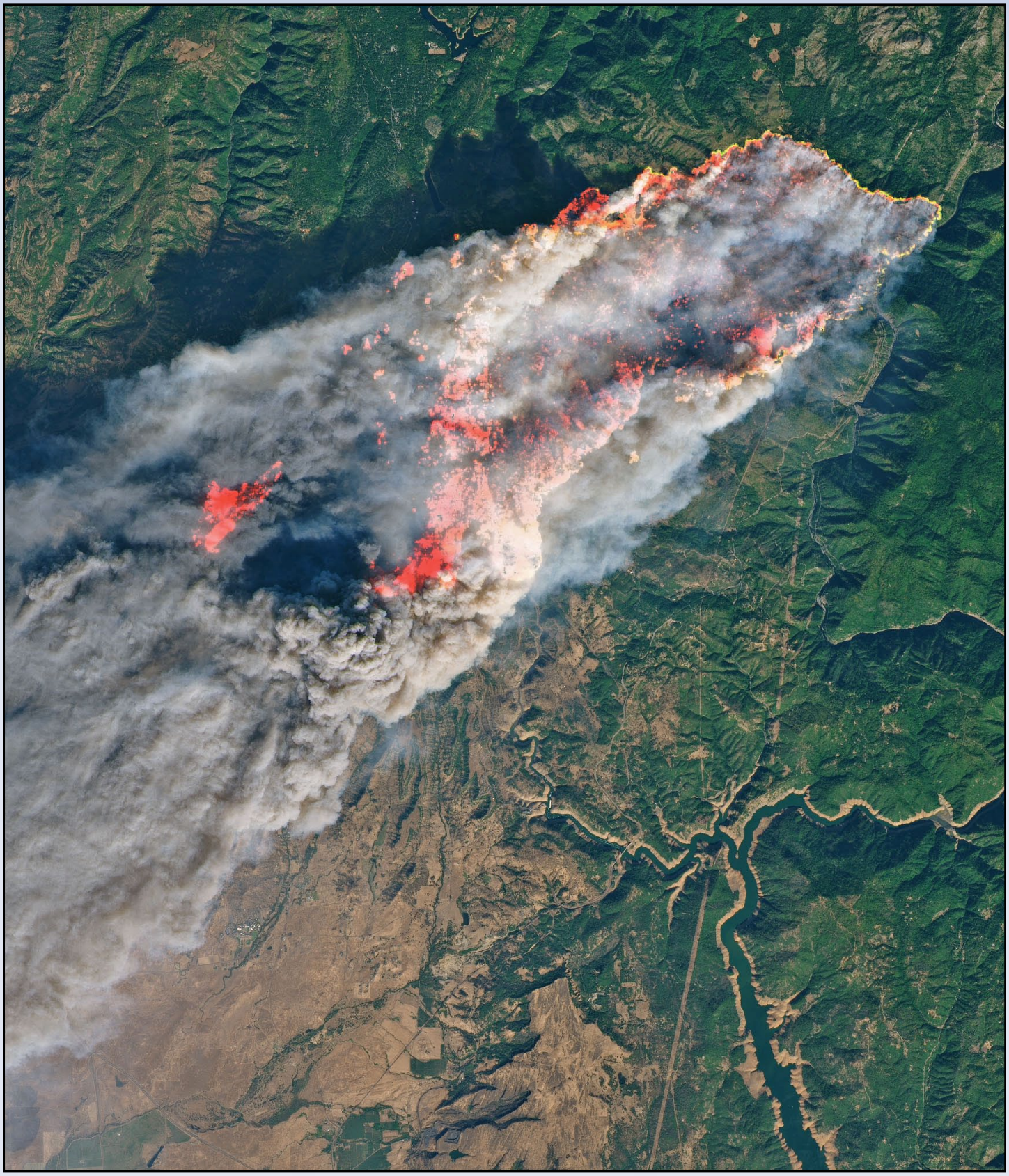
GEO Newsletter

Group for Earth Observation

Group for Earth Observation No 60 - December 2018



The Operational Land Imager on the NASA/USGS satellite Landsat-8 acquired this image of the so-called Camp Fire in Butte County, northern California, at 10.45 am local time on November 8, 2018.
Image: NASA / USGS

GEO to Visit EUMETSAT in 2019

EUMETSAT have agreed to host GEO's 4th quadrennial visit to their Headquarters in the German city of Darmstadt during July, 2019.

The event is open to anyone with an interest in Weather Satellites and Earth Observation in General.

If you are considering attending, you are advised to pre-register, without obligation, so that the likely number of participants can be catered for.

Full details appear in Francis Bell's illustrated article on pages 4 and 5 of this Newsletter.

GEO MANAGEMENT TEAM

Director and Public Relations
Francis Bell,
Coturnix House, Rake Lane,
Milford, Godalming, Surrey GU8 5AB,
England.
Tel: 01483 416 897
email: francis@geo-web.org.uk

General Information
John Tellick,
email: information@geo-web.org.uk

GEO Newsletter Editor
Les Hamilton,
email: geoeditor@geo-web.org.uk

Technical Consultant (Hardware)
David Simmons
email: tech@geo-web.org.uk

Webmaster and Website Matters
Alan Banks,
e-mail: webmaster@geo-web.org.uk

GEO Shop Manager
Nigel Evans
(Assistant: David Simmons),
email: shop@geo-web.org.uk

Management Team
David Anderson Rob Denton
Clive Finnis Carol Finnis
Peter Green David Taylor

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

Meteor M N2-2 Launch Delay

Last issue we reported that Russia's next Meteor weather satellite, Meteor M-N2-2, was provisionally set for launch this December.

However, the WMO's OSCAR website now states that the launch is now likely for March 2019. You can keep up to date with any changes to this date at the following URL

https://www.wmo-sat.info/oscar/satellites/view/483

Visit GEO on Facebook

http://www.facebook.com/groupforearthobservation

Group for Earth Observation

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

From the Editor

Les Hamilton

The past three months have been particularly eventful weatherwise, with major hurricanes and cyclones wreaking havoc on coastal states in both North America and Asia, not to mention severe weather events in Europe, with flash flooding in the Malaga province of Spain and storms bringing Rome to a standstill by depositing some 30 centimetres of hailstones on its main thoroughfares.

But what is so surprising is that *GEO Newsletter* readers close to these events have not sent in a single eye-witness report. It would be really appreciated if readers could contribute to the GEO Newsletter by providing news reports on such events, possibly accompanied by photographs and relevant satellite imagery they have themselves received, for future issues.

Material will always be welcome, by email, to

geoeditor@geo-web.org.uk

We are fortunate this quarter to have been forwarded an article by Olga Denisenko who works for **EOS Data Analytics**, the USA-based company which provides a unique solution to Earth Observation image processing and analysis. Briefly, EOS Platform provides everything you need for online image processing in a browser. It is actually a set of four mutually integrated cloud products for searching, analysing, storing, and visualising geospatial data: *Landviewer*, *Processing*, *Vision* and *Storage*. Individually, each serves a unique function, but together they provide a powerful toolset in the GIS field. You can read the article on page 7.

All four tools of EOS Platform may be tested, free of charge at

https://eos.com/platform

It is in open *beta* now, and the the EOS Team would be very grateful for feedback. *LandViewer*, reviewed in GEOQ 56 (December 2017), is being updated on a regular basis, based on feedback from users and general EO market needs. Feedback can be emailed to

support@eos.com

EOS have also recently launched a free online video course for EOS Platform users: there are video lessons about *LandViewer*, and the rest of the tools. If you're interested, the course is available at:

https://www.geo.university/courses/the-eos-platform

Finally, an apology is due to Robert Moore, whose piece on Kamchatka (page 12) lurked out of sight somewhere on my PC for more than six months before I came across it.

Contents

Darmstadt Visit – 2019

Thursday, July 4, 2019

Francis Bell

This formal photograph shows the GEO contingent inside the entrance hall of EUMETSAT's HQ together with their Director General plus other EUMETSAT staff on the occarion of our 2007 visit.

Since GEO's initial visit to EUMETSAT's HQ in Darmstadt, Germany in 2007 we have repeated the event on a four yearly cycle. As best I can judge, each visit has been very worthwhile with our members being technically informed by visiting the very heart of EUMETSAT's satellite control facilities and, just as importantly, meeting the people running their systems.

I'm very pleased to announce that EUMETSAT have agreed to GEO's request to visit their HQ again on Thursday July 4, 2019. The fine details of such a visit still have to be arranged but I expect it will be a full day visit, which will include a tour of their buildings, including their operations centre, some formal sessions of presentations and, hopefully, as in the past, a pleasant lunch.

On the following day, Friday July 5, 2019, I hope we can arrange a visit to the European Space Operations Centre (ESOC), which is also in Darmstadt, plus a visit to the large satellite ground station at Usingen about 30 kilometres farther north. I emphasise that these Friday visits still have to be arranged, so at this time they cannot be guaranteed; however, we have managed to include ESOC and Usingen events in our previous visits to Darmstadt.

There should be no charge for the formal visits to EUMETSAT, ESOC or Usingen but you may be asked for a small contribution to cover transport, administration costs plus local guides. These still have to be determined but perhaps €20 should be enough.

Personal travel arrangements and accommodation must be left to the individual visitors to arrange and finance themselves. In the past a small group of hotels within walking distance of the EUMETSAT HQ and ESOC have proved popular. It may be possible that a GEO group discount for these hotels can be negotiated but this is dependent of arrangements still to be agreed.

If you wish to register for this Darmstadt visit please send your name and address by email to Robert Denton, a GEO Management Team member, at the following email address

g4yrz@wxsat.org

The ESOC building in Darmstadt.
Photographs inside the buildings were not allowed.

Our visiting GEO group, together with local staff, standing outside some of the 'T-Systems' communication dishes at the Usingen Ground Station.

The operations room inside EUMETSAT's HQ together with our visiting GEO group just visible in the background.

Part of the Ground Station at Usingen. At the time the photograph was taken the two dishes shown were carrying EUMETCast transmissions, although there have been subsequent changes to their use.

You do not have to be a GEO member to take part in this visit: just have a dedicated interest in weather satellites and Earth observation. There is no specific time scale for registration because the event is in mid 2019, six months away, but please register as soon as your have decided you wish to be included in the visit.

Further details relating to this visit will be forwarded to those people who register for the visit as they become available.

Member Input

EUMETSAT have asked me if there are any specific topics we would like to be informed about during the formal presentation part of our visit. Personally I may not be up-to-date enough to make such a request but have told EUMETSAT that I will forward to them suggestions from our members.

If you have any topics which you think would be particularly beneficial to our group please let me know at

francis@francisbell.com

and I will forward these to EUMETSAT.

The photographs above were taken during a previous visit to Darmstadt and Usingen.

GEO Outreach

Visit to the Echelford Amateur Radio Society (EARS)

Francis Bell

Some of the audience attending the GEO presentation to the Echelford Amateur Radio Society

It's quite rewarding to receive positive feedback from the radio rally events which GEO attends. This time it was the spring of 2018, when we had a stand at the *East London Radio and Computer Rally* held at Kempton Park, west London. As usual it was a busy day with our stand displaying our literature and computer slide shows of recorded weather satellite images.

One of the visitors to our stand was John Osborne, who turned out to be the secretary of the *Echelford Amateur Radio Society* (EARS). He was sufficiently interested in what we were demonstrating that, after the show, he contacted me and asked if GEO could give a presentation to his local radio club about weather satellite reception in general, and particularly on the use of SDR dongles for live signal reception.

As requested, David Simmons and I attended one of their club meetings. The location was a room in a large sports pavilion close to the edge of the river in Walton on Thames.

As expected of radio amateurs, those attending the meeting seemed very knowledgeable and, as best I could judge, soon had a grip of the technical issues relating to weather satellite reception.

From some of the questions we were asked I think some of their members were going to try for their own reception. Any follow-on membership of GEO is unknown but the literature distributed during the evening gave suitable references to our website and the GEO-Subscribers *YAHOO* Group at

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

for follow-on interest.
My thanks go to David Simmons for his support and for attending this presentation with me.

New EOS Platform

lets you run Image Processing Tasks in a Browser

EOS Data Analytics Team

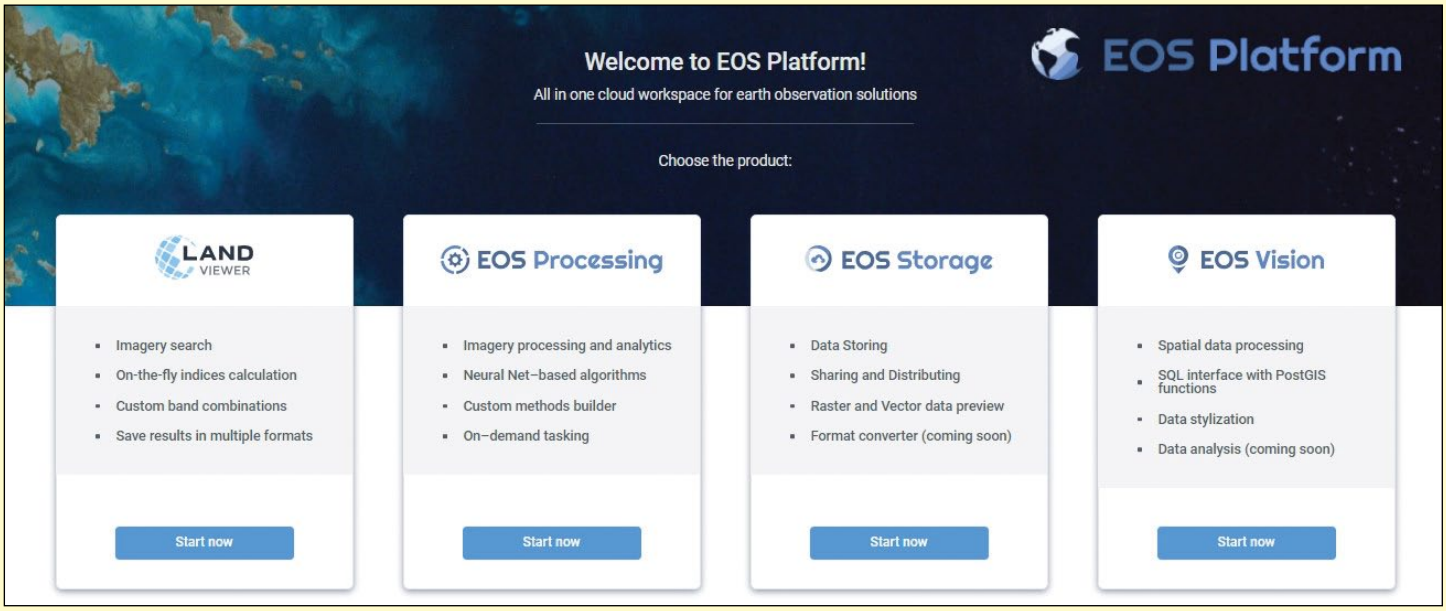


Figure 1 - The EOS Platform Welcome Screen

Most of your image analysis tasks that used to require *ENVI* or *Erdas Imagine* software are now available online thanks to **EOS Platform**. This new game-changing cloud service launched by *EOS Data Analytics* provides GIS professionals with a one-stop solution for search, analysis, storage, and visualisation of large amounts of geospatial data.

With **EOS Platform** you get access to a suite of four mutually integrated EOS products, which together provide a powerful toolset for geospatial analysts. Image data is stored in cloud-based **EOS Storage** and is available for image processing or remote sensing analysis at any time: this can be a raw user file, imagery obtained from **LandViewer** or an output file from **EOS Processing**.

There are at least two reasons why image processing is the platform's major asset: the processing of large data amounts runs online and offers as many as 16 workflows with even more coming soon. On top of that, users can get the best cartographic features of **EOS Vision** for vector data visualisation and, to be announced in the future, its analysis.

Data Diagnostic platform

When it comes to raster data, you can work with a variety of satellite and airborne datasets in LandViewer, EOS Processing, and EOS Storage.

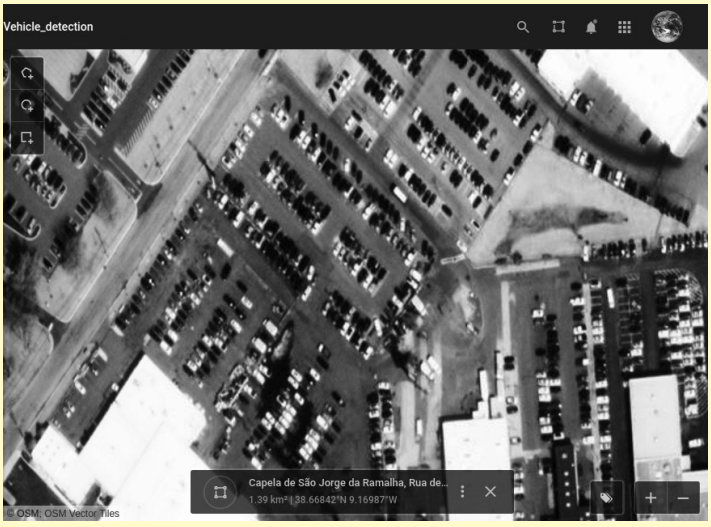


Figure 2 - A parking lot in Portugal, imaged by the WorldView-3 satellite.

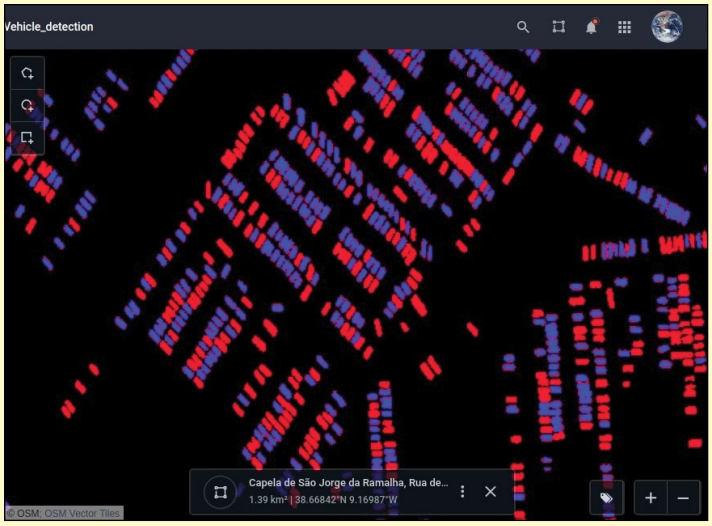


Figure 3 - The same parking lot after applying the vehicle detection algorithm.

Users can also upload their own GeoTiff, JPEG or JPEG 2000 files, and apply GIS data processing algorithms via API or from the web interface. EOS Vision is your tool for vector data operations with multiple formats support (ESRI Shapefile, GeoJSON, KML, KMZ).

LandViewer can be found at:

https://eos.com/landviewer

The Complete Image Processing Package

EOS Processing offers a great experience with its sixteen processing workflows, including the popular raster tools (merge, reprojection, pansharpening), remote sensing analytics, photogrammetry, and proprietary feature extraction algorithms that can't be found anywhere else.

Get your data ready for the upcoming LiDAR analysis and 3D modelling, as they'll become available soon.

Such pre-processing tasks as cloud detection or radiometric calibration help you refine raw data for further analysis: you can correct images for atmospheric effects and obtain the real ground radiance or reflectance values.

Object Detection, Change Detection, and Classification

The convolutional neural networks, pretrained by EOS Data Analytics to extract features from imagery, let you apply state-of-art methods to detect objects and track changes from space.

- Having only a set of multi-temporal images and change detection workflow, you can track how illegal deforestation progresses over time.
- Edge detection can show the exact boundaries of your agricultural lands down to the last pixel.
- It is possible to estimate the parking lot traffic of largest shopping centres with car detection algorithm (Figures 2,3).

The Best of Spectral Analysis

Products within EOS Platform support almost all remote sensor types, and the user can choose from a long list of spectral indices to calculate on the fly.

Aside from the complete set of vegetation indices (NDVI, ReCI, ARVI, SAVI, AVI, etc.), there are also indices to outline landscape features (water, snow and ice - NDWI, NDSI) and burned areas (NBR). The greatest thing is that here you get the freedom of experimenting with spectral bands and can create custom band combinations that best fit your purposes (Figure 4).

Customise and Analyse

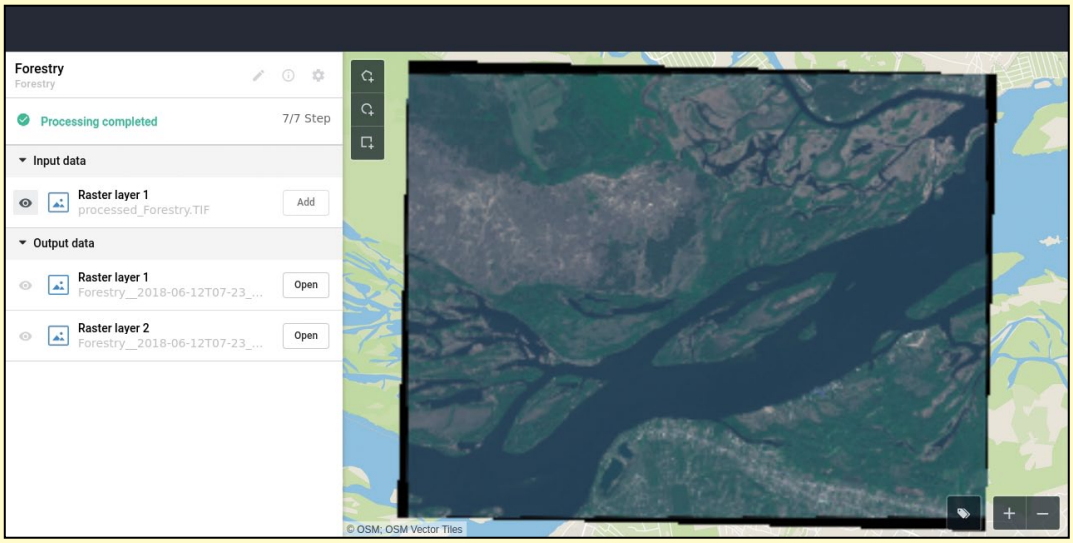
The user-friendly interface of EOS Processing makes it easy to manage processing workflows depending on the user's business needs. You can set the parameters for processing and repeatedly use such customised workflow to automate high-frequency analytical tasks. Future updates will add an ability to create custom algorithms from the available data processing operations.

Agriculture, Forestry, Oil and Gas, and more Industries

A tandem of EOS products offers a much-needed solution for individuals, businesses, and organisations across numerous industries.

With vegetation indices and crop classification features, agronomists can continuously monitor crop conditions to detect plant diseases, pests and droughts. Forestry specialists can assess fire damage, monitor forest health, track and enforce logging restrictions.

Figure 4 - AOI - Texas, USA. NDVI of an area calculated from Landsat 8 image taken in October 2015



Classification of coniferous vs. deciduous forests in Ukraine using a Sentinel-2 image.

Figure 5

This is the original satellite image.

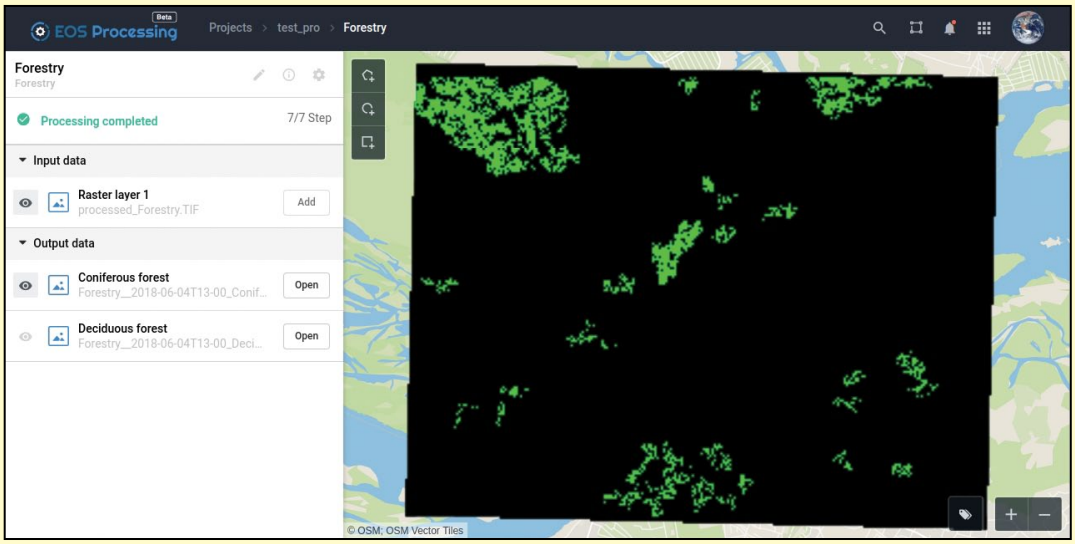


Figure 5a

This is how the image appears after applying an algorithm to highlight areas of **coniferous forest**.

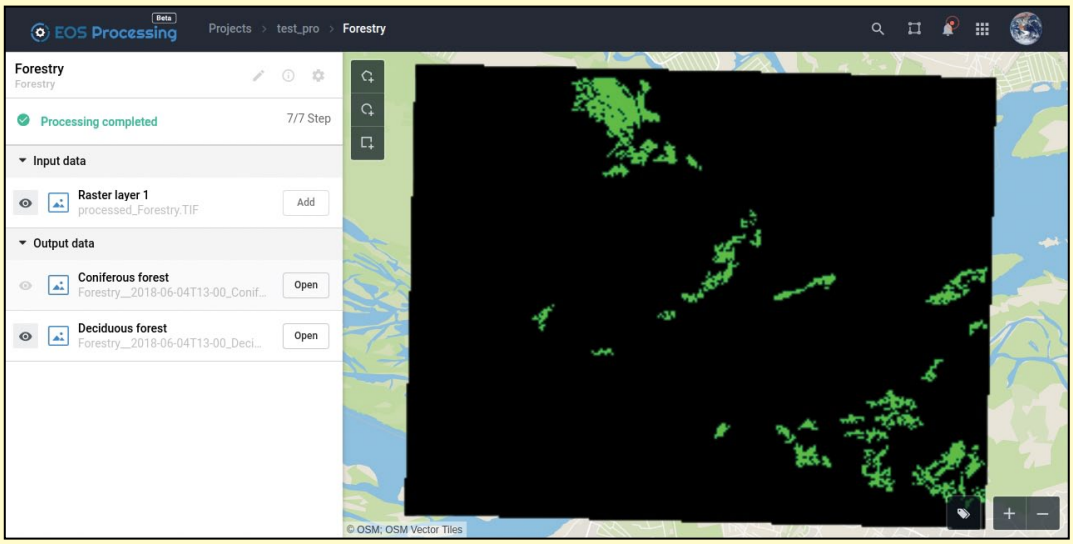


Figure 5b

This is how the image appears after applying an algorithm to highlight areas of **deciduous forest**.

EOS Platform is a great choice for regional and urban planning, helping users to identify land cover classes to generate a vegetation map. It can also make a complete list of urban features like buildings, roads, and other major features in a region.

The platform can tackle disaster management by measuring flood extent and finding fire boundaries. When it comes to oil and gas, it is capable of identifying oil rigs and assessing their environmental impact.

EOS Data Analytics uses cloud-based services to address different industries with a single platform, scientifically proven analytics, scale-ups, and it builds products that could add value to remote sensed data to deliver expert-level results for your business.

Unlock the full potential of Earth observation data with EOS Platform, directly in your browser at

https://eos.com/platform

Quarterly Question

Francis Bell

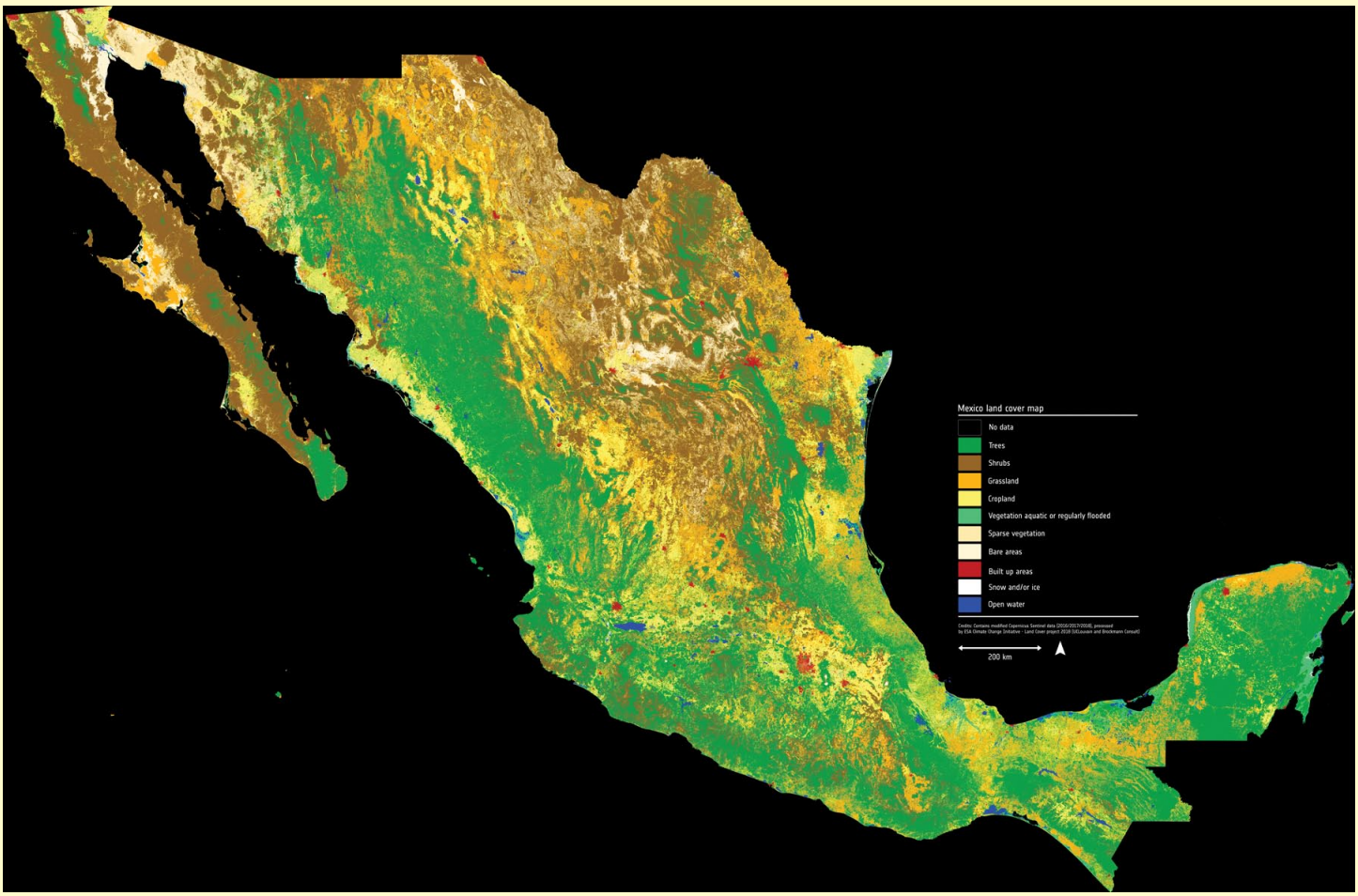


Image: ESA

Quarterly Question 59

My thanks to those readers who responded to Quarterly Question 59 with the question relating to volcanoes located in Italy. The question contained images of Mount Vesuvius and Mount Etna but specifically asked for the name of another Italian volcano which lies on an imaginary straight line between Vesuvius and Etna with the note that this third volcano has been particularly active and newsworthy this year.

The answer was Mount Stromboli which is located on an island just off the mainland coast of Italy. As best I know there are only three active volcanoes in Europe: I have visited two of them, and may perhaps visit the third at some time in the future.

Quarterly Question 60

If you are in their system, ESA regularly disseminate to you an '*Image of the Week*' which is also available on their Internet site. I usually find these images and the informative text accompanying them interesting. For this particular image I did not need to read the text to identify the country illustrated because I instantly recognised its characteristic coastal outline, having visited its west and east coasts several times.

This Quarterly Question is straightforward: 'Name the country shown in this satellite image'. Email answers to me by February 28, 2019, at

francis@geo-web.org.uk

The Quarterly Question has been provoked by the image I received from ESA which I personally did recognise, but to help others in identification, note that the image shown is about 3,000 km wide, 2,500 km from north to south and with a conventional north/south orientation. The straight lines which make up some of the north and southeast boundaries of the country are political boundaries with adjacent countries otherwise the outline is geographical. The country is not an island but attached to other land masses to the north and south.

Some notes from ESA which accompanied the image are shown overleaf, slightly edited by myself to remove the name of the country.

Zooming in on the Landscape

As part of a scientific collaboration with the country's Space Agency and other local scientific public entities, ESA has combined images from the Copernicus Sentinel-2 mission to produce a detailed view of the different types of vegetation growing across this entire country. The high-resolution land-cover map combines images captured by Copernicus Sentinel-2 between 2016 and 2018.

Sentinel-2 is a two-satellite constellation built for the EU's Copernicus environmental monitoring programme. Each identical satellite carries a multispectral imager that can distinguish different types of vegetation and crops. It can also be used to determine numerous plant indices such as the amount of chlorophyll and water in leaves to monitor changes in plant health and growth.

The mission has a myriad of uses, one of which is to provide information to map land cover so that changes in the way land is being used can be monitored. Thanks to this Copernicus mission and to ESA's Climate Change Initiative Land Cover project, this country's land cover has been mapped at a resolution of 10 metres/pixel.

Land-cover mapping breaks down the different types of material on Earth's surface, such as water bodies, different forms of agriculture, forests, grasslands and artificial surfaces. This information is important for understanding changes in land use, modelling climate change, conserving biodiversity and managing natural resources. This is a valuable source for scientific studies and practical applications alike.

Daniela Jurado from the country's National Commission for the Knowledge and Use of Biodiversity said:

"*Having access to such a detailed map is not only useful for scientific research such as understanding fluxes associated with the carbon cycle, but also for managing our natural resources and for conserving biodiversity. It is also important for land-use management and for monitoring urban expansion.*"

Alejandra Aurelia López Caloca, from the Centre for Research in Geospatial Information Sciences added:

"Indeed, this new map reveals a lot about our country. It is very helpful for studying the growth of cities and how rural areas are transitioned into urban environments. In addition, it is going to be a real help to understand where bodies of water are highly dependent on precipitation and to pinpoint those areas that are at risk of flooding. "The new map allows us to identify the status land cover, specifically the agricultural kind so this will really help us understand how our land is being farmed."

ESA has been coordinating global land cover maps since 2002 through its *GlobCover and Climate Change Initiative Land Cover* projects at a resolution of 300 metres. But with the Copernicus Sentinel-2 pair now in orbit, land cover can be mapped at a resolution of 10 metres. In the same vein, a land-cover map of other areas is also now available.

Copernicus 20 Years On

It was in 1998 that the manifesto that gave rise to Europe's Copernicus environmental programme was signed. With seven Sentinel satellites already in orbit delivering terabytes of data every day, Copernicus is the biggest provider of Earth observation data in the world.

This manifesto proposed that an operational environmental monitoring programme be created, and today, 20 years later, Copernicus is in full swing, providing services that use satellite data to help address today's challenges such as urbanisation, food security, rising sea levels, diminishing polar ice, natural disasters and, of course, climate change.

A very important principle is that all satellite data offered through Copernicus are completely free of charge and open to anyone in the world.

While the European Union is at the helm of Copernicus, ESA develops, builds and launches the dedicated Sentinel satellites. It also operates some of the missions and ensures the availability of data from third party missions. EUMETSAT also plays a role in operating the ocean part of the Sentinel-3 mission, and it will be responsible for Sentinel-4, Sentinel-5 and Sentinel-6 when they are launched.

To date, there are seven Sentinel satellites in orbit: a pair of Sentinel-1 radar satellites, a pair of Sentinel-2 optical satellites, a pair of Sentinel-3 satellites carrying a suite of instruments, and the single-satellite Sentinel-5P mission to monitor air pollution.

There are already 150 000 users registered with ESA's data hub, but since the data are available to anyone, the real number, although unknown, is much higher.

The next three Sentinel missions are currently being built and there are another six mission concepts being assessed. These new missions and the development of new markets for data will take Copernicus into the future and while the success of the first 20 years has undoubtedly been thanks to the strong partnerships between the EU, ESA and service providers, the programme is evolving alongside a fast-changing landscape for Earth observation.

Source: ESA

Kamchatka and its Volcanoes

Robert Moore

The geology and wildlife of the Kamchatka peninsula make it, for me, one of the most fascinating parts of the globe but it is perhaps the part I am least likely to visit. Ice and snow-bound in the winter and cloud-covered for much of the year, it is worth watching out for good satellite images.

Ice is a major feature of the area (at roughly the same latitude as Scotland). The sea ice and land ice interact with the ocean in ways that produce weather patterns totally different from anything seen in our eastern Atlantic environment.

Metop-A produced a fine image on March 25, 2018, and with the peninsula being snow covered at that time of the year, many of Kamchatka's spectacular volcanoes were easy to see. The volcanoes are Kamchatka's best-known feature and the range is a UNESCO World Heritage Site.

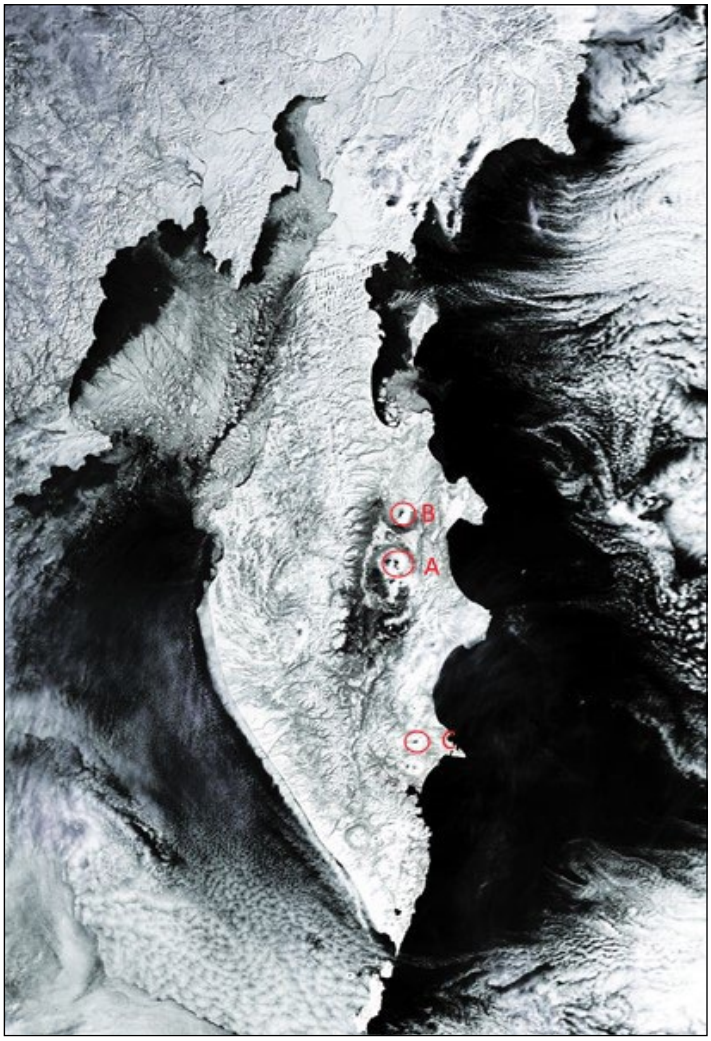
Three of these volcanoes are clearly visible in the METOP image:

- The eastern 'eye' of the 'face' half-way up the image is **Kluchevskaya**, a perfectly conical volcano, currently erupting. It is the largest active volcano in the northern hemisphere.
- Just to the north of it is **Shiveluch**, another very active volcano that had a massive eruption during 2017.
- To the south, just inland from the small spur protruding to the east is **Zhupanovsky**. This volcano had been quiet since 1959, but became active again in 2015, resulting in some interesting changes to its shape!

There is detailed information, superb pictures and satellite imagery of these three and all the other volcanos in the peninsula at

https://volcano.si.edu/volcano.cfm?vn=300540

where you can also refer to maps which are very helpful in identifying features in the satellite images.



Kamchatka and its Volcanoes
Image © EUMETSAT 2018

Another very useful site if you want to explore this remote region from your desktop, is

https://en.wikipedia.org/wiki/Volcanoes_of_Kamchatka

'Camp Fire' destroys Paradise

On the morning of November 8, 2018, California experienced its most destructive ever wildfire. The blaze—a satellite view of which appears on the front cover—was first reported around 6.30 am local time near Camp Creek Road in Butte County, and spread rapidly on the back of near 80 kilometres per hour winds which prompted the Butte County Sheriff's Office to order the evacuation of the town of Paradise and a number of other threatened communities.

In the event, the fire advanced so rapidly that the majority of Paradise's 27,000 residents were unable to evacuate before the fire arrived, and firefighters had to cease firefighting and turn their attention to rescuing residents fleeing the inferno. By evening the same day, the fire had destroyed 20,000 acres, while over fifty thousands residents had been evacuated from Paradise, Concow and other threatened communities nearby.

By the following morning, the devastation had spread across one hundred thousand acres, and more than 80% of all buildings in Paradise had been destroyed. These numbered over 7000 structures, including five schools.

Three weeks following the event, with the fire at last fully contained, 88 fatalities had been recorded while over 200 persons were still unaccounted for.

September 2018 'Medicane'

John Tellick

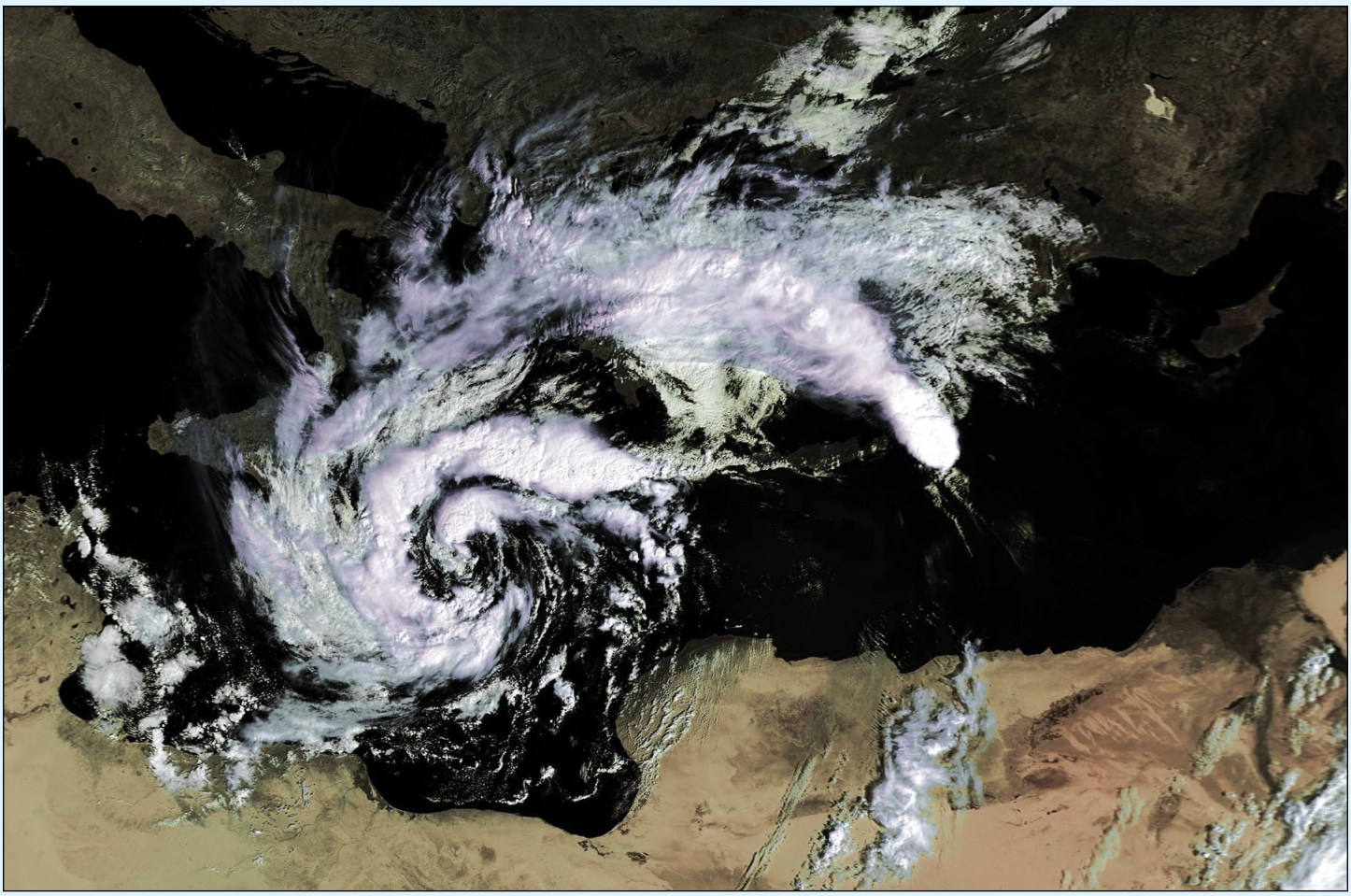


Figure 1 - The 'medicane' starts developing in the Mediterranean Sea in this Metop-B image dating from 08:30 UT on September 28, 2018
Image © EUMETSAT (2018)

Several years ago, whilst viewing a Meteosat VIS image from the Mediterranean region, I was astonished to see a perfectly formed 'hole in the middle' hurricane in the Adriatic. I phoned one of our meteorologist members who said it was not a hurricane (you don't get them in the Mediterranean) but a well formed intense area of low pressure. Listening to a recent BBC weather forecast the presenter, mentioning a storm in the Mediterranian, used the term '*Medicane*'.

So straight away I checked the latest MSG HRV image and, sure enough, a storm was brewing, as illustrated in the above Metop-B image.

Figures 2 to 5 on the following page show the rapid development of the storm in just five hours. A day later (figure 6) it's virtually all over. The storm has lost its intensity but it's remnants cover the whole of Greece.

The following text explanation has been summarised from Wikipedia. The Wikipedia URL appears at the foot of this page, from where interested readers can learn much more detailed information./

Mediterranean tropical-like cyclones, sometimes referred to as Mediterranean hurricanes or 'medicanes', are meteorological phenomena observed in the Mediterranean Sea. Their occurrence has been described as *not particularly rare*. Tropical-like systems were first identified in the Mediterranean basin in the 1980's when widespread satellite coverage first identified these low pressure areas sporting a prominent central 'eye'.

Due to the dry nature of the Mediterranean region, the formation of tropical and subtropical cyclones is infrequent, with only 100 recorded tropical-like storms between 1947 and 2011. Most systems remain at or below tropical storm intensity, but on a few rare occasions, some storms have been observed reaching the strength of a Category1 hurricane, i.e. sustained winds of at least 74 mph (119 kph). No agency, however, is officially responsible for monitoring the formation and development of 'medicanes'. A chart showing windspeeds for this storm appears at the foot of the next page.

text continues on page15

https://en.wikipedia.org/wiki/Mediterranean_tropical-like_cyclone

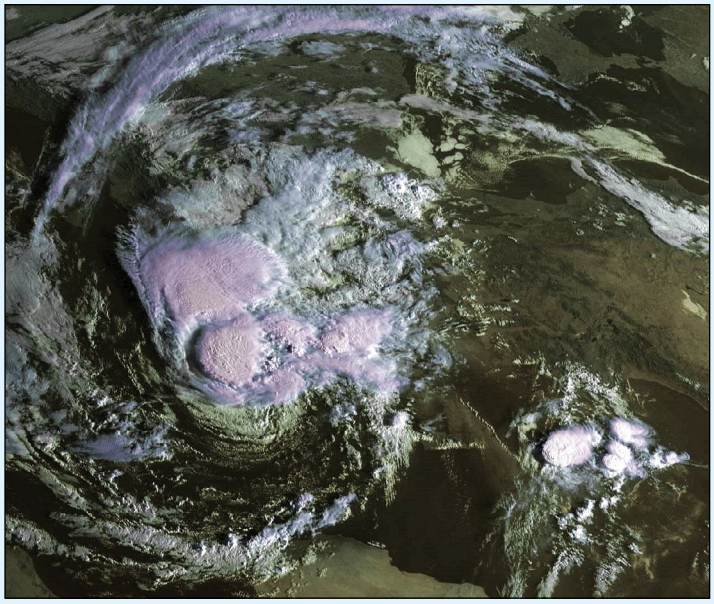


Figure 2 - Meteor HRV image of the storm at 05:45 UT on September 29
Image © EUMETSAT (2018)

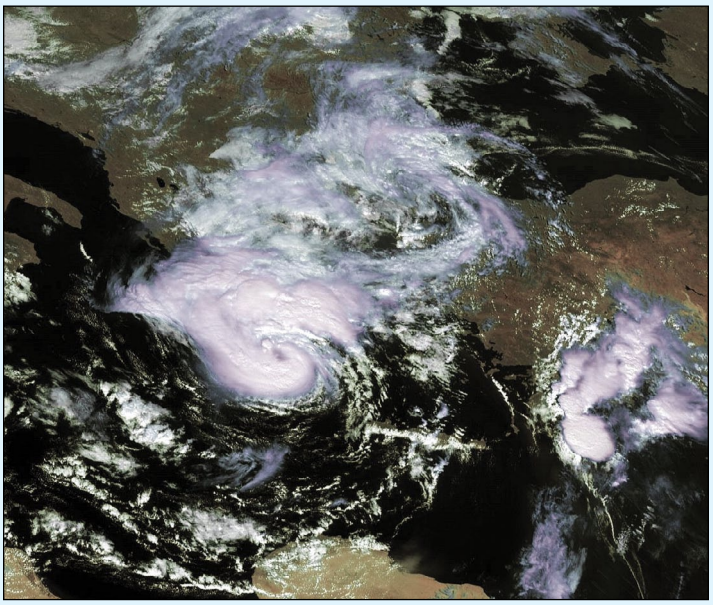


Figure 5 - Meteor HRV image of the storm at 11:00 UT on September 29
Image © EUMETSAT (2018)

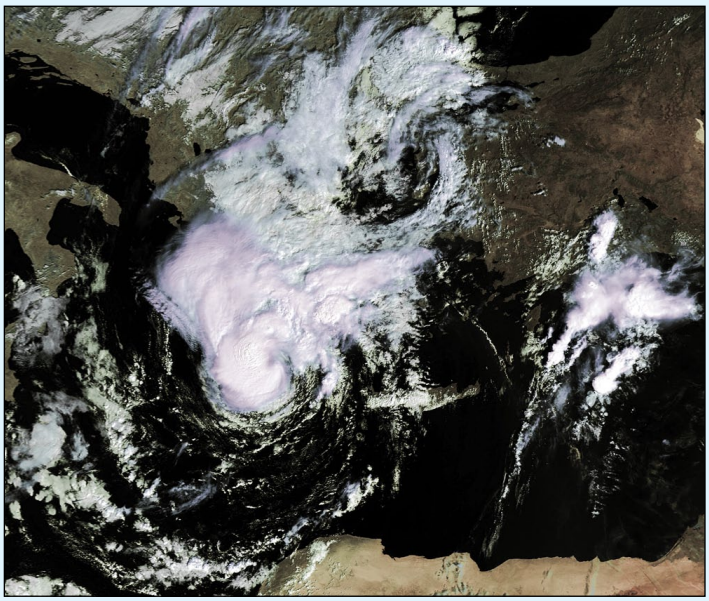


Figure 3 - Metop-A image of the storm at 08:10 UT on September 29
Image © EUMETSAT (2018)

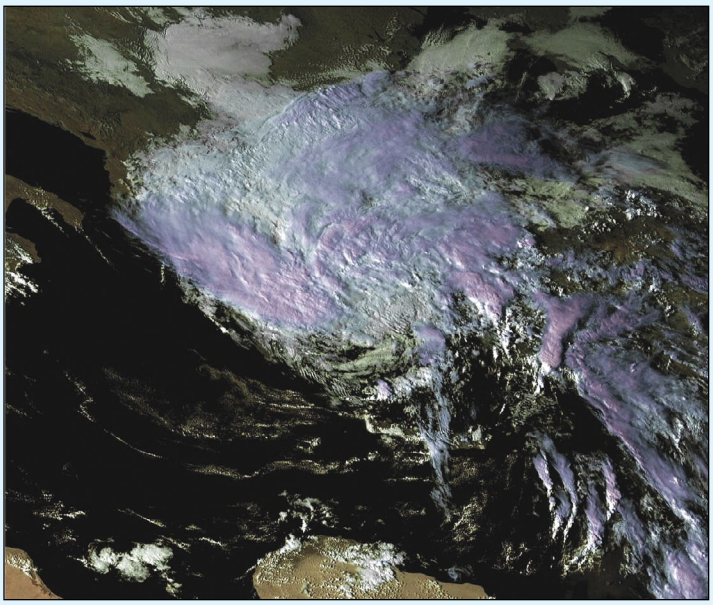


Figure 6 - Meteor HRV image of the storm at 14:00 UT on September 30
Image © EUMETSAT (2018)

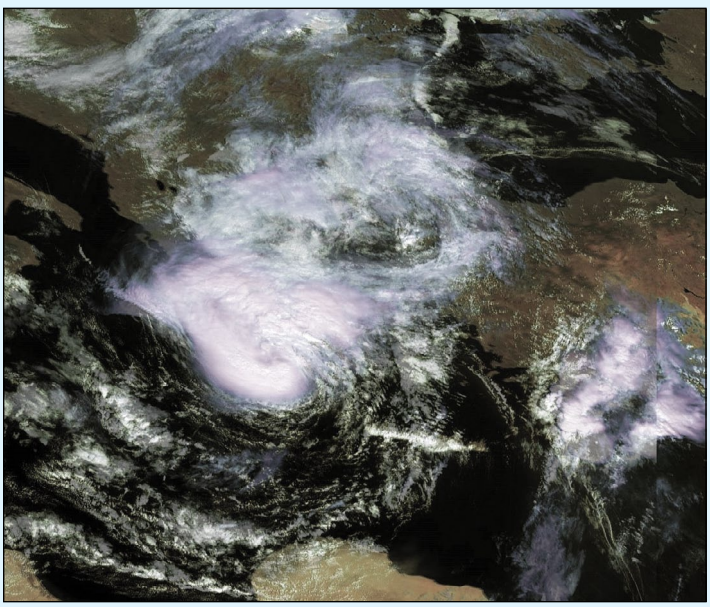


Figure 4 - Meteor HRV image of the storm at 09:30 UT on September 29
Image © EUMETSAT (2018)

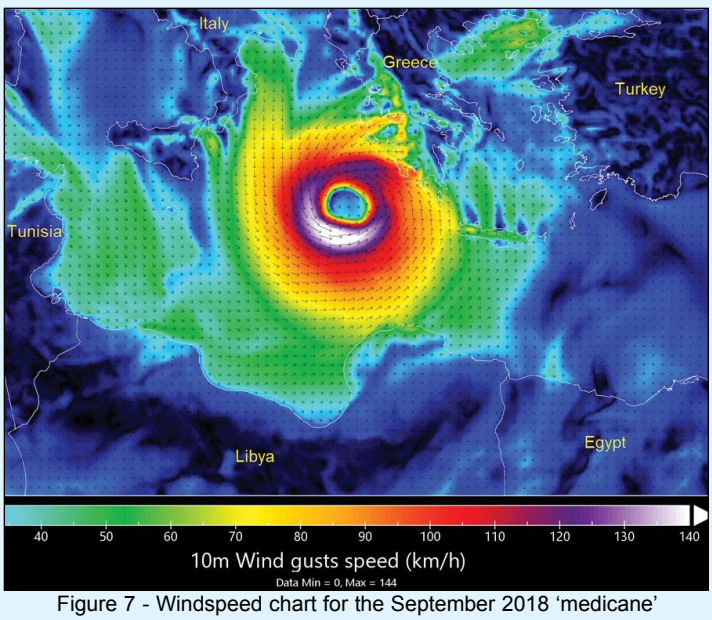


Figure 7 - Windspeed chart for the September 2018 'medicane'
Map by Andrej Flis - Input data by Meteo France.
www.severe-weather.eu

Tropical cyclogenesis typically occurs within two separate regions of the sea. The first region, encompassing areas of the western Mediterranean, is more conducive for development than the other, the Ionian Sea to the east. However, on very rare occasions, similar tropical-like storms may also develop in the Black Sea. The rough mountainous geography of the region raises additional difficulties despite being favourable for the development of severe weather and convective activity in general, and only with abnormal meteorological circumstances can a 'medicane' form. Numerous studies have been conducted on the impact of global warming on Mediterranean tropical cyclone formation, generally concluding that fewer yet more intense storms would form.

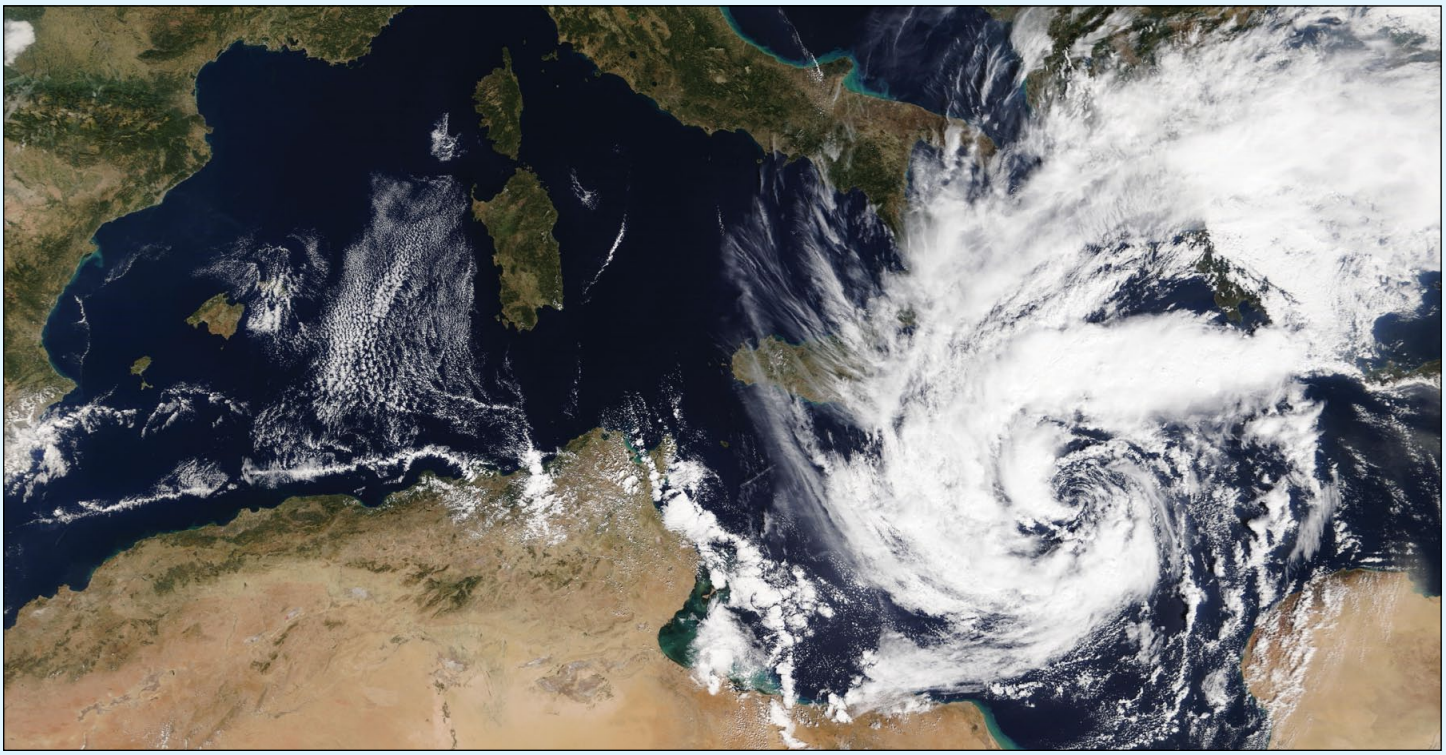
The development of tropical or subtropical cyclones in the Mediterranean Sea can usually only occur under somewhat unusual circumstances. Low wind shear and atmospheric instability induced by incursions of cold air are often required. A majority of '*medicanes*' are also accompanied by upper-level troughs, which provide the energy required for intensifying atmospheric convection—thunderstorms—and heavy precipitation. The baroclinic properties of the Mediterranean region, with high temperature gradients, also provides the required instability for the formation of tropical cyclones. Another factor, rising cool air, provides necessary moisture as well. Warm sea surface temperatures (SSTs) are mostly unnecessary, however, as most '*medicanes*' derive their energy from warmer air temperatures. When these favourable circumstances coincide, the genesis of warm-core Mediterranean tropical cyclones, often from within existing cut-off cold-core lows, is possible in a conducive environment for formation. The development of tropical-like cyclones in the Mediterranean can occur year round, with activity historically peaking between the months of September through the following January.

Damaging Medicanes

Several notable and damaging '*medicanes*'are known to have occurred. In September 1969, a North African Mediterranean tropical cyclone produced flooding that killed nearly 600 individuals, left 250,000 homeless, and crippled local economies.

A 'medicane' in September 1996 that developed in the Balearic Islands region spawned six tornadoes, and inundated parts of the islands.

Several 'medicanes' have also been subject to extensive study, such as those of January 1982, January 1995, September 2006, November 2011, and November 2014. The January 1995 storm is one of the best-studied Mediterranean tropical cyclones, with its close resemblance to tropical cyclones elsewhere and availability of observations. The '*medicane*' of September 2006 is well-studied, due to the availability of existing observations and data. In November 2011, the NOAA's Satellite Analysis Branch monitored a '*medicane*', named *Rolf* by the Free University of Berlin (FU Berlin), though it ceased doing so the following month. In 2015, NOAA resumed issuing advisories for tropical systems in the Mediterranean region. In 2018, a developing storm killed four people in Tunisia due to flooding rains.



NASA's Terra satellite acquired this image of the 'medicane' at 10:05 UT on September 29, 2018.
Image: NASA

Activity at Krakatau

NASA Earth Observatory

Activity at the Indonesian volcano **Anak Krakatau** is not unusual; eruptions have occurred sporadically over the past few decades. And before that, it was the site of the infamous, deadly eruption of 1883. It is somewhat unusual, however, for satellites to obtain cloud-free views, as they did in September 2018.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's *Aqua* satellite acquired the wide view (figure 1) on September 24. The MultiSpectral Instrument (MSI) on the European Space Agency's Sentinel-2 acquired the more detailed image (figure 2) on September 22. Both images show volcanic ash and steam streaming southwest over the waters of the Sunda Strait.

Local sources reported that this eruption has been ongoing since June 19, 2018, with ash plumes having been observed rising to altitudes up to 1800 meters. As of September 24, the eruption had not yet affected air travel in southeast Asia, according to news reports. The local alert status remained at 'caution', which is the second-highest level.

The plume was also visible from the International Space Station, from where European Space Agency astronaut Alexander Gerst snapped a photograph of the plume on September 24 (figure 3).

You can view more of Alexander's photographs from the ISS on *Flickr*

https://www.flickr.com/photos/astro_alex/

and *Instagram*

https://www.instagram.com/astro_alex_esa/

Story by Kathryn Hansen

Figure 1 - Location of Anak Krakatau in the Sunda Strait
NASA image by Joshua Stevens, using MODIS data from NASA EOSDIS/LANCE and GIBS/Worldview

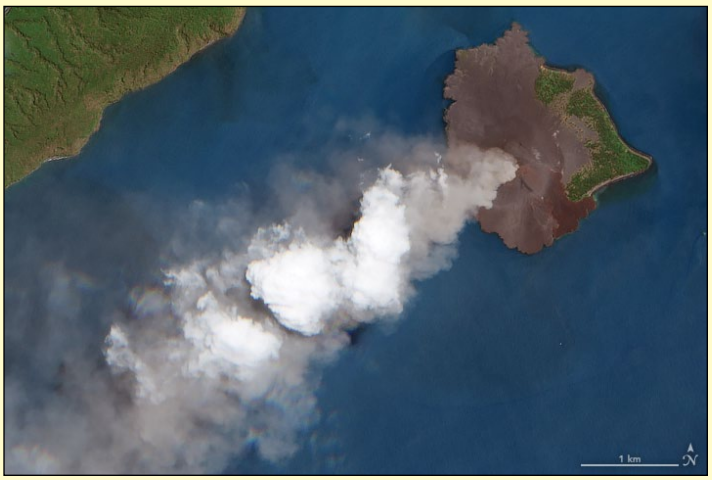
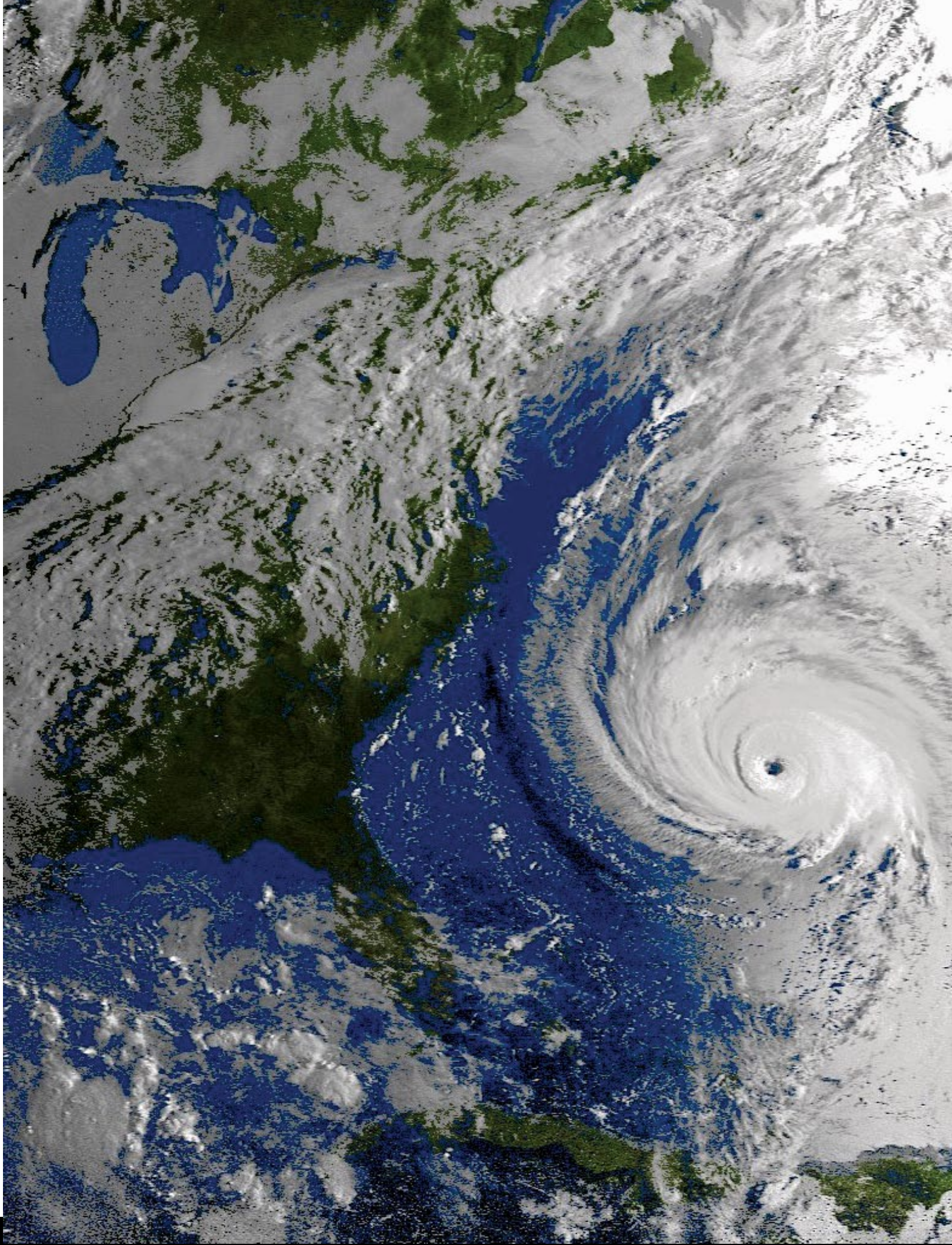


Figure 2 - Sentinel-2 image of the plume on September 22, 2018
Image: modified Copernicus Sentinel data (2018) processed by the European Space Agency.

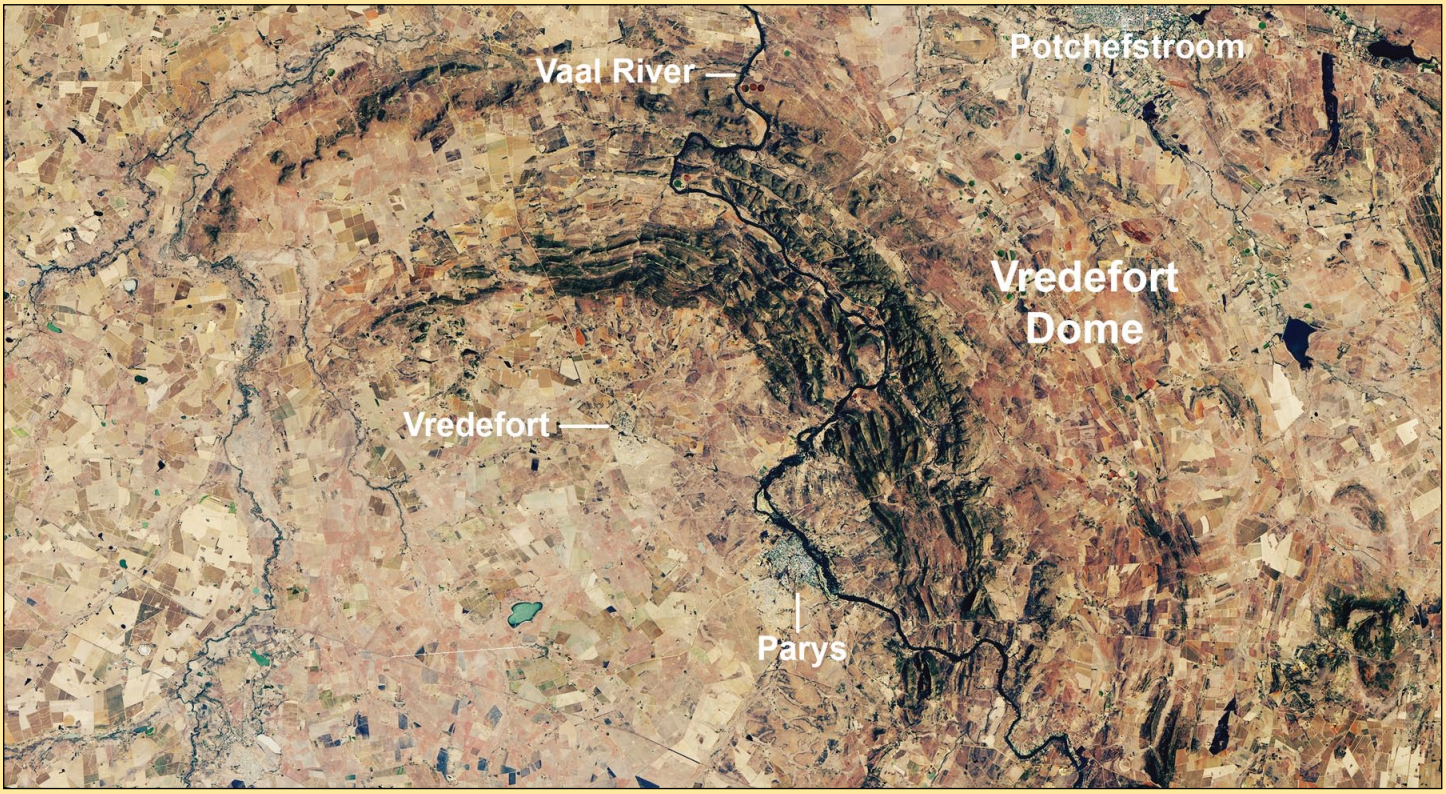
Figure 3 - The plume from Anak Krakatau, photographed from the ISS
Photo ESA / Alexander Gerst



Reader Keith Fraser sent in this APT image from NOAA 15, acquired on September 12, 2018. It depicts Category-4 Hurricane Florence, still two days out in the Atlantic, with the eye particularly prominent.

Vredefort Crater

NASA Earth Observatory



Vredefort crater, imaged NASA's Landsat-8 Operational Land Imager (OLI) on June 27, 2018.
Image by Lauren Dauphin, using Landsat data from the U.S. Geological Survey.

About two billion years ago, an asteroid measuring at least ten kilometres across hurtled toward Earth. The impact occurred southwest of what is now Johannesburg, South Africa, and created a temporary dent in the surface, 40 km deep by 100 km wide. Almost immediately after impact, the crater became wider and shallower as the rock below started to rebound and the walls collapsed. The world's oldest and largest known impact structure was formed.

Scientists estimate that when the rebound and collapse ceased, Vredefort Crater measured somewhere between 180 and 300 kilometres wide. But more than two billion years of erosion has made its exact size hard to pin down.

"*If you consider that the original impact crater was a shallow bowl, such as you would serve food in, and you were able to slice horizontally through the bowl progressively, you would see that it's diameter will decrease with each slice you take off*," stated Roger Gibson of University of the Witwatersrand, and an expert on impact processes. "*For this reason, we are unable to categorically fix where the edge now lies*."

According to Gibson, the uplift at the centre of the impact was so strong that a 25 km section of Earth's crust was turned on end. The various layers of upturned rock eroded at different rates and produced the concentric pattern still visible today. Vredefort Dome, which measures about 90 km across, was observed on June 27, 2018, by the Operational Land Imager (OLI) on Landsat 8.

Notice that only part of the ring is now because areas to the south have been paved over by rock formations that are less than 300 million years old. The young rock formations have begotten fertile soils that are intensely cultivated.

The darker ring in the centre of this image, known as the Vredefort Mountainland, has shallow soils with steep terrain not suitable for farming, so it remains naturally forested. Along the ridges in Mountainland you can see white lines: these are the hardest layers of rock, such as quartzite, which resist erosion. The outer part of Mountainland has exposed rocks that are roughly 2.8 billion years old; this is the Central Rand Group, source of more than one-third of all gold mined on Earth.

Visitors to the impact site today can witness geologic time by traversing just 50 km from Potchefstroom toward Vredefort. The journey takes you from shallow crustal sedimentary rocks deposited between 2.5 and 2.1 billion years ago, ending with 3.1 to 3.5 billion-year-old granites and remnants of ocean crust that were once about 25 km below Earth's surface.

"*Such exposed crustal sections are incredibly rare on Earth*," said Gibson. "*The added bonus here is that the rocks preserve an almost continuous record spanning almost one-third of Earth's history*."

Story by Kathryn Hansen.

Arctic Sea Ice Reaches 2018 Minimum

NASA Earth Observatory

After starting the year with record lows in January and February, Arctic sea ice extent fell during September to the equal the sixth lowest average extent during the 40-year satellite record. According to researchers at the National Snow and Ice Data Center (NSIDC), the actual minimum extent was achieved on both September 19 and September 23, the latter date one of the latest seasonal minima on record. In the Antarctic, the annual maximum sea ice extent was reached on October 2, this the fourth lowest austral maximum in the satellite record

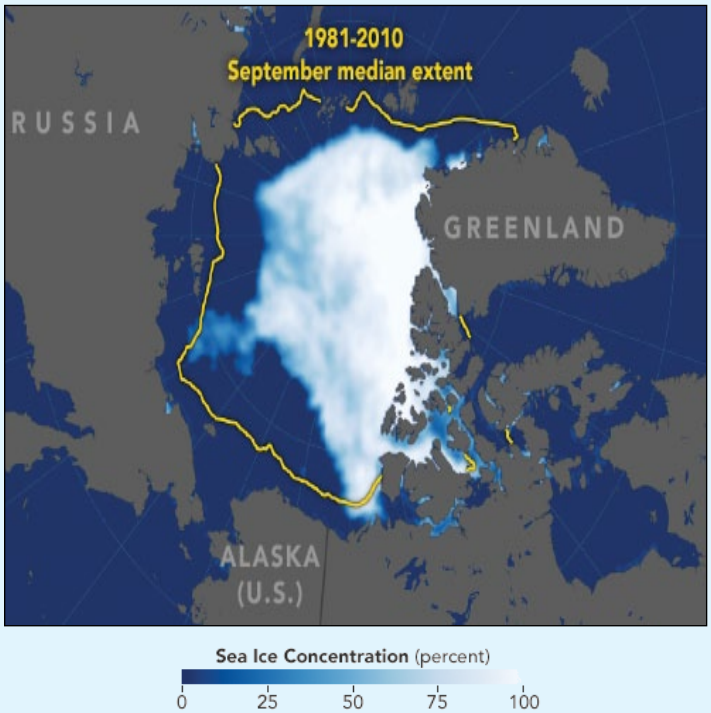
Analyses of satellite data showed that the Arctic ice cap shrank to 4.59 million square kilometres (Mkm^2), equal sixth lowest summertime minimum on record. Arctic sea ice follows seasonal patterns of growth and decay, thickening and spreading during the fall and winter and thinning and shrinking during the spring and summer. But in recent decades, increasing temperatures have led to significant decreases in summer and winter sea ice extents. The decline in Arctic ice cover will ultimately affect the planet's weather patterns and the circulation of the oceans.

The map above shows the minimum Arctic sea ice extent measured on September 19, 2018, defined as the total area in which the ice concentration is at least 15%. The yellow outline shows the median September sea ice extent from 1981–2010. The lower image is a mosaic compiled by the Canadian Ice Service using data collected between September 18 and 24 by the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on NASA's *Aqua* and *Terra* satellites.

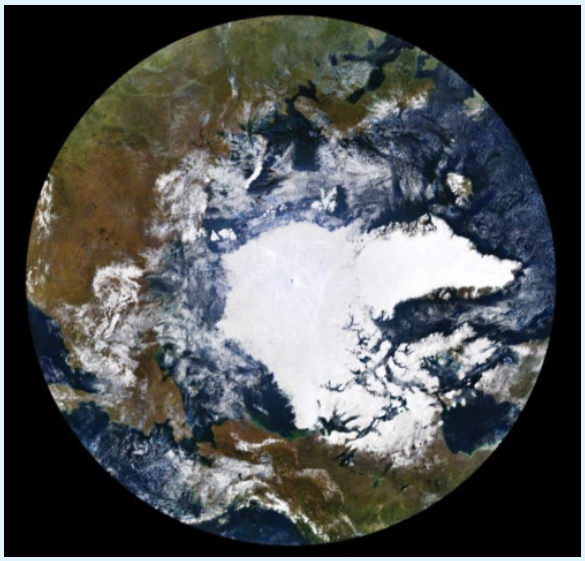
The 2018 minimum is 1.63 Mkm^2 below the 1981–2010 average ice minimum. NASA scientists have calculated that Arctic sea ice has lost roughly 54,000 km^2 of ice for each year since the late 1970s—equivalent to losing a chunk of sea ice the size of Maryland and New Jersey for every year.

One of the most unusual features of this year's melt season has been the reopening of a polynya-like hole in the ice pack north of Greenland, where the oldest and thickest sea ice of the Arctic typically resides.

"T*he combination of thin ice and southerly warm winds helped break up and melt the sea ice in this region*," said Melinda Webster, a sea ice researcher at NASA's Goddard Space Flight Center. "*This opening matters for several reasons. For starters, the newly exposed water absorbs sunlight and warms the ocean, which affects how quickly sea ice will grow in the following autumn. It also affects the local ecosystem, such as seal and polar bear populations that rely on thicker, snow-covered sea ice for denning and hunting.*"



NASA Earth Observatory image by Joshua Stevens, using data from the National Snow and Ice Data Center.



Polar mosaic courtesy of the Canadian Ice Service.

October 24 will mark the 40th anniversary of the launch of the *Nimbus-7* satellite, which began the long-term, consistent record of measurements of polar ice extent and distribution from space.

"*In view of the significant regional and interannual variability, if we didn't have the satellite record there would be a great deal of uncertainty as to what the full change in the Arctic sea ice cover has been*", stated NASA scientist Claire Parkinson. "*But the 40-year record of satellite measurements reveals quite definitively that the Arctic sea ice coverage has decreased substantially.*"

Story by Maria-José Viñas, NASA's Earth Science News Team, with Mike Carlowicz, NASA Earth Observatory.

Volga River Delta and the Caspian Sea

NASA Earth Observatory

Image: NASA

On July 2, 2018, the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's *Terra* satellite acquired a spectacular true-colour image of Russian's Volga Delta as it pours into the Caspian Sea.

The Volga River drains more than 1.3 million square kilometres of catchment area, including farmland, industrial sites, wildlands and cities. At its terminus, the braids of the Volga fan outward, creating a broad, fertile delta as it flows into the saline Caspian Sea. More than 500 channels carry the river through the delta and into the sea.

The fertile Volga Delta sustains a rich fishing industry as well as being home for endangered endemic species including several species of sturgeon. It is an important breeding and migratory route for birds as well as the northernmost natural location where the lotus (*Nelumbo nucifera*) thrives. Lotus are more typically found in the tropics.

The swirling couloirs in the northwestern section of the Caspian Sea are created by a combination of sediment from the Volga and from land runoff flowing into the waters and from growth of phytoplankton. These plant-like microscopic organisms often reproduce in large numbers when temperature, hours of daylight, and nutrients are suitable, resulting in huge blooms that can easily be seen from space.

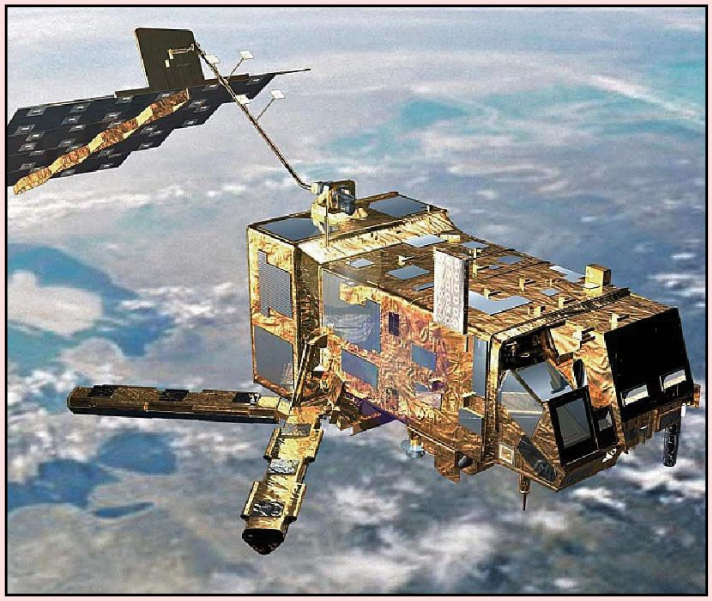
METOP-C TAKES TO THE SKIES

Les Hamilton

Metop-C, the third and final member of the first-generation Metop satellites, was launched at 0.47 UT on November 7, 2018 to continue the provision of data for weather forecasting from polar orbit. Like its two predecessors, Metop-C was launched atop a Russian Soyuz ST-B rocket fitted with a Fregat-M upper stage, but whereas previous launches took place at the Baikonur Cosmodrome in Kazakhstan, this one blasted off from Europe's Spaceport in French Guiana. A special feature of launch preparation in Guyana was the separate transportation of the three stages of the launch vehicle and the space head, which were crated and airlifted out from Baikonur in three massive Antinov cargo planes, and their subsequent assembly on the launcher using a mobile service tower.

The Metop-C payload module is unloaded from the aeroplane's stern.
Image: EUMETSAT

Metop-C being transported to the launchpad
Photo ESA-CNEA-Arianespace



An artist's view of the Metop-A spacecraft in orbit
Image credit: ESA, EUMETSAT

Some 60 minutes following lift-off, the Fregat upper stage delivered the four tonne Metop-C satellite into orbit and contact was established soon thereafter via Yatharagga Ground Station in Australia.

The Metop satellites have been developed by ESA under a co-operation agreement to form the space segment of the *Eumetsat Polar System*, Europe's contribution to a multi-orbit polar system shared with the National Oceanic and Atmospheric Administration (NOAA) of the United States.

The anticipated operational life span of each Metop was five years, and it was originally envisaged that each successive Metop satellite would take over from its predecessor. But, thanks to the extraordinary longevity shown by Metop-A and Metop-B, and the continuing high quality of the products they disseminate, the mission will continue as a three-satellite constellation, further increasing the wealth of data for weather forecasting. This is expected to continue until the de-orbiting of Metop-A, currently planned for 2022.

In-orbit commissioning of Metop-C and its payloads by EUMETSAT is now under way in partnership with ESA, CNES and NOAA, and should be complete by the end of January 2019. Then, once EUMETSAT has fully validated the output products, it is planned to release real-time data to users during spring 2019.

Metop-C will also ensure the smooth transition with the Eumetsat Polar System - Second Generation, developed in cooperation with ESA, with the objective of launching the first *MetOp Second Generation* satellite in 2022

The Soyuz launcher being positioned on the launchpad
Photo ESA-CNEA-Arianespace

The Soyuz rocket sits atop its launchpad, ready for the installation of the Metop-C weather satellite, one day prior to its launch from French Guiana's Kourou Space Centre, on November 7, 2018.
Credit: Arianespace

The Metop satellites make up the space segment of the EUMETSAT Polar System, delivering data for modern weather forecasting, as well as climate and environmental monitoring. Metop-C carries a total of **twelve instruments**, eight of which monitor Earth's environment, plus four additional data dissemination packages. A brief overview of the main features of each of these is summarised below.

Metop Instrument Overview

The Metop satellites carry a set of **seven 'heritage' instruments** provided by the United States' National Oceanic and Atmospheric Administration (NOAA) and the French Space Agency (CNES), and a newer generation of **five European instruments** that offer improved sensing capabilities to both meteorologists and climatologists.

Several of the instruments measure similar aspects of the atmosphere, namely temperature and humidity, but use a variety of measuring techniques to acquire their data. This approach is crucial for numerical weather prediction, which not only requires high-quality observations but also needs huge amounts of data from different sources to feed into the models.

Metop-C Launch
Photo ESA-CNEA-Arianespace

With its sophisticated array of instruments and diverse measuring techniques Metop can provide outstanding data sets to advance the field of meteorology, which ultimately improve the accuracy of weather forecasting and our understanding of climate change.

The European Instruments

Infrared Atmospheric Sounding Interferometer (IASI)

IASI is one of the most advanced on-board instruments measuring infrared radiation emitted from the surface of the Earth to derive data of unprecedented accuracy and resolution on humidity and atmospheric temperature profiles in the troposphere and lower stratosphere.

The Microwave Humidity Sounder (MHS)

MHS acquires measurements at various altitudes of atmospheric humidity, including rain, snow, hail and sleet, and temperature by measuring microwave radiation emitted from the surface of the Earth.

The Global Navigation Satellite System Receiver for Atmospheric Sounding (GRAS)

GRAS is a Global Positioning Satellite (GPS) receiver that operates as an atmospheric-sounding instrument, providing a minimum of 500 atmospheric profiles per day through a process of GPS radio occultation. GRAS supplies atmospheric soundings of the temperature and humidity of the Earth's atmosphere.

Advanced Scatterometer (ASCAT)

ASCAT, an enhanced follow-on instrument to the highly successful scatterometers flown on ESA's ERS-1 and ERS-2 satellites, measures wind speed and direction over the ocean. Its six antennas allow for simultaneous coverage of two swaths on either side of the satellite ground track, providing twice the information of the earlier instruments. ASCAT also contributes to activities in areas as diverse as land and sea ice monitoring, soil moisture, snow properties and soil thawing.

Global Ozone Monitoring Experiment-2 (GOME-2)

GOME-2 is a spectrometer that collects light arriving from the Sun-illuminated Earth's atmosphere or a direct view to the Sun and decomposes it into its spectral components. The recorded spectra are used to derive a detailed picture of the atmospheric content and profile of trace gases such as ozone, nitrogen dioxide, water vapour, oxygen and bromine oxide.

The Heritage Instruments

These are identical instruments with those carried by the earlier NOAA AVHRR satellites (NOAAs 15-19).

Advanced Microwave Sounding Units (AMSU-A1 and AMSU-A2)

The AMSU instruments measure scene radiance in the microwave spectrum. The data from these instruments are used in conjunction with the High-resolution Infrared Sounder (HIRS) instrument to calculate the global atmospheric temperature and humidity profiles from the Earth's surface to the upper stratosphere. The data are also used to provide precipitation and surface measurements including snow cover, sea ice concentration and soil moisture.

High-resolution Infrared Radiation Sounder (HIRS/4)

HIRS/4 is a 20-channel radiometric sounder measuring radiance in the infrared (IR) spectrum. Data from HIRS/4 are used in conjunction with data from the AMSU instruments to calculate the atmosphere's vertical temperature profile, as well as pressure from the Earth's surface to about 40 kilometres altitude. HIRS/4 data are also used to determine ocean surface temperatures, total atmospheric ozone levels, precipitable water, cloud height and coverage and surface radiance.

Advanced Very High Resolution Radiometer (AVHRR/3)

AVHRR/3 provides day and night imaging of land, water and clouds and measures sea surface temperature, ice, snow and vegetation cover by scanning the Earth's surface in six spectral bands in the range 0.58 - 12.5 microns.

Advanced Data Collection System (A-DCS)

A-DCS, provided by CNES, provides worldwide in-situ environmental data collection and Doppler-derived location services with the basic objective of studying and protecting the Earth's environment. A-DCS, also known as Argos, is an advanced version of the system presently operated jointly by NOAA and CNES.

Space Environment Monitor (SEM-2)

SEM-2, provided by NOAA, is a spectrometer that provides measurements to determine the intensity of the Earth's radiation belts and the flux of charged particles at the satellite's altitude. It also supplies knowledge of solar terrestrial phenomena and warnings of solar wind occurrences that may impair long-range communication, high-altitude operations, damage to satellite circuits and solar panels, or cause changes in drag and magnetic torque on satellites.

Search And Rescue Processor (SARP-3)

SARP-3, provided by CNES, receives and processes emergency signals from aircraft and ships in distress and determines the name, frequency and time of the signal. These preprocessed data are then fed into the Search And Rescue Repeater (SARR) instrument for immediate transmission to Search and Rescue Satellite (SARSAT) distress terminals on the ground.

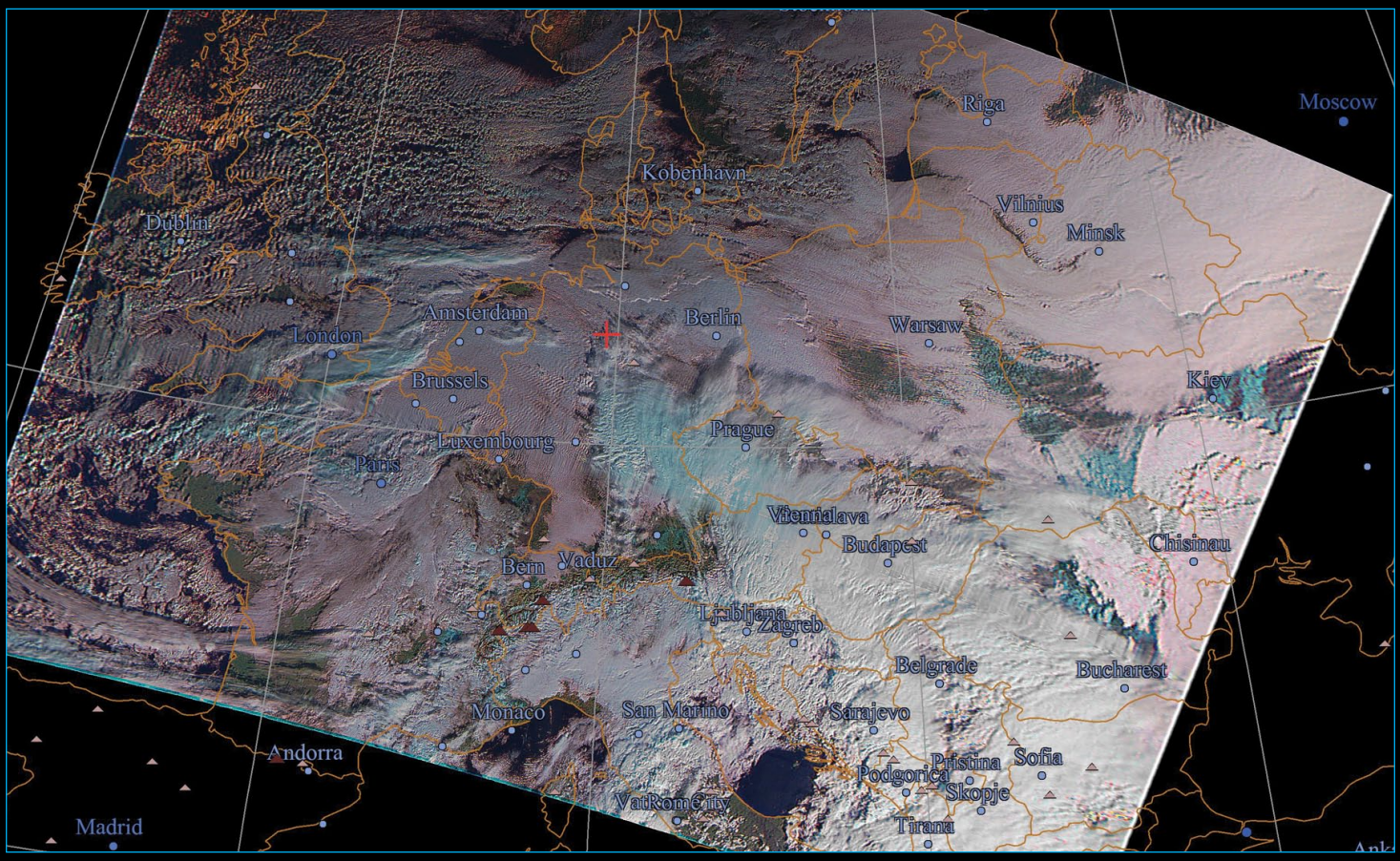
Search And Rescue Repeater (SARR)

SARR, provided by the Canadian Department of Defence (through NOAA), receives and down-links emergency signals from aircraft and ships in distress and provides a down-link for data received by the Search and Rescue Processor (SARP-3). SARR receives distress beacon signals on three separate frequencies, then translates and retransmits them to Local User Terminals on the ground. These terminals process the signals, determine the location of the beacons, and forward the information to a rescue mission control centre.

Acknowledgement

Thanks are due to ESA for making the above information available through its website.

This photograph, taken on October 15, 2018 from the ISS by cosmonaut Oleg Artemyev, shows the Uluru Rock formation, which lies some 300 kilometres southwest of Alice Springs in the south of Australia's Northern Territory. Uluru, one of the most amazing attractions of our planet, was formed about 680 million years ago, and is considered to be the biggest single rock in the world.



This is a section from a Meteor M2 LRPT image received on November 20, 2018 by Joachim Scharrer from Hannover in Germany. Joachim received the signals using an RTL SDR-Dongle, SDRsharp and a selfbuild QFH-Antenna, followed by processing in *MeteorGIS*.

Currently Active Satellites and Frequencies

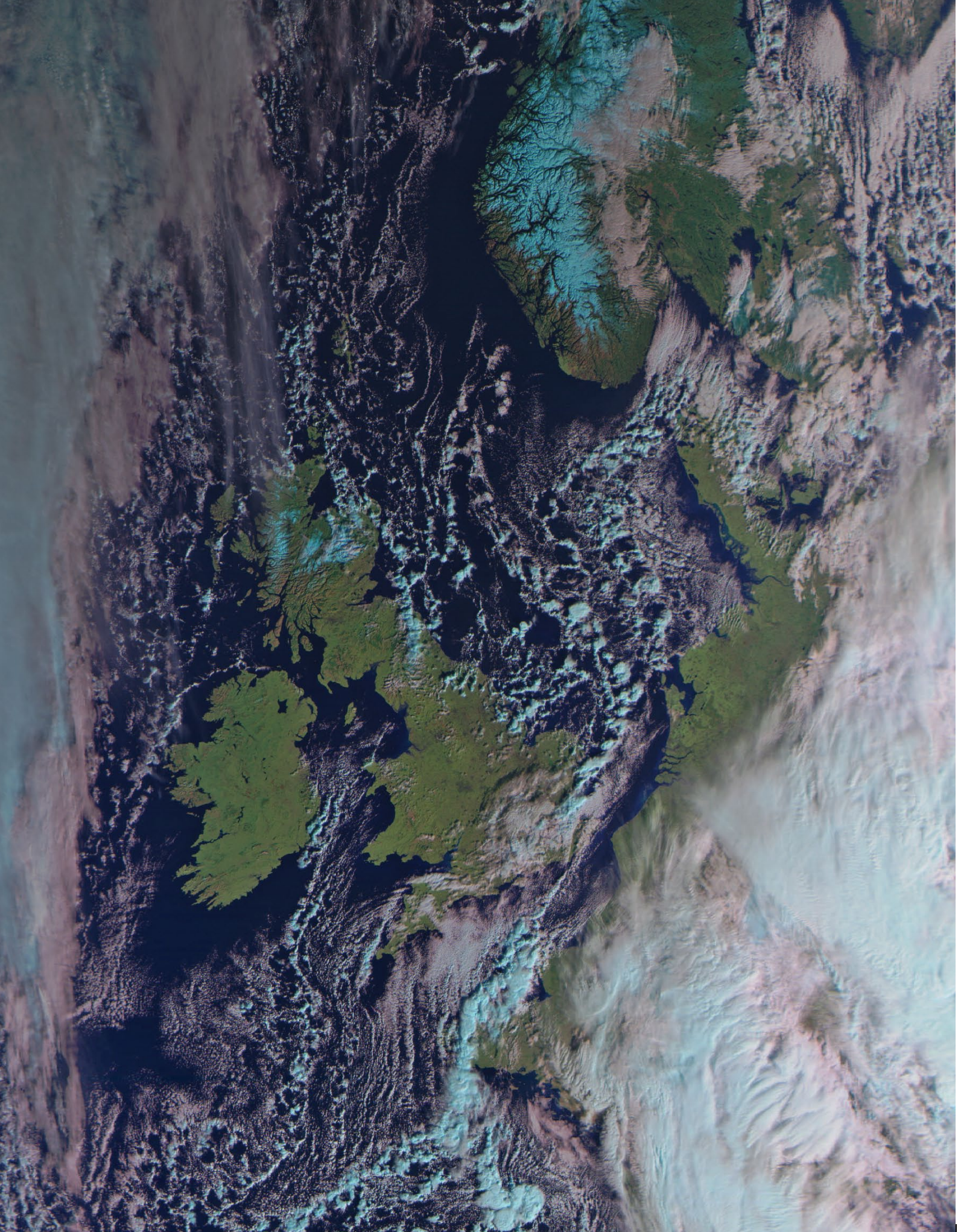
Polar APT/LRPT Satellites			
Satellite	Frequency	Status	Image Quality
NOAA 15	137.6200 MHz	On	Good
NOAA 18	137.9125 MHz	On	Good
NOAA 19	137.1000 MHz	On	Good [1]
Meteor M N1	137.0968 MHz	Off	Dead [7]
Meteor M N2	137.9000 MHz	On	Good

Polar HRPT/AHRPT Satellites				
Satellite	Frequency	Mode	Format	Image Quality
NOAA 15	1702.5 MHz	Omni	HRPT	Weak
NOAA 18	1707.0 MHz	RHCP	HRPT	Good
NOAA 19	1698.0 MHz	RHCP	HRPT	Good
Feng Yun 1D	1700.4 MHz	RHCP	CHRPT	None: Device failure
Feng Yun 3A	1704.5 MHz	RHCP	AHRPT	Inactive [2,9]
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
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	GVAR 1685.7 MHz	LRIT 1691.0 MHz	75°W	Backup East
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]
GOES-16 (E)	GRB 1686.6 MHz	HRIT 1694.1 MHz	75°W	On[8]
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	86.5°E	On
Feng Yun 2F	SVISSR	LRIT	112.5°E	On
Feng Yun 2G	SVISSR	LRIT	105.5°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 15 also transmits EMWIN on 1692.70 MHz
6 There has been no imagery from Feng Yun 2D since June 30, 2015. Since Feng Yun 2G is operating from the same position (86.5°E), it is likely that FY-2D is now in standby as a backup satellite.
7 On March 20, 2016, Meteor M1 suffered a catastrophic attitude loss, frequently pointing its sensors towards the sun. The following day all signals ceased and it seems highly probable that this satellite is now incapable of imaging the Earth.
8 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.
9 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.



On October 28, northwest Europe felt its first taste of winter when a surge of Arctic air descended over the region.
This Meteor M2 image was received in Aberdeen, Scotland by Les Hamilton.