The **GEO** Quarterly

Group for Earth Observation

GEO
Group for Earth Observation

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

33
March 2012

Editorial

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Thanks to a query from Peter Burden, who sent us an *Envisat* image he had obtained through the Envi-Ham project, we have an article, 'Sahara Revealed', starting on page 32. When I first saw Peter's image, I was quite taken aback. It was extraordinary—quite unlike any satellite image I had seen before. Peter was also uncertain as to what it displayed and expressed the hope that we could cast some light on the features shown. My research led to this article, which met with Peter's approval. I hope you enjoy reading it too.

When GEO was first established it was hoped that the content of the *GEO Quarterly* magazines would be largely reader driven, an aspiration that has rarely been realised. But Peter's approach—sending in a query with an image—just shows how easily a significant article can be realised. So do, please, consider making contributions to *your* Quarterly: this can be in the form of letters to the editor, articles about satellites, the weather, Earth imaging, and of course requests for information on a topic that intrigues you. You <u>can</u> make the difference, even if it is just by triggering the imagination as Peter has done.

We don't as a rule receive many contributions for our *Feedback* column: none at all this issue. It would be nice to receive informed comment about *GEO Quarterly* articles, be it additional background information, corrections or criticism. I hope that every reader would feel free to email the editor with comments. It's all about promoting and discussing our interest in the world around us and sharing that elusive item of knowledge that can enhance everyone's enjoyment.

This issue sees a minor 'Spring Clean' for the *Quarterly*. The **GEO Shop** listing finds a new home on the back page with the **Helplines** and **Membership Form** now also located at the end of the magazine. This will permit articles to flow more freely through the pages of the Quarterly.

This first issue of 2012 contains an eclectic mix of material from the descriptive to the technical. There are several interesting items of general reading from the NASA Earth Observatory; Ed Murashie's visit to the Vandenburg Air Force base just prior to the launch of NASA's NPP satellite; an overview of EUMETSAT's new *ePort* Internet utility; *Tutioune*, a fantastic new software development for monitoring EUMETCast and Envi-Ham signals; and lots more besides. I hope you enjoy this issue and look forward to hearing your views on it.

Contents

The GEO Report

Francis Bell

I recently asked David Anderson, our Membership Secretary, for details of our current members. He provided me with this detailed table. I am concerned with the issues which the table seems to reveal. Our total membership number is in decline, which poses the question: '*Why should this be happening*'. Should our group's aims and objectives be reviewed to encompass wider interests or should we be more diligent regarding the maintenance of our existing membership?

With the current membership subscription at its present level, membership income only just covers GEO's running costs. Also, it is important to have a wide membership because of the resources of talent and experience which members can share with each other. If you have any suggestions for attracting a wider membership, please let me know. In the meantime, I will try to progress the renewal of recent lapsed members: this will include those in the USA. On a personal level, I will try to promote GEO by writing articles relating to our interests in weather satellites and submit this material to appropriate publications. And finally, please don't forget to renew your own membership when it falls due.

Help with the GEO Shop

I have written before about the importance of the *GEO Shop*. Not only does it make a profit for us, providing a financial buffer should it ever be needed, but importantly it provides access to items of hardware for satellite reception that an individual member could find extremely difficult to source independently.

The issue at the moment relates to additional help which is needed to run *GEO Shop*. Clive and Carol Finnis, who established the shop in 2004, have given notice of their intention to relinquish their shop responsibilities in the latter part of this year. Our most sincere thanks go to Clive and Carol for all they have done for us in the past, and not forgetting David Simmons, who has acted as assistant shop manager in recent years. I am pleased to report that David will continue to fulfil his role as assistant shop manager but this leaves us looking for someone new to take over from Clive and Carol.

The main responsibility for the new Shop Manager will be holding and dispatching items of stock, together with appropriate packaging materials. Access to a convenient Post Office would be an advantage. The stock is not very bulky and is contained in a few cardboard boxes. Clive and Carol may be in a position to continue to look after the placement of orders and finances: these details can be established once the new Shop Manager has been appointed.

GEO Membership		
	August 2011	August 2010
Australia	6	7
Austria	5	4
Belgium	8	11
Canada	2	4
Denmark	0	1
Finland	2	2
France	9	10
Germany	9	5
Hong Kong	1	1
Ireland	8	6
Italy	11	11
Japan	1	1
Mauritius	1	1
Netherlands	29	28
New Zealand	6	7
Norway	4	2
Portugal	0	1
Spain	8	6
Spain	8	6
Sweden	5	5
Turkey	1	1
USA	13	21
Vietnam	1	1
Totals		
Europe	99	93
Rest of World	35	45
UK	268	285
Overall	402	423

GEO Membership Figures

Can you help out here? GEO needs a response to this request for a member to take on this responsibility because, without a shop, we are all disadvantaged. For finer details of responsibilities please contact myself at *francis@geo-web.org.uk* or Clive at *tech@geo-web.org.uk.*

Future Events

March 17   Werkgroep Kunstmanen will be holding one of their regular meetings In Utrecht, The Netherlands.

March 31   Tornado and Storm Research Organisation (TOORO) is holding one of their six-monthly meetings in Oxford. Last year GEO was represented and gave a presentation at one of the TORRO meetings. There is considerable interest overlap between GEO and TORRO hence attendance at a meeting is very worthwhile. For details of this meeting visit

www.torro.org.uk

April 22   The West London Radio and Electronics Show will be held at Kempton Park. GEO have a stand booked for this show.

May 12   Werkgroep Kunstmanen will be holding one or their regular meeting in Utrecht, The Netherlands. A number of UK based GEO members have said they will attend this meeting and all UK members are encouraged to be supportive of our Dutch friends on this occasion. For further details for the meeting visit

www.kunstmanen.net

June 8   GEO's visit to SSTL at Guildford. Please see the separate notice relating to this proposed visit.

June 17   Newbury Radio Rally and Boot Sale. GEO will be attending this popular rally with a stand running live EUMETCast reception. The venue is Newbury Show Ground. For details of this event visit

www.nadars.org.uk

Sep 14/16   AMSAT-UK will be holding their annual colloquium at the Holiday Inn, Guildford. Note that the date for this meeting is six weeks later than in previous years because of accommodation arrangements dictated by the Olympic Games. In the past GEO has contributed to the AMSAT_UK meetings. For details of this meeting visit

www.uk.amsat.org

Sep 28/29   The National Hamfest exhibition and show is to be held for the fourth time at the Newark Show Ground. The show is sponsored by the RSGB and the Lincoln Short Wave Club. GEO will again have a stand running live satellite reception. This is a large two-day show, with easy access and is well worth a visit. For more details visit

www.nationalhamfest.org.uk

Volcanoes: A Quarterly Challenge

Instead of the usual *Quarterly Question*, I thought it might be interesting, as a variation, to pose a *Quarterly Challenge* this time. The idea was prompted by my recent visit to Indonesia with its selection of volcanoes forming a section of the 'Pacific Ring of Fire'. During my visit I saw many volcanoes, some of which are still active. See photograph on page 12.

I thought it would be interesting to challenge members to receive images of volcanoes and then submit their best image(s) for publication. There are active and extinct volcanoes on all the continents so there is scope for members living in any part of the world to receive images showing volcanoes. For this challenge, <u>any</u> satellite image of <u>any</u> extinct or active volcano is acceptable, provided it has been received directly from satellite. I can think of a number of satellites which offer live reception, potentially generating volcano images within the scope of this challenge.

The challenge will be left open till the end of the year. If you have something of interest, please submit it without delay as entries published can be spread over a number of *Quarterlies*. Please send entries to myself at

francis@geo-web.org.uk

Since drafting the above text I have received a very interesting image displaying a volcano. I will submit this image myself for potential publication in our next Quarterly: it will act as an example image, plus the reminder to members that the challenge is running for the rest is this year.

GEO Visit to Surrey Satellite Technology Limited (SSTL)

Surrey University's involvement with satellites goes back to the early 1980s with UoSAT-1 and UoSAT-2. Subsequent research and commercial development led to the design and production of many specialist 'small' satellites by SSTL. In the past some privileged members of GEO will have enjoyed a tour of SSTL's facilities on Surrey University's campus. However, as a result of the growth of SSTL, they have moved to larger purpose-built facilities on the nearby Research Park. GEO's recent contact with SSTL has resulted in an invitation for GEO members to have a guided tour of the new SSTL facilities. The arranged date for this tour is Friday June 8. On the same day, other activities are being arranged for our members and it is hoped to have a meeting room with facilities for displays and demonstrations. The finalised details for this day will be published on our website. This visit to SSTL is a unique opportunity for us to visit the very latest satellite production facility in the country. If you wish to register for this visit, email your details to Rob Denton at

international@geo-web.org.uk

and follow details to be published on our website nearer the time.

Quarterly Question 32

My thanks go to the following members who submitted answers to *Quarterly Question 32*. This question related to naming a river in southwest Madagascar, which was conspicuous on a satellite image because of the visible sediments distributed across the river's flood plain. The name of the river in question is 'Onilahy', and it discharges its waters into the Mozambique Channel in southwest Madagascar at the town of Saint Augustin. Answers were received from

Elmar Bogels, Brunssum, Netherlands
Bill Baily, G4GUC, UK
Ken Morgan, VK3CEK, Australia
Anders Hook, Sweden
Peter Burden UK
Andreas Lubnow, Germany

I think that, if I had been faced with this question, I would have researched an answer using *Wikipedia*. I'm sure some members submitting an answer did this. However,

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Missing your Copy of
GEO Quarterly?

If your copy of GEO Quarterly fails to arrive by mail within four weeks of the advertised publication time, please address your queries to *Membership Secretary*, who can arrange for a replacement copy.

Contact Details

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Loughborough LE12 6PP
England, UK.

Telephone: 01509 820 067
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Cover and Full Page Images

Front Cover

This is a section from an image acquired by the new NASA NPP satellite's *Visible Infrared Imager Radiometer Suite* (VIIRS), on January 19 this year. The high-resolution image shows striking detail of the state of Florida.

Image: NASA/NPP

Inside Front Cover

Memories of last year's wonderful May weather come from Mike Stevens, who sent us this lovely NOAA-19 AVHRR image from the 12:24 UT NOAA 19 pass on May 1, 2011.

Image © EUMETSAT 2011

Inside Back Cover

This is a 'first' for GEO Quarterly, a three-channel colour composite image from Russia's *Meteor 3 No1* satellite. Acquired on October 22, 2009, the image includes part of the Black Sea, Turkey and the islands Crete and Cyprus.

Image: SRC Planeta - http://planet.iitp.ru/english/index_eng.htm

Back Cover

Francis Breame provided this Envisat MERIS image which shows a section of the of east Greenland coastline. It dates from September 11, 2011, just at the end of the melting season. Great swirls of brash ice can be seen drifting down the coast.

Image: ESA

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Winter finally arrived in Scotland when an area of high pressure hovered over the country for several days during early November last year. This MODIS image from NASA's *Aqua* satellite shows Scotland all but cloud-free at 13:05 UT on November 7. Mist is beginning to obscure the Northwest Highlands and the Outer Isles, but the most striking features are the glens filled with valley fog. Across the Central Highlands snake the broad valleys containing Loch Tummel and Loch Tay, merging in the east into the broad strath carrying the River Tay. To the west, the fog continues along Glen Ogle and Glen Falloch to join the roughly triangular mass of fog obscuring Loch Lomond.

Image: NOAA

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Ukraine's new Sich-2 Earth Resources Satellite acquired this spectacular image of San Francisco Bay on September 18 this year. Sich-2 can image at a resolution of just eight metres, thirty times better than the MODIS spectroradiometers flown on NASA spacecraft. In this view, both San Francisco and Oakland international airports are clearly visible, as is the former island prison, Alcatraz.

Image: Dniprokosmos

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This Metop-A image of New Zealand, acquired via EUMETCast on December 21, 2011, was sent in by Mike Stevens. Not only are both main islands in clear view, but there are interesting cloud formations to the east of North Island.

Image © EUMETSAT 2011

Sea Ice off Southwestern Alaska

A NASA Earth Observatory Report
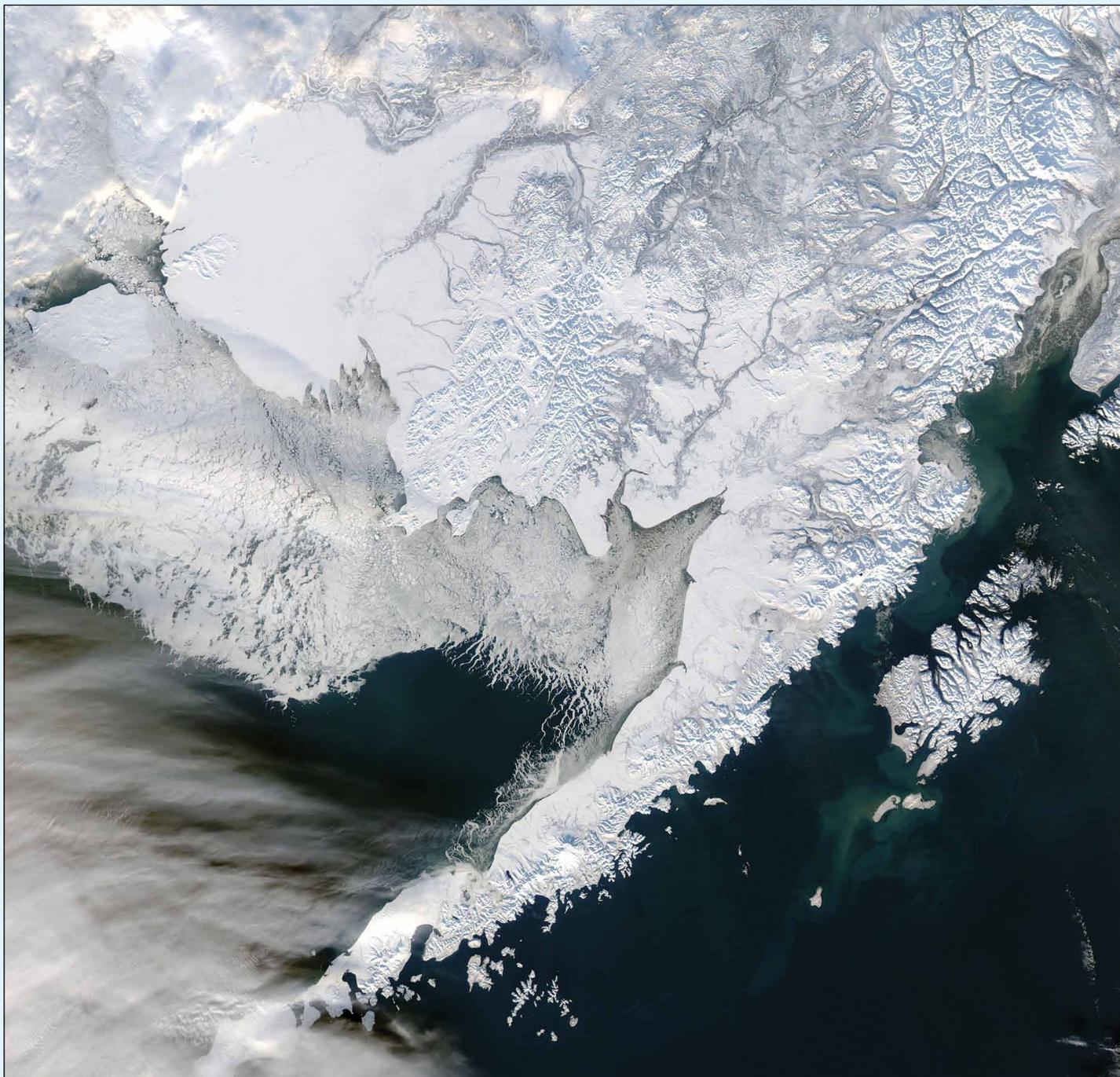
Snow rested on the land surface while ice rested on the seas surrounding southwestern Alaska in early 2012. The Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's *Aqua* satellite captured this image on January 15. Pristine snow blankets the mountains and plains, and tendrils of sea ice fill Bristol Bay.

Arctic sea ice waxes and wanes throughout the year, and conditions around Alaska, and in the Bering Sea, fluctuate each season and from year to year. The sea ice extent last January, though not a record, was nevertheless the highest it had been for several years, according to the National Snow and Ice Data Center.

North of the area in this image, a heavy November storm followed by continuing harsh weather conditions had prevented the delivery of much-needed winter fuel to the city of Nome. Thick sea ice continued to hamper efforts to reach the area throughout early January until a Russian tanker finally succeeded on January 16, 2012.

Overall, Arctic sea ice typically grows throughout the month of January, reaching its peak in late February or March.

NASA images courtesy Jeff Schmaltz, LANCE/EOSDIS
MODIS Rapid Response Team at NASA GSFC.

KATABATIC WINDS
Rake Antarctica's Terra Nova Bay

A NASA Earth Observatory Report
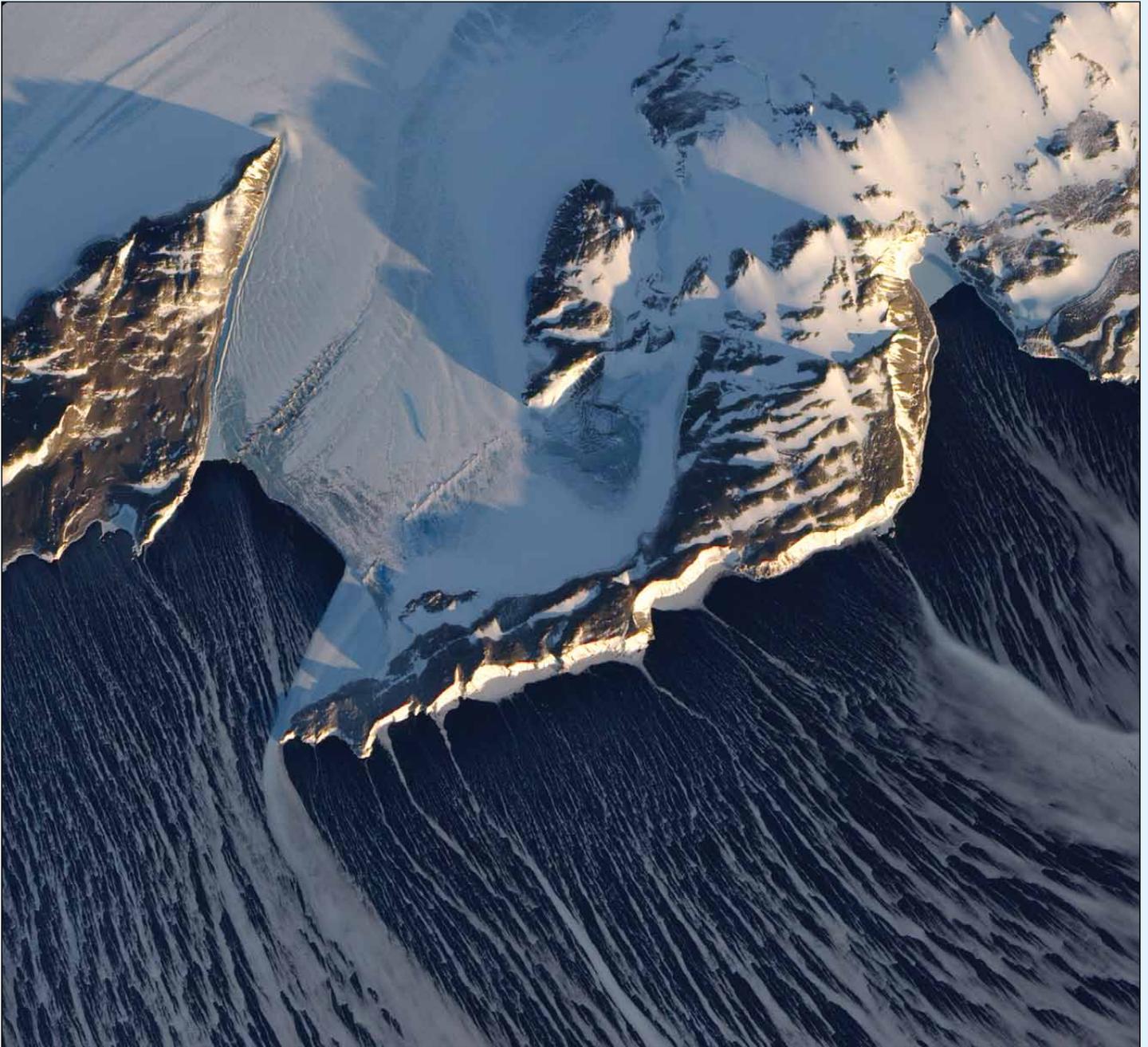
Shortly before the onset of spring in the southern hemisphere, Antarctica's *Inexpressible Island* (upper left) and the *Northern Foothills Mountains* (top right) were illuminated by a glimmer of low-angle sunlight when the Advanced Land Imager (ALI) on NASA's Earth Observing-1 (EO-1) satellite captured this image on September 16, 2009. The seaward slopes of the mountains are gleaming white and cast long shadows inland over the Nansen Ice Sheet.

The scene provides two indications of the bay's persistent and fierce katabatic

winds—downslope winds that blow from the interior of the ice sheet toward the coast. One is the windswept ground in the mountainous terrain where, in many places, the pattern of bare rock and snow drifts suggests that the winds have scoured snow from upwind slopes and deposited it on the lee sides. The second sign is the parallel white streamers of newly formed sea ice on the open waters of Terra Nova Bay (lower right), which are continually being pushed out to sea by the strong offshore winds, creating a pocket of open water known as a polynya.

The winds are responsible for making this location an ideal spot for Adélie penguins, which have a colony on *Inexpressible Island* and at other sites around Terra Nova Bay. Unlike Emperor penguins, which breed on the sea ice, Adélie penguins nest on ice-free land, which must be accessible to them via open water and close to their marine food supply.

This NASA Earth Observatory image was created by Jesse Allen and Robert Simmon, using EO-1 ALI data provided courtesy of the NASA EO-1 team and the USGS.

My Meteosat System: 1975 - 2012

Guy Martin

Receiving Meteosat images via EUMETCast is all too easy these days. Just buy the kit, software and licence, and everything is simply laid on a plate for you. But 35 years ago, when Meteosat-1 represented the absolute height of technology in the weather satellite arena, it was a very different matter, as Guy Martin explains.

I have always been interested in weather, mainly because there is always something to see, something to look forward to. Maybe the endless summers of 1975/1976 were a bit boring weather-wise, but generally, our position on the eastern edge of the Atlantic Ocean always throws something new at us.

The first weather satellite I heard of was *ATS-3* which, as I remember, was parked at 75°W. When there was high pressure to the west of us, I went to the highest point on the North Downs, with the best receiver and antenna I could muster, and I thought I briefly heard something. Most likely it was just a few stray electrons that had lost their way. It was a non-starter.

When *Meteosat-1* was launched, I wrote to the European Space Agency, not expecting much of a reply. Imagine my surprise when a three quarter inch document with a German postmark fell through the door. It contained full details on how to receive images, schedules and everything you could possibly want. It was produced by the University of Dundee and gave details of their system, even down to the circuit diagrams of various modules.

Aerial

My project to receive *Meteosat-1* began June 1975. First was the aerial. Consulting the trusty RSGB manual, I decided on a loop yagi. It was easy to make. I had plenty of plastic covered aluminium strip that was used for tying cables on to cable trays and the local hardware shop stocked aluminium of various shapes and sizes. After some drilling and riveting and scaling the RSGB 1.3 GHz design, I ended up with a three metre long loop yagi which was duly fixed to a wall of the house which, luckily, pointed due south. A short length of low-loss *shf* cable bought the signal into a small upstairs back room which was my workshop.

Receiver

My next problem was a receiver. In those days there was no easy and cheap access to shf GAsFETs or MMICs as we have now. The answer was to do some plumbing and I built an *Interdigital* mixer, again with some cloning from the RSGB book. Anyone who has worked in television (the old analogue variety) will remember vision patch panels which used *Musa* U-links and *Musa* cables for longer jumpers. *Musas* were made from
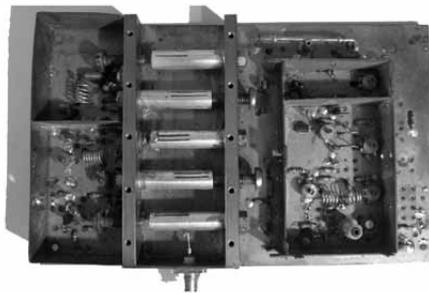
The author's home-built
Meteosat Receiver

silver coated brass tubes. When unbolted from the U-section it turned out that they were exactly the right size for 1691 MHz. After announcing this discovery around the coffee table at work, other radio amateur colleagues found that the cable Musas, which were slightly longer, were good for 1296 MHz.

The receiver is pictured above, somewhat cannibalised. On the right was a relay, switching between two crystals of 97.093 MHz and 97.312 MHz. A 16x multiplier chain to the right of the *Interdigital* mixer multiplied these frequencies to 1553.5 MHz and 1557 MHz which, when mixed with the two available downlink frequencies, gave an IF of 137.5 MHz. This became the norm for this type of kit as it enabled it to interface with a VHF orbiting satellite receiver.

The centre pole of the mixer connected to a Schottky diode, a bit difficult to find in those days, but luckily, my workplace was not adverse to the odd home project. This in turn fed through a matching stage and a dual gate FET amplifier. There was also an LED 'happy light' that worked off the DC generated by the injection frequency; useful to know it's all working OK even if you don't receive anything.

The VHF section was fairly conventional, except that the oscillator scanned around 137.5 MHz until a signal was received and then locked on to it using AFC. This system worked really well, and got around the need for another crystal to convert down to the IF of 10.7 MHz. Any converter crystal drift was cancelled out by the local oscillator AFC. A 30 kHz crystal filter was scrounged from some old PMR kit and the IF amplifier was the tried and trusted CA3089. It was lined up at work, brought home, and connected to the aerial; amazingly, it received the satellite's tell-tale chirping signal plus a lot of noise.

I could clearly hear the sub-carrier but the noise was obviously too much for any sort of clear image. I now had to reduce the noise. A colleague mentioned a phase-lock

loop detector, the idea being that, instead of the whole IF noise bandwidth being detected, the PLL tracked the signal and the noise bandwidth was the bandwidth of the loop filter. Through visits to the work library, local library and book shops, pretending to look for a book to buy, I eventually learned how to construct one. It worked fairly well; the noise was reduced somewhat and a lot was learned but some sort of preamp was going to be needed, just a strip line preamp on fibreglass PCB using two BFR34 transistors. I couldn't even find any *Teflon* PCB material in small (and cheap) quantities. Using BFR34s probably wouldn't have made much difference anyway. Although not the ideal choice, it worked, and now the signal was usable though still noisy.

Display

How would I display the hoped-for images?. I found two *Muirhead* fax machines in the back of technical stores at work. On enquiring of the Engineer-in-Charge it transpired that he thought they had already been thrown out long ago: so I was given the job of getting rid of them. On taking them apart they appeared to have circuitry for start and stop tones and phasing signals but the two phase 50 Hz *selsyn* motor needed an external drive. The difficult bit, the mechanics were all there; the easy bit, the electronics I could cope with.

At this point some test equipment was needed, so I built a WEFAX test unit which generated start tone, phasing, stepped grey scale or grille and stop tone. These signals could be output individually or in sequence to simulate a picture. It contained a lot of CMOS chips and became a very useful piece of kit. All this could, of course, be done with a single PIC chip these days. Back then it was *Veroboard* and lots of chips.

A decoder was built to get the baseband signal using a 567 PLL, locking to the sub-carrier and a full wave detector. I also added a gamma stage to lift the blacks. Three diodes around a 741 op-amp with a few resistors improved the image immensely. The 567 recovered subcarrier was divided down to 50 Hz to drive the motor circuitry. This consisted of two power transistors into a backwards toroidal mains transformer which made an inverter to drive the 115 V, 50 Hz *selsyn* motor. It was fired up, start tone arrived, the motor started, phasing let the helix turn and the picture appeared on the paper moving sideways across it.

Arrggh! The machine gearing was for 180 rpm but, in the excitement of the moment, I failed to check. It should of

course have been 240 rpm. After a little cursing and head scratching, it dawned on me that if the motor drive was upped to 66.6 Hz it would rotate at 240 rpm, and 66.6 Hz is easily divided down from the 2400 Hz subcarrier to keep everything in sync. I also managed to buy, very cheaply, some boxes of paper and writing edges for the machine. One box was document paper but two of them contained image paper which gave nice deep blacks. The image was produced by passing a current from the writing edge, through the paper and into the rotating helix, which is grounded. Iron atoms are transferred to the chemical in the paper, turning it black. The writing edge wears away and eventually (or sooner with the use I was giving it) needs replacing. The pictures were usable but had lots of speckles due to the noise in the system.

Dish Antenna

At that time I used to take an excellent magazine called *VHF Communications* and the issue that next dropped through my door described how to make a dish from sheet aluminium. Following another visit to the aluminium shop and some trigonometry and careful measuring and drilling of holes, a 6-foot dish was constructed out of eight aluminium petals and mounted on the garage roof. The garage had a flat roof with a good aspect to the south. I saw a design for a coffee-can feed horn which would have exactly the right beam width when placed at the focus of this dish. Unfortunately, American coffee cans are somewhat bigger than ours and no amount of searching in B & Q could find a paint tin of the correct dimensions. There was an excellent non-ferrous metal suppliers in Farringdon in London. I rather cheekily phoned them and asked if they had any 4.25 inch brass tube. The reply was: 'of course sir, minimum purchase is 1 foot'.

I called in and asked for one foot of 4.25 inch brass tube. It took four chaps to carry this 4-metre length of tube to the cutting machine, where they sliced off a one foot length, weighed it and worked

Unfortunately, none of Guy's original images has stood the test of time. The Fax paper actually decomposes with age due to the chemicals it contains. This is the first ever image transmitted from Meteosat-1 on December 9, 1977.
Image © ESA

out the price. The piece of tube was cut to the size of the coffee can, one end was sealed over with copper sheet, and a small probe was placed inside and connected to an N-connector. This was placed at the focus of the dish with a length of low loss feeder to the receiver and the signal was absolutely clean. Not a trace of noise to be heard. I had a working *Meteosat* reception system.

Framestore

It became apparent that a better display system was needed. Paper wasn't readily obtainable and was not easily archived; it tended to fade and turn brown. Sepia prints might have been in fashion once, but not for Meteosat images. In addition, because Fax machines are not quiet even with the workshop door closed, complaints were received from other members of the household when, for example, tracking summer thunderstorms moving up from France at 11.30 pm.

At that time the BBC was beginning to use a device called a synchroniser to keep signals from remote cameras in step with the main cameras. A synchroniser is, in reality, a framestore. I decided to build my own framestore—and a TV monitor to go with it. At that time there were a number of electronic shops in the London area, so a 17-inch tube was purchased together with ready-made line scan and field scan modules. I built a video amp, and after a bit of carpentry, soon had a working monitor in a not very smart wooden box. There was a junk shop near where I worked that stocked computer mainframe stuff. He didn't seem to sell much except to myself and my colleagues. I think most of it was broken up and sold as scrap metal. One day, he had some large PCB panels full of 4116 RAM chips, exactly the same as used in the synchronisers. These were purchased cheaply, and with help from the synchroniser circuit diagrams, I designed a framestore for Meteosat use. It was quite a bit simpler as the signal was monochrome, not colour. Each Meteosat image consisted of 800 lines of 800 pixels. I opted to discard every fourth pixel and every fourth line, giving me a 600 line, 600 pixel system which fitted easily into the CCIR TV standard. The family was happy. There were no more clunking noises late at night. And the fax machines went to their final resting place quite a bit later than was originally intended.

Electronic Storage

It was about this time that the BBC B computer became very popular and it had a large following at work. We had already interfaced floppy drives to it and there was a large group of us engaged in doing all sorts of stuff with it, some of which was even used for broadcasting purposes.

One day, the junk shop had in its window a 40 MB MFM Winchester drive, which following negotiations, was purchased very cheaply. This generated great interest at

work and the management even had ideas about storing graphics on it. As a result, a delegation returned to the shop to discover there were six more Winchesters available; needless to say we bought the lot.

The plan was now to interface these to BBC computers as a means of archiving Meteosat images. We learned from a contact in the USA that we required DTC510B controller cards to interface with the MFM drives and convert them into SCSI devices. We returned to the junk shop, found they had some, and bought six. All that was needed now were a few chips to interface the SCSI bus into the BBC B's 1 MHz bus.

Each controller card had an EPROM on board, which was configured with the drive parameters. We had to design and make an EPROM programmer that would work on the computer as well as a UV light box for erasing the EPROMS. This project was growing fast, but luckily we had the management's blessing (they wanted one set to use as a caption generator). So the work wasn't all relegated to lunchtimes.

Eventually one set was complete and we set about formatting the Winchester. It took three hours—but got there in the end—and we had 40 MB of storage. Fantastic in those days. I could now feed the Meteosat digitised images into the computer via the user port and save them on the hard drive (Winchester). Archived material could be displayed on the TV. No more threats of being banished to the shed.

Final Thoughts

About this time I moved house and there was no room for the six-foot dish on the patio or pitched garage roof. But luck was on my side. The BBC Comms guys asked me one day if I would like a 4-foot dish, which of course I accepted. It proved ideal for my coffee-can feed horn and fitted on a simple frame made of cut down scaffold tubes.

Soon though, the *Timestep* downconverter and LNA came along and the 3-metre Yagi came back into operation, with the LNA mounted right by its radiating element. This setup continued right up to the point where (luckily for us, no so for EUMETSAT) the satellite power amplifier failed and dissemination was transferred to Hot Bird the later Eurobird.

Nowadays we are so lucky that receiving MSG is so easy with an extremely helpful EUMETCast staff, all components available off-the-shelf, excellent reasonably priced software (some even freely available). It's just plug and play really, and archiving and hardcopy are no problem. I have to say I miss the challenge of constructing my own equipment and brainstorming problems with colleagues, but dealing with the digital signals would certainly have proved a challenge. It's so much easier to pick a feed off Eurobird and get on with other projects.

The Vandenberg Tours

Viewing the Infrastructure behind the NPP Launch

Ed Murashie

Nothing beats seeing the rocket and satellite up close and hearing some behind-the-scenes stories to gain a greater appreciation for the NPP satellite. Thanks to Bill Sobczak from the *United Launch Alliance* team and Tim Trenkle from *Qinetiq,* that is exactly what we are going to get to do.

Space Launch Complex-2W tour

Bill, one of the Spacecraft Integrators for the NPP mission, agrees to show us around SLC-2W for an intimate tour of the Delta II. Bill knows this complex well: after all, he helped modify it! Working for *Fairchild Space Company* in 1973, Bill found himself at Vandenberg AFB and later at *McDonnell Douglas*, updating a launch pad for NASA and commercial space for the *Iridium* series of satellites. In the 70s and 80s, Bill launched over a dozen *Atlas* launchers before he moved to SLC-2, where he has worked since 1985.

Bill saw the rise of the Delta programme when it was NASA's preferred rocket until its fall in the early 80s when NASA switched to the shuttle; then its final rise in the late 80s after the *Challenger* accident forced NASA to switch back to expendable rockets.

When asked if he was still as excited to be part of the ULA team launching rockets today as he was when he started we get a surprising answer:

> *'Even more so. Every one is different and every mission you get so much gratitude when it is successful. It involves so many companies and people, including professors who spend their entire lives on experiments, and when you see it come to fruition and you see the expressions on their faces and experience the thanks afterwards it makes you and everyone feel good. It makes it worth it. It's a big team effort. Gravity Probe B for instance, headed by Dr Francis Everitt of the physics lab at Stanford University, developed an idea to prove Einstein's theory about space and time in the 60s and 70s, but there was no way to implement it with the technology at that time. Eventually we ended up launching it in 2004, and he proved the theory was correct. You also have Google Earth and GPS in your golf cart because of all of the satellites we launched from here on Delta and Atlas.'*

Another enthusiastic ULA team member, Jorge Quintanilla, Lead Mechanical Engineer, later joins us at the end of the Delta tour. Jorge got his start at *McDonnell Douglas* 23 years ago and has been working at Vandenberg AFB for 14 years. He spent his first nine years working at the *Huntington Beach* factory, manufacturing the Delta II rockets. 'My first nine years we built the first 100 and the past 14 years they built the last few', says Jorge. Jorge had the pleasure of launching one of the rockets he built. Both Jorge and Bill have spent time working at the Cape supporting the Delta IIs launches there—but prefer the California weather.

As we walk up to the security gate we leave our identification so that, in case of emergency, they could account for everyone on the pad. As we walk to the launch pad, Bill points out the RP-1 fuel tank and liquid oxygen (LOX) tank nearby, protected by a blast wall, and also the 500 kW generator.

From right to left, Jorge Quintanilla, Bill Sobczak and Ed Murashie.

There are reminders on the public address system announcing that there is much activity on the pad. SLC-2W is a government-owned launch pad operated by ULA as a contractor. We learned that the tower is 54 metres tall and was brought from White Sands in the 70s, where it was used for the *Little Joe II* project. When the tower was converted from Delta use to Delta II use, a 4 metre spacer was added to the bottom to account for the larger fuel and LOX tanks. The teal blue 54 metre tall mobile service tower (MST) rolls back 90 metres eight to nine hours before launch, exposing the freestanding rocket next to the fixed umbilical tower. Yes, it is a freestanding rocket. Unlike the Delta-IV and others, the first stage is set on top, bolted to the launch pad, and the nine GEM solid rocket motors then attached. The bolts are removed and the rest of the rocket is assembled and launched unrestrained.

The rocket can withstand winds up to 75 kph and can be protected by surrounding it with the MST, which can withstand winds of up to 135 kph. 'Because the MST acts like a sail, 100 kph winds can get you sea sick if you stop moving while working on the top levels',

Look up from right to left - fixed umbilical tower and mobile service tower

The 'business end' of the GEMs with a larger air ignited one to the left
photo credit NASA/KSC

says Jorge. 'The launch of P91 was so windy that, when I was arming the rocket, I saw the vehicle come off one of the six legs it sits on.' Bill adds that when the rocket sways during launch countdown, the engine gimbals compensate for the movement, just as they would during flight. Jorge tells us that the *Gravity B* rocket and workers were on the pad during an earthquake that shook the site enough to remove one of three bumpers fitted between the rocket and tower. Another anxious time was when the rocket leaned over slightly while a solid rocket motor was being attached, because some of the bolts securing the pad were not tight enough.

Bill's first stop is at the flame trench, where the main engine's exhaust vents, and he points to the nearby tank on the hill that holds 950 000 litres of water. Three minutes before launch, water starts to pass through three 40 cm pipes to a ring surrounding the main engine at a rate of 22 000 litres per minute. That flow would empty an average swimming pool in four minutes. The water acts as a sound suppressor, preventing shock waves from damaging the rocket and pad. The water flows downhill into a pond where it is later collected, filtered and pumped back into the storage tank. 'During initial launch, what most people think to be smoke is actually steam,' Bill comments. The pad sustains little damage because of the water, the ablation material that coats some of the structures and the fact that the rocket takes off quickly once the solids ignite.

Around the corner we enter the fixed umbilical tower, where the air conditioning system is located. It provides the clean cool air that travels up the tower, through tubing to the fairing that surrounds the satellite on top of the rocket. We quickly move into the MST and come face-to-face with 'the business end of the rocket' as Bill and others call it. 'Flames come out the bottom and the pointy end is up'. In front of us are the GEM and main engine nozzles. The first things we notice are the numbers painted on each GEM. Even though each GEM is serialised, the factory determines the performance of each motor, matching them to get the proper balance of thrust, and paints the number on the side. A lot of planning goes into the rocket trajectory and timing because of the GEMs. First, they are held on to longer than launches at the Cape, because the controllers need to make sure they drop into the ocean at a prescribed location—not on top of the oil platforms off the California Coast. Because of the flames during launch, the three air ignited GEMs have covers in the nozzles to protect them; these get blown off when they ignite. The flight characteristics of these 'Kevlar Frisbees' have been studied and weights are added to ensure they land somewhere where they will not hurt someone or damage property. When the GEM casings land in the ocean they immediately break up, sink to the bottom of the ocean and become fish habitat.

'The first mile is the toughest,' says Bill, where it takes over 4000 kN of total thrust with 3000 kN coming from the solids to overcome the 227 tonne launch mass. Without the GEMs, the *Rocketdyne RS-27A* main engine would not have enough thrust to lift the rocket off the pad. Having read that fir wood was used in the Atlas rocket [1], a question is raised when seeing what looks to be a wooden patch on a GEM; this is because the GEMs and portions of the rocket body are covered with cork, covered by fire retardant epoxy. Cork is the best insulator to handle the aero heating over 1000 degrees. Other things we see are the six points that support the rocket, one of which pulls away just at launch so that it does not interfere with the main engine's turbine exhaust. Before we leave, we look at the *RS-27A* main engine, which controls the rocket pitch and yaw, and the two small *Rocketdyne* vernier engines mounted on opposite sides of the rocket. These verniers control the rocket's roll and attitude so that the onboard telemetry antennas point towards the ground receivers while in flight.

The next stop is level-2 of the MST. To get there we have to climb a few stairs since they did not extend the elevator to the ground when they added the 4 metre section to the tower. Levels A, B and C are the added lower levels: level-1 is just above the GEMs, level-2 is above the centre of the body, level-3 houses the changing room and a guard which limits access to the clean rooms in the levels above, level-4 is the second stage and levels-5 and -6 are the payload area. Level-6 has the ability to be raised or lowered to match the payload requirements. When the elevator doors open, we immediately see the blue rocket body with the 2 m high NPP decal above the NASA logo. The nine-section decal is rolled on to the rocket body at the factory when it is in a horizontal position. A tunnel runs along the side of the rocket and Bill explains that it contains the electrical wires and linear explosive charge that would split the rocket open during a destruct sequence.
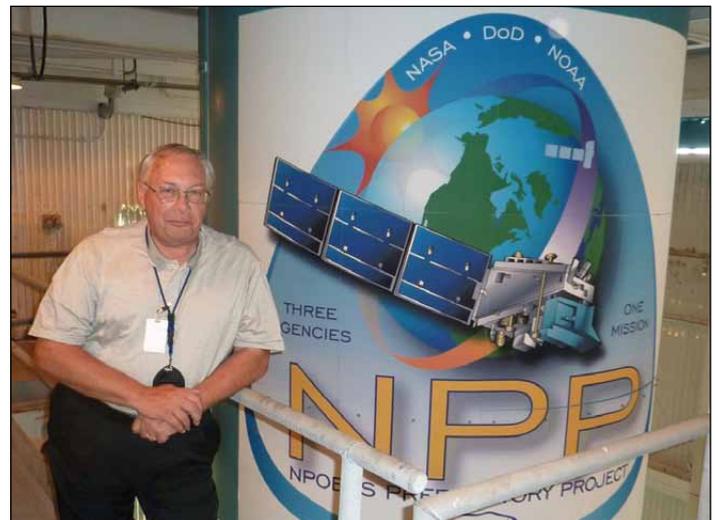
Bill Sobczak standing next to the NPP logo

Riding the elevator up to the level-3, we step outside and, from 28 metres above the launch pad, we have a magnificent view of the California Coast, the nearby Atlas Abres launch pad and *Astrotech*, where the satellite is being processed. What a view! We re-enter at the interstage level where the 4-metre section houses the second stage nozzle. Peering into the darkness of the interstage through a clear port on the side of the rocket, we can just barely make out the nozzle that fill most of the 2.5 metre diameter interstage. One more step outside on the other side of the MST and we are now looking at netting extended out from the Fixed Umbilical Tower. 'When the rocket is launched and the umbilical cables are pulled, you don't want them to hit the structures—so they land in this catch net, which protects them so we don't have to rebuild them,' Bill comments.

The view from Level 3. Ocean to the right, MST rails center bottom and *Astrotech* in the distance on the horizon.

Taking the elevator up to the 5th floor, we first stop on level-4 to put on our clean-room booties. As the elevator door opens we finally see the top of the rocket body. Bill points to the metal structure on top of the rocket, with its electrical boxes and wiring, explaining that this is the navigation system; on top of this structure is also where the payload fitting (PAF) and satellite will attach. As we look around, we see the adjustable level-6 and the two-piece fairing, which had been cleaned and bagged.

We head down the elevator, pick up our badges again, and head to the conference room where we will sit down and ask Bill and Jorge our many questions. We ask how long a mission takes and are told that typically, Bill would start working with the customer to define the rocket specifications and requirements two years in advance. NPP took a little longer, with first contacts made in 2004 before the project was put on hold.

Entering the conference room, we can understand why ULA is a rewarding place to work: the walls are decorated with photos of the many successful missions, and rocket models stand in the corner. With the launch's excellent 98.7% success rate, Bill quickly says, 'We are only as good as our last launch. For the next one, with over 10,000 components that have to work on every launcher, you only get one chance'. Asking about the team of engineers who come out from the factory to work on the rocket, Jorge comments that one person comes out to make sure the rocket gets delivered properly, but that is it. We get a sense that what makes the Delta II work well is consistency and competency. They were all built with only minor changes, like the fairing material and solid rocket motors. This is what allows Jorge to be familiar with each one. '*Iridium* made records launching eleven rockets in one and a half years from SLC-2W', Bill adds.

Asking about the competitors, Bill comments: 'We have seen new businesses starting up, they don't find it easy and we wish them the best. This isn't an easy business. In general, competition makes us better too. We remain on our toes'.

Asking what is next for ULA after the end of the Delta-II, Bill responds on having the Delta-IV and possibly making a rocket man-rated (capable of carrying humans) now that they don't have the shuttle. It would not be the first time to have done man-rated rockets: look at Mercury with the Atlas, Gemini with the Titan II and SkyLab and Apollo with the Saturn. Inquiring what happens between missions and how he keeps busy, Jorge explains that immediately after a launch, when the pad is still hot, they hose it down to remove the corrosives then thoroughly inspect it. After the pad is

secure there are other tasks, like off-loading new equipment for the next launch. Other tasks are pad maintenance, which include constantly painting the tower. It is like the Golden Gate Bridge—by the time you get to one end it is time to start at the other end again; but they have a standard workweek with the weekends off.

Jokingly, we ask if there are any traditions, like lining up stuffed animals at the end of the flame trench at the Cape. Jorge finally relates that the pad technicians cut Lead Pad Engineer Tom Knowles' tie before tower roll back to prevent a launch scrub turnaround, and that another person grows and serves dill pickles in the control room during a launch. Bill comments: 'Occasionally a launch manager brings the *Staples*' "That's Easy" button and presses it right after the launch or spacecraft separation to break the tension.

'The final ten minutes, until the last 7 seconds (when green board is announced), is always a tense time' during a launch, no matter how many times you have been through one, says Bill. Jorge adds, 'Every one is different and leaves a memory imprint'.

Walking away, we realize that what makes the Delta program so successful is not only the consistent hardware, but also the totally dedicated and enthusiastic employees who love their job. Veterans like Bill and Jorge, plus their impressive launch team members, will keep ULA successful now and in the future.

Astrotech Tour

Tim Trenkle is a Launch Site Support Engineer with *Qinetiq*, contracted by NASA Kennedy Space Center to oversee the NASA operations at Vandenberg. Tim agreed to show us around *Astrotech*, a commercial facility contracted by KSC to process the NPP satellite before it was attached to the Delta-II rocket. Tim, a veteran like Bill, with over 30 years of experience in the satellite field, is very familiar with the NOAA weather satellites. He worked at the *RCA Astro Electronics Company* in East Windsor New Jersey, where the first weather satellite was designed before being transferred to the *Lockheed* facility in Sunnyvale. He was even involved with the last NOAA satellite, NOAA-N', and points out the old NASA facility nearby that has processed the NOAA satellites since the 60s.

Astrotech is one of two facilities with which NASA bids for satellite processing, *SSI* on south base being the other. Exiting Tim's office, we learn that about a dozen *Astrotech* employees and 20-40 visiting personnel from the spacecraft team are there at various times. Tim indicates the buildings on the other end of the property and comments that there

they have the *High Bay East*, *High Bay West* and *High Bay Airlock*. Next door is a new taller bay, added a few years ago, for other Vandenberg missions. The airlock in front of the west high bay provides access to the east and west high bays. We arrive at the airlock just as the payload transporter arrives; this will carry the satellite from the west high bay to the launch pad some three kilometres away. As they start to roll up the high bay airlock door, Tim points to the large bagged cylinder stack already in the airlock, commenting that it is the can that will protect the satellite on the journey to the pad. We learn that, when the satellite is ready, it will be bagged, loaded into the cylinder, placed on the transporter and driven at 8 kph maximum speed to the launch pad some 3 km away. Cylinders of nitrogen on the transporter will keep about 480 kPa of positive pressure in the can. This will keep contaminates out and the satellite free of moisture.

Mike Lyons, overseeing the operation, is a Senior Manufacturing Engineer for *Ball Aerospace* which built the spacecraft bus and the Ozone Mapper Profiler Suite. Mike has worked on four spacecraft busses in the past ten years. 'It is exciting, having started working on NPP ten years ago, to be pulled off for a while and then to come back. It was good to see the initiation of this and its final closure', Mike comments. He was generous enough to allow us into the west control room, located behind the west high bay. From there, we see a large window in the opposite wall opening to the

Tim Trenkle Backfilling Nitrogen Tanks

18 x 12 m, 13.5 m tall west high bay clean room. Stepping up to the window, we see the NPP satellite on its stand, tilted up and draped with a semi transparent bag. Mike informs us that the satellite is ready to go, pointing out each of the instruments and the star sensors that help orient the spacecraft while in orbit. Tim points out the nitrogen panel and lines that are purging some of the instrument cavities and bags which keep moisture out of the area. He also indicates the hazardous vapour monitor that has been in use since the spacecraft was fueled. We talk about the smooth 34-hour truck ride from Boulder, Colorado and the shock sensors that monitored the ride. Ending our discussion in the control room, we talk about how the spacecraft is attached to the payload adapter ring, which was already in the clean room. Tim informs us that it uses a four-bolt tie-down system with four springs and a secondary latch system that gently push the spacecraft from the Delta-II during separation.

When asked about *Ball Aerospace*, Mike shares: 'It is a friendly atmosphere where everybody knows everybody; it has 2400 employees but everybody works together as a team, one person picking up the slack for the other'. He mentions that they have added another clean room in Boulder to remain competitive with the bigger companies, and are working to get bigger satellites.

We say goodbye, wishing Mike good luck on the launch. Walking back to the office with Tim, we stop by a trailer filled with nitrogen cylinders. Mike hops up into the trailer and checks one set of cylinders, observing that they are only at 5500 kPa. He opens a valve to back fill them from the 17000 kPa bottles. 'We use grade C nitrogen gas for tighter moisture and hydrocarbon specs,' Tim says. Saying our goodbyes, we ask what's next after NPP and Tim informs us of the *NuStar* satellite on a *Pegasus* next year.

NPP in the Astrotech VAFB West High Bay with the control room window in the lower left. Photo credit Ball Aerospace

Having joined us on this tour, meeting and being educated by the dedicated folks working on the NPP mission, I hope you have learned a thing or two and can now appreciate what it takes to get NPP off the ground.

Postscript

On an exceptionally clear California night on October 28, 2011, NPP was successfully launched from Vandenberg at 2:48 am PDT. The launch lit up the area and could be seen jettisoning it's solid rocket motor and main engine cutoff. The author is sincerely grateful to all who provided the opportunity to become educated on the NPP and Delta-II rocket. Thank you.

Reference

1   http://ulalaunch.com/site/pages/Education_FunFacts.shtml

NPP transporter and the transport can leave to go to the launch pad
Photo credit NASA/KSC

Indonesian Odyssey

Francis Bell

Regular readers will recall that I sometimes report on my travels, and if possible publish any satellite image I receive using my mobile APT station. I have reduced the size and weight of my kit so that the wire turnstile, receiver and recorder all fit into a suitcase without compromising room for normal holiday luggage.

In November 2011 we visited Indonesia for a cruise, together with planned visits to the islands of Java, Flores, Bali, West Timor and Komodo: and yes, we did see the Komodo Dragons. Every island was magical, not only for the natural beauty but also the opportunity to meet the friendly people. Throughout the our 19-day visit the weather we experienced was perfect: an occasional thunderstorm, but otherwise hot and sunny. This part if the world is part of the Pacific 'Ring of Fire', and there were volcanoes everywhere, some dangerously active: 35 died when *Kelut* erupted in 1990 and there were a further 138 fatalities during the *Merapi* eruption in November 2010.

On the subject of disasters, two struck the area soon after we left. Cyclone *Sendong* struck Mindanao in the Philippines, killing hundreds of people. In another incident, a boat reportedly carrying 350 refugees was lost while sailing across the Flores Sea, an area we had serenely navigated about a week previously.

While cruising, I scarcely had an opportunity of establishing my APT station on board the ship. I was not too fussed about this because so many other interesting activities had priority. However, after the cruise had finished we had a three-day stopover on the island of Bali, in a hotel with extensive gardens and beach access. I naïvely thought I would set up my APT station outside the hotel with a clear view of the sky. The reality was that, with the discomfort of 35°C and 100% humidity, I couldn't trust myself to assemble my station out of doors, let alone sit nearby waiting for a suitable satellite pass. On the last day of our stay I judged that, if I were to receive any sort of satellite image, I had to take the softer option and assemble my equipment in the cool comfort of the hotel room. This idea was extremely speculative because, although I had access to the room's balcony where I could locate the station, I had no idea of the extent to which the building might obscure any weather satellite signals. I had no option but to try. Success: exactly as predicted, NOAA 19 very cooperatively crossed the sky visible from the west facing balcony. If the balcony had faced any other direction, or I had tried for the previous satellite pass, I would have received almost nothing.

Considering the circumstances, I was astonished with APT image which I did manage to record with my Heath Robinson set-up propped up on the edge of a hotel balcony among its hanging shrubs. The image was far from perfect but for a one-off opportunity I was pleased with the result. The received APT image shows, curving from top left to bottom right, the Malay peninsula, the islands of Samoa, Java, Sumba, Flores and Timor plus other islands.

For a comparison image which includes the same area that I recorded, see page 16 of *GEO Quarterly 32*, where an image from Fred van den Bosch is displayed. Fred's image was received at his new home in Vietnam.

For a brief review of typhoons over the Philippines, refer to page 18 of *GEO Quarterly 32*.

Francis with two new friends. The attractive girls were also talented, and wanted to practice their English on visitors. Both girls plan to be teachers when they grow up.
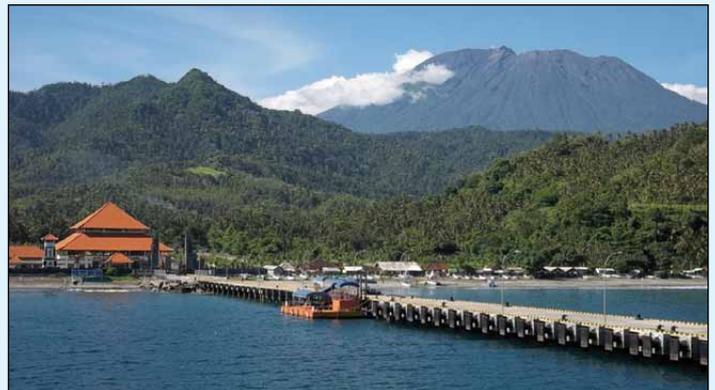
A volcano close to the north coast of Bali - part of the *Ring of Fire*

The satellite receiving station on the first floor hotel balcony.
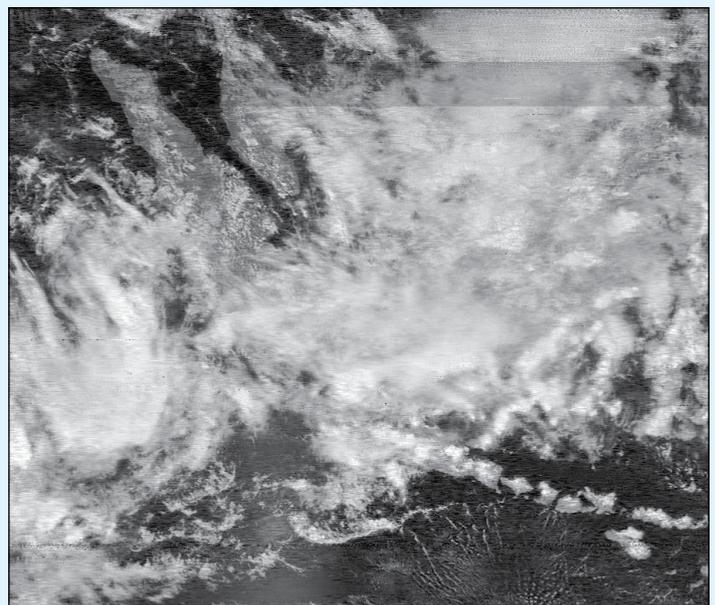
NOAA 19 image received from Bali at 14.20 local time December 4, 2011

RECEIVING TWO SATELITES ON ONE DISH

Mike Stevens

Living here on Portland can have great advantages, especially in the summer months: lots of blue sky and blue sea. But in the winter it's a different story: strong to gale force winds and heavy rain with salt laden air coming on to the Island which, as you can imagine, is very corrosive to antennas and satellite dishes. To date I have changed three satellite dishes and four TV antennas and had to repair a couple of amateur radio antennas.

So, when it was time to replace my 65 cm EUMETSAT dish, which was rapidly disintegrating, I had to decide what type and size of replacement to purchase.

At the time, I had just applied for an Envisat License, and most articles explaining the system seemed to suggest a 1.2 m dish. But I am on the extreme south coast, with a clear take-off in all directions except north, so would I need a dish that size? I decided on a 1-metre dish, along with a stand I could bolt down to the patio to prevent it from being blown over in the winter gales. These, and a twin output LNB, were promptly ordered from the Satellite Shop and were delivered within a couple of days.

Having read an article by Arne Van Belle in GEO Quarterly [1], I realised that it was possible, with a lot of delicate adjustment, that I might be able to receive two satellites from the same dish, so the 1-metre dish should prove OK for both satellites. Great! Decision made.

The kit arrived and construction began: nothing complicated at all. It's a large dish, but it fitted together very well. I then drilled holes to match the mounting bracket in the patio and bolted the bracket down securely. Then I had to mount the dish on the bracket, which was a bit more complex because of its size and shape. But a bit of holding, while tightening bolts at the same time, eventually secured the dish to the mounting bracket. That was the easy part: dish alignment was next and that was to prove very tricky indeed.

I have described this alignment procedure before in a previous article [2], but that was with just a single output LNB. This time I planned to permanently instal a dish fitted with a twin LNB to feed two *DVB World* receivers. My first operation involved setting up the dish using *EUMECast* transmissions from the *Eurobird 9A*

This Envisat MERIS image of Crete was captured by the author,
using his twin-LNB antenna, at 08:55 UT on October 20, 2011.
Image courtesy ESA

This Envisat MERIS image shows Cyprus, and was captured at 08:04 UT on September 5, 2011.
Image courtesy ESA

This Envisat MERIS image showing Sicily was captured at 09:18 UT on September 22, 2011.
Image courtesy ESA

satellite at 9°E, as this satellite has the stronger signal. I located 9°E using a compass, adjusted for the local magnetic variation and set the satellite dish to this mark. Immediately, my meter shot to full scale deflection and, when I opened up the *DVB World* receiver (which was already programmed for *EUMETCast* reception), the signal strength was 100% with quality at 85%. That was perfect—but how would it shape up once I had located the *Eutelsat W1* satellite at 10°E.

The next part of the operation was locating *Eutelsat W1*, basically a one-degree move. Easy you might say! But not so simple when it has a much weaker signal.

In Arne's article, he stated that the optimal distance between the 9°E and 10°E LNBs should be 17 mm when using a 1-metre, standard offset dish, so this was a good starting point. I drew a line beneath the LNB arm to the center point of the mounting bracket then, immediately below the LNB, I measured out 17 mm and drew another line back to the centre point, I then had a small angle which when checked with a compass was 1 degree.

I then turned on the *DVB World* (already programmed for *Eutelsat*), moved the dish arm to a point directly over my new mark (17mm away from the first one), I had a signal immediately. I used a TV Broadcast station (Press TV), and this was giving me a signal strength of 90% and quality of 80%. It was then time to switch that off and start the IP button. As soon as this was done I had a signal from the *Envisat* station at 78% signal strength and 60% quality, with data coming in.

I then rechecked the signal from *Eurobird 9*, and was amazed at the results: I had 95% signal strength and 60% quality. I checked all the coordinates again to be sure then locked the satellite dish securely.

So there it was, two satellites being received on a single 1metre dish, both with very good reception. I have been monitoring the signals for quite a few months now and having the larger dish for *EUMETCast* has been a great benefit as I know longer lose signal strength when it rains. Also, the *Eutelsat* signal remains fairly constant. There are a few anomalies during the day but, by and large, its signal strength remains constant.

So, to sum up, what I have is a single 1-metre satellite dish, ground mounted, with a twin output LNB. One LNB feed goes to the *EUMETCast* system receiver connected to my *Acer* PC, and handles the complete system without a RAMDisk; the other feed serves the *Eutelsat/ Envisat* system on my *E-Machine* PC. Both systems work in conjunction with one another with no problems at all. Additionally, my dish is on the ground and more sheltered from the damaging winter gales.

When I presented this article to you previously, some of the information was omitted. My apologies for that. I hope this update clarifies the installation that I have and how I arrived at it. If you too are receiving both *EUMETCast* and *Envi-Ham* data, do give this a try. You may

The author's 1-metre dish fitted with the twin LNB

A close-up view of the twin LNB

be surprised at what you can achieve. And as you can see above, the pictures are stunning. Happy weather watch from Portland. My thanks to David Taylor and Arne Van Belle for the excellent articles on Envisat reception: they helped me a lot.

References

1   A New Challenge: GEOQ 29, page 21
2   Envi-Ham DDS with Windows XP: GEOQ 30, page 43

Tutioune

New software to analyse your EUMETCast and Envi-Ham systems

Esko Petäjä

The background to this article is my need to have a better signal measurement system to align my Envisat and EUMETCast antennas for satellite reception. Most users do this using software supplied with their DVB reception hardware. Such software typically shows signal level and quality as a percentage: very seldom do they show the real values. There are units you can purchase which will show real values and provide a spectrum display, but they are generally very expensive.

As a radio amateur, I have been studying ways to transmit digital pictures by radio. During this study I discovered an interesting measurement tool that can be used with Digital Amateur Television (DATV) using DVB-S. Jean Pierre Courjaud (F6DZP) has developed a software tool named *Tutioune* for the reception and measurement of DATV. *Tutioune* also incudes a Web Monitor facility which receives data from individual stations and displays pictures and signal levels on a Google Map. Originally, this was developed so that radio amateurs could share their signal levels and QSL pictures on the Internet, but I have been using it in weather satellite reception to show my Envisat receiving status online as well as my most recently received image.

The Basics of Satellite Transmission

The theoretical maximum signal power output from a communications satellite, its equivalent isotropically radiated power (EIRP), is only realised in the direction of maximum antenna gain. Even then, many factors can reduce the received power, such as

- the distance the signal has to travel from satellite to receiver
- attenuation if the signal travels through rainfall
- unwanted RF noise received at the antenna

EIRP is measured in dBw (decibels relative to one watt), and satellite operators publish charts where this power is plotted on the Earth's surface. Figure 1 shows such a chart for *Eurobird 9A*.
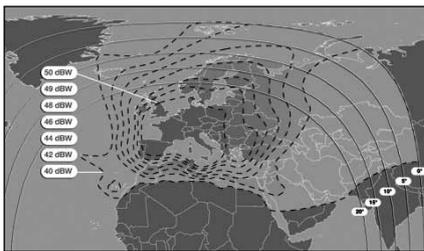
Figure 1 - EIRP chart for Eurobird 9A

Signals are attenuated during transmission. Attenuation depends on the location of the ground station: stations here in the north (Finland) lie farther from the satellite, which means that attenuation is greater. If the signal passes through rain, the attenuation becomes greater still. Additionally, the antenna also receives background noise from the atmosphere, the ground and the LNB, the most noise coming from the ground. All this means that a station in the north, where the elevation angle of the satellite is low, receives a noisier signal than a station farther south. Signal quality depends on the ratio between the received signal and the noise level.

Tutioune

Tutioune is a newly developed software utility, specially developed to provide DVB technicians with a tool that allows precise measurement and display of Digital ATV (DVB-S) signals. The program can be used with a number of DVB-S PCI satellite receiver cards, such as the TechnoTrend TT-S2-3200.

Tutioune v 1.0 can be downloaded from the website of Jean Pierre Courjaud at

http://www.vivadatv.org/index.php

but, unless you are reasonably proficient in French, you will probably feel more at home with the English version at

http://www.vivadatv.org/viewtopic.php?f=60&t=104

On the same page you will find links to the *tutioune.ini* file, the bridge driver software and files needed for the video display feature of the program.

There is also an on-line guide to *Tutioune*, in English, at

http://www.vivadatv.org/viewtopic.php?f=61&t=105

In order to download the program, you must first join the *Viva DATV* forum (which is free) and log in. First, you have to download and install the special *SAA7146A* PCI bridge driver software, then you can download and install *Tutioune* itself. Full instructions for all this appear on the website. The first time you run *Tutioune*, the image illustrated in figure 4 is displayed on your PC display.

I use the *TT S2-3200 DBV-S2* reception card, which has an *STB 0899* demodulator and an *SAA 7146A PCI* bridge which manage communication from the card to the *Windows* software application. The *SAA Bridge* driver allows the software to read more variables from the demodulator and tuner than a standard driver.
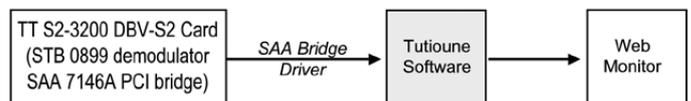

Figure 2 - The basic architecture of the Tutioune system

As will be explained later, the *Tutioune* software shows various parameters related to the received signal, and its *Web Monitor* feature can display the signal status and last received image from my station on to the Web.

My reception and measurement system is shown diagrammatically in figure 3. Following the antenna, a splitter divides the signal between the *Envisat* reception system and the *Tutioune* measurement software. My *Envisat* system consists of a *Technisat* reception card and the *EnviHamBrowse* software developed by Francis Breame, which converts files into JPG format. Additionally, it also saves the last received image as a file which can then be sent
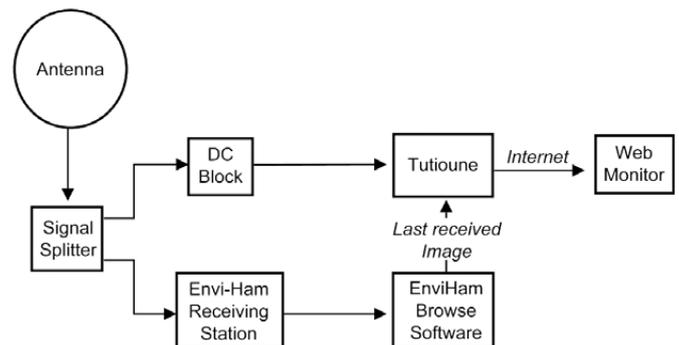

Figure 3 - Schematic of the author's system
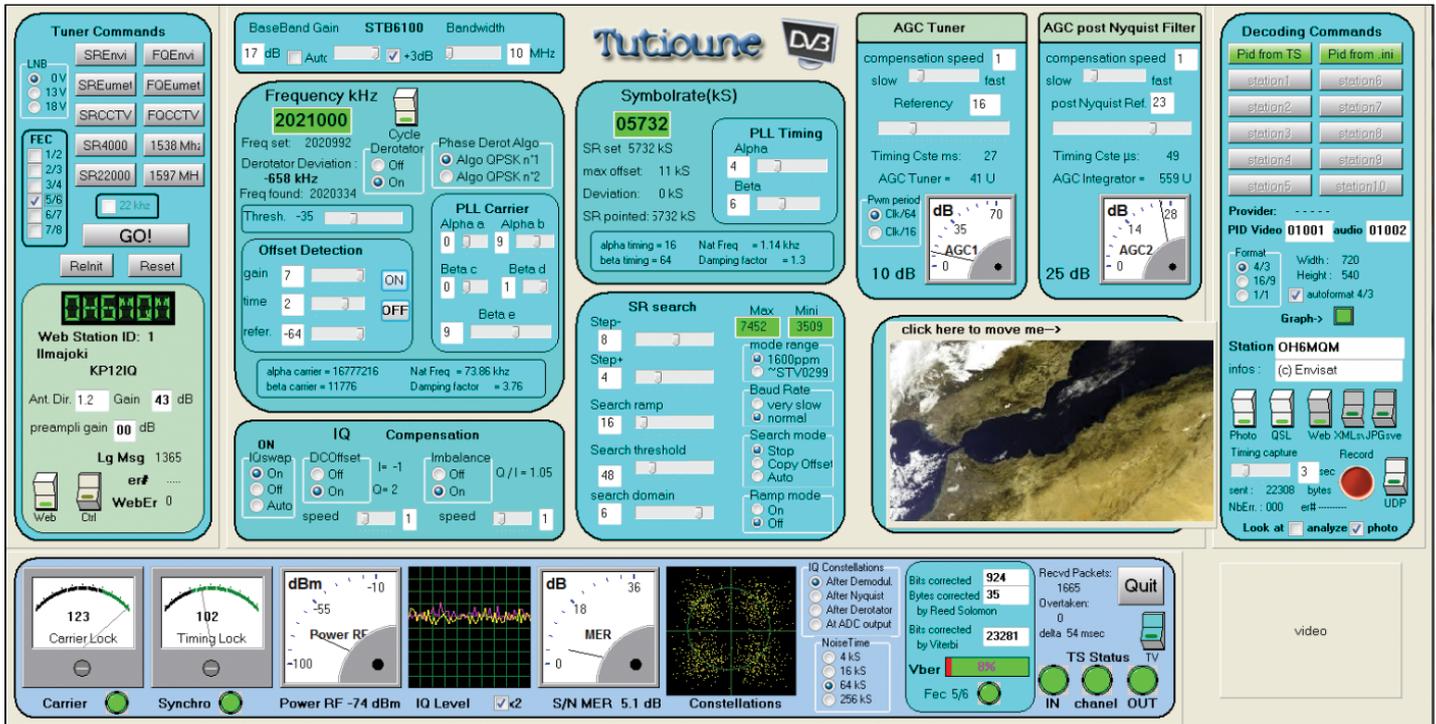
Figure 4 - The Tutioune main screen with Envisat and EUMETCast settings

from *Tutioune* to the Web Monitor, where it can seen by others. The *Tutioune* measurement system is connected to the signal splitter through a DC-blocking capacitor, so that it can only be used as a measuring and monitoring station. In order to analyse the signal, *Tutioune* must be tuned separately to the received frequency, which, for Envisat, is 2021 MHz.

There is a lot information available on the *Tutioune* measuring system but I will only discuss the most important features:

- tuning frequency and symbol rate, and how to configure the *Tutioune.ini* file
- the meanings of basic reception parameters and how to use the measuring panel
- publishing information using *Web Monitor*.

More information can be found on Jean Pierre's website at

http://www.vivadatv.org

Tuning Frequency, Symbol Rate and the Tutioune.ini File

Tuning frequency can be done manually by simply entering the required frequency in the green box of the frequency panel (figure 5). Tuning the symbol rate can similarly be accomplished using the green box in the symbol rate panel (figure 6).

In order to make the use of *Tutioune* more convenient for daily use, you must, of course, supply the software with all the parameters relevant to *Envisat* and *EUMETCast.* Panels on the *Tutioune* display allow the user to input this information but, if you wish to make regular checks, this can become a tedious process. Fortunately, *Tutioune* solves this problem through its accompanying *Tutioune.ini* file, which you can edit with the parameters you require. *Tutioune* will then load these parameters every time you run the software, and they can be activated by clicking one of the preset buttons.

Figure 7a shows the panel of presets as it appears when you run *Tutioune* for the first time. Each carries a dummy name or frequency such as *SR0001*, *Freq1*, etc. The right-hand set of buttons relates to the frequency of the named satellite. If you click on one of these buttons, you will see the 'Frequency' field in figure 5 update. The left-hand set of buttons is used to select the Symbol Rate for the satellite. If you click one of these buttons, you will see the 'SymbolRate' field in figure 6 update. The captions I edited into the *Tutioune.ini* file appear in figure 7b. The set of variables I edit into my *Tutioune.ini* file are listed in Table 1.
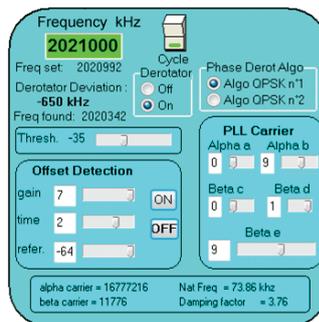

Figure 5
Manual Frequency Tuning
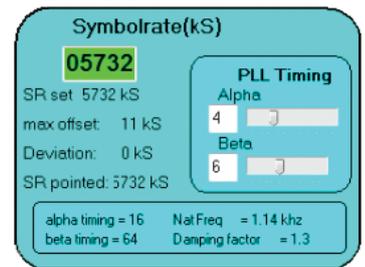
Figure 6
Manual Symbol Rate Tuning
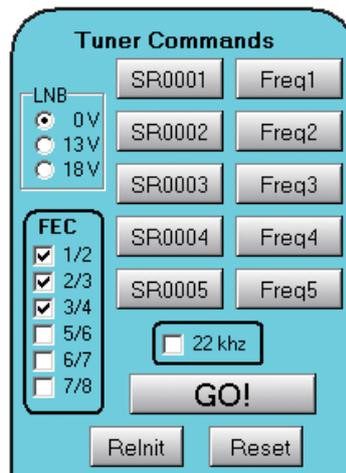
Figure 7a
Default Preset Buttons
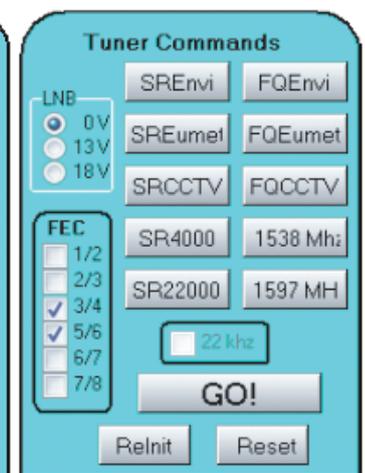
Figure 7b
Programmed Preset Buttons

SR1Text = SREnvi		SR2Text = SREumet		SR3Text = SRCCTV	
SR1Value = 5732		SR2Value = 27500		SR2Value = 27500	
Freq1Text= FQEnvi		Freq2Text= FQEumet		Freq3Text= FQCCTV	
Freq1Value = 2021000		Freq2Value = 1377000		Freq3Value = 1911000	
Fec12=0	Fec23=0	Fec34=1	Fec56=1	Fec67=0	Fec78=0

Table 1
The author's Tutioune.ini parameters for Envisat, EUMETCast and CCTV
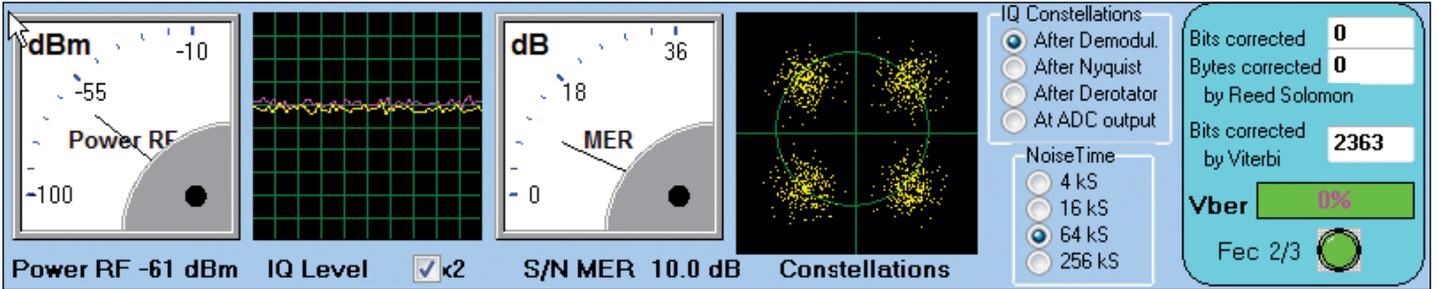
Figure 8a - The Measuring Panel displaying Medium Reception Correction
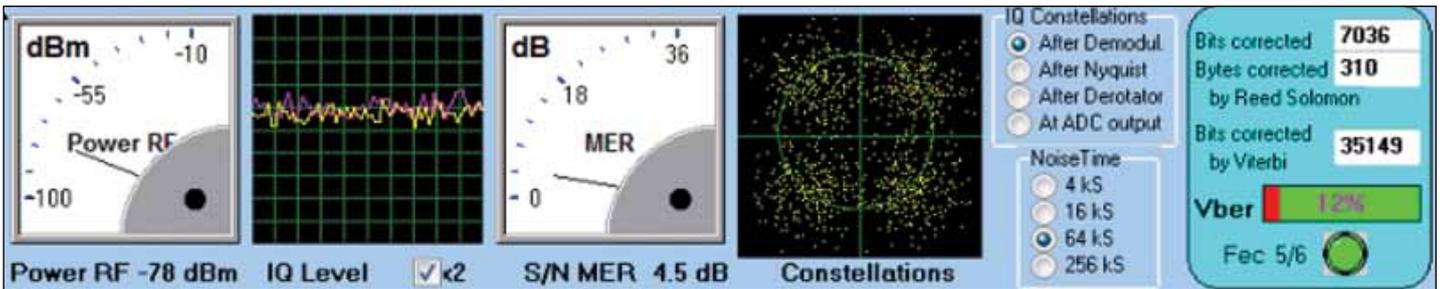
Figure 8b - The Measuring Panel displaying Low Reception Correction
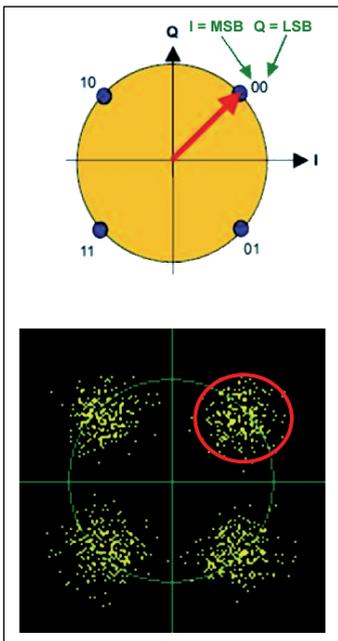
Figure 9
QPSK Modulation (top)
and a Constellation
showing modulation error
(circled red at bottom)
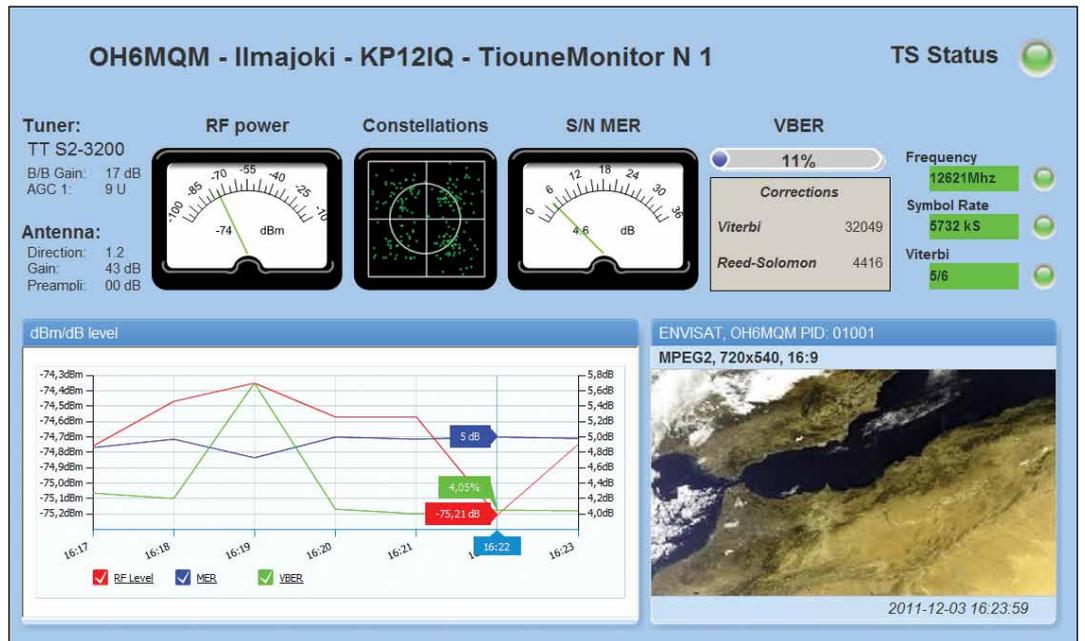
Figure 10
The Author's Web Monitor Display
http://www.vivadatv.org/tutioune.php?om_id=OH6MQM&station_id=1

Figure 11 - Google Map
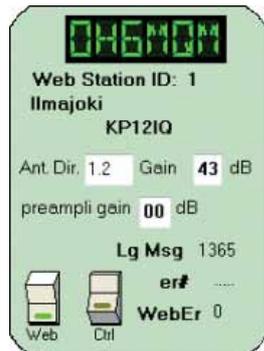
Figure 12 - Station Panel
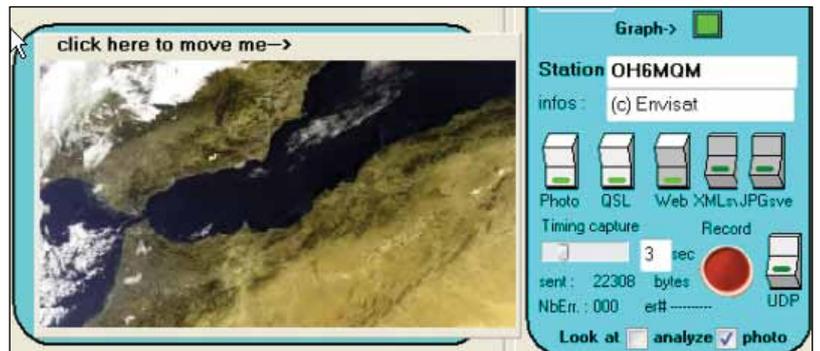
Figure 13: Panel for last received Envisat picture

The Basic Reception Parameters

The *Measuring Panel* (figure 8) allows you to keep track of a number of important parameters related to reception.

RF Power (dBm)

The unit for RF Power is the dBm, which is an abbreviation for the power ratio in decibels (dB), of the measured power, referenced to one milliwatt (mW).

IQ level

This graph allows you to see the digital IQ level inside the demodulator by displaying the level of the IQ signal

MER (dB)

MER is a measure used to quantify the performance of a radio transmitter or receiver in a communications system using digital modulation. The demodulated and detected signal can be used as a reasonably reliable estimate for the ideal transmitted signal in the MER (modulation error ratio) calculation. The *ETSI ETR 290* DVB measurement guidelines state that MER is the best overall method for determining the signal quality. Although bit error rate (BER) has been widely addressed as an important digital transmission measurement in this context, MER provides a much earlier indication of transmission impairments.

Constellation

In DBV-S 'SR' is the number of Symbols received per second. In DVB-S QPSK modulation, each Symbol can be considered as a couple (I,Q) corresponding to a point in the constellations diagram (figure 9: top). Each of the positions in the four quadrants of the constellations-diagram can be decoded as 00, 01, 10 or 11. In good decoding, each point will be close to the centre of its quadrant; if reception is poor, the points are more widely dispersed.

MER calculates this dispersion. Figure 9: bottom, shows how the symbols are located in quadrants, and the modulation error where the points are dispersed. The red circle in the upper right quadrant illustrates the modulation error.

Working Principle of Corrections

Reed–Solomon (RS) correction consists of non-binary cyclic error-correcting codes invented by Irving S Reed and Gustave Solomon. They described a systematic way of building codes that could detect and correct multiple random symbol errors. The *Viterbi* decoder uses the *Viterbi* algorithm for decoding a bitstream that has been encoded using forward error correction. *Viterbi* decoding was developed by Andrew J Viterbi 1967. In the final panel of figure 8, 'Vber' describes the percentage of packets that are being *Viterbi* corrected.

Using the Panel for Signal Measurement

The measurement panel works under different measuring conditions, as explained below.

If the signal level goes down, you can see from the panels that, when MER falls, the constellations clouds disperse. First, the *Viterbi* corrector begins to work and you can see the number of bits corrected by *Viterbi* growing. When the *Viterbi* method can't correct all the Symbols it receives, the *Reed Solomon* corrector starts up to add a further correction. When the numbers of bits corrected becomes too high, it signifies that *Viterbi* and *Reed Solomon* cannot correct the entire stream and the value of 'Vber' is high.

Figure 8a shows an example of medium reception. RF power is -61 dBm, S/N MER = 10.0 dB, the Constellation points are close together and only *Viterbi* correction is active (Vber = 0%).

Figure 8b gives an example of low reception. The RF power is -78 dBm and S/N MER is only 4.5 dB. The Constellation points are widely dispersed with both Viterbi and Reed Solomon correction in action (Vber = 12%). In this state, the system is very near to losing reception completely.

Publishing Information using Web Monitor

I use Web Monitor to publish signal information and my last received picture on the Web. The *Viva DATV* website includes a *Google Map* showing all stations that have been registered by their users.

http://www.vivadatv.org/tutioune.php?what=map

If the station is actively sending data to the *Viva DATV* website, the icon will be green: a red icon means that the station is not currently active. At the time of writing, my station is the only one operating from Finland. Figure 11 shows my station on the map. If you click on my location icon, you can view my Web Monitor display (figure 10) when the station is active.

You can also access my Web Monitor directly from

http://www.vivadatv.org/
tutioune.php?om_id=OH6MQM&station_id=1

Setting up the Web Monitor

To set up the Web Monitor you must

- configure the web setting in the *Tutioune.ini* file
- start Web Monitor, and
- activate web picture sending.

The first thing you need to do to get the Web Monitor working is to edit your *Tutioune.ini* file correctly. The most important things are *OM_ID* and *ForumPassword* which need to be same as the ID and password you use to log into the *Viva DATV* forum.

Table 2 lists all the information I edited into the *[WebMonitoring]* section of my *Tutioune.ini* file in order to operate the Web Monitor.

OM_ID	Your *Viva DATV* forum ID
ForumPassword	Your *Viva DATV* forum password
Station_ID1	1
Locator	Your radio callsign
Ville	Your home town/location
DirectionAntenne	1.2 (dish diameter in metres)
GainAntennedB	43
GainPreamplidB	00

Table 2
Additional Tutioune.ini parameters needed for the Web Monitor

Parameters written into the *Tutioune.ini* file can be seen in the 'Station' panel. Web Monitor is started by clicking the Web button in figure 12. If the settings are correct, then the *LgMsg* parameter should show a value in the range 1300-1500, as shown in figure 12.

To be able to send my last received picture into *Web Monitor*, it is necessary to:

- set the Photo, QSL and Web buttons as shown in figure 13
- add additional information, which can be written into the 'Station' and 'infos' fields.
- place the *TiouneQSL.jpg* image in the same folder in which the application is installed (this image can be automatically generated by using *EnviHamBrowse*).

(Detailed information about this can be found from the *EnviHamBrowse* documentation).

Using Web Monitor

My station Web Monitor (figure 10) shows the parameters explained earlier. Additionally, signal levels can be seen according to time.

Tuner Cards that can be used with Tutioune

Tutioune needs a card that has an STB0899 demodulator and SAA7146A interface chip. The The *Technisat TT-S2-3200* card that I use is very sensitive and can receive IP data, which means that it is suitable for Envisat and EUMETCast data reception. Older cards like the now obsolete *Technisat Skystar 2 PCI* are less sensitive and are not so suitable for this purpose.

Very Severe
Cyclonic Storm Thane

On Christmas Day 2011, a depression in the Bay of Bengal started to deepen rapidly and, during the subsequent 24 hours, developed into *Cyclonic Storm Thane*. By December 28, *Thane* had become *Very Severe Cyclonic Storm Thane*, the only such storm to hit the region all year. Equivalent to a category one hurricane on the Saffir-Simpson Hurricane Scale, *Thane* produced sustained windspeeds of 120 kph. Winds finally peaked on December 29, with winds of 150 kph, just as the Metop satellite pictured the cyclone skirting the northern tip of Sri Lanka on its way to making landfall on the north Tamil Nadu coast near Cuddalore, southeast of Puduchery.
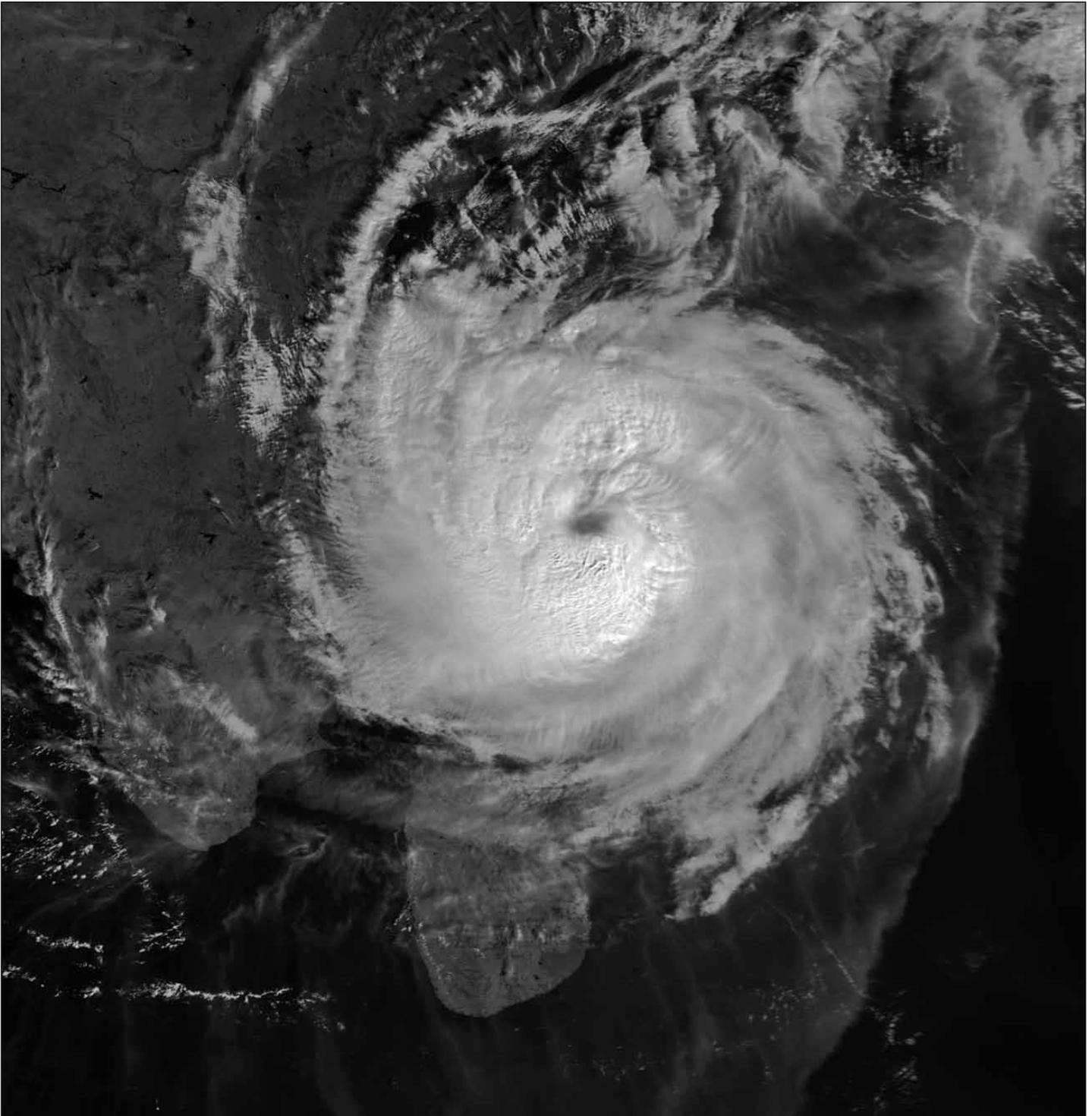
Data from the 04:25 UT Metop-A pass on December 29, 2011, received over EUMETCast by David Taylor's Metop Manager, was used to combine two 3-minute chunks into a single image, processed for display by his HRPT Reader software. The southern tip of India, and part of the island of Sri Lanka can be seen at the centre of the image.

Using and Organising Weather Satellite Data

Robert Moore
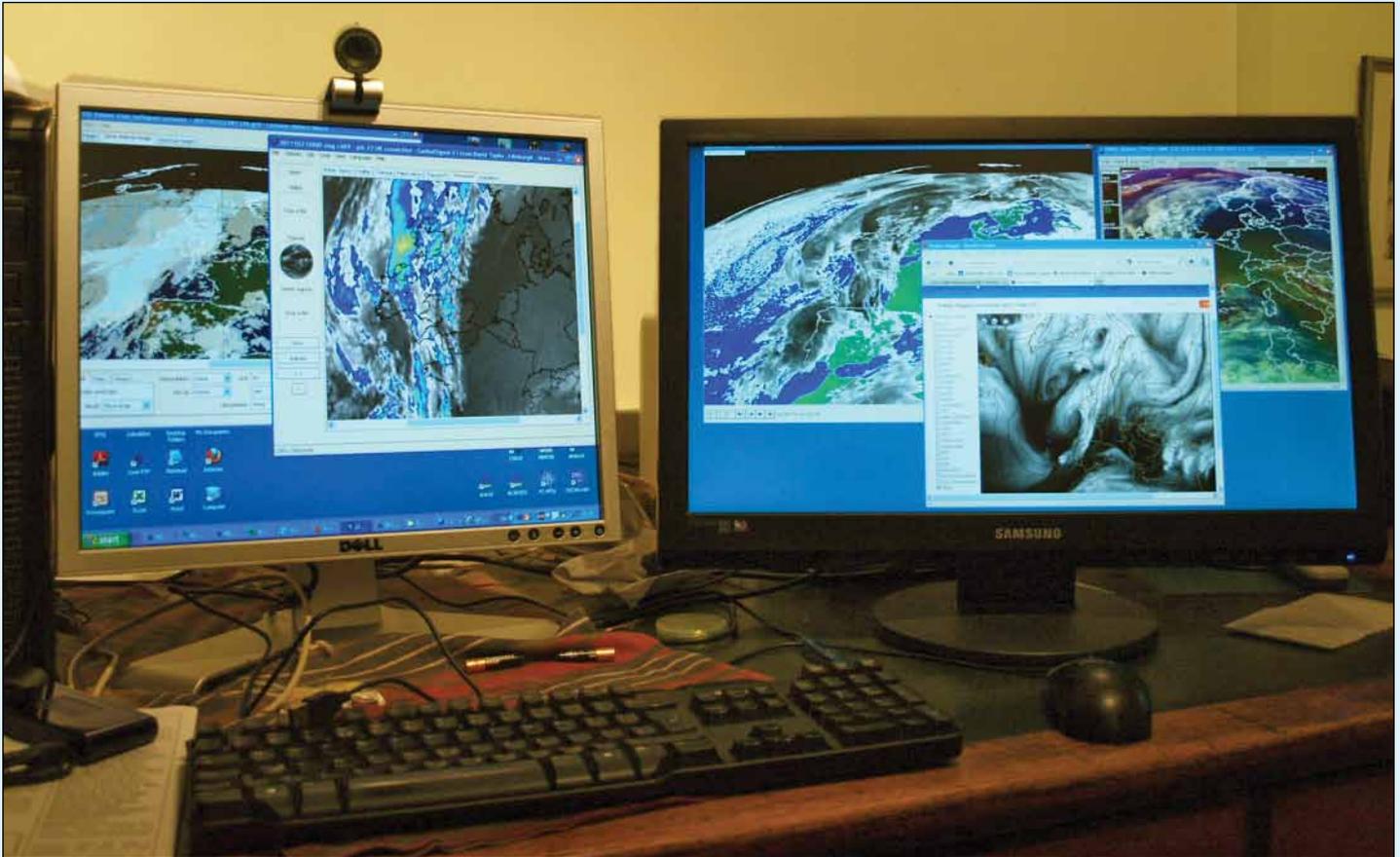
The two screens show *EUMETCast* data in various formats

In the previous issue of *GEO Quarterly* I gave readers a quick look at my set up for receiving weather satellite data; this time I will outline how I use the data. Most of us receive far more data than we can actually use and we are therefore selective in what we eventually process. Thinking about my own approach, I use the data in three modes.

The first is in a flush of enthusiasm as a new data stream— or new visualisation software—becomes available. This tends to be a rapidly passing phase and can result in some software being moved from the desktop to a 'Less Used' folder, because it does not make regular or significant contributions to my everyday requirements

My second mode of viewing weather satellite data might be characterised as starting from the question: 'What is the weather doing today?'. To answer this question, and depending on the time of day, I will look at either the latest high resolution or infrared image of the UK. This I will then widen to the North Atlantic with the latest MSLP chart overlaid. A North Atlantic 72-frame animation of infrared RSS images is an essential adjunct to this, to indicate the likely arrival or departure of cloud cover or frontal systems. A quick look at all these data, plus the MSLP chart from Northwood, often precedes an expedition to the hills, or a long drive—or deciding whether it is worth getting the astronomical telescope set up before dark. Sometimes, usually in the evening, I will then go for a bit of a tour, looking at the weather in the South Tyrol (where my son and his family live), or in Gujerat (where I have taught, and have friends); the Himalayas, which I fear I
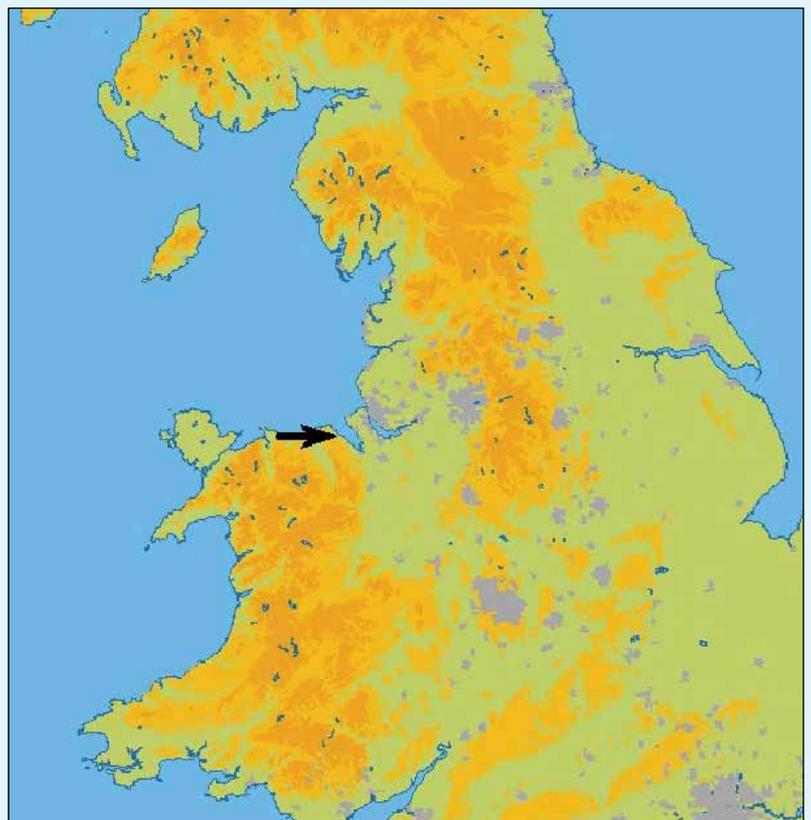
will never see from ground level; Newfoundland or the Kamchatka peninsula which are both normally wreathed in cloud and therefore 'hard to see'. Occasionally I will send pictures from my 'tour' to the *GEO Quarterly* Editor. If there are active hurricanes I will occasionally follow them in an ad hoc way. But these latter uses of the data are really just curiosity—which can, nevertheless, lead to some interesting observations and recourse to *Google Earth* or textbooks, and unscheduled late nights!

One subsidiary, but for me, extremely interesting issue, is the local weather. I have water on two sides, the River Dee to the north-east and the Irish Sea to the north-west. The map overleaf indicates my location

The water keeps us a little warmer in the winter, which is when I become particularly interested in the sea surface temperature data. Late summer and autumn 2011 saw a series of very short-lived and violent rain storms sweep up the Dee towards Chester and Crewe, partly attributable to land/water temperature differences: but of course one can detect neither SST nor land temperature through clouds. By contrast, we are in the Snowdonia rain shadow. Wales averages 1,444 mm of rain per year. In the last six years, my weather station has reported an average rainfall of 890 mm a year—just less than two thirds of the Welsh average. But I live about 35 miles from Snowdonia, which has, over the past 30 years, averaged 4,473 mm, over three times the Welsh average. Moist south-westerly air is forced up over the mountains where it deposits its moisture as rain, thus drying the air that arrives at my weather station. The impact of the mountains on my local rainfall can sometimes be seen on the rain radar but I have yet to find any way of spotting it directly on the satellite imagery.

My third analytical mode derives from the question: 'Can I really understand what the weather is doing?' This is me trying to get a better grip on how weather develops and how to identify frontal systems: upper troughs (tricky), wind shear and rainfall, both to improve my knowledge of meteorology and to enable me to pit my wits against the forecasters. This latter may seem silly, when you think of the numerical data Met Offices have available—the weather models they use and the massive computer power they deploy—but the real objective is for me to learn. At the local or regional scale one can sometimes beat the experts—but not often. By 'weather' I mean, by the way, North Atlantic and UK weather; I never go into much detail outside my own corner of the globe.

In this mode I am likely to be using multiple 'Jobs' in *GeoSatSignal*, including those relating to water vapour images (which are useful for identifying frontal areas), and one of the 'Precipitation CLUTS' to spot potential rainfall. *GRIBViewer* is used to see cloud types and heights, while Rob Alblas' *xrit2pc* is invaluable in showing how the air masses are moving. Fred van den Bosch's handy little program for animating the MSLP and 500 mb pressure charts from *GRIBViewer* may also be utilised. Unfortunately, these GRIB data come without a scale, so one can only say: 'This is low pressure and it's forecast to develop in this way' (but that *is* quite useful when combined with other information). The IR animation for the North Atlantic is, again, essential for me in this mode of operation.

This intensity of use of the *EUMETCast* data is likely to take over a large part of a day or evening. There may be books on satellite imagery and meteorology on the desk and floor while the *EUMeTrain ePort* page at

http://www.eumetrain.org/eport.html

will at some time be open on one of my screens (The 'Europe' option covers the North Atlantic and the whole of Europe). The *ePort* page is particularly useful for Thermal Front Parameters and upper level winds on the synoptic scale. The *ePort* analysis uses much the same data as I have, but is clearly using algorithms to which I do not have access. As these *ePort* analyses are only a few hours adrift of real time, I also find it helpful to see how their interpretations compare with mine—which is just a way of saying that I get my homework marked by the experts.

It will not have escaped readers notice that I have made no reference to high resolution HRPT imagery from the NOAA satellites, Metop or MODIS. I find these images fascinating, but mainly in my 'touring' mode. The high resolution images from *EUMETCast,* and my own NOAA reception, do however come into their own when there is vigorous convection over the UK, because one can usually pick out the towering cumulus clouds and developing 'anvils'.

Perhaps, as an academic, I may add one final comment to these notes: there are very interesting parallels between meteorology and the social sciences. In neither can we conduct experiments, in both we deal, in the end, with probabilities. Both progress with advances in theory, data acquisition and methods of analysis; each aspect stimulates and challenges the others. But a breakthrough in one is of limited value on its own. While it's not quite as simple as this, I am constantly struck by the parallels between my day time job and my hobby—and if I wished to stretch a point I might argue that time spent on the hobby is time well spent because of this. But I don't, because I enjoy it.

The Aurora

... viewed at night over the American Midwest from the International Space Station

A NASA Earth Observatory Report

When viewed from the International Space Station, the night sky is illuminated by light from many sources. For example, the Midwestern United States presents a nighttime appearance not unlike a patchwork quilt when viewed from orbit.

In the image above, the artificial light from human settlements appears with a characteristic yellow tinge: the green light of the aurora borealis also shines brightly in this view—even seeming to reflect off Earth's surface in Canada. A small white patch of light at top right in the image is almost certainly lightning from a storm on the east coast. Part of the ISS appears across the top of the image.

This astronaut photograph highlights the Chicago metropolitan area as the largest cluster of lights, next to the dark

patch of Lake Michigan. The other largest metropolitan areas include St. Louis, Minneapolis–St. Paul, and the Omaha–Council Bluffs region on the Nebraska–Iowa border. The northeastern seaboard lies just beyond the Appalachian Mountains, a dark winding zone without major cities.

City light clusters give an immediate sense of relative city size. Demographers have used nighttime satellite imagery to make estimates of city populations, especially in the developing world, where growth can be rapid.

The sense of scale changes significantly in oblique views. Des Moines is 200 km from Omaha and 375 km from Minneapolis, yet the distances appear roughly the same in this view.

In contrast to the regular township pattern, interstate highways converge on St. Louis, Chicago and other large cities, much like wheel spokes around a central hub. Rivers, major visual features by day, become almost invisible at night. The course of the Mississippi appears as a slightly meandering zone from Minneapolis through St. Louis and continuing out of the lower right corner.

Astronaut photograph ISS029-E-12564 was acquired by the Expedition 29 crew on September 29, 2011, using a Nikon D3S digital camera with a 20 mm lens, and was provided by the ISS Crew Earth Observations experiment and Image Science & Analysis Laboratory, Johnson Space Center.
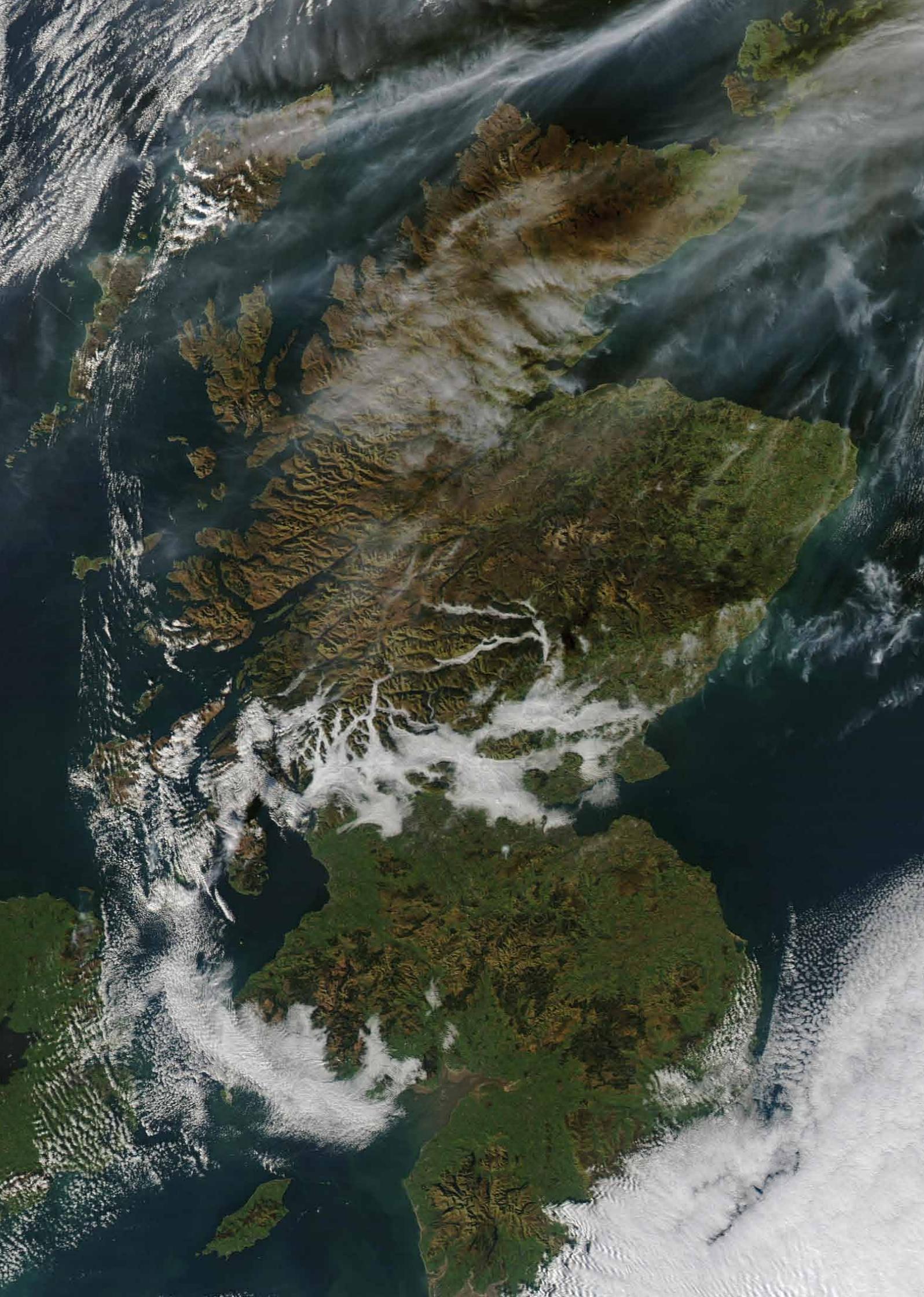
2011'S FINAL TROPICAL STORMS

John Tellick

The last days of 2011 featured two tropical storms—Cyclone Thane, already well developed, and Benilde, which began as a category-4 *Tropical Storm No 4* and was later upgraded to *Cyclone Benilde*. Both these cyclones were in the Indian Ocean, Thane in the northern Indian Ocean/Bay of Bengal and Benilde, 'harmlessly' in the southern Indian Ocean.

Category-1 *Cyclone Thane* (figure 1) tracked west from the Bay of Bengal making landfall close to Puducherry on December 30. Thane reportedly brought torrential rain and gale force winds of up to 145 kph which uprooted hundreds of trees, and knocked down electricity poles and mobile phone towers, leading to power and communications outages in several areas. Roads in the region were closed by uprooted trees and train services were disrupted.

There was an associated storm surge of 1.5 metres which flooded low lying coastal areas causing extensive damage to hundreds of hectares of standing paddy crops in the coastal districts of Cuddalore, Villupuram, Nagapattinam and Thanjavur. There was also extensive damage to small fishing boats. Despite the storm warnings in force (with twenty thousands people using relief shelters), there were fatalities, 39 in Cuddalore, south of Chennai and a further seven in Puducherry. Some people who refused to go to relief centres and remained in low lying villages found themselves marooned.

A recent study has linked increasing air pollution over the Indian sub-continent to an increase in the intensity of Tropical cyclones off its shores. In a warming climate, most prediction models suggest that tropical cyclones will increase in intensity although their frequency is unlikely to change. That means stronger winds and more rain causing greater flash flooding and storm surges.
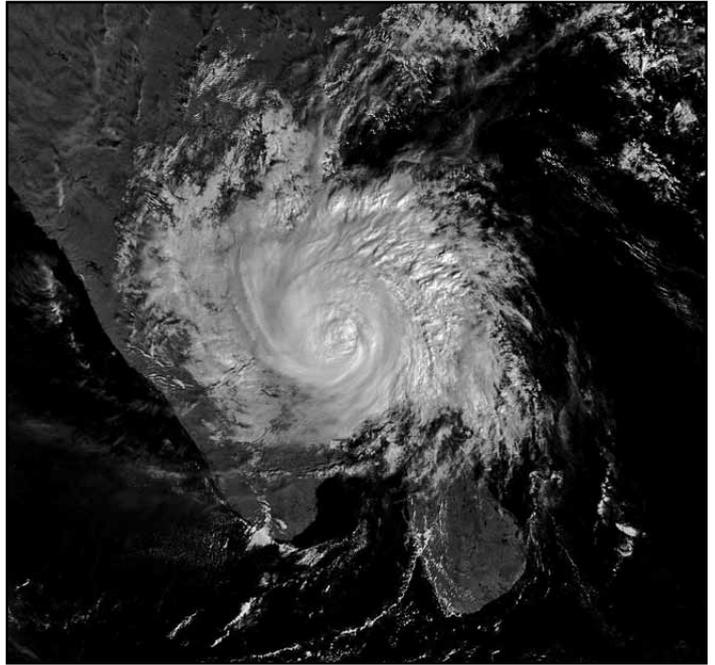

Figure 1 - Cyclone Thane makes landfall on December 30, 2011 (Metop-A).

Two nuclear power plants are situated on the Kalpakkam coast and, while both employed operating procedures for cyclone emergency conditions, neither stopped running and emerged from the storm safe and undamaged.

There is a detailed report on Cyclone Thane's development in Wikipedia.
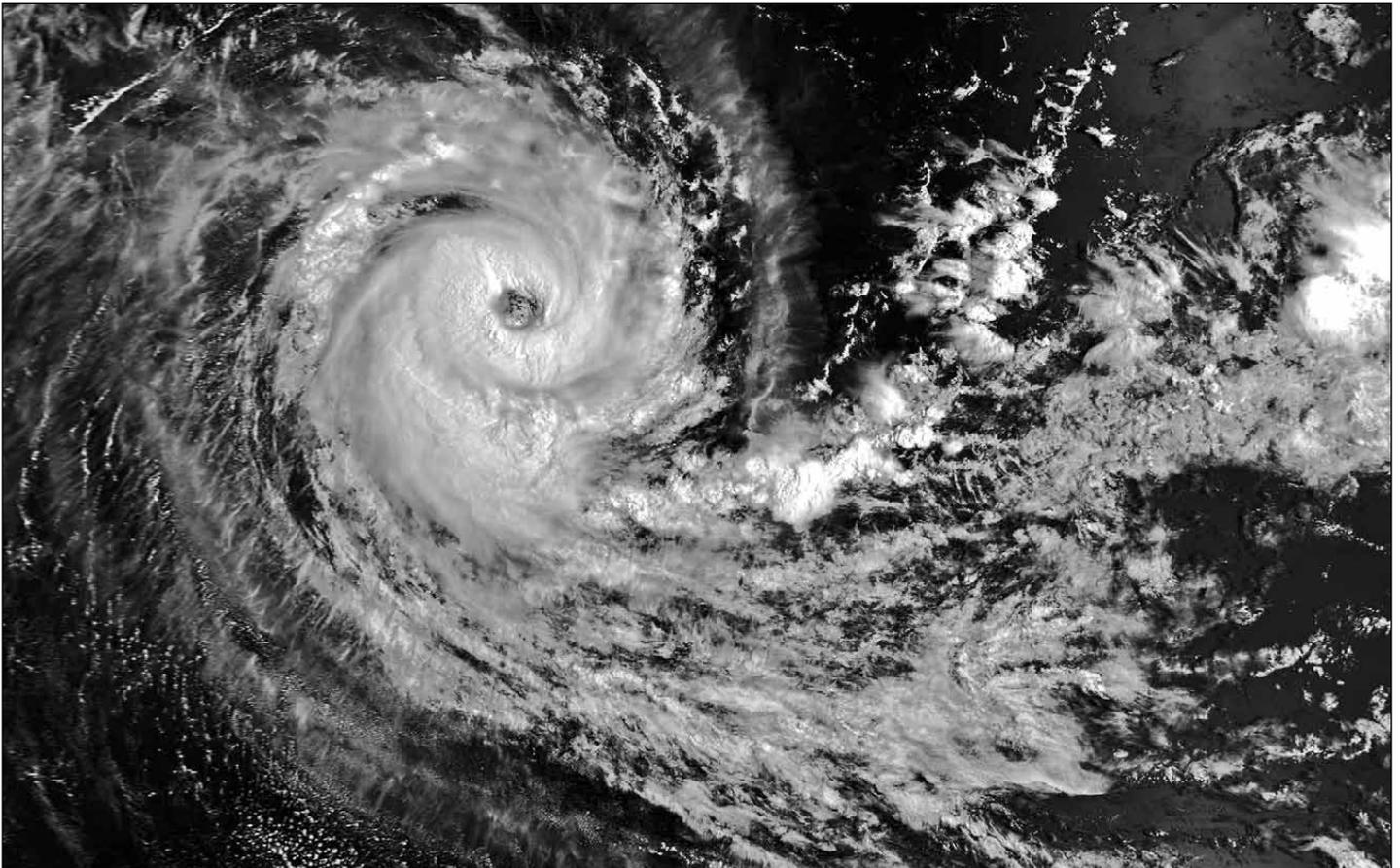
Figure 1 - TS 'Four' developed into category-1 cyclone Benilde, exhibiting the classic 'hole in the middle' on December 31, 2011 (Metop A)

Minus 30 and Falling

Europe suffers its harshest winter for decades

Les Hamilton

Following a relatively mild start to 2012, winter struck Europe with a vengeance during the final week of January. As high pressure from Siberia spread rapidly westwards, the continent suffered some of its lowest temperatures for decades. Many countries, swept by blizzards and gripped by severe cold, had to battle to clear snow from roads and railways. By the first weekend of February, over two hundred had perished from the cold while many more were suffering from hypothermia and frostbite.

Almost half of the fatalities occurred in **Ukraine**, most of them homeless people, some of whom were found simply lying dead on the streets: others died in their homes. Many hundreds more were hospitalised, suffering from hypothermia and frostbite. With overnight temperatures falling as low as -33°C, the authorities deployed over 1700 heating shelters across the land, predominantly for the homeless, and provided them with hot drinks, boiled potatoes and pork fat (a traditional Ukrainian dish). Hospitals were instructed not to discharge homeless patients to protect them from the cold. In the capital, Kiev, schools and colleges were closed while supermarkets were reporting food shortages because delivery trucks were struggling to access them in daytime temperatures as low as minus 25°C.

Hundreds of small towns and villages in southern **Romania** were left without electricity after strong winds toppled trees and brought down power lines. Police, ambulance crews and the army were all drafted in to rescue hundreds of motorists stuck in their cars following persistent blizzards. Up to a metre of snow fell in just 24 hours, derailing a train and forcing authorities to ban traffic from Romania's two motorways until the weather improved. In some places, the temperature plunged to -32.5°C and several deaths were recorded, with several hundred victims, many homeless, taken to hospitals or rescue centres suffering from hypothermia. Eighty percent of the Danube river was frozen over, preventing shipping accessing the Black Sea. Parts of the sea also froze near the Romanian coastline, and some of the country's ports, including the largest, Constanta, were closed in the face of strong winds and driving snow.

Several towns and cities in **Bulgaria** experienced record low temperatures, with -29.4°C reported in Kneja and -31.4°C in Sevlievo. Over 1000 schools were closed across the country, much of which was under an 'orange alert', warning of dangerously low temperatures after sixteen towns recorded their lowest temperatures since records began over a century ago. There were about a dozen deaths due to the cold, and in Sofia, it was so cold that cash machines were freezing up. Parts of the River Danube froze over.

The first week of the freeze caused 40 deaths in **Poland** where the temperatures plunged to -35°C in some areas.

In **Russia**, temperatures fell to -21°C in Moscow but only one person was reported to have died of the cold. But the low temperatures across Eastern Europe prompted Russian gas provider *Gazprom* to warn over supplies to Europe. The Russian gas export monopoly provides a quarter of Europe's gas markets, but was now receiving more requests for export than it could physically accommodate as home demand in Russia rose.

Heavy snow caused disruption across Europe, carpeting much of **Italy**, where there was traffic chaos in Bologna, Milan. Rome experienced only its second day of snow in fifteen years as 5 cm of white flakes covered palm trees and ancient ruins across the city. In Venice, canals started freezing over in a temperature of -5°C. In central Italy, heavy goods lorries were barred from motorways, rail services were reduced and several *Serie-A* football matches were called off because of the wintry conditions.

Temperatures also plunged in **France** where southern areas were hard hit by snow and ice as the temperature fell seven degrees below the seasonal norm. In Corsica, at least 20 cm of snow covered the centre of the Mediterranean island and most mountain passes were closed. Power cuts hit some 60,000 homes on the island and the neighbouring French mainland.

In **Bosnia**, two helicopters were used to supply remote villages in the north of the country with food and medicine after almost 300 people were cut off in temperatures of -10°C. Some of these villages had no electricity for several days and crews were working around-the-clock trying to repair power lines. Helicopters were also deployed in neighbouring **Serbia** to evacuate dozens from snow-blocked villages. They also uplifted nine people who attended a funeral but could not return home over icy, snow-choked roads. Further teams of workers ploughed through snowdrifts to take supplies and aid to thousands of residents in mountain villages cut off by the weather. The situation was dramatic, with snow up to five metres deep in some areas and only the rooftops of buildings visible.

In **Slovakia**, two people died in temperatures of -24°C and in neighbouring **Czech Republic**, a 47 year old homeless man was found frozen to death in the eastern city of Karvina. The Republic also claimed the doubtful distinction of recording Europe's lowest overnight temperature: -38.1°C.

In **Slovenia**, winds of up to 180 kph blew off roofs and prompted authorities to close some schools. And as temperatures plunged in **Albania**, the state ombudsman temporarily re-homed fifteen families in his Tirana office. In **Hungary**, numerous schools suspended classes, including one that claimed it could not afford the high heating bills.

In **Macedonia**, a fishery had to use pneumatic drills to break ice and get to the fish. And local hunters were using tractors to take food to animals in the mountains of southwestern Satornja, where roe deer and other small game animals were on the verge of starvation because they could not feed for the deep snow.

Soon after the first snow fell in **Belgium**, there were over 1100 kilometres of traffic jams on roads and highways, smashing the previous 'record' of 948 km in February 2010.

In the **Netherlands**, icebreakers were deployed to clear access to Rotterdam harbour, but the optimistic Dutch were eyeing the conditions with anticipation, hoping that the Friesland canals would become sufficiently frozen to allow the classic *Elfstedentocht* 200 km race to be held for the first time since 1997 (see GEOQ 22, page 16).

The GEO Report

one of our members, Peter Burden, has personal knowledge of this river: he once spent three days actually camping in the area, so I guess no research was necessary on his part.

Another member, Anders Hook reported that the Swedish version of *Wikipedia* was more informative than the English version. I didn't know there was any difference but apparently there is.

CD of Darmstadt Visit

This is a reminder that a CD containing the day's presentations during GEO's visit to EUMETSAT is still available. The EUMETSAT staff devoted considerable time and effort into preparing this material specially for our visit, and then compiling them all onto a CD. I still have a number of copies of this CD left, and if any member wants one they should contact myself. UK members should write to me and enclose six postage stamps.

Members in Europe or Rest of World can send an email request to me, supplying their full postal address. Note the stamps cover the cost of distribution, the disc is free of charge.

The disc is full of informative and technical data and the presentations, which are in *PowerPoint* format are:

- MSG-Meteosat - By Marianne Koening
- EUMETCast Evolution - By Klaus-Peter Renner
- METOP/ EPS - 5 Years in Orbit - By Dieter Klaes
- Meteosat Third Generation (MTG) Presentation - By Peter Albert
- The New NOAA Polar Sysyem Including NNP - By Francois Montagner
- Overview of Satellites and EUMETSAT - By Sally Wannop
- UNS Enhancements - By Sally Wannop

Sich 2

Ukraine's latest Remote Sensing Satellite

Les Hamilton

Figure 1 - Sich-2 as it might appear from orbit
Image: State Space Agency of Ukraine (SSAU)
www.nkau.gov.ua

Figure 2 - Sich-2 launch
Image: SSAU
www.nkau.gov.ua

Just seven days prior to the 20th anniversary of the nation's independence, Ukraine successfully launched its fifth satellite, Sich-2, into Earth orbit. The launch, aboard an *ISC Kosmotras Dnepr* carrier rocket, took place from the Yasny launch base in the Orenburg Region of Russia on August 17, 2011. The new satellite, which ultimately cost $30 million to develop and launch, will provide accurate data to help monitor disaster situations and check on the growth of crops across the nation.

None of the previous four Ukraine-operated satellites remains operational but Sich-2 sent its first test images of Earth from orbit within days of its launch and is expected to become fully operational by the end of this year. Sich-2 carries both optical and infrared imagers, as well as *Potential*, a complex of scientific instrumentation which will study space plasma particles and electric and magnetic fields in the upper atmosphere. *Potential* includes:

*   *DN Probe*, to study neutral particles of space plasma
*   *DE Probe* to study charged particles of space plasma
*   *EZ Probe*, the satellite's hull potential indicator relating to plasma
*   *ODHD*, the on board data collection and handling system

Also, for the accomplishment of experimental tasks on the measurement of Earth's magnetic field, a LEMI-016M high-precision lux-gate magnetometer is installed on the satellite.

History

Sich-2 is the third Ukrainian spacecraft in the series named 'Sich', which means 'Owl'. The first, Sich-1, which was based on the design of the former Soviet Union's *Okean-O1* remote sensing satellite, was placed into orbit by a *Tsyklon-3* carrier rocket in August 1995, the first Ukrainian satellite to be launched following the nation's independence. The payload also included six other satellites: RASAT (Turkey), NigeriaSat-2 and NigeriaSat-X (Nigeria), EduSat (Italy), AprizeSat-5 and AprizeSat-6 (USA).

The second Sich satellite, *Sich-1M*, was also based on *Okean-O1*, and was launched by a *Tsyklon-3* on December 24, 2004. Unfortunately, the orbit circularisation burn of the upper stage of the carrier rocket shut down prematurely, leaving the spacecraft in a lower-than-planned orbit. Although *Sich-1M* was able to operate for a short period, interaction with Earth's upper atmosphere caused its orbit to decay rapidly, and the satellite burned up on April 15, 2006, less than sixteen months into what had been planned to be a three-year mission.

The Satellite

The Sich-2 satellite was designed to enable low-cost observation of Earth's surface from space, replacing the larger spacecraft of the Soviet era. The project began in the 1990s but financial problems kept it on the ground during the first decade of the 21st century. The new-generation Sich-2 spacecraft was derived from the *Egyptsat-1* satellite, developed in Dnepropetrovsk by *KB Yuzhnoe* for the Egyptian government, and launched in 2007.

Many readers will surely have fond memories of the two earlier Sich satellites, which transmitted APT visible and radar images on

137.40 MHz. But Sich-2 is a very different craft: its optical scanner is capable of resolving details on Earth's surface with a resolution of 8 metres and will transmit its images digitally to ground stations. Although this resolution is considerably lower than that of high-end remote sensing satellites such as *Ikonos* (1 m greyscale, 3 m colour), *GeoEye-1* (0.4 m/1.65 m) and *OrbView-3* (1 m/4 m), Sich-2's images and data will nonetheless prove highly useful for applications such as cartography, environmental and disaster monitoring, and agricultural and real-estate planning. But Sich-2 has no APT: it transmits it's data in the S-band (between 2 GHz and 4 GHz). Figures 6 to 8, three of the early test images, illustrate the resolving power of Sich-2.

Solar panels (underside)
X-band antenna
GPS receiver antenna
Multiband optical Earth surface imager
Particles Experiment
Infrared Earth imager
S-band antennas
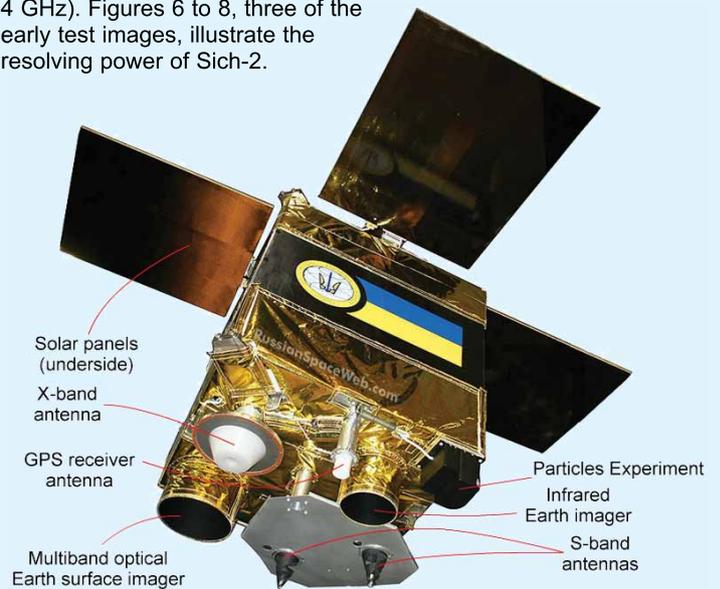
Figure 3 - The Sich-2 satellite was designed to carry downward-pointing optical (left) and infrared (right) sensors to photograph the Earth surface. A communications system can be seen in the center.
Copyright © 2011 Anatoly Zak

Sich-2 is a small Earth Remote Sensing satellite based on *Yuzhnoye's* MS-2-8 micro satellite platform and built under Ukraine's National Space Program. Designed using a wide range of polymeric and composite materials, Sich-2 really is a tiny spacecraft (figure 4), with a nominal mass of just 170 kg: but it punches well above its weight. Its forerunner Sich-1, by contrast, weighed a whopping 1.95 tonnes while Sich-1M was even more massive at 2.22 tonnes. The satellite is equipped with an opto-electronic scanner with one panchromatic and three spectral bands, a mid-infrared scanner and the *Potential* scientific instrument complex (figure 5). Sich-2 will image along an approximately 46 kilometer-wide swath with its optical imager, and a 55 kilometres-wide swath width with its mid-infrared imager. The spacecraft is stabilised with the help of special reaction wheels which maintain its position during orbit and help enable high-precision pointing of its sensors toward ground targets. Tests carried out on Sich-2 on August 25 indicated that all on board equipment was functioning properly.

The Sich-2 project is supported by a ground control complex, an information development centre and a communications and data

Figure 4 - Sich-2 undergoing configuration and testing
Image: SSAU

Figure 5 - The *Potential* Scientific Instrumentation
Image: SSAU

Figure 6 - This Sich image shows part of the city of Nikopol, on the right bank of the Dnieper river in Ukraine. The patchwork of cultivated fields surrounding the town is clearly visible.
Image: SSAU

Figure 7 - This Sich-2 test image was acquired on August 31, 2011, and shows bridges crossing the Dnieper river in Kiev, the state capital of Ukraine.
Image: SSAU

Figure 8 - This Sich-2 image dating from September 13, 2011, shows the diamond mining town of Mirny in eastern Russia. Prominent near centre is the enormous pit of the Mir Diamond Mine.
Image: SSAU

Figure 9 - An aerial photograph showing the *Mir* Diamond Pit at Mirny, the second largest man-made hole in the surface of the Earth.
Image: Vladimir Artukhov/Wikipedia Commons

transmission system. An S-Band communication system (2-4 GHz) on board the satellite is responsible for receiving flight control commands from the ground and transmitting telemetry data to mission control about the health of all on board systems. A GPS receiver aboard Sich-2 provides highly accurate navigational data about the satellite's position. The power supply system uses four solar arrays to generate electricity and store it in an on-board battery (figure 5).

Sich-2 Parameters	
Mass	169 kg
Orbit	668 km
Inclination	98.074°
Stabilisation	3-axis
Max deviation angle from nadir	30°
Power consumption (max)	372 W
Power consumption (daily average)	59 W
Operational lifespan	5 years
Imaging capability	50 000 km^2/day

Sich-2 ERS Equipment Specifications	
Multispectral Scanner	
Panchromatic range	0.51 - 0.90 µm
Multispectral channels	0.51 - 0.59 µm 0.61 - 0.68 µm 0.80 - 0.89 µm
Pixel step projection at nadir	~ 8.2 m
Swath width at nadir	~ 48.8 km
Mid-Infrared Scanner	
Spectral range	1.51—1.70 µm
Pixel step projection at nadir	~ 41.4 m
Swath width at nadir	58.1 km
Data Subsystem	
Memory	2 GB
Data transmission rate	30.72 Mbps

Figure 10
One of Sich-2's first test images, showing the Volkov River exiting Lake Ilmen and flowing through the Russian city of Novgorod.
Image: SSAU

Imagery

Images currently released demonstrate Sich-2's resolving power to good effect. Figure 7 shows the centre of the Ukraine state capital Kiev, bisected by the Dnieper River. Bridges crossing the river and islands in the stream show prominently. Figure 8 is particularly interesting, and was taken when Sich-2 flew over the town of Mirny in Eastern Siberia. Of particular note in this image is the enormous circular hole at lower centre, the *Mir Diamond Mine*. This open pit mine is 525 metres deep and 1,200 m in diameter; it is the second largest man-made hole in the world (and the 4th deepest) after Bingham Canyon copper mine in Utah, USA. The airspace above the mine is closed to helicopter traffic nowadays because the severe downdraughts that it generates had caused a number of helicopters to crash after they were sucked into the cavity. The sheer scale of the endeavour can be judged from the aerial view of the pit shown in figure 9, where it completely dwarfs the town itself.

The full page image opposite really shows the satellite's capabilities. Sich-2 acquired this detailed image of the San Francisco Bay and its environs, covering approximately 11 x 16 km, during an overpass of America on September 18, 2011. The tiny island in the top left corner of the view is the infamous Alcatraz. At bottom left can be seen the runways of San Francisco International Airport while Oakland International Airport stands on the stubby peninsula at centre right.

The Long Road from Conception to Launch

By early 2009, the launch of Sich-2 had been expected to take place before the end of that year, but lack of funding forced it to be rescheduled many times. By the beginning of 2011, with Sich-2 already delivered to the launch base, the head of the Ukrainian space agency, NKAU, informed the press that organisational problems between Ukraine and Russia had forced another launch delay: to a window between May and early June. The launch campaign finally commenced in April with a target date of June 20. Delays with the delivery of some of the Dnepr carrier's seven secondary payloads—two *NigeriaSat* cubesats did not arrive till June 10—caused this to slip till the end of the month.

At the start of July, the mission slipped yet again, to July 21. Then new delays pushed it back to July 28, then, almost immediately, to August. Finally, the order to fuel the missile was received and, on August 5, official sources at last declared that the launch would take place on August 17. The Dnepr rocket finally lifted off on time, at 07:12:20 UT, from the Yasny missile deployment area and successfully attained orbit. According to NKAU, the Ukrainian space agency, Sich-2 took its first test images on Aug. 25, 2011,

Application Areas

The Sich-2 Space System is a powerful tool for obtaining instant data about large areas of land, sea and ocean, as well as monitoring space weather and geophysical effects in the Earth's ionosphere. In Ukraine, these data will be used to benefit most economy sectors: to provide information for public administration, scientific institutions and a wide range of private sector consumers. The national Sich-2 space system has monitoring applications in the following major areas:

- Agricultural resources.
- Water and land resources.
- Emergency situations.
- Earth's ionosphere.

Monitoring Agriculture

Space images from Sich-2 will play a crucial role in supporting effective decision-making in agriculture. They will allow the usage of existing cultivated areas to be assessed by calculating the total extent of cropped areas, monitoring crop rotation compliance,

following the ripening process of grain crops and making preliminary forecasts as to their probable yields. It will also be used to detect and predict adverse effects resulting from wind and water erosion and waterlogging. Figure 6 clearly shows a patchwork of cultivation in the hinterland of the city of Enerhoday on the Dnieper River.

Monitoring Water and land Resources

Sich-2 data will be valuable in observing the condition of offshore zones and inland waters, and tracking coastline and river channel changes. The data will also prove valuable in identifying areas of forest cover: classifying them as deciduous or coniferous, detecting new cutting areas, fire sites and windthrow as well as studying environmental conditions that hinder active forest management.

Emergency Monitoring

Space images from Sich-2 will be valuable for monitoring both natural and man-made disasters, including floods, snow drifts, fires and harmful substance emissions. They will be especially helpful in organising transport for rescuers and their equipment, damage assessment and monitoring recovery operations.

When identifying an emergency in its initial phase, lower spatial resolution imagery such as that provided by AVHRR (NOAA) and MODIS (Terra, Aqua) instruments is most useful. Although Sich-2 nominally takes visible images measuring just 48.8 x 48.8 km, it is also capable of taking images in swaths of up to 300 km, so is ideal in this context too. However, with its relatively high resolution

capability of 8.2 m, Sich-2 will be extremely useful in the later stages of operational monitoring, when it will assist in identifying the most critical localities affected by an emergency and help in damage assessment. Sich-2 will also be able to keep track of ongoing situations such as forest fires and coastal pollution.

Monitoring the Ionosphere

The main task of the *Potential* scientific package installed aboard Sich-2 is to monitor space weather and record geophysical information about the ionosphere. At altitudes below 800 km, the dynamics of gas particles plays an important role in the behaviour of ionospheric plasma. Direct measurements of such particles were carried out from satellites in the 1970s and early 1980s but the volume of information acquired was negligible. *Potential* will make use of new technologies to explore the ionosphere at a brand new level and on a long-term basis.

Summary

Flight-design tests of Sich-2 were completed on October 10 when all of the spacecraft's instruments were declared to be functioning normally.

Although direct reception of data from Sich-2 will probably never impinge into the realm of the amateur satellite enthusiast, this diminutive satellite shows what can be concentrated into a small package. Some of the early test images show a stunning degree of detail, and we can only hope that, once fully commissioned, Sich-2 imagery will continue to be made available.

Subscribe to these Free Publications
Francis Bell

Last December, I received three publications relating to my interests in Earth observation: *Planet Earth* from the Natural Environment Research Council (NRSC), *Image* from EUMETSAT, and *ESA Bulletin 148*, all as a result of being on these organisations' mailing lists. Two of these publishers are already considering producing their magazines only in electronic form, available via the Internet. Although I do use the Internet to research topics, I would be very disappointed if printed materials ceased to be available. Therefore, I am specifically encouraging all readers who might be interested, to apply for inclusion in the publishers' mailing lists. This brings a double benefit: you will receive a personal printed copy of each periodical and attention will be drawn to the fact that printed materials are still widely appreciated. Please register, at least, for *Planet Earth*, published four times a year and *Image*, published twice per year: this may help to secure their future in printed form.

Planet Earth Review

I enjoyed almost all the articles this contained as most overlapped with my personal interests in Earth observation. Though containing some technical information, the articles were not difficult to read and, from my own perspective, I found the following particularly interesting:

- The Sun's activity linked to winter weather
- Meteors as a source of the rare metals in the upper Earth's crust
- Atmospheric forensics and ozone depleting compounds
- The risky business of earthquakes
- The world's nitrogen cycle and the balance between global warming and cooling
- The tale of dimethyl sulphoxide and the sulphur cycle in the oceans

I particularly liked the last article, as I have recently being following Open University materials relating to 'Smell of the Sea' chemistry.

The NERC is the UK's main agency for funding research training and knowledge exchange in environmental science. Their work tackles some of the most urgent and fascinating issues such as climate change, and natural hazards from the deepest oceans to the outer atmosphere. Research centres include the British Antarctic Survey, British Geological Survey, Centre for Ecology and Hydrology, National Oceanography Centre, National Centre for Atmospheric Science and National Centre for Earth Observation.

Contact Information
Planet Earth
To join their mailing list, email your request, giving your full postal address, to **requests@nerc.ac.uk**, or write to Planet Earth Editors, NERC, Polaris house, North Star Avenue, Swindon SN2 1EU UK.

ESA Bulletin
For a copy, write to Distrimail, Postbus 122, 2370 AC, Roelofarendsveen, The Netherlands and ask to be put on their mailing list.

EUMETSAT Image
The best option is to visit their web site and enter your name and address details. Then, in the comments box, make your request to be put on the *Image* mailing list. The URL is

http://www.eumetsat.int/Home/Main/ AboutEUMETSAT/Contact_Us/index.htm?l=en

You can also write to their postal address, EUMETSAT User Services, Eumetsat-Allee 1, 64295 Dermstadt, Germany.
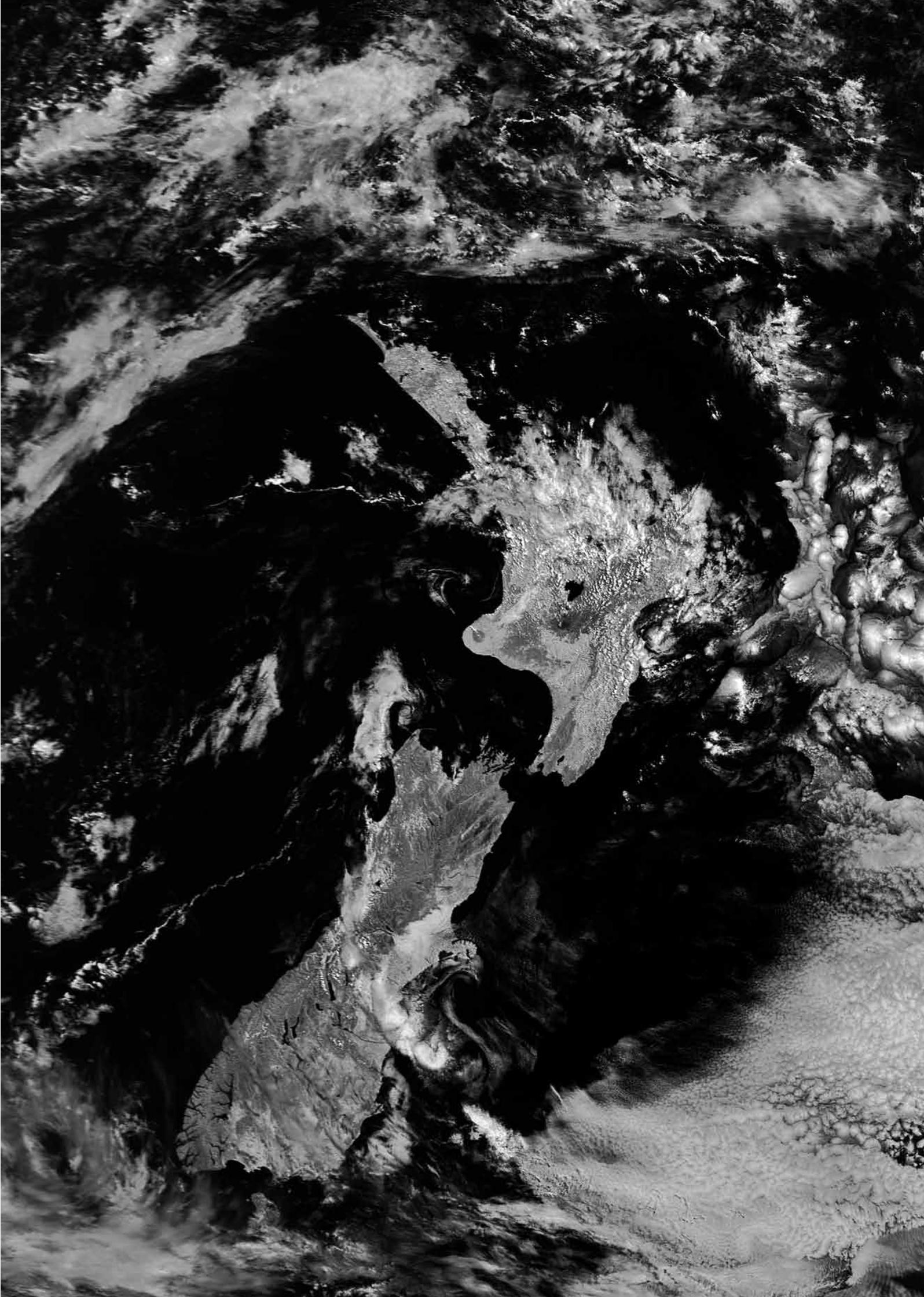
Запорізька АЕС

Zaporizhzhya Nuclear Power Plant

Les Hamilton

The title of this piece probably comes as a surprise to you. Surely GEO is not investing in the nuclear fuel industry? Rest assured. This is not an article about nuclear power: it just happens that there is a wealth of interesting satellite imagery based around the *Zaporizhzhya NPP* in the Ukrainian city of Energodar.

What triggered my interest in such an obscure and remote place was a test image from Ukraine's new Earth observation satellite, *Sich-2*. Reproduced in figure 5, this false coloured image with a resolving power of 8 km/pixel depicts the city of Energodar, where the Zaporizhzhya NPP is located.

Map showing the location of Energodar and the Zaporizhzhya Nuclear Power Plant

Even the most cursory glance at this image draws the eye to the large rectangular feature at upper left. This is the cooling pond associated with the *Zaporizhzhya NPP*, whose six massive reactor buildings can be seen lined up at its northeast corner. My first impression on seeing this was that the city of Energodar must be quite small: but not so—it has a population of over fifty thousand. The truth lies in the size of the cooling pond itself, which is 3.5 kilometres wide. Figure 1 is a view of the station's six reactors, viewed from Nikopol, across the Dnieper.

View from Satellites

A few years ago, we reported on a discussion thread from the *GEO-Subscribers forum* relating to the nature of a distinctive black spot that had been observed in high-resolution NOAA infrared images. The case in question related to the Surgut hydroelectric plant in central Siberia (*GEO Quarterly No 13, page 14*).

Given that the *Zaporizhzhya NPP* is the largest nuclear plant in Europe, it seemed highly likely that it too would leave its mark in the form of a hot-spot in IR imagery. The water in the cooling pond recycles through the reactors, as a coolant, so will necessarily be at a higher temperature than its surroundings. Figure 2, an HRPT image from a Metop-A late afternoon pass last February, does indeed reveal a prominent black spot precisely where expected. Several more such spots indicate the locations of other power installations.

Figure 3 was created from the same Metop-A pass using the *Temperature* tab of David Taylor's *HRPT Reader* software. The warmest feature in the image is the water in the Sea of Azov, which is just at freezing point (0°C). The northern part of the sea is several degrees cooler and is clearly covered in ice. Almost everything else in the image is colder; the Dnieper river and its Kakhovka reservoir are encased in ice (yellow-green) but the *Zaporizhzhya NPP* cooling pond (orange dot) is clearly much warmer than its surroundings.

Energodar and its Surroundings

Energodar is one of he youngest and most promising cities in Ukraine, now the energy capital of the nation. In 1969, all that existed here was a 30 kilometre stretch of sandy hills bordering the Dnieper river, and which was quite unsuitable for agriculture. It was here, on the left bank of the Kakhovka Reservoir, that it was decided to build the Zaporizhzhya Thermal Power Plant, now the largest of its type in Ukraine, and on June 12, 1970, the first granite block was set among the sand dunes at the entrance to the future town. Today Energodar is one of the most comfortable cities in Ukraine with a population of 55 thousand people.

Figure 1 - Zaporizhzhya Nuclear Power Plant
*Image: Wikipedia Creative Commons*
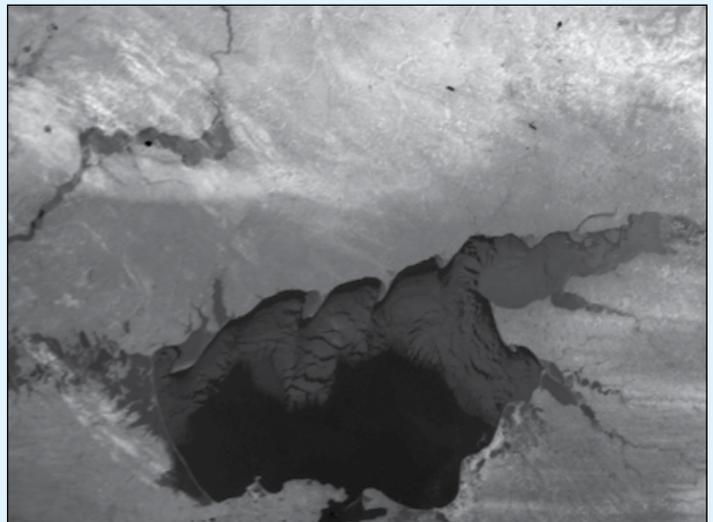
Figure 2 - Metop-A acquired this channel-3 image of southern Ukraine on February 16, 2011. A hot-spot on the shore of Kakhovka reservoir reveals the location of Energodar/Zaporizhzhya nuclear power plant (see map).
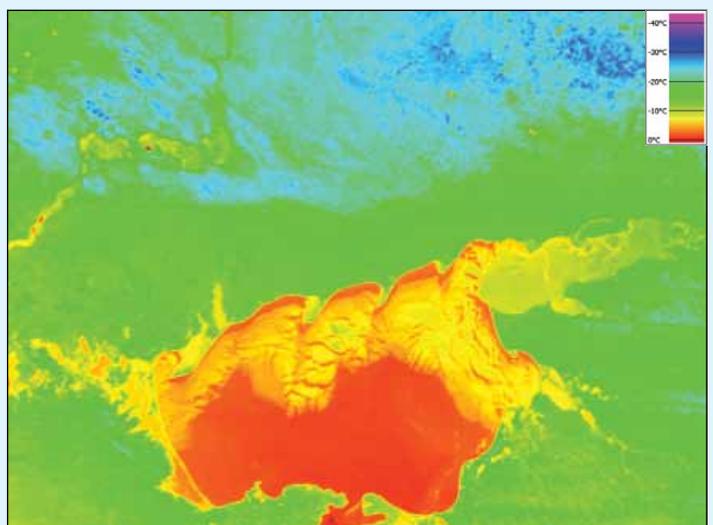

Figure 3 - The same Metop image, this time rendered using the 'Temperature' tab in David Taylor's HRPT Reader software. In this image, deep orange over the Sea of Azov represents 0°C while the darkest blue represents -33°C.

Figure 5 - Ukraine's new Sich-2 satellite took this 8-metre resolution image of Energodar on September 12, 2001, while undergoing initial testing. The large rectangular cooling pond adjacent to, and west of the Zaporizhzhya Nuclear Power Plant is hard to miss. The six nuclear reactor buildings can be seen, in a row, from the northeast corner of the pond.
Image: State Space Agency of Ukraine (SSAU)
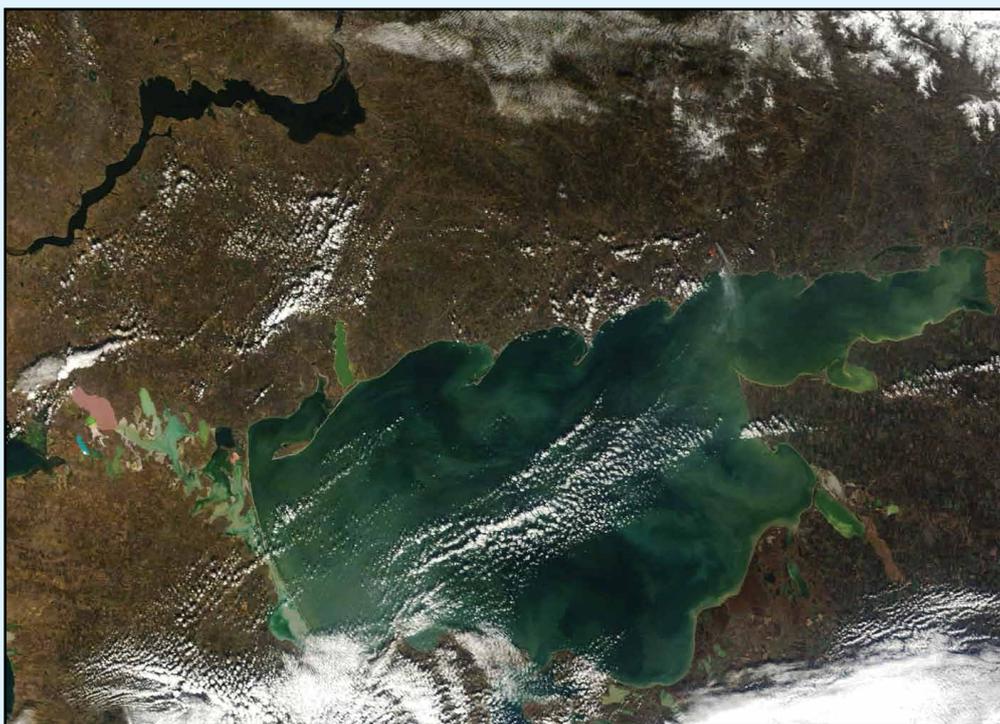
Figure 6 - In this segment from a 250-metre resolution Terra MODIS image from November 17, 2011, it is just possible to spot the cooling pond at Energodar.
Image: MODIS Rapid Response Team at NASA/GSFC

In 1978, the decision was taken to build the Zaporizhzhya NPP, now the largest Nuclear Power Station in all Europe, producing 20% of Ukraine's electricity. The first four power units came into operation between 1984 and 1987, Unit 5 followed in 1989 and Unit 6 was commissioned in 1995. The plant now outputs 6000 megawatts of electrical power and generates 40-42 billion kWh of energy annually.

The 240 kilometre long swelling on the Dnieper river is the Kakhovka Reservoir, formed following construction of the Kakhovka Hydroelectric Power Station dam lower down the Dnieper in 1955. The reservoir took almost three years to fill and is now one of the most picturesque places of Ukraine. It boasts an abundance of bream, carp and other fish, and attracts both amateur and professional fishers all year round. The area surrounding the reservoir has been turned into the *Dneprovsky Porogy State Nature Reserve* and the *Veliky Lug National Park*.

NPP – the First Months in Orbit

Checkout – Problems – First Images

Les Hamilton

As you read this, the **N**POESS **P**reparatory **P**roject satellite (NPP) has been in orbit, undergoing testing, for five months. But, as is almost *de rigeur* for these missions, everything has not gone entirely to plan. Checkout of the full suite of instruments was delayed after an anomaly occurred in the Visible Infrared Imaging Radiometer Suite (VIIRS). VIIRS, which observes the Earth at 22 visible and infrared wavelengths, made its first measurements on November 21, but engineers detected a decrease in sensor sensitivity in four of its near-infrared and visible channels.

All NPP's instruments were scheduled to be operationally active by mid-December, but as a precaution, checkout activities on all five of them were put on hold until the VIIRS situation was resolved. After several weeks of effort, the anomaly was found to be due to the presence of tungsten oxides on the surface of the mirror, most probably originating during the coating process. Checkout resumed on January 18, and it was anticipated that the commissioning programme would be completed around the end of February 2012.

NPP Mission Overview

The launch of the *Seastar* satellite in 1997 marked the beginning of NASA's Earth Observing System (EOS). The names of many of the subsequent EOS satellites will surely resonate with *GEO Quarterly* readers: TRMM, Landsat-7, QuikSCAT [1], EOS AM-1 (Terra), Jason-1, EOS PM-1 (Aqua), ICESat, Aura [2] and other members of the 'A-Train' [3]. These craft have monitored all facets of Earth's biosphere: clouds, oceans, vegetation, ice and the atmosphere. NPP is the first of a new generation of satellites which will extend and improve these global environmental observations for many years into the future.

The NPP Science Instruments

NPP carries five Earth monitoring packages, which will, collectively

- map land cover
- monitor changes in vegetation
- measure sea and land surface temperatures
- monitor sea ice, land ice and glaciers
- track atmospheric ozone and aerosols
- monitor natural disasters such as volcanic eruptions, wildfires, droughts, floods, dust storms and hurricanes

The five instruments in question are the

- *Visible/Infrared Imager Radiometer Suite* (VIIRS)
- *Cross-track Infrared Sounder* (CrIS)
- *Clouds and Earth Radiant Energy System* (CERES)
- *Advanced Technology Microwave Sounder* (ATMS)
- *Ozone Mapping and Profiler Suite* (OMPS).

With the exception of CERES, these are all new state-of-the-art instruments. CERES is the same device that currently flies aboard both *Terra* and *Aqua*.

NPP will monitor the health of our planet from space, and the data acquired will provide an important link between the current generation of Earth-observing satellites and the missions to follow in the years ahead.

NPP observes Earth's entire surface twice daily, once during the day and again overnight, from an altitude of 824 kilometres, making its ascending node crossing at 1.30 pm local-time and dumps its data to the Svalbard ground station once every orbit. The data are then be sent to the NOAA Satellite Operations Facility in Suitland, Maryland via fibre optic cable for processing by the Interface Data Processing Segment. NOAA and NASA then make the data available through various archive capabilities.

The **ATMS** is a passive microwave radiometer, which can operate equally effectively in both clear and cloudy conditions to provide high spatial resolution microwave measurements of temperature and moisture. Paired with CrIS, ATMS can produce global sets of high-resolution temperature and moisture profiles used for weather forecasting and study.

Weighing quarter of a tonne, **VIIRS** is the largest instrument aboard NPP and supports 22 spectral channels across the visible and infrared regions of the spectrum, in the range 0.4 µm to 12 µm. In many respects, VIIRS is similar to the MODIS device carried by the *Terra* and *Aqua* satellites. The majority of the VIISR channels have 'Moderate' spatial resolution of 0.76 km/pixel at nadir, but five of them have the superior 'Imaging' resolution of 0.38 km/pixel. Although this might at first give the impression of a poorer resolution capability than MODIS, where two of the 36 channels boast a resolution of 0.25 km/pixel, VIIRS provides much improved cross-track image quality. It is well known that MODIS images deteriorate badly towards the extremities of the swath: this will be very much less so in VIIRS imagery.

The front cover of this magazine carries a true colour VIIRS image showing Florida, acquired by NPP at 17:57 UT on January 25. A wider greyscaled view appears opposite.

CERES measures both solar energy reflected by the Earth and heat energy radiated from the planet itself, the two key aspects of Earth's radiation budget. Some of the sunlight reaching Earth is reflected straight back into space by clouds, snow and ice; the remainder warms land, air and oceans, which later radiate this energy back into space. The changing role of clouds in this system is one of the biggest unknowns in climate science. NPP's CERES will continue to extend the record of the quantity of energy entering and exiting the top of Earth's atmosphere begun by *Terra* and *Aqua*.

CrIS and the **ATMS** work in tandem to provide global high-resolution profiles of temperature and moisture. These advanced atmospheric sensors create cross-sections of storms and other weather conditions, helping with both short-term 'nowcasting' and long-term forecasting. CrIS measures continuous channels in the infrared region, and has the ability to measure temperature profiles with accuracy comparable to the Atmospheric Infrared Sounder (AIRS) on Aqua. NOAA will be using CrIS for numerical weather prediction and, because it is a brand new instrument, its use on NPP provides a real-world test of the equipment before NOAA's upcoming Joint Polar Satellite System (JPSS) missions.

OMPS measures the ozone layer in Earth's upper atmosphere, tracking the status of global ozone distributions, including the 'ozone hole' over the Antarctic. Closer to the ground, OMPS also monitors harmful ozone in the troposphere to help improve air quality monitoring. OMPS data combined with cloud predictions helps to create the *Ultraviolet Index*, a guide to safe levels of sunlight exposure.

NPP - Overview

NPP is a unique satellite, with a design lifetime of five years, conceived as a bridge between NASA's current EOS satellites and the forthcoming series of Joint Polar Satellite System (JPSS) satellites.

NASA will operate NPP for its first three months in orbit to complete satellite and instrument checkout, after which the JPSS program will operate NPP from the NOAA Satellite Operations Facility in Suitland, Maryland.

NPP will collect long-term climate data while at the same time taking those measurements necessary for day to day weather forecasting. NPP represents a critical first step in preparing for the next-generation satellite system, with the following major goals:

- To continue and extend the global observations initiated by the *Terra*, *Aqua*, and *Aura* missions
- To provide NOAA and the operational community with preoperational risk reduction demonstration and validation for selected JPSS instruments, and algorithms, as well as ground processing
- To provide NOAA with necessary data for operational weather forecasting until JPSS becomes operational.

NOAA will provide data from NPP to meteorologists for weather forecasting, and to climate scientists to address an array of research questions. Climate scientists will use the data to enhance their understanding of climate change, meteorologists to make more accurate live-saving weather forecasts and warnings, and emergency responders to monitor and react to natural disasters.

NPP temperature and moisture profiles will be used as input to weather forecast models to help improve weather forecast capabilities. NOAA will evaluate the performance of the new instruments, VIIRS, CrIS, ATMS, and OMPS, and become familiar with their data products prior to their becoming the source of NOAA's operational data record with the first JPSS satellite.

NPP Renamed

On January 25, 2012, NASA renamed the NPP satellite as the *Suomi National Polar-orbiting Partnership* (Suomi NPP) to honour Verner Suomi, often dubbed 'the father of satellite meteorology.' Suomi, whose parents came to the United States from Finland in 1902, spent most of his working life as a meteorologist at the University of Wisconsin where he made many scientific and engineering contributions that proved fundamental in the development of Earth monitoring from space. Suomi pioneered remote sensing from polar-orbiting satellites with Explorer-7 as early as 1959 and geostationary satellites with ATS-1 in 1966. Importantly, Suomi invented the 'spin-scan' camera which enabled the GOES series of satellites to make continuous images of Earth, leading to the satellite animations which are now a common feature of TV weather broadcasts.

Suomi's interest in satellite meteorology wasn't confined to Earth and he was also involved with the early NASA missions to Venus, Jupiter, Saturn, and Uranus. You can read more about Verner Suomi's career at

http://earthobservatory.nasa.gov/Features/Suomi/

References

1 QuikSCAT - GEOQ 9, page 26
2 NASA's Aura Satellite - GEOQ 7, page 16
3 Full steam ahead for the A-Train - GEOQ 11, page 18
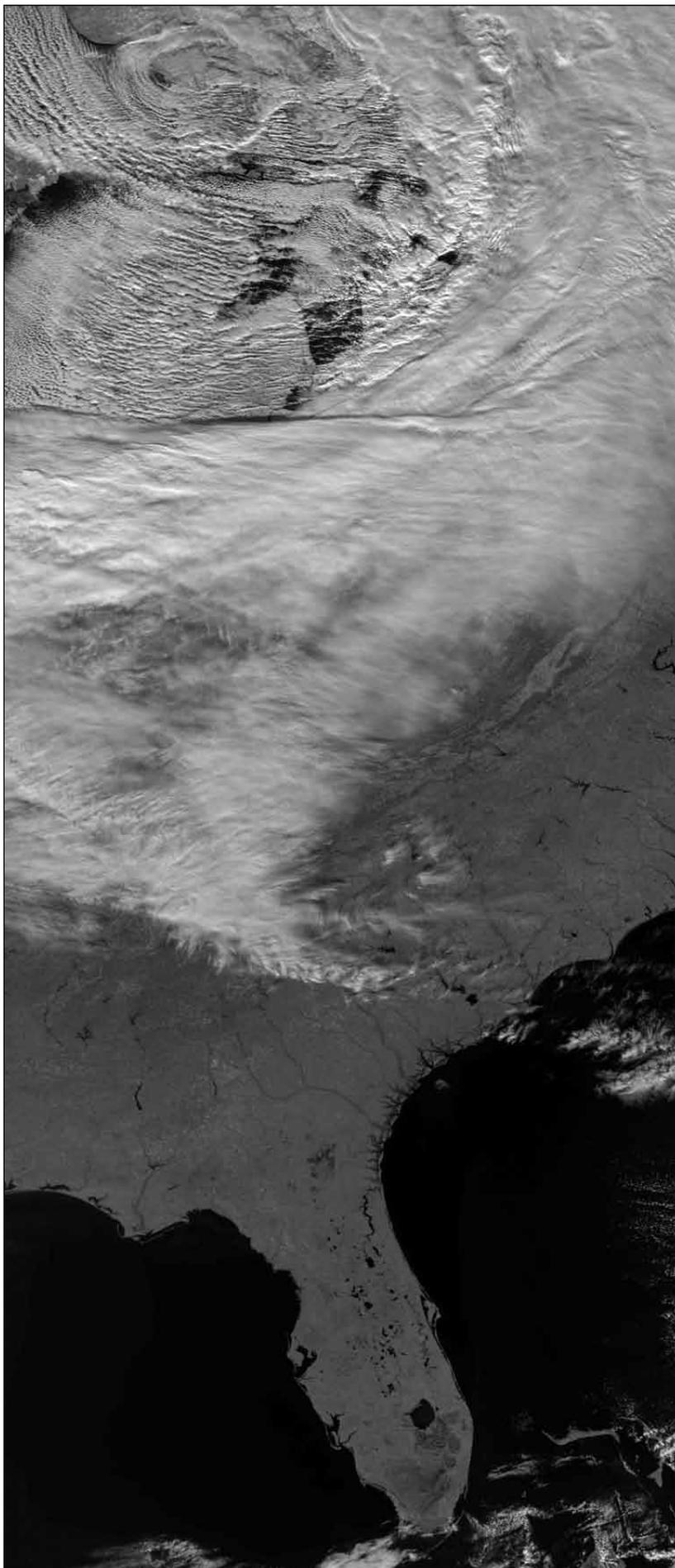
The NPP VIIRS acquired this grayscale image of the USA between 17:57 - 18:04 UT on January 19, 2012, the first day all 22 channels were active.
Credit: NASA/NOAA

Aniakchak National Monument

A NASA Earth Observatory Report
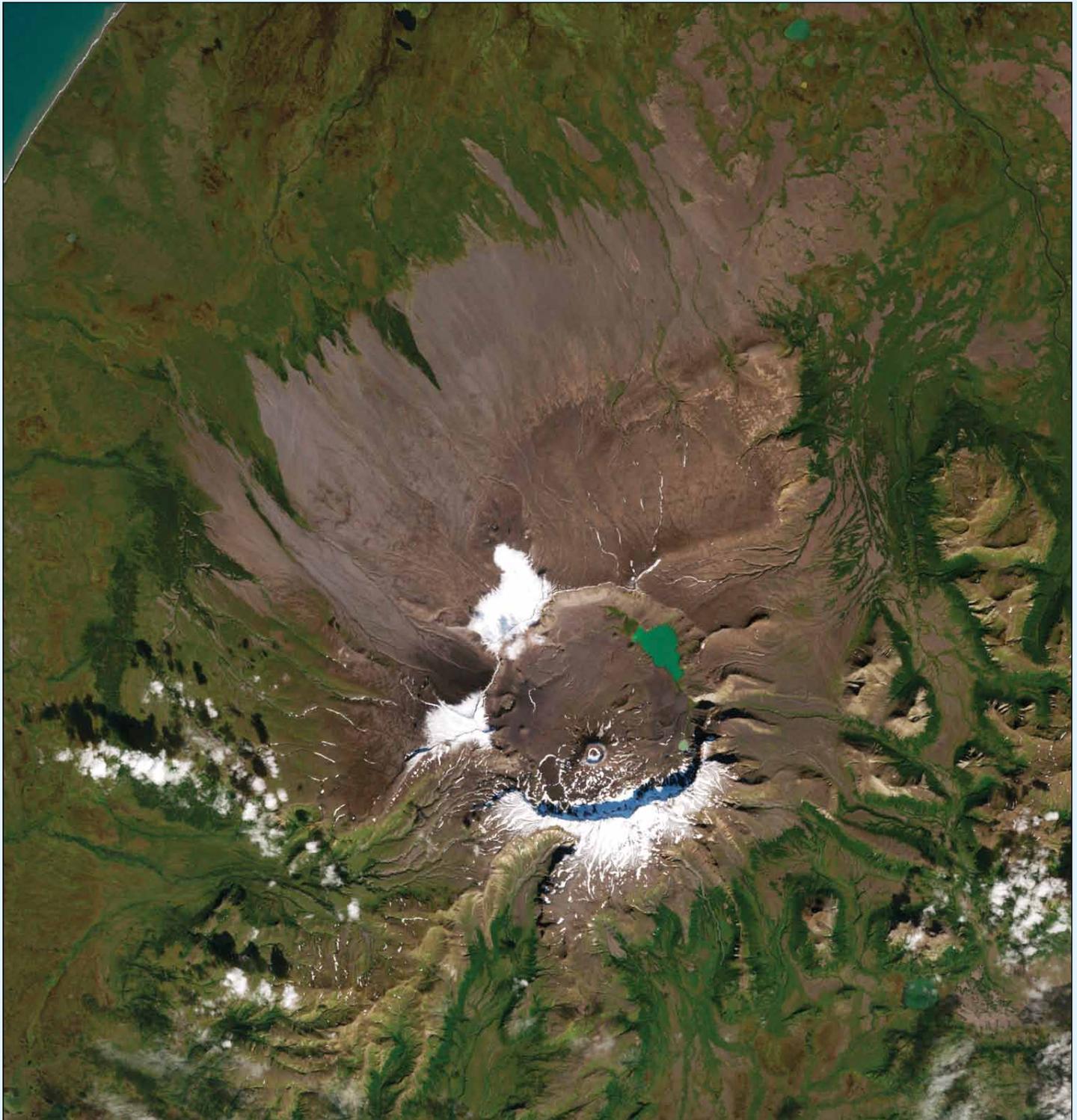
The Enhanced Thematic Mapper Plus instrument carried by the Landsat-7 satellite captured this natural colour image of Aniakchak National Monument and Preserve on September 15, 2000.

The caldera dominates the view, its southern rim casting a blue-gray shadow over nearby snow and ice. A lake lies near the caldera's northeastern margin. Vegetation is scarce immediately around the caldera, but slopes are green farther away. The Preserve derives its name from this 10 kilometre wide caldera on the Alaskan Peninsula.

The caldera formed about 3,500 years ago when an explosive eruption blew away roughly 1,000 metres of overlying mountain and more recent seismic activity has pockmarked the caldera with cinder cones and lava flows.

This NASA image was created by Jesse Allen and Robert Simmon, using Landsat data provided by the United States Geological Survey.

Sahara Revealed

Envisat MERIS imagery provides spectacular detail

Les Hamilton

Last November, Peter Burden emailed me the image below and commented: 'I have attached an Envisat (MERIS) image [1] of the Libyan Desert, centred on 22.6°N, 25.3°E. MSG confirmed that there was no cloud cover in the region at that time.' Peter found the image interesting and wondered whether *GEO Quarterly* readers would too. Peter also hoped that it would be possible to explain some of the detail revealed in his image. I had to agree that it was rather mysterious,

particularly when compared with a (MODIS) image [2] from a few days earlier from NASA's *Aqua* satellite (opposite page). The Envisat image shows greater detail than the MODIS one, though both have similar ground resolving power (300 m/pixel for MERIS, 250 m/pixel for MODIS). MERIS also displays a much wider range in both colour and contrast, and the great sweeping arcs on the eastern side of its image are barely discernible on the MODIS version.
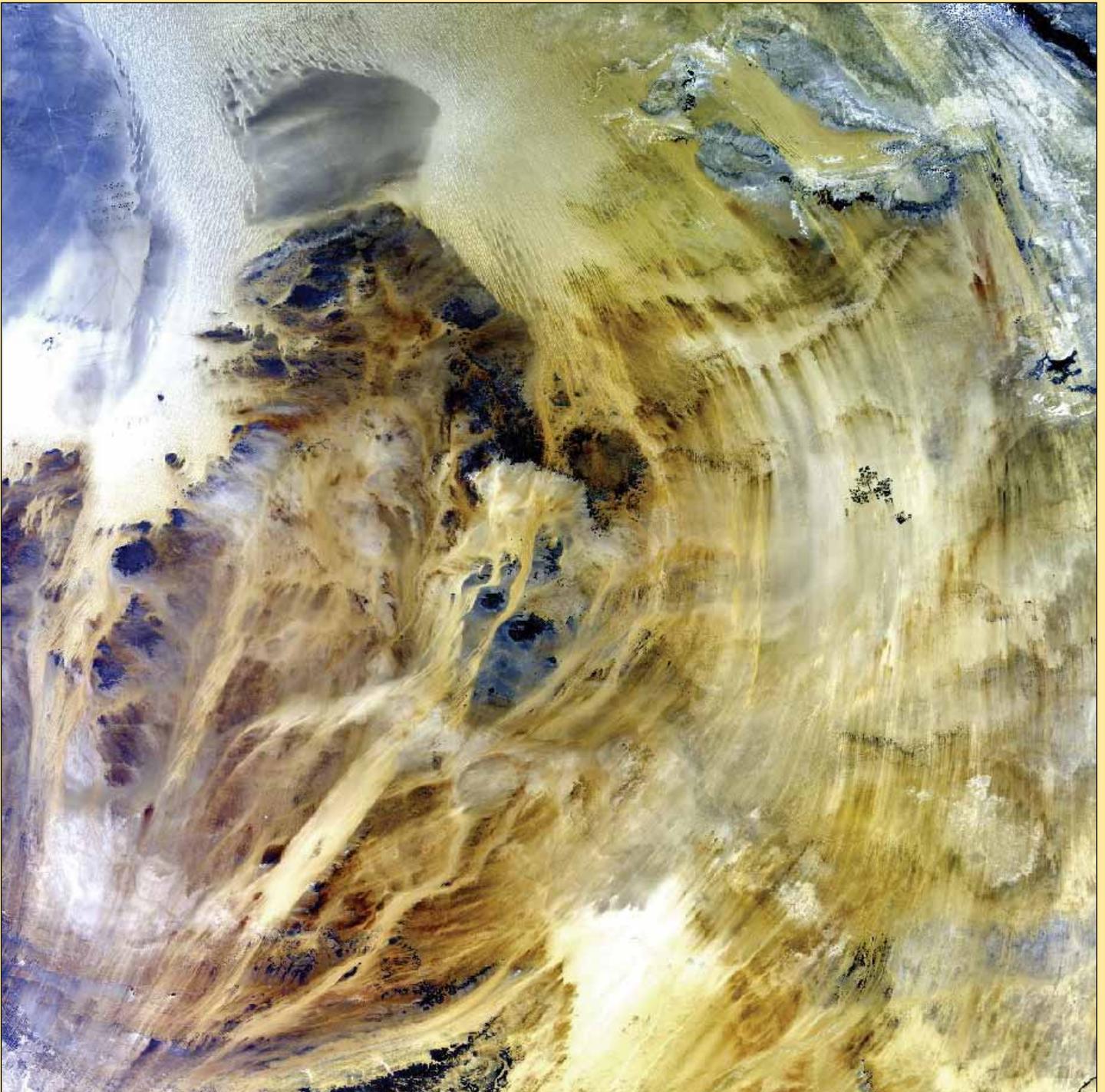
Figure 1 - Peter Burden's spectacular Envisat MERIS image of the Libyan Desert, acquired via the Envi-Ham project at 08.39 UT on November 25, 2011
Image: ESA
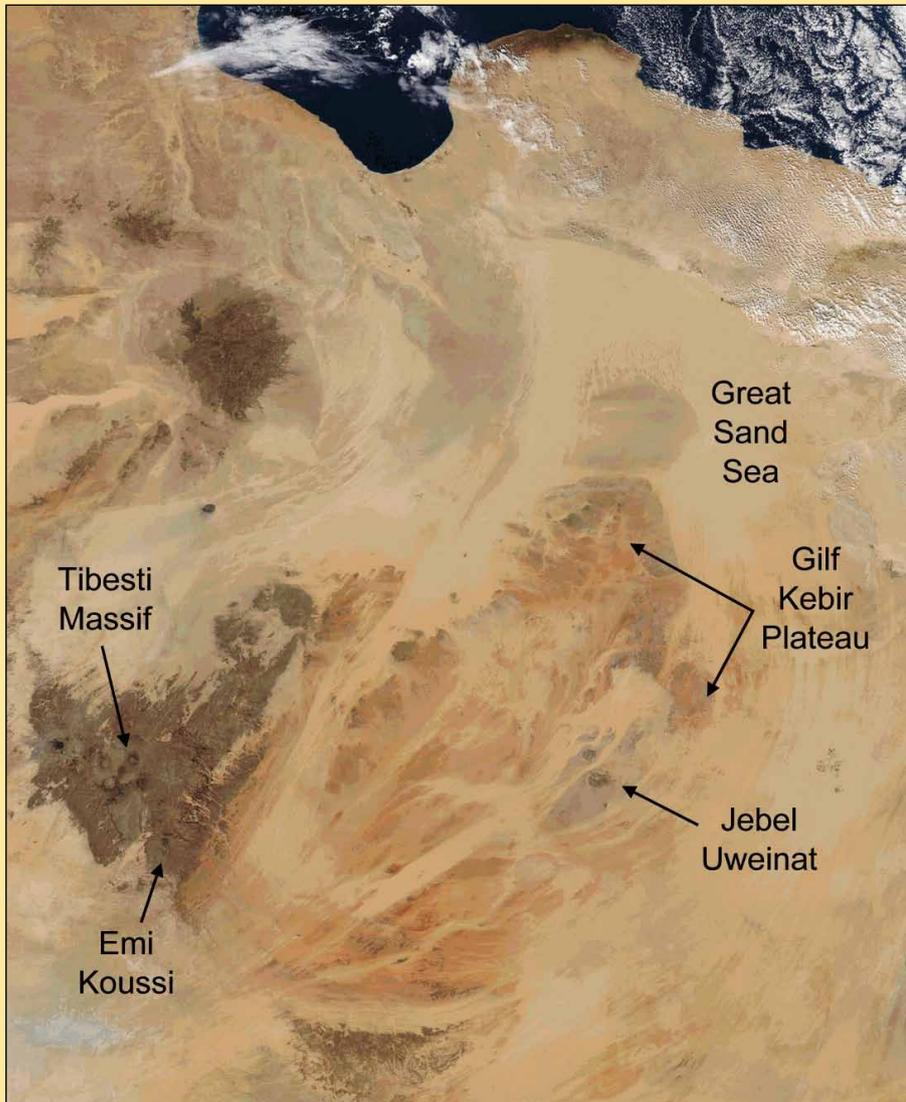
Figure 2 - An annotated Aqua-MODIS image from November 19, 2011, showing the Lybian Desert.
Image: MODIS Rapid Response Team at NASA/GSFC

Figure 3 - The 1934 m high mountain Jebel Uweinat on the border between Libya and Egypt.
Image: NASA ISS image ISS016-E-34241

Figure 4 - Detail from Cave of the Swimmers
Photo: Paul Ealing/Flickr
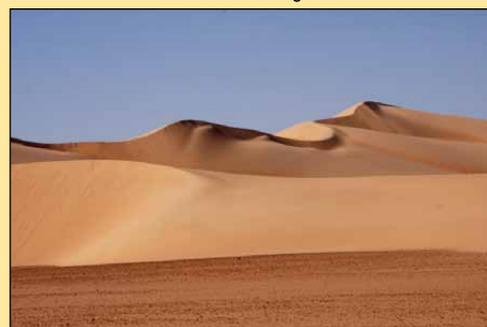
Figure 5 - Sand dunes near Jebel Uweinat
Photo: Imolcho/Flickr

Figure 6 - Wind-sculpted sandstone outcrops
Photo: image: Sejanc/Flickr

Figure 7 - Wind-sculpted sandstone outcrops
Photo: image: Sejanc/Flickr
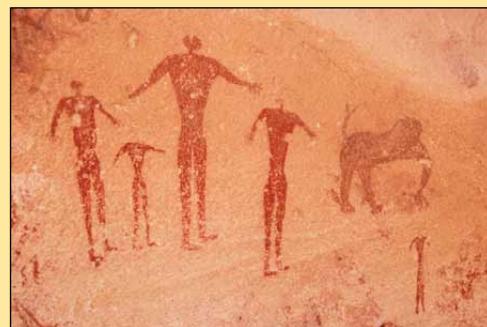
Figure 8 - Prehistoric Rock Art near Jebel Uweinat
Photo: Imolcho/Flickr

The Libyan Desert

The region shown in figure 1 is the Libyan Desert, a roughly square, 1.3 million km² stretch of the eastern Sahara shared between Libya, Egypt, and Sudan. This is one of the most arid places on Earth, where some locations may experience a total absence of rainfall for years, even decades, on end. Even in the highlands, rain may fall as infrequently as once every five to ten years. As an example, the mountain Jebel Uweinat had no rainfall from 1998 until 2006. Temperatures in the Libyan Desert are very high: indeed, the highest air temperature ever recorded on Earth, 57.8°C, occurred in the town of Azizya (40 km southwest of Tripoli) in 1922. The desert as a whole is unremittingly flat with the exception of elevated massifs around Libya's border with Egypt and Sudan and farther south at Uweinat, where Libya's highest mountain, Jebel Uweinat (1934 m) stands. Otherwise, the desert consists of gravelly plains, rock outcrops and vast ergs—areas of shifting sand dunes. Although nomadic herders are known to cross the region, permanent habitation is possible only at a few scattered oases.

The Great Sand Sea

The light coloured region at top centre of figure 1 is the southern part of the *Libyan Erg*, often referred to as the *Great Sand Sea.* This part of the Sahara Desert contains the most massive sand dunes on Earth: the erg covers an area the size of France and is characterised by dunes up to 120 metres high. This is the most arid area in the Sahara with water almost totally absent. Long stretches of dunes show up well, stretching roughly from northeast to southwest on the image.

The Great Sand Sea smothers the barren frontiers of Libya and Egypt and supports no permanent habitation. The parallel ridges of sand dunes run for hundreds of kilometres and travellers through the region must be exceptionally well prepared: there is not a single well or water source in its 400 000 km² extent, conditions that are extreme even by Saharan standards.

Gilf Kebir

The dark mass occupying much of the upper left-central part of figure 1 is the Gilf Kebir (*Great Barrier*), an 8000 km² sandstone plateau with a mean elevation of around 300 m but which rises to around 1100 metres in the south. It lies in the southwest corner of Egypt. Like most of the other sandstone plateaux of the Sahara, its southern rim rises in sheer cliffs separated by deep valleys known as wadis.

The northernmost edge of the plateau is drowning in sand from the Great Sand Sea and, in the northeast, erosion has fragmented the cliffs into small islands of upland. At the extreme north of Gilf Kebir stand the entrances to three large vegetated valleys which have been used by tribesmen for grazing their animals: *Wadi Talh* on the northwest, *Wadi Adb el Malik* in the centre and *Wadi Hamra* in the northeast. The sand in the centre of the plateau is reddish and Wadi Hamra is filled with red sand ('hamra' is Arabic for 'red').

The plateau is known for its rugged beauty, remoteness and the dramatic cliff paintings (pictographs) and rock carvings (petroglyphs) which hark back to an earlier era of abundant animal life and human habitation. The famed *Cave of the Swimmers* lies here, in Wadi Sorra (figure 4). Many Neolithic artefacts have been discovered in the plateau and the southern stretch of Gilf Kebir and its major eastern valleys house some of the richest concentrations of Neolithic rock art in the entire Sahara.

Although the plateau's cap of resistant sandstone has protected it for millennia, there is stark evidence in the image that it is gradually being broken down. The southern edge of the Great Sand Sea has breached Gilf Kebir and can clearly be seen eating deep into the plateau. As the prevailing winds relentlessly drive the dunes ever southward, they eventually gain the summit of the uplands before funnelling down the prominent valleys to the south, effectively cutting the plateau in half.

Jebel Uweinat

Jebel Uweinat (1,934 m) is a mountainous massif on the Libya-Egypt border. Harsh and arid terrain, Uweinat is characterised by bare rocky plateaux and sandy plains, although its western slopes do harbour a few oases supporting grass and bushes while an important spring, the Ain Dua, emerges from the foot of the massif on the Libyan side.

Figure 3 is a photograph of Jebel Uweinat taken from the International Space Station. The western side of the massif, which lies entirely within Libya, is a ring-shaped granitic complex some 25 km in diameter, the eroded remains of an ancient dome intrusion. To the east, the plateau consists of the more typical Saharan sandstone. In Neolithic times the region was clearly heavily populated by both humans and a wide variety of animal fauna, as evinced by the plethora of petroglyphs representing lions, giraffes, ostriches, gazelles, cows and humans (figure 9).
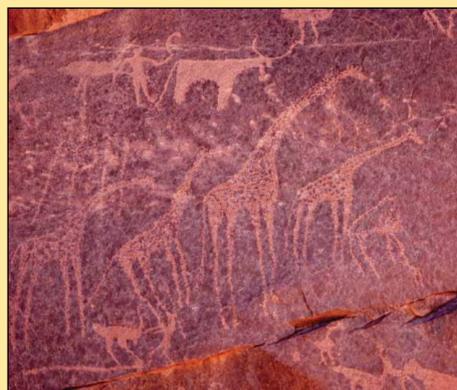

Figure 9 - Animal petroglyphs
Photo: Imolcho/Flickr

Yardangs

The lowlands surrounding the Uweinat plateau typically consist of sand dunes and rocky outcrops (figures 5-7), many of the latter eroded into weird shapes by relentless abrasion from wind and sand. Indeed, the entire eastern sprawl in figure 1 reveals an intriguing pattern of parallel lines curving round the entire upland area from the Great Sand Sea in the north to Chad's Tibesti Massif in the southwest. It is tempting to infer that this pattern is due simply to drifting sand, but reference to satellite images over the years, and to *Google Maps*, shows it to be a permanent feature of the terrain.

To understand these features it is necessary to relate them to the elemental forces at work in the environment of the Libyan Desert. As noted already, water is extremely scarce here, so the main agent of erosion is the wind, which has a powerful tool— sand—at its disposal. Moreover, winds here tend to be strong and blow primarily from the same direction. When laden with sand, these winds erode sedimentary rocks along lines of weakness in their strata, as well as removing all surrounding sand down to the bedrock. If the bedrock itself is not uniformly hard, the winds will sandblast grooves and hollows out of the softer parts of its surface. Over time the winds cut away enough material to leave a sleek-shaped ridge that runs parallel to the wind, similar in shape to the bottom of an overturned boat (figure 11).


Figure 10 - A wind-sculpted limestone yardang.
Photo: Banco de Imágenes/Flickr

Such a ridge is known as a yardang. Depending upon the winds and the composition of the rocks from which they are carved, yardangs may form very unusual shapes, such as the grotesque pillar of rock in figure 10, carved from limestone in the Egyptian quarter of the desert. Yardangs are generally restricted to the most arid and sand-poor parts of deserts where vegetation and soil are minimal. It has been suggested that the rock from which the Great Sphinx in Egypt was carved may have been a yardang.

Yardangs are most commonly created from softer rock types like sandstone, shale and limestone but have also been observed in banded crystalline rocks such as schist and gneiss. Extensive areas of low lying desert areas can be eroded into long parallel ridges which gradually break up into

separate hills, each eventually assuming the shape of a yardang. The result is a yardang field. One of the world's most extensive yardang fields is found in the Lut Desert of Iran. Part of it is illustrated in figure 11 where the typical 'upturned boat' shape of the individual yardangs is clear. Since yardang ridges always form parallel to the prevailing winds, they reveal the wind direction during their creation. Some of the largest yardangs in the world are found here, where individuals may reach tens of kilometres in length and attain heights of 60 to 80 metres. This entire system occupies an area of approximately 150 x 50 kilometres.

Mega Yardangs

In many of the world's desert areas, yardangs can assume gigantic proportions. Termed mega-yardangs, they show up as prominent parallel striations in satellite imagery of, for example, the Lut Desert of Iran, the Libyan Desert, the central Sahara, the Namib Desert and even the High Andes.

Figure 12 shows one of the most spectacular wind erosional features on Earth, the large concentration of mega-yardangs situated to the east of the volcano Emi Koussi in the Tibesti Mountains of Chad (at 3445 m in altitude, Emi Koussi is the highest mountain in the whole of the Sahara Desert). The individual yardang ridges here are up to 20 kilometres long with some reaching almost 150 metres in height: the ridges are separated from each other by troughs which range between 500 metres and two kilometres wide.

Mega-yardangs are typically kilometres in length and many tens of metres in height and tend to be found in arid regions where the prevailing winds are particularly strong and persistent, and always blow from the same quarter. Figure 13, taken by the USGS in Mongolia's Qaidam Basin, shows an extensive field of mega-yardangs stretching all the way to the horizon.

Conclusion

A comparison between figures 1 and 10 leads to the almost inescapable conclusion that the extensive parallel features in the eastern Libyan Desert are lines of mega-yardangs.

Reference

Mega-Yardangs: A Global Analysis by Andrew S Goudie

> *http://www.uabcs.mx/geologia/ geo_bajamx/geomorfologia/ Goudie_megayardangs_07.pdf*

Glossary

1 MERIS - Medium Resolution Imaging Spectrometer (Envisat)
2 MODIS - Moderate Resolution Imaging Spectrometer (Aqua)

Figure 11 - A field of yardangs in the Lut Desert of Iran
Image: Alexandros.Papadopoulos/Flickr
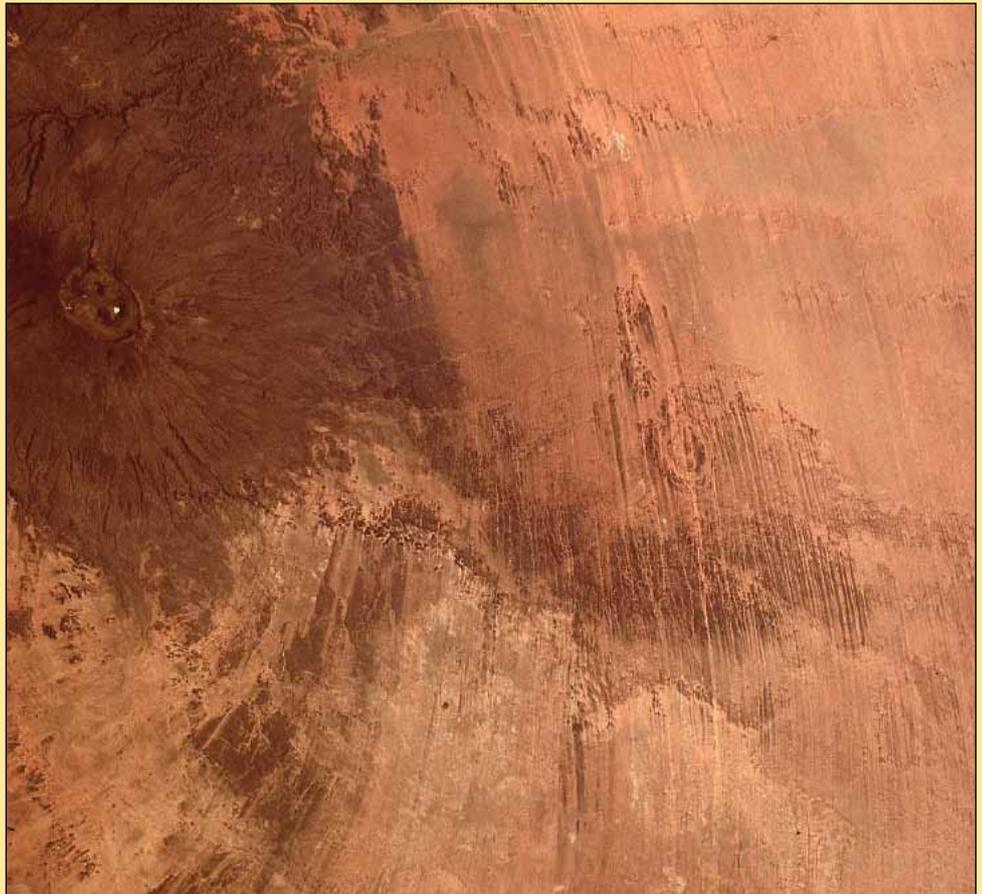
Figure 12 - A Landsat image showing extensive fields of mega-yardangs east of Emi Koussi in the Tibetsi Massif.
Image: NASA

Figure 13 - Mega-yardangs stretch into the distance in this image taken in in the west-central Qaidam Basin
Photo: Paul Kapp - University of Arizona/USGS

Using Antenna Diversity with APT

A report from New Zealand on the Wrasse *WeSaCom* APT-06AD receiver

Don Weston

In mid 2011, I decided to resurrect my interest in receiving APT images and purchased from Germany a *Wrasse WeSaCom APT-06* receiver. To my surprise, after re-erecting my original turnstile antenna—dating from the late 1980s—my first images started out better than expected. However, after a week or two, the images started to deteriorate so I started building a QHA antenna to see if that solved the problem.

From the start, the QHA had the edge on the old turnstile at very low pass elevations but I was never able to match those first images. Initially I suspected bad connections, but it soon become apparent that the receiver was slowly failing and was 'all over the place': I was receiving only a few minutes on good passes and the IR channel was virtually useless as the whites were either covered in 'hash' or were over modulated. No adjustments of any sort were able to cure the problem.

The Wrasse WeSaCom APT-06 Receiver

I contacted the manufacturers with sample imagery, clearly showing the problem, and without hesitation a replacement was forwarded. This turned out to be the superior *APT-06AD* model, with the added antenna diversity (AD) feature, a very generous gesture on their part.

When I originally ordered the *APT-06*, I had considered purchasing the AD model but, on past experience, did not see what justification there was having two aerials. Reception with the replacement receiver proved more constant and more sensitive. I was now receiving clear imagery down to 70°S and beyond, but still suffered from unknown 'hash' points where the signal deteriorated. Each aerial had its own unique

'hash' points. In due course I decided to make use or the AD feature of the *APT-06AD*, and finally, in early December, connected the receiver up to my two aerials, mounted about four metres apart. The improvement proved astounding.

Clean imagery was now being received from a 0° horizon in the south to about 7.5° in the north, where most passes cut out cleanly behind a hill. If that hill were not there I would be able to get the maximum 15 minutes reception, but 13 -14 minutes

The author's roof with, QHA, Davis radio weather wtation (solar powered) and turnstile.
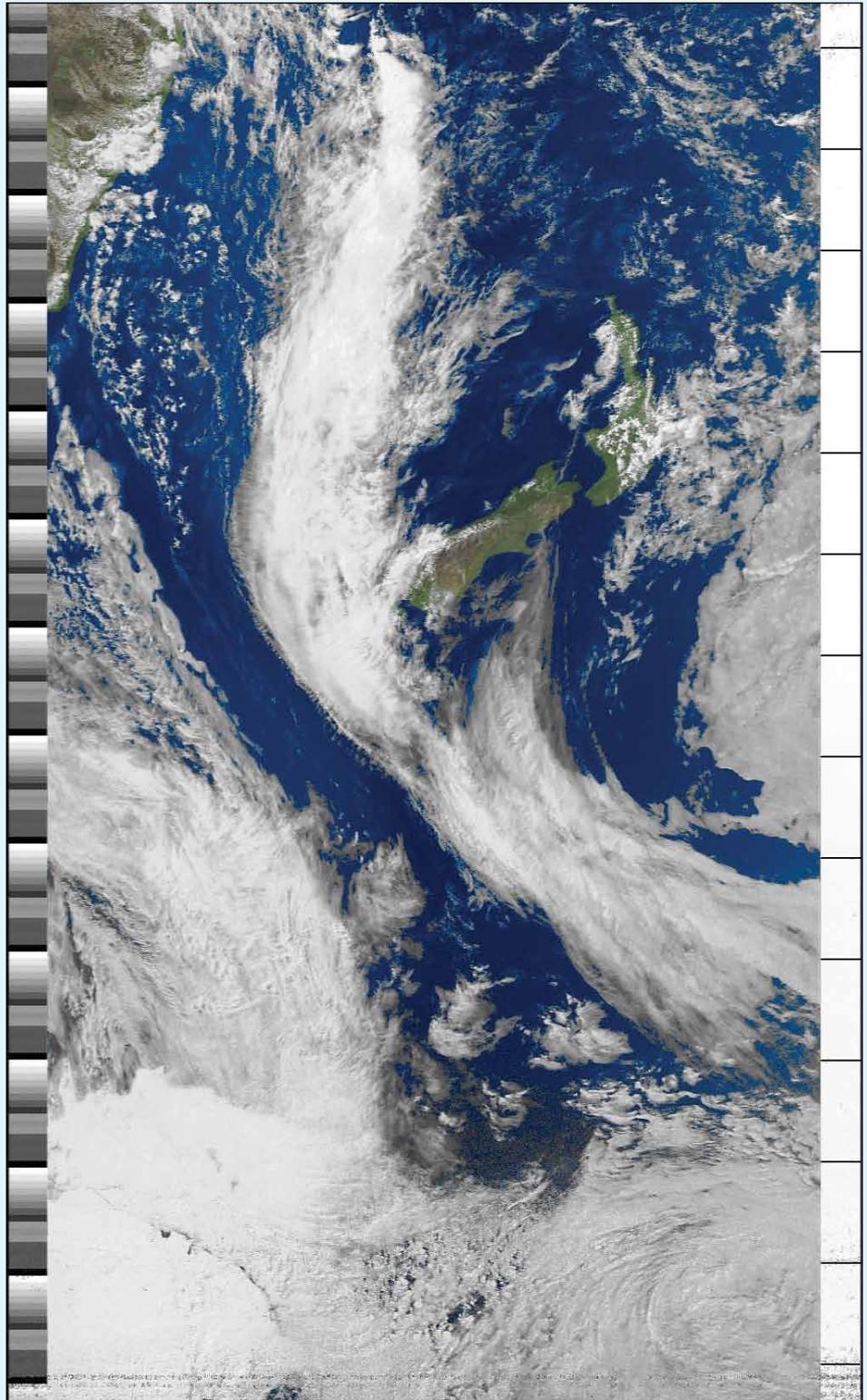
This NOAA 18 image comes from the 16:41 NZST pass on December 2, 2011

is obtainable. I've learned that the easiest way to get into AD mode is to switch the power to the receiver off then back on: while the five red LED's are blinking press the **=>** button and the green LED starts blinking, indicating AD mode. Switching the power back on without pressing the **=>** button defaults the system to single antenna mode (my turnstile).

What has amazed is how quickly the northbound passes start giving clean unadulterated imagery, usually within about 10 seconds of the signal first being obtained; reception remains pristine throughout until a clean cut-out at the end of the pass.

Before I started using the AD feature, I could never get more than a few minutes of IR imagery from the early morning and night time passes: now they are much improved too, just like the later afternoon passes.

While I'm sure I understood how the AD worked, I think there is more to it than that. Each aerial on its own never gave a great performance at low elevations, although the QHA did initially have an observable edge over the turnstile. I would not have thought that taking the best data from each aerial would be capable of coming up with anything like what I'm now getting. Something else is at work and, while I know nothing about aerial technology, I do know a bit more about interferometry (as where an array of multiple radio telescopes obtains higher resolution by combining weak radio signals). This is what I believe may be happening with my 2-aerial array, and seems to be borne out by the very much increased volume coming from my receiver's internal speaker when a pass is coming over.

Another interesting point is that I've been able to positively identify local obstructions that cause signal dropouts at certain compass points and low elevations. To my surprise, they turned out to be nearby trees. I have two that are a few degrees above my aerial array at about 50 and 100 feet away. One of my trees is an evergreen pine so, unless I chop it down or top it, it will always be an obstacle. The more distant tree stands 180° opposite, across the road, so I can't do much about that. However, in autumn, it will loose it's foliage and a bettor signal will be able to sneak through it.

As to other obstructions, maybe power poles and power lines, as well as spurious reflections off roofs and buildings, which I'm sure did account for very short dropouts. These are now eliminated because the two aerials between them can never be occulted at the same time—one might say that my aerial array now has 3D 'vision' and can see around thin objects like power poles and TV aerials.

Now, this sort of signal interference is virtually eliminated. I have also been making some remarkable combination images using Craig Anderson's *WxToImg* software.

http://www.wxtoimg.com/

I like these morning passes, processed in IR with precipitation, as they give me a good indication of the weather that may be coming up for the day ahead. The 'stitching' together of these images into such seamless montages is somewhat mind boggling.

At points where I know both aerials get a different signal due to a nearby tree or low elevation, the AD can be observed switching very rapidly from one antenna to the other. I have been receiving clean images from satellites that never exceeded 5° elevation and were over 3000 kilometres away—and even more distant at the extremities of the passes. Of course all this is very much a game of luck based on 'reception conditions', which are never constant as I realised way back in the late 80s. Looking at my ever growing collection of passes poses the question as to why some weren't better than they were. One often turns to aerial and connection problems, but for sure, the unpredictability of signal reception plays a major role in this game.

The particularly fine image on page 41 was obtained from NOAA 18 at 16:41 NZST on December 2, 2011 with the turnstile aerial alone: it represents almost a full 14 minutes of APT. It starts at 0.7°S and ends cleanly at 7.5°N where the hill occults the signal. To be sure, I had never ever received clear passes of this duration before and this is now a normal state of reception.

On a final note I see from my wxsat logs of November 25, 1989 that I had a rare 12 minute pass recorded, and an average of around ten minutes was as good as it got in those days. So, without doubt, the ability to receive APT in my case has certainly improved.

Tutioune

You really should use one of the following PCI cards:

- TechnoTrend TT S2-3200
- Skystar HD (not HD2)
- KNC One HD
- Mystique Satix DVB-S2
- Satelco EasyWatch HDTVS2 PCI

which all have an STB0899 demodulator and SAA7146A interface chip. At present it is not possible to use any of the USB tuners, such as the *Skystar USB* box, with *Tutioune*. It is hoped, however, that a driver for USB tuners using the same STB0899 demodulator will be developed in the not too distant future.

Acknowledgements

Currently Active Satellites and Frequencies

Polar APT Satellites	
Satellite	Frequency
NOAA 15	137.620 MHz
NOAA 18	137.9125 MHz
NOAA 19	137.100 MHz

Polar HRPT/AHRPT Satellites		
Satellite	Frequency	Transmission Mode(s)
NOAA 15	1702.5 MHz	HRPT
NOAA 16	1698.0 MHz	HRPT (LHCP)
NOAA 18	1707.0 MHz	HRPT
NOAA 19	1698.0 MHz	HRPT / EUMETCast
Feng Yun 1D	1700.4 MHz	CHRPT
Feng Yun 3A	1704.5 MHz	non standard AHRPT
Feng Yun 3B	17.405 MHz	AHRPT
Metop A	1701.3 MHz	AHRPT/EUMETCast
Meteor M N1	1700 MHz	non standard AHRPT

Geostationary Satellites			
Satellite	Transmission Mode(s)		Position
Meteosat 7	1691 MHz WEFAX (test only)		57.5°E
Meteosat 8	Met 9 backup	EUMETCast RSS	9.5°W
Meteosat 9	LRIT	EUMETCast	0°
GOES-E	LRIT	EUMETCast	75°W
GOES-W	LRIT	EUMETCast	135°W
MTSAT-2	LRIT	EUMETCast	145°E
Feng Yun 2E	SVISSR/LRIT	EUMETCast	104°E

Expand your Horizons with the EUMETRAIN ePort

Robert Moore

The majority of GEO members pursue their interests on the fringes of a much wider community of scientists, mathematicians, computer scientists, engineers, meteorologists and administrators. These latter work at the very highest levels of technical expertise, and with considerable ingenuity, to get satellites up, data down and information out. Our readers have many interests, ranging from making and developing hardware, writing computer programs, or just buying equipment off the shelf and downloading software written by others. For those of us with an interest in the weather, there are now materials available that were beyond our wildest imagination twenty years ago. I guess most of us just make do with visualising what we can receive ourselves. But we do not have to stop there, because there are many resources which enable us to maximise the benefits (and enjoyment) of the data we receive. Most notable among these is the *EUMeTrain ePort* website.

As I describe on page 20 of this issue, I do my weather forecasting with the resources I have to hand: *EUMETCast* satellite imagery, weather charts, and data from my own weather station. The barograph trace from the latter is essential to monitor pressure changes and the passage of fronts. If I leave it at that, I can enjoy my hobby and produce some pretty good weather forecasts. But the *ePort* web page enables me to go further.

At one level this might be seen as 'cheating', because I am not simply using the data I receive myself. But the people who produce the *ePort* pages are using data from Meteosat, Metop and NOAA satellites—just like me. The main difference is that they have computer-power available that is second only to that of the intelligence agencies. With this they engage in *Numerical Forecasting*, a process that demands vast quantities of data and immense processing power. Of course, they know a lot more about meteorology than most of us, which means that they can make much more sophisticated use of the satellite data. I would strongly recommend you, when you have your usual array of satellite images on screen, to visit

http://www.eumetrain.org/eport.html

and select **Europe** from the *ePort* drop-down menu at the top of the page. This will take you directly to a page displaying a base map of Europe and the North Atlantic (figure 1) with labelled check-boxes down both sides. The set of boxes at top right will be immediately familiar: 'Meteosat Second Generation'. Ticking any of these options allows you to superimpose an MSG image or derived product on to the map: the same visible, IR or water-vapour image that you may already have on your screen, but also 'Pseudo IR' and 'Pseudo WV' images derived from *Numerical Forecasting* to compare actual with predicted images.

I normally start with the left hand boxes, which are headed ECMWP NWP [1] . When you tick any check-box, the relevant chart will be superimposed on the map. This is where you benefit from the professionals' computer-power

and expertise, by adding their products to your own desktop. If you click on the label beside any box, a pop-up window gives a brief explanation of the feature.

I usually start off by superimposing the MSLP [2] chart over an MSG IR image, just to confirm the synoptic view I already have. This chart does not show fronts, so I click on TFP [3] which gives an indication of where the fronts might lie. Fronts are sloping weather formations, and TFP shows them at altitude. There is a rather complex plot available that will enable you to locate the edge of the front at sea level, but TFP plus the WV6.2 image will give a very clear general indication of where the fronts are. Figure 1 shows the TFP plot superimposed over the 12:00 UT MSG WV6.2 image for November 25, 2011, after a screenshot had been imported into *Paintshop Pro*, and the fronts inserted freehand in red and blue. I can tell which are the warm and cold air masses by ticking the box for the MSG *Air Mass* option, which resulted in the image reproduced in figure 2.

There are many other interesting overlay features to explore, such as:

- *Streamlines 300* shows the wind direction at the top of the atmosphere (and thus the jet stream)
- *T500* gives the temperature a little below this, so we can begin to explore activity in the upper air.

Troughs and ridges in the upper atmosphere can have a profound effect on the weather. From what I have read, upper level troughs can bring some nasty surprises for weather forecasters, but they are not always easy to spot.

Half way down the right hand side of the map is the item NWCSAF. Clicking the arrow beside it reveals a drop-down menu with more features that can be plotted over the main map; the first two items in the list are Cloud Type (CT), and Cloud Top Temperature and Height (CTTH).

Ticking the SYNOP option brings up the data for weather stations and plots them across the chart. Initially, these are far too small to read but, by selecting the zoom tool at the top left corner of the chart, you can repeatedly click on any chosen station to zoom in and read its data. These data are presented in the standard format, familiar to weather observers (figure 3).

The zoomed data for Luqa airport (Malta) at 06:00 UT on the November 29, 2011 (figure 4) shows that the temperature was 16.4°C and the dew point 13.2°C. The sea level pressure was 1021.3 millibars, having risen 0.5 millibars after a downward trend. The wind speed was between 15 and 19 knots on a bearing of about 100°, the sky was 75% obscured by cloud and it was raining. Note: the brown lozenge-shaped object on this image is just a crude coastal representation of the islands of Malta and Gozo.

If you tick 'Soundings', you bring up a series of interactive markers on the chart: left clicking on any of these locations will display a window with a set of four radiosonde charts. I can't say I use these charts much because I'm not very good at interpreting them, but they are just another of the many features of this very comprehensive page.

There is a lot more to be discovered in *ePort*, and lots to learn, and I would urge you to try it for yourself. What makes the **Europe** feature so important is that it can be used to overlay various features, including derived data, on the base map to build up weather images that are not available in any one of the programs I have on my computers. And if you want to pursue this further, try **Africa** from the *ePort* drop-down menu. The options differ somewhat, but the general idea is the same.

On-line Briefings

From time to time, David Taylor gives notice of an on-line briefing from *EUMeTrain*. Very few GEO members seem to take part, which is great pity. These briefings link interested persons
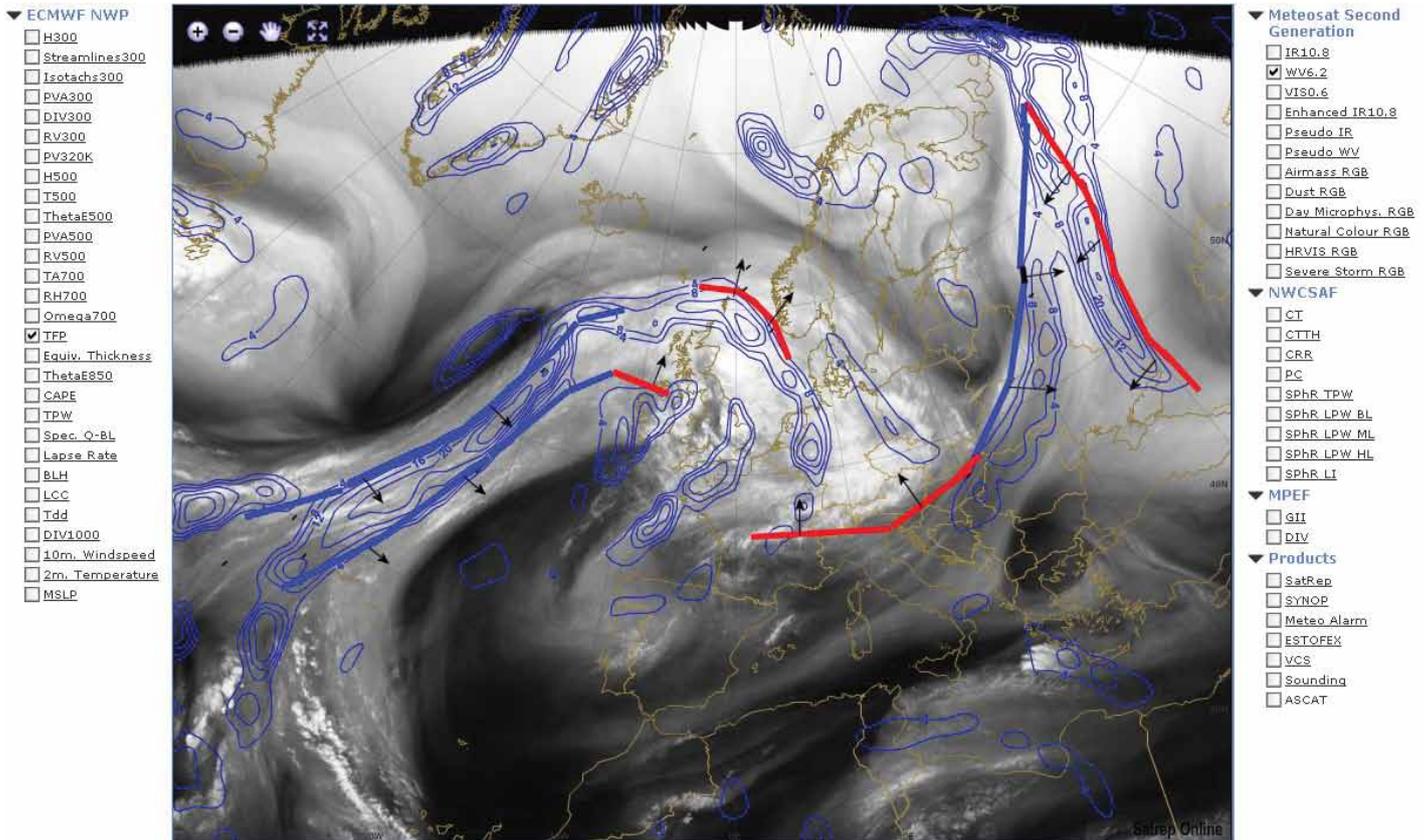
Figure 1 - A, ePort display comprising an MSG WV6.2 image with superimposed TFP plot and hand-drawn fronts added by the author

from weather services and research institutions, who talk about the weather, view charts and discuss possible interpretations, or discuss particular themes. Participants may be spread as far afield as the Azores, Finland, Turkey and western Europe. Scotland and Wales are regularly represented but I have never seen anyone from England. You can simply watch and listen, or you can join in by asking questions and offering opinions if you wish. These briefings are recorded and so may be accessed after the event.

EUMeTrain On-line Courses

EUMeTrain offer on line courses. The October offering was *Ocean and Sea Week* and, at the end of November, there was *LSA-SAF Week* which gave an in-depth view of these data, their limitations, how they are used and future plans for development and dissemination. The LSA_SAF data are variables derived through often complex computations, and it was especially interesting to learn from these lectures how they are constructed and validated.

Some very basic issues were discussed that give pause for thought. For example, is *Land Surface Temperature* what would be read on a thermometer in the back garden; is *Sea Surface Temperature* the reading obtained on a thermometer lowered over the side of a boat?

No they are not. The sun shines on Earth and satellites measure its radiation reflected back from the ground, sea and clouds as well as that radiated from the atmosphere. So we need to be very clear about what we see in our imagery—the images we use are simply electromagnetic energy of solar origin reflected or radiated from Earth. The implications of this may be explored further by viewing some of the November lectures recorded and available on the *EUMeTrain* web site.

The *EUMeTrain* home page contains 'Showcase' examples demonstrating how images may be interpreted. The page also has links to the training materials and lectures, and to the *Manual of Synoptic Satellite Meteorology*.

I'm sure that many readers are missing out on good things if they are not accessing this site, which is supported by *EUMETSAT*. Anyone who would like to expand their horizons gently could start by looking at **Today's Images** to get a taste of what is waiting and freely on offer for them.

———————————

Glossary

1   European Centre for Medium-Range Weather Forecasts Numerical Weather Prediction
2   Mean Sea Level Pressure
3   Thermal Front Parameter
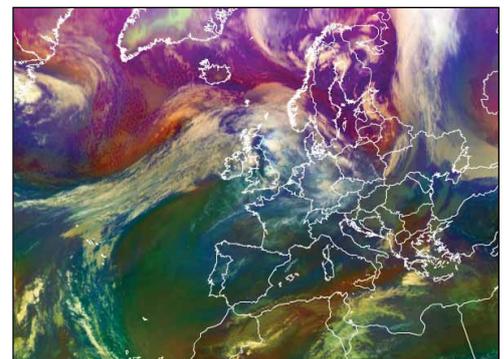
Figure 2 - An example of the MSG Airmass option
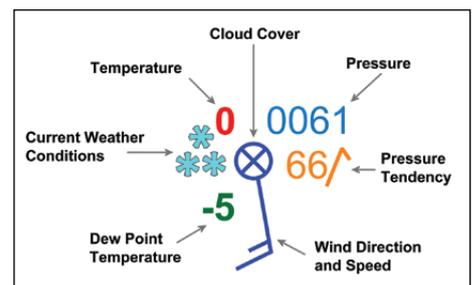
Figure 3 - The station weather symbol code
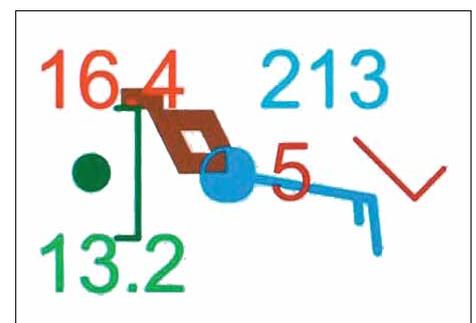
Figure 4 - Station data for Malta

LEE WAVE CLOUDS STREAM ACROSS THE UK

Peter Burden
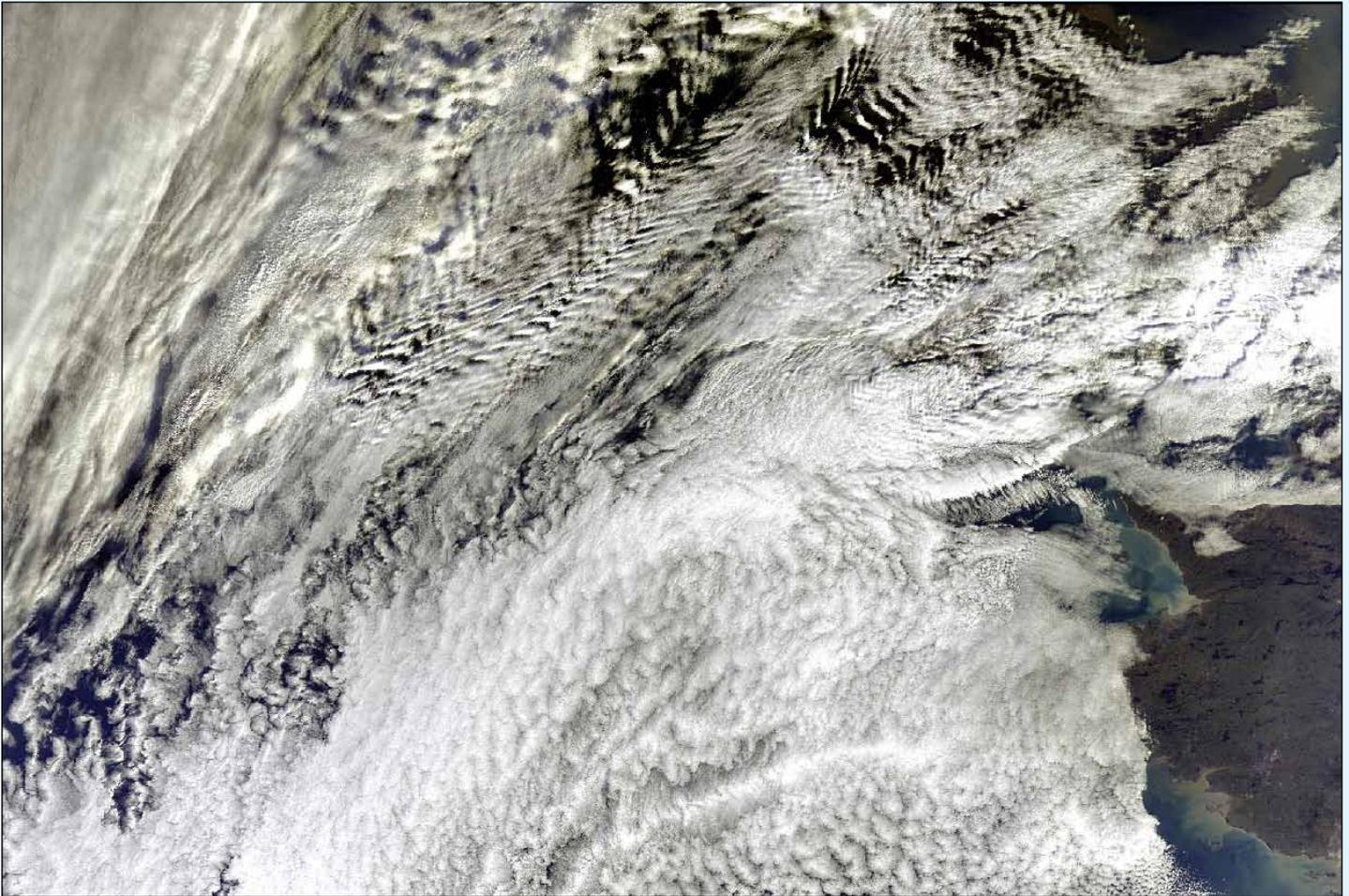
Envisat MERIS image courtesy ESA

Peter Burden is always on the look-out for interesting weather features in the *Envisat* MERIS images he acquires through the *Envi-Ham* project. The image above, looking down on the southern half of the UK and northern France on December 26, 2011, is a case in point.

Peter relates: 'It was interesting to observe that, with the southwesterly wind, the clouds were formed as they reached Ireland. These lee wave clouds are produced by orthographic lifting of air which, after passing over a mountain, oscillates

up and down as it advects. If the air lifts upward and cools through expansion as it rises to its saturation temperature during this process, the water vapour within condenses and becomes visible as cloud.

In the image above, the leading western edge of a front is approaching County Kerry, a mountainous area of Ireland. This is shown in the forecast chart at lower left. Additionally, to clarify the geography, I have produced the image at lower right, where a green underlay indicates the land features.
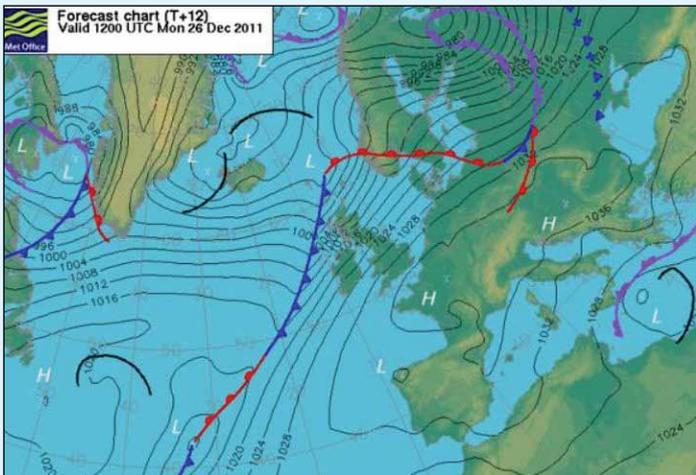
The noon weather chart showing the approaching front and the southwesterly airstream over Ireland and England.
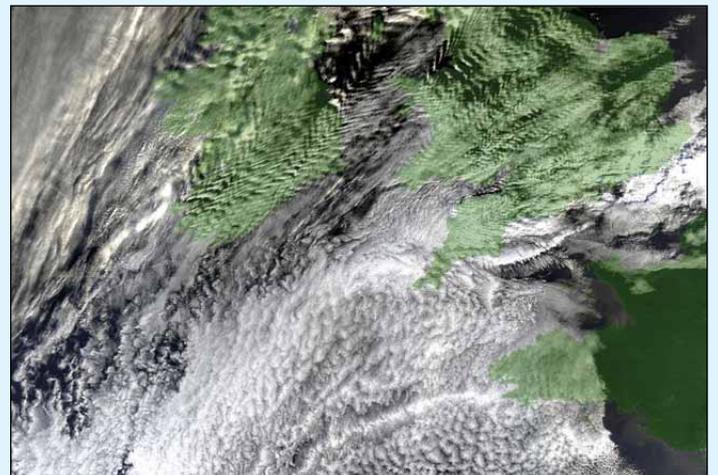
The same MERIS image with an underlay to show the land areas.

EUMETCast On-Line Registration Guide

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

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

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

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

GEO Helplines

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

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

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

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

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

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

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

- email: mike1g4cfz@msn.com

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

- gmartin@electroweb.co.uk

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

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

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

Weather Satellite Reports

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

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

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

You can read the bulletins from this URL

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

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

Internet Discussion Groups

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Gridding, Overlays and Captions
Please note that readers' satellite images should be provided **without** added grid lines, country outlines or captions unless these are considered essential for illustrative purposes within an article.

If your article submission contains embedded images and diagrams, please note that you must **also submit copies of the original images** in one of the formats described above: these are essential for page make-up purposes.

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

    Les Hamilton
    8 Deeside Place
    Aberdeen AB15 7PW
    Scotland

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

geoeditor@geo-web.org.uk

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

www.yousendit.com

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

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- UK residents may pay by means of a **personal cheque** or **Postal Order** made payable to '*Group for Earth Observation*'
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