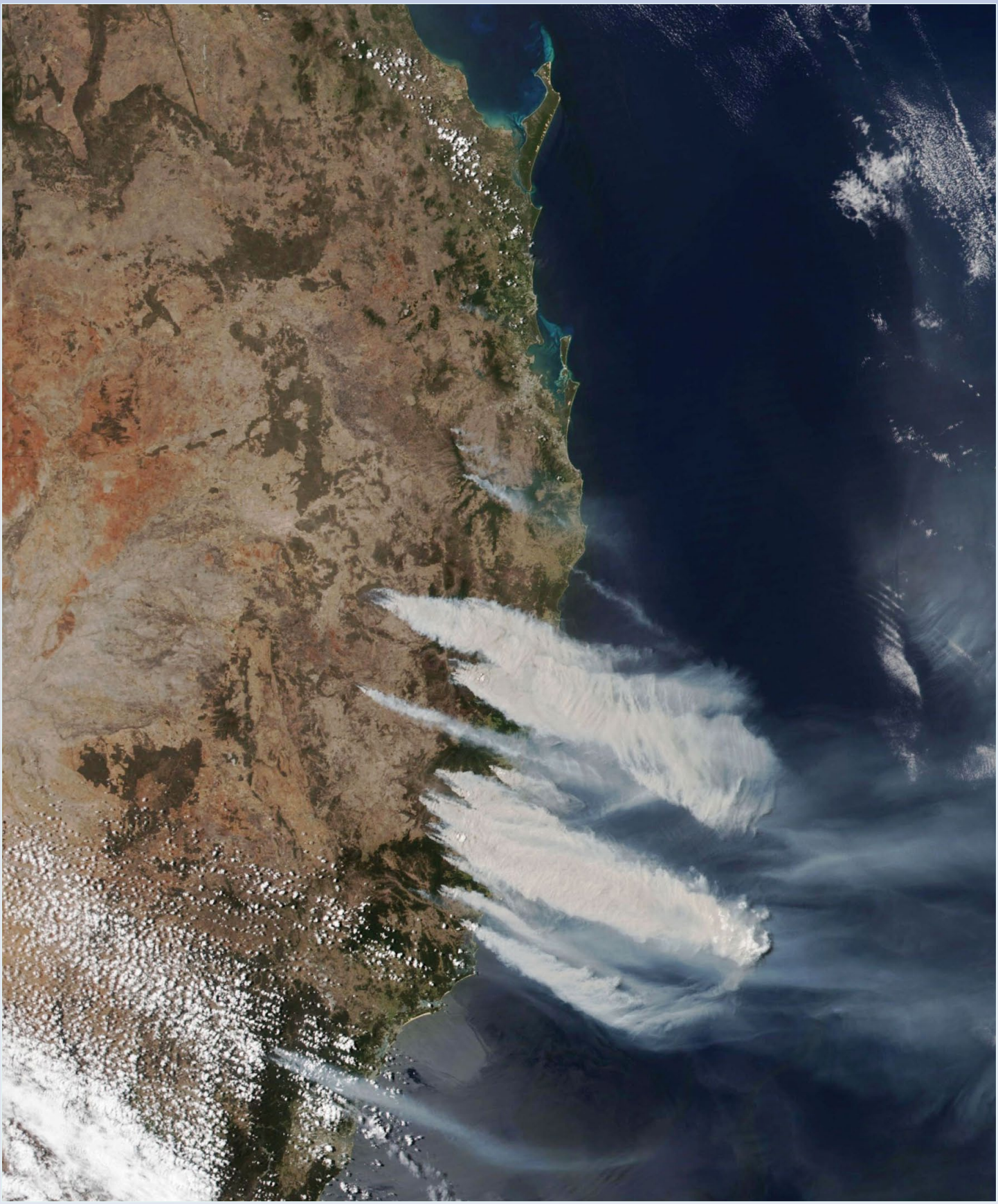
GEO Newsletter

Group for Earth Observation

Group for Earth Observation No 64 - December 2019



Smoke plumes from bush fires in New South Wales, Australia were imaged by the NOAA-NASA Suomi NPP satellite on November 8, 2019
Image: NASA

Useful User Groups

Weather Satellite Reports

This group provided weekly reports, updates and news on the operational aspects of weather satellites.

https://groups.io/g/weather-satellite-reports

SatSignal

This end-user self help group is for users of David Taylor's Satellite Software Tools, including the orbit predictor WXtrack, the file decoders GeoSatSignal and SatSignal, the HRPT Reader program, the remapper GroundMap, and the manager programs - MSG Data Manager, GOES-ABI Manager, AVHRR Manager etc.

https://groups.io/g/SatSignal

MSG-1

This forum provides a dedicated area for sharing information about hardware and software for receiving and processing EUMETCast data.

https://groups.io/g/MSG-1

GEO-Subscribers

This is the official group is for subscribers of the Group for Earth Observation (GEO), aimed at enthusiasts wishing to exchange information relating to either GEO or Earth Observation satellites.

https://groups.io/g/GEO-Subscribers/

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Group for Earth Observation

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Visit GEO on facebook and link to dozens of news items from NOAA, NASA, ESA, EUMETSAT and much more ...

http://www.facebook.com/groupforearthobservation

From the Editor

Les Hamilton

Since the September Newsletter, GEO's Internet Forum has left **YAHOO Groups** and moved to a new provider, **Groups IO**. All members of the forum, and all previous posts, have been transferred to our new Group, which you can access at the following URL

https://groups.io/g/GEO-Subscribers/

The most recent posts are available at

https://groups.io/g/GEO-Subscribers/topics

Groups.IO operates similarly to Yahoo Groups but offers several new features which you are encouraged to explore from its website. In particular, images and documents can now be incorporated directly in posts as attachments, a feature that has already proved popular with contributors.

On page 7 Francis Bell explains plans for a new visit to EUMETSAT during July 2020. A hoped-for visit in 2019 failed to take off, much to the disappointment of many interested parties who had failed to register their interest. We at GEO have to shoulder the blame for this: because we did not stipulate a closing date for registrations it was decided that the numbers involved were insufficient for a viable visit. The 2020 visit is being organised by Werkgroep Kunstmanen, GEO's sister organisation in The Netherlands, and GEO members are welcome to participate.

It does take time to organise a programme of events with EUMETSAT and ESOC, so we are stipulating that, if you wish to participate, UK readers should inform Francis Bell by March 31, 2020 at the latest (and preferably sooner if practical). GEO will then liaise with Werkgroep Kunstmanen in making final arrangements.

Please remember that contributions from readers detailing their activities are always welcome, by email, to the editor at

geoeditor@geo-web.org.uk

Contents

The GEO Report

Francis Bell

When GEO was first established in November 2003, the decision was made to operate within the structure of a UK Limited Company. The reason for this was that some of our planned activities such a selling electronic equipment, could, in extreme cases involve safety issues: hence the umbrella of a company to take responsibility rather than an individual was judged a sensible approach. I have just renewed GEO as a limited company even though currently our turnover of equipment is close to zero. With an existing company structure in place it seems appropriate to continue with this structure for the time being. The renewal fee to Companies House is only £13 a year. As a consequence of this decision I will have to submit to Companies House our annual accounts for 2019. However, because of our recent much reduced financial turnover, I will do the accounting myself, hence there will be no charge to GEO when submitting these accounts. I will try to publish the accounts in the next Quarterly Newsletter. A statement of our current position is that we have about £8,600 in the bank with only very small commitments in the coming year.

One suggestion that has been made to me is that we use some of our bank balance to subsidise a GEO visit to EUMETSAT and ESOC in Darmstadt next year. No decision has been made but it would be interesting to receive feedback relating to this suggestion. Responses by email, please, to

francis@geo-web.org.uk

It has been very encouraging to learn about the developments at Dundee. The University of Dundee has for many years received public funding for their weather satellite project, enabling public access to their ever growing catalogue of satellite images. However, my understanding is that the public funding via NERC has been withdrawn, hence Dundee University has had to close their original project which has now been adopted by a voluntary group, but still using some of the established equipment on a new site in Errol, just west of Dundee.

The photograph below shows some of the equipment being transferred. A new company has been established called **Dundee Satellite Station Ltd**., which is currently looking after the equipment and progressing the necessary planning consent and *OfCom* licence for the new site. I think it's great that the Dundee project is to continue and I offer my congratulations to all those involved in this extended project.

Some of the Dundee University satellite project equipment being dismantled ready for removal to the new site at Errol.
Photo: Dundee University

Quarterly Question

Francis Bell

My thanks to those readers who responded to **Quarterly Question 63** and for their supportive comments regarding the interest they have in our regular Earth observation question. The answer to the question, which was to name the island shown in the satellite image, was 'Gran Canaria'. The text of the question did say it was an island in the Canaries group but the issue was to identify the individual island. The shape of the island was a specific clue because other islands in the group have irregular shapes whereas Gran Canaria is almost round in coastal outline, just as you might expect from a volcano pushing out of the deep ocean floor.

The answer to the additional question about the name of this island group is explained in the following extract from *Wikipedia*, the point being that the islands have nothing to do with canaries but are more related to dogs.

> The name *Islas Canarias* is probably derived from the Latin name *Canariae Insulae*, meaning 'Islands of the Dogs', a tern that was applied only to Gran Canaria. According to historian Pliny the Elder, the Mauretanian king Juba II named the island Canaria because it contained 'vast multitudes of dogs of very large size'.
>
> Alternatively, it is said that the original inhabitants of the island, Guanches, used to worship dogs, mummifying them and treating them as holy animals. Some hypothesise that this dog-worship was closely connected with the ancient Egyptian cult of the dog-headed god Anubis. Other theories speculate that the name comes from the Nukkari Berber tribe living in the Moroccan Atlas, named in Roman sources as Canarii.

The connection to dogs is retained in their depiction on the Canary Islands' coat-of-arms.

It is considered that the aboriginals of Gran Canaria called themselves '*Canarios*'. It is possible that ,after being conquered, this name was pluralised in Spanish to refer to all of the islands as the Canarii-as.

What is certain is that the name of the islands does not derive from the canary bird; rather, the birds are named after the islands.

continued overleaf ...

The Quarterly Question image of an island located in the Persian Gulf.

Quarterly Question 64

The Quarterly Question this time is based on the image shown on page 5. The question is straight forward: '**Name the island shown in the right-hand half of the image**'.

The orientation of the image is geographically conventional with north at the top: and for scale, the island stretches about 40 kilometres from north to south.

My interest in this island was generated by my casual researches into the exact location of the country of Qatar. In October 2019, the world Athletic Championships were held in Qatar, and although I knew approximately the location of the country I thought I would look up some of my archived satellite images of the area and perhaps even identify the athletics stadium where the championships were being held.

During this search I came across this image—with Qatar just outside the frame to the east—but showing an adjacent island in the Persian Gulf on which I had set foot a number of times! My times on this island were brief as it was just a short stop-over for aircraft refuelling during flights from the UK to Goa, India (which nowadays can be done nonstop). I never stayed on the island to experience its popular holiday water-related accommodation which can be seen as small horseshoe arcs at the bottom right of the island image.

Just to confirm the question: **Name the island (country) shown in the satellite image**. The island is located in the Persian Gulf with the state of Qatar not far away.

Postscript.

The island has been in the news recently on BBC TV because of the strategic importance of a UK naval base there, with the navy currently patrolling the international shipping lanes in the Persian Gulf because of the current oil disputes.

Answers to

francis@geo-web.org.uk

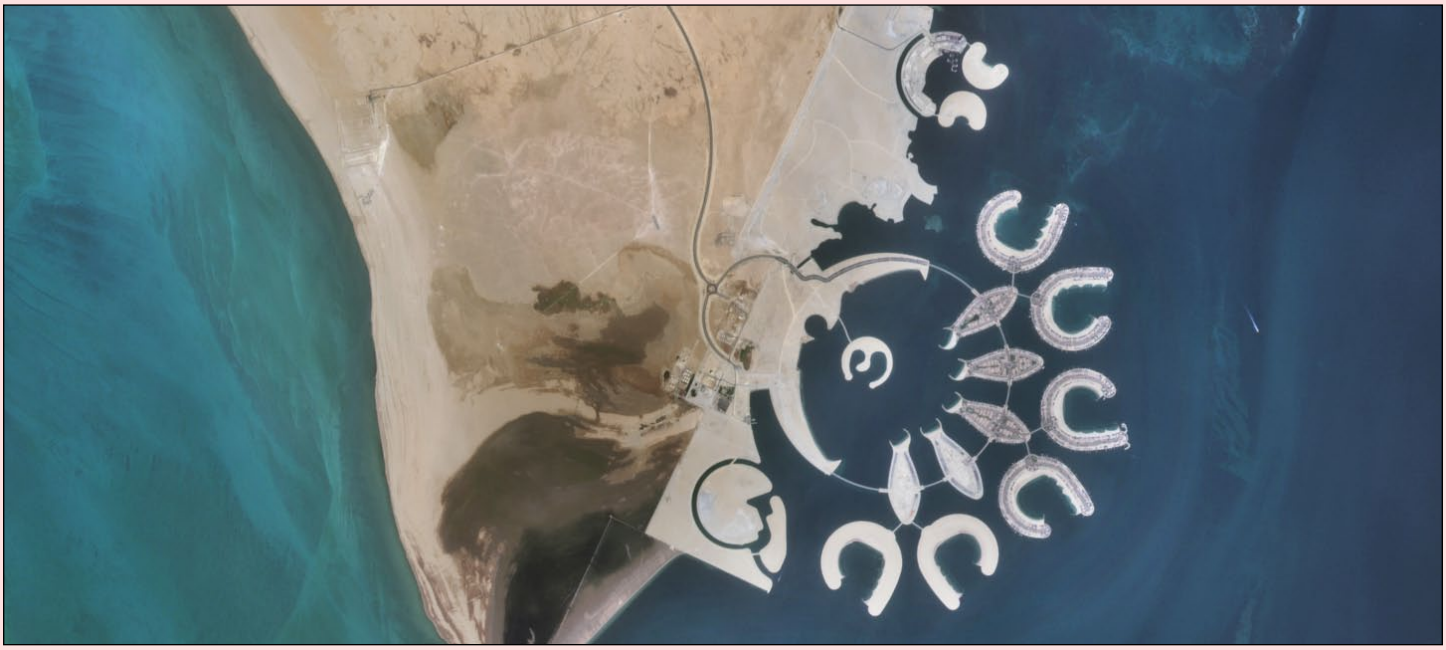
or to

francis@francisbell.com

by February 25, 2010.

Extra

Purely as a matter of interest, a close-up segment from the above ESA Copernicus image, showing the horseshoe arcs referred to above, is reproduced below.



Tahiti

This image from the EU Copernicus Sentinel-2 mission pictures the Pacific island of Tahiti in French Polynesia.

Made up of two ancient volcanic cones, Tahiti Nui and Tahiti Iti, connected by the Isthmus of Taravao, it is surrounded by coral reefs and is home to French Polynesia's capital, Papeete.

Darmstadt Visit 2020

Francis Bell

In collaboration with our Dutch friends, **Werkgroep Kunstmanen**, it is intended to organise a combined visit of both GEO and Werkgroep members to the headquarters of EUMETSAT and ESOC, both located in Darmstadt, Germany. The dates agreed for this venture are the 2nd and 3rd July, 2020.

At the time of writing this notice, no specific agenda for the visit has been fixed but, if it's similar to our previous events, it will consist of a visit to each of the Headquarter buildings, which will include some local staff presentations on topics relevant to our amateur user groups. We may even have the chance to ask about technical issues, which would be useful information relating to EUMETSAT's and ESA's future plans.

The current expectation is to spend the first full day, July 2, visiting EUMETSAT HQ, then half of the following day at ESOC. Visits to other establishments have not been fixed but may be possible; realistic suggestions would be welcome. Perhaps we can use any spare time for our own GEO and Werkgroep Kunstmanen presentations and business.

The above visits are mainly free of charge but there may be minor costs for making local arrangements. But the cost to an individual should not be more than 10 or 20 euros. However, all travel and accommodation costs are the responsibility of the individual member.

In order to confirm the above arrangements and make it worthwhile, I consider that we need a group size of about 20 (or more) from the UK. If you are interested in taking part in this visit as a member of the GEO contingent, please register your interest via a brief email to

francis@francisbell.com

no later than March 31, 2020, and you will be sent information about hotels in Darmstadt where our group could be staying for one or two nights. This will enable me to liaise with Werkgroep Kunstmanen, who are the prime movers in this venture.

Note that a registration at this stage is not a total commitment on your part but will give the organisers an idea of the scale of the event.

As soon as our group size reaches about 20 or more we can be more specific about wishes in our consultations with EUMETSAT and ESOC.

The EUMETSAT Headquarters Building
Photo: Rob Alblas

Delegates pictured outside EUMETSAT's Darmstadt HQ in July 2015.
Photo: David Taylor

Antennas at Usingen
Photo: Ruud Jansen

Stop Press: A draft Agenda for July 2 at EUMETSAT HQ appears on page 8

EUMETSAT

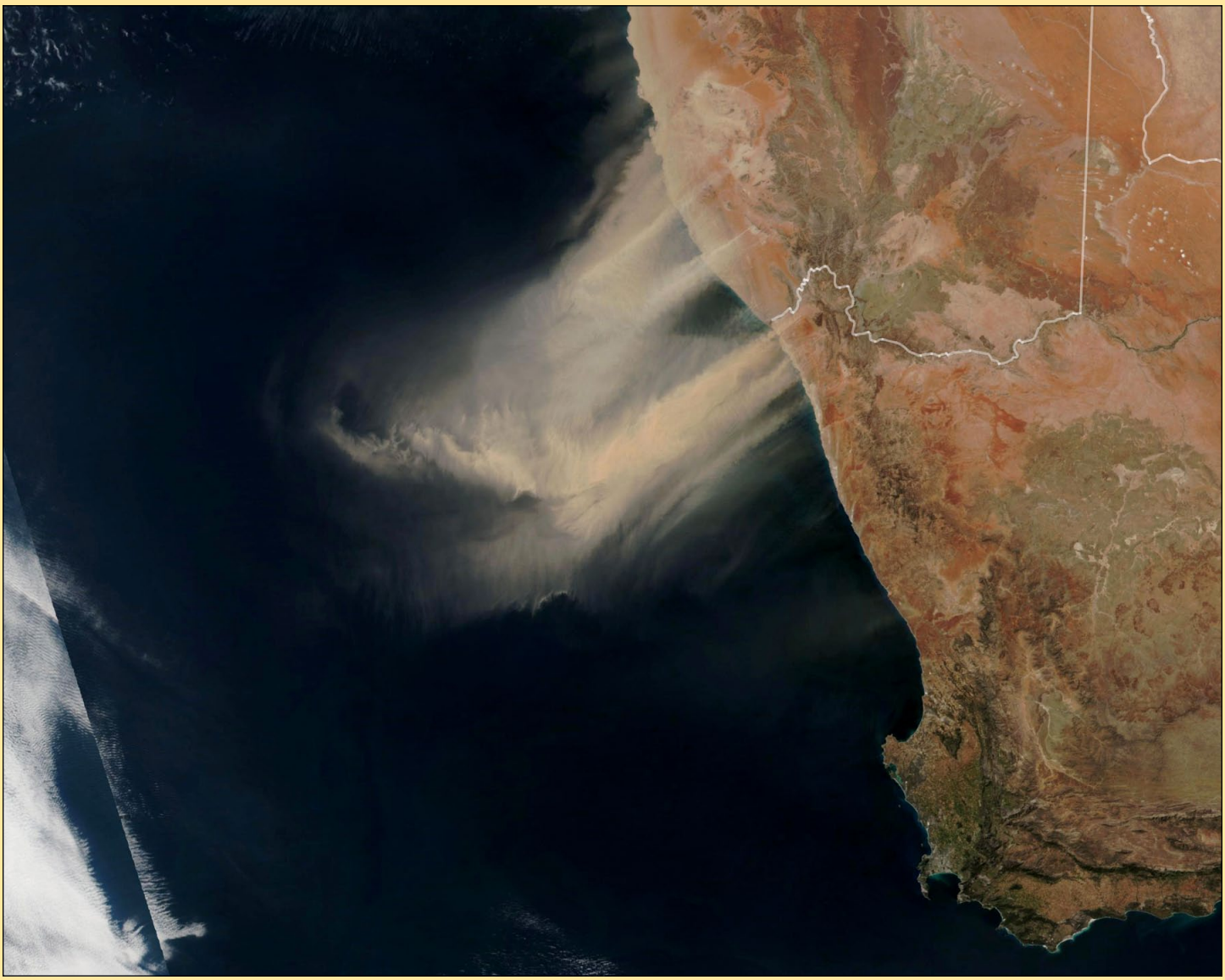
Visit of the Group for Earth Observation
Agenda

2 July 2020
EUMETSAT Briefing Gallery
09:00 – 17:00

	Registration as of 08:30	
09.00-09.05	**Welcome address**	
09:05-09:15	**Overview of Current Satellite Operations**	
09:15-9:45	**Overview of the MTG Mission**	
09:45-10:15	**Overview of the EPS-SG Mission**	
10:15-10:30	**User Preparation for MTG and EPS-SG**	
10:30-10:50	*Coffee break*	
10:50- 11.30	**Data Access Evolution – EUMETCast**	
11:30-12:00	**Data Access Evolution – New Data Services**	
12.00-13:30	*Group Photo and Lunch break*	
13:30-15:00	**Data Reception Systems**	Presentation by GEO
15:00-15:20	*Coffee Break*	
15:20-15:35	**Update on User Service Activities**	
15:35-16:10	**Presentation of selected case studies**	
16:10	**Wrap-up**	
16:15-17:00	**Tour of EUMETSAT Mission Control Centre**	

Dust Storm in Southern Africa

NASA Earth Observatory



the NOAA-NASA *Suomi NPP* satellite imaged this dust plume on September 25, 2019.

People in coastal towns along the west coast of southern Africa watched skies turn red on September 25, 2019. A fierce wind picked up and carried huge plumes of sand and dust westward toward the Atlantic Ocean.

The plumes were observed that day at 12:25 UT by the Visible Infrared Imaging Radiometer Suite (VIIRS) on the NOAA-NASA *Suomi NPP* satellite. The event covered a wide area north and south of the Orange River, which forms part of the border between Namibia and South Africa.

The *South African Weather Service* reported that the winds lofted enough particles into the air to produce moderate to poor visibility. Indeed, photographs from people in Alexander Bay show dark, hazy skies and streets that are barely visible. According to news reports, aircraft were unable to land at nearby airports.

The amount of dust lofted from land in the Southern Hemisphere is negligible compared with that of the Northern Hemisphere. Africa's Sahara Desert, for example, is one of the world's major dust sources. Still, when winds blow over dry areas of the Southern Hemisphere, dust storms can be fierce. A similar scene unfolded in October 2018, when a thick, narrow plume streamed from the same area.

NASA Earth Observatory image by Lauren Dauphin, using VIIRS data from NASA EOSDIS/ LANCE and GIBS/Worldview, and the Suomi National Polar-orbiting Partnership.

Story by Kathryn Hansen.

Lake St. Clair

European Space Agency

Lake St Clair, imaged by Copernicus Sentinel-2 mission on March 26, 2019.

The Copernicus Sentinel-2 mission takes us over Lake St Clair, forming the border between Ontario, Canada to the east, and Michigan, US to the west.

The Saint Clair River is visible at the top of the image and flows southwards, connecting the southern end of Lake Huron with Lake St. Clair, visible in the centre of the image. The river branches into several channels before reaching the lake, creating a seven-mouth delta. Much of the area surrounding the delta is used for agriculture.

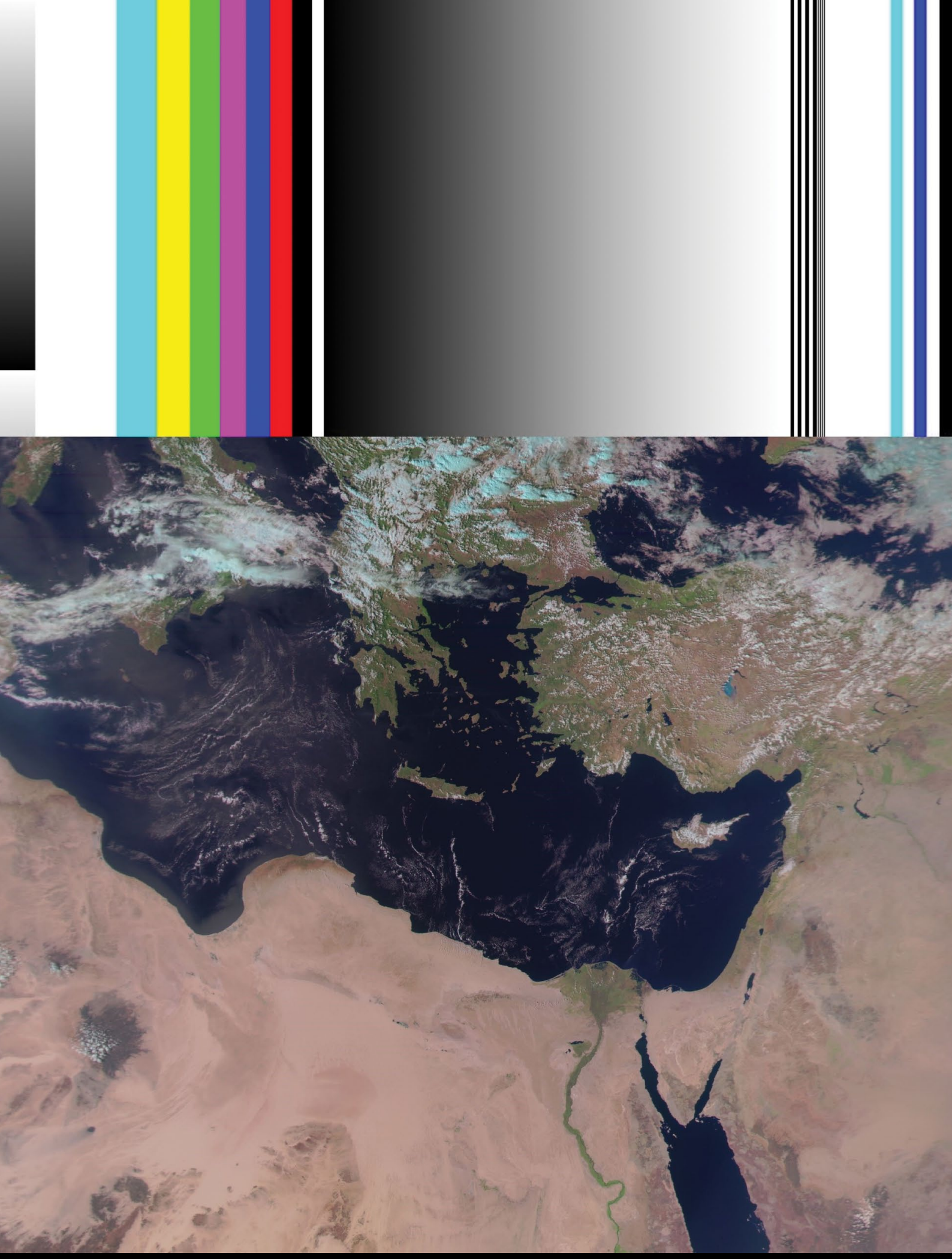
The Thames River, visible east of the lake, begins in a swampy area of Ontario before emptying its muddy waters into Lake St. Clair. Here the murky-coloured waters mix with the turquoise waters from the Saint Clair River, creating the fusion of colour visible in the heart-shaped lake. The waters then exit the lake via the Detroit River.

Lake St Clair is approximately 40 kilometres long and 40 km wide, with an average depth of around three metres. The lake is a popular site for fishing and boating and more than 100 species of fish inhabit the lake, including walleye, rainbow trout and muskellunge.

Detroit, the largest city in Michigan, is visible directly above the Detroit River. The city lies on a relatively flat plain and the extensive network of roads in the city are clearly visible in the image.

Detroit is nicknamed the ‘Motor City’, as it was the key hub for American auto-manufacturing for over a century. It was also home to the first mile of concrete highway, the first four-way three-colour traffic light and the world’s first urban freeway.

In this wintery image, captured on March 26, 2019, many of the frozen lakes northwest of Lake St Clair can be seen partially frozen over. The Copernicus Sentinel-2 mission allows inland bodies of water to be closely monitored.



On September 26, 2019, this northbound pass of Meteor M2-2 was interrupted by the transmission of a ‘Test Card’ image.
Thanks to Enrico Gobbetti for forwarding this unusual image.

Rifting and Calving on the Amery Ice Shelf

NASA Earth Observatory

Story by Kathryn Hansen.

The last time a major iceberg calved from East Antarctica's Amery Ice Shelf, there were no satellites poised to document the event. Scientists in the 1960s relied on aircraft, ships and land-based studies to survey the ice shelf and its progeny. Now, more than half a century later, satellites have captured riveting space-based views as another huge 'berg has broken away from the shelf.

The images opposite, acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on NASA's *Aqua* and *Terra* satellites, show the iceberg on three relatively cloud-free days during September 2019. The iceberg, named D-28, measures 1636 square kilometres, about the same area spanned by the city of Houston.

For ice shelves and glaciers that reach the ocean, calving is part of the natural cycle of advance and retreat. Compared to melting, the fastest way for glaciers to lose mass to the ocean is through rifting and the subsequent calving of icebergs. But there are still plenty of unknowns about how ice shelves and icebergs work. How do factors like waves, winds, melting from the shelf's underside, and even the structure of the ice, contribute to a calving event?

Scientists working to answer these questions face a basic challenge: calving events are hard to observe. They happen infrequently and in remote locations. And if you try to make observations from the surface, there's the hazard of getting too close to an event with such explosive energy.

NASA snow and ice scientist Catherine Walker, and colleagues Helen Fricker (Scripps/UCSD) and Jeremy Bassis (University of Michigan), have taken another approach. They use satellite data to study the large systems of rifts that propagate across ice shelves as a precursor to calving. Over the past 20 years, rifts at Amery have been the most active—growing faster and more continuously than any other ice shelf around Antarctica.

Walker, Fricker, and Bassis originally focused on an area of ice called the 'loose tooth'. You can see this segment in figure 1; it appears to have a tenuous connection to the shelf, given its location between two large rifts. But the scientists eventually moved their attention west of the 'loose tooth', where one of the rifts had picked up speed. They described their findings in a 2015 paper in the Journal of Glaciology.

"*So, we thought, maybe this side will go first*," Walker said, which is exactly what happened

... concluded on page 13

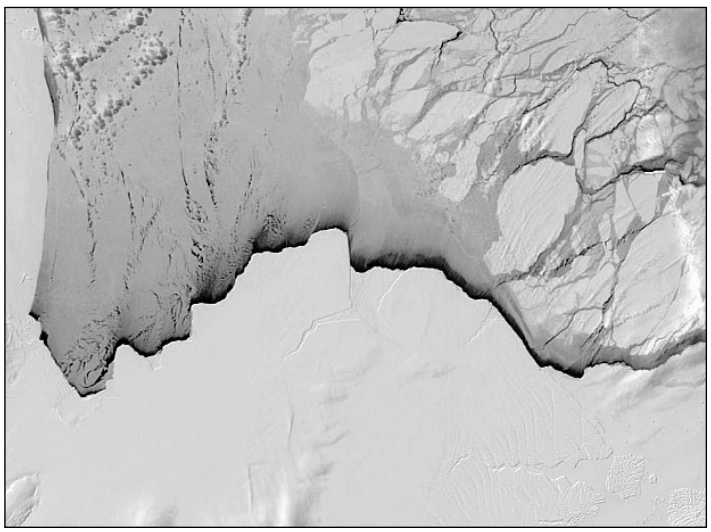


Figure 1 - September 13, and a thin crack across the ice betrays the imminent calving of D28

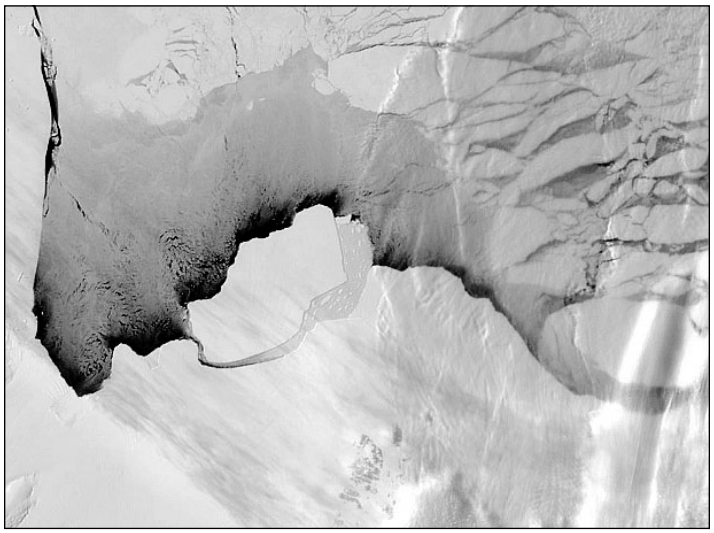


Figure 2 - September 23, with D23 already free from the ice shelf

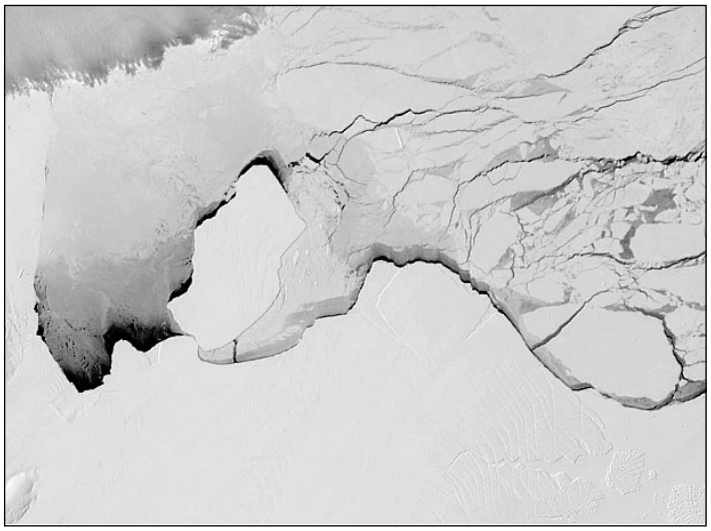


Figure 3 - September 30, with D23 now well clear of the ice shelf

NASA Earth Observatory images by Lauren Dauphin, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview.

when D-28 broke away. "*It's still quite surprising how fast it went, though; the three of us have been looking at it often—most recently in April 2019—and we didn't foresee that it would be gone by October.*"

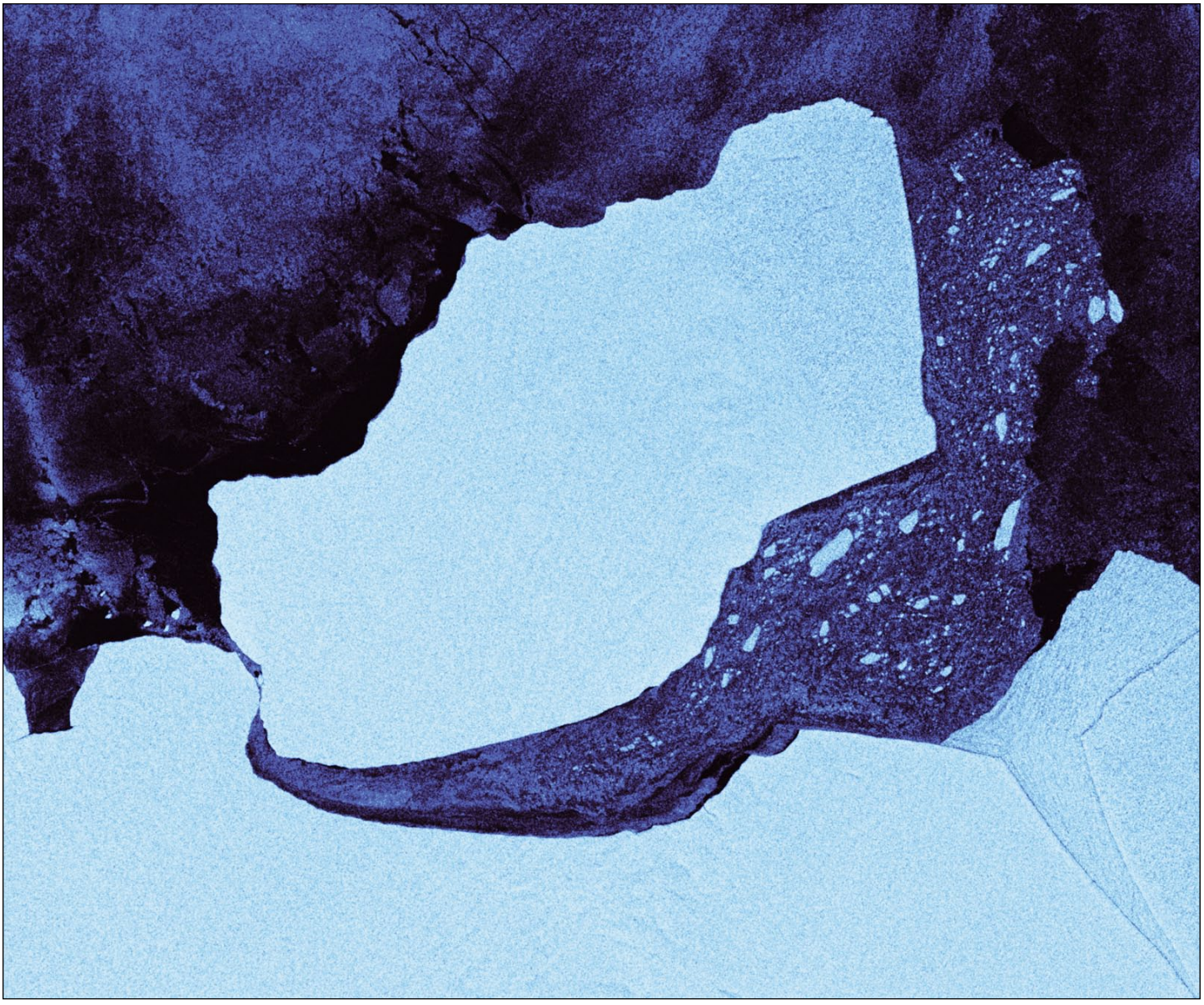
The latest calving event provides more observations for the researchers to study. Analysis of D-28, combined with continued monitoring of the rifts, could help them better understand the factors leading to the creation of new icebergs, as well as what happens afterwards.

'*East Antarctica is a place often thought to be pretty stable and less affected by warming ocean and atmosphere trends," Walker said. "It will be interesting to compare calving events and see what this latest event tells us, and how that might be informative of what's starting to happen in East Antarctica.*'

Sentinel-1 Images the Amery Calving Event

European Space Agency

The huge iceberg, dubbed D28, that broke off the Amery Ice Shelf in Antarctica, has an area of around 1600 square kilometres—about the size of Greater London. Approximately 30 km wide and 60 km long, it is estimated to weigh over 300 billion tonnes. Captured by the Copernicus Sentinel-1 mission, the radar image below shows the scene after the berg broke away. It is estimated to have calved from the Amery Ice Shelf between September 22 and 25. Scientists state that this is the biggest calving from the Amery Ice Shelf in 50 years. Satellites will continue to monitor and track the iceberg, as it poses a threat for ships in the vicinity.



A Pulse of Water for Lake Powell

NASA Earth Observatory

Story by Michael Carlowicz.

Heavy snowfall in the Rocky Mountains during winter and spring 2019 provided a much-needed pulse of meltwater into Lake Powell, the second largest reservoir (by maximum water capacity) in the United States. Still, the effects of long-term droughts and rising air temperatures, combined with increasing demands for water in the American Southwest, mean that the lake is still nowhere near its highs from the 1980s and 90s.

Lake Powell stretches across southeastern Utah and northeastern Arizona. Water managers first started filling the reservoir in 1963 when the Glen Canyon Dam was completed along the Colorado River. By the mid-1980s, the lake approached its full capacity. Water levels dropped due to drought and then rose again in the late 1990s. Lake levels have been mostly dropping over the past 20 years, punctuated by a few strong water years like 2019.

Figure 1, acquired by the Thematic Mapper on the Landsat 5 satellite on April 20, 2012, when then lake was near its highest spring level since 2000 following abundant of precipitation in 2011. Figure 2 was acquired by the Operational Land Imager on Landsat 8 on May 2, 2019. A second Landsat 8 image dating from August 31, 2019, shows the lake near its peak level for this year.

As of September 29, 2019, the water elevation level at Glen Canyon Dam was 3615.49 feet, and the lake stored 13.29 million acre-feet (maf) of water, about 55% of capacity but more than 100 feet below 'full pool'. On May 1, 2019, before the abundant snow cover started melting, the lake stood at 3584.65 feet and held 10.34 million acre-feet of water. In May 2012 (comparison image), Lake Powell stood at 3636.83 feet and held 15.63 maf. (One acre-foot equals about 326,000 gallons.)

Snow arrived late in the 2018-19 winter, but when it did, it was heavy and frequent. Spring temperatures in the Rocky Mountains remained cooler than normal, keeping snow cover from melting quickly. A major snowfall in late June in Colorado raised snow water equivalents—a measure of the amount of water in the snowpack on the mountains—to 40 times the June norm in the state. The Upper Colorado River basin as a whole reached snow water equivalent levels about 130% of the long-term median.

Figure 1 - Lake Powell on April 20, 2012

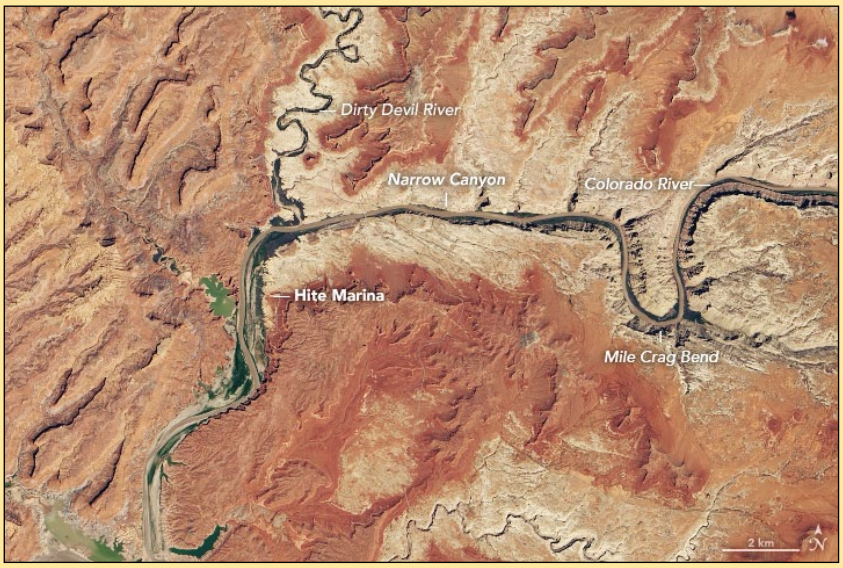
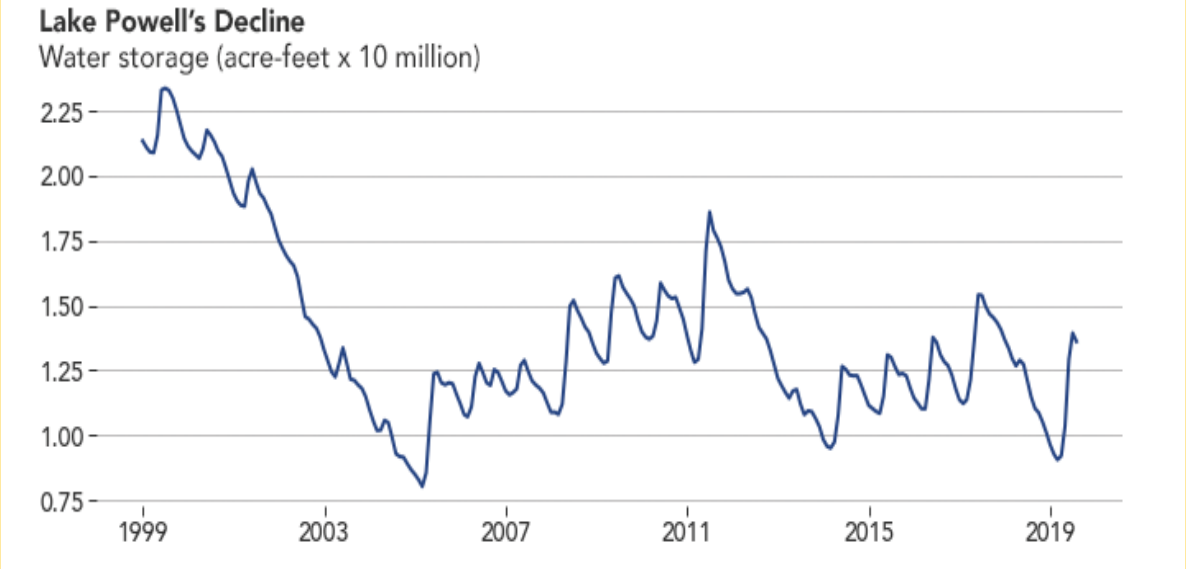


Figure 2 - Lake Powell on May 2, 2019

Figure 3 - Lake Powell on August 31, 2019



The abundance of snow in 2019 ended a severe drought that kept water flows into the river at 43% of normal in 2018. According to the *US Bureau of Reclamation* (USBR), which manages Lake Powell, 'the total water year 2019 unregulated inflow to Lake Powell is projected to be 13.19 million acre-feet (122% of average).'

January 1999 - August 2019

The boom in 2019 will help to stabilise water storage in the lake. However, it will take several more years of abundant snow and rain to offset the steady decline since 1999, as shown in the graph above. Lake Powell was around 94% capacity in 2000. It sank to an all-time low in 2005.

USBR reported in September 2019:

> *'During the 19-year period 2000 to 2018, the unregulated inflow to Lake Powell, which is a good measure of hydrologic conditions in the Colorado River Basin, was above average in only four out of the past 19 years. The period 2000-2018 is the lowest 19-year period since the closure of Glen Canyon Dam in 1963, with an average unregulated inflow of 8.54 maf, or 79% of the 30-year average (1981-2010). (For comparison, the 1981-2010 total water year average is 10.83 maf.)'*

A century of river flow records and several centuries of tree-ring data show that there is some precedent for the dry years of the past few decades: extended droughts have been part of the long-term climate variability of the American Southwest. However, global warming is expected to make droughts more severe. For a long view, see the Earth Observatory feature 'World of Change: Water Level in Lake Powell', which documents changes in lake levels each spring since 1999 at this URL

https://earthobservatory.nasa.gov/world-of-change/LakePowell

NASA Earth Observatory images by Lauren Dauphin and Joshua Stevens, using Landsat data from the U.S. Geological Survey and water storage data from the Bureau of Reclamation.

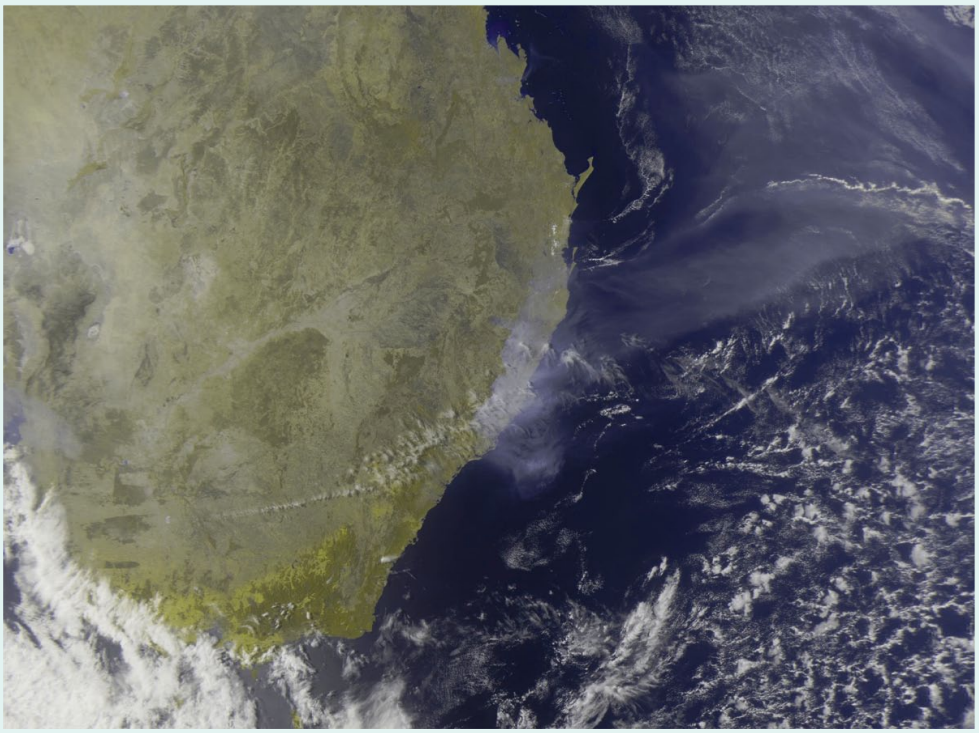
Meteor M2-2 shows Australian Bushfires

Chris van Lindt

I took this image from Meteor M2-2 on November 11, which clearly shows the smoke plumes arising from the bush fires in Northern New South Wales/Southern Queensland.

Here in Brisbane we can also clearly see the smoke haze and even the smell of the fire.

The smoke trail is drifting hundreds of kilometres to the East and according to reports, it can be seen from New Zealand!



2019 Ozone Hole is the Smallest on Record

NASA Earth Observatory

Story by Ellen Gray, NASA Earth Science News Team.

Abnormal weather patterns in the upper atmosphere over Antarctica dramatically limited ozone depletion in September and October 2019, resulting in the smallest ozone hole since 1982, NASA and NOAA scientists reported.

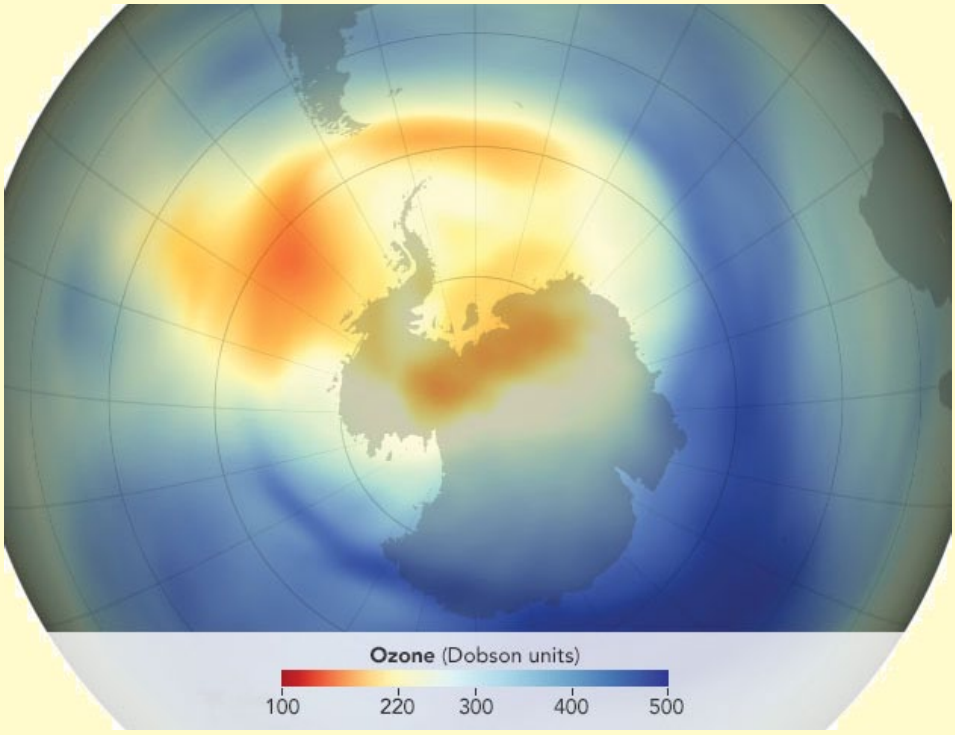
The annual ozone hole reached its peak extent of 16.4 million square kilometres on September 8, 2019, and then shrank to less than 10 million km^2 for the remainder of September and October. During years with normal weather conditions, the ozone hole typically grows to a maximum area of about 20 km^2.

"*It's great news for ozone in the Southern Hemisphere*," said Paul Newman, chief scientist for Earth Sciences at NASA's Goddard Space Flight Center. "*But it's important to recognize that what we're seeing this year is due to warmer stratospheric temperatures. It's not a sign that atmospheric ozone is suddenly on a fast track to recovery*."

NASA and NOAA monitor the ozone hole via complementary instrumental methods. NASA's *Aura* satellite, the NASA-NOAA *Suomi NPP* satellite, and NOAA's J*PSS NOAA-20* satellite all measure ozone from space. *Aura's* Microwave Limb Sounder also estimates levels of ozone-destroying chlorine.

At the South Pole, NOAA staff launch weather balloons carrying ozone-measuring sondes, which directly sample ozone levels vertically through the atmosphere. Most years, at least some levels of the stratosphere are found to be completely devoid of ozone.

"*This year, ozonesonde measurements at the South Pole did not show any portions of the atmosphere where ozone was completely depleted,*" said atmospheric scientist Bryan Johnson at NOAA's Earth System Research Laboratory.



The Ozone Hole on September 8, 2019
NASA Earth Observatory image by Joshua Stevens, using data courtesy of NASA Ozone Watch

This is the third time in the past forty years that weather systems have caused warm temperatures that limit ozone depletion, stated NASA Goddard atmospheric scientist Susan Strahan. Similar weather patterns in the Antarctic stratosphere produced small ozone holes in September 1988 and 2002.

"It's a rare event that we're still trying to understand," said Strahan. "If the warming hadn't happened, we'd likely be looking at a much more typical ozone hole."

There is no identified connection between the occurrence of these unique patterns and changes in climate.

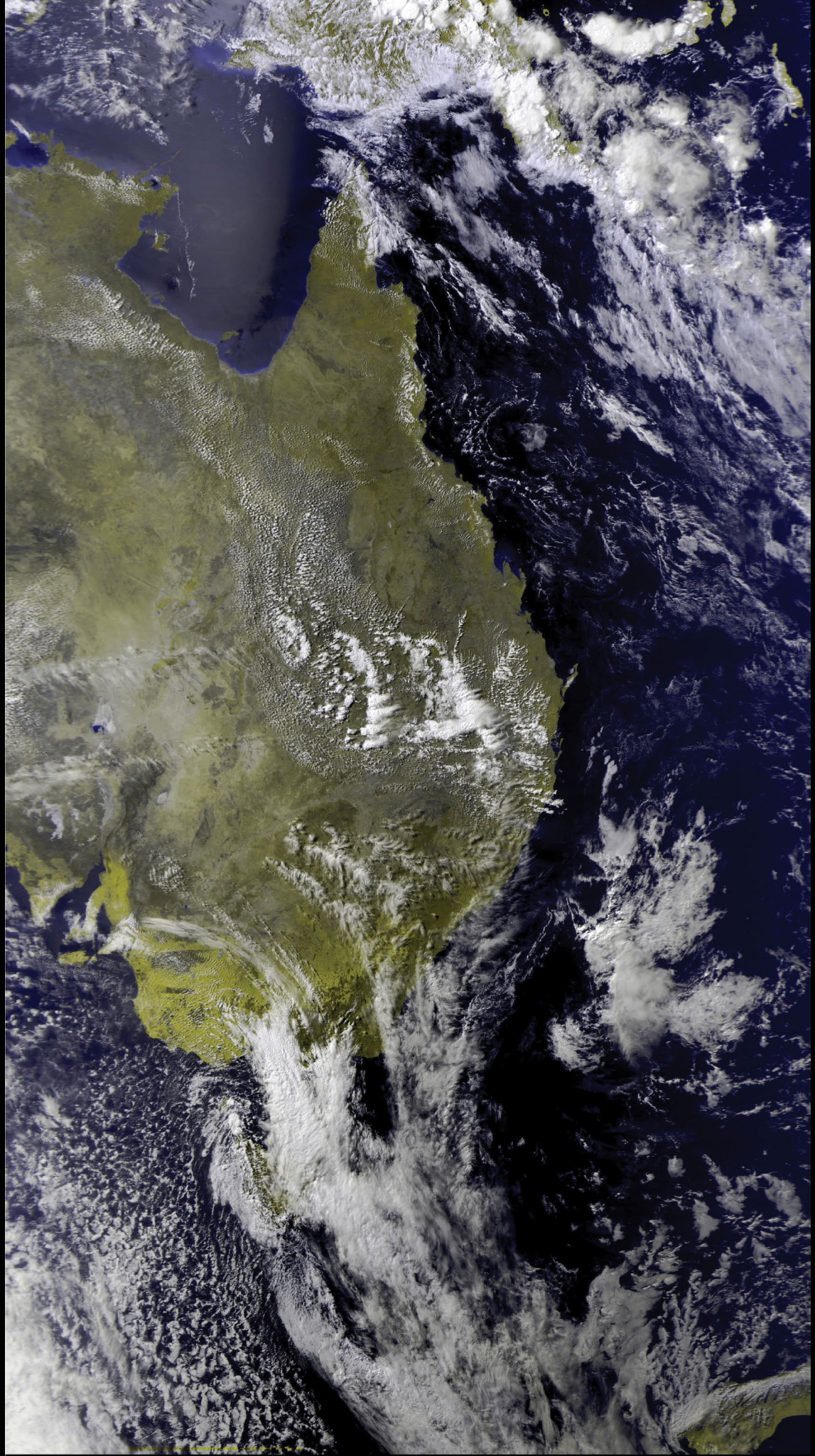
This YouTube video illustrates how the ozone hole has reduced in recent years

https://youtu.be/6BUT16jfoKk

The weather systems that disrupted the 2019 ozone hole are typically modest in September, but this year they were unusually strong. At an altitude of about 20 kilometres, temperatures during September 2019 were 16 degrees Celsius warmer than average—the warmest in the 40-year historical record for September by a wide margin. In addition, these weather systems weakened the Antarctic polar vortex, knocking it off its normal centre over the South Pole and reducing the strong September jet stream around Antarctica from a mean speed of 260 kilometres per hour to a speed of 110 kilometres. This slowing vortex rotation allowed air to sink in the lower stratosphere, where it had two impacts.

The sinking air warmed the Antarctic lower stratosphere, minimizing the formation and persistence of polar stratospheric clouds, a main ingredient for the ozone-destroying process. Second, the strong weather systems brought ozone-rich air from elsewhere in the Southern Hemisphere to the area above the Antarctic ozone hole.

As of mid October, the ozone hole has remained small but stable. It is expected to gradually dissipate in the coming weeks.



The recent flurry of activity relating to Meteor M2-2 prompted Chris van Lint to get his QFH out of mothballs and give it a clean. This image, acquired on September 27, 2019, includes the entire eastern part of Australia, with Papua New Guinea to the north, albeit in cloud, and South Island of New Zealand at lower right.

Lake Balaton, Hungary

European Space Agency

The Copernicus Sentinel-2 mission takes us over Lake Balaton in western Hungary. With a surface area of around 600 square kilometres and a length of around 78 kilometres, this freshwater lake is the largest in central Europe.

The lake is fed mainly by the Zala River at its western end. The lake water flows out near the eastern end via an artificial channel called the Sió, which eventually feeds into the River Danube.

Originally five separate water bodies, the barriers between have been eroded away to create the lake as it is today. Remnants of the dividing ridges can be seen in Balaton's shape—with the Tihany Peninsula on the northern shore narrowing the width of the lake to approximately 1.5 kilometres.

Lake Balaton's striking emerald-green colour in this image is most likely due to its shallow waters and chemical composition. It is heavy in carbonates and sulphates, and there are also around 2000 species of algae that grow in its waters.

The lake supports a large population of plant and animal species. During migration and wintering sessions, the site is an important staging area for thousands of ducks and geese.

Owing to its pleasant climate and fresh water, the Lake Balaton area is a popular tourist destination. The mountainous northern region is known for its wine, while popular tourist towns lie on the flatter southern shore.

Sentinel-2 is a two-satellite mission to supply the coverage and data delivery needed for Europe's Copernicus programme. The mission's frequent revisits over the same area and high spatial resolution allow changes in inland water bodies to be closely monitored.

Early Season Fires Burning in New South Wales

NASA Earth Observatory

Story by Kathryn Hansen.

In November 2019, destructive bushfires raged near the coast of New South Wales, Australia, sending smoke billowing over the Tasman Sea. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite acquired this image of the smoke plumes on November 7, 2019.

Fires that day burned from north of Sydney to near the border with Queensland with thick smoke blowing southeast over the Tasman Sea. According to the *New South Wales Rural Fire Service*, 29 of the 69 fires burning across the state remained uncontrolled.

Bushfire season in New South Wales typically runs from October through March. Just one month into the 2019 season, news reports state that the amount of burned area has already surpassed that of the past two years combined.

The spate of fires is visible in our front cover image, acquired at 2:30 pm local time on November 8, 2019, by the Visible Infrared Imaging Radiometer Suite (VIIRS) on the NOAA-NASA Suomi NPP satellite.

Three hours after the Suomi-NPP image was acquired, the New South Wales Rural Fire Service reported 96 fires burning across the state with 57 remaining uncontained. Seventeen of these were emergency-level fires (the highest alert level for a bushfire). According to news reports, that's the highest number of emergency-level fires the state has seen burning at one time.

Amid the burning, citizens of coastal cities watched their skies turn orange-red and air quality was degraded. In Port Macquarie, the air quality index (a scale that indicates pollution levels) was well into the hazardous category. That's the level at which everyone is at risk for the pollution to affect their health.

Burning bans have been put in place in some areas amid forecasts for continued severe fire weather—warm temperatures paired with strong winds. The region also has been drier than usual; the lack of rainfall in New South Wales led to one of five driest January-October periods on record.

NASA Earth Observatory image by Lauren Dauphin, using VIIRS data from NASA EOSDIS/ LANCE and GIBS/Worldview, and the Suomi National Polar-orbiting Partnership.

Typhoon Hagibis Floods Japan

After forming in the Philippine Sea and rapidly intensifying into a powerful category 5 storm on October 5, 2019, super typhoon Hagibis gradually weakened as it approached Japan. Yet when, as a category 2 storm, Hagbis' made landfall on the Izu Peninsula on October 12, its broad wind field and record-breaking rain devastated the island of Honshu. The storm caused widespread flooding, mudslides, power outages, and wind damage.

The image opposite was captured on October 10, 2019 by ESA's Copernicus Sentinel-3 mission at a time when it was comparable in strength to a category-5 hurricane, and exhibited an eye 60 kilometres across.

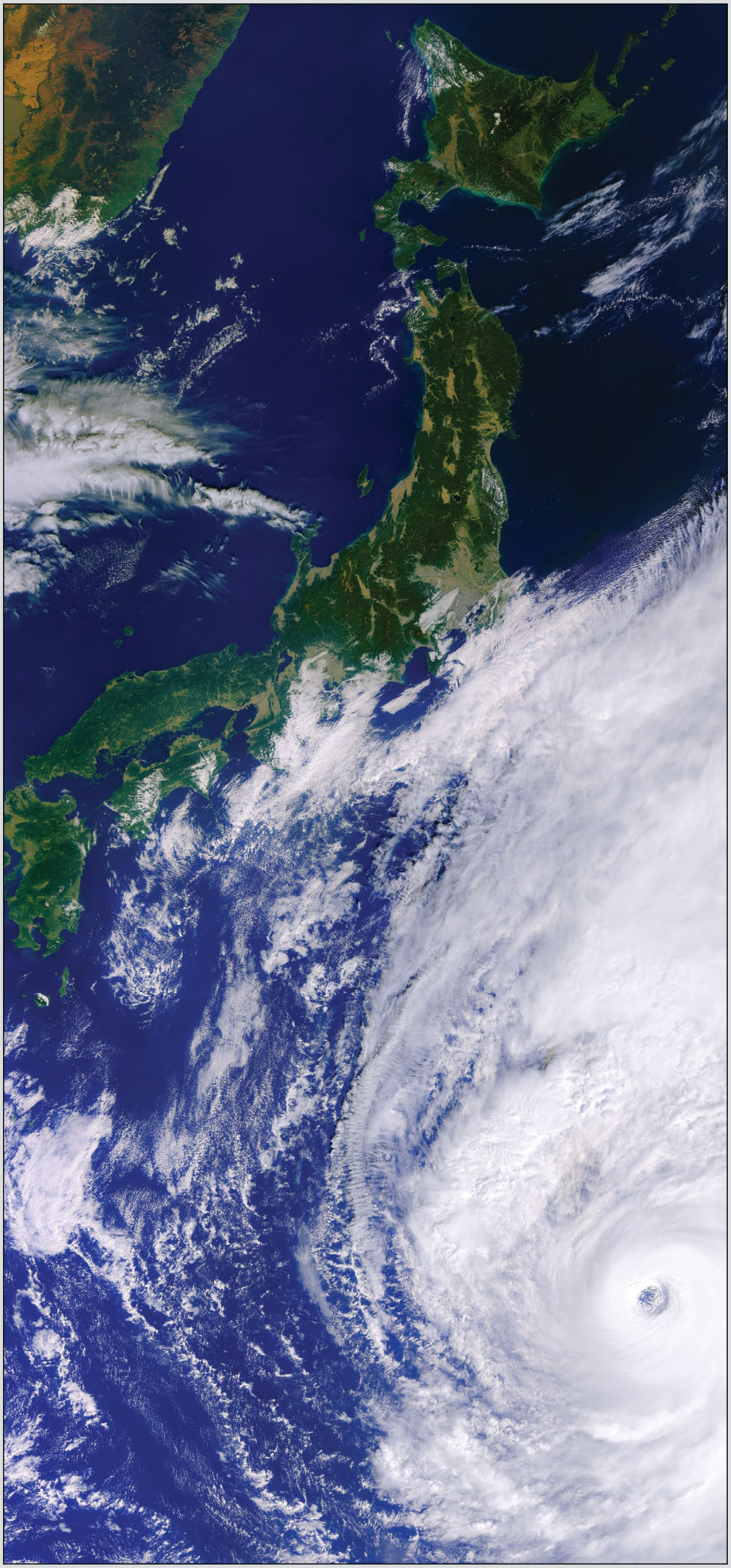
While typhoons regularly hit Japan, meteorologists say Hagibis was particularly damaging because of the angle of its attack and where it made landfall. Storms usually strike southern Japan first and weaken rapidly by the time they reach Tokyo and other population centres in central Honshu. In this case, the storm stayed offshore until making landfall just 130 kilometres southwest of Tokyo.

That allowed Hagibis to draw energy from the sea longer than most storms do. When it made landfall, the storm was also interacting with higher level winds in the jet stream, which spread the strongest winds over a larger area than usual.

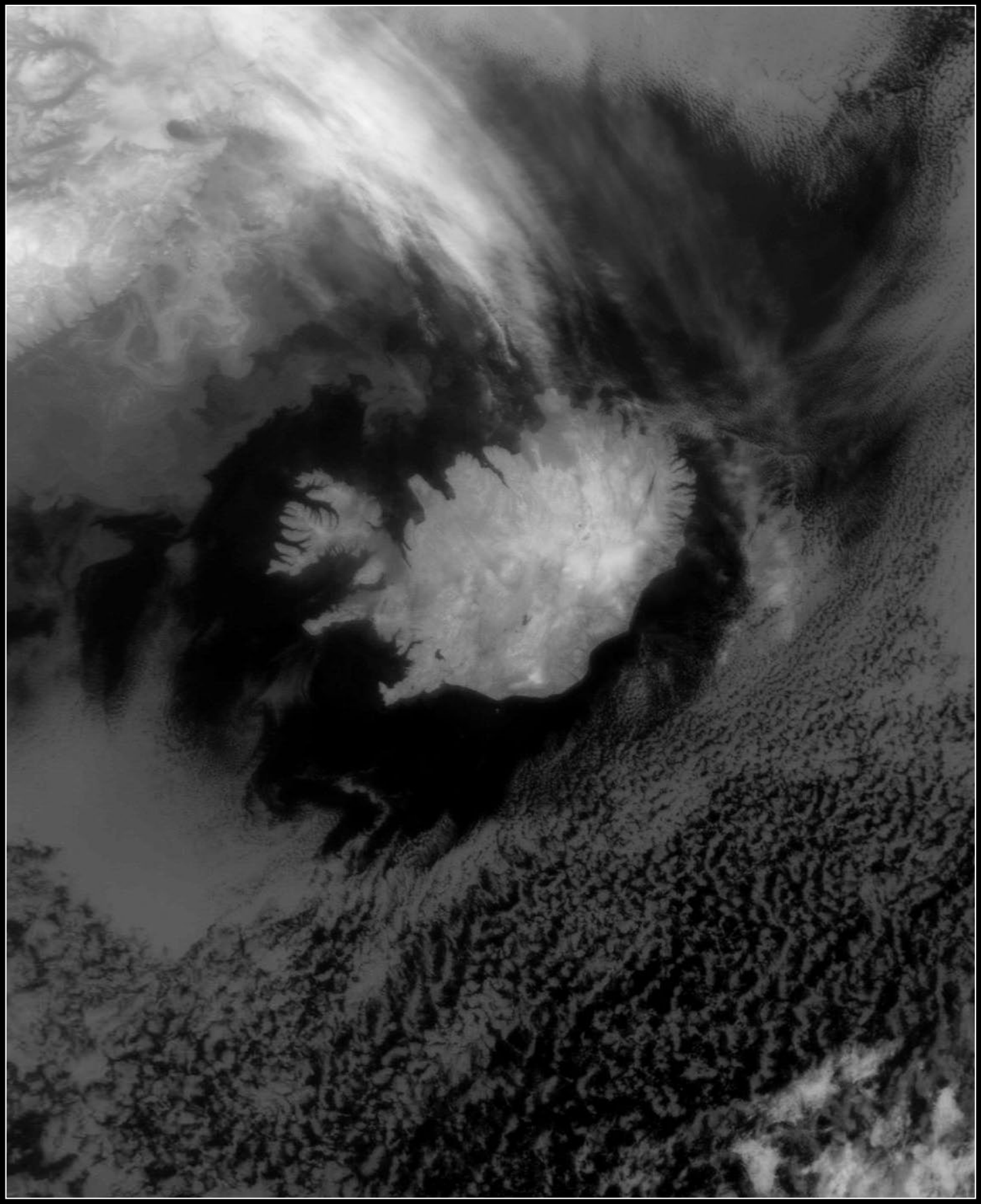
According to press reports, Hagibis caused dozens of deaths, hundreds of injuries, flood damage to at least 10,000 homes, and power outages in many more. River embankments collapsed in at least 66 places on 47 different rivers and streams. One of the areas hardest hit by rain was Hakone, which received 922.5 millimetres of rain fall in just one day.

Text abridged from a NASA Earth Observatory report by Adam Voiland.

https://earthobservatory.nasa.gov/images/145736/hagibis-floods-japan



Typhoon Hagibis imaged heading towards Japan on October 10, 2019.



As the northern hemisphere days shorten around the end of the year, the production of colour composite images from Russia's Meteor satellites provides less and less detail. Now is therefore the time to concentrate on the infrared images that both satellites are now transmitting on Channel-5, particularly when the land temperature plummets below freezing.

Joachim Scharrer sent in this Meteor M2 IR image he acquired on November 27, 2019, which has captured Iceland almost completely free of cloud.

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 [8]
Meteor M N2	137.1000 MHz	On	Good
Meteor M N2-2	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	RHCP	AHRPT	Inactive [2,10]
Feng Yun 3B	1704.5 MHz	RHCP	AHRPT	Active [2]
Feng Yun 3C	1701.4 MHz	RHCP	AHRPT	Active [2]
Metop A	1701.3 MHz	RHCP	AHRPT	Good
Metop B	1701.3 MHz	RHCP	AHRPT	Good
Metop C	1701.3 MHz	RHCP	AHRPT	Commissioning
Meteor M N1	1700.00 MHz	RHCP	AHRPT	Dead [8]
Meteor M N2	1700.0 MHz	RHCP	AHRPT	Good
Meteor M N2-2	1700.0 MHz	RHCP	AHRPT	Good

Geostationary Satellites				
Satellite	Transmission Mode(s)		Position	Status
Meteosat 8	HRIT (digital)	LRIT (digital)	41.5°E	IODC
Meteosat 9	HRIT (digital)	LRIT (digital)	3.5°E	On [5]
Meteosat 10	HRIT (digital)	LRIT (digital)	9.5°E	Off [4]
Meteosat 11	HRIT (digital)	LRIT (digital)	0°W	On [3]
GOES-13	GVAR 1685.7 MHz	LRIT 1691.0 MHz	60°W	Off
GOES-14	GVAR 1685.7 MHz	LRIT 1691.0 MHz	105°W	Standby
GOES-15 (W)	GVAR 1685.7 MHz	LRIT 1691.0 MHz	128°W	On [6]
GOES-16 (E)	GRB 1686.6 MHz	HRIT 1694.1 MHz	75.2°W	On[6,9]
GOES-17	GRB 1686.6 MHz	HRIT 1694.1 MHz	137.2°W	[11]
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	123.5°E	Backup/Off [7]
Feng Yun 2E	SVISSR	LRIT	86.5°E	On
Feng Yun 2F	SVISSR	LRIT	112.5°E	Standby
Feng Yun 2G	SVISSR	LRIT	99.5°E	On
Feng Yun 2H	SVISSR	LRIT	86.5²E	
Feng Yun 4A	HRIT (digital)	LRIT (digital)	99.5°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 prime Full Earth Scan (FES) satellite
4 Meteosat backup Full Earth Scan (FES) satellite
5 Meteosat prime Rapid Scanning Service (RSS) satellite.
6 GOES 15 also transmits EMWIN on 1692.700 MHz
GOES 16 also transmits EMWIN on 1694.100 MHz
GOES 17 also transmits EMWIN
7 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.
8 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.
9 GOES Rebroadcast (GRB) provides the primary relay of full resolution, calibrated, near-real-time direct broadcast space relay of Level 1b data from each instrument and Level 2 data from the Geostationary Lightning Mapper (GLM). GRB replaces the GOES VARiable (GVAR) service.
10 Although Feng Yun 3A's status is recorded on the wmo-sat website as 'inactive (end of operation)', it continues (as of June 2018) to transmit imagery.
11 GOES 17 is expected to start operations during January 2019.