The GEO Quarterly

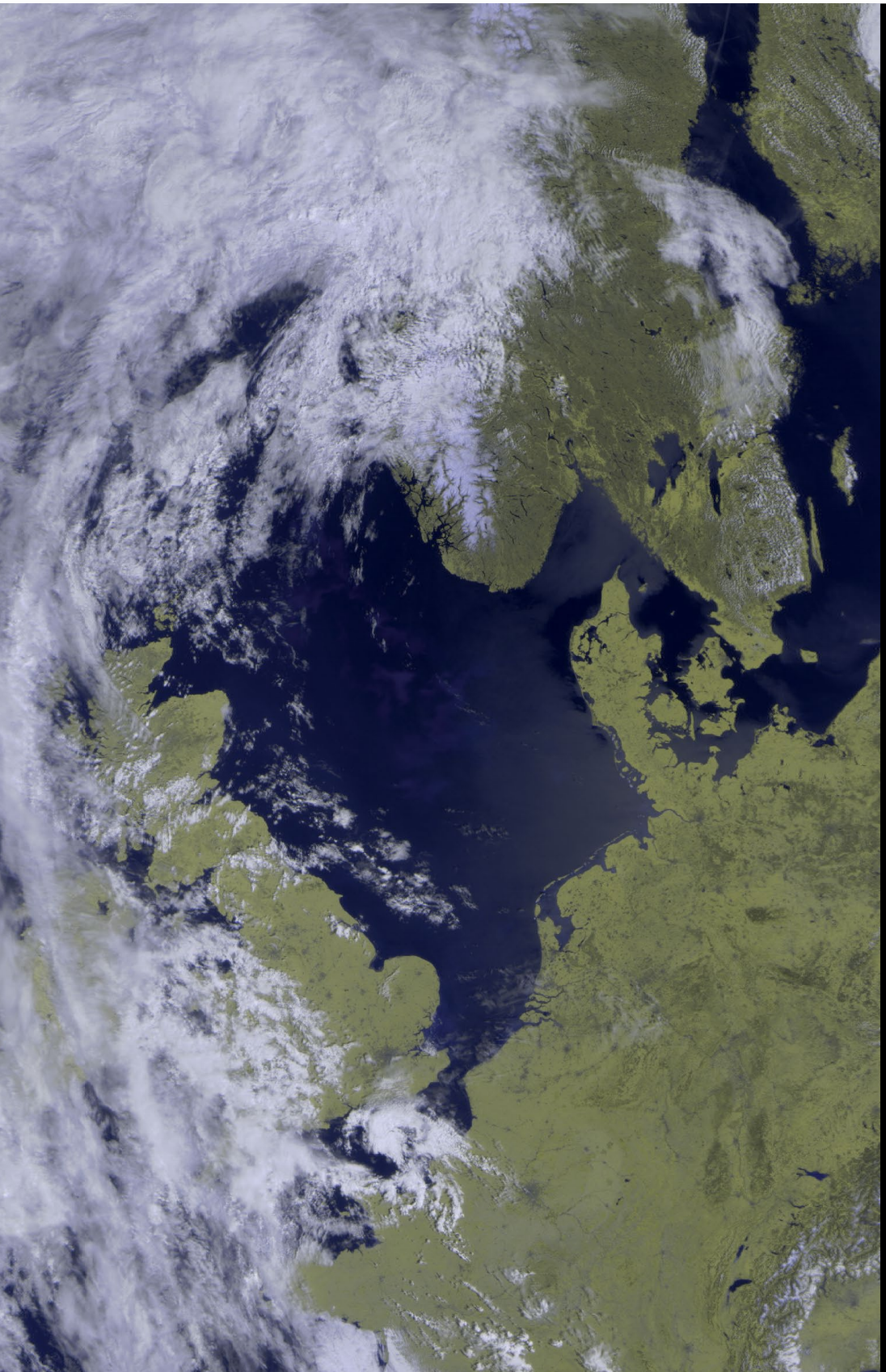
Group for Earth Observation

Group for Earth Observation

The Independent Amateur Quarterly Publication for Earth Observation and Weather Satellite Enthusiasts

47

September 2015



Inside this issue . .

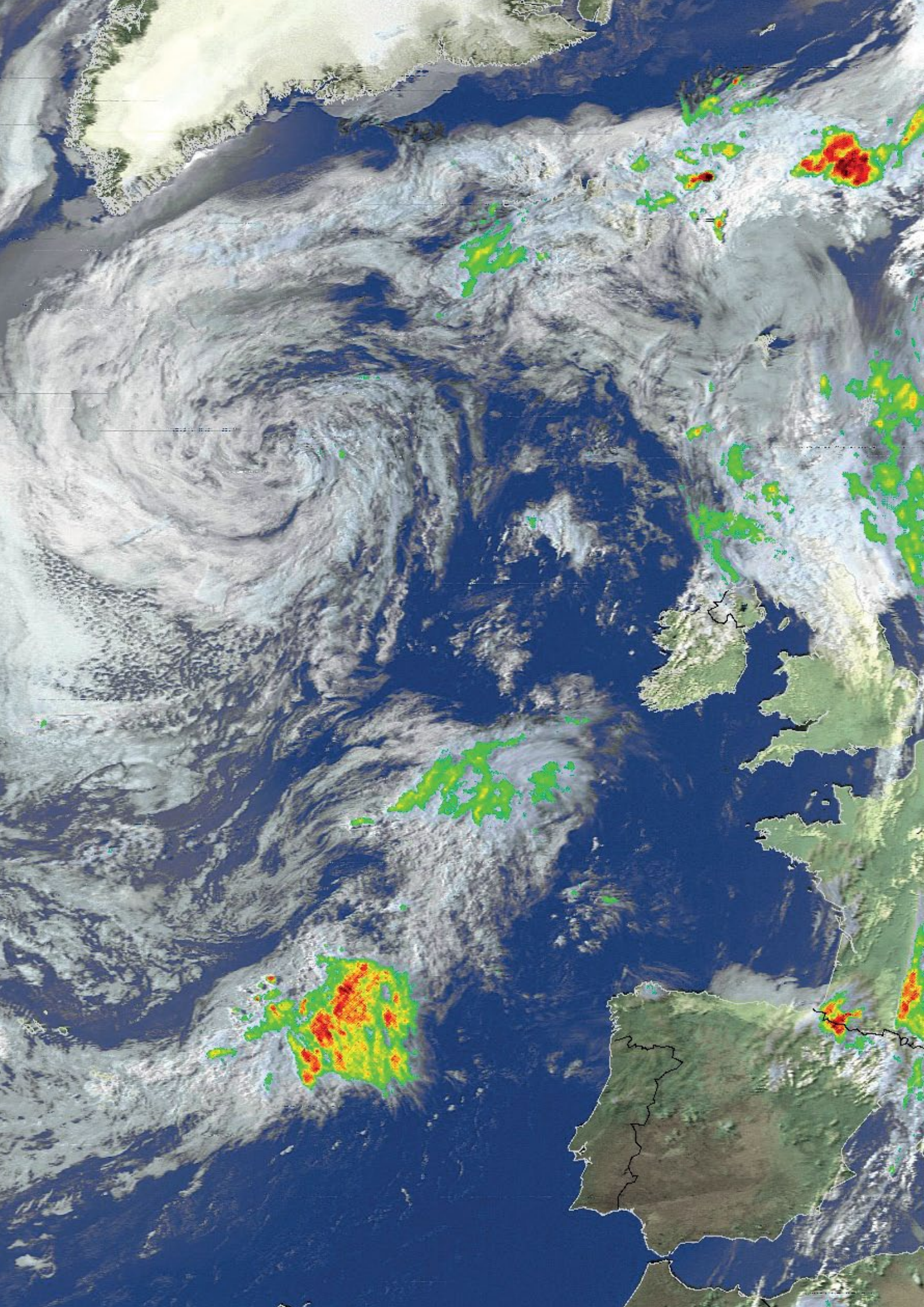
This issue opens with a colourful photo-essay from David Taylor relating to GEO's summer visit to EUMETSAT HQ in Darmstadt.

*David Taylor has produced an application called L**RPT Image Processor** which can manipulate Meteor M2 images saved in RGB125 format to produce a variety of new products including Vegetation, Thermal and Infrared. The software also provides tools for histogram equalisation, sharpening, and application of colour palettes.*

John Tellick follows up an earlier article by discussing Eutelsat-10 *signal variation, and also reports on the launch of MSG-4, the final satellite in the current geostationary series.*

Since last issue, Sentinel-2A has been started imaging. Les Hamilton provides an introduction to this new high-resolution satellite, accompanied by some spectacular imagery.

Plus articles on the Hubbard Glacier, Suomi observations of summer auroras, Franz Josef Land, and a spectacular Solar halo.



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Editorial

Les Hamilton
geoeditor@geo-web.org.uk

I'll start by reminding readers that our next issue, due in December, will be provided to all subscribers as a printed magazine (as well as a PDF document). Accordingly, the copy deadline is a fortnight earlier than was the case for this issue. We hope you will rally round with articles and images to make this a truly 'bumper' issue to conclude 2015.

Presentations from the Darmstadt Visit

1 - Overview of Current Satellite_Operations (.ppt 30 MB)
2 - EUMETCast DVB-S2 Operations and Future HVS (.pptx 8 MB)
3 - Future Satellite Services - Sentinel-3 (.pptx 5.2 MB)
4 - Future Satellite Services - MTG (.pptx 114 MB)
5 - Case Studies (.pptx 69 MB)
6 - Data Centre Update (.pptx 6 MB)
7 - User Services Activities Update (.pptx 6 MB)

These may all be downloaded from the GEO website at the following URL
http://www.geo-web.org.uk/darmstadt-2015.php#PowerPoint

Production of this issue of GEO Quarterly has been fraught with difficulties. Holidays notwithstanding, the GEO Quarterly PC suffered two BSOD failures during production, and it was fortunate indeed that the Quarterly could be rescued. A new PC will be required for the December issue, which will include Francis Bell's report on the GEO visit to EUMETSAT in Darmstadt last July.

I hope you enjoy this issue, which contains a large number of interesting satellite images.

Copy deadline for the December issue of GEO Quarterly is Sunday, November 15.

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GEO visits EUMETSAT in Darmstadt

July 2-3, 2015

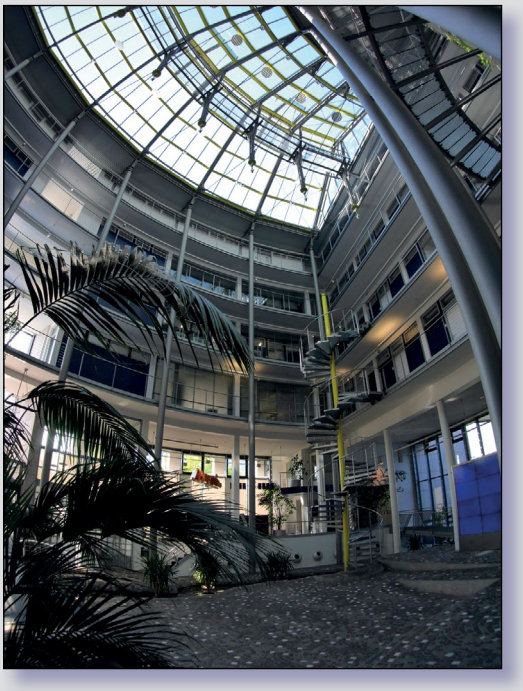
Photographs © David Taylor

A half-scale model of an MSG satellite in the EUMETSAT grounds

A scale model of a polar orbiting Metop satellite

The GEO delegates outside EUMETSAT's Darmstadt HQ in July 2015.

http://www.geo-web.org.uk/darmstadt-2015.php



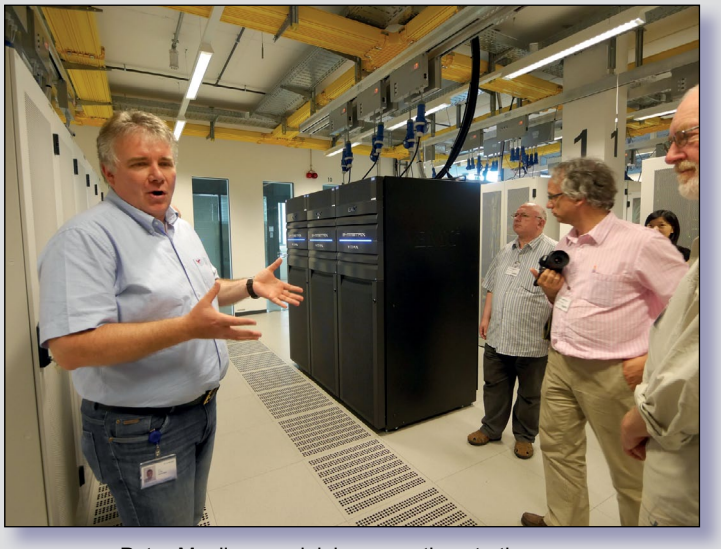
The impressive atrium at EUMETSAT HQ
There's actually a stream flowing through it.

Some of the speakers and Twitter staff for our day: Sally Wannop, Sancha Lancaster, Kim-Hui Gaune and Klaus-Peter Renner.

Part of the new Data Centre complex at EUMETSAT

This is the library for EUMETSAT's hard-copy publications

Phil Harvey, our guide, in the EUMETSAT control room



Peter Muellner explaining operations to the group

Jochen Kerkmann's presenting case studies

Enjoying refreshments following the EUMETSAT HQ visit

A somewhat depleted GEO group pictured after the ESOC visit, as some of the party had already started on their journeys home.

The ESOC building.
Unfortunately, we were not permitted to take photographs inside.

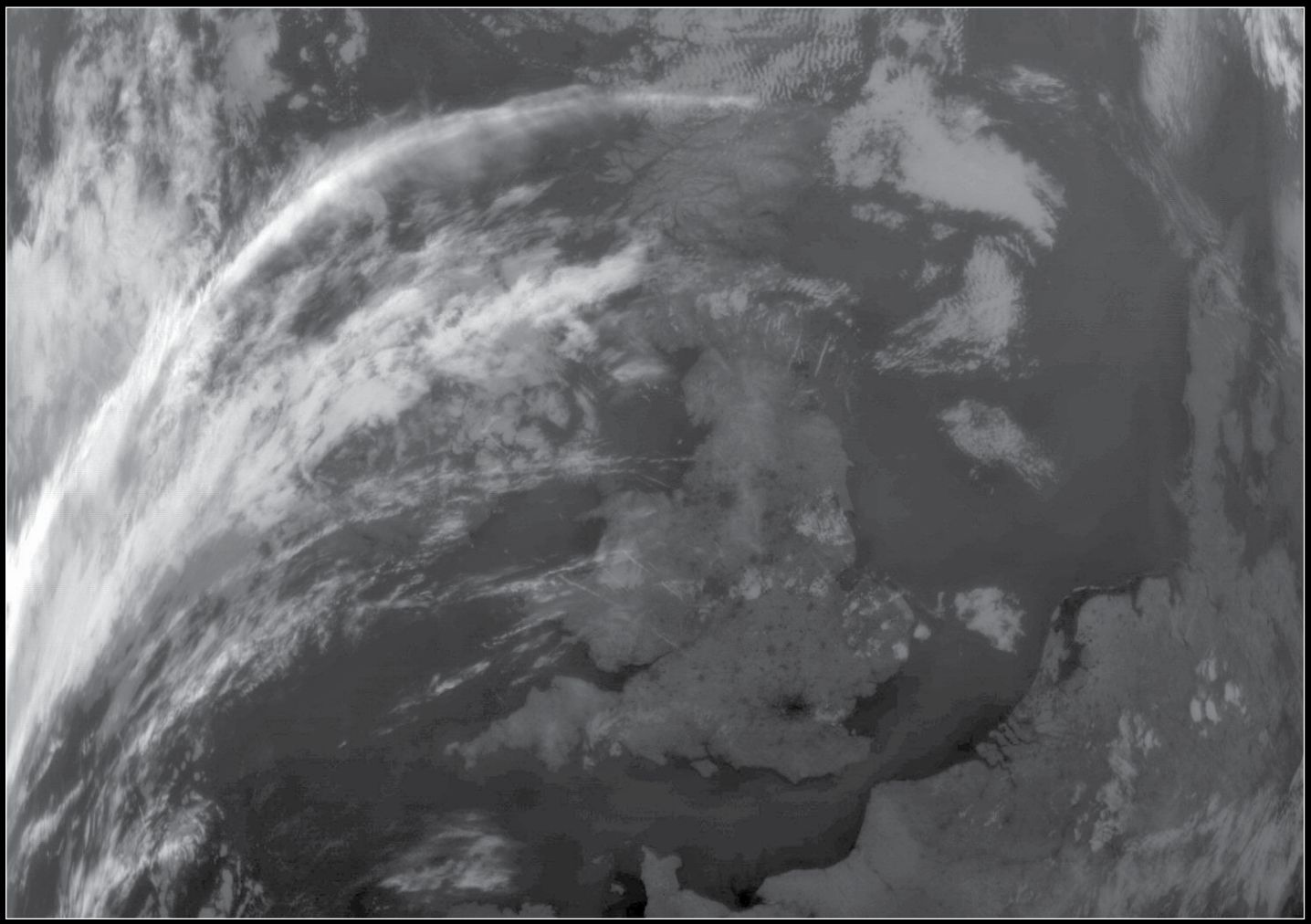
A relaxing group meal at the super Khan Mongolian Barbeque, where Mark Drapes (our joint guide for the ESOC tour) joined us.

Contrails

from both above and below

Close to sunset on the evening of June 3, 2015, **Douglas Deans** acquired an interesting Meteor-M2 infrared image that clearly showed the presence of aeroplane contrails over northern Wales. And at about the same time, *Robert Moore* spotted, and photographed, a set of brilliantly illuminated contrails against a clear sky. Both images are reproduced below.

Robert Moore's photograph of aeroplane contrails



Douglas Deans Meteor M2 image, showing the same contrails from orbit.

Enhance your Meteor M2 Experience with

LRPT Image Processor

David Taylor

Program Background

Like many other readers, I had been dabbling with Meteor M2 imagery in recent months, and quickly became aware of one feature that currently available software lacked: the ability to combine the three Meteor LRPT channels into realistic false-coloured images.

Those of you who download NOAA HRPT imagery will be well aware that excellent results can be formed by combining channels 1, 2 and 4, to create the 'classic' RGB124 coloured images. In theory, this can also be achieved for Meteor as the frequency ranges of the two satellites' channels are almost identical, as illustrated in the tables below.

NOAA	
Channel 1	0.58 - 0.68 µm
Channel 2	0.725 - 1.00 µm
Channel 4	10.30 - 11.30 µm

Meteor M2	
Channel 1	0.50 - 0.70 µm
Channel 2	0.70 - 1.10 µm
Channel 5	10.55 - 11.50 µm

One problem is that Meteor M2 transmits its channel-5 image with the warmer areas as light tones and cold regions in dark tones, displaying dark clouds and light coloured land. NOAA reverses this prior to transmission, providing images with the more familiar light cloud features and darker land and sea.

A second problem is that I have yet to find calibration data for digital level to brightness temperature, so I have had to estimate this by comparison with other satellite data.

Meteor RGB125 images

If you select the three Meteor LRPT channels as red, green and blue respectively in Oleg's *LrptOffLineDecoder*, you end up with images like the one shown in figure 1, where there is a strong red bias, especially in the seas. But because these images contain the complete sets of values for all three LRPT channels, it is a straightforward matter to tease them apart with software and recombine them in more interesting interpretive ways.

LRPT Image Processor

This was the rationale behind the development of *LRPT Image Processor*, a simple program that converts Meteor RGB125 images into a number of more useful formats. Some of these are simply combinations of the original channels, while others result from the application of Colour Lookup Tables (CLUTs) to produce more realistic false-colour images.

LRPT Image Processor can be downloaded from

http://www.satsignal.eu/software/LRPT-processor.html

and is free to use. No registration is required.

To install *LRPT Image Processor*, extract all the files from the ZIP archive into a directory outside the **C:\Program Files** tree: I suggest **C:\Tools\SatSignal\LRPTprocessor**.

Usage

LRPT Image Processor can remove the edge compression present in the raw scan data from *Meteor-M N2* LRPT data (and does so by default), to create a Meteor RGB122 image, pseudo-NOAA RGB124 image, vegetation image, infrared image, thermal image and a false-colour image based on

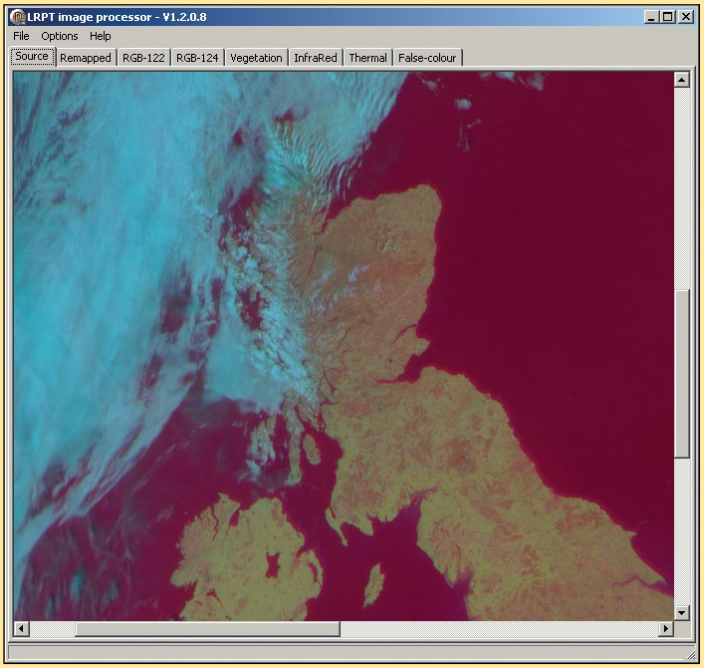


Figure 1 - The original RGB125 Meteor M2 Image from April 21, 2015

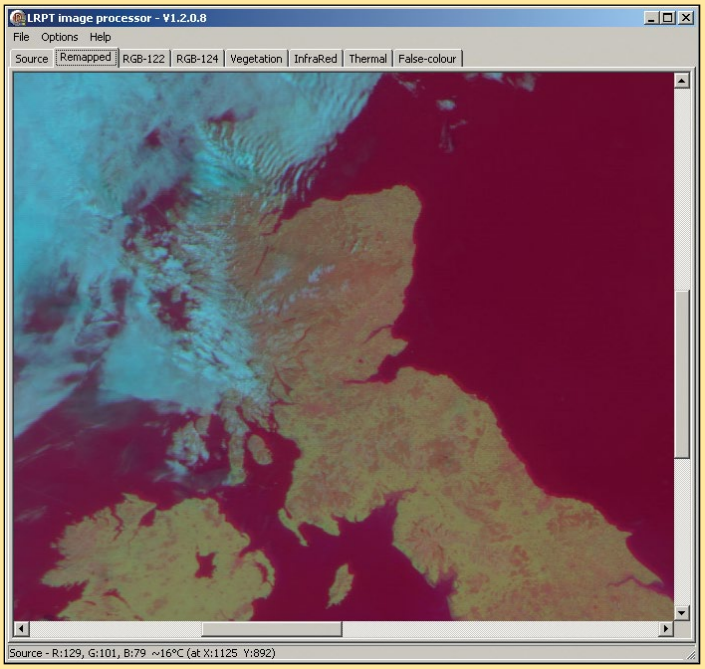


Figure 2 - The Geometrically Corrected RGB125 Meteor M2 Image

a provided 256×256 CLUT. The thermal components do rely on you initially saving an RGB125 Meteor image from *LrptOffLineDecoder*, where

channel 1 (0.5 - 0.7 µm)	=>	Red
channel 2 (0.7 - 1.1 µm)	=>	Green
channel 5 (10.5 - 11.5 µm)	=>	Blue

You can load such an image, in either BMP or JPG format, into *LRPT Image Processor* from the command-line, by using drag-and-drop on to the program interface, or via the *File|Open*

continued on page 8

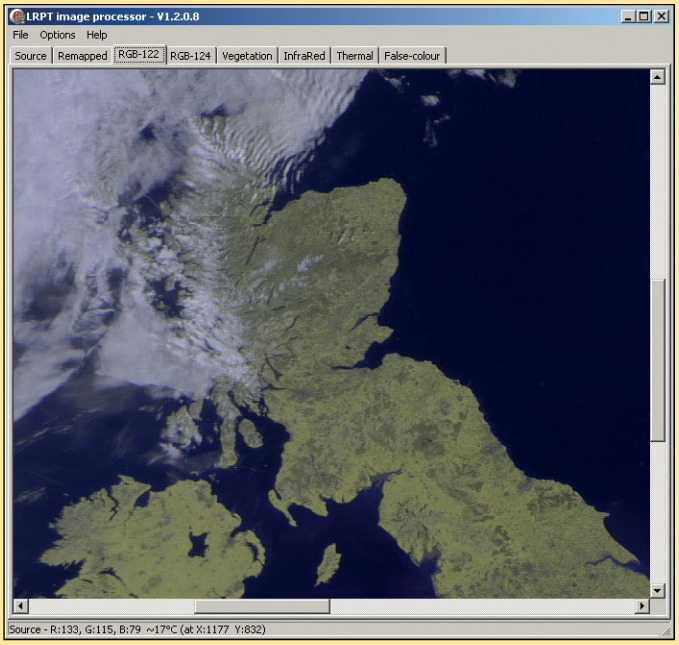


Figure 3 - The standard Meteor RGB122 image

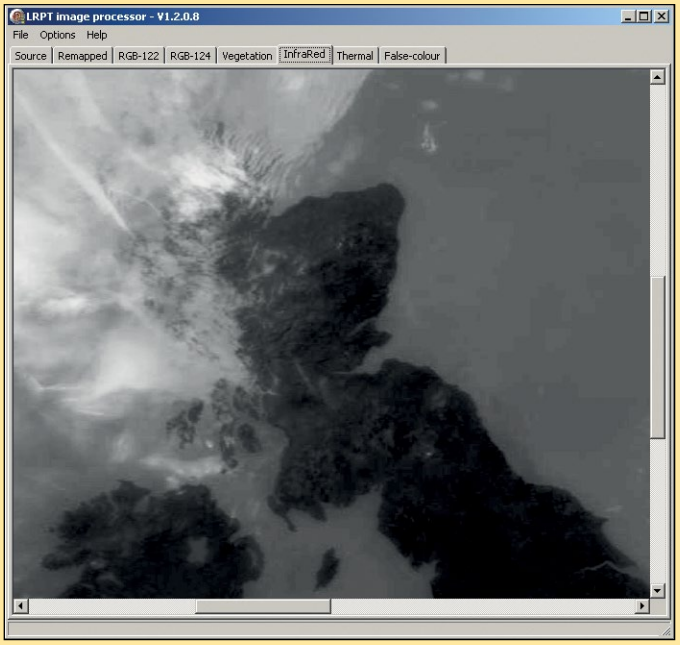


Figure 6 - Infrared image derived by inverting Meteor channel 5

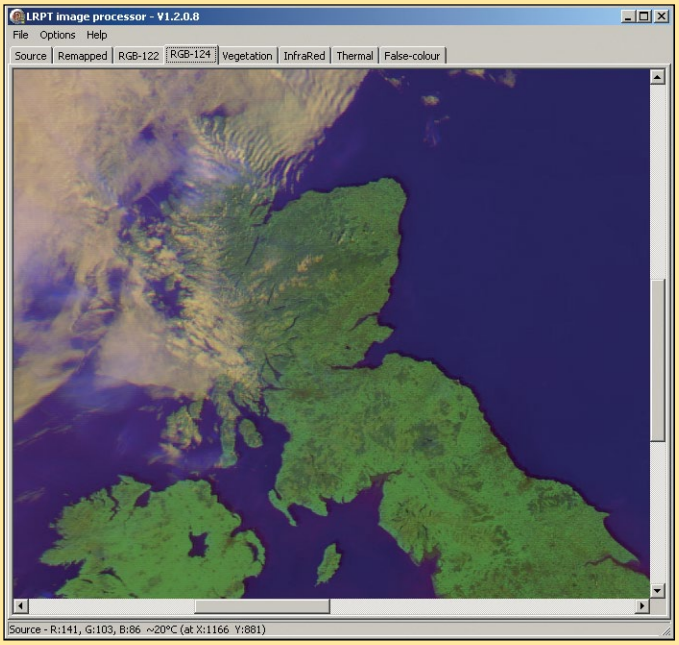


Figure 4 - Mimicking NOAA's RGB124 image

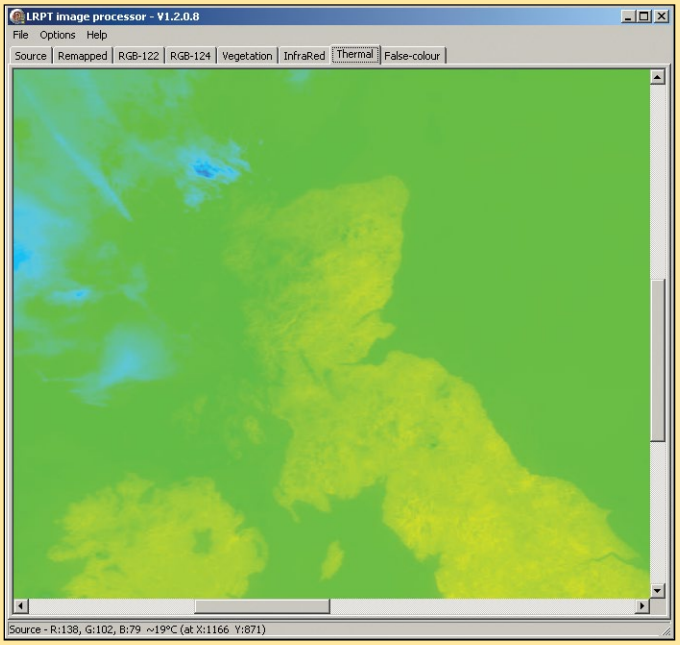


Figure 7 - The Thermal image

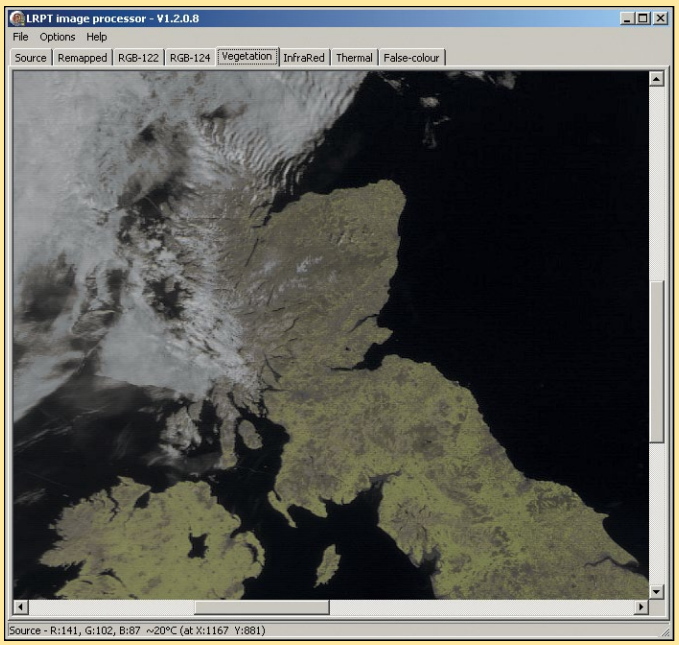


Figure 5 - Vegetation Index derived from channels 1 and 2

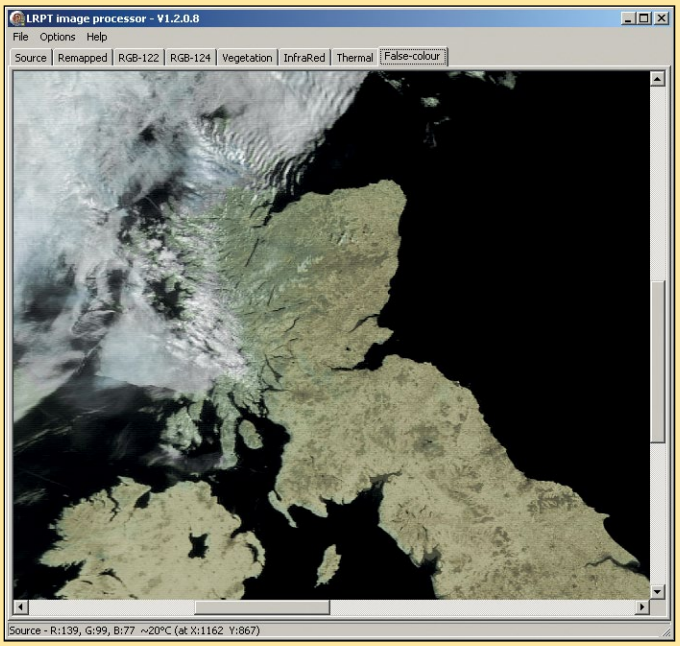


Figure 8 - The False-colour Image created by applying the *TempToColourHLS* CLUT

menu. After a short delay while processing takes place, all the images generated are automatically saved in the same directory as the input image, and in the same format (BMP or JPG). These images can be inspected individually by clicking on the various tabs at the top of the screen. Initially, because each image is shown at full resolution, only a small section appears on screen. But a left-click over the image toggles it between full size and fit-to-screen.

Histogram Equalisation

As readers who regularly acquire Meteor M2 imagery will be well aware, the infrared images from Meteor's channel-5 often show very low contrast. When *LRPT Processor's* 'InfraRed' tab is displayed, a right-click over the image reveals a pop-up menu that provides four histogram equalisation options ranging from 'none' to 'strong' (figure 9). Lower levels of equalisation improve detail in light coloured areas (clouds) while higher levels reveal progressively more detail in darker regions (land). The four levels of equalisation are compared in figure 10.

The 'False-colour' tab also allows a choice of histogram equalisation and sharpening, both accessed by a right- mouse click (figure 12). Note that the sharpening will also make the compression in the original data more obvious.

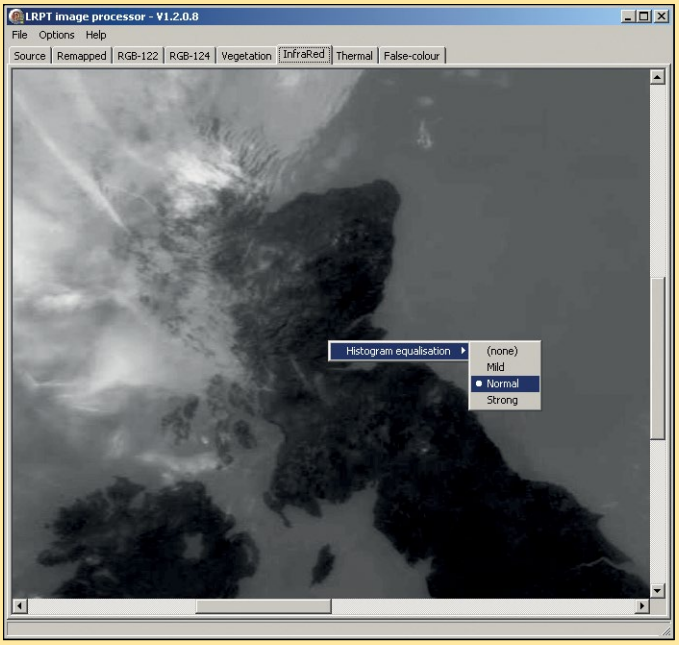


Figure 9 - The right-click histogram equalise menu that operates on the Infrared tab.

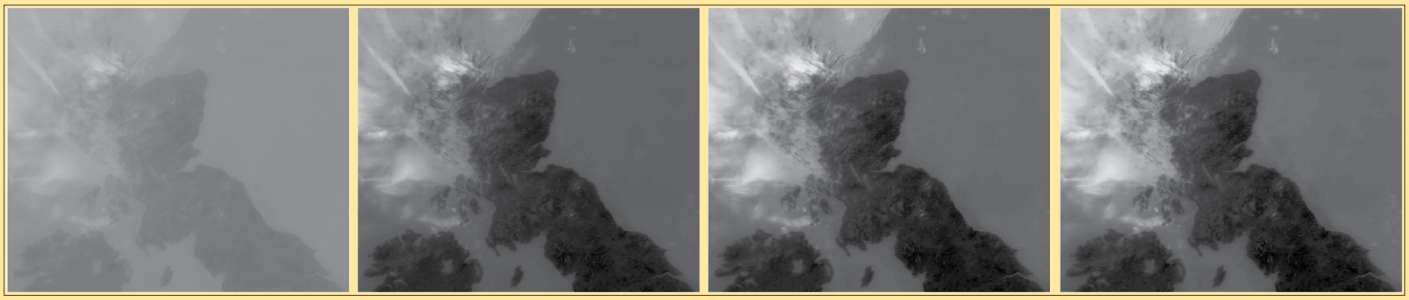


Figure 10 - The Histogram Equalise options available on the Infrared Tab (from left to right): None, Mild, Normal and Strong.

The Options Menu

The '*Options*' menu allows you to

- Rotate an image: used for flipping imagery from northbound passes into an upright position.
- Select a CLUT, which determines the appearance of the image in the 'False-colour' tab.
- Reveal the 'Setup' panel.

This final option allows the user to select which of the seven images displayed on *LRPT Processor's* tabs are actually saved when the software is activated, whether or not to apply geometrical correction to the images, and the preferred output format (figure 11).

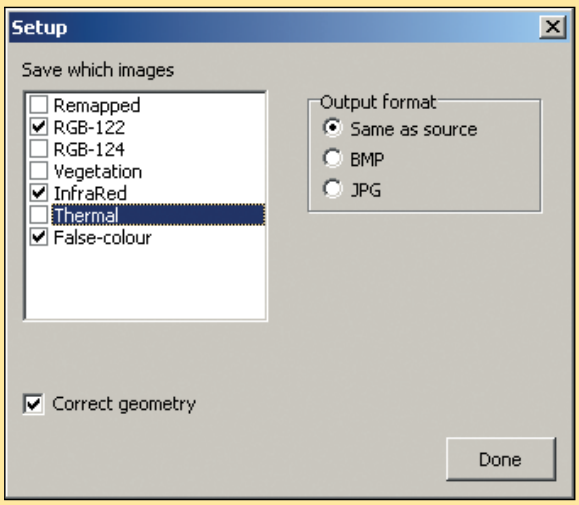


Figure 11 - The LRPT Processor 'Setup' panel.

The program has been developed in *Embarcadero's Delphi* using *Windows-8.1/64*, but I would expect it to work on *Windows XP-SP3* and later. *Windows-XP/64* and *Vista/64* may not work as expected (and these operating systems are not supported). It will also work in Linux, under WINE.

To run LRPT Processor, my *Runtime Library Bundle* must also be installed. It can be downloaded from

http://www.satsignal.eu/software/runtime.html

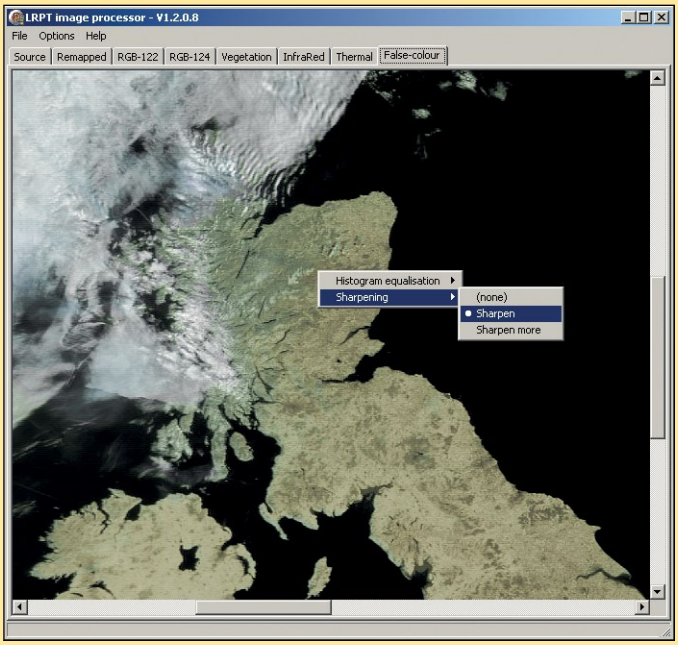
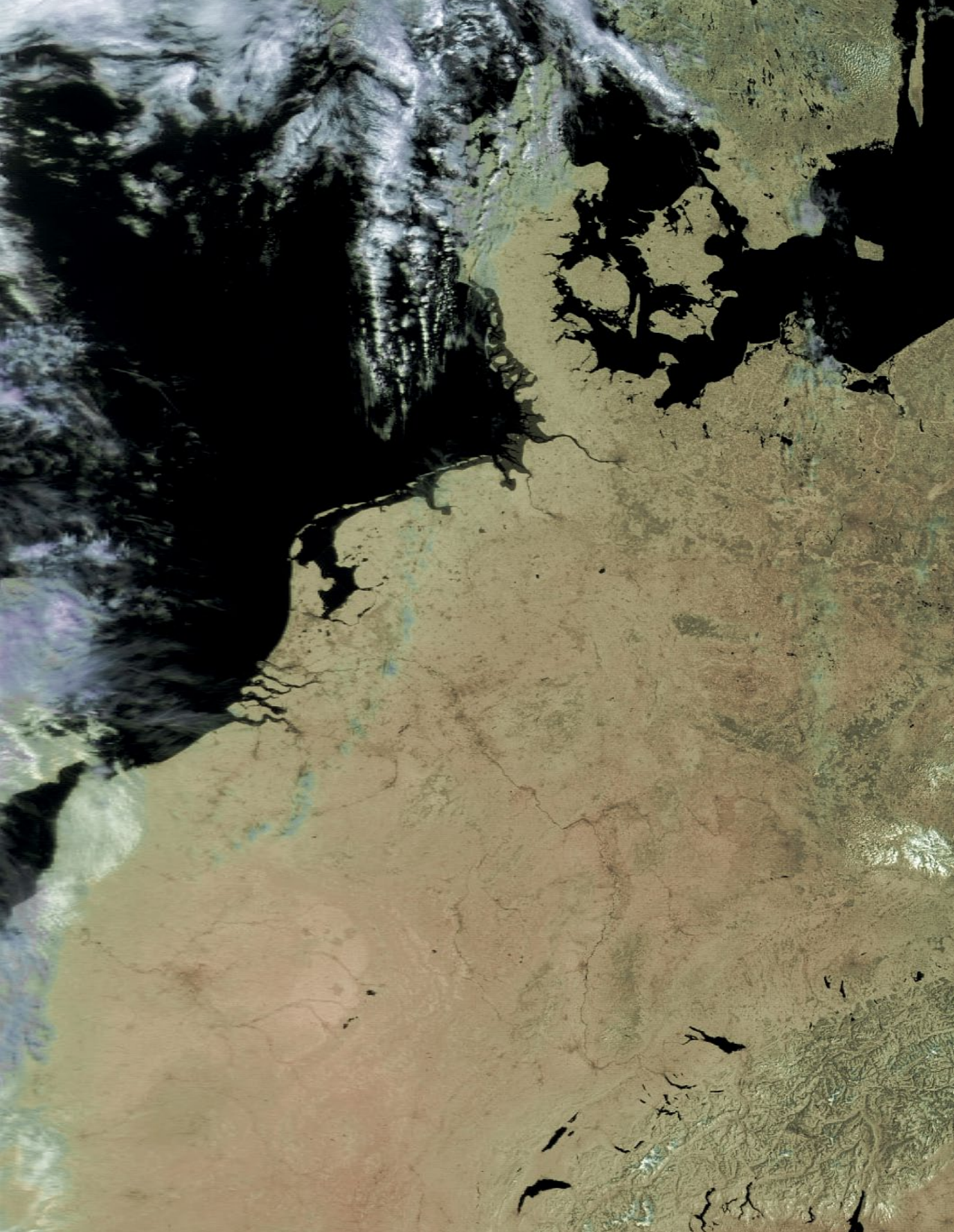


Figure 12 - The sharpening menu on the 'False-colour' tab.



This segment from the 09:55 UT Meteor M2 pass on August 3, 2015 was created using the false-colour option in LRPT Image Processor

Advance of the Hubbard Glacier

NASA Earth Observatory

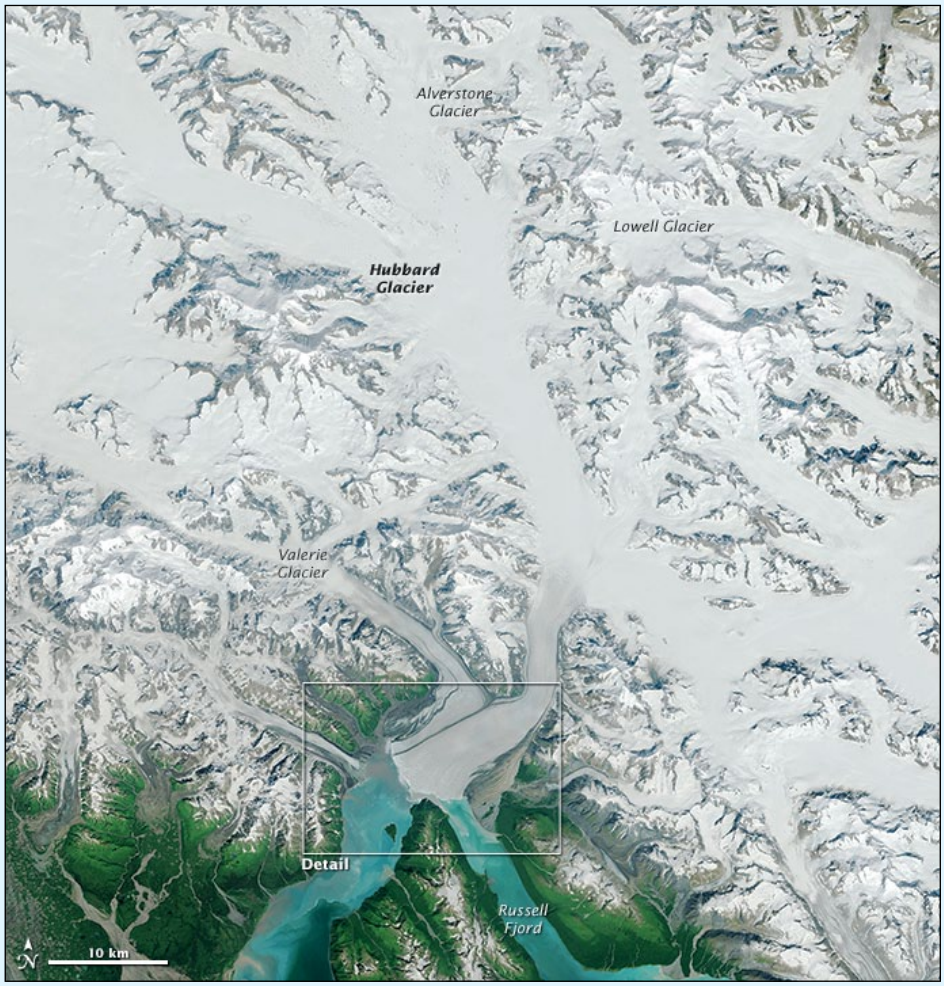
Since measurements began in 1895, Alaska's Hubbard Glacier has been thickening and steadily advancing into Disenchantment Bay. This advance runs counter to so many thinning and retreating glaciers nearby in Alaska and around the world.

The upper image on this page, acquired by the Operational Land Imager (OLI) on **Landsat-8**, shows Hubbard Glacier on July 22, 2014. The lower image shows a close-up of the glacier's terminus on that day. For reference, yellow lines indicate the location of the terminus on August 1, 1978, and on July 13, 2002.

According to Leigh Stearns, a glaciologist at the University of Kansas, Hubbard's advance is due to its large accumulation area, the glacier's catchment basin extending far into the *Saint Elias Mountains*. Snow that falls in the basin either melts or flows down to the terminus, causing Hubbard to steadily grow. In addition, Hubbard is building up a large moraine, shovelling sediment, rock, and other debris from Earth's surface on to the glacier's leading edge. The moraine at the front gives the glacier stability and allows it to advance more easily because the ice does not need to be as thick to stay grounded. (If it is thin, it can start floating and will not necessarily advance.)

Twice in the past hundred years—in 1986 and again in 2002—the moraine has made contact with Gilbert Point and blocked the entrance to Russell Fjord. With nowhere to drain, runoff caused the water level in the fjord to rise rapidly.

The image below, acquired on July 13, 2002 by the Enhanced Thematic Mapper Plus on **Landsat-7**, shows the glacier the last time that it sealed the fjord. Water levels to rose 0.24 metres per day, eventually reaching 18 metres above sea level. However, the closure was temporary, and on August 14, the combination of water pressure and heavy rains overpowered the encroaching ice and debris and burst through the natural dam to return the fjord to normal levels.

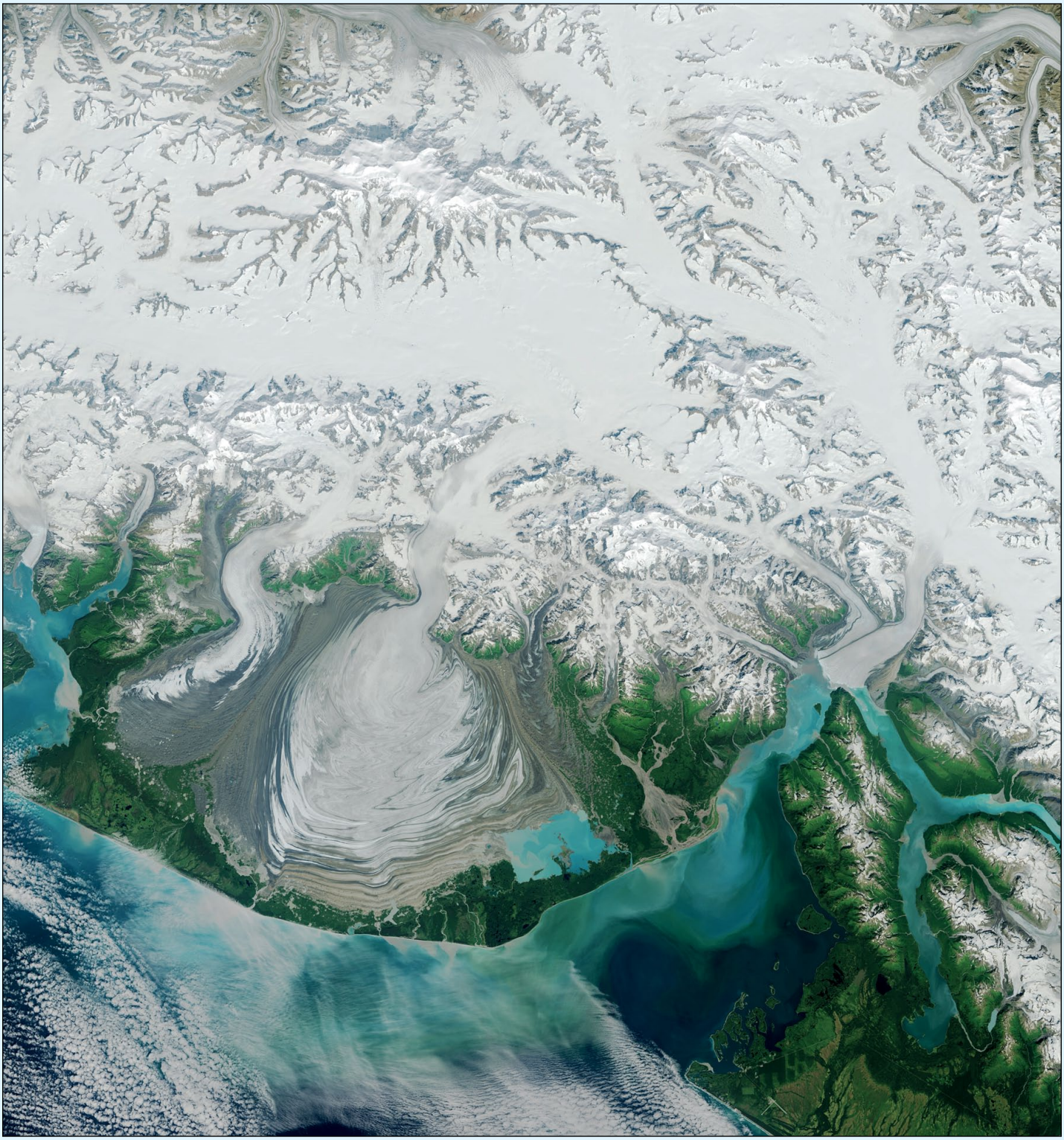


The Hubbard Glacier, imaged by Landsat-8 on July 22, 2014

NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey and Hubbard Glacier data provided by Marcy Davis of The University of Texas at Austin

The Hubbard Glacier terminus, imaged by Landsat-8 on July 22, 2014

NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey and Hubbard Glacier data provided by Marcy Davis of The University of Texas at Austin



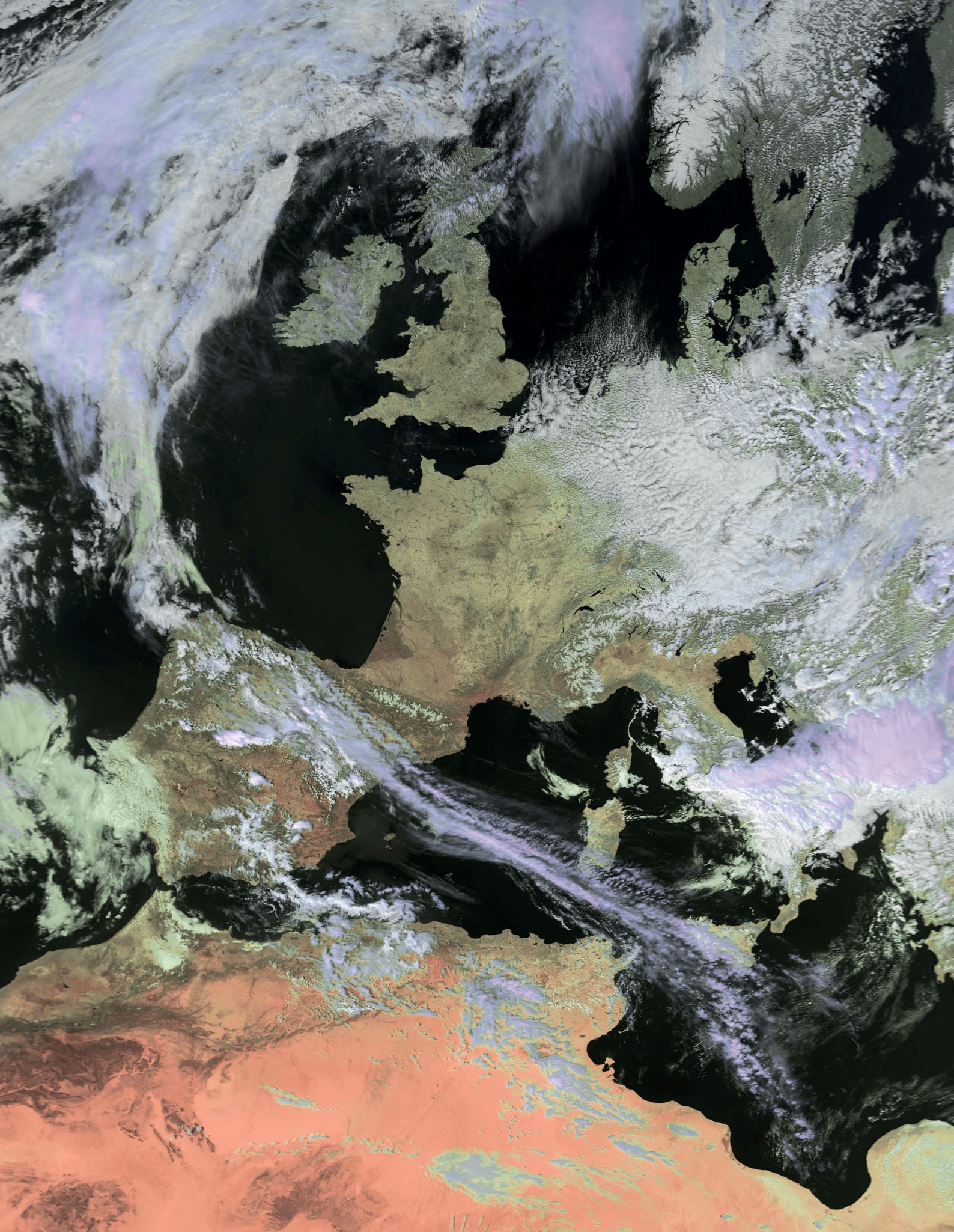
A broader view of the hinterland of the Hubbard Glacier, here entering the sea north of Gilbert Point at centre right of the image
NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey and Hubbard Glacier data provided by Marcy Davis of The University of Texas at Austin

In 2002, while attending a glaciology conference in nearby Yakutat, Alaska, a town that depends on Russell Fjord's marine life, Stearns asserted that: "Understanding Hubbard's behaviour is scientifically interesting, but it also has immediate consequences for the town of Yakutat."

Those consequences provoked her to investigate what controls the terminus position and its advance, and to estimate when the fjord might become permanently blocked. The findings, recently accepted for publication in the *Journal of Geophysical Research*, explain how the mechanics at the terminus override the influence of other climate fluctuations.

One estimate suggests that the fjord could permanently close by 2025. But Hubbard's terminus is nearly 14 kilometres wide and does not advance at the same rate across its entire width. The region adjacent to Gilbert Point, where the closure would occur, advances more slowly because seawater passing through the gap constantly erodes the ice. Based on the current rate of advance at the gap, Stearns estimated that closure could occur by 2043. Stearns cautions, however, that these closure dates are "projections based on our current observations, and should be viewed with scepticism."

Text by Kathryn Hansen.

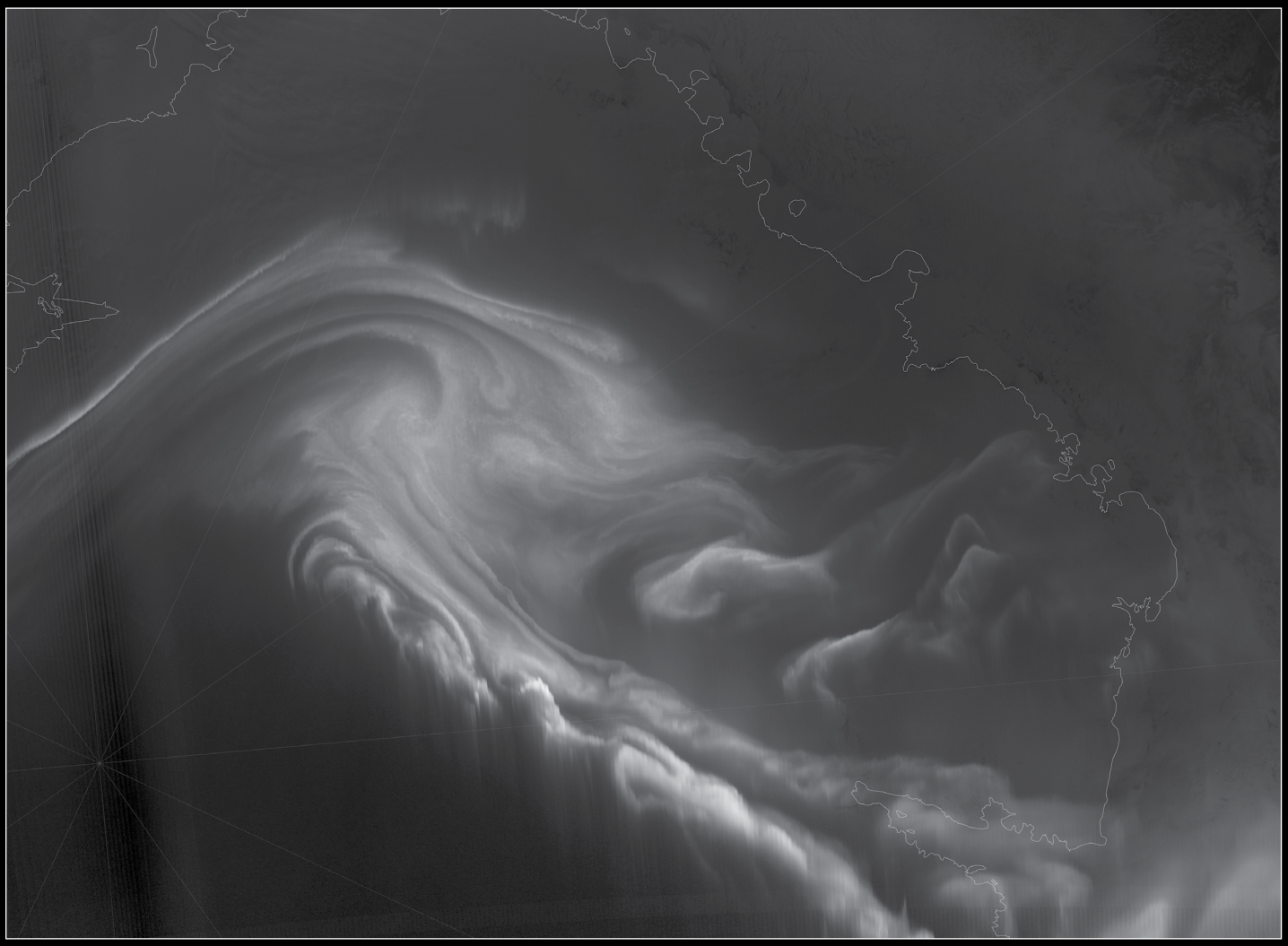


Mike Stevens downloaded this NOAA-19 HRPT image via EUMETCast on April 5, 2015, showing the UK and France enjoying a particularly fine spring day.

Suomi Images

Midsummer Auroras

NASA Earth Observatory



This year, midsummer was marked by spectacular auroras at both poles. Solar flares and coronal mass ejections (CMEs) sent streams of electromagnetic energy directly towards Earth, creating nighttime light-shows that stretched deep into mid latitudes.

The *Visible Infrared Imaging Radiometer Suite* (VIIRS) on the NPOESS ***Suomi NPP*** satellite acquired this view of the Aurora Australis, the *Southern Lights*, over Antarctica in the early morning hours of June 24, 2015. The atmospheric light show was captured by the VIIRS 'day-night band', which detects low light levels such as auroras, airglow, city lights and reflected moonlight. In this image, the sensor detected the visible light emissions that resulted from energetic particles raining down from Earth's magnetosphere into the gases of the upper atmosphere.

For the previous two weeks, sunspot AR12371 had been highly active as it moved across the Earth-facing side of the Sun, and overnight on June 20-21 launched a CME toward Earth, causing a severe geomagnetic storm two days later. Skywatchers as far south as Texas reported the Aurora Borealis on the horizon. Another flare, which burst from the region early on June 23, may have produced the display shown in this image.

Auroras occur when solar flares and CMEs—or even strong solar wind streams—disturb and distort Earth's magnetosphere, the region protected by Earth's magnetic field. The result is a flow of particles into the upper atmosphere (at altitudes between 100 and 400 kilometres) which excite oxygen and nitrogen molecules into releasing photons of light. The results are rays, sheets, and curtains of light in the sky, centred around both of the planet's magnetic poles.

NASA astronaut Scott Kelly captured several photographs of the auroral storms from his perch on the International Space Station on June 22 and June 23. These are reproduced on the next page.

NASA Earth Observatory image by Jesse Allen, using VIIRS day-night band data from the Suomi National Polar-orbiting Partnership.

NASA astronaut Scott Kelly captured this photograph of an aurora from the International Space Station, 400 km above Earth, on June 22, 2015. Image: NASA

NASA astronaut Scott Kelly captured this photograph of an aurora from the International Space Station on June 23, 2015.

Waw an Namus

NASA Earth Observatory

Seen from space, few other extinct volcanoes look as exotic and spectacular as Waw an Namus. The volcano, located deep in the Sahara Desert in the Fezzan region of southwestern Libya, appears as a smear of dark basaltic ash and tephra that contrasts sharply with the light-coloured sand of the Sahara Desert.

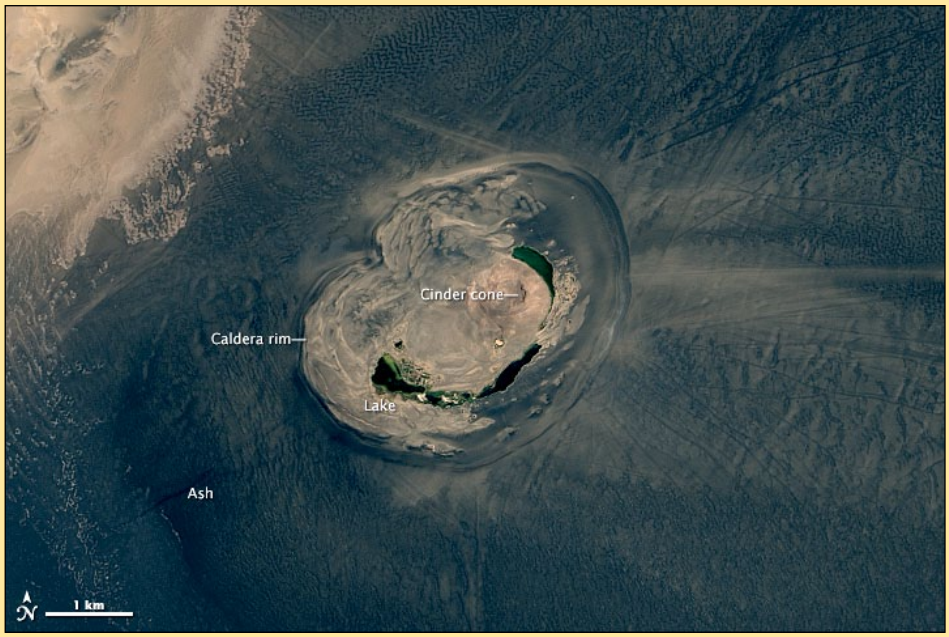
The Operational Land Imager (OLI) on **Landsat 8** captured this view of the feature on May 29, 2015. While the precise date of the most recent eruption is not known, the lack of erosion and weathering implies that it probably occurred during the last few thousand years. South of the ash field, mud streams have begun the slow process of eroding the tephra and ash away. The ash field extends around a much smaller caldera that is about 4 kilometres wide. Calderas are hollowed-out circular depressions that form at the summit of volcanoes when magma is withdrawn or erupted from a shallow underground magma reservoir.

The lower image shows a closer view of the caldera. Within it, three small salty lakes ringed with vegetation are visible. The volcano gets its name from the lakes, which are reportedly home to thriving communities of mosquitos: in Arabic, 'Waw an Namus' means "crater of mosquitos." The edge of a cinder cone is also visible near the centre of the caldera. Cinder cones are steep, conical hills that accumulate around volcanic vents. They are made from small glassy rock fragments that pile up around vents as ash and congealed lava erupts.

The beauty and unique appearance of Waw an Namus has long fascinated travellers. In 1969, anthropologist Froelich Rainey described the feature this way:

> *The whole effect of Waw an Namus is weird. Quite suddenly we seemed to be in the shadow of a cloud, but the sky was clear and looking closely at the desert sand I noticed that it had changed from yellow to black with a thin surface layer of what looked like coal cinders. Then, after crossing about ten kilometres of this black desert, and without warning, we were abruptly halted by a huge crater perhaps three kilometres in diameter. In the centre rose a brown volcanic cone surrounded by a series of narrow crescent-shaped blue lakes. There were occasional date palms and bamboo growing about the lakes and one small hut. The dark sand, the isolation, and the obvious record of what had happened there all contributed to the awesome spectacle before us.*

A general view of Waw an Namus



A close-up view of the Waw an Namus caldera.

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

Inside the caldera.
Photo: Rudolf Baumann/Wikimedia Commons

A simple practical cooling solution for the Ayecka SR1 Receiver

John Din

During recent months I have noted concerns relating to the cooling of the **Ayecka SR1** receiver. I have recently installed one of these for my EUMETCast reception, and found that my unit became quite hot after operating continuously over a 24-hour period: so I decided to design a simple cooling system to ensure that it did not overheat.

My device consist of a 10 mm thick plywood base measuring approximately 100 × 125 mm, and two 100 mm lengths of 25 × 25 mm aluminium angle moulding screwed down 110 mm apart (figure 1).

A third length of angle moulding is used to mount a 12 volt fan, salvaged from a failed computer power supply unit, between the strips that support the SR1 receiver. The fan is powered from a standard 12 volt plug-top unit.

This assembly supplies cooling air under and above the case of the SR1, and of course through it via the casing air holes.

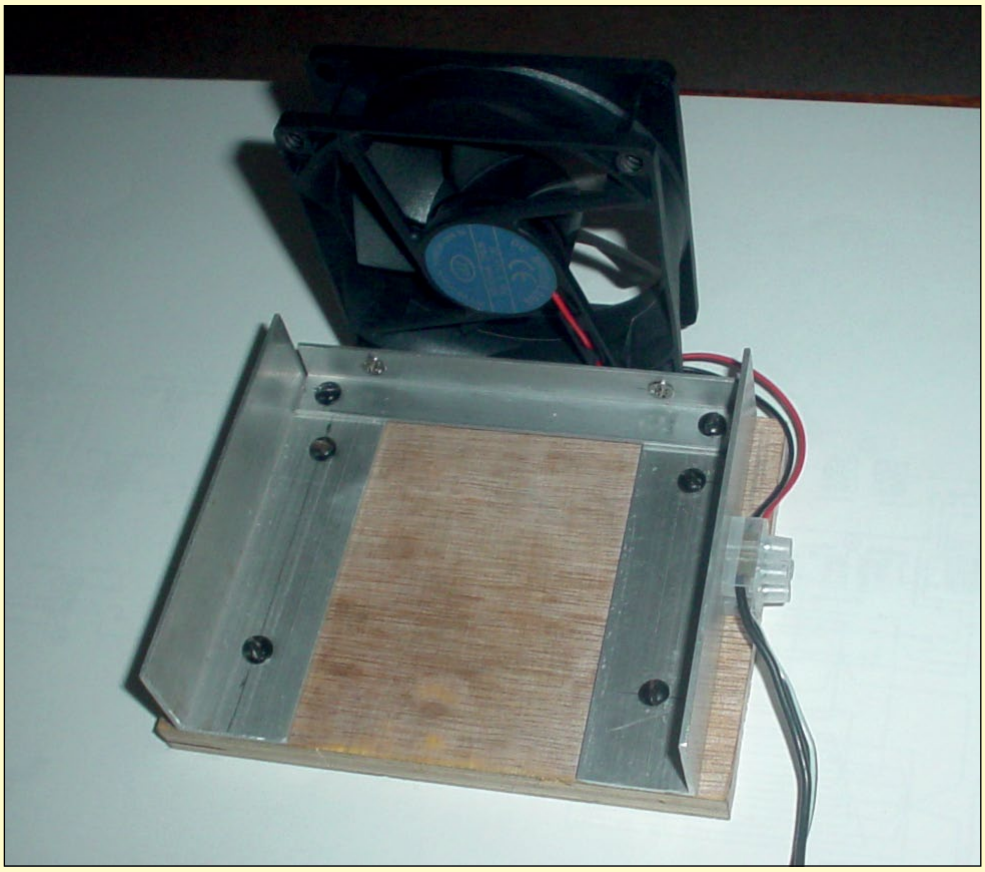


Figure 1 - The frame which holds the SR1 close to the fan

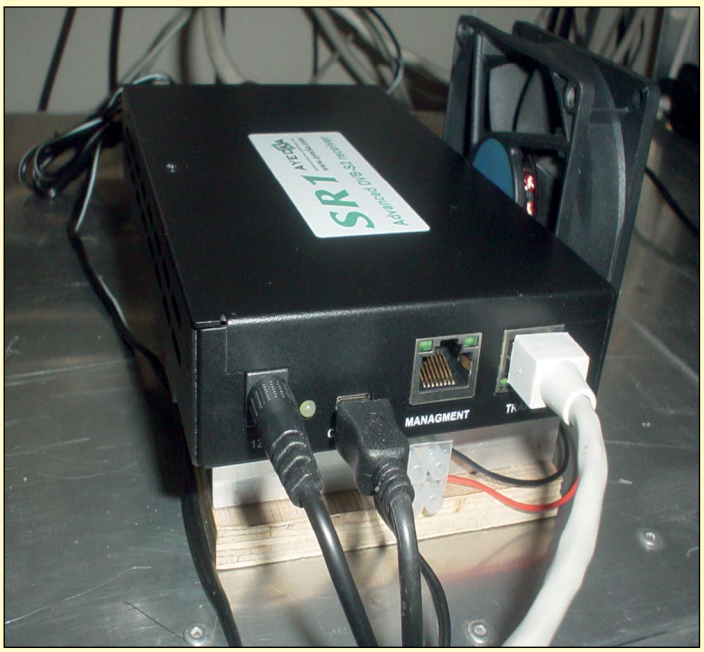


Figure 2 - The Ayecka SR1 positioned in its frame

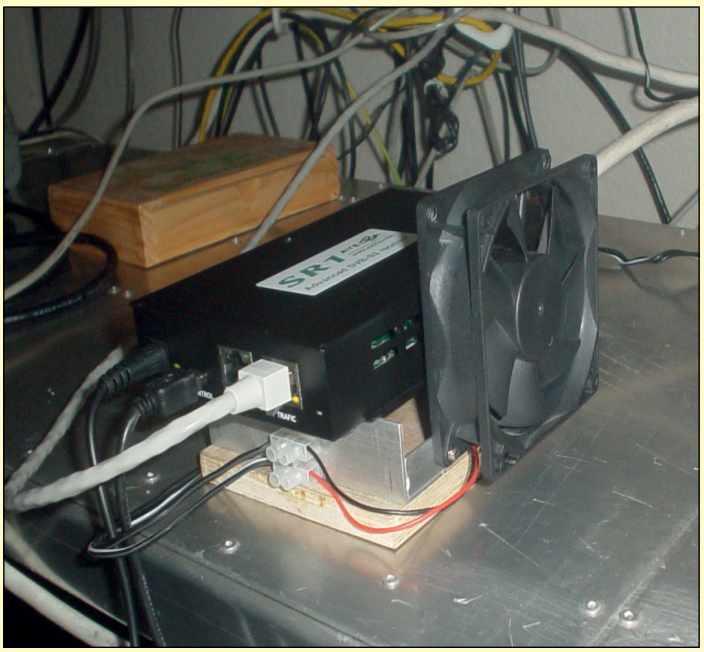


Figure 3 - A side view, showing the Ayecka SR1 next to the cooling fan

Belgium's PROBA-V Satellite

views the cloud-free Eutope

John Tellick

This nearly cloud-free view of Europe is part of a global mosaic of *Proba-V* images acquired on 9 March, 2015. The *Proba-V* satellite was built by Belgian company *QinetiQ Space*.

Our green continent is depicted at a resolution of 333 metres/pixel, with snow capping the peaks of the Pyrenees and Alps bordering Italy. Proba-V is a miniaturised ESA satellite tasked with a full-scale mission: to map land cover and vegetation growth across the entire planet every two days.

The camera's continent-spanning 2250 km field of view collects light in the blue, red, near-infrared and mid-infrared wavebands, ideal for monitoring plant and forest growth as well as inland water bodies.

Proba-V images are processed and distributed to hundreds of scientific end users by VITO, Belgium's **Flemish Institute for Technological Research**, extending the dataset of previous generations of the *Vegetation Instrument* flown on the Spot-4 and Spot-5 satellites.

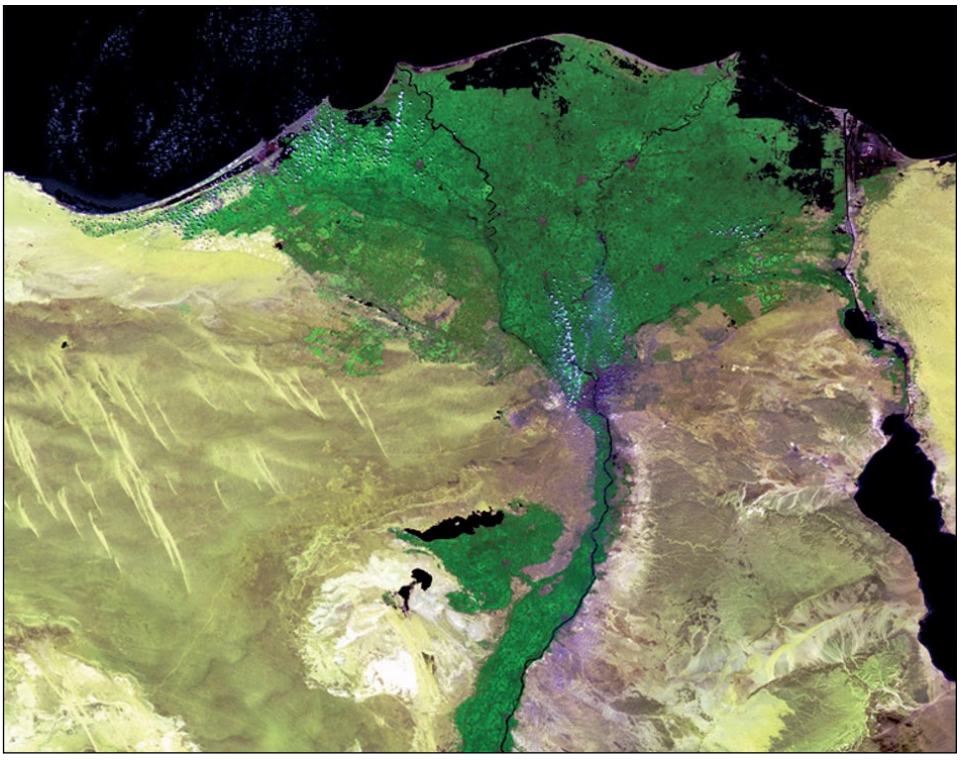
Image: ESA

ESA's Redu Centre in the Belgian Ardennes, which handles communications with ProbaVThe Proba V control centre.
Image: ESA

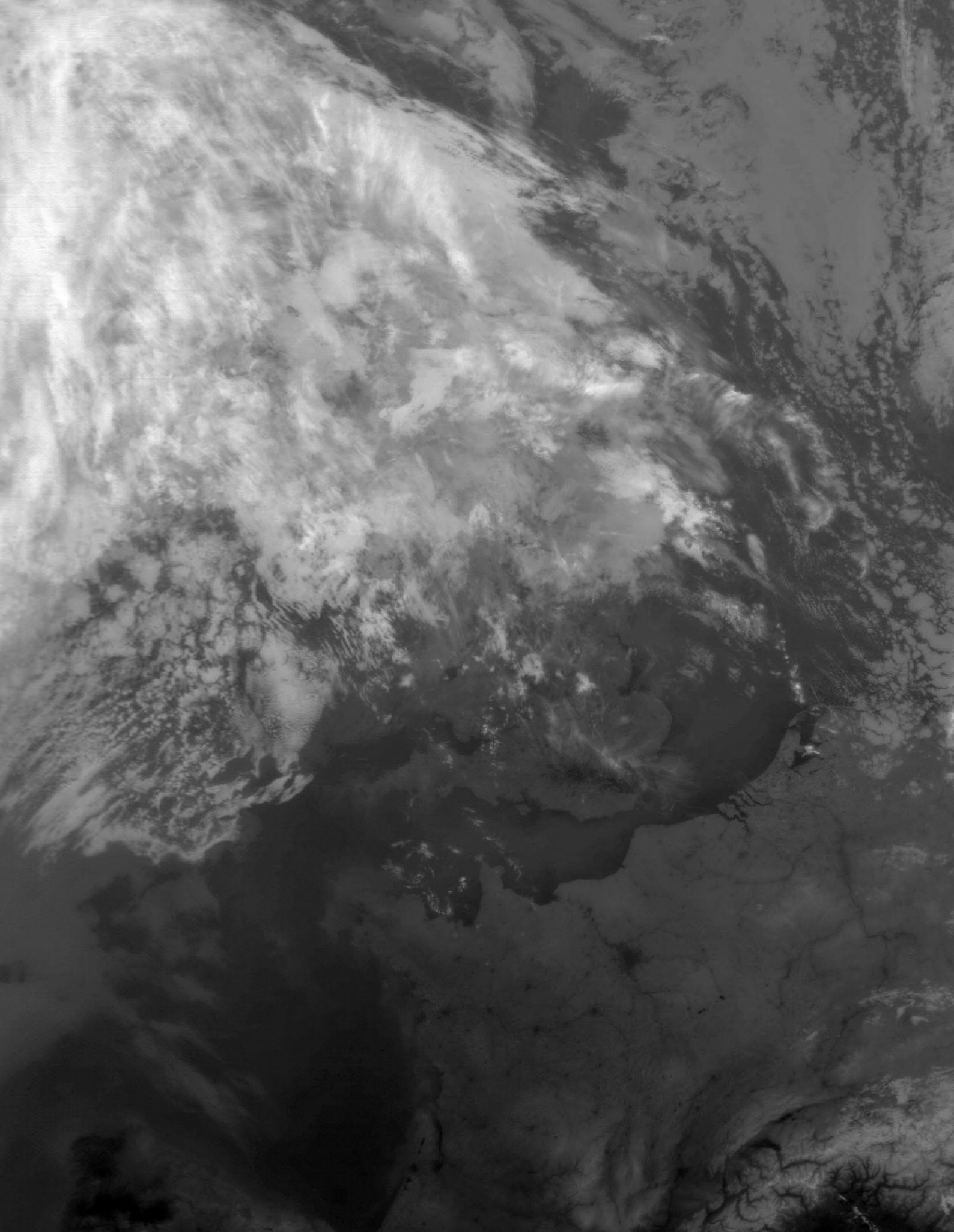
ESA's **Redu Centre** in Belgium's Ardennes region is responsible for controlling and testing a range of satellites as part of ESA's ground station network. It is also home to the Space Weather Data Centre as part of ESA's Space Situational Awareness Preparatory Programme.

The centre provides S-band links for ESA's network of ground stations, as well as in-orbit testing for a wide range of telecommunication and navigation satellites. Today, it is providing communications for the *Artemis*, *Integral* and *Proba* satellites, as well as backup facilities for the *XMM-Newton* X-ray space telescope.

This site, pictured above, currently hosts 43 steerable dish antennas operating in a wide variety of frequency bands (S, Ku, Ka, L, C) with diameters ranging from 4.5 metres to 20 metres.



This Proba-V image dramatically depicts the River Nile as it flows through the desert.
Image: ESA



Most Meteor M2 images posted on the Internet tend to be colour composites. But single channels can also be interesting. This is the 21:16 UT channel-5 infrared image from July 9. Following hot weather over France and southern England, numerous ‘Heat Islands’ stand out, most notably around Paris and London

Sentinel 2A

Les Hamilton

The European Space Agency's 1200 kg **Sentinel-2A** satellite was successfully launched from the Kourou Spaceport in French Guiana at 01:52 UT on June 23, 2015. Sentinel flies in a sun-synchronous polar orbit, 786 kilometres above the Earth, with a descending node at 10:30 local time to provide optimum solar illumination. This satellite adds high-resolution optical imaging to the European Union *Copernicus* environmental monitoring system, which got under way with the launch of the Sentinel-1A radar satellite last year.

An EU flagship space initiative, *Copernicus* has been seven years in the making, has been designed to operate for more than 20 years, and will provide operational information on the world's land surfaces, oceans and atmosphere, to support environmental and security policymaking and meet the needs of citizens and service providers [1,2,3].

> **Copernicus** is the new name of the European Commission's Earth Observation Programme, previously known as GMES (Global Monitoring for Environment and Security). The new name was announced on December 11, 2012, by European Commission Vice-President Antonio Tajani, and pays homage to Polish mathematician and astronomer Nicolaus Copernicus (1473-1543) who, in the 16th century, led the drive to understand our environment.

Sentinel-2 is the second unit of a constellation that will eventually number twenty satellites providing the most comprehensive data for environmental and security applications available anywhere in the world. Sentinel-2A will complement the all-weather, day-and-night radar imagery provided by Sentinel-1A, launched on April 3, 2014. Sentinel-2B, an exact twin of Sentinel 2A, is scheduled for launch in mid-2016.

Spacial Resolution (m)	Band Number	Central Wavelength (nm)	Bandwidth (nm)
10	2	490	65
	3	560	35
	4	665	30
	8a	842	115
20	5	705	15
	6	740	15
	7	783	20
	8b	865	20
	11	1016	90
	12	2190	180
60	1	443	20
	9	945	20
	10	1380	30

Details of the 13 spectral bands available in Sentinel 2A's Multi Spectram Instrument (MSI).

Sentinel-2A being encapsulated within the half-shells of the Vega rocket fairing, on 6 June 2015.
Image © ESA / M Pedoussaut, 2015

The Vega fairing holding the Sentinel-2A satellite in the launch gantry at Europe's Spaceport in Kourou, French Guiana.
Image © ESA / M Pedoussaut, 2015

Integration of the fairing of *Vega VV05*, carrying Sentinel-2A, in the launcher assembly area at Kourou, French Guiana.
Image © ESA / M Pedoussaut, 2015

Sentinel-2A carries an innovative wide-swath high-resolution multispectral imager with thirteen spectral bands which will open a new perspective on our land and vegetation. The combination of high resolution—offering a maximum of 10 metres/pixel—with a swath width of 290 kilometres and frequent revisit times will provide unprecedented views of Earth.

To put this into perspective, the highest resolution MODIS images from NASA's *Terra* and *Aqua* satellites have a ground resolution of 250 metres per pixel. Sentinel-2's Multi Spectral Imager is capable of delivering four channels of imagery at 25 times this resolution.

The Mission

The Sentinel-2 mission is based on two identical satellites flying in the same orbit but phased 180° apart. Sentinel-2B, which will complete the constellation, is due for launch in about a years time. The full mission specification will cover the entire Earth's land surface, large islands and inland and coastal waters at a high revisit frequency of five days at the equator, and will provide information for agricultural and forestry practices and for helping manage food security. The satellites' images will be used to determine various plant indices, such as leaf area, chlorophyll and water content indexes. This is particularly important for effective yield prediction and applications related to Earth's vegetation.

As well as monitoring plant growth, Sentinel-2 can be used to map changes in land cover and to monitor the world's forests. It will also provide information on pollution in lakes and coastal waters. Images of floods, volcanic eruptions and landslides will contribute to disaster mapping and help during humanitarian relief efforts.

Sentinel-2 is the result of close collaboration between ESA, the European Commission, industry, service providers and data users. Demonstrating Europe's technological excellence, its development has involved around sixty companies, led by *Airbus Defence and Space* (Germany) for the satellites and *Airbus Defence and Space* (France) for the multispectral instruments. The mission has been supported in kind by the *French Space Agency CNES* to provide expertise in image processing and calibration, and by the *German Aerospace Center DLR* who provide the optical communication payload, developed by *Tesat Spacecom GmbH*.

Liftoff of Vega VV05 carrying Sentinel-2A from Kourou on June 23, 2015.
Image © ESA / M Pedoussaut, 2015

This is a segment from Sentinel 2A's first image, showing the city of Genoa in Italy, and its hinterland.
Image © ESA

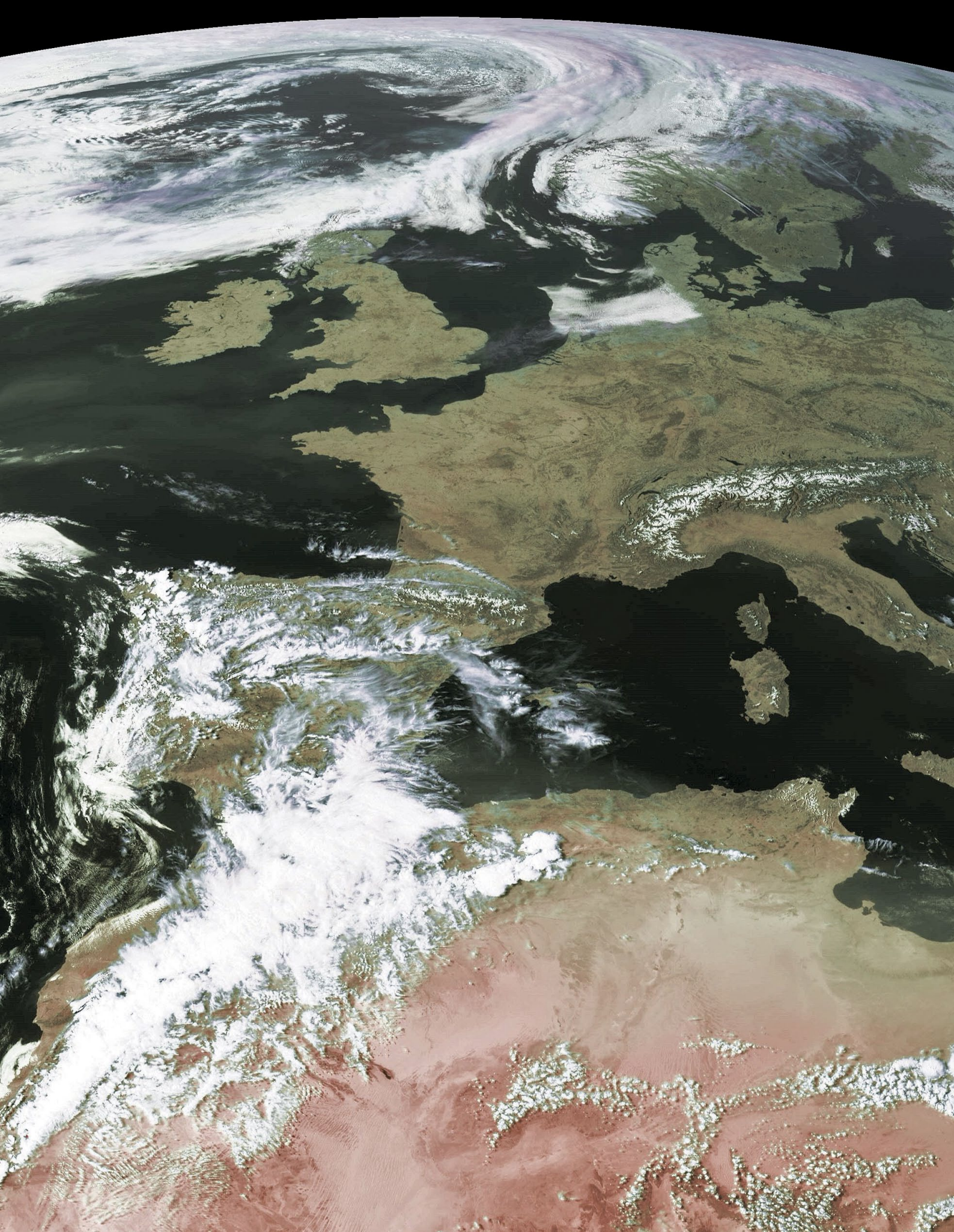
This is a segment from Sentinel 2A's first image, shows individual buildings in the city of Milan at 10 metre/pixel resolution.
Image © ESA

This final item of technology allows the Sentinel-2 satellites to transmit data via laser to satellites in geostationary orbit that carry the *European Data Relay System* (EDRS). This is a new space data highway which allows large volumes of data to be relayed very quickly and made available to users as rapidly as possible.

References

ESA's Sentinel Satellites - GEOQ 35, page 6 (September 2012)
Sentinel 1A images Pine Island Bay - GEOQ 42, page 14 (June 2014)
Sentinel 1A images The Netherlands - GEOQ 42, page 24 (June 2014)

The resolving power of Sentinel-2A is demonstrated in this image, captured on July 26, 2015, which shows ships queuing along the Danube near the Romanian town of Zimnicea..



Mike Stevens discovered this interesting Meteosat-10 image while rummaging through his archives. It dates from April 21 this year, and shows most of western Europe bathed in sunshine, while Spain and Morocco seem to have been caught up in a maelstrom of cloud.

Final MSG Satellite in Orbit

John Tellick

The last in the **Meteosat Second Generation** series of satellites is now safely in orbit and under the control of EUMETSAT. An end to another *Meteosat Era*. The next, major step, will be **Meteosat Third Generation**, an entirely different system, comprising a constellation of two satellites—one for imaging, the other for sounding—and three-axis stabilised rather than using the current spin-stabilisation design.

GEO members who took part in our July visit to EUMETSAT also visited ESOC, where, a week prior to the satellite's launch, they were shown round the same control room in which ESA personnel are seen celebrating the success of the mission in the photograph below.

ESA Reported the event as follows:

At midday on July 26, 2015, ESA formally handed control of Europe's last Meteosat Second Generation weather satellite, MSG-4, to EUMETSAT, the European Organisation for the Exploitation of Meteorological Satellites.

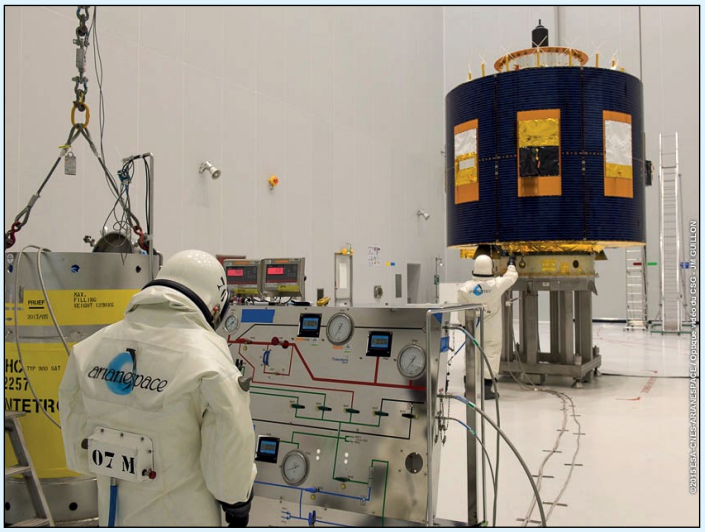
MSG-4 had been operated from ESA's European Space Operations Centre, ESOC, in Darmstadt, Germany, since it separated from an Ariane rocket shortly after launch on July 15. A team of operations engineers, software and ground station specialists, and flight dynamics experts, worked round the clock to shepherd the satellite through its first dozen days in space—the critical launch and early orbit phase—on EUMETSAT's behalf.

During this period, the satellite was moved into geostationary orbit and various elements of its platform were activated and checked. This included critical manoeuvres such as firing the apogee thrusters, changing the satellite's orientation and unlocking the camera's scan mirror.

Now in its planned geostationary slot some 36 000 km above Europe, MSG-4 will go through payload commissioning to serve as the in-orbit 'hot backup' to its three sibling satellites, MSG-1 to -3. All are used for weather forecasting, and play a crucial role in 'nowcasting' high-impact weather events and climate research. They are operated by EUMETSAT, with ESA responsible for their design, development and in-orbit delivery.

The ESA mission control team in the Main Control Room at ESOC on July 24, celebrating adding '*MSG-4*' to the Mission History Wall.
Image © Copyright ESA / D Danesy

MSG-4, the final satellite in Europe's highly successful Meteosat Second Generation (MSG) series lifts off from Europe's Spaceport in Kourou, French Guiana, on an Ariane-5 launcher, on July 15.
Photo: ESA-CNES-ARIANESPACE



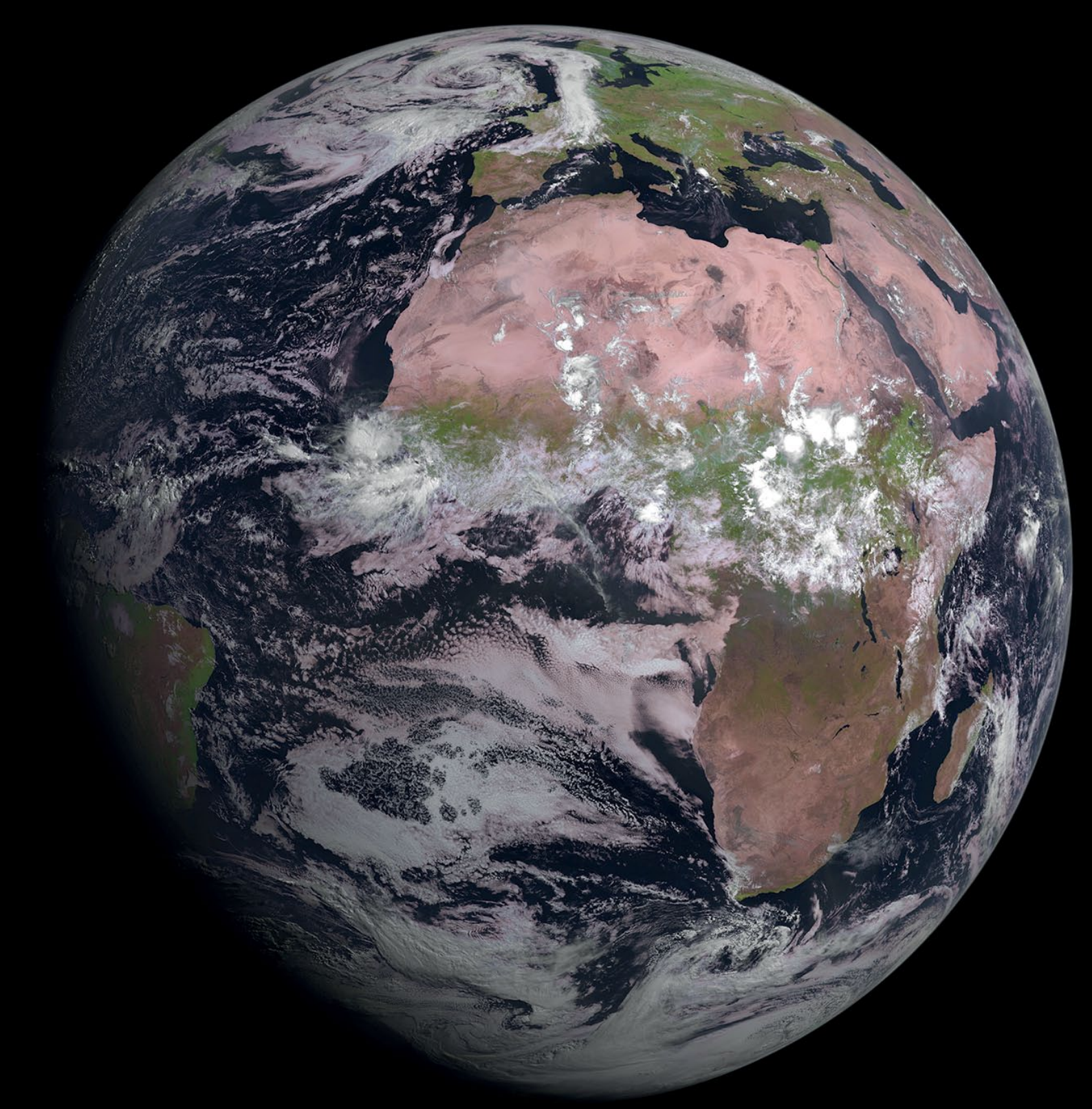
MSG-4's propulsion tanks are filled during launch preparations.
Photo: ESA-CNES-ARIANESPACE

Weighing some two tonnes, MSG-4 is the 142nd satellite built by *Thales Alenia Space* to be launched by *Arianespace*. During the eleven days of the craft's LEOP (Launch Early Operation Phase), spacecraft controllers from ESA and EUMETSAT finalised MSG-4's final configuration and orbit, then activated and checked the functionality of the various components on its platform.

Following handover, EUMETSAT will begin commissioning the satellite and its sensors, a two-month phase of check-out and assessment, followed by four-months for imaging and product testing, including calibration and validation.

Once commissioning is complete, MSG-4 will be renamed **Meteosat-11**, and will be stored in orbit until such time as it is required to replace one of its predecessors.

It will then take over services and ensure the smooth transition to Meteosat Third Generation in 2019.



MSG-4 SEVIRI First Image
4 August 2015 10:00 UTC

Full Disk Image - RGB (1.6 µm - 0.8 µm - 0.6 µm)

Meteosat-11

EUMETSAT

MSG-4 delivers its first image

The Spinning Enhanced Visible and Infrared Imager instrument on MSG-4 captured its first image of Earth on August 4, 2015. This demonstrates that Europe's latest geostationary weather satellite, launched on July 15, is performing well and is on its way to becoming fully operational when needed after six months of commissioning.

The first image is a joint achievement by ESA, EUMETSAT and the European space industry. For its mandatory programmes, EUMETSAT relies on ESA to develop new satellites and procure the recurrent satellites like MSG-4. This cooperation model has made Europe a world leader in satellite meteorology by making best use of the two agencies' expertise.

Meteorological Technology International (MTI)

Fritz Zajicek

Thanks to Francis Bell´s information in the last *GEO Report,* I was very interested to get this publication and did an Internet search. I quickly found the source and discovered how easily you can read and save the publication. Let me share this information with all interested *GEO Quarterly* readers.

How to get MTI

Choose ***www.ukipme.com*** in your browser. I tested it with *Firefox* 38.0.5 and *Windows IE* 9 [and it also works beautifully in *Google Chrome* — Ed].

Go to '**Publications**' in the menu bar and click on '**Meteorological**' in the drop-down menu. Now you can click the '**Read Now**' button to open and read the edition of your choice in the *zmags* viewer.

In early June 2015, when this information was compiled, all editions back to September 2011 were available. There is also an option to '**Subscribe**' to the magazine, free of charge.

If you prefer to read the publication in PDF format, print it out or save it in your digital library, you can also download the whole PDF document or selected pages easily by clicking the '**Download**' icon: in the small reading menu, choose from 'all pages / shown pages / selected pages' and finally click '*Download*' and follow your standard download process.

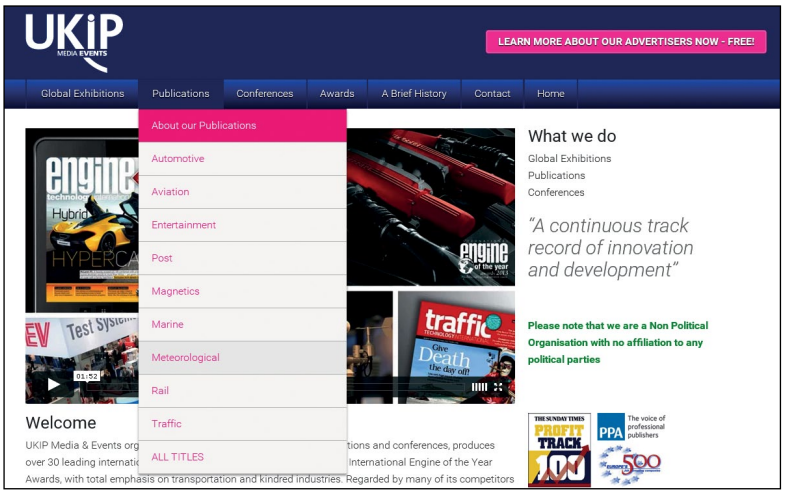
The complete April 2015 edition consists of 104 pages and takes 16.5 MB on the drive.

Background information about MTI

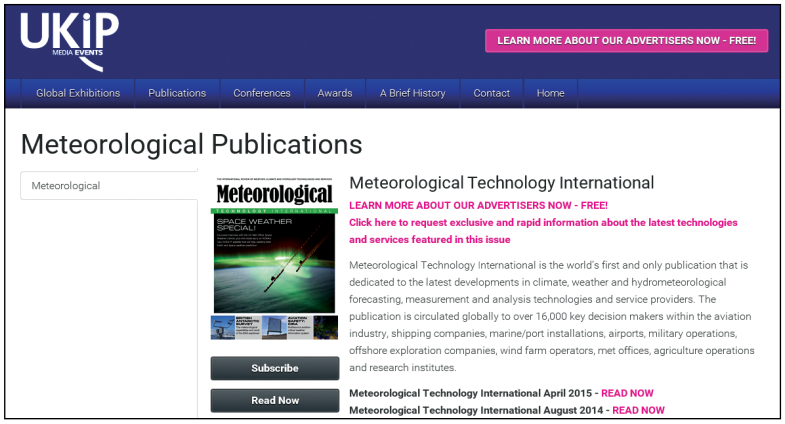
MTI is the world's first and only publication that is dedicated to the latest developments in climate, weather and hydrometeorological forecasting, measurement and analysis technologies and service providers. It is published by *UKIP Media & Events*.

MTI was launched in November 2009 to great acclaim from the industry. At least since 2012 MTI, has been published twice a year with a spring and an autumn edition. In 2015 MTI will be published in April and September.

The publication will be distributed globally to more than 18,500 key decision makers within all the national, regional and international meteorological offices and service providers, as well as to the major purchasers and users of weather, climate and hydrology technologies and services, including the aviation industry, airports, military operations, space centres, marine ports, shipping companies, energy industry, offshore facilities, wind farms and the agricultural industry. In addition, a further 9,500 copies will be sent out digitally.



The 'Publications' Menu



The 'Meteorological Publications' Page

Using the on-screen *zmags* viewer

The download options panel

PERITO MORENO GLACIER

NASA Earth Observatory

The 30 kilometre long **Perito Moreno Glacier**, one of the largest in Patagonia, is located among the icefields of the southern Andes and is the centrepiece of the *Parque Nacional Los Glaciares*. The glacier descends from an elevation of 2100 metres in the Southern Patagonian Icefield to just 180 metres above sea level in the waters of Lago Argentino.

Perito Moreno is the region's most famous glacier because it periodically cuts off Brazo Rico, the major southern arm of Lake Argentino by means of an ice dam. The glacier advances across the lake until it meets the opposite shoreline and its ice tongue becomes grounded to form a natural dam. This dam prevents lake water from circulating from one side to the other, which results in muddier and 'milkier' water concentrating in Brazo Rico. Water flows down under the glacier from the mountains, not only carrying the mud into the lake but also helping lubricate the glacier's downhill movement.

Meltwater runoff from the surrounding mountains can raise the water level in Brazo Rico as high as 30 metres above that in Lago Argentino, exerting hydrostatic pressure which leads to the formation of drainage tunnels and fractures within the ice. Ultimately, this pressure causes the ice tongue to rupture catastrophically in a great natural spectacle. The dam collapsed spectacularly in March 2004, and the image shows a new ice dam across the Brazo Rico arm of Lago Argentino forming the following November.

This process repeats every four to five years as the glacier grows back towards the opposite shoreline. The repeated ruptures have made the glacier and lake a major tourist attraction in the region. A more recent rupture occurred in March 2012.

The past extent of glaciation in the region is marked by several valleys formerly filled by flowing ice. A particularly striking example of this landscape feature is in the centre of the image, where five glacial valleys converge to a central star-shaped outflow valley. Widespread recession of the glaciers in southern Patagonia has occurred over the last 30 years, possibly due to warming of the regional climate. Contrary to this trend, Perito Moreno seems to be maintaining an equilibrium between ice formation in the mountains and ice loss due to melting and calving into Lago Argentino.

Astronaut photograph *ISS010-E-5803* acquired on November 4, 2004 shows a new ice dam forming across the Braco Rico.

Image: *NASA/JSC*

Spectacular 22° Solar Halo

John Tellick

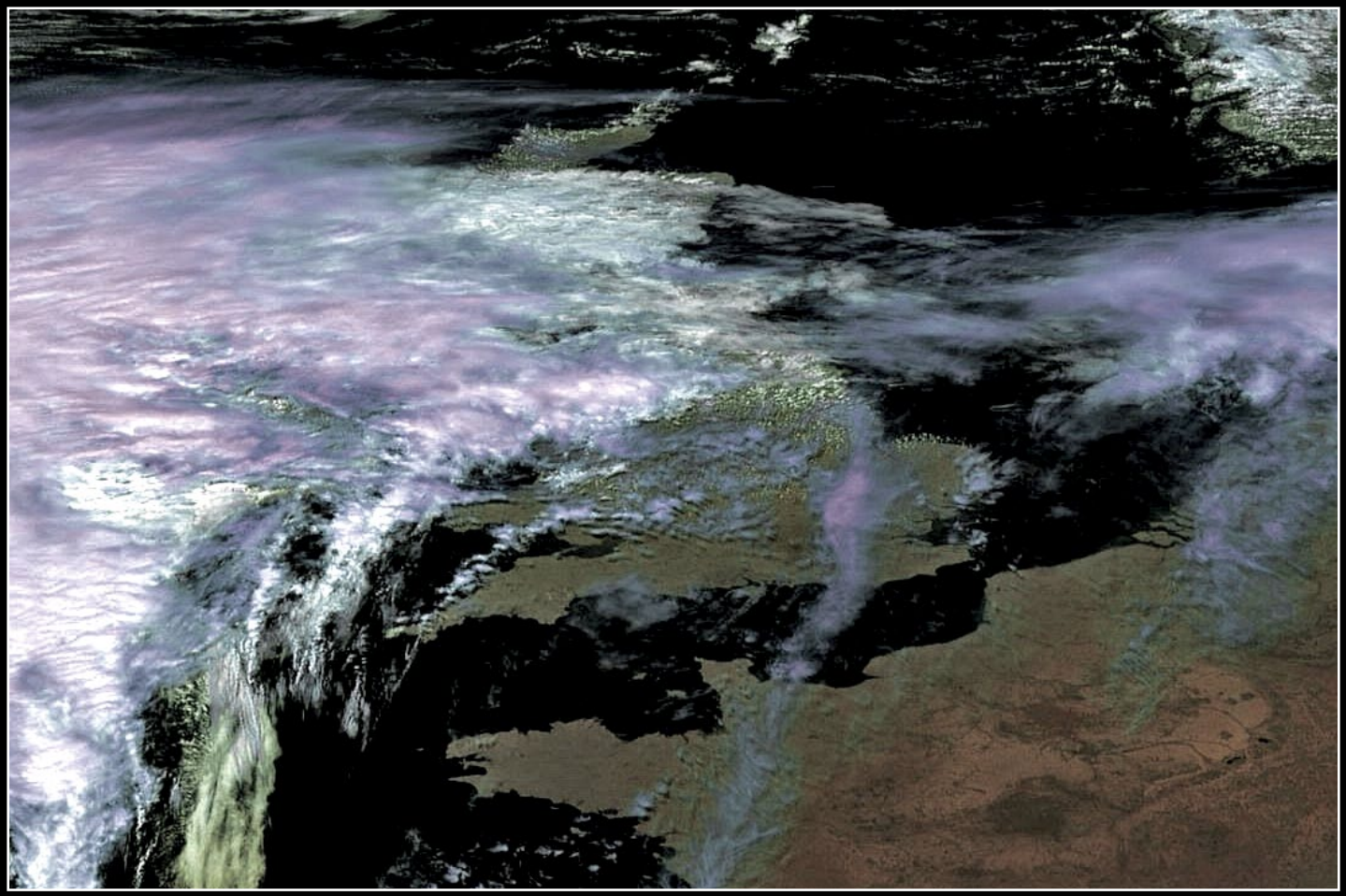
On August 2 this year, the sky over southeast England was almost clear, with just a thin veil of high-altitude cirrus cloud. The sun was shining brightly, but was surrounded by a spectacular halo. In the immediate vicinity of the sun, the sky was girdled by a darker region, which was itself bounded by an iridescent brighter halo of light. This was an example of the 22-degree halo.

This halo owes its origin to ice crystals suspended within cirrus or cirrostratus clouds at altitudes of 5 to 10 kilometres, where the temperature hovers between -30°C and -40°C at this time of the year. These crystals are rod-shaped prisms with a hexagonal cross section, and are orientated randomly within the clouds. When light rays from the sun pass through the 60° apex angle of these prisms, they are refracted, a process that is repeated when they re-emerge. This double refraction produces deviation angles in the range 22° to 50°.

The minimum possible angle of deviation varies a little with wavelength (21.54° for red light and 22.37° for blue light), and is generally quoted as 22°. The wavelength dependence results in the inner edge of the halo being reddish while its outer edge shows a bluish tinge. Because some of the sunlight has been redirected into the bright halo, the region between it and the sun appears darker than the sky in general.

The segment from the 13:00 UT Meteosat-10 image, shown below, clearly shows the wispy high-level cloud band lying to the west of the Thames estuary.

The sun, surrounded by a 22° helo.
Photo: John Tellick



This is a segment taken from the 13:00 UT Meteosat-10 image on August 2, 2015.

Some thoughts on
EUTELSAT-10 Signal Variation

John Tellick

I have written before about '*rain fade*' [1] and the severe effect, in my case, of water drops accumulating on the face of my LNB, which considerably reduces SNR, never mind the attenuation of the rain itself and rain bearing cloud.

There have been discussions on the **MSG-1 Yahoo Group** this year regarding varying signal levels on *EUMETCast* transmissions from **Eutelsat-10**, other than the lower transmitted power contours compared with **Eurobird-9** under clear sky conditions. Some contributors suggested that it might be that the satellite has some slight inclination, the effect being exacerbated by slight dish off-pointing. I tried several avenues to get an answer from *Eutelsat*, but to no avail. Their final comment was to suggest that I contact my service provider: which is *EUMETSAT*, not *Eutelsat*.

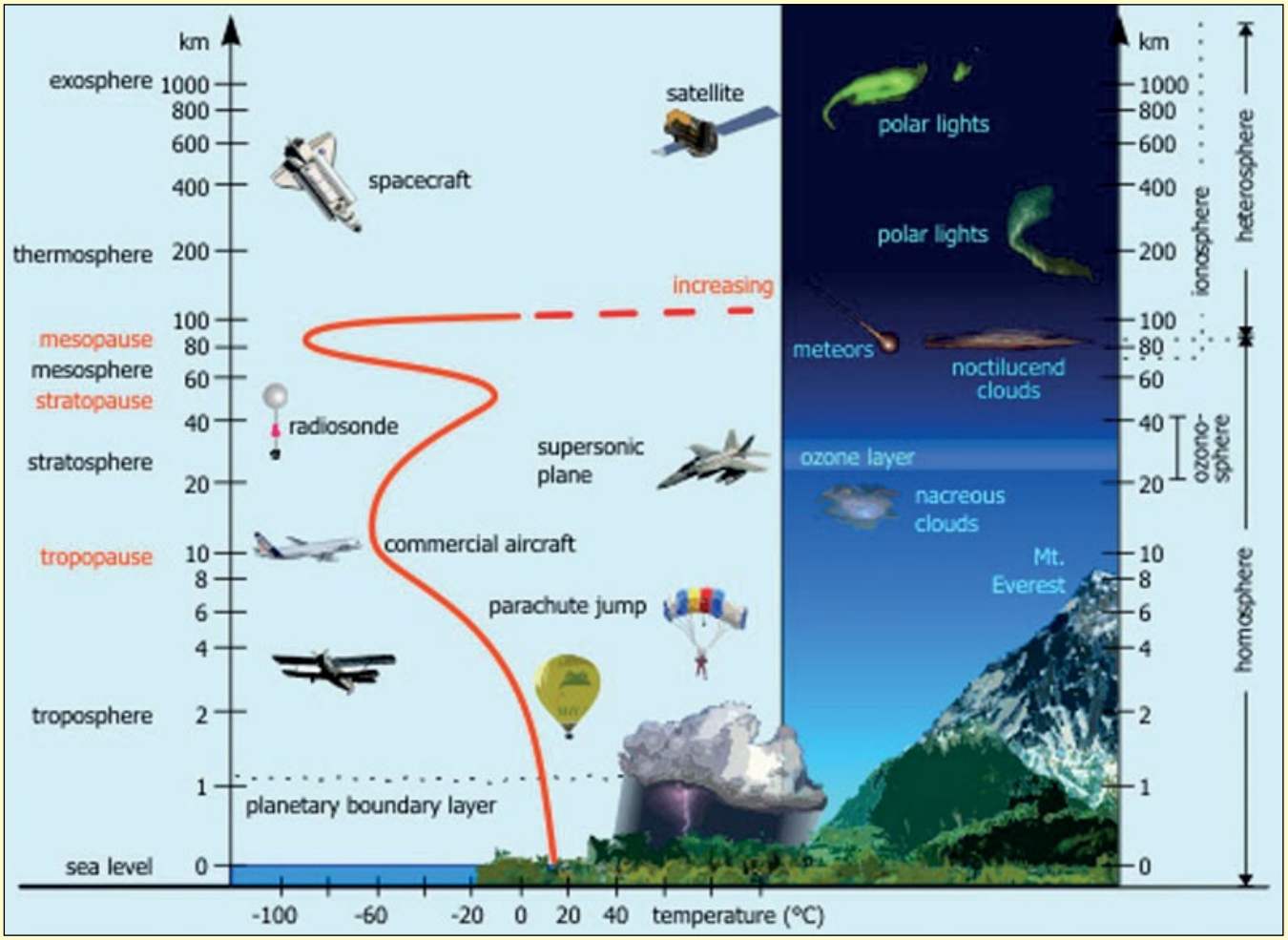


Figure 1 - Basic structure of the atmosphere
Image: theozonehole.com

This I did, and was told that the service is performing as specified—with a suggestion that I might do some research on satellite signal propagation to answer some of my questions. Thus I learned that several factors conspire to degrade our satellite signals.

I'm not a radio 'ham', but I was an enthusiastic 'shortwave listener', and later a TV and FM DXer for many years from the early 60's and through the 70's and 80's. This only came to an end when my 'rather large' antenna array—which had survived the 1987 'hurricane'—finally came down during the *Burns Day Storm* over January 25-26, 1990. I was aware of the various mechanics of 'atmospheric layer radio propagation': D, E, F1 and F2 layers and tropospheric propagation (figure 2 overleaf). My best catch was TV from Zimbabwe via trans-equatorial-skip.

However, I rather thought that line-of-sight satellite transmissions, at (very) much higher frequencies, would be immune to tropospheric and ionospheric disturbances: but I was wrong.

My *DVBWorld* box on the old *Eurobird-9* DVB-S EUMETCast SS and SQ reading didn't alter under clear sky conditions: SS was always 98% with an 85 cm dish.

My *SR1* receiver, with a 1m dish and an *Inverto Black Ultra* LNB, shows the SNR altering by a few decimal points of a dB all the time under clear sky conditions, and the 'mean' level altering between day and night. Also, even the 'mean' levels appear to alter over longer periods (days and weeks). I don't know how accurate the *SR1's* SNR and link margin readouts are, or how sensitive, but they indicate these variations all the time.

The first obvious thing is that, during daylight hours, the Sun's various radiations are 'zapping our side of the Earth's atmosphere.' At night time our side is in shadow, yet some of our atmospheric layers are still 'active'.

I found a great deal of useful information in an article on the **Radio-electronics.com** website, written by Ian Poole, in which he explains the structure of the atmosphere, and how interaction between its layers and incoming radiation causes ionisation, which affects radio propagation. Additionally, in the troposphere and ionosphere, refraction and absorption of radio waves can occur.

An effect which I found quite fascinating and important was that of **Faraday Rotation**, which causes different elements of a radio signal to travel in different ways. In particular, the effect can rotate the plane of polarisation, which causes reception problems. This happens because the ionosphere is a magneto-ionic region and linear polarisation can be twisted as it passes through this layer owing to this magneto-ionic effect.

Eutelsat-10, along with most other, if not all, Ku-band satellites, uses linear, horizontal and vertical signal polarisation. This allows frequency sharing and overlapping, and the ability to transmit far more channels. A satellite due south of your location will have 'accurate horizontal and vertical polarisation', but satellites to the east and west of your location increasingly appear to tilt—as does their signal polarisation, a phenomenon called skew. So our LNB has to be rotated clockwise/anti clockwise from 'vertical' to accurately match any skew in the received signal.

This I have found to be most important when setting up a dish, as even a small misalignment causes SNR degradation from the unwanted 'other polarisation.' However, trying to track—albeit it small I suspect—varying skewing of the Eutelsat-10 signal due to Faraday rotation, is a lost cause. Once you get out into 'free space' there is very little to affect satellite signals other than attenuation caused by the sheer distance to geostationary orbit.

Ian also touches on the problem of **Ionospheric Scintillation**, which can change the angle of arrival of signals well into the microwave region. The effects are related to the location of the receiving station and the general level of geomagnetic activity, latitude,

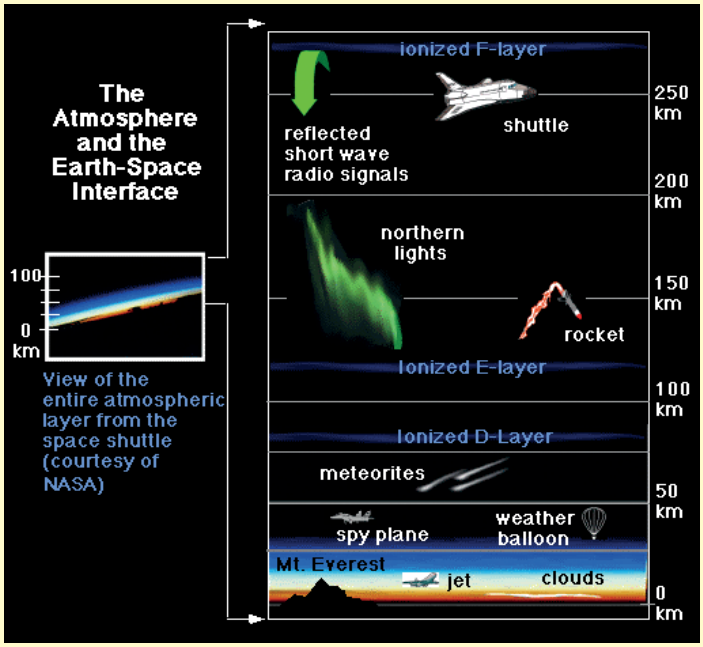


Figure 2 - Layers within the Atmosphere
Image: NASA

and local time of day. Radio transmissions can also be affected by ionospheric scintillation but this is considered to be negligible on radio frequencies above about 2 GHz.

Ian's final section deals with Tropospheric propagation effects such as signal bending as a result of refraction, scintillation, and attenuation.

Readers interested in consulting Ian Poole's article can find it at this URL

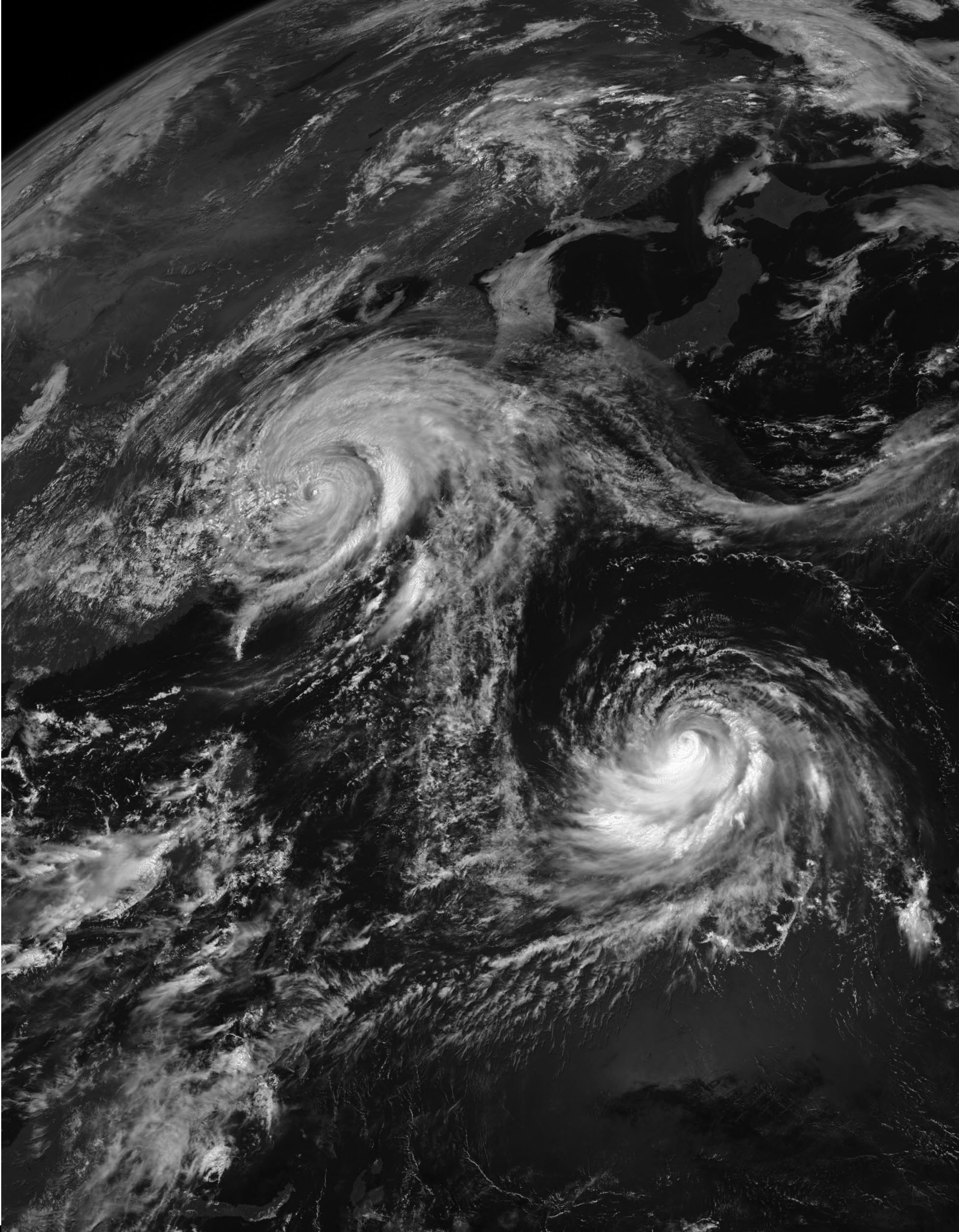
http://www.radio-electronics.com/info/satellite/satellite_sig_prop/satellite_signal_propagation.php

There is obviously a lot happening to our satellite signals before they reach the LNB, even under clear sky conditions.

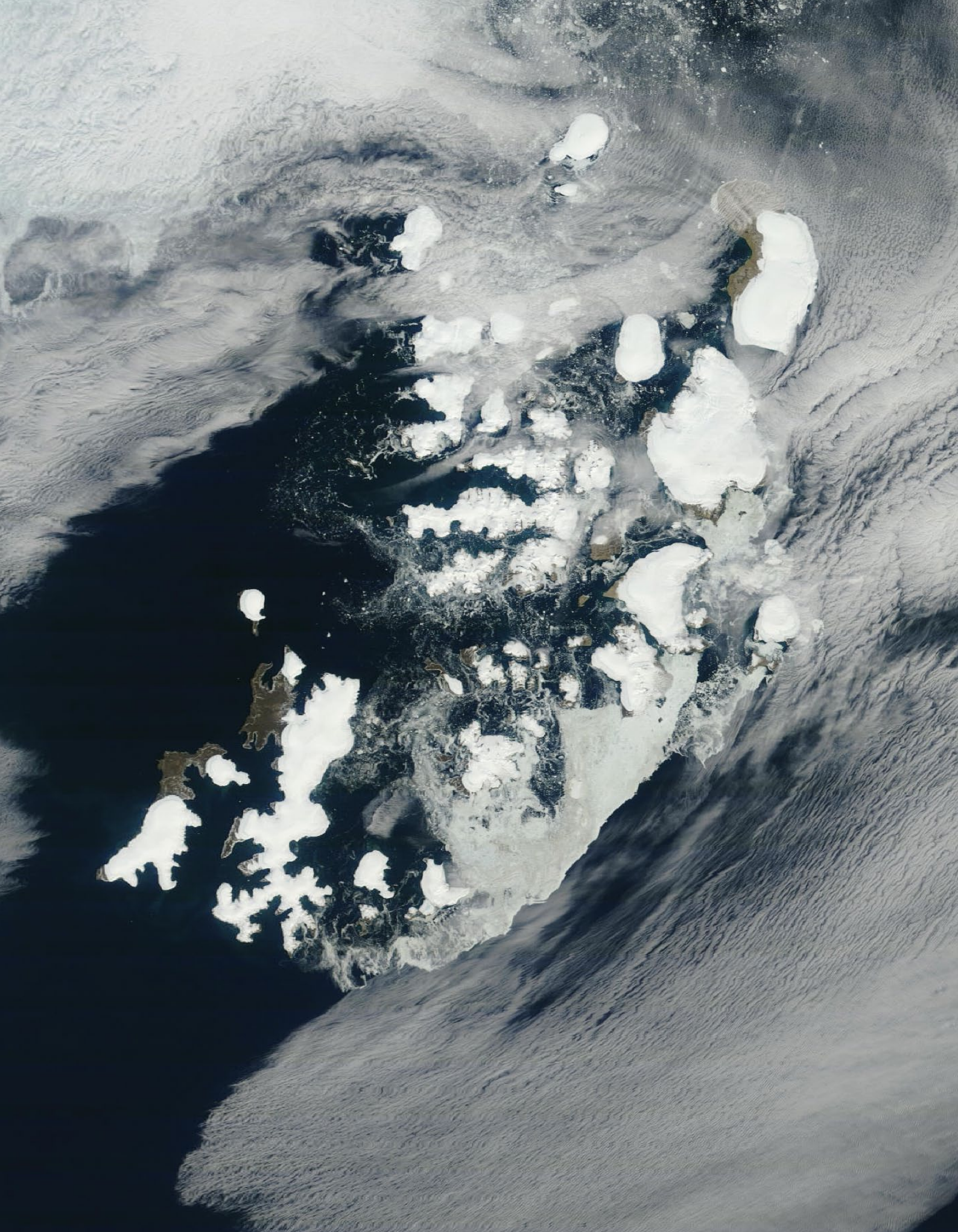
Reference

EUMETCast DVB-S2 Experiences - GEOQ 46, page 6, June 2015

Typhoon Soudelor photographed from the ISS at 08:44 UT on August 5, 2015, as the storm advanced towards Taiwan.
Image: Astronaut photograph ISS044-E-30716 provided by the ISS Crew Earth Observations Facility and Earth Science and Remote Sensing Unit, Johnson Space Center



This segment from a high resolution visibloe image acquired by Japan's geostationary MTSAT2 at 03:01 UT on July 11, 2015 shows super typhoon Chan-hom making landfall on China's Zhejiang province, where some million people were evacuated from their homes.. Windspeeds of up to 173 km/ hour were recorded, and some locations received over 400 mm of rain in 24 hours.



Rarely is Russia's Arctic archipelago of **Franz Josef Land**, situated at 81° north, revealed as it was on August 2 this year, in this splendid MODIS image from NASA's ***Terra*** satellite.
Image: LANCE Rapid Response/NASA/GSFC

FRANZ JOSEF LAND

Summarised from Wikipedia

Franz Josef Land, pictured on the previous page, is a totally uninhabited archipelago of 191 islands, straddling 81° degrees latitude in the Arctic Ocean and 900 kilometres from the North Pole. It constitutes the northernmost part of Archangelsk Oblast in Russia. In total, the islands cover 16,134 square kilometres and stretch 375 kilometres from east to west and 234 kilometres north to south. The largest island, at 2740 km^2, is George Land, but three others exceed 1,000 km^2: Wilczek Land, Graham Bell Island and Alexandra Land.

Eighty-five percent of the archipelago is glaciated, although large unglaciated areas are located on the largest islands and many of the smallest ones. Cape Fligely, situated at 81°50' north on Rudolf Island, is the northernmost point of the Eastern Hemisphere.

The archipelago was named after emperor Franz Josef I of Austria by the 1873 Austro-Hungarian North Pole expedition led by Julius von Payer and Karl Weyprecht. The islands were annexed by the Soviet Union in 1926 and have been a nature sanctuary since 1994. They became part of the Russian Arctic National Park in 2012.

Franz Josef Land experiences 141 days per year of midnight sun (from April 12 to August 30) and, during the winter, 128 days of polar night (from October 19 to February 23). Even during summer the angle of the sun ray spreads the limited radiated energy over a large area. Further cooling is caused by the high amount of cloudiness. The sea starts to freeze in late September and reaches its annual maximum in March, at which time ninety-five percent of the sea is ice-covered. The ice starts to decrease in May and suffers a major melting in June, with the minimum occurring in August or early September.

Climate

During winter, high-pressure and clear skies can send the temperature down to −40 °C. Frequent low-pressure weather produces strong winds and precipitation, with spells when the temperature creeps up to and above freezing. During such shifts, the temperature can change by 20°C within just a few hours.

During summer the temperature is much more uniform, averaging between 0°C and 3°C at Hayes Island. Fog is most common during the summer and average annual precipitation at the coastal stations is between 100 and 150 millimetres, with the wettest months being from July through September.

Flora

More than 100 species of lichen are found on the islands, as well as sixteen species of grass and about 100 species of algae. Over fifty species of vascular plants have been recorded, the most common being Arctic poppy and saxifrage, which grow everywhere. Common in wet areas are alpine foxtail, buttercups and polar willow.

Fauna

Forty-one species of birds have been documented in the archipelago, of which fourteen breed. These are dominated by seabirds such as the fulmar and kittiwake, which are common throughout the archipelago, while seven other species, including the purple sandpiper, Arctic skua, glaucous gull, ivory gull, Arctic tern, snow bunting and common eider prefer nesting on flat tundra.

There is a polar bear presence on Franz Josef Land, and also a population of Arctic foxes, which typically have their territories near seabird habitats.

Marine Mammals

Being declared as a marine mammal sanctuary, the islands have a rich biodiversity of rare marine mammals.

Three species of seals habit the archipelago, the harp seal being the most common. Walruses, which were formerly hunted, dramatically reducing their numbers, have been internationally protected since 1952 and their populations have since been on the increase, with between one and three thousand now living in the archipelago.

Minke whales, humpback whales, and beluga whales are commonly seen around Franz Josef Land, and less commonly orcas and narwhales.

Human activity

There is no infrastructure to support tourism and the islands can only be reached by icebreaker. The most frequent service is a three-week North Pole tour with a Russian nuclear-powered icebreaker which stops by the islands. The most popular destinations are areas with bird cliffs and walrus colonies, such as Cape Flora on Northbrook Island and Cape Rubini on Hooker Island, as well as historical remains such as Nansen's hut on Jackson Island.

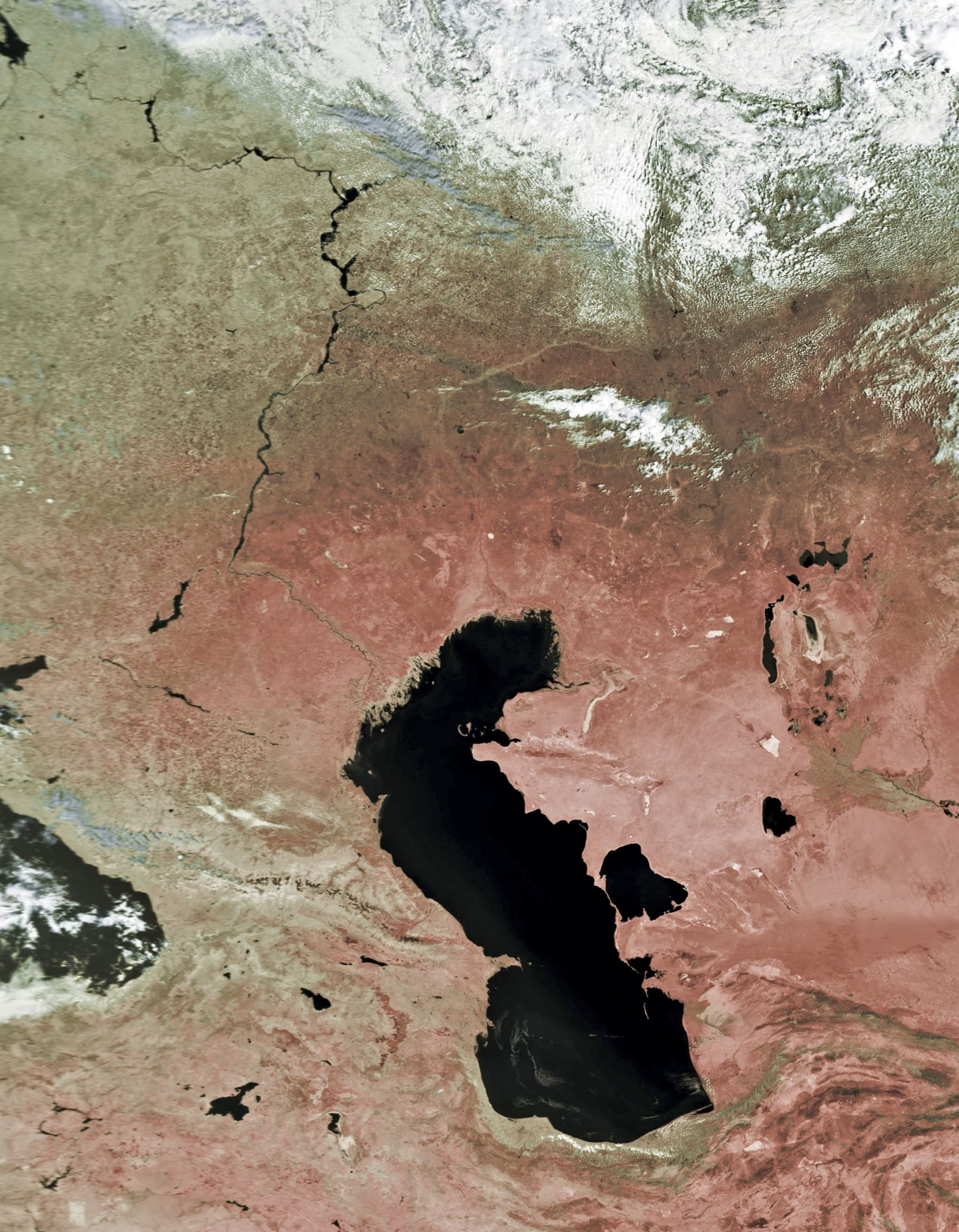
Source: Wikimedia

Cape Tegethoff on Hall Island
Image: Polarstar / Wikimedia

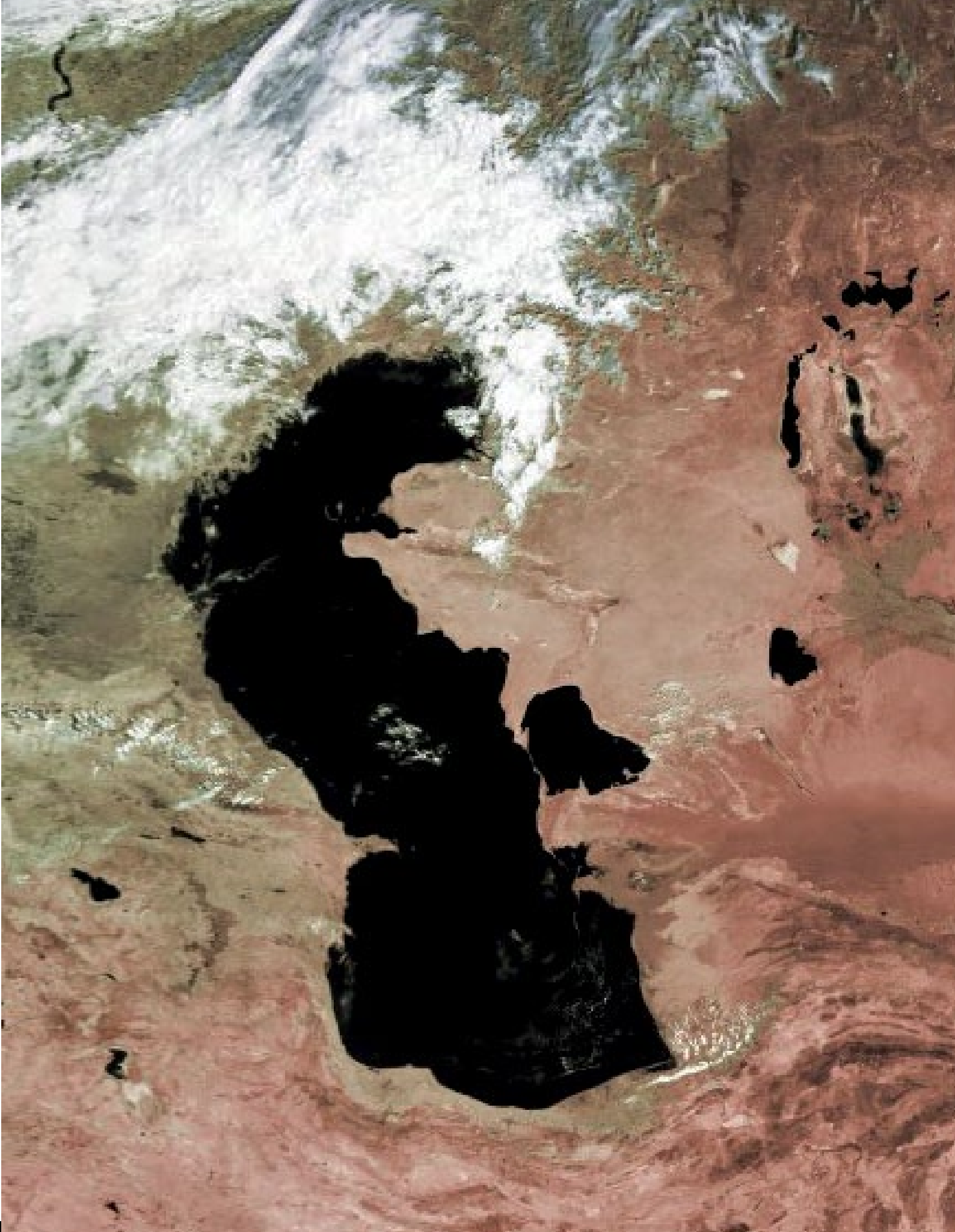
Cape Flora - Franz Joseph Land
Image: Christopher Michel

Heiss Island - Franz Joseph Land
Image: Sergei Slepnev / Wikimedia

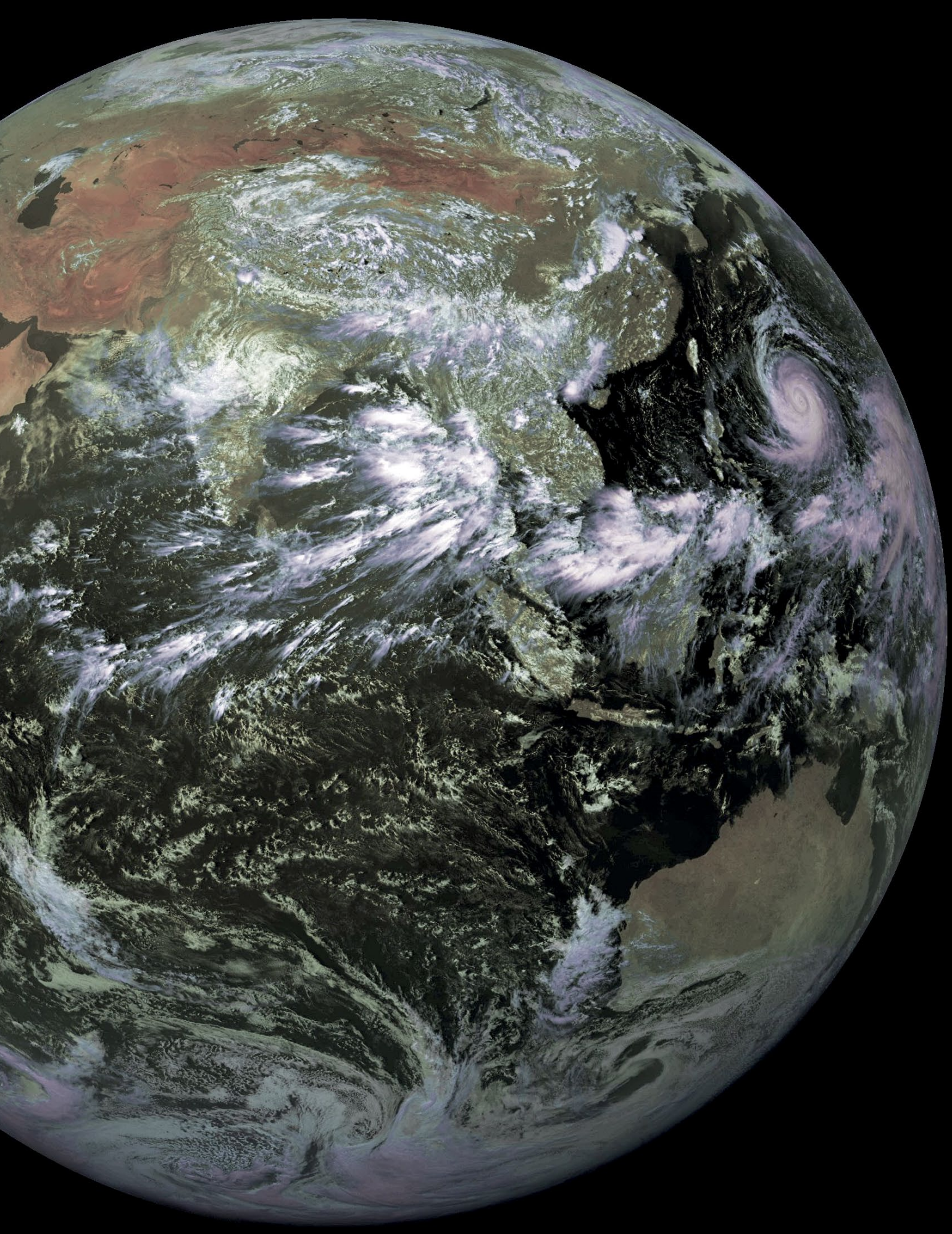
https://en.wikipedia.org/wiki/Franz_Josef_Land



Mike Stevens submitted this fine Metop-B image from August 11, 2015, which shows the Volga river snaking from the Rybinsk reservoir (at the extreme top left) towards the Caspian Sea. To its right you can see the remains of the Aral Sea, with its eastern lobe much reduced in extent.



What a difference a week makes! In this Metop-A image from August 19, 2015, also sent in by Mike Stevens, you can see that the eastern lobe of the Aral Sea has been significantly replenished.



This image from China's latest satellite, **Feng Yun-2G**, was sent in by Mike Stevens. To the right hand side you can see Category-5 Typhoon Soudelor advancing towards Taiwan.
Image © EUMETSAT 2015

Unusual Meteor 2M Image

Enrico Gobbetti

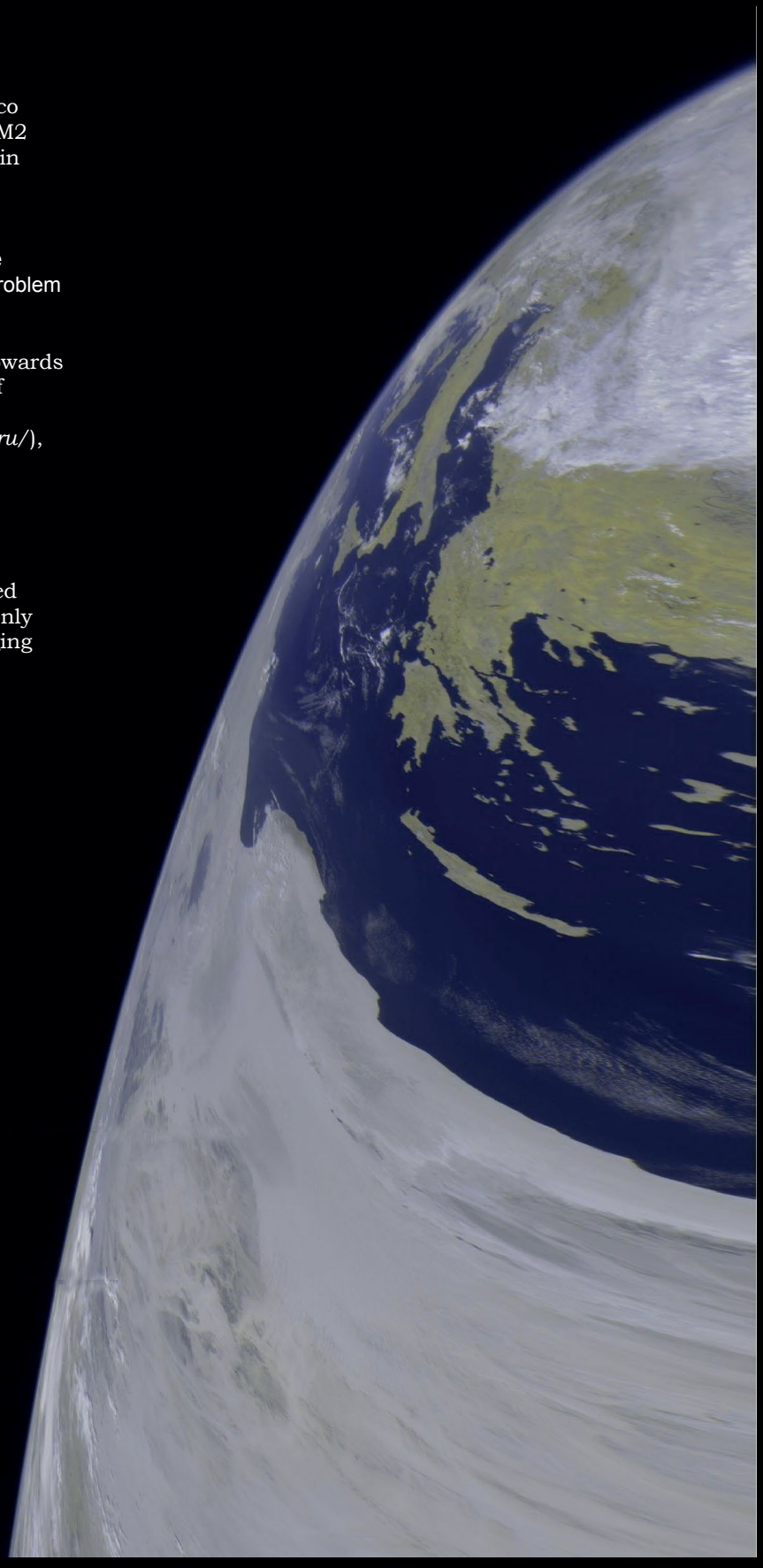
On August 18 this year, an email from Enrico Gobbetti, reported on a remarkable Meteor M2 image he had just received from his station in Italy.

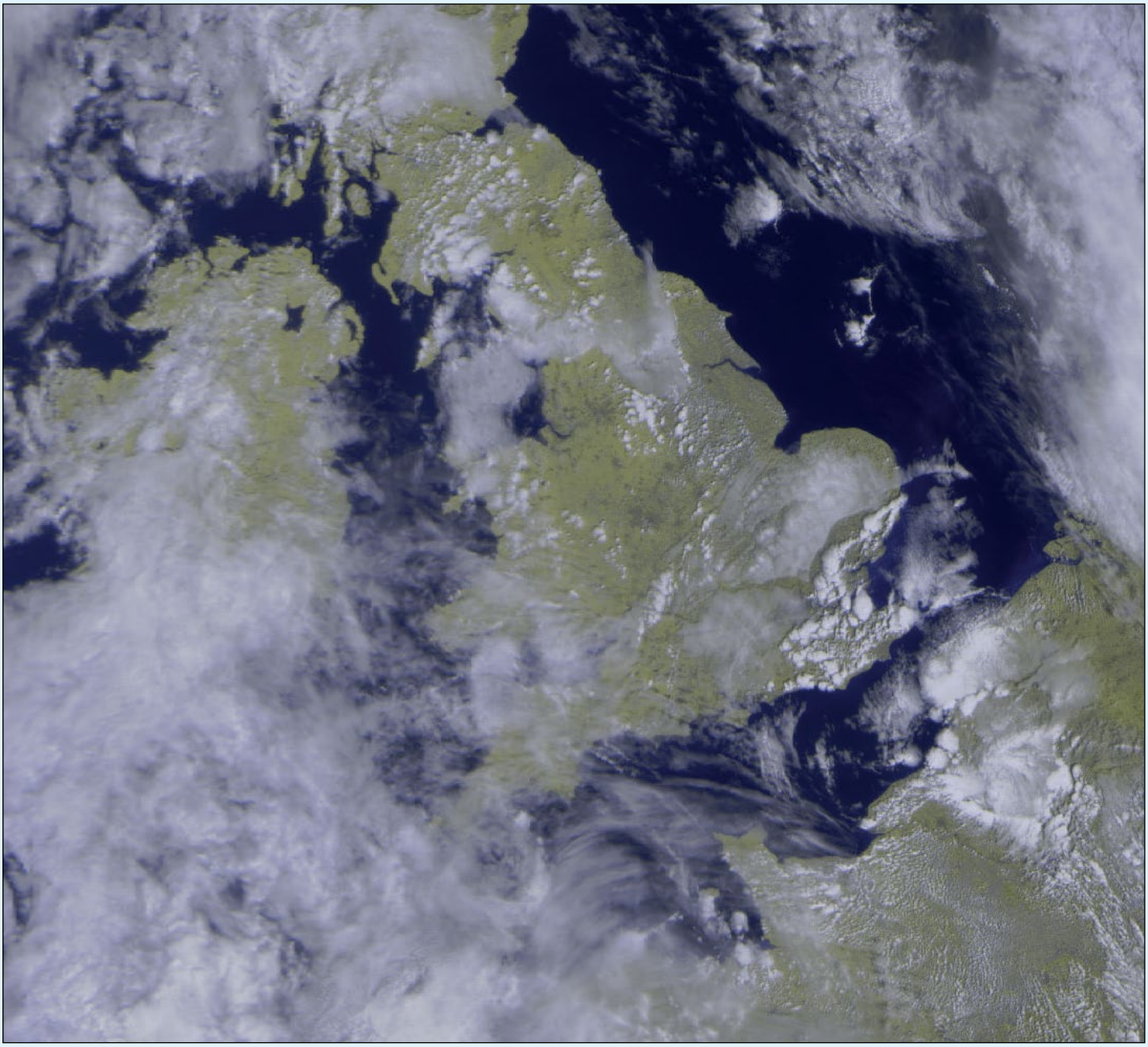
"This morning, I received from Meteor M-N2, on Orbit 5759, at approximately 07:15 UT, a strange image, which I think may be due to a technical problem on the Meteor M2 satellite."

It is clear that the satellite is not pointing towards the nadir, but is skewed towards the limb of Earth. After querying the situation with the Robonuca website (*http://meteor.robonuka.ru/*), Oleg replied:

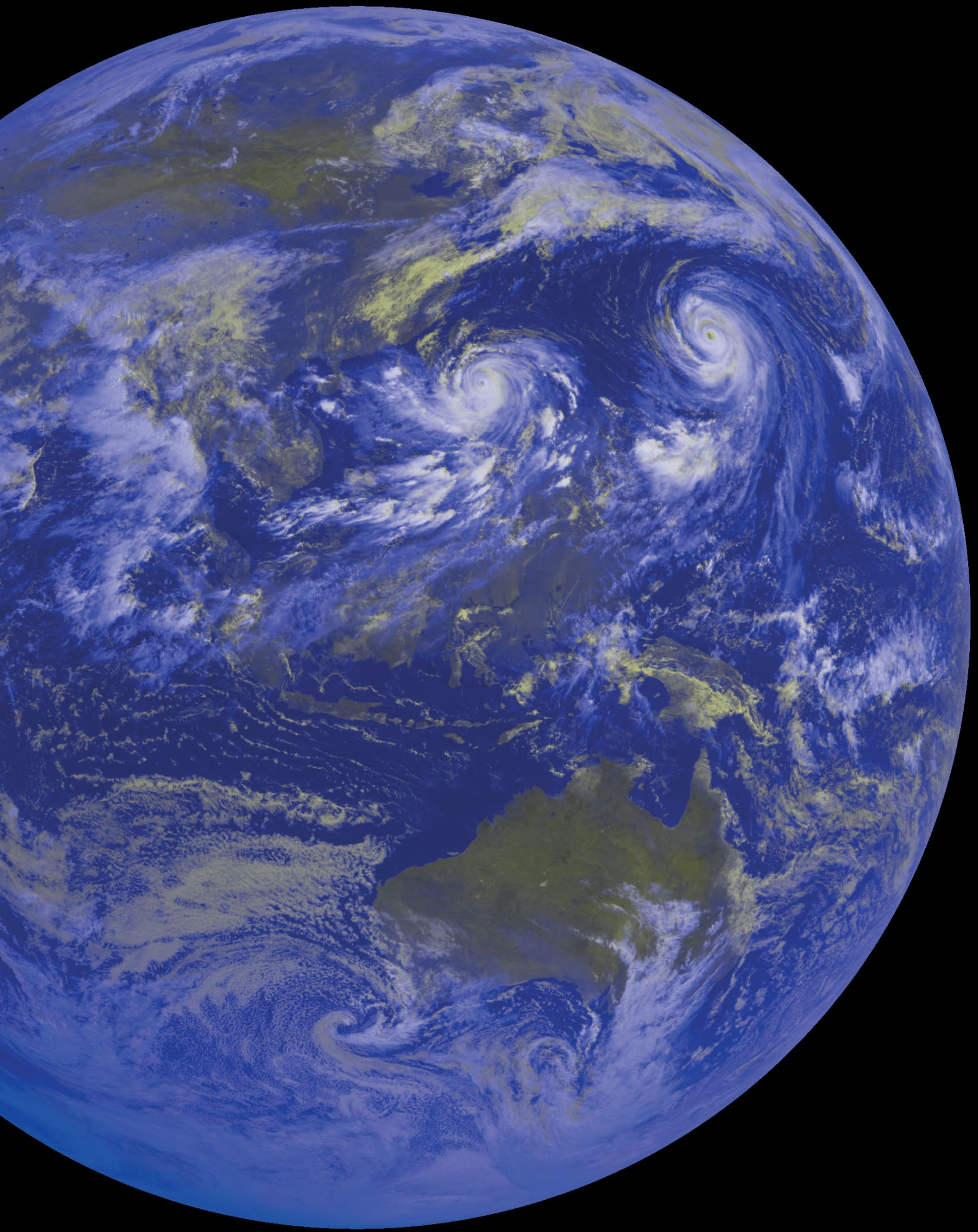
"It was a small rotation of the spacecraft. This is happening for the second time this month."

So it seems that this was a brief, but planned manoeuvre of the satellite, as this was the only abnormal image received on that date. Imaging returned to normal on the following pass.

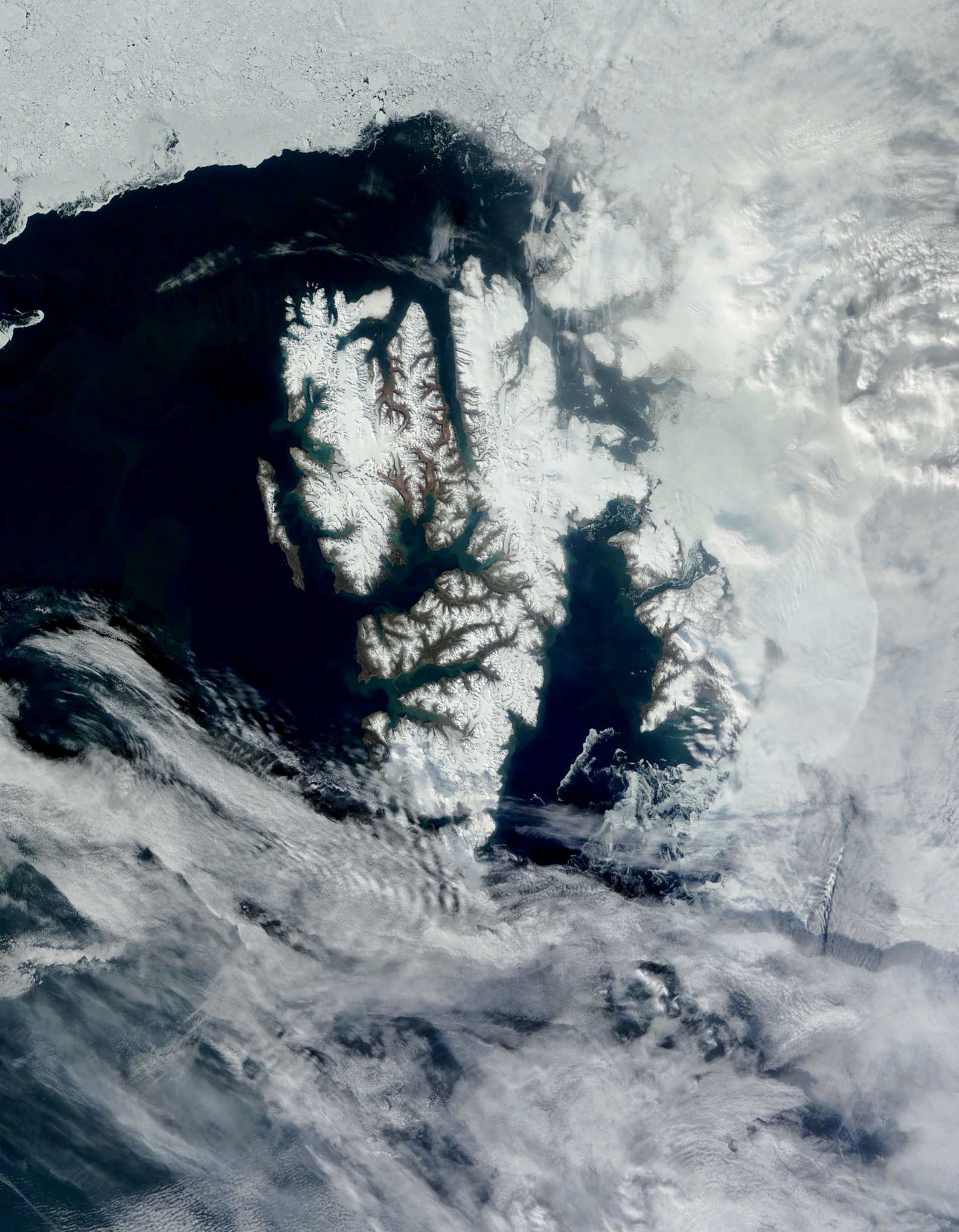




Thunderstorms forming over northwest France threaten England in this segment from the 09:31 UT Meteor M2 pass on August 16, 2015.



This colour composite image from China's Feng Yun 2F satellite, acquired at 02:30 UT on August 21, 2015, includes two huge typhoons traversing the western Pacific ocean. Typhoon Goni can be seen battering the Philippines, chased closely by Typhoon Atsani.



All to frequently, Norway's Arctic island of Spitzbergen is hidden from view by cloud. But on July 9, 2015, a large window opened up in the cloud deck, revealing its intricate, glacier covered terrain to the MODIS instrument aboard NASA's Terra satellite..

Image: LANCE-MODIS/NASA/GSFC

The Weather Experiment

The Pioneers who Sought to See the Future

(Peter Moore, Chatto and Windus, London, 2015, pp 395)

A Book Review by Robert Moore

This is a book that almost any GEO member will find interesting, but each may read it in a different way. This volume is at the same time an important contribution to the history of science, an introduction to the biographies of the pioneers of meteorology and an insight into the intellectual life and personal relationships of the scientific establishment of 19th century Britain. Above all, it is an account of an heroic period in the development of meteorology and of the larger-than-life figures who made it.

Most readers will be aware of how modern our understanding of the weather is and how relatively primitive our knowledge was until late in the 19th century. Alternative theories of weather and storms led to fierce debates amongst leading scientists in the UK, Europe and North America. *The Weather Experiment* is rich in biographical detail and in sketching the outlines of these key scientific debates. To this reviewer, two great seafarers stand out above all others but many readers will find the account of the early attempts to explore the upper atmosphere interesting, amusing and hair-raising. In 1862, **James Glaisher** and **Henry Coxwell** took flight in a balloon: Glaisher took instruments he had made for the purpose and Coxwell managed the balloon. As they approached 29,000 feet (5.5 miles), Glaisher passed out but remained conscious enough to see Coxwell, undoubtedly suffering from hypoxia (oxygen starvation), climb out of the basket to free a valve that had become tangled below the balloon. Both landed with the data and their lives. Thus meteorology advanced!

Francis Beaufort was a distinguished naval officer, rising to the rank of Admiral, being made Hydrographer to the Navy and elected a member of the Royal Society. He is perhaps most commonly remembered for the Beaufort Scale, an innovation which enables seafarers the world over to use common terminology, and thus exchange mutually understandable information. But Beaufort was also a meticulous surveyor and hydrographer. Under his supervision the whole British coastline was charted accurately. Furthermore, he recognised the potential of the telegraph. It was the rapid transmission of information that later made it possible to chart the weather and to give warnings of weather hazards. Beaufort was a polymath and, according to Peter Moore, a kind of 19th century *Wikipedia*. If you wanted to know something: 'Ask Beaufort'. The location of Osborne House on the Isle of Wight was the answer to a question addressed to Beaufort by none less than Prince Albert. All of these talents combined with administrative capabilities and political skills made him a key figure in the intellectual history of Britain and the development of meteorology.

Robert Fitzroy was Beaufort's protégé. Again, he is a man usually remembered for one thing: captaining the Beagle on Darwin's great voyage of discovery. But it was Fitzroy's expedition, not Darwin's. Fitzroy was making his own studies of the sea and the winds, while exploring and charting the difficult coastlines at the southern tip of the Americas. He kept weather records during the voyage, and throughout his career Fitzroy remained an assiduous recorder and collector of data; he recognised that in science there is no substitute for data. He was also, and perhaps remains, one of the greatest seamen of all times, not least in that he always brought his ship and crew home safely in conditions where others failed.

Parliament made Fitzroy a grant to study the winds. This he did, and one outcome—made possible by the use of the telegraph—was the development of storm warnings and the hoisting of cones to warn coastal seafarers of imminent dangerous weather. The disastrous sinking of the *SS Royal Charter* on the North Wales coast underlined the need for such warnings (and the better education of ships' captains). Many lives were saved when the warnings were heeded, and lost when they were not. After Fitzroy's death, Parliament withdrew from the project. Fitzroy's original grant to study the winds had been made in order to shorten sailing times to the Antipodes, not to save lives. Samuel Plimsoll was to encounter similar attitudes to the safety of life at sea.

Fitzroy, whilst a brilliant seaman, was clearly a very 'difficult' character and not an easy officer to serve under. He was a prolific writer of reports and his two books on weather, *Barometer And Weather Guide* (published by the Board of Trade in 1859) and *The Weather Book: A Manual of Practical Meteorology* (1863) remained in use for many years. The latter was recently reprinted. Fitzroy also invented the Fitzroy barometer; falling pressure foretold deteriorating weather, and it was barometric data telegraphed to Fitzroy that formed the basis of the meteorological analysis that was then telegraphed out to ports and harbours. Fitzroy founded the Meteorological Office in 1854.

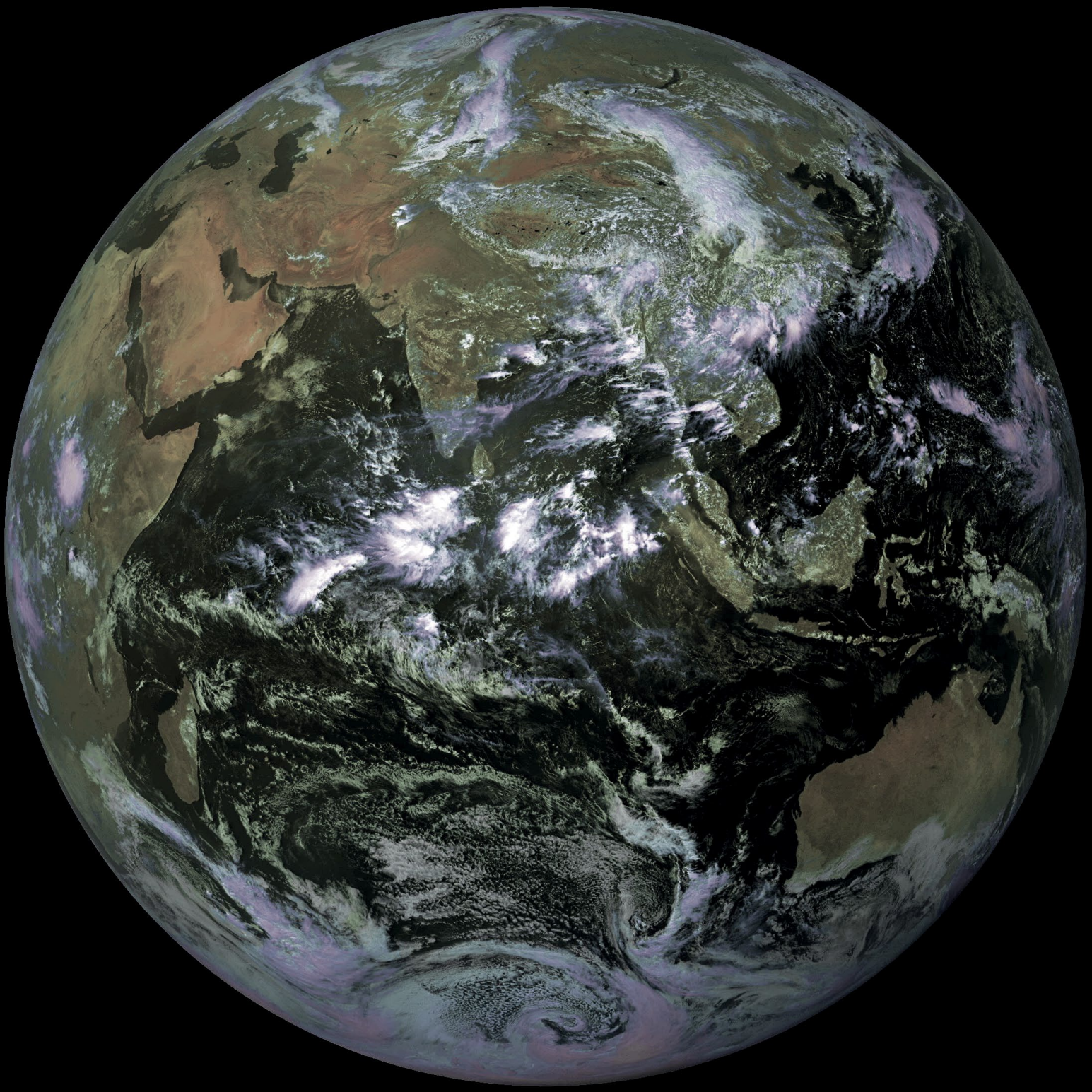
Fitzroy's later life was marked by a breach with Darwin and by Parliamentary ridicule at the idea of predicting the weather (Beaufort had spoken in terms of probabilities, a concept lost on politicians and newspaper editors). His coastal cones were reinstated by demands from seafarers and marine interests, and his weather 'forecasts' appeared in *The Times*, mainly, it seems, for the benefit of the horse-racing fraternity.

Fitzroy's nemesis was **Francis Galton**, who coined the term 'anticyclone', but is today largely remembered with a mixture of contempt and mirth (I used some of his work to illustrate lectures on how not to do science). Does anyone remember Galton today? Fitzroy, who died by his own hand, has a mountain in South America named after him, a road in Exeter and a very large chunk of the North Atlantic.

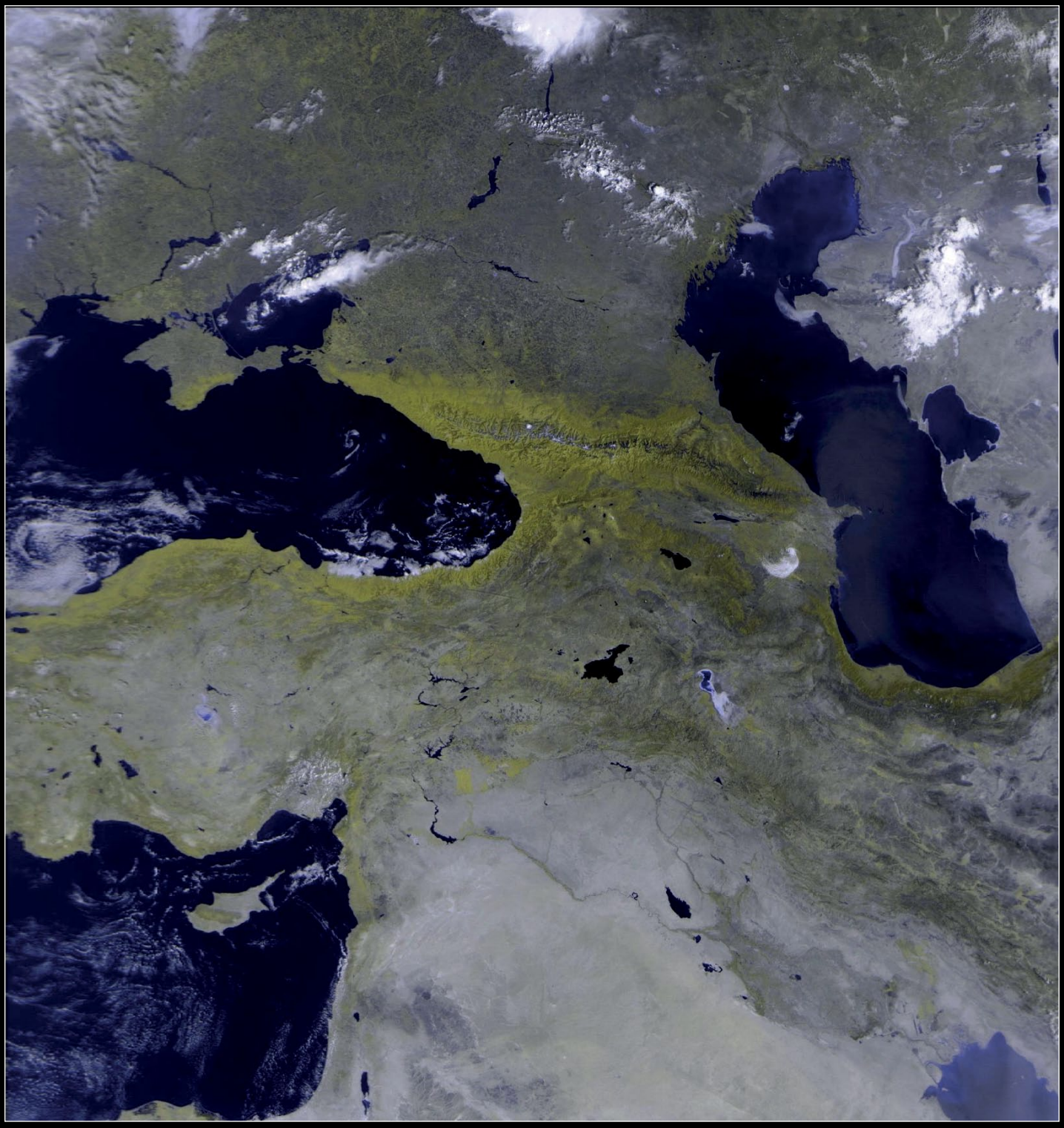
Reading or dipping into *The Weather Experiment* will remind readers of the enormous debt we owe to the pioneers. I wonder what Beaufort and Fitzroy would have made of the imagery that we see today thanks to EUMETSAT, NOAA and the UKMO, and how they would have envied us the internet!

Recounting anecdotes from famous lives cannot do justice to *The Weather Experiment,* which is not only richly populated with the famous figures of 19th century science and politics but also with often heated scientific debates. Like nearly all science, meteorology did not develop by great men thinking great thoughts in their book-lined studies or laboratories, but through debate and ferocious argument upon which reputations often depended. Peter Moore sets out the scientific foundations of meteorology that emerged from these debates.

Finally, I would like to point out that I am not related to the author of this splendid book, though it might have occurred to some readers that I am a former seafarer.

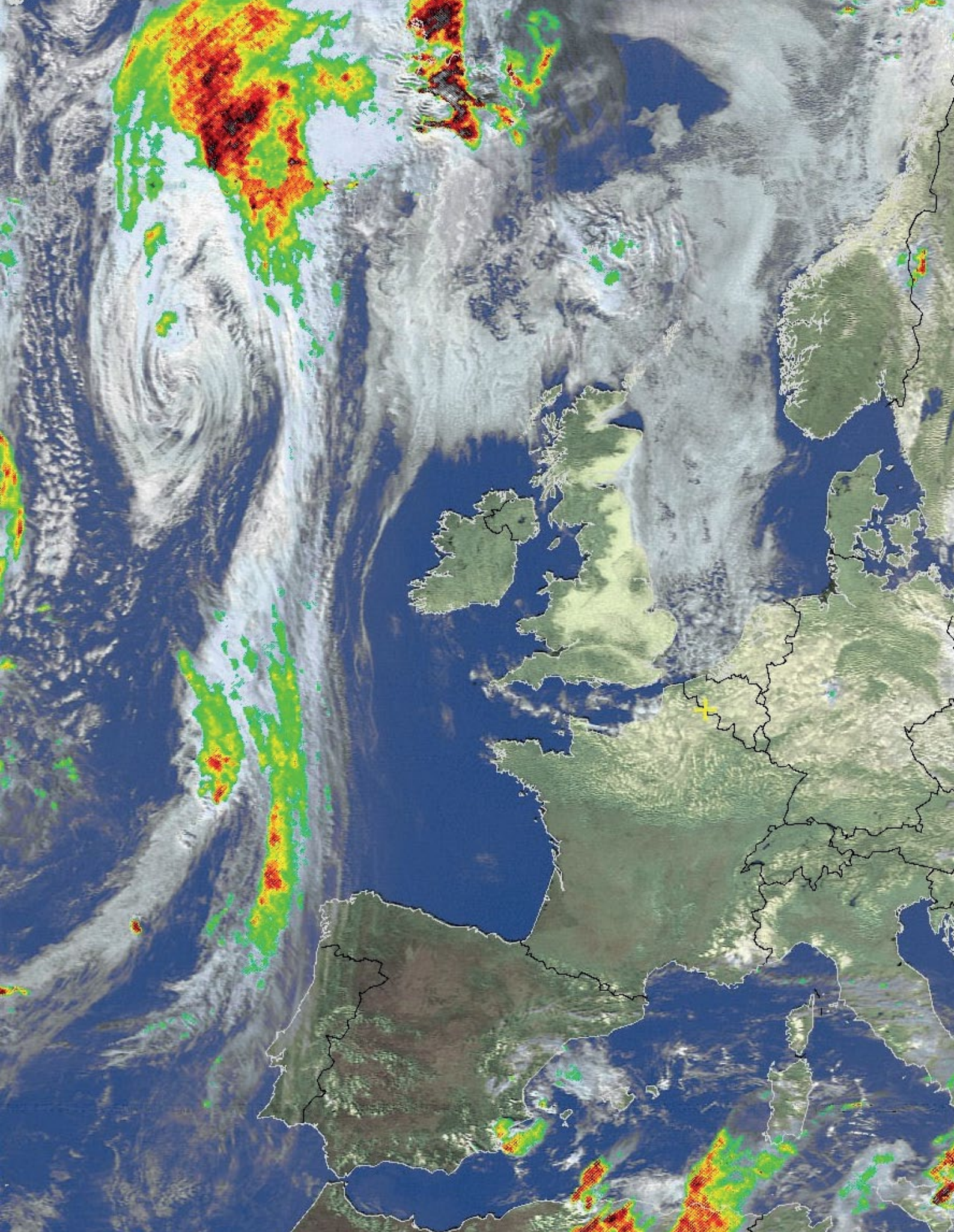


This splendid colour composite image was created by Mike Stevens, using the 06:30 UT data from China's **Feng Yun 2F** geostationary satellite, downloaded from EUMETCast, on September 3, 2015.



Enrico Gobbetti acquired this Meteor M2 LRPT image, showing excellent, cloud-free views of the Black Sea, Mediterranean Sea and Caspian Sea on September 3, 2015.

André T'Kindt sent in this striking NOAA-19 channel-2 APT image from the 13:50 ascending pass on September 8, 2015.
It shows the amazing diversity of weather across Great Britain: brilliant sunshine in the west but cloaking low cloud in the east.



André T'Kindt produced this HVCT+precipitation colour composite image from the same NOAA-19 pass reproduced on the previous page.

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 N2	137.1000 MHz	On	Good [1]

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 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.

Cover Image Details

Front Cover

It's the first day of July and summer has arrived over western Europe with a vengeance. Hot air funnelling up from North Africa and Spain gave many places their hottest July day ever. This is the scene as imaged from Russia's **Meteor-M2 N1** satellite at 10:43 UT on July 1, 2015. Later that day London experienced 36.7°C, Paris 39.7°C and Westdorpe in Zeeland Netherlands 36.5°C, all breaking previous July records.

Image: Les Hamilton using RTL/SDR#/QPSK Demodulator v 1.4

Inside Front Cover

This 17:51 UT **NOAA-15** image from André T-Kindt shows the situation over western Europe on July 2, 2015, with a rainfall overlay picking out thunderstorms generated by the high temperatures.

Inside Back Cover

Enrico Gobbetti acquired this **NOAA-19** HRPT image from his station in Italy at 13:18 UT on July 19, 2015. The entire Meditarranean area basks in sunshine, broken only by cloud over Morocco's Atlas mountains and southeast Spain.

Back Cover

This splendid MODIS image, acquired by NASA's **Aqua** satellite on July 12, 2015, shows Ellesmere Island (the tenth largest in the world) and Axel Heiberg Island in Canada's northern province of Nunavut enjoying the height of summer. In the north of Ellesmere Island, the Mountains of Grant Land still carry an ice cap almosr 900 metres deep, a remnant of the last Ice Age.

Image: LANCE Rapid Response/NASA/GSFC

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.

Copy for GEO Quarterly

Original contributions relating to any aspect of Earth Imaging should be submitted in electronic format (although handwritten and typed copy will be accepted).

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.

Please note that it is preferred that satellite images are provided **without added grid lines, country outlines or captions** unless these are considered essential for illustrative purposes in an accompanying article.

Submission of Copy

Materials for publication should be sent to the editor,

Les Hamilton
8 Deeside Place
Aberdeen AB15 7PW
Scotland

The most efficient way to do this is by **email attachments** to the following address

geoeditor@geo-web.org.uk

Particularly large attachments (8 MB and above) can be transmitted via *Hightail*

https*://wwwhightail.com/*

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England, UK.

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The Group for Earth Observation Limited is a company in England and Wales, limited by guarantee and having no shares. The company number is 4975597. The registered office is Coturnix House, Rake Lane, Milford, Godalming GU8 5AB.

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

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