The GEO Quarterly

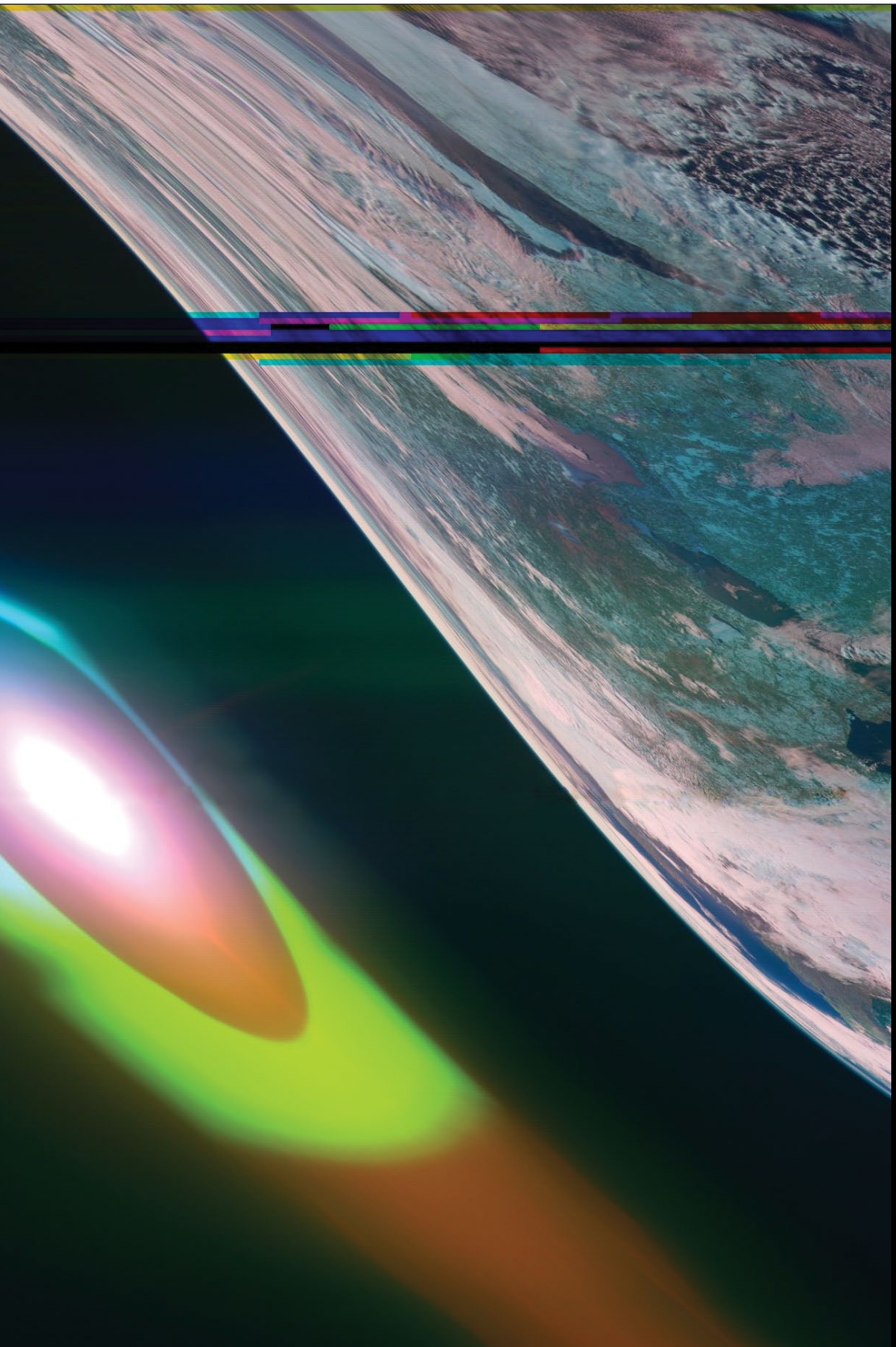
Group for Earth Observation

Group for Earth Observation

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

50

June 2016



Inside this issue . .

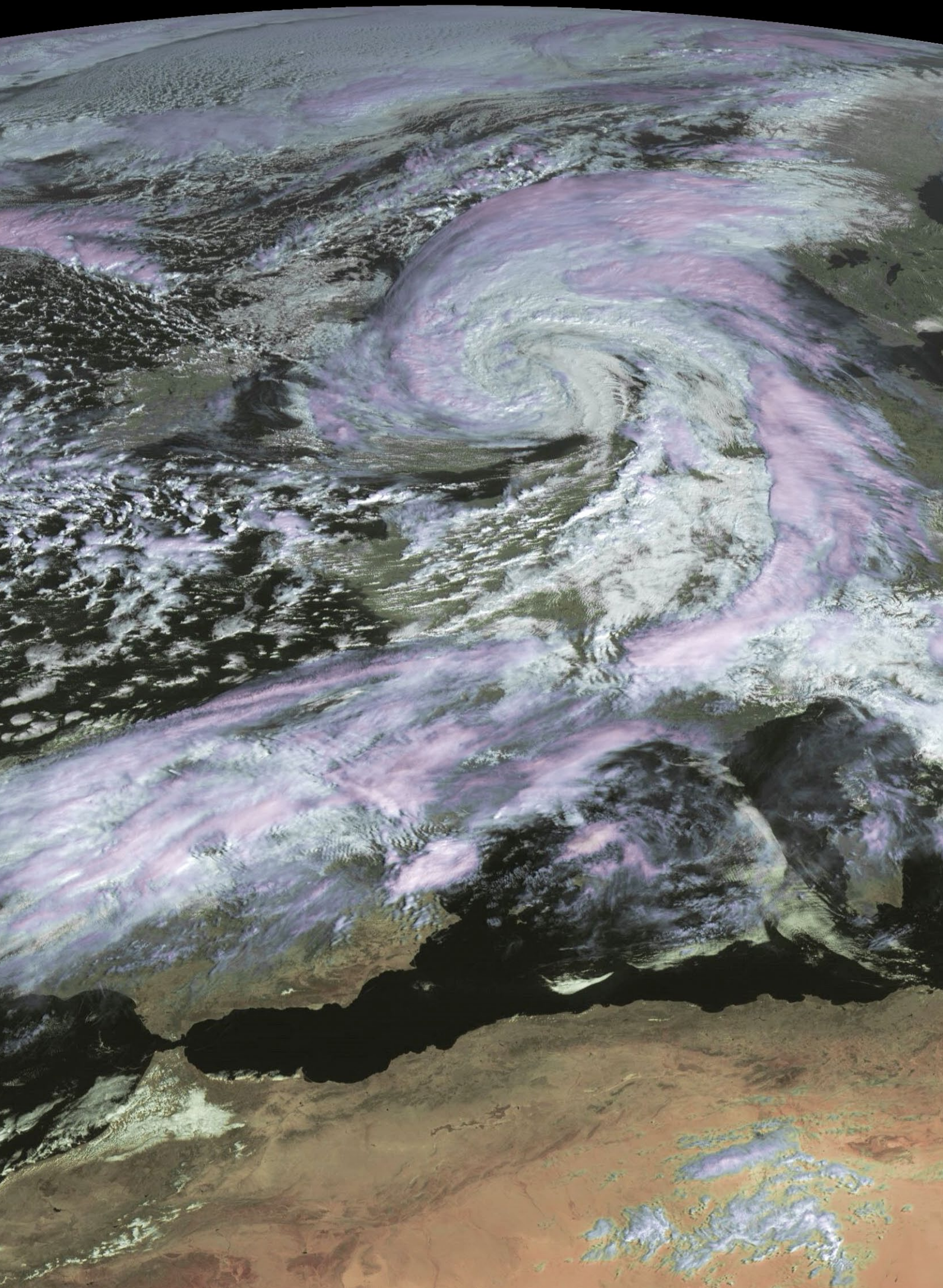
In this landmark 56-page 50th edition, Mike Stevens sets the ball rolling with an essay on his lifetime's hobby, detailing his adventures from the early days of APT satellite imaging to EUMETCast.

We also have a well researched article from Robert C Masur on 'Geospatial Information Technologies', and its application to, among other things, oceanography, climatology and meteorology.

We also take a look at imagery from the final few orbits of the Russian Meteor-M1 satellite, which totally lost its stabilisation, leading to images like the one shown here, which includes the sun.

Following the widespread displays of Nacreous Cloud over Europe last spring, Les Hamilton has produced an illustrated article about these rare cloud phenomena.

And as usual, there is a host of articles from NASA's Earth Observatory website dealing with such varied topics as icebergs calved by the Nansen Ice Shelf, and springtime snow over the Alps. There is also an illustrated report from ESA on the new Sentinel 1B satellite.



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Editorial

Les Hamilton
geoeditor@geo-web.org.uk

This *GEO Quarterly* magazine is a landmark issue: our 50th. Much has changed since the *Launch Issue* in early 2004, just a couple of months after the first Meteosat Second Generation satellite (MSG-1) commenced routine operations as Meteosat-8. In those days, transmissions were received using a simple *Skystar* PCI DVB receiver expansion card.

And how fortunate, in retrospect, that Meteosat-8 suffered an early failure of its solid state power amplifier, bringing to an end direct dissemination of its data: for out of this misfortune, *EUMETCast* was born, the system now used so widely by the majority of GEO members to access satellite images from around the world.

GEO was very much the brainchild of Francis Bell, who has worked tirelessly since 2003 to promote our organisation with user groups and agencies around the world. Undoubtedly the highlights have been the numerous Symposia he organised here in the UK, and particularly the three trips he arranged for GEO members to EUMETSAT HQ in Darmstadt, and to the ESOC facility nearby. We all owe Francis a huge debt of gratitude.

What will the next 50 issues bring? Whatever it is, we wish you well for the future, and hope you enjoy this special issue.

Copy deadline for the September issue of GEO Quarterly is Sunday, August 28, 2016.

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The GEO Report

Francis Bell

It is with great satisfaction that I acknowledge the 50th publication of *GEO Quarterly* and offer my congratulations to all who have contributed to its content in the past. A very special thank-you to Les Hamilton who has been our editor for almost every issue. Of course we acknowledge the current difficulties maintaining the scale of the Quarterly because of lack of relevant contributions, which is probably related to the rapid availability of technical information via the Internet: however, our Quarterly is still valued by many of our members and impresses casual readers—so long may publication continue.

Copernicus

From my amateur perspective I am trying to follow ESA's *Copernicus* programme with its Sentinel satellites. I am trying to come to terms with challenging new data rates from EUMETCast's High Volume Service, which is necessary to accommodate these new data streams. This is a dimension all of us will all have to come to teams with in order to receive this new data. The occasional images processed and distributed by ESA are often stunning. Any member with experience or advice on this subject please write an article or something informative and send it to our editor as this hat the potential to benefit all our membership.

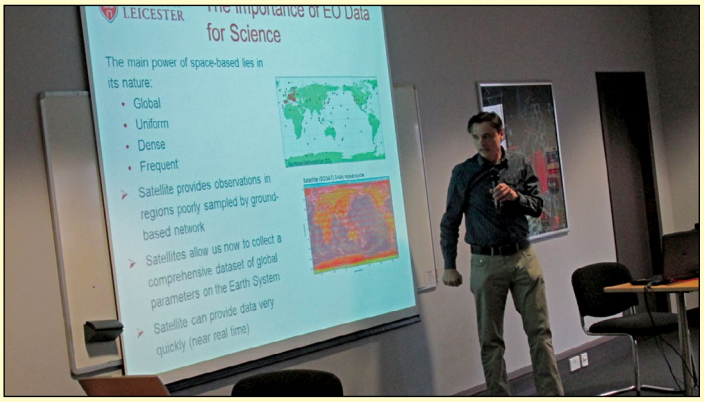
Symposium 2016 Report

The GEO Symposium held at the NSC Leicester on April 23 proved, as in the past, to be an excellent event, with several informative formal presentations plus the opportunity for members to meet with each other and exchange ideas and experiences. It proved to be a busy day from about 9.00 am till the end of the AGM at 5.00 pm.

Nicholas Coyne, a dissemination engineer from EUMETSAT, giving his illustrated presentation relating to *Sentinel* image data.

Our speakers from EUMETSAT and Leicester University were outstanding, plus two direct contributions from our own members. There were three *Skype* sessions, two with our member in Scotland and one with a member speaking from ESOC Germany. There was a lunchtime bonus of listening to Tim Peake's live transmissions from the ISS. Two of our members had provided equipment to facilitate reception of these live signals.

The afternoon programme included a presentation from Rob Alblas, who had travelled from the Netherlands to be with us. He talked about specific issues of *EUMETCast* reception. This was followed by Francis Bream, who presented a technical analysis of *EUMETCast* data beyond the normal image transmissions. I'm still on a learning curve on this aspect of data analysis!



Dr Hartmut Boesch from Leicester University's Space Science Department discussed the importance of Earth observation for science.

Delegates preparing to receive live voice transmissions from Tim Peake on the ISS. Hand tracking the antenna provided about seven minutes of clear reception.

GEO member Francis Breame presenting his analysis of aspects relating to *EUMETCast* data beyond the regular transmitted images.

A slight digression from technical issues was the playing of a five minute extract from a BBC TV programme recently shown on BBC's *One Show*. It featured Francis Bell with two of his 'old boys' from the Royal Grammar School, Guildford, contacting Helen Sharman, past cosmonaut aboard *Mir*. The programme was in celebration of the 25th anniversary of Helen Sharman's time on the *Mir* space station, but also included a live contact between the RGS boys and Tim Peake on the ISS.

A screen-shot from the BBC's '*One Show*' programme, which featured Francis Bell, together with two 'old boys' from his school, talking to Helen Sharman. The event was in recognition of 25 years since Helen Sharman's flight on the Mir space station.

Helen Sharman talking to Francis Bell and Royal Grammar School 'old boys' during the BBC '*One Show*'.

The feedback I have received relating to the symposium from the speakers and delegates has all been very positive.

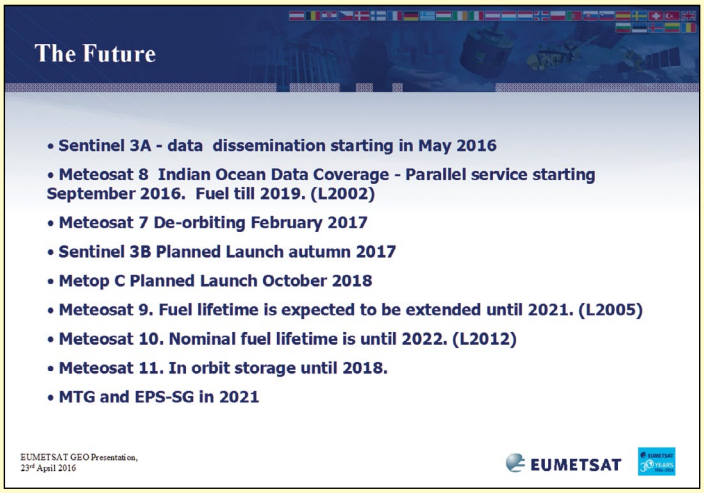
Note that, because only 25 members attended the symposium, the GEO MT decided not to charge for the event. In any case, the money raised would not have covered the costs involved in hiring the accommodation with its excellent technical support. It was recognised that the costs would be covered by GEO funds.

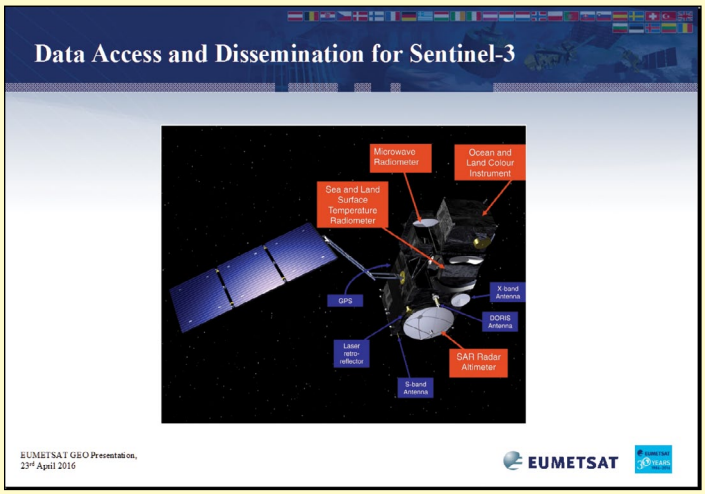
The GEO MT had a separate meeting at lunch time. During this meeting we discussed a potential new framework for GEO membership which included ideas for free membership using only electronic communication plus the suggestion for a two year membership maintaining the present subscription at £15. We also noted Nigel Evans' comments about the future of the *GEO Shop,* with sales now almost exclusively for SR1 DVB receivers.

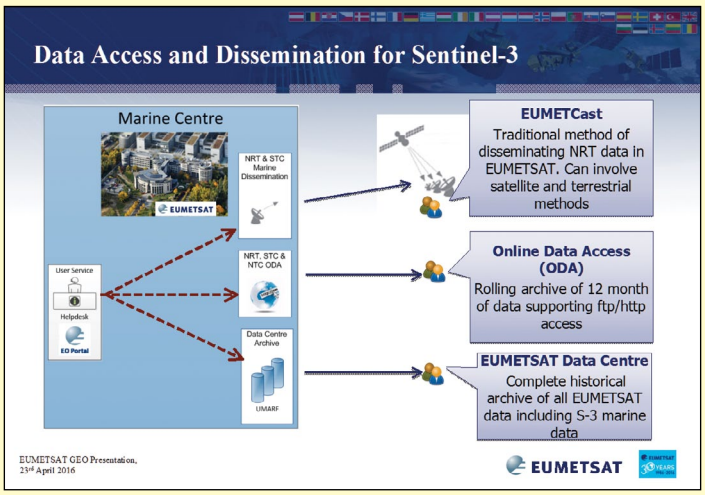
I have copies of the *PowerPoint* presentations from EUMETSAT, Leicester Space Centre, Rob Albas and David Taylor. These are available for download from the GEO website at

http://www.geo-web.org.uk/symposium2016.php

Selected Slides from Nick Coyne's Presentation



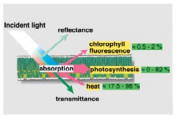


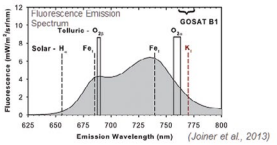


Selected Slides from Hartmut Boesch 's Presentation

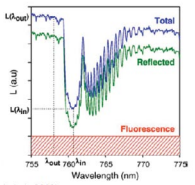
Fluorescence from Plants

- Photosynthesis is the process by which plants harvest sunlight to produce sugars from CO_2 and water. It is the key source of energy for all life on Earth
- Plants re-emitting photons in the red – near-IR range as a pathway to dissipate excess light intensity
- ➢ Fluorescence is directly linked to photosynthesis and thus carbon uptake
- ➢ Fluorescence signal is small but it can be measured from the filling-up of solar (Fraunhofer) lines from satellite (JAXA GOSAT and NASA OCO-2)
- ➢ ESA Explorer 8 FLEX





(Joiner et al., 2013)



(Meroni et al., 2009)

Big Data Challenge

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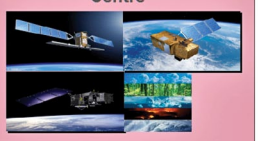
- Sentinels produce EO datasets with unprecedented spatial and temporal resolution and unprecedented data volume
- We are truly entering the world of big EO data:
  - Great opportunities but also great challenges
  - Big/dedicated infrastructure is needed
  - Re-think analysis methods (data mining, machine learning)

Sentinel Data at CEDA Data Centre



•Sentinel 1A > 1 TB/day
•Sentinels 1A/B, 2A/B, 3A/B: ~10 TB/day

Thanks to V. Bennett

JASMIN/CEMS "super-data-cluster"

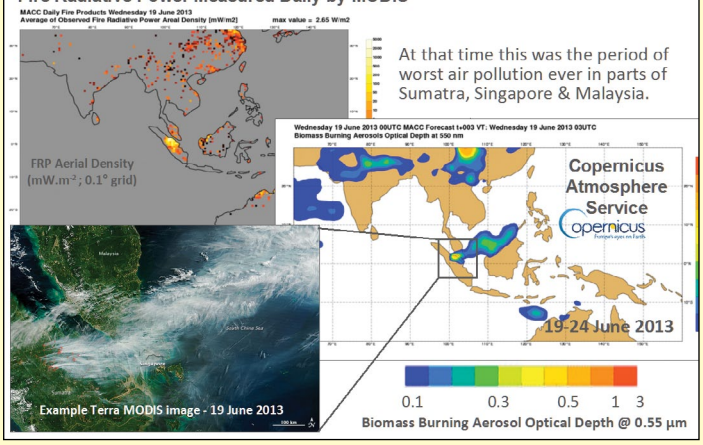
- **16 Petabytes** high performance storage
- **~5,000** computing **cores**

National Centre for Earth Observation

Biomass Burning Smoke Emissions

KING'S College LONDON

Fire Radiative Power Measured Daily by MODIS



At that time this was the period of worst air pollution ever in parts of Sumatra, Singapore & Malaysia.

Summary

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- Satellites are a critical resource that help us to better understand the Earth system and to address the key societal challenges associated with a quickly growing population and a changing world
- Advances in technology allow exciting, new missions that will provide us with new insights and novel datasets
- We are also moving into a phase of operationalization of EO programs such as Copernicus
  - Much more open data policy
  - Free and easy data access
  - Great opportunities for science and commercial applications
  - Unprecedented data volume poses major challenge
  - UK should be well prepared to benefit from Copernicus (CEDA, NCEO)

David Taylor's Presentation

David Taylor addressed the Symposium via Skype. One of his slides (below) showed the configuration of his own EUMETCast system, which is sure to be of interest to many readers..

My PC Configuration

Reception PC		Processing PC			
TelliCast software RAMdisk			MSG Data Manager software	MSG Animator software	GeoSatSignal Software
	Windows 10 Pro	Windows 10 Pro	Processes HRIT & LRIT files from reception PC into images	Processes images into real-time animations	Processes images into multi-channel, false-colour, rectified animations
Network card	Network Card	Network card			
|	|	|			
Dish LNB DVB-S2 IP/Receiver	Network Hub provides 1 Gbps connection				

GEO Members AGM, April 23, 2016

This meeting took place at the National Space Centre Leicester at approximately 4.00 pm, with Francis Bell in the chair. In the absence of a secretary, Robert Coombs volunteered to take the minutes.

1 Francis Bell, as director of GEO Ltd., reported that the legal requirement of the company structure and accounts were kept up-to-date with Companies House. The cost of running the company is only £13 a year and Francis does all the administration for this. Mrs Nadine Bell remains company secretary.

2 **The accounts**: Two notices relating to GEO's accounts covering the past 15 months had been on display during the symposium day, and members had the opportunity to inspect these figures. It was noted that, as of the end of March 2016, the balance in the accounts were
   - Membership Account £3,183
   - Shop Account £14,285.

   The meeting unanimously agreed that the accounts were a true and accurate record of GEO's financial affairs.

3 **Membership Report**: A notice giving details of GEO's current membership had been on display during the day. The notice showed that current membership is
   - UK 152
   - Europe 77
   - Rest of world 31

   a total membership 260. The membership secretary was thanked for his time spent on the group's behalf.

4 **The Editor's Report**. Again, this report had been on the notice board during the day but, as a reminder, the chairman read the report to the meeting. The main issue raised in the report related to the lack of copy being received for publication, making it difficult to produce a regular worthwhile paper Quarterly. It was recognised that electronic publications may be more realistic.

5 **Shop Report**: Nigel Evans had reported earlier in the day that the shop's stock was very limited and mainly consisted of SR1 receivers with about 40+ being in stock now. Turnover is now so slow that the stock of SR1 is not likely to be replaced. In his absence Nigel and Michele were thanked for their diligence in running the shop, particularly for the SR1 sales, because without such a service many GEO members would have struggled to buy a receiver for the new EUMETCast data format.

6 There was an open discussion which lasted for about 25 minutes, relating to the future format of GEO membership. It was noted that the cost of running electronic only membership of GEO would be very small hence no membership fee would be needed. A regular GEO newsletter could be published on the web site and user group forums. It was noted that one of the GEO user groups has 820 recorded visitors.

Discussion continued, with many members contributing their ideas. Support was expressed for three electronic Quarterly publications with an additional paper copy once a year. It was noted how many members enjoyed and admired the printed Quarterly. Those members of the Management Team present acknowledged the discussion and the ideas put forward. It was suggested that GEO could widen its interest areas and further topics could be included in the Quarterly. It was suggested that GEO should try to involve more educational establishments to be active in GEO's interest areas, and an article in the Times Educational Supplement might be worthwhile.

The meeting closed with a statement from the chair that all the discussions that had taken place would be considered carefully by the Management Team.

The meeting closed at 5.00 pm.

Since the symposium the management team has confirmed that for the foreseeable future membership will be for two years with a subscription of £15. The rationale behind this decision being the reduced costs of a posted printed Quarterly only once a year the other Quarterlies being electronic, other benefits of membership remain unchanged.

Future Events

GEO will be represented at the AMSAT-UK colloquium on July 29-31, 2016, which will be held at the Holiday Inn Guildford. For further details visit the website

www.amsat.org.uk

GEO will again have a stand at the South London Radio and Computer Fair held at Kempton on Sunday November 13, 2016. For details visit the website

www.radiofairs.co.uk

Cover Image Details

Front Cover

This unusual image was transmitted by **Meteor M1** on March 20, 2016, shortly after the satellite suffered a catastrophic loss of stabilisation. This frame transmitted by the rapidly tumbling satellite was captured by Dutch weather satellite enthusiast '*Happysat*', and shows the sun at lower left as the craft travelled south over Scandinavia.

Image: Alex/Happysat, Netherlands

Inside Front Cover

This image of **Storm Katie**, which swept across the British Isles in the early hours of March 28, 2016, then spent the day ravaging The Netherlands, comes from a **Meteosat** Image acquired by Mike Stevens at 11.30 UT that day. This storm generated winds in excess of 100 miles per hour (160 kph) over parts of southern England and prompted the Dutch weather bureau to issue a code yellow storm warning for all parts of the Low Countries where coastal winds of 110 kph were recorded.

Image © EUMETSAT 2016

Inside Back Cover

This section from a **Metop-B** pass was acquired by Mike Stevens on April 17, 2014. The scene stretches from Svalbard in the north to the English Channel, and shows the North Sea area enjoying a brief ridge of High Pressure either side of unseasonable wintry blasts from the Arctic.

Image © EUMETSAT 2016

Back Cover

This beautiful image covering Scandinavia and The Netherlands comes from the 08.57 UT pass of Meteor M2 on April 21, 2016.

Image: Les Hamilton

WEATHER SATELLITES

A Hobby to Enjoy

Mike Stevens G4CFZ.

Well that's a statement for a start: 'A hobby to enjoy'. It can be pure frustration at times, full of joy at others; it can drives you to distraction and test your brain power to its limit; but it's so rewarding when everything finally falls into place and you see those first images appear on your screen. What a feeling of elation and success! So how did it all begin for me?

I was talking to a work colleague and he mentioned a hobby he was into at the time: weather satellite reception. I was so fascinated with what he was telling me that he gave me some tips on where to start. One subject that kept coming up was reception of APT (Automatic Picture Transmission) from NOAA Polar Orbiting Satellites. The equipment was available from two companies, *Dartcom* in Devon and *Timestep*—then based in Newmarket—so I promptly ordered all the kit I required and awaited its arrival.

I carefully unpacked all the kit, crossed dipole antenna, receiver and, of course, all the connecting cables and

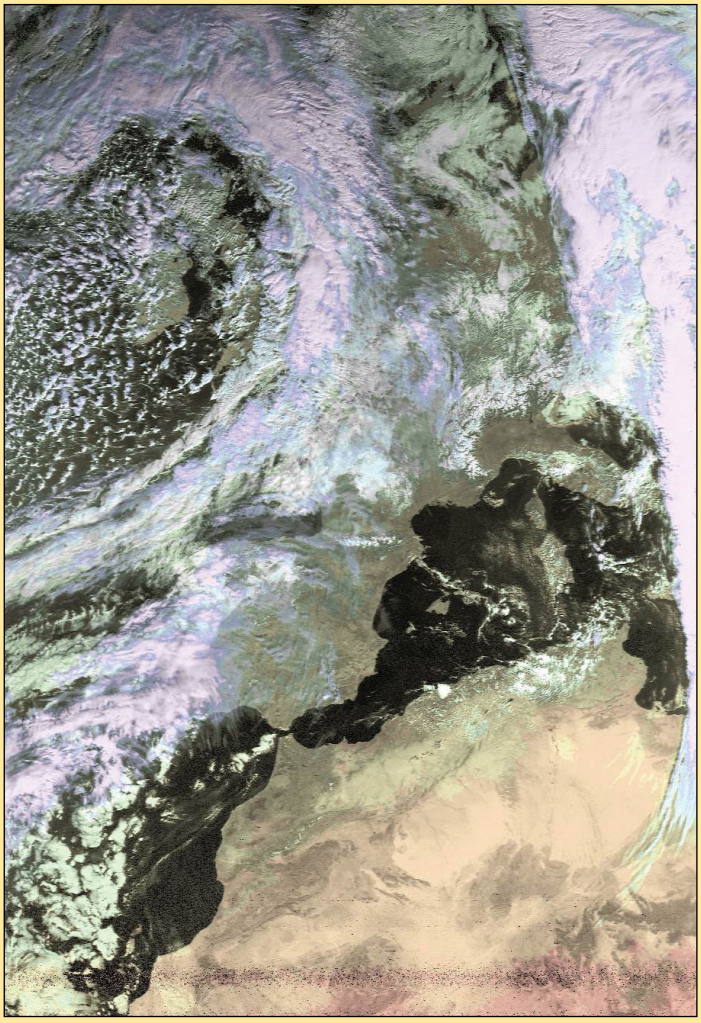


Figure 1 - A typical NOAA 14 image processed with SatSignal

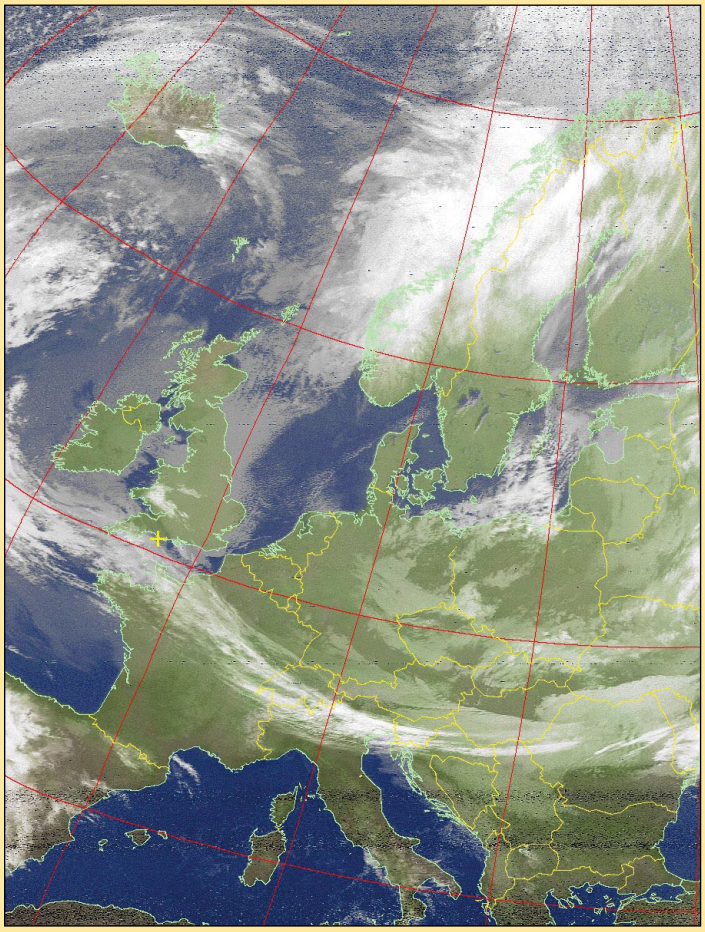


Figure 2 - A typical NOAA-14 infrared image processed with WXtoImg

assembled everything. I erected the antenna about four metres off the ground, made all the connections to my *E-Machine* Computer, then had to find some software to convert the radio signals received from the satellites into images.

The first step was to use a program called **WXSat**, which demodulated the audio signals transmitted by the satellites and stored the data as WAV files. Although this software could also produce images from this data, it was not long before I came across David Taylor's excellent programmes for satellite hobbyists, which at this stage meant **WXtrack** to predict when the satellites were in range, and **SatSignal** to decode the images (figure 1).

I still use *Wxtrack* today as it is an excellent satellite tracking program that gives all the times and passes of the relevant satellite you are tracking. In my case, in those early days, it was NOAA-14, and I will never forget that first pass over my location with its tick-tock signal coming from the receiver and the picture it produced. It was amazing. A new world had suddenly opened up in front of

me.

The next piece of software I purchased was **WXtoImg**, written by Craig Anderson from New Zealand, a very interesting program which had the advantage of demodulating the incoming signals and creating the images in a single step. *WXtoImg* (figure 2, 3) gave a lot

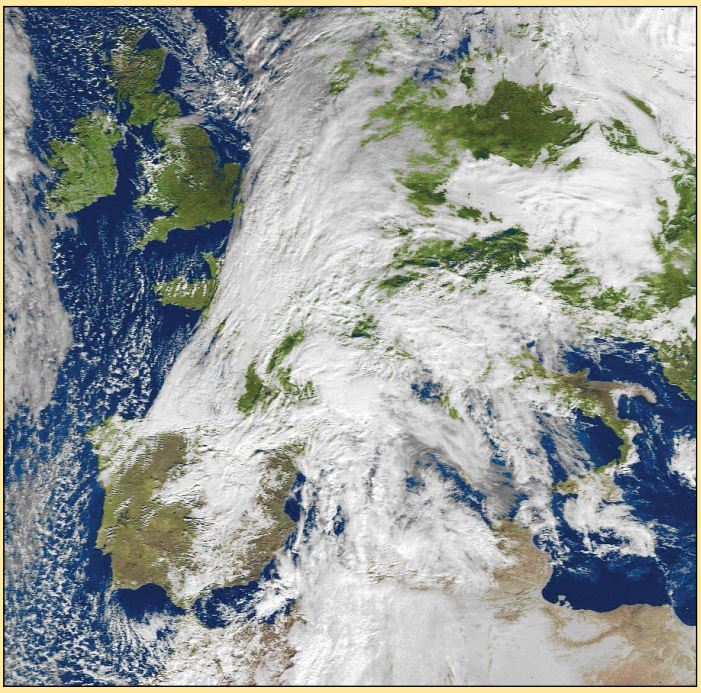


Figure 3 - A NOAA-14 multispectral image processed with WXtoImg

more detail on precipitation and complemented *SatSignal*, but both were exceedingly good.

Polar Orbiter reception with the American NOAA Satellites continues to this day following launches of NOAAs 15/16/17/18/19, each bringing better quality pictures as their systems advanced. Although some of these satellites have been decommissioned over the years, NOAAs 15, 18 and 19 are still giving excellent pictures to this day. But now everyone has better equipment, in particular stronger and faster computers, and many enthusiasts now receive large quantities of high-resolution data from a system called *EUMETCast*, about which, more later.

In the past few years, some new Polar Orbital Russian Satellites, the Meteor Class have appeared on the scene, and started to arouse the interest of home users back to direct reception of data. With up to date equipment and software, Meteor M2 is causing a lot of excitement among hobbyists at the moment and producing excellent Images of our Earth. I have not progressed into that direction as I have other interests to occupy my time, one being learning to get to grips with Windows-10, but that's another story.

So, moving on, I next started to explore WEFAX (Weather Facsimile Data), a format transmitted by the geostationary **Meteosat** Satellites stationed over the Equator. Meteosat-1 was launched in November 1977, the first of this new generation Geostationary Satellites, and it marked the start of a continuous high quality service for Europe and Africa. Unfortunately, Meteosat-1 failed fairly early in its life, and I think my earliest data would have come from Meteosat-2, which was launched in June 1981.

As you can see from figure 4, the picture its quite different

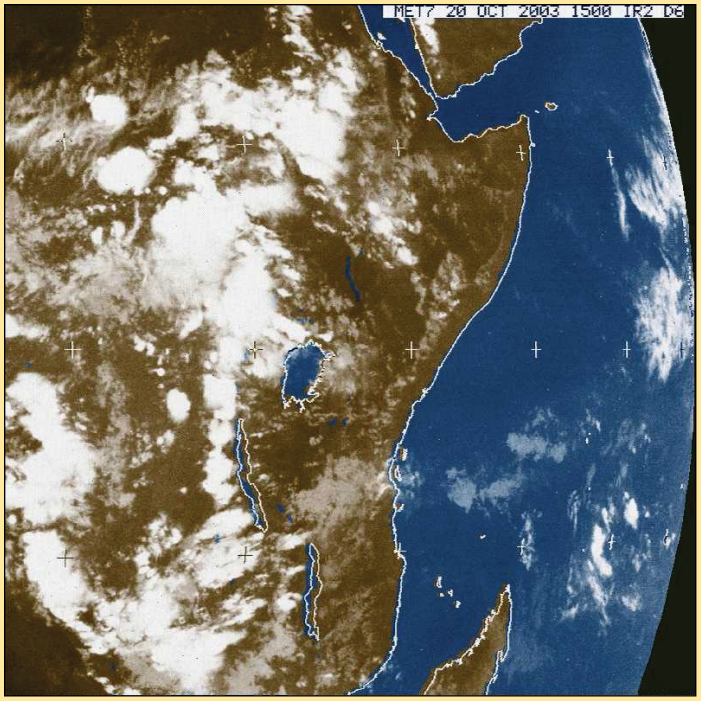


Figure 4 - A typical WEFAX image showing west Africa

from what we receive today, both in quality and clarity, but it was still an achievement to obtain that kind of image at that time, even with the low specification computers then available. But it got a lot better when *Windows XP* came on the scene we had a system you could work with, and still today, many enthusiasts are reluctant to give it up. So, with the launch of the Meteosat Satellites, emerged a new era of Weather Satellite Reception. It was a whole new ball game.

EUMETSAT

In March 1983, it was decided that a new specialised operational organisation was required to manage all aspects of Earth-Observing satellites, and the convention for the future EUMETSAT Organisation was agreed. At the same time, the Member States of the European Space Agency agreed to initiate the Meteosat Operational Program (MOP), involving the construction of three further satellites to be handed over to EUMETSAT. These, which became known as Meteosats –4, -5 and -6, were launched between 1989-1993. On November 15, 1995, control of the Meteosat Satellites in orbit was passed over to EUMETSAT, and Meteosat-7, the last in that series, was launched on September 2, 1997. It says much for the technology of that time that Meteosat-7, moved across to cover the Indian Ocean area in December 2005, is currently still operational.

In May 1991 the EUMETSAT Council decided to establish an independent ground segment to replace the system established by ESA in 1977. This was the start of the Meteosat Transition Programme (MTP), which covered the phasing out of the MOP to the start of the Meteosat Second Generation (MSG) programme. Meteosat-8 (MSG-1) was launched in 2002 but, during the testing phase, an onboard solid-state power amplifier failed, making it impossible to disseminate user services directly. This caused great concern, and led to the development of a system called **EUMETCast**, whereby data was relayed to users using DVB satellite technology, a system that still operates successfully today.

Currently EUMETSAT have three MSG Operational Satellites, Meteosats -8, -9 and -10. The organisation

also operates two Polar Orbiting Satellites, **Metop-A** and **Metop-B** and are cooperating with NASA and NOAA with the **Jason-1/2** and now **Jason-3** Orbital satellites. They are also cooperating with the European Space Agency (ESA), on their Copernicus project to provide the European Union with Earth observation data: Sentinel-3A, launched on February 16, 2016, is the latest Copernicus satellite.

Unlike their predecessors, which transmitted only analogue WEFAX, the Second Generation satellites transmit digital data. **Meteosat-10**, operational since 2012, is currently the newest of the geostationary satellites, and provides full data for the entire hemisphere every 15 minutes from its SEVERI (Spinning Enhanced Visible and Infrared Imager) instrument, and is expected to remain in service until at least 2022. **Meteosat-8** remains in good health as the back-up satellite should service from Meteosats -9 or -10 be interrupted. **Meteosat-9**, has run the RSS (Rapid Scan Service) since April 2013. This involves scanning only the northern third of the hemisphere but supplying data every five minutes. Though it has not yet been brought into service, **Meteosat-11** is already stored in orbit until it is required by EUMETSAT.

Digital Reception

Reception of these digital satellites was the area I moved into. The quality and quantity of data was much greater than before and my transition was taken care of with the excellent, new *DVB-World* digital tuner, which gave consistent results from the satellites. Perhaps most important in this respect was the ever fast-moving technology of computers. Windows XP was an amazing operating system which performed well without too much fuss, could be easily programmed for all the excellent satellite related software, mainly from David Taylor. They proved quick and easy to instal, and had you up and running in no time at all. I still use them to this day.

Taking what we receive today for granted, it still has to be realised that these satellites play a very important part in current weather forecasting, and are there for the primary role of detecting and forecasting developing high impact weather such as thunderstorms and fog. They have become vital for the safety of lives, property and infrastructure but, as amateur weather hobbyists, we are privileged to see all this data thanks to the co-operation of EUMETSAT, for which I thank them.

The *Metop* polar orbiting satellites are producing some brilliant images of our Planet and I have been receiving them via *EUMETCast* since they were launched and commissioned. The Metop satellites orbit the Earth once every 101 minutes, constantly scanning the planet below. Every few minutes, data is downloaded to EUMETSAT HQ in Darmstadt then re-transmitted over the *EUMETCast* system to the user fraternity. The image quality is excellent (one kilometre/pixel resolution, figure 5), and data files received from both satellites can be processed using David Taylor's *Metop Manager* software.

There are two Polar Orbital Satellites operated by NASA, named **Aqua** and **Terra** which produce even higher resolution imagery (250 metres/pixel), and these also are streamed via EUMETCast. The imaging device on these satellites if termed MODIS (Moderate-resolution imaging spectroradiometer), and their data can be resolved using another program from David Taylor, *MODIS L1 Viewer*. Figure 6 is a typical screenshot showing MODIS L1 Viewer in action. It's software I use all the time: try it, and you wont be disappointed.

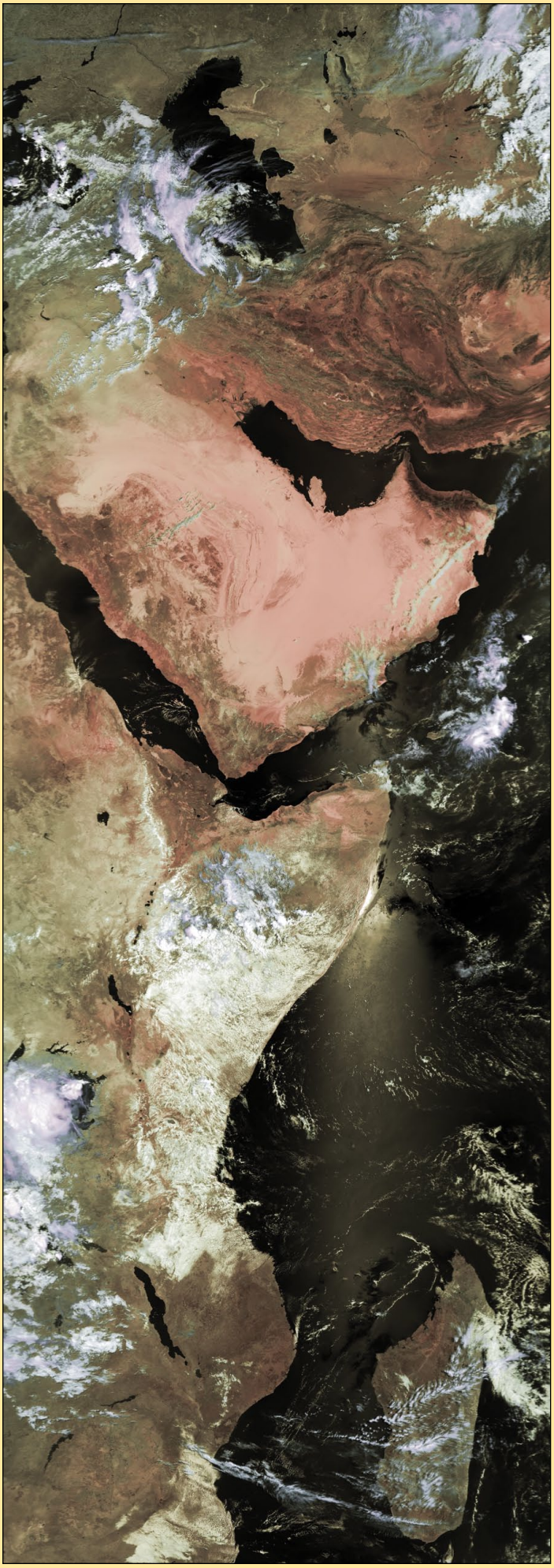


Figure 5 - A Metop-1 image from October 3, 2015
Image © EUMETSAT 2015

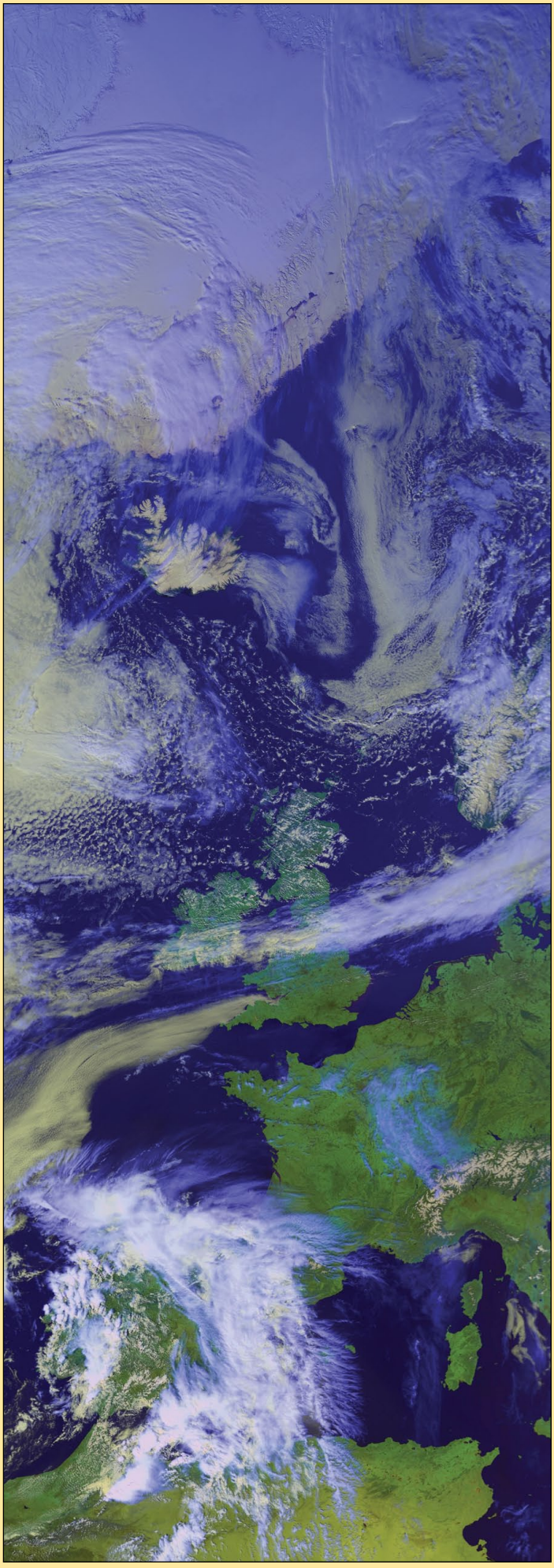


Figure 6 - A Modis L1 image acquired via EUMETCast
Image © EUMETSAT 2015

You will recall my mention of APT earlier. APT images have a resolution of 4 km/pixel, Now you can receive the High Resolution Picture Transmissions (HRPT) from the NOAA Satellites via EUMETCast and, using David Taylor's *AVHRR Manager* software, you will get a complete pass which you can feed into his HRPT Reader program to create some amazing quality pictures. My computer is running all the time and is so very interesting to watch the pass build the pictures (figure 7).

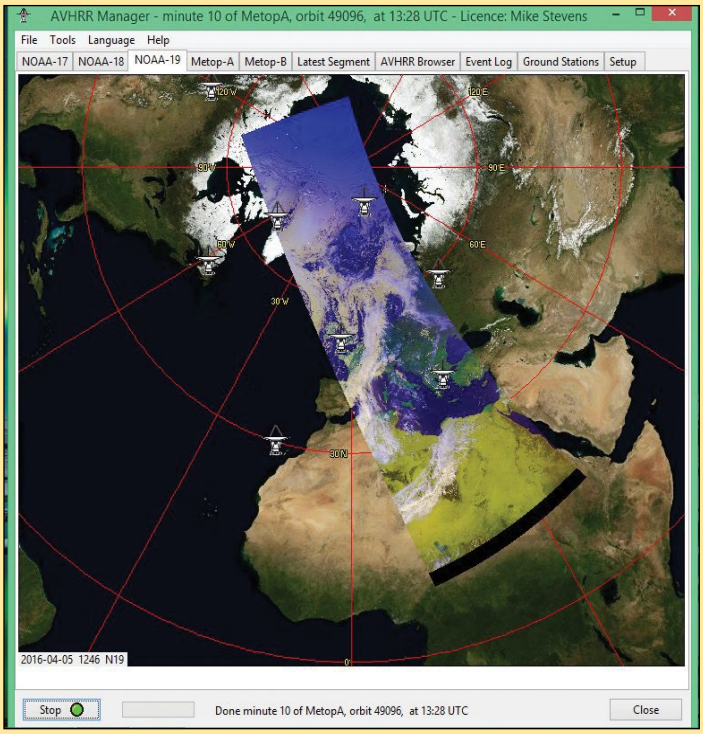


Figure 7 - An HRPT image being received with AVHRR Manager via EUMETCast
Image © EUMETSAT

Well there you have it. We now have a DVB system delivering masses of data, not just from Europe but from all round the world: from the USA with their GOES-E and GOES-W, across to the Indian Ocean with Meteosat-7, then further East from the Chinese Satellite Feng Yun-2G, and finally from Japan Weather Bureau's latest Satellite, Himawari-8, which covers a massive area from Kamchatka in the North down to New Zealand and Antarctica. So I see weather from all over this planet of ours, amazing, and all can be received through the EUMETCast System.

The Envi-Ham Project

The next project to come on stream was a very interesting one: run by ESA, it was called the Env-Ham Project, and allowed those interested, by application and invitation, to take part to receive data and images from the **Envisat** satellite. My thanks to Francis Bell, who was instrumental in organising the project.

You first had to apply to the *Envisat Team* for a licence, and provided you were accepted, you then received all the information via several emails, one of which you had to sign and return, together with details of your station. This enabled the DDS Team to issue you with a Site Key and a DDS Key. Once you had received all the relevant information you were able to start to set-up your station. It was then I decided to replace my old beaten-up satellite dish. Winter Storms here on the South Coast tend to damage kit very quickly, so I opted for a 1 m dish and a Twin LNB as I intended to receive both *EUMETCast* and *Envi-Ham* from the same dish using two separate feeds

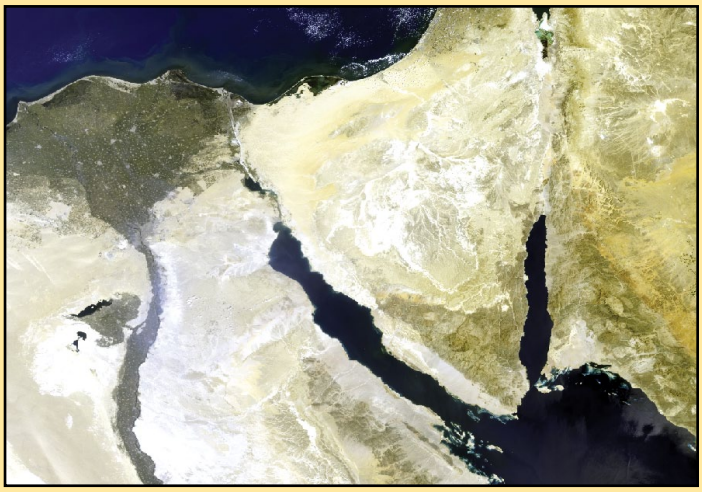


Figure 8 - A detailed image of the Sinai peninsula received through the Envi-Ham project.
Image: ESA

back to the twin *DVB World* receivers. The adjustment was going to be tricky because the *EUMETCast* transmissions were from *Eurobird-9* located at 9°E while the *Envisat* data came from *Eutelsat W1* at 10°E. Making a very fine adjustment, I was able to locate *Eurobird-9* very easily as it delivered a very strong signal. I then moved my dish approximately 17 mm east and located *Eutelsat.* Both signals were 'solid copy' and, when I switched on after all the adjustment, I found rock-steady signals and data started to flow in.

To decode this data I used the software supplied by ESA, called VISAT, and the pictures were quite stunning (figures 8, 9) and so different from those from *EUMETCast*, but with even more quality and detail. It was amazing. It was unfortunate that early in the project, the Envisat satellite failed and has never been recovered. But I hope that, one day, ESA may let us participate in another similar project as it really was ground breaking stuff—and I still have my two *DVB-World* receivers just in case.

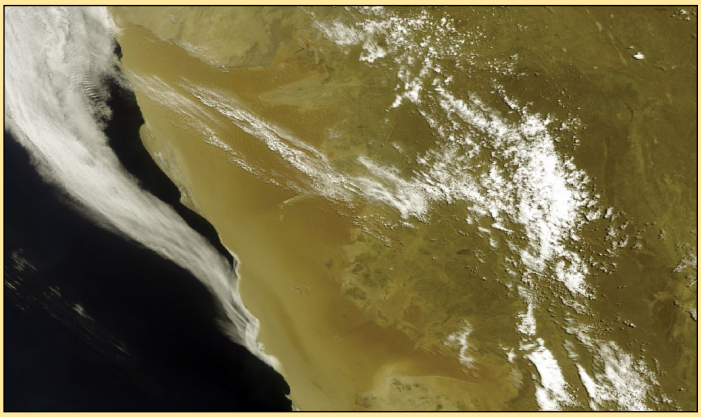


Figure 9 - A detailed image of the coast of Namibia received through the Envi-Ham project.
Image: ESA

Windows 7

While all the above was going on we had something else to get used to—a new Microsoft operating system called *Windows-7*. It took some time to become familiar with this as quite a few variations had to be made to the reception system: we had to deal with firewalls, command line operations and the use of separate *Tools* and *Files* folders outside the *Program Files* folder. But, as it turned out, it has now become a very big favourite of many users, who prefer to remain with *Windows-7* for as long as possible.

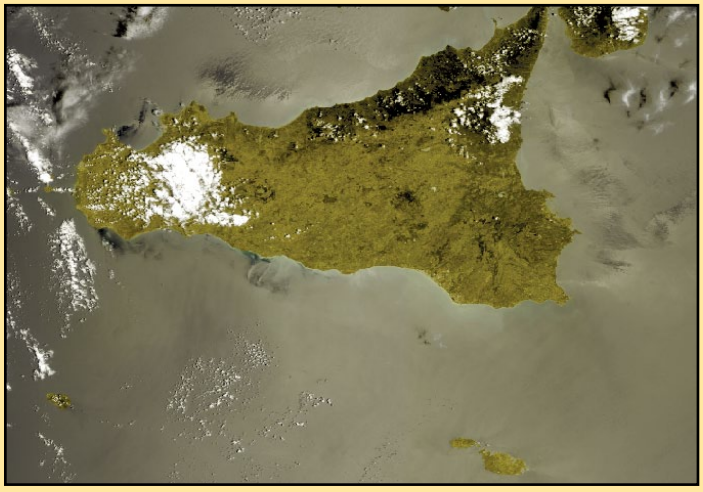


Figure 10 - A detailed image showing the island of Sicily received through the Envi-Ham project.
Image: ESA

Windows 7 was eventually followed by *Windows 8.1* a system that I currently use. This gives me very good reliability and good satellite program processing, but I do have one PC running the new *Windows 10*, which I keep a very close eye on—but so far so good.

The New DVB-S2 Transmission Format

I continued to enjoy my *EUMETCast* experience until rumours started to abound during 2013/2014 that *EUMETCast* was to transition from DVB-S to DVB-S2, a new transmission format that was required to handle the ever increasing flow of satellite data through the system. This also meant use of a new satellite, retuning and new software. I thought: "here we go again", and I was right.

But one of the first things that came to light when it had been officially announced we were going to have to change everything was the cost of the Tuners. EUMETSAT-approved DVB-S2 Tuners were being priced at over £400, which at the time I thought was grossly overpriced. Indeed, they were expensive to the point that many members—bearing in mind that most are retired, and like me on a limited budget—would be hard pressed to spend that amount of cash on a tuner for DVB-S2 reception.

So I went hunting for something that would be equally as good but less expensive, and came across a company in Hong Kong called *TBS* who manufactured DVB-S2 tuners. These tuners could operate with the new *EUMETCast* transmissions, so I contacted TBS, heralding the start of a special cooperative relationship that has lasted to this day.

I was offered to test a *TBS-6925 PCIe Card*, which could be conveniently fitted into an expansion slot within the computer, and was delighted to accept. I was sent a sample, and so the trials started. The first thing was to install and set-up the card, which was very easy. The tuner started up, and when all the system parameters had been set in *Windows-7* the DVB Data came flooding in. It was then just a case of linking in all the software to decode the images. This proved to be an excellent tuner.

Then, in late 2014, test transmissions of the new DVB-S2 VCM service began, but unfortunately the TBS-6925 tuner would not remain locked to the signal. Following a quick email to TBS Support, a new set of software was sent to me the following day, and installed. Once the PC had been rebooted, the tuner remained locked to the DVB-S2 transmission and I was able to copy all the test files with

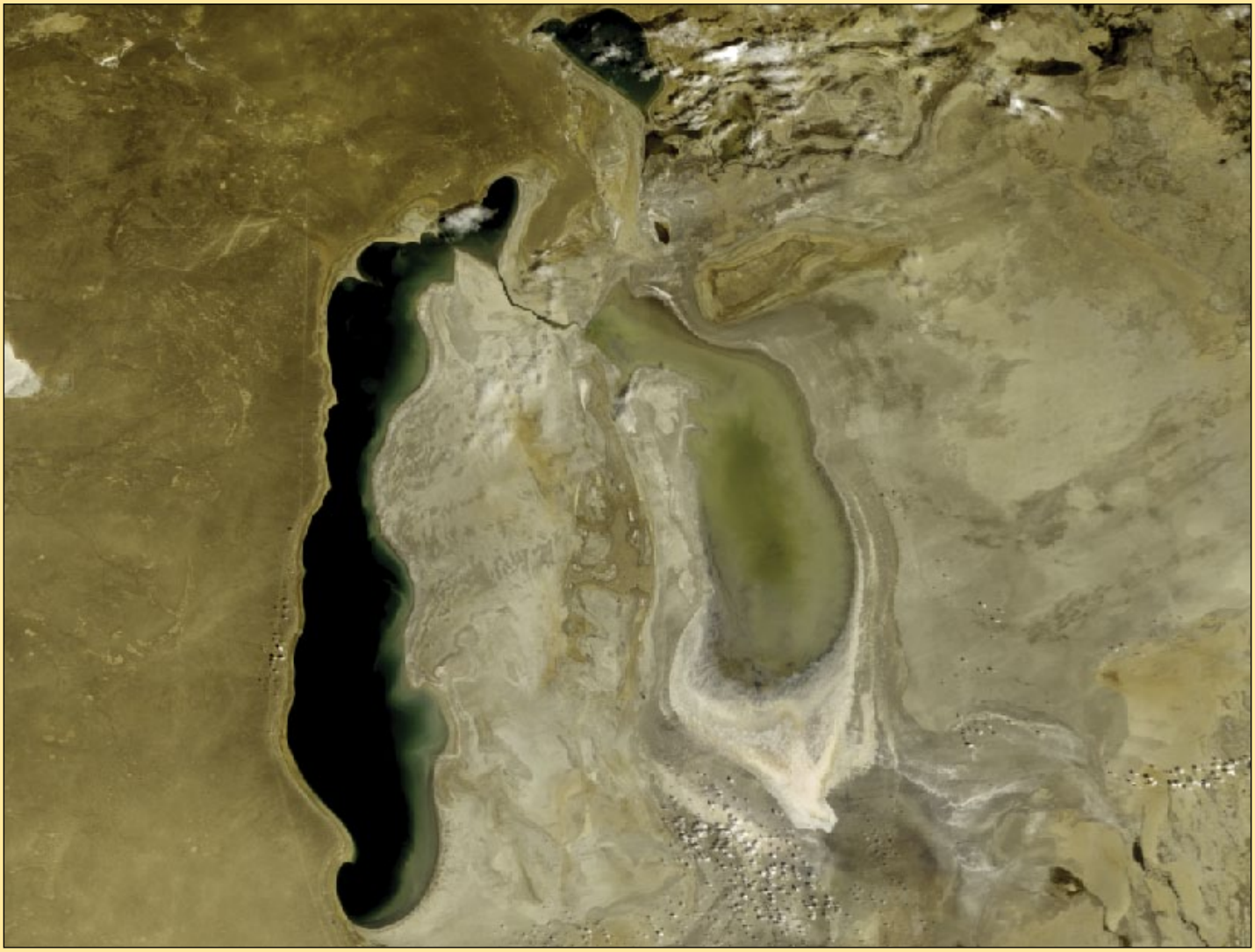


Figure 11 - This *Envisat* image of the Aral Sea, dating from August 19, 2011 illustrates the satellite's amazing resolution.
Image: Envi-Ham/ESA

no lock out: and it continued to perform well as soon as the Real Time Data came on-line.

Since those early days of the new transmissions I have been privileged to test all the new TBS Tuners (TBS-5925, -6925, -6908 and the latest TBS-6903). All these have worked extremely well with DVB-S2 VCM and are continuing to do so; and all are priced at well under the £400 mark.

Prior to this, and before the new system was under way, the satellite dish had to be repositioned towards, coincidently, the same satellite that had been used for the Envi-Ham project, so again a move east of about 17 mm at the end of the LNB to obtain **Eutelsat 10A** at 10°E, so no problem there.

I have to admit that, in the early days, I did experience some software conflicts, but with the help of other members and TBS Support we now have reliable tuners that are capable of delivering the massive amount of data to our computers, and at the moment coping well.

The Data Services

The new DVB-S2 system offers two types of data: the one we all use, called *Basic Service*, that delivers the same data we have been taking since the start of *EUMETCast*, and the *High Volume Service*. The latter has yet to be made available, but I have already been receiving test files with TBS-6903 without any loss of packets. However, I am unsure as to how much data we will be able to cope with once the system goes Real Time Live. I am confident that the tuners will cope but not sure if we will have enough computer capability to decode all the data. This is unknown territory at the moment, and we must simply wait and see.

Finally

So there you have it: a lifetime with weather satellite reception—or so it seems. Do I still enjoy it? Hell yes! It's the challenges of setting a reception system up and getting it to work, then sitting back and watching all the amazing images explode on the computer screen. I found the move over from Amateur Radio—with an interest in receiving all signals—to this hobby seemed a natural progression, and like the dawn of a new age. And sending in articles for the Quarterly helps others to enjoy the hobby and gain experience of all the equipment and systems.

So I hope this has given all the new members an insight into how this hobby we love so much has progressed. And with all the technical aspects of programming and the computer up-grades we have also had to overcome, can see the challenges that faced us. But if you have a passion for something you will meet that challenge head on—and win as well. So don't be put off, remember we had to learn as well.

Happy weather watch from Portland.

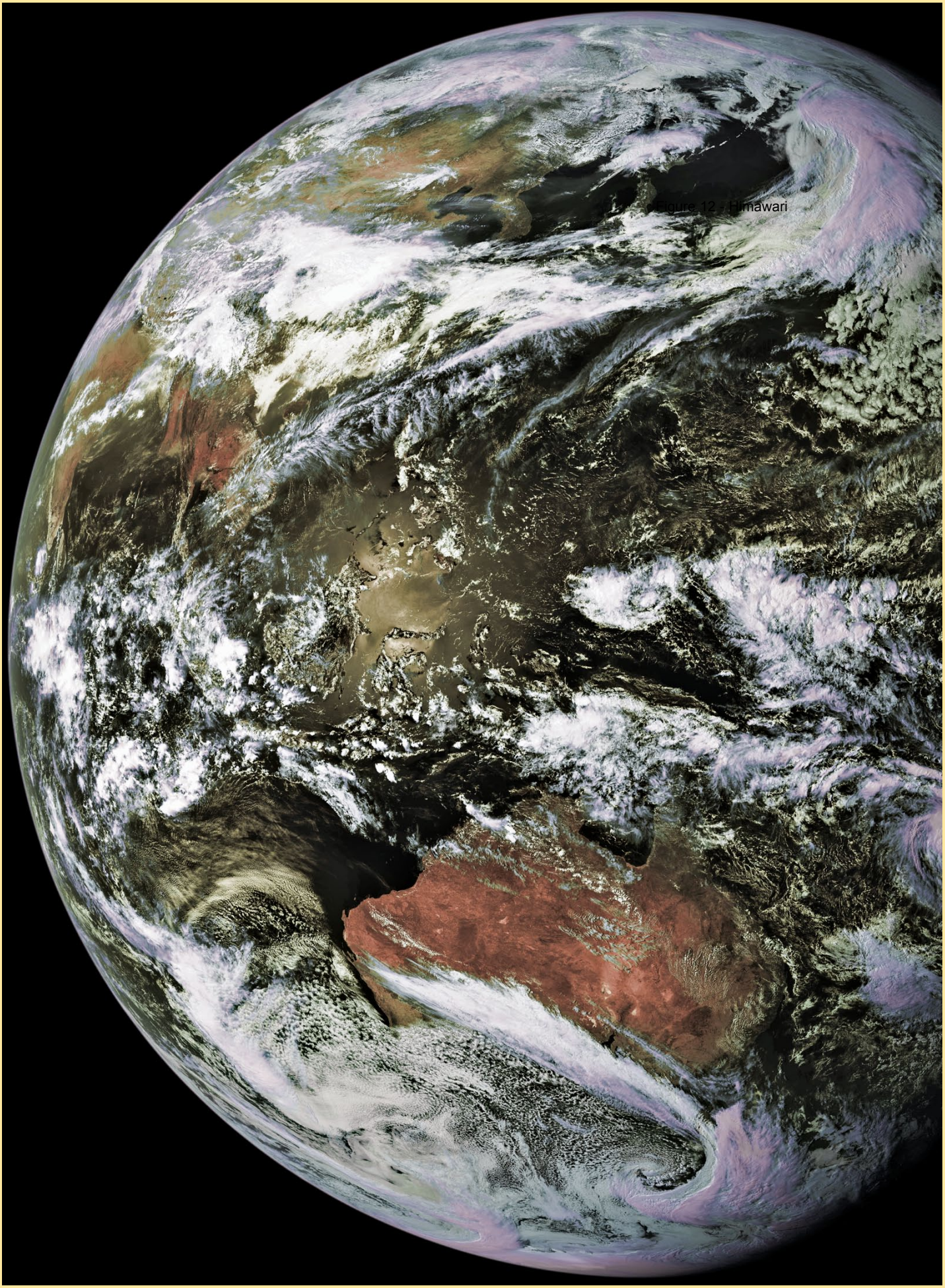


Figure 12 - Japan's latest geostationary satellite, Himawari-8, is one of the latest additions to the EUMETCast service. This is a section from the image captured by the satellite at 05:30 UT on April 5, 2016.

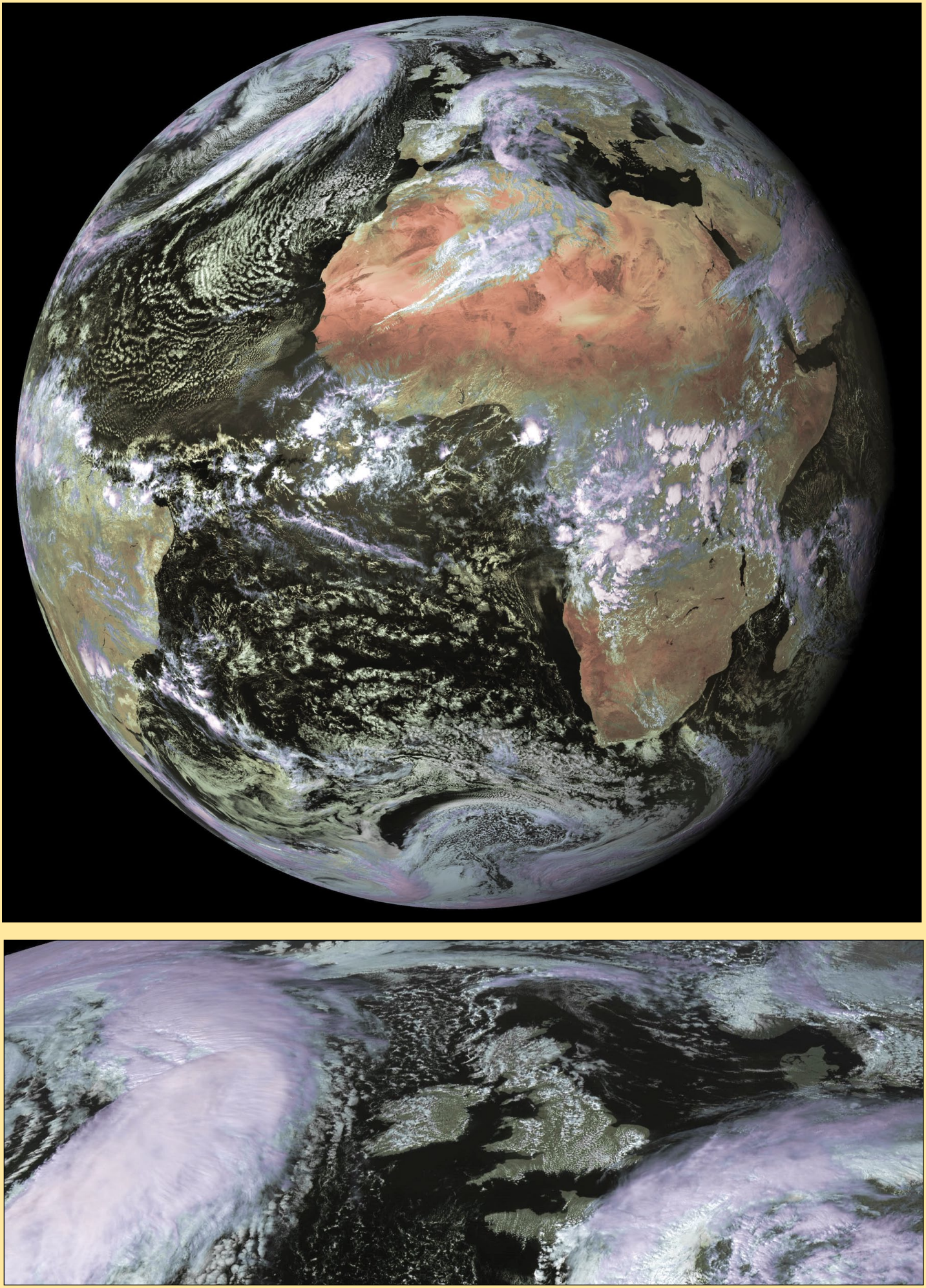


Figure 13 - Meteosat-10 image acquired at 15.00 UT on March 31, 2016: Full Disc (above), British Isles section (below).
Image © EUMETSAT 2016

Quarterly ? Question

Francis Bell

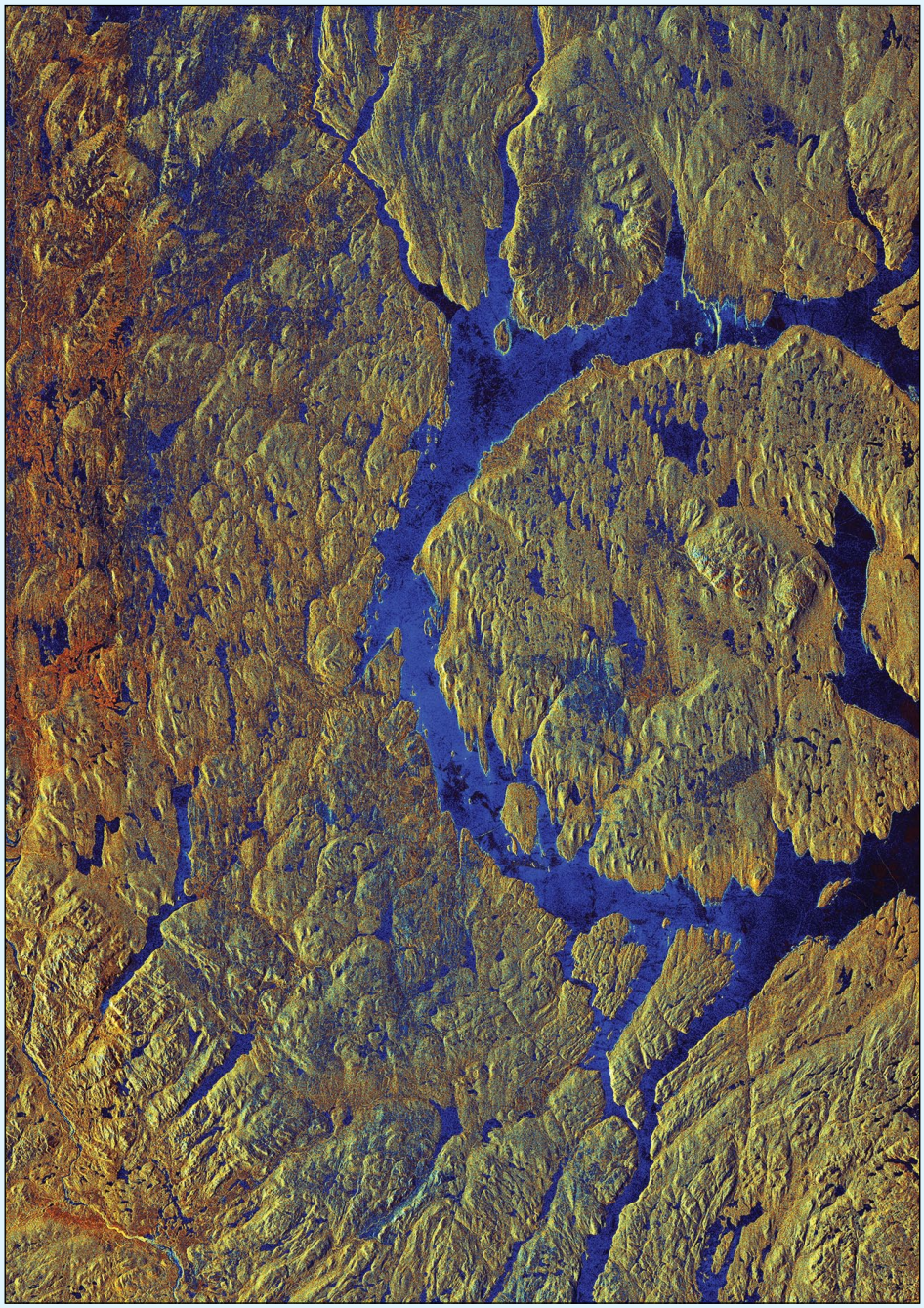
Quarterly Question 49

My thanks to those members who emailed me with the correct answer to the last Quarterly Question, which related to a satellite image showing the southern tip of South America. The main island in the image is Tierra del Fuego (the land of fire) which is politically divided between Chile and Argentina.

I was prompted to ask the question because it's part of the world which I have visited for purely recreational reasons with nothing political or commercial in the background. The commercial dimension has been important in the past because, prior to the opening of the Panama Canal on August 15, 1914, the sea passages around the tip of South America were vital, providing the to only sea route between the Pacific and Atlantic Oceans.

The port of Punta Arenas is in this region. In the past this was an important refuelling stop for steam ships because of the local coal mine, hence offering the opportunity top up on coal. Interestingly, the commercial interest in the area nowadays is related to petroleum extraction, not coal. The other relatively small but attractive local port I visited was Ushuaia, which is the capital Terra del Fuego.

I'm not sure of all the human history of the area, which apparently goes back 8,000 years, but for commercial and geographical reasons I can understand the political and territorial ambitions of both Chile and Argentina claiming sovereignty over the area. The current status is the division of the island between these two countries.



Quarterly Question 50

The rationale behind the idea for this question was prompted by an image I saw in the background during our recent symposium *Skype* contact with Mark Drapes, who was in the central control room at ESOC. In the background, on a large screen, there was a rolling display of images, quite unrelated to our *Skype* conversations. I was surprised to recognise one or two of the images which I feel sure were selected from of ESA's 'Image of the Week'. It so happens that I have a small collection of these published images, and recognised two of the series which was being shown: one illustrated a vigorous marine algal bloom, and the other a distinctive geological terrestrial feature. It is this second image, reproduced opposite, which is the subject of this Quarterly Question.

The question is this: "Name the circular feature shown in the image, together with any other facts and figures which you consider to be informative about it".

To help identify the image in question, note that the scale is such that the major diameter of the circular feature shown is about 100 km. It may also help to identify the location by knowing that most surface water in the area is frozen during the local winter and may well be covered in snow. However, this image was acquired during the summer. Answers by email please to

Francis Bell francis@geo-web.org.uk

by Sunday, August 28, 2016.

Space:UK

The UK Space Agency distribute a very informative 26 page A4 paper publication several times a year. The publication covers activities related to the UK space industry plus related sciences. I always find it interesting to read and very well illustrated.

The April 2016 edition understandably covers Tim Peake's activities on the ISS but also covers other topics. I have followed some of the references given in this edition and found them very interesting.

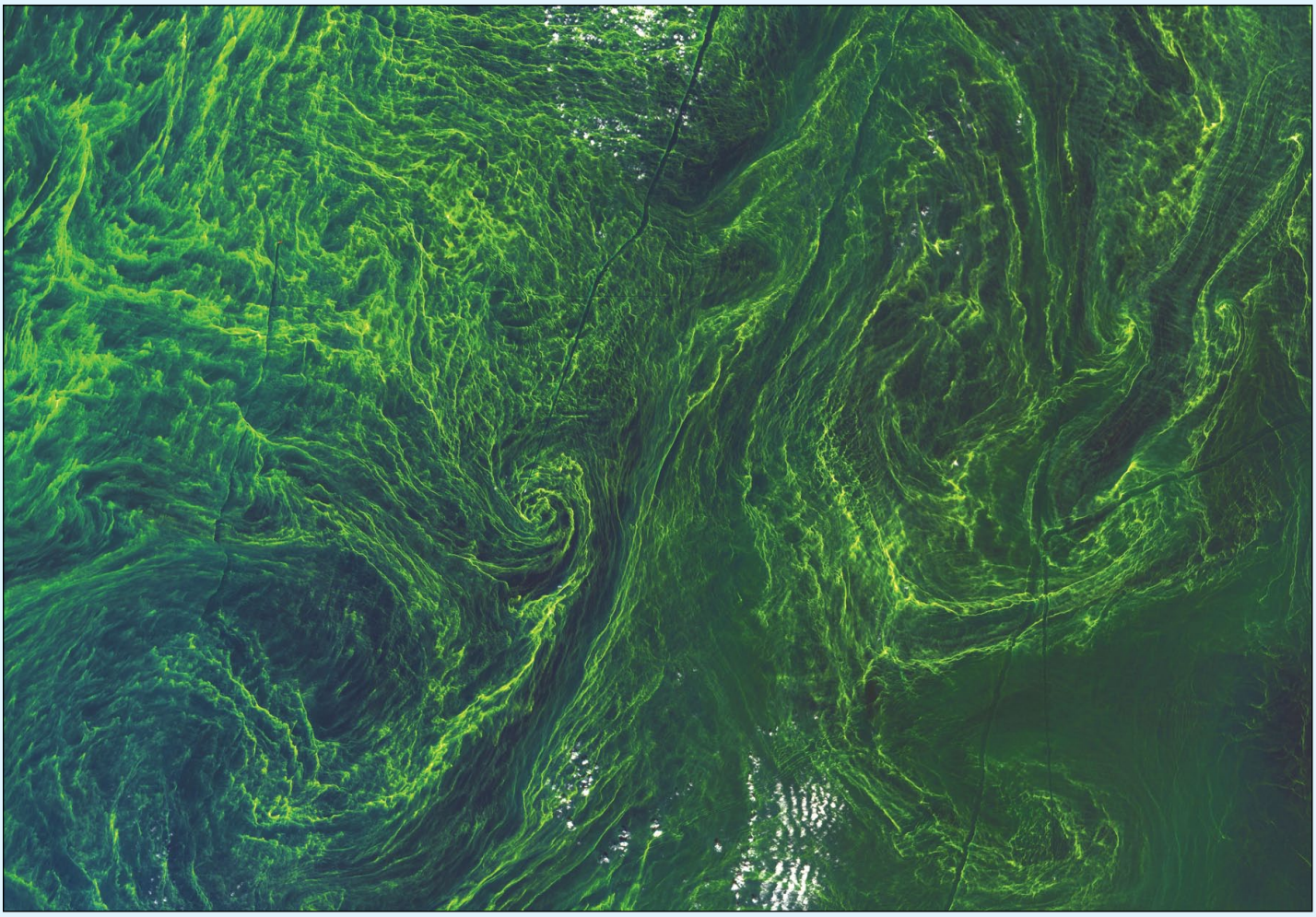
This publication is available free of charge on request. I suggest that, if you wish to be added to their mailing list for this publication, you write to:

UK Space Agency (Space:UK Publication)
Polaris House
North Star Avenue
Swindon
SN2 1ET

Ask to be added to their mailing list and say that you want the material for your own personal or educational interests. Don't expect a reply, but one day you may receive your copy. You could try asking for the April 2016 to be sent to you.

The front cover of the latest 'Space:UK ' publication

Algal Bloom



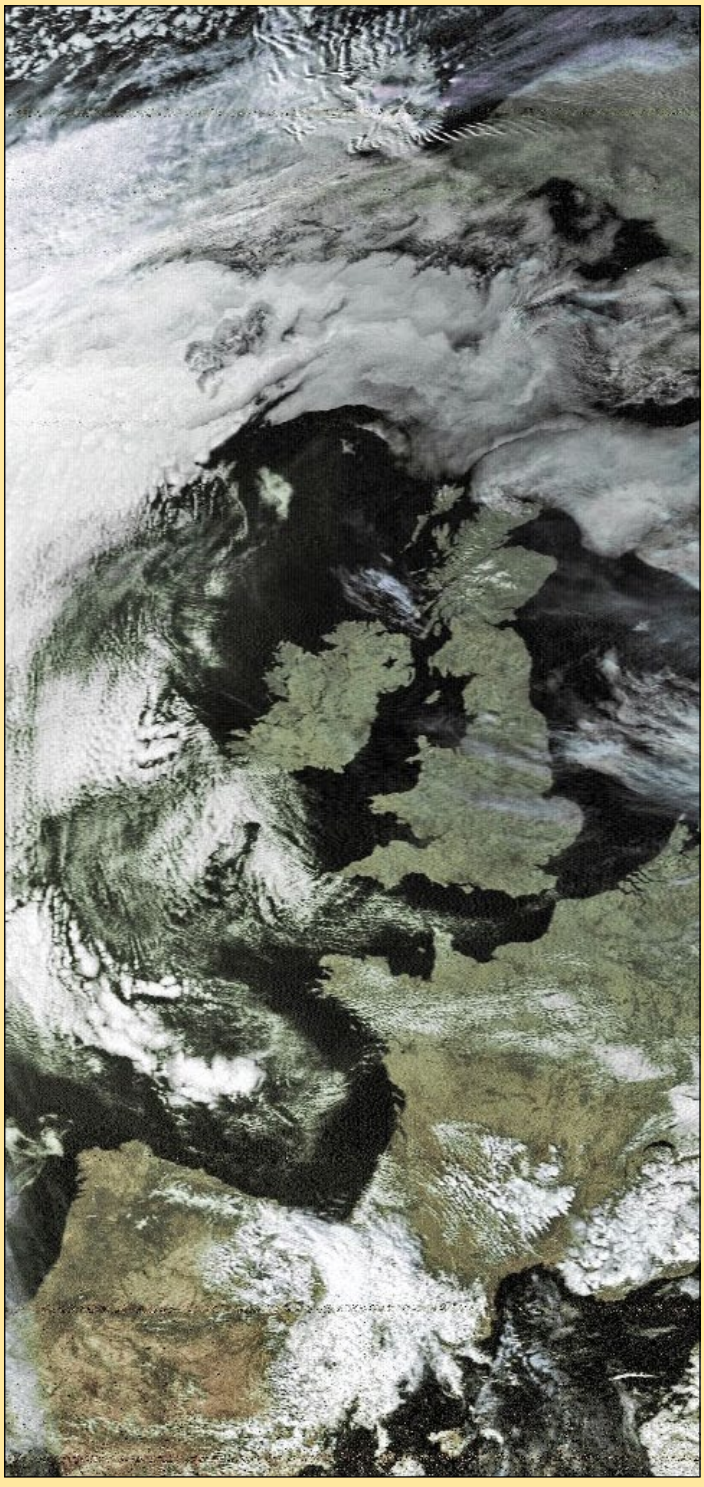
The Sentinel-2A satellite captured this spectacular image of the central Baltic Sea on August 7, 2015.
The image shows detail down to 10 metres across, revealing exquisite detail of an algal bloom.
Image: ESA

What a Difference a Day Makes

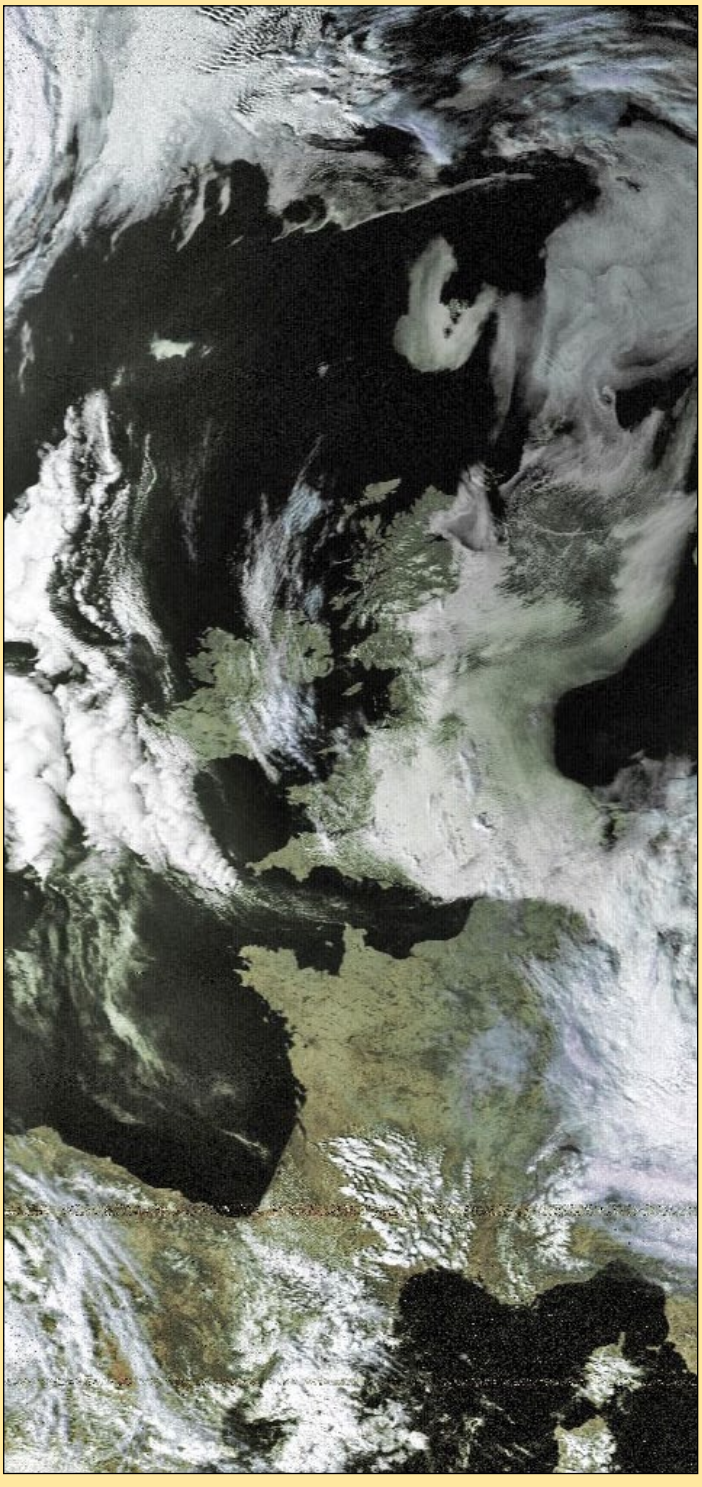
Les Hamilton/David Taylor

Last March, David Taylor sent me these two NOAA-19 APT images detailing the British Isles and western Europe. The left-hand image, acquired on March 14, shows a high pressure area located over the North Sea, producing clear skies beneath which the whole of Britain basked in sunshine, at the same time deflecting Atlantic depressions towards Iceland. Had this been summer, it would have been expected that the fine sunny weather would continue for several days.

But in March the sea is cold and the warming influence of the sun relatively weak, and overnight the temperature dropped producing widespread swathes of fog. The following day, gentle on-shore breezes brought yet more fog to the eastern coasts, a situation that scarcely changed for several days. The second image, dating from March 15 shows the situation: while the east of Britain sulked under fog and low cloud, to the west it was sunshine every day, with temperatures in the high teens in many places.

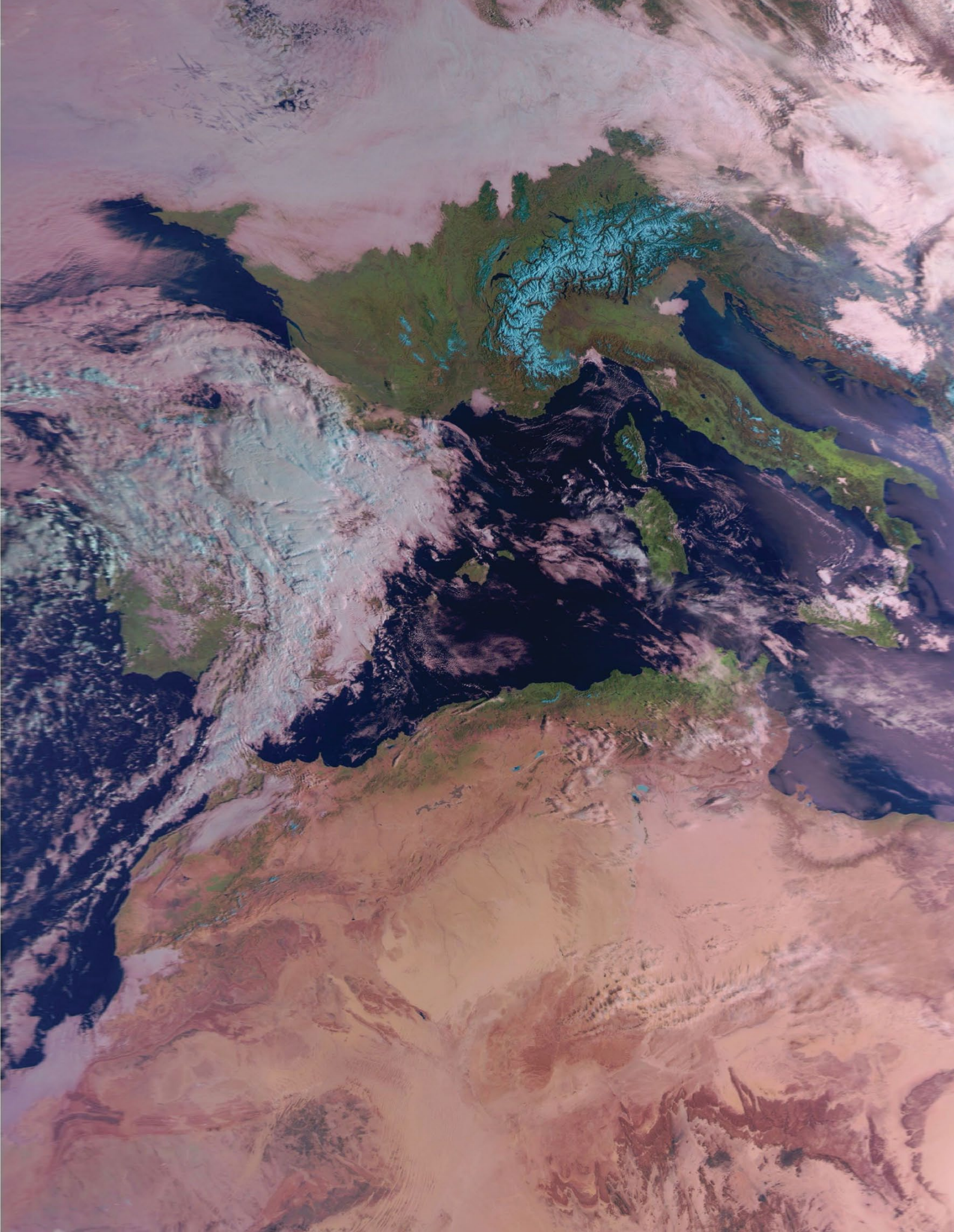


NOAA 19 at 13:41 UT on March 14, 2016



NOAA 19 at 13:30 UT on March 15, 2016

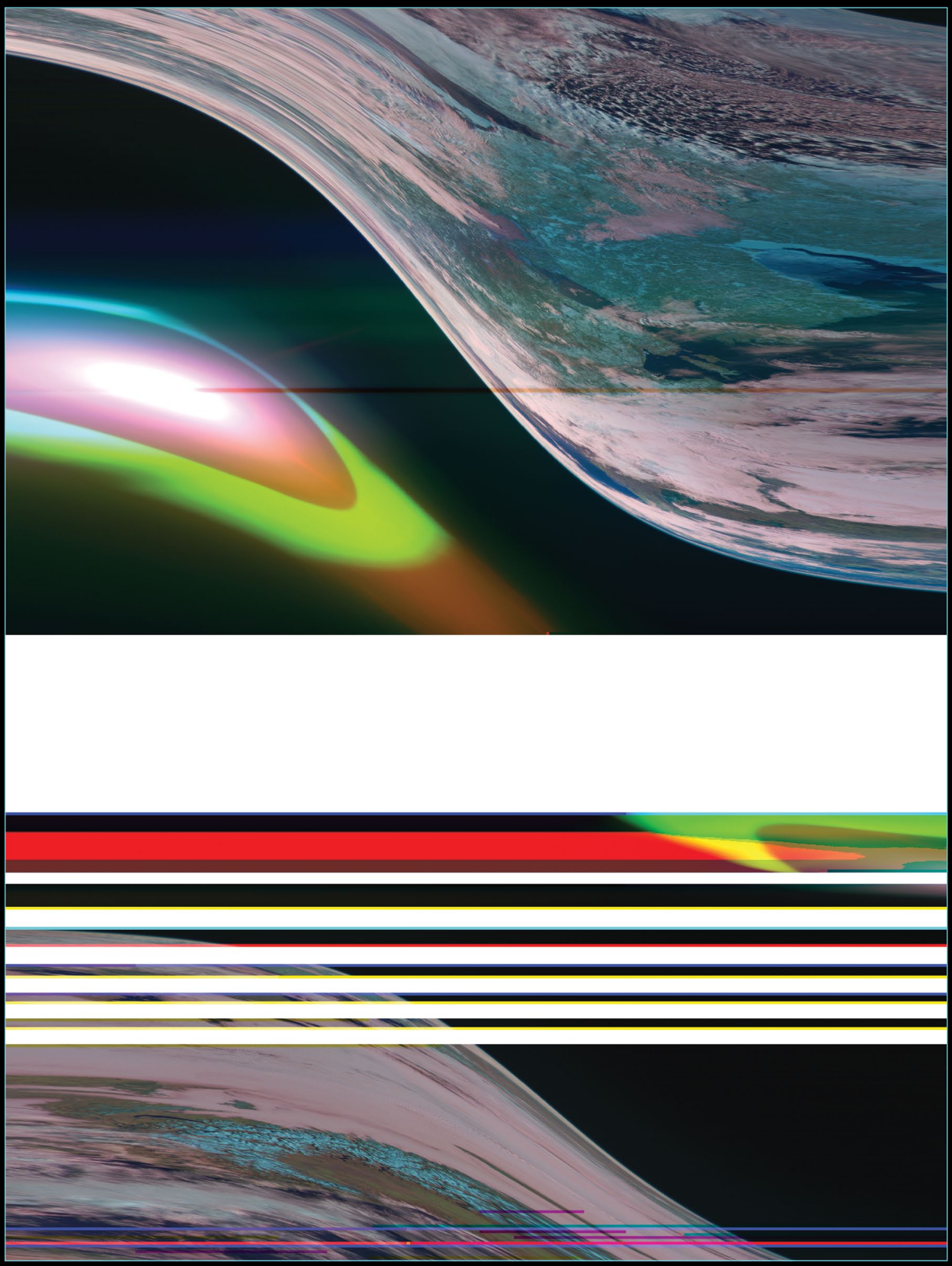
Reception equipment: indoor QFH, RX2 receiver, WXSat wave file capture, PassControl scheduling, SatSignal-6 offline processing.



This lovely Meteor M1 image, acquired at 07:34 UT on March 19, 2016, was sent to us from Italy by Enrico Gobbetti. Great swathes of low cloud cover northern France and the North Sea but the snow-covered Alps, Italy and north Africa are beautifully portrayed.

Wayward Meteor M1 Images the Sun

Les Hamilton



On the morning of March 20, on its 07:25 UT pass, Meteor M1 produced this remarkable image. At the time, the satellite was flying southwards, directly down the length of the Baltic Sea then over the Alps, which can be discerned in the lower part of the image. The craft is clearly spinning, with the Earth's limb prominent throughout. The unusual large oval artefact in the upper section of the image is the sun. Image captured by Les Hamilton using an RTL dongle and SDRSharp software and plugins by Vasili Beliakov.

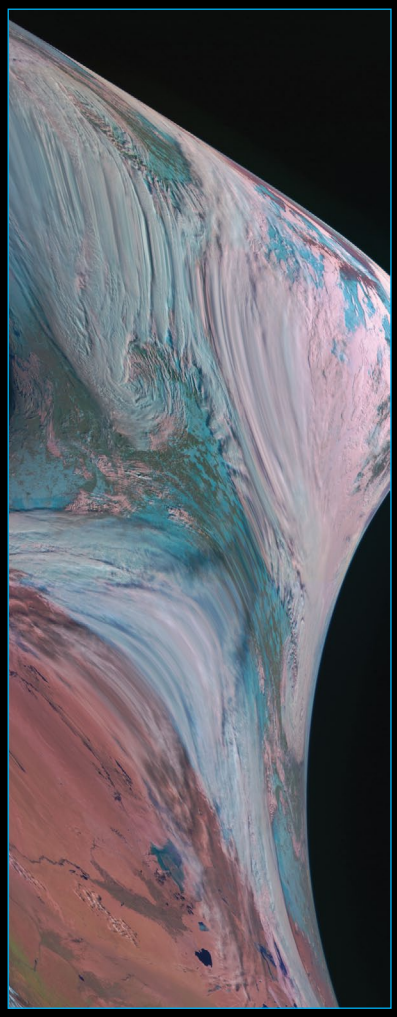


Image: Marquis/Moscow / 03:10 UT

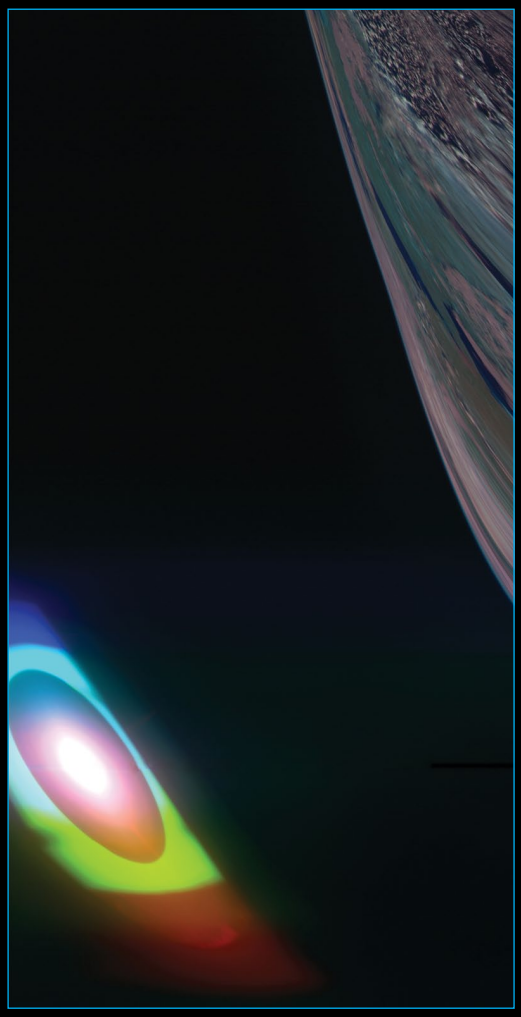


Image: Marquis/Moscow / 05:51 UT

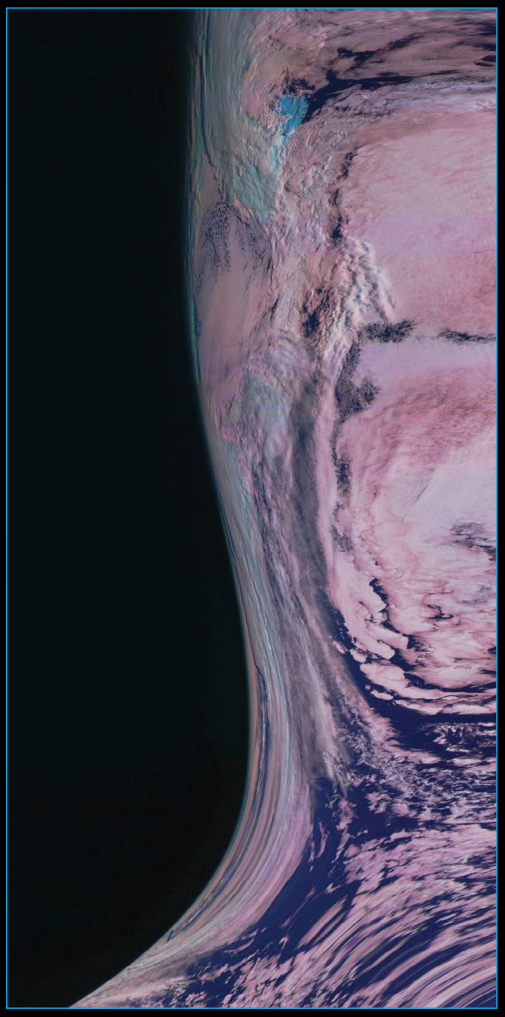
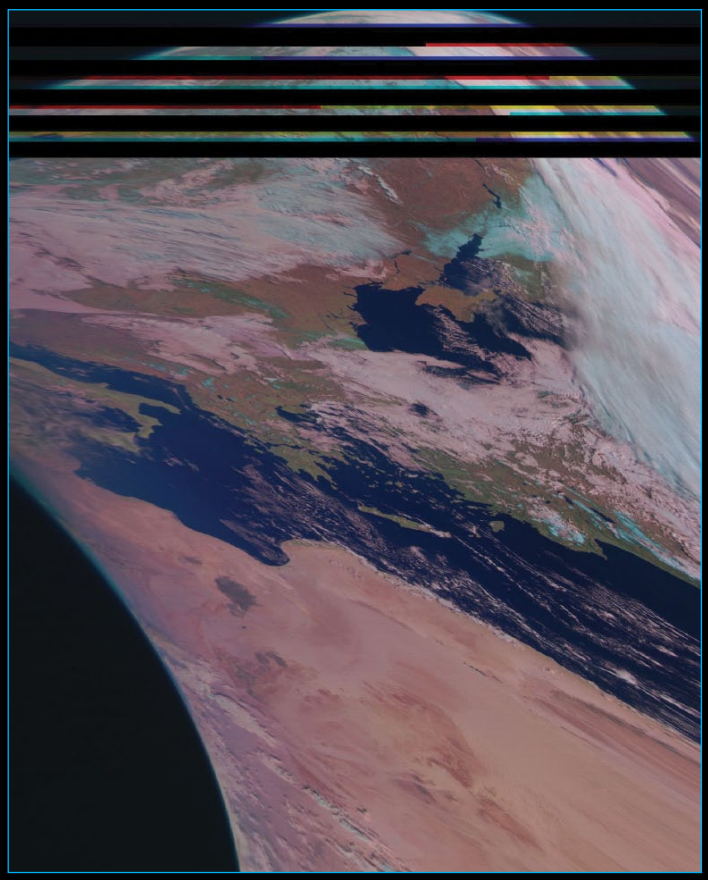
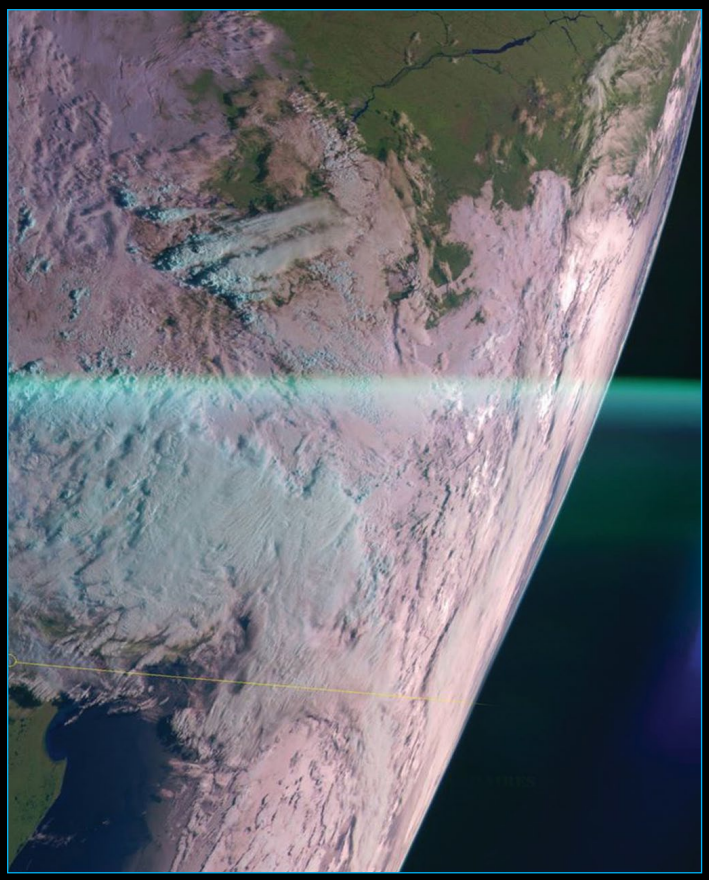


Image: Eric Knapps/Belgium / 09:09 UT

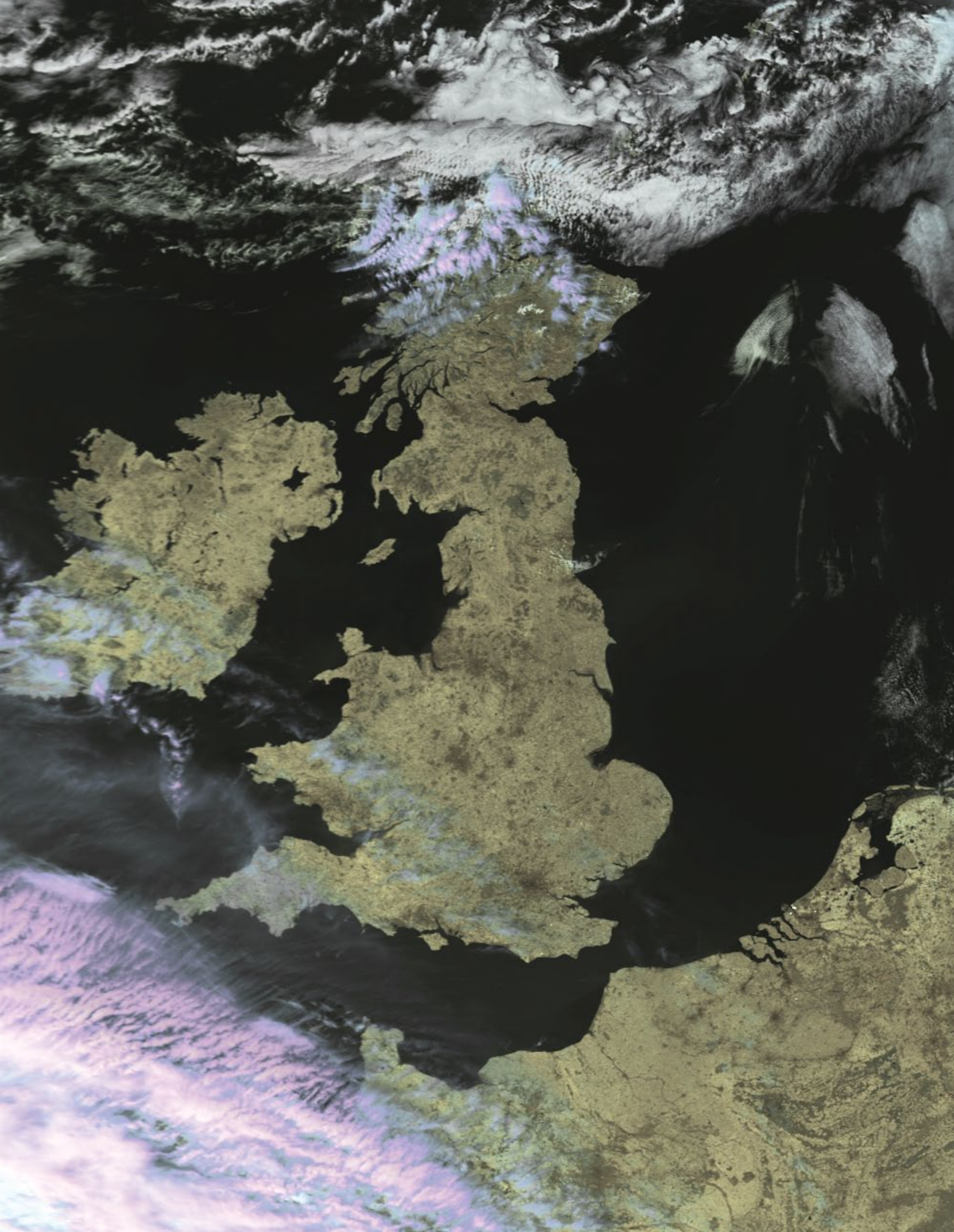


March 20 at 05:50 UT (Cesare Buzzi/Italy)



March 20 at 09:09 UT (Walter Diego Spaltro/Uruguay)

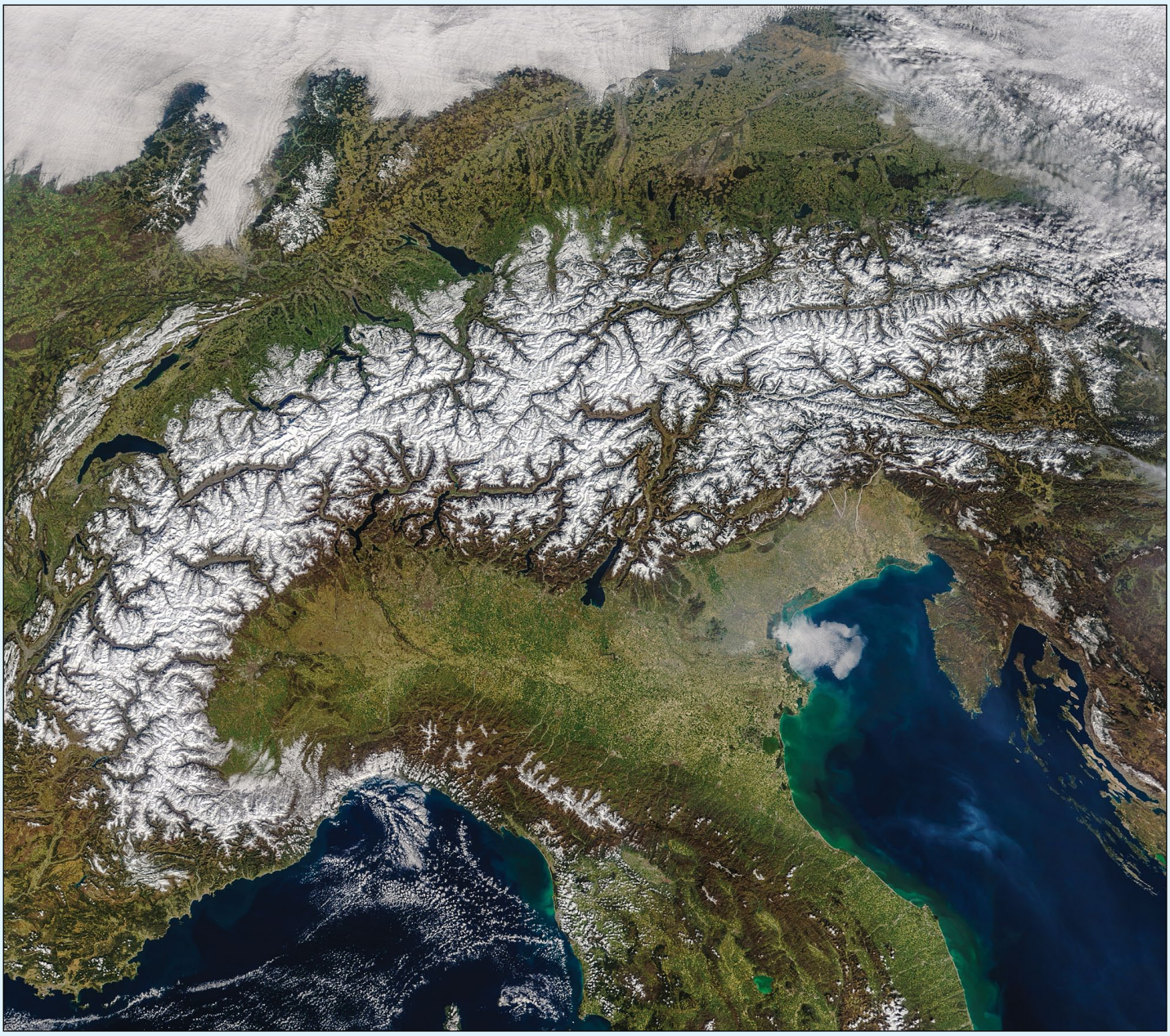
Thanks to Alex (Happysat) for sending in a selection of images from around the world documenting the imagery from the spinning Meteor M1 during March 20, 2016.



This splendid image showing the British Isles, Belgium and The Netherlands almost completely cloud-free, was captured by the NOAA-19 satellite at 13.18 UT on April 20, 2016. Thanks to David Taylor for forwarding it to *GEO Quarterly*.

Spring Snow Cover in The Alps

NASA Earth Observatory



Late winter storms dropped a fresh coating of snow across the Alps in mid-March 2016. The fresh powder was a welcome sight for skiers and the many resorts that cater to them. Though spring sunshine is becoming more abundant, temperatures on the upper slopes have remained low enough to preserve the snow cover.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** satellite acquired this nearly cloud-free image of the Alps on March 20. The Alps, which includes 29 mountains that exceed 4000 metres in height, stretches 1200 kilometres across eight nations and it is the longest mountain chain situated entirely within Europe.

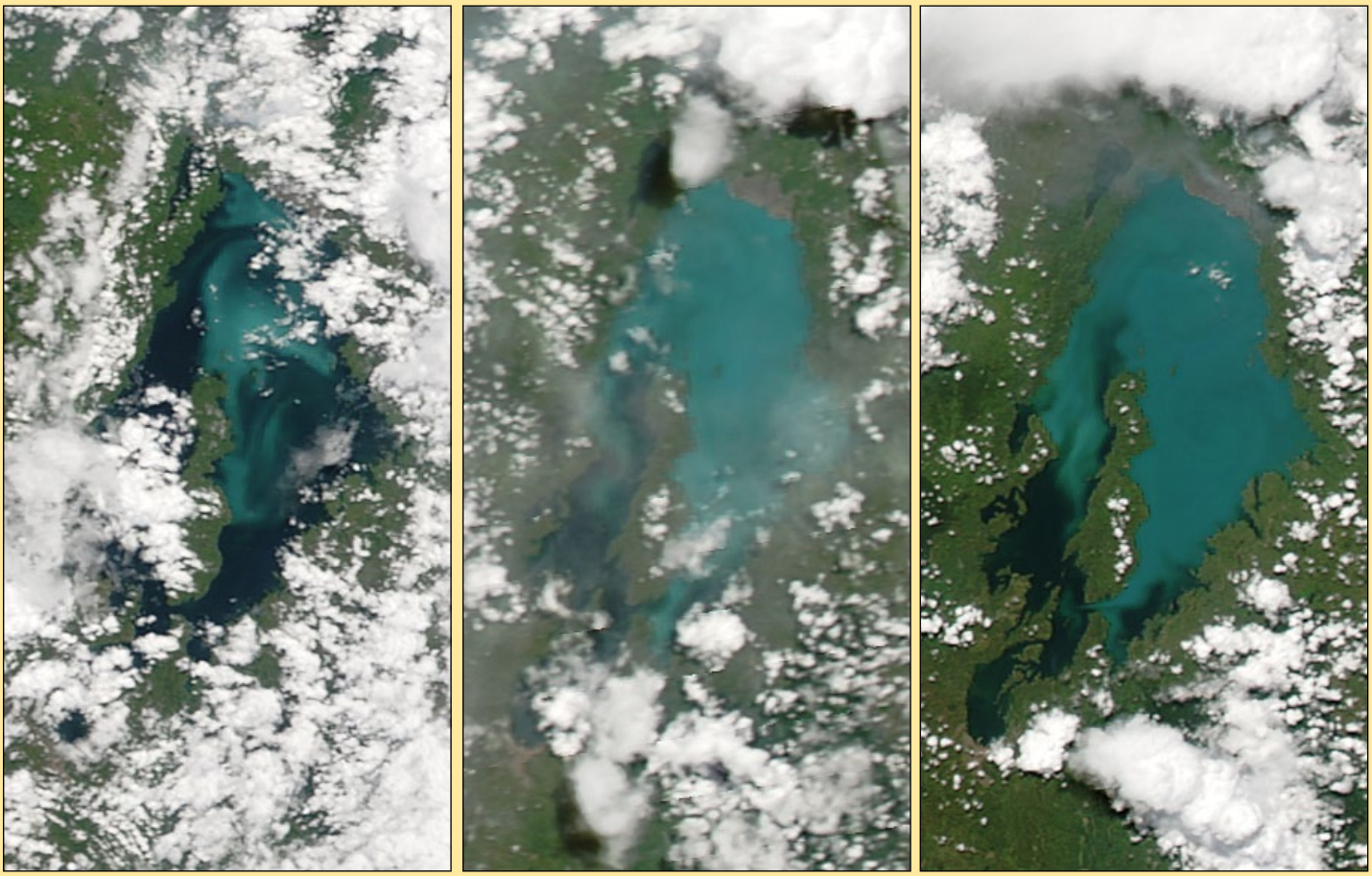
Across the Alps, snow cover was late to arrive during the winter of 2015-16, and early November snowfall—the usual start of the season—was followed by weeks of above-average temperatures. Many locations did not see substantial snow until after New Year' Day. Weather patterns became more seasonable in January and February, and a heavy March snowfall of between 40 and 100 centimetres in some areas gave hope to the skiing tourist industry.

This season, as well as its predecessor, fit with the long-term trend in the European Alps. For much of the 20th century, snow cover increased slightly or held steady, but during the 1980s and 90s, average winter snow cover started to decrease, and winter rainfall increased at lower altitudes, a trend that has continued into the 21st century. Though the average area covered by snow in any given winter has not changed much, the depth and duration of the snow cover has decreased, particularly in the southeastern and southwestern mountains and in areas below 2000 metres altitude.

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

Sudden Colour Change on Lake Kivu

NASA Earth Observatory



April 10, 2016 April 18, 2016 April 20, 2016

In April 2016, the waters of Lake Kivu in central Africa changed colour unexpectedly. The blue freshwater lake turned milky as viewed from boats and from space. Such a sudden change would attract the attention of people anywhere in the world, but it commands particular attention to those who live on the edge of a lake known to harbour potentially deadly stores of gas.

Lake Kivu is one of Africa's *Great Lakes*, and straddles the border between Rwanda and the Democratic Republic of the Congo. The lake is a source of drinking water and fish, as well as a transportation route, for nearly two million people.

Lake Kivu is connected to the volcanic plumbing of the East African Rift, and there are vast stores of dissolved methane and carbon dioxide in its depths: a concern, because other lakes in Africa have been known to abruptly discharge gases and suffocate people nearby. For this reason, scientists have been monitoring water and volcanic conditions through the *Lake Kivu Monitoring Program* (LKMP), and engineers have been developing a platform for extracting those gases to produce energy and to reduce the hazard.

Augusta Umutoni, head of the LKMP, noted that her research team had detected seismic and volcanic activity in April, which initially heightened concern about the lake. But it turned out that April's colour change was actually much less ominous. Lake Kivu is going through a *whiting event* similar to those that occasionally happen on the Great Lakes of North America. Whiting occurs when air and water temperatures rise—as does the pH level near the surface—in a lake that is rich in calcium carbonate. As the temperature and pH rise, the carbonates start to precipitate out of the water as calcite particles that have a white or gray colour (phytoplankton blooms can also lead to whiting-like effects).

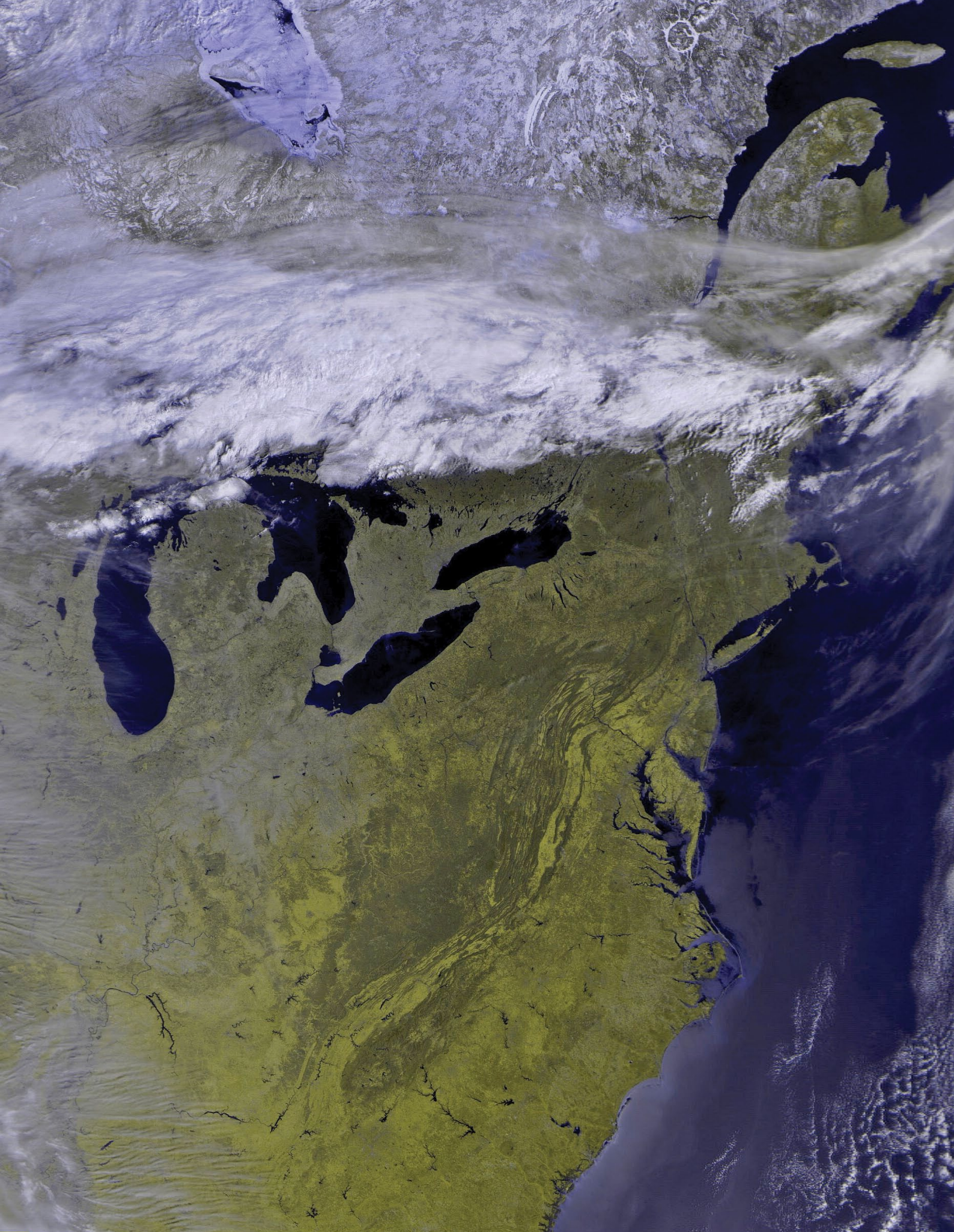
"We don't yet know for sure what caused this particular whiting event at Lake Kivu," said Martin Schmid of the Swiss Federal Institute of Aquatic Science and Technology. "It is certainly unusually strong, but there have been similar weaker events before. It can be caused by a phytoplankton bloom, by high surface water temperatures, or by a combination of both."

Mixing of surface waters with lower layers can bring up more calcium and nutrients from the depths and promote blooms or whiting events. Although such mixing occurs annually, the intensity of response of carbonate precipitation varies. East African lakes are known to respond to El Niño events, and the current episode may also have had an affect on the physical processes in the lake.

The *Moderate Resolution Imaging Spectroradiometer* (MODIS) instruments on NASA's *Terra* and *Aqua* satellites peeked through the clouds to acquire three natural-colour images of Lake Kivu's whiting event, as illustrated above.

NASA images by Jeff Schmaltz, LANCE/EOSDIS Rapid Response.

Caption by Michael Carlowicz, with image interpretation help from Cynthia Ebinger (University of Rochester), Jarmo Gummerus (ContourGlobal/KivuWatt Ltd.), and Augusta Umutoni (Lake Kivu Monitoring Program).



This fine image from Meteor M2 was posted on the *GEO-Subscribers YAHOO Group* on April 19, 2016 by Jim Scheffler. Meteor's 1 km/pixel resolution easily picks out the Manicouagan Crater and the St Lawrence Estuary in Canada, as well as all the Great Lakes save Superior and the contorted ranges of the Apalachian mountains in the USA.

An Introduction to Geospatial Information Technologies

Robert C. Mazur (va3rom@gmail.com)

Most of the information for this article was obtained from the excellent '*Eyes in the Sky 2*' web-based *Geospatial Information Technologies* (GIT) course, but other sites also provided invaluable background information. The terms 'data' and 'telemetry' are often used interchangeably to mean the same, but technically, telemetry is data metered (measured) from a distance (remotely), and transmitted via landline or wireless (tele) to another location. References to *Google Earth* (GE) mean the 'Pro' version which *Google Inc*. has now released for free use with enhanced features not available in the 'standard' version.

Figure 1 - Google Earth GIS
This illustrates just a few components and capabilities of GIT, combining layers of GPS tracks, waypoints, plus photographs all layered on a GE virtual Earth, and all with realistic viewing angles and vanishing points.

Let's 'GIT' Going

Geospatial Information Technologies is defined as the study of the Earth ('geo') as seen from above, so you'd think that this means only geography, geology, or geophysics. But it's also used in many other sciences such as oceanography, climatology, meteorology, biology, palaeontology, archeology, forestry and husbandry. GIT combines metering devices (hardware) with computer programs (software) to collect, process, analyze, and compare various sets of data (figure 1). These 'datasets', in analog and/or digital form, can come from collections of past or present seemingly unrelated sources, such as maps, charts, satellite images, land surveys, weather records, ground/aerial photographs, and so on. While scientists and other professionals may be the primary users of GIT, most of us use parts of it every day, whether we know it or not.

GIT has three components:

1 Global Positioning System (GPS).
2 Geographic Information Systems (GIS).
3 Image analysis programs.

Global Positioning System

Thirty-two low-earth orbiting (LEO) satellites form the *Global Navigation Satellite System* (GNSS) 'constellation' which continuously transmits geo-reference radio plus very accurate date and time signals on the L-Band frequency 'L1' at 1575.42 megahertz (MHz) for civilian use, and on 'L2' at 1227.60 MHz for military use (encrypted). The GNSS is a free to use, world-wide navigation system controlled and maintained by the United States *Department of National Defense* (DND). The uncorrected positional 'fix' error is normally no more than ±10 metres, but weather, terrain, vegetation, structures, radio frequency interference (RFI), etc., can and do affect received GPS signal quality, and therefore accuracy.

Today's smartphones use the GNSS with their built-in GPS receivers to 'follow' us around, automatically recording position, speed, altitude, direction, et al. Even if you turn off its internal GPS (or it malfunctions), as long as your smartphone is powered on it's still a radio 'transponder', surreptitiously working in the background, sending and receiving telemetry to/from any cell

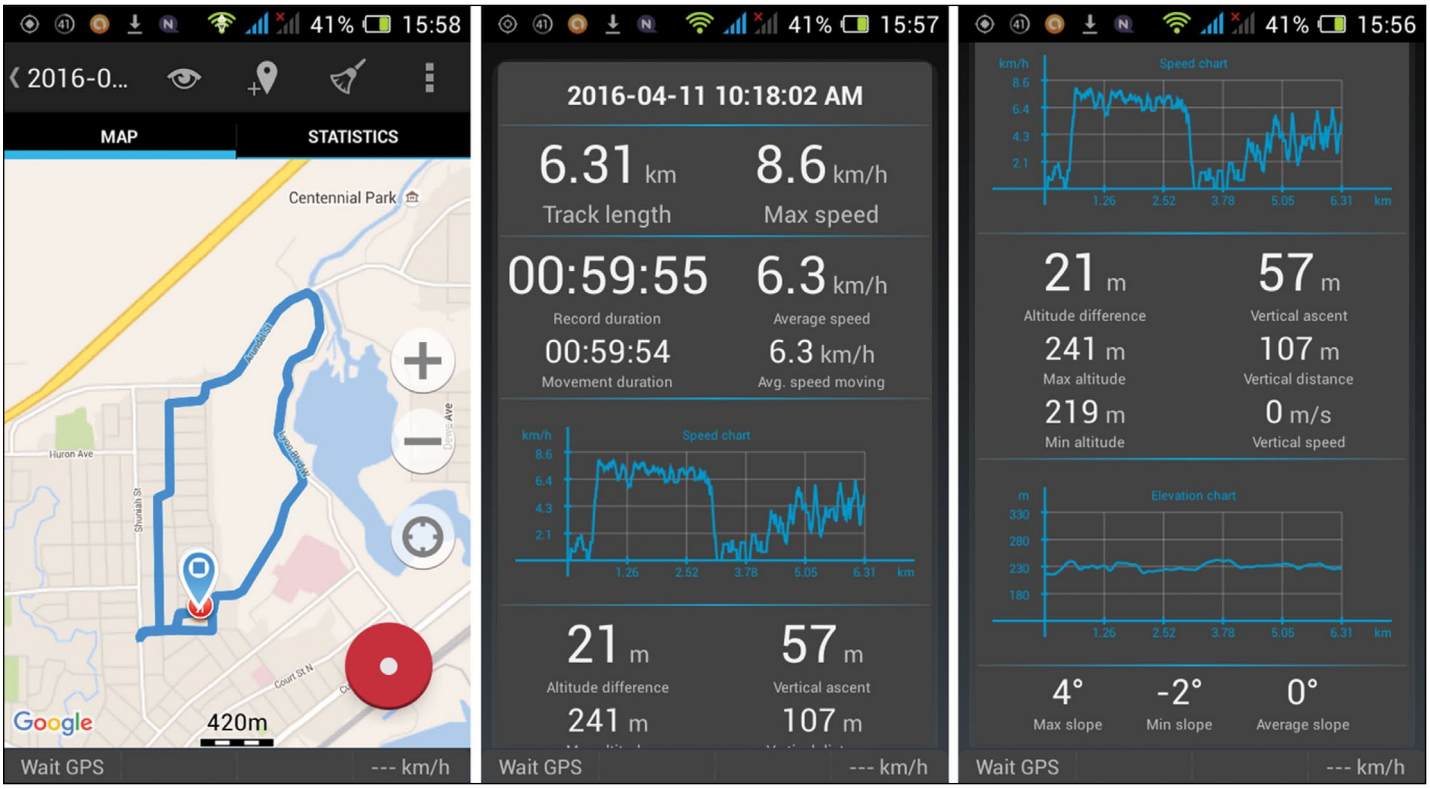


Figure 2 - Smartphone GIT
Smartphone GPS tracking programs provide basic GIT functions using cellular systems, internal GPS, and internet mapping technology.

tower(s) within radio range ('pinging'). Because each tower 'knows' exactly where it is, it can 'tell' your smartphone what 'ballpark' it's in, so it can still track (or be tracked), albeit with less accuracy.

But if your smartphone can ping two or more towers, it can use 'old school' radio direction finding (RDF) to calculate a much more accurate position. We can also reverse this process, and anyone who has ever misplaced their smartphone (or had it stolen) has probably used a *Find My Phone* application, augmented with *Google Inc*. internet mapping technology, to search for, and hopefully locate it.

Smartphones have become the perfect portable *grab 'n go* data/telemetry collection tool of choice for many people (figure 2), and this 21st century digital 'Swiss army knife' device can do the jobs of all the other 'stuff' that we lugged around in the past for emailing, talking, texting, tracking, mapping, snapping, videoing, recording, logging, etc.

What's in a NMEA?

The *National Marine Electronics Association* (NMEA) is the regulatory body for all maritime electronic devices (including GPS) in how they communicate with each other, and these devices are called NMEA 'talkers' and/or NMEA 'listeners'. The United States navy pioneered the GPS concept, and developed its use in the 1960s (Vietnam War) with a simple, five satellite constellation which provided positions to U.S. warships (but only once per hour).

GPS communications uses NMEA 'sentences' containing various GNSS telemetry, and all sentences begin with the dollar symbol ($) plus 'GP', a left-over relic from the old IBM punch computer card days when '$' preceded various system commands (*$JOB*, *$DATA*, *$END*, etc.).

Today, there are many possible sentence structures, transmitted as a serial stream, that you can view directly, and/or save to a file for analysis and/or data sharing, but the 'GGA' construct is the sentence commonly used to extract GNSS positional (and other) information by your GPS receiver and/or software.

Note: I've added extra spaces between items 12 and 14 for editing purposes only, and the actual sentences are continuous comma separated value (CSV) alphanumeric strings:

```
      1         2       3 4         5 6 7  8   9    10 11   12 13 14   15
      |         |       | |         | | |  |   |    |  |    |  |  |    |
$GPGGA,195639.000,4827.1470,N,08912.5859,W,1,05,1.6,224.4,M,-35.0,M,  , 0000*6E
```

1 Time UTC (hours, minutes, seconds, and decimal seconds)
2 Latitude (degrees, minutes, decimal minutes)
3 N or S (North or South)
4 Longitude (degrees, minutes, decimal minutes)
5 E or W (East or West)
6 GPS Quality Indicator:
  0 - fix not available,
  1 - GPS fix,
  2 - Differential GPS fix
7 Number of satellites in view (00-12)
8 Horizontal dilution of precision (DOP) ranging from 0 to 20 (< 2 is excellent)
9 Antenna altitude above/below mean sea level (geoid)
10 Units of antenna altitude (M = metres)
11 Geoidal separation, the difference between the WGS-84 Earth ellipsoid and mean sea level (geoid), "-" indicates mean sea level below ellipsoid
12 Units of geoidal separation (M = metres)
13 Age of differential GPS data, time in seconds since last SC104 type 1 or 9 update or null field when DGPS is not used
14 Differential reference station ID (0000-1023)
15 Checksum (telemetry error checking)

Unfortunately, every other GPS manufacturer also developed their own proprietary file formats (*Garmin*, *Magellan*, et al) for use only with their own hardware and software, making data file exchanges between different (and very pricey, back then) GPS receivers difficult for the average user.

By the mid-1990s, with the rapid growth and widespread use of the internet, a universal method of GPS data exchange was required with NMEA, the many proprietary formats, and internet websites designed with HTML. This came in the form of the *eXtensible Markup Language* (XML), which is used to store

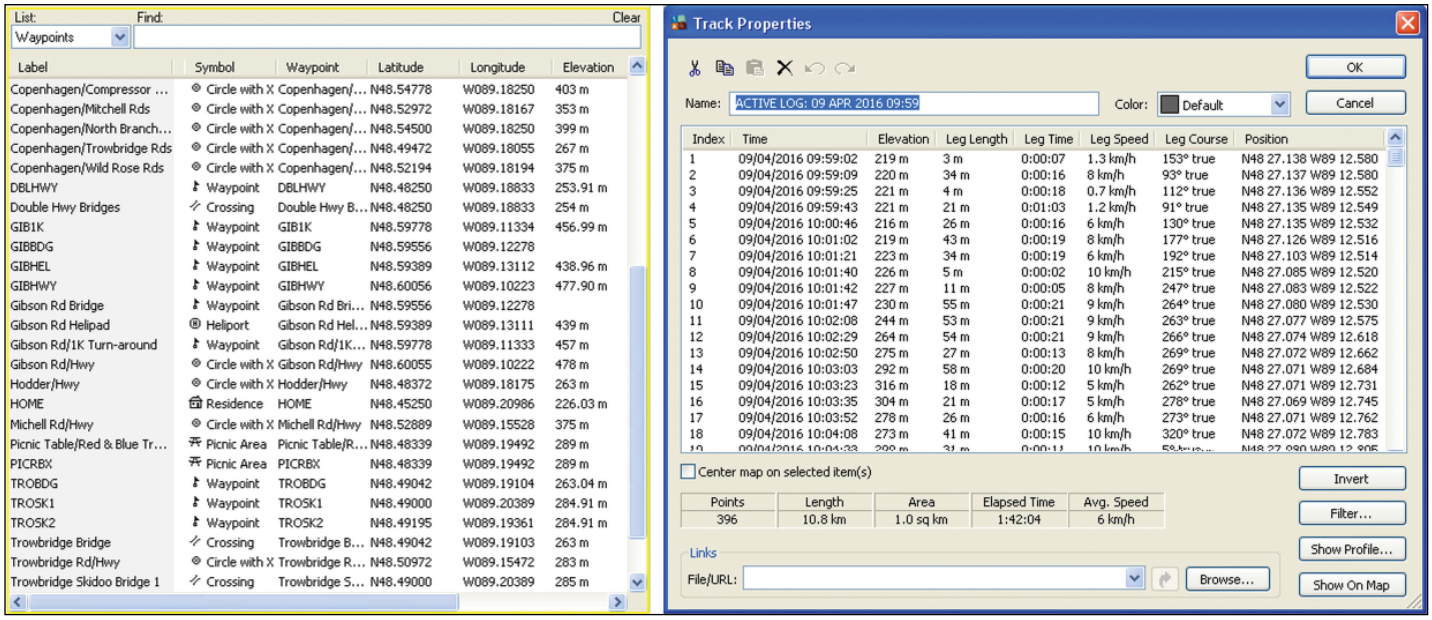


Figure 3a - GPX Waypoints and Tracks Display

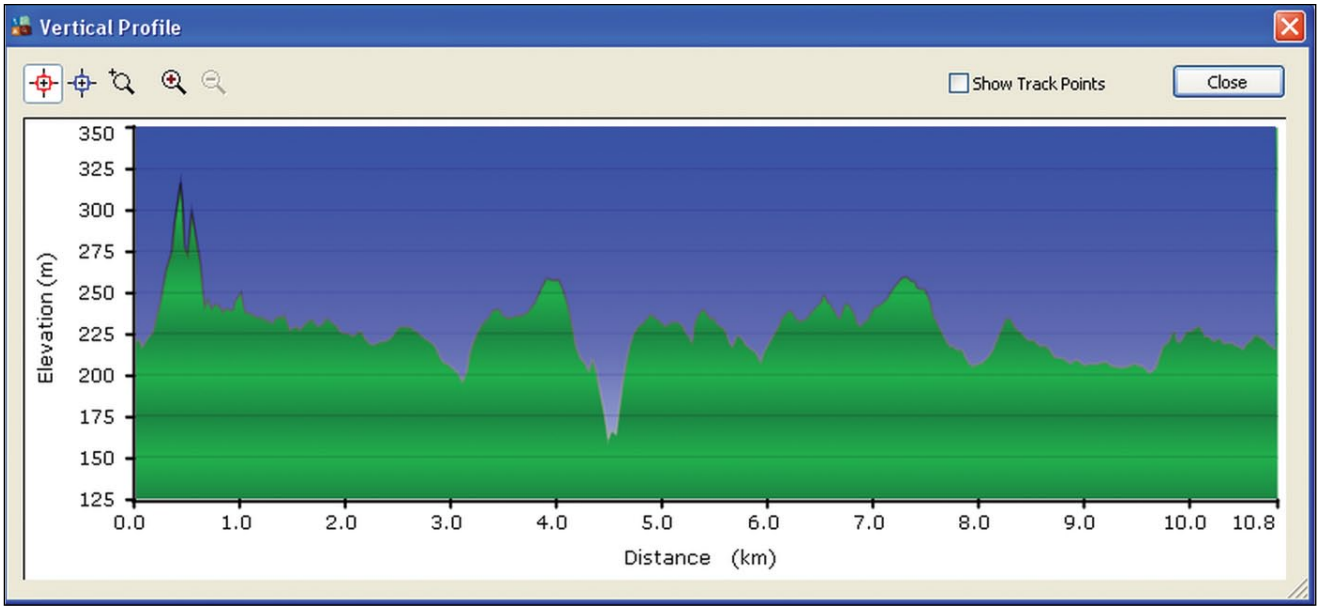


Figure 3b - GPX Tracks Terrain Vertical Profile Display

and transport data across the internet and different computer operating systems and hardware, giving birth to the *GPS eXchange Format* (GPX). However, in order to be truly universal, GPX only contains the metadata (data that provides data about other data) required for basic mapping and plotting purposes.

Figures 3a and 3b display various GPX data in more user-friendly visual/text formats (POIs/waypoints, tracks, and elevation profile).

A. GPX POI or waypoint format:

```
<wpt lat="48.492774926126003" lon="-89.224721984937787">
      <ele>274</ele>
      <time>2008-09-03T02:52:43Z</time>
      <name>Cascades Parking Lot</name>
      <cmt>48 29'33"N 89 13'29"W</cmt>
      <desc>48 29'33"N 89 13'29"W</desc>
      <sym>Parking Area</sym>
      <extensions>
      <gpxx:WaypointExtension
      xmlns:gpxx="http://www.garmin.com/xmlschemas/GpxExtensions/v3">
      <gpxx:DisplayMode>SymbolAndName</gpxx:DisplayMode>
      </gpxx:WaypointExtension>
      </extensions>
</wpt>
```

B. GPX track segment format:

```
<trkpt lat="48.452507006004453" lon="-89.209797000512481">
      <ele>223.63999999999999</ele>
      <time>2016-04-07T19:34:23Z</time>
</trkpt>
```

GPS Reflections

Atmospheric water vapour is a 'good' and very important greenhouse gas (water in invisible gaseous form) continuously created and removed by the *Water Cycle* processes of evaporation and condensation (figure 4a). It's the 'stuff' of all life and weather on this planet, but it's also the least studied and understood greenhouse gas. In the 1990s, *Atmospheric Rivers* (AR) of water vapour (named so by Zhu and Newell) were discovered 'flowing' in different 'channels' around the world (figure 4b); these are extremely long but narrow corridors which carry huge amounts of water, easily exceeding that of a dozen 'mighty' Mississippi Rivers. Conventional radiosonde balloons (very high-flying weather balloons with telemetry transmitting/recording equipment, plus a parachute) are sent up twice a day by world-wide stations to gather various atmospheric characteristics, including vapour content.

Water vapour also dramatically affects microwave radio signals as they travel down through the atmosphere, and a network of GPS ground stations (mostly in the United States) continuously monitors the overhead 'integrated precipitable water vapour' (IPW or PWV) measured in millimeters of water. The IPW is the amount of water that would be collected in an imaginary cylindrical cup, if it were instantly converted back to liquid form.

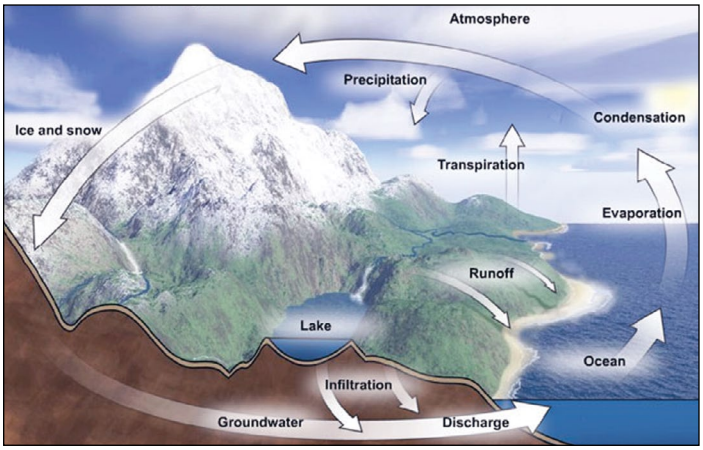


Figure 4a - The Water Cycle
Courtesy NOAA.

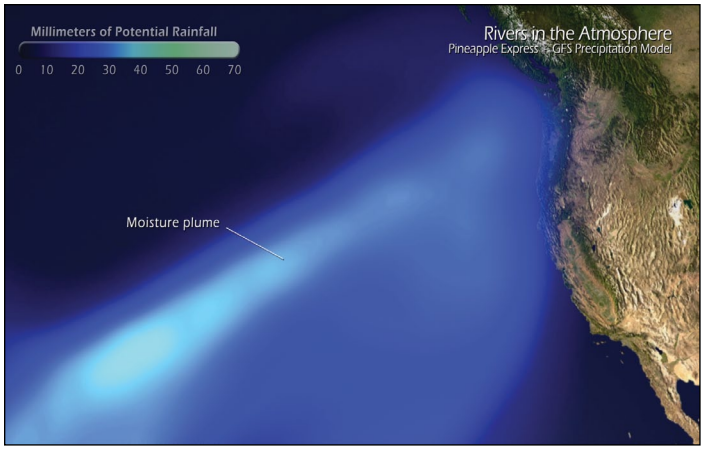


Figure 4b - An Atmospheric River
Courtesy NOAA.

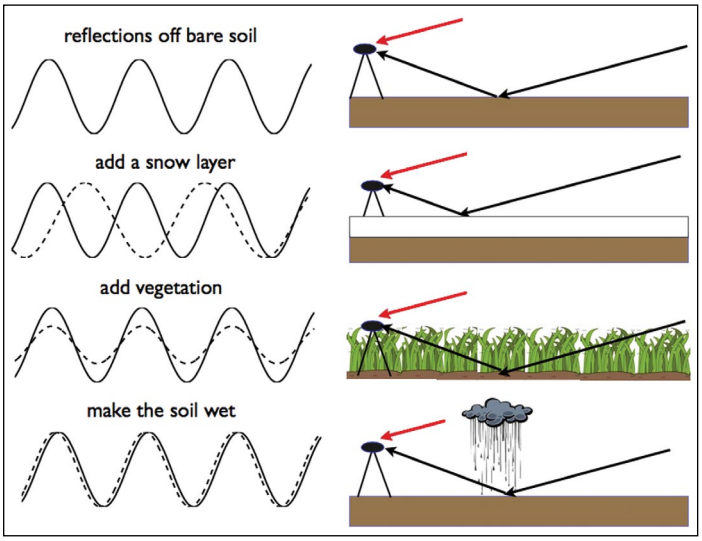


Figure 4c - Reflected GPS Signals
Special receiver sites measure any differences between direct (not reflected) and indirect (reflected) GPS signals. Bare soil reflection establishes a reference signal (sinusoidal wave) having a certain frequency, phase, and amplitude. When signals reflect off snow (dashed line) the frequency changes, and off vegetation (normal moisture content) the signal is attenuated. Increased soil moisture caused by liquid precipitation causes only a very slight signal phase shift. Courtesy GPS Reflection Research Group.

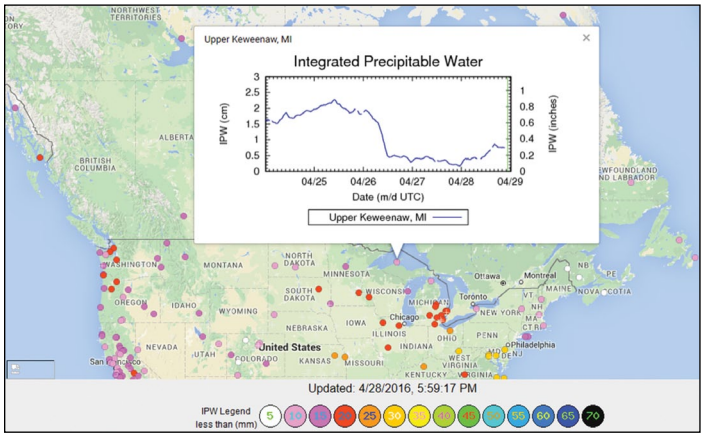


Figure 4d - GPS-IPW Stations
Five days of overhead IPW readings collected by the Keweenaw GPS-IPW station. We are too far apart for our IPW numbers to match, but they are usually inside the same colour ball range scale (bottom).
Courtesy NOAA.

Today, a series of specially equipped geosynchronous Earth orbiting satellites (GOES) stationed over the equator assist in spotting and tracking AR, just like any other weather phenomena.

Strong storm systems bounce microwave signals around as they penetrate them (GPS 'ricochet'), and this effect is used to determine internal wind speeds and directions—especially useful to know for forecasters tracking 'monster' hurricanes. Salt water bodies also easily reflect microwaves back into space, and these can be received by satellites or high flying aircraft, and analyzed to extract oceanographic information.

Reflected GPS signals are used for analyzing the various effects terrain, vegetation, water, snow, or ice has on them (figure 4c). Over the past 20 years, more and more uses have been—and still are being—discovered, including earthquake and volcano monitoring, measuring plate tectonics, creating digital terrain elevation models, and so on.

What's really neat and exciting is that hobbyists/students can use inexpensive SDR dongles and free DSP software to experiment with GPS signals using new RTL-SDR's with a built-in bias-T power supply (among other things) with 'active' [bias-T powered] GPS 'patch' antennas to receive the GNSS L2 frequency.

Here's an interesting [classroom] experiment/project: Compare the strengths of GPS signals received during the day, week, month, and year as the relative humidity (RH) changes at your location. RH is related to the dew point (DP) or "wet bulb" temperature, and amazingly, your overhead column of IPW can be roughly calculated if you know either value (Smith, and Reitan IPW equations refer). A computerized personal weather station (PWS) providing DP and/or RH is preferred over a more distant source of weather information, but you use the tools and resources available.

To check my calculated values, I have to use a GPS-IPW monitoring station over 100 kilometres away so there's about +/- 20 percent deviation between values (see Figure 4d).

Geographical Information Systems (GIS)

GIS build layered 'sandwiches' of separate datasets (often seemingly unrelated) in either 2 or 3 dimensions (2D/3D) on a virtual Earth surface (figures 1 and 5). You can select which layer combinations you want to view, change their transparencies, magnification (zoom) levels, viewing angles, or time of day and/or year. You look at things from ground level, from up high, or 'fly' over/under layers. But the real power of GIS is the ability to measure/extract almost any geophysical property such as distances, angles, areas, temperatures, intensities, densities, sizes, and many others. GIS programs usually have large memory caches to download/store internet or other data beforehand, and then you can disconnect and move to/work in areas where there may be no outside data access. Popular GIS include: *Google Earth* and *ArcGIS* for 'general purpose' use,

Digital Atmosphere for meteorology, and *Depiction* for disaster planning.

The KML Cometh

A GIS company called *Keyhole Inc*. created an XML variant called the *Keyhole Markup Language* (KML) because GPX didn't have the capabilities required to store non-GPS related metadata (images, web links, view angles, etc.), and KML became the 'backbone' of *Keyhole's Earth View GIS*. During Gulf War II (2003), it entered the limelight when the major news networks used *Earth View* to broadcast near real-time, 3D colour, high resolution animations of allied military actions (a common practice pioneered by CNN). Shortly thereafter, *Google Inc*. bought *Keyhole Inc*., and *Earth View* was renamed *Google Earth*.

A. KML placemark format (basic):

```
<Placemark>
      <name>HOME</name>
      <TimeStamp><when>2008-09-03T03:03:59Z</when></TimeStamp>
      <styleUrl>#waypoint</styleUrl>
      <Point>
            <coordinates>-89.209860,48.452498,226.03</coordinates>
      </Point>
</Placemark>
```

B. KML track segment format (basic):

```
<Placemark>
      <name>ACTIVE LOG: 07 APR 2016 13:33-349</name>
      <snippet/>
      <description><![CDATA[
      <table>
            <tr><td>Longitude: -89.211944 </td></tr>
            <tr><td>Latitude: 48.459676 </td></tr>
            <tr><td>Altitude: 787.369 ft </td></tr>
            <tr><td>Speed: 4.1 mph </td></tr>
            <tr><td>Heading: 262.3 </td></tr>
            <tr><td>Time: 2016-04-07T19:20:53Z </td></tr>
      </table>
      ]]></description>
            <LookAt>
                  <longitude>-89.211944</longitude>
                  <latitude>48.459676</latitude>
                  <tilt>66</tilt>
            </LookAt>
      <TimeStamp><when>2016-04-07T19:20:53Z</when></TimeStamp>
      <styleUrl>#track</styleUrl>
            <Point>
                  <coordinates>-89.211944,48.459676,239.99</coordinates>
            </Point>
    </Placemark>
```

Fortunately, you don't need to know how to 'read' or 'write' GPX or KML because the GPS and/or GIS does this for you, but you can do so if you really want/need to modify old or create new files. GPX and KML (basic) are close enough in format and metadata for easy translation back and forth. GPX to KML conversion is 100 percent, but KML to GPX will depend on what is embedded besides basic GPS information, because anything else will be 'lost in translation'.

KML quickly became a GIS lingua franca because it allows you to create a KML file with say GE, then send it to someone who may use another GIS like the Environmental Systems Research Institute (ESRI) ArcGIS or vice versa (figure 5).

Note: A KMZ file is a compressed ('zipped') KML file or a group of KML files.

The *Geographic Markup Language* (GML) is another XML variant, developed by the *Open Geospatial Consortium* (OGC) for use by geographers, cartographers, et al as a modelling language for creating and exchanging geographic data of all types which are beyond the capabilities of KML.

Image Analysis Programs

For the purpose of this article, 'programs' means the awesome and free *Java*-based program called *ImageJ* (figure 6). The '*Eyes in the Sky*' course covers it in great detail (along with ArcGIS), but I can only touch on a couple of its uses because I'm still learning what it can do.

You are probably familiar with *Photoshop* or *GIMP*, two very popular digital darkroom and image processing programs, and while *ImageJ* has many of the same features, its real power comes from the ability to mathematically manipulate image data to present it in different ways (visually and/or numerically), and this can be put to good very use for analyzing satellite and other images using something called a 'lookup table' (LUT).

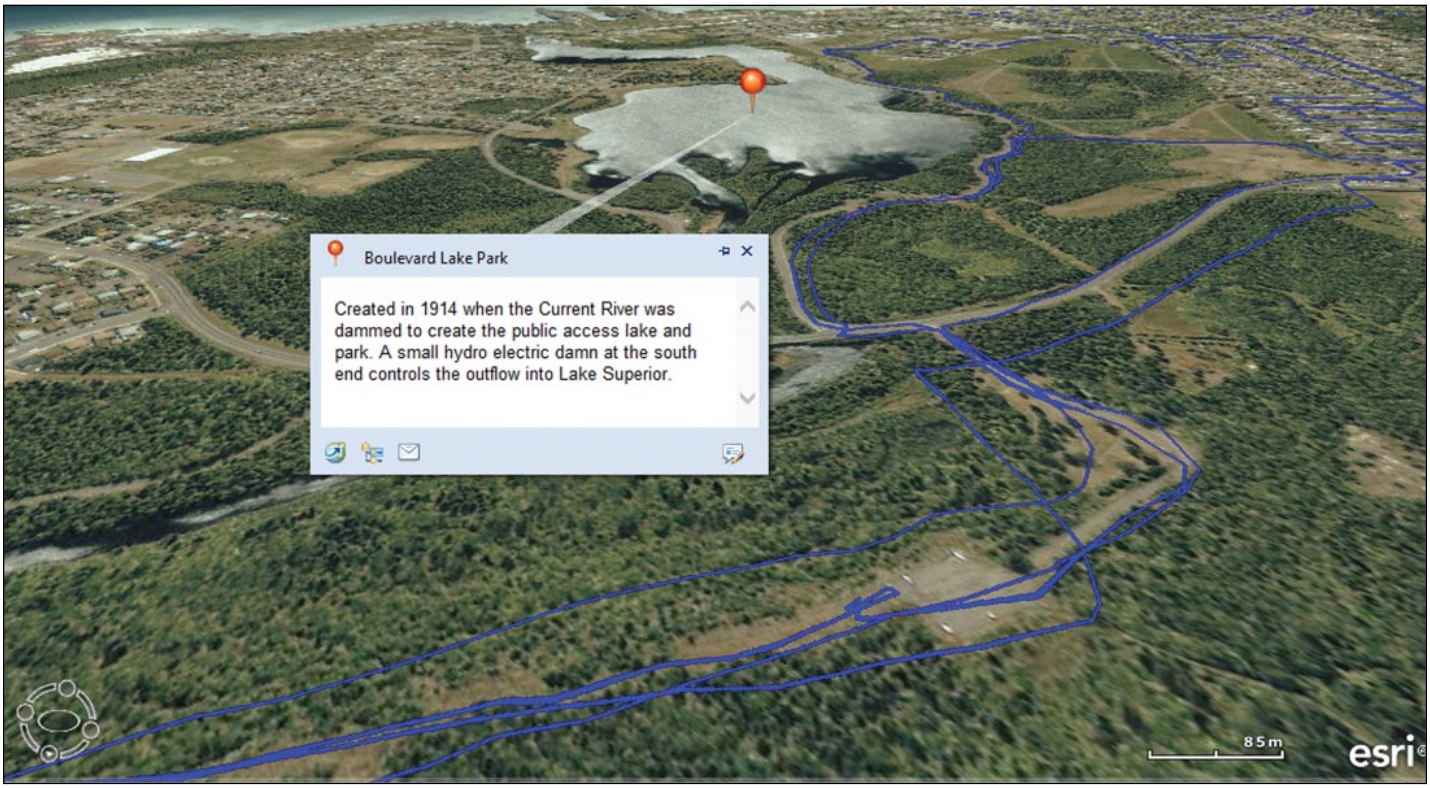


Figure 5 - ArcGIS GIS View

ArcGIS handles waypoints and place markers a bit differently than Google Earth does, plus it has many more features and functions, including support for GML. This rotated view of Figure 1, looks down from north of "The Bluffs" trail ridge, towards the Lake Superior basin, and all that you see would have been underwater 10000 years ago (Lake Minong).

Courtesy NOAA

As GEO readers know, weather satellites don't actually measure temperatures: they measure various wavelengths or energy levels of the Electromagnetic (EM) spectrum ranging from infrared and visible light, to ultraviolet. For example, APT pristine satellite images are composed of varying levels (up to 256) of grays (the 'grayscale'), represented in digital (binary) form by 0s and 1s, where one byte (8-bits) is *00000000* (0) for black or 'hot' and *11111111* (255) for white or 'cold', with all other levels of grays in between. The grayscale can also be mapped to the red, green, blue (RGB) additive [primary] colour scale between (0, 0, 0) for black or 'hot' and (255, 255, 255) for white or 'cold'.

Satellite infrared (IR) and visible sensors 'see' thermal and visible radiances reflected/emitted from cloud tops, water, land, vegetation, and other living things, but the resulting images are visually dull, of low contrast, and lacking detail, so they are usually mapped against a standard scale [thermal] LUT, ranging from minus 109 °C (grayscale value 255) to plus 56.8 °C (grayscale value 0) in 0.6 °C increments. All other LUTs are derived from this standard (see Figure 7).

Image processing software maps various LUTs (grayscale and colour) onto satellite images to look for/detect: hurricanes, forest fires, snow, ice, thunderstorms, vegetation, precipitation, fog, etc., and *ImageJ* has many predefined LUTs that you can use/modify (or you can create new ones). Some of the things I tried to do with *Photoshop/GIMP* were very time consuming, or too difficult, but they become trivial with *ImageJ* (figure 8).

Another useful feature lets you to look at terrain profiles modelled in either 2D or 3D. For example, looking at the GIS images of my hikes across *The Bluffs* (figures 1 and 5), even with the tracks (in blue) overlaid on to the terrain, it's still not easy to get the actual 'lay of the land' unless you are familiar with the area, because dense forest and vegetation hide the terrain's underlying ruggedness. I created a digital elevation model (DEM) using a *Natural Resources Canada* (NRC) web mapping tool, then processed it with *ImageJ* using the 'Plot Profile' and 'Surface Profile' tools (figures 9a/b). Note: A DEM also uses the 256-level grayscale, but instead of a temperature, each gray level represents a height.

Image Measurements

I suspect that most of us have large collections of great looking terrestrial/aerial photographs, satellite images, plus assorted charts and maps, etc., but unless you can extract useful information from them, then do something with this, of what good are they beyond their artistic or historic values? This is where *ImageJ* really shines, with

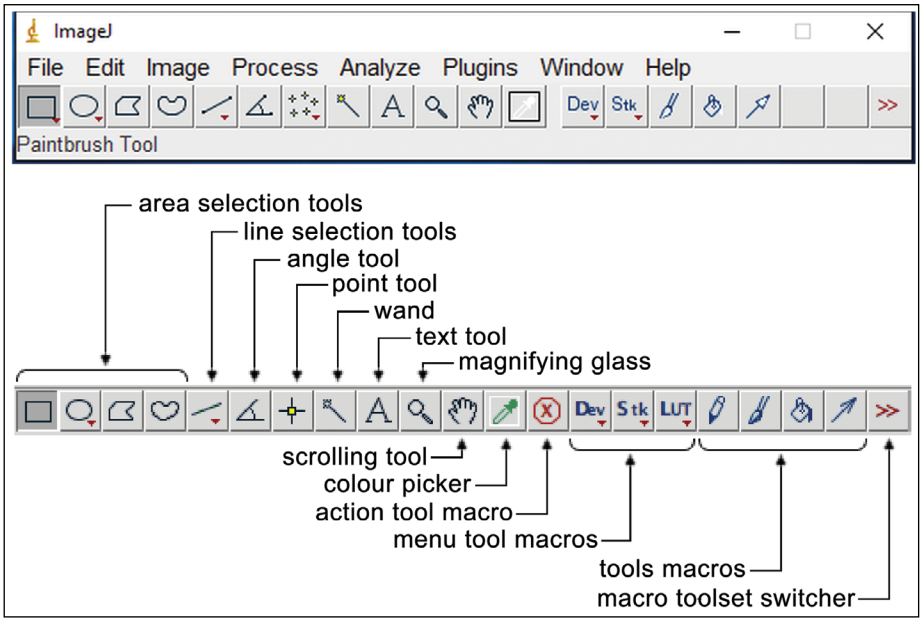
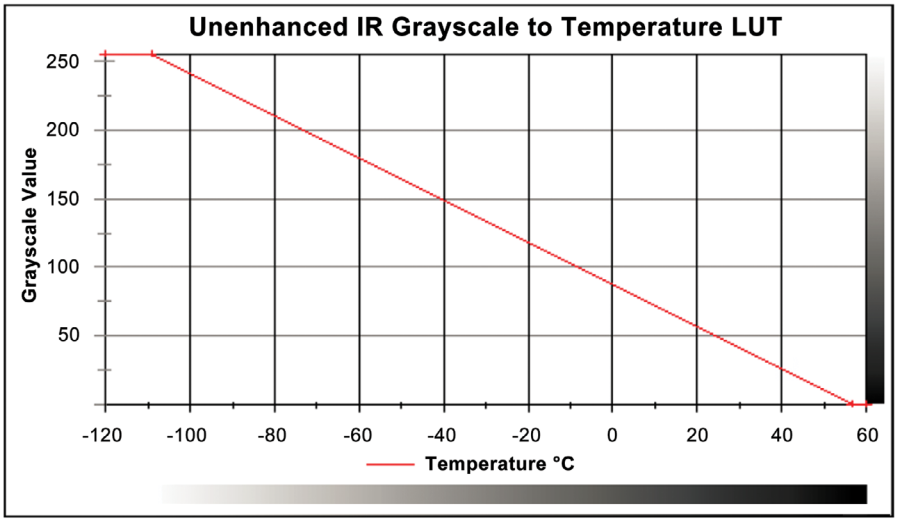
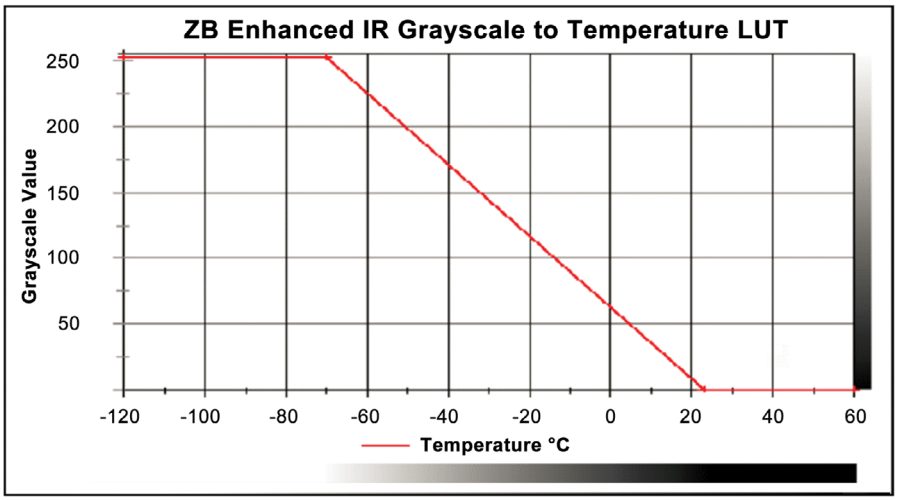


Figure 6 - ImageJ
Courtesy ImageJ User Manual.





A general purpose enhancement useful for northern latitudes and in the winter season.

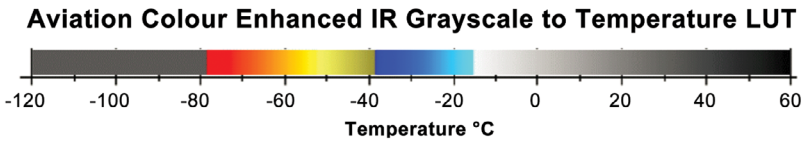


Figure 7 - IR Grayscale and LUTs
Courtesy Catalogue of Enhancements for Weather Satellites.

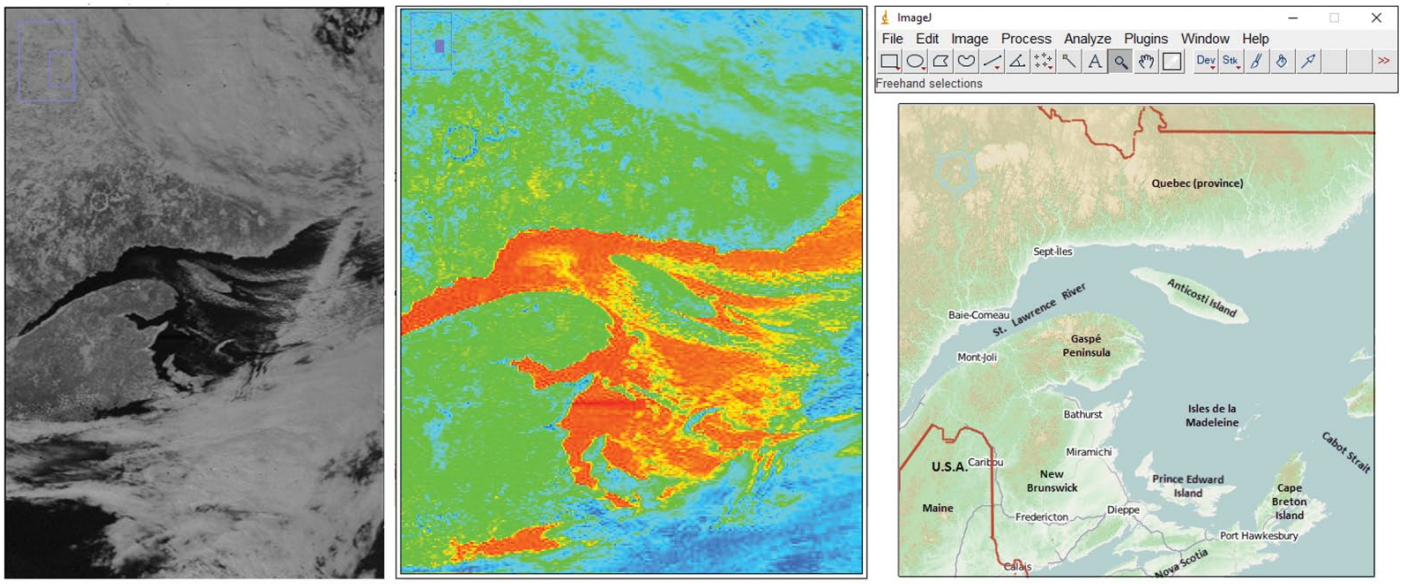


Figure 8 - ImageJ and APT

I noticed something "funny" in the received NOAA-19 pristine image (left). Enlarging the area of interest (Gulf of St. Lawrence), and applying the ImageJ "spectrum" LUT (centre), delineated the low, warmer cloud tops from the high, colder ones revealing von Karman vortices.

Insert map courtesy Natural Resources Canada.

its powerful image calibration capabilities and ability to very accurately measure and extract useful information from pictures/images of blood drops, flora, stamps, coins, bodies of water, vegetation, clouds, terrain, etc.

There are three image calibration methods:

1 Use any embedded reference scale metadata (*ImageJ* automatically detects this).
2 Use the *ImageJ* line tool to measure a visual reference scale bar (common to charts and maps).
3 Use the *ImageJ* line tool to measure some geographic feature with known dimensions.

In the case of Figure 10a (obtained using *Flash Earth*), *ImageJ* didn't detect any embedded reference scale metadata, and there's no visual reference scale bar in the image, so I'm left with option 3. Finding a visible, and preferably large, geophysical feature and zooming in on it allows you to very accurately use the line tool (figure 10b). A handy visual reference scale bar can be added and merged into the image, completing the process (see Figure 10c).

After calibration, *ImageJ* calculated the total area imaged (in Figure 10a) as approximately 291,057 square kilometres, or exactly 818.8172 km by 355.9257 km. There is a sizeable list of measurement types from which you can select, depending on what you want to determine, but for now we only need areas, perimeters, lengths, and angles. It was very easy to measure various atmospheric and terrain features (cloud trail lengths, their deflection angles, length of von Karman vortices, etc.), with all the results recorded by *ImageJ* in a nice tabulated list you can save and import using other programs for any additional processing (i.e. spreadsheet and/or database).

Some Geodata Sources

We can collect various data/telemetry using our own equipment, and finding additional datasets is very easy using the internet. The *National Oceanographic Atmospheric Administration* (NOAA) has huge amounts of free online 'stuff' to keep you busy for years. Many countries have also been busy converting treasure troves of old analog files to digital format, and storing them (along with recent digital data) on free internet archives for all to use (the Canadian **GeoGratis**, for example).

The *Flash Earth* website is a great and simple source of daily satellite imagery. One interesting use is collecting a month (or more) of daily images taken over the same area, and then loading the entire collection into *ImageJ*, creating an animated 'flip-book'. Besides being able to rapidly see daily cloud cover changes, you can also spot any seasonal changes, or perhaps spot some unusual surface feature using this 'blink comparator'.

The End of the Beginning

Well, that's the end of this 'short' introduction to GIT. Hopefully, you've enjoyed reading it, and perhaps I've wheted your appetite so you'll want to delve a little deeper into this fascinating field.

References and Resources

- A Passive Reflectometry and Interferometry System
  M Martín-Neira (1993)
- ArcGIS
  http://tinyurl.com/z9fbqkq
- Atmospheric Rivers and Bombs
  Young Zhu and Reginald E. Newell (1994)
- Atmospheric Rivers
  http://tinyurl.com/zrv3d8p
- Catalogue of Enhancements for Weather Satellites
  Ton Lindemann (2006)
- Depiction
  http://www.depiction.com
- Digital Atmosphere
  http://tinyurl.com/86mrc2t
- Digital Elevation Model
  http://tinyurl.com/pjqvm64
- Eyes in the Sky 2 GIT Course
  http://tinyurl.com/ygc6p5p
- Flash Earth
  http://www.flashearth.com
- GML
  http://tinyurl.com/jk9x3vb
- Google Earth
  http://tinyurl.com/l7wnc3c

continued on page 33

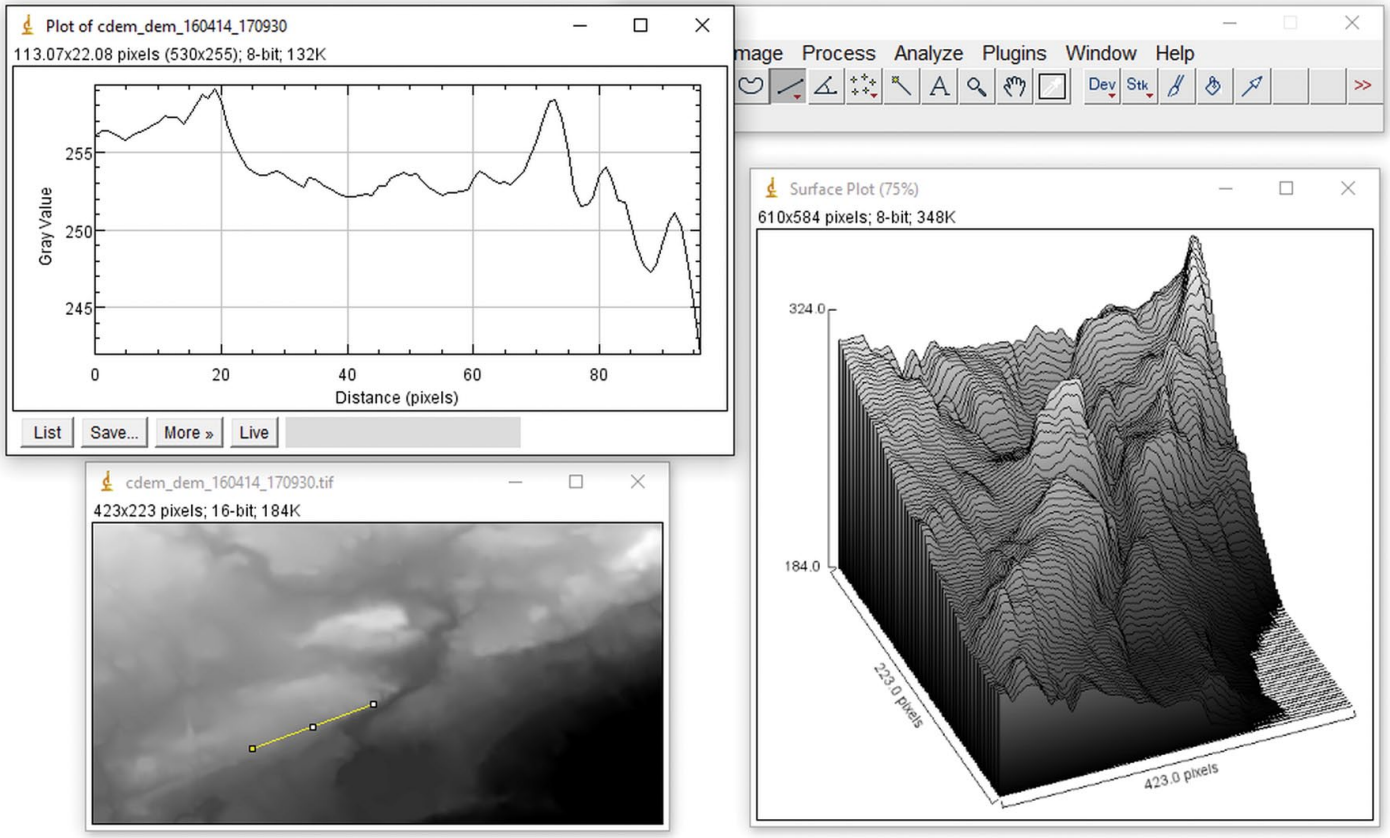


Figure 9a - ImageJ with Terrain Profiles 1
A custom DEM image with a line segment drawn across part of “The Bluffs” cliff trail (left), with resulting 2D profile plot of the line segment (top), along with the grayscale 3D elevation plot of the entire area down to the Lake Superior shoreline (184 m above MSL). The Current River flows through a deep crevasse gouged out during the last Ice Age, cutting the terrain in half (right).

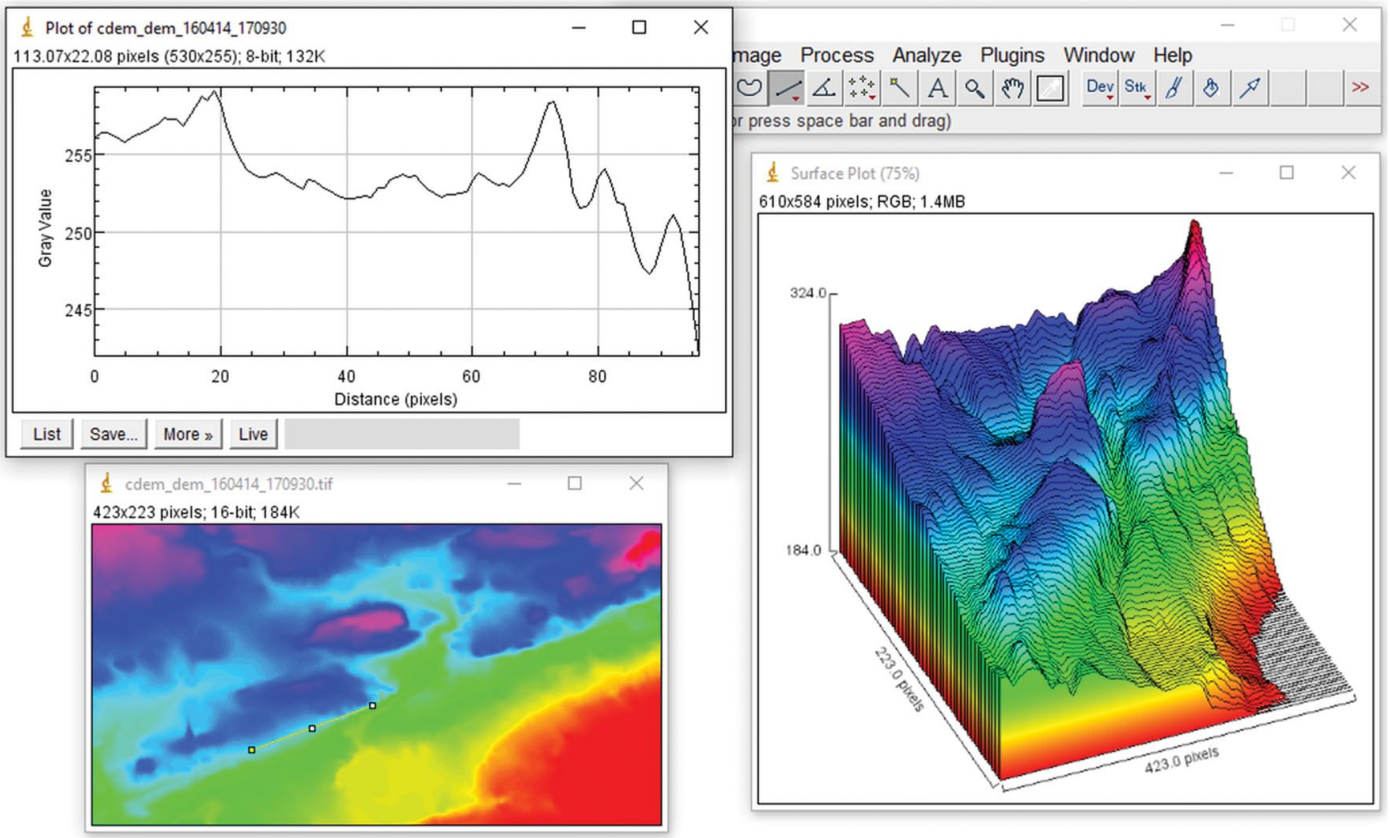


Figure 9b - ImageJ with Terrain Profiles 2
Same view as image 9B, but now the “spectrum” LUT is applied to the DEM image, enhancing the 3D elevation plot.

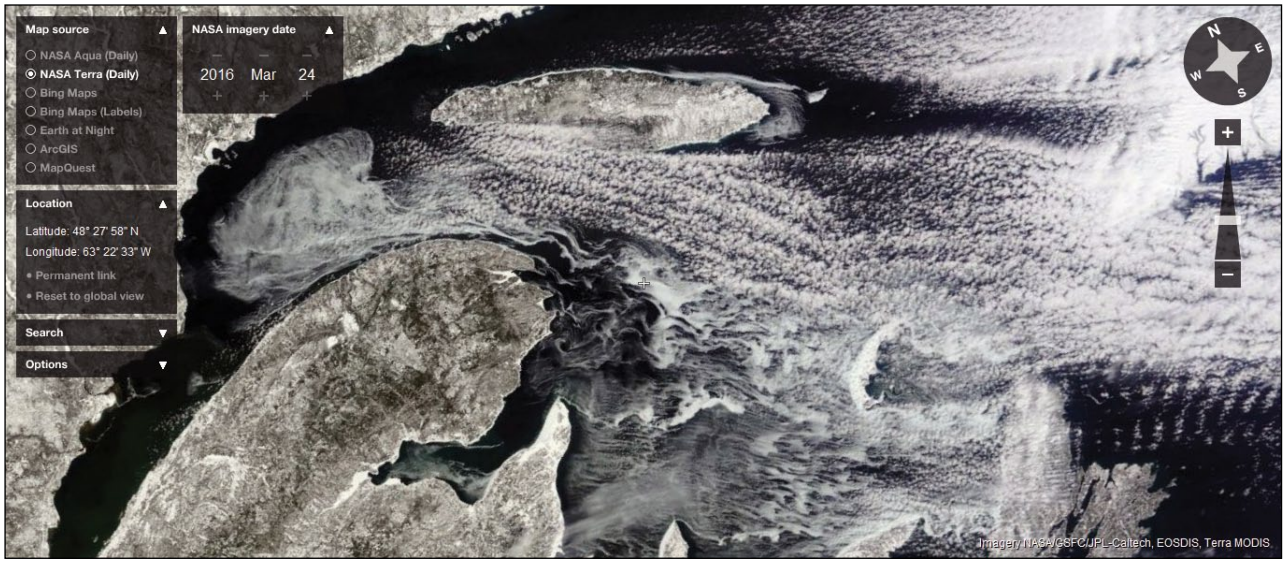


Figure 10a - Von Karman Vortices and Deflected Cloud Streets

After noticing von Karman vortices in the NOAA-19 image, I waited for Meteor M2 to pass over the same area for a high resolution view, but by then, most the vortices had dissipated (of course). Using Flash Earth, I found this earlier in the week image of excellent vortices along with deflected clouds streets.

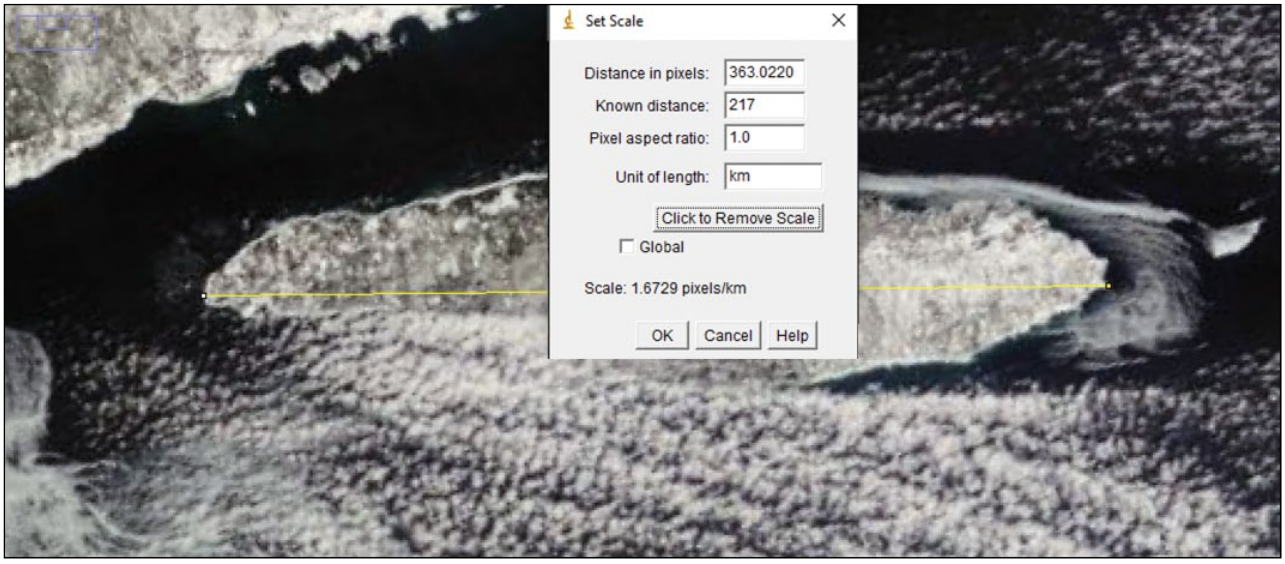


Figure 10b - Image Calibration Step 1

Anticosti Island is exactly 217 km from end to end, so I zoomed in, then used ImageJ's line tool to bisect it, and selected the "Set Scale" function to fill in the distance and unit of measurement (reference values), in this case "217" and "km".

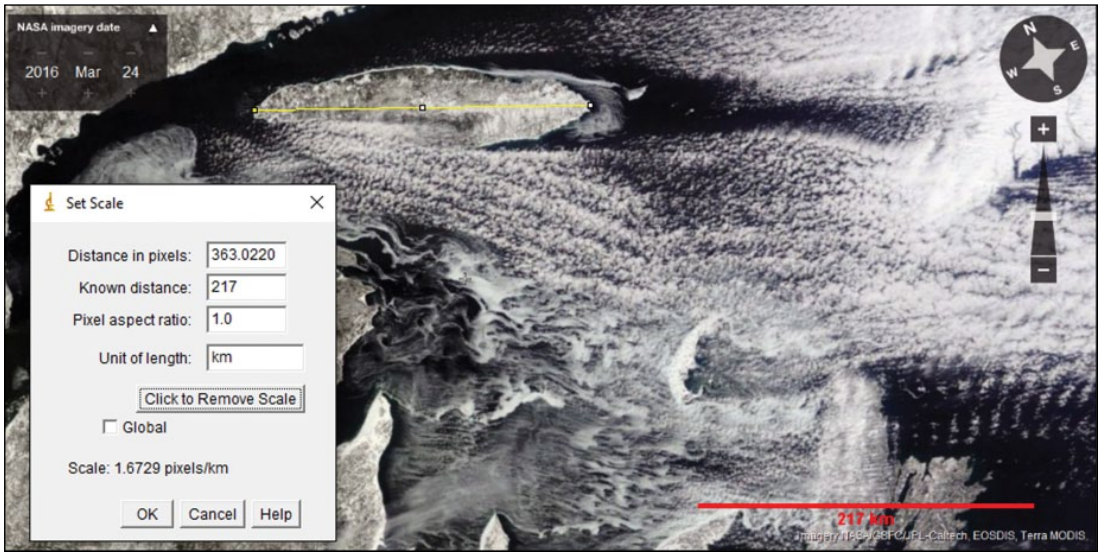


Figure 10c - Image Calibration Step 2

An optional step, but highly recommended especially if you send images to others because having a visual reference scale bar (lower right in red) means that anyone can calibrate ImageJ just by measuring it and entering its reference values.

- GPS (History)
  http://tinyurl.com/7kqedfu
- GPS (GPS Reflection Research Group)
  http://tinyurl.com/zfdcexl
- GPS and Water Vapour
  http://gpsmet.noaa.gov
- GPX
  http://tinyurl.com/onk5j3g
- ImageJ
  https://imagej.nih.gov/ij
- KML
  http://tinyurl.com/6unjcjt
- NMEA
  http://tinyurl.com/hta3mby
- NOAA
  http://www.noaa.gov
- NRC (GeoGratis)
  http://tinyurl.com/jku7g4d
- VA3ROM (My Website)
  http://www.va3rom.com

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Group for Earth Observation

and Receive the latest news from EUMETSAT, ESA, NOAA, NASA and many others through their Twitter feeds

David Taylor provided this revealing image of Greece and Turkey, acquired from Metop-01 on April 4, 2016.

Oresund Bridge

Nasa ASTERWEB

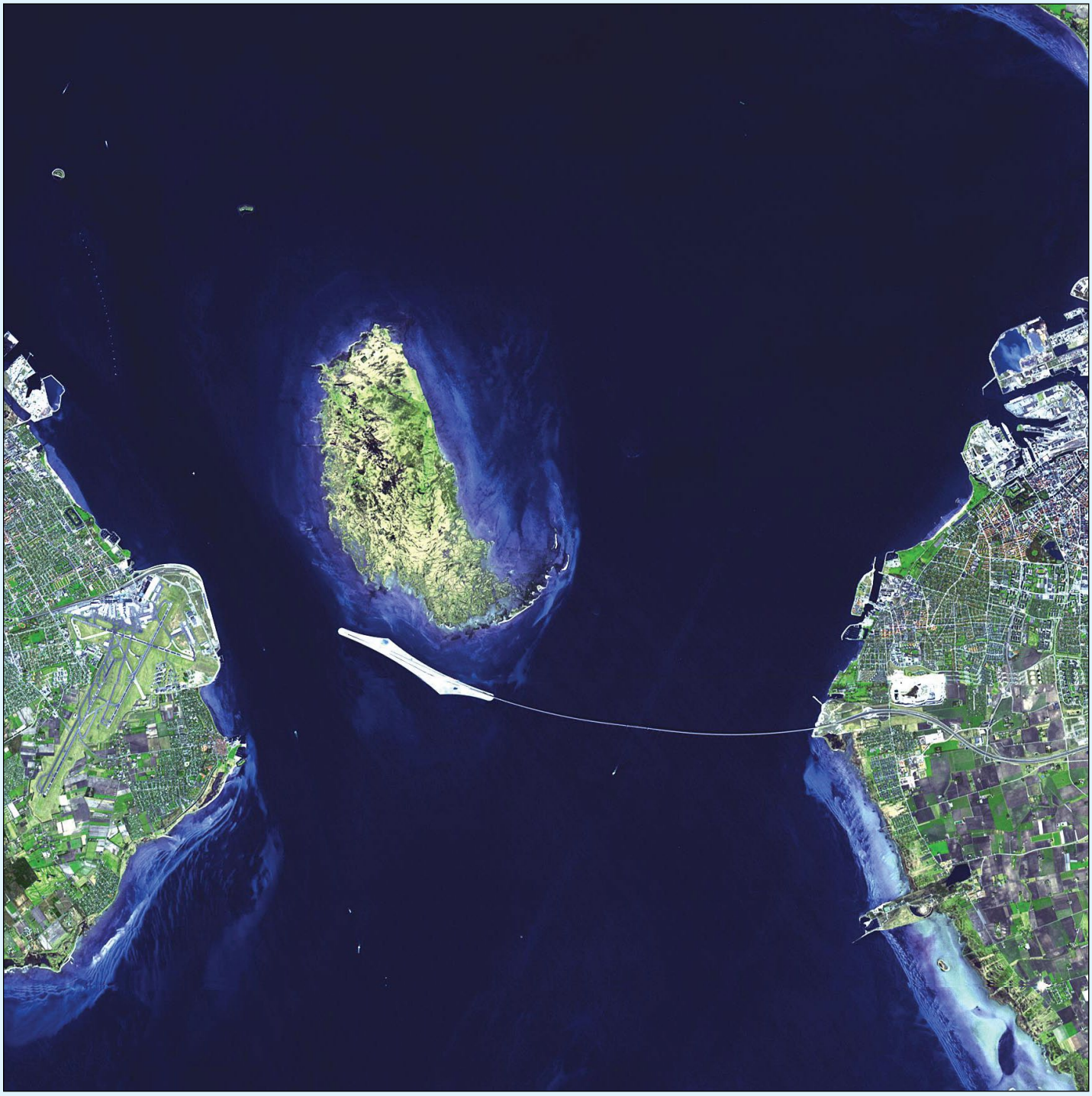


Image: NASA/METI/AIST/Japan Space Systems, and US/Japan ASTER Science Team

In 1991, the governments of Denmark and Sweden agreed to build a bridge to connect the two countries across the Oresund Strait. The 16 kilometre long Oresund link between Malmo, Sweden (right) and Copenhagen, Denmark (left) was completed and opened to traffic in 2000. Denmark and Sweden were linked once more—7,000 years after the Ice Age when they were landlocked. The Oresund Bridge is the world's longest single bridge carrying both road and railway traffic. The high bridge, with its record-breaking cable-stayed span of 490 metres, is designed to harmonise both structurally and aesthetically with the approach bridges. The connection starts on the Denmark side near the airport, as an underwater tunnel that emerges on to a man-made island. From there, the bridge continues to the Sweden side.

This **ASTER** image acquired on April 10, 2004 by NASA's Terra satellite is centred near 55.6°N, 12.7°E, and covers an area of 25 kilometres square.

Sentinel 1B Delivers

European Space Agency

Launched on April 25, 2016 from Europe's Spaceport in French Guiana, **Sentinel-1B** has produced its first images only two hours after the radar was switched on—a record time for a space radar. These first observations were taken a little more than two days following launch, at 05:37 UT on April 28, after Sentinel-1B had followed a complicated routine to deploy its 12-metre long radar and two 10-metre long solar wings, as well as passing a series of initial checks. The first image, 250 km wide, captured Svalbard, the Norwegian archipelago in the Arctic Ocean, with the Austfonna glacier clearly visible.

At ESA's operations centre in Darmstadt, Germany, mission controllers thoroughly checked the satellite's control, navigation and power systems, among others, during the intense first few orbits. The team also conducted the complex unfolding of the radar wings and solar arrays.

> '*It may feel a little like a routine because we launched three Sentinel satellites in less than 12 months, but of course it is not*,' noted Volker Liebig, ESA's Director of Earth Observation Programmes. '*Getting a satellite into orbit is always thrilling and every time we do this I am quite nervous. Our engineers and industry have shown what we can achieve with this fourth Sentinel delivering a first image in record time. We have another important part of the Copernicus missions in orbit. A great achievement from a great team.*'

Sentinel-1A is used by *Copernicus* services as well as by many users worldwide, under a free and open data policy. More than 30 000 users have registered to download Sentinel data, taking some four million products already. *Sentinel-1A* has already helped in coping with many natural disasters worldwide, such as floods and earthquakes.

> '*With another important milestone reached, we now have the fourth satellite in orbit and the Sentinel constellation as we envisaged it becomes a reality. This will enable our Copernicus services to get better and more data faster – and therefore help generate more information to a broader user community on a full, open and free of charge basis. This is exactly what we planned for with Copernicus*,' said Philippe Brunet of the European Commission, after the *Sentinel-1B* launch.

When *Sentinel-1B* reaches its final orbit, on the opposite side of Earth from *Sentinel-1A*, the radar vision constellation will be complete, meeting the coverage and revisit needs of *Copernicus*. In the coming months, the new satellite will be tested and calibrated before it is declared to be operational.

Each of the Sentinel-1 satellites carries an advanced radar that images Earth's surface through cloud and rain, whether it is day or night. It is expected that the constellation will produce more than 10 terabytes of data per day once it is fully operating.

The European Commission leads Europe's Copernicus environmental programme and coordinates the broad range of services to improve the management of the environment, safeguarding lives every day. ESA is responsible for developing the family of Sentinel satellites and ensuring the flow of data for these services.

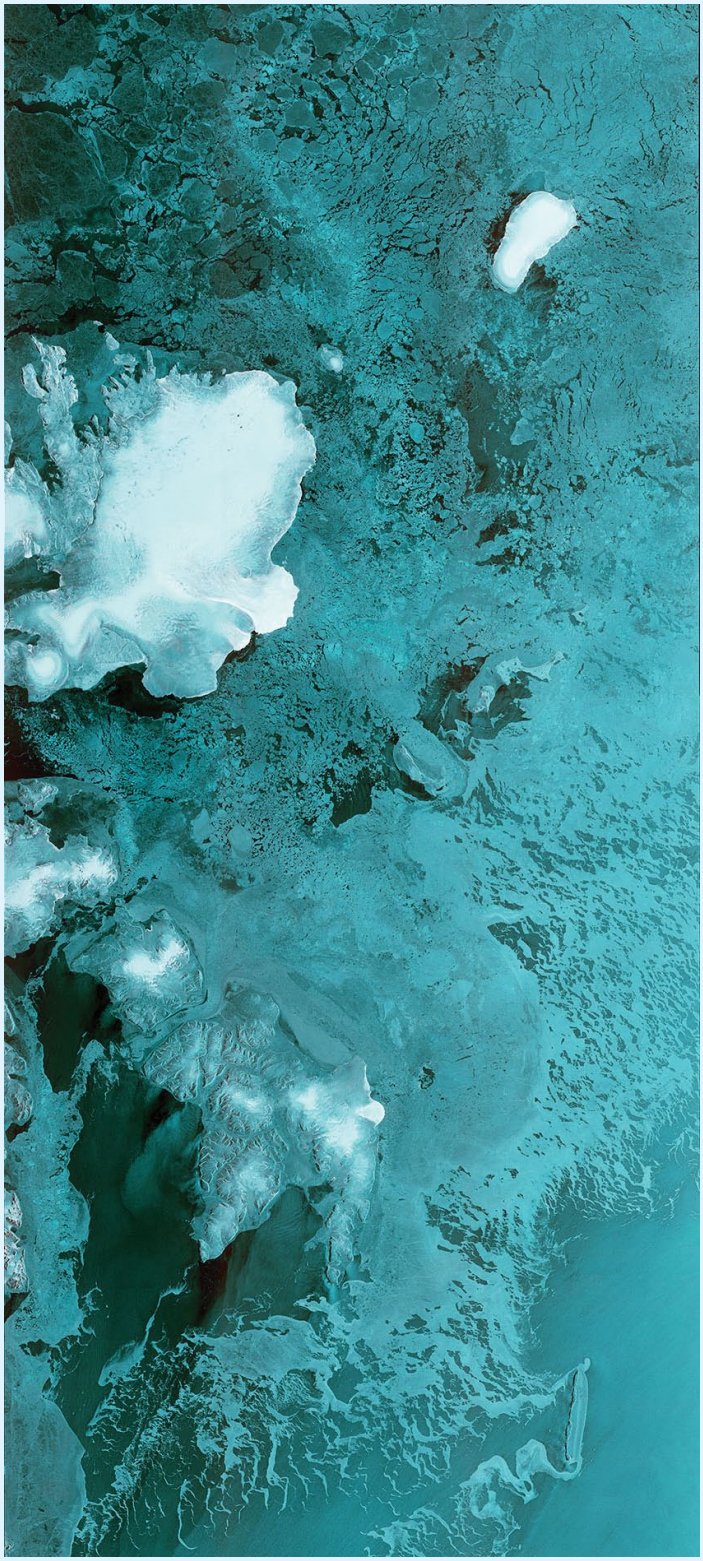


Figure 1 - Sentinel 1B's first image

Contains modified Copernicus Sentinel data [2016], processed by ESA

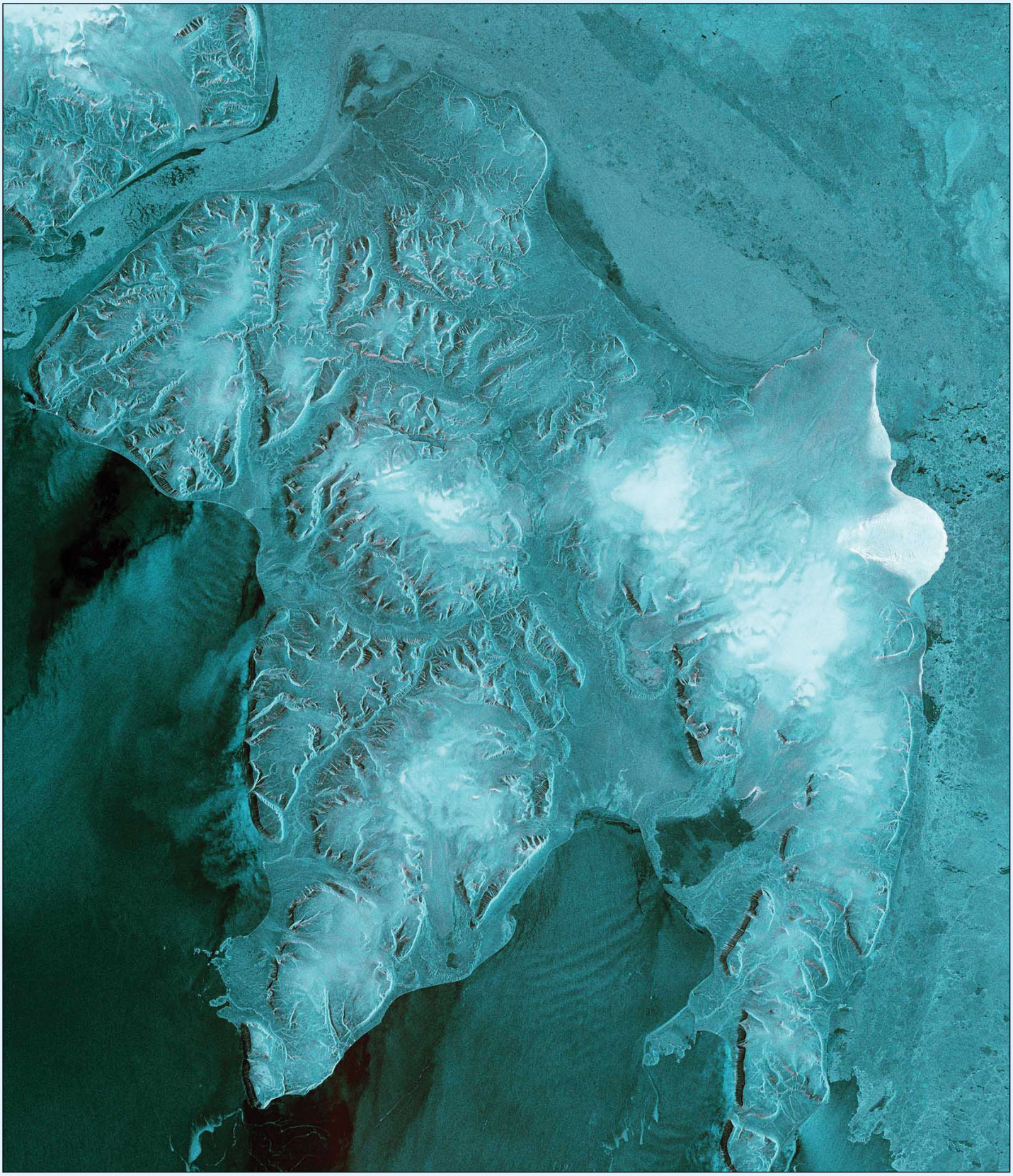


Figure 2 - Edgeøya or Edge Island
Contains modified Copernicus Sentinel data [2016], processed by ESA

Sentinel 1B's First Image

Sentinel-1B's first data strip (figure 1) stretches 600 kilometres, from 80°N through the Barents Sea, and shows Norway's Svalbard archipelago on the left, was captured just two hours after the satellite's radar was switched on. Sentinel-1B lifted off from Europe's Spaceport in French Guiana at 21:02 UT on April 25 aboard a Soyuz rocket. It joins its twin, *Sentinel-1A*, to provide more 'radar vision' for Europe's environmental *Copernicus* programme.

Edgeøya or Edge Island

This full resolution subset of Sentinel-1B's first data take shows Edgeøya, one of the islands making up the Svalbard archipelago (figure 2).

Austfonna Ice Cap

This full resolution subset of the first Sentinel-1B image shows Norway's Nordaustlandet island in the Svalbard archipelago, covered by the Austfonna ice cap (figure 3).

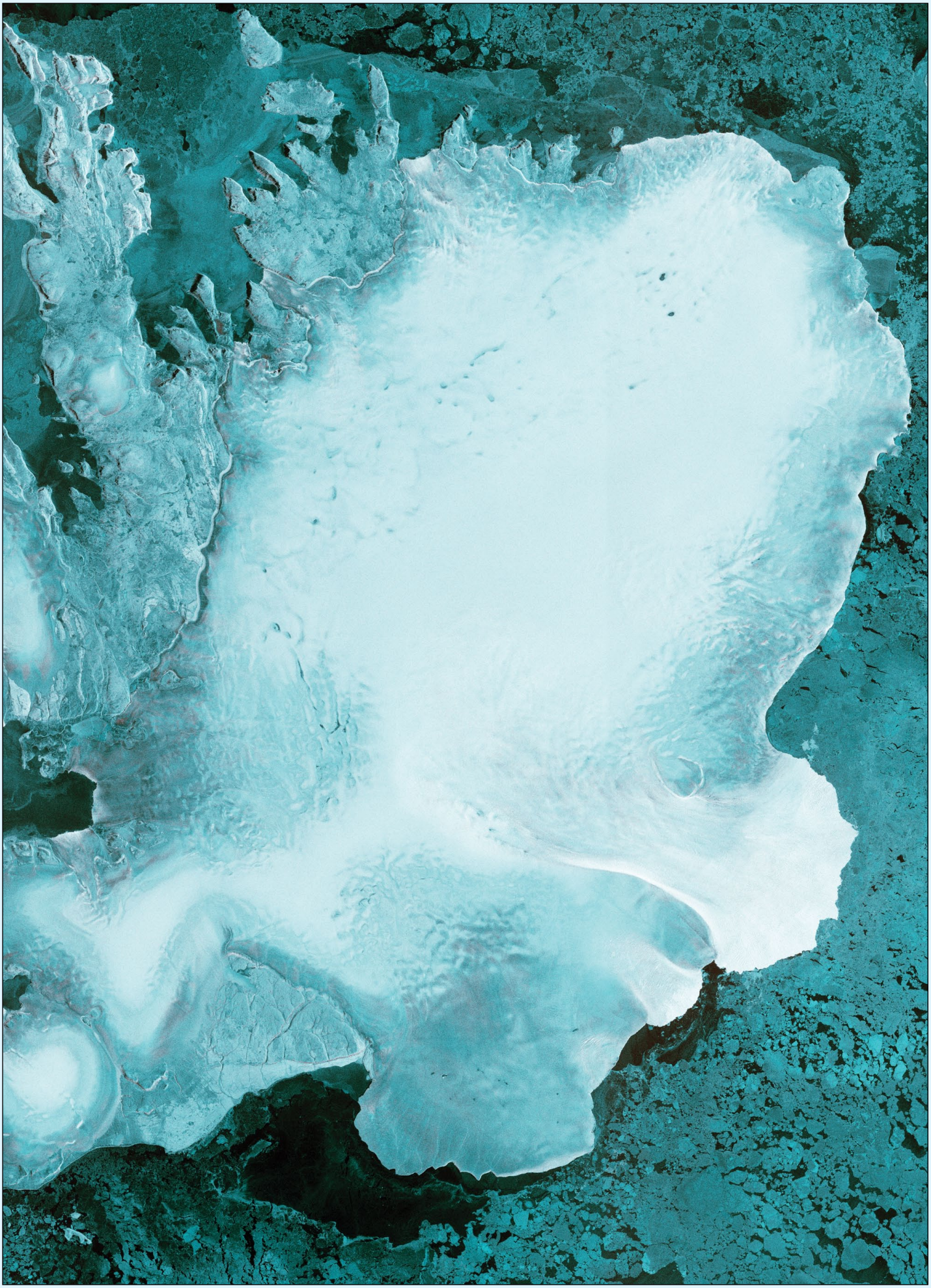
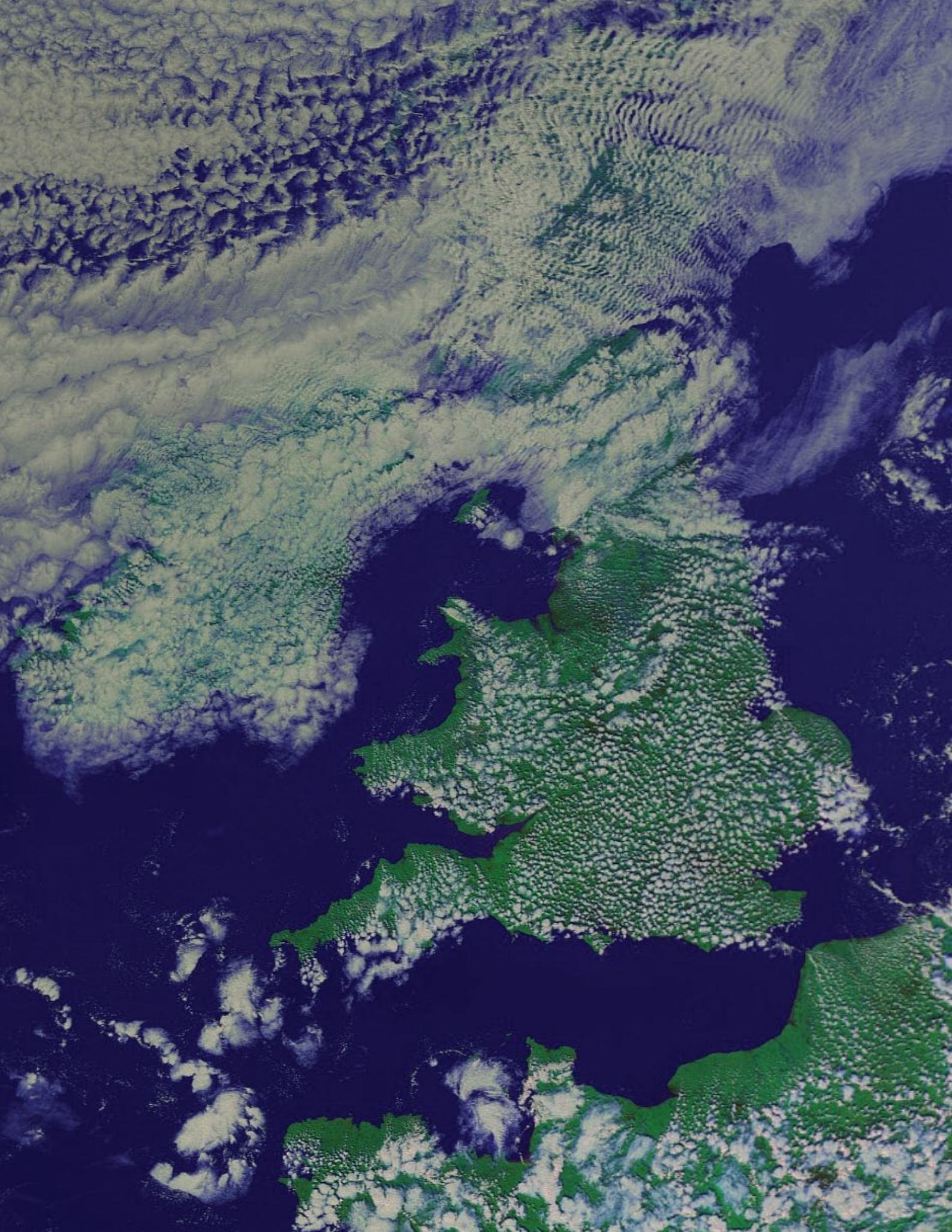


Figure 3 - Nordaustlandet island

Contains modified Copernicus Sentinel data [2016], processed by ESA



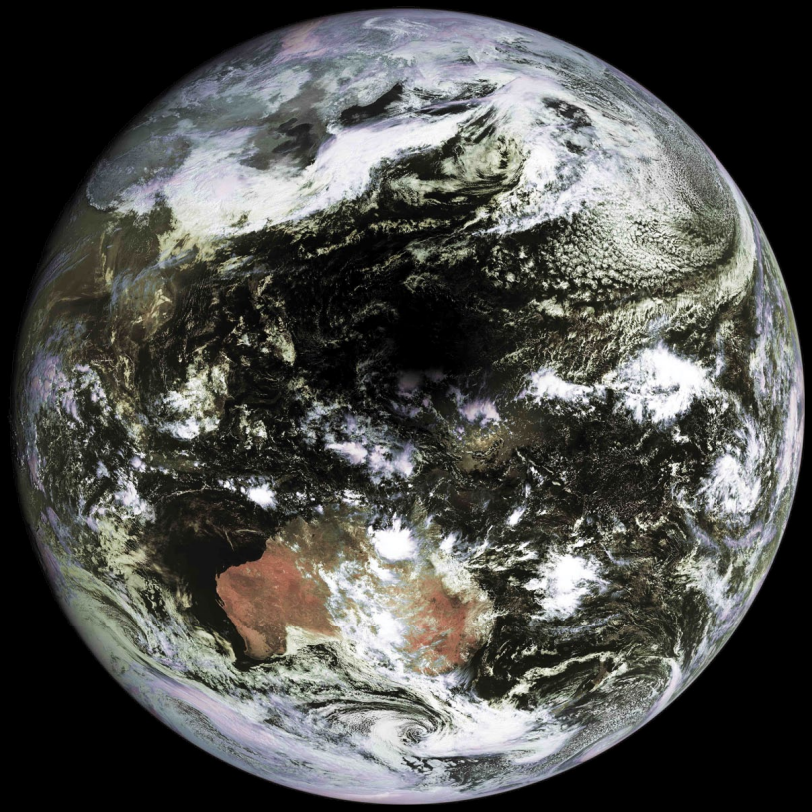
This is a image of the British Isles on April 17, 2016 comes from NASA's ***Terra*** satellite. This satellite offers a ground resolution of 250 metres/pixel. Despite appearances to the contrary, most of Scotland enjoyed a mainly sunny day, interrupted by short cloudy interludes as the high herringbone cloud passed by.

Japanese Satellite Observes

Total Solar Eclipse over Pacific Ocean

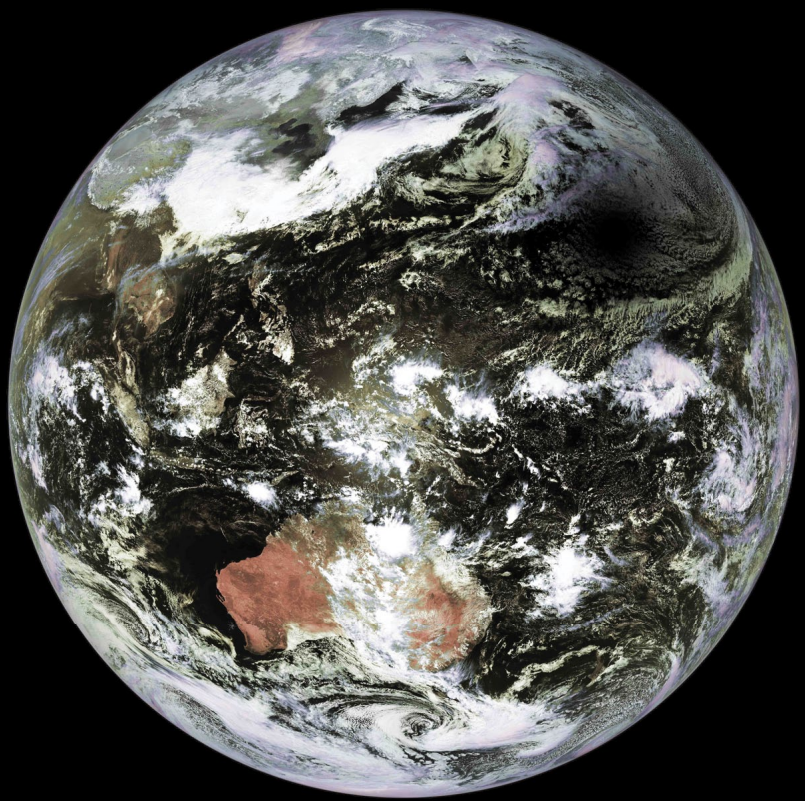
John Tellick

These two images from Japan's latest geostationary satellite, Himawari-8, illustrate the March 10 total eclipse over the Pacific Ocean. When the two images are compared, a large swathe of cloud north of Australia has 'disappeared' during totality.



Himawari 8 image at 01.30 UT on March 10, 2016

Image: EUMETSAT 2016



Himawari 8 image at 03.00 UT on March 10, 2016

Image: EUMETSAT 2016

Mother-of-Pearl Cloud

Image: NASA/Wikimedia Commons

Les Hamilton

Between January 28 and February 2, 2016, regular twilight displays of amazing multicoloured clouds decorated the skies above the British Isles and much of western Europe. Not uncommon over polar regions of the planet, such displays of **Mother of Pearl** clouds, are relatively rare at latitudes farther than 30° from the poles. And although several minor instances have been recorded over the years, a display such as this year's had not been seen since 1996. The first hint I had of anything unusual was on the morning of January 31, from the car-park at my local Sainsbury's store, where, shortly before sunrise, an intensely bright purple-hued cloud glowed in the pre-dawn sky. After completing my shopping, the cloud was still visible, and I made all haste homewards to photograph the phenomenon. Normally, mother-of-pearl cloud has faded to insignificance by the time that the sun rises, but in this case the display was so intense that it was still clearly visible (figure 1). Indeed, I had to include the roof of my house to exclude the glare of the sun itself from the photograph.

Figure 1 - Mother-of-Pearl Cloud over Aberdeen on January 31, 2016.

Polar Stratospheric Clouds

Mother-of-Pearl cloud, more formally known as *Nacreous Cloud*, is a type of **Polar Stratospheric Cloud** (PSC), which forms at altitudes between 15 to 25 kilometres in the stratosphere. Because the stratosphere is extremely dry, it rarely supports significant cloud. But during the extreme cold of polar winters, when the temperature falls to -78°C and below, optically thin clouds composed of tiny ice crystals and/or supercooled water droplets can form. Completely invisible during the hours of daylight, they are normally at their most conspicuous during the hour preceding dawn or following sunset, when the sun is already several degrees below the horizon. Due to their high altitude and to the curvature of the Earth, PSCs receive sunlight from below the horizon and reflect/refract it towards the ground, shining brightly even though the sky may be nearly dark. A NASA photograph (figure 8) taken from a high-altitude jet emphasises just how far above the normal cirrus cloud deck these mother-of-pearl clouds are situated.

Figure 2 - Wavelike PSCs observed during the January 1996 display.

PSCs have an almost translucent appearance. Sunlight originating from below the horizon is forward-scattered within the clouds to produce an overall pearly-white appearance, while their tiny water droplets and ice crystals cause coloured Interference fringes by diffraction. Because of their altitude, PSCs rarely seem to move during the hour or so that they remain visible, and often take the form of wave clouds downwind of mountain ranges. It is suggested that this wavelike appearance results from gravity waves induced in the lower stratosphere by lee waves within the troposphere. Figure 2, taken from Aberdeen during the 1996 PSC display, shows such wavelike clouds just a few tens of kilometres downwind (east) of the Cairngorms mountain range.

Figure 3 - A bird caught in silhouette against a nacreous cloud

Figure 4 - This brief, highly iridescent cloud was observed in January 1999.

Figure 5 - This cloud, observed after sunset on December 9 ,2012, suggests strong winds in the stratosphere.

Figure 6 - A Mother-of-Pearl cloud formation observed on the evening of February 2, 2016, a few kilometres west of Aberdeen..

Types of PSC

PSCs are classified into two types: Ia, b and c, and II according to their chemical composition, which can be measured from the ground using LIDAR, a the technique that can also determine their altitude and ambient temperature.

- Type Ia PSCs contain relatively large, aspherical particles of crystalline compounds of water and nitric acid, in particular nitric acid trihydrate $HNO_3.3H_2O$ (often referred to as 'NAT').
- Type Ib PSCs contain small, spherical particles of a supercooled solution containing both sulphuric and nitric acids dissolved in water.
- Type Ic PSCs consist of small non-spherical particles of nitric acid in water.
- Type II PSCs, which are relatively rare in the Arctic, consist of water ice only, and are the only true mother-of-pearl clouds. In the Antarctic, temperatures below -88 °C frequently result in the appearance of type II PSCs. Temperatures as low as this are rarely attained in the northern hemisphere, where it is believed that the generation of lee waves by mountains may locally cool the lower stratosphere, thus promoting the formation of nacreous cloud.

Type I PSCs are optically much thinner than the Type II clouds, and slightly warmer, forming at -78ºC. Rather than being composed of water alone, they consist mainly of hydrated droplets of nitric acid and sulphuric acid. Type I PSCs can display iridescence under certain conditions (just like any other cloud in fact) but always less spectacular than nacreous clouds. Occasionally, there may be patches of nacreous cloud embedded within them.

Type II PSCs, also known as **nacreous** or **mother-of-pearl** clouds, are composed of crystals, and form at a slightly lower temperature (-85°C). Their temperature is below that of the lower stratosphere, and they are composed of water-ice crystals about ten microns across. It is the overall uniformity in size of their crystals that produces the characteristic bright iridescent colours by diffraction and interference.

Polar Stratospheric Clouds and the Ozone Hole

Following many decades during which CFCs (chloro fluoro carbons) were used as aerosol propellants and refrigerants, chlorine compounds have been escaping into the atmosphere and diffusing up to the stratosphere. The ozone layer is mainly found in the lower portion of the stratosphere, from approximately 20 to 30 kilometres altitude, overlapping the region where PSCs can form.

PSCs were long regarded as curiosities and of no real consequence, but research has shown that Type I clouds in particular are involved in harmful destruction of stratospheric ozone over the Antarctic and Arctic. The surfaces of the particles that make up Type I PSCs act as catalysts, which convert originally benign chlorine compounds into active particles known as free radicals (for example ClO, chlorine monoxide). When sunlight returns to the Arctic and Antarctic during polar springtime, each of these radicals is capable of destroying many ozone molecules through a series of chain reactions.

The presence of PSCs is doubly harmful because they also remove gaseous nitric acid from the stratosphere, a species that would otherwise react with active chlorine particles, helping to reduce their numbers and thus minimise ozone depletion.

Summary

Polar stratospheric clouds (PSCs) play a central role in the formation of the ozone hole above the Antarctic by providing surfaces upon which chemical reactions take place to produce active forms of chlorine, which directly destroy ozone molecules.

Figure 7 - This particularly fine display of nacreous cloud was photographed in 2002 by Florentin Moser
Image licensed under the Wikimedia Creative Commons Attribution

Figure 8 - The colourful Mother-of-Pearl clouds seen near the top of this image were photographed from a high-flying jet aircraft by Paul Newman. The PSCs are located high above the darker cirrus clouds at the bottom of the picture.
Image courtesy of NASA (Paul Newman, GSFC).

WXtoImg

Professional Version of the popular APT Receiving and Processing Package now Free to Use

Les Hamilton

In recent times, a number of APT weather satellite enthusiasts had reported on their inability to obtain Upgrade Keys for **WXtoImg**, one of the most popular software packages for both receiving and processing signals from the American NOAA satellites (figure 1).

In January 2016, the **Upgrade** option was removed from the *WXtoImg* website, though no explanation was given. Then, in mid February, the Home Page was modified, presenting the visitor, without charge, with **Upgrade Keys** for both the *Standard* and *Professional* versions of the program (figure 2).

WXtoImg, developed by New Zealander Craig Anderson, first came to notice in 2001 as a command-line driven program which could convert WAV files produced by other programs into images. But within a year, *WXtoImg* had developed into an all-in-one software solution for weather satellite reception and processing, with functionality to add country outline overlays, and allow user control over the colours of boundaries, rivers, cities etc.

But it seems that Craig Anderson has now ceased developing this highly popular software—version 2.10.11 dates back to 2010, and the 2.11.2 beta version to April 2013—and decided to offer the program free to use.

One important point: the 'Full Names' listed below must be entered precisely as shown, with the same mix of lower and upper case letters.

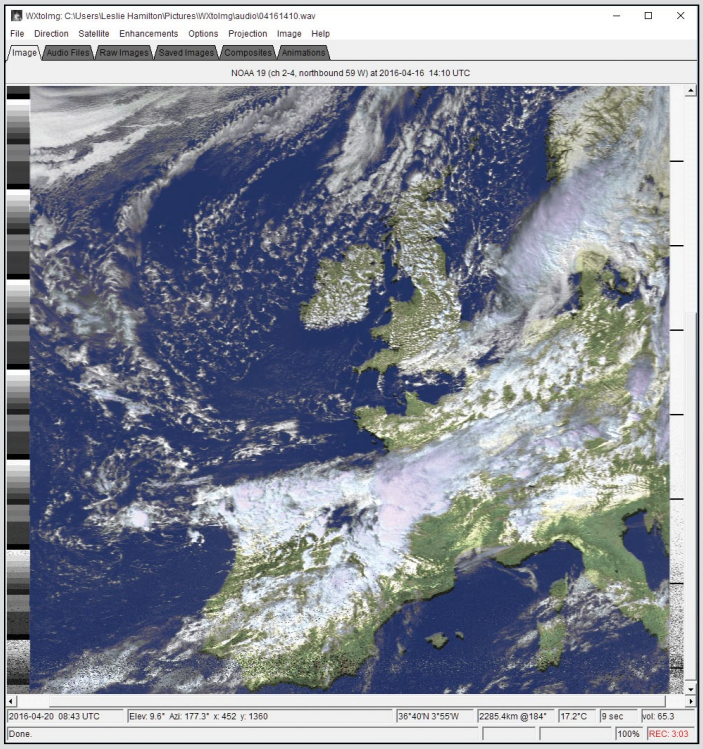


Figure 1
A typical WXtoImg screen, showing a colour composite image for the 14.10 UT NOAA 19 pass on April 16, 2016.

WXtoImg Version 2.10.11 Released
The latest stable version is 2.10.11 DOWNLOAD

Standard Edition Upgrade Key
Install in Help -> Enter Upgrade Key (use upper/lower case exactly as below)

Full Name: WXtoImg Standard
Email Address: *your email address*
Upgrade Key: EDG9-T4PH-QFPT-G86U-FB2X

Professional Edition Upgrade Key

Full Name: WXtoImg Professional
Email Address: *your email address*
Upgrade Key: ZC7W-KRKY-QLWT-4ZCT-AEB2

Figure 2
The universal Upgrade Codes, which became available at ***http://www.wxtoimg.com***/ during February 2016.

Nansen Ice Shelf Sheds Huge Icebergs

NASA Earth Observatory

Last Issue, *GEO Quarterly* carried a report that the Nansen Ice Shelf was splitting from Antarctica. In the months since, the process has accelerated, and two large icebergs have calved along the line of the previously reported crack.

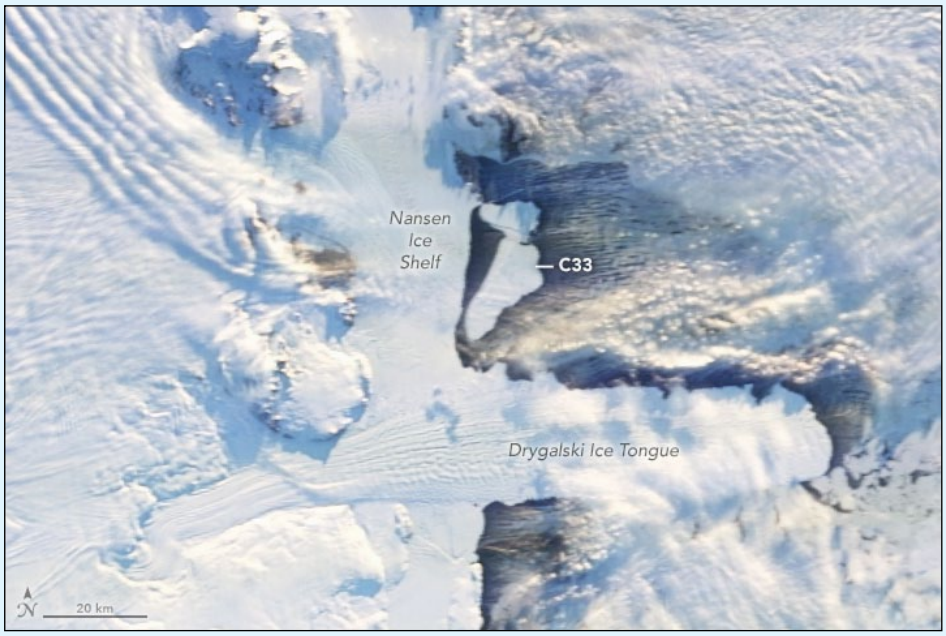
The progression of the crack was visible in a pair of satellite images acquired in December 2013 and 2015 [1]. Ryan Walker and Christine Dow, glaciologists at NASA's *Goddard Space Flight Center*, flew along the crack in late 2015. It was clearly still attached. On April 6, 2016, with southern winter soon to set in, satellite imagery indicated that the cracking ice front was still holding on.

But 24 hours later, during the final few days before winter darkness set in, the Moderate Resolution Imaging Spectroradiometer (MODIS) on the **Terra** satellite acquired this image as the 'bergs broke away.

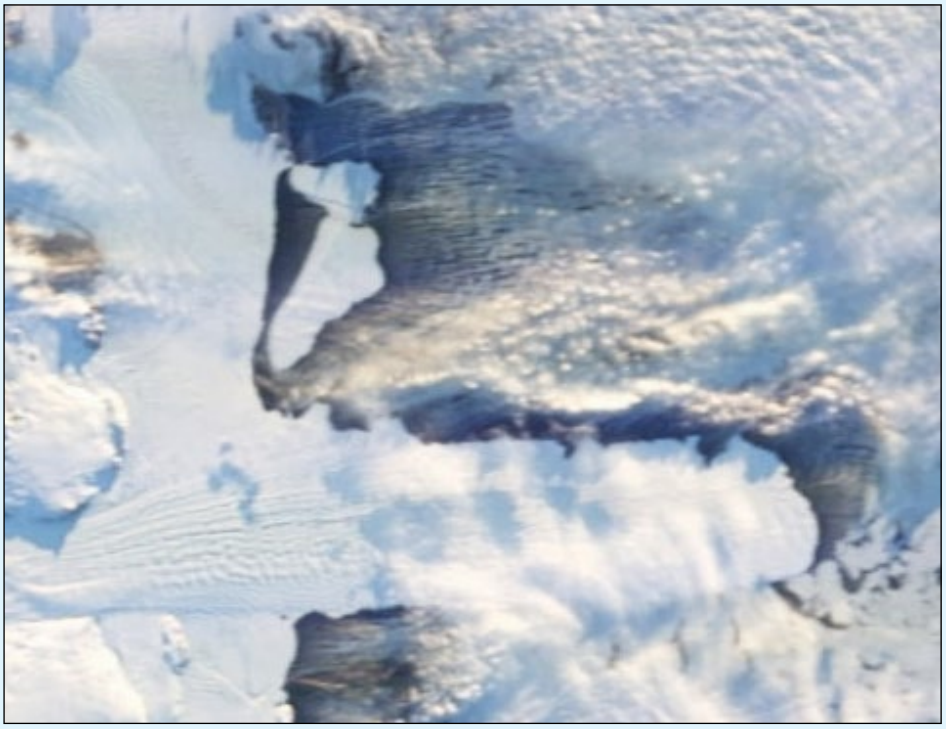
The Nansen Ice Shelf previously measured about 35 × 50 kilometres. For comparison, the Drygalski Ice Tongue just south of Nansen stretches 80 kilometres into the sea. Of the two 'bergs shed from Nansen, only the larger one meets the size criteron for naming and tracking by the *US National Ice Center*: it has been named C33.

But why did the crack finally give out? According to Walker, summer melting probably helped to weaken and break up the shelf fragments and sea ice (the mélange) within the crack, which acted like glue to keep the 'bergs attached. Summer melt also could have helped the deeply fissured ice to break further, completing the crack across the shelf.

Once broken off, the new icebergs would have been pushed away from the shelf by the strong katabatic winds that blow out to sea. Walker emphasized that this is routine iceberg calving—there are indications that similar events occurred there in the 1960s—and not a collapse of the ice shelf itself. Nonetheless, scientists are concerned for a different reason: the icebergs are threatening scientific equipment in the area. Scientists at New Zealand's *National Institute of Water and Atmospheric Research* (NIWA) say that the 'bergs are deep enough that they cold-snag a mooring deployed in Terra Nova Bay. The mooring collects data on the effects of climate change on sea ice and ice shelves. According to oceanographer Mike Williams: 'We won't know until we go back next summer whether it is still there. We could lose a whole year of data. If that happens it will leave a gap in our research and that's unfortunate. However, it is a risk we have to take. We could see the crack from satellite images but predicting when an ice shelf will calve is difficult. It could have happened any time in the next five years'.



The newly calved icebergs off the Nansen Ice Shelf

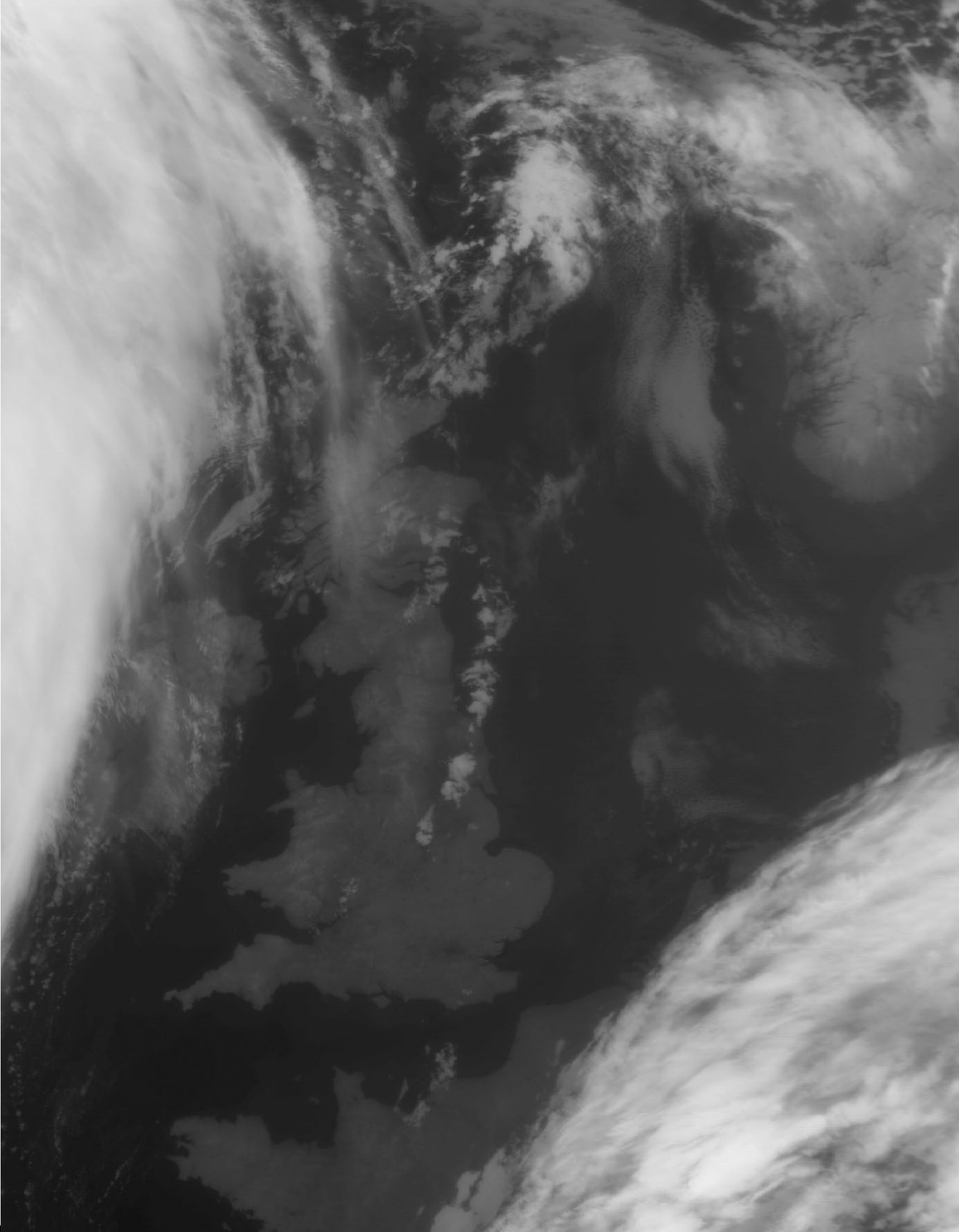


An enlarged view of the calved icebergs

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

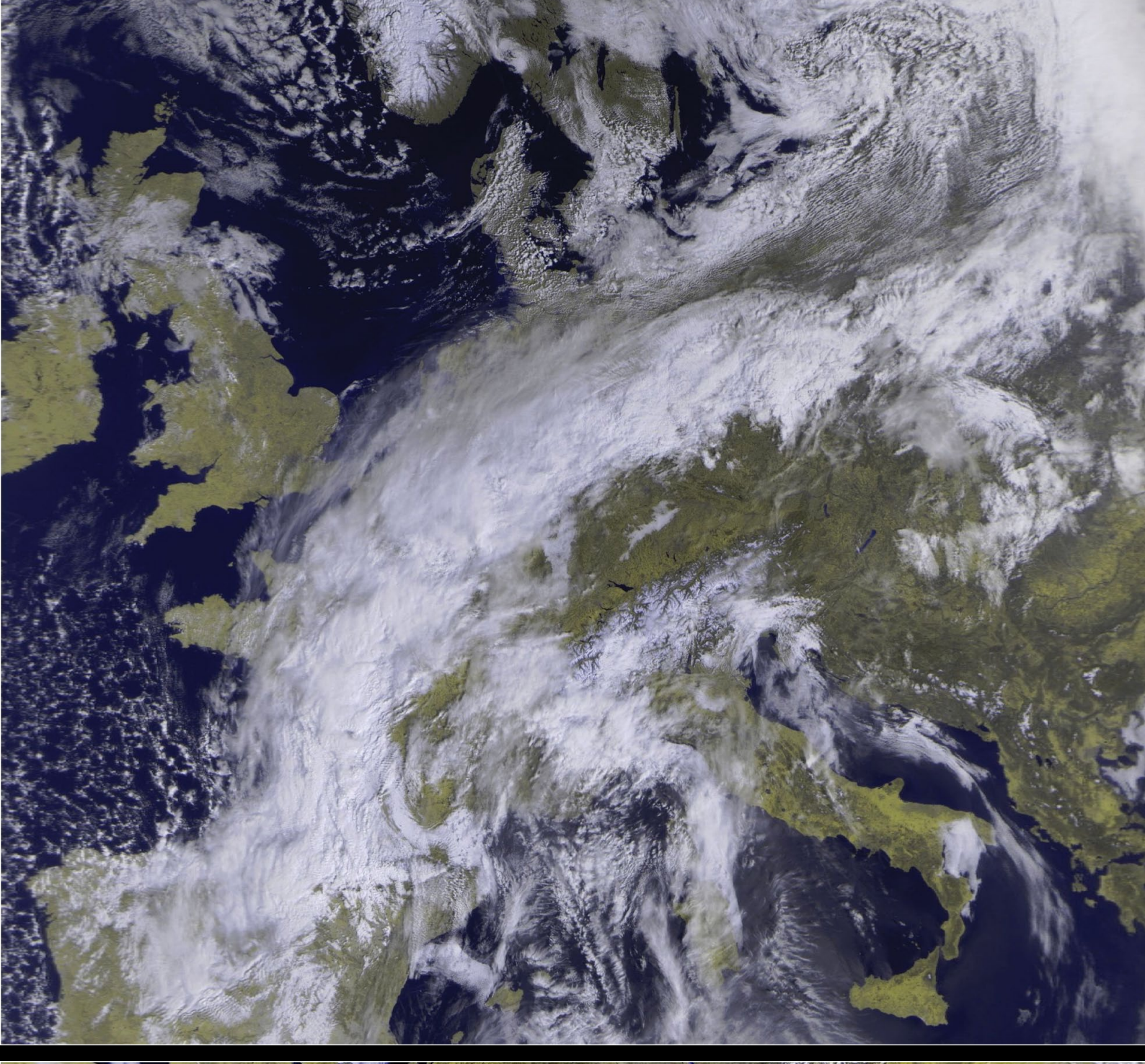
Reference

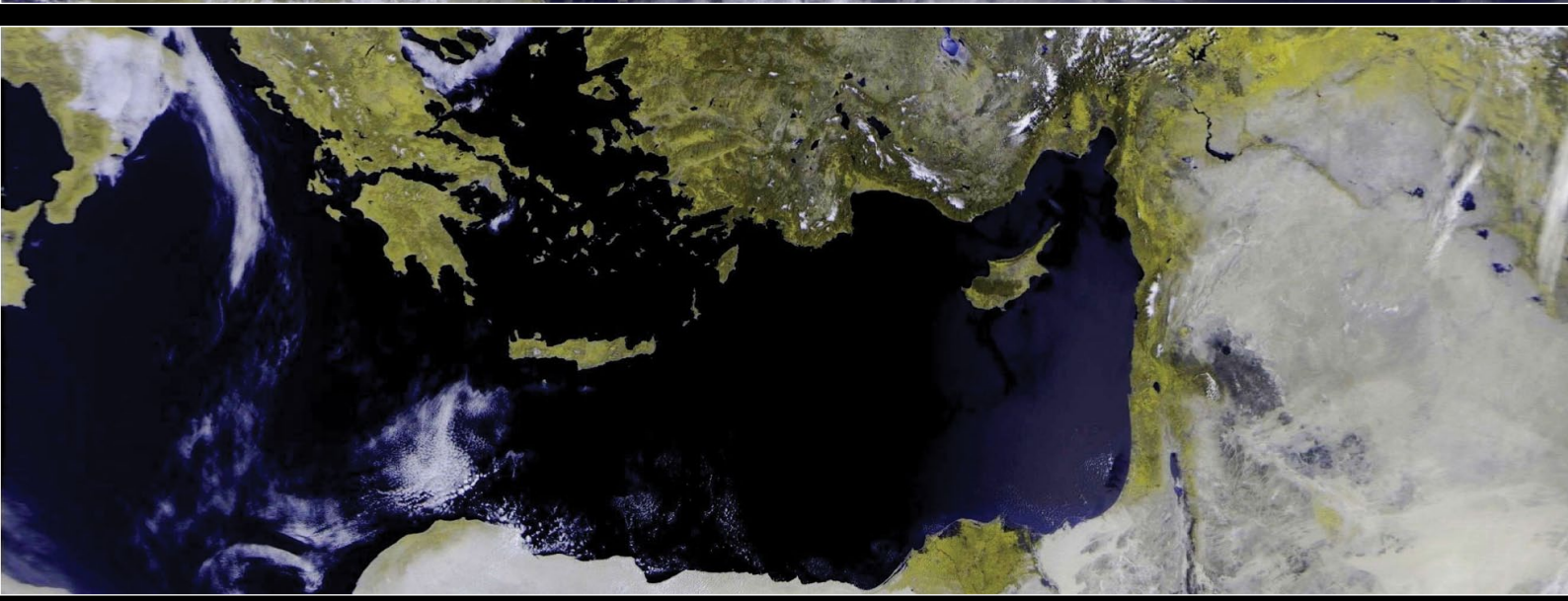
1 Nansen Ice Shelf Splitting from Antartcica GEO Quarterly No 49 (2016), page 49.



Following the demise of Meteor M1 on March 20, 2016, Meteor M2's LRPT was reactivated the following day, making overnight infrared images available once more. This channel-5 image, acquired at 20.43 UT on March 31 by Les Hamilton, shows the British Isles shivering under a brief ridge of high pressure.

Jeff Kelly captured this striking image from Meteor M2 on March 31, 2016, showing 'Nice representation of the winds affecting the North East USA'.





Enrico Gobbetti submitted these two fine images from Meteor-M2, both acquired on March 31, 2016.
The upper image was acquired at 09:15 UT and the lower one an orbit earlier at 07:36 UT.

Is the Ocean Melting the Ice?

NASA's OMG Mission

NASA Earth Observatory

At 1.7 million square kilometres, the Greenland ice sheet is three times the size of Texas. On average, the ice is about 1600 meters deep and contains enough water to raise global sea levels about 6 meters were it all to melt.

Global sea level rise is one of the major environmental challenges of the 21st Century and Greenland is central to the problem. Its massive ice sheet touches the sea along more than 44,000 kilometres of jagged coastline. Hundreds of fjords, inlets and bays bring ocean water right to the edge of the ice and, in some places, under it. This means that the ice sheet is not just melting from warm air temperatures above: it is also most likely being melted from water below.

For this reason, a team of scientists led by the Jet Propulsion Laboratory's Josh Willis have launched the **Oceans Melting Greenland**, or OMG, field campaign. Started in the summer of 2015, OMG is a five-year airborne and ship-based mission to study the

Figure 1 - Sonar map of part of the Greenland Coastline
NASA Earth Observatory map by Joshua Stevens, using Oceans Melting Greenland (OMG) data courtesy of Josh Willis/JPL.

Figure 2 - NASA Photo: Josh Willis

role of the oceans in melting Greenland's ice. Researchers will examine the temperatures and other properties of North Atlantic waters along the coast, while also making measurements of the glaciers that reach the ocean. The OMG team is also building a profile of the sea floor around the island in order to better model how warm, deep ocean water might flow into those fjords and reach the glacier edges.

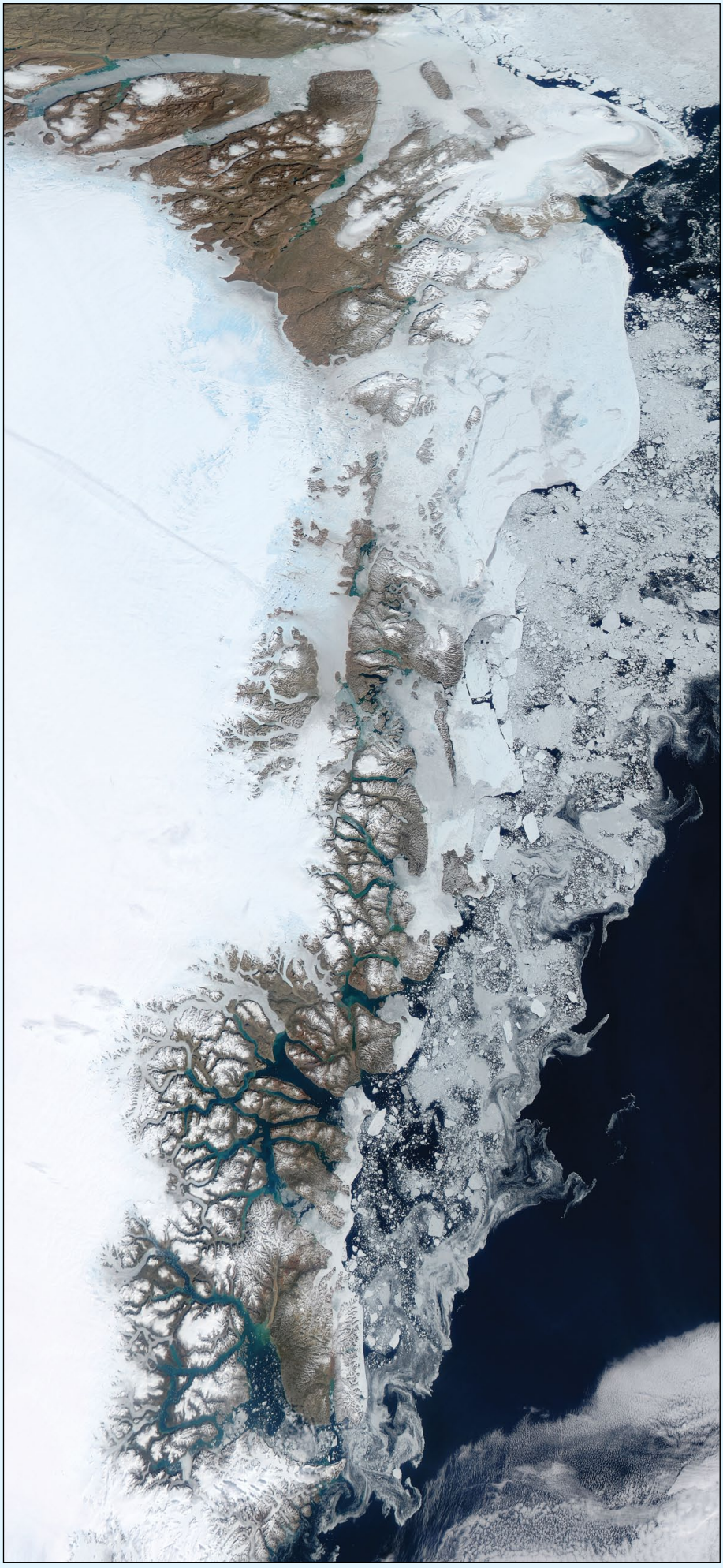
The map (figure 1) shows some early results from OMG. In the late summer of 2015, the OMG team outfitted a fishing boat with sonar equipment to map the shape of the sea floor (the bathymetry) along the west coast of Greenland. The depth of the water is shown in shades of blue, with the deepest shades representing the deepest parts. Note the deep trench offshore from the Cornell and Ussing Braeer glaciers. Many of these canyons were cut into the sea floor during the advance and retreat of ice during the most recent Ice Age.

In this part of the North Atlantic, the warmest water is actually in the deepest parts of the sea, below waters that are cooled by cold Arctic air temperatures and winds. The OMG mapping effort will help the team to determine where deep Atlantic warm water might be able to reach the ice through the complicated currents and circulation around these canyons.

In March and April 2016, the OMG team began another phase of their campaign. Flying out of Iceland and Greenland, the team has been using a NASA G-III aircraft to survey coastal glaciers. The plane is equipped with the *Glacier and Ice Surface Topography Interferometer* (GLISTIN-A), a type of radar that can generate high-resolution, high-precision measurements of the height of coastal glaciers. The team will make such survey flights each spring through 2020 to track changes in glacier extent, as evidence of growth or thinning in each melt season.

In the summer or fall of 2016, the third part of the research campaign will begin. The team will fly along both coasts and release 250 expendable sensors that can measure the temperature and salinity of coastal waters from the surface to a depth of 1000 metres. These measurements of temperature properties will help to complete the puzzle of how the ocean and ice are interacting, leading researchers to build better models of ice sheet changes and sea level rise.

Caption compiled by Mike Carlowicz from reporting by Patrick Lynch and Carol Rasmussen, NASA Earth Science Communications.



Greenland's coastline imaged on July 16, 2015 by NASA's Aqua satellite

NASA image courtesy Jeff Schmaltz, LANCE/EOSDIS MODIS Rapid Response Team at NASA GSFC

BETTER THAN GOOD

Superb imagery from Sentinel-3A

ESA

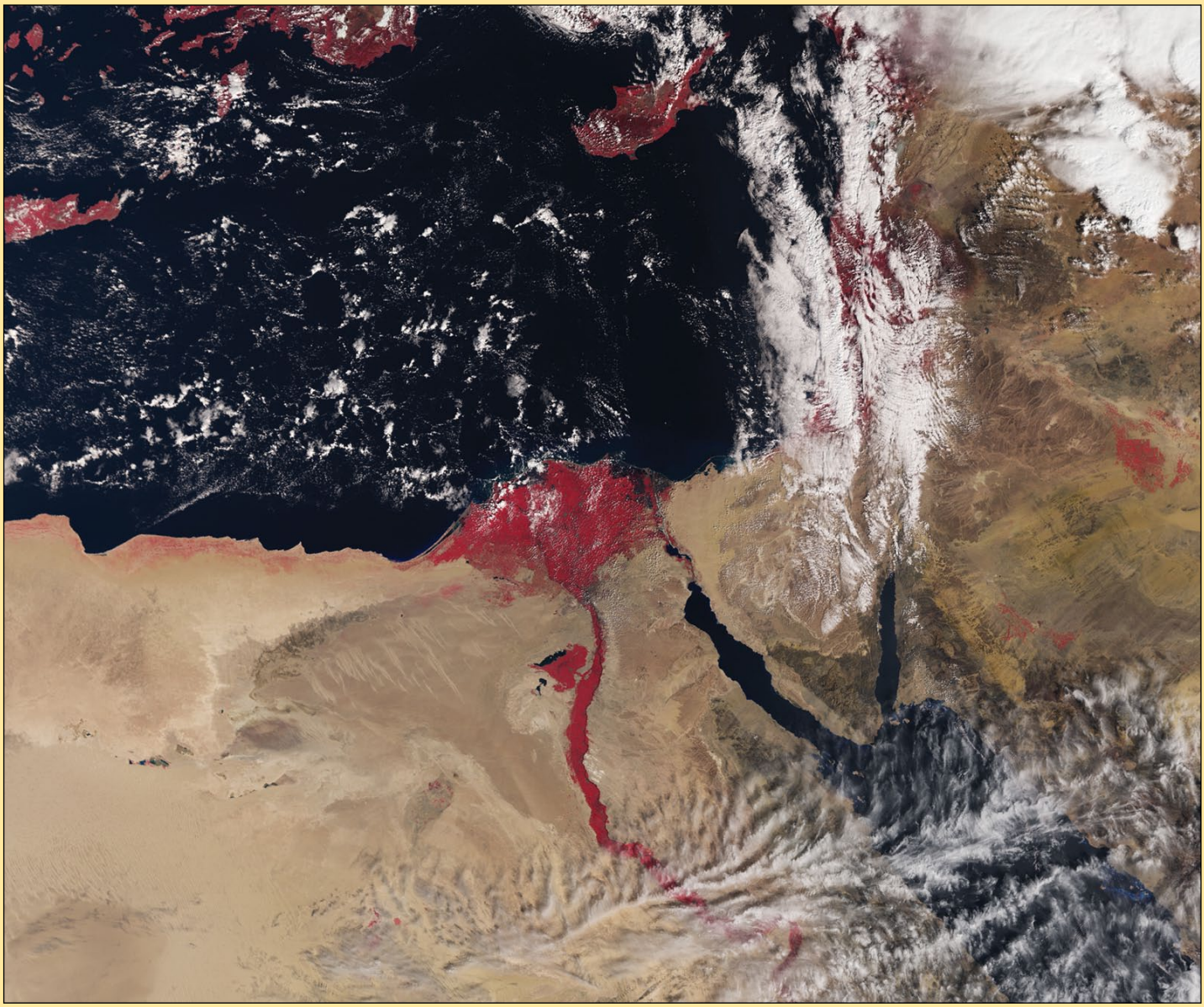


Image © ESA / Contains modified Copernicus Sentinel data [2016], processed by ESA

The new **Sentinel-3A** satellite recently began providing data from orbit, and this very early image recorded on March 3, 2016 takes us over the River Nile, its Delta and the surrounding desert areas of northeast Africa and parts of the Middle East.

Very distinct is Egypt, a country connecting northeast Africa with the Middle East, home to millennia-old monuments still sitting along the lush Nile valley. In the centre of the image, its capital city Cairo is visible with the Nile snaking northwards, along with the Red Sea just further east. Also evident are the islands of Cyprus further north in the Mediterranean Sea and parts of Crete on the very left.

One of the suite of sophisticated instruments that will measure Earth's oceans, land, ice and atmosphere, Sentinel-3's **Sea and Land Surface Temperature Radiometer** (SLSTR) samples the energy radiating from Earth's surface in nine spectral bands, including visible and infrared. This instrument improves on the capabilities of the **Advanced Along-Track Scanning Radiometer** carried by the **Envisat** satellite of 2002–12, including a wider swath of 1400 kilometres, new channels and a somewhat higher spatial resolution. Combining radiometer and colour data helps us to understand the state of vegetation better.

Launched earlier this year on February 16, Sentinel-3 will systematically measure Earth's oceans, land, ice and atmosphere to monitor and understand large-scale global dynamics. It will provide essential information in near-real time for ocean and weather forecasting, among other major applications.

Over land, this innovative mission will provide a bigger picture by monitoring wildfires, mapping the way land is used, providing iindices of vegetation state and measuring the height of rivers and lakes, thus complementing the high-resolution measurements of its sister mission, Sentinel-2.

Transit of Mercury

Robert C. Mazur (va3rom@gmail.com)

Although this is somewhat off-topic, I thought GEO readers might be interested in my efforts to photograph the May 9, 2016 transit of the planet Mercury across the face of the sun.

Figure 1 is one of my best pictures of the event, taken at 0811 EDT (1411 UT). While not as spectacular as a transit of Venus, given Mercury's much smaller size, I was pleasantly surprised at the results. Focusing was tough, even with my DSLR's 'live view', and I should have pre-focused on something the night before. Then I used a shutter speed of only 1/100 s and DIN of 100; I should really have used 1/1600 s and DIN 1600 because the effective focal length (EFL) of my 125 mm diameter *Makutsov* (mirror) scope is 1250 mm.

The result was some motion blur, and Mercury isn't quite round as a result. I overlaid the image on to a transit report sheet where you would normally draw your observation of the event, and tried to match their different scales as closely as possible (figure 2).

The DSLR was directly coupled to the scope as you would with any other lens, but focusing had to be manual and, in bright daylight, it was very hard to get it right. What made it more interesting was the small sunspot group (to the northeast of Mercury) which I measured using *ImageJ* to be over 12,500 km across (as compared to the sun's diameter of 1.392 million km), which is almost over 2½ times the diameter of Mercury.

The original image cut off the bottom of the sun, so I cheated by used *Photoshop* to copy, flip and paste part of the top solar limb at the bottom of the image. Also, there are a few classic 'donut hole' shaped dust rings caused by the *Mak* mirror focusing, and them being visible in bright sunlight. Otherwise, without the sunspot group, it was a pretty boring event and I only watched Mercury move across for the first couple of hours, on and off, while I played ham radio with the International Space Station (ISS) and a couple of other telemetry transmitting amateur radio Cubesats using my handheld VHF/UHF radio and beam antenna.

So, I've managed to see solar transits of both Venus and Mercury. Seeing Mercury is a rare event for me, because I've only seen the planet at night a couple of times and have never photographed it before since it's a tough target.

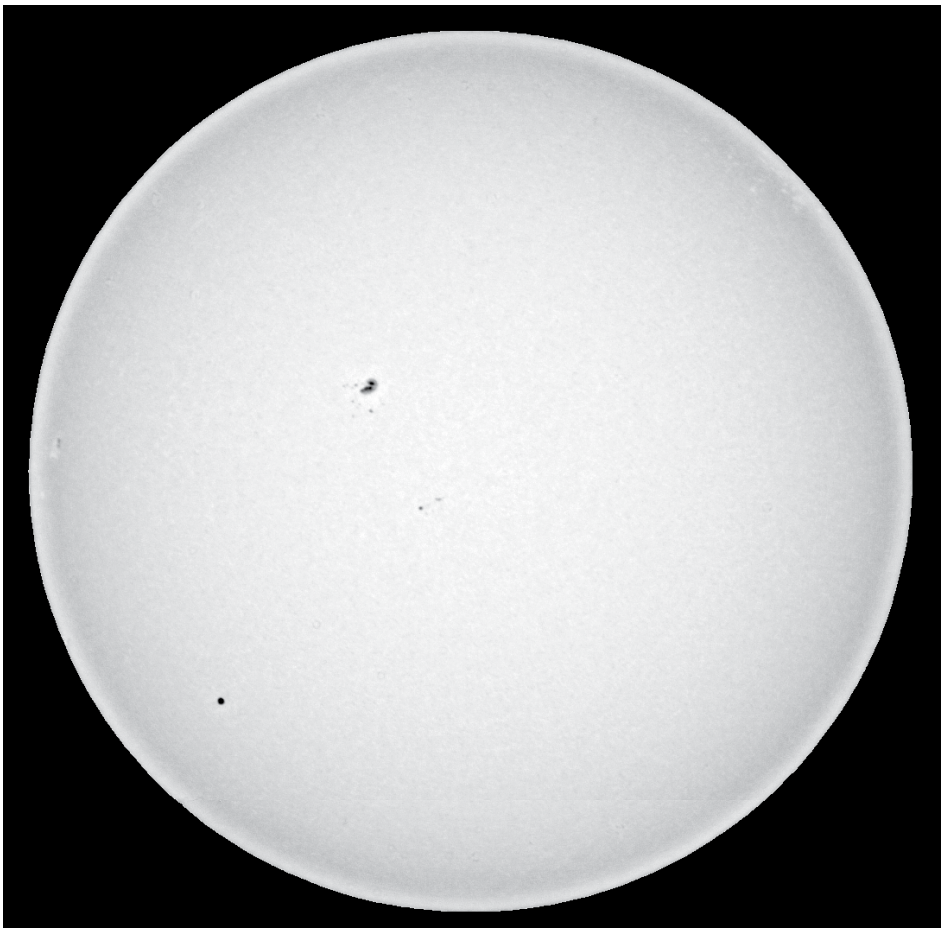


Figure 1 - The Transit of Mercury

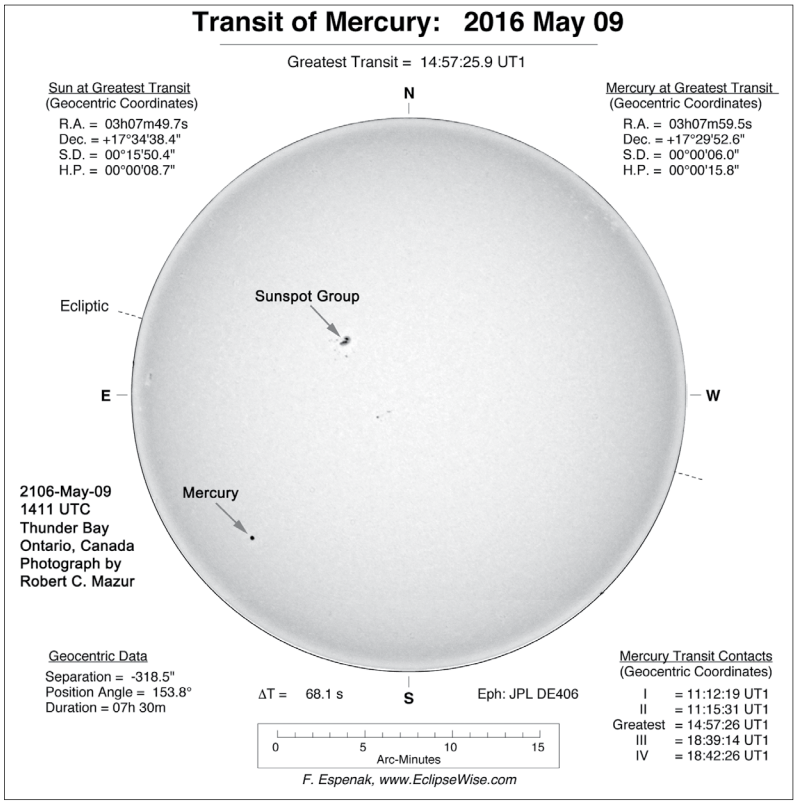


Figure 2 - The Transit of Mercury overlain on a Transit Report Sheet

2015 was the Hottest Year on Record

NASA Earth Observatory

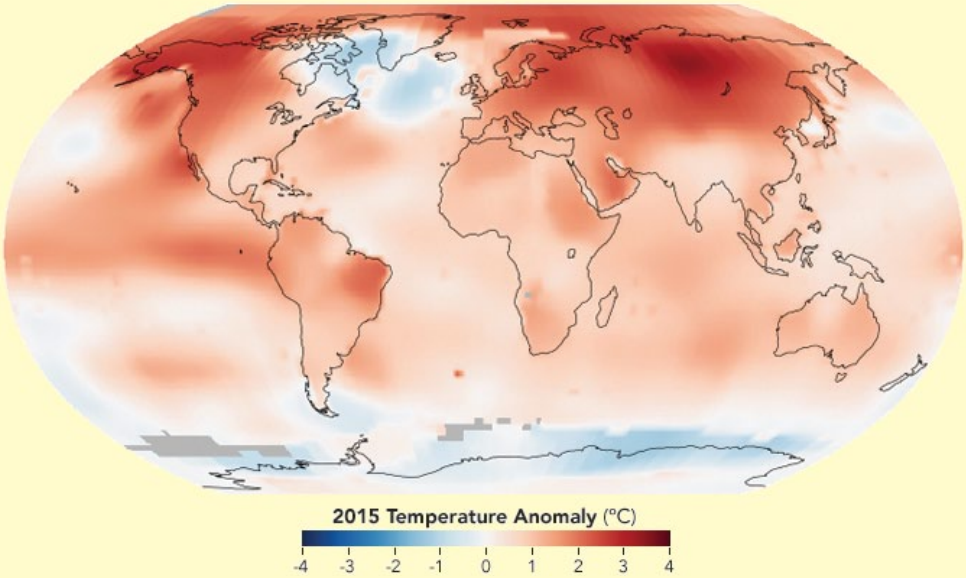
On January 20, 2016, scientists from NASA and the National Oceanic and Atmospheric Administration (NOAA) released their analyses of surface temperatures for the past year. The NASA team found that globally averaged temperatures from January through December 2015 were 0.87 degrees Celsius above the norm (defined as a 1951–1980 base period). The previous record—set last year—was 0.74°C above the norm. For the planet, 2015 was more than a full degree Celsius warmer than temperatures in 1880, when consistent record-keeping began.

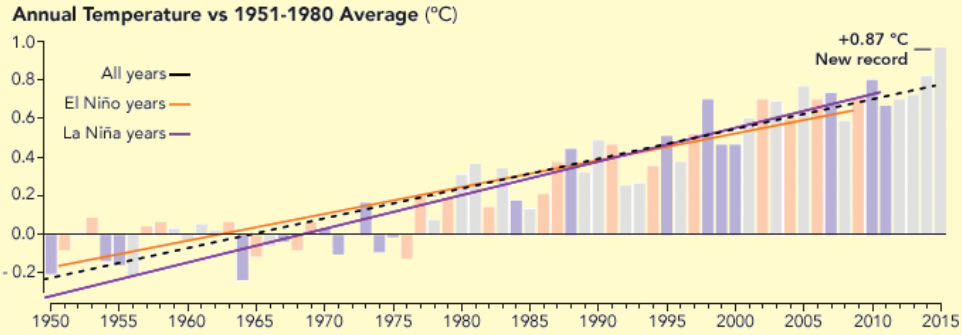
Working independently, NOAA researchers found 2015 to be 0.90°C above the 1901–2000 average. According to their analysis, 2015 was the second warmest year on record for the continental United States, Africa, and Europe. It was the warmest year for Asia and South America. Globally, new monthly temperature records were set in every month except January and April.

The map depicts global temperature anomalies in 2015. It does not show absolute temperatures, but instead shows how much warmer or cooler different regions of the Earth were compared with a baseline average from 1951 to 1980.

The team from NASA's Goddard Institute for Space Studies (GISS) assembles its temperature analysis from publicly available data acquired by roughly 6,300 meteorological stations around the world; by ship- and buoy-based instruments measuring sea surface temperature; and by Antarctic research stations. This raw data is analysed using methods that account for the varied spacing of temperature stations around the globe and for urban heating effects that could skew the calculations. For more explanation of how the analysis works, read '**World of Change: Global Temperatures**' [1].

The 2015 temperature record continues a long-term warming trend that has largely been driven by increased carbon dioxide and other greenhouse gases that humans have emitted into the atmosphere. Most of the warming has occurred in the past





35 years, with 15 of the 16 warmest years on record occurring since 2001.

Phenomena such as *El Niño* or *La Niña*, which warm or cool the tropical Pacific Ocean, can contribute to short-term variations in global average temperature. The graph shows temperature trends in relation to *El Niño* and *La Niña* events.

Orange bars represent global temperature anomalies in *El Niño* years, with the orange line showing the trend. Purple bars depict *La Niña* years, and the purple line shows that trend. Neutral years are shown in gray, and the dashed black line shows the overall temperature trend since 1950.

Note that, while *El Niño* conditions dominated the Pacific Ocean for most of 2015, it was not officially an *El Niño* year in strict climatological terms because ocean conditions did not manifest themselves until April 2015. In the past, the highest global temperature records were often set in *El Niño* years, which suggests that 2016—with *El Niño* becoming strong as of mid-January—appears likely to be another very warm year.

'2015 was remarkable even in the context of the ongoing *El Niño*', stated NASA GISS Director Gavin Schmidt. 'Last year's temperatures had an assist from *El Niño*, but it is the cumulative effect of the long-term trend that has resulted in the record warming that we are seeing.'

'Climate change is the challenge of our generation', said NASA Administrator Charles Bolden. 'Today's announcement not only underscores how critical NASA's Earth observation program is; it is a key data point that should make policymakers stand up and take notice. Now is the time to act on climate.'

Reference

1 http://earthobservatory.nasa.gov/Features/WorldOfChange/decadaltemp.php

NASA images by Joshua Stevens, based on data from the NASA Goddard Institute for Space Studies. Caption by Mike Carlowicz.

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	Dead? [7]
Meteor M N2	137.1000 MHz	On	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 On March 20, 2016, Meteor M1 suffered a catastrophic attitude loss, frequently pointing its sensors towards the sun. The following day all signals ceased and it seems highly probable that this satellite is now incapable of imaging the Earth.
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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Particularly large attachments (8 MB and above) can be transmitted via *Hightail*

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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

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for reception of NOAA APT and Meteor M2 LRPT

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This stick does not come with SDR software or instructions.

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DVB-S USB 2102 Receiver	60.60	67.00	---------	70.60	77.00	---------
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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
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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).

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