

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

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Live Meteosat-8 reception on a laptop PC as demonstrated during the GEO Symposium at the National Space Centre, Leicester, May 2004

Inside this issue . . .

GEO Symposium: Report and photographs from Leicester ...

... also included is Robert Moore's Symposium presentation: 'Observing the Weather with MSG-1'

Rob Hollander presents the first part of his treatise: 'Antenna Theory and Measurement'

Read about the Space and Weather activities at Callington Space Centre

Lawrence Harris shares his experience of the historic Venus Transit

David Painter attempts to demystify the role of DVB in present-day weather satellite reception

John Tellick details how to get the most out of your Satellite-TV dish using multi-feed reception

We have a beginners' guide to using Satsignal, David Taylor's APT image processing software

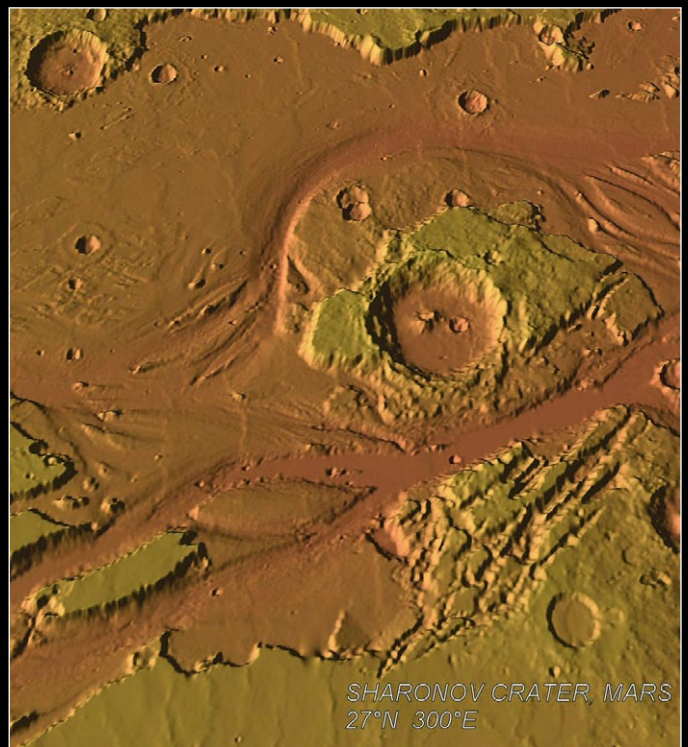
Mike Stevens describes how he became involved with weather satellites



Rob Hollander from *Werkgroep Kunstmanen* in expansive vein as he discusses the RQFH antenna with a visitor to GEO's May 1 Symposium, held in the National Space Centre, Leicester. Read Rob's article, *Antenna Theory and Measurement*, on page 26.
Photo: David Taylor



David Taylor (left) with Vibeke Thyness from the Norwegian Meteorological Institute, who both received awards at the EUMETSAT conference in Prague last May, David for for the best software demonstration and Vibeke for the best poster (on the sea-ice SAF's work).
Photo: Cecilia Taylor



Sharonov Crater on Mars
 This image was prepared using the 64 pixel/degree Mars MOLA data. Douglas Deans explains how you can create images like this in *Software Showcase* on page 38.
Image: Douglas deans

Who would have thought at the beginning of this year that GEO would become the success that it has? Here we are, with our third issue, thanks to the efforts of all those readers who have so kindly supported us. We have received many, many, messages of congratulations, and one point is pre-eminent among these: you approve most wholeheartedly of GEO's policy of addressing the needs of beginners to the weather satellite field. This continues on page 46 with an in-depth look at David Taylor's Satsignal software which creates NOAA APT images from WAV recordings.

But GEO has to appeal to the full spectrum of enthusiasts. To further this ideal, this issue contains the first part of a seminal treatise by Rob Hollander on the RQHA antenna, aimed towards the more advanced user. You can read Rob's authoritative account on page 26.

Everyone on the GEO team sends their congratulations to David Taylor (Satsignal Software) for the award bestowed on him by the delegates at last May's *EUMETSAT* Meteorological Satellite Conference in Prague. David was presented with a scale model of the *MetOp* satellite after the software presentation he made at the event was voted the best in show (see photo opposite).

Finally, it is with sadness that we have to report the passing of our respected contributor from Australia, Arthur Andrews. Arthur's articles in the *Quarterly* were highly thought of and will be sorely missed. A brief tribute from his long-time friend Michael Stubbs-Race appears on page 3.

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The **GEO** Report



Francis Bell

I know that elsewhere in this issue there is a report about our Leicester symposium so my comments on this subject will be brief. However, I do think it necessary for me to thank those people associated with the day. The full management team of *GEO* were there with the single exception of Peter Wakelin who is still enduring a back injury. Peter continues to write for *GEO* and looks after the dispatch of our Quarterly publication. Our thanks to him and best wishes for a speedy recovery.

Others at Leicester must be thanked. The speakers are listed elsewhere, but perhaps our main thanks should go to the 60 delegates who turned up to support the day. For a new organisation such as *GEO* this level of support is most encouraging. I cannot leave this topic without a special acknowledgment of our friends from the Netherlands who went to so much trouble and attended our symposium at their own expense. I admire their skills and resourcefulness in weather satellite reception; I just wish I was that good! They have their own meeting in Utrecht on September 11, 2004 and if they will allow me (and others from *GEO*), I will try my best to attend.

One final point about Leicester—I have made a provisional booking for next year—April 30 2005. Please put this date in your diary now. Details will follow much nearer the time, of course.

Still on the subject of meetings, *AMSAT-UK* invited *GEO* to their colloquium in Guildford at the end of July where I provided live weather satellite reception for all three days as well as making presentations in their lecture programme on the Saturday. I hope we can give a full report from Guildford in our next Quarterly.

I have also noted that NOAA are holding a conference in Miami in December this year (see notice on page 4). I will do my very best to attend and promote the interests of our membership. I consider this to be a high priority for us, with a mutual exchange of information and an opportunity to learn about NOAA's plans for the future. I hope to meet friends there again.

Ken Ashworth is *EUMETSAT*'s man at NOAA and he has become a good friend. He can keep us up to date with NOAA's programmes. Of particular interest to us in Europe are the polar orbiting satellites but I also recognise *GEO*

has members in north and south America interested in NOAA's geostationary GOES satellites. Ken was recently in the UK attending a *EUMETSAT* Council meeting in Exeter and I met him at Heathrow airport together with John Tellick. For about one hour Ken gave us a briefing about NOAA's programmes.

It is a priority for *GEO* that we should represent the interests of our membership to those agencies planning, launching and operating weather satellite. I try to have a broad perspective here and acknowledge that other groups exist whose interests overlap those of *GEO*. I have addressed and actioned this issue over the past month and I await responses. I was delighted to receive *AMSAT-UK*'s unsolicited invitation for us to attend their meeting in Guildford and I thank them for that. I hope *GEO* can make a significant contribution.

Subscriptions

In looking at the finances of *GEO* I think the annual subscription may be unsustainable for much longer. It was set at the lowest possible level to attract membership and will remain there for the remainder of 2004. Thereafter it must be reviewed. I still think membership of *GEO* is stunning value and we will keep it that way. However, please understand that it may be necessary to raise the subscription in the future to keep us solvent.

Membership

Our membership is currently about 500. It would help if this figure increased. I feel sure I don't have to explain that *GEO*'s main cost is for the printing and distribution of our *Quarterly*. The more members we have the more widely these costs can be spread. Please encourage others to join *GEO*. I would not wish members solely for the sake of increasing our numbers, but I do sincerely believe there are many potential members out there who *just do not know about GEO*. Please spread the word and ask others to join if they show interest.

Here comes a disappointing note. I have previously indicated a wish for *GEO* to have a higher profile in representing educational interests. Some pages in this publication reporting and reflecting education is my ambition. If you feel you can help out in this area please get in touch with myself or any other member of *GEO*'s management team. On the same issue, at Leicester, a member pointed out to me the age structure of the delegates. I expect you will be able to judge this for yourself from the photographs elsewhere in this issue. Again this is a matter which I would like to address but I don't know quite how. Someone to volunteer please! These two issues are related.

Letters and Articles

Sprinkled through our previous publications, at our editor's discretion, are letters and articles written by me. I sometimes write as an innocent. My question about 'Forward Error



Ken Ashworth (right) with John Tellick at Heathrow Airport

Correction' was an example. It is very rewarding to receive responses to these questions and my particular thanks to Alan Sowards for his contribution which appears on page 8. I'm on a learning curve here but just about understand why Meteosat-8 data comes in blocks rather than scrolling images.

At other times I know I can be much more aggressive, provocative and rightly offer a kick in the groin to established views. That was the style of my article about the death of our planet and global warming. I have received a letter from a potential member and my thanks to him, but I still defend every word I wrote (except that Tokyo should have been Kyoto). Atmospheric levels of carbon dioxide are dynamic but in my view global warming is electromagnetic not molecular. I offer a strong criticism of the media, particularly television, for not understanding these issues.

I do like watching science programmes on the TV but one programme in June was hysterical beyond belief. The thread of the story line was that the Gulf Stream will stop as a result of melting polar ice. I certainly agree that the ice is melting but the present disposition of the continents and oceans coupled to rotation of our planet will just not allow the Gulf Stream to stop. I consider this media hysteria to be ill-judged. The authors of this story couldn't even model clay yet alone ocean circulation. *Okay—I've done it again!* But I'm right and unrepentant. What I didn't even tell our editor was that my article about planetary carbon dioxide and global warming was refereed by four distinguished scientists before I submitted it for publication. That is not to say every item of content was agreed. The arguments are mine alone and not written light-heartedly. This planet *is* warming and we don't know why! Of course I am supportive of the scientific process: hypotheses, theories and laws—then they turn out to be wrong, so we have to start over again. People much more clever than I are good at doing this but what I don't like is media hysteria.

On the subject of oceans my sincere apology to Southampton Oceanographic Sciences for not acknowledging the electron micrographs they sent to me and which were published in *GEO Q2*. From whatever your perspective they are beautiful images.

Snow

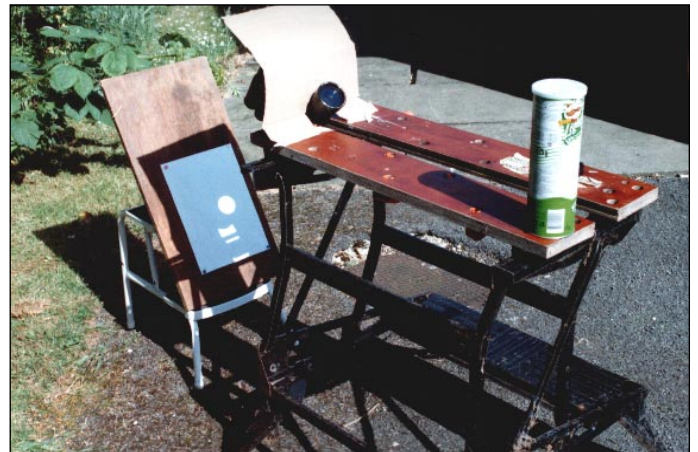
I'm still interested in snow. On a Meteosat-8 image I thought I could see snow on Sicily. I telephoned Peter Wakelin. 'Peter, does it ever snow on Mount Etna?'. Reply: 'Well the last time I cycled up Etna I had to turn back because of the slush and snow'. I'm still looking for an image of snow on the Troodos mountains. Look out for an article from Peter Bradley in *GEO Q4* on the subject of the 'East African Glaciers and Ice Fields', a follow-up to my 'Snows of Kilimanjaro' piece in *GEO's* Launch Issue.

Thanks

Finally more thanks. I have a very good friend, David Simmons, who will be embarrassed to read this. David was at Leicester and is planning to come to Guildford. When I get stuck with technical problems he comes to my house and helps me out. My thanks to him. But *GEO's* biggest vote of thanks must be to our *contributors*. I hope they are satisfied to see their work in such a fine publication—which is also a tribute to our editor.

The Transit of Venus

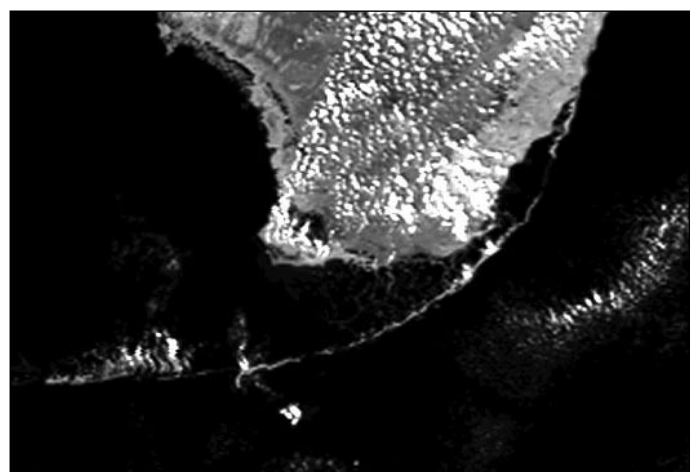
I thought subscribers might be interested in this photograph I took of my solar observatory during the recent transit of Venus. Well you don't often have a chance to do this. Just try! The shadow from the tube of *Pringles* (sour cream and chive flavour) gave me a regular check of azimuth. Elevation was more delicate and required me to slacken the clamp on my workbench and tilt the binoculars. Focal length for the image was 90 cm. I was within three minutes of acquiring the published time for the transit and three minutes for its loss. Okay, so my binoculars have some chromatic aberration and edges are not always perfect.



Two things puzzle me. Why was my image upside down compared with published images? And when can I see the next transit of Mars?—No answers please, the answers are embedded in the text!—And yes, I did eat the Pringles. For a more in-depth report on this Venus transit, read Lawrence Harris's article on page 15.

Key West

Thanks must go the Stephen Padar for the image of Key West shown here. Stephen lives in Florida and is experienced in weather satellite reception.



I spent some time with him at a NOAA conference in Miami about two years ago. It is very encouraging when *GEO* members respond to small questions posed in our Quarterly publication. It shows that people actually read our Quarterly rather than just looking at the pictures. It was in *GEO Q1* that I asked: 'Could anybody submit an image of Key West?' (That was my Ernest Hemmingway connection; he had a house

there). Stephen has done just that and our thanks to him. The Image is HRPT from NOAA-16 from March 4, 2004.

Although I have been there, Stephen's image prompted me to examine a map of Key West, which is an island connected to the mainland by bridges and causeways. It is about 6 km long and 1.5 km wide so not easy to image from a weather satellite. It has a small airport. If you're not sure of Key West's location, it is the most southerly tip of Miami State, and is the southernmost point of the contiguous USA; that is you can get to it by road! Although the climate there is delightful it is not tropical. My map revealed that Key West is about 120 km north of the tropic of Cancer.

There is one state in the USA which is tropical and that is Hawaii. It's about 200 km south of the tropic of Cancer. American sugar-cane barons annexed the islands against the wishes of the indigenous Polynesians on July 7, 1898. If you want to know the importance of sugar-cane as a crop re-read GEO Q2 page 27. Well British colonial history isn't perfect either and Hawaii does now give the Americans somewhere warm to go to and get married—several times!

Obituary

Silent Key - Vale VK2AAE.

by *Michael Stubbs-Race VK2ASR (G3JYE)*

It is with profound regret I have to record the passing of *Arthur Andrews* VK2AAE (Andy), following a heart-attack, on May 19, 2004, at the age of 67 years.

A friend of mine for many years now, we enjoyed putting the world to right several evenings through the week. Andy was a keen amateur and most *professional* in his conduct on air.

He was widely known for his many articles written on weather satellite imaging and farming matters for the various magazines he had served for the past 15 years at least.

Andy had wide-ranging interests, including an excellent grasp of satellite imaging, which would have been his favourite subject. He was engaged in proving trials for a new satellite receiving system up until the time of his death.

I shall indeed miss his friendly voice, as I am sure his vast readership will miss his many reader-friendly articles and advice.

Our heartiest condolences go to Hazel, his wife of 42 years, daughter Helen and son Nigel (VK4FNA).

Requiescat in Pace

The 2004 Satellite Direct Readout Conference 'A Decade in Transition'



Darrell R Robertson

NOAA invites Direct Readout users to its upcoming "2004 Satellite Direct Readout Conference: A Decade in Transition", scheduled for December 6-10, 2004 at the Hilton Miami Airport and Towers Hotel, Blue Lagoon Drive in Miami, Florida.

NOAA expects more than 250 participants from more than 40 countries to attend. NOAA and NASA are cooperating in this year's conference to bridge the L-Band and X-Band user community with the goal of serving as an information exchange.

The conference will also provide a forum for vendors to display and discuss their products and services. NOAA is currently working on a web site where more details will be available in the near future, at:

<http://DirectReadout.noaa.gov/miami04/>

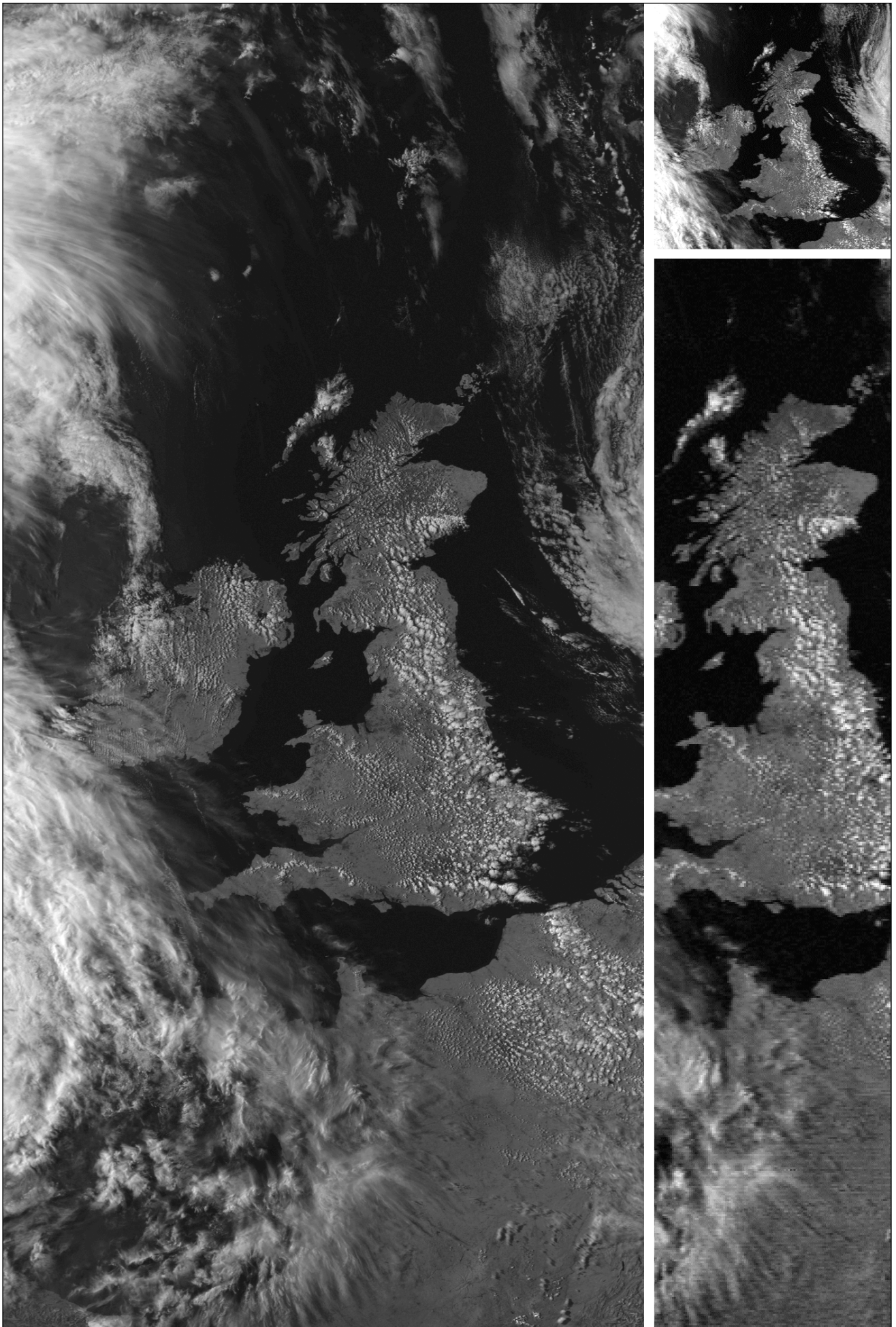
During the next decade, the transitioning into new technologies for NOAA satellite systems will result in significant changes. These will affect all current and future users of NOAA satellites, particularly those who receive data directly from the satellites. In time, all users will have to modify or replace current receiving equipment and basic processing software as the next generations of satellites begin operation. The purpose of this Direct Readout Conference is part of a continuing effort to prepare all users for these changes.

HRPT and APT A Comparison

David Taylor sent us both the HRPT and APT versions of the 16:06 UT channel-2 (vis/near IR) pass from NOAA-12 on June 25 this year, which shows a ridge of high pressure over Great Britain (*opposite page*).

When launched in 1991, NOAA-12's evening passes at around 18:30 UT were too under-illuminated to produce good channel-2 images. But now, as a result of the continuous precession of the satellite's orbit, NOAA-12 is providing some exceptional afternoon imagery.

David makes an interesting comparison between the APT image (inset top, and enlarged, lower right) and the HRPT image. The enhanced HRPT detail, where the maximum ground resolution is one kilometre per pixel is clearly apparent. The APT images have a maximum ground resolution of only 4 km per pixel.



NOAA-12 channel-2 image acquired by David Taylor on June 25, 2004 (16:06 UT)
The main image is from the HRPT data stream. The APT image is shown at upper right using the same resolution, and at lower right, a strip is enlarged to provide a direct comparison with the HRPT image.

NASA's Other Earth Observing Spacecraft

Part 1 - Spacecraft Currently in Orbit

Peter Wakelin

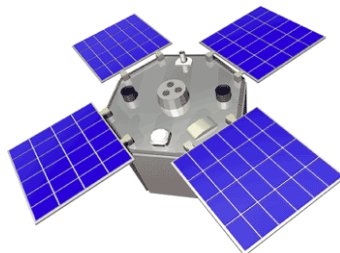
The NOAA polar-orbiters and the GOES geostationary weather satellites are familiar to our readers but there are numerous other NASA Earth observing spacecraft either in operation or in the design and construction phase. These spacecraft are providing huge amounts of data for NASA's Earth Science Enterprise (ESE), and others, to increase our knowledge of atmospheric composition, the carbon cycle, climate variability and change, the Earth's surface and interior and the water and energy cycle as well as the weather.

NASA joined the Coordination Group for Meteorological Satellites (CGMS) in 2003 and at the 32nd annual meeting of the CGMS held in Sochi, Russia in May 2004, provided information on their present and future research and development spacecraft. That information has been used as a basis for this article and I am grateful to the CGMS Secretariat for making it available so promptly.

ACRIMSAT

(Active Cavity Radiometer Irradiance Monitor Satellite)

Launched in December 1999, this satellite measures total solar irradiance to determine the character and variability of solar radiation.



ACRIMSAT

Terra

(Measurement of Earth's climate system)

Some readers will be familiar with imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) carried on this satellite but it also incorporates the instruments CERES (Clouds and the Earth's Radiant Energy System), MISR (Multi-angle Imaging Spectro-Radiometer), MOPITT (Measurement of Pollution in the Troposphere) and ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer).

This is an international mission, launched in late 1999, with instruments supplied by Japan and Canada as well as the USA and provides global data on the state of the land, oceans and atmosphere.

Jason-1

(Ocean surface topography)

This is a joint mission between the US and France and carries equipment to measure sea surface height with great precision. In addition to an array of laser retroreflectors and a solid state radar, it carries a microwave radiometer and a DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) receiver as well as a GPS tracking system. It has been in orbit since December 7, 2001 and is a follow-on mission to the highly successful TOPEX/Poseidon.

Aqua

(Collects information about the Earth's water cycle)

Like Terra, Aqua carries MODIS and CERES. It also carries infrared and microwave measuring devices to derive temperature and humidity profiles of the atmosphere and has been orbiting since May 4, 2002.

ERBS

(Earth Radiation Budget Satellite)

Launched from the Space Shuttle Challenger nearly 20 years ago, this satellite is still returning useful data. It was designed to investigate how energy from the Sun is absorbed and re-emitted by the Earth and to determine the effects of human activities (such as the burning of fossil fuels and the use of CFCs) and natural occurrences (such as volcanic eruptions) on the Earth's radiation balance.

Landsat 7

(Acquires 30 m resolution imagery of the Earth)

The Landsat series of imaging spacecraft started in 1972 and has been very successful. The latest one, now nearing the end of its five-year design life, provides moderate resolution digital imagery of the Earth's continental and coastal areas with global coverage on a seasonal basis using the ETM+ (Enhanced Thematic Mapper Plus) instrument. Operated by the US Geological Survey since the year 2000, its data applications include agricultural efficiency, air quality, aviation safety, coastal management, public health and water management.

Landsat's sun-synchronous orbit repeats the same ground track after 16 days and, on the daylight side of its orbit, passes overhead in mid-morning when average cloud cover over land is at its minimum.

NMP EO-1

(New Millennium Program Earth Observing-1)

EO-1 was designed to demonstrate and validate advanced instruments and spacecraft systems but has returned useful scientific data as a by-product of its testing. ALI (Advanced Land Imager) data is used to measure land use changes. It was launched in November 2000 into an orbit similar to that of Landsat 7.

ICESat

(Ice, Cloud and Land Elevation Satellite)

The primary goal of ICESat is to quantify ice sheet mass balance and understand how changes in the Earth's atmosphere and climate affect polar ice masses and



ICESat

global sea level. ICESat also measures the distribution of clouds and aerosols, as well as land topography, sea ice and vegetation cover. The sole scientific instrument on ICESat is the Geoscience Laser Altimeter System (GLAS) which combines a precision surface lidar (Light Detection And Ranging) with a sensitive dual-wavelength cloud and aerosol lidar. The lidar technique requires the satellite's position to be known precisely and ICESat collects data for calculating its position in space by using onboard GPS receivers augmented by a network of ground GPS receivers and satellite laser ranging stations.

ICESat was launched on January 13, 2003 into a near-polar 600 kilometre circular orbit with a ground track repeat cycle of precisely half a year.

QuikSCAT

(Quick Scatterometer)

Launched in June 1999, this satellite carries *SeaWinds*, a specialised microwave radar for measuring sea surface wind speed and direction for global climate research and operational weather forecasting and storm warning. An almost identical instrument was launched on Japan's ADEOS 2 spacecraft in December 2002 to provide similar observations beyond the QuikSCAT mission.

TOPEX/Poseidon

(Topographic Experiment/Poseidon)

This joint mission between France and the US began its global ocean monitoring in August 1992. It carries a dual-frequency NASA radar altimeter, a single frequency CNES (Centre National d'Etudes Spatiales) radar altimeter and a microwave radiometer. To measure the spacecraft's precise position it is equipped with GPS receivers, a laser retroreflector array and a DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) receiver.

TRMM

(Tropical Rainfall Measuring Mission)

TRMM is a joint mission between NASA and JAXA (Japan Aerospace Exploration Agency) to measure tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation which shapes both weather and climate around the globe. Launched in November 1997, the satellite is operating well beyond its three year design life. Its instruments include CERES (Clouds and the Earth's Radiant Energy System), LIS (Lightning Imaging Sensor), TMI (TRMM Microwave Imager), VIRS (Visible and Infrared Scanner) and a precipitation radar.

Its low inclination orbit means it operates only between latitudes 35°N and 35°S but around 90 percent of the 1,100 cubic kilometres of rainwater that reaches the surface every day fall within this area.

SORCE

(Solar Radiation and Climate Experiment)

Launched in January 2003, SORCE is a joint project with the University of Colorado's Laboratory for Atmospheric and Space Physics in Boulder. The 290 kg spacecraft was orbited by a Pegasus XL rocket which was carried aloft by a modified L-1011 carrier plane. The drop over the Atlantic Ocean was followed by successful burns of all three Pegasus XL stages. SORCE



The launch of SORCE in 2003

carries two main instruments; TSIM (Total Solar Irradiance Monitor) and SOLSTICE (Solar-Stellar Intercomparison Experiment) to measure the total solar output for climate studies.

UARS

(Upper Atmosphere Research Satellite)

The Space Shuttle Discovery lifted off on September 12, 1991 carrying this very large, complex spacecraft. It was released three days later and began many years of gathering data on the high atmosphere including measurements of solar UV irradiance and solar flux as a function of time, energetic electron atmospheric energy input and the mapping of atmospheric winds.

GRACE

(Gravity Recovery and Climate Experiment)

GRACE is a cooperative mission with Germany to obtain an accurate global determination of both the static and the time-variable components of the Earth's gravity field. It was launched on a Russian rocket on March 17, 2002 and carries the Star Camera Assembly and SuperSTAR accelerometers as well as instruments to measure its precise position.

The above is just a brief outline of some of NASA's research satellites; much more can be learned by entering a spacecraft's name in an Internet search engine. Part two will give some details of spacecraft nearing launch and others currently under development.

Forward Error Correction Explained

Alan Swards

In the column 'In Tray' in the launch issue of GEO Quarterly, Francis Bell asked about forward error correction. 'How can you correct an error which has not happened yet?' he asked. This short article aims to demystify the subject without getting into the detail of how the error-correction codes work.

ARQ Anyone?

In earlier days of communications, the normal method of coping with errors in transmission or reception of a message was to ask for a repeat. This procedure, known later as ARQ (automatic repeat request), involved the use of a back channel to send the request over. With two operators involved in an exchange, this is of course no problem, but if there is no back channel (such as in the case of DTH TV—direct to home television), or if there are many receivers for a message, some of whom may have received it OK and others not, the ARQ procedure cannot be used. It is interesting to note that, although ARQ is regarded by some as impossibly archaic, all the traffic on the Internet still uses it, embedded in the familiar TCP/IP protocol.

Forward Error Correction

To cope with the exceptions, the idea was developed of including additional information with the transmitted signal: this would enable any errors to be corrected at the receiving end. This was done by passing the transmitted digital bit-stream through an encoder which added redundant parity bits according to an algebraic algorithm, outputting a longer sequence of code bits called a codeword. The codewords were then transmitted to the receiver which used a suitable decoder to extract the original bit sequence. Suitable choice of the algorithm permitted errors to be detected and corrected. This approach was known as forward error correction (FEC).

Improved Coding Schemes

In 1955, another scheme of coding was introduced, known as convolutional coding, in which the data is processed as a stream of bits rather than blocks of data. The advantage of this approach is that the encoding of any bit is strongly influenced by the bits that preceded it—in other words, the scheme has memory. The decoder can then take into account this memory when trying to estimate the most likely sequence of data that would have produced the observed sequence of code bits. Early decoders used a process known as sequential decoding that used a systematic procedure to search for a good estimate of the message sequence, but this procedure was complex and time-consuming and did not offer graceful degradation.

Improved Decoding Schemes

In 1967 Andrew Viterbi invented a decoding scheme which has become the standard for decoding convolutional codes. At each code interval, the decoder compares the actual received code bits with those which might have been produced for each possible memory state transition. It chooses the most likely sequence within the particular time frame, using metrics of similarity. The Viterbi algorithm requires less memory and processing than the earlier approach and performs robustly.

Deep Space Needs FEC

Later developments included the concatenated code, in which an algebraic coder is followed by a convolutional coder, with the reverse for decoding. This approach combined the advantages

of the algebraic code in handling burst errors with those of the convolutional code with random errors. Thus any burst errors resulting from the convolutional decoder would be effectively corrected by the algebraic decoder. Performance was further improved by using an interleaver between the two stages to mitigate any bursts that might be too long for the algebraic decoder to handle. Codes of this type were used by *Voyager 2* on its encounter with Uranus in 1986 and are used for the *Deep Space Network* and the US Air Force *Satellite Control Network*.

Extra Bits Needed

The encoding process used in forward error correction produces a number of additional bits for each given number of data bits and these are added to the transmitted bit-stream, which increases the amount of data to be transmitted. For example, a 40 MHz bandwidth satellite transponder may have only 23 MHz available for TV data as the remaining 17 MHz are used for parity bits. Other schemes produce one parity bit for each data bit—this is known as a rate $\frac{1}{2}$ code. Other common codes use rate $\frac{3}{4}$, rate $\frac{5}{6}$, rate $\frac{7}{8}$. Generally, the more parity bits added, the more powerful the code, but at some point the additional data to be sent begins to cut into the channel capacity, and a compromise is necessary.

FEC Is Everywhere

FEC coding is becoming very common today as it offers significant improvements in performance and the required processing power is available cheaply on chips. The common Compact Disk, for example, uses block coding FEC to protect against read errors (no back channel available here!), as do DVDs and computer hard drives. Common coding schemes used are the Reed-Solomon, Golay, BCH and Hamming codes. DTH TV would be quite impracticable without FEC as the satellite transponder power would have to be hundreds of watts or the receive antenna several metres in size. Cellular (portable) telephones also make use of FEC to obtain adequate range performance with the low output power that has become the norm.

Turbo Coding

The most recent development in FEC is turbo coding, invented in the early 1990s by two French engineers. This scheme uses two relatively simple convolutional codes and an interleaver to produce a block code. The interleaver is designed such that the second encoder gets an interleaved version of the same data that went into the first encoder, thus the second encoder generates an independent set of code bits. It has the great merit that it performs within a fraction of a decibel (dB) of the theoretical limit calculated by Shannon. Such codes are beginning to be introduced into DTH TV systems.

How Much Do You Get?

To put some real numbers on the table, assume that we have a channel for which we require a bit error rate of 10 to the power -6 (i.e. 10^{-6}). Convolutional codes can provide an improvement of about 5.5 dB compared with an uncoded system, while concatenated codes manage 7.75 dB. The turbo code, on the other hand, can produce an improvement of 10 dB. When you think of antenna diameters or transponder output powers in terms of decibels, these are powerful numbers!

Receiving Weather Satellites from Vietnam

Fred van den Bosch

At least once a year we visit the family of my Vietnamese wife Minh. They live in Nha Trang, a nice quiet bathing village on the east coast of Vietnam, about 400 km north of Ho Chi Minh City. Since last year I have been trying

to receive weather satellites there. That first year I had a lot of problems finishing my equipment due to a lack of time and a hard disk crash of my laptop. Fortunately I was able to borrow an antenna and receiver so that I

could receive some pictures. This year I planned to do it better. I started earlier with rebuilding the antenna and receiver but the travelling for my job cost me a lot of time so I finished everything just shortly before our leaving.

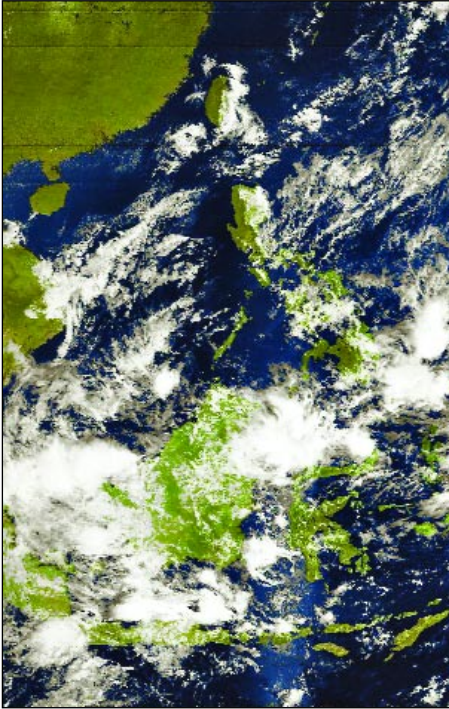


Figure 2 - NOAA-17 at 02:16 UT



Figure 3 - NOAA-17 at 04:07 UT

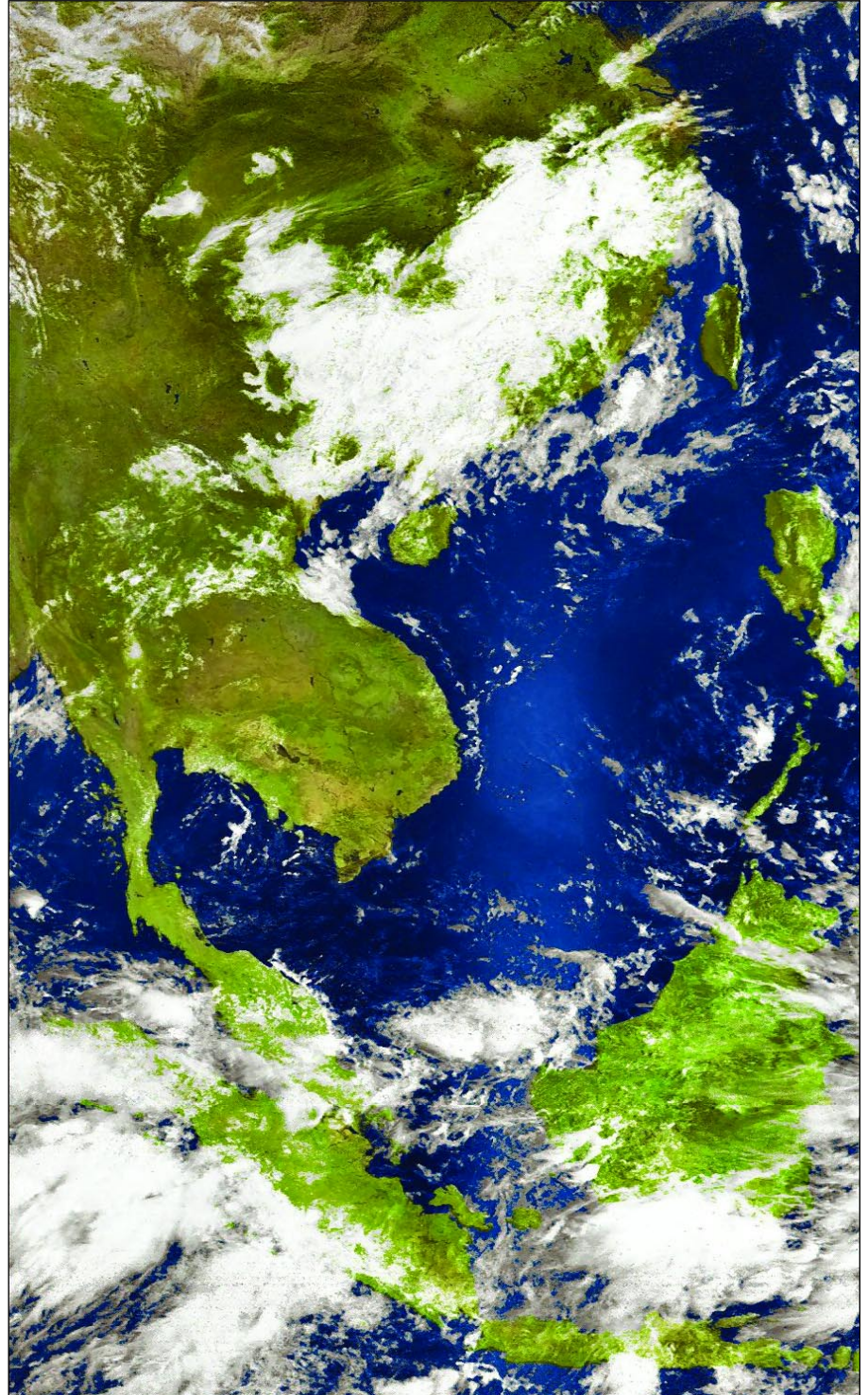


Figure 4 - NOAA-17 at 03:07 UT on March 16, 2004

Antenna

The antenna I used was the PITA 137, a QFH antenna developed by Ruud Jansen and described in the Dutch magazine *De Kunstmaan* of April 2000. The filars are made from measuring tape (figure 1). My antenna is basically the same as Ruud Jansen's but I changed a couple of things, based on the borrowed antenna and my experiences in using it.



Figure 1 - The antenna mounted on a roof-top ladder

Very bad weather in Holland shortly before our departure meant that I could only test the antenna indoors. In general reception results in my house are very bad. But I put the antenna in front of a window and set out to see if I could receive a signal. That turned out to be possible so I decided to take the risk and do further testing in Vietnam in a much better temperature. And the results there were surprisingly good. The antenna was placed on a ladder on the roof of the house, about 12 metres above the ground.

During a couple of days there was a storm and it became clear that my antenna was not really storm-proof—the filars became all twisted and bent. The whole antenna was leaning over by about 30 degrees because the small tripod I used could not stand the pressure of the wind. Nevertheless the images I made that day (March 9, 2004) are rather good. You can hardly see any difference compared with 'normal' days (figures 2,3). Figure 3 shows more noise because this was a rather low pass and in that direction there are mountains.

Figure 4 shows an image taken after righting the antenna. At the top is China, Vietnam is prominent at centre while most of Indonesia can be seen to the south.

Receiver

The receiver is an *RX137* from the Dutch book *Handboek Weersatelliet-ontvangst* of Rene Reudink. I bought it second hand. The receiver was originally built in a rather big cabinet, so I rebuilt it in the smallest possible cabinet and added a few features—like a switch for predefined frequencies.

Program

I use *WXtoImg* for decoding the signals. An advantage of this program is that it gives pass lists in both UT and local time for those who want to see which areas are shown on the images. As Ground Station Location I used latitude 12.25°N and longitude 109.18°E. The time difference compared with UT is +7 hours. In my original experiments, I used a minidisk for storing the satellite signals but the colours of my MSA-pictures were terrible. I haven't looked for the reason yet. In Vietnam I choose the easiest solution: I sent the signals directly to my laptop and obtained much more satisfying colours.

The Images

I was a bit limited in the number of useful passes available. Rising early during my holiday is in general 'out of discussion'. In the evening the darkness comes rather early. Beside that there were also the social duties. Family and friends often visited or invited us out just at those times when the best passes were due (indeed, having a holiday is a tough task!). But I succeeded in receiving some nice images. And that was of course the main reason of doing all the 'hard work': receiving pictures from a part of the world you don't get so often.

Suggestions for Articles

Finally, I would like to finish with a 'wish list' for the kind of articles I would like to see appearing in future issues of *GEO Quarterly* (to help me improve my images).

How can you improve your images with photo programs like *Paint Shop Pro* or *Photoshop*. I don't mean combining images in the way that Ferdinand Valk described in his recent article but the more 'basic' things, such as:

- what options are useful and how to use them
- what colours to use (because I am a bit colour blind)
- how to remove noise etc. from the images. I use *WXtoImg* but there are perhaps better ways.
- how to give all your images the same colour / brightness / contrast (as a start for combining images - *WXtoImg* does not work completely satisfactorily here).

Of course there are books about this but my idea is to have an article with operations specific for weather satellite images. At least I can use the hints!

Well, what about it! [Editor]

Here's a great opportunity for some of you more experienced GEO readers to share your techniques with Fred and other relative newcomers to weather satellite imaging. Please send your contributions to:

editor@geo-web.org.uk

Callington Space Centre



Beth Rose

Callington Space Centre is positioned 50° 30"N, 4° 19"W in Cornwall, UK. It is dedicated to the promotion of Space, Astronomy, and the awareness and use of science and technology. It seeks to motivate and educate the students and the community of today. The centre runs a wide variety of courses ranging from residential overnight experiences and open days, to courses directed at talented students. The Centre also runs adult astronomy workshops using the latest telescopes, and wishes to encourage their use by everyone in the local community.

The centre is also engaged in setting up a weather station for reception of APT and Geostationary satellites, with some equipment donated by *Dartcom* (a local company). There are also plans to receive directly data from the latest EUMETSAT MSG digital satellite and to provide direct reception of the NASA and ESA television services. This will provide a higher degree of technical background information for the students.

These future developments will allow the development of the Callington Space Centre as a cross-curriculum resource and enable it to keep abreast of all the latest advances and space-related developments. The Centre has fostered a wide variety of local support, and is encouraging interest within the community by demonstrating the extent of the work that is going on at the Centre by its open days and other activities.

New educational modules have been written with the focus on primary students, aiming to

make them more aware of the technology we use to gather data on Earth. This will hopefully provoke students to take up technical courses having left college, and help in maintaining the countries leading role in remote observing and space technology development.

The centre has applied to EUMETSAT for educational data access to the newly launched Meteosat Second Generation Satellite (Meteosat-8), which would not have been possible without the continued lobbying of certain individuals within the amateur community to keep the data access free for educational use. This will provide a massive amount of data for use by the whole of the Callington Community College.

NASA Scholarship

On a personal level, my time at the Centre has been extraordinary, and ten months ago I had the opportunity to travel to America. A scholarship placement with NASA is not the conventional work experience for students studying the first year of their A levels! However through the Callington Space Centre this proposal became a reality and threw up a landscape of opportunities to all involved.

For a chance to experience the wonders of NASA, each student had to go through a six month selection process to demonstrate to the judges that they possessed "The Right Stuff". The fifteen candidates varied hugely and all had qualities which might secure them a place. The selection was tough and enduring involving intelligence tests, endurance runs and many other disciplines bringing out both the best in

The Weather Station

Mike Grocott

The Weather station we are setting up within the Space Centre is designed to encourage the public to become more aware of the benefits that satellite technology gives us. Most people think of space as being either shiny things in the night sky or astronauts; many do not realise the leading role the UK has in the field of remote observation. The Space Centre and the weather branch hope to address that lack of understanding.

The whole system was brought sharply into focus on the afternoon of Friday, March 26 this year, when one of our students switched on the system and captured the image of a cyclone heading towards the coast of South America, a classic image of a natural phenomenon. The ease with which the image came down and its clarity were exceptional and as we all realise, people love anything that is easy. The event was made more special when, on the news that night, the students heard the report of the cyclone. They understood the excitement of discovering news before anyone else around them. The image is now on the college intranet where it is provoking more interest than ever in the idea of watching the Earth from above.

Although still in its early stages the idea is for me to get the students to start learning how to use the software to develop the colour imaging etc. I have found that students tend to find more time to use computers than I can!. We are always looking for support and advice so please let us know of any good sites or tips to make life easier for a busy teacher and information hungry students.



Figure 1 - The ISSET Champions 2003 (Beth's Team). Beth is pictured at far right of the group as the crew prepare to launch their rocket at Johnson Space Centre.



Figure 2 - Students of St.Mellion Primary school, Mike Grocott Director of the Space Centre, Portreeve of Callington. Front row - Dr. Martynov, Interplanetary Scientist and Cosmonaut Alexander Volkov (right).



Figure 3 - Callington Space Centre students Beth, Zak and Julia, with Mike Grocott, present a book of condolence to Astronauts Bonnie Dunbar and Andy Thomas.



Figure 4 - The Weather Station at Callington Space Centre



Figure 5 - The APT antenna and Meteosat dish



Figure 5 (above)
The Meteosat-7 image
pictured during reception

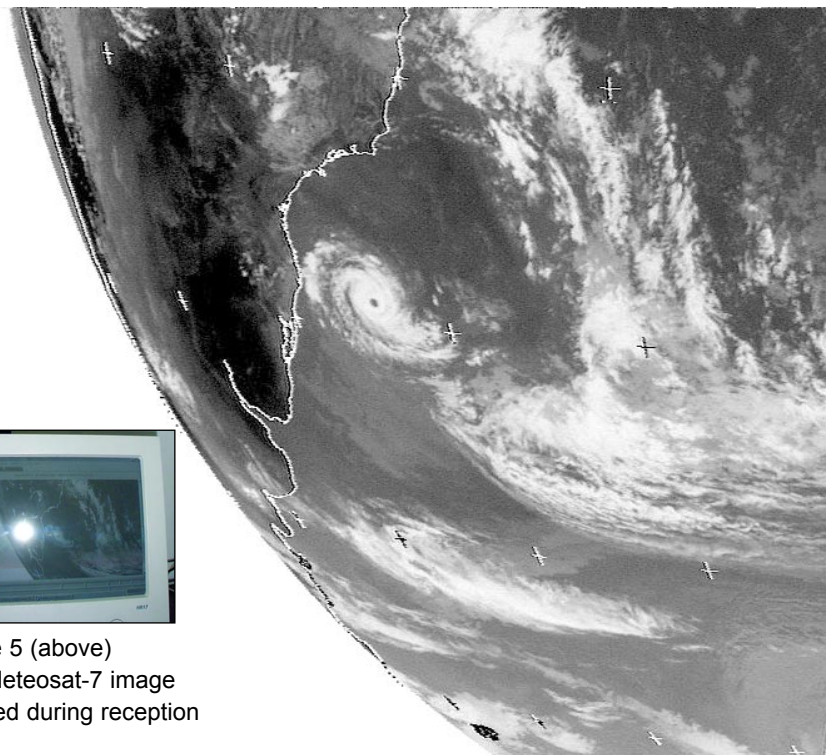


Figure 6 - The Meteosat-7 image of the cyclone in the south Atlantic Ocean

people, and sometimes the worst, each discipline carefully constructed so that all areas of skill could be tested. After months of waiting my name was announced as one of three students who would represent the Space Centre, County and Country embarking on the adventure of a lifetime to experience the extraordinary!

Two other students, Zak Bourn, Julia Geall and myself travelled with Mike Grocott, Director of the Space Centre to the USA. Mike had helped lead this trip several times in the past, returning each year with an ocean of enthusiasm. Every year the experiences were spectacularly different, from watching a launch as a VIP at the exclusive VIP observation point, to participating in a BBC documentary.

After a short flight (sitting next to the ex-mayor of San Francisco!) we arrived in Florida to experience the first week working with employees at the Kennedy Space Centre. There was a huge difference from the tour we were on to the usual tours that excite thousands of visitors each year. A presidential pass ensured that we would see the highly restricted zones and watch how the Rocket Scientists really work.

An exclusive look inside the VAB (Vehicle Assembly Building) caused an outburst of gasps at the sheer height and volume of this fascinating building. The VAB is where the Space Shuttle Orbiters, such as Columbia and Endeavour are assembled before launch, and it is thick with the history of space travel and exploration. This building has fascinated many an audience at presentation evenings with its wonderful array of facts and stories. The flag painted on the side of the building is the largest hand-painted American flag in the world, and the roof could accommodate an American football stadium, with an acre's worth of parking!

Launch pad 39A, is where the shuttles spend their final hours on Earth before being launched in to space and is an inspiring place to be. The general public are positioned on a lookout tower just over a mile from the actual launch pad peering through binoculars. However the Space Centre team, being guests of importance (!) were driven up to the final VIP observation point where NASA employees are allowed to stand. From this angle it was hard to imagine how much power is dissipated on launch as there are few signs of stress on the framework, and it was strange to realise that this was the final stop before the moon, and probably the closest I would ever get.

The second day of the trip proved to be the most exciting. The team of NASA employees who were chaperoning the students managed to arrange a rare visit to view the Mars Rover before its launch to the Red Planet. This is a phenomenal piece of technology! We were told that this 'wondrous object' has only been witnessed by as few as one thousand people—and I was

one of them! Any human contact with the sensors on the Rover would distort the results obtained from Mars, and millions of dollars would be wasted.

It is hard to describe what it was like to see the Rover, being at the very forefront of science, technology and space exploration. There is nothing to compare it with due to it being so unique, and the best explanation would not convey the fascination that gripped me and the other students. There was great excitement back in the UK when we heard news of the successful landing of the two Rovers, Spirit and Opportunity, knowing that what I had seen was now on Mars.

Physics took on a whole new meaning whilst studying with rocket scientists, as I could see the result of calculations and measurements, and the lesson experienced whilst on a roller-coaster is one I shall never forget! However even a good roller-coaster could not compare with the astronaut training facilities, some of which enabled us to push our bodies to the limit.

The Centrifuge was probably the most memorable part of Astronaut Training. This machine simulates the effect of being launched in an Orbiter putting 3G's of pressure on your body, and it was extraordinary to feel the blood draining from your arms. 3G's were great to experience: however the first astronauts had to endure 16G. Your body can continue functioning for a split second at 12G but after that you pass out.

The second week introduced the academic element as we became *Texan Aerospace Scholars* at the Johnson Space Centre in Houston. The group was presented with a three-day challenge involving presentations, analysing rocks, driving Rovers and launching chemical rockets. Three teams emerged with each member taking on a different role; from rock analyser to Rover Control Man. One team captain was also required with each team electing a Callington Space Centre student introducing extra rivalry!

One of my responsibilities as captain was overseeing the distribution of the \$330 million budget with which to make Landers and rockets, and to spend on experiments we wished to conduct. Throughout the challenge we had to cope with pay-cuts, the occasional bonus and declaration of materials that had been classified as unsafe. With each memo new plans had to be formulated and every idea carefully discussed until a solution was found.

It was a fun but sometimes fraught couple of days as each team fought to become the International Space School Educational Trust (ISSET) champions of 2003 (which eventually resulted in my team winning!).

A poignant and reflective opportunity in Houston was the presentation of a book of condolence to NASA for the crew of Columbia; tragically killed during February

2003. The book was signed by members of the local community and presented to Bonnie Dunbar (STS 61-A, STS-32, STS-50, STS-71, STS-89) and Andy Thomas (STS-77, STS-89, Mir, STS-102 next flight STS-114) two of NASA's most prolific astronauts. An assurance from Bonnie Dunbar that the book would be given to Sean O'Keefe Head of NASA emphasised the presence and strong links with NASA that Callington Space Centre is forging.

The final day of the trip was utterly astonishing. Each student had been given a personal invitation from Johnson Space Centre to watch the live video link-up of the launch of the Russian Soyuz carrying one American Astronaut and one Russian Cosmonaut. This event was hugely important to NASA and the Russian Space Programme, as it was the first launch since Columbia and the first time that only two astronauts would be sent to the International Space Station (usually three are sent).

As we drove into Johnson Space Centre, passing the armed security, we saw television crews lining the road watching the build-up to the launch and waiting for the slightest bit of information. I could not believe that they were 'staking out the place' and likewise they could not believe that students from the UK were attending the launch as invited guests of NASA. It was at that point that I realised I would be the only journalist to witness the event as it happened, from inside NASA Headquarters!

The launch was the most exciting and exhilarating moment of the trip, and yet it was excruciatingly slow. As the countdown commenced, the auditorium fell silent, and everyone became fixated on the screen until eventually the Soyuz exploded with a tremendous amount of power and started to gradually lift from the Earth. There were a few stunned silent seconds before the auditorium erupted with cheers and camera flashes catching the historic moment. The Callington Space Centre students had not only watched but had also become part of space travel history. This is just one of the many interesting opportunities the Space Centre offers annually for students who are determined enough to gain a place!

It is not just NASA that the Centre has links with, it has strong relations with the Russian space programme as well. The Callington Space Centre was opened on the 22nd of January 2004 by Colonel Alexander Volkov who has spent a total of over 13 months in space aboard the MIR Space Station as a Cosmonaut, he was accompanied by his friend and translator Dr Martynov who is a Chief Scientific advisor and Interplanetary Scientist, as well as having been the head of Ballistics in Russian Mission Control (Energia). Our guests were exceptionally impressed with the set-up of the Centre, and enjoyed speaking to the students about their perceptions of science and space exploration after they had unveiled a plaque to

commemorate the opening of the Callington Space Centre.

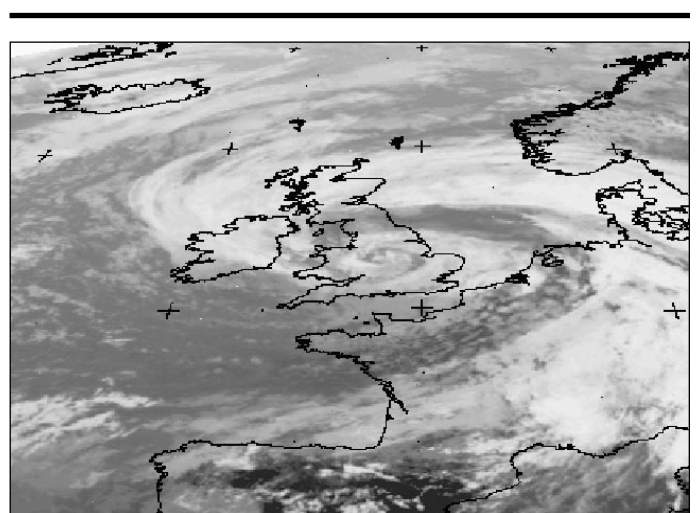
Students can gain scholarships to represent the United Kingdom in Moscow as part of the Russian Space Olympics. Like the NASA scholarship, there is a lengthy selection procedure with Physics, Mathematics, Literature and Computing Exams to be completed, but the resulting lifetime experience exceeds by far the little pressure felt by sitting a couple of small exams.(honest!)

It was not just the trip which has made me so excited about Space, Science and Technology, but also working at the Space Centre with younger and older members of the community. Residential courses have to top my list of Space Centre activities. Children are now on waiting lists to try the Callington Space Centre experience, building rockets, learning about the latest telescopes and astronomy; and hopefully soon they will be able to see live weather pictures from space via the new weather station.

The community is becoming excited about science and space and students are volunteering to sit GCSE Astronomy several years earlier than they will be sitting their compulsory exams. Becoming an astronaut or rocket scientist is now more achievable. Space is the future and the Callington Space Centre is part of that.

If anybody is interested in any of the courses on offer or the public open evenings, they should contact Mr. Mike Grocott, Director of the Space Centre, our contact details are on the website at:-

www.callingtonspacecentre.co.uk



Peter Wakelin provided this Meteosat-7 infrared image received at 1200 UTC on 23 June 2004. It depicts an unusually vigorous summer depression crossing Britain. The central pressure dropped to 982 hPa which is within 5 hPa of the June UK record which occurred on June 5, 1944 (that storm delayed the D-Day landings by 24 hours). High winds on 23 and 24 June felled many trees and road, rail and sea traffic was disrupted. In some places, June's average rainfall fell in just 24 hours.

The Transit of Venus

June 8, 2004

Lawrence Harris

It is amazing to realise just how many objects cross the face of the sun: artificial Earth satellites, such as the ISS; the Moon (during a solar eclipse); a few asteroids and of course the two inner planets, Mercury and Venus. When early astronomers first realised, by laborious calculation, that the inner planets could cross the disc of the sun, they also realised that this gave a rare opportunity to calculate the Earth-sun distance. This was of extreme importance at that time because this fundamental distance was not accurately known: there had been a few estimates but what we know now as the true distance (about 93 million miles) was simply unknown.

Transits of Venus are rare. They happen in pairs over one hundred years apart. No-one alive today saw the last one—in 1882.

Much has been commented about the safe viewing of transits—and rightly so. Unlike a solar eclipse the transit of a planet across the face of the sun is not easy to see. The planet itself is very small against the bright backdrop. Mercury is smaller than Venus and further away from Earth, so when it transited the sun last year few people without suitably equipped telescopes were able to see it. Venus is larger and also nearer, but I personally doubt whether anyone would have seen the tiny black circle without optical aid. A much better way to view most solar phenomena is to project the sun's image from a refracting telescope.

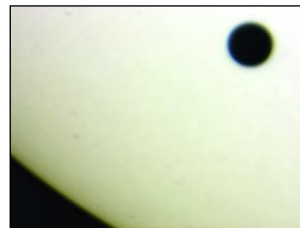
On the evening before the transit I was using my telescope under clear skies but decided to finish about midnight because I had to be up for the transit for 6 am BST. Where was the sun going to rise? I have some unwelcome trees surrounding my observatory; a huge one due south that cuts weather satellite signals until they reach over 30 degrees elevation, and two on my east. At 6 am I was looking across the garden and smiling because the sun had risen between these trees and was clearly going to give me a good view for some hours.

I opened the observatory, powered up the telescope and computer, fitted the solar filter and web camera, and focused the instrument. Locating the sun took me an unusually long time—about 5 minutes—and by the time I finally found the solar limb, Venus had just entered. This 'first contact' (ingress) is of great interest to those doing projects about

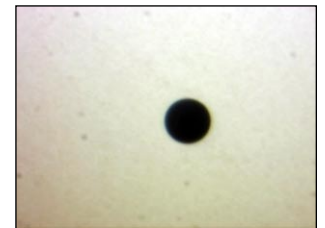


Ingress - 05:49 UTC

the transit—but, hey.—I just wanted to watch. I therefore decided to observe the early stage of Venus entering the sun's disc so that I could look out for the *Black Drop* effect. This was reported by Venus transit watchers of previous centuries and took the form of a black elongation between the disc of the planet and the edge of the sun's limb. It has been reported to last several seconds. I watched the separation of Venus during ingress but hardly anything like a black drop appeared. The image was so clear that I was reluctant to fit the web camera, but I did so anyway. Remember that these days, astronomers are using telescopes with optics of a quality unobtainable in previous years. I suspect that the *Black Drop* effect may have been a function of imperfect optical systems.



07:51 UT



09:04 UT

From then on, everything was recorded for posterity. I collected a large number of 30-second video sequences using a *Toucam Pro* webcam and *K3CCDTools*, a freeware program (at least the version that I used), and collected about 4 Gb of video.

Rather unfortunately, the sun was devoid of sunspots and faculae. These can act as reference points during transits. Instead, I tried to include some of the sun's limb for many of the sequences, though during the middle phase this was not possible.

As the end of the transit approached, I took more sequences because I wanted to include all of the egress, especially any *Black Drop* effect. This proved successful and my final sequence included the last few seconds of Venus in front of the sun.

The next transit is in eight years' time but it won't be visible from Britain. We were therefore very lucky with this one, even though not all areas of Britain had clear skies. For me, it was the best astronomical event that I have been able to record—and I was able to produce a picture in the early stages, for my 5-year old grandson to take to school to show the teacher. It made his day.



Egress - 11:02 UTC

Symposium 2004

Les Hamilton

The dust has settled, the computers, antennas and display tables have gone: all that remains of GEO's inaugural Symposium at the National Space Centre in Leicester last May 1 are fond memories of a truly wonderful day. The packed program featured no fewer than three separate systems downloading live DVB reception of Meteosat-8 imagery, demonstrations of bending copper-pipe filars for the RQHA antenna, talks from a wide range of speakers, the chance to discuss problems with experts and, not least, the opportunity to visit the Space Centre itself, with its topical *Beagle-2* display and its amateur radio station operating GEO's own *GBOGEO* callsign.

First impressions are always important. Visitors to *Symposium 2004* were held spellbound the instant they entered the auditorium by David Taylor's projections of stunning Meteosat-8 imagery on to a big screen. Another major point of focus was Francis Bell's display of live MSG imagery on a laptop PC, illustrated on the front cover of this issue, which emphasised just how rapidly improving technology is bringing high quality imaging from the digital satellites within everyone's reach. There was also an impressive display of official Meteosat-8 images in the form of colour posters, courtesy *EUMETSAT's* Gordon Bridge.

The Symposium was opened by Francis Bell, who welcomed over 60 delegates and speakers. We were delighted to welcome a strong representation from the Dutch weather satellite organisation, *Werkgroep Kunstmanen*, but our most travelled visitor was C S Loh from Kuala Lumpur in Malaysia. Congratulations were offered to *EUMETSAT* on the occasion of the first anniversary of operational imagery from Meteosat-8 (which fell the previous day). It was emphasised that GEO's overriding philosophy was that 'this is a meeting of friends'—we should all enjoy the occasion.

The Speakers

Charles Bishop

Fittingly, the day's proceedings were opened by Charles Bishop, Chief Executive of the Space Centre, who started by explaining that he is not a scientist, but a professional in the field of visitor attraction management—and had previously worked at both Alton Towers and Madame Tussauds in this capacity.

Charles traced the development of the National Space Centre from the mid 1990's, when it was but a mere brainchild of Leicester University, through to its realisation on the site of a former sewage works. Construction commenced during 1999 and the Centre

doors first opened to the public in summer 2001, when it proved so popular that there were regularly 2-hour queues of visitors awaiting admission.

Currently, pride of place in the Centre goes to the *Beagle-2* display, and we learned how this 65 kg Mars lander had developed, through miniaturisation, from an original concept design the size of a family car! Despite the lander's ultimate demise, the Beagle Project really had captured the interest of the public, and the launch of the parent *Mars Express* craft was watched, within the Centre, via a live video feed from Kazakhstan. All this is just part of the Centre's drive to excite people about Space and the next major project will be the building of the *Human Spaceflight Gallery* in time for opening in June 2005.

Geoff Griffiths

An amateur radio station, manned by volunteers, operates within the National Space Centre. Its main purpose is to educate the public in the use of amateur radio through satellites, not just in the field of voice traffic, but also the decoding of satellite transmissions to learn about diagnostics of onboard instruments. Free training courses are offered to radio amateurs, where they are instructed how to operate through satellites. The station has also been able to offer opportunities for school groups to question astronauts aboard the International Space Station. Geoff pointed out that, for Symposium Day, they were operating as an HF station under GEO's own *GBOGEO* callsign, and Ann-Marie Evans took the opportunity to visit the station during the afternoon to make a contact with Poland !

Gordon Bridge

We were specially pleased to welcome *EUMETSAT's* representative, Gordon Bridge, to the Symposium. Gordon outlined the Meteosat-8 story from its funding by a consortium of European national weather services to its role in providing the regular 15-minute scans of weather cover over the oceans of the Earth that are essential for today's short-range forecasting. Gordon described the Meteosat ground segment and revealed that the extent of automation is such that only two or three people are needed to control all three operating Meteosats. The *EUMETCast* dissemination system currently in place for Meteosat-8 will continue for future MSG satellites, even though they will also provide a concurrent direct broadcast facility.

Gordon's talk was well illustrated with slides showing various stages in the development of Meteosat-8 and the appearance of images from all its data channels.



Nadine Bell signing in delegates attending the Symposium
Photo: David Taylor



Nigel Evans and Rob Hollander (right) bending RQHF filars
Photo: Cecilia Taylor



Model of the ill-fated *Beagle-2* Mars lander on display at the National Space Centre



David Taylor (2nd left) discussing his MSG Data Manager software with delegates during the GEO Symposium



Ruud Jansen from *Werkgroep Kunstmanen* holding an impromptu discussion during the afternoon session



The amateur radio station at the National Space Centre, operating GEO's *GB0GEO* callsign for the day



Visitors enjoying hands-on experience of live MSG reception
Photo: Ray Godden



Symposium visitors enjoying a display of Meteosat-8 imagery on the big screen



The display of posters and images by *EUMETSAT*
Photo: David Taylor

But the highlight was a presentation of animations, many in colour, from Meteosat-8. We were regaled, inter alia, by developing thunderstorms over east Africa, a swarm of aeroplane contrails sweeping laterally across Europe, Cyclone Gafilo swamping Madagascar, sand blowing from the western Sahara over the Atlantic, diurnal fog waxing and waning over the Mediterranean, and smoke and hotspots from last summer's forest fires in Portugal.

Finally, Gordon looked to the future and revealed that planning for Meteosat Third Generation, targeted for 2015, was already under way. New features of MTG were likely to include lightning detection and both IR and UV/Vis atmospheric sounding.

Gordon Bridge's entire presentation, including some amazing weather movies, is available from GEO as a 2-CD set. Anyone interested should send a request to Francis Bell, enclosing three first-class postage stamps.

David Taylor

David explained, with the aid of a Powerpoint PC slideshow, the latest developments in using his MSG software suite to create images from the DVB *EUMETCast* relays of MSG data from the *Hot Bird-6* satellite. David described features of the 2-PC system initially recommended by *EUMETSAT*, where a computer of relatively moderate specification could be used to download the data but then pass it to a second networked PC of higher specification for processing and image storage. These systems work well, but advances in design now mean that a single PC with a 2- to 3-GHz processor plus a gigabyte of memory can handle the entire task on its own. David also explained the functionality of each program in his MSG software suite, suitably illustrated by both still slides and animation sequences.

David Taylor has kindly made his entire presentation available to GEO readers on a CD ROM. This is a **Powerpoint** slideshow which covers all the hardware and software issues needed to set up a PC for reception of Meteosat-8 imagery; specifications of various PC systems (twin/single), hardware components, DVB card installation and many useful tips. If you would like a copy of David's presentation, which includes a number of images and animations, please send the Editor £5 for your copy, which includes the cost of P&P. Cheques and postal orders should be made payable to 'Group for Earth Observation'. (You may also send cash, but at your own risk).

Robert Moore

Robert has been an enthusiastic user of Meteosat data for many years, and described his experiences in setting up his MSG station. He detailed how his location in north Wales had proved ideal for studying weather arriving from the Atlantic Ocean, and how the increased resolution of Meteosat-8 has furthered these studies. Robert's talk is presented in full starting on page 42

Arne van Belle

We were privileged to have several members of the Dutch *Werkgroep Kunstmanen* present, all well known for their pioneering work in the field of MSG reception. Arne opened by presenting live Meteosat-8 images on his laptop, projected on to a large screen. Amazingly, this was accomplished using a 35 cm dish with standard 0.6 dB *ALPS* LNB!. With the MSG software still running in the background, Arne proceeded to show us an animation detailing the launch of NASA's *Terra* satellite and continuing to show, in animation, how the instrumentation aboard it operated.

Next followed Arne's own illustrated presentation detailing how to set up an MSG station, covering both the hardware side, and a walk-through of setting up the *Telique* software. He then returned to MSG Data Manager to illustrate how both HRIT and LRIT images build up, and concluded by running the current day's animation showing the cloud over England.

This was followed by a series of archived animations created using *GeoSatsignal*: a 24-hour June 2003 global animation, dust storms over the Mediterranean and the Canary Islands, the birth of a hurricane off west Africa and the Brazil cyclone.

Arne then simultaneously brought up a satellite-TV channel via the DVB link and followed up by treating us to several movie sequences created by a Spaceflight Simulator program. Finally, he returned to MSG Data Manager, which had continued to operate flawlessly in the background all this time—without compromising synchronisation or image acquisition: all possible thanks to a 3.5 GHz Pentium 4 processor!

Rob Hollander

Rob, another member of *Werkgroep Kunstmanen*, gave a presentation on QFH antennas and their radiation patterns. Rob made the point that a half-turn QFH provided better reception for satellites close to the horizon than the alternative quarter-turn version. Most of Rob's presentation, and much more, is detailed in his article on page 26.

Open Forum

Francis Bell set the forum in motion with a brief overview of GEO, detailing the group's creation in November 2003 and its status as a limited company. Discussions ensued on matters as diverse as upgrading the RX2 PIC to handle the new APT frequencies for the NOAA N and NOAA N-prime satellites, the likelihood of 'pager' problems on the higher 137.9125 MHz channel, using David Taylor's ATOVS Reader program, preferences for a paper Quarterly rather than an electronic CD version etc. etc.

Finally, with everyone's queries answered, Francis Bell concluded the day with a vote of thanks to everyone who had contributed towards making the day such an unqualified success.

Earth Imaging News

Peter Wakelin

Weather Satellite Explodes

The Defense Meteorological Satellite Program (DMSP) F-11 spacecraft exploded during April. It was launched on November 28, 1991 and retired four years later. USSTRATCOM catalogued 56 fragments large enough to be detected by the US space surveillance network. Orbital data for the DMSPs are not made public but two-line elements are maintained by hobbyist visual observers. Greg Roberts, in Capetown, observed this satellite after the explosion and found it to be more or less on track with no change to its visual appearance, indicating that the energy from the explosion was insufficient to significantly change the orbit or shatter the satellite completely. Surprisingly, two-line data for the fragments were released, which made it easy to establish that the explosion occurred at about 1500 UTC on April 15.

It is probable that the build-up of pressure in a battery or gas tank caused the explosion. Shortly after launch, DMSPs, and their NOAA cousins, use hydrazine thrusters to trim their orbits. These thrusters are then rendered inoperative. Unspent hydrazine has caused many fragmentations in the past but this is believed to be the first time that a weather satellite has suffered such a fate.

New Chinese Satellites Under Construction

The first two spacecraft in the next-generation Feng Yun 3 series of polar-orbiters are being built and the first, **FY-3A**, is expected up in 2006. There are to be 7 spacecraft in this series and they will operate until 2020.

In addition to a suite of atmospheric sounders, there will be three imagers, one of which, the Visible and Infrared Radiometer, will transmit real-time data in the new AHRPT format on 1704.5MHz. Transmission characteristics will be very similar to those of the European METOP which will transmit on 1701.3MHz but, unlike METOP, there will be no LRPT broadcast at 137MHz.

The other imagers are the 20-channel Medium Resolution Spectral Imager (MERSI) which is very similar to the MODIS on some Western spacecraft and a Microwave Radiation Imager (MWRI).

NOAA-N' (N-prime) Future Still Unclear

NOAA N' was severely damaged in a factory accident last year and, at the time of writing, a decision on the future of the N-prime mission is still awaited. There would appear to be three options: Repair the damaged satellite, build a new one, or scrap the mission completely. Some sources indicate that the damage was too severe to be repaired. The second option is expensive and would take several years. If the third option is taken, then the demise of APT could come several years sooner than anticipated as NOAA-N, due up next February, would be the last to carry APT.

Should the N-prime mission not go ahead, then the risk of the NOAA series failing before the next-generation NPOESS becomes operational (2010 at the earliest) is greatly increased. Three military DMSP craft (now operated by NOAA) are believed to be operational and a further four await launch so some data would still be available. However, the direct-readout data stream from the DMSP craft is not available to hobbyists.

In the meantime, the European METOP data should come on-stream and the NPOESS Preparatory Project (NPP) is due to follow.



NOAA N-prime lies prostrate after its fall at the Lockheed Martin plant on September 6, 2003.

Image: NASA/NOAA/Lockheed Martin

MSG-2 Launch Preparation Under Way

MSG-2 was taken out of storage in April and Arianespace will launch it early in 2005. The month of launch is dependent on the availability of the various versions of the Ariane-5 launch vehicle and possible co-passengers but should be known by September.

Following the failure of one SSPA (Solid State Power Amplifier) on MSG-1, the design was modified and extensively tested. The SSPAs for MSG-2 were subsequently delivered in May. Retrofitting to correct other anomalies encountered during MSG-1 commissioning has also taken place.

An anomaly encountered on the SEVIRI MDU (Main Detector Unit) on MSG-2 during an optical vacuum test resulted in the unit being replaced by the one destined for MSG-3.

The MSG-2 system validation test is currently under way to ensure compatibility between the satellite and the ground segment which has been upgraded to cater for two operational spacecraft.

Forthcoming Weather Satellite Launches

- The next NOAA polar-orbiter, **NOAA N**, has been delayed until February, 2005.
- **GOES N** is due up on December 1, 2004.
- At the CGMS 32 meeting held in Sochi, Russia in May, the Russians reported that **Sich 1M** would be launched in September, 2004.
- The Chinese give October 2004 for the launch of their next geostationary satellite, **Feng Yun 2C**, which will be stationed above 105E longitude.
- November 2004 is the earliest that the Japanese could launch **MTSAT 1R** following the failure of the H-IIA rocket at its last launch attempt.

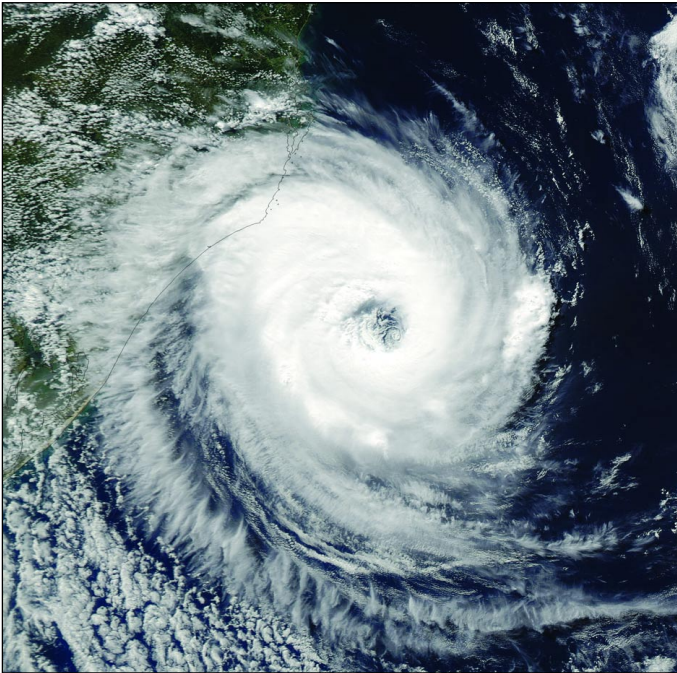


Figure 1 - A true-color MODIS image of 'Cyclone Catarina' acquired by NASA's Aqua satellite on March 27.
Image: Jeff Schmaltz, MODIS Land R R Team at NASA GSFC.

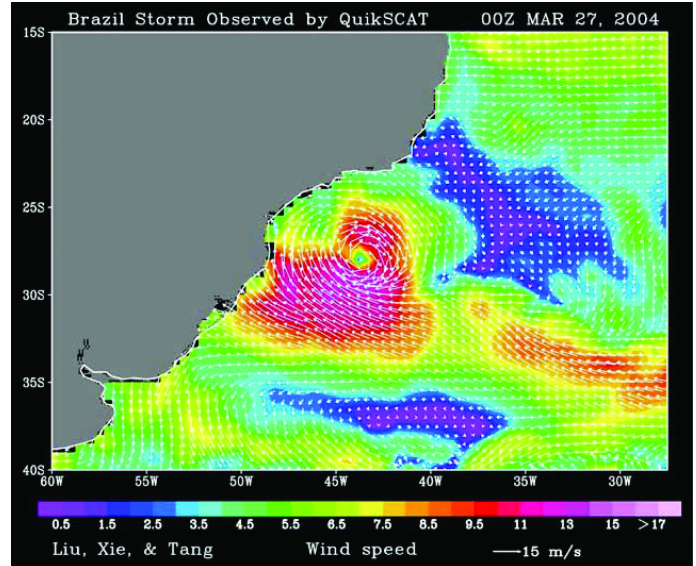


Figure 2 - NASA's QuikSCAT spacecraft and its *Seawinds* instrument produced this image of the first hurricane ever recorded in the southern Atlantic on March 27. The white arrows represent wind speed and direction: the colours indicate mean wind speeds.
Image: W. Timothy Liu at JPL, Project Scientist of QuikSCAT

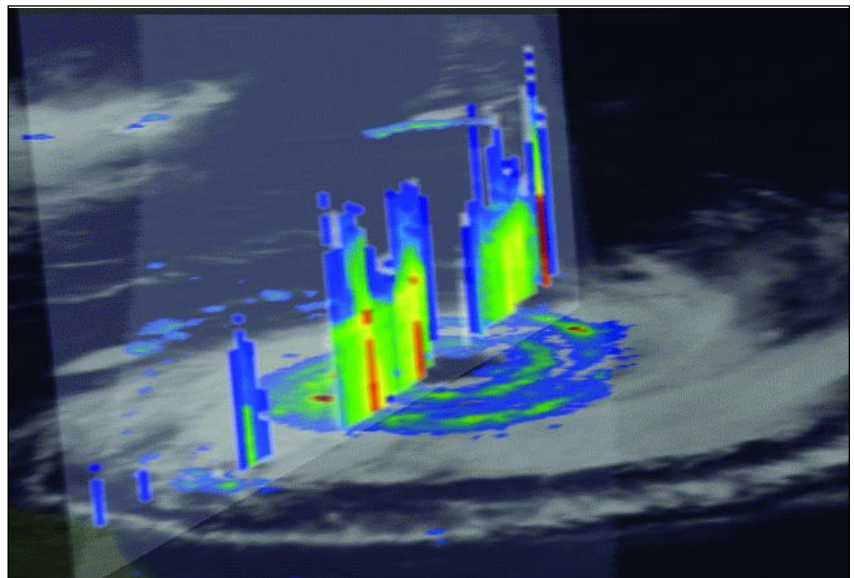
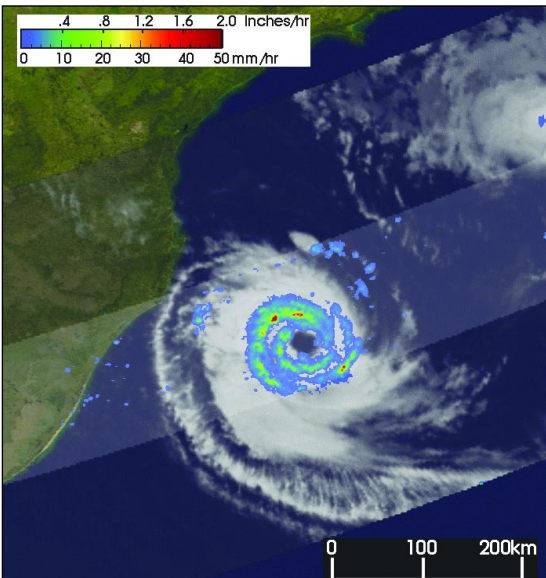


Figure 3 (left) and Figure 4 (right) - TRMM representations of 'Cyclone Catarina'
Images produced by Hal Pierce (SSAI/NASA GSFC)

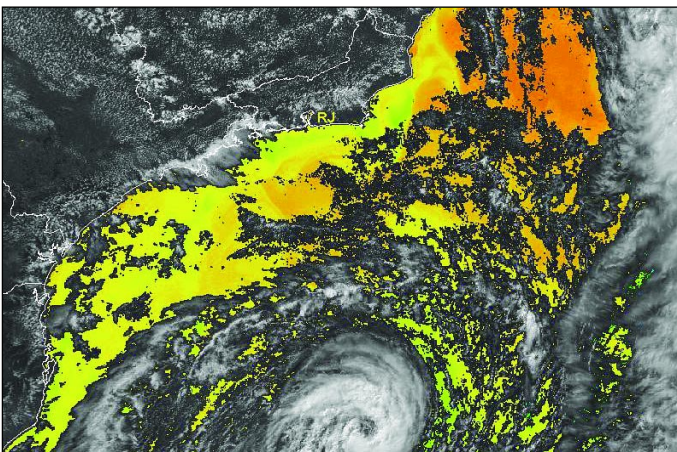


Figure 5 - A NOAA-16 image of the storm acquired on March 25 by Raul Teixeira from Ceará, Brazil.



Figure 6 - This image was taken from the International Space Station just as the storm was about to make landfall.

A STORM TO REMEMBER

Les Hamilton and Raul Fritz Teixeira

Just days before *GEO Q2* went to press there occurred one of the most amazing and unexpected weather events. Almost certainly the first of its type since weather satellites started revealing the Earth's weather patterns in the 1960's, a cyclonic storm developed in the south Atlantic Ocean off the coast of southern Brazil. The theories behind such an event were recounted by Peter Wakelin in our previous issue [1]. Here we look at the event in more detail.

This particular storm was first observed in a NOAA-16 image acquired at the Ceará State Department of Meteorology in Funceme, Brazil by Raul Teixeira. Raul told us:

'A rare cyclone/hurricane is visible near the coast of the south of Brazil in this NOAA image which I obtained at my site near the equator in north-northeastern Brazil. It is a NOAA-16 AVHRR channel-1 (visible) image, overlaid with the mcsst/NOAA sea surface temperatures (figure 5). The red and orange colours indicate the warmest areas. The letters 'RJ' show the position of Rio de Janeiro City. The image was obtained at 17:14 UT on March 25 when the eye of the cyclone was at 28°42 S and 41°55 W. The storm travelled westward almost 300 km during the following 24 hours. The processing of the image was made by the 'TeraScan' System. Unfortunately the image doesn't show all the cyclone/hurricane because it was situated at the end of the pass.'

The very next day, the MODIS instrument aboard NASA's *Terra* satellite alerted the world that something highly unusual was taking place by acquiring a startling image showing what appeared to be a hurricane in the south Atlantic Ocean; an image that appeared on the inside front cover of *GEO Q2*. Figure 1 shows a second MODIS image taken by the *Aqua* satellite shortly before the storm smashed into Brazil on March 27.

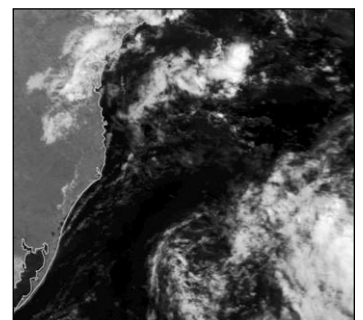
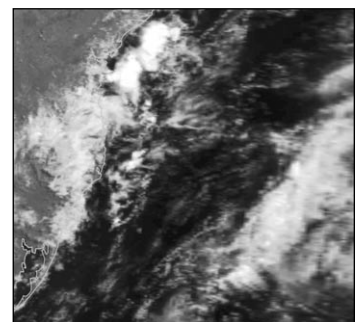
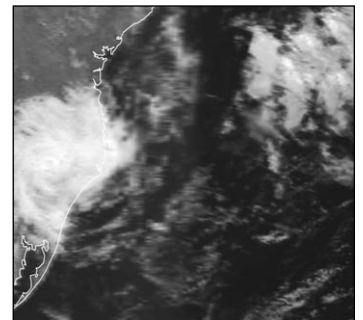
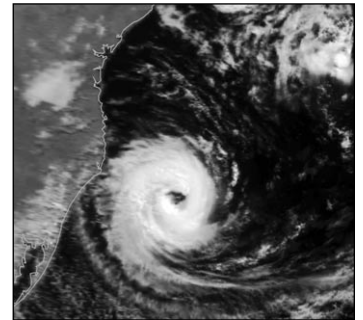
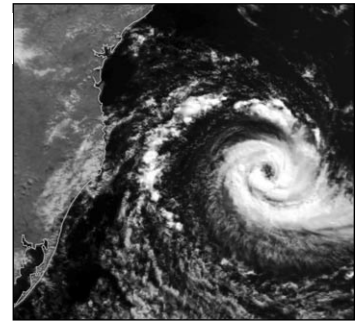
This part of the world experiences cyclonic storms so rarely that although Brazil has weather stations along its southern coast, it lacks the meteorological buoys and instrumented aeroplanes for in-situ measurement of wind and rain from tropical storms over the Atlantic—the main reason why the storm was unnamed. Such storms that do occur in this area rarely make landfall anyway.

The winds were estimated to be a little greater than 120 kph and the US National Hurricane Center in Miami considered the storm to be a full-fledged Category-1 hurricane. Previously, only two tropical cyclones had ever been noted in the south Atlantic basin. Some Brazilian meteorologists disagreed however, stating that the storm had weaker maximum winds and therefore classified it as an extratropical cyclone.

The two sides based their estimates on satellite data only, due to the lack of ground-based wind measuring devices. CPTEC (the Center for Weather Forecasts and Climatic Studies) and INMET (the National Institute for Meteorology in Brazil) produced a technical note stating that the storm, had displayed hybrid characteristics. During the first days following its formation the storm, unofficially named *Catarina* by meteorologists, exhibited a cold nucleus with winds rotating around it in the same direction at both low and high levels (extra-tropical cyclone) while in its final phase it developed into a 'hurricane', with winds characteristically rotating around the eye in opposite directions at upper and lower levels. Analysis of damage indicated wind velocities which were close to 150 kph. However, *Catarina* displayed a clear, well-defined eye for well over 36 hours, a feature that would be unusual for any storm below hurricane-strength.

QuikSCAT

NASA's Quick Scatterometer satellite (QuikSCAT) carries the *Seawinds*



These five NOAA-17 images above show the progress of the storm between March 26-30.

Images: NOAA SAA

Processing: L Hamilton

(using HRPT Reader/Groundmap)

instrument, designed to measure wind speeds over the world's oceans. Although surface winds of about 90 kph were indicated on March 26, the satellite was not ideally positioned to measure the eye where the highest wind speeds occur. But it was a different matter on March 27, when the storm was confirmed as Category-1 and bordering on Category-2 on the Saffir-Simpson 5-level scale (*figure 2*).

TRMM

The Tropical Rainfall Measuring Mission spacecraft (TRMM), which is a joint venture between NASA and the Japanese space agency, monitored the storm using its precipitation radar several times during the days leading up to landfall. This radar penetrates the clouds and detects falling rain within the spiralling bands of cloud to generate false colour images of the storm that depict rain-rates throughout the cyclone (*figure 3*).

Figure 4 is a vertical slice through the storm which reveals mainly moderate intensity rain (yellow) with an embedded area of heavy rain (red) in the western eye-wall. A single area of intense rain (darker red) appears in an outer rain band east of its centre.

Landfall

Catarina made landfall near Criciúma, a town of some 180,000 inhabitants, situated at the southern coast of Santa Catarina. It then moved on to Torres, a famous beach resort (whose population swells to 400,000 during the summer) on the northern coast of the neighbouring state of Rio Grande do Sul, about 520 miles southwest of Rio de Janeiro.

The storm lashed Brazil's southern coast with strongly gusting winds and heavy rain during the night of Saturday to Sunday, March 27-28. Some 500 homes were completely destroyed and an estimated 32,000 more damaged, rendering some thousands of terrified residents—who had never experienced such a storm before—homeless. Many buildings were damaged by falling trees and in the town of Ararangua at least 5,500 buildings lost their roofs. Over the region as a whole several hundred thousand people suffered disruption to power and water supplies while communications between many towns and villages were severed as trees brought down telephone wires.

Overall, at least two people were killed and over 30 injured on land while 12 more were lost at sea after two fishing boats sank nine miles offshore in waves four to five metres high. Two fishermen were rescued from the sea after many hours drifting in the water in lifebelts. By Sunday March 28 it was generally agreed that winds had exceeded the 118 kph hurricane threshold, with some estimates reaching 150 kph, which is well above hurricane strength.

Acknowledgments

- Thanks to Peter Bartlett for additional information used in compiling this report.
- ISS Image ISS008-E-19646 on page 20 courtesy of Earth Sciences and Image Analysis Laboratory, Johnson Space Center (<http://eol.jsc.nasa.gov>)

Reference

- 1 Why are South Atlantic Hurricanes so Rare? - Peter Wakelin, GEO Q2, page 45, May 2004

Copy Deadline for GEO Q4 - Thursday, September 30, 2004

The Editor is always on the lookout for articles and images for the GEO Quarterly. These can relate 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 should the need arise.

Please note, however, that **major articles** containing numerous illustrations should be submitted earlier than the date above so that they can be prepared and made up into pages in time for publication.

Images and Diagrams

Images can be accepted in any of the major bitmap formats, 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.

We can also scan original photographs, negatives and slides.

Please note that we do require individual copies of each of your images/drawings (which are not embedded within your article) for make-up.

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

Digital Weather Satellites and DVB



(Or what's DVB got to do with it?)

David Painter

The first of the new **Meteosat Second Generation** (MSG) weather satellites is already launched and in orbit, and it is the first in a succession of 'Digital' weather satellites. What are the implications for those wishing to receive weather images? And what does 'DVB' mean?

This article was written to give an introduction to DVB and will hopefully help answer some of the questions you may have. It will also introduce you to the minefield of abbreviations that 'pepper' our new Digital Weather satellite system. Please see the Glossary at the end to help ease the pain.

EUMETSAT's original aim was to broadcast the MSG1 data from its satellites directly to users using its own complete data transmission system. This system was developed by *EUMETSAT* to suit its own specific needs and required specific hardware and software designed to integrate into its existing distribution system. This meant that to receive the data as originally intended, users would be required to obtain or build 'unique' hardware to physically receive the new data stream.

The Good News (for us)

The failure of one of the solid state power amplifiers (SSPA's) on board the MSG1 satellite during the testing phase caused a major rethink within *EUMETSAT* about how to redistribute the data from the new satellite. The eventual solution was to integrate the MSG1 data stream into the existing ATOVS 'broadcast standard' downlink from the *Hot Bird-6* broadcast satellite. This meant using another operator's system, so the data had to fit within the space available to it and be compatible with someone else's system hardware and **not** fit *EUMETSAT's* original MSG1 dissemination plan.

The result of this was that the hardware required by the end users would now no longer need to be 'unique' to the *EUMETSAT* system, and could be an 'off-the-shelf' receiver/decoder unit built to an industry standard already in use. But why did *EUMETSAT* choose DVB?

It is extremely lucky for the amateur fraternity that the majority of European digital satellites are based around the Digital Video Broadcasting standard (DVB for short), as this meant that the MSG data downlink **had** now to become compatible with the satellites in orbit and domestic DVB equipment.

This meant a **massive** cost saving for all users in the hardware required to physically receive the signal; the minimum required dish size was reduced, the LNB became a universal domestic one and the receiver became the off-the-shelf, well proved and available *Skystar2* PC card.

EUMETSAT still had software issues to resolve but the difficult matter of how to receive the signal had already been cheaply solved for us. This does **not** mean that the trusty soldering iron is redundant yet: it just means that there will, hopefully, be other projects for it to do later.

Because the DVB standard is really a group of standards that 'knit' together, it allows an operator to 'pick and choose' or 'tweak' the parts that suit the needs of the operator. The versatile DVB standard allowed *EUMETSAT* to rapidly tailor the system needed to deliver a data 'package' to an end user or customer, without loss or corruption of that data via a domestic system.

EUMETSAT chose to broadcast a special format data stream called *Tellicast*, that uses the *Tellique* software. This *Tellique* software is vital as it manages the delivery of the data streams and reassembles the DVB data packets transmitted by the DVB satellite back into computer data files that can be accessed by the users' software.

The reconstituted computer data files are reformed into the three separate data 'channels' that comprise the *Tellicast* data stream:

- Channel 1-ATOVS- Rapid Scan data
- Channel 2-HRIT data
- Channel 3-LRIT data

However, the data format used for the 'transport' part of the distribution from the *Hot Bird-6* satellite to the receiver conforms to the DVB standard as already mentioned.

The outstanding advantage of the DVB standards are that the data contained **within** the 'packets' produced by a DVB multiplexer can be a variety of formats, data rates and types, and come from a wide variety of sources. The DVB 'transport' system chosen by *EUMETSAT* is based around an MPEG2 data stream but the data within that stream does **not** have to be MPEG data.

It's rather like getting on a plane; when you board the plane at the start of your journey both you and your baggage are together. During the trip, your baggage is carried separately, in a separate container. You and your baggage are not turned into parts of the aeroplane, you are merely **in** it. At the destination airport, you and your baggage will be reunited (hopefully), though possibly after a considerable delay.

The DVB transport stream does **not** change the data within, it just transports it with a measurable delay. Specialised software is then required to reconstitute a continuous data stream from the separated and delayed DVB data packets. There are many functions carried out by the *Telique* software, not least the prioritisation of the data packets, to ensure timely arrival of the most important data first. It is this reconstituted data stream that your data manager and decoding software can cope with.

The *Tellicast* data to be carried is put into a 'virtual container' (VC) or data 'packet'. Each data packet has two different types of error protection to protect it en route between the broadcast satellite and the end user's receiver: *Reed Solomon* (inner coding) and *Viterbi* (outer coding), which are applied within an RF modulator.

DVB – The history

The DVB group was founded in 1992 by a number of international companies whose aim was to produce a practical, **universal** digital transmission standard that would be adopted globally for all methods of digital broadcasting. The first aim was to produce a standard specification that would be adopted by the international satellite operators for the latest generation of broadcast and telecommunications satellites.

The unusual thing about all the DVB standards is that they were to be 'open-source', meaning that there were to be no intellectual property rights issues. The DVB standards could be used freely worldwide without any licence agreement. This helped to ensure that the standard was very widely and easily integrated into all sorts of applications. The development of mass produced chip-sets was critical to its success as a global standard.

To date there are over 300 companies involved directly with the DVB project and who make thousands of products to the DVB standards that have now been established. There are now about forty standards covering everything from *Digital Terrestrial Television* (DVB-T) to DVB-C for *Cable-To-Home*. All these standards are being adopted and regulated by the European Telecommunications Standards Institute (ETSI) and each DVB standard gets its own number. (The DVB-S standard is EN 300 421).

DVB-S ('S' for satellite)

The specification that was produced in 1994 was called DVB-S, and was based around a method of modulating data on to a single RF carrier using a method called QPSK (Quadrature Phase Shift Keying).

This has now been adopted worldwide and has formed the basis for many other standards. It can use a data stream that has been MPEG encoded or it can carry data, audio or video signals encoded in a variety of ways, including *IP* (Internet style data). The hardware standard is designed to deliver a data 'packet' to its destination with a specification of less than one uncorrected error event per hour. Effectively error-free at the destination.- So long interference(.

EUMETCast

The details for the *EUMETCast* DVB Ku band signal, which carries the Tellicast data, are listed as:

The Hot Bird-6 Satellite

This is a digital satellite equipped with its own multiplexers, which means it can incorporate many small DVB-compatible uplinks from many sources into one single DVB compliant multiplex for transmission. It is unknown at this time if the *EUMETCast* data is multiplexed on board the satellite or whether it is uplinked already integrated into one large multiplex at Usingen in Germany.

Current details of what else is on *Hot Bird-6* can be found at:

<http://www.lyngsat.com/hb6.shtml>

Transponder centre frequency: 11.096Ghz

This is the exact RF frequency of the centre of the multiplex channel. (Transponder 129). Uplink source *T-Systems*, Germany.

Downlink Frequency: 1.346Ghz

This is the transponder frequency minus the LNB local oscillator frequency (9.75Ghz). This is the 'real' frequency that the DVB card tunes in to after down-conversion to extract the data.

Symbol rate: 27500 ks/sec

This is the data-rate transmitted by the transponder to which the card is tuned. It means the same as 27.5 mega symbols per second (i.e. the same as domestic Astra DVB).

It must be noted that a 'symbol' is one phase/amplitude state of the RF carrier, so the actual data rate is **not** the same as bits per second. (each symbol can transmit more than one bit of information).

FEC = Auto

FEC stands for *Forward Error Correction*. Based upon the DVB standard you wish to use, and the data rate you wish to transmit, there are known degradations

that can affect your signal. The 'operator' can then 'tweak' the specification of the DVB signal according to whom they want to be able to receive an error-free signal. This can affect service area and required dish size, as well as the 'robustness' of the signal within that area. The target specification is one error-event per transmission-hour at the input of the receiver.

Generally, *Forward Error Correction* adds into the signal a proportion of error-correction data. The more error-correction data you send, the lower your 'useful' data rate is. The more *Forward Error Correction* you add, the more robust your signal is. Typical values of FEC are $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$ and $\frac{7}{8}$.

PID (*Packet Identifier*)

Each data stream within the multiplex is made up of packets of information that are identified exactly with their function and where they 'belong'. A sort of address label and time stamp.

The information that is compiled to make a DVB multiplex can arrive at a multiplexer from many different data sources and in many differing formats and rates. The multiplexer can be thought of as a rotary kitchen knife that slices up all the data streams depending upon certain rules.

Data for a particular stream is chopped up and packed into a VC without any additional error correction. A PID is added to the packet to give it a unique label stating from which data stream it has come. This data packet then passes through the multiplexer where it is *Forward Error Corrected* by a QPSk modulator.

You must configure your computer to select just one of the many data streams that may be present within the multiplex, which are being simultaneously received by your DVB card, by specifying which PID packets you want to use. PID values can be specified in hexadecimal (HEX) or decimal (e.g. FFFF or 1634). The PID determines which packets you will pick out from the hundreds of channels that may be contained within one DVB data stream.

Modulation of the Information

The data is *Reed/Solomon* coded (inner coding) to prevent 'random' losses of data, and *Viterbi* Coded (outer coding or convolutional coding) to protect that data from being destroyed by 'burst' type noise en route to the user's receiver. Finally, the data is output for transmission as a modulated RF signal which is then 'upconverted' (multiplied to the correct transmitter frequency) and amplified for onward transmission by the satellite.

Your receiver needs to be set up with the same parameters as the encoding modulator or it will not be able to distinguish the 'true' data from the error correction data and be unable to decode it correctly.

The DVB compatible *Skystar2* card and currently available software will hopefully open the door to other exciting possibilities as more 'digital' satellites are launched. It is not known yet if the new NOAA satellites when launched will be compatible and be DVB compliant but, as DVB standards are presently the ones most widely used in digital transport systems today, we can but hope.

The future for digital weather satellites has started and there are a whole lot more things to learn, from setting up your 'new' PC, DVB card and software, to understanding the new data that has been made **freely** available to you. There is also an ever more focussed awareness of the effects the weather can have in the media and in education, so it is an exciting time for the amateur who has access to millions of pounds worth of technology through the humble PC.

Reference

- Digital Television Broadcasting (DVB) via terrestrial and satellite channels - Dr. Mario Cominetti and Dr. Alberto Morello, R.A.I.

Glossary (or Pain Killers?)

- **DVB** - **D**igital **V**ideo **B**roadcast - a specification for doing various things in a European Digital way.
- **MSG1** - **M**eteorat **S**atellite **G**eneration, satellite number one.
- **SSPA** - A precision amplifier that cost a lot of money and failed during testing.
- **LNB** - **L**ow **N**oise **B**lock converter - a device that converts high RF frequencies into lower ones.
- **Tellicast** - A proprietary software package devised by *T-Systems* of Germany to re-assemble data packets into something a computer may understand from the *Tellicast* data.
- **ATOVS** - Data provided by NOAA satellites from a suite of instruments providing environmental data about the Earth's atmosphere.
- **HRIT** - **H**igh **R**ate **I**nformation **T**ransmission - as it says on the packet.
- **LRIT** - **L**ow **R**ate **I**nformation **T**ransmission - not as many packets as HRIT.
- **MPEG** - **M**oving **P**icture **E**xpert **G**roup - a consortium of companies that produced standards for data transmission of video/audio. The standards produced are called MPEG/MPEG2 etc.
- **PID** - **P**acket **I**Dentifier- information within a DVB data packet, that identifies the packet as being part of a data stream or 'channel' **or** as performing some other function within the DVB system (synchronisation, time stamp etc.)
- **Reed Solomon** - a method of error correction applied to a data stream, that protects it against interference that may cause the loss of single packets of data from that stream. (referred to as 'inner coding')
- **Viterbi** - a method of error protection applied to a data stream that protects against interference that may cause the loss of groups of data packets (referred to as 'convolutional coding').

Concluded on page 41 ...

Antenna Theory and Measurement

Radiation Patterns, Sensitivity and Polarisation



Rob Hollander

Introduction

The measurement of the radiation pattern, sensitivity and polarisation of my RQHA has been on my wish-list for years. The Resonant Quadrafilary Helical Antenna is described in detail in Technote-1999-1, which can be found on

www.kunstmanen.nl

under 'downloads'. The RQHA is, in theory, an ideal antenna for APT-reception in the 137 MHz band. In 2003 an 'antenna measuring group' was formed by several members of the Dutch *Werkgroep Kunstmanen*: Harrie van Deursen, Arne van Belle, Peter Smits and myself combining our skills and instrumentation. After half a year of preparations we were able to make the first measurements in November 2003. This article deals with antenna theory, measurement set-up and protocol, and the first results. A second article will describe the results of measurements planned for April and May 2004. The preliminary results gave us confidence in the used procedures. Moreover we learned how to adapt these procedures so that the measured results could be compared with theory.

Theory

The radiation pattern, polarisation and gain of a transmitting antenna are the same as the sensitivity pattern, polarisation and gain of this antenna in receiving mode. It is however much easier to calculate the radiation pattern than to calculate the sensitivity pattern. So we start with a feed-current in our antenna and calculate the corresponding EM-field instead of calculating the current induced in it by an EM-field. There are many computer programs to calculate antenna performance but the real problem is not the calculation (a few lines of program code) but defining the geometry of the antenna in 3D and the input and output (several pages of code). Moreover, if you want to understand what is going on, it is much more instructive to write the program yourself.

With the new generation of programs that use vector calculations like *Matlab*, it is a pleasure to write the code. All efforts can be directed to the solution of the problem, the solution of the Maxwell equations for the EM-field of a current element in vector notation and the description of the antenna geometry in vector notation as well. A full description would be beyond the scope of this article but interested readers may have a look at the web-site www.kunstmanen.nl under 'downloads' in the pdf-file TechNote-2004-1.

The basics of EM-theory can be found in many textbooks like *Jackson* [1]. An alternating current produces EM-waves consisting of alternating electric and magnetic fields. The electric field vector is perpendicular to the magnetic field vector and both vectors are perpendicular to the propagation direction. The waves travel with the speed of light from the antenna outward, and beyond a certain distance (more than 2.5 wavelengths) a more or less spherical wave is formed. From that point on, the 'far field' approximation can be used. In order to calculate the field of an antenna, the antenna is divided into small elements, each carrying an alternating current. At resonance this current is a standing wave and can be described by:

$$I(s) = I_A(s) \exp(j\omega t) \exp(j\delta) = I_0 \cos(ks) \exp(j\omega t) \exp(j\delta) \quad (1)$$

where $k = 2\pi/\lambda = \omega/c$ gives the wave number, λ is the wavelength, $\omega = 2\pi f$ gives the radial frequency and c is the speed of light. The current at any position s along the antenna has an amplitude of $I_A(s) = I_0 \cos(ks)$, alternates with a radial frequency ω , and has a relative phase angle of δ . To simplify the calculations the complex notation $\exp(j\alpha)$ is used instead of $\sin(\alpha)$ or $\cos(\alpha)$ wherever possible, with j the imaginary unit.

Since EM-fields are linear, we can find the field of an antenna by summation of the fields produced by all individual small current elements. We have to keep in mind that EM-fields are transverse fields, which implies that the radial component of the field in the propagation direction is zero. We can write (in vector notation) for the θ and φ components of the electric field vector at position r in space, indicated by the polar co-ordinates (r, θ, φ) , due to a current element ds at the position r_s indicated by polar co-ordinates $(r_s, \theta_s, \varphi_s)$:

$$E_\theta(r) = -j\omega\mu_0 \exp(j\delta) \frac{\exp(-jkr)}{4\pi r} \int J_A(s) \hat{u}_s \cdot \hat{u}_\theta \exp(jk\hat{r}_s \cdot \hat{u}_r) ds \quad (2)$$

$$E_\varphi(r) = -j\omega\mu_0 \exp(j\delta) \frac{\exp(-jkr)}{4\pi r} \int J_A(s) \hat{u}_s \cdot \hat{u}_\varphi \exp(jk\hat{r}_s \cdot \hat{u}_r) ds$$

The vectors \hat{u}_θ , \hat{u}_φ , \hat{u}_s , \hat{u}_r and \hat{r}_s are respectively:

- the unit vector in the θ -direction
- the unit vector in the φ -direction
- the unit vector in the direction of the current at position s
- the unit vector in the r -direction
- the vector from the origin to the current element at position s .

We have dropped the common factor $\exp(j\omega t)$, so the amplitude of the field strength is shown. These field components E_θ and E_ϕ produced by the current are orthogonal and can be measured with a simple dipole antenna, which is linearly polarised. Using the definition of the polar co-ordinates from *figure 1*, we see that E_θ corresponds with the vertical component and E_ϕ with the horizontal component of the field, if we are looking in the r -direction.

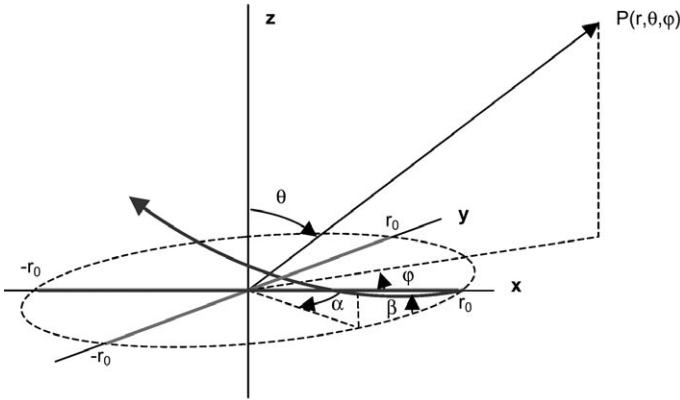


Figure 1 - Co-ordinates used in the calculations. The antenna axis is in the z -direction and the imaginary cylinder formed by the helical parts has radius r_0 . (see also fig.2)

If we want to measure E_θ we need a vertical dipole and to measure E_ϕ a horizontal one. If E_θ and E_ϕ are equal, then the field can be linear or circularly polarised depending on their phase relation. If the measured field strength is independent of the orientation of our receiving dipole (thus independent of being horizontal, vertical or of all orientations in between) then the polarisation is circular: RCP or LCP. Now the role of the transmitting antenna and the receiving antenna can be interchanged; we can measure the sensitivity of our RQHA for the direction of polarisation with a rotating transmitting dipole. However, this gives us only an idea of the degree of circular polarisation. If we want to measure both RCP and LCP polarisation contributions separately, another method has to be used.

The field can be described not only by the two orthogonal components E_θ and E_ϕ where the orthogonal unit vectors \hat{u}_θ and \hat{u}_ϕ form the orthonormal base,

$$E(r) = E_\theta(r) \hat{u}_\theta + E_\phi(r) \hat{u}_\phi \quad (3)$$

but any orthonormal base can be used; e.g. \hat{u}_R and \hat{u}_L defined as:

$$\begin{aligned} \hat{u}_R &= \frac{1}{\sqrt{2}} (\hat{u}_\theta - j \hat{u}_\phi) \\ \hat{u}_L &= \frac{1}{\sqrt{2}} (\hat{u}_\theta + j \hat{u}_\phi) \end{aligned} \quad (4)$$

The electric field is now split into two orthogonal fields E_R , the RCP-field, and E_L , the LCP-field:

$$E(r) = E_R(r) \hat{u}_R + E_L(r) \hat{u}_L \quad (5)$$

The components E_R and E_L can be expressed as:

$$\begin{aligned} E_R &= \frac{1}{\sqrt{2}} (E_\theta + j E_\phi) \\ E_L &= \frac{1}{\sqrt{2}} (E_\theta - j E_\phi) \end{aligned} \quad (6)$$

The RCP field has its electric field vector rotating CW when looking towards the oncoming (!) wave. This means that a right-hand circularly polarised wave is propagating as a left-hand screw—this is called ‘negative helicity!’ This definition comes from classical optics, was adopted for EM-waves as well, but is nowadays sometimes confusing. Please note that the signs used in the equations in this article form a consistent set. If the definition of the time in the current is reversed another consistent set of signs should be used, as some people prefer, because they think that it is more elegant that an outgoing wave has a positive sign for its radial phase-factor instead of the negative sign in $\exp(-jkr)$.

The axial ratio, a measure of circular polarisation, can be defined in several ways. If we use:

$$AR = \frac{\|E_R\| - \|E_L\|}{\|E_R\| + \|E_L\|} \quad (7)$$

then we have pure circular polarisation for $AR = 1$ and pure linear polarisation for $AR = 0$.

There are two representations: one based on unit vectors \hat{u}_θ and \hat{u}_ϕ is appropriate for the description of linearly polarised fields; the other based on \hat{u}_R and \hat{u}_L is appropriate for the description of circularly polarised fields. The information from measurements only applies to the absolute value of the field strength (or the square root of the emitted power). The relation between these two representations (equation 6) looks simple but is in fact complex.

Simulation Results

The calculation is performed by taking integrals over all current elements starting at one point along a full loop. The distal point at the bottom was chosen, as in the *Kilgus* article [2]. The four half-loops are each one half wavelength in length. A cosine function is assumed for the amplitude of the current along the loops, corresponding with a ‘phase’ along the loops that runs from zero to 2π , which brings us back to the distal point after one full loop:

$$J_A(s) = J_0 \cos(ks) \quad (8)$$

with maximal values at the distal-point at the bottom ($J_A(0) = J_A(\lambda) = +J_0$) and at the feed-point at the top ($J_A(\lambda/2) = -J_0$). For resonant antennas and a feed at the current maximum this model is close to reality.

The program can calculate the E-fields for full-turn, half-turn and quarter-turn quadrafilar antennas. The design parameters are:

- frequency
- number of turns (1, $\frac{1}{2}$ or $\frac{1}{4}$)
- ratio of diameter over axial length
- the distance from the centre of the RQHA to the point where the field strength is calculated
- the 'helicity' of the helix
- the phase of half-loops 2 and 4 relative to half-loops 1 and 3,
- the azimuth angle ϕ for the elevation scan performed in the θ -direction.

The fields are calculated as a scan over all angles θ for the selected angle ϕ . The fields of an RQHA are independent of ϕ , as was stated by *Kilgus*, which is once more verified by these calculations. The relevant polar plots of E_θ , E_ϕ , E_R and E_L are shown in *figure 3*.

Although it is simple to calculate the absolute field strength at a selected distance (as long as the 'far field' approximations are valid), this is not done. Only the angular dependence is shown as this is the relevant information for radiation patterns. The factor:

$$factor = \omega\mu_0 J_0 \frac{\exp(-jkr)}{4\pi r} \quad (9)$$

in equation (2) is ignored. This makes the choice of the distance and frequency as design parameters a bit strange since the presented results do not depend on these parameters. However, these parameters are incorporated in the program so that, when not only the radiation pattern but also the absolute field strength is wanted, the program is able to calculate this simply by multiplication of the results with the above mentioned factor.

In the calculations, the origin is taken as the centre of the antenna (*Kilgus* [2] takes the distal point at the bottom as origin). The half-loops are numbered 1,2,3,4 counting counter-clockwise, looking from the top downward (*Kilgus* counts 1,3,2,4). The phase, δ , of the current in half-loops 2 and 4 (inductive large loop) has to be $-\pi/2$ relative to half-loops 1 and 3 (capacitive small loop) to get the RCP (right-hand circular polarisation) in the upper hemisphere.

Note that the twist of an RQHA for RCP-APT reception (*helicity* of helix = -1) is the opposite of the LCP-example in *Kilgus's* article [2] where *helicity* = +1! If the *helicity* is -1 and the phase, δ , is $+\pi/2$ we have RCP in the lower hemisphere; if the *helicity* is +1 and the phase is $-\pi/2$, we have LCP in the lower hemisphere while for $+\pi/2$ we get LCP in the upper hemisphere. So

there is one possibility out of four to get the correct antenna by chance. It is thus possible to turn the RQHA upside down with its terminals at the bottom, if you want another BALUN design!

The code for the *Matlab* program is supplied in TechNote 2004-1. With the program it is easy to tailor the ratio of diameter over axial length to the desired radiation pattern and the required circular polarisation at the horizon.

The radiation pattern of an RQHA is the result of a delicate balance of constructive and destructive interference of the fields of the individual parts. The field at the horizon is produced by the helical parts while the fields up and down are produced by the radial parts (more or less). The field in the upper hemisphere is the result of constructive interference and the absence of the field in the lower hemisphere is the result of destructive interference. Addition of the fields of the parts has to be done by adding the real and imaginary components individually; then the absolute value can be calculated and shown in graphs like *figure 3*.

Measurement Set-up

A mobile, battery operated set-up was made by the group, partly from existing units, although some new units also had to be built. A small transmitter and impedance matching network feed the transmitting antenna, which is a crossed dipole, to produce circularly polarised fields. Flipping the antenna changes the direction of polarisation from LCP to RCP. An attenuator is used to adjust the power so that the receiver, approximately 100 yards away, is not overloaded. About 1 μ W was used in the experiments. The AUT (antenna under test) was the *RHQH-12*, connected by a 50 Ω cable with an electrical length of $\frac{3}{4}$ lambda to an antenna amplifier (*HRA-137*). This $\frac{3}{4}$ lambda is the total length of the cable from the top of the antenna to the amplifier, thus including the 'internal' cable of the 'infinite BALUN' and the 'length' of the connectors. This cable transforms the real impedance of the antenna (at its feed point at the top) from 31.5 Ω @ 137.5 MHz to a real impedance of 79 Ω , suitable for the antenna amplifier input.

The receiver was an *HRX-137*, fitted with a special buffered signal strength output. The output voltage was calibrated as a function of the input voltage. Although the output is approximately a log-function of the input, several wiggles show up in the curve due to the internal circuit of the *CA3089*. There are better signal monitor ICs, but a 9-th order polynomial fit represented our calibration curve nicely, so that this fitted curve could be used in the analysis of the measurements.

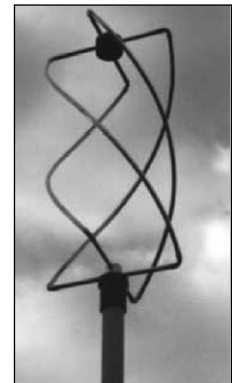


Figure 2
The RQHA on my roof under the Dutch sky

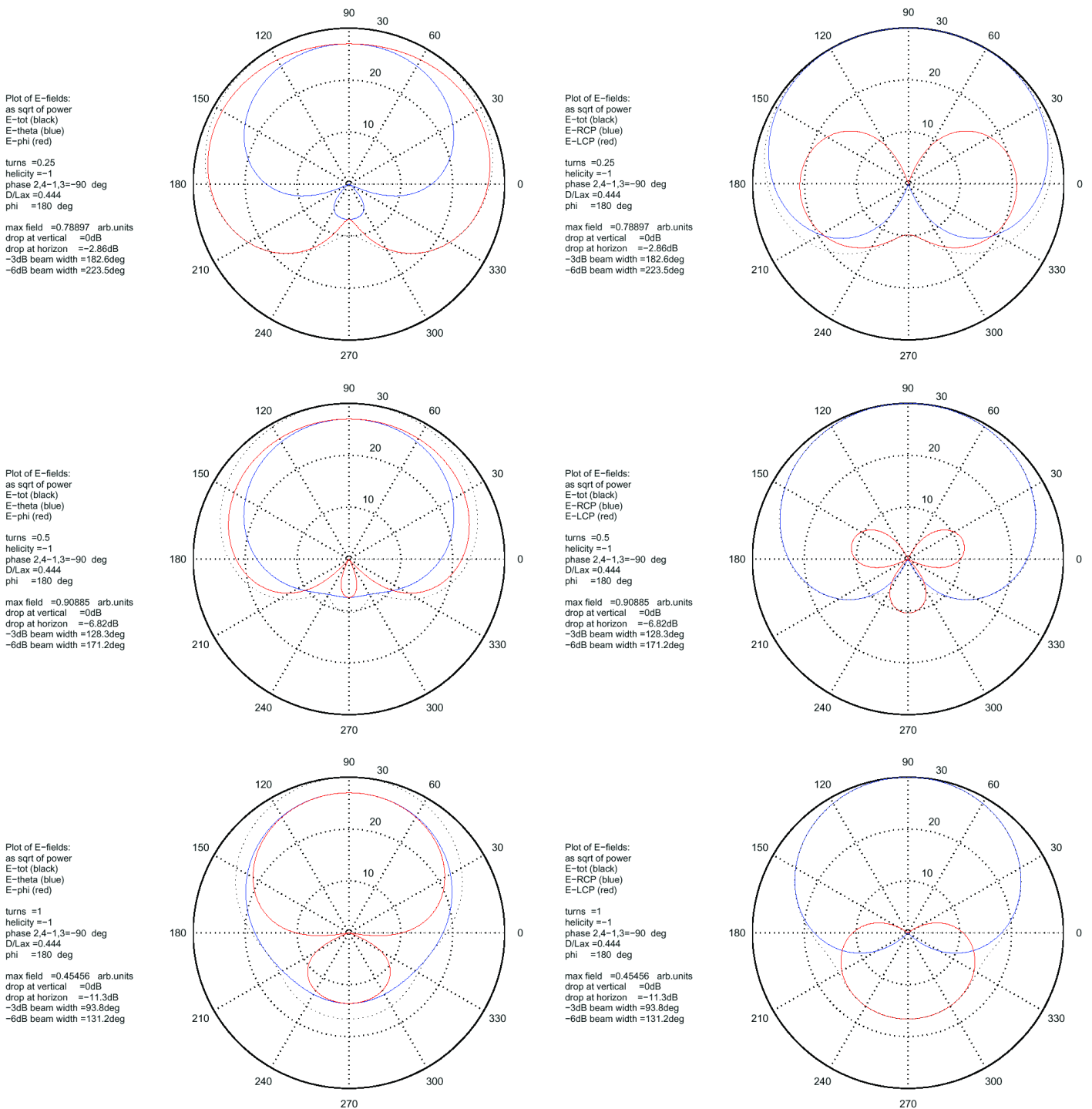


Figure 3 - Radiation patterns for an RQHA with a diameter over length ratio of 0.444. At the top the patterns for a quarter-turn antenna are shown. In the middle the results for my design with a half turn are shown and at the bottom the results for a full turn antenna.

The output voltage was measured with an 8-input ADC-unit made from a kit from *Conrad-Elektronika*. This ADC-unit is controlled by the control lines DTR and RTS from the serial port of a laptop and read out by the status lines DSR and CTS. A measuring program has been written in *Pascal* to collect the data and store them on disk. At intervals of selectable

length, e.g. one second, a selectable number of samples, e.g. 10, are converted and averaged to suppress noise to less than 1-mV. Not only the signal strength is recorded but also the voltages representing the angles of the AZ (azimuth) and EL (elevation) rotors. These are produced with multi-turn linear pot-meters coupled to the rotor shafts and are sampled at almost

the same instant as the signal voltage. This procedure gives three values per sample record, completely defining the required information independently of the speed of the rotors and without synchronisation problems. The relations between readings and angles were calibrated and proved to be very linear (high impedance loading of the pot-meters was used).

A 12 V battery, from which a stabilised 15 V d.c. is made by a dc-dc converter (specially built for this occasion) powers the whole set-up. It is the supply for the laptop, the receiver, the ADC-unit and the rotor steering. The receiver has an additional internal 12 V stabiliser and the ADC-unit a 9 V stabiliser, a second 5V stabiliser for the pot-meters and a 5 V reference for the ADC. Recordings are $\pm 1\text{mV}$ on a range of 5 V.

In future measurement sessions, a rotating dipole will be used for the measurement of E_θ and E_ϕ , while two dipoles at 90° , placed a quarter of a wavelength distant, will be used to measure E_R and E_L . This is shown below in *figure 8*.

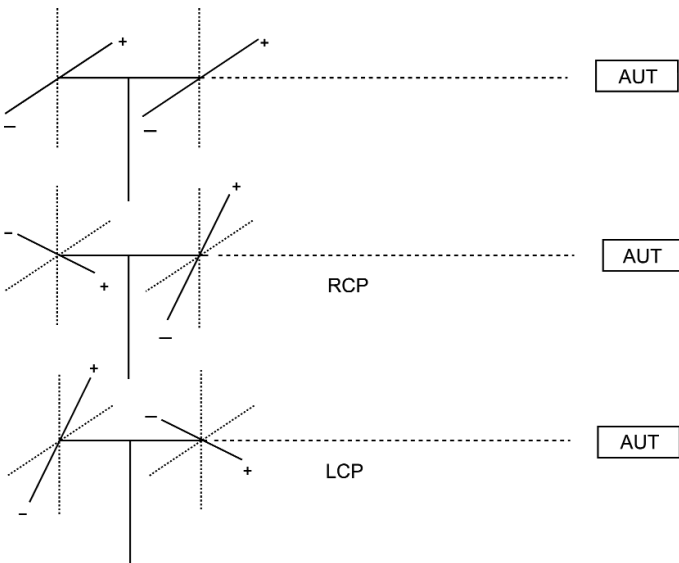


Figure 8 - Set-up for circular polarisation measurements using two transmitting dipoles at 90° and a quarter wavelength apart. The phase of the feed is indicated with + and - signs. The change from RCP to LCP is obtained by reversing the phase of one dipole (180° rotation) or, as shown in the figure, by a 90° rotation of both dipoles.

Measurements

For our experiments we choose a site with two hills about 100 yards apart, one for the transmitter and one for the antenna under test (AUT) (*figure 11*). First we tested the effect of the circular polarisation of the transmitting antenna with a receiving antenna consisting of a simple dipole. A variation of 5.6 dB was found by an AZ-scan when the antennas were in line. The use of a reflector reduced this variation to 2.8 dB. We concluded that the reception of the dipole is seriously influenced by the material at the rear of the antenna; in our case a rather massive piece of metal from the rotors. At the transmitting side a crossed dipole without reflectors was used. There we did not have any metal in the vicinity, except for the feed cable. The circular polarisation is probably not perfect, but good enough for the measurement of the radiation pattern. For a cross-polarisation measurement, to be done in a later trial, we have to use pure LCP and RCP fields.

To make pure circularly polarised antennas is not simple. The best approach is to use two identical, linearly polarised dipole antennas, fed in phase, one a quarter wavelength behind the other, and at $+90^\circ$ or -90° . Depending on the orientation, we get RCP or LCP. If the phase is not exactly correct then the distance between the two dipoles can be adjusted. It is good practice to match the dipoles to $100\ \Omega$ and feed them in parallel from a $50\ \Omega$ source.

The set-up illustrated in *figure 8* makes the measurement symmetric for RCP and LCP. It will be clear that if we want to measure small LCP contributions to a dominant RCP sensitivity, that the circular polarisation of the transmitting antenna has to be more precise than that.

We mounted the *RQHA-12* and made AZ-scans at three different EL-angles. One scan was made with the axes of the transmitting and receiving antennas in line, corresponding with the situation of a satellite overhead. A second AZ-scan was made at an angle of 45° between the two axes, corresponding with a satellite at an EL of 45° . The third AZ-scan was made with the axes at 90° , corresponding with a satellite at the horizon. The EL-scan was made in two steps. First, the EL-rotor tilted the *RQHA-12* from axes in line and antennas facing each other over 180° till the RQHA was irradiated from the rear; then the AZ-angle was changed by 180° and the same EL-tilt was performed to produce the second half of the full EL-scan. Results are shown in *figure 9* and have to be compared with the theoretical pattern of *figure 3*.

Analysis

The dB values in *figure 9* (vertical scale) are relative to $1\ \mu\text{V}$ at the input of the receiver, from which the gain of the antenna amplifier should be subtracted to get the antenna signal. However this time we were interested in the patterns and less in the gain. The constant sensitivity at all AZ-angles is remarkable, although it was meant to be so. Also the EL-scan is very symmetric and close to what it should be, as illustrated in *figure 10*.

The ratio of diameter over axial length of 0.444 was selected according to Wang^[3] to get a decrease of about 6 dB at the horizon (I live in the city and wanted some reduced sensitivity at the horizon to avoid terrestrial interference) and we indeed find a reduction of 7 dB. Even the lobe at the bottom, which should not be there, is identical with that also found by Kilgus^[2] on his antennas 35 years ago.

In *figure 10*, the calculated and measured results are shown for the elevation scan—the most interesting feature. It is clear that the RCP-part of the radiation pattern in the upper hemisphere is well described by the calculations. The lobe in the lower hemisphere is probably due to LCP-contamination of the transmitted field.

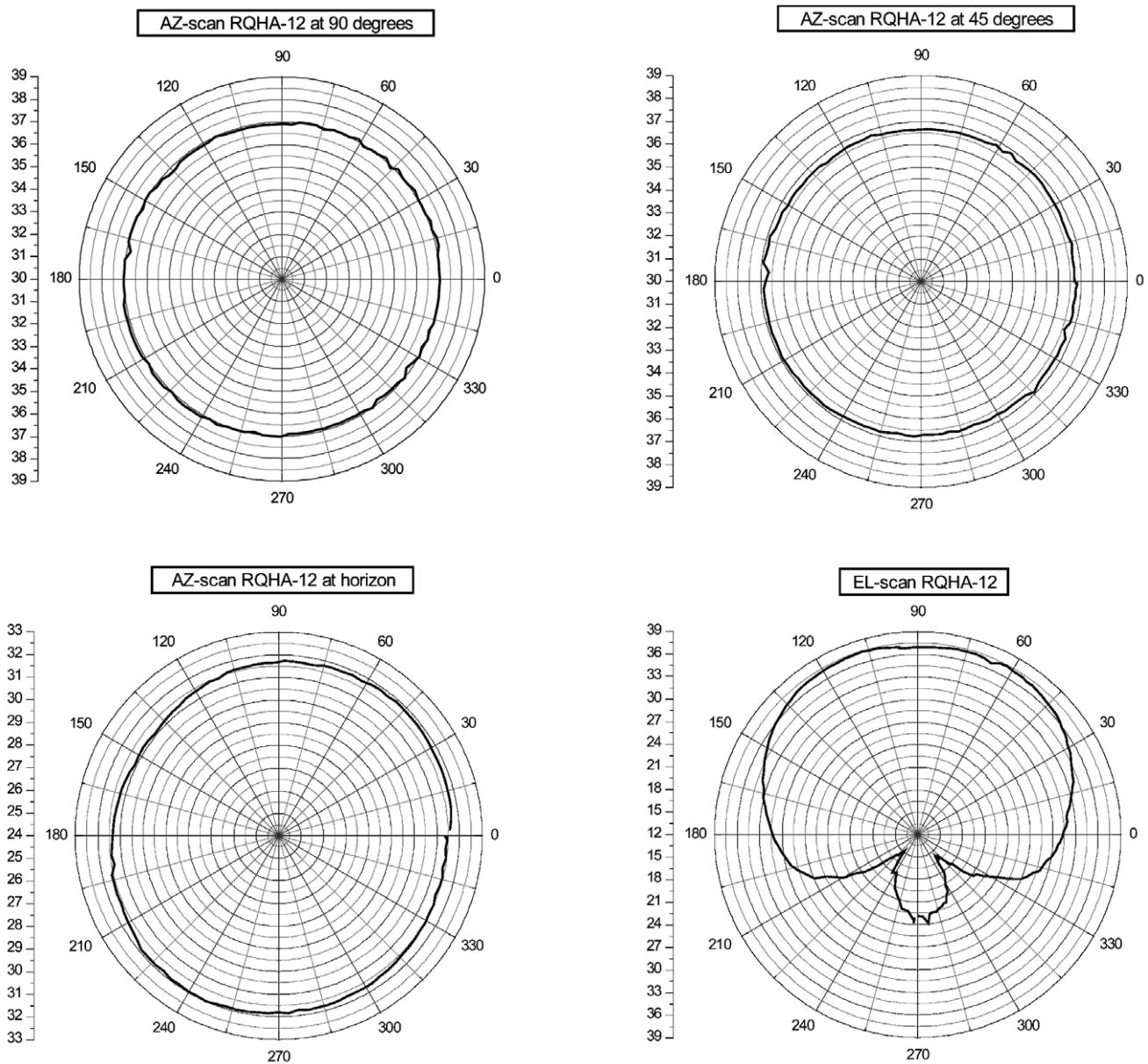


Figure 9 - Measured sensitivity patterns of my RQHA with a D/L ratio of 0.444. At the top-left an AZ-scan is shown where the RQHA axis is pointing toward the transmitter (should be insensitive to the small linear polarisation component of the transmitting dipole). At the top-right an AZ-scan is shown at an elevation of 45 degrees, showing a deviation of ± 0.2 dB from perfect constant sensitivity. At the bottom-left an AZ-scan is shown for an elevation of zero degrees (at the horizon), showing a deviation of ± 0.5 dB. At the bottom-right an elevation scan is shown (the pattern is independent of the azimuth angle!). Note that the vertical dB-scale of the figure at the bottom-left is different!

Conclusions

Although expectations were high, we are astonished by the results. It seems that all the care in making the construction pays off. From the electrical measurements it was already clear, that the phasing of the RQHA, with an inductive and a capacitive loop, is almost perfect. Now it is also clear that the radiation pattern is close to perfect. We conclude that the RQHA is not only in theory an ideal antenna for the reception of polar orbiting satellites, but that the RQHA can also be an ideal antenna in practice when properly made.

References

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- 2 C.C. Kilgus, Resonant Quadrafilar Helix, IEEE Transactions on Antennas and Propagation, Vol. AP-17, May 1969, pp 349-351.
- 3 H.S.C. Wang, Theoretical design and predictions of volute antenna performance, IEEE Transactions on Antennas and Propagation, Vol. AP-39, No.8, August 1991, pp 1227-1230.

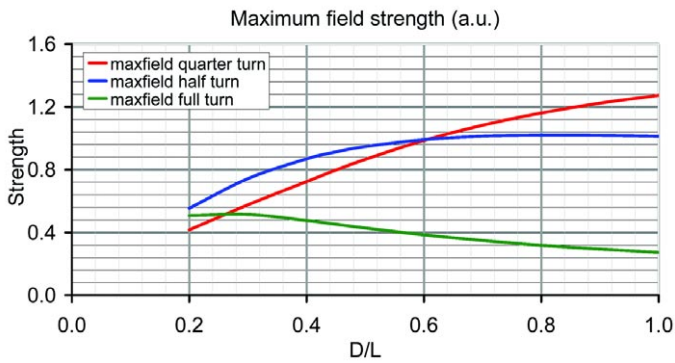


Figure 4 - Maximum field strength as a function of the diameter over length ratio (number of turns as parameter). The maximum field strength for a dipole is 0.694 and for a crossed dipole 0.909 in the same arbitrary units (a.u.).

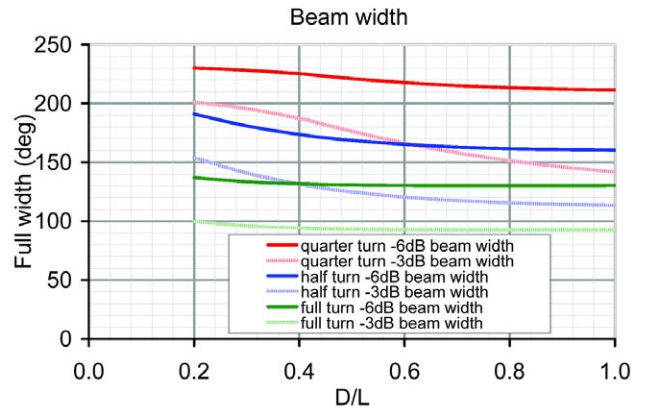


Figure 5 - Full beam width as a function of the diameter over length ratio (number of turns as parameter).

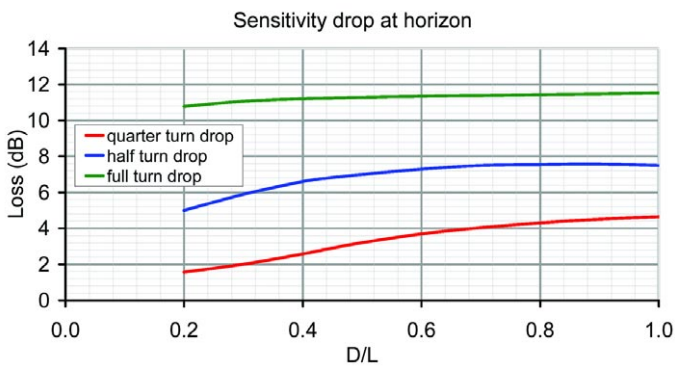


Figure 6 - Sensitivity drop at the horizon as a function of the diameter over length ratio (number of turns as parameter) relative to the maximal sensitivity.

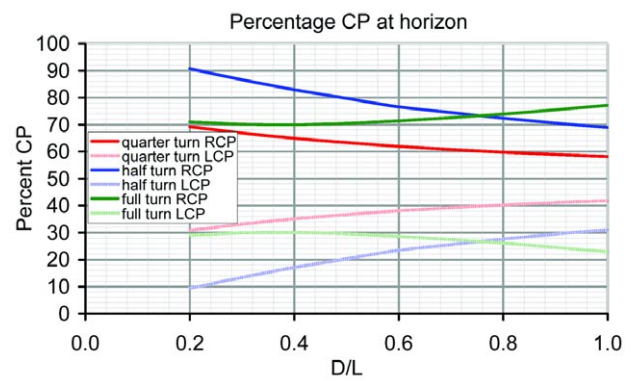


Figure 7 - Percentage of circular polarisation at the horizon as a function of the diameter over length ratio (number of turns as parameter). The polarisation upwards is 100% RCP.

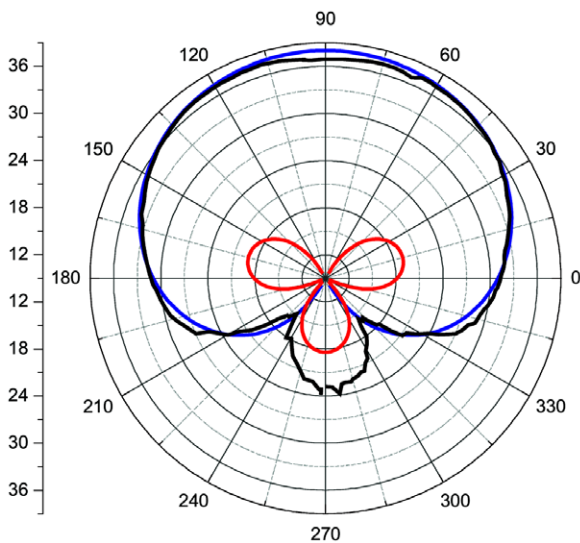


Figure 10 - Comparison of the calculated (blue for RCP and red for LCP) and the measured (black) radiation pattern of my RQHA. A (not perfect) RCP transmitting antenna (crossed dipoles with phase loop) was used. The vertical scale is in dB (see text).



Figure 11 - The RQHA-12 under test (notice the weight to balance the set-up)

Multi-feed Satellite Reception

John Tellick

One thing I forgot to mention in my article on LNBS in GEO Q2 was that the poor LNB has to withstand freezing in the winter and being baked in the summer sun. The LO frequencies must remain within quite tight tolerances, typically $\pm 2\text{-}3\text{ MHz}$ over the temperature range -40°C to $+60^{\circ}\text{C}$ and any drift of the LO will of course alter the frequency of the block downloaded IF band in sympathy.

If you are using an 85 cm offset dish for EUMETCast (as recommended by EUMETSAT), you can use the same dish for the reception of other satellites by placing additional LNBS on a dual or multi-feed bracket.

My original set up (figure 1) was a dish and LNB centred on 13°E for Hot Bird-6 EUMETCast reception with another LNB mounted slightly to the left (looking at the dish) for reception (slightly off-beam) of the Astra cluster at 19.2°E for satellite TV.

Since the EUTELSAT ERP is lower than that of Astra the dish and Hot Bird LNB is centred on 13°E for maximum signal. Owing to the stronger ERP of Astra, one can afford to be slightly off beam and receive a slightly lower signal.



Figure 1 - The original setup

Later, I wanted to receive the South East regional programmes from BBC TV, which are transmitted DVB via Astra at 28.2°E . for the Kent/Sussex coastal weather forecasts. With my dish centred on 13°E , 28.2°E . is quite a split, but the Astra satellites at that



Figure 2 - Lining up the LNB with a Technisat 'Satfinder' meter

location have an ERP to work into a 45 cm dish. I found that by placing a third LNB to the left of the 'offset' 19.2° LNB—which would be even more 'offset'—the signal from 28.2°E came romping in with no problem at all and at a high level.

As you will see, my dish is on the ground on a 'non piercing roof mount' stand which allows endless easy adjustment and experimentation which I'd not be happy doing 'up a ladder.' It also allows me to connect the receiver and TV adjacent to the dish in order to allow easy identification of the satellite.



Figure 3

Temporary installation for the reception of Astra 28.2°E (using a camera tripod). Note the slightly higher LNB position due to the lower satellite elevation.

Having said that, you will find the TechniSat 'SatFinder' level meter invaluable if you plan to experiment with multi-feed reception from one dish and I can thoroughly recommend it.

The LNB will require adjusting for polarisation offset ('skew'). That means that the further around the geostationary arc the satellite is, the more it appears to tilt in relation to the horizon; this twists the vertical and horizontal polarised signals out of alignment. For satellites to the west of 0° . the LNB needs to be skewed to the right (looking south) and for satellites east of 0° , the LNB needs to be skewed to the left. Linear polarised signals from a satellite at 0° should be perfectly horizontal and vertical without any skew. The further a satellite is around the arc, away from 0° , the more the skew. This is important for two reasons. One is to obtain maximum signal from the channel you actually want and the other is to minimise cross-channel polarisation from signals of the opposite polarisation.

To squeeze all the channels transmitted into the bandwidth available on the satellite, the vertical and horizontal channels overlap one another slightly (figure 4): described as the frequency offset. So, if your LNB is not properly aligned (polarisation offset) you will pick up a little bit of the polarisation you don't want whilst reducing the polarisation you do want, which will cause some interference. Professionals line up LNBS with a spectrum analyser which shows the

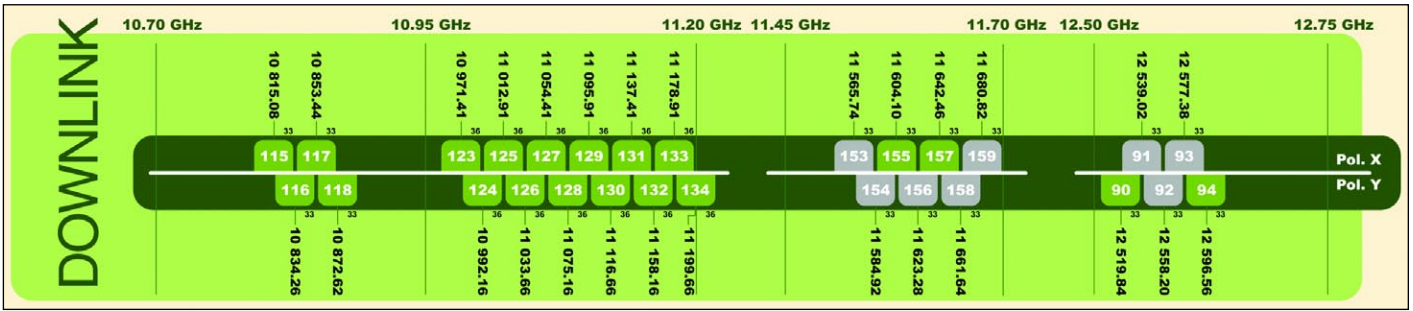


Figure 4 - Hot Bird-6 downlink frequency plan. Note the overlap between H and V channels

power level relationship between the two polarisation bands and allows accurate skewing for maximum level at one polarisation and minimum on the other.

If you want the ultimate in multi-feed reception then you want the Wave Frontier dish—up to 16 LNBS on one dish. WOW!

The toroidal design and sub-reflector allow every LNB to be at a ‘proper’ focal point (and therefore at its optimal position, along the line of the LNB bracket) across an arc of some 40 degrees. An LNB mounted away from the centre point of an ordinary offset dish is a bit of a compromise—but it works.



Figure 5

The 'Wave Frontier' dish with 10 LNB's

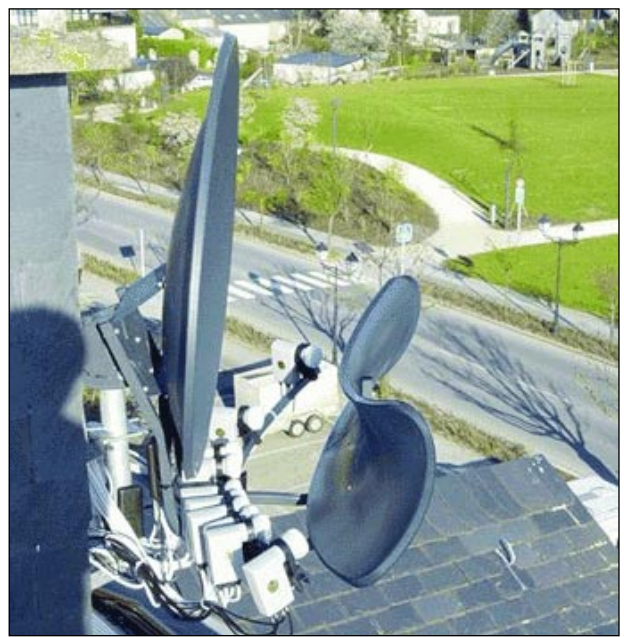


Figure 6

The 'Wave Frontier' dish installed and in action

Weather Satellite Frequencies

Polar Orbiting Satellites	Frequencies (MHz)	
	APT	HRPT
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

Download NASA 2-line Elements

Satellite tracking programs require regular updates of the NASA 2-line element sets that are essential for calculating the positions of Earth-orbiting satellites. One of the best Internet sources for these files is Celestrak at: <http://www.celestrak.com>

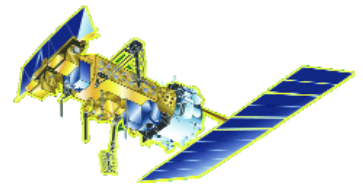
Elements for many groups of satellites are updated daily. Particularly useful are:

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

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

Weather Satellites ...

How it all began for me



Mike Stevens (G4CFZ) e-mail: mikeg4cfz@tiscali.co.uk

I became interested in all types of radio reception some years ago when I first started listening to Short Wave. This prompted me to try for the Radio Amateur Exam, which I passed, then subsequently the Morse Test. After purchasing my first HF rig and going 'on air' with that brand new call sign I soon discovered there was a new world at my fingertips: so I worked the world and enjoyed every moment of it. My best DX contact was Pitcairn Island from an early morning CQ call—I shall never forget that one.

But it was some time before I discovered that weather satellites were within my reach. One day at work I just happened to read a scientific paper which mentioned weather reception by amateurs and came complete with a picture. As I worked for a large corporate company with a good network system it was easy to put out a question about the subject. This I did; just a simple 'anybody know anything about satellites for weather and how you receive them' question.

Within a quarter of an hour, back came a reply from Michael, a friend of mine who worked on a site about 10 miles away. His reply came with two programs, one called *Wxsat*, the other *Wxtrack*. Well! This was a bonus as you can imagine, and as soon as I started to open *Wxtrack* I was amazed at the picture before me. There and then I suddenly realised that this was the hobby for me.

I installed both of the programs and started to learn how to use them. It was fantastic! Here I had all the information I required. I had the frequency the satellites transmitted on, I knew when they passed over or near to my location. All that I needed now was a suitable receiver and antenna.

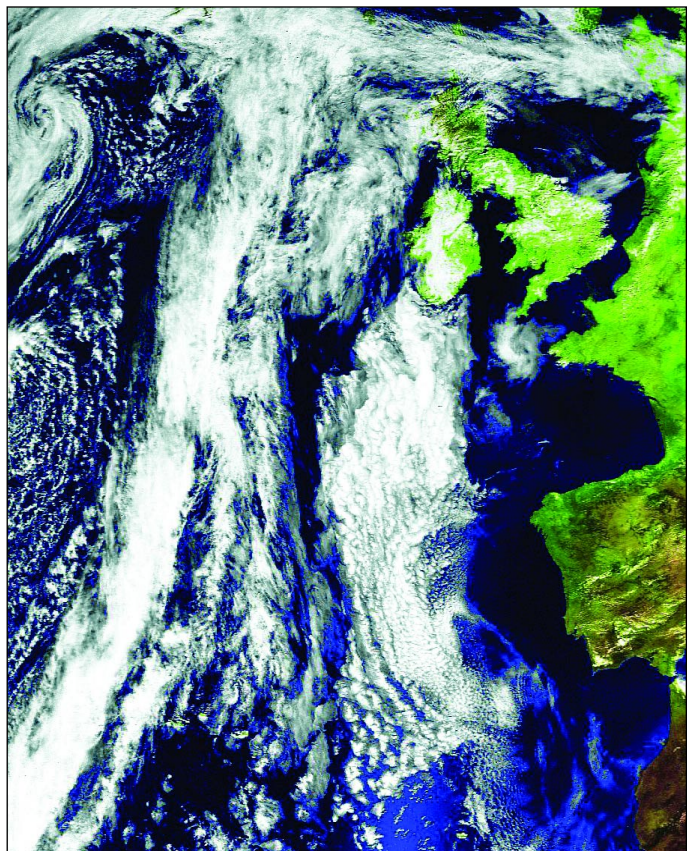
Then I had a look at *Wxsat*. That took a bit more time to understand and even to this day I am still experimenting with the settings to get the best images. But we do have a *Wxsat* expert in the group: Les Hamilton has written an article ^[1] on the subject and it is very informative, any newcomer would do well to read it. He has also produced a step by step guide which can be accessed on the GEO website at:

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

So to the equipment. My initial choice was the Timestep *Proscan* Weather Satellite Receiver with a Turnstile Antenna and Pre-amp. Also, for back-up, I purchased an RX2 Kit (as yet unbuilt). The cheques were posted off, and after waiting very impatiently for

the equipment to arrive, it was all delivered safely and undamaged a few days later—so assembly began.

The Antenna was very simple to assemble but to those who are new to this game, do please read the instructions fully before starting. One of the most important points is to make sure the elements are placed correctly on the pole and that you ensure the lower elements are in line with the top ones. Once you are happy with that you can connect the co-ax cable. You must take care to connect the short length of co-ax (the phasing harness) correctly otherwise this will cause the antenna to be out of phase and result in signal loss.



A typical NOAA image

There has been an excellent article in GEO recently by Arne van Belle ^[2], regarding the use of Satellite TV co-ax cable with a weather satellite antenna. I have been using this for some time and have found it to be extremely good for this type of application. It has low loss, matches well and is weather-proof—important where I live on the Dorset coast due to salt water corrosion.

I next connected the pre-amp to the other short length of cable. You have several choices; you can solder direct as I did or you can use F-connectors with the pre-amp mounted into a waterproof box. I actually used a combination of both. As I stated before I live near the sea and in winter we get lots of storms with high winds and spray resulting in a very corrosive atmosphere. So I needed to make all connections waterproof and secure. I soldered the main co-ax cable from the antenna to the pre-amp and the outgoing connections to an F-socket with plug, all inside a waterproof box. It is still going strong to this day.

The Timestep receiver is an excellent item. It's a case of 'out the box, plug in and use'. All the connections are clearly marked and it can be used manually or under computer control. The 12-volt supply required by the pre-amp is fed from the antenna socket and is adequate for the unit.

Once all the connections were complete it was time to switch on and listen for a satellite with *Wxtrack* running to track it and *Wxsat* set to record. My first satellite was NOAA 12 and as it entered my signal area that familiar 'tick tock' sound started. Suddenly a picture was starting to build up before me, in colour, but dark. I increased the gain control which improved it and further adjustments were made until the quality of the picture was good. Amazing! I had my first colour weather picture from a live satellite.

The next satellite pass was to be NOAA 15 and I tweaked *Wxsat* ready for this pass. Again the picture started to build and this time it was perfect; the colour was good and the contrast, visibility and detail were excellent. I was hooked! My next satellite was Meteor 3-05 and although it was in black and white the details were outstanding. How we miss this satellite these days.

It was at this point that John, another friend, who unbeknown to me was also interested in weather satellite reception, advised me to download a copy of *WxtoImg*, an extremely versatile satellite software program.

For those who have not seen this software in action take it from me it is excellent, I have recently purchased the upgrade and the 3-D effect it creates is stunning. I also find that the precipitation mode provides one with an accurate picture as to the location of heavy rain and storms. It is well worth the cost which supports Craig Anderson for updating the software. My thanks to our friends in New Zealand for this excellent offering.

With APT Polar Orbiting transmission reception sorted I now wanted to copy data from Meteosat-7. This looked to be a challenging project but as John

was moving on to Meteosat-8, I was lucky—he sold me his old kit comprising a Timestep down converter with LNB and dish. The dish was an ex analogue satellite unit, so a bit of work was required to change over the LNB and make a bracket to attach the dish to a mast. Again I used satellite TV co-ax cable for the feed from the converter to the receiver which works fine.

Assembly was completed by fitting the dish to the mast, attaching the LNB to the down-converter and connecting the power supply.

I had a rough idea of the location of the Geostationary Satellite Meteosat-7 and upon switch on I heard a signal from the speaker. I had already installed the *JVComm 32* software which I loaded up. Sure enough. There was a picture coming in. I checked the exact location of Meteosat-7 using *Wxtrack*, which from my location it is azimuth 177.21°, elevation 32.34°. A magnetic compass was used to orientate the dish precisely, taking into consideration magnetic variation, which at that time was 3.25°.

On completion of the operation I switched on the system and there it was—a perfect Meteosat-7 picture. The image of the south Atlantic cyclone reproduced on page 46 of GEO Q2 was one of those created using this very system.

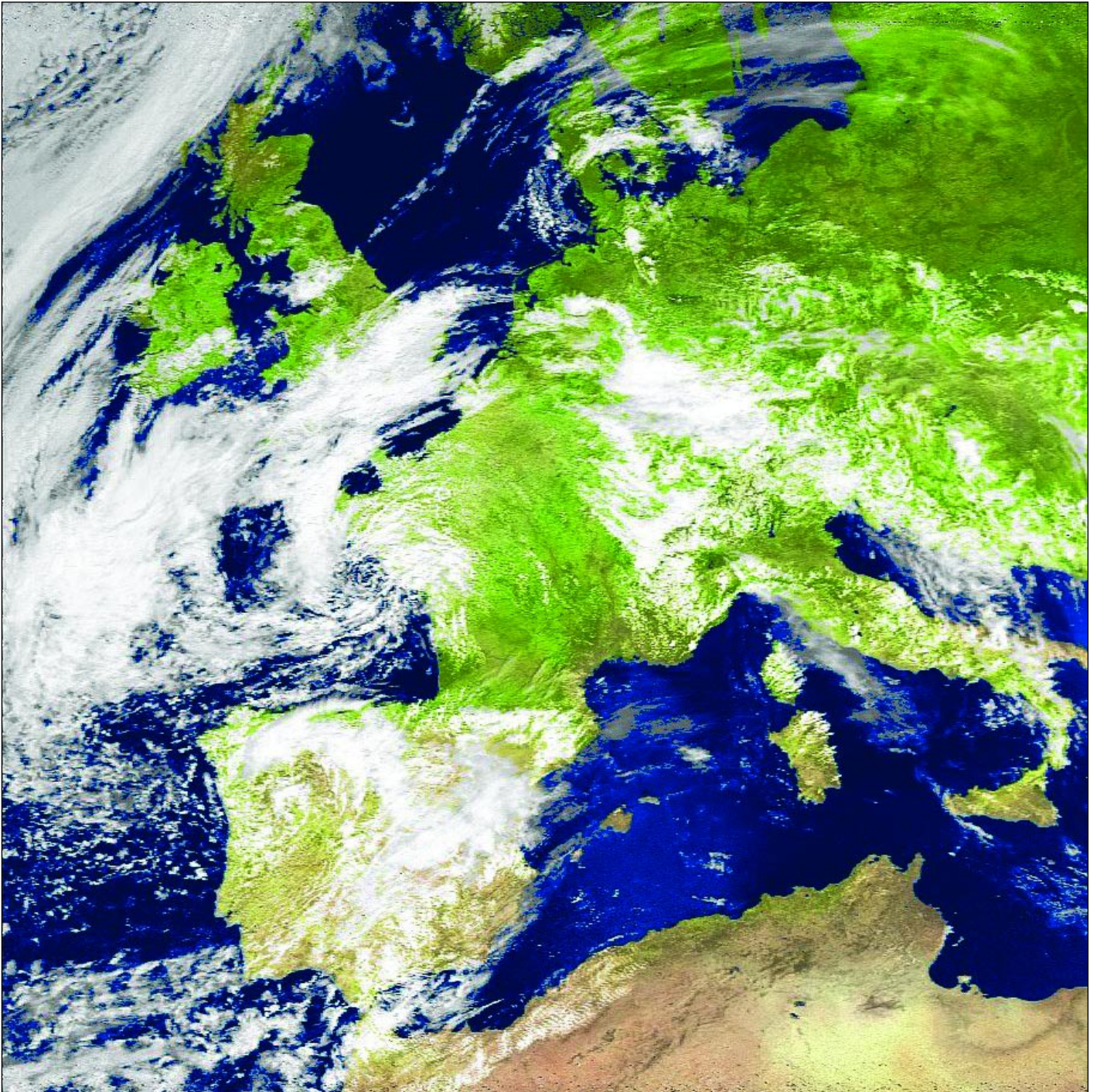
So where to go next? Will it be HRPT? Or Meteosat-8? I have applied for my licence from *EUMETSAT* but to date nothing has been heard. Apparently there is a problem in the system between our Met Office and *EUMETSAT* but I have been assured this will be sorted out in time. Incidentally I have to say that the help and advice I have received from *EUMETSAT* on this matter has been excellent. I have not found a friendlier organisation to deal with—most polite and helpful.

I would love to tackle HRPT but the set up is expensive so I will look for someone ready to sell a set-up then try it, as I still consider that the polar orbiting satellites can and do produce some excellent pictures and each one is so different in detail.

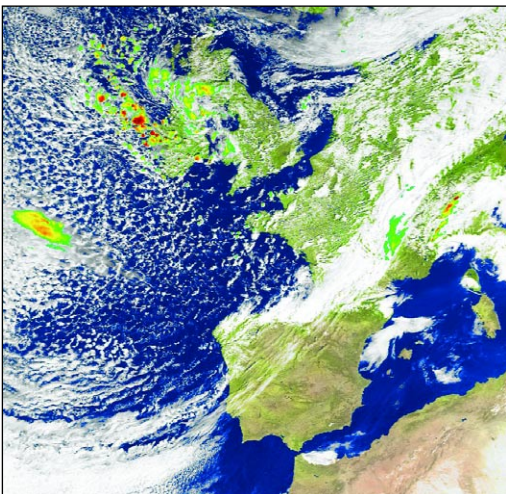
I hope this article has been of help to some of you. Everything is described just as it happened and the results are there to be seen. This is one of those hobbies where you have to persevere until you get the results you want. If at first you fail then try again. Also, there are websites that will help you get all the information you require—and we now have the experts within *GEO* who will assist where they can. So keep on trying. It's fun, and rewarding when it all goes well.

References

- 1 First Steps in Setting up an APT Ground Station
Les Hamilton - GEO Q1 - page 42
- 2 Using Satellite TV Co-axial Cable
Arne van Belle - GEO Q2 - page 14



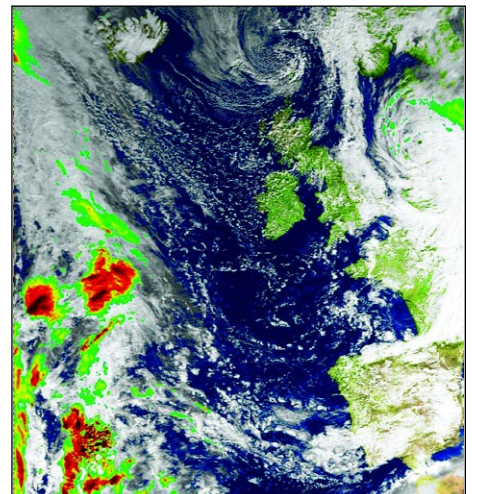
Mike Stevens obtained this NOAA 17 image at 11:43 UT on May 1, 2004. Processed using WXTolmg in MSA mode.



Two further NOAA 17 images from Mike Stevens illustrating the MSA (multispectral analysis) mode of WXTolmg with additional precipitation overlays.

Left: NOAA 17 at 11:10 UT on March 21, 2004.

Right: NOAA 17 at 11:50 UT on March 6, 2004.



SOFTWARE SHOWCASE



Douglas Deans - douglas@dsdeans.freemove.co.uk

With all the excitement generated by the wonderful images and science being returned from the Mars Exploration Rovers, Spirit and Opportunity, I thought this would be an appropriate time to have a look at the updated 3DEM program which offers the opportunity (excuse the pun) not only to make 3 dimensional images of the surface of the earth but other planets such as Mars. 3DEM works on all Windows platforms and will produce three dimensional terrain scenes and flyby animations from a wide variety of freely available data sources. Those include

- USGS Digital Elevation Model (ASCII DEM) files.
- USGS Spatial Data Transfer Standard (SDTS DEM) files.
- USGS National Elevation Dataset (NED) files.
- USGS Global 30 Arc Second Elevation Data Set (GTOPO30 DEM) files.
- NOAA Global Land One-km Base Elevation (GLOBE DEM) files.
- NASA Shuttle Radar Topography Mission (SRTM) files.
- NASA Mars Orbiter Laser Altimeter (MOLA) files.
- NASA Mars Viking Orbiter Digital Topographic Map (DTM) files.

3DEM allows low resolution flyby of DEM landscapes using OpenGL. The path through space is recorded in memory during flight, allowing subsequent creation of a full resolution mpeg animation along the flight path. Real-time flyby animations can be created in AVI or MPEG format. A sample flyby is provided on the CD.

The program has now been updated to version 18.8 and includes a number of improvements. These are too numerous to list in full and many are probably of little interest for amateur use, but two which do seem worth mentioning are improved red/blue 3D anaglyph images and better support for the GTOPO30 and GLOBE terrain models. One noticeable change is that the program can no longer deal with the original Mars MOLA files and now requires the 64 or 128 pixels per degree data. Even compressed the 64 data comprises four files constituting over 500 Mb of download, and so can really only be considered by those with a broadband connection.

In order to provide a useful step by step guide for producing wonderful images, and to alleviate lengthy data downloads, Software Showcase has allocated a complete CD (GS3) comprising a package full of useful guides, help and prepared data.

Let me explain what is on the CD and how best to use it. Unlike the other CDs in the showcase, GS3 sets out not just to provide programs and data but to be a complete learning tool for producing first class 3D images and flybys. Firstly and most importantly I recommend you read the three published articles by Ed Murashie and Les Hamilton both experienced users of the software and data, and now included with the CD. The articles make reference to some of David Taylor's programs which can be downloaded from his web site at www.satsignal.net, but are also available in CD GS1 from the Showcase Library.

By following the articles and using both the data and the specially prepared files on the CD it should be possible to produce fascinating 3D images of anywhere on Earth and selected areas of Mars (see offer below). In addition to help with producing first class images from your own or downloaded HRPT data, a selection of HRPT images remapped in *GroundMap* for use in the 3DEM program and already accompanied by their own georeferencing files has been included.

It has only been possible to include a quarter of the Mars MOLA 64 data on the CD, due to the size of the files. But for readers who may want the full set of Mars MOLA 64 data, but do not have broadband, I would be happy to provide a CD, at cost, with the full set. Please contact me, by e-mail, mail or telephone (01786 822828) to arrange this.

I would also like to thank Ed Murashie and Les Hamilton for allowing their articles to be included on the CD and a special thanks to Les who provided many of the prepared data files for the HRPT options.

In the hope of encouraging readers to try this, I have produced a coloured 3D image of the Sharonov Crater on Mars. This was prepared using the 64 data and is reproduced on the inside front cover of this issue..

All the above and more is available on GS3. The 3DEM program can be downloaded from

<http://www.visualizationsoftware.com/3dem.html>

with lots of other information, images and excellent flybys.

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

GS1 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 these programs.

WXtrack	Satellite Tracking Program	v 3.4.2
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 images	v 4.1.0
GroundMap	Rescales satellite images	v 1.3.8
RX2 PassControl	Computer control program for the RX2 receiver	v 2.2.8

GS2 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 with folder names. * implies a DOS program.

Collection D02	Recall (wave file recorder), 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), Satmon (wave file recorder).
AGSatTrack	Satellite tracking program v 1.33
Circuit	Documents for the Circuit Wxsat receiver and the UOSat receiver (PDF format)
e-weatherman	Downloads current weather conditions from the Internet direct to your computer
Element Manager	2-line element manager v 1.58
Footprint	Satellite tracking program v 2.10
Irfan View	Image/slideshow viewer v 3.80
JVcomm32	Evaluation version (APT/FAX/SSTV decoder)
Macintosh Kepler editor	Edits verbose AMSAT format elements. Mac OS X and OS9 only.
NeoPaint	Image processing program (30 day evaluation)
Paintshop Pro	Image processing program (30-day evaluation)
Satscape	Satellite tracker and wave file recorder v 2.00
Splitter	Utility program for splitting and reuniting large files
WXtolmg	WAV file recording and decoding program with many options. v 2.5.10

GS3 **3DEM Package for 3D Terrain Visualisation**
This 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 by Ed Murashie.

GS4 **Image CD**
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.

GEO Helplines

Douglas Deans, who will be familiar to our readers through his Software Showcase column, has offered to put himself forward as *GEO's* first *helpline* member

Douglas was one of the first enthusiasts to embrace the new **DVB technology** now in use to disseminate **Meteosat-8** imagery, and he will be delighted to pass on his experience to help others who are just starting to set up their equipment (or who are still at the stage of just thinking about it).

Contact Douglas at:

- telephone:(01786) 82 28 28
- e-mail:douglas@dsdeans.freemove.co.uk

Douglas adds that he is **also happy to help with queries on other aspects** of the weather satellite scene, such as APT and HRPT.

Extending the GEO Helplines

Douglas has set the ball rolling by kindly offering his services. But of course, any GEO reader who is of a mind to help others with their hobby is welcome to add his name to the list. If you would like to do so, please send a brief note to the editor, stating your name and contact details, and the specific area in which you feel you can be of help. Contact details for the editor appear in the right-hand panel on page 1.

To date, two other *GEO* subscribers have added their names to *GEO's* Helpline Service:

John Tellick

John has been involved in extensive dialogue with EUMETSAT for many years, and is the man to contact with queries about **registering for Meteosat-8 and the EUMETCast dissemination system**. John is also happy to field any more general queries about weather satellites.

Contact John at:

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

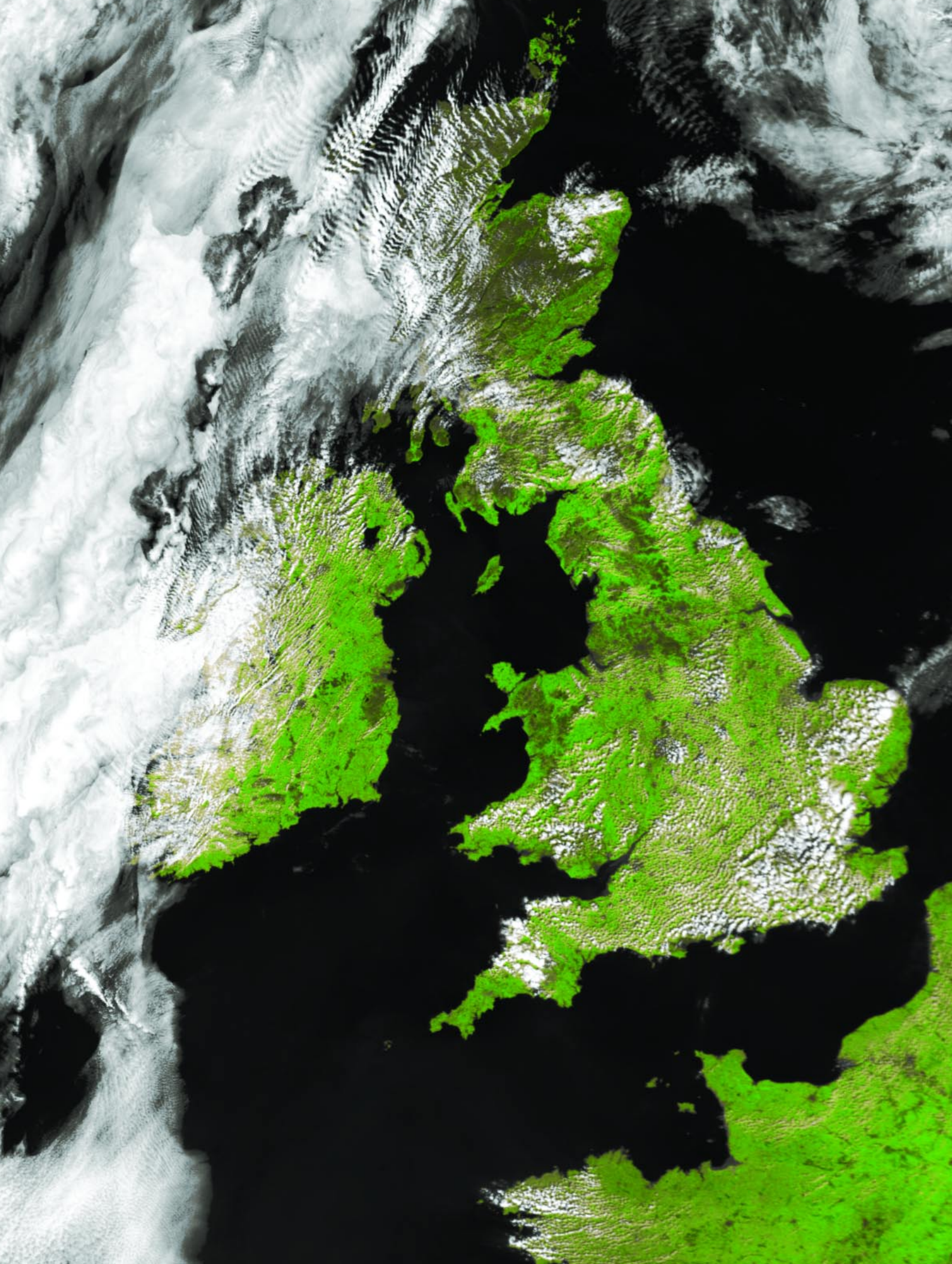
Keith Holland

Keith has been imaging from the APT polar orbiting weather satellites on the 137 MHz frequency as well as the geostationary Meteosat-7 (Wefax). Keith will be pleased to hear from readers requiring assistance in these areas.

Contact Keith at:

- e-mail: geo@koholland.plus.com

E-mail contact can of course be made at any time, but we would ask you to restrict telephone contact to the period 7.00-9.00 pm in the evenings.



Summer arrives early in Great Britain - Fantastic cloud formations off north-west Scotland - NOAA 17 at 11:41 UT on May 16, 2004
Image: NOAA Satellite Active Archive (www.saa.noaa.gov) Processing: HRPT Reader (vegetation mode)

Join GEO-Subscribers

The Official GEO Internet Discussion Group on YAHOO!® Groups

GEO has its own *private* and *moderated* on-line discussion forum on *Yahoo!® Groups*.

It is called *GEO-Subscribers*

The aim of this Group is to provide a means for efficient on-line communication between *GEO Quarterly* subscribers.

GEO-Subscribers allows you to share information, ask questions and receive speedy responses, most particularly from those involved in the day-to-day running of *GEO*. For example, if you are having problems with your NOAA or Meteosat hardware or software, post details of your problem on *GEO-Subscribers* and tap into the combined experience and expertise of the Group's 200 members. If someone has the answer to your problem, you can expect a reply within 24 hours (often much less).

Many of our readers have already benefited from this service—so can you!

To sign up with *GEO-Subscribers*, either

- send an e-mail asking to be placed on the list to:

GEO-Subscribers-subscribe@yahoogroups.com

- or visit the *GEO* website at

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

and type your e-mail address into the *YAHOO* 'send' window at the foot of that page. Then click on the *Yahoo!Groups* logo to submit your request.

Please note

Since *GEO* was established early in 2004, a number of other individuals have set up Internet discussion/news groups under the '*GEO*' banner.

But there is **only one** official Group run under the auspices of *GEO* itself—*GEO-Subscribers*. If you wish to be kept up to date with the latest news from *GEO*, or to bring your queries to the notice of members of the *GEO* Management Team, this is the Group to which you must subscribe.

The *GEO* Management Team cannot be guaranteed to monitor, or respond to queries placed on any of the other Internet Newsgroups.

Digital Weather Satellites and DVB

... continued from page 25

- **FEC** - Forward Error Correction - a way of protecting the data stream against errors during transmission. The greater the expected losses, the higher the proportion of error correction added.
- **QPSK** - Quasi Phase Shift Keying – a method of placing the data stream on to a suitable RF frequency carrier wave. The information modulates the RF carrier wave by changing the phase of the carrier.
- **DVB-S** - The satellite digital standard for DVB transmissions in Europe and a growing number of other countries.
- **Virtual Container** (VC) - the data stream provided for DVB transmission is cut up into packets. Other information is added to identify and time-stamp it. The data packet that results is sometimes referred to as a 'virtual container'.
- **Symbol Rate** - the rate of change of the modulated RF carrier produces differing 'states' that can be detected by a suitable receiver. These 'states' are called 'symbols' and can be attributed a binary value, e.g. 00, 01, 10, 11 etc. The symbol rate is the number of possible detectable 'symbols' per second.
- **EUMETCast** - *EUMETSAT*'s data distribution system.
- **Tellicast** - a registered name (*T-Systems* Germany). The data stream management component of the *EUMETCast* system.
- **Multiplexer** - a device for 'slicing up' a number of data sources to produce a single data stream.

Many thanks to John Tellick and David Taylor for their assistance during the writing of this article.

More information about DVB can be acquired from:

<http://www.dvb.org>

Further information on the MSG programme:

<http://www.eumetsat.de>

Please Keep Your e-mail

Address up to Date

Many thanks to all those readers who submitted their e-mail addresses to *GEO* when they subscribed.

However, we are all well aware just how easy it is to lose touch when an e-mail address changes after switching to a new ISP or upgrading to Broadband etc. We also sometimes experience problems simply because a handwritten e-mail address proves difficult to read.

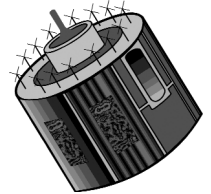
If your e-mail address has changed since you first subscribed to *GEO*, please take a moment to inform the Membership Secretary, Nigel Evans, so that your contact details can be updated. Needless to say, he would also appreciate hearing if you have recently moved house.

The Membership Secretary can be contacted at:

members@geo-web.org.uk

Observing the Weather

with MSG-1



Robert Moore

I operate a small amateur weather station in North Wales. This consists of a standard instrument shelter with dry and wet-bulb, maximum and minimum thermometers and an electronic rain gauge on the workshop roof. Earth and grass temperatures are recorded on the lawn. The barograph is kept indoors. Because of the hill and deep tree-cover to the south of the house I can not record sunshine or wind but I do have a fine view to the north and north-west which enables me to see weather developing from those directions. I write a quarterly weather report for the magazine produced by our community council—now nearly always containing either an HRPT or MSG-1 image. HRPT coverage is restricted by the roof of my house to the east and, because of surrounding trees, I can see no further south than latitude 40°N. Whilst HRPT North Atlantic coverage is excellent, MSG-1 fills a very important southerly gap for me.

I am essentially an amateur: my naval training in meteorology dates from pre-satellite days and concentrated on oceanic weather, basically the Atlantic depression and the tropical storm. Later, as a short-wave listener, I developed an interest in radio propagation which rekindled my interest in the weather. In my retirement I intended to learn a bit more about the Atlantic weather when it reaches the coast. Terrain effects are a particular interest of mine, having lived in two rain shadows (the Grampians in Aberdeen and now Snowdonia in North Wales). I now live close to the 'Welsh Riviera', renowned for its sunshine. On one day last year Capel Curig had the heaviest rainfall in the UK whilst Prestatyn, a mere 43 kilometres away, recorded the most sunshine.

It is also very noticeable how our weather often differs from the remainder of the UK. Furthermore, I can drive to Queensferry or Liverpool, or over the Clwydian hills (journeys of 15, 25 and 12 km respectively) and encounter radically different conditions from home in terms of temperature, precipitation, fog, visibility etc. I suspect that the relatively shallow parts of the Irish Sea warm up and cool fairly quickly and influence the weather in North Wales.

Winter images from HRPT have shown that there can be a very steep temperature gradient from the warm middle regions of the Irish Sea towards cooler inshore and estuary waters and finally very cold land surfaces. *Figure 1* shows a straight line in the clouds over Liverpool Bay, a line that persisted all day. The MSG-1



Figure 1 - Straight line in the clouds over Liverpool Bay

animation showed a continuous stream of cloud from the north-west dissipating along the line—presumably the effect of the warm sea on the cloud. The cloud 'line' is also visible in the MSG-1 image (*figure 2*).

Satellite imagery has thus offered me a good opportunity to indulge my interests in radio, space and computing alongside my interest in weather. For the future I have two tasks. One is to bring myself up to speed and learn more meteorology. This has been going well and I am learning a lot from reading some of the many excellent books available—a selection of which I have listed at the end of this article. TORRO (Tornado and Storm Research Organisation) web-based discussions are invaluable. One thing is clear—I am never going to understand numerical analysis—the very thought of it induces an urgent need to lie down in a darkened room.

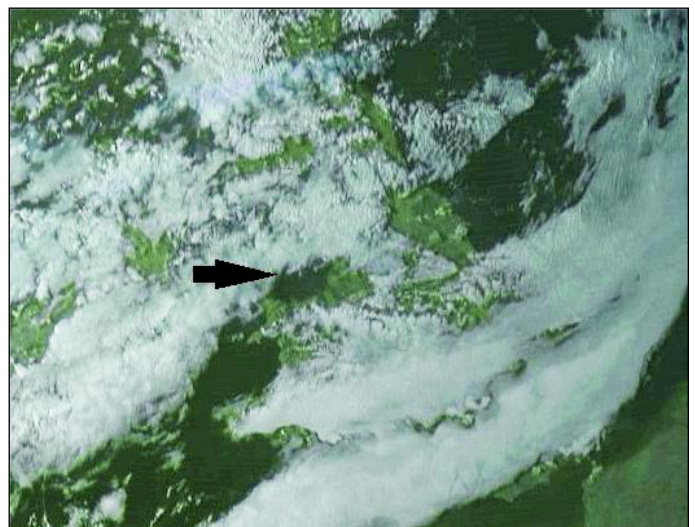


Figure 2 - The straight line in the clouds over Liverpool Bay as shown by MSG-1 (March 28, 2004)

Image: © EUMETSAT 2004 - Processing: GeoSatsignal

Secondly I have to learn to interpret satellite data for micro-scale weather. MSG-1 offers so much more than HRPT in terms of seeing the dynamics of weather (for example clouds at different levels travelling in opposite directions) and it is continuous, 24 hours a day. I must confess to still being at the stage where I find myself just gazing at some of the jaw-dropping imagery from the UK and beyond. I guess many of us are still at that stage—just looking at the images of our world in wonder and apprehension. That we can do this is thanks not only to *EUMETSAT* but to David Taylor and others who can work magic with computers.

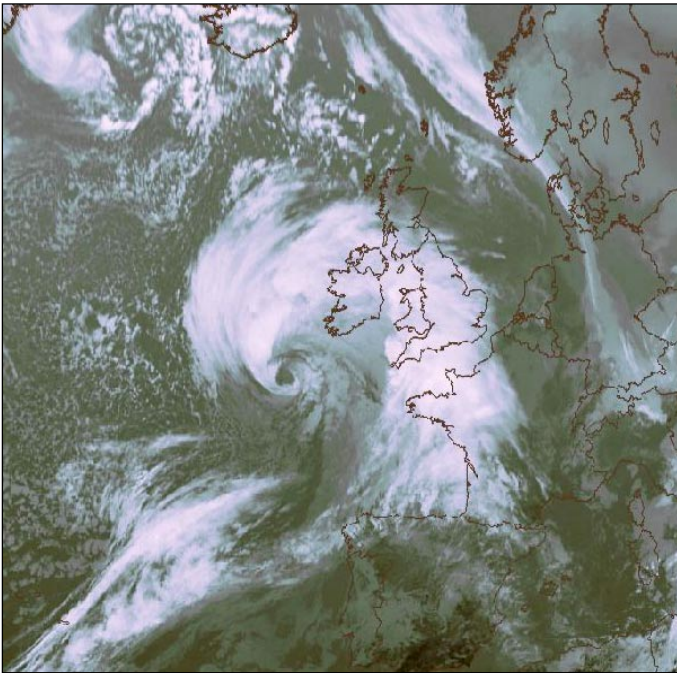


Figure 3 - The November 13, 2003 storm over the UK
Image: © EUMETSAT 2003

So now I'm teaching myself how to interpret the images. I am using the learning aids provided by *EUMETSAT* and the CDs produced by the Dutch and Finnish Meteorological Institutes and the Central Institute for Meteorology and Geodynamics (supported by *EUMETSAT*). In addition, I use radar imagery to monitor local precipitation (rain shadow effects are quite clear). An HF whip aerial on my chimney brings in radio-fax weather charts and I also make use of the web-based weather maps that many of us access through *GeoSatSignal* and *Autoget*. At present I'm still at the stage of studying MSG-1 imagery and tying it in with the MSLP charts and local observations—but the upper air now beckons, especially with the MSG-1 animations.

With HRPT, I used to keep the best image near to noon and the noon MSLP chart in an archive. I was planning to archive my MSG-1 images by keeping, say the noon visible, the midnight IR image and the two charts—plus, of course, animations of anything especially interesting. But with so much archived data already available I may spare myself the effort for the routine data. I am currently keeping all my HRIT images (all



Figure 4 - The 'thundersnow' front on January 28
Image: © EUMETSAT 2003

channels) for one week so that anyone in the TORRO organisation who is investigating severe weather can ask me for images; I have had two calls so far and apparently the material was very useful.

So, in summary, how is this amateur using MSG-1? I'm learning from it and planning some systematic observation on my local micro-climate and I'm supporting colleagues interested in weather. I should point out that I am also reading, researching and writing in my own professional field—thus ensuring a very active retirement.

Memorable Moments

There have been some memorable weather images for me during this first year with MSG-1 (I suppose we really should call it *Meteosat-8* now). *Figure 3* shows the centre of an Atlantic depression which passed over Ireland on November 13, 2003. It stopped over Donegal before turning sharply east and crossing the Irish Sea (rattling my dish on the way) then disappearing off southern Norway on the 15th. Why did it turn so sharply?

A tongue of extremely cold Arctic air crossed the country on January 28. This was closely monitored by local observers throughout the UK and was thus well documented right across the country. It was accompanied by very unusual 'thundersnow' events—that is, snow with thunder and lightning. My animation tracked the cold tongue across the UK and right down into Europe. The HRV close-up in *figure 4*



Figure 5 - The ground view on January 28

shows the point at which the front crossed my station—the clouds appear to lag behind the front because the cold air was cutting under them. *Figure 5* shows the view at ground level at the same time. An hour later I could pick out details on Cumbrian hillsides, 70 miles away through the crystal-clear arctic air.

My piece de resistance so far has been to spot a 'rope cloud' running from St David's Head to Finisterre (*figure 6*). Rope cloud is a thin line of convective cloud caused by cold air sinking from a decaying cold front.

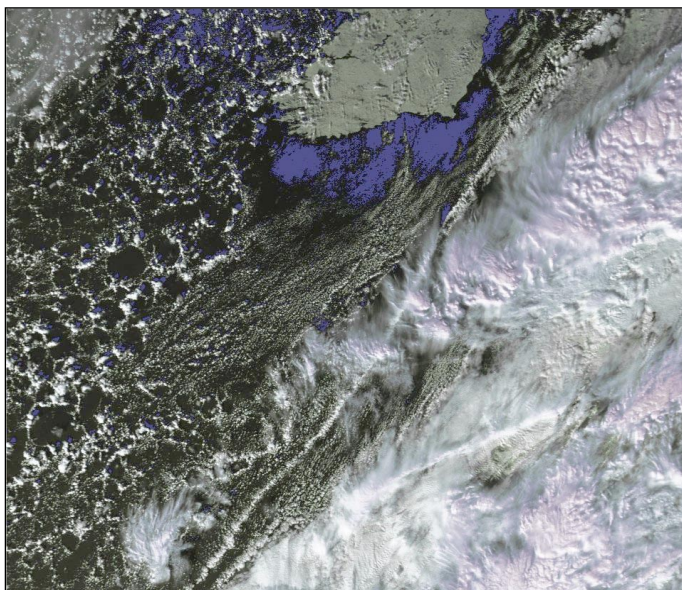


Figure 6 - 'Rope cloud'

In this case there was precipitation associated with the rope cloud because ice crystals from high level cloud were seeding the rain. Ton Lindeman is writing this up for publication. We hope this will be a significant contribution to theoretical debates in meteorology. This may be typical of the sort of contribution that amateurs can make; few professionals will have the time to browse around every image—they will be working on research programmes, forecasting deadlines or specific highly focused projects. This leaves room for the amateur observer to contribute his or her three ha'porth. For myself, I hope to understand the weather in this corner of North Wales better in a few years' time.

(Robert Moore is Emeritus Professor of Sociology. He has held Chairs in the Universities of Aberdeen and Liverpool - Ed)

Some Useful Titles

Ahrens, D C: Meteorology Today

An Introduction to Weather, Climate and the Environment, West Publishing Company (Minneapolis/St Paul) 1994

This is an excellent student text book complete with case studies and test-yourself exercises. It is very well illustrated and carefully explained throughout.

Whilst an extremely useful and handsomely presented volume it is oriented to North America. Why can't we have a European equivalent?

Bader, M J et al

Images in Weather Forecasting, Cambridge University Press, 1995

This volume should be the satellite observer's bible. It has everything as of 1995 including extremely detailed discussions of the interpretation of satellite imagery (including radar imagery). Ideal for observers in the UK.

Unfortunately this book is out of print and will be neither revised nor reprinted. Inter-library loan is probably the only way to get it. If you are lucky enough to find one second-hand expect to pay a good price for it—if I'm not there first!

Conway, E D and the Maryland Space Grant Consortium

An Introduction to Satellite Imagery Interpretation - Johns Hopkins University Press, 1997

Comes with a CD. This is almost certainly the best readily available book on interpreting satellite images. Although USA-oriented, it is full of interesting and useful material which is relevant on this side of the Atlantic.

Dunlop, S

Weather - Harper Collins, 1999

A short and useful book with plenty of illustrations that will fit into your shirt pocket.

Dunlop, S

How to Identify Weather - Collins 2002

This should really be called 'how to identify clouds' and as such it is an absolutely essential handbook for the amateur observer.

File, D

Weather Facts - Oxford University Press, 1990

How to understand the weather and climate and their impact on commerce and society—an interesting book but perhaps not ideal for our purposes.

Hardy, R

Teach Yourself Weather - Hodder and Stoughton, 1998

Just that – a useful first book on the weather.

Reynolds, R

Philip's Guide to Weather - George Philip, 2000

A well-illustrated guide-book with discussions of local weather observation and, briefly, the use of satellites in meteorology.

Watts, A

The Weather Handbook - Waterline Books, 1999

This was the introductory text that taught me the most – excellent on weather systems and how they 'work', interpretation of weather charts and elementary interpretation of weather satellite imagery. The book tells you what to look for on the charts, in the sky and on your screen.

The CD set

Manual of Synoptic Satellite Meteorology Conceptual Models

This CD, produced by the Royal Netherlands and Finnish Meteorological Institutes and the Central Institute for Meteorology and Geodynamics (supported by EUMETSAT), is an invaluable tool. It will probably take most of us more than a year to work through. The higher your level of science education (especially physics) the more you will get out of it, but everyone will learn from and enjoy this—and it's free.

IN TRAY

The Column for Readers' Letters and Queries

Hi Les,

I like GEO and I am looking forward for No.2. I think the way you write about technical stuff is quite good, to encourage other people with a different view on our Earth, and I think that GEO is an enrichment...

So go on....

Kindest regards,

Klaus Bolst, Bochum.

Dear Editor,

Perhaps you would allow me to ask a question of your membership.

Recently I have taken an interest in our Earth's fluid environments: our oceans and atmosphere. Now I don't like coincidences, that is the juxtaposition of two seemingly unrelated events. I know they happens but I still don't like them.

I have noticed that the volume of the Earth's atmosphere as measured at sea level pressure is the same as the volume of the Earth's oceans.

The question is this: "Is this a coincidence or an equilibrium"? And, do I have to wait a billion years to find out?

As usual I have my own view which is expressed above but I don't understand the dynamics; hence the request for help from your membership. Consider Mars!

Francis Bell

Hi John

I would like to thank all of the management team for the symposium. Thank you for your very hard work to make it happen and to Nadine Bell for getting roped in too.

I really enjoyed the first magazine which rekindled my interest. The speakers were really interesting and there was something for everyone.

I have registered for my licence for MSG with Eumetsat and I am looking to get the system up and running.

Again thank you all for Saturday.

Best regards

Pete

Hi Les

Please find a letter for inclusion in GEO. Its' by a friend of mine, Joe Loy, to whom I loaned GEO Q2 for a read. I am trying to entice him into GEO.

Best Wishes

Brian Walker

Joe Loy writes:

Sir,

I read with some interest the article 'Death of a Planet' by Francis Bell. I take under consideration some of the points raised but really take exception to a number of statements, because of practical experience, rather than academical knowledge.

The jumps back and forward in geological time tended to break my concentration and, may I say, were not relevant to the subject and may be off-putting to ordinary readers. Was it necessary to introduce technical terms unfamiliar to many readers, or was it a ploy from an academic to impress lesser individuals? I say that because I believe in *facts*: a theory still remains such until proven. However, I recognised both the terms and what they are relative to, and say quite firmly that it has nothing to do with the subject in hand but to the environment to which plants are exposed.

Let us first examine what 'Global Warming' is. It is a theory, first proposed in the late sixties/early seventies and presented to the *Club of Rome* as a fact that the planet was in danger from the burning of fossil fuels. It was accompanied by a computer program which purported to prove that the theory was indeed fact. This idea was debunked by a computer literate person who showed that whatever was input, including complete nonsense, the result was always global warming!

As you may have guessed, my interest is in the practical use of data available on atmospheric gases. Having been engaged in training and leading personnel in the Mines Rescue Service, where correct identification of a particular gas was vital because it may have been the turning point for success or failure in terms of human life for both themselves and others. The figure given for the concentration of carbon dioxide in air is not as stated in the article but was identified originally as 0.03%. It still remains so, contrary to the efforts of some scientists to foist wrongly obtained information on us in support of dubious purposes.

A second point requiring reconsideration is the stated nearly 6% for the carbon dioxide level in the lungs. The norm for this figure, allowing humans to breathe at a rate and depth whilst resting, is 4%. Increase of the level marginally above this causes rate and depth to increase,

whilst marginal decreases have the opposite effect. It is quite commonly known that hyperventilation depletes the basic level of CO₂ in the lungs and can reduce the triggering of the breathing reflex, often to a lethal extent. I have practical knowledge of these facts from studying the results of tests performed on himself by Professor Haldane of Edinburgh, in which he recorded copious notes. I also experienced some of these things when I was a voluntary patient in experiments at Edinburgh Royal Victoria Hospital in the early '70's.

Inclusion of material about evolution in the animal kingdom and deprivation of the planet of necessary carbon have no relevance in relation to humanity. It happened that way because the planet created the conditions suitable as each new species evolved and I suspect that it was the change which created the evolution I am quite sure that, when all ken of our generation and those following is forgotten, it is quite probable that man will be replaced by something else more fitted to the changes. It could possibly be an improvement!

Those concerned about global warming, climate change and greenhouse effect vary from politicians, bright-eyed optimists who have found a cause and the invariable silver tongued rogue out to make a financial killing. My response to all is a weary, knowing smile.

Joe Loy, Workington

Launch News

'*Aura*', the third and final member of NASA's first series of Earth Observing flagships was finally launched from Vandenberg Air Force Base, California at 3:01 PDT on July 15 into its 705 kilometre-high orbit.

Aura now joins *Terra* and *Aqua* on NASA's mission to understand and protect the Earth's atmosphere. The *Aura* mission has three key aims: to investigate the recovery of the ozone layer, determine the processes that control air quality and investigate climate change. The first scientific data from the satellite are expected within 30 to 90 days. We hope to include an article about the new satellite in a future issue of GEO Quarterly.

APT Image Processing using David Taylor's

SatSignal

Les Hamilton - lesw.hamilton@tiscali.co.uk
<http://myweb.tiscali.co.uk/wxsatellite>

Following our presentation in *GEO Q1* describing how to set up a basic APT weather satellite ground-station, a number of readers have responded with requests for articles which explain how they can improve their NOAA APT images. In this issue we take you a stage further as we explain how the same NOAA WAV files you created with *Wxsat* can be processed by a more versatile software application, *SatSignal*. *SatSignal* not only converts WAV files into satellite images but allows the user to remove speckles and noisy image lines as well as manipulate contrast, brightness and colour rendition.

The development of *SatSignal* by David Taylor started away back in 1999 and, following suggestions and feedback from many enthusiasts around the world, it has developed into the state-of-the-art program it is today. It should be noted from the outset, however, that this software cannot itself capture the satellite signals—you still require a program such as *Wxsat* to create the WAV files first.

SatSignal comes in two versions, unregistered and registered. Many satellite imaging enthusiasts find that even the free unregistered version offers all the functionality that they require—at least in their early forays into satellite imaging. But to unlock the full power of the program, registration is required.

Installing SatSignal

To install *SatSignal* you require **two** items of software, the *Satsignal* archive (*satsignal4nn.zip*) and the runtime library bundle (*runtimes-setup-100.zip*). Both are available from David Taylor's website or from *Software Showcase* [1]. Open the runtime bundle using *Winzip* and double-click on the file *runtimes-setup.exe* to start the installation. Once complete, create a new folder on your computer called '*Satsignal*' then open the *satsignal4nn.zip* program file in *Winzip* and extract **all** its files into this folder. Finally, for convenience, create a Desktop shortcut by dragging the *satsignal.exe* icon from this folder on to your PC Desktop using the right-hand mouse button and then clicking '*Create shortcut here*'. You are now ready to start using *SatSignal*.

The Unregistered Version of Satsignal

Whilst *Wxsat* can produce excellent images from WAV files, results do depend critically on the system used. Both the wx-receiver output level and the type of soundcard utilised affect your results, and a set of parameters that provides good images on one computer is unlikely to do so on another.

Satsignal takes much of the hassle out of APT image processing by fully analysing each WAV file prior to decoding and optimising basic decoding parameters before creating the images. As a result, performance is not hardware-related and anyone following the methods outlined below should obtain top quality images. *Satsignal* simultaneously decodes each WAV file into four separate images which can be viewed on the four tabs on the main *Satsignal* screen as shown below.

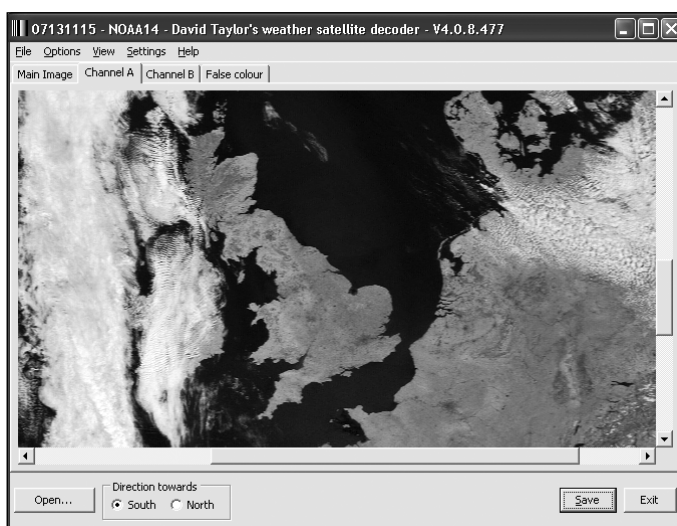


Figure 1 - the Channel-A tab showing a visible image

The four tabs are:

- **Main Image:** a raw image consisting of the channel-2 visible image and the channel-4 infrared image side by side
- **Channel-A:** a modified channel-2 image
- **Channel-B:** a modified channel-4 image
- **False colour:** a colour composite image

Unless specified otherwise, all images shown in this article were produced using a WAV file recorded from the 11:15 UT NOAA-17 pass on July 13, 2003, one of the many wonderful sunny days experienced that summer. The colour version on the outer back cover was created using a newly installed, unregistered copy of *SatSignal*, under the program's default settings. What you see is a screen dump of the *Satsignal* window as it appears in Windows XP™, using a vertical screen

Decoding a WAV File

To use *Satsignal* you must already have available a NOAA satellite WAV file that has been created using *Wxsat* or *WXtoImg*. Load this into *Satsignal* by clicking <File> on the main menu-bar, selecting <Open>, then

navigating to the folder containing the WAV file itself. Double-click on this WAV file to initiate processing (for your first attempt, try to choose a good overhead pass without any interference)

The WAV files from weather satellite APT are always created with a nominal sample-rate of 11025 Hz. If *Satsignal* finds this to be accurate, processing starts immediately. However, if you are using a slow, older computer, the sample-rate may differ slightly from this figure (even a 5 Hz deviation will make the decoded images slant), and *Satsignal* will recommend a revised value; if this is in the range 11,010 to 11,040Hz, accept it. If the value suggested by *SatSignal* is outside this range, it is likely that there is something wrong with the wave file or, less likely, with your soundcard.

If this still fails to provide straight (i.e. vertically aligned) images, use the <Settings → Sample frequency → user> option which permits you to adjust the sample-rate in single hertz increments. A good way to determine the optimal value is to select a weak but 'clean' signal, and set the sampling frequency mid-way between the upper and lower values at which lock is lost (i.e. the image just starts to slant). The new sample-rate value will be stored for future use.

Decoding is highly processor-intensive and the time taken to produce your images depends crucially on the specification of your computer. Table 1 lists the processing times for the *same* WAV file on a variety of computers. On a very basic 233 MHz Pentium-1 laptop with 32 Mb RAM, image processing took (nearly) forever—just four seconds less than ten minutes to complete the task. Increasing the available RAM has a dramatic effect; 192 Mb reduced processing time by a factor of more than twenty, still with a very modest processor. So the message is clear—the more RAM you have the better. Faster processors help too, but their effect is much less significant. Low specification computers can take a *very* long time indeed, and *the author recommends a minimum 64 Mb of RAM*.

Optimising the Images

In line with their primary objective of helping to analyse our planet's weather, NOAA satellites have been designed mainly to image Earth's cloud cover. Clouds reflect brightly in sunlight, but land and sea surfaces have a low albedo (reflectivity). This means that while cloud rendition is excellent, land regions frequently show up very poorly by comparison. Two tools, 'Equalise histogram' and 'Gamma correct' will frequently help to produce more pleasing results.

Gamma Correction

Satellite APT produces images containing 256 grey-scale tones, ranging from black through a range of intermediate greys to white. A typical NOAA image may emphasise the white and light greys (cloud), leaving the darker greys (land) at a very low level. The gamma correction tool allows the intensities at the

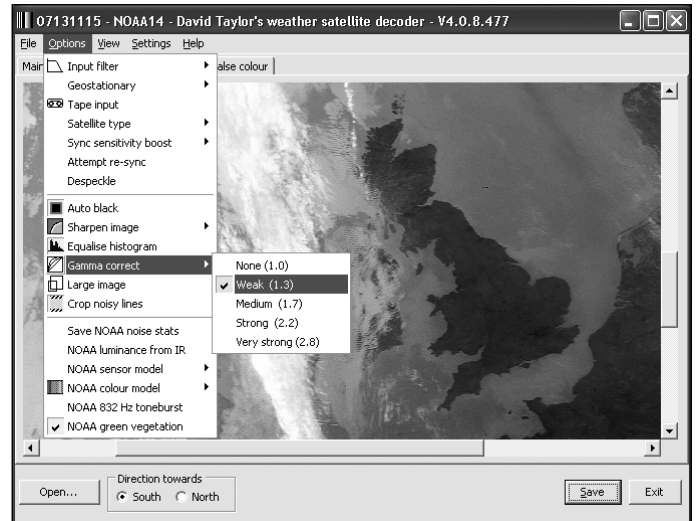


Figure 2 - the Channel-B tab showing an infrared image

Processor	Speed (MHz)	RAM (Mb)	Processing Time
Pentium I	233	32	9 min 56 sec
Pentium II	366	192	27 sec
Pentium III	500	256	19 sec
Pentium IV	2800	1000	5 sec

Table 1 - Processing times

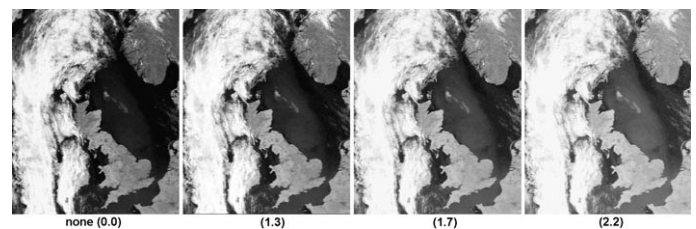


Figure 3 - Gamma correction (channel-2 - visible)

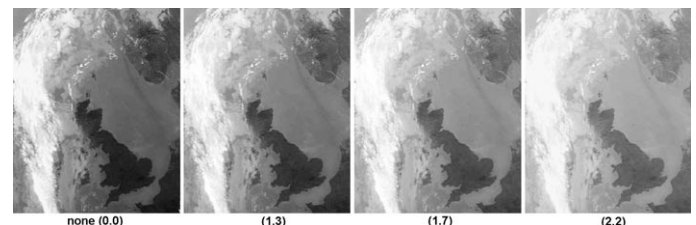


Figure 4 - Gamma correction (channel-4 - infrared)

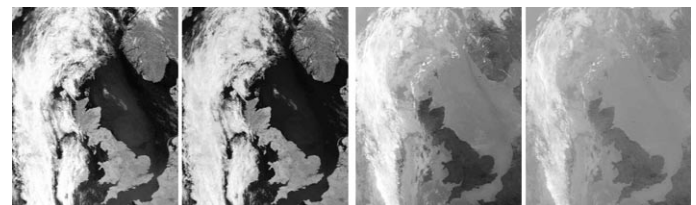


Figure 5 - Histogram equalisation

The right-hand image of each pair has been histogram equalised: Channel-2 (left pair) and Channel-4 (right pair)

'white' end of the spectrum to be reduced while those at the 'black' end are enhanced. No image information is lost: intensities are simply redistributed so that they produce a more aesthetically appealing result on the PC screen. *Satsignal* offers five levels of gamma correction from zero to 2.8. The default, which gives good results for well-illuminated summertime passes

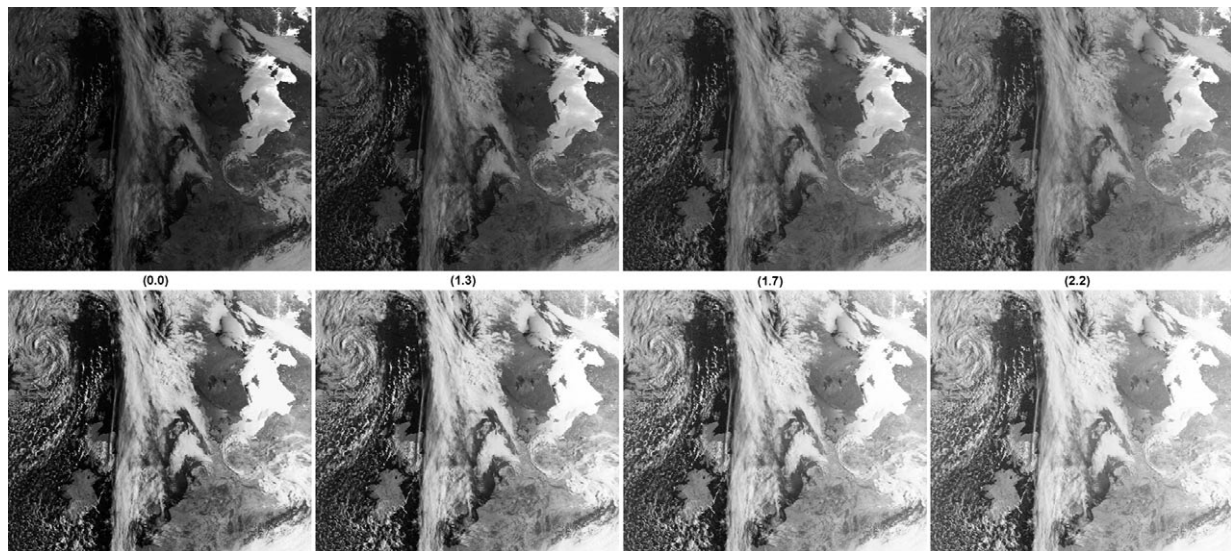


Figure 6 - Histogram equalisation applied to the NOAA-15 image acquired at 07:13 UT on April 16, 2004

is 1.3. In an image where the land is particularly dark and featureless try increasing the gamma. From the menu-bar click <Options → Gamma correct> and make your choice from the fly-out list (*figure 2*). Results of different gamma settings on a segment from the Channel-2 visible/near-IR image are shown in *figure 3*. Note how Scandinavia in particular benefits as the gamma is progressively increased. On the other hand, cloud definition over the Atlantic Ocean deteriorates. *Figure 4* shows how the same range of gamma adjustments affects the Channel-4 infrared image: again, land detail is progressively enhanced while definition in the bright clouds suffers. Choose the gamma setting that meets your requirements best.

Histogram Equalisation

This useful tool is found in the same menu under <Options → Equalise histogram> and may also be seen in *figure 2*. Histogram equalisation redistributes the greyscale intensities over the image so that each of the 256 levels in the image is distributed evenly across the brightness range. This does not generally make much impact with well-illuminated visible light images, but often results in a startling improvement in infrared images. *Figure 5* illustrates the effects of histogram equalisation, at the default gamma setting of 1.3.

Histogram equalisation may also prove advantageous when preparing images from morning satellite passes when the sun is low in the sky and illumination is uneven. *Figure 6* shows just this situation with the 07:13 UT NOAA-15 pass from April 16: the sun is still low in the eastern sky and the right-hand side of the image is much more strongly illuminated than the left.

The upper row of images in *figure 6* shows the effects of gamma correction alone, which tends to result in rather 'flat' images with a restricted range of tones. Application of histogram equalisation to each is shown in the lower rank of images. The actual choice of parameters will be dictated by the particular part of the image that you are trying to enhance.

Why Register?

On registering *Satsignal*, many worthwhile new options present themselves. One of the most useful is the *Illumination adjust* feature which compensates in a much more effective manner for the lateral lighting imbalance present in images like *figure 6*. *Figure 7* shows just how much detail can be preserved using this option. While cloud over the Atlantic is now nicely rendered, the subtle light variations over the Baltic Sea are retained—altogether a much more satisfying result than any of the versions in *figure 6*.

If you look carefully at *figure 7* you will also note the presence of a toolbar above the image. This greatly simplifies the use of the program by providing one-click pathways to many of the most common options.

While the basic program offers just a single colour scheme, registration opens the door for the use of several predefined palettes and also allows you to create your own. The left-hand image in *figure 8* employs a user-defined palette that adds blue to the sea surface while the right-hand image uses the supplied 'temperature' palette. Additional palettes can be created using a dedicated utility program called *LUT-Maker*. *Figure 8* also illustrates the addition of automatic captions, gridding and country outlines to the images.

A detailed appraisal of the registered version of *Satsignal* is beyond the scope of this article. However, if past experience is anything to go by, most users will be keen to register and experiment with the new features for themselves.

Reference

1. *Satsignal* is available from Software Showcase. You can also download it yourself from <http://www.satsignal.net> on David Taylor's website. You will find the link to *Satsignal* under the 'Satellite Tools' section. The link to the runtime library bundle is on the *Satsignal* page under the section headed 'Requirements'.

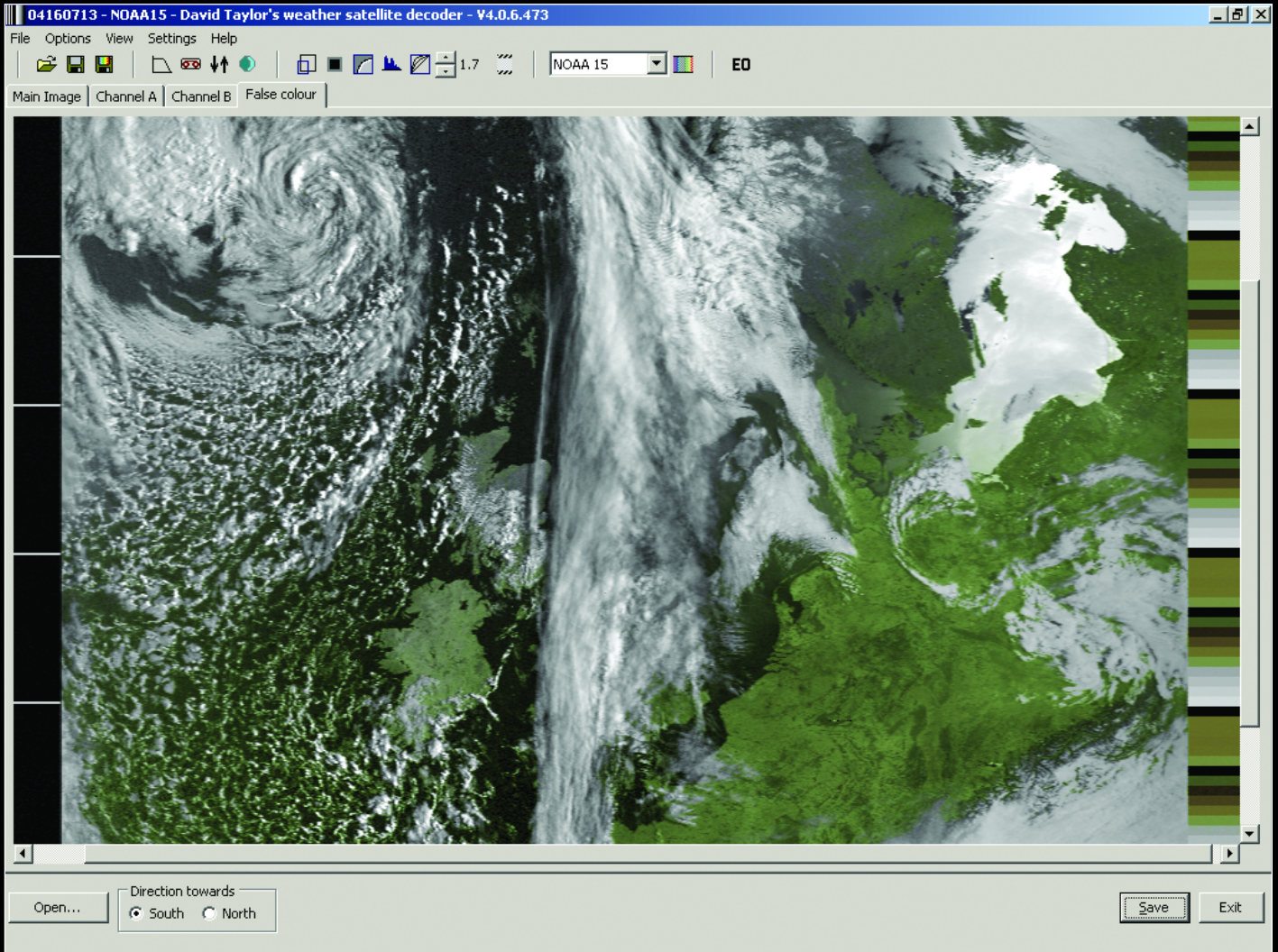


Figure 7 - The NOAA-15 image, processed using the registered version of Satsignal, and modified by application of the strongest 'NOAA illumination adjust' setting.

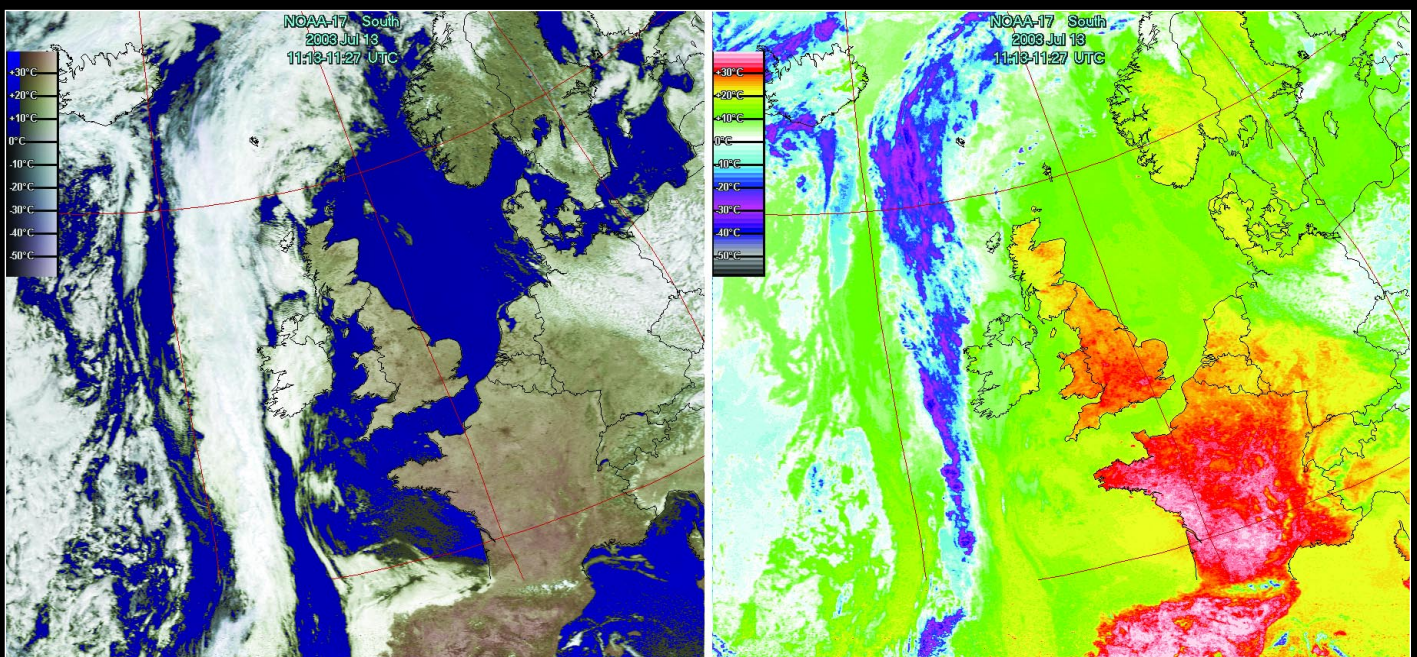
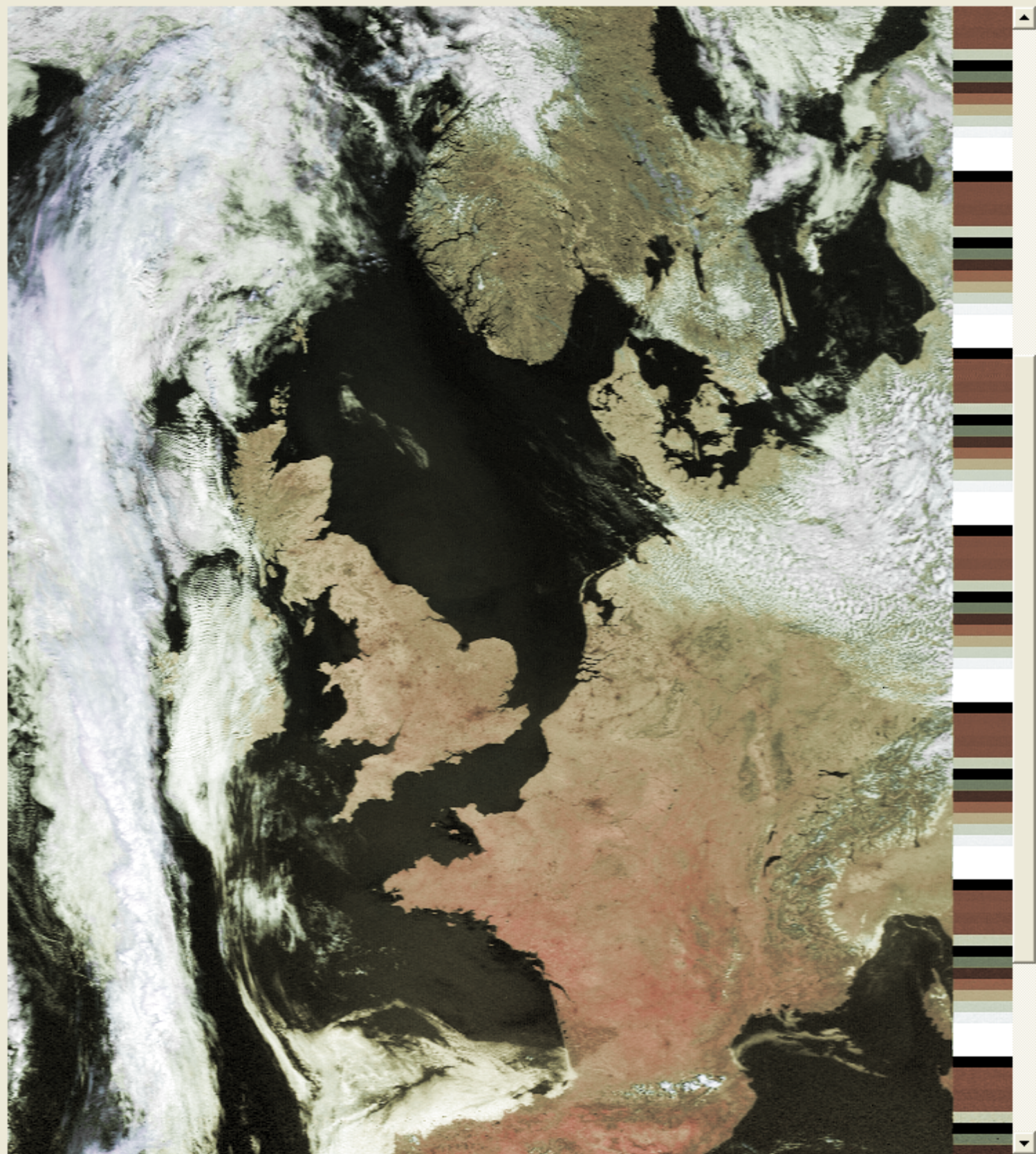


Figure 8 - The NOAA-17 image, processed using the registered version of Satsignal, displaying colour palettes, country outlines and captions. The left-hand image uses a customised palette, that on the right shows the in-built 'thermal' palette.



Open... Direction towards South North Save Exit