The GEO Quarterly

Group for Earth Observation

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

56

December 2017

Inside this issue . .

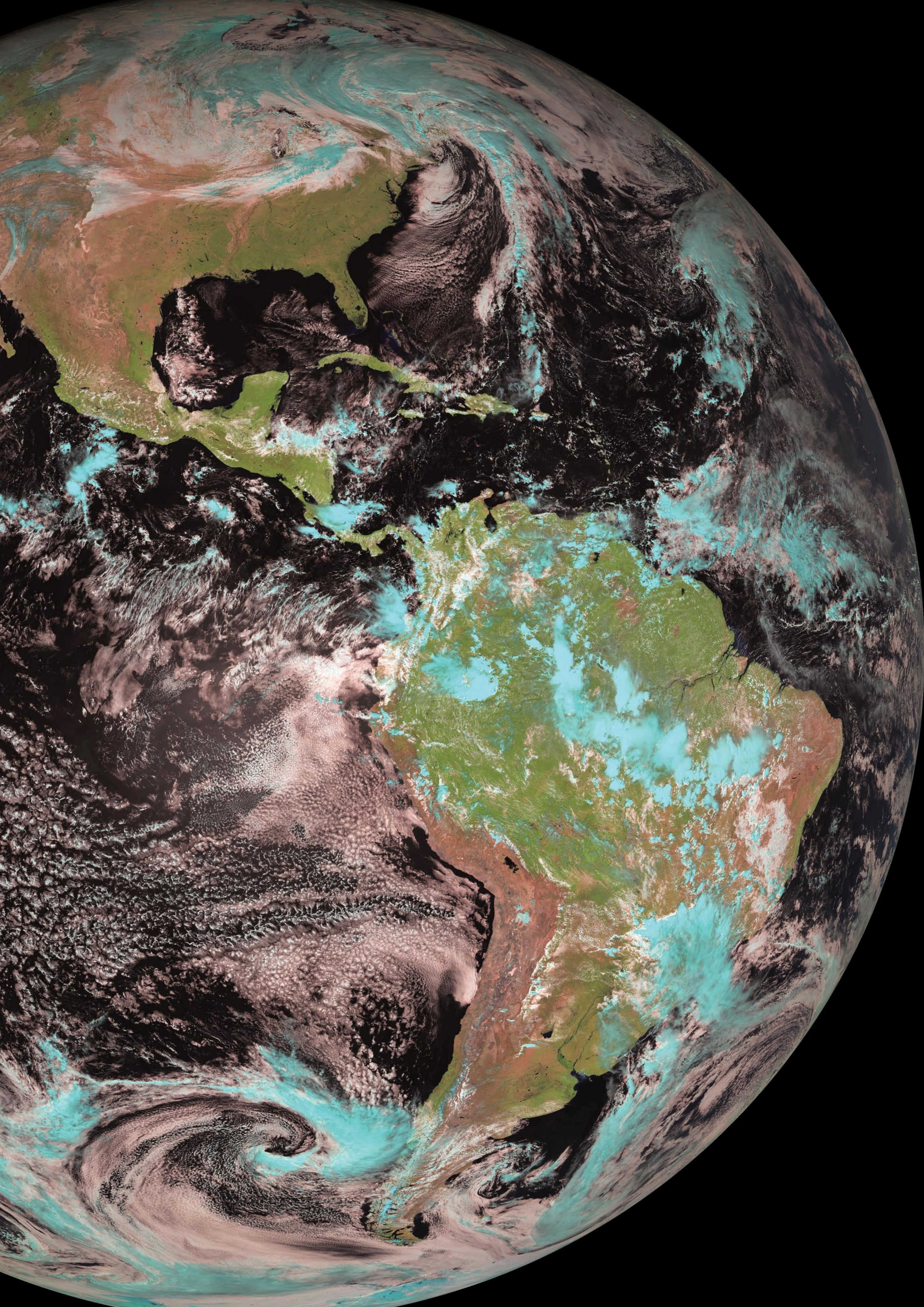
This image is a clip from a high-resolution Feng Yun-3 transmission acquired—using home-brew equipment—by members of GEO's Dutch counterparts, Werkgroep Kunstmanen. Inside this Quarterly, Rob Alblas and Ben Schellekens describe their project and encourage GEO members to take up the challenge with them.

After long years of waiting, the JPSS-1/NOAA 20 weather satellite was launched in mid November and is currently undergoing a period of testing prior to being commissioned. You can read about this new satellite in our bumper 64-page issue.

We also have an illustrated article from John Tellick, who discusses the incidence of sunglint in satellite images.

This past year saw an event of major importance in Antarctica when there was a spectacular disintegration of the Larsen C ice shelf. Les Hamilton has compiled a 6-page article that traces this event from its historical roots up to the present day.

And there are NASA Earth Observatory reports on such diverse topics as Fires in the Falklands, Algal Blooms in Lake Erie, Lake Balkhash, the shrinking Ozone Hole, The Bosphorus and the Aral Sea.



Editorial

Les Hamilton

geoeditor@geo-web.org.uk

Since *GEO Quarterly* first appeared in Spring 2004, the most notable omissions from its pages have been self-build projects for readers as the near simultaneous rise of *EUMETCast* all but completely quenched improvisation and invention. But at last, in our final issue, Rob Alblas and Ben Schellekens, members of the Dutch group *Werkgroep Kunstmanen,* reveal how their efforts to develop a homebrew system for capturing high-resolution imagery from Metop and Fengyun-3 satellites has come to fruition. Hopefully some of our readers will follow in their footsteps and keep us informed via the GEO-Subscribers *YAHOO* Group.

It is also time to look back in time and reprise articles from two stalwarts of earlier days. I have chosen Cedric Roberts RIG article which provides timely information about power surges—and what can go wrong if you don't protect against them. And we must not forget the roots of our hobby, expressed by Ed Murashie in his illustrated essay on TIROS-I, the very first Earth imaging weather satellite.

Finally, on behalf of the entire Management Team, thanks to all our readers, old and new, for supporting GEO over the years. Hopefully we have helped you to maximise your enjoyment of our shared hobby of weather satellite imaging. We will remain available to provide assistance and answer queries via the GEO Subscribers *YAHOO* Group at

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

and we leave a legacy of PDF copies of all 56 Quarterlies on our website as a reference source at

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

Masthead Photograph - Aberdeenshire's most famous mountain, Lochnagar

Contents

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

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

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

The GEO Report

Francis Bell

Although our group is undergoing some changes, our policy to retain the background structure of a limited company remains.

The **Group for Earth Observation Limited,** No. 4975597, was established almost exactly 14 years ago to provide an umbrella of responsibility for individual members in case of serious mistakes or claims against individuals who were acting on behalf of the group. In such unlikely circumstance, the liability would rest with the company rather than any individual. Fortunately, we have never had such problems but we continue with the limited company structure for legal background security. The running cost is £15 for registration of directors which continues to be myself as director and Mrs N Bell as company secretary. We annually submit a summary of our accounts to Companies House and these are a matter of public record.

Because GEO did not hold its regular annual meeting last year, no accounts were available to members. To ensure this does not happen again this year, a summary accounts for the year 1st December 2016 to the end of November 2017 is set out in Table 1, from which it can be seen that we have just enough money in our membership account to publish our planned December printed Quarterly but almost nothing thereafter.

The shop account has a substantial balance due to the small profits we have made over the years from sales. This money is a reserve which will keep GEO viable during the foreseeable future or until we start requesting subscriptions again for GEO membership. We do have some assets in the form of two computers used at shows but as they are several years old their monetary value is almost zero.

Internet Influence over GEO Subscriptions

During the 14 years since GEO was established there have been rapid changes in communication technology, with new material being published almost instantaneously via the Internet, with a consequent decline in printed paper material. GEO has been engulfed with these changes to the extent that some of our own Quarterly publications have been available solely in electronic form via the Internet and our website.

Once the infrastructure has been established, there is a very low cost to electronic publication, hence leading to the GEO Management Team re-evaluating the necessity of asking for a member subscription. Since mid 2017 we have been accepting renewals and new memberships but have not been asking for a subscription. How viable such a policy is will only be revealed in the long term; however, in the short term GEO renewals and new memberships are welcome without a subscription.

Membership Matters

Please see the adjacent membership list as of July 2017 (Table 2). We will maintain our established registered membership, held by our membership secretary, which means that GEO still has the ability to communicate with them when appropriate via email. For those members who joined more recently—via the '*GEO-Subscribers YAHOO Group*'—we will be able to keep in touch electronically and post news on this forum, together with our GEO website at

www. geo-web.org.uk

At a recent radio show at Kempton, I promoted GEO membership with a leaflet telling people how to join GEO, and the benefits of membership. The Text of this leaflet is shown opposite.

GEO Accounts
November 2016 - November 2017

Shop Account			
Income		**Expenditure**	
Opening Balance	£19,769.00	Repayments to Space-Band	£9,460.00
Net Sales Receipts	£11,140.00	Repayments due to Space-Band	£6,493.00
		PayPal charges	£410.00
		GEO Shop Expenses	£432.00
		PayPal and 1&1 (website) charges	£95.00
		Cash in hand	£70.00
	£30,909.00		£16,890.00
Closing Balance	£14,019.00		
Membership Account			
Income		**Expenditure**	
Opening Balance	£3,262.00	Quarterly printing and postage	£2,436.00
Membership Subscriptions	1,665.00	PayPal charge	50
		Rally Expenses	165
		Chairman's Personal Expenses	97
	4,927.00		2,748.00
Closing Balance	2,179.00		

Table 1 - GEO Accounts for the year 2016-2017

Free Membership of the Group for Earth Observation (GEO)

To join GEO and learn more about Earth Observation and related topics, subscribe to the GEO-Subscribers YAHOO Group at

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

and click on the 'Join Group' button. You will find that the benefits of GEO membership include:

- Advice and technical support about hardware and software relating to the live reception of geostationary and polar orbiting weather satellites.
- Advice about gaining free access to recent satellite Earth images from EUMETSAT, ESA and NOAA plus the Russian and Japanese satellites.
- Access to our 'GEO Shop' - but note that the future of the shop is uncertain.
- Invitations to join our annual meetings, which are typically held at the National Space Centre, Surrey Satellite Technology or EUMETSAT's HQ in Darmstadt, Germany.
- Support for live satellite reception in schools or other groups plus advice about displaying satellite images.

In return you can offer your own knowledge and experience of Earth satellite reception, hence benefitting other members.

Once you have joined, you can look in more detail at the people who have been using this site and their messages by visiting the above URL and selecting 'Conversations' from the menu. You will also find references for posting your own messages.

GEO Subscribers is subject to rules, and moderated by members of GEO's Management Team.

The number of people currently registered on the Yahoo User Group is 865. It is difficult to assess, but some of these people will be casual users of the site but a substantial number could be considered GEO members.

Annual Meeting

Members will have noticed that we missed our annual meeting this year, thus making a meeting in 2018 more attractive than usual. No decision has been made relating to a 2018 meeting but the idea is to combine our meeting with a visit to EUMETSAT's HQ in Darmstadt Germany. We have visited Darmstadt before in 2007, 2011, and 2015 with these events also incorporating visits to nearby ESOC .

Personally I would be delighted if there were support for a Darmstadt visit, which would give us the opportunity to be brought up-to-date with developments relating to EUMETSAT and ESA satellites, and the dissemination of Earth images. Additionally, a visit to their expanding on-site computer storage facilities would be great. Perhaps more important than the technical parameters of a visit would be the opportunity to meet again the friendly and helpful staff at EUMETSAT's Ops. Help Desk.

If there is support for a visit to Darmstadt, I suggest a date close to July 5, 2018 with an ESOC visit the following day. Note that this is just a suggestion and nothing has been booked or agreed with EUMETSAT or ESOC. If you think you would like to attend such a visit please let me know by email, as soon as possible, to

francis@geo-web.org.uk.

An alternative to the above suggestion could be to hold our meeting at the National Space Centre, Leicester, as we have done several times in the past.

In either case there would be no charge to delegates for attendance but individuals would have to cover their own personal expenses.

GEO Shop

Almost every edition of our GEO Quarterly has contained a page devoted to equipment available from our GEO shop. The shop was started soon after the formation of GEO by Clive Finnis supported by his wife Carol. Carol still looks after GEO's *PayPal* account.

After a few years the shop facilities were taken over by Nigel Evans assisted by his wife Michele. GEO is particularly grateful to Nigel who, in recent years, has given GEO members access to satellite reception equipment, particularly the SR1 receiver, which would otherwise have been extremely difficult to purchase by individuals in the UK.

In this particular case the receivers had to be imported from Israel into the UK with advance payment of VAT, after which Nigel then had to perform upgrades to the receiver's software before selling them to GEO members. Our sincere thanks to Nigel for his time and technical skills in making a range of satellite reception equipment available to our members which might otherwise have been difficult to buy elsewhere.

Membership Analysis - July 2017

Area	Members	Totals
United Kingdom	**166** (165)	166 (165)
Europe		
Austria	4 (4)	
Belgium	5 (6)	
Denmark	2 (1)	
Finland	1 (1)	
France	7 (6)	
Germany	8 (8)	
Ireland	5 (6)	
Italy	10 (12)	
Netherlands	14 (15)	
Norway	3 (3)	
Slovakia	1 (1)	
Spain	5 (5)	
Sweden	8 (8)	
Switzerland	1 (1)	
Turkey	0 (1)	
Europe Total		74 (78)
USA		14 (13)
Rest of World		
Australia	6 (6)	
Brazil	0 (1)	
Canada	3 (3)	
Hong Kong	1 (1)	
Mauritius	1 (1)	
New Zealand	3 (3)	
South Africa	3 (3)	
Thailand	1 (1)	
Vietnam	1 (1)	
Rest of World Total		19 (20)
Total Membership		273 (276)

November 2016 figures in brackets

Table 2 - GEO Membership Breakdown

Quarterly ? Question

Francis Bell

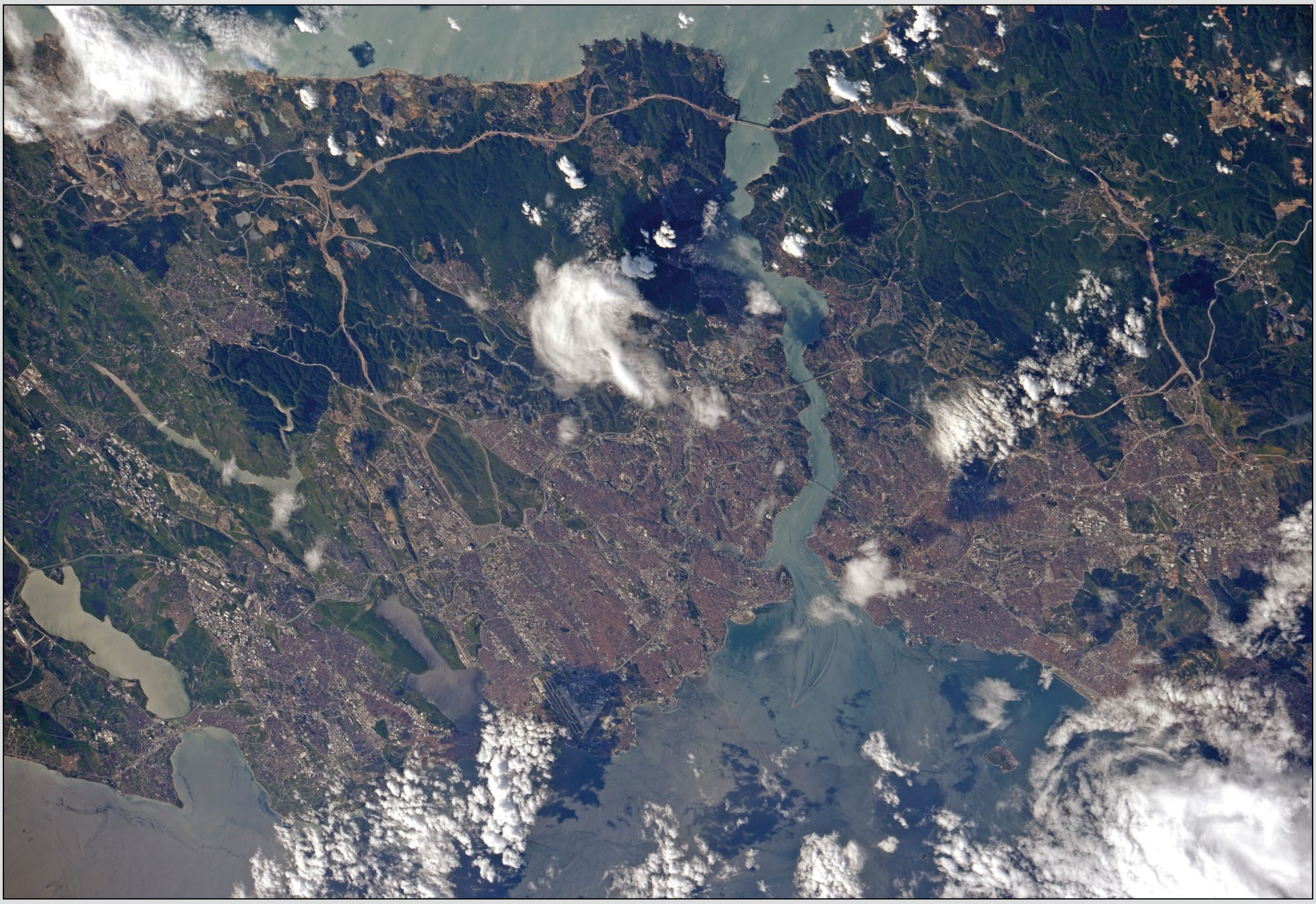


Photo credit: Tim Peake / NASA / ESA

Quarterly Question 55

My thanks to those members who responded to the last Quarterly Question, which related to the Earth's overall sea level. We are told by the scientific community that Earth's sea level is rising significantly due to the melting of the ice: principally the Antarctic and Greenlandic ice caps. The Quarterly Question asked what or where, is the absolute reference for worldwide sea level from which any changes can be measured.

Unfortunately, those members who responded to the question only quoted the land height reference for the UK. This is a reference point in Newlyn, Cornwall, defined by the UK's Ordinance Survey many years ago when surveying the whole country. I believe this is still the reference level used today but I'm not sure about any level calculation which is needed to recognise that the UK is located on a curved surface, that is, the surface of the Earth which is a sphere. I'm sure someone will be able to tell me. If anyone knows about such a world-wide reference for sea level measurements perhaps you could write a paragraph or two and send it to our editor or myself.

Quarterly Question 56

This Quarterly Question relates to a photograph taken by the UK's astronaut Tim Peake during his six month stay on the International Space Station just over a year ago. The photograph, above, shows a large city with a population in excess of fifteen million people, very slightly to the left of centre. **The question is straightforward: 'Give the name of this ancient city shown in the photograph'.**

It is worth noting that the photograph may have been taken using a hand-held camera, hence the view might not have the resolution of a dedicated onboard instrument. However, the main geographical features shown should enable you pick the area of the Earth where the photograph was taken and hence identify the city in question.

Note that the scale of the photograph is about 30×50 kilometres. Because the photograph is likely to have been taken by a personal camera, the recorded image is likely to be in the visible colour light spectrum. The orientation of the photograph shows north at the top. The main clue to the area photographed is the area of water shown at the bottom of the photograph, this called the Sea of Marmara.

As usual I take extra interest in these photographs and Earth images if they shows somewhere I have visited—which is again the case with this photograph. I spent one day in this city and visited three mosques but not the golden one!

Please send your answers to **francis@francisbell.com** before the end of February 2018.

JPSS: The Joint Polar Satellite System

Les Hamilton

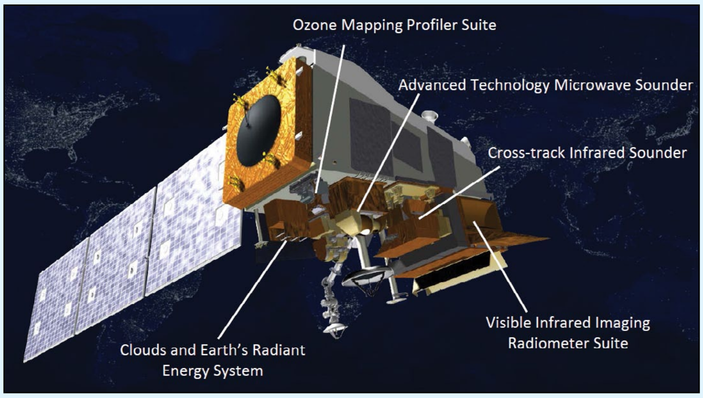
The JPSS-1 satellite lifted off from Vandenberg Air Force Base, California, at 9:47 UT on November 18, 2017, and be renamed NOAA-20 when it reaches its final orbit. Following a three month period during which the satellite's instruments will be tested and calibrated, scientists and forecasters will be able to utilise the it's data officially. The satellite is designed to operate for a minimum of seven years, with the potential for extended operation for several more years thereafter.

The data NOAA 20's advanced instruments provide will improve weather forecasting: such as predicting hurricane tracks and helping to recognise climate patterns that can influence the weather, such as El Niño and La Niña. They will also help emergency managers to respond to events such as wildfires, floods and volcanic eruptions, as well as helping communities to recover from severe weather by providing better images of the damage.

The Delta II rocket carrying JPSS-1 stands on the launchpad. The satellite will become NOAA 20 once in orbit.
Image: United Launch Alliance / NASA

It's more than eight years since NOAA 19, the final satellite in the **Polar Orbiting Environmental Satellites** (POES) series, was placed in orbit. This satellite continues to disseminate AVHRR imagery well past its design lifetime of five years, as do NOAA 18, launched in 2005 and NOAA 15 which will celebrate 20 years in orbit on May 13, 2018.

It was originally planned to follow the POES fleet with a new generation of environmental observation satellites to monitor Earth's weather, atmosphere, oceans, land, and near-space environment: the **National Polar-orbiting Operational Environmental Satellite System** (NPOESS). This was proposed to replace and amalgamate both the United States Department of Defense's DMSP satellites and the civilian NOAAs, with the first launch projected for around 2013. But issues with sensor developments resulted in a succession of delays, sending the project well over budget, and the White House pulled the plug on it early in 2010, deciding instead to continue with a bipartite military/civilian system.



This schematic diagram illustrates the positioning of the various sensors on the JPSS-1 satellite
Image: NASA

The new NOAA/NASA (civilian) project became the **Joint Polar Satellite System** (JPSS), and a fixed price contract of $248 million for the JPSS-1 spacecraft was agreed with *Ball Aerospace & Technologies Corporation.* The Defense Department's project was called **Defense Weather Satellite System** (DWSS), but this was cancelled by the US Air Force in 2012.

The JPSS is developed by the *National Aeronautics and Space Administration* (NASA) on behalf of the *National Oceanic and Atmospheric Administration* (NOAA), who are responsible for the operational phase of JPSS. Two satellites are planned for the JPSS constellation of satellites, which, once operational, will be known as NOAA 20, NOAA 21 etc.

Suomi-NPP

The Suomi National Polar-orbiting Partnership satellite (Suomi NPP), previously known as the National Polar-orbiting Operational Environmental Satellite System Preparatory Project (NPP) and NPP-Bridge was originally intended as a pathfinder for the NPOESS programme. Suomi was launched in 2011 as a gapfiller between the POES and JPSS satellites, flying new instruments, on a new satellite bus, as a measure to ensure continuity of climate.

Such has been the success of the Suomi-NPP satellite that it has become the *de facto* first member of the JPSS constellation. JPSS-1/NOAA 20 will join Suomi NPP in the same polar orbit, and will also provide scientists with observations of atmospheric temperature and moisture, clouds, sea-surface temperature, ocean colour, sea ice cover, volcanic ash, and fire detection.

JPSS Instrumentation

The JPSS-1 spacecraft is based upon the design of Suomi-NPP but with an updated communications system for downlinking the raw, unprocessed data back to Earth. It carries the same five state-of-the-art instruments

JPSS System Architecture
Credit: NASA

which will provide sophisticated meteorological data and observations of Earth's atmosphere, land and oceans.

ATMS

The Advanced Technology Microwave Sounder (ATMS) instrument is the next generation cross-track microwave sounder providing 22 channels of atmospheric temperature and moisture for operational weather and climate applications. ATMS collects microwave radiation data from Earth's atmosphere and surface throughout both day and night—even through clouds—to provide sounding observations needed to retrieve profiles of atmospheric temperature and moisture for civilian operational weather forecasting as well as continuity of these measurements for climate monitoring purposes.

CERES

The Clouds and the Earth's Radiant Energy System (CERES), senses both solar-reflected and Earth-emitted radiation from the top of the atmosphere down to Earth's surface.

Cloud properties are determined using simultaneous measurements from other JPSS instruments such as the VIIRS and will lead to a better understanding of the role of clouds and the energy cycle in global climate change. Measurements from CERES help scientists understand the links between the Earth's incoming and outgoing energy and the properties of the atmosphere that affect that energy.

The first CERES instrument has flown on NASA's Terra satellite since late 1999.

CrIS

The Cross-track Infrared Sounder (CrIS) instrument is the first in a series of advanced operational sounders that will provide increasingly accurate, detailed atmospheric temperature and moisture observations for weather and climate applications. CrIS is the successor to the High Resolution Infrared Radiation Sounders (HIRS) flown aboard NOAA's POES satellites.

Daily CrIS measurements are used by NOAA's National Weather Service to enhance numerical weather prediction model forecasts, aiding in both short- and long-term weather forecasting. Over longer time scales, they will help improve understanding of climate phenomena, such as El Niño and La Niña—including continental transport of greenhouse gases.

CrIS also measures atmospheric chemistry and can detect the concentration of greenhouse gases, including carbon dioxide, primarily in the middle and upper atmosphere. The information from CrIS helps significantly in improving weather and climate prediction, including both short-term weather 'nowcasting' and longer-term forecasting.

OMPS

The Ozone Mapping and Profiler Suite (OMPS) is an advanced suite of three hyperspectral instruments, which will extend the total-ozone and ozone-profile records that already encompass more than 25 years. These records are used by ozone-assessment researchers and policy makers to track the health of the ozone layer. The improved vertical resolution of OMPS data products allows for better testing and monitoring of the complex chemistry involved in ozone destruction near the troposphere. OMPS products, when combined with cloud predictions, also help produce better ultraviolet index forecasts.

OMPS collects total column and vertical profile ozone data and continues the daily global data produced by current ozone monitoring systems—the Solar Backscatter Ultraviolet Radiometer (SBUV/2) and Total Ozone Mapping Spectrometer (TOMS)—but with higher fidelity and larger

This *Black Marble* image of Europe was created from VIIRS data collected by the Suomi-NPP satellite
Image: NOAA (2016)

swaths. The Ozone Mapping and Profiler Suite (OMPS) will measure the concentration of ozone throughout Earth's atmosphere. OMPS-N, a nadir-pointing instrument, will fly on the JPSS-1 satellite mission and will be used to generate total column ozone measurements.

VIIRS

The Visible Infrared Imaging Radiometer Suite (VIIRS) collects visible and infrared imagery and global observations of land, atmosphere, cryosphere and oceans, and also flies aboard Suomi-NPP. VIIRS generates many critical environmental products concerning snow and ice cover, clouds, fog, aerosols, fire, smoke plumes, dust, vegetation health, phytoplankton abundance and chlorophyll. VIIRS features daily multi-band imaging capabilities to support the acquisition of high-resolution atmospheric imagery, plus other instrument products, including visible and infrared imaging of hurricanes and detection of fires, smoke and atmospheric aerosols. The VIIRS' Day/Night Band sensor captured the widely popular and beautiful *Earth at Night Black Marble* images (above).

The maritime forecasting products of sea ice and ocean nutrients from VIIRS help the maritime and commercial fishing industries—further improving vessel routing and making fishery management more efficient. The agricultural industry benefits from fire monitoring and vegetation index—along with weather warnings—which are critical to production yield.

VIIRS produces higher-resolution and more accurate measurements of sea surface temperature, as well as an operational capability for ocean-colour observations and products. Ocean-colour is an indicator of water quality supporting a wide range of decisions from fishing to tourism. The VIIRS' Day/Night Band also provides nighttime imagery, which is essential for Alaska during the winter months.

VIIRS provides global coverage twice a day with 750 metre resolution across its entire scan. This is a substantial improvement for ocean ecology and carbon research studies, as well as for establishing accurate estimates of sea surface temperature which are essential for predicting hurricanes and other types of severe weather.

VIIRS operates in 22 bands of the electromagnetic spectrum, between 0.412 µm and 12.01 µm:

- 5 'imagery' bands at 375 metre/pixel resolution
- 16 'moderate' bands at 750 metres/pixel
- 1 low-light Day/Night band at 750 metres/pixel

With a 3060 km swath at the satellite's average altitude of 829 km, and nearly constant resolution from nadir to limb, VIIRS imagery will be a tremendous resource for operational forecasters. This swath width is able to provide complete Earth coverage every 24-hour period.

VIIRS imaging optics include a 19.1cm Aperture and a 114cm Focal length. The average orbit power for the instrument is 200 watts. In total the instrument weighs 275kg.

In Orbit

JPSS-1 now joins Suomi NPP, the joint NOAA-NASA weather satellite, providing a constellation of two, highly sophisticated satellites, each circling the Earth fourteen times a day, and providing full, global observations for weather prediction. Suomi NPP, which was initially planned as a research and risk reduction mission when it launched on October 28, 2011, became NOAA's primary operational satellite for global weather observations on May 1, 2014.

References

This article merely scrapes the surface of a fascinating and complex system, Those interesting to delve further into the intricacies of the JPSS system are recommended to visit the EO Portal at

https://directory.eoportal.org/web/eoportal/satellite-missions/j/jpss

For more details of the VIIRS Black Marble imagery, visit

https://earthobservatory.nasa.gov/IOTD/view.php?id=90008

From the Editor's Keyboard

Les Hamilton

After fourteen eventful years, this is destined to be your final edition of the *GEO Quarterly* magazine. GEO was convened at a meeting of former members of the *Remote Imaging Group* in late 2003, dissatisfied with the direction that the group was taking, and the launch edition of this magazine appeared in March 2004.

Pointedly, the birth of GEO occurred at almost the same time as the fledgling EUMETCast service started outputting its complete 12-channel SEVIRI data every 15 minutes in January 2004, heralding a major change in the amateur approach to weather satellite imaging. Prior to this, the emphasis was firmly on providing members with construction projects, aimed principally at the NOAA APT satellites. These included adjusting and interfacing with the YU3UMV framestore for the display of satellite images, building antennas of different designs and constructing the RF1 and RX2 receivers from kits of components.

But during the lifetime of GEO such activities have come almost to a standstill, particularly as the EUMETCast service expanded to make available high resolution images from the NOAA, Metop, Fengyun, Suomi, Terra, Aqua, GOES and Himawari satellites: it's now just so easy to download all this data via a DVB-S2 satellite feed. Direct reception of satellite images has been largely abandoned, apart from a brief flurry of interest in Meteor LRPT reception using USB DVB-T dongles a couple of years back.

Nowadays I have been reduced to trawling internet sites, particularly *NASA Earth Observatory*, to fill our pages with items that members could easily look up for themselves. Contributions from readers have dwindled almost to zero, and compiling Quarterlies has become a chore I can well do without.

What is the Way Ahead for GEO?

Despite the apparent total lack of invention on the part of our members in the British Isles, there are enthusiasts 'out there' who have been working hard on the lost art of direct reception of high resolution weather satellite images. In this respect I commend to you the article on page 18 by Rob Alblas and Ben Schellekens from our Dutch counterparts, **Werkgroep Kunstmanen**, who have developed hardware and software that can receive images directly from the European Metop satellites and the Chinese Fengyun-3 series.

Members of the *werkgroep* have never lost the desire to develop new hardware and software, and the big breakthrough came in 2015 when Ben Schellekens successfully decoded an image from part of a Metop pass over The Netherlands. Development has continued, and the group has finally designed a system that will decode and display high-resolution imagery from NOAA, Meteor N2, Metop and Fengyun-3 polar orbiting satellites.

Werkgroep Kunstmanen publish details of all their projects in a quarterly magazine entitled '*De Kunstmaan*', the September cover of which is illustrated here. Francis Bell, David Taylor and myself have been members of this group for some years, and although the magazine is of course printed in Dutch, all non-Dutch subscribers receive a PDF English version too. If you are interested in projects relating to direct reception of satellite imagery, and would like to subscribe to this magazine, visit

http://www.kunstmanen.net/index.php

From the **Contact** menu option, select **Membership** for instructions, in English, for joining.

Membership is €30 per year, which brings you four copies of the magazine. The easiest form of payment is by *PayPal*.

Future Articles

Although this will be the final edition of *GEO Quarterly* magazine, GEO will continue as a web-based organisation via its website at

www.geo-web-org.uk

and the GEO-Subscribers *YAHOO* Group at the URL shown across the foot of this page.

If, in future, any GEO member comes up with an article they wish to share with others, I will continue to be available at

geoeditor@geo-web.org.uk

to create a PDF version which can be made available from the GEO Website and notified to members by email (or GEO-Subscribers).

The new era of direct satellite reception has started and will assuredly be boosted by the recent launch of JPSS-1. Surely there are members who would wish to join in this 'new wave' of interest!

Useful Websites

Finally, here is a list of some of the websites from which I have culled images to fill the pages of *GEO Quarterly* over the years. If you have enjoyed reading excerpts from NASA Earth Observatory, you can continue following these interesting topics at the links below.

NASA Earth Observatory

https://earthobservatory.nasa.gov/
https://earthobservatory.nasa.gov/NaturalHazards/

MODIS

https://modis.gsfc.nasa.gov/gallery/showall.php
https://lance-modis.eosdis.nasa.gov/cgi-bin/imagery/realtime.cgi

Sentinel 1

http://www.esa.int/spaceinimages/Missions/Sentinel-1

Sentinel 2

http://www.esa.int/spaceinimages/Missions/Sentinel-2

Sentinel 3

http://www.esa.int/spaceinimages/Missions/Sentinel-3

BREAKUP OF THE LARSEN ICE SHELVES

Les Hamilton

During the latter half of the 20th century, up until the late 1990s, the Antarctic Peninsula was one of the fastest-warming locations on Earth. And although temperatures since have stabilised—indeed fallen slightly—this has left a serious legacy for the Larsen ice shelves along its eastern margin. Until 1995 there were three ice sheets here, Larsen-A, Larsen-B and Larsen-C, but in January of that year, Larsen-A disintegrated. This occurred well before the arrival of NASA's Terra satellite with its 250 metre imaging resolution (in December 1999), and as far as I can detect, no images of this event exist. But seven years later, when Larsen-B suffered its sudden and rapid disintegration, it was well documented by satellite observations as illustrated below. And on July 12, 2017, when a huge iceberg (A68) measuring almost six thousand square kilometres in area and weighing over one trillion tonnes broke free from Larsen-C, this surely signalled the start of its demise.

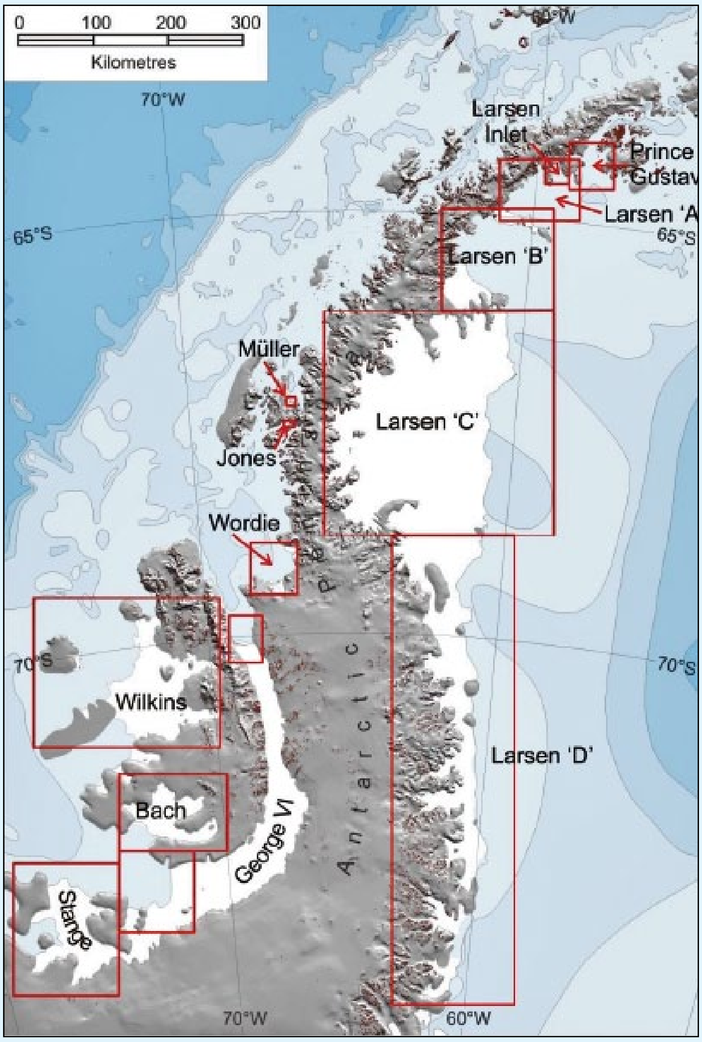


Figure 1 - The Antarctic Peninsula, showing the Larsen Ice Shelves
Map courtesy Wikimedia Commons / A. J. Cook and D. G. Vaughan

The Disintegration of Larsen-B (2002)

During the Southern Hemisphere summer of 2002, between the end of January and early March, the MODIS instrument aboard NASA's ***Terra*** satellite documented the spectacular disintegration of part of the Larsen-B ice shelf. Figure 2 on page 8 was acquired on January 31, just prior to the commencement of the breakup.

By February 17, the leading edge of the C-shaped shelf had already retreated about 10 kilometres as the ice began to splinter (figure 3), and the next clear view of the area showed that a number of long narrow icebergs had fractured from the south of the shelf (figure 4).

By March 5, imagery analysed at the University of Colorado's *National Snow and Ice Data Center* (NSIDC) revealed that disintegration of the northern section of the Larsen-B ice shelf was well advanced with the ice now broken into a blue-tinged mélange consisting of slush and icebergs drifting into the Weddell Sea (figure 5). A total of some 3,250 square kilometres of shelf area had broken apart during a 35-day period beginning on January 31, bringing the total ice loss over a five year period to 5,700 square kilometres and reducing the area of Larsen-B to a mere 40% of its original extent.

Many of these bergs were too tall and narrow to float upright and had toppled over and spread out across the bay like a neat row of books that had been knocked off a shelf. When the bergs tipped over, the pure ice from the underside of the ice shelf became exposed, and the pale blue colour was primarily due to the reflection of sunlight from this ice (because pure, thick ice absorbs a small amount of red light).

The final two images were captured as the austral autumn arrived and show the bright blue colour of the ice debris field fading as the remnants of the shelf became covered by the first snows of the season. Seasonal sea ice began to form, locking most of the ice debris in place for the winter, although the April 13 image (figure 7) shows that a few of the largest icebergs from the southern portion of the shelf had already drifted out of the area.

The 220 metre thick Larsen-B shelf was fed by glaciers streaming from the interior of the peninsula. Based on ice-flow studies, and the sediment thickness beneath it, scientists believe that it had been stable for at least ten thousand years, and possibly even since the end of the last major glaciation 12,000 years ago. At the time, the Larsen-B event was the largest single breakup of its kind known in the previous 30 years, and released 720 billion tonnes of ice into the ocean. Over the peninsula as a whole, the extent of its seven ice shelves has declined by a total of about 13,500 square kilometres since 1974.

Inevitably, such an event fuels speculation that its origin lies in the 0.5°C per decade climate warming trend in this region between the 1940s and the end of the century. Icebergs that break from ice shelves and float off to melt in warmer ocean waters do not raise global sea levels because the ice shelves themselves are already floating, even before the ice breaks away. However, should Antarctica's great ice sheets, which rest on land, lose their mass to the ocean, sea levels would rise. There's enough frozen water in the West Antarctic Ice Sheet alone to lift global sea levels by

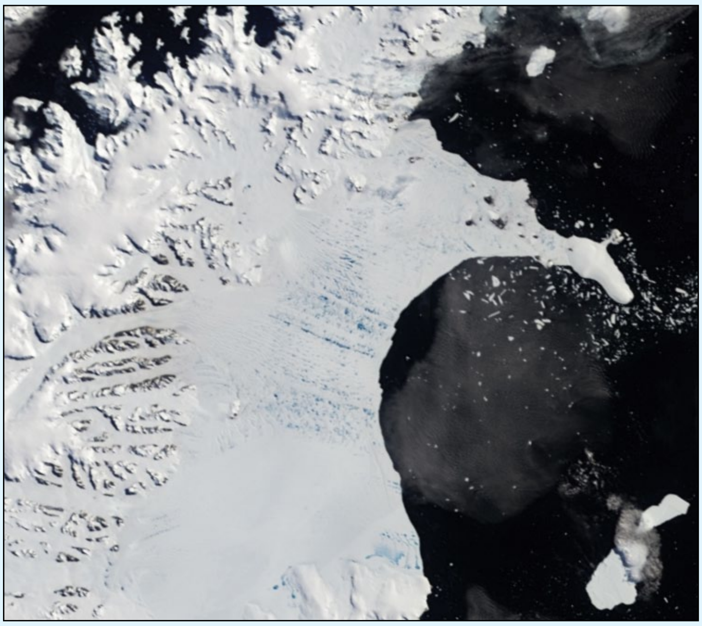


Figure 2 - Larsen-B on January 31, 2002

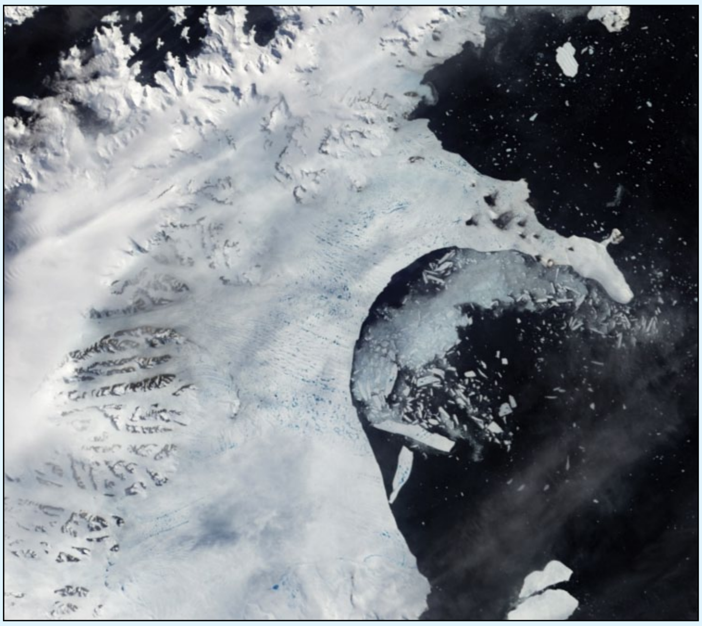


Figure 3 - Larsen-B on February 17, 2002

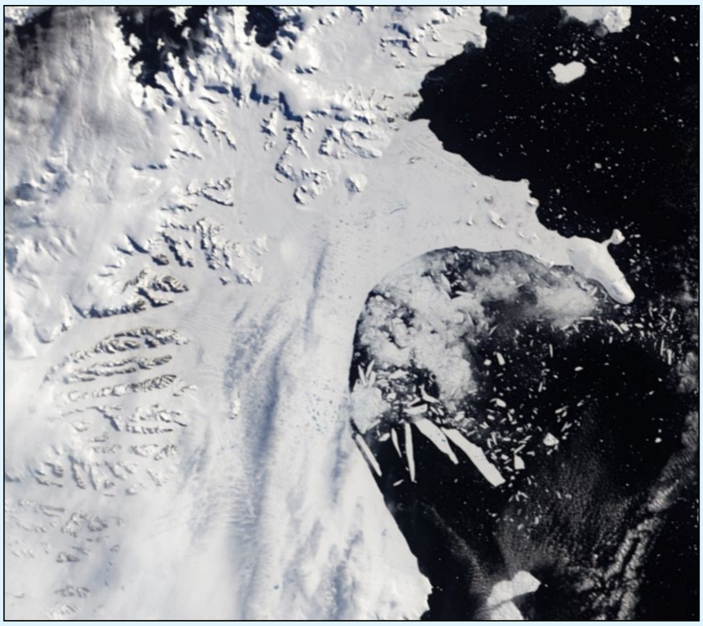


Figure 4 - Larsen-B on February 23, 2002

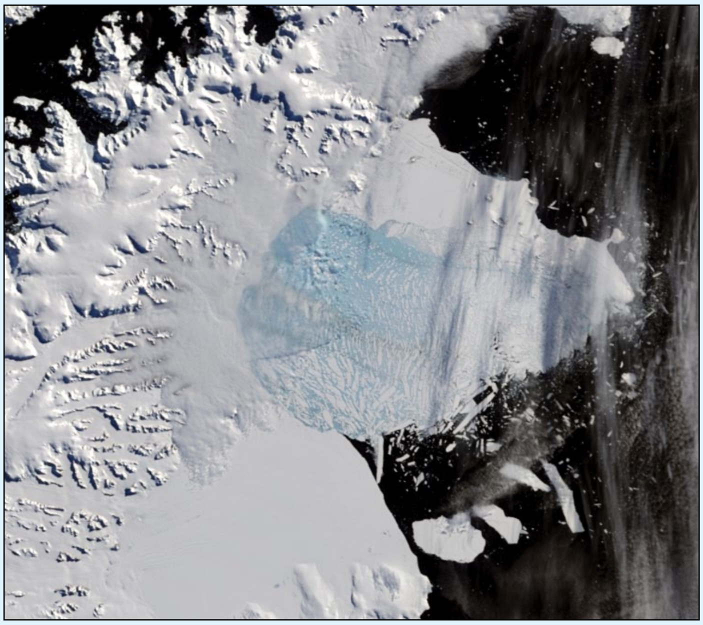


Figure 5 - Larsen-B on March 5, 2002

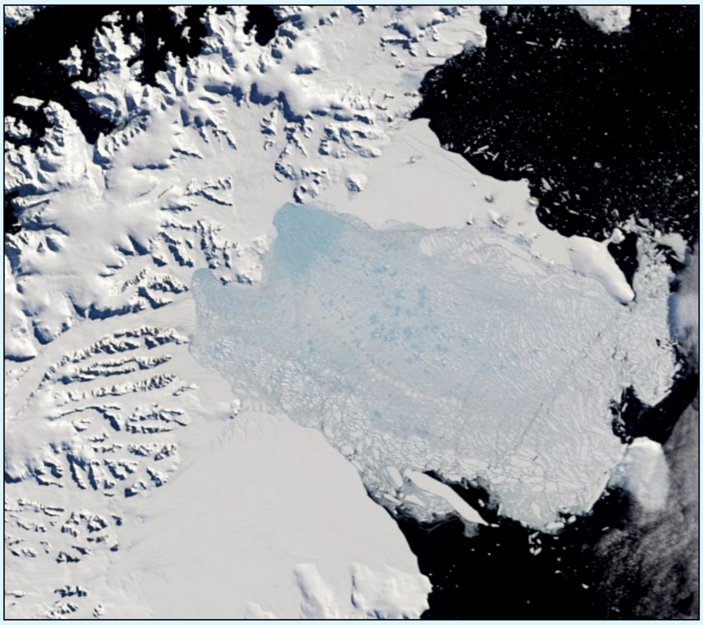


Figure 6 - Larsen-B on March 17, 2002

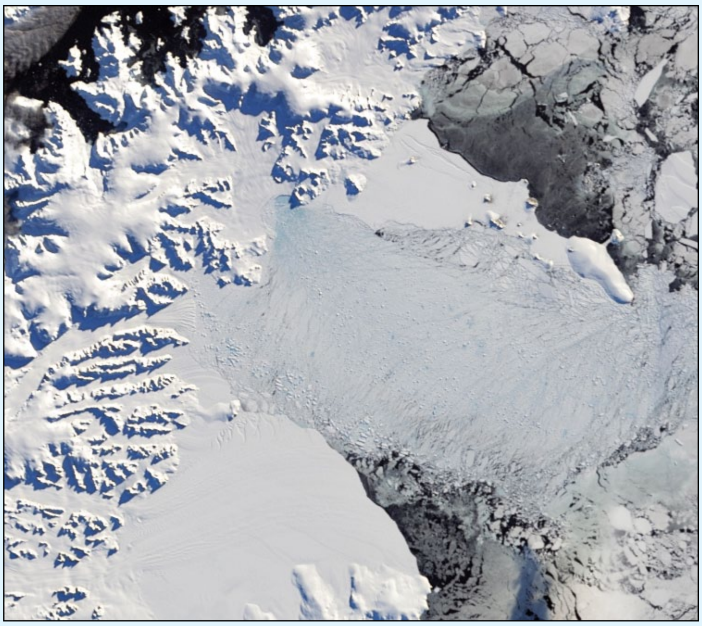


Figure 7 - Larsen-B on April 13, 2002

Images courtesy Ted Scambos, National Snow and Ice Data Center, University of Colorado, Boulder, based on data from MODIS six metres. Such melting would also alter the salinity of the seawater and threaten many species of marine life.

The collapse of Larsen-B appears to have been due to a series of warm summers on the Antarctic Peninsula, which culminated with an exceptionally warm summer in 2002. As the region warms during late summer, melt ponds collect on the ice surface. This meltwater acts to enhance fracturing of the ice by filling small cracks, the weight of the meltwater then deepening crevasses and eventually causing the shelf to splinter. Satellite images have provided substantial observational proof that this is in fact the main process responsible for the peninsula shelf disintegration.

Other factors might also have contributed to the unusually rapid and near-total disintegration of the shelf. Warm ocean temperatures in the Weddell Sea that occurred during the same period might have caused thinning and melting on the underside of the ice shelf. As the surface melt ponds began to fracture the shelf, strong winds or waves might have flexed the shelf, helping to trigger a runaway break up.

The ice debris field did not become a permanent fixture in Larsen Bay, and as seasonal sea ice melted the following summer, the mélange began to drift away with the currents.

The Disintegration of Larsen-C (2017)

The first hint of activity in the Larsen-C ice shelf came in 2014 with the development of a narrow rift developing on its surface. By August 2016, at the end of the Antarctic winter, it was clear that the rift along Larsen-C had grown considerably longer during the austral winter. Figure 8, acquired by the *Multi-angle Imaging SpectroRadiometer* (MISR) instrument aboard NASA's Terra satellite shows the rift clearly.

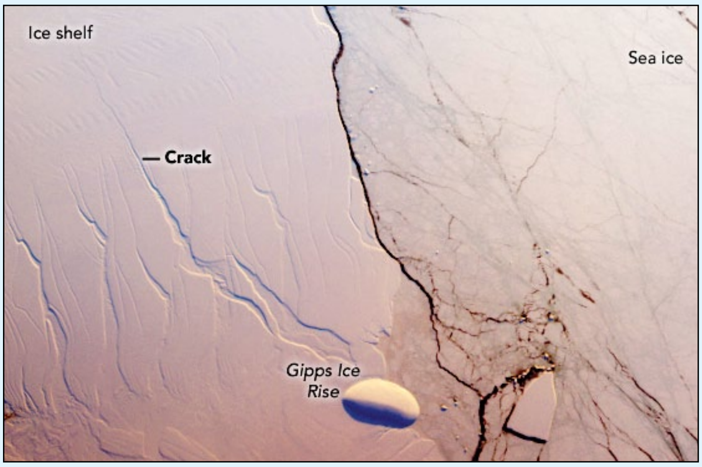


Figure 8 - This MISR image acquired on August 22, 2016, was the first to show the accelerated growth of the rift in the Larsen-C ice sheet.
Image: NASA / GSFC / JPL, MISR Team

By November, the arrival of longer days and favourable weather prompted members of NASA's *IceBridge* team to fly aboard their DC-8 research aircraft to take a closer look at the crack (figure 9). They saw that the rift in Larsen-C now measured some 100 metres in width by half a kilometre in depth—completely through to the bottom of the ice shelf, though not yet straddling its entire width.

Scientists continued to observe growth of the crack during the sunlit months of late 2016 and early 2017, scientists watched closely as the crack stretched ever farther across the Larsen-C ice shelf, threatening to eventually create one of the largest icebergs ever recorded. Even after

Figure 9 - The Larsen C crack viewed from NASA's DC-8 research aircraft on November 10, 2016
Photo: John Sonntag / NASA

winter returned to the southern hemisphere, observations continued, courtesy of the Thermal Infrared Sensor (TIRS) on NASA's **Landsat-8** and radar imagery from Europe's **Copernicus Sentinel-1** mission.

On June 17, 2017, Landsat 8 captured figure 10, which shows the relative warmth or coolness of the landscape. Orange depicts where the surface is the warmest, most notably the areas of open ocean and of water topped by thin sea ice. Light blues and whites are the coldest areas, spanning most of the ice shelf and also some areas of sea ice. The blue hue of the crack itself indicates that relatively warm ocean water is not far below the ice surface.

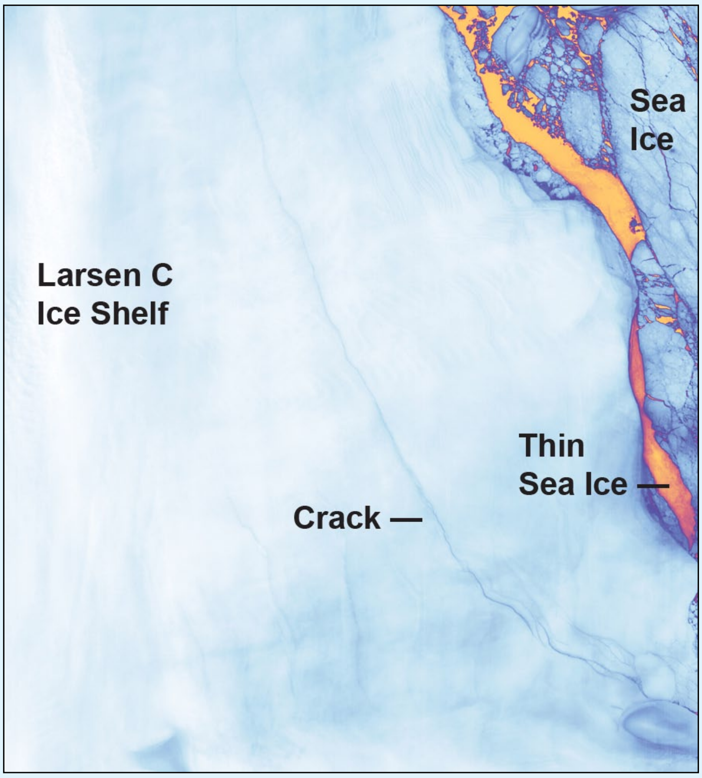
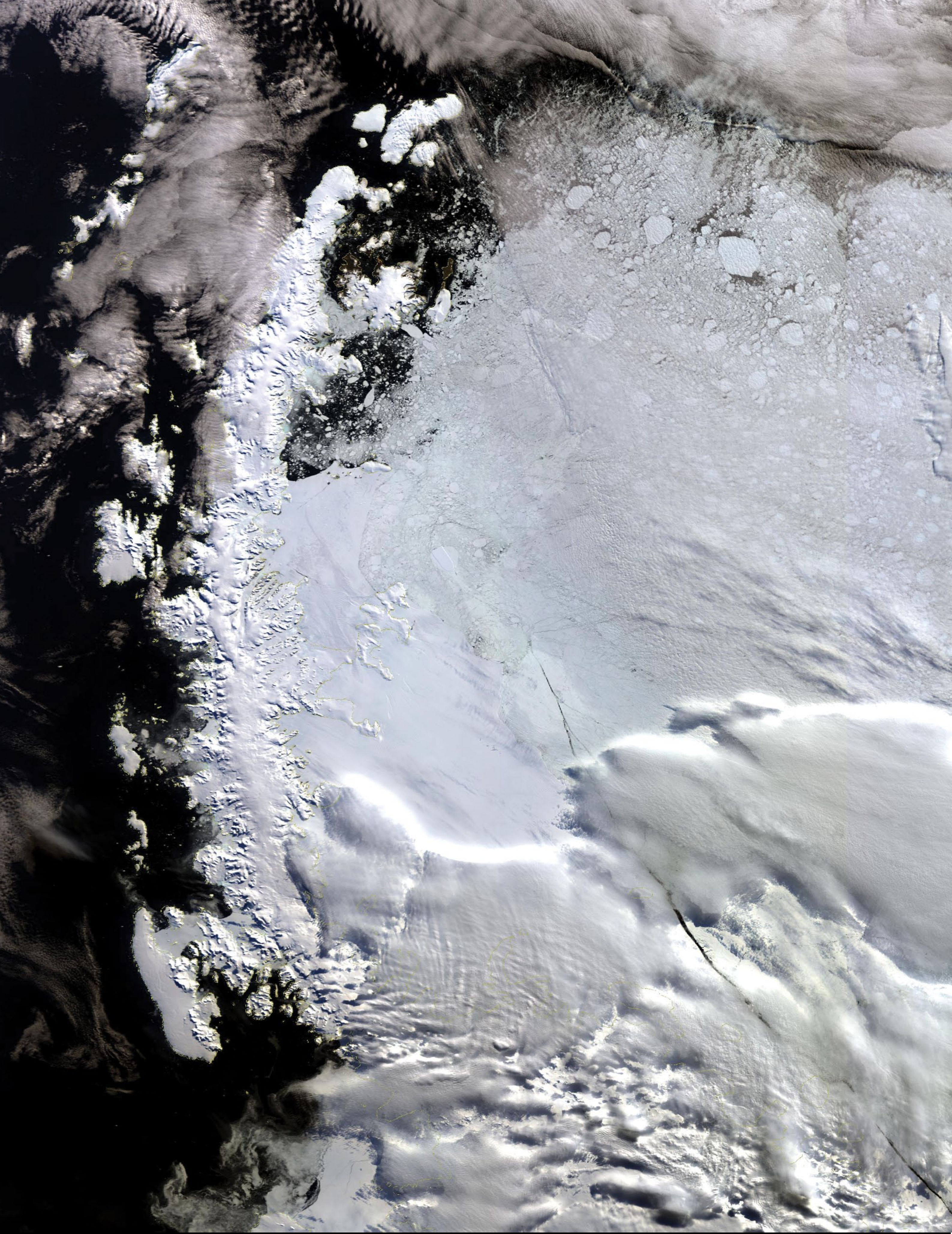


Figure 10 - Landsat-8's TIRS imaged the crack on June 17, 2017.
NASA image by Joshua Stevens, using Landsat data from the USGS

The crack had been lengthening rapidly during 2017, and by the end of June only a few kilometres remained between the end of the fissure and the ocean. Scientists from Project MIDAS, an Antarctic research consortium led by Swansea University in the UK, used radar images



GEO Reader Peter Kinghorn acquired this virtually cloud-free MODIS image of the Antarctic Peninsula—from NASA's Terra satellite—on February 6, 2017. The Larsen-C ice shelf is prominent to the east of the peninsula, in the centre of the image.
Image: LANCE Rapid Response / NASA / GSFC

from the Copernicus Sentinel-1 mission started to keep a close eye on the rapidly changing situation. The synthetic aperture radar (SAR) on Sentinel-1A imaged the crack on June 28 following a period during which it had been widening rapidly as ice near its leading edge was being weakened by generally westerly winds tending to push it eastward, and again on July 12 when it observed the final separation of iceberg A-68, a huge lump of ice more than twice the size of Luxembourg, from the Antarctic Peninsula (figure 12).

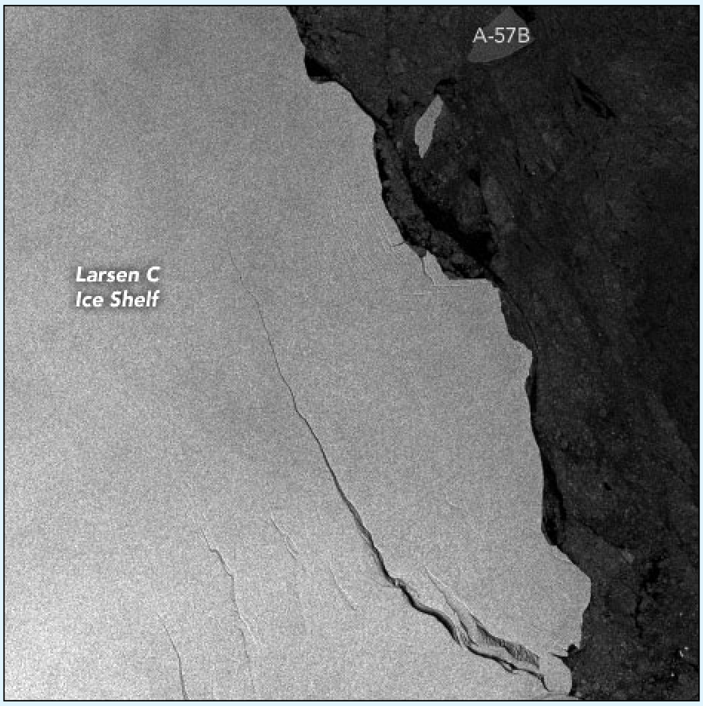


Figure 11 - Sentinel 1A imaged the widening crack on June 28, 2017.
Image: modified Copernicus Sentinel data (2017) / European Space Agency

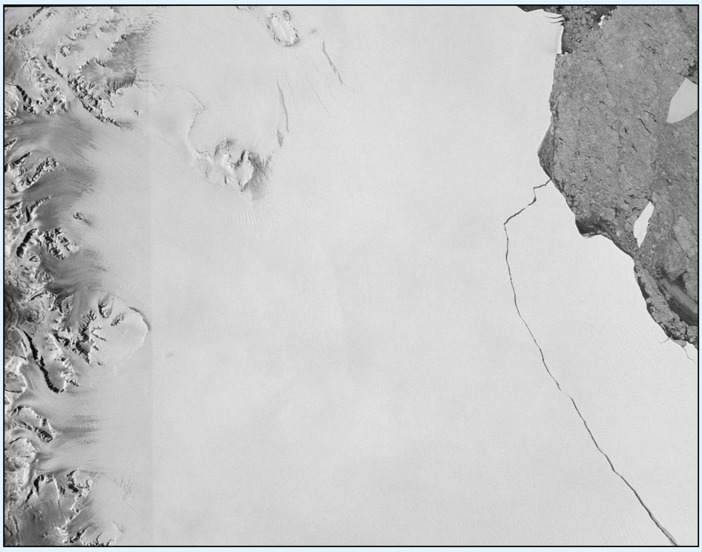


Figure 12 - Sentinel'-A captured the first image showing that a giant iceberg had calved from the Larsen C ice shelf on July 12, 2017.

With an area of around 6000 square kilometres and weighing an estimated trillion tonnes A-68 is a truly enormous iceberg—about 10% of the original Larsen-C ice shelf. It contains approximately the same volume of water as Lake Ontario in North America.

The loss of such a large chunk from Larsen-C is significant, because ice shelves along the peninsula play an important role in buttressing glaciers that feed ice seaward, effectively slowing their flow. Earlier such events at the Larsen-A and -B shelves indicated that when a large portion of an ice shelf is lost, the flow of the glaciers behind can accelerate, contributing to sea-level rise.

In September 2017, as the return of daylight to the Antarctic began to illuminate the region, the Moderate Resolution Imaging Spectroradiometer(MODIS) on NASA's *Terra* satellite was able to acquire the first true-colour day time image showing the massive iceberg separated from the Larsen-C ice shelf. Figure 13 was captured on September 11. Throughout the previous week, offshore winds were pushing sea ice away from the shelf and out to sea. The residual thin layer of frazil ice (gray mottled streaks on the dark ocean) did not offer much resistance, allowing iceberg A-68A to move out over the ocean.

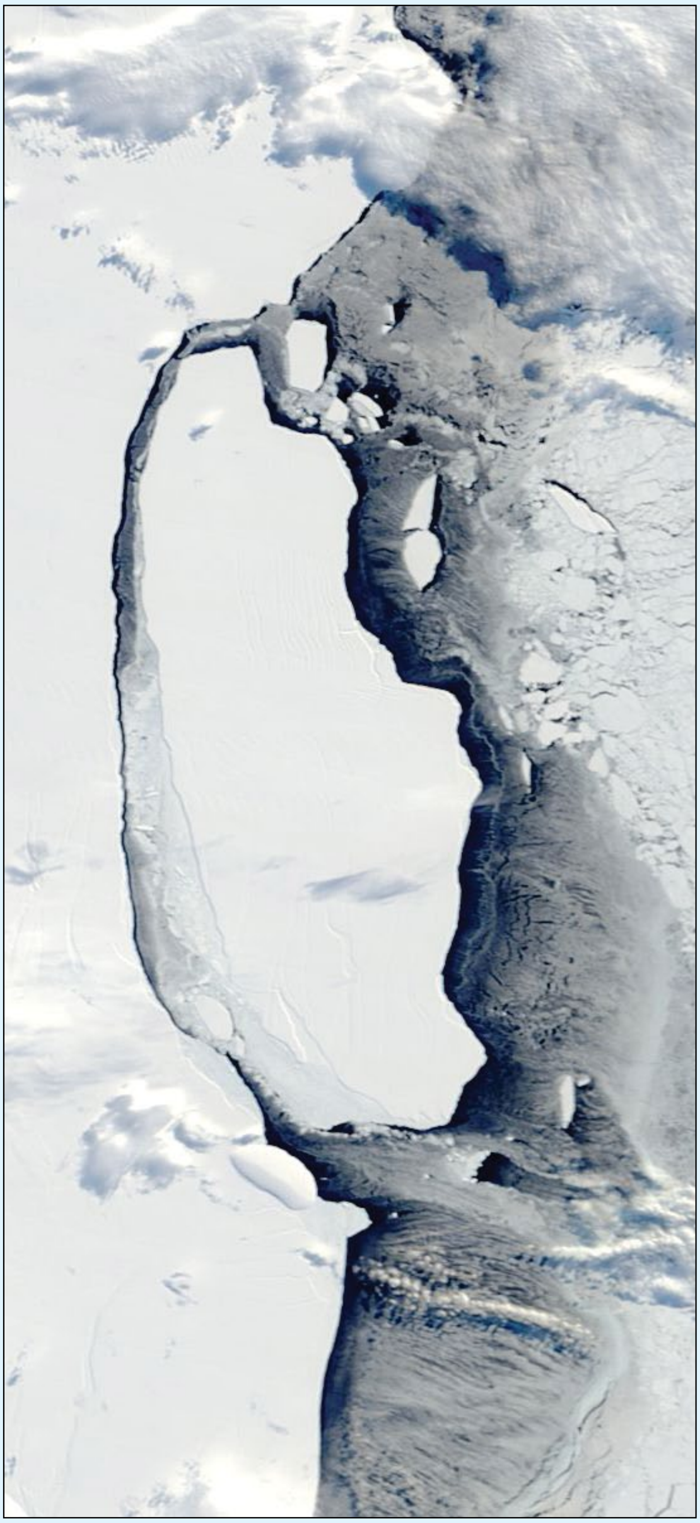


Figure 13 - NASA's Terra satellite captured this MODIS image of the calved A-68A iceberg on September 11, 2017
Image: Jeff Schmaltz, MODIS Land Rapid Response Team, NASA GSFC

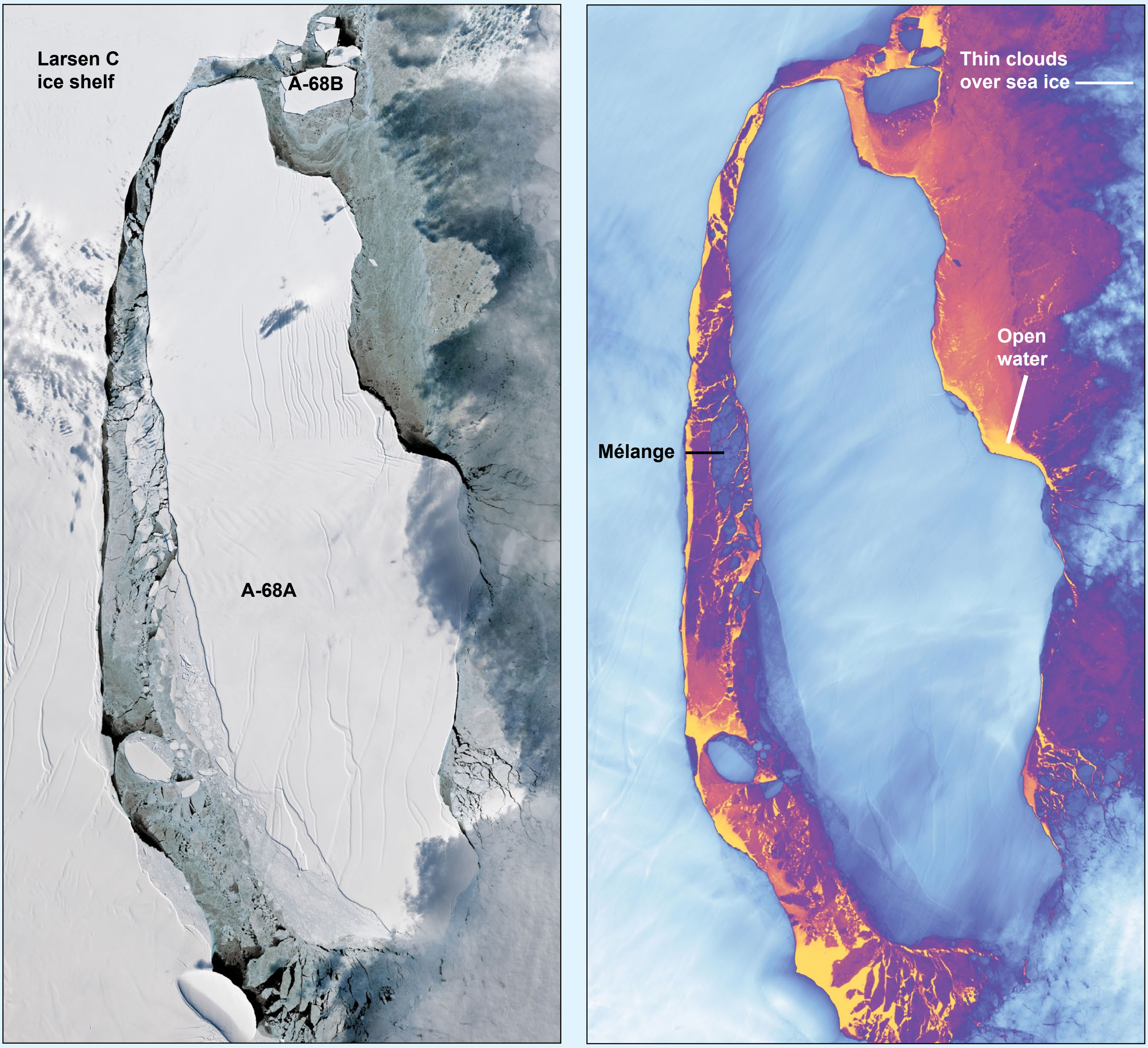
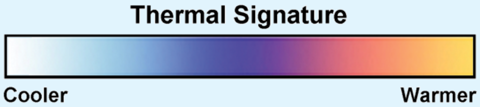


Figure 7 - Iceberg A-68 imaged in visible light (left) and in thermal infrared (right) in mid September, 2017.
NASA Earth Observatory images by Joshua Stevens using Landsat data from the U.S. Geological Survey. Story by Kathryn Hansen.

A-68 Adrift

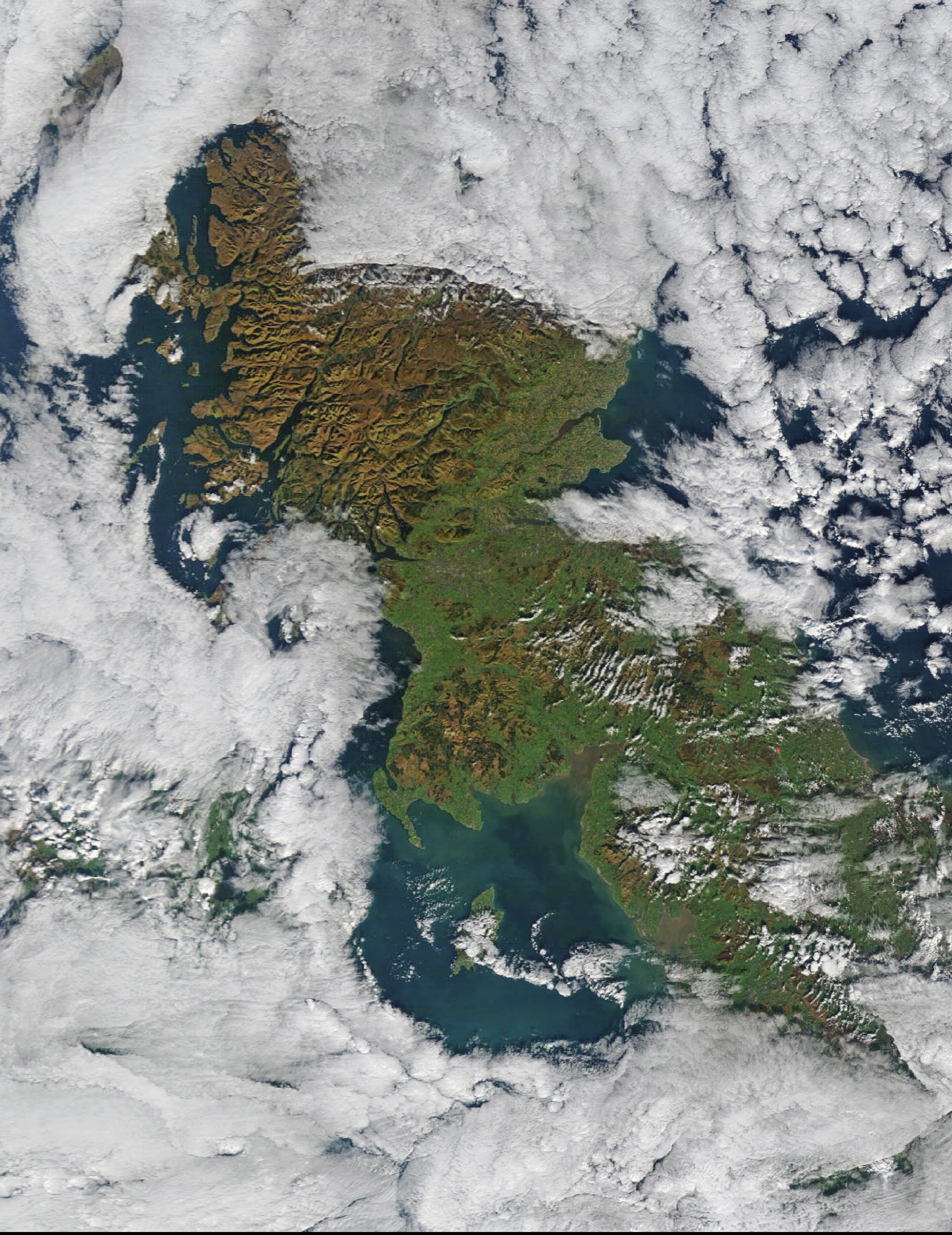
On September 11, 2017, the *Moderate Resolution Imaging Spectroradiometer* (MODIS) on NASA's **Terra** satellite captured the visible light image of iceberg A-68 (left-hand image above) while the *Operational Land Imager* (OLI) and the *Thermal Infrared Sensor* (TIRS) on **Landsat 8** acquired the detailed IR image reproduced above right.

The MODIS image at left shows the iceberg in natural colour. The rifts on the main berg and ice shelf stand out, while clouds on the east side cast a shadow over the berg. The thermal image on the right shows the same area in false-colour. Note that the clouds over the ice shelf do not show up as well in the thermal image because they are at about the same temperature as the shelf itself. Thermal imagery has the advantage of showing where the colder ice ends and warmer water of the Weddell Sea begins. It also indicates differences in the thickness of ice types: for example, the mélange is thicker (has a colder signal) than the frazil ice, but thinner (warmer signal) than the shelf and icebergs.



Both images show a thin layer of frazil ice, which offers little resistance, as winds, tides and currents try to move the massive iceberg away from the Larsen-C ice shelf. In the course of several weeks of observations, scientists observed the passage between the main iceberg and the front of the shelf widen. This slow widening came after an initial back-and-forth movement in July broke the main berg into two large pieces, which the *U.S. National Ice Center* named A-68A and A-68B.

The collisions also produced a handful of smaller bergs too small to be named, one of which has been drifting northward in the passage since the break. Notice how the edges of this piece appear much sharper than the edges of the shelf or A-68A, whose margins have already been rounded by blowing snow and gravity: the smaller piece has been battered and reshaped by recent collisions, resulting in its highly defined edges.



The ruggedness of Scotland's Northwest Highlands is revealed in this weather window, captured by the MODIS instrument aboard NASA's Terra Earth Observatory on November 2, 2017
Image: LANCE Rapid Response/NASA/GSFC

Salar de Atacama

Les Hamilton

Chile's Atacama Desert is probably the driest place on Earth, large parts of it having gone without moisture for as long as people have been keeping track. Yet some precipitation does fall in the region, and that water helps to shape the landscape.

Within this arid environment lies a salt flat, or playa named Salar de Atacama. Surrounded by mountains—the Andes to the east and the Cordillera de Domeyko to the west—this is the largest salt flat in Chile, and has no drainage outlets. The salar, which lies at an altitude of 2300 metres, has an area of some 3000 km^2 and measured approximately 100 km from north to south and 80 km in width. The Landsat 7 satellite acquired the false-colour image at right on March 21, 2002. Red indicates vegetation, the most abundant of which occurs around springs that dot the northern edge of the saltpan. Nearby soils that support some vegetation appear tan and brown.

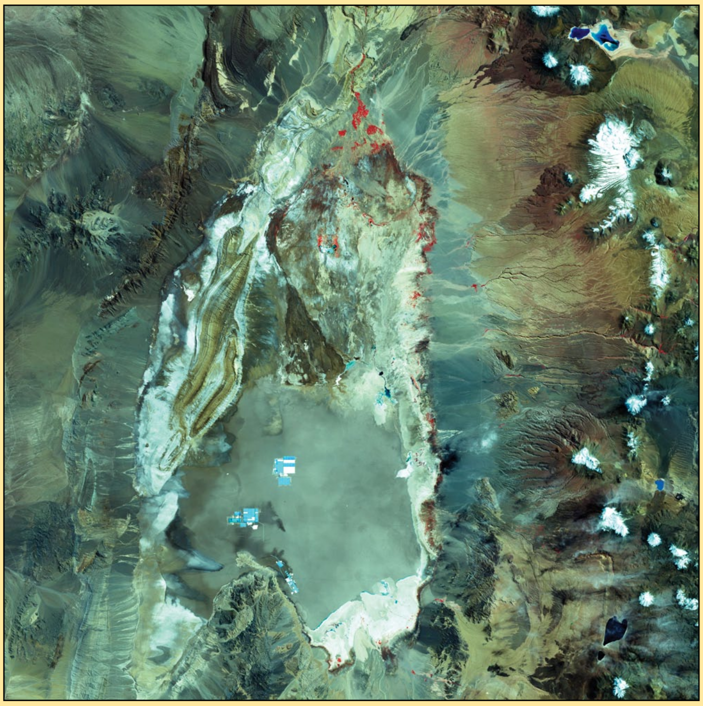
A view across Salar de Atacama, with Licancabur volcano beyond
Image: Francesco Mocellin / Wikimedia Commons

Although it sits at a much higher elevation, the Salar de Atacama resembles California's Death Valley as a flat area lying between mountain ranges. Most of what little precipitation falls usually drains off the mountains and flows into nearby valleys, creating alluvial fans. The salt flat is a geologically young, dynamic system. Occasional floods do reach the saltpan, when flood waters transport gravel, sand, clay, and salt. Heavier materials such as gravel and sand tend to drop out of the water sooner, coming to rest outside the saltpan whereas clays and salts can hitch a ride all the way to the playa.

Floods initially stir the sediments inside Salar de Atacama, but material eventually settles into layers of clay and salty water. Because the playa lacks drainage, water is lost solely through evaporation. As it evaporates, salts remain behind and form crusts. Inside the saltpan, mottled light blue indicates surface salt crusts.

The white colour around the perimeter of the saltpan indicates a zone of clay and carbonate-rich material that alternately forms a crust on the surface and redissolves with rising and falling groundwater. Northeast of the playa, white indicates snow and ice on the volcanic Andean peaks. Volcanic rocks and soils range in colour from burnt orange to tan.

Around the playa, the false-colour green indicates rocks that would appear red to human eyes. Blue indicates older



Salar de Atacama false colour image, acquired by Landsat 7 in 2002
NASA Earth Observatory image created by Jesse Allen, using Landsat data *provided by the United States Geological Survey*

sedimentary rocks (deposited by wind and water) and igneous rocks (formed from cooling lava or magma) that support no vegetation.

Not surprisingly, Salar de Atacama is extensively mined for salts, and turquoise and white rectangular evaporation ponds can be seen in the centre of the saltpan, particularly in the Sentinel 2A image opposite. Particularly important is lithium extraction, as Salar de Atacama is the world's largest and purest active source of the metal and contains 27% of the world's known reserves. High lithium concentration in its brine (2,700 parts per million), a high rate of evaporation (3,500 mm per year), and extremely low annual rainfall (<30 mm average per year) make finished lithium carbonate easier and cheaper to produce here than anywhere else. Also extracted here is boron,as boric acid (up to 0.85 g/l in the brines).

Salar de Atacama
Image: Roman Bonnefoy / Wikimedia Commons

This image of Salar de Atacama, the largest salt flat in Chile, was acquired by ESA's Sentinel 2A satellite on November 15, 2017

Image: Modified Copernicus data © ESA / Sentinel (2017)

Receiving Satellites the Hard(?)-Ware Way

Rob Alblas** and **Ben Schellekens

With the arrival of EUMETCast, a huge amount of satellite data is now available for amateurs. This has made the purchase of specific equipment for each type of satellite unnecessary. Even imagery from polar satellites can be received via EUMETCast, thus eliminating the need of a complex and, for many people, unreachable rotor system. The problems facing amateurs are therefore shifted from electronics and mechanics to computer and networks. For many people interested in '*just*' the pictures, this is a blessing; for others it's an impoverishment of the hobby.

Reception in the old-fashioned way is still possible, but the final NOAA satellite was launched a long time ago now (2009). If the NOAAs are decommissioned, not only APT but also HRPT disappears and *Timestep* equipment, especially the decoder unit, becomes worthless.

In the meantime, new satellites have been launched that send their data to the user in the same way, that is, 'live' via the 1700 MHz band. The Russian Meteor system still resembles HRPT: the same receiver can be used, but the decoder must be different. For other satellites like Metop and the Chinese Fengyun, the case is radically different. The very simple HRPT format has been replaced by more advanced formats: these permit a much higher data rate, are provided with FEC (Forward Error Correction), and are transmitted using QPSK. This requires a different receiver and a much more complex decoder, items that are not readily available to the amateur, and which are highly expensive. There remains then just one option: to design and build them yourself.

Table 1 provides an overview of the polar satellites that can be received. I've added Fengyun-1 for completeness, but this series has long ceased to be active. In fact, on January 11, 2007, China conducted an anti-satellite missile test, destroying FY-1C using a 'kinetic-kill' vehicle travelling in the opposite direction [6].

The active Meteor-N2 also transmits at 137 MHz via LRPT, which can be received with a simple SDR dongle. However, only three of the six channels are available in this mode. In the 1700 MHz band, all six channels are always available, with higher quality imagery (and without the annoying bar every so many lines). Meteor is referred to as Advanced HRPT, but it seems to me to be too much honour compared to Metop/Fengyun-3, as will be shown later.

At least one more Metop and some type-3 Fengyuns will be launched in the future.

In order to be able to continue receiving polar satellites—in addition to a rotor system and dish—you will require the flowing:

- a QPSK receiver
- a decoder for HRPT / Meteor / Metop / Fengyun
- software for converting the received data to files and to create pictures

Nowadays, such systems can be realised with *Software Defined Radio*, but at the higher bit rates it can be difficult because it produces very large files with raw data that must be demodulated and decoded. A picture can only be made after the data has been received. Watching 'live' with a current normal PC is not possible.

The 'old-fashioned' hardware method then gives opportunities.

Satellite	Modulation	Data Rate	Format	Channels	Number
NOAA	PSK, split-phase	665.4 kb/s	HRPT	AVHRR, 5x	3
Fengyun-1	PSK, split-phase	1.3 Mb/s	CHRPT	10	0
Meteor N1	PSK, split-phase	665.4 kb/s	AHRPT	6	0
Meteor N2	PSK, split-phase	665.4 kb/s	AHRPT	6	1
Metop	QPSK	4.66 Mb/s	AHRPT	AVHRR, 5x + more	2
Fengyun-3	QPSK	5.2-5.6 Mb/s	AHRPT	VIRR, 10x + more	3

Table 1

A group like ***Werkgroep Kunstmanen*** appears to be valuable because people with different disciplines work together. In particular, receiver, decoder and software had to a large extent to be developed from scratch.

The Receiver

In order to receive Metop and Fengyun, a QPSK receiver is required. QPSK means that data bits are transmitted in four different phases, unlike PSK, where two phases are used to pass a logic '0' or '1'. Thus, with QPSK, 2 bits can be transmitted at the same time: this saves bandwidth.

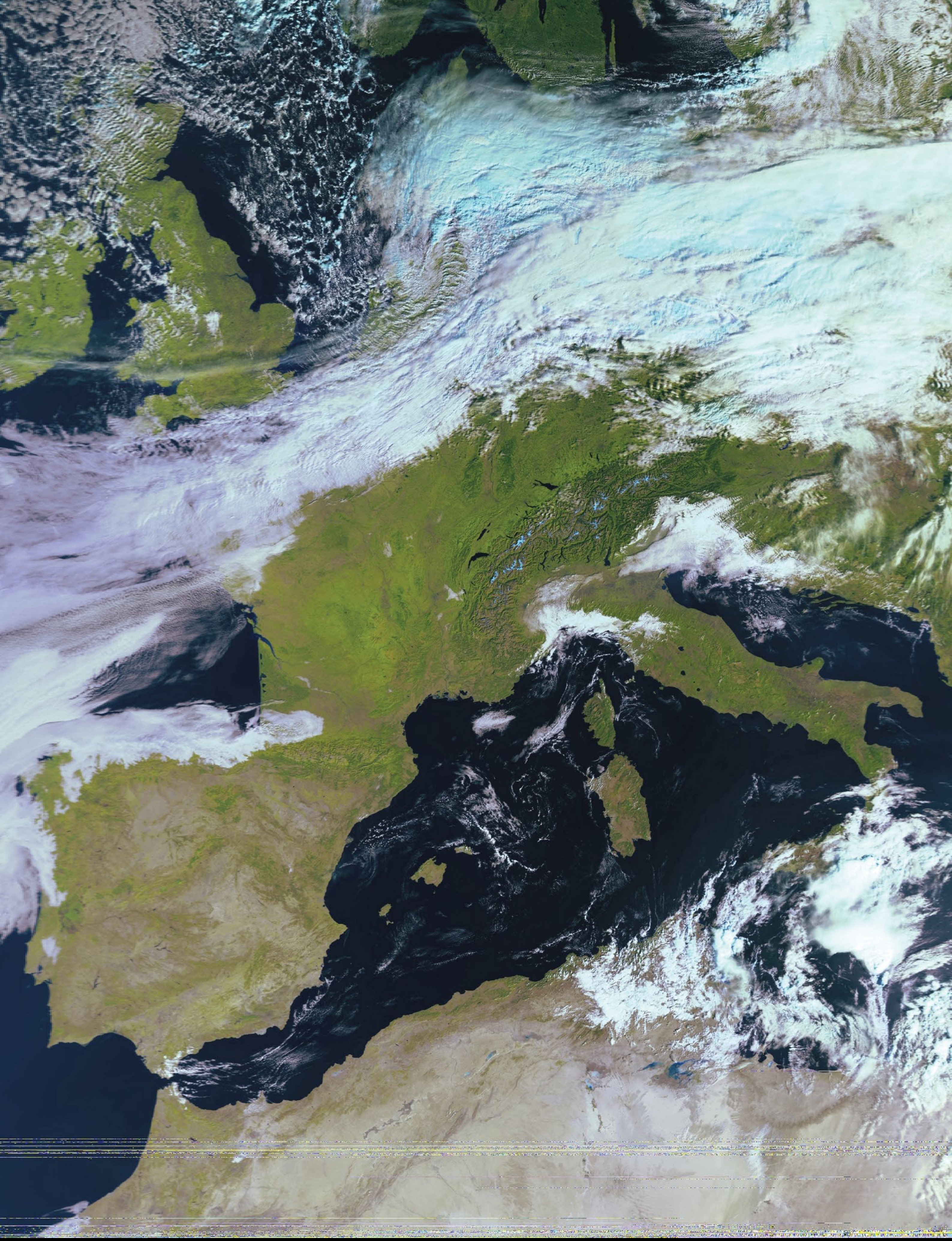
Demodulating QPSK is a separate subject. No carrier is sent, so this must be regenerated. Demodulation is done with a so-called *Costas loop*. This is a much more complex circuit than a simple phase demodulator as required for HRPT/Meteor. I cannot describe this circuit in detail here, but a comprehensive description, including the mathematics, can be found in our magazine 'De Kunstmaan' [1] and of course on the Internet.

The art is now to realise the demodulator in a simple and elegant way, which is easy to build with components that are (and remain) readily available. In particular, component availability has given us some headaches. But I think we have succeeded well, designing a receiver able to receive QPSK in addition to the old PSK from NOAAs and Meteor. The block diagram in Figure 1 gives an impression of what is needed. The part with the *LT5546*, the actual QPSK demodulator, and everything to its right, forms the *Costas loop*. The receiver delivers a 2-bit data stream (one bit of which is inactive in the case of PSK reception).

The Decoder

The decoder must convert the received bitstream into a format that will allow easy processing by the software. Transfer to PC is via USB. The hardware has already been described in GEOQ 30 [2]. It is based on an FPGA, Field Programmable Gate Array. This chip enables any digital circuit to be realised. The functional description is made in a special language, **VHDL.** At first glance, this language looks like 'normal' software languages such as **C** and **Pascal**, but it also has the ability to describe parallel processes in a way that connects to digital circuits.

Using a special program (a so-called synthesiser) the description is translated into digital components available in the FPGA. This information is translated into a bit series and then loaded into the FPGA. As a result, the desired functionality is now available in the FPGA. The circuit can now be easily adapted by reprogramming, avoiding the need of a soldering iron. This makes it possible to extend the existing HRPT, CHRPT and Meteor decoders, as described above [2], with Metop and Fengyun. (Note that an FPGA is not like a microcontroller. The



This Metop image, from a pass on October 5, 2017, was captured by Harrie van Deursen using the receiver described in this article, followed by processing using Rob Alblas' wsat software.

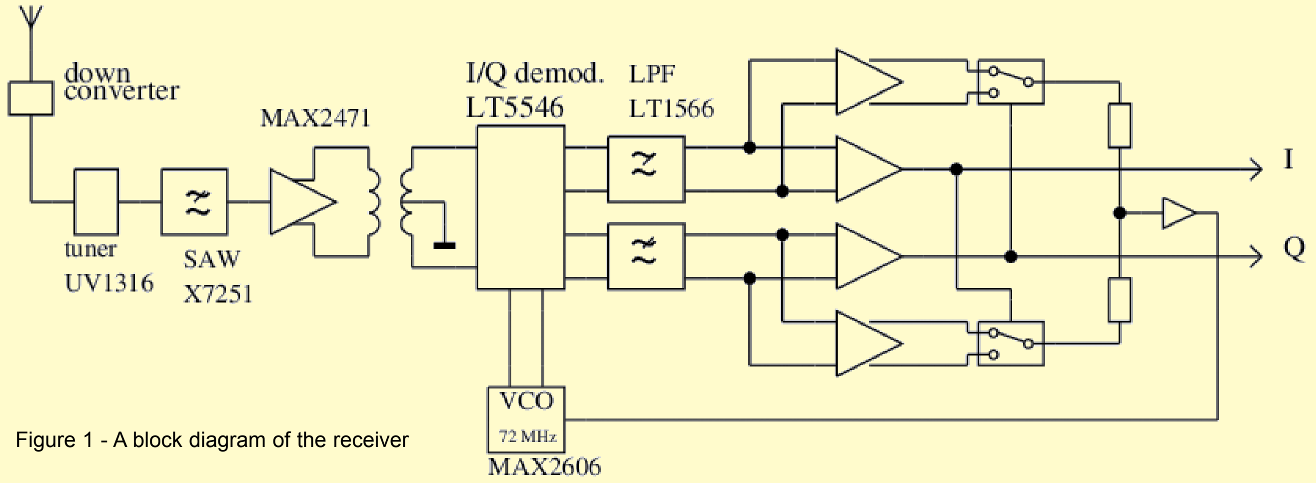


Figure 1 - A block diagram of the receiver

loaded bit sequence ensures that digital components in the FPGA are connected in the desired way and then becomes inactive.)

As mentioned in the table, there are some different data formats in circulation. The HRPT format of the old NOAAs is very simple. The data is almost exclusively from the AVHRR instrument, with the structure shown at the top of figure 2. The bits are packaged in a frame to which a synchronisation word is added. Of the 110900 bits 60 are used for the sync word, 102400 for the AVHRR data and the rest (8440 bits) for calibration and housekeeping purposes. A simple calculation shows that, at a bit rate of 665.4 kb/s, the transfer of this frame takes 110900/665.4 =1/6 second, meaning 6 lines per second.

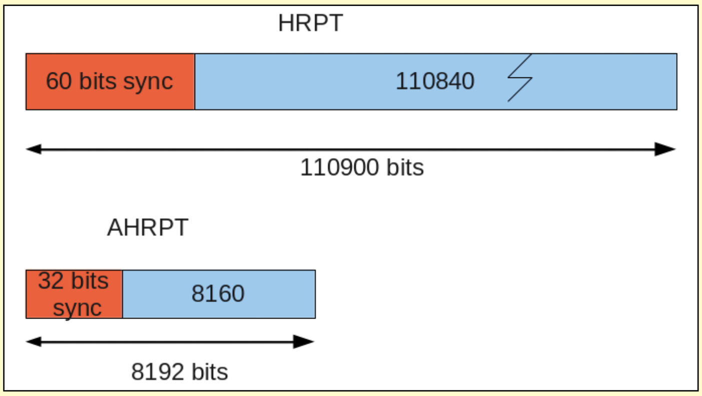


Figure 2 - Comparison of the Frames of HRPT and AHRPT

Upon reception, it is a matter of counting which bits belong to which channel and which pixel. No error correction is possible, which is also not necessary in this simple, low bit rate format. The decoder only needs to recognise the synchronisation word and then sends the rest of the bits to the PC as 10-bit units (one unit being 2 bytes).

With Metop it's a very different story. Although this satellite contains the same AVHRR instrument as the NOAAs, it's image data amounts to only a fraction of the total being transmitted. Metop includes the following data:

- AVHRR: about 622 kb/s
- IASI: CO_2 detection, 1500 kb/s
- GOME: Global Ozone Monitoring, 400 kb/s
- And more.

While, in the case of NOAA, the frame is adapted to the data to be sent, this is not possible with Metop with its different, large data streams. Instead, a short frame of 8192 bits is used (figure 2, bottom). The data for each line to be transmitted is divided into pieces, along with additional bytes that indicate which data type is present and where the start and end points of the line are. On the receiving side, these pieces must be stuck together again. This is a much more complex task for the software, but this method gives much greater flexibility. This explains the 'A' in AHRPT (Advanced HRPT).

Both the more complex build-up and the larger bit rate increase the bit error problem. To begin with, the higher bit rate (4.6 Mb/s versus 0.6654 Mb/s) gives a higher noise level in the receiver. This has been partially overcome by using QPSK, with 2 bits transmitted at the same time: the required bandwidth is hereby halved. However, QPSK per se is more sensitive to noise as the 'distance' between the 4 phases is smaller compared to the 2 phases of PSK, given the same total transmit power.

In addition, the frame contains control bytes that are crucial for correct decoding. Whereas a bit error in HRPT results in a wrong value pixel, such an error in a control byte could result in a whole block of data being lost because it is not recognised as belonging to, for example, AVHRR.

For this reason, FEC (Forward Error Correction) is applied. Simply said, additional bits/bytes are added to the stream, and these allow the reception system to detect and even correct errored bytes to some extent. This results in much better data quality, despite adding additional bits, which means more bandwidth needed, so more noise.

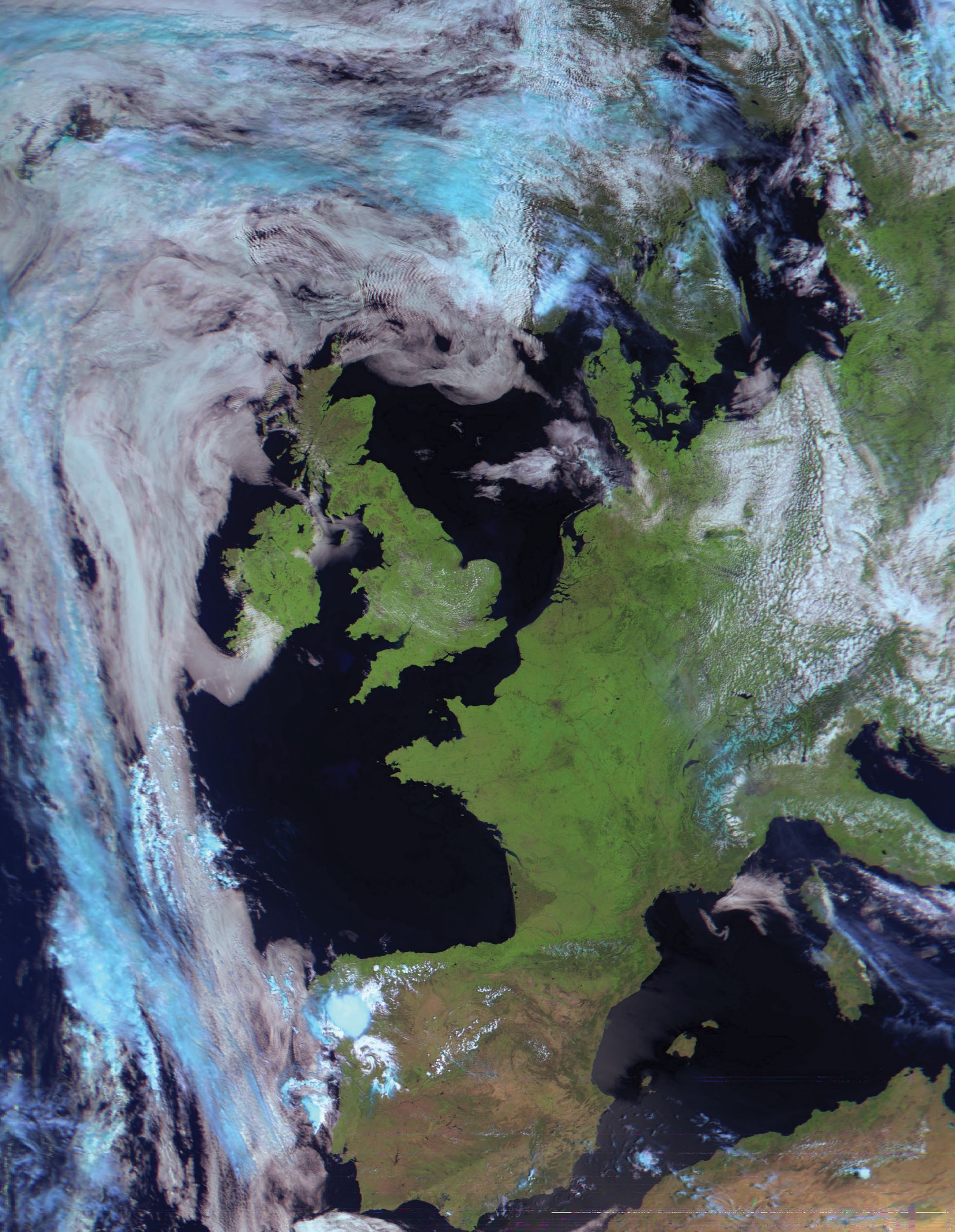
There is a lot of mathematics behind FEC, which I will not go into. But with a very global description, some insight can be gained. Both Metop and Fengyun use *Viterbi* encoding and *Reed-Solomon* error correction.

Viterbi Encoding

Simply speaking, *Viterbi* encoding means that the bits to be transmitted are smeared out in time in two different ways, thus doubling the number of bits needed to transmit them. On the receiving side, the original bitstream can be recovered, with approximately 2.5 dB profit. This, despite the fact that doubling the number of transmitted bits means an increase of bandwidth and thus noise. This coding was also used in the Voyager spacecraft, and contributes to the fact that signals from these deep space spaceships are still being received (and useful).

Metop/Fengyun uses a modified version with 1/3 of the encoded bits not being transmitted. The advantage will be somewhat lower, but more bits (net) can be transmitted in the same bandwidth. This process is termed *Punctured Viterbi*. As a result the bitstream to be transmitted is a factor of 4/3 higher than the original bitstream, instead of 2 times.

Because this encoding in the transmitter takes place at bit level, as the last operation before the transmitter, the *Viterbi*



Harrie van Deursen acquired this Feng Yun 3C image, using the receiver described in this article, on May 25, 2017 and processed it using Rob Alblas' wsat software.

decoding must first be done on the receiving side. After that, the synchronisation word can be searched, and the bits can be neatly merged into the correct bytes (figure 3). This figure also illustrates another function not present with HRPT: the 'derandomiser'. On the transmit side (in the satellite) all bits except the 32 synchronisation bits are edited with a fixed pattern. This is done to prevent too many *zeros* or *ones* being sent consecutively. On the receiving side, the original bit sequence can be retrieved by performing the same operation again using the same fixed pattern. Only a very small amount of the logic processing in the decoder is needed for this.

All operations referred to in figure 3 are performed by the hardware decoder. The vast majority of the available logic in the FPGA is required for the *Viterbi* decoder; the remainder of the processing does not require so much.

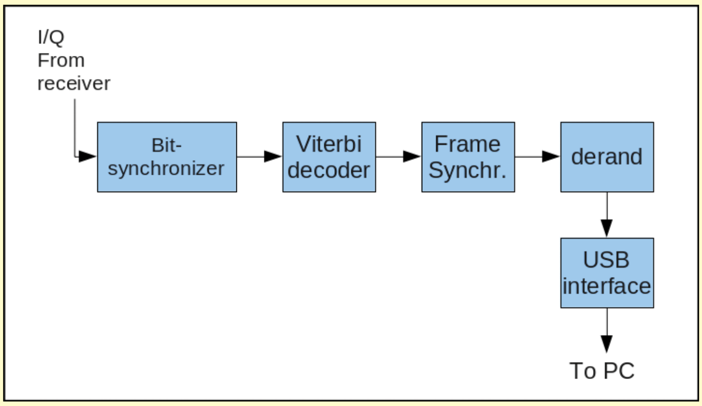


Figure 3 - Decoder Construction for Metop

Reed-Solomon Correction

What follows is the *Reed-Solomon* correction. In short, a number of bytes are added to each block of fixed length. These bytes can detect errors throughout the block and even correct them to some extent. Figure 4 shows the structure.

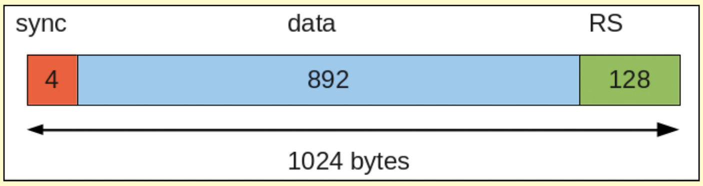


Figure 4 - Construction frame with Reed-Solomon correction block

The synchronisation word is not included in the correction process because it has already completed its work (without synchronisation, further decoding, including correction, would not be possible anyway). The rest of the frame consists of a data block and a block of correction bytes.

Reed-Solomon correction is easy to realise in software and is therefore not built into the hardware. Also, it could not be built into the used FPGA. (*Reed-Solomon* correction is also used with compact disc and DVB-S.)

Metop versus Fengyun.

The design of the Fengyun data stream initially appears identical with that of Metop. Both use the same *Viterbi* encoding and the same *Reed-Solomon* correction. However, some parts are implemented quite differently.

QPSK and *Viterbi* fit very well together, and figure 5 shows the layout for Metop. The single bitstream is converted into pairs using *Viterbi* encoding, as explained; these 2 streams are then transmitted via ***I*** and ***Q***. At the receiving side, decoding recreates the original single bitstream.

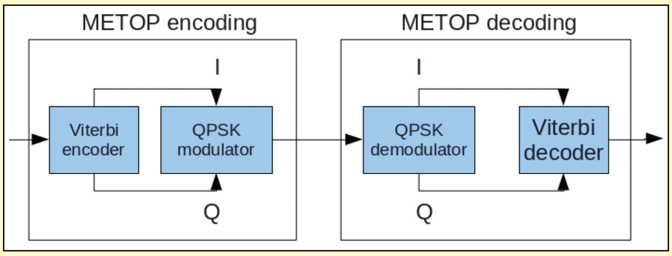


Figure 5 - Metop data transmission.

In the case of Fengyun, however, a more difficult route is taken, as shown in figure 6. This time, the ***I*** and ***Q*** parts are treated completely separately; the ***I*** gets the even bits, the ***Q*** the odd bits.

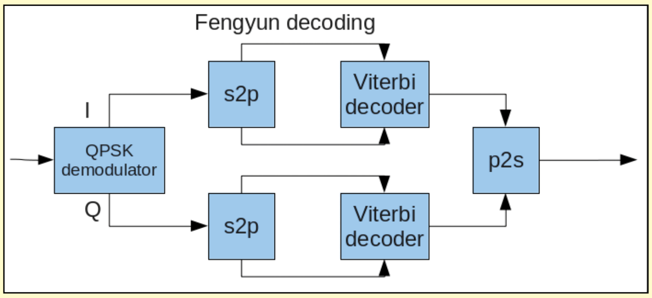


Figure 6 - Fengyun data transmission (receiving part)

On the receiving side, therefore, two consecutive bits of ***I*** must be presented in parallel to the *Viterbi* decoder (s2p: series to parallel). On the ***Q*** side, the same happens, with a second *Viterbi* decoder. Following decoding this results in two bits that need to be set 'sequentially' (p2s: parallel to series), so it is necessary to fiddle with the bits, and two *Viterbi* decoders are required. I am not sure what the benefit of the Fengyun method is and would be interested to hear from anyone who does. I can be contacted at

r@alblas.demon.nl

Ultimately, it has also been possible to 'push' this decoder into the same hardware, so that as a result, all current polar weather satellites can be decoded by the same unit.

Meteor

A final word about the Russian Meteor satellite(s). Although the format they use is also referred to as AHRPT, it is actually a slimmed down version of Metop/Fengyun method. There is no FEC, only a single main stream of data, and broadcasting is done using PSK/split-phase, as with HRPT. The only true similarity is the use of a short frame, along with a (simplified) mechanism for sending the data in each line, in pieces, across various frames.

Construction, Adjustment and Required Software

The QPSK receiver consists of two circuit boards connected to each other with a flat cable. The antenna signal enters the tuner board (left) which has an IF of 36 MHz. The demodulator board (shown between the tuner and the display) extracts the ***I*** and ***Q*** signals that go directly to the decoder (right).

With the design of two PCBs for the receiver, the structure and testing is relatively simple. Moreover, this gives more flexibility. For example, another front end can be chosen.

To make the construction as simple as possible, an off-the-shelf TV tuner (UV1316) is used. The tuner is controlled (tuned) by an *Arduino* via I²C. The receiver is tuned to the correct satellite with a rotary switch. A second switch is used to select between PSK (for NOAAs and Meteor) and QPSK. An LCD display shows the satellite name and signal strength.

The tuner is capable of receiving up to 845 MHz, so a down-converter is always needed to receive 1700 MHz signals. This downconverter is also the subject of one of our activities.

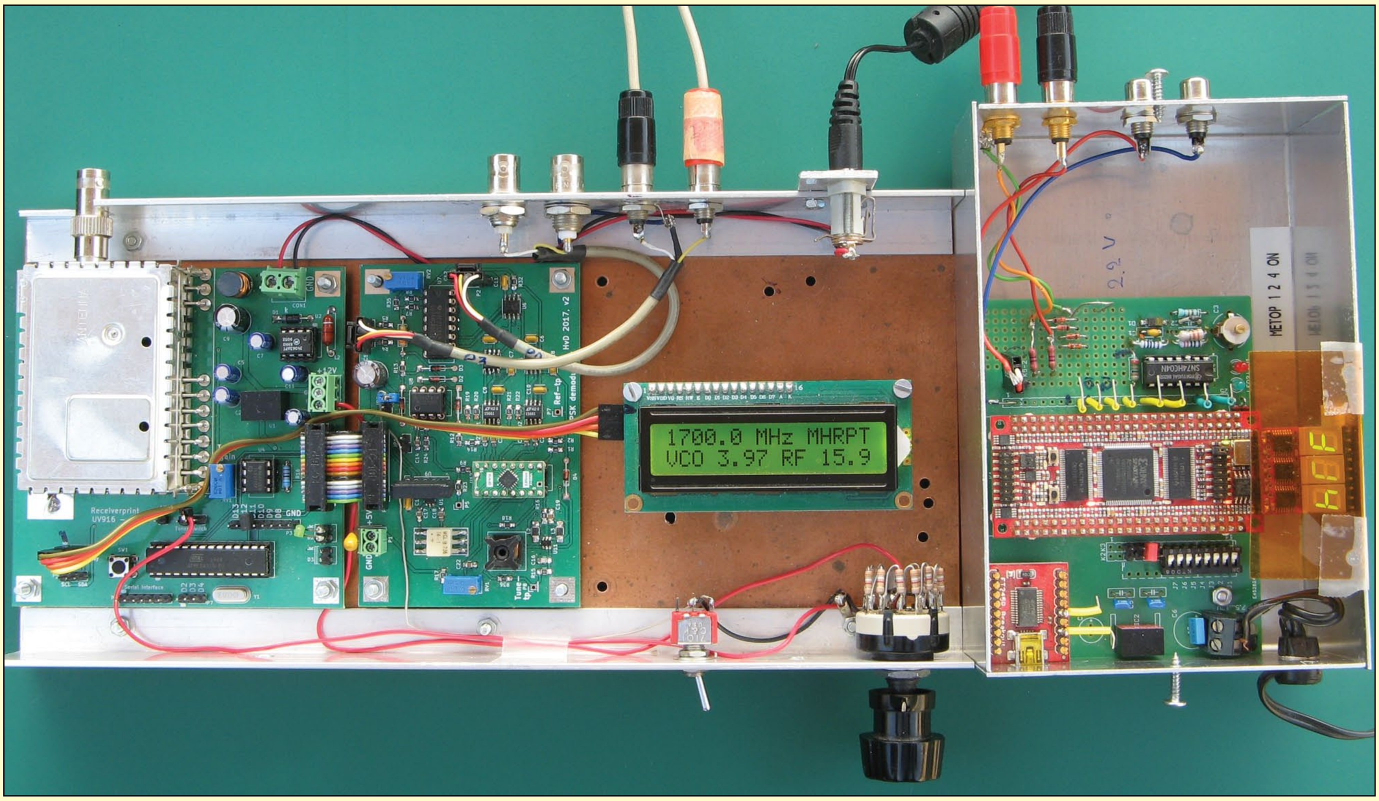


Figure 7 - The Receiver and Decoder

The QPSK receiver can be built in two evenings: experience with soldering SMD components is a requirement. Some parts are difficult to obtain.

For members of our working group, a complete package of items can be ordered, including PCBs and mounted LT5546 on an adapter board. The latter is a very difficult part to solder and is illustrated in figure 8.

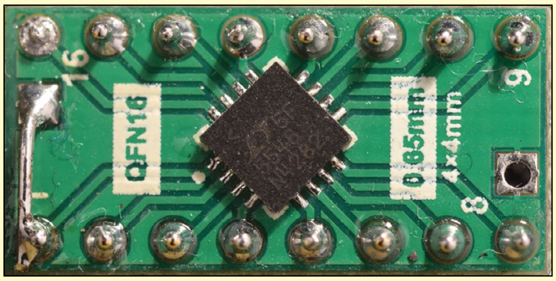


Figure 8 - The. Adapter PCB with the LT5546 I/Q Demodulator

Adjustment of the receiver is not difficult, but requires an oscilloscope that can work in XY mode: a signal generator is not required. Adjustment can be done on the NOAA or Meteor PSK signal, and then on the QPSK signal from Metop or Fengyun. A working antenna controller and downconverter is therefore required.

For the decoder a ‘GODIL’ module was used: this contains all the parts that are difficult to solder. Together with a module for the USB connection and some additional components, this part is very easy to build, possibly even on an experimental board.

My website [3] provides full details concerning all aspects of this project—in English—and also the bit-files needed to program the FPGA.

For software, the program ‘**wsat**’ (not wXsat) is needed. This catches the data from USB, does the *Reed-Solomon* correction, shows one of the received channels ‘live’ and stores the data on hard drive. Some manipulations are possible, like combining channels into a false colour picture, and making format conversions for HRPT Reader [4]. The software is available for both *Linux* and *Windows*.

Epilogue

This project, which has been created by several members of the Kunstmanen group, has not only given us a possibility for receiving new weather satellites directly, but taught us a great deal about these satellites.

One question that we are sometimes asked is whether we can provide a ready-built receiver and decoder. Unfortunately, there are quite a few problems with this. Up until now, only a few of these devices have been built, and this is insufficient to ensure that a built and shipped device will operate without (re)-adjustment, and continue to work correctly. For a self-builder this is not a problem, but for an inexperienced user who is not in contact with whoever built the unit, this is a problem, as our manpower is limited.

This article is written to show you that, even for amateurs, receiving and processing more advanced satellites is feasible. Any contributions from others working in this field are more than welcome. Like GEO, there are just a few people who write articles for our magazines. Our magazine is now also available in English, as PDF, so if you want to join our working group... [5]

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FIRES IN THE FALKLAND ISLANDS

NASA Earth Observatory

On September 28, 2017, the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's **Aqua** satellite acquired this true-colour image of fire and smoke in the Falkland Islands.

The Falkland Islands, a territory of the United Kingdom, sit in the South Atlantic Ocean about 600 kilometres east of Argentina and 1,350 kilometres north of the Antarctic Circle. Comprised of 778 islands in total, the two largest islands are West Falkland and East Falkland. These islands' rocky, hilly, and mountainous terrain gives way to boggy, undulating plains. Because of the near-constant wind and cool climate, few trees grow on the islands. Instead, grassland and heath dominate the vegetative landscape. About 92% of the land is used for agriculture, most of which is based in raising sheep and cattle. Indeed, the sheep and cattle far outnumber the permanent human population on the island.

In the early springtime, farmers often deliberately burn pastureland to encourage growth of fresh vegetation. When lambs are born, the ewes and young are moved to fresh grassland to graze. Smoke from fires in this image, which is clearly visible blowing across East Falkland Island, most probably arises from prescribed or agricultural fires designed to improve pastureland.

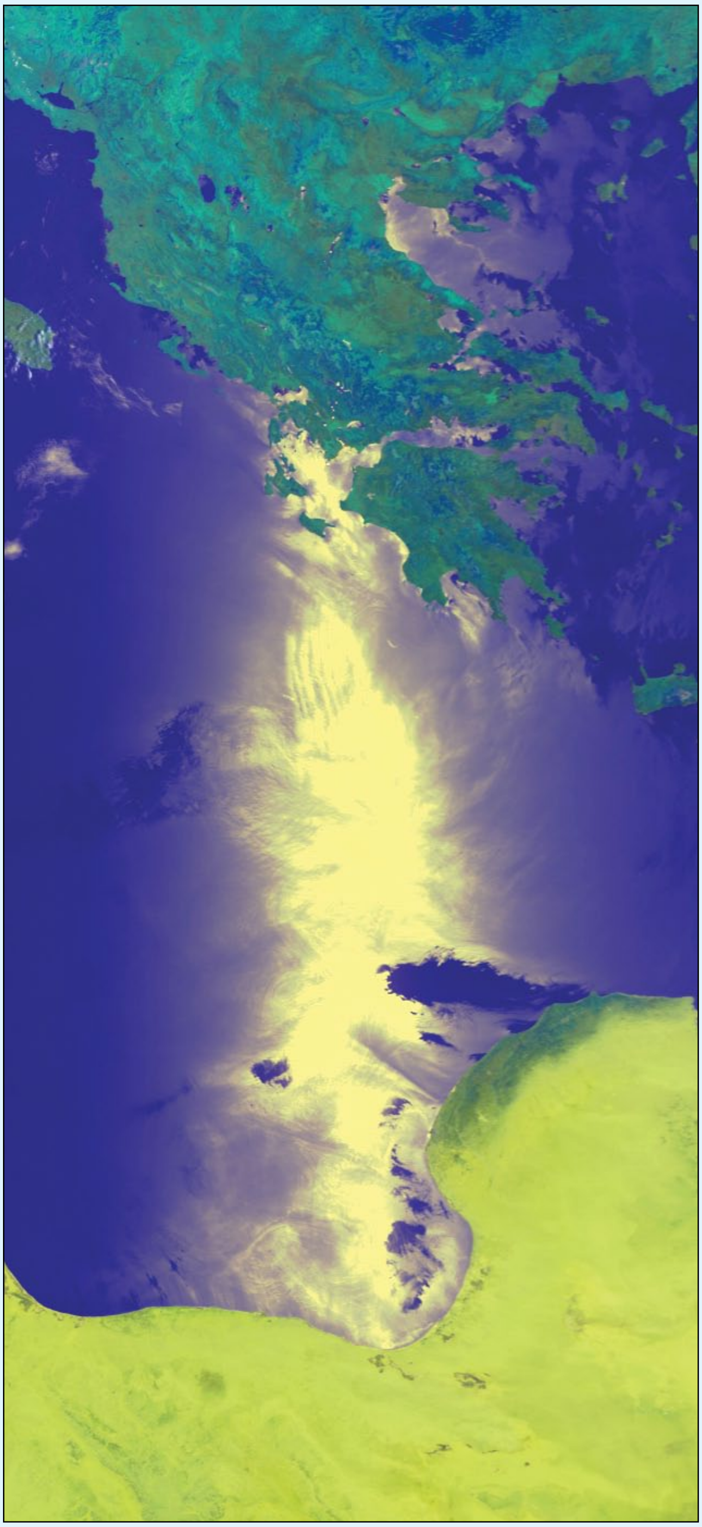
Image: Jeff Schmaltz, MODIS Land Rapid Response Team, NASA GSFC

Sunglint on Satellite Images

John Tellick

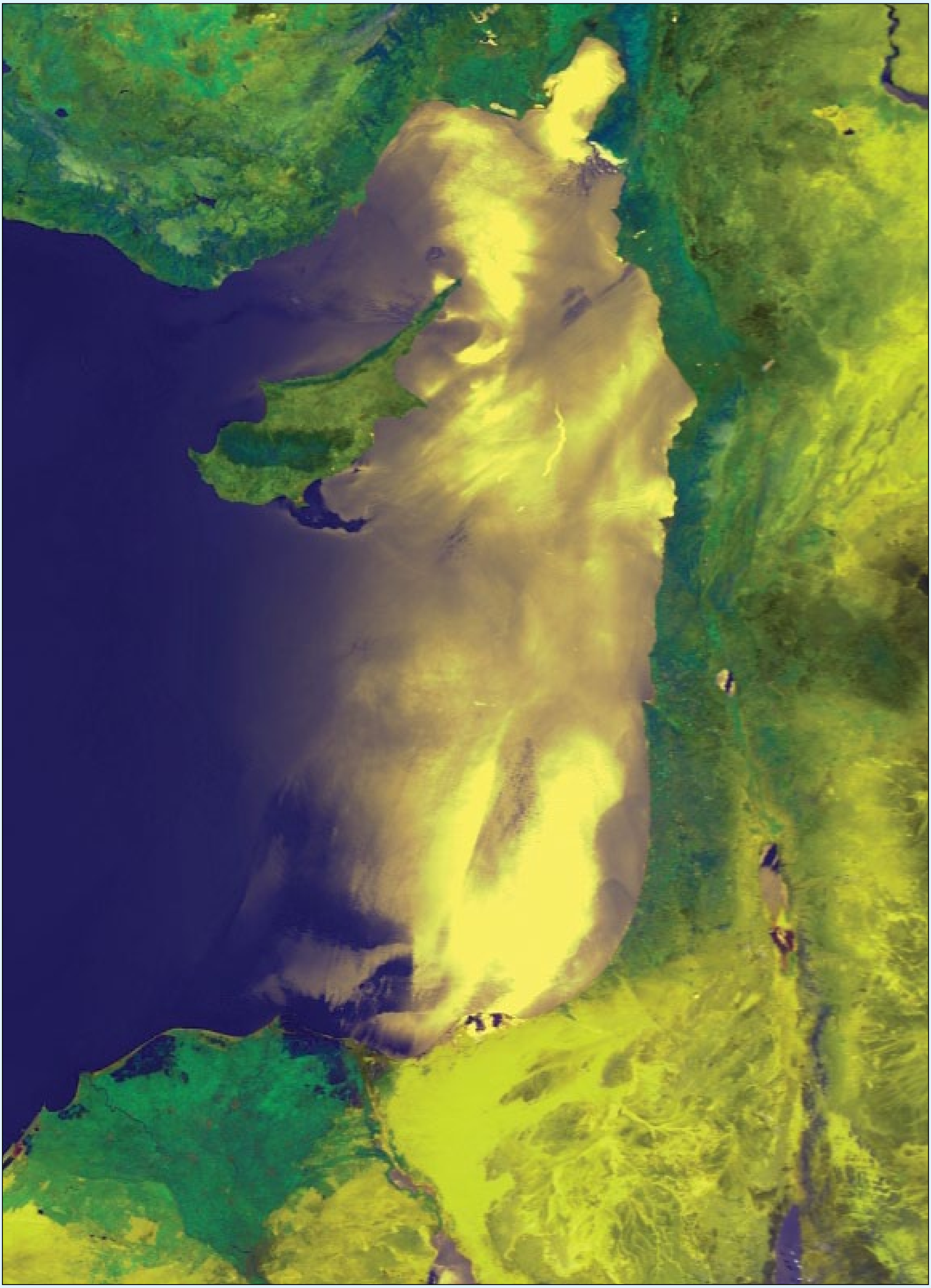
Sunglint is a phenomenon that is observed when sunlight reflects from the surface of the ocean at the same angle as it reflects back to the satellite sensor viewing the surface. In the affected area of the image, smooth ocean water becomes a silvery mirror, while rougher surface waters appear dark. I'm sure all readers will have seen sunglint on polar satellite images quite regularly, and there have been some fairly spectacular examples in the Mediterranean this year.

I find that the phenomenon is enhanced if you use an RGB125 channel combination: i.e. channel 1 for red, channel 2 for green and channel 5 for blue.

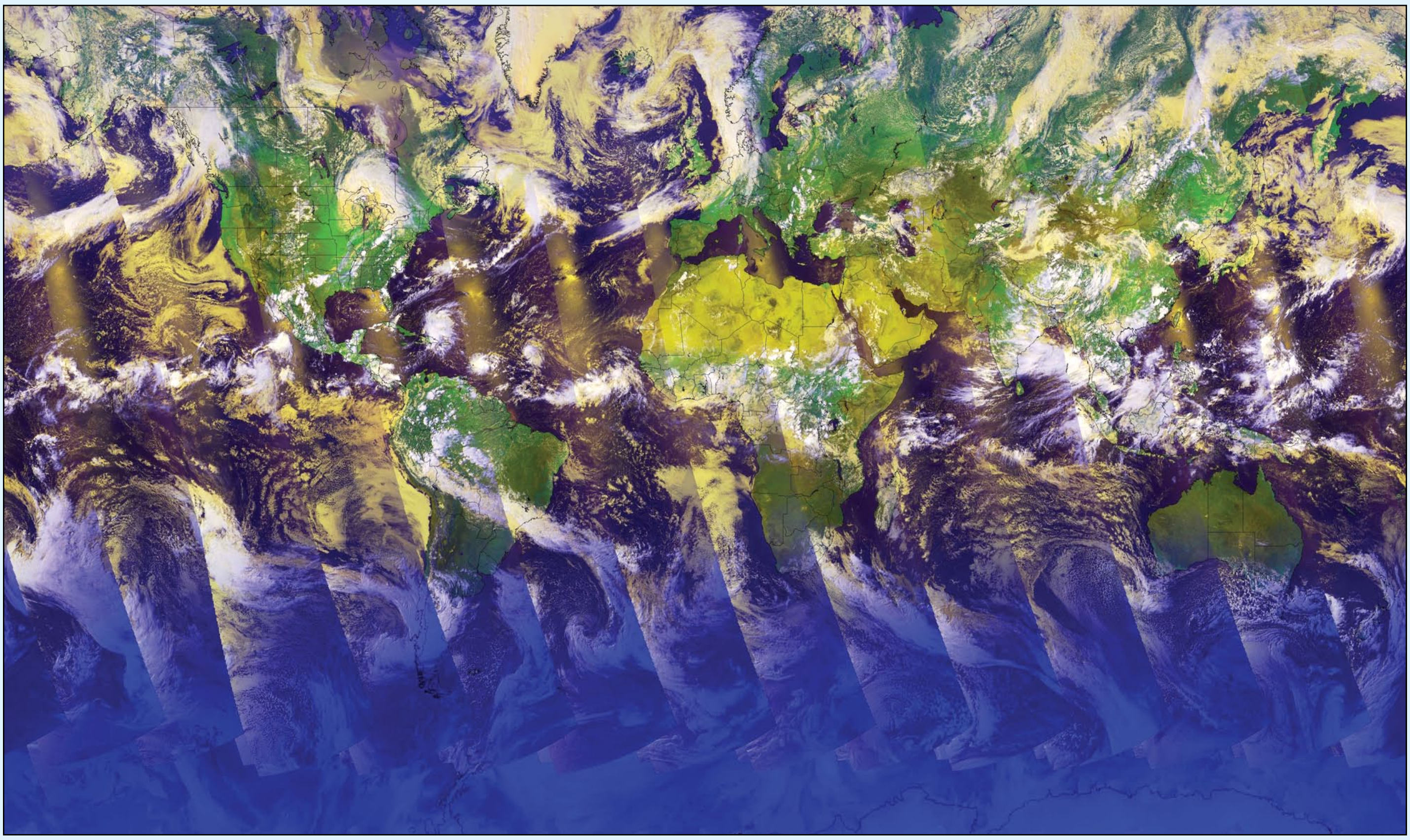


This Metop-B image from June 30, 2017 shows strong sunglint between Greece and Libya.
Image © EUMETSAT 2017

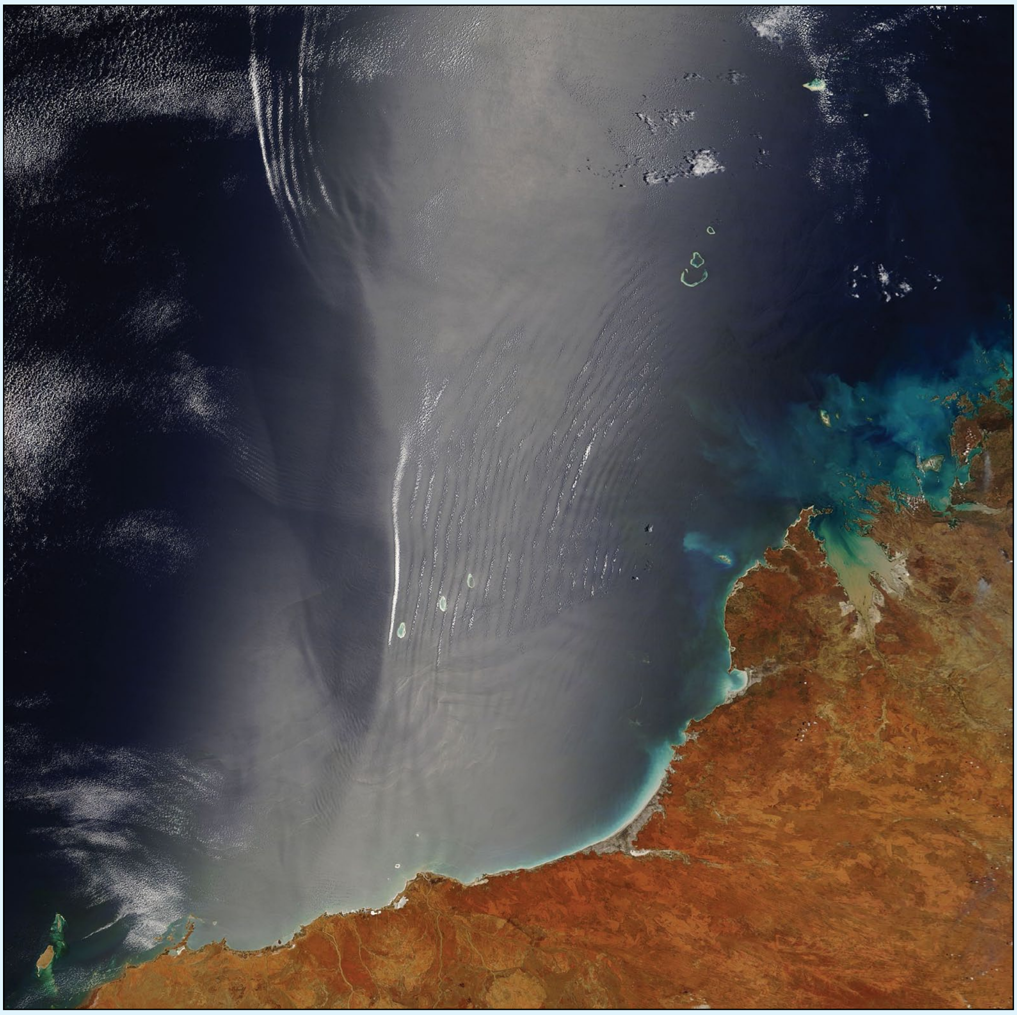
This Metop-A image from July 7, 2017 shows strong sunglint between Sicily and Tunisia.
Image © EUMETSAT 2017



This example of sunglint on the eastern Mediterranean sea was observed by Metop-A image on July 10, 2017
Image © EUMETSAT 2017



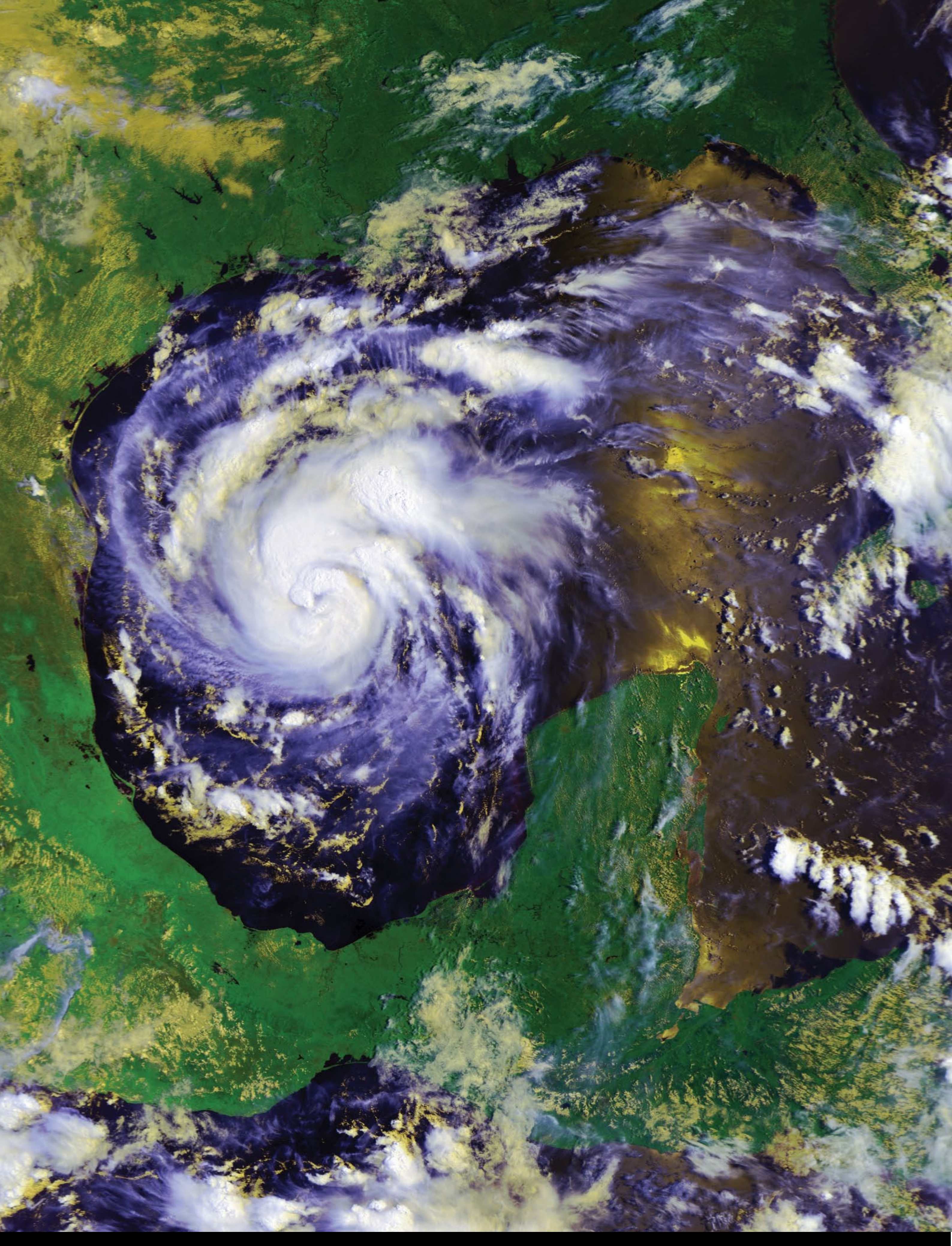
In this composite image where 24 hours worth of NOAA 19 GAC passes for August 17, 2017 have been combined, sunglint can be observed on every pass that includes ocean surface north of the equator



This MODIS image from NASA's Terra satellite, over Shark's Bay in Western Australia, shows gravity waves within an area of sunglint.
Image NASA

Sometimes the sunglint region of a satellite image reveals interesting ocean or atmospheric features that the sensor does not typically record. This image of the ocean between NW Australia and Indonesia shows a large, overlapping wave pattern within the sunglint region of the image.

This wave pattern is not due to large ocean waves, however but from atmospheric gravity waves above the surface of the ocean. Atmospheric gravity waves form when buoyancy causes air to rise and gravity pulls it back down. On its descent to the low-point of the wave (the trough), the air touches the surface of the ocean, roughening the water. The long, vertical dark lines show where the troughs of gravity waves have roughened the surface. The brighter regions show the crests of the atmospheric waves, beneath which the water is calm and reflects light directly back towards the sensor. Clouds commonly form at the crests of the waves, and such clouds are visible throughout this scene.



Sunglint in the Caribbean as Hurricane Harvey advances on Texas in this Metop-A image acquired on August 24, 2017
Image © EUMETSAT 2017

Lake Erie Abloom

NASA Earth Observatory

On September 26, 2017, the Operational Land Imager (OLI) on the **Landsat 8** satellite captured a natural-colour image of a large phytoplankton bloom in western Lake Erie (figure 1). The bloom was first reported in mid-July in Maumee Bay, just east of Toledo and by late September had extended east into the central basin and north toward the coast of Ontario. At the time of this image, the highest densities were detected along the coast of Ontario and in Maumee and Sandusky bays.

According to the *National Oceanic and Atmospheric Administration*, the bloom contains *microcystis*, a type of freshwater cyanobacterium. These cyanobacteria can produce toxins that can contaminate drinking water, pose a risk to human and animal health when there is direct contact (skin irritant, respiratory distress), and generally disturb coastlines.

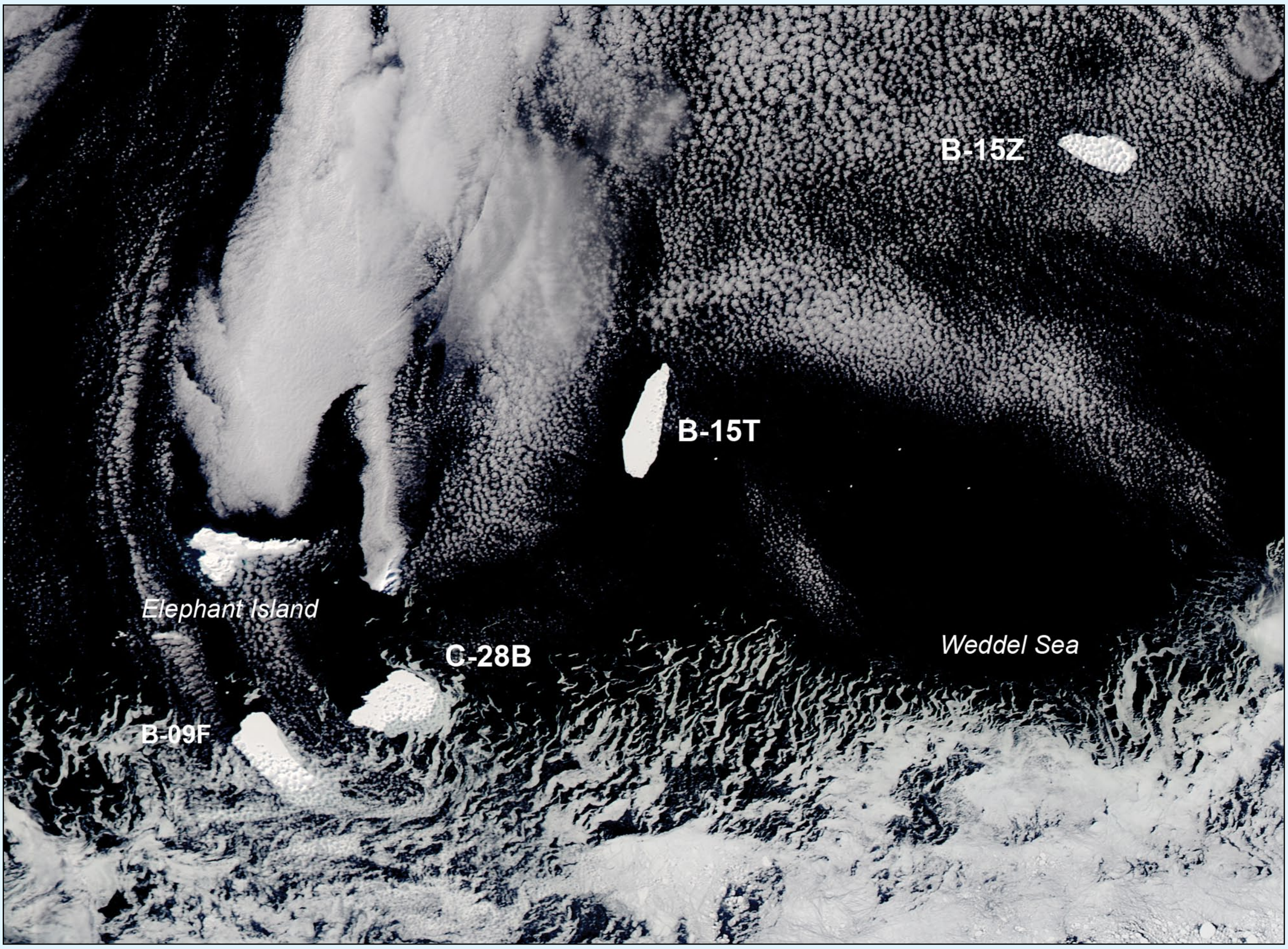
Figure 3 - A MODIS view of Lake Erie from Terra on September 24, 2017
NASA Earth Observatory image by Joshua Stevens using MODIS data from LANCE/EOSDIS Rapid Response

Warm water temperatures and nutrients from farm runoff can sustain phytoplankton blooms well beyond the summer. While leaves and crops on land have taken on typical autumn oranges and browns, Lake Erie continues to display vivid shades of green. Blooms form at the mouth of the Maumee River, then commonly drift into the central basin where the outflow of the Detroit River pushes them away. In calm conditions, lack of mixing allows the formation of scums—areas where cyanobacteria clump together into floating mats. These are the brightest green areas in the image.

Figure 1 - Phytoplankton bloom over western Lake Erie
NASA Earth Observatory image by Joshua Stevens using Landsat data from the U.S. Geological Survey

End of the Iceberg Life Cycle

NASA Earth Observatory



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

If Antarctic icebergs could talk, they would have epic stories to tell of calving, colliding, breaking apart, and drifting thousands of miles across the ocean. Since they don't talk, scientists rely on satellites to piece together the life stories of icebergs, some of which have been adrift for decades.

Four icebergs of various sizes and ages are visible in figure 1, which shows a region of the Southern Ocean, near the Weddell Sea and the Drake Passage. It was acquired on October 20, 2017, by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's ***Aqua*** satellite. A fifth white feature in the image may have the appearance of an iceberg, but is in fact Elephant Island—buried under snow and ice—where Ernest Shackleton famously sought refuge in 1916, following his expedition's entrapment in the Antarctic ice.

Icebergs are named based on the quadrant of Antarctica from which they calve. Most of the icebergs in this image—those whose designations start with the letter 'B'—come from the Ross Sea area and have drifted counter-clockwise around the continent. Iceberg B-09F is a fragment that broke from the B-9 iceberg, which calved from the Ross Ice Shelf of West Antarctica in 1987. It has taken the massive iceberg more than two decades to drift out of the Ross Sea and along the coast to the Mertz Glacier in East Antarctica. Along the way, it broke apart, and one segment became B-09B (not pictured), which in turn collided with the floating tongue of Mertz Glacier in February 2010 and formed -28 iceberg. C-28 subsequently broke apart into pieces including C-28B, pictured here.

The two other icebergs pictured (B-15T and B15Z) broke from B-15, the largest iceberg ever measured with satellite imagery. When that berg calved from the Ross Ice Shelf in March 2000, it was almost as large as the state of Connecticut.

The icebergs in this image were carried to their present locations by a combination of ocean currents: the coastal countercurrent, which flows counterclockwise close to Antarctica; and the Weddell Sea Gyre, which spins clockwise and pushes the bergs into the western Weddell Sea to the north.

As they continue to drift north, these bergs will probably get kicked back toward the east as they encounter the powerful Antarctic Circumpolar Current funneling through the Drake Passage. This passage keeps these bergs from continuing counter-clockwise around the continent, forcing them to quickly whip north toward the equator and rapidly melt.

Tiros-I

Ed Murashie

This article first appeared in the December 2003 edition of the Remote Imaging Group Journal

One of the nicest gifts received is one that you can't justify buying yourself; then you receive it as a surprise. Such was the case earlier this year when I saw an *ebay* auction for some TIROS slides. I was intrigued but, without seeing a picture or better description, I decided not to bid on them. After the auction closed, I checked out who won them but it seemed that nobody had even placed a bid.

Yet on my birthday, my best friend handed me a present that rattled like a puzzle box. Upon unwrapping it, I discovered a metal slide box containing an old paper manual titled *TIROS I Picture Documentation* and 300 black and white slides. Well, you can imagine how I spent that evening! TIROS-I was launched on April 1, 1960 and was designed to test the feasibility of a Space-based camera to obtain weather pictures. From April 1 until June 29, TIROS-I transmitted 22,952 images, of which 19,389 were used for weather forecast purposes. Within an hour and a half after launch, the first image showed ice blockage in the St Lawrence Seaway (figure 2). The first major storm, a cyclone in the South Pacific to the north of New Zealand, was imaged on April 10 and the data was sent to Australian meteorologists (figure 3).

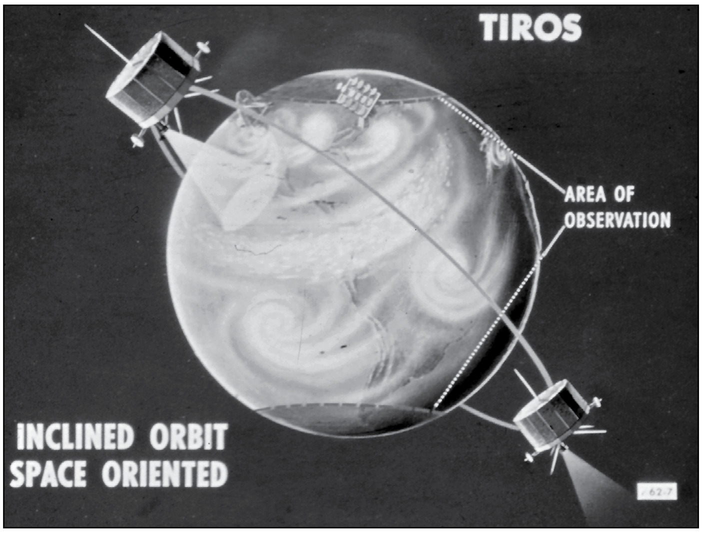


Figure 1 - An early TIROS publicity poster

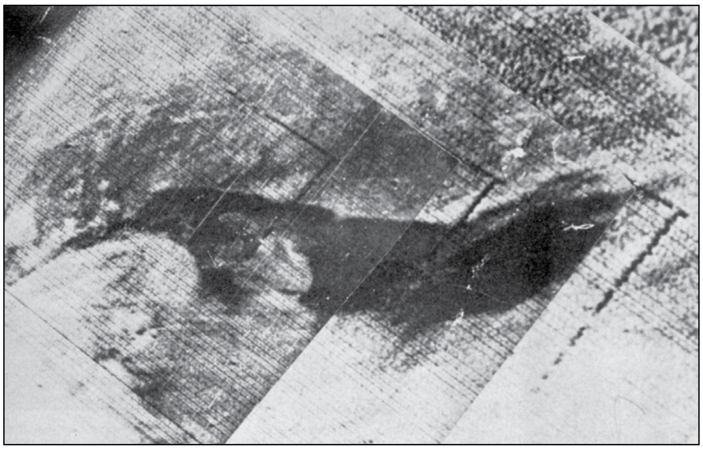


Figure 2 - The very first TIROS image

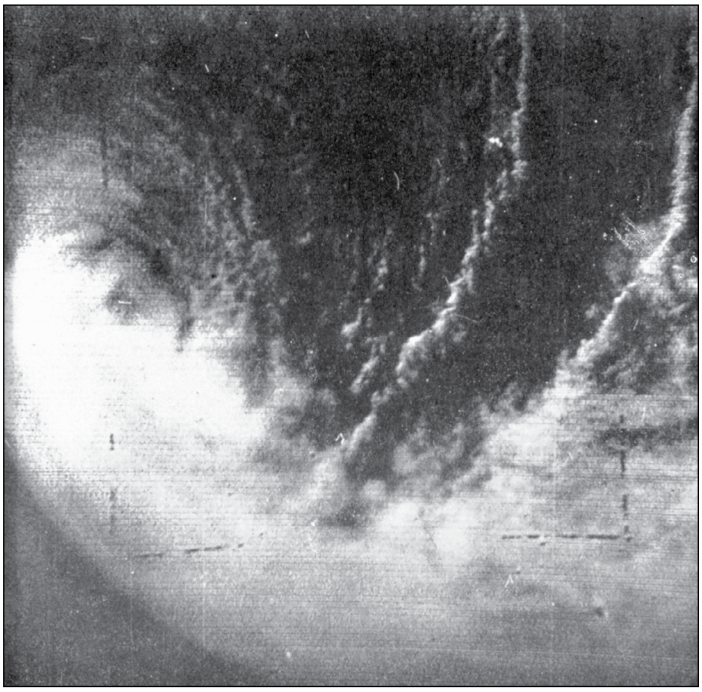


Figure 3 - The April 10, 1960 Pacific storm

A rocket launch on June 1, 1960 was going to be scrubbed because of lack of weather data over the Gulf, but was performed at the last minute because of a TIROS weather chart received at the station. These are just a few of the results obtained from TIROS I. The TIROS experiment was declared a success.

Two 500-scan-line TV cameras were mounted to the bottom base plate of the satellite as shown in figure 4. One camera had a 104° wide-angle lens which covered a nominal 600,000 square mile area, about twice the size of Texas, with a 2.7 kilometre/pixel resolution. The other camera had a 12° narrow-angle lens, which covered a 5000 square mile area with a 0.5 kilometre/pixel resolution (figure 5). The satellite only took visible images of the sunlit Earth: no infrared or night-time images were taken.

Each camera used a *vidicon* tube, half an inch in diameter and four inches long instead of the bigger, heavier, image *orthicon* tubes used in commercial TV cameras. The *vidicon* tube contained a thin transparent photo-conductive layer, positive electrode. The tube's electron beam first deposited a layer of electrons on this surface, then the shutter opened for 1.5 milliseconds and the image of the Earth was focused on this layer. Where light struck the surface, the photo layer became conductive; where there was no light, the layer remained non-conductive. The deposited electrons repositioned themselves based on the conductivity. Finally, the electron beam scanned the surface and where there were still electrons, the beam was deflected; where there were no electrons, the beam passed through and a current was measured from the electrode.

The 500-line scanning process took two seconds to complete. The process was repeated either 10 or 30 seconds later, after the electrons had been flushed from the surface and a new layer deposited. The cross and

Figure 4 - TIROS instrumentation, cameras in the foreground with the tape recorder between them

L-shaped cross-hairs were etched on to the glass surface of the *vidicon* and used to correct for electronic and data presentation distortion. An optical filter was used to pass only the red end of the visible spectrum, thus avoiding blue haze. The satellite could be commanded to send real-time pictures when it was within a 1500 mile range of the two *Command and Data Acquisition* stations (CDA), or record them any time on an onboard magnetic tape recorder.

Each camera had it's own independent tape recorder which could store up to 32 images taken at 30-second intervals. Separate timers commanded the tape recorders 'on'. When the satellite was over one of the CDA's, it would playback the stored images in 100 seconds, in reverse order, and then could transmit real-time images at either 10-second or 30-second intervals. An image including the western USA with the Baja California peninsula prominent is shown in figure 6. Note that the image is sideways-on. Turn the page 90° clockwise to view it normally.

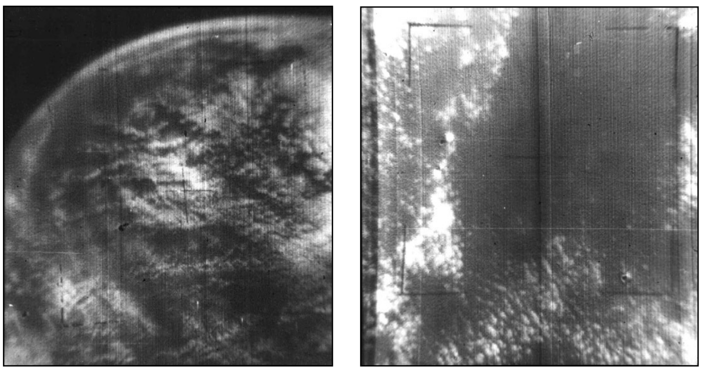


Figure 5 - A comparison between the wide-angle (left) and narrow-angle cameras aboard TIROS-1

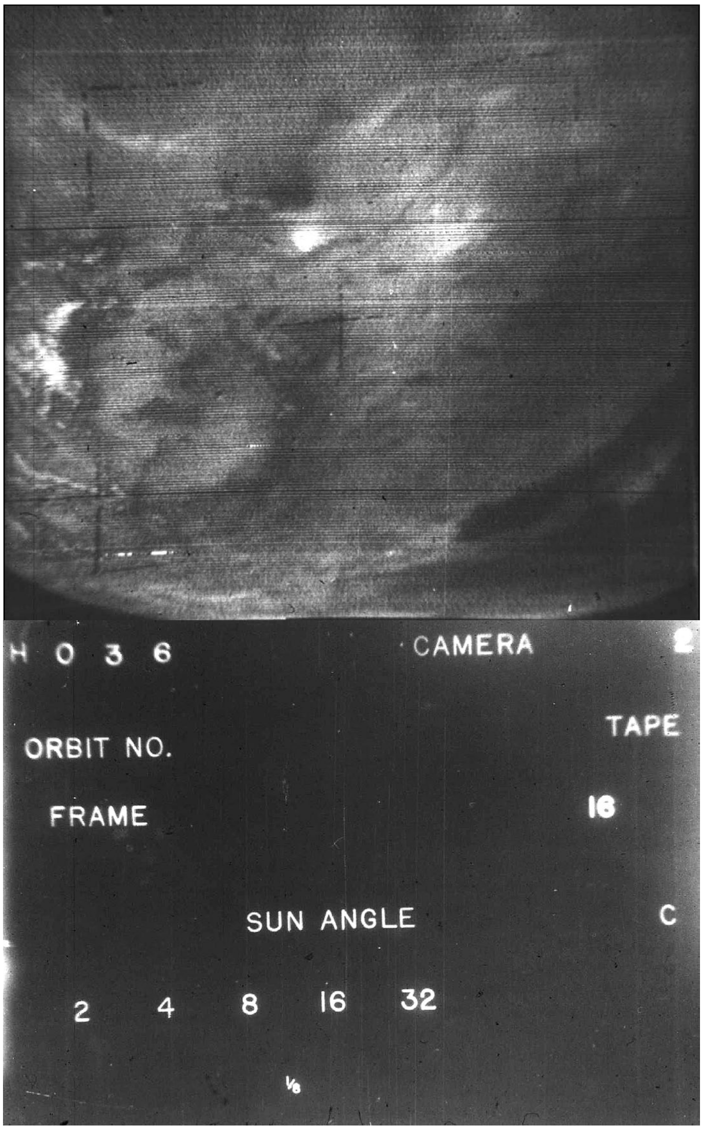


Figure 6 - A TIROS image of the USA showing Baja California (side-on), with the panel-board below.

When transmitting real-time images, the satellite could send either camera image or alternate between the two on the same transmission frequency. The two CDA's were Kaena Point in Hawaii and Fort Monmouth in New Jersey. Fort Monmouth was chosen because it was close to the RCA Laboratory headquarters in Princeton New Jersey: they were the contractor for the TIROS satellite. Each camera had it's own 2-watt transmitter which was connected to the four antennas located on the underside of the satellite. The camera or tape data frequency-modulated an 85 kHz sub-carrier which then frequency-modulated a 235 MHz carrier. The slow scanning rate allowed a transmission bandwidth of 30 kHz instead of a typical TV bandwidth of 6 MHz, which in turn permitted the use of a low power transmitter. Having two independent cameras, recorders and transmitters provided redundancy, which was especially useful on TIROS III when one camera failed early in its mission.

The nearly circular 390 nautical mile orbit of TIROS I is depicted in figure 1. The 48° inclination allowed the spacecraft to image the Earth from 55°S to 55°N latitude when the Earth was below the satellite, about one-third of each daylight orbit. The orbital period was 99.24 minutes. The satellite was spin stabilised between 8 and 12 rpm, with the spinning axis parallel to the cameras.

As the images were received, they were displayed on a TV screen and recorded on magnetic tape. Under the

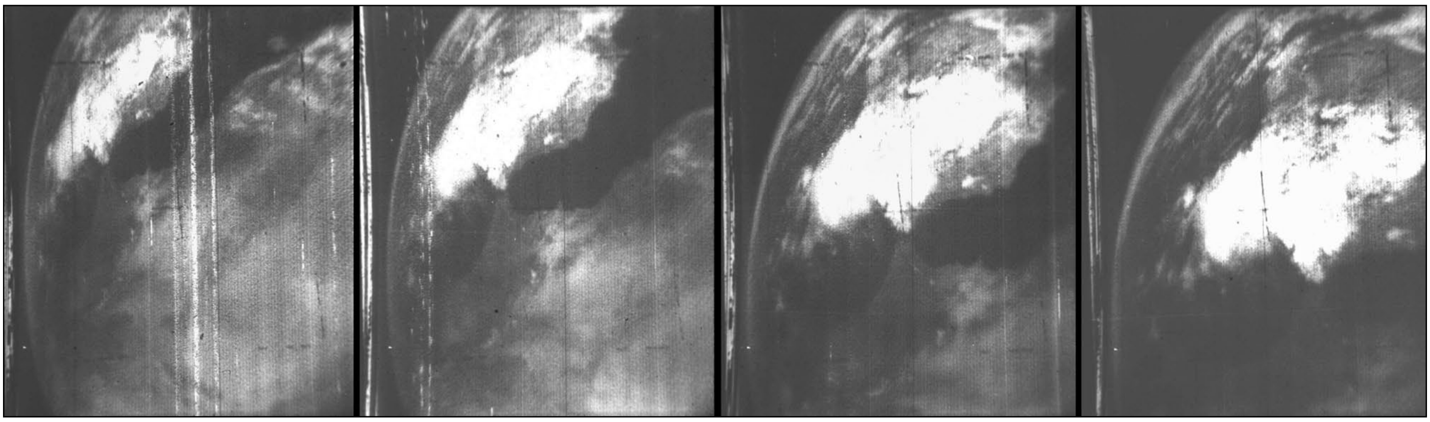


Figure 7 - Successive TIROS-1 images show the satellite motion as it passes northbound over north Africa and France

TV screen was a lighted panel-board that displayed the station, orbit number, frame number, camera number, sun angle and tape or direct mode (figure 6). The sun angle and frame numbers are the summation of the digits. A 35 mm camera was then used to photograph the TV screen and lighted panel board. My 1960 slides are copies of those original filmstrips.

Using information from the satellite's Earth horizon sensors and tracking data, a library of projection grids was created. The slides were then loaded into a projector and the image was projected on to a table with one of the grids (figure 8). The projector was adjusted until the scale matched the grid and the grid was moved and rotated until the horizon and Earth features matched the image. The major weather features were then sketched on to the projection grid. Next, the weather features were transferred by hand to a rectangular transfer grid chart. Finally, these weather features were transferred by hand to the final latitude-longitude weather chart and weather symbols were added.

Figure 8 - Preparing a Weather Chart

Figure 9 shows a completed chart made from one of these TIROS I images. Computer methods were developed to generate the maps during the TIROS II mission. The original weather charts were discounted for the first few days because of perceived location inaccuracies. It wasn't until the third day when the *Air Weather Service* and *Naval Weather Service* proved their location accuracy using the coast of North Africa that they were then radio facsimiled to all US and European meteorologists.

The images are available from the *National Climatic Data Center*, Asheville, NC and an additional set is retained at the *Goddard Spaceflight Center* for reference purpose.

Acknowledgments

My thanks to the following information sources, which proved invaluable in compiling this article.

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- Weather Bureau - TIROS I Picture Documentation. Washington D.C.; Meteorological Satellite Laboratory, March 1961

Figures 1, 2, 3, 6 and 8 courtesy the National Oceanic & Atmospheric Adminstration (NOAA), NOAA Central Library

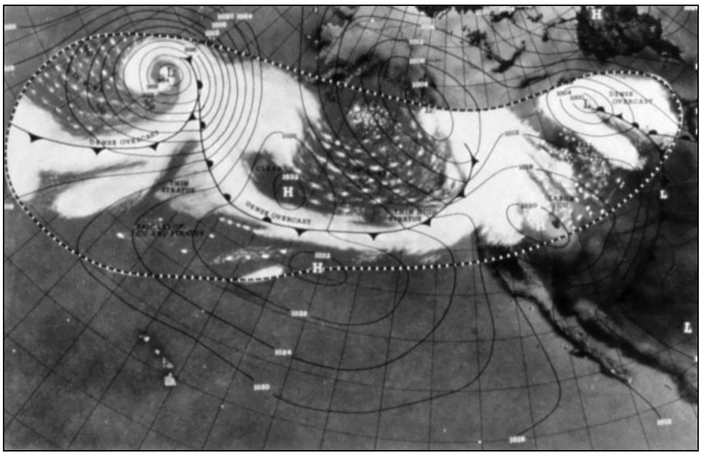
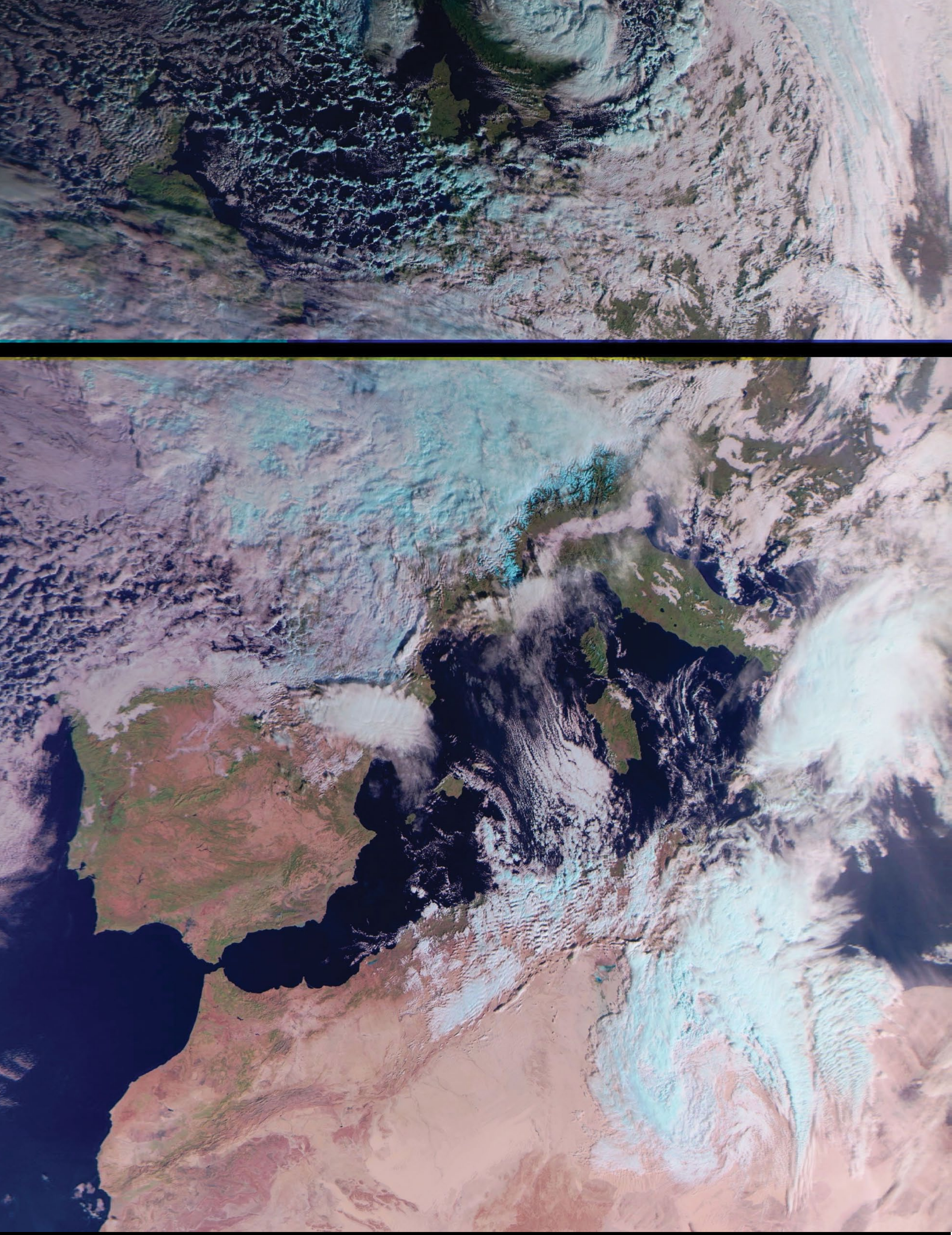


Figure 9 - A finished weather chart based on a storm in the north Pacific Ocean during May 19-20, 1960



Enrico Gobbetti captured this image from Meteor M2's 09:09 November 11 pass when the satellite was transmitting three visible channels, the infrared having been temporarily deactivated, presumably for decontamination of its sensors.

Lake Balkhash

NASA Earth Observatory

The Aral Sea and Lake Balkhash have a lot in common, both lakes being located in an arid part of central Asia and both sitting in endorheic basins (neither has an outlet) so that both both are somewhat saline. But whereas the Aral has become severely desiccated since the 1950s, Balkhash is currently enjoying a moderate (though almost certainly temporary) expansion. Spanning 16,400 square kilometres in eastern Kazakhstan, Lake Balkhash is the largest lake in central Asia and fifteenth-largest in the world. The natural colour image of the southwestern part of Lake Balkhash shown opposite (figure 3) was captured by the Operational Land Imager (OLI) on Landsat 8 on October 9, 2017.

Water in the western part of the lake is almost fresh—suitable for drinking and industrial uses—whereas the eastern side of the basin is brackish to salty. The western side is also murkier, permitting light to penetrates to only around one metre, compared with more than five metres on the eastern side. This murkiness, and the water's milky, yellow-green colour, is most likely due to sediments suspended in the water.

> *"The lake is very shallow, and it is windy nearly every day, so waves can stir up sediments from the bottom,"* stated Niels Thevs of the University of Greifswald (Germany) and the Central Asia office of the World Agroforestry Center.

Anywhere between 70 to 80 percent of tBalkhash's water comes from the Ili River, which enters the lake along its eastern shoreline. The surrounding delta (green) is now one of the largest wetlands in Central Asia.

> *"I imagine that the wetlands of the Ili Delta look like the wetlands around Aral Sea did 50 years ago,"* said Thevs.

Thevs describes large parts of the Ili Delta th)at are only accessible by boat, where you can cruise for hours amid 3-metre tall reeds. These reeds (*Pharagmites australis*) are considered invasive in the United States but not so in the Ili Delta, where the plant is an important part of the ecosystem. Thevs also describes parts of the delta where the water is so crystal clear that you can see fish and water plants up to 8 metres below.

If you were to cruise in a boat across the main part of the lake, you could count 43 islands with a combined area of 66 square kilometres, according to Zhanna Tilekova of Kazakh National Technical University, who has published research on the region's geoecology. However, those numbers can change. Tilekova noted that, as water levels decline, new islands form and the area of existing islands increases. In the western part of the lake, Tasaral island (outside this image, to its north) and Basaral island (highlighted in figure 3 - next page) are the largest. Ortaaral and Ayakaral islands (figure 2) are also relatively large. Vegetation, probably small brown shrubs (*Saxaul*), can grow on these islands. The white areas are salt pans.

Story by Kathryn Hansen.

Figure 1 - Lake Balkhash, imaged by the MODIS instrument aboard Nasa's Aqua satellite on October 11, 2017
Image: LANCE Rapid Response/NASA/GSFC

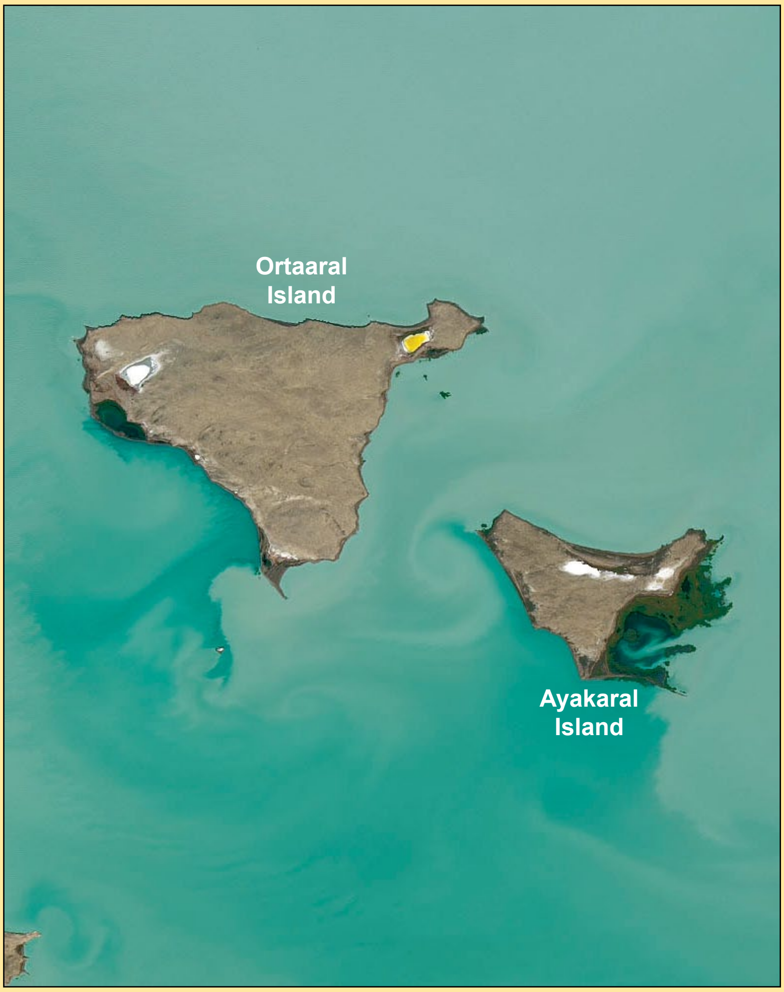
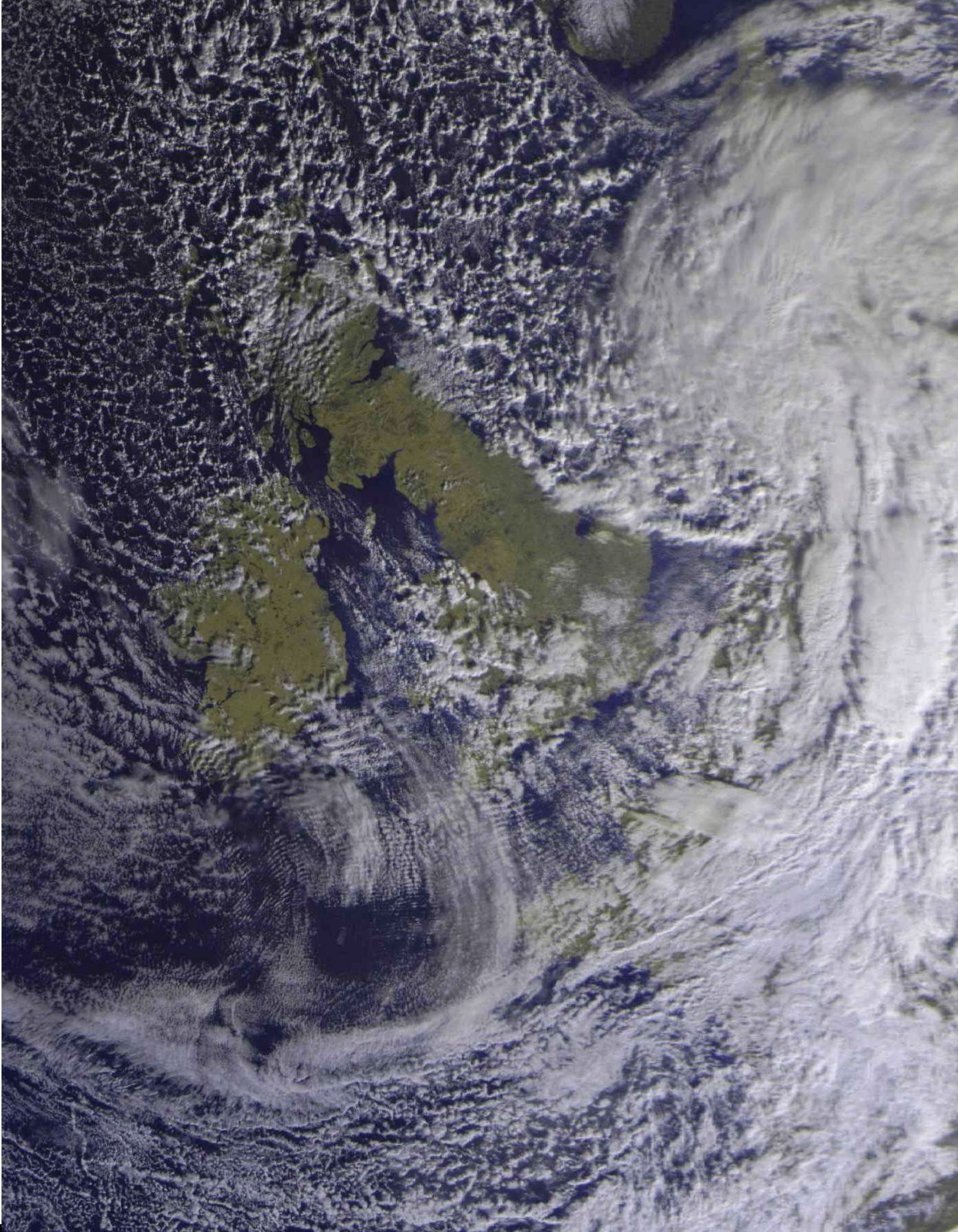


Figure 2 - This detail from the main image opposite shows Ortaaral and Ayakaral islands to the southwest of Lake Balkhash
NASA Earth Observatory image by Joshua Stevens using Landsat data from the U.S. Geological Survey

Figure 3 - The southwestern portion of Lake Bakkhash as imaged by Landsat 8 on October 9, 2017
NASA Earth Observatory image by Joshua Stevens, using Landsat data from the U.S. Geological Survey



Harry Arends captured this image from Meteor M2's 10:33 UT pass over The Netherlands on November 12, 2017,which shows a blast of Arctic air engulfing the British Isles. The LRPT Meteor data were received using an RTL-SDR dongle and SDRsharp v 1601 software.

LAND VIEWER Update

Download Sentinel 2A 10-metre imagery

Les Hamilton

Last March, in *GEO Quarterly No 53*, I introduced readers to **Land Viewer**, an on-line initiative from California based **Earth Observation Systems** (EOS). This is a cloud-based tool that allows users to search and analyse huge amounts of Sentinel-2 data stretching back up to 180 days. Land Viewer is an on-the-fly, real-time image processing and analysis service, which, claim EOS, can provide:

- instant access to petabytes of new and archive data
- the ability to find geospatial images on any scale in two mouse clicks by selecting the required territory on the map or by location name
- on-the-fly imagery analytics, with the option to download any images required for business purposes.

There seems little doubt that the version offered earlier in the year was a beta version, as the current offering is considerably slicker, and features some major improvements.

Navigation and Image Selection

Land Viewer is accessed from the following URL

https://lv.eosda.com/

which reveals the screen illustrated in figure 1. This screen forms the background to all site operations, which are controlled by buttons to either side of the display. Some of the tools are inactive until a satellite scene has been selected.

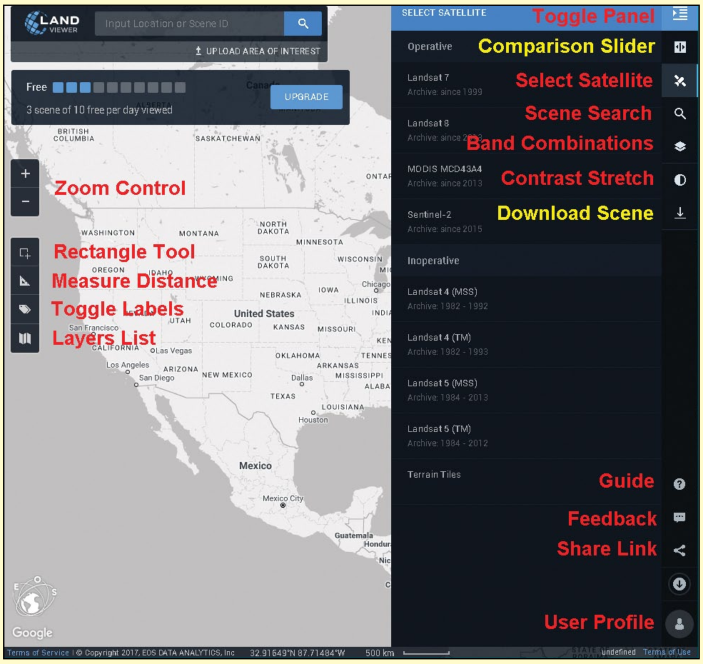


Figure 1 - The opening Land Viewer screen (annotated)

The map of the world opens, by default, over the United States, but can be freely dragged around the screen with the left mouse button. Zooming in and out is achieved using the mouse's scroll button, or by clicking the **Zoom Control** buttons on the screen. Bearing in mind that each Sentinel-2 tile (image) measures only 100 kilometres square, it is wise to use the **Rectangle Tool** to draw a fairly small rectangle around your chosen area. This will concentrate search results where you want them. If you click the **Layers** button, and select '*Satellite*', the map will be replaced by a satellite view of the scene. An example is shown in figure 2, where the map has been dragged to the Canary Islands and zoomed in to Tenerife.

To display the available Sentinel-2 images, click the **Sentinel-2** button in the right-hand panel. The panel's contents now change to show thumbnail pictures of all archived Sentinel-2 data for the previous 90 days. Notice that not every thumbnail in figure 2 includes Tenerife: some include parts of the island of La Gomera to the southwest. This is because images that merely overlap the selected rectangle very slightly will be included in the thumbnail selection.

If you now wish to download the full resolution '*Red*', '*Green*' and '*Blue*' image tiles for processing into a colour composite, click the appropriate thumbnail.

Signing In

At this point, or perhaps later when you click a download button, you will be asked to 'Sign in' to Land Viewer, and the window shown in figure 3 appears. There is no payment involved: this is just a necessary formality to control the quantity of free imagery amateurs can download (ten images per day; though commercial users can pay for unlimited access at $49.99 per month). If you already have a *Facebook*, *Google* or *Linkedin* account you can sign in simply by clicking the appropriate button. Otherwise, just enter your email address in the appropriate field and provide a password of your choice.

Downloads, as stated, are free for amateur use, but are restricted to ten different scenes each day.

The criterion here is clicking on a thumbnail, not making the subsequent download, so do think carefully and scan through all the thumbnails that are presented before making your selection. After selecting a thumbnail, a colour composite of the Sentinel image is superimposed over the screen as illustrated in figure 4. You can use the **Zoom Controls** to enlarge this image and examine it in detail. Clicking the **Toggle Labels** button adds/removes labels to the image to help you find your way around it. You are now ready to download the individual '*Red*', '*Green*' and '*Blue*' files.

Downloading Sentinel L1 Image Files

As soon as you have selected an image by clicking on its thumbnail, the previously inactive tools at upper right in figure 1 become available, most importantly the **Download Scene** button. Clicking this button updates the right-hand panel once more with the details shown in figure 5. Select **Analytic**, highlighted in the red rectangle. This updates the panel once more, this time providing access to all 12 channels of Sentinel-2 data. Figure 6 shows the upper part of this screen, which contains the three channels needed for creating true-colour images. Helpfully, these are labelled **B02 - Blue**, **B03 - Green** and **B04 - Red**.

When the mouse is hovered over each of these channels in turn, a download arrow pops up to the right (as shown for the blue channel in the illustration). Click this once and repeat for the other two channels. Immediately, new panels pop up at the bottom right corner of the screen, stating that the file has been 'queued' (figure 8). These files do not start to download

Figure 2 - The island of Tenerife is selected against a 'Satellite' background

immediately: usually there is a delay of a few minutes, but within five minutes or so, they should have downloaded on to your hard drive. Do not keep clicking a download link believing that it has failed to register; if you do so, you will simply end up downloading multiple copies of the same file. As a general rule, each file amounts to about 100 megabytes of data.

At upper left on figure 4 you can see the counter, a series of ten small rectangular boxes, which measure the progress of your downloads for a particular day. In this instance, only the first of the boxes if filled with solid blue, showing that this was the first image I selected. Once all boxes are filled, you have used up your quota for the day.

Processing Sentinel-2 RGB Files

The final RGB image of Tenerife appears in figure 10 on page 36.

To combine each set of three Sentinel-2 files that you download you will require a program called **Sentinel2toJPEG**, compiled by David Taylor, and which can be downloaded from

http://www.satsignal.eu/software/Sentinel2toJPEG.zip

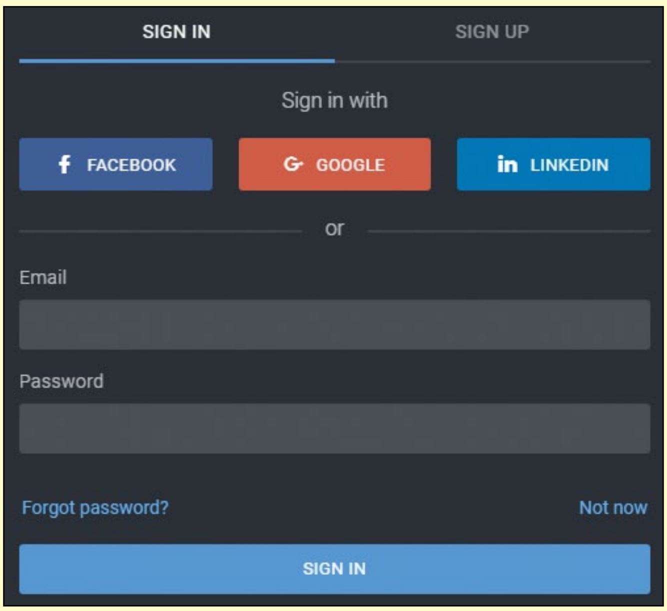


Figure 3 - The sign-in screen

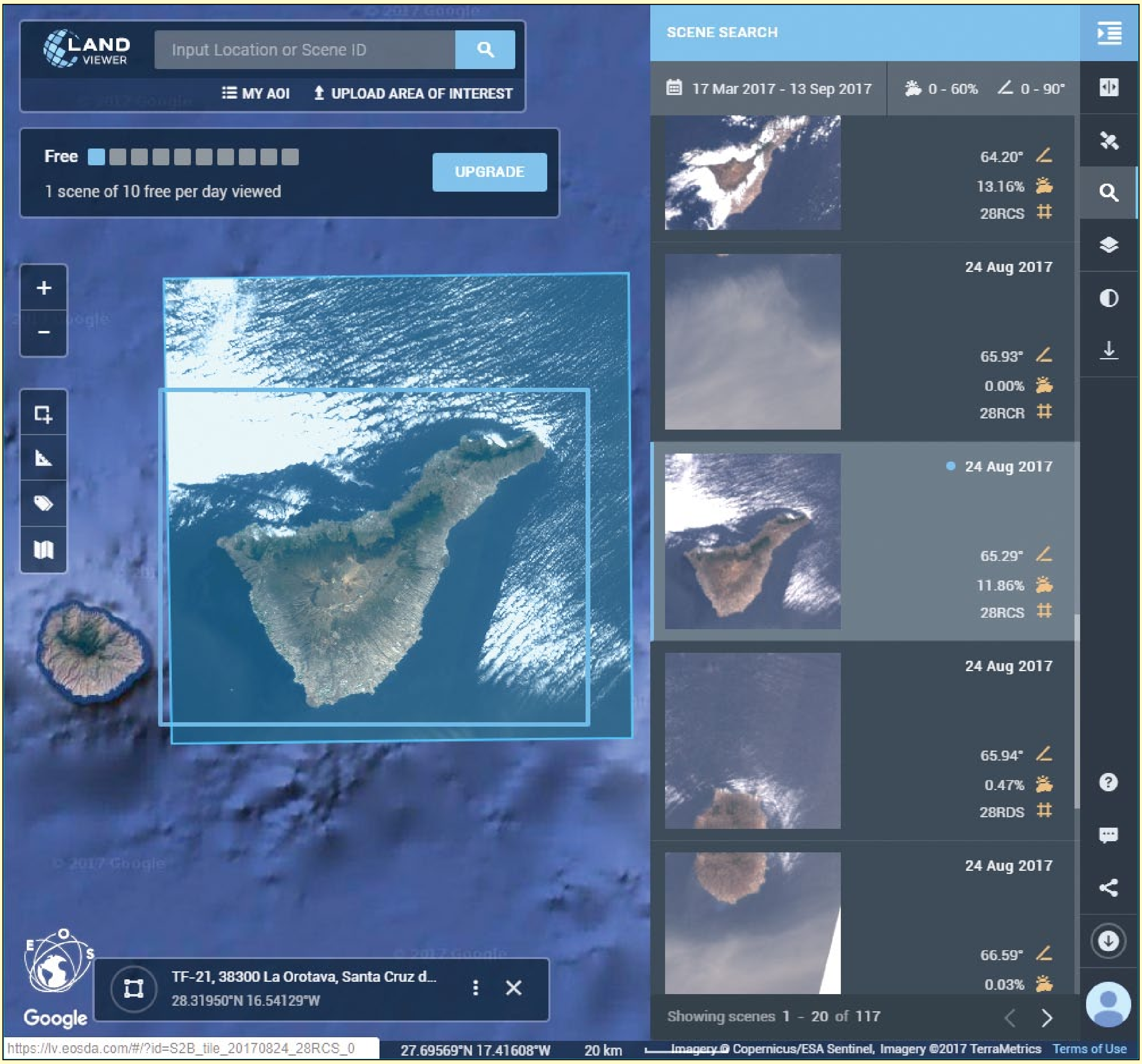


Figure 4 - After selecting a thumbnail, the tile outline (large blue square), and Sentinel-2 image are overlain on the map

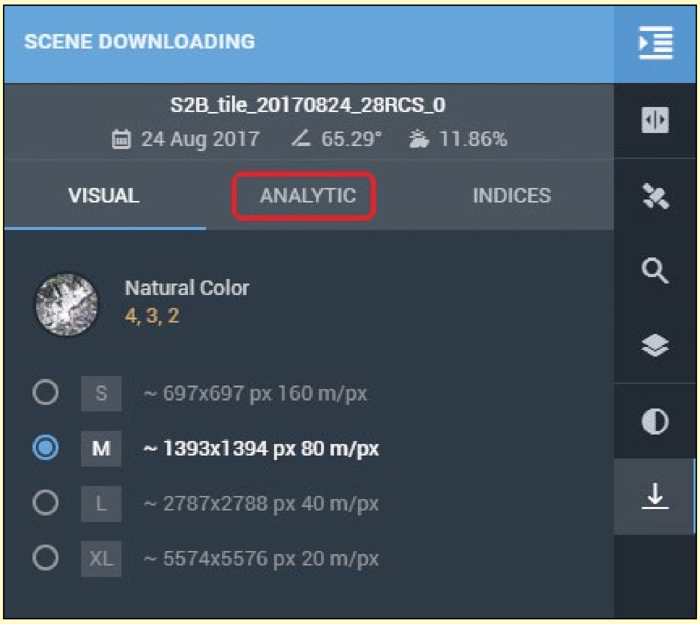


Figure 5 - Select 'Analytics' here

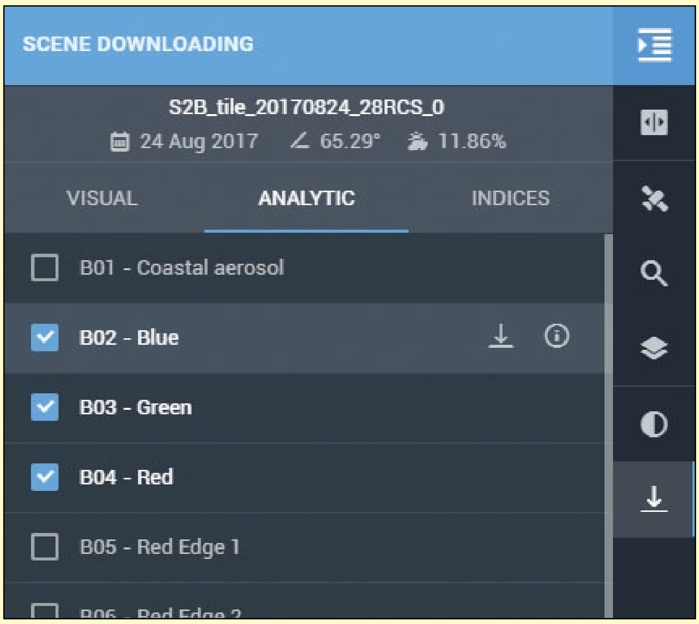


Figure 6 - Download the R, G and B files here

David has also prepared a web page detailing how to obtain Sentinel-2 data, and with a number of splendid samples of the type of imagery that can be obtained at

http://www.satsignal.eu/wxsat/Sentinel/Sentinel-2A.html

Use of this software was explained in detail on page 31 of GEO Quarterly 53. If you missed this, you can download a PDF copy of this quarterly from the GEO website at

http://www.geo-web.org.uk/quarterly/geoq53.pdf

Other Satellites

When you first open Land Viewer, you are presented with a list of eight potential sources of satellite data. Only two of these provide data that can be decoded by the *Sentinel2JPEG* software, Sentinel -2, which is the subject of the foregoing, and Landsat-8, and both of these are described in the *GEO Quarterly 53* article referred to above..

Other Features: Calendar, Sunshine and Cloud

At the top of the Scene Search screen (figure 4) is the panel illustrated in figure 7, which allows user selection over the images displayed.

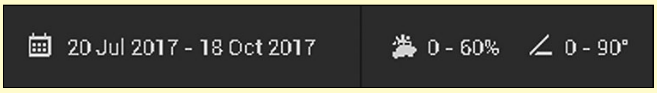


Figure 7 - The Image Control Panel

Clicking the date at the left hand side opens a calendar on which dates where Sentinel-2 imaged your region of choice are highlighted in yellow. Double-clicking one of these dates brings that scene into view immediately. By default, the calendar provides data stretching back just 90 days, but there is a '**Custom Button**' that can extend this to 180 days (the maximum) or even reduce it to just the previous week.

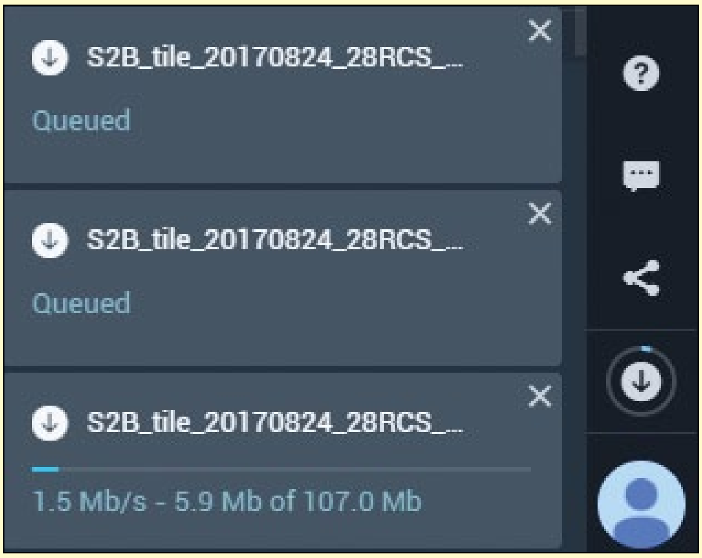


Figure 8 - Files queued for downloading

Clicking the right-hand part of this panel displays graphs showing the cloudiness and solar elevation relevant to the area selected across the date range chosen. Although clicking over these graphs refreshes the scene list, in my experience, it had no effect on the particular images displayed.

Conclusion

Land Viewer is a superb tool which allows the amateur to access brilliant high-resolution images from Sentinel-2 and Landsat-8, the former at 10 metres/pixel, the latter at 30 metres/pixel. There are features I have not covered but which readers can explore for themselves: applying **Contrast Stretching** to images, exploring the **Band Combination** option or using the **Comparison Slider** to compare a Sentinel image with a GoogleMap background ('Satellite' from the Layers List).

Figure 9 - Sentinel 2A captured this image of Venice on October 16, 2017
Image: Modified Copernicus data © ESA / Sentinel (2017)

Figure 10 - The final RGB true-colour image of Tenerife
Image: Modified Copernicus data © ESA / Sentinel (2017)

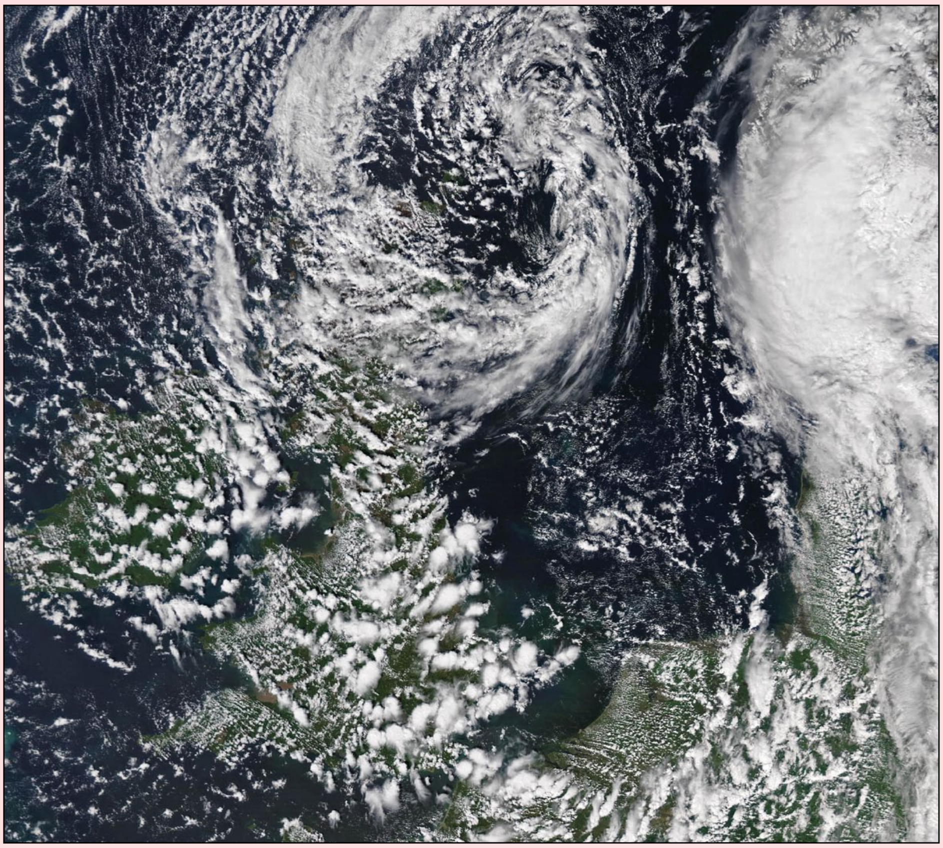
Coping When Nature Runs Wild

Cedric Roberts M.B.E.

This article first appeared in the December 2003 edition of the Remote Imaging Group Journal

How often have you been transfixed when a thunderstorm raged overhead? Of all of Nature's elements a thunderstorm is surely one of the most aweinspiring, a reminder that Man is but a small part of a complex and wonderful world. Some find these storms of such interest that they motor for miles in an attempt to get as close to them as is possible: the 'Storm Chasers' of the mid-United States in particular. Others feel so intimidated that they retire to a dark cupboard or sit beneath the stairs. Most, however, treat thunderstorms as part and parcel of a typical summer in this country, an event that soon passes, leaving the countryside or town with that pervading smell of moist soil or wet tarmac.

One such storm moved into the West Midlands on May 13, 2003 at around 13.40 UT, and was to have a most profound effect upon my daily life over the next few months. The day, up till that time, had been warm and sunny with occasional light showers, until the appearance of towering cumulo-nimbus cloud from the west heralded the imminent arrival of a storm. After a brief fall of small hail the first lightning strike occurred some miles away and I immediately began the task of pulling as many plugs as I could from my rather complicated computer system.



NASA's Aqua satellite acquired this MODIS image of the British isles just one hour following the fateful lightning discharge that destroyed much of the author's weather equipment
Image: LANCE Rapid Response/NASA/GSFC

Since I run a co-operating climate station with the Met Office and have a dual set-up for satellite acquisition, HRPT, wefax and the new MSG, I make use of three computers, all networked together. In addition, one of these carries a modem and it was the connection to this that I was most anxious to remove. A frenetic period ensued as I worked as quickly as possible to remove plugs and leads, only to be thwarted by Nature! A vivid flash with an instantaneous clap of thunder brought my work to a premature end. I heard a distinct 'crack' somewhere in the room but was very relieved to find that most items seemed to be functioning.

How mistaken I was! On careful examination—once that the storm had passed—I found that several items were no longer working. I tried the *Dartcom* HRPT system only to discover that the signal from computer to dish rotator was working, but that the return signal was not. Turning my attention to my automated weather logger it was obvious that this too, had suffered some damage, as the LCD display was blank. I next found that the 21-inch monitor to the main climate computer had failed though the computers did, in fact, seem to be working. As the rest of the day passed and I probed deeper into my equipment it quickly became obvious that major damage had been sustained.

Over the course of the following week, more and more items were found that were malfunctioning. On the roof the *Vector Wind System* had been blown and the *Skye* radiometer was also damaged, though the electronic sunshine sensor on the same mast had not been affected. In the logger the memory boards had been blown and serious damage had been done to the analogue to digital converter.

All of these items had to be removed and replaced, a task that I had to 'farm out' to others as my health prevented me from performing the work myself. As of today, October 12, most items have been replaced with just the analogue to digital board requiring attention. The work to the computer, logger and satellite system has so far cost over £900 though the loss of data has been far more of a problem. I have always treated thunderstorms with the utmost respect, having had a grandmother who was so petrified of them that she turned all mirrors, removed cutlery from the table and opened doors and windows. However, I had never previously sustained any damage from a storm during the half-century that I had been submitting data.

Careful reflection on the events of that day has revealed several things. Firstly, I had not suffered a direct strike, but a surge in the mains and wiring had been the cause of much of the trouble. Indeed, the same flash had moved north westwards across the sky from my area and had struck houses at Colley Gate near Cradley Heath. The roof of one house had been removed and a woman who was on the telephone at the time ended in the local hospital. Had I taken a direct hit, I am left wondering how much more damage would have ensued and I was left pondering if I had taken the possibility of damage from lightning far too lightly. This brings me to one final point, that of trying to discover what, if any, kind of protection against such damage can be made. I have turned my attention to surge protection plugs in the computer leads, but have no real wish to install a lightning conductor on the roof.

Weather Ready Nation

Ed Murashie

With the launch of the geostationary satellite GOES-R last year and last month's launch of the polar satellite JPSS-1, now more than ever is the United States a weather-ready nation. Not only is the United States better prepared but so is the world, since the data from these two satellites is shared freely with over 200 countries. What you may not know is that polar satellites contribute 85% of the data that goes into prediction models, and that data sharing agreements are made through the United Nations instead of thousands of mutual agreements. Individual country agreements may not have been made in some cases because of the current relationship among those nations.

The fully intergrated, JPSS-1 weather satellite ready for launch at Vandenberg Air Force Base
Photo: Ball Aerospace

JPSS-1 is short for *Joint Polar Satellite System* and is a joint venture between the *National Oceanic and Atmospheric Administration* (NOAA) and the *National Aeronautic and Space Administration* (NASA). But its origins came from a program called the National Polar-orbiting Operational Environmental Satellite System (NPOESS) which was to have been a joint venture between NOAA, NASA and the Department of Defense (DOD).

The idea was to combine all of the US weather satellite systems into one. But in 2010 congress abandoned the idea leaving NOAA/NASA's JPSS and DOD's DMSP systems separate. This worked well, since NOAA and NASA have been partners since the launch of the first TIROS on April 1, 1960. In October 2011, shortly after the NPOESS concept was abandoned, the *NPOESS Preparatory Project satellite* (NPP) was launched. NPP was later renamed Suomi NPP on January 24 2012 in honor of Verner E Suomi, a meteorologist at the University of Wisconsin who is considered the father of satellite meteorology.

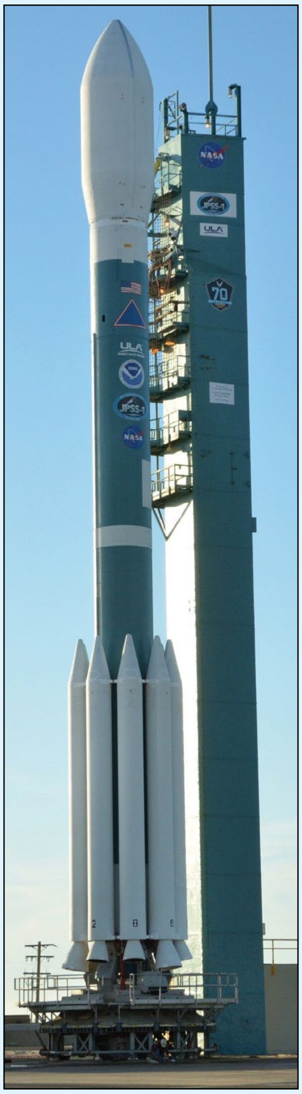
The scene at Vandenburg Air Force Base as the Delta II rocket awaits lift-off
Photo: Ed Murashie

NPP was the bridge between the previous generation weather satellites like NOAA-19 and the new generation JPSS-1, which was renamed NOAA-20 after it achieved orbit and started enabling systems. It was meant to be the research satellite version of JPSS-1 but, after proving its capability, it became the primary operation weather satellite in May 2014. The data from NPP was accurate enough to allow the Florida Governor to declare a statement of emergency six days prior to Hurricane Irma making landfall. When asked if it was accurate enough to eliminate hurricane hunter flights through the eyes of hurricanes, and radiosondes, a National Weather Service representative said they will always use the additional data to improve prediction models.

It is obvious what NOAA gets out the joint relationship and satellite data. But what is NASA's role; and what if anything do they get out of the data? First, NASA is the satellite bus, payload and launch vehicle acquisition partner with operations out of Goddard Spaceflight Center in Greenbelt Maryland. As for the data, NASA asks the big questions like,'is the ozone hole getting bigger', 'what is happening to the length of the growing seasons' and 'is there an imbalance in the radiation Earth budget'? It uses data from NOAA and other satellites to answer these questions. For the answers to these questions read on.

NOAA 20

NOAA-20 carries all of the same instruments as Suomi NPP but was designed from the beginning as the first operational, next generation satellite, with a seven year lifespan instead of five. Les Hamilton has done a great job of describing the instruments in a separate article in this issue so here I will focus on the Delta II rocket that gave JPSS-1 a boost into space, some interesting JPSS details and the CubeSats that hitched a ride.



Delta II primed for take-off
Photo: Ed Murashie

NOAA-20, 4.51 metres long and weighing 2295 kilograms, was launched on Delta II's most powerful 7920-10C configuration, while NOAA-19, at 1438 kg, was launched on the least powerful Delta II 7320-10C configuration. It had nine GEM 40 solid rocket motors of which six were ground lit and three air lit after the burnout of the six. Besides touting its 98.7% success rate, this is one of the most accurate rockets in regards to placing a payload in a precise orbit, which it did with NOAA-20. The NOAA-20 orbit is the same polar orbit as NPP and proceeds it by 50 minutes with a local crossing time of 1:30 pm. This was the 154th Delta II rocket since its first flight in February 1989 and the second to last, with the final one scheduled to launch ICESAT in Sept 2018 from Vandenberg AFB.

Hitching a ride, mounted to the second stage with JPSS-1, were four CubeSats. **MakerSat-0** from the Northwest Nazarene University in Idaho is a proof-of-concept mission with the second mission being the 3D printing, assembly and launch of MakerSat-1 from the International Space Station. **EagleSat-1** from the Embry-Riddle Aeronautical University in Arizona will test the use of super capacitors in the battery bank and measure of the orbit decay rate using GPS. **RadFx-Sat** from the Radio Amateur Satellite Corporation in Maryland and Vanderbilt University in Tennessee will measure the radiation effects on CMOS memory circuits. **MiRaTA** from the Massachusetts Institute of Technology will test new radiometer and GPS receiver technology which, if successful, could find its application in future generation weather satellites.

JPSS-1 is the first of four satellites in this series with currently planned launches in 2021, 2028 and 2031. After a successful ninety day check out phase, NOAA-20 will become the primary operational weather satellite with Suomi NPP as the secondary operational satellite. NOAA-20 is based on the same Ball Aerospace BCP-2000 spacecraft bus as Suomi NPP. More about the spacecraft bus and two paper models that be printed out and assembled can be found at this URL.

http://www.ball.com/aerospace/programs/jpss-1

As with fixed priced contracts, a few features were dropped on NOAA-20, including search and rescue capability, space environment monitoring and the Low Rate Data transmission that we amateurs could have received. What is included are the suite of five instruments, raw data transmissions to the TDRS satellites, the Svalbard (Norway) and McMurdo (Antarctica) stations at 8.215 GHz 300 MBps and a data subset at 7.812 GHz 15 MBps through the High Date Rate channel, HRD. Data will be available to the users through the data distribution center, data archive or direct broadcasts. The improved sounder data will improve the prediction models and narrow the uncertainty cone of hurricane paths. The low light capability of the VIIRS has already proven useful on the Suomi NPP in monitoring the power outages of Puerto Rico after Hurricane Maria (see overleaf). VIIRS data will help improve early fire detection and lead to more efficient deployment of firefighters and equipment. After Suomi NPP's and JPSS' operational lives are over they will be the first weather satellites to be de-orbited instead of contributing to space junk.

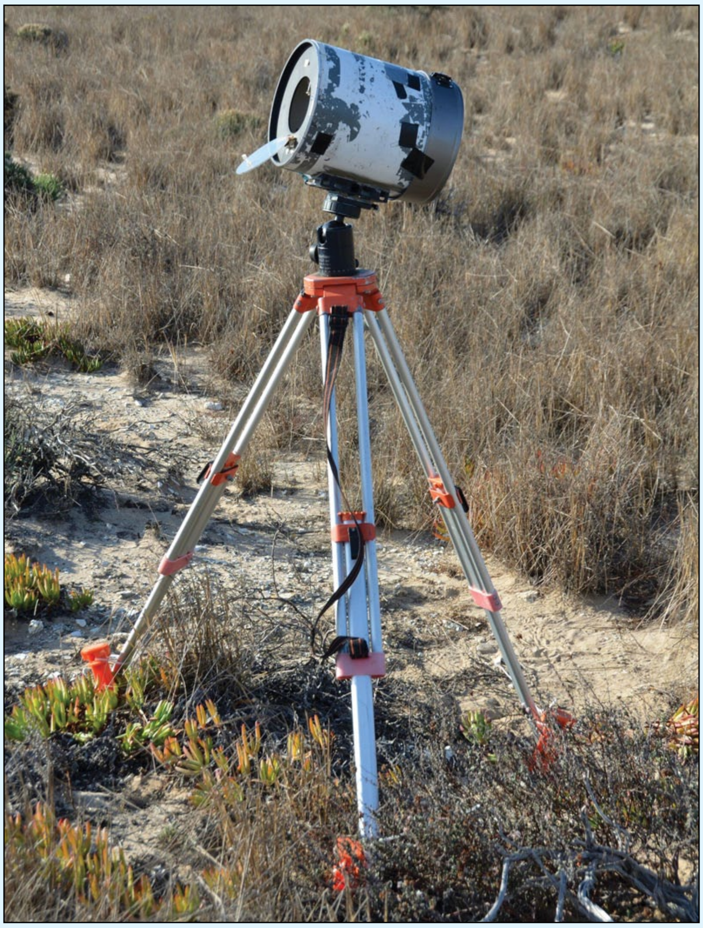
Earlier a few NASA questions were asked; here are the answers. The ozone hole was shown to be smaller over the past years. As for the growing season it has lengthened in the northern hemisphere over the past few decades. For the radiation budget balance, the earth has taken in slightly more energy than it has radiated out. That energy has been shown to be stored in the top layer of the oceans.

I want to thank NOAA for the invitation to their briefing and reception and to ULA and Ball Aerospace for handouts which helped in this article. I want to especially thank Michael Stonecypher, 30th Space Wing Public Affairs Officer at Vandenberg AFB, for allowing me to attend the press briefings, tower rollback and launch attempt. Without his help I would not have the information and photos used in this article.

Finally as NPP was renamed Suomi NPP to honor Verner Suomi, NOAA-20 is carrying a plaque with the names of seventeen people who significantly contributed to the project but passed away before it launched. Also the fixed mobile launch tower had a banner with the name of two ULA colleagues who recently passed away. The hope is that the relatives of these folks know the dedication their loved ones put into this satellite will lead to saving lives.

Photographing the Launch

One of the things that interested me at the launch pad besides the rocket were the remote camera set-ups left there by members of the press. There were set-ups like this one from a 20 year veteran who had a custom enclosure with a small cover that flipped down exposing the lens at launch and sound triggered to a first-timer who had a small camera with no protection.



An automated camera used to photograph the JPSS-1 launch
Photo: Ed Murashie

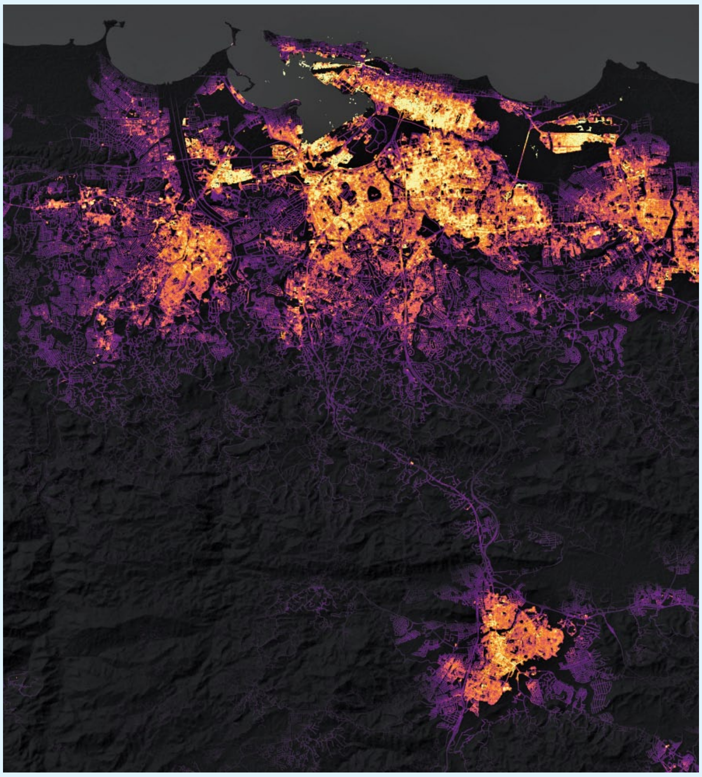
Everything had to be thought through from the stakes that held down the tripod to the exposure settings. They were set up near the pad about seven hours before the launch and picked up three hours after it. If given the chance I will try my own setup at a future launch.

Puerto Rico City Lights

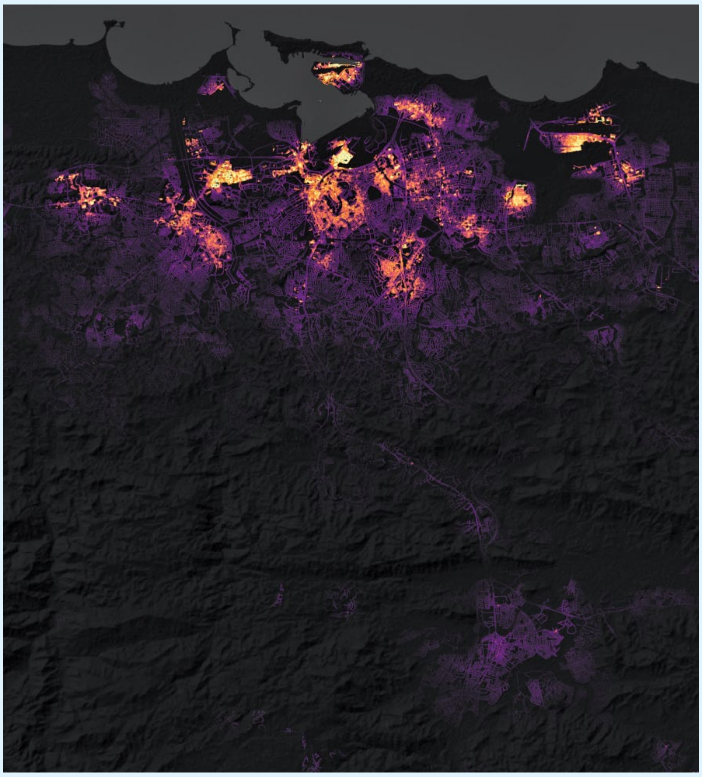
After Hurricane Maria tore across Puerto Rico last September, it quickly became clear that the destruction would pose daunting challenges for first responders. Most of the electric power grid and telecommunications network was knocked offline. Flooding, downed trees, and toppled power lines made many roads impassable. Being able to know exactly where the power was out would allow better deployment of rescue and repair crews and those distributing life-saving supplies.

Although all this happened before NOAA 20 became operational, Suomi NPP carries an identical complement of sensors and was able to acquire before-and-after images of Puerto Rico's nighttime lights, thanks to the satellite's VIIRS 'day-night band', which detects light in a range of wavelengths from green to near-infrared, including reflected moonlight, light from fires and oil wells, lightning, and emissions from cities and other human activity.

The two images below show lighting around the capital, San Juan. The upper image shows the city lights on a typical night prior to Maria making landfall, based upon cloud-free and low moonlight conditions. The lower image shows the identical region after the hurricane had passed.



The city lights of San Juan, capital of Puerto Rico, show brightly in this image taken prior to the devastation caused by Hurricane Maria
NASA Earth Observatory image by Joshua Stevens, using data courtesy of Miguel Román, NASA GSFC, and Andrew Molthan, NASA MSFC

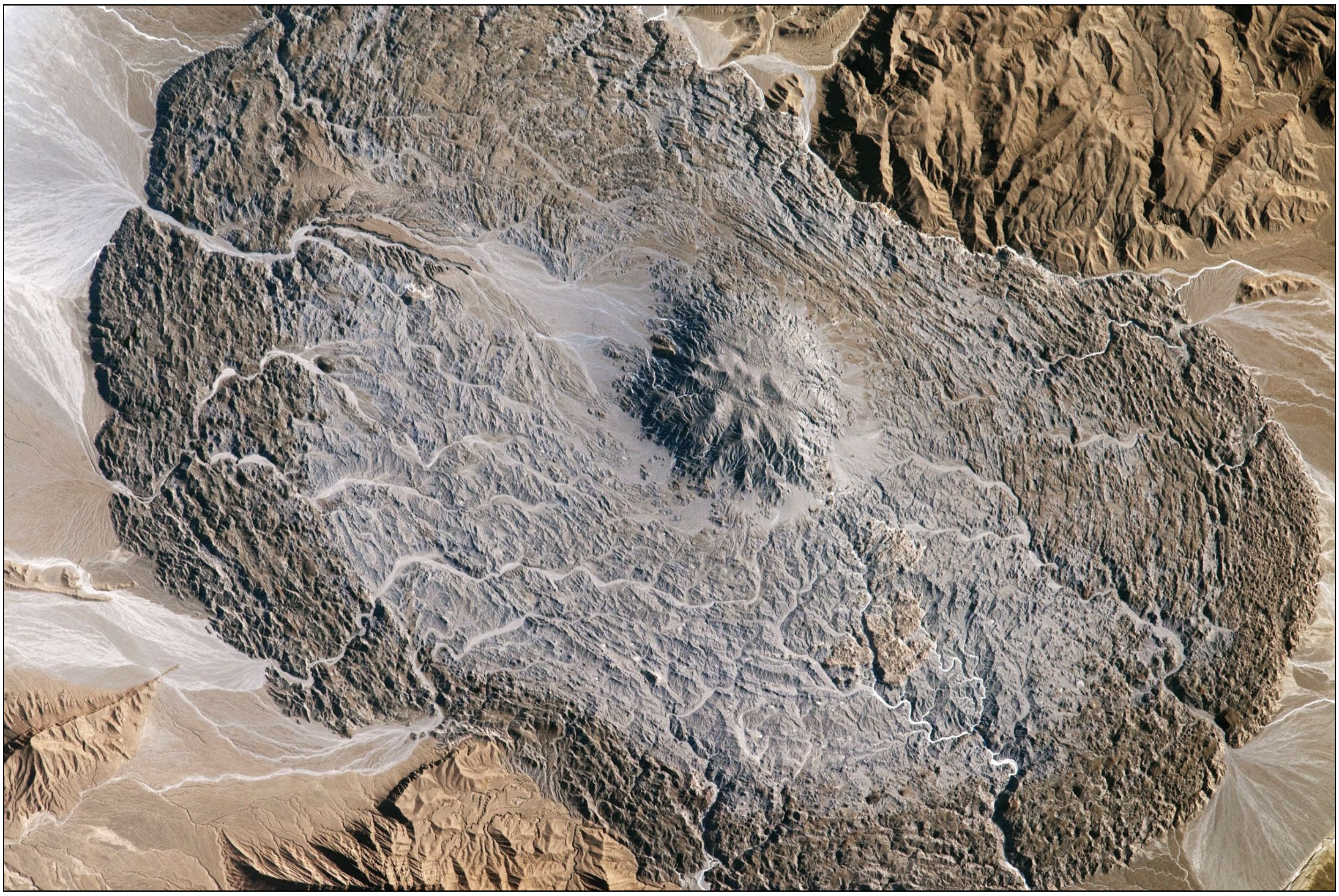


Widespread power outages are apparent in this image of San Juan after the passage of Hurricane Maria, a composite created from data taken on the nights of September 27 and 28 to minimise the intrusion of cloud.
NASA Earth Observatory image by Joshua Stevens, using data courtesy of Miguel Román, NASA GSFC, and Andrew Molthan, NASA MSFC

SALT GLACIER

in Iran's Zagros Mountains

NASA Earth Observatory



An unnamed salt glacier in southeast Iran

Astronaut photograph ISS052-E-8401 was acquired on June 24, 2017, with a Nikon D4 digital camera using a, 1150 millimetre lens, and is provided by the ISS Crew Earth Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center.

The scale and form of many impressive features on Earth's surface can only be fully appreciated through an overhead view. Astronauts onboard the International Space Station may enjoy the best overhead view of all.

The Zagros Mountains of southeastern Iran are the location of numerous salt domes and salt glaciers, formed as a result of the depositional history and tectonic forces that have operated in the region. While many of these landscape features are named on maps, the salt glacier in this photograph remains unnamed on global maps and atlases.

The vaguely hourglass-shaped morphology of the salt glacier is due to the central location of the salt dome, which formed within the central Zagros ridge crest. Salt extruded from the dome and then flowed downslope into the adjacent valleys. For a sense of scale, the distance across the salt glacier from northwest to southeast is approximately 14 kilometres.

Much like what happens in flowing ice glaciers, concentric transverse ridges have formed in the salt, perpendicular to the flow direction. While bright salt materials are visible in stream beds incising the salt glacier, older surfaces—those farther from the central salt dome—appear dark, most likely due to windblown dust deposition over time or incorporation of sediments in the salt during flow.

Another view of the salt glacier, acquired by ESA's Sentinel-2A on October 4, 2017

Image: Modified Copernicus data © ESA / Sentinel (2017)

New Water in the Aral Sea

NASA Earth Observatory

Figure 1 - The Aral Sea Basin on August 22, 2017

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

What remains of the large inland lake is a fraction of what it was in the 1950s and 60s. In those years, the government of the former Soviet Union diverted so much water from the Amu Darya and Syr Darya—the regions's two major rivers—to irrigate farmland, that it pushed the hydrologic system beyond the point of sustainability. During subsequent decades, the fourth largest lake in the world has shrunk to roughly a tenth of its former size and divided into several smaller bodies of water.

Figure 1, captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's ***Terra*** satellite, shows the Aral Sea in central Asia on August 22, 2017. While the lake was much smaller in August 2017 than it was in the 1960s, some growth in the eastern lobe of the South Aral Sea represents an improvement over August 2014, when that lobe was completely dry.

Instead of pooling in one large basin, water flowing down the two rivers now ends up in either the North Aral Sea (fed by the Syr Darya) or the South Aral Sea (fed by Amu Darya). The Kok-Aral dike and dam, finished in 2005, separates the two water bodies and prevents flow out of the North Aral into the lower-elevation South Aral. The dam has actually led fisheries in the North Aral Sea to rebound, even as it has limited flow into the South basin.

Managers use a sluice gate to let some water flow from the North Aral into the South Aral. During wet and snowy years, these releases are common, in dry years, they are rare. In 2017, heavy outflow from the North Aral in the winter, spring, and summer caused the eastern lobe of the South Aral to partially refill, explained Philip Micklin, a geographer emeritus from Western Michigan University.

Large releases from the Toktogul Dam, a reservoir on a tributary of the Syr Darya, increased the flow of the river during the winter. In the spring, unusually warm temperatures melted enough snow pack and glacial ice in the Tien Shan mountains to keep the river high. To a lesser degree, flow from the Amu Darya may have contributed to the partial replenishment of the eastern lobe in 2017 as well.

Figure 2 and figure 3 show the pathway water follows as it flows down the Syr Darya, into the North Aral Sea, and eventually the South Aral Sea. The Operational Land Imager (OLI) on Landsat 8 collected the image on August 5, 2017. At the time, the sluice gates at the dam appeared to be open, and water was flowing past the Tsche-Bas Gulf and into the South Aral.

“However, this year’s events do not signal a restoration of the eastern lobe as a permanent feature,” said Micklin. “Since the early 2000s, the eastern lobe revitalises during heavy flow years and then dries completely, or nearly completely in low flow years. I see this process continuing for the foreseeable future.”

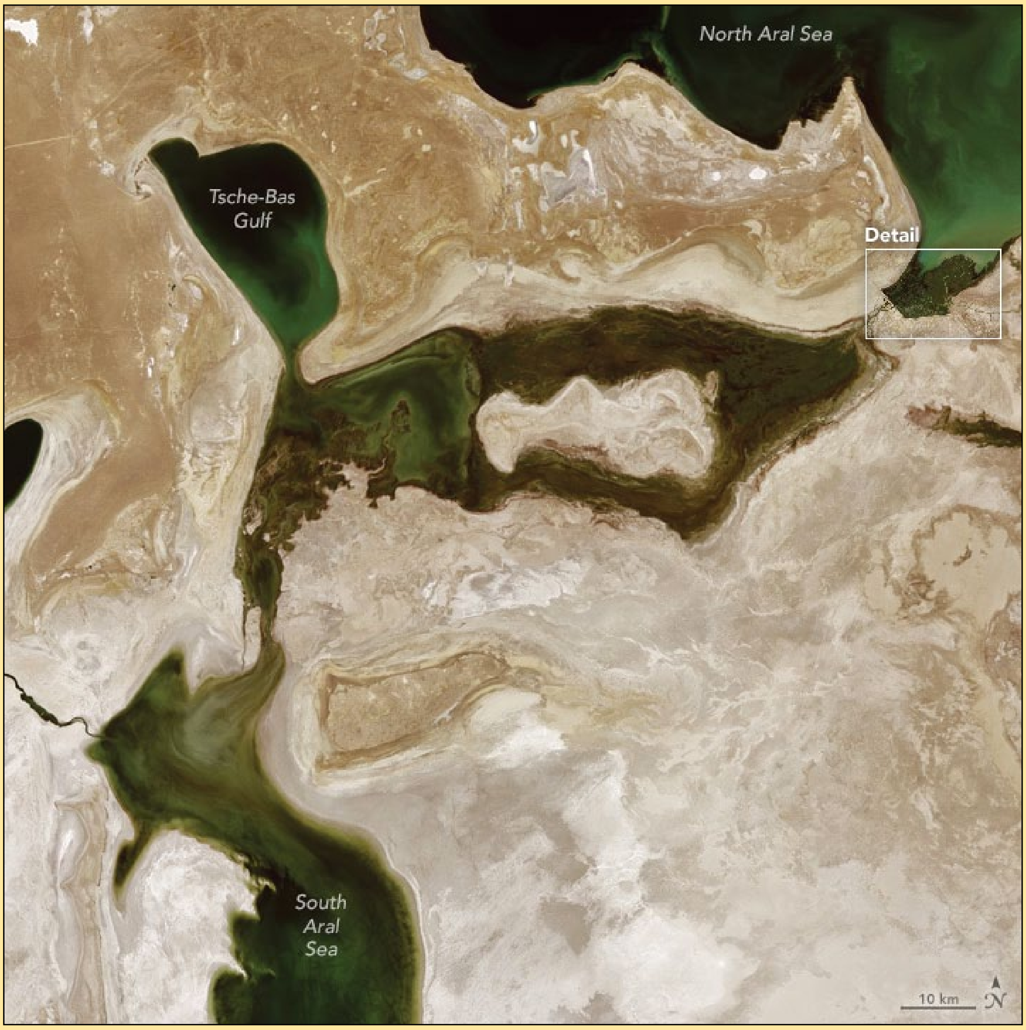


Figure 2 - The water pathway from the mouth of the Syr Darya, past Tsche-Bas Gulf to he Southern Aral
NASA Earth Observatory image by Jesse Allen, using Landsat data from the U.S. Geological Survey

Figure 2 - Detail showing the Syr Darya delta where it enters the North Aral Sea and the Kok-Aral Dam
NASA Earth Observatory image by Jesse Allen, using Landsat data from the U.S. Geological Survey

The Ozone Hole is its Smallest

for nearly 30 years

NASA Earth Observatory

Observations during 2017 have shown that the 'hole' in Earth's ozone layer—which forms over Antarctica at the end of each southern winter—was the smallest on record since 1988.

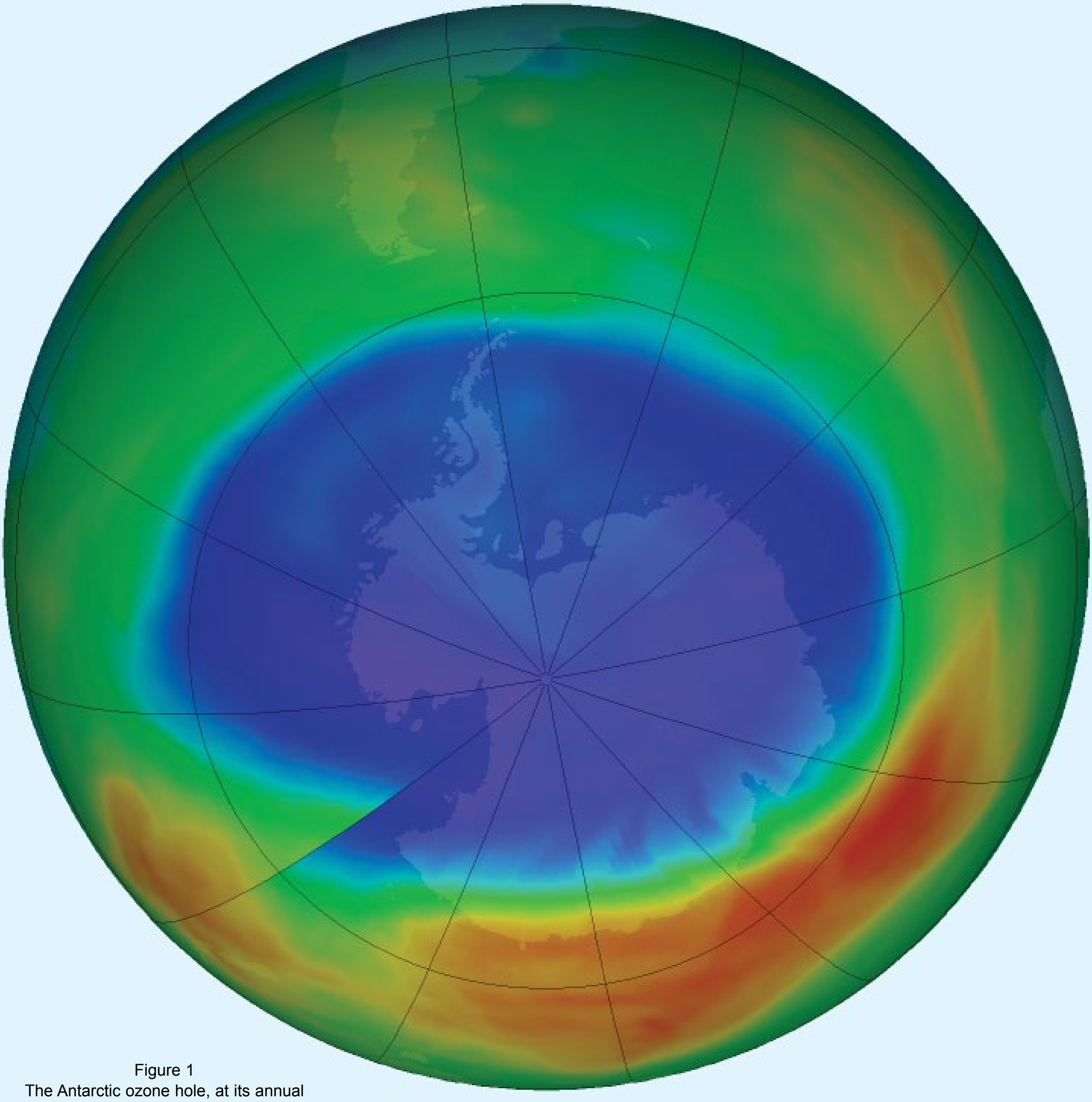


Figure 1
The Antarctic ozone hole, at its annual maximum extent, on September 11, 2017.

According to NASA satellite estimates, the ozone hole reached its annual peak **extent** on September 11, 2017 when it spread across 19.6 million square kilometres, an area about 2.5 times the size of the United States. Ground- and balloon-based measurements from the National Oceanic and Atmospheric Administration (NOAA) agreed with the satellite measurements. The average area of ozone hole maxima since 1991 has been roughly 26 million square kilometres.

The map opposite (figure 1) shows the Antarctic ozone hole at its widest extent for the year, as measured on September 11. The observations were made by the Ozone Monitoring Instrument (OMI) on NASA's ***Aura*** satellite.

> *"The Antarctic ozone hole was exceptionally weak this year,"* stated Paul Newman, chief scientist for Earth sciences at NASA's Goddard Space Flight Center. *"This is what we would expect to see given the weather conditions in the Antarctic stratosphere."*

The smaller ozone hole in 2017 was strongly influenced by an unstable and warmer-than-usual Antarctic vortex, a low-pressure system that rotates clockwise in the atmosphere over far southern latitudes (similar to polar vortices in the northern hemisphere). The vortex helped to minimise the formation of polar stratospheric clouds (PSCs); the formation and persistence of PSCs are important precursors to the chlorine and bromine reactions that destroy ozone.

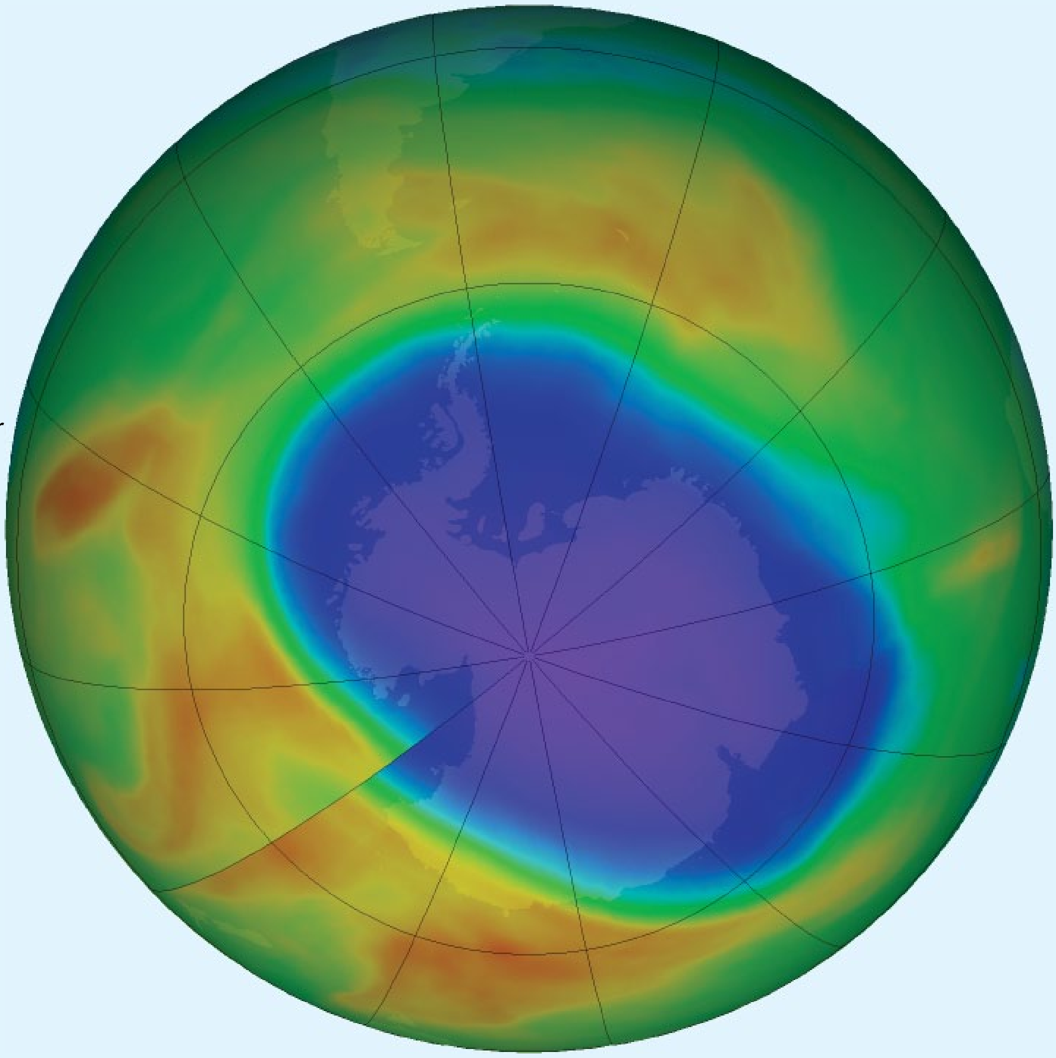


Figure 2
The Antarctic ozone hole, at its annual maximum concentration, on October 12, 2017.

Although warmer stratospheric weather conditions have reduced ozone depletion during the past two years, ozone holes are still large because atmospheric concentrations of ozone-depleting substances (primarily chlorine and bromine) remain high enough to produce significant yearly ozone loss. The smaller ozone hole extent in 2017 is due to natural variability and is not necessarily a signal of rapid healing.

First detected in 1985, the Antarctic ozone hole forms during late winter in the Southern Hemisphere as returning sunlight catalyses reactions involving man-made, chemically active forms of chlorine and bromine. These reactions destroy ozone molecules in the stratosphere. At high altitudes, the ozone layer acts like a natural sunscreen, shielding the Earth's surface from harmful ultraviolet radiation that can cause skin cancer and cataracts, suppress immune systems, and damage plants.

Thirty years ago, the international community signed the Montreal Protocol on Substances that Deplete the Ozone Layer and began regulating ozone-depleting compounds. The ozone hole over Antarctica is expected to gradually become less severe as chlorofluorocarbons (CFCs) continue to decline. Scientists expect the Antarctic ozone hole to recover back to 1980 levels by 2070.

Figure 2 shows the Antarctic ozone hole on October 12, 2017, as observed by OMI. On that day, the ozone layer reached its annual minimum **concentration**, which measured 131 Dobson Units, the mildest depletion since 2002. (One Dobson Unit equals the number of ozone molecules required to create a layer of pure ozone 0.01 millimetres thick at a temperature of 0°C and a pressure of one atmosphere.)

As both images show, the word hole is not literal; scientists use it as a metaphor for the area in which ozone concentrations drop below the historical threshold of 220 Dobson Units. During the 1960s, long before the Antarctic ozone hole occurred, average ozone concentrations above the South Pole ranged between 260 and 320 Dobson Units. Globally, the ozone layer today ranges from 300 to 500 Dobson Units.

> *"In the past, we've seen ozone at some stratospheric altitudes go to zero ozone by the end of September,"* said Bryan Johnson, NOAA atmospheric chemist. *"This year, our balloon measurements showed the ozone loss rate stalled by the middle of September and ozone levels never reached zero."*

Editor's Note: The uneven seam in the contours of the data (lower left quadrant of each image) marks the location of the international date line. Ozone data are measured by polar-orbiting satellites that collect observations in a series of swaths over the course of the day. The passes are generally separated by about 90 minutes. Stratospheric circulation slowly shifts the contours of the ozone hole during each 24 hour period (just as winds shift the location of clouds). The contours move little from any one swath to the next, but by the end of the day, the cumulative movement is apparent at the date line.

Credits

NASA Earth Observatory images by Jesse Allen, using visuals provided by the NASA Ozone Watch team.

Story by Katy Mersmann, NASA GSFC, and Theo Stein, NOAA Office of Oceanic and Atmospheric Research, with Mike Carlowicz, Earth Observatory.

GOES-16 on the Move

Ed Murashie

By the time you read this, GOES-16 will still be drifting to 75.2°W or will have reached its destination. The milestone dates for the transition of GOES-East operations from GOES-13 to the new generation GOES-16 are as follows:

- November 30: HRIT/EMWIN from GOES-16 will be shut off while drifting eastward.
- December 5: GOES-13 GVAR will also be broadcasted through GOES-14 at 105°W.
- December 11: GOES-16 will stop its drift at 75.2°W.
- December 14: At approximately 1530Z GOES 13 will turn off the LRIT and GVAR transponders.
- December 14: At approximately 1545Z GOES 16 will turn on the HRIT transponder and the ground system will start broadcasting HRIT/EMWIN as the operational GOES East satellite.
- January 2: GOES 14 will turn off the GVAR transponder.

To get on the GOES-R HRIT/EMWIN Broadcast Status email list contact Seth Clevenstine, NOAA Direct Broadcast Manager, at

seth.clevenstine@noaa.gov

Reception of GOES-15 LRIT (Low Rate Information Transmission at 1691 MHz and 128 kBps) and GOES-16 HRIT (High Rate Information Transmission at 1694.1 MHz and 400 kBps) are within the capability of the amateur community. Having received GOES-13 and GOES-15 LRIT, it will be interesting to see the HRIT products from GOES-16 with its advance capability.

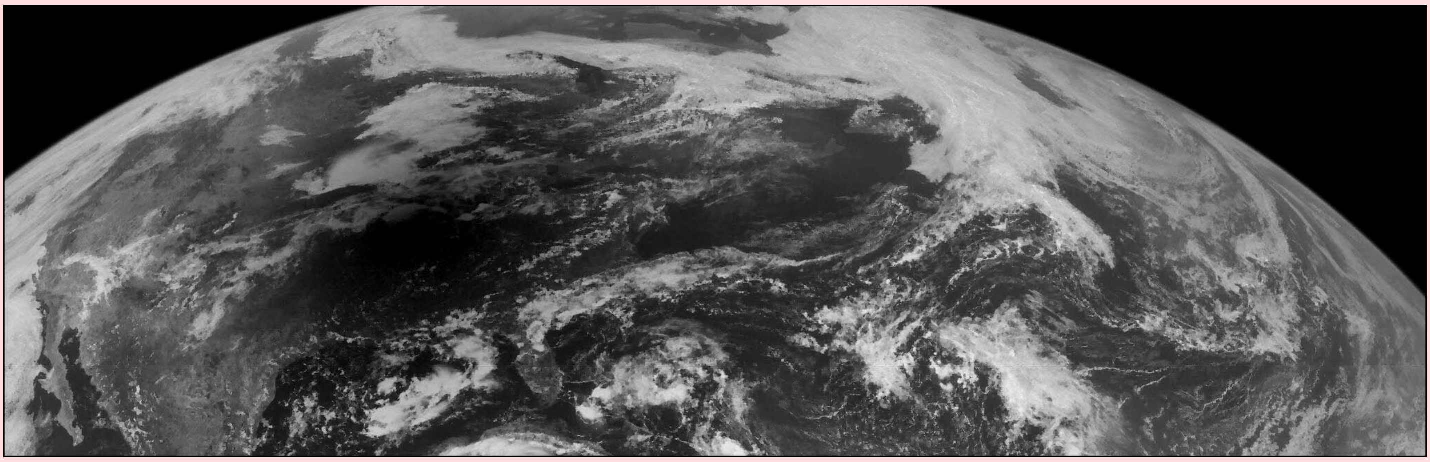
My previous LRIT system is described at

http://proengineered.com/ lrit0501/lrit0501_002.htm

The author's six foot dish on its Pelco PT1250P/PP pan-tilt mount

My current homebrew system starts with a six foot dish on a *Pelco PT1250P/PP* pan-tilt mount. The six foot dish is more than

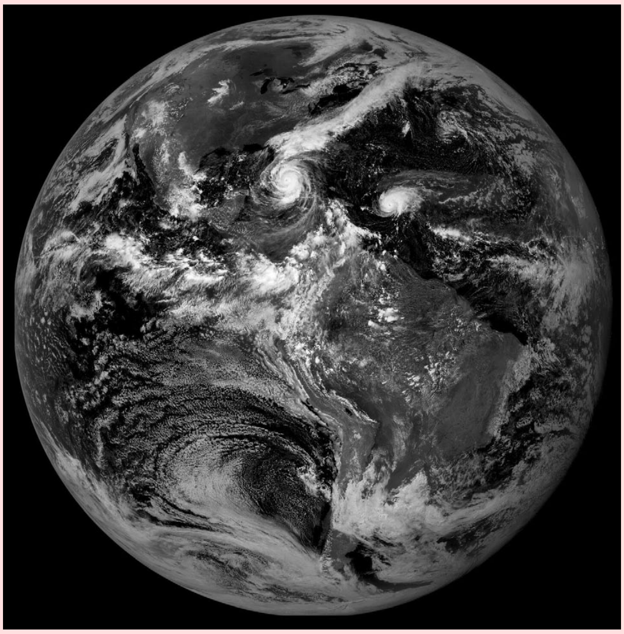
The satellite modem / FPGA formatter card / PC that comprise the author's system



This is a GOES-13 image, received by the author, showing the darkening due to the total solar eclipse of August 21, 2017

I need but eliminates the need for error correction, and the Pelco unit allows the dish to point at either GOES satellite or track polar satellites. The signal enters a feed horn with two 90° probes connected to a Mini-Circuit quadrature combiner for right hand circular polarization (RHCP). RHCP is optimum for receiving polar satellites and helps with the linear polarization differences between GOES-East and -West. If you were only intending to receive one GOES satellite, it would be better to use a smaller dish with a linear feed.

The output of the combiner goes to a kit-built *Sam Jewell G4DDK* very low noise 1.7GHz amplifier (34 dB gain with a 0.24 dB noise figure). Next is a *Mini-Circuits ZQL-1900LNW* amplifier with an additional 28 dB gain to drive the 50 feet of LMR-400 coax cable running into the house. Once inside the house the signal passes through a 1685 MHz bandpass BSC Filter that is 20 MHz wide to eliminate local radar noise and then into a *CDM-IP-300L Comtech* satellite modem. The modem displays a GOES-13 received signal strength of -63.5 dB, a signal to noise ratio of 12.5 dB, a raw bit error rate of <3.0E-5 and a *Viterbi* corrected error rate of <1E-12. The output of the modem goes to a FPGA frame formatter which is described on my website and then to a notebook PC through a USB connection.

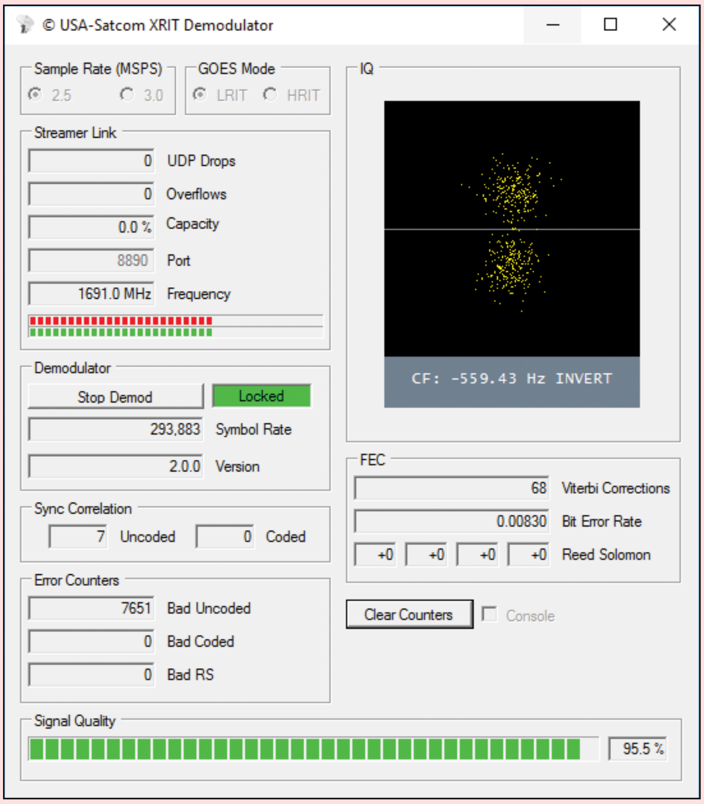


This Full Disk GOES-13 LRIT image shows Hurricane Irma to the left and Hurricane Jose on September 9, 2017

Every few years I enjoy lecturing at the Satellite Educators Association Conference at Cal State Los Angeles. I describe the satellites, how to get the data on the Internet and then how to assemble an APT station. It was fun finding the parts for the homebrew LRIT system and assembling the station but it is not appropriate for the school teacher audience. But this year might be different. Lucas Teske (www.teske.net.br/lucas/) with his Open Satellite Project and Joe Steinmetz (http://usa-satcom.com/) have inspired me by decoding the GOES LRIT signal with a $85 grid antenna, SPF5189 LNAs and the Mini *Airspy* SDR dongle. All of these components are readily available. Time to clear off the workbench and start a new project.

To finish my story, I was sitting around waiting for the recent solar eclipse which had a 50% chance of being obscured by clouds. I was thinking about my options when I realized it would be fun to fire the LRIT system back up and watch the moon's shadow on the Earth, so I reassembled the system and captured a few images. I kept it running through the hurricane season and then kept the excitement going by attending the JPSS-1 launch. Now I am looking forward to decoding GOES with the mini-*Airspy* SDR dongle and checking out the new GOES-16 HRIT images. So for me there is as much fun working with the satellite hardware as there was decoding WEFAX.

On a final note, it was thanks to the polished versions of my GEO articles, thanks to editor Les Hamilton—which I showed off when trying to sell myself to Vandenberg AFB—that led to me actually being invited to the JPSS-1 launch as a member of the press.



A GOES signal being received by the Satcom XRIT demodulator

Bridging the Bosphorus

NASA Earth Observatory

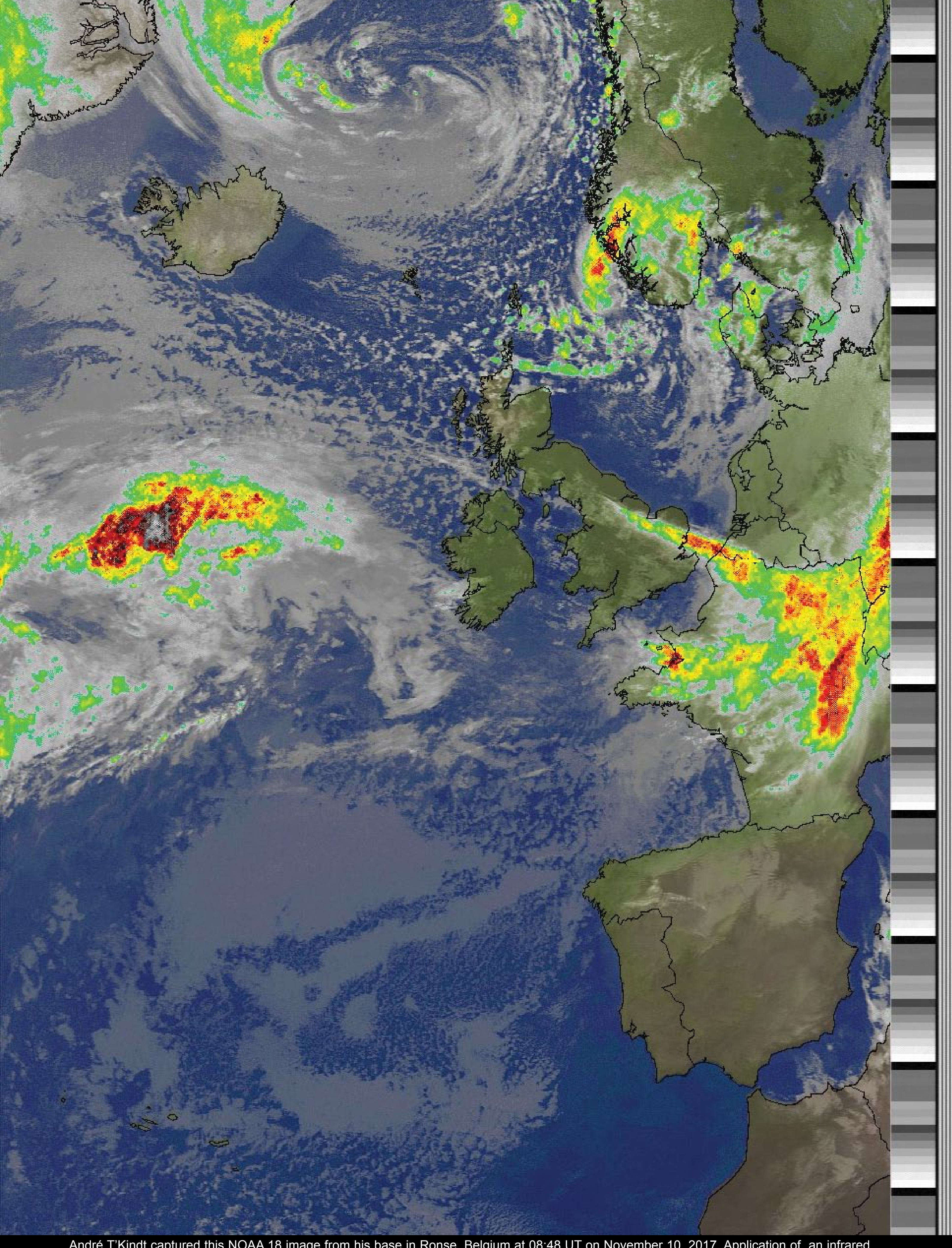
Astronaut photograph ISS051-E-12977 is provided by the ISS Crew Earth Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center. The image was taken by a member of the Expedition 51 crew.

On April 13, 2017, an astronaut aboard the International Space Station focused a Nikon D4 digital camera fitted with an 1150 mm lens on the Bosphorus, the strait which famously divides Europe (lower half of the image) from Asia (upper). Turkey's largest city, Istanbul, flanks both shorelines. Forested parks at lower left contrast with the red roof tiles of the cityscape, one of the most striking features of Istanbul when viewed from space. Two of the three bridges that span the Bosphorus appear in this image—the **Bosphorus Bridge** (right) and the **Fatih Sultan Mehmet Bridge** (left), the latter named after Mehmed the Conqueror.

Highways lace the city, connecting clusters of high-rise buildings that stand out from the tiled roofs, and which cast more shadow than shorter buildings. **Taksim Square** is the centre of modern Istanbul, appearing as an open space near the **Dolmabahce Palace**, the administrative heart of the Ottoman Empire in pre-republic centuries.

The Bosphorus enables significant amounts of international shipping to move between the Mediterranean Sea and the Black Sea and if especially important as an outlet for Russian oil products. In this photograph, a few ships are visible in the waterway. At several points they need to make dangerously sharp turns, with coastlines obstructing visibility. This is especially true at Yeniköy and Kandilli Point. Navigation is made more hazardous because currents can reach up to four metres per second. The risks of navigating the Bosphorus are multiplied by the heavy ferry traffic linking the European and Asian shores.

To reduce the number of ships and to improve safety in this narrow waterway—just 1050 meters wide at the Bosphorus Bridge—officials have proposed to dig a new waterway, the Kanal Istanbul, which would connect the Mediterranean and Black Sea at a point 70 kilometres to the west of Istanbul.



André T'Kindt captured this NOAA 18 image from his base in Ronse, Belgium at 08:48 UT on November 10, 2017. Application of an infrared precipitation overlay illustrates heavy rainfall over eastern France, with the threat of rain approaching England for the following day.

Hurricane Ophelia and the UK's Red Sun

John Tellick

Hurricane Ophelia, the eastern-most Atlantic hurricane ever recorded, was the tenth consecutive hurricane—and the sixth major one—of the very active 2017 Atlantic hurricane season. Several islands in the Caribbean were devastated in quick succession by Hurricanes Irma and Maria, and finally Ophelia.

Ophelia had non-tropical origins south of the Azores on October 6 from a decaying cold front. Located within a favourable environment, the storm steadily strengthened over the following two days, drifting north and then south-eastwards before becoming a hurricane on October 11. After fluctuating in intensity for a day, Ophelia finally strengthened into a major hurricane on October 14, brushing the archipelago with high winds and heavy rainfall as it started migrating over progressively colder waters to its northeast. This caused Ophelia to start weakening as it progressed towards Ireland and Great Britain early on October 16, when, now reduced to an extra-tropical cyclone, Ophelia became the second storm of the 2017–18 UK and Ireland windstorm season.

In the Republic of Ireland, a national emergency was declared as winds of up to 120 kilometres/hour ravaged the country, claiming three lives and causing extensive damage to properties. All schools were closed for two days as a precaution as the nation's worst storm for over 50 years damaged power networks (over three hundred thousand consumers were cut off) and caused widespread disruption to travel as many businesses remained closed for the day. Over much of Great Britain and Northern Ireland, a yellow weather warning was issued with forecasts of winds gusting up to 100 kph. Early the following day, the cyclone crossed the North Sea and struck western Norway with wind gusts of up to 70 kph in Rogaland county, before weakening during that evening. The system made additional landfalls in Sweden and Finland, before dissipating over Russia.

The Red Sun.

Here in SW London, on October 16, whilst Ophelia was raging off the west coast of Ireland, the day started sunny and warm with light winds. I was checking tree shadows and solar outage on my EUMETCast dish, gradually aware of the sky becoming milky with thin high cloud, but still 'sunny' though with an increasing 'pinkness'

I went off to Kingston-upon-Thames around midday for lunch by the river, the sky becoming increasingly cloudier, and the sun increasingly red. Almost as the minutes passed, it became darker and darker with the sky turning a red/brown colour creating a really creepy atmosphere. One really felt that the Four Horsemen of the Apocalypse were about to appear out of the cloud.

Everywhere took on a deep sepia tinge with colours of buildings and trees being distorted. It became so dark around 13:30 GMT that street lamps came on and cars used their headlights. It was quite an experience and very eerie. The unusual and rather alarming Red Sun phenomenon lasted for several hours, well into late afternoon, but that apart, London, at least, was calm and warm all day.

As will be seen from the Metop-A RGB visible image on that day (figure 4), Ophelia had earlier picked up Saharan dust blowing in the Atlantic from North West Africa and later smoke from forest fires in Portugal and Spain. This appears to be evident heading north in the Bay of Biscay on the image.

Figure 1 - The Red Sun, photographed by the author at approximately 11:50 GMT in the morning

Figure 2 - The red sky over the river, photographed by the author

Figure 3 - The track of Ophelia from the Azores to Scandinavia
Image created by Brenden Moses using WikiProject Tropical cyclones/Tracks. The background image is from NASA. Tracking data is from NHC.

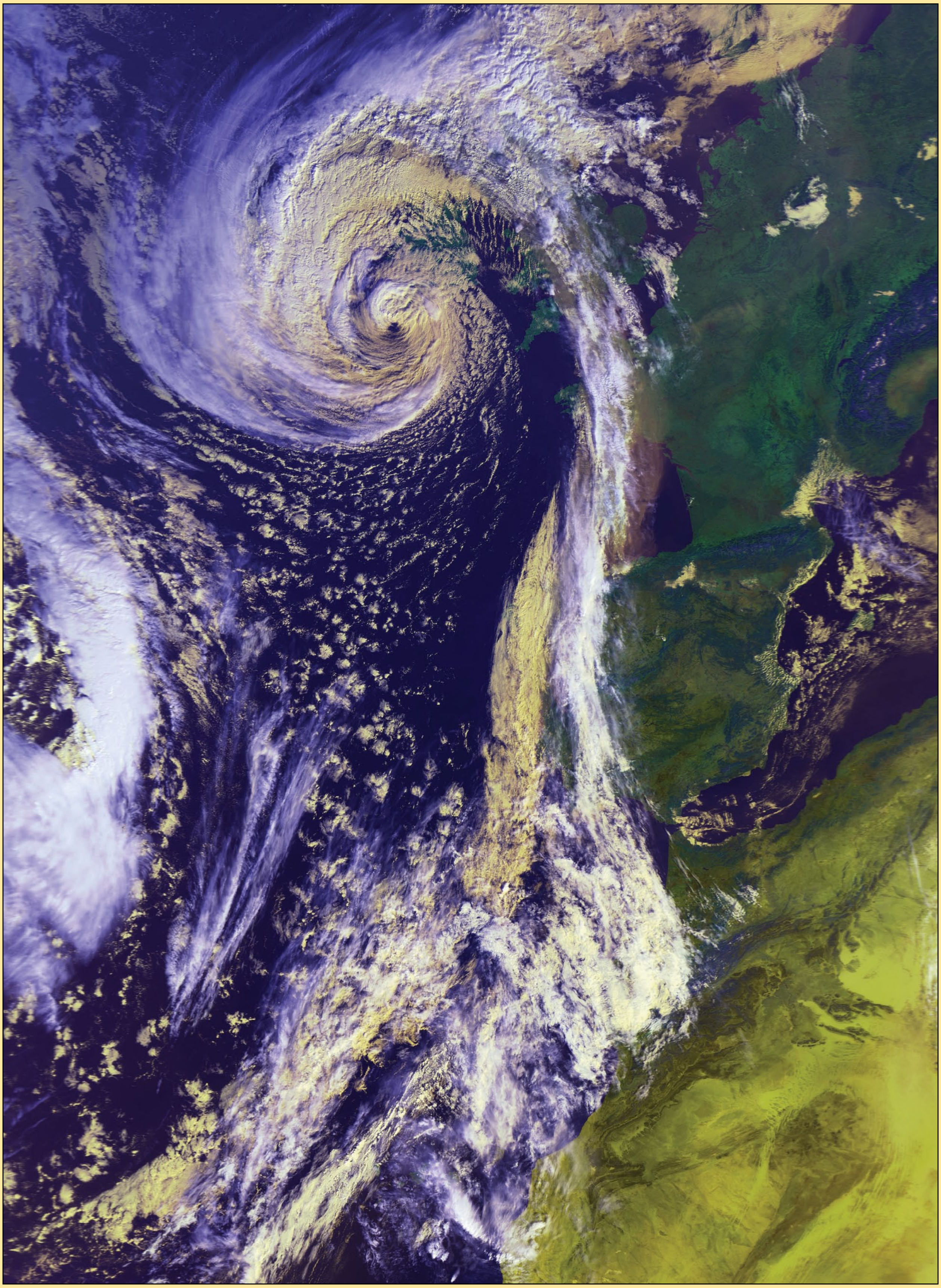


Figure 4 - This false colour Metop-A image dating from 10:31 UT on October 16 shows a plume of sand being drawn from the Moroccan Sahara
Image © EUMETSAT (2017)

The points on the track map of Hurricane Ophelia (Figure 3) show the locations of the storm at 6-hour intervals. The colour of each marker represents the storm's maximum sustained wind speeds as classified in the Saffir–Simpson scale, and the shape of the data points indicates the nature of the storm, according to the legend at right.

Tropical depression	≤38 mph	≤62 km/h
Tropical storm	39–73 mph	63–118 km/h
Category 1	74–95 mph	119–153 km/h
Category 2	96–110 mph	154–177 km/h

●	Tropical cyclone
■	Subtropical cyclone
▲	Extratropical cyclone

Forty Years of Meteosat

European Space Agency

ESA's first Earth observation satellite, Meteosat-1, was launched on the 23rd of November 1977. When it took its place in the sky, it completed coverage of the whole globe from geostationary orbit and laid the foundations for European and world cooperation in meteorology that continues today.

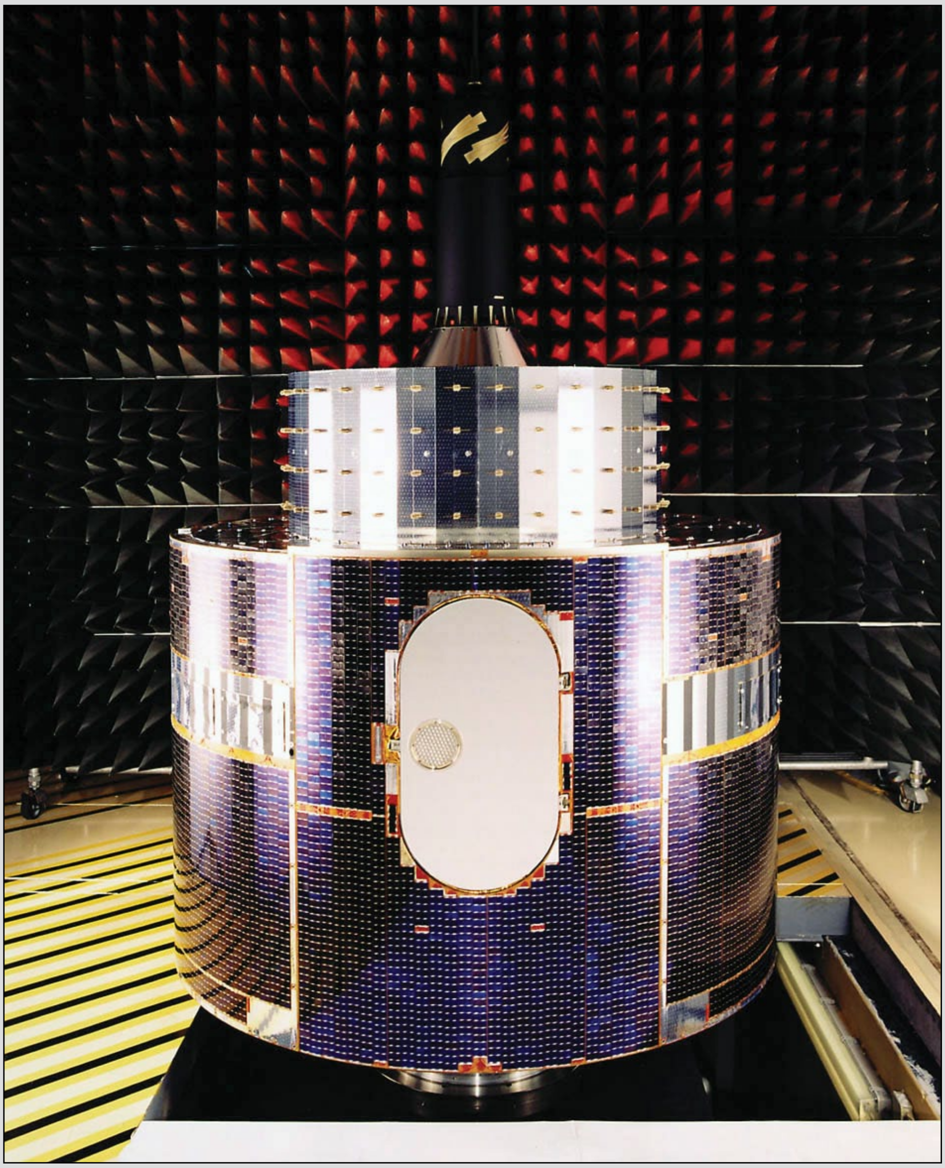
Weather—and particularly extreme weather—affects everything we do. Being able to see the whole disc of Earth allows forecasters to see developing weather systems, as well as working out wind speed and direction based on cloud movements. Atlantic hurricanes appear on Meteosat images long before they interact with land, and data from space help to predict their tracks.

Before weather satellites, forecasters relied on surface observations from land, ships and buoys, along with some information about the atmosphere provided by balloon-borne radiosondes, kites and aircraft. Satellites provided a vast new array of information that, coupled with new computer models, helped to make forecasts more reliable for longer periods.

Meteosat was an important milestone in European cooperation in space. Individual countries had pioneered monitoring of the ionosphere from space and the European Space Conferences of the 1960s agreed in principle that there should be a European weather satellite. But it was not until Meteosat that the potential for meteorological satellites began to be fulfilled.

Meteosat was initiated as a French project, with involvement both from their *Centre National d'Études Spatiales* (CNES) and the French meteorological service. At the same time, the *European Space Research Organisation* (ESRO), a forerunner of ESA, was considering possibilities for polar-orbiting and geostationary satellites. ESRO decided on a geostationary satellite, which would clearly be a duplication of the French effort.

Over a long period of fact-finding and negotiation, the foundations were laid for the Meteosat project to evolve from a French one to a European one. Rather than uproot the whole operation from France, it was decided to establish an ESA office in Toulouse, from where Meteosat could be developed and guided.



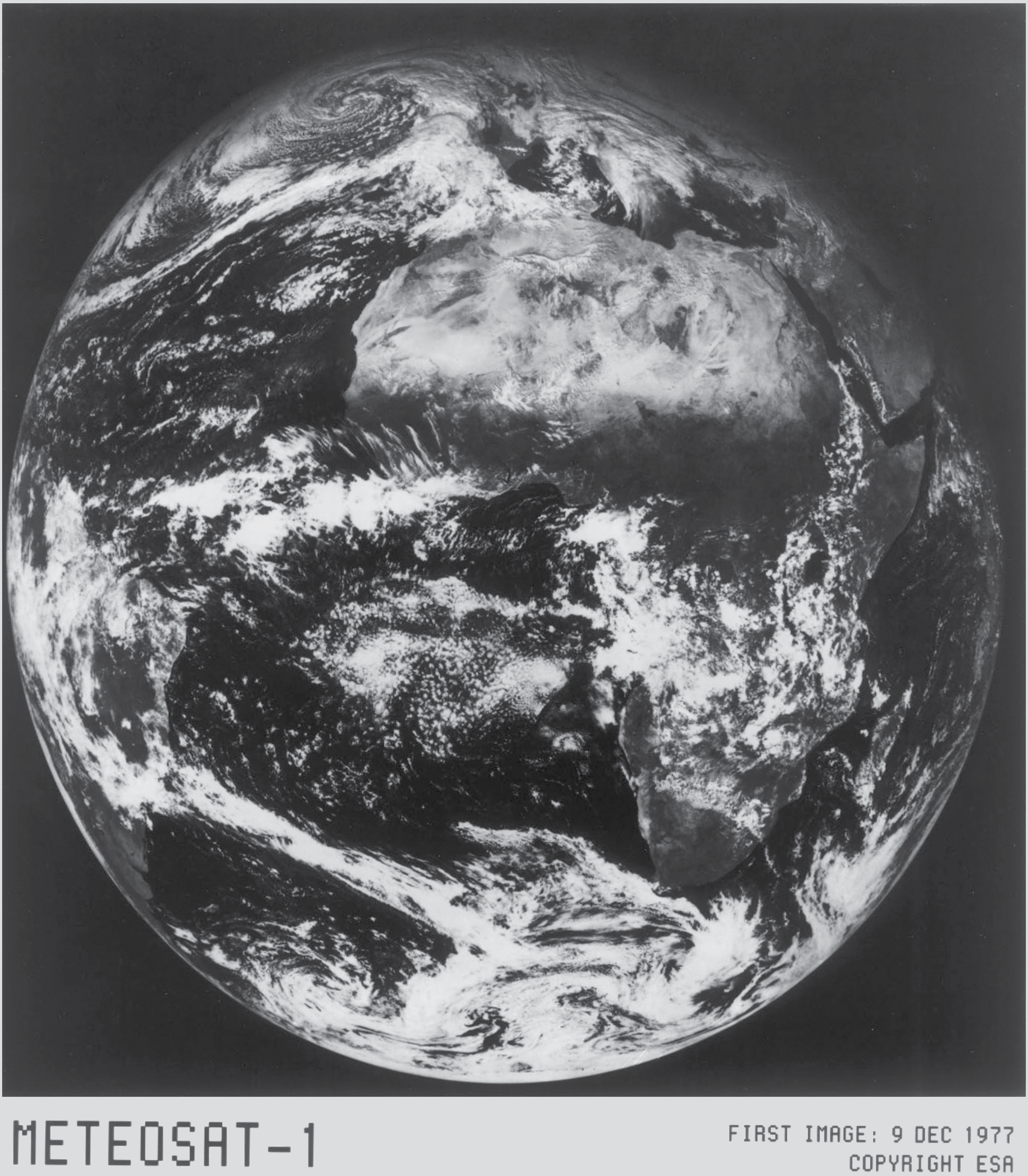
Life sized model of the original Meteosat-1 satellite
Image: ESA

Meteosat-1 lifted off from Cape Canaveral in Florida at 13:35 UT on November 23, 1977, reached its operational orbit on December 7, and sent back ts first image on December 9. It was the first satellite in geostationary orbit to have a water vapour channel to track the motion of moisture in the air.

The new satellite required great improvements in ESA's computing power, both for telemetry and for image data processing. From its position over the Greenwich meridian, Meteosat-1 could scan Earth's full disc every 30 minutes, with the data being provided in near-real time to users.

Since the launch of Meteosat-1, 40 years of imagery and derived meteorological data from it and its successors have helped to significantly improve weather forecasting. There are 35 years' worth of Meteosat imagery available online and the satellite's record of imaging from space constitutes an important body of evidence in climate science.

Although the early meteorological satellites were not envisaged as tools for measuring climate change, images



of changes in land cover or polar ice and data on sea-surface temperatures have become very useful for climate research and modelling.

There was a gap of almost a decade between the launch of Meteosat-1 and the official founding of *EUMETSAT*, the European organisation created to exploit satellite data for weather and climate research with the global community. Today, with clear operational responsibilities and funding, *EUMETSAT* has become a global player in satellite meteorology. With thirty member states, *EUMETSAT* continues to develop new satellite programmes in cooperation with ESA.

The Meteosat programme always has one satellite in the operational position at 0º longitude. Craft of the Meteosat Second Generation series retained the drum-shaped design of the original, shown on the previous page, although they were two and a half times larger and offer improved resolution: 12 spectral channels as opposed to three on the original system, and faster scanning.

Looking to the future, Meteosat Third Generation is in development, with new capabilities such as lightning detection, and will guarantee continued European monitoring of the atmosphere from space into the 2030s.

Useful references for reception from
Weather and Earth Observation Satellites

Francis Bell

You can visit our GEO website for almost anything you want to know about the reception of polar orbiting and geostationary weather satellite images. Also, you can follow GEO news items on Facebook, Twitter and User Groups from links on our Home Page at

www.geo-web.org.uk

If you want to join GEO today, which is now free of charge, then you can find out more about Earth Observation and related topics by visiting the Group for Earth Observation on Yahoo at

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

and clicking the **Join Group** button.

The International Space Station

The following website shows live views from experimental cameras on the ISS but reception is subject to orbit and communication links

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

For an audio ground link, sometimes accompanied by video from inside the space station

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

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

Predicting Satellite Passes

For satellite prediction times for your own location, visit

http://heavens-above.com/

and click the link '*Change your observing location*'. On the world map that appears, zoom in to your location and click it. A marker appears on the map and your location coordinates are displayed beneath it.

Next, move back to the opening page and click the link '*Satellite database*', and enter tne name of whichever satellite interests you from the following list (exactly as shown, including space):

NOAA 15
NOAA 18
NOAA 19
Meteor M2
ISS

Click the 'Update' button, then select the 'All Passes' link from the information on screen.

Satellite Frequencies

These are frequencies and approximate pass times for polar orbiting weather satellites for the UK.

NOAA 19	137.10 MHz	around 1.00 pm
NOAA 18	137.91 MHz	around 12.00 noon
NOAA 15	137.50 MHz	around 4.00 pm
Meteor M2	137.90 MHz	around 9.00 am

Note that these passes are also available at night: just add 12 hours. Also note that the times may be plus or minus about 45 minutes according to any specific orbit.

The NOAA satellite signals are FM modulated with a band width of about 45 kHz. Decoding software for the NOA satellites is quite widely available free of charge. Try the *WXtoImg* program available for download from

www.wxtoimg.com/downloads

European Satellites

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

What do you need for personal reception at home are

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

Once established, such a system will run indefinitely. Approximate costs are:

- Dish and LNB - be resourceful
- Receiver, about £350 from GEO
- A licence and dongle from EUMETSAT, £70
  Note this is a once only payment.
- Software, around £50, again a one off payment.

Also available is free software for displaying geostationary satellite images from Rob Alblas in the Netherlands. Visit his website at

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

Alternatively try David Taylor's software which is outstanding and easy to use, but for which there is a modest charge. David Taylors web site is

www.satsignal.eu

On the opening page, from the 'Satellite Tools' menu, click 'MSG Data Manager' for an example of available software for EUMETCast reception. You can download the software and evaluate it for 28 days before deciding to making a payment to register it. (MSG means: ' Meteosat Second Generation').

Receiving Images via a Software Defined Dongle

Although the NOAA and Meteor satellites can be received on dedicated—but expensive—receivers, many enthusiasts enjoy excellent results using inexpensive RTL-SDR dongles costing around £10. This is particularly so for Meteor M2, whose signals are digital LRPT.

You will need to download appropriate software to operate your dongle, and you will find all the help you need in a deteiled, illustrated article on pages 27-32 of GEO Quarterly No 48, which you can download from

http://www.geo-web.org.uk/quarterly/geoq48.pdf

which details all the relevant download links for the SDRsharp receiving software, Meteor and tracker plugins and Orbitron tracking program that are required.

If you find this process daunting, you can download portable Installation Suites for receiving Meteor from

http://leshamilton.co.uk/MeteorLRPTSuite.htm

These are zipped packages containing absolutely everything you require for Meteor reception. All you have to do is extract them on to your PC with *WinZip*. Packages are available for Windows XP, WIndows 7 and Windows 10. This page also describes the few actions that you have to do to modify the system: inserting your station coordinates into Orbitron, running the Zadig program to instal drivers for the dongle and fine-tuning the frequency in SDRsharp.

Note that, once you have installed USB drivers for your dongle, it is recommended that you should always use the same USB port for live signal reception.

Space:UK

The publication 'Space:UK' is available free of charge. Just email

info@ukspaceagency.bis.gsi.gov.uk

stating that you would like to receive a printed copy of 'Space:UK', providing your full name and address, and stating that you wish the publication for personal use. For a more comprehensive view of UK space activities visit

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

Or write a letter, asking to be put in their mailing list for Space:UK, to their office at

UK Space Agency,
Polaris House,
North Star Avenue, Swindon SN2 1SZ

Images of the Pacific Rim

If you are interested in viewing geostationary images of the Pacific Rim, the Japan Meteorological Agency has a website where you can view full disc images (and images of eastern asia) taken at 10 minute intervals during the previous 24 hours from its *Himawari* satellite. These may be viewed as visible, infrared or colour composites, and there is an option to run animations of 3, 6 or 12 hours duration.

www.jma.go.jp/en/gms

Images are available to view as 'small' (default) or large (1024 pixels square), and can be downloaded, if desired, by right-clicking them and selecting the 'Save image as ...' option.

Visit GEO on Facebook

http://www.facebook.com/groupforearthobservation

Group for Earth Observation

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

Copernicus Online Data Access

Update

Les Hamilton

In GEO Quarterly 54 I explained how to access data from the Copernicus Sentinel-3 satellite. At that time (June this year) you simply had to visit the CODA web page, apply for a password, and download the data. Now you must access the CODA page indirectly, from the EUMETSAT Earth Observation Portal at

https://eoportal.eumetsat.int/userMgmt/login.faces

If you already have a username and password for the EO Portal, input these in the fields provided and click 'LOGIN'. If not, click the link 'NEW USER - CREATE NEW ACCOUNT'.

After logging in, a new page appears with several options: select 'COPERNICUS ONLINE DATA ACCESS'. and you will be directed to the CODA page. Downloading imagery proceeds as described in the earlier article.

Cover Image Details

Front Cover

Illustrating the resolution of images from China's **Feng Yun 3C** polar orbiting satellite, this is a vignette from the image reproduced in full on page 17.

Image: Harrie van Deursen

Inside Front Cover

NASA's GOES 16 geostationary satellite was launched into a storage orbit at 89.5°W a year ago, from where it has been undergoing. Mike Stevens captured this superb colour composite image on October 30, 2017, created from channels 5, 3 and 2. On November 30, 2017, GOES-16 is scheduled to begin a drift to the GOES-East position at 75°W, arriving December 11

Image © EUMETSAT 2017

Inside Back Cover

This lovely image section from China's polar orbiting **Feng Yun 3C** satellite was captured, using a home-built system, by Peter Kooistra on September 24, 2017. These Feng Yun orbiters rival NASA's Terra and Aqua satellites, providing up to 250 metre/pixel image resolution.

AHRPT image captured by Peter Kooistra

Back Cover

NASA's **Terra** satellite observed Hurricane Ophelia as it tracked northwards towards Ireland on October 16, 2017. Believed to be the most powerful storm ever in the western Atlantic ocean, the remnants of Ophelia caused devastation throughout the Irish Republic.

Image: LANCE Rapid Response/NASA/GSFC

Useful Facebook Pages

APT Group	https://www.facebook.com/groups/Satellite.apt.group/
EUMETSAT	https://www.facebook.com/eumetsat/
GEO	https://www.facebook.com/groupforearthobservation
ESA	https://www.facebook.com/EuropeanSpaceAgency
NASA	https://www.facebook.com/NASA/
NASA Solar System	https://www.facebook.com/nasasolarsystem/
NASA Solar System	https://www.facebook.com/NOAA/
UK Space Agency	https://www.facebook.com/spacegovuk/
Werkgroep Kunstmanen	https://www.facebook.com/kunstmanen

Currently Active Satellites and Frequencies

Polar APT/LRPT Satellites			
Satellite	Frequency	Status	Image Quality
NOAA 15	137.6200 MHz	On	Good
NOAA 18	137.9125 MHz	On	Good
NOAA 19	137.1000 MHz	On	Good [1]
Meteor M N1	137.0968 MHz	Off	Dead? [7]
Meteor M N2	137.9000 MHz	On	Good

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

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

Notes

1 LRPT Signals from Meteor M N2 may cause interference to NOAA 19 transmissions when the two footprints overlap.

2 These satellites employ a non-standard AHRPT format and cannot be received with conventional receiving equipment.

3 Meteosat operational backup satellite

4 Meteosat Rapid Scanning Service (RSS)

5 GOES 13 and GOES 15 also transmit EMWIN on 1692.70 MHz

6 There has been no imagery from Feng Yun 2D since June 30, 2015. Since Feng Yun 2G is operating from the same position (86.5°E), it is likely that FY-2D is now in standby as a backup satellite.

7 On March 20, 2016, Meteor M1 suffered a catastrophic attitude loss, frequently pointing its sensors towards the sun. The following day all signals ceased and it seems highly probable that this satellite is now incapable of imaging the Earth.

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.

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

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, or EUMETCast, updated every Monday.

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.

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.

Copy for GEO Quarterly

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

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

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

Submission of Copy

Materials for publication may be sent to the editor,

Les Hamilton
8 Deeside Place
Aberdeen AB15 7PW
Scotland

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

geoeditor@geo-web.org.uk

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

https://wwwhightail.com/

or from a link to your Drop Box.

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

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.

GEO Shop

Manager: Nigel Evans
email: geoonlinestore@gmail.com

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

PayPal

Ayecka-SR1 DVB-S2 VCM USB Receiver

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

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

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

NEWSKY RTL2832U/R820T2 SDR DAB USB MCX Socket Special Dongle

for reception of NOAA APT and Meteor M2 LRPT

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

This stick does not come with SDR software or instructions.

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

TechniSat SatFinder Antenna Alignment Meter

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

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

GEO Quarterly - Back Issues

(Only available to GEO Members)

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

UK members price - £3.80

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

UK members price - £8.00

Current Price List

	Members' Prices			Prices for non-Members		
	UK	EU	RoW	UK	EU	RoW
Ayecka SR1 DVB-S2 Receiver	375.00	385.00	390.00	---------	---------	---------
Edimax USB 2.0 Fast Ethernet Adapter	15.00	17.00	18.00	---------	---------	---------
DVB-S USB 2102 Receiver	60.60	67.00	---------	70.60	77.00	---------
SDR Dongle kit for APT/LRPT	20.00	25.00	26.00	---------	--------	--------
Technisat Satfinder Alignment Meter	26.50	29.50	---------	29.50	32.50	---------
GEO Quarterly Back Issues (subject to availability)	3.80	4.60	5.60	n/a	n/a	n/a
GEO Quarterly (PDF on CD) 2004-2016 (Annual compilations - state year)	8.00	8.80	9.30	n/a	n/a	n/a
GEO Membership - 2-year subscription (4 PDF magazines and one printed magazine per year)	15.00	15.00	15.00	15.00	15.00	10.00

All prices are in £ sterling and include postage and packaging

Ordering and Shipping

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

Orders should be sent by email to

geoonlinestore@gmail.com

or made through the GEO Website at

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

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

PayPal

Not yet a GEO Member?

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

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

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

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

Inverto-Black-Ultra High-Performance LNBs

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

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

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

Edimax USB 2.0 Fast Ethernet Adapter

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

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