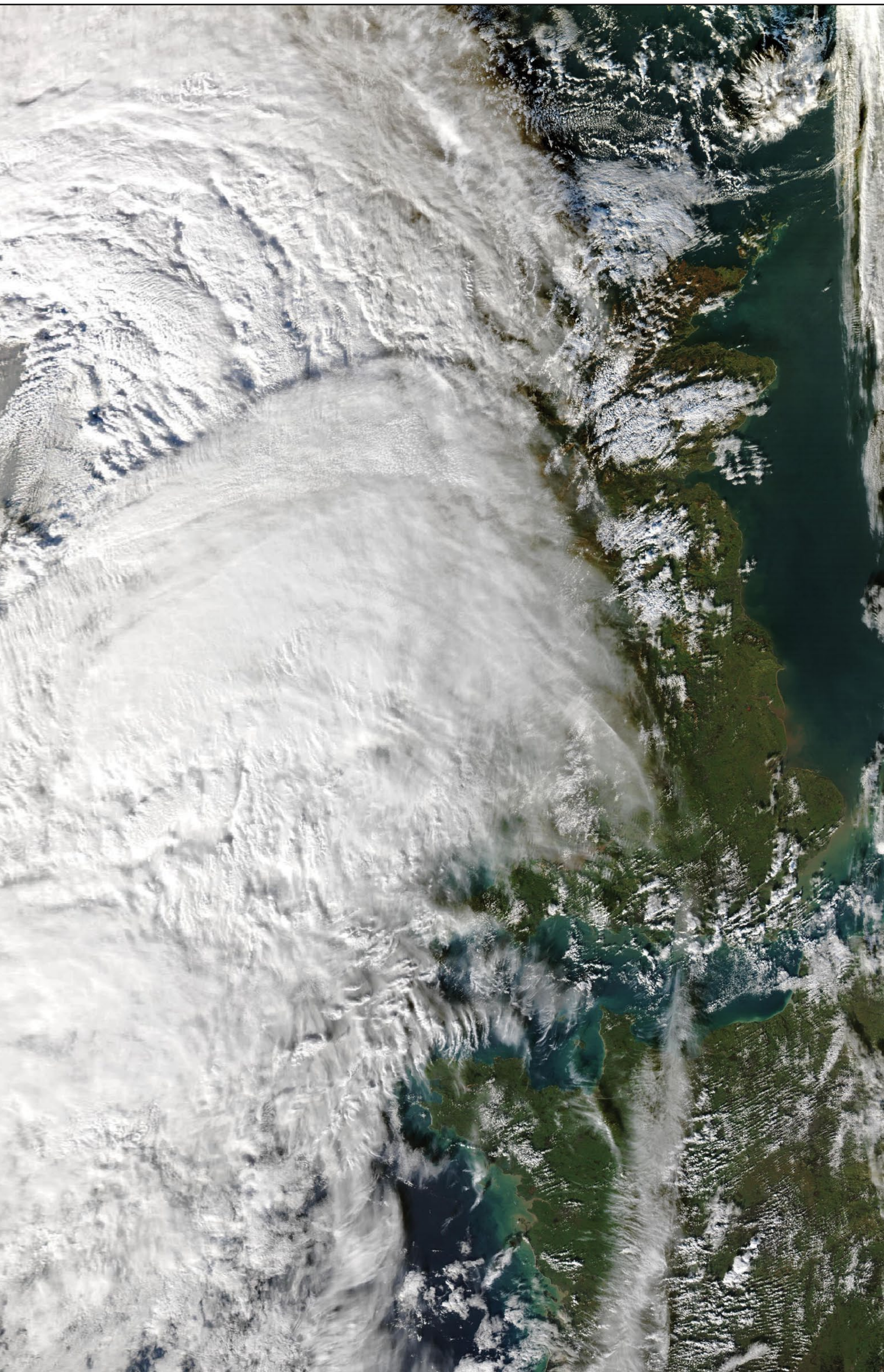
The GEO Quarterly

Group for Earth Observation

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

49

March/April 2016



Inside this issue . .

This issue coincides with the first imagery received from ESA's newest Copernicus satellite, Sentinel 3A. You can view some of these striking images inside, and read about the capabilities of this exciting new satellite.

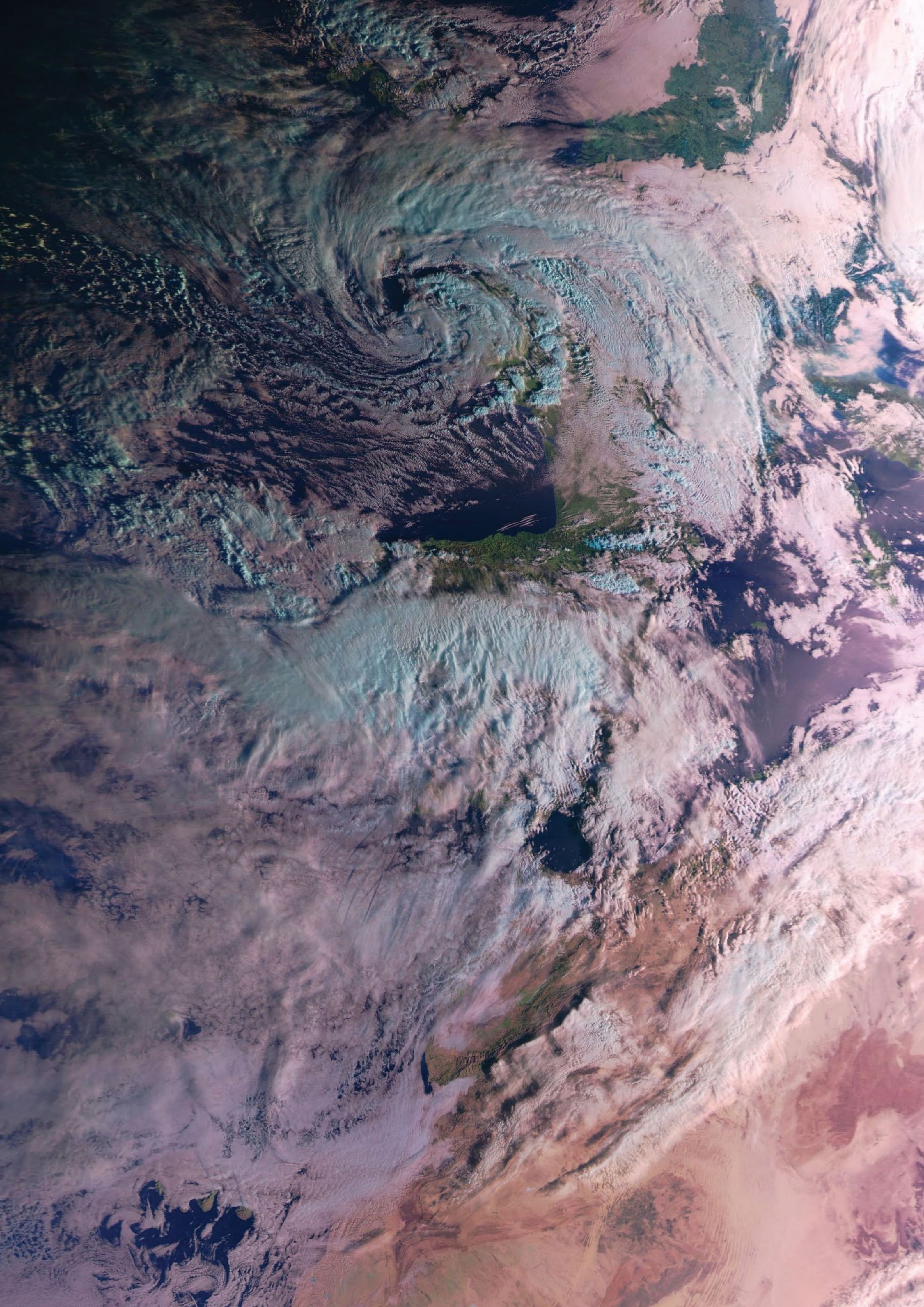
There are two articles relating to hole-punch clouds in this issue: one, a particularly colourful example from Australia and the other a view from satellite, over Mississippi and Louisiana.

John Tellick writes about ESA's Proba-1 satellite, which is still providing remarkable images 15 years after gaining orbit.

A year on from the EUMETCast changeover to DVB-S2, John Barfoot shares some tips that could improve members' experiences.

On the Russian satellite scene, Les Hamilton brings you up to date with the latest news, in particular the transfer of LRPT transmissions to the older Meteor M1 satellite.

And there is a host of articles from NASA's Earth Observatory website dealing with such varied topics as El Nino, Hofsjokull Ice Cap, the Northwest Passage and cloud streets over the Great Lakes.



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

As you will no doubt have realised by now, this Quarterly has arrived rather later than normal, hence its 'March/April' branding. By Copy Deadline I had received only a handful of contributions from readers, and must thank Francis Bell and John Tellick in particular for sourcing material for me well past the 'last minute' for acceptance.

Even so, a full Quarterly has only become possible through my extensive raids on NASA websites for material, as you can appreciate from the 'Contents' table below. Over the years I have used this option to fill the odd blank page: in this issue, it is the predominant contributor.

On a more cheerful note, following a suggestion from a member, GEO is prepared to **celebrate the 50th issue of the Quarterly** by providing every reader with an extra printed paper copy at no extra cost. Of course, we must have content worthy of such a move, and this is where **you** come in. We require articles worthy of this issue from our members, by the copy deadline below. You can read more about this on page 8.

Meanwhile, I hope you enjoy our first issue of 2016. It has taken a great deal of hard work to put this together.

Copy deadline for the June issue of GEO Quarterly is Sunday, May 29, 2016.

Contents

The GEO Report

Francis Bell

The past two months have kept me very busy both with my GEO activities and my amateur radio interests. The text below is a reminder about our **Symposium** meeting, to be held on Saturday April 23, 2016, at the **National Space Centre**, Leicester. It has taken me a long time to negotiate with the institutions for whom the speakers work but the effort is currently looking very worthwhile because of the qualities and experience of those who have already agreed to attend. All are experienced and will bring us up-to-date with the latest satellite developments.

During the time I was engaged with the symposium planning, I was contacted by the BBC who wanted to celebrate the 25th anniversary of Helen Sharman's time on the MIR space station. Helen Sharman was the first British astronaut. I guess the BBC's interest in her flight was precipitated by the fact that Tim Peake is now on the ISS, and over the next few weeks there are plans to have radio contacts between him and a number of UK schools.

In fact, 25 years ago, I was the very first amateur to speak with Helen Sharman on MIR, and this was followed the next day with my school's radio group holding a planned question and answer session with Helen. With my cooperation and contacts, the BBC went to a lot of trouble to reconstruct our Royal Grammar School's contact with MIR, making their recordings close to the original radio room in the school, together with the original radio equipment. The BBC recordings also included two of the original 'boys' involved with the contact, now about 40 years old, plus Helen Sharman herself, but this time located somewhere in London and not a few hundred of miles out in space. After their recording session in Guildford, the BBC team travelled on to a Bristol school where a scheduled contact was due with Tim Peake on the ISS. This turned out to be successful.

The recordings eventually formed part of the BBC 1 programme the 'One Show' which was shown on February 26, 2016. The effort on the part of the BBC and others to make this recording was considerable, all for less than a five minute on air: nevertheless it was a fun experience!

My interest with the ISS continues, and I regularly record images from the experimental HDTV cameras carried on it.

Reminder of GEO's Symposium Meeting 2016

I hope most of our GEO members will have already noted the date and location of our symposium, which is Saturday April 23, 2016, at the National Space Centre, Leicester. A full page notice about this event did appear on page 10 of our previous issue, GEO Quarterly No 48, in December 2015. Since that date there have been confirmations from a number of invited speakers although others remain outstanding.

My personal ambition for this meeting has related to gaining information abut the additional Earth observation data streams we can expect to receive from EUMETSAT and other sources in the near future. A few years ago, the European Commission provided the initiative for the **Copernicus** project which promptly evolved into the planning of a series of Earth observation satellites monitoring the land, oceans and atmosphere.

Francis Bell speaking live to Helen Sharman as part of the BBC's reconstruction of the radio contact with Helen on the MIR space station 25 years ago. From left to right: Francis Bell, Angellica Bell (BBC presenter) and Old Boys Peter Hibbs and Les Starkie.

This is an image from an ISS HDTV camera looking almost south. The image shows a slightly oblique view of the southern tip of Africa with Namibia in the lower foreground and the Cape of Good Hope centre right. Live images from these experimental cameras are available most of the time, just visit the web site referred to in the Beginners' Checklist on page 29.

This '*Sentinel*' series of satellites was judged more appropriate than one or two giant satellites similar to the recently decommissioned *EnviSat*.

Several of these *Sentinel* satellites have already been launched and are providing stunning images. The great bonus for users is the underlying philosophy of the programme: that the data is to be made freely available to end users.Some images are already available from ESA but my understanding is that future dissemination is to be split between ESA and EUMETSAT. It is this programme of data dissemination, together with other topics, which I hope can be a core focus during our Symposium. I know EUMETSAT are testing their new High Volume Service (HVS) but further advice about its reception would be most welcome at our meeting.

The confirmed speakers for the day are as follows:

- Dr Hartmut Bosch, Head of Earth Observation Science Group, University of Leicester
- Nicholas Coyne Dissemination Engineer, EUMETSAT
- Thomas Ormston Scientist ESOC (This may be a video contact rather than attending in person)

- Outstanding invitations are still with NOAA and Surrey Space Centre.

It already looks as though we will enjoy a busy and worthwhile day of activities, but I would continue to welcome contributions from our members, relating to sharing their own personal skills and experiences from which we can all benefit. Please volunteer if you can contribute to the day's programme: a presentation or display would be equally appreciated.

Please contact me directly, by email, if anything needs planning in advance

francis@francisbell.com

We will hold a members' AGM towards the end of the day.

Registration

You can just turn up on the day, even with non-member guests, but it helps the administration process if you can register in advance. Just email your details to

liaison@geo-web.org.uk.

Cost

We try to keep costs to a minimum but do have to pay for the hire of the venue: hence there will be a charge of £15 per person. The bonus here is that this includes free car parking and free entry into the NSC exhibition areas.

Location

Just to remind you the NSC is located 1.5 miles north of Leicester city centre with its rail and bus services. By car the approach to the NSC is well signposted.

Accommodation

If you are staying overnight in Leicester there are many modestly priced hotels. A hotel many GEO members have used in the past is the

Ibis Hotel,
St George's Way,
Constitution Hill,
Leicester LE1 1PL
Tel: (+44) (0)1162487200

You can also contact them via the Internet:
Google 'IBIS LEICESTER CITY HOTEL'.

Timings

Registration will be from 9.00 am, and we have to clear the premises by 5.00 pm. Lunch and coffee breaks during the day will be included in the program.

I look forward to seeing many of you on April 23, 2016. Please remember to promote this meeting with your friends because non GEO members are welcome to attend as well. And a final reminder that free parking and free access to the NSC Exhibition areas are included in the cost of entry.

Meteor Satellite News

LRPT Data Switches to Meteor M1

Les Hamilton

Last issue we revealed that Russia's **Meteor M1** satellite, which had been silent for thirteen months, had been reactivated on November 6, 2015 and, for a while, we had two Meteor satellites transmitting LRPT imagery. But in the months since, Meteor M2 has ceased transmitting LRPT, while Meteor M1,which has negotiated a number of problems. now disseminates the LRPT data.

Meteor M1 (2015)

On reactivation, Meteor M1 was initially transmitting channels 1, 2 and 3, but the two former were operating well below strength. This meant that colour composite images could not be produced and only the greyscale imagery from channel-3 was significant [1]. On the ascending evening pass of November 12, the transmission format was changed to channels 3, 4 and 5, affording an excellent channel-5 infrared image of a storm heading northwards over the North Sea (figure 1). Ireland is clearly visible, left-centre at the foot of the image; Iceland can be seen at upper left.

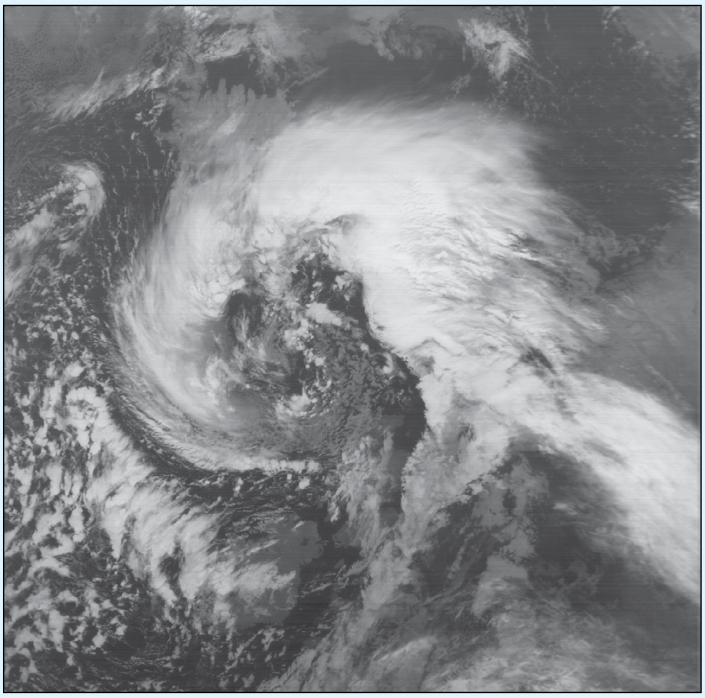


Figure 1
A Meteor M1 channel-5 infrared image acquired at 19:36 UT on November 12, 2015

What was quickly apparent in all Meteor M1 images was the fact that no image could be decoded until the satellite was high in the sky, generally between 50° and 60° elevation from my location in northeast Scotland. This has been widely attributed to an antenna pointing problem: it is speculated that it had failed to deploy fully, and that signals from it were being partially shielded by the body of the satellite itself.

Alas, this transmitting format proved short lived because the infrared sensors failed on December 1. The final channel-5 image I obtained appears in figure 2.

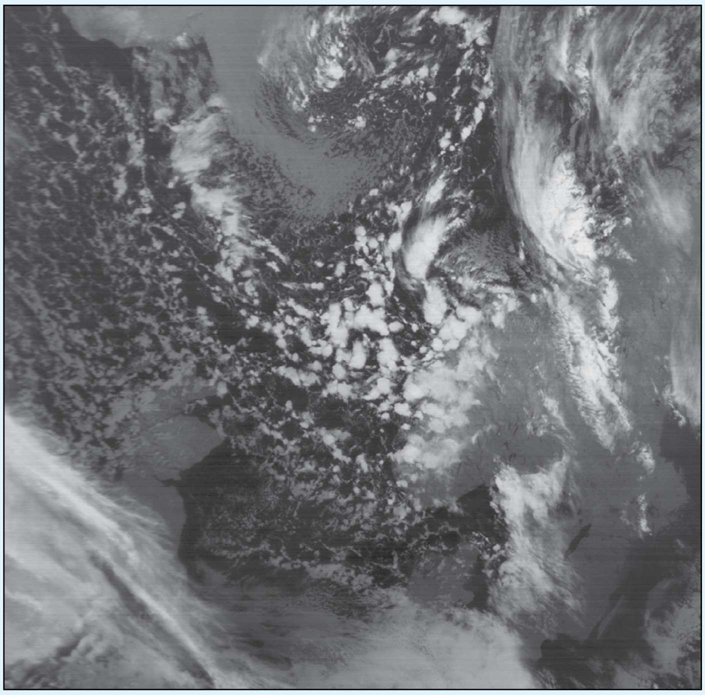


Figure 2
The final Meteor M1 channel-5 infrared image, acquired at 18:14 UT on November 30, 2015

Meteor M1's output immediately changed back to channels 1, 2 and 3, now all transmitting at full strength. Figure 3 shows a colour composite image created from the morning pass on December 4. The image is bright to the east and dark to the west because the satellite was flying close to the terminator between night and day.

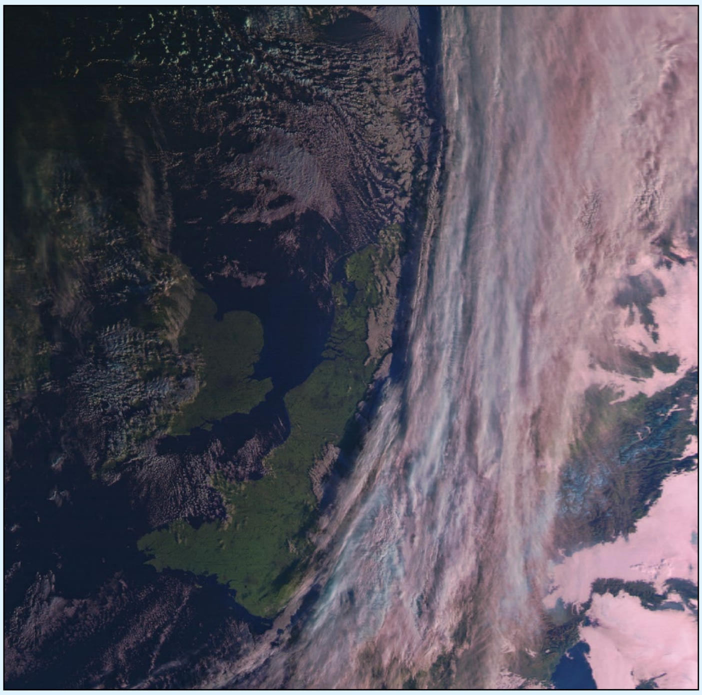


Figure 3
This Meteor M1 RGB123 composite image was acquired at 08:41 UT on December 4, 2015

Continuing Problems

But all was not well with Meteor M1, which was known to have had pointing problems at the time it was switched off in favour of Meteor M2 in 2014. Indeed, officials reported at that time that the failure of the attitude control system had rendered the satellite inoperable. But clearly, Meteor M1 has been brought back into a usable state, even though some recent images have been obtained which clearly give an oblique view of the countries below, and which include a section of Earth's limb (figure 4).

Figure 4
This skewed image from December 21, 2015, shows Meteor M1 pointing towards the eastern horizon.

Another ongoing problem, which reared its head most noticeably during the shortest days of the year, was an inability to produce coherent images until Meteor M1 had descended well into the illuminated hemisphere. An example is shown in figure 5. I don't recall anyone venturing an explanation, but as the effect always disappeared as the overall illumination increased, it may well be that the craft's ageing batteries are unable

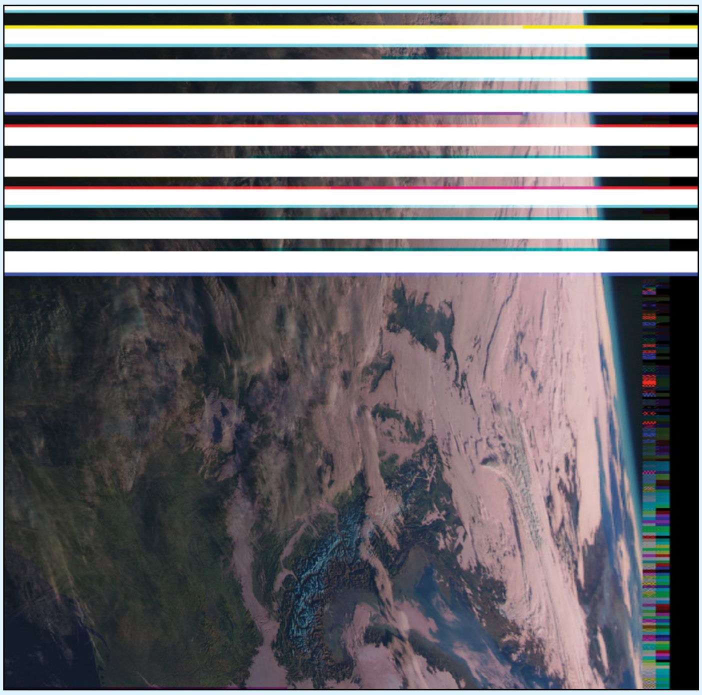


Figure 5
This image from December 19 shows Meteor M1 struggling to transmit its imagery. There is also a degree of skew towards the horizon.

to supply Meteor M1 with all the power it requires throughout its traverse of Earth's dark side.

Meteor M2

It proved a big surprise when LRPT signals from Meteor M2 suddenly ceased after December 10, 2015 (and have not been restored three months later). It was a given that the footprints of the two Meteors were due to overlap for a spell during January 2016, and it was anticipated that Meteor M1 would be switched off at that time.

It eventually transpired that the LRPT suite aboard Meteor M2 was interfering with the operation of other packages carried by the satellite (just as happened in the case of ESA's Metop satellites). Meteor M2 continues to provide HRPT data streams, but it seems probable that its LRPT stream will not now be reactivated. The final Meteor M2 image I received is shown in figure 6.

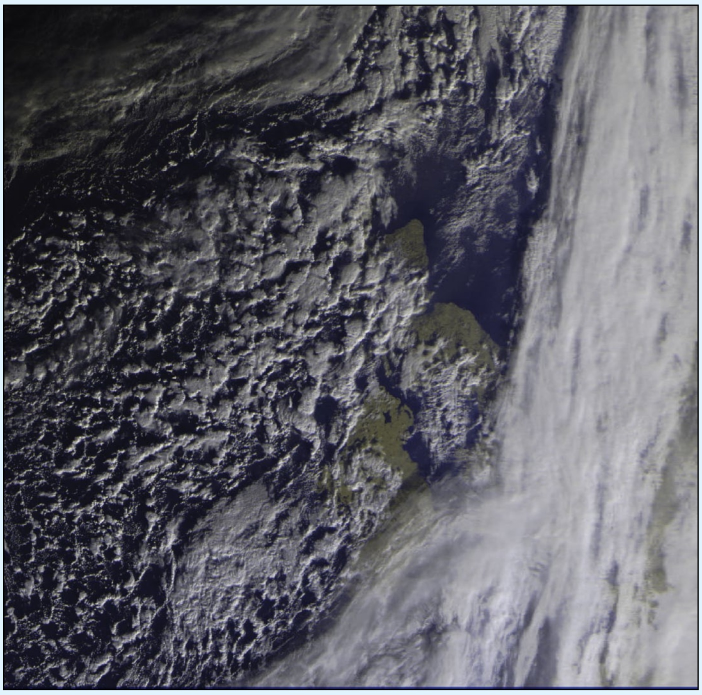


Figure 6
This is the final Meteor M2 image received in northeast Scotland, from the 11:12 UT pass on December 10, 2015.

Meteor M1 (2016)

Although signals from Meteor M1 continued to be strong during the early weeks of 2016, images received from northern hemisphere locations remained quite poor and unevenly illuminated due to the low angle of the sun. But a possible foretaste of what was to come came from Norberto Filipe, who posts on the *GEO-Subscribers YAHOO* Group. Norberto lives in Buenos Aires, Argentina, and one of his superb summer time RGB123 images of southern South America, which dates from December last year, appears on the following page.

As February approached, Meteor M1 appeared to be settling down. With improved solar illumination, 'stripy' images like figure 5 became a thing of the past, and skewed perspectives as illustrated in figure 4 became noticeably less frequent. From my location, early morning images started to show good detail towards the southern extremities of the passes, particularly of the snow-covered Alps, Italy and Greece. Figure 8 is a typical example, acquired from the final few minutes of the 07:15 UT Meteor M1 pass on January 24.

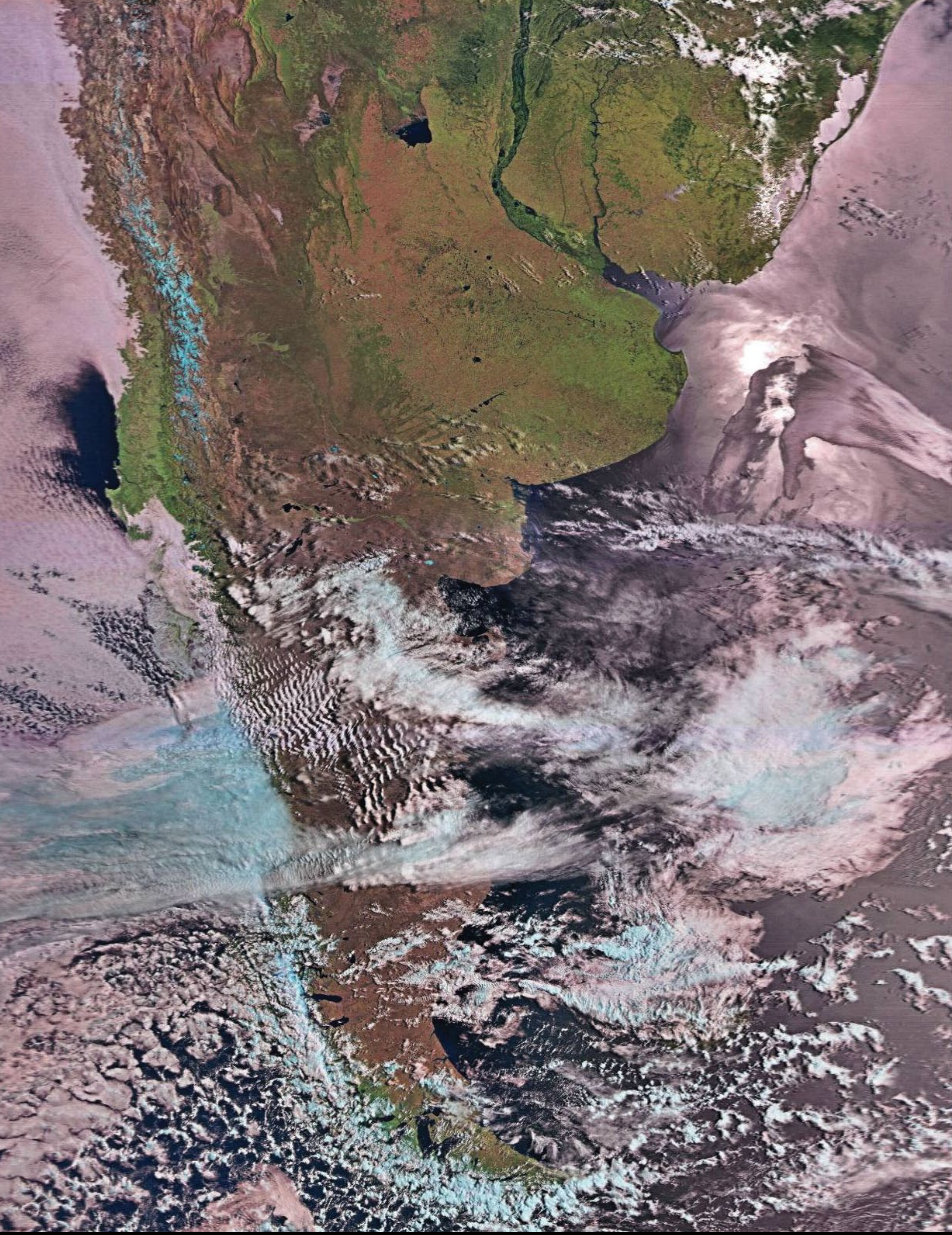


Figure 7
Norberto Philipe, a contributor to the GEO-Subscribers Yahoo Group, lives in Buenos Aires, so was ideally located to receive summertime images from Meteor M1 during December 2015. This RGB123 image, dating from December 11, provides a stunning image covering Uruguay, along with much of Argentina and Chile.

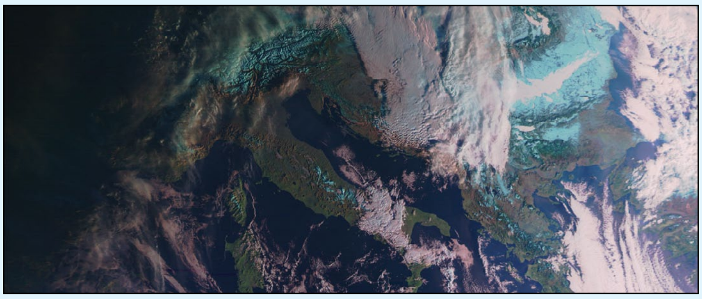


Figure 8
Improving illumination in late January 2015 resulted in excellent detail over the Alps, Italy and Greece.

Another Problem

On February 13, I received an email from Enrico Gobbetti alerting me to a change in the waveform of the Meteor M1 transmission (figure 9).

The principal peak centred on 137.0968 MHz was much lower than normal, and was flanked by a number of smaller satellite peaks.

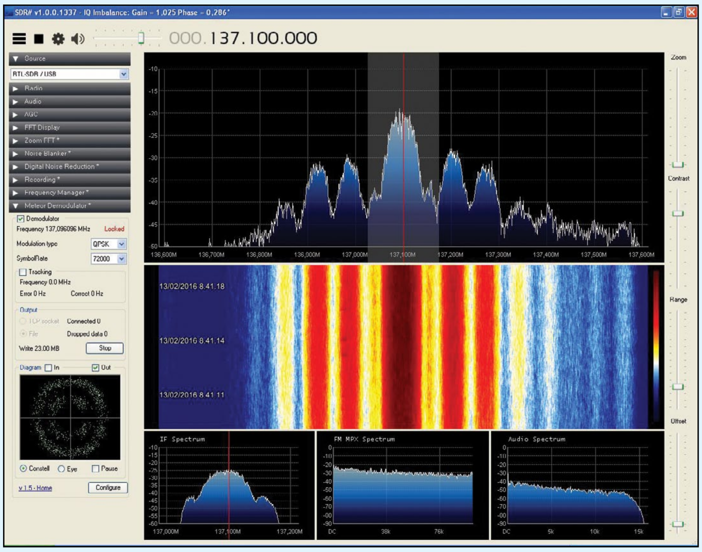


Figure 9
This screenshot illustrates the change in the Meteor M1 waveform that was first apparent on February 13, 2016.

Despite this, Enrico, who uses a sophisticated receiver and tracking antenna, was still able to decode images as normal. However, for everyone relying on RTL-SDR dongles, imaging became much more difficult. In my situation, the LRPT stream only started to decode when the satellite was almost overhead on a high elevation pass, and produced images much shorter in scope than previously. Satellite passes an orbit farther east or west refused to decode into images at all.

No explanation has been forthcoming as to what exactly was happening to the satellite transmissions, but as suddenly as it had started, the unusual behaviour stopped. On February 19, Meteor M1 was again transmitting its familiar single peak and imaging seemed to me to be even better than previously. Indeed, for the first time ever, I received a Meteor M1 image showing the whole of Spain: previously my images rarely stretched much farther south than the Pyrenees.

Perhaps the additional peaks in the display were due to telemetry between the ground station and Meteor as technicians updated the systems aboard the craft. At any rate, at the time of reporting (early March), Meteor M1 is producing excellent images from northern hemisphere locations, with the promise of even better to come as summer beckons (figure 10).

References

1 GEO Quarterly 28, page 9 (December 2015)

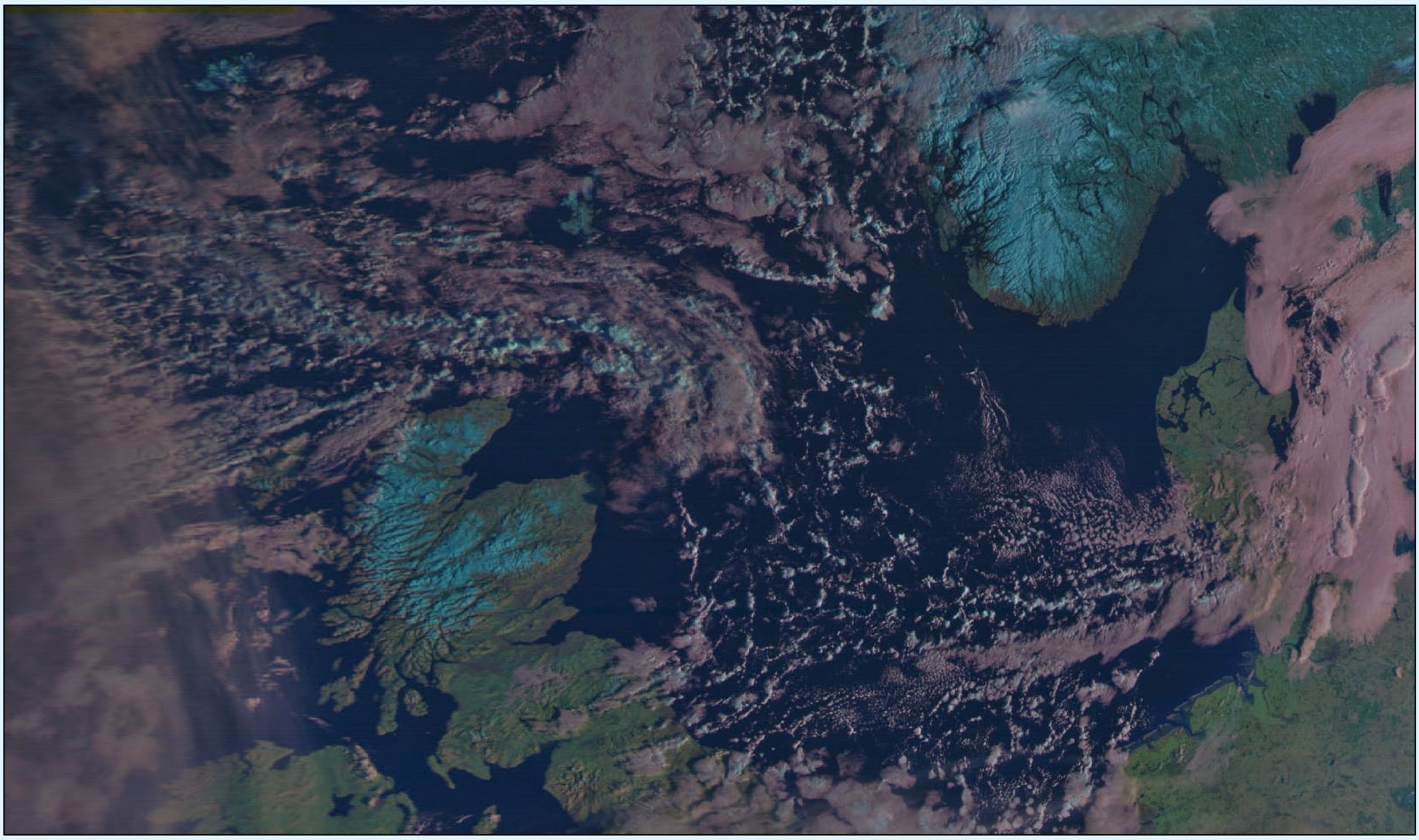


Figure 10
This RGB123 segment from the 08:11 UT pass on February 28 illustrates the improved performance of Meteor M1 following its signal anomalies earlier in the month. The regions highlighted in cyan are the snow-covered mountains of Norway and Scotland.

From the Editor's Keyboard

Les Hamilton

The next issue of *GEO Quarterly* is destined to be our 50th since the organisation was founded in late 2003. But there are now serious questions to be addressed if the *Quarterly* is to continue much longer.

Evolution of the Editor's Rôle

Having previously served for four years as both Copy Editor and Make-up Editor for the Journal of the *Remote Imaging Group*, I was invited to fill a similar rôle for the new organisation. With cutting-edge developments aplenty at this time, particularly relating to the MSG2 satellites and their novel image dissemination via DVB, there was material aplenty to fill the magazines for some considerable time.

As editor, I enjoyed receiving a regular flow of articles from members throughout the three-month gestation period of each *GEO Quarterly* magazine. Personally, this was a great time, as I was always one of the first to learn about interesting new developments in the field of weather satellite imaging. In those days, I tended to spend a quarter to half an hour almost every day preparing copy for the *Quarterly* and consulting with the authors on the layout and presentation of their material. There was no rush; the pace was leisurely, and very enjoyable.

But much has changed since then. As the Internet broadened its reach, and higher transmission speeds evolved, much of the information sought by GEO members became available almost immediately from the Web. Certainly, in the last two years particularly, members' submissions have dried to a trickle: for this issue, by the copy deadline, I had received only three one-page articles: from John Barfoot and John Tellick (2), which is the principal reason for the lateness of this issue. I now find myself only rarely firing up the GEO Computer, apart from a period of absolute frenzy after the copy deadline has expired.

Far from those heady, leisurely days, when making up *GEO Quarterly* was a breeze, I now regularly find myself 'painted into a corner' as it were at copy deadline, and having to work my socks off for two to three weeks to produce each magazine. Years ago, I was happy to fill the odd 'blank' page with short, illustrated stories from the *NASA Earth Observatory* website. A glance at the Contents listing on page 1 of this issue reveals that the majority of articles now come from this source. These articles, in addition to those I choose to research and compile myself mean that these days I am having, single-handedly, to produce three-quarters—if not more—of *GEO Quarterly*.

Decision

Now in my seventies (how time flies), I informed the Management Team at the end of last year that I was not prepared to place myself in this pressure situation any longer. I explained that it was up to them and the members in the field, either themselves, or by identifying willing authors amongst their personal contacts, to furnish me with suitable articles during the 3-month run-in to each issue of GEO Quarterly.

I am perfectly willing and able to do the tasks I was earmarked to do when GEO was formed—editing and making-up **other peoples**' submissions. But henceforth, I will no longer be spending many hours of my time searching the Internet for inspiration: it's up to you!

GEO Quarterly 50

Some time ago, one of GEO's members sent me an email with a suggestion for a major article, which he promised to have ready for *GEO Quarterly No 50*. He also suggested that it would be a nice touch if this particular issue could also be made available to all members as a printed, paper magazine. I put this suggestion to the Management Team during our January meeting, and they readily agreed that GEO could afford to do this at no additional cost to our readers.

If ever there were an incentive to write articles for *GEO Quarterly*, related to Earth Imaging and Weather Satellites, surely this is it. Issue 50 is earmarked for June, and the copy deadline is Sunday, May 29.

As I only return from vacation the previous day, this will probably delay the magazine's appearance till late June, but with your help and cooperation, I cling to the hope that it will be an issue well worth waiting for.

Suggested Topics for Articles

Topic areas that spring most readily to mind are the talks and presentations that will be made at the April Symposium in Leicester. These talks alone could probably generate sufficient text and images for the entire magazine. If you are planning to attend the Symposium, and are prepared take notes and produce an article, have a word with Francis Bell at the start of the day, basically to prevent duplication: it would be rather counter-productive if several attendees independently submitted reports on the same item.

Many GEO members are regularly downloading huge volumes of data via *EUMETCast* every day. Why not select a particularly interesting image and research features of the region and/or cloud patterns displayed—much in the manner evident in the NASA Reports in this issue—to produce an attractive short article?

Other viable topic ideas might include

- Information about Sentinel 3
- Using Linux to receive and process *EUMETCast*
- *EUMETCast's* new High Volume Service
- Information concerning the new *TelliCast* client for HVS

And of course, if you have any tips and tricks that improve your satellite imaging experience, do please share them.

It would be a great shame if *GEO Quarterly 50* can not be developed into an issue worth reading and preserving. I suggest that this is an opportunity not to be missed, but it does require everyone to rally round. I cannot possibly do this single-handedly.

I look forward to your cooperation, and to receiving regular email submissions from you during April and May, to

geoeditor@geo-web.org.uk

But please don't leave everything to the last minute. Please do your utmost to make your submissions well before the May 29 copy deadline.

Quarterly ? Question

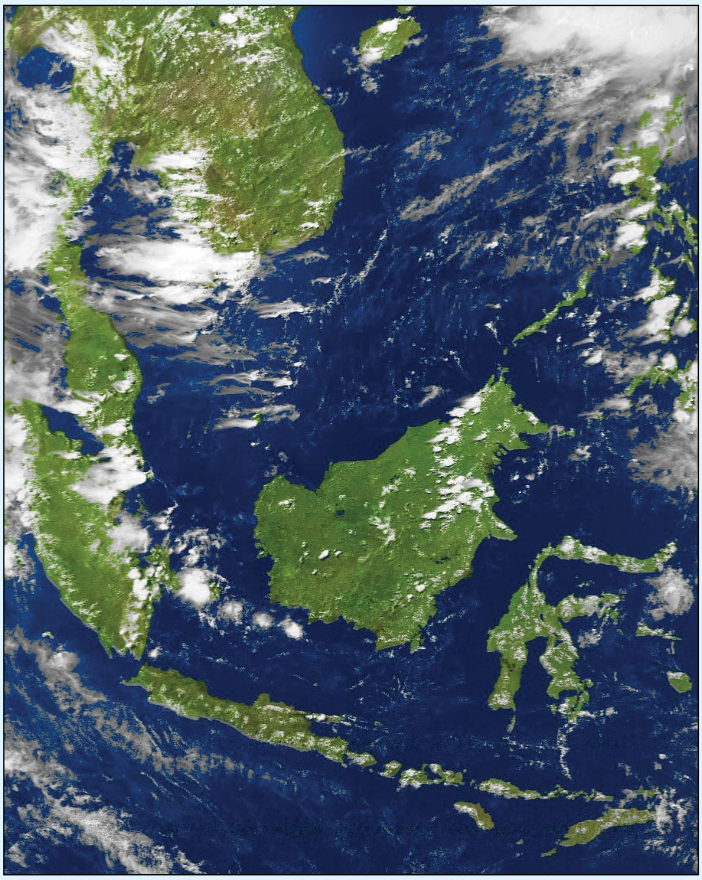
Francis Bell

Quarterly Question 48 related to naming those islands in the world which are politically divided between more than one country. The challenge was to name as many of these islands and countries as possible. Unfortunately I did not receive many answers, so I am relying on my own personal researches to provide a limited answer.

A number of the islands in question are illustrated here, together with captions saying something about each island. Not included is our local example of the Republic of Ireland and Northern Ireland which is politically split between the Republic of Ireland and the UK.

In my travels I have visited four of the six islands mentioned here, all of them delightful in different ways. I'm sure my list is not comprehensive so further contributions would be most welcome.

Borneo



Borneo is the third-largest island in the world and the largest island in Asia. The island is divided among three countries: Malaysia and Brunei in the north, and Indonesia to the south. Approximately 73% of the island is Indonesian territory. In the north, the East Malaysian states of Sabah and Sarawak make up about 26% of the island. The sovereign state of Brunei, is located on the north coast, and comprises about 1% of Borneo's land area.

The May 25, 2015 NOAA 19 APT image shown above was provided by Fred van den Bosch who lives in Vietnam.

Timor

The island of Timor is split between Indonesia and East Timor, the sovereign state of East Timor comprising the eastern half of the island. The country's size is about 15,400 km^2. East Timor

was colonised by Portugal in the 16th century, and was, up till November 1975, known as Portuguese Timor. The subsequent Indonesian occupation of East Timor was characterised by a highly violent decades-long conflict between separatist groups and the Indonesian military. In 1999, following the UN-sponsored act of self-determination, Indonesia relinquished control of the territory, and East Timor became the first new sovereign state of the 21st century on May 20, 2002.

Image: Wikimedia Creative Commons

Hans Island

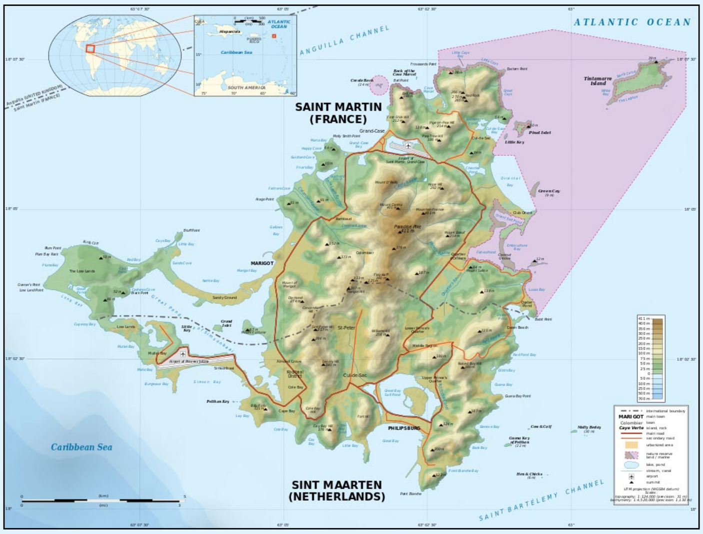
Hans Island is a small, uninhabited barren knoll 1.3 km^2 in area measuring 1,290 × 1,199 metres, located in the centre of the Kennedy Channel of Nares Strait: the strait that separates Ellesmere Island from northern Greenland and connects Baffin Bay with the Lincoln Sea. Hans Island is the smallest of three islands located in the Kennedy Channel. The strait is 35 kilometres wide here, placing the island within the territorial waters of both Canada and Denmark.

A theoretical line down the middle of the strait passes through Hans island.

Image: Image: Wikimedia Commons

continued overleaf ...

Saint Martin



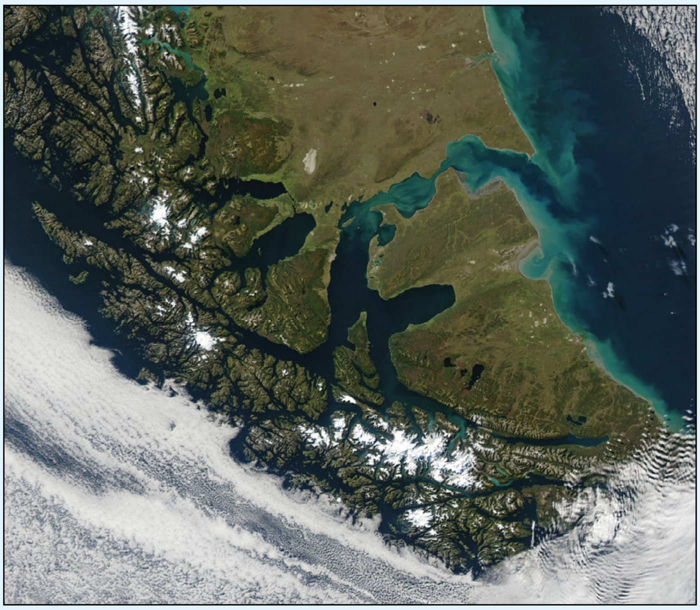
Saint Martin is an island in the northeast Caribbean, approximately 300 kilometres east of Puerto Rico. The 87 km^2 island is divided roughly 60/40 between France and the Netherlands. The two parts are roughly equal in population. It is the smallest inhabited island divided between two nations. The division dates to 1648. The southern Dutch part comprises Sint Maarten with the northern French part comprising of the Collectivity of St. Martin, and is an overseas collectivity of France.

Image: Eric Gaba / Wikimedia Commons

Quarterly Question 49

The latest Quarterly Question is straightforward. Name the two countries shown in the image below, and name the island which is politically split between them. Answers to Francis Bell please, on or before May 29, 2016, to

francis@francisbell.com



This MODIS image, captured by NASA's **Terra** satellite on March 28, 2003, shows two countries, and including an Island which is split politically between them. **Quarterly Question 49** relates to naming this island and the two countries involved. To help recognise the area shown, note that the image dimensions are approximately 550 × 700 kilometres.

Image: MODIS Land Rapid Response Team at NASA GSFC

Cover Image Details

Front Cover

It's 13:00 UT on December 29, 2016, and *Storm Frank* is bearing down on Great Britain. NASA's **Aqua** satellite acquired this MODIS image of *Frank's* cloud mass shortly before it wreaked havoc over most of the country, causing both wind damage and unprecedented flooding.

Image: LANCE Rapid Response/NASA/GSFC

Inside Front Cover

Enrico Gobbetti received this **Meteor M1** image from the 08:32 pass on February 13, 2016. Due to antenna misalignment, southbound images from this satellite can not be decoded till the satellite is close to zenith: in this case, imagery starts above the very north of Scotland.

Inside Back Cover

Improved performance from **Meteor M1** in early spring resulted in this attractive RGB123 image of Great Britain, acquired by Les Hamilton on March 7 this year. The cyan colouration over the Scottish Highlands and the English Pennines is indicative of snow and ice cover.

Back Cover

NASA's **Terra** satellite captured this image showing ship trails over the Bay of Biscay on February 20, 2016.

Image: LANCE Rapid Response/NASA/GSFC

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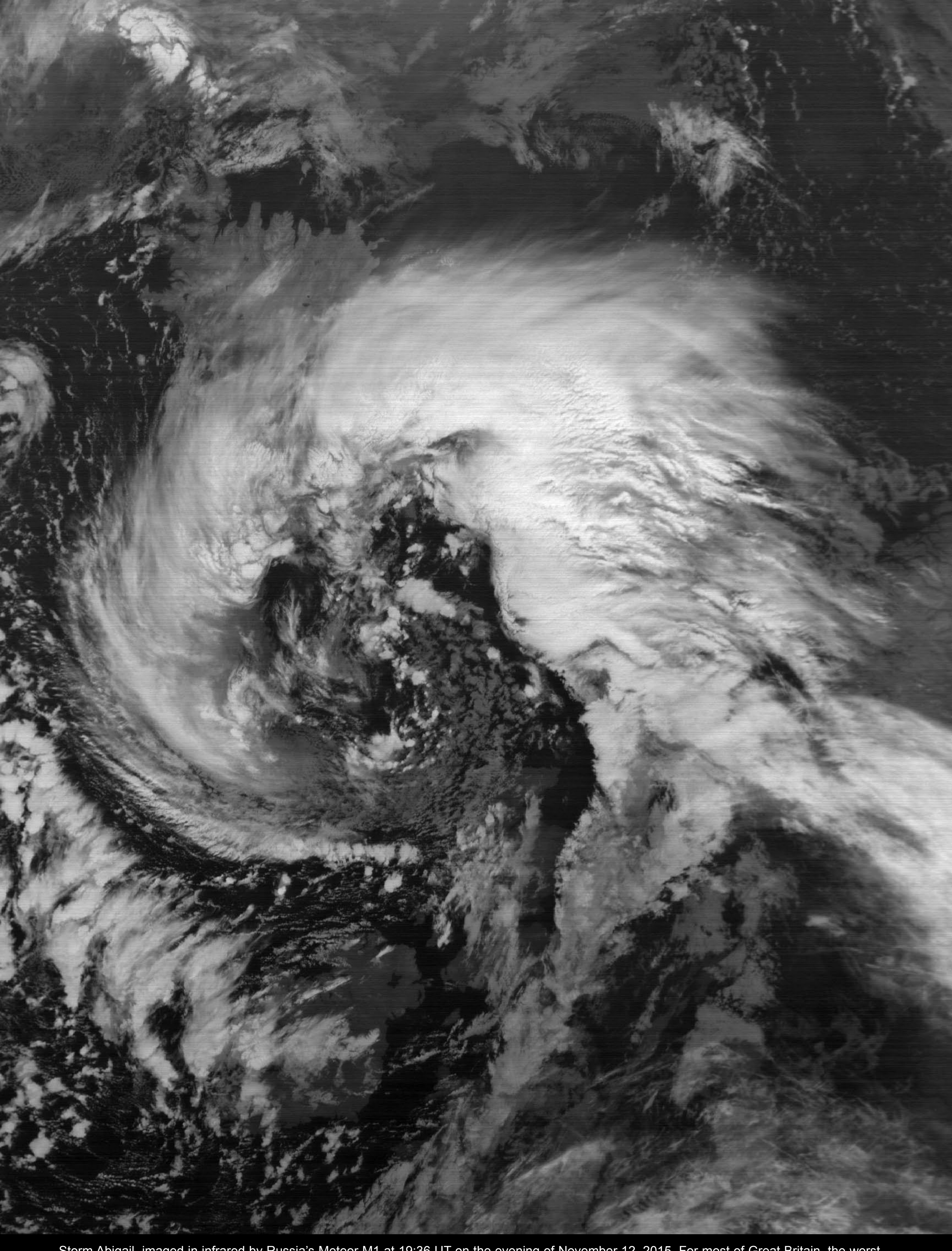


Storm Abigail, imaged in infrared by Russia's Meteor M1 at 19:36 UT on the evening of November 12, 2015. For most of Great Britain, the worst is past, but Scotland's Western and Northern Isles still face a night of winds of up to 120 kph. On the following day, all schools on the islands were closed and all inter-island ferries remained in port.

Gains at Hofsjökull Ice Cap

NASA Earth Observatory

Winter storms can blanket Iceland almost entirely with snow. The relative warmth of summer and autumn, however, exposes a spectacular, varied landscape. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's ***Terra*** satellite acquired this natural-colour view (figure 1) of the Nordic island nation on November 9, 2015.

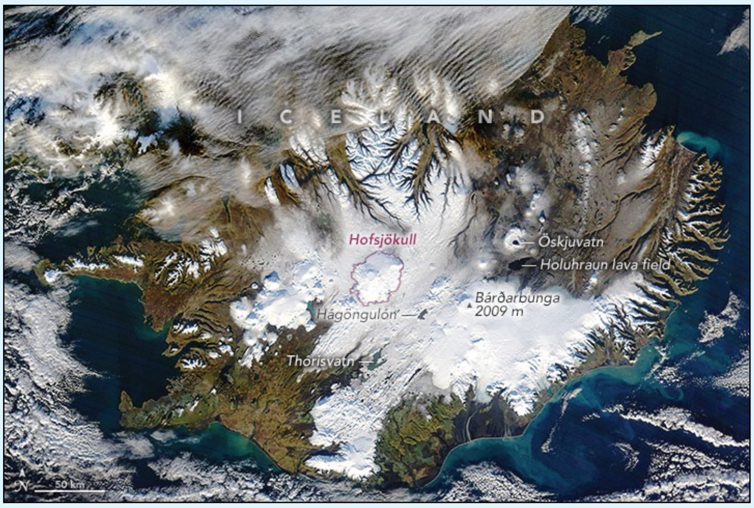


Figure 1 - Iceland on November 9, 2015
Image: LANCE/EOSDIS Rapid Response

According to Thorsteinn Thorsteinsson, a glaciologist at the Icelandic Meteorological Office, visible snow cover is typical for November, compared with conditions during the past 15-20 years, but compared with the reference period of 1961-1990, snow cover was 'almost certainly' less than average in the highland and mountain regions above 400 metres elevation.

The melting of seasonal snow cover accentuates the boundaries of Iceland's permanent ice caps. The ice caps appear smooth and rounded in contrast with the snow-covered interior plateau and the snow-capped ridges along the glacier-carved coastline.

All ice caps in Iceland have been retreating rapidly and losing volume since 1995. In October 2015, however, scientists from the Icelandic Met Office showed that the **Hofsjökull** ice cap, outlined in red, had gained mass according to their ground-based measurements.

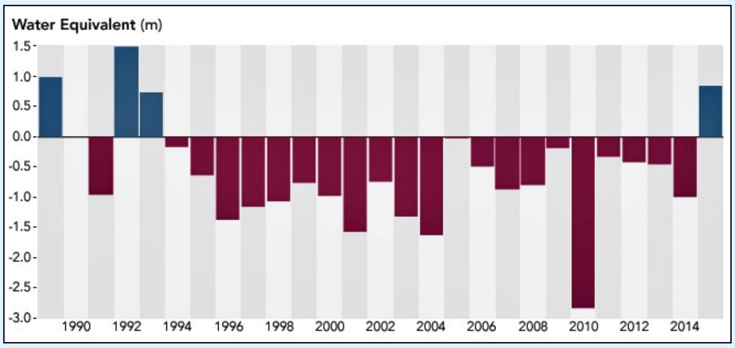


Figure 2 - Annual mass balance of Thjórsárjökull: 1990-2014

An ice cap that has gained more mass than it has lost is said to have a positive mass balance. The graph (figure 2)shows the annual mass balance of **Thjórsárjökull**, one of the ice cap's three basins, since the start of measurements in 1989. **Thjórsárjökull's** mass balance in 2015 was positive for the first time since 1993.

The ice cap's increase in 2015 has been due to abundant winter precipitation and cool summer temperatures. In spring 2015, the thickness of winter snowfall on the ice cap's three basins ranged from 25 to 60 percent above the 1995-2014 average. In the summer, melting was limited because of cool northerly winds.

The situation changed in the autumn, as September and October were unusually warm. When temperatures rise, melt water flows into the island's numerous lakes and reservoirs. **Hálslón** reservoir, the long and narrow feature on the east side, holds glacial meltwater. **Öskjuvatn** crater lake, **Hágöngulón** reservoir, and **Thórisvatn** natural lake and reservoir also stand out because they are dark and surrounded by snow.

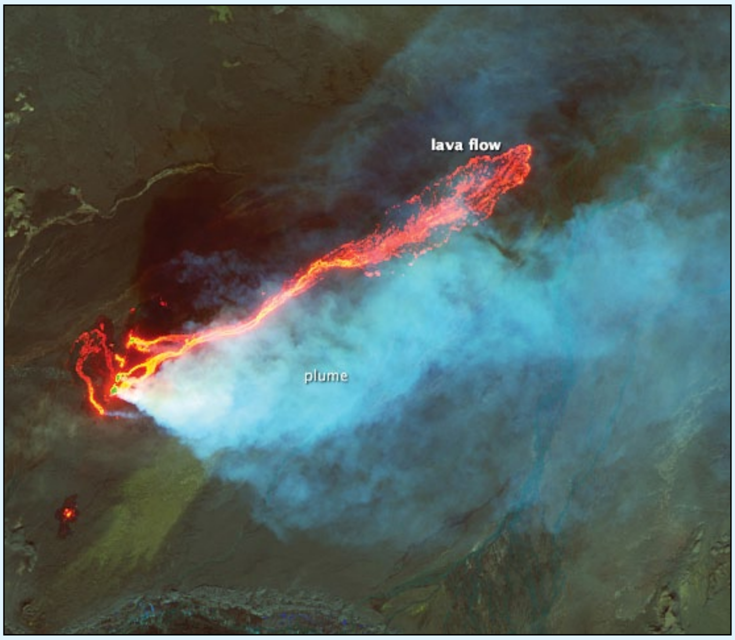


Figure 3 - A lava flow in the Holuhraun Lava Field
Image: Icelandic Met Office

But one of the more prominent dark features, just south of **Öskjuvatn**, is not water at all—it is actually a fresh lava field from the **Holuhraun** eruption (August 2014 to February 2015). During the eruption, lava poured from fissures just north of the **Vatnajökull** ice cap and near the **Bárðarbunga** volcano, and by January 2015 had spread across more than 84 square kilometres. False-colour satellite imagery (figures 3,4) makes it even more apparent that **Holuhraun** is not a lake.

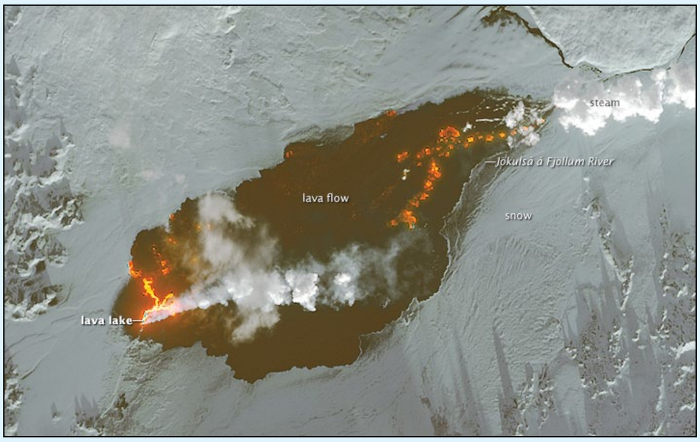


Figure 4 - Activity in the Holuhran Lava Field (January 5, 2015)
Image: LANCE/EOSDIS Rapid Response

True to its name, Iceland is shown in figure 5 covered in a white blanket of ice and snow. Low layers of clouds float over the Greenland Sea (left) and the Atlantic Ocean (bottom). Iceland's southern, low-lying coastlines are greyish-tan, while the rest of the island remains pristine white.

The uniform colour hides the exact boundaries of Iceland's four permanent ice caps—**Langjokull** and **Hofsjokull** in the interior west, **Myrdalsjokull** on the southern coast, and **Vatnajokull** on the eastern coast. The ice caps have a smooth, rounded appearance that contrasts with the snow-covered interior plateau of the island as well as with the rugged, glacier-carved coastlines. Vatnajokull is the largest of the four, and rests on top of three active volcanoes. The heat from these volcanoes causes the underside of the ice cap to melt, slowly building up meltwater in the volcano's caldera. When the meltwater spills over the lip of the caldera, it releases a torrent of water known as a glacial melt flood.

Iceland sits just south of the edge of the Arctic Circle at the intersection of two tectonic plates, which accounts for its volcanic activity. Located on a mid-ocean ridge between the North American and the Eurasian tectonic plates, Iceland is being slowly pulled in two as the two plates spread apart. As the plates retreat, magma from deep in the Earth wells up to the surface. Much of the interior portion of the island is covered in lava fields.

The harsh climate that might be expected based on the island's closeness to the Arctic Circle is softened by the tail end of the Gulf Stream, which flows up through the Atlantic Ocean bringing heat from the tropics. Unlike its eastern neighbour, Greenland, large portions of Iceland shake off their wintry cover each year. But between the lava fields, cold deserts, and the tundra that dominates the northern parts of the island, only about 20-25 percent of the land is habitable, mostly along the south and eastern coasts.

Figure 5 - Iceland under snow, observed by NASA's Aqua satellite on January 28, 2004.
Image courtesy Jeff Schmaltz, MODIS Land Rapid Response Team at NASA GSFC

Partial Opening of the Northwest Passage

NASA Earth Observatory

There was a time when the *Northwest Passage* was considered a maritime Holy Grail, a route highly desired and sought after, but so elusive. For most of the recorded history of North America, the Passage has been nearly impassable and often deadly. But with the modernisation of ships and the warming of the Earth, cruising and sailing through the Canadian Archipelago from Baffin Bay to the Beaufort Sea has become more common: but it's not necessarily easy.

Figure 1 shows the Northwest Passage as it appeared on August 31, 2015, to the **Suomi-NPP** satellite. According to an August 31 analysis by the *Multisensor Analysed Sea Ice Extent* (MASIE) product—created by the *US National Ice Center* and posted by the *National Snow and Ice Data Center*—the northern route was considered to be mostly ice-filled for the sake of navigation (figure 2).

An image, acquired on the same day by the Operational Land Imager (OLI) on **Landsat 8**, zooms into the white rectangle superimposed over the Suomi image (figure 3) and shows that much of the white covering the Northwest Passage is cloud cover, not sea ice.

The Northwest Passage is a complex winding maze of sounds, channels, bays and straits that passes through often ice-choked Arctic waters. Mariners refer to two main routes: the southern passage and the northern passage.

The **southern route** generally follows that taken by Roald Amundsen between 1903–1906, when his crew completed the first successful transit through the region. The southern passage goes south of Prince of Wales Island and Victoria Island (and sometimes King William Island) and enters the Beaufort Sea south of Banks Island. It includes several narrow and shallow waterways that are better suited to small ships than large commercial vessels. This southern or '*Amundsen*' passage was open for several weeks during the summer of 2015.

The **northern passage** runs through Lancaster Sound, Parry Channel,

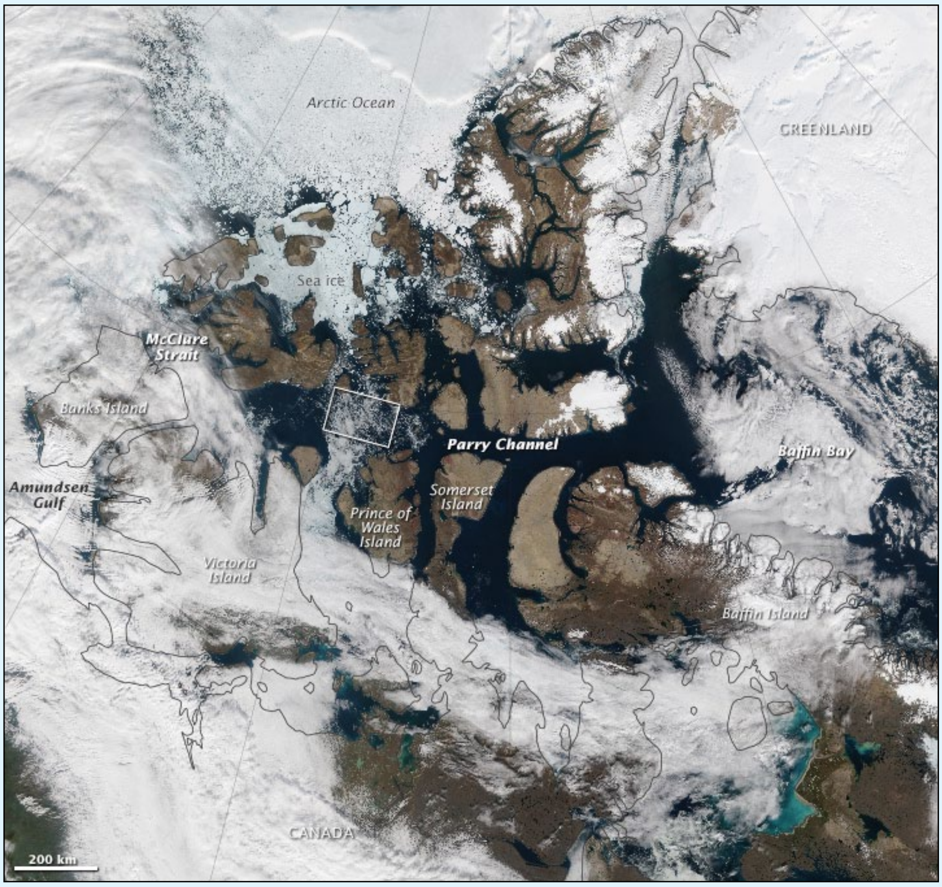


Figure 1 - The Northwest Passage as imaged on August 31, 2015 by the Visible Infrared Imaging Radiometer Suite (VIIRS) aboard the Suomi-NPP satellite

Figure 2 - The MASIE map showing the two routes of the Northwest Passage
Image: National Snow and Ice Data Center

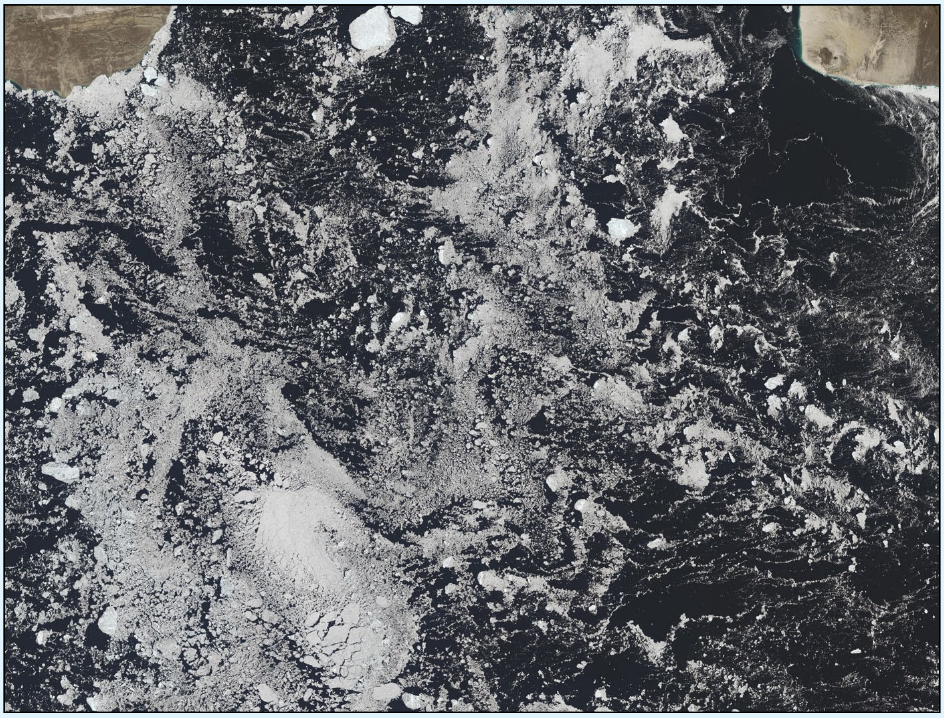


Figure 3 - This Landsat 8 image shows cloud cover in the Northwest Passage.

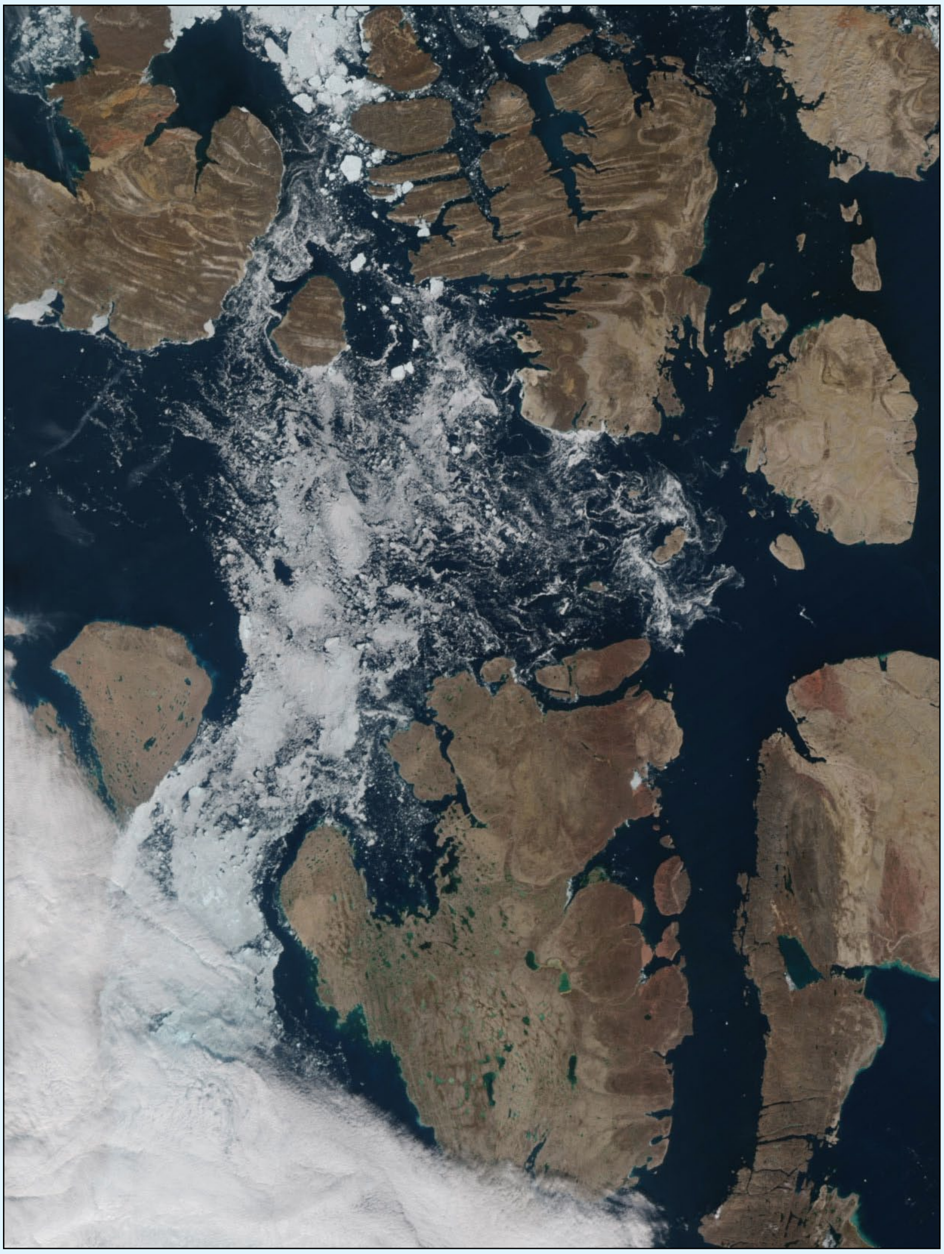


Figure 4 - A zoomed section of the Suomi image, highlighting the brash ice and cloud north of Prince of Wales Island.

and McClure Strait—waterways that are wider, deeper, and more suited to large ships. In the satellite images, the Parry Channel is filled with a melange of sea ice, though it does not appear to be completely frozen over.

As NASA ice scientists Walt Meier and Claire Parkison note, the opening of the Northwest Passage is not so unusual nowadays, particularly along the southern route. However, with the warming of the Arctic and the shrinking of sea ice during the past three decades, the southern passage is now open more often and for longer stretches of each summer. According to Canadian government sources, as many as transits of this passage were made as recently as 2012. The number of ships crossing the Northwest Passage has been steadily increasing since the 1980s.

But even as Arctic sea ice declines, the opening of the Northwest Passage is not necessarily a sure bet in any given year. The Northwest Passage does not always correlate with the overall sea ice because it is dependent to some degree on ice drifting into and out of the channels. You can have a relatively high ice year overall when the passage clears out, yet you can have a relatively low ice year such as 2015 when the passage still contains ice. There is less ice in recent years than there used to be, and the passages are more easily navigable than formerly, but specific conditions from year to another can vary substantially.

A new paper published in Geophysical Research Letters notes that a warm and mostly ice-free Arctic will not necessarily mean smooth sailing through the Northwest Passage any time soon. The ice that forms in these channels and bays is often some of the thickest in all of the Arctic. That makes it more likely to survive through the summer at a thickness that could harm ships.

Image Credits

NASA Earth Observatory images by Jesse Allen, using VIIRS data from the Suomi National Polar-orbiting Partnership. Suomi NPP is the result of a partnership between NASA, the National Oceanic and Atmospheric Administration, and the Department of Defense.

Landsat data from the US Geological Survey.

Multisensor Analyzed Sea Ice Extent (MASIE) data courtesy of the National Snow and Ice Data Center.

The EUMETCast Changeover

Postscript to a problem

John Barfoot - sounio@aol.com

Introduction

Early last year, in *GEO Quarterly 45*, I explained how two colleagues from the South Downs Planetarium, Gavin Myers and Dick Barton *, and I successfully achieved the EUMETCast changeover by using the TBS-6983 PCIe Card as described by Mike Stevens in *GEO Quarterly 44*.

However, we were left with a few 'wrinkles' which I listed at the end of my article. These still remain, but we live with them as they don't stop good reception of the MSG HRIT images. In fact, the 'disappearing Quality Bar problem' was cured on my computer by TBS Support who took control of it by means of *TeamViewer*. Despite doing the same on Gavin's computer, the cure isn't 100% for some reason: but thanks are due to TBS for the effort they put into trying to solve the problem.

The BER (Bit Error Rate) problem is still with us but a work-around has been found by Gavin and is described below.

The BER Problem

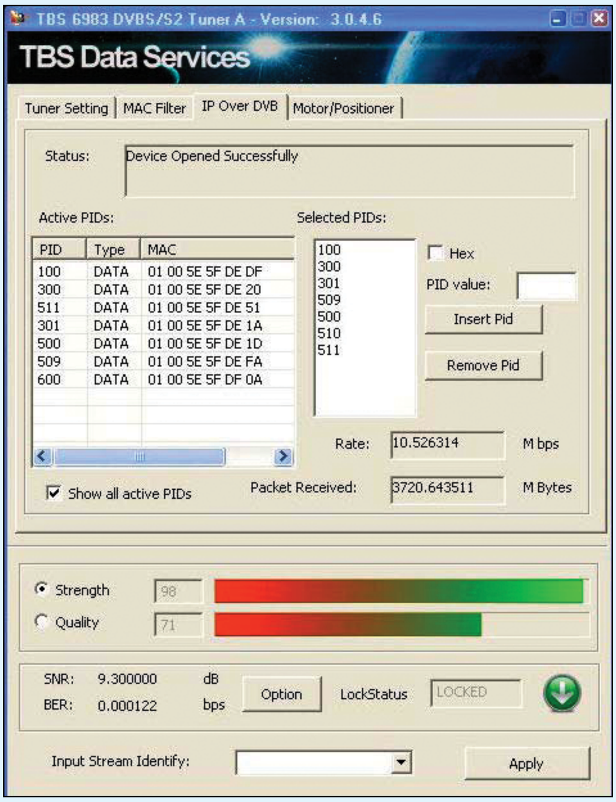
As written in GEO Quarterly 45,

> *'....... 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.'*

Originally, this problem did not affect me because my SNR was low owing to the physical location of my antenna. Figure 4 in the previous article shows it mounted on my balcony with a wrought iron balustrade partially obscuring the satellite view. Although this worked well, my signal strength <u>was</u> low and the SNR was only 7.9. I then raised the antenna by about 100 cm and managed to find the satellite again (not easy) by viewing my computer screen by means of *TeamViewer* on my tablet. The SNR only improved to over 9.2 typically but I was dismayed to find that the HRIT images now suffered from missing segments when it occasionally improved.

It seems that this only occurred when the SNR exceeded approximately 9.3 **and** the list of 'Active PIDs' showed PID 600—even though this was **not** on the list of 'Selected PIDs'. Once it appeared, PID 600 was impossible to deselect by using 'Remove PID', so there was no apparent way round the problem—except by degrading the reception back to a lower SNR.

Sometimes, even with PID 600 showing in the list, the BER would stay at zero and reception would be fine; but as soon as the SNR went above the threshold of 9.3, the BER would be above zero and missing image segments would occur.



The 'rogue' PID600 in the Active PIDs list causing the BER figure

The Work-Around

The permanent way round the problem (as devised by Gavin) is as follows. At computer switch on, set up alternative program *BDAData* to run at start-up instead of *TBS IP-data*. Cancel any error message which comes up and let *BDAData* start up. As soon as the 'lock' indicator goes green on the program window, exit the program. Then manually run *TBS IP-data* and carry on as normal. You will find that PID 600 does not appear and no missing segments occur.

Although *BDAData* and *TBS IP-data* are both set up **not** to receive PID 600, only the *BDAData* controls this feature of the card. Luckily for us, the card remembers the *BDAData* setting even when it is subsequently set to run with *TBS IP-data* - which does not.

Can anyone give an explanation, or think of a better way round this problem? Any information would be gratefully received.

I would be pleased to hear from you at

sounio@aol.com

I'm sad to report that Dr Barton succumbed to a heart attack on January 7. He will be greatly missed by his family and friends.

Amazing Fallstreak Hole over Victoria

Les Hamilton

Photo: Michelle Hawkins

Around midday on November 3, 2015, a the cloud phenomenon pictured above appeared in the skies above Wonthaggi in Victoria, Australia, a formation known as a fallstreak hole [1,2].

People tend to come up with wild theories when they see a bizarre phenomenon like this in the sky for the first time. Residents took photos of the large rainbow-filled hole in the clouds that some dubbed a ‘rapture cloud’ and there was a host of different ideas as to what the colourful formation actually was. There were the usual theories concerning aliens; suggestions that it was related to a government experiment designed to manipulate the weather; as well as more far-fetched theories such as it being the end of a wormhole in space or a portent of the end of the world.

Ben Stewart, an IT consultant from Melbourne who was with his family on Philip Island—about 140 km south-southeast of Melbourne—spotted the odd cloud formation and likened it to something out of the *Independence Day* movie. Stewart related that he and his family had watched the clouds for a while, trying to determine what the strange formation was. Stewart said that he had seen unusual weather patterns many times previously, as he was growing up in Northern Victoria, but this one was among the most bizarre.

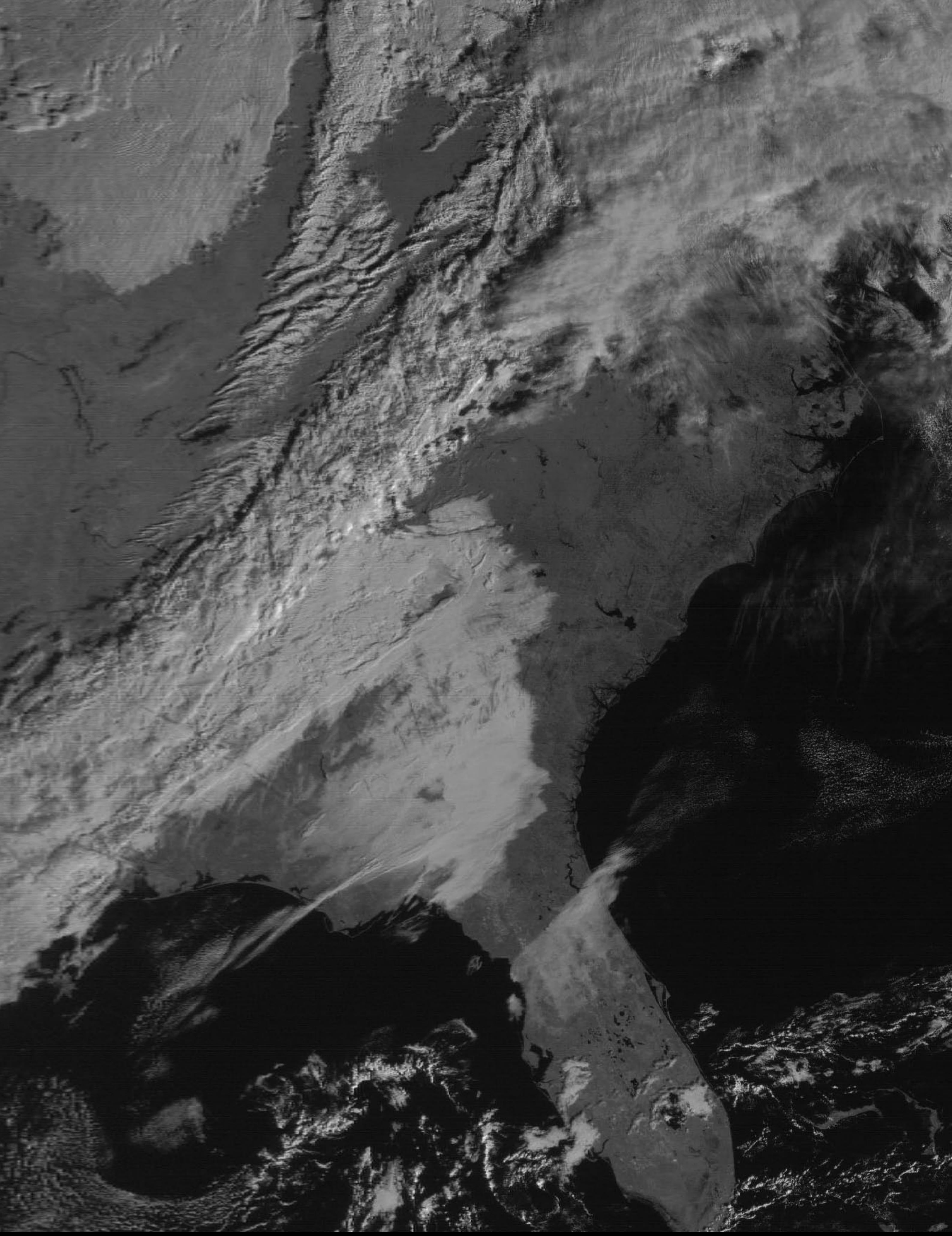
However, there’s no reason for people to worry about an alien invasion or the end of the world. The phenomenon is neither a UFO nor a sign of impending doom. Formation of a fallstreak cloud—also known as a hole-punch cloud—can occur when the temperature in the clouds is well below freezing, and is often triggered by the passage of an aeroplane.

Lower level clouds, where temperatures frequently lie between zero and -15°C, normally consist almost entirely of water droplets, not ice crystals. This may come as a surprise when you consider that the freezing point of water is 0°C but, in the absence of suitable seed crystals or nuclei (such as suspended ice crystals or dust particles), water droplets do not spontaneously freeze until cooled to around -40°C. These water droplets, which remain liquid at temperatures below 0°C, are said to be supercooled.

An aircraft flying through clouds can seed an abrupt crystallisation of these droplets, causing ice to form and ‘snow out’ along its flight path. The hole left in the cloud is a fallstreak hole.

References

Fallstreak Holes - GEOQ 32 - page 9 (2011)
Fallstreak Holes over West Virginia - GEOQ 32 - page 13 (2011)



This segment from a November 12, 2015 channel-3 Meteor-M1 image was acquired by Jim Scheffler just a few days after the satellite's revival on November 6.

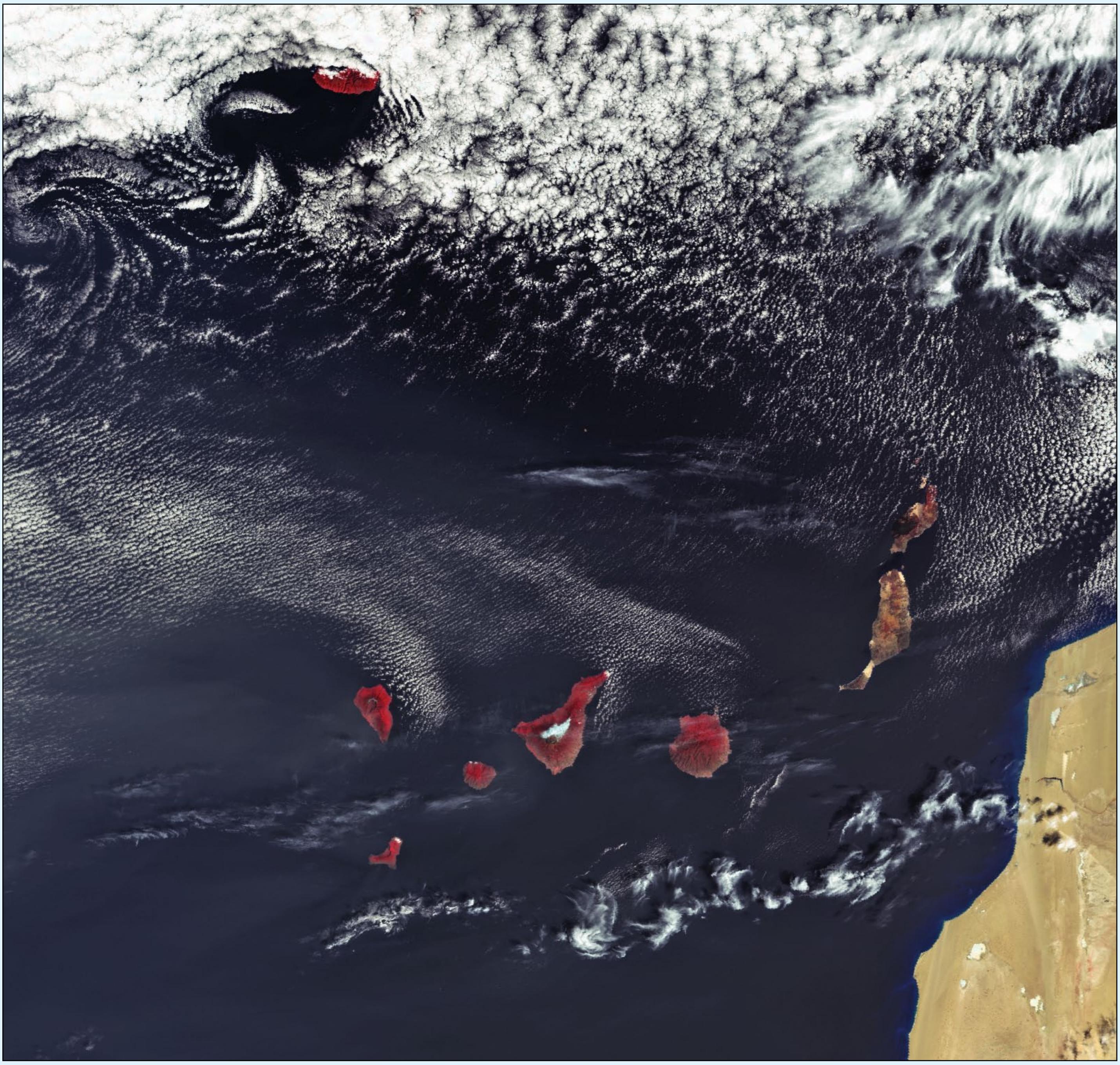
Islands in Red

ESA

This is one of the first images from **Sentinel-3A**'s *Sea and Land Surface Temperature Radiometer* (SLSTR). Acquired at 11:23 UT on March 3, 2016, using the instrument's visible channels, this false-colour image features the Spanish Canary Islands, the Portuguese island of Madeira and the northwest coast of Africa.

The vegetated islands appear red in contrast to the Western Sahara, which has little vegetation. The snow-capped peak of Mount Teide on the island of Tenerife is clearly visible.

Both SLSTR and Sentinel-3's *Ocean and Land Colour Instrument* (OLCI) will be used to monitor plant health. As the SLSTR scans Earth's surface, it senses visible light and infrared radiation (heat) in a number of different spectral channels. The thermal infrared channels will soon be working once the instrument has finished outgassing water vapour. This procedure is necessary because the infrared channels must be cooled to operate properly. The SLSTR will measure global sea- and land-surface temperatures every day to an accuracy of better than 0.3ºC.



The Canary Islands and Madeira, imaged by the SLSTR instrument aboard Sentinel-3

Image: ESA © Copernicus data (2016)

Solar Outage Monitoring

David Taylor

Twice a year, each spring and autumn, the sun crosses the equator directly behind each geostationary satellite in the *Clark Belt*. When the main beam of your *EUMETCast* dish is in direct line of sight with the sun, a sun outage occurs: focussed by the dish, the LNB is bombarded by the sun's RF radiation. This causes a drastic deterioration of the receive C/N (carrier to noise ratio). Basically, the satellite signal is overwhelmed by unwanted signals (noise) from the sun. This phenomenon is also known as *Sun Transit Interference*. Solar outages only affect downlinks (receivers), not uplinks (transmitters). Be aware that outages also occur in cloudy conditions, as the RF radiated by the sun is only dampened slightly by clouds.

A solar outage will effectively cause about 10 minutes loss of signal from that satellite. On the days before and after the sun is precisely aligned with a satellite there will be less outage. The actual days and times depend on your latitude and longitude, longitudinal position of the satellite, diameter of the dish and the received frequency. The larger the dish diameter and higher the frequency, the shorter time and the fewer days Sun Outages last.

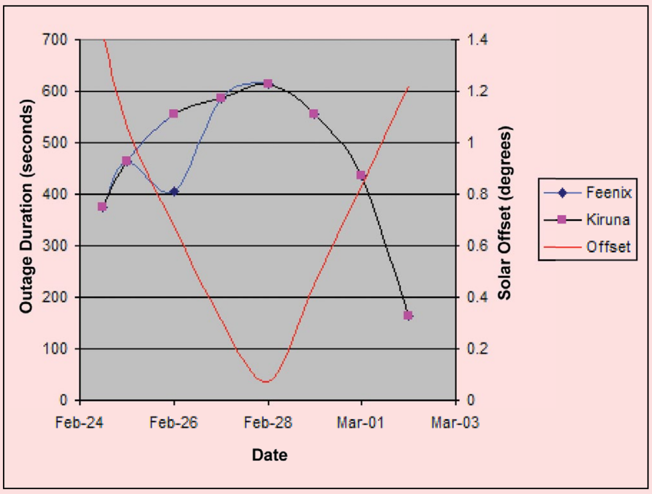
Below is the result of using the output from Ernst Lobsiger's *TClogSummary* program to compare the expected and actual outages due to the sun when it is directly in line with *Eutelsat 10A,* from which the DVB-S2 service is broadcast. As the sun is a prolific radio noise source, it causes the signal to noise ratio of the signal to be decreased, and with the signal level here in Edinburgh, the decrease is enough to trigger the *Ayecka* SR1 to stop receiving the *EUMETCast* High Volume Service (HVS). Such events can be recorded by *TelliCast* (see below) and the times of signal loss and reacquisition are logged.

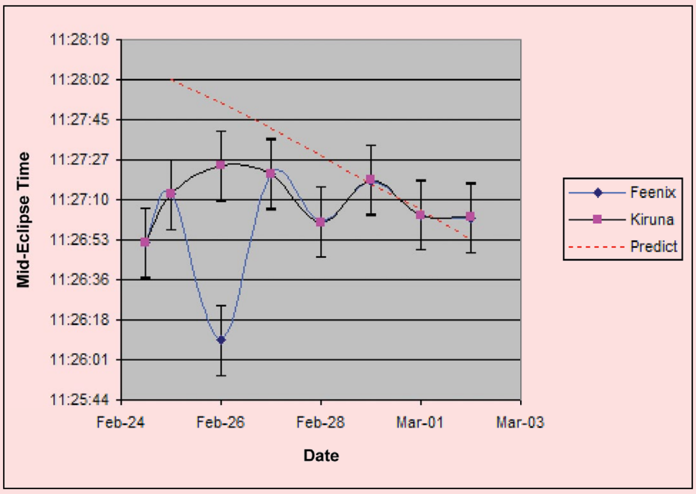
Below I have listed the results from a two of my systems in Edinburgh in Spring 2016. As the error-script is only triggered 30 seconds after LOS, 30 seconds must be subtracted from the time recorded. Similarly, as it is uncertain within 30 seconds as to when the signal returned, 15 seconds has been added to the last times recorded as a best approximation. I've also plotted the solar offset so that you can judge how accurately the antenna is aligned. It seems to be that the elevation is spot-on, as the day with the longest outage was the day with the closest approach. I plotted the theoretical mid-time of the outage versus the mean of AOS and LOS times, but these results appear much more variable. Comments welcomed.

Acknowledgement

Thanks to Arne van Belle for providing the explanation as to exactly why solar outages occur.

Date	Solar offset	Start time PC Feenix	End time PC Feenix	LOS (actual)	AOS (estimated)	Duration	Mid-point time	Predicted closest
2016-02-24	1.43	2016/02/24 11:24:14	2016/02/24 11:29:44	2016/02/24 11:23:44	2016/02/24 11:29:59	375	11:26:51	
2016-02-25	1.06	2016/02/25 11:23:50	2016/02/25 11:30:50	2016/02/25 11:23:20	2016/02/25 11:31:05	465	11:27:12	11:28:02
2016-02-26	0.68	2016/02/26 11:23:17	2016/02/26 11:29:17	2016/02/26 11:22:47	2016/02/26 11:29:32	405	11:26:09	11:27:52
2016-02-27	0.31	2016/02/27 11:22:58	2016/02/27 11:31:58	2016/02/27 11:22:28	2016/02/27 11:32:13	585	11:27:21	11:27:41
2016-02-28	0.07	2016/02/28 11:22:23	2016/02/28 11:31:53	2016/02/28 11:21:53	2016/02/28 11:32:08	615	11:27:01	11:27:29
2016-02-29	0.45	2016/02/29 11:23:11	2016/02/29 11:31:41	2016/02/29 11:22:41	2016/02/29 11:31:56	555	11:27:18	11:27:17
2016-03-01	0.83	2016/03/01 11:23:56	2016/03/01 11:30:26	2016/03/01 11:23:26	2016/03/01 11:30:41	435	11:27:03	11:27:06
2016-03-02	1.22	2016/03/02 11:26:10	2016/03/02 11:28:10	2016/03/02 11:25:40	2016/03/02 11:28:25	165	11:27:02	11:26:53
		Start time PC Kiruna	End time PC Kiruna					
2016-02-24		2016/02/24 11:24:14	2016/02/24 11:29:44	2016/02/24 11:23:44	2016/02/24 11:29:59	375	11:26:52	
2016-02-25		2016/02/25 11:23:50	2016/02/25 11:30:50	2016/02/25 11:23:20	2016/02/25 11:31:05	465	11:27:12	
2016-02-26		2016/02/26 11:23:17	2016/02/26 11:31:47	2016/02/26 11:22:47	2016/02/26 11:32:02	555	11:27:25	
2016-02-27		2016/02/27 11:22:59	2016/02/27 11:31:59	2016/02/27 11:22:29	2016/02/27 11:32:14	585	11:27:21	
2016-02-28		2016/02/28 11:22:23	2016/02/28 11:31:53	2016/02/28 11:21:53	2016/02/28 11:32:08	615	11:27:00	
2016-02-29		2016/02/29 11:23:11	2016/02/29 11:31:41	2016/02/29 11:22:41	2016/02/29 11:31:56	555	11:27:19	
2016-03-01		2016/03/01 11:23:56	2016/03/01 11:30:26	2016/03/01 11:23:26	2016/03/01 11:30:41	435	11:27:03	
2016-03-02		2016/03/02 11:26:10	2016/03/02 11:28:10	2016/03/02 11:25:40	2016/03/02 11:28:25	165	11:27:03	





Bolivia's Lake Poopó Disappears

NASA Earth Observatory

Lake Poopó was a former saline lake located at an altitude of approximately 3700 metres in the Bolivian Altiplano Mountains, and at times spanning an area of some 3,000 square kilometres. Sitting high in the Bolivian Andes, this lake is particularly vulnerable to fluctuations because it is shallow: typically no more than three meters deep. The left-hand image, acquired by the Operational Land Imager (OLI) on NASA's **Landsat 8** satellite, shows the lake as it was during April 2013, when it still held water.

Today, however, what used to be Bolivia's second-largest lake and an important fishing resource for local communities, has almost completely dried out. News reports blame recurrent drought and the diversion of the lake's water sources for mining and agriculture. The image on the right, which dates from January 2016, shows the now-arid lake basin.

In a typical year, rainfall during the wet season (December through March) recharges the lake directly, and via increased inflow from the Desaguadero River. But, more than a month into the current wet season, drought persists.

This is not the first time that Poopó has evaporated; the lake last dried up in 1994, and in that instance, it took several years for water to return, and even longer for ecosystems to recover.

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

Southeast England's Brief Winter

John Tellick

As of the end of January 2016, winter in the southeast of England has often been windy, wet and very mild. But thankfully, not as windy and wet as parts of Wales, northern England and Scotland, which were buffeted and rained on by autumn storms *Abigail*, *Barney* and *Clodagh*, all of which caused disruption during November. And there was no respite as frequent deep depressions and frontal systems—including storms *Desmond*, *Eva* and *Frank*—brought record-breaking rainfall over much of Scotland, Wales and northern England throughout December and early January. In Scotland, the rainfall record for the entire month was broken as early as January 8, with repairs to flood damage likely to exceed a billion pounds. Kent and East Sussex, however, experienced just a little flooding in the late December early January period.

Winter finally arrived—for a few days—during the third week of January when nearby continental high pressure took charge and kept the stream of Atlantic depressions at bay. Here in the southeast, we enjoyed some lovely days with crisp, clear cold sunny days and frosty nights with light winds. However the Midlands, north of England and Highlands of Scotland in particular, had heavy snow.

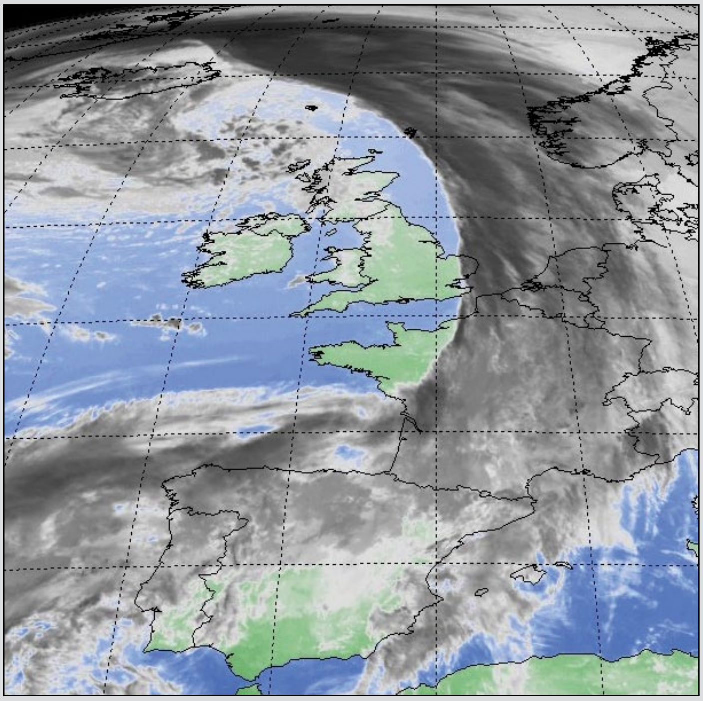


Figure 1 - A weather front clears England on January 22, 2016.
Image © EUMETSAT 2016

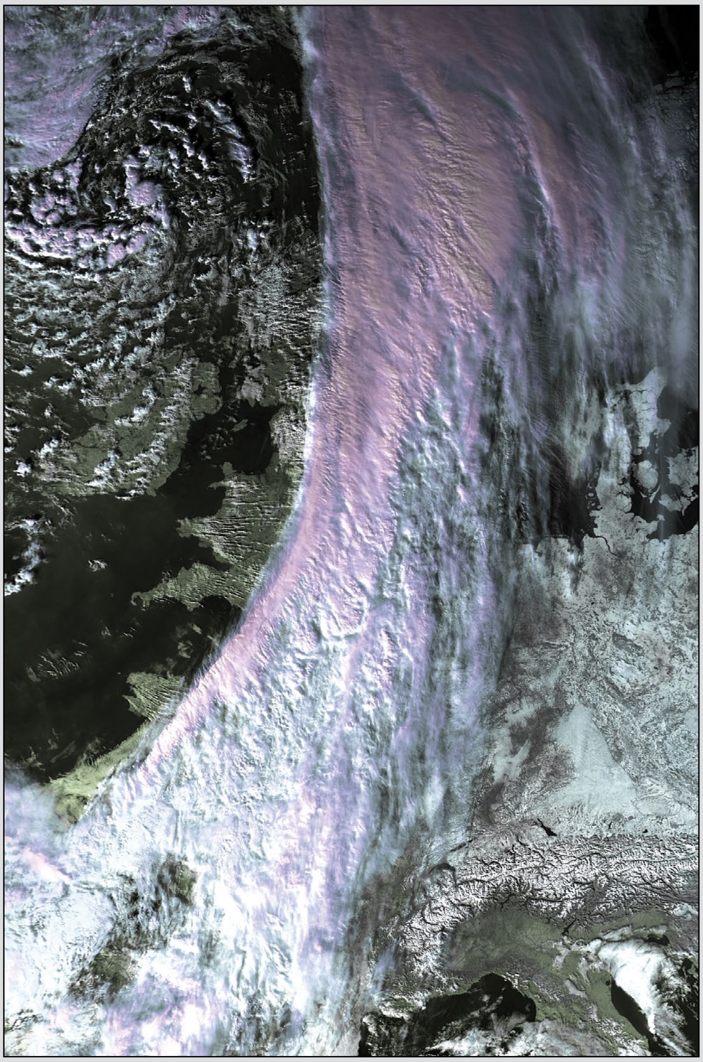


Figure 2 - The weather front imaged by NOAA 19 at 13:20.
Image © EUMETSAT 2016

Our brief SE taste of winter was cleared away by an Atlantic depression, the front of which shows up well on the January 22 MSG-3 IR image (figure 1) and 13:20 UT NOAA 19 image (figure 2), which show the front moving across the UK with northern Europe clear and covered with snow, still under the influence of the high pressure area.

Temperatures began to rise again and on January 24 it was 15°C in my garden at 13:00, where we have had some daffodils in bloom for a couple of weeks now. Geraniums have remained in full bloom in my window boxes throughout the winter and my wild garlic is already coming into flower (figure 3).

What of the rest of winter? We shall see.

Figure 3 - Wild garlic in bloom in the author's garden in January.

El Niño Should Now Be Near Its Peak

NASA Earth Observatory

If past events help to predict future ones, then we have probably reached the peak of the 2015–2016 *El Niño* event. Warmer than average waters in the eastern tropical Pacific Ocean should start to cool off and shift westward: by summer, the tropical Pacific might be back in a neutral state, or *La Niña* cooling could kick in, as it has done following major *El Niños* of the past. But will the ocean respond in the way it did in 1938 and 1998 this time? Given that the planet is warmer than at any time in the past 135 years, there are no guarantees.

According to researchers from the *National Oceanic and Atmospheric Administration*, water temperatures in the **Niño3.4** region of the tropical Pacific [1]—an area that is usually the focal point of such events—broke a record in December 2015. Sea surface temperatures averaged 2.38° Celsius above the norm, surpassing December 1997, which was 2.24°C above normal. For October through December 2015, the three-month temperature average for the **Niño3.4** region was equal to the record high from the same months in 1997.

The data maps opposite compare sea surface heights in the Pacific Ocean as measured by NASA on January 17, 2015, before the event began, and again on January 18, 2016. Note that the January 2015 map shows remnants of a weak 2014 *El Niño* event that kick-started the intense 2015-2016 event. The maps below show conditions in the middle of each of the past 13 months as *El Niño* has developed.

The measurements come from the altimeter on the *Jason-2* satellite and show averaged sea surface height anomalies. Shades of red indicate where the ocean stood higher than the normal sea level (warmer water expands to fill more volume). Shades of blue show where sea level and temperatures were lower than average (due to water contraction). Normal sea-level conditions appear in white.

In their January 14 update, NOAA's *Climate Prediction Service* stated:

'A strong El Niño continued during December, with well above-average sea surface temperatures across the central and eastern equatorial Pacific Ocean. El Niño has already produced significant global impacts and is expected to affect temperature and precipitation patterns across the United States during the upcoming months. Most models indicate that a strong El Niño will weaken with a transition to ENSO [2]-neutral during the late spring or early summer.'

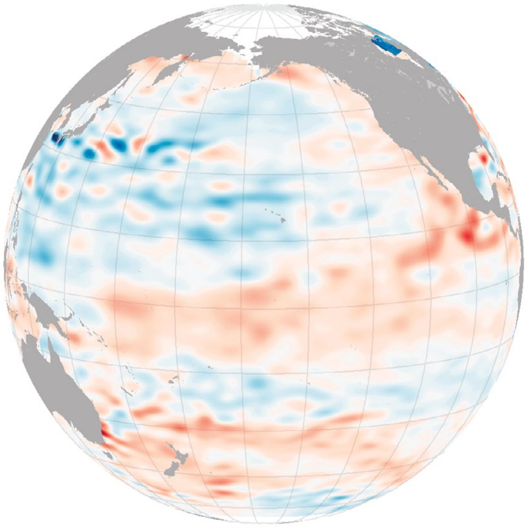


Figure 1 - January 17, 2015

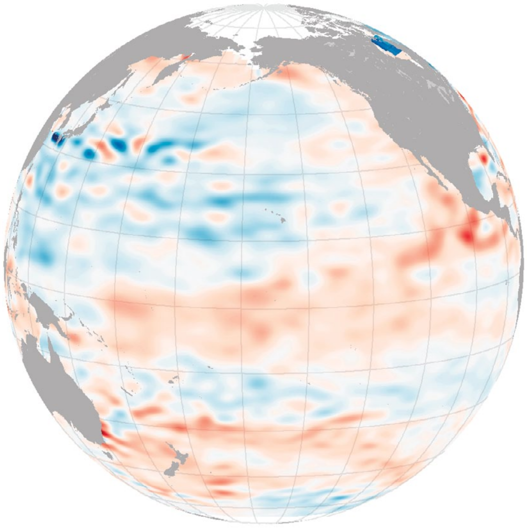
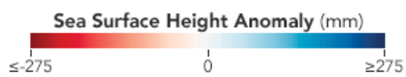


Figure 2 - January 18, 2016



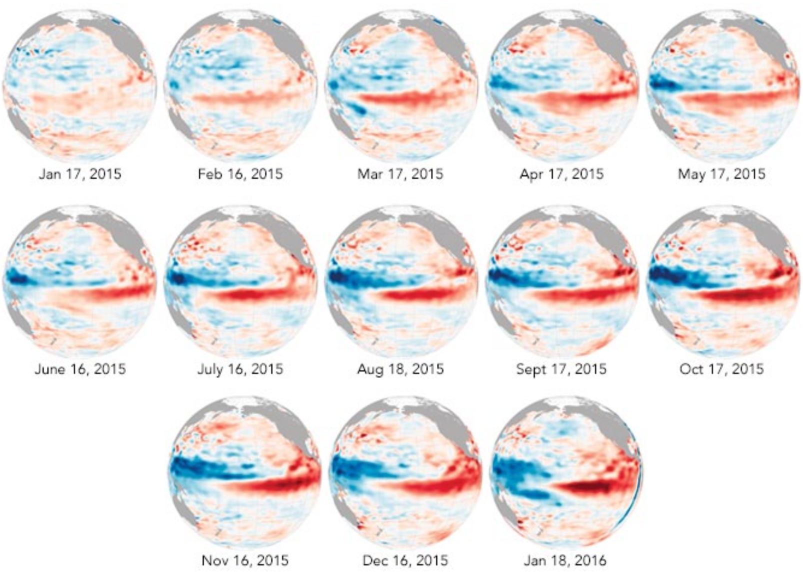


Figure 3 - 13-month comparison

Thus far, precipitation has followed the classic El Niño patterns observed in the 1997–98 and 1982–83 events. In the southern United States the winter has been cooler than normal and quite wet, while the Pacific Northwest has been soaked by rain and snow storms. Across the Pacific, Indonesia and other areas have been dry.

Reference

1 The **NINO3.4** index is an El Niño/Southern Oscillation indicator based on sea surface temperatures, and is the average sea surface temperature anomaly bounded by 5°N to 5°S and 170°W to 120°W in the Pacific. This region has large variability on El Niño time-scales, and experiences changes in local sea-surface temperature that are important for shifting the large region of rainfall typically located in the far western Pacific. An El Niño or La Niña event is identified if the 5-month running-average of the **NINO3.4 index** exceeds +0.4°C for El Niño or -0.4°C for La Niña for at least six consecutive months.

2 ENSO: El Niño–Southern Oscillation.

NASA Earth Observatory maps by Joshua Stevens, using Jason-2 data provided by Akiko Kayashi and Bill Patzert NASA/JPL Ocean Surface Topography Team.

ESA's Proba-1 Images Uluru

John Tellick

GEO Quarterly has featured ESA *Proba* satellite images several times over the years and this low sun angle Proba-1 image of Ayers Rock in Australia taken in September 2015 shows that it is still operating well after 14 years in space.

Uluru/Ayers Rock in the Australian outback, is shown here imaged from 600 km away by the smallest camera on ESA's smallest satellite—the technology demonstrator turned-operational Earth-observing mission, *Proba-1*.

Measuring less than one cubic metre, *Proba-1* was the first in ESA's series of satellites aimed at flight-testing new space technologies. It was launched in October 2001 as an experimental two-year mission, but is still going strong after 14 years in orbit, having since been reassigned to ESA's Earth observation team.

Proba-1's main instrument is the *Compact High Resolution Imaging Spectrometer* (CHRIS), acquiring 13 square km scenes at 17 metres spatial resolution in 18 user-selected visible and near-infrared wavelengths.

This agile satellite can also deliver up to five different viewing angles, and to date has acquired nearly 20,000 environmental science images. Additionally, *Proba-1* carries an experimental High Resolution Camera (HRC) which acquires monochrome images at 5 metres resolution.

Other innovations included what were, at the time, novel gallium-arsenide solar cells, the use of startrackers for attitude control, one of the first lithium-ion batteries—now the longest such item operating in orbit—and one of ESA's first ERC32 microprocessors to run *Proba-1's* agile computer.

Uluru

Towering 348 metres above its surroundings, the monolithic Uluru was formed from compressed layers of sandstone when this part of Australia was a shallow sea.

These layers were subsequently tilted and uplifted and the striations cutting across its summit result from horizontal sandstone layering.

Uluru is the world's largest monolith, and is a sacred site to Australia's Aboriginals. It is 3.6 kilometres in length and two kilometres wide. The walk around it covers 9.4 kilometres.

Figure 1 shows Uluru as imaged by *Proba-1's* HRC in 2004, Figure 2 shows virtually the same scene in 2015.

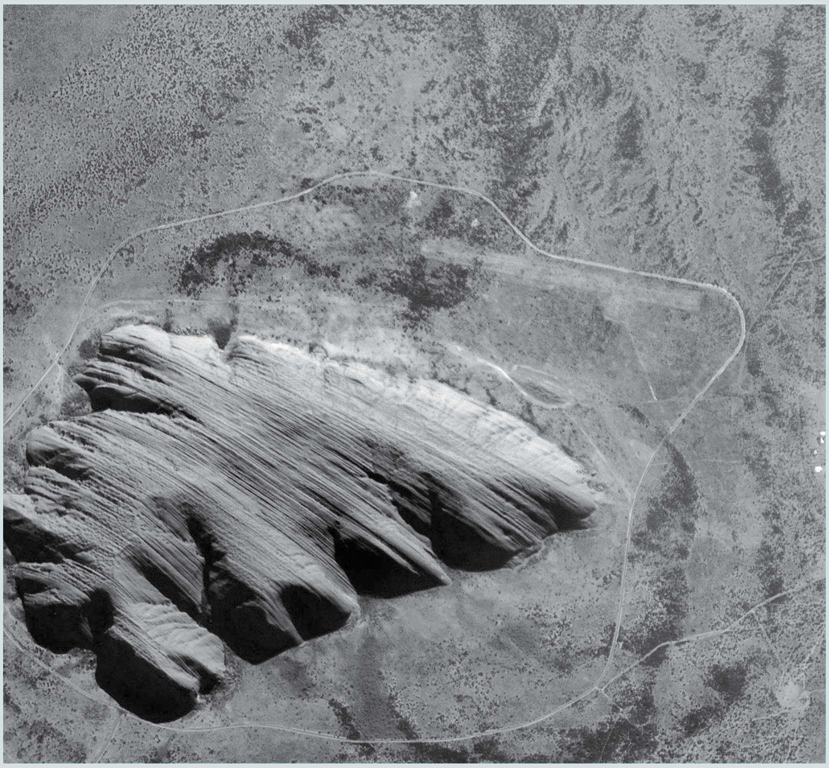


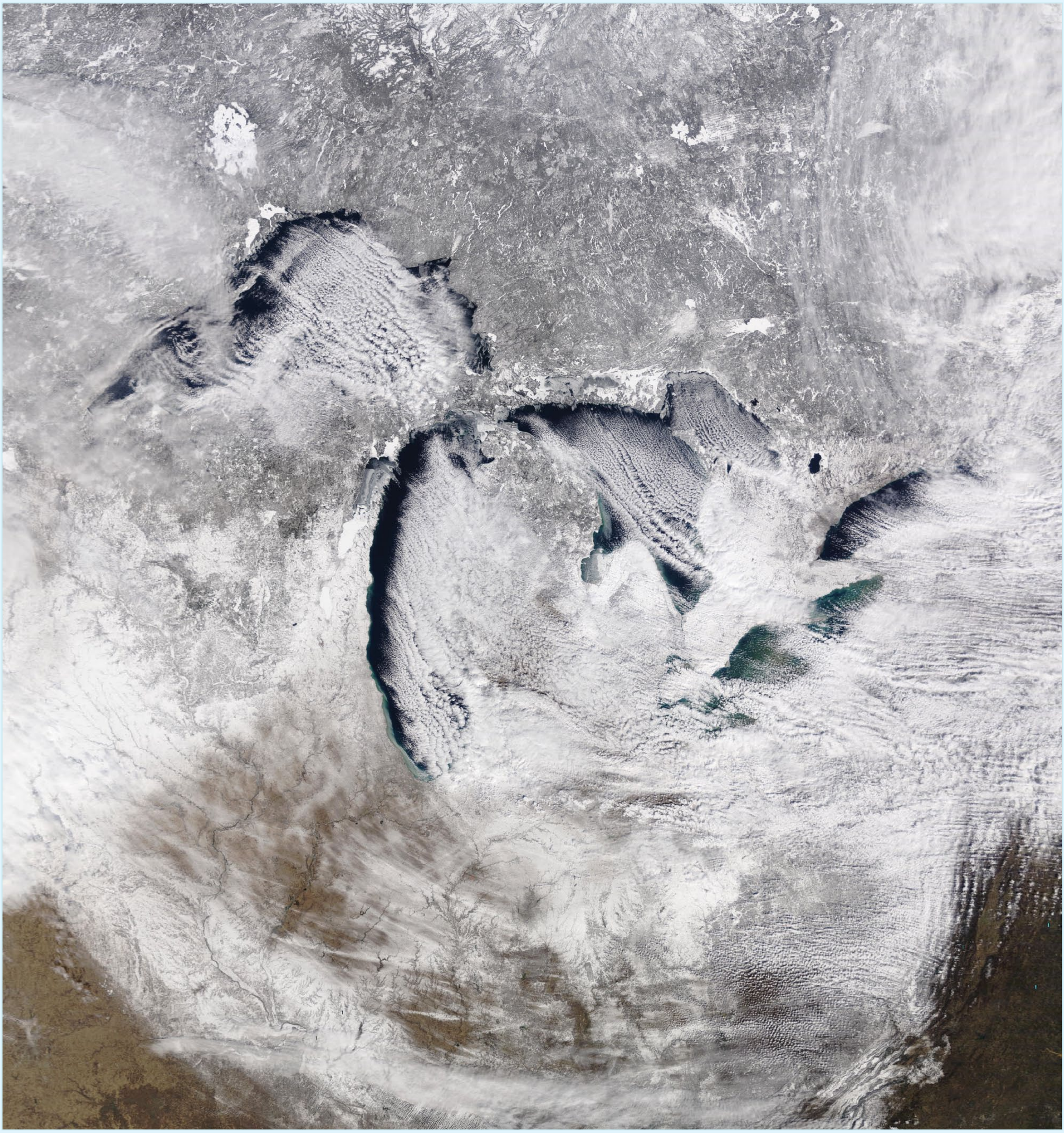
Figure 1
Uluru, imaged by Proba-1's HRC on April 24, 2004.
Image: ESA

Figure 2
Uluru, imaged by Proba-1's HRC on September 8, 2015.
Image: ESA

CLOUD STREETS

over the Great Lakes

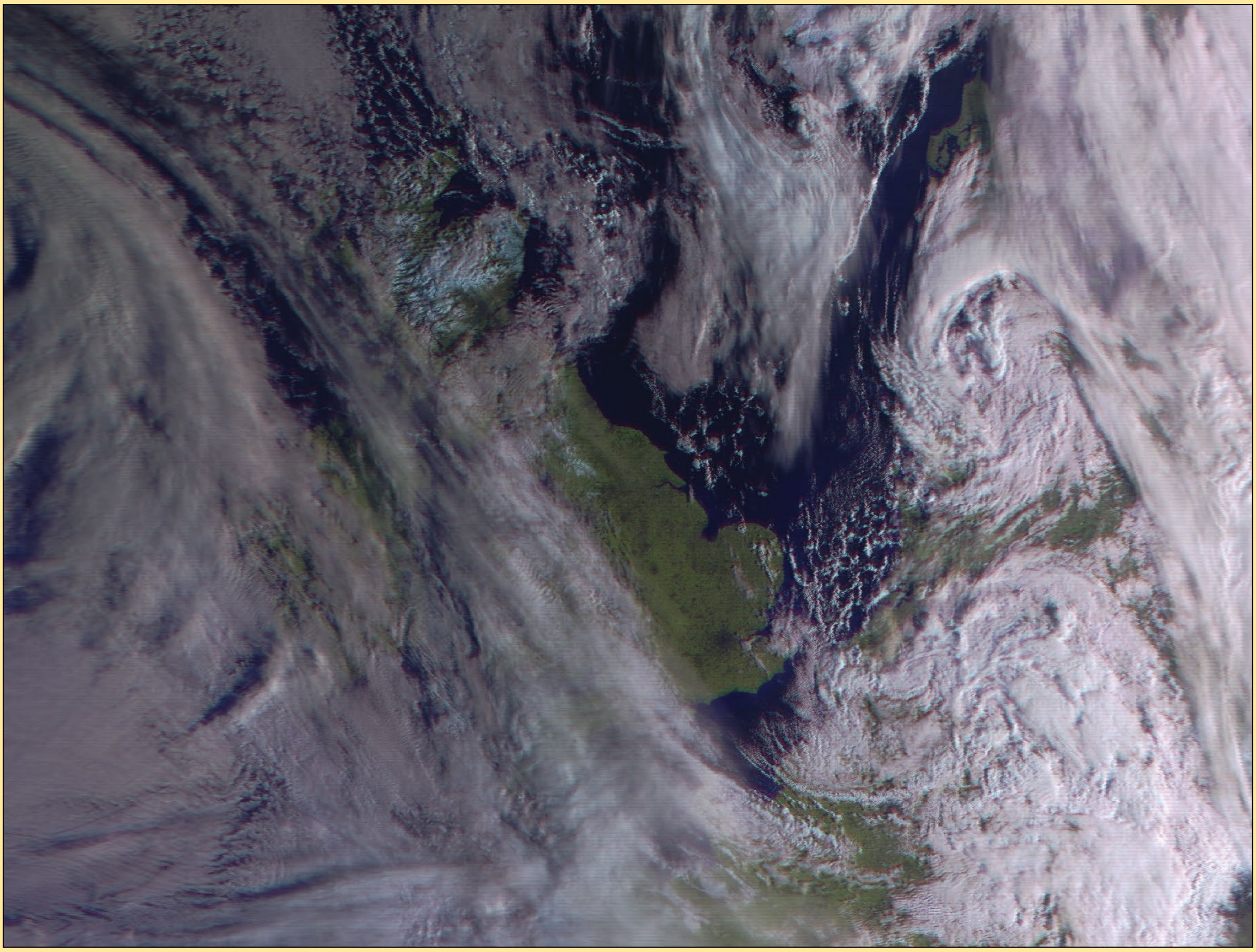
NASA Earth Observatory



On February 11, 2016, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** satellite, acquired this natural-colour image of the cloud streets over the Great Lakes. These long, parallel bands of cumulus clouds form along cylinders of rotating air. But first, cold air from the northwest had to pass over the comparatively warmer lake water, imparting warmth and moisture into the rising air mass.

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

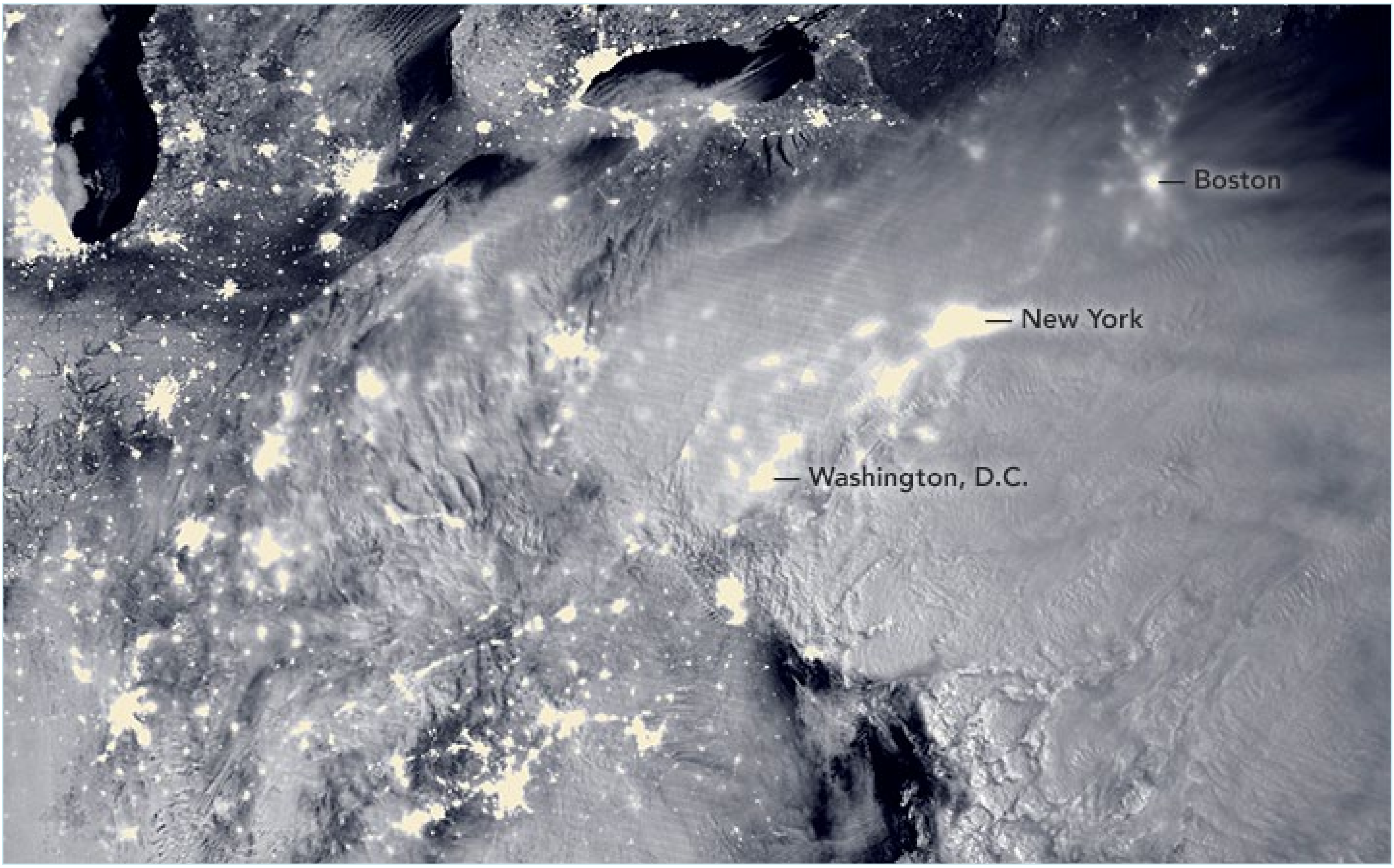
Helen Sharman in her London base talking to Francis Bell about the contact she had with the Royal Grammar School, Guildford while she was on the MIR space station.



Les Hamilton captured this segment from the 08:26 UT Meteor M1 pass on March 3, 2016 using an RTL-SDR dongle and SDRsharp software. The delicate cyan shading over much of Scotland and the Pennines is indicative of lying snow and ice.

Blizzard by Moonlight

NASA Earth Observatory



This image from Suomi-NPP's VIIRS instrument shows the heavy January snowfall over the eastern USA, illuminated by moonlight.

A massive winter storm system pummelled the eastern United States in late January 2016, when two low-pressure systems merged into a potent nor'easter that dropped heavy snow from Virginia to New England. By late afternoon on January 23, snowfall totals were approaching record levels in several states, and hurricane-force winds were battering the coastlines and leading to serious flooding.

The *Visible Infrared Imaging Radiometer Suite* (VIIRS) on the **Suomi NPP satellite** acquired this image of the storm system at 07:15 UT on January 23, 2016. The image was composed through the use of the VIIRS 'day-night band', which detects faint light signals such as city lights, moonlight, airglow, and auroras. In the image, the clouds are lit from above by the nearly full Moon and from below by the lights of the heavily populated East Coast. The city lights are blurred in places by cloud cover (**the full image appears on the following page**). Jeff Halverson, a University of Maryland meteorologist, summarized the storm system in *The Washington Post* as follows:

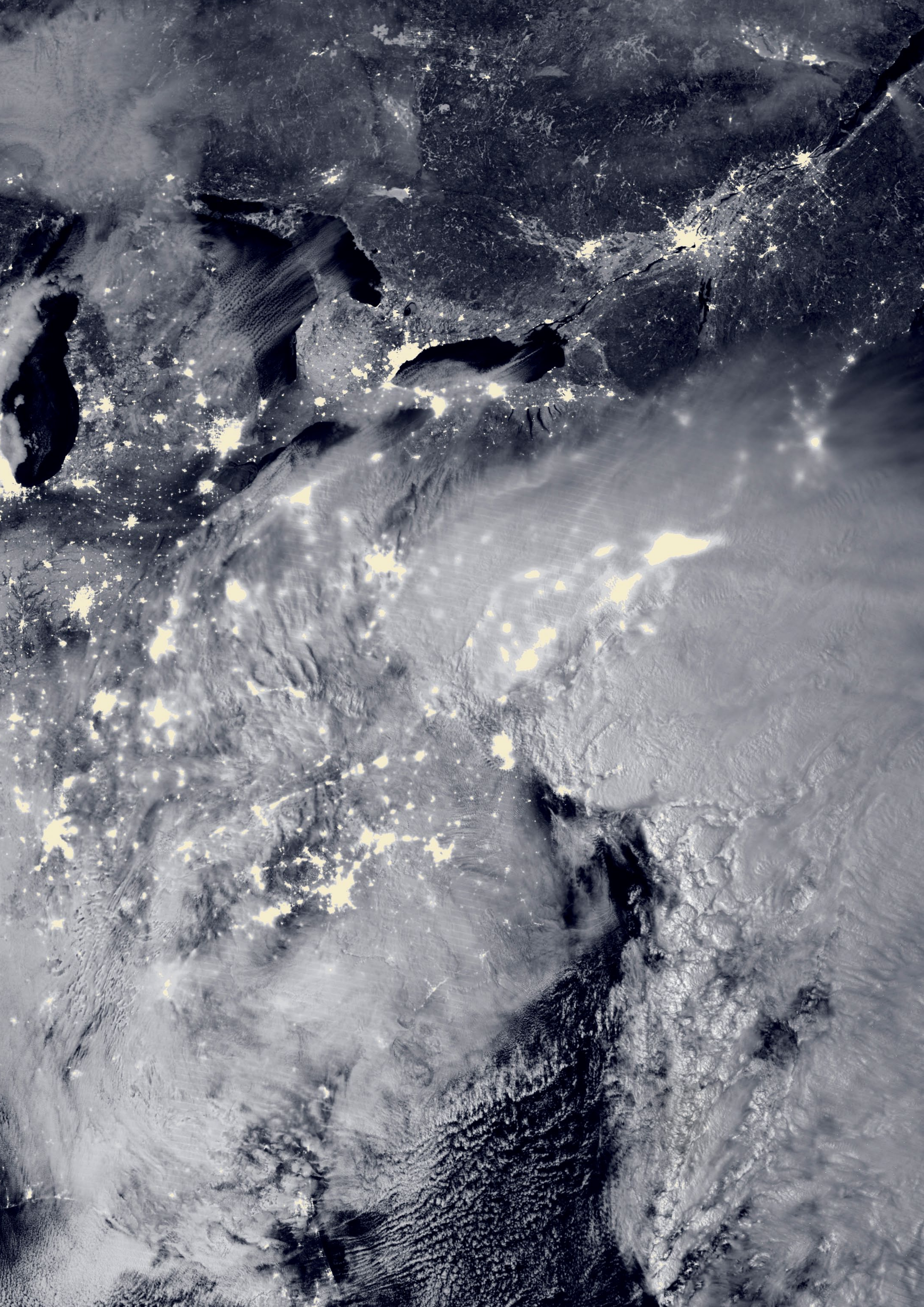
'Combine a very energetic jet stream disturbance with warm, Gulf Stream water, a deep sub-freezing air layer, and tropical moisture, and what you get is an East Coast snowstorm for the record books. The storm is called a nor'easter, or coastal low—a wintertime breed of mid-latitude cyclone powered by contrasting air temperatures. The Arctic air mass that recently invaded the mid-Atlantic, combined with an unseasonably warm Gulf Stream just offshore, will provide the necessary temperature contrast.

'Snow totals have topped 76 centimetres in at least four states, and at least 30 centimetres have been recorded at locations in eight states, with many more hours left to the storm. Snowfall rates reached as high as eight centimetres per hour, and blizzard warnings were in effect from Virginia to Massachusetts throughout January 24. As of 19:30 UT on January 23, the National Weather Service reported snow totals 101 centimetres in Glengary, West Virginia, 84 cm in Frederick, Maryland, 60 cm at Dulles Airport and 41 cm at the National Zoo in Washington.

'Locations closer to the coast, such as Norfolk, Virginia, saw no more than five centimetres of snowfall but dealt with wind gusts of 120 kilometres per hour. The strong winds over the Atlantic Ocean piled up seawater along the shore, which was already high due to the full Moon, a combination that caused coastal flooding near Cape May and Ocean City, New Jersey, and at Lewes, Delaware, where waters rose to three metres, sending a metre-high storm surge onshore.

'According to various news reports, at least eight people have died storm-related deaths, and thousands spent a night stranded in cars and trucks on highways in Pennsylvania and Kentucky. At least 9,500 flights have been cancelled, and citizens have been ordered to stay off the roads in some cities and towns.'

NASA image by Jeff Schmaltz and Joshua Stevens, LANCE/EOSDIS Rapid Response. Caption by Mike Carlowicz



Beginners' Checklist

For receiving Images from Weather Satellites

Francis Bell

From time to time I receive an invitation to give a presentation to an amateur radio club, relating to GEO and direct satellite reception. Recently, together with David Simmons, I attended a **Reading Amateur Radio** *Club* meeting, where we spent a full evening giving talks and demonstrating equipment for weather satellite reception. I think the evening went well and prompted much discussion afterwards with the appreciative and technically very competent club members.

In anticipation of passing on some of the detailed references made during the evening I had prepared an information sheet which was distributed at the end of the meeting.

GEO's busy stand at the **Harwell and District radio rally** held in February 2016. David Simmons can be seen talking to visitors who generally expressed interest in our group with several of them buying SDR dongles to progress their own data reception. The computers showed examples of both polar orbiting and geostationary satellites images, and judging by how much was taken during the day, our literature was also well received.

A few days later, both by email and when David and I were at the **Harwell Radio Rally** manning the GEO stand, I received several requests for a copy of the information sheet distributed earlier at Reading. With these requests in mind, I have reproduced the contents of this sheet below. Remember, this is only the briefest summary relating to satellite image reception, but for an absolute beginner it provides some useful references.

1 The International Space Station (ISS)

These websites show live views from experimental cameras on the ISS but are subject to orbit and communication links. For camera links, visit

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

and for the audio ground link, and sometimes video from inside the space station, visit

http://www.nasa.gov/multimedia/nasatv/iss_ustream.html

For a full screen image click the bottom right corner of the camera image.

2 Satellite Predictions

For satellite prediction times for the Reading area, go to

http://heavens-above.com/

Click '*Change your observation location*' and enter your station's coordinates. For example, try 51.3°N, 0.70°S for Reading. Satellites of interest are NOAA 15, NOAA 18, NOAA 19, Meteor M1, Meteor M2, and ISS.

To display the times for each satellite click on '*Satellite Data Base*', then type in the satellite name exactly as shown above. Finally, click the '*Update*' box then '*All Passes*'.

3 Frequencies and Times for Polar Satellites:

NOAA 19	137.1 MHz	about 1.00 pm
NOAA 18	137.91 MHz	about 12.00 noon
NOAA 15	137.50 MHz	about 4.00 pm
Meteor M1	137.1 MHz	about 8.0 am
Meteor M2	137.1 MHz	about 10.0 am

Note that these passes are also available overnight, at approximately 12 hours later. Also, all the above times may be ± about 45 minutes according to any specific orbit. The NOAA satellite signals are FM with a bandwidth of about 45 kHz and decoding software is quite widely available free of charge

For the NOAA satellites, try **WXtoImg** from

www.wxtoimg.com

For the Meteor M1 and M2 signals, which are digital LRPT, refer to Les Hamilton's article in GEO Quarterly No. 48, pages 27-32. **Note that**, currently, Meteor M2's LRPT is switched off, but Meteor M1 is transmitting.

4 European Satellites

The European agencies *EUMETSAT* and *ESA* operate a number of weather and Earth observation satellites in both polar and geostationary orbits. Images from these satellites are being disseminated continuously 24/7 so, once a receiving station is established, there is an almost non-stop stream of incoming image data.

Requirements for Home / Personal Reception

- A dish about 85 cm diameter or a little larger, together with a suitable LNB
- a good coax connection to a receiver which is usually situated next to a computer
- a newish computer with software fast enough to deal with the incoming data
- a decryption dongle from EUMETSAT, plus software to display the incoming data.

Once established, such a system will run indefinitely.

Likely costs

- Dish and LNB - be resourceful

- Receiver, about £350 from GEO
- a licence and dongle from EUMETSAT - £70 (a once only payment)
- Software, approximately £50, again a one off payment, but there are free options.

Software for Displaying Geostationary Satellite Images

Free software is available from **Rob Alblas** in the Netherlands at

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

http://www.alblas.demon.nl/wsat/software/index.html

You can also email Ron at

kunstmanen@alblas.demon.nl

with a request for software.

Alternatively, you can obtain outstanding, easy to use software for a modest charge from **David Taylor** at

www.satsignal.eu

From the opening page there is a sub menu '*Satellite Tools*' from which you should select 'MSG Data Manager', the software for EUMETCast reception (MSG means: ' Meteosat Second Generation').

5 Software Defined Radio Dongles

If you are intent on receiving images from the Russian Meteor satellites without having to purchase an expensive receiver, an RTL-SDR dongle is the receiver of choice. For software to drive the SDR dongle, visit

http://rtlsdr.org/softwarewindows

There are some variables according to the chipset in the dongle, and your computer's chipset and operating system, hence this advice to download directly your own software. Just follow the on-screen guidelines on this website.

6 The GEO Website.

Go to the GEO website for almost anything you want to know about the reception of polar orbiting and geostationary weather satellite images

www.geo-web.org.uk

Also, follow GEO news items on **Twitter, Facebook** and **User Groups** linked from the GEO website.

To join GEO, for £15, fill in and submit the form on the website at

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

7 UK Space Activities

The publication '**Space: UK**' is available free of charge: just send an email to

info@ukspaceagency.bis.gsi.gov.uk

stating that you would like to receive a printed copy of 'Space:UK', and providing your full name and address. Say that you want the publication for personal use.

For a more comprehensive view of UK space activities, visit

https://www.gov.uk/government/publications/space-sector-magazine-spaceuk

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FeedBack

The page where readers can express opinions about GEO Quarterly Matters

Email: geoeditor@geo-web.org.uk

Hi Les,

Thank you for another superbly interesting magazine No 48. I'm writing to say how useful I have found Barry Smith's "What's Your Horizon" article, and the www.heywhatsthat.com website, which I had not encountered before. As a mapaholic, APT dabbler, radio Tx and Rx hobbyist, and living in a fairly hilly part of the West Midlands where Freeview propogation has been problematic, this tool would have proved invaluable to me before, for several purposes, and I'm so grateful it has been publicised.

Please pass my thanks to Barry!

Regards,
Colin Prior, Halesowen, West Midlands.

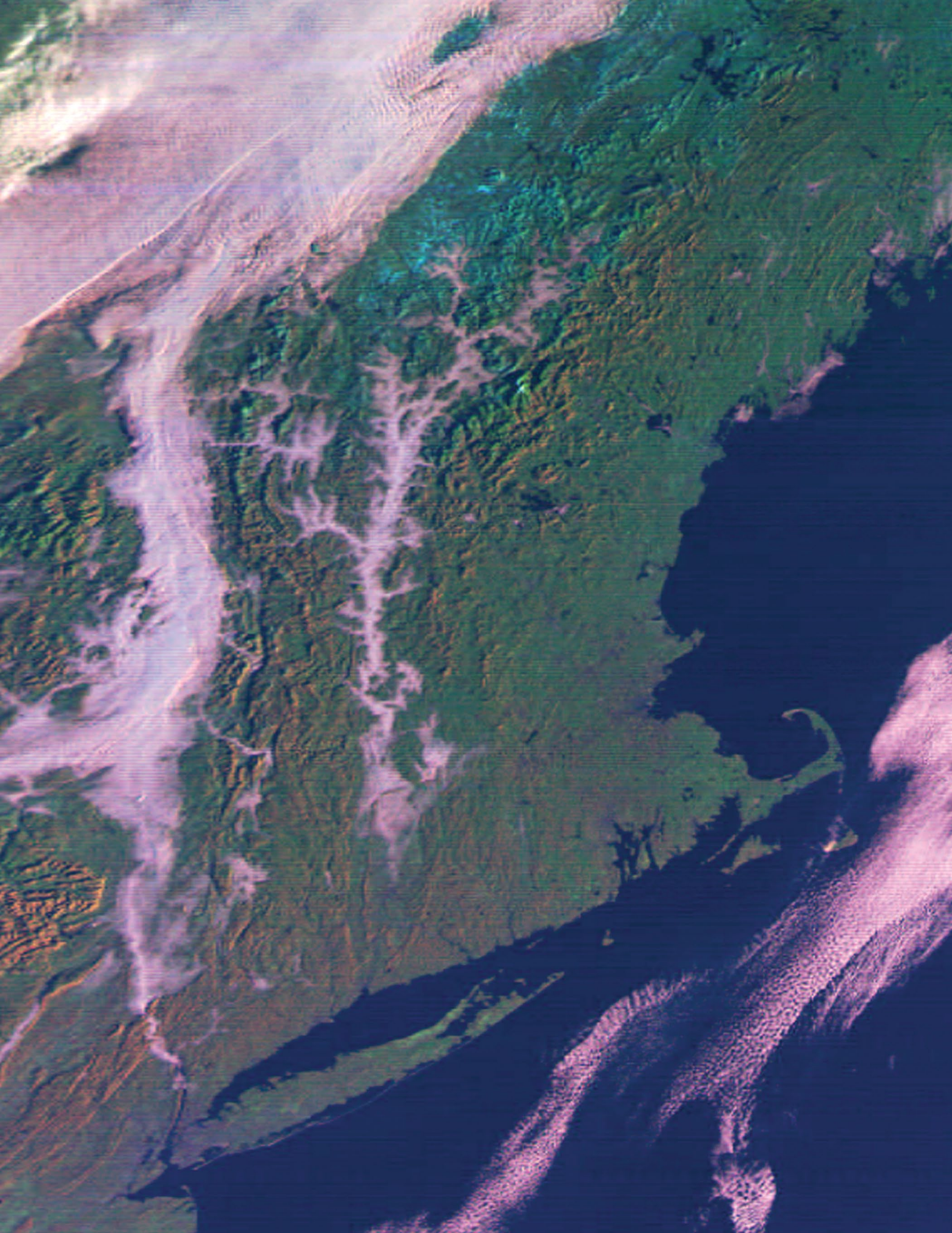
Hi Les

I thought you might be interested in some additional information to go with your image of the Malaspina Glacier along the southern coast of Alaska. Not indicated in the image is the scale. The mouth of the glacier, where it meets the Gulf of Alaska, is about 100 kilometres across.

During the Klondike Gold Rush in fall and winter of 1897/1898, at least four parties attempted to cross the glacier northward toward the gold fields in Canada, about 500 km away. There were many people out to make a buck off the ignorant gold seekers, not the least of which were ship owners along the west coast of the US, who wanted to put their worn-out ships to use. The parties, about 100 men, were all suckers for the corrupt claims of an easy route to gold by sailing to Yakutat Bay adjacent to the Malaspina Glacier.

The route was so treacherous that 41 died trying to reach the Klondike. One party of nineteen required three months just to cross the glacier, but when this group had dwindled to nine survivors, they decided to turn back. Only four completed the trip to the coast alive.

Best regards,
Whitham Reeve, Anchorage, Alaska, USA.

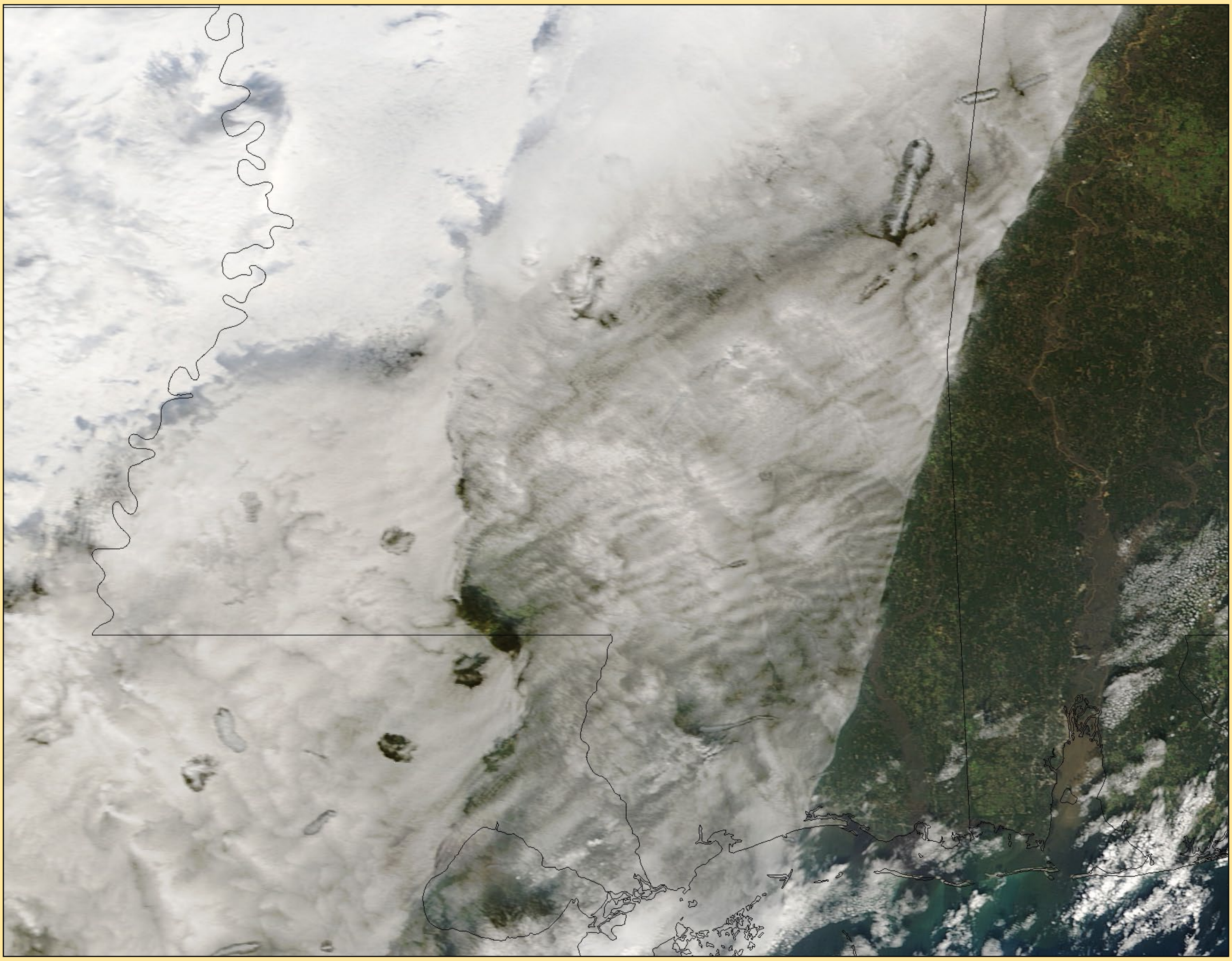


This Meteor M1 image from December 6, 2015 reveals striking detail of the White Mountain Range that stretches through New Hampshire and Maine. Also prominent in this scene, posted on GEO-Subscribers by Hendricus Lulofs, are Cape Cod and Long Island.

Hole-Punch Clouds

over Mississippi and Louisiana

A NASA Earth Observatory Report



In elementary school, students learn that water freezes at 0° Celsius, which is true most of the time: but there are exceptions to the rule. For instance, water containing very few impurities—such as dust or pollution particles, fungal spores, and bacteria—can be chilled to much cooler temperatures and still remain liquid, a process known as supercooling.

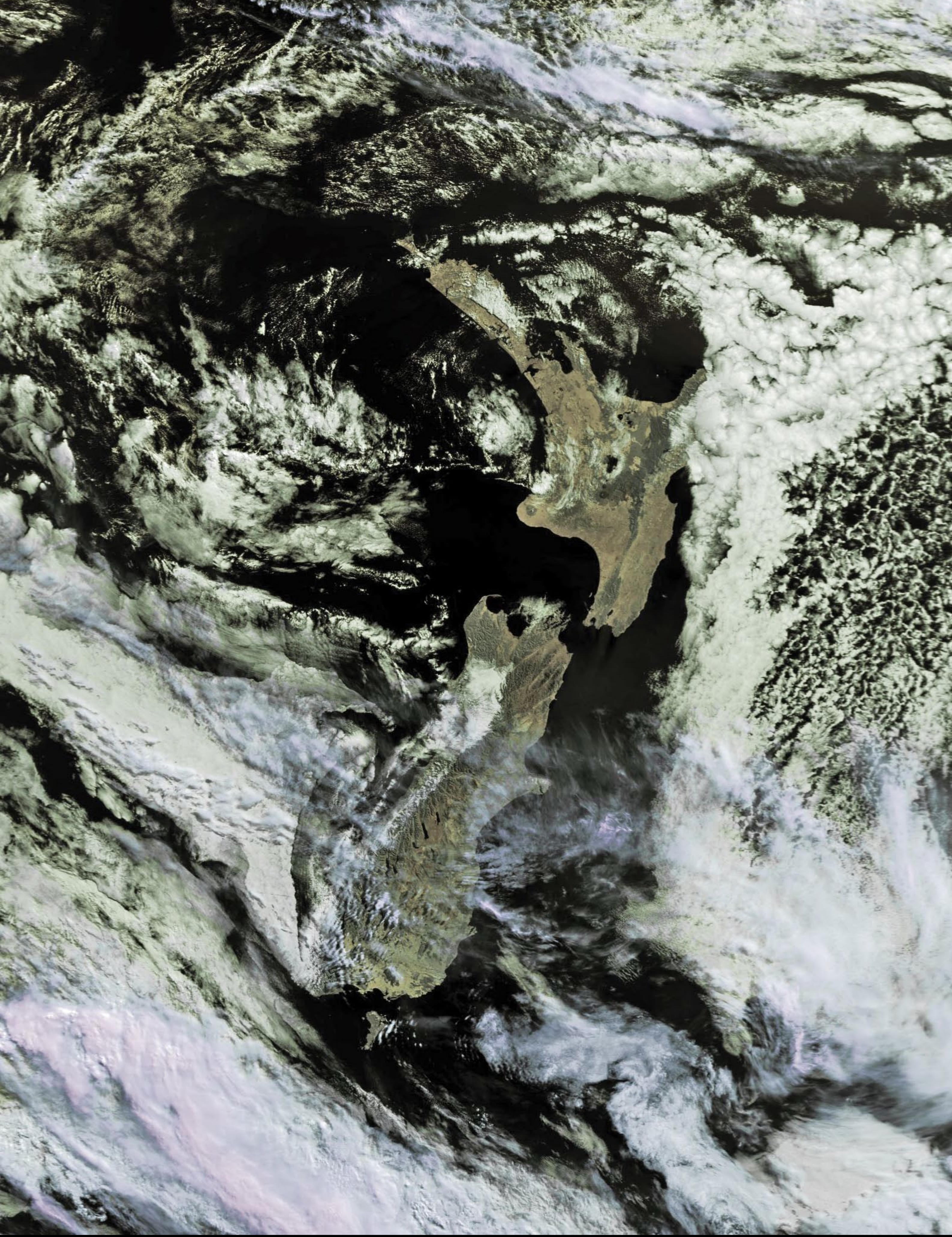
Supercooling may sound exotic, but it occurs pretty routinely in Earth's atmosphere. Altocumulus clouds, a common type of mid-altitude cloud, are mainly composed of water droplets supercooled to a temperature of about -15°C. Altocumulus clouds with supercooled tops cover about 8% of Earth's surface at any given time.

Supercooled water droplets play a key role in the formation of hole-punch and canal clouds, the distinctive features shown in this satellite image. Hole-punch clouds—also called fallstreak clouds—usually appear as circular gaps in decks of altocumulus clouds; canal clouds look similar but the gaps are longer and thinner. This natural-colour image shows both hole-punch and canal clouds over Mississippi and Louisiana, as observed on December 29, 2015, by the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's **Terra** satellite.

Both these phenomena form when aircraft fly through cloud decks rich with supercooled water droplets, and produce aerodynamic contrails. Air expands and cools as it moves around the wings and past the propeller, a process known as adiabatic cooling. Air temperatures above jet wings often cool by as much as 20 Celsius degrees, pushing supercooled water droplets to the point of freezing.

As ice crystals form, they absorb nearby water droplets. Ice crystals are relatively heavy, so they tend to sink. This triggers tiny bursts of snow or rain that leave gaps in the cloud cover. Whether a cloud formation develops hole-punch or canal depends on the thickness of the cloud layer, the air temperature, and the degree of horizontal wind shear. Both descending and ascending aircraft—including jets and propeller planes—can trigger hole-punch and canal clouds.

NASA image by Jeff Schmaltz, LANCE/EOSDIS Rapid Response. Caption by Adam Voiland.



Mike Stevens submitted this splendid, nearly cloud-free Metop-1 image of New Zealand, that he obtained via *EUMETCast* on March 2, 2016.
Image © EUMETSAT 2016

EUMETCast Reception

with the TBS-6903 Tuner Card

Mike Stevens

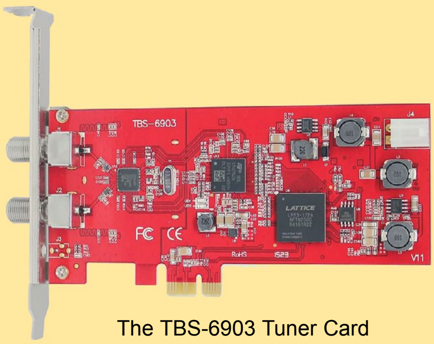
Well, here we go again: yet another PCIe Card from our friends over in the Far East, and an extremely good Tuner it is. I have been testing one of these **TBS-6903** cards since September 2015 on both the *EUMETCast Basic* and *High Volume* services and, as I write this short article, it is ticking away in the background receiving the *Basic Service* without any packet loss.

This tuner is now in production and is available from the TBS Website. In addition, we have a UK Company who will be stocking these units and who will give GEO Members a little discount. You can contact me for details at

stevens312@btinternet.com

Basic Specifications

- Frequency Range: 950-2150 MHz
- Dual Channels: DVB-S2/S 8PSK, QPSK 16APSK, 32APSK ACM/VCM
- Supports: CCM, ACM, VCM, Multiple Transport Stream
- Supports Data Burst & Tone Burst
- Supports DiSEqC2.X and Motor
- Works on Windows XP/Vista/7/8/10/Linux
- Available PCI Express x1, x4, x8, or x16 Slots.



The TBS-6903 Tuner Card

The demodulator, is a more robust reliable and advanced chip giving excellent selectivity and sensitivity, and is ideal for *EUMETCast* reception.

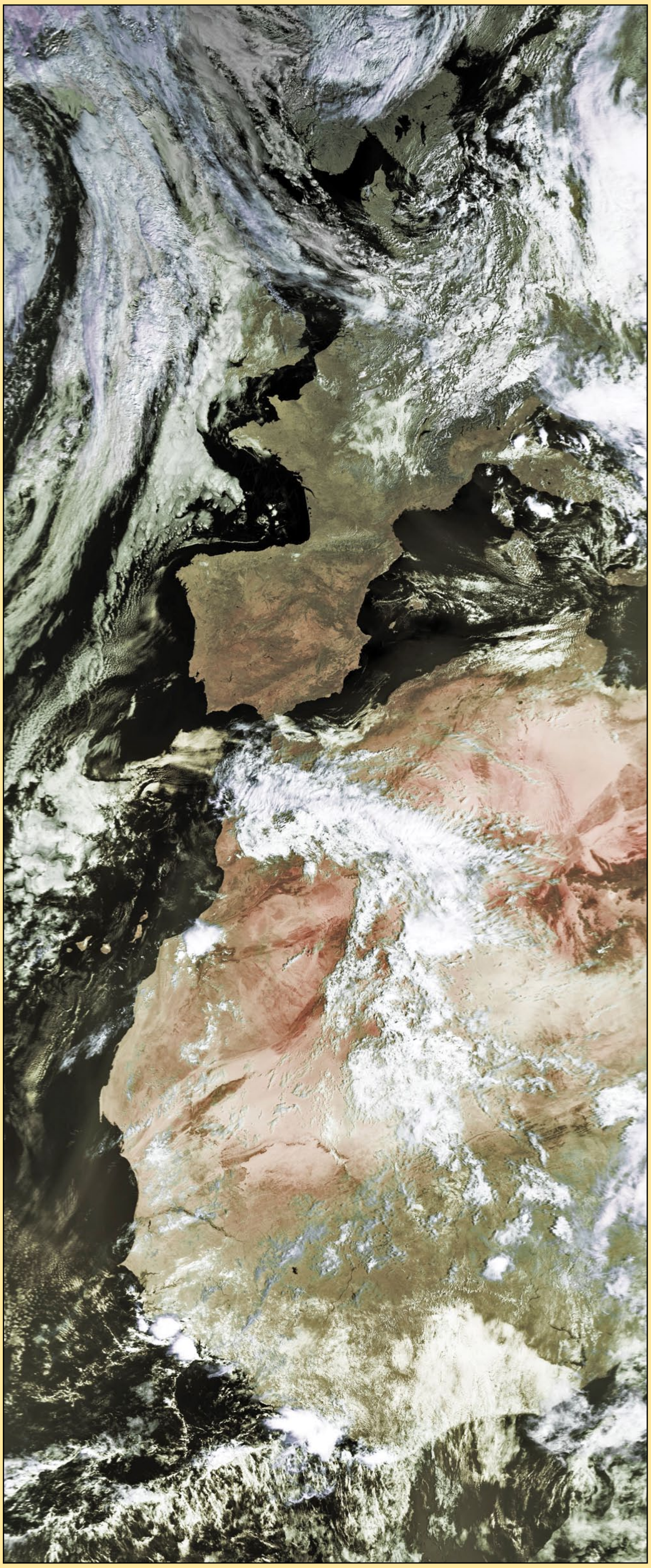
I don't think I need to go into the full details of installation and set-up as past issues, especially last December's one, *GEO Quarterly 48*, carry full details on both installation and software.

You will of course have to download all the latest software from the TBS Website on

tbsdtv.com/downloads

and install according to my instructions in the previous Quarterly. And don't forget the **dpinst32/64** file: this is most important.

I think that, in the future, we are going to see many more tuners and cards from TBS and, with all the advancements in satellite technology providing ever better (and more) data and information from EUMETSAT, we have some exciting times ahead of us



This image acquired from Metop-2 on September 20 last year illustrates what can be achieved with the TBS-6903 Tuner Card
Image © EUMETSAT 2015

Waves Above and Below the Water

NASA Earth Observatory

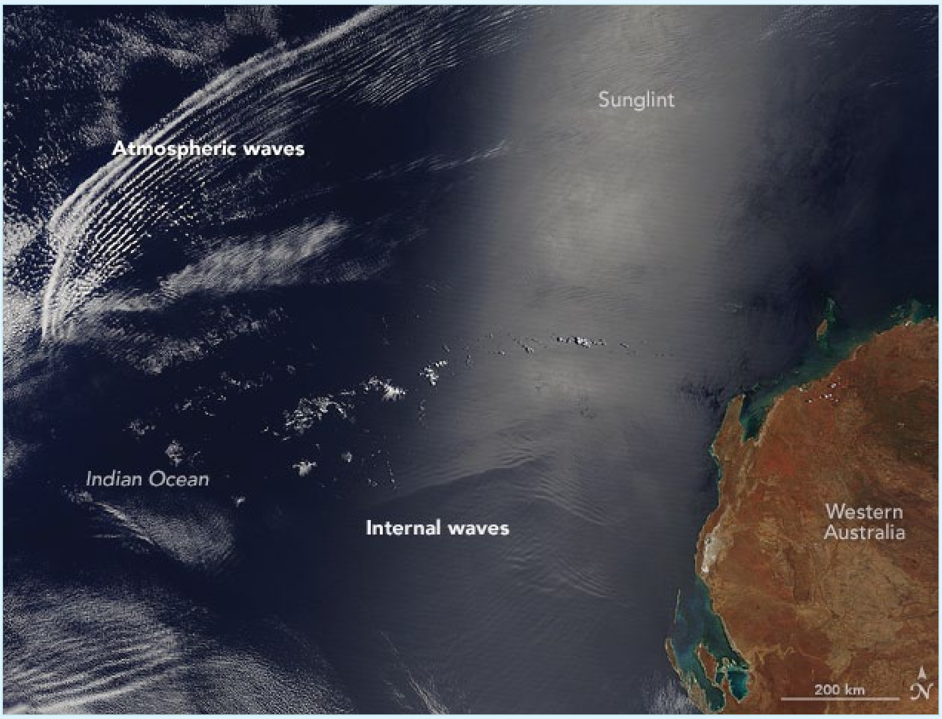
Two kinds of waves are visible in the image opposite, yet neither is the kind you are probably familiar with.

At 03:05 UT on February 10, 2016, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** satellite acquired this natural-colour image of wave patterns off the coast of Western Australia. Well offshore to the north and west, atmospheric waves are made visible by parallel bands of white clouds. Closer to the coast, the bright area of water is sunglint: the reflection of sunlight directly back toward the satellite imager. This sunglint makes it possible to see the faint ripples of internal waves, large waves that propagate below the water surface, within the depths of the sea.

Waves form in the atmosphere for a variety of reasons. Sometimes the movement of an air mass over an elevated feature such as a mountain ridge, a volcano, or an island amidst a flat sea, will force air to rise then sink, creating ripples in the sky like those propagating across the surface of a pond. At other times, the collision between different air masses can cause a rippling effect.

It is unclear what caused the atmospheric waves in this image. Off the west coast of Africa, we often see waves form when the dry air from the Sahara moves out over the much moister air over the tropical Atlantic Ocean. The dry air tends to push the moist air higher into the atmosphere, causing water vapour to form droplets and amass into clouds. The moist air rises, then gravity pulls it back down; the warm air rises again, then falls again. A series of cloud ripples mark the edges of the wave front as it propagates and dissipates.

It is also possible (though perhaps less likely because of the distance) that the wave patterns in the image have their origin inland. Western Australia is mostly desert and relatively flat, so it is possible that an atmospheric wave pattern could have formed when an air mass rode up over the Hamersley Range (just outside the scene) and out toward the sea.



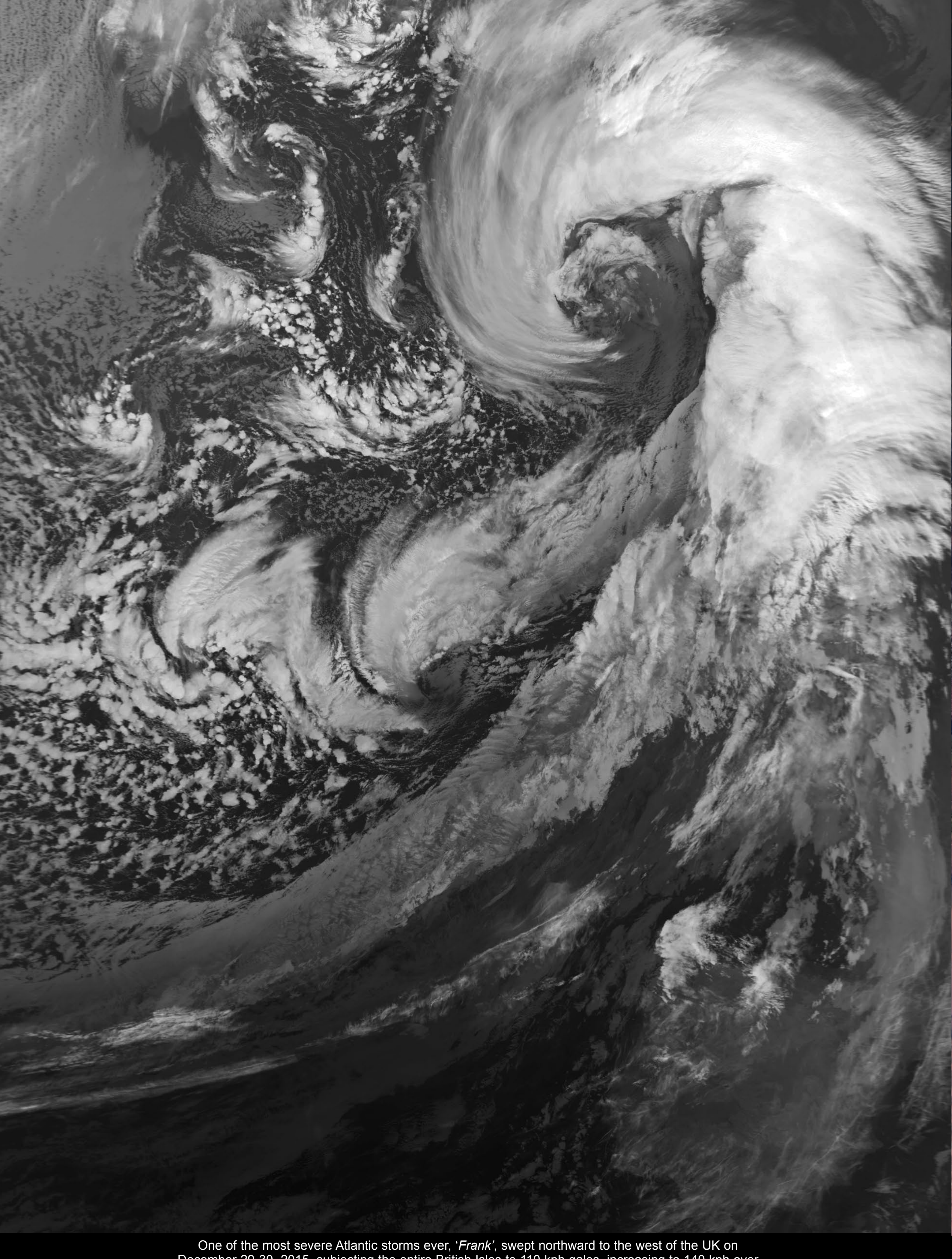
Gravity Waves to the West of Australia
Image: NASA

Internal waves are quirky phenomena that were scarcely known to science until the satellite era. They can be hundreds of metres tall and tens to hundreds of kilometres long. Enhanced by sunglint in the image above, these long wave forms moving across the sea surface are a visible manifestation of slow waves moving tens to hundreds of metres beneath the sea surface.

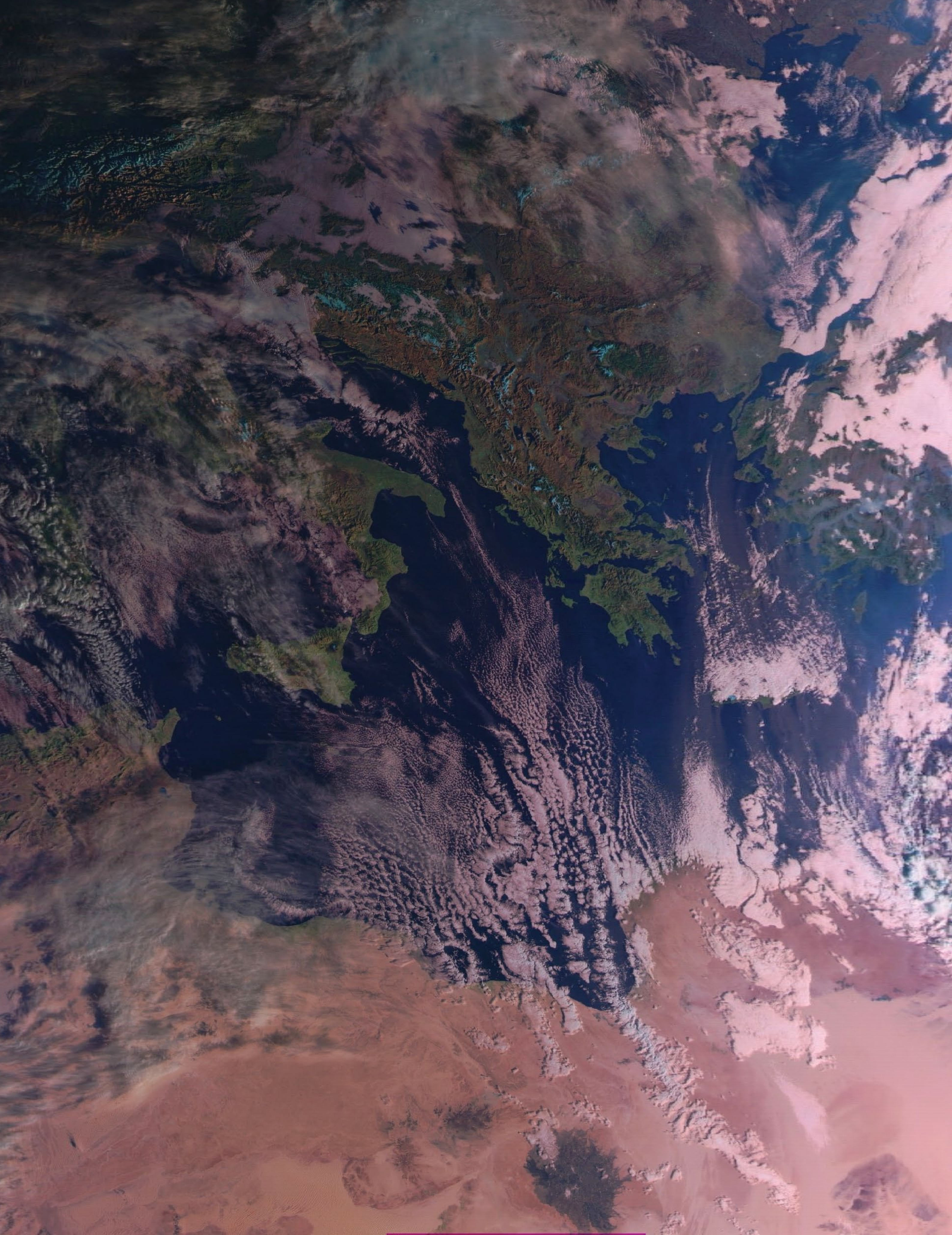
Internal waves form because the ocean is layered. Deep water is cold, dense, and salty, while shallower water is relatively warmer, lighter, and fresher. The differences in density and salinity cause layers of the ocean to behave like different fluids. When tides, currents, and other large-scale effects of Earth's rotation and gravity drag water masses over some sea floor formations, they can create wave actions within the sea that are similar to those happening in the atmosphere.

If you were on a boat, you would not necessarily see or feel internal waves because they are not expressed at the surface as different wave heights. Instead, they show up as smoother and rougher water surfaces that are visible from satellites. As internal waves move through the deep ocean, the less dense water above flows up and down the crests and troughs. Surface water bunches up over the troughs and stretches over the crests, creating alternating lines of calm water at the crests and rough water at the troughs. Calm, smooth waters reflect more light directly back to the satellite, resulting in a bright, pale stripe along the length of the internal wave. The rough waters in the trough scatter light in all directions, forming a dark line.

'There are definitely ocean internal waves in this image,' stated environmental engineer Nicole Jones of The University of Western Australia. 'We have measured them off the coast of Ningaloo with instruments in the water. The different directions of the wave fronts are most likely due to the different sea floor slope directions in this region.' She also noted that internal waves play an important role in global ocean circulation and mixing, which is critical to an understanding the ocean's role in climate and in the movement of nutrients and carbon from the depths to the surface and back. Jones and colleagues also study internal waves for their potential impact on drill rigs and other offshore structures.



One of the most severe Atlantic storms ever, '*Frank*', swept northward to the west of the UK on December 29-30, 2015, subjecting the entire British Isles to 110 kph gales, increasing to 140 kph over the western and northern isles. This channel-4 infrared image was acquired by Metop-A at 20:27 UT.



This beautiful Meteor-M1 RGB123 image of the Balkans, Italy and eastern Mediterranean was acquired by Alex (Happysat) from his station in the Netherlands on November 13, 2015.

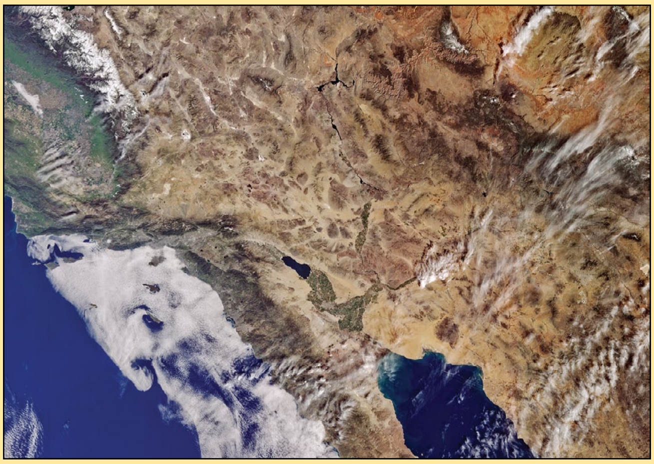
Sentinel-3A's First Images

ESA

Just two weeks after launch, the latest *Sentinel* satellite has offered a taster of what it will provide for the EU's *Copernicus* Earth observation programme. **Sentinel-3A**'s very first image, captured at 14:09 UT February 29, shows the transition from day to night over Svalbard, Norway. As well as showing the snow-covered archipelago, the image also details Arctic sea ice and some cloud features.

The first image acquired by Sentinel 3A
Image ESA

Another image (below), delivered at 17:44 UT on the same day, features California, Arizona and Mexico, and also captures the city of Los Angeles.



Sentinel 3A imaged California and Los Angeles
Image ESA

On the following page is shown an image acquired on March 1, which includes Spain, Portugal, the Strait of Gibraltar and North Africa.

A;; these images were captured by Sentinel 3A'a *Ocean and Land Colour Instrument* (OLCI). With heritage from **Envisat**, this new instrument has 21 spectral bands, a resolution of 300 metres and a swath width of 1270 kilometres.

Offering new eyes on Earth, OCLI will allow ocean ecosystems to be monitored. It will also support vegetation, crop conditions and inland water monitoring as well as providing estimates of atmospheric aerosol and clouds—all of which bring significant benefits to society through more informed decision-making.

Volker Liebig, ESA's Director of *Earth Observation Programmes*, stated:

> 'This first image already reveals the true versatility of Sentinel-3A. The mission will be at the heart of a wide range of applications, from measuring marine biological activity to providing information about the health of vegetation. Given its extensive payload, Sentinel-3A is a real workhorse that is set to make a step change in the variety of data products provided to users.'

Carrying a suite of instruments working together, *Sentinel-3A* is arguably the most complex of all the Copernicus Sentinels. Once commissioned, it will systematically measure Earth's oceans, land, ice and atmosphere to monitor large-scale global dynamics and provide critical near-realtime information for ocean and weather forecasting.

Philippe Brunet, Director of the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and Small- and Medium-sized Enterprises, said,

> 'The launch of Sentinel-3A further expands the fleet of dedicated missions for Copernicus services. This mission is particularly important as it will contribute to the Copernicus Marine Environment Monitoring Service and the global land component of the Copernicus Land Service.'

Following the satellite's launch and early operations phase, which was completed in record time, it will spend the next five months being commissioned for service. Given its extensive payload, Sentinel-3A promises to be a real workhorse that is set to make a step-change in the variety of data products provided to users.

Once commissioned, ESA will hand over satellite operations to EUMETSAT. The mission will then be managed jointly, with ESA generating the land products and EUMETSAT the marine products for application through the Copernicus services.

Alain Ratier, EUMETSAT's Director-General, added:

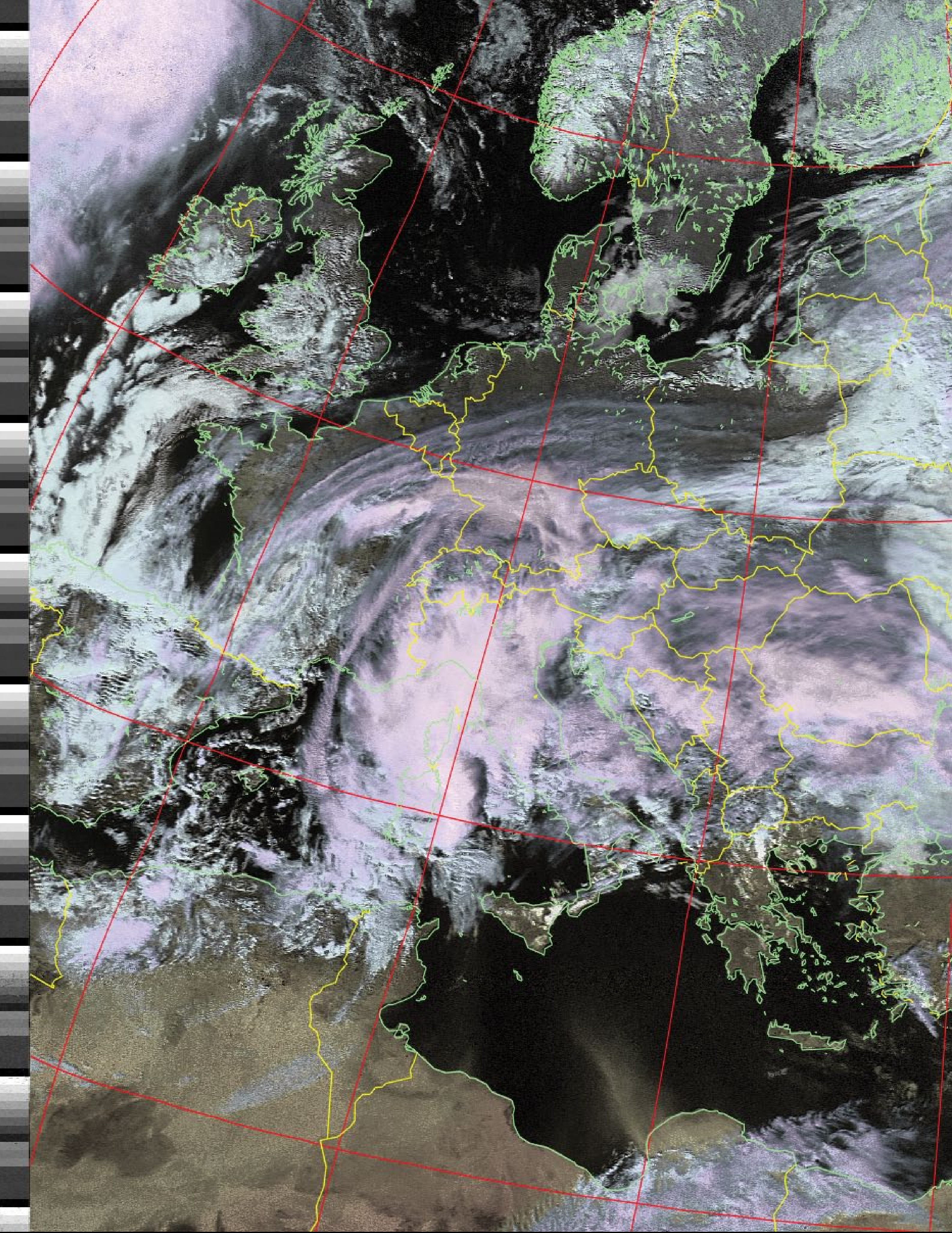
> 'This first image is a promise to the marine user community. As the operator of the Sentinel-3 marine mission, we are delighted to see the first fruit of our cooperation with ESA and the European Commission, and we are looking forward to delivering many more images and products to users after the commissioning.

These first images are just the beginning. OLCI was the first instrument to be switched on. In the coming days there will be more news from Sentinel-3's altimeter, which measures the height of the ocean surface, and the radiometer, designed to measure land and sea-surface temperatures.

Acknowledgement

Thanks to John Tellick for sourcing this material for GEO Quarterly.

Featuring Spain, Portugal and North Africa, this is one of the first images from the **Sentinel-3A** satellite. The image was taken by the satellite's *Ocean and Land Colour Instrument* on March 1, 2016 and clearly shows the Strait of Gibraltar between the Atlantic and Mediterranean. Swirls of sediment and algae in the seawater can be seen along the southwest coast of Spain and along the coast of Morocco. The instrument picks out Morocco's dry desert, snow-covered peaks of the Atlas Mountains and greener vegetated northern areas of Spain.

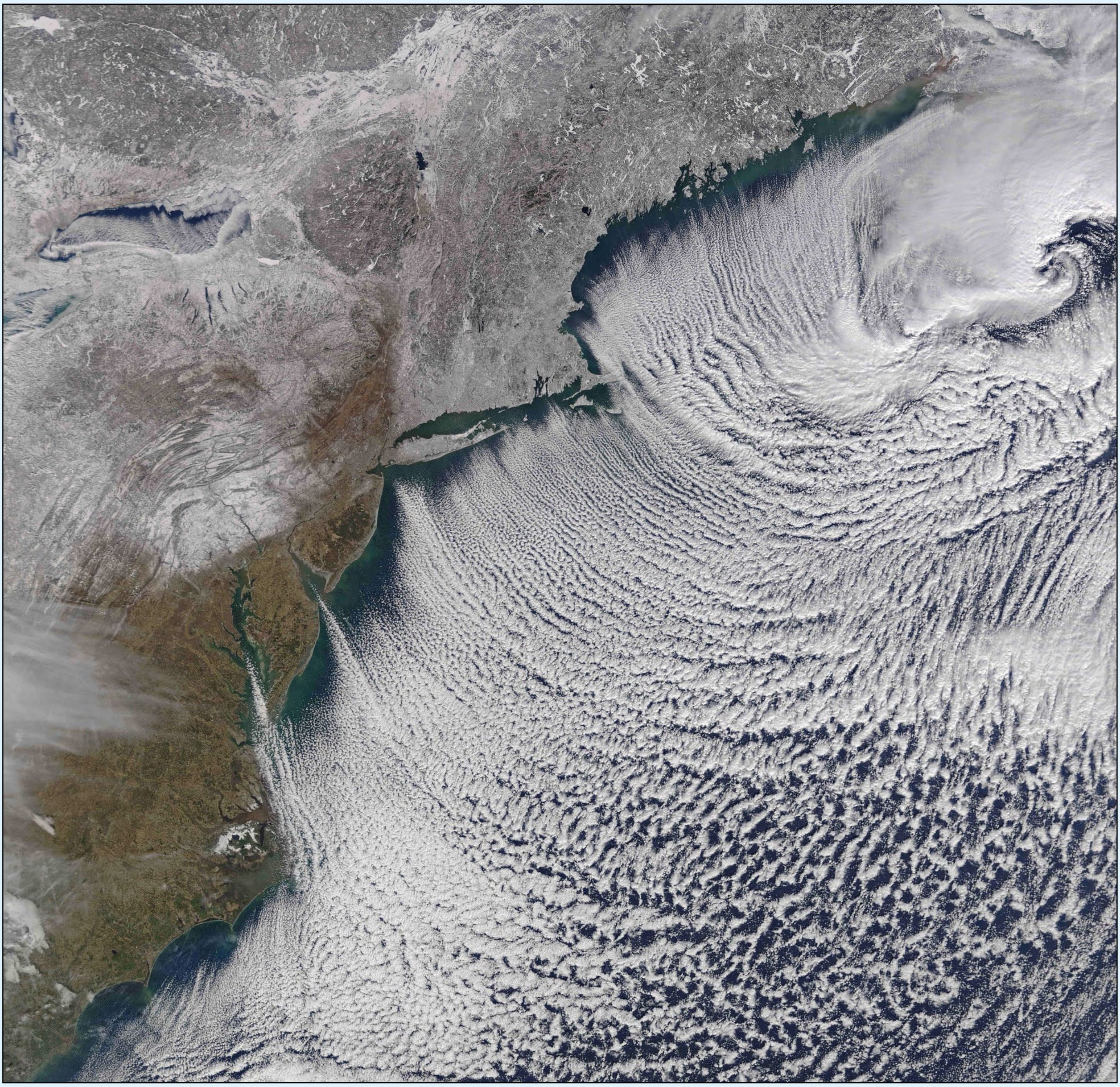


This NOAA 19 APT image from Alex (Happysat),acquired in mid afternoon on February 28, shows what appears to be a plume of sand blowing over the Mediterranean Sea from the Libyan desert.

CLOUD STREETS

John Tellick

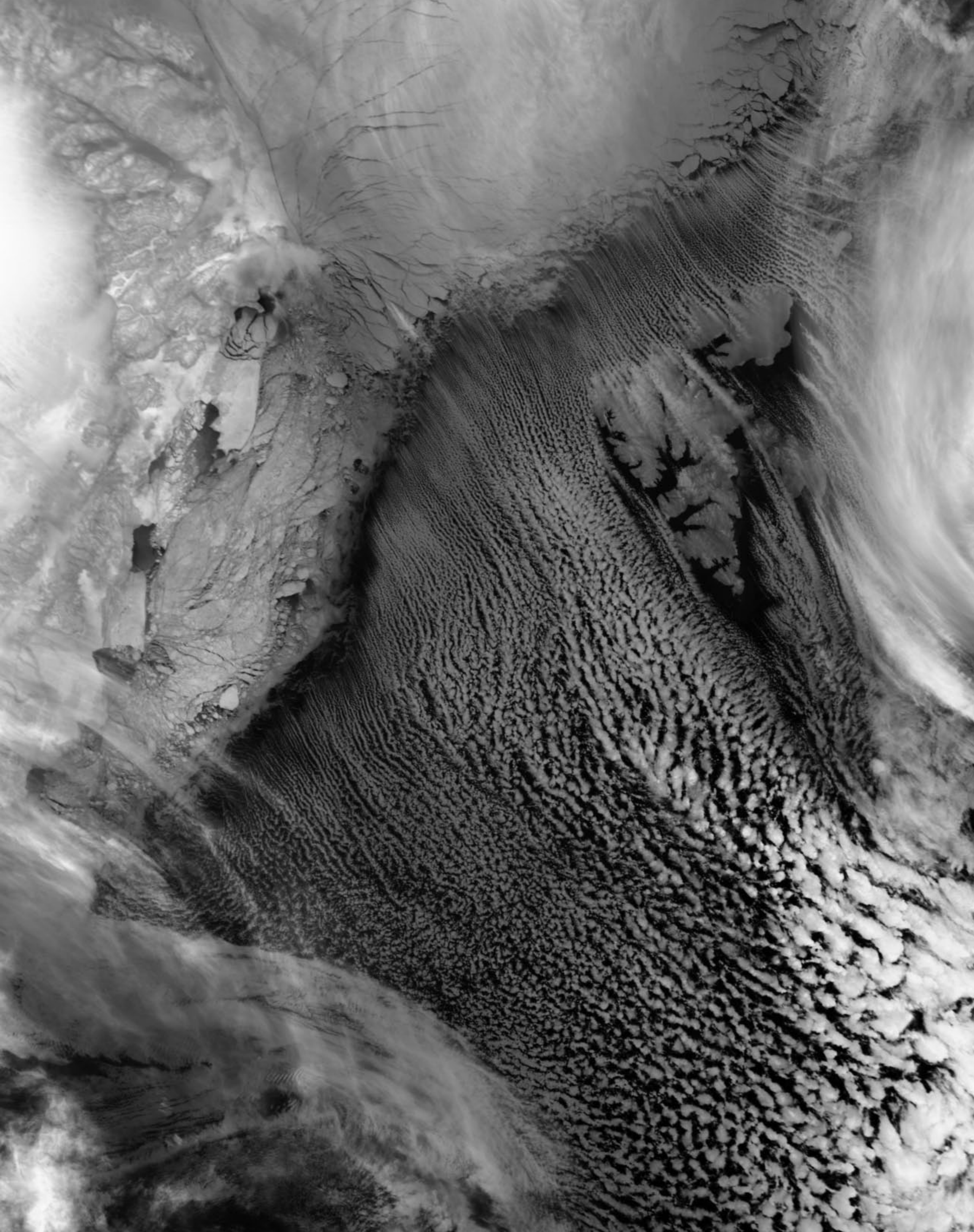
GEO Quarterly has published images of this phenomenon this in the past but there have been some really good images of cloud streets recently. A particularly impressive one was captured by NASA's MODIS instrument on its **Terra** satellite at 15:35 UT on February 14, 2016 along the eastern seaboard of the US, as shown in the image below. On that day a high pressure area brought strong, very cold winds from the north and northwest across much of the region and out into the Atlantic, where it blew over warmer water forming the cloud rolls typical of this phenomenon.



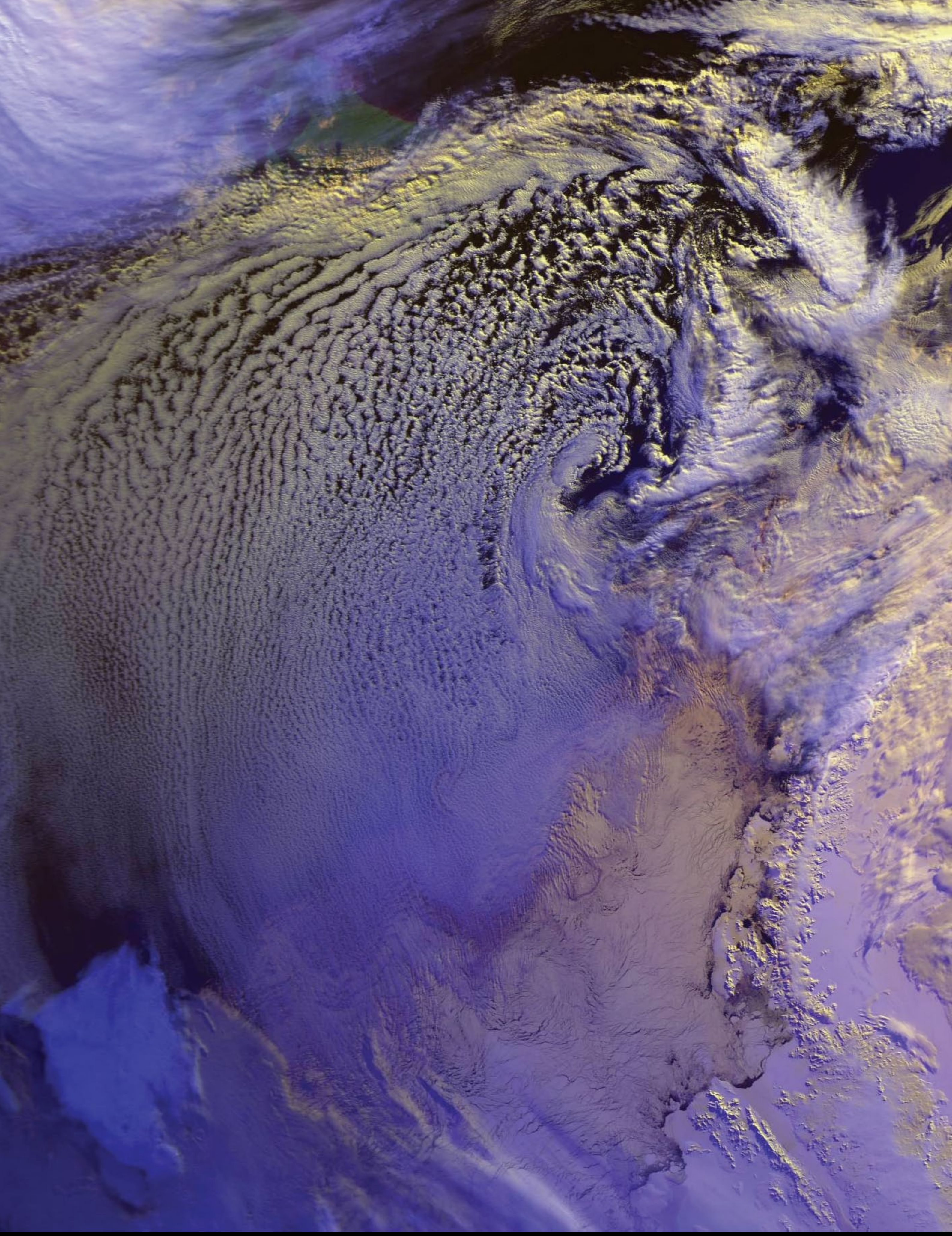
These Cloud Streets off the eastern seaboard of the USA were captured by NASA's Terra satellite on February 14, 2016.
NASA image by Jeff Schmaltz, LANCE/EOSDIS Rapid Response.

Cloud streets are long parallel bands of cumulus clouds which form when cold air blows over warmer water and a warmer air layer (temperature inversion) rests over the top of both. The water gives up heat and moisture to the cold air above it, and columns of heated air naturally rise through the atmosphere. The temperature inversion acts like a lid so, when the rising thermals hit it, they roll over and loop back on themselves, creating parallel cylinders of rotating air. As this happens, the moisture cools and condenses into cumulus clouds that line up parallel with the direction of the prevailing winds. Other recent examples are shown on pages 42-44.

In this Metop-02 channel-4 infrared image, cloud streets are seen forming as cold air blows eastward from Sakhalin island over the Sea of Okhotsk on January 30, 2016.



This December 26, 2015 channel-4 infrared image from Metop-02 shows Svalbard interrupting a line of cloud streets that formed as cold air from the Arctic ice pack advected across the Greenland Sea.
Image © EUMETSAT 2015



Though not so recent, a low sun angle in this Metop-02 image acquired on September 20, 2011 shows cloud streets off the coast of Antarctica to advantage.
Image © EUMETSAT 2011

Iceberg B-09B Moving Again

NASA Earth Observatory

Iceberg B-09B is on the move again. For several years, the 50-kilometre-long ice island has been jammed up a bay in East Antarctica and creating desperate times for a colony of penguins. Now it is drifting into the Southern Ocean again.

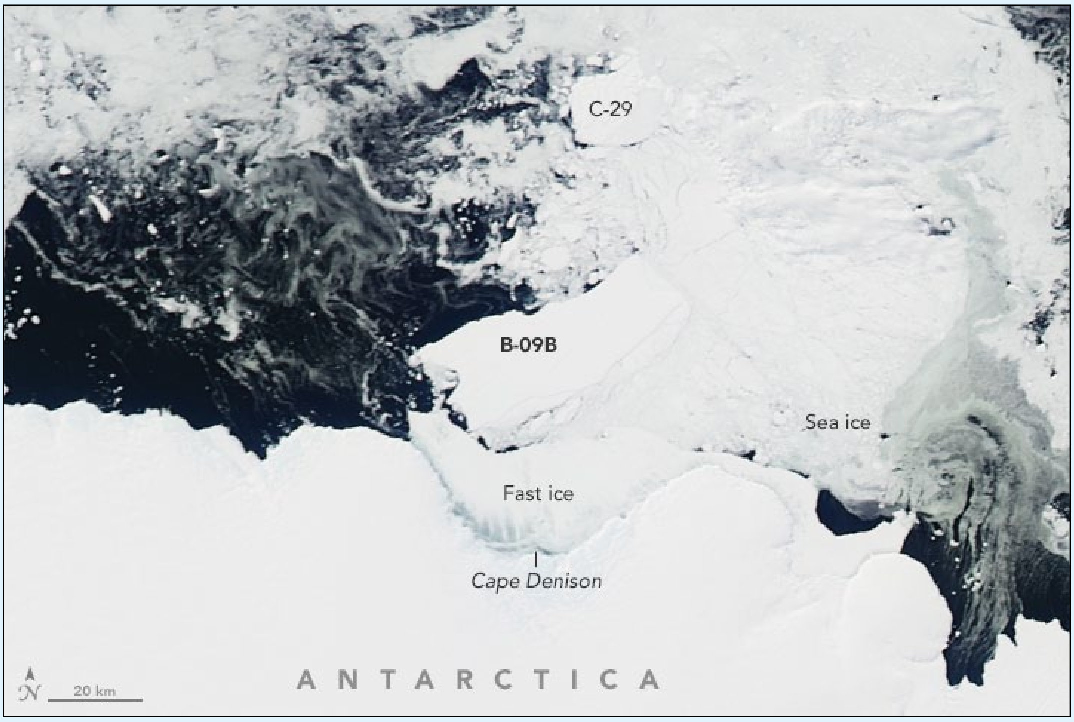


Figure 1 - Commonwealth Bay, Antarctica, filled with fast ice and blocked on February 18, 2013

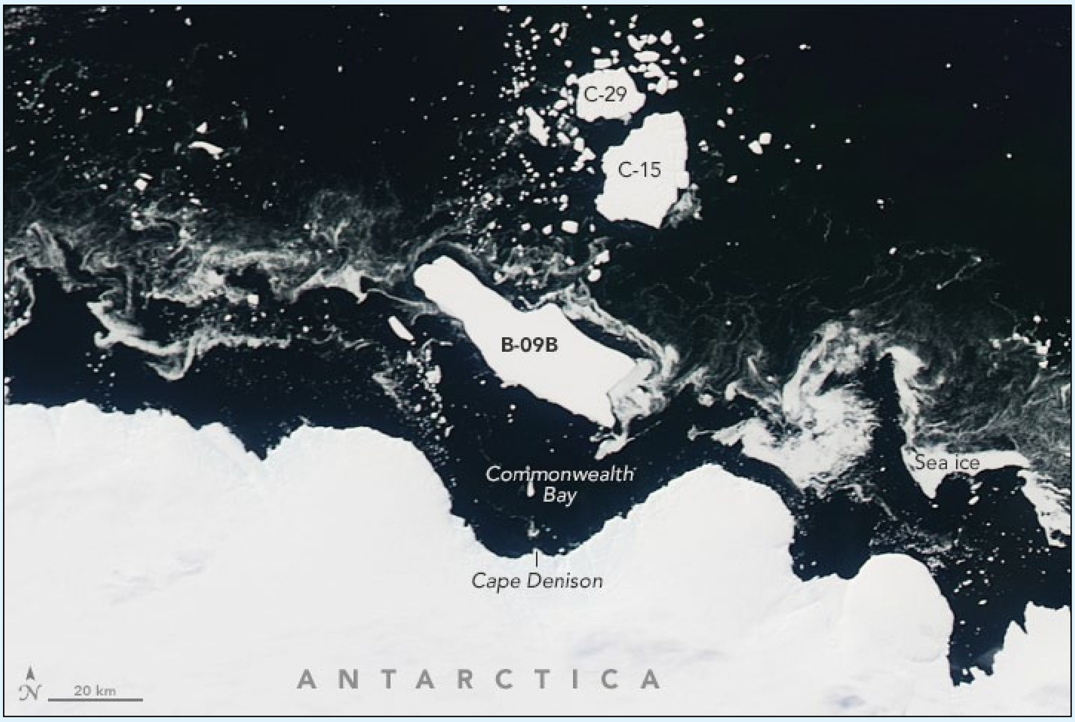


Figure 2 - Commonwealth Bay, Antarctica, nowopen water in February 18, 2016

B-09B is a remnant of Iceberg B-09, which broke off from the Ross Ice Shelf in the late 1980s. By 1993, B-09B had become grounded in the Wilkesland Sea, near the Mertz ice shelf.

But the berg's journey around East Antarctica continued, and the remnant ice pummelled the floating snout of Mertz Glacier in February 2010. The collision created a new, large berg and B-09B again came to a halt at the end of 2010, parking in Commonwealth Bay off East Antarctica, where it has since remained.

During the following five years, Commonwealth Bay transformed from frequently open water to an area beset by year-round sea ice. The collection of icebergs north of the bay—principally B-09B, but also others including C-15 and C-29—blocked sea ice from drifting westward with the ocean currents. As a result, fast ice accumulated in the bay, growing as much as three meters thick. A colony of Adélie penguins that had once lived near the water's edge at Cape Denison suddenly had to shuffle 60 kilometres to find open water and food. And without sufficient food to raise their chicks, the colony's population plummeted.

The bay was transformed again in February 2016 when its sea ice broke up, providing access to Cape Denison for the first time in six years. Figure 1 shows the situation February 18, 2013 with Commonwealth Bay completely blocked by B-09B and filled with fast ice. Figure 2, which was acquired on February 18, 2016 after Iceberg B-09B had drifted offshore, shows the bay to be ice free. Both MODIS images were acquired by NASA's *Aqua* satellite.

NASA Earth Observatory images by Jesse Allen, using data from the Level-1 and Atmospheres Active Distribution System (LAADS).

Hurricanes Develop Early in 2016

NASA Earth Observatory

Hurricane Season is considered to last from June 1 till November 30 in both the north Atlantic Ocean and the central Pacific Ocean. But this is not exclusively so, and **Alex**, which evolved from a tropical depression on January 14, became the earliest hurricane in the Atlantic basin since 1938 and just the fourth January hurricane in 150 years of records. And just three days before, tropical storm **Pali** strengthened into the earliest hurricane ever recorded over the Central Pacific Basin.

Hurricane Alex

This storm developed some 800 kilometres south of the Azores as a Category-1 hurricane, but weakened before making landfall on Terceira Island as a tropical storm the following day. *Alex* prompted hurricane and tropical storm warnings for the Azores and the closure of schools and businesses, but in the event brought only gusty winds and heavy rain to the archipelago, causing only minor damage.

Alex was not just unusual for being a hurricane in the dead of winter; it was also unusual as just the second storm on record to form so far north and east in the Atlantic (30°N, 30°W). The map below shows the track of Alex relative to the tracks of all reported storms in NOAA's record from 1842 to 2015.

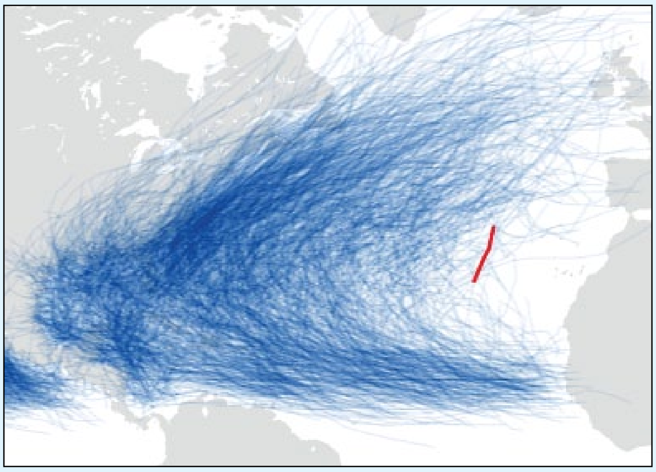


Figure 1 - The track of Hurricane Alex
NASA map by Joshua Stevens, using data from NOAA and Unisys Weather

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** satellite captured this view of hurricane Alex shown in figure 2. Two hours after the image was acquired, the storm was reported to have sustained winds of 140 kilometres per hour and a central pressure of 981 millibars.

Hurricanes do not typically form when sea surface temperatures are below 26°C, yet *Alex* to formed when water temperatures in the northeast Atlantic were roughly 22°C. But these water temperatures were 0.5° to 1.0° warmer than normal. More importantly, a low-pressure trough in the upper atmosphere meant air temperatures aloft were quite cool compared with the water below, and the <u>decrease in temperature</u> from the surface to upper levels was strong enough to create convective instability. Thunderstorm activity gradually caused upper level warming so that the system transitioned from an extra-tropical to a tropical cyclone.

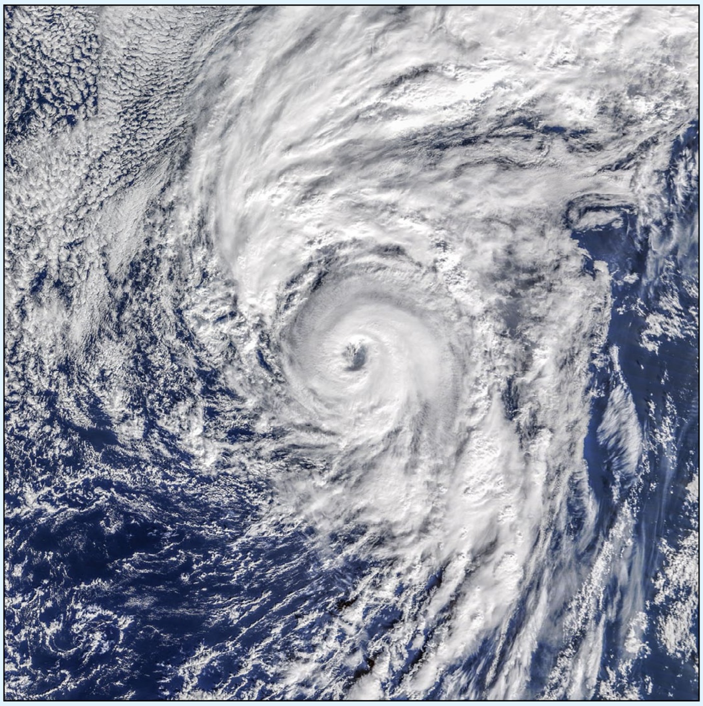


Figure 2 - Hurricane Alex
NASA image by Jeff Schmaltz, LANCE/EOSDIS Rapid Response

According to Jason Samenow of The Washington Post, the first named Atlantic storm usually forms on July 9. Only 0.5 percent of tropical storm activity in the Atlantic has ever occurred prior to the start of June.

Hurricane Pali

Pali became a hurricane nineteen days earlier than the previous record holder, Hurricane Ekeka of 1992. The *Central Pacific Hurricane Center* noted that Pali provided *'yet another record to stack on the ever-growing pile of recent records due in large part to the ongoing strong El Niño.'*

Also notable was Pali's location. The map below shows the path of Pali from January 7-12, 2016, in context with all global storm tracks in NOAA's record from 1842 through 2015. Historically, not many storms have ventured so close to the equator so far out in the middle of the Pacific basin. Pali's track appears relatively erratic and loopy because the storm is situated within a zone of low pressure, blocked to the north by a belt of high atmospheric pressure and

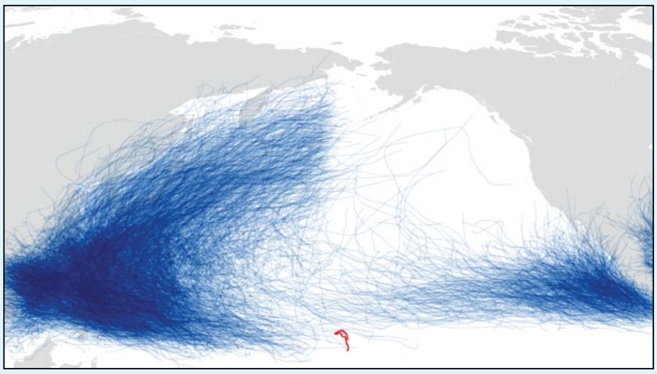


Figure 3 - The track of Hurricane Pali
NASA map by Joshua Stevens, using data from NOAA and Unisys Weather

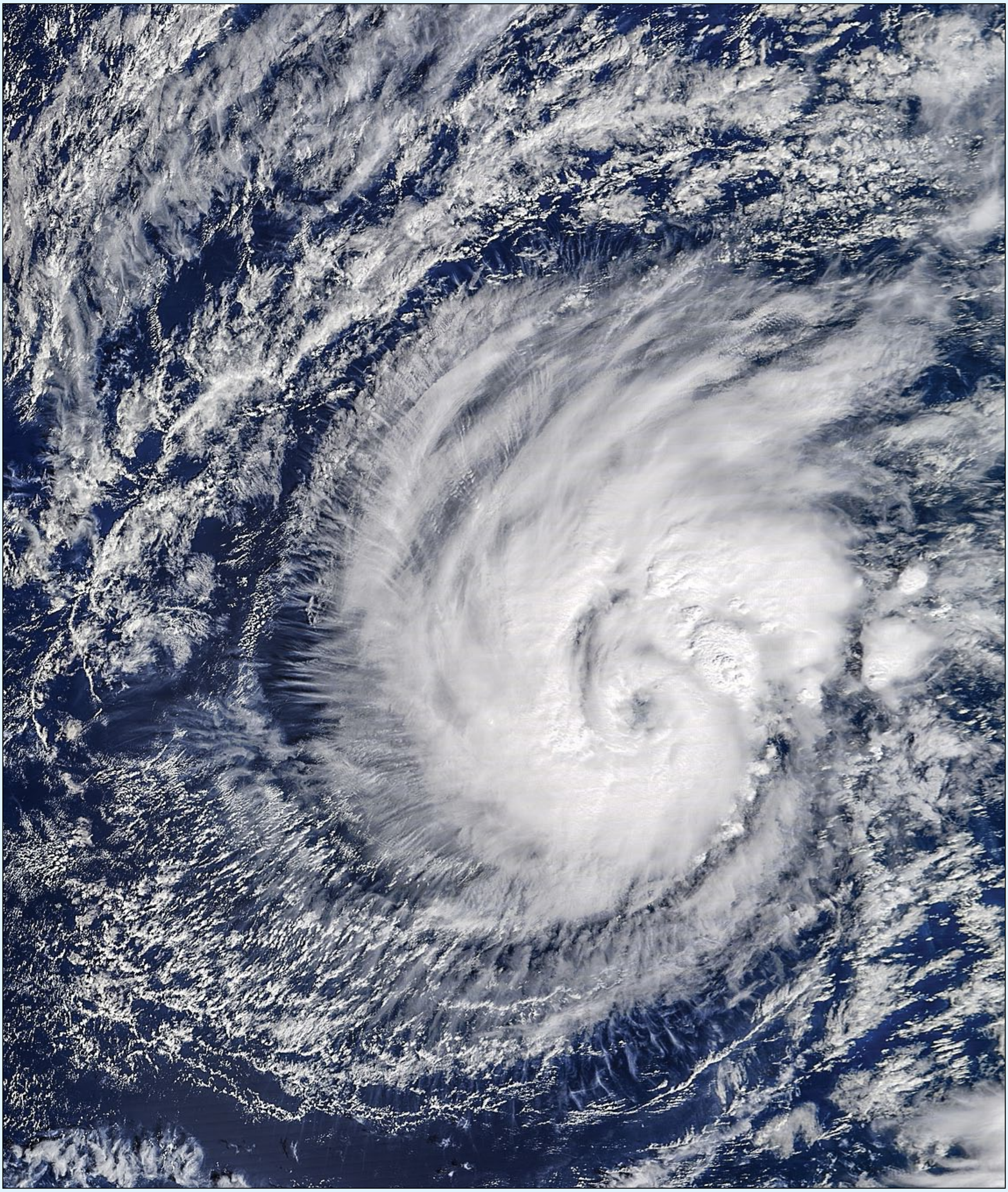


Figure 4 - Hurricane Pali
NASA image by Jeff Schmaltz, LANCE/EOSDIS Rapid Response

winds blowing from the east, and blocked to the south near the equator by strong winds blowing from the west..

Figure 4, captured by the MODIS instrument aboard NASA's **Terra** satellite, shows the storm spinning over the central Pacific, where *Pali* had developed a clear eye as well as pronounced cirrus banding along much of its perimeter.

Using observations made shortly after this image was acquired, meteorologists classified the storm as a Category-1 hurricane with maximum sustained winds of 140 kilometres per hour. Its location, some 2,300 kilometres northeast of Hawaii, meant that Pali's main effect was to churn up higher-than-usual surf. The cyclone peaked on January 12 as a Category-2 storm, then weakened back to category 1 the following day.

Nansen Ice Shelf Splitting from Antarctica

NASA Earth Observatory

A floating shelf of ice attached to the coast of Antarctica appears ready to shed an iceberg into the Southern Ocean. Over the course of two years, a small crack in the **Nansen Ice Shelf** has grown large enough to spread across nearly its entire width. The Operational Land Imager (OLI) on NASA's **Landsat 8** satellite acquired the images opposite on December 26, 2013, and again on December 16, 2015.

Ice shelves line the perimeter of Antarctica and come in all shapes and sizes. The Nansen shelf measures about 35 × 50 km while the nearby Drygalski Ice Tongue, just to the south of it, stretches 80 kilometres into the sea [1].

These floating shelves are important for holding back the flow of ice from the interior of the continent to the sea. Ice that sloughs from a floating shelf does not raise sea level. But when part of the ice shelf is lost, the seaward flow of land ice can accelerate—a phenomenon that contributes to sea level rise.

Christine Dow and Ryan Walker, scientists at NASA Goddard, visited the ice shelf in November and December 2015. Their goal was to install GPS stations on the ice shelf to record its subtle flexing due to ocean tides. On December 10, they flew along the crack in a helicopter while looking for sites to install the GPS stations. Dow captured the photograph opposite during the flight.

> *'There's a huge crack, miles long and sometimes over a hundred yards wide, which runs more or less parallel to the front of the ice shelf,'* wrote Walker in a blog post at the time. *'Over the winter, the sea surface freezes and traps small icebergs in the crack, producing a fascinatingly broken ices cape.'*

In early March 2016, with southern winter soon to set in, satellite imagery indicated that the cracking ice front was still attached to the shelf. Even in winter, strong winds can prevent the water beyond the shelf from freezing, so it is unclear whether the front will separate soon or hang on like a loose tooth.

> *Dow is talking with researchers about examining the crack during the coming summer field season. 'I'm really interested to see whether this feature is occurring because of the topography around the ice shelf, or whether it was initially created by surface water flowing into a small ice surface crack,'* she said. *'We're planning an intensive survey of this feature in the coming years and will hopefully get a handle on the causes.'*

The Nansen Ice Shelf, imaged by the Landsat OLI in December 2013.

The Nansen Ice Shelf, imaged by the Landsat OLI in December 2016.

The crack across the Nansen Ice Shelf, photographed in March 2016.
Photo: Ryan Walker / NASA / GSFC

Reference

1 B15A Iceberg Latest - GEOQ6, page 11 (2005)

NASA Earth Observatory images by Jesse Allen, using Landsat data from the U.S. Geological Survey
Caption by Kathryn Hansen

Currently Active Satellites and Frequencies

Polar APT/LRPT Satellites			
Satellite	Frequency	Status	Image Quality
NOAA 15	137.6200 MHz	On	Good
NOAA 18	137.9125 MHz	On	Good
NOAA 19	137.1000 MHz	On	Good [1]
Meteor M N1	137.0968 MHz	On	Fair [7]
Meteor M N2	137.1000 MHz	Off	Good [8]

Polar HRPT/AHRPT Satellites				
Satellite	Frequency	Mode	Format	Image Quality
NOAA 15	1702.5 MHz	Omni	HRPT	Weak
NOAA 18	1707.0 MHz	RHCP	HRPT	Good
NOAA 19	1698.0 MHz	RHCP	HRPT	Good
Feng Yun 1D	1700.4 MHz	RHCP	CHRPT	None: Device failure
Feng Yun 3A	1704.5 MHz	---	AHRPT	[2]
Feng Yun 3B	1704.5 MHz	---	AHRPT	[2]
Feng Yun 3C	1704.5 MHz	---	AHRPT	[2]
Metop A	1701.3 MHz	RHCP	AHRPT	Good
Metop B	1701.3 MHz	RHCP	AHRPT	Good
Meteor M N1	1700.00 MHz	RHCP	AHRPT	Fair [7]
Meteor M N2	1700.0 MHz	RHCP	AHRPT	Good

Geostationary Satellites				
Satellite	Transmission Mode(s)		Position	Status
Meteosat 7	HRIT 1691 MHz / WEFAX 1691 MHz		57.5°E	On
Meteosat 8	HRIT (digital)	---	3.5°E	Standby [3]
Meteosat 9	HRIT (digital)	LRIT (digital)	9.5°E	On [4]
Meteosat 10	HRIT (digital)	LRIT (digital)	0°W	On
GOES-13 (E)	GVAR 1685.7 MHz	LRIT 1691.0 MHz	75°W	On [5]
GOES-14	GVAR 1685.7 MHz	LRIT 1691.0 MHz	105°W	Standby
GOES-15 (W)	GVAR 1685.7 MHz	LRIT 1691.0 MHz	135°W	On [5]
MTSAT-1R	HRIT 1687.1 MHz	LRIT 1691.0 MHz	140°E	Standby
MTSAT-2	HRIT 1687.1 MHz	LRIT 1691.0 MHz	145°E	On
Feng Yun 2D	SVISSR	LRIT	86.5°E	Off [6]
Feng Yun 2E	SVISSR	LRIT	104.0°E	On
Feng Yun 2F	SVISSR	LRIT	112.0°E	On
Feng Yun 2G	SVISSR	LRIT	86.5°E	On

Notes

1 LRPT Signals from Meteor M N2 may cause interference to NOAA 19 transmissions when the two footprints overlap.
2 These satellites employ a non-standard AHRPT format and cannot be received with conventional receiving equipment.
3 Meteosat operational backup satellite
4 Meteosat Rapid Scanning Service (RSS)
5 GOES 13 and GOES 15 also transmit EMWIN on 1692.70 MHz
6 There has been no imagery from Feng Yun 2D since June 30, 2015. Since Feng Yun 2G is operating from the same position (86.5°E), it is likely that FY-2D is now in standby as a backup satellite.
7 This satellite was switched off on October 1, 2014 but its LRPT was reactivated on November 6, 2015. Imaging can be excellent, but the satellite does have pointing difficulties and from time to time produces distorted imagery when its sensors deviate from the nadir.
8 The LRPT transmitter aboard Meteor M2 was interfering with the operation of other instruments aboard the satellite, and was switched off on December 11, 2015.

EUMETCast On-Line Registration Guide

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

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

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

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

Weather Satellite Reports

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

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

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

You can read the bulletins from this URL

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

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

Internet Discussion Groups

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

APT Decoder

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

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

GEO-Subscribers

This is GEO's own group, where members can exchange information and post queries relating to any aspect related to weather satellite reception (hardware, software, antennas etc), Earth observation satellites and any GEO-related matter.

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

Satsignal

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

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

MSG-1

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

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

WXtoImg-l

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

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

GEO Helplines

Douglas Deans, Dunblane, Scotland.

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

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

John Tellick, Surrey, England.

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

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

Geoff Morris, Flintshire, NE Wales.

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

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

Mike Stevens, Dorset, England.

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

- email: mikeg4cfz@gmail.com

Guy Martin, Kent, England.

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

- gmartin@electroweb.co.uk

Hector Cintron, Puerto Rico, USA.

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

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

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

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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.

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Materials for publication should be sent to the editor,

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8 Deeside Place
Aberdeen AB15 7PW
Scotland

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geoeditor@geo-web.org.uk

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

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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

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 - £375.00
EU members price - £385.00

NEWSKY RTL2832U/R820T2 SDR DAB USB MCX Socket Special Dongle

for reception of NOAA APT and Meteor M2 LRPT

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

This stick does not come with SDR software or instructions.

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

TechniSat SatFinder Antenna Alignment Meter

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

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

Current Price List

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

All prices are in £ sterling and include postage and packaging

Ordering and Shipping

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

Orders should be sent by email to

geoonlinestore@gmail.com

or made through the GEO Website at

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

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

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 may be available, but it is advisable to check before ordering.

UK members price - £3.80

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

UK members price - £8.00

Inverto-Black-Ultra High-Performance LNBs

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

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

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

Edimax USB 2.0 Fast Ethernet Adapter

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

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