate of Franz Joseph Land, which sits about 1,000 kilometres from the North Pole, can be extremely harsh, especially in winter. The average temperatures are just 2°C in summertime and -22°C during the winter.

The archipelago is part of the *Russian Arctic National Park*, which also includes not only Franz Josef Land but also the northern part of Novaya Zemlya. Glaciers cover about 85% of the islands year-round, especially on the larger ones. In most areas vegetation, where it exists, is limited to moss and lichens, although certain buttercups and poppies bloom in moist areas along with stands of polar willow. Due to the severe conditions, tall shrubs and trees cannot survive.

Severe Storm hits Canada

Damian OHara
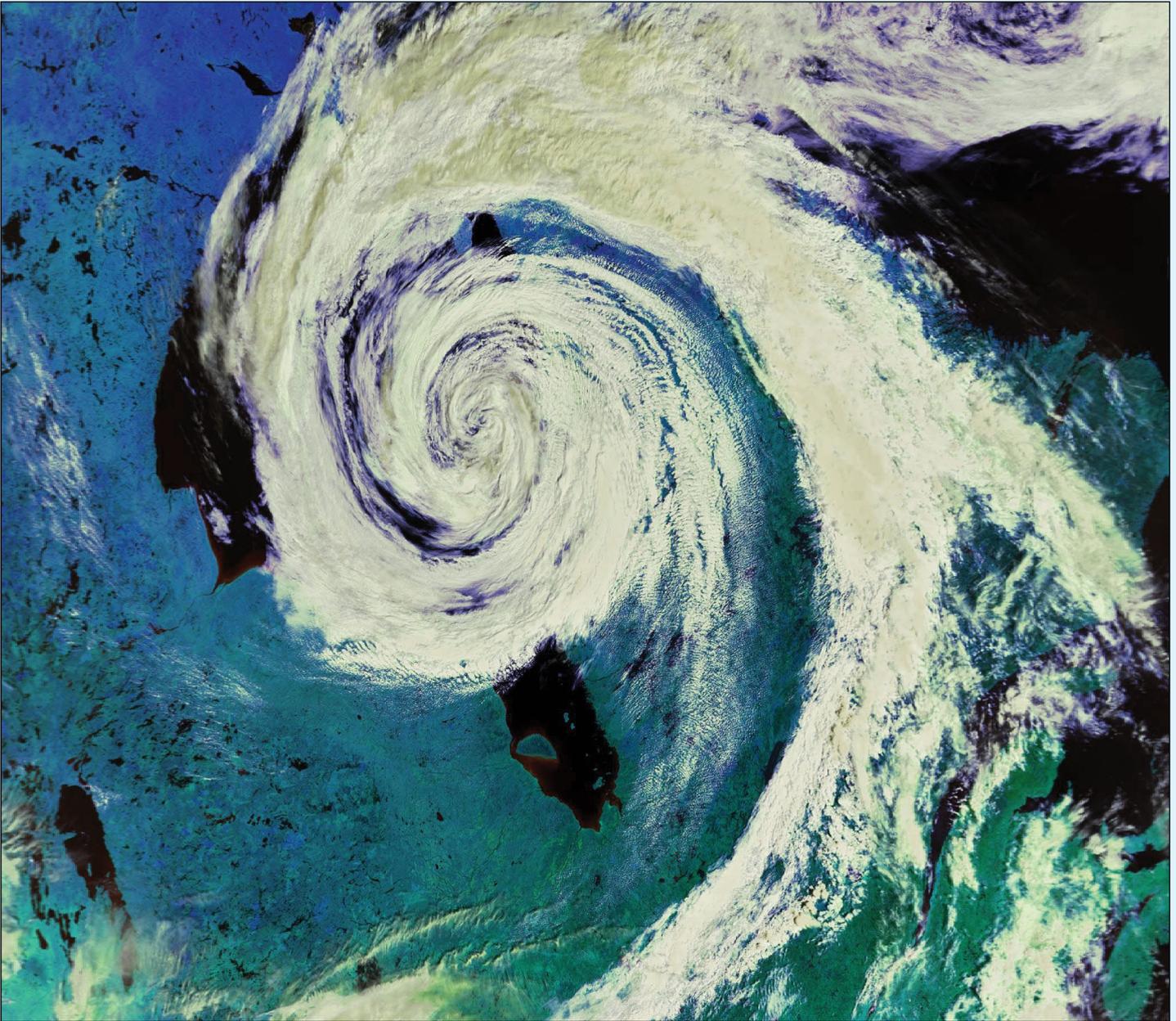
This Metop-B image showing the storm receding across Hudson Bay was acquired at 14:20 UT on August 10, 2016
Image © EUMETSAT 2016

I thought GEO Readers might be interested to see this **Metop-B** image that I downloaded via *EUMETCast*, which shows a major storm that had been causing some issues on the ground as it tracked across Canada. At the time of capture the storm obscured much of Hudson Bay, but James Bay and Akimiski Island are clearly visible to the South.

During the previous two days, this low-pressure system travelled east from Saskatchewan into Manitoba. In addition to large hail, intense rain and high winds, the storm spawned three reported tornados, one of them an *Enhanced Fujita Scale 2* tornado (EF2) which touched down in the *Waywayseecappo First Nation* about 280 kilometres northwest of Winnipeg during the early evening of August 8. *Environment Canada* assessors claimed that this tornado had wind speeds of between 180 and 220 kilometres per hour.

In the wake of the storm, one home was destroyed and seven others were damaged, their roofs twisted and shingles pulled off by the tornado. In the high winds, a 72-passenger school bus was toppled over and the air was filled with debris. Remarkably though, no-one was hurt in the event: the couple who lived in the home that was demolished had fortunately left it just an hour previously.

Some 70 people who fled their homes were put up in the Russell Inn just west of the community not long after the tornado hit between 5:30 pm and 6 pm.

I run a website of occasional images at

http://satblog.co.uk
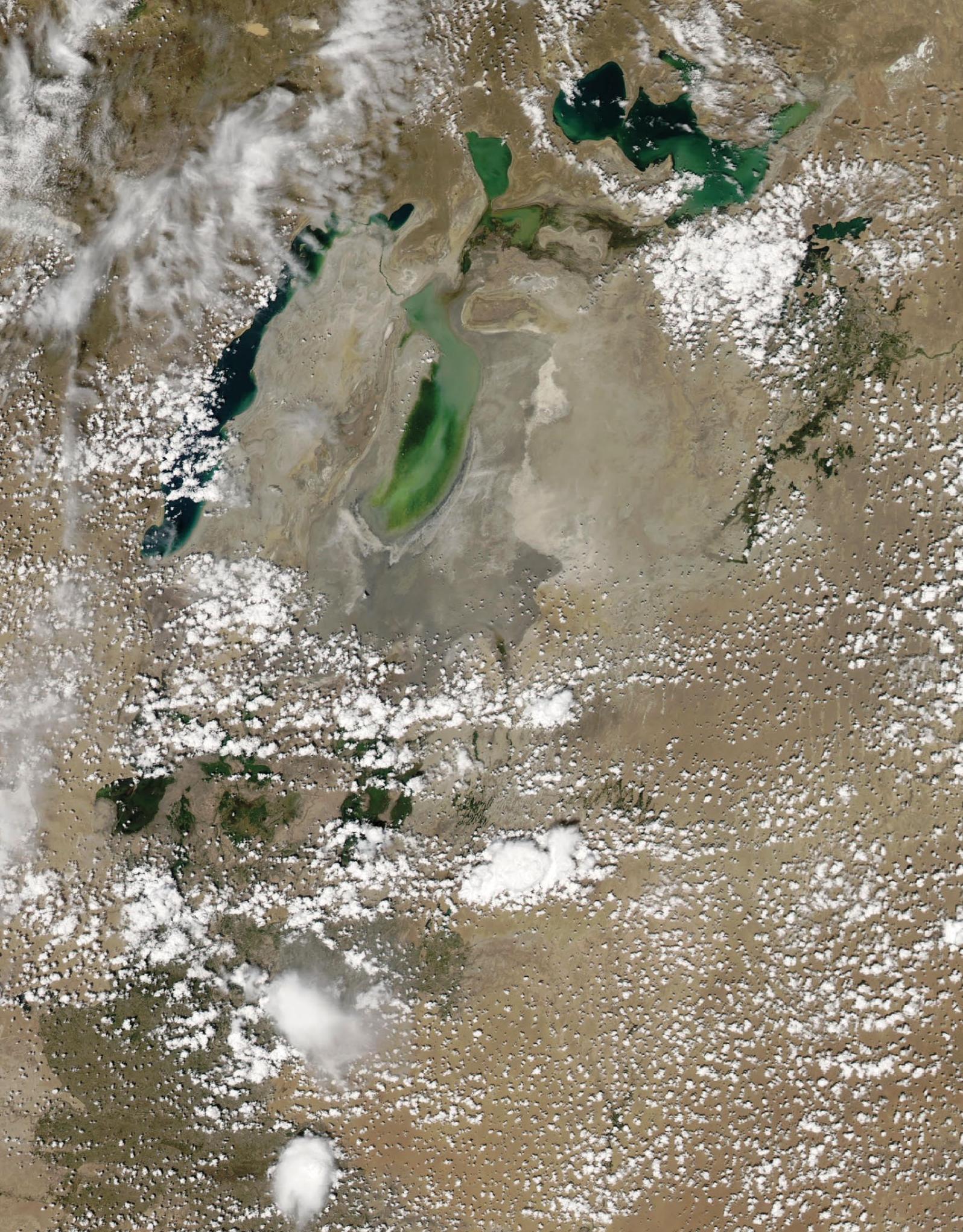
The Aral Sea was imaged by NASA's Aqua satellite on June 3, 2016, producing this MODIS image of the region. Compared with a year earlier, when it was completely dry, the eastern lobe of the Aral Sea now contains water.
Image: NASA/GSFC Rapid Response

GEO Outreach

Spacelink

Francis Bell

The GEO stand with literature and computer displays at the SpaceLink event in readiness for visiting students.

SpaceLink is an organisation, mainly based in the south of England, with the main objective of promoting space science within schools. The group regularly visits schools to make presentations and demonstrations relating to aspects of space science, including the direct reception of satellite data such as NOAA APT and EUMETCast.

In June of this year, *SpaceLink* held a full day event for interested schools at Broadwater School near Guildford, and GEO was invited to contribute to the day's activities.

The day consisted of a programme of brief formal presentations together with several breaks offering the students practical experiences in activities related to space science. GEO had a stand, and most of the students were introduced to the possibility of receiving weather satellite signals directly into their own homes or schools. The majority of students seemed genuinely interested in this potential hobby and enthusiastically gathered some of our GEO and EUMETSAT literature before departing our display area.

For more information about *SpaceLink* please visit their website at

www.spacelink.org

If you know of any schools which may be interested in receiving support in the area of space science I suggest you contact *SpaceLink* or GEO.

GEO member Robert Coombs, chairman of the *SpacLink* group with Lucie Green, solar physicist and a regular presenter on TV science programmes.

A section of the student audience at Lucie Green's presentation relating to solar science research at the *SpaceLink Experience*. The students thanked her for turning to sun on each morning!

Visiting students to the *SpaceLink Experience* collecting GEO and EUMETSAT literature from the GEO stand following the demonstrations.
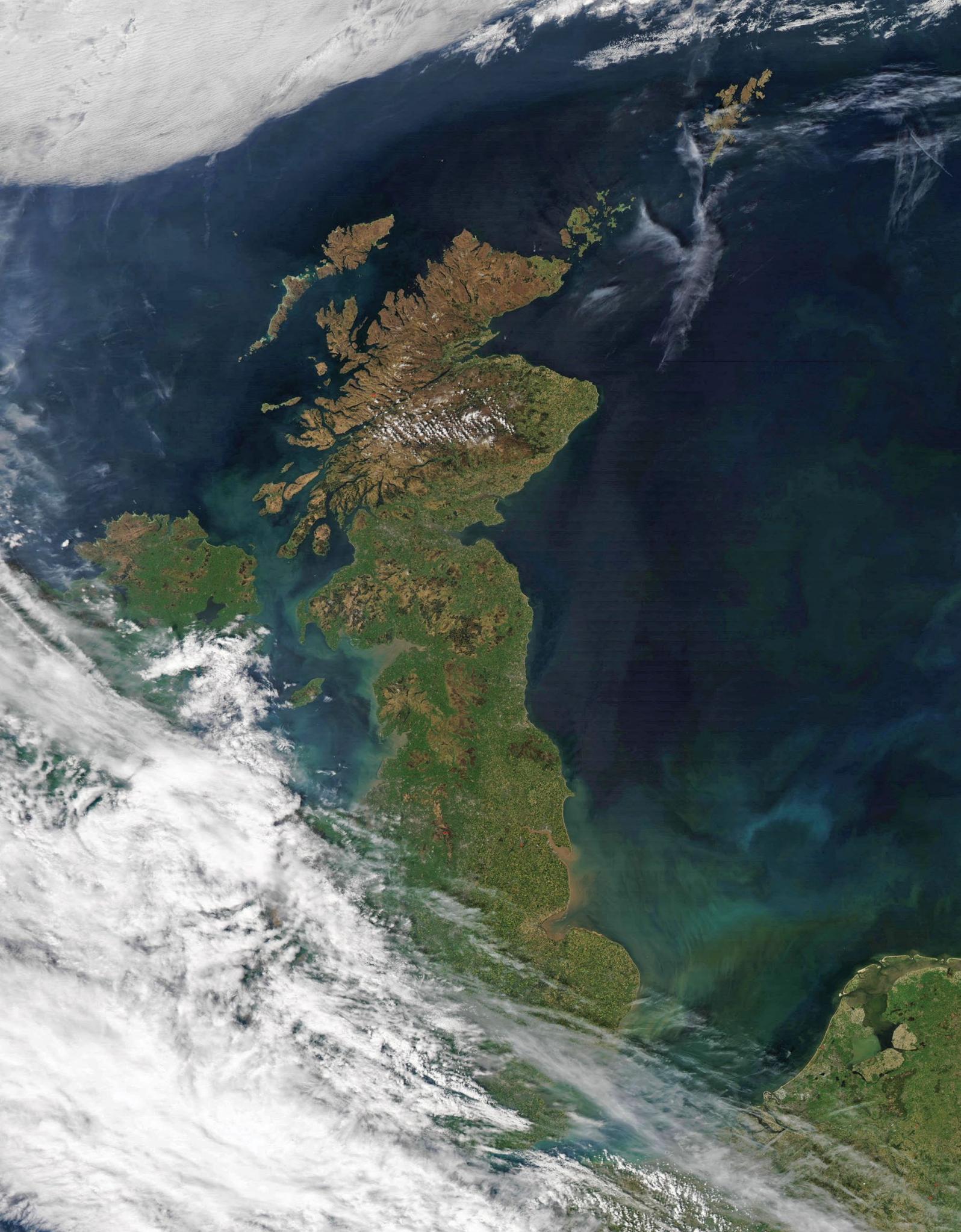
On May 9 this year, David Taylor spotted a particularly fine MODIS image of 'Sunny Scotland' acquired by NASA's *Aqua* satellite. Unfortunately, the scene was split between two successive image segments but, following a little manipulative wizardry using his *MODIS Defragger* and *CorrectGeometry* software, followed by slight tweaking in *Paint Shop Pro*, the image above was realised.

Image: NASA/GSFC

Cloud Free Iceberg A-56

NASA Earth Observatory

Cloudy skies often obscure satellite views of Earth and can hamper scientific research. But sometimes, the sheer beauty of a scene makes up for it. That was the case on June 1, 2016, when the NASA/NOAA **Suomi NPP** satellite captured an image of low stratus clouds perfectly framing iceberg A-56 as it drifted in the South Atlantic Ocean. Figure 1 shows a wide view of the area, acquired by Suomi's *Visible Infrared Imaging Radiometer Suite* (VIIRS). Figure 2 shows a detailed view of the iceberg and its immediate surroundings.

Measurements made by the *US National Ice Center* (USNIC) a few days prior to the acquisition of the image indicate that the iceberg is about 26 kilometres long by 13 kilometres wide. These dimensions equate to an area of about five times that of Manhattan.

Based on satellite imagery, it's hard to say for sure why the hole in the cloud cover formed immediately above the iceberg. On average, icebergs usually move more slowly than clouds (kilometres per day as opposed to kilometres per hour). NASA glaciologist Kelly Brunt suggested the possibility that, after the cloud bank moved into the vicinity of A-56, the relatively unobstructed path of the clouds over the ocean surface was interrupted by the thermal instability created by the iceberg. Steve Palm, a research meteorologist at NASA Goddard, agreed that the iceberg could have disrupted the air flow, or modified the atmosphere such a way as to cause the clouds nearby to dissipate.

According to Palm: "*When an obstacle is big enough, it can divert the low level flow around it. This causes divergence*
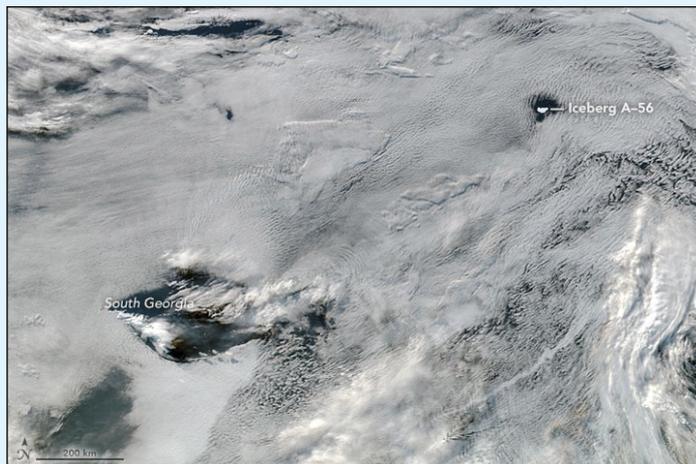
Figure 1 - Iceberg A-46 in relation to South Georgia

of the flow at low levels and a corresponding convergence and sinking motion above and downstream of the obstacle. The sinking motion warms and dries the air, causing a hole in the clouds. This is a common phenomenon, often caused by islands."

Brunt and Palm emphasise that these explanations are based solely on looking at the satellite images. Closer analysis of meteorological data collected by instruments on the ground, or generated by atmospheric modelling, could point toward other causes.

NASA image by Jeff Schmaltz, LANCE/EOSDIS Rapid Response
Caption by Kathryn Hansen
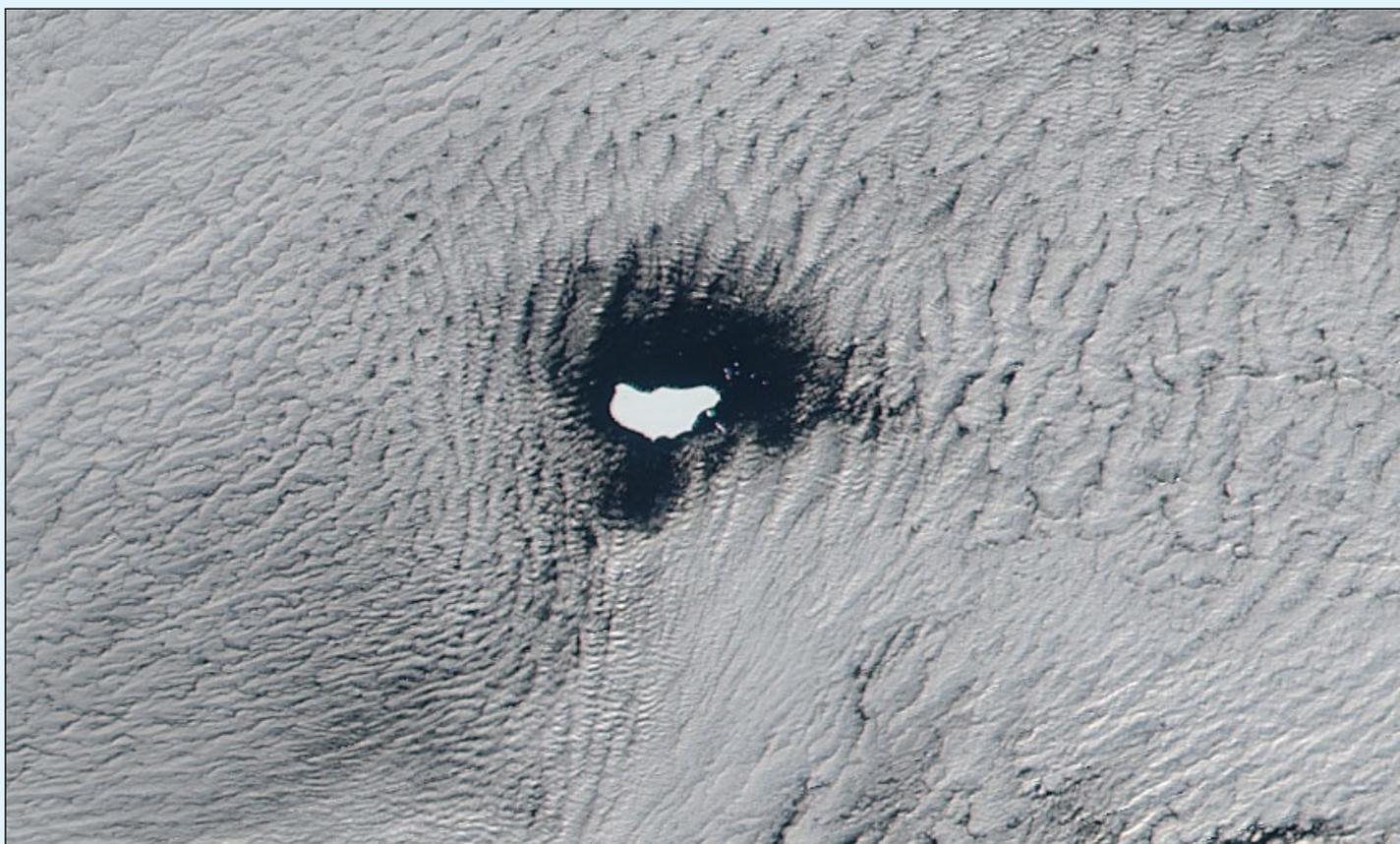
Figure 2 - A close-up segment of the above image, showing Iceberg A-46 in its cloud hole.
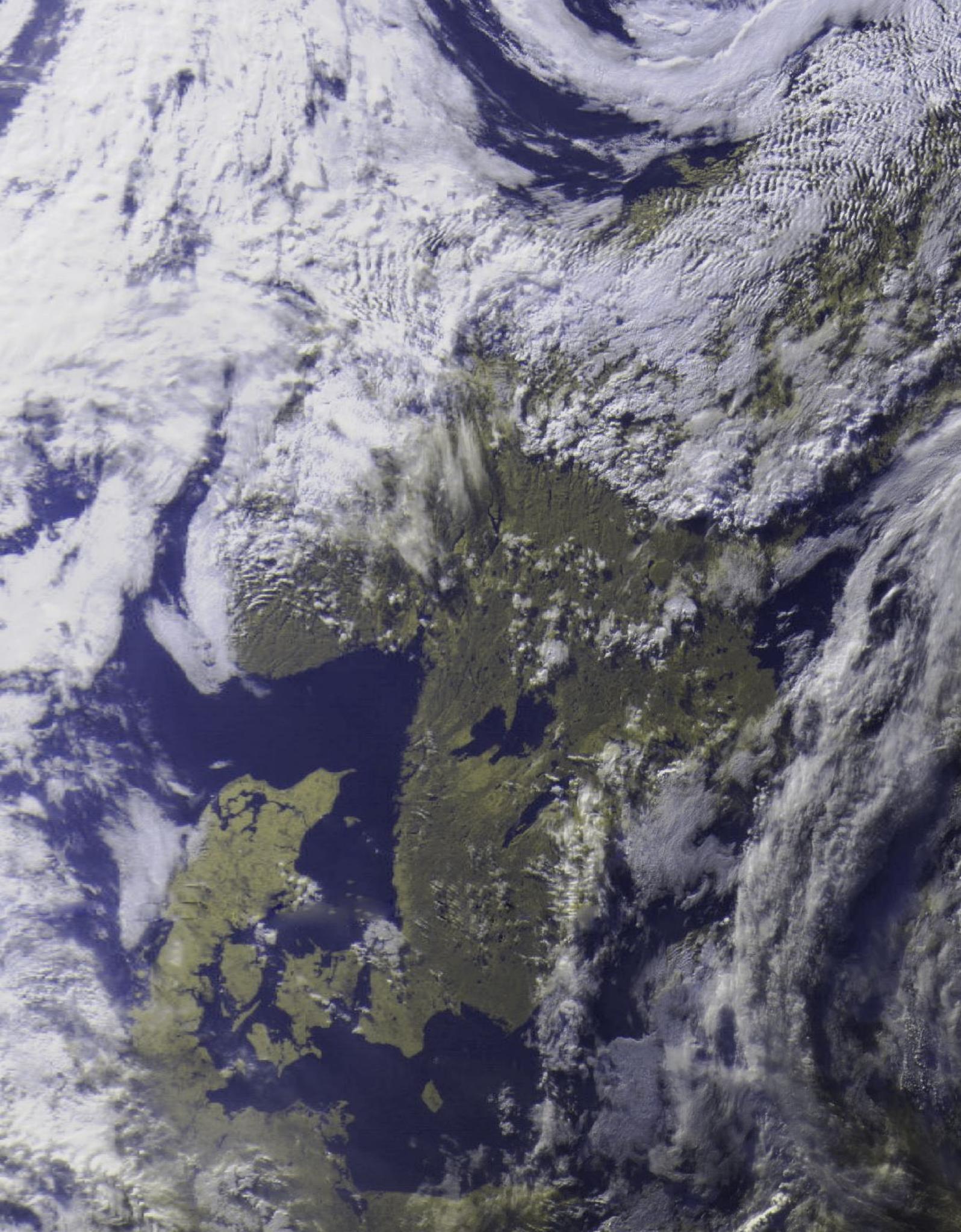
It's the summer solstice, and Meteor M2 is enjoying a spell of evening sunshine. This image, acquired from the 18:38 UT pass on June 21, 2016 reveals parts of Denmark, Norway and Sweden peeking through the clouds.
Image: Les Hamilton

Unusual Cloud Feature in Mid Wales

Robert Moore
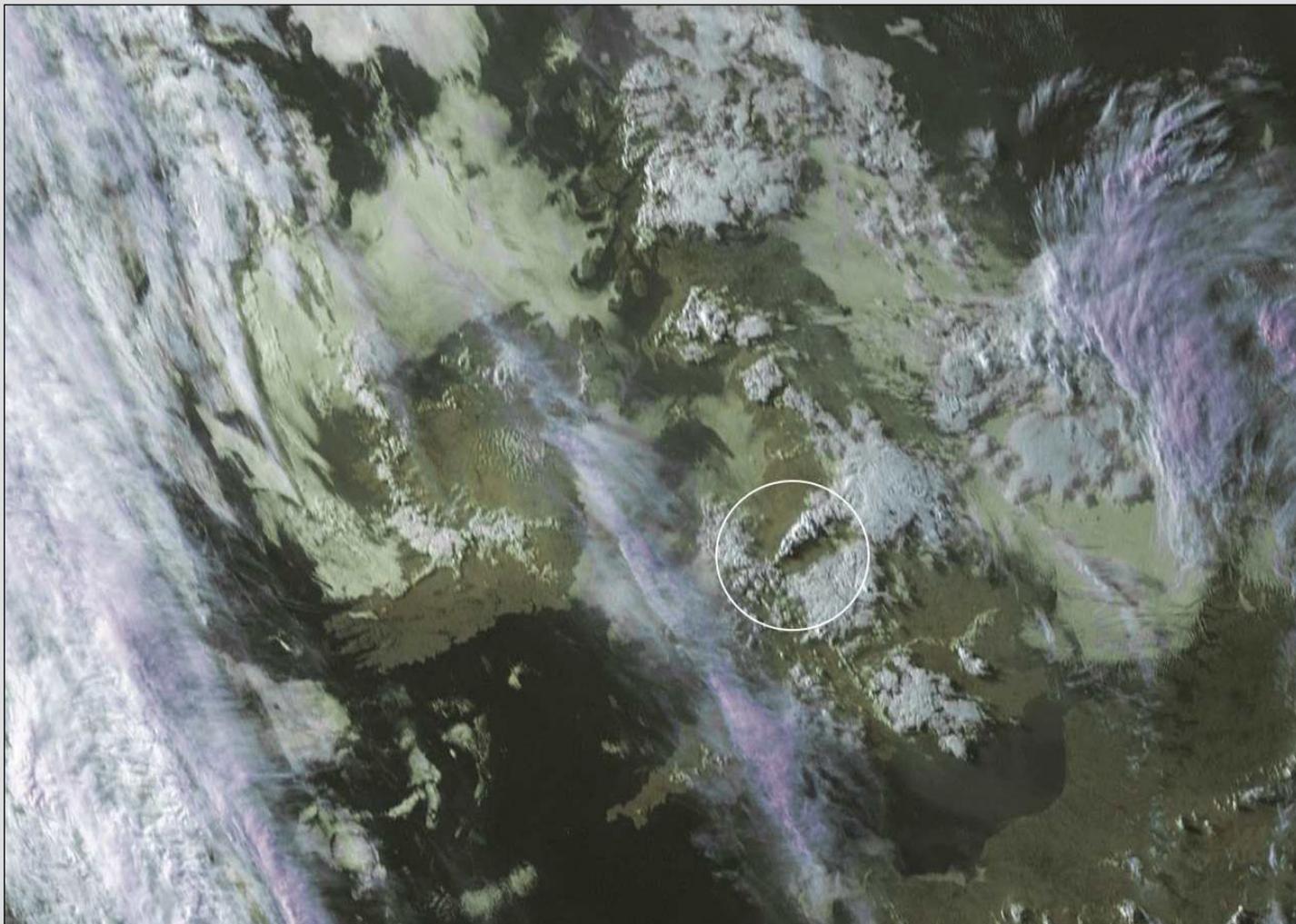
Meteosat-10 imaged the UK at 18.00 UT on June 9, 2016
Image © EUMETSAT 2016

There was a rather interesting-looking cloud structure lying roughly from mid-Wales to Manchester on June 9, 2016 (circled in the Meteosat-10 image above).

The south westerly end was very pointed, so out of curiosity I consulted an Ordnance Survey map. The point was right on Breidden Hill, a very prominent hill just to the north of Welshpool. My best guess is that this was orographic cloud formed by the rise of warm and damp south-westerly air over the hill. We are able to pinpoint the end of this cloud because Breidden Hill stands in otherwise gently rolling countryside, near the village of Criggion. The hill is a very striking feature of the landscape, visible from some distance both from the road and the railway.

Radio enthusiasts may know that Criggion was one of the locations for a radio station transmitting on very low frequencies for signalling the launch of nuclear weapons from submerged UK submarines (presumably with US permission). The other two sites were Anthorn and Rugby. A memorable train journey from Aberdeen to Aberystwyth in the early 1980s took me past all three sites. The Criggion station was dismantled some years ago.

It's nice to see Breidden doing what hills do—creating orographic cloud - rather than launching a war.

Breidden Hill rising above Criggion Village
Photo: GoogleEarth/StreetView

ALASKA'S MALASPINA GLACIER

European Space Agency
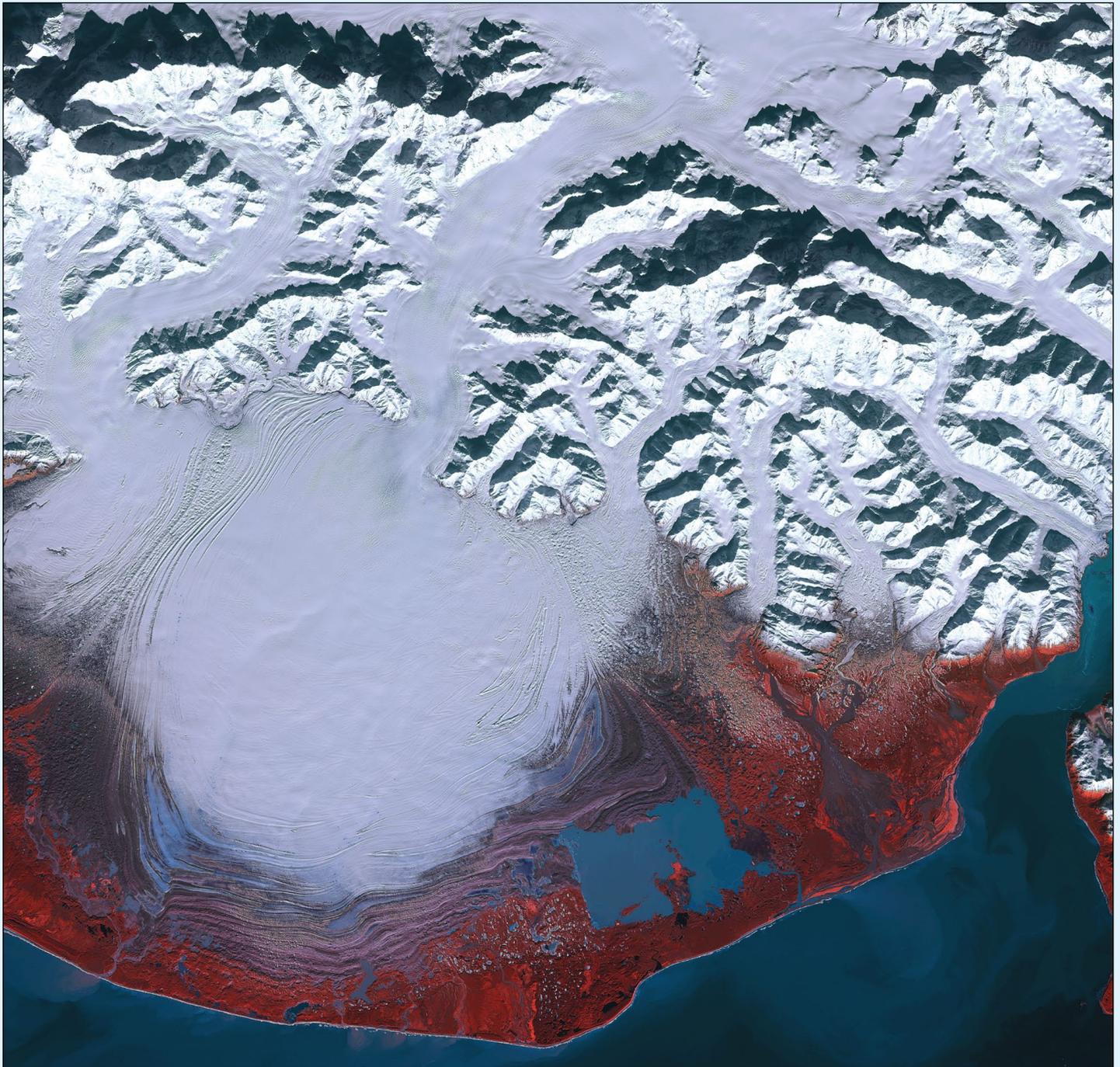
The **Sentinel-2A** satellite takes us over southeastern Alaska to the Malaspina Glacier. Throughout the past 12.5 million years, the climate and topography of this area have been favourable for glaciers and, during the Ice Age, a vast ice sheet covered this spot. When temperatures rose, an interglacial period began.

The coastal mountains and the maritime climate of this area provide the perfect setting for glaciation: some of the world's longest and most spectacular glaciers are found here. Malaspina is a piedmont glacier—meaning that ice flows down a steep valley then spills out and spreads across a relatively flat plain. Malaspina is the largest of its kind, with an area of about 3900 square kilometres.

In this false-colour image, red depicts vegetated areas while purple shows rock. The wavy purple lines around the lower half of the glacier are moraines, consisting of rock, soil and other debris that have been deposited by the glacier. Satellite data show that the elevation of Malaspina has dropped over recent decades, an ice loss that has made a significant contribution to sea-level rise.

This image was acquired on March 8, 2016. The low sun level at Alaska's high latitudes during this season is evident by the shadows cast north by the Elias Mountains.
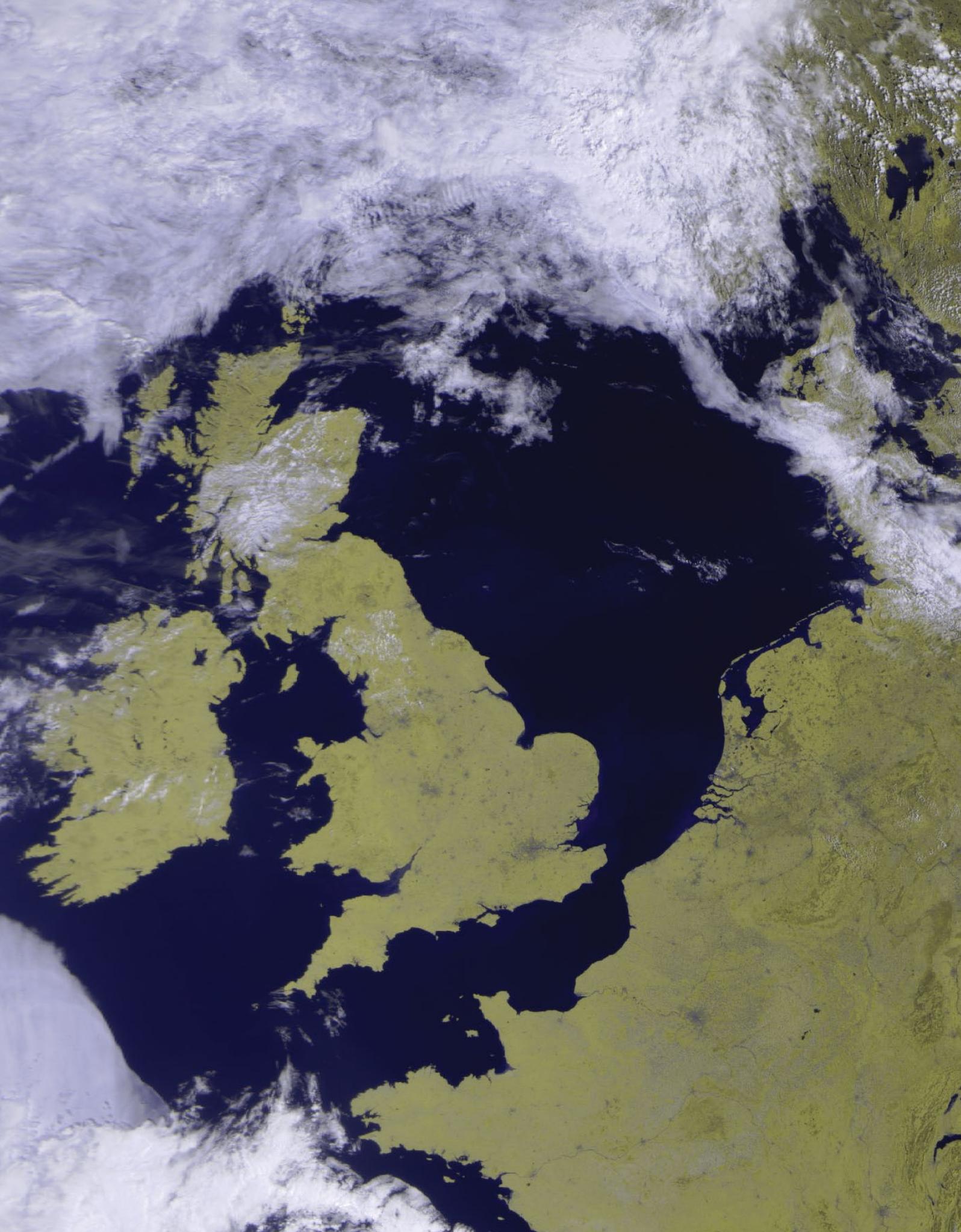
Summer arrived with a vengeance on July 19 this year when temperatures soared into the 30s Celsius over
much of England, the Netherlands and France. Meteor M2 captured this largely cloud-free scene.

Passage Through Nunavut

NASA Earth Observatory
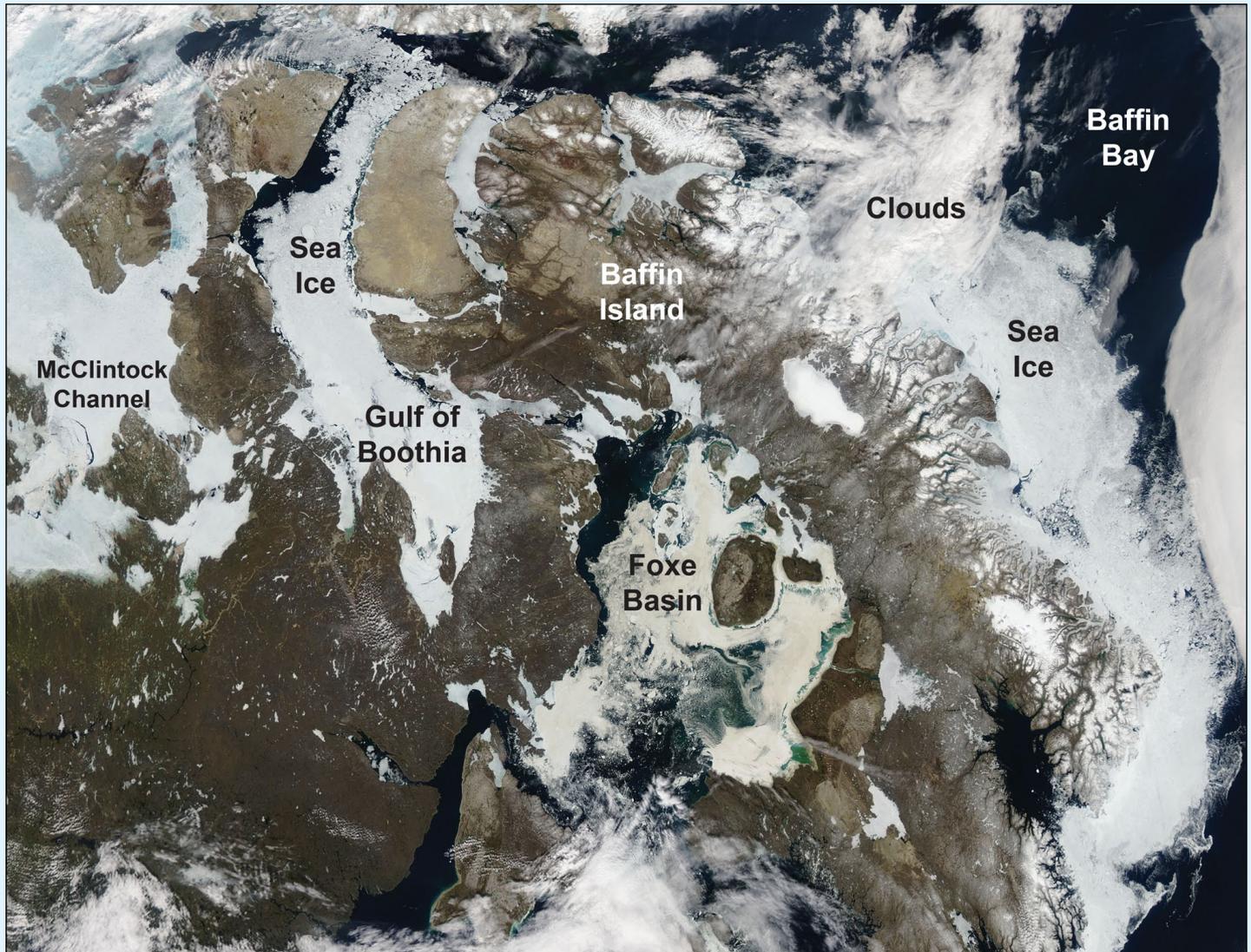
Summer usually brings foggy and cloudy conditions to Baffin Island in the remote reaches of Canada's Nunavut Territory. But on July 5, 2016, nearly-cloud free conditions provided an unusually clear view of the region.

This natural-colour image was acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Aqua** satellite. Nunavut encompasses most of the Canadian Arctic Archipelago, a network of high-latitude islands embedded within the Arctic Ocean. The scene shows a southern part of the archipelago, with a bank of clouds hangs offshore of western Greenland.

While Baffin Island is not Nunavut's northernmost isle, much of it falls within the Arctic Circle. This means cold, dark winters with many days when the sun never rises above the horizon. Temperatures plunge, and gulfs, bays, and other waterways freeze over with sea ice. With the onset of summer and increasing sunlight, that ice begins to break up.

In this image, summer sea ice still clogs the McClintock Channel and Gulf of Boothia. It persists in the fjords of Baffin Island and the narrow passage of Davis Strait. In contrast, ice in some of the larger bodies of water (such as Baffin Bay) has broken up, revealing the dark surface of the sea.

The waterways toward the left and top of the image are part of the southern route of the Northwest Passage, a winding maze of sounds, channels, bays, and straits that sometimes allows ships to pass from the Atlantic to the Pacific Ocean. For most of the recorded history of North America, the Passage has been nearly impassable. But the modernisation of ships and the warming of Earth has made voyages through the Canadian Archipelago more common. According to news reports, the *Nunavut Impact Review Board* is considering whether to allow a luxury cruise ship to navigate from Alaska through the thawing southern passage in August 2016.

By August and September, further melting could make these waterways look dramatically different. In August 2015, the southern passage opened for several weeks, while the northern passage remained clogged. But whether the passage will completely open in 2016 remains to be seen. Winds can move ice in unpredictable ways, pushing it into and out of channels.

NASA image by Jeff Schmaltz, LANCE/EOSDIS Rapid Response. Caption by Kathryn Hansen.

Antarctic Peninsula Ice Flow

European Space Agency

Successive radar images captured by the **Copernicus Sentinel-1A** satellite between December 2014 and March 2016 were used to create this spectacular map showing how fast the ice flows on the Antarctic Peninsula. The map was constructed by tracking the movement of ice features in pairs of radar images taken twelve days apart.

The Antarctic Peninsula is a narrow mountainous finger or spine of land extending northwards, away from the Central Antarctic ice sheet (lower right corner) and comprising the northernmost arm of the Antarctic ice sheet.

The colour scale indicates the speed of ice movement in metres per day, ranging from *one centimetre* or less per day in dark blue, and up to *one metre* per day in red. The vivid colours trace a complex network of channels along which streams of ice flow from the high mountains down towards the coast, where the ice flow speeds up and spreads out into floating ice shelves. The white area on the western flank of the peninsula is where snowfall is likely to have concealed features and so prevented tracking between the image pairs.

As one of the most dynamic glacial environments on Earth, this region has been experiencing rapid climate warming over recent decades. Since 1991, satellites such as ESA's *ERS* and *Envisat* have observed the disintegration of various ice shelves, including the northern portion of the Larsen ice shelf and the Wilkins ice shelf.

The Sentinel satellites, developed by ESA, are central to Europe's environmental monitoring Copernicus programme, which is committed to long-term operational services for a wide range of applications. This example shows the spectacular potential of the **Sentinel-1** mission for routine mapping and monitoring the surface velocity of glaciers and ice sheets. The combination of Sentinel-1A and -1B will support comprehensive and long-term monitoring of changes in ice sheet velocity and how they respond to climate change.

The Sentinel-1 ice velocity product was presented at ESA's Living Planet Symposium in Prague, Czech Republic in May 2016 and three weeks earlier at the European Geosciences Union General Assembly in Austria.

Rate of Ice Flow (metres/day)

0.01   0.1   1.0   10

0   200 km
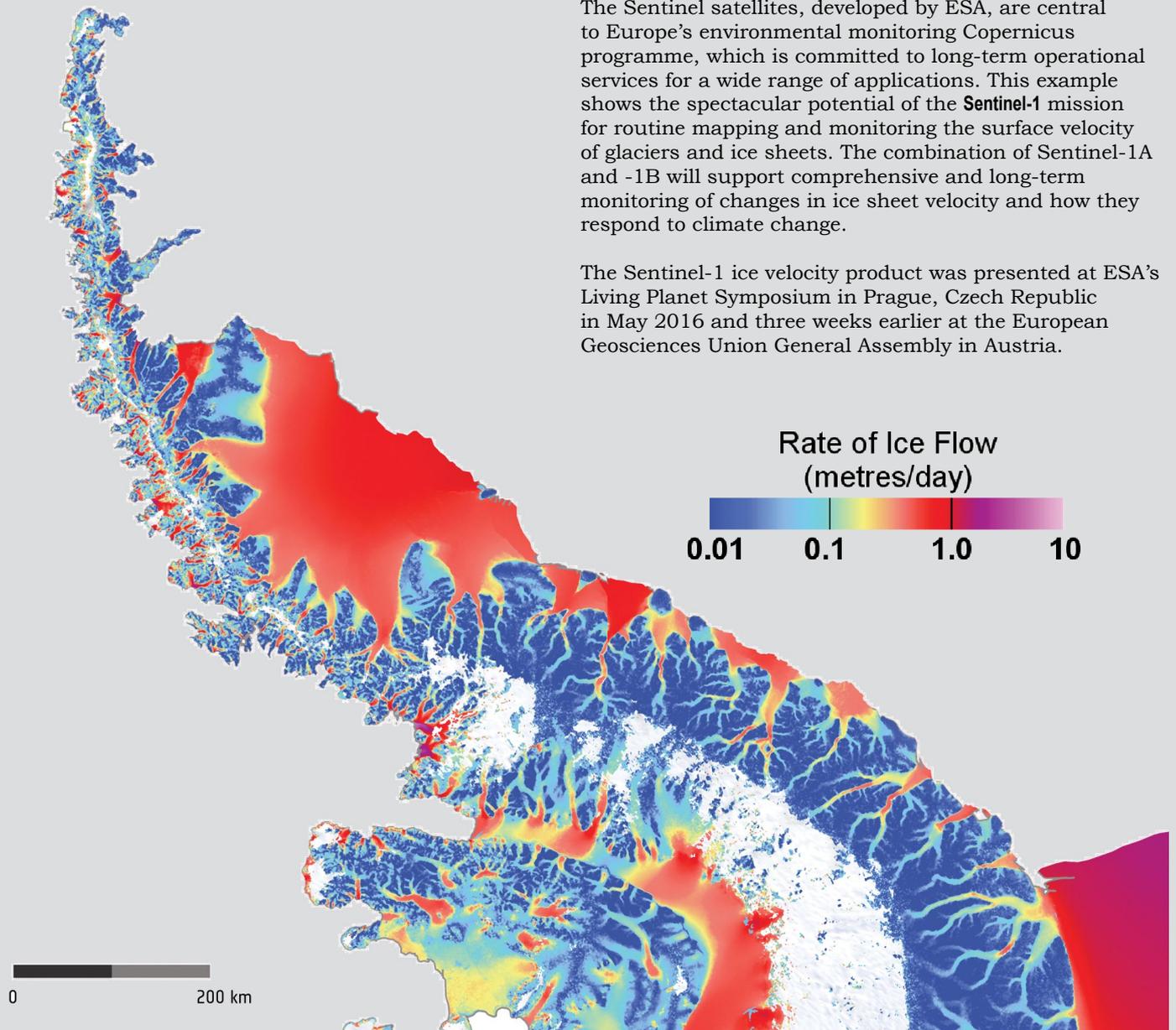
Image: ESA
Copyright contains modified Copernicus Sentinel data (2015), processed by Enveo

Aurora and Manicouagan Crater

NASA Earth Observatory
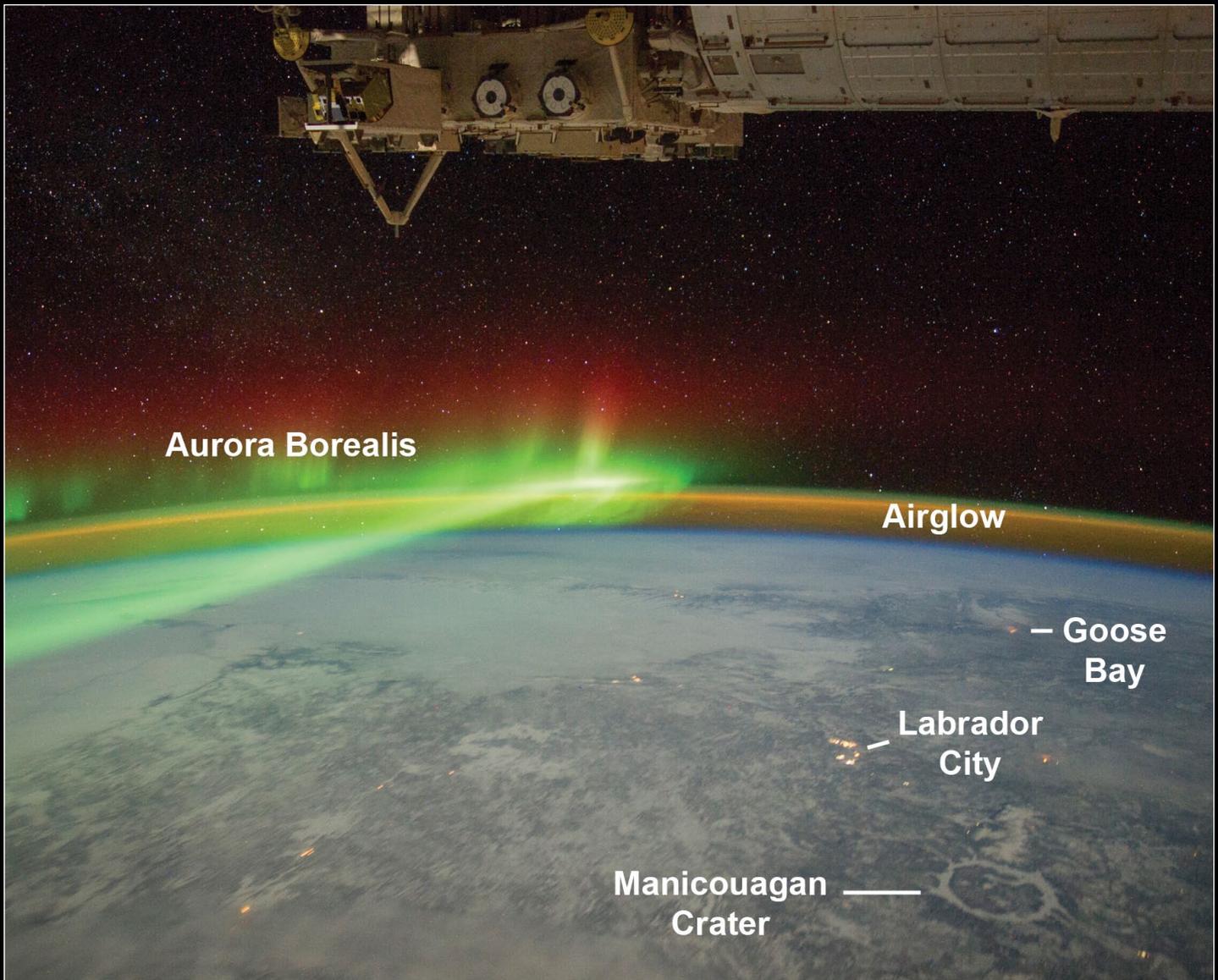
An astronaut aboard the International Space Station adjusted the camera for night imaging and captured the green veils and curtains of an aurora that spanned thousands of kilometres above Quebec, Canada. See also our front cover for an unannotated version of this image

Snow and ice in this winter image reflect enough light from stars, the Moon, and the aurora to reveal details of the landscape. On the lower right, we see a circle of ice on the frozen reservoir that now occupies the 70 km diameter Manicouagan impact crater. Additionally, city lights reveal small settlements such as Labrador City, and the Royal Canadian Air Force base at Goose Bay on the Labrador Sea.

The *Aurora Borealis* glow in the night sky when charged particles in the *Solar Wind* accelerate through Earth's magnetosphere. These particles collide with atoms in the atmosphere: the green and red colours are caused by the release of photons from oxygen atoms. The fainter arc of light that parallels the horizon is known as airglow. This is another manifestation of the interaction between Earth's atmosphere and radiation from the Sun.

The atmosphere shields life on Earth from the Sun's harmful radiations, as well as causing small asteroids to burn up or catastrophically explode before hitting the ground. Larger asteroids can occasionally penetrate the atmosphere and collide with our rocky planet—with dramatic effects.

Geologists know that a large asteroid slammed into Earth roughly 214 million years ago, creating a crater about 100 kilometres across on the landmass that is now part of Canada. The impact caused a shock wave to radiate across Earth's surface, followed closely by high-velocity winds. Near the impact point, wind speeds could have exceeded 1000 kilometres per hour. The shock wave and air blast would have severely damaged and killed plants and animals out to distances of at least 500 kilometres—as far as Goose Bay. After millions of years of erosion by glaciers and other processes, the Manicouagan crater has been reduced to about 60 kilometres in width.

Astronaut photograph ISS030-E-110900 was acquired on February 3, 2012, with a Nikon D3S digital camera using a 28 millimetre lens, and 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 30 crew.

Receiving APT Weather Images from NOAA Satellites
using an RTL-SDR Dongle

Devendra Kulkarni
(email: devendrakulkarni5@gmail.com   twitter:https://twitter.com/dak5755)

The Automatic Picture Transmission (APT) system is an analogue image transmission system developed for use on weather satellites. It was introduced in the 1960s and over four decades has provided image data to relatively low-cost user stations at locations in most countries of the world. A user station anywhere in the world can receive local data at least twice a day from each satellite as it passes overhead. Their reception can be done using low cost DVB-T USB sticks containing the RTL820T or RTL820T2 chipset (figure 2) along with a QFH, Turnstile or Double Cross Antenna (figure 3), which can be homebrewed from PVC pipes, copper or coaxial cable.

As of July 2016, there are three NOAA APT satellites in service: NOAA 15, NOAA 18 and NOAA 19.

Essential Software

SDRSharp is a freeware Software Defined Radio interface which allows us to tune into the desired frequency. It is now distributed under the *Airspy* banner, and can be downloaded from their website at

http://airspy.com/download/

When you have downloaded *SDRSharp,* extract it into the folder where you wish to store it.

Orbitron is a satellite tracking system for radio amateur and observing purposes. It's also used by weather professionals, satellite communication users, astronomers, UFO hobbyist and even astrologers.

Orbitron shows the positions of satellites at any given moment (in real or simulated time). It's **free** (Cardware), and it's probably one of the easiest and most powerful satellite trackers. It can be downloaded from

http://www.stoff.pl/

WXtoImg is a fully automated APT and WEFAX weather satellite (wxsat) decoder. The software supports recording, decoding, editing, and viewing on all versions of Windows, Linux, and Mac OS X.

http://www.wxtoimg.com/
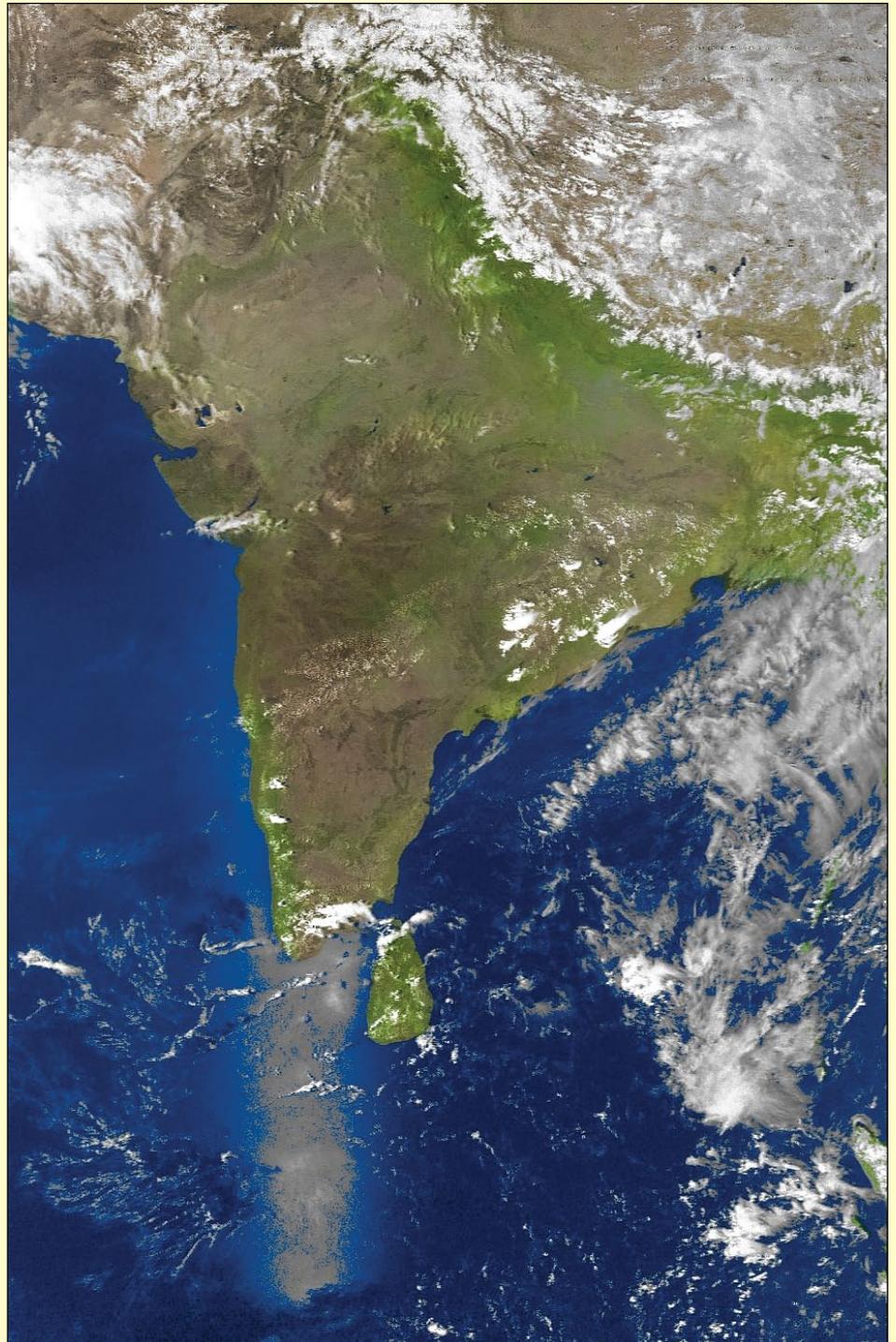
Figure 1 - This NOAA 19 image has been processed as MSA in WXtoImg

Figure 2 - A DVB-T dongle with RTL2832U, RTL820T or RTL820T2 chipset for reception.

Figure 3 - The author's homebrew QFH antenna for NOAA reception

WXtoImg is now in the public domain (free) as explained in the previous issue [1] of *GEO Quarterly*.

VB-Cable (Virtual Audio Cable) is an audio driver that will port the audio from *SDRSharp* directly into *WXtoImg* for live decoding. You can download VB-Cable from

http://vb-audio.pagesperso-orange.fr/Cable/

After downloading and installing VB-Cable, open Windows Control Panel and double-click 'Sound'. The *Sound Manager* panel shown in figure 4 should appear.
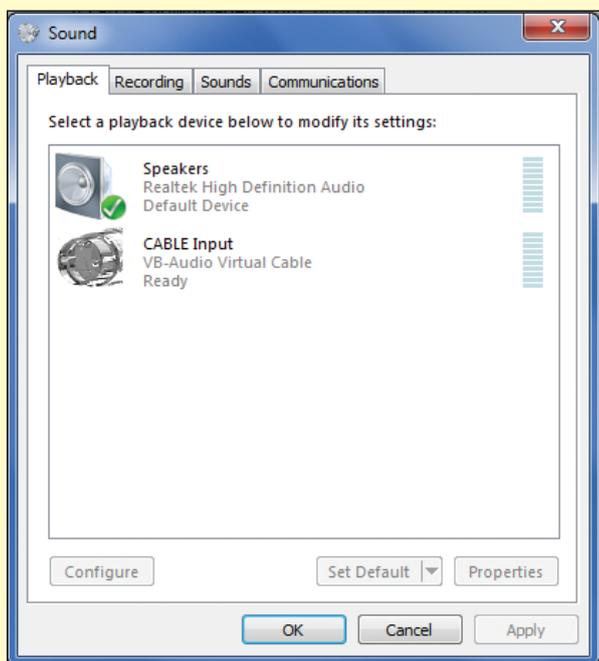

Figure 4 - The Windows Sound Manager playback tab

Set the default playback device as **Speaker**. This will allow you to mute the speaker while a satellite signal is recorded in the background using *Virtual Audio Cable.*

Set the default Recording device (figure 5) as **CABLE Output**. By setting VB-Cable as default recording device, *WXtoImg* will port the audio directly from the SDR's audio output.
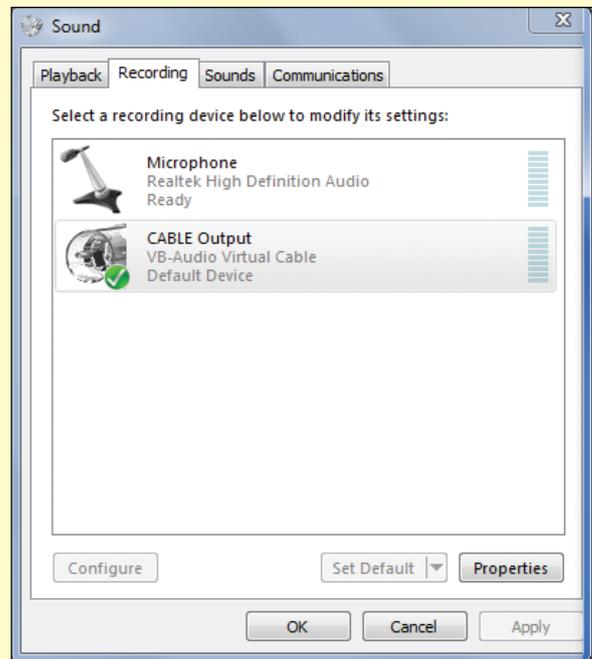
Figure 5a - The Windows Sound Manager recording tab
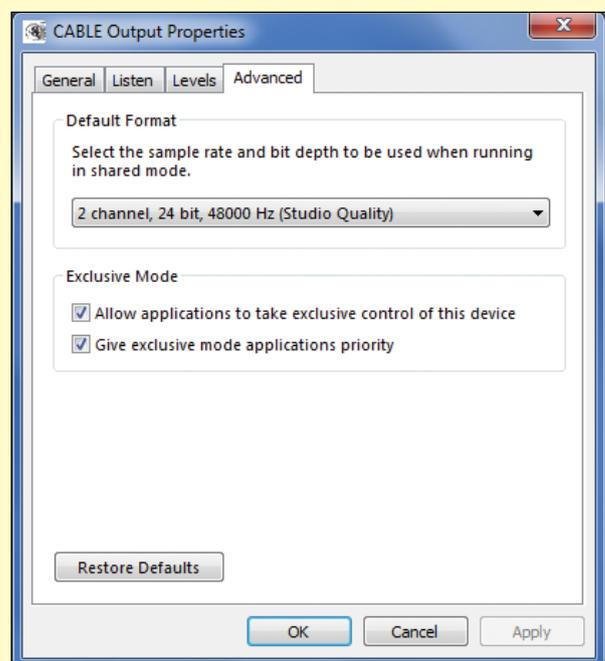
Figure 5b - The Windows Sound Manager advanced tab

Click the 'Properties' button on this screen to reveal the CABLE Output properties screen, and set the default format to 48000 Hz (Studio Quality).

Drivers for the RTL Dongle

Instal the RTL820T/RTL820T2 or RTL2832U drivers using the **Zadig** driver utility which is bundled with *SDRSharp*. To do this, you must first plug an RTL-SDR dongle into one of your computer's USB ports so that the **Bulk Interface** options become accessible. Now run **Zadig** as Administrator, to download and install the required driver. Make sure that the drop-down selector shows: '*BulkIn Interface (Interface 0)*'. If you can't see this option, click 'Options' and tick 'List all devices' first.

Installing the DDE Tracker Plugin

Download the DDE Tracker plugin from

http://rtl-sdr.ru/uploads/download/ddetracker.zip

This zip file contains three DLL files which you must copy into the *SDRSharp* folder. The zip file also contains a text file which contains the Magic Line, which you must copy and paste into the **Plugins.xml** file (which can be found in the *SDRSharp* folder).

Interfacing Orbitron with SDRSharp and DDE Tracker

The most important task in configuring **Orbitron** to engage with both *SDRSharp* and the *DDE Tracker* module is to open the '*Orbitron/Config*' folder and edit its 'setup.cfg' file to add an entry for the *SDRSharp* driver. Load '*setup.cfg*' into a text editor such as *Wordpad/Notepad* and add the following two lines at the end of the file immediately following the [Satellites] section, then resave it.

```
[Drivers]
SDRSharp=C:\SDRSharp\SDRSharp.exe
```

Set the *SDRSharp* directory by replacing the default 'C:\' with the path to the SDRSharp folder.

Configuring Orbitron
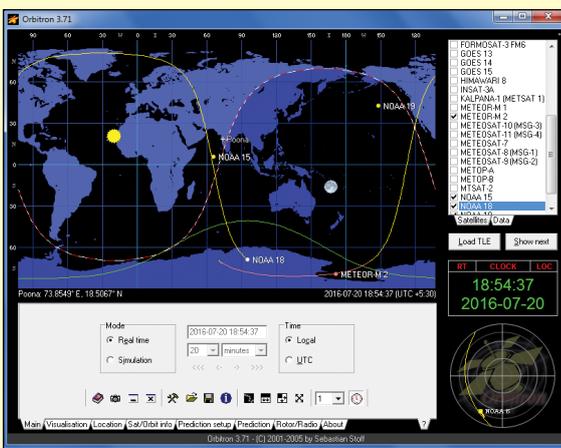
Figure 6 - Orbitron

Once the program is installed, start up *Orbitron* and click the Setup Icon

Open the '*TLE Updater*' tab and in the 'Group' field, select 'Weather'. Finally, in the right-hand panel, where you will find a list of satellite names, tick NOAA 15, NOAA 18 and NOAA 19.

Open the 'General' tab, and set your time zone.

Open the 'TLE Updater' tab and click on the farthest right icon to update the TLE files over the internet.

In the 'Miscellaneous' tab, set the AOS notification elevation at which you wish each satellite will give an audible alert as it approaches. It will also help to automatically trigger the satellite reception.
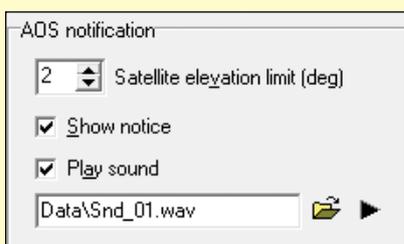
Figure 7 - Setting the AOS elevation alert

Finally, it is important to open the 'Extra' tab and select the final option 'AOS Notification: Make Satellite Active', then click 'Apply', as illustrated in figure 8.
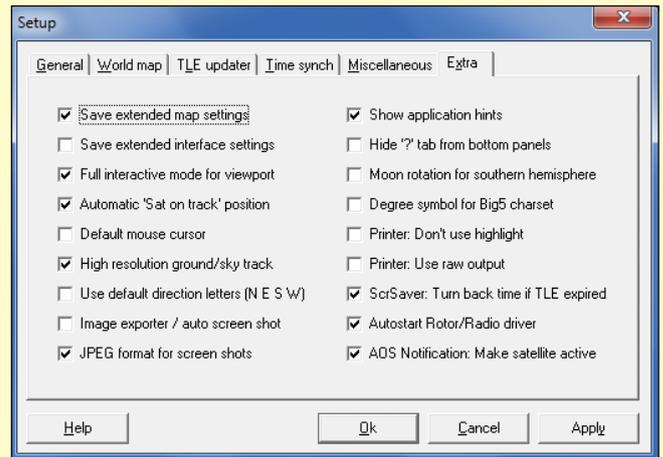
Figure 8 - Orbitron's *Setup/Extra* tab.

Set Satellite Frequency

Select the 'Rotor/Radio' tab at the foot of the Orbitron screen and enter each satellite frequency into the **Dnlink/MHz** section This helps to cancel the Doppler Effect on the APT image. Make sure you have installed the DDE Tracker into *SDRSharp*, and Driver is set to 'SDRSharp'.

Frequencies:
NOAA 15 – 137.6200 MHz
NOAA 18 – 137.9125 MHz
NOAA 19 - 137.1000 MHz

Getting Started with SDRSharp

After installing the drivers for SDRSharp, start up *SDRSharp.exe*. In the top panel at upper left set the **Source** to RTL-SDR (USB) as we are going to receive the satellite signals via an RTL dongle connected to a USB port on the computer.
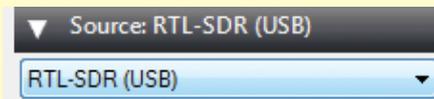
Figure 9 - Selecting the RTL-SDR USB driver

Open **Radio** and select Narrow FM (NFM), set the 'Bandwidth' to 32000, 'Order' to 10 (the minimum value for the audio filter), keep the 'Snap to Grid' option selected and select 'Correct IQ'.
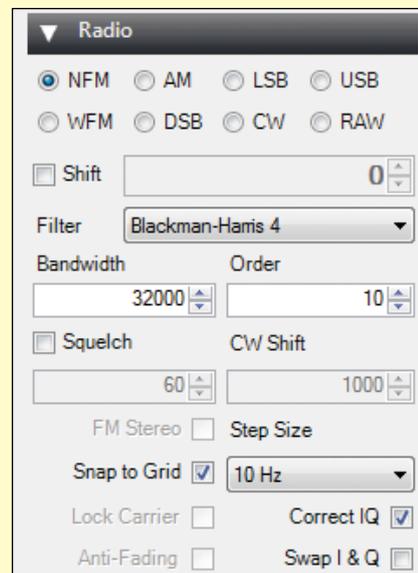
Figure 10 - The Radio Panel

Open the **Audio** panel, where it is required to set the 'Output' to CABLE Input (VB-Cable) – which will virtually pull the audio into the *WXtoImg* software.

Turn OFF both the 'Unity Gain' and 'Filter Audio' options.
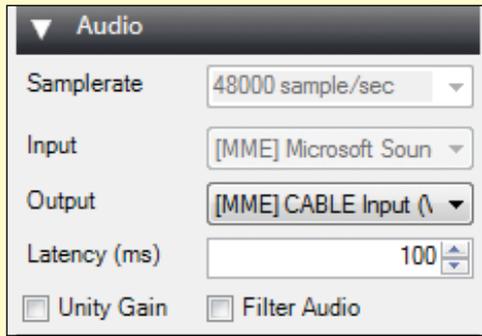
Figure 11 - The Audio Panel

Open the **AGC** panel and make sure that the AGC is turned off (i.e. not ticked).
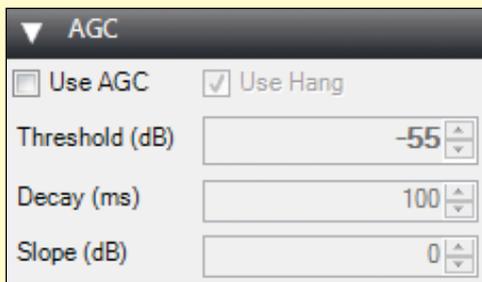
Figure 12 - The Automatic Gain Control Panel

Turn **off** the 'Audio Noise Reduction' and 'IF Noise Reduction'. If turned on the APT image might be smooth but loss of image quality and sharpness will occur.
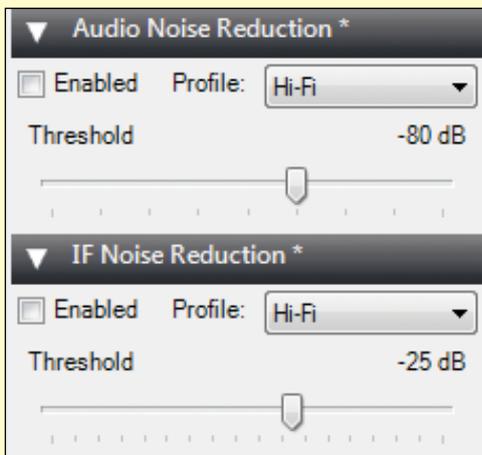
Figure 13 - The Noise Reduction Panel

Setting up the RTL SDR Controller

Settings for the RTL-SDR dongle are accessed by clicking the 'wheel' icon at top-left of the *SDRSharp* user interface. The Controller panel is illustrated in figure 14.

The **Sample Rate** can be selected from a number of set values, and I have found reception to work well using 1.8 MSPS, 1.4 MSPS and 0.900001 MSPS.

Adjust the **RF Gain** manually – usually you can set it up to 48 dB. If the reception of the signal is low try setting it up at 49.6 dB.
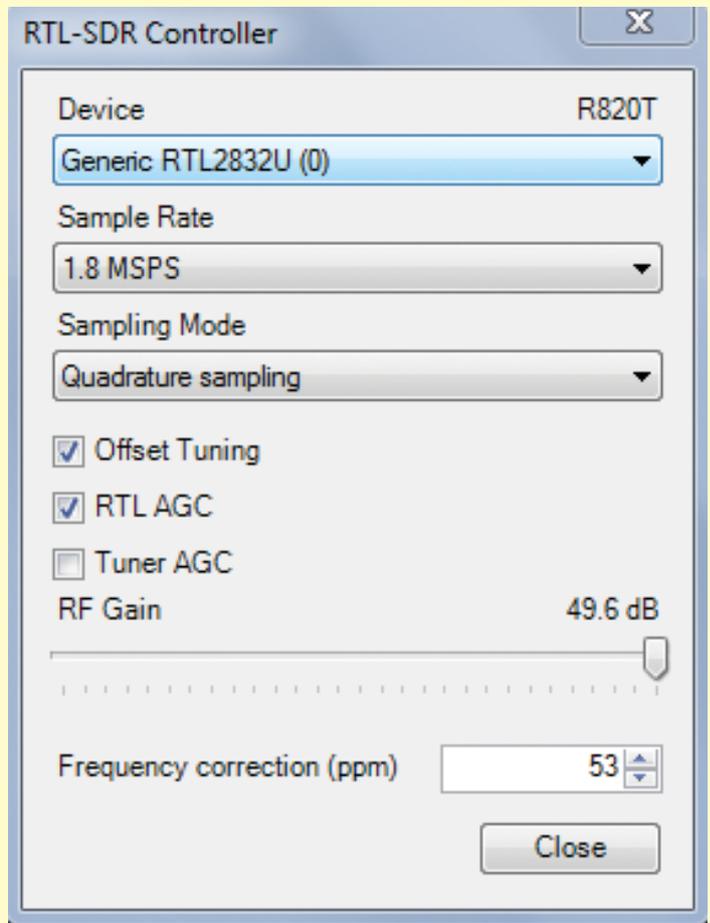
Figure 14 - The SDRSharp Controller Panel

Frequency correction (ppm) is required because RTL-SDR dongles are not precisely accurate. Because it is important that the satellite signal is precisely centred on the *SDRSharp* screen for optimum reception, this control can be used (usually under zoom) to fine tune the satellite reception peak to the centre of the display. Tutorials on frequency correction can be found online. In my case, I require frequency corrections between 53 and 76 ppm.

Configuring the DDE Scheduler

Now you have to enter appropriate commands into the **DDE Scheduler** (figure 16 - overleaf) in order to start and stop recording when a satellite is within range.

To open the scheduler, click the 'Config' button on the 'Tracking DDE Client' panel (figure 15).
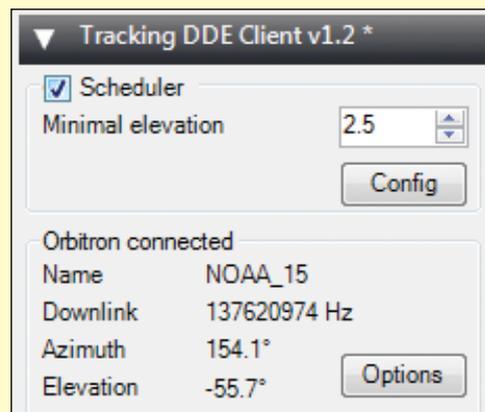
Figure 15 - The DDE Panel
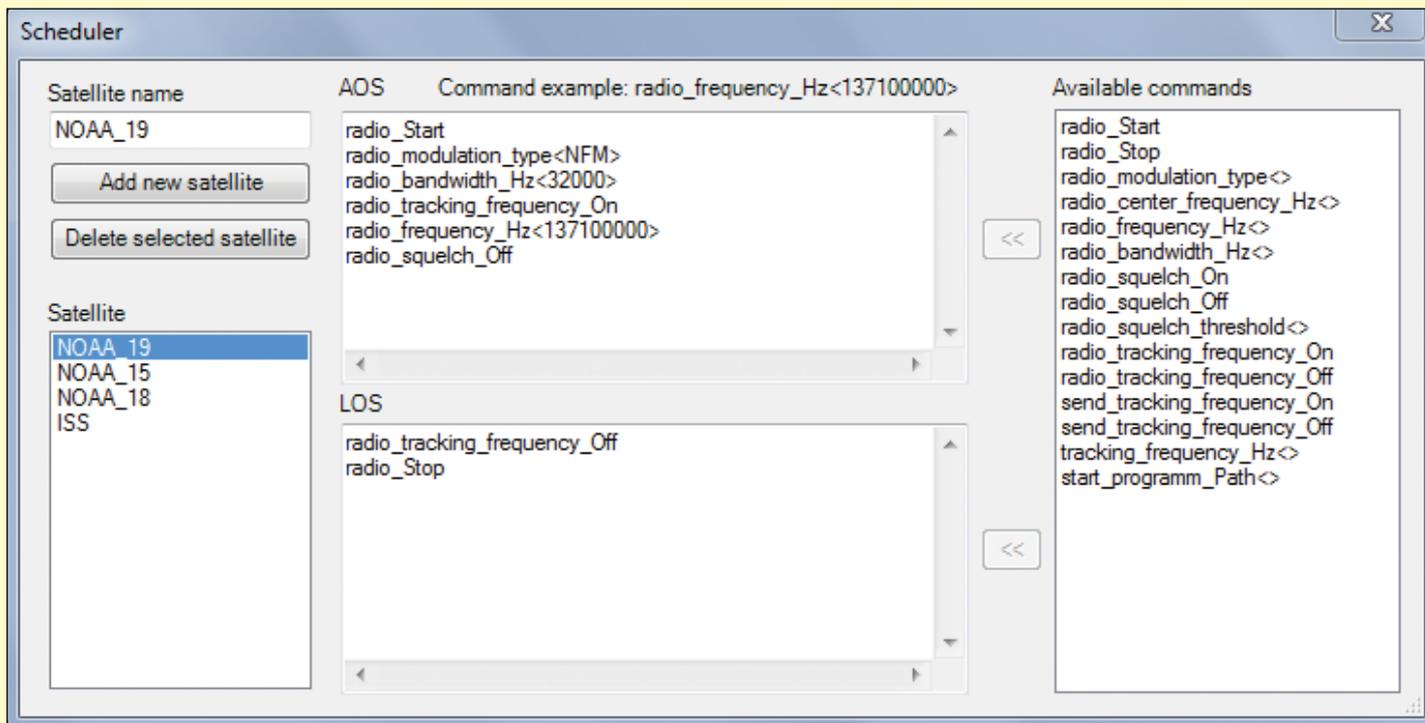
Figure 16 - The DDE Scheduler

Enter The Satellite Name, Click on '*Add new Satellite*' and insert the commands as shown in above screenshot.

To enter a command, click to select it, then click the '<<' button beside the AOS or LOS panel as appropriate. The values between the angle brackets must be inserted manually by clicking between them then typing from the keyboard. Note that radio bandwidth and frequency <u>must</u> be entered as herz (not kiloherz or megaherz) as illustrated above for NOAA 19.

Setting up WXtoImg

If you have installed WXtoImg for the first time, you must start by setting up your Ground Station Location by going to **Options > Ground Station Location**. The city you are in should

suffice, but you can be more accurate by entering an exact latitude and longitude if you want.

Next, go to **Options > Recording Options**, and ensure the correct device, *CABLE Output,* is selected under the soundcard option. Also, here, you can select '*Record only when active APT satellites are overhead*', and adjust the '*with maximum elevation above (degrees)*' and '*record only when satellite is above (degrees)*' settings (figure 19).

Finally, to enable automatic recording and image processing, go to **File> Record** to display the WXtoImg recording options screen (figure 20). If you click the '*Image Settings'* button, you can select the image types you want from a menu. Click the 'Auto Record' button, and WXtoImg will enter recording mode as soon as you run the program.

Figure 17 - Setting Station Details in WXtoImg
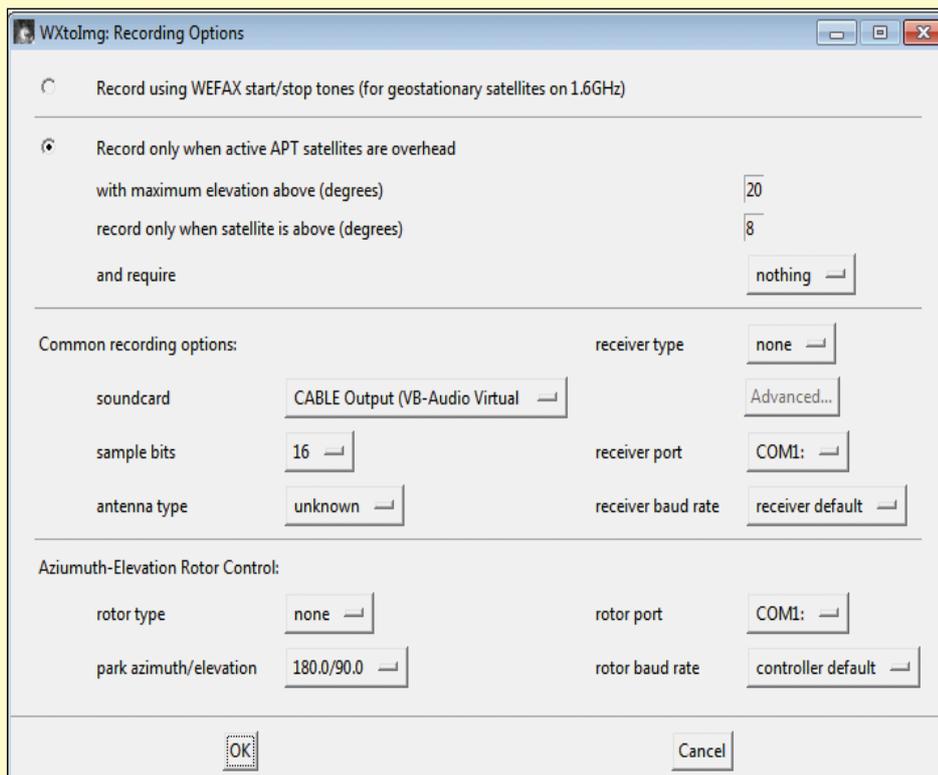
Figure 18 - Setting Recording Options in WXtoImg
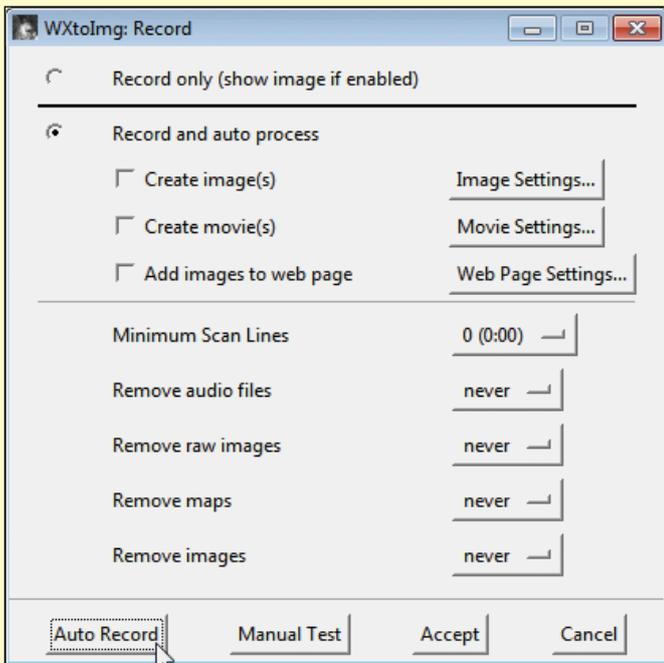
Figure 19 - WXtoImg's Record Options Screen

Examples of Received WXtoImg Images
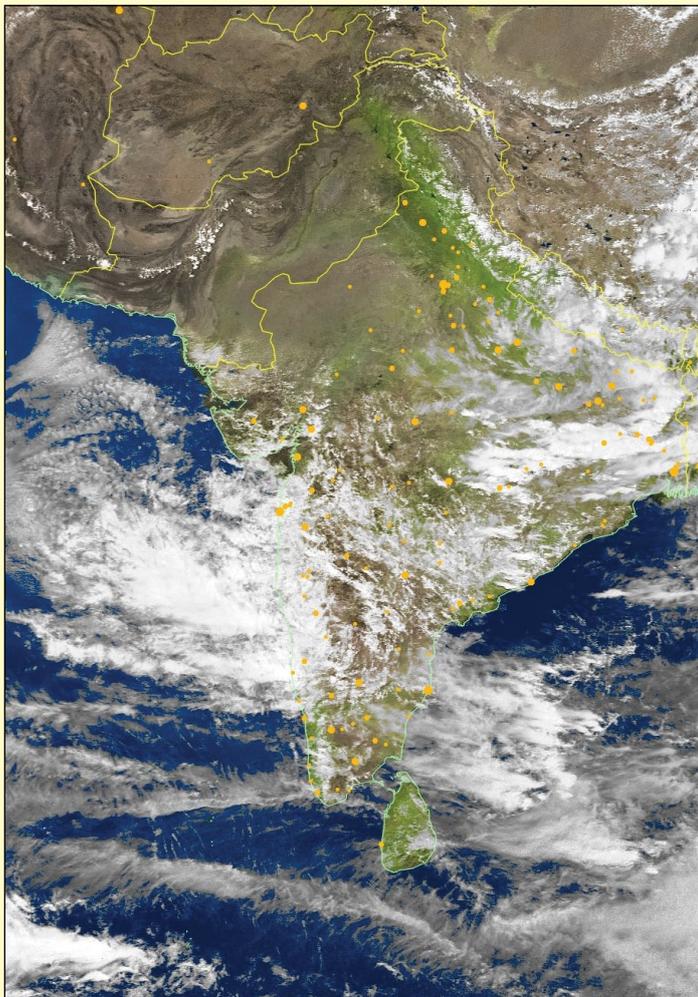
Figure 20 - A WXtoImg MSA image
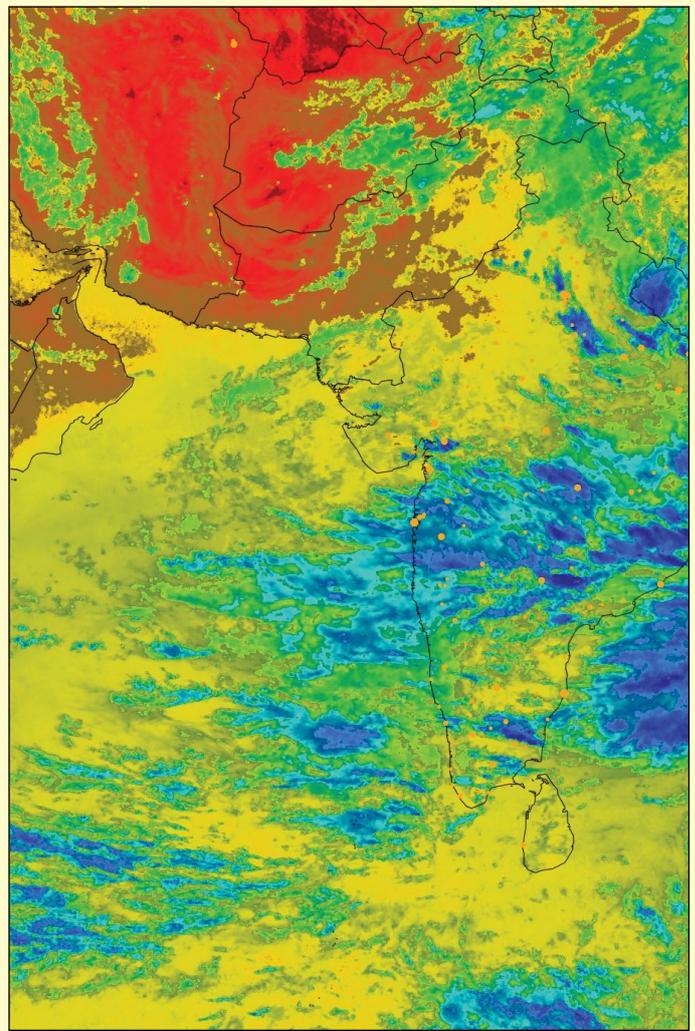
Figure 21 - The same image processed with the 'Thermal' option
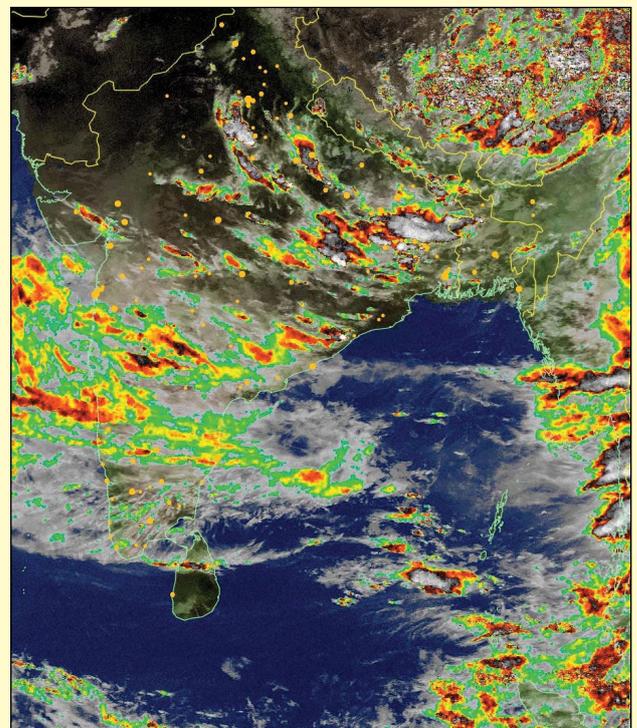
Figure 22 - A NOAA image processed using the 'MCIR with Precipitation' option

References

1   WxtoImg Upgrade Keys now Free -   GEO Quarterly 50 (December 2015), page 43
2   Receiving Images from Meteor Satellites - GEO Quarterly No 48, page 27
3   User's Guide for Building and Operating Environmental Satellite Receiving Stations – NOAA
     http://noaasis.noaa.gov/NOAASIS/pubs/Users_Guide-Building_Receive_Stations_March_2009.pdf
4   RTL-SDR Tutorial: Receiving NOAA Weather Satellite Images
     http://www.rtl-sdr.com/rtl-sdr-tutorial-receiving-noaa-weather-satellite-images/

Swirls of Ice in the Labrador Sea

NASA Earth Observatory

When pilot Jeff Davis saw this cyclone-like formation from 11,000 metres, he thought he had spotted a storm.

'I've never seen anything like this,' he said in an interview. *'At first sight I thought it was a hurricane-type low-pressure system, but quickly realized what I was seeing was not clouds, but surface ice. I knew, based on the surface formation, I had to take some photos. This was a rare sight.'*

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** and **Aqua** satellites acquired these two views of an ice eddy off the coast of Labrador, Canada, on July 2, 2016.

Davis, who has been piloting trans-Atlantic flights for 16 years, said it was his first time spotting such a formation. That's because clear skies, and air and water temperatures, must align to make a formation like this visible from cruising altitude, according to Walter Meier, a cryospheric researcher at NASA.

'First, the viewer needs daylight, a cloudless sky, and lucky timing. If the eddy is too small or compact, you won't see it. If the ice is too thick, or if it's melted, you're not going to see it either,' said Meier. *'There's not a lot of time between those two extremes.'*

When the ice melts, it breaks into chunks, like crushed ice in a cocktail. Then, ocean currents stir those chunks into the cyclone-like vortex. This happens both in spring (as ice thaws) and in autumn (during melt). Even then, however, such a vortex won't form unless it has certain temperature conditions: warm enough for the ice to fragment, but cool enough for it to remain frozen.

While the opportunity to view an eddy like this is rare because of frequent cloudiness over Arctic seas, Meier notes that ice eddies are pretty common. The formations can be large (several hundred kilometres across), or small (just several hundred metres). The chunks of ice in such eddies can be several metres across, posing a hazard for ships.

NASA Earth Observatory image by Jesse Allen, using data from the Land Atmosphere Near real-time Capability for EOS (LANCE). Caption by Pola Lem.
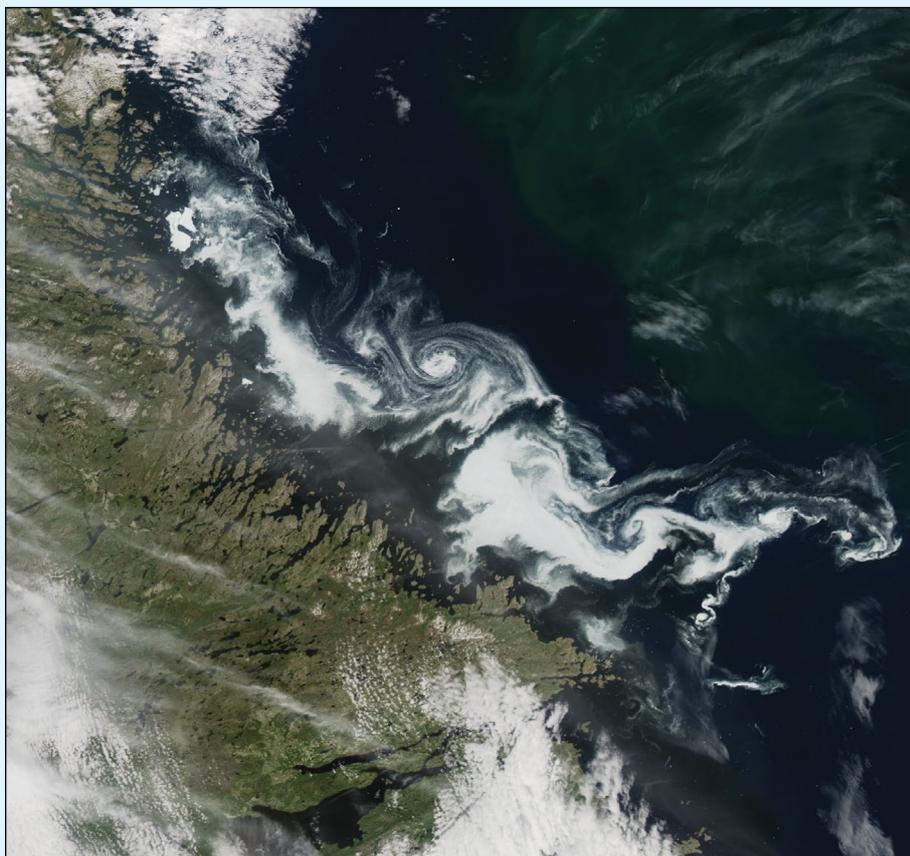
The Ice Swirl as imaged by Terra at 15:10 UT
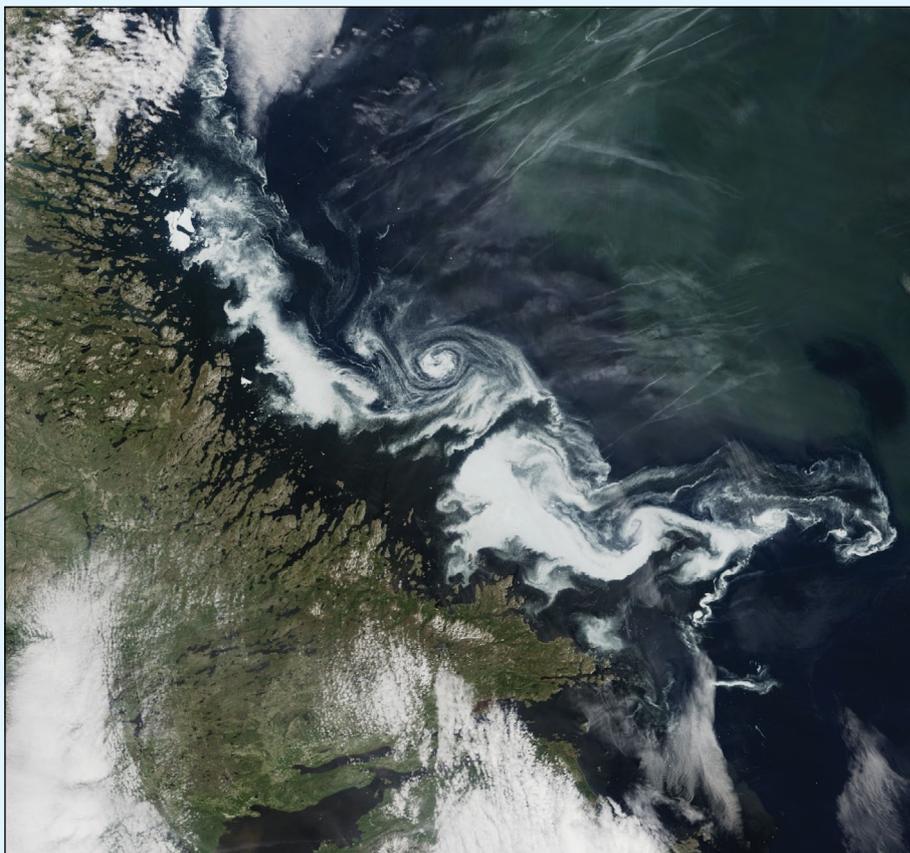
The Ice Swirl as imaged by Aqua at 16.55 UT
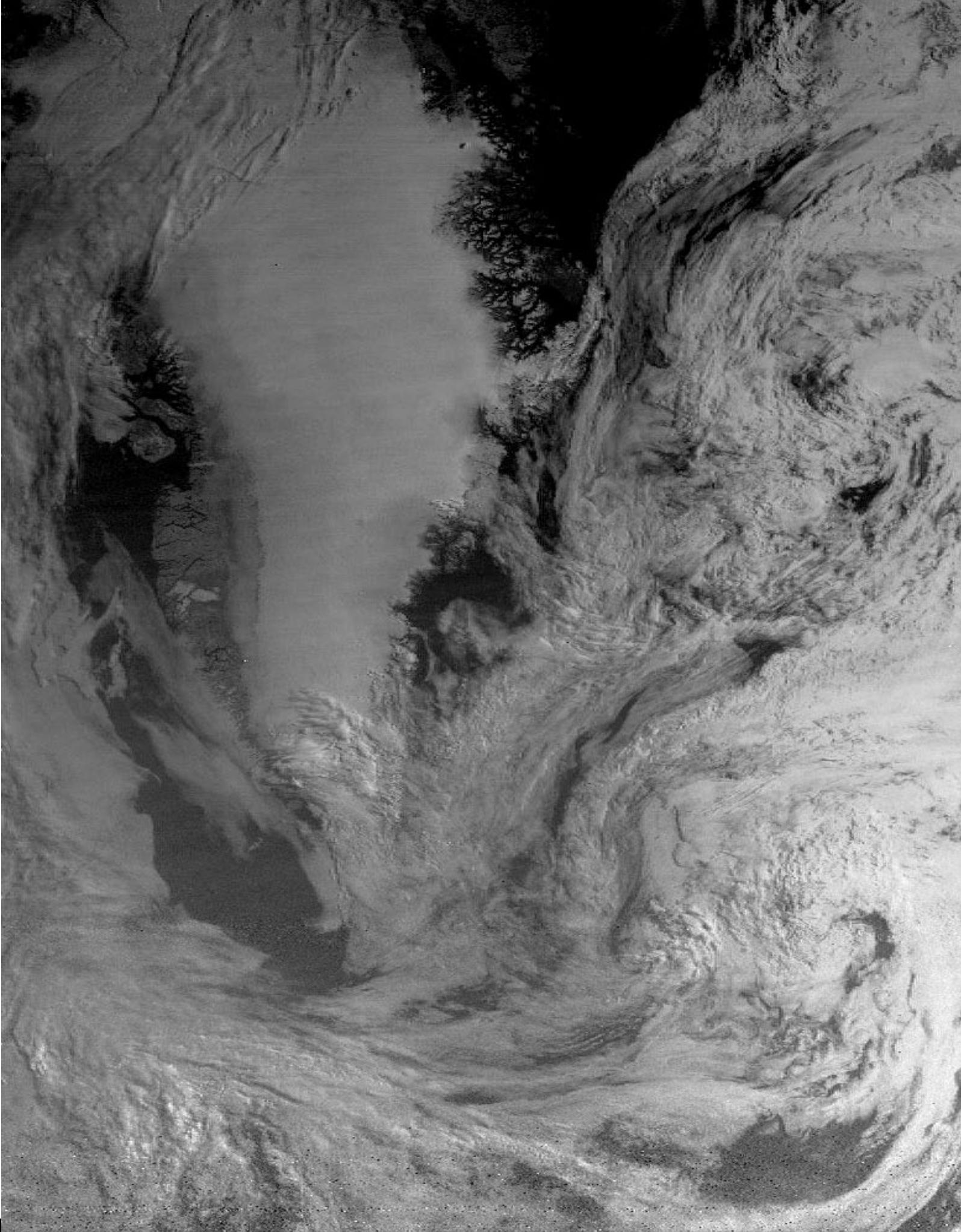
Gary Teale, who recently joined GEO, is cutting his teeth on APT from the NOAA satellites. Gary sent us this splendid channel-2 image showing most of Greenland cloud-free, which he acquired from NOAA 15 at 9.13 UT in July 23, 2016.
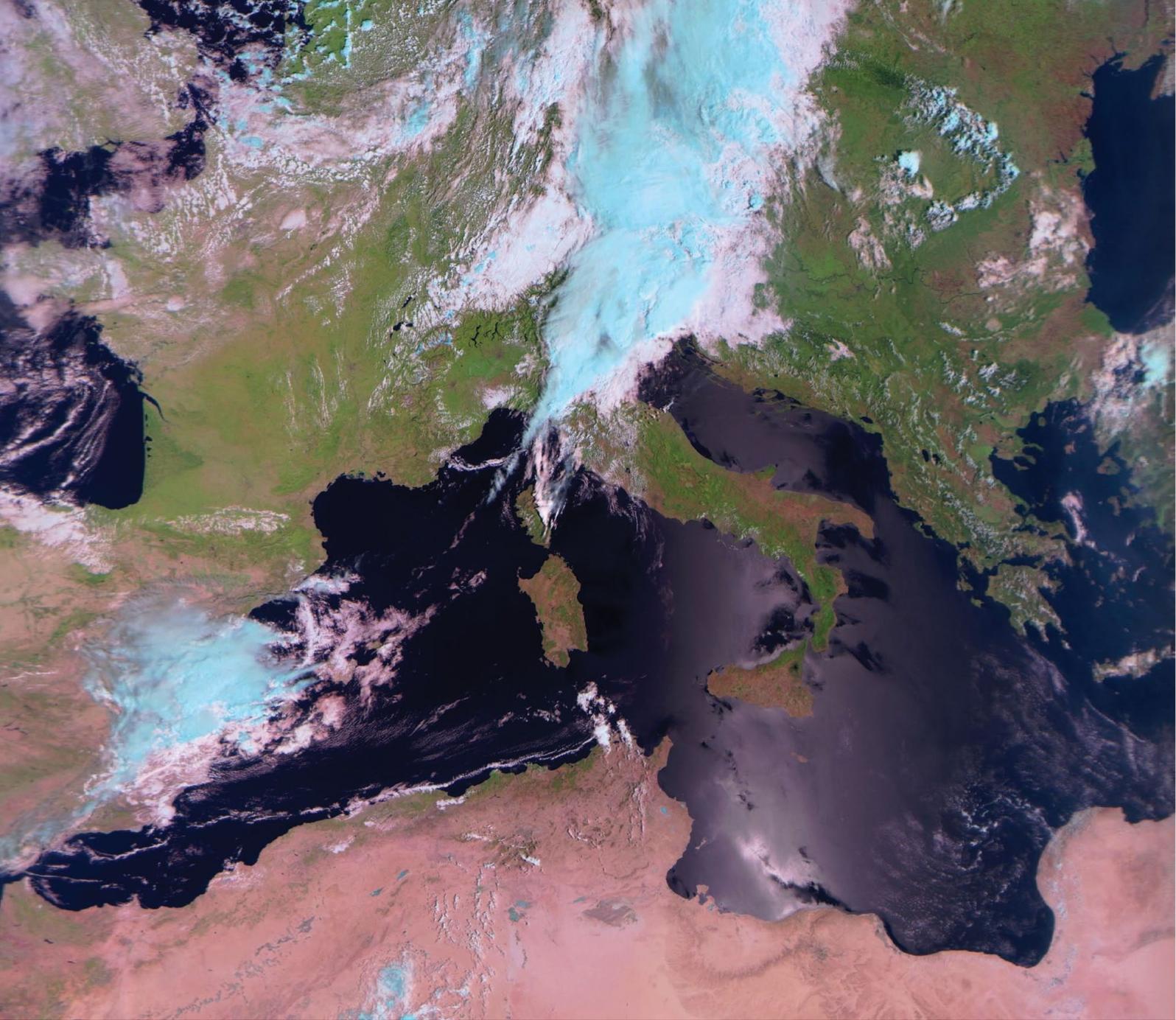
Enrico Gobbetti received this RGB123 image from Meteor M2 on August 10, 2016, providing us with a superb view of the Mediterranean Sea and its environs. The lower images show full resolution crops of Sicily and Corsica/Sardinia.

RF Attenuation

Francis Bell

I know that, for the best reception of satellite images, your dish needs a clear view of the relevant part of the sky. But a recent experience did surprise me a little. I have a one-metre dish located at ground level at the front of my house. As with all such installations, I first set it up on a temporary basis, but once working and receiving excellent *EUMETCast* signals I was reluctant to relocate it, hence its semi permanent position.

Recently, quite by chance, I happened to check the received signal strength from this dish using the 'SR1 Console' software I downloaded from *SpaceBand.* In fine weather my receive signal strength with this system is just in the green close at 12.0 dB, hence my surprise when checking the signal strength later found it to be down to 7.0 dB, although I have to say the incoming processed images still looked perfect.

A critical view of the dish immediately revealed the problem. The success of the hanging basket close to the dish had produced not only a beautiful floral display but also a shadow over roughly one third of it: very attractive and rural, but certainly degrading the received signal strength.

The solution was easy. I moved the hanging basket a little further away from the satellite dish and this immediately restored my signal strength.

With this experience I'm not surprised that trees can be a major factor influencing the reception of satellite signals when just a few colourful petals can have the same effect.

Another example of nature's interaction with my satellite reception related to swallows. However, in this example I did not detect any attenuation of the RF reception. I love to see these swallows and, for whatever reason, they visit me each year in August and early September. Not only do the swallows love my 137 MHz crossed dipole antenna but also the reflectors on my 2-metre dipole.

Very attractive, but even a few petals can reduce the signal strength received at the dish's surface.

Several families of swallows trying to check satellite weather images from EUMETCast in planning their imminent flight to Africa.
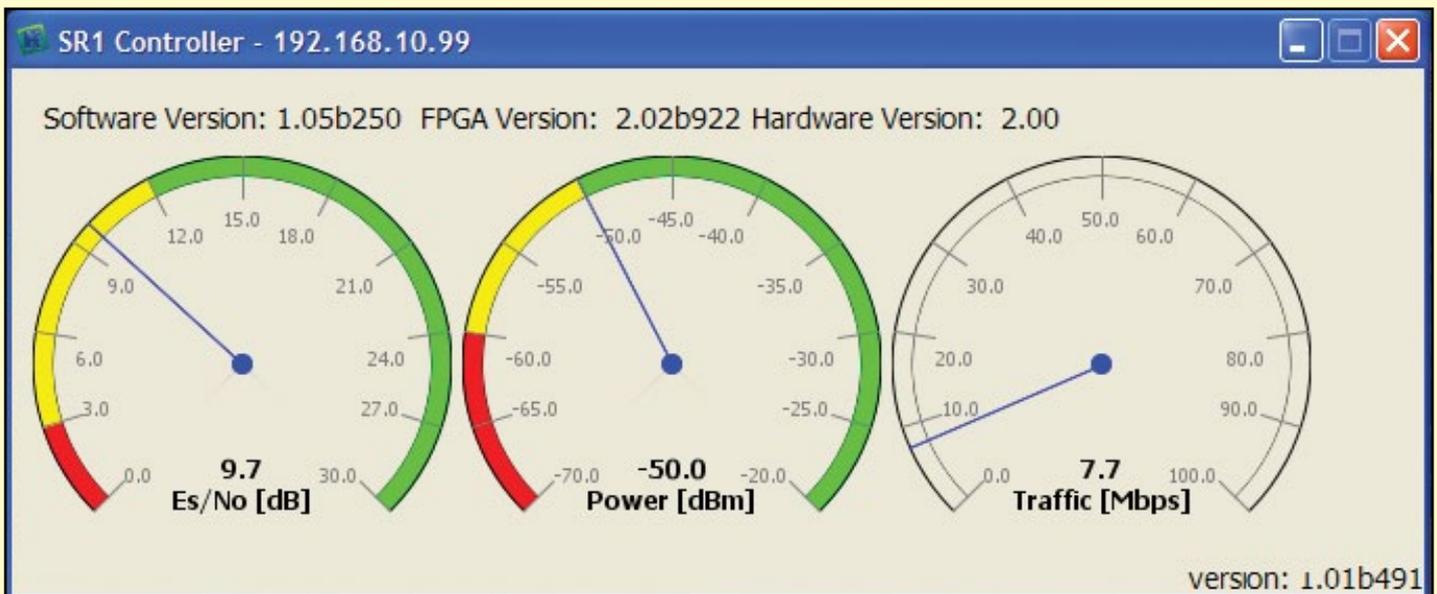
This screen shot of the *Console*, shows a typical reading I receive during *EUMETCast* reception. I find this facility very useful when aligning a dish for the first time and then monitoring the subsequent reception, which can vary according to weather conditions or obstructions.
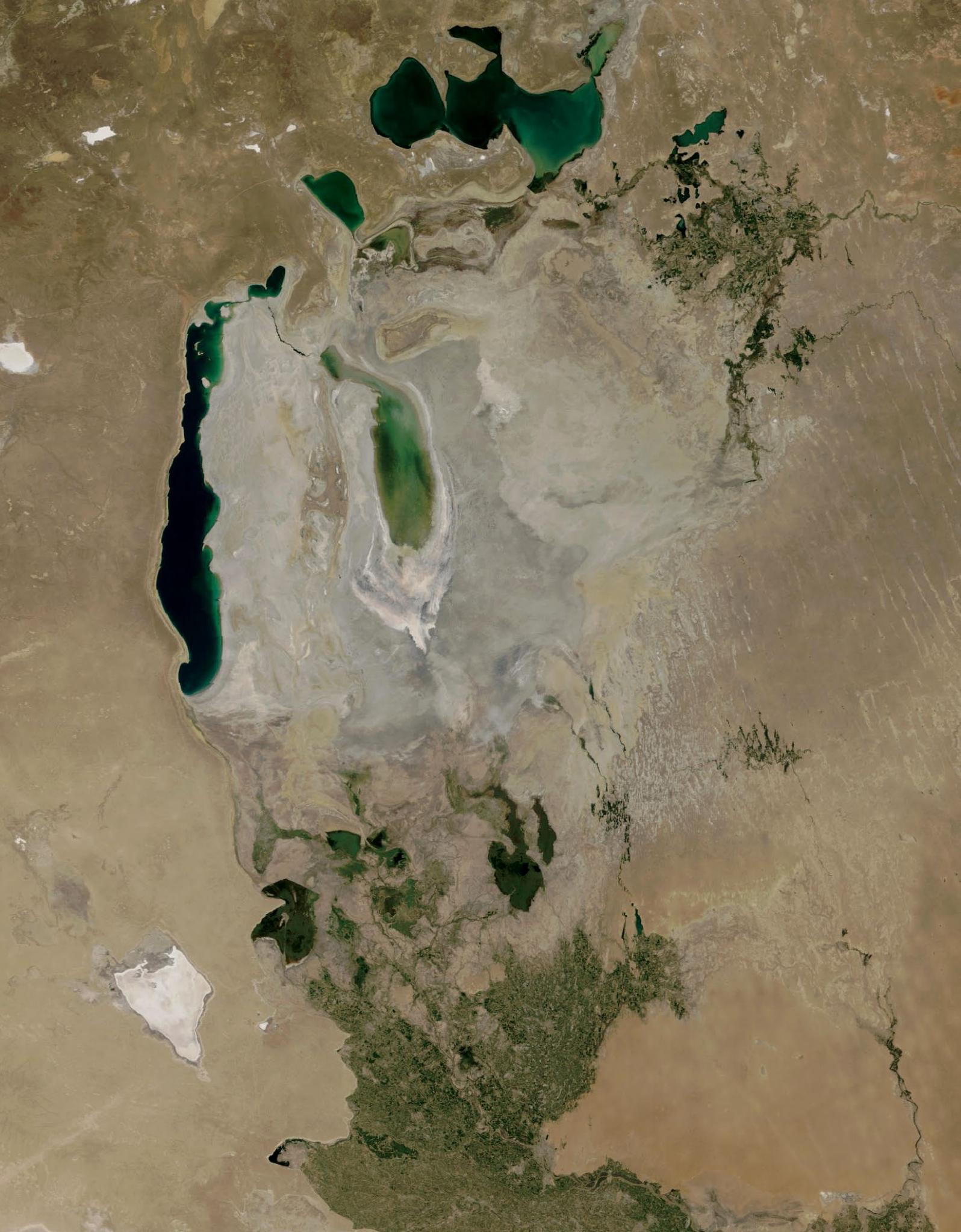
NASA's *Terra* satellite produced this MODIS image of the Aral Basin on August 3, 2016. The eastern lobe of the Aral Sea continues to hold water while the marshy deltas of the Syr Darya (north) and Amu Darya (south) are plain to see, the latter river failing to reach the South Aral Sea.
Image: NASA/GSFC Rapid Response
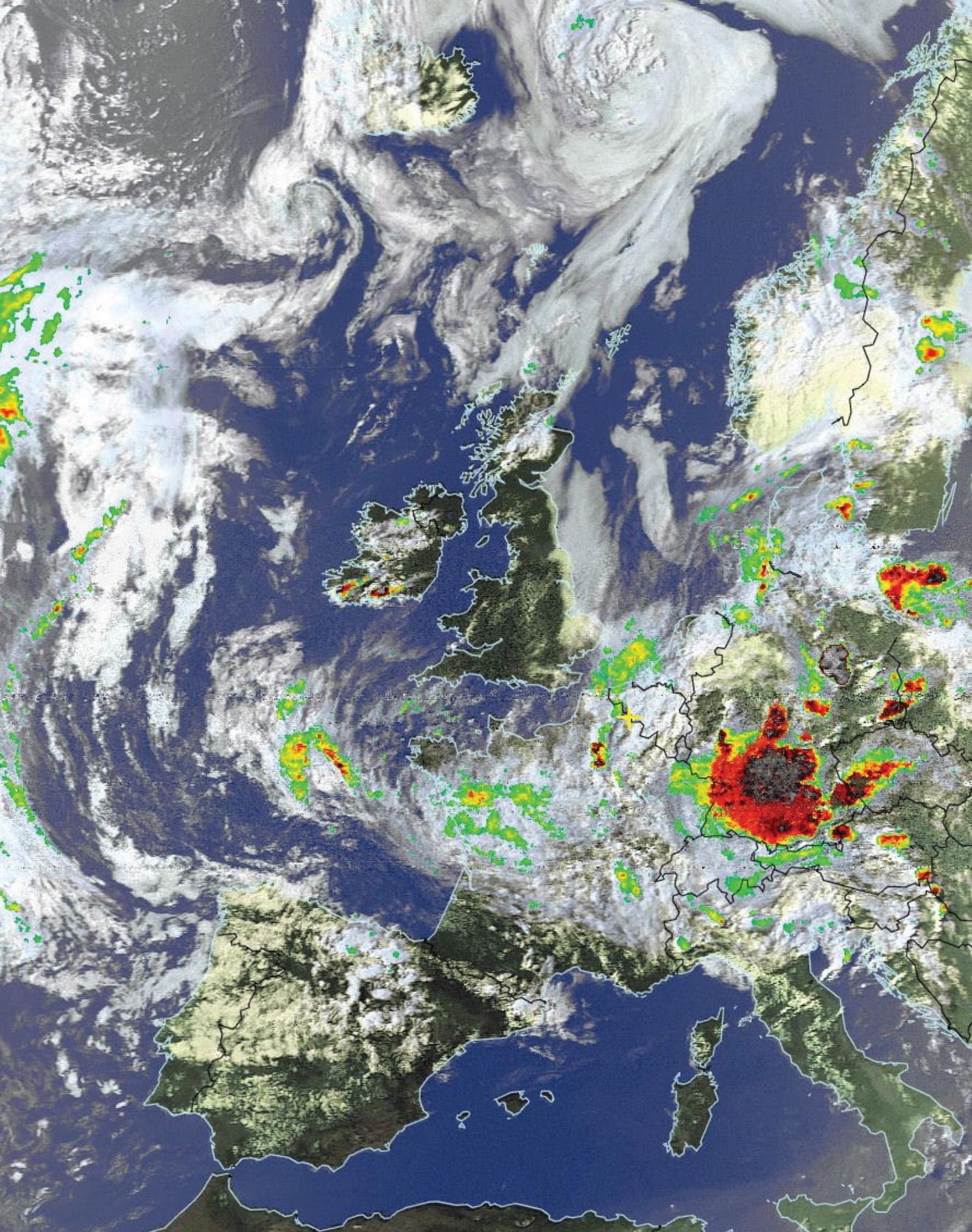
On May 30,2016, a rash of heavy thunderstorms tracked across central Europe. In Germany, there was severe flooding near Stuttgart, and in the town of Hoppstaedten, 35 people were injured by a lightning bolt during a children's football match. The referee, who was hit directly, was rushed to hospital by helicopter. Two other adults suffered serious injuries and thirty children aged between nine and eleven were slightly hurt and taken to hospital for tests. In France, three children and an adult who had been sheltering from a sudden thunderstorm were fighting for their lives after they were among eleven people struck by lightning during a birthday party in a Paris park. And in southern Poland, a man was killed when he was struck by lightning as he descended the Babia Gora mountain. **Andre T'Kindt** captured the situation with this **NOAA-18** APT image, processed with the HVCT and Precipitation Overlay,

Sea Ice in the Bellingshausen Sea

NASA Earth Observatory
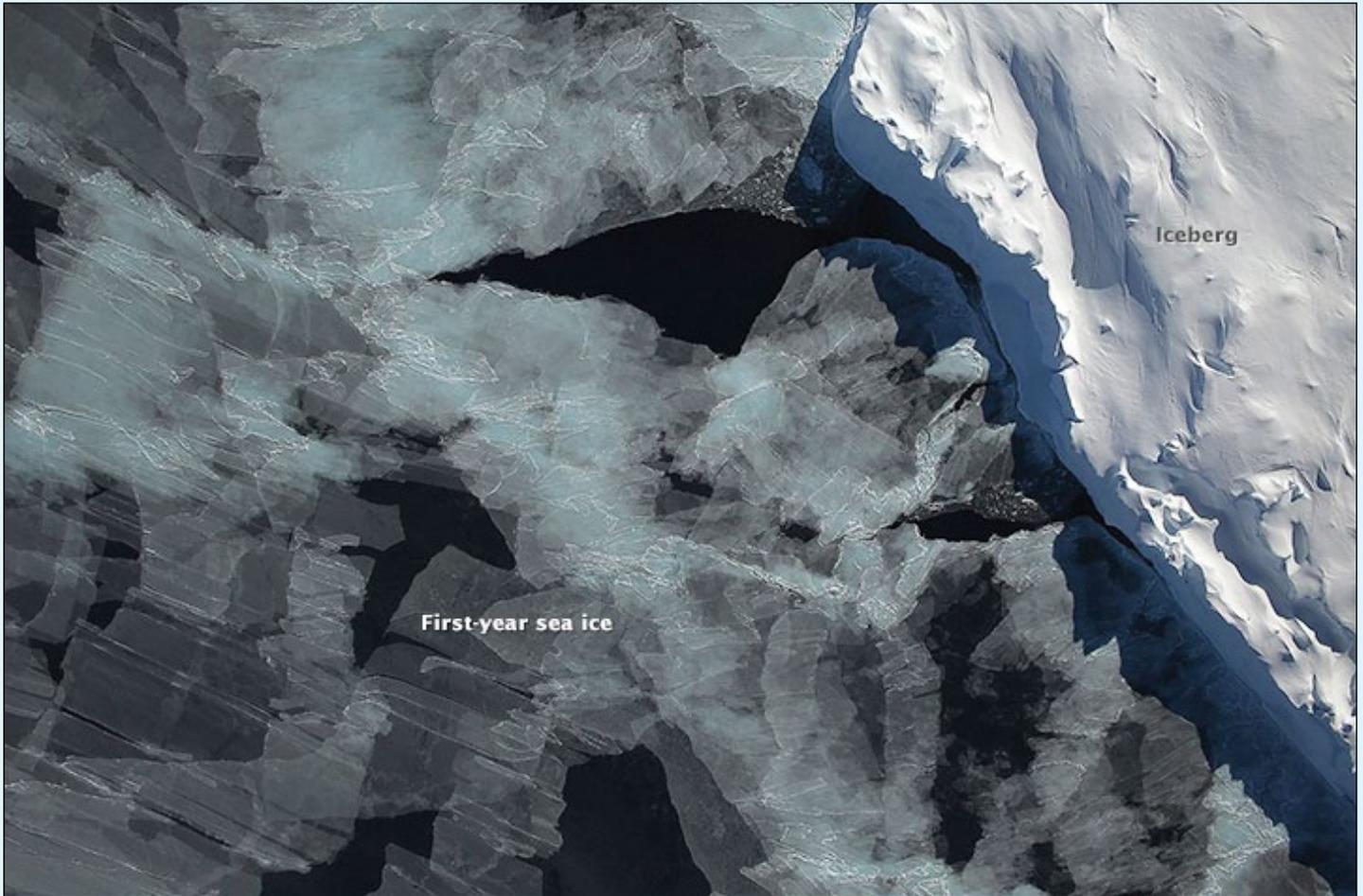
First-year sea ice in the Bellingshausen Sea off Antarctica on September 15, 2015.
Instrument: Aircraft Sensors - DMS

Antarctica—the continent at the southernmost reach of the planet—is fringed by cold, often frozen waters of the Southern Ocean. The extent of sea ice around the continent typically reaches a peak in September and a minimum in February. The photograph above shows Antarctic sea ice on November 5, 2014, during the annual cycle of melt.

The image was acquired by the Digital Mapping System (DMS), a digital camera installed in the belly of research aircraft to capture images of terrain below. In this case, the system flew on the DC-8 during a flight as part of NASA's *Operation IceBridge*.

Most of the view shows first-year sea ice in the Bellingshausen Sea, as it appeared from an altitude of 328 meters. The block of ice on the right side of the image is older and thicker, and was once attached to the Antarctic Ice Sheet. By the time this image was acquired, however, the ice had broken away to form an iceberg. Given its close proximity to the ice sheet, this could have been a relatively new berg.

The Bellingshausen Sea is located just off the icy continent's west side, tucked under the peninsula that reaches up toward South America. Sea ice in this sea is generally on the decline. In contrast, sea ice in the Ross Sea has seen growth, which contributed to the record high extent of sea ice around Antarctica in September 2014. But despite gains in Antarctica, research has shown that global sea ice is still decreasing.

The complex behaviour of sea ice around Antarctica is one reason why the *IceBridge* mission flies over the area every autumn (which means spring in the Southern Hemisphere). *IceBridge* also surveys ice each spring over the Arctic. But in autumn 2015, the mission parted with tradition and flew over both the Arctic and Antarctic simultaneously for the first time in the mission's seven-year history. The additional measurements of sea and land ice in the Arctic are expected to provide insight into how the summer melt season continues to affect the ice. The flights planned for autumn 2015 are outlined in the maps below.
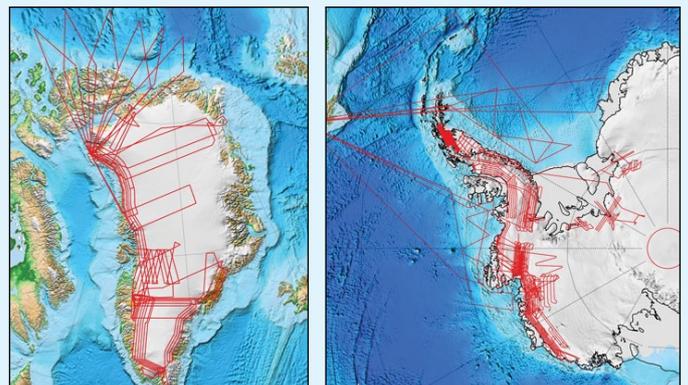
IceBridge flights planned over the Arctic
and Antarctic during autumn 2015.

Eruption on Bristol Island

NASA Earth Observatory

Before the advent of satellites and seismic monitoring, volcanic eruptions in distant places would usually go unnoticed unless they were absolutely extraordinary. Today, scientists can pick up signatures of events occurring far from any human observers.

That was the case in late April and early May 2016, when satellite sensors detected signs of a volcanic eruption in the far South Atlantic Ocean between South America and Antarctica. Mount Sourabaya, a stratovolcano on Bristol Island, appeared to be erupting for the first time in 60 years. There is no human presence on Bristol island, which is almost always covered in glacial ice and snow.

Bristol island is a member of the South Sandwich group, highlighted at the extreme right of this map.
Image: Wikimedia Commons

The Operational Land Imager (OLI) on the **Landsat 8** satellite acquired the two false-colour images opposite on April 24 and May 1, 2016. The images were built from a combination of shortwave-infrared, near-infrared, and red light (Landsat bands 6-5-4) that helps detect the heat signatures of an eruption. Both images show the heat signatures (red-orange) of what is likely hot lava, while white plumes trail away from the crater. The band combination makes the ice cover of the island appear bright blue-green.

With a roughly rectangular shape, 12 × 14 kilometres, Bristol Island is one of the largest in the South Sandwich Islands chain.

Figure 2 - Bristol Island, imaged by the ASTER instrument on NASA's Terra satellite on December 17, 2006

The highest peak on the island stands 1100 meters above sea level, and due to the remote location and the lack of landing sites amidst its ice cap, the stratovolcano is one of the least studied in the world: its last known eruption was reported in 1956.

Bristol island was discovered by a British expedition under James Cook in 1775 and named in honour of naval officer Augustus Hervey, 3rd Earl of Bristol. The first recorded landing was made by Carl Anton Larsen in 1908.

The island remains uninhabited and is administered by the United Kingdom—as a British Overseas Territory—as part of the South Georgia and South Sandwich Islands dependency.
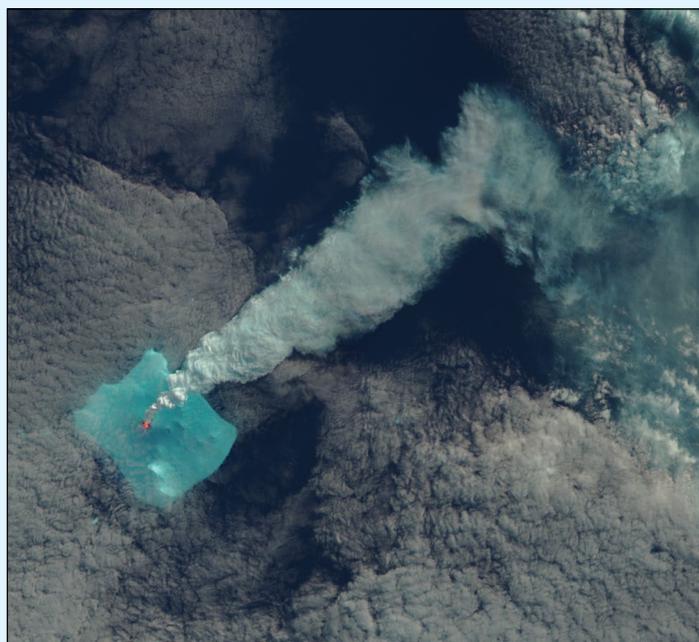
Bristol Island eruption on April 24, 2016
NASA Landsat-8 Image
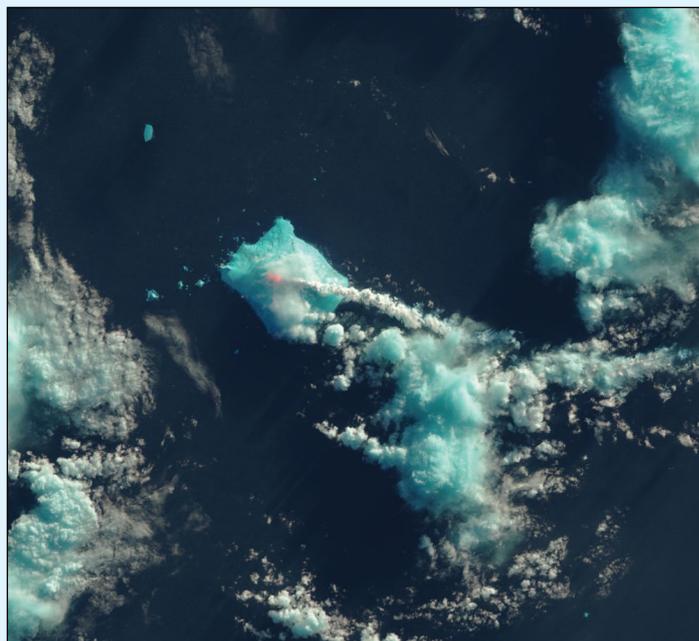
Bristol Island eruption on May 1, 2016
NASA Landsat-8 Image

Sentinel-1A Observes the
Zachariae Isstrom Glacier
European Space Agency
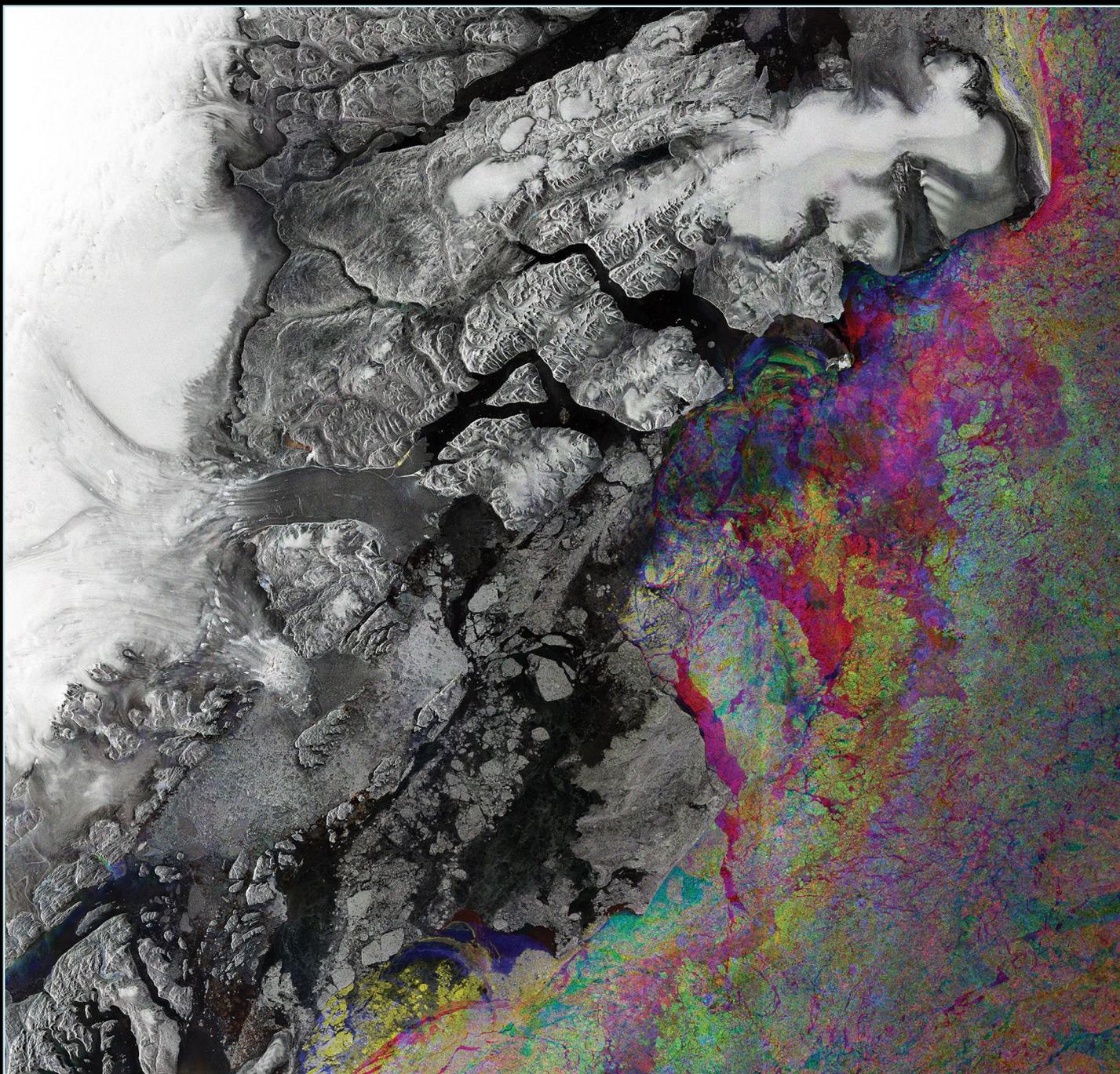
This image, taken over part of northwest Greenland's coast, combines three images from *Sentinel-1A*'s radar, acquired on February 15, March 10 and April 3, 2016.

The shades of grey on the left side of the image depict the static landmass, while the colours on the right show changes in sea-ice type and cover between the three radar scans. Near the centre-left you can see the **Zachariae Isstrom glacier**, which is losing about five billion tonnes of ice a year to the ocean.

Zachariae's dynamics have been changing over the last few years, calving high volumes of icebergs, which will inevitably affect sea levels. It is estimated that the entire Zachariae Isstrom glacier in northeast Greenland holds enough water to raise global sea levels by more than 46 cm.

Scientists have determined that the bottom of Zachariae Isstrom is being rapidly eroded by warmer ocean water mixed with growing amounts of meltwater from the ice sheet surface.

Zachariae and the nearby Nioghalvfjerdsfjorden to its north are two of six glaciers being monitored in near-real time by *Sentinel-1* through a new web portal by the UK's *Centre for Polar Observation and Modelling*. The portal provides frequent maps of ice velocity for key glaciers in both Greenland and Antarctica.

The polar regions are some of the first to experience and visibly demonstrate the effects of climate change, serving as barometers for change in the rest of the world. It is therefore critical that polar ice is monitored comprehensively and in a sustained manner.

Taklimakan Desert

... a Factory for Dust Storms

NASA Earth Observatory
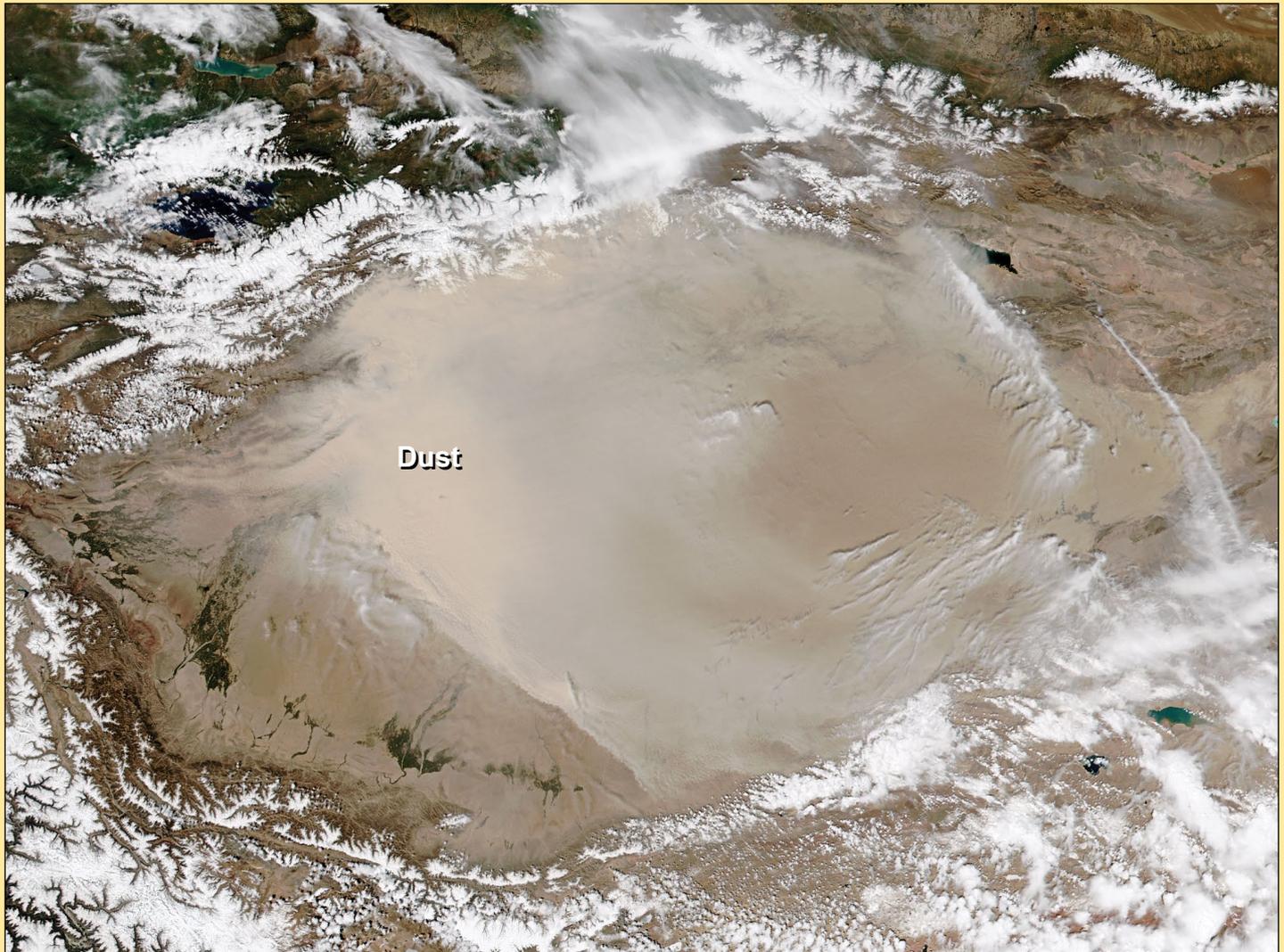
The Taklimakan desert is one of the driest, most barren expanses on Earth. Flanked by mountain ranges on three sides and parched by the resulting rain shadow, parts of the Tarim Basin receive no more than 10 millimetres of rain per year. It is no surprise that plant life is scarce. With little vegetation to hold sand in place, some 85% of the Taklimakan consists of shifting sand dunes. Only the dune fields of Saudi Arabia's Rub' al Khali cover a larger area. Taklimakan's dunes can soar to heights of up to 200 to 300 metres.

With so much sand and so little vegetation or moisture, dust storms are a regular occurrence, particularly in the spring. On May 1, 2016, the *Visible Infrared Imaging Radiometer Suite* (VIIRS) on the **Suomi NPP satellite** captured this natural-colour image showing a wall of dust being pushed southwest across the Tarim Basin by northeasterly winds.

The Tarim Basin is bordered by the Kunlun Shan mountains to the south and the Tian Shan mountains to the north. (The Tian Shan is covered with snow and partly obscured by clouds in this image.) The basin opens up on its eastern edge, but that is not generally a way out for dust. Prevailing low-altitude winds almost always blow from the east, keeping most dust below the crests of the mountain ranges—and thus trapped within the basin. In spring, strong surface winds can sometimes lift dust up to 10 kilometres, where higher altitude winds transport the dust beyond the ranges and across China and the Pacific ocean. In the image presented here, however, the dust appears to be relatively low in the atmosphere.

Dust storms can lead to public health problems in populated areas downwind by transporting small particles, bacteria, and viruses that infiltrate human respiratory systems. Dust storms also affect Earth's climate by scattering and absorbing incoming solar radiation and changing the properties of clouds.

NASA image by Jeff Schmaltz, LANCE/EOSDIS Rapid Response
Caption by Adam Voiland
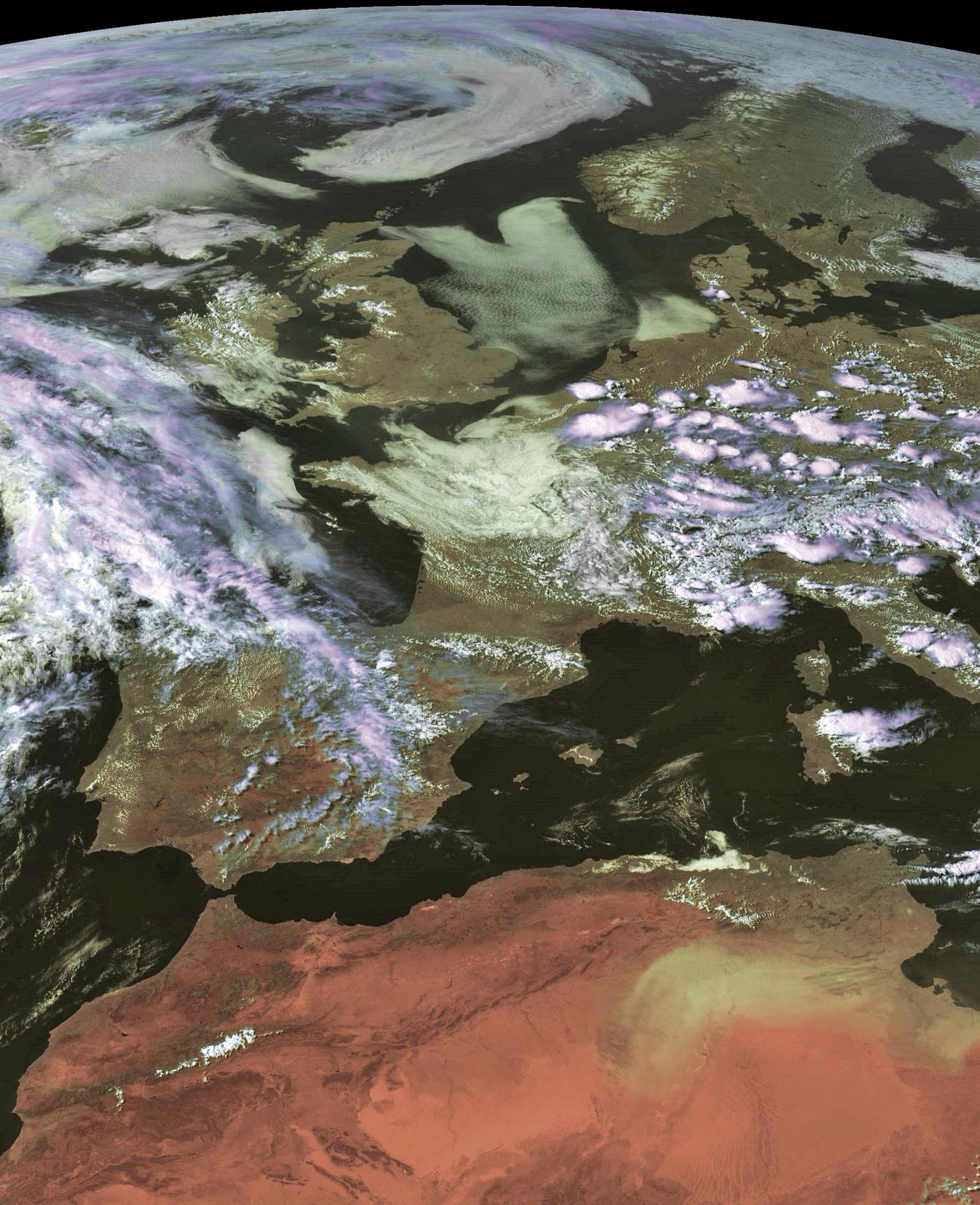
Mike Stevens acquired this interesting Meteosat-10 image on June 7, 2016, showing the British Isles basking in sunshine, many locations recording temperatures of up to 25°C, while a rash of thunderstorms caused flooding from Paris to eastern Germany.
Image © EUMETSAT 2016=

Lake Tengiz

NASA Earth Observatory

In orbit above the semi-desert grasslands in Kazakhstan, an astronaut aboard the International Space Station photographed Lake Tengiz, the only large lake (1590 km^2) in northern Kazakhstan. Through white wisps of cloud, the image opposite shows the 50 kilometre-long eastern shore of the lake, with its thin winding islands and white beaches.

The islands and intervening waterways provide a rich habitat for birds in this part of Asia. At least 318 species of birds have been identified at the lake, 22 of them endangered. It is the northernmost habitat of the pink flamingo. The lake system is Kazakhstan's first UNESCO World Heritage Site, and it has been declared a *Ramsar* [1] wetland site of international importance.

Part of the richness of this region is its complex hydrology. Fresh water enters the system via the Kulanutpes River, so there are small lakes (upper right) full of fresh water. But in this closed basin, the water in the main lake (left) slowly evaporates, becoming salty. Winds stir up waves on the main lake, dispersing sediment and salt and making the water a cloudier and lighter blue-green.

The strange shape of the islands is not easy to interpret. They may be drowned remnants of delta distributaries of the Kulanutpes River. Westerly winds have probably had a smoothing effect on the shorelines, especially in a shallow lake like Tengiz, which averages only six meters in depth.

The lake has an exciting history for people who follow space exploration. In 1976, a Soyuz spacecraft landed in the lake near the north shore (top left). The capsule crashed through ice and sank during an October snowstorm when the prevailing temperature was -22°C. Because of low power, the capsule was unheated, and it was many hours before the airtight capsule was located and divers could attach flotation tanks to raise it to the surface. It was then dragged ashore across the ice by helicopter. The rescue effort took nine hours before the crew was able to safely exit the capsule.
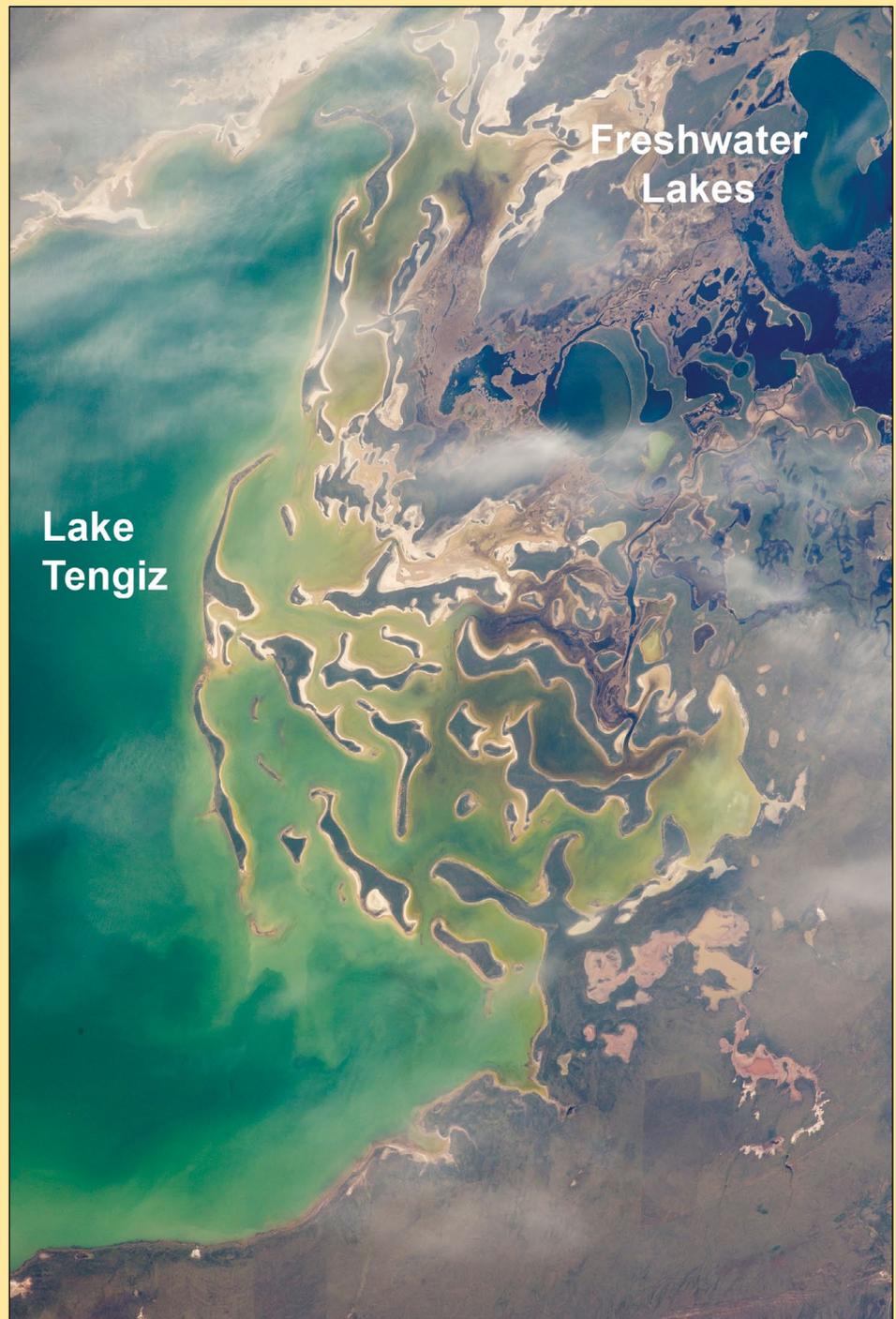
Figure 1
Astronaut photograph ISS047-E-83092, showing lake Tengiz, acquired on April 26, 2016
Credit: NASA/ISS Crew Earth Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center.

The Korgaljinski Lakes

To the east of Lake Tengiz, a salt lake with no outlet and fluctuating depth, are the Korgaljinski (or Kourgaldzhin) Lakes, a network of freshwater lakes mixed with marshland, connected by the Nura River. Home to hundreds of plant and bird species, and dozens of mammal species, the area has been designated a Ramsar wetland site.

NASA's Landsat 7 satellite imaged Lake Tengiz and Korgaljinski Lakes in July 2001 (figure 2). Lake Tengiz dominates this image—a nearly uniform patch of blue-green outlined
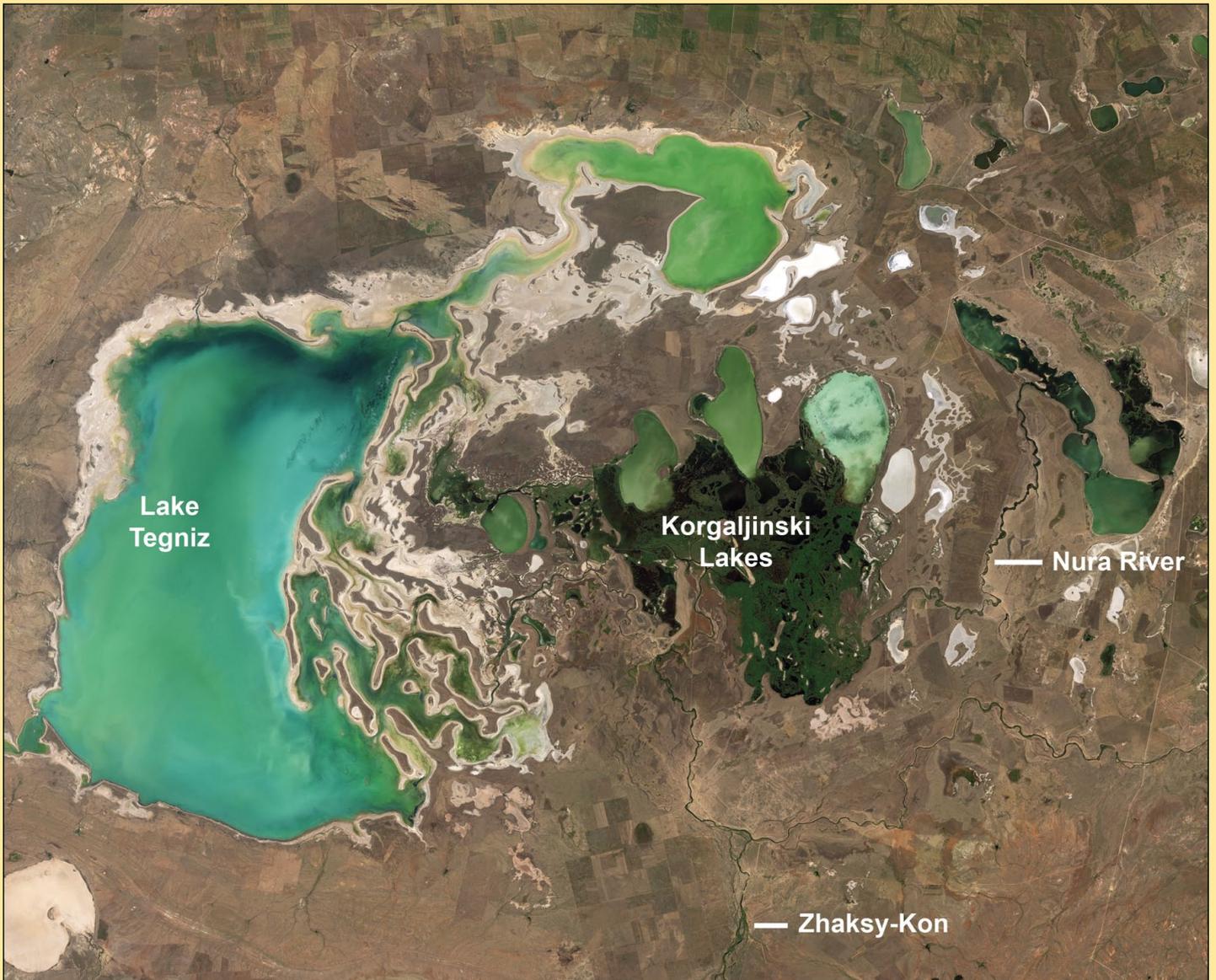
Figure 2
This view of Lake Tengiz and the associated Korgaljinski lakes was captured by Nasa's Landsat-7 satellite on July 29, 2001
NASA image created by Jesse Allen, using Landsat data provided by the United States Geological Survey

by off-white. The lake's pale lining indicates that its water level has dropped, exposing a now-dry shoreline. To the east of Lake Tengiz, but connected to it via meandering waterways, are the Korgaljinski Lakes, three large patches of pale blue-green, resembling the hue of Lake Tengiz, which lie at the northern end of this marshy area. To the south, smaller water bodies mix with deep green vegetation. Looking like a delicate thread of deep blue, the Nura River appears to the east of these lakes. From the south, another river, the Zhaksy-Kon, also feeds this wetland network. Lush green vegetation in this area contrasts sharply with the otherwise arid landscape.

Uninsulated power lines formerly electrocuted many birds in this area until they were taken down and replaced with a solar power station. The World Bank also initiated a project to clean up mercury pollution and provide a safe alternative water supply for local residents.

References

1   http://www.ramsar.org/
2   http://earthobservatory.nasa.gov/IOTD/view.php?id=88181
3   http://earthobservatory.nasa.gov/IOTD/view.php?id=9027

Where Exactly is Lake Tegniz?

Lake Tegnitz lies six hundred kilometres northwest of the more familiar Lake Balkhash, the 15th largest lake in the world, which is shown at the foot of figure 3..

Figure 3
NASA's Aqua satellite acquired this MODIS image on July 15, 2015, showing the location of LakeTegnitz in relation to Lake Balkhash.
Image: NASA/GSFC Rapid Response
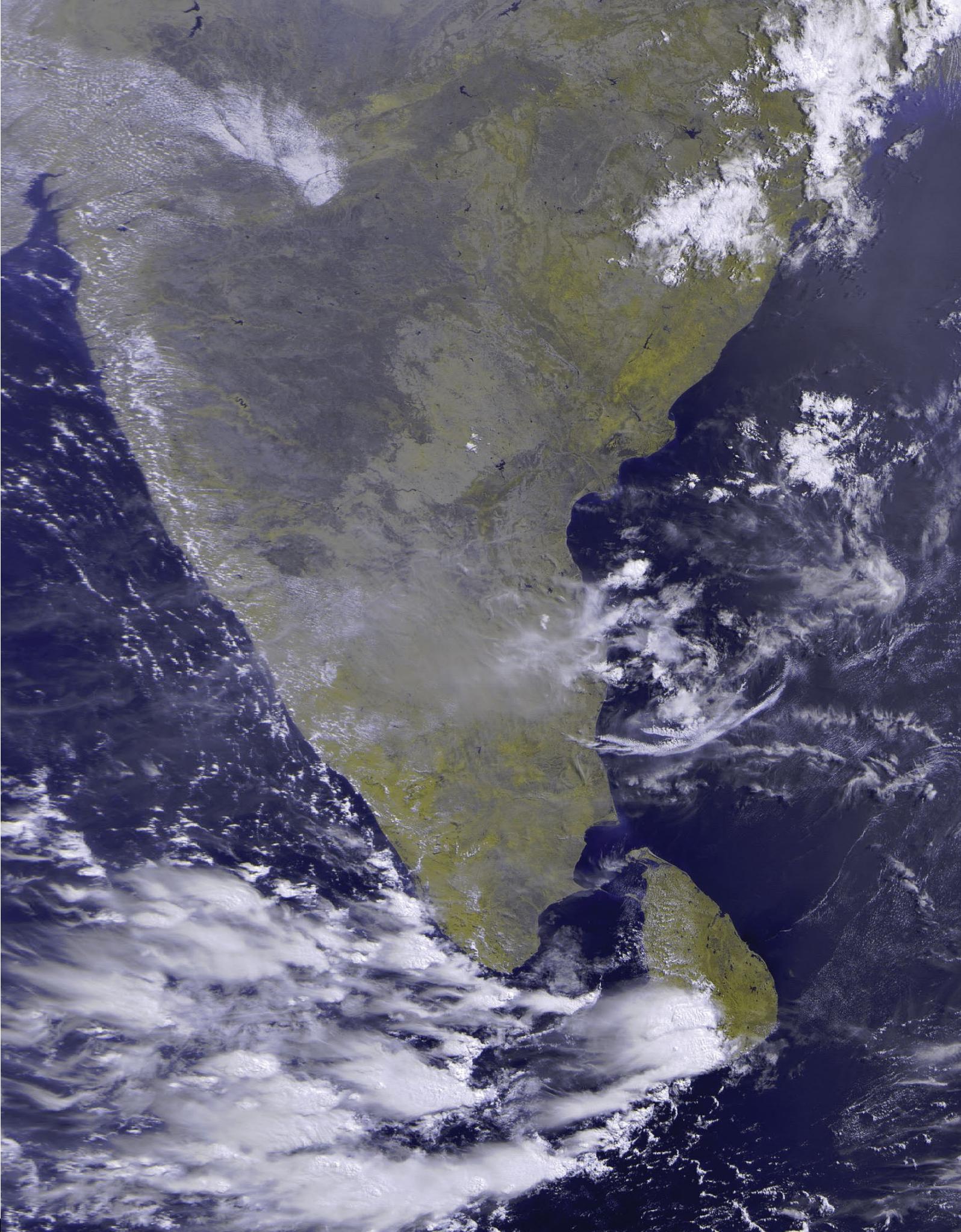
This image of India and Sri Lanka was provided by Devendra Kulkarni from Puna, India. The image was obtained at 09.20 local time on May 27, 2016 using an RTL-SDR dongle and homebrew QFH antenna.

Always on the look out for spectacular EUMETCast images, Mike Stevens sent in this section from a Metop-B
pass over Asia on August 23, 2016, showing both the Caspian and Aral seas in cloud-free detail.
Image © EUMETSAT 2016
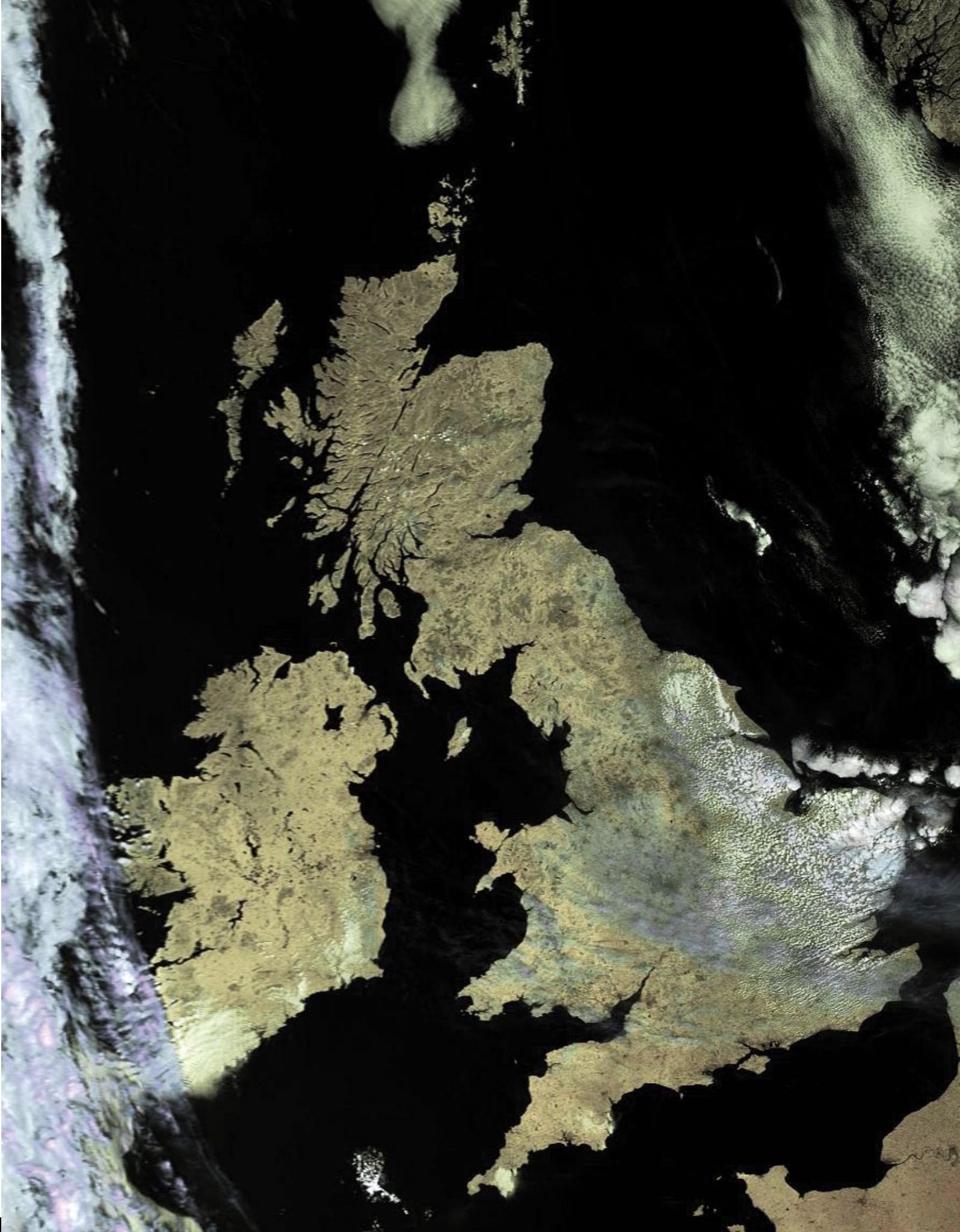
This Metop–B image from the 09:52 UT Metop–B pass on August 16, 2016 was acquired from the *EUMETSAT Advanced Retransmission Service* (EARS), transmitted via EUMETCast, by David Taylor, to illustrate a particularly fine spell of weather during a generally damp and cloudy summer.

GEO Outreach

AMSAT Colloquium

Francis Bell

I have been a member of AMSAT-UK for about 30 years. The group's interests relate mainly to amateur radio and satellites with their potential for personal amateur radio communication plus space related science and engineering.

It is no coincidence that AMSAT's annual meeting or colloquium is held in Guildford each year. I believe the University of Surrey, now based in Guildford, was the focal organisation establishing the UK branch of AMSAT. As a schoolmaster teaching in a Guildford secondary school, living locally, together with my existing interests in amateur radio, it was not surprising that I became interested in AMSAT-UK's activities and live reception of their *UoSAT 1* and *UoSAT 2* satellites 30 years ago. Over the subsequent years Surrey University has continued with its space science and generated the internationally respected SSTL company.

Since our foundation, GEO has attended AMSAT's annual colloquium, usually with a display stand demonstrating live weather satellite reception and sometimes giving a formal presentation relating to our interest in weather satellite reception.

Again this year we attended the AMSAT colloquium with a stand and literature relating to our members' interests. I'm not sure of the exact number, but about 80 delegates attended the weekend plus a number of day visitors, and almost all of these people visited the GEO stand.

Not surprisingly, the topic which kept recurring during the colloquium related to the interest in schools generated by Tim Peake's six months on the ISS and the *Principia* project. During Tim's time on the ISS he had scheduled contacts with around ten schools. This, of course, has generated a longer-term interest in space science and radio communication, not just with those schools who did contact Tim directly, but also a wider interest in space related topics with which schools can cope.

For me the stars of the weekend were two 15-year-old girls from Sandringham school—Jessica Leigh and Polly Gupta—who were confident and articulate in presenting to the meeting their school's live contact with Tim Peake while he was on ISS. My later conversation with them confirmed the longer-term interest the experience had generated with them and their school.

I am progressing the contacts made during this weekend and hope there will be long-term interest shown by the individuals and school representatives I met during this weekend.

For more information relating to AMSAT-UK, visit their website at

www.amsat-uk.org

Delegates attending the AMSAT colloquium first presentation related to 'SSTL LEO MEO GEO and Beyond'

The live satellite receiving station in operation over most of the weekend.

Jessica Leigh and Polly Gupta describing their school's contact with Tim Peake.

Jessica and Polly giving their presentation to an attentive audience.

Two families with their primary school children taking an interest in satellite reception literature. Subsequently their local school have been given supportive information about possible weather satellite reception into their school.

Jessica and Polly visiting the live satellite ground station which operated over the whole weekend. Note GEO's stand in the background.

Francis Bell with Jessica Leigh and Polly Gupta.

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INTERVIEW
Professor Bertrand Calpini talks equipment standards and the need for more collaboration between the public and private sectors

Francis Bell

GEO members may be interested in receiving their own copy of the publication '**Meteorological Technology International**'. I am on the mailing list for this publication, which is produced twice annually, and reviews weather, climate and hydrology technologies. Typically, I receive my copies in April and September, the latter which I guess is timed to promote the *Meteorological Technology World Expo* held annually in Belgium. GEO have been invited to attend this event several times but so far logistics have restricted our attendance. The current publication consists of 152 pages with 31 well written articles including:

- Hurricane Hunters
- Space Weather Prediction
- Precipitation measurements
- Solar Radiation
- Carbon Emissions
- and many others

As best I can judge this is a free publication, and if you want your own copy I suggest you write to:

Meteorology Technology International
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Surrey RH41DF

Or you could try emailing simon.willard@ukipme.com

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Cloud Gravity Waves

NASA Earth Observatory
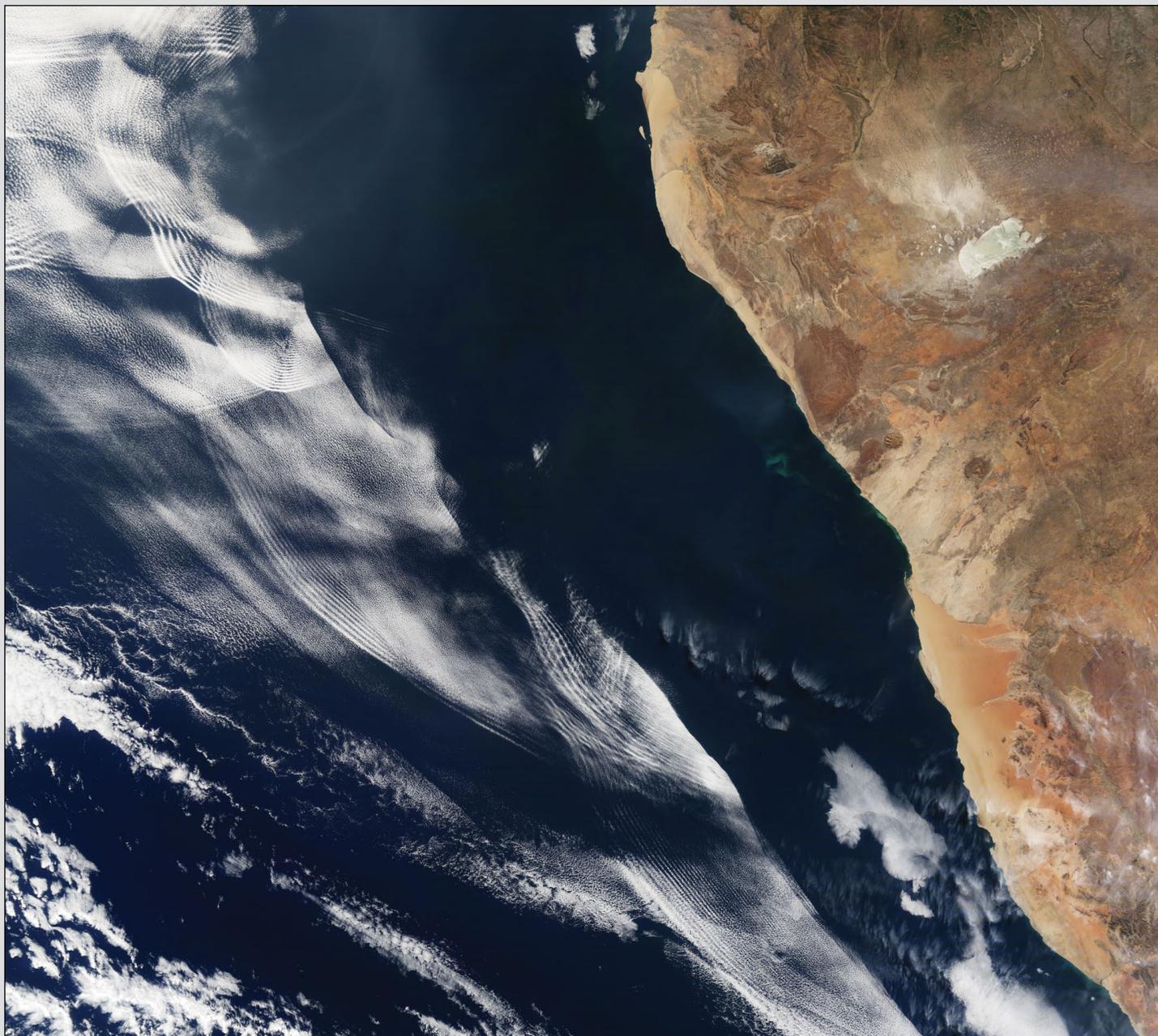
On June 26, 2016, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** satellite acquired this natural-colour image showing Cloud Gravity Waves off the coast of Angola and Namibia.

Similar to a boat's wake, which forms as the water is pushed upward by the boat and pulled downward again by gravity, these clouds are formed by the rise and fall of colliding air columns.

Off of west Africa, dry air coming off the Namib desert—after being cooled during the night—moves out beneath the balmy, moist air overlying the ocean and pushes it upwards. As the humid air rises to a higher altitude, its moisture condenses into droplets, forming clouds which gravity rolls into wave-like shapes. When the moist air rises, it cools and sinks back down again. As

it descends towards the Earth, the moist air is pushed up again by the dry air. Repeated again and again, this process creates gravity waves. Clouds form during the upward wave motions and evaporate when they move downward again.

Such waves will often propagate in the morning and early afternoon. During the course of the day, the clouds move out to sea and stretch out, as the dry air flowing off the land causes the moist ocean air to advect westward.

In this image, the clouds form several hundred kilometres off the coast, but at times when the air is less dry or westerly winds are less strong, they can actually be seen hugging the coast.

NASA Earth Observatory image by Jesse Allen, using data from the Land Atmosphere Near real-time Capability for EOS (LANCE). Caption by Pola Lem.

The Carrington Effect

NASA Astronomy Picture of the Day

A spectacular aurora over Thingvallavatn Lake in Iceland, photographed August 24, 2016 by Juan Carlos Casado
Image © Juan Carlos Casado (TWAN, Earth and Stars)

Admire the beauty but fear the beast. The beauty is the aurora overhead, here taking the form of a great green spiral, seen between picturesque clouds with the bright Moon to the side and stars in the background. The beast is the wave of charged particles that creates the aurora but might, one day, impair civilisation.

Over a century and a half ago, during September 1-2, 1859, following notable auroras seen all across the globe, a pulse of charged particles from a coronal mass ejection (CME) associated with a solar flare impacted Earth's magnetosphere so forcefully as to create the *Carrington Event*, one of the largest geomagnetic storms on record. The associated 'white light flare' in the solar photosphere was observed and recorded by English astronomers Richard C Carrington and Richard Hodgson.

A relatively direct path between the Sun and the Earth might have been cleared by a preceding CME. What is certain is that the *Carrington Event* compressed the Earth's magnetic field so violently that currents were created in the telegraph network, so great that many wires sparked and gave telegraph operators shocks. Were a Carrington-class event to impact the Earth today, speculation holds that damage might occur to global power grids and electronics on a scale never yet experienced. The featured aurora was imaged in late August this year over Thingvallavatn Lake in Iceland, a lake that partly fills the fault that divides Earth's large Eurasian and North American tectonic plates.
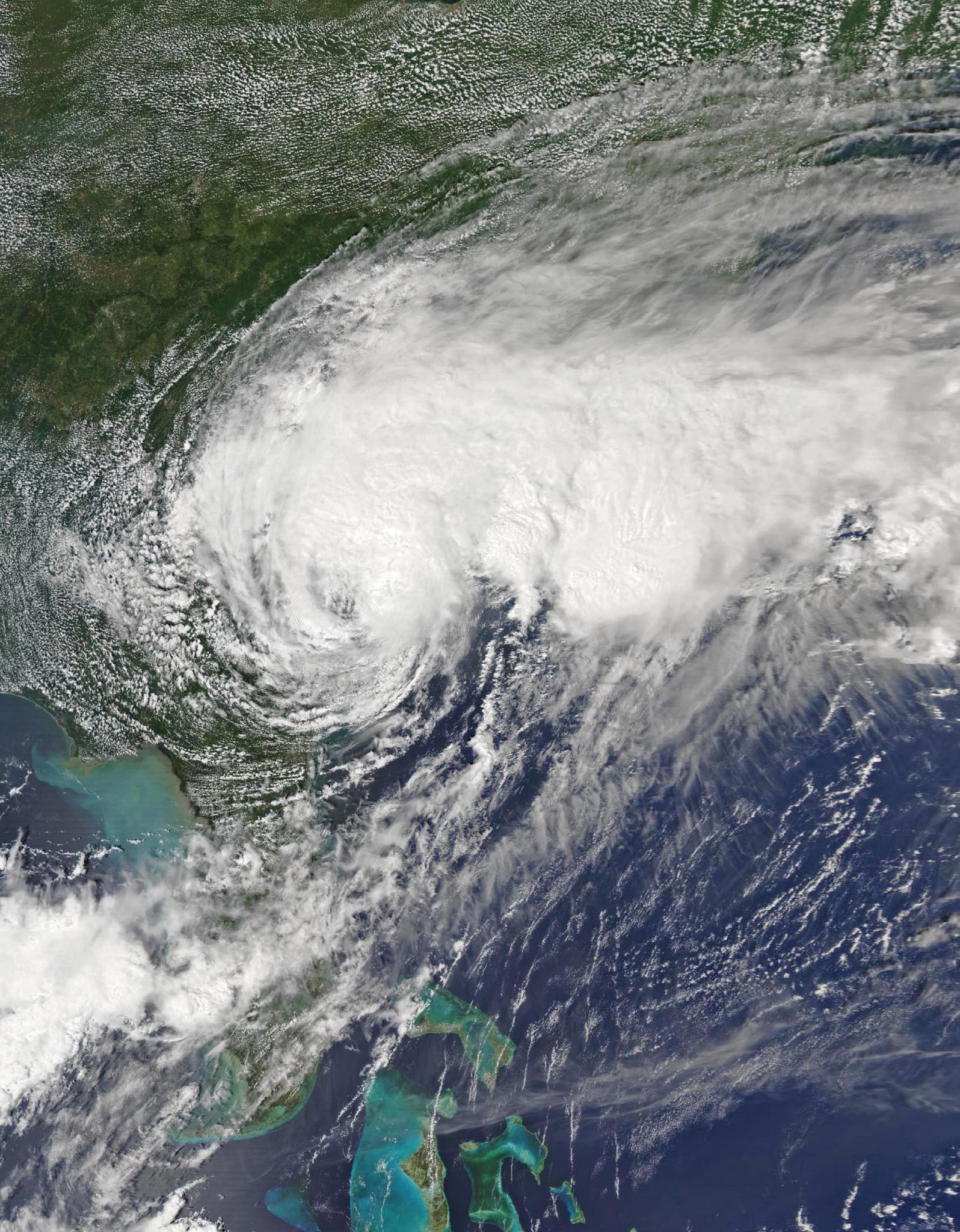
This MODIS image of Category-1 hurricane Hermine was acquired by NASA's Aqua satellite on September 2. Beaches the length of the eastern seaboard were closed for the weekend, even those on New York's Long Island. A number of Labor Day events were affected, including Saturday's Bruce Springsteen concert in Virginia Beach which was rescheduled to the Monday.

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? [7]
Meteor M N2	137.1000 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	---	AHRPT	[2]
Feng Yun 3B	1704.5 MHz	---	AHRPT	[2]
Feng Yun 3C	1704.5 MHz	---	AHRPT	[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? [7]
Meteor M N2	1700.0 MHz	RHCP	AHRPT	Good

Geostationary Satellites				
Satellite	Transmission Mode(s)		Position	Status
Meteosat 7	HRIT 1691 MHz / WEFAX 1691 MHz		57.5°E	On
Meteosat 8	HRIT (digital)	---	3.5°E	Standby [3]
Meteosat 9	HRIT (digital)	LRIT (digital)	9.5°E	On [4]
Meteosat 10	HRIT (digital)	LRIT (digital)	0°W	On
GOES-13 (E)	GVAR 1685.7 MHz	LRIT 1691.0 MHz	75°W	On [5]
GOES-14	GVAR 1685.7 MHz	LRIT 1691.0 MHz	105°W	Standby
GOES-15 (W)	GVAR 1685.7 MHz	LRIT 1691.0 MHz	135°W	On [5]
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	86.5°E	Off [6]
Feng Yun 2E	SVISSR	LRIT	104.0°E	On
Feng Yun 2F	SVISSR	LRIT	112.0°E	On
Feng Yun 2G	SVISSR	LRIT	86.5°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 operational backup satellite
4   Meteosat Rapid Scanning Service (RSS)
5   GOES 13 and GOES 15 also transmit EMWIN on 1692.70 MHz
6   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.
7   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.

EUMETCast On-Line Registration Guide

If you require to register as a first-time user for any of the free EUMETCast data streams such as MSG, NOAA AVHRR, Metop etc., or need to renew an existing subscription, this must be done on-line.

GEO has produced a step-by-step guide to the entire process at

http://www.geo-web.org.uk/eumreg. php

This guide also contains a direct link to the official EUMETCast on-line registration form, which can otherwise prove somewhat tricky to locate.

Weather Satellite Reports

If there is a single Internet Forum that is relevant to all weather satellite enthusiasts, it must surely be Douglas Deans' Weather Satellite reports.

Here you will find every conceivable type of information about weather satellites, whether polar or geostationary, APT, HRPT, LRIT, EUMETCast or whatever.

Absolutely everything is covered, and the information is updated every week. Special additional bulletins may be issued if an important change takes place mid week.

You can read the bulletins from this URL

https://groups.yahoo.com/neo/ groups/weather-satellite-reports/info

or, even better, elect to have the reports sent to you by email every Monday.

Internet Discussion Groups

There are a numerous Internet-based discussion groups of interest to weather satellite enthusiasts. The home page for each group provides an email address through which you can request membership. Even a blank email containing the word 'subscribe' in its Subject line is all that is required.

APT Decoder

This is a group where users of Patrik Tast's APTDecoder can share information and problems.

https://groups.yahoo.com/neo/ groups/APTDecoder/info

GEO-Subscribers

This is GEO's own group, where members can exchange information

and post queries relating to any aspect related to weather satellite reception (hardware, software, antennas etc), Earth observation satellites and any GEO-related matter.

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

Satsignal

An end-user self-help group for users of David Taylor's Satellite Software Tools (SatSignal, WXtrack, GeoSatSignal, HRPT Reader, GroundMap, MSG Data Manager, AVHRR Manager and the ATOVS Reader).

https://groups.yahoo.com/neo/ groups/SatSignal/info

MSG-1

A forum dedicated to Meteosat Second Generation (MSG), where members share information about the *EUMETCast* reception hardware and software.

https://groups.yahoo.com/neo/ groups/MSG-1/info

WXtoImg-l

A forum for users of the *WXtoImg* software application for receiving and processing imagery from the NOAA satellite APT signals.

https://groups.yahoo.com/neo/ groups/wxtoimg-l/info

GEO Helplines

Douglas Deans, Dunblane, Scotland.

All aspects of weather satellites from APT, HRPT to Meteosat-9 DVB/ EUMETCast systems.

- telephone:(01786) 82 28 28
- e-mail: dsdeans@btinternet.com

John Tellick, Surrey, England.

Meteosat advice: registering for the various MSG services, hardware and software installation and troubleshooting. John will also field general queries about any aspect of receiving weather satellite transmissions.

- telephone: (0208) 390 3315
- e-mail: info@geo-web.org.uk

Geoff Morris, Flintshire, NE Wales.

Geoff has lots of experience with aerial, coax connectors, mounting hardware etc. and has also done a lot of work with the orbiting satellites. Geoff has been a EUMETCast Meteosat user for some time and is familiar with David Taylor's MSG software. He should be able to share his experiences with newcomers to this branch of the hobby.

- Tel: (01244) 818252
- e-mail: gw3atz@btopenworld.com

Mike Stevens, Dorset, England.

Assistance with reception of EUMETCast to include Metop-A and Metop-B; also MSG Data reception and set-up within the PC, assistance with dish alignment and set-up, and installation and set-up of TBS DVB-S2 units.

- email: mikeg4cfz@gmail.com

Guy Martin, Kent, England.

Guy is prepared to advise anyone who wishing to receive MSG/Metop using Windows 2000 or XP. Can also help with networking and ADSL router setup.

- gmartin@electroweb.co.uk

Hector Cintron, Puerto Rico, USA.

Hector is prepared to field enquiries on HRPT, APT, EMWIN and NOAAPORT

- Phone: 787-774-8657
- e-mail: n1tkk@hwic.net

Email contact can of course be made at any time, but we would ask you to respect privacy by restricting telephone contact to the period 7.00 - 9.00 pm in the evenings.

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Please note that **major articles** which contain a large number of illustrations should be submitted **as early as possible before copy deadline**, to give time for preparation prior to publication.

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- Payment by **direct bank transfer** can be arranged. Please email ***members@geo-web.org.uk*** for BIC and IBAN details.

Name (please PRINT clearly)

Email Address (please print very clearly)

Address

Declaration

I wish to join GEO, the Group for Earth Observation, for a period of two years.

Town/City

I sign below to confirm that I have no objection to my membership details being held on a computer database and understand that these details will be used *exclusively* for internal GEO administraton purposes.

Postcode/ZIP   **Callsign**

Country

Signature

Telephone Number   **FAX**

Date

Your subscription is valid for two years from your date of application and entitles you to all the privileges of membership of the Group for Earth Observation, including four issues of GEO Quarterly. Please note that your subscription will commence with the issue of GEO Quarterly that is current at the time of your application. Back issues, where available, may be ordered from the GEO Shop.

Please send your completed form to:
David Anderson (GEO subs),
35 Sycamore Road,
East Leake
Loughborough LE12 6PP, UK

GEO Subscriptions
35 Sycamore Road,
East Leake,
Loughborough LE12 6PP
England, UK.

If you prefer not to remove this page from your Quarterly, a photocopy or scan of this Membership Form is perfectly acceptable

GEO Shop

Manager: Nigel Evans
email: geoonlinestore@gmail.com

For our full range, visit **GEO Shop** at
http://www.geo-web.org.uk/shop.php

PayPal

Ayecka-SR1 DVB-S2 VCM USB Receiver

This advanced DVB-S2 VCM Receiver has been extensively tested by both EUMETSAT and GEO, and has proved to be exceptionally suitable for trouble-free reception of the EUMETCast DVB-S2 transmissions that became standard from the start of 2015.

The price includes a USB cable, wall power supply, shipping and *Paypal* fees.

UK members price	-	£375.00
EU members price	-	£385.00

NEWSKY RTL2832U/R820T2 SDR DAB USB MCX Socket Special Dongle
for reception of NOAA APT and Meteor M2 LRPT

- Frequency range: (*100) 700 kHz - 1864 MHz
- MCX Socket
- Active Crystal Oscillator
- Reinforced Socket

This stick does not come with SDR software or instructions.

|		
UK members price	-	£20.00
EU members price	-	£25.00

TechniSat SatFinder Antenna Alignment Meter

This sensitive meter is a great help in setting up and aligning the dish for maximum signal. The meter comes with full instructions.

UK members price	-	£26.50
UK non-member's price	-	£29.50

GEO Quarterly - Back Issues
(Only available to GEO Members)

Paper copies of back issues of GEO Quarterly may be available, but it is advisable to check before ordering.

UK members price	-	£3.80

Annual compilations of GEO Quarterly back issues in PDF format are available on CD. Be sure to state the year of each annual compilation that you wish to order.

UK members price	-	£8.00

Current Price List

	Members' Prices			Prices for non-Members		
	UK	EU	RoW	UK	EU	RoW
Ayecka SR1 DVB-S2 Receiver	375.00	385.00	390.00	---------	---------	---------
Edimax USB 2.0 Fast Ethernet Adapter	15.00	17.00	18.00	---------	---------	---------
DVB-S USB 2102 Receiver	60.60	67.00	---------	70.60	77.00	---------
SDR Dongle kit for APT/LRPT	20.00	25.00	26.00	---------	--------	--------
Technisat Satfinder Alignment Meter	26.50	29.50	---------	29.50	32.50	---------
GEO Quarterly Back Issues (subject to availability)	3.80	4.60	5.60	n/a	n/a	n/a
GEO Quarterly (PDF on CD) 2004-2014 (Annual compilations - state year)	8.00	8.80	9.30	n/a	n/a	n/a
GEO Membership (4 PDF magazines and one printed magazine per year)	15.00	15.00	15.00	15.00	15.00	10.00

All prices are in £ sterling and include postage and packaging

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Ordering and Shipping

We will ship by post, so please allow a few days for items to arrive in Europe and perhaps a few weeks for the Rest of the World.

Orders should be sent by email to

geoonlinestore@gmail.com

or made through the GEO Website at

http://www.geo-web.org.uk/shop.php

Goods are normally shipped within 28 days, subject to availability.

PayPal

Not yet a GEO Member?

GEO can provide most of the items advertised (with the exception of GEO Quarterly back-issues and CDs) to both members and non members: but non-members cannot benefit from the discounted members prices.

Why not join GEO and take advantage of the discounted prices we can offer you as a member?

Annual Subscription Rate for all regions in now £15 (UK)

For this you will receive 4 electronic (PDF) copies of GEO Quarterly Magazine. In addition, you will be mailed **a printed version** of the December magazine.

Inverto-Black-Ultra High-Performance LNBs

GEO currently recommends these LNBs for EUMETCast reception. We are currently **not stocking** this item but it is available at **Amazon**.

http://www.amazon.co.uk/gp/product/B001ONAEKI/

Twin LNB 40mm 0,2dB	£15.50
Single satellite LNB	£ 9.95

Edimax USB 2.0 Fast Ethernet Adapter

This adapter enables you to add a *second* network connection for your PC/Laptop, to connect to the Ayecka SR1 Traffic port, thereby relieving loading on the home network. Typically, you would assign this adapter with an IP address on the same network as the SR1 i.e 192.168.10.103. Data from the SR1 passes directly to the PC whilst its internet connection remains on your usual home network 192.168.1.xxx (Management Port).

UK members price	-	£15.00
UK non-members price	-	£17.00