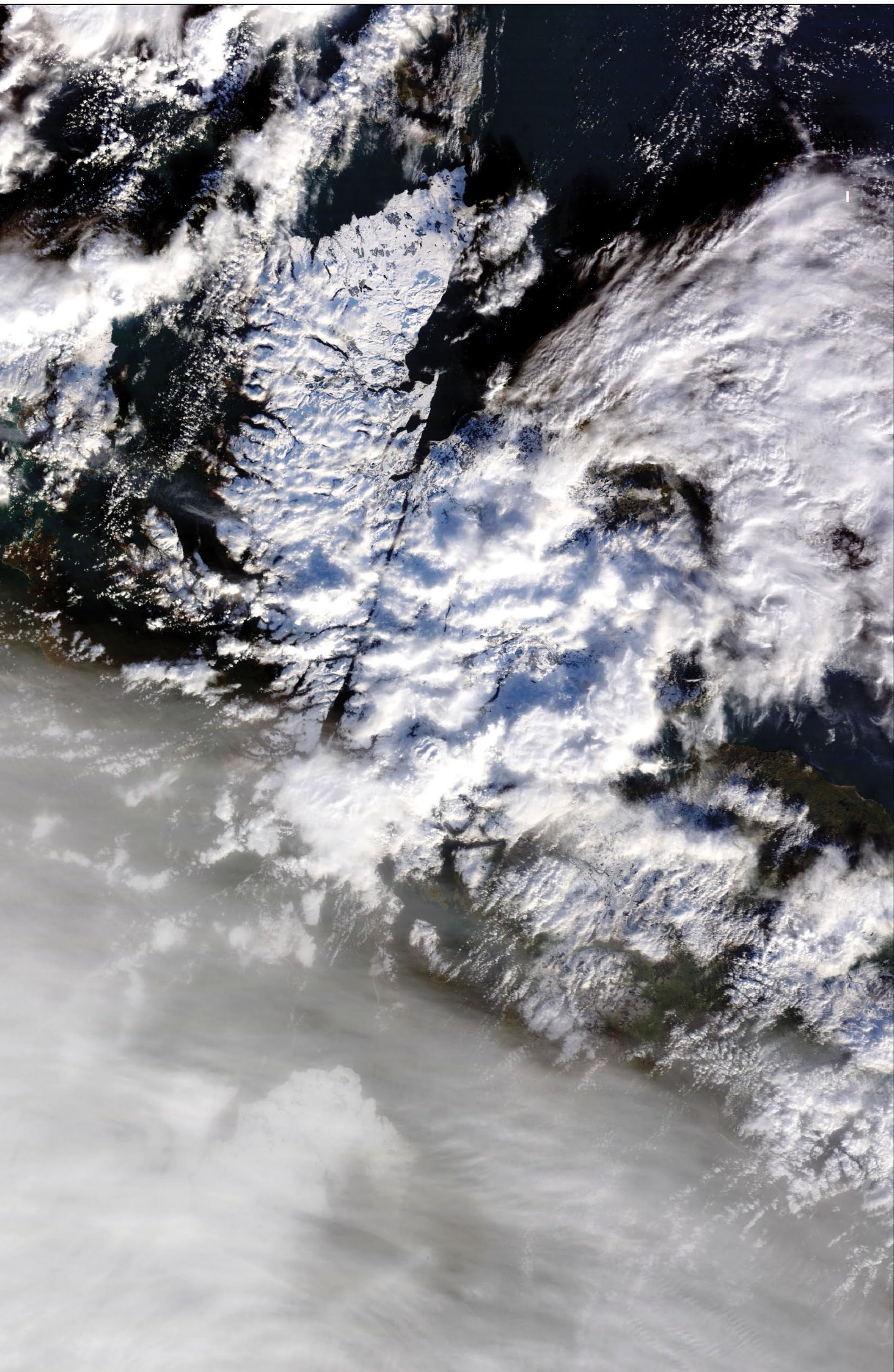
The GEO Quarterly

Group for Earth Observation

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

45

March 2015



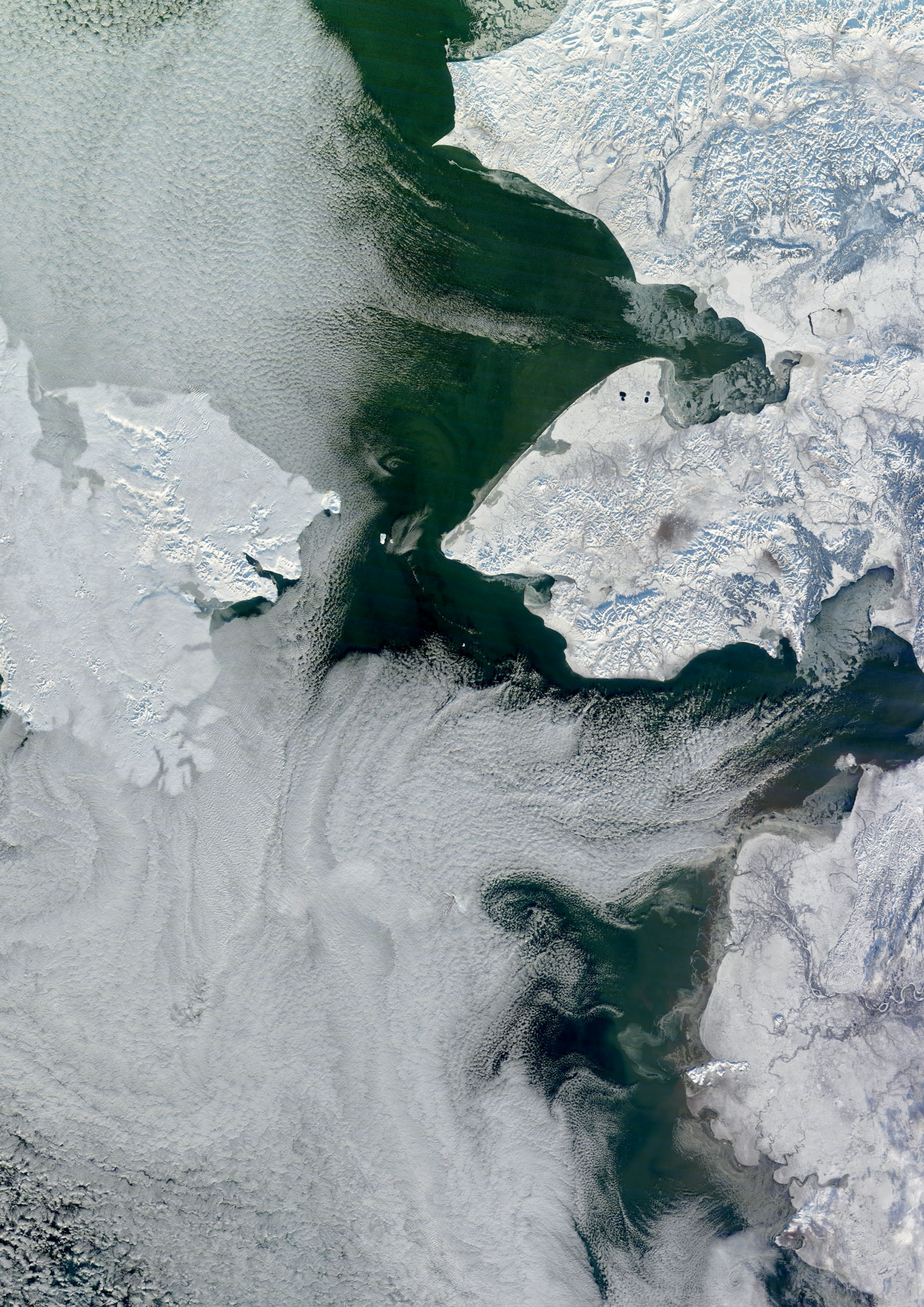
Inside this issue . .

Russia's new Meteor M2 satellite has received lots of publicity in recent issues. This quarter, Rob Alblas turns to its HRPT data output and explains the HRPT Data Structure behind the images.

Paul Geissmann, who lives in Switzerland, frequently faces the problem of heavy snowfall interfering with his EUMETCast reception. Here, he explains the simple heating solution that now guarantees him continuity of reception.

Hopefully, all our EUMETCast enthusiasts have now successfully engineered the changeover to the Eutelsat 10A satellite. If you are still experiencing problems, John Barfoot describes how he and colleagues at the South Downs Planetarium effected their changeover 'without tears'.

During the past six months, satellites have been observing one of the most significant volcanic events in Iceland for centuries: the eruption of the sub-glacial volcano Bardarbunga. Les Hamilton has prepared an informative feature on this ongoing situation, lavishly illustrated by both satellite and ground-based imagery.



Publisher
Published by *The Group for Earth Observation Limited*, a company in England and Wales, limited by guarantee and not having share capital.
The Company Number is 4975597.

The registered office is Coturnix House, Rake Lane, Milford, Godalming, Surrey GU8 5AB, England.

Printing (December Issue)
Hedgerow Print,
16 Marsh Lane,
Crediton, Devon EX17 1ES.
Tel: 01363 777 595

Editorial

Les Hamilton
geoeditor@geo-web.org.uk

Welcome to the first issue of GEO Quarterly for 2015. As explained earlier, the March, June and September issues of this publication will henceforth be available only in electronic (PDF) format. In addition to a similar copy in December, all members will also receive a printed (paper) version of the magazine. The PDF format is much more flexible, and allows for the inclusion of a greater number of readers' images. It also allows us for the first time to produce full colour throughout the magazine.

I have spent a vast amount of time sourcing material for this first PDF issue, and hope that everyone finds it a worthwhile document. But a glance at the contents listing below shows a disappointing dearth of contributors. We really do need many more contributions from our readers, explaining their own slant on the hobby of weather satellite imaging.

One particular disappointment is the apparent lack of evidence that GEO readers are pursuing the new Russian Meteor satellite. As an out and out APT enthusiast, I was immediately attracted by the possibilities offered by this LRPT satellite, but despite the excellent article by Raydel Abreu Espinet in the December issue, I found that all was not plain sailing. I had to tackle a number of problems before I was able to receive satisfactory images. In the hope that my experiences will be of benefit to others, I have outlined my progress in an article starting on page 41.

I have initiated what I hope may become a regular thread on page 50, displaying a satellite image received almost a quarter of a century ago. I will be pleased to continue this theme if readers care to submit interesting early images from the NOAA, Meteor, Cosmos and Okean satellites for consideration. Brief details of the reception equipment, and any noteworthy content within the images themselves will also be welcome.

Copy deadline for the June issue of GEO Quarterly is Sunday, May 17, 2015.

Contents

The GEO Report

Francis Bell

I'm sure that for many of us the past few months have been significant for the continued live reception of the new S2 VCM *EUMETCast* service. At my home, I installed a new receiver and aligned my dishes for the new service well in advance of the deadline for the end of the old service. This was my insurance against total loss of service should there have been unforeseen problems with my new receiver. However, I know that other individuals, and even national agencies, quite understandably left it to the last minute to upgrade their systems for the new service, hence a run on our Shop services late last year.

I must congratulate Nigel Evans and his wife Michele who look after the *GEO Shop*, and have dealt with the dispatch of new receivers to our members. This has involved technical knowledge relating to the receiver's configuration before dispatching it to members; the farsightedness in ordering the units well in advance from a manufacturer outside the EU; and also coping with the necessary international payments and local UK VAT demands. This has been a valuable service to our membership without which many of us would now be without live *EUMETCast* reception.

Darmsdadt Meeting

Please double-check the date in your diary for our scheduled visit to the EUMETSAT Head Quarters on July 2, 2015. This visit has been confirmed with EUMETSAT but the fine detail of the programme has still to be arranged according to the wishes of those attending. My personal preference is for a tour of their facilities, which will now include their recently opened new building, and also presentations relating to EUMETCast's new high data rate services, which would be very informative. If you have any particular ideas relating to our visit to EUMETSAT HQ, Darmstadt, please let me know as soon as possible and I will endeavour to progress any suggestions.

Accommodation in Darmstadt

I will be staying at the *Ibis Hotel* in Darmstadt because it is reasonably priced at about £40 per night for a twin room and is within walking distance of both EUMETSAT's HQ and ESOC. If you wish to contact the hotel, use the Internet. Alternatively, their details are:

Hotel Ibis
Darmsdadt
Kasinostrasse 6
Darmstadt 64293
Germany
Tel ++ 49 615139700

Unlike previous Darmstadt visits, we will <u>not</u> be visiting Usingen, because the *EUMETCast* uplink services have been moved away from Usingen—which lies only about 40 km from Darmstadt—to a site in Austria. However, there is a plan to visit the nearby ESOC HQ on July 3, 2015, also in Darmstadt, and a half-day there with a structured programme should be very worthwhile.

Membership

It is disappointing to notice the steady decline in GEO membership numbers. I think the changing technologies over the past ten years have perhaps persuaded people to use Internet service to gain access to Earth images hence the decline in live reception. However, for me it is both the challenge of live reception and the interest in the received data which gives me a buzz. Where it is reasonably possible, please encourage friends and other GEO members to maintain their membership and where possible promote GEO to individuals, clubs and institutions.

Meteor M2

We would welcome further reports about the reception of the services provided by this recent Russian weather satellite. Images and reports directly to our editor please. This is not a trivial request because this series of satellites should offer very low cost live weather satellite reception to interested parties for many years to come.

Quarterly ? Question

My thanks to all those members who sent in answers to **Quarterly Question 44**, which related to an image I received from the International Space Station (ISS).

Remember, if you have an Internet connection you can receiver live images from the ISS for yourself. There are several cameras on board the ISS, each giving a different view of the Earth below using visible wavelengths just like commercial TV. If you want to receive these images for yourself, log on to

www.ustream.tv/channel/iss-hdev-payload

Images vary according to the position of the ISS and which of the cameras is operational.

The Quarterly Question image was one showing Cyprus, together with a little of southern Turkey. The specific question related to the historic mineral wealth of Cyprus and the principal metal mined on the island. I consider the answer to this question to be the metal copper. Bronze is an alloy of copper and tin, the combination of which gives an alloy which is harder than the individual components, hence its value in the past for making knives, spears and other tools in the *Bronze Age*.

A secondary reason for picking this island image for the question was my personal affection for Cyprus, which I have visited several times. Today, for political reasons, it is split into Cyprus and North Cyprus with the United Nations still overseeing the political boundary which run through the divided city of Nicosia. My tours of the island

This image was captured by the International Space Station on February 23 this year
and is the subject of Quarterly question 45

by motor cycle, car, taxi and bus have revealed its geographic beauty, history and delightful climate.

Correct answers identifying the island as Cyprus and the metal as copper were obtained from Alistair Dunlop (UK), Laurence Holderness (Pembrokeshire West Wales) and Andreas Lubnow (Braunschweig Germany). Alistair and Laurence also provided the following extended details:

Alistair Dunlop

The island in question is Cyprus, with the coastal outline of the north east of the island, together with its tail, unmistakable. The main valuable metal extracted on Cyprus was Copper. There was—if I remember school correctly—a *Copper Period* before the Bronze Age. Copper can be work-hardened to form a reasonable edge: not as sharp as properly knapped flints but much more versatile in regard to shape. Copper plus tin makes bronze. I can't remember offhand the ratios, but not a lot of tin is needed to produce bronze, which takes and holds an edge much better than work-hardened copper: plus, it's relatively easy to manufacture. Tin was fairly scarce in the ancient Mediterranean but plentiful in distant places such as Cornwall. Ancient writings and isotope ratios in recovered artefacts have been interpreted as showing a significant trade between such distant places and centres of ancient civilisation. Some of this trade went by sea past the Strait of Gibraltar–claimed by some people to be the original Pillars of Hercules–but overland transport would probably be safer and more reliable, at least in times of peace.

Laurence Holderness

The picture is of course, Cyprus. Having lived there for five and a half years you cannot mistake it. Two ores for the Bronze Age would be Copper and Tin. You mentioned the Troodos range: another material found there is Asbestos, there being mines in that area, normally surrounded in dust. I wonder what the health ratings is like for the workers there?

I lived there from 1958 to 1961 as a single man (RAF), at the end of the EOKA troubles, and when Cyprus obtained its independence. For us this meant we could get out and about and travel the island. My second stay was from 1964 to 1967, with my wife. We both enjoyed our time there but have not been back subsequently. Maybe just as well to remember it as we knew it when there last time. I have '*Googled*' it, and it has changed vastly. Limmasol, where we lived, has expanded along with those various villages that we knew. I regard Cyprus as a second home and I'm always pleased when I can pick up an APT image of it from my home here in West Wales.

Quarterly Question 45

The image associated with this question is one I recorded at home via the Internet. It was transmitted from the International Space Station on February 23, 2015. The local time at the image site would have been approximately mid afternoon. The image shows the junction of three of the North American Great Lakes. The question is to name the three Greats Lakes shown in the image.

The question is made more difficult because the area is experiencing very cold winter weather with some lake surfaces being covered with ice, hence showing up as white. However, a major clue to the answer is the fact that there are parts of three lakes shown. The image is orientated with north approximately at the top with an image width of about 600 miles.

Answers should be submitted, no later than May 10, 2015, to

francis@geo-web.org.uk

Cover and Full Page Image Details

Front Cover

NASA's **Terra** satellite captured this fine MODIS image of Scotland on January 14. Strong overnight gales had brought blizzard conditions that severed power to some seventy thousand consumers in the Western Isles and Northwest, forcing all schools on the Islands to close that day.

Image: LANCE-MODIS/NASA/GSFC

Inside Front Cover

Rarely ever seen in such cloud-free detail, NASA's **Terra** satellite captured this sparkling image of the Bering Strait on November 6, 2014. The strait is just 82 kilometres wide between Cape Dezhnev on Russia's Chukchi peninsula and Cape Prince of Wales on Alaska's Seward Peninsula. The two Diomede islands are clearly visible at the half-way point.

Image: LANCE-MODIS/NASA/GSFC

Inside Back Cover

André t'Kindt provided this false colour **NOAA-18** APT image, processed in WXtoImg, from the 16:51 UT pass on January 28, this year.

Back Cover

This is the view of Iceland acquired by the MODIS instrument aboard NASA's **Aqua** satellite on February 11, 2015. As usual at this time of the year, the nation is almost totally under snow and ice. But the dark Holuhraun lava field stands out, and from it you can make out the white plume of steam and volcanic gases stretching eastwards, and its dark shadow over the ice farther north.

Image: LANCE-MODIS/NASA/GSFC

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The Northeastern corner of the United States has suffered one of its most severe winters for a long time with persistent frosts and heavy snowfalls. This image from a **Meteor 2M** pass on February 20 was posted on *GEO-Subscribers* Internet Forum by Jeff Kelly, whose caption "*COOOOLD!!!*" captures the essence of the situation perfectly.

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This beautiful **Metop-B** image showing the British Isles was received by *David Taylor* on January 8, 2015. The exceptionally low angle of the sun at this time of year creates deep shadows which add sparkle and relief to the scene.

Image © EUMETSAT 2015

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It's Christmas Day 2014, and *Les Hamilton* received this revealing **Meteor M2** channel-5 infrared image during its 20.01UT pass. Britain, France and the Netherlands are all shivering beneath cloudless skies, while an advancing Atlantic storm was to bring gale force winds and snow that temporarily closed both Manchester and Leeds Bradford airports the following day.

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Enrico Gobbetti sent in this **Meteor M2** image dating from January 4, 2014. The main focus of this RGB123 image is Spain, but if you look carefully in the upper left quadrant, you will see aeroplane contrails casting shadows on the cloud deck beneath.

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This **Aqua** MODIS image dating from November 6, 2014—early summer in the southern hemisphere—shows a region to the west of Antarctica's McMurdo Sound. At upper left, the famed *Dry Valleys* are conspicuous, leading toward the coastal *Wilson Piedmont Glacier*, beyond which the sea ice is beginning to fracture and disperse. At upper right, the prominent bay on the coast of Victoria Land is *Granite Harbour*, its southern shore defined by the Mackay Glacier Tongue. The name derives from the great granite boulders found on its shores.

Image LANCE-MODIS/NASA/GSFC

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On the coldest evening of the winter so far, December 4, 2014, *Alex* (Happysat) from the Netherlands captured this impressive **Meteor M2** channel-5 infrared image stretching from Spain to the north of Scotland at 19:52 UT.

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Approximately once a month, **Meteor M2** switches off its infrared LRPT channel and transmits instead channels 1, 2 and 3 for a day or two. Spectacular images result, such as this February 9 one from *Enrico Gobbetti*, which shows the British Isles swathed in an anticyclone. This particular channel combination depicts snow and ice in a cyan tone, and snow on the Scottish Highlands, and upland areas in England and Wales stands out. A number of cloud wakes are prominent, raised by the interaction of mountain ranges with the languid anticyclonic circulation, and at upper left can be seen a number of aeroplane contrails, and the dark shadows they cast on the clouds.

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André t'Kindt obtained this **NOAA-18** image from the 16:20 UT pass on January 13, 2015, which dramatically shows the succession of snow-laden clouds that brought blizzards to much of Scotland.

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Jim Scheffler received this **Meteor M2** image of the eastern USA on January 17, showing exceptional detail of the Appalachian mountain ranges. Cloud streets sweep out into the Atlantic, and the frozen Manicouagan reservoir is prominent to the north of the St Lawrence estuary.

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This fine **Meteor M2** image of Eastern Australia was acquired by Chris van Lint on February 13, his first attempt at reception with an SDR–RTL dongle.

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Mike Stevens spotted this splendid **Metop-B** image showing virtually the entire New Zealand archipelago free from cloud on November 15, 2014.

Image © EUMETSAT 2014.

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After the storm, this was Meteor M2's mid morning view of the British Isles and North Sea area on February 24, 2015.

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This is a **Meteor M2** HRPT image from a Russian archive, showing ice in the Bering Sea on February 15, 2015.

Image:Planet.itp.ru

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NASA's **Terra** satellite captured this MODIS image of the Black Sea on February 22, 2015.

Image LANCE-MODIS/NASA/GSFC

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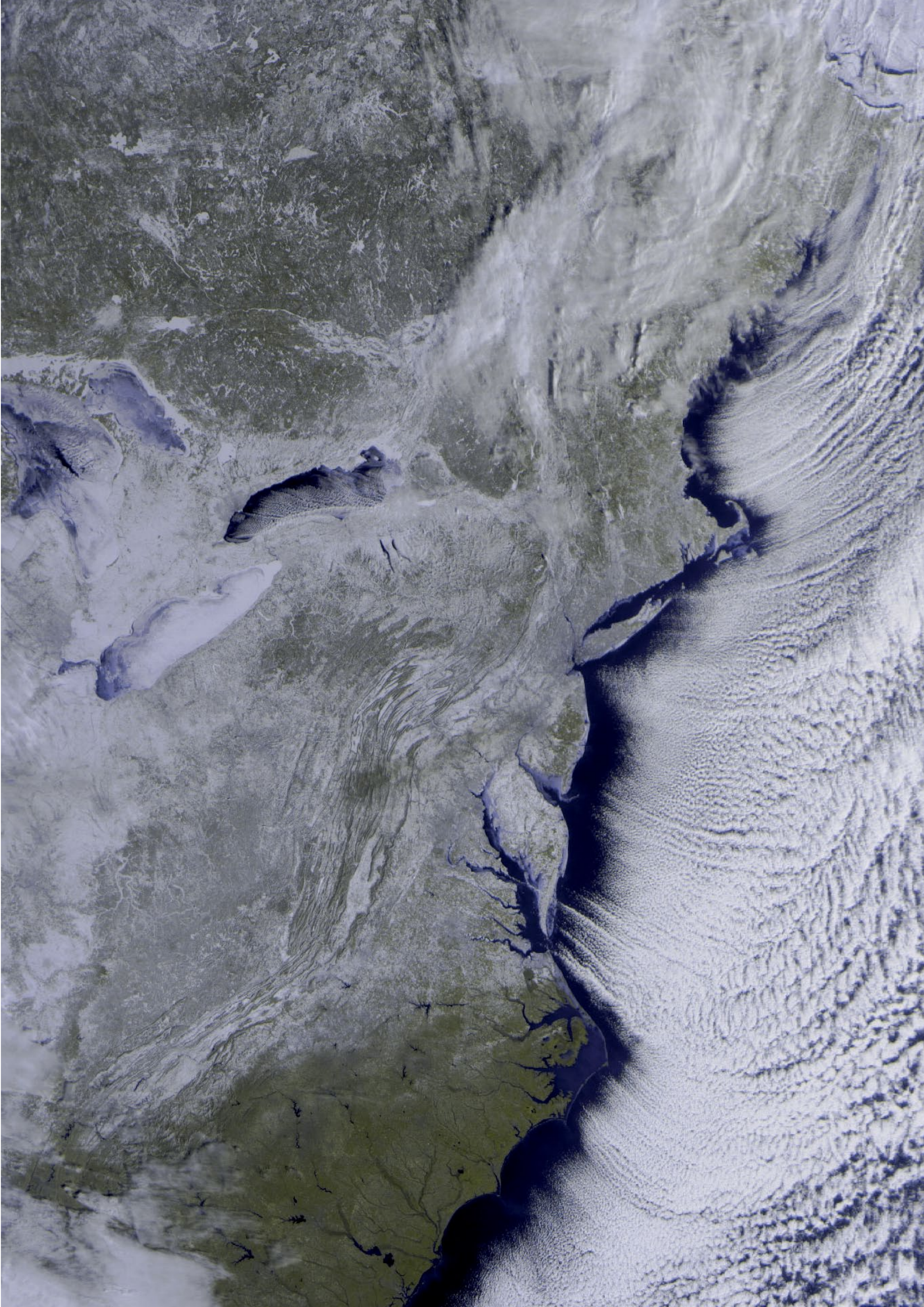
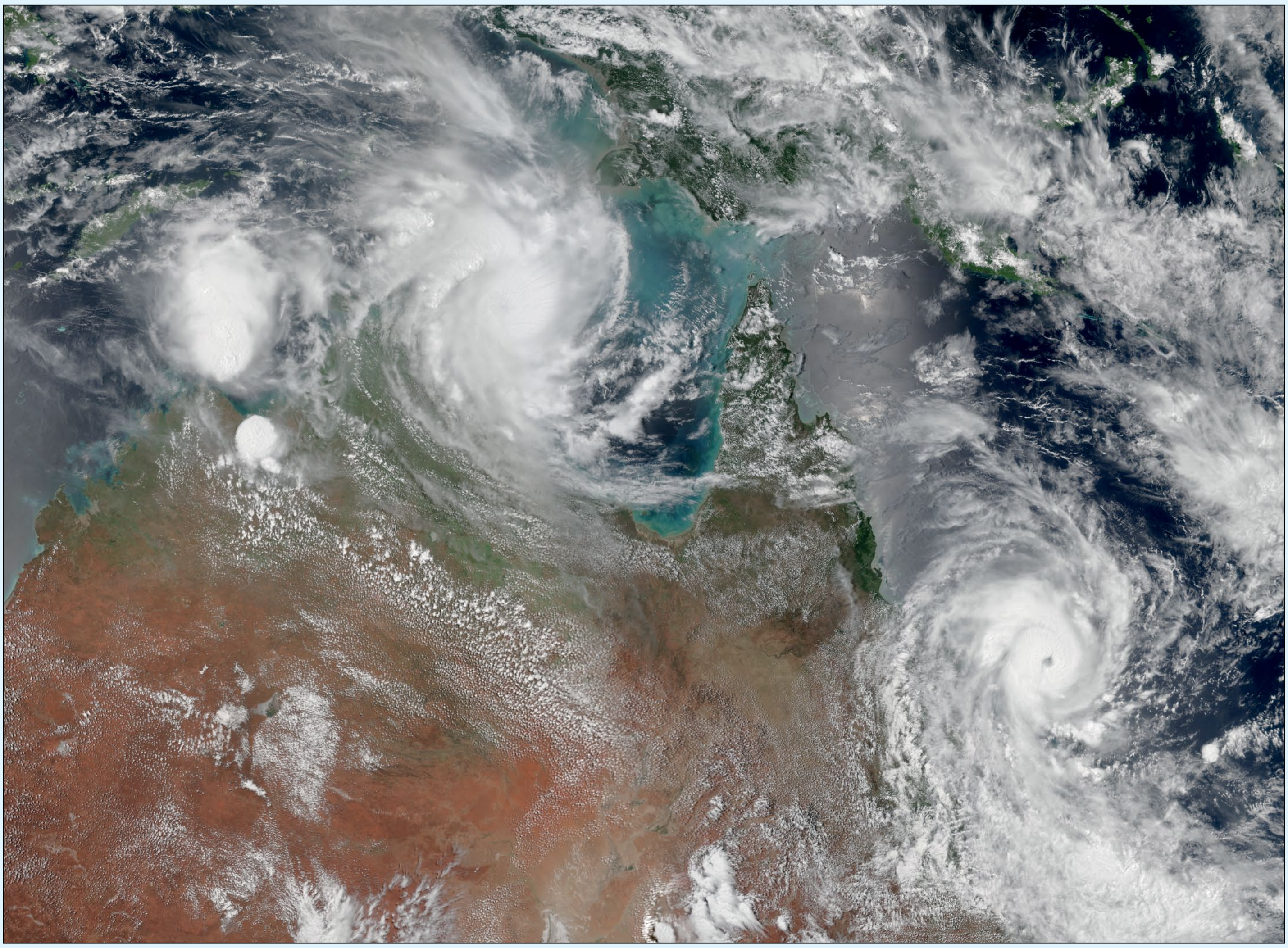
NASA's **Terra** satellite imaged the ice-encased Hudson Bay and part of Baffin Island on February 22, 2015.

Image LANCE-MODIS/NASA/GSFC



Cyclones Lam and Marcia batter Australia

Les Hamilton
(including material from NASA Earth Observatory)



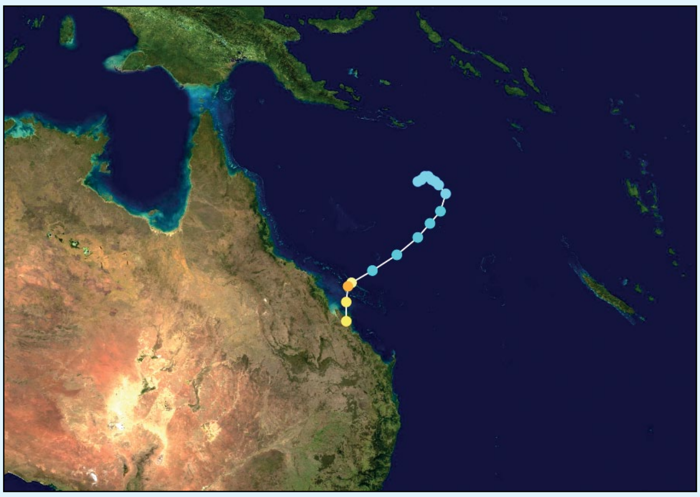
NASA Earth Observatory image by Jesse Allen, using VIIRS data from the Suomi National Polar-orbiting Partnership

Northern Australia was battered by two potent tropical cyclones on the same day, February 19, 2015. **Cyclone Lam** struck the north-central coast near Milingimbi, some 400 km east of Darwin around 2 am Australian central time, while **Cyclone Marcia** made landfall on the east coast of Queensland near Rockhampton and Yeppoon around six hours later. This was the first time since routine satellite coverage began in the 1970s that two severe tropical cyclones made landfall in Australia within the same 24 hour period.

At landfall, Lam had estimated wind speeds of approximately 165 kph but Marcia came ashore with winds of 205 kph. At one stage, Marcia briefly reached *Category 5*, only the sixth storm of that strength to impact on Australia since records began. As a rule, storms of this magnitude rarely penetrate so far south (around latitude 22°S).

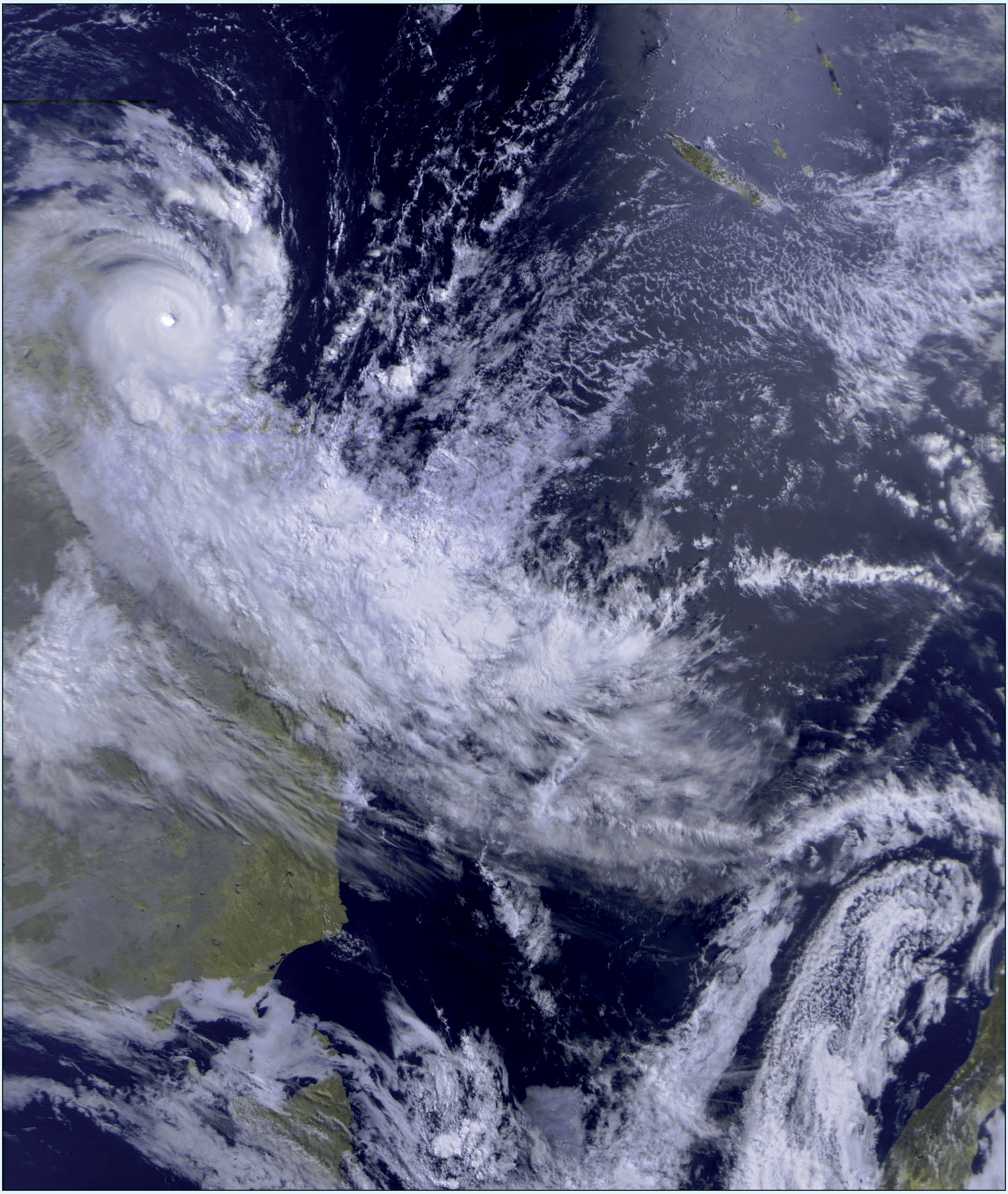
The Visible Infrared Imaging Radiometer Suite on the **Suomi NPP** satellite captured the image above—a composite from two passes—which shows both cyclones at around midday on February 19. As of February 20, no deaths had been reported from the storm, though damage assessments were still to be made in many of the remote towns.

Water and power were lost in several areas hit by Lam, and Marcia knocked out power for at least 50,000 homes in Queensland. Cyclone Marcia wrought widespread property damage along the central Queensland coast, with the insurance



The track followed by Cyclone Marcia
Source: Track: Keith Edkins/Wikimedia

http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=85335



industry declaring the event a catastrophe. Roofs were destroyed and power lines and trees felled in the town of Yeppoon, the only populated area to feel the full force of Marcia at its most powerful. The cyclone weakened to Category-3 by the time it reached the city of Rockhampton, which nevertheless also suffered widespread wind damage, flash flooding and power outages.

Chris van Lint, who lives near Brisbane in Australia, supplied this **Meteor 2M** image showing Cyclone Marcia over Queensland on February 20, 2015. Chris reported that the 210 kph winds did not affect Brisbane very much, but that the heavy rain associated with it was a bit of a worry, recalling for many people the severe flooding caused by Cyclone Oswald back in January 2013. Residents of lower lying areas of the city queued for sandbags to safeguard their properties and some thirty roads were closed due to localised flooding, with more heavy rain expected to continue overnight.

The image also shows most of Tasmania to the south of the mainland and part of New Zealand's South Island in its lower right hand corner. At upper right can be seen New Caledonia, including the two small islands east of Caledonie Nouvelle.

The EUMETCast Changeover

How we achieved it without tears

John Barfoot - sounio@aol.com

Introduction

Several years ago, Dick Barton, Gavin Myers and John Barfoot, collectively known as 'the Weathermen' at the South Downs Planetarium (in Chichester), decided to set up a receiving station for EUMETSAT MSG HRIT transmissions, using David Taylor's **MSG Data Manager**, **GeoSatSignal**, and **MSG Animator**. Prior to that we had been successfully receiving APT transmissions for many years – even winning a GEO competition for best image on a particular day (see GEO Quarterly Number 20, December 2008).

For setting up the original MSG receiver, we were initially helped by David Simmons who was kind enough to speed up our EUMETSAT learning curve. Since then, we have been successfully receiving good data for several years, which has been a great help for some of the Planetarium activities. The receiver system comprised a one-metre dish, an external receiver (*Sky 2PC USB*) and a dedicated desktop, running *Windows XP*. At about the same time, John and Gavin set up similar systems at their respective homes in Ashtead (Surrey) and Aldwick (West Sussex). A slight difference was that the antennas were smaller than that of the Planetarium and the receivers were internally mounted *Technisat SkyStar 2* PCI cards. Good results ensued from all three setups.

Then, out of the blue, came news that, to continue receiving EUMETSAT data, we would need new receivers and we would need to re-align our dishes. This would have to be done before the end of 2014.

The Changeover

As we had several months to consider our options, we decided to adopt a 'wait and see' period, during which time we would learn what the various GEO experts recommended. This view was endorsed by David Simmons via email contact. So with D-Day approaching we were very encouraged to read Mike Stevens' article on page 13 of GEO Quarterly 44, outlining how to use a *TBS-6983 PCIe* card which would fit directly into our *Windows XP* PCs.

Gavin tracked down a suitable supplier, who was happy to supply the cards with a small discount; so, with the necessary software, including drivers and instructions, downloaded from the TBS site (figure 1), the first card was installed in the Planetarium computer in early December. At this time, signals were being transmitted from both the *Eurobird* and the *Eutelsat 10A* satellites and, after a little experimentation, we managed to achieve signal lock with good image reception. It was then decided that the antenna location should be changed to a lower, more sheltered and more mechanically rigid position because directional stability would be more important with *Eutelsat 10A* due to its weaker transmitter power.

Having done this, and with a new *Inverto* single satellite LNB fitted (available from the GEO Shop), it was time to accurately align the dish. This was achieved by pointing

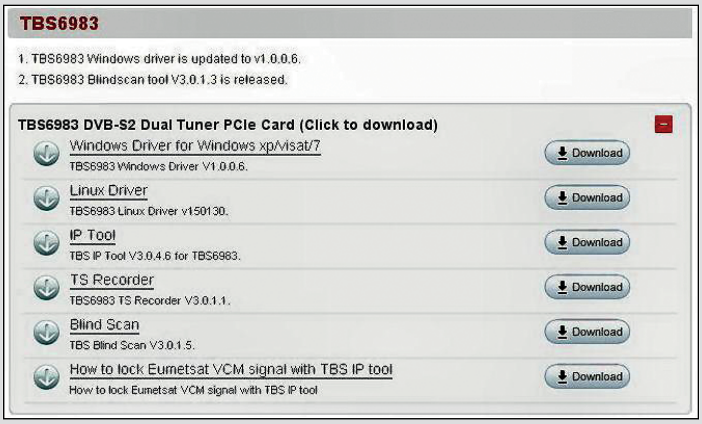


Figure 1 The TBS Download Screen

Gavin's *Canon EOS* camera, which has an in-built router, at the computer screen showing the *TBS Data Services* window (Figure 2) and monitoring the picture via Wi-Fi on a *Nexus 7* tablet at the antenna site. The alignment was very critical and the best achievable SNR was around 12.

Similar exercises, including new LNBs, were successfully carried out at Gavin's home location in Surrey and John's in West Sussex, using an IP camera to monitor the screen (figure 3), so that we are all now successfully receiving EUMETSAT data. Gavin has decided to install a larger dish to improve reception but John has space limitations (figure 4). Nevertheless, he is getting good results with a typical SNR of 7.9.

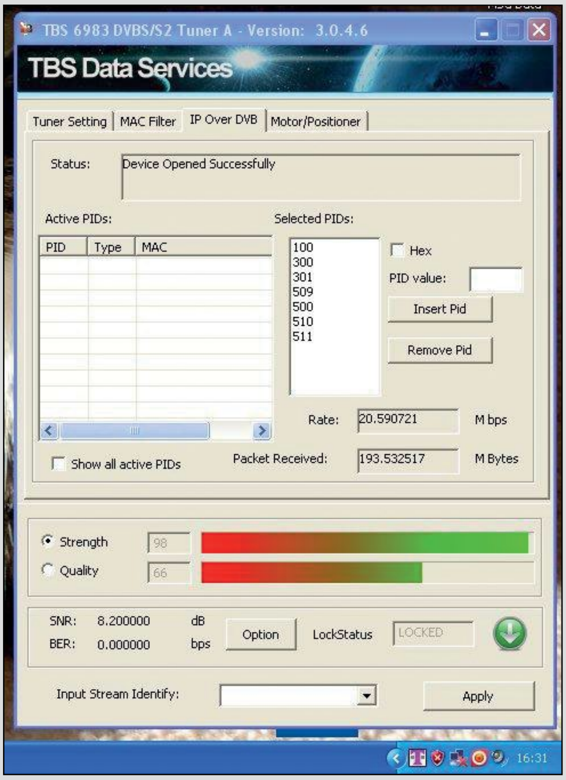


Figure 2 - The TBS Data Services Window

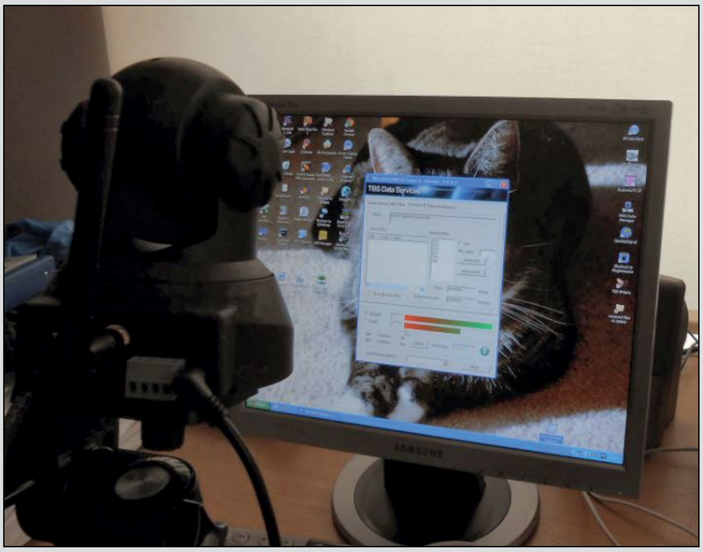


Figure 3 - Using an IP Camera to aid Dish Alignment

Figure 4 - John's Antenna: not the ideal location

During the whole process we had several email 'discussions' with Mike Stevens who was a great help. Consequently, we would like to thank him for his excellent GEO article and his subsequent assistance and advice. Without his work with TBS we would not now have the relatively low-cost solution that we have adopted.

Wrinkles

There are still some minor wrinkles which need to be ironed out—but which are beyond our control. The first is that the TBS Data Services window shows <u>two</u> bar graphs—one for 'Strength' and the other for 'Quality'. However, the 'Strength' bar never falls below 50%, even with the LNB removed from the focus point of the dish. More importantly, the 'Quality' bar vanishes after a time (sometimes hours) and the 'Lock Status' changes to 'Unlocked' (figure 5). The SNR information also vanishes. However, the little pink *Tellicast* 'T' stays pink and reception carries on as per normal (figure 6). The only way back to normality is to restart *Windows*.

Thirdly, the 'BER' (Bit Error Rate) on my computer remains resolutely on zero, whereas with Gavin's machine, it is sometimes zero and sometimes shows numeric values, accompanied by image segment losses—whenever the SNR value is between 9.3 and 9.8. Above or below these numbers, the 'BER' is zero and no segments lost.

Lastly, there are two 'radio' buttons labelled 'Strength' and 'Quality', and it is possible to highlight one or the other,

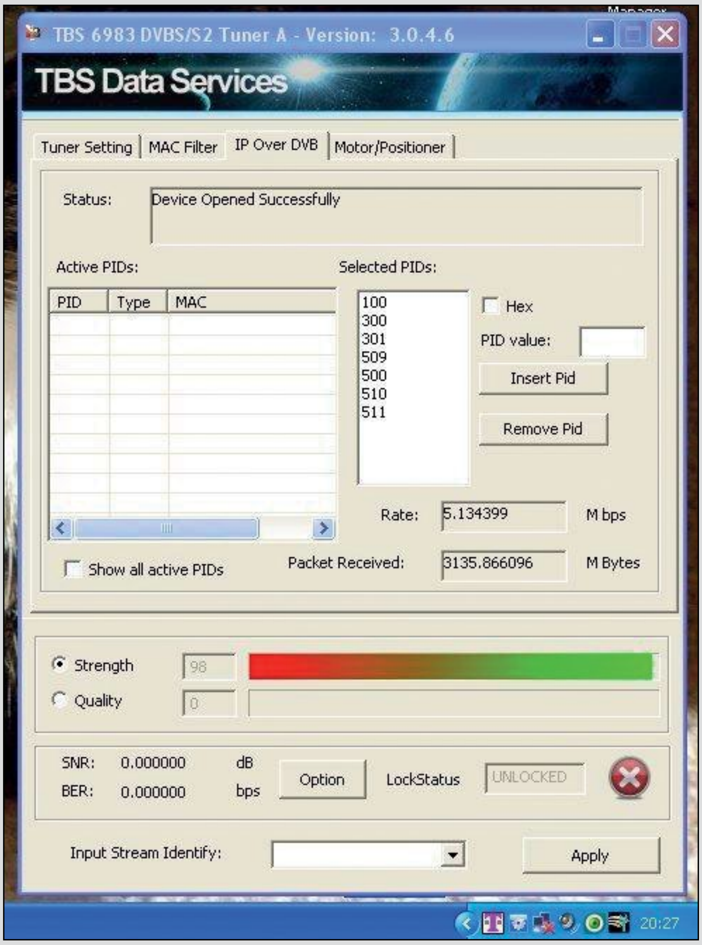


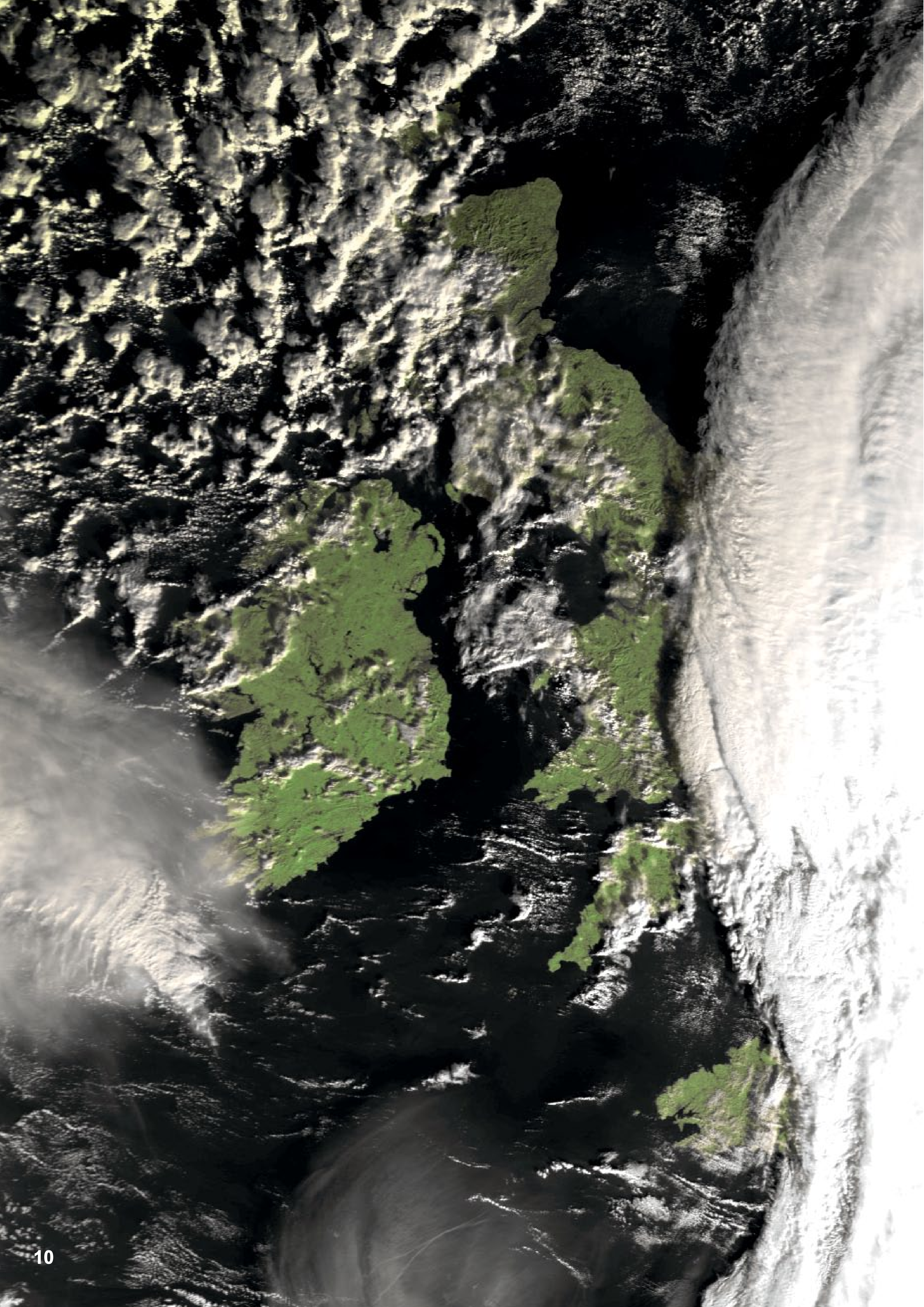
Figure 5 - TBS Window with Missing Quality Bar

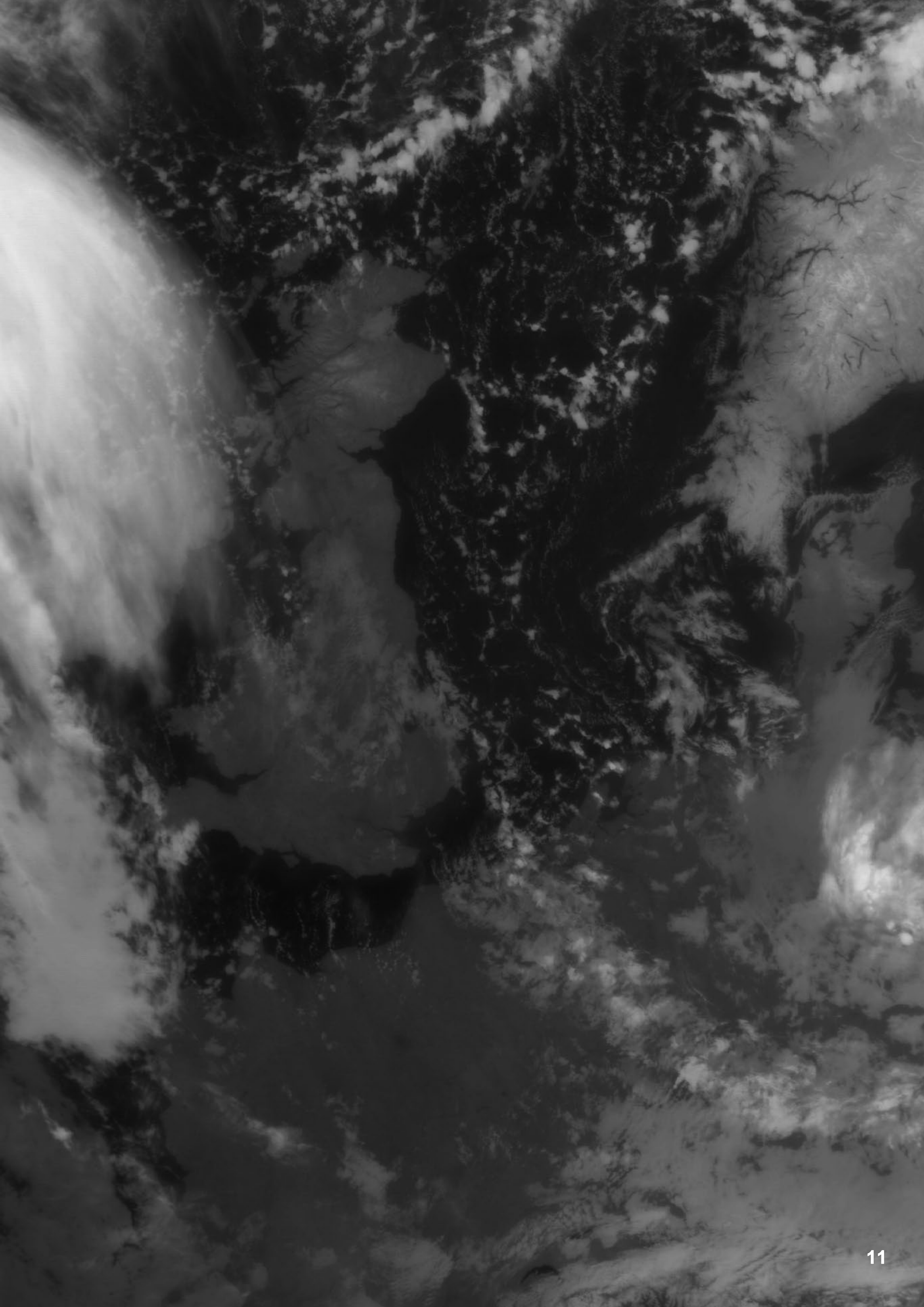
but with no effect on the rest of the display. We cannot see what the function of this choice is.

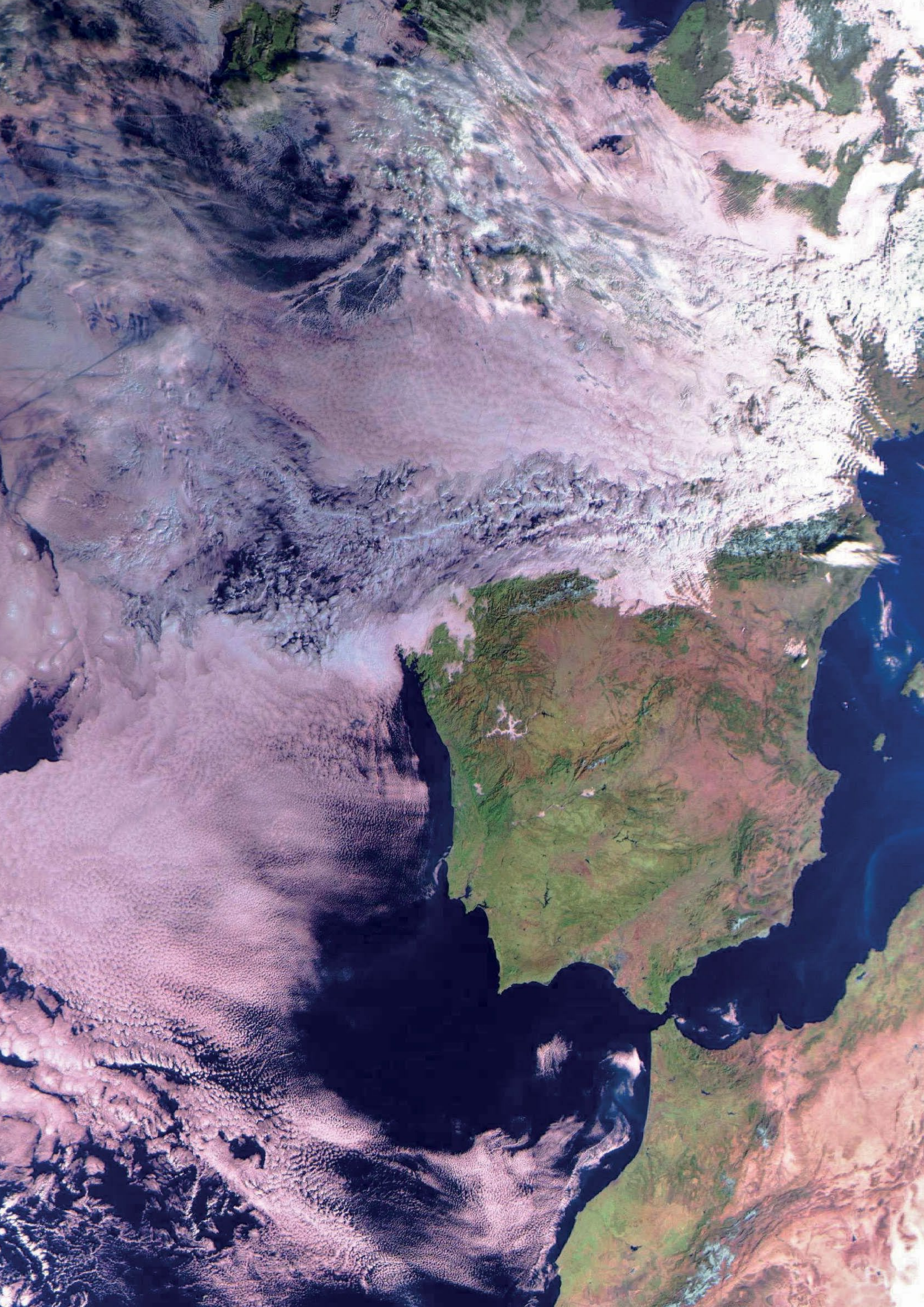
Conclusion

When we first discovered that changes would be needed, we were a little dismayed but, with GEO's help, and Mike Stevens' in particular, it has been a far less daunting task than anticipated. However, we all have the feeling that the system is less robust than before, necessitating larger dishes and possibly more dependent on weather conditions for good reception – particularly heavy rain. Time will tell.

Figure 6 - New location for Planetarium dish







Rocketing into the Northern Lights

NASA Earth Observatory

The interaction between the solar wind's charged plasma and Earth's atmosphere produces auroras. These Northern and Southern Lights have danced across the night sky, mesmerising and inspiring observers for centuries. For scientists, this dance of light leads to many questions regarding how Space Weather affects Earth's atmosphere.

On January 28, 2015, NASA-funded scientists launched a rocket-borne experiment into the Northern Lights to learn more about how they heat the planet's atmosphere. The **Auroral Spatial Structures Probe** (ASSP) was launched from the Poker Flat Research Range about 50 kilometres north of Fairbanks, Alaska. The research team captured time-lapse photos of the Oriole IV sounding rocket and payload amidst the aurora borealis (right).

The ASSP carried seven instruments to study the electromagnetic energy that can heat the thermosphere—the second highest layer of the atmosphere—during auroral events. The interaction of waves and particles from the solar wind, Earth' magnetosphere, and the upper atmosphere can cause 'Joule heating'. Essentially, the electrical currents on the edge of space run into a resistant medium (the air in the atmosphere) and generate heat in a process similar to that of a toaster coil or electric stove. This heating can expand the atmosphere upward and increase the friction, or drag, on spacecraft and satellites.

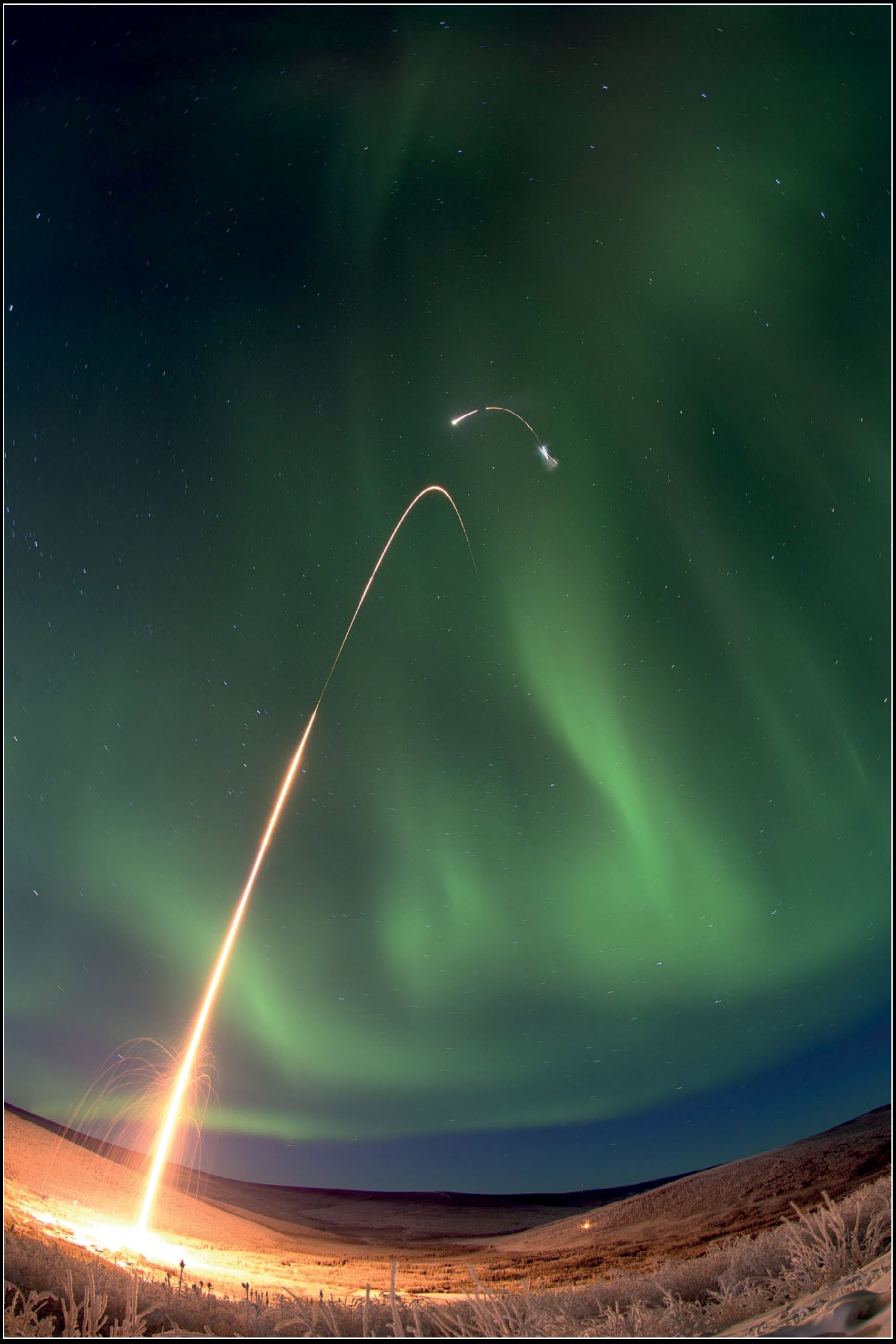
The ASSP launch occurred just two days following the successful launches of the *Mesosphere-Lower Thermosphere Turbulence Experiment* (M-TeX) and the *Mesospheric Inversion-layer Stratified Turbulence* (MIST) experiment. Two pairs of instrumented rockets were launched about 30 minutes apart to study how solar winds and auroras create turbulence in the upper atmosphere and cause particles to diffuse between atmospheric layers. The launches included the release of harmless trimethyl aluminium vapour to help researchers trace diffusion at high altitude.

Recent solar storms have resulted in major changes to the composition of the upper atmosphere above 80 kilometres, enhancing concentrations of nitrogen compounds. Such compounds can be transported into the mid layers of the atmosphere, where they can contribute to ozone destruction. However, meteorological conditions do not always allow such transport to occur, and the impact of solar activity on the Earth is therefore not solely about the Sun as a source of energetic particles, but also how Earth's meteorological conditions determine the fate of these particles in the atmosphere.

There is a video of the ASSP launch at

https://www.youtube.com/watch?v=spcibOOLqEE

The launch of ASSP
Photograph: Lee Wingfield, NASA.



The ASSP launching from Alaska against an auroral background.
Photograph: Jamie Adkins, NASA

The HRPT Data Structure used by
the New Meteor Satellites

Rob Alblas

This article originally appeared in the October 2014 issue of ‘De Kunstmaan’

In 2009, Russia launched a new polar weather satellite, **Meteor-M N1**. Both its frequency band (1700 MHz) and its bit rate (665.4 kb/s) corresponded to the NOAA satellites, so receivers did not need to be adjusted to accept its signals. The data format, though, was completely different (AHRPT), and some time ago I adjusted the HRPT decoder [1] to deal with this. This satellite, incidentally, did not transmit APT.

Recently, Russia launched a modified satellite in its *Meteor 3M* series: **Meteor-M N2**, now more commonly designated **Meteor M2**. In the future, more of these satellites will be launched, a total of six between 2014 and 2021. This satellite transmits the same information as Meteor-M N1 (the only one of its type launched), but in a somewhat different form. Both the decoder and the software—the program *WSAT* [2,3] —had to be adjusted. An important difference between the Meteors on the one hand and NOAAs on the other is the simultaneous transmission by Meteor of the additional near-infrared channel—which is time-shared on the NOAAs. In order to maintain the data rate, this necessitated the reduction of the horizontal resolution from 2048 to 1572 pixels (1540 pixels for the Meteor N1).

The NOAA imaging instrument is the so-called Advanced Very High Resolution Radiometer, or simply AVHRR. Its counterpart aboard the Meteors is called the Multispectral Imaging Scanning Radiometer, or simply MSU-MR. The table below shows how the various spectral channels available correspond very closely between these two instruments.

Spectral sensitivity	Meteor (N1, N2)	NOAA
0.58 - 0.68 µm	x	x
0.725 - 1.00 µm	x	x
1.58 - 1.64 µm	x	a
3.55 - 3.93 µm	x	b
10.30 - 11.30 µm	x	x
11.50 - 12.50 µm	x	x

Table 1 – Channels on Meteor and NOAA
(For NOAA channel 3, either a or b is transmitted)

The first three of the Meteor channels, which are in—or close to—the visible region of the spectrum, correspond to those of the MSG geostationary satellites. Assigning these channels to blue, green and red respectively allows you to easily create beautiful false colour images.

The Meteor Data Structure

The structure of the NOAA data is entirely based on 10 bits per word. All bits relating to a complete line stand in a frame, preceded by a synchronisation word. That word is recognised by the decoder as signifying the detection of a new line of data. It is then just a question of counting to determine which bit belongs to which channel and x-position. A NOAA frame (which is no more than a set of bits), contains 110 900 bits, of which 2048 × 5 × 10 = 102 400 bits are allocated to the AVHRR channels. The rest are calibration data, including 60 bits for the sync word, etc.

In Meteor, the data structure is quite different, and is based on 8-bit words (i.e., bytes in this case), with a frame length of only 256 bytes (Meteor-N1) or 1024 bytes (Meteor-N2). This means that several frames are needed for a complete line of data. The number of bits per image pixel for Meteor is, however, also 10, which means that a special scheme must be used to transmit 10 bits using bytes. Table 2 shows the differences between the NOAA and Meteor satellites.

	NOAA	Meteor-M N1	Meteor-M N2
Bits per frame	110 900	256	1024
Frames per line	1	50	12.5
Sync word (hex)	284 16F 35C 19D 20F 095	1A CF FC 1D	1A CF FC 1D
X-resolution	2048	1540	1572

Table 2 – Characteristics of NOAA satellites and the two Meteors
(Meteor N2 has a slightly higher resolution compared with Meteor N1)

The Meteor M N1 Data Structure

The structure of the N1 data, for one line (with 6 channels) looks like this:

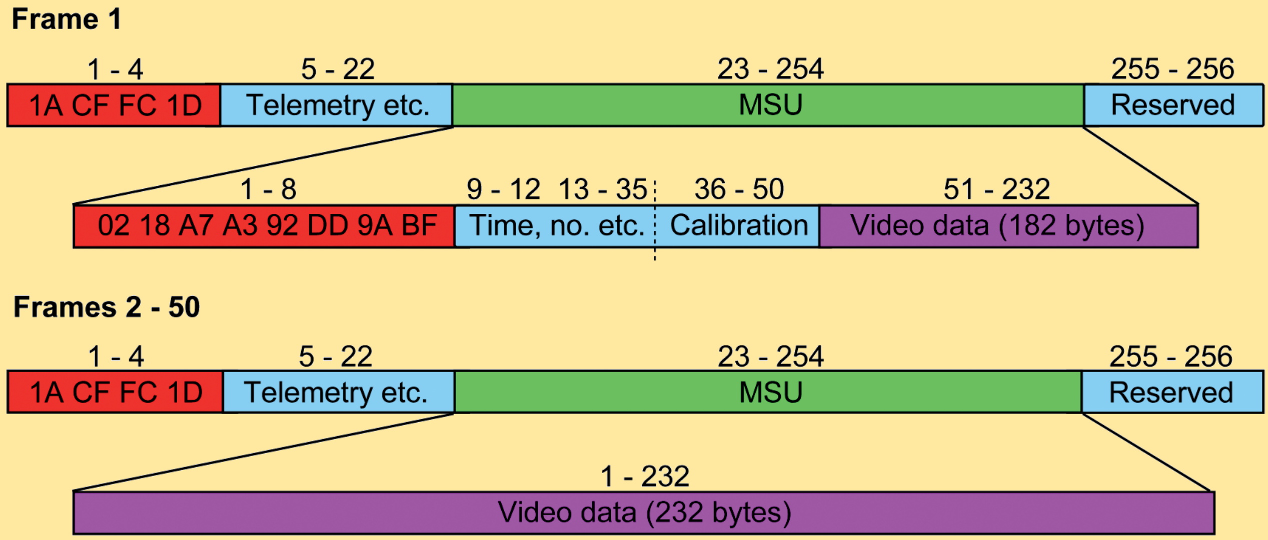


Figure 1 – The Data Structure for Meteor-M N1

The data is divided into 50 frames. The synchronisation word 1A 1D FC CF is used by the decoder in order to recognise the AHRPT-N1 frames. Since there are 50 frames, the first frame of each line must be identified. Hence, the second 8-byte synchronisation word, that is only present in the frame that contains the first MSU. Recognition of this 2nd synchronisation word is handled by the software.

Because of this synchronisation word, as well as the calibration data, there is, in this frame is less room for the “video data”: only 182 bytes in the first frame compared with 232 bytes in frames 2-50. Altogether, that gives 182 + 49 x 232 = 11550 bytes. For each channel, 11550 / 6 = 1925 bytes, and since each pixel requires 10 bits, there is room for 8 x 1925 / 10 = 1540 pixels, which is exactly equal to the horizontal resolution of the images.

To accommodate the 10-bit data in bytes, the following schedule is adopted:

Byte No	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
1	ch1[9]	ch1[8]	ch1[7]	ch1[6]	ch1[5]	ch1[4]	ch1[3]	ch1[2]
2	ch1[1]	ch1[0]	ch1[9]	ch1[8]	ch1[7]	ch1[6]	ch1[5]	ch1[4]
3	ch1[3]	ch1[2]	ch1[1]	ch1[0]	ch1[9]	ch1[8]	ch1[7]	ch1[6]
4	ch1[5]	ch1[4]	ch1[3]	ch1[2]	ch1[1]	ch1[0]	ch1[9]	ch1[8]
5	ch1[7]	ch1[6]	ch1[5]	ch1[4]	ch1[3]	ch1[2]	ch1[1]	ch1[0]

Table 3 – How a set of 4 pixels from channel-1 are stored in 5 bytes

The ten bits each from pixels 1- 4 of channel-1 are stored in 5 bytes. The same four pixels from channel-2 are similarly stored in the next 5 bytes, and so on for channels 3, 4, 5 and 6. After these 30 bytes have been allocated, it starts all over again for pixels 5-8. After 385 of these 30-byte sets, all the channels have been allocated.

Note that the number of bytes in a video frame (182 or 232) is not divisible by 30. This means that a frame does not contain an integer number of such sets.

In summary, reception of the serial bit-stream is as follows:

- The decoder receives the serial bit stream and searches for the 32-bit sync word. With this, both the beginning of a frame and the byte boundaries in the bitstream are known. This is transferred via USB to the PC.
- The data is put in a file, beginning with the start of a frame (this is therefore in general not the first frame of a line).
- Software searches the file for the first frame with the 64-bit 2nd sync word.

Then it’s a matter of counting, to fish out the desired data.

The Meteor M N2 Data Structure

As mentioned, Meteor-M N1 was one of a kind. Subsequently, in Meteor-M N2, the data format has changed although the basic information is virtually identical. The frame length has been increased from 256 to 1024 bytes; so, for one line, four times fewer frames are required (50 / 4 = 12.5). With Meteor M N1, it was necessary for one line to contain an integer number of frames, but with Meteor-M N2, there are frames which contain data for two successive lines (note the fraction 12.5).

I do not know the reason for this change between Meteors N1 and N2. The efficiency is higher because of it, allowing the X resolution to be increased slightly from 1540 to 1572 pixels per line, but hardly worth it in my opinion as the increase is a mere 2%.

Each main frame of 1024 bytes contains a sync word, telemetry data and MSU blocks, containing the picture-data of part of a line:

Figure 2

The MSU blocks need to be extracted and then, together with MSU blocks of other frames, combined again into a new byte-stream.

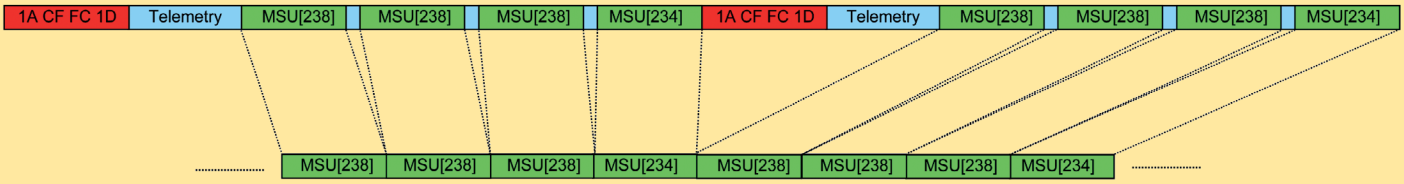


Figure 3

This new set of bytes is a framed structure in itself, with it's own 8 bytes MSU synchronisation word. Note that we have now completely left the 1024-frame world. Also, the MSU boundaries, although still drawn, are not important anymore; we have just created another "endless" stream of bytes.

The MSU frames have a length of 11850 bytes. Each frame contains the MSU sync word, calibration data and the actual pixel data, as illustrated in figure 4.

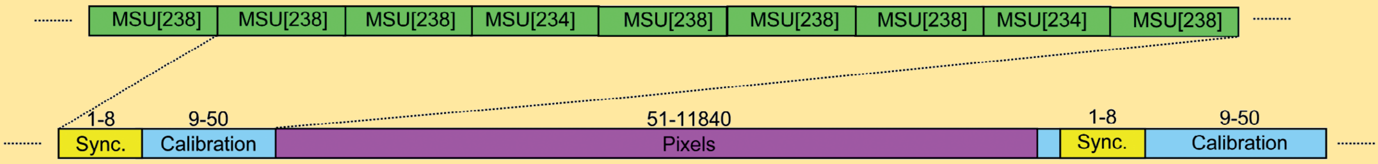


Figure 4

The coding of the 10-bits pixels into bytes is exactly the same as with Meteor-M-N1 satellite. With this information it's just a matter of byte-counting to extract and separate the 6 channels, and translate them into a standard picture format.

Required Hardware and Software.

To receive and process the Meteor-data a new decoder and software is needed. On my web-site you can find information how to build such a decoder; it can handle NOAA and both Meteor types (although Meteor-N1 isn't active anymore).

The decoder connects to a PC via USB.

On my web-site you can also find software (both for Windows and Linux) to capture the received data, for all mentioned satellites. Some processing is possible, e.g. make false colour pictures, and export to a standad picture format like pgm/ppm. The raw data is saved in a separate file, and can be processed by other programs like HRTReader.

Literature

The data structure of Meteor-N1 and N2 is described on the following websites:

- http://planet.iitp.ru/english/spacecraft/meteor_m_n1_structure_eng.htm
- http://planet.iitp.ru/english/spacecraft/meteor_m_n2_structure_eng.htm

Hardware and software

1. New generation decoder for HRPT and derived formats
http://www.alblas.demon.nl/wsat/hardware/hardware2.html

2. WSAT for Windows
http://www.alblas.demon.nl/wsat/software/soft_win.html

3. WSAT for Linux
http://www.alblas.demon.nl/wsat/software/soft_linux.html

Figure 5
Photo of the Meteor-M2 spacecraft during integration
Image: Roskosmos

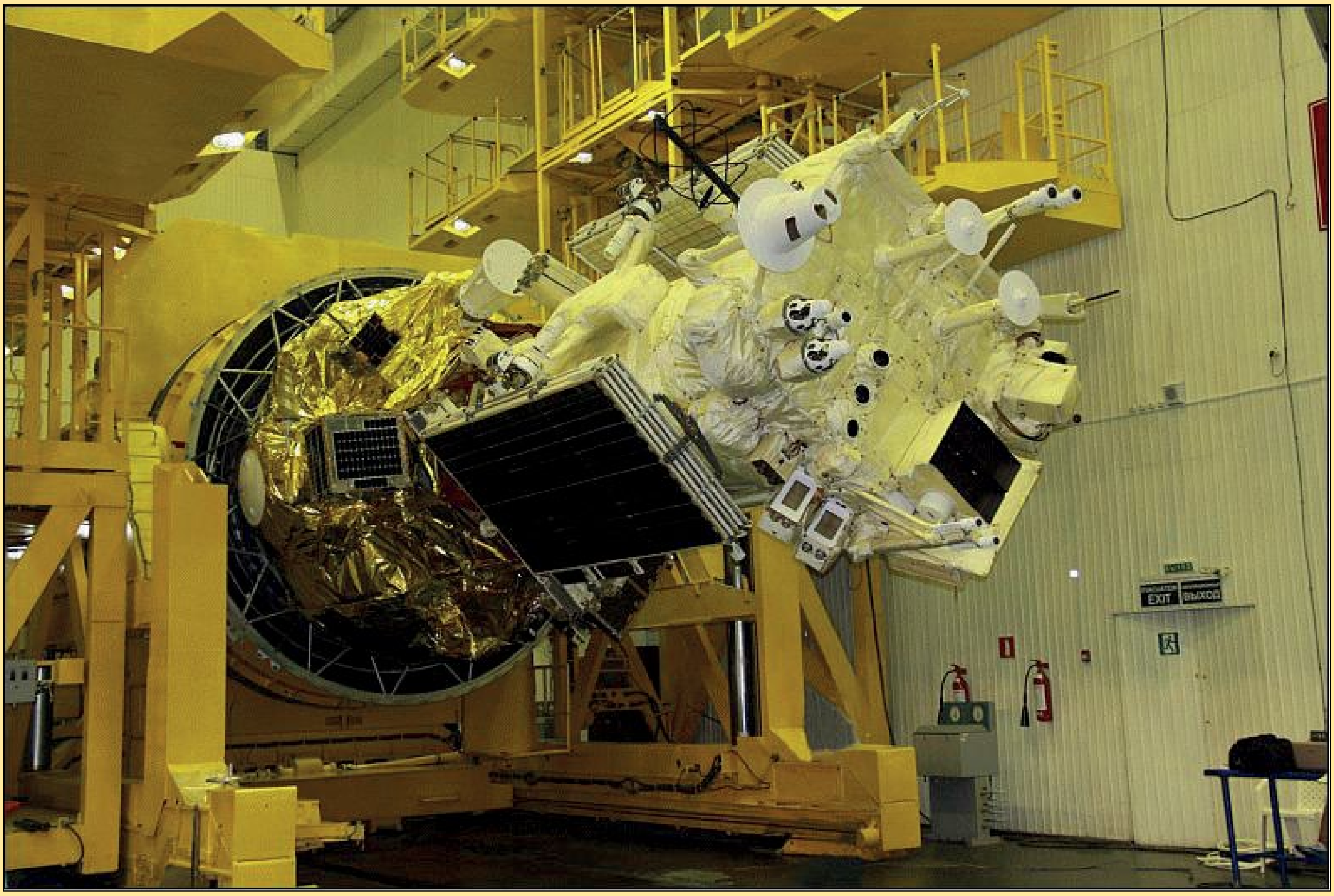


Figure 6
The fully assembled payload section of the Soyuz-2.1b/Fregat launch vehicle, including Meteor-M2 and secondary payloads
Image © Roskosmos, Anatoly Zak

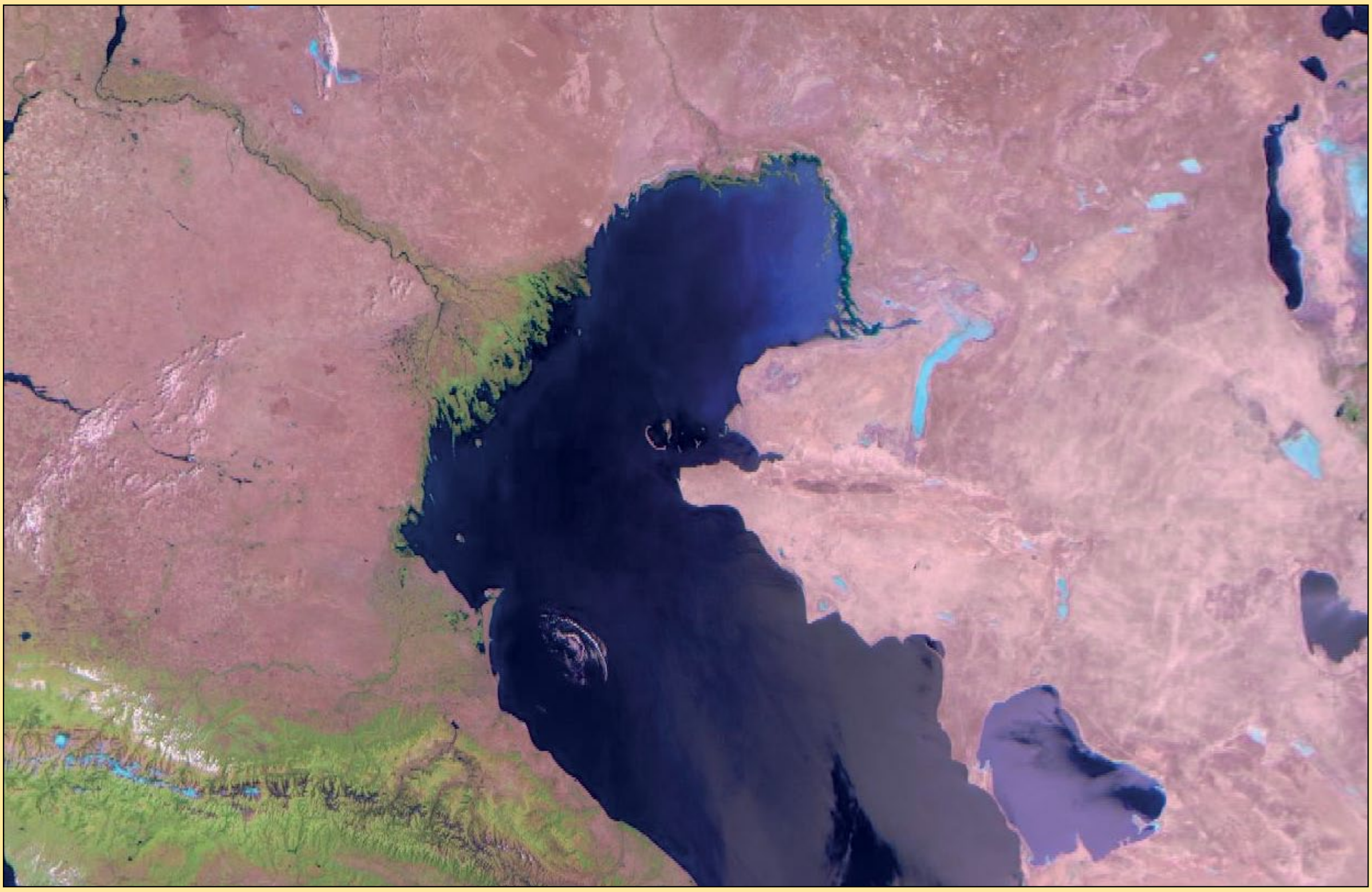
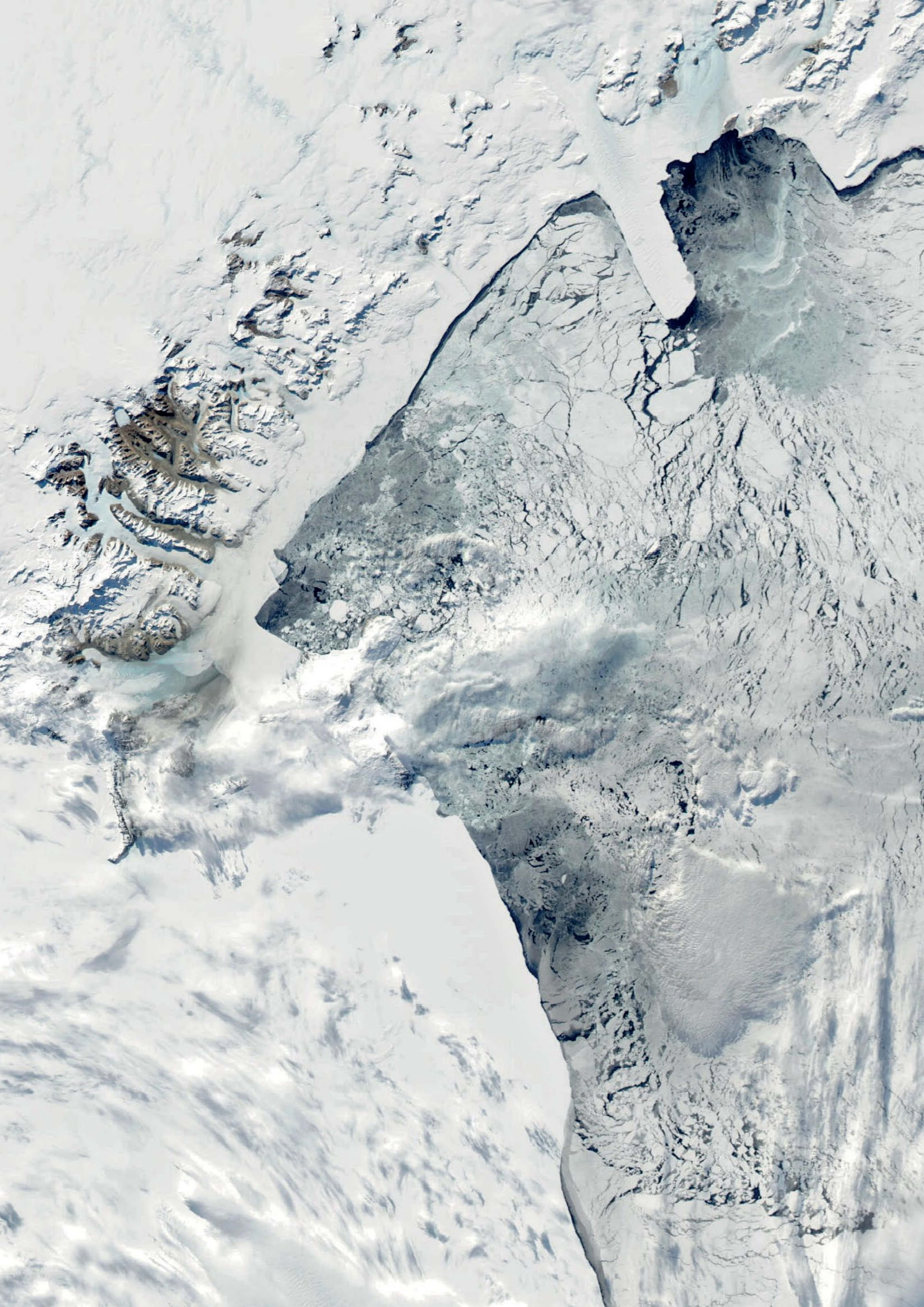


Figure 7
This image showing the Volga delta and the northern Caspian Sea on August 17, 2014 was processed by the author using WSAT
Raw Meteor-M N2 HRPT data provided by Martin Blaho



GULF OF ALASKA DUST EVENT

A NASA Earth Observatory Report

When glaciers grind against underlying bedrock they produce a silty powder with grains finer than sand. Geologists call it *glacial flour* or *rock flour*. This iron- and feldspar-rich substance often finds its way into rivers and lakes, colouring the water brown, grey, or aqua, and when water levels are low, this flour can dry out on riverbanks and deltas, becoming dust that the winds can loft into the air.

That's what was happening on October 28, 2014, when the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's *Aqua* satellite captured this image of northerly winds blowing dust from the Copper River Delta over the Gulf of Alaska. Dust events are most common in this area in the autumn, when river and lake levels in south central Alaska are at their lowest.

This was the first dust event in the Copper River Valley to be detected by MODIS sensors during 2014, south central Alaska having seen comparatively few such events because it had been wetter than usual, with river and lake levels remaining high. But despite the conditions, a high-pressure system over central Alaska generated katabatic winds strong enough to dry out the riverbanks and lift an impressive amount of dust. Indeed, the storm picked up so much material that, when the dust plume reached Middleton Island, surface visibility dropped as low as 8 kilometres.

Though the extent of the plume was notable when MODIS passed over, the event was relatively short-lived in comparison with others that have occurred in this area in recent years. A two-week dust event in 2006, for instance, produced dense plumes that deposited between 60 and 160 kilotons of dust into the Gulf of Alaska—about the same amount normally transported by eddies in its surface waters.

NASA image courtesy Jeff Schmaltz, LANCE MODIS Rapid Response Team at NASA GSFC. Caption by Adam Voiland.

Seasonal Changes in the Antarctic

Les Hamilton

While browsing near real time images on NASA's LANCE/MODIS website [1] last November, I was intrigued to observe a hitherto unsuspected glacier tongue stretching into McMurdo Sound from the Victoria Land coast of Antarctica (figure 1). A little research revealed that this is the tongue of Mackay Glacier, which descends eastward from the Antarctic polar plateau into the southern part of Granite Harbour. It was discovered by the South Magnetic Pole party of the 1907-09 British Antarctic Expedition, and named after party member Alistair Mackay. Granite Harbour was named in 1902 by the British National Antarctic Expedition aboard the *Discovery*, while searching for safe winter quarters for the ship.

The images below, both acquired by NASA's **Terra** satellite, show the same scene as it was last November, with McMurdo Sound still within the embrace of ice, and in February 2014, at the height of summer with the sound largely ice free.

Reference

1 LANCE/MODIS Near Real Time Imagery
http://lance-modis.eosdis.nasa.gov/cgi-bin/imagery/realtime.cgi

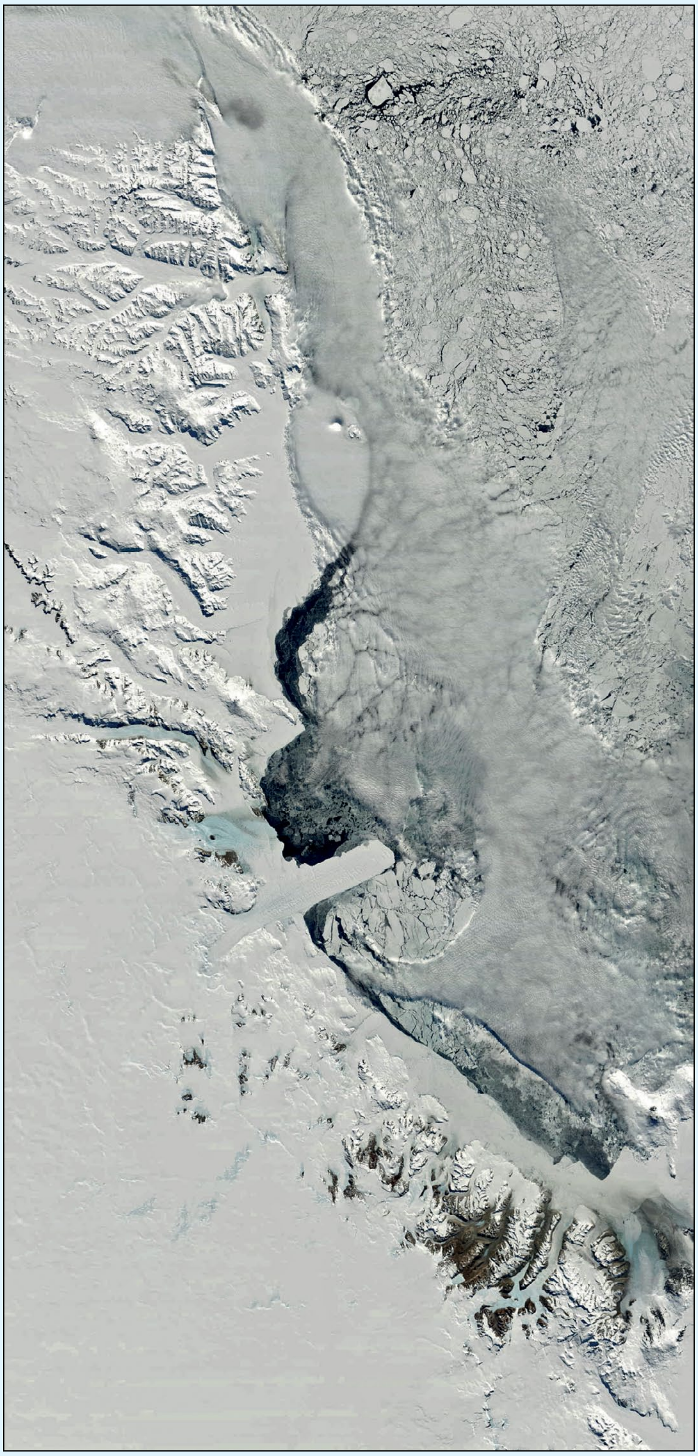


Figure 1
A *Terra* MODIS image from November 15, 2014, showing the Dry Valleys, Granite Harbour and the Mackay Glacier Tongue, in early summer.

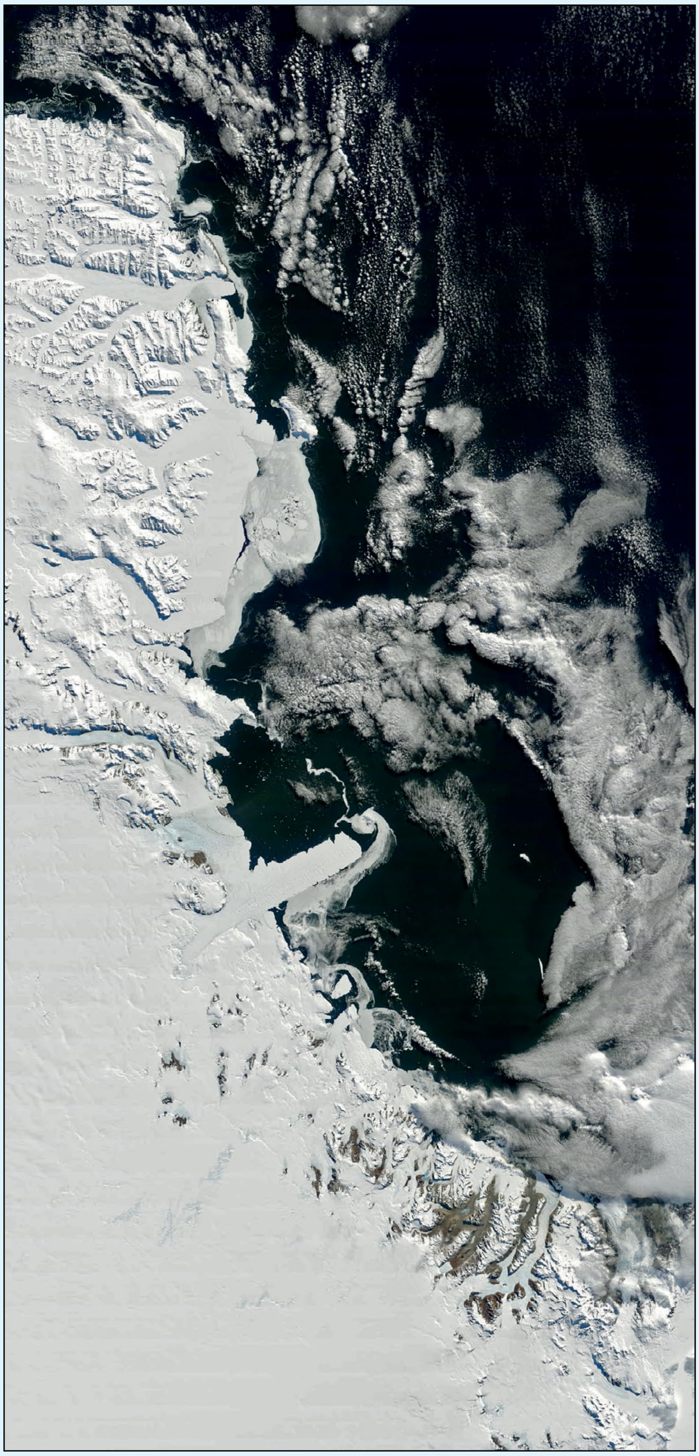
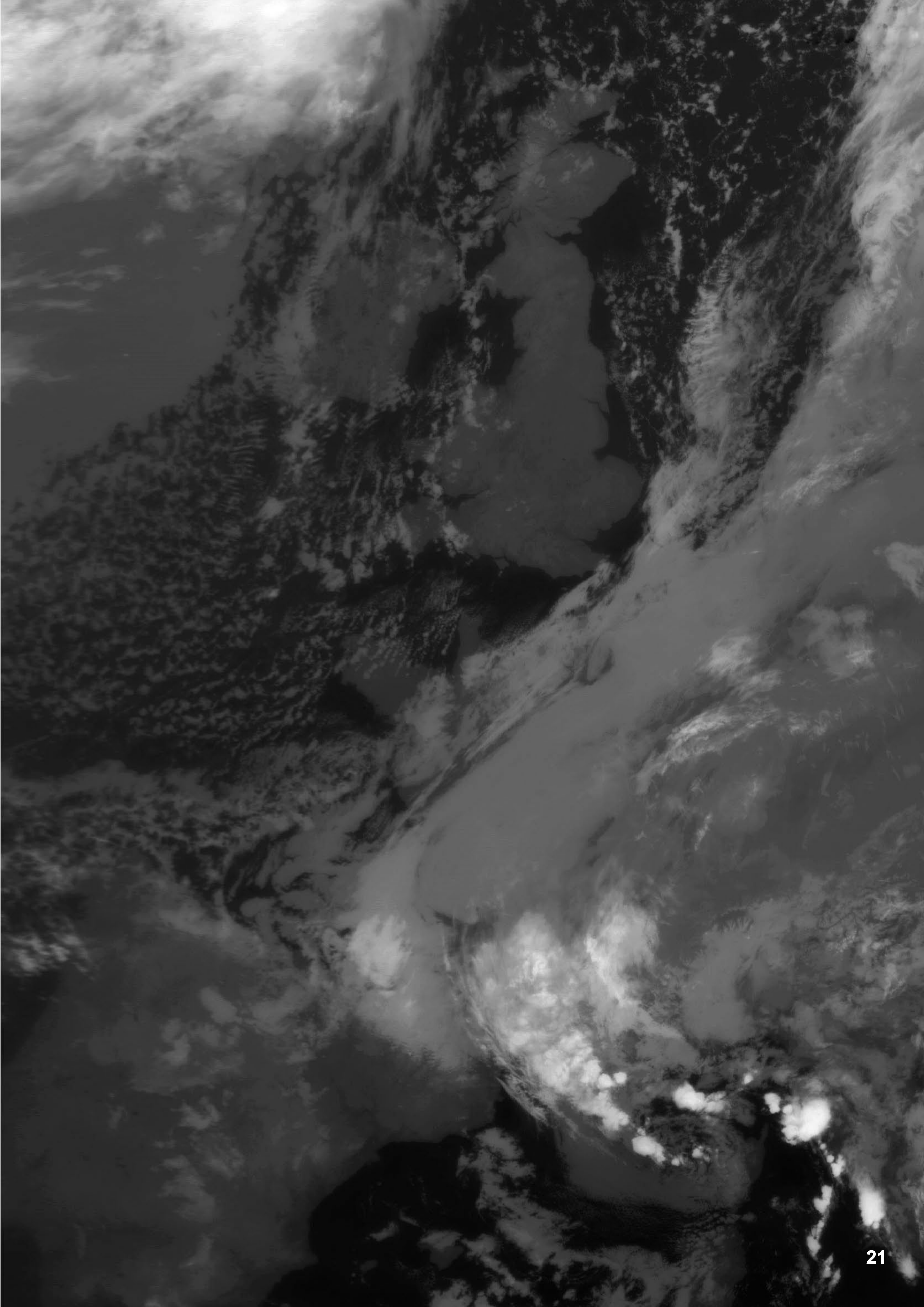


Figure 2
A *Terra* MODIS image from February 1, 2014, showing the Dry Valleys, Granite Harbour and the Mackay Glacier Tongue at the height of the Austral summer.



Lake Effect Snow Swamps Upstate New York

A NASA Earth Observatory Report

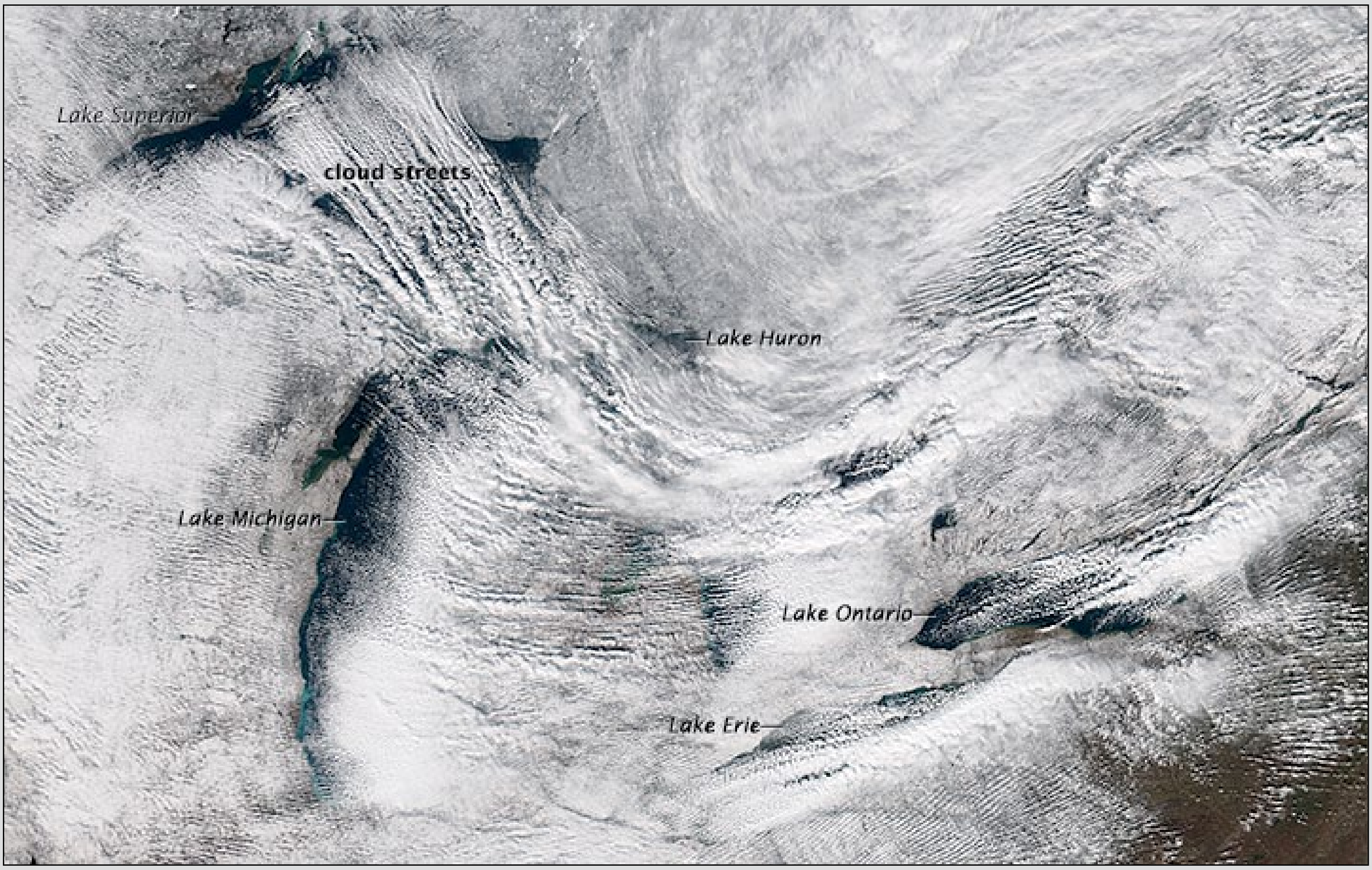


Figure 1 - A Suomi NP image of Lake Effect Snow east of the Great Lakes

On November 5, 2014, spiral-shaped Super Typhoon Nuri lost its eye and began to morph into a comma-shaped extra-tropical cyclone as it approached the cool waters of the Bering Sea. After undergoing a rapid strengthening process that meteorologists call *bombogenesis*, what emerged was one of the most intense extra-tropical cyclones ever recorded in the North Pacific, a storm with a minimum central pressure that plunged to 924 millibars, close to the all-time record of 913 millibars.

Two weeks later, the downstream effects of the so-called *Bering Sea Superstorm* lingered on in the form of a massive lake effect snowstorm that dropped several feet of snow in communities just east of Lake Erie. While the *Bering Sea Superstorm* did not directly cause the snow event in New York, it did set the stage for it by nudging the jet stream into an unusual shape that sent a pulse of cool Arctic air south over the central United States.

As that dry, cool air rushed over the Great Lakes, it picked up moisture from their comparatively warm waters, creating long cloud lines known as **cloud streets**. The Visible Infrared Imaging Radiometer Suite (VIIRS) aboard the *Suomi* satellite captured a natural colour view of these cloud streets moving southeast across Lake Superior and east across the other lakes on November 18, 2014 (figure 1).

When such clouds reach the edges of the lakes, they cool as the land surface forces them upwards, making it harder for them to retain their moisture: so they drop it as snow. In this case, the west-southwesterly winds lined up perfectly with the long axis of Lake Erie, allowing the air to pick up an extraordinarily large quantity of moisture. According to the National Weather Service, more than 152 centimetres of snow had fallen by November 18 with yet more was forecast to fall.

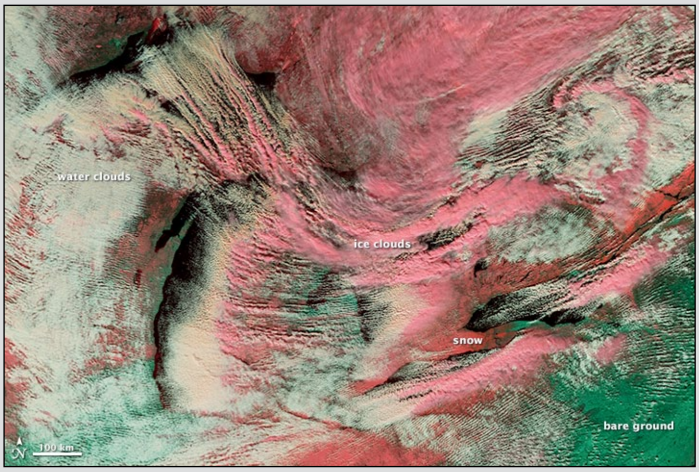


Figure 2 - A false colour image enhances the effect of the snow

Captured at the same moment as the natural colour image, a false colour image (figure 2) was created by assigning blue light to show up as red, and two shortwave infrared bands to show as green and blue. This band combination is useful for distinguishing between snow on the ground (dark pink), ice clouds (light pink), and water clouds (white). Bare ground is green.

NASA Earth Observatory images by Jesse Allen and Adam Voiland, using VIIRS data from the Suomi National Polar-orbiting Partnership.

Bárðarbunga

Les Hamilton

Sitting astride the mid-Atlantic ridge, Iceland, the *Land of Fire and Ice*, has long been famed for its active volcanoes, many with scarcely pronounceable names. Readers may recall the subglacial eruption beneath the **Vatnajökull** icecap in October 1996, which created a glacial outflow flood—a virtual tsunami carrying chunks of ice weighing hundreds of tonnes—which destroyed the Gigjukvisl Bridge and severed Iceland's Ring Road. More recently, the April 2010 eruptions of **Eyjafjallajökull** were notable for the disruption they caused to air traffic across Europe, when some twenty nations closed their airspace for several days as a precaution.

The latest event, located in and around the northwest of Vatnajökull icecap, is centred on the **Bardarbunga** subglacial stratovolcano and the adjacent, ancient **Holuhraun** lava field, and has developed into the biggest continuous outbreak of volcanic activity experienced on Iceland for centuries.

Bardarbunga (2009 metres), Iceland's second highest mountain, lies buried beneath some 850 metres of ice near the northern edge of Vatnajökull icecap in the Vatnajökull National Park: its caldera, ten kilometres wide and 700 metres deep, is totally obscured by the ice. But the volcano itself is just one element of a 5000 square kilometre volcanic system which includes a fissure swarm 25 km wide and almost 200 km long that extends into the Holuhraun lava field to the volcano's northeast.

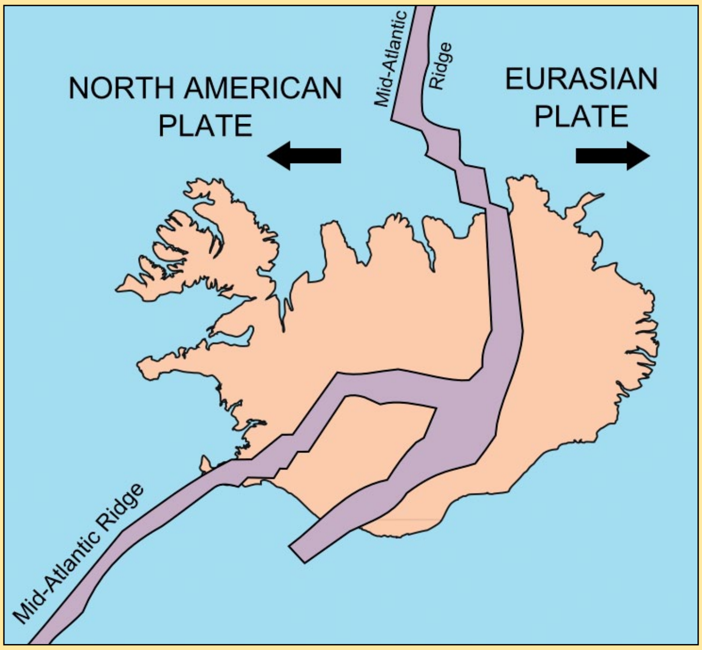


Figure 1 - The mid-Atlantic Ridge passes through Iceland
Image: USGS

This entire region has lain dormant for some considerable time. The Holuhraun lavas were laid down as long ago as 1797, and though the remote and little-known Bardarbunga has erupted frequently during historical times, its last recorded eruption was over a century ago, in 1910. But during recent years the region has been experiencing intermittent earthquake activity, and since 2007 seismicity around Bardarbunga and the fissure swarm to its north had been gradually increasing. Following a rash of around 1600 nearly continuous earthquakes, starting in the early morning of August 16, 2014, the activity became so intense that a seismometer (loaned by the University of Cambridge) was rushed to Dyngjujökull by Icelandic Coast Guard helicopter to monitor events, and installed the very next day. By August 18, more than 2,500 earthquakes had been detected in the region, most at depths between five and ten kilometres, although there was still no evidence of actual volcanic activity. Three days later seismic events showed no sign of decreasing and earthquake measurements indicated that the magma was still between 5-10 km deep, but deformation and GPS measurements revealed that a 25 km long intrusion dyke was forming below Dyngjujökull. Over the ensuing days, several earthquakes between 4.5 and 5.0 MMS (Moment Magnitude Scale) were recorded under the Bardarbunga caldera, and by August 23 the frequency of earthquakes caused by propagation of the dyke had become so high that it was almost impossible to quantify them accurately.

Figure 2
This Image of Iceland acquired by NOAA-19 on June 1, 2012 clearly shows the vast Vatnajökull icecap, with the locations of Bardarbunga and the Holuhraun lava field marked.

As August drew to a close, the final few days of the month were characterised by intense seismic activity, well over a thousand quakes being recorded most days, some of them with a magnitude significantly greater than five. By now, the dyke intrusion beneath Dyngjujökull was believed to be 40 kilometres long, although there was still no evidence that lava had reached the surface.

Just a few minutes after midnight on August 29, the first brief phase of the eruption began when a small quantity of lava emerged from an old volcanic fissure on the Holuhraun lava field about five kilometres north of the Dyngjujökull ice margin. Finally, just after 4 am on the final day of the month, the eruption began in earnest from the same fissure, estimated from web-camera sightings to be around 1.5 kilometres long. By 7 am the lava—accompanied by gas and steam emissions rising several hundred metres above the fissure—was emerging continuously in a steady flow about a kilometre wide, and already stretching three kilometres towards the northeast. Meanwhile, magnitude 5.0 earthquakes continued to be recorded in the Bardarbunga caldera.

It was fortunate indeed that the eruption did not emerge explosively via Bardabunga's caldera, but instead progressed as a lateral intrusion from near the volcano's main chamber towards the Holuhraun field. Had it done so, the results could have been catastrophic, causing major flooding which would impact on the lives of farmers living downhill from the volcano, as well as Iceland's profitable tourism ventures in Vatnajökull National Park. As in the 1996 eruption, there would be a high possibility that communications across the south of Iceland would be severed, forcing long detours all the way around the island to reach this area.

Because of cloud, no satellite imagery of the eruption was available till September 1, when the *Advanced Land Imager* (ALI) on NASA's Earth *Observing-1* (EO-1) satellite captured the first high-resolution view of the scene (figure 3). The image is a composite of a natural-colour observation from August 27 overlain with an overnight infrared view from September 1. The night view combines shortwave IR, near IR, and red wavelengths (bands 9-7-5) to tease out the hottest areas within the vent and lava field. The image shows a fissure at least a kilometre long, with lava flowing to the northeast.

NASA's *Terra* satellite captured a daytime image of the Vatnajökull icecap on September 5, which shows a great plume of steam and gases rising from the Holuhraun fissure (figure 4). The following day, *Landsat-8* captured an image of the fissure and gas plume in much greater detail (figure 6). This false-colour image, combining shortwave infrared, near infrared, and green light (OLI bands 6-5-3), shows fresh lava as bright orange and red, ice and the plume of steam and sulphur dioxide as cyan and bright blue, liquid water as navy blue, and bare or rocky ground around the lava field in shades of green or brown.

And to prove that evidence of the Bardarbunga eruption does not require high resolution satellite imagery, Peter Kooistra provided a December 1 LRPT *Meteor-M2* infrared image of Iceland, where the thermal signature of the event shows clearly as a black dot (figure 5).

A high level of seismicity continued for the remainder of 2014 as new eruptive fissures opened, releasing rivers of lava, spewing impressive lava fountains high in the air, and releasing columns of steam and gases up to three kilometres into the atmosphere. By the close of September, the eruption had already spewed out more sulphur dioxide than any other Icelandic volcano

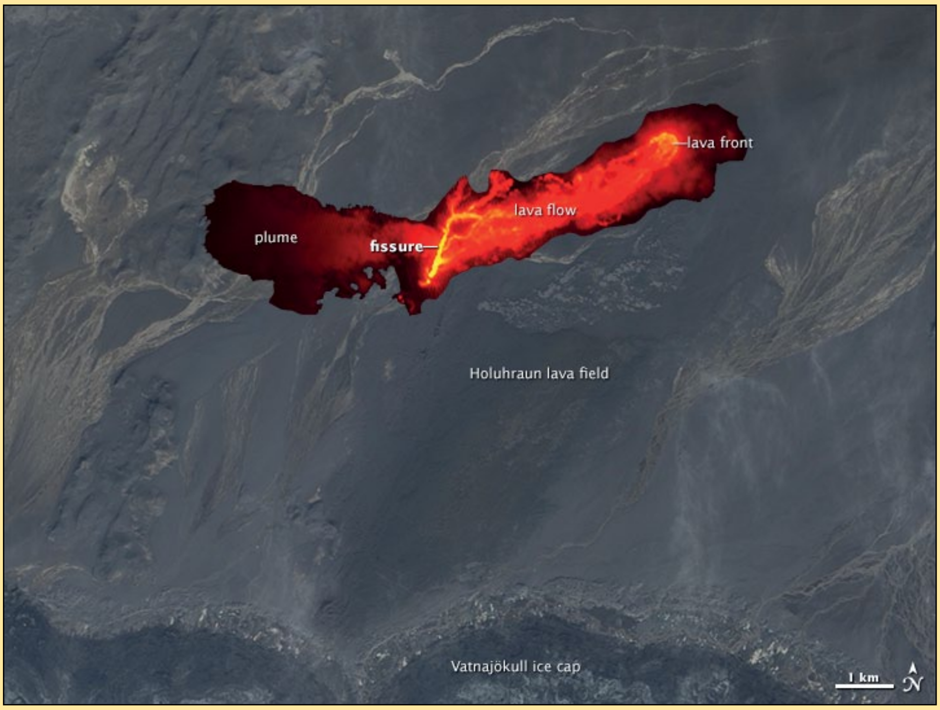


Figure 3 - This Earth Observing-1/ALI composite image, created by overlaying an infrared night view from September 1 over a natural-colour visible image dating from August 27, clearly shows the active fissure and its associated lava stream.

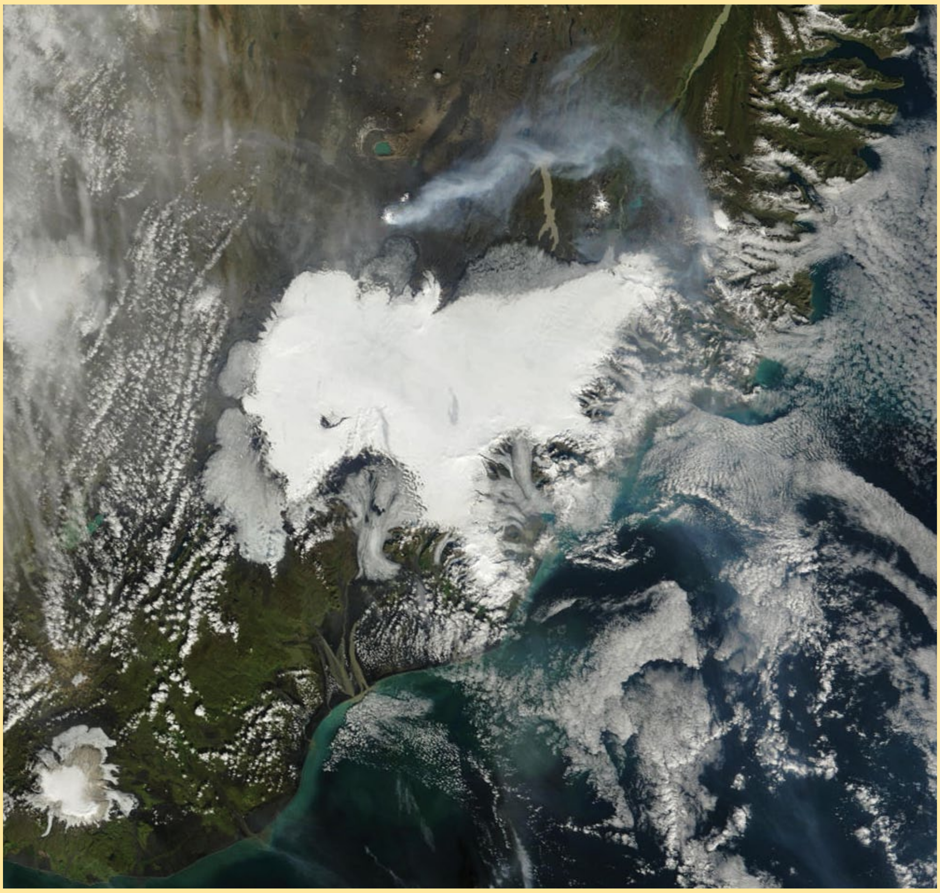


Figure 4 - NASA's Terra satellite acquired this image of the Vatnajökull icecap, with the eruption plume clearly visible to its north, on September 5, 2014.

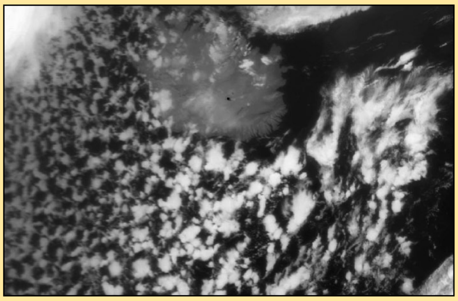


Figure 5
Peter Kooistra from Gouda in the Netherlands captured the thermal signature of Bardarbunga (black dot) in this evening Meteor-M2 infrared image from December 1, 2014.

during recent centuries. These gas emissions contained life-threateningly high concentrations of sulphur dioxide, necessitating the use of gas masks and gas meters by observers.

By November 9, the eruption had spread molten rock across 70 square kilometres and shaken the ground with more than 700 earthquakes measuring magnitude 3.0 or stronger, of which at least 60 exceeded magnitude 5.0. While emissions of ash were relatively modest, researchers from the University of Iceland and the Icelandic Met Office estimated that between 40,000 and 60,000 tonnes of sulphur dioxide (SO_2) were being released from the fissure <u>every day</u>—twice as much as the whole of industrialised Europe emits in a year. The emission gases also contained lesser quantities of carbon monoxide (CO), carbon dioxide (CO_2), hydrogen chloride (HCl) and hydrogen fluoride (HF), as well as copious quantities of steam (H_2O).

High though these quantities are, they pale into relative insignificance when compared with the 8-month long gas-rich eruption of the Laki fissure in 1783-4 which, in addition to outpouring some 14 km^3 of basalt lavas, is estimated to have released at least ten times the mass of sulphur dioxide as Bardarbunga per day. Laki's clouds of poisonous gases killed over 50% of Iceland's livestock, leading to a famine that caused the deaths of approximately quarter of the country's human population.

As yet, the Bardarbunga event comes nowhere close to creating such a degree of devastation, but it is, of course, still erupting. As of the end of 2014 the eruption was showing no signs of abating, the total mass of lava erupted at that time covering an area of 83 km^2 to an average depth of 14 metres, a total volume of 1.1 km^3.

A thermal image of the Holuhraun eruption site, produced by the

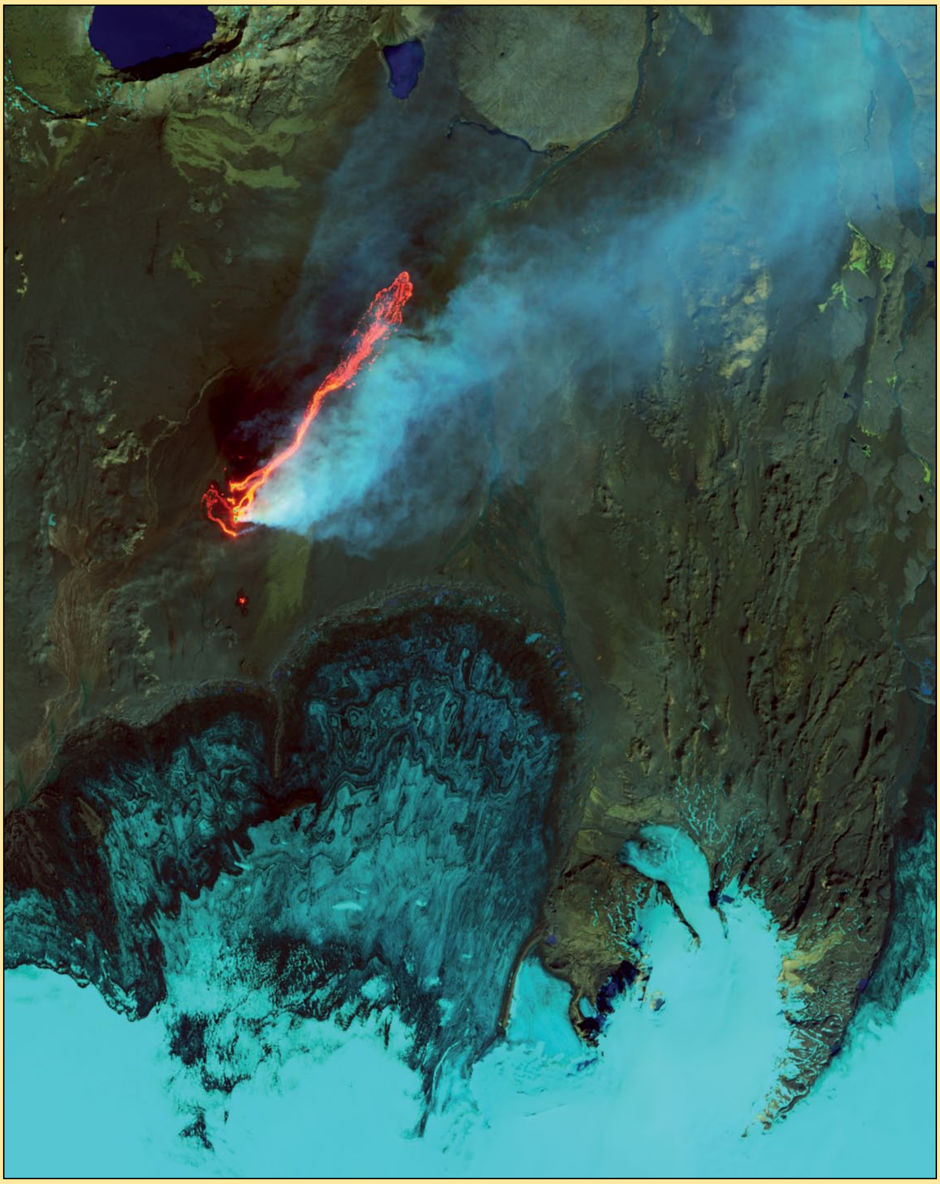


Figure 6 - This Landsat false-colour image dating from September 5 shows the Holuhraun fissure and associated steam and gas clouds in high resolution. Part of the Vatnajökull icecap appears at the foot of the image, showing as cyan in this channel combination,
Image: NASA Earth Observatory image by Jesse Allen, using USGS Landsat data

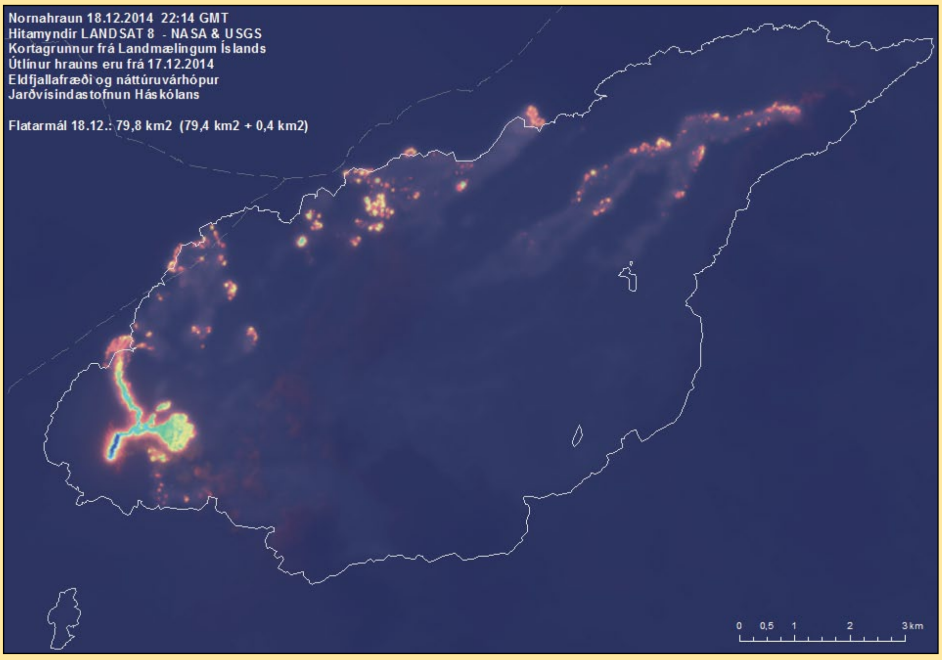


Figure 7 - This thermal image of the eruption site was created from Landsat-8 and Sentinel-1 data acquired on December 18, 2014.
Credit: NASA/USGS/ESA/University of Iceland

University of Iceland's Earth Sciences Institute from *Landsat-8* and *Sentinel-1* data on December 18 (figure 7), reveals a glowing underground lava river originating from the Bardarbunga crater, and flowing northeast beneath solidified lava for some 14 kilometres to the edge of the new lava field.

When the outlines of the new lava field and the road (dotted line) were added to the image, it could be seen that a large part of the lava field's northern edge, close to the road, is active. At the time, the lava field measured 79.8 km^2, larger than the entire Reykjavík metropolitan area. It's the largest lava flow in Iceland—or anywhere on the planet—for 230 years.

Eruption Update

You can keep up to date with events in Iceland at the URL below, which contains links to a month-by-month appraisal of events

http://en.vedur.is/earthquakes-and-volcanism/articles/nr/2947

The two photographs opposite, taken from the air by Peter Hartree just five days later, give some idea of the extent of this eruption. You can view more of Peter's photographs at:

https://www.flickr.com/photos/41812768@N07/15145848192/

YouTube Video

You can enjoy a three minute YouTube video above the Holuhraun lava field, filmed using Phantom 2 quadcopters to capture viewpoints of exploding magma too dangerous to be approached by manned aircraft

https://www.youtube.com/watch?v=_L6Phuwqi7Y

And there are some spectacular views of lava fountains from *Reykjavik Helicopters*

http://www.reykjavikhelicopters.com/volcano-iceland/

Figure 9
A spectacular aerial photograph of lava fountains being emitted by the Bardarbunga volcano, captured by Peter Hartree on September 4, 2014
Image: Wikimedia Creative Commons

Figure 10
Another aerial photograph, showing extensive lava flows snaking away from Bardarbunga on September 4, 2014
Image: Peter Hartree/Wikimedia Creative Commons

Figure 11 - Great clouds of steam and gases issue from the Holuhraun fissure
Photo: Milan Nykodym/Flickr

The Growth of the Lava Field

As of January 6, 2015, the Holuhraun lava field had spread across more than 84 square kilometres, making it larger than the island of Manhattan. Holuhraun is now Iceland's largest basaltic lava flow since the Laki eruption in 1783–84. Figure 13, a false-colour view captured by the Operational Land Imager (OLI) on **Landsat-8** on January 3, depicts the lava field with a combination of shortwave infrared, near infrared, and red light (OLI bands 6-5-4). The plumes of steam and sulphur dioxide appear white, newly-formed basaltic rock is black and fresh lava bright orange. A lava lake is visible near the western tip of the lava field, while plumes of steam rise from the eastern margin, where the lava meets the Jökulsá á Fjöllum river.

By way of comparison, figure 12 shows exactly the same area during the eruption's early days on September 6 last year, again observed by **Landsat-8**, when much of the lava was flowing in incandescent rivers across the surface. By January, most of the lava reaching the eastern edge travelled the length of the field through closed sub-surface lava tubes.

While Holuhraun continues to spew copious amounts of lava and sulphur dioxide, some observations suggest that the eruption may be slowing down. Icelandic scientists have shown that the sinking of the floor of Bardarbunga's subglacial caldera has decreased from 80 centimetres to 25 centimetres per day—a sign that less magma is moving toward the surface. In addition, magnitude 5 or greater earthquakes that used to occur daily had all but died out by mid January. Additionally, satellite observations of heat flux showed a decline from more than 20 gigawatts in early September to fewer than 5 gigawatts by the end of November.

This is not to say that the eruption is nearly over. Every day throughout January, in addition to countless minor earthquakes within the lava field, between 30 and 60 earthquakes were recorded in the Bardarbunga caldera, where only one day failed to produce at least one quake measuring between magnitudes 4.0 and 4.9, and the average daily maximum was 4.7.

But by the end of the month, there were definite signs that the eruption was on the wane, and during the first week of February the number of caldera quakes averaged between 20 and 30, with the most severe only just

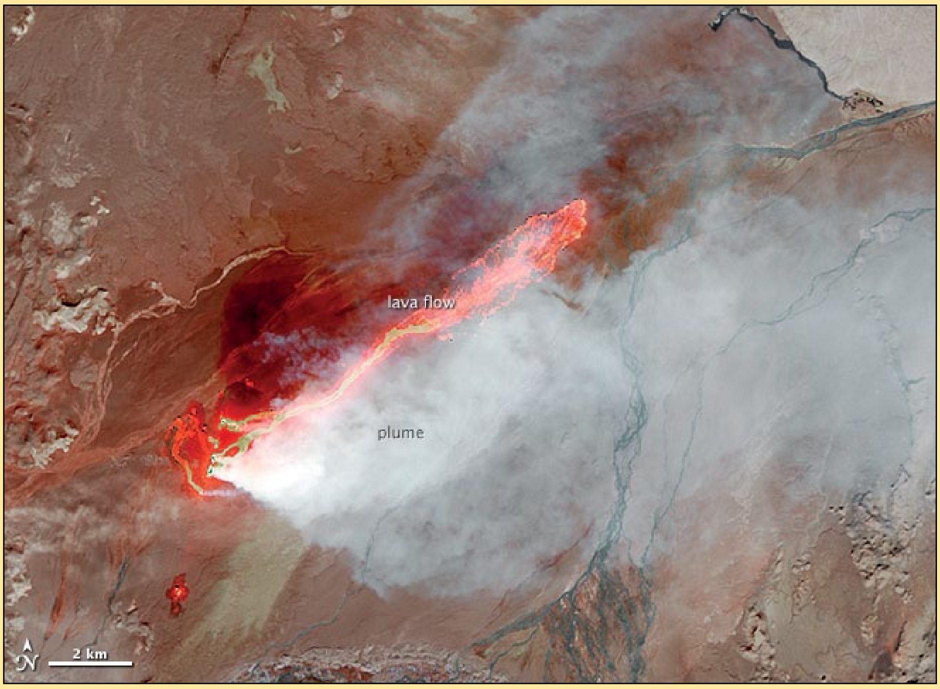


Figure 12 - The Holuhraun lava field on September 6, 2014, at which time most of the lava was flowing above ground in lava rivers.
NASA Earth Observatory image by Jesse Allen and Josh Stevens, using Landsat data from the USGS.

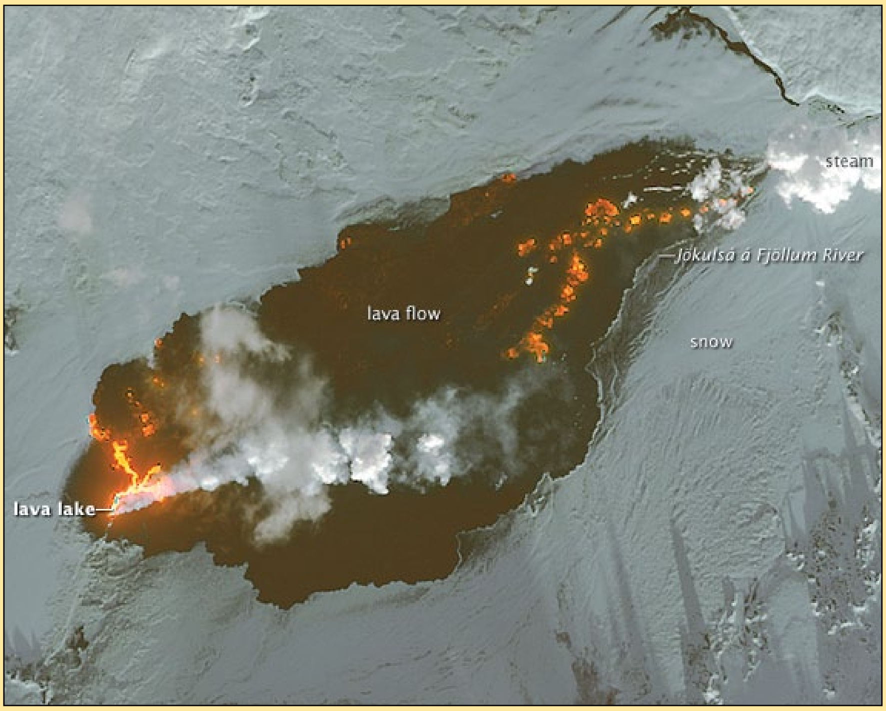


Figure 13 - The Holuhraun lava field on January 3, 2015 when most of the lava was travelling beneath the surface in lave tubes.
NASA Earth Observatory image by Jesse Allen and Josh Stevens, using Landsat data from the USGS.

reaching magnitude 4.0. On February 14, the Icelandic Met Office reported that the new lava field had reached an extent of exactly 85 km². Figures 14 and 15 show the extent of the new lava.

As February progressed, activity at Bardarbunga and throughout the Holuhraun region continued to show a steady decline, and during the final three weeks of the month the average number of earthquakes in the caldera had dropped to between 10 and 15 per day with only a handful of events reaching magnitude 4.0 or greater. Over February as a whole, the average maximum tremor magnitude experienced daily had dropped to below 3.0.

Figure 17, a thermal image acquired by NASA's Landsat-8 satellite on February 21, shows clearly how, compared with earlier images such as the two reproduced above, activity throughout the lava field had decreased, thermal

... concluded on page 29

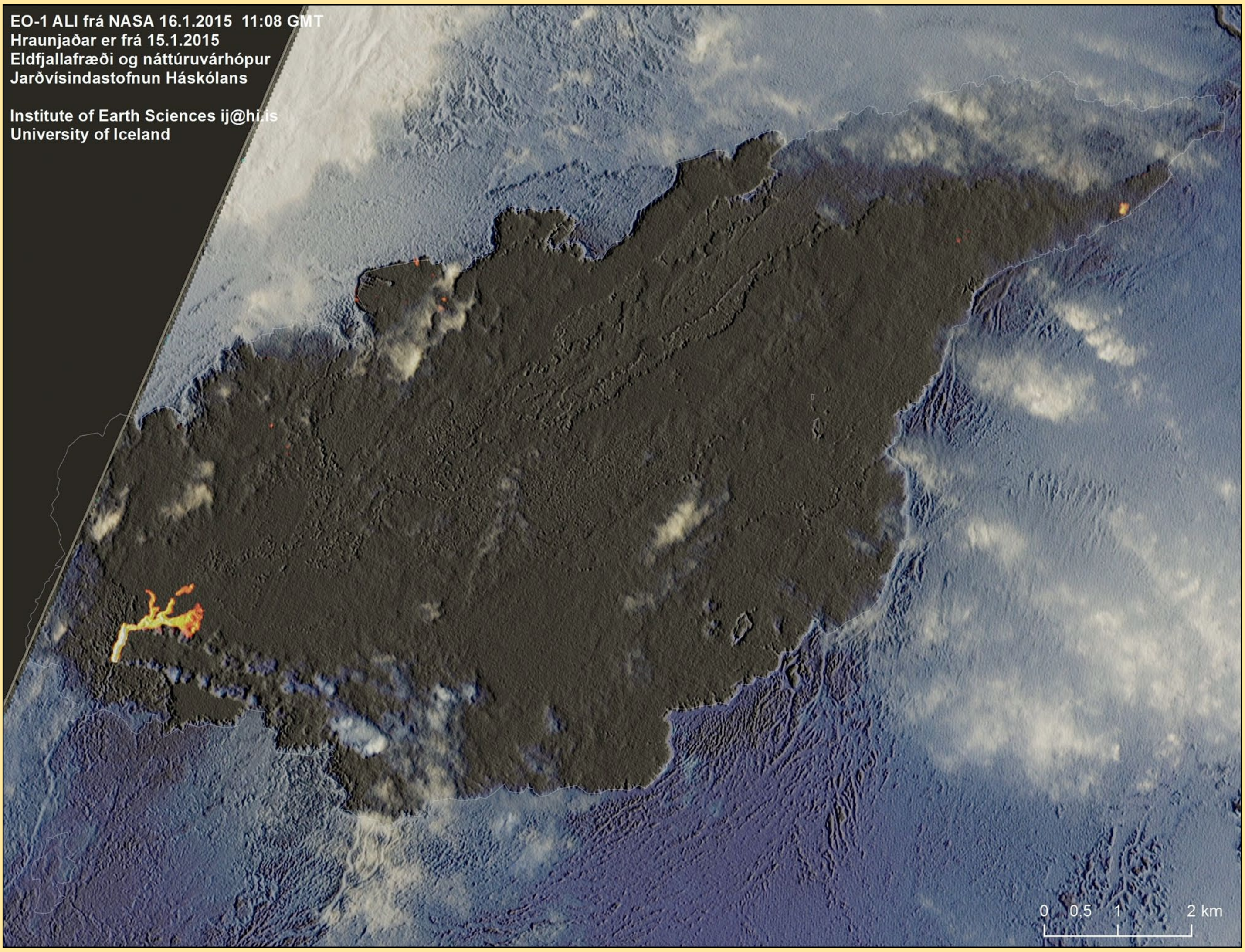


Figure 14 - This NASA ***EO-1/ALI*** satellite image dating from 11:08 UT on January 16, 2015 shows the extent of the active Holuhraun lava field which shows dark against the surrounding snow and ice covered terrain. Faint outlines have been added where clouds obscure the margins of the field.
Credit: NASA/Iceland Institute of Earth Sciences

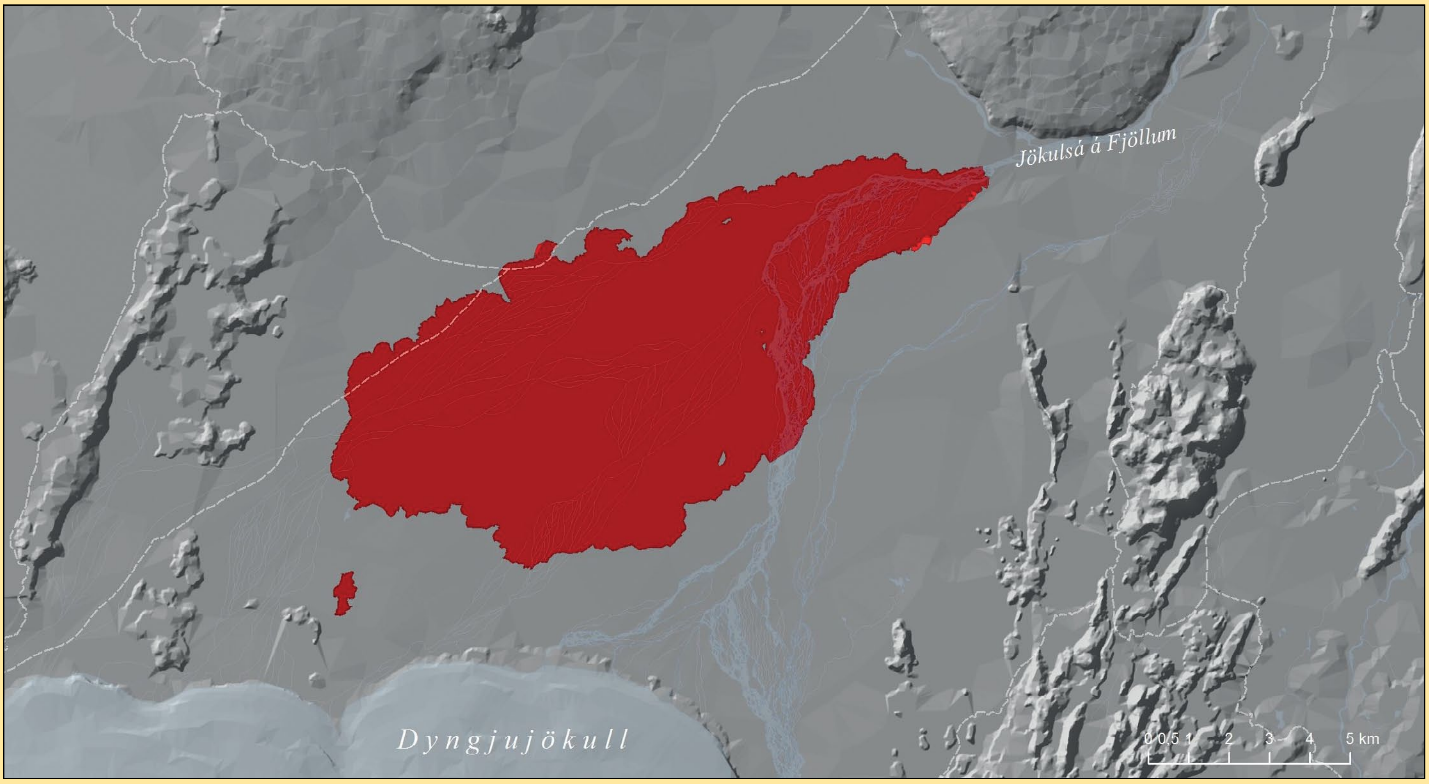


Figure 15 - This overview map is based on an ESA *Sentinel-1* radar image acquired on February 12.
This was the date on which the area of the new lava field reached the landmark area of 85 km^2.
Image: Icelandic Institute of Earth Sciences/ESA

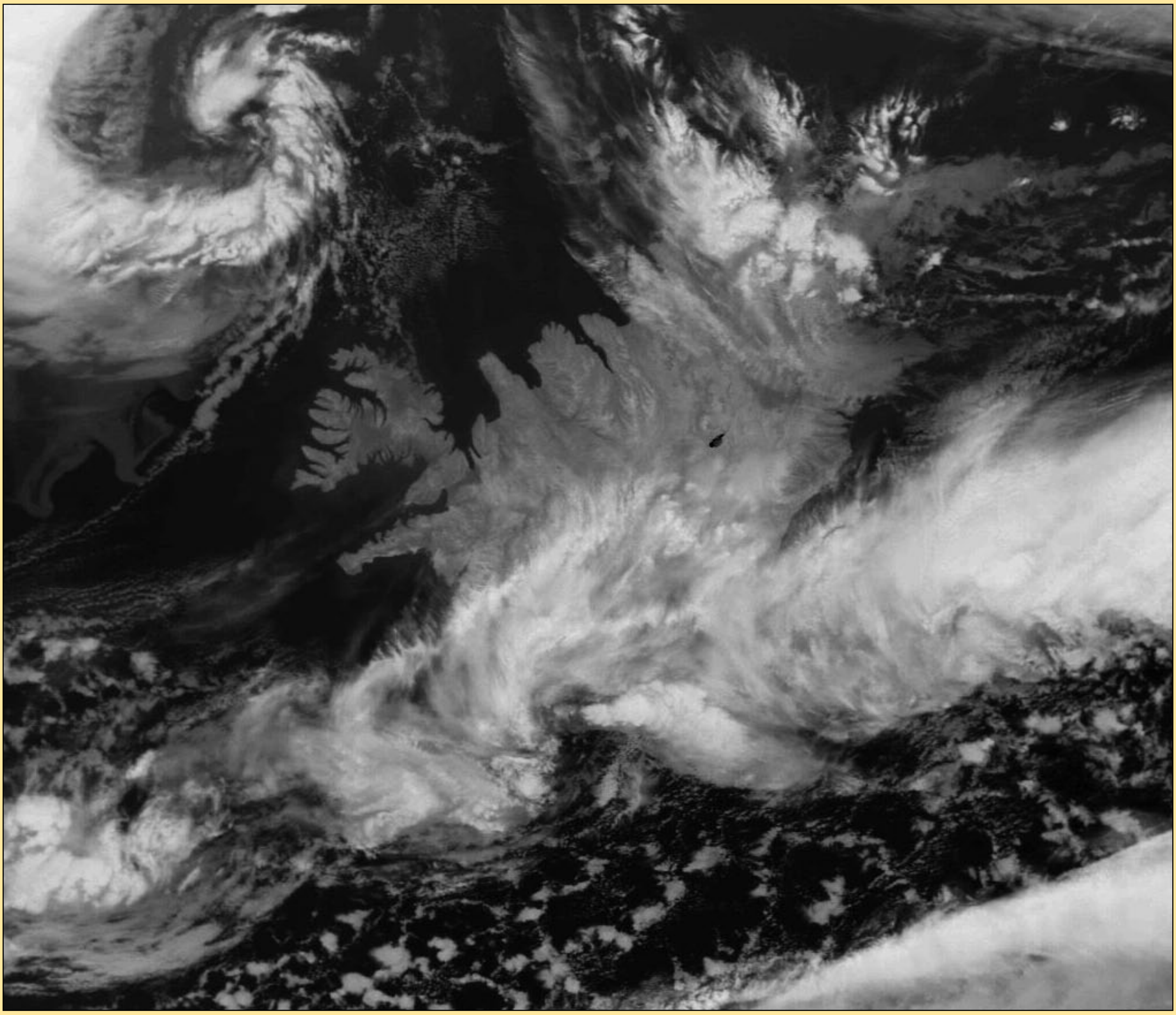


Figure 16 - NASA's *Terra* satellite acquired this 1-km resolution band-31 infrared image of Iceland just after noon on January 11, 2015. The active Holhuraun lava field shows as a well defined hot spot.
Image: NASA/GSFC/LAADS Web

signatures showing that vulcanism was now confined to the southern crater and the northeastern tip of the field.

Nevertheless, in the words of the Iceland Meteorological Office [5], seismic activity in this region "can still be considered strong ... the volcanic eruption has now been going on for almost half a year ... and could still continue for many months".

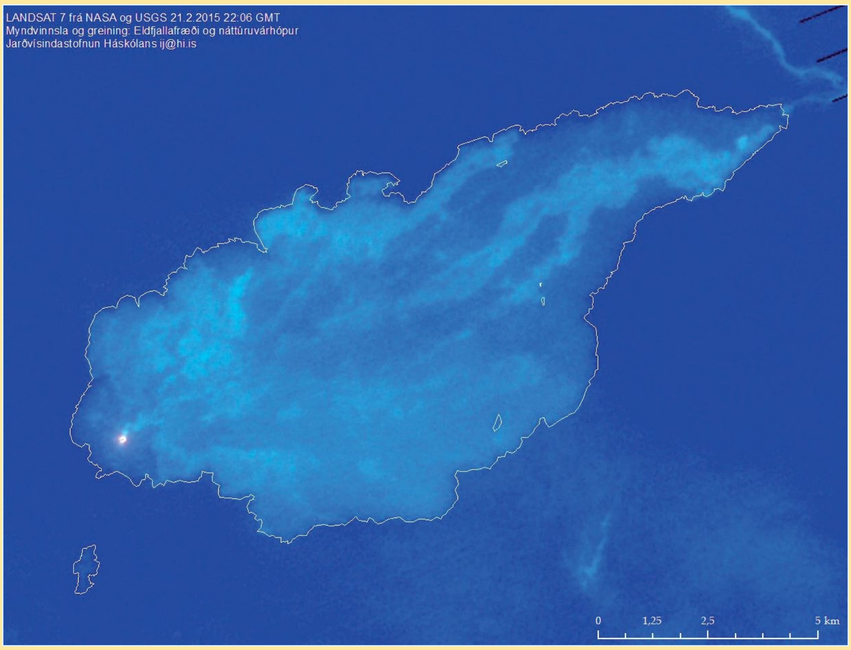
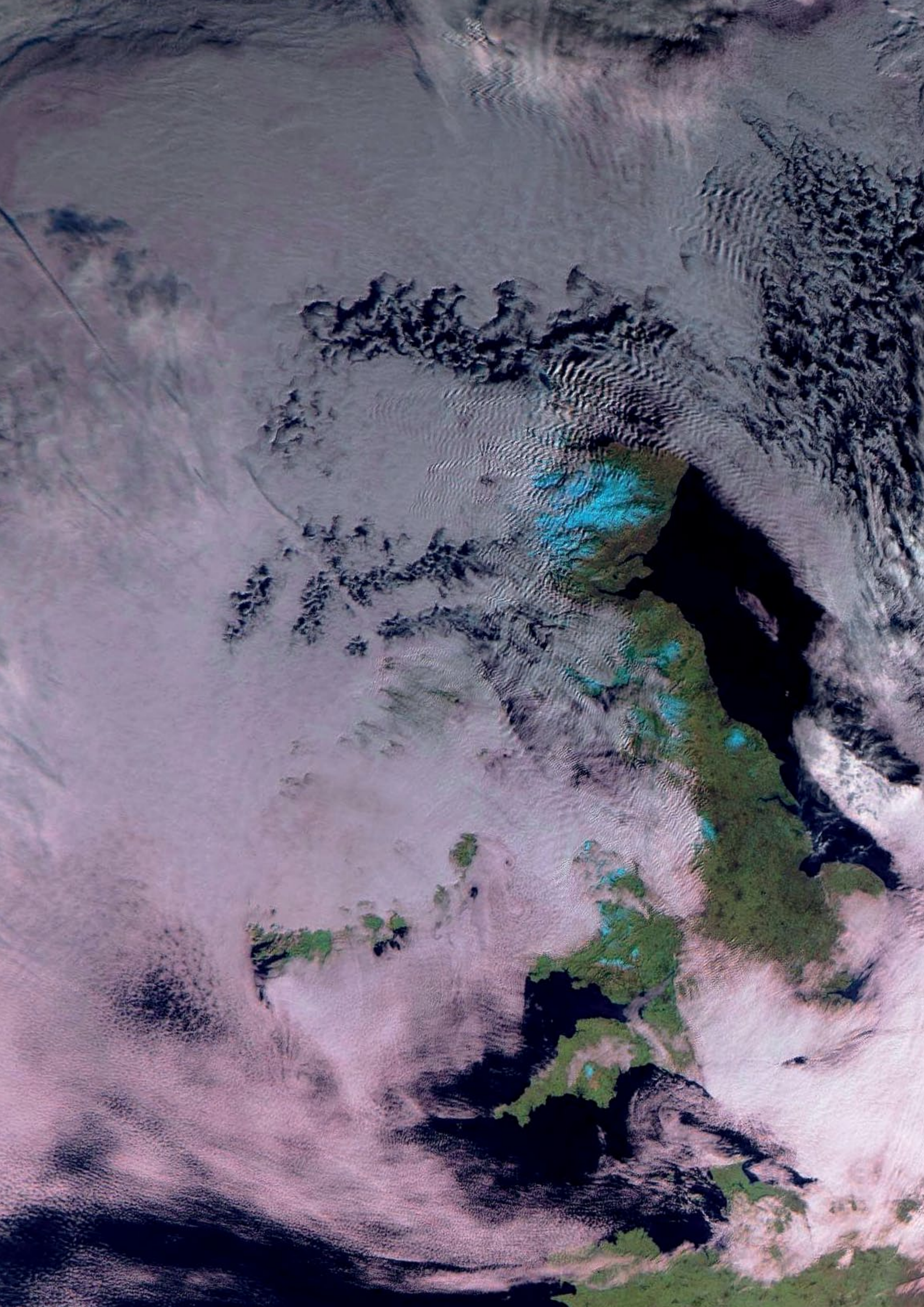


Figure 17 - A *Landsat-8* thermal image from February 21, 2015 shows visible volcanic activity is now confined to the southern crater and the northeastern tip of the lava field.
Image: NASA/USGS/Icelandic Institute of Earth Sciences.

Sources

1 Bardarbunga
http://en.wikipedia.org/wiki/Bárðarbunga
2 Holuhraun
http://en.wikipedia.org/wiki/Holuhraun
3 Volcano Discovery
http://www.volcanodiscovery.com/bardabunga.html
4 NASA Earth Observatory
http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=85031
5 Icelandic Institute of Earth Sciences
http://earthice.hi.is/bardarbunga_holuhraun/
6 Iceland Met Office
http://en.vedur.is/earthquakes-and-volcanism/articles/nr/2947



Pico de Fogo Erupts

Les Hamilton

After 19 years of dormancy, Pico do Fogo, the highest summit on Cape Verde's Fogo island underwent an intense flank eruption on November 23, 2014. In the weeks that followed, lava flows advancing at over 100 metres per day have destroyed two villages located within the volcano's caldera, forcing thousands of residents from their homes and threatening a forest reserve.

The Advanced Land Imager (ALI) aboard NASA's **Earth-Observing 1** (EO-1) satellite captured an image of the island on December 24, 2014, providing a broad view of its most distinctive feature, the Cha Caldera (figure 1) a month after the eruption commenced. The nine kilometre wide caldera has a western wall that towers a thousand metres above the crater floor, but its eastern rampart is no more, having collapsed in antiquity.

Figure 1 - The island of Fogo in the Cape Verde Republic

A more detailed view inside the caldera appears in figure 2, which shows the volcanic plume streaming from a fissure at the southwestern base of Pico de Fogo. Both of the villages destroyed by the eruption—Portela and Bangaeira—were located within the caldera. Just two weeks after the eruption broke out, on December 6, lava poured into Portela: two days later it entered Bangaeira. The volcanic plume obscures the remains of the two villages, but white roofs of a few structures are visible just left of the plume, near the top of the image. In addition to the northerly flow that affected these villages, the eruption also produced lava flows that moved towards the south and west.

The false-colour image shown in figure 3 is the same scene imaged in shortwave infrared, clearly showing the thermal signature of the eruption.

The last time Fogo erupted was 1995, when lava came within a few kilometres of Portelo, but did not cause serious damage. Prior to that, Fogo erupted in 1951, 1909, and several times in the nineteenth century. You can view a spectacular gallery of photographs of the 2014 eruption by Martin Rietze at

http://www.mrietze.com/web13/Fogo14.htm

NASA Earth Observatory images by Jesse Allen using EO-1 ALI data provided courtesy of the NASA EO-1 team

Figure 2 - A close-up view of the eruption

Sentinel-1 Interferometry

By processing two radar images from ESA's Sentinel-1A satellite, one acquired prior to the eruption on November 3 and the other after it on November 27, it has been possible to generate the interferogram shown in figure 4.

Deformations on the ground cause phase changes in radar signals, that can appear as the rainbow-coloured patterns in false coloured composite images.

Results like these are being used by Earth scientists to help them map the volcano's subsurface magmatic system, perform geophysical modelling of the volcanic eruption mechanics and assist the relief efforts on the ground. This stunning result has unequivocally demonstrated the great potential of Sentinel-1 for geophysical applications. Radar images from the Sentinel-1A satellite are currently helping to monitor ground movements at the recently erupted Fogo volcano.

Mapping for Emergency Response

Scientists can use the deformation patterns revealed by interferograms to understand the subsurface pathways of molten rock moving towards the surface. In this case, the radar showed that the magma travelled along a crack at least 1 kilometre wide.

By acquiring regular images from Sentinel-1 it will be possible to monitor subsurface magma movements even before eruptions take place, and use the data to provide warnings, particularly valuable in locations where there are few sensors on the ground.

Sources

NASA Earth Observatory

http://earthobservatory.nasa.gov/IOTD/view.php?id=84987

ESA

http://www.esa.int/spaceinimages/Images/2014/12/Sentinel-1_maps_Fogo_eruption

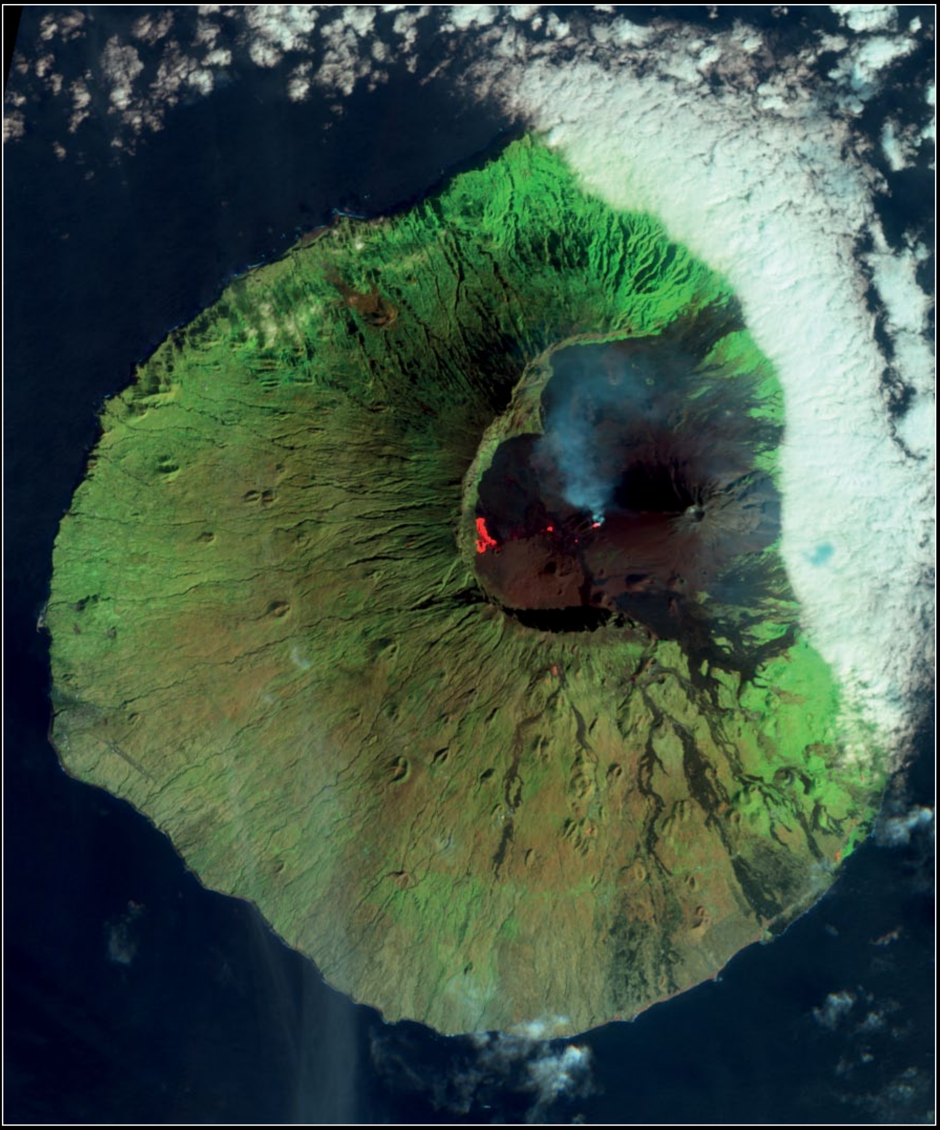


Figure 3 - Pico de Fogo imaged in shortwave infrared

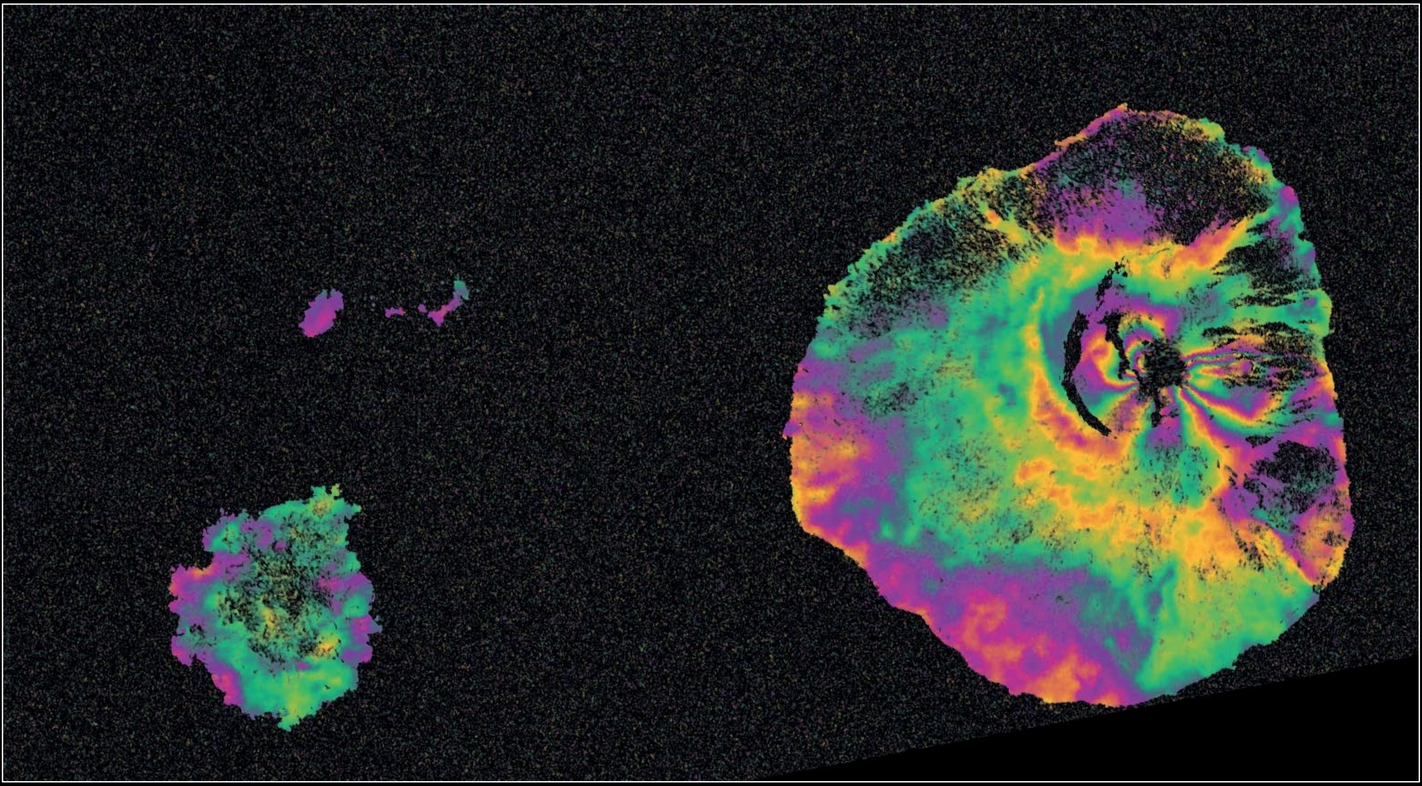
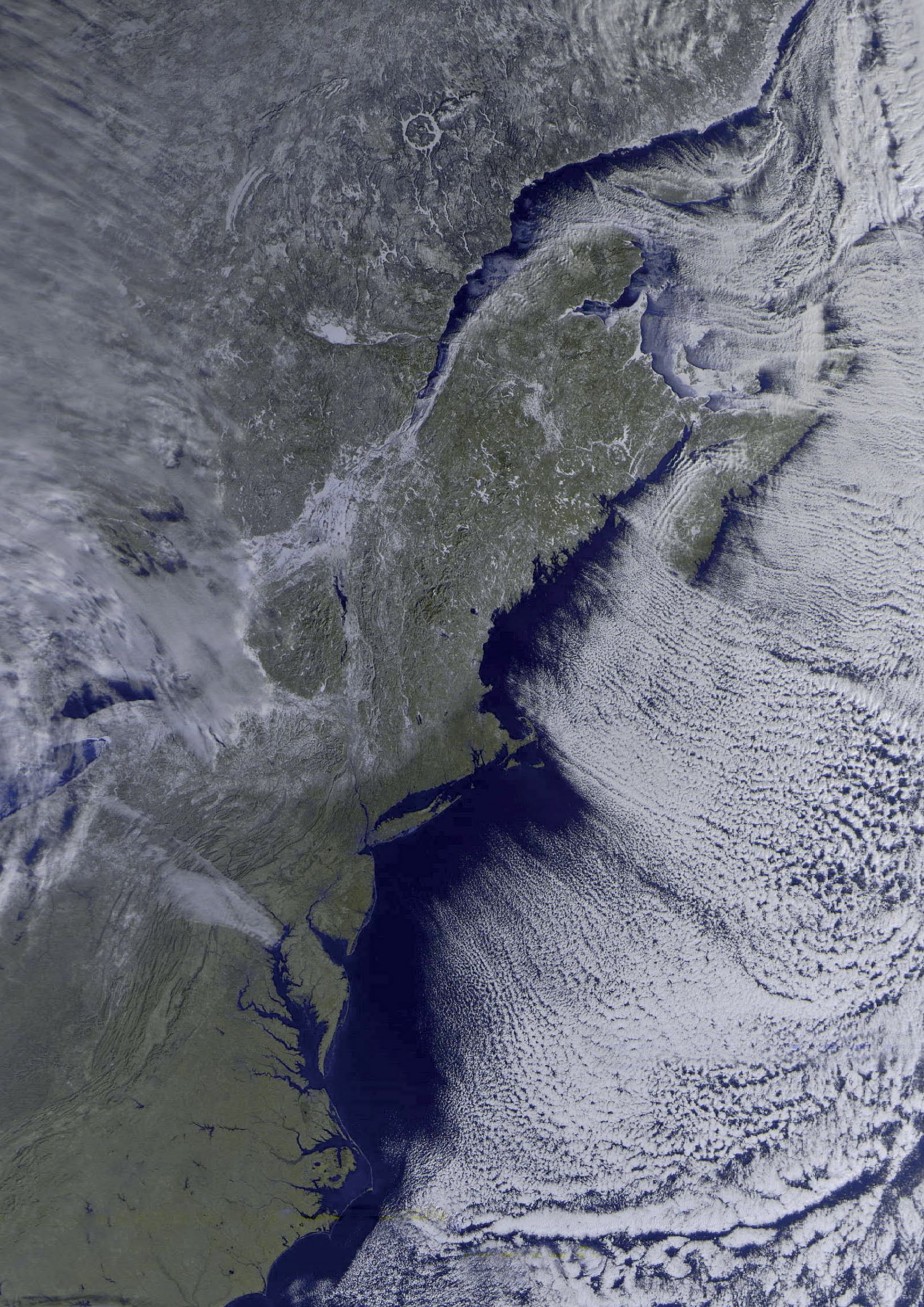


Figure 4 - An interferogram created from radar images acquired by Sentinel-1 before and after the eruption
Credit: Copernicus data (2014)/ESA/Norut-PPO.labs–COMET-SEOM InSARap study



Snow Problems

with a Parabolic EUMETCast Dish

Paul Geissmann (satellitenpaul)

My location lies in the city of St Gallen, in Switzerland, just south of the western end of the Bodensee (Lake Constance), and 17 kilometres north of the 2504 metre *Säntis*, the highest mountain in the Alpstein massif of northeastern Switzerland.

You can find me on a map if you enter the following details (Wilenstrasse 60, CH 9014 St.Gallen) into *Dishpointer* at

http://www.dishpointer.com/

Many a winter I have had the problem of removing snow and ice from my parabolic dish antennas. Since my dishes are installed at heights of between 4 and 6 metres, clearing the snow has not always been easy. It was a particular problem in the case of the 150 cm parabolic dish I use for EUMETCast. Its reception is very sensitive with respect to snow, particularly with regard to the decibel level. If, for example, there is a layer of 50 cm of **dry** powder snow over the dish, the maximum reception level from EUMETCast I can expect is only 10-11 dB. And if a layer of **wet** snow is lying on the dish, its parabola becomes so distorted that virtually no reception is possible. This is where it is a big advantage to use an offset dish (figure 1).

Thanks to a heater that I recently installed on the 150 cm EUMETCast dish, I no longer have any problems. The heating system consists of an 8 metre long heating cable which runs at about 110 watts. This cable is attached to the dish using 10 cm wide adhesive aluminum foil (figure 4). Of course, I can change the dish heater only when snowfall is expected. The LNB I use with this dish is shown in figure 3, and can be obtained from *Satellite Super Store* at:

http://www.satellitesuperstore.com/

At the moment, only my EUMETCast dish is heated in this way, but you can see the result in figure 2. My other dishes (120 cm and 170 cm) are going to be fitted with similar heating cables later this year.

You can see my Station in figure 5 on the next page.

Figure 1 - Snow on the author's parabolic EUMETCast dish (unheated)

Figure 2 - The same EUMETCast dish with the heater in operation

Figure 3 - The LNB used with the EUMETCast dish

Figure 4 - The rear of the author's 150 cm dish, showing the 110 W heating cable held in place by adhesive aluminium tape.

Figure 5 - Paul Geismann's impressive station console. The EUMETCast screen can be seen at centre left.

Figure 6 - Paul Geismann's array of antennas pictured after snowfall on January 15. The EUMETSAT dish is free of snow.

Cyclone Bansi and its Electric Eye

Les Hamilton

Tropical Cyclone *Bansi* formed north of La Reunion Island in the Southern Indian Ocean on January 11, 2015, triggering cyclone warnings for both La Reunion and Mauritius. At that time Bansi was tracking slowly east-southeast with maximum sustained winds of 60 kilometres per hour. But even at this early stage, MODIS imagery from NASA's *Terra* satellite indicated that there were powerful thunderstorms wrapped tightly around the storm's eye, and in a wide swathe curving around its eastern quadrant.

Within 24 hours, *Bansi* had strengthened from a minimal tropical storm into a Category-3 cyclone, now with maximum sustained winds of 185 kph. By January 13 the eye of the cyclone was almost 20 kilometres wide and ringed by high, powerful thunderstorms: with maximum sustained winds having increased to 240 kph, *Bansi* was now equivalent to a Category 4 hurricane on the *Saffir-Simpson* wind scale. Situated just 300 kilometres north of Port Louis, the capital city of Mauritius, *Bansi* was moving slowly to the northeast, as forecasts were predicting that it could eventually reach Category-5.

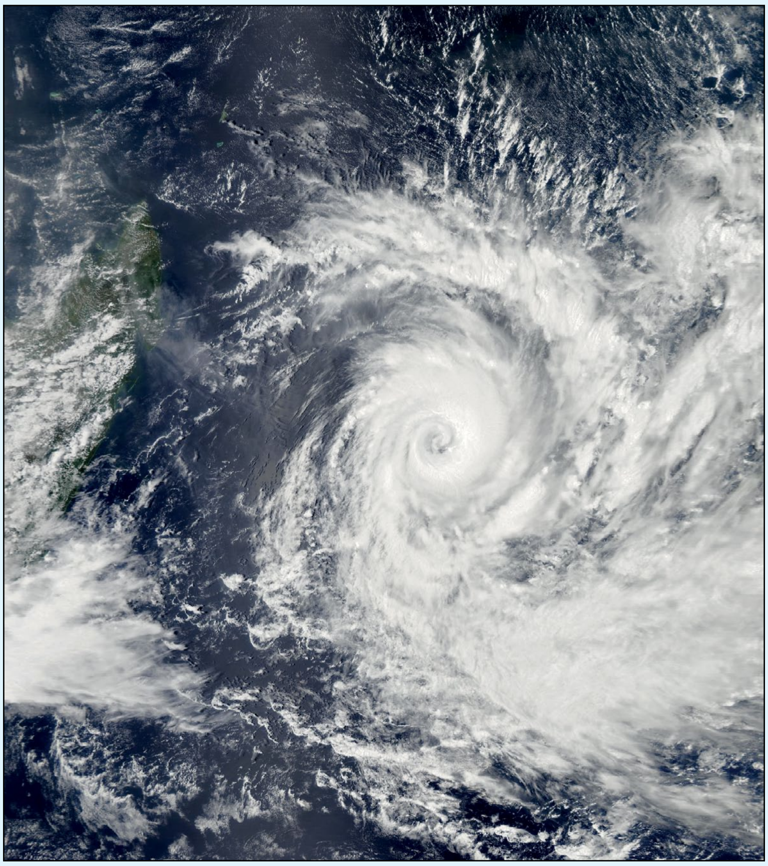


Figure 1 - NASA's Terra Satellite captured this image of Cyclone Bansi bearing down on the islands of Mauritius and La Reunion on January 14, 2014. The island nation of Madagascar can be seen at the left of the scene.
Image: LANCE/MODIS Rapid Response Team at GSFC

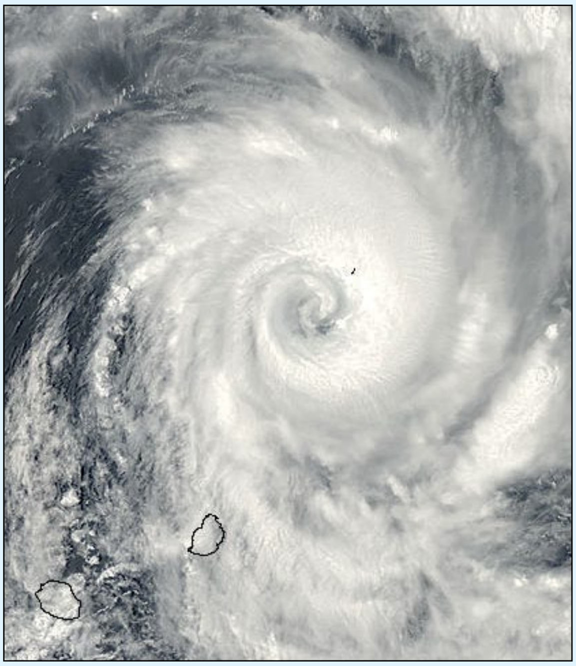


Figure 2 - This Terra MODIS image from January 14, shows the relative locations of the islands La Reunion Left) and Mauritius to Cyclone Bansi.

Figure 1 opposite shows *Bansi*, with its well developed eye and spiralling bands of cloud as imaged by the MODIS instrument aboard NASA's **Terra** satellite on January 14, by which time it had temporarily weakened to Category-2, and the eye had become filled with cloud. But when NASA-NOAA's **Suomi NPP** satellite's *Visible Infrared Imaging Radiometer Suite* (VIIRS) targeted the storm early on January 15, it had regained its power and strengthened back to Category 4. The the eye was once again clear of cloud and had increased its width to 54 km (figure 3). During these two days, *Bansi* brought gusty winds and beneficial rainfall to

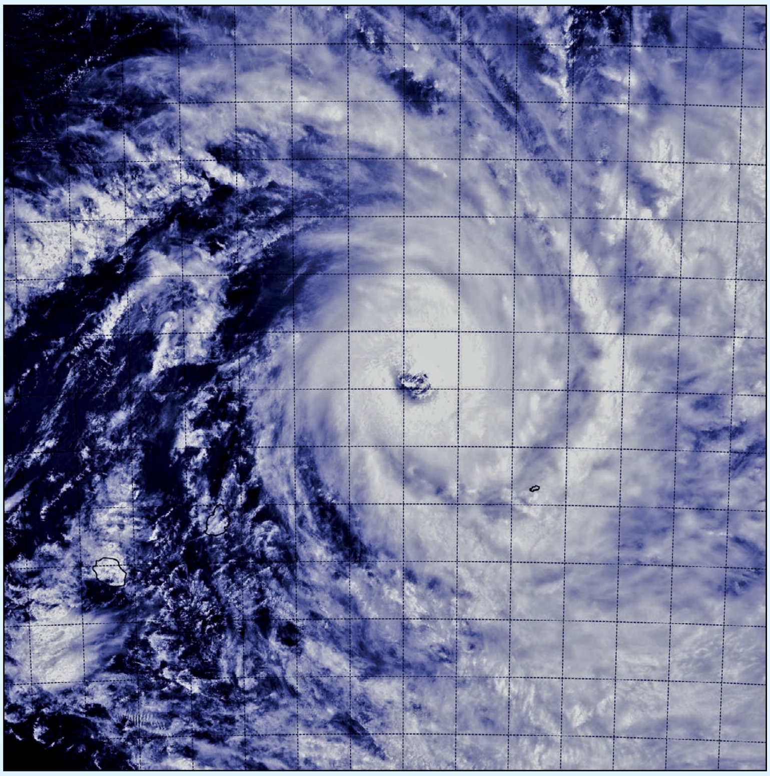


Figure 3 - NOAA-NASA's Suomi NPP satellite passed over Tropical Cyclone Bansi at 09:46 UT on January 15 as the storm's eye re-opened.
Image Credit: NOAA/NASA/NRL

Figure 4 - Cyclone Bansi as photographed at night from the International Space Station, the eye of the storm illuminated by lightning.
Photo: NASA Astronaut photograph ISS042-E-135015

Mauritius, although the cyclone's eye came no closer than 450 km to the north of the island. Nevertheless, weather warnings prompted the authorities to close schools for two days, while *South African Airways* cancelled flights to and from the island's international airport as sustained winds exceeded 200 kph at times. The cyclone later made a direct hit on remote Rodrigues Island, an autonomous outer island of the Republic of Mauritius, as a Category-5 storm, before finally weakening and dying out over open waters in the Southern Indian Ocean.

The Electric Eye of Cyclone Bansi

Figure 4 above is a photograph of tropical cyclone *Bansi* as seen at night by astronauts aboard the International Space Station (ISS). The images were take when the ISS was east of Madagascar. By the time this photo was taken on January 12, *Bansi* had achieved tropical cyclone strength, with sustained maximum winds over 185 kilometres per hour. The dim swirl of the cloud bands covers the ocean surface and the eye of the cyclone is brilliantly lit by lightning in or near the eye wall. The low-light settings of the camera used to take the image accentuate the contrast. The camera also accentuates the yellow-green air glow above the Earth's limb, an atmospheric phenomenon frequently seen by astronauts. Stars appear above the air glow layer, and the solar panels of a docked Russian spacecraft are visible at upper left).

The Astronaut photographs (figures 4 to 6) were acquired by the ISS Expedition 42 crew on January 12 using a Nikon D4 digital camera and 28 mm lens. They are provided by the ISS Crew Earth Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center.

Sediment

On January 19, after Bansi had blown itself out, NASA's **Aqua** satellite spotted sediment stirred up the cyclone around St Brandon (also known as Cargados Carajos). St Brandon is an

Figure 5 - Another photograph taken from the ISS shows the almost cloud-free eye of Cyclone Bansi, its walls brilliantly illuminated by the lightning from raging thunderstorms.
Photo: NASA Astronaut photograph ISS042-E-135030

Figure 6 - Another Astronaut image of Cyclone Bansi, this time with a huge lightning discharge in its outer regions.
Photo: NASA Astronaut photograph ISS042-E-135037

archipelago consisting of more than 50 islands, plus sand banks, shoals, islets coral ridges and vast sand flats on an extended reef, belonging to Mauritius, and located some 400 kilometres to its northeast. Figure 7, acquired by the MODIS instrument aboard **Aqua** as it passed over the Cargados Carajos Shoals, is a visible image showing the results of Bansi's powerful winds. Sediment stirred up from the ocean floor around the Shoals had coloured the waters around them.

Information Sources

http://www.nasa.gov/content/goddard/bansi-southern-indian-ocean/
http://earthobservatory.nasa.gov/IOTD/view.php?id=85162

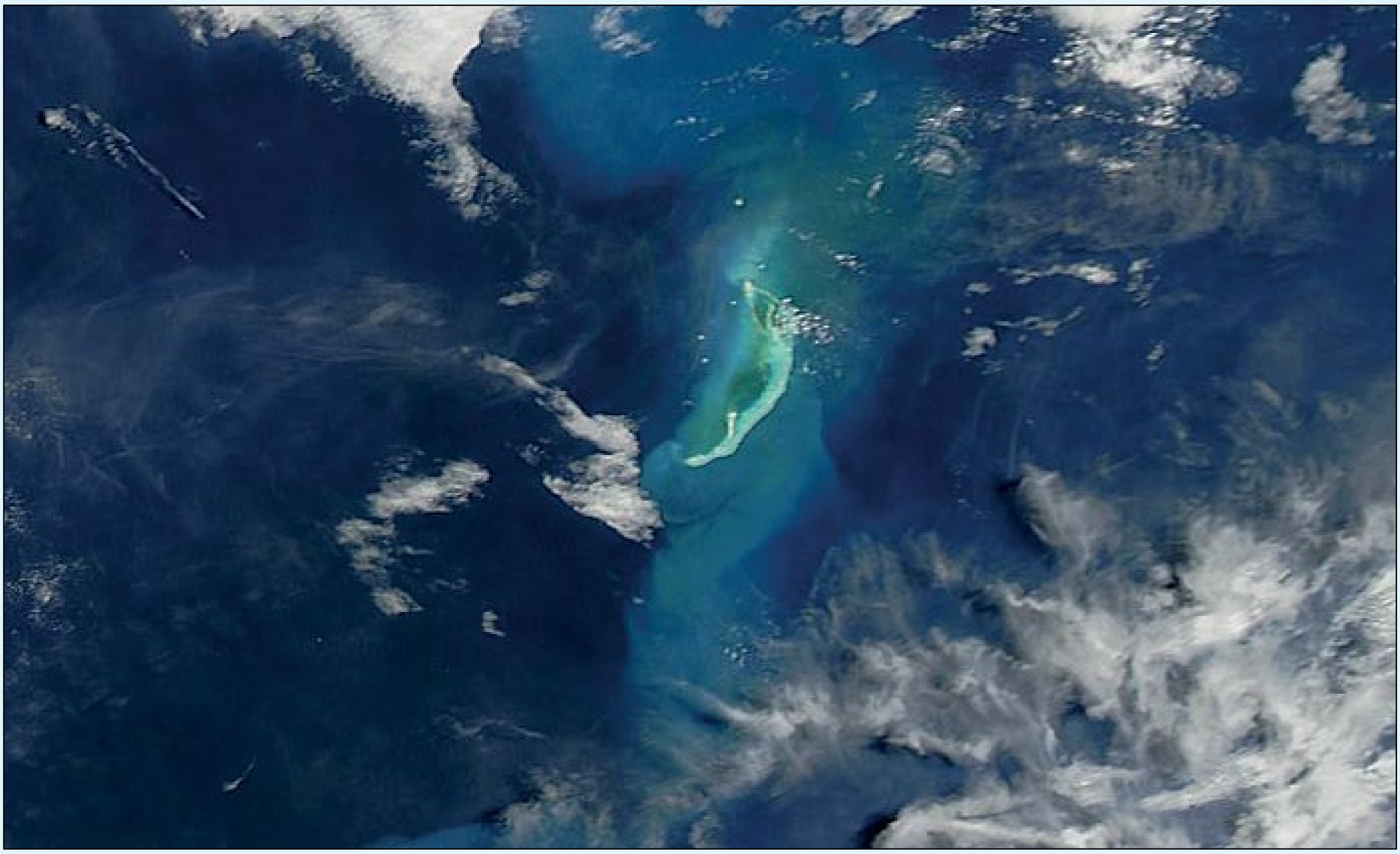
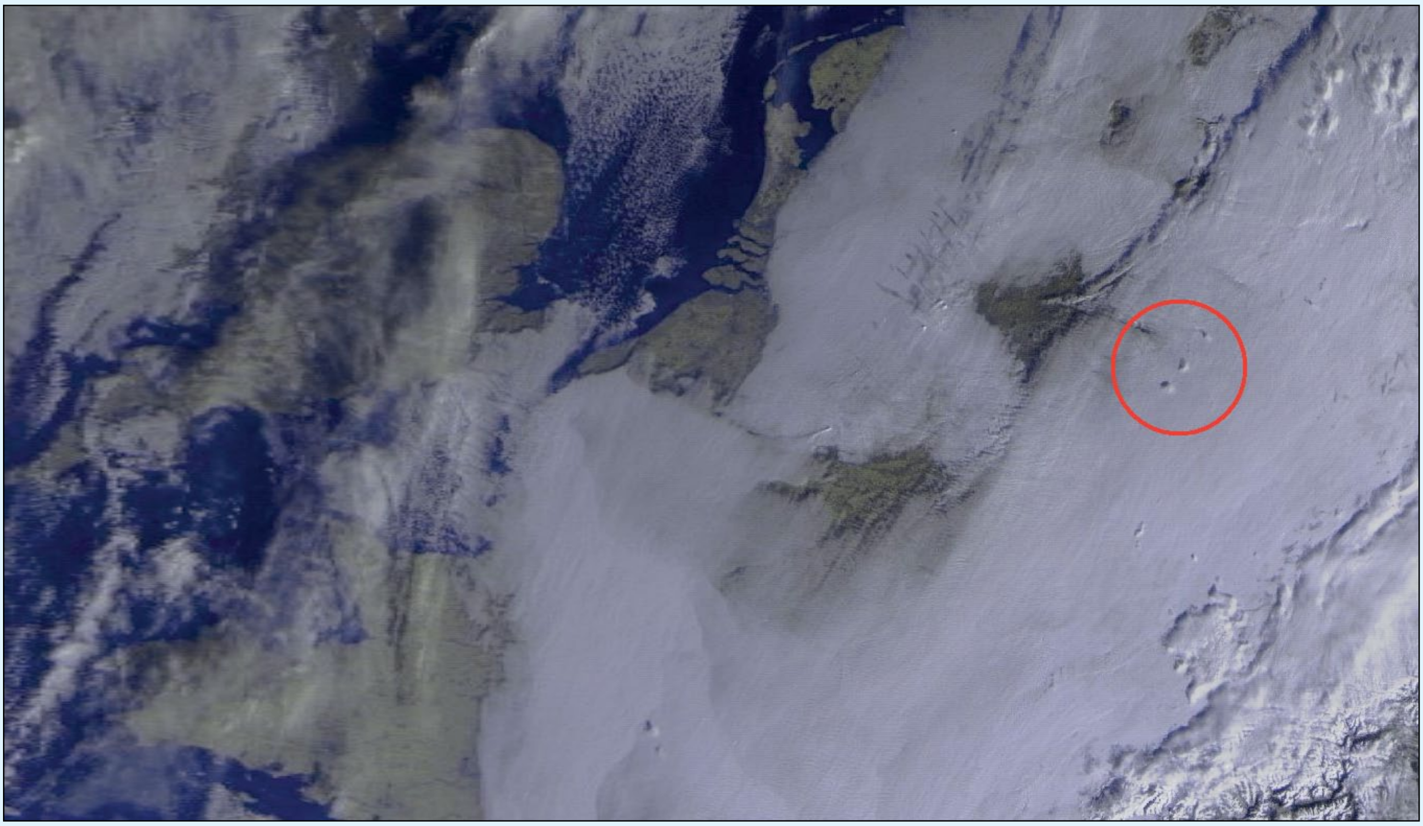


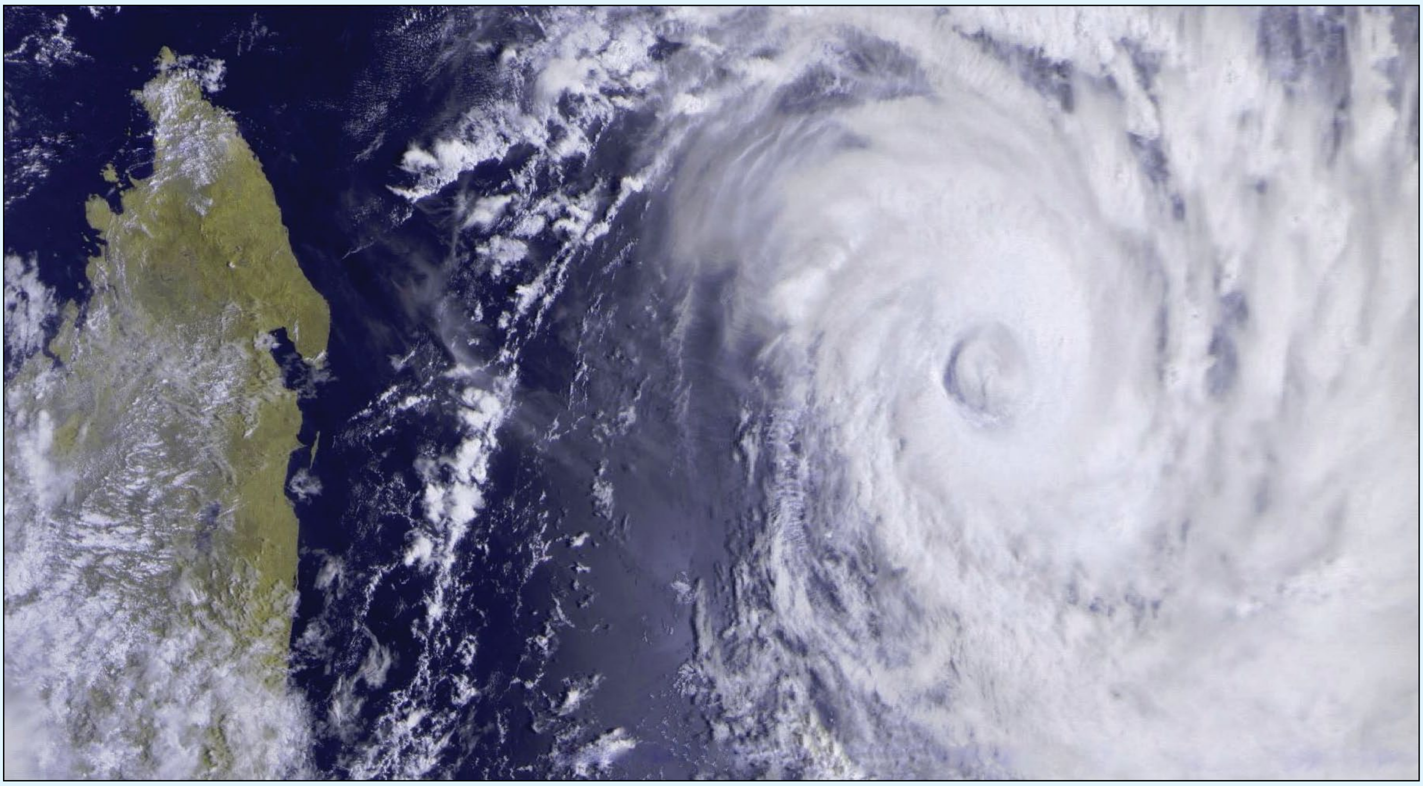
Figure 7 - Sediment stirred up from the sea floor by Cyclone Bansi colours the waters around the St Brandan archipelago.
Image NASA Goddard MODIS Rapid Response Team

Power Station Plumes Imaged by Satellite



One of our Dutch enthusiasts, Alex (*Happysat*), captured this early morning **Meteor M2** image from the 08:33 pass on January 24 this year. The low elevation of the sun has created shadows from the clouds of smoke and gases released from three of the coal-fired power stations in Germany's Ruhr valley (circled in red). The plants are located at Inden, Hambach and Garzweiler in the state of North Rhine-Westphalia, and are due to be decommissioned in a few years time due to the environmental pollution that they cause.

Cyclone Bansi Imaged from Mauritius



Jacques Gentil captured this **Meteor-M2** image of *Cyclone Bansi* in the Indian Ocean on January 14, 2015. Jacques has an interesting website at ***http://www.maufox.net/weather.htm*** which includes NOAA imagery of cyclones dating back to 1999.

Trials and Tribulations

Receiving LRPT from Meteor M2

Les Hamilton

As an enthusiast who cut his teeth on NOAA-9 and NOAA-10 almost 30 years ago, and who has never ventured beyond APT weather satellite transmissions, I viewed the arrival of Meteor-M2 as a godsend. Not only does it transmit in the familiar 137 MHz band like the NOAAs, but it disseminates real-time LRPT imagery at HRPT resolution. A browse on the Internet shows clearly how reception of this new satellite has been embraced by amateur enthusiasts from all round the world: Australia, Brazil, USA, Japan and numerous European nations. But not, it would seem from GEO Members here in the UK. I had anticipated that members' contributions on the new Meteor would form a significant part of the content of this Quarterly—but nothing!

What's the problem? Have all our UK members been so seduced by the terabytes of (non real-time) satellite imagery proffered by *EUMETCast* that they have lost the desire to return to the grass roots of the hobby and enjoy real-time imaging once more. Or is acquiring imagery from Meteor-M2 proving more problematic here in the UK than elsewhere?

I have to be honest here and admit that, for me, acquiring Meteor-M2 proved to be an arduous and problem-strewn process. Reading Raydel Abreu Espinet's article in the previous issue [1] made it all seem so easy, but there are unexpected pitfalls en route for the novice and the unwary. In the hope that my experiences in coming to grips with Meteor transmissions and solving a number of problems may be of value to others, I will relate the steps that have finally allowed me to obtain good quality images on a regular basis.

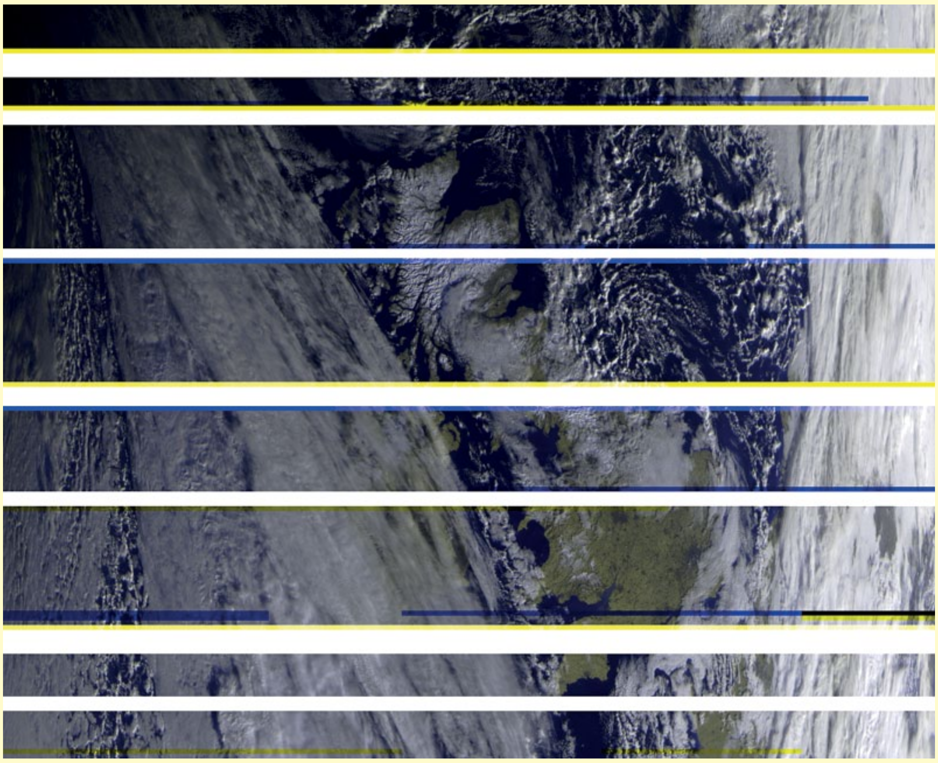


Figure 1 - Part of a Meteor-2M signal received using a rooftop antenna

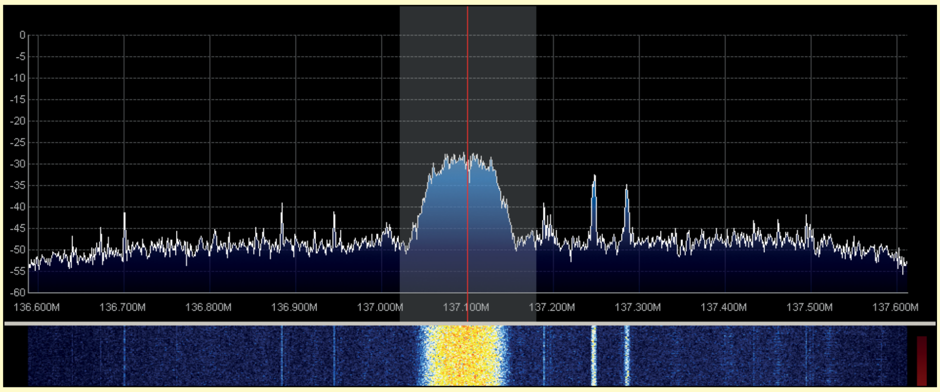


Figure 2 - A strong Meteor-2M signal displayed in SDR#

First Steps

Last September, having purchased the appropriate RTL-SDR dongle, I started tuning in to FM radio stations. This seemed simple enough, and using the amplification slider within the *SDR Sharp* (SDR#) software, I could hear the transmissions clearly. I already knew what to look for in terms of a Meteor-M2 signal, but try as I might, although the satellite passed at high elevation, the 'hump' on the trace absolutely refused to appear. I could not understand the reason for this, nor could others whose help I sought. I put the dongle aside and thought no more about for a couple of months.

With imagery by this time appearing regularly on the Internet, I decided to try again. Although I had picked up FM radio on the dongle, the only reason I could think of for my lack of success was that, somehow, the dongle was at fault. I ordered a new dongle, and it worked first time. The FM radio signals were vastly stronger than before, and when I tuned in to the next available Meteor-M2 pass, there was its signal (figure 2). The problem had been a faulty MCX adaptor lead; but, because it had allowed very weak VHF radio signals into the computer (but not those from the weaker Meteor-M2), this was not obvious to me at the time. In the event, there proved to have been nothing wrong with the original dongle itself; so a second adaptor was purchased, allowing me the luxury of being able to use two computers to compare reception from different antennas from the same transmission.

But my problems were by no means over. The next hurdle was my usage of the *SDR Sharp* software. Annoyingly, this program possesses neither a *Help* file nor a *User Guide*; not even the most basic instructions to guide a beginner. As a result, I found myself frequently recording what I believed to be a Meteor-M2 signal, only to find the recording devoid of any Meteor image content. This was partly my own fault for forgetting the instruction that the incoming signal must be centred on the display screen: I was so relieved to see a Meteor signal building up, even when off-centre, that this totally slipped my mind. Presumably the distributors of SDR# consider all users of their software to understand this point, which is a dangerous fallacy. Experimenters like myself who have no background in radio, do need help. If anyone connected with SDR# reads this, please *get cracking and provide a User Guide and Help feature with the software*.

First Images

I have two antennas for 137 MHz, mounted under the eaves of the house, and these have provided sterling service for NOAA APT for many years. I anticipated the same for Meteor but I was quickly disillusioned. Figure 1, dating from January 19, clearly shows what was potentially a fine image of the British Isles, with Scotland largely covered by snow. We know that a fault aboard Meteor-M2 results in a white band appearing on its LRPT images at approximately 6½ minute intervals, and the broad white band at the very top of the figure is one of these. But every one of my images was beset by multiple white horizontal bands at irregular intervals varying between fifteen and thirty seconds or so. It did not matter which antenna I used, turnstile of QFH; the problem was always there, totally destroying the images.

For sure, there was nothing amiss with the Meteor signal level (figure 2). My signal strength compared favourably with other examples posted on the Internet. I'm not one who normally sits staring at the PC screen while a signal comes in: I schedule the satellite passes in the *Baseband Recorder* module, and deal with the recorded WAV files later at my leisure.

But this issue demanded my attention, and when I did take the time to view an entire pass, I saw clearly that there were intermittent bursts of severe interference (figure 3). From time to time this was sufficiently powerful to completely suppress any evidence of the Meteor-M2 signal for several seconds at a time (figure 4). There is a strong Meteor signal in there. Honest!

It didn't require a magician to match these bursts of interference with the unwanted white lines that were breaking up my images. When the recorded WAV file was loaded into *Audacity* (figure 5), the bursts of interference were evident as blocky intrusions.

I live in Aberdeen, in northeast Scotland, the centre of the UK's North Sea Oil industry. During the past decade, the city has become encircled by industrial and business estates related to this, all no doubt pumping communications through the airwaves. I tried one day to minimise the effects of this by taking a mobile station down to the coast, but results were even worse. Aberdeen Bay was full of anchored oil support vessels, and it seems probable that ship-to-shore communications may well be part of my interference problem. I next travelled some 25 kilometres away from Aberdeen, up Deeside, and tried again, but reception continued to be as bad as ever. Next May, when I take a vacation on the Isle of Skye off Scotland's West Coast, I intend to take my mobile station with me and try again. Previous experience of receiving NOAA satellite images there on 137.91 MHz with my R2FX receiver (the non pager hardened version) indicated that there was no such interference problem there.

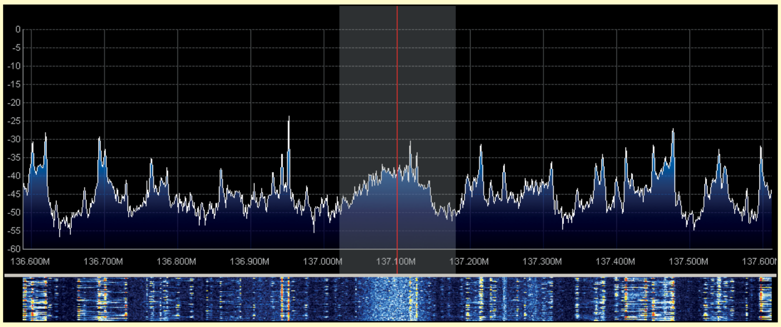


Figure 3 - A burst of interference on 137.1 MHz

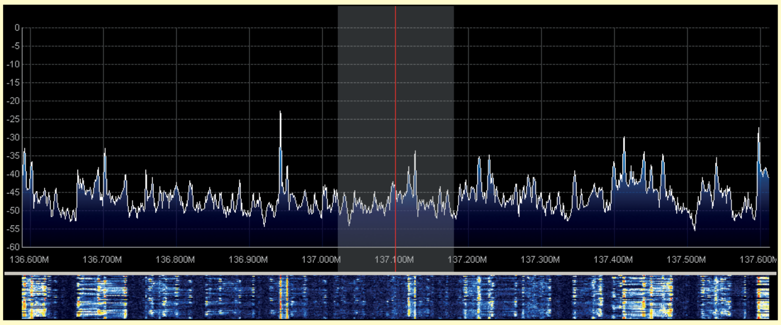


Figure 4 - The Meteor-2M signal totally overwhelmed by interference

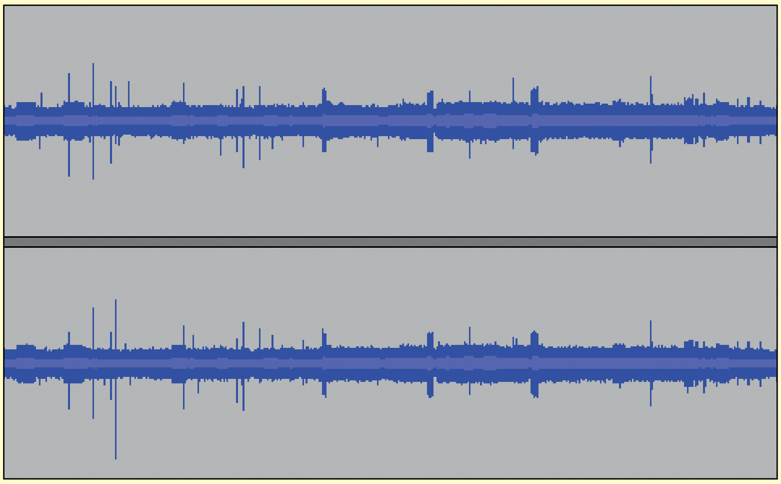


Figure 5 - Part of the saved WAV file (viewed with Audacity) that produced the Meteor image shown in figure 1.

Figure 6 -The home-brew QFH antenna mounted on the back lawn.

Limited Success at Last

I had to find some way of blocking the unwanted interference that was ruining my Meteor-M2 reception, and my first experiment was to erect an outdoor QFH. The logic here was that the received Meteor signal would be stronger with an outdoor antenna. A washing pole was conveniently situated between my house and its neighbour to the east, offering a secluded corridor of sky lying along Meteor-M2's high elevation descending morning passes, and a QFH antenna was lashed to it.

My first effort was encouraging: the pass contained almost 2½ minutes of flawless imagery, but was, of course, curtailed when Meteor's flight carried it behind rooftops. But this was a most encouraging improvement. Next, I raised the QFH on to the garage roof, which made a greater area of sky available. But this proved counter-productive as the interference returned. Repeated testing confirmed that the houses were blocking the interference when the QFH was mounted low down, so merely raising the antenna higher was not an answer.

The Final Solution

My plans were finally taking shape, but the scope of my images was being limited by this restricted corridor of sky. My home is situated on a south-facing hillside, and the back garden is, in the main, two metres lower than the house. Even though it is surrounded by buildings, trees and tall hedges, an antenna placed in the middle of the lawn would 'see' a much greater area of sky: my hope was that there would be an oasis of radio silence there. Figure 6 shows this antenna in situ, conveniently linked to the RTL-SDR dongle by a 30-metre length of coax fed through the kitchen window. The two curious cats in attendance are Felix and Rufus.

My first effort, with the QFH in this new location just two metres above ground, immediately bore fruit. Almost four minutes of perfect image resulted from the pass, by far my best at that time (figure 7). There was absolutely no interference with the antenna in this new location. A comparison with figure 1—the same pass captured on a second computer where the dongle was connected to a loft-mounted antenna—illustrates the vast improvement in image quality obtained.

I have improved matters still further by noting from a satellite tracking program whether each Meteor-M2 path lies to the east or west of my location. I then move the QFH from one side of the garden to the other to minimise the potential shielding effects of buildings, tall trees and a high hedge to maximise the area of clear sky beneath the satellite's track. This now guarantees me at least four minutes of perfect signal for any Meteor pass with a maximum elevation of 60° or greater. And with the highest elevation passes—over 70°—images of five minutes duration have been received (figure 8).

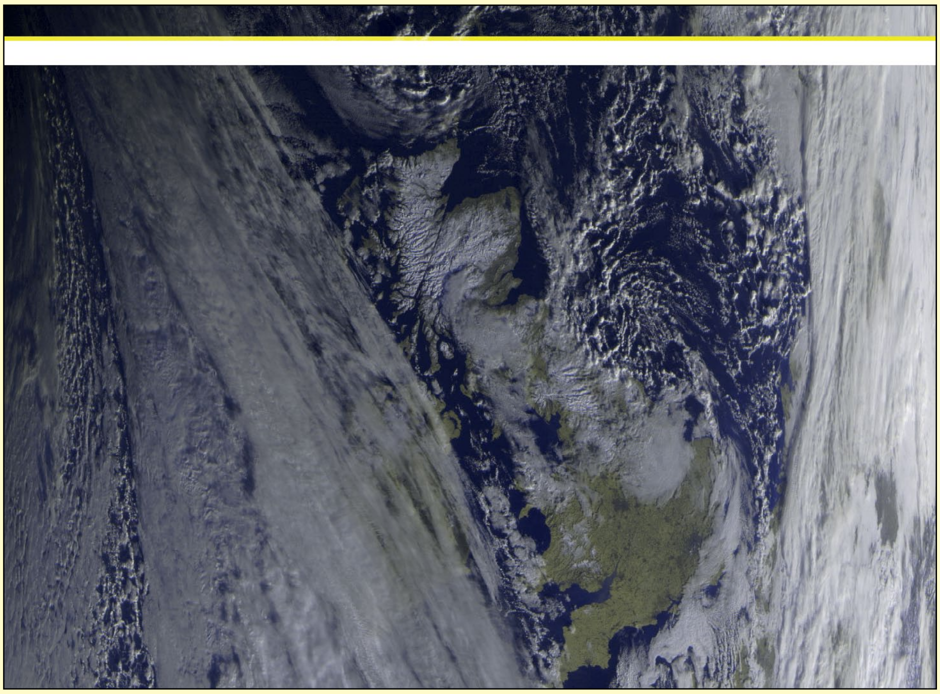


Figure 7 - This is the same Meteor-2M pass as shown in figure 1 but captured on a 2nd PC using a QFH antenna in the garden.

There does seem to be an issue regarding the strength of the Meteor-M2 signals. Having been used to successfully decoding NOAA APT even when the satellite was far to the east or west of my location, I find that Meteor passes with maximum elevation below 50° rarely deliver sufficient signal strength to decode any imagery at all. Other users, equipped with a preamp, seem to fare much better than I do, suggesting that it is probably best to use a preamp for reception of this satellite. Another pointer in this direction is my lack of success with the *Linux* solution. All my successful imaging has been on the *Windows* platform. I have decoded several passes using *Linux/GNU Radio*, which showed an excellent and stable constellation pattern during reception, only to find that the eventual image consisted of only a few scattered lines on an otherwise blank canvas. Everything

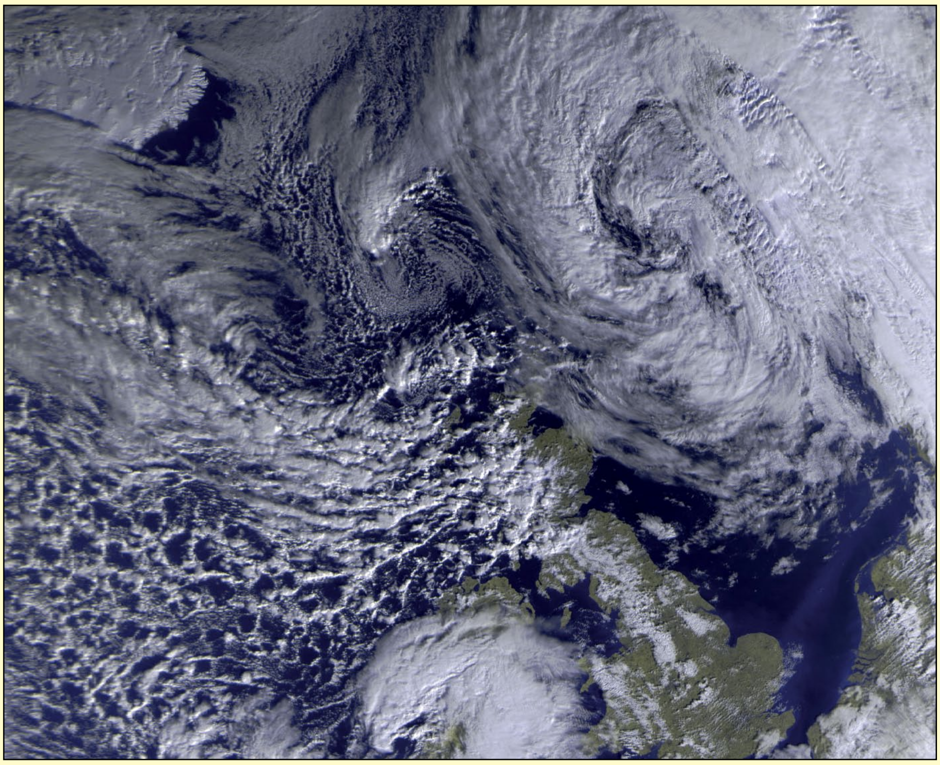


Figure 8 - One of my most interesting Meteor images so far, a full five minute uninterrupted pass on March 1, 2015. Iceland is prominent at upper left as shower clouds advance on Scotland, while much of England and the Netherlands are enjoying a sunny, spring-like day.

did seem to be going to plan, which again suggests to me that a preamp might make all the difference.

I do have one insurmountable problem on my southern horizon, where tall conifers in a neighbouring garden will always restrict my range south to approximately the latitude of Brittany. Nevertheless, this is more than enough to embrace the entire British Isles, which keeps me happy.

Overlap with NOAA Satellites

Combatting ground-level interference is one matter, but what happens when one of the NOAA satellites overlaps with Meteor M2 and potential interference arrives from the sky? I'm pleased to state that I have recorded a Meteor-M2 pass which coincided for many minutes with one from NOAA-19, and suffered no problems. The NOAA transmission is of course saved as a modulated audio tone, whereas that of Meteor is modulated on to the signal baseband by QPSK (Quadrature Phase Shift Keying).

Was it all worth it?

With three NOAA satellites still operating, and modern receivers such as my R2FZ completely rejecting the annoyance of pager interference in the 137 MHz band, were my efforts with Meteor-M2 justified? Absolutely!

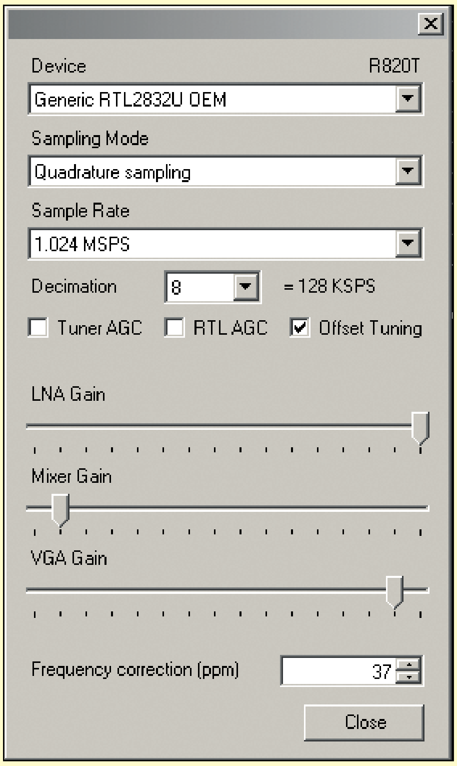


Figure 9 - The new RTL-SDR controller

Bearing in mind that NOAA APT imagery has a ground resolution of 4 km/pixel at best, Meteor LRPT images show far greater detail: they offer the same 1 km/pixel ground resolution as HRPT, albeit slightly downgraded, but the difference is scarcely noticeable. You can view a direct comparison between the LRPT and HRPT versions of the <u>same</u> Meteor transmission on Rob Alblas' website, at the following URL:

http://www.alblas.demon.nl/wsat/meteor_cmp.html

If you are fortunate enough to receive good horizon-to-horizon Meteor reception from your station, great. But even the five minutes maximum I can receive show a region stretching from Sweden to the English Channel, and in far greater detail than APT. Another advantage is that NOAA APT imagery is 8-bit whereas Meteor is 10-bit. Consequently, Meteor images have a greater range of tones, and winter images are far 'brighter' than their NOAA counterparts. Even at the turn of the year, it was still possible to make reasonable colour composite images from Meteor 2M transmissions.

Latest Developments

Raydel Abreu Espinet has advised us that a new SDR# driver for the RTL-SDR was recently made available on **rtl-sdr.ru** (figure 9). It provides manual amplification settings for the LNA/Mixer and VGA gain stages as well as software decimation. The three separate gain stages offer much greater control over optimisation of signal SNR and interference management. The decimation feature allows you to sacrifice some bandwidth for increased ADC bit resolution as well as allowing you to zoom in on the spectrum. It also means you can use a higher sample rate, which will improve SNR. The driver can be downloaded from

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

To install the plug-in, extract the updated DLL files from the ZIP file and copy them into your SDR# folder, replacing the older versions. There is a caveat here: if you have been using the unofficial GUSB SDR# driver (which features the manual amplification options, but <u>not</u> decimation), you must also remove its 'magic line' from the *<frontendPlugins>* section at the foot of the *SDRSharp.exe.Config* file.

Using Decimation

In addition to the new features described above, another advantage is that, by using decimation, you can save a WAV file that can immediately be decoded by the **LrptRx** software (i.e., you no longer need to downsample it using *Audacity)*. The recommended setting is a sample rate of 1.024 MSPS with a decimation of 8 which will produce a WAV file with sample rate of 128 kHz, more than enough for decoding the LRPT data. As usual, be sure always to tune 137.100 as the <u>centre frequency</u> and enable **Correct IQ** and **Offset Tuning**. I can add that I have been equally successful recording Meteor M2 using 2.048 MSPS with a decimation of 16. Figure 10 shows the appearance of the waveform in SDR Sharp when decimation is being applied.

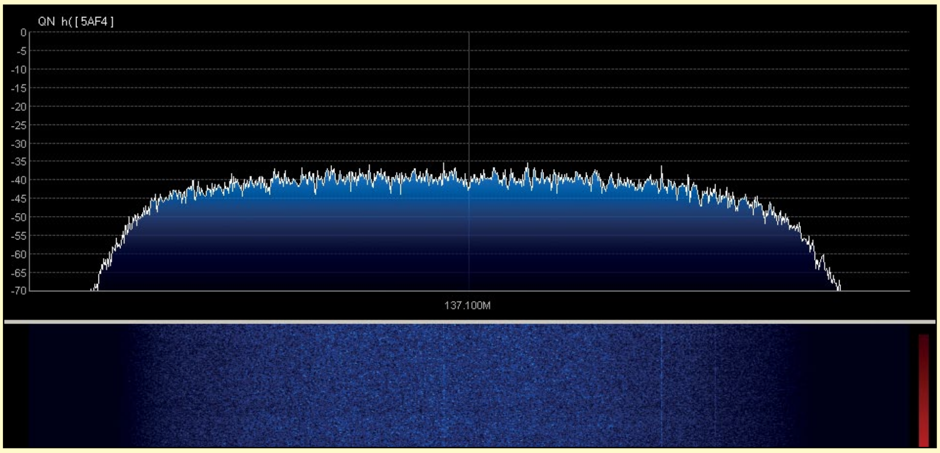


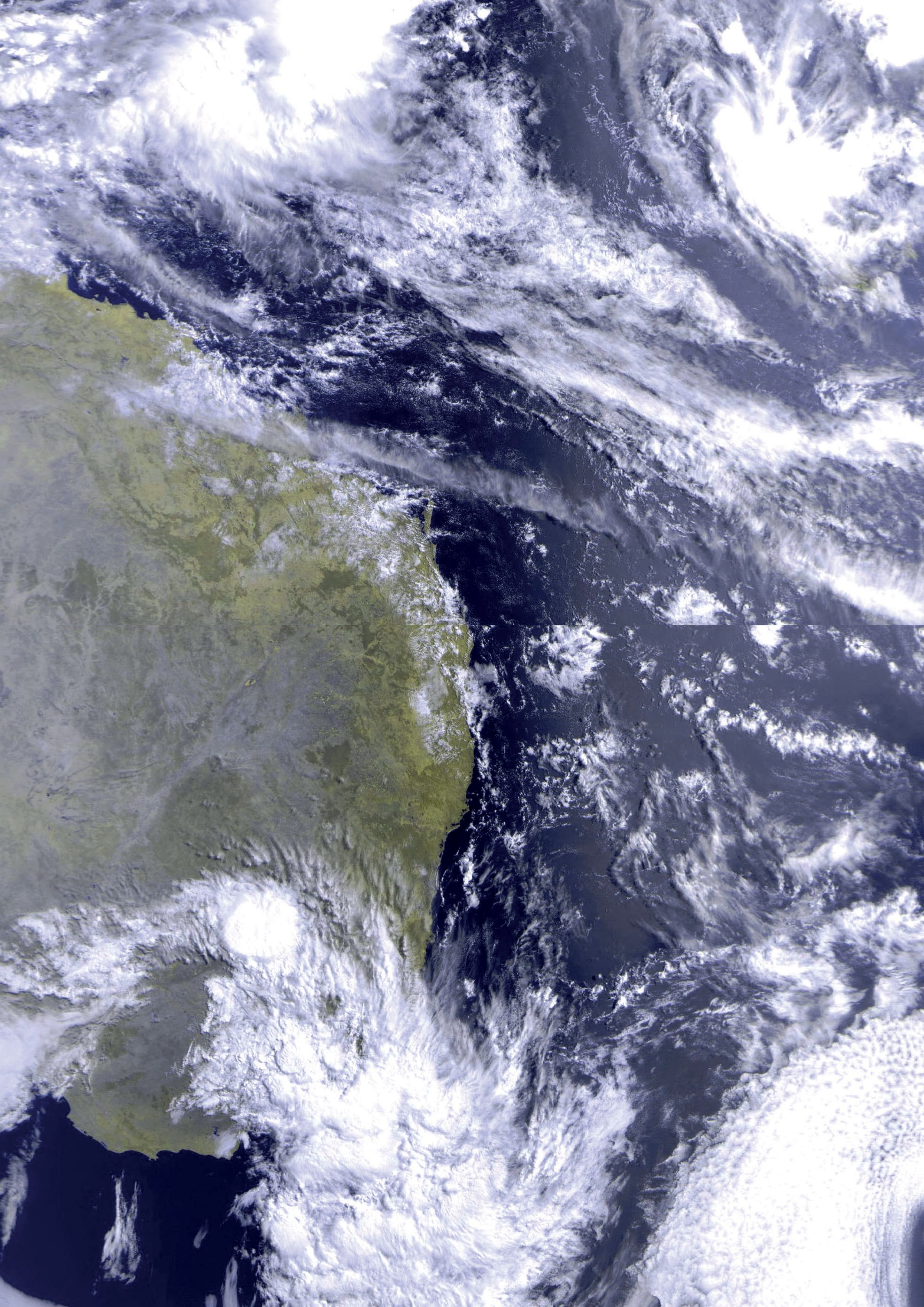
Figure 10 - A Meteor M2 LRPT signal being recorded using the decimation feature of the new SDR controller.

There is another caveat here: if you are in the habit of running the baseband recorder to save Meteor transmissions as 8-bit PCM IQ WAV files, these will <u>not</u> decode in **LrptRx**. You must be sure to save these WAV files as 16-bit PCM IQ (thanks to Peter Kooistra for advising of this essential point).

If you do inadvertently save a Meteor M2 file as 8-bit, it is easy to convert it to 16-bit: just load it into *Audacity* then resave it (without making any modifications to it). The file will now decode correctly in **LrptRx** because *Audacity* saves as 16-bit by default.

Reference

1 Receiving Meteor M with an RTL-SDR Dongle
Reydel Abreu Espinet: GEO Quarterly No 44, p.6 (December 2014)



Despite Antarctic Gains

Global Sea Ice Is Shrinking

NASA Earth Observatory

Claire Parkinson, Senior Climate Scientist based at NASA 's Goddard Space Flight Center, has been studying polar sea ice for about four decades and has been speaking to public audiences for nearly as long. And it was those public audiences which provoked one of the NASA climatologist's latest research projects.

"When I give public lectures or talk with people interested in the topic of polar ice" said Parkinson, "somebody will often say something like: '*The ice is decreasing in the Arctic but increasing in the Antarctic, so don't they cancel out?*'"
"The answer is no, they don't cancel out."

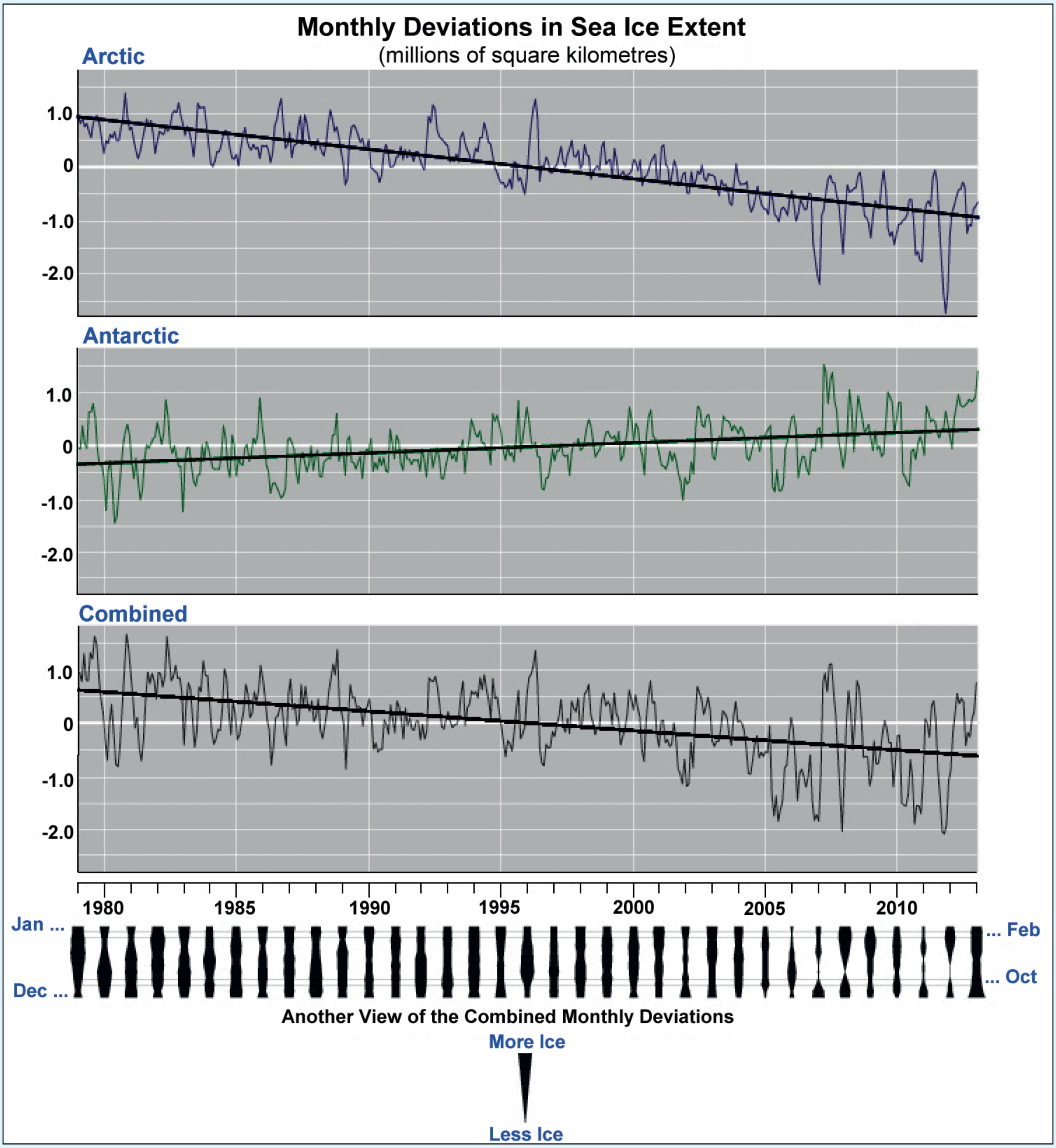


Figure 1 - Comparing monthly deviations in sea ice cover

During the past decade, sea ice around the Arctic Ocean has reached record lows several times, while the extent of ice around Antarctica has reached new highs. This has led to public misconceptions about climate change and the ice around Earth's poles. Parkinson's instincts and scientific experience told her that growth in one place did not necessarily offset losses in the other. But instincts are not enough. She dug into the data.

Examining 35 years of sea ice data, Parkinson has shown that increases around Antarctica do not make up for the accelerated Arctic sea ice loss of the last few decades. Earth has been shedding sea ice at an average annual rate of 35,000 square kilometres since 1979—the equivalent of losing an area of sea ice larger than the state of Maryland every year.

Even though Antarctic sea ice reached a new record maximum in September 2014, global sea ice is still decreasing because the decreases in the Arctic far exceed the increases in the Antarctic.

The line graphs in figure 1 plot the monthly deviations and overall trends in polar sea ice from 1979 to 2013, as measured by satellites. The top line shows the Arctic, the middle one Antarctica, while the third line shows the global, combined total. The sparklines at the bottom of the graphs show each year separately, enabling month-to-month comparisons across each year. The thickness of each sparkline indicates the overall growth or loss in sea ice globally. The thinning of the sparklines is indicative of the downward trend in total polar sea ice.

Parkinson analysed microwave data collected by NASA and the US Department of Defense satellites between November 1978 and December 2013. She determined the global ice extent for each month (figure 1) and found that the global trend was down in all months of the year—even those corresponding to the Arctic and Antarctic sea ice maxima. The findings were published in December 2014 in the *Journal of Climate*.

Furthermore, the global sea ice loss has accelerated. From 1979 to 1996, the ice loss was 21,500 square kilometres (km^2) per year. This rate accelerated from 1996 to 2013 to 50,000 km^2 lost per year, annual losses larger than the states of Vermont and New Hampshire combined. The maps in figure 2 and figure 3 show respectively the extent of Arctic and Antarctic sea ice in 1979 and 2013.

Sea ice has diminished in almost all regions of the Arctic, whereas the increases in the Antarctic are less widespread geographically. Although sea ice cover expanded in most of the Southern Ocean between 1979 and 2013, it decreased substantially in the Bellingshausen and Amundsen seas. These two seas are close to the Antarctic Peninsula, a region that has warmed significantly in recent decades.

Parkinson also found that the annual cycle of global ice extent is more in line with the annual cycle of Antarctic ice than Arctic ice. The global minimum ice extent occurs in February, as does the Antarctic minimum extent. The global maximum sea ice extent occurs in either October or November, one or two months following the Antarctic maximum. This contrasts with the Arctic minimum (September) and maximum (March).

Averaged over the 35 years of the satellite record, the planet's monthly ice extents range from a minimum of 18.2 million km^2 in February to a maximum of 26.6 million km^2 in November.

One of the reasons people care about sea ice decreases, is because sea ice is highly reflective, whereas the liquid ocean is very absorptive. When sea ice coverage is reduced, less sunlight is reflected back into space and more is trapped in the atmosphere, ocean and land.

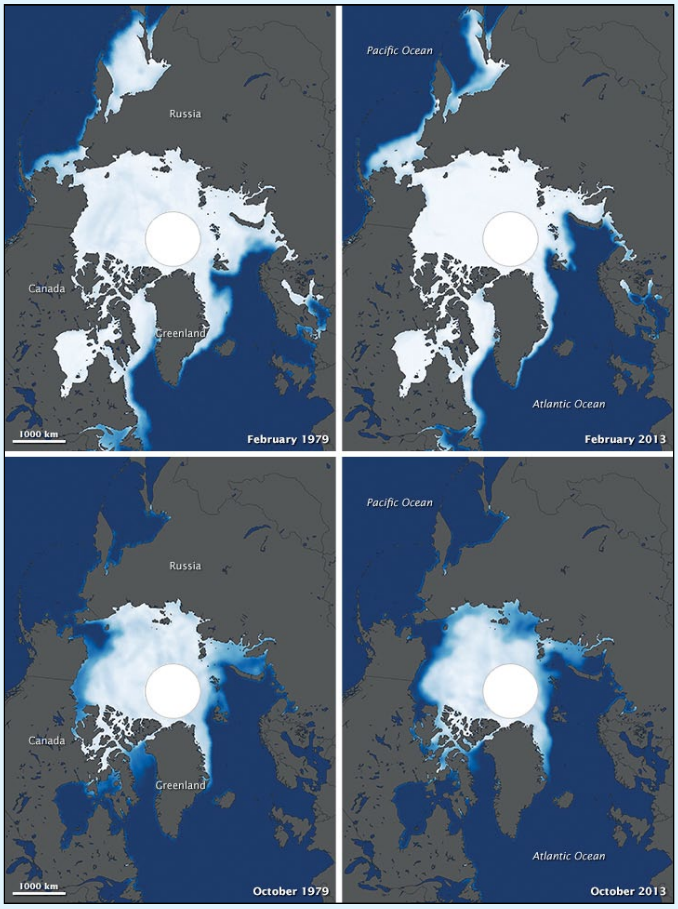


Figure 2 - Arctic ice extent in 1979 and 3013

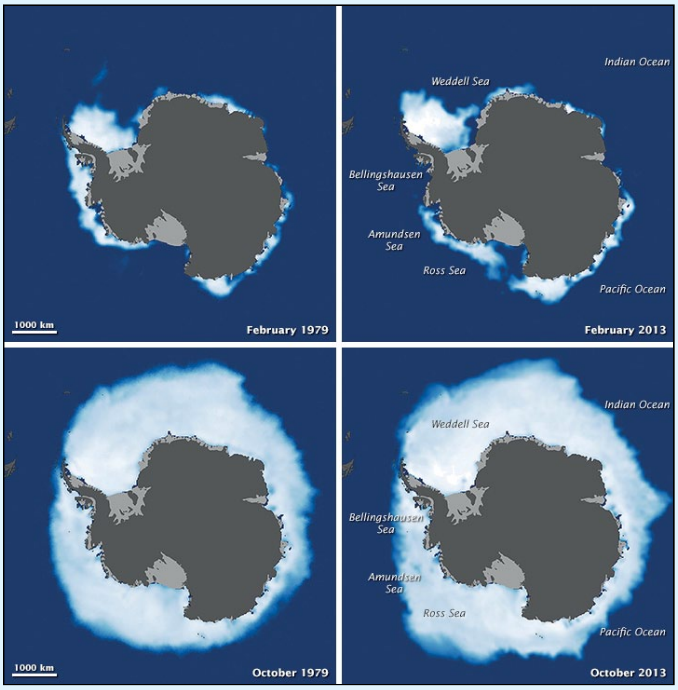
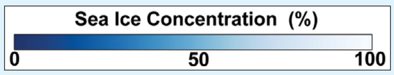


Figure 3 - Antrctic ice extent in 1979 and 3013

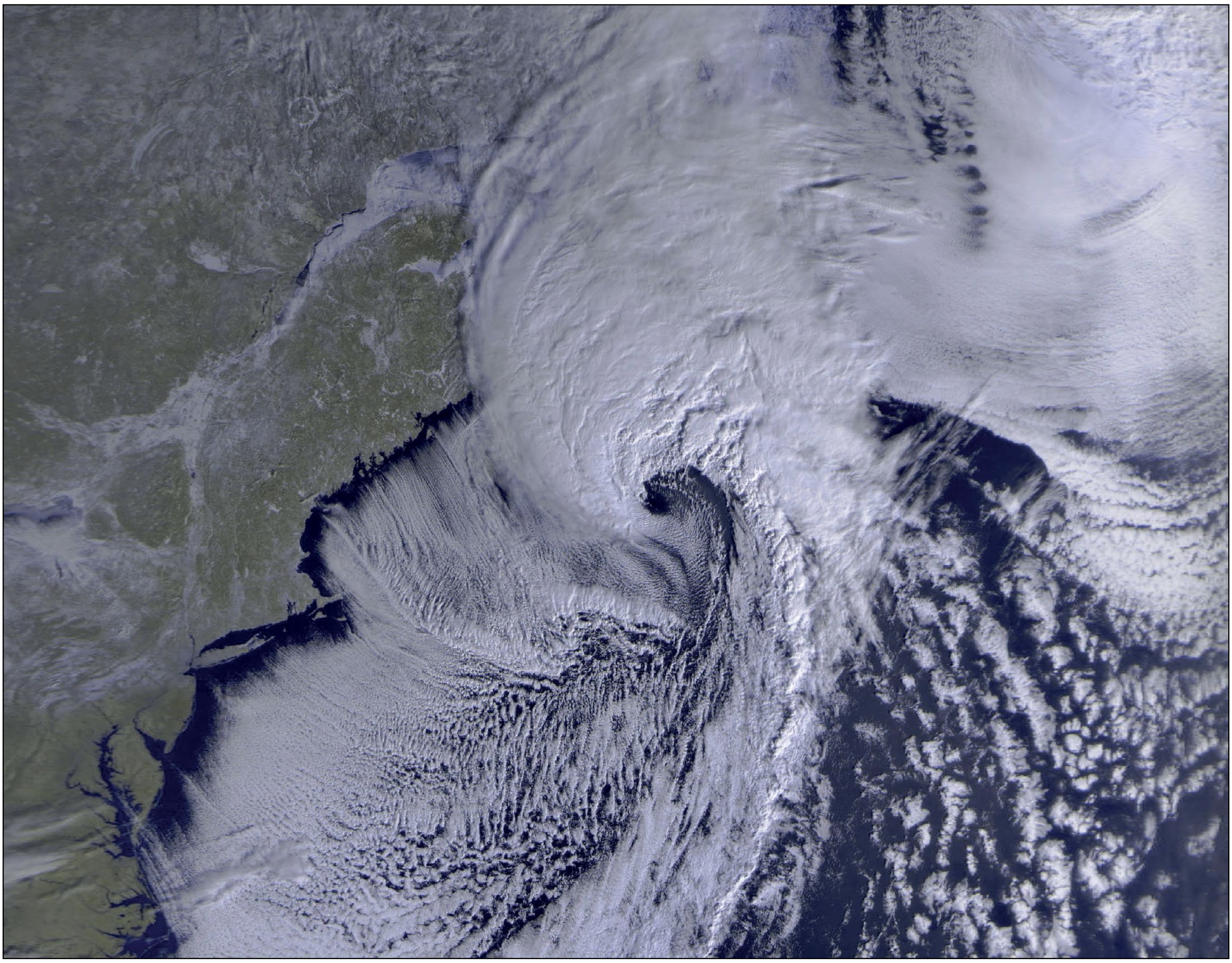


Credits

Earth Observatory images by Joshua Stevens
Text by Maria-Jose Vinas and Mike Carlowicz.

Instruments

The Special Sensor Microwave/Imager (SSM/I) aboard the Defense Meteorological Satellite Program (DMSP) F8, F11, and F13 platforms and the Special Sensor Microwave Imager/ Sounder (SSMIS) aboard DMSP-F17)



The eastern United States has been battered by a number of severe winter storms this year. Jim Scheffler captured this Meteor M2 image on February 3, showing intricate cloud detail of a storm that left a metre of snow on the ground, with more expected the following weekend.

End of Line Stock from the GEO Shop

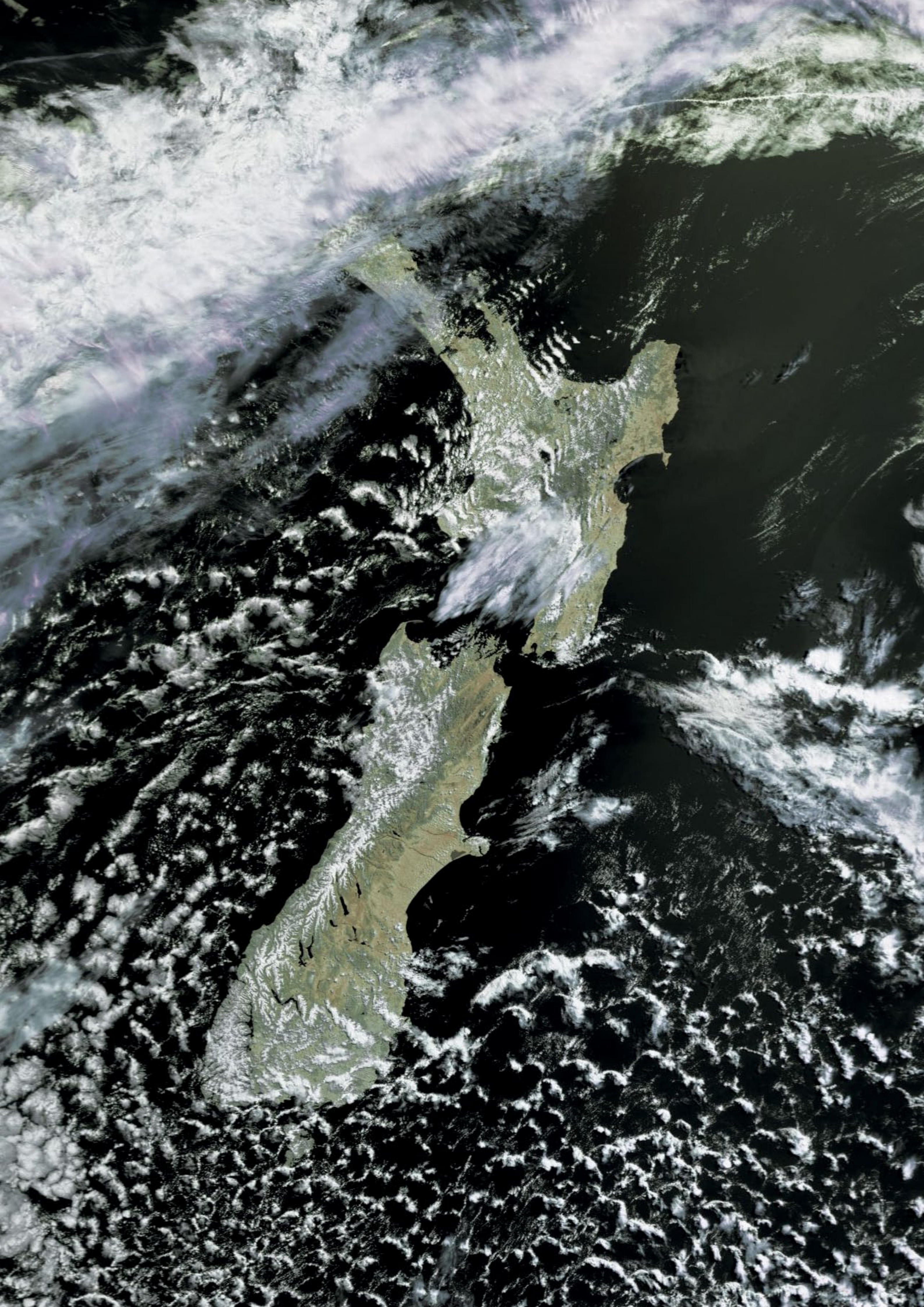
The *Sandpiper* turnstile antenna is ideal for the reception of both NOAA APT and Meteor LRPT on 137.1 MHz. No more are being manufactured and we have only a very few left in stock.

UK only: Members £71.00 Non members £83.50

The DVB World DVB-S USB2102 is a superior 'free-to-air' DVB satellite TV and data receiver. No longer suitable for EUMETCast reception, it remains fully serviceable for the reception of DVB Television on a PC.

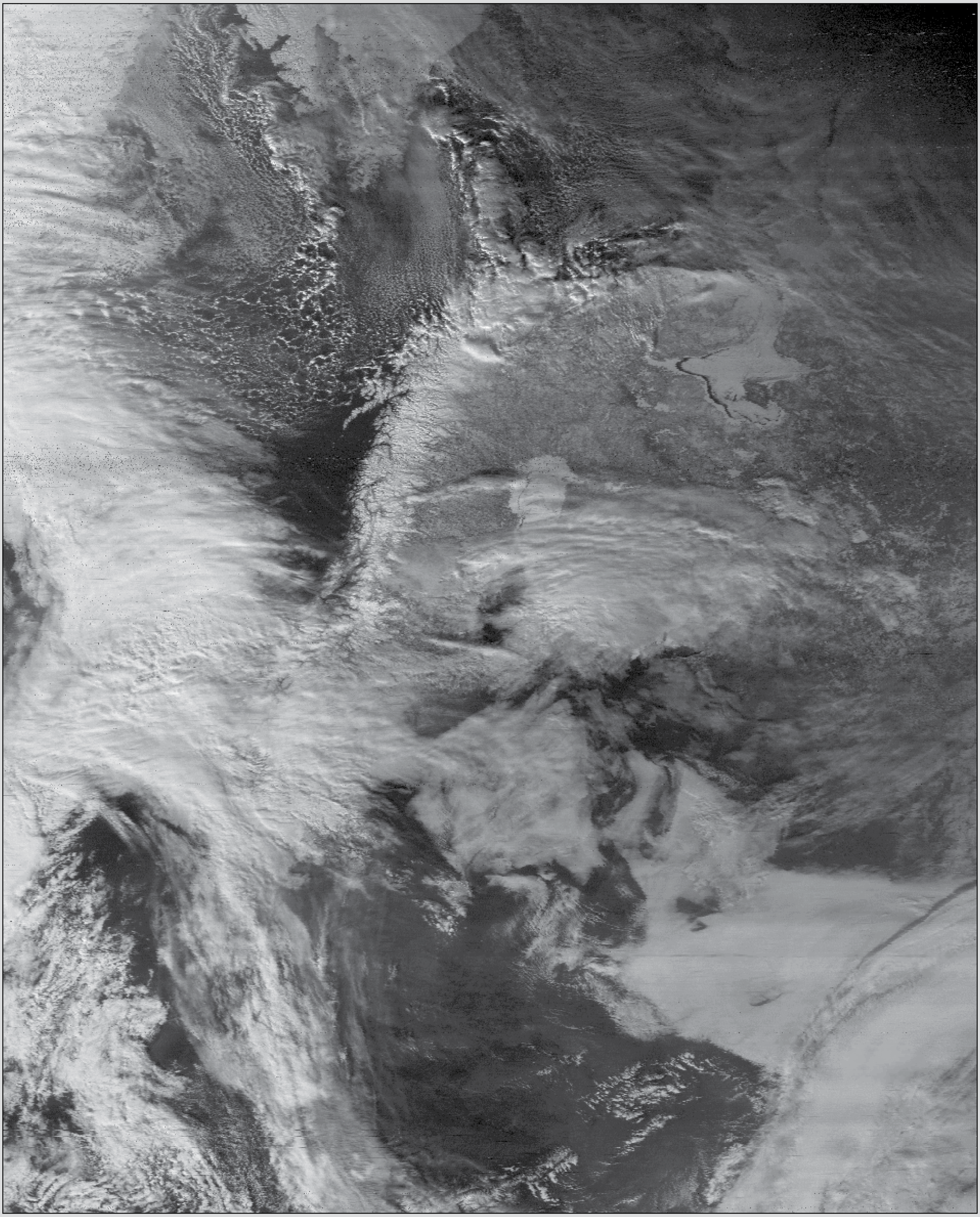
Only a very few remain in stock.

UK Members: £50.60 Non members £60.60
EU Members: £57.00 Non members £67.00

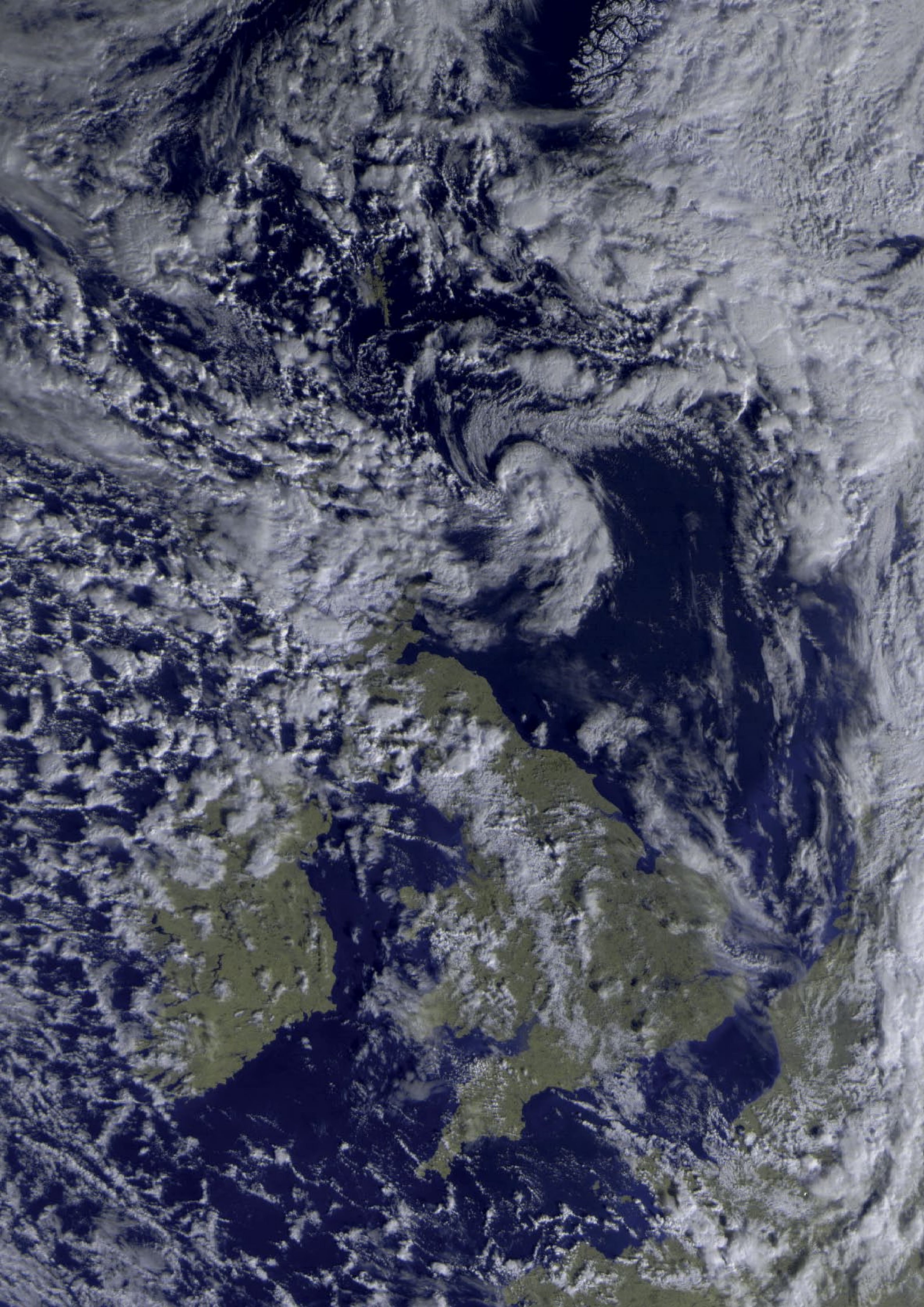


From the Archives

Les Hamilton



This is a Russian Meteor 3-03 APT satellite image from March 17, 1991, showing Scandinavia still firmly in the grasp of winter. It was received on 137.85 MHz, using a turnstile antenna and *Proscan* receiver followed by image processing with Christian Bock's *WXSat* software. Compare with the recent Meteor M2 image of the British Isles on the following page to reveal the great strides taken in satellite imaging since then.



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]

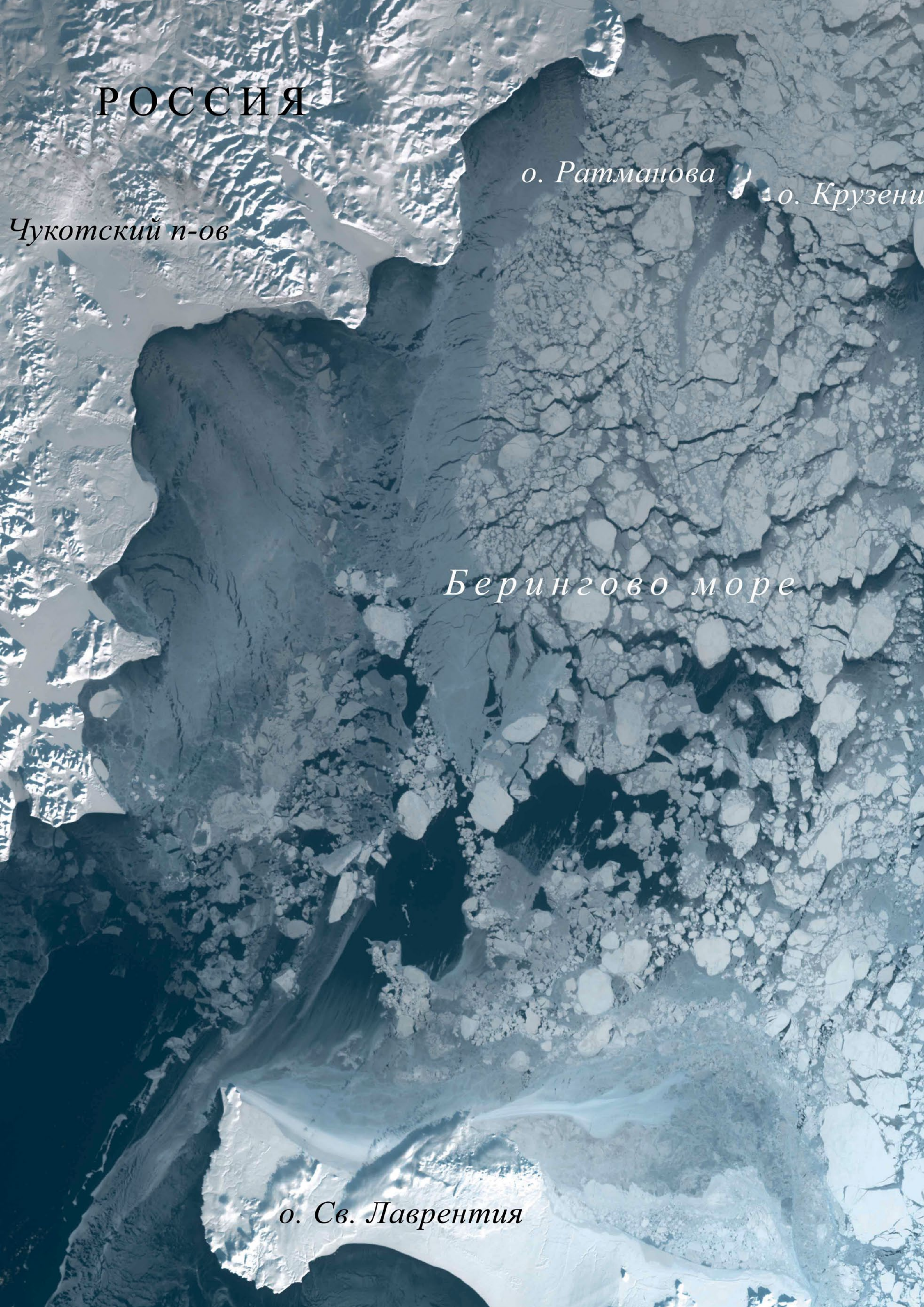
Polar HRPT/AHRPT Satellites				
Satellite	Frequency	Mode	Format	Image Quality
NOAA 15	1702.5 MHz	Omni	HRPT	Weak
NOAA 18	1707.0 MHz	RHCP	HRPT	Good
NOAA 19	1698.0 MHz	RHCP	HRPT	Good
Feng Yun 1D	1700.4 MHz	RHCP	CHRPT	None: Device failure
Feng Yun 3A	1704.5 MHz	---	AHRPT	[2]
Feng Yun 3B	1704.5 MHz	---	AHRPT	[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

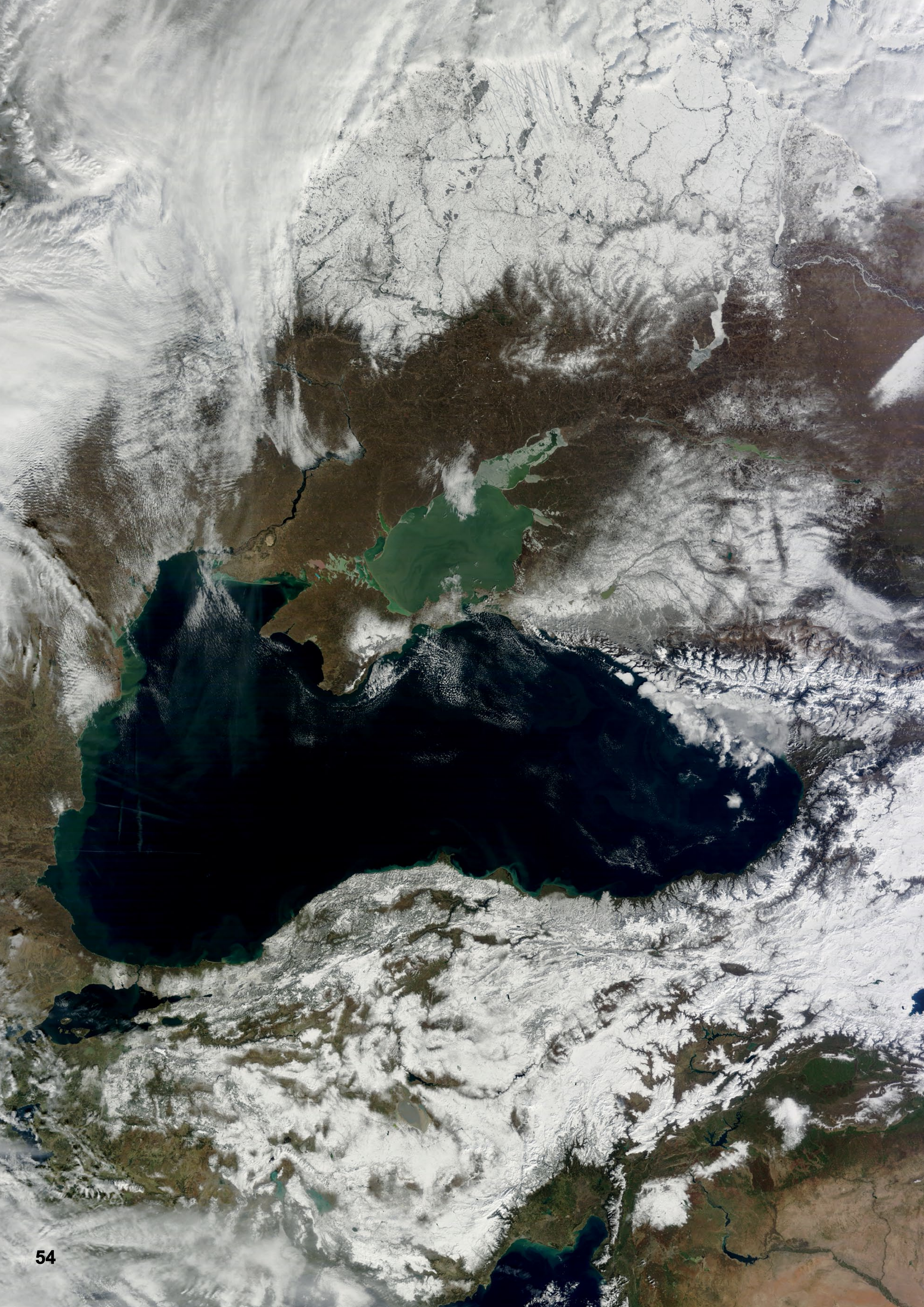
Geostationary Satellites				
Satellite	Transmission Mode(s)		Position	Status
Meteosat 7	HRIT 1691 MHz / WEFAX 1691 MHz		57.5°E	On
Meteosat 8	HRIT (digital)	---	3.5°E	Standby [3]
Meteosat 9	HRIT (digital)	LRIT (digital)	9.5°E	On [4]
Meteosat 10	HRIT (digital)	LRIT (digital)	0°W	On
GOES-13 (E)	GVAR 1685.7 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	On
Feng Yun 2E	SVISSR	LRIT	104.0°E	On
Feng Yun 2F	SVISSR	LRIT	112.0°E	On

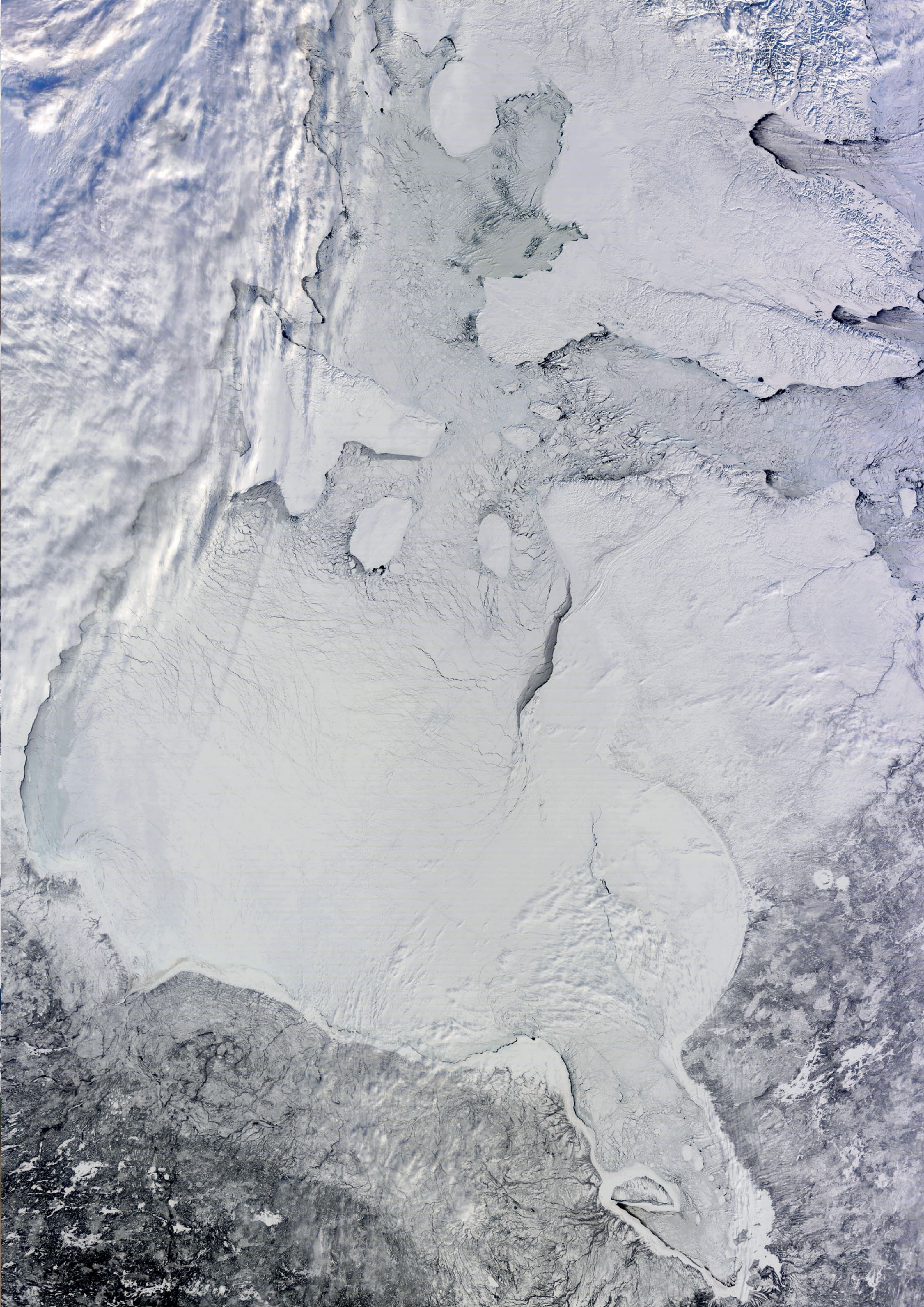
Notes

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

Paul Geissmann (see article on page 35) sent in this image showing a fox caught on his webcam during the night


РОССИЯ
о. Ратманова
о. Крузенш
Чукотский п-ов
Берингово море
о. Св. Лаврентия





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/

Group for Earth Observation

Membership Application Form

PayPal

MasterCard Maestro VISA AMEX VISA Electron

Current Subscription Rate for <u>All Members</u> is £15

This will bring you 4 electronic (PDF) GEO Quarterlies
You will also be mailed a *printed copy* of the December issue

You can make your annual GEO Membership payment by any of the following methods:

- **PayPal** - Visit the GEO Shop website at ***http://www.geo-web.org.uk/shop.php*** and add your subscription to your basket
- UK residents may pay by means of a **personal cheque** or **Postal Order** made payable to '*Group for Earth Observation*'
- Payment by **direct bank transfer** can be arranged. Please email ***members@geo-web.org.uk*** for BIC and IBAN details.

Name (please PRINT clearly)

Address

Town/City

Postcode/ZIP

Callsign

Country

Telephone Number

FAX

Email Address (please print **very** clearly)

Declaration

I wish to join GEO, the Group for Earth Observation, for a period of one year.

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 administration purposes.

Signature

Date

Your subscription is valid for one year 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

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

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 - £365.00
EU members price - £375.00

Receive NOAA APT and Meteor M2 LRPT with an SDR-RTL dongle

This RTL2832 R820T dongle for SDR DAB DAB+ and FM radio has a frequency range from 24 to 1700 MHz, and comes complete with an SDR Driver CD, 2 MCX-SMA aerial patch leads and 5 adapters (SMA/BNC male and female, BNC-SO239, and SMA male/SMA male).

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

Current Price List

	Members' Prices			Prices for non-Members		
	UK	EU	RoW	UK	EU	RoW
Ayecka SR1 DVB-S2 Receiver	365.00	375.00	380.00	---------	---------	---------
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	---------	--------	--------
Sandpiper Turnstile Antenna	71.00	---------	---------	83.50	---------	---------
GEO-PIC 1.0 for the RX2 Receiver	7.00	7.80	8.40	7.00	7.80	8.40
Martelec MSR40 EPROM	10.00	10.75	11.25	10.00	10.75	11.25
80 cm dish	72.00	---------	---------	79.00	---------	---------
Ku band universal LNB	13.70	15.20	---------	20.20	21.70	---------
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

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

80 cm Dish

This quality solid steel offset dish, designed for digital and analogue reception, is coated with electrostatic polymer. The bracket has been heat dipped and zinc treated for maximum corrosion protection. Complete with LNB.

UK members price - £72.00
UK non-members price - £79.00

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.

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.

GEO Quarterly - Back Issues

(Only available to GEO Members)

Paper copies of back issues of GEO Quarterly <u>may</u> 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

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 PIC 1.0 for the RX2

Programmed with the new channel frequencies required for NOAAs 18/19.

UK members price - £7.00
UK non-members price - £7.50

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