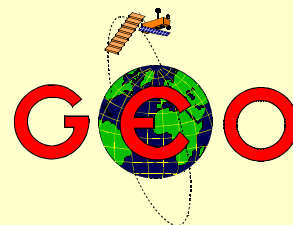


# The **GEO** Quarterly

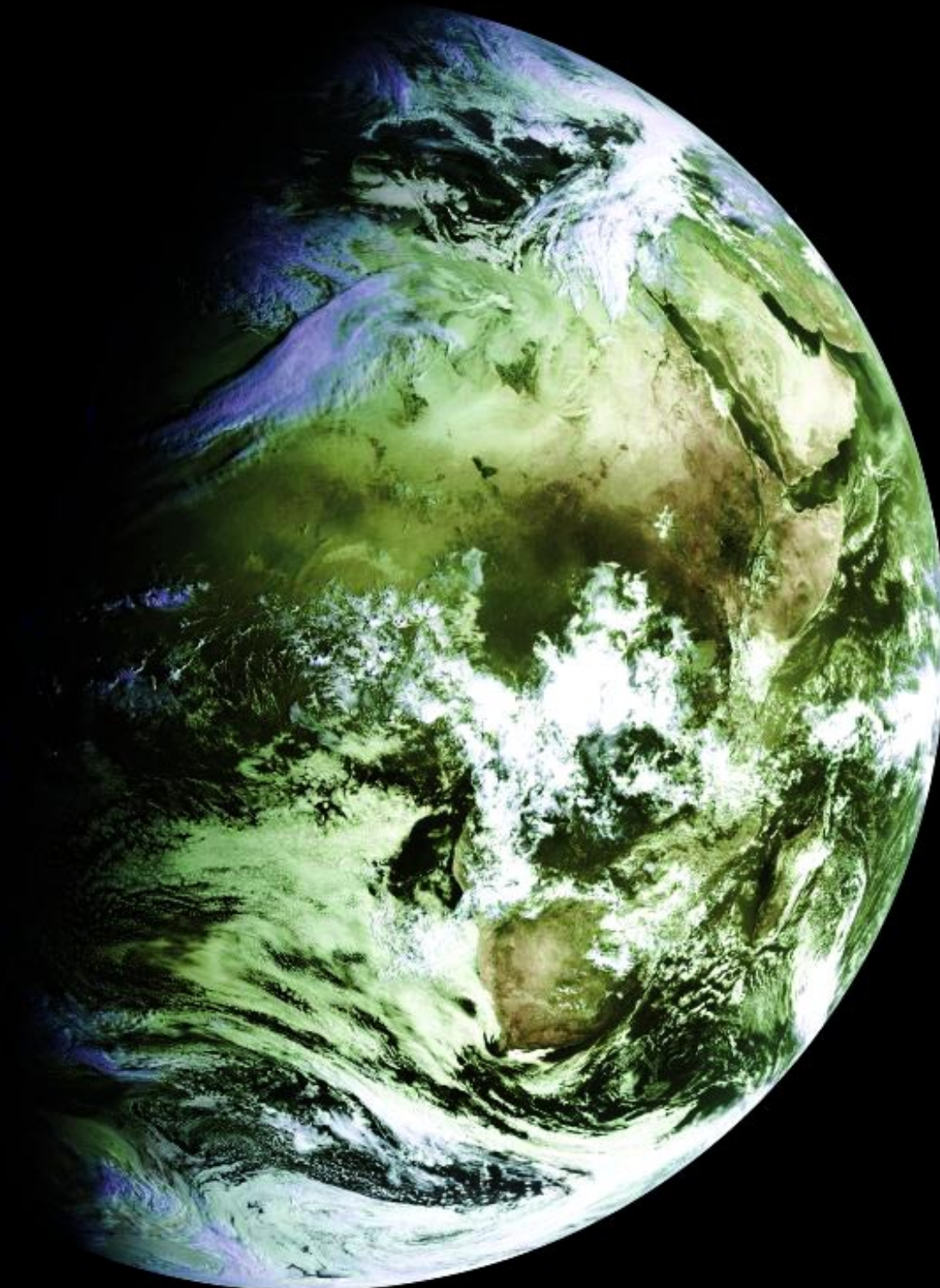
Group for Earth Observation



[www.geo-web.org.uk](http://www.geo-web.org.uk)

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

*Number 2  
May/June 2004*



## *Inside this issue . . .*

*Create a Radio Horizon  
Table for your Location  
Bill Johnston explains ...*

*David Taylor reports from  
Darmstadt as MSG finally  
goes operational*

*John Coppens details how  
to decode the NOAA APT  
satellites under Linux  
(and Windows) using  
WXtoImg*

*Utilising satellite-TV  
co-axial cable in your  
weather satellite station*

*Van Karman Cloud  
Vortices: Where and why  
do these amazing cloud  
phenomena occur?*

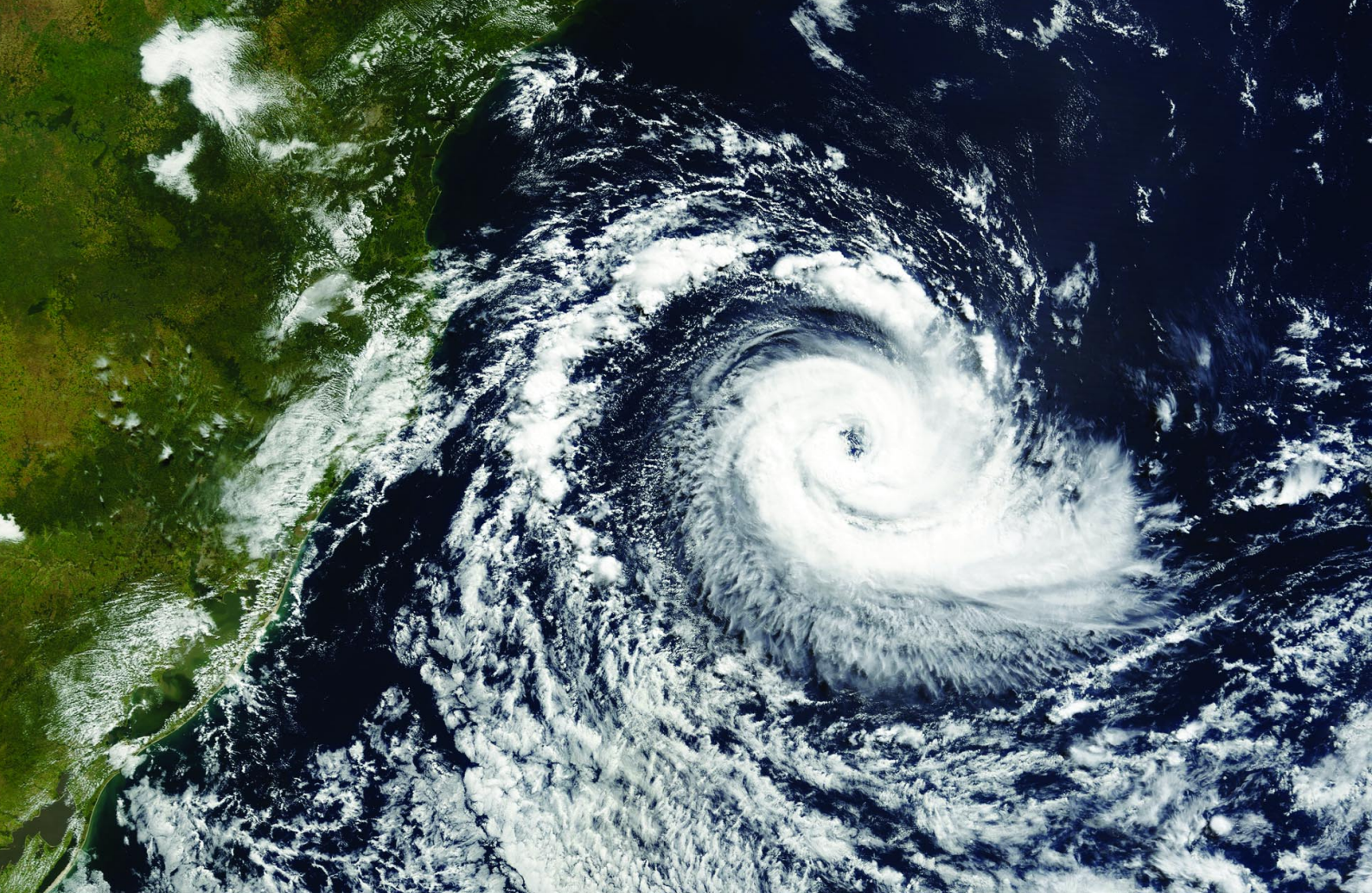
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committing suicide?  
Francis Bell debates the  
issues ...*

*The MSG EUMETcast  
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Tellick explains ...*

*The Indian Space  
Programme - part 2. More  
fascinating insights from  
Peter Wakelin*

*and much more ...*





NASA's *Terra* satellite acquired what is believed to be the first ever direct observation of a cyclone in the South Atlantic Ocean on March 26, 2004. This Moderate Resolution Imaging Spectroradiometer (MODIS) image shows the storm off southeast Brazil.  
*Image: Jacques Desclotres, MODIS Land Rapid Response Team at NASA GSFC*



A blue halo of phytoplankton curls around the Falkland Islands in this amazing true-color *Aqua* MODIS image from January 26, 2004.  
*Image: Jacques Desclotres - MODIS Land Rapid Response Team, NASA GSFC.*





Group for Earth Observation  
www.geo-web.org.uk

Welcome to the second issue of the *GEO Quarterly*. Our thanks to all of you who applied for a copy of our Launch Issue earlier this year, and specially to everyone who contacted us with supportive comments.

By the time you read this, the first *GEO* Symposium will have taken place at the National Space Centre in Leicester. Look up the *GEO* website (<http://www.geo-web.org.uk>) to view photographs taken on the day. A full illustrated report on the Symposium will be published in *GEO Q3*.

This quarter, we have several interesting contributions from overseas readers. Bill Johnston explains how to compile a Radio Horizon Table to help make the most of those low elevation satellite passes; Fred van der Bosch details an improved technique for integrating satellite images into Digital Atmosphere; John Coppens describes how *Linux* users can decode NOAA APT using *WxtoImg* while Arne van Belle extols the virtues of satellite-TV coaxial cable.

There are also regular submissions from stalwarts Francis Bell, who has some controversial ideas on global warming and climate change, and Peter Wakelin, who continues on the theme of the Indian Space Programme.

We do hope there is something to everyone's taste in this issue—now turn the page and enjoy your copy of *GEO Q2*.

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# The **GEO Report**



**Francis Bell**

In writing this introduction my first task is clear and predictable. It is to express my admiration for the team who, in such a short space of time between *GEO's* conception and its first publication, have done so much planning and used so much of their precious time for the benefit of potential members. Included in there should also be thanks to those who contributed text copy, data and images for the launch issue of *GEO Q1*: without such contributions we would have little to publish.

## **Feedback**

From the feedback we have received it would be difficult to judge *GEO Q1* as anything other than a very great success. At the time of writing, hundreds of our publications have been distributed and the statistics indicate that about 38 % have gone overseas, the rest of course within the UK.

The feedback we have received has been complimentary and encouraged us to continue with the future programme of the new group. *GEO's* editor has told me that he already has plans for *GEO Q3*. Copy already exists, and we hope to include a report about our Leicester meeting at the National Space Centre on 1st May 2004. This will be followed by *GEO Q4*, with a report about our anticipated activities at the AMSAT-UK colloquium in Guildford at the end of July 2004.

## **Joining GEO**

If you have not yet joined *GEO*, please do. The group does need to be financially viable from its membership's subscriptions because *GEO* has no commercial support. Indeed, as a matter of policy, we have decided to be independent of any commercial support. Advertising of course will be accepted in due course. The very modest £12 a year must be the best value-for-money subscription anybody interested in an amateur, technical or educational matter can spend.

## **Support**

Werkgroep Kunstmanen, the user group based in the Netherlands, have been very supportive of *GEO* and a special thanks must go to them. Some of them are coming to Leicester. Likewise, thanks for the support we have received from Australia and the USA, plus many other countries.

## **Other Issues**

There are of course issues which our new *GEO* organisation must face. We are pleased to address these. From my perspective four spring readily to mind.

1. Our group must continue with a high profile for the benefits of the membership. We should represent the interests of direct-readout amateurs and educational users to national and international bodies. The UK Meteorological Office, EUMETSAT, NOAA, WMO, Ofcom and others must remain a priority for us. The achievements that members of *GEO's* management have already established should not be underrated. If it had not been for this commitment in the past our access to our hobby would not be as attractive as it is today. This work must continue.
2. *GEO* needs to service the needs and interests of those individuals and institutions already familiar with weather satellites. We need to keep up to date with a changing technology, from WEFAX analog to digital, with the associated high-speed data processing that goes with it.
3. We need to service the needs of absolute beginners. The commonest comment I receive either on paper or email is: 'How do I/we get started with weather satellite reception.' *GEO* must support these people. To raise expectations for potential members and then fail to service this demand would be unkind.
4. It has been very striking since *GEO* was featured in the Times Educational Supplement (March 2004), that there is a demand from a wide spectrum of schools for information about getting started with weather satellites. Again the 'How do I do that', request? Of these enquiries, about a third have come from geographers, a third from scientists and the rest from educational advisors and head teachers.

## **Schools and Education**

It would be of great benefit to schools if a practicing teacher accepted an advisory role within *GEO* for education. Firstly to deal with how to get started then subsequently to address the benefits within education of following such a strategy. Live weather satellite reception is not a solution looking for a problem to solve; rather, it can broaden the perspective and opportunities within the existing curricula.

I am a retired science teacher myself and I know the benefits of these activities in schools, but time constraints prevent me from taking on this role within



*GEO*. This is an invitation for someone to take on a role such as this. Somebody go for this please! Some educational news or pages in our quarterly publication would be welcome.

### **Administrative Structure**

Some potential *GEO* members have asked about the administrative structure of our new organisation. The response is easy. A decision was taken by *GEO*'s management group to form the company *Group for Earth Observation Limited*. This is a company in England and Wales, limited by guarantee but having no shares. The framework for this company was professionally written and describes in broad terms *GEO*'s interests in weather satellites and then, very specifically, how the company is to be run.

Although running our group generates some administration, it does impose a discipline and structure which are in the public domain. A request to *Companies House* in Cardiff will give access to all the fine details for anybody anxious to read them. *GEO* will ensure that members have access to these structural details, perhaps published on a CD-ROM, as the pages in our Quarterly are just too precious for a routine text which is in the public domain anyway.

It may be worth noting that most major groups, for example the RSGB, use the administrative structure of a company limited by guarantee. Our corporate structure allows *GEO* to make any day-to-day rules it deems fit for running our organisation. In due course these must be formulated, put to the membership and published. A single sheet of A4 paper should be all that is needed for this task. Hopefully, these additional working rules will be adopted but, in the meantime, there is the absolute security within the existing company legal framework.

### **GEO Symposium 2004**

The Leicester symposium will be almost concurrent with this issue of *GEO Q2*. If you have the time, please come to Leicester. **You can register on the day, at the venue.** Just turn up at the National Space Centre, central Leicester. If not you can read about Leicester in *GEO Q3*.

### **AMSAT-UK Colloquium**

We are planning to attend AMSAT-UK's meeting in Guildford in late July 2004. AMSAT members are mainly interested in amateur radio satellites. I have been a member for many years but there is an overlap of interests between AMSAT and *GEO*. It is hoped that *GEO* will be able to offer three days of live weather satellite reception during AMSAT's meeting and also offer some lectures and demonstrations within their programme. The dates are July 30 to August 1, 2004. Please see our web site for the latest details.

### **In this Issue**

In this information-packed Quarterly I hope we have provided something for everyone, with a wide range of articles from both home and overseas.

I am particularly pleased to note that my plea for information on the absence of hurricanes in the south Atlantic Ocean has been answered so definitively by Peter Wakelin in his article on page 45. I am also astounded to realise that, since I wrote my piece, Earth observing satellites have only newly imaged what is believed to be the first ever example of a cyclone in that part of the world—see the upper image on the inside front cover.

Other offerings include a fascinating piece from Bill Johnston of New Mexico on how he has derived a radio horizon table for his station (page 31). This is created as an *EXCEL* spreadsheet, and allows him to judge how best to tackle one of his favourite weather satellite activities—imaging from ultra low-elevation satellite passes.

Taking a totally new direction, John Coppens explains how readers who make use of the *Linux* operating system can also enjoy the hobby of weather satellite imaging; from neighbouring Brazil, Raul Teixeira of the Ceará State Department of Meteorology has submitted examples of the imagery produced at his station (page 29) while Arthur Andrews returns with his regular column.

### **And Finally ...**

Again our thanks must go to our editor and the rest of the management team for launching and now placing in orbit this *GEO Quarterly* publication.

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## **NOAA Satellite Predictions for the UK**

With such a packed issue this quarter, we regret that we do not have the space for a page of weather satellite pass predictions. As most enthusiasts now generate their own data using computer software, we hope you will not be overly inconvenienced. But do let us know if you have strong feelings on the matter.

For readers who do require a printed page of NOAA pass predictions, these can be downloaded, as an *Acrobat* PDF document, from the following address:

<http://myweb.tiscali.co.uk/les.hamilton/predict.htm>

As always, do let us know how you feel about this issue. If there turns out to be a major demand to have these predictions printed in the Quarterly, we will do our very best to meet your needs.



# The Indian Space Programme

## Part 2

Peter Wakelin

### Early Rocket Development

India's first rockets were very modest affairs aimed at sending a small payload high into the atmosphere and were quite incapable of attaining sufficient speed to reach orbit. The first instrumented sounding rocket was launched from the Thumba range, near Thiruvananthapuram, in the far south of India, on November 21, 1963.

Within 10 years, after gaining much experience in using these simple single-stage solid-fuelled rockets, the programme to develop a multi-stage vehicle capable of launching a small satellite was started. Appropriately called SLV-3 (Satellite Launch Vehicle), the rocket stood 22 m high, weighed 17,000 kg when fully fuelled and could put a 40 kg payload into low Earth orbit if launched eastwards to take advantage of the Earth's rotational speed of about 1500 km/hour at the latitude of India. The first launch took place on August 10, 1979 and, although lift-off was successful, a jammed valve in the second-stage control system prevented the Rohini Technology Payload reaching orbit.



An SLV3 rocket pictured on its launch-pad

The next three SLV-3 launches successfully placed Indian-built satellites into orbit between 1980 and 1983 and India became the seventh nation to launch its own satellite after the USSR, USA, France, Japan, China, and the UK. During this period, development of an augmented SLV (ASLV), capable of launching a 150 kg payload, was taking place. It weighed 39,000 kg and was almost 24 m high and the first launch attempt was made on March 24, 1987. It was unsuccessful, as was the second attempt some 15 months later, and both Indian payloads, together with a German remote sensing payload on the second flight, were destroyed.

This setback resulted in a four-year gap in launches whilst the problems were investigated and eventually overcome. Success came on May 20, 1992 when a 107 kg payload was successfully orbited. The SLV-3 and the ASLV were experimental vehicles intended to aid the design and construction of a more powerful rocket capable of launching a significant payload into the sun-synchronous orbit required for Earth observation satellites. This orbit requires an inclination to the

eastward equatorial direction of about 98 degrees so, in this case, the low latitude of India is a disadvantage as the Earth's rotational speed becomes a hindrance rather than a help. The Polar Satellite Launch Vehicle (PSLV) made its first launch attempt in 1993.

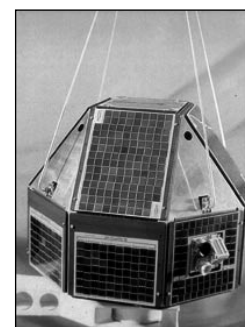
### Early Indian Satellites

The very first satellite was *Aryabhata*, which provided technological experience in building and operating a satellite system. It was launched by the USSR in 1979 as it would be another 15 years before India could launch such a massive (360 kg) payload. With remote sensing seen as an important goal, the second satellite, named *Bhaskara* after the 7<sup>th</sup> century Indian astronomer Bhaskar Acharya, carried television and microwave imagers for remote sensing experiments. It was also launched by the USSR, as was a second very similar spacecraft in 1981.

Four small *Rohini* satellites, each with a mass of about 35 kg, were built primarily to measure the performance of the SLV-3 vehicle carrying them into orbit but the last two to be launched also incorporated simple equipment for remote sensing studies. As mentioned above, the first one failed to orbit but the others were successful.



A model of an ASLV3 rocket



A Rohini satellite

The name INSAT (Indian National Satellite) is likely to be more familiar to readers. However, despite the name, the four in the first series (INSATs 1A, B, C and D) were neither built in India nor launched from India. They were large, 1300 kg, 3-axis stabilised, combined meteorological and communications satellites purchased from the USA and launched between 1982 and 1990 into geostationary transfer orbits; 1A and 1D by US Delta rockets, 1B by the Space Shuttle Challenger and 1C by a European Ariane-4 rocket from French Guiana. They then reached geostationary orbit using their own power. INSAT 1A and 1C operated for less than two years but the other two were long-lived.



Indian satellite designers and builders were not idle during the period when the INSAT 1 spacecraft were being purchased from, and launched by, foreign nations. Work was proceeding steadily on the construction of a series of remote sensing satellites to operate in low sun-synchronous orbits. As some of these would be ready for launch before India's PSLV was available, launch services were purchased from the USSR for three of the first series of IRS (Indian Remote Sensing) satellites.

IRS 1A and 1B were identical craft and carried two types of camera known as Linear Self Scanning Sensors (LISS 1 and LISS 2). LISS 1 has a spatial resolution of 72 metres with a ground swath width of 148 km. LISS 2 comprises two separate sensors with a resolution of 36 metres mounted in such a way as to provide a composite swath of 147 km. Both LISS 1 and LISS 2 operate in four spectral bands covering the visible and near infrared region. IRS 1A was launched on a Vostok rocket from Baykonur, in Kazakhstan, on March 17, 1988 and IRS 1B followed from the same launch pad in August 1991.

Further advances in satellite and launch vehicle development took place in the 1990s and they will be the subject of part three of this series.

### ISRO Centres

The Indian Space Research Organisation was established in 1969, initially within the Department of Atomic Energy, but was transferred to the newly formed Department of Space in June 1972. Most of the early development work took place at Thumba but, over time as the industry expanded, centres were set up across the entire country and many thousands of new, highly skilled jobs were created. A brief description of a few of the major Centres follows.



A view of the VSCC campus

The Vikram Sarabhai Space Centre (VSCC) is located in Thiruvananthapuram and is the lead centre for rocket and launch vehicle projects. Research and development activities cover avionics, aeronautics, materials and mechanical engineering, solid propulsion systems and propellants. All of India's launch vehicles were developed there. VSCC also operates an ammonium perchlorate (oxidiser) experimental plant at Aluva, some 250 km to the north.

The Satish Dhawan Space Centre, named after the late Professor Satish Dhawan who was Chairman of ISRO from 1972 to 1984, is situated at Sriharikota on the east coast some 100 km north of Chennai (Madras). It is India's 'Cape Canaveral' from where all of the nation's satellite launches have taken place. A second launch pad has now been constructed.

The Space Applications Centre was established in 1972 at Ahmedabad when several units within ISRO were merged. As the Indian space programme is very much applications-driven, the bulk of development work on satellites is carried out here. The Centre carried out early communications experiments like the Satellite Instructional Television Experiment (SITE) and developed the payloads of the INSAT spacecraft (except for the first four which were purchased from the USA) and all the remote sensing satellites. In addition to developing hardware, the Centre processes huge amounts of data from satellites.

The ISRO Satellite Centre (ISAC) at Bangalore is where satellite's power, control and telecommunications systems are developed and where spacecraft assembly and testing take place.

The SLV-3 and ASLV rocket engines used solid fuel but the Liquid Propulsion Systems Centre was established at Thiruvananthapuram to develop liquid-fuelled rocket motors for the PSLV and later launch vehicles. The control systems for the SLV-3 and ASLV were also developed there. Rocket motor test facilities are located nearby at Mahenragiri.

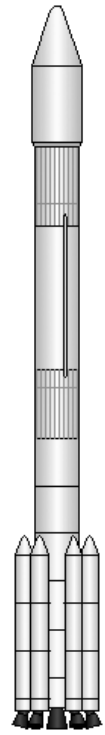
ISRO, over the years, established a comprehensive network of ground stations to provide telemetry, tracking and command (TTC) support to satellite and launch vehicle missions. These facilities are grouped under ISRO Telemetry, Tracking and Command Network (ISTRAC) with its headquarters at Bangalore. ISTRAC has TTC ground stations at Bangalore, Lucknow, Sriharikota, Thiruvananthapuram, Port Blair (Andaman Islands), Brunei, Biak (Indonesia), Bearslake (Russia) and Mauritius.

### Acknowledgements.

I am indebted to ISRO and the National Remote Sensing Agency for making so much information available on their websites:

<http://www.isro.org>

<http://www.nrsa.gov.in>

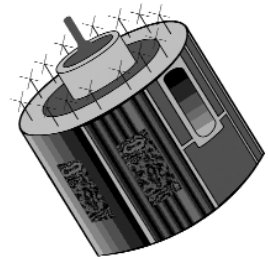


The polar satellite launch vehicle (PSLV)



# Meteosat-8

## Operational Imagery on the WWW

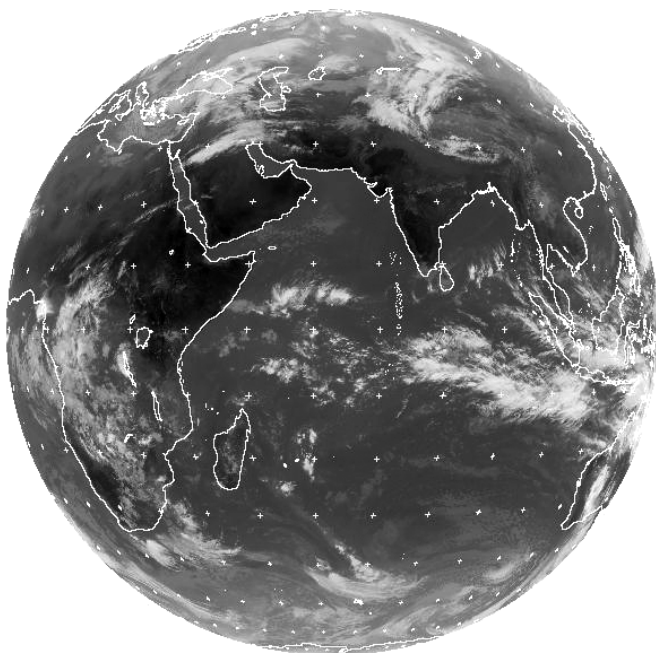


The first of *EUMETSAT*'s Meteosat Second Generation satellites, formerly MSG-1, finally became fully operational as Meteosat-8 on January 29 this year when it commenced routine operations. GEO readers who are not yet equipped to download their own raw Meteosat data can consult an archive of near real-time image data from Meteosats -5, -7 and -8 at:

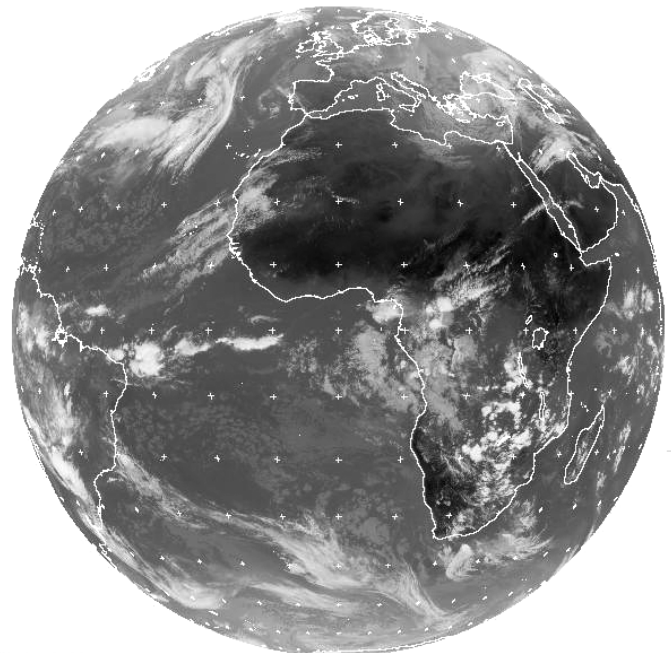
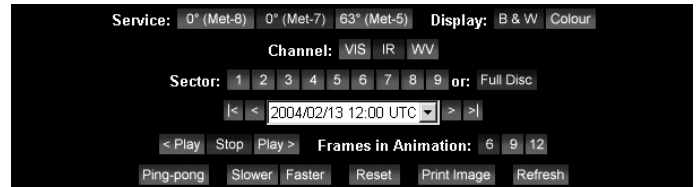
<http://oiswww.eumetsat.org/IDDS-cgi/listImages>

This web page is headed by a control panel which allows the visitor an extensive choice of Meteosat Images at the click of a mouse button. You can view the latest available static and animated Meteosat WEFAX Imagery. It should be noted that all images, including those from Meteosat-8, are in the familiar 800 pixels square WEFAX format - you do not have access to high-resolution MSG imagery.

**Meteosat-8** images are available in four wavelengths, 0.6  $\mu\text{m}$  visible, 3.9  $\mu\text{m}$  IR, 6.2  $\mu\text{m}$  WV and 10.8  $\mu\text{m}$  IR. All are available at 1-hour intervals, with the 10.8  $\mu\text{m}$  IR images also available at 30-minute frequency.



MET5 13 FEB 2004 0900 DTOT



MET7 13 FEB 2004 1200 DTOT

Images are available in all the traditional WEFAX segments as well as full Earth disc. There is also an option to display a coloured version of each image (not a colour composite, though). If desired, movies can be displayed showing the most recent frames (maximum 12 frames). **Meteosat-7** provides similar options, except that only three channels are available. Data from **Meteosat-5**, located at 63°E over the Indian Ocean, is restricted to full-Earth images at 3-hourly intervals.

### Important Note

All Meteosat images on the *EUMETSAT* web server are subject to *EUMETSAT* copyright. If you wish to reuse these Meteosat images, for example on your personal website, *EUMETSAT*'s copyright credit **must** be shown by displaying the words 'copyright 2004 *EUMETSAT*' on each of the images you display.

All Meteosat images on this page, are  
copyright © 2004 EUMETSAT

# Earth Imaging News

**Peter Wakelin**

## Fire at Indian Rocket Plant

A major fire killed six workers at the Solid Propellant Space Booster Plant at the Satish Dhawan Space Centre in Sriharikota on February 23. Nine workers were nearing the conclusion of a propellant curing operation involving a segment of rocket motor containing about 14,500 kg of a mixture comprising atomised aluminium fuel, ammonium perchlorate oxidiser and a polybutadiene binder. Whilst removing the lower plate of a casting assembly, the propellant caught fire and only three workers were able to escape from the blaze albeit with severe burns. The building was extensively damaged due to the intense heat generated but, as a second cast-cure facility was built for such contingencies, the Indian Space Research Organisation do not anticipate any significant delays to any of their programmes.

## NPOESS First Launch Delayed

The US Air Force has awarded Northrop Grumman Space and Mission Systems a contract modification for a 21-month delay to the launch of the first satellite in the next-generation National Polar-orbiting Operational Environmental Satellite System. The delay has been attributed to the need to match a new funding profile and to make some engineering changes to enhance capabilities and reduce technical risks.

The first NPOESS satellite will not now be launched until 2010 at the earliest which will greatly increase the probability that the current polar-orbiters together with NOAAs N and N-prime, still to be launched, will not be able to maintain a full service until the new craft become operational.

However, there are still four remaining DMSP (Defense Meteorological Satellite Program) spacecraft to be launched between now and 2010 but, although now operated by NOAA, their direct-readout access is restricted. If all goes well, data from the first European polar-orbiting weather satellite, METOP, should come on stream in 2006.

## Monitor-E 1 Due for Launch in June

Russia's Monitor-E 1 spacecraft is one of nine small satellites to be launched on a single Rokot launch vehicle from Plesetsk, Russia in June into a 540 km sun-synchronous orbit. Its two high-resolution imagers are designed for research of natural resources and the monitoring of land usage and emergency situations such as natural disasters within Russia. Fast-response can be achieved by tilting the imagers thus obviating the need to wait until the spacecraft's ground track is optimal.

The panchromatic imager has a spatial resolution of 8 metres and can scan a 94 km swath within the 730 km observing zone. The multispectral scanner can return 20 m resolution images to the main receiving centres and reduced resolution imagery to the numerous, widely distributed, small receiving stations.

## MTSAT 1R Launch Delayed

As surmised in the last issue, it has now been confirmed that the launch of MTSAT 1R will be delayed until at least November. This follows the failure of the last launch attempt by the H-IIA on November 29 2003. At the time of writing (late March), efforts are being made to recover the solid-fuelled booster rocket from the ocean floor. Its apparent failure to separate prevented the upper stages from reaching sufficient speed to orbit the payload.



MTSAT - Image: Space Systems/Loral.

MTSAT 1R was built by Space Systems/Loral in the USA and is based on SS/L's standard LS-1300 three-axis stabilised spacecraft. It incorporates many of the state-of-the-art technologies developed for the US GOES satellites and will be located over the equator at 140° east longitude replacing the aged and ailing GMS-5. Meanwhile, GMS-5 continues to transmit WEFAX imagery derived from nearby GOES-9.

## USA May Adopt EUMETCast-style System for NPOESS

The Low Rate Data (LRD) from the next-generation NOAA spacecraft will be broadcast at 3.88 Mbps (about six times faster than the current HRPT transmissions) and will require an antenna about 90 cm diameter. The High Rate Data (HRD) will come down on 7.8 GHz at 20 Mbps requiring an accurately steerable antenna of about 1.8 m diameter. A few *GEO Quarterly* readers may find direct reception of HRD within their capability (and budget) but most will be pleased to hear that the Integrated Program Office, in cooperation with NOAA/NESDIS, is also investigating alternative communications capabilities such as the rebroadcast of processed imagery and other data via the Internet or 'commercial' services. The success of the *EUMETCast* system will undoubtedly influence their decision.

## India Signs Imaging-related Agreements

A programme of cooperation between the Indian Space Research Organisation and the Brazilian Space Agency was agreed and signed in New Delhi in January. The programme envisages joint research in space and atmospheric sciences, exchange of proposals for remote sensing applications, the

. . . . . *continued on page 23*



# Using Wxtoimg Images in Digital Atmosphere

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In December 2003, I posed the question as to whether there was a more intelligent way to use pictures from *WXtoImg* in *Digital Atmosphere*. Then I had some e-mail discussions with Ton Lindemann of *Meteo Maarssen*. His website (in Dutch) is worth a visit.

[www.meteo-maarssen.8m.com](http://www.meteo-maarssen.8m.com)

This further instalment has been developed on the basis of these contacts. It is still a trial-and-error story, but now in a structured way. New maps can be developed very quickly, especially after you have gained initial experience with my techniques.

## Setting up WXtoImg

Open <Options> on the *WXtoImg* menu-bar, and click on <Projection Options...> to display the *Projection Options* input screen (figure 1). Here you must input values for the latitude, longitude, north, south, west and east boundaries, and scale—choose values that will give the image area you want. Additionally, in the <Options> menu, uncheck 'disable map overlay'—this method will not work correctly if the overlay is absent. Finally, move to the <Projection> menu and select 'Orthographic'.

Now you are ready to generate your satellite image. Do so, and write down its width and height in pixels (this will appear on the status line at the bottom of the screen, just before the image is displayed). Finally, choose <Image/White background> and save the image as a BMP file (the image format **must** be BMP for later importing into *Digital Atmosphere*).

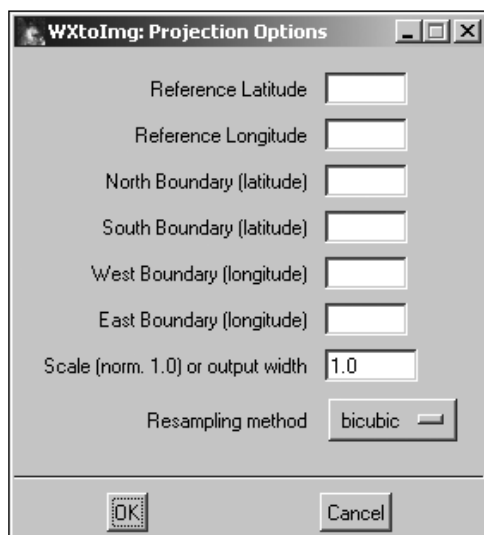


Figure 1  
The WXtoimg parameter screen

## Setting up Digital Atmosphere

Open <Map/Generate map-->Enter lat/lon> and use the horizontal and input exactly the same longitude and latitude values you used in *WXtoImg*. Next, enter the width and height values you wrote down earlier into their respective fields (figure 2) then click 'OK' to generate a map.

You will now have to resort to a little trial and error to select a scale that generates more or less the same size of map as the *WXtoImg* image—precision is not so important at this moment. Once you have generated a map that looks ok, save it with <Map/Save map> as a BMP.

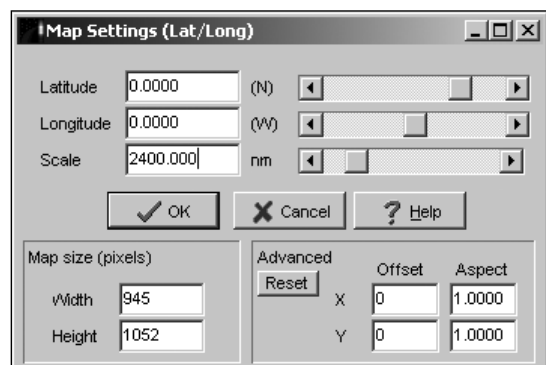


Figure 2  
The Digital Atmosphere parameter screen





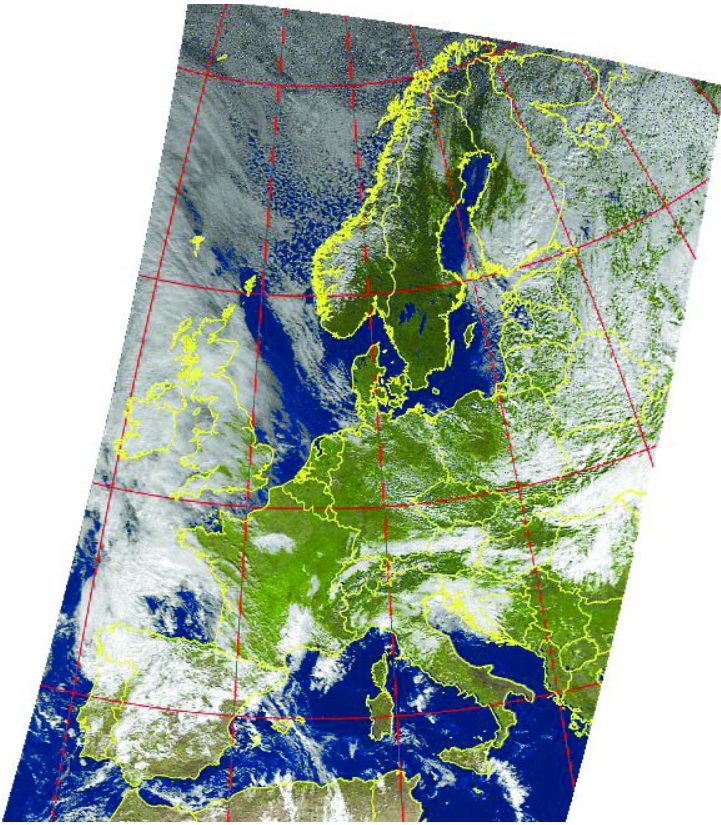


Figure 5

A WXtoImg orthographic image, is created, complete with country outlines (12:18 UT pass from October 12, 2003).

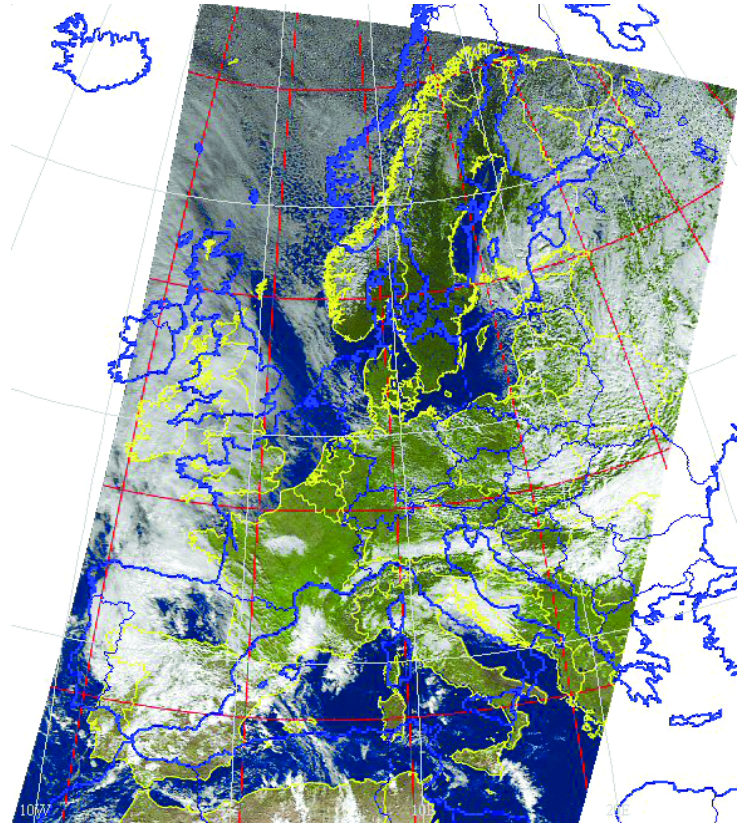


Figure 6

First attempt loading the image into Digital Atmosphere. Registration between image and map is poor.

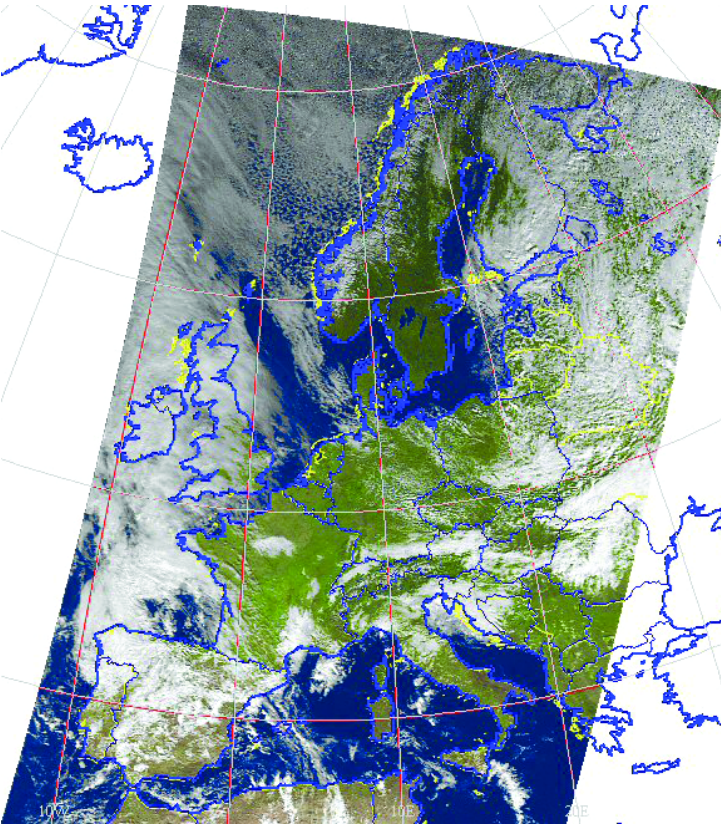


Figure 7

Following fine tuning, as explained on the opposite page, the image and map now show excellent registration

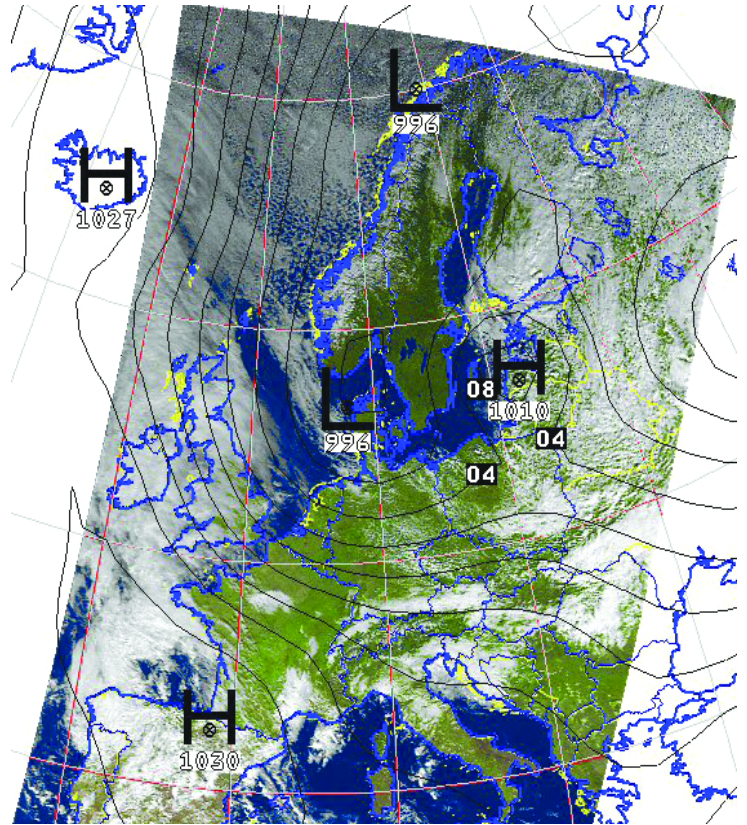


Figure 8

The WXtoImg image into Digital Atmosphere, with added synoptic sea-level pressure overlay.



## Fine-tuning

Repeat the following steps until both maps fits exactly.

1. Choose <Map/Load map> from the *Digital Atmosphere* menu-bar and read in the *WXtoImg* image.
2. Choose <Map/Add basemap> to project the DA-map over the image. At this stage, it is unlikely to match correctly.

	Wxtoimg							Digital Atmosphere				
	Lat	Lon	N	S	W	E	Width	Lat	Lon	Scale	Width	Height
1	55	5	75	35	-25	35	800	55.73	4.95	3250	800	696
2	55	26	61	47	-10	15	600	54.18	25	1167	600	515

Figure 4 - Samples of typical parameter sets following fine tuning

Now we must try to make the DA-map fit by making changes in the <Map/Generate map/Enter lat/lon.> window (figure 2).

3. Make small changes to the Latitude field to move the map in vertical direction
4. Making changes to the Longitude field will move the map horizontally.
5. Adjust the Scale factor for overall resizing of the map.
6. Make further small changes as necessary by repeating steps 3, 4 and 5. After clicking 'OK', *Digital Atmosphere* will generate a new map
7. Repeat step 1, because only after step 2 can you judge the result

It can happen that meridians do not fit exactly on to each other. In this case, you can try rotating the image in *WXtoImg* by changing the 'reference longitude'.

## Finishing Off

Save the *Digital Atmosphere* map for the last time (figure 3). This must be done because every lay-out has its own base map and parameter-files. Always open

this corresponding map before loading a picture with a different layout from *WXtoImg*.

The dimensions of the map can be changed by modifying the 'width' parameter in *WXtoImg*. Always make sure that the width and height in *Digital Atmosphere* have the same values as in *WXtoImg*.

Below are two examples of parameter sets I have found useful. The first one gives an image of Europe

including Iceland, the second Holland and England (figure 4).

Figure 5 shows the morning NOAA 17 pass from February 5, 2004. Figure 6 shows this image used as a background for *Digital Atmosphere*, overlain with the noon sea-level isobars.

## Software Links

*Digital Atmosphere* can be downloaded from

<http://www.weathergraphics.com>

The program is shareware, but remains fully functional for a trial period of 30 days, after which certain features, including the map drawing facility, cease to work. You have to register the program to restore these functions.

*WXtoImg* can be downloaded from:

<http://www.wxtoimg.com>

This program is also shareware, and though it has many useful features, the various map projections are only accessible within the registered version.

# Coming in the Next Issue of the *GEO Quarterly* ...

Interest in the first issue of the *GEO Quarterly* has been world-wide, and the members of the steering group have been delighted with the response to their new venture.

Not only have we received numerous testimonials regarding *GEO Q1*, but readers have risen magnificently to the cause by providing more articles than we can possibly publish in one single issue—but do *please* keep these articles and images coming in.

*GEO Q3*, planned for July/August is already well under development with a number of contributions already finalised, and others in the pipeline.

- For enthusiasts of the RQFH antenna, Rob Hollander presents the first instalment of a two-part articles on Antenna Theory and Measurement, in which he discusses such topics as radiation patterns, sensitivity and polarisation.
- Peter Wakelin continues his treatise on the Indian Space programme
- We will have an illustrated article detailing the both the weather and space-orientated activities of of the Callington Space Centre in Cornwall
- For the mobile weather satellite enthusiast, Fred Van den Bosch describes how he captured weather images while on a holiday in Vietnam
- There will be a full illustrated report on the *GEO Symposium* held at the National Space Centre in Leicester on May 1

# 'MSG Goes Operational' Event

## Darmstadt - February 9, 2004

David Taylor - davidtaylor@write-me.com

I was recently lucky enough to be invited to an internal Eumetsat event - 'MSG Goes Operational—When inspiration meets dedication it deserves celebration'. Although the satellite actually went operational on January 29, the event itself took place on Monday, February 9, allowing me a little more time to write my own presentation!

The format of the day was for all *EUMETSAT* staff to attend a common morning session, where speakers from the organisation spoke about MSG-1 and four members of the user community introduced topics covering 'How do users work with the MSG data'. There then followed a toast by the Director-General of *EUMETSAT* and a light lunch, followed by parallel presentations in the afternoon from the four members of the user community and further presentations on Search and Rescue, Weather Phenomena seen from Meteosat, and the GERB instrument. During the afternoon it was possible for staff (and presenters!) to visit the MSG Control Centre.

### Morning Session

Tillmann Mohr's (Director-General of *EUMETSAT*) presentation was entitled 'Looking back with pride'. He identified three key dates for MSG-1; 1984, 1994 and 2004. 1984 was when a brainstorming session in Avignon decided the basic concept requirements for MSG as the follow-on to the existing Meteosat programme. June 1994 saw the final go-ahead being given by all nations, and 2004, of course, was when MSG-1 became operational as Meteosat-8. (Dr Mohr has been involved with *EUMETSAT* since its early days as a spin-off from ESRO/ESA, and has written a fascinating history about making *EUMETSAT* the organisation we know today.)



*EUMETSAT* Director-General Tillmann Mohr

Alain Ratier (Director of Programme Development) spoke about *Achievements throughout commissioning*, including the various problems encountered and how they were handled. Of course, the major issue was the failure of the SSPA (solid state power amplifier), and the consequent move to dissemination of data via the Hot Bird-6 DVB system.

Mikael Rattenborg (Director of Operations) spoke about *MSG-1 becomes Meteosat-8*.

The four user presentations which were introduced in the morning were from Herve Roquet (Meteo France), Wolfgang Benesch (Deutscher Wetterdienst—German Weather Service), Hans Rosenkrans (KNMI—Royal Dutch Weather Service), and David Taylor from SatSignal Software. I finished my talk quoting the two questions I am asked most often - my own FAQs - which are: 'Is it still working?' and 'What is the cut-out in the high-resolution visible channel?'

### Afternoon Sessions

Unfortunately, as I was involved in either giving my own presentation, interviews, or involved in meetings during the afternoon, I never got to hear the other speakers. I did manage to squeeze in a quick guided tour to the Control Centre during lunch, though!

### Some Things I Learned

I was most surprised by the number of people in *EUMETSAT* who seem to know me, and who obviously follow the postings on the *MSG-1 Yahoo Group*! People were keen to explain about some of the things I had asked.

The first question concerned how you manoeuvre a spinning satellite, for example to change the orbit. As far as I could tell, the only thrusters available were attached to the spinning part of the satellite, so if they were operated continuously they could not provide the unidirectional thrust required for an orbit change. The answer is that the thrusters are not operated continuously, but in very short bursts; for example, a 100 millisecond burst every rotation. It might take a hundred or more such bursts to get the desired momentum change. Operating the thrusters in pairs avoids any spin change. Clever, eh?

Many of us have experienced missing segments, and wondered if it was our system or the transmission that was at fault. My FAQ 'is it still working?' triggered a





The full-sized model of MSG1 outside EUMETSAT HQ



Sally Wannop at MSG-1 control



Cranes around EUMETSAT HQ block C-band reception



The Meteosat Transitional Program (MTP) control room



MSG Data Manager display on a large screen in the foyer



Cutting MSG-1's birthday cake

chance to see how *EUMETSAT* themselves monitor missing segments. Wow! It's a lot more complex than I imagined. The flow of segments is monitored as they are processed within *EUMETSAT*, as they are sent to the link for *Hot Bird-6* satellite transmission, as they are transmitted back from *Hot Bird-6* (at two Ku-band receiving stations), and finally, after retransmission over the *Atlantic Bird* C-band link, at two C-band receiving stations.

Not only is the presence or absence of a segment known, but also the exact time of each event in the segment file's progress. Somewhat amusingly, at the moment, *EUMETSAT* cannot monitor the C-band transmission as well as they would like because there are some building site cranes in the way! They need to find another location for their local C-band antenna. I'm sure we've all been down that path!

As a result of talking about missing segments, and out-of-order segments, we investigated a problem that I had observed. The thing I learned there was that the segment system works well for 'live' data, generated over a period of time as a satellite scans the Earth. However, different problems are faced with some of the derived data and foreign satellite data. Because the entire image is generated at once, the segment files may all have the same timestamp when they reach the point of transmission. Thus, instead of the *EUMETCAST* system simply being able to transmit the data in the order it is generated, it may try and transmit all the data at the same time, resulting in a scrambled segment order. All the data is there—it's just not in the sequence you expected! This problem can be solved with some fine-tuning at the sender's end.

Yet another thing that should have been obvious to me, and yet only became so during my visit to the control room, was the way the geometric correction of the images works. Basically, the image will typically be slightly imperfect as the satellite may be tilted or off-axis compared with an ideal orbit. During the life of the satellite, the orbit inclination may vary from a couple of degrees through zero up to perhaps five degrees or more at the end of its life. By allowing some inclination, fuel is conserved. You can correct this because the orbit is well known (from the Kepler data) and fine

adjustments can be made by comparing the satellite image with well-defined points on the ground. However, I had always considered this as dealing with a complete scan, and matching the whole picture to a map of the Earth. Not so with *Meteosat-8*! Because the image segments are transmitted in near real-time, the entire image is not available while the scan is in progress, so the image correction must be carried out using the predicted error rather than the as-measured error. Presumably, after the scan, the quality of correction is checked and used to make the correction for the next scan. Well, perhaps that is obvious now but it only became obvious to me by watching the process at work!

### **Acknowledgements**

There are many people at *EUMETSAT* who made this event possible and I am very grateful for being invited to speak. Anne Taube in particular went out of her way to ensure that everything was ready for me and the other speakers in good time for the sessions while Sally Wannop took time to discuss User Services with me, including a number of issues where the differing approach in different countries is causing some problems. Even after a long day, Nick Coyne was happy to chat about some of the more 'IT'-related aspects of the operation.

## ***A Moonlight Sonata . . . in sea***

### **Francis Bell**

A few months ago duty called and I was dispatched by H.M. to the Caribbean. Of course as well as the lovely warm climate there I love the clarity of the atmosphere. There are not many places in the world when the setting sun just disappearing over the horizon will give you that four second colourful ride through the visible spectrum. Red, through green to sapphire blue—faster than you can read this sentence.

There was another manifestation of the visible spectrum which I noticed. It can be seen regularly in this country also: a rainbow. Occasionally there were showers but often with the sun still shining. With a correct sun and rainfall angle this is the recipe for a rainbow. Over a period of a few days I saw several.

Now it so happened that on February 5, 2004 there was a full moon in the night sky. A tropical full moon is spectacular: at our UK latitudes we never see it so high in the sky. I was impressed. There was no light pollution and a clear haze-free atmosphere. With just moonlight the light level was bright enough to walk around safely.

On this occasion there were still a few clouds clearly visible in the sky and sometimes, when they occulted the moon, a halo developed around the moon. Of course I have seen this before but it made me think about rainbows again.

***With the moon at the correct angle in the sky and a falling shower, is it possible to see a rainbow with moonlight alone?***

I'm sure a physicist could describe the spectral composition of the reflected light from the moon. However, the issue is this: given the correct alignment of raindrops and moonlight, is a rainbow produced under these conditions? Can you see it? Has anybody seen one?

Responses to the editor please. As usual, here is a clue: Don't ask a physicist what you can see—believe your eyes.

# Using Satellite TV Co-axial Cable

Article by

**Arne van Belle**  
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Translated by

**Chris van Lint**

Regardless of whether you are receiving weather satellite transmissions in the 137 MHz or 1700 MHz range, both require a co-axial cable connection between the antenna and / or downconverter. If your Meteosat downconverter is located indoors (or if long distances are to be covered), low loss co-axial downlead is required. However, low loss co-ax is both difficult to find and rather expensive. Not many people seem to be aware that a good alternative to this special low loss co-ax is available for use by amateurs.

## Theory

Co-ax is available in different impedances; the most often used types being 50 ohm and 75 ohm. The impedance is determined by the spatial relationship between the inner diameter of the shield and the diameter of the inner conductor.

Radio amateurs use 50 ohm, whilst for cable and satellite television, 75 ohm is used. There is a good reason for this: a 75 ohm cable with the same outer diameter exhibits lower loss compared with 50 ohm co-ax. However, radio amateurs at times push hundreds of watts through the co-ax to their antenna, but 75 ohm is not suitable for this purpose as it causes a mismatch which can damage the transmitter. Since we are not using our co-ax for transmission, it would be better to choose an impedance which causes minimal loss and this is 75 ohm.

Losses in co-ax may be divided into conductor losses and dielectric losses. Conductor losses are due to the fact that a finite resistance occurs over long lengths (several ohm per 100 metres). This is particularly important for the inner conductor. A thicker inner conductor provides less resistance but necessitates

using a thicker outer sheath in order to maintain the correct impedance. Therefore, large diameter co-ax usually exhibits lower loss. Nevertheless the dielectric (the insulation between the inner conductor and shielding) is also a factor in determining loss. Solid polymer material such as transparent polythene

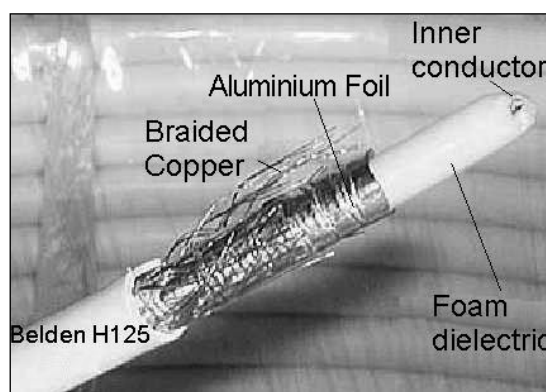


Figure 1 - Satellite TV co-axial cable

exhibits higher loss as compared to air. As it is not possible to keep the inner conductor centred using air alone, a dielectric containing air pockets or a foamed polymer is present in low loss co-ax.

In addition to loss, the shielding efficiency is also important. If it is too low, the signal will leak to the outside or, worse still, interfering signals could penetrate to the inner conductor. A solid copper outer sheath would prevent entry of just about anything but would make the co-ax very inflexible and expensive. Consequently, a combination of copper or aluminium foil with braided copper wire is used, and provides much better shielding than braided copper alone (figure 1).

Co-ax type	Ohm	Diameter mm	Type Connector	Loss in dB per 100 meter / frequency			Screening (dB)	Capacity pF/m	Velocity factor
				12/100	33.6/1000				
RG59CU	75	6.15	BNC/F 6mm	12/100	33.6/1000			68	0.66
H125	75	6.8	F 7mm	6.0/100		29.7/2050	> 85	55	0.81
KOKA799	75	6.8	F 7mm	5.7/100	19.1/1000	29.0/2150	> 85	67	0.8
MK90A	75	6.7	F 7mm	4.4/50		30.2/2200	> 75		0.84
CX5S	75	6.8	F 7mm	5.1/50	24.0/1296				0.8
RG58CU	50	4.95	BNC	17.8/144	64.5/1296			100	0.66
Aircell 7	50	7.3	N special	7.9/144	26.1/1296	37.9/2320		74	0.83
RG213	50	10.3	N	8.5/144	27.5/1296	41.0/2320		96.8	0.66
Aircom+	50	10.8	N special	4.5/144	14.5/1296	21.5/2320		84	0.85
H2000Flex	50	10.3	N	4.8/144	15.7/1296	21.8/2320		80	0.83

Table 1 - Comparisons between different types of co-axial cable



**Practice**

With the emergence of TV satellites, low loss 75 ohm TV co-ax (which can be used up to 2200 MHz) is no longer expensive. Well-known brands are *Belden H125*, *Wisi MK90A* and *Hirschmann Koka 799*. Good low loss TV co-ax has an outer diameter of between 6 mm and 7 mm, a copper inner conductor, white foam dielectric, aluminium foil and a tinned copper braid. The plastic outer cover is either white or black.

*Beware! Cable with a green outer cover is underground cable, which is not UV resistant.*

Since TV co-ax has non-standard dimensions, common BNC or N-connectors can no longer be used. However F-connectors are available for this type of co-ax but these are of lower quality and result in somewhat higher losses. This should not pose a problem as long as they are used following the first preamplifier / downconverter or at 137 MHz. Don't use F connectors between the antenna and the preamplifier / downconverter on 1700 MHz!



Figure 2 -Crimping pliers and inset tool

At 137 MHz, TV co-ax may be connected directly to the antenna with F connectors. Although a minor mismatch (from 50 to 75 ohm) will result, in practice this seldom causes problems. An advantage of F connectors is that they are cheap and can be fitted with ease. There are two versions; the screw-on type and the crimp type. Both have to fit properly on to the TV-co-ax. Various diameters of co-ax and connectors are available commercially and care should be taken to ensure that the correct connector is used! For the crimp version an appropriate inset tool and crimping pliers are required (figure 2). The inset tool can also be used for the screw version. Screw the F connector on to the inset tool and fasten with an 11 mm spanner. It is now easier to screw the connector on to the co-ax.

If you are using screw connectors I would advise that, after screwing on the connector, a short length of shrink tubing is applied over the connector barrel and co-ax to prevent both entry of water and loosening of the connector.

Carefully remove the outer insulation over a length of approx. 12 mm without cutting into the braid or foil. To facilitate this, carefully cut the outer shield with a

sharp knife whilst bending the cable slightly until the cut tears open. Straighten the braid and fold it back over the outer sheath but leave the aluminium foil around the dielectric.

Now cut the foil and dielectric all round at about 9 mm, leaving 3 mm. If necessary smooth the foil over the dielectric. Next screw the F connector on to the cable. Continue turning the connector until the dielectric (covered with foil) is clamped against the conical part, inside the connector. This causes the inner conductor to be centred and creates a good contact between the foil and the connector barrel. Never turn it so far as to cause the dielectric to protrude at the screw-on side of the connector opening!

If the screwing-on process proves to be difficult, a bit of

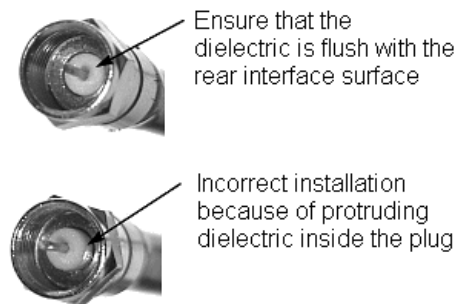
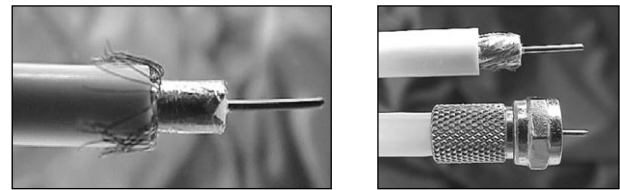


Figure 3 - Wiring up an F connector

*Vaseline* may be applied to the outer sheath. Do not turn too far, as this may cause the foil to tear internally. Finally cut the inner conductor if it protrudes more than 4 mm outside the connector nut.

A minor disadvantage of F connectors is that, in order to ensure a lasting connection, they have to be fastened with a 11 mm spanner. This is because the F-connector does not have any spring contacts like BNC or



Figure 4 - Various connector types

N-connectors. Take care however not to apply excessive force and over-fasten!

Good adapters are available which can interconnect F, BNC or N connectors, allowing the cable to be connected to existing equipment. But if you build your own equipment, it is of course better to fit them with F connectors in the first place!

Unfortunately *Teflon* is seldom used in F connectors which makes them difficult to solder without melting the insulation. But there is a simple way to achieve a good soldered connection. You need an F connector (crimp or screw type) which is drilled out with a 7 mm or 8 mm drill until the nut can be removed. This nut is now soldered on to the tin case, centred on the 4 mm

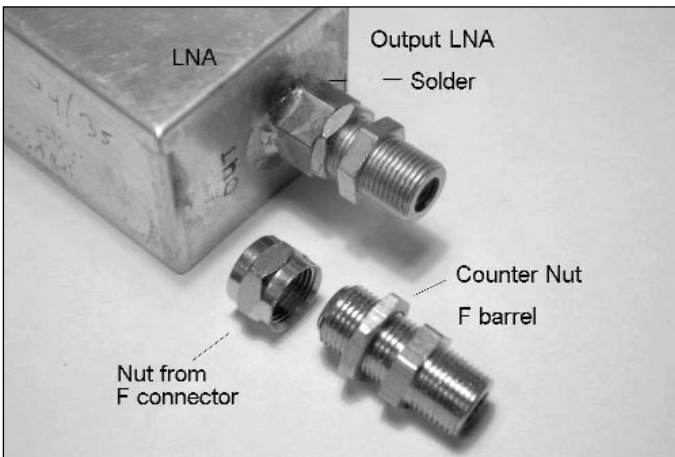


Figure 5 - Lock-nutting the F connector in position

hole in the tin. For the inner conductor, a small length of 1 mm silvered copper wire is soldered to the PCB track to which the connector is to be fitted.

Allow about 2 mm of the inner conductor to protrude outside the soldered-on nut. Next take an F coupling barrel and screw it into the nut, over the inner conductor. With an additional nut (some pot meter nuts also fit), the F barrel can be lock-nutted in place. You now have a good connection which may be replaced later if something goes wrong unexpectedly (damaged screw thread or moisture in the connector).

To waterproof F connectors is not really difficult. Rubber covers are available which fit snugly over the TV co-ax and the F connectors. If the cover is coated with *Vaseline* on both sides, a good waterproof connection, which can easily be removed, is obtained. Ensure that the front of the cover seals around the hexagonal nut or the surface of the case.



Figure 6  
Rubber cover

It is also possible to buy more expensive waterproofing covers which click around the connector; these are filled with a type of gel which provides waterproofing. However

these versions are difficult to remove.

### Conclusion

Good satellite-TV co-ax is not only cheaper, but also results in lower loss, when compared with *Aircell* or *RG213*. Because we are not transmitting, the minor mismatch from 50 to 75 ohm seldom presents a problem. If TV co-ax is used between a preamplifier and the *LNC 1700* Meteosat downconverter, this mismatch can be mitigated to a large extent by carefully adjusting the first trimmer in the LNC for maximum signal.

When using a single stage preamplifier, either as an integral part of the antenna (active feed), or one connected directly to the antenna, TV co-ax can be used successfully over distances of up to 20 or 30 metres from your Meteosat downconverter. When receiving APT on 137 MHz, a cable run of up to 100 metres between a masthead preamplifier and the receiver can easily be achieved.

TV / Satellite shops often offer a variety of brands of co-ax at reasonable prices. If a type is identified as 'digital' satellite TV co-ax, a low loss and better degree of isolation is indicated compared with cheaper varieties. This type is excellent for use at 1700 MHz. (Ask for Belden H125, Wisi MK90A or Hirschmann Koka799). The cheaper varieties (e.g. CX5S or other unbranded types) are also suitable for 137 MHz.

### One Final Hint

I always wind some red adhesive tape around the shrink tubing and the co-ax to differentiate my antenna downloads from the multitude of other cables (see figure 4). Whenever a thunderstorm threatens, I always remove all red-labelled cables!

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## New Download Address for WXSAT Software

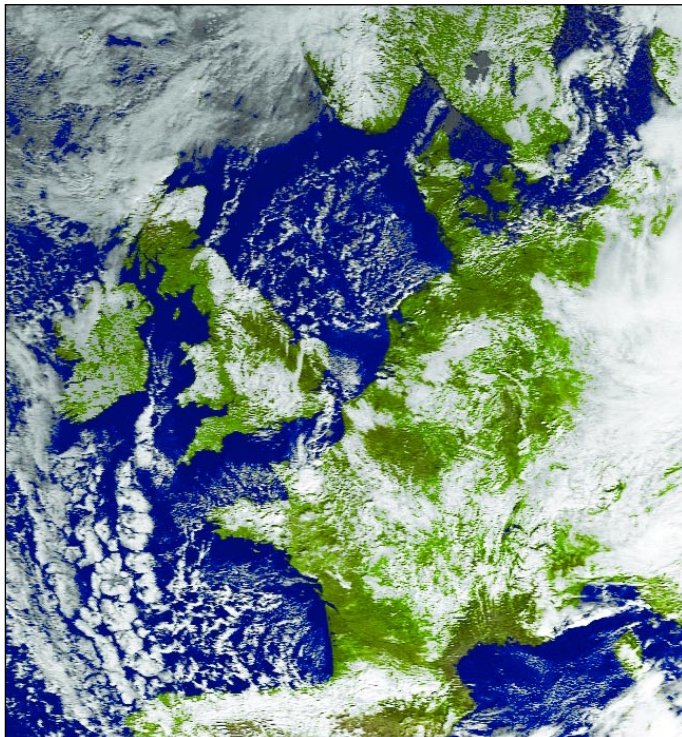
Shortly before GEO Quarterly No 1 was printed, major reconstruction work by Marius Rensen on the HF-FAX site resulted in a change of address for downloading the popular WXSAT satellite decoding software.

GEO readers trying to achieve this using the address published on page 44 of our Launch Issue would have been disappointed.

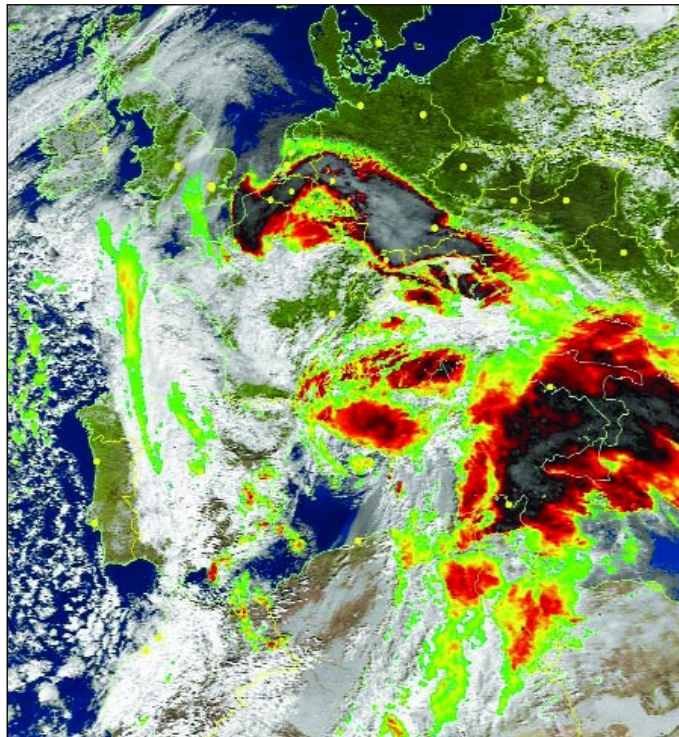
The new address for WXSAT is:

[http://www.hffax.de/html/hauptteil\\_wxsat.htm](http://www.hffax.de/html/hauptteil_wxsat.htm)

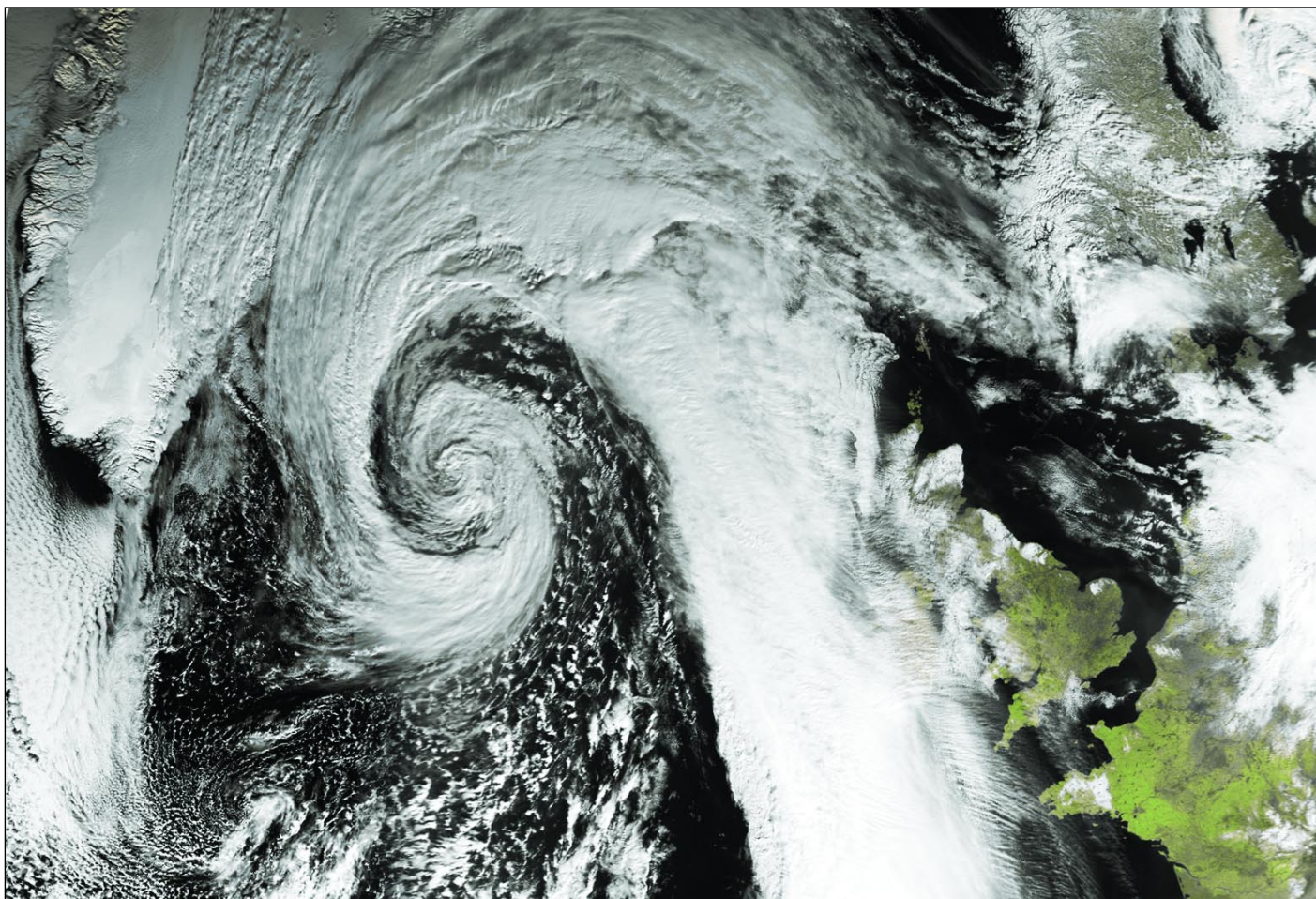




**Hartmut Schaksmeier** from Remscheid, Germany captured this NOAA-17 APT image showing northern Scotland blanketed in snow on February 29 this year. The image was processed using the MSA enhancement in Craig Anderson's *WXtoImg*.



**Gerry Berg** from Wilnsdorf, Germany acquired this NOAA-17 image of stormy central Europe on February 21, 2004. This MSA + precipitation image created with *WXtoImg* clearly shows the extent of precipitation. (DK1RR@aol.com)



This image presages the end of the 'Big Freeze' that gripped the UK in late February. A composite of two NOAA 17 HRPT passes processed in 'vegetation' mode using David Taylor's HRPT Reader, followed by remapping using Groundmap, the image shows the advance of an Atlantic depression while northern Scotland and eastern England remain blanketed under snow.

Image credit: NOAA Satellite Active Archive (SAA) at <http://www.saa.noaa.gov/> - Processing: Les Hamilton



# MSG *EUMETCast* Reception



John Tellick

Meteosat-8 became the *0° operational Meteosat satellite* in January 2004. Had things gone to plan, logistics and reception of this satellite would have been quite different. At the end of 2003, Meteosat-7 would have been stationed at 10°W to continue WEFAX and HRI (PDUS) dissemination till the end of 2005 (which it continues to do from 0°) while Meteosat-8 would have been at the 0° location transmitting HRIT and LRIT on 1695.15 MHz and 1691.0 MHz respectively: reception of this satellite would have been very different to the situation we have today.

We would have been using our familiar prime-focus dishes with 'coffee can' feed-horns and the *EUMETSAT* recommended dish sizes of **2.4 m** for HRIT and **1.8 m** for LRIT for reception of MSG satellites! Apart from that, receivers—well the Viterbi and Reed-Solomon signal processing part—would have been complex and very costly. I think it safe to say that, under those constraints, nobody would now be downloading HRIT and very few LRIT.

## How Things Have Changed

Owing to problems with MSG-1's SSPAs (detailed in GEO Quarterly No 1 and on our website), *EUMETCast* was born and a new method of meteorological data distribution has evolved in Europe. Will the rest of the world catch up and adopt this system? *EUMETCast*, using the proven (domestic) satellite TV DVB standard, has proved in a short time to be robust, flexible, very expandable and allows selective encryption.

Currently *EUMETCast* is disseminating HRIT, LRIT (including foreign satellite data), Meteosat-7 data, Meteosat-5 data, ATOVS data, RSS data, 'Met. products' and DWDSAT. Other services will be added in the future including data from MetOp-1, Europe's new polar orbiting meteorological satellite due for launch late 2005. All this can be received (in Europe) on cheap widely available domestic satellite TV hardware. Plus, of course, the *Tellicast* reception software, a USB dongle and display software (see pages 7-9 of GEO Quarterly 1) and a well specified computer.

## A Brief Guide to the Front End

Users of Meteosat-7 WEFAX will be familiar with prime-focus dishes with a 'coffee can' feed-horn and some with offset dishes and active feeds. Both systems (mostly) will use a two channel downconverter to change the 1.69 GHz signals to 137.5 MHz. This gave three advantages: you could use your polar orbiting APT receiver to receive Meteosat, use much cheaper

cable and have longer cable runs between dish and receiver, and did not require an LNA.

The early days of 10/11GHz satellite TV also used prime-focus dishes and I still have both my 1.8 m and 2 m dishes though they are now in retirement, hidden at the end of the garden. Satellite ERPs were quite low in the early days and front ends 'noisy' compared with today's electronics, hence large dishes were required. Higher powered *Astra* satellites changed all that and dish sizes came down; nowadays most people use offset dishes—which get even smaller with increasing satellite ERPs.



The old and the new

On the left, the 1-m Meteosat-7, 1.69 GHz dish with 'coffee can' feed horn and to its right the 85 cm offset dish with LNBs for Eutelsat *EUMETCast* (at 13°E) and *Astra* (at 19.2°E).

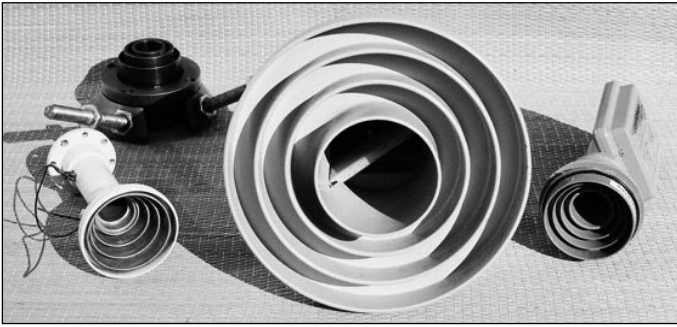
## The Mystery of the Offset Dish?

An offset dish can be thought of as a top segment cut from a prime-focus dish, with its reception device attached. It is taller than it is broad with its reception device situated near the bottom of the dish and adjusted to point up into the dish. This has three advantages; the dish is shallower in profile, less 'angled up' in an elevation sense while the reception device does not sit in the signal path and partially block the signal as in the case of a prime-focus dish.

## The Low Noise Block (LNB) Downconverter

This 'collects' the 10/11/12 GHz signal at the focal point of the dish, amplifies it and downconverts it to a more practical frequency (IF) to send over cheaper cable (compared to what would otherwise be required) to the receiver.

In the early days the Ku 'satellite TV band' was fairly narrow—10.95 to 11.75 GHz if my memory serves me correctly, though not all of it was used. The Low Noise



#### Prime focus dish feed horns

Left, Ku-band scalar feed horn on magnetic 'polarotor'  
 Rear, Ku-band feed assembly from my original 1.8 m dish  
 Right, Ku-band scalar feed horn on early LNB  
 Centre, C-band feed horn [with 'polariser slab'] for comparison

Converters (LNCs) used in those days had a reasonable gain but were noisy and very expensive. My first Ku band LNC in 1985 was an *Avantek LNC* with 1.5 dB noise and cost something like £1,500 alone!

Also, in those days LNCs were single polarity. To change the polarity you required a polarotor which could be either an electro-mechanically adjustable probe or a magnetic polarisation changer called a *Ferotor* or an orthomode transducer – 'wave-guide splitter', feeding two LNCs for vertical and horizontal. Otherwise you had to go to the dish and turn the LNC by hand. LNCs also required a Ku-band scalar feed horn attached to the LNC wave-guide.

The feed-horn is important since it collects the signal and directs it to the LNC/B probe. It must 'see' the whole dish otherwise the signal will be attenuated, but it should not 'see' outside the dish as it will then pick up noise from the sky or reflected signals from nearby walls etc.

Feed horns are specific to the type of dish in use. Modern LNBs designed for offset dish reception don't, I believe, work as well with a prime focus dish as an LNB with a scalar feed-horn designed for prime-focus dish reception. The satellite TV band was later extended with an 'upper Ku-band', a DBS band for *EUTELSAT* and Intelsat satellites and the 'Telecom band' for French satellites.

This included the region of 11.75–12.75 GHz which required yet another LNC with a different frequency local oscillator (10.75 GHz). French Telecom satellites used circular polarisation instead of linear.

When *Astra* began their service, satellite TV went 'domestic DTH' as opposed to having been a feed for the cable-TV providers which enthusiasts had been receiving. That saw the introduction of the voltage switched polarity LNB; two polarities from one, fixed, LNB. In addition, the feed-horn was incorporated into the LNB structure and offset dishes became the norm. The feed-horn is tailored for use with offset dishes regarding the above 'what it sees' requirements.

After a few years satellite capacity was increased owing to the number of broadcasters requiring channels and this led to an 'enhanced' band by extending downwards from 10.95 GHz to 10.70 GHz. A new enhanced receiver or a frequency changer was required to deal with the widened downconverted IF signal. Finally the band was extended to what we use today 10.7 – 12.75 GHz.

This brought problems because you could not convert the whole new wider band with a single local oscillator: you now needed two, as well as means of switching between them, as well as switching the signal polarity. Voltage switching was already in use for changing polarisation and *Astra* decided to use a 22 kHz tone to switch the local oscillators. This works well and does not interfere with the signal in the way that voltage polarisation switching does. The Universal LNB was born and, owing to digital signal transmission (as well as the 'old' analogue), these new LNBs had to exhibit lower phase noise—the noise generated by the local oscillator—than previous LNBs.

So, your modern LNB covers the band from 10.70 to 12.75 GHz, incorporates a feed-horn, has high gain (55 dB is typical), low noise (0.6 dB typical), low phase noise (is digital signal capable), has two tone switched local oscillators— 9.75 GHz without 22 kHz tone and 10.60 GHz with 22 kHz tone and can switch between vertical (~13 V) and horizontal (~18 V) polarised signals—all controlled automatically from your receiver. Also the LOs must have very little drift from being frozen in winter to being baked in summer sunshine. And all this for £15 odd. Compared with my original professional LNC cost of £1,500 I think that is quite remarkable. Add to that an 85 cm offset dish for around £50, a *TechniSat SkyStar* DVB receiver card for around £45 and software at around £100, then, for a **total** of £210 – 230 (plus a reasonable computer, of course) you have yourself a state-of-the-art *EUMETCast* HRIT/LRIT receiver.

Who would have thought it just 18 months ago?

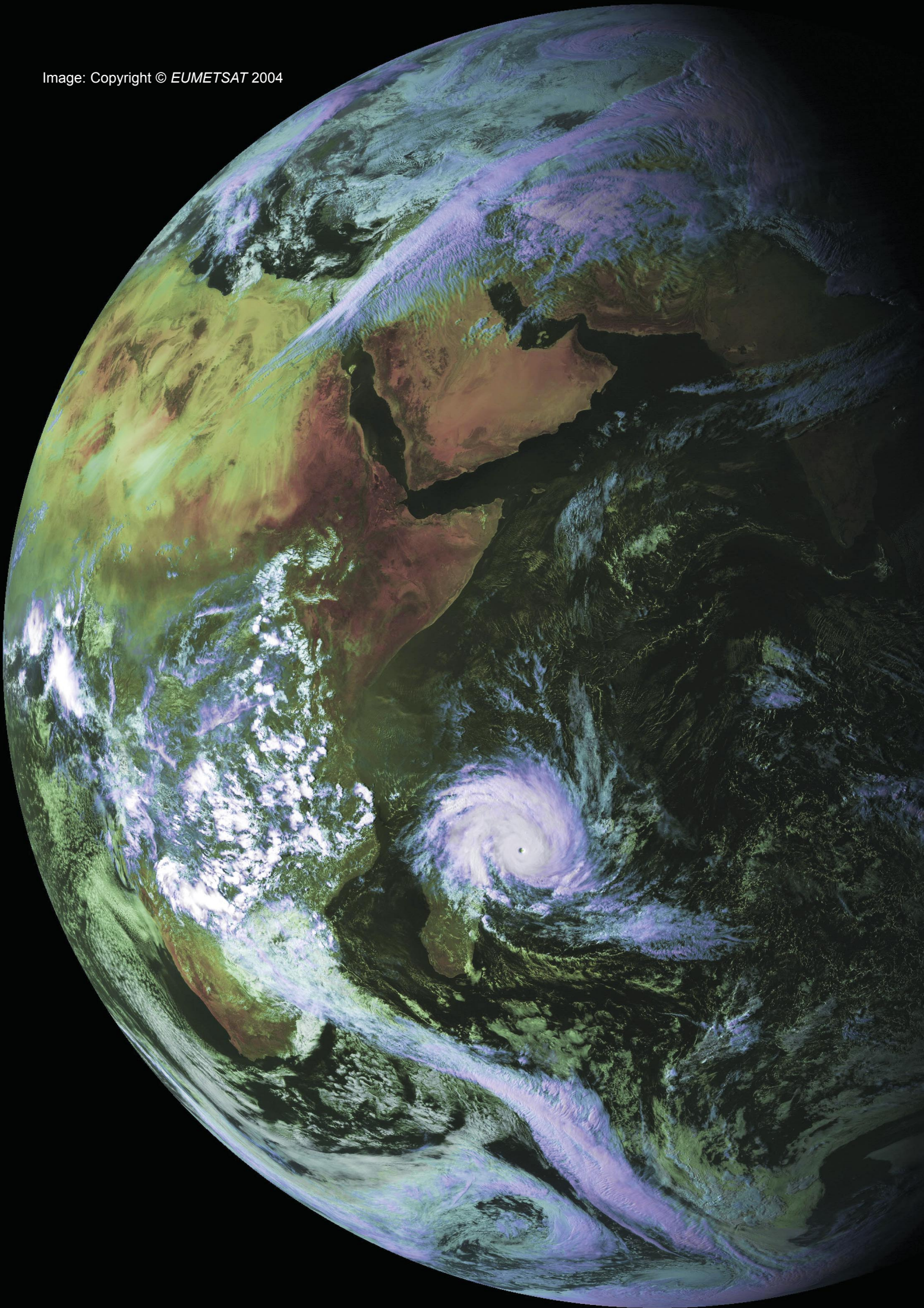


#### Various LNBs

2nd from left, *Avantek* single LO, single polarity 'lower band' (1985). Far left, *Chaparral* Wide-band (10.7 to 12.75 GHz) 2 x LO, single polarity (1994). Note both have WR-75 flanges (slots) for connection to a wave-guide (to the right) for connection to scalar feed horn. 3rd from left (black) an early *Astra Cambridge Juno 2* FSS LNB with voltage switched V/H polarity single LO. The rest are modern day LNB's.



Image: Copyright © EUMETSAT 2004





# Cyclone Gafilo

## Swamps Madagascar

In the early morning of March 7 2004, category-5 tropical cyclone *Gafilo*, hit the northeastern coast of Madagascar. The most devastating Indian Ocean storm for at least 10 years, *Gafilo* ripped across the island republic not once, but twice. According to a UN estimate, this major catastrophe left as many as 700 000 victims in its wake, including 74 fatalities and 177 missing; as many as 100 000 were rendered homeless. Damage to agriculture raised the spectre of widespread food shortages and malnutrition among children.

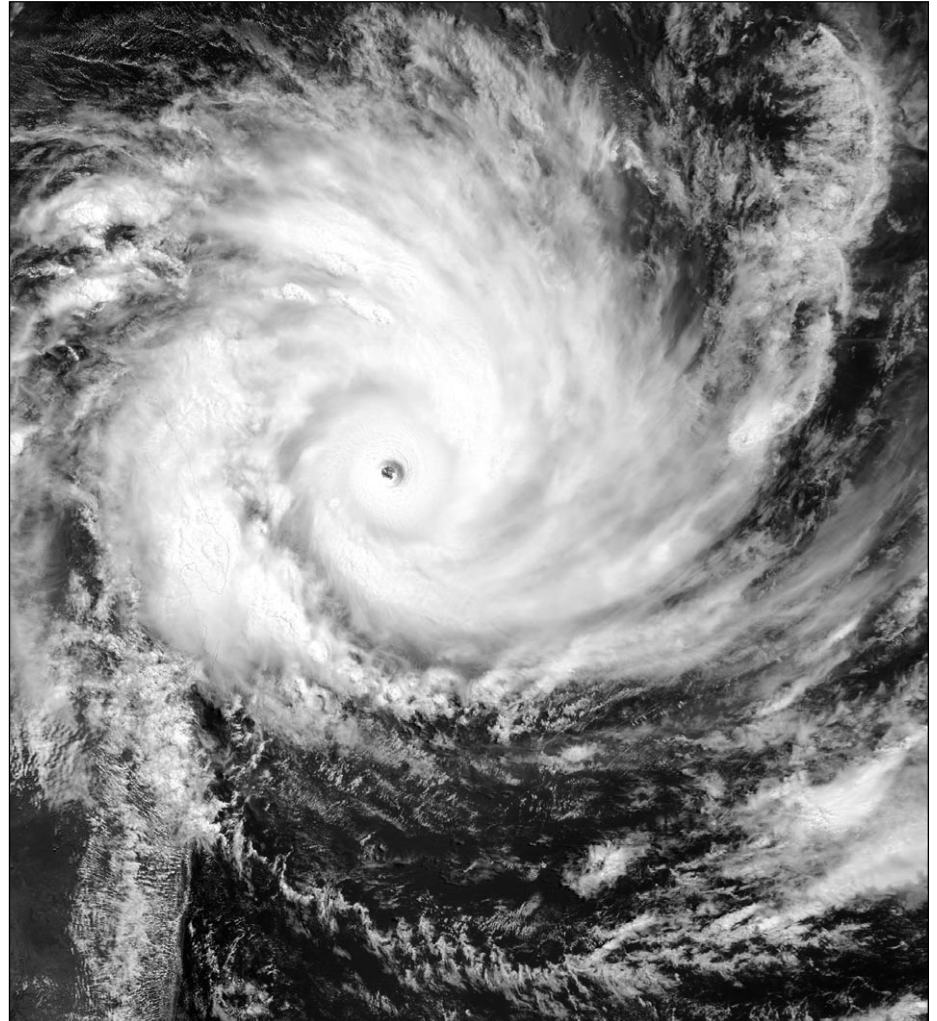
*Gafilo* made landfall near the city of Antalaha in the northeastern part of the island on March 7, crossing northern Madagascar before entering the Mozambique Channel the following day. There, the storm gained strength then backtracked and returned to hit the southwest of the island.

The high-resolution Meteosat-5 image on the facing page, was provided by David Taylor and shows *Gafilo* on March 6, the day before it made landfall near the north-east city of Antalaha.

The image was downloaded via the Meteosat-8 link at 12:30 UT on March 6, 2004 then processed in false colour using Geosatsignal4.

The town of Antalaha was almost entirely destroyed by winds of up to up to 225 kilometres per hour. Several deaths and injuries were recorded as the torrential deluge and high winds destroyed 95% of buildings in the region leaving an estimated 55,000 inhabitants without shelter.

*Gafilo* continued to cut a swathe



a close-up look at *Cyclone Gafilo* from the MODIS instrument aboard NASA's Terra satellite on March 6, 2004. At the time this image was taken, *Gafilo* had sustained winds of approximately 80 mph with gusts to 115 mph.

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

across the northern part of Madagascar as winds exceeding 200 kph—with some gusts reported in excess of 300 kph—devastated the entire region, destroying buildings, uprooting trees and flooding towns before sweeping back out to sea.

Further loss of life was incurred when the ferry *Samson* foundered en route between Anjouan island in

the the Comoros group and Madagascar. All but two of the 115 passengers and crew aboard perished in the mountainous seas.

By the time *Gafilo* made its second pass from the southwest, its winds had abated to 150 kph and caused little further damage or casualties. Finally, on March 11, *Gafilo* was downgraded to a moderate storm as it departed Madagascar.

# View from the Other Side



Arthur Andrews VK2 AAE - [andrews@hwy.com.au](mailto:andrews@hwy.com.au)

Well, by all accounts the first issue of the *GEO Quarterly* was a great success judging by the feedback received by the GEO team. My thanks to the readers who contacted me and said they enjoyed my article; such feedback makes it all worthwhile.

I would be the first one to admit that my knowledge of meteorology is very basic and my interpretation of weather events as seen by the satellites is very amateurish to say the least. A few years ago I wrote an article in another publication, which contained a satellite image I had captured in which I identified, what I thought was a tornado. I was later contacted by a retired meteorologist who thoroughly explained what the phenomenon I had observed actually was. It appears I have erred again, as Brian, an officer in the USAF Weather Agency, disagrees that my interpretation of the image shown in *GEO Q1*, Fig 4, Page 32, is a thunderstorm. He thinks that it is a good example of an area of marine stratus. He no doubt is correct: the only reason I thought it was a thunderstorm was the apparent thunderheads poking up through the cloud. I have a lot to learn and welcome any correction where I have made the wrong interpretation. Thanks Brian.

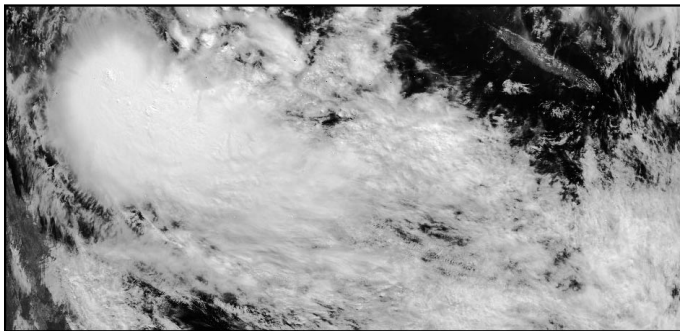


Figure 1 - Tropical Cyclone *Grace* off the Queensland coast

Our Tropical Cyclones have been fairly late this year and as I write *TC Fay* is about to cross the west coast just above Port Hedland. She is rated Category 4, which means she comes under the 'severe' heading, with destructive winds and torrential rainfall. Luckily, if she continues on her present course, she will pass over a sparsely populated area. Unfortunately she is too far west for me to get any HRPT images. *TC Grace* approached the east coast a few days earlier but did not actually make landfall, but bounced back into the Pacific and headed south east. However she caused widespread flooding in northern Queensland and very high seas down as far as the New South Wales eastern seaboard. I wonder if it is coincidence that the female variety of cyclones tend to be more destructive than

their male counterparts. Figure 1 is a NOAA 17, channel-1, image of *TC Grace* as she moved away from the Queensland coast. The island of Noumea can be seen at the top right and at the extreme top right is an interesting weather feature looking something like a Catherine Wheel. However I will not hazard a guess as to what it is.



Figure 2 - Bushfire smoke

It is not often that I can look at an event occurring on the ground and also see it on a satellite image. Where we live, which is near heavily wooded ranges, we are always on the lookout for bushfires, especially at the moment because of the drought. It was with some trepidation that one afternoon we saw very thick cloud of smoke from a bushfire which was only about 25 km away and which covered a few kilometres in area (figure 2). As the smoke was so dense and widespread I wondered if it could be seen from space. NOAA-16 was due to make an almost overhead pass and I hoped it would behave itself, as the previous pass imagery had been useless. Obviously knowing that I required a good pass the satellite behaved impeccably and the imagery was perfect. Sure enough the smoke could clearly be seen. Figure 3 is a much magnified portion of a channel-1 image from NOAA-16. Smoke can be seen billowing from the dark area, which are the heavily wooded ranges. To be absolutely sure that it was not cloud I looked at the channel-3A IR image of the same pass and saw that the hot spot of the fire

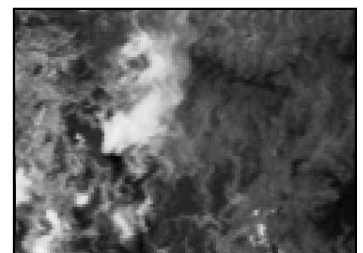


Figure 3 - Smoke plume

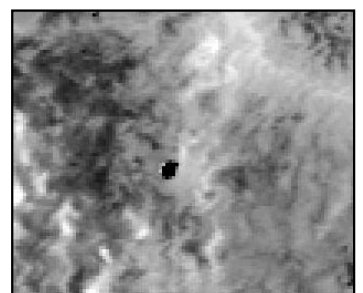


Figure 4 - Hot-spot

showed up clearly (figure 4). This fire was soon brought under control by the local volunteer bushfire brigades and damage was minimal.

Now for a bit of trivia. One morning whilst I was waiting for the NOAA17 morning pass I noticed on David Taylor's *WXtrack* tracking programme that the satellite was on a collision course with the moon and was rather interested to see how the tracking screen would handle it. On arrival at the moon the satellite completely disappeared under it and emerged a few seconds later on the other side. Intrigued, I conducted a couple of experiments and found that the LEOs passed under the geostationary satellites whilst the sun and moon passed over them, as of course they should. I wonder if the ISS passes under the orbiting weather satellites as it is in a much lower orbit. Knowing David's attention to detail, I would bet it does.

A couple of weeks ago I was sent a 1.2 m centre-focus dish for testing and appraisal. The dish, which is of Chinese manufacture, is collapsible and can be used in either a fixed or portable situation. It consists of 6 light metal 'petals', two rounded centre plates and a round metal cradle. It takes one person less than half an hour to assemble or disassemble which makes it ideal for fieldwork. Excellent images were received from the HRPT and CHRPT satellites using this dish. I suppose it would have to be good though, as the Chinese have hundreds of years practice making woks!

I mentioned last issue that I was interested in finding out how hot it got at the dish during summers. Temperatures appear to be between 15 to 20°C higher than the shade temperature on hot cloudless summer days. On our hottest day this summer, with a shade temperature of 42.2°C, Hazel's oven thermometer mounted by the LNA at the dish measured 63°C.

Following heavy rains in Queensland back in January, flood-water has been making its way slowly inland and has started to fill Lake Eyre, the first time for four years. The first explorers and settlers thought that the



Figure 5 - NOAA-16 channel-3 IR showing Lake Eyre

large salt pan lake was always dry but, every now and again, following good rains in Queensland and the Lake Eyre basin, the lake will begin to fill, but not often to full capacity—which is a pretty rare occurrence. The Lake Eyre Basin, which in the main is arid, or semi arid, covers an area of 1.2 million square kilometres, about twice the size of Texas in the USA. The Lake is 9690 square kilometres in area and is 15 metres below sea level. Figure 5 is a NOAA-16 channel-3 image of Lake Eyre received on March 27. The water flowing into the lake is white. A large volume of water can be seen at the top right, partially covered by speckled cloud, and the two rivers feeding the lake can also be seen. The grey areas of the lake are the salt flats, not yet covered by water.

Last Sunday saw the end of our stupid daylight saving and our time zones are back to normal, thank goodness. Autumn has come and at last our temperatures are beginning to fall after a very torrid summer. Although some parts of Australia have had good rains, we are still in drought and received only 13 mm for the whole of March.

*Cheers for now,  
Arthur*

## Earth Imaging News

... continued from page 7

launch of a Brazilian micro-satellite for atmospheric studies by India and the establishment of a ground station in Brazil for receiving remote sensing data from ISRO's RESOURCESAT 1.

In the same week, Antrix Corporation of India's Department of Space signed an agreement with Space Imaging, USA which gives Space Imaging rights to sell data from RESOURCESAT 1, and the forthcoming CARTOSAT 1, worldwide. Space Imaging have been accessing the older Indian satellites IRS 1C and 1D for several years.

India has also agreed to undertake the task of providing satellite imaging and aerial services for creating digital mapping of the

Maldivian Islands and for setting up a Remote Sensing Unit in the Maldives. The National Remote Sensing Agency in Hyderabad will execute the project which will involve the creation of medium-scale maps of the entire archipelago and large-scale maps of selected regions.

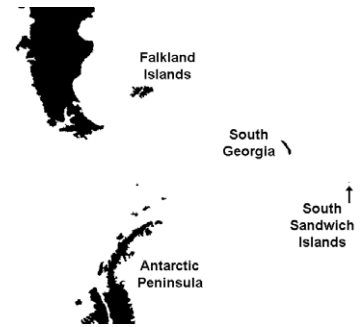
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# South Sandwich Island Cloud Wakes



## NASA Earth Observatory News

<http://earthobservatory.nasa.gov/Newsroom/NewImages/>

In the Southern Atlantic Ocean some 845 km east of South Georgia Island lies an arc of eleven volcanic islands extends roughly 400 km from north to south. These are the South Sandwich Islands, whose volcanic peaks stand on the Earth's *South Sandwich Plate*, which is moving eastward at the stately pace of 7 cm per year.

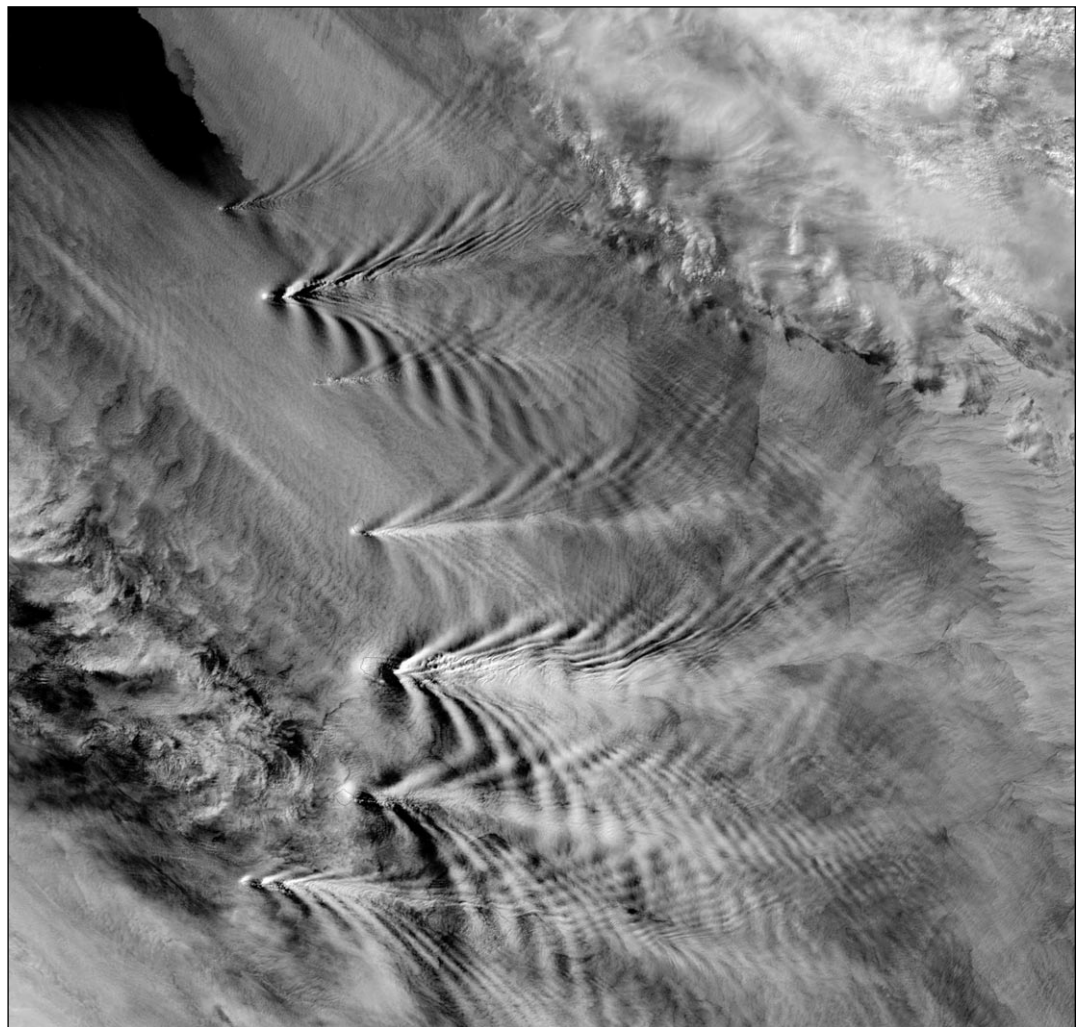
As it encounters the South American Plate, the South Sandwich Plate is forced to pass underneath, hence the formation of the South Sandwich Islands less than 5 million years ago. The islands' peaks range in between 550 metres and 1,100 metres in elevation and stand in about 2,600 metres of water.

As is apparent in this image, the islands are tall enough to disrupt the cloud forming and flowing around them. Most of this scene is dominated by a large formation of low-level stratiform clouds that appears to be flowing in a southeasterly direction (from upper left to lower right).

However, appearances are deceiving, as the wake patterns extending due eastward from each island suggest that the air mass is moving to the east. Alternatively, it is possible that there are two air masses moving in slightly different directions—a lower wind pattern moving due east with a slightly higher wind pattern moving southeast.

*The clouds in the upper right-hand corner of this scene are higher level cirrus and altocumulus. You can see where they are casting shadows on the lower level stratiform cloud deck in several places.*

Notice how the size of the waves, as well as the angle they form coming off the islands, correlates with the height of the islands. For example, the peak on Zavodovski, the northernmost of the islands, stands at 551 m, while that on Visokoi, the island just south of it, is 1,005 m tall. The taller Visokoi peak produces a more



substantial wake pattern. Also notice how the wakes produced by the islands are fanning out and forming interference patterns where they meet one another.

This scene was acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS), flying aboard NASA's *Aqua* satellite, on January 27, 2004.

*Image courtesy Jacques Descloitres,  
MODIS Land Rapid Response Team at NASA GSFC*

# Death of a Planet by Autotrophic Suicide



**Francis Bell**

The issues I wish to discuss relate to carbon dioxide gas in the atmosphere and to global warming. The two issues are intertwined through misunderstanding and misinformation. I offer my perspective on both issues.

I don't think anybody who lives in the UK and has any interest in our planet and its weather/climate pattern can doubt that we are experiencing global warming. Last summer the highest UK temperature ever was recorded. Mild winters and warm moist summers. Actually, I love it. I do not need a statistician or meteorologist to tell me our climate is changing. I just walk out into the garden or look at my heating bill. However, I sincerely doubt the capacity of humans to influence the underlying forces responsible for these changes: the scales are so enormous. But there remains the intellectual challenge of trying to identify and perhaps quantify the causes and the forces involved.

This is where I am about to expose my personal understandings and beliefs for public criticism because I don't believe for an instant that carbon dioxide in our atmosphere, over say, the last several million years, has had the slightest effect on global warming. *Such gas concentration changes that there have been are trivial beyond belief compared with the thermal budget of our planet.*

There is compelling evidence establishing the fact that carbon dioxide has increased in Earth's atmosphere over the last 100 years. Instruments in a monitoring station on Hawaii which have analysed clean air that has blown over the Pacific Ocean for thousands of kilometers shows this trend clearly. Over that same 100 years global warming has occurred. *Wow!* Here comes the beguiling argument: 'The increased carbon dioxide in the atmosphere has caused the global warming'. I assert that such an argument is rubbish and illustrates nothing more than a spurious correlation with no causation whatsoever. And yes, I do know the IR absorption spectrum of carbon dioxide, and yes, it is a greenhouse gas. But this is the establishment argument which has recently prevailed: but it isn't true. The effects of increased carbon dioxide in our atmosphere must be thermally close to zero.

I accept that the above personal view is unconventional but so were the views of Galileo. There is a substantial scientific community promoting the causation between the increase of carbon dioxide in the atmosphere and global warming. There are international and inter-

governmental conferences—Helsinki, Tokyo, Buenos Aires—where these issues are discussed. Most commendable, but it doesn't make the underlying arguments more credible. The press and electronic media must accept a burden of responsibility in promoting this misconception. I think the media are close to hysteria; ill judged and ill researched: their reports are presented for the purpose of sensation and circulation rather than information. There is about as much substance in the average media report about carbon dioxide in the atmosphere as you find in reports of UFOs, the Bermuda Triangle and the Loch Ness Monster. Read the stuff—it's pitiful! In the same paragraph, the average journalist can't struggle through the concepts of oxides of carbon associated with global warming; oxides of sulphur associated with acid rain—yes I believe this one; and free chlorine as the cause of ozone depletion (and yes I believe that as well). I can excuse journalists. They just want copy to their editor and next day move on a totally different subject. Perhaps I can excuse the politicians with their fine qualities of intellectual manoeuvrability and electoral adaptations. It's harder to excuse and tolerate the scientific community who should know better than to promote this tenuous connection.

Okay, so how can I be so confident in my assertion that a trivial change in atmospheric carbon dioxide is not affecting the thermal budget of our planet. There are two points; one is about the carbon dioxide the other concerns global warming. Both are true but there is only a tenuous connection between them.

## ***The Evidence***

Consider carbon dioxide. There is geological and biological evidence which strongly indicates that 200-300 million years ago the atmospheric carbon dioxide level may have been 10 to 100 times greater than today's 0.035%. But the biology on this planet flourished under these conditions.

The evidence comes for carbonaceous deposits such as coal and oil which we all readily recognise but also from deposits of limestone and chalk.

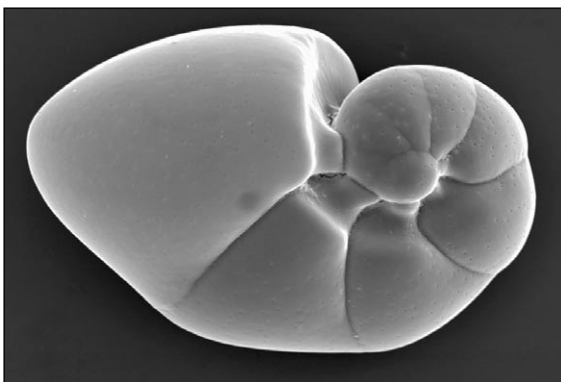
Consider coal. When the coal deposits were laid down approximately 300 million years ago the primary production of plants must have been awesome, locking up huge amounts of carbon from atmospheric carbon dioxide. Nowhere in the world today, except some cold acid bogs, is net fixation of carbon taking place. You may consider some of our major forests. I've been to



them. The canopy of a rain forest is an impressive place to be—beautiful and diverse. There is a high standing biomass but autotrophic production is matched by voracious heterotrophic respiration: certainly with no net carbon fixation. The carbon is too precious. Have a look around the world and see how much biology there is. The answer is very little. Most of the Earth's land masses are either cold or arid; the oceans are marine deserts. Marginal seas are productive and some temperate and tropical land is productive but most of our planet is not. **Biologically our planet is dying through lack of carbon dioxide!**

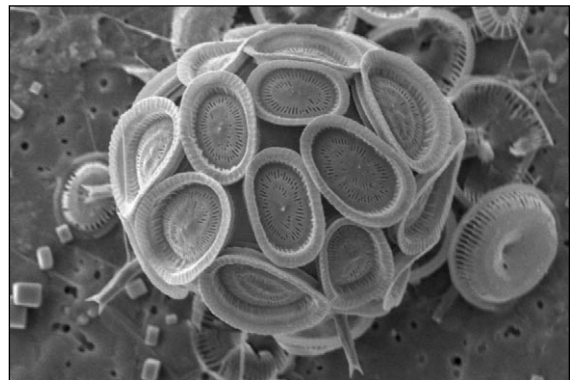
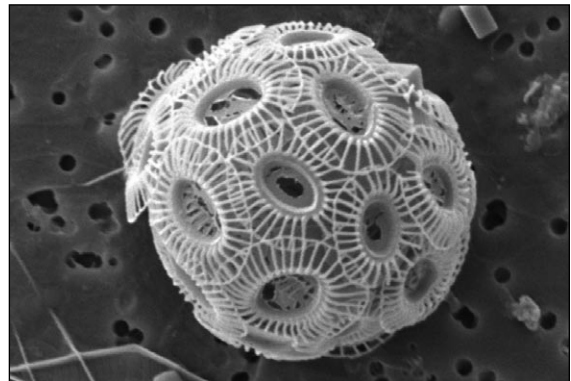
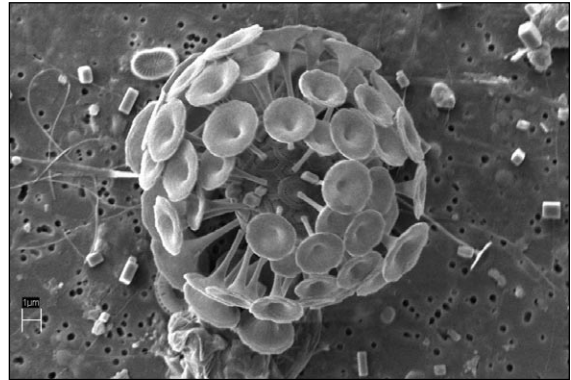
### Where Has all the Carbon Gone?

Where has the carbon that once supported such vigorous life gone? Deposits of coal and oil account for some of this depletion. But also consider the process of locking up carbon in another form via the sea. Microscopic marine organisms, typically *coccoliths* and *foraminifera*, have evolved with a capacity to convert soluble bicarbonate, which results from the dissolving of carbon dioxide in water, into the much less soluble carbonate. This reaction, which is associated with the presence of calcium and of the enzyme carbonic anhydrase, produces the highly insoluble mineral calcite (calcium carbonate). These plants use the resulting crystalline calcite as skeletal material. If there is subsequent deposition of the skeletal material in the remains of these plants the original carbon dioxide is lost to the atmosphere and locked up in marine sediments. Yes, I know these sediments can be subducted and heated with subsequent volcanic outgassing but this process is just too slow to keep pace with deposition. By this mechanism carbon dioxide has been progressively removed from our atmosphere to establish today's very low level. I was going to write the word equilibrium but I'm not sure that our atmospheric carbon dioxide is in equilibrium: it's too dynamic.



*Niridea* - a typical foraminifera species

Quite recently I was walking along the south coast at Saltdean, East Sussex. The chalk cliffs there are very clear. I looked at them and thought if there was ever an apt metaphor it was: 'I'm looking at the tip of the iceberg'. These carbonaceous deposits are common in England and are distributed all over the world in what we would call rocks, or beneath the sea as marine



Three coccolith species  
From top down, *Discosphaera tubifera*,  
*Emiliana huxleyi* and *Syracosphaera pulchra*

sediments. I have had the privilege to swim along the Great Barrier Reef in Australia. No, not all 2500 kilometers of it, but enough to be impressed. The process is the same: dissolved bicarbonate is crystallised with calcium as carbonate material for the coral polyp, hence building a reef over time.

Consider some evidence from animal evolution. The consequences for diminishing atmospheric carbon dioxide have been profound. Deep within my lungs the carbon dioxide level is close to 6%. My body chemistry with its high metabolic rate keeps it this way. This is against a background level of carbon dioxide in the air close to zero. I have to maintain this differential otherwise my body chemistry will slow and I will die. Anybody who knows the story of *Apollo 13* will know the crisis they had when coming back to the Earth. It was not the lack of oxygen which was critical. It was the build-up of carbon dioxide in the air they were breathing that threatened the astronauts' lives. We have to maintain that 6% differential to stay alive.



Chalk cliffs on the south coast of England at Saltdean, East Sussex: 'Is this where the Earth's carbon dioxide has gone?'

Photo: Francis bell

### ***Evolution in Animals***

Consider the evolution of some animal groups about 200 million years ago. The two supreme examples must be birds and mammals. Up to that point animals would have been poikilothermic, that is, maintaining a temperature dependent on their environment: generally we describe them as cold blooded. An increase in metabolic rate offered by decreasing carbon dioxide levels triggered the evolutionary alternative of being homeothermic or warm blooded. With atmospheric carbon dioxide declining there was the opportunity for metabolic rates to increase and for animals to be thermally independent of their environment. The pulmonary to atmosphere differential increased so animals could exploit this. *Archaeopteryx*, a protobird from 165 million years ago, would have descendants running a faster metabolic rate hence the evolution of the birds.

The same would have been true of mammals. An early mammal such as *Morganucodon* about 210 million years ago would have been able to run its body chemistry faster, subsequently evolving into the warm blooded furry creatures we know today. Just remember why was this possible. Atmospheric carbon dioxide was diminishing because it was being locked up in marine sediments. This analysis may also account for the return of the *Teleosts* (bony fishes) to the sea with their subsequent evolutionary success.

### ***Evidence from Plants***

Well, if there is evidence here for the success of three classes of vertebrates, they are on a winning streak. What about plants? They are losing. Less carbon dioxide means less primary production. Today the access to carbon dioxide is a severe limiting factor for most plants.

Consider some tropical monocotyledons. The two best examples are maize and sugar cane. It's no coincidence

that we grow these as crops, GM or not. Try driving across Nebraska, Illinois, Georgia or Kentucky: 'it's devastatingly dull', (not my quote). Look at how much maize is growing. Try driving along the Pacific coast of Queensland and look at the sugar cane fields. Yes, I would rather do this. These plants have evolved in desperation for access to the diminishing atmospheric carbon dioxide. Their photochemistry, cyclic and non-cyclic photo-phosphorylation is conventional but they have evolved a chemical pathway for the subsequent fixation of carbon which avoids the negative feedback of some chemical pathways present in most other plants. The net result is that under conditions where carbon dioxide is limiting, they do better than other plants. And we grow them as crops!

Calculations suggest that human activity annually vents about six billion tonnes of carbon dioxide into our atmosphere. Yet measurements indicate the sustained increase of atmospheric carbon dioxide is only about half this figure. Where has the missing three billion tonnes gone? Research, if you believe it, indicates the Amazon rain forests are mopping it up. I might suggest a marine sink. However, plants desperate for carbon dioxide, growing in otherwise favourable conditions, avidly mop up the extra available carbon dioxide. **Wow!** You don't have to be a member of *Mensa* to work that out; it just reinforces most of my text above. **This planet is desperate for extra carbon dioxide!**

I have tried to argue the case that carbon dioxide in the past has been very much higher than today's level and that life on the planet today is dangerously low because carbon dioxide has been geologically sequestered. What about the global warming?

### ***Global Warming***

Let us accept that we are experiencing global warming. What are causes? I will not be able to answer this question but I can address the issues.



The Earth has experienced cyclic periods of ice ages and inter ice age warming most certainly not affected by humans and any small influence humans may have had on the atmosphere. My analogy here for a geological heat wave is a wave in water. Suppose a small stone were dropped into a garden pond. Small waves would be produced and the height of these waves could be measured. The height of the wave is the equivalent of a thermal displacement. Now go out into the middle of the English Channel on a very calm day and drop the same size stone into the water. Can the ripples it produces be observed and measured? The answer must be yes. But what might be harder to detect in a small boat would be the gentle Atlantic swell almost imperceptibly raising and lowering the boat with a period of about 30 seconds and, more importantly, the tidal levels would be changing the height of the boat with a periodicity of hours. At least 20 celestial factors affect tides plus many terrestrial factors. But we myopically look at the ripples from the stone and debate them.

There are other candidates for the causation of global warming besides carbon dioxide. Our Earth's internal dynamics: convection and magnetic field changes. The same applies to our sun. I know these are being studied and I expect the major factors affecting the thermal budget of the Earth will be identified, but for the time being don't anybody tell me the major causation of global warming is the minute change in atmospheric carbon dioxide. I don't believe it.

I am not, repeat, not tolerant of indiscriminate venting

of exhaust gases and particulate materials into our atmosphere and the same applies to aqueous discharges into our seas. I must opt for the weak anthropic argument. 'This is my planet; I was born here; I am well suited to the planet as it is; I have nowhere else to live so leave the planet alone'. I have to stop short of suggesting that it would be biologically more interesting and dynamic to live here if the carbon dioxide in our atmosphere was, say, ten times its present level!

Any reader who wishes to take issue with any of the above views is invited to put pen to paper and make a submission to the editor.

With a suitable acknowledgment the above text is copyright free.

### ***A Postscript or Short Digression.***

News about the planet Mars is quite rightly topical. People interested the dynamics of the Earth are naturally interested in our neighbourhood planet. The life—the atmospheric and hydraulic history there—may be the Earth's future. Yes, there is still life on Mars. The evidence is overwhelming. I offer an award of a *Getmapping* aerial photography CD-ROM showing Greater London to the first person who writes to me (at the address listed on page 1) giving the transcription amino acid for DNA sequence CGA on Mars. A one word answer is all that is needed. A clue is that the question could have been put in four ways and the answer is the simplest in the series. I am confident that I know the answer: even for Mars.

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## ***Measuring Evaporation.***

***Cedric Roberts M.B.E.***

Though all of us are well aware of rainfall and the effects that can arise if we get either too much or too little, many people have no real conception of evaporation. Yet this is vital to water supplies, for evaporation is basically the opposite to rainfall. We are constantly losing water by evaporation that is going on from all water surfaces, from the land itself and from vegetation.

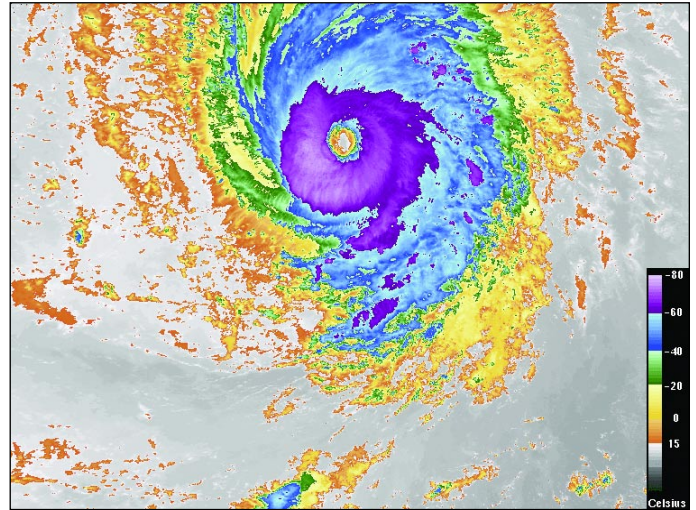
Attempts have been made for many years to measure evaporation and devices now exist for doing just this from water surfaces, from the surface of the soil and from leaves. The method in use at meteorological stations is the measurement of evaporation from water surfaces, and is generally used to give an idea of how much water is being lost as opposed to the amount being accrued from rainfall. Three types of instrument are in general use for

measuring evaporation from free water, the evaporation tank, the Piche evaporimeter and the Lysimeter.

It would take far too long to describe each instrument in use, so I shall devote my time to the main device in use here, the Piche evaporimeter. This consists of a graduated glass tube marked in millimetres that has, clamped across its base, a small circular porous paper disc of standard size: the instrument itself is housed in the Stevenson thermometer screen. The disc is at the bottom when the tube is inverted and so, as water is evaporated from the wetted paper surface, the water level in the tube falls thus enabling a measurement of evaporation to be made. Having the paper disc at the base ensures that it is always kept wet as long as any water remains in the tube and this must be regularly 'topped up'. The instrument is simple to use and is

relatively inexpensive, merely requiring that it is removed from the Stevenson screen if any severe frost is expected.

Readers who require further knowledge on the Lysimeter and the evaporation tank can find references to these in any good Meteorological glossary. I have referred here only to the Piche evaporimeter. You will have gathered from the text that the instrument is graduated in millimetres and so evaporation is measured in this unit also, a valuable asset since rainfall is also measured in millimetres. If we keep a careful check on rainfall in mm over a period, and evaporation in mm for the same period, we have a quick and easy idea of whether, over that period, water is being gained by rainfall or lost at a greater rate by evaporation from a free water surface.



Raul Fritz B Teixeira from Ceará State Department of Meteorology at Funceme in northeast Brazil ([www.funceme.br](http://www.funceme.br)) sent in some examples of the satellite images captured at his station using a *TeraScan* System. Reproduced above are two NOAA-16 AVHRR images of Hurricane Isabel made at 16:15 UT on September 8, 2003. The left-hand image is the ch-1 (visible) image; to its right is the ch-4 IR image, enhanced using a customised colour palette created with *TeraScan*. The coldest temperatures are in purple and correspond to the cirrus shield's overcast region and also anvils and ice at the top of cumulonimbus.



True to its name, Iceland is seen covered in a white blanket of ice and snow in this January 28, 2004 true-color image acquired by the MODIS instrument aboard NASA's Aqua satellite. The uniform color hides the exact boundaries of Iceland's four permanent ice caps—Langjokull and Hofsjokull in the interior west, Myrdalsjokull on the southern coast, and Vatnajokull, the largest of the four, which rests on top of three active volcanoes.

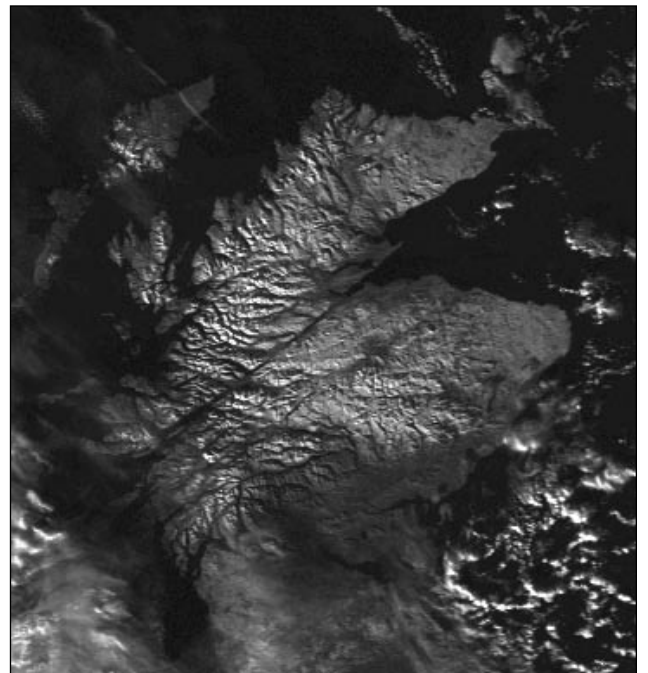
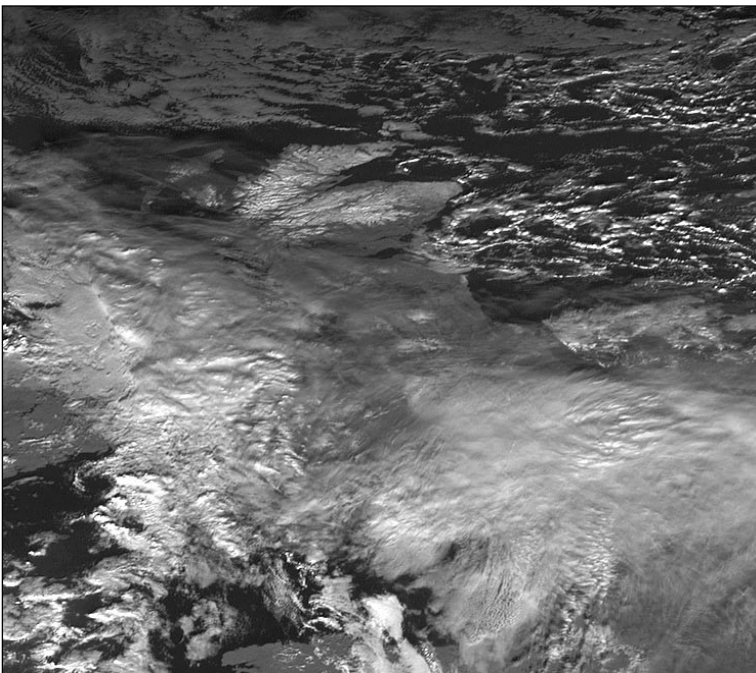
The heat from these volcanoes causes the underside of the ice cap to melt, slowly building up meltwater in the volcano's caldera. When the meltwater spills over the lip of the caldera, it releases a torrent of water known as a glacial melt flood.

*Image courtesy Jeff Schmaltz  
MODIS Land Rapid Response Team at NASA GSFC*





Cedric Roberts sent us this Meteosat-8 image he downloaded on Monday, March 22 this year. It is the 15:00 UT transmission and illustrates shower activity over the UK under a NW wind. Many of these showers are wintry with snow, hail and squally conditions.



The days leading up to New Year 2003 brought contrasting extremes of weather to Scotland. On the night of December 27-28, a polar low struck, gale-force winds and drifting snow causing severe disruption to the north of the country. There followed a day and a half of the most beautiful calm sunny weather, and the images above illustrate beautifully the extent of the snow cover. The left-hand image was submitted by Ian Deans and came from the MSG-1 HRV transmission at 15:00 on December 30. The right-hand image comes from the 13:37 UT NOAA-16 channel-1 HRPT pass the same day. But these images already presage the turmoil that was shortly to follow—the thick band of cloud already seen spreading north over England was the fore-runner of the worst New Year storm to hit Scotland in living memory. Throughout that afternoon and early evening winds whipped up to gale force, driving heavy rain before them. In both Edinburgh and Aberdeen the traditional open-air New Year festivities were cancelled with some hundred thousand revellers being sent home in Edinburgh and another 50 000 missing out in Aberdeen.

*MSG image © EUMETSAT 2003*

# A Radio Horizon Table

**Bill Johnston, K5ZI**

Those of us who utilise signals from orbiting satellites have a paramount interest in knowing when a satellite's signals are available at a given ground location. This is just another way of saying that we need to know when a satellite is above the local horizon, since for all practical purposes the commonly used VHF and microwave radio signals travel to and from satellites along a line-of-sight path.

All satellite orbital prediction computer programs provide this critical information. The time at which a satellite appears above the horizon for a particular pass is known as 'rise time' or 'acquisition of signal' (AOS). Similarly, the time when a satellite sets is the 'set time' or 'loss of signal' (LOS). Commonly available programs for personal computers correctly predict AOS and LOS with an accuracy of a fraction of a second.

What one must keep in mind, however, is that such programs compute AOS and LOS based on the 'theoretical horizon,' i.e., the horizon which would exist if the Earth were perfectly smooth, with no hills, trees, buildings, or other obstructions to get in the way of your antenna's view of the sky. The elevation angle of the theoretical horizon is 0 degrees at all points of azimuth. On the other hand, a nearby building might well protrude, say, 20 degrees of elevation above the zero-degree theoretical horizon, thereby blocking satellite signals up to that elevation angle for the width of the building (which itself might cover many degrees of azimuth).

The signal from a satellite rising behind a building will therefore become available at a later time and at a higher elevation angle than your computer program predicts. By taking into account all obstructions as seen throughout a complete circle around your antenna site, you can characterise what is termed the 'true local horizon,' or, for our purposes, the 'radio horizon.' Having a local radio horizon table consisting of the elevation angle of the true horizon at each point of azimuth can be quite useful in understanding why satellite signals are sometimes not available when the computer program says they should be. Additionally, such a table can sometimes go a long way toward identifying sources of interference and objects which degrade satellite signals without completely blocking them. Some orbital prediction programs will even allow you to enter your horizon table data into the program, thereby optimizing tracking by your antenna.

There are several methods which can be used to compile your local radio horizon table. One simple and

relatively fast technique is to use a surveyor's transit. The instrument is first positioned on a stable tripod and properly levelled. Then the transit is rotated in azimuth by 1-degree increments (for a coarser table you might use 5-degree increments). The transit's cross-hairs are placed on the true horizon at each of these points and a note made of both the azimuth and elevation angles. The complete circle, then, will produce a table of 360 data pairs with suitably fine resolution for almost any analysis you might want to conduct.

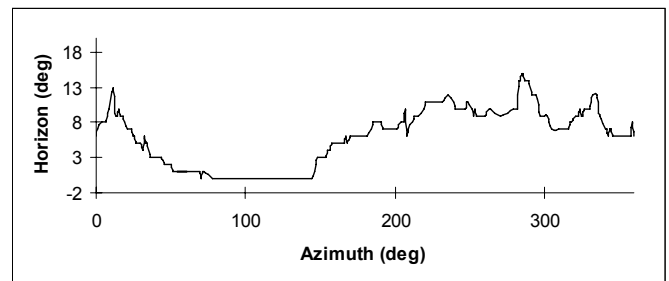


Figure 1 - Horizon-table graph (Excel)

Not everyone will have access to a transit, of course, and there are other methods which will produce equivalent results. In my own case (although I do own a transit) I chose to use my HRPT weather satellite image receiving system to electronically compile a horizon table for my own station location in southern New Mexico. The method is exceedingly simple, albeit, not for the impatient.

For a period of time I kept a sheet of paper next to the HRPT antenna rotator controllers. In several columns, lines numbered from 1 to 360 (indicating azimuth points) provided spaces where the corresponding observed radio horizon elevations could be pencilled in. Each time I captured a satellite image, I simply made a note of the azimuth and elevation angles at which AOS and LOS occurred and jotted down the elevations at the appropriate entries on the paper. I chose to define AOS as the point at which the decoder locked on to the signal, and LOS as the point at which the decoder lost lock. This eliminated the ambiguity of the short period between detection of a measurable signal by the receiver, and the point at which the signal is strong enough for the decoder to make sense of it.

An advantage of collecting data through actual observation of satellite signals is that the horizon figures arrived at are automatically 'adjusted' for such factors as refraction and reflection, neither of which could be easily accounted for through visual sightings with a transit. Moreover, the measurements are





Figure 2 - The peak on the horizon at azimuth 333°

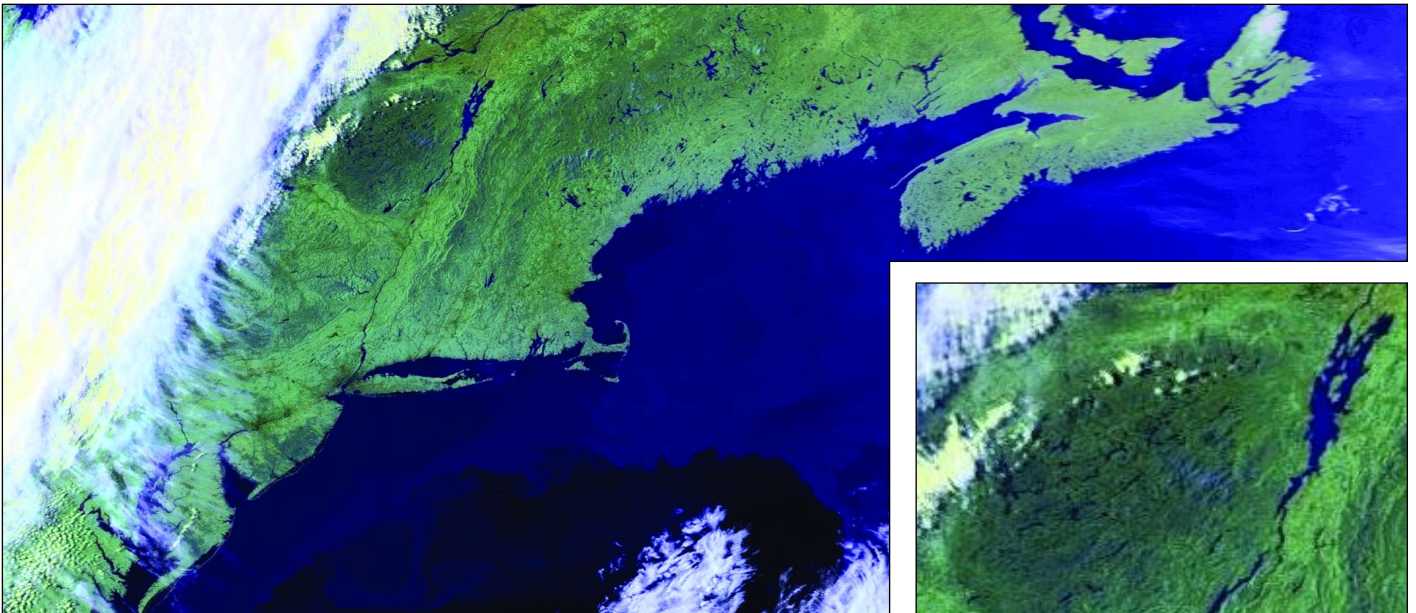


Figure 4 - This NOAA-12 pass from May 2001 gave a maximum elevation of only 0.9°, yet imaged areas almost 3000 miles from the receiving station.



Figure 3 - The mountains to the south at 204° azimuth



Figure 5 - An enlarged detail from the same NOAA 12 pass as Figure 4, showing Long Island, the Hudson River Valley, and Lake Champlain.



specific to the radio frequencies at which the observations are taken. In my case, all data were recorded at the HRPT frequencies centred around 1.7 GHz. One's own radio horizon table, of course, should be compiled through measurements at whatever frequency is of greatest interest.

Once I had accumulated sufficient data for my horizon, the results were plotted as a graph as shown in figure 1. While this can be done with pencil and graph paper, there are many computer programs which will not only display the data in graphical form, but will permit you to manipulate it for further analysis with a click of the mouse. One piece of software which will do the job, and which I use extensively, is *Microsoft Excel*. However, since I wasn't versed in *Excel's* graphing capability, I enlisted the aid of my friend Jon Haas, KD5OHH, who set up the spreadsheet and its accompanying graph in a matter of minutes. It isn't necessary to collect data for every point on the horizon, as *Excel* will interpolate missing points on the graph, just as you will do manually if working with pencil and paper. You'll find that the horizon table has much more utility if you collect and record data (either visually or electronically) for at least 200 or more azimuth points, particularly if you have a very irregular horizon.

As the graph reveals in figure 1, my station, at 5,200 feet (1,585 m) above sea level, is surrounded by mountains on three sides but has an open horizon to the east and southeast. The highest nearby peak, about four and a half miles to the south-southwest, is a little over 9,000 feet (2,750 m), and as such presents a radio horizon at that point of about 9° elevation. Other peaks, which are no more than 7,000 feet (2,130 m) altitude, are much closer and consequently result in radio horizons at great as 12°.

The highest point on my radio horizon happens also to be my one and only man-made obstruction—an 11-foot diameter parabolic dish antenna intended for another project—which I mounted too close to my HRPT antenna (itself an 8-foot diameter dish). The 11-foot dish obstructs the sky to an elevation of about 15°, from roughly 278° to 295° azimuth. It's not quite as bad as it sounds though, as the hills behind the obstructing dish mask the sky to an elevation of 9° already, so my poor planning actually cost me only an additional 6° of elevation through the width of the large dish.

In addition to the graph already referred to, I've included some photographs taken from my HRPT antenna location. Near the centre of figure 2 is a peak about a mile away whose azimuth is 333°. The outline of the peak is clearly seen on the graph (the vertical scale of which has been intentionally exaggerated for clarity). At the left side of the same photo is seen the edge of the 11-foot dish, which in turn shows up as the large 'peak' on the graph, between about 280 and 295 degrees azimuth. Figure 3 shows the view to the south. Near the centre, at 204° azimuth, can be seen a pair of

adjacent peaks known locally as the *Rabbit Ears*. These show up at the corresponding point on the graph as a sharp spike which drops off into a mountain pass just to the right.

Obstructions which mask the sky below 16° elevation may seem unimportant to some readers, as many observers consider satellite passes below 20° elevation to be unusable anyway. But the fact of the matter is that for a well constructed system whose components are in accurate adjustment, this is a prime reception area which can extend your imaging by hundreds of miles. Indeed, I do most of my own imaging with satellite passes whose maximum elevation does not exceed 15 degrees. To the east and southeast where there are no mountains, I regularly record images from satellites which skim barely 2° above the horizon. Occasionally, with the aid of refraction and tropospheric ducting, I capture images from passes which don't rise above the horizon at all. On these short passes the satellites actually skulk a degree or two below the horizon, while the antenna sweeps the horizon at 0° elevation.

The accompanying HRPT image, showing part of the Maritime Provinces of Canada and the northeastern United States (figure 4), was captured from a NOAA-12 pass whose maximum elevation above the theoretical horizon did not exceed 0.9° at my location. The pass lasted only four minutes, but after processing in *WinHRPT*, it produced an image with exquisite detail of areas nearly 3,000 miles (4,800 km) from my location. This was an ascending pass whose azimuth began at 39° and ended at 69°. Examination of my horizon table shows that the true horizon ranges from 1° elevation, upwards to 3°, within that arc. In other words, the satellite was never above the true local horizon at any time during the pass!

With a carefully adjusted system, it is not unusual to capture below-the-horizon images such as this one. However, images from the vast majority of HRPT passes conform precisely to the true physical horizon which I've recorded in my radio horizon table. I never cease to be fascinated to see the receiver's signal strength meter swing from zero to full scale within a couple of seconds of the time the satellite reaches the elevation angle shown in the table for the corresponding azimuth.

The horizon table, then, serves as a planning tool for image reception. For passes in the west and northwest, for example, I know not to waste my time if the predicted maximum elevation is less than 8° or so. If the pass will rise to 10° or higher, I'm certain to receive an excellent image for at least part of the pass, showing weather systems far out into the Pacific Ocean. The zone between 8° and 10° maximum elevation is adventure-land, where I'm occasionally rewarded with glimpses of territory as far away as Alaska.

To the east and southeast, where the true horizon and the theoretical horizon are the same, I generally see the signal pop on or off at exactly the moment the computer program says the elevation angle has reached 0°. But this is also a prime area to benefit from atmospheric refraction, which often enables one to receive usable signals down to -0.5°, and occasionally as far as 2° or more below the horizon.

When you consider that building a radio horizon table through direct observation of satellite signals requires watching AOS and LOS over hundreds of passes (and many passes will duplicate what you've already

recorded), it becomes apparent that it takes quite a while to form a reasonably complete picture of your local radio horizon. Nonetheless, I personally found the task very enjoyable and instructive. It's not something you have to do every time you receive an image. Instead, if you do it when you have the time and you feel like it, you'll get a great deal of satisfaction each time you fill in another blank spot in your table. And the greatest enjoyment comes when you have enough data to begin matching it to the physical horizon, and understanding why satellite signals sometimes appear and disappear in seemingly peculiar ways.

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## ***Copy Deadline for GEO Q3 - Wednesday, June 30, 2004***

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The support GEO has so far received from its readers has been magnificent; indeed, so many articles and images were received for this issue that GEO Q3 is already well under way.

The Editor is always on the lookout for articles and images relating to all aspects of Earth Imaging, especially:

- Technical articles concerning relevant hardware
- Construction projects
- Weather satellite images
- Reports on weather phenomena
- Description of readers' satellite imaging stations
- Activities from overseas
- 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 (floppy disc, CD or e-mail attachment). But we will also accept handwritten or typed copy.

### ***Images and Diagrams***

Images can be accepted in any of the major bitmap formats, e.g, JPG, BMP, GIF, TIFF etc. Images in both monochrome and colour are welcomed for inclusion. Line drawings and diagrams are also welcome in Windows metafile and postscript formats.

Please note that images and drawings must not be embedded within the text of your article, but should be submitted as

individual files. ***Submission of Copy***

All materials for publication should be sent to the Editor, Les Hamilton, 8 Deeside Place, Aberdeen, AB15 7PW, Scotland.

Materials may also be sent as attachments to the following e-mail address:

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

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## ***Weather Satellites and their Frequencies***

Polar Orbiting Satellites	Frequencies	
	APT (MHz)	HRPT (MHz)
NOAA-12	137.50	1698.0
NOAA-14	-	1707.0
NOAA-15	137.50	1702.5
NOAA-16	-	1698.0
NOAA-17	137.62	1707.0
Feng Yun 1C, 1D	-	1700.4

Geostationary Satellites	Location	Frequencies
		WEFAX (MHz)
GOES-E	USA 75°W	1691.0
GOES-W	USA 135°W	1691.0
Meteosat-5	INDOEX 63°E	1691.0
Meteosat-6	Europe 10°E	1691.0
Meteosat-7	Europe 0°	1691.0, 1694.5
Meteosat-8	Europe 0°	DVB

## ***Where to Download NASA 2-line Elements***

Satellite tracking programs require regular updates of the NASA 2-line element sets that they use to calculate the positions of Earth-orbiting satellites. One of the best Internet sources for these files is Celestrak at:

***<http://www.celestrak.com>***

Elements for many groups of satellites are updated daily. Particularly useful are:

***<http://celestrak.com/NORAD/elements/weather.txt>*** (most weather sats)

***<http://celestrak.com/NORAD/elements/resource.txt>*** (Okean and Sich)

***<http://www.celestrak.com/NORAD/elements/stations.txt>*** (ISS)

# WXtoImg - Receive APT on both Windows and Linux

John Coppens ON6JC/LW3HAZ [4] - john@jcoppens.com

*WXtoImg* is one of those strange programs that may at first frighten the casual user but offers an impressive performance for its price (free for the limited version). It does most of what has to be done in automated APT reception and processing, and does it very well indeed. Some say I'm somewhat biased (or worse) towards Linux, but I feel that somehow this operating system reflects part of the radio amateur spirit. Do continue reading - there's a Windows version for the others too!

I freely admit that software offerings for Linux are somewhat limited, not entirely unlike the recent problems we have faced in electronic component procurement. But generally, programs that are available are of excellent quality, offer many options, and are very reliable (and free, with source code!). A case in point is the *WXtoImg* [2] program, which is available on the Internet, both for Windows and Linux (there's also a MacOS version but it isn't updated as frequently).

*WXtoImg* comes in two forms; the 'standard' version which is free, and which is the one I'm describing below, and the 'professional' version, for which a low registration fee is required. The latter adds several projections, some processing options, and can even automatically create and update web-pages with your images.

## Installing WXtoImg

Installing *WXtoImg* in Linux is easy—there's just one executable file. Copy *xwxt* to */usr/local/bin* where the operating system will find it, and you're set. (If you use Windows, then just double-click the *wxinstnnnn.exe* file and installation is automatic, complete with a desktop short-cut icon.)

There's a command line version for Linux, which permits execution of all reception and processing from batch files (in fact, it consists of a suite of 5 command-line programs: *wxtoimg*, *wxrec*, *wxmap*, *wxproj*, and *wxbatch*, each of which does the task which its name implies).

The most recent few versions display a nag screen which waits for 10 seconds before enabling the rest of the program. (Personally, I do not approve of this method of trying to get the user to register. Still, you will normally never stop the program, so it's not too bad either). A stumbling block with Linux programs is the sometimes more austere user interface. Some of this is noticeable in *WXtoImg*.

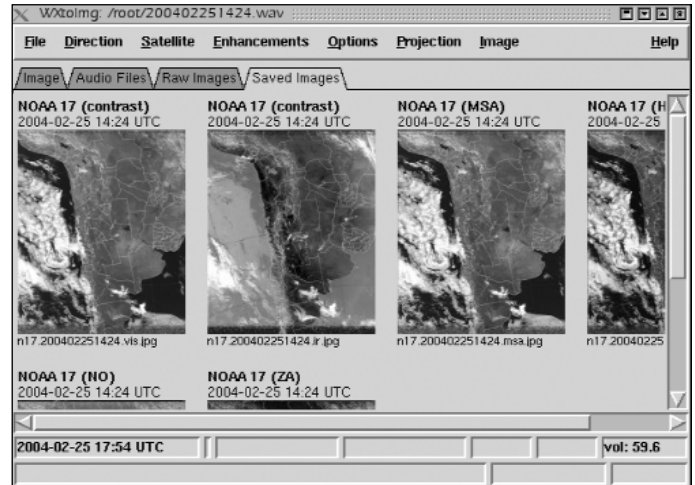


Figure 1 - Thumbnail page of recently decoded images

You can select from several options to start processing:

- Select an existing audio file
- Select what's called a 'raw image'
- Select 'Record'

Standby (waiting for a 2400 Hz carrier) and reception take no noticeable CPU resources and I leave them running all the time. Once an image has been received, it takes the PC just a few seconds to do the processing and to generate the final image. A new feature in the most recent versions of *WXtoImg* is that they actually show the raw satellite image during reception.

Figure 6 (page 37) shows the program after processing an audio file (or receiving a satellite pass). Note the tabs above the image—this is another relatively new feature and permits you to browse through thumbnails of your images (fig. 1), for example, or to check which audio files are still available:

## Available features

Let's have a quick look at the main menus, and discuss some of the possibilities.



Figure 2



**File Menu**

In the File menu (fig.2) there are many options, but the most frequently used probably be *Open Audio File...*, *Save Image as...* and *Record....* In most cases this will be very straightforward. Under Linux, I prefer to use the standard *GTK gmixer* application, which I am more comfortable with (I don't like the aesthetics of *WXtoImg's* built-in mixer).

The use of most options is simple, as most of the parameters (JPEG quality, recording settings etc.) need only be programmed once into the Options menu item.

**The Direction Menu**

The Direction item (fig.3) allows you to select a satellite direction manually or to leave *WXtoImg* to do this automatically for you.

**The Satellites Menu**

The Satellite menu (fig.4) permits selecting the satellite manually. This is useful if, for some reason, the program gets confused by very weak signals or strange schedules, or older passes for which *WXtoImg* doesn't have orbital data stored.

**The Enhancements Menu**

Interesting though, are the enhancements you can select. I haven't seen another program that permits so many excellent—and different—algorithms for processing the received imagery. For example, the 'ZA' infrared enhancement is excellent where intense storms develop, as the normal IR image tends to saturate in the white clouds. The ZA remaps the intensities and nicely shows the storms centres. Also useful is the 'NO' enhancement, which colours clouds starting at -25°C or so, down to -90°C. We had some very severe storms here in Argentina a couple of months ago, and they were very nicely rendered using this mode (I even warned the local Civil Defence authorities).

All the time, temperature at the cursor position is available on the screen (except for a bug, that stops the display of temperature after saving a file—I've notified the problem to the author). The value corresponds quite well with reality.

**The Options Menu**

The Options menu (fig.8) is the most complicated—I had never really considered that the actual reception of images depended on so many factors!

Several items that are normally only used when post-processing images, such as despeckling, and sharpening are available. The **despeckling** algorithm works fine on removing shot-noise. I was originally very sceptical about despeckling, after having tried several algorithms on other programs, but I must admit that the one implemented in *WXtoImg* works very well!

Be careful when setting the level though. While the default value of 2.0 works fine, I personally prefer to use 2.5. A value of 3.0 despeckles less while a setting of 1.0 is basically useless—it modifies cloud detail strongly and does not really improve the image (you can check the effects of different despeckle settings in fig.9)

**Interpolate** makes a brave try to interpolate the video (or the audio) and double the resolution. This succeeds in some images but in others the image just becomes larger without any noticeable improvement. The **Noise Filter** works, but, as expected also removes some of the details of the image, which is really unavoidable, I guess...

The **Illumination Compensation** again makes a brave attempt to compensate for predictable variations of light conditions in the images. Though some images do improve, in extreme cases the image gets too noisy because of the increased gain being applied.

**Active APT Satellites** lets you select, as the name implies, the satellites for which Kepler elements have to be fetched from the Web, and which have to be monitored. (*WXtoImg* downloads the data from the *Celestrak* [1] website.

On the same menu, you can also program the satellite's frequency (to control a receiver, for example), and to assign a priority in case two satellites have overlapping passes.

**Ground Station Data** is, as you would expect, where you input your station information (name, latitude and longitude), though the registered version has the possibility of synchronising with the NMEA data stream from a GPS receiver (I use the Internet to sync the PC's clock and a program called *Chrony* [3] which connects to NTP servers, measures the PC's crystal frequency error and, using saved statistics, is able to correct the clock should the

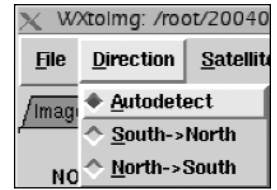


Figure 3



Figure 4



Figure 5  
Projection menu

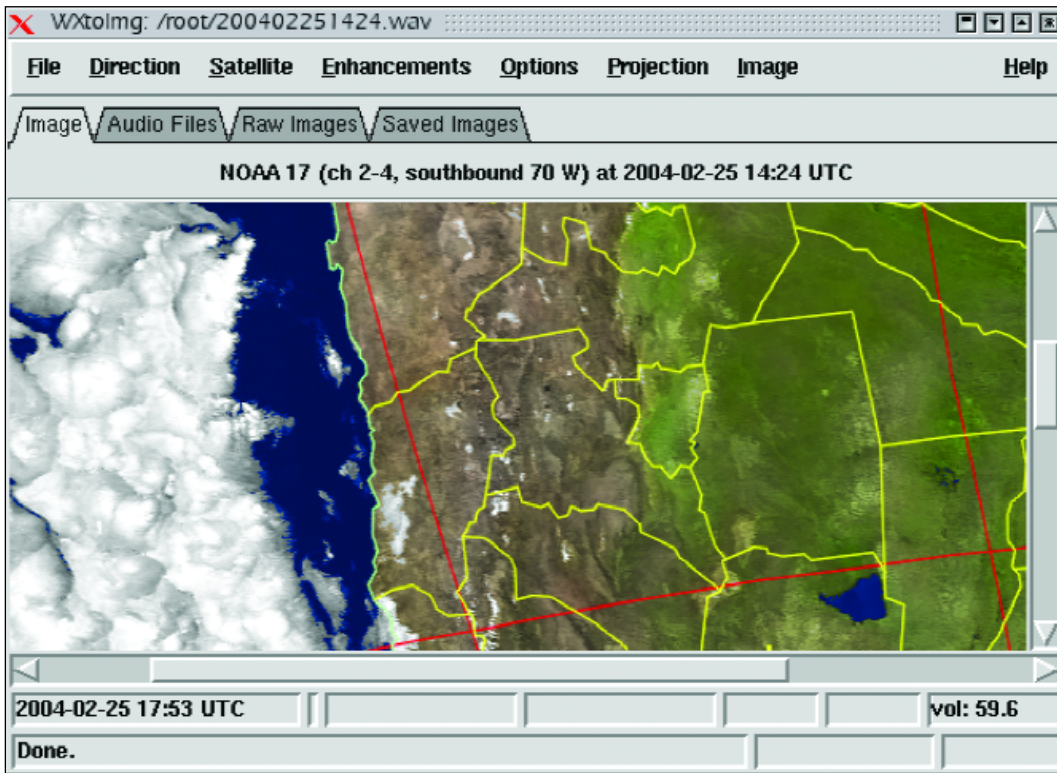


Figure 6: WXtoImg: a screenshot with the program running

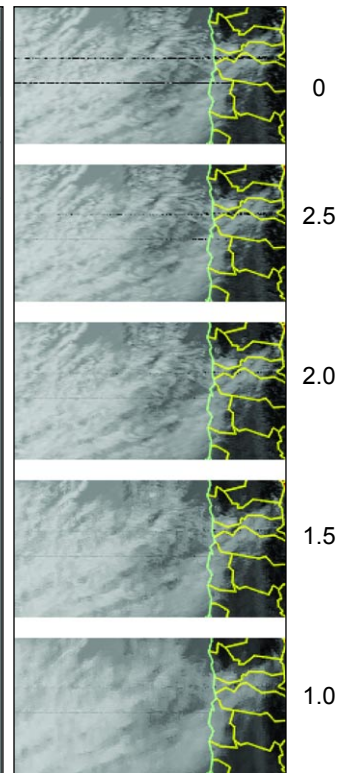


Figure 9  
Despeckle Options

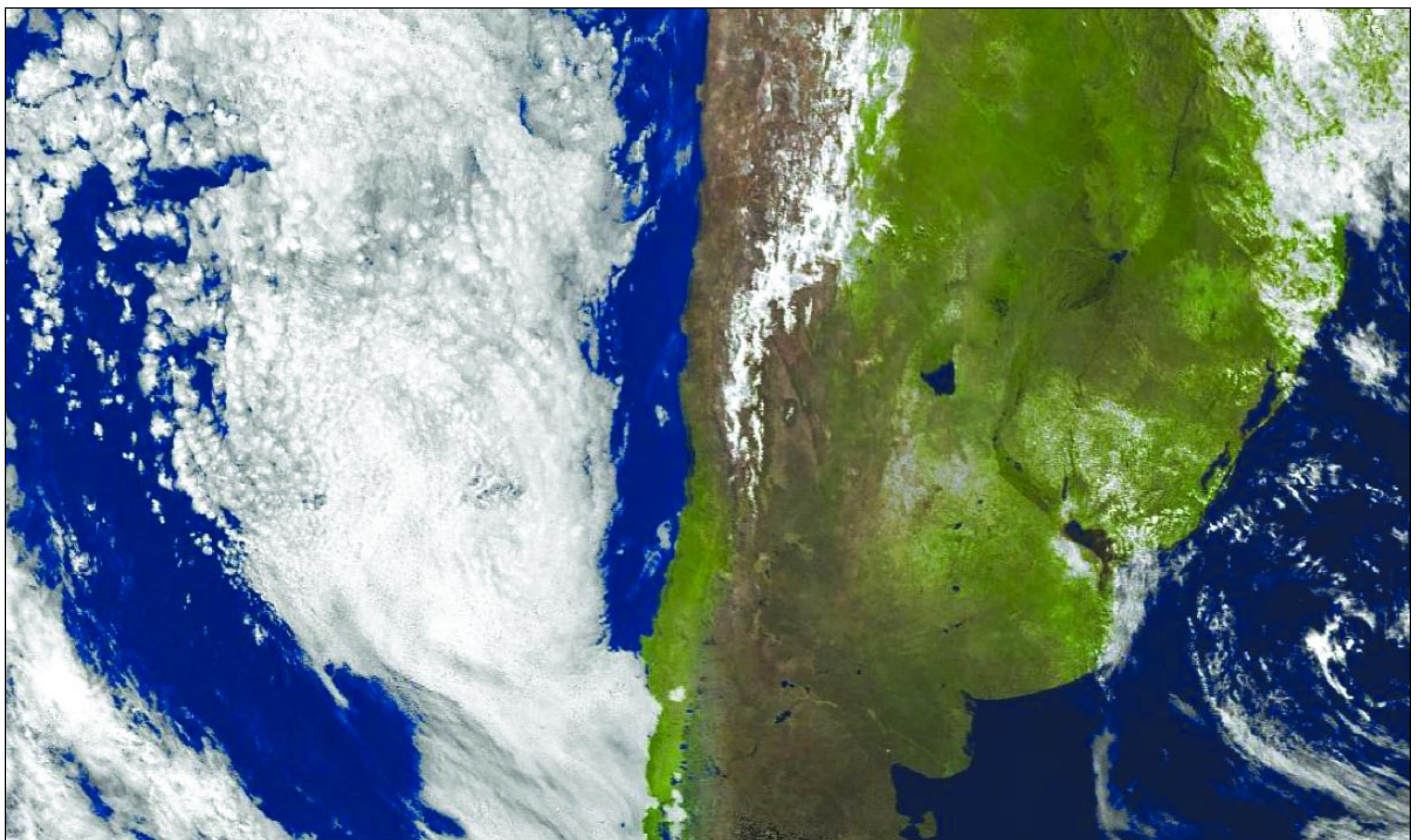


Figure 7 - A two-pass composition of NOAA-17 multispectral analysis images

Internet connection drops temporarily.

**Recording Options** offers four different methods for initiating recording:

- Start using WEFAX start tones
- Record when a 2400 Hz tone is detected (with safeguards at the beginning and end, the method that I normally use)
- Record when the sound level rises—nice if you have a squelch implemented in your receiver, preferably a tone-activated squelch.
- Record when an APT satellite is overhead. The program has its own orbital prediction program built-in, so it can activate the receiver using those data. In my particular location this system is not very useful because I'm actually living on the slope of a rather steep hill; in some directions I have a minimum elevation of only 25° to 30° while in other azimuths I can actually receive the satellite till it is under the horizon—this defeats the minimum elevation setting for me. To paint it another way: I have only sunsets, the sun rises well behind the 'mountain'.

Just one final option—it really goes on and on—is **Map Overlay**, which even permits you to select how the maps are going to be overlaid on the images, how detailed they're going to be and the colours and line widths used to display boundaries, etc.

### Projections

The projections menu (fig.5) is the item that is most restricted from the registered version, I guess. It offers three projections:

- Normal (as sent by the satellite)
- Equidistant cylindrical, a projection which I particularly have little use for
- And Eckert IV, which is a very interesting one, as it permits fairly easy combination of the images from two consecutive passes. In fact, in the registered version, this combination can be done automatically.

The registered version offers a lot of other projections, some of which seem interesting, other less so.

### Image

The image menu really contains a lot of things I'd rather leave to a paint program. But then *WXtoImg* is targeted as a 'do-it-all' program that does everything from reception to publishing, so any post-processing enhancement has to be provided too. The only two items I ever use are the *Move Map Overlay* (rarely, if for some reason the Internet connection breaks down and the map slips in the image) and even more infrequently, the *Magnify Area* option, to look at an enlargement of part of an image. It's often interesting to observe the *Enhancement Curves* though.

### Help

The *Help* menu does just that, and quite well. It has several chapters on the different aspects of the normal use of *WXtoImg*, and also provides help for the command line version (which might otherwise prove rather tricky). *Help* also has the tools to register the program and to enable the features unavailable (greyed-out) in the unregistered version. I can vouch for the development activity on the program. Though I haven't registered yet (I plan to do so real soon now). I have sent the author details of a few problems and always had a helpful reply.

### Some Final Musings

*WXtoImg* is performing excellently here. So much so I have pretty well archived the processing program I wrote a few years ago. The splash screen with the 10 seconds delay bugs me a little, particularly as it wasn't there in previous versions. On the other hand, the program runs here for weeks on end, so it does not make me suffer too much.

As a free program, the relation between performance and price would probably be acceptable, but in a Linux world where most programs are free, performance is normally judged separately—and *WXtoImg* scores very well indeed.



Figure 8  
Options menu

### References

- [1] <http://www.celestrak.com>  
Dr. Kelso's unique Kepler information database
- [2] <http://www.weather.net.nz/wxtoimg/>  
Software to decode APT and WEFAX signals from weather satellites
- [3] <http://chrony.sunsite.dk/>  
is a pair of programs which are used to maintain the accuracy of the system clock on a computer.
- [4] <http://www.jcoppens.com/sat/index.en.php>  
My own humble site (chronically in development), with some info on satellites and equipment, and recent satellite APT imagery



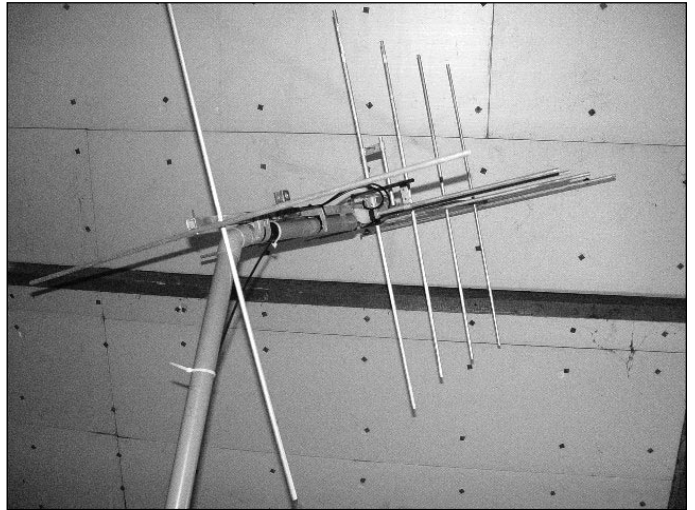
## Receiving Weather Satellites in Belgium

**François Verstraelen**

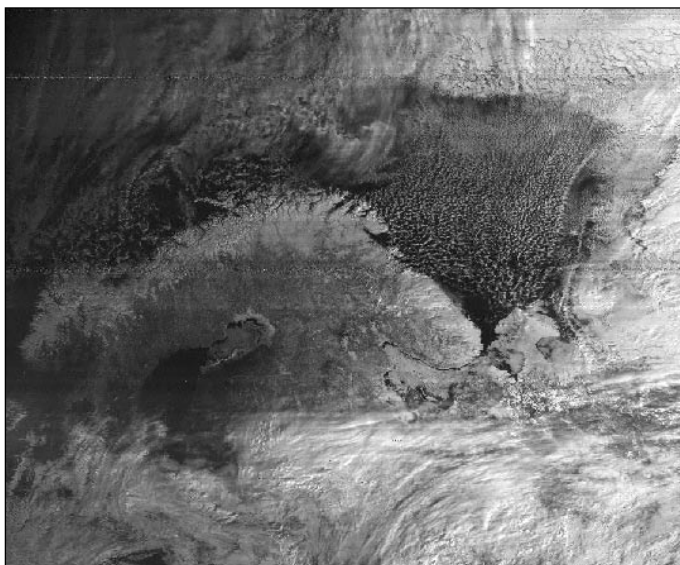
I first took an interest in weather satellite reception in the mid 1980's and must have been one of the first amateurs in Belgium to do so. But after a few years, I gave up the hobby and became more concerned with watersports and short-wave radio. For the past six years, though, I'm back on stage with the wx satellites.

I use a home-made HRX 137 receiver (Dutch concept) to acquire images from the NOAA APT satellites, and have two antennas which I built myself. The first antenna is a crossed dipole with an LNA built into the mast, which is for general use. It stands free and gives good pictures from about Denmark down to Gibraltar.

The other antenna is a 5-element crossed Yagi without LNA which I built from very cheap aluminium tubes. The original concept was from the authors of the book '*Weersatelieten*', which was published in late 1970: I still have it in my hobby shack. It was—as far as I know—the first book that gave very good help for *how* to receive weather satellites in those early days.



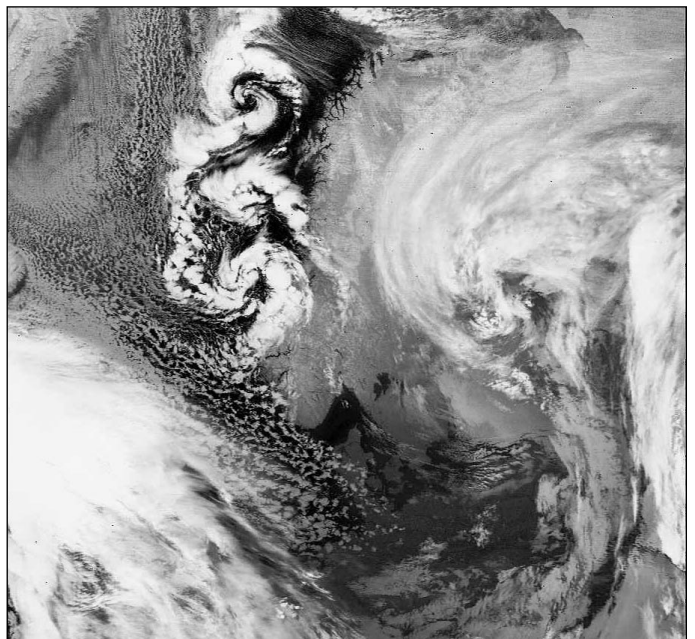
The 5-element crossed Yagi mounted in the roof-space



A memory of days long gone—a Meteor 3-05 image taken with the crossed Yagi, extending the range deep into the Arctic.

I've tried many antennas over the years, and for me this Yagi is one of the best. I must say that the antenna is mounted with a fixed elevation of 65°. I adjust it to the desired azimuth by hand because the antenna is under the roof.

I use this Yagi only to 'see' farther in the N.E direction towards Russia and the Baltic states during the winter period. It gives me very fine pictures. I use the Yagi with *no* rotator because the it is located in the loft, *underneath* the roof of my house (about 10 meters above the ground). I produce images using *Wxsat* and



A NOAA 15 channel-4 image obtained using the crossed dipole antenna at 08:34 UT on January 25, 2002 showing Polar Low's sweeping down the Norwegian coast.

*WxtoImg* software and track the satellites with *Footprint* and *WXtrack*.

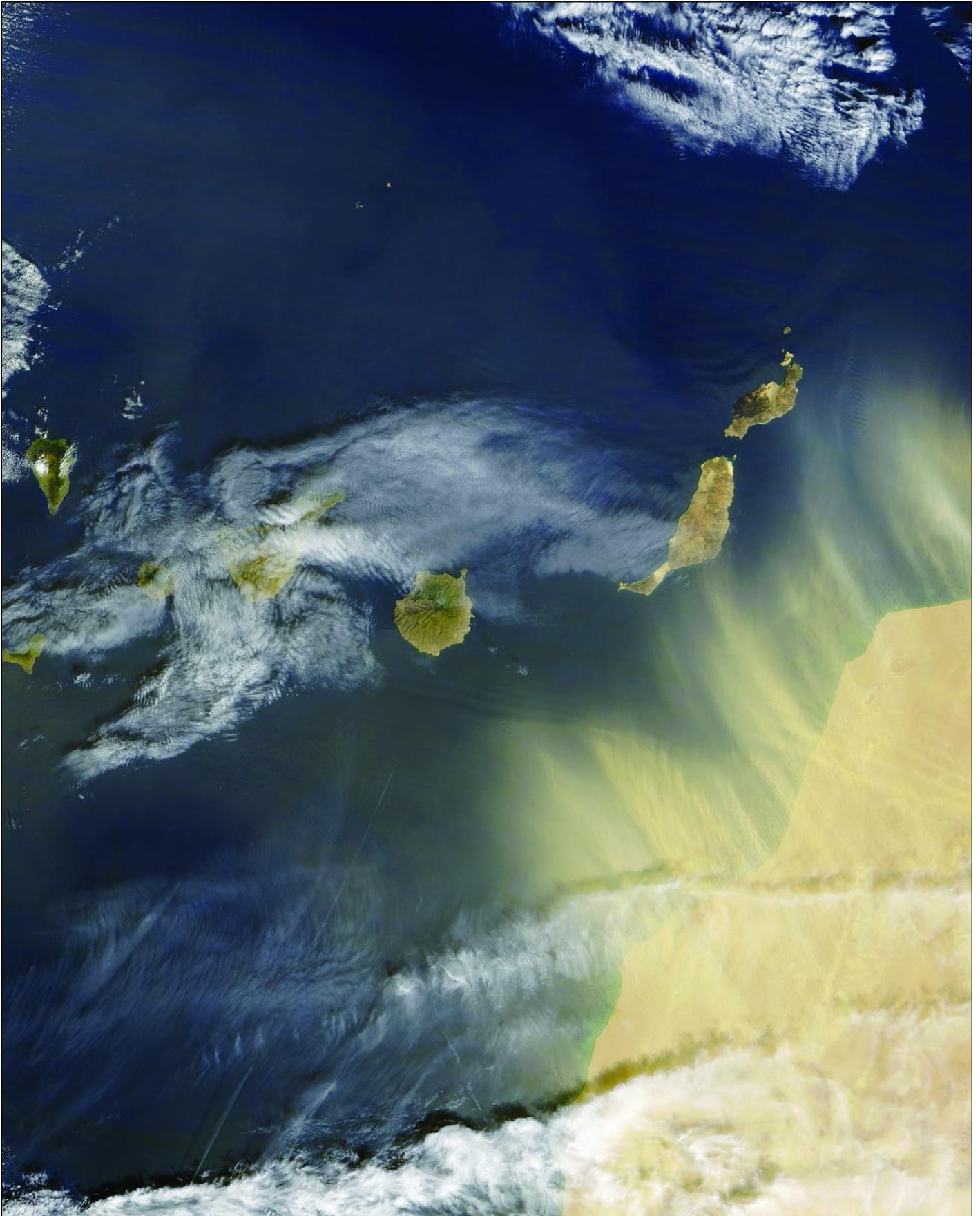
A few months ago, I bought a complete HRPT installation from an amateur in the Netherlands, but as yet I have not set it up. But some day soon I hope to start with the reception of HRPT.

*François Verstraelen is 55, is married with two daughters, and lives in Turnhout in the northeast part of Belgium.*

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### Weather Brief

A ferocious winter storm hit the eastern Mediterranean on February 12 closing roads and airports throughout Turkey. Twenty crew were missing, feared dead, after their boat foundered in gale force winds near Istanbul. Up to 40 cm of snow was reported in the village of Busa. In Greece, the severe weather brought heavy snowfall, causing chaos in Athens where overnight temperatures plummeted to -9°C, recovering only to -1°C by the following midday.



This true-color image captured by the Moderate Imaging Spectroradiometer (MODIS) instrument aboard NASA's Terra satellite on February 17, 2004 shows bright yellow streamers of dust sweeping from the coast of Morocco toward the Canary Islands. Just off the coast of **Lanzarote**, the northeastern-most of the **Canary islands**, gravity waves caused by the high winds driving the dust storm create dark and light stripes on the water. More gravity waves stretch from **Gran Canaria**—the round island toward the centre of the group—towards the Moroccan coast.

*Image: Jacques Descloitres, MODIS Land Rapid Response Team, NASA GSFC*

## European Publications On-line

**Simon Kennedy**

In response to Francis Bell's article regarding free European publications, GEO readers may be interested to learn that all of these publications, plus archive versions, are available to download from the Internet as PDF documents. The relevant addresses are:

### Image

[www.eumetsat.de](http://www.eumetsat.de)

(then select Publications/IMAGE Newsletter from the left hand frame)

### ESA Bulletin

<http://esapub.esrin.esa.it/bulletin/bullets.htm>

### Earth Observation Quarterly

<http://esapub.esrin.esa.it/eoq/eoq.htm>

## *EUMETSAT Operations Bulletin*

The download address for EUMETSAT Operations Bulletin No 10 printed on page 40 of GEO Q1 inadvertently contained a 'rogue' space character. The correct address is:

<http://www.eumetsat.de/en/dps/helpdesk/documentation/pdf/newsbulletin10.pdf>

## *Cover Colour Images*

### *Front*

The crescent Earth as captured from Meteosat-8 by Cedric Roberts on February 2, 2004

Image: © EUMETSAT 2004

### *Back*

Saharan dust being carried over the Alps. NOAA-17 APT captured by Gerry Berg at 10:28 UT on February 21, 2004. The image was processed with *WXtoImg*, using the MSA mode (see report on page 43).

### **Official GEO Internet Discussion Group**

**GEO** has its own, private and moderated on-line discussion forum, called 'GEO-Subscribers'.

The aim of the Group is to provide a forum where **GEO** members can share information, ask questions and receive speedy responses.

To sign up, send an email to:

[GEO-Subscribers-subscribe@yahoogroups.com](mailto:GEO-Subscribers-subscribe@yahoogroups.com)

asking to be placed on the list.

## *Erratum*

No doubt some of our eagle-eyed readers noticed a minor glitch on page 11 of the 'Polar Low' article in GEO Q1. Figure 5 displayed a repeat of figure 1. The correct image, displaying the final shreds of the dying storm, appears below.



Figure 5 - NOAA 16 - 00:11 UT on December 22, 2003

## *Visit the GEO Website*

Have you visited GEO's website yet? If not, point your web browser towards

<http://www.geo-web.org.uk>

A recent e-mail from Geoff Derby suggested that it would be useful to have a *Glossary of Terms* included in each edition of *GEO Quarterly*. It is certainly something worth thinking about, though perhaps not in every issue. But in fact, the GEO website has a full page of such abbreviations and acronyms at:

<http://www.geo-web.org.uk/acronyms.html>

Talking of the website, remember there are pages devoted to joining GEO, a beginners section devoted to APT imaging from the NOAA satellites and several pages about the new Meteosat-8 satellite and the *EUMETCast* and *C-Band* dissemination services. If you would like to see some high-resolution coloured images from the Meteosat satellites, please turn to:

[http://www.geo-web.org.uk/met\\_samples.html](http://www.geo-web.org.uk/met_samples.html)

### *GEO Members' Ideas*

We are always interested to hear from GEO readers. If you have ideas that you believe could help our website to serve you, the membership better, do please send your thoughts and ideas to our webmaster, Ray Godden. Ray can be contacted by e-mail via:

[webmaster@geo-web.org.uk](mailto:webmaster@geo-web.org.uk)



# SOFTWARE SHOWCASE



**Douglas Deans - [douglas@dsdeans.freemove.co.uk](mailto:douglas@dsdeans.freemove.co.uk)**

For this second issue of GEO Quarterly, it is back to work with a look at the most popular CD and a brief update review to one of the better known programs. There are times when software updates are in short supply and I intend to use those quieter moments to remind readers, especially those new to the hobby, of the contents of some of the Showcase CDs. This issue we look at GS1.

GS1 provides, in one neat package, all of David Taylor's weather satellite programs complete with the necessary runtime libraries and many extras. However there is much more to this CD. To make it a complete working package it includes over 600 Mb of program extras which serve two purposes. Firstly there is lots of raw data, specifically for each of David's programs, to let new users use, experiment with, and enjoy them without having to produce or source their own raw data. Looking back, I can well remember how frustrating it was to install a new program and not know what data to use or indeed where to find it.

Secondly there are lots of high-resolution images to let you see just what can be achieved with the software. A mixture of images from polar and geostationary satellites are provided with some examples, including animations, from the new pride of the European fleet—Meteosat 8 (MSG-1). Details on how to order this CD, or indeed any of the other Showcase CDs, are provided below.

## **JVComm32 v 1.30 pre**

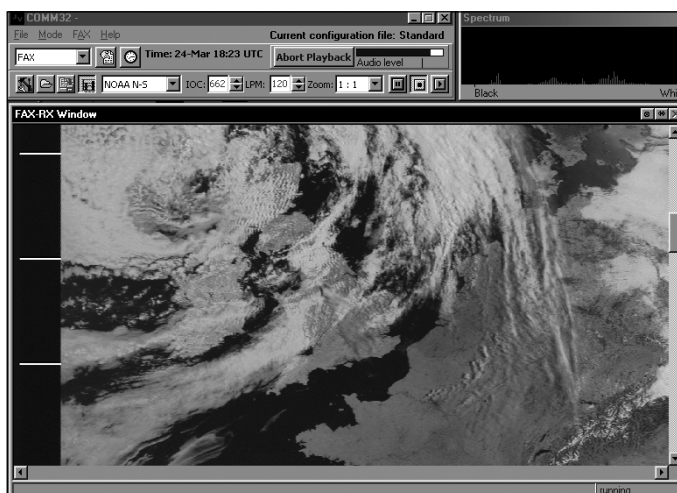
JVComm32, written by Eberhard Backeshoff, is probably one of the best known multi-purpose programs for the reception of FAX, RTTY / SYNOP / NAVTEX and SSTV. It can be used on all Windows operating systems from Windows 95 up to the present 2000 and XP options.

Version 1.30 pre, will become full release version 2.00 when the help and support files are completed. Can I take this opportunity to remind readers of some of the more interesting and useful features of the program? It can be used for the reception of HF-FAX weather charts, weather images from low earth orbiting satellites (e.g. NOAA), geostationary weather satellites such as Meteosat, plus RTTY, SYNOP and NAVTEX messages. In addition, the program can be used for the reception and transmission of amateur-radio SSTV (Slow Scan TeleVision). In SSTV mode, JVComm32 receives and transmits all the modern popular free run modes including the new high resolution *Pasokon* modes P3, P5 and P7.

Some of the new features in this upgrade include 'fine tuning' for RTTY, and a luxurious NAVTEX / SYNOP / RTTY message viewer.

One of the real attractions of this program is its ability to work using a computer's soundcard and, although there is a range of other optional interfaces, I suspect the soundcard route will be the attractive one to most users. JVcomm32 is available on GEO Software CD, GS2. For further information or to download the program go to

<http://www.jvcomm.de>



JVcomm32 in action decoding a NOAA 17 image

## **How to Purchase CDs**

Simply write to the address below requesting **GS1**, **GS2**, **GS3** or **GS4**. Prices are £5 for any single CD, 2 for £8, 3 for £11 or all 4 for £14. Please enclose cash or cheque (made payable to Douglas Deans not GEO) for the appropriate amount. Nothing else is required.

The cost includes the CD, packaging and posting, a small donation towards the cost of overheads, the cost of overseas orders and the search for new or updated software. No fee is asked from overseas members although an exchange of software or interesting satellite images is always welcome.

**Orders are normally dispatched on the day of receipt.**

## **Order your CDs from:**

Douglas Deans, 17 Montrose Way,  
Dunblane, Perthshire FK15 9JL, Scotland.

# Software Catalogue

## *The Weekend the World's Weather Went CRAZY!*

**Gerry Berg (DK 1RR)**

Saturday, February 21, 2004 was the day the weather went crazy all round the world.

In Canada, meteorologists were speaking of a 'weather bomb' as heavy snowfalls deposited up to 90 cm in some places. These sudden unusually heavy snowfalls almost paralysed normal life in northeast Canada. The blizzard completely buried even 4-lane highways under enormous snowdrifts, and 400 articulated lorries were snowed in on the trans-Canada Highway during the heaviest snowfall since 1944.

By contrast an exceptional heatwave in Australia saw the temperatures rise to 41°C in Queensland while the mercury reached a scorching 46° in New South Wales, 11 degrees above normal for February. In Sydney, temperatures reached 45°.

But it was much nearer home, in Europe, that much of the crazy weather was observed.

*The image on the back cover of this issue shows the situation in Europe as seen from NOAA 17 at 10:28 UT on February 21. Major sandstorms over the Sahara Desert can be seen whirling aloft huge quantities of sand which are being transported northwards over Italy, the Alps, and central Europe. The image at top right on page 17 was processed from the same pass to show the extent of precipitation over central Europe that day.*

In Bavaria, the Saharan dust turned the sky a range of unusual colours; first blue-white, then yellow, orange and ochre. On the Mediterranean island of Minorca, motorists found their cars covered in a thick layer of orange dust.

Cold northern air coming into contact with the warm Saharan air was also responsible for capricious weather over Italy. While northern Italy experienced heavy snowfall, the south of the country basked in temperatures as high as 25°C.

Continuous storms over Spain caused substantial damage and heavy snowfall in the north of the country closed many mountain passes: those that were open were only passable by vehicles fitted with chains. On the Mediterranean coast some beaches were white with snow. Severe weather in the south-west of Gran Canaria devastated greenhouses full of bananas, tomatoes and cucumbers. Forty holidaymakers had to be rescued when their hotel was flooded.

<b>GS1</b>	All David Taylor's weather satellite programs and libraries including the current releases of WXtrack, SatSignal, HRPT Reader, GeoSatSignal, GroundMap, RX2 PassControl and many other program extras. This disc also contains a large quantity of sample files, many of high-resolution data, for use with the programs		
	WXtrack	Satellite Tracking Program	v 3.4.0
	SatSignal	Creates images from wave files	v 4.0.8
	HRPT Reader	Converts raw HRPT data files into images	v 2.5.2
	GeoSatSignal	Manipulates geostationary weather satellite data	v 4.1.0
	GroundMap	Rescales satellite images	v 1.3.6
	RX2 PassControl	Computer control program for the RX2 receiver	v 2.2.8

<b>GS2</b>	A wide range of software for all aspects of weather satellite reception including tracking, receiving, monitoring and image manipulation. Content is detailed below but many other extras are provided. Titles correspond to folder names. * implies a DOS program.		
	Collection D02	Recall (wave file decoder). Palette (modifies wxsat colour palettes).	
	Collection D03	Scanner recorder v 1.8 (wave file recorder). *NOAA95 / *FENG99 (Software for the NOAA 95 HRPT project)	
	Collection D04	Wxsat v 2.59 (Wave file recorder/decoder). Satellite Monitor (Wave file recorder).	
	AGSatTrack	Satellite tracking program	v 1.33
	Cirkit	Documents for the Cirkit Wxsat receiver and the UOSat receiver. (PDF format)	
	e-weatherman	Provides current weather conditions from the Internet to your computer	
	Element Manager	2-line element manager	v 1.58
	Footprint	Satellite tracking program	v 2.10
	IrfanView	Fast image/slideshow viewer	v 3.80
	JVcomm32	JVcomm32 evaluation (APT/FAX/SSTV decoder)	v 1.30
	Macintosh Kepler editor	For editing verbose AMSAT format elements. Mac. OS X and OS9 only	
	NeoPaint	Neopaint for Windows Image processing program (30 day evaluation)	v 4.0
	Paint Shop Pro	Paintshop Pro Image processing program( 30-day trial)	v 7.04
	Satscape	Satellite Tracker/decoder	v 2.00
	Splitter	Utility program for splitting and reuniting large files	v 4.0
	WXtolmg	WAV file acquisition and decoding program	v 2.5.9

<b>GS3</b>	<b>3DEM package for 3D terrain visualisation</b> The CD includes the full set of GLOBE tiles to allow you to produce excellent images and flybys from HRPT images. Also included is a selection of Mars MOLA files, sample images and helpful guides.
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<b>GS4</b>	<b>Image CD (New)</b> - A wide selection of high-resolution remote images from a range of satellites including stunning imagery from the Space Shuttle missions. A full description and source is provided for each image.
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# IN TRAY

## The Column for Readers' Letters and Queries

**Dear Les,**

I've a number of points to raise arising from the launch issue of GEO Quarterly.

I was interested to note that the latest issue of Image reports the creation of another group called GEO, the acronym stands for Group on Earth Observation, so is slightly different from 'GforEO' if I can express it like that. 'GonEO'. is an '...ad-hoc inter-governmental group [set-up] ... to oversee coordination and integration of the different Earth Observation Systems.'

Your article on The Polar Low Phenomenon is interesting with some good images but surely the copyright for Figure 1 should be to NOAA and not Ferdinand Valk? As has been discussed at various times in the past NOAA state that they are happy for images from their spacecraft to be published as long as they receive the copyright credit. As so much is made elsewhere in the journal of the copyright issues surrounding MSG images it seems churlish not to also observe and recognise NOAA's copyrights.

Finally, congratulations on the journal and particularly the use of A4 sized paper. The size really allows the images to be displayed to full effect. The full page MSG images are stunning.

Best wishes,

Simon Kennedy, Guildford, Surrey

**Editor's reply to Simon . . .**

**Dear Simon,**

The copyright issue is interesting, not least because NOAA openly provide their data, paid for by the public purse, free to everyone. EUMETSAT, on the other hand, do not - you generally have to pay for their data products, and they demand a copyright notice. NOAA only request a credit for materials directly downloaded from their websites. So in the case of NOAA images, directly downloaded by users such as Ferdinand, it has always been the custom to credit the person who created the image, and not NOAA.

**. . . and Simon's follow-up**

**Les,**

I asked Darrell Robertson of NOAA for clarification and I include his response below:

*Simon,*

*NOAA satellite images are in the public domain (i.e. paid for by the citizens of the United States for public use). No copyright is required but NOAA does request, when using its data, especially for commercial*

*purposes, that proper credit be given to the agency. Typically the use of the NOAA logo and a brief statement of what the image is and how or where the image was obtained will suffice (i.e. NOAA-17 1-km visible image from February 23, 2004. This image was obtained from the NOAA Satellite Active Archive).*

*Regards, Darrell*

*Darrell R. Robertson*

*Satellite Data Services Team Lead*

*NOAA/NESDIS Direct Services Division*

This appears to conform largely to what you say. Best wishes to you and GEO. My membership form will be in the post when work and my 2 year old and 6 week old daughters allow.

*Simon Kennedy*

**Hi Les**

My copy popped through my letter box, in Felixstowe, at 09.09 this morning. A nice looking mag, well done. I shall be having a long slow coffee break this morning. My thanks to the GEO launch team. My membership form will be in the post tonight.

Regards,

*Bill Price, Felixstowe, Suffolk.*

**Les**

Thanks for the new GEO magazine, CONGRATULATIONS, its brilliant. I will be joining the new group fairly soon. Keep up the good work.

*Kind Regards, Mike Stevens. G4CFZ*

**To the GEO Team**

Take bow, gentlemen. The new magazine is superb quality. An auspicious start, long may it continue.

Best wishes,

*Norman Munro, Isle of Lewis.*

**Posted on GEO-L**

I've just received my first copy of GEO and I wasn't disappointed - a truly professional publication - I'll definitely be subscribing!

I also was surprised and impressed with the A4 size. This allows much better detailed pictures, for example the glorious full colour Earth view. Keep up the good work.

Best regards,

*John Silver, Whiteley, Hampshire.*

**Posted on GEO-L**

The GEO Quarterly has just landed in my letter box here in Melbourne, Australia. The best way to describe it is ...stunning!!!!

I'm most impressed with the A4 format. Just look at the outside back cover and page 29 !! I'd be most proud to get one of my images in there in all that glorious colour.

I haven't had time to read it yet. That'll come later this evening after the kids are in bed and the wife watches her television.

Well done, and thank you.

Lindsay Vincent, Victoria, Australia.

**Dear Editor**

Cedric Roberts recently provided an excellent article regarding evaporation. I wonder if Cedric would be so kind as to publish how he calculated the respective average evaporation data based on sunshine - temperature / rainfall rate over the past year. I have looked through a couple of meteorology books but have not found the answer.

Peter Bartlett, Pinner, Middlesex.

(Cedric Roberts' reply appears on page 28 of this issue - Ed)

**Les**

GEO Q1 arrived this morning. Certainly looks nice in the larger format - only reservation I've got is the note about future issues possibly coming out on CD rather than in paper format. I can understand the economics surrounding this but personally I prefer something I can read anywhere/anytime without having to be continually stuck in front of a screen. I'd be willing to pay a little more if need be to maintain a paper offering.

But that's for future mulling - I've seen enough to officially join up.

Colin Knight, Eastleigh, Hampshire.

**Dear GEO Editor,**

Congratulations for the launch issue of The Geo Quarterly. The magazine is great. Its articles and images are very good. I know it is already a great success among amateurs (and professionals!).

Regards,

Raul Fritz B. Teixeira, Department of Meteorology, Foundation for Meteorology and Water Resources of the State of Cear , FUNCEME Brazil.

(www.funceme.br)



# Why are South Atlantic Hurricanes so Rare?

*Peter Wakelin*

In his letter in the last issue of *GEO Quarterly*, Francis Bell correctly identified one of the essential ingredients for hurricane formation as high sea surface temperatures. 27 degrees C is considered to be the minimum requirement and this value is reached in the South Atlantic regularly but only over a very small area when compared with other ocean basins.

In addition, these values are reached only in a shallow surface layer a few metres in depth and whenever a potential storm circulation is established, the strengthening winds churn up the sea causing the surface temperature to drop by several degrees so, in order to develop, any potential storm has to keep moving over very warm water.

As the South Atlantic receives the same solar radiation as the other southern oceans, there must be another reason for the lower temperatures and this can be found by looking in a world atlas. The shape of the South Atlantic basin does not favour warm tropical waters for two reasons:

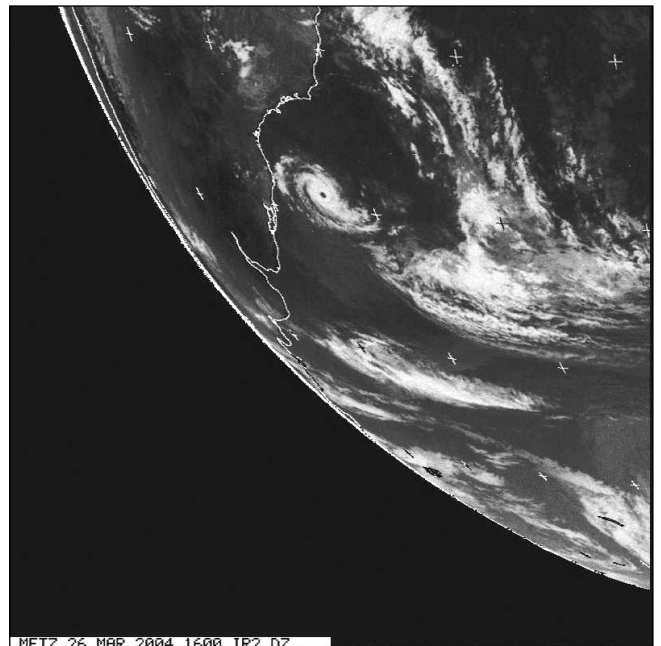
- 1 Ocean currents circulate counter-clockwise in southern oceans and the cold waters of the Benguela Current are carried northwards past St Helena and onwards to Ascension, warming all the time before turning westwards towards Brazil. However, unlike in the Pacific and Indian Oceans, the South Atlantic is narrow at tropical latitudes and the water soon turns southwards again as the Brazil Current. Consequently only a very small area east of Brazil reaches the necessary temperatures.
- 2 The shape of the Antarctic continent results in near-freezing water at more northerly latitudes in the South Atlantic than anywhere else in the southern oceans; at 50°S latitude off SW Africa, the sea temperature is around 3°C at its summer peak. Compare this with the 18°C or thereabouts at latitude 50° in the North Atlantic.

Southern Oceans reach their highest temperatures in March but it is interesting to see that, at the time of writing in late March, the warmest waters in the entire Atlantic are north of the equator. In addition to needing high sea temperatures to develop, it is also essential that winds in the lowest few kilometres of the atmosphere remain light during the initial formation as any significant wind shear will disrupt the development. Light winds occur in the tropical 'convergence zone' where the winds from the trade-wind belts converge. This can be looked upon as the 'thermal equator' and tends to follow the seasons

across the true equator. In the Atlantic, this thermal equator very rarely ventures very far south, almost certainly due to the all-the-year-round high temperatures in the 'bulge' of west Africa.

Very near to the equator, significant wind circulations cannot form and the majority of hurricanes (typhoon is another name for the same thing) form near latitude 15°. At this latitude in the South Atlantic, the upper wind regime generally precludes hurricane formation and this, together with the small area of warm sea means that South Atlantic hurricanes are extremely rare.

Had I written this a week earlier, I would have concluded by saying that no hurricane has been observed in the South Atlantic since satellite monitoring of the oceans began about 40 years ago but the image on the inside front cover, and the one below, show that this is no longer true.



Mike Stevens sent us this Meteosat-7 D7 segment from 16:00 UT on March 26, clearly showing the cyclone in relation to the South American coast.

*Image © EUMETSAT 2004*

An Internet search will reveal much about hurricanes but for an in-depth study I recommend

[http://www.bom.gov.au/bmrc/pubs/tcguide/global\\_guide\\_intro.htm](http://www.bom.gov.au/bmrc/pubs/tcguide/global_guide_intro.htm)

For current global sea temperatures try

<http://www.ssec.wisc.edu/data/sst.html>

# Von Kármán Cloud Vortices

Les Hamilton

In early February this year, Gerry Berg of Wilnsdorf, Germany sent me a number of coloured NOAA-17 APT images displaying interesting cloud whorls over the Tyrrhenian Sea. Gerry suggested that he was observing a series of von Kármán vortices, and one of his images appears inside the back cover of this issue. The effect was visible over two full days, and appeared to emanate from the island of Elba opposite the NE corner of Corsica as illustrated by the two channel-2 NOAA-17 HRPT segments opposite.

I don't recall seeing such a phenomenon in this part of the world before, and decided to learn more about the intriguing von Kármán effect.

## Theodore von Kármán

Theodore von Kármán was born in Budapest in 1881 where he trained as a mechanical engineer before undertaking undergraduate studies and eventually his PhD at Göttingen in Germany. Von Kármán was one of the pioneers of early aeronautics, building a prototype helicopter for the Austro-Hungarian Army during the First World War and becoming involved over the years in the development of Zeppelins, gliders, airplanes and even rockets. He designed and built the World's first wind tunnel, and it was in that device, while investigating the relative merits of streamlined and cylindrical spars on biplane configurations, that he first observed the eponymous vortex pattern. Among his lifetime achievements, von Kármán became head of Caltech's *Guggenheim Aeronautical Labs* in Pasadena from 1930 to 1957, he was a co-founder of *NASA's Jet Propulsion Laboratory* and was instrumental in founding both the *International Academy of Astronautics* and the *von Kármán Institute* in Brussels.

## The von Kármán Effect

Von Kármán vortices form when prevailing winds are disturbed by an object, generally an island or group of islands, which possesses sufficient elevation above sea level to obstruct the normal airflow. On encountering the island, a disturbance is set up in the airflow, and this propagates downstream in the form of a double row of vortices exhibiting alternate directions of rotation.

The effect consists of two roughly parallel rows of vortices positioned such that a vortex in one row is situated mid-way between two adjacent vortices in the other row (figure 3). Initially, these vortices are comparable in size with the island that creates the

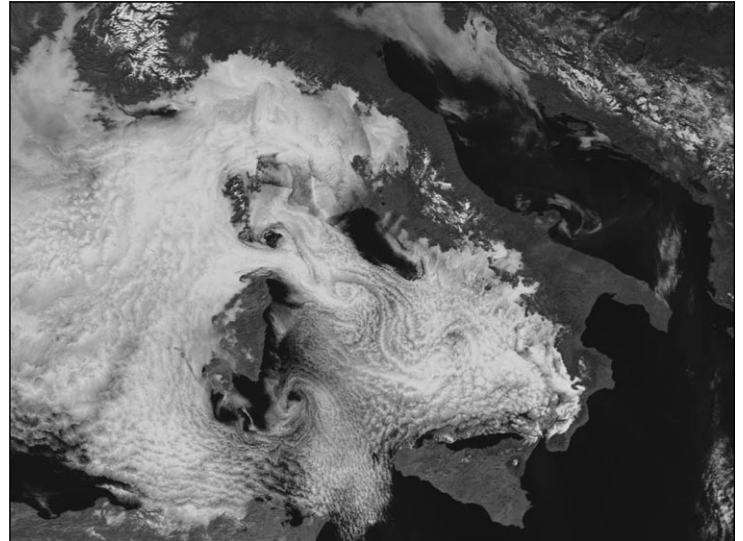


Figure 1 - NOAA-17 - 09:56 UT - February 5, 2005  
Image: NOAA SAA - Processing: HRPT Reader / Groundmap

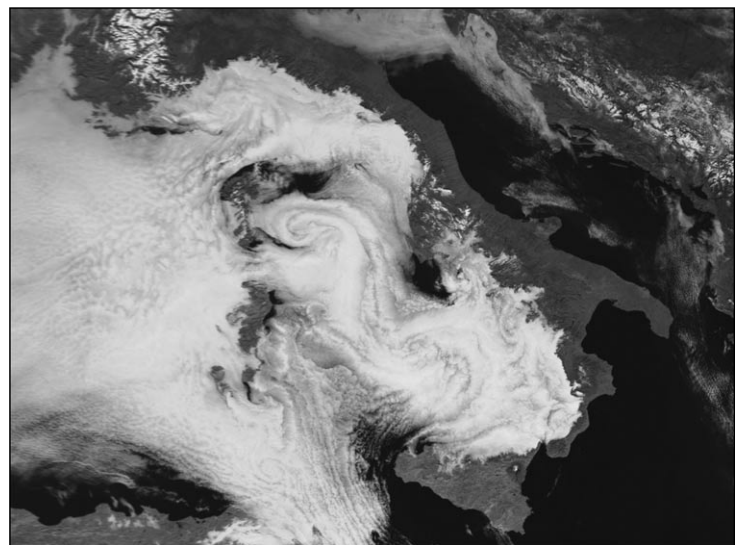


Figure 2 - NOAA-17 - 09:33 UT - February 6, 2005  
Image: NOAA SAA - Processing: HRPT Reader / Groundmap

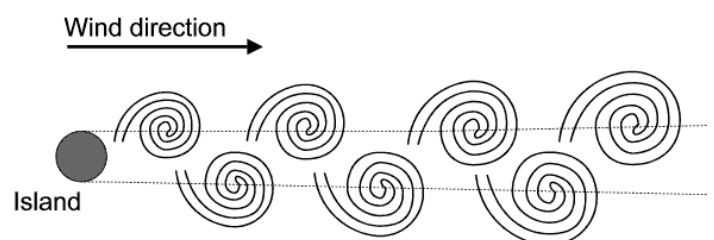


Figure 3 - Schematic illustration of the formation of von Kármán vortex streets in the lee of an island.

disturbance in the first instance. But later, as the vortices drift downstream, they tend to increase in diameter and gradually move farther apart: they may persist to form a wake up to 100 kilometres in width and extending several hundreds of kilometres in length. An island creates a pair of new vortices roughly once every 8 hours and these may persist for as long as 30 hours. All the vortices in one row have similar circulation, but opposite to those in the other row.

The resulting vortex streets are easily identified in satellite images on account of the characteristic formations they create in marine stratocumulus cloud sheets. These clouds are often associated with a well marked temperature inversion in the lower levels of the atmosphere, the height of which is important in determining whether the air flows more easily *around* the island rather than *over* it. Von Kármán vortex streets are more likely to occur in a linear low-level air-stream flowing steadily at around 35 kilometres per hour. Such vortex streets are frequently observed as cloud wakes in the lee of the Canary and Cape Verde Island groups; Madeira; the Pacific islands of Guadalupe (west of Baja California) and Juan Fernandez (off Chile); and Jan Mayen island in the north Atlantic ocean.

### **Examples of Cloud Vortex Streets**

The *Landsat-7* image reproduced in figure 4 shows clouds near the Juan Fernandez islands off the coast of Chile. **Alejandro Selkirk Island** (famous as the location for the Robinson Crusoe story) is situated near the lower left-hand corner of the image. This island is approximately 1.5 kilometres in diameter and rises precipitously some 1600 metres from the surrounding ocean into a layer of marine stratocumulus clouds. A steady wind blowing northward towards the equator creates vortices which flow from the eastern edge of the island with a clockwise rotation and with a counter-

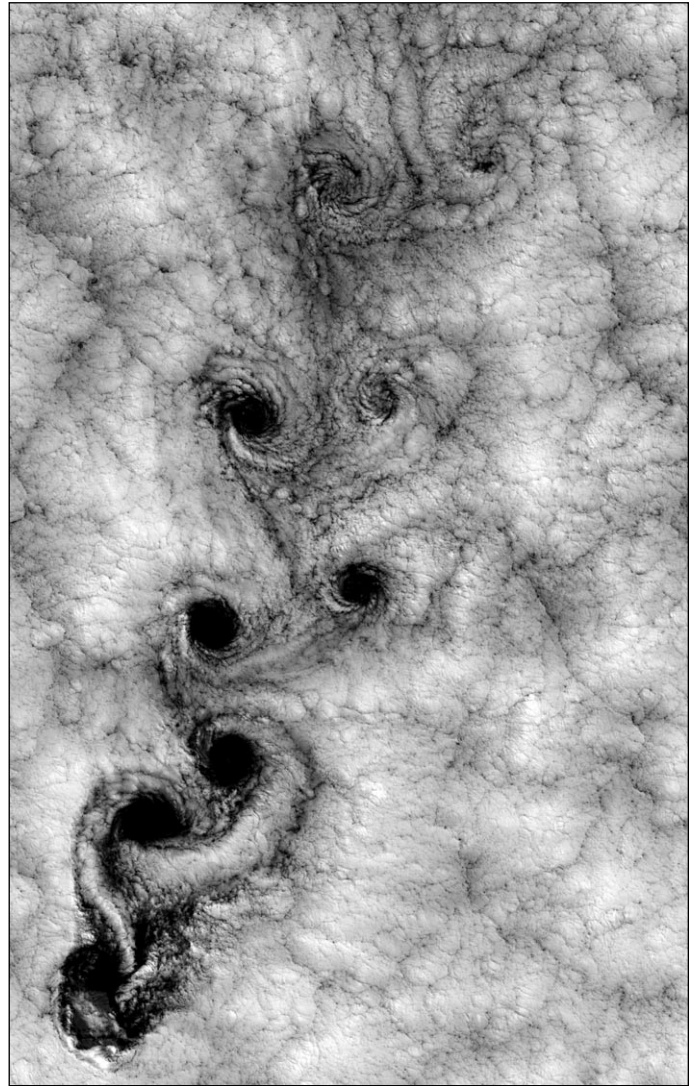


Figure 4 - A Landsat-7 image dating from September 15, 1999 showing a splendid von Kármán vortex street being shed by the Juan Fernandez Islands off the coast of Chile.

*Image courtesy Bob Cahalan, NASA GSFC*

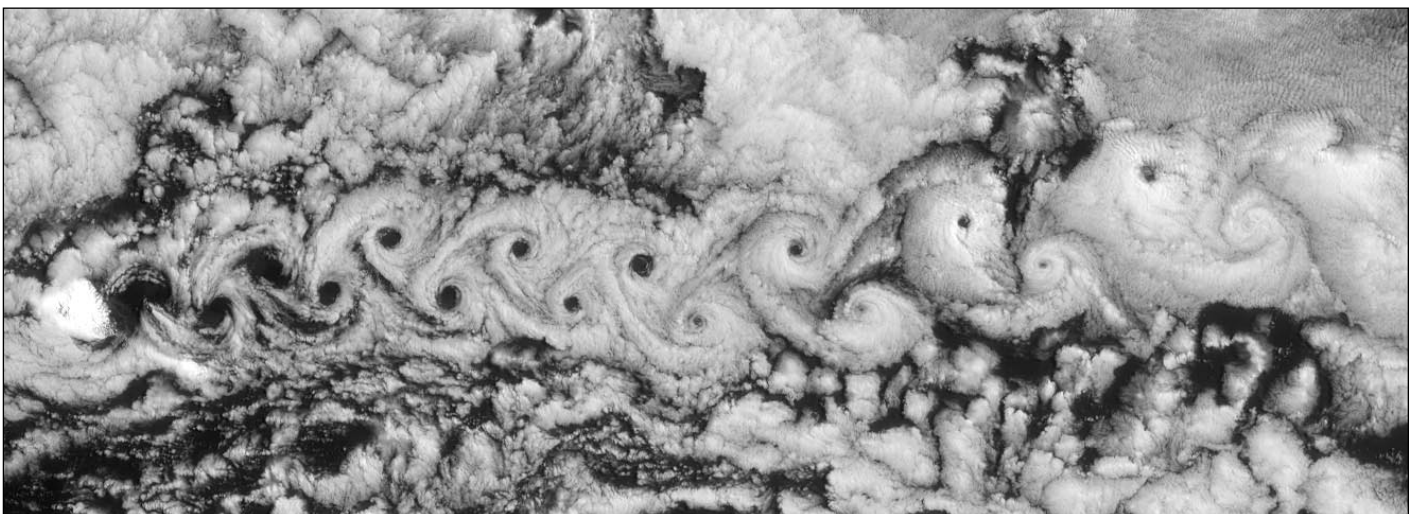


Figure 5 - This ranks as possibly the longest von Karman vortex street ever imaged by satellite. It was observed emanating from Jan Mayen island in the northern Atlantic ocean by the Multi-angle Imaging Spectroradiometer (MISR) aboard NASA's Terra spacecraft on June 6, 2001

*Image Credit: NASA/GSFC/JPL, MISR Team*



clockwise motion from its western edge. The vortices grow as they advect hundreds of kilometers downwind.

Both clockwise and counter-clockwise vortices are generated by air-flow around the island. Much of the island air tends to be cloudless because of a local 'land breeze' circulation set up by the greater heat capacity of the waters surrounding the island. As each vortex separates from the island's leeward side, it engulfs a 'parcel' of some of this clear air. These parcels of clear island air can subsequently be carried within the vortices for considerable distances before they mix into the surrounding clouds and disappear.

What is believed to be the longest cloud vortex street ever viewed by a satellite is shown in figure 5. It was imaged stretching approximately 365 kilometres southward (right) from Norway's *Jan Mayen Island* by the multi-angle imaging spectroradiometer (MISR) aboard NASA's *Terra* Earth observation satellite on June 6, 2001.

Jan Mayen is an isolated island located in the north Atlantic Ocean about 650 kilometers northeast of Iceland. At the northern end of the island rises the 2200 metre high volcano *Beerenberg*, which is more than sufficient an obstacle to produce frequent cloud wakes. The cloud-covered island is situated at lower left in this image and the volcano can be seen rising from its centre (north is at the left-hand side of this image). Fifteen open vortex centres and at least three closed vortices trail behind the island in this view. The entire cloud street covers an area of about 365 x 158 kilometers: again a cloud-clearing effect is apparent at the vortex centres until they finally become closed at the sixteenth eddy.

Obtaining images of von Kármán vortex streets from Jan Mayen Island should be well within the capability of many GEO readers, particularly if they receive HRPT or MSG. Figure 6 shows a NOAA 14 HRPT segment containing a vortex street being shed from Jan Mayen island while figure 7 illustrates how well Meteosat-8 detects cloud wakes around the *Canary Islands*.

*GEO readers are encouraged to look out for this phenomenon and to submit their own images of cloud wakes for future publication.*

Finally, the lower image on the inside back cover of this Quarterly is a true-color MISR image of a von Kármán vortex street, in this instance shed by the eastern Pacific island of *Guadalupe* lying 260 kilometers west of Baja California. The rugged terrain of this volcanic Mexican island, about 35 kilometers long, reaches a maximum elevation of 1300 metres (north is to the left). The orientation of the vortex street indicates that the wind direction is from lower left to upper right (northwest to southeast). The areas within these vortex centres tend to be clear because the



Figure 6 - Vortex street streaming from Jan Mayen Island  
NOAA 14 HRPT - March 23, 2001

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rotating motions induce a vertical wind component that can break up the cloud deck.

### References and Further Reading

- <http://www.rta.nato.int/RTOhistory/TvK.htm>
- [http://daac.gsfc.nasa.gov/CAMPAIGN\\_DOCS/OCDST/vonKarman\\_vortices.html](http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/vonKarman_vortices.html)
- [http://www.space.com/scienceastronomy/planetearth/vortex\\_street\\_001213.html](http://www.space.com/scienceastronomy/planetearth/vortex_street_001213.html)
- <http://www.ocean.washington.edu/research/gfd/cloud/clouds.html>
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- <http://www.knmi.nl/~floor/artikelen/zenit/karman/>
- <http://www.aerodyn.org/People/vonKarman.html>

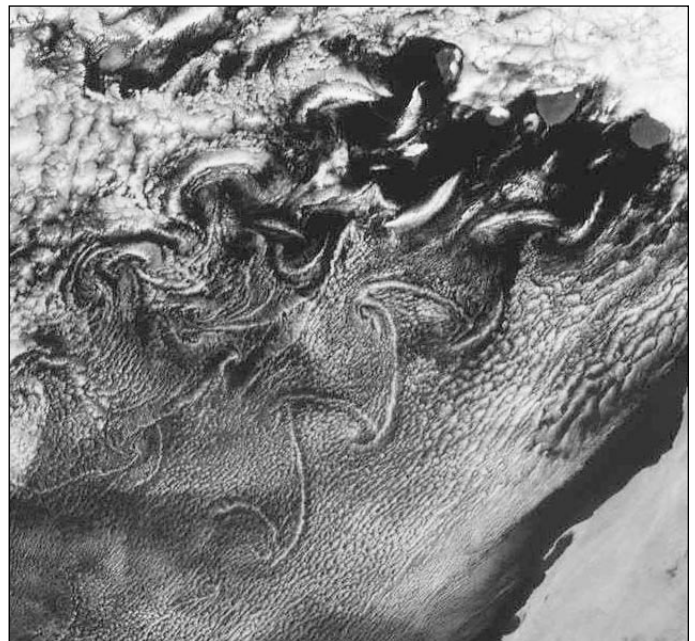
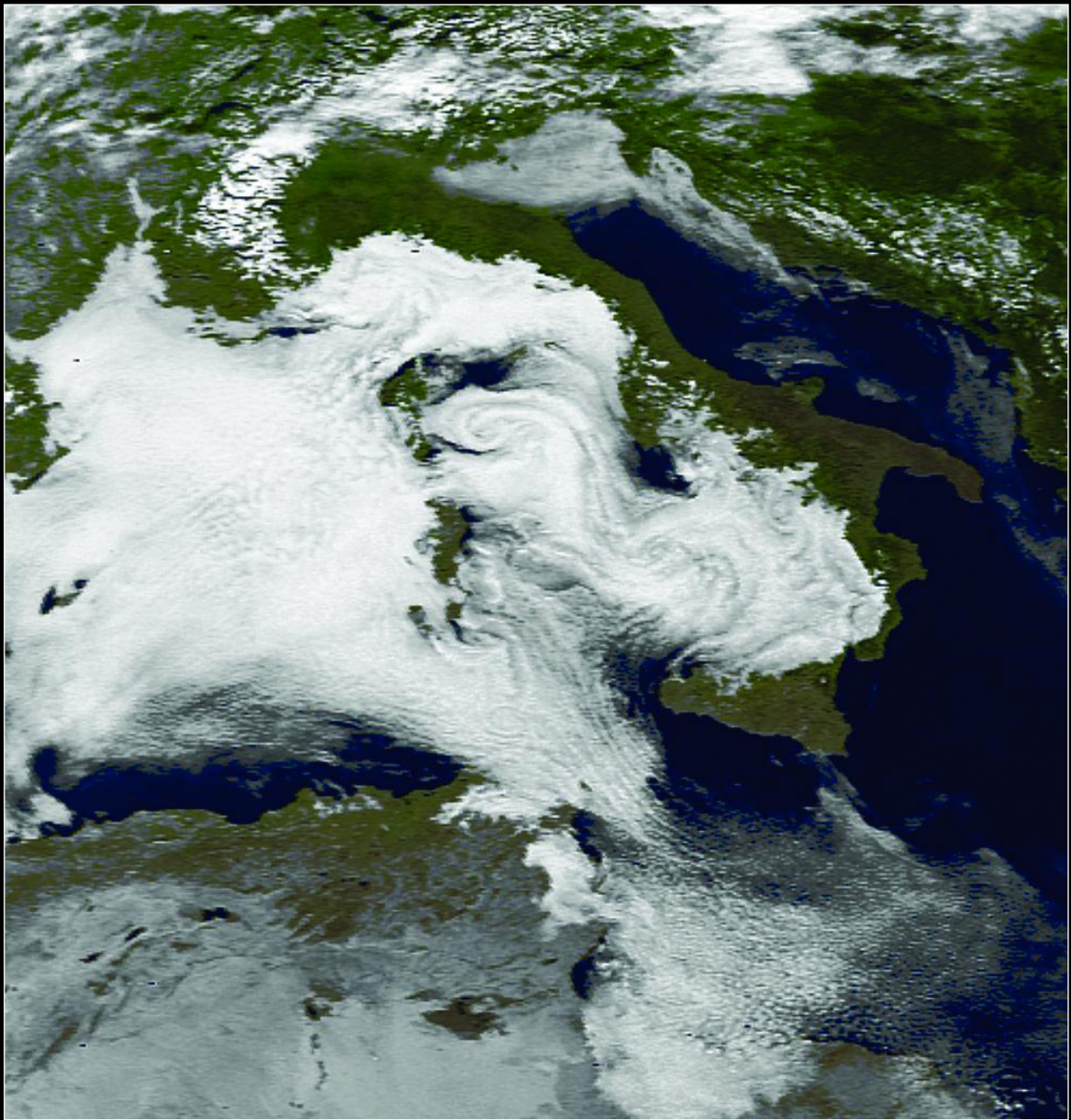


Figure 7 - Von Kármán cloud wakes generated by the Canary Islands, imaged by MSG-1 in May 2003

Processing: Cedric Roberts Image © EUMETSAT 2003





Gerry Berg of Wilnsdorf in Germany spotted what he took to be von Karman vortices coursing south over the Tyrrhenian Sea between Italy and the islands of Corsica and Sardinia, apparently spawned by the Island of Elba. NOAA 17 APT image - 09:30 UT on February 6, 2004.



Von Kármán cloud wakes being spawned from Guadalupe Island - June 11, 2000 (see article on page 25)

*Credit: Jacques Descloitres - MODIS Land Rapid Response Team, NASA GSFC.*



