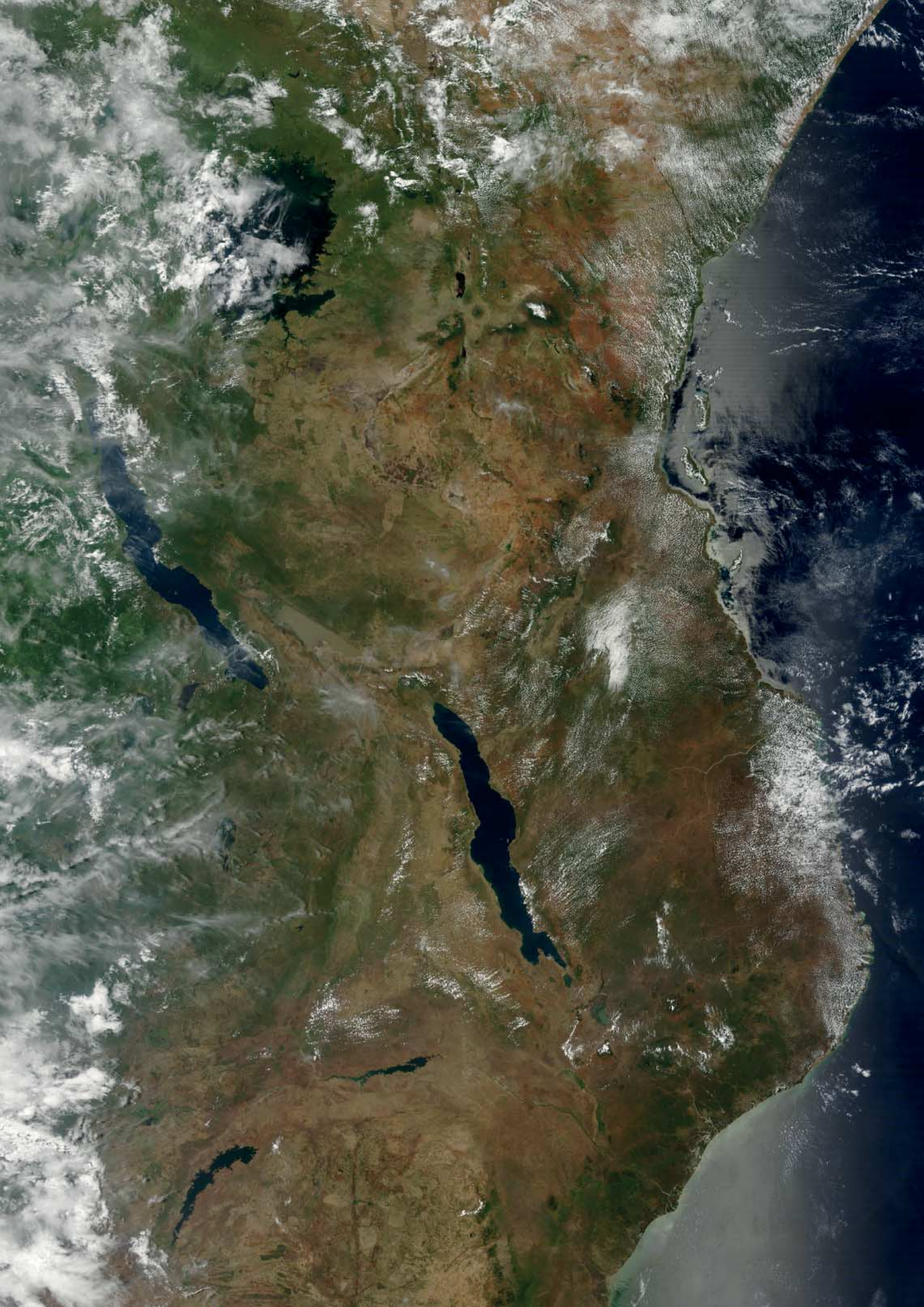## Inside this issue . . .

Esko Petäjä turns his attention to earthquakes, discussing how satellite observations can help in their prediction, and explaining how an inexpensive sensor and free software enabled him to participate in the Quake Catcher Network.

In an extract from Paul White's 'Clouds Across the Moon', he describes some of the early days of weather satellite imaging, when ESSA, ATS and Nimbus were the state-of-the-art spacecraft.

For readers with an interest in environmental monitoring, and who need to publish information from a database on the Internet, Andreas Lubnow describes a project which harnesses a Geiger counter to add radiation data to his existing EUMETSAT station.

There is another article to help readers obtain the most out of David Taylor's L1 Viewer, tips on fine-tuning a EUMETCast computer to handle the new MSG-3 data, a report from NASA on the current climate warming trend and more besides ....

Editorial

Les Hamilton
geoeditor@geo-web.org.uk

Firstly this quarter, apologies for two compilation errors that are rectified on page 12 of this issue: the omission of Robert Moore's Falkland Islands image and some incorrect total-ozone maps. I hope these errors did not spoil your enjoyment of the December issue.

A new approach to the reception of NOAA APT imagery has made an appearance recently, based on the use of inexpensive DVB-T digital TV/Radio USB dongles plus public domain Software Defined Radio (SDR) software. Rob Alblas has kindly translated and updated his article, which originally appeared in *De Kunstmaan*, for GEO. There are also a number of videos on *YouTube* that show the technique in action, and the URL below makes use of precisely the same set-up that Rob describes. The image is seen building up on the PC monitor and really looks to be of excellent quality. Of course, for users in the UK, there must be the caveat that pagers could be a problem, but the cost involved is so miniscule that we hope many readers will take up the challenge and let us hear about their experiences.

http://www.youtube.com/watch?v=o7bKsPYfOhg

We are fortunate in having three major feature articles this issue, from Andreas Lubnow, Esko Petäjä and Paul White. Don't be put off by the unusual title of Andreas' essay. The radiation data aspect simply relates to a currently ongoing project, and the main thrust of the article actually deals with a topic that should prove useful to many GEO readers: how to publish data from environmental monitoring stations (including EUMETCast and Weather Stations) on the Internet. Some aspects of this, such as the use of MRTG, will already be familiar to some of you. Esko's article discusses the topic of earthquakes and their possible prediction from satellite evidence, and also includes details of a project he has undertaken—joining the *QC-Network* via an inexpensive earthquake sensor and free software. Paul's submission is a modified extract from his e-book '*Clouds Across the Moon*', and deals with the early days of weather satellite imaging, specifically from the ATS, ESSA and Nimbus orbiters.

A reminder to everyone that this is the second issue during which Rob Denton is running his *Farthest West* imaging challenge (see page 33 of the December Quarterly), with a prize for the best entry. The closing date for sending your images to Rob has been revised to April 20, to get them in before the copy deadline for the next issue.

Finally, please note that the **copy deadline** for GEO Quarterly 38 is a little earlier than usual, **Saturday, April 27, 2013**. This is because many contributors tend not to submit copy till the very last minute (often past the deadline), leaving me with a mad rush to publish the magazine on time. As I am on holiday for much of the month of May, it is essential to receive all the copy in good time. My December *Quarterly* reached me only two days before the Christmas holiday, and I suspect some readers may have had to wait even longer for theirs. The copy deadline is intended for important last minute news, and major articles, specially those with diagrams, images and photographs, really should be submitted at least two weeks earlier.

Contents

The GEO Report

Francis Bell

I notice that in the first paragraph of my report in *GEO Quarterly 36,* I offered congratulations to EUMETSAT and ESA for the successful launches of MSG-3 and Metop-B in 2012. Now, further congratulations are in order because of the successful commissioning of each satellite, and as best I can judge from reports, all the instruments and systems are working perfectly.

I do follow daily the bulletins published by EUMETSAT and knew approximately when MSG-3 (Meteosat-10) was to enter service as the primary satellite at zero longitude. However, I am slightly embarrassed to admit that, in late January, I was mystified as to why I could not display images from MSG-3. I operate two systems, and both behaved in the same way: that is, they displayed relayed images from GOES-E, GOES-W and other satellites, but images from zero longitude were missing.

I contacted David Taylor, the author of my decoding software, and he instantly identified the problem: my software was still configured for MSG-2 reception. A simple change in the 'set up' menu—switching from MSG-2 to MSG-3—instantly resolved the problem and I am now receiving beautiful images from this new Earth observation satellite. There is an article from David Taylor on page 5 to help others who may be experiencing the same problem as I did.

Meetings

During a recent GEO Management Team meeting, we discussed possible dates and venues for our next symposium. For several years, we have held very successful events at the National Space Centre (NSC) Leicester. This venue has proved attractive because of its central location, the meeting facilities which it provides plus the bonus of access to the exhibitions areas. However, we have to recognise that, in recent years, there has been a decline in the numbers of members attending our symposiums and this is compounded by an increase in the cost of hiring the facilities at the NSC. Our meeting discussed the issues without taking a specific decision relating to a symposium in 2013. However, we did decide to research other potential venues and, if a decision is taken, details will be published in *GEO Quarterly* and on our website.

Other possible visits in mind are to the *National Oceanography Centre* and/or *Astrium*, both in Portsmouth. Each of these is being researched, and again, plenty of notice will be given to members of times and dates.

Director's Workload

During our annual management meeting in November 2012, I indicated that I wished to reduce some of my GEO responsibilities and consequent workload . I have agreed to list some of the tasks which I think could usefully be undertaken by others, and the management team will try to progress some degree of devolution. This is an invitation: if you think you have the time and inclination to contribute to the running of GEO in, say, financial matters, organising meetings or other day-to-day matters, please contact me or another member of the GEO management team.

EUMETSAT Book

I still have a small number of copies of the book documenting EUMETSAT's first 25 years. If you would like a copy, please contact me directly by email at

francis@geo-web.org.uk

The book is free but you will have to pay the carriage and packing charge for this weighty 1.8 Kg book.

Turnstile Antenna

In November 2012, I was very pleased to be able to test a new turnstile antenna specially designed for APT reception and manufactured for GEO by *Sandpiper Aerials*. My tests related to the successful reception of NOAAs 15, 18 and 19 signals. A further report appears on the next page. It is particularly important to have this antenna available to GEO members because the QFH antenna which we formerly offered for sale is no-longer available.

Downconverter

A few week ago, I was contacted by a member in the USA who was looking for a downconverter taking 1.6 GHz to 137.5 MHz. He wanted it as part of a project to establish an HRPT receiving station. It so happened I had exactly what he wanted because these downconverters were in common use in the early days of Meteosat reception. The downconverter was duly shipped to the USA and, after minute examination by US customs, was delivered to our member. In due course I hope we can have a report about this project. The lesson here is that if you still have a downconverter tucked away in your shack, you should look after it; someone may have a worthwhile use for it in the future.

Volcanoes

Although it is not too late to submit your entry, I have so far not received any members' images of volcanoes. The invitation to submit an image of a volcano was issued last year so, if you have something which you think may be worth publication, please send it to myself of our editor. We will keep this invitation open for the rest of 2013.

Subscriptions

Members will have noticed that we increased our subscription rates from December 2012, something over which we had little control because of the sharp increase in postage rates. Printing costs have been moderately stable for several years but we cannot escape the increases in postage and carriage charges. Nearly all our subscription income is spent on printing and postage, only a tiny amount being used to cover other overheads. I hope the increase in subscriptions will not compromise any member's decision to remain supportive of our group.

Electronic Membership

We are actively researching a form of electronic membership to our group. Details will be made available as soon as a decision has been made and appropriate systems are in place.

Forthcoming Events

April 21, 2013
The West London Radio and Computer Show. This show is held at Kempton, and GEO will have our usual stand there.

QUARTERLY QUESTION

Quarterly Question 35

Quarterly Question 35 asked about the orbital altitude of Europe's polar orbiting weather satellite Metop-B, launched in 2012 and now operational. When I posed the question, the answer I had in mind was 817 kilometres, the figure published on both the EUMETSAT and ESA websites. My thanks to the following members who took an interest in the question and submitted correct answers: Elmar Bogels (Brunssun, The Netherlands), Adrian Chamberlain (Coventry, UK) and Pete Bently (UK). All quoted a figure of 817 km or a figure acceptable close to it.

There are several parameters to be considered when quoting a single figure average for an orbital altitude. The orbit may be slightly elliptical, so its instantaneous altitude will depend on the reference position on Earth's surface from where it is measured. The Earth is not a perfect sphere because its rotation makes it slightly oblate, and thus flattened at the poles. Earth's radius is 6,378.2 km at the equator but only 6,357.8 km at the poles, a difference of 21.4 km. Hence the altitude of a satellite, even one in a hypothetical perfectly circular orbit, would vary from any quoted mean orbital altitude for different locations on the Earth.

Quarterly Question 36

This question was prompted by the answer to Quarterly Question 35. Just out of curiosity, I wondered how many times further away geostationary satellites are compared with low earth orbiting satellites. I did the calculation and the scale of the answer surprised me: that is just how far away geostationary satellites are from the surface of the Earth. A geostationary orbit is perfect for a telecommunications satellite but a compromise for a satellite that images or monitors the surface of the Earth: however, the distance from Earth's surface for the latter is absolutely dictated by the orbital dynamics for this favoured position.

Question 36 is: 'How many time further away from the surface of the Earth is a geostationary Earth observation satellite such as Meteosat-10 compared with a low Earth orbiting satellite like Metop-B'. To calculate the answer divide the altitude of the geostationary orbit by 817 and quote the answer to the nearest whole number with no decimal places. I will accept answers plus or minus one, when compared with my own calculation.

Here is a second less serious mathematical question prompted by the author Douglas Adams and his publication: A Hitchhiker's Guide to the Galaxy', which gave the answer to 'The Ultimate Question of Life the Universe, and Everything'. Numerically, the answer to this question in the story is the same as the question relating the ratio of altitude for a low earth orbiting satellite compared with a geostationary one. **This secondary question is**: What is the name of the computer in the story, which generated the answer to this ultimate question?' Just a two word answer will be correct.

Answers should be submitted to Francis Bell at

francis@geo-web.org.uk

before April 27, 2013, the copy deadline for GEO Quarterly 37.

GEO Shop's new APT Antenna

For the past year or so, the *GEO Shop* has been unable to supply new turnstile antennas for the reception of APT signals. Happily, this shortcoming has now been resolved with the availability of a brand new APT antenna manufactured for us by **Sandpiper Aerial Technology Ltd** of Aberdare, Mid Glamorgan.

http://www.sandpiperaerials.co.uk/

Discussions resulted in an agreement to produce a prototype for GEO to test. If this proved successful, they would produce batches for us as required. I collected the prototype at November's *Kempton Radio Rally* and, a few days, later tested it at my home in Surrey.

During my tests, the antenna was mounted on a modest supporting mast, just outside my front door, at a little above head height. I did, of course, ensure that the coax connections were in accordance with the supplied diagram. This has to be correct because of the right hand circular polarisation of the incoming signal, and simply involved the connection of a short loop of coax, in addition to the coax downlead to my receiver. Satellite signals were fed into my RX2 receiver, in turn connected to a laptop computer running *WXtoImg* capture and display software. The image below came from a NOAA-19 pass on November 30.

Cover and Full Page Images

Front Cover

Alan Banks sent in this Metop-A image showing Super Typhoon Bopha as it bore down upon the Philippines on December 3, 2012.

Image © EUMETSAT 2012

Inside Front Cover

This November 13, 2012 MODIS image from NASA's *Terra* satellite includes Zambia, Mozambique and Tanzania, and highlights some of the lakes of East Africa's Rift Valley: from north to south, lakes Victoria, Tanganyika and Malawi. To the southwest are two artificial lakes (reservoirs): Kariba (far left), the world's largest artificial lake, and Cahora Bassa (centre).

Image: LANCE-MODIS/NASA/GSFC

Inside Back Cover

Paying homage to ESA's *Envisat* mission, Francis Breame sent us these two superb examples of the satellite's output: a detail of west Africa including Gambia and Guinea-Bissau, with their rivers showing prominently (top); and another of Sudan, highlighting the confluence of the White Nile with the Blue Nile (bottom).

Image: ESA

Back Cover

This is the first image from the recently launched Metop-B to be sent in by a reader. Mike Stevens was impressed by this picture of New Zealand acquired from the 21:04 UT pass on February 1, and downloaded via his EUMETCast system.

Image © EUMETSAT 2013

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This November 12, 2012 MODIS image from NASA's *Terra* satellite shows almost the whole of Argentina, remarkably free from cloud, from Rio de la Plata all the way south to Tierra del Fuego. The River Negro is a prominent feature, flowing eastward from the confluence of its two tributaries, the Limay and the Neuquén. The Negro is an important source of hydro-electricity, and its waters irrigate the province's apple and pear orchards.

Image: LANCE-MODIS/NASA/GSFC

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This is a *Terra* MODIS channel-2, 250-metre resolution image dating from January 16, 2012, showing part of England and The Netherlands in the embrace of snow and ice as winter's harshest weather arrived, driven by high pressure over the Continent.

Image: NASA/GSFC LAADS Web
Processing: David Taylor's MODIS L1 Viewer

Page 25

Mike Stevens submitted this Metop-A image which captures the transition of the UK and Netherlands out of January's two-week spell of freezing weather. Much of Scotland, England and The Netherlands are covered by snow in this midday image from Metop-A on January 26, but the advancing Atlantic depression effected a rapid thaw that cleared most of the snow within 48 hours.

Image © EUMETSAT 2013

I started receiving a worthwhile signal almost immediately that NOAA-19 cleared my southern horizon and, considering the rather unfavourable location of the antenna (my house was partly blocking the northern horizon), I thought this was great. Above a satellite elevation of about 30°, my signal meter gave a full scale deflection. It's also worth noting that I did not use a masthead preamplifier and that the coax run to the receiver was about 15 metres. I judged the antenna to be well manufactured and easy to assemble: it should be a valuable resource for anyone wishing to start APT reception or upgrade an existing system.
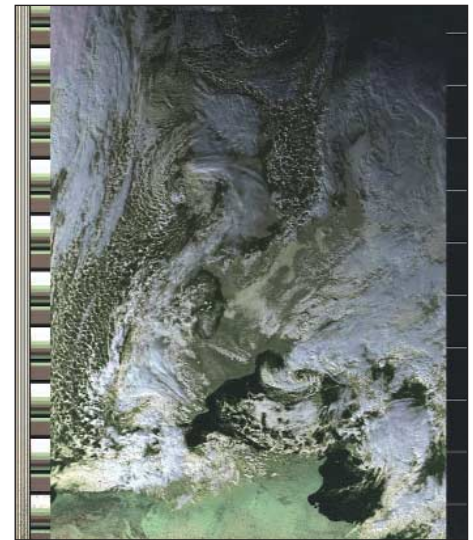
Turnstile of QFH?

It is no secret that I have long preferred the turnstile antenna to the QFH (Quadrifilar Helical antenna). I accept the attraction of the latter for its superior gain for signals from close to the horizon, however with a trade-off of less gain from high elevation signals. Cosmetically, a QFH antenna my look good and will be robust in exposed or maritime conditions, but personally, I find it almost impossible to believe that a QFH will outperform a well constructed turnstile.

But what are your views? I invite anyone in the world to test a QFH antenna against a well located, well designed turnstile antenna, for RF performance, and hope that you will send your reports and comments to

The prototype GEO APT antenna on test in Francis Bell's front garden

the Editor, for the benefit of all our readers.

It is not known how long APT reception will remain available: it may last for ten years; it could end tomorrow. NOAA-19 is the last of the American APT satellites, and LRIT is now the universal standard that has taken over from the obsolescent APT format which we have enjoyed receiving for about 40 years.

This NOAA-19 image was received at about 13:00 UT on November 30, 2012.

Any reader wishing to purchase the new turnstile antenna can find details on the GEO Shop page of our website, and on the advertisement on the back cover of this issue. Also note that the *WXtoImg* software for decoding APT signals is freely available at

http://www.wxtoimg.com/downloads/

Receiving a NOAA-18 signal with a USB Dongle and SDR Software

The image below shows *SDR#* playing a previously recorded NOAA-18 signal at the same time as the image is being decoded by *WXtoImg*. Despite the very low signal level, the switch between the VIS and IR channels is clearly seen in the 'waterfall' as the pattern is alternately wide and narrow.

At top left on the screen, the input device can be chosen, e.g. the USB receiver or, in this case, an input wav file. The *Centre* frequency is grayed out, but the processing frequency can still be chosen for this recording. At the bottom of the screen is the recording pane, with recording selectors for

Baseband (the digitised signal before any SDR processing) and *Audio*.

Recording is off in this example because the signal comes from a prerecorded satellite pass.
This is version v1.0.0.1000 of *SDR#*.
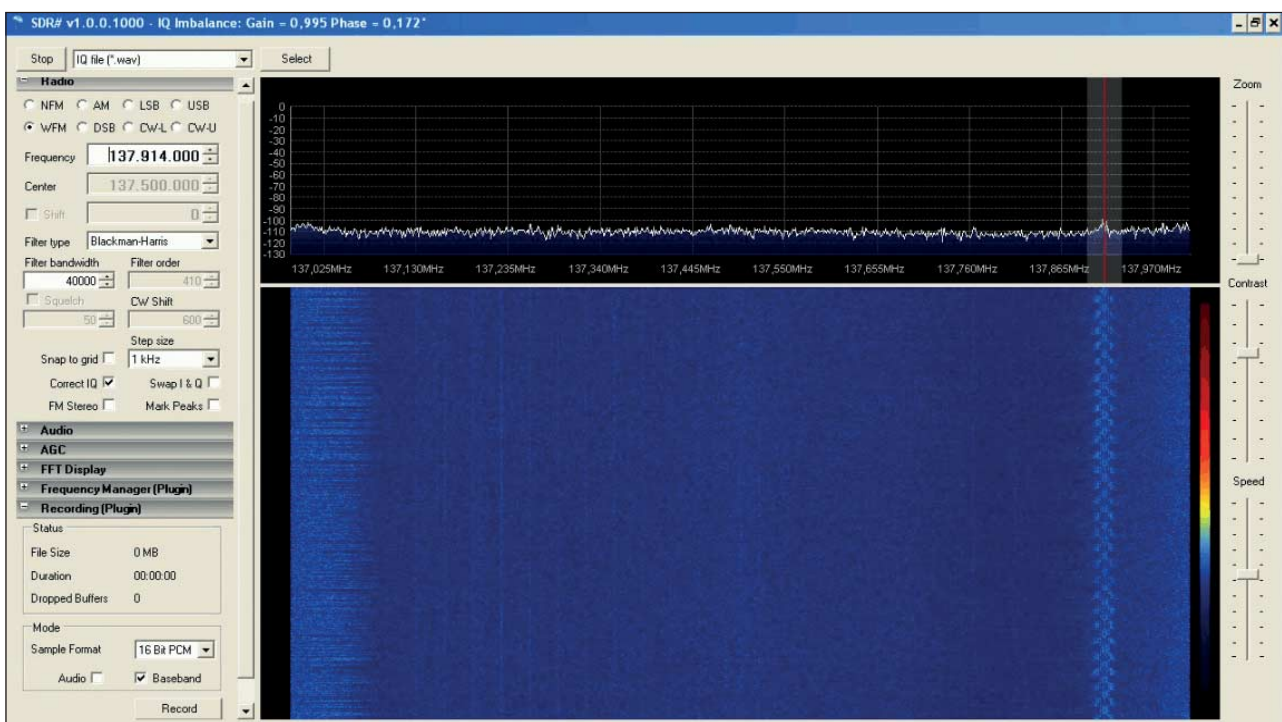
A NOAA 18 signal, received on a USB Dongle, being decoded with SDR# software - Read Rob Alblas' Article on page 14.

Fine-Tune your Software to Receive
MSG-3 on EUMETCast

David Taylor

Meteosat-10 (MSG-3) came on stream as EUMETSAT's prime operational geostationary weather satellite on January 21 this year, replacing Meteosat-9 (MSG-2). As far as your *SkyStar DVB* and *TelliCast client* settings are concerned, there is no need to change anything. However, adjustments do have to be made to *MSG Data Manager* to receive data from this new satellite, as outlined below.

You must first stop *MSG Data Manager* processing by pressing the button with the bright green LED, at the lower left on the screen, marked '*Stop*'.

Now go to the **Setup tab** (figure 1), open its **Channel Selection tab** and than the **FSD tab**, to make the following checks and changes. Ensure that **Generic naming** is checked then click the '*Advanced*' button at the lower right of the screen to enter the **Advanced Setup tab**, where you must select 'MSG-3' from the **Satellite** drop-down selector (figure 2).
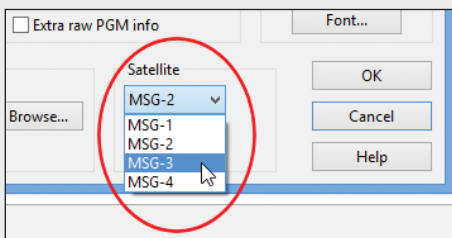
Figure 2 - The Satellite selector menu

After changing the satellite, you will see a message panel which advises you that a program restart is required after you leave the Advanced Setup screen (figure 3). Acknowledge the message with a click on '*OK*'. Ensure that **Delete other** below the **Satellite** drop-down selector is **not** checked and close the **Advanced Setup tab** by clicking '*OK*' (figure 4).
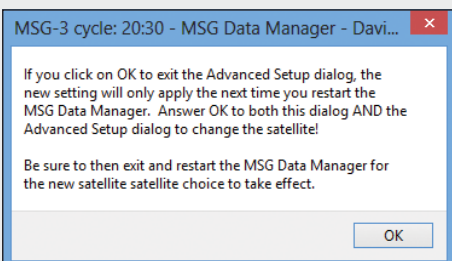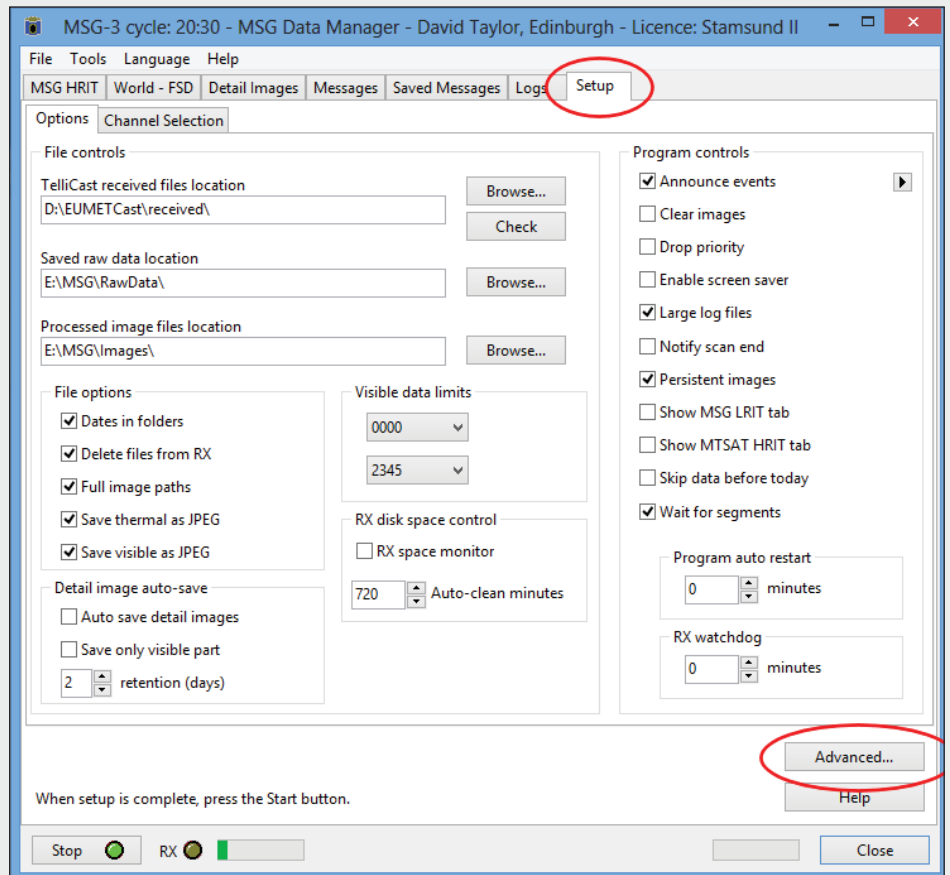
Figure 3 - The reminder message panel

Figure 1 - The main MSG Data Manager screen highlighting the the 'Setup' tab and 'Advanced' button.

Finally, if *MSG Data Manager* is still running, stop it with the '*Stop*' button then press the '*Close*' button to exit.

Next time you run *MSG Data Manager*, your changes will have taken effect and you should receive Meteosat-10 (MSG-3) data.

As a final check, open the **Logs tab**, where the window should display a message like:

> '*Program V2.6.8.1069 start on MSG-3*'

to confirm that the MSG-3 satellite has indeed been selected. Now press the '*Start*' button. There may be a short delay if you have a backlog of the new MSG-3 data to process.

The intention in the *MSG Data Manager* settings is that source data other than MSG-3 will <u>not</u> be deleted, and that FSD labelled MSG1, MSG2, MSG3 or MSG4 will all be accepted and processed.

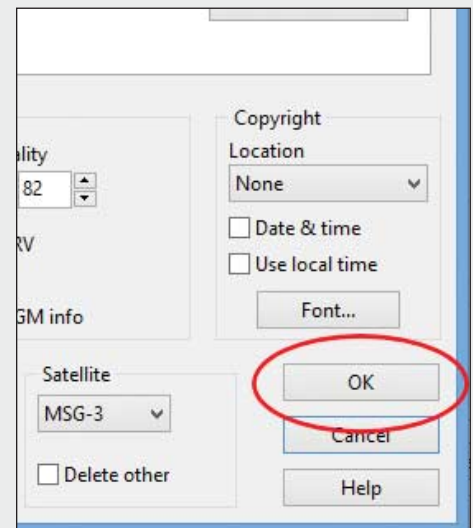If you are running the MSG Animator software, you should close and restart that program as well.

Figure 4 - Exiting the Advanced Setup Tab

David Taylor's MODIS L1 Viewer

Alan Banks

MODIS Satellites - Terra and Aqua

The Moderate Resolution Imaging Spectroradiometer (MODIS) is a key instrument aboard NASA's *Terra* (EOS AM) and *Aqua* (EOS PM) satellites. *Terra's* orbit around the Earth is timed so that it passes from north to south across the equator in the morning, while *Aqua* passes south to north over the equator in the afternoon.

The MODIS instrument has a viewing swath width of 2,330 km and views the entire surface of the Earth every one to two days. Its detectors measure 36 spectral bands between 0.405 and 14.385 μm, and it acquires data at three spatial resolutions: 250 metres, 500 metres, and 1 kilometre.

Data is accessible from:

- EUMETCast
- the LAADS Website
- the Modis Rapid Response website (near real time images)

LAADS Web is NASA's web interface to the *Level-1 and Atmosphere Archive and Distribution System* (LAADS). The mission of LAADS is to provide quick and easy access to MODIS Level-1, Atmosphere and Land data products. *LAADS Web* allows you to:

- Search, order, and download MODIS products.
- Visually browse MODIS products.
- Access tools to use with MODIS products.
- Get help, including tutorials and contact information.

Of the MODIS instrument's 36 channels, one can access all of them at 1 km resolution via the LAADS website. Fewer channels are available at the higher spatial resolutions.

EUMETSAT's EUMETCast Dissemination Service

In addition to the established data delivered for some years (Meteosats, Foreign Satellite Data, NOAA Regional AVHRR and Metop Global AVHRR), the *EUMETCast* service now delivers registered users with 18 channels of 1-km resolution raw MODIS L1 data covering Europe and the Arctic Ocean.

The MODIS L1 Viewer

This program from David Taylor allows one to visualise image or fire data from raw MODIS L1 files, acquired either from the Internet or *EUMETCast*. The data is delivered in 5-minute segments, in HDF format, and the software allows you to combine multiple 5-minute segments from the same pass into a larger image. Both the raw data, and several derived false-colour images are available.

From version 3 and upwards of the *MODIS L1 Viewer*, you can process all three resolutions (250 m, 500 m or 1 km) of data from the LAADS website, and produce false-colour combinations from visible or infra red bands.

Installing the L1 Viewer Program

MODIS L1 Viewer can be downloaded from David Taylor's website at

http://www.satsignal.eu/software/modis-L1-viewer.html

as a ZIP file. David recommends that the program is not installed in *Windows* 'Program Files' folder, especially if you use *Vista* or *Windows-7*. Instead, create a new folder such as *C:\David_Taylor* and extract the zipped file into this. The extracted files include *ModisL1viewer.exe*, along with several language files and *dll* files.
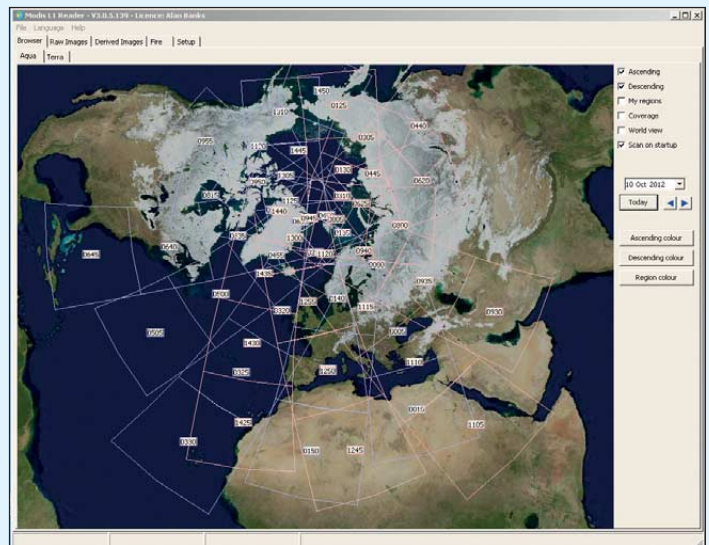

Figure 1 - MODIS segments displayed in the L1 Viewer

If this is the first time you have used any of David Taylor's software packages, you must also download and install his *Runtimes Library* file from

http://www.satsignal.eu/software/runtimes-setup.100.zip

The extracted file will be *runtimes-setup.exe*, which is installed simply by double-clicking it.

Additionally, you should download *cities.dat* and *countries.dat* files from the following URLs and extract their contents into the *ModisL1Viewer* folder.

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

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

Finally, it would be useful to create a shortcut to the *ModisL1viewer.exe* file on your PC's desktop.

Using the Program

If you intend to use the program for MODIS data downloaded via *EUMETCast*, you will need to be running at least one instance of David Taylor's *MSG Data Manager* software. This is the program that manages the MODIS-L1 data received by the *EUMETCast* software and stores it in the following subfolders

MSG-1\Images\MODIS-L1 and
MSG-1\Images\Fire.

However, the program can be used on its own if you intend to use it for MODIS data downloaded over the Internet from the LAADS website.

The first thing you have to do when running *MODIS L1 Viewer* is to set up the program for operation by making adjustments to parameters in the **Setup** tab (figure 2). You will find the button to open this tab at the top right of the opening screen, shown in figure 1.

These include some basic housekeeping operations such as using the **Program Control** '*Browse*' buttons to navigate to the folders where *MSG Data Manager* stores the MODIS L1 images, and the Fire Images. Once done, these locations are retained by the software for future use. This applies to *EUMETCast* data. For all data sources, you must to make a
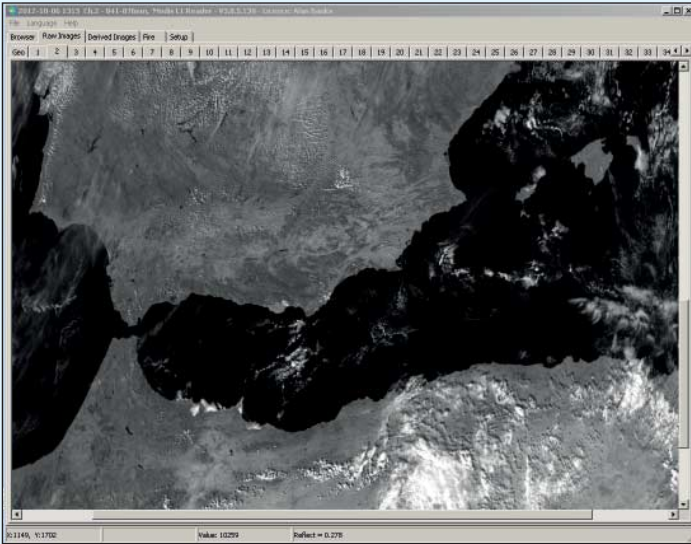
Figure 2 - The 'Raw Images' tab

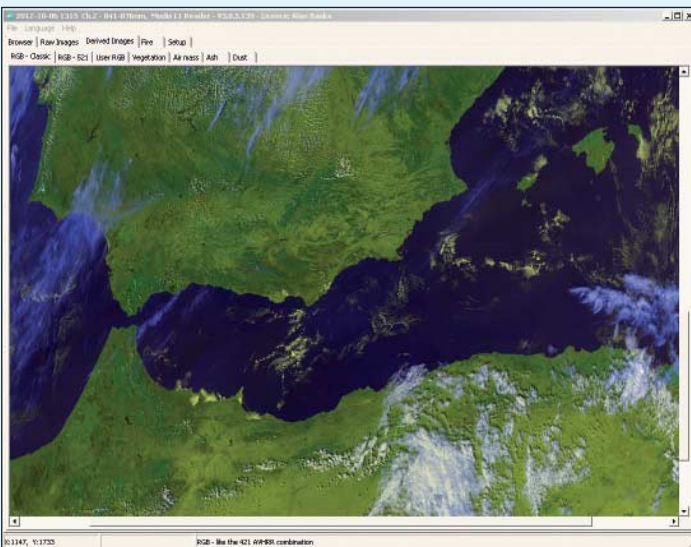Figure 5 - A result obtained with the 'User' RGB option

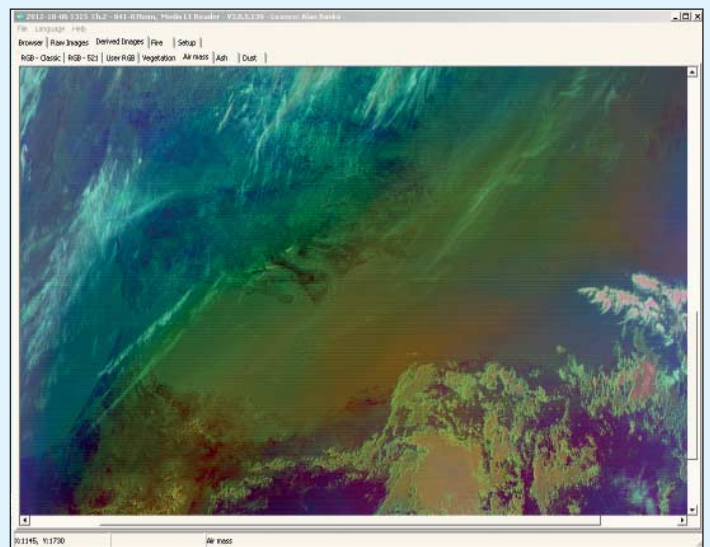Figure 3 - The classic RGB composite colour image

Figure 6 - The Vegetation, Air Mass, Ash and Dust option

Figure 4 - An RGB image created by combining channels 5, 2 and 1.
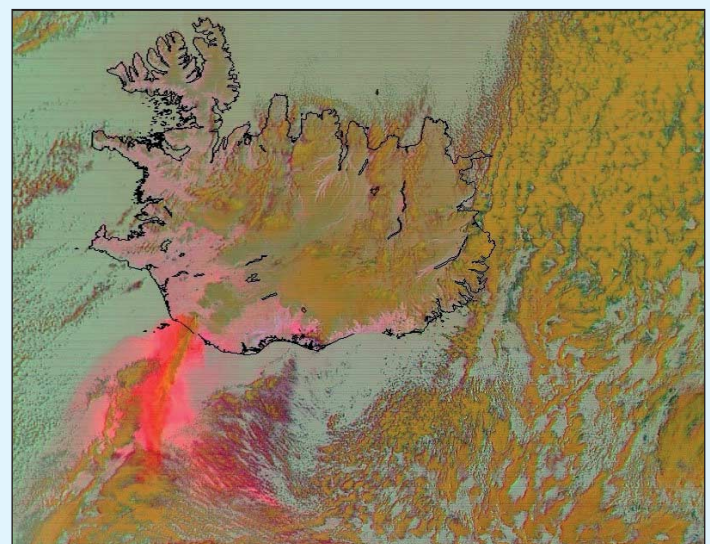
Figure 7 - The Ash Plume from the Eyjafjallajkull Volcano

similar adjustment in the **Save Files** panel to point to the folder where the processed images are to be saved, and select from the **Image save format** drop-down menu the format in which you wish your images to be saved.

Depending on the source of your MODIS L1 files, you must select one of the radio buttons in the **Channel Group** panel.

EUMETCast only makes 18 of the 36 MODIS channels available so, if you are using *EUMETCast* files, select **EUMETCast channels**. If you are using files obtained from *LAADS Web*, or a combination of both sources, you should select **All channels**. The effect of this is to display either 18 or 36 buttons at the top of the **Raw Images** tab. This selection can be changed at any time, but will require a program restart.

Figure 8 - The Setup Tab

There are further selections you can make on the **Setup** tab (figure 8). These include **Defrag Raw Data**, which reduces the pixelation at th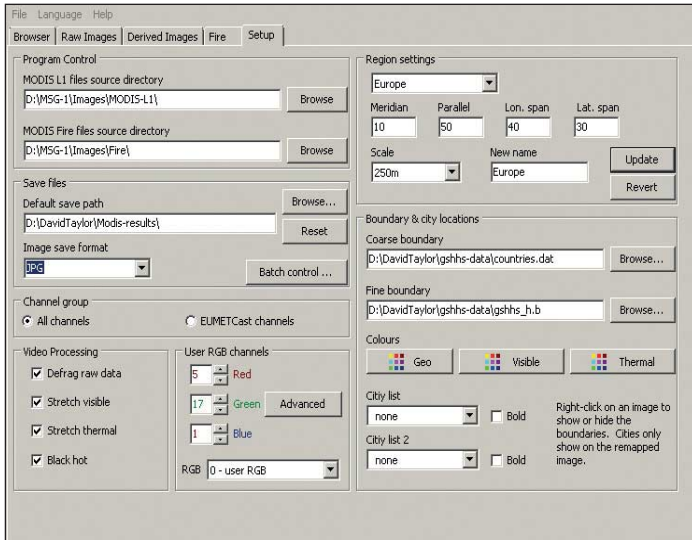e edges of MODIS images; **Stretch visible** and **Stretch thermal**, which are effectively brightness controls; **Black hot**, which most prefer to use; and **User RGB**, which provides some ten options where you can define which channels will be mapped on to red, green and blue for creating colour composite images.

Region Settings is a drop-down menu where you can select the areas for remapping the final images, e.g. 'Europe', 'UK', 'Iceland'. For now select **Scale** as 1 km, although you would normally select a value matching the resolution of the raw data downloaded from the Internet or *EUMETCast.*

Finally, there are the **Boundary** and **City** choices. For now, use the **Coarse Boundary** *Browse* button to navigate to the folder containing the *countries.dat* file. The drop-down box **City list** allows you to select from files of city location data (such as *cities.dat*) placed in the Modis L1 folder.

Setting up the Browser

On opening *MODIS L1 Viewer*, you are presented with the **Browser** tab, which provides a graphical view of the data available for a particular date (figure 1). There are a number of tick boxes on the right hand side of this tab to tailor the browser display to your particular requirements.

Either **Ascending** or **Descending** (or both) must be selected. **My Regions** highlights the preselected regions in a colour of your choice; **Coverage** outlines the overall extent of the data available, outlined in yellow; **World View** replaces the default view of Earth looking down on the North Pole, as illustrated in figure 1, with an equatorial view. If the **Scan on startup** tick box has been selected, the program will check to see what data are available in the source directory and display them. You can refresh this by clicking on the **Today** button.

You can navigate through the data stored on your PC by use of the **calendar** control. **Today** displays the current day's data, and you can step the display backwards and forwards a day at a time by means of the **next/previous** arrow buttons below the calendar. Finally, the three palette buttons below the calendar allow you to select different colours for ascending and descending passes, and for region outlines.

Using the Browser

The location of each MODIS image segment that has been downloaded is indicated on the browser map by a coloured rectangle. In figure 1, the ascending and descending pass images are differentiated by colour, pink and blue, each conveniently labelled with the acquisition time of the

segment. You can select either a single segment, or a set of adjacent segments, to be processed. How long one retains data from *EUMETCast* is down to the individual: I keep mine for two weeks.

Decide which satellite to use by selecting either the **Aqua** or **Terra** tab. You can now display any image segment by double-clicking its outline on the browser, when it will be displayed in the **Raw Images** tab. Here you can review each of the 18/36 MODIS channels by clicking on the buttons at the top of the screen (figure 2). The **GEO** button displays the location of the image you are viewing over a map.

You can also display an image consisting of a series of adjacent MODIS segments joined together. Left-click once on each segment outline shown on the browser, followed by a right-click, then choose **open multiple** to display the result. For data downloaded from the Internet, you can drag-and-drop a file from *Windows Explorer* on to the **Browser tab**.

A right-click on the displayed image reveals a pop-up menu offering options to add country boundaries and coordinate grid to the image, zoom in/out, adjust the visible channel brightness, remap to a different region and Save the image. Other options will be variously greyed out, depending on what is available for a particular channel/image.

What can be achieved with all this data has yet to be fully explored by software users. Although the spatial resolution available via *EUMETCast* is the same as EUMETSAT's Metop satellites, more spectral channels are available. The question is whether by combining channels in different ways, one can show detail not available elsewhere?

The availability of higher resolution 500 m and 250 m data from the Internet (see below) allows the user greater detail. NOAA, in their published images, tend to go for photorealism. This software allows users to explore different channel combinations in producing false colour images. David Taylor has already provided some channel combinations for users, taken from some of his other software, to produce image colours many will be familiar with.

Composite Images

On opening the **Derived Images** tab, you are presented with a number of options for combining different MODIS channel images into colour composites, to highlight features. The results of some of these are illustrated in figures 3-6.

- RGB Classic   (figure 3)
- RGB – 521   (figure 4)
- User RGB   (figure 5)
- Vegetation, Air Mass, Ash and Dust   (figure 6)

In the **user RGB** tab, a right-click menu allows you to substitute any of the ten user RGB settings you may have defined. The **Ash** setting is useful for highlighting a volcanic ash plume, like those from Iceland's Eyjafjallajkull volcano, which caused air traffic chaos in April and May 2012 (figure 7).

Level 1 and Atmosphere Archive and Distribution Center

If you are not a *EUMETCast* user, you can still enjoy the experience of creating MODIS images in the *L1 Viewer* because NASA makes MODIS data (from both the *Terra* and *Aqua* satellites) available from the LAADS website. The LAADS website offers a huge number of files in HDF5 format, with resolutions down to the 250 m level. However, you do need to be quite selective in choosing an area of interest as each HDF5 datafile is very sizeable, generally of the order of 150-180 MB. The files can be retrieved from an ftp server using a standard ftp client.

To order MODIS files, you must first visit

http://ladsweb.nascom.nasa.gov/data/search.html

Displaying results 1 - 10 of 128.   1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Next | View All

Time	Product	File Name	Size	Online	Add	Browse
2012-306 09:15	MOD021KM	MOD021KM.A2012306.0915.005.2012306194726.hdf	160 MB	Yes	☑	+ View RGB
2012-306 21:20	MOD021KM	MOD021KM.A2012306.2120.005.2012307102859.hdf	68 MB	Yes	☑	+ View RGB
2012-307 08:15	MOD021KM	MOD021KM.A2012307.0815.005.2012307172748.hdf	156 MB	Yes	☑	+ View RGB
2012-307 08:20	MOD021KM	MOD021KM.A2012307.0820.005.2012307173126.hdf	163 MB	Yes	☑	+ View RGB
2012-307 22:00	MOD021KM	MOD021KM.A2012307.2200.005.2012310041933.hdf	74 MB	Yes	☑	+ View RGB
2012-307 22:05	MOD021KM	MOD021KM.A2012307.2205.005.2012310042524.hdf	64 MB	Yes	☑	+ View RGB
2012-308 09:00	MOD021KM	MOD021KM.A2012308.0900.005.2012313124229.hdf	153 MB	Yes	☑	+ View RGB
2012-308 21:05	MOD021KM	MOD021KM.A2012308.2105.005.2012313125213.hdf	74 MB	Yes	☑	+ View RGB
2012-309 08:05	MOD021KM	MOD021KM.A2012309.0805.005.2012310152537.hdf	159 MB	Yes	☑	+ View RGB
2012-309 21:50	MOD021KM	MOD021KM.A2012309.2150.005.2012310153005.hdf	70 MB	Yes	☑	+ View RGB

Select Online Checkboxes   Select Offline Checkboxes   Clear All Checkboxes

Figure 9 - Selecting MODIS HDF5 files from the LAADS Website

Figure 10 - A MODIS image showing England and Wales almost totally cloud-free
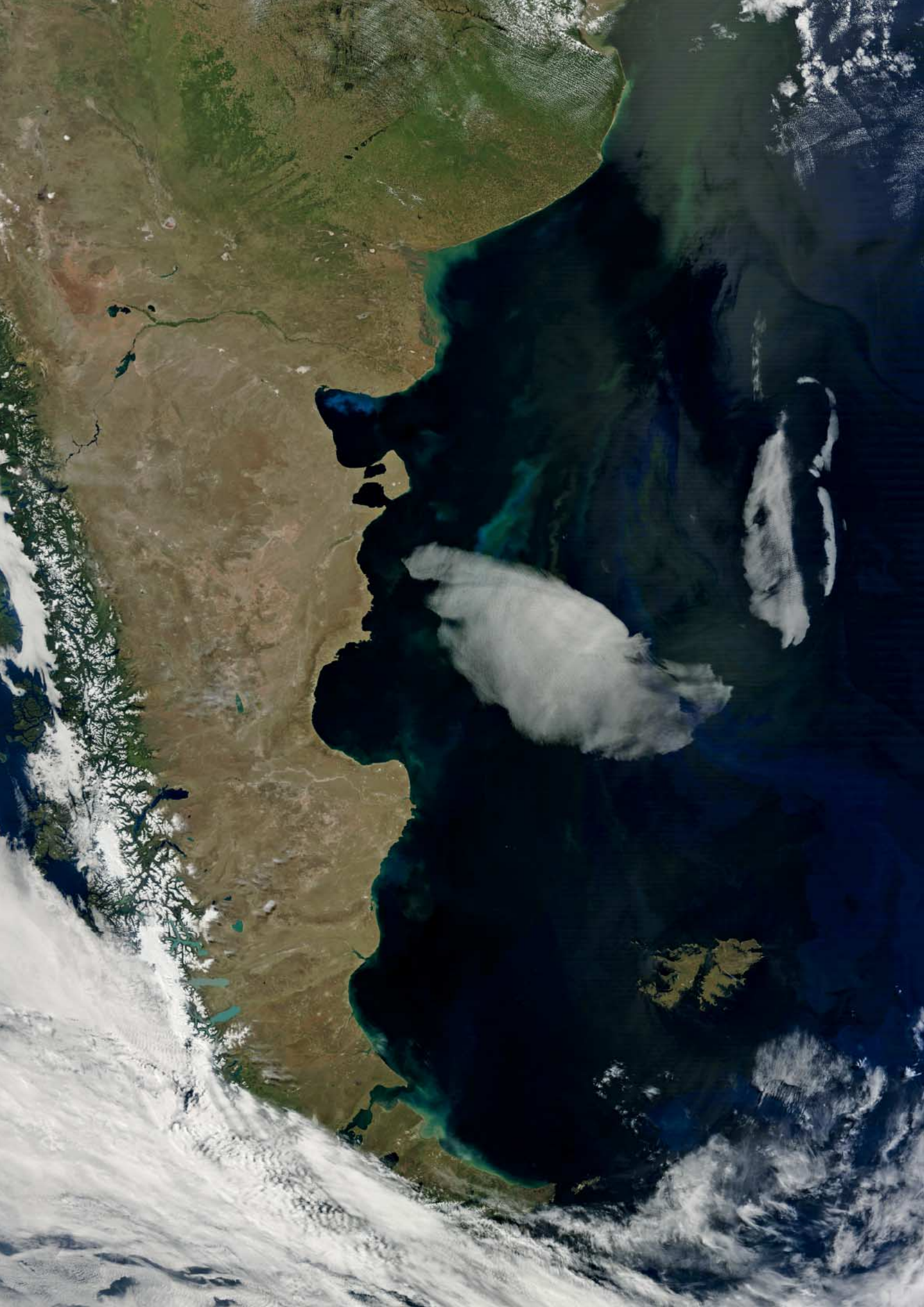
Direct reception of
Metop-A Imagery

Jordi Mas - EA3 AGY   *email: jordimas@smc.es*

Jordi Mas from Barcelona has been receiving Metop-A imagery directly from the satellite, and thought GEO readers might be interested to see his results.

Jordi writes:

Figure 1 shows part of an image I received from a Metop A pass on December 1, 2012.

Information about the design of my demodulator equipment and the capture software I used can be found on the website of my friend Oleg, at

http://sat.cc.ua/index.html

The reception system consists of a

- 1.2 m parabolic dish antenna
- modified *Kuhne* convertor
- 3-cavity bandpass filter
- *Comtech* SLM-7650 modem demodulator
- Yaesu G-5500 rotator
- ERC-M interface
- *WxTrack* and *HRPT Reader* from David Taylor.

The display in figure 2 shows the reception of the AHRPT signal, and figure 3 shows the demodulator in operation.
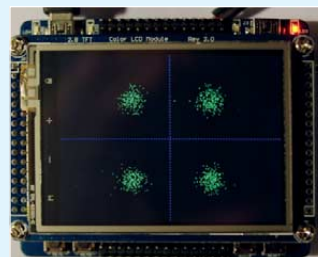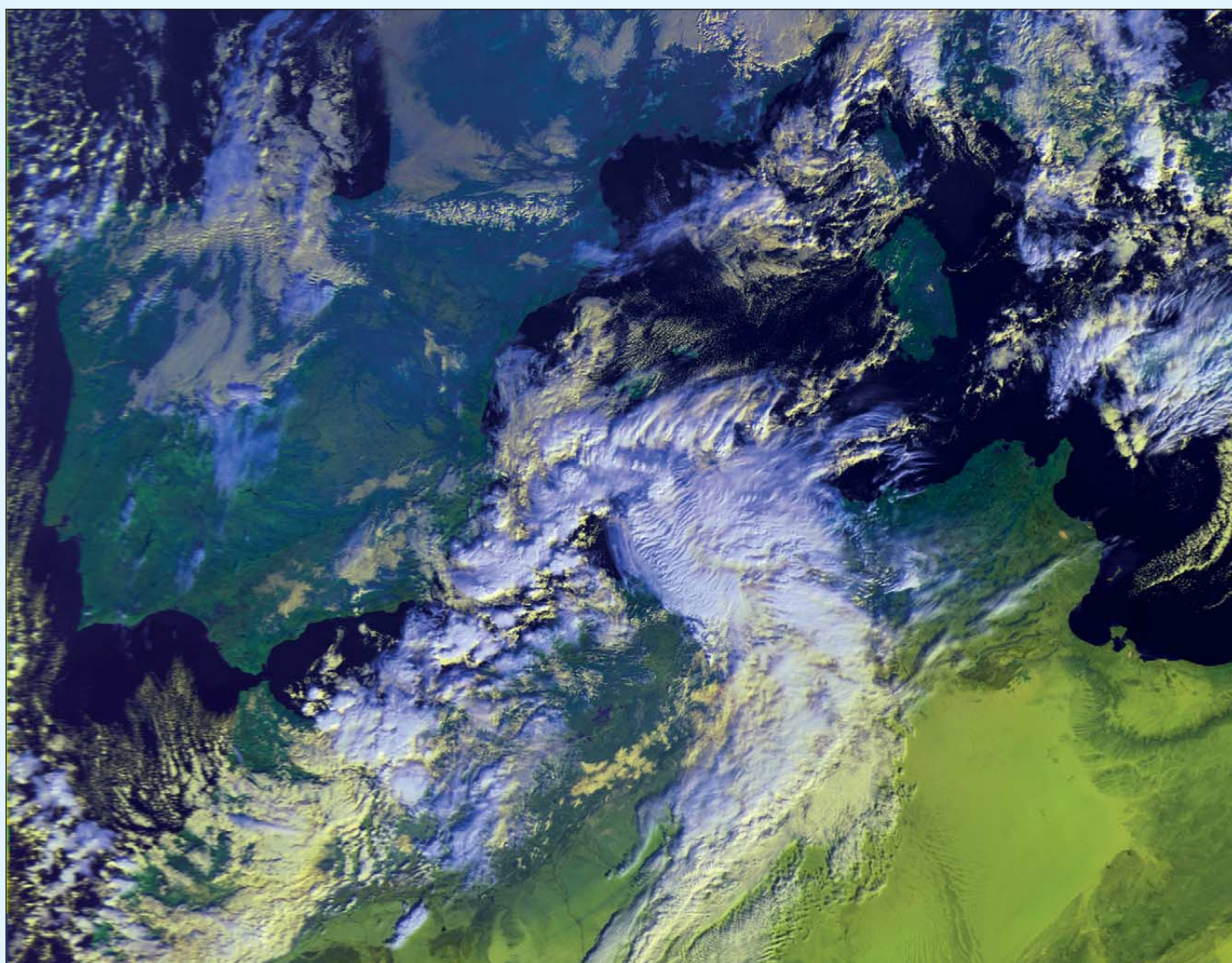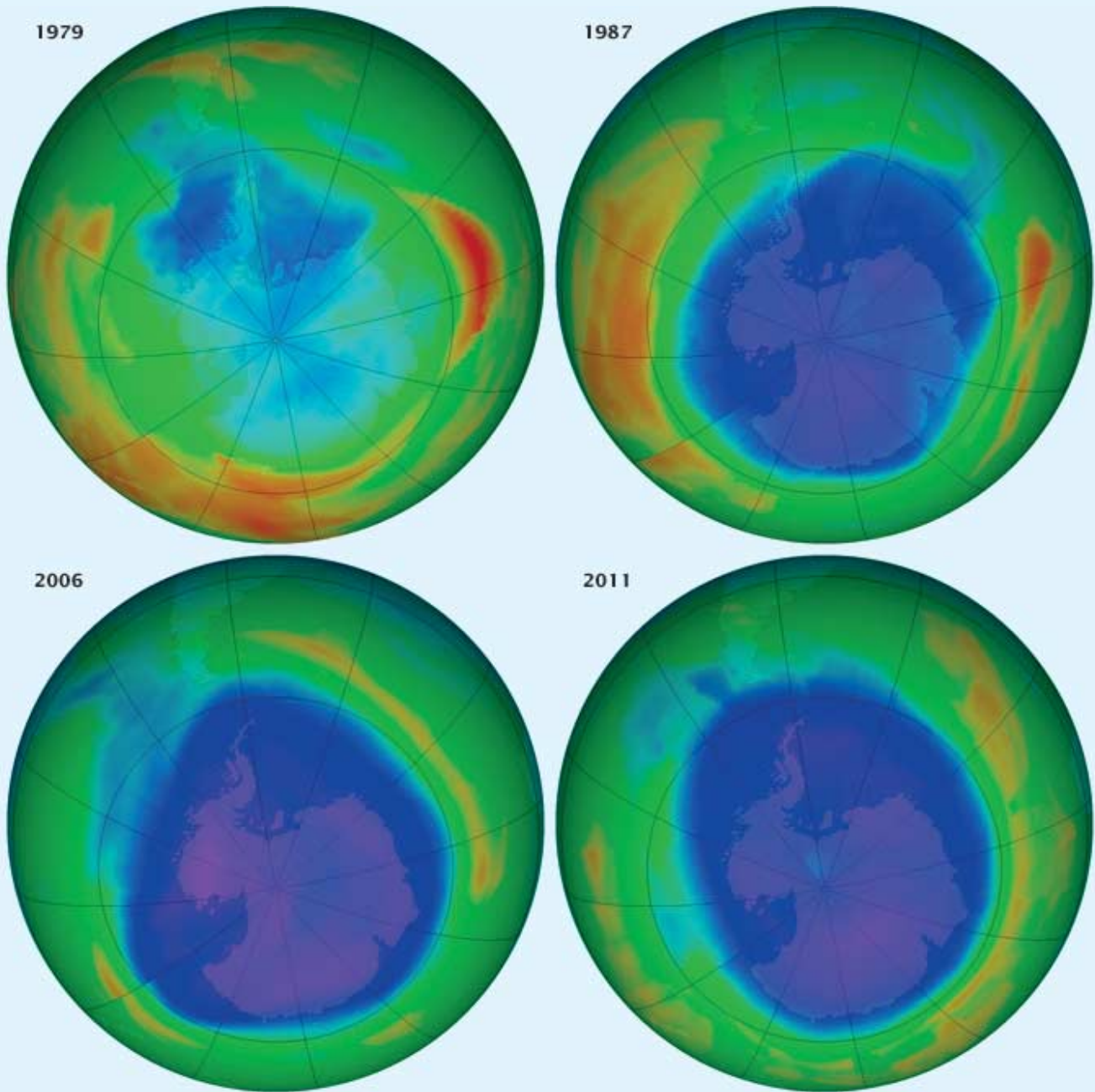

Figure 2

Figure 3

Figure 1 - Part of a Metop-A pass received by direct reception of the satellite's AHRPT signal, on December 1, 2012.

1979   1987   2006   2011

These are the four total-ozone maps that should have accompanied the article on page 18 of GEO Quarterly 36
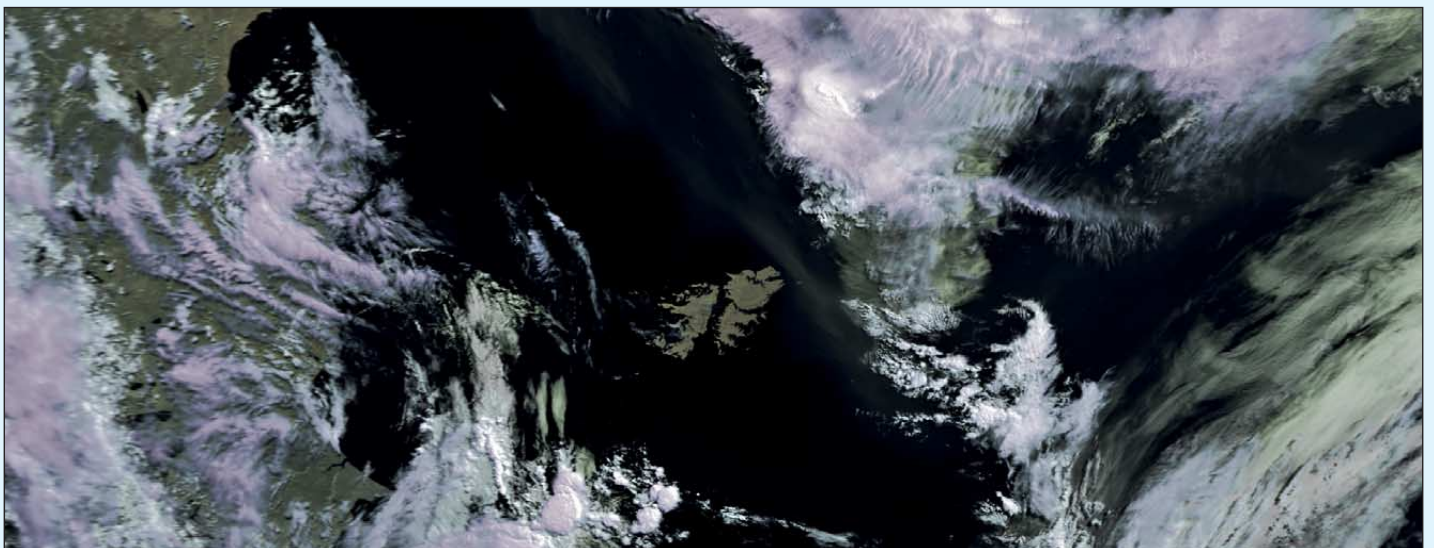
This is the Terra MODIS image from Robert Moore that failed to make an appearance in our previous
issue. Acquired on January 10, 2012, the Falkland Islands are prominent in the south Atlantic ocean.
Image © EUMETSAT 2012

David Taylor's MODIS L1 Viewer

where the process is fairly straightforward, making choices from a series of drop-down menus as follows:

- Select Satellite: Terra (or Aqua) MODIS
- Select Group: Terra (or Aqua) Level 1 Products
- Next click on one of the following three options:
  - MOD021KM (1 km resolution)
  - MOD02HKM (500 m resolution)
  - MOD02QKM (250 m resolution)
- Select Temporal Type: This can be either a range of dates (US Format) or just a single day. To avoid too many choices, keep to a narrow range. Note that the current day's images are not available.
- Select Collection: Choose item No. 5 (Modis Collection 5 - L1, Atmos and Land)
- Spatial Selection: This is best done by selecting latitude/longitude and drawing a rectangle on the map of the world that appears.
- Coverage Selection: I choose 'Day'.
- Metadata – ignore this item - I've never used it.
- Saved Parameters: this section allows you to save your current search parameters (or load a set already saved), so that you can download files for the same set of parameters again with minimum effort - a useful shortcut.
- Press 'search'.

A new window now opens showing all the passes that are available (figure 9). A quick browse RGB selector to the right of each entry lets you view any image before you download it. Since all files are selected by default, you really need to click the **Clear all Checkboxes** button first and select only the image files that you want. File sizes are given.

- Click the **Order files now** button at the foot of the page.

A new page appears where you are asked to enter an e-mail address. The location of your selection of files will be sent to you in an email.

- Select Delivery Method: 'FTP pull' is the option to use.

Now, click the **Order** button and await confirmation notifying you that your files are ready. This generally takes no longer than a minute or so, and a new screen pops up containing the **Order Id** link. Click this to learn details for retrieving your files. You will also receive an email with the same information, which includes the name of the folder where your selection of files can be found, and also, importantly, the parameters you need to enter into your FTP client.

Viewing HDF5 Files in the L2-Viewer

There are two ways to load HDF5 files into the L1-Viewer. If you have downloaded a folder of several MODIS segments, use the **File / Browse directory** option. The result will be identical with what has been described above for *EUMETCast*-derived MODIS images (figure 1), and you can select from the screen either a single image or a selection of images for joining.

Note: *MODIS L1-Viewer* will only load folders of 1-kilometre HDF5 files in this manner. Author David Taylor confirms this, stating that computers would not be able to cope with the sheer bulk of 500 m and 250 m files. However, individual high-resolution files can be loaded by means of the **File / Open L1 file** option.

Conclusion

This is another excellent program from David Taylor, which I find an invaluable extra tool in visualising the Earth. It is in constant development, and registered users have access to the author and other users through the *SatSignal YAHOO* Group at

http://tech.groups.yahoo.com/group/SatSignal/

The *MODIS L1 Viewer* gives excellent results, even with the *EUMETCast* 1 km MODIS images, which seem to me to be slightly better than *Metop* ones. And of course, the images produced from the higher resolution MODIS data are outstanding, and to me well worth the cost of the software. Figure 10 shows a typical MODIS high-resolution image of a particularly cloud-free England.

I have recently explored combining data of different spatial resolutions to achieve an RGB image at 250 m. To do this one has to take the two 250 m channels from LAADS (only channels 1 and 2 are available at this resolution) along with an additional channel at 500 m or 1 km, also from LAADS. Other users are experimenting with the program and reporting back via the *SatSignal Yahoo Group*. This allows David Taylor to respond to users' ideas and suggestions for further software development.
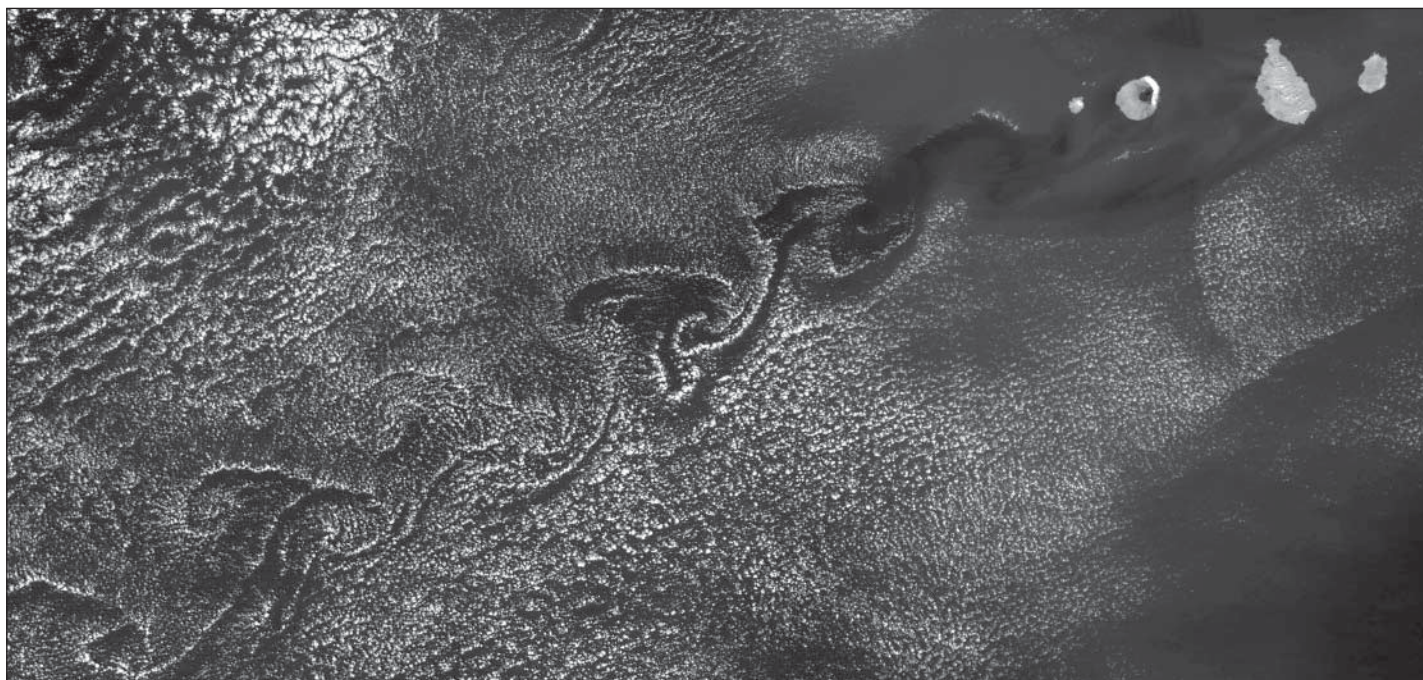
This Channel-2 Aqua/MODIS image from the LAADS website shows a series of vortices west of the Cape Verde Islands on January 8, 2013
Image: NASA/GSFC

A Low-Cost APT Receiver Based on SDR

Rob Alblas

This article was first published in the September 2012 issue of '*De Kunstmaan*',
and has been translated and updated for GEO by the author.

Up to some time ago, receivers were built purely with hardware: preamplifier, IF with a certain bandwidth and demodulators (AM, FM, single-sideband etc.) were designed and built for a specific application. These manipulations can also be described in mathematical formulas, and therefore they can be calculated by a computer. This must be done real-time, so a lot of calculation power is needed.

With present-day computers, it is possible to design a *Software Defined Receiver* (SDR), which is based on software instead of on hardware. The advantage of a software-receiver is that it is much more flexible; a disadvantage is that a fast computer is needed, which must not spend too much power in other applications. The calculations must continue smoothly; a short stop because, for example, *Windows* finds it necessary to download a program update from the Internet, may give problems. There is a little bit of timing-flexibility in the calculation process. If a fixed delay during signal processing is no problem, then results of calculations can be buffered so that, if the calculation stops for a moment, an output signal can still be provided from the buffer.

A software receiver, of course, needs an antenna signal, which first must be amplified to a certain level. Also, digitising and processing a 137 MHz APT signal is difficult, let alone a 1.7 GHz or 12 GHz signal. Therefore, that part of the frequency spectrum which contains the signal(s) of interest is first converted to a lower frequency band. After that, the spectrum is digitised and sent to the computer. So a little hardware-processing is still needed, especially for amplifying and down-converting the signal. The computer will then take care of the remaining processing: filtering, demodulation, decoding FM radio stereo or even demodulating AM to get the picture from the 2400 Hz carrier of an APT signal.

Hardware

Recently TV/FM receivers in the form of USB dongles have been coming on the market. They are meant for the reception of digital TV (DVB-T) and radio via a PC. Because of the big market for these devices they are extremely cheap; I bought mine for just €16.

These devices contain two parts: the amplifier/down-converter part, and the TV-part. Some of these receivers can be 'misused' as a front-end for Software Defined Radio; the output of the down-converter, after digitisation, is sent directly to the computer (via USB), bypassing the TV/radio part. The device I have can handle input frequencies from 48 MHz up to 1700 MHz (although there seems to be a unusable gap between 1100 MHz and 1250 MHz).

The USB-dongle (figure 1) contains:

- An antenna input (top-right),
- A tuner, converting a part of the spectrum to a lower frequency band,
- An 8-bit AD-converter, capable to handle up to three mega samples per second,
- a TV/radio processing part, which is not needed, and is bypassed for SDR,
- A USB-interface, to send the digitised signal to the computer.

Figure 1 - This is the entire hardware part of the APT receiver.

Note that, for normal applications of this dongle (TV, radio), there is no real SDR involved: signal processing is done by hardware inside the dongle.

Software

The dongle used for SDR does, of course, need software for:

1 Control: Tuning, where it selects the frequency band to be processed (maximum bandwidth 3 MHz)
2 Processing: The actual Software Defined Radio part.

For FM radio, the 3 MHz bandwidth is too small to catch the whole 87-108 MHz band, so the dongle-receiver needs to be 'hardware-tuned'. But processing a single radio channel is no problem. A single channel of classic TV (4.5 MHz, with sound carriers 5.8 MHz) cannot be handled at all, because of the bandwidth of 6 MHz.

On the other hand, the frequency band containing NOAA-APT (between 137 and 138 MHz) can be handled as a whole, meaning that, in principle, multiple NOAA signals could be processed simultaneously with one single dongle.

A nice piece of free software is available from the Internet: SDR# (pronounced as 'SDR Sharp') [1]. This contains both the control and processing functions. Figure 2 shows the software in use while recording an APT signal from NOAA 18. At the top of the image you can see the received frequency spectrum. The signal is not strong at all, but that has to do with my antenna set-up. The lower part of the image displays the so-called 'spectrum waterfall', which visualises the signal strength on each frequency in time, time being shown along the vertical axis. Therefore, the picture 'moves' from top to bottom, like a waterfall. The colour shows the signal strength: blue is weak and red is strong (a coloured version of this figure appears on page 4).

The control panel for both for the hardware (frequency centre) and software (received frequency and all the other buttons) functions is at the left of the screen.
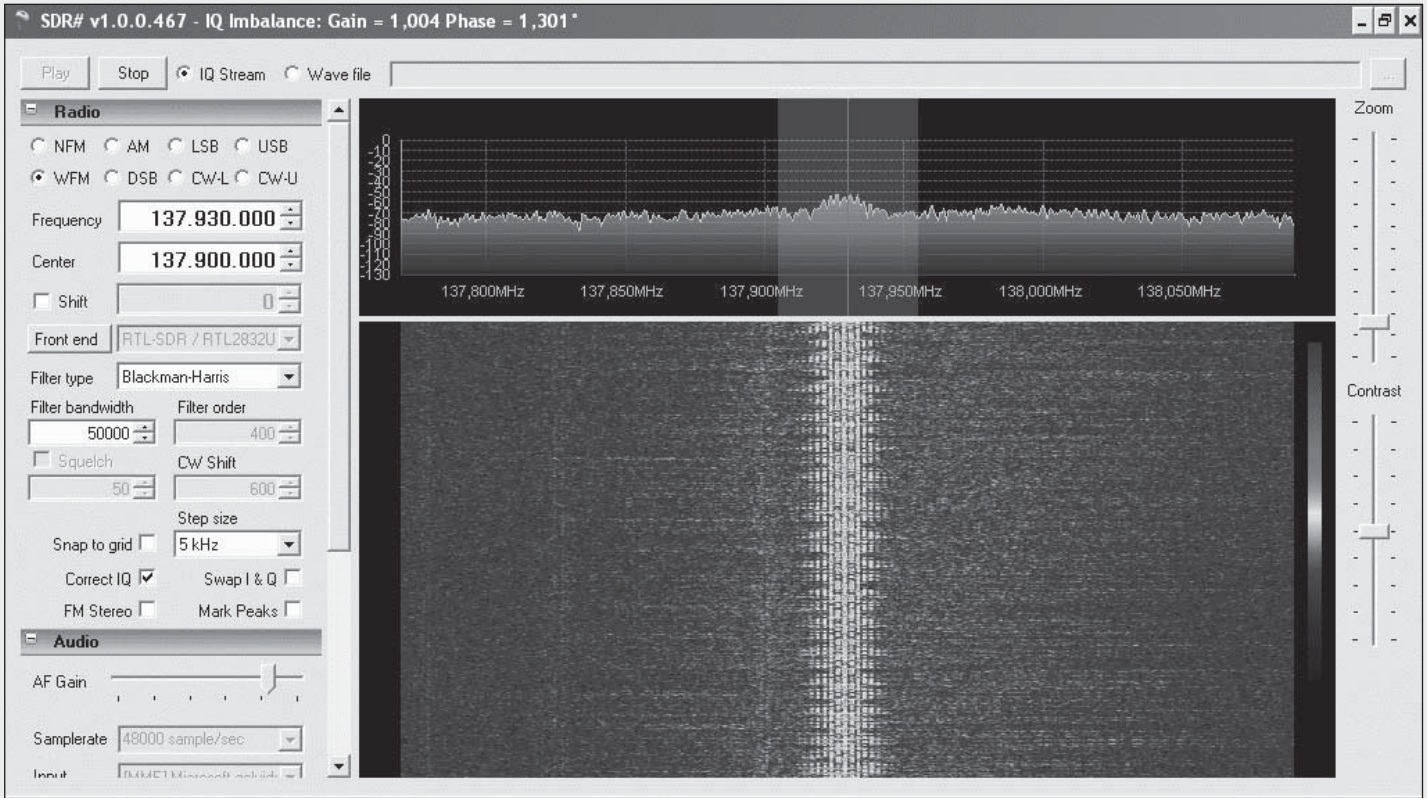
Figure 2 - The computer screen showing the SDR# software while receiving a NOAA APT signal.

The actual SDR settings are:

- Bandwidth filter
- Demodulation type: Narrow band FM, Wide band FM, AM SB etc.
- AF gain (after demodulation)

Besides this, the signal, following demodulation, is sent to the audio part of the PC and, with newer versions of SDR#, it can even be recorded, resulting in a *.wav* file on the hard disk.

For APT, the IF bandwidth is set to 50 kHz, and wideband FM (WFM) is chosen. Narrowband FM might sound more logical, but the NFM demodulator has too narrow a band for APT, less than 25 kHz. Unfortunately, my receiving conditions are currently too bad to do a fair comparison between the two types, but I have heard from others that the narrow band FM option is really unsuitable for APT.

Post Processing

Post processing can be done with programs like *WXtoImg*, and there are two possibilities:

1 Connect the sound output of the PC to the sound input of another (or the same) PC and record directly using *WXtoImg*.
2 Use the recording feature in SDR#, resulting in a *.wav* file. This *.wav* file needs first to be converted to a sample rate compatible with wxtoimg: 11025 bytes/sec since the recorded sample rate is not adjustable in SDR#, as far as I can see. This conversion can be done using *Audacity*, a free audio editor/recorder [3]. Apart from sample rate adjustment, the sound also needs to be amplified (with *Audacity*) to obtain a usable *.wav* file for *WXtoImg*.

(Note: There are two sample rates in this story: the SDR sample rate when digitising the received signal, and the audio sample rate, used to record the sound signal.)

This simple receiver doesn't make your expensive APT receiver obsolete. There are some disadvantages: the noise figure is not very good and it is more sensitive to pager interference. Still, very acceptable results are possible. As said, my receiving conditions are not very good as you can

see from figure 3, which was made using an indoor crossed dipole antenna with no separate preamplifier used: just the dongle itself. My hardware receiver, which is certainly not the best there is, gives better results.
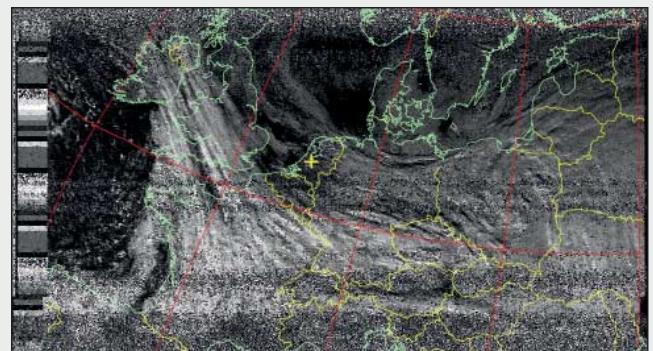

Figure 3 - A NOAA image recorded with an indoor antenna and SDR#

Figure 4 shows what is possible with a good APT antenna, again without using a preamplifier. This NOAA 19 picture was received by one of our *Kunstmanen* members, Peter Kooistra, using:

- Antenna: WSP 137 (a cross dipole with ground plane)
- SDR-stick: Hama Nano
- Demodulator: WFM
- Bandwidth: 50 kHz

Wxtoimg was used to record directly the sound from SDR#.

Other Points to Note

The **HF Sample Rate** may be too high for your PC to handle. This can be tested by tuning into an FM radio station. If the sound sometimes stops, then decrease the data rate to 1 Mb/s (the default is 2 Mb/s, the maximum is 3 Mb/s.)

HF Gain: This is done in the dongle, but under the control of software. It can be controlled by AGC or manually. AGC may not work properly for weak signals, in which case, switch it off and set the gain manually to a higher level (note that maximum gain also may give problems).

Both settings are hidden behind the **Configure button**, at the very top of the SDR# window. Note that the buttons in the software sometimes change from version to version; in figure 2, which shows an older version, the button is called '*front end*', and is located below the frequency settings.

Another interesting feature is recording. Instead of the audio alone, the baseband (the digitised signal before any SDR processing) can also be recorded. That may be of particular interest if experimentation with different SDR settings is needed at the same input signal, or to test self-made or adapted SDR-software (the source code of SDR# is available from internet). A received digitised signal is then always available. SDR# can read the recorded baseband file, and different settings at the same signal can be done. That includes tuning at a particular frequency within the received range. This way, simultaneous reception of multiple (APT) signals (and afterwards decoding them one by one) is a reality. Note that this recording option results in huge files, so don't enable it if not needed.

Other Applications

Connecting a length of wire to the antenna input gives an FM stereo receiver. Unfortunately, short wave radio isn't possible using this dongle alone as its lowest frequency is 48 MHz. Connected to cable-TV, the received frequency spectrum around a TV station can be observed but, as said earlier, the received frequency band is unfortunately a maximum 3 MHz. But with a bit of shifting of the central frequency, the video carrier is visible, as well as the sound carriers at 5.5 and 5.74 MHz (I think these values are a bit different in the UK). The sound carriers are FM modulated, so they can be processed by SDR# and made audible (one at a time, so not in stereo).

An other application can be tracing interference signals. A wireless alarm I have, using 433.9 MHz, sometimes had a very short range. Using a netbook with a dongle and SDR#, I was able to see a carrier containing an FM audio signal at the same frequency. Walking with my netbook+dongle in the street, I was able to trace the transmission, which appeared to come from a neighbour's wireless headphone. They changed their frequency (shown nicely in the spectrum on my netbook), and my alarm started working properly again.

Conclusion

This is a very versatile receiver, for nearly no money. Maybe it is not a replacement for a hardware APT receiver, but it's still a nice gadget to have and to 'play' with. Adding a
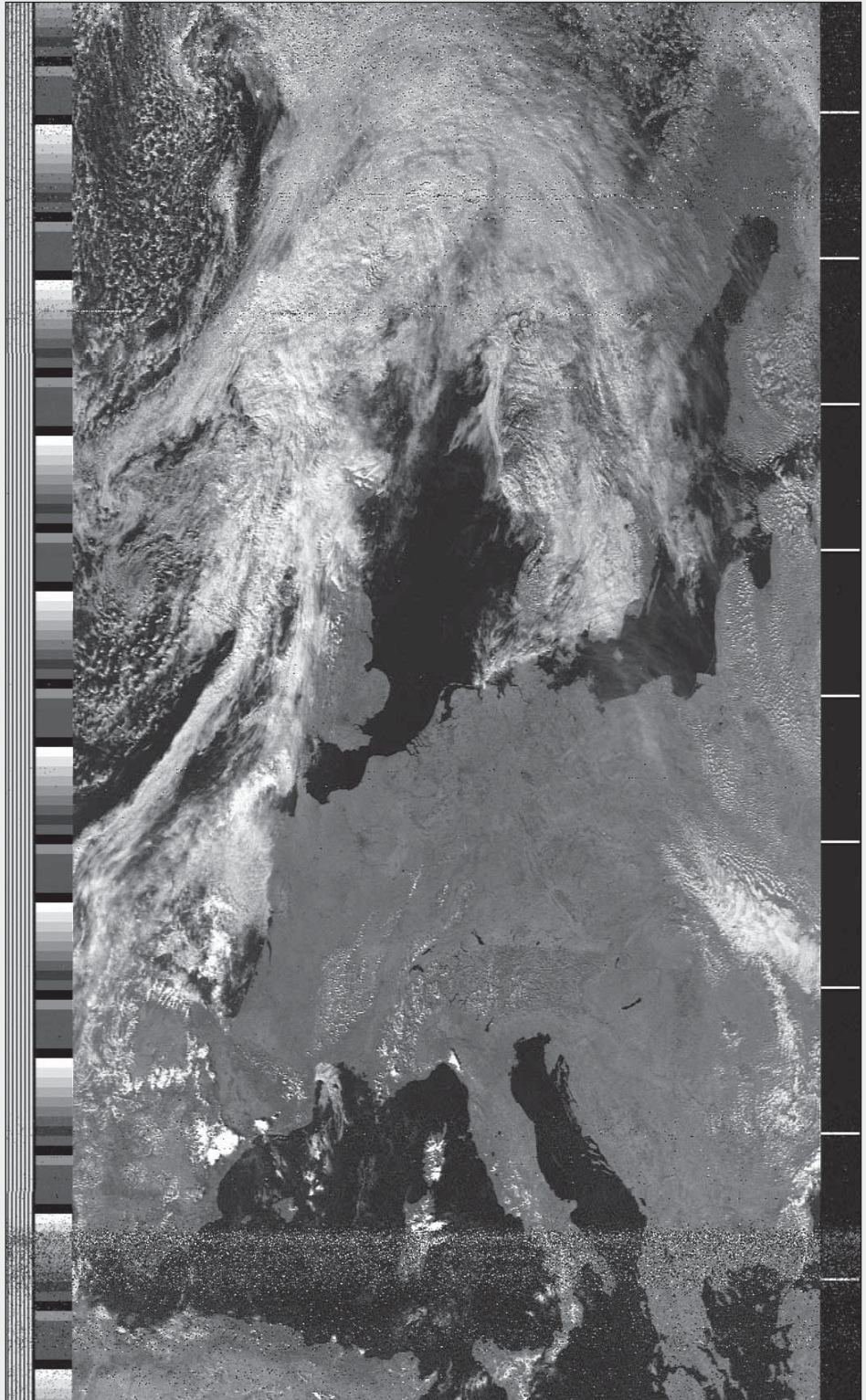

Figure 4 - NOAA 19, recorded by Peter Kooistra, using the SDR dongle.

preamplifier and/or pre-filtering may be necessary to give more acceptable results for specific applications, like APT.

The SDR# software (written in C#) is still under construction, so checking the website [1] now and then for new features is advisable.

'The code of the DSP is released under the MS-RSL license. This basically grants you the right to view the code for your own education, but you cannot redistribute it or redistribute modified copies (derived works.) The rest of the application is under the MIT license.'

References

1. SDR# web-site - http://sdrsharp.com
   Program for Windows:
   http://sdrsharp.com/downloads/
   sdr-stable.zip
   (the current version I use is v 1.0.0.1000)
2. USB driver for SDR#:
   WinUSB, http://sourceforge.net/projects/
   libwdi/files/zadig/
3. Audacity - http://audacity.sourceforge.net/

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Adding Radiation Data

To Your Home-Built Environmental Monitoring Station

Andreas Lubnow, DL6AAS (a.lubnow@ieee.org)

Background

Basically, this article is about environmental monitoring. It all began, when Geiger-Mueller-counter kits with an RS232 interface became available for around €50. Since this interface produces an impulse count value every minute, I started to think how I could include these numbers alongside the values I already gather from and about EUMETCast (BER, SNR etc). Since I have been following David Taylor's approach using MRTG for gathering that data, I came up with a method to include these radiation numbers too.

In short, I use a COM-Server to be able to publish those values in a network, use the Sens2Serv! shareware software to store them in a MySQL database, use a Perl script to call them with MRTG, and publish the resulting graphics and webpages.

Technikakademie Braunschweig (Braunschweig Technical School) is a public vocational school in the City of Brunswick, Lower Saxony, Germany.

http://www.technikakademie-bs.de

Founded some 85 years ago, and with currently over 600 students enrolled, it is the largest technical school in Lower Saxony and one of the largest nationwide. Training is offered in civil engineering, electrical engineering, computer science, mechanical engineering, and mechatronics.

To motivate technical issues, as well as to illustrate and deepen instructional content, our school maintains and operates an amateur radio station with the call sign DL0TSB. Currently the station is active on shortwave and on 2 m / 70 cm, here mainly in APRS and PR, and may also be contacted via *EchoLink*. Reception facilities are available for the Meteosat *EUMETCast* and the now terminated ESA *Envi-Ham* data streams, 137 MHz WXSAT, RTTY, HF-FAX, and for numerous digital modes such as HFDL (data transmissions from aircraft) and D-ATV. Additionally, a *Perseus* SDR receiver ranging from 10 kHz to 30 MHz is available online.

Our Present Infrastructure

As part of the curriculum, students have to carry out a 160 hour project, the goal of which is the development of their occupational competence. The *EUMETCast* data stream facility, including the processing of the received images for the World Wide Web, was set up as part of one such project. In the context of another project, a Java-based application had been developed to store data gathered from a *WS2300* type weather station into a *MySQL* database for presentation and further processing.

With the arrival of an *AS622* Geiger counter and an *AS602* counter module, developed by DL3HRT and sold by AATiS [1] as a kit for around €50, we have now had the opportunity to expand the scope of environmental data with a new and interesting value. AATiS is short for *Arbeitskreis Amateurfunk und*

Telekommunikation in der Schule e.V. (Amateur Workgroup for Amateur Radio and Telecommunication in Schools). Every minute, this counter module provides a figure correlated to radiation in the beta and/or gamma range, depending on the counter tube used. This figure is called the IPM (Impulses per Minute) value. So, the task was to integrate these IPM values into the existing infrastructure of data storage, processing, and visualisation. The starting point of this work was that the following function blocks already existed:

* MySQL database for storing the WS2300 generated weather data,
* MRTG installation for the visualisation of data e.g. weather data, *EUMETCast* reception data, plus other relevant network data such as throughput,
* Automated upload procedures for the presentation of data on the WWW.

Building the Counter

The layout and schematics of the Geiger counter and the counter module are based on an article published in 2011 in the German magazine *AATiS Praxisheft 22*. The design is pretty straightforward, comprising just five transistors and a few other components for the actual Geiger counter, and a small prefabricated printed circuit board for the counter module with LCD display and RS232 serial interface. Originally a single tube design, we have built the counter on two breadboards in a simple plastic housing (figure 1). One circuit board accommodates the power generation block (transistors T1 - T3) to operate the counter tube at a few hundred volts (see below), and the other board houses that portion of the circuitry (transistors T4 - T5) to interface with the counter module and to flash an LED whenever a radiation incident occurs. The entire circuit is supplied from an external 5 V DC power source.

The design with those two breadboards was chosen so that an existing counter tube, model *SI39G*, could easily be placed between the boards. Additionally, an external counter tube can be attached with a BNC connector and a short coaxial cable. This enables us to operate the significantly
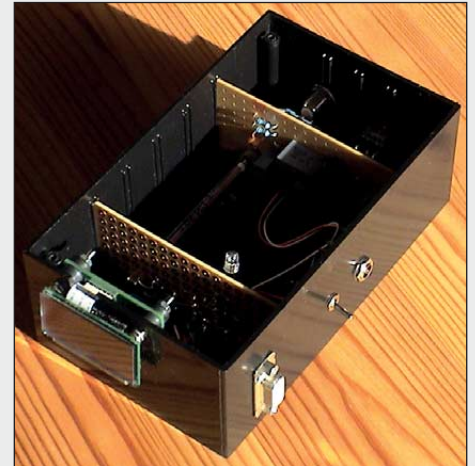

Figure 1 -   The Counter Module mounted in its Plastic Case

more sensitive model *LND72511* counter tube [2] as an external tube (figure 2).

A switch is used to choose between these two tubes (cold selection) and to properly select the correct operating voltage for the tubes, 400 V for the SI39G and 500 V for the LND72511. The setup, with two different counter tubes, has some additional benefits, because comparative measurements between the counter tubes are possible as well as operation without a bulky external tube.

Figure 1 shows the Geiger counter and counter module. The counter module display is at the front, the *SI39G* is to the left, between the breadboards, and the BNC connector and switch for tube operating voltage selection are on the back. Figure 2 shows the model LND72511 counter tube, base mounted with a BNC connector cable.

Figure 2 - The LND72511 Counter Tube

What Data is to be Processed?

As already mentioned, the counter module unprompted, delivers an IPM value at its RS232 interface every minute. By nature this value is an integer, i.e. a simple number without sign and decimal point, which comes at a data rate of 4800 bit/s in the popular 8N1 format. Figure 3 shows an 18 minute trace recorded with serial sniffer software. We have used *Procomm Plus,* but of course any other serial sniffer software will give a similar result.
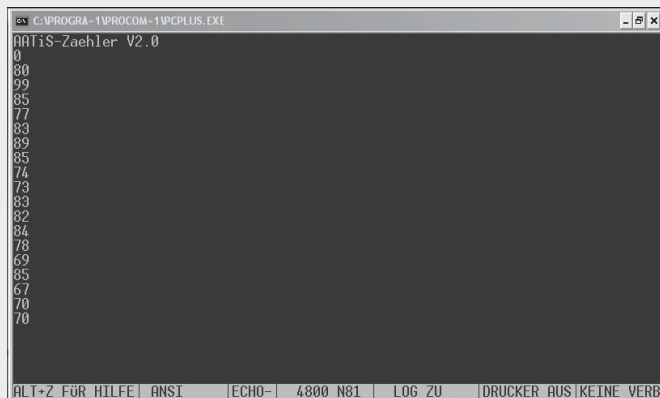

Figure 3 -   Recording of the data available at the RS232 interface of the counter module with the *LND72511* counter tube attached

Publishing Serial Data on the Network

To store the IPM values in a database for further processing, a two-step procedure is used. The first step is to feed the unmodified serial data to a server—available on the local network—from where it is then written automatically into a database in a second step.

For step one, there is a choice between pure software solutions such as *Piracom [3]* and a serial COM server as a standalone hardware setup. In both cases, any other networked device can pick up the data available at that serial RS232 interface. We have decided to go for the hardware solution, since this variant turns out to be very compact and it does not require a dedicated serial COM port—which is no longer readily available on some modern-day computers. We have acquired a *Mini/Industry 58211* COM server from Wiesemann and Theis (W&T) (figure 5, page 20). This device may be operated not only as a Telnet server or as a telnet client, but also as an FTP (file transfer protocol) server or client.

Telnet is a protocol for terminal emulation, where the data transmission is character-based. Telnet permits an active exchange of characters between an attached serial device and the COM server, and vice versa. This return path may be used should the serial device have an option for signalling. When operating as a Telnet server, the incoming serial data will be forwarded to the standard Telnet port 23 of the COM server. This mode is useful for 'listening' to the data production of a serial device such as our Geiger counter, so we use this setting in our project. When operating as a Telnet client, a serial terminal attached to the COM server may connect with a Telnet server available on the network. This mode is not used in our project.

In contrast, the exchange of data via FTP is not character-based but file-based. With FTP it is possible to write or read entire files to or from the serial interface of the COM server. But since the IPM values are one continuous sequence of characters, reading them as a file will never be finished, ruling out both FTP modes.

W&T offers the easy-to-use configuration software *WuTility* for their devices. We have used this software to set all parameters of the interfaces (4k8, 8N1, IP settings of the COM server) and the mode of operation (Telnet server mode, figure 6).

With the Geiger counter now linked to the COM server and the native *Windows* telnet client connected to this server, the screen shows the familiar IPM values, but this time transported via the Telnet network protocol (Figure 4). To connect a *Windows* telnet
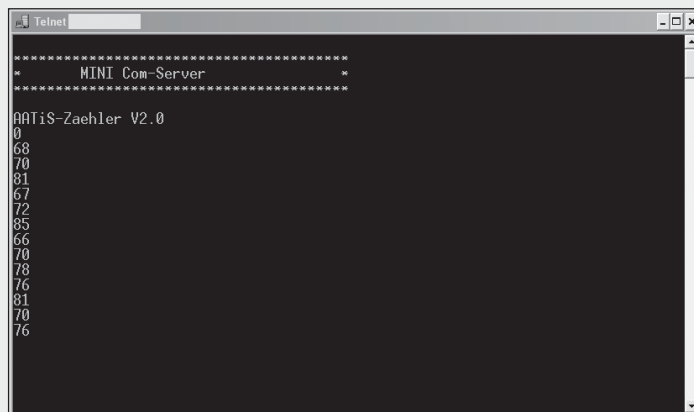

Figure 4 - Recording the IPM values (counter tube LND72511) sent via Telnet

client to a server, you simply type telnet x.x.x.x from the command line interface, where x.x.x.x is the IP address of the COM server.

How to store Network Published Data into a Database

Now, the IPM values are available throughout the network, and we are one step closer to storing them in a database. An Internet search directed us to *Sens2Serv!* [4]. This shareware takes data from networked sensors and (measurement) equipment and writes formatted data fields into any database system (Oracle, Access, SAP, MySQL, DB2, FoxPro, ...) or to a CSV file. After installation, *Sens2Serv!* is ready to access *Oracle* and *Access* databases, but other databases like *MySQL* may be accessed via a connection string as well.

When an application connects to a database or a data file you let *ADO* or *ADO.NET* utilise a provider to do the job for you. A connection string contains the information that the provider needs to know to be able to establish a connection to the database or the data file. Because there are different providers, and each provider has multiple ways to make a connection, there are many different ways to compose a connection string [5].

A connection string consists of a series of 'Keyword-Value Pairs' separated by semicolons. An equals sign (=) connects each keyword and its value. The information in the connection string is passed on to the provider. Our connection string looks as follows

{MySQL ODBC 5.1 Driver};Server=x.x.x.x;Database=as622;User=user;Password=password;Option=3;

As seen in this connection string, '**{MySQL ODBC 5.1 Driver}**', the appropriate MySQL ODBC driver is required. At the time of writing this was driver version 5.1. **http://www.connectionstrings.com** very comfortably guides you to the correct connection string, and in addition gives a link to the correct driver for a number of different database systems and applications. After driver installation, it should appear (figure 7) in the driver tab under

Control Panel -> Administrative Tools -> Data Sources (ODBC)

Obviously, a *MySQL* database system must also be available. *XAMPP* [6] is a good starting point should you have to install one, since it not only installs *MySQL* but also a plethora of useful tools and packages.

Going back to the connection string once more, the entry '**Database = as622**', the target database, 'as622' in our case, must also be accessible. In the case of *MySQL*, access may be checked with *HeidiSQL* [7]. Other database systems come with similar client software and/or have a web browser interface to access the database system.

To create a new database on a database system, the correct SQL command is '**CREATE DATABASE as622;**', where 'as622' is the database name, which of course can be chosen differently. SQL stands for Structured Query Language and is a standardised

command and query language for database systems. It is important to note that a <u>semicolon</u> terminates each SQL statement before it is sent to the database system. For better readability, the use of capital letters is common practise with SQL, but not essential.

Finally, we have to create a table for the storage of—and access to—the IPM values. Since *Sens2Serv!* will have to fill this table, *Sens2Serv!* and this table should follow identical naming conventions for fields and types. In our case, the SQL command to create the table '*as622*' is as follows:

```
CREATE TABLE `as622` (`as622` INT(10) UNSIGNED NULL DEFAULT NULL,
        `datum` CHAR(50) NULL DEFAULT 'kein datum',
        `zeit` CHAR(50) NULL DEFAULT 'keine zeit',
        `zeitstempel` CHAR(50) NULL DEFAULT 'kein zeitstempel'  );
```

This table contains four fields of sufficient field size (10 or 50 characters, respectively). The first field (field type integer) is called 'as622' and will later collect the IPM values. The following three fields are of field type character and, unlike integer declared fields, may also contain non-numerical strings.

The reason for this is that *Sens2Serv!* conveniently provides the option to add time and date information alongside the IPM value. Colons are included in this information, thus requiring the character field type CHAR. NULL means that a value for this field may be omitted. In this case the specified default value is entered automatically. For expressions consisting of more than one word like 'kein zeitstempel' (no timestamp), the entire expression has to be placed in quotation marks. Again, it is helpful to check the correct execution of this CREATE command with *HeidiSQL*.

After these preparatory steps, we can proceed with the configuration of *Sens2Serv!* Figure 8 shows a number of statements to be entered in the 'Datei' (file) configuration tab. Since we intend to use a *MySQL* database system, the database type to choose is 'user-defined'. The connection string and the table structure have already been discussed above. The four field names and field types have to match those in the table definition, and are correlated with Ausschnitt (Section) 1 to 4 (figure 9). Defining the length of the field 'as622' carrying the radiation data as 10 significant digits with zero decimal places (Dec = 0) seems to be sufficient for IPM values. Those of the three other fields have to agree with the structure of the time and date information generated by *Sens2Serv!*

As just mentioned, sections 1 to 4 are defined in the protocol configuration tab. Every minute, Section 1 (field 'as622') picks up the first 10 characters received from the RS232 port and interprets these as a number. Sections 2 to 4 are filled with *Sens2Serv!'s* own date, time, and timestamp values, respectively. This is a nice feature to automatically correlate each received IPM value with a proper timestamp.

The next step is to integrate the W&T COM server in the device configuration tab (figure 10). Plausibility checks of the received data, for example (IPM value >= 0), are defined in the check tab (figure 11). Entries in the feedback tab are not required, since no commands have to be sent to the counter.

After clicking the green 'Anwenden' (Apply) button, a new IPM value should appear in the monitor tab every minute (figure 12). The two characters trailing that numerical value show the ASCII characters CRLF, which is the *Windows* ENTER key, and is sent by the counter with each value. A red status 'EIN' (ON) signals that the COM server is connected properly, a blue message 'as622 ok' means that the database access is working as well.

Since database access is now up and running, a complete set of data is now stored every minute. Again, this should be checked with the *HeidiSQL* client software. After a successful login to the database system, and selecting the database and the table, the 'Data' tab in the main window displays the data in the order

of reception (figure 13). The 'as622' field holds the IPM values: date and time are available in the DD.MM.CCYY (field datum) and HH:MM:SS (field zeit) format, respectively. The 'Zeitstempel' (Timestamp) field conveniently combines date and time in just one field without any dots and colons, and with four additional millisecond digits, making it very easy, for example, to find the latest IPM value.

Based on the *LND72511* data sheet, IPM values can also be converted into a *dose* without difficulties. If we restrict ourselves to the linear section in the double logarithmic representation, that is IPM values below 250,000, the following approximate formula may be used:

$$\text{Dose in mGy/Hr} = (\text{IPM value} / 347562) \char`^ 1,0748388$$

This formula uses the fact that the relationship between *dose* and IPM value can be described by a power function. Until now all IPM values measured were well below 250,000, so this limitation is more of a theoretical nature. 'Gray' (Gy) is a unit derived from the SI units joule and kilogram, and describes the absorbed energy per mass caused by ionizing radiation. For X-ray, gamma, and beta radiation, one *gray* is identical to one *sievert* [8]*.*

Processing Data

Since the IPM values are stored in a database, they can be processed in many ways. Two approaches of different complexity will be briefly presented here.

1 Generation of an *Include File* for shtm or shtml files, so called Server Side Includes (SSI)
2 Processing of data using *MRTG* (Multi Router Traffic Grapher), a programme for graphical analysis and display of numerical data, which has already featured extensively in earlier editions of GEO Quarterly [12 - 14].

Creating and Embedding an Include File

To easily integrate dynamic values into a web page, include files are a fine alternative to the more complex PHP. A prerequisite, though, is that the Web server needs to accept server-side includes (all web servers can be configured to do so), and that the website's file needs to be uploaded to the web server as shtm or shtml. These do not differ in any way from conventional htm or html files: the leading 's' in the file extension indicates the include mechanism.

To include dynamic data, we run the SQL command

**select as622 into outfile 'C:/transfer/ipm.txt' from
as622 order by zeitstempel desc limit 1;**

invoked by a script every 15 minutes, asking for the latest IPM value written to the file *ipm.txt* which, in our case, resides in the folder *C:/transfer/*. Prior to that, however, we have to run

del C:/transfer/ipm.txt

to delete the existing *ipm.txt*, otherwise this export will not work. This SQL command sorts the content of the field 'as622' in descending order (desc) according to data in the 'Zeitstempel' (Timestamp) field, then limits the result to just the latest entry (limit 1), re-directing the query result into a file (into outfile). This file is subsequently transferred via FTP to the web server. There, this file will be called by

<!--#include file="ipm.txt" -->

placed at the desired position in the page's source to show the latest IPM value

http://212.28.102.138/wx_history.shtm

Processing with Multi Router Traffic Grapher (MRTG)

The graphical representation of numerical values with *MRTG* [15] offers more functionality but is somewhat more complex to configure. *MRTG* was originally developed to measure network traffic data and to automatically generate and update web pages

Figure 5 -   The Mini/Industry 58211 COM server. The RS232 interface is to the left and the Ethernet-based network interface to the right.
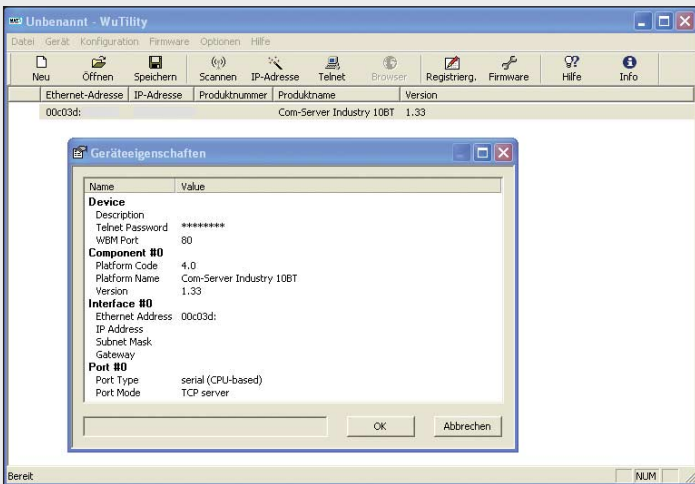

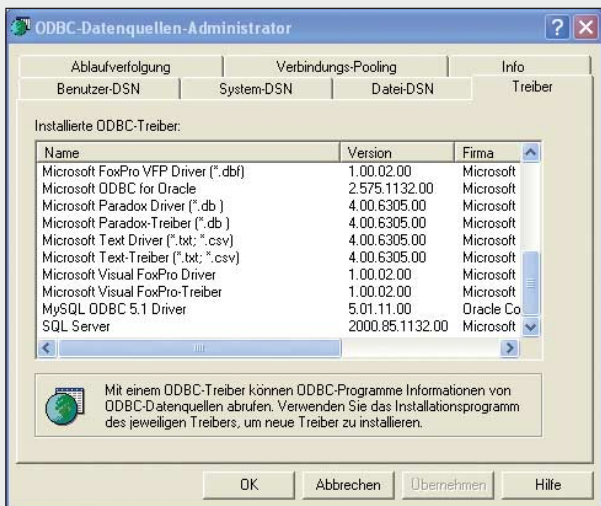Figure 6 - Configuration of the COM server with *WuTility*

Figure 7 -   The MySQL ODBC 5.1 driver has been installed correctly and can be addressed with the connection string
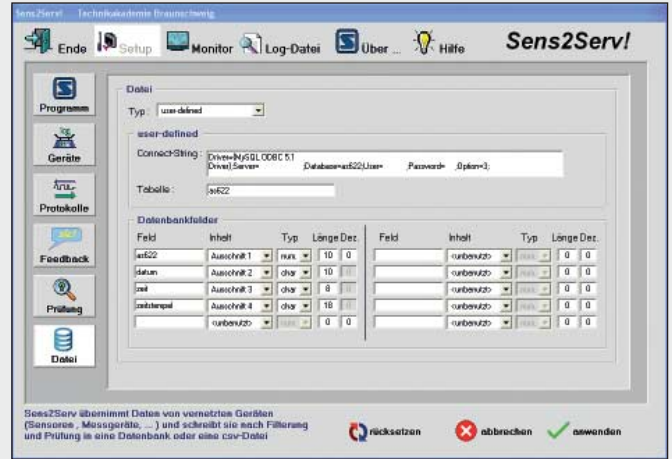

Figure 8 - Configuring Database Access with Sens2Serv!

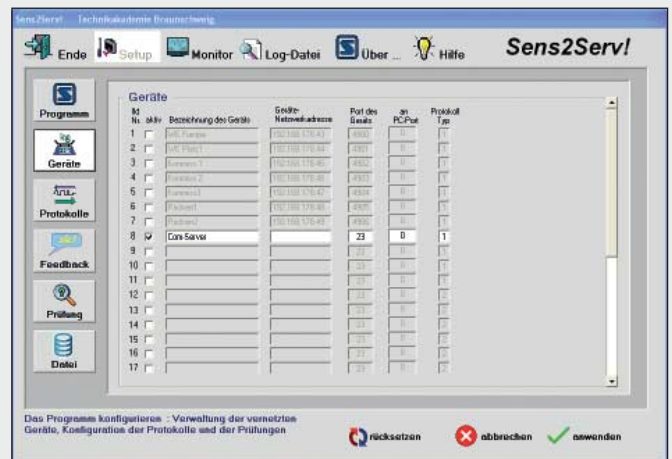Figure 9 - Defining Field Contents

Figure 10 - Integrating the COM Server

Figure 11 - Plausibility Checks of the Received Data

Figure 12 - Reading Live Data and *Sens2Serv!* Status Messages
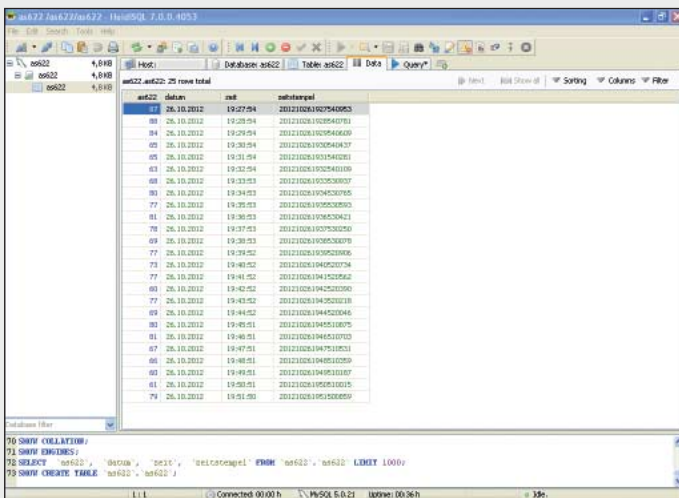
Figure 13 - The Database fills up with IPM Values

Figure 14 - The Perl Package Manager lists all installed packages of the Perl Installation
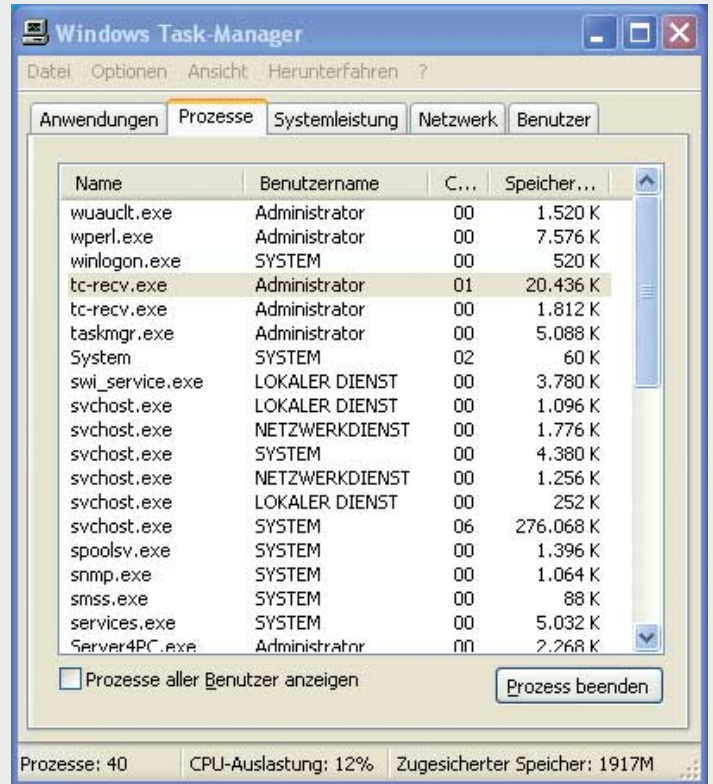
Figure 15 - wperl.exe is listed in the Task Manager, hence MRTG is running.
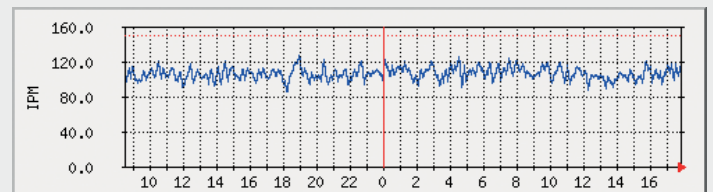
Figure 16 - IPM values measured at our location

displaying that traffic data. When configured properly, *MRTG* can visualise almost any positive integer value.

To work with *MRTG, Perl* has to be installed first [9] because *MRTG* is *Perl*-based. But beware: after the initial installation, *Perl* has to be made 'database-capable', since database content is be visualised. To do so, run the *Perl Package Manager* and install *DBI*, the database-independent *Perl* interface (figure 14).

The Perl script above (Listing 1) takes care of the actual database query and hand-over of the result to *MRTG*.

It is stored as 'as622_ipm.pl' in the *MRTG \bin* folder. Clearly visible are the connects and disconnects of the database connection, the SQL select statement, and the 'data print-out' for *MRTG* (the four print statements), as *MRTG* expects data in this format. The reader is advised to consult *MRTG's* documentation for in-depth explanation of these statements

http://oss.oetiker.ch/mrtg/doc/mrtg-reference.en.html

MRTG starts by calling

       C:\Perl\bin\wperl.exe mrtg --logging=eventlog mrtg.cfg

from the *mrtg\bin* folder. Since the user is not alerted to errors in the scripts and/or the *mrtg.cfg* file, it is wise to check the Task Manager and look for the *wperl.exe* entry (figure 15) to verify that *Perl* and *MRTG* are running. If you want to stop *MRTG*, you have to terminate the *wperl.exe* process through the Task Manager. *MRTG* by default generates four different graphs representing the course of the IPM values over a day (figure 16), a week, a month, and a year.

```
use DBI;
$dbh = DBI->connect('DBI:mysql:as622;host=x.x.x.x', 'user', 'password',{ RaiseError => 1 });
$sth = $dbh->prepare('select as622 from as622 order by zeitstempel desc limit 1');
$sth->execute();
$result = $sth->fetchrow_hashref();
print "0\n";
print "$result->{ipm}\n";
print "0\n";
print "0\n";
$dbh->disconnect();
```

To make use of this script a few lines have to be added to the mrtg.cfg. It must be noted though that all statements in parentheses are for illustration only and not part of mrtg.cfg

Timezone[_]: local time	(Time base for MRTG)
Options[_]: growright	(Graph grows from left to right)
Interval: 5	(MRTG collects data every 5 minutes)
EnableIPv6: no	(No network queries using IPv6)
RunAsDaemon: yes	(MRTG daemon mode, useful for continuous operation)
WorkDir: C:\mrtg	(MRTG working directory)

Listing 1
The Perl Script which takes care of the actual database query and hand-over of results to MRTG

```
#----------------------------------------------------------
#     AS622 IPM
#----------------------------------------------------------
```

Target[AS622_ipm]: `perl as622_ipm.pl`	(MRTG data source)
MaxBytes[AS622_ipm]: 150	(Maximum value of variable 1 (IPM values))
MaxBytes2[AS622_ipm]: 150	(Maximum value of variable 2 (not used here))
Title[AS622_ipm]: AS622 Impulses per minute	(html title of the generated web page)
Options[AS622_ipm]: integer, gauge, nopercent, growright	

(integer: values are integer, gauge: data values are absolute not incremental, nopercent: no percentages, growright: graph grows from left to right)

YLegend[AS622_ipm]: IPM	(Legend of the y-axis)
ShortLegend[AS622_ipm]: .	(Unit string for Max, Average and Current)
LegendI[AS622_ipm]:	(String of Bytes in)
LegendO[AS622_ipm]: IPM:	(String of Bytes out)
Legend1[AS622_ipm]:	(String of variable 1)
Legend2[AS622_ipm]: IPM	(String of variable 2)
PageTop[AS622_ipm]: <H1>AS622 Impulses per minute</H1>	

(Additional information at the beginning of the web page)

```
#----------------------------------------------------------
```

At Technikakademie Braunschweig, we use MRTG to some extent

http://wetterprojekt.ta-bs.eu/mrtg/

In addition to the *EUMETCast* data stream values for **data traffic**, **packet loss**, **reception quality and strength**, **bit error rate** (BER) and **signal-to-noise ratio** (SNR), plus values derived from our *WS2300* weather station for **temperature**, **humidity**, **air pressure**, **rainfall**, **dew point**, **wind chill** and **wind speed**, we also run *MRTG* on our uninterruptible power supply and our GPS-based NTP timeserver.

To analyse network related data with MRTG, an SNMP agent has to be enabled on the device to be monitored. Simple Network Management Protocol (SNMP) is an 'Internet-standard protocol for managing devices on IP networks.' Devices that typically support SNMP include routers, switches, servers, workstations, printers, modem racks, and more [10].

On a *Windows* computer, the SNMP agent can be installed through **Control Panel -> Software -> Add Windows Components -> Management and Monitoring Tools -> SNMP**. You configure and run the SNMP agent as a service in **Administrative Tools -> Services**.

To monitor more specific items such as the UPS load you have to make use of so-called Object Identifier (OID) [11] which has a very comprehensive list of these OIDs.

Summary

This paper shows how data from a home-built Geiger counter can be processed using standard software and hardware and made ready for display on the Internet. The following processing chain was set up:

Geiger counter -> COM server -> Sens2Serv! -> MySQL database -> MRTG -> www

All scripts and configuration files are available from the author, on request, at

a.lubnow@ieee.org

References

  1 AATiS - www.aatis.de
  2 LND72511 counter tube - http://www.lndinc.com/products/156/
  3 Piracom - http://pira.cz/eng/piracom.htm
  4 Sens2Serv!
     http://www.serielleschnittstelle.de/index.php/
     standard-software/sens2serv.html
  5 How to compose a connection string
     http://www.connectionstrings.com/Articles/
     Show/what-is-a-connection-string
  6 XAMPP - http://www.xampp.de
  7 HeidiSQL - http://www.heidisql.com
  8 Gray - http://de.wikipedia.org/wiki/Gray
  9 Perl - http://www.activestate.com/activeperl
 10 SNMP Devices - http://en.wikipedia.org/wiki/SNMP
 11 Object Identifier - http://www.oidview.com/mibs/detail.html
 12 Monitoring EUMETCast (D Taylor) - GEOQ 8, pp 5-6
 13 Extending EUMETCast Monitoring (D Taylor) - GEOQ 21, pp 33-35
 14 David Taylor's MRTG Guide
     http://www.satsignal.eu/mrtg/performance_howto.php
 15 Graphical Representation with MRTG
     http://oss.oetiker.ch/mrtg/
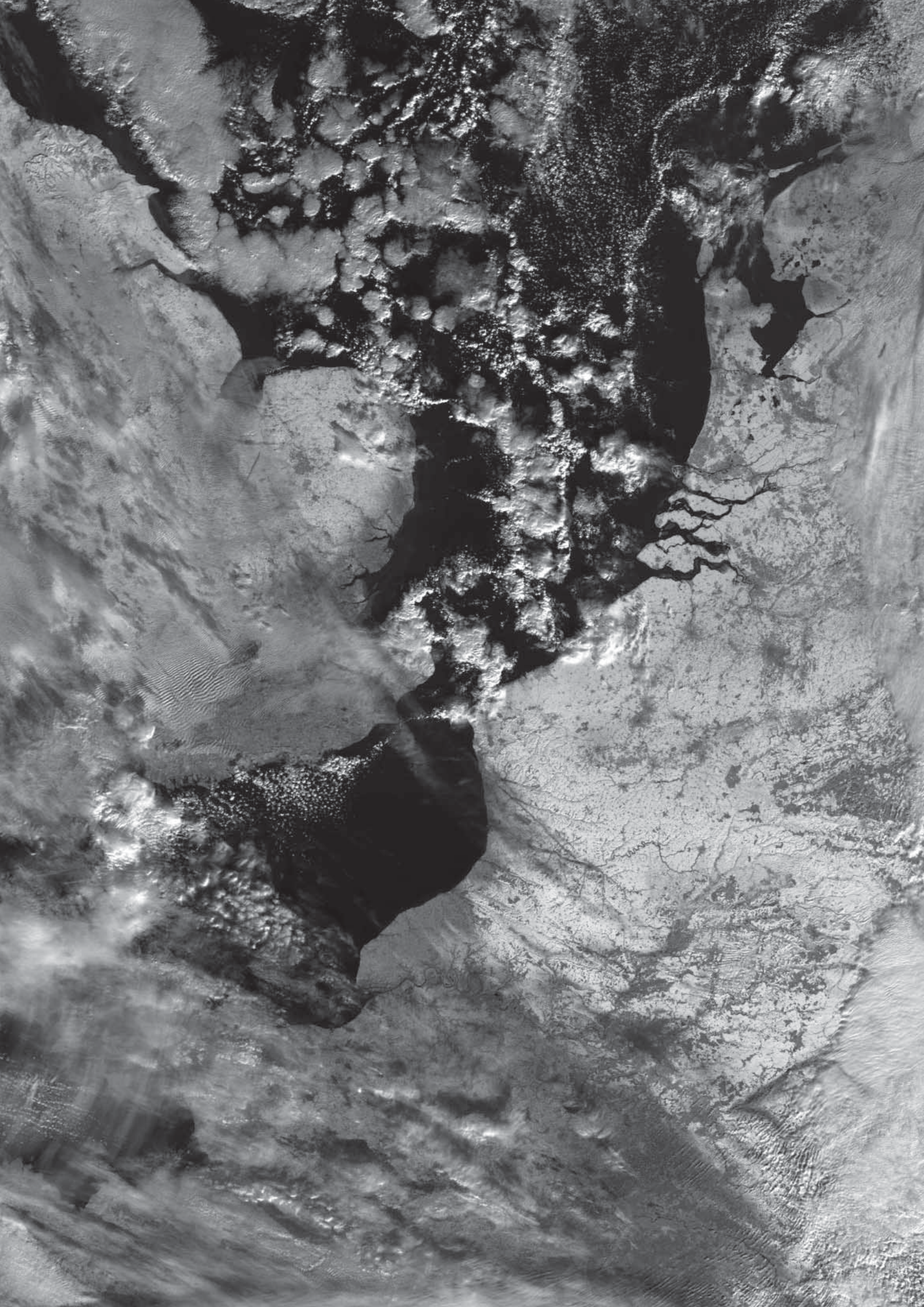
NOAA finds Long-Term
Climate Warming Trend

Adapted from a Science@NASA Report - January 15, 2013

NASA scientists have determined that 2012 was the ninth warmest of any year since 1880, continuing a long-term trend of rising global temperatures. With the exception of 1998, the nine warmest years in the 132 year record have all occurred since 2000, with 2010 and 2005 ranking as the hottest.

NASA's Goddard Institute for Space Studies (GISS) in New York, which monitors global surface temperatures on an ongoing basis, released an updated analysis that compares temperatures around the globe in 2012 with the average global temperature from the mid 20th century. The comparison shows how Earth continues to experience warmer temperatures than were prevalent several decades ago.

A video showing a colour-coded map displays a progression of changing global surface temperatures anomalies from 1880 through 2012. The final frame represents global temperature anomalies averaged from 2008 through 2012. It can be viewed at the following URL

http://science.nasa.gov/media/medialibrary/ 2013/01/15/splash2.jpg/image_full

The final frame of the video represents global temperature anomalies averaged from 2008 through 2012. Figure 1 shows the video frame for 1884 and figure 2 that for 2012.

The average temperature in 2012 was about 14.6°Celsius, 0.6°C warmer than the mid 20th century baseline. The new analysis indicated that the average global temperature has risen about 0.8°C since 1880.

Scientists emphasise that weather patterns will always cause fluctuations in average temperature from year to year, but the continued increase in greenhouse gas levels in Earth's atmosphere assures a long-term rise in global temperatures. Each successive year will not necessarily be warmer than its predecessor, but on the current course of greenhouse gas increases, scientists do expect each successive decade to be warmer than the previous one.

"*One more year of numbers isn't in itself significant*," maintained GISS climatologist Gavin Schmidt. "*What matters is that this decade is warmer than the last one, which*
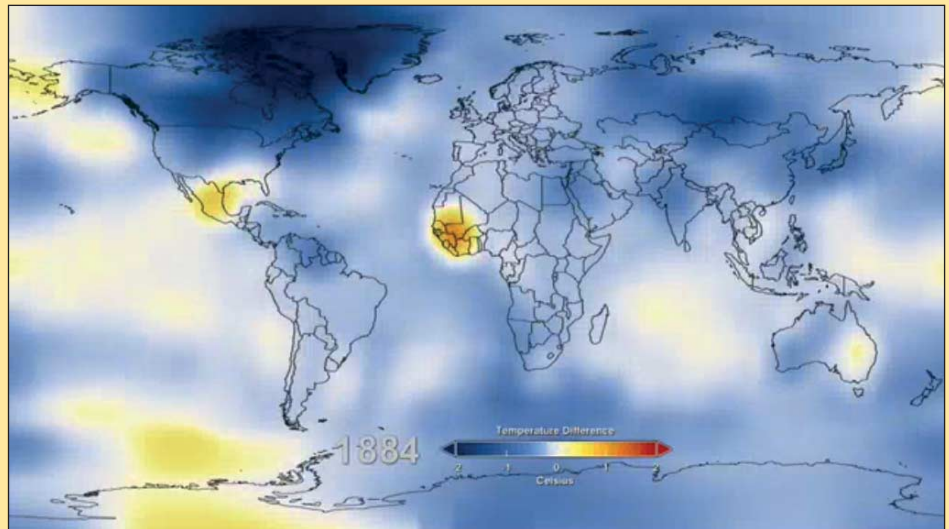
Figure 1 - Mean Global temoperatures in 1884
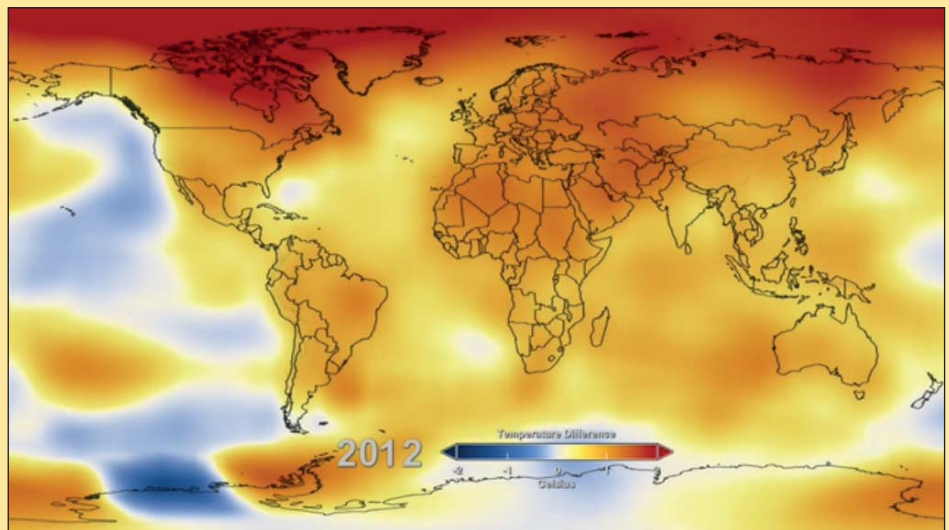
Figure 2 - Mean Global temoperatures in 2012

in turn, was also warmer than the decade preceding it. The planet is warming because we are pumping increasing amounts of carbon dioxide into the atmosphere."

Carbon dioxide is a greenhouse gas that traps heat and largely controls Earth's climate. It occurs naturally and is also emitted when fossil fuels are burned for energy. Driven by increasing man-made emissions, the level of carbon dioxide in Earth's atmosphere has been rising consistently for decades.

The carbon dioxide level in Earth's atmosphere was about 285 parts per million in 1880, the first year in the GISS temperature record. By 1960, the atmospheric carbon dioxide concentration, measured at NOAA's Mauna Loa Observatory, had risen to some 315 parts per million. Today, that measurement exceeds 390 parts per million.

While the globe experienced relatively warm temperatures in 2012, the continental US endured its warmest year on record by far, according to NOAA, the official keeper of US weather records.
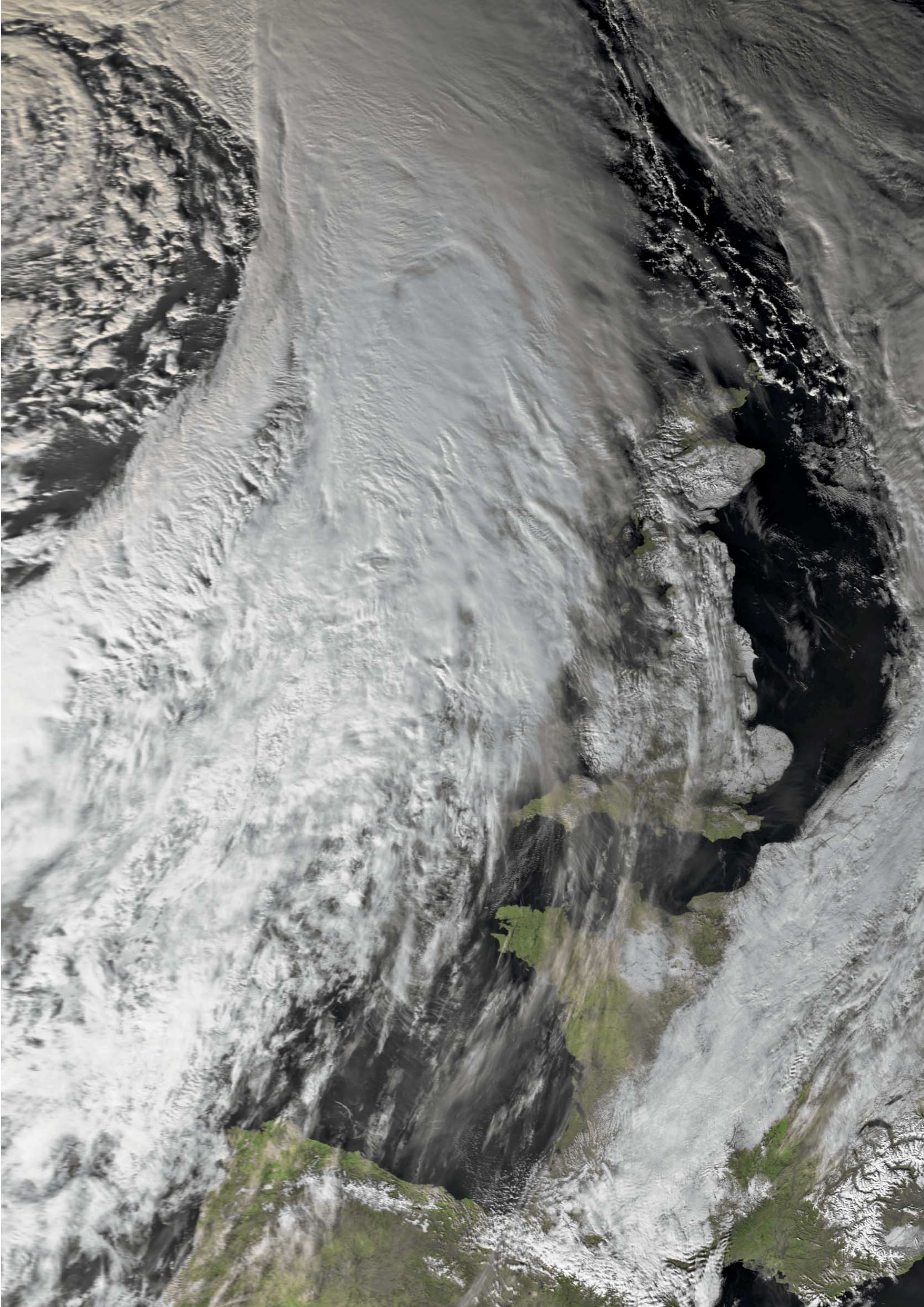
EARTHQUAKE

Monitoring and Prediction

Esko Petäjä

I have business friends living in the region of Emilia-Romagna in northern Italy, and heard from them that a large earthquake occurred near where they live last May. The map below (figure 1) shows the area where the earthquake took place, and figure 4 illustrates the effect of the quake on buildings in Cavezzo, Modena province.
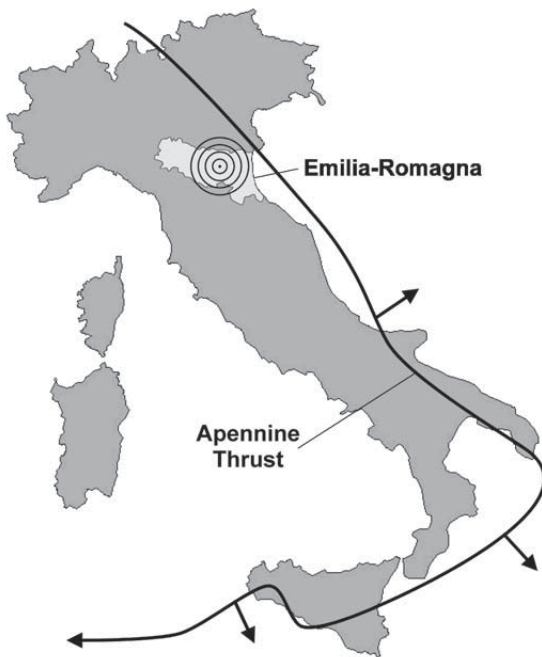
Figure 1 -　Map of Italy highlighting Emilia-Romagna province, the region affected by the earthquake, and the Apennine thrust fault.

This raised my interest to study more how to monitor earthquakes and how satellites are used today for earthquake prediction. I also learned about an interesting earthquake monitoring system where private users can share their information over a network and then view the global earthquake situation on the *QCN-Network*.

I'm going to start with basic background information about earthquakes before describing how this system works and how to utilise it and the *QCN-Network* [1]. Finally, I will describe how satellites are used to predict earthquakes today.

Where do Earthquakes Occur?

Earth's crust is made from several pieces called plates, which are moved around by convection within the mantle and are always colliding or pulling away from each other. Earthquakes occur throughout the world all the time, most of them along the edges of oceanic and continental plates. Earthquakes usually occur where

two plates run into each other or slide past each other. Figure 3 shows the planet's main oceanic and continental plates and their boundaries. The map (figure 1) shows the Apennine thrust, close to Emilia-Romagna, where approximately one millimetre per year of active movement, is taking place. The Apennine thrust has produced several damaging historical earthquakes in this area, such as the one at Ferrara in 1570.

Different Characteristics of Earthquakes and their Effects

Geologists measure earthquake motions and study their characteristics measuring their period, amplitude, frequency and direction of motion of their seismic waves. The point where an earthquake actually originates is called its *hypocentre* (or focus), and can lie deep within the Earth. The point on the surface of the Earth, directly above the focus, is known as the *epicentre*.

An earthquake produces two types of waves, *Body Waves* that travel through the interior of the Earth, and *Surface Waves,* that move across the planet's surface.

There are two forms of Body Wave: *P-waves* (primary waves), longitudinal compression waves that travel in the direction of propagation and S-waves (secondary waves), shear waves transverse to the direction of propagation. P-waves travel through any type of material at speeds ranging from 5000 m/s in granite and 1450 m/s in water. *S-waves* travel more slowly, and only through solids (at roughly 60% of the speed of P-waves), yet are more powerful and often much more destructive.

When the energy of an earthquake reaches the surface of the Earth, it creates two types of *Surface Waves*, each named after its discoverer. *Rayleigh Waves* have an amplitude that decreases exponentially with the depth of the *hypocentre* and can travel around the Earth's crust several times before dissipating. Rayleigh waves cause the ground to shake in an elliptical motion, and travel with a rippling motion similar to the that of waves on water. *Love Waves* move the ground from side to side in a horizontal plane at right angles to the direction of propagation. The horizontal shaking resulting from Love Waves is particularly damaging to the foundations of structures (figure 6).

How Earthquakes are Monitored

When an earthquake occurs, elastic energy is released, sending out vibrations that travel throughout the Earth. Earthquake vibrations are detected on a seismometer, and are displayed as a trace on a seismograph. The seismometer must be able to move with the vibrations. Older seismographs, like the one drawn below, also acted as a seismometer. Modern seismometers are piezoelectric, piezo resistive or capacitive micro electro-mechanical systems (MEMS) devices.
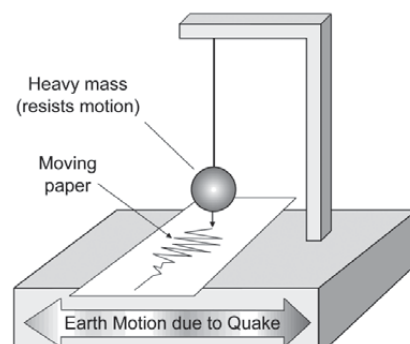
Figure 2 - Principle of a simple seismograph
Credit: Copied from an original diagram by USGS

The significance of an earthquake is measured on the *Richter* or *Mercalli* scale ratings. The *Richter* scale was invented and named during 1935 by American seismologist Charles Richter, and is a measure of the total energy emitted by an earthquake. The amplitude of waves recorded by seismographs are adjusted mathematically for variations in their distances from the epicentre to produce a magnitude index for the earthquake. This value is not a measure of how much the ground shakes at any particular

place but relates to the entire energy output of an earthquake. The Richter magnitudes increase logarithmically, which means that the energy of the quake increases tenfold with for each magnitude number. The *Mercalli* intensity scale is based on observations from <u>earthquake damage</u> and is not derived instrumentally. It was Invented by the Italian seismologist Giuseppe Mercalli. Table 1 compares earthquakes in both *Richter* and *Mercalli* scales while figure 3 shows a typical seismogram (the trace produced by a seismograph).

Richter Magnitude	Mercali Intensity	Description
2	I	Usually not felt but detected by instruments.
	II	Felt by very few people
3	III	Felt by many, often mistaken for a passing vehicle.
	IV	Felt by many indoors; dishes and doors disturbed.
4	V	Felt by nearly everyone. People awakened. Cracked walls, trees disturbed.
5	VI	Felt by all. Many run outdoors. Furniture moves. Slight damage occurs.
	VII	Everyone runs outdoors. Poorly built buildings suffer severe damage. Slight damage everywhere else
6	VIII	Everyone runs outdoors. Moderate to major damage. Minor damage to specially designed buildings. Chimneys and walls collapse.
7	IX	All buildings suffer major damage. Ground cracks, pipes break, foundations shift.
	X	Major damage. Structures destroyed, ground badly cracked. Landslides occur.
8	XI	Almost all structures fall. Bridges wrecked. Very wide cracks in ground.
	XII	Total destruction. Ground surface waves seen. Objects thrown into the air. All construction destroyed

Table 1: Earthquake significance on both Richter and Mercalli scales.
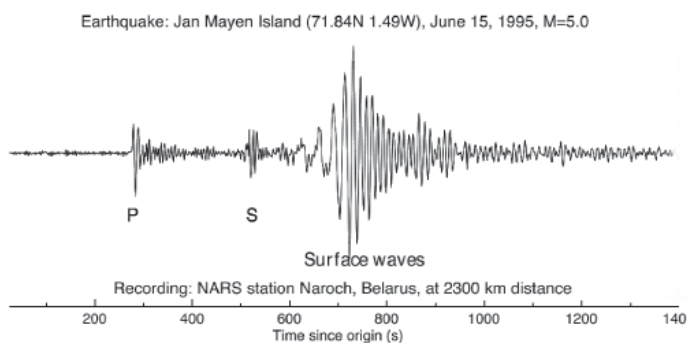
Figure 3 -   A typical earthquake seismograph showing the arrival of P-waves before S-waves,
Credit: USGS

The QCN-Network

The *Quake-Catcher Network* (QCN) [1] provides software and sensors so that individuals can join together to improve earthquake monitoring, earthquake awareness and the science of earthquakes. At this moment there are around 1500 active sensors in the network. If you are interested to obtain a sensor, the standard package can be ordered from

http://qcn.stanford.edu/join-qcn/request-a-sensor

for the price of $49 US + shipment cost. The QCN network software needed (BOINC) can be downloaded free of charge. The QCN website has excellent detailed instructions on installing and configuring both sensor and software. I will describe how this system works and what its usage possibilities are. Figure 7 shows, schematically, the architecture of my QCN Station.

1 - The Sensor

QCN sensors are Micro-Electro-Mechanical Systems (MEMS) accelerometers, which are simply microchips with a very small set of force-balance cantilever beams inside them. The balance mass weight is compensated by a low-level electrical voltage. QCN uses a series of sensor types, some embedded in devices such as laptops and some connected by USB to computers. The QCN sensors measure accelerations between -2g and +2g (where g is Earth's gravitational constant: $9 \cdot 81$ ms^{-2}) along three axes, and the software samples the sensor 50 times per second. The sensor used in my station is shown in figure 8.

2 - The Processing

Requirements for the processing PC are minimal: it can be equipped with *Windows*, *Linux* or *Apple* operating system. A powerful PC is not needed. I use an *Intel Atom* unit using *Windows XP,* running *Plane Plotter* and the weather station software at the same time without any problem.

3 - The Software

The Software used in the QCN is BOINC (Berkeley Open Infrastructure for Network Computing), an open source package for volunteers to do grid computing. It was originally developed to support the *SETI@home* project, a scientific experiment that uses Internet-connected computers in the Search for Extraterrestrial Intelligence (SETI) by analysing radio telescope data. BOINC has since become useful as a platform for other distributed applications in areas as diverse as mathematics, medicine, molecular biology, climatology, and astrophysics. The intent of BOINC is to make it possible for researchers to harness the enormous processing power of personal computers around the world. When a significant tremor is detected at a station, the software sends a 'trigger message' to the server in a small XML packet with enough information to figure out information about the quake (latitude/longitude, time, sensor type). Figure 9 shows the main QCN screen running in the BOINC software. Tabs at the top of the screen display different project statistics; the buttons on the left provide access to user account settings.

BOINC software operates a system which provides 'Credits' to each user for work done for the project on their workstation. These amount to 50 'BOINC Cobblestones' per 24-hours of sensor monitoring [2].

4 - SAC Files

The software algorithm checks if motion was significant by comparing each point with the standard deviation of the signal in the long-term window prior to the trigger event. If the criteria match, the SAC (Seismic Analysis Code) files are saved. This file includes a one-minute recording buffer prior to the trigger and a two-minute buffer after it.

5 - The SAC File Viewer

SAC files contain binary data which can be visualised using special Seismogram Viewer programs. The yellow trace shows the motion vector in the north-east direction, red the east-west motion vector and blue the up-down motion vector. The time line is shown at he bottom. The different waves can be seen clearly in the red graph (P-waves arrive first, followed by S-waves and finally ground waves). I use the *SeisGram2K* seismogram viewer, freely available from

http://alomax.free.fr/seisgram/SeisGram2K.html

to visualise data. Figure 10 shows a *SeisGram2K* SAC visualisation from the Italian earthquake of May 20, 2012.

7 - The QCN Server

The QCN Servers (3 different units), based on *Linux* and the *MySQL* database, are located in Stanford University, California, and consist of the following services:

- Database
- BOINC scheduler
- Web pages
- Data upload and analysis server
- Event detection.

Figure 4 - Buildings Reduced to Rubble
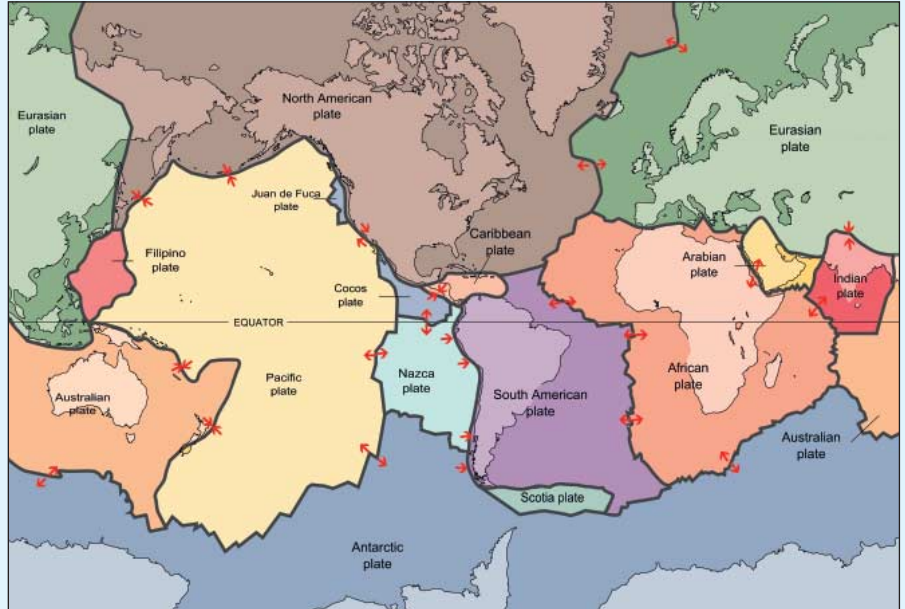*Photo: Mario Fornasari/Wikimedia*

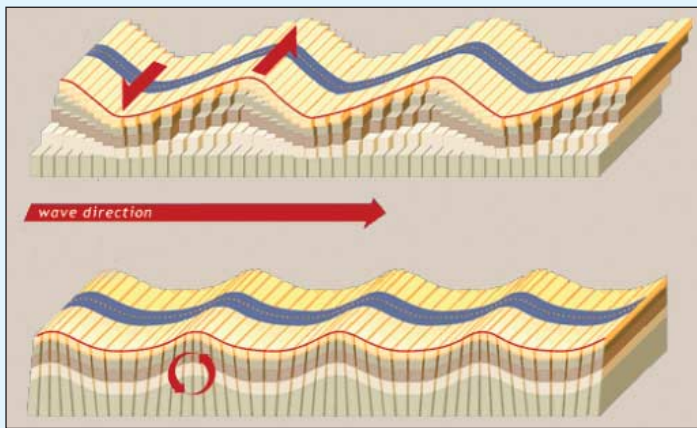Figure 5 - Map showing the Earth's major Tectonic Plates
Image: USGS

Figure 6 - Love Waves (top) and Rayleigh Waves (bottom)
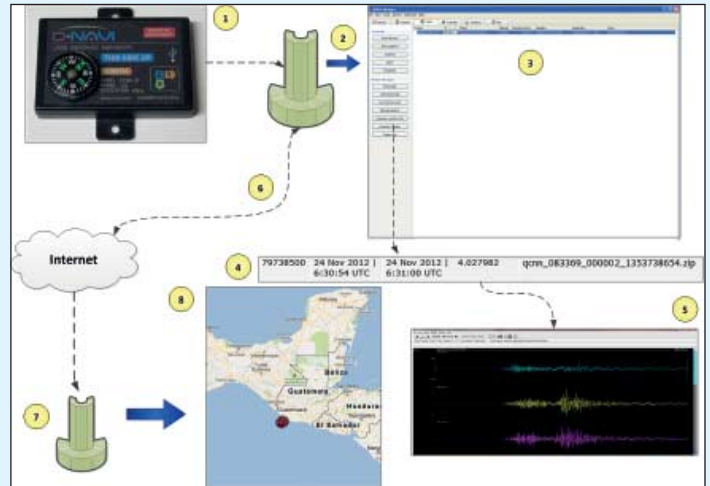*Image: USGS*

Figure 7 - Schematic showing the Author's *QCN Station*
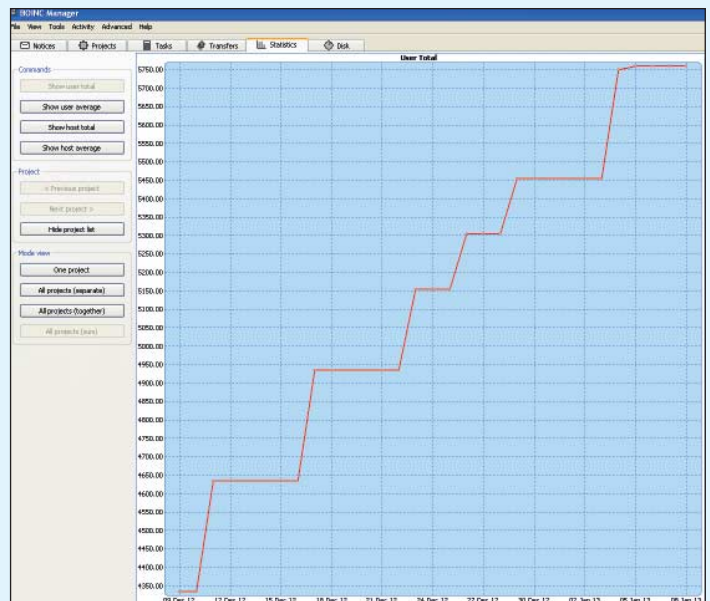

Figure 8 - The Sensor used in the Author's Station
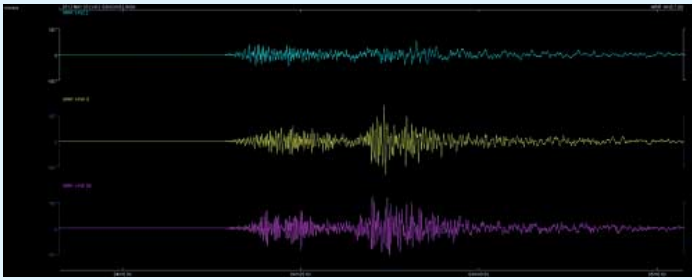

Figure 9 - QCN Software running under BOINC

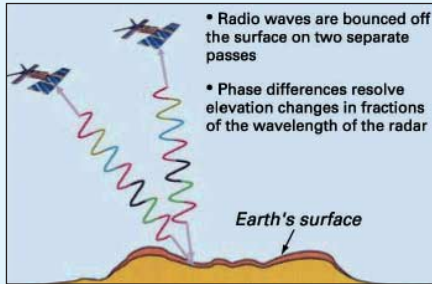Figure 10 - A *SeisGram2K* SAC trace of the May 2012 Italian Earthquake

Figure 12 - Principle of *InSAR* Radar
Image: USGS

Figure 11 - QCN Network Data for December 2012
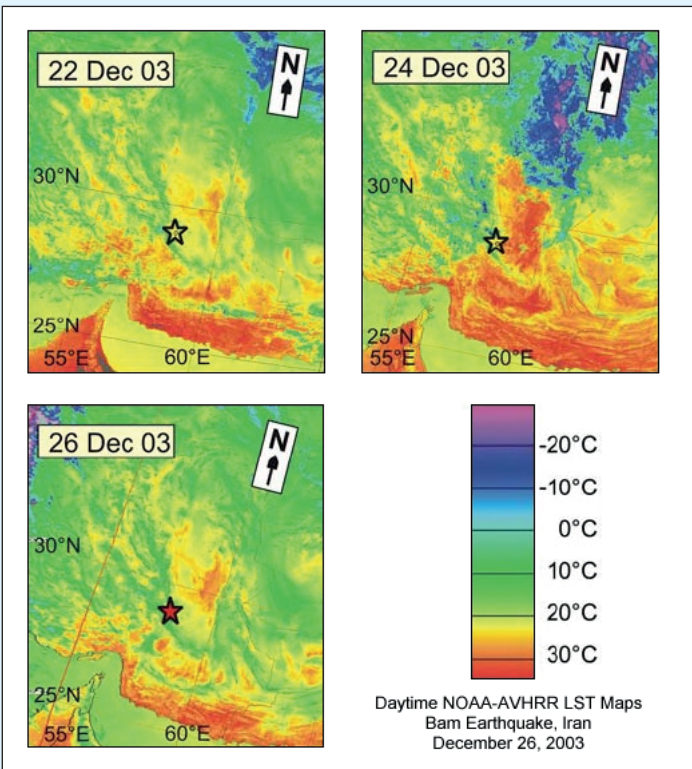
Figure 14 - NOAA-AVHRR LST maps of Iran before and after the Bam earthquake on December 26, 2003 (Choudhury, 2005)
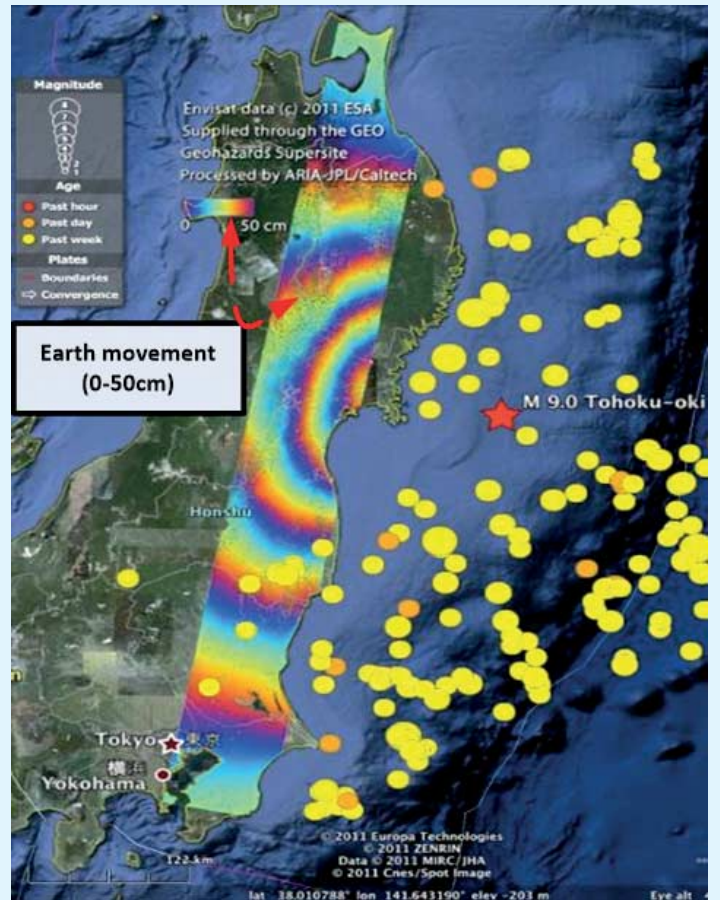
Figure 13 - Movement measured by Envisat during Japan Earthquake
Image © ESA
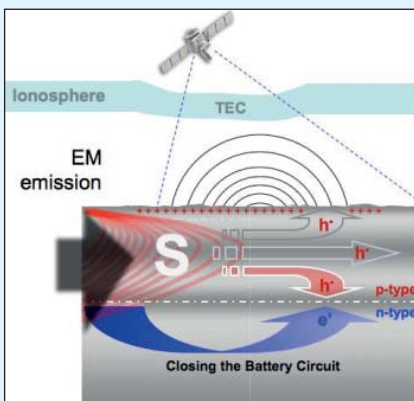
Figure 15 - Rocks are working like batteries effect.
Image: NASA/Ames Associate
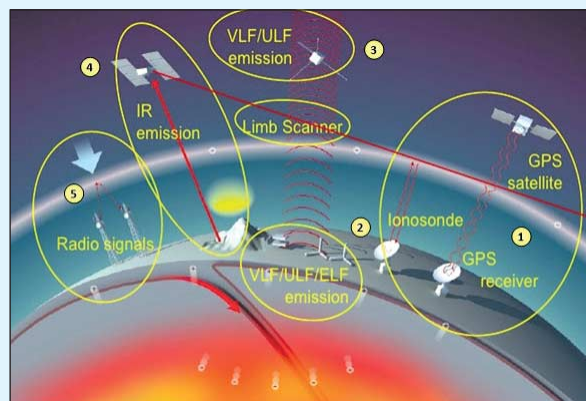
Figure 16 - Measurement methods for detecting Ionospheric Disturbance
Image: SSTL
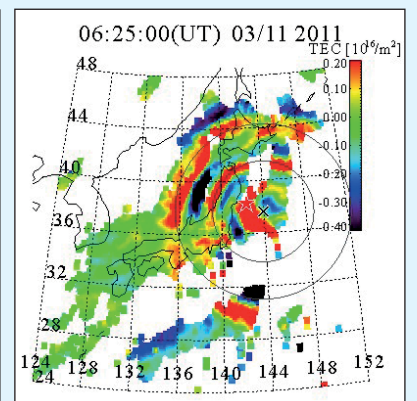
Figure 17 - TEC measurement over the Tohoku Earthquake in 2011
Image © NIICT, Japan

The system has computed 60 million triggers over three years. If the server determines that your PC has been involved in a seismic event, it will send a request to upload the SAC (full waveform) files for this event.

The **Database Server** manages all station information and trigger information. The **BOINC Scheduler** handles BOINC client requests for new work units, triggers, etc. The **QCN Web Page Server** carries work to display all BOINC web pages including triggers etc.

The **Data Upload Server** receives a small (~300 byte) packet of XML whenever a trigger occurs in a station. This file includes the event time, host time offset, x/y/z sensor reading, significance threshold etc. If the server determines that this computer was involved in a seismic event, it will send a request to the station to upload the SAC (full waveform) files for this event (the BOINC 'intermediate upload' feature). The **Event Detection Server Processes** scan the new trigger (stored in a MySQL memory table) every 0.2 seconds, a simple process which compares USGS-detected/reported events with our sensor network. The **QCN Web Page Server** shows recent earthquake data, based on date from all its network stations at

http://qcn.stanford.edu/sensor/maptrig.php

Figure 11 shows QCN network data over Europe from December 2012, as displayed on my PC workstation. Locations of user stations are indicated, and earthquakes shown as red markers. You can display data for specific periods by adding a suffix to the URL, for example,

http://qcn.stanford.edu/sensor/maptrig.php?timeint=D

'D' = the last day, 'W' = the last week and 'M' = the last month.

Earthquakes can only be seen on this map and there is no interface available to show the data on your own background or using GIS software.

Earthquake Monitoring and Prediction by Satellites

There are multiple ways in which satellites can be used to predict earthquakes:

- InSAR (Envisat and ERS-2)
- Temperature abnormalities detected by satellite
- Ionospheric disturbances

InSAR (Interferometric Synthetic Aperture Radar)

There are a number of Earth orbiting satellites that carry InSAR equipment, which works by sending down radar pulses and measuring the microwave energy that bounces back. Additionally they can also record the phase of the returning waves. Two of the best known satellites were ESA's Envisat and the veteran ERS-2 (which served for 16 productive years), but both have now ceased operating. Both satellites carried onboard InSAR, and by comparing the phase shift between radar images before and after an earthquake, changes in ground position could be measured with an accuracy of millimetres. Figure 12 illustrates the principle of InSAR radar.

Using data acquired on February 19 and March 21, a ground shift of about 2.5 m eastwards and a downward motion of Honshu Island's east coast were been detected. Figure 13 show movement measured by Envisat.

Temperature Abnormalities

During 1980s and 90s, Russian and Chinese scientists noticed some strange thermal anomalies associated with earthquakes in Asia. Shortly before the Zhangbei earthquake near the Great Wall of China in 1998, where ground temperatures in the region had been around -20°C, thermal sensors detected temperature increases as large as 6° to 9°C. This means that satellite IR sensors could be useful for predicting earthquakes. Another example was in western India just before the powerful Gujarat quake on January 26, 2001 where thermal anomaly was as large as +4 C°. And in the case of the Bam quake in Iran on December 16, 2003, post-earthquake analysis using NOAA AVHRR land surface temperature data indicated a short-term increase of

between 5° and 10°C in surface temperature shortly before the event (figure 14, where the star symbol indicates the epicentre).

Ionosphere Disturbances

The ionosphere is distinguished from other layers of Earth's atmosphere because it is electrically charged through exposure to solar radiation. There are many cases when satellites have picked up disturbances in this region of the atmosphere, 100 to 600 km above areas that have later been hit by earthquakes. One of the most important of these disturbances is a fluctuation in the density of electrons and other electrically-charged particles in the ionosphere, which can be detected in many ways, including GPS signals, VLF/ULF emission and VLF radio signal propagation.

The background and reasoning for this effect are that when rocks are compressed—as when tectonic plates shift—they act like batteries and generate electric currents powerful enough to be measured from orbit in multiple ways (figure 15). These include the use of GPS satellite signals (1), magnetometers (2), satellites capable of receiving VLF/ULF signals (3), IR emission (4) and monitoring VLF Radio signal propagation (figure 16).

Of particular interest is the use of GPS satellite signals, where the Total Electron Content (TEC) of the atmosphere is measured by a ground station using the delay and phase shift between the two GPS satellite frequencies (L1 C/A and L2 P/Y). Observations show that concentric waves begin to appear in the ionosphere a few minutes after earthquake onset, above the epicentre. Figure 17 shows a TEC plot taken during the Tohoku Earthquake in March 2011.

Earthquake Early Warning Satellite System Activities

There was an article in GEO Quarterly 35 describing a GEO visit to *Surrey Satellite Technology Limited* (SSTL) in the UK. During my study, I found out that they are playing a very active role in developing a satellite-based early warning system. Their concept is to make use of *Disaster Monitoring Constellation* satellites [3], small satellites which cost only a fraction of the cost of normal satellites, many of which are already active.

Usage of GPS Position to Measure Plate Movement

Geodesy is the science of measuring the Earth's shape and positions on it. It is possible to measure plate motions directly using GPS. Plates typically move just few centimetres/year, but changes could be used to predict earthquakes (figure 18)
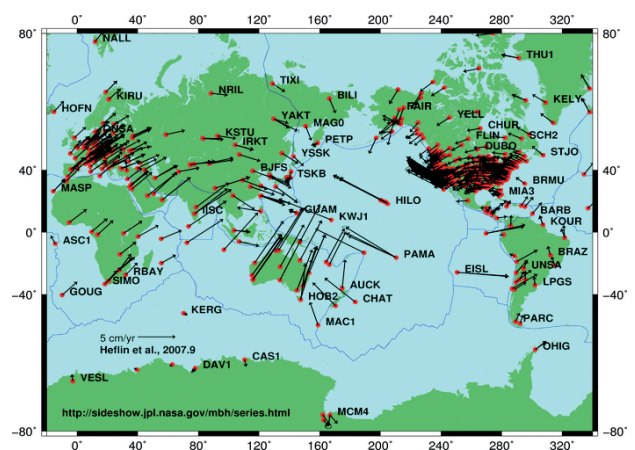

Figure 18 - Global plate motion measured by GPS on April 17, 2008
Image: NASA

References

1 Quake-Catcher Network
   http://qcn.stanford.edu
2 Cobblestone (named after Jeff Cobb of *SETI@home*), is 1/200 day of CPU time on a reference computer that does 1,000 MFLOPS based on the *Whetstone* benchmark. More information can be found on http://boinc.berkeley.edu/wiki/Computation_credit
3 Disaster Monitoring Constellation
   http://en.wikipedia.org/wiki/Disaster_Monitoring_Constellation

The Early Years of Satellite Meteorology

Adapted from Chapter 2 of '*Clouds Across the Moon*'

Paul White

By the late 1960s, the use of satellites to look at the weather was increasingly common, but the technology itself was still in its infancy. Even by the end of the *Apollo* era, there were still many experiments designed to determine whether data from satellites were as reliable as those from traditional ground and atmospheric measurements.

Early satellites were launched with a life-span of just a few months, and their images were examined on their return to Earth. These included the early Soviet *Kosmos* satellites as well as American efforts. Advances in communication techniques later allowed signals from an orbiting satellite to be sent back to a receiving station on Earth, where they could be translated into photographic images.

Although primitive by present standards, the absence of modern circuit board, micro-chips and programming techniques meant that satellite developers had to cram a large amount of complex, bulky, interconnected mechanical workings into a relatively small space. Ingenious solutions were arrived at to achieve simple aims, such as using electromagnets that would align with the Earth's magnetic field in order to maintain a satellite's orbital attitude.

Two basic types of satellite orbit are discussed in this article: geostationary and geosynchronous. Geostationary satellites are placed in a position above the Earth that allows them to observe the same features on the ground at all times. Geosynchronous satellites orbit the planet in such a manner that they pass over the same place on the ground at roughly the same time every day. They are effectively always following the same path, but the rotation of Earth underneath them means that each time they return to a specific point in their orbit, they are over a different part of the planet.

Images from a number of different types of satellite will be described: ATS, ESSA and Nimbus.

ATS

ATS stands for Application Technology Satellite, of which five were launched between December 1966 and August 1969. Unfortunately, three of these craft failed and only *ATS-I* and *ATS-III* returned useful data. The description that follows applies to *ATS-III*, by far the most successful, returning useful data for eight years [1] (figure 2).

ATS-III was launched on November 5, 1967 and placed in high Earth orbit (HEO) at an altitude of 36 000 kilometres, in a position above the equator that allowed observation of the American, African and European continents. Its primary aim was to investigate new ideas in satellite photography, meteorology, and communications technologies, and a total of eleven experimental functions were on board. Although the satellite was launched by NASA, the experiments it ran involved collaboration with a number of other countries, as well as academic institutions and private companies

The camera used to image the Earth was developed by Dr Verner Suomi of the University of Wisconsin-Madison's Space Science and Engineering Centre, and is shown in figure 1. While in orbit, the satellite spun at around 120 rpm, and with each spin scanned a narrow line representing 3.2 km of latitude on Earth's surface. On the next spin it scanned a slightly lower latitude and, over 2400 revolutions, it would achieve full coverage. It took roughly 20 minutes to
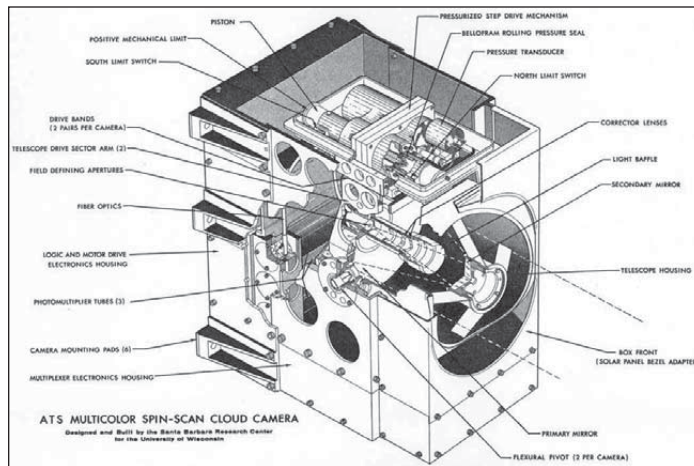
Figure 1 - The ATS-III Multi-colour Spin Scan Cloud Camera system
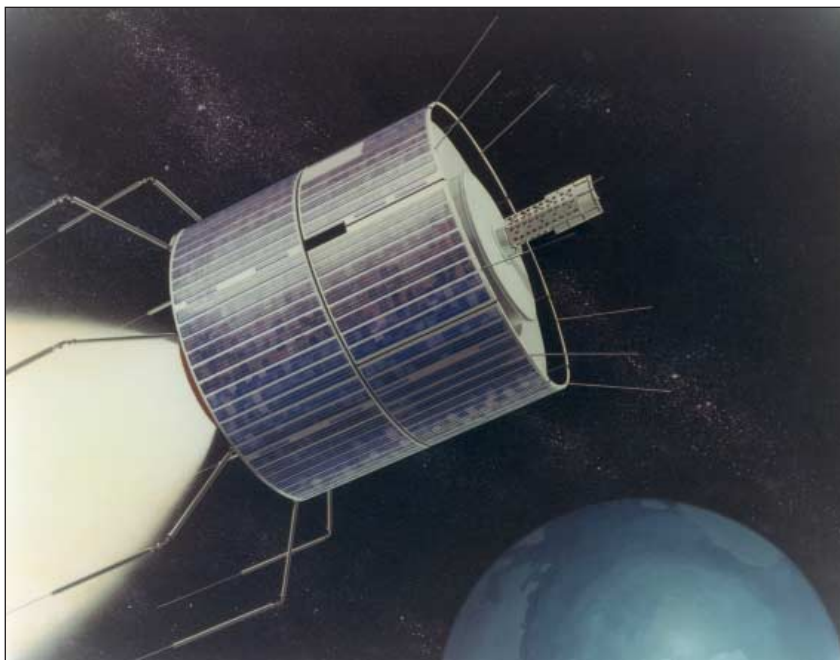Image: NASA ATS Image Collection

Figure 2 - Artist's depiction of ATS-III in orbit
Image: NASA

Figure 3 - Verner Suomi
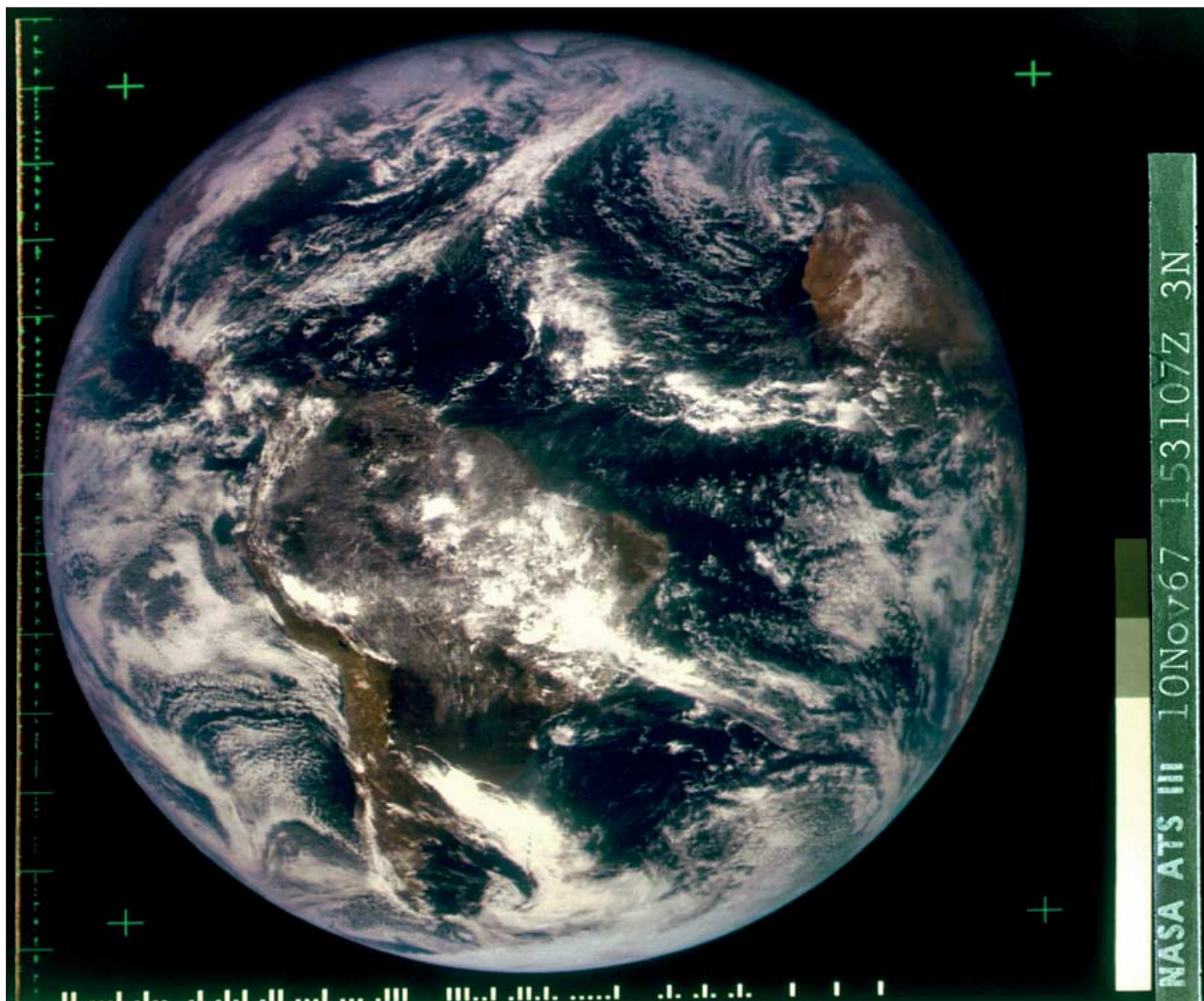*Image: University of Wisconsin-Madison, Madison.*

Figure 4 - An ATS-III colour image of Earth received at 15:31 UT on November 10,1967
Image: Space Science and Engineering Center (SSEC), University of Wisconsin-Madison, Madison.

compose an entire image, after which the camera would reset itself and the process would start anew.

GEO Readers may recall that the latest NASA/NOAA satellite was named Suomi-NPP as a tribute to Dr Verner Suomi (figure 3) and the work he carried out in this field.

Each colour image comprised a blue, green and red channel. Unfortunately, these three channels worked for barely three months before the red and blue channels ceased to function, though monochrome images were still being produced until the mid 70s. At the time, this revolutionised satellite meteorology. The frequent transmission of images changed high altitude cloud photography from interesting 'after the fact' imagery to almost real-time imaging; this allowed meteorologists to see weather systems as they developed and predict more accurately how they were likely to behave. The additional experiments on board the satellite allowed cloud movements to be tied in with observations of other atmospheric conditions, as well as ground-based readings, and investment in satellite technology and meteorology increased significantly.

ATS-III became the first satellite to photograph the full Earth from space in high quality colour (figure 4), and this led to the first colour time lapse film of the Earth from space, which can be viewed at this URL

http://www.youtube.com/watch?v=KCIH6RVlHaw

Interestingly, *ATS-III* possessed a direct link with the *Apollo* moon landing missions by providing real-time TV transmissions for broadcasting by Radio Caracas in Venezuela [2]. It is important to note that *ATS-III* served purely as a relay for these TV signals. It took approximately half an hour for the satellite's own camera to create a single image and reset itself, and it did not have the capacity to broadcast even its own images live. It would also not have been possible for *Apollo 11* to send a signal direct to the satellite as it would not have been visible at the time. The main TV signal for *Apollo 11*'s moon-walk (Extra-Vehicular Activity, or EVA) was received by stations in Australia and transmitted by the communications satellite *Intelsat* to Houston, after which it was relayed to the rest of the world.

ATS-III broadcast its signal to Earth over VHF frequencies, which were received on VHF antennas of various types, as illustrated in figure 5. The analogue signals from *ATS-III* were then digitised, different levels of brightness being assigned numerical values which were stored on tape for later analysis, but the systems were bulky and slow.

According to NASA, a single digitised ATS image could use up an entire tape reel (and four reels for a colour image). Ultimately, seven-track 18-inch reels came into use, and
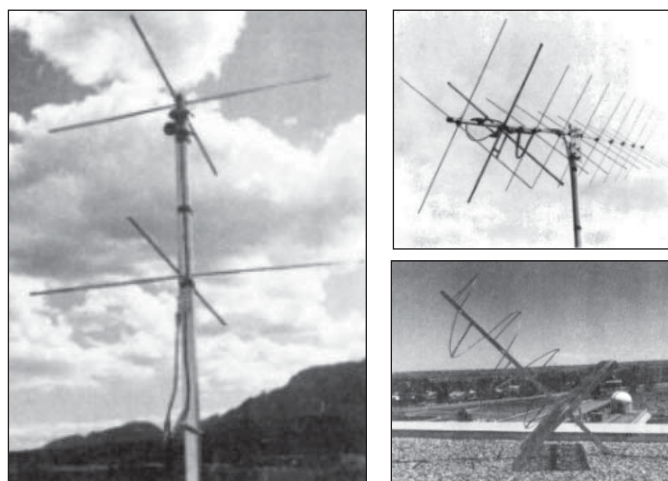

Figure 5 - Antennas used to receive ATS III
Crossed dipoles with reflector (left), Crossed YAGI (upper right) and a 3-turn helical antenna (lower right).

these could store 70 images, roughly a day and a half's worth of data. It took an estimated four hours between transmission from the satellite until an image became visible on a terminal on the ground.

Verner Suomi set out to derive quantitative measurements of winds based on cloud motion as depicted in successive *ATS-III* images. Early efforts were laborious affairs, and involved printing out each image strip using characters such as '*', '/' and ')' to simulate a greyscale. These printouts were then pasted together to create huge images measuring up to 100 square metres in area [3]. Cloud motion was then determined using a cross-correlation algorithm to determine the cloud displacement in successive images.

Later, a computer-based video system caller WINDCO was developed. This used an instant replay analogue disk which supported image animations and allowed the operator to transfer the location of clouds in each image on to paper tape (figure 6). After a further transfer to punched cards, this data was submitted to the university's *Univac 1108* mainframe computer, which output cloud displacement vectors, plotted over a map of the Earth.

Figure 6 - An operator at the WINDCO terminal
Image: SSEC, University of Wisconsin-Madison

ESSA

Environmental Science Services Administration launched the *ESSA* series of 2nd generation TIROS (Television Infrared Observation Satellites) probes through the 1960s [4]. These satellites tended to be rather short-lived, with working lifetimes of between one and three years (figure 7).

These probes were geosynchronous polar-orbiting satellites, operating at a much lower orbital altitude of around 1400 km, and taking roughly two hours to complete each orbit. They covered the entire Earth's surface in 24 hours. The satellite's twin cameras were mounted at 180° to each other along the side of the cylindrical craft, and as the satellite cartwheeled in orbit, the camera facing the ground would take an image. Mosaics of these images were made on a polar stereographic projection, centred on the poles, for both the northern (figure 8) and southern hemispheres.

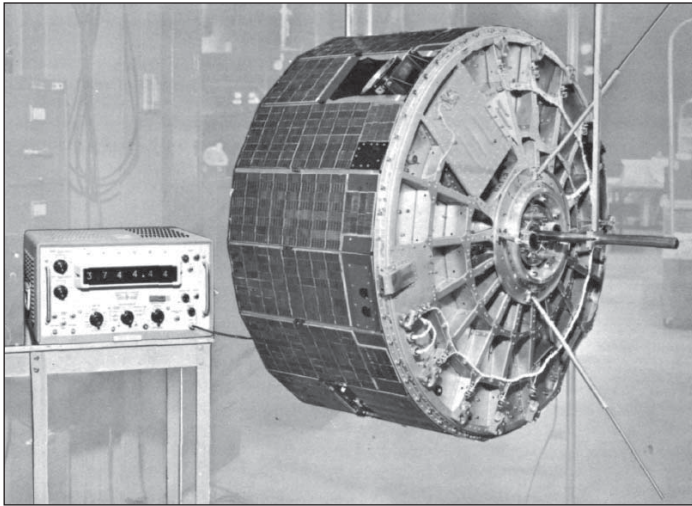The ESSA satellites carried the Advanced Vidicon Camera Systems (AVCS) [5] to image the Earth, and also a tape

Figure 7 - ESSA-1 undergoing moment of inertia testing
Image: NASA

recording system for storing the data for later transmission to receiving stations. The exact coverage would vary depending on the altitude of the satellite in its somewhat elliptical orbit, but each individual image covered an area roughly 1200 kilometres square, where each line of the TV transmission spanned close on three kilometres. The orbital periods were designed so that the images were recorded in daylight, effectively meaning that photographs were taken during one hour of each orbit. One image was taken roughly every 260 seconds, with an exposure time of around 8 seconds. A diagram showing the orbital paths for *ESSA* satellites is shown in figure 9. These paths were the same for each *ESSA* satellite.

Interestingly, the odd- and even-numbered ESSA satellites transmitted their images to Earth in completely different ways. ESSAs 1,3,5,7 and 9 recorded all their images by means of on-board tape recorder and stored them on magnetic tape. Later, when the satellite was orbiting within range of one of ESSA's two ground receiving stations—in Virginia and Alaska—these images were transmitted to Earth.

The received images were recorded on photographic film using kinescopes, and also transferred to magnetic tape, with numerical values used to represent different levels of brightness. These tapes were used in 'high powered computers' (sic), to create images that could be displayed on cathode ray computer monitors and transmitted by fax to other agencies throughout the world.

On the other hand, ESSAs 2,4,6 and 8 provided direct transmission of their data to ground stations around the world by Automatic Picture Transmission (APT) immediately after acquisition [6]. Although it took the camera only about eight seconds to acquire each photograph of the Earth, it took the APT system 352 seconds (almost six minutes) to transmit each image, which covered a 1200 x 1200 kilometre area with a spatial resolution of approximately three kilometres. Eventually, there were over 300 APT receiving stations located around the world, and the images were immediately available to anyone capable of building a receiver. For the first time, amateurs could collect images, and the website for Douai Abbey [7] mentions that Benedictine monks at this English Abbey produced satellite images by recording their signals using radio receivers (although it is not clear to which satellite they specifically listened).

Nimbus

At the same time as the *ESSA* program of active meteorological satellites, *Nimbus* satellites were being launched as research and development tools to test out new atmospheric sensing techniques, and pioneered the AVCS
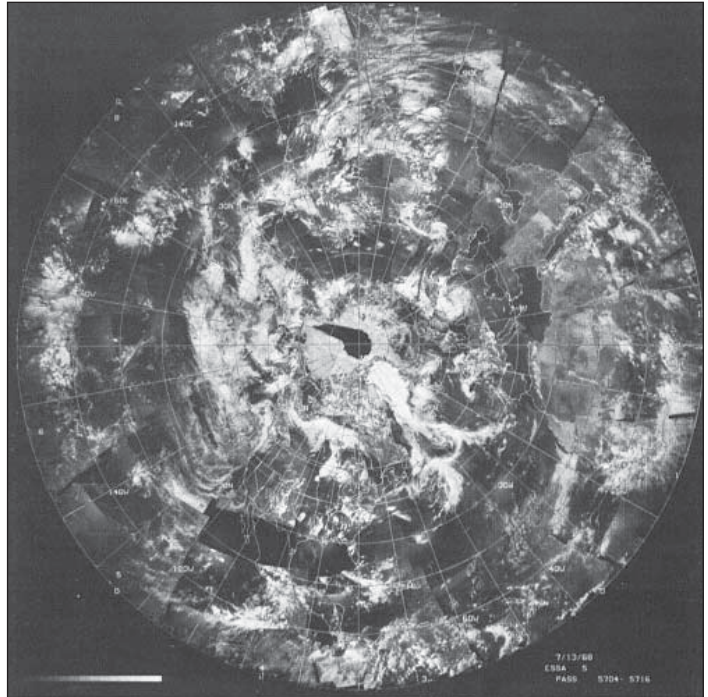

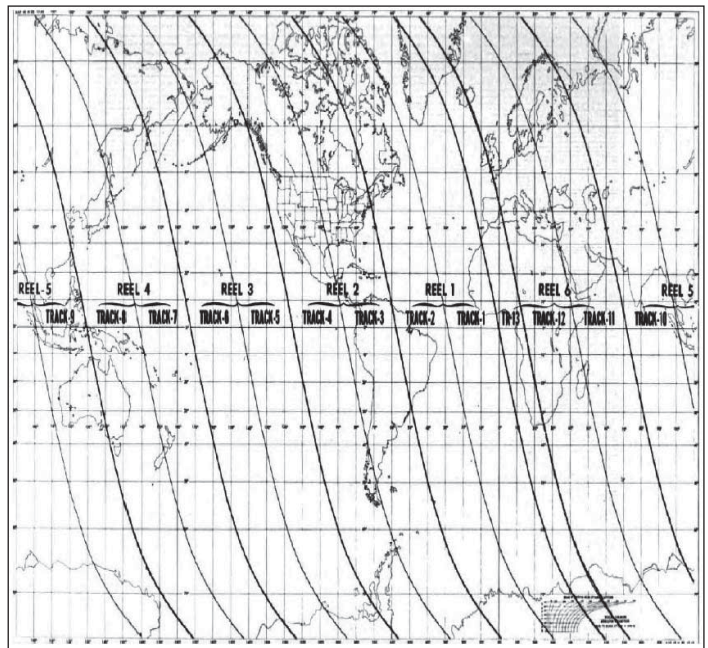Figure 8 - A typical ESSA northern hemisphere composite image
Image: NOAA

Figure 9 - ESSA satellite tracks
Image: NOAA

Figure 10 - An artist's impression of Nimbus-1 in orbit
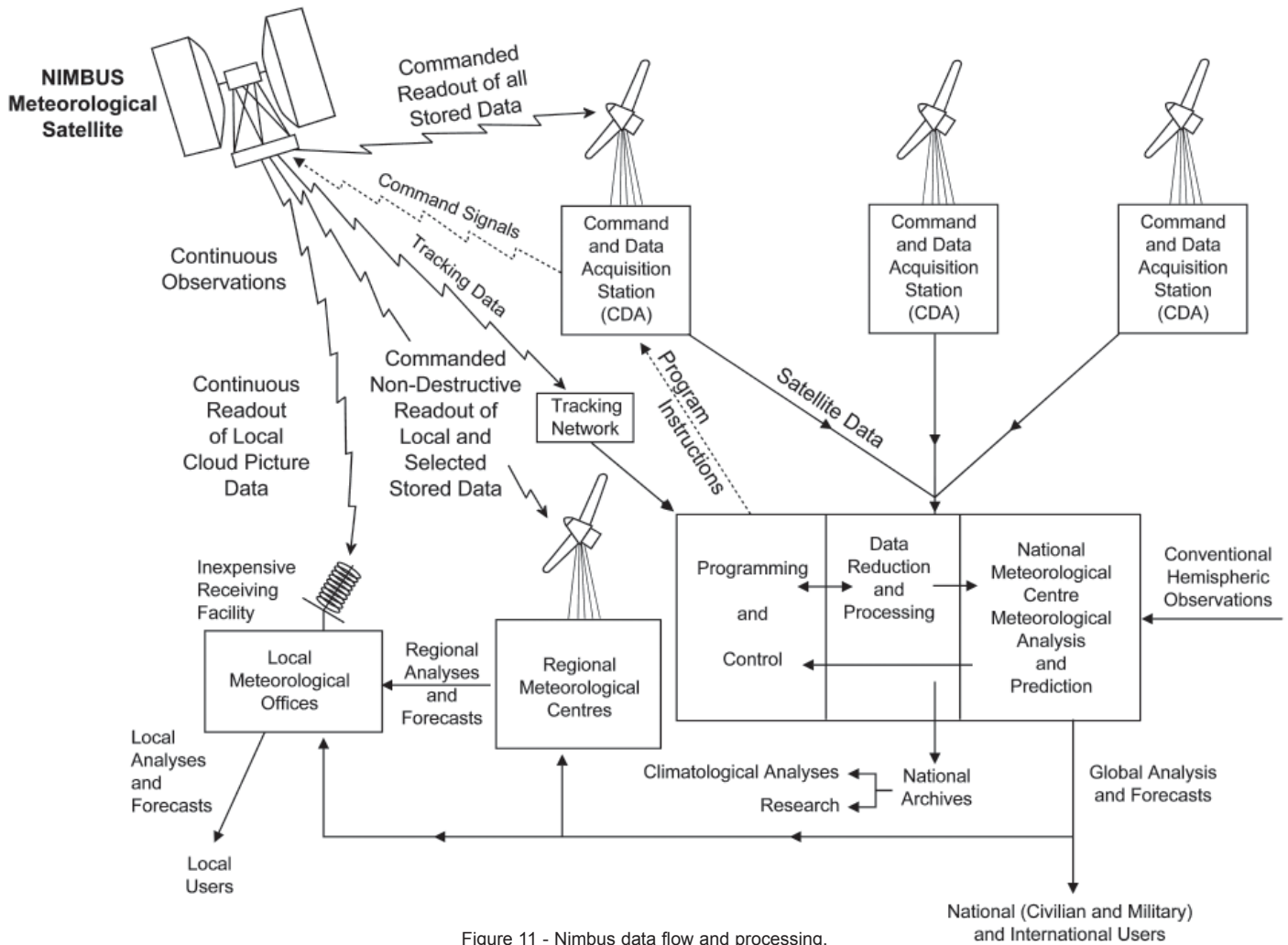*Image: NOAA*

Figure 11 - Nimbus data flow and processing.
Redrawn from a diagram originally published in Flight magazine, November 30, 1961.

and APT techniques used in *ESSA* satellites. They had a secondary mission of providing useful meteorological data [8]. Figure 10 comes from a NASA painting featuring *Nimbus-1* orbiting the Earth.

Like *ESSA*, the *Nimbus* satellites were polar orbiting geosynchronous craft, but they orbited somewhat lower than the *ESSAs* at around 800 kilometres, and each orbit was completed in less than two hours. Whilst *ESSA* used two cameras, *Nimbus* satellites had three, one pointing straight down and the other two angled at 35° on either side so that, despite the lower orbital altitude, considerable ground coverage could be achieved.

Each line of AVCS imaging [9] equated to just over a kilometre, a complete image required six seconds to take, and successive images were taken 90 seconds apart. The three-camera array produced a composite picture covering an area of 830 x 2700 kilometres.

In parallel with the AVCS system, APT was also used [10]. Images retained on the photo-sensitive surface of the vidicon were read out at four lines per second to produce an 800-line picture. A 5-watt TV transmitter then relayed these to APT ground stations on 136.95 MHz. Each image measured 1660 km square and has a resolution of 3 km. Each image was stored electrically on a plate and
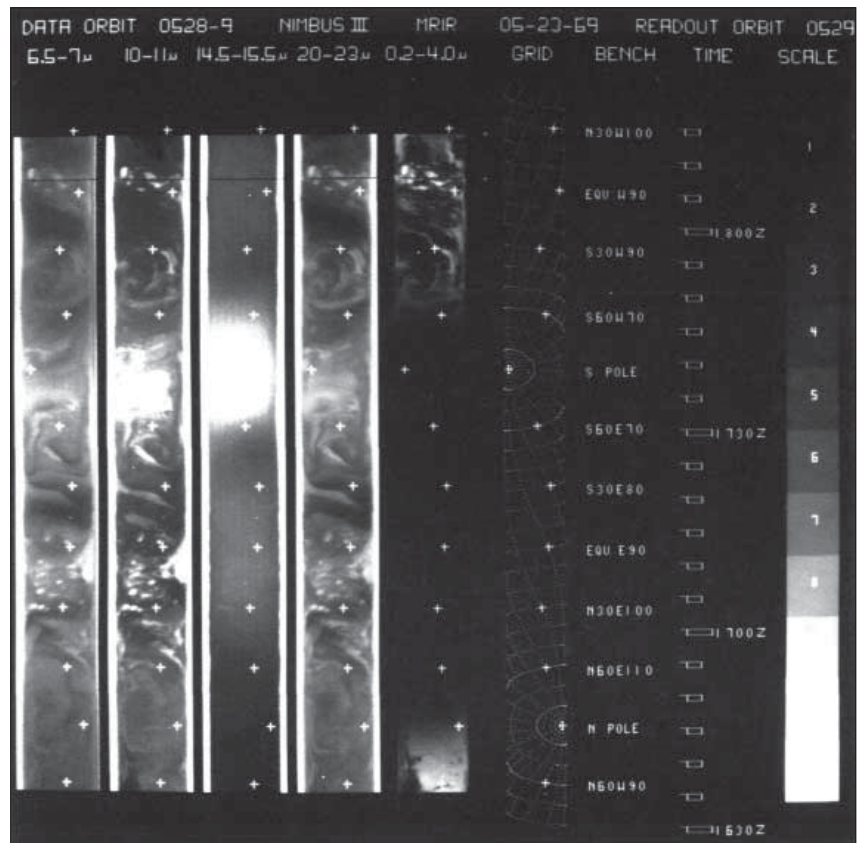
Figure 12 - A single orbital pass transmission from Nimbus-3
Image: NASA/GSFC

readings from the plate were transmitted to Earth. The complete imaging cycle took just under four minutes to complete.

Figure 11 illustrates schematically how the *Nimbus* satellite data was transferred, collected and distributed. *Nimbus* images were available to anyone with a suitable decoder, and NASA's history web page [11] reports the uses to which European meteorological agencies put the data.

The VHF signals sent by the satellite were received by the same type of dipolar antennas as *ESSA* transmissions, and were processed in the same way as *ESSA* signals. Figure 12 shows a single orbital transmission from May 24, 1969.

Summary

Satellites orbiting the Earth in the 1960s were engaged in data collection for meteorological agencies not just in the USA but worldwide. They operated slightly differently to today's craft in that they all used cameras that scanned the Earth and recorded the images on magnetic tape. Data from these tapes were transmitted to ground stations, either automatically or on demand, using VHF signals. Receiving stations recorded these signals and converted them to TV images, which were photographed using kinescopes. These images could then be sent over fax networks, and participating countries could record images directly.

NASA used satellite imagery to work out forecasts for launch dates for their *Apollo* missions, and also for the landing areas after re-entry. They also used the satellite images to help determine what the astronauts described from their view in space. Satellite imagery and other forecasts were supplied by *ESSA*, who also worked closely with other government agencies, including the Department of Defense.

References

1. NASA ATS Mission Page
   http://science.nasa.gov/missions/ats/
2. ATS Mission Archive
   http://www.nasa.gov/centers/goddard/missions/ats_prt.htm
3. McIDAS: 25 Years of Interactive Processing
   http://www.ssec.wisc.edu/mcidas/software/mcidas25_bams.pdf
4. NASA ESSA Mission Page
   http://science.nasa.gov/missions/essa/
5. Advanced Vidicon Camera System
   http://nssdc.gsfc.nasa.gov/nmc/
   experimentDisplay.do?id=1966-008A-01
6. ESSA 2 APT System
   http://nssdc.gsfc.nasa.gov/nmc/experimentDisplay.do?id=1966-016A-01
7. Douai Abbey Website
   http://www.douaiabbey.org.uk/wilfrid.htm
8. NASA Nimbus Mission Page
   http://science.nasa.gov/missions/nimbus/
9. Nimbus Advanced Vidicon Camera System
   http://nssdc.gsfc.nasa.gov/nmc/experimentDisplay.do?id=1964-052A-01
10. Nimbus APT System
    http://nssdc.gsfc.nasa.gov/nmc/experimentDisplay.do?id=1964-052A-02
11. NASA History
    http://history.nasa.gov/SP-168/section1.htm

Editor's Note

Readers wishing to pursue an interest in these early satellites will find a wealth of links in '*Clouds Across the Moon*' to additional information not covered in detail above. These also include catalogues of *ESSA* and *Nimbus* imagery.

Readers interested in sampling some of the coloured ATS-III images will find a collection spanning the period November 8, 1967 to January 24, 1968 at the following URL

*http://library.ssec.wisc.edu/spinscan/images/*
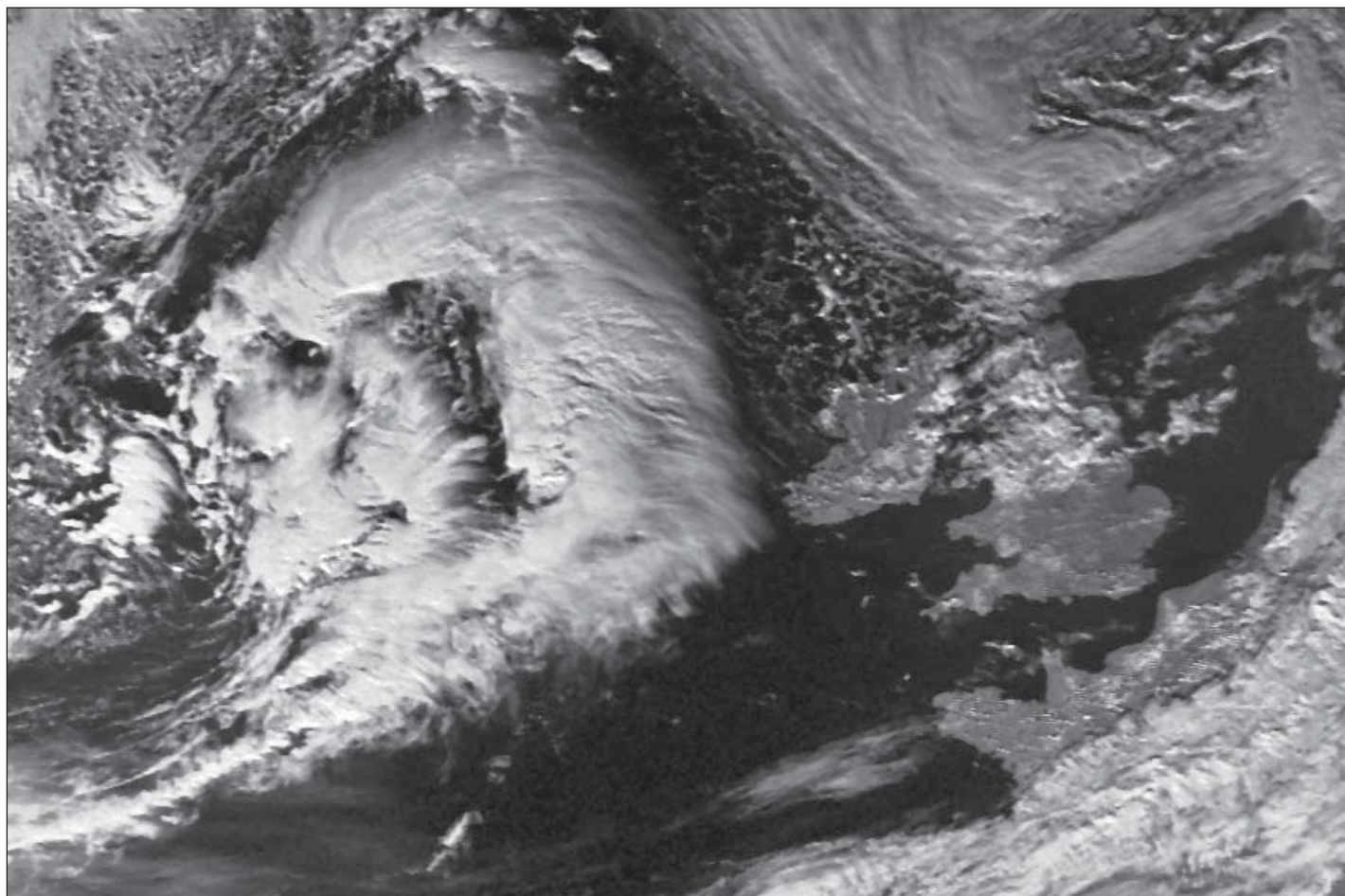
This visually spectacular, compact Atlantic depression heading for the UK was imaged by NOAA-19 at 13:39 UT on January 30, 2013. This APT channel 2 image was captured using *WXSat*, and processed with *SatSignal*.
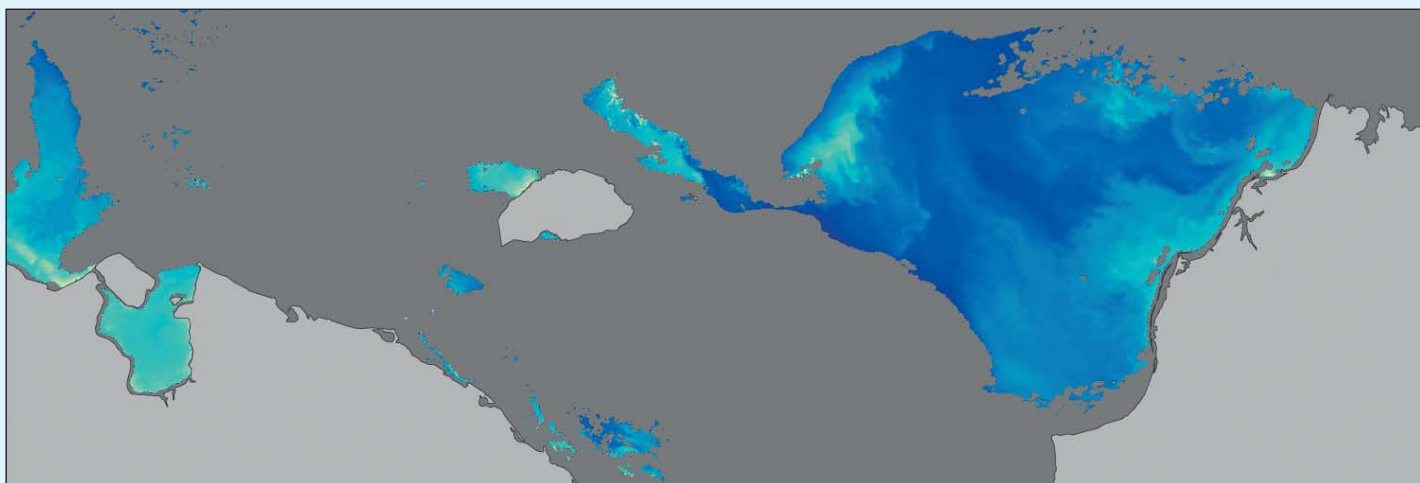
Sea Ice Skylights Spur
Phytoplankton Blooms

A NASA Earth Observatory Report

Text adapted from *Melt Pond 'Skylights' Enable Massive Under-Ice Bloom in the Arctic* by Rebecca Lindsey, NOAA ClimateWatch Magazine
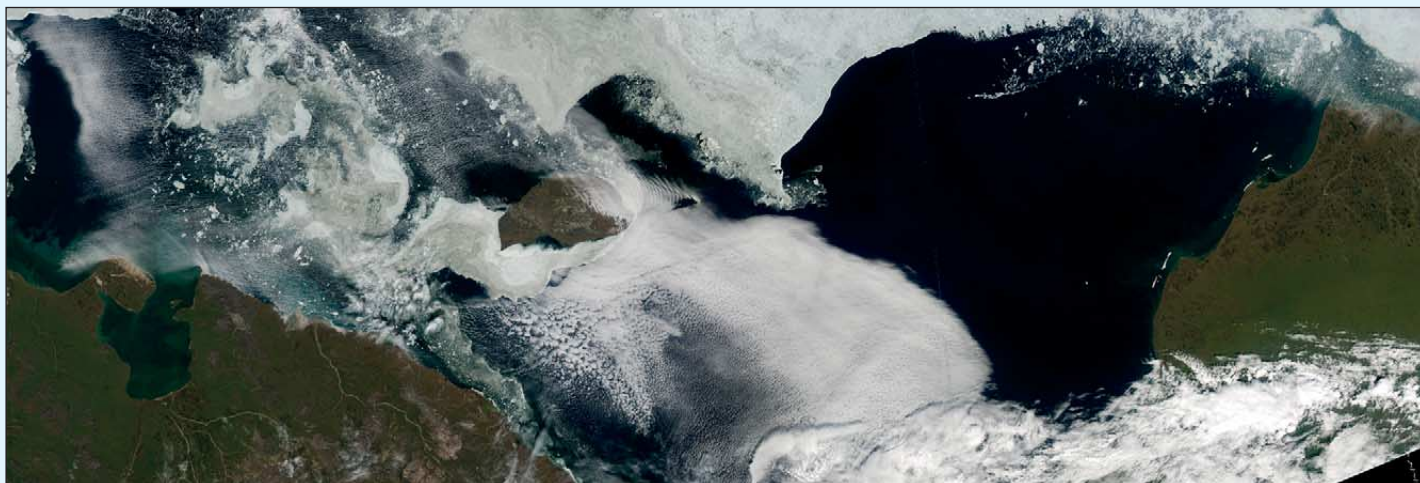
Wrangell Island and the Chucki Sea as viewed by *Aqua* on July 10, 2011.

Chlorophyll Concentration (mg/m^3)

0.1　　　　1.0　　　　10　　　　100

A plot of chlorophyll levels (due to plankton blooms) in the same region, as detected by *Aqua* on July 10, 2011.

For much of the winter, the sun barely rises over the Arctic Circle. In mid-winter, it doesn't rise at all. Most of the Arctic Ocean is capped by ice, and beneath this, phytoplankton—the microscopic, photosynthesising organisms that underpin the entire ocean food web—take a "long winter's nap". But when sunlight returns in the spring and the ice retreats, it's like a cover being drawn off the roof of a greenhouse. The water along the edge of the retreating ice explodes with blooms of phytoplankton.

The images above offer two views of a phytoplankton bloom in the Chukchi Sea, northwest of Alaska, as imaged by the MODIS instrument aboard NASA's Aqua satellite on July 10, 2011.

The upper image is a natural colour view while the lower one is a plot showing the concentration of phytoplankton in milligrams per cubic meter of seawater. Blue indicates areas with low concentrations of chlorophyll, and yellow indicates areas with high concentrations; land is light gray, and areas where MODIS could not collect data due to clouds or sea ice blocking the satellite sensor's view are dark gray.

North of Wrangel Island, the sea ice has a dingy look in the natural colour image. Although this could result from sediment, its distance from shore—plus the fact that the ice is fringed by waters with extremely high levels of chlorophyll—suggests that the ice has been discoloured by algae and other phytoplankton.

According to Arctic oceanographer Karen Frey, the discolouration is consistent with an unusual phenomenon that she encountered while on a research cruise in the Chukchi Sea in July 2012: a massive bloom of phytoplankton stretching some 100 kilometres beneath the ice-pack. Historically, the ice in this area had been thick enough, even in spring, to keep the waters beneath in darkness. But in the past decade ice conditions have changed dramatically, leaving a thinner ice cover laced with shallow ponds of meltwater. These ponds act like skylights, allowing light to filter through and support phytoplankton blooms beneath the ice.

————

NASA Earth Observatory images created by Jesse Allen, using MODIS data from the Land Processing Distributed Active Archive Center (LP DAAC).

Comparing the Winds of

Hurricanes Sandy and Katrina

A NASA Earth Observatory Report

The scenes of devastation and wreckage left behind by Hurricanes *Sandy* (2012) and *Katrina* (2005) were tragically similar. Both storms flooded major cities, cut electric power to millions and tore apart densely populated coastlines. But from a meteorological perspective, the storms were very different.

Katrina was a textbook tropical cyclone, with a compact, symmetrical wind field that whipped around a circular low-pressure centre. Like most tropical cyclones, *Katrina* was a warm-core storm that drew its energy from the temperate waters of the tropical Atlantic Ocean. *Sandy* exhibited similar characteristics while blowing through the tropics but, as the storm moved northward, it merged with a weather system moving in from the west and started to make the transition into an extratropical cyclone.

The two names sound similar, but there are fundamental differences between these two types of storm. While tropical cyclones draw their energy from warm ocean waters, extratropical cyclones are fuelled by sharp temperature contrasts between masses of warm and cool air. Extratropical cyclones also tend to be asymmetric, with broad wind and cloud fields shaped more like commas than circles. So, when a tropical cyclone becomes extratropical, its wind and cloud fields expand dramatically. The strongest winds generally weaken during this process, but occasionally a transitioning storm retains hurricane force winds: such was the case with *Sandy*.

The two wind maps on this page illustrate some of the differences between *Katrina* and *Sandy*. The map of *Sandy's* winds (figure 1), produced using data from the radar scatterometer flying aboard the Indian Space Research Organization's *Oceansat-2*, shows the strength and direction of *Sandy's* ocean surface winds on October 28, 2012. The map of Hurricane *Katrina's* winds (figure 2), shown to the same scale, was created from similar data acquired on August 28, 2005 by
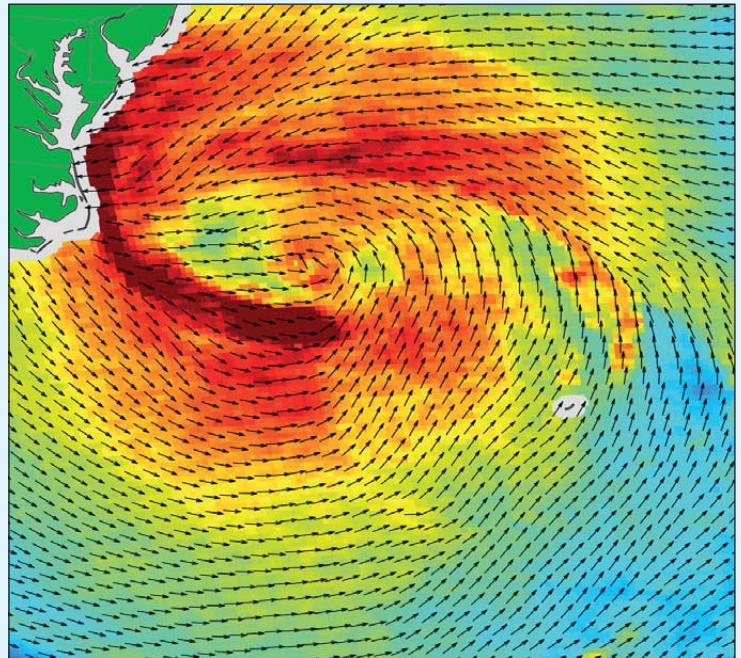
Figure 1 - Hurricane Sandy in 2012

the radar scatterometer aboard NASA's *QuickSCAT* [1] satellite, which ceased operation in late 2009. In both maps, wind speeds above 65 kph are shown in yellow, above 80 kph in orange and those above 95 kph as dark red (figure 3).

The most noticeable difference is the extent of the strong wind fields. For *Katrina*, winds above 65 kph stretched about 500 kilometres from edge to edge of the storm; for *Sandy*, winds of that intensity stretched a full 1,500 km.

Katrina's winds were more intense, but they covered less area, with the result that *Katrina's* storm surge as the hurricane impacted New Orleans was, locally, higher than *Sandy's*. But because of its sheer size, *Sandy* caused its destructive surge over a much longer stretch of coastline.

Another difference between the two storms was the location of the strongest winds. For tropical cyclones in the northern hemisphere, and Hurricane *Katrina* was typical, the strongest winds are usually located just east of the central eye, amidst a ring of violent thunderstorms called the eye wall.

In the case of *Sandy*, however, the weakest winds were found to the east, which strongly suggested that the storm had already begun interacting with the weather system to its northwest and a blocking high over Greenland to its northeast.

References

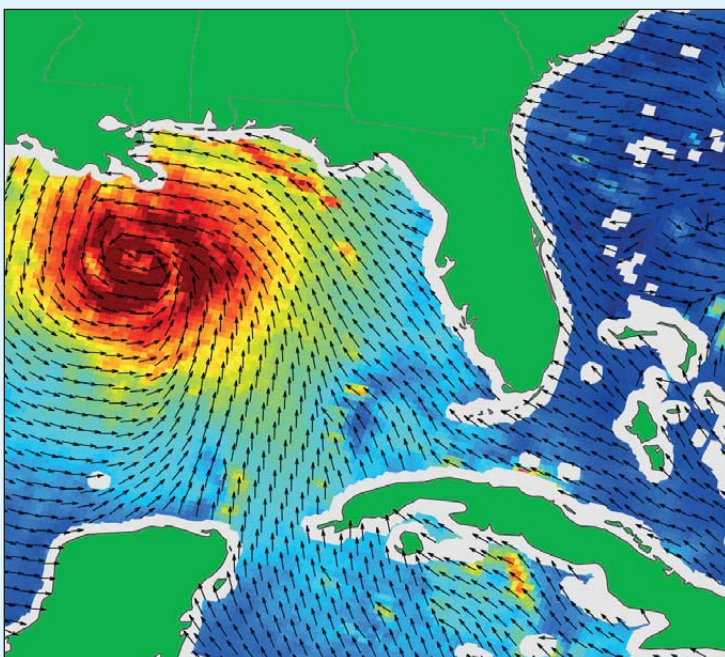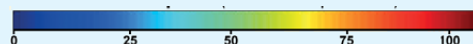1   QuikSCAT: NASA's Eyes on Ocean Winds - GEOQ 9, p.26 (2006)

Figure 3 - Windspeed in kilometres per hour
Data courtesy of the Jet Propulsion Laboratory's QuikSCAT and the Indian Space Research Organization OceanSat-2 missions.

Figure 2 - Hurricane Katrina in 2005

Fires Across Cape York Peninsula

A NASA Earth Observatory Report

Australia's largest and most frequent bush fires occur in springtime, in the tropical savannas of northern Australia. On November 25, 2012, the MODIS instrument aboard NASA's *Aqua* satellite captured this natural-colour image of wildfires burning on Cape York Peninsula, the northernmost part of Queensland. Smoke plumes from multiple fires are visible streaming to the west.

On Cape York Peninsula, the dry season arrives in March and, by late November, grasses and woodland trees are at their most flammable. In this case, steady 20 kph winds have helped to sustain fires that were probably started by lightning and human activity.

NASA image courtesy Jeff Schmaltz, LANCE Rapid Response Team at NASA GSFC.

Sea Ice Retreats in the
Northwest Passage

A NASA Earth Observatory Report

The Peary Channel separating Melville Island and Victoria Island is choked with ice on July 17, 2012.
NASA image by Jesse Allen, using data from the Land Atmosphere Near real-time Capability for EOS (LANCE).

Just over two weeks later, the Peary Channel appears largely ice-free on August 3, 2012.
NASA image by Jesse Allen, using data from the Land Atmosphere Near real-time Capability for EOS (LANCE).

Ice retreated rapidly in the Parry Channel, part of the famous Northwest Passage, between mid-July and early August 2012.

These images, acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite, show significant changes over two weeks. The top image shows Parry Channel choked with ice on July 17. The lower image shows the same region on August 3, when open water dominated the scene, with only remnant ice still clinging to the shores of Victoria and Melville Islands. On July 30, ice cover was roughly 33% compared with the long-term median of 79%.

However, thin sea ice can evade detection by satellite sensors such as MODIS yet still be thick enough to impede shipping so, while the Parry Channel appeared almost entirely free of ice, it was not necessarily open for navigational purposes. Close examination of the image from early August does show lingering patches of ice south of Melville Island.

Regardless of whether ships can easily pass through it, recent studies suggest that certain organisms have begun to take advantage of open water along the Northwest Passage. A 2007 study on *Neodenticula seminae,* a plankton species

historically endemic to the Pacific Ocean, discovered that the species had turned up in the North Atlantic. The research suggested that the plankton's route included the Canadian Arctic Archipelago.

And a 2012 study on bowhead whales, where individuals were tracked using satellite transmitters, revealed that Pacific and Atlantic populations had begun to overlap in the Northwest Passage as early as August 2010.

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

Auroras light up the Antarctic Night

A NASA Earth Observatory Report
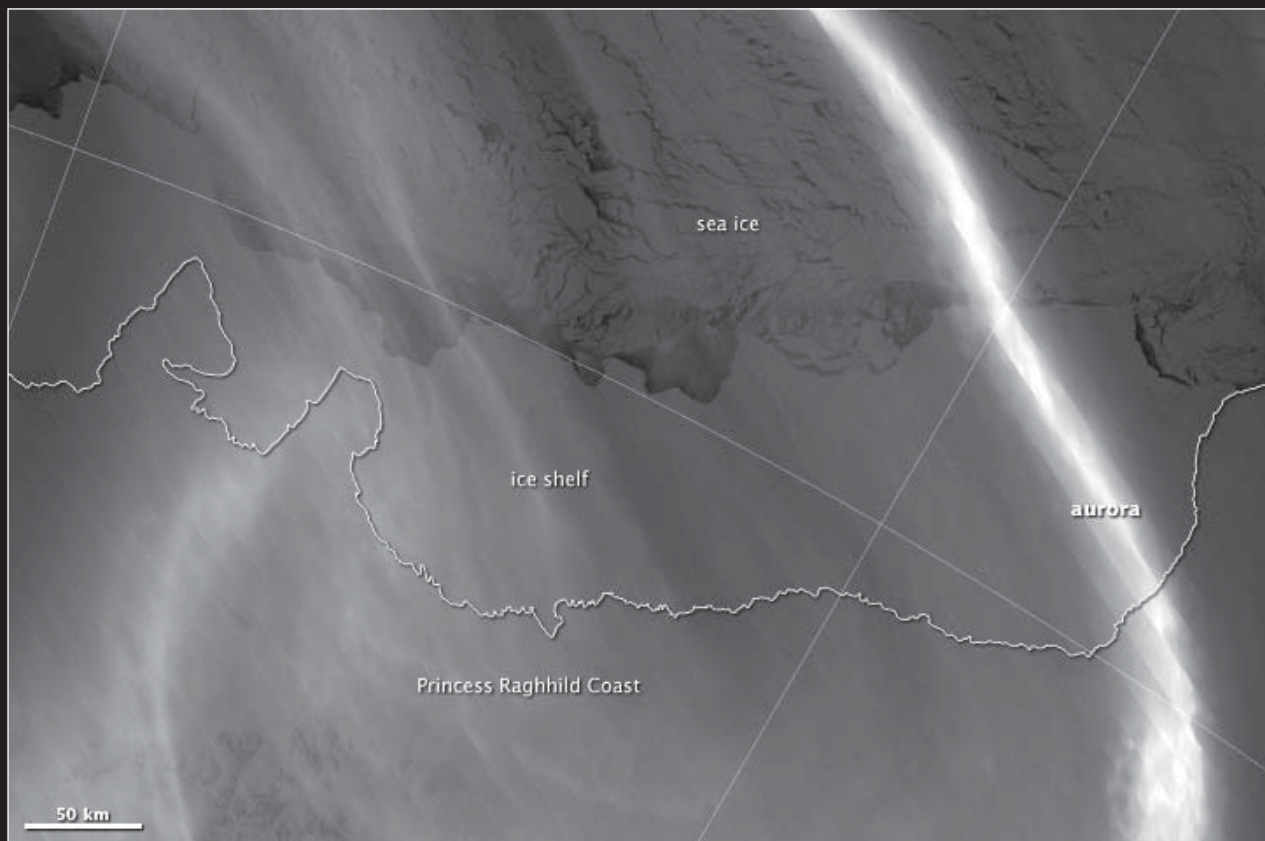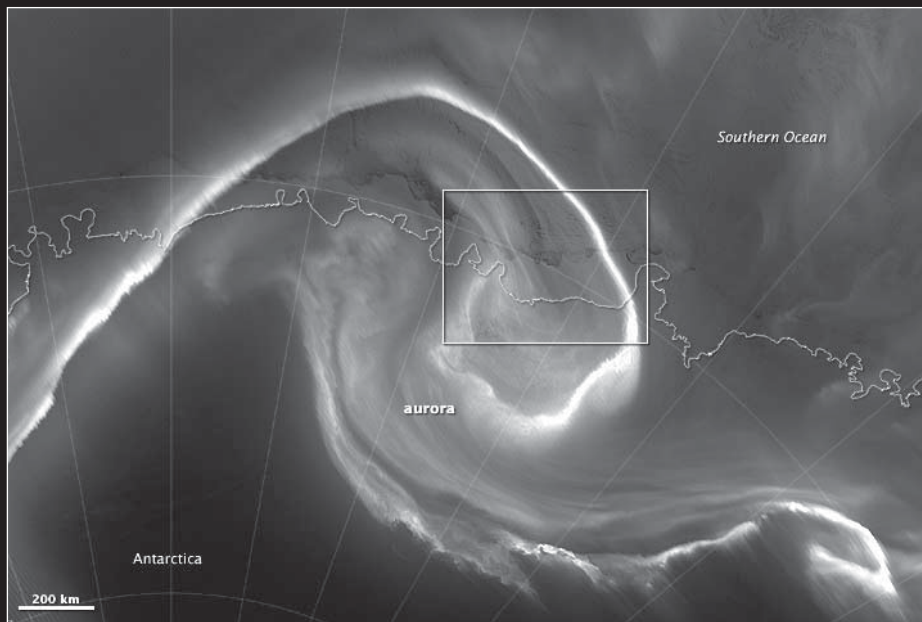
On July 15, 2012, the Visible Infrared Imaging Radiometer Suite (VIIRS) on the **Suomi NPP** satellite captured this night time view of the *aurora australis* over Queen Maud Land and Princess Ragnhild Coast of Antarctica. The image was captured by the instrument's *day-night* band, which detects light in a range of wavelengths from green to near-infrared. In the image above, the sensor detected the visible auroral light emissions created by energetic particles raining down from Earth's magnetosphere into the gases of the upper atmosphere. The slightly jagged appearance of the auroral lines is a function of the rapid dance of the energetic particles at the same time that the satellite is moving and the VIIRS sensor is scanning.

The lower image is a close-up view of the region outlined by the box in the upper image. Light from the aurora was bright enough to illuminate the ice edge between the ice shelf and the Southern Ocean.

Retreat of the Antarctic Peninsula's

CRANE GLACIER

Les Hamilton

This narrative starts in early 2002, when, with the Antarctic summer at its height, the Larsen-B ice shelf underwent a catastrophic collapse. Located on the eastern coast of the Antarctic Peninsula, this 3 250 square kilometre shelf of floating ice, 220 metres thick, completely splintered into fragments between January 31 and March 7. Ice shelf collapses had been recorded previously, but never had such an event been observed on this scale.

Figure 1, captured by the MODIS instrument aboard NASA's *Terra* satellite on January 31, hints at the start of the breakup. The ice shelf (in the centre of the image) shows parallel lines of blue meltwater pools, arranged thus because the water was draining into existing crevasses. Beneath a thin layer of clouds, a smattering of icebergs appears in the dark, open waters of the bay. By February 23 (figure 2), a number of long, narrow icebergs had fractured from the southern end of the shelf, and by March 7 the shelf had disintegrated into a mixture slush and icebergs that filled the bay and soon became locked into place by new seasonal sea ice. Figure 3 shows the scene three years later after the remains of the shelf had dispersed into the ocean.

Based on studies of ice flow and sediment thickness beneath Larsen-B, scientists believe that it had existed for at least 400 years prior to this event, and, very probably, since the end of the last major glaciation 12 000 years ago.
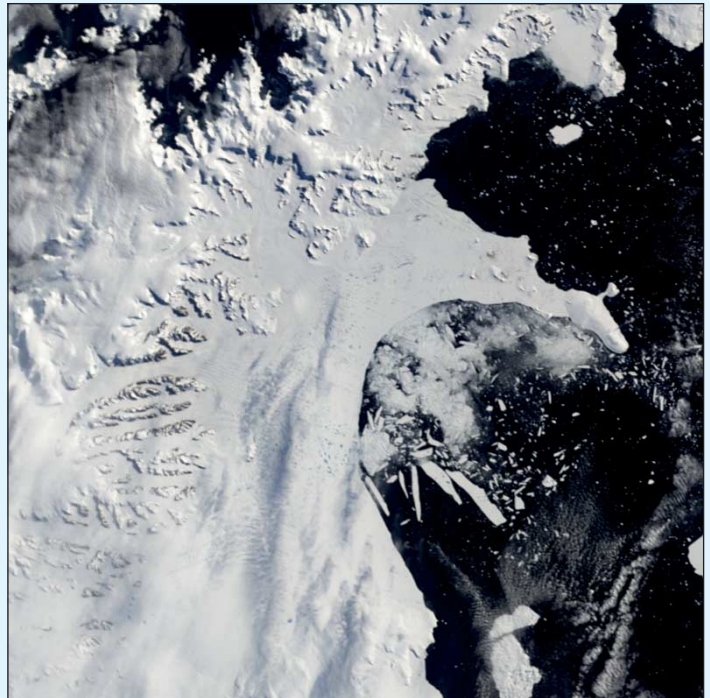
Figure 2 - The Larsen B Ice Shelf on February 23, 2002
Terra MODIS Image: NASA
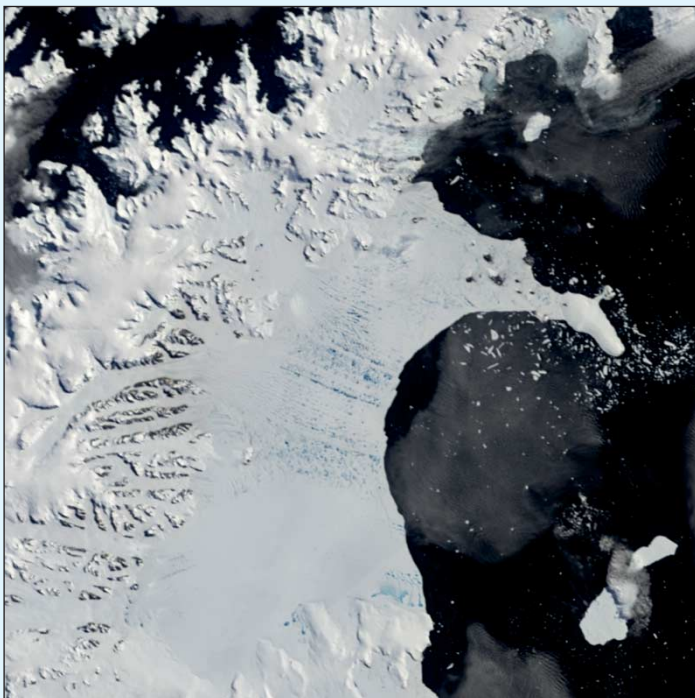
Figure 1 - The Larsen B Ice Shelf on January 31, 2002
Terra MODIS Image: NASA
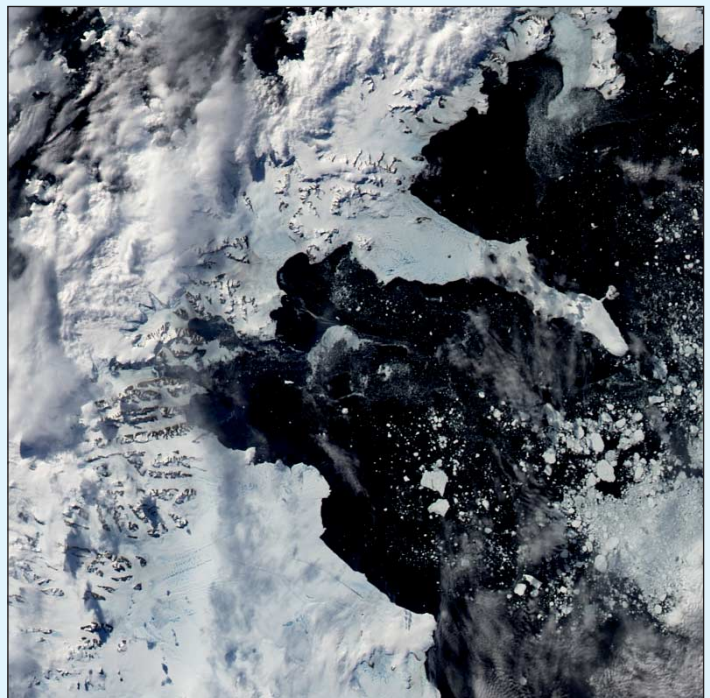
Figure 3 - The same area on February 18, 2005
Terra MODIS Image: NASA

The collapse of the Larsen-B ice shelf appears to have been due to a series of warm summers over the Antarctic Peninsula, culminating with an exceptionally warm one in 2002. Significant surface melting due to warm air temperatures created melt ponds; these acted like wedges which deepened crevasses and eventually caused the shelf to disintegrate. To give an idea of the actual scale of events, the original ice shelf had an area approximately the same as the island of South Georgia, and the mass of ice involved in the disintegration was estimated to have been 720 billion tonnes.

The Larsen-B ice shelf exerted a buttressing effect which slowed the advance of its fifteen tributary glaciers. But during the ten years following the shelf's disappearance, the flow of most of these glaciers has accelerated significantly. The faster flow of the ice,
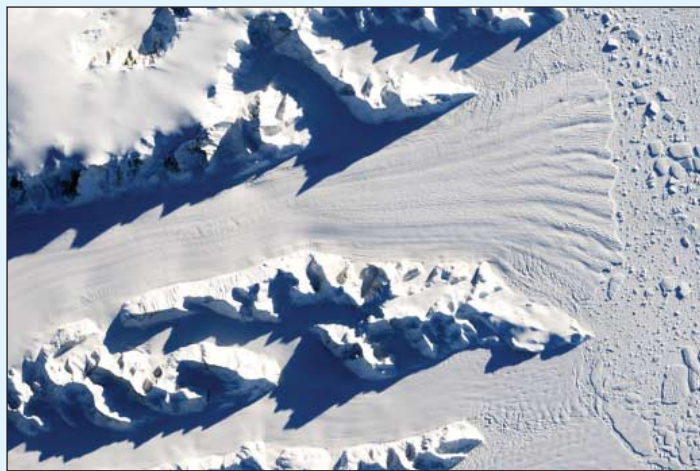
Figure 4 - A *Landsat-7* image of Crane Glacier on April 6, 2002
Image: NASA

Figure 5 - Landsat-7 image of Crane Glacier on February 20,2003
Image: NASA

Figure 6 - The Retreat of Crane Glacier
NASA Earth Observatory image created by Jesse Allen and Robert Simmon,
using EO-1 ALI data provided courtesy of the NASA EO-1 team.

coupled with the calving of icebergs when it reaches the coast, has resulted in the glaciers retreating inland. The total ice being lost from these ice streams is currently estimated to be of the order of ten billion tonnes per annum.

The Retreat of Crane Glacier

The most dramatic change has been observed at Crane Glacier, the longest of the Antarctic Peninsula's glaciers, which flows east-northeast for 50 kilometres through a deep trough into Exasperation Inlet on the east coast. The speed of Crane Glacier has increased threefold since the demise of the Larsen-B Ice Shelf, during which time its terminus has retreated by more than 12 kilometers.

The two images from NASA's *Landsat 7* satellite show how Crane Glacier has retreated during the past ten years. Figure 4 was captured on April 6, 2002, about two months after the dramatic ice shelf collapse. The snout of Crane Glacier can be seen extending into the bay like a fan, while the waters of the bay itself are choked with slush and icebergs from the collapsed ice shelf.

Throughout the summer of 2003, remaining fragments of the ice shelf continued to broke away while the mélange of ice detritus the previous summer's collapse began to drift away. Without the stabilising presence of the ice shelf, Crane Glacier started to retreat dramatically, its fan-shaped terminus becoming 'C' shaped as its central region crumbled faster than its edges, the latter stabilised through friction with their containing mountainsides.

The unusually bright blue tinge of the ice debris in the February 20 image (figure 5) results from reflections from the pure ice on the undersurfaces of the ice shelf fragments. Many of the icebergs that crumbled from the edge of the shelf were too tall and narrow to float upright, and they toppled over. The surface of an ice shelf becomes covered by snow, but the underside is very pure ice which absorbs a small amount of red light. Photo-like satellite images such as these are made by combining the satellite's observations of red, green, and blue wavelengths reflected from the Earth's surface. When all these visible wavelengths are reflected equally, the surface appears white; but when some of the red light has been absorbed, the reflected light takes on this cyan tinge.

Figure 6 is based on an image captured by the *Advanced Land Imager* (ALI) instrument on the *Earth Observing-1* (EO-1) satellite, with added outlines to illustrate the location of the terminus of Crane Glacier in April 2002, February 2003, and February 2006. The image actually dates from February 24, 2012, but remains relevant because there has been no further retreat by the glacier since 2006.

Sources

Collapse of the Larsen B Ice Shelf
http://earthobservatory.nasa.gov/Features/WorldOfChange/larsenb.php

Larsen B Ice Shelf Collapse
http://earthobservatory.nasa.gov/IOTD/view.php?id=2351

Retreat of Crane Glacier
http://earthobservatory.nasa.gov/IOTD/view.php?id=43459

Meteosat–10 Operational
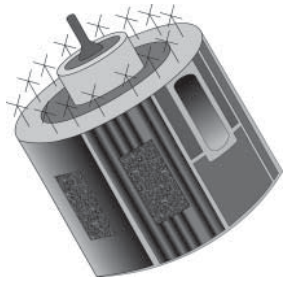
On January 21, 2013, Meteosat-10 took over from Meteosat-9 as EUMETSAT's prime operational geostationary weather satellite, after being moved to 0º. Launched on 5 July last year as MSG-3, this latest Meteosat Second Generation satellite now provides the operational weather and climate monitoring service over Europe and Africa. Meteosat-9 has been drifted to the 9.5°E slot where has taken over the Rapid Scanning Service (RSS) from Meteosat-8, following its short spell of parallel dissemination with Meteosat-10. Meteosat-8, now drifted to 3.5°E, is the operational backup for Meteosat-10 (and if need be, also for Meteosat-9).

Meteosat-9 and -10 now form the two-satellite configuration, where Meteosat-10 provided full disc imagery of the European and African continents and adjacent seas every 15 minutes while Meteosat-9 delivers the more frequent RSS images every five minutes.

The GEO Report

continued from page 2

September 9-13, 2013

The European Space Agency (ESA) are holding a symposium ' The living Planet' in Edinburgh. GEO will be requesting space in the 'Poster Exhibition' area where will display visual materials relating to GEO's activities together with informative leaflets for delegates.

September 13-15, 2013

The Royal Meteorological Society are holding their second amateur conference at Reading University. At the first conference, GEO gave a presentation to the meeting and had a display stand running live EUMETCast reception. We have offered to make a similar contribution this year. The conference should be of interest to anyone interested in climate and weather. For full information visit

**http://www.rmets.org/events/
rmets-amateur-conference-2013**

September 27-28, 2013

The National Hamfest which is held on the Newark show ground. This is a busy two day event and GEO will have a display stand in the main exhibition hall.

FEEDBACK

**The column for Readers'
Letters, Queries and Discussion**

Email: geoeditor@geo-web.org.uk

Dear Francis,

I just wanted to drop you a note to address a few items you raised in your last *GEO Report*. I'm a recent re-subscriber. I couldn't tell you when I lapsed, but It pretty much was just down to running out of hours in the day, and my focus being elsewhere.

Shortly after the severe 2010/2011 winter, I treated myself to a new *Davis Vantage VUE* Weather Station and got it mounted properly in November 2011. This was more to satisfy more my own curiosity.

Meeting you (and the gentleman with you), along with the fantastic quality of your publications, re-kindled my interest. I also re-activated my EUMETCast ftp download account, and I've a bunch of (fairly poor, it must be said) scripts that automatically pull in the 30-minute LRIT files, which I process for viewing later. Also, I'm hoping to get my *RTL-E4000* SDR back from an extended loan, and I think I'll try using it for APT reception.

Unfortunately, I don't think I'd get permission from the wife to put up my own dish for direct reception. That said though, how difficult would it be to add an LNB to our existing sky dish?

Lastly, should you consider going down the road of a PDF-only subscription, I would be interested in taking you up on it.

Regards
John Ronan, EI7IG

Currently Active Satellites and Frequencies

Polar APT Satellites			
Satellite	Frequency	Status	Image Quality
NOAA 15	137.6200 MHz	On	Good
NOAA 17	137.5000 MHz	On	None: scan motor failure
NOAA 18	137.9125 MHz	On	Good
NOAA 19	137.1000 MHz	On	Good / Note 1
Meteor M N1	137.1000 MHz	Sporadic	Note 1

Polar HRPT/AHRPT Satellites				
Satellite	Frequency	Mode	Format	Image Quality
NOAA 15	1702.5 MHz	Omni	HRPT	Weak
NOAA 16	1698.0 MHz	RHCP	HRPT	Good
NOAA 17	1702.5 MHz	RHCP	HRPT	None: scan motor failure
NOAA 18	1707.0 MHz	RHCP	HRPT	Good
NOAA 19	1698.0 MHz	RHCP	HRPT	Good
Feng Yun 1D	1700.4 MHz	RHCP	CHRPT	None: Device failure
Feng Yun 3A	1704.5 MHz	---	AHRPT	Note 2
Feng Yun 3B	1704.5 MHz	---	AHRPT	Note 2
Metop A	1701.3 MHz	RHCP	AHRPT	Good
Metop B	1701.3 MHz	RHCP	AHRPT	Good
Meteor M N1	1700.0 MHz	---	AHRPT	Note 2

Geostationary Satellites				
Satellite	Transmission Mode(s)		Position	Status
Meteosat 7	HRIT 1691 MHz / WEFAX 1691 MHz		57.5°E	On
Meteosat 8	HRIT (digital)	LRIT (digital)	3.5°E	On [5]
Meteosat 9	HRIT (digital)	LRIT (digital)	9.5°E	On [4]
Meteosat 10	HRIT (digital)	LRIT (digital)	0°W	On
GOES-12	---	GVAR 1685.7 MHz	60°W	On
GOES-13 (E)	LRIT 1691.0 MHz	GVAR 1685.7 MHz	75°W	On [3]
GOES-14	---	---	89.5°W	On standby
GOES-15 (W)	LRIT 1691.0 MHz	GVAR 1685.7 MHz	135°W	On [3]
MTSAT-1R	LRIT 1691.0 MHz	HRIT 1687.1 MHz	140°E	On
MTSAT-2	LRIT 1691.0 MHz	HRIT 1687.1 MHz	145°E	On
Feng Yun 2D	LRIT	SVISSR	86.5°E	On
Feng Yun 2E	LRIT	SVISSR	104.0°E	On

Notes

1 LRPT Signals have been reported from Meteor M N1 but are sporadic with periods off. This satellite's carrier frequency can cause interference to NOAA 19 when the two footprints overlap.
2 These satellites employ a non-standard AHRPT format and cannot be received with conventional receiving equipment.
3 GOES 13 and GOES 15 also transmit EMWIN on 1692.70 MHz
4 Meteosat Rapid Scanning Service (RSS)
5 Meteosat operational backup satellite

Ci4-2 Showcase

Ukraine's Sich-2 satellite imaged Lake Mead, the largest reservoir in the United States on September 16, 2012. Stretching for 180 kilometres behind the Hoover Dam on the Colorado River, the reservoir can hold 34 cubic kilometres of water when completely filled.
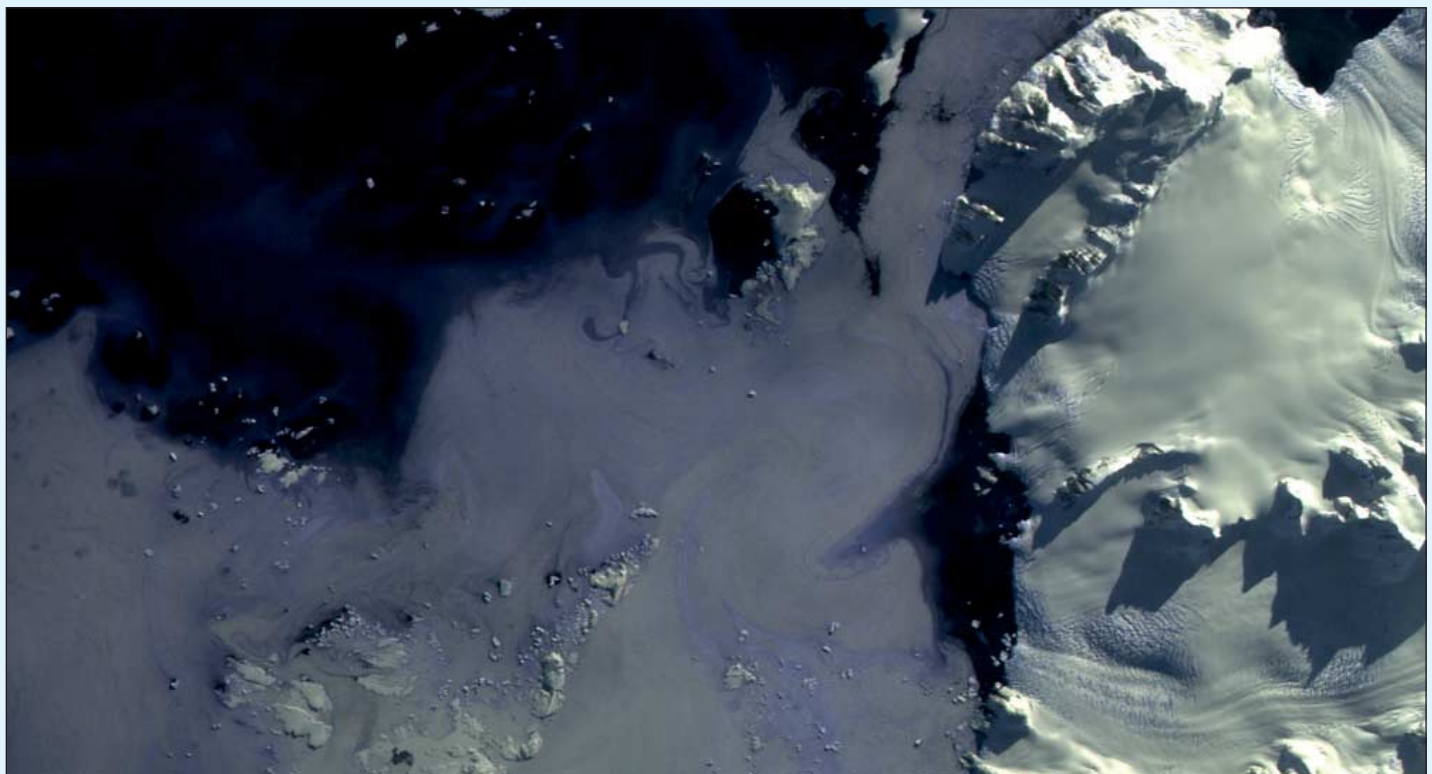
Sich-2 captured this spectacular image as it flew over Antarctica on September 9, 2012. The precise location of this image is unknown, but the low angle of the sun highlights the mountains and glacier to the right of the image in spectacular fashion.

Images © Dniprokosmos
(www.dniprokosmos.dp.ua)

EUMETCast On-Line Registration Guide

If you require to register as a first-time user for any of the free EUMETCast data streams such as MSG, NOAA AVHRR, Metop etc, or need to renew an existing subscription, this must be done on-line.

GEO has produced a step-by-step guide to the entire process at

http://www.geo-web.org.uk/eumreg.html

This guide also contains a direct link to the official EUMETCast on-line registration form, which can otherwise prove somewhat tricky to locate.

GEO Helplines

Douglas Deans
Dunblane, Perthshire, SCOTLAND.
All aspects of weather satellites from APT, HRPT to Meteosat-9 DVB/EUMETCast systems.

  • telephone:(01786) 82 28 28
  • e-mail: dsdeans@btinternet.com

John Tellick
Surbiton, Surrey, ENGLAND.
Meteosat-9 advice: registering for the various MSG services, hardware and software installation and troubleshooting. John will also field general queries about any aspect of receiving weather satellite transmissions.

  • telephone: (0208) 390 3315
  • e-mail: info@geo-web.org.uk

Geoff Morris GW3ATZ
Shotton, Flintshire, NE WALES.
Geoff has lots of experience with aerial, coax,connectors, mounting hardware etc. and has also done a lot of work with the orbiting satellites. Geoff has been a EUMETCast Meteosat-9 user for some time and is familiar with David Taylor's MSG software. He should be able to share his experiences with newcomers to this branch of the hobby.

  • Tel: (01244) 818252
  • e-mail: gw3atz@btopenworld.com

Mike Stevens
Portland, Dorset, England.
Advice and assistance offered on **EUMETCast** (MSG, NOAA and Metop).

  • email: mikeg4cfz@gmail.com

Guy Martin G8NFU
Biggin Hill NW Kent, ENGLAND
Guy is prepared to advise anyone who wishing to receive **MSG/Metop** using Windows 2000 or XP. Can also help with networking and ADSL router setup.

  • gmartin@electroweb.co.uk

Hector Cintron
San Juan, Puerto Rico, USA
Hector is prepared to field enquiries on HRPT, APT, EMWIN and NOAAPORT

  • Phone: 787-774-8657
  • e-mail: n1tkk@hwic.net

Email contact can of course be made at any time, but we would ask you to respect privacy by restricting telephone contact to the period 7.00-9.00 pm in the evenings.

Weather Satellite Reports

If there is a single Internet Forum that is relevant to all weather satellite enthusiasts, it must surely be Douglas Deans' *Weather Satellite reports*.

Here you will find every conceivable type of information about weather satellites, whether polar or geostationary, APT, HRPT, LRIT or whatever.

Absolutely everything is covered, and the information is updated every week. Special additional bulletins may be issued if an important change takes place mid week.

You can read the bulletins from this URL

http://tech.groups.yahoo.com/group/ weather-satellite-reports/

or, even better, elect to have the reports sent to you by email every Monday.

Internet Discussion Groups

There are a numerous Internet-based discussion groups available to weather satellite enthusiasts. You can join any of these by sending an e-mail to the appropriate address, with a request to subscribe. Indeed, a blank e-mail containing the word 'subscribe' in its Subject line is all that is required. Some of the more useful groups and their contact addresses are listed below.

APT Decoder
This is a group where users of Patrik Tast's APTDecoder can share information and problems.

http://tech.groups.yahoo.com/ group/APTDecoder/

GEO-Subscribers
This is GEO's own group, where members can exchange information and post queries relating to any aspect related to weather satellite reception (hardware, software, antennas etc), Earth observation satellites and any GEO-related matter.

http://tech.groups.yahoo.com/ group/GEO-Subscribers/

Satsignal
An end-user self help group for users of David Taylor's Satellite Software Tools (SatSignal, WXtrack, GeoSatSignal, HRPT Reader, GroundMap, MSG Data Manager, AVHRR?Manager and the ATOVS?Reader).

http://tech.groups.yahoo.com/ group/SatSignal/

MSG-1
A forum dedicated to Meteosat Second Generation (MSG), where members share information about the EUMETCast reception hardware and software.

http://tech.groups.yahoo.com/ group/MSG-1/

The Editor is always delighted to receive articles and images for inclusion in GEO Quarterly. These can relate to any aspect of Earth Imaging, especially

  • Technical articles concerning relevant hardware and software
  • Construction projects
  • Weather satellite images
  • Reports on weather phenomena
  • Descriptions of readers' satellite imaging stations
  • Activities from overseas readers
  • Letters to the Editor
  • Problems and Queries for our experts to answer

Contributions should of course be original and, where possible, should be submitted to the editor in electronic format (e-mail attachment, CD, DVD). But of course, we would also accept handwritten or typed copy.

Please note, however, that **major articles** which contain large numbers of satellite images, photographs or other illustrations should be submitted **as early as possible**, so that they can be prepared and made up into pages in time for publication.

Images and Diagrams
Images can be accepted in any of the major bitmap formats: **JPG, BMP, TIFF** etc. Images in both monochrome and colour are welcome. Line drawings and diagrams are preferred in WMF, EPS or postscript formats. We can also scan original photographs, negatives and slides.

Gridding, Overlays and Captions
Please note that satellite images should be submitted **without overlays** such as grid lines, country outlines and captions unless these are considered essential **for illustrative purposes within an article**.
If your article submission contains embedded images and diagrams, please note that you **must also submit copies of the original images** in one of the formats described above: these are essential for page make-up.

Submission of Copy
Materials for publication should be sent to the editor,

  Les Hamilton
  8 Deeside Place
  Aberdeen AB15 7PW
  Scotland

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

  geoeditor@geo-web.org.uk

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

  www.yousendit.com

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And finally . . .
When you have material ready for the following issue of GEO Quarterly, please submit it **as soon as it is ready**—do not wait till the deadline above: this will simply create an editorial log-jam and delay publication.

Group for Earth Observation

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Envisat imaged West Africa, including Cape Verde, the Gambia and Guinea-Bissau with its offshore islands, on December 12, 2011.
Image © ESA

Envisat imaged the confluence of the White and Blue Nile rivers at Khartoum on November 23, 2011.
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