The *GEO* Quarterly

Group for Earth Observation
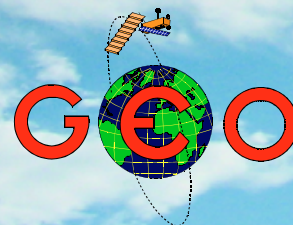
GEO

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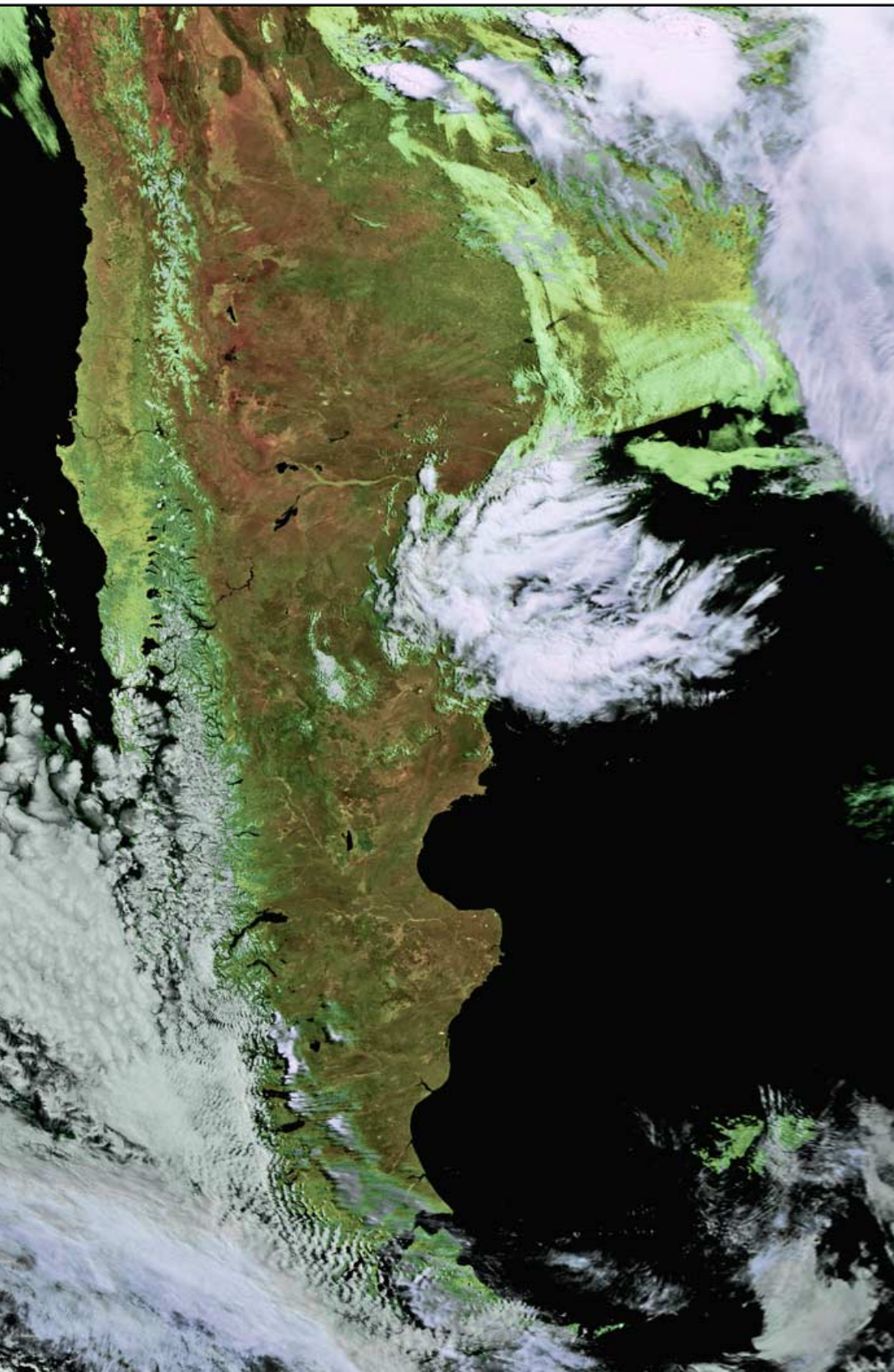
Inside this issue . . .

Join GEO on a visit to EUMETSAT's Head-quarters in Darmstadt, Germany on July 5-6 this year—details inside.

EUMETSAT's MetOp-A satellite is now in orbit and transmitting whole-world high resolution imagery . . .

Douglas Deans reviews MetOp Manager, the essential imaging software for MetOp-A ...

How do you prepare your PC system for MetOp? Peter Green guides you through the essentials ...

David Taylor has advice on managing the ever-increasing flow of EUMETCast data into your PC system ...

We investigate the Ever-Expanding Ozone Hole, which reached record proportions last year

Earth Browser: Andrew Thornton reviews this remarkable satellite image and weather profiling Internet software

Plus much more ...

MetOp-A Special Issue

Follow 'Satellites View' every Month
in Radio and Communications Monitoring Monthly

Radio and Communications Monitoring Monthly provides a regular 4-page Weather Satellite column, "Satellites' View", by Lawrence Harris. In addition, there is an annual 'special' issue covering WXsats containing additional features and reviews written by Lawrence.

Radio and Communications Monitoring Monthly (ISSN 1749-7809) is the magazine of choice for all serious radio enthusiasts and is available from most good newsagents as well as direct from the publishers.

Subscriptions are available world-wide. For more information contact *Nice One Publishing Ltd*, Tel: +44 (0)1202 862690 or visit the website

www.monitoringmonthly.co.uk

A ll the talk these days seems to centre on Europe's first polar orbiting weather imaging satellite, MetOp-A, and the wonderful HRPT images that are being delivered from its AVHRR instrument. If you are still sitting on the fence wondering what all the fuss is about, this issue of GEO Quarterly should open your eyes and, hopefully, encourage you to pursue this exciting new avenue of interest. And to help you on your way, Douglas Deans has produced a most helpful article (page 25) to guide you through the intricacies of David Taylor's new *MetOp Manager* software.

T his quarter we have a bulging post-bag of comments from readers: do please continue to air your thoughts in our columns. We are always pleased to hear what you say whether it be to correct our misconceptions, offer new perspectives on topics that we cover or just to say how much you enjoy *GEO Quarterly*.

G EO has now completed three busy and highly stable years with an almost constant membership figure around the 500-550 mark. But we have been working to a very tight (almost zero) profit margin and an increase in membership would be beneficial. Please take every opportunity to introduce like-minded friends to GEO.

G EO has been fortunate to have a highly dedicated Management Team: everyone listed in the panel opposite has covered in full all expenses (telephone, stationery, postage, travel, air fares, hotels, etc) resulting from their work on GEO's behalf. As Francis Bell explains overleaf, we currently face rising production and distribution costs, making it prudent to increase our subscriptions from March 1. We hope that you will agree that the consistently high standard of service GEO provides is worth just that little extra to guarantee the Group's future.

W e look forward to your support in what promise to be exciting years ahead

Contents

Responsibility for Constructional Projects and Software
Every effort is made to ensure that the technical and constructional articles published in this Quarterly are correct. However, the ultimate responsibility is with the reader to ensure the safety of constructions and for any interfacing with other equipment. GEO cannot accept liability for shortcomings in any published design or any constructions carried out by members or other third parties.

The *GEO Report*

Francis Bell

As I compose this report, GEO is entering its fourth year as an established Group with our aim of supporting those amateur, educational and non commercial users interested in observing the Earth, particularly by the direct or indirect reception of weather satellite images. Inevitably we have a turn-over of membership as readers interests change with time. I am always aware of the changing nature of our hobby, with the trend seemingly to be moving away from direct reception of satellite signals and towards the use of retransmitted or archived Earth images. For myself, there is no substitute for live satellite reception using equipment I have built myself, even accepting that more pristine archived images may subsequently be available. Fortunately, members who fail to renew always seem to be compensated for by new members joining. To these new members I offer a sincere welcome to our friendly and talented Group. Please be aware that your contributions to the Group, in any form, will always be welcome.

Annual Subscription

The annual membership subscription has been set at a very modest figure to encourage new membership and to retain our existing members. However, it must be recognised that, as a consequence of this policy, our Group's financial reserves are very slender. Most of our expenses relate to the production and distribution of our Quarterly magazine, though banking charges are also significant. Both postal and banking charges have increased recently and, although the Management Team have addressed these issues, we are still faced with some increased charges. As a consequence, it was decided to revise the membership subscription scale of charges for 2007. The new UK membership is increased to £20, European membership £24 and the rest of the world £28. Nobody likes increases but it's either this or cuts in our services.

Membership Secretary

Recent GEO Quarterlies have carried notices inviting applications for somebody new to embrace the role of Membership Secretary. Nigel Evans, supported by his wife Michele, has fulfilled this role since the start of GEO but now, quite understandably, wishes to pass on responsibilities to someone new. I am very pleased to announce that we received two responses from members and after very amiable discussions David Anderson agreed to act

as GEO's Membership Secretary until further notice. David's contact details appear in the Information panel on page 1 of this issue. Our thanks to David for agreeing to take over this vital role within the group: without its membership GEO would not exist. And of course, our sincere thanks to Nigel and Michele for their support in looking after our interests over these past three years. The contact e-mail continues to be

members@geo-web.org.uk

PayPal

While looking at our banking costs it became clear that the process of making payments for membership subscriptions and shop payments could be streamlined if we added *PayPal* to our payment methods. Accordingly a *PayPal* account was opened in November 2006 and our brief experience since then indicates that its simplicity is making it an easy and popular method for payments. There is a small saving compared with credit cards but the convenience of *PayPal* seems to be making it a favoured method of payment.

GEO's display at last November's Kempton rally

Diary Dates in 2007

Dates for your diary were published in the December Quarterly and there are separate notices elsewhere in this edition relating the May Symposium and to GEO's July visit to EUMETSAT in Darmstadt, Germany.

Please read these notices carefully. In addition here is a summary of our events for 2007.

- April 15 - The Kempton radio and computer rally.
- May 12 - GEO's annual Symposium at the NSC Leicester.
- July 5/6 - GEO's visit to EUMETSAT's HQ in Darmstadt Germany.
- July 20/22 - GEO at AMSAT's meeting in Guildford. Please note that this is a revised date for the AMSAT meeting which has been brought forward one week.
- September - The two day Leicester amateur radio rally.

- Sept 24/28 - GEO hope to have a presence at the EUMETSAT/AMS meeting in Amsterdam
- November - Kempton amateur radio and computer rally.

Our friends in The Netherlands, *Werkgroep Kunstmanen*, will be holding meetings in Utrecht on March 10, May 12, September 8 and November 10.

The Quarterly Question.

The last Quarterly Question related to the date and exact time of launch for MetOp-A. The answer, which was widely published, was October 19, 2006 at 1628 UT. I received several entries by email and, as promised, I picked a winner on December 25. The winner is Adrian Chamberlain. Adrian or his nominee receive the free entry to our Symposium.

Late News - New Event

BHROP (the British Rocketry Oral History Programme) have invited GEO to run a demonstration and information stand, including live weather satellite imaging, during the **BROHP Conference** on April 12-14, and perhaps make a presentation to bring delegates up to date with the latest weather satellite information. GEO members interested in attending this conference, which is being held in Charterhouse School, Godalming, Surrey, should visit the BROHP web site at:

http://www. brohp.org.uk

Topics to be covered at the conference will include:

- Space related matters
- UK Space Industry
- UK Space Science and Exploration
- Education and Space
- History of Space Flight

The previous *Quarterly Question* was pretty straightforward. In this issue we pose a slightly more engaging problem: '*How far does MetOp-A travel in exactly 365 days?*'.

The official ESA datasheet states that MetOp-A orbits at a mean altitude of 817 km and that each complete orbit takes 101 minutes. You also require to know the mean radius of the Earth, which is 6373 km.
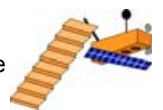
Using the *precise* figures quoted above, determine the total distance flown by MetOp-A, to the nearest million kilometres.

GEO Symposium

Saturday, May 19, 2007

Francis Bell

GEO's popular annual symposium will once more be held in the National Space Centre (NSC) Leicester, an excellent venue which we have used several times previously. This year the date has been chosen to avoid the Bank Holiday weekend, which should make travel easier. The date is May 19, 2007 and the Symposium takes place between 9.00 am and 6.00 pm.

Both last year and in 2005 we enjoyed a packed programme, with numerous talks from expert speakers occupying much of the time. By the end of the day everyone agreed they had enjoyed the experience immensely, but that one essential ingredient was in short supply—there just was not enough time to enjoy the workshops and to chat at length with the other delegates.

One of the workshops during Symposium 2006

Following numerous requests we aim to put this right in 2007 and to this end have decided that the main thrust of the Symposium will be directed towards practical workshops and small group tutorials, together with some speakers and our AGM. This will generate a busy day but perhaps not as hectic as in the past. A full programme for the day, which will include our ever-popular raffle with its bargain 'goodies', will be published on our website when more details have be confirmed.

Remember: this is your Symposium, and as GEO members you are entitled to have a say as to what takes place on the day.

Anyone wishing to make a presentation, or run a workshop or demonstration on the day, is encouraged to contact Francis Bell at:

francis@geo-web.org.uk

Likewise, if there is any specific topic which you would like us to arrange for Leicester,

please email your thoughts and ideas. Remember, the rationale for holding our event is to share our collective experiences: please contribute if you can.

Cost

The cost is £12, payable on the day, and which includes entry into the NSC's impressive exhibition area.

Food, travel and accommodation are the responsibility of each individual delegate. There is a cafeteria within the NSC which delegates are welcome to use.

The NSC is located close to the centre of Leicester with easy road rail and bus links. There is free parking at the NSC.

Overnight Accommodation

In previous years, most of GEO's Management Team, along with invited speakers and members who have had to travel from afar, have booked overnight accommodation in Leicester for the Friday evening and have enjoyed a meal together. We recommend the *Campanile Hotel* which is conveniently located a little over a mile from the NSC. GEO members have used this hotel before.

Details:

Campanile Hotel,
St Matthews Way,
Bedford Street North,
Leicester LE1 3JE
Tel: 0116 261 6600
Fax: 0116 261 6601

Email: leicester@envergure.co.uk

Arne van Belle setting up at Symposium 2006

Clive Finnis in discussion with visitors to the **GEO Shop** stall during Symposium 2006

Any GEO member, together with wife, partner or friends, is welcome to attend the Symposium.

Pre-registration

In order to ensure that we are prepared for the numbers attending the Symposium we would appreciate you pre-registering (although you do not pay till the day of the event). Please register by sending an email to Peter Green at

international@geo-web.org.uk

You *can* register on the day if need be, but pre-registration is preferred. The GEO Management Team look forward to seeing you in Leicester on May 19

The Symposium Programme

As we are holding the Symposium later in the year on this occasion, a final programme for the day has yet to be drawn up. However, we anticipate a weather-related talk from keynote speaker Storm Dunlop as well as demonstrations of live reception of Meteosat, NOAA AVHRR and MetOp imagery. We hope to have David Taylor back to discuss the latest developments in the ever-burgeoning EUMETCast service and how his software is developing to cope with these.

To learn the latest news, keep consulting the GEO Website at

http://www.geo-web.org.uk/sym07.html

from late March onwards.

Acknowledgement

All photographs on this page courtesy Ferdinand Valk.

THE EXPANDING OZONE HOLE

Record Ozone Depletion Recorded in 2006

Les Hamilton

The Antarctic *Ozone Hole* proved something of a sensation when it was first discovered quarter of a century ago. But despite our efforts to eradicate the pollution that is its underlying cause, recent ozone measurements made by ESA's *Envisat* and NASA's *Aura* satellites have shown the ozone hole to be as large as ever. Indeed, actual ozone loss over the Antarctic reached a record high on October 2, 2006, at 40 million tonnes, exceeding the previous record ozone loss of 39 million tonnes for 2000.

What is Ozone?

Ozone is a form of oxygen which occurs in trace quantities in the upper atmosphere. Unlike normal oxygen (O_2), where every molecule contains two atoms, the ozone molecule (O_3) contains three oxygen atoms. This key difference bestows on ozone its critical life-giving property. Ozone absorbs solar ultraviolet radiation so strongly (over 97%) that even the minute traces of the gas present in the stratosphere protect life on Earth and render our planet habitable. Over 90% of atmospheric ozone resides in the stratosphere, at altitudes between 10 and 50 kilometres, with the maximum concentration at approximately 30 km.

Ozone is continuously created in the upper atmosphere by the interaction between high-energy solar UV radiation and normal oxygen. But ozone lives life on the edge. Other particles already naturally present in the atmosphere, particularly, nitrogen oxides created in electric discharges, are continually destroying ozone. The natural levels of ozone in the atmosphere are, therefore, always a delicate balance between the processes that create it and those that destroy it.

The total mass of ozone in the atmosphere is about 3 billion tonnes. This may seem a lot, but this represents a mean concentration of just 0.6 parts per million. The peak concentration, at an altitude of around 30 kilometres, can reach as much as 15 parts per million. To give a better picture of ozone concentration, this is generally measured in Dobson Units (DU). See the grey side panel for details.

In the absence ozone the intense UV radiation from the sun would sterilise the Earth's surface. The planet would be totally lifeless as neither plants nor animals could survive. Stratospheric ozone absorbs almost all the sun's highly energetic UV-B

radiation and around half the UV-A. Even so, excessive exposure to sunlight can still cause sunburn and lead to skin cancer and eye damage.

The Ozone Hole

The Antarctic Ozone Hole was discovered by the British Antarctic Survey, from ground-based measurements made at Halley Bay, Antarctica, between 1981 and 1983. The findings were reported in 1985 and satellite measurements confirmed that the springtime ozone loss was a continent-wide feature.

Further research conducted at the US McMurdo Station, backed up by NASA stratospheric aircraft flights into the Antarctic region in 1987, indicated conclusively that the ozone loss was related to the presence of chlorine and bromine atoms in the stratosphere. It was also established that this chlorine and bromine derived from man-made chlorofluorocarbons (CFCs) which had migrated up from the lower atmosphere.

The average atmospheric ozone concentration is around 300 Dobson Units. What scientists refer to as the *Ozone Hole* is not of course totally devoid of ozone but is a region where ozone depletion is particularly severe—often resulting in the concentration falling to around 100 DU. Any region where ozone concentration falls below 220 DU is considered to be part of the ozone hole. Figure 1 shows the ozone hole as determined by the OMI (Ozone Monitoring Experiment) aboard NASA's *Aura* satellite on October 4, 2004. The critical 220 DU contour is highlighted.

Figure 2 is an OMI image acquired on September 29, 2006 and shows the ozone concentration in the stratosphere above the South Pole. Greens and yellows show areas with the highest ozone concentrations, blues and purples show where it is lowest. A purple veil of extremely low ozone levels stretches across most of Antarctica. The increased extent of the Ozone Hole since 2004 is clear to see.

CFCs

CFCs (chlorofluorocarbons) are man-made chemicals which were formerly used as propellants in spray cans, refrigerants, electronics cleaning agents, and in foam and insulating products. Unfortunately, the very properties that make them so useful—chemical inertness, non-toxicity and

What is the Dobson Unit?

Satellite sensors and other ozone-measuring devices measure the total ozone concentration for the entire atmospheric column. The Dobson Unit is a way to describe how much ozone there would be in the column if it were all squeezed into a single layer.

If all the air in a vertical column extending from the Earth's surface to the upper edge of the atmosphere could be placed at a temperature of 0°C at atmospheric pressure it would be 8 kilometres tall. All the ozone, under the same conditions, would stack up to just 3 millimetres. The Dobson Unit is defined as that concentration of ozone that would create such a layer 0.01 millimetre deep. Over the entire Earth the ozone layer's notional layer 3 mm deep therefore amounts to about 300 DU.

http://ozonewatch.gsfc.nasa.gov/ facts/dobson.html

insolubility in water—also make them resistant to removal from the lower atmosphere. Small quantities of these CFCs eventually find their way up into the stratosphere where UV radiation slowly breaks them down, releasing chlorine and bromine atoms which are highly effective at destroying ozone.

Eventually, this process will exhaust all the stratospheric CFCs and allow the ozone layer to recover but this will certainly take more than half a century to achieve. Meanwhile, the reduced ozone levels will continue to increase the quantity of harmful ultraviolet radiation reaching the Earth's surface.

When does the Ozone Hole form?

The Antarctic ozone hole forms each year during Spring (September-November in the southern hemisphere), when the total ozone concentration is found to decline sharply by some 60% over most of the Antarctic continent.

During the cold dark Antarctic winter, polar stratospheric ice clouds (PSCs) form when temperatures drop below -78°C. These clouds are responsible for chemical changes that promote production of chlorine and bromine atoms from CFCs. When sunlight returns to the South Pole after the darkness of the polar winter, it triggers the chemical reactions involving
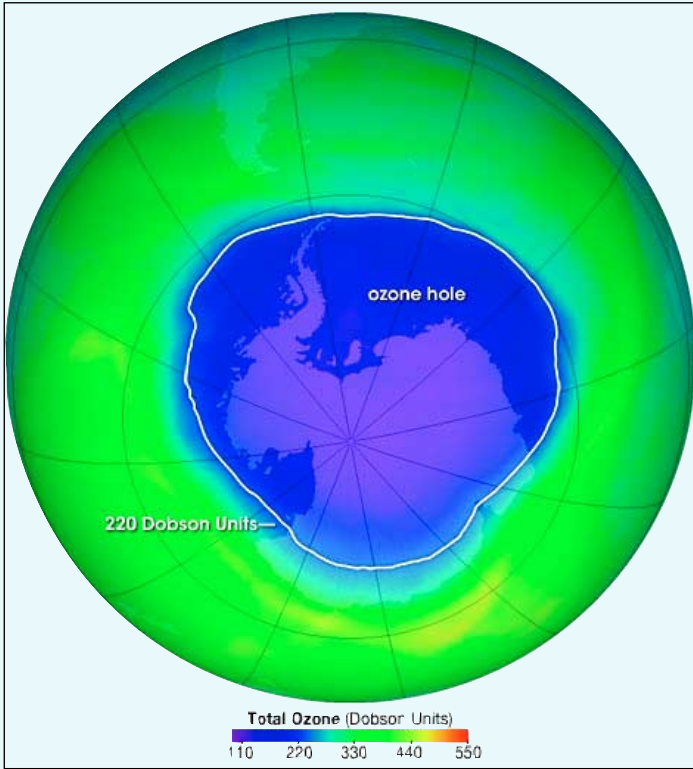
Figure 1 - The ozone hole on October 4, 2004, the 220 DU contour highlighted

NASA image courtesy the Scientific Visualisation Studio at Goddard Space Flight Center.
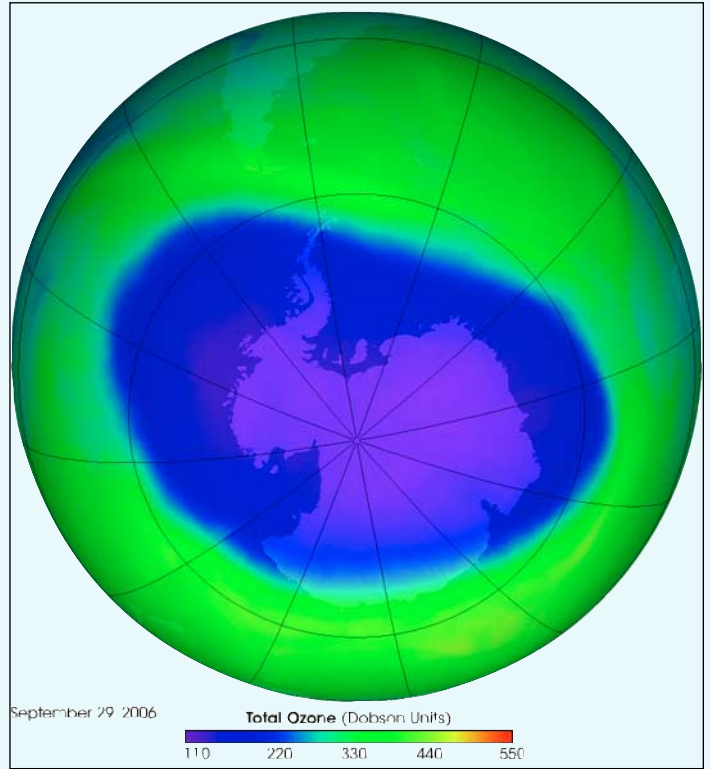
Figure 2 - The ozone hole on September 29, 2006

NASA image courtesy the Scientific Visualisation Studio at Goddard Space Flight Center.
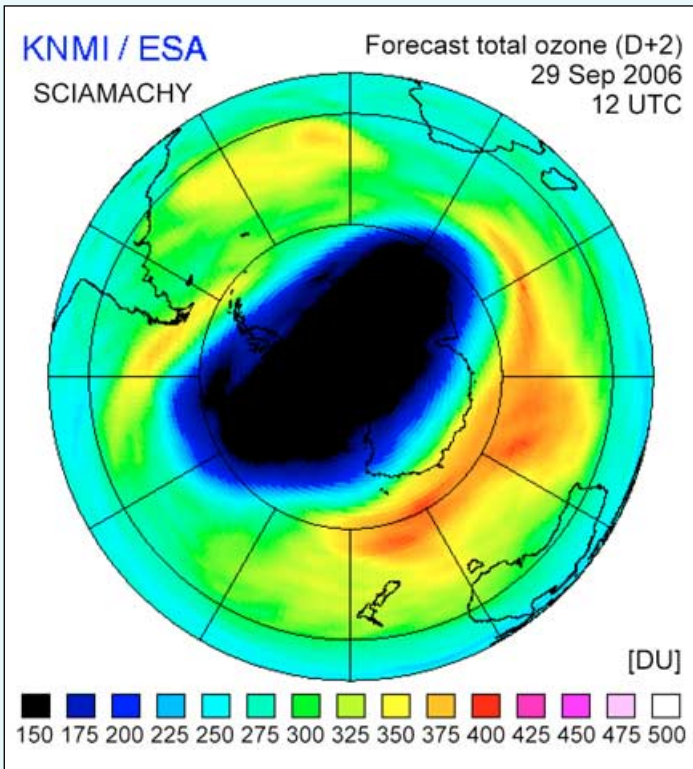
Figure 3 - The 2006 ozone hole on September 29, 2006 as measured by the SCIAMACHY instrument onboard Envisat

Ozone loss is derived by measuring both the area and depth of the ozone hole. The 2006 ozone hole has an area of 28 million square km, nearly as large as the record ozone hole extension during 2000, while its depth is around 100 Dobson Units, rivalling the record low ozone recorded in 1998.

The record ozone loss during 2006 was attained because both these measurements occurred simultaneously. A combination of very low stratospheric temperatures with sunlight is required to sustain the processes that deplete ozone, and the record depletion last September/October resulted because temperatures above Antarctica fell to their lowest since 1979.

Credits: KNMI/TEMIS

Figure 4

The area of the Antarctic ozone hole at 12:00 GMT of each day from GOME (1996-2002) and SCIAMACHY (2003-2006) Assimilated Ozone Fields.
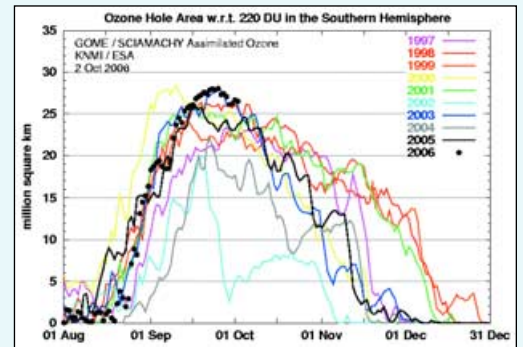
Credits: KNMI/TEMIS

Figure 5

The ozone loss at 12:00 GMT of each day from GOME (1996-2002) and SCIAMACHY (2003-2006) Assimilated Ozone Fields.
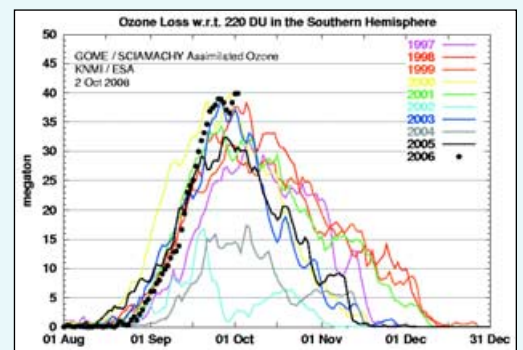
Credits: KNMI/TEMIS

Figure 6

The depth of the Antarctic ozone hole at 12:00 GMT of each day from GOME (1996-2002) and SCIAMACHY (2003-2006) Assimilated Ozone Fields.

Credits: KNMI/TEMIS
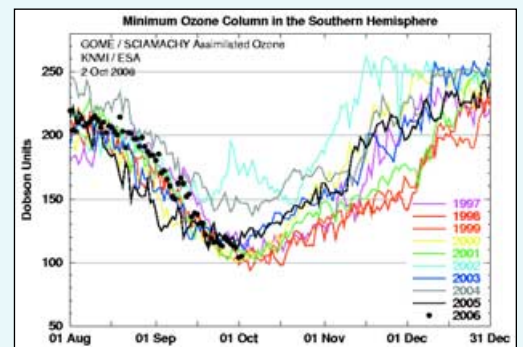
chlorine (and bromine) and ozone in the stratosphere. Each chlorine atom initiates a chain reaction that can destroy hundreds of ozone molecules.

This process starts in mid-August each year, peaking in late September or early October. As summer approaches and temperatures in the stratosphere rise, conditions become less favourable for the ozone-destroying reactions. Winds surrounding the South Polar region weaken, allowing the ozone-depleted air inside the vortex to mix with ozone-rich air outside it: this enables the ozone layer to stabilise once more, until the following spring.

Although some ozone depletion also occurs in the Arctic during the Northern Hemisphere spring, winter temperatures in the Arctic stratosphere are less severe than in the Antarctic and ozone depletion is correspondingly less.

The Montreal Protocol

In 1987, the Montreal Protocol banned the use of the most serious man-made ozone-destroying chemicals and there are signs that the atmospheric concentrations of some of these have begun to decline. Chlorine and bromine concentrations in the stratosphere should reach a maximum in the first few years of the 21st century, when ozone concentrations should, correspondingly, be expected to fall to their lowest levels.

From this point the Antarctic Ozone Hole should start to recover, but the process will be slow and it could be at least a further decade before conclusive evidence of this will be detectable. The complete recovery of the Antarctic ozone layer is not expected to occur until at least the year 2050—and probably considerably farther into the future. Today NASA scientists use the latest tools, including satellite observations and computer models of atmospheric chemistry and weather, to determine what effect this ban has had and how long we may have to wait for a full ozone layer recovery. NASA shares the latest information and satellite images of the ozone hole with the public on its Ozone Watch website at:

http://ozonewatch.gsfc.nasa.gov/

How is Ozone Monitored?

Currently, global ozone concentrations are constantly monitored by two satellites in low Earth orbit, NASA's *Aura* and ESA's *Envisat*. The former collects data using the OMI instrument, the latter via its SCIAMACHY imaging spectrometer.

OMI

The **O**zone **M**onitoring **I**nstrument is a nadir-viewing, wide-field-imaging UV and visible spectrometer designed to monitor ozone and other atmospheric species, including aerosols. It is the key instrument on *Aura* for monitoring the recovery of the ozone layer.

The OMI instrument can distinguish between aerosol types such as smoke, dust and sulphates, and can also measure cloud pressure and coverage, which provide the data needed to derive tropospheric ozone. OMI is a contribution of the Netherlands's Agency for Aerospace Programs (NIVR) in collaboration with the Finnish Meteorological Institute (FMI) to the EOS *Aura* mission. Figures 1 and 2 are OMI images which compare the ozone holes of 2004 and 2006.

SCIAMACHY

The **S**canning **I**maging **A**bsorption **S**pectrometer for **A**tmospheric **CH**artograph**Y** is an imaging spectrometer whose primary mission objective is making global measurements of trace gases in the troposphere and in the stratosphere. The solar radiation transmitted, backscattered and reflected from the atmosphere is recorded at relatively high resolution over a wide wavelength range ideally suited to the detection of clouds and aerosols. This instrument yields total column values and distribution profiles in the stratosphere for aerosols and trace gases, including ozone. Figure 3 shows the total ozone forecast derived from SCIAMACHY for September 29, 2006 (the same date as in figure 2).

GOME

The **G**lobal **O**zone **M**onitoring **E**xperiment was a spectrometer aboard ESA's ERS-2 satellite which made high-resolution measurements of spectra reflected from the atmosphere in a wide wavelength range from the ultraviolet to the near-infrared. *GOME* enabled retrieval of the total ozone column from the Earth's surface to the top of the atmosphere as well as its vertical distribution.

The 2006 Situation

ESA have been collecting ozone statistics over the Antarctic since 1997, thanks to *GOME* and, since 2003, from *SCIAMACHY*.

Figure 4 illustrates the extent of the ozone hole from 1997 to the present day as a set of coloured traces. The ozone hole itself is defined as that area on the globe, in millions of square kilometres, where the ozone column values fall below 220 DU.

Figure 5 shows similar plots for the actual ozone loss, defined as the mass of ozone required (expressed in megatons) to fill the ozone hole to 220 DU over its whole area.

Figure 6 plots the year-by-year depth of the ozone hole. This depth is the lowest ozone column value (in DU) for latitudes below 30° South.

In each of these figures, data for 2006 is highlighted as a prominent dotted line. Together, the graphs provide compelling evidence that the ozone hole continues to expand and that the restorative process has yet to kick in. Indeed, over the past decade the ozone level has lowered by about 0.3% per year on a global scale.
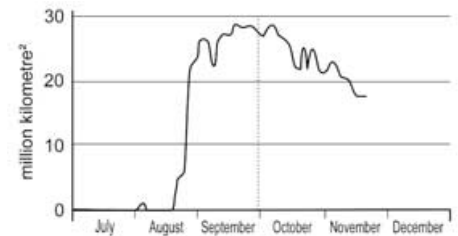
Figure 7 - Area of the 2006 Ozone Hole
Data: http://ozonewatch.gsfc.nasa.gov/
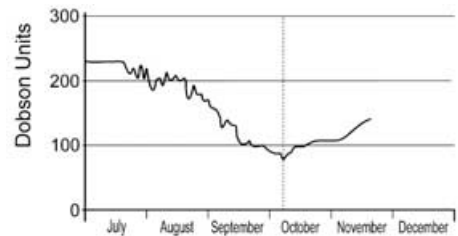
Figure 8 - Minimum Ozone during 2006
Data: http://ozonewatch.gsfc.nasa.gov/

On October 8 the OMI on NASA's Aura satellite, which measures the total quantity of ozone from the ground to the upper atmosphere over the entire Antarctic continent, observed a low value of only 85 DU in a region over the East Antarctic ice sheet.

Also, scientists from NOAA's Earth System Research Laboratory in Boulder, Colorado, who use balloon-borne instruments to measure ozone directly over the South Pole, discovered that the total column ozone had plunged from 300 DU in mid-july to just 93 DU by October 9.

More importantly, in the critical layer lying between approximately 12 and 25 kilometres above the Earth's surface, only a minuscule 1.2 DU of ozone remained (having plunged from an average non-hole reading of 125 DU in July and August), showing that in this layer of the atmosphere, the ozone had been almost totally destroyed.

Studies on the ozone layer will continue apace and the recently launched *MetOp-A* satellite, which includes *GOME-2*, a next-generation ozone-monitoring instrument, will be lending its weight to guarantee continuity of observations of this vital environmental factor well into future decades.

Acknowledgements

This article could would not have been possible without extensive references to the public domain websites of both NASA and ESA.

Further Reading

Stratospheric ozone monitoring and research:

http://www.ozonelayer.noaa.gov/

Ozone Hole watch

http://ozonewatch.gsfc.nasa.gov/

Ellesmere Ice Shelves Under Threat

Satellite Images show Ayles Ice Shelf Breaking Up

Les Hamilton

Ellesmere Island is not a name that trips lightly off the tongue. Most people have never heard of it. Yet it is the tenth largest island on the planet with an area of 196 000 km2 (Great Britain, with an area of 245 000 km2 comes 8th). Ellesmere Island is located at the north of the Canadian territory of Nunavut, adjacent to northwest Greenland, and is notable because it possesses the only ice shelves in the Arctic. Early in the 20th century, the explorer Robert E Peary discovered that the island's northwest coast was fringed by an ice shelf some 500 kilometres long. But the ravages of the 20th century have steadily eroded this to just 10% of its original extent: all that remains today are the six separate and much smaller Alfred Ernest, Ayles, Markham, Milne, McClintock and Ward Hunt ice shelves.

Unlike Antarctic and Greenlandic ice shelves, which are the floating seaward extensions of massive glaciers, the Ellesmere Island ice shelves have been built up over many centuries by persistent winds which blew landward, compressing and thickening the sea ice into a solid plate against the northern coastline.

Part of the Ellesmere Island coastline showing the location of two of the ice shelves (*Terra* image - 20:45 UT on August 13, 2005)

Image: MODIS Rapid Response Team

The Ellesmere ice shelves are believed to have been in position for several thousand years but throughout the 20th century, the largest of them, the Ward Hunt Shelf, has experienced a history of disintegration. A stretch of thick landfast sea ice more than 10 metres thick along the northern coastline of the island, this shelf lost 600 square km of ice following a massive calving incident during 1961-1962. And the breakup has continued into the current century with another fragmentation episode between 2000-2002 when it split in two and calved a number of sizeable ice islands.

The summertime 'population' of Ellesmere Island is sparse and consists of some 150 or so military, atmospheric and environmental personnel divided between just three locations—Alert, Eureka and Grise Fjord. During winter this falls to just 50 or so hardy souls. The outcome of course, is that events relating to the ice shelves readily escape detection, a case in point being the almost total loss of the Ayles Ice Shelf in August 2005—an occurrence only recently confirmed by studying historic satellite images and seismic data, despite being biggest ice shelf collapse in Canada's far north in 30 years.

The Arctic summer of 2005 was unusually warm and temperatures rising a full 3°C above the norm resulted in a strong overall decline in Arctic sea ice. It is believed that these elevated temperatures, low accumulations of new sea ice around the shelf's margins and high offshore winds combined to effect the breakup.

The Ayles Ice Shelf, imaged shortly after separation at 19:05 UT on August 13, 2005 (at the mid point of the northern coastline as shown above)

Image: MODIS Rapid Response Team

On August 13, 2005, some time between 17:30 and 18:30 UT, the Ayles Ice Shelf finally broke free from Ellesmere Island and began drifting out to sea, leaving a trail of ice debris in its wake and filling the mouth of the fjord with huge ice blocks. The coloured MODIS image opposite, acquired by NASA's *Terra* satellite at 16:10 UT on August 13, 2005 shows the shelf still intact little more than an hour before separation. A second *Terra* MODIS image (above) acquired at 19:05 UT the same day, clearly shows the start of the breakup (which took under an hour) as a lead of open water between the shelf and the Ayles Fjord glacier. The actual breakup event was sufficiently powerful that tremors were picked up on Alert's earthquake monitors 250 kilometres away.

Within an hour the former ice shelf had become a giant ice
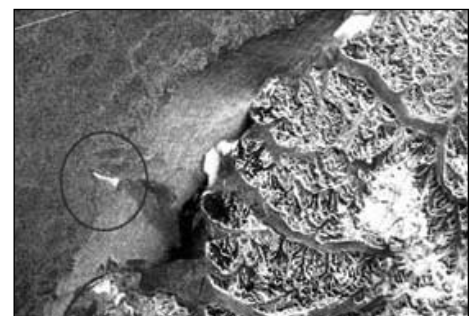
A *RadarSat* image showing the position of the former Ayles Shelf at 02:42 UT on August 15, 2005

Image: Canadian Space Agency

EUMETCast and MetOp Data
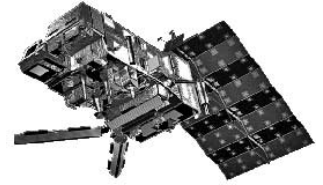
Dealing with the ever-increasing EUMETCast data

David Taylor

The year 2006 has seen the steady growth of services offered on *EUMETCast*—the easy to set up wide-bandwidth broadcasting service from *EUMETSAT*. Whilst the major event was the launch of *MetOp-A* and the subsequent provision of a continuous HRPT feed from this new European polar orbiting satellite, there have been a number of other service additions, the effects of which can be seen in the attached graphs.

The data in the graphs opposite show the throughput on my main *EUMETCast* receiver PC on December 2. Note that this only shows the data I have chosen to take, and it is **not** the total throughput from *EUMETCast:* that will be substantially greater. This PC, which is probably fairly representative of a typical *EUMETCast* system, now receives

- Meteosat-8 and foreign satellite data
- NOAA-17 and NOAA-18 regional AVHRR data
- Free basic DWDSAT data
- MetOp global AVHRR data.

The data collection uses the standard SNMP/MRTG tools and was described earlier (GEO Quarterly No 11, page 30).

AVHRR - one station

The first live data from the regional AVHRR service was received on March 14. This is the service where multiple EUMETSAT ground stations in Spain (Canary Islands) and elsewhere receive live data from NOAA-17 and NOAA-18, then send it to Darmstadt for collation and onward rebroadcasting over EUMETSAT. It is part of the EUMETSAT Advanced Retransmission Service (EARS). On the *Yearly* graph you can see a perceptible rise in the throughput during mid-March, even though just one station was active.

AVHRR - multiple stations

Later in the year, in mid-July, two new stations were added to the *EARS-AVHRR* service—one in Lannion, France, and the other in the Svalbard archipelago north of Norway. My own system shows an increased throughput rate from the end of July. In mid-August data from the Canary Islands station at Maspalomas was added, allowing the *EARS-AVHRR* system to offer data from three stations. Some passes would result in a total of 31 minutes continuous HRPT data!

DWDSAT - free for all

On September 13, rather out of the blue, Deutcher Wetterdienst (DWD) announced that the basic subset of its DWDSAT data would be available to all via *EUMETCast*. I only added *DWDSAT* to my main PC on November 22 when DWD started to include some high-resolution reprocessed NOAA polar orbiter data to the stream. However, this does not seem to have had a very noticeable effect on the throughput.

MetOp - continuous global HRPT

The most recent event came at the end of November 2006 when the AVHRR data stream from the MetOp-A satellite was released. This provides world-wide, continuous coverage from MetOp-A at 1-kilometre ground resolution, providing spectacular images of course, some of which appear elsewhere in this issue.

But the data-rate, as HRPT direct-readout user will know, is 665.4 kb/s and, after including the *add calibration and spatial location* information, rather more than this is transmitted by *EUMETCast*. Even after the built-in compression in the *TelliCast*
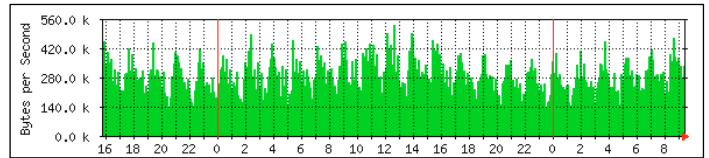
Daily Graph (5-minute average) - Maximum: 527 kB/s, Average: 269 kB/s
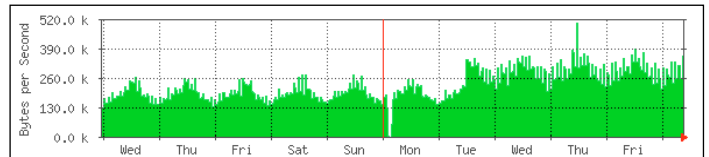
Weekly Graph (30-minute average) - Maximum: 502 kB/s, Average: 216 kB/s
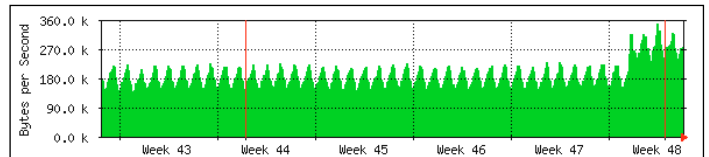
Monthly Graph (2-hour average) - Maximum: 347 kB/s, Average: 188 kB/s
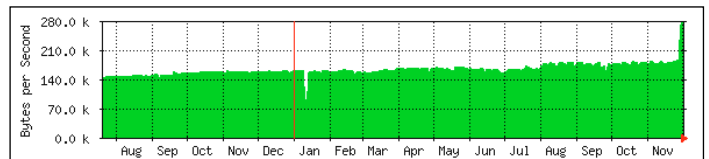
Yearly Graph (1-day average) - Maximum: 279 kB/s, Average: 163 kB/s

system, the net effect was to increase the average daily throughput from 180 kB/s to 280 kB/s by the end of the year—an increase of more than 50%!

Of course this great increase meant that those who had not optimised their systems in preparation for the new data were looking for hints and tips on avoiding data loss. Fortunately, due to investigation by GEO members, including Arne van Belle and Douglas Deans, a number of fixes were to hand.

How the Data Throughput Varies

The *Weekly* graph above shows a spike on the Thursday when data was accidentally sent twice during a period of scheduled maintenance at *EUMETSAT*. The periodic nature of data volume is more obvious in the earlier part of this graph where Meteosat-8 data made up the majority of the throughput. As the satellite only views one face of the Earth there is less compressed data during the night than during the day. (Were the data not compressed, the throughput would be constant. By the way, it is a lossless compression which is used so no data is lost or damaged). Following the addition of MetOp-A data on the Tuesday, the throughput graph becomes more complex because the 100-minute span of MetOp-A data (also compressed, so that there is less throughput during the night-time part of the pass) is superimposed on the daily variation of the Meteosat-8 data. The *Daily* graph perhaps illustrates this best of all.

Outages

There were a couple of times during the year where data throughput was reduced—one in early January when Meteosat-8
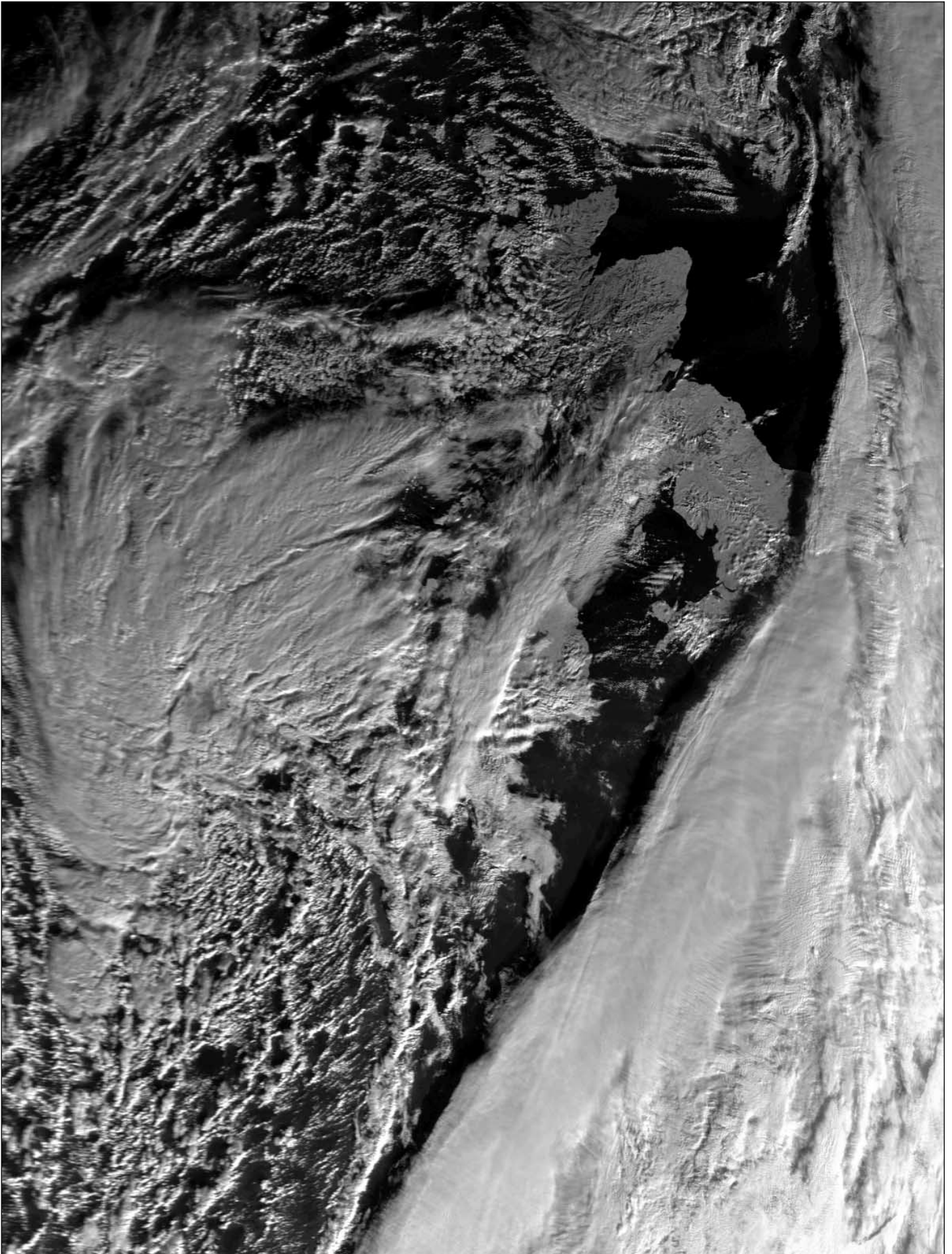
An image from the 10:07 UT **MetOp-A** pass on December 1, 2006 showing the British Isles, captured by **David Taylor**. The data are stored on board the satellite then dumped to Svalbard on the subsequent orbit before being disseminated. The image above comes from the 1.6 µm reflective IR channel-3.

Image © EUMETSAT 2006

was being decontaminated (so no thermal channel data was available from the normally cooled detectors), and a glitch around the third week in September when Meteosat-8 suffered a glitch and data from the standby satellite (Meteosat-9) was substituted.

More recently, we have seen a couple of *EUMETCast* glitches where some of my own systems lost lock during the event and failed to recover without manual intervention. One example of that can be seen on the *Weekly* graph, early on the Monday morning.

The outlook?

In summary, we are now receiving around double the data throughput compared with 15 months ago (as far back as my graphs show) from about 140 kB/s to 280 kB/s daily average. What will the next 15 months bring?

Appendix

Optimising your System

MetOp brings a great deal more data to your Receive PC as each 3-minute file occupies 28 MB, which totals approximately 550 MB per hour (13 GB per day). A twin-PC configuration is recommended where one PC is devoted to reception and the other to processing.

You can use a standard satellite-TV RF splitter to feed two PCs from a single dish and LNB. You can also get dual-output LNBs should you wish.

You need to enable PID 510 (decimal) on your SkyStar by right-clicking on the green satellite icon then running *Setup4PC*. Choose '*Data services*', uncheck '*Hexadecimal*' then enter '*510*' in the field to the left of '*Insert*' and click the Insert button. You will also have to add a new data channel named EPS-10 to your recv-channels.ini file.

I very much recommend using a separate directory for receiving *MetOp* AVHRR data in order to limit the number of files in each directory. Do not use the wildcard entry [*] as a way of directing all data to a single '*Received*' directory as this reduces your control over which data are received (and may flood your PC with unwanted data from MetOp). Figure 1 illustrates the required changes to your recv-channels.ini file.

```
[EPS-10]
target_directory=received-AVHRR
```

Figure 1
Modification to the **recv-channels.ini** file

If it does not already exist by default, it is vital to specify a <u>temporary</u> directory in your *TelliCast* system. This is so that the *MetOp* files can safely be built up from the incoming packets of data in their own

folder, prior to being moved on to the 'received' directory once they are complete. If your software tries to access these data files before they have built up fully (which can take as long as 30 seconds) you may end up with incomplete data.

If you are running a RAMdisk, ensure it is at least 80 MB in size. You must also edit the 'file_database_size' entry to make sure that the *TelliCast* software uses the new value. 80 MB is actually 83886080 bytes, but I like to allow a little margin and specify just 80000000 bytes for the file size (seven zeros).

You will have to ensure that the code shown in figure 2 is added to your recv_ini file.

```
[parameters]
    tmp_directory=temp
    file_database_size=80000000
```

Figure 2
Required changes to the **recv-.ini** file

80 MB doesn't actually allow much margin in the event of signal errors and recovery attempts. Already, reports have been

received where the *FSY file* increased to over 92 MB. This suggests that, for the most robust systems, a RAMdisk and '*file_database_size*' of 150 MB should be safe. Alternatively, you can just miss some segments!

If you run your system for less than 24 hours per day, you may be able to get away with a smaller size (but not less than 70 MB), but if you run 24/7 you should err on the larger size.

Why does MetOp data appear to halt when the satellite nears the North Pole?

Finally, a minor mystery. When *MetOp* approaches the North Pole it comes within range of the Svalbard ground station where stored data for the completed orbit is dumped. However, the data you receive via EUMETCast appears to halt for a few minutes.

The data from a full pass can actually be transmitted in slightly less time than MetOp's orbital period, resulting in a data gap between the end of one pass and the start of the next (remember, the files you download are all one orbit delayed).
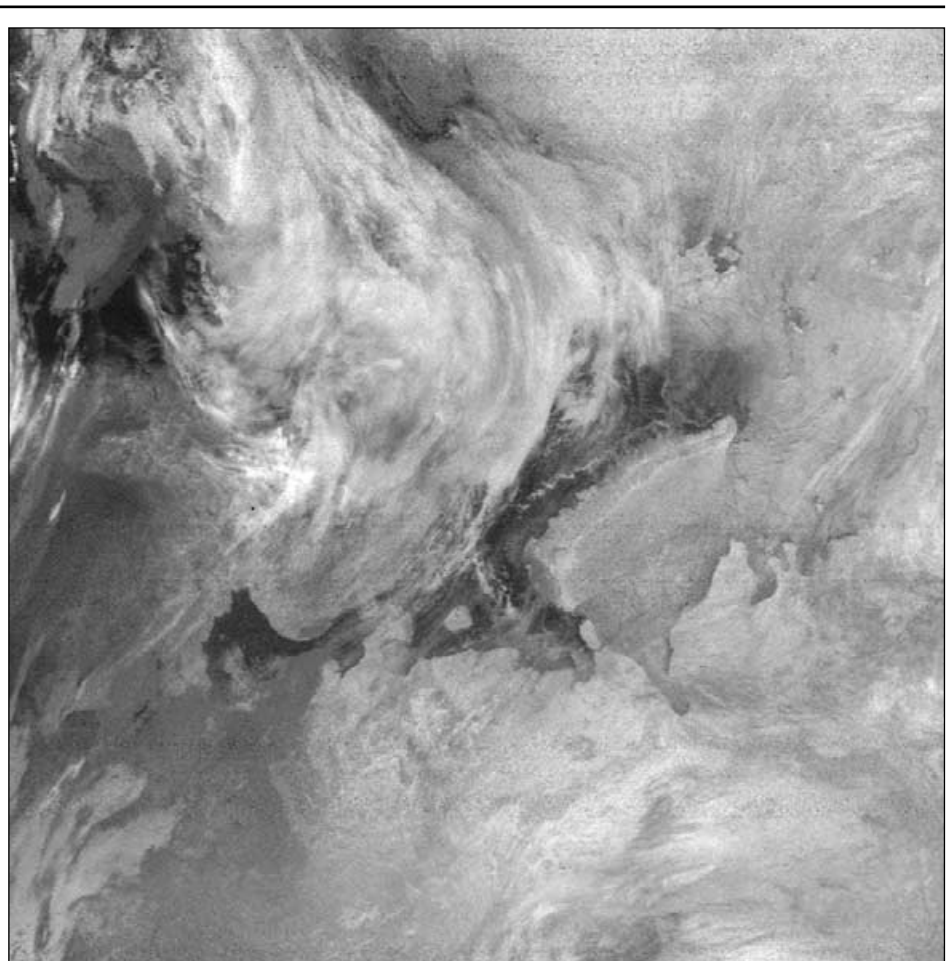
Anders Höök was impressed by the image of the Arctic that appeared in GEO Q12 page 31. Anders has been experimenting with his R2FX receiver using twin antennas and sent us this infrared APT image stretching all the way to the North Pole. The satellite was NOAA-18, northbound at 08:37 UT on December 30 last year (maximum elevation 15°). The second antenna Anders uses is a simplified 'tall thin' QFH type which he will describe in the June GEO Quarterly.

Modifying your EUMETCast PC to
Receive MetOp Data

Peter Green

Have you always wanted to receive world-wide HRPT images? Well you can now: from Europe's first Polar Orbiting weather satellite. MetOp-1 is now transmitting AVHRR test data which is available free of charge via *EUMETCast*. Elsewhere in this issue you will see numerous examples of the high quality images that are now available to you.

Firstly, you will want to know that your system is capable of handling the MetOp data. A Pentium III 1-GHz or faster PC is recommended and if you are using David Taylor's *MetOp Manager*, this program requires about 100 MB of memory for its own operation. In total, *European Polar System* (EPS) AVHRR data will consume from 7 to 14 GB of your hard disc storage space per day depending on the format in which you save the data. So you need to make sure that your hard disk is big enough to store this, taking into account the number of days worth of data you wish to retain.

Licence

You need to update your licence to be able to receive MetOp. Your next stop should be the GEO website at

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

where you will find a copy of the new EUMETSAT registration form, which you require in order to amend your licence (all *EUMETCast* licences are now done on-line). GEO has prepared a guide, with explanations, to filling this out with everything you need. There is also a link that, when clicked, will open a new window with the actual blank on-line form where you can update your licence details to include MetOp.

Updating Your Computer

Whilst waiting for EUMETSAT to inform you that your licence has been updated, its time to start to get to grips with your computer, adding RAMdisk and updating the *rec.ini* and *recv-channels.ini* files.

It is recommended that you run RAMdisk, which will help you eliminate lost segments in your other *EUMETCast* programs. If you are already running a RAMdisk, ensure it is at least 80 MB in size. Arne van Belle's excellent article from GEO Q6 June 2005 will help you set this up; the article has been updated especially for MetOp and is available on-line at

**http://www.satsignal.eu/
wxsat/atovs/RAMdisk.pdf**

Also remember to edit the entry in the *recv.ini* file to tell the *TelliCast* software to use the new size of RAMdisk. 80 MB is actually 83886080 bytes, but it is advisable to allow a little margin and specify just 83500000 bytes for the file size. Be sure to check the number of zeros carefully!

recv.ini
```
[locations]
......
file_database_directory=Z:\receiving
[parameters]
......
file_database_size=83500000
......
```

The file may well contain other lines (shown here as ......) which you should **not** touch.

RAM Disk Limits

There may be limits on the size of a RAMdisk using the free *AR Soft* RAMdisk product (which you can download from the Yahoo MSG-1 group, provided you are a member). There have been successful reports of an 80 MB RAMdisk on a 512MB Windows 2000 system, and a 300 MB RAMdisk on a 2 GB Windows XP system. Arne van Belle has achieved a 132 MB RAMdisk on his 1-GB system.

When these values are exceeded though, although the *ARsoft* product will run, the size of the RAMdisk turns out to be smaller than configured. If you try to set an excessively large RAMdisk you obtain an error in the Event Viewer and it fails to load at all.

Therefore, even though you have plenty memory, be careful not to set the RAMdisk too large. Setting it to 300 MB may actually hang your system and require you to reboot in *Safe Mode* to reset the value to a lower level.

Modifying the '*recv-channels.ini*' File

You need to add a new data channel named *EPS-10* to your *recv-channels.ini* file. Most likely, your file will already include entries for Meteosat-9 HRIT data. Just add the entry for EPS as illustrated below.

```
——— recv-channels.ini ———
[EUMETSAT Data Channel 2]
target_directory=received
......

......
[EPS-10]
target_directory=received-AVHRR
......
```

I recommend using separate directories for MSG-1 and MetOp AVHRR data to limit the number of files in any directory. Do not use the wildcard entry [*] as a way of directing all data to a single 'received' directory: you will lose much of the control over which data you receive, and may flood your PC with unwanted data from MetOp! Removing the [*] entry may be a major change to your *recv-channels.ini* file, but it's worth it.

Temporary Path

During reception, a file can take up to 30 seconds to build up. If your software attempts to process such a file before it is complete you can end up with a missing segment. This can be avoided by specifying a temporary folder (temp) where files can build up away from the main receiving directory. These files can be moved to the 'received' directory once each is complete.

```
——— recv.ini ———
[parameters]
......
tmp_directory=temp
......
[logging]
log_file_size=1000000
log_file_number=2
log_level=quiet
......
[locations]
......
log_file=>>recv.log
......
```

You should also ensure that the logging level is set to 'quiet' to reduce disk activity, and also have *TelliCast* buffer the log data before writing by using the '=>>' specifier in the 'log_file=' value. If this entry is not present in *recv.ini* by default you must add it.

Finally, you also need to enable **PID 510** on your *SkyStar* software using your *Setup4PC* program. To do so, right-click on the green satellite icon and run *Setup4PC,* select 'Data services' and uncheck 'Hexadecimal'. Now type '510' in the field left of the 'Insert' button: when done, click this button.

Conclusions

You should now be in a position to receive MetOp data when your licence is updated. I have not found it plain sailing as my RAMdisk has been filling up very

Surgut

Les Hamilton

At the conclusion of our editorial last issue, I recommended turning attention to NOAA infrared images to seek interesting features during the winter months. And even before this edition of the *Quarterly* was mailed out, John Say had started the ball rolling. John has been enjoying the NOAA-18 high-resolution images disseminated through the *EUMETCast* EARS-AVHRR service [1] and, on November 25, spotted an interesting dark object in the 21:46 UT evening pass. John reported his discovery on the AVHRR Newsgroup [2] and initiated a lively debate as to its origin.

The dark object in question was located at 61°30'N, 73°58'E in the city of Surgut in central Siberia and took the form of a circular blob with a curving 'handle'. What appeared to be a plume of smoke or vapour could be seen trailing westward from the base of the 'handle'. A colour composite IR image made by combining data from channel-4 and channel-5 appears in figure 1, which also depicts the Ob river winding prominently across the scene.
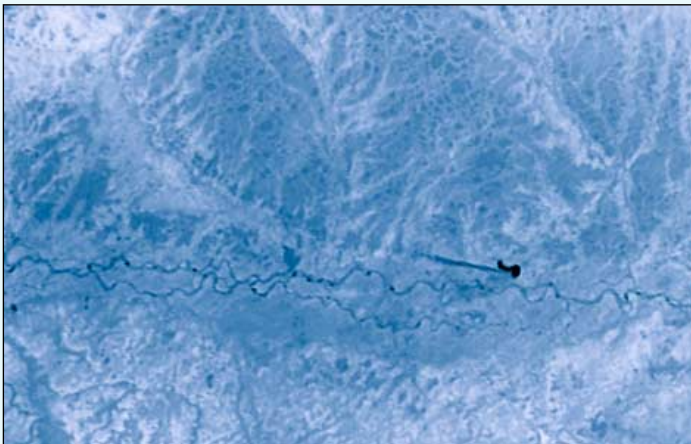
Figure 1 -   A channel 4+5 composite IR image from the 21:46 UT NOAA-18 pass on November 25, 2005.
Image: SMIS (http://smis.iki.rssi.ru)

At this time of year Siberia is in the grip of winter and, with exceptionally high pressure in charge (1043 mb) and cloudless overnight skies, the outdoor temperature had plummeted to -30°C and below—ideal conditions for IR imaging. Figure 2 shows the same image following reprocessing with the *Temperature* tab in David Taylor's HRPT Reader [3] software. Everything in the scene, including the Ob river, is frozen solid. But the dark blob—the source of the vapour plume—now stands out as a prominent orange hot-spot, with a temperature of 'only' -6°C. The plume is
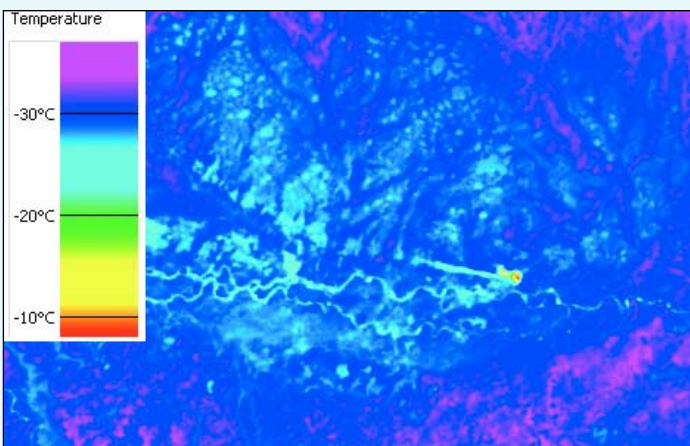
Figure 2 - The same NOAA-18 image, reprocessed to show temperatures

even more apparent (and twice as long) in the daytime MODIS image from NASA's *Terra* satellite (figure 5, opposite page) dating from a few days earlier. The course of the Ob bisects the main image horizontally before turning northward to complete its journey to the Arctic Ocean. The circular inset shows the white plume at the full 250 m/pixel resolution of the MODIS instrument. Because of the low elevation of the sun, a dark shadow cast by the plume is clearly visible to its north.

Surgut

Surgut is not a name that comes readily to mind but it is a major Siberian city with a population approaching 290 000. Surgut was founded on the right bank of the Ob river by the Cossacks in 1594, one of the first cities to be built in Siberia. Present-day Surgut is a major player in the oil and gas industry and is one of the main administrative and supply centres for the Western Siberian oil fields. The basis of its economy is its fuel and energy complex, which is involved with prospecting, oil and gas-production, pipeline enterprises, power stations, oil-refining and gas-processing plants: these collectively employ over 80 000 workers. Over 59 million tonnes of oil and in excess of 14 billion cubic metres of natural gas are produced in Surgut annually.

All this industry requires energy—lots of it—and the first of two huge power stations, *Surgut Hydroelectric Power Station No 1* (figure 3), was commissioned in February 1972, to be followed a few years later by *Surgut Hydroelectric Power Station No 2* (figure 4). At this time of the year, with the Ob frozen solid, the vast quantities of liquid water required for hydro-electric operations is quite simply unavailable. The Surgut power stations have the capability to operate as thermal power stations, fuelled by natural gas—a necessity during winter's deep freeze—and, with a combined output of 8000 megawatt (MW), provide electric power not only for the Tyumen area but a surplus to export to other regions of Russia as well. Station No.1 also includes two CHP (combined heat and power) units which provide Surgut with the lowest cost municipal heating system in the region.

Figure 3 - Surgut hydroelectric power station No 1 (left)
Figure 4 - Surgut hydroelectric power station No 2 (right)

Credit: RAU UESR

Power Station No 1 is the largest hydro/thermal power station in all Russia with an output of 4800 MW. This is four times that of the average UK power station and exceeds even the huge DRAX coal-fired power station near Selby, North Yorkshire (3945 MW). It goes without saying that two adjacent power plants with a combined output of 8000 MW will burn a huge volume of natural gas and that their flues will emit vast clouds of steam. The masthead includes a photograph (courtesy the Surgut municipality) which shows both stations in operation. There can be little doubt that the plume in figure 1 represents cloud condensing from the steam being emitted by the power plants' five gigantic flue stacks.

Figure 5
Central Siberia as imaged by the MODIS instrument aboard NASA's Terra satellite at 06:20 UT on November 18, 2006 with Surgut and its environs shown at full 250-metre resolution (inset).

Image: MODIS Rapid Response Project, NASA/GSFC

The existence of semi-permanent cloud over power stations has been chronicled in GEO Quarterly previously [5]. Peter J Bradley learned that such a cloud he had regularly spotted in France's Loire Valley was produced by steam from the cooling towers of a nuclear power station.

With one mystery solved, another remains: what is the circular black blob with the curved 'handle'? Alan Banks was first to make a suggestion after using *Google Earth* [4] to home in on the Surgut region. Alan noticed what appeared to be a 'reservoir' exactly the same shape as the dark blob on the NOAA-18 images (figure 6) and, because it was black it would have to be pretty warm to show up so well: 'for this amount of heat there would have to be a pretty big power station to warm all that water in the middle of Siberia.'

Figure 6 - The 'reservoir' at Surgut
Image:© 2006 DigitalGlobe/Europe Technologies

Alan Sewards entered the debate with the suggestion that the dark object might in fact be a cooling pond for the two power plants and that the plume might be air warmed by this pond, which was being carried off by the wind. Alan continued to say that the pond would not have to be all liquid as long as it was deep enough for liquid water to exist throughout the winter. The ice at the surface would be warmer than ice on adjacent unwarmed soil or river (-6°C as noted above), and would

Figure 7 - The Surgut power stations, with their giant flues evident.
Image:© 2006 DigitalGlobe/Europe Technologies

therefore show up as such on satellite imagery: 'note that power stations of this type reject about twice their electrical output as heat into the cooling ponds and flues; for a 4.8 GW plant this a lot of heat!' Zooming in ever more closely, the twin power stations soon come into view, located just at the 'neck' of the 'reservoir' (figure 7).

Finally, to complete the picture, I checked some summertime HRPT images, when hydro-electricity generation should have taken over. And indeed, the great cloud plumes had totally vanished.

References

1   GEO Q10, page 7; GEO Q11, page 21.
2   http://groups.yahoo.com/AVHRR
3   www.satsignal.eu/
4   http://earth.google.com
5   Reflections - GEO Q10, page 38.

Acknowledgements

Cover and Full-Page Image Details

Front Cover

Snow on the Andes is conspicuous in this MetOp-A image submitted by Alan Banks. This is just a clip from an original covering the entire continent of South America and downloaded via EUMETCast's global data service on December 2, 2006.

Image © EUMETCAST 2006

Inside Front Cover

An impressive ash plume spews from Mount Etna in this November 24 MODIS image from NASA's Aqua satellite.

Image: MODIS Rapid Response Team/GSFC

Inside Back Cover

Dozens of active bush fires burn between Lake Eildon and Dartmouth Reservoir in Victoria, Australia in this MODIS image from NASA's Aqua satellite, on December 11, 2007.

Image: MODIS Rapid Response Team/GSFC

Back Cover

New Zealand is seen surrounded by a semicircle of cloud in this MetOp-A image dating from 21:25 UT on December 9, 2007. Processing in Vegetation mode by HRPT Reader.

Image © EUMETSAT 2006

Page 7

MetOp-A observed Typhoon Utor poised over the Philippines at 00:58 UT on December 9, 2006. Also clearly in view are the island of Sulawesi and eastern Borneo.

Image © EUMETSAT 2006

Page 20

This 250-metre resolution MODIS image from NASA's *Aqua* satellite, acquired on November 15 last year, shows bluish plumes of smoke from numerous fires on Australia's Cape York peninsula.

NASA image courtesy the MODIS Rapid Response Team, GSFC

Page 22

This splendid NOAA-17 image was acquired by David Taylor at 11:33 UT on December 3, 2006 and shows the first major storm to his the UK this winter. Many places experienced winds of well over 100 kph. Editor Les Hamilton was rudely awakened at 6 am that morning when, with the storm at its height in NE Scotland, one of his chimneys crashed on to the roof before shattering on the ground below.

Image © EUMETSAT 2006

New Editor
Required by GEO

Disappointingly, no offers to take up the post of GEO Editor have yet been received and, although Les Hamilton has kindly agreed to continue in post as an interim measure, this situation is hardly ideal. This is a post that should appeal to a member who is proficient in document and image processing on a personal; computer, and who would like to support GEO more proactively.

Interested parties please contact

Cape Farewell

Francis Bell

↑
Cape Farewell

Cape Farewell, photographed from the air by the author

was determined by headwinds and the position of the jet stream with the bonus of flying over a sequence of established airports.

It was the Greenland dimension which was the bonus for me. At home I have received many APT images which have included the southern tip of Greenland but that is close to the limit of my reception range for the NOAA satellites. Southern Greenland is often cloud-covered but some of my images do show the island's southern tip without clouds; but this was scant preparation for what we saw through a crystal clear atmosphere from an aeroplane flying at 10,000 metres. We flew just a few miles south of Cape Farewell, the southern tip of Greenland, and I was ideally placed occupying a window seat facing north. Quite by chance, I had my camera with me and started to take photographs. Even though the view was through the engine exhaust I was subsequently pleased with

Readers may recall the distressing events which Nadine and I experienced during a two-way transatlantic crossing we undertook last September [1], when we encountered one hurricane and bad weather almost every day we were at sea. However, not deterred by this bad experience, with family plus grandchildren to be visited before Christmas, we travelled to America again for a six day visit during December—but this time by air: London Gatwick to Raleigh/Duram North Carolina.

A globe and a length of string will identify the shortest route between these two airports, a great circle route which takes the aircraft over the Atlantic Ocean for about 90% of the flight. However, I was slightly surprised by the route we actually took. It was: London, Western Isles of Scotland, Iceland, the southern tip of Greenland, Canada and down the eastern seaboard of the USA. I expect the route

The reassembled turnstile antenna
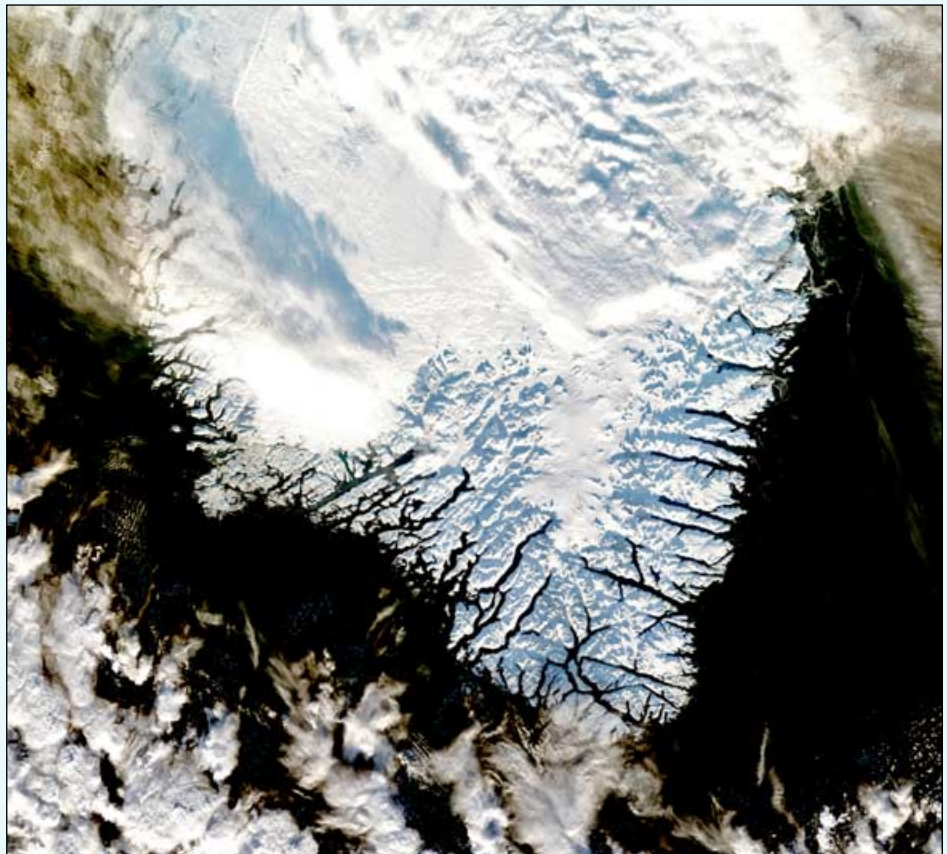
Southern Greenland, including Cape Farewell, as imaged by the MODIS instrument aboard NASA's *Terra* Earth observing satellite just a few hours earlier at 14:20 UT on December 9, 2006.

Image: MODIS Rapid Response Team/
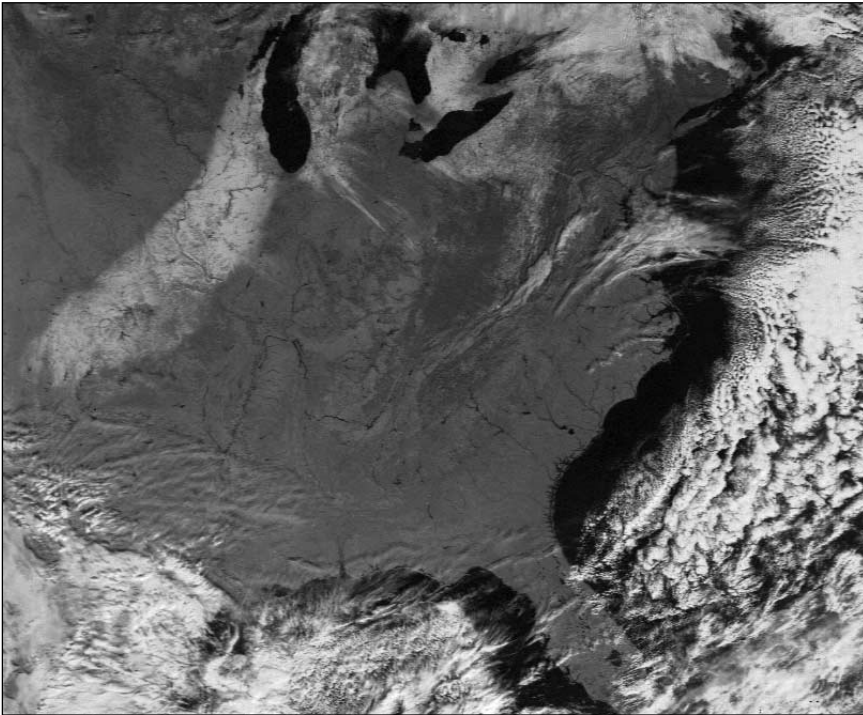
This NOAA-17 image captured by the author on December 9, 2006 shows a spectacular swathe of snow stretching southwest from Lake Michigan

Book Review

Francis Bell

the results. The cabin staff saw what I was doing and one remarked that she had never seen such a clear view of Cape Farewell all the times she had flown this route.

In the foreground were rocky islands surrounded by a smooth, black glassy sea which created many inlets, and in the background were mountains which I took to be mainland Greenland. These islands were 90% covered in snow and ice, the remainder barren rock. I think that the sea must have recently been frozen, keeping it wave free and, with no snow cover, it looked black. Although the scene looked beautiful and stark in the sunlight, it also appeared inhospitable and devoid of life. No wonder departing visitors to Greenland were happy to call this place Cape Farewell.

On reaching our son's home in North Carolina I set up my APT receiving station, which consisted of a GEO turnstile antenna, a Dartcom preamp, a Ray Godden designed RX2 receiver and a Dell laptop computer. Before leaving home I did experiment with different antennas but my empirical tests indicated none performed as well as the turnstile. The problem was that the turnstile would not fit into my suitcase: I had to take it apart to fit and then reassemble it on site. The site for the antenna was not ideal as the house where we were staying is located in a gentle valley surrounded by trees and I could only conveniently locate the antenna six feet above the ground. However, the system did work well for high elevation satellite passes.

I recorded passes on most days, the near midday passes of NOAA-17 and NOAA-18 producing some good results using the visible light channel, even though the early December light levels, in full sunlight at high latitudes, is not ideal. I noted the lack of interference for NOAA-18 on 137.91 MHz—there are no pagers on this frequency in the USA.

The prevailing weather we experienced in North Carolina was not typical for December. Cold, clear polar air was sweeping down from Canada and pushing most of the weather and clouds well to the south generating a clear landmass for the satellites to image. Without overlaying country and state boundaries my images had to be viewed with care to identify particular locations. It was interesting to look at the river patterns and other water masses to navigate around these images of the USA. The European images which I am used to have, of course, so many coastal features that it is usually possible to identify locations without the use of a map overlay. A white band on the image stretching from the southern tip of Lake Michigan for several hundred miles was, I'm sure, recent snow cover as the sinuous rivers are visible against the general white background.

Editor's Note

We are always please to hear about members experiences at temporary locations, holiday or work related. Please keep the reports and images coming in.

Reference

1   Atlantic - GEO Q12, page 43

While in America recently, I visited a '*Discovery Channel*' shop where, while browsing around, I found a small but interesting selection of books on sale. One book which particularly caught my eye was entitled '*The Weather Identification Handbook*'. The book looked informative and was attractively illustrated so I decided to buy it. It was only after I'd made that decision that I noticed Storm Dunlop's name as the author. This name registered with me because Storm is a GEO member.

I have read the book and found it very informative and well presented. The first third of the book is devoted to cloud classification. The author's advice is to become familiar with basic cloud types followed by the different forms which they can exhibit. This core material is well illustrated with tables and photographs. The remainder of the book is fascinating with its illustrations and explanations of many different atmospheric phenomena related to clouds, precipitation, light and weather. I was particularly interested in the author's comments about rainbows by moonlight and aircraft contrails, both topics which have been discussed in GEO Quarterlies. The book contains sections on

- Cloud Classification
- Cloud Formation
- Optical Phenomena
- Colour in the Sky
- Visibility
- Precipitation
- Winds
- Severe Weather
- Weather.

I would certainly recommend this book to anybody interested in clouds and the weather. My copy came from the USA and cost $16.95, equivalent to about £9.00. The book may or may not be on the shelves of UK book shops but, when I asked my local book shop and *Waterstones*, both said they could get it in for me. I expect there would be some additional cost for an individual order. The details of the book are:

'The Weather Identification Handbook', by Storm Dunlop
Paperback, 192 pages.
First published by Harper Collins (UK 2002)
Now published by Lyons Press (USA 2004)
ISBN 1-58574-857-9
Price £7.76 at *Amazon.co.uk*

This book is well worth putting on a birthday or Christmas present list. I understand the same author has four other related books in print but I have not seen these. Storm has been invited to our Leicester symposium and I hope to learn more from him there.

GEO to Visit EUMETSAT

Headquarters in Darmstadt

For some months now, GEO Management have been negotiating behind the scenes to organise a visit to the nerve centre of weather satellite operations in Europe. The outcome is an outstanding opportunity for GEO members to visit *EUMETSAT's* HQ in Darmstadt, Germany. Additionally, we are planning visits to other nearby space centres including the receiving ground station at Usingen. **The two-day visit is planned for Thursday-Friday, July 5-6, 2007.**

Provisional Programme

Thursday, July 5

Commencing at 9.00 am, EUMETSAT will host us for a full day at their headquarters in Darmstadt. This will include:

- A tour of the control centre
- A tour of the archive facilities
- Some presentations, including
  - The status of EUMETSAT's Operational Services
  - Getting the most out of MSG data
  - Unwrapping the mystery of EPS
- Lunch at some stage
- A chance to meet EUMETSAT staff
- Our own GEO meeting if judged appropriate.

Friday, July 6

At 8.00 am we will depart for Usingen, escorted by a member of EUMETSAT's staff, a drive of about an hour and a half. Usingen is the location for EUMETSAT's satellite receiving ground station where we hope to have access to the control buildings for the MSG antenna as well as a general tour of the site.

In the afternoon we will return to Darmstadt to visit ESA's European Space Operations Centre (ESOC). We will have an escorted tour of their site and facilities. The visit will conclude at 4.00 pm.

Travel, Accommodation etc.

GEO is making no charge for the two-day programme but all travel, accommodation, meals and other expenses are the responsibility of individual delegates. Any GEO member from the UK or continental Europe will be welcome, together with their partner.

Coordination

Peter Green is coordinating the group list. To register your interest in this unique event, please email your details to Peter at

international@geo-web.org.uk

EUMETSAT HQ, Darmstadt
Image: EUMETSAT

Further information will be published on the GEO website as it becomes available. Group travel and group accommodation may be possible but are not guaranteed at this stage. If numbers have to be limited, selection will have to be in favour of the early registrations.

Stay with GEO at the Darmstadt Ibis Hotel

GEO has reserved a number of rooms for members at the Ibis Hotel, Darmstadt from July 4-7, for our visit to EUMETSAT and ESOC. EUMETSAT is within walking distance of the hotel, so no transport is required.

We do hope that all those wishing to attend will stay at the hotel, where we will be very pleased meet our members from mainland Europe.

The room rates per night:

- Monday-Friday: €65
- Friday-Monday: €59
- Breakfast per person <u>extra</u>: €9.50 per day

These rates include all taxes and service charges. You may of course book for a longer or shorter stay.

All of the 84 air-conditioned guest rooms feature shower/WC, satellite television, telephone, and modem connection.

Please book direct with the hotel quoting reference 47537 GEO

Steffi Horstmann, Manager
Ibis Darmstadt, Kasinostraße 6
D – 64293 Darmstadt
Tel: (49) 06151 / 397-00
Fax: (49) 06151 / 397-0123
Email: H3287@accor-hotels.com

GEO looks forward to renewing old acquaintances and making new friends at Darmstadt. We are sure that everyone who attends will experience a very enjoyable and exciting few days.

Fires on Cape York Peninsula

The 250-metre resolution MODIS image on page 20 (overleaf) depicts Australia's Cape York peninsula as viewed by NASA's *Aqua* satellite on November 15 last year.

This region is mainly tropical savannah, a mixture of grassland, shrubs and small trees with a thin perimeter of tropical forest lining the coastal areas. Both traditional Aboriginal land owners and modern farmers and ranchers use fire to maintain this landscape and bluish plumes of smoke from numerous fires burning across the peninsula are clearly visible—quite distinct from the confetti of bright cotton wool clouds dotting the image.

Places where the savannahs have recently burned show as deep brown, compared with the lighter tan colour of the unburned terrain and the deep green of the tropical forests. Skies over the Gulf of Carpentaria are hazy, probably a mixture of smoke and thin clouds.

NASA image courtesy the MODIS Rapid Response Team, Goddard Space Flight Center.
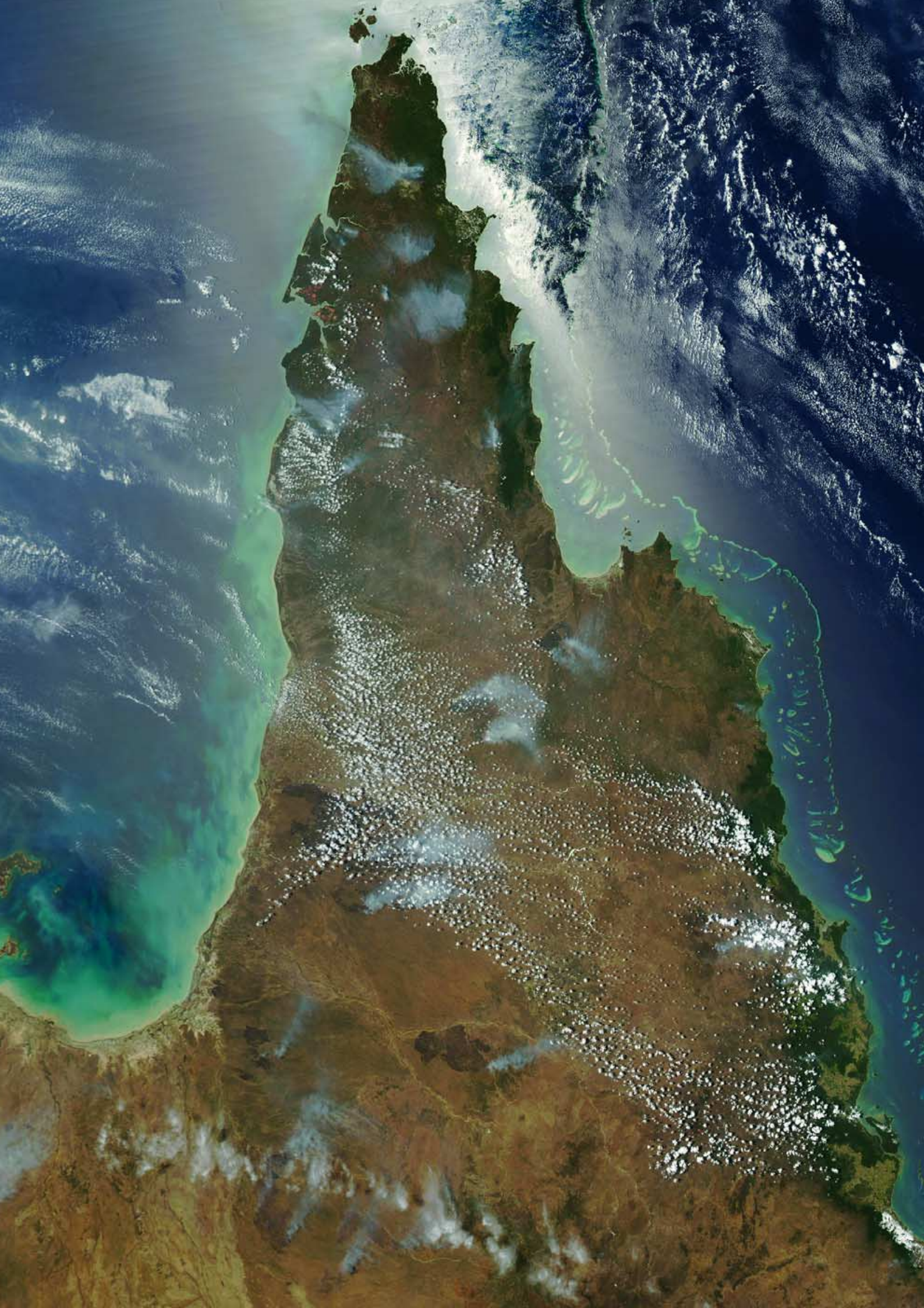
In the Bleak Midwinter . . .

. . . Fog and frost cause chaos across England

Les Hamilton

In the week leading up to last Christmas, England found itself under the influence of a persistent area of high pressure which brought freezing fog to many parts of the country, severely disrupting air travel.

Particularly badly hit was London's Heathrow airport where all domestic flights were cancelled several days in a row and international flights were seriously curtailed. In all, many hundreds of flights (40% of all scheduled) were abandoned leaving tens of thousands of would-be passengers stranded.

Graham Whitehead sent us the MetOp-A image opposite which clearly shows the fog enshrouding the capital and Midlands. **Alan Banks** also received this image and was sharp-eyed enough to spot the vapour plumes from a group of power stations, starkly highlighted by the low angle of the sun. Careful examination of the area immediately surrounding the Humber estuary shows five vapour plumes, all trailing southeastward. The enlarged image below shows them in greater detail and they are identified on the sketch map.

The power stations, five of England's largest coal-fired plants, are: Ferrybridge (1955 MW), Eggsborough (1960 MW), Drax (3870 MW), West Burton (1972 MW) and Cottam (2008 MW).
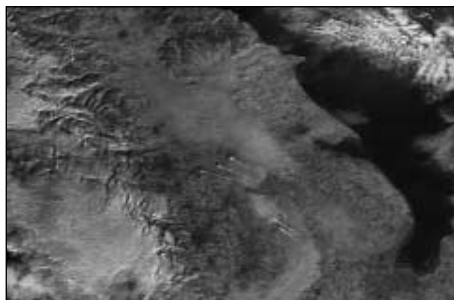
Enlargement from main image showing
the power station vapour plumes
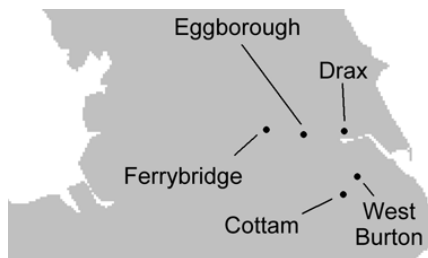
Locations of the five power stations
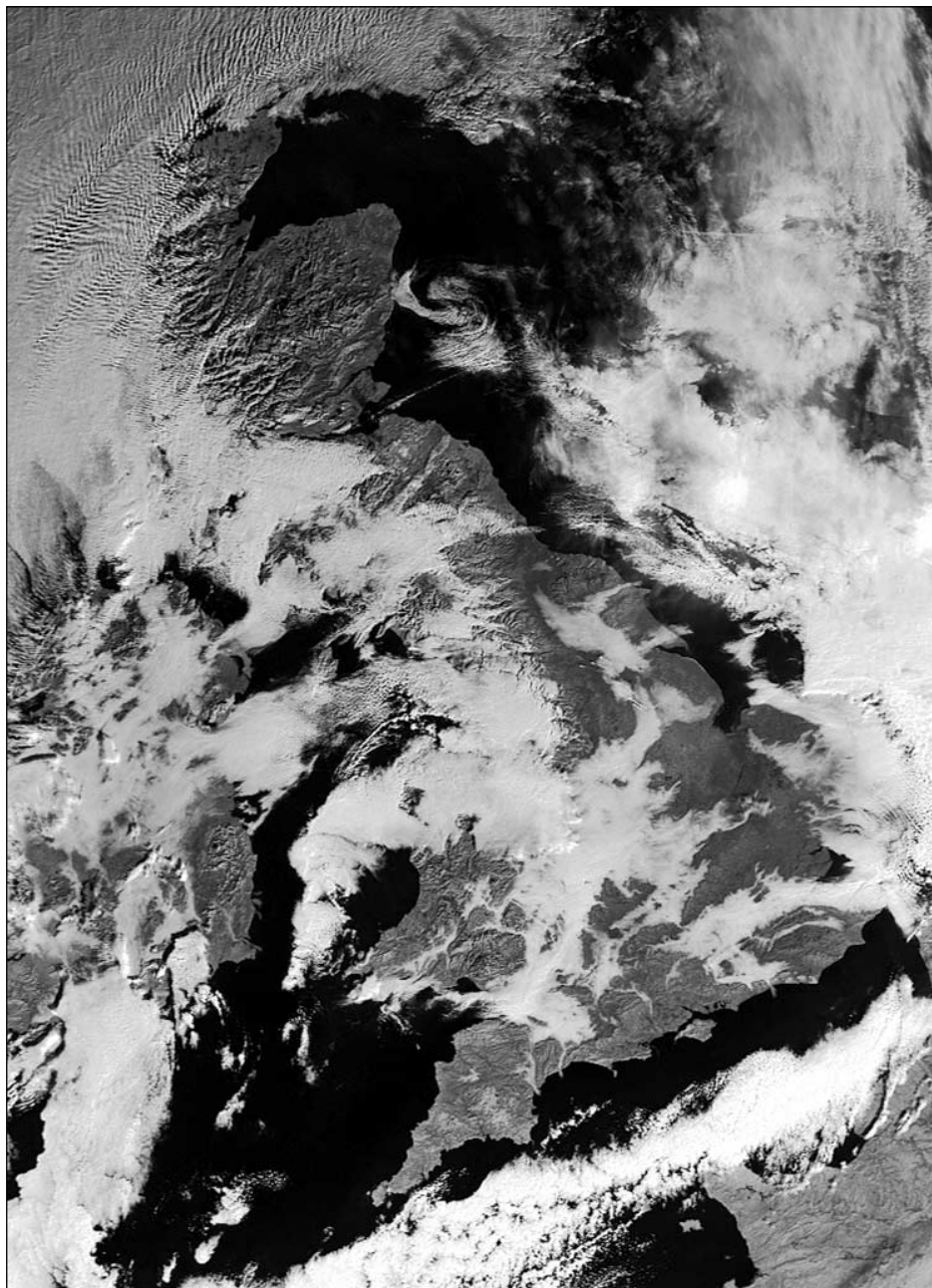
Graham Whitehead provided this splendid 10:25 UT December 20 image from **MetOp-A**. The image was captured via EUMETCast using David Taylor's *MetOp Manager*, and *HRPT Reader* software then enhanced with Adobe Photoshop.

Image © EUMETSAT 2006
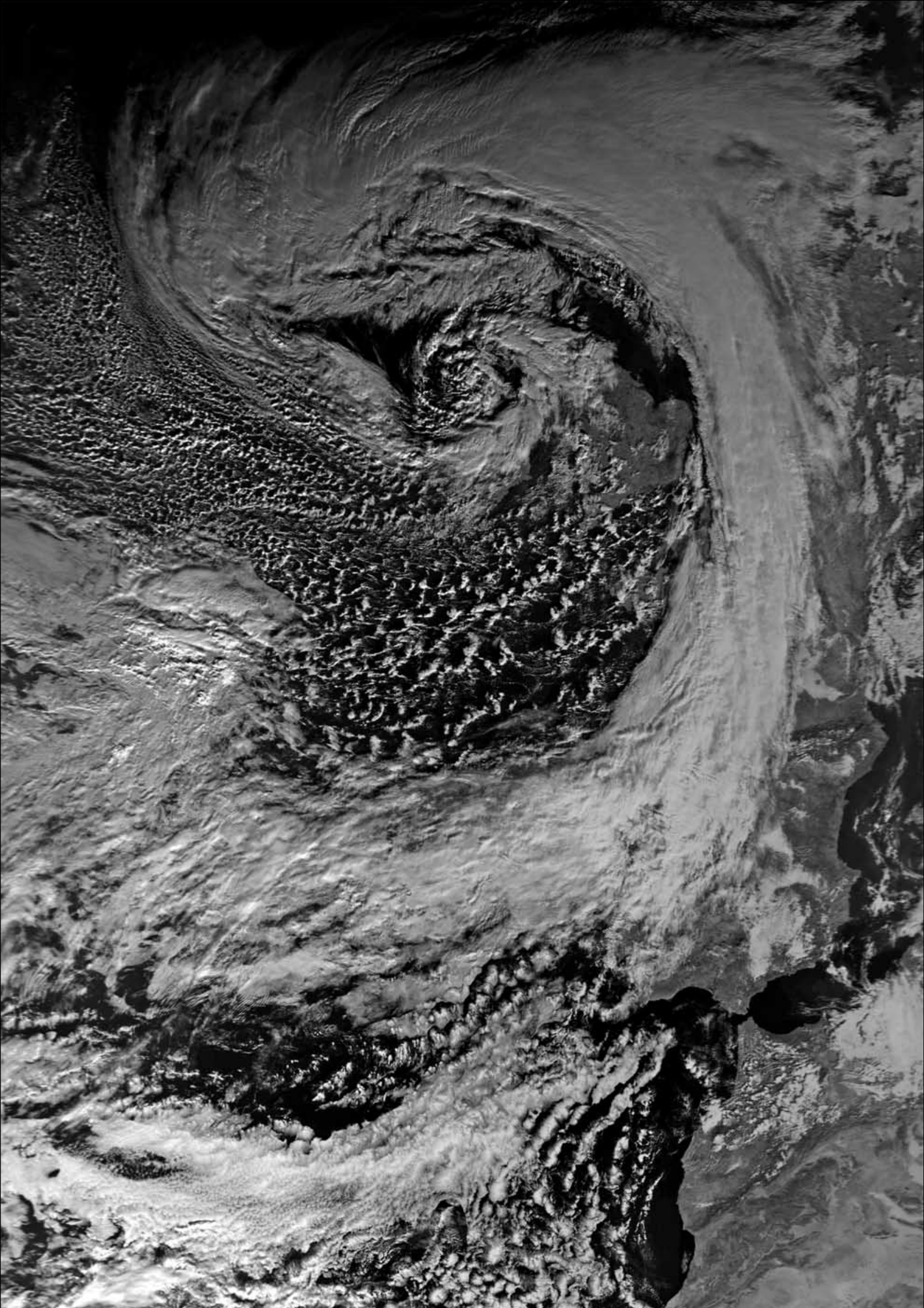
GEO Shop

Manager: Clive Finnis
e-mail: shop@geo-web.org.uk
FAX: +44 (0) 1202 893 323

R2FX APT Weather Satellite Receiver

This diminutive German-built APT receiver is packed with features and is the ideal receiver for the newcomer to the hobby. May be affected by pagers on the upper NOAA frequency of 137.91 MHz.

UK member's price   -   **£135.00**
UK non-member's price   -   **£149.00**

R2FX Accessory Pack

This contains everything required to implement a complete APT receiving system when used with the R2FX receiver. It comprises:

- 137 MHz Turnstile Antenna
- UK plug-in power supply
- PC audio lead + PC Serial 'computer control' lead
- Aerial lead (20 m with fitted connector)
- CD of PC shareware starter software
- Instructions

We do not normally ship outside the UK as this receiver should be available elsewhere more cheaply from the manufacturer. But contact the GEO Shop if you wish a quote.

UK member's price - **£59.00**   UK non-member's price - **£69.00**

TechniSat SkyStar 2 PCI Card

This 'free-to-air' DVB satellite TV and data receiver card recommended by EUMETSAT must be installed <u>inside</u> your computer. It comes with comprehensive installation instructions and a CD-ROM of driver software (if you do not feel confident about installing cards inside your computer, we recommend the USB version above)

UK members price   -   **£53.50**
UK non-members price   -   **£59.50**

TechniSat SatFinder Antenna Alignment Meter

This sensitive meter is a great help in setting up and aligning the dish for maximum signal. The meter comes with full instructions.

UK members price   -   **£21.50**
UK non-member's price   -   **£24.50**

TechniSat SkyStar 2 USB Box

This external 'free-to-air' DVB satellite TV and data receiver plugs into a USB port on your computer and comes complete with power supply, USB cable and a CD-ROM of driver software.

UK   -   **£94.50**
Continental Europe   -   **£119.50**

Telestar Universal Ku-band 0.6 dB Universal LNB

(or similar model)
Digital satellite TV Universal LNB for use with the SkyStar receivers above or any DVB satellite TV receiver.

UK members price   -   **£11.00**
Continental Europe   -   **£17.50**

Telestar 80 cm dish and Universal 0.6 dB LNB

(or similar model)
A quality German made aluminium dish and LNB with an AZ/EL mount to fit onto a vertical pole. (Wall or patio mounts are available from local satellite TV dealers)

UK members price   -   **£49.00**
UK non-members price   -   **£56.00**

Ordering and Shipping

We will ship by post, so please allow a few days for items to arrive in Europe and perhaps a few weeks for the Rest of the World.

Orders should be sent to:

GEO Shop,
44 Disraeli Road
Christchurch BH23 3NB
Dorset, England

If you are paying by credit card, you can FAX us your order to:

+44 (0) 1202 893 323

GEO PIC 1.0 for the RX2

Programmed with the new channel frequencies required for NOAA-18.

UK	-	**£7.00**
Continental Europe	-	**£7.80**
Rest of World	-	**£8.40**

GEO/Dartcom EPROM v 1.3

This new EPROM for the Dartcom APT receiver is available exclusively from GEO.

UK	-	**£10.00**
Continental Europe	-	**£10.75**
Rest of World	-	**£11.25**

Martelec MSR40 EPROM

UK	-	**£10.00**
Continental Europe	-	**£10.75**
Rest of World	-	**£11.25**

What if you are not a GEO Member?

GEO can provide most of the items advertised (with the exception of GEO Quarterly back-issues and CDs) to both members and non members. However, the latter cannot benefit from the discounted prices available to members.

Why not join GEO and take advantage of the discounted prices we can offer members.

Subscription Rates (12 months/4 issues of *GEO Quarterly*) are just £18 (UK), £21 (EU) and £24 (rest of world).

GEO Members' PRICE LIST

	Members Prices			Non Members		
	UK	EU	RoW	UK	EU	RoW
APT Equipment						
R2FX APT Receiver (no PSU)	135.00	-	147.00	149.00	-	161.00
R2FX Accessory Pack	59.00	-	-	69.00	-	-
Dartcom high quality QFH antenna	259.00	279.00	-	279.00	299.00	-
Turnstile APT antenna	37.50	-	-	42.50	-	-
GEO- PIC 1.0	7.00	7.80	8.40	7.00	7.80	8.40
GEO/Dartcom EPROM v 1.3	10.00	10.75	11.25	10.00	10.75	11.25
Martelec MSR40 EPROM	10.00	10.75	11.25	10.00	10.75	11.25
EUMETCast Equipment						
TechniSat SkyStar 2 PCI Card	53.50	55.00	-	59.50	61.00	-
Technisat Skystar USB box	94.50	113.50	-	119.50	123.50	-
Telestar 80 cm dish with LNB	49.00	-	-	56.00	-	-
Telestar Ku band universal LNB	11.00	12.50	-	17.50	19.00	-
Technisat Satfinder alignment meter	21.50	24.50	-	24.50	27.50	-
Miscellaneous						
GEO Quarterly Back Issues (subject to availability)	3.50	4.20	5.10	n/a	n/a	n/a
GEO 2004 CD (PDF back issues)	8.00	8.80	9.30	n/a	n/a	n/a
GEO 2005 CD (PDF back issues)	8.00	8.80	9.30	n/a	n/a	n/a
GEO 2006 CD (PDF back issues)	8.00	8.80	9.30	n/a	n/a	n/a
GEO Membership (4 x *GEO Quarterly*)	20.00	24.00	28.00	20.00	24.00	28.00

All prices are in £ sterling and include postage and packaging

NOAA Satellite Predictions

(Based on Latitude 52°N, Longitude 2°W, times in UT/GMT)

Date	NOAA 12 137.50 MHz	NOAA 15 137.50 MHz	NOAA 17 137.62 MHz	NOAA 18 137.91 MHz
Mar 01	05:33 07:13 15:22 17:02	05:49 07:29 15:39 17:19	11:04 12:44 20:54 22:34	01:36 03:17 11:32 13:12
Mar 02	05:08 06:48 14:58 16:37	05:25 07:05 15:15 16:55	10:41 12:21 20:31 22:11	01:26 03:07 11:21 13:01
Mar 03	04:43 06:23 16:12 17:53	05:02 06:41 14:52 16:31	10:18 11:58 20:08 21:48	01:15 02:56 11:11 12:51
Mar 04	05:58 07:38 15:48 17:28	06:18 07:58 16:07 17:48	09:55 11:35 19:46 21:24	01:05 02:46 11:01 12:41
Mar 05	05:34 07:14 15:23 17:03	05:54 07:34 15:43 17:23	11:12 12:52 21:01 22:42	02:35 04:17 12:30 14:12
Mar 06	05:09 06:49 14:59 16:38	05:30 07:10 15:20 16:59	10:49 12:29 20:39 22:19	02:25 04:06 12:20 14:02
Mar 07	04:44 06:24 16:13 17:54	05:06 06:46 14:57 16:35	10:26 12:06 20:16 21:55	02:15 03:56 12:10 13:51
Mar 08	06:00 07:40 15:49 17:29	06:22 08:02 16:12 17:53	10:03 11:43 19:53 21:32	02:04 03:45 12:00 13:41
Mar 09	05:35 07:15 15:24 17:04	05:58 07:39 15:48 17:28	09:40 11:20 21:09 22:50	01:54 03:35 11:49 13:30
Mar 10	05:10 06:50 15:00 16:39	05:35 07:15 15:25 17:04	10:57 12:37 20:46 22:27	01:44 03:25 11:39 13:20
Mar 11	04:46 06:25 16:14 17:55	05:11 06:51 15:01 16:40	10:33 12:14 20:24 22:03	01:33 03:14 11:29 13:09
Mar 12	06:01 07:41 15:50 17:30	06:27 08:07 16:16 17:57	10:10 11:50 20:01 21:40	01:23 03:04 11:19 12:59
Mar 13	05:36 07:16 15:25 17:05	06:03 07:43 15:53 17:33	09:47 11:27 19:39 21:17	01:13 02:54 11:09 12:48
Mar 14	05:11 06:51 15:01 16:40	05:39 07:20 15:29 17:09	11:04 12:45 20:54 22:35	01:03 02:43 12:38 14:20
Mar 15	04:47 06:26 16:15 17:57	05:16 06:56 15:06 16:45	10:41 12:21 20:31 22:11	02:33 04:14 12:28 14:10
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Mar 17	05:37 07:17 15:27 17:06	06:08 07:48 15:57 17:38	09:55 11:35 19:46 21:25	02:12 03:53 12:07 13:49
Mar 18	05:12 06:52 15:02 16:41	05:44 07:24 15:34 17:14	11:12 12:52 21:02 22:43	02:02 03:43 11:57 13:38
Mar 19	04:48 06:28 16:17 17:58	05:20 07:00 15:11 16:50	10:49 12:29 20:39 22:19	01:52 03:33 11:47 13:28
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Mar 22	05:14 06:53 15:03 16:42	05:49 07:29 15:39 17:18	09:40 11:20 21:10 22:51	01:21 03:01 11:17 12:56
Mar 23	04:49 06:29 16:18 17:59	05:25 07:05 15:15 16:54	10:57 12:37 20:47 22:27	01:10 02:51 11:06 12:46
Mar 24	06:04 07:44 15:53 17:34	05:01 06:41 14:52 16:31	10:34 12:14 20:24 22:04	02:41 04:22 12:36 14:18
Mar 25	05:39 07:19 15:29 17:08	06:17 07:58 16:07 17:48	10:11 11:51 20:01 21:40	02:30 04:11 12:25 14:07
Mar 26	05:15 06:55 15:05 16:43	05:54 07:34 15:43 17:23	09:48 11:28 19:39 21:17	02:20 04:01 12:15 13:57
Mar 27	04:50 06:30 14:40 16:19	05:30 07:10 15:20 16:59	11:05 12:45 20:54 22:35	02:10 03:51 12:05 13:46
Mar 28	06:05 07:45 15:54 17:35	05:06 06:46 14:57 16:35	10:42 12:22 20:32 22:12	01:59 03:40 11:55 13:35
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Apr 02	05:42 07:22 15:31 17:11	04:47 06:27 16:16 17:57	10:26 12:06 20:17 21:56	01:08 02:49 11:04 12:43
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Apr 05	06:07 07:47 15:56 17:37	05:16 06:56 15:06 16:45	10:57 12:37 20:47 22:27	02:17 03:58 12:12 13:54
Apr 06	05:43 07:23 15:32 17:12	04:52 06:32 16:21 18:02	10:34 12:14 20:24 22:04	02:07 03:48 12:02 13:43
Apr 07	05:18 06:58 15:08 16:47	06:08 07:48 15:57 17:38	10:11 11:51 20:02 21:41	01:57 03:38 11:52 13:33
Apr 08	04:53 06:33 14:44 16:22	05:44 07:24 15:34 17:13	09:48 11:28 19:39 21:18	01:46 03:27 11:42 13:22
Apr 09	06:08 07:49 15:58 17:38	05:20 07:00 15:10 16:49	11:05 12:45 20:55 22:35	01:36 03:17 11:32 13:12
Apr 10	05:44 07:24 15:33 17:13	04:57 06:36 16:26 18:07	10:42 12:22 20:32 22:12	01:26 03:07 11:22 13:01
Apr 11	05:19 06:59 15:09 16:48	06:13 07:53 16:02 17:43	10:19 11:59 20:09 21:49	01:15 02:56 11:11 12:51
Apr 12	04:54 06:34 14:45 16:23	05:49 07:29 15:38 17:18	09:56 11:36 19:47 21:25	01:05 02:46 11:01 12:41
Apr 13	06:10 07:50 15:59 17:39	05:25 07:05 15:15 16:54	11:13 12:53 21:02 22:43	02:36 04:17 12:30 14:12
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Apr 20	04:57 06:37 14:47 16:25	05:58 07:38 15:48 17:28	10:11 11:52 20:02 21:41	01:23 03:04 11:19 12:59
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Apr 23	05:22 07:02 15:12 16:51	04:47 06:27 16:16 17:57	10:42 12:22 20:32 22:12	02:33 04:14 12:28 14:10
Apr 24	04:58 06:38 14:48 16:26	06:03 07:43 15:52 17:33	10:19 11:59 20:10 21:49	02:22 04:04 12:18 13:59
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Apr 27	05:24 07:03 15:13 16:52	04:52 06:32 16:21 18:02	10:50 12:30 20:40 22:20	01:51 03:32 11:47 13:27
Apr 28	04:59 06:39 14:49 16:28	06:08 07:48 15:57 17:38	10:27 12:07 20:17 21:57	01:41 03:22 11:37 13:17
Apr 29	06:14 07:54 16:03 17:44	05:44 07:24 15:34 17:13	10:04 11:44 19:55 21:34	01:31 03:12 11:27 13:07
Apr 30	05:49 07:29 15:39 17:18	05:20 07:00 15:10 16:49	09:41 11:21 21:11 22:52	01:20 03:01 11:16 12:56

Date	NOAA 12 137.50 MHz	NOAA 15 137.50 MHz	NOAA 17 137.62 MHz	NOAA 18 137.91 MHz
May 01	05:25 07:05 15:14 16:53	04:56 06:36 14:47 16:25	10:58 12:38 20:48 22:28	01:10 02:51 11:06 12:46
May 02	05:00 06:40 14:50 16:29	06:12 07:53 16:02 17:42	10:35 12:15 20:25 22:05	02:41 04:22 12:35 14:18
May 03	06:15 07:55 16:04 17:45	05:49 07:29 15:38 17:18	10:12 11:52 20:02 21:41	02:30 04:11 12:25 14:07
May 04	05:50 07:30 15:40 17:20	05:25 07:05 15:15 16:54	09:49 11:29 19:40 21:18	02:20 04:01 12:15 13:56
May 05	05:26 07:06 15:15 16:55	05:01 06:41 14:52 16:30	11:06 12:46 20:55 22:36	02:09 03:50 12:05 13:46
May 06	05:01 06:41 14:51 16:30	06:17 07:57 16:06 17:47	10:43 12:23 20:33 22:13	01:59 03:40 11:54 13:35
May 07	06:16 07:56 16:05 17:46	05:53 07:33 15:43 17:23	10:20 12:00 20:10 21:49	01:49 03:30 11:44 13:25
May 08	05:52 07:32 15:41 17:21	05:30 07:10 15:19 16:59	09:57 11:37 19:47 21:26	01:38 03:19 11:34 13:14
May 09	05:27 07:07 15:16 16:56	05:06 06:46 14:56 16:35	11:14 12:54 21:03 22:44	01:28 03:09 11:24 13:04
May 10	05:02 06:42 14:52 16:31	06:22 08:02 16:11 17:52	10:50 12:31 20:40 22:21	01:18 02:59 11:14 12:53
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May 12	05:53 07:33 15:42 17:22	05:34 07:14 15:24 17:04	10:04 11:44 19:55 21:34	02:38 04:19 12:33 14:15
May 13	05:28 07:08 15:18 16:57	05:10 06:50 15:01 16:40	09:41 11:21 21:11 22:52	02:27 04:08 12:22 14:04
May 14	05:03 06:43 14:53 16:32	04:47 06:27 16:16 17:57	10:58 12:38 20:48 22:28	02:17 03:58 12:12 13:54
May 15	06:18 07:59 16:07 17:48	06:03 07:43 15:52 17:33	10:35 12:15 20:25 22:05	02:07 03:48 12:02 13:43
May 16	05:54 07:34 15:43 17:23	05:39 07:19 15:29 17:08	10:12 11:52 20:03 21:42	01:56 03:37 11:52 13:33
May 17	05:29 07:09 15:19 16:58	05:15 06:55 15:05 16:44	09:49 11:29 19:40 21:19	01:46 03:27 11:42 13:22
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May 23	06:21 08:01 16:10 17:50	06:12 07:52 16:02 17:42	10:51 12:31 20:41 22:21	02:25 04:06 12:20 14:01
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Jun 03	05:09 06:49 14:59 16:38	05:10 06:50 15:01 16:39	09:57 11:37 19:48 21:27	02:12 03:53 12:07 13:48
Jun 04	06:24 08:04 16:13 17:54	04:46 06:26 16:16 17:57	09:34 11:14 21:04 22:45	02:01 03:42 11:57 13:37
Jun 05	05:59 07:39 15:48 17:29	06:02 07:43 15:52 17:32	10:51 12:31 20:41 22:21	01:51 03:32 11:46 13:27
Jun 06	05:35 07:15 15:24 17:03	05:39 07:19 15:28 17:08	10:28 12:08 20:18 21:58	01:41 03:22 11:36 13:16
Jun 07	05:10 06:50 15:00 16:39	05:15 06:55 15:05 16:44	10:05 11:45 19:56 21:35	01:30 03:11 11:26 13:06
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Jun 10	05:36 07:16 15:25 17:05	05:43 07:23 15:33 17:13	10:36 12:16 20:26 22:06	02:40 04:21 12:35 14:17
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Jun 16	04:47 06:27 16:16 17:57	05:00 06:40 14:51 16:30	09:57 11:37 19:48 21:27	01:38 03:19 11:33 13:14
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Jun 30	05:41 07:21 15:30 17:10	06:07 07:47 15:56 17:37	09:35 11:14 21:04 22:45	02:35 04:16 12:29 14:11

GEO Helplines

Douglas Deans, Dunblane, Perthshire, SCOTLAND
All aspects of weather satellites from APT, HRPT to Meteosat-8 DVB/EUMETCast systems.
- telephone:(01786) 82 28 28
- e-mail: dsdeans@tiscali.co.uk

John Tellick, Surbiton, Surrey, ENGLAND
Meteosat-8 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

Keith Holland, London, ENGLAND
Specifically, help for APT users (137 MHz band).
- e-mail: geo@koholland.plus.com

David Strickland, Truro, Cornwall, ENGLAND
David has set up his own wireless network system of three computers. He has interests in electronic design and prototyping, general computing, microchip processors with various facilities and of course MSG satellite imaging. He will be happy to discuss any of the above topics, and to help anyone local, including viewing his setup.
- e-mail: David@Strickland.uk.com

Geoff Morris GW3ATZ, Shotton, Flintshire, NE WALES
Geoff has lots of experience with aerial, co-ax,connectors, mounting hardware etc. and has also done a lot of work with the orbiting satellites. Geoff has been a *EUMETCast* Meteosat-8 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

Guy Martin G8NFU, Biggin Hill NW Kent, ENGLAND
Guy is prepared to advise anyone who wishes to receive MSG under Windows 2000.
- agm@tonbridge-school.org

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

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

Useful Internet Discussion Groups

There are a number of 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.

GEO-Subscribers
This is a group where GEO members can exchange information relating to either GEO itself or Earth observation satellites and related matters.

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

Satsignal
An end-user self help group for users of David Taylor's Satellite Software Tools including the orbit predictor WXtrack; the file decoders GeoSatSignal and SatSignal; the HRPT Reader and image creator program; the image remapper GroundMap; and software for the EUMETCast service—the MSG Data Manager, the 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 can share information about the EUMETCast reception hardware and software for the Meteosat geostationary satellites.

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

METOP
A forum for users of high-resolution AHRPT data from the MetOp satellite, available via EUMETCast.

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

AVHRR
A forum for users who download high-resolution EARS-AVHRR data from the NOAA polar orbiting weather satellites via EUMETCast.

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

ATOVS
A Group for discussions about using ATVOS data. With 40 sounder channels (20 microwave, 19 thermal and 1 visible), there is a vast amount of data available. Data from the whole world is available from CLASS (www.class.noaa.gov) and for an extended Europe, via EUMETCast.

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

Weather Satellite Reports
A group providing reports, updates and news on operational aspects of weather satellites.

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

WXtoImg
Users of the WXtoImg software package for capturing and imaging NOAA APT can air their problems, discuss its features and ask questions about it.

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

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Earth Imaging News

Peter Wakelin

DMSP 17 Launched

A *Boeing Delta 4M* vehicle launched the 17th weather satellite in the Defense Meteorological Satellite Program from Vandenberg, California on November 4. The satellite was placed into the usual 850 km sun-synchronous orbit with a single burn of this powerful rocket's second stage. Some time after spacecraft separation from the rocket there was a fragmentation event (see below) but the payload was not affected. An early switch to protective 'safe mode' was attributed to software issues, according to a NOAA report.

More Fragments Threaten Spacecraft

During a period of almost 12 months to the beginning of May 2006 no satellite breakups were detected but since then no fewer than nine have fragmented. The possible causes of fragmentation include a direct collision with another orbiting body (even a tiny fragment travelling at orbital speeds has colossal kinetic energy); a build-up of pressure within fuel tanks and batteries causing rupture; or even a very small leak leading to a satellite spinning faster and faster until it breaks up. Another cause is deliberate destruction and two of the nine fragmented for this reason.

Cosmos 2423's deliberate destruction on November 17 was not unexpected as the previous satellites in this class of 7-ton Russian military Earth-imaging craft suffered the same fate. The Russians like to ensure that no part of these spacecraft survive atmospheric re-entry and fall into the wrong hands. As they operate in very low orbits, the orbital lifetimes of fragments tend to be short and most burned up within a few weeks.

The Chinese have admitted that the destruction of their *Feng Yun-1C* weather satellite on January 11 was the result of the successful test of an anti-satellite weapon. At the time of writing, evidence is emerging that several earlier attempts had been made to destroy a satellite, possibly the same one. Hundreds of fragments large enough to be tracked by radar have been catalogued but there will be thousands more tiny ones in long-lifetime orbits as Feng Yun was circling Earth at 850 km altitude.

After successfully lofting *DMSP-17* into orbit on November 4, the Delta 4M second stage had ample fuel remaining to reduce speed significantly and make a steep descent into the Pacific Ocean, thereby avoiding the possible damage or injury on the ground that could result from a natural decay. However, soon after payload separation, and a full orbit before the successful re-entry burn, at least 60 trackable pieces of debris were ejected. The mechanism for this debris generation is not yet understood and an investigation is under way to determine the cause and prevent similar occurrences in future Delta 4 launches.

Another Delta fragmented on December 3 after being dormant in orbit for 17 years. This was the Delta-2 vehicle used to launch NASA's Cosmic Background Explorer (COBE) into a 900 km sun-synchronous orbit but the Delta was in a 685 x 790 km orbit at the time of the breakup. This fragmentation was not expected as the vehicle had been 'passivated' at the end of its mission by venting all remaining volatile materials. A collision with another piece of debris is the most likely cause of this breakup.

Also in December, the second stage of the H-2A vehicle used to orbit Japan's second classified Information Gathering System (IGS) spacecraft last September fragmented. As the perigee of its orbit was only 430 km, the lifetimes of these fragments will be short.

GOES 13 Completes On-Orbit Testing

Previously known as GOES-N, this Boeing-built satellite was launched in May, 2006 and is the first of three of a more advanced design. After carrying out basic engineering tests for a month after launch, Boeing turned GOES 13 over to NASA for performance testing in mid-summer. In December and early January, NOAA carried out science and operations performance testing and on January 5 turned off the instruments in preparation for on-orbit storage until required.

Enhancements over the earlier GOES spacecraft include:

- Improved Image Navigation and Registration (INR) by using star trackers.
- A more stable optical bench to isolate thermal deformations of the spacecraft from the Imager and Sounder instruments.
- An improved Data Collection System so that more Data Collection Platforms can use the link at the same time.
- An improved power subsystem enabling better management during eclipse periods.
- Design life has been increased to 10 years and expected propellant lifetime increased to at least 13 years.
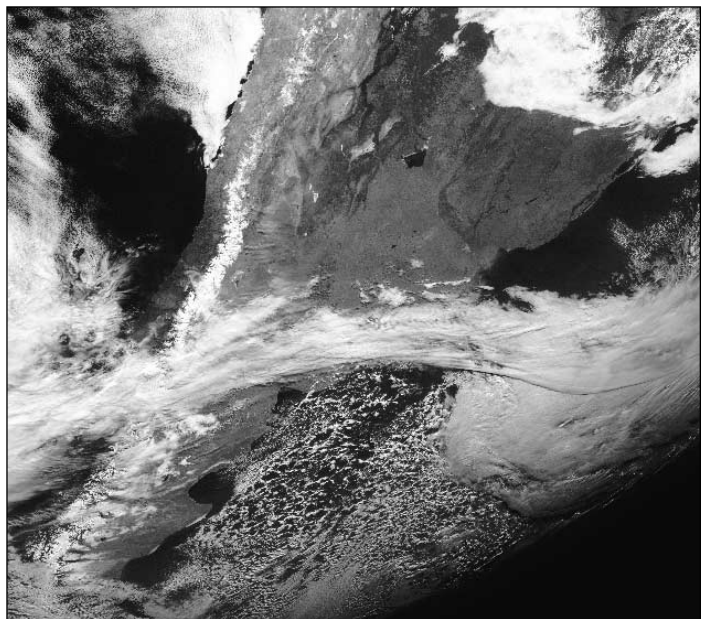
A GOES-13 visible image from June 22, 2006 showing Argentina and southern Chile on a largely fine Winter afternoon
Credit: NASA/GSFC

Formosat-3 is an Outstanding Success

Since its launch in April, 2006, this joint US/Taiwanese project, which is also known as COSMIC (Constellation Observing System for Meteorology, Ionosphere and Climate), has resulted in greatly improved accuracy in profiling temperatures and water content in the high atmosphere.

The set of six tiny satellites is probing the atmosphere in a new way and takes measurements above the entire planet. *COSMIC* works by detecting the tiny changes in the speed of signals received from the numerous GPS (Global Positioning System) satellites when the atmosphere intervenes as it inevitably must on several thousand occasions every day.

In a test conducted at the European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading, UK, scientists found that the inclusion of *COSMIC* data significantly improved stratospheric temperature forecasts over the northern hemisphere. Further information on the *COSMIC* programme can be found on the University Corporation for Atmospheric Research's website at:

http://www.cosmic.ucar.edu

NOAA Satellites Helped in Saving 272 Lives in 2006

NOAA's geostationary and polar-orbiting satellites, together with the Russian's Cospas craft make up the international Search and Rescue Satellite-Aided Tracking System called COSPAS-SARSAT. In the US and surrounding waters alone, 272 people were saved last year after signals from emergency beacons were detected by spacecraft, and their positions relayed to the appropriate Rescue Coordination Center. Worldwide, and since the the system was created in 1982, there have been more than 20,300 rescues. With the phasing out of the older beacons operating at 121.5 and 243 MHz in the next two years, the number of rescues is likely to rise as the 406 MHz beacons, which use GPS technology, become the new standard.

Cassini Views Earth From Beyond Saturn

The planet Mercury is difficult to observe from Earth because it orbits much closer to the Sun than we do and their angular separation rarely exceeds 25°. Viewed from the vicinity of Saturn, Earth is always within 7° of the Sun so the spectacular image below was taken whilst Cassini was passing through Saturn's shadow to avoid camera damage.
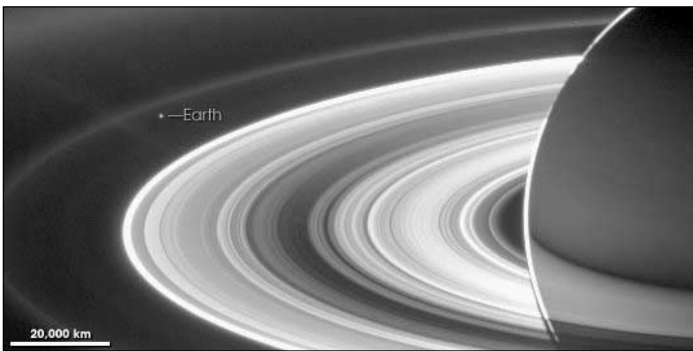
Cassini images Saturn and Earth
Credit: CICLOPS Team

The image is a composite made up from 165 separate images taken with the wide-angle camera on the Cassini spacecraft over nearly three hours on September 15, 2006. This back-lit image of the rings shows them as never seen before and reveals unprecedented detail in the ice and dust particles that make up the rings. At the time of the image, Cassini was about 2.2 million kilometres from Saturn and just short of 1,500 million kilometres from Earth. Links to the Cassini-Huygens mission and more remarkable images can be found on the website of the Cassini Imaging Central Laboratory for Operations (CICLOPS) at:

http://CICLOPS.org

40 Years of Geostationary Weather Satellites

On December 6, 1966, *ATS-1* (Applications Technology Satellite) was launched to became the first spacecraft to routinely image Earth from the geostationary orbit. The Spin-Scan camera on board was the idea of University of Wisconsin-Madison scientist Verner E Suomi and, although the US now uses three-axis stabilised satellites for their GOES

The ATS-1 Spacecraft
Credit: NASA

programme, the second generation Meteosats and the Chinese FY-2 series still use the spin-scan system.
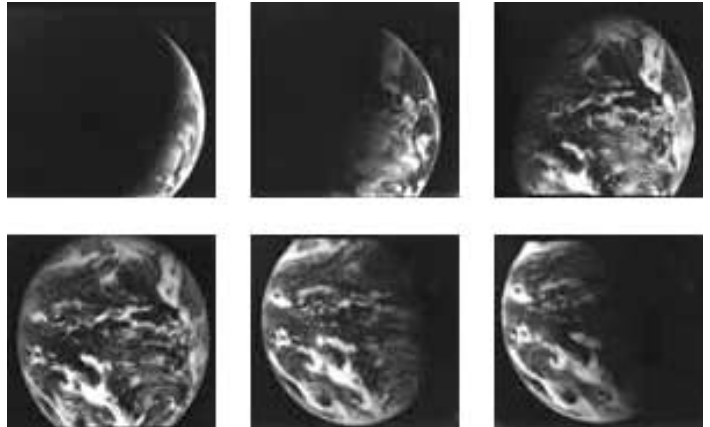
Sequence of ATS-1 Images taken on December 12, 1966
Credit: Space Science and Engineering Center, University of Wisconsin-Madison

By modern standards, *ATS-1* looks rather crude and its imagery, which was in the visible part of the spectrum only, was of low resolution. WEFAX imagery was transmitted on 135.6 MHz

China Launches Feng Yun 2D

The fourth geostationary weather satellite launched by China lifted off from the country's most southerly launch site at Xichang at 0053 UTC on December 8 on board a Chang Zheng-3A rocket. After checkout it is expected to operate simultaneously with the still-functioning FY-2C satellite.

A further four spacecraft in the FY-2 series are to be launched before the next-generation FY-4 series is developed. Six of the latter are planned for launch before 2020 as are 12 in the FY-3 series of polar-orbiting spacecraft, according to sources within the China Meteorological Administration. The first FY-3 is expected to be launched this year.

FY 2D lifts off from Xichang in mountainous Sichuan Province
Credit: Xinhua

India's PSLV Launches Four Satellites

In its tenth flight conducted from the Satish Dhawan Space Centre at Sriharikota, north of Chennai, India, the Indian Space Research Organisation's Polar Satellite Launch Vehicle (PSLV) successfully launched four satellites on January 10. They were India's *CartoSat-2* and Space capsule Recovery Experiment (SRE-1), Indonesia's *LAPAN-TUBSat* and Argentina's *PehuenSat-1*. For the first time, a Dual Launch Adapter (DLA) was used in the PSLV to accommodate two primary satellites in tandem.
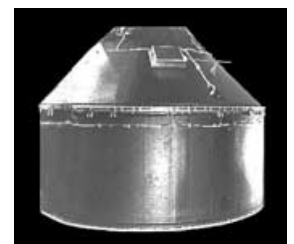
The tiny PehuenSat attached to the DLA
Credit: ISRO

The 680 kg main payload, *CartoSat-2*, mounted above the DLA, was the first satellite to be injected into the 635 km sun-synchronous orbit, followed 45 seconds later by the DLA with the tiny 6 kg *PehuenSat* (pronounced pea-when-sat) mounted upon it. Two minutes later, *SRE-1* was separated and, after a further 190 s, *LAPAN-TUBSat* was separated. All the payloads were

MetOp Manager

A Review of David Taylor's new Receiving Software

Douglas Deans

The successful launch and deployment of Europe's first polar orbiting meteorological satellite, MetOp-A, has already made it possible to receive global—yes worldwide—HRPT data via the *EUMETCast* system. In time, regional data will also become available via *EUMETCast* and also for users equipped to receive the satellite's direct read-out LRPT and AHRPT signals.

The first trial MetOp-A data started being disseminated through *EUMETCast* during November 2006 and will continue well into spring 2007—until the satellite is, hopefully, declared fully operational.

The quantity and complexity of the new data meant that new software would be needed and, once again, a good friend of the weather satellite community, David Taylor, came to the rescue. Within a few days of the first trial data appearing, a beta version of *MetOp Manager*, his new software, was available …a remarkable feat.
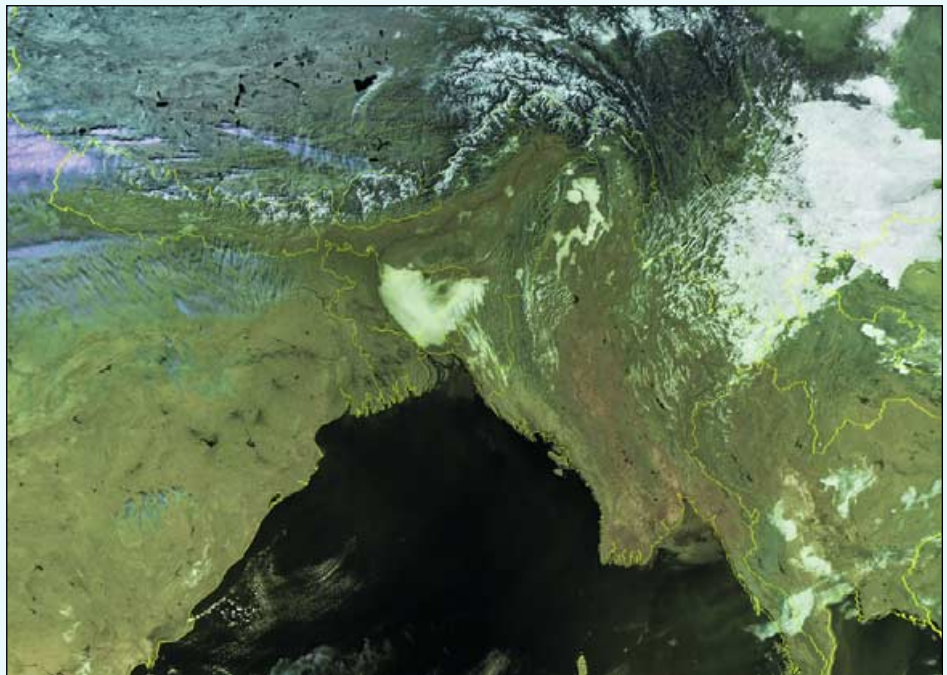
Figure 1 - The Bay of Bengal and Bangladesh, with the snow covered Himalayas to the north.
Image © EUMETSAT 2007

Figure 2 - A false coloured image showing part of Antarctica
Image © EUMETSAT 2007
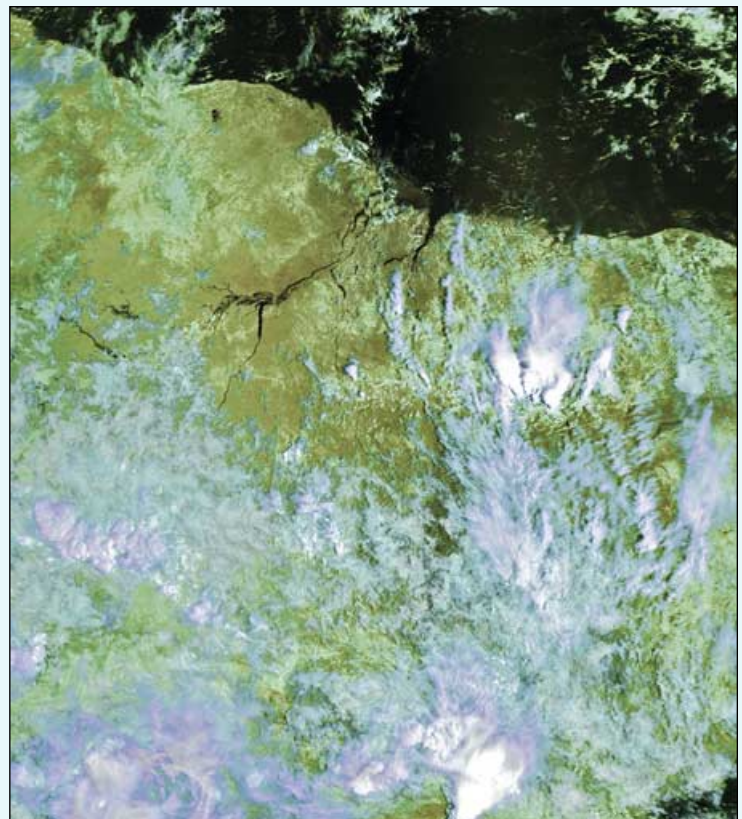
Figure 3 - A false coloured view over South America, showing the Amazon basin.
Image © EUMETSAT 2007

Readers wishing to learn more about the launch of MetOp and the satellite's wide ranging suite of on-board instruments should refer to articles in the previous issue of GEO Quarterly [1,2].

MetOp's Data Services

A brief word about the services which the satellite will provide. These can be divided into three basic categories:

- The **Direct Readout Service** will provide both AHRPT and LRPT data streams for those with receiving stations and appropriate receivers and antennas. AHRPT carries all instrument data whilst the LRPT service will provide ATOVS (MHS, AMSU-A and HIRS) at full resolution plus three of the AVHRR channels in JPEG compressed format.

- The **Global Data Service** already provides, in near real-time to the user community, products generated from instrument data. All instrument data recorded during the previous orbit of MetOp are dumped to the Central Data Acquisition Station (CDA) located on the island of Spitzbergen in Svalbard. The time to complete one orbit is about 102 minutes. The data received at the CDA is transferred to the EPS Core Ground Segment (CGS) located at *EUMETSAT* headquarters in Darmstadt, Germany, where it is processed for distribution via the *EUMETCast* system. Global data products originating from the NOAA spacecraft will also be generated in the EPS CGS and disseminated via *EUMETCast*.

- The **MetOp Regional Data** service is provided by the *EUMETSAT* Advanced Retransmission Service (EARS). EARS comprises three separate polar satellite instrument data services. These are the existing EARS-ATOVS and the pilot EARS-AVHRR and EARS-ASCAT.

Some of the data rates and quantities are incredible given that many are being provided as full resolution global data. I anticipate that the majority of amateurs will be mainly interested in the global AVHRR data. That in itself is a challenge with 28 MB files (each containing a 3-minute chunk of data) arriving every few minutes. That represents over half a <u>gigabyte</u> of data per hour, constituting an additional 14 GB per day for those running 24/7. So as well as data quantities to consider, data through-put [3,4] will also be a serious factor.

The EPS data channels and rates are not yet finalised and there is a likely prospect that NOAA data will also be transmitted through the EPS system at a later date. However, for the moment, let
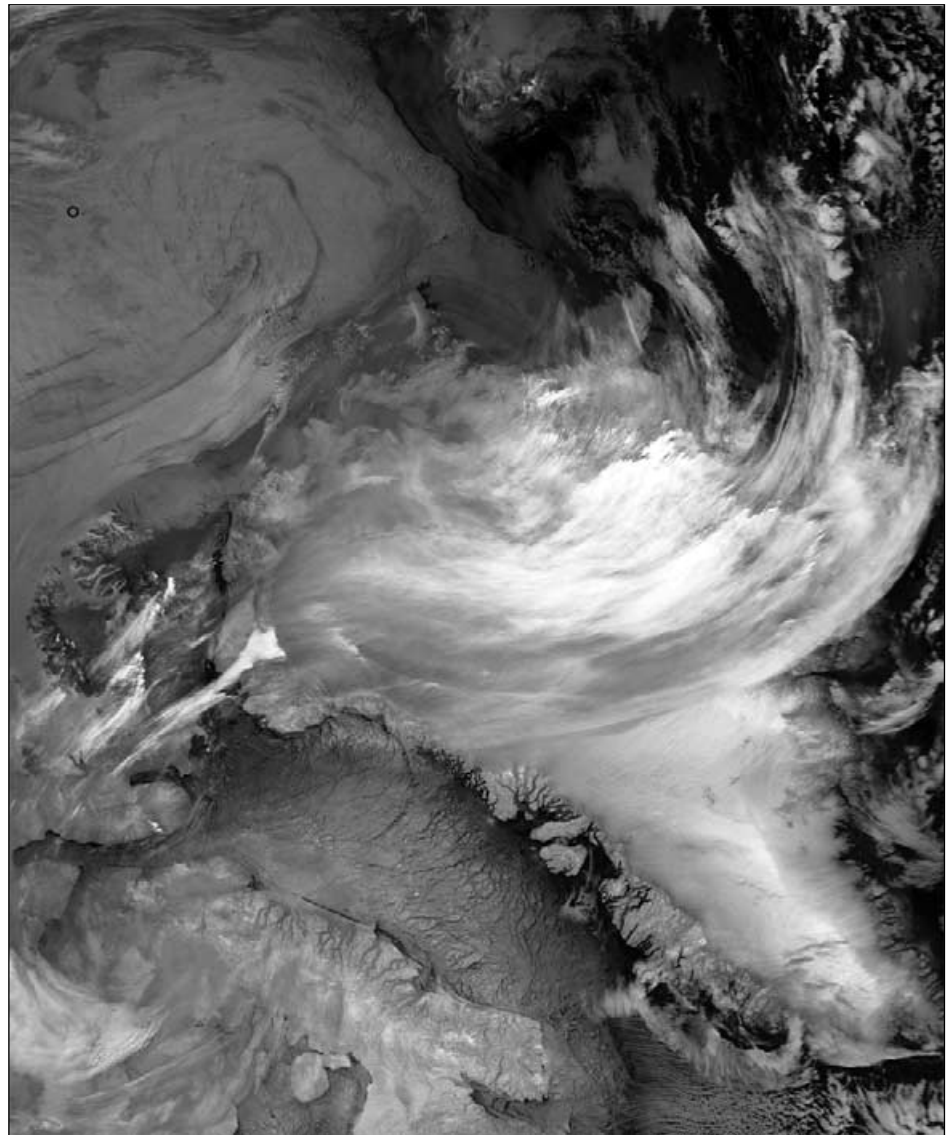
Figure 4 - Channel 4 IR image of Greenland, Arctic ice and the North Pole (circled at upper left)
Image © EUMETSAT 2007

us concentrate on MetOp-A and in particular the global AVHRR data.

MetOp Manager (MOM)

I don't know quite how he does it but, within a few days of the first preliminary uncalibrated AVHRR test data being made available through *EUMETCast*, David Taylor had this new software up and running. Although it has already evolved from its early beginnings into a sophisticated program, *MetOp Manager* is still a work in progress. Indeed, I expect there will be further exciting and useful options available by the time you read this.

As far as amateurs are concerned, the real gem from MetOp-A is the global AVHRR data providing 6-channel, 1-km resolution of the entire world and made available via *EUMETCast* about 1 hour 40 minutes later; i.e. one orbit delayed: unbelievable! A lot of sophisticated data is already provided from MetOp (with more to come, since commissioning is not yet complete as I write), but whether much will be of interest to amateurs, only

time will tell. David Taylor is keeping a very open mind on this and his program may well be developed further in the future to cater for other data forms.

Processing AVHRR Data with MOM

We must remember that global data presents a completely new challenge for all of us, so let us consider some of the issues that had to be addressed.

- How do we handle new data of the order of 13 GB per day? The raw data file format has changed from that sent by the NOAA satellites, and as such cannot be utilised directly in programs such as *HRPT Reader*.

- How can days worth of global data be best saved and then retrieved in a meaningful way ? There has to be some form of visual interface which allows users to pick data on a time and date basis, or from a geographical location.

- How many segments of data do we wish to see at any one time ? As
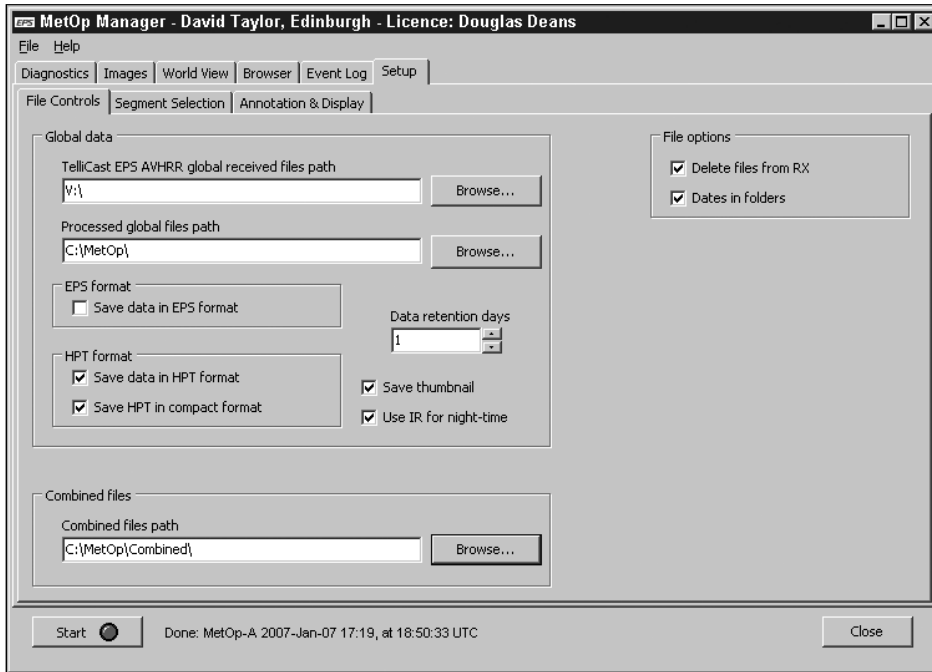
Figure 5 - The MetOp Configuration Screen

David said to me, each of our computers will now be similar to an SAA database with a graphical interface to allow selection of images. In some ways it is more onerous than SAA since the NOAA satellites could not handle global HRPT data but only preselected areas from recordings. So we can see the sort of searching questions confronting David even at the concept stage of his software.

Let us now examine just how solutions to all those issues have been incorporated into MOM.

When *MetOp Manager* is first loaded, it is important to go to **<Setup tab/File Controls>** and ensure all the options are set up correctly for your particular computer arrangement. Let us look in some detail at what is required here, as any errors at this stage can cause problems. Once set up, the program can be left in full automation.

A typical setup page is illustrated above in figure 5. The first box, labelled '*Tellicast EPS AVHRR global received files path*' should point to the folder where the raw MetOp data is being stored. Of course, for those using a two-computer system, this will look across the network to the relevant folder on the 'receive' computer.

The '*Processed global files path*' should contain the location where you want MOM to store your processed data. By default the program forms a new folder under MSG-1 but I prefer to see this data completely separated from the geostationary stuff, hence the MetOp folder seen in the figure. The choice is yours.

MOM Save Formats

MetOp Manager allows you to save files in both EPS format and HPT formats. EPS is the format in which the data is sent and is used by MOM to produce its quicklooks and the other channel view options. The EPS format is quite different from the 'L1B' HRPT format we have been used to receiving from the NOAA satellites and so <u>cannot</u> be used in programs such as *HRPT Reader*. However, David has uniquely been able to offer the additional option of saving

the data in 'HPT' format, which can be read by his existing *HRPT Reader* with all the options and advanced features that it offers.

I know this has caused him considerable work but it has meant that a program that most of us already have can continue to be utilised, avoiding the extra cost of a new viewing and processing platform. David has to be applauded for this work and I understand, certainly at the time of writing, that he is the only author to provide an L1B to HPT conversion. So I suggest that saving in HPT format is all that is needed.

The current image is always loaded into MOM anyway and any further looks at either individual segments (or should that be chunks!) or combined segments is best done with *HRPT Reader*—which of course allows you to enjoy the full processing options which that program offers. In addition, saving both formats will make a huge 'hole' in your hard drive. EPS format alone amounts to over 13 GB each day. Again, it is for you to choose but, at least initially, I would suggest keeping '*Save data in EPS format*' unticked and ticking <u>both</u> options in the '*HPT format*' box.

'*Data retention days*' is self explanatory but be careful not to set this too high unless you have a very generous hard drive.

MOM includes a superb option (described later) for combining the downloaded 3-minute chunks so that you can produce
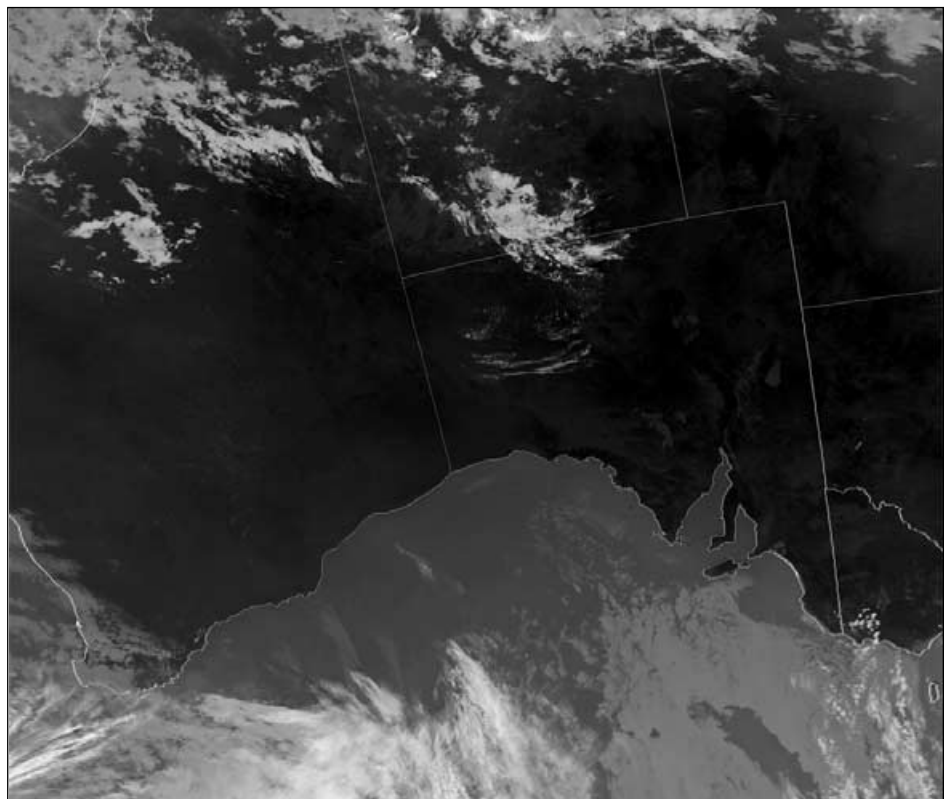
Figure 6 - Southern Australia basks in the sunshine in this channel 4 IR image
Image © EUMETSAT 2007
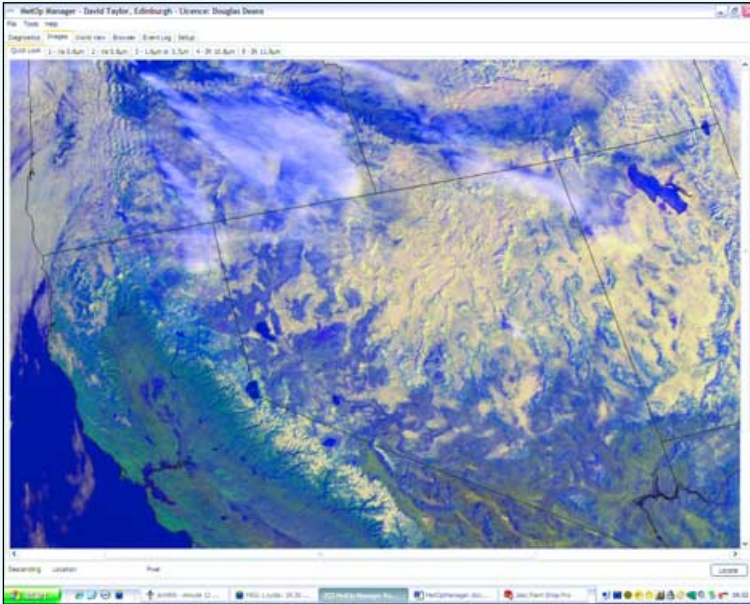
Figure 7 - A Quicklook over America's west coast
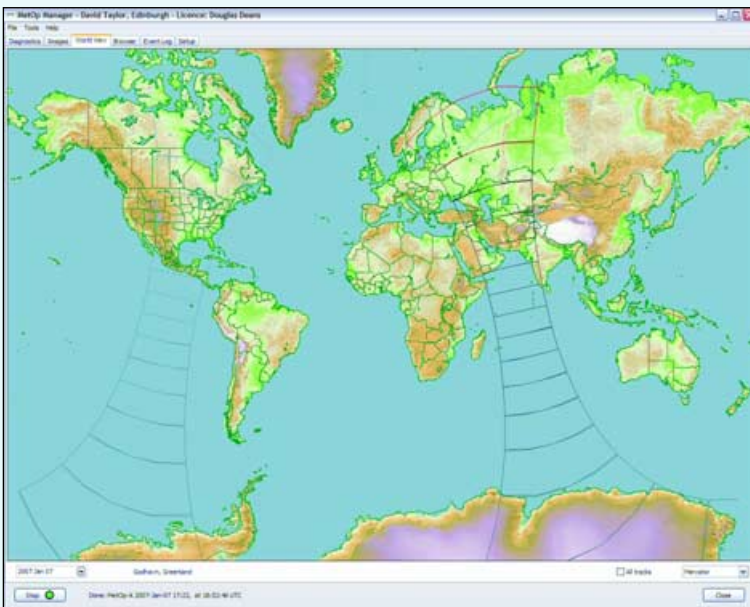
Figure 8 - The World View, showing incoming chunks of MetOp data

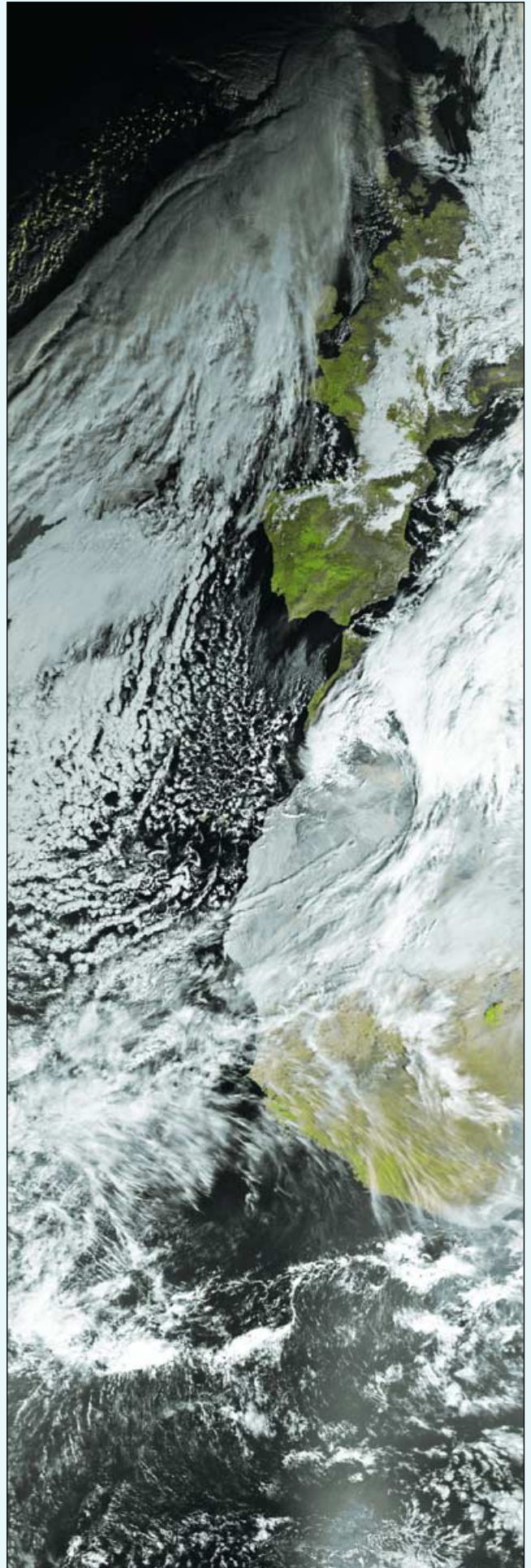Figure 9 - The Browser View, showing processed chunks of MetOp data.

Figure 10 - A 22-minute image created by joining 8 MetOp data chunks
Image © EUMETSAT 2006

images of longer than three minutes duration. Create an empty folder in a suitable location then use the 'Browse' button to enter this in the '*Combined files path*' field.

In the '*File options*' box, '*Delete files from RX*' simply deletes the raw data after it has been processed and saved by MOM. However, a word of warning here: if this is <u>unticked</u> the program will continue to re-process the same files over and over again. The '*Dates in folders*' option ensures that the folder you have selected for the processed data uses the subfolder structure *year/month/day* etc. This can be very useful and I strongly recommend ticking this option.

Once you have raw data coming in, click on the **<Images>** tab, press the green start button and start enjoying this wonderful global imagery; and be prepared to be seriously impressed! Figure 7 shows the '*Images*' window containing a quicklook image of California.

There are two interesting options when an image is displayed in this window

- a single left-click of the mouse zooms in to the image: clicking the mouse a second time zooms back out. When the mouse pointer is over the image a hint is provided for a few seconds to remind you of this option.
- a right mouse-click over the image displays a menu which offers a range of boundary styles that can be used on the image overlay.

In the **<Setup/Annotation & Display>** tab there is a useful setting called '*Auto-switch image display*'. This allows the coloured quicklook to be shown when there is sufficient illumination but automatically switches to an IR channel-4 one when there is not, a very handy feature for providing detail in night-time images. The other channel tabs that can be seen in figure 7 make it possible to view a greyscale version of any of the five basic wavelengths in addition to the coloured quicklook.

Finally, if you wish MOM to store thumbnails for use as quicklook images in other parts of the program, check the '*Save thumbnail*' option (recommended).

The World View Tab

Remember, MetOp is a polar orbiting spacecraft that makes ascending and descending passes covering the entire world. There has to be a graphical way of representing not only the satellite's current position, but to record where it has been over the days for which you retain data.

Figure 8 shows the *World View* window where, by default and to avoid clutter, the previous orbit is shown on the map with the current 3-minute segment

highlighted in red; the rest of that orbit is shown in shades of grey, becoming progressively lighter the farther back in time you go. However, if you wish, there is an option to view all tracks: descending in red, ascending in blue.

Also, note the option to choose the date should you wish to look back at stored files from passes of previous days. There are several map styles offered, including Mercator and Plate Carré as well as detailed North and South polar projection maps which are really excellent for studying those fascinating parts of our world.

The Browser Tab

One of the most useful facilities of MOM is the Browser tab, shown in figure 9. Here you can select a single chunk for viewing or a sequence of chunks for joining. You can preview the joined sequence as a 'quicklook' image, edit it if necessary then combine the chunks for viewing in *HRPT Reader*, a powerful tool which can provide spectacular images from any part of the world. If you press the '*Today*' button then all the orbits so far for the current day will be shown (in accordance with whether you have the *Ascending* or *Descending* boxes or both ticked). Each 3-minute chunk is displayed and there is also an option to show the UTC time inside each chunk.

Joining Chunks

How do we join chunks to view a combined image? Select the area you wish to view by means of the mouse. Click the left mouse button and keep holding it down while you drag it down and to the side until the desired area is included in the selection box—then release the button. The chunks best fitting that area will be highlighted in red as shown in figure 9. If your selection proves not to be exactly as you wanted then existing chunks can be deleted or adjacent ones added by double clicking on them with the mouse—a very neat and useful option.

Once you have selected the correct group of chunks the image they represent can be previewed by clicking the '*Preview*' button. Note that this is only possible if you checked '*Save thumbnail*' on the *Setup* tab as mentioned earlier. If all is well then press the '*Combine*' button and the joined chunks will be saved as an HPT file in the '*Combined*' folder you created earlier during program setup.

If '*Open in reader*' is ticked, the combined image will be opened automatically in *HRPT Reader* (provided, of course, that you have this software). Polar projections are again made available to simplify your choice of chunks over the polar regions.

I do hope that my guide to MetOp Manager's main features will encourage you to have a look at this excellent

software and open up the enjoyment of some wonderful global imagery. There are other exciting options available in the program ... but let me leave something for you to discover for yourself.

Conclusions

MetOp Manager is still evolving as we become more experienced with handling the quality and quantity of this fabulous data. World 1-km AVHRR imagery is simply breathtaking and, for those already using the *EUMETCast* system, is available at no extra cost.

There is a great deal of further global data yet to come from MetOp-A including ATOVS, IASI and Scatterometer data. I would anticipate that the majority of amateurs will probably not want much of this although those interested in amateur meteorology may be interested in the ATOVS service comprising HIRS, AMSU and MHS.

David Taylor has stated that he will keep an open mind to future developments of the program to deal with other data but much will depend on demand. However, just to see global, 6-channel, 1-km HRPT imagery makes this program an absolute must. By way of a taster to those contemplating setting up, I have provided a number of interesting MetOp-A images recently taken from my own system. Please remember that, for purposes of publication, those images are at considerably reduced resolution and size compared with the original saved data.

The Images

Images from MetOp-A can be obtained from all round the Earth every day via *EUMETCast* and the illustrations in this article are designed to whet your appetite. Even monochrome images such figure 4 showing Greenland and its surroundings can be spectacular.

The images reproduced above are necessarily reduced in size for publication in *GEO Quarterly*, but it is worth a reminder that the originals were all received with a maximum ground resolution of 1.1 kilometres per pixel, identical with the HRPT imagery disseminated by the NOAA satellites. Alan Banks' front cover image depicting the Andes really highlights the resolving power of the AVHRR instrument under optimum conditions.

References

1   A Successful Launch for MetOp-A
     GEO Quarterly 12, page 9.

2   MetOp-A Onboard Instrument Review
     GEO Quarterly 12, page 6.

3   EUMETCast and MetOp Data
     GEO Quarterly 13, page 10 (this issue)

4   EUMETCast Data Throughput
   GEO Quarterly 11, page 30.
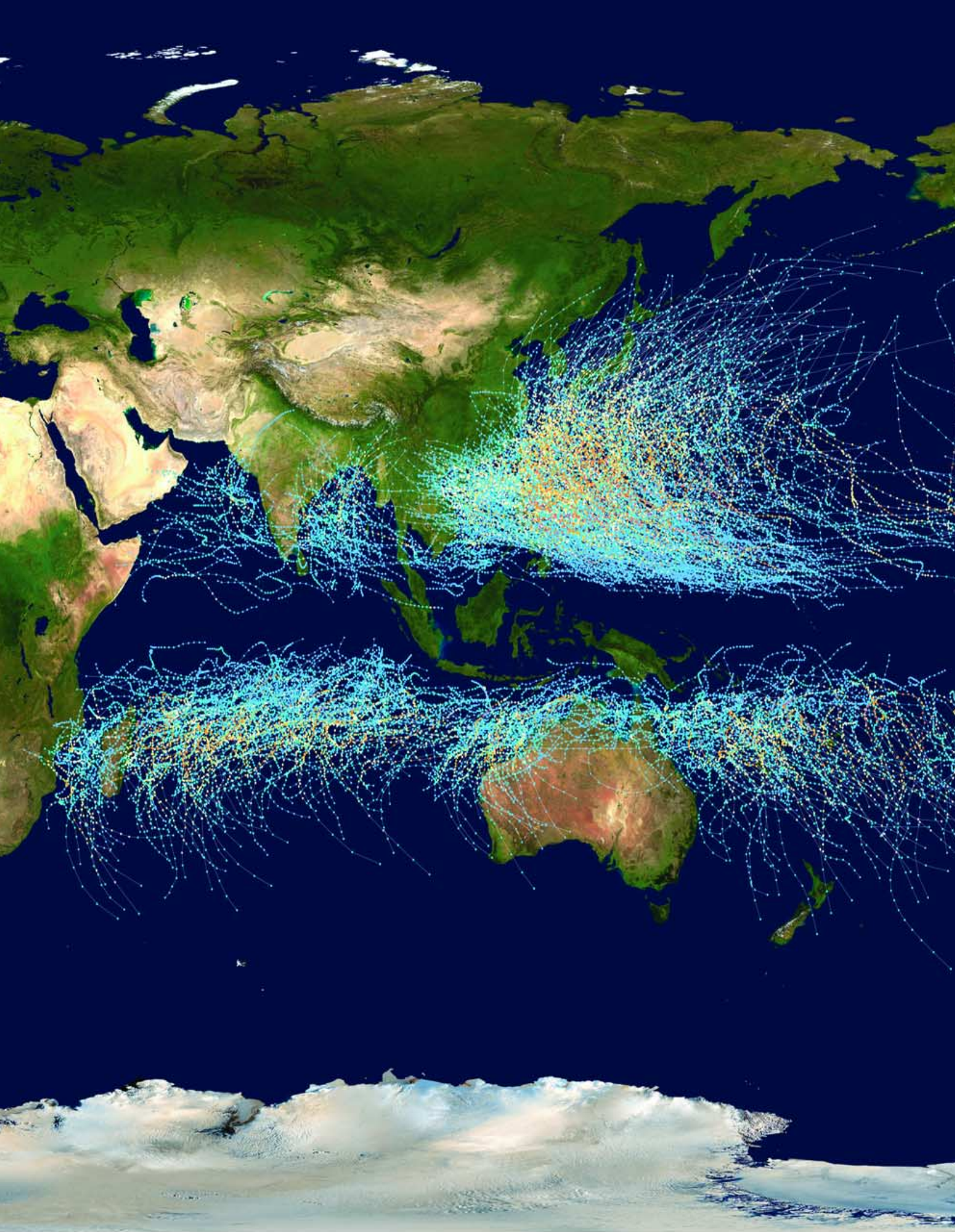
This map depicts the tracks of all tropical cyclones which formed worldwide between 1985 and 2005. The points show the locations of the storms at six-hourly intervals and the colours the strengths on the Saffir-Simpson Scale (key at lower right of image). The original background image comes from NASA's Blue Marble: Land Surface, Shallow Water, and Shaded Topography (*http://visibleearth.nasa.gov/images/2433/land_shallow_topo_east.tif* and *http://visibleearth.nasa.gov/images/2433/land_shallow_topo_west.tif*)
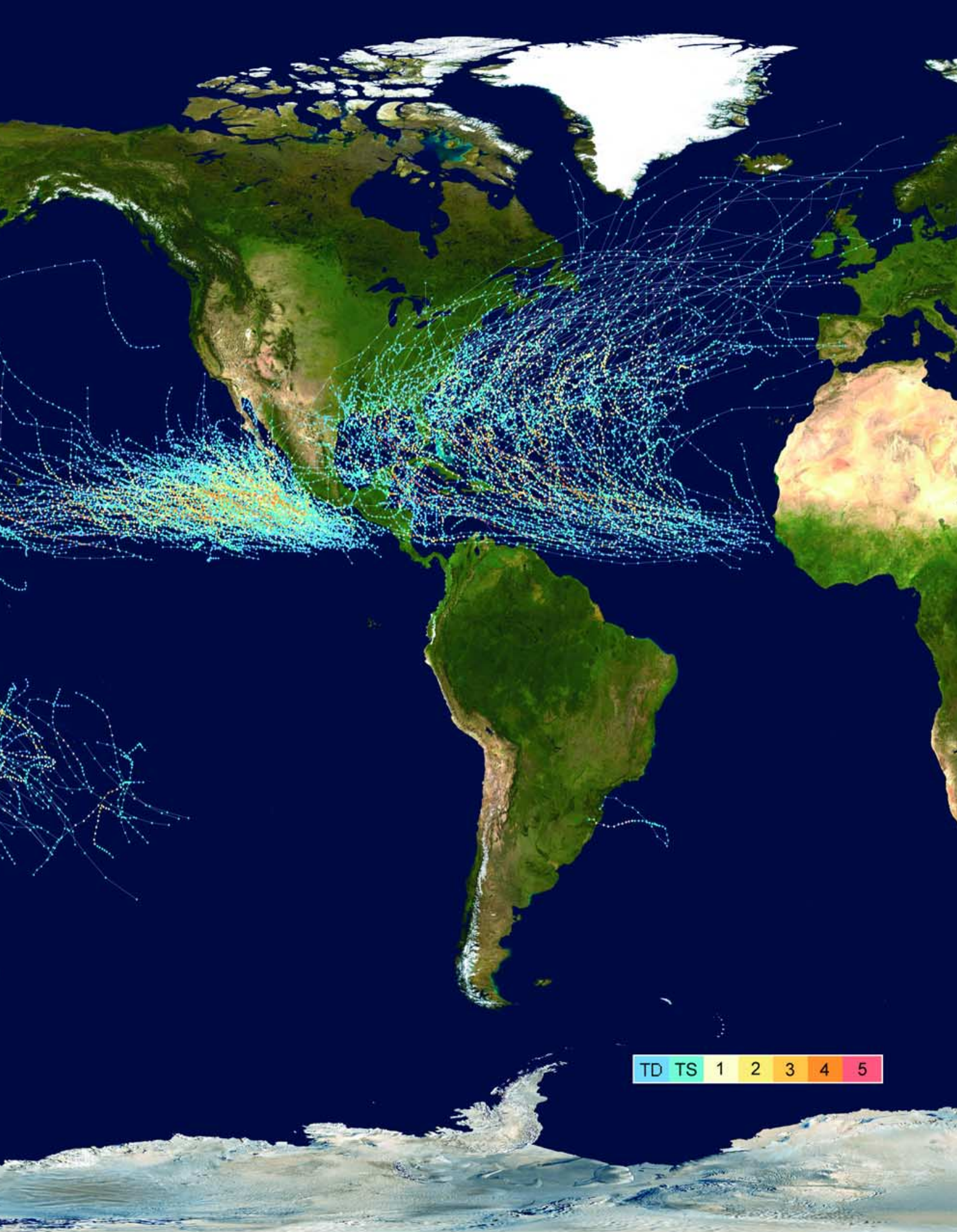
Geostationary Satellites

How They Get There and Why They Don't Stay in Place
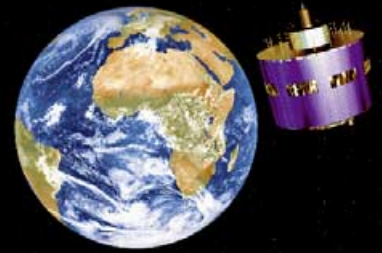
Peter Wakelin

A point on the equator is moving to the east at 465 m/s due to the Earth's rotation so a satellite awaiting launch is moving east at this speed multiplied by the cosine of the latitude of the launch site. The job of the propulsion system is to raise the payload to 35,900 km above the equator—and moving due east—with a speed of 3074 m/s, where it will complete one revolution in 23 h 56 m 4s to precisely match the Earth's rotation. This is not exactly 24 hours because, although there are 24 hours in a day, the Earth rotates 366 times in a 365 day year.

A Possible Launch Profile

The launch vehicle lifts off, heading due east, accelerating the payload and upper stage rocket to a speed of about 7,700 m/s for a 300 km circular orbit. It will cross the equator slightly more than 90° of longitude east of the launch site at an angle (its orbit inclination) numerically similar to the latitude of the launch site.

The next firing occurs at the equator but with a significant lateral component to the thrust to reduce the inclination and increase speed to about 10,200 m/s. This speed will place the satellite into a typical eccentric GTO (Geostationary Transfer Orbit) with an apogee near the required final altitude. It will take about six hours to coast up to apogee by, which time it will again be over the equator but the speed will have dropped to about 1,600 m/s.
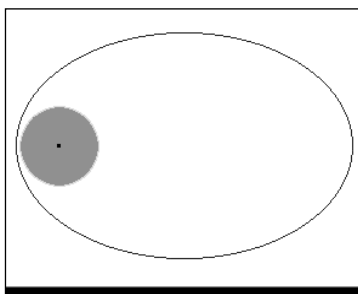
A typical GTO drawn to scale

The next firing occurs at apogee, again with a significant lateral component, and increases speed to about 3,074 m/s and reduces the inclination to zero. As it is unlikely that the payload will be exactly above the required longitude, the speed is adjusted slightly so that it drifts slowly relative to the Earth below. An increase in eastward speed will push the satellite to a higher, longer-period orbit and it will appear to drift to the west. Once at the required longitude, the speed is again adjusted to stop the drift.

Launch Efficiency

Almost all satellite launches use multi-stage vehicles so that the minimum possible mass, other than payload, is accelerated to orbital velocity. From the launch scenario described above, it is obvious that the best site for launching a geostationary satellite lies on the equator. Not only does an equatorial site have the greatest eastward velocity, it also means that no propellant has to be used to reduce the inclination as it will inevitably be zero.

Some launches do take place from a floating platform on the equator in the Pacific Ocean but the majority are from sites on land. Kourou (French Guiana) at 5° and Sriharikota (India) at 14° are not far from the equator but Chinese, American and Russian launches are increasingly disadvantaged by their higher latitudes. The Russians use the Baikonur cosmodrome in Kazakhstan for their launches to geostationary orbit but at 45.6° N, much more propellant is needed. Of course, for polar orbits, the eastward speed of the launch site is a disadvantage and Russia's high latitude cosmodrome at Plesetsk (62.8°N) is the most efficient.

Launch profiles do vary for different vehicles and for other reasons; for example, there may be restraints on lighting conditions requiring the craft to be in sunlight at a particular time, so the boost to GTO may not occur at the first equator crossing. The initial orbit may not be circular; it may be more efficient to get to a greater altitude (and therefore a slower speed) for the burn to GTO if an inclination reduction is made simultaneously. Another possibility, which has been used several times, is to use the 'super-GTO'. Rather than make any inclination change at low altitude, the super-GTO burn takes the payload up to 40,000 km or more above the equator where its speed will be well under 1,000 m/s and a significant change in direction can be made with little expenditure of fuel. Any fuel economy here though has to weighed against the extra fuel needed to attain the higher speed required to reach the greater altitude.

Perturbing Forces

Ideally, a geostationary satellite's orbit should be perfectly circular (i.e. its eccentricity should be zero), it should remain exactly above the equator (i.e. its inclination is zero) and its altitude should be such that the orbital period exactly matches the Earth's rotation (i.e. its mean motion is 1.002738). With the control mechanisms on modern spacecraft it would be possible to attain these precise parameters after orbit insertion but, although there is no atmospheric drag at geostationary altitude, there are other forces constantly acting on the spacecraft.

Obviously, Earth's gravity is dominant at geostationary altitude but our moon is only ten times more distant so its influence is far from insignificant, as is that of the much more massive, but also more distant, Sun. As neither of these bodies remains in the equatorial plane they tend to pull the satellites out of their desired orbits, changing both inclination and eccentricity. However, these perturbations can be predicted and, if a satellite is launched to a longitude where it is known that inclination will decrease for a time, then a small initial inclination would be desirable as it would save propellant and extend the satellite's operational lifetime.

The Earth's uneven mass distribution also causes small perturbations so the forces acting on MTSat-1R over 140°E longitude will not be precisely the same as those acting on Meteosat-7 over the Indian Ocean. Even the equator itself is not a perfect circle; an ocean swimmer in the Maldive Islands is about 140 m nearer to the centre of the Earth than one in Papua New Guinea. Satellites tend to sample all longitudes equally as the Earth spins beneath so that variations of gravity with longitude average out, but with geostationary satellites, which remain at the same longitude, this is not the case. MTSat-1R is located above a bulge so needs more east-west station-keeping manouevres than Meteosat-7 which is, so to speak, 'stuck in a hole'.

Some Real Orbits

Two-line elements sets (TLEs) are derived mainly from radar data but optical sensors are also used for the more distant objects. TLEs for geostationary satellites are much less accurate than those for near-Earth

objects but here are three for familiar satellites which, after comparison with previous and later TLEs, look to be reliable:

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METEOSAT 7
1 24932U 97049B  07012.67678219  .00000092  00000-0  00000+0 0  1278
2 24932 002.9592 080.0218 0001044 259.7347 072.7832 01.00273906 34299
GOES 12
1 26871U 01031A  07012.48004676 -.00000224  00000-0  00000+0 0  8508
2 26871 000.4164 267.6906 0002457 019.3046 282.1063 01.00278753 20117
HOT BIRD 6
1 27499U 02038A  07009.81468216  .00000105  00000-0  10000-3 0  2786
2 27499 000.0195 027.8377 0007265 265.9105 121.5018 01.00276540 16088
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All the mean motions (the penultimate parameter in line 2) are very close to the ideal value and that for Meteosat-7 is spot-on: but even small discrepancies accumulate over time necessitating an east-west station-keeping manoeuvre. However, only very tiny speed adjustments are required, needing small amounts of propellant.

Two of the inclinations are very small (the second term in line 2) but that of Meteosat-7 is almost 3 degrees. Of these three satellites, Meteosat-7 is the oldest (it was the 49th launch of 1997 as shown in the 2nd term of line 1) and is now getting low on propellant.

At *.0007*, Hot Bird-6 shows the greatest eccentricity (the 4th parameter in line 2) which equates to about 60 km difference in altitude between apogee and perigee.

The author took these two photographs of the Hot Bird cluster at 13°E just two hours apart on the night of January 12/13.
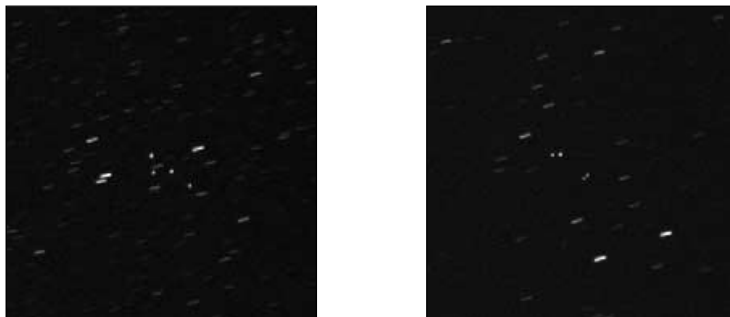
Photographs of the Hot Bird cluster. The right-hand image was taken 2 hours later than the left-hand one.

With the camera fixed, the satellites appear as points of light whereas the stars appear to trail as a consequence of Earth's rotation during the 5 second exposure time. Any departure from zero eccentricity will show as an east-west oscillation about the mean position over 24 hours and a north-south oscillation will be the consequence of a non-zero inclination. Over just two hours, the relative positions have changed significantly. An idea of the actual separation of the satellites can be derived from the length of the star trails which equates to about 15 kilometres at that distance. Although there's a lot of space up there, satellite operators constantly monitor separations to reduce collision risk and transponders spread across a cluster of spacecraft still offer safer redundancy than a single, larger spacecraft.

Dead but Unburied

Old satellites, rocket casings and debris in low orbits will eventually succumb to atmospheric friction but, for perigees above 1,000 km, the orbital lifetimes run to thousands of years and dead geostationary satellites will orbit for ever unless action is taken to remove them. It was shown above that an increase in speed of about 1,500 m/s was needed to transfer from GTO to geostationary orbit. To de-orbit a satellite at the end of its useful life would necessitate carrying sufficient fuel to reduce its speed by this same amount, which is not feasible at present. The current way of dealing with old geostationary satellites is to avoid using up all the propellant for station-keeping manoeuvres and to keep a little in reserve to boost them up to slightly higher orbits to greatly reduce the risk of a collision with operational spacecraft.

Many of the early geostationary satellites were never boosted to higher orbits and some fail unexpectedly and cannot be raised. There are now hundreds of objects up there and a look through the TLEs shows that perturbations have increased the inclinations of many of them to more than 10°: so they occupy a huge volume of space. However, every one crosses the equator twice a day so it is only a matter of time before an operational satellite is destroyed in a collision.

quickly, meaning that I have sometimes needed to reboot several times a day. To cure this you must get to grips with the *recv.channel.ini* file.

If, like myself, you experience difficulties, remember that you are not alone: there are several avenues of help available. Become a member of the Yahoo *GEO-Subscribers*, *MetOp* and *SatSignal* groups, where there is a wealth of experience and good humoured help on hand. You can search each group's archive to browse questions and answers from other members.

Good luck and enjoy this great new facility.

Internet References

On his website, David Taylor has very extensive 'how to' sections on problems plus useful FAQs. Many thanks to David for making his website available for details in this article:

www.satsignal.eu

And if you need help registering with EUMETSAT, consult the GEO website at

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

In Memorium
David Ransom Jr

We are sad to report that David Ransome Jr, one of the early pioneers of graphical satellite tracking software, sadly lost his battle with congestive heart failure on November 5, 2006.

David will be best remembered by many GEO readers as the author of *STSOrbit Plu*s, which he originally devised during pre-*Windows* days for tracking Space Shuttle missions. The program was used daily at the USAF Central Computer Complex at Cape Canaveral and at half a dozen NASA and aerospace control centres around the USA. But, unselfishly, David also made the program available free to all without need of registration, and *STSOrbit Plus* became the tracking software of choice for thousands of amateur satellite enthusiasts worldwide during the 1980s and 1990s,

David's passing is a great sadness for the many people he helped over the years and the friends who knew him. He will be sadly missed.

Powerless

Francis Bell

In GEO Quarterly No 11, Arne van Belle wrote an article that examined the noise level and power consumption of his computer systems and how to minimise both dimensions. That prompted me into action because, in the back of my mind, I have for several years suspected that my own systems were consuming excessive electricity. For about 30 years our household electricity consumption, in a detached house and with two children, was predictable at about 1000 kWh (units) per quarter.

Over the years the bills have increased, directly related to the cost of electricity, but our quarterly consumption has remained remarkably stable—until a few years ago when I became interested in weather satellites and associated computers. My cavalier approach has often been to leave everything switched on, sometimes productively for satellite animations, but often by default on my part. *Just leave the systems running and they will look after themselves!*

I have noticed in recent years that our average quarterly household electricity consumption has increased from about 1000 units to 1200 units. Because I deal with household bills this increase was secretly transparent to the rest of the family but it did register with me because I had to pay the bill. I quietly suspected I was the culprit. A pertinent clue was that early on a winter's morning, coming down stairs, I noticed that my study—with all its electrical equipment—was the warmest room in the house!

Because of publicised national, international and environmental sensitivities to excessive energy consumption, not to mention the fact that I have to pay the bill, I thought I would investigate the power consumption of my systems.

I discussed the issue with a friend and I produced a rough design for a prototype instrument to clip around a cable to measure its power consumption, assuming a mains voltage. However, before any further development, my friend telephoned me saying that he had seen an advertisement by an electrical supplier offering an instrument similar to the one we had discussed. Not wishing to reinvent the wheel, I bought the advertised product. What an eye opener this was to be!

The device in question was a plug-in-the-wall meter with several function settings and a digital readout; the parameters it measures are time, voltage and current. Any electrical equipment can be plugged into its outlet socket to measure power consumption, either instantaneous or over a period of time.

I used the meter with most of the electrical items in my study and was appalled by the findings it revealed. Table 1 shows the results of my research. Adding up all the standby mode figures I discovered that I was consuming 92.8 watt (W). In total my careless use of electrical equipment has more than accounted for our increased quarterly consumption. I am still researching the rest of our house's electrical consumption.

The plug-in-the-wall meter

As a result of my measurements I have divided my study into blocks of equipment which can now be isolated by means of table-top mains switches. This now enables me to use one computer system or radio at a time without powering up everything.

<u>Note</u>: professional advice should be sought at all times when dealing with mains electricity.

What has disturbed me is the fact that my new flat screen monitor, a *Philips 170/B*, and my *Dimension 1100* Dell computer both automatically run on standby: you have to pull the plug from the wall to turn them off. There is no indication from the equipment itself, such as LEDs, that they are on standby. The same is true for my satellite TV box and VCR which, like other electrical equipment in my study, have no mains on/off switches. With a combination of mains switches for a block of equipment and individual switches, mains consumption (and also alas the house heating) has been reduced.

Electrical standards dictate that mains power sockets should be about 30 cm above floor level. This means that very often you have to crawl under a table or behind furniture to turn off or unplug an electrical item: hence my course of action of introducing accessible mains switches.

Unit	Comments	Off	Standby	On
Dartcom satellite radio receiver	With a masthead preamplifier	0	-	11.3
RX2 receiver	With a masthead preamplifier	0	-	6
Philips 170/B flat screen monitor	Standby is a forced condition There is no LED to indicate it is in standby mode	9.0	9.0	38.7
Dell Dimension 100 computer	After 5 minutes warm up Standby is a forced mode	9.5	9.5	73.0
AP computer	After warming up for five minutes This is my main MSG receiving computer	22.5	22.5	83
Samsung SyncMaster 753S monitor	When receiving a video signal	0	0	62
Epson CX3650 printer	There is a mains switch on the top panel of this printer	0	<1	72
Dell Inspiron 1300, 17-inch laptop	Small power consumption when charging the battery	0	0	27
Dell 1100 printer	This has its own mains switch at the rear	0	18	20
Linksys radio for Internet	This has an on/off switch but, if the mains transformer is plugged in, it is always on and warm	18.8	18.8	23
Sky box	This is always on when connected to the mains	9	9	9
Toshiba VCR with no switch	When it's connected to the mains it is on	14	14	21
Matsui 1409 TV	This has a mains switch on the front panel	0	12	88

Table 1

IN TRAY

The Column for Readers' Letters and Queries
e-mail: editor@geo-web.org.uk

Editorship

Congratulations on GEO Q12 that arrived earlier this month. The organisation has made huge progress since its inception 3 years ago, but I recognise that the Quarterly is becoming an increasing headache. No replacement editor has yet been found and an increasing proportion of articles are being written by the core team. I would like to share a few thoughts about the situation and what could be done.

Voluntary organisations are always run by a small core team who do most of the work and, where they are geographically dispersed, that team is usually 1-2% of the membership. Interestingly, overseas members seem to make a disproportionate contribution, probably because they are particularly passionate—as demonstrated by their membership of an organisation in another country. Magazines and journals have traditionally been the mainstay of geographically dispersed voluntary organisations because they act as a surrogate for physical meetings which rarely/never happen. Editors seem particularly hard to come by because the commitment is large and regular, and difficult to hand over. Bizarrely, the amount of time and effort required to produce a magazine actually seems to have gone up with the advent of desktop publishing, and the importance of a journal appears to have diminished slightly with the advent of the Internet.

I recommend that you consider very carefully the objectives of the Quarterly before deciding upon the next step. I estimate that GEO has around 500 members globally, 30 of whom are probably actively giving something back to the hobby; the rest are passive supporters. Producing a regular quality Quarterly for such a tiny audience, from so few active sources, is always going to be a challenge. In this situation options could be:

1. Stop producing the Quarterly. Focus more on enhancing the discussion forum, website and shop.
2. Reduce the frequency of the Quarterly
3. Completely change the Quarterly... One annual issue, one annual wall calendar containing best of members' images, two compendiums of the best/most useful discussion forum threads
4. Rotate the editorship with each issue... quality would deteriorate but essence and spirit would continue
5. Increase membership fee to £50 p.a. and pay someone to do it (quality would still deteriorate) Being clear about the objectives for the Quarterly is a good place to start.

Today it has the feel of being the centre-piece for the group, which appears to be unsustainable.

Cheers,
Ben Ramsden, NSW, Australia

Editorial Reply

All the points you raise are particularly relevant and I'm sure that, subliminally at least, we have all been aware of them. Particularly the 'core' element in creating articles.

My own situation is rather catch-22: I can cope adequately with being Editor; I can cope adequately with being a feature writer.

But the reality is that I am writing, in some issues, up to 40% of the content <u>*as well as*</u> *Editing all the received contributions. It is this dual role that I find so overly time-consuming, not helped, as you rightly conjecture, by the relative paucity of contributions from our majority UK membership.*

*I*nterestingly, *your point about surrogate meetings seems not to be correct. The Dutch, despite holding their own meetings five times per year, continue to be our most regular contributors. It seems almost as though meeting more often fuels the fires of enthusiasm. They are certainly very much more active in progressing the hobby than members in the UK.*

You are also correct about the workload increasing, not so much because Desktop Publishing is itself difficult to master, but because it opens up so many possibilities that did not previously exist, most notably the ability to insert photographs, drawings and tables at will. In addition, the A4 format we use requires multi-column typesetting (rendering make-up a bit like solving a huge jig-saw puzzle). The smaller A5 format was dead easy - just keep going in a straight line, as it were.

Another problem is related, I believe, to the general age range of our membership. By far the majority are in the 55+ age group, many retired and with plenty time on their hands to pursue hobbies. GEO Symposium meetings turn up very few members below this threshold—the younger generation who have grown up with personal computers and who almost certainly possess the skills required to make up and edit the Quarterlies are notably absent. I am just fortunate in having been involved with Desktop Publishing at an early stage during my involvement in the Education Sector. What GEO really needs to do now is attract the multitalented younger generation and harness their skills.

Les Hamilton (caretaker Editor)

Contrails

Contrail formation is dependent on the humidity of the air an aircraft is passing through. I note the number and persistence of trails each morning from my weather station at Westgate (Co. Durham) and make reports to Lancaster University, who are conducting research into the environmental effects of the phenomenon. In the course of these observation I have noted the following:

- Contrails do not readily form in fresh polar air.
- If any cirrus cloud is present, and an aircraft passes near or through it, a vapour trail may start or become more persistent.

Also, as one might expect, an approaching warm front shows this well.

Fresh polar air is invariably dry at high altitudes but its humidity will increase as warmer tropical air moves into it, which prevents or reduces evaporation of a trail, rendering it persistent.

The shape of a trail is affected by the vortices created by the aircraft *and* by the effect of gravity on the ice particles produced when a persistent trail 'freezes out'. When one flies near a trail, this precipitation can be seen as fallstreaks.

Spreading of the trail is also affected by wind. The trails, then, are influenced by ambient temperature, ambient humidity and ambient wind. This is, to some extent, offset by the resulting increase in albedo due to increased cloud and the cooling effect of particulates also found in jet exhaust.

- There is a a useful reference on pages 167-170 of '*Spacious Skies*' by Richard Scorer and Arjen Verkaik, published by David and Charles (ISBN 0-7153-9139-9)

Cheers,
John Say, Stanhope, England.

Strait of Dover

I am 90 years old and have lived in Australia for the last 50 years. As a child we often went to Margate or the other seaside resorts for holidays. During the last war I was stationed at RAF Manston during the Battle of Britain, and afterwards lived and worked on the South Coast. How wonderful it was for me to see the article and maps by John Tellick in the December GEO Quarterly. What memories it brought back. This latest edition is well up to the high standard you set from the beginning. Congratulations.

Doug Thwaites, Queensland, Australia.

Polar Mesospheric Clouds

Having only recently joined GEO, I have just come across Peter Wakelin's comments on polar mesospheric clouds (PMCs) and their possible visibility in satellite images [1]. I discussed this with the late Professor Mike Gadsden some years ago but was asked by him not to mention it until he had been able to publish a paper on the subject.

Professor Gadsden did In fact publish three relevant papers [2, 3,4] in which he reported being able to detect PMCs in visible-light Meteosat images, obtained

around local midnight when the satellite was in eclipse, for the years 1983 to 2000. Under such conditions the clouds were backlit and thus readily detectable. He noted frequent changes in structure and height, with the clouds appearing as a single layer, a thickened layer, or double layers. This he interpreted to mean that the PMCs were actually a single thin layer with large-scale undulations, most probably caused by planetary waves.

It should be noted that, although closely related, PMCs are differentiated from noctilucent clouds (NLCs), which are more frequently visible from the ground, in that PMCs occur from the poles down to latitudes of approximately 70°N and 70°S. NLCs, by contrast, do not occur at latitudes higher than about 60°N and 60°S, so there is a clear gap of about 5° to 10° between the two types. In addition, although NLCs are also thought to occur as a thin layer, their small-scale structure is believed to result from localised waves, possibly even related to features on the surface. Peter Wakelin's observations of 2005 June 22/23 were actually of noctilucent clouds, not PMCs.

Fewer PMCs were observed in the southern hemisphere than in the northern hemisphere, presumably because of the different planetary-scale flow regimes in the two hemispheres. Comparison of the data for 341 northern-hemisphere occasions when NLCs were reported shows that there is no correlation between the occurrence of PMCs and NLCs: They are independent phenomena.

References:

1   GEO Q7, September 2005, page 9

2   Gadsden, M., Structure in polar mesospheric clouds seen from a geostationary spacecraft, Geophysical Research Letters, 27, (22), 2000, pp. 3671-3674

3   Gadsden, M., Structure of polar mesospheric clouds seen from a geostationary satellite, Advances in Space Research, 27, (10), 2001, pp. 1697-1702

4   Gadsden, M., Polar mesospheric clouds: The year-to-year changes shown in 17 years of images from both hemispheres, Advances in Space Research, 28, (7), 2001, pp. 1083-1088

Storm Dunlop

The Largest Tabular Iceberg

Further to your note (GEO Q12, Dec.2006, p.26) on the break-up of the B15A iceberg, the original section (B15) was not the largest tabular berg ever known. That distinction belongs to an iceberg discovered by the crew of a U.S. Coastguard icebreaker in November 1956. It was 335 km long and 97 km wide, and thus had an area of about 32,400 sq.km. - that's bigger than the size of Belgium (30,528 sq.km).

In those pre-satellite days, tracking of icebergs was not particularly easy, especially with the limited number of ships in Antarctic waters, so the subsequent fate of that monster is unknown.
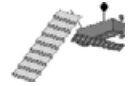
An excellent image of B15, taken on 13 April 2000, shortly after it had broken away from the Ross Ice Shelf in late March, may be found at:

http://earthobservatory.nasa.gov/ Newsroom/NewImages/images.php3?img_id=2717

Storm Dunlop

News in Brief

El Niño Gains Strength

The weak El Niño event reported in our previous issue continued to gain strength during the final quarter of 2006 and was rated as 'moderate' by the World Meteorological Organisation. By the end of the year, El Niño was firmly established in the tropical Pacific Basin where sea surface temperatures were already 1.5°C warmer than usual.

El Niño is a periodic warming phenomenon in the central and eastern Pacific Ocean which upsets normal weather patterns. Since El Niño first appeared last August it has brought drought to Australia, which has been hit by a combination of unusually cold dry conditions and strong winds, storms to islands in the western Pacific and extremely heavy rainfall in Kenya, Somalia and Ethiopia.

The December 5, the MODIS spectroradiometer aboard NASA's Terra satellite obtained the image opposite, which shows a swathe of smoke more than 25 kilometers wide spreading southeast from fires in Victoria's Great Dividing Range toward the Tasman Sea. According to news reports, 50 fires—most of them in remote forests and parks—were burning out of control across Victoria in early December. Australia's misery continued throughout the month as the December 11 true-color MODIS image on the inside back cover shows. It was not till early January 2007 that the rains came, the first for almost five years in some districts, disrupting play in both the 5th cricket Test Match between Australia and England and the Australian Open Tennis Championships.

**Tornado Strikes London, England**

During 10 minutes of mayhem around 11 am on December 7, 2006, a small tornado tore through the Kensal Rise district of northwest London. In less than a minute over a hundred Edwardian terraced houses situated in a network of tree-lined avenues were damaged in the storm, the most severely affected having entire roof sections ripped off and walls demolished as streets became strewn with rubble. At least six people suffered injuries and some twenty properties were rendered uninhabitable.

The tornado was spawned by a squall line that crossed southwest England, bringing gales rain and thunder. The NOAA-17 satellite image reproduced opposite clearly shows the situation shortly after midday, with the squall line located over the English Channel. Douglas Deans sent in the 11:00 UT radar image from *AvBrief* (www.avbrief.com) which appears on the inside back cover. The bright red

Smoke from December 5 Forest Fires in Victoria
Image: MODIS Rapid Response Team
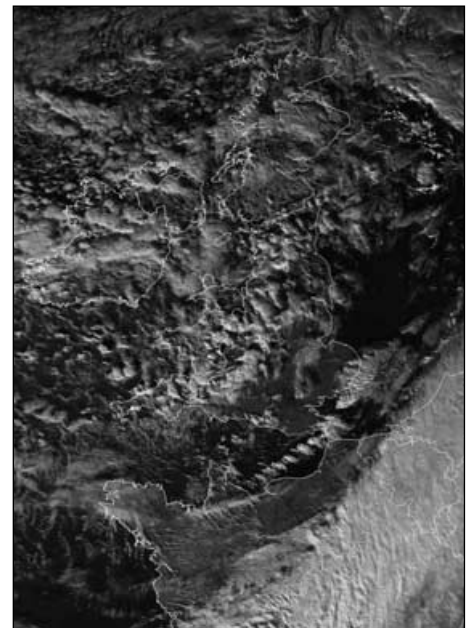
This NOAA-17 channel-2 HRPT image was acquired at 12:15 UT on December 7, 2006
*Image: NOAA CLASS Archive (www.class.noaa.gov)*

colours over London indicate the severity of the storms along the squall line.

The tornado itself was rated T4 on the TORRO 10-point scale, meaning localised winds exceeding 160 kph. Great Britain actually experiences between 30 and 40 tornadoes in an average year but most form well clear of populated areas and many are relatively weak.

Europe's Worst Storm for 8 Years

Europe suffered its deadliest storm since 1999 over January 18/19 this year, causing at least 47 fatalities in seven countries. Britain took the brunt of the storm with severe gale force gusts of up to 159 kph being recorded. A million consumers in Germany alone lost power while airports across the continent were forced to cancel hundreds of flights.
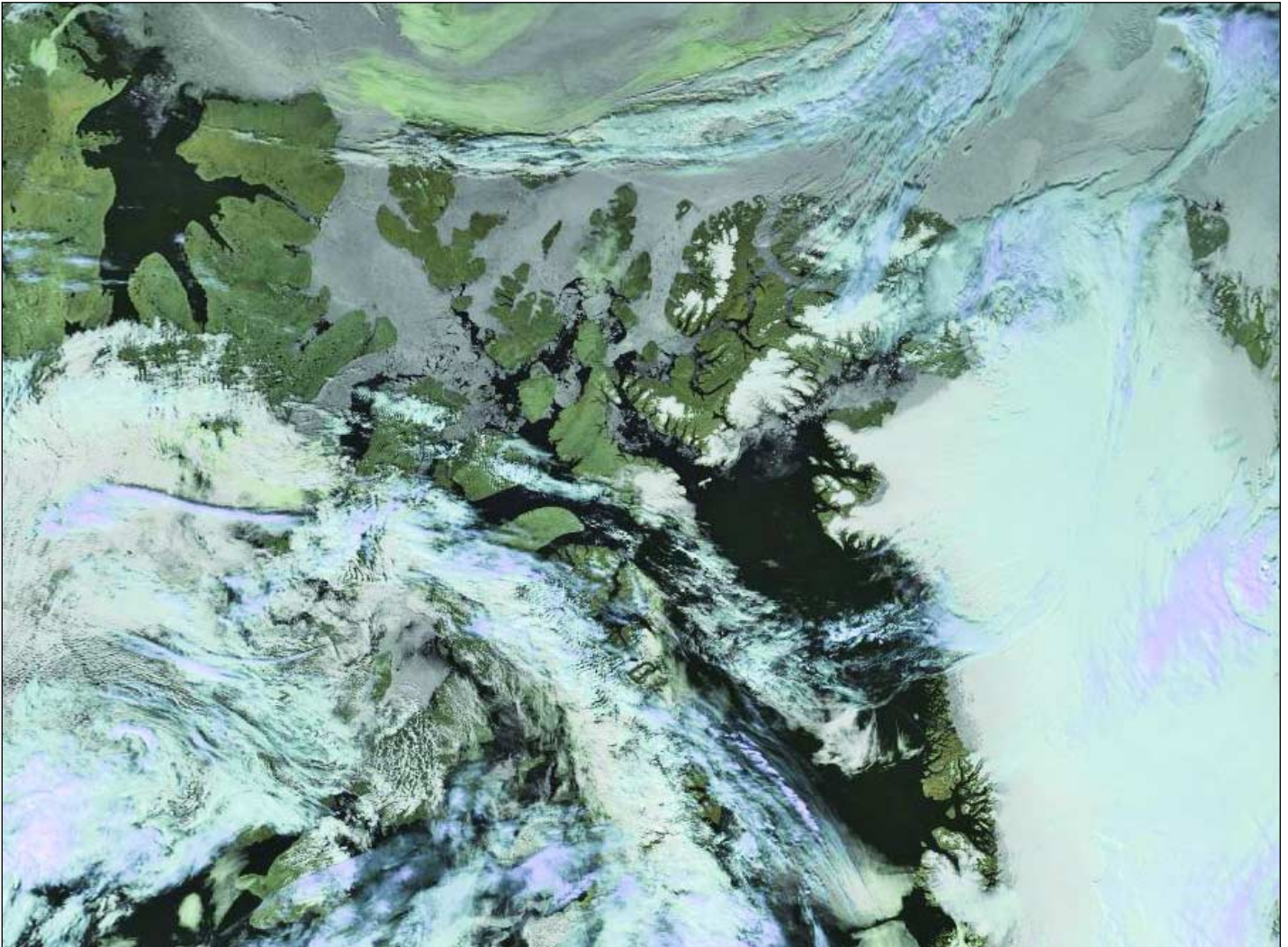
Mike Stevens sent us this image which he received via EUMETCast's EARS-AVHRR service on July 28 last year. The image came from the 16:54 UT NOAA-18 pass and shows a region of northern Canada inaccessible to those of us who rely on direct reception of APT or HRPT. Although Baffin Island is almost completely obscured by cloud, both Devon Island and Ellesmere Island show well at upper centre, as do Victoria Island and Banks Island farther west. The prominent peninsula at the top-left of the image is Cape Bathurst on the Canadian mainland with, immediately below (east of) it, Franklin Bay.
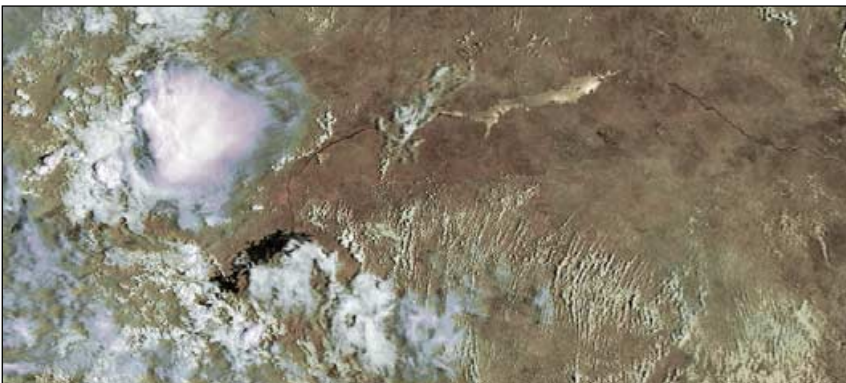
Above and right are two more fascinating images cropped from a **MetOp-A** pass submitted by **Alan Banks**. Imaged at 07:25 UT on December 10 when the satellite was travelling southward across east-central Africa, the raw data was disseminated via the MetOp world-wide, orbit-delayed high-resolution data stream on *EUMETCast*.

The image above shows much of the course of the Zambezi river as it flows along the Zambia-Zimbabwe border and includes two of the largest human-made lakes in the world: Kariba Lake (left) impounded by the Kariba Dam and right of centre, highlighted by sunglint, Cahora Bassa lake. There are large hydro-electric power plants at both Kariba and Cahora Bassa dams.

The image at right, part of the same MetOp-A pass, shows Lake Victoria, the largest body of fresh water in Africa, engirdled by lakes Kyoga (top), Albert, Edward, Kivu and Tanganyika. With a surface area just fractionally under 69 000 square kilometres, Lake Victoria is the largest tropical lake on Earth and the second largest freshwater lake on the planet (only Lake Superior in North America is larger).

Lake Victoria is the principal source of water for the 6695 kilometres long White Nile, although the river's most distant tributary flows from southern Rwanda and through Tanzania before emptying into Lake Victoria.
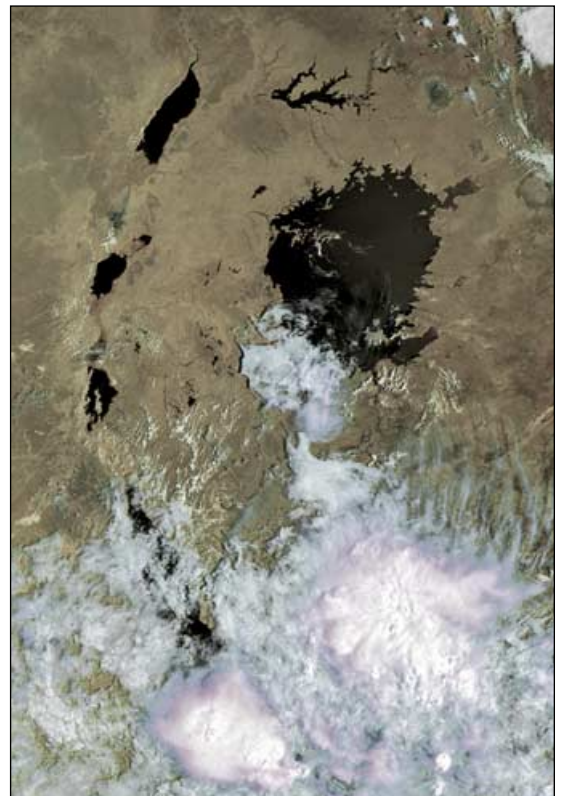
Images © EUMETSAT 2006

Publishing ⬢ EUMETSAT
Weather Satellite Data on the Internet

EPS METOP

The addition of trial MetOp global high-resolution AVHRR imagery to the *EUMETCast* data stream late last year posed the inevitable questions as to the legality of posting images and derived products on readers' websites. Graham Whitehead undertook a lengthy dialogue with EUMETSAT which clarified the situation. The types if data that **you can legally display** on your websites are listed below and can be consulted at

http://www.satsignal.eu/software/publishing-data.htm

where further information may be added to cover additional services on offer in the months and years ahead.

Meteosat Data and Products

- The 6-hourly 'essential' Meteosat data; those images received at 00:00, 06:00, 12:00 and 18:00 UT
- Meteosat derived products
- Data and products offered through the Meteosat Internet Service
- All SAF products

MetOp Data and Products

- MetOp AHRPT (Advanced High Rate Picture Transmission) data
- MetOp LRPT (Low Rate Picture Transmission) data
- MetOp global and regional level-1 MHS and IASI subset products
- MetOp global and regional level-2 MHS, ASCAT, GRAS, GOME-2 and IASI products

NOAA Data disseminated through EUMETCast

- MetOp AMSU-A data
- MetOp AVHRR data
- MetOp HIRS data
- NOAA AVHRR data
- NOAA MHS data
- NOAA AMSU-A data
- NOAA HIRS data

Data that is more than 24 Hours Old

EUMETSAT data and products that are older than 24 hours may be freely posted on websites regardless of whether you yourself have stored them following download via *EUMETCast* or they have been retrieved from EUMETSAT's own archive.

Acknowledging EUMETSAT's Copyright

Should you display any data or products from the above categories on your website you must include the text

'Copyright EUMETSAT (year)'

beside each item. If in doubt, check the numerous examples printed in this Quarterly.

Meteosat Data that Requires a Licence

Meteosat licensed data and products comprise the 15-minute, 30-minute, hourly and 3-hourly Meteosat image data plus all data disseminated through the licensed Meteosat Internet service. These products **may not be placed on your website**, as the dissemination of these to third parties, which includes Internet broadcasting, is forbidden.

## MetOp Data that Requires a Licence

MetOp licensed data and products comprise all global and regional level-1 IASI (except for the above subset), ASCAT, GRAS and GOME-2 products. These products **may not be placed on your website**, as the dissemination of these to third parties, which includes Internet broadcasting, is forbidden.

If in doubt, send EUMETSat your query by completing the email response form at:

http://eumetsat.int/Home/Head/Contact_Us/indes.htm

Ellesmere Ice Shelves Under Threat
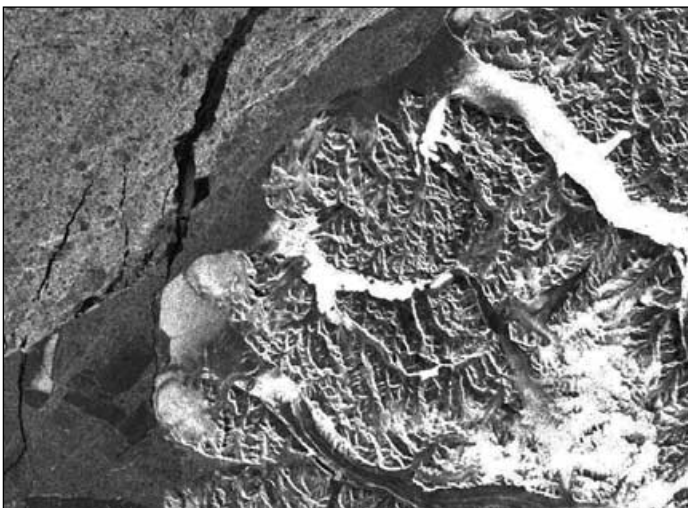
RADARSat image taken on December 31, 2006, clearly showing the detached Ayles ice island as the tooth-shaped object at lower left.

Image: Canadian Space Agency

island, with an area of 66 km² and an estimated thickness of 37 metres a kilometre offshore. During the next few days it drifted some 50 km west, then back east again, before freezing into the sea ice about 15 kilometres offshore. It has since remained locked in this position throughout the summer of 2006. The RadarSat image opposite, shows its location on December 31, 2006. It is believed that it is just a matter of time before the former ice shelf is released, when it could become a potential hazard to navigation and oil and gas extraction should it drift south towards the Beaufort Sea.

Researchers suspect that the loss of the Ayles Ice Shelf is due to Global Warming although they cannot conclusively prove that it was a consequence of man-induced Climate Change. But taking into account the events of the past hundred years, the breakup was 'consistent with the larger body of evidence indicating that the climate is warming and predictions that the greatest effects are likely to take place at high latitudes'.

Researchers believe that many more changes are in store and recently, a Canada-U.S. team predicted that the Arctic Ocean could be devoid of summer ice as early as 2040, if not possibly sooner.

Earth Browser

Andrew Thornton

For the amateur weather buff who cannot afford all the gear to receive real time images from GOES, NOAA or MSG, *EarthBrowser* will do this for you without any special programs or hardware. The software is available in shareware versions for both *Windows* and *Mac* PCs and, although some features are disabled in the free version, it remains a fascinating piece of software.

What is EarthBrowser?

EarthBrowser presents a real-time three-dimensional model of the Earth with continuously updating global information. It uses an advanced ray-tracing algorithm plus high resolution satellite imagery to create an extremely accurate picture of the Earth. The globe can be easily rotated and magnified to give a distant or close-up view of our planet from space

Installation

EarthBrowser can be downloaded from

http://www.earthbrowser.com/

as a single installation file (8 MB for Windows 2000/XP, 10 MB for Macintosh) which installs effortlessly on your computer. System requirements are at least 128 MB RAM, an installation of *Quicktime* and an Internet connection. Should you enjoy EarthBrowser you can register it for $23.95 and convert your existing demo version into the fully functioning program.

Starting out

When you first run *EarthBrowser* the program opens by displaying the default view, a full globe of the Earth (figure 1). Operation of the program is largely controlled by the *Tool Window*, which is a small panel containing 16 small icons whose functions are indicated in the illustration below.
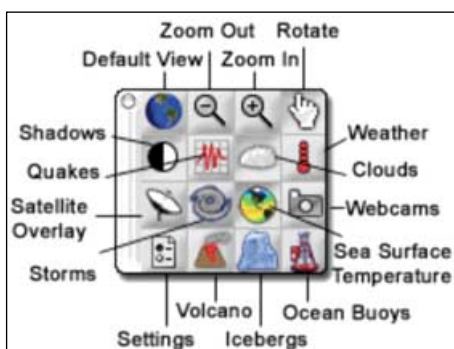
The EarthBrowser Tool Window

The four icons along the top row allow you to navigate the screen, the bottom left button opens a preferences dialogue and the other seven toggle information overlay displays.

Navigation Tools

The two zoom buttons allow you to alter the scale of the display. The more you zoom in, the more detailed the overlays become. To enlarge the view, click the '*Zoom in*' tool, place the cursor over the centre of the region of interest then hold down the mouse button until the desired degree of zoom has been achieved (figure 2). The '*Zoom out*' tool works the same way. If the region of interest is not in view, click the '*Rotate*' tool then <u>drag</u> the mouse over the Earth to rotate it. The '*Default*' tool cancels all user adjustments and returns to the default view of figure 1.

Weather Forecasts

When you click the Tool Window's red '*Thermometer'* button, weather symbol icons pops up over selected cities to indicate the prevailing conditions (sun, cloud, rain etc). See, for example, the 'sunshine' icons over Glasgow, Prague and Budapest in figure 2. Further, when you click over any such map location a *Weather Forecast Window* appears showing a summary of current weather conditions. This includes the current temperature, wind speed and direction, humidity, pressure, visibility and dew point as well as a 7-day forecast in the form of iconised weather symbols for the week ahead. A click on the '*Camera'* button displays the locations of webcams and, when you click on one of these, an image from that location is displayed. Figure 2 shows a zoomed map of Europe where both the weather forecast window and the webcam features have been selected for Manchester. The *Weather Forecast Window* is also shown in figure 4.

EarthBrowser holds data for thousands of cities across the globe and their weather data are updated hourly. More weather icons become visible as you zoom in closer. Registered users can control the level at which an icon displays using the *City List Window*.

The *Weather Forecast Window* also displays the relevant national flag for the city and clicking on this launches the *CIA's World Factbook* page for that country in your web browser. This can prove an

Features of EarthBrowser

- 15-meter per pixel resolution worldwide (only available in the registered version)
- Three high-resolution 500-metre base maps of the Earth
- Satellite cloud overlays which are updated daily
- Global 7-day weather forecasts for over 17,000 locations
- Live hurricane and tropical storm tracking
- A full year of weekly sea surface temperature animations
- Satellite cloud animations, which are updated every 3 hours
- Live earthquake map with magnitudes and links
- Live data for over 250 ocean buoys
- Antarctic iceberg tracking
- Daily fire hotspot display
- Views from hundreds of webcams all over the globe
- Political borders/Tectonic plate boundaries
- Over 15,000 volcanoes with links to more information
- Times in cities of all world time zones
- Links to facts about countries all over the world

excellent source for educational information about countries around the world.

Clouds

Clicking on the '*Cloud'* button in the *Tool Window* toggles the cloud overlay on and off. This overlay is generated by combining cloud information from geosynchronous satellite images and stitching them together. The global cloud montage is continuously updated every three hours from midnight GMT. *EarthBrowser* can download and store up to five days of recent cloud images and display them as a movie. You control the length of the animated cloud sequence from the **<Options→Cloud animation>** sub-menu which specifies how many hours (or days) of historical cloud data you wish to see animated. In the demo version of EarthBrowser, you can set this to show just the current cloud cover ('Now') or '3 hours' and '6 hours' but registration extends this to a full five days of 3-hourly animation.

Satellite Overlay

The *Satellite Overlay* button toggles an overlay of high-resolution cloud images

approximately one day old over the display. These images have a resolution of 500 metres per pixel and match the underlying base map exactly. The images are provided courtesy NASA/JPL-Caltech and are updated daily at irregular times and only cover certain areas of the globe.

Storms

The '*Storms*' button displays any currently active tropical storms across the world, the storm icons showing both the name and current wind-speed of each storm. Also displayed, as a
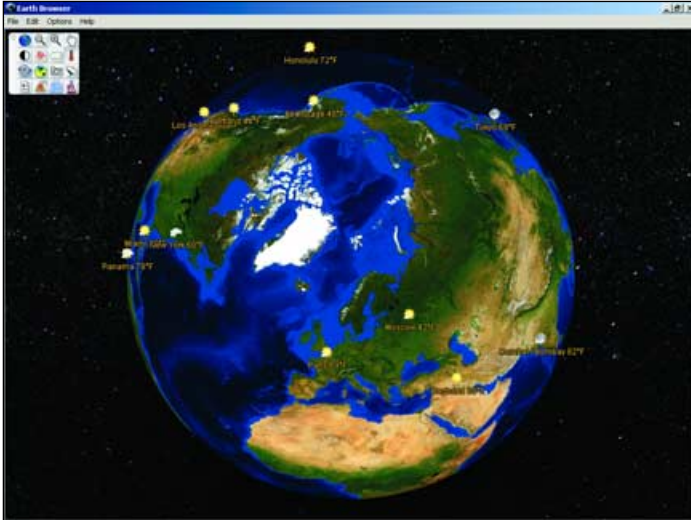

Figure 1 - The default Earth view showing city temperatures

Figure 2 - A zoomed image showing city temperatures in Europe

Figure 3 - The same image with satellite cloud overlay toggled off

Figure 4 - The weather forecast panel for Manchester
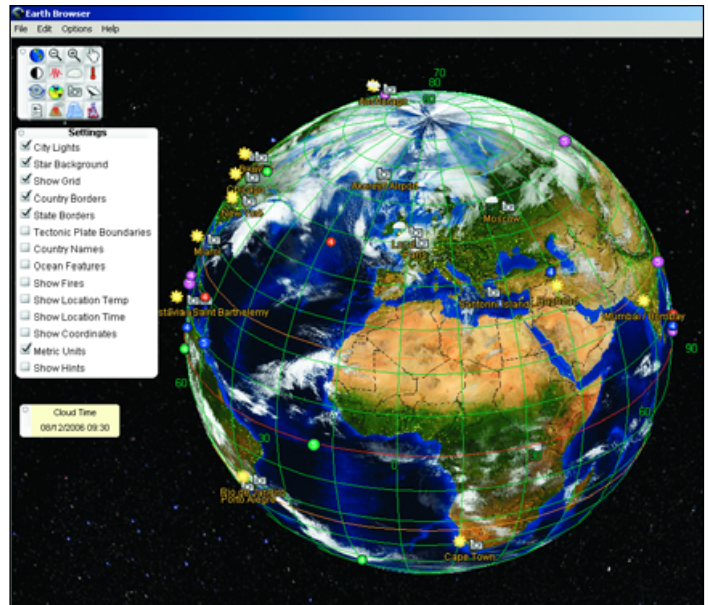
Figure 5 - Overlay options

multicoloured line, is the path of the storm—each different colour indicates the strength of the storm at the time its eye crossed that location. Clicking on the storm icon opens a web page with more information about it and other storms in the neighbourhood.

Sea Surface Temperatures

The '*Sea Surface Temperature*' button toggles on and off an animation sequence of weekly sea surface temperatures (an 8-day average) for the previous year. A legend is displayed in the lower left corner of the window to show the temperature scale and date of the current animation frame. Sea surface temperature data is obtained from the NASA Physical Oceanography Distributed Active Archive Center.

View Settings

The '*View Settings*' button at the bottom left of the Toolbox Window opens a panel from which you can control which features you wish to see overlain upon the display: country borders, latitude/longitude grid, country names, plate boundaries, location temperature, time, coordinates and much more. This allows you to tailor maps to your own taste. As with all the other options described above, anything you select becomes the default until changed—so next time you run it *EarthBrowser* will show exactly the same display (apart from ongoing cloud overlay and weather updates) as when you left it.

EarthBrowser is Shareware

EarthBrowser is a freely distributed, copyrighted program which is available without charge in demonstration mode. Many features, however, are wholly or partially disabled. When zoomed, the cloud overlay is somewhat blocky and quite low definition; you cannot add new locations or webcams to the database; animations are restricted to just six hours and there is no user control over the duration of sea surface temperature animations.

A 'Register' window repeatedly pops up asking you to purchase the full product. although this can be closed by clicking the small circle in its top left-hand corner. If you find the features of EarthBrowser useful, registering the full version for just $23.95 is definitely well worthwhile.

Radar Satellites

Part 2 - Synthetic Aperture Radar (SAR) Imaging

Peter Wakelin

The Basics of Imaging Radar

An imaging radar works very much like a flash camera in that it provides its own 'light' to illuminate an area and take a snapshot picture—but at radio wavelengths. Instead of a camera lens and film, a radar uses an antenna and a computer.

A typical radar measures the strength and round-trip time of the microwave signals that are emitted from an antenna and reflected off a distant surface. The antenna alternately transmits and receives pulses at particular microwave wavelengths (in the range 1 cm to 1 m) and polarisations (waves polarised in a single vertical or horizontal plane). For an imaging radar system, about 1,500 high-power pulses per second are transmitted with each pulse having a duration (pulse width) of typically 10-50 microseconds. The pulse normally covers a small band of frequencies centred on the frequency selected for the radar. At the Earth's surface, the energy in the pulse is scattered in all directions with some reflected back toward the antenna. This <u>backscatter</u> is received by the antenna in a specific polarisation (horizontal or vertical but not necessarily the same as the transmitted pulse) and these echoes are converted to digital data and recorded for later processing and display as an image. The chosen pulse bandwidth determines the resolution in the range (cross-track) direction; greater bandwidth means finer resolution.

In the case of imaging radar, the radar moves along a flight path and the area illuminated by the radar, or footprint, is moved along the surface in a swath, building up the image as it does so. The length of the radar antenna determines the resolution in the along-track direction of the image; the longer the antenna, the finer the resolution in this dimension. Synthetic Aperture Radar (SAR) refers to a technique used to synthesise a very long antenna by combining signals (echoes) received by the radar as it moves along its flight track. Aperture means the opening used to collect the reflected energy that is used to form an image. A synthetic aperture is constructed by moving a real aperture or antenna through a series of positions along the flight track.

As the radar moves, a pulse is transmitted at each position and the return echoes pass through the receiver
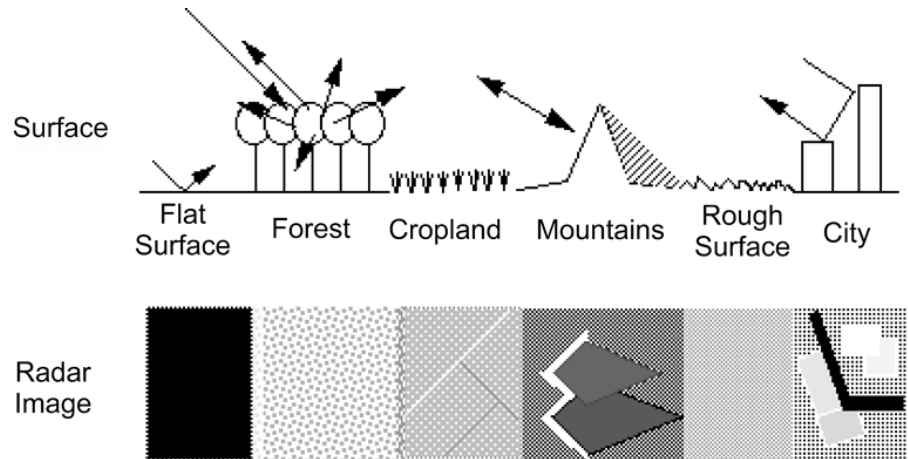

Figure 1 - Imaging different types of surface with radar

to an 'echo store'. Because the radar is moving relative to the ground, the returned echoes are Doppler-shifted. Comparing the Doppler-shifted frequency to a reference frequency allows many returned signals to be 'focused' on a single point, effectively increasing the length of the antenna. The trick in this focusing operation, or SAR processing, is to correctly match the variation in Doppler frequency for each point in the image, which requires precise knowledge of the relative motion between the platform and the imaged objects.

SAR is now a mature technique and provides unique capabilities as an image tool and, because SARs provide their own illumination, can operate day and night. Also, because radar wavelengths are much longer than those of visible and infrared light, SARs can 'see' through cloud and dust.

Interpreting Radar Imagery

In general, the rougher the surface being imaged, the brighter the backscatter will appear on the image. Flat surfaces that reflect little or no energy back towards the radar will appear dark though, in cities for example, multiple bounces reflecting energy back to the radar can result in flat surfaces appearing bright. Vegetation is usually moderately rough on the scale of most radar wavelengths and appears grey in images (figure 1).

Backscatter is also sensitive to the target's electrical properties, including water content; wet objects will appear brighter than similar dry ones. Backscatter will also vary depending on the polarisation used and many SARs

This Shuttle Imaging Radar-C image shows widespread oil pollution (visible as black streaks) in the Bay of Bengal in October 1994

Credit: NASA/JPL

can transmit using either horizontal (H) or vertical (V) polarisation—and also receive in either mode leading to four possible combinations. Differing observing angles also affect the backscatter and, as most SARs are side-looking, this angle varies considerably across the imaged swath. In addition, on some spacecraft, the radar angle is adjustable, so the image swath is not fixed relative to the spacecraft's ground track.

From the above, it is clear that the raw data need very careful interpretation, and much post-reception processing is required to derive the maximum benefit from the information received.

Applications of Radar Images

Observations of the Earth using SAR have a wide range of practical applications including:

On the Oceans:

- Illegal dumping of oil or its accidental spillage is readily detected in radar images and observing natural seepage from oil deposits can be useful to the oil industry.
- Surface wind and currents can be determined from the patterns in the images.
- In shallow water, SAR imagery permits one to infer the ocean floor topography.
- At high latitudes, ice monitoring is an important use for radar images enabling ice thickness, type and concentration to be determined and open leads detected.

On Land:

- The ability of SAR to penetrate cloud makes it valuable in monitoring the use of land, especially in frequently cloudy areas. For the same reason, after a major cyclone, SAR imagery can give early indications of the extent of devastation.
- Some geological features are enhanced in radar images due to the oblique viewing of the sensor and its ability to penetrate low-density vegetation cover.
- Interferometric SAR (InSAR) can be used, under suitable conditions, to derive elevation models or to detect small surface movements caused by volcanic eruptions, earthquakes or glacier movement.

This brief introduction to SAR imaging concludes with images derived from satellite-borne SAR. The US, Japan, Europe and Canada all operate radar imaging satellites and the next part will look at some of these programmes.

Acknowledgement

Much of the technical description of SAR above has been abridged from a very informative paper *What is Imaging Radar?* by Tony Freeman of NASA's Jet Propulsion Laboratory which can be found at:

http://southport.jpl.nasa.gov
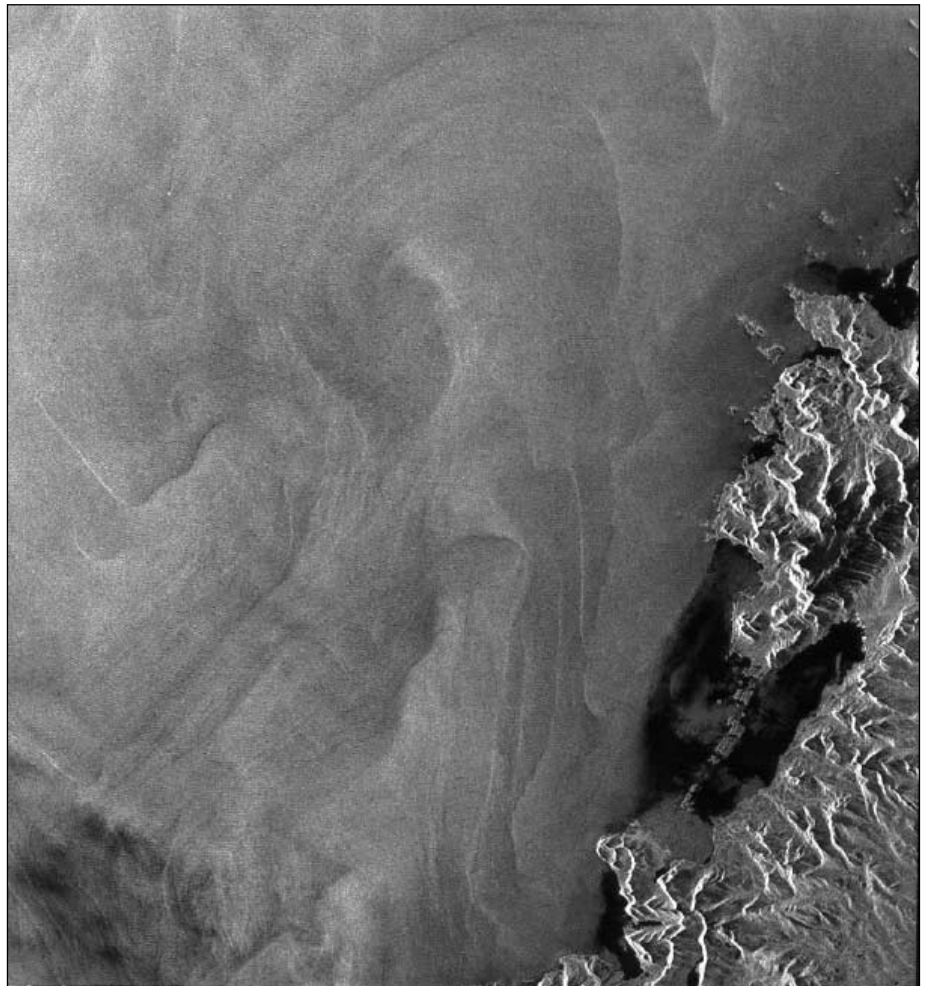
This large ocean eddy, seen as near-circular concentric lines, was captured by ERS-1's SAR in Shelikof Strait, Alaska on October 28, 1991. Eddies in this region are important for fisheries

Credit: ESA
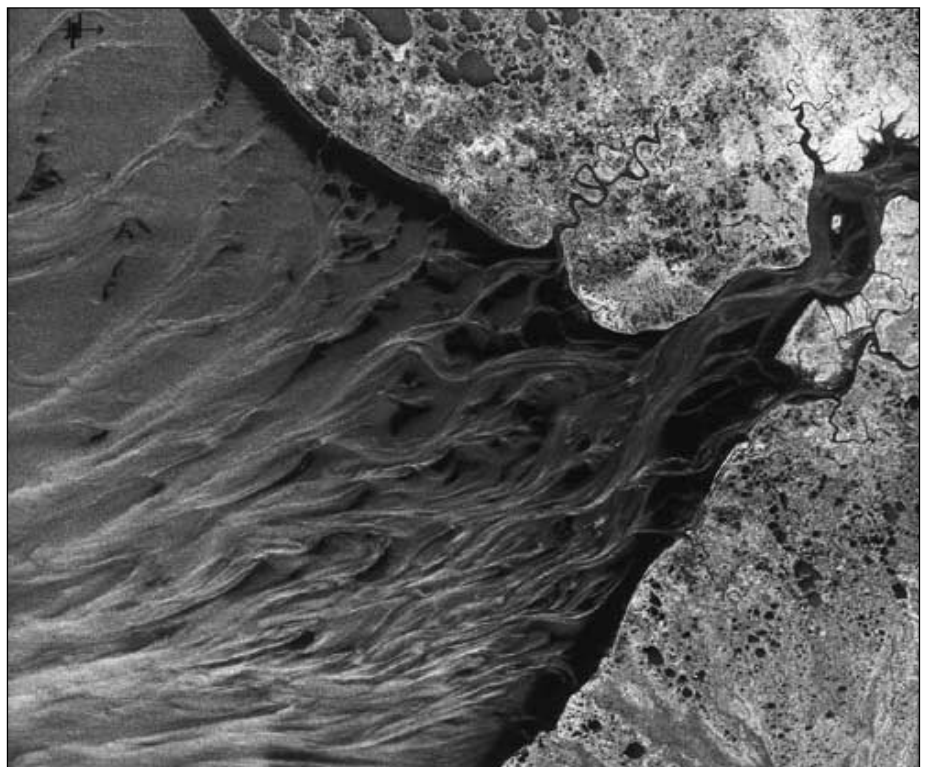
This image of the Kuskokwim River delta in Alaska was taken by Seasat's SAR on July 13, 1978 and shows patterns formed by river water flowing around submerged sand bars

Credit: NASA/JPL

SOFTWARE SHOWCASE

Douglas Deans - *dsdeans@tiscali.co.uk*

Well, as anticipated in my last column, the launch of MetOp-A has resulted in a brilliant new program from the keyboard of David Taylor. **MetOp Manager** was released just a few days after the first trial MetOp data was made available over the *EUMETCast* system. There is a separate in-depth review of the new software on page 25 of this issue, so I have intentionally left the program description below very basic. Please refer to that article for a fuller appraisal of the software and its uses. For those using the *EUMETCast* system, or intending to do so, this new data allows you to view 5-channel, 1-km imagery of the entire world. Now that is impressive!

There is not much else to report but I note that Scott Hather, author of the well known **Satscape** software, has indicated some interest in a new approach to his program, so that is something to look forward to. I reproduce below an edited extract from Scott's website which gives some details. Scott says:

'I had planned, one day, doing a Satscape for *Dot Net*, but as this platform has yet to materialise on other systems (as Microsoft said it would), I've opted for Java instead. I didn't know how to program in Java, so I've started learning. The advantage of Java, of course, is that it runs on about any platform. You write it once and then the same program runs on Windows, Mac OS, Linux, Solaris, most mobile phones and pocket gadgets: in fact anything that can run Java

applications. The reason for the move is that the current Satscape is written using Visual Basic 6, which is getting old now, has quite a few bugs in the language, and Microsoft are no longer developing it. It makes more sense to use one of the more modern object oriented programming languages and Java now seems the clear winner. Anyway, I've just started work on Satscape for Java, but don't expect to see it any day soon as it's going to take time, although I will put some early versions on the site for you to try out—just to see if they will actually run on other operating systems."

MetOp Manager v 1.0.2

This is the excellent new program from David Taylor. As customary with David's software there is a 30 day free trial of the full product for evaluation. Thereafter, to continue using the program, registration is required. My full review of this software and some of the incredible images it can produce appears on page 25.

GS1	All David Taylor's weather satellite programs and libraries, including the current releases of WXtrack, Satsignal, HRPT Reader, GeoSatsignal, GroundMap, RX2 PassControl and many other program extras. This disc also contains a large quantity of sample files, many of high-resolution data, for use with these programs.	
	AVHRR Manager	Processes and manages the files for HRPT via EUMETCast	v 1.3.0
	GeoSatSignal	Manipulates Geostationary weather satellite images	v 6.0.6
	GRIB Viewer	Viewer for GRIB format files	v 2.1.2
	GroundMap	Rescales satellite images	v 2.0.4
	HRPT Reader	Converts raw HRPT data files into images	v 2.6.8
	Kepler Manager	Organises files of 2-line element data	v 1.2.8
	MetOp Manager	Processes and manages AVHRR files from MetOp satellites	v 1.0.2
	MSG Animator	Automatic animation of MSG images following reception	v 2.5.4
	MSG Data Manager	Processes and manages the files received from MSG satellites	v 2.5.4
	RX2 PassControl	Computer control program for the RX2 receiver	v 3.0.8
	SatSignal	Creates images from wave files	v 5.0.4
	WXtrack	Satellite Tracking Program	v 3.6.2

GS2	A wide range of software for all aspects of weather satellite reception, including tracking, receiving, monitoring and image manipulation. Content is detailed below but many other extras are provided. Titles correspond with folder names. * implies a DOS program.	
	Collection D02	Recall (wave file recorder), Palette (modifies Wxsat colour palettes).	
	Collection D03	Scanner recorder v 1.8 (wave file recorder), *NOAA95/*FENG99 (software for the NOAA 95 HRPT project)	
	Collection D04	Wxsat (wave file recorder/decoder), Satmon (wave file recorder).	v 2.59
	AGSatTrack	Satellite tracking program	v 1.33
	APTDecoder	Program for capturing APT audio and processing images	v 1.0.3.72
	Cirkit	Documents for the Cirkit Wxsat receiver and the UOSat receiver (PDF format)	
	Element Manager	2-line element manager	v 1.59
	Footprint	Satellite tracking program	v 2.10
	Irfan View	Image/slideshow viewer	v 3.80
	JVcomm32	Evaluation version (APT/FAX/SSTV decoder)	v 1.40 pre
	Macintosh kepler editor	Edits verbose AMSAT format elements. Mac OS X and OS9 only.	
	NeoPaint	Image processing program (30 day evaluation)	v 4.60
	Orbitron	Satellite Tracking Program	v 3.70
	Paintshop Pro	Image processing program (30-day evaluation)	
	PhotoFiltre	Image retouching program with many extras	v 6.1.5
	Satscape	Satellite tracker and wave file recorder	v 2.02
	Space-Track TLE Retriever	Generates TLE files in 'Celestrak' style from data sets recovered from Space Track	
	Splitter	Utility program for splitting and reuniting large files	
	WXtoImg	WAV file recording and decoding program with many options.	v 2.7.3

GS3	**3DEM Package for 3D Terrain Visualisation** This CD includes the full set of GLOBE Tiles to allow you to produce excellent images and flybys from HRPT inages. Also included is a selection of Mars MOLA files, sample images and helpful guides by Ed Murashie.
GS4	**Image CD** A wide selection of high-resolution remote images from a range of satellites, including stunning imagery from the Space Shuttle missions. A full description and source if provided for each image.
GS5	**Mars Rover Panoramics** A chronological account, in panoramic images, of the NASA Mars Rovers' progress across the Martian Terrain

MetOp Manager v 1.0.2 is available on GEO software CD, GS1. For further information, or to download the program go to:

http://www.satsignal.eu/

NeoPaint v 4.6

Many of you will know this excellent software which started life as a DOS program and has developed to a sophisticated graphics package.

Version 4.6 includes a 'Create texture' option in the *Picture* menu. This can be used to make repeating texture patterns. NeoPaint describes a texture as a special type of image that can be tiled to create a seamless filled area, background or wallpaper. A 'Copy Multiple' option has also been added to the *Edit* menu to allow duplication of a selected area multiple times across an image. The number of copies, direction and distance between copies can be specified.

There are many other minor additions and bug fixes. The software has a free 30-day trial before registration is required for further use.

NeoPaint v 4.6 is available on GEO software CD, GS2 or for further information and to download the program visit:

http://www.neosoftware.com/npw.html

Powerless

My recommendation is that, if you have not already done so, you should buy or borrow a meter similar to mine [1] to enable you to monitor the power consumption of your electrical equipment. These data will enable you to decide whether you want to leave your system(s) on for extended periods of time or only turn them on for active use.

Sometimes in life I have to bury my head in my hands with despair. I noticed recently that politicians have been suggesting a tax on tungsten filament incandescent light bulbs because they consume more energy than an equivalent fluorescent tube. As an innocent bystander who only has low energy bulbs throughout his house, I judge I am competent to make a judgment relating to this suggestion.

In my view the intellectual capacity of many politicians is close to zero. Just because somebody is a Minister doesn't mean they are competent: it often means there is nobody else to fulfil the job. I despise the suggestion about taxing light bulbs—it's about as relevant as the mediaeval tax on windows. If the government wants to get a grip on this issue, let them legislate for electrical manufacturers to position an

on/off switch on the front of every appliance they sell. No clandestine stand-by modes running at 10 W! Just ensure that when the switch is set to off, that's what it means—completely off.

If Ministers want an informed opinion about energy-saving they can knock on my door any time rather than publicly wallowing in their own ignorance.

Reference

1 The meter I used was a *WeTekom Energy Meter* bought from a catalogue. The cost was £10.

For a catalogue tel: 0800 083 5070 or visit their web site at **www.westfalia.net**. I have been told that similar meters are available from UK hardware shops, e.g. B & Q.

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operating normally after separation. At 1,292 kg, excluding the DLA, this was the heaviest payload to be launched by the PSLV which was originally designed to put a 1,000 kg payload into a 900 km sun-synchronous orbit.

CartoSat-2, the twelfth in the Indian Remote Sensing (IRS) series, is an advanced remote sensing satellite capable of providing scene-specific spot imagery. It will join the other six IRS satellites which are in service: *IRS 1-C*, *IRS 1-D*, *OceanSat-1*, Technology Experimental Satellite (TES), *ResourceSat-1* and *CartoSat-1*. It carries a panchromatic camera with a resolution better than one metre that can be steered up to 45 degrees along and across the track and will provide imagery for cartographic applications. The National Remote Sensing Agency in Hyderabad began receiving imagery from *CartoSat-2* soon after launch.

The *Space Capsule Recovery Experiment* was a complete success; the capsule was retrieved from the Bay of Bengal, not far from its launch site, after a successful de-orbit and splash-down precisely as planned.

LAPAN-TUBSat is a cooperative venture between the Indonesian Space Agency, LAPAN, and the Technical University of Berlin. The 56 kg satellite carries two CCD cameras with ground resolutions of 5 m and 200 m and is returning imagery as planned.

PehuenSat is a tiny, 6 kg package from Argentina that will remain attached to the DLA. Developed by the University of Comahue in Argentina, AMSAT Argentina and the Argentina Association for Space Technology, it is intended to provide a platform for amateur radio experiments between the colleges and universities of Argentina.

Demystifying the Butterfly Effect

Storm Dunlop

An item in a recent issue of *New Scientist* prompted me to discuss the suggestion in GEO Q12, page 26 that the breakaway of the tabular iceberg in Antarctica was an example of the Butterfly Effect.

In fact, it was not. The so-called '*Butterfly Effect*' does not exist, although it has come to be understood as suggesting that small actions may have large or even catastrophic results. But this was not at all what Lorenz meant in 1972 when he gave the lecture 'Predictability: Does the Flap of a Butterfly's Wings in Brazil Set off a Tornado in Texas?'

To quote from my *Dictionary of Weather*:

"Lorenz concluded, not that small changes would necessarily lead to large effects, but that the question is currently unanswerable and will probably remain so for the foreseeable future. Errors in weather forecasting are inevitable and come from inadequate data coverage, incomplete knowledge of the underlying physics and the fact that approximations cannot be avoided in formulating the equations used for human or computer predictions. The term—formally known as 'sensitive dependence on initial conditioning'—should be used to suggest that there are limits to predictability, not that such an effect exists."

Edward Lorenz discusses this on pages 14 and 15 of his book, *The Essence of Chaos* (University of Washington Press, Seattle, 1993), where he points out that a small event could just as well prevent a major effect at a later time. Lorenz originally used a seagull as an illustration of sensitive dependence. The change (to 'butterfly') was made by the session convener, who was unable to check with Lorenz when submitting programme titles. Lorenz also mentions how Ray Bradbury wrote a short story where the death of a prehistoric butterfly affected the outcome of a present-day presidential election, and how Stewart, in his novel, *Storm*, suggested that a man sneezing in China could result in people shovelling snow in New York.

Lorenz lays the blame—if such it is—for popularising the erroneous conception of the Butterfly Effect on James Gleick and his book *Chaos*. It may have arisen from the butterfly shape of the 'strange attractor' that Lorenz found when he examined the first chaotic system.
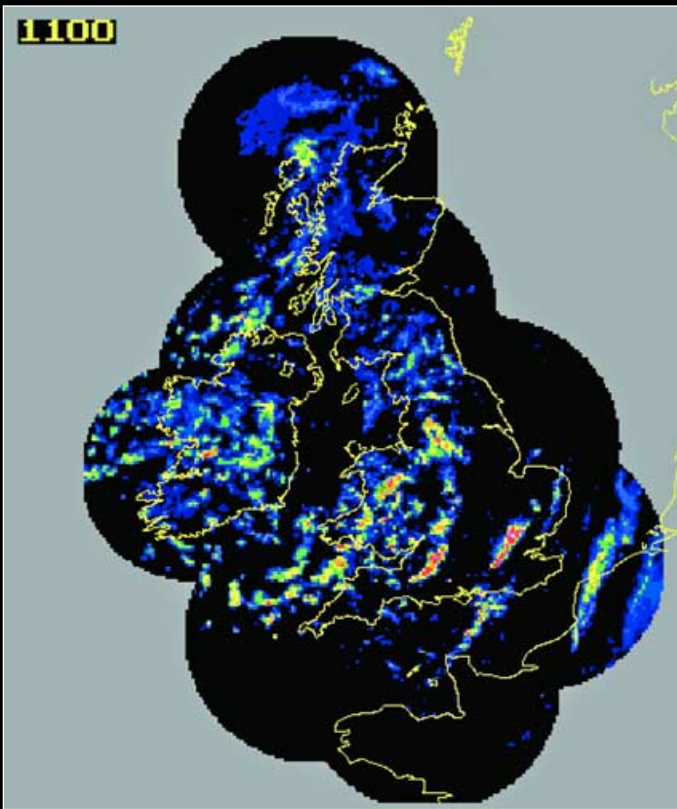
A radar image provided by Douiglas Deans, depicting the squall line that produced the London tornado on December 7, 2006

Image © AvBrief
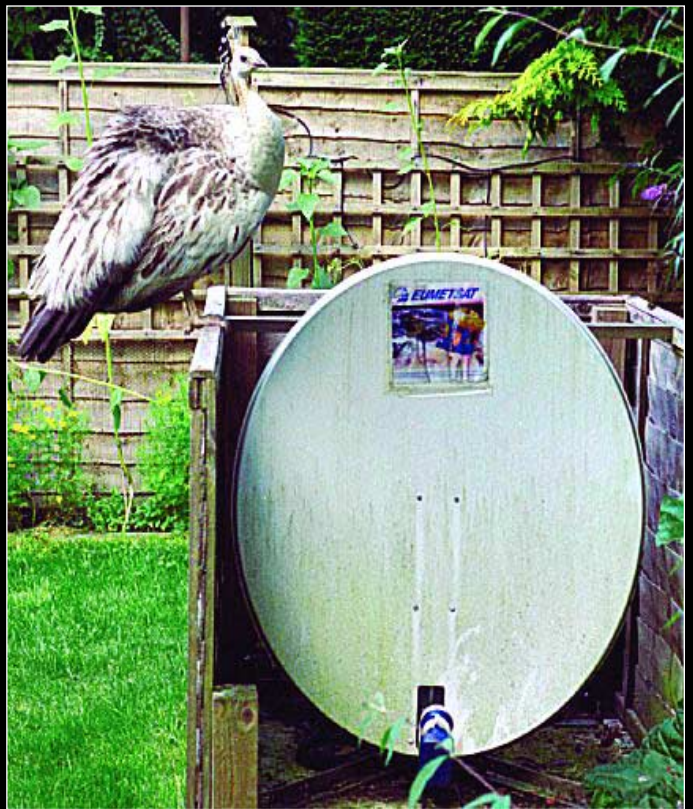
Continuing our occasional 'bird' theme, **Francis Breame** submitted this photograph showing a rogue peahen (not his own) taking an interest in his *EUMETCAST* dish antenna.

Bush fires rage in the Great Dividing Range of Victoria, Australia in this *Terra* MODIS image dating from December 11, 2006

NASA image courtesy the MODIS Rapid Response Team, Goddard Space Flight Center