# The GEO Quarterly

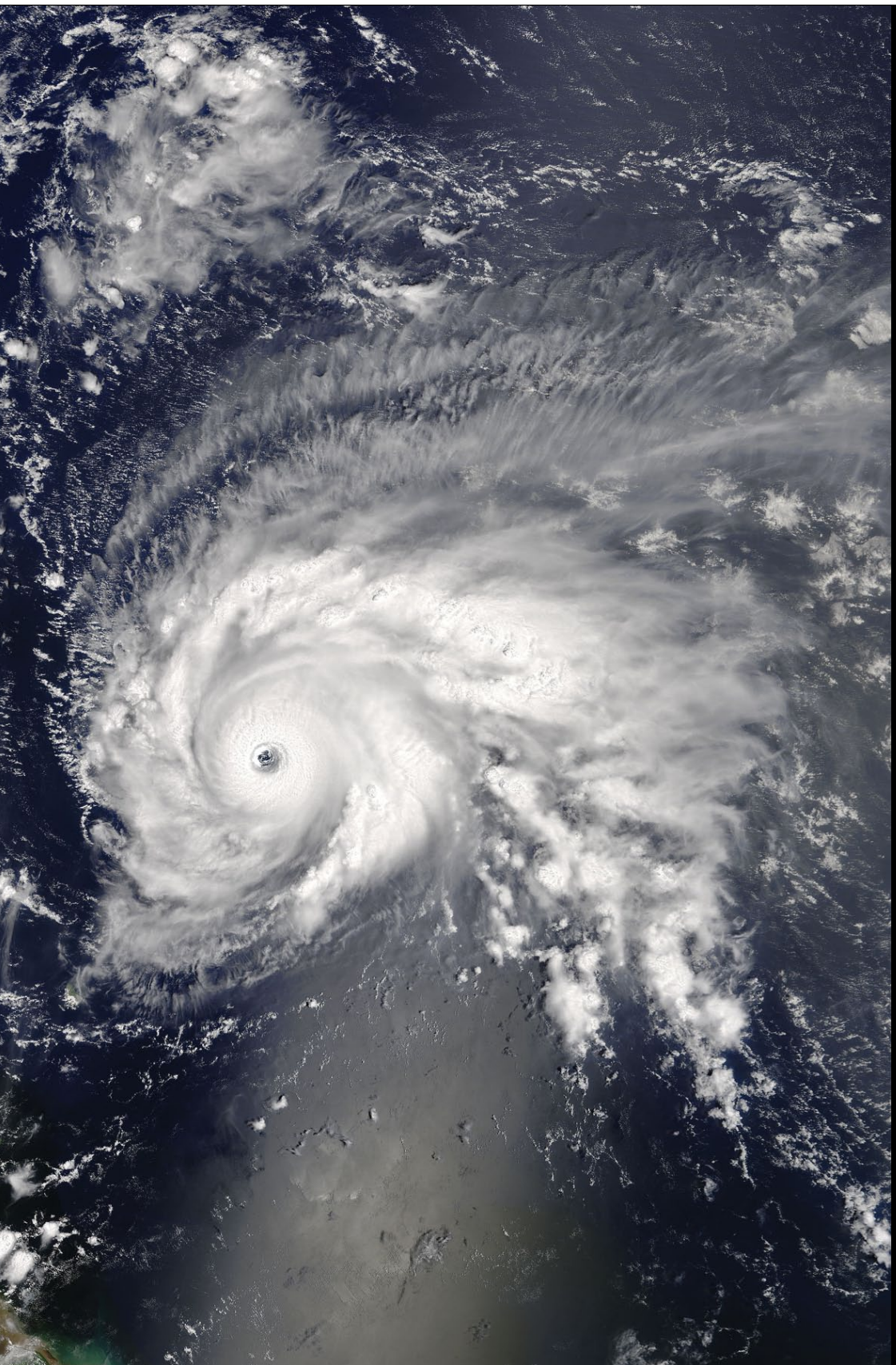
Group for Earth Observation

Group for Earth Observation

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

**55**

**September 2017**

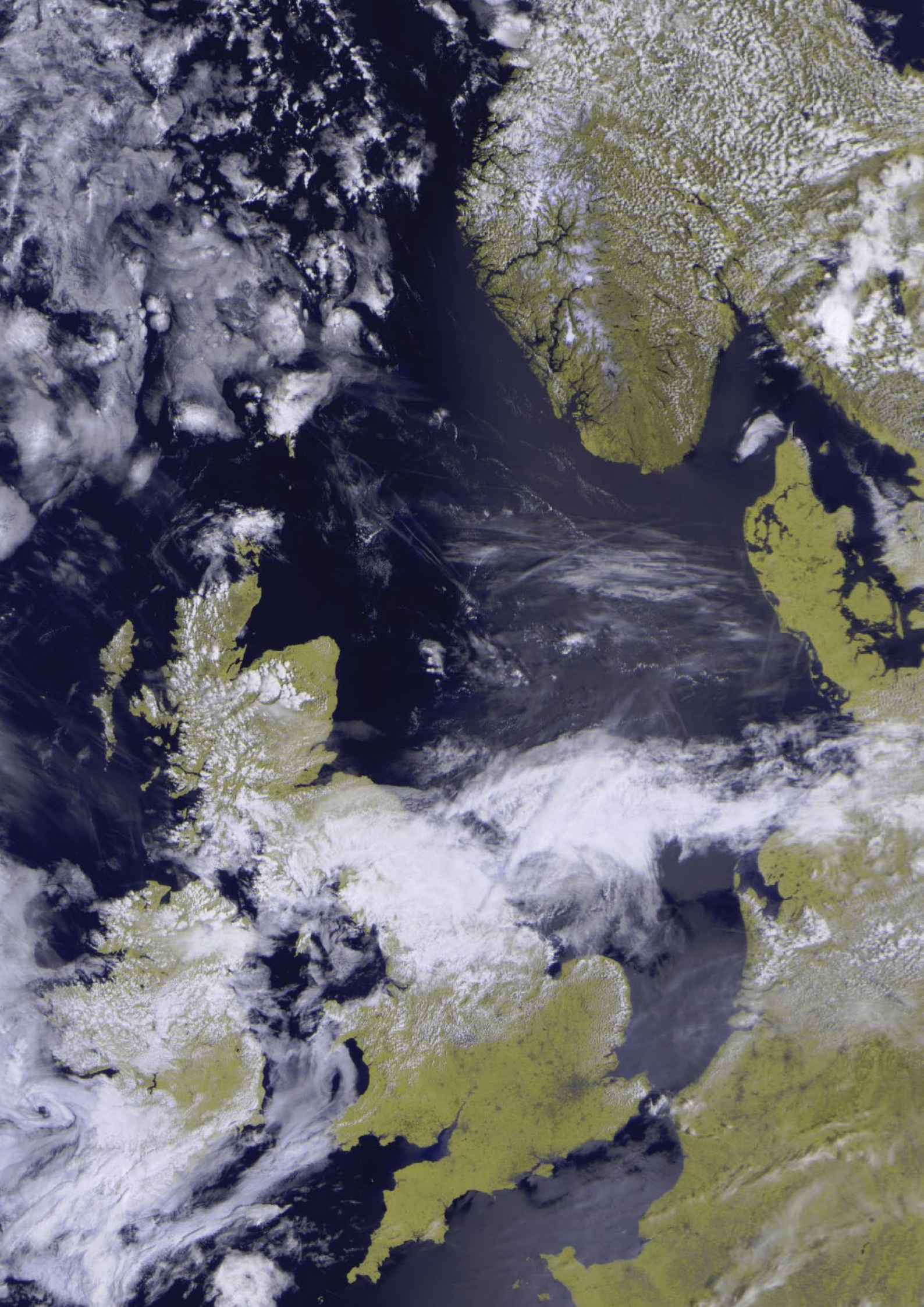
## Inside this issue . .

*Not surprisingly, in view of recent events in the Caribbean, imagery of both the hurricanes and the islands themselves are prominent in this issue. In particular, there is a revealing report from NASA Earth Observatory highlighting difference in the appearance of a number of islands before and after the storm hit. The image shown here is of Hurricane Jose which followed Irma.*

*We also have articles by John Tellick on the subject of sprites, those ephemeral discharges that leap up beyond the stratosphere from thunderstorms.*

*We also cover Earth's polar regions with articles on the Antarctic peninsula, ice breakup in the Amundsen Gulf and the south Patagonian Icefield.*

*And of course there is the usual eclectic mix of short features from NASA's Earth Observatory.*



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# Editorial

***Les Hamilton***
***geoeditor@geo-web.org.uk***

GEO Management held a *Skype* meeting this past July to address the future of our Quarterly Magazine. Despite numerous pleas to the members for support regarding the provision of original content, it has been clear for a long time that almost all information is nowadays being propagated via on-line media, particularly the *GEO-Subscribers YAHOO Group*. Regrettably therefore, it has been decided that the printed December issue, GEO Quarterly 56, will mark the end of its run.

The meeting accepted that this was an inevitable sign of the times. The availability of information on the internet and an active GEO Subscibers Yahoo Group meant that ideas, solutions and offers of help were available in 'real time', rather than having to wait weeks for the next edition of the magazine.

As is the case in this issue, most of the content has been gleaned from public domain internet sites, such as those of NASA and ESA, a burden shouldered by John Tellick and myself. As I explained last issue, I wish to rid myself of this huge demand on my time, and will retire as editor at the end of this year to pursue my own interests.

However, I am still prepared to make up any articles submitted by GEO members, and have assured the Management Team that I will be happy to create PDF copies of any such articles, which will then be made available for download on the GEO Website at

***http://www.geo-web.org.uk***

Also, I will continue to be available by email using

***geoeditor@geo-web.org.uk***

**Copy deadline for the December issue of GEO Quarterly is Sunday, November 26, 2017.**

## *Contents*

# The GEO Report

***Francis Bell***

At the time of writing these notes we seem to be at the height of the hurricane season in the central Atlantic and Caribbean. I have been following the progress of Hurricanes *Harvey* and *Irma* for personal reasons.

Hurricane *Harvey* approached the coast of Texas while I was staying in the USA, in the state of North Carolina (N.C), about 1,500 miles away from the hurricane. There was no risk of its effects reaching N.C., but I was perceptive of its effects and of the excessive rain deposited in Houston and adjacent areas of Texas. When I returned to the UK after our visit the hurricane was still newsworthy and I was able the see it on selected images transmitted by *EUMETCast* which I regularly receive at home (image below).

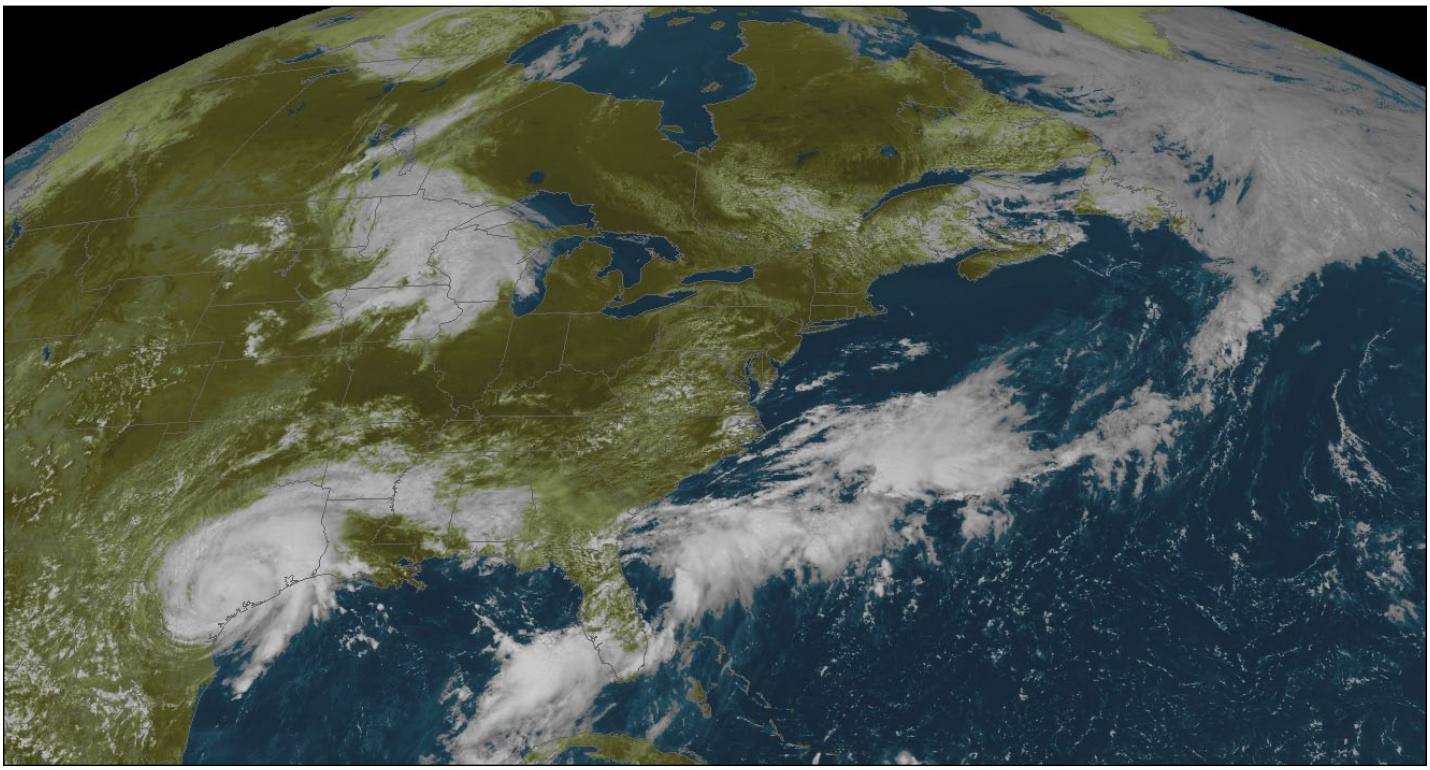
As I write, *Irma* is still classified as a maximum strength category five hurricane and is just passing the Windward Islands. I have visited these islands several times and can imagine the damage such a violent storm can do to these fragile environments. I can particularly remember the island of St Martin, which I visited in the 1990s and swam around some of the beautiful coral reefs along the palm lined coast. It so happened that I visited the same island about five years later, but in the interim it had endured a force two hurricane. The damage that I saw was considerable, with coral reefs all but destroyed and the dead coral lying on the beaches as white pieces. Many of the palm tress were missing and about half of those remaining were at an angle of about 45 degrees. I am concerned about the damage that a force five hurricane could do to these fragile small islands and then potentially to the larger territories of Hispaniola and Cuba—which I have also visited in the past.

I continue to follow the latest hurricane season using my *EUMETCast* system, which retransmits images from the *GOES E* American satellite as well as those from the European *Meteosat 10*.

My August visit to the USA was timed not only for a visit to my son and his family in N.C. but also to see the total solar eclipse on the August 21, 2017, which was visible in a strip across the whole of the USA. From my son's house in N.C. we had to travel about 150 miles south into South Carolina to be within the total eclipse band. The travel was worthwhile because, during our visit to S.C., we had nearly clear sky and a near-perfect view of the eclipse. Totality was a great experience which lasted only for about one and a half minutes but was a once in a lifetime experience.

**Members' Meeting**

On matters more directly relating to GEO, I wish to express a little concern that we have not held our usual members annual meeting this year. Several times requests have been made for members' preferences for such a meeting but I have received so little feedback that no action has been taken. I think the best course of action is to arrange a meeting some time in 2018 and members can attend or not according to their preference. I have a number of ideas and I hope a decision can be published in our next Quarterly.



This GOES-E image, acquired via EUMETCast on August 27, 2017, shows Hurricane Harvey battering Houston, Texas.

**Forthcoming Events**

GEO will again be attending the *South London Radio and Computer Rally* at Kempton Park, where we will have a stand displaying recorded satellite images and information about GEO membership. The show is open between 10 am and 3 pm on Sunday the November 5, 2017. For further information consult

***www.radiofairs.co.uk***

The '*Meteorological Technology World Expo*' is to be held in Amsterdam between October 10-12, 2017: previously this Expo has been held in Brussels. Its move to Amsterdam may be of interest to our GEO members in the Netherlands. The Expo is free to attend as a visitor. As well as many commercial display stands I expect that EUMETSAT will be attending, so the event should be of interest to GEO members. For more information go to

***www.MeteorologicalTechnologyWorldExpo.com.***

The *Radio Society of Great Britain* (RSGB) is holding its annual convention between October 13-15, 2017 at Kents Hill Park Conference Centre, Timbold Drive, Kents Hill, Milton Keynes MK76BZ. For further details go to

***www.rsgb.org/convention***

I note from the draft lecture programme two items that may be of special interest to GEO members. They are '*How Space Weather Affects Radio Signals*' and a presentation by AMSAT-UK about satellites. I note that AMSAT-UK, instead of having their own annual colloquium, are this year sharing their event with this RSGB convention. Our own GEO might find this potential sharing of a RSGB's meeting a useful idea for the future.

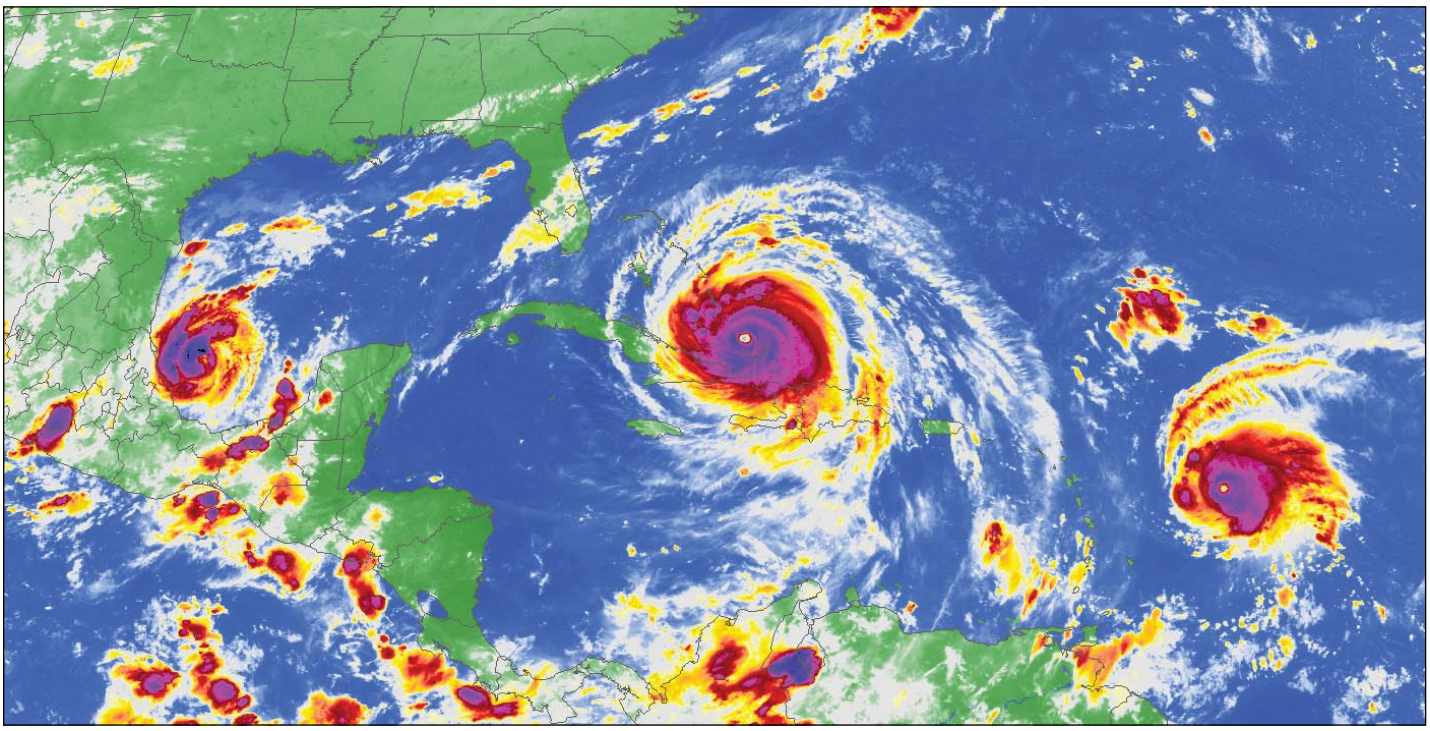
The Royal Meteorological Society are holding a one day event in London and the programme looks attractive. For further information go to the Royal Met's web site at

***www.weatherlive.net***

WeatherLive, the ultimate day out for weather enthusiasts, with an opportunity to talk about the nation's favourite topic, takes place in Central Hall Westminster, London on Saturday November 4, 2017.


This year the Royal Meteorological Society is working with the Royal Horticultural Society and the Royal Photographic Society to discuss 'Gardening in a Changing Climate', to find the next Weather Photographer of the Year. The event will also mark the anniversary of the 1987 storm. Further information is available on the MetS website at

***https://www.rmets.org/***



This is an infrared image from the GOES-E satellite, acquired by Francis Bell on September 8, 2017, showing the Atlantic hurricane season at its peak. Hurricane **Katya** sits in the Caribbean, and **Irma** is shown just north of the Dominican Republic with **Jose** further to the east over the Atlantic.

*Image © EUMETSAT 2017*

# Quarterly Question

*Francis Bell*

**Quarterly Question 54**

The last Quarterly question related to satellite photographs of Greece and the coastline of South America. My background interest in these images related to the fact that I had visited the three capital cities shown on the images. My thanks to those members who emailed me with the correct answers which were:

- Athens which could be clearly seen in the image of Greece,
- Montevideo on the north bank of the River Plate estuary shown in the images of South America and
- Buenos Aires further inland on the south bank of the river.

This Quarterly Question is a little different from previous questions because this time without my own research I don't know the answer, but that does not stop me asking the question!

**Quarterly Question 55**

Regular reports on radio and TV news programmes and other sources make statements stating that the world's sea level is rising steadily. The figure seems to be about two centimetres in the last 20 to 30 years. Along with this sea level change there is a steady rise in the temperature of our atmosphere, oceans and Earth surfaces as indicated by absolute measurement. I can understand melting ice, warmer oceans and a more dynamic atmosphere, as evidenced currently by hurricanes Irma and Jose. I can understand the absolute measurements and their consequences, but what I can't understand is how you measure sea level changes in such fine detail, that is, to the nearest centimetre or less against such a variable background.

Ocean levels are dynamic. There are about 20 celestial factors which affect tidal levels and there are also meteorological factors such as pressure, wind and temperature which also affect sea level. Even some land surfaces are bobbing up and down, so how can sea level be measured so accurately?

**The Quarterly Question is this: "What is the reference level for measuring sea level changes".**

Perhaps the answer is not a one line statement but please don't let this stop you submitting an answer even if it needs a several page article—which it might!

Answers by email, please, to

***francis@geo.org.uk***

before November 26, 2017.



## Cover Image Details

**Front Cover**

On September 8, 2017, NASA's Terra satellite acquired this true-colour image of category-4 Hurricane Jose as it tracked towards several Caribbean Islands that had already been devastated by the massive Hurricane Irma. Venezuela sits in the far south of the image, with the Leeward Islands on the eastern side of the storm. Thick bands of thunderstorms circled Hurricane Jose's very clear and well-defined eye.

*Image: LANCE Rapid Response / NASA / GSFC*

**Inside Front Cover**

This lovely image from Russia's ***Meteor-M2*** satellite was captured at 10.07 UT on July 5, 2017 using an RTL dongle.

*LRPT image captured by Les Hamilton*

**Inside Back Cover**

This Meteor M2 LRPT image acquired on August 11, 2011 was submitted by Enrico Gobbetti. It takes advantage of one of the rare occasions when the satellite transmits channel 3 (visible) in place of the more usual channel 5 (IR), to render an RGB123 image.

*LRPT image captured by Enrico Gobbetti*

**Back Cover**

NASA's Terra satellite observed this image of sun-drenched Italy on August 13, 2017, during perhaps the most severe heatwave ever experienced in the region. Rome, Naples and Florence had been baking in temperatures in excess of 40°C. Even in the mountains the temperatures have been well above average, forcing closure of summer skiing on the Stelvio Pass glacier (altitude 3,450 metres) for the first time in 90 years..

*Image: LANCE Rapid Response / NASA / GSFC*

# A Menacing Line of Hurricanes

***NASA Earth Observatory***

Meteorologists struggled to find words to describe the situation as a line of three hurricanes—two of them major and threatening land—brewed in the Atlantic basin during early September 2017 (figure 1).

Forecasters were most concerned about **Hurricane Irma**, which was on track to make landfall in densely populated South Florida on September 10 as a large category-4 storm. Meanwhile, category-2 **Hurricane Katia** was headed for Mexico, where it was expected to make landfall on September 9. And just days after Irma devastated the Leeward Islands, the chain of small Caribbean islands braced for another blow—this time from category 4 **Hurricane Jose**.

The Visible Infrared Imaging Radiometer Suite (VIIRS) aboard the **Suomi NPP** satellite captured data to construct a mosaic of all three hurricanes as they appeared in the early hours of September 8, 2017. The images were acquired by the VIIRS 'day-night band', which detects light signals in a range of wavelengths from green to near-infrared, and uses filtering techniques to observe signals such as city lights, auroras, wildfires, and reflected moonlight. In this case, the clouds were illuminated by a nearly full Moon. The image is a composite, showing cloud imagery combined with data on city lights.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** satellite acquired a natural-colour image of Irma (figure 2) at 16:00 UT on September 8, 2017.

The NASA *Short-term Prediction Research and Transition Center* remarked on the storm's 'buzz saw appearance'. The *National Weather Service* field office in Miami warned of 'large airborne projectiles' and cautioned that some locations might become 'uninhabitable for weeks or months' after the storm. Eric Blake, a meteorologist with the *National Hurricane Center* tweeted that he had 'never seen anything like this in the modern record'.

In some respects, **Irma** is an unusual and record-breaking storm. On September 8, the storm had generated more accumulated cyclone energy—a term meteorologists use to describe the destructive potential of a hurricane—than any other Atlantic storm on record, according to meteorologist Philip Klotzbach of *Colorado State University*. Irma also broke a record for generating the most accumulated cyclone energy in a 24-hour period.

*Story by Adam Voiland.*

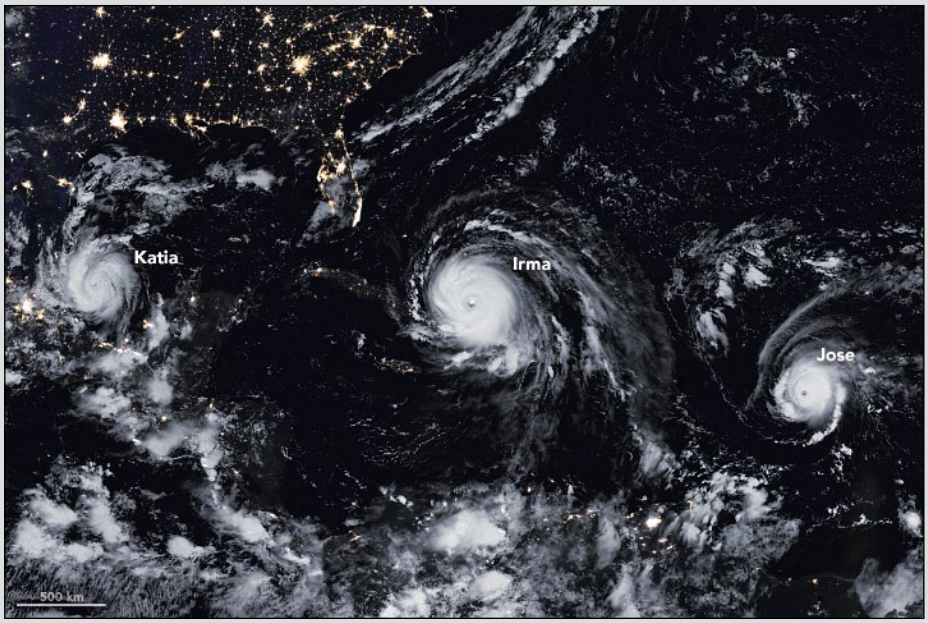



Figure 1 - Three simultaneous hurricanes in the Atlantic Basin on September 8, 2017
*NASA Earth Observatory images by Joshua Stevens and Jesse Allen, using VIIRS day-night band data from the Suomi National Polar-orbiting Partnership*

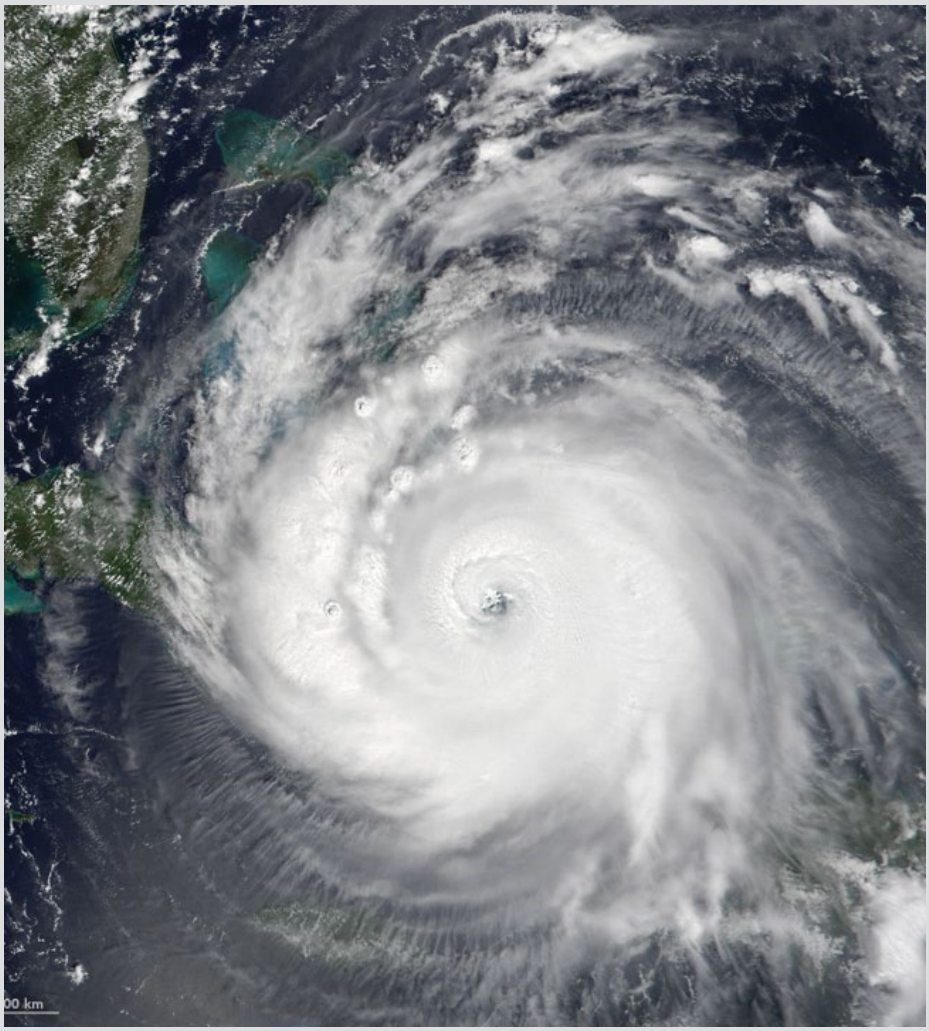


Figure 2 - NASA's Terra satellite images Hurricane Irma on September 8, 2017
*Earth Observatory images by Joshua Stevens and Jesse Allen, using Terra MODIS data from the Land Atmosphere Near real-time Capability for EOS* (LANCE).

# Oregon's Crater Lake

***Les Hamilton***

Crater Lake, Oregon, with Wizard Island prominent in the foreground
*Image - Wikimedia Commons / Stuart Seeger, San Antonio Texas*

Established in 1902, Crater Lake National Park in the Cascade Mountains of southwest Oregon is the fifth-oldest national park in the USA. It's most notable feature is the caldera of Crater Lake, a remnant of a former volcano, Mount Mazama, a probable 3,600 metre peak that exploded and collapsed in a catastrophic eruption approximately 6,000 to 8,000 years ago. The lake surface stands 1,883 metres above sea level and is surrounded by a caldera rim that rises between two hundred and five hundred metres above it.

The caldera is endorheic, meaning that no streams drain into it and therefore, water is lost from it only by evaporation and seepage. The lake's contents are replenished solely from precipitation as snow and rain. Crater Lake has a maximum depth of 594 metres, and is the deepest body of water in the United States. This depth was first calculated by geologist Clarence Dutton and his team using measurements made with piano wire and lead weights. Making comparisons based on average depth, Crater Lake (350 m) is the deepest in the Western Hemisphere and the third-deepest on Earth.

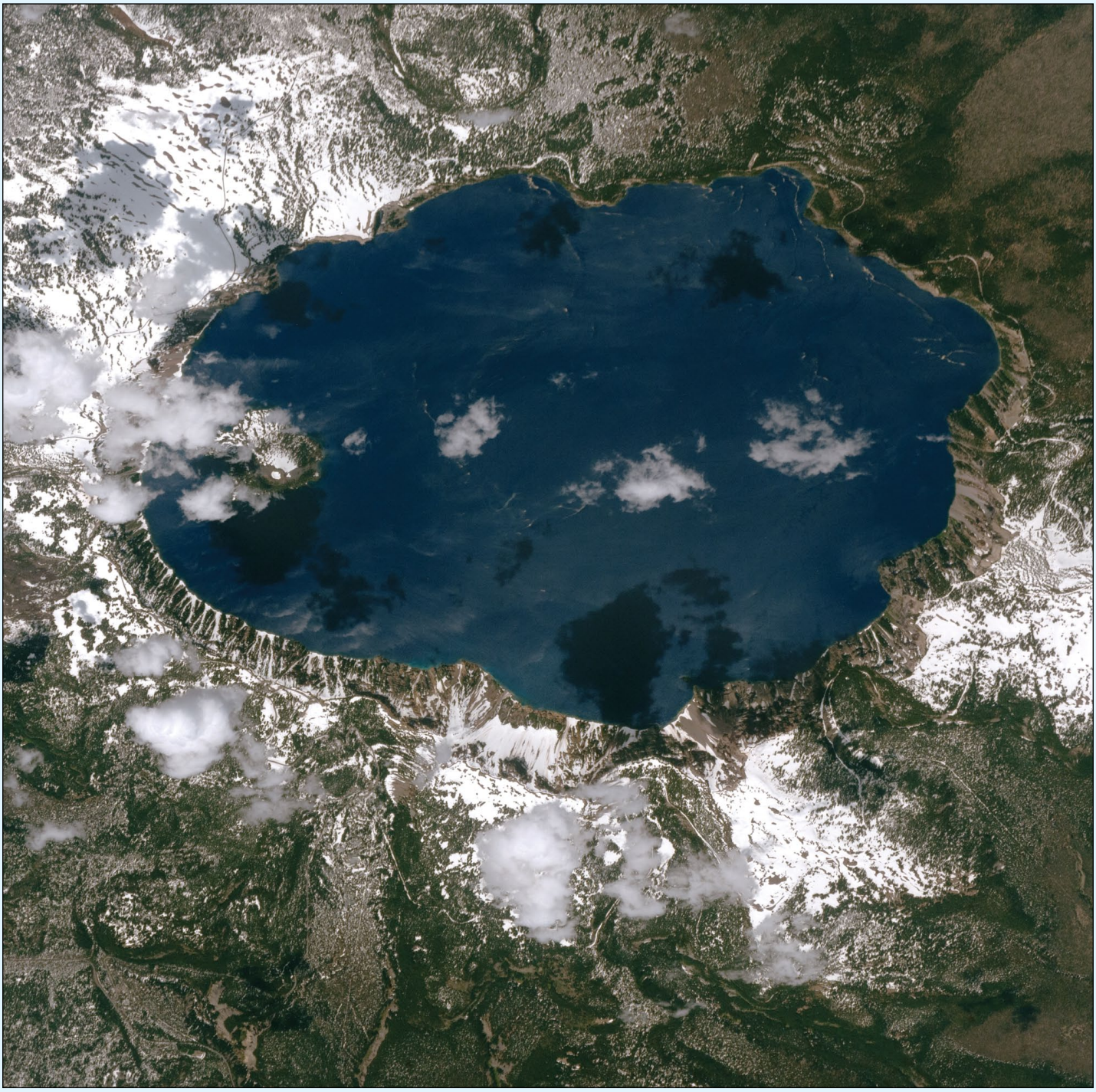
On June 26, 2017, an astronaut aboard the International Space Station shot the photograph of Crater Lake reproduced on the following page. Snow still blankets most of the slopes surrounding the crater, and clouds cast dark shadows on the lake surface. Wizard Island, formed from a cinder cone that erupted after Crater Lake began to fill with water, lies to the left of the image, almost hidden by the clouds over the western part of the lake.

In 2016, more than 750,000 people visited the Crater Lake National Park, which includes Crater Lake and the surrounding 740 square kilometres. Part of the reason the lake is so popular is the fishing. In the late 1800s, several species of fish were introduced to the lake, though only rainbow trout and Kokanee salmon (the landlocked version of sockeye salmon) remain today. Since none of these was native to the lake, fishermen are not required to obtain a permit.

The image was taken by a member of the Expedition 52 crew and has been cropped and enhanced to improve contrast, and lens artifacts have been removed.

**Sources**

NASA Earth Observatory, Wikipedia



Crater Lake, viewed from the International Space Station on June 26, 2017

*Astronaut photograph ISS052-E-8744 was acquired on June 26, 2017, with a Nikon D4 digital camera using an 1150 millimetre lens, and is provided by the ISS Crew Earth Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center.*

Crater Lake Panorama Spring 2016
Image: Wikimedia Commons / Achmathur

# Gigantic Jets Over Hawaii

*John Tellick*

Every night, the **Gemini Cloudcam** atop Mauna Kea in Hawaii monitors storms approaching some of the world's largest telescopes, often capturing lightning bolts forking down to the ground below. On July 24, however, something very different was observed: a gigantic jet, related to sprites but more powerful, and easier to see with the naked eye (figure 1). Cloudcam video caught at least three of these jets springing from the tops of a powerful growing thunderstorm, the reaching all the way to the ionosphere some 80 kilometres above.

Gigantic Jets are much rarer than sprites. While sprites were discovered in 1989 and have since been photographed in their thousands, it was not until 2001 that Gigantic Jets were first recorded from Puerto Rico and Taiwan. Even today, only a few dozen Gigantic Jets have ever been seen, mostly over open ocean.

Sometimes called '*Space Lightning*', Gigantic Jets and their cousins the sprites are true space weather phenomena. They inhabit the upper atmosphere alongside auroras, meteors and noctilucent clouds. Some researchers believe they are linked to cosmic rays: subatomic particles from deep space that strike Earth's upper atmosphere to produce secondary electrons that could provide the spark for these upward bolts.

The link to cosmic rays is particularly interesting at this time because, for the past two years, space weather balloons have been observing a steady increase in deep space radiation penetrating the atmosphere. This increase is largely due to the decline in the solar cycle as flagging solar wind pressure and weakening sunspot magnetic fields allow more cosmic rays into the inner solar system—a trend that is expected to continue for years to come. These changes could result in more Gigantic Jet sightings in the future.

You can view a time-lapse video of the thunderstorm captured by the Gemini Cloudcam on the night of July 24, 2017 at the following URL

***https://www.youtube.com/watch?v=ZMc0_k6CKd0***

Figure 1 - The Gigantic Jet observed by the Gemini Cloudcam
*Photo credit: Gemini Observatory/AURA/NSF*
*Discovery and Image Processing by Steve Cullen*

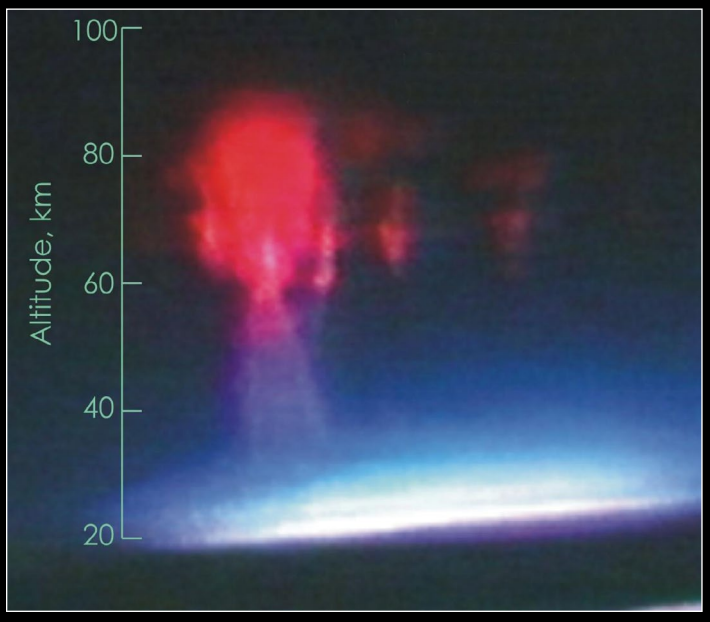



Figure 2 - The first ever colour image of a Red Sprite
*Image: Wikimedia / NASA/University of Alaska*

**Upper-atmospheric lightning**

Upper-atmospheric lightning or ionospheric lightning are terms sometimes used by researchers to refer to a family of short-lived electrical-breakdown phenomena that occur well above the altitudes of normal lightning and storm clouds. Upper-atmospheric lightning is believed to consist of electrically induced forms of luminous plasma. The preferred usage is transient luminous event (TLE), because the various types of electrical-discharge phenomena in the upper atmosphere lack several characteristics of the more familiar tropospheric lightning.

There are several types of TLEs, the most common being sprites, which are flashes of bright red light that occur above storm systems. C-sprites (short for 'columniform sprites') is the name given to vertical columns of red light. C-sprites exhibiting tendrils are sometimes called 'carrot sprites'. Other types of TLEs include sprite halos, blue jets, gigantic jets, blue starters, and ELVESs. The acronym ELVES (Emission of Light and Very Low Frequency perturbations due to Electromagnetic Pulse Sources) refers to a singular event which is commonly thought of as being plural. TLEs are secondary phenomena that occur in the upper atmosphere in association with underlying thunderstorm lightning.

The first colour image of a sprite was obtained during a 1994 NASA/University of Alaska aircraft campaign to study the phenomenon. The event was captured using an intensified colour TV camera. The red colour was subsequently determined to be produced from nitrogen fluorescent emissions, excited by a lightning stroke in the underlying thunderstorm.

# Hurricane Irma

## turns Caribbean Islands brown

***NASA Earth Observatory***


Figure 1 - The British and U S Virgin Islands

Hurricane Irma churned across the Atlantic Ocean during early September 2017, battering several Caribbean islands before moving on to the Florida Keys and the U.S. mainland. As the clouds cleared over places like the Virgin Islands, the destruction became obvious, even from space.

The natural-colour images in figure 1, captured by the *Operational Land Imager* (OLI) on the **Landsat 8** satellite, show some of Irma's effect on the British and U.S. Virgin Islands. The views were acquired on August 25 and September 10, before and after the storm passed. They are among the few relatively cloud-free satellite images of the area so far.

The most obvious change is the widespread browning of the landscape. There are a number of possible reasons for this. Lush green tropical vegetation can be ripped away by a storm's strong winds, leaving the satellite with a view of more bare ground. Also, salt spray whipped up by the hurricane can coat and desiccate leaves while they are still on the trees.

Irma passed the northernmost Virgin Islands on the afternoon of September 6. At the time, Irma was a category-5 storm with maximum sustained winds of 295 kilometres per hour. According to news reports, the islands saw 'significant devastation'.

A close-up of Virgin Gorda (figure 2, next page) gives a better sense of the changes. Note how some of the vegetation on the south and west of the island is a bit greener, probably because it was partly shielded from winds by the hills in the centre. Differences in ocean colour most likely stem from differences in the ocean surface: rougher surfaces scatter more light, and appear brighter and lighter.

The destruction is also clearly visible on Barbuda (figure 3). This small island in the eastern Caribbean was directly hit by the category-5 storm early on September 6. These images were acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** and **Aqua** satellites. The left-hand image shows Barbuda on August 21; the right image shows the ravaged landscape on September 8.

In contrast, vegetation on Antigua appears relatively healthy and intact. With the storm's centre passing to the north, the island sustained less damage. Ground reports noted that by September 7, electricity had been restored to most of the island, and the international airport reopened.

*NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey.*
*Story by Kathryn Hansen.*

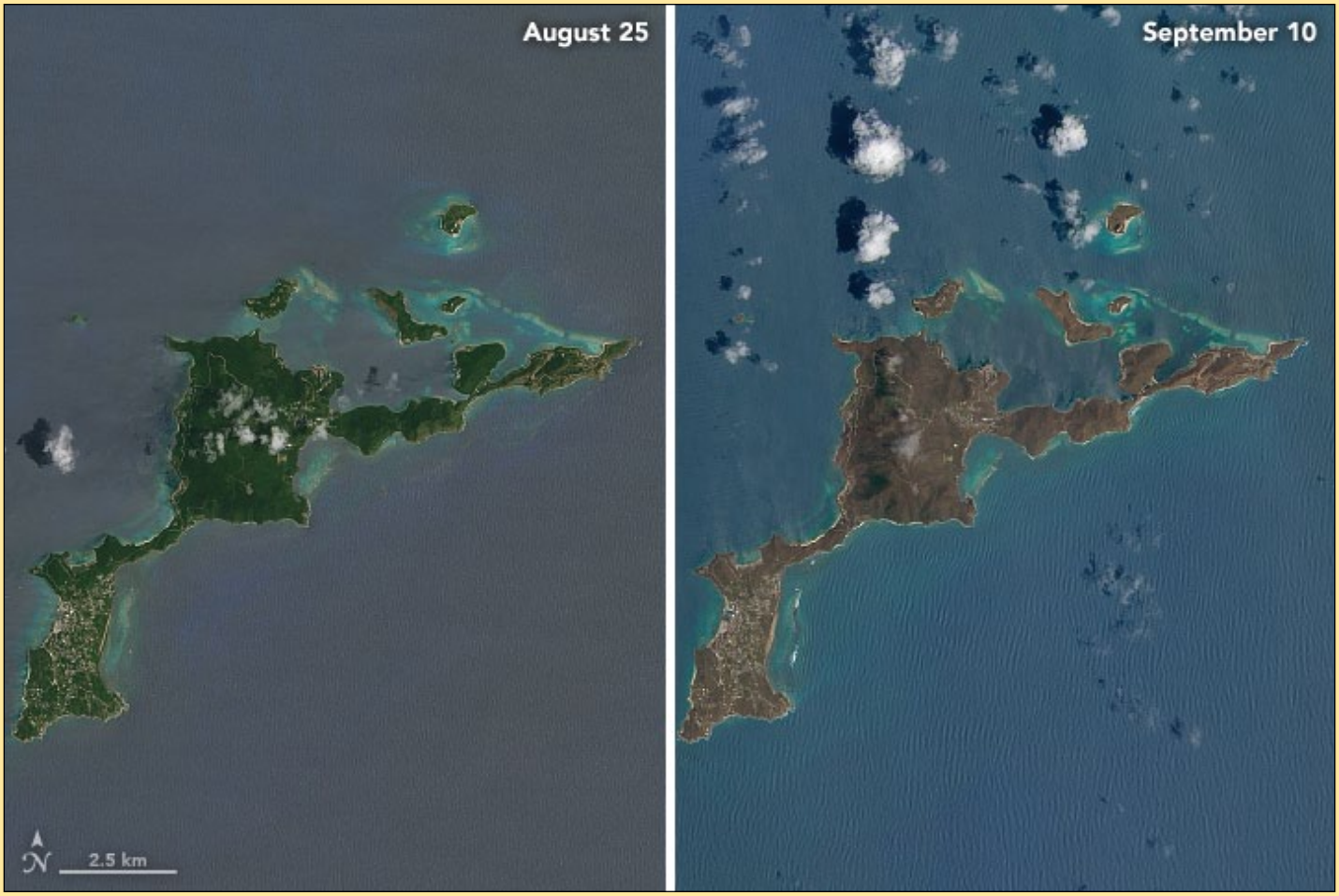



Figure 2 - Close-ip view of Virgin Gorda

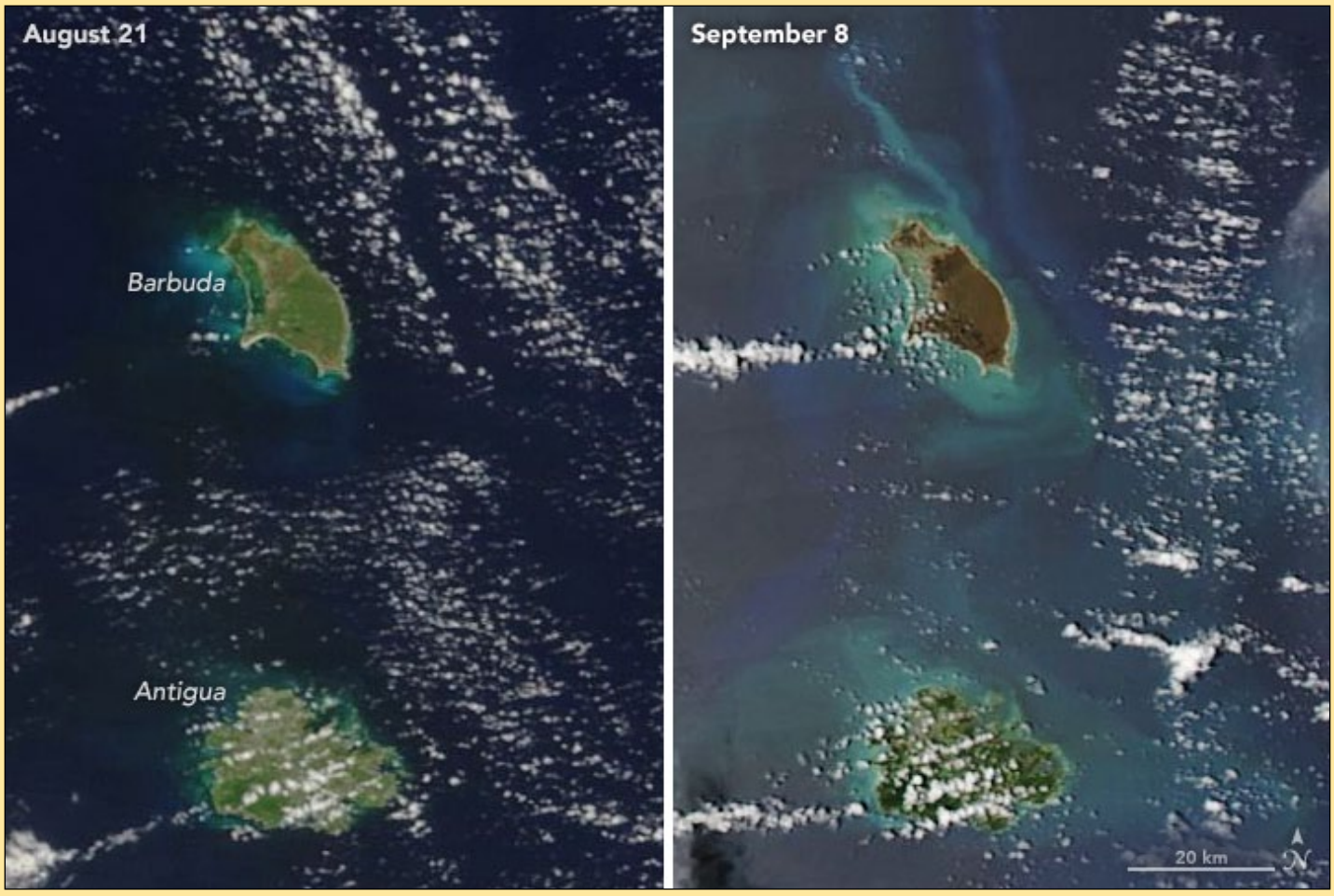



Figure 3 - Antigua and Barbuda

# Jellyfish Sprites over Europe

***Spaceweather.com***


So-called 'Jellyfish Sprites', photographed over Austria during a thunderstorm

On June 20, 2017, a thunderstorm over Austria unleashed a spectacular display of lightning. Observers on the ground witnessed blinding flashes of crackling light. The most amazing aspect of this outburst, however, was to be found high above the clouds at an altitude of some 80 kilometres—in the realm of the sprites

Martin Popek photographed the display from his private observatory in Nýdek, Czechia (Czechia was adopted as the official name for the Czech Republic on September 16, 2016), more than 500 kilometres away from the storm. Such distances are ideal for seeing above the tops of towering thunderclouds.

'Jellyfish sprite events like these are produced by very impulsive cloud-to-ground lightning flashes draining positive charge from the stratiform rain region in large thunderstorms,' explained lightning scientist Oscar van der Velde of the Technical University of Catalonia, Spain. 'Somehow, in a process that researchers only partially understand, the resulting electric fields draw jellyfish forms out of the cloud tops.'

The tops of the sprites were surrounded by a saucer-like halo of red light, noted van der Velde. 'The halo is evidence of intense electric fields at 80-90 km shaking up the electrons (colliding with nitrogen to produce light) for such a short time that sprite streamers cannot form. At lower altitudes the field exists longer, allowing the jellyfish sprite streamers to grow from electron avalanches.'

Although sprites have been seen for at least a century, most scientists did not believe they existed until after 1989 when sprites they were photographed by cameras onboard the space shuttle. Now 'sprite chasers' routinely photograph sprites from their own homes.

Popek used a *Watec 910HX* security camera with *UFOCapture* software from

http://sonotaco.com/e_index.html

to catch his sprites, one such display being shown in the photograph above.

Source credit: Spaceweather.com / Martin Popek
Thanks to John Tellick for submitting this material.

# Mackenzie Meets Beaufort

***NASA Earth Observatory***

The Mackenzie River delta feeding sediment into the Beaufort Sea

*NASA Earth Observatory image by Jesse Allen, using Landsat data from the US Geological Survey.*
*Story by Mike Carlowicz.*

The Mackenzie River is the leading source of freshwater flowing into the Arctic Ocean. It's also a leading source of sediment flowing into that basin. The **Operational Land Imager** (OLI) on the **Landsat 8** satellite acquired this image of the Mackenzie Delta on July 19, 2017. At the time, the Beaufort Sea was coloured with milky tan brush strokes of sediment in various levels of dispersal after pouring out of the river.

The Mackenzie is the largest and longest northward-flowing river in North America, and the second largest on the continent (after the Mississippi). The watershed drains a huge but mostly unsettled portion of Canada: population density along the 4,200 kilometre river is just one person per square kilometre.

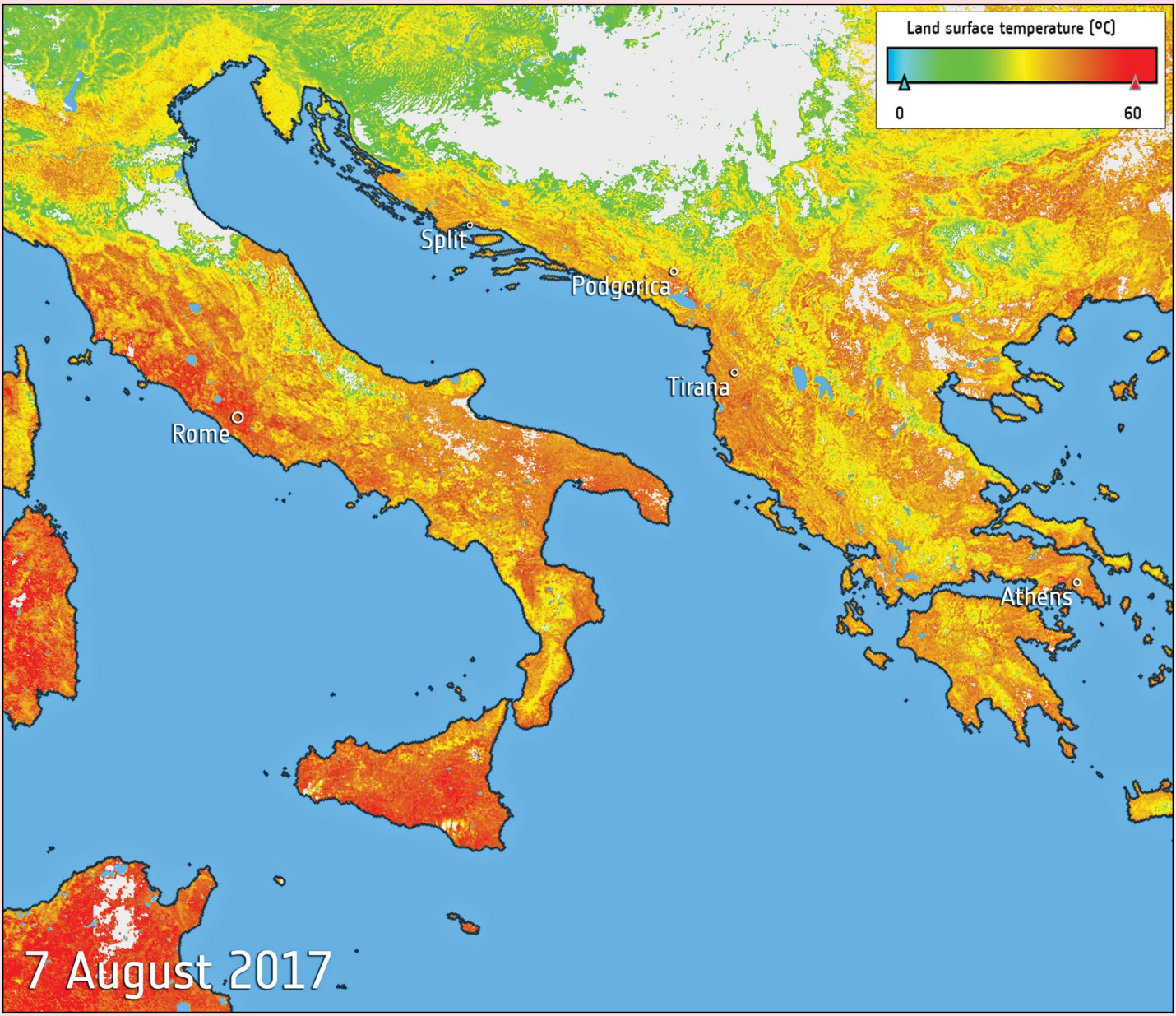
About 7% of the fresh water that flows into the Arctic Ocean each year comes out the Mackenzie and its delta, and much of that comes in large pulses during June and July after the *freshet*—the spring thaw when inland ice and snow melts and floods the river. This flood carries with it tremendous amounts of dissolved organic material and sediment.

The freshet pushes out a lot of material, and most of that sediment is derived from erosion of the Rocky Mountains through the Liard River, a major tributary to the Mackenzie. The erosional debris comes mostly from old sedimentary rocks (shales, sandstones, limestone) in the Rocky Mountains. This is fine-grained suspended material that the river pushes out into the coastal ocean. The fact that you see some dispersion in the Beaufort Sea indicates that the delivery has been going on for some time.

In a study published in 2014, a NASA-led research team demonstrated that fresh water flowing from rivers into the Arctic Ocean can have a significant effect on the annual extent of sea ice cover. Warm water discharges can accelerate the melting of sea ice near the coast. It also can have a wider impact on climate by creating more open water, which absorbs more heat from sunlight.

# Sweltering Southern Europe

***European Space Agency***






During early August 2017, southern Europe was in the grip of a relentless heat wave, fuelling wildfires and water shortages. Information from the **Copernicus Sentinel-3A** satellite has been used to map the sweltering heat across the region.

The map above shows that, on August 7, 2017, temperatures of the land surface rose above 40°C—not an usual occurrence over the previous few weeks. Much of Italy, including Rome, Naples, Florence, Sardinia and Sicily had been suffering these highs. With numerous towns and cities on the ministry of health's maximum heat alert, the Italians have aptly dubbed the heat wave '*Lucifer*'. Extreme temperatures have also been recorded in Spain and Portugal, the Balkans and Greece.

As well as wildfires and water shortages, the heat has also led to some tourist attractions being closed, to ill health and even some fatalities, and the drought is also threatening crops.

The map uses data from the satellite's *Sea and Land Surface Temperature Radiometer*, which measures energy radiating from Earth's surface in nine spectral bands. The map therefore represents temperatures of the land surface, not air temperature which is normally used in forecasts.

On August 3, 2017, the MODIS instrument on NASA's **Aqua** satellite acquired this image showing several phytoplankton blooms in the Caspian Sea. Often harmless, these blooms are an important food source for marine life, but they can deplete the water's oxygen and suffocate marine life, and produce toxins that can be harmful to both aquatic creatures and humans.

*Image by Norman Kuring, NASA's Ocean Color web - Caption by Adam Voiland.*

# The Volga Delta

***John Tellick***

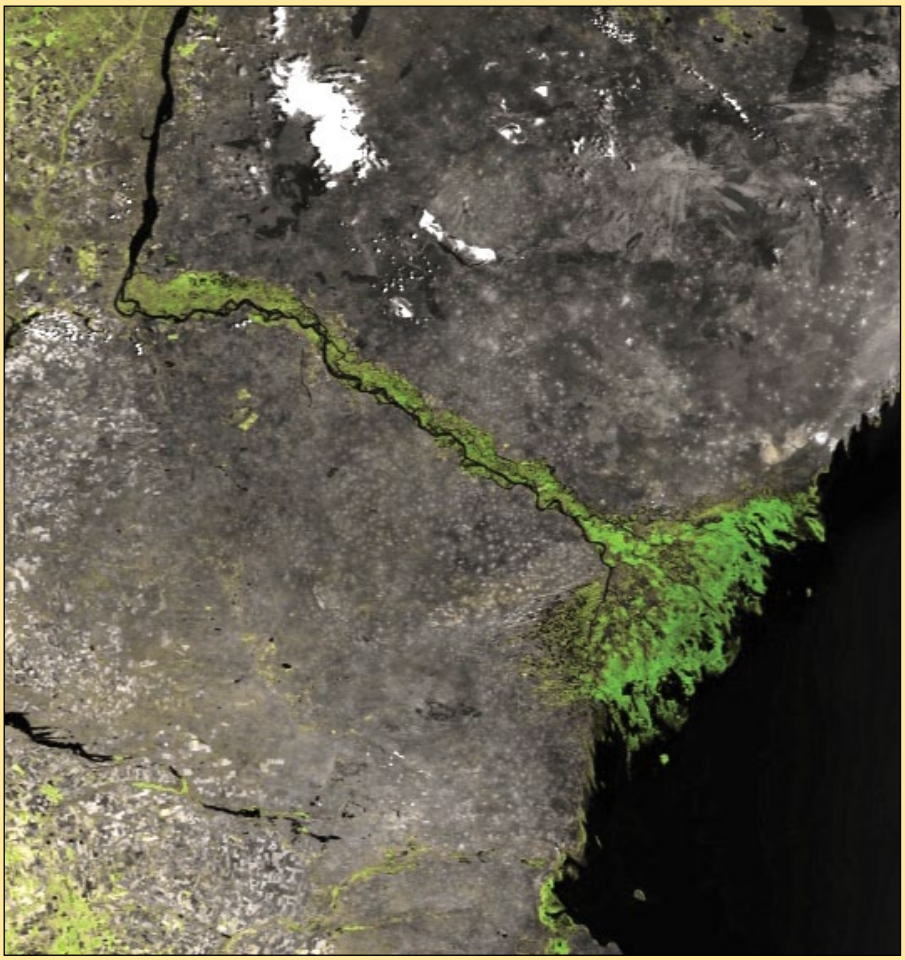
The Volga River delta is the largest in Europe, and is situated where Europe's largest river system, the Volga, drains into the Caspian Sea in Russia's Astrakhan Oblast. The delta is located in the Caspian Depression—the far eastern part of the delta lying in Kazakhstan. The delta drains into the Caspian approximately 60 kilometres downstream from the city of Astrakhan.

The Volga Delta has grown significantly during the past century because of changes in the level of the Caspian Sea. In 1880, the delta had an area of 3,222 km²; today it covers an area of 27,224 km² and is approximately 160 km across. It has a classical 'delta pattern'. The delta lies in the arid climate zone, characterised by very little rainfall, in a region that receives less than 25 millimetres of rainfall in January and in July in normal years. Strong winds often sweep across the delta and form linear dunes. Along the front of the delta are muddy sand shoals, mud flats, and banks.

The changing level of the Caspian Sea has resulted in three distinct zones in the delta. The higher areas of the first zone are known as '*Baer's mounds*,' named after researcher Karl Ernst von Baer who worked in this region. These mounds are linear ridges of clayey sands, up to 22 metres in height (averaging about eight metres) and up to 10 kilometres long. Between these mounds are depressions that fill with water and become either fresh or saline bays. These depressions used to form part of the early, very deep river delta, but have gradually become separated from it. Because of their isolation from the fresh waters of the Volga, they are now becoming increasingly saline. Together they form an extremely diverse area which, because of the varying degrees of wetness and salinisation, houses a wealth of flora and fauna.

The second zone is the delta proper, which generally has very little relief (usually less than one metre), and is the site of active and abandoned water channels, small dunes and algal flats. The third zone is composed of a broad platform extending up to 60 kilometres offshore, and is the submarine part of the delta.

The delta has been protected since the early 1900s, with one of the first Russian nature preserves (Astrakhan Nature Reserve) having been set up there in 1919. Much of its local fauna is considered endangered. The delta is a major staging area for many species of water birds, raptors and passerines. Although the delta is best known for its sturgeon, catfish and carp are also found in large numbers.



This *vegetation index* Metop-A segment from July 27, 2017 highlights the Volga delta, and also cultivation north of the river as it flows east towards the delta through an arid region.
*Image © EUMETSAT 2017*

Industrial and agricultural modification to the delta plain has resulted in significant wetland loss. Between 1984 and 2001, the delta lost 277 km² of wetlands—an average of approximately 16 km² per year—from natural and human-induced causes. The Volga discharges large amounts of industrial waste and sediment into the relatively shallow northern part of the Caspian Sea, including fertilisers that nourish the algal blooms that grow on the surface of the sea.

**Algal Blooms**

Given adequate sunlight and nutrients, phytoplankton populations can swell into blooms large enough to be visible from space. On August 3, 2017, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Aqua** satellite acquired the image opposite (page 10) showing several such blooms in the Caspian Sea.

Phytoplankton blooms are often harmless, and are an important food source for marine life. Other times, blooms can be harmful; they can deplete the water's oxygen and suffocate marine life, and produce toxins that can be harmful to both aquatic creatures and humans.

Lake Urmia is visible west of the Caspian Sea, close to the bottom left hand corner of the image. Microscopic organisms periodically turn the lake's salty water striking shades of red and orange, as is the case here.

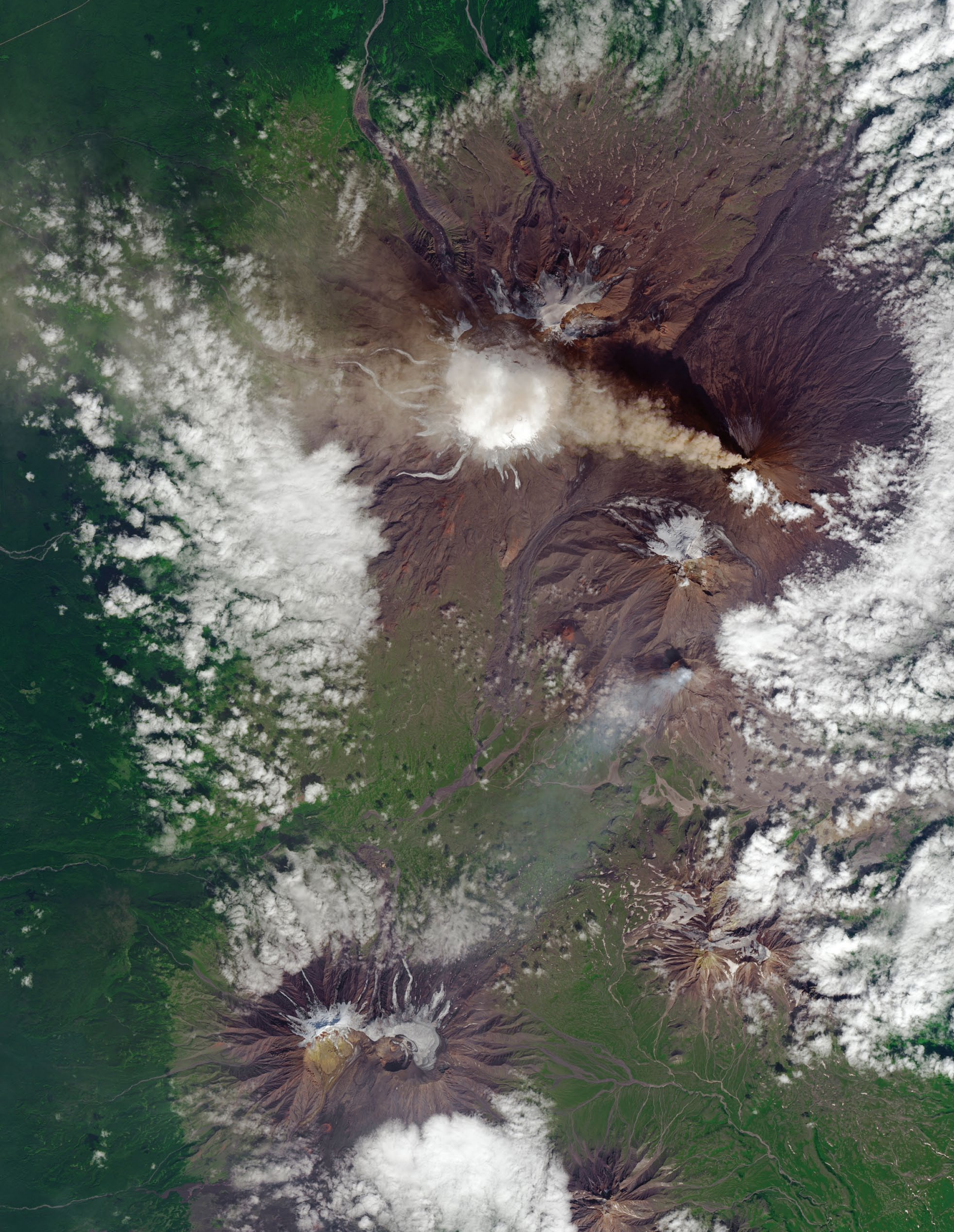
# Sunglint on the Aegean and Mediterranean

***NASA Earth Observatory***


On July 6, 2017, the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's **Terra** satellite captured this image of sunglint on the waters around Crete and the Aegean Islands. The phenomenon of sunglint is a matter of optics. Areas where the sea surface is smoother reflect more sunlight directly back to the satellite's imager. In contrast, areas of rougher water appear darker because light is scattered in many more directions.

Dry, cool winds from the north, called the *Etesian* winds, are common over the Aegean Sea during summer. On the windward side of the islands, those winds pile up the water and disturb the surface. But as those air masses run into the islands and their rocky peaks, a "wind shadow" with much calmer winds (and seas) form on the leeward side of islands (in this case, the south sides). Darker areas amid the bright streaks could be the result of wind or water turbulence, or perhaps breaks in the wind-blocking land topography.

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

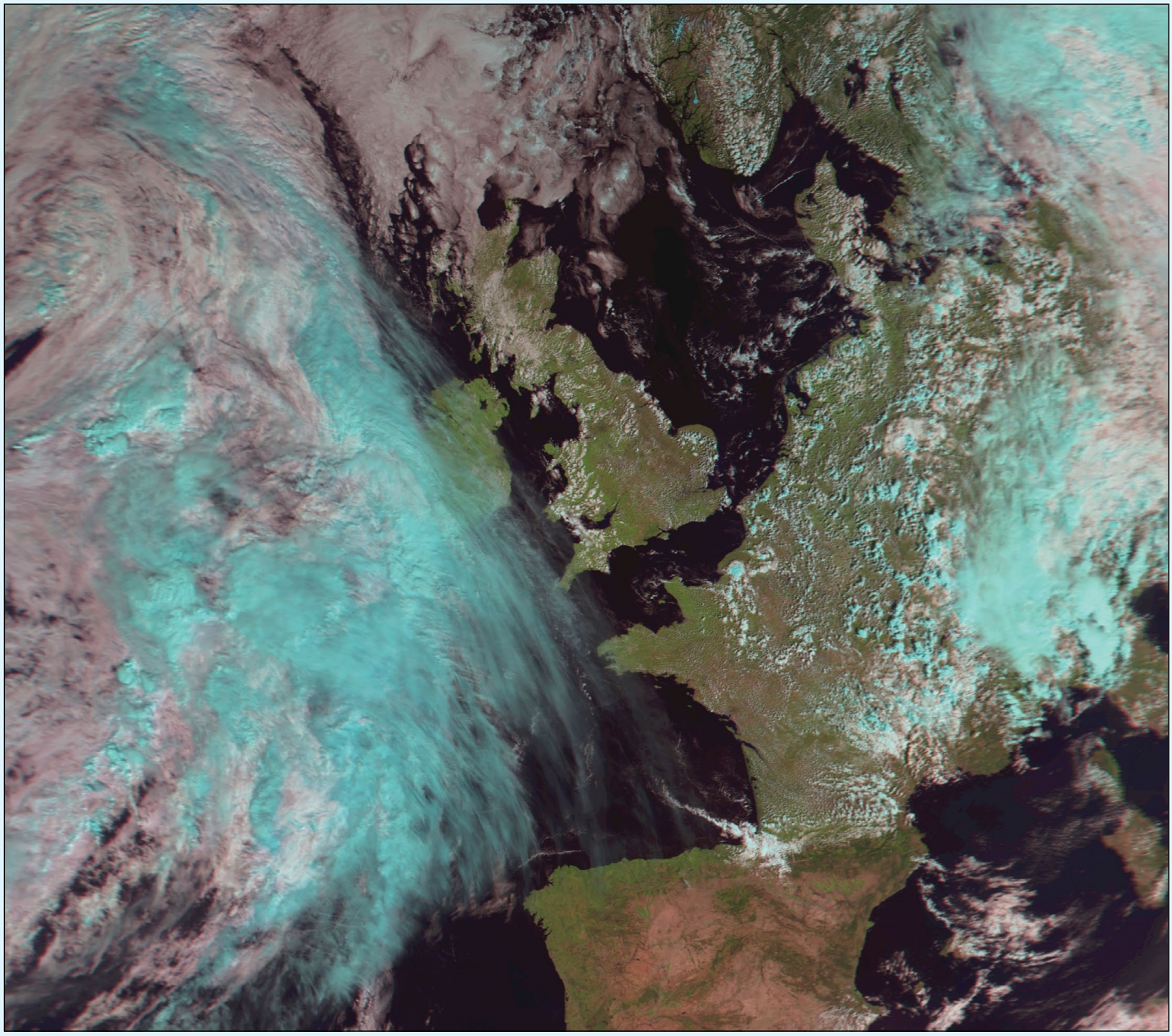


Landsat-8's Operational Land Imager observed a volcanic plume streaming west from the Kamchatka's Klyuchevskoy volcano on August 19, 2017. The ash plume was at a height of roughly 6 kilometres on the day this image was collected.
*Earth Observatory images by Joshua Stevens, using Landsat data from the US Geological Survey*

# Direct Reception of Feng Yun 3C

*Les Hamilton*

For more than a year now, Peter Kooistra from Gouda in The Netherlands has been corresponding with me about the home-brew system he has been constructing for the reception of high-resolution satellite images. Though the project is not yet complete, he is already receiving some superb imagery, exemplified by this RGB composite from the Chinese Feng Yun 3C polar orbiting satellite. The quality of the image is undeniable but at present, its length is limited by trees and houses surrounding Peter's location. Peter does not currently have a rotator, and the pass was hand tracked from his garden.



Peter Kooistra received this Feng Yun 3C image on September 2, 2017

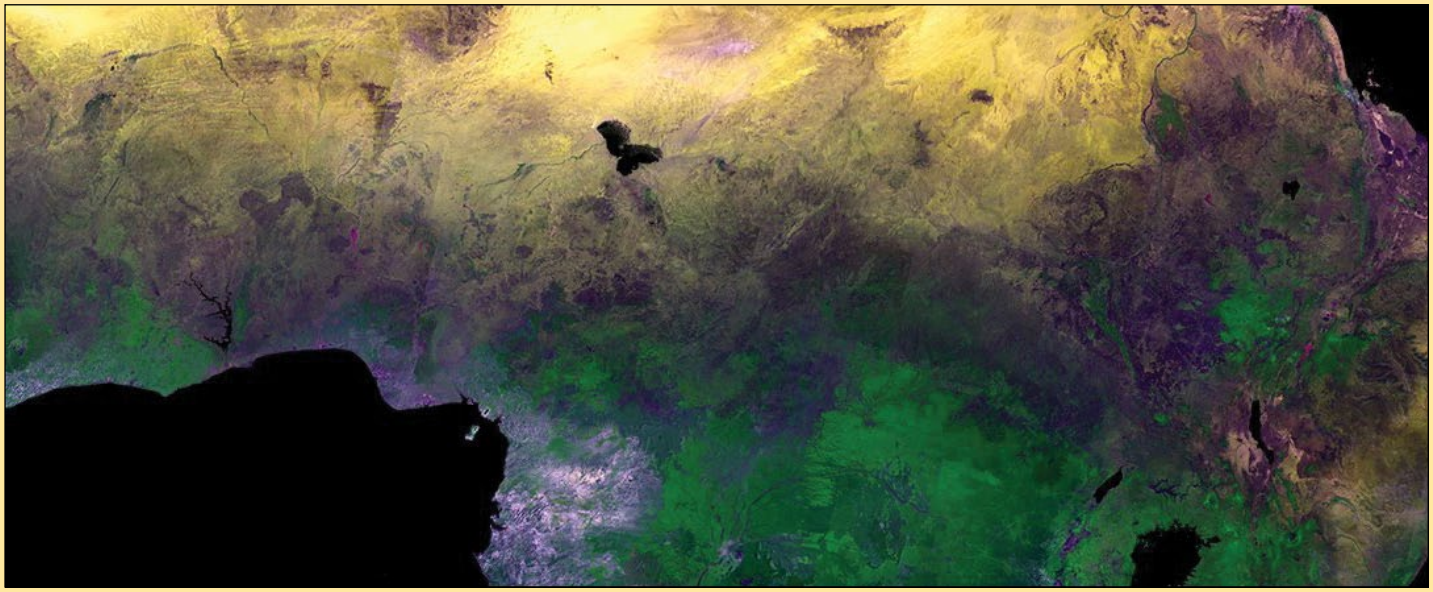
**For the interest of readers, Peter has provided this description of his system**

The **hardware** consists of a homemade, 1.1 metre mesh dish mounted on a camera tripod (F/D = +/- 0.3), a 2.5 turn homemade helical feed tuned to around 1700 MHz, and an old Dartcom Meteosat LNC purchased on Ebay. Connections are through good quality N-connectors, 1.2 m of *Ecoflex10* cable from feed to the LNC, and 5 m of *Ecoflex10* cable from LNC output to an *Airpy*-mini receiver.

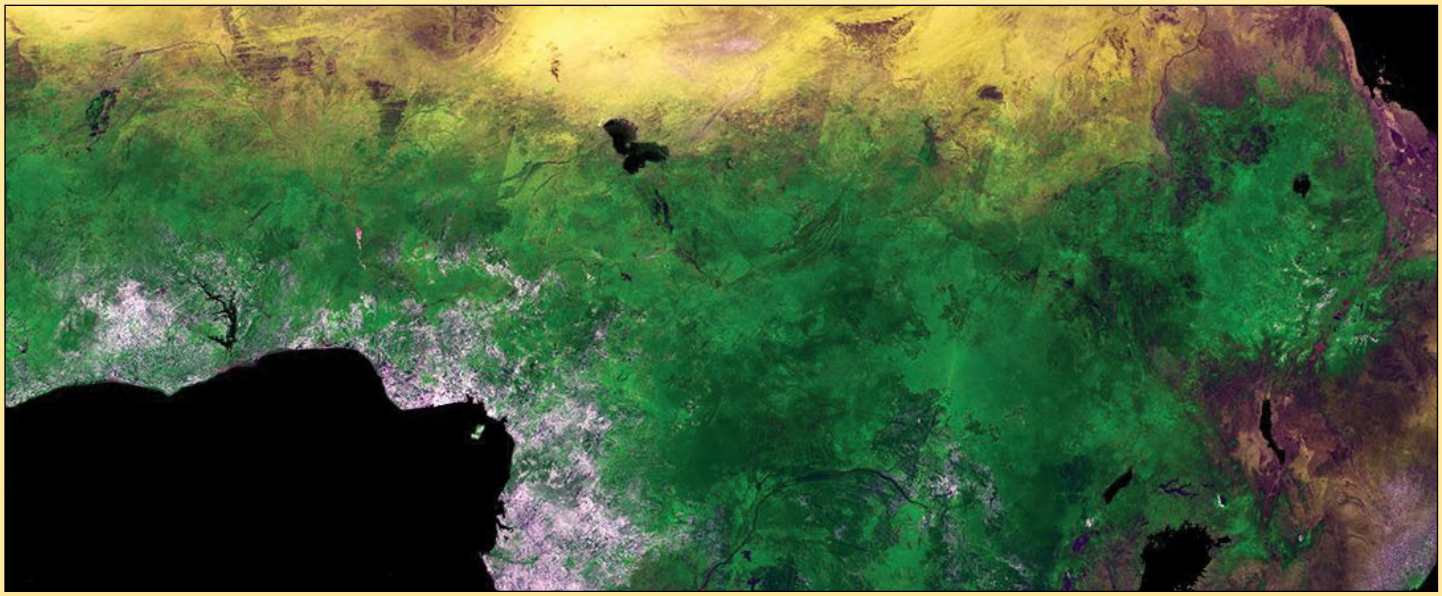
**Software** includes *Orbitron* for tracking the satellite, SDR# 1.450 for signal reception (including the baseband recorder plugin). Feng Yun's output is processed in a demodulator running in *Gnuradio For Windows*, the .RAW output going into a DOS-based decoder from *Trango* (USA-Satcom). This decoder, though operational, is not yet finished, and still under development. Next, the .bin output from the decoder goes into Oleg's *MeTFY3x* software, and finally, Oleg's C10 output is processed by David Taylor's *HrptReader*.

# Proba-V Monitors the African Sahel

***European Space Agency***



Proba-V captured this image during February 2016
*Image © ESA-Belspo 2017, produced by VITO*



Proba-V captured this image on September 2, 2016
*Image © ESA-Belspo 2017, produced by VITO*

ESA's **Proba-V** minisatellite reveals the seasonal changes in Africa's sub-Saharan Sahel, with the rainy season allowing vegetation to blossom between February (figure 1) and September (figure 2). The semi-arid Sahel stretches more than 5000 kilometres across Africa, from Senegal and Mauritania on the Atlantic coast to the Sudan on the Red Sea. The few months of the rainy season in the Sahel are much needed in these hot and sunny parts of Africa, and are critical for the food security and livelihood of their inhabitants. The name Sahel can be translated from Arabic as coast or shore, considered as the ever-shifting landward 'coastline' of the arid Sahara Desert.

Smaller than a cubic metre, **Proba-V** nevertheless images the entire land surface of Earth every two days, allowing researchers around the globe to trace gradual shifts in vegetation. Launched on 7 May 2013, Proba-V is a miniaturised ESA satellite tasked with a full-scale mission: to map land cover and vegetation growth across the entire planet every two days. Its main camera's continent-spanning 2250 kilometre swath width collects light in the blue, red, near-infrared and mid-infrared wavebands at 300 metre resolution and down to 100 metre resolution in its central field of view.

VITO Remote Sensing in Belgium processes and then distributes **Proba-V** data to users worldwide. An online gallery highlights some of the mission's most striking time lapse sequences, including views of storms, fires and deforestation. One of these videos relates specifically to the Sahel region.

***http://proba-v.vgt.vito.be/en/timelapses***

A gallery of still imagery from Proba-V can be viewed to

***http://proba-v.vgt.vito.be/en/proba-v-gallery***

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

# Where Tectonic Plates Go for a Swim

***NASA Earth Observatory***

There is an obvious difference between the dark green coniferous forests that dominate the western shore of Tomales Bay and the lighter green grasslands on the east side. But the differences between the two shores run much deeper than the vegetation. Tomales Bay lies about 50 kilometres northwest of San Francisco, along the edges of two tectonic plates that are grinding past each other. The boundary between them is the **San Andreas Fault**, the famous rift that partitions California for hundreds of miles.

The Operational Land Imager (OLI) on **Landsat 8** captured this natural-colour image of part of Tomales Bay on March 1, 2017. In figure 1 you can see that the direction of the fault follows the orientation of Tomales Bay, running from the head of the Bay through Olema Valley toward Bolinas Lagoon.

Lagunitas Creek, a northward-flowing stream that offers critical habitat for the endangered coho salmon, roughly traces the fault and is shown in more detail in figure 2.

To the west of the Bay is the Pacific plate; to the east is the North American plate. The rock on the western shore of the Bay is granite, an igneous rock that formed underground when molten material slowly cooled over time. On the opposite shore, the land is a mix of several types of marine sedimentary rocks. In Assembling California, John McPhee calls that side '*a boneyard of exotica*', a mixture of rock of '*such widespread provenance that it is quite literally a collection from the entire Pacific basin, or even half of the surface of the planet*.'

As the plates shift, the ground west of the San Andreas Fault moves northward. On average, movement along the fault averages about 3 to 5 centimetres per year—about the speed that fingernails grow. However, that movement is anything but steady. The two plates tend to lock together until extreme amounts of pressure build up; and when the pressure reaches a breaking point, an earthquake sends the plates lurching. During the Great 1906 San Francisco Earthquake, a road at the head of Tomales Bay was offset by nearly 6 meters.

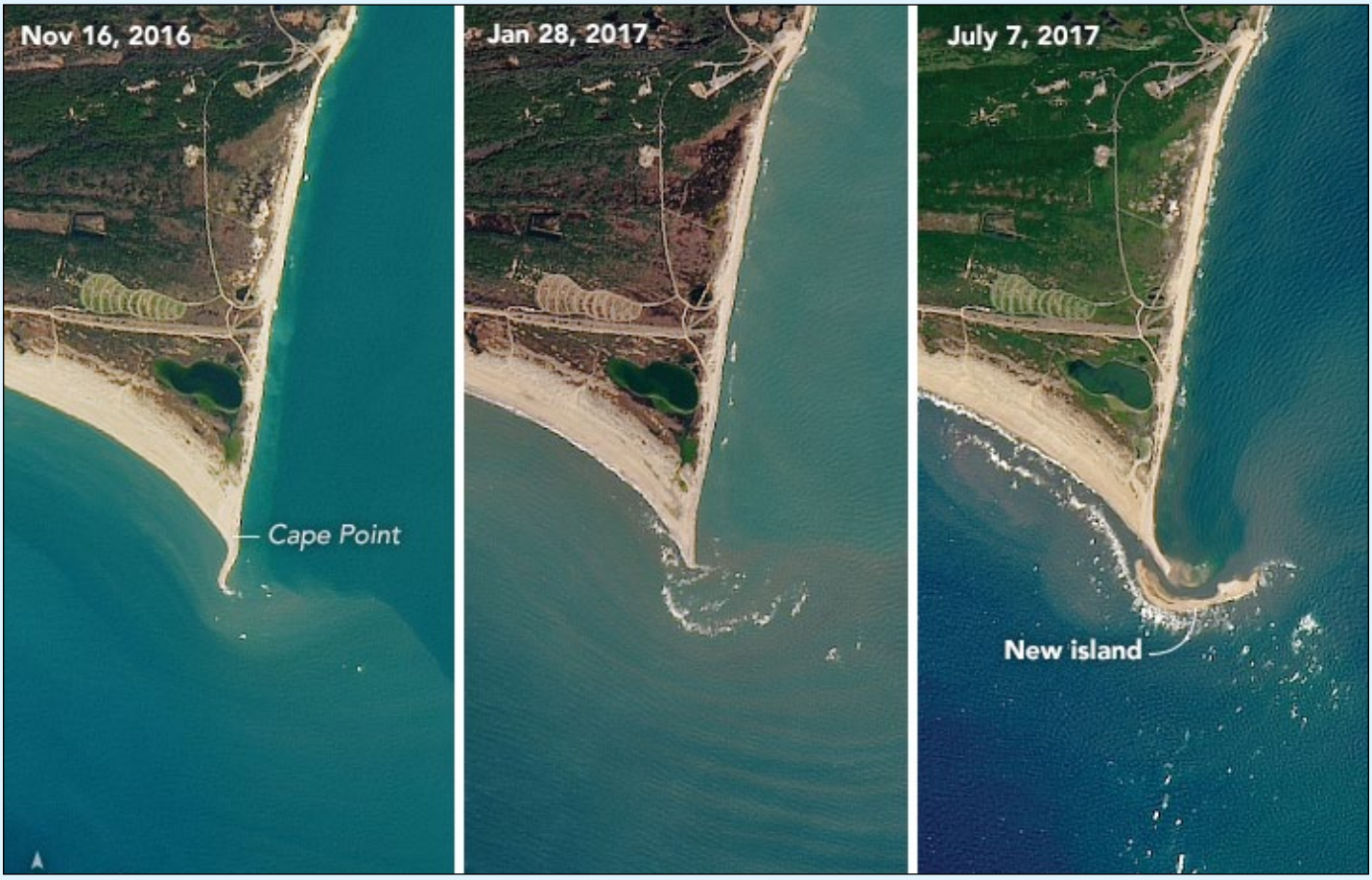
*NASA Earth Observatory images by Jesse Allen, using Landsat data from the US Geological Survey. Story by Adam Voiland.*


Figure 1 - The San Andreas Fault follows the direction of Tomales Bay


Figure 2 - Lagunitas Creek

# New Island forms off Cape Hatteras

***NASA Earth Observatory***




*NASA Earth Observatory images by Jesse Allen and Joshua Stevens, using Landsat data from the U.S. Geological Survey*
*Story by Kathryn Hansen.*

The waters off of North Carolina's barrier islands have been called a 'Graveyard of the Atlantic'. Countless ships have been wrecked there, due to the area's treacherous weather and currents, and its expansive shoals. These shoals are, by definition, usually submerged. But occasionally parts of them can rise above sea level.

These natural-colour images, acquired by the Operational Land Imager (OLI) on the **Landsat 8** satellite, show the shoal area off of Cape Point at Cape Hatteras National Seashore—the site of a newly exposed shoal nicknamed Shelly Island. The first image was captured in November 2016. When the second image was acquired in January 2017, waves were clearly breaking on the shallow region off the cape's tip. The site of those breakers is where the island eventually formed, visible in the third image captured in July 2017. The new island measures about a mile long, according to news reports.

'What exactly causes a shallow region to become exposed is a deep question, and one that is difficult to speculate on without exact observations,' said Andrew Ashton, a geomorphologist at the Woods Hole Oceanographic Institution. 'A likely process would be a high tide or storm-driven water elevation that piled up sediment to near the surface, and then water levels went down exposing the shoal. Waves then continue to build the feature while also moving it about.' While the exact mechanism for the formation of Shelly Island is mostly unknown, the phenomenon is not uncommon. Cape Lookout, the next cape down the barrier islands (to the southwest, beyond this image) has had several islands form on its shoal over the past decade or two.

The shoreline and cape tips along North Carolina's barrier islands are constantly in motion. Cape tips are sculpted by waves and currents that hit from all directions. Meanwhile, sediment is carried up and down the coastline and often deposited near the cape tips. Each cape has a so-called 'cape-associated shoal' lurking underwater. These shallow submerged mounds of sand, which rise to anywhere from 10 metres to a few meters below the surface, can extend for tens of kilometres.

'Tidal flows moving up and down the coast are diverted by the capes and result in a net offshore current at cape tips and deposition at the shoals,' Ashton explained. 'Occasionally, a portion of the shoal becomes exposed and forms an island.'

# Severe weather at EUMETCast Aflenz uplink station

*John Tellick*

The Aflenz Ground Station
*Photo: Erich Voggengerger.*

We are all used to rain-fade on the signal strength of our EUMETCast reception at our own receiving locations during periods of heavy rain. But this can also happen due to weather conditions at the uplink ground station, something that was dramatically demonstrated on the evening of Sunday July 9, 2017.

It was a warm clear-sky evening here in southwest London, and while the GEO management team were having a Skype meeting I was simultaneously watching EUMETCast imaging. My SR1 SNR was at 13.1 dB at 18:00 UTC but I noticed that it slowly began to deteriorate between 18:30 and 18:45. Strange, since it was still clear sky outside.

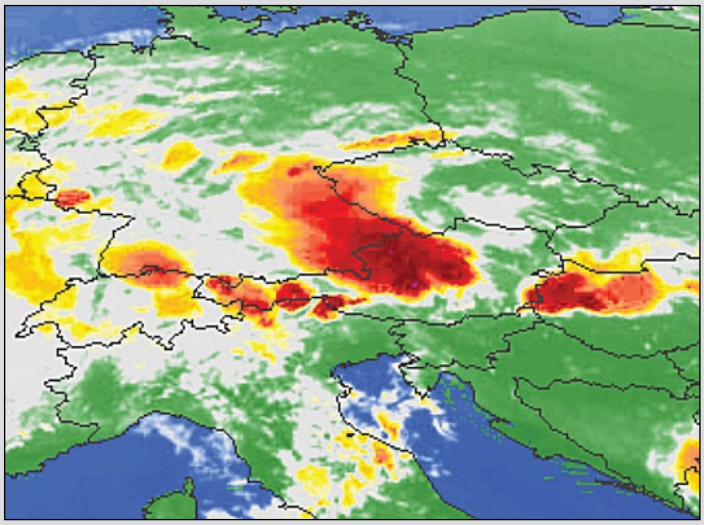
The deterioration slowly but relentlessly got worse, until at 19:39 UTC my SNR reading had fallen to 8.3 dB, still with clear sky conditions. Looking at the Meteosat 10 IR imaging and animation it was clear that large storms had built up in western Austria and were migrating east, passing over the Aflenz ground station. These storms were severe, producing very heavy rain and hail, and lasted a considerable time—see sequence of IR images for the area on the following page.

I had never seen such a deep and prolonged reduction in received SNR caused by rain-fade at the uplink station since EUMETCast (Ku-band) transmissions started. The severe weather in Austria continued on Monday, July 10 when a tornado touched down near Vienna airport and some parts of eastern Austria had hail stones the size of golf balls.

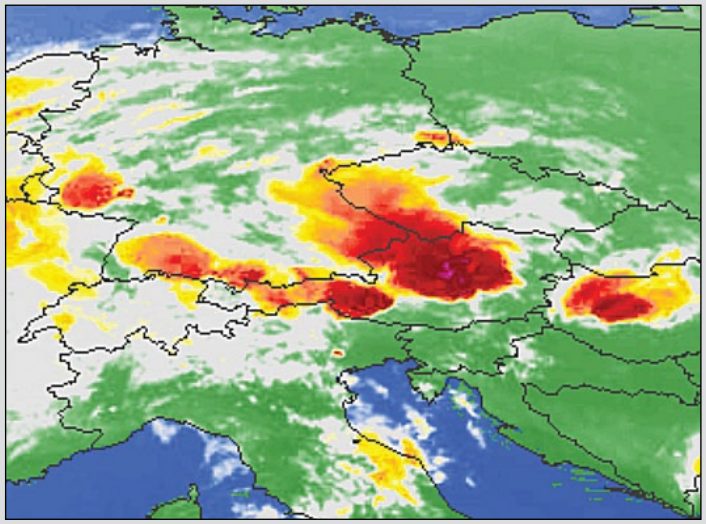
Aflenz is located on the southern flank of the Hochschwab massif, the mountains in Europe with the largest population of chamois. It is situated to the southwest of Vienna in the Styria region. The Aflenz Ground Station itself encompasses more than 50 antennas. The largest antenna weighs 275 tonnes and has a diameter of 32 metres, the equivalent of eight car lengths. Each antenna is dedicated to a specific satellite, which is responsible for transferring data to a specific region of the globe. All antennas send their data at the speed of light to geostationary satellites located 36,000 kilometres above Earth's equator, with data racing across the universe at a speed of 300,000 km/sec. This allows for the transmission of huge multimedia data volumes across the globe within fractions of a second; amongst others, for the large Austrian customer, the PCB manufacturer AT&S, which needs to communicate with its business sites in China and India.

The Teleport Aflenz also enables the live broadcasting of Austria's world-renowned events such as the Vienna New Year's Concert, the Life Ball and the Vienna Opera Ball to viewers across the globe.

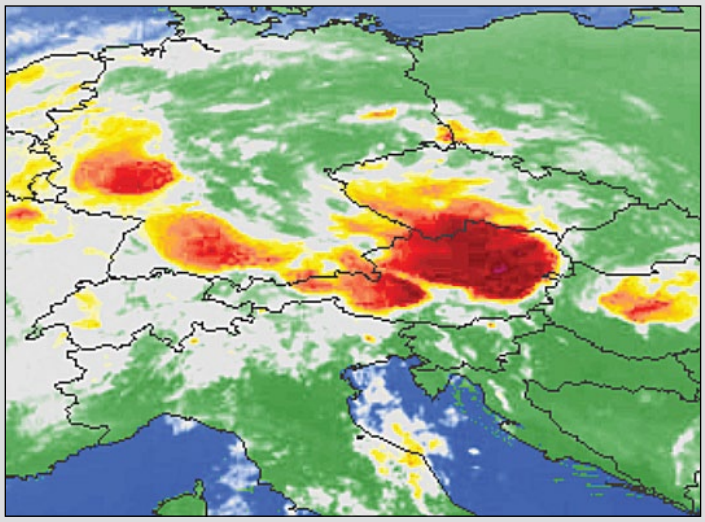
A photovoltaic park—*A1 Earth Station Aflenz*—which was built in 2013, generates the electric power for the satellite station at Aflenz. This photovoltaic open-field plant covers an area of 4,800 square metres and encompasses a total of 790 photovoltaic modules. The park



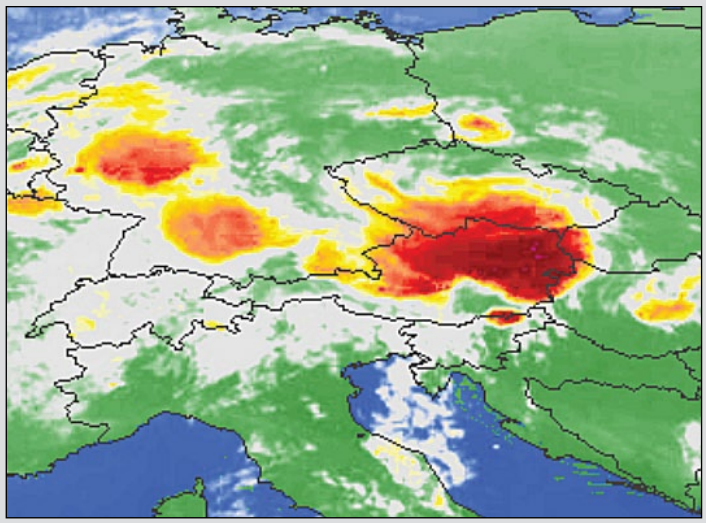
Meteosat 10 IR image at 18:00 UTC



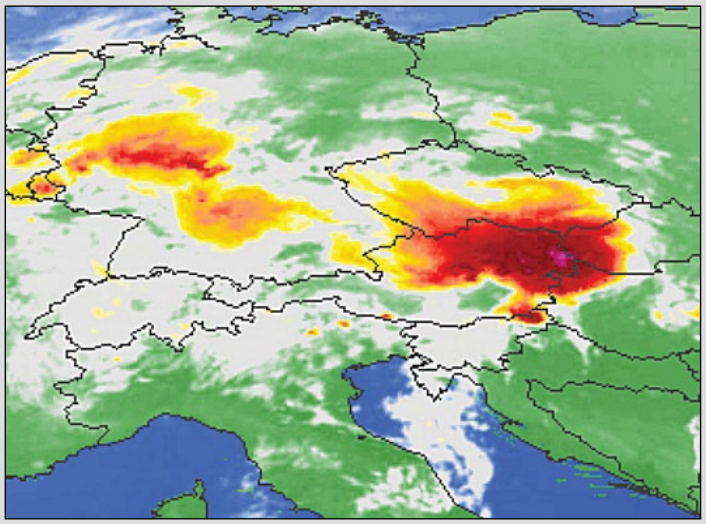
Meteosat 10 IR image at 19:00 UTC



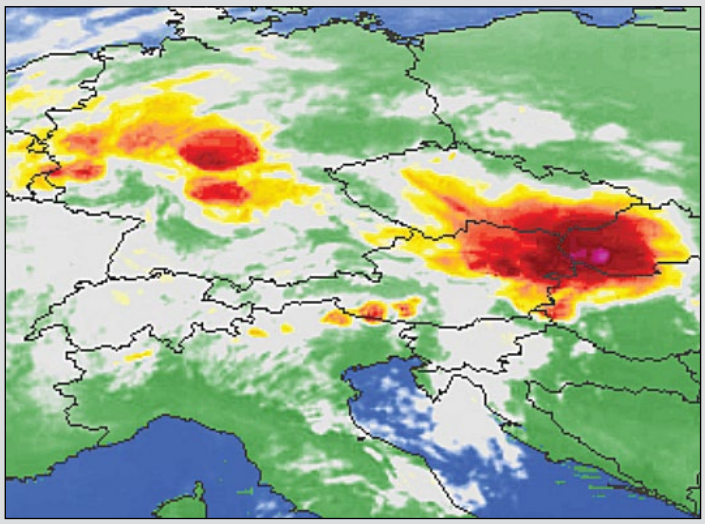
Meteosat 10 IR image at 20:00 UTC



Meteosat 10 IR image at 21:00 UTC



Meteosat 10 IR image at 22:00 UTC



Meteosat 10 IR image at 23:00 UTC

produces 190,000 kWh per year and the supplied energy is directly fed into the Aflenz Ground Station. Thanks to this use of solar energy, it has been able to reduce CO2 emissions by 90,000 kg per year. The building, which was designed by the internationally renowned Vienna architect Gustav Peichl, is almost invisibly integrated into the landscape and provides space for state-of-the-art high-tech equipment for ultra-fast data transmission over an area of 6,500 square metres. It is regarded as one of Austria's most successful architectonical achievements and has received several architectural awards.

# Ice Breakup in Amundsen Gulf

***NASA Earth Observatory***

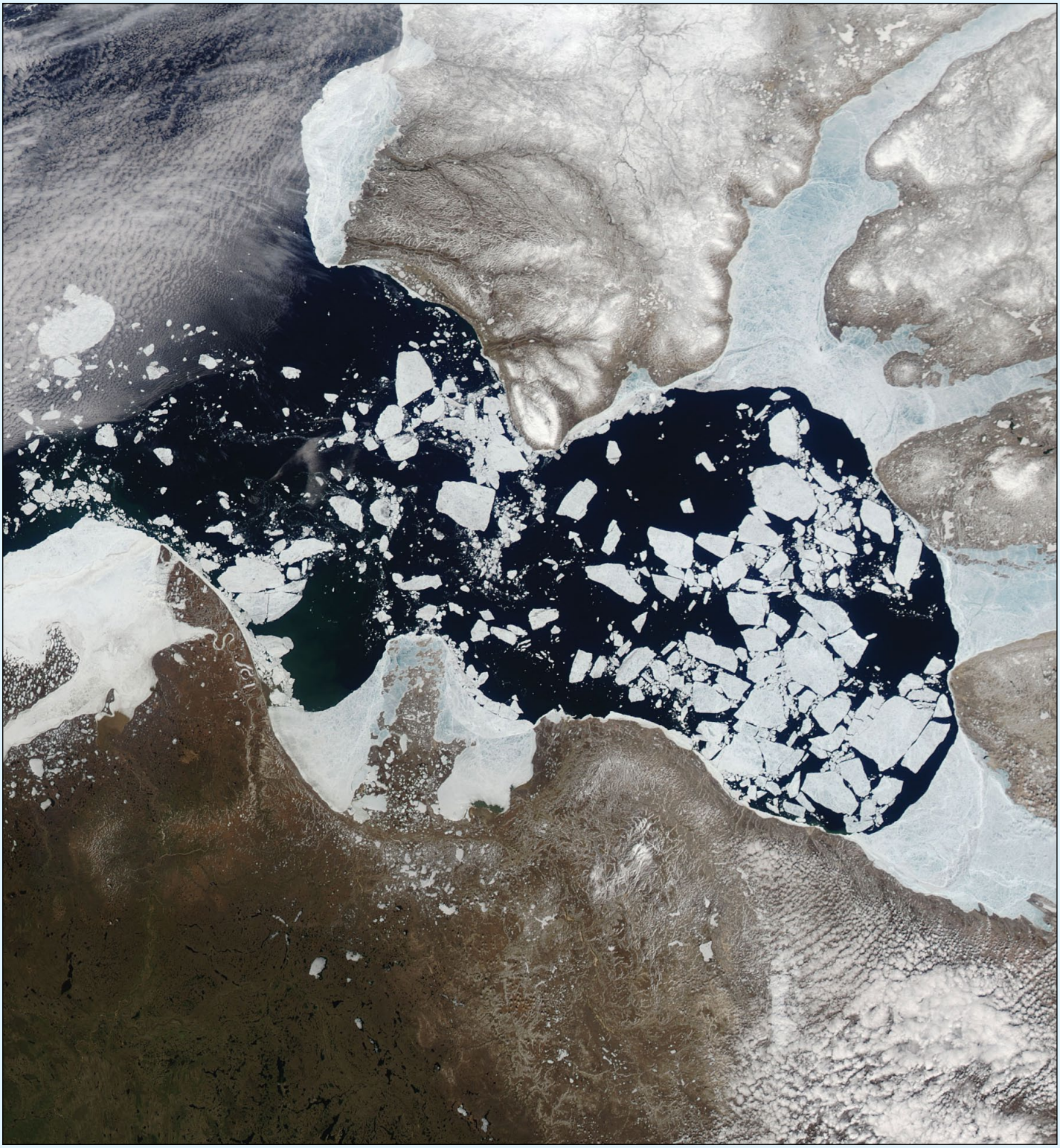


*Image: Jeff Schmaltz, MODIS Land Rapid Response Team, NASA GSFC*

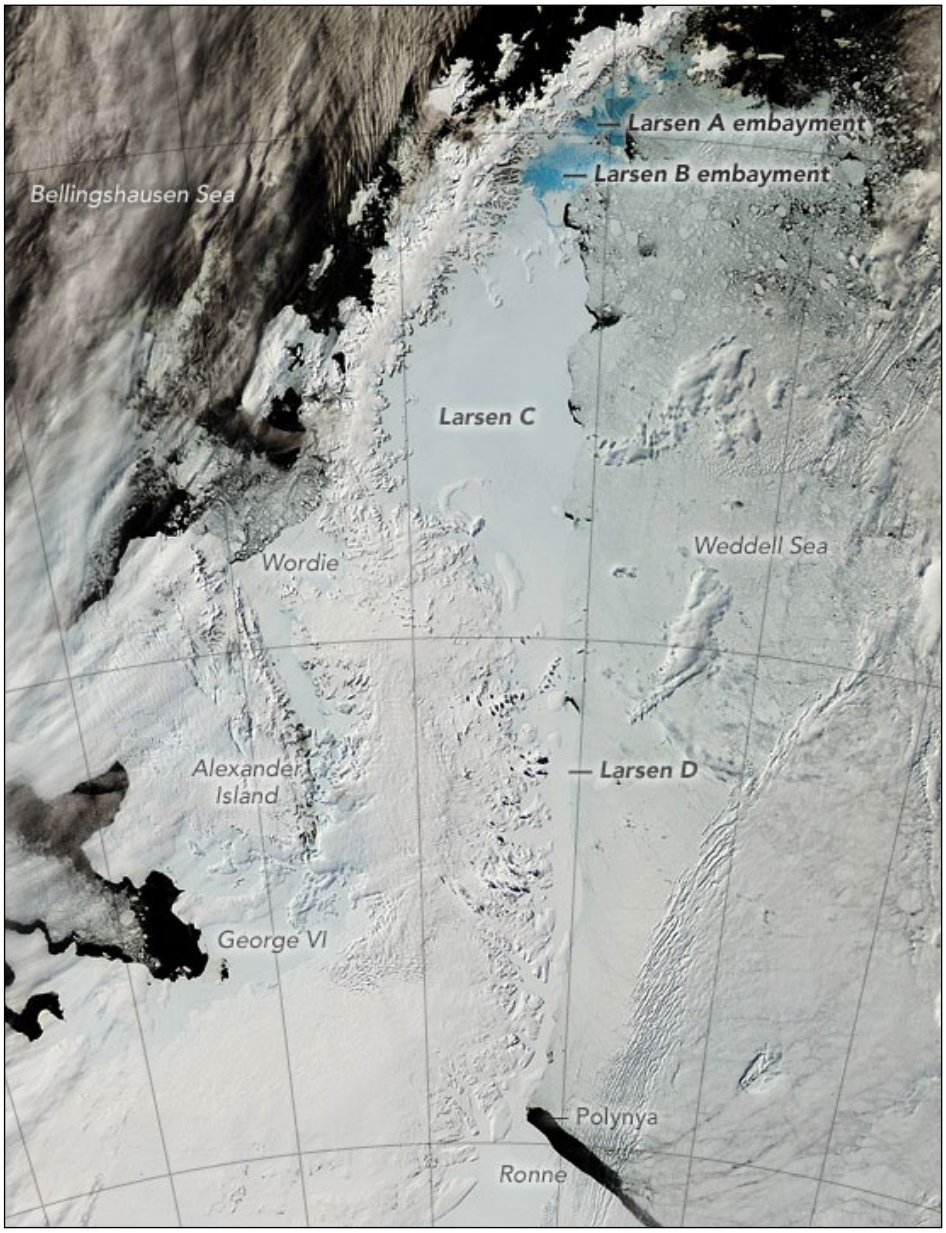
On June 8, 2017, the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's **Aqua** satellite captured a stunning true-colour image of ice breakup in the Amundsen Gulf.

Sitting north of the Northwest Territory, Canada, the Amundsen Gulf separates the mainland from Banks Island (north) and Victoria Island (northeast). Frigid temperatures typically keep the Gulf wearing a heavy coat of ice well into July, with ice break-up as late as August in some years. Warm winter and spring temperatures have contributed to substantial break up in early June this year.

# Antarctica's Most Studied Peninsula

***NASA Earth Observatory***

It is rare for satellites to get a clear view of the whole Antarctic Peninsula, one of the largest contributors to sea level rise during the past half-century. In the winter, polar darkness hides this rocky, ice-covered strip; in the summer, clouds usually block the view. But every now and then, usually in January or February, the clouds break. That is what happened on January 8, 2016, when the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's ***Aqua*** satellite captured this remarkably clear view of the peninsula.




The ice-covered and mountainous peninsula stretches 1,300 km into the Southern Ocean. An arcing underwater ridge connects the tip of the peninsula with several small islands (South Georgia, South Sandwich, and South Orkney) then continues to Tierra del Fuego, the southernmost point of South America.

As with most of Antarctica, the feature that dominates the peninsula and the ocean surrounding it is ice: the glaciers and ice sheets, the ice shelves, the icebergs and the thin crust of sea ice that forms on the ocean surface in cold weather. Just a few percent of the peninsula's land area is ice-free, and in some places the ice is as thick as 500 metres. The rare exposed areas (brown) are mainly isolated crags and mountain peaks—nunataks—that poke up through the ice layer.

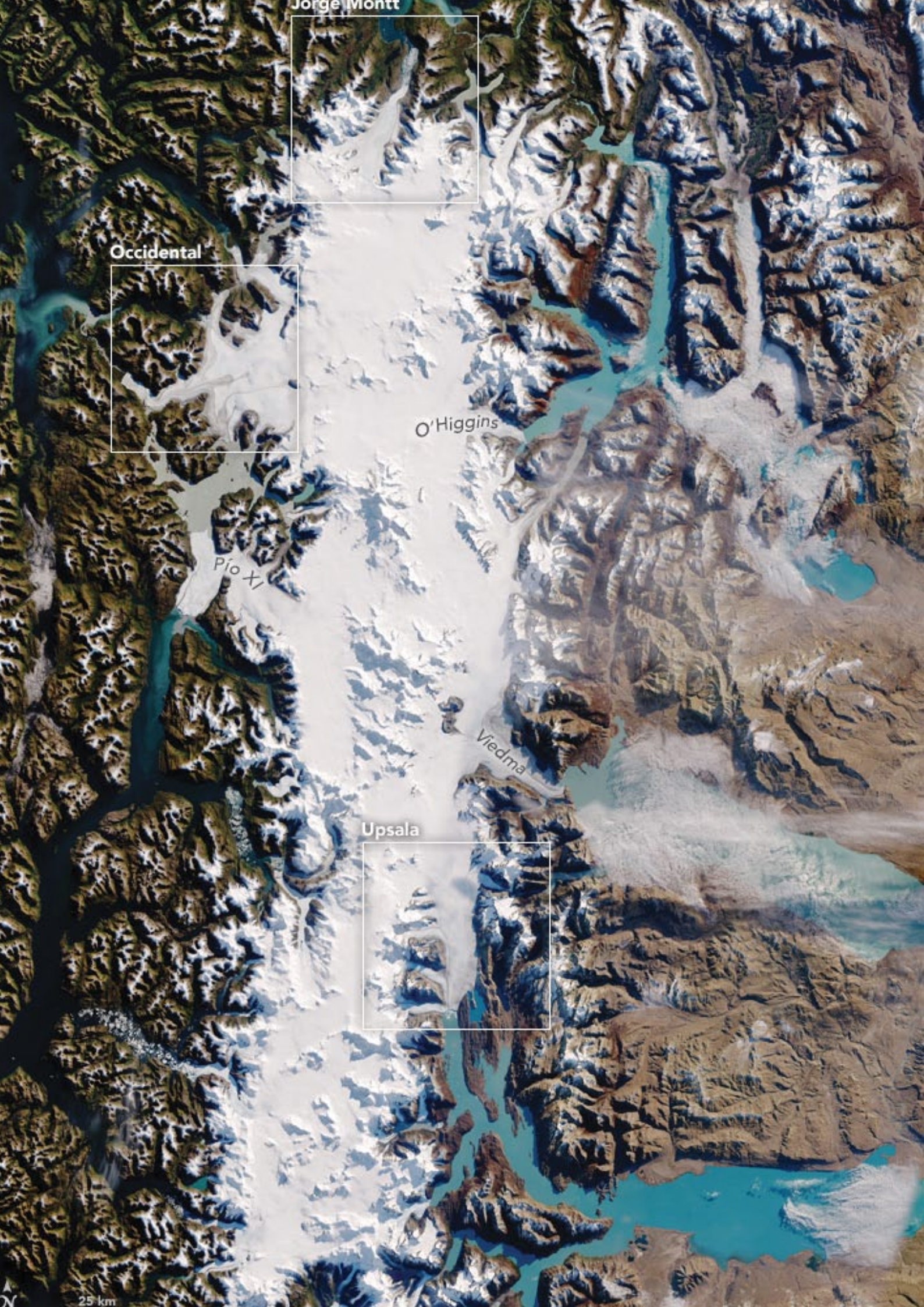
In recent decades, weather stations have measured fluctuating temperatures on the Antarctic Peninsula. Between 1951 and 2000, temperatures rose by 2.8°C, faster than anywhere else in the world. However, air temperatures then began an equally rapid swing in the opposite direction, dropping by roughly 1°C between 2000 and 2014. Meanwhile, surrounding ocean temperatures have been warming since the 1990s, particularly on the western side of the peninsula opposite the Larsen C Ice Shelf.

While changing air temperatures may have had some effects on the ice, scientists increasingly believe that warming waters have changed the peninsula's glaciers and ice shelves the most. Alison Cook and David Vaughan of the British Antarctic Survey analysed satellite observations and aerial photographs shot between the 1940s and 2010 and found that, of the 860 glaciers on the peninsula, 90 percent had retreated since they were first photographed a half-century ago. Of these, 30 glaciers lost more than ten square kilometres ($km^{2)}$ of ice, 190 lost between one and ten $km^2$, and 558 glaciers lost 1 $km^2$ or less. Eighty-two glaciers advanced, most by less than one kilometre.

A similar story has played out on the ice shelves. Seven of the twelve ice shelves along the coasts have become smaller since 1960, with losses totalling more than 28,000 square kilometres in all. Larsen A (3,736 $km^2$ in the 1960s), Larsen B (11,958 $km^2$ in the 1960s), and Wordie (1,917 $km^2$ in the 1960s) have changed the most, losing much of their ice. George VI glacier has lost some ice, but it remains about 92 percent of the size it was in 1947. Larsen C has been relatively stable, but is poised to calve an iceberg the size of Delaware. Larsen D, which has expanded by four percent, is the only ice shelf that has grown larger over the past 50 years.

The Fleming, Hariot, and Prospect glaciers—which flow off the peninsula into Wordie Bay—retreated the most. Hektoria, Crane, and Jorum—glaciers that flow into the Larsen B embayment—have also retreated significantly. All of these glaciers saw rates of ice loss accelerate significantly when adjacent ice shelves, which helped hold them in place, broke up.

*NASA Earth Observatory image by Jesse Allen, using data from the Level 1 and Atmospheres Active Distribution System (LAADS). Caption by Adam Voiland*


Jorge Montt
Occidental
O'Higgins
Pío XI
Viedma
Upsala
25 km

# South Patagonian Icefield

***NASA Earth Observatory***

Patagonia is one of the windiest and wettest regions on Earth. Westerlies gain moisture and momentum as they cross the Pacific Ocean, and when they reach South America they ride over the Andes, through fjords, and across two icefields. Having spent several field seasons on and around the South Patagonian Icefield, glaciologist Michele Koppes of the *University of British Columbia* knows first-hand the challenges posed by the elements.

> '*The katabatic winds that drain down the eastern slopes can pick you and your heavy backpack right off your feet and turn you over like a turtle*,' stated Koppes, a phenomenon she experienced a few times while trying to reach glaciers in Torres del Paine and Los Glaciares National Park. '*The winds can blow tents right off their stakes and send them tumbling across lakes*.'

And then there is the moisture to contend with too. Precipitation can be intense on the west side of the icefields, which receive up to four metres of rain and snow per year; it is more moderate in the east, which receives less than one metre per year. Koppes has spent weeks at a time waiting for weather clear enough for an airplane to fly her to the glaciers to collect data. She has met climbers huddled in tents for more than a month on end waiting for a window of weather favourable enough for ascending the pinnacles on the icefield's east side.

Scientists endure these conditions in order to gain better understanding of how and why the Patagonian icefields are shrinking.

> '*The glaciers in this region are changing rapidly*,' said Eric Rignot, a glaciologist at NASA's Jet Propulsion Laboratory and the University of California-Irvine. '*They are, in fact, melting away at some of the highest rates on the planet. The reason is that they are not only melting from the top because of warm air, but also from below, where they come in contact with ocean and lake waters*.'

Often shrouded in clouds and mist, the entirety of the South Patagonian Icefield is rarely visible from space. This mosaic shown in figure 1 (previous page) combines cloud-free images acquired by the Operational Land Imager (OLI) on the **Landsat 8** satellite on April 29, May 1, and May 24, 2016.

The North and South Patagonian icefields are the remnants of a much more expansive ice sheet that reached its maximum size

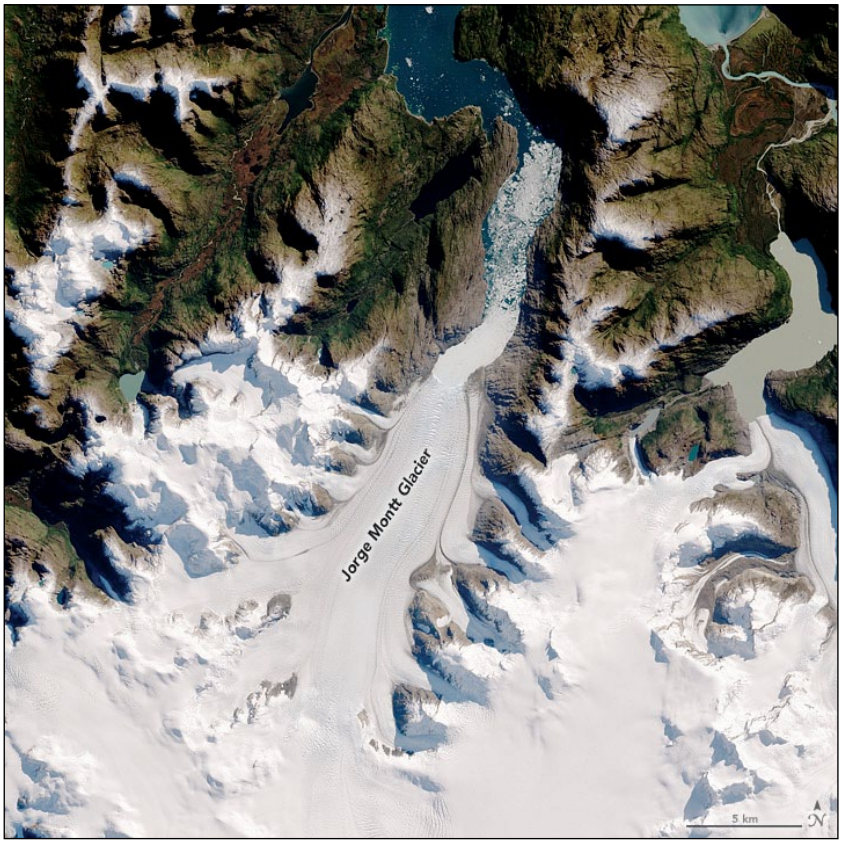



Figure 2 - The Jorge Montt Glacier on April 29, 2016

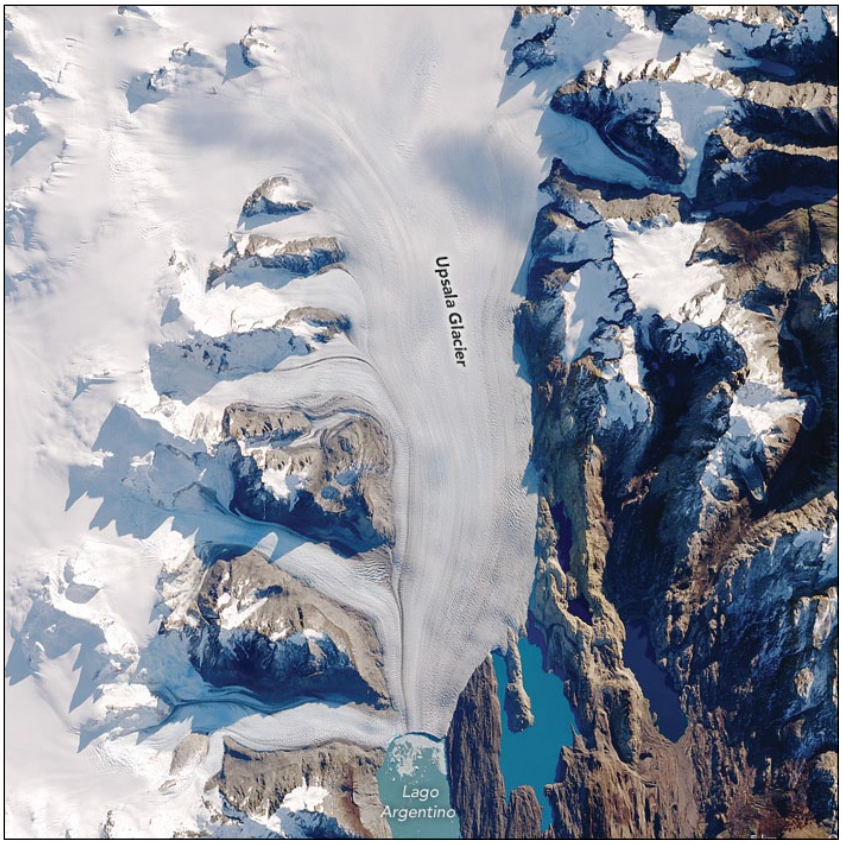



Figure 3 - The Upsala Glacier on May 24, 2016

about 18,000 years ago. The modern icefields are nowadays just a fraction of their original sizes, though they remain the southern hemisphere's largest expanses of ice outside Antarctica. Today, the South Patagonian Icefield spans about 13,000 square kilometres, about four times greater than the north icefield. Its ice spreads across the border between Chile and Argentina. (The north icefield, in contrast, lies entirely within Chile.)

The differences between the western and eastern sides are clear to see in figure 1 where the landscape west of the icefield is much greener, driven by the intense precipitation that drops out of warm, wet Pacific air masses as they ascend the mountains. Land around the fjords support large trees and lush forest cover.

> '*The vegetation is so dense that it is sometimes impossible to penetrate without a machete and a lot of patience*,' claims Koppes.

Many of the fjords are choked with icebergs, especially in front of Jorge Montt. The presence of icebergs indicates the rapid disintegration and retreat of these glacier systems. Ice becomes concentrated within ten kilometres of the glacier fronts due to shallow sills at the mouths of these fjords, which ground and trap the larger bergs. Thick plumes in the fjords highlight the huge amount of sediment that the glaciers erode as they slide down toward the ocean.

In contrast, glaciers on the eastern side of the icefield terminate in some of the largest proglacial lakes in the world. The lakes are filled with so much fine sediment from the glaciers—known as glacial flour—that their turquoise colour can be seen from space.

Detailed images provide a closer look at some of the icefield's largest, most notable glaciers. Jorge Montt, located on the north end of the South Patagonian Icefield, flows from south to north, emptying into a fjord that ultimately angles west toward the Pacific Ocean. Since the mid 1980s, the speed of ice flow has fluctuated, with particularly spectacular retreat events documented in the 1990s. In all, the glacier retreated 13 kilometres between 1984 and 2014. Figure 2 shows the glacier's former extent in the 1980s, visible as the tan-gray area devoid of vegetation around the ice. This glacier has thinned and retreated so fast that vegetation has not yet had a chance to fill in. During peak retreat, the glacier was thinning vertically at a rate of 31 metres per year.

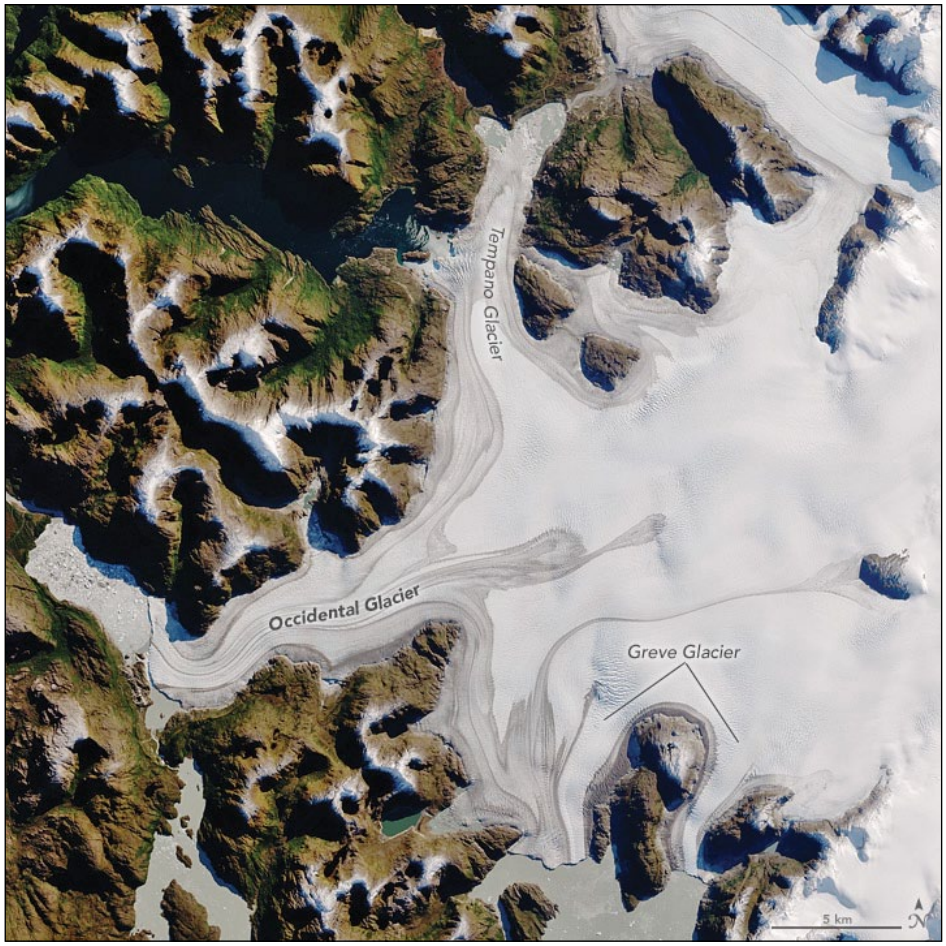


Figure 4 - Occidental and Greve glaciers on April 29, 2016

> '*When we flew over this glacier in 2014 to survey its thickness*,' Rignot recalled, '*the airplane was at an altitude that would have put us inside the glacier in the 1980s.*'

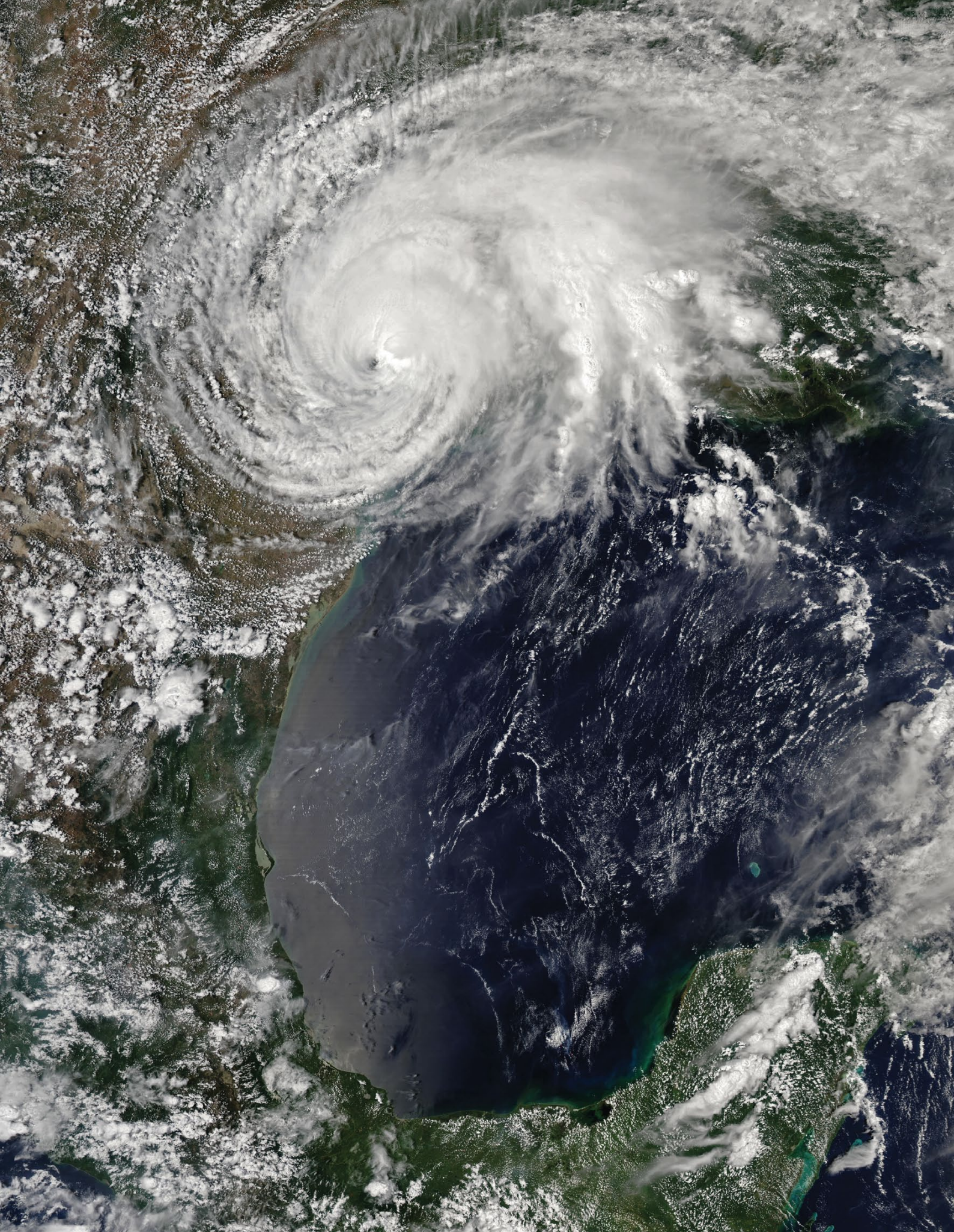
Upsala Glacier, on the eastern edge if the icefield, and flowing into Lago Argentino, is also among it's largest and longest glaciers (figure 3). Its retreat has been ongoing since the place was first documented in 1810. The light brown rock along the glacier's edge would have been covered with ice in the 1980s. Between 1985 and 2001, the glacier doubled its speed, then slowed down, and has since speeded up again.

Occidental, another of the larger glaciers, has retreated less than its neighbours—only about one kilometre since the 1980s. It drains ice from a basin that spans almost the entire icefield, the ice flowing via a deep trough that extends below sea level (figure 4). Both Occidental, and Greve Glacier to its southeast, flow along the flank of the active Lautaro volcano. Bands of volcanic ash are visible atop these glaciers at low elevation.

Occidental sheds its icebergs into a small, shallow proglacial lake where they are trapped and then slowly melt away. Greve also calves icebergs into a shallow lake, which is dammed to the south by Pío XI Glacier. According to Rignot, there used to be a farm in the valley in front of Greve, but he had to move away when the valley became blocked by the advance of Pío XI which resulted in the formation of the lake. According to Koppes, the great worry is that continuing addition of water to this ice-dammed lake will slowly cause the terminus of Pío XI to float, which may cause a catastrophic outflow of water that would flood the neighbouring regions.

Meltwater from the Patagonian icefield as a whole contributes to sea level rise. The contribution is less than that which comes from Greenland and Antarctica, but scientists plan to keep studying the region from space, from the air, and on ground. Understanding the evolution of these glaciers helps to understand how glaciers in Greenland and Antarctica might look in a future, much warmer climate.

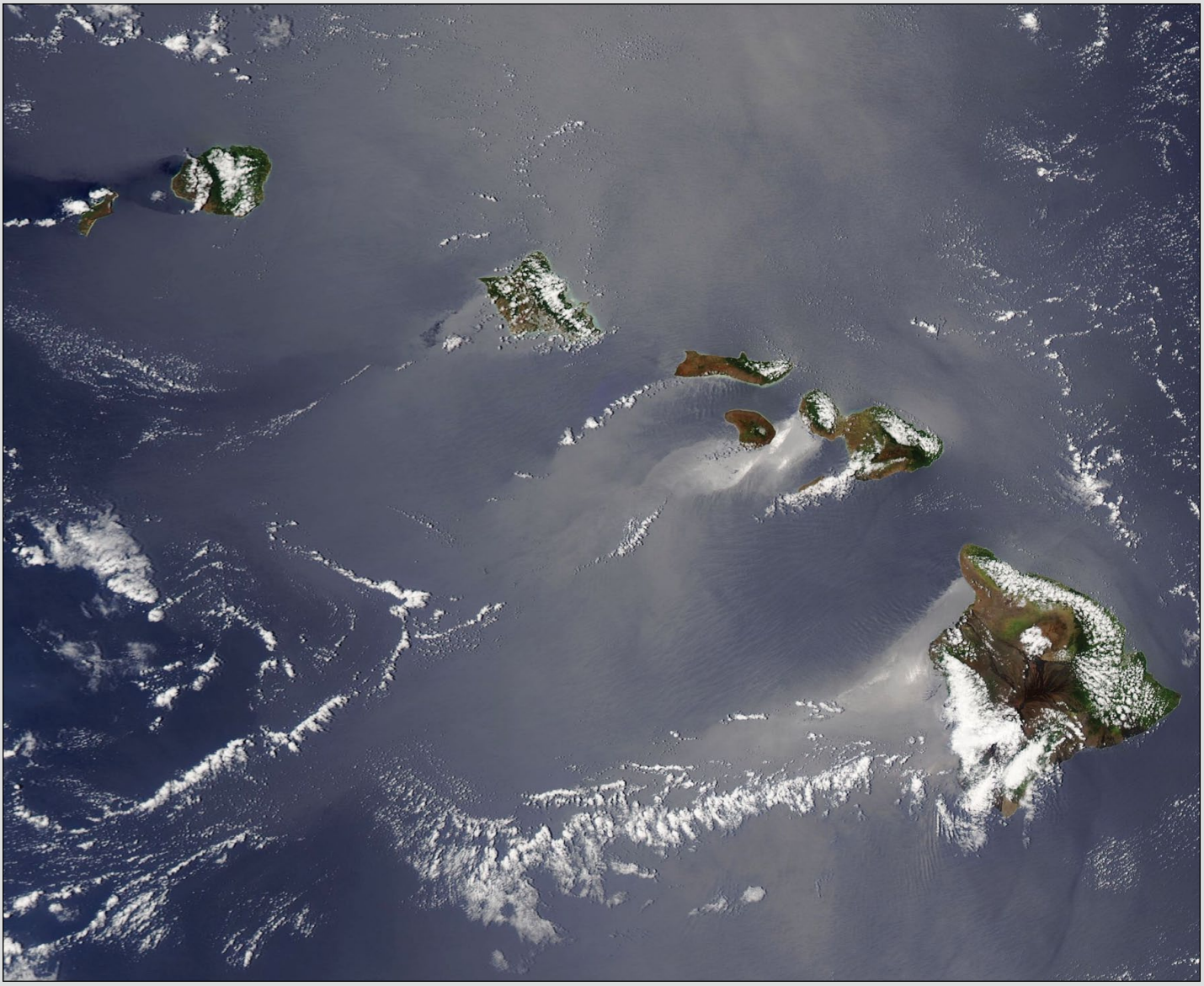
*NASA Earth Observatory images by Jesse Allen, using Landsat data from the US Geological Survey. Story by Kathryn Hansen.*



This MODIS image of Hurricane Harvey making landfall near Houston, Texas was captured by NASA's Aqua satellite on August 26, 2017.
*Image: LANCE Rapid Response / NASA / GSFC*

# Sunglint Around Hawaii

***NASA Earth Observatory***



A combination of sunglint and cloud helped to create a stunning image of Hawaii in late July 2017. The Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's Aqua satellite acquired this true-colour image on July 27.
*Image Credit: Jeff Schmaltz, MODIS Land Rapid Response Team, NASA GSFC*

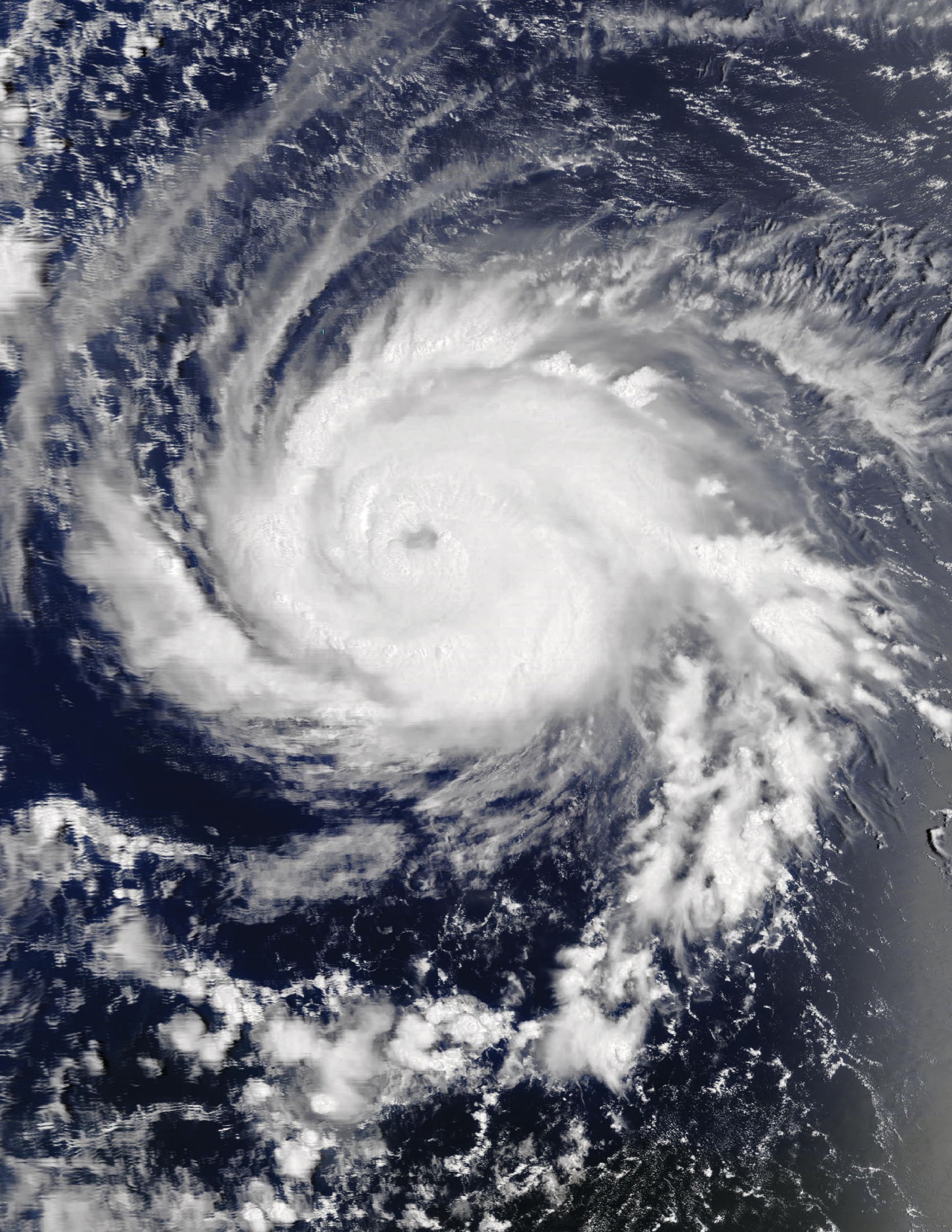
The beautiful Hawaiian Islands are made up of eight major islands stretching across almost 2,400 kilometres of the Pacific Ocean. The rugged landscape of the islands was created by volcanic activity over millions of years, with the oldest island, Oahu, estimated to have been created between 3.4 to 2.2 million years ago. The process continues to this day, with two active volcanoes on Hawaii. Kilauea has been in continuous eruption since 1983 while Maunaloa last erupted in 1984. Loihi, an underwater volcano, has been intermittently pouring lava into the ocean since 1996, a process that may ultimately result in the creation of a new island.

From the lower right (southeast) to the upper left (northwest), the islands visible in this image are the 'Big Island' (Hawaii), Maui, Kahoolawe, Lanai, Molokai, Oahu, Kauai, and Niihau. Clouds cover parts of each island, obscuring much of the green vegetation from view. The visible landscape appears mostly dark tan or black rocky outcroppings, where rainfall is lower and less vegetation grows.

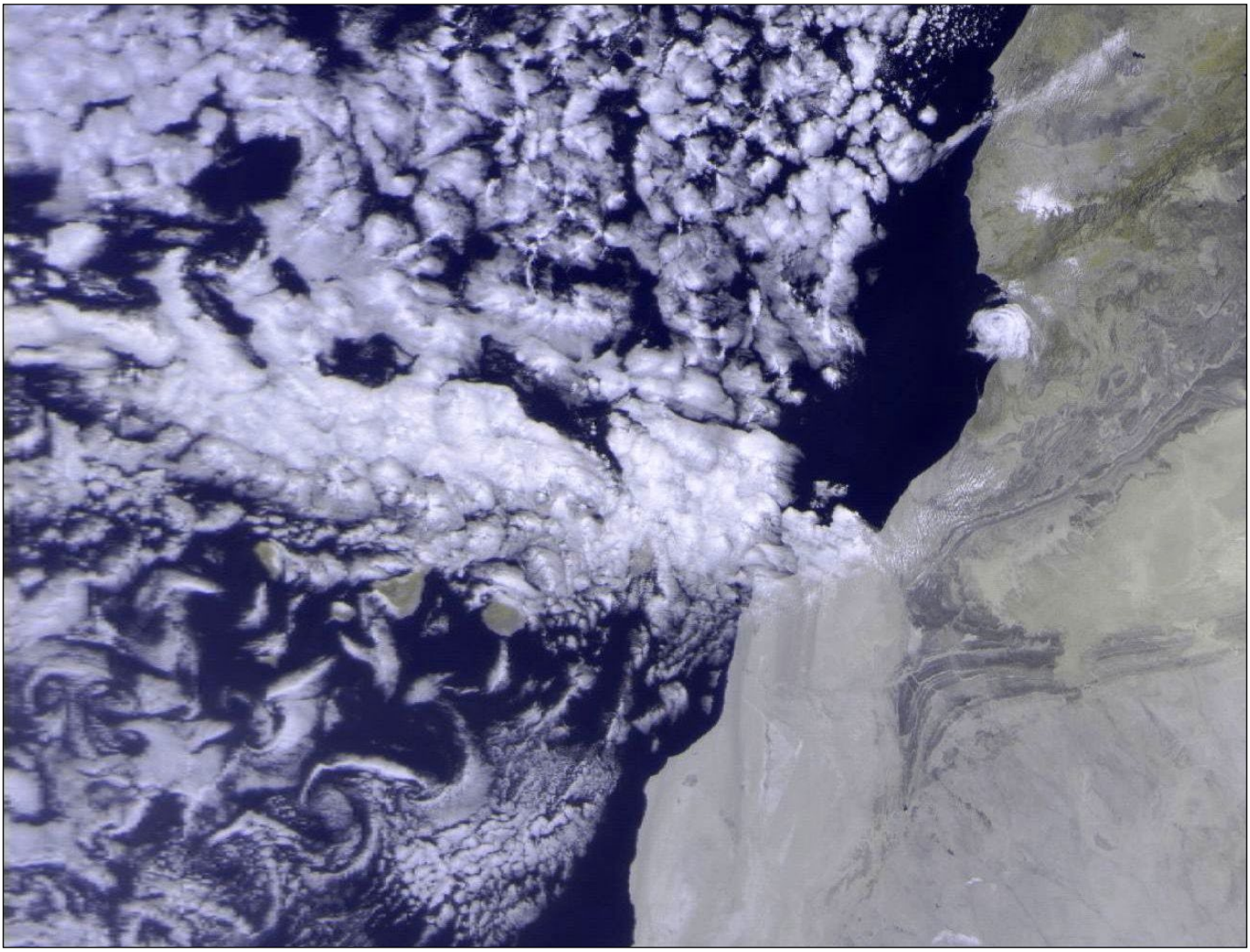
Sunglint occurs when light is reflected from waters of the surface of the ocean back towards the sensor, and it creates a silvery appearance in true-colour images. Sunglint reveals turbulence in the surface of the water. If the surface were perfectly smooth, then—like a mirror—we would see the sun's reflection as a large circle. Because the surface water is ruffled and roughened due to wave action, the reflection becomes scattered and softened, creating the silver-coloured sunglint region.

In this image, the water surfaces around the Hawaiian Islands are roughened in varying patterns. Calmer waters on the leeward sides of the islands, are indicated by brighter silver colour on the southwest side of most islands. In contrast, the cloud cover sits primarily on the windward side of the islands.

Hurricane Irma was imaged by NASA's Terra satellite as it approached Cuba on September 7, 2017
Image: *LANCE Rapid Response / NASA / GSFC*



Hurricane Jose was imaged by NASA's Terra satellite as it approached the Caribbean on September 7, 2017
Image: *LANCE Rapid Response / NASA / GSFC*



Enrico Gobbetti sent in this fascinating Meteor M2 image that he acquired at 09:43 UT on September 10,2017, showing cloud vortices around the Canary Islands.

# Using Facebook Intelligently

***Les Hamilton***

It's well known that there is a vast quantity of ephemera, drivel and downright trash peddled on Facebook. **But the platform does have its serious side, and many highly respected organisations now use Facebook to showcase their activities**. The table below includes a list of sites that GEO Members should find really interesting and informative.

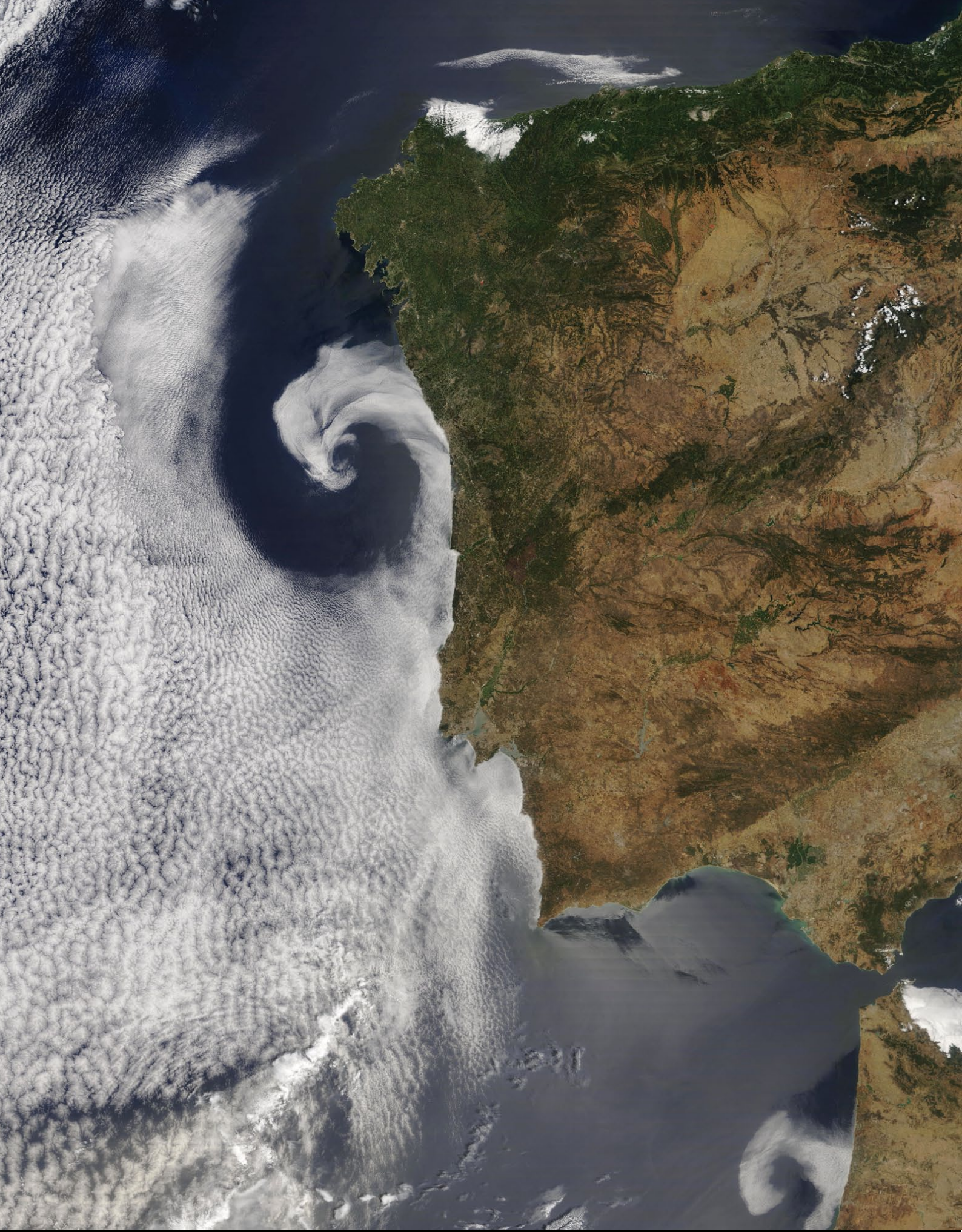
I do not have a personal Facebook page myself, so to be able to access sites of interest, I have created a 'dummy' Facebook account, under an assumed name, and using a temporary email address that I have since deactivated.

No-one can bombard me with trivia, nor try to 'Friend' me, as my own name will not bring up a Facebook entry. Also, since I have deactivated the email address, I do not get bombarded by messages from Facebook.

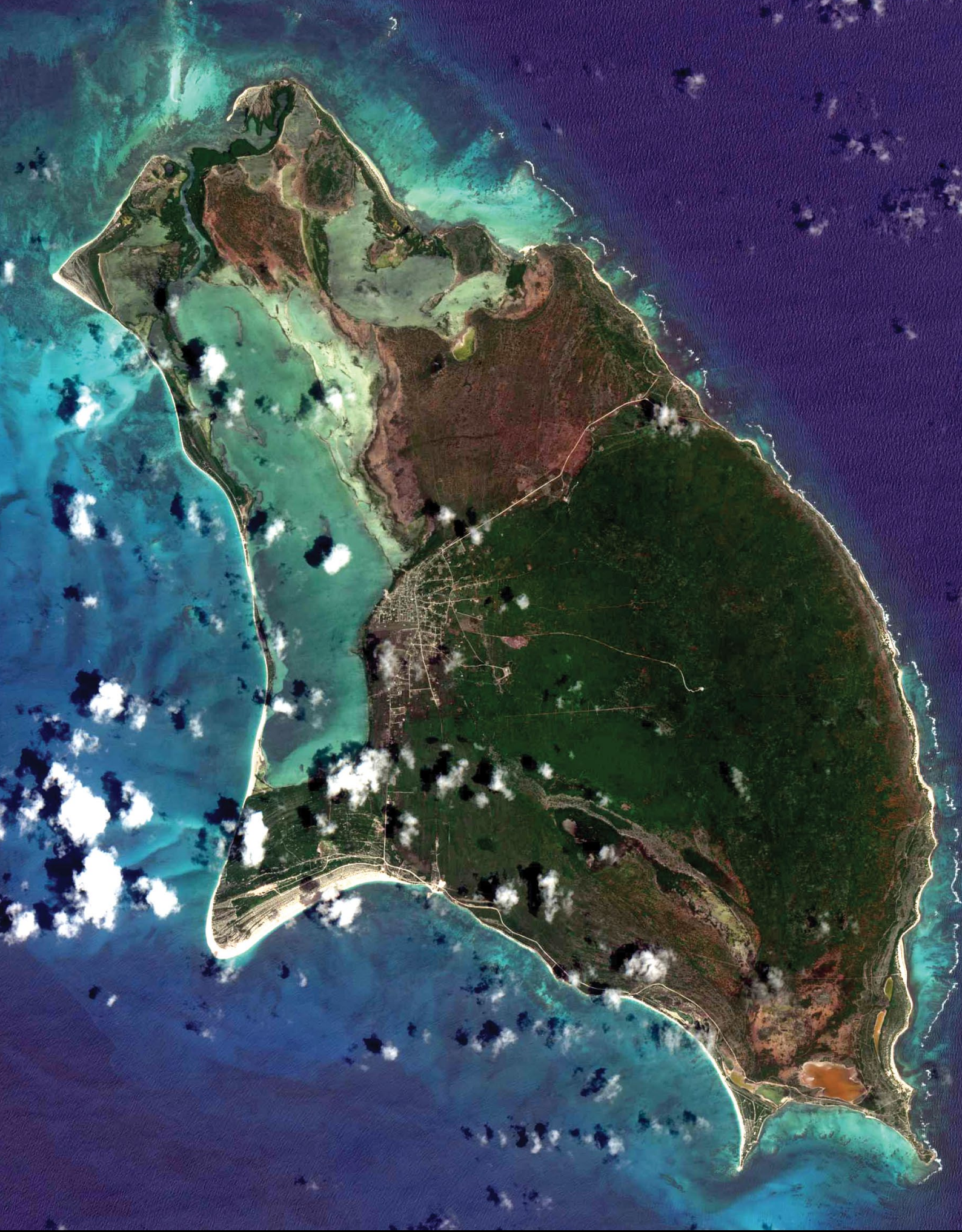
Having accomplished this, I still need to use the email address and username under which I created my 'dummy' account to sign into Facebook before browsing the many interesting Facebook Sites out there.

GEO Members are encouraged to post links to pages of interest that fall under GEO's umbrella of interest, on GEO's own Facebook page.


| | |
|---|---|
| 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/ |
| NOAA | https://www.facebook.com/NOAA/ |
| UK Space Agency | https://www.facebook.com/spacegovuk/ |
| Werkgroep Kunstmanen | https://www.facebook.com/kunstmanen |



On July 16, 2017, NASA's **Terra** satellite captured this image of a mid-latitude (extratropical) cyclone off the coast of Portugal. In the vicinity of the Iberian Peninsula, these systems are relatively slow-moving and tend to be poorly developed in summer: they often form clouds without any precipitation. In contrast, fast-moving systems dominate in winter when they are more developed and often linked to heavy rain and strong winds.
*Image: LANCE Rapid Response/NASA/GSFC*



The Caribbean island of Barbuda was images by ESA's Sentinel 2A satellite on August 30, 2017, prior to being struck by Hurricane Irma
*Image: Modified Copernicus data © ESA / Sentinel (2017)*

# 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 | 137.1000 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**

## Ayecka-SR1 DVB-S2 VCM USB Receiver

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

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


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

## NEWSKY RTL2832U/R820T2 SDR DAB USB MCX Socket Special Dongle

for reception of NOAA APT and Meteor M2 LRPT


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

This stick does not come with SDR software or instructions.

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

## TechniSat SatFinder Antenna Alignment Meter


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

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

## GEO Quarterly - Back Issues

(Only available to GEO Members)



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

**UK members price - £3.80**

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

**UK members price - £8.00**

## Current Price List

| | Members' Prices | | | Prices for non-Members | | |
|---|---|---|---|---|---|---|
| | UK | EU | RoW | UK | EU | RoW |
| Ayecka SR1 DVB-S2 Receiver | 375.00 | 385.00 | 390.00 | --------- | --------- | --------- |
| Edimax USB 2.0 Fast Ethernet Adapter | 15.00 | 17.00 | 18.00 | --------- | --------- | --------- |
| DVB-S USB 2102 Receiver | 60.60 | 67.00 | --------- | 70.60 | 77.00 | --------- |
| SDR Dongle kit for APT/LRPT | 20.00 | 25.00 | 26.00 | --------- | -------- | -------- |
| Technisat Satfinder Alignment Meter | 26.50 | 29.50 | --------- | 29.50 | 32.50 | --------- |
| GEO Quarterly Back Issues (subject to availability) | 3.80 | 4.60 | 5.60 | n/a | n/a | n/a |
| GEO Quarterly (PDF on CD) 2004-2016 (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.

## 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**