

The **GEO** Quarterly



Group for Earth Observation

Group for Earth Observation

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

Number 32

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Inside this issue . . .

The big news this quarter is the successful launch of the NPOESS NPP satellite, the successor to the current NOAA weather satellites. Inside is an illustrated account of the launch, while Ed Murashie provides a detailed overview of the new satellite's capabilities and instrumentation.

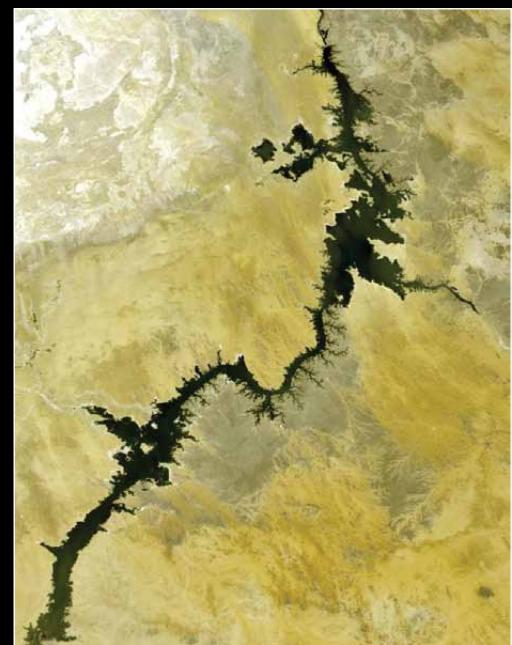
Also newly aloft are the first of ESA's constellation of Galileo geolocation satellites: John Tellick explains.

Esko Patäjä describes his enthusiasm for lightning detection and describes how he integrates this data with his weather satellite imagery.

Fallstreak holes, also known as hole-punch clouds, have been observed in our skies for decades. Once thought a manifestation of UFOs, their true cause is now revealed.

There are also features on Arctic melting, Antarctica, Typhoons over the Philippines, Autumn in Kamchatka ...

... and much more.



Francis Breame provided GEO with some amazing Envisat MERIS imagery, which he received through the Envi-Ham project. The upper image shows a large area of Egypt, including the River Nile, Nile delta and the Red Sea. At lower left is a zoomed section of the same image displaying the city of Alexandria and the Suez Canal. The lower right image shows an enlargement of Lake Nasser, behind the Aswan Dam.

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Editorial

Les Hamilton

You will notice that this issue of *GEO Quarterly* arrives under a change in editorship. As some of you may be aware, Peter Green, who has carried the editorial flag for the past two years, has recently undertaken new employment which has left him with little time to edit the previous two issues. Completing the September issue, in particular, proved a real struggle, and Pete asked me how I felt about a return to the editor's chair.

I sympathise fully with Pete because I had a similar problem for several years because of the demands of caring for a nonagenarian parent beset by Alzheimer's Dementia; that ate into my time and forced me to give up the editorship. But this is all in the past now and I am again in a position where I can devote the required time to editing *GEO Quarterly*. I'm sure I speak for both the GEO Management Team and our readership in thanking Pete for his efforts to keep the Quarterly afloat. In addition, Pete also took delivery of the magazines and mailed them off to you, a role he will continue to fulfil: so he will not be totally lost to GEO.

I'm delighted to report that there has been much improved reader involvement this issue which has helped me no end, as I had only four weeks to compile this issue: normally one has the relative luxury of three months to do this. For a change, the report on our Darmstad trip comes from Rob Alblas, one of the stalwarts of *Werkgroep Kunstmanen*, while David Taylor reports on what was clearly a stimulating visit to Oslo to attend the EUMETSAT User Conference.

Esko Patäjä has prepared a detailed illustrated feature on his lightning detection station and explains how he uses the information he gains in conjunction with his weather satellite images. And in the first part of a series of articles for readers just starting out with APT reception, Ron Hahn describes the basics of his system. Ron will follow this up with details of capturing and processing the actual images next time.

This issue completes the eighth year for *GEO Quarterly*, and also marks a new beginning for weather satellites as NOAA finally embarked on its bold new venture, the NPOESS Preparatory Project (NPP). Designed as the successor to the current constellation of American polar orbiting weather satellites, the first NPP craft was successfully orbited last month, as reported on page 31. Ed Murashie has been on a guided tour of the facilities at Vandenburg Airforce Base, where the launch took place, and will document this in the March Quarterly. In this issue though, Ed provides an overview of the NPP Mission, and details the instruments it carries.

And finally, may I wish all our readers the very best of good cheer for the Festive Season, and a healthy and prosperous 2010.

Contents

GEO Report	Francis Bell	2
GEO Symposium 2011 Report	Francis Bell	3
EUMETSAT Visit 2011	Rob Alblas	5
Fallstreak Holes	Les Hamilton	9
Fallstreak Holes over West Virginia	NASA Earth Observatory	13
Straylight	Les Hamilton and David Taylor	14
NOAA Satellites Save 2338 People in 2010	NOAA	15
Cover and full page image details		15
Weather Satellites in Vietnam	Fred van den Bosch	16
Sea Ice and Icebergs off East Antarctica	NASA Earth Observatory	17
Philippines Suffer yet more Typhoons	John Tellick	18
EUMETSAT User Conference - Oslo, 2011	David Taylor	20
GEO Shop		23
GEO Membership Renewal Form		24
Helplines and Internet Discussion Groups		25
Copy deadline for the next issue of GEO Quarterly		25
Arctic Meltdown	Les Hamilton	26
Unseasonable Snow in Northeast USA	NASA Earth Observatory	28
Envi-Ham Image and Quarterly Question	Francis Bell	29
Successful Launch for NPP	NASA/NOAA	31
ESA Launches its first Galileo Satellites	John Tellick	32
An Introduction to APT Weather Satellite Reception	Ron Hahn	34
The Ultimate Weather Satellite Enthusiast	Robert Moore	36
Lightning Detection and Weather	Esko Patäjä	37
The Buddleja Effect	Francis Breame	42
Possible Fallstreak Hole seen from Wisely	Francis Breame	42
NPP, NiPPY and the Workhorse	Ed Murashie	43
Spring arrives in Antarctica	John Tellick	46
Feedback	Readers' Letters	48
A Kamchatkan Autumn	NASA Earth Observatory	48

The **GEO Report**

Francis Bell



This has been a busy year for GEO, attending rallies, shows and conferences. There were the Kempton rallies (twice), our own Symposium in Leicester, the Newbury rally, GEO's visit to EUMETSAT in Darmstadt, the RSGB sponsored National HamFest near Newark and the TORRO (Tornado and Storm Research Organisation) meeting in Oxford. I gave weather satellite presentations at the Newark and Oxford meetings. In addition to these events, I had my own club field days plus Brownie Guides international JOTA weekends: all featuring live *EUMETCast* reception. The Darmstadt visit is reported by Rob Alblas (page 5) who views the event from a Dutch perspective. I'll report on some of the other events, with photographs, in the March 2012 issue.

Membership

David Anderson, our membership secretary, has drawn attention to our falling membership, which now stands at about 400 compared with the 500+ we enjoyed a year or two ago. I am certain that some members fail to renew by default, not because of dissatisfaction with the group. I know I have written this before but please, when you do receive your renewal notice, treat it as a privileged invitation to join a prestigious, international and influential group. If you actively don't wish to renew, I would appreciate a short email giving your reason for non-renewal. This might allow us to address any issues which concern our membership. Please don't fail to renew just by default: let it be an active decision.

GEO Shop

I would like to take this opportunity of thanking Clive and Carol Finnis for establishing and running the *GEO Shop* for our members benefit. Not only does the shop give us access to equipment which would be difficult or impossible to source privately but also it makes a profit which provides a financial buffer to call on should it be needed. Also, thanks to David Simmons who has acted as assistant shop manager for about two years and is your first point of contact for orders. I will ask Clive and Carol to write a short history of the shop for publication in a future Quarterly.

The Quarterly Question

I am always pleased to receive responses to the Quarterly Question, which shows that some readers are interested and taking the trouble to respond. Sometimes I struggle to find a suitable question which will appeal to a broad section of our membership. [Here is an invitation](#): if any reader would like to submit their own suggestion for a question, that would be great. If you think you may have a question of interest please send it to me at

francis@geo-web.org.uk

and I will forward it to the editor.

Satellite Update

I would very much like to see a page of *GEO Quarterly* devoted to satellite news or updates. We have done this in the past and I miss the information it contained: I'm sure others have as well. I sometimes have to refer to data contained in *De Kunstmaan* (Werkgroep Kunstmanen's publication) or to EUMETSAT's 'Image' brochure. It would be great if a GEO

member were to take over responsibility for an informative page in *GEO Quarterly*. Once the format and layout of the page were established, it should not be too time consuming to revise it each quarter. Please, if you are willing to take on this responsibility and keep such satellite data up-to-date, then please get in touch with me or the GEO editor. I judge that this could be a rewarding task, keeping our membership informed of satellite news. This page could replace our APT satellite prediction page. I can supply samples of a potential layout to anyone who may be willing or interested in this job.

I have recently become interested in EUMETSAT's rapid scanning service. If you have any experience in receiving this service, I would love to hear from you. Contact myself or if you have copy material, I'm sure it would be well received by our editor.

Coming Events

March 31, 2012

TORRO is holding one of their regular meetings in Oxford. For details of this meeting and other matters relating to TORRO visit their web site at

www.torro.org.uk

April 15, 2012

This is the date for the South London Radio and Computer rally. GEO regularly have a stand here.

May 12, 2012

Werkgroep Kunstmanen are holding one of their regular meetings in Utrecht. It would be supportive if some of our UK GEO members were to attend. Our Dutch friends do consistently support our meetings. Their web site is at

www.kunstmanen.net

June 17, 2012

This is the date for the Newbury open air rally and I expect GEO will have a stand there, with appropriate shelter.

September 22, 2012

This event and date has still to be confirmed but it is a possible date for our **GEO Symposium in Leicester**. We will invite TORRO members, should they wish to come, or even share the meeting with us. [Please note that this event is still in the planning stage](#). More details will appear in the March 2010 issue of *GEO Quarterly*.

September 28-29, 2012

These are the dates for the two day National HamFest held on the Newark Showground. GEO will have a stand there.

Finally

In October 2011, EUMETSAT had a stand at the Meteorological Technology World Expo held in Brussels. Sally Wannop, the *Head of EUMETSAT User Services*, was on their stand when visited by GEO's John Tellick. Sally said to him: 'When are you coming to see us again—in 2013? We loved having you last time'.

Well you can't get better than that!

GEO Symposium Report

May 7, 2011

Francis Bell

The was our sixth annual symposium to be held at the National Space Centre (NSC) in Leicester, a venue which seems to be favoured by our membership, this time attracting approximately forty delegates. An advantage of the NSC as a venue is its location close to the centre of the UK plus easy access, free parking and free entry into the NSC's exhibition areas. Interestingly this year, on the same day as our symposium, the NSC were hosting a theme day devoted to *Star Wars*, with consequent storm troopers providing entertaining displays in the public areas.



Storm Troopers guard the GEO conference area at the NSC

I was delighted to see about eight of our Dutch friends, members of *Werkgroep Kunstmanen*, who had taken the trouble and expense to attend our meeting in the UK. Two of their number also contributed to the formal presentation programme. Many of us stayed overnight in the same Leicester hotel and enjoyed an evening out in the town together, and a delightful evening meal.

The support of our Dutch members must be noted and I encourage our own membership to attend *Werkgroep Kunstmanen* meetings in Utrecht if they can. I will certainly be attending one of their meetings in 2012. Please see the other notice in this Quarterly.

The conference area we use for our symposium in the NSC is ideal because it can easily be divided into a presentation room for about 80 people while leaving the other two thirds of the area free for displays and demonstrations. Within the demonstration area we had:

- John Tellick running live *EUMETCast* together with much literature.
- GEO had an area, again running *EUMETCast*, and with additional laptop computers showing recorded images from MSG and Envisat, again with a variety of literature from ourselves and EUMETSAT.
- *GEO Shop* was in attendance, with Clive and Carol Finnis offering a wide range of items for sale and, understandably, did brisk business during the day.
- *Werkgroep Kunstmanen* mounted an extensive display of both current and historical equipment and again ran a variation on live *EUMETCast* signals.
- Other members had their own personal display tables.

The programme of presentations ran in two sessions, morning and afternoon. From my perspective, every presentation was of interest and subsequent feedback from delegates seemed to confirm this. Although I have to admit I did not understand every element of the HRPT decoding project.

In outline the programme was as follows:

- A welcome to all the delegates by myself.
- A talk by Kerian Jones for the NSC about their role in recording the movements of near objects in space, their records being passed on to other international agencies.
- I gave a brief presentation about the *Envi-Ham* project and invited delegates to take away some raw data files which I had recorded at home. The rationale behind this was to enable interested members to practise processing data before establishing their own live *Envi-Ham* receiving stations. Later in the day a number of members did take up this offer.
- David Taylor gave an update on *EUMETCast* reception and the steps required to handle the masses of data now flowing. *EUMETCast* provides not only European geostationary satellite imagery, but also data from worldwide geostationary and several polar orbiting satellites. Requirements of software installation for the newer versions of Windows were discussed, and David showed examples of the new RGB (red, green & blue) colour mapping in *GeoSatSignal*. There is now so much data available that minimising the flow and the amount stored is much more important, and several methods of control were mentioned (PIDs, recv-channels.ini and program controls). David concluded by showing how he has used *MRTG* software to monitor correct operation of his systems.
- Rob Alblas gave a detailed talk about his development of an HRPT decoder. Elements of his project were available for examination on the *Werkgroep Kunstmanen* display area.
- David Anderson, at short notice, gave us a briefing about the TORRO group. This is a UK based organisation of both amateurs and academics, interested in extreme weather phenomena. TORRO's website is at

www.torro.org.uk

and delegates were encouraged to visit it to learn details of TORRO's activities.

- David Taylor presented 'Gadget Corner', which related to three



Kerian James presents his talk on Near Earth Objects

USB stick devices which fit into your pocket for easy travelling. The first was the *Ventus GPS*, a GPS logger which can record your position during the day. Second was the *Marine Gadget Radar*, which allows the plotting of ship positions with a simple antenna—ideal for those seaside trips. Finally, there was the *FUNCube Dongle Pro*, a receiver from AMSAT UK covering the VHF and UHF ranges, which is already being used to receive APT pictures in conjunction with an SDR (software defined radio) program running on your PC. These receivers with their broadband front-ends may need additional filtering in good VHF locations. Arne van Belle showed more gadgets, including SMD workshop tools and a Russian radiation detector.

GEO AGM

It was encouraging that almost all the delegates stayed for the AGM. I acted as chairman for this meeting. In my report I tried to cover the significant events of the past year. I identified our group's main aims and objectives having remained unchanged, that is, to promote the interests of our members, and to support amateur, educational and non-commercial users of weather satellites.

I identified the changes that have taken place in our management team. Peter Green is editor with Les Hamilton as assistant editor. Rob Denton has taken over the role of international liaison. Peter Wakelin has retired as a member of our management team. I noted his contributions each quarter with his 'Satellite Update' which will be missed. Ray Godden has retired as webmaster but still remains within our management team. On behalf of GEO I expressed thanks to all the past and present management team: without them GEO would not exist.

It was noted that GEO does try to attend appropriate rallies, exhibitions and conferences when possible. The past year had included rallies at Newbury, Kempton (twice), the RSGB sponsored two-day National Hamfest at Newark and, for the first time, the Royal Meteorological Society conference in Reading. For a combination of reasons, we were no able to attend the NOAA conference in Miami, but we did send our literature and display materials which apparently were well received and conspicuous in NOAA's display area. A report from this conference was expected to be available during our coming visit to Darmstadt.

For the 'Any Other Business' agenda item I suggested that delegates consider any future policies we should address, which might enlarge our membership and benefit other groups who may not be aware of weather satellite reception.

Individual reports were given by those members of the management team who were present.

David Anderson, our membership secretary, reported a decline in membership, which now stands at about 430 whereas, in the past, it had been over 500. David said he would publish details of membership in a coming Quarterly.

Clive and Carol Finnis reported that the shop continues to be busy and, with the changing technology, they are always trying to keep up-to-date with their stock. The shop made a profit last year of about £2,000 and the current balance in the shop account is £8,414. I personally thanked Clive and Carol because, without their efforts, our membership would not have such easy access to the vital items of hardware we all use. Thanks were also expressed to David Simmons who is very busy fulfilling his role as assistant shop manager.

I reported on the membership financial position. A full statement of accounts was available to all the delegates. Basically the membership side of our finances had just broken even over the year. There was an unexpected expense repaying two sponsors a total of £3,000, and the cost of buying computers and software for publication of the Quarterly. This was balanced by reduced printing and distribution costs. Our opening balance for the year was £2,176 with a turnover of £13,901 and a closing balance of £2,305. if any



The Werkgroep Kunstmanen Display Area



Clive and Carol Finnis happily pointing out one of the DVB World receivers they had available for sale on their stand.

member would like to see the full accounts, as available at the AGM, please email a request to me at

francis@geo-web.org.uk

Other Business

The main discussion here related to widening our membership. It was decided to approach TORRO and exchange information about our activities and areas of mutual interest.

The day ended with the raffle and draw which had raised about £150 during the day. The star prize was a Ray Godden R2FX APT receiver which went to Rob Denton. I have subsequently discovered this receiver is in regular use with Rob. I have an audio recording of the AGM if anyone would like to borrow it.

EUMETSAT Visit - 2011



Rob Alblas

On July 7/8, a number of members of Werkgroep Kunstmanen, together with members of GEO, paid a visit to EUMETSAT in Darmstadt. We made a similar visit in 2007.

The programme consisted of a number of lectures from EUMETSAT, a visit to various control centres in Darmstadt and an excursion to the antenna park in Usingen. There was also a visit to the ESOC space operations centre in Darmstadt.

From our Werkgroep, among others, Ben Schellekens, Arne van Belle, Peter Smits, Rob Alblas, Hendrik Jalving and Elmar Bogels all attended, as well as one of our German members. In total there were 28 participants, the majority of GEO members coming from Great Britain.

For us, this visit started with a long car journey to Darmstadt, which lies just to the south of Frankfurt. After this long trip, we indulged ourselves at a Greek restaurant where we found enough materials to make a fanciful demonstration of the working of an XY-rotator (figure 1).

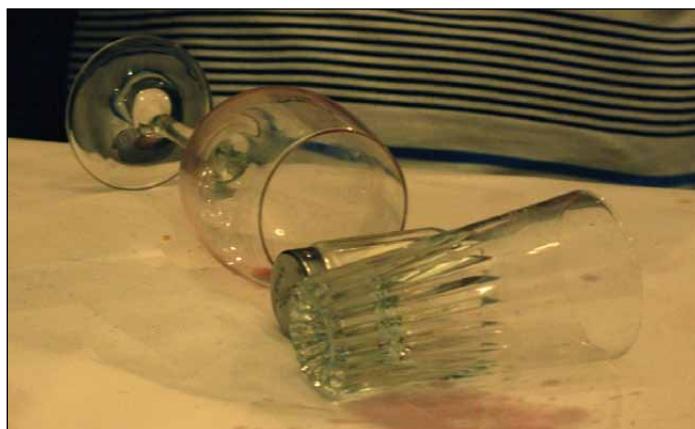


Figure 1 - A fanciful representation of an XY rotator

The next morning we set off to EUMETSAT headquarters (figures 2, 3). In the hall, our attention was taken by the enormous screen with live weather pictures. In one corner of the hall a very particular manner of showing pictures was to be seen: on a globe of the world! (figure 4). Perhaps this is something worth copying? It would be a beautiful addition to our stand but would depend on us obtaining a grant.

The series of lectures was introduced by Sally Wannop, *User Support Manager* at EUMETSAT.

After a word of welcome from EUMETSAT's *Director of Operations*, Mikael Rattenborg, Sally provided an overview of the current state of affairs concerning MSG, as well as the plans for the future: see figure 5. Next the *Earth Observation Portal* (EOP) came under consideration. It's through this, via one central location, that all EUMETSAT's archived data becomes available.



Figure 2 - The EUMETSAT Headquarters Building



Figure 3 - A model of the MSG Satellite in the Garden at EUMETSAT



Figure 4 - A satellite image projected on the inside of a globe

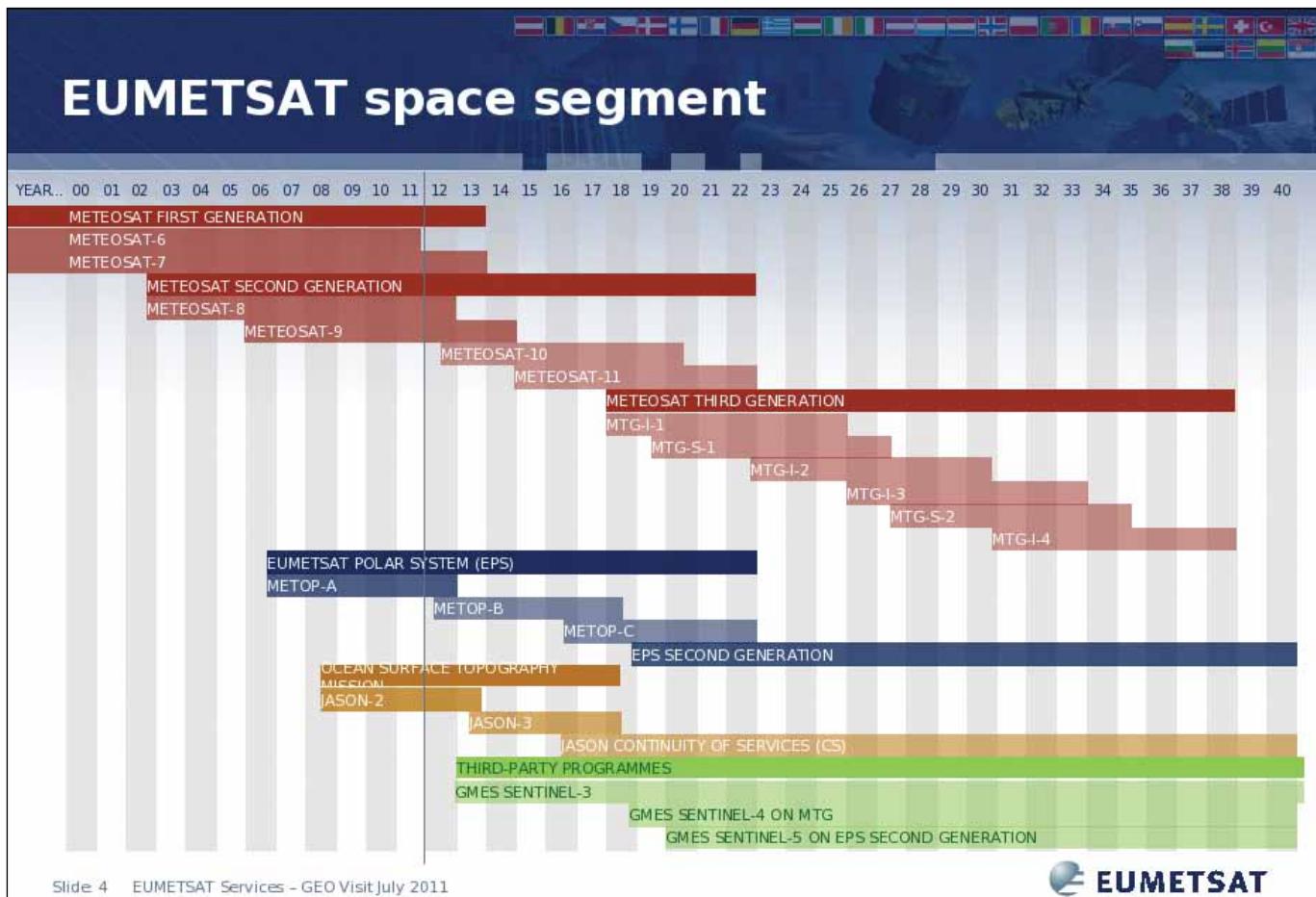


Figure 5 - A summary of EUMETSAT's Future Mission Plans

After this, Marianne König detailed how, through the combination of several MSG channels, diverse atmospheric matters can be explained. One can think here of the detection of fog, particulates and so on. The future (Third Generation) satellites will be also be equipped for detecting lightning activity.

Dieter Klaes held a presentation about Metop. Here we had the chance to learn about future developments in the *EUMETCast* system. The quantity of data which is disseminated by means of this system will only increase, the more so once Meteosat Third Generation comes into service. Because of this, a new generation of DVB (DVB-S2) will be necessary. With the current DVB-S, a data rate of 31 Mbps is possible: with DVB-S2 this can become 44 to 66 Mbps, which is very close to the theoretical maximum. Consequently, your old DVB-S receiver will eventually have to be replaced. Although there are already DVB-S2 receivers available for purchase at the present time (among others, from DVBWorld), it's advisable for now not to purchase one of these dearer types. There

are several types that support specific modes—but it is not yet certain which mode will be used (probably VCM).

The official line from EUMETSAT is: 'Do not prepare for, or worry about, DVB-S2. It is far too soon for that!'

Around midday we enjoyed a guided tour through the *Control Centres* and the *Data Centre*. The control centre for the MSG satellites contains an impressive number of monitors (figure 6). In the control centre for polar satellites such as Metop, yet another aspect came to the fore. At the moment in time that this polar satellite passes over Svalbard, the data from a complete orbit is dumped. Then, absolute silence must reign in the control centre, in case of possible problems which can appear during this critical transfer. We were thus requested to leave the area. Figure 8, taken in the centre just four minutes before this event, shows a screen displaying details of an upcoming Metop pass.

In the basement is found the area where all data is archived. If a request comes in for data from,

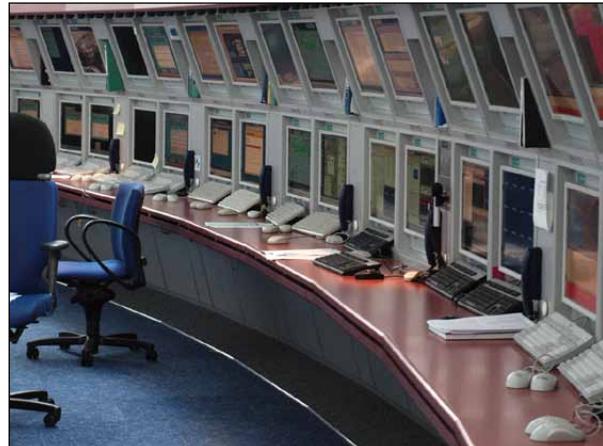


Figure 6 - The MSG Control Centre with its array of Monitors



Figure 7 - The Metop Control Centre

2011-188 11:02:03	
Metop A, Orb:24461	NOAA 19, Orb:12424
AOSO(SVL1)-00:03:55	AOSO(SVL2)-01:36:55
Upcoming Orbit : 24461	Upcoming Orbit : 12425
CDA : SVL1	CDA : SVL2
TM duration : 15:30	TM duration : 15:20
TC duration : 12:56	TC duration : 12:31
Starts at : 2011-188 11:05:59	Starts at : 2011-188 12:38:59
Last Pass Orb: 24460	Next Pass Orb: 24461
CDA : M61	CDA : M61
TM duration : 15:09	TM duration : 15:38
TC duration : 12:24	TC duration : 13:02
St.: 2011-188 10:16:30	St.: 2011-188 11:57:14
Last Pass Orb: 12422	Next Pass Orb: 12426
CDA : SVL2	CDA : SVL2
TM duration : 15:54	TM duration : 14:11
TC duration : 13:19	TC duration : 10:59
St.: 2011-188 09:34:47	St.: 2011-188 14:22:01

Figure 8 - The Screen showing details of Metop and NOAA-19 passes

for example, a number of years ago, it's here that the relevant tape is fetched from a rack (figure 9), read and replaced. The type of storage medium is always being renewed with advancing technology.



Figure 9 - Part of one of the carousels containing tape archives

After lunch there followed presentations concerning the *Third Generation* of geostationary satellites which will come into use in 2017. In contrast with the current 2nd generation and first generation satellites, the third generation consists of twin satellites: an *imager satellite* (MTG-I) and a *sounder satellite* (MTG-S). The **imager** satellite makes the weather pictures, where 16 spectral channels (presently 11) will be used, with a resolution of between 0.5 km and 2 km (at present 1 km and 3 km). Also, there is a lightning detector on board which will map total lightning activity around the world. The **sounder** satellite contains both an infrared and a UVN (ultraviolet,

visible light and near infrared) sounder. In the case of the imager, a backup satellite will also be launched but there will be no such backup for the sounder.

An important difference between the current and previous generations of geostationary satellites is that *Meteosat Third Generation* (MTG) is three-axis stabilised, whereas the older generations were spin stabilised.

Finally, François Montagner told us about the cooperation between EUMETSAT and NOAA concerning polar satellites: the Joint Polar Satellite System (JPSS). The NOAAs and Metops complement each other.

A CD has been put together with all the presentations. UK readers who would like a copy can request one, in writing, from Francis Bell, stating their postal address and enclosing four first class stamps to cover the cost of postage (postal details for Francis can be found on page 1 of this Quarterly).

In the evening we went for a meal with a number of EUMETSAT employees in a typical Biergarten.

The following day we travelled by coach to Usingen, approximately 70 km to the north of Darmstadt (on the opposite side from Frankfurt). Here we enjoyed an extensive guided trip through the antenna park. Only a small fraction of the antennas are for EUMETSAT-EUMETCast; the majority of the more than 100 dishes in place are intended for satellite-TV.



Figure 10 - Antennas for MSG-1, MSG-2 and MSG-3

Figure 10 shows the antennas that receive the raw data from MSG. In the background can be seen the antenna for the yet to be launched MSG-3. These antennas have a diameter of approximately 21 metres and must be aimed very accurately. The antennas are regularly steered, whereby they are turned slightly to make certain that their direction is optimal. This action is only apparent from the sound of the motor as the correction to the antenna is very small.

The raw data is sent from here to Darmstadt by means of microwave links (figure 12). Because a small hill stands in the way, a relay station has been placed on top of it. In case of interruptions, the data can also be transferred by means of cables. Generally speaking, the quality using the microwave link is better (with less chance on data errors).

After processing in Darmstadt, the data are returned to Usingen, whence they are sent to the *Eurobird* satellite (figure 11) which then provides the distribution over Europe. Figure 13 shows an overview of part of the antenna park. There seems to be an antenna hidden behind every bush...



Figure 11 - Uplink to Eurobird
Photo: Arne van Belle



Figure 12 - The Usingen Transmission Tower



Figure 13 - An overview of the Usingen Antenna Park

Back in Darmstadt, we still had to visit the ESOC Space Centre. There is not much of interest to see here just now. The Main Control Room was unfortunately closed on account of rebuilding work. In 2007, we were able to see it. Unfortunately, the policy at ESOC is much stricter than at EUMETSAT and visitors are not allowed into the control rooms. Because of this, the tour was restricted to a mere

peek in from the corridor, and viewing the posters and satellite models/fragments in the showcases.

That same day we had to set off home again. All in all, it was an interesting excursion. There are many more photographs to be seen at:

<http://www.alblas.demon.nl/reis/EUMETSAT/index.html>

Fallstreak Holes

or Hole-Punch Clouds

Les Hamilton

A few years ago, *NASA Earth Observatory* featured two remarkable images under the banner of its *Image of the Day*. Figure 1 is a photograph taken of the sky above Arcadiana, a region of the Gulf coast of Louisiana stretching between New Orleans and Texas [1].

On January 29, 2007, inhabitants saw unusual looking cloud formations that appeared for all the world as though holes had been punched right through the cloud layer. Often dubbed 'hole-punch' clouds, these phenomena are correctly termed 'fallstreak holes'. Not only were these clouds visible to ground-based observers but they were also captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) flying aboard NASA's *Terra* satellite (figure 2). Indeed, a veritable swarm of these holes, some circular and others elongated, showed up in the MODIS image over an area of cloud stretching across Oklahoma, Arkansas, Louisiana, and Texas.

Fallstreak holes have been observed for many years but it is only recently that the cause of their formation has become understood. Often, in the past, the phenomenon had been considered to be evidence for UFOs, and as recently as October 2009 a fallstreak hole that appeared in the sky over Moscow fuelled widespread reports of a 'mystery UFO' above the city. The cause is much more mundane and has for several decades been considered to be related to a combination of low temperatures and air traffic.

The cloud blanket shown in figure 2 consisted of supercooled clouds, where water existed as liquid droplets even though the temperature was well below freezing. Such clouds are by no means unusual. Figure 3, a colour composite AVHRR image created using David Taylor's HRPT Reader software [2] also shows the fallstreak holes to good effect, as does the enlarged channel-2 image (figure 4). HRPT Reader also created a thermal image (figure 5) which shows that the temperature of the affected cloud mass was in the range -25°C to -35°C. On the other hand, through the fallstreak holes, temperatures (of land or lower cloud levels) are considerably lower, generally above -10°C.

Throughout the day, aircraft from Dallas-Fort Worth international airport passing through this cloud mass were clearly causing its supercooled water droplets to freeze rapidly; the more massive ice crystals fell from the cloud deck, creating the 'punch-holes' while, as figure 1 shows, some of the tinier ice particles remained suspended in the centre of the hole.

Recent Research

In December that same year (2007), Andrew Heymsfield, a scientist at the *National Center for Atmospheric Research* (NCAR) based at Boulder, Colorado, was present at an event that was, fortuitously, to lead to his establishing that the most likely cause of these cloud holes was aeroplanes on their take-off and landing flight paths [3].

At the time, Heymsfield was participating in an unrelated project, the *Ice in Clouds Experiment*, which aimed to predict the number of ice particles nucleating in clouds at temperatures warmer than -37°C. The NCAR operates a



Figure 1 - Seen from below, one of the many fallstreak holes observed over Arcadiana on January 29, 2007



Figure 2 - A segment from a 250 m resolution MODIS image showing some of the fallstreak holes that developed over Louisiana on January 29, 2007
Image: Jeff Schmaltz, MODIS Rapid Response Team at GSFC

Lockheed C-130 Hercules aircraft equipped with a range of spectrometers to measure aerosol, cloud droplet, and ice particle size distributions, as well as upward and downward Doppler cloud radar, plus an upward-viewing twin-wavelength polarization LIDAR to provide remote sensing data. It was during a flight aboard this craft, north of Fort Collins, Colorado, that the LIDAR detected light snowfall from a layer of cloud 1.5 kilometres above the C-130.

It was not till some months later, when reviewing data logged by the aircraft's video cameras during that flight, that Heymsfield and colleague Patrick Kennedy noticed a gap in the otherwise unbroken deck of altocumulus clouds above their plane, as well as a band of snow that extended to the ground. This hole measured 1 × 1.8 kilometres and had the same orientation as the standard flight tracks of commercial aircraft in the region. Radar from the ground picked up a strange echo in their wake, indicating oddly-shaped snowflakes.

A subsequent review of flight track records from the *Federal Aviation Administration* revealed that turboprop planes operated by two airlines had flown close to the hole's location

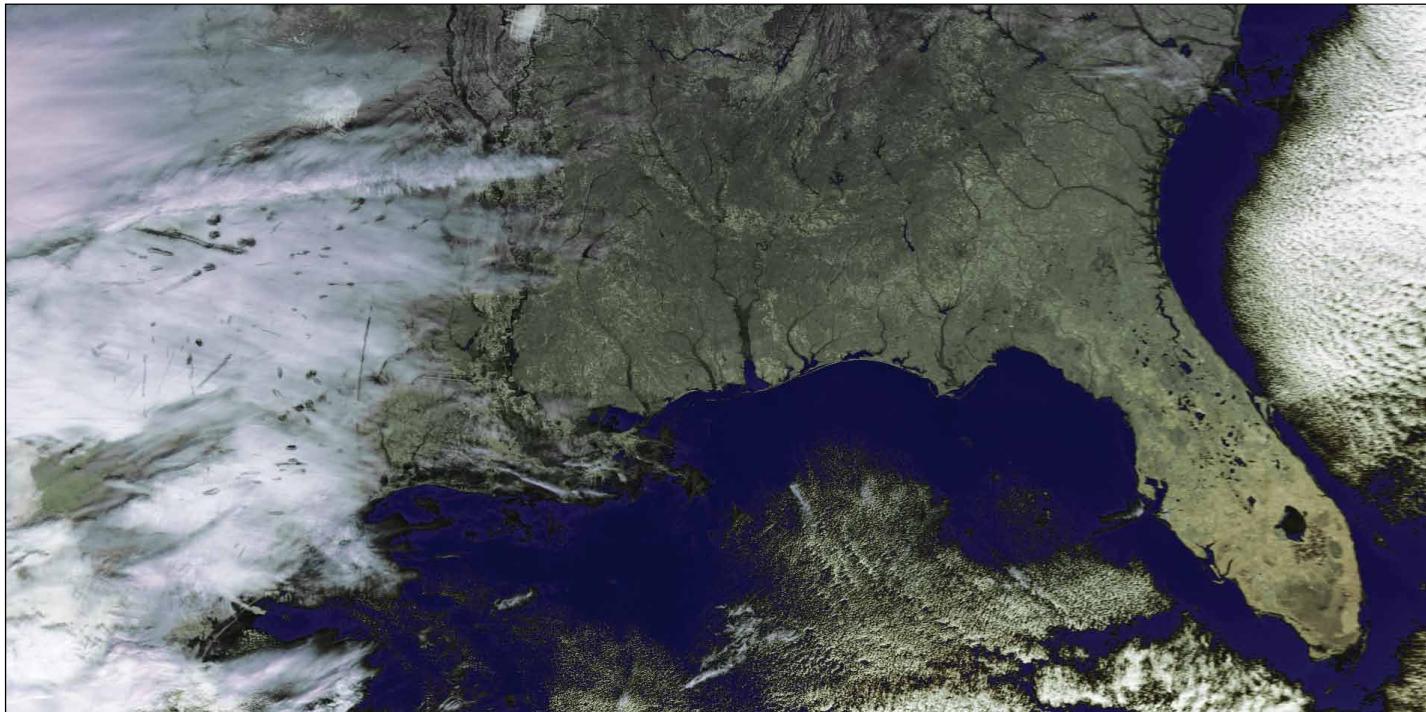


Figure 3 - This NOAA-17 image acquired at 16:27 UT on January 29, 2008 shows the fallstreak holes in the cloud at the left-hand side

Image: NOAA CLASS Archive



Figure 4 - An enlargement of the channel-2 NOAA-17 image

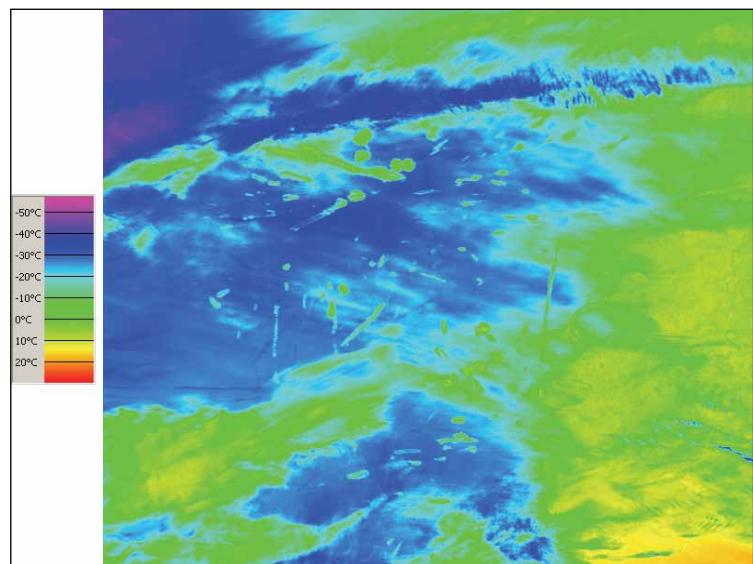


Figure 5 - A thermal version of the same NOAA-17 image

about an hour earlier, following a standard flight path, and seemed to have produced the subsequent band of snow. The research plane had in fact flown through the snow produced by the fallstreak hole. Snow crystals began falling about five minutes after the second aircraft flew through the cloud and snowfall, in a band about 30 km long and 4 km wide, continued for about 45 minutes, resulting in about five centimetres of snow on the ground. Away from the fallstreak hole only very light snow occurred and it failed to make significant accumulations.

Normally, snowflakes and raindrops need a nucleus—a speck of dust or salt—around which to form. But supercooled water can freeze instantly if it cools rapidly to around -40°C. To confirm this idea, the researchers compared the snowflakes that fell on either side of the fallstreak hole with the ice crystals that fell directly beneath it. The snowflakes that fell from the hole were simpler and more plate-like than those that originated in the surrounding clouds. The latter snowflakes had acted

as condensation nuclei, and accumulated drops of liquid water as they fell. But in the centre of the hole, all the liquid had either frozen or evaporated and there were no droplets remaining to collect on the snow. Heymsfield surmised that an airplane flying through that cloud was likely to have caused ice particles to form and 'snow out' along its path, leaving a fallstreak hole behind.

Why?

The idea of aircraft creating fallstreak holes relates to the cooling of air as it passes over the wings, causing supercooled water droplets to spontaneously turn into ice crystals without the requirement of condensation nuclei (see side panel on page 12).

His team found that—at lower altitudes—jet planes can punch holes in clouds and create small quantities of rain and snow. Their research determined that this precipitation was triggered by supercooled water droplets below about -5°C. As a plane flies through mid-level cloud layers, it



This fallstreak cloud was photographed near Linz, Austria on August 17, 2008 by H Raab
Image courtesy Wikipedia Commons



A fallstreak cloud visible over Omarama, New Zealand in May 2006
Image courtesy Dollsworth: Wikipedia Commons



This Fallstreak Hole was photographed from near Mobile, Alabama, USA - Image: Joel Knain/NASA
This image has been featured on NASA's *Astronomy Picture of the Day* website at <http://apod.nasa.gov/apod/ap040112.html>

forces the air to expand rapidly and cool. As a result, supercooled water droplets in the cloud freeze to ice, then turn to snow which can fall to the ground. This creates a gap in the cloud which can expand to create a spectacular fallstreak hole in the cloud layer. This inadvertent seeding of clouds can be produced by any aircraft, whether jet or propeller driven, and the resulting fallstreak holes are often observed near the ends of airport runways.

In the case of propeller driven aircraft, the ice crystals are formed by adiabatic^[4], expansion of air at the tips of the propeller blades at temperatures as high as -8°C . For aircraft in general, ice crystals form as air expands above the wing surfaces when the temperature is below -20°C . In both scenarios, the resultant cooling chills the air down to -37°C or below, causing the supercooled droplets to freeze spontaneously without the need of a seed nucleus.

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<http://journals.ametsoc.org/doi/pdf/10.1175/2009BAMS2905.1>
- 4 Adiabatic: a thermodynamic process in which no heat is neither gained nor lost.
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<http://www.nasa.gov/topics/earth/features/hole-punch.html>

Supercooled Water in the Atmosphere

Lower level clouds, where temperatures frequently lie between zero and -15°C , normally consist almost entirely of water droplets, not ice crystals. This may come as a surprise when you consider that the freezing point of water is 0°C but, in the absence of suitable seed crystals or nuclei (such as suspended ice crystals or dust particles), water droplets do not spontaneously freeze until cooled to around -40°C .

Such water droplets, which remain liquid at temperatures below 0°C , are said to be supercooled. Most lower level clouds consist of supercooled water droplets.

Higher level clouds, where the temperatures falls between -15°C and -40°C , consist of a mixture of supercooled droplets and ice crystals. By the time a cloud temperature has fallen to -40°C , it will consist almost entirely of ice crystals.

Droplets of supercooled water often exist in stratiform and cumulus clouds and aircraft flying through them can seed an abrupt crystallization of these droplets. This can cause ice to form on the plane's wings unless it is fitted with a de-icing system.

When supercooled water drops fall as rain the result can be freezing rain. When the supercooled drops strike ground which is already at or below freezing, they freeze instantly, coating roads, pavements, power lines and trees with a thin film of ice. Readers living in South and West Yorkshire will remember events of January 12, 2010, when freezing overnight rain caused a heavy ice glaze on the roads and caused major disruption to commuter traffic.

In extreme cases, freezing rain can produce an ice storm, such as the event that hit Ontario and Quebec, Canada in January 1998. Mature trees were felled and electricity power lines flattened under the sheer weight of the encrusting ice. Around three million people were without electricity, some for as long as six weeks.

Fallstreak Holes over West Virginia

A NASA Earth Observatory Report



NASA image by Rob Simon, using Landsat-5 data from the USGS Global Visualization Viewer. Image interpretation courtesy Andrew Heymsfield.

Looking up on a chilly December morning in 2009, residents of rural West Virginia, southwest of Charleston, would have seen a halo of light bursting through the thin bank of clouds that hung overhead. The light was streaming through hole-punch clouds and canals, most likely created by passing aeroplanes. This image, taken by the *Landsat-5* satellite on December 11, 2009, shows the unique conditions in which such holes can form.

When aeroplanes, particularly propeller aircraft, pass through the clouds, they disturb the air, which expands in the turbulence created by the propellers and wings. As the air expands, it cools, and the supercooled water droplets in the clouds freeze into ice. These ice crystals act as seeds upon which other water droplets freeze. Over time, the clouds around the disturbed area disappear and an ice cloud grows.

Clouds created in this manner take two different forms: hole-punch clouds and canals. The hole-punch clouds consist of an ice cloud

surrounded by a halo of clear sky where the water in the clouds has frozen into ice and disappeared. Canals resemble contrails, and are long streaks where ice clouds are continuously being formed as the aircraft travels within the altocumulus cloud layer.

The image above was made using both infrared and visible light, a combination that makes it possible to distinguish between water and ice clouds. The main cloud blanket is pale blue and pink, the warmer tones of clouds consisting of water droplets. In the hole-punch clouds, however, can be seen the iridescent blue signature of ice crystals, surrounded by a halo of clear sky. A similar blue streak from a canal runs across the top left.

The surrounding cloud bank was made up of altocumulus clouds at an altitude of between 2 000 to 7 000 metres, which radiosonde data showed had temperatures between -5°C and -20°C. Despite the chill, this image reveals that the clouds were made of water droplets, and not ice.

Stray Light

A source of unwanted artifacts in Meteosat imagery

Les Hamilton and David Taylor

Although we are used to the periods during the spring and autumn when the sun is in line with our satellite dish and interference results, the sun can also cause problems for the SEVIRI imager used in the spinning Meteosat Second Generation (MSG) geostationary satellites. Just as you can get flare when taking photographs into the sun, so there can be effects on the images from the MSG satellites depending on the exact angle of the sun relative to the sight line of the imager. As the sun's elevation relative to the satellite varies throughout the year, so the effects vary as well.

These effects are mainly seen around midnight in spring and autumn when the sun shines on the imager, peeping out above the polar regions. If you only run during the daytime, you're less likely to see these artefacts.

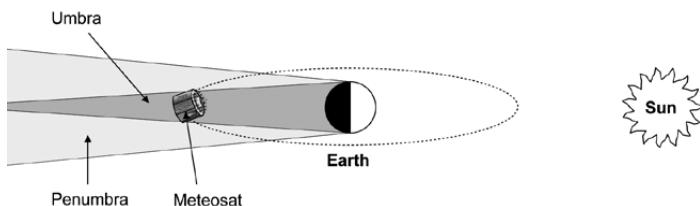


Figure 1 - Meteosat in Eclipse

This drawing illustrates what are known as the *eclipse seasons*, those times in the year when Meteosat enters Earth's shadow. Eclipse seasons occur between late February and mid April, and from late August to mid October.

Occasionally, images can be degraded when unwanted sunlight intrudes into the radiometer, mainly when Meteosat is in the eclipse penumbra and at least part of the sun is visible from the satellite when it is over the night hemisphere of Earth. For obvious reasons, these intrusions are most troublesome on infrared and water-vapour images. The sequence of images at the foot of this page illustrates the problem. EUMETSAT dubs this unwanted radiation as '*straylight*'.

What is Straylight

The SEVIRI instrument carried by MSG satellites consists of a scan mirror, a three-mirror telescope and a set of filters and lenses that illuminate a cluster of infrared and visible light detectors. Each acquired image of Earth is projected on to each detector in such a manner that, in principle at least, any light ray arriving on the detector originates from a specific location on Earth (figure 3).

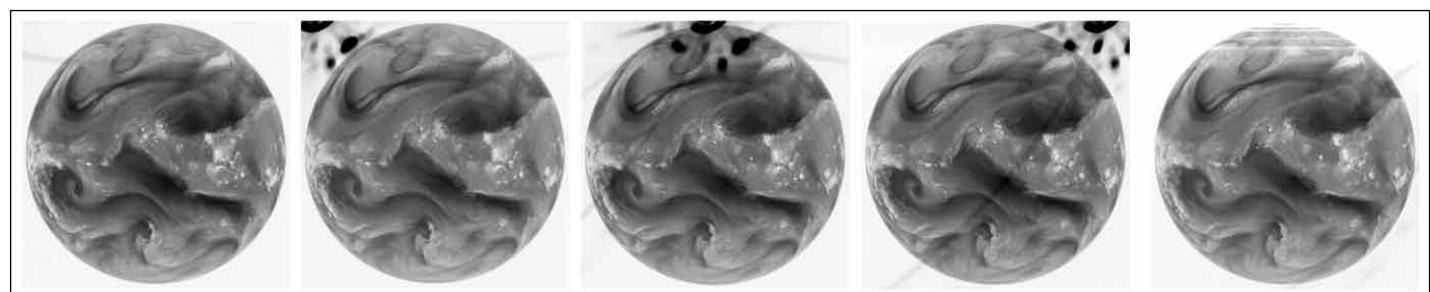


Figure 2 - Five Meteosat WV images acquired around midnight on April 14 1997 show the typical effects of straylight from the sun entering the radiometer
Images © 1997 EUMETSAT

Unfortunately, additional light rays, sometimes referred to as 'parasitic light' can reach the detector. Parasitic light does not arrive by the regular optical path (figure 3, left) but by

- diffuse scattering off the mirrors. (figure 3, centre)
- reflections off non-optical parts of the telescope such as baffles etc. (figure 3, right)
- other effects, such as diffraction.

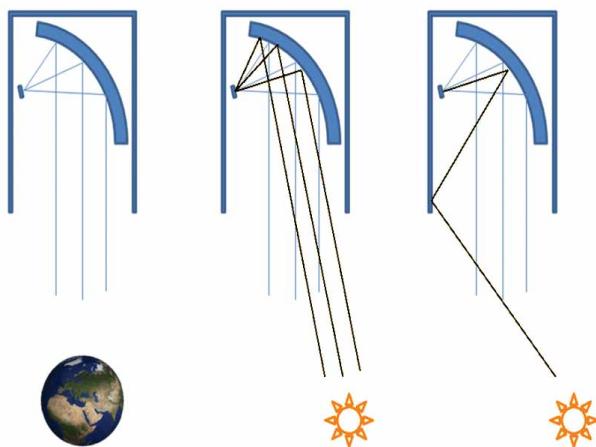


Figure 3 - How straylight reaches the Meteosat detectors
Source: EUMETSAT

Good telescope design helps to minimise the incidence of straylight, but any particularly bright light source can potentially contribute straylight to an image. The prime source of straylight in SEVIRI images is, of course, the sun but a secondary source, despite being orders of magnitude fainter, is the moon. As yet, artefacts caused by straylight emanating from bright objects on the Earth, such as clouds, have not yet been identified.

The amount of straylight affecting an image depends on various factors, most importantly the position and angle of the sun relative to the telescope. For the reasons explained above, straylight is only observed during spring and autumn: during the remainder of the year the sun is too far north or south of the equator. Straylight is observed only during the night, when Meteosat is directly opposite the sun in its orbit.

The SEVIRI spectral channels are not all equally sensitive to sunlight. The VIS-06, VIS-08, NIR-16 and HRV channels were designed to be sensitive to reflected visible light while the IR-3.9 channels are sensitive both to reflected visible and infrared

frequencies. All remaining IR channels were designed to measure thermal radiation emitted from Earth's atmosphere and do not respond to reflected solar radiation. Only direct illumination arising when the sun is actually in the image will have an effect on those channels (see Figure 4).

It follows that straylight can only be expected in the VIS-06, VIS-08, NIR-16, HRV and IR-3.9 channels. In practice, straylight is really only significant in the IR-3.9 channel, given that there is little useful signal in the other four channels during night-time.

Because straylight can arise from various light paths, a variety of complex effects can be produced, such as those in figure 5, which shows patterns that depend on the distance to the sun as well as visual artefacts in both the horizontal and vertical directions. The vertical extent of the image is achieved by moving the scan mirror the same way as for Earth imaging. The horizontal extent is built up by the satellite rotation, again the same as Earth imaging.

Summary

The factors describing the intensity of straylight include

- the angle between satellite (telescope), rotational plane and the sun, given by date — and to a lesser degree the satellite attitude
- the angle between the Sun and the telescope's line of sight in the rotational plane of the satellite
- the scan mirror position
- the individual detector and, thereby, the spectral channel.

Correcting for of Straylight Effects

The EUMETSAT Image Processing Facility cannot predict complex straylight patterns such as that shown in figure 5, but it does allow for a correction based on a simple distance law towards the sun. This correction is activated only for the IR3.9 channel since, for the other IR channels, straylight does not exert a significant effect.



Figure 4
A straylight artifact on a Meteosat IR-3.9 image
Image © EUMETSAT

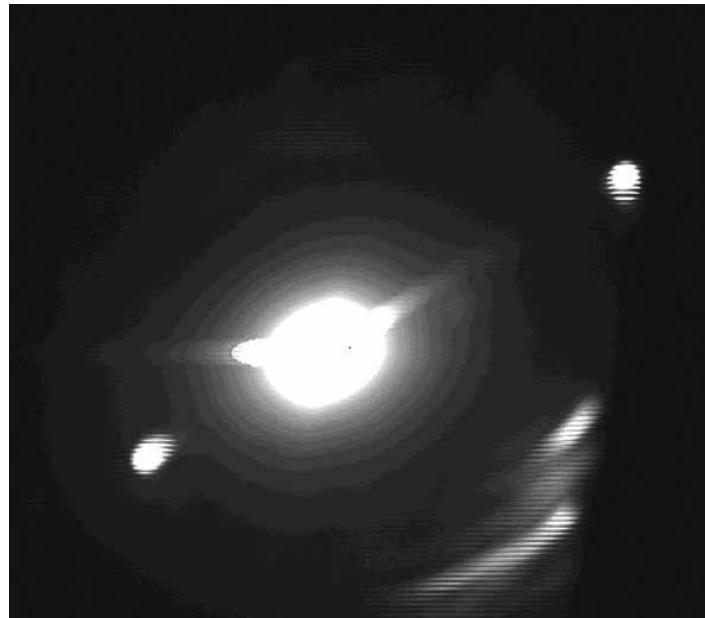


Figure 5
A straylight pattern around an image of the Sun in the NIR1.6 channel
Image © EUMETSAT

During image data processing, straylight estimation is performed before the image lines are resampled. The straylight contribution is calculated its contribution to each individual detector line is calculated, after which it is subtracted from the line. Finally, the corrected line data is subject to a resampling process to create the final Level 1.5 image.

Because of this correction process, it is unlikely that GEO readers ever experience straylight artefacts in their images these days. But if anyone has images from the eclipse periods that show unexpected aberrations, do please send them to the editor for possible inclusion in a future Quarterly.

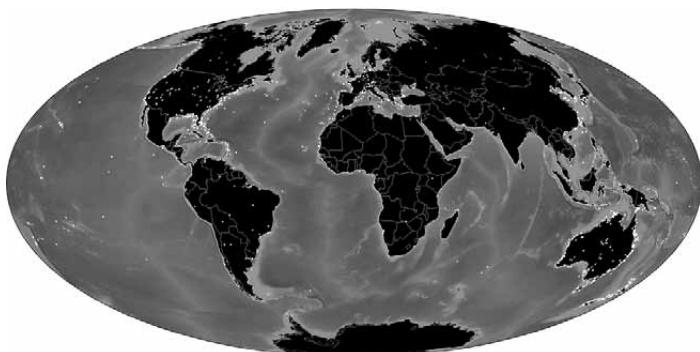
Acknowledgement

Thanks to EUMETSAT for making much of the information in this article available on the pages of their website

Reference

Known Meteosat Image Anomalies - GEOQ5, p5 (2005)

NOAA Satellites Helped to Save 2,338 People in 2010



Besides serving as the backbone for all weather forecasts, NOAA's satellites also provide another relatively unknown service: search and rescue. The Search and Rescue Satellite Aided Tracking system (COSPAS-SARSAT), is an international program that provides rescue assistance around the world. The NOAA GOES and POES satellites, along with Russia's COSPAS satellites, can detect signals from search and rescue beacons and relay their positions back to land. NOAA's SARSAT facility in Maryland works closely with the U.S. Coast Guard and Air Force to coordinate rescues in U.S. territories. In 2010, the COSPAS-SARSAT program was responsible for saving 2,338 lives internationally, and 295 lives in the U.S. The position of each rescue is plotted as a white dot on the map above.

Cover and Full Page Images

Front Cover

This image has been created from measurements taken by the AMSR-E instrument aboard NASA's Aqua satellite on September 9, 2011, and depicts the sea ice in the Arctic at its lowest extent for the year.

Image: NASA

Back Cover

This MODIS image acquired by NASA's *Terra* satellite on August 10, 2011 serves to illustrate the depletion of sea ice from Russia's Arctic coastline. The course and delta of the Lena river are easily identified, flanked by the Verkhoyansk mountains. The New Siberian Islands are prominent in the ocean to the north.

Image: NASA

Page 45

Showing that APT still has much to offer is this visible channel image from the 12:59 UT pass on October 28, 2011. The low winter sunshine accentuates the cloud structure as a depression encroaches on Britain.

Image: Les Hamilton

Weather Satellites in Vietnam

Fred van den Bosch

This year I made my dream come true: living in Asia. Not in Bali, which is what I had wanted since I was eight years old, but in Vietnam, where my wife comes from. Last year we bought a piece of land in a small village about 20 km West of Nha Trang. Nha Trang is the beach resort of Vietnam. We left Holland at the end of February 2011 and by mid-March, the beginning of the dry season, construction of our house had started. Because work on the house continued seven days a week, with an average of 10 men and women—occasionally 20—on the job, construction was completed in late July, when we moved in. Late in August, the container with our stuff arrived. In it were my R2FX receiver and PADAT antenna, so it was time to try to receive satellites again.

During construction, we considered where to place my antennas. One of the pillars was built a little higher, so that a mast can be attached to it. Near the pillar, a pipe was inserted through the wall into my room to carry antenna leads.

Because I have the highest house of the environment, I am rather afraid of lightning. Not without reason: the phone line at the house where we stayed during construction was hit by lightning and I saw a flash coming from the phone modem. By a great stroke of luck, the wireless modem and my netbook, both in use, survived it. Arne gave me some very useful hints for lightning protection; some of them are already implemented while others have yet to be done. Fortunately, according to the locals, the lightning season is over, so hopefully I will have some time to install the missing lightning conductors.



For this reason I have not set up the mast yet. I have therefore placed the PADAT antenna on a tripod and, should the weather be very bad I can lay it flat on the roof. Although the metal water tank on the roof is higher up than the PADAT, I do not want to count on it (to protect the antenna from lightning). The reception is definitely good, as shown in figure 2, a recording from 20-09-2011.

Once the house is decorated—and that could well take up a considerable time—I want to do more with weather satellites. Unfortunately I cannot receive MSG here so it will be mainly APT. In addition, there are certainly further (wild) plans.

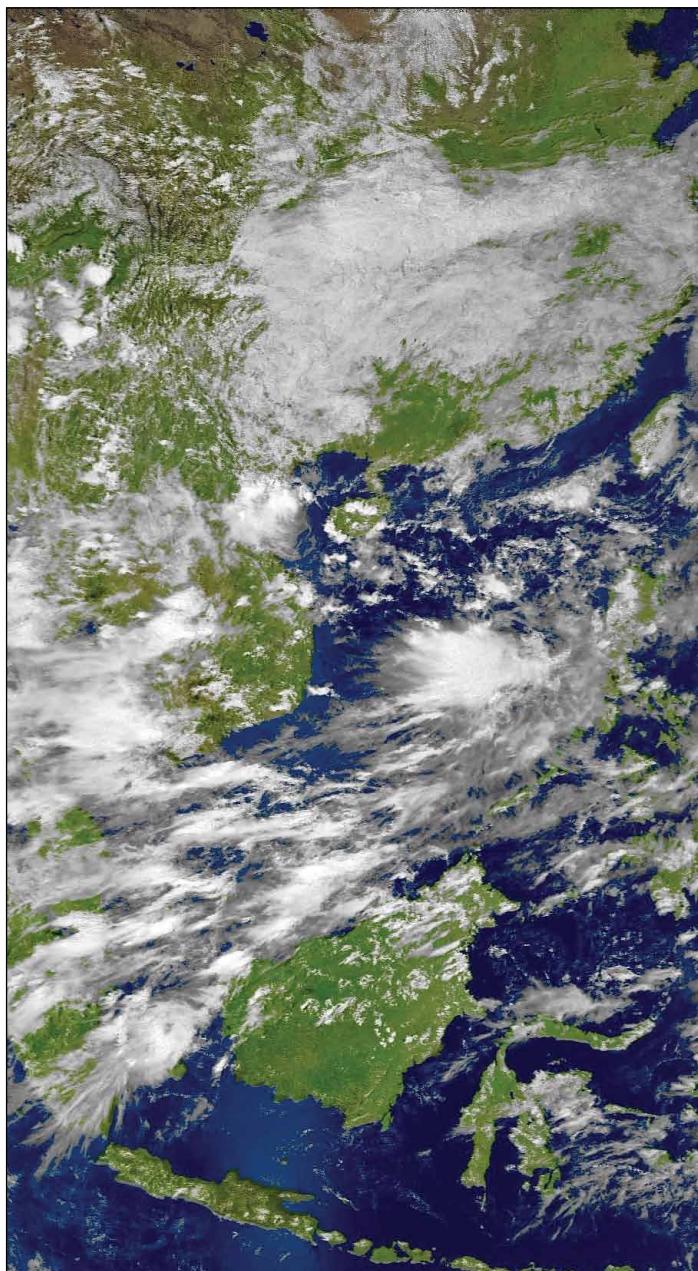
Meteosat 7

I will try to receive it here. This satellite has an elevation of approximately 30°, a rather favourable position for me. I'll have to make an antenna for this although I still have a down-converter. Last year, at Air Displays by the Royal Dutch Air Force, I tested it with Hendrik Jalving's antenna. Even in Holland we received pictures from Meteosat 7!

HRPT

This will be 'a bit more difficult'. To be sure, I have ordered the GODIL module for decoding. Now 'only' the antenna, the rotors and the receiver have to be constructed. This will clearly be a long-duration project.

I remain a member of the Dutch Workgroup and GEO and so I hope to stay informed of all developments. If there are any on this side of the world, I will certainly let you all know about them.



Sea Ice and Icebergs off East Antarctica

A NASA Earth Observatory Report



NASA image created by Jesse Allen and Robert Simmon, using EO-1 ALI data provided courtesy of the NASA EO-1 team
Caption by Michon Scott based on image interpretation by Ted Scambos, National Snow and Ice Data Center

Though composed entirely from frozen water, naturally occurring ice is rarely uniform. On October 7, 2011, the Advanced Land Imager (ALI) on NASA's Earth Observing-1 (EO-1) satellite captured this image displaying a variety of ice types off the coast of East Antarctica. Brilliant white ice fills the right half of the image. This is *fast ice*, deriving its name from the fact that it holds fast to the shore: it is thick enough to completely hide the underlying seawater, hence its brilliant white colour. Trapped within the fast ice, and stuck along the edge of it, are icebergs, which calve from ice shelves attached to the coast. These ice shelves can range in thickness from tens to hundreds of meters and the icebergs they calve often tower above the surrounding sea ice. One iceberg, drenched with meltwater, has toppled and shattered (top right corner of the image).

The icebergs along the edge of the fast ice are probably grounded on the shallow sea floor and their presence may well help to hold the fast ice in place. Farther out to sea is *pack ice* that drifts with winds and currents. Much thinner than the fast ice, the translucent pack ice appears in shades of gray.

The pack ice includes some newly formed sea ice. As seawater starts to freeze, it forms tiny crystals known as *frazil*. Although the individual crystals are only millimetres across, enough of them assembled together become visible from space as delicate swirls in the open water. *Frazil* crystals can coalesce into thin sheets of ice known as *nilas*, which often slide over each other and eventually merge into thicker layers of ice.

Philippines Suffer yet more Typhoons

John Tellick

I reported briefly in GEOQ 31 about category-4 typhoon *Nanmadol* which crossed Luzon the northern island of the Philippines in August. The 2011 storm season in the NW Pacific has been very active as the storm track diagram shows. Notice how many storms crossed the Philippines. On several occasions this season there were two systems active at the same time as with *TS Roke* and *Typhoon Sonka*—which was close to Japan on July 19.

Having endured *Typhoon Nanmadol* in August, worse was to follow: two typhoons within a week at the end of September and the beginning of October. *Typhoon Nesat* was followed by *Typhoon Nalgae* in less than a week, crossing the same area of Luzon and causing damage, flooding and loss of life (figure 2).

Michael Carlowicz of NASA Earth Observatory reported:

In a matter of five days, the Philippines and south eastern Asia were hammered by two intense tropical storms in late September and early October. Several months worth of rain fell within a week—a deluge even by tropical standards—on Luzon in the northern Philippines, as well as in northern Vietnam and the Chinese island of Hainan.

Figure 3 shows average rainfall totals in the Western Pacific from September 26 till October 2, when *Typhoon Nesat* and *Super Typhoon Nalgae* passed through. The heaviest average rainfall, more than 350 millimetres, appears in dark blue. Localized rainfall could be significantly higher. The lightest rainfall, less than 50 millimetres, appears in light green.

Superimposed on the rainfall totals are the storm tracks for *Nesat* and *Nalgae*, with maroon indicating the strongest storm intensity, and pink indicating the weakest. *Typhoon Nesat* reached category-3 strength, with winds estimated at 195 kph late on September 26, when it crossed into the heavily populated island of Luzon (figure 4). The storm weakened but still maintained typhoon force winds when it reached Hainan on September 29.

Nalgae was a category-4 super typhoon when it made landfall in the on October 1, with winds approaching 240 kph (figure 5). The storm was later downgraded to tropical storm force, but continued to approach Hainan and Vietnam two days later.

According to news reports, almost three million Filipinos were affected by the storms. At least 58 people were killed and another 28 were reported missing as of October 3. More than 300,000 people were being housed in evacuation centres, and damage estimates were approaching US\$200 million. In southern China, roughly 140,000 people were evacuated, losses approached US\$ 251 million, and at least four people lost their lives.

Having visited the Philippines twice, I'm pleased to say that the weather was wonderful—though perhaps a bit too hot and humid. However, I caught in a tropical storm whilst taking an 18 hour ferry journey (on an old Isles of Scilly ferry) back from Vava'u to Tongatapu (Tonga). It wasn't much fun to say the least. The outward leg, travelled by light plane, was straight out of a glossy travelogue, flying over the islands in an azure Pacific, thanks to BBC TV.

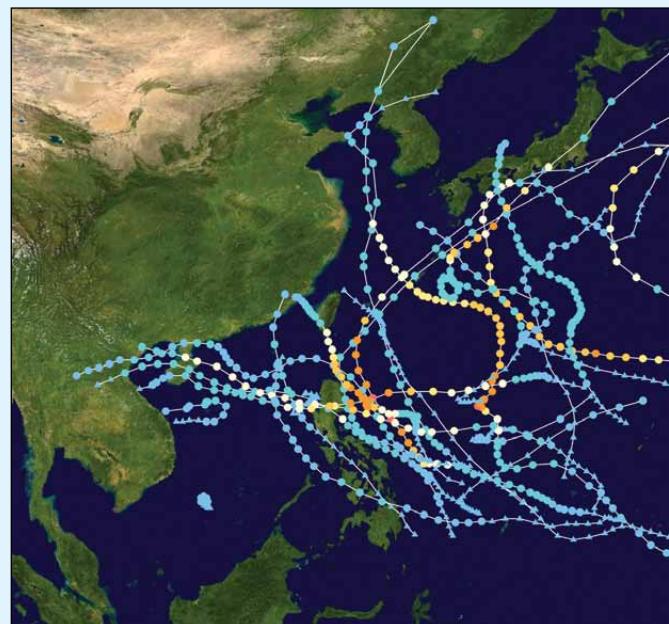


Figure 1 - NW Pacific Storms (2011)
Credit: Wikipedia Commons

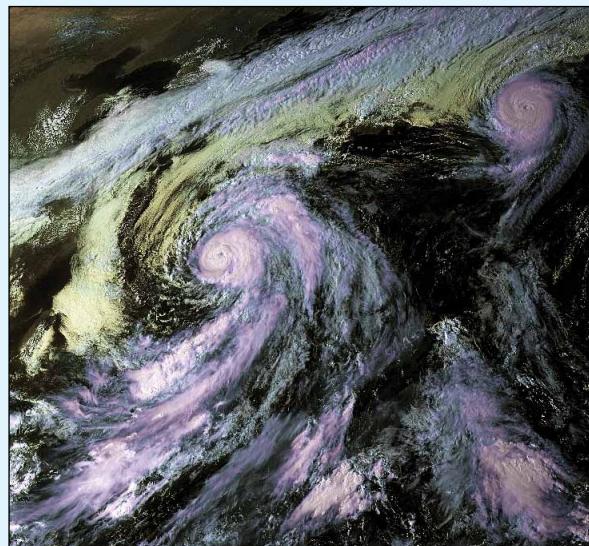


Figure 2 - Tropical Storm Roke and Typhoon Sonka
MTSAT image acquired on September 19, 2011
Credit: EUMETSAT © 2011

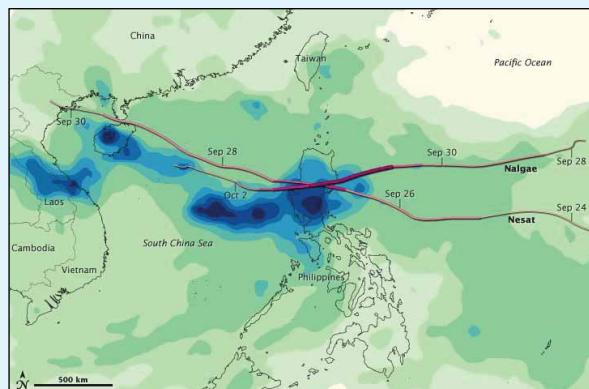


Figure 3 -Tracks and rainfall from typhoons Nesat and Nalgae
Credit: Weather Underground – www.wunderground.com

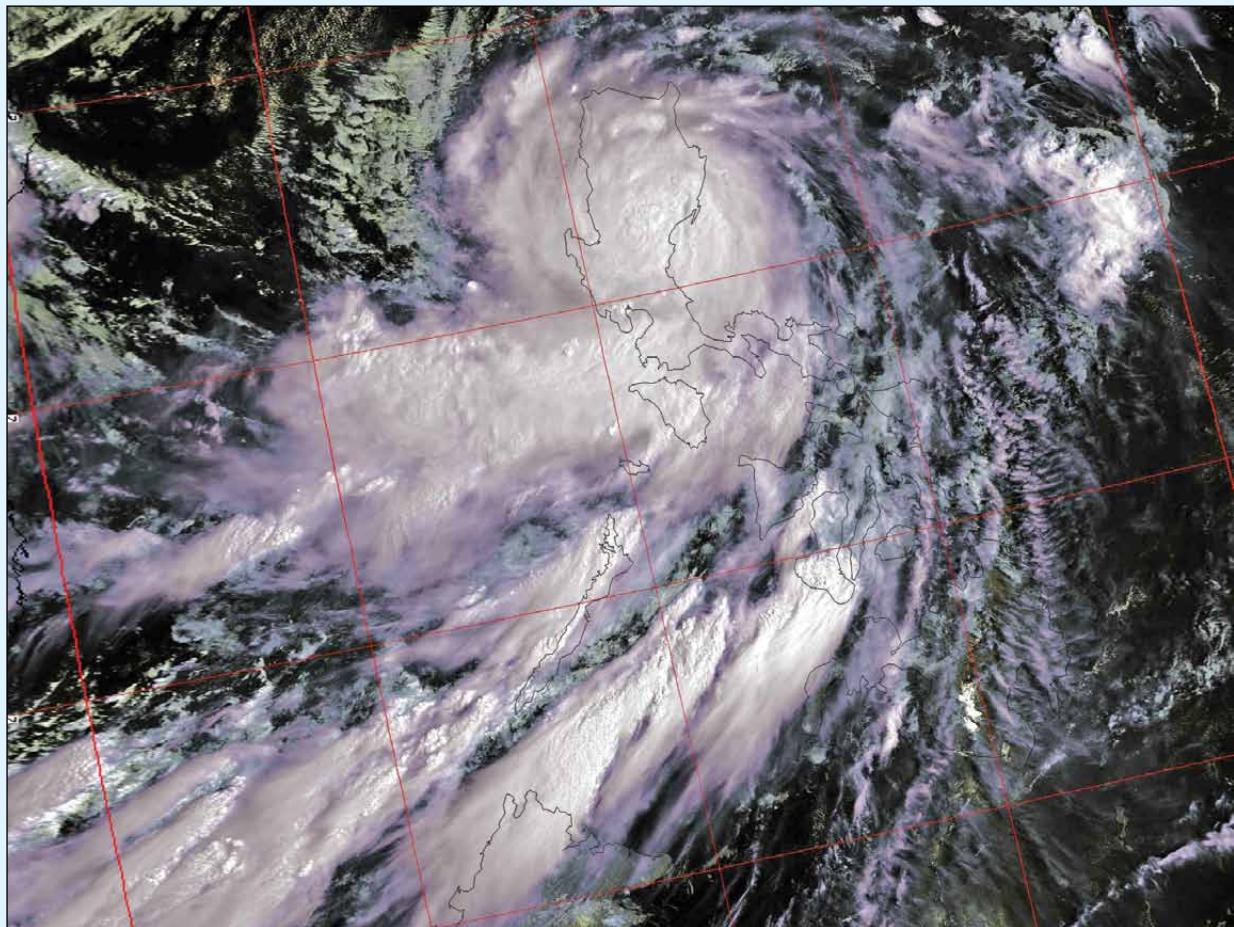


Figure 4 - Typhoon Nesat tracks across the Philippines in this image from Metop-A dating from September 27, 2011
Credit: EUMETSAT © 2011

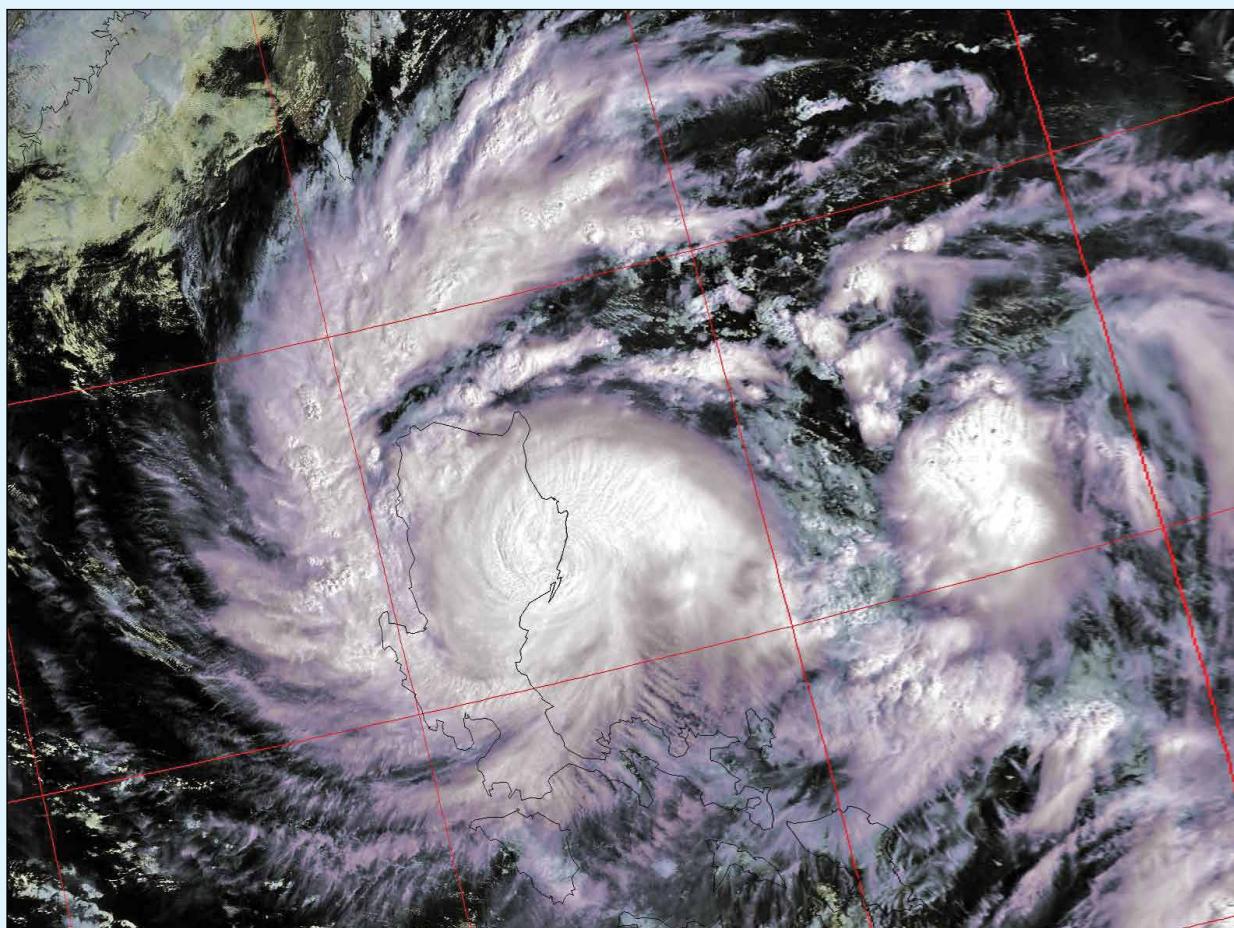


Figure 5 - Typhoon Nalgae tracks across the Philippines in this Metop-A image dating from October 1, 2011
Credit: EUMETSAT © 2011

EUMETSAT User Conference

Oslo, Norway - September 5-9, 2011

David Taylor

The EUMETSAT Meteorological Conference was held at the Oslo Kongressenter, where some of the ground floor windows were still boarded up following last July's explosion. With the EUMETSAT flag boldly displayed outside the conference centre, there could be no doubt where to go (figure 2). The main hall could easily accommodate the record 400-plus delegates expected to attend.



Figure 1 - The main auditorium at the Oslo Kongressenter

The opening session included presentations by EUMETSAT's new Director General, Alain Ratier (figure 3), pictured with the Director General of the Norwegian Meteorological Institute, Anton Eliassen. The early history of EUMETSAT was covered by its founding Director, John Morgan, who gave a highly entertaining talk including two books he would like to have had at the start: *The Complete Idiot's Guide to Creating an International Organisation* and *Building your own Satellite Organisation for Dummies*.

Lunchtime on the first day can sometimes be a bit of a hit-and-miss affair but fortunately the organisers had provided delegates with a list of eateries in the neighbourhood, categorised by price and style. The low-cost Thai food at the *Rice Bowl Restaurant* proved very popular, and the place was packed out minutes after the last morning presentation was over. Those who thought 'It's Norway, it will rain', were not disappointed.

By far the major sessions (by number) were those devoted to *Current and Future Satellites, Instruments and their Applications*. In the USA, GOES-R is the first of the higher-capability geostationary satellites, due for launch late in 2014. In Europe, Meteosat Third Generation (MTG) will comprise a pair of satellites, one an imager and the other a sounder, due for launch in 2018/2019. Rather closer are the next polar orbiting satellites, with the USA's NPP due in October 2011 (so it may be in orbit by the time you read this), and the next European Metop satellite in spring 2012.

Of these satellites, only Metop-B is a direct follow-on to an existing satellite (Metop-A). NPP includes many new instruments, as do GOES-R and MTG. All these instruments will need to have their data calibrated and validated after they reach orbit, and only once this is complete will data be released to the user community.

Japan's GCOM-W1 hardware has suffered from the earthquake in early 2011, when the wall of the clean room at the Tsukuba Space Center collapsed; this allowed some hardware to become



Figure 2 - The Oslo Kongressenter. Some ground floor windows left of the entrance are boarded up. Note the EUMETSAT flag outside.



Figure 3 - Alain Ratier (right) and Anton Eliassen



Figure 4 - The Rice Bowl Restaurant

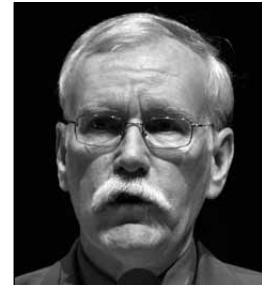


Figure 5
Mark Mulholland

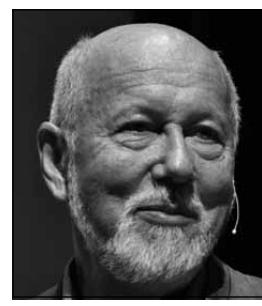


Figure 6
Olav Orheim

contaminated and other items were damaged. While the hardware has now been cleaned up, the schedule has been delayed.

Once again, data formats were discussed. For example, some of the Japanese HDF4 products will also be available in HDF-5, GeoTIFF and netCDF-4 formats. EUMETSAT also talked about netCDF as a format for the future.

RF Interference

Although members receiving APT in the UK have had to live with RF interference from pages for many years, it seems that this problem may be spreading to the US, where *LightSquared* are proposing to use frequencies extremely close to reserved space allocations for a high-powered urban broadband service. It appears that this has been driven by President Obama's broadband Initiative, and whilst I had heard of this from the GPS community (recall that the basic SNR of GPS is less than 0 dB), it appears

that some of the 1.7 GHz allocation used by weather satellites is being removed, with high-powered transmitters placed in those bands, immediately adjacent to the remaining polar orbiter and geostationary allocations. Mark Mulholland from NOAASIS gave a most entertaining talk about this serious problem, concluding with a quote from Vice Admiral Jon L Boyes: 'Radio frequency management is done by experts who meld years of experience with a curious blend of regulations, electronics, politics and not a little bit of larceny. They justify requirements, horse-trade, coerce, bluff, and gamble with an intuition that cannot be taught other than by long experience.'

Arctic Plenary

A highlight for me was the talk given at the Arctic Plenary by Dr Olav Orheim, Senior Adviser to the Research Council of Norway. His title was: '*The changing Arctic climate: What and how do we know?*' He ended by showing a slide of polar bears enjoying music and TV from an iPod, whilst drinking beer and looking forward to enjoying some roasted penguin (see figure 9 on page 21).

A packed lunch was the incentive to attend this lunch-time session, as if any incentive were needed.

Volcanic Ash

Although the conference's broad theme was the Arctic, there was of course, a lot of interest in volcanic ash, and several papers were presented on this topic. It's fair to say that a lot more is now known about ash and its effects, even though the general press may not have given that impression. Among the presentations was one by the UK Met Office, presented by Roger Saunders. One advantage which the Met Office have is their atmospheric model, which allows more accurate derivation of ash concentration from satellite observations than the raw values would provide. The question of whether the total ash in a plane's flight path may be more important than just its concentration was also raised, although quite how this would be tested in practice is open to question.

Posters and Exhibition

During coffee breaks, and outside the oral presentations, there was the opportunity to look at both the exhibition and the posters. There were far more papers offered than could be accommodated, even with the parallel conference sessions, so presenters were offered a poster area instead. While Tuesday afternoon was the official time set aside for viewing posters, you could visit at any time and ready your questions for the presenters. A welcome feature of many posters was the chance to take away an A4-sized summary of the work being presented. I did miss the chance to vote for the best poster, a feature they have run in previous years (figure 10).

We were lucky in having not only the industry's top firms at the exhibition, showing off their software and systems, but also EUMETSAT themselves, who put on an impressive display with a row of laptops showcasing a variety of products and services. A number of EUMETSAT staff were on hand throughout the week to answer questions and discuss topics of mutual interest.

Figure 11 shows EUMETSAT's display, with the big screen for detailed examination of any of the products on the portables. Note the Norwegian fine art in the background, where there were seats for the delegates to use their own PCs with free Wi-Fi access.

Norwegian Meteorological Institute

In addition to providing the logistics for much of the conference, Met.no had a most interesting stand with a large screen display of the software they use to help their forecasters. For an example of the quality of their work, combining excellent visual presentation with actual numbers (rather than just symbols) visit their forecast for Oslo at

<http://www.yr.no/>

then click on 'Oslo', then 'Hour-by-hour'.



Figure 6
Roger Saunders

At the time of writing it was all showing sun but, when we were there the rain was indicated as 'estimated mm', as well as a symbol. Not dumbing down, thank goodness! The institute also had an art display of Arctic-related images in the conference centre, with postcard-size versions that you could just take away. Most generous, and really excellent images (figure 12).

Social Programme

A EUMETSAT User Conference would not be complete without an extensive social program, designed to help delegates meet in less formal surroundings and make new friends. The Oslo conference was no exception, with three such events:

- A welcome drink on Sunday evening at the conference centre.
- We had a real treat on Monday evening, as the Icebreaker (how appropriate) reception was held in the world-renowned *Fram Museum*, just a short distance from the centre of Oslo. It was a boat trip there and coaches back (figure 13). The museum houses the original *Fram* which was involved in three major Arctic and Antarctic expeditions with Fridtjof Nansen, Otto Sverdrup and Roald Amundsen. It is quite impossible to imagine making a major sea voyage in such a small boat, let alone being in Arctic conditions, especially when you are in a warm museum, walking on the deck with a drink and canapé in hand (figure 14).

<http://www.frammuseum.no>



Figure 8 - The conference ended with closing remarks from Volker Gartner

- Wednesday's Conference Dinner was held at the excellent *D/S Louise* restaurant (figure 15) in Oslo's popular Ake Brugge area. Even without the consideration of catering for three hundred people, the food was first class, and there was plenty of wine or your favourite tipple. This was an excellent choice for the dinner and could not have been bettered. It went on long after I left near midnight.

Thanks to the sponsors of the Social Programme.

Summary

This was the best regular *EUMETSAT User Conference* I have attended. There was lots happening, plenty of folk to talk with, old friends to meet, excellent lectures, a friendly city, and first-class social events.

The organisers, especially Madelaine Pooley and her team—and the local Norwegian team—are to be congratulated on their efforts and the results. Many thanks.

Look out for the 2012 EUMETSAT Meteorological Satellite Conference in the resort town of Sopot, Poland from September 3-7, 2012. If it's half as good as this one, it will be well worth attending.



Figure 9 - Illustration from the Arctic Plenary Session

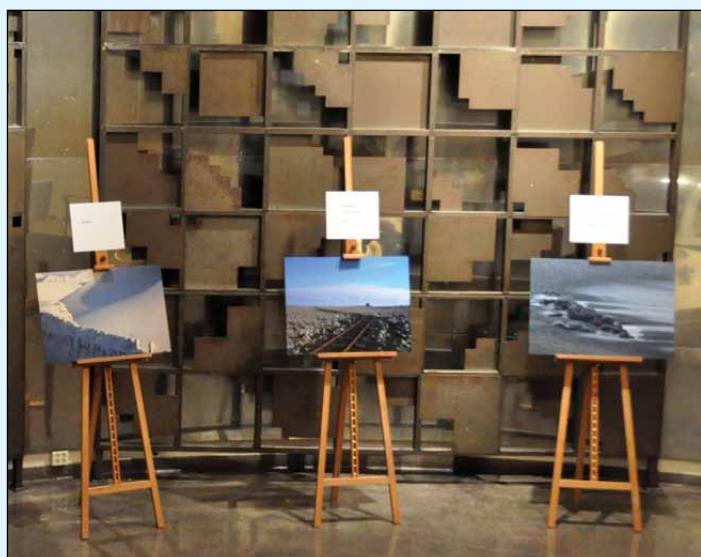


Figure 12 - Some of the Arctic-related images on display



Figure 10 - A coffee break in the exhibition area , with the Norwegian Met Office large-screen display.



Figure 13 - Awaiting the next boat to the Fram Museum

Figure 14 - Socialising aboard *Fram*

Figure 11 - The EUMETSAT display, with a big screen and a range of products on laptops.



Figure 15 - Restaurant D/S Louise

Arctic Meltdown

Permanent Arctic Sea Ice falls to an all-time Record Low

Les Hamilton

Last March, GEO Quarterly reported that the concentration of permanent Arctic sea ice had fallen to its lowest ever recorded January level in 2011. Had that trend continued, there was a distinct possibility that the winter maximum extent might also attain a record low value: and it very nearly did. Arctic sea ice extent for the month of March turned out to have the second lowest maximum in the satellite record, on March 7, when it tied with 2006 for the lowest winter figure yet of 14.56 million km².

Figure 1 is a sea ice map prepared at the University of Bremen, showing the ice extent on March 7. This is based on observations by the Japanese microwave sensor AMSR-E, flying aboard NASA's *Aqua* satellite. Data received from two servers, one in the US and another in Japan, are used to produce these maps. The sea ice concentration retrieval is based on the ASI (ARTIST Sea Ice) algorithm, which uses the 89 GHz (about 3 mm wavelength) passive microwave channels of AMSR-E.

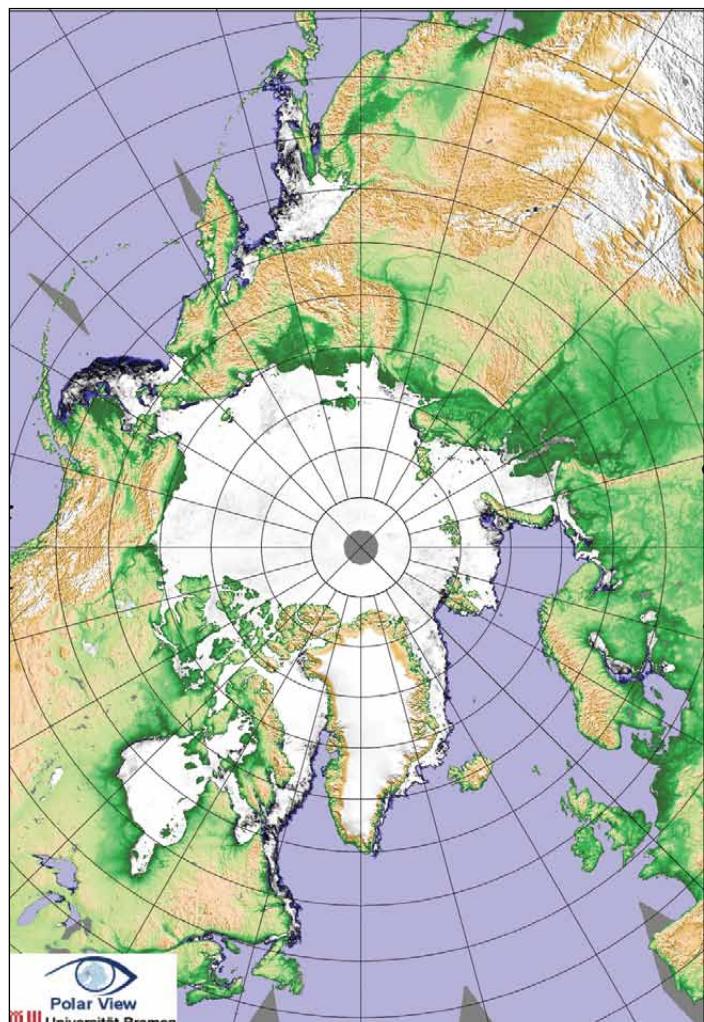


Figure 1 - Sea ice extent on March 7, 2011
Image: University of Bremen

From this 'low' winter maximum, there was every possibility that there might be record losses in ice cover as the seasons progressed, but the melt got off to a slow start in **April**, when the sea ice declined more slowly than usual, at no time coming near to approaching a record low for the month, as occurred in March. Towards the end of April though, warm conditions over the eastern Arctic and Siberia prompted an early retreat of snow cover from central Russia and open water areas (polynyas) started to form near Franz Joseph Land and along the coast in the Kara Sea, and melting also started in Hudson Bay and Hudson Strait.

Arctic sea ice extent for **May** was the third lowest in the satellite data record since 1979, continuing the long-term decline. Sea ice decreased at a near average rate, while air temperatures in the Arctic remained generally above average. Polynyas continued to develop in the Beaufort, Chukchi, and Laptev seas, and in Hudson Bay. These open water areas absorb the sun's energy, and help

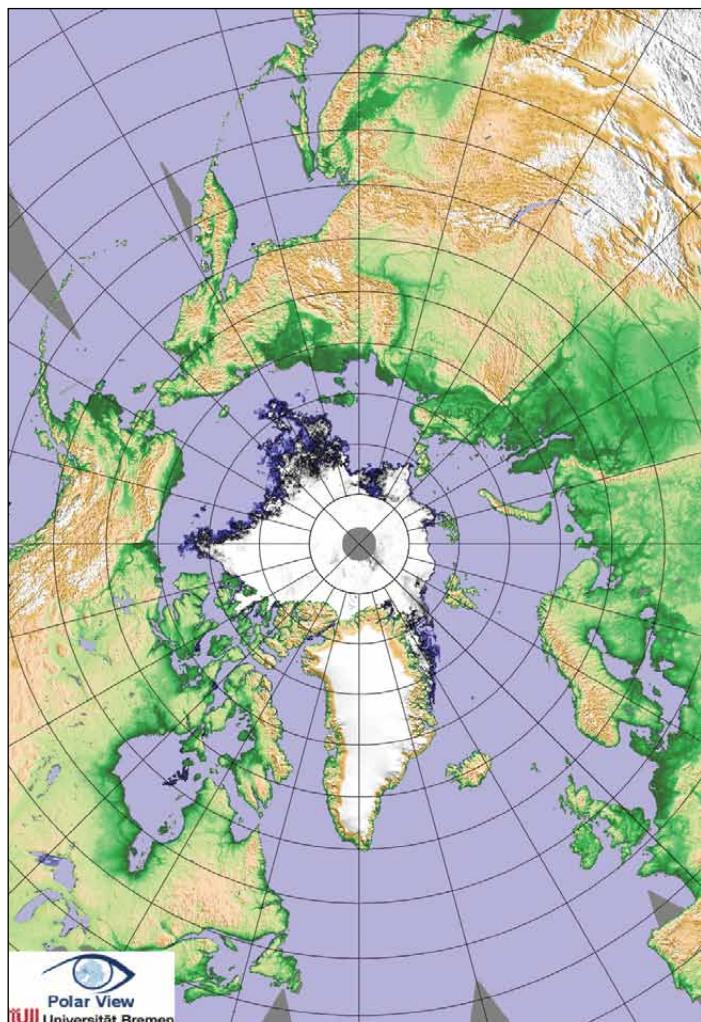


Figure 2 - Sea ice extent on September 8, 2011
Image: University of Bremen

to promote further ice melt. Overall, ice extent during May was already decreasing at an average of 50,000 km² per day. Average air temperatures for May were averaging around 4.5°C higher than normal in the Beaufort and Chukchi seas, western Siberia, and in the Kara Sea, the locations where ice retreated and polynyas formed. By contrast, temperatures were 2 to 5°C below normal in Baffin Bay and the East Siberian Sea.

The **June** ice extent was lower than normal throughout much of the Arctic Ocean, and especially so in the Kara Sea region. Ice also started to break up off the coast of Alaska in the Beaufort Sea. The rate of sea ice decline was now greater than in June 2007, the year when the September sea ice minimum extent reached its record low. Ice loss in the Kara Sea became almost double its rate of the previous four years (2007 to 2010) and ice all but disappeared from its southern reaches.

Ice continued to retreat rapidly throughout the first half of **July** due to a persistent high-pressure cell over the northern Beaufort Sea which led to above-average air temperatures over much of the Arctic Ocean. Sea ice was particularly low in the Barents, Kara, and Laptev Seas, Hudson Bay and Baffin Bay. Air temperatures over the North Pole (at the 925 millibar level, roughly 1,000 metres) were 6°C to 8°C higher than normal, while temperatures along the coasts of the Laptev and East Siberian seas were 3°C to 5°C above the norm for the time of year.

The high pressure broke down briefly towards the end of July, slowing ice loss and spreading out the ice pack and making it

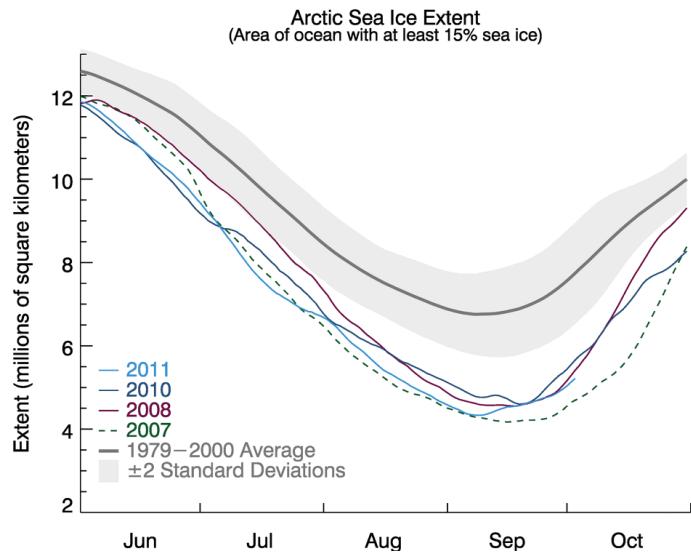


Figure 3

This graph above shows daily Arctic sea ice extent during summer 2011 (as at October 1), along data for the previous three lowest years for the minimum ice extent. Light blue indicates 2011, dashed green 2007, dark blue 2010 and purple 2008. Dark gray shows the 1979 to 2000 average with the gray band around the average line representing the two standard deviation range of the data.

Credit: National Snow and Ice Data Center Source: NSIDC

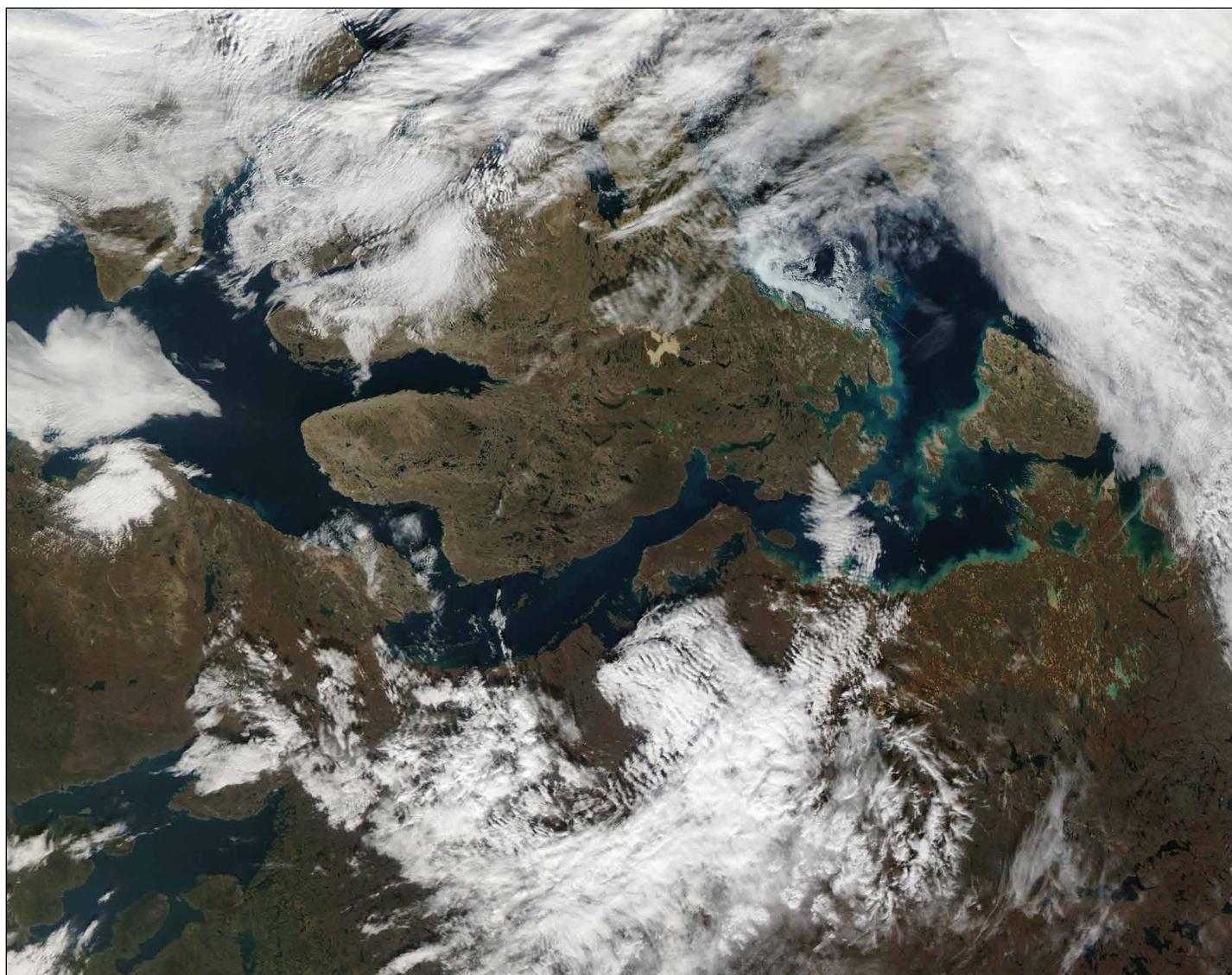


Figure 4 - The western end of Canada's Northwest Passage: Victoria Island is prominent at the centre of the image with Amundsen Gulf to its west. The Aqua MODIS instrument acquired this image on September 14, 2011, during a clear slot just a few days after sea ice minimum

Credit: NASA/GSFC, Rapid Response

thinner. When the pressure rose again in early **August**, the ice resumed its decline at a brisk pace, although its total extent remained higher than for the same period in 2007. Sea ice remained low across almost all of the Arctic, with the exception of some areas in the East Greenland Sea. Across the ocean, however, the southern route of the Northwest Passage appeared to be largely free of ice. In the Kara Sea, the combination of a high-pressure cell with low pressure to the west resulted in strong northward ice movement, pushing the ice pack away from the coast and reducing its extent. This same weather pattern also increased the movement of ice out of Fram Strait, between Greenland and Spitsbergen.

By early **September**, as in recent years, northern shipping routes had opened up. The Northern Sea Route across Russia was open from mid August till late September, while the southern 'Amundsen Route' of the Northwest Passage, through the straits of the Canadian Arctic Archipelago, had opened for the fifth year in a row.

Analysis of Sea Ice Data

The *National Snow and Ice Data Center* (NSIDC) obtains its data from the Special Sensor Microwave Imager/Sounder (SSMIS) carried on the *DMSP-F17* satellite. This data record, using an algorithm developed by the NASA team at *Goddard Space Flight Center*, provides the longest series of sea ice extent data, stretching back to 1979. The *University of Bremen*, on the other hand, employs an algorithm based on high resolution information from the *JAXA AMSR-E* sensor aboard NASA's *Aqua* satellite. This allows small ice and open water features that are not observed by other products to be taken into account.

The Final Verdict

On September 9, the sea ice extent was very close to the record low set in 2007, according to NSIDC. By their calculations, the ice covered 4.34 million km² of the Arctic Ocean on that date, the second lowest minimum in the satellite record and only marginally above the figure for 2007. Scientists at the University of Bremen, who use a slightly different method to calculate their sea ice extent from AMSR-E measurements, declared that 2011 actually surpassed 2007, setting a new record low of 4.240 million km² on September 8, one percent below the previous figure. The image on the front cover of this issue is a NASA realisation created from measurements taken by *AMSR-E* on September 9. It depicts the sea ice at its lowest point and, notably, shows the Northwest Passage, the sea route that threads through the islands of northern Canada to link the Atlantic and Pacific Oceans, to be entirely ice free. Figure 4 is an *Aqua MODIS* image of the Northwest Passage, acquired a few days later during a clear spell of weather, that shows no apparent ice in the Passage.

Conclusions

This year, ice cover over the Arctic Ocean was more dispersed than in 2007, with many small open water areas within the ice pack. While different monitoring centres do show slightly different numbers, all of the data agree that Arctic sea ice is continuing its long-term decline. The last five years (2007 to 2011) have produced the five lowest extents for seasonal sea ice minimum in the continuous satellite record (figure 5).

During the record low year of 2007, conditions were ideal for melting. Skies were clear, wind patterns were favourable and helped to thin the ice, while generally warm air temperatures promoted its melting. In 2011, there were more typical weather patterns but continued warmth over the Arctic, according to NSIDC, meant that the ice was already thin and spread out before the seasonal melting even started. This supports the idea that the Arctic sea ice cover is continuing to thin. Models and remote sensing data also indicate this to be the case. A large area of low concentration ice in the East Siberian Sea, visible in NASA Moderate Resolution Imaging Spectroradiometer (MODIS) imagery, suggests that the ice cover this year was particularly thin and dispersed. There is a superb *Terra MODIS* image, dating from August 10, 2011, on the back cover of this issue. To the left of the image, the course and delta of the Lena river are easily identified, flanked by the

Year	Average Arctic sea ice extent for September (mkm ²)	Trend (% per decade relative to the 1979-2000 average)
2007	4.30	-10.2
2008	4.67	-11.1
2009	5.36	-11.2
2010	4.90	-11.6
2011	4.61	-12.0

Figure 5 - Trends in sea ice minimum during the past five years

Verkhoyansk mountains on its east. The New Siberian Islands are prominent in the ocean to the north, with just the barest suspicion of brash ice to their east.

Climate models have suggested that the Arctic could lose almost all of its summer ice cover by 2100 but in recent years, ice extent has if anything declined faster than current models predict. For sure, the next few years in the Arctic promise to be extremely interesting.

Acknowledgement

Much of the information contained in this report has come from the monthly NSIDC Arctic News and Analysis RSS feeds, and from the NASA Earth Observatory website.

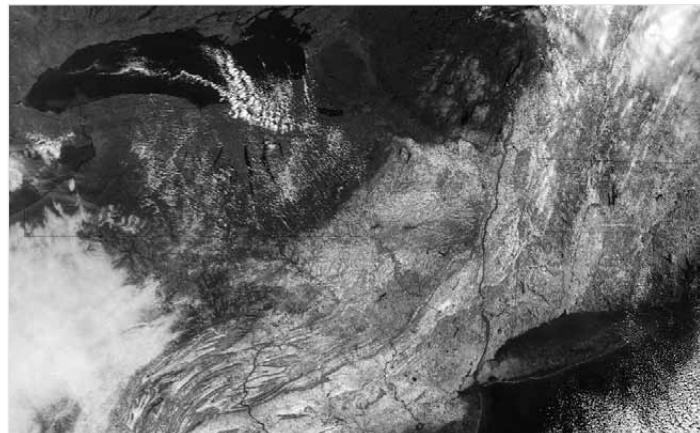
The front cover image, as well as a revealing HD movie showing one year in the Arctic sea ice cycle come from

<http://earthobservatory.nasa.gov/IOTD/view.php?id=52230>

Unseasonable Snow in NE of the USA

A NASA Earth Observatory Report

An unseasonably early snowstorm on Saturday, October 29, 2011 dropped as much as 80 centimetres of the white stuff on some parts of the northeastern United States. The nor'easter left wet, heavy snow on trees that were still loaded with leaves. The group that manages Central Park in New York estimated that they might lose some thousand of their trees because of damage caused by the unprecedented snowstorm. Many of the trees that line the edge of Central Park snapped under heavy snow, and many had to be cut down.



A swath of snow sweeps from West Virginia to Maine in this *Terra MODIS* image acquired on October 31, 2011
NASA image courtesy Jeff Schmaltz, MODIS Rapid Response Team, GSFC

The storm broke snowfall-total records in cities throughout the US Northeast and produced wind gusts of 111 kph along the Massachusetts coastline. More than 3 million homes and businesses lost electricity because of the storm, including a record

(Continued on page 48)

The Quarterly Envi-Ham Image

Francis Bell

My Quarterly Envi-Ham image submission (on page 30, overleaf) shows the southern two thirds of the island of Madagascar. Although the image was time stamped 06:53:14 UTC, local time is indicated by the cloud shadows on it. I used a one-metre dish and a *DVB World* receiver (bought from the *GEO Shop*), with the signal being fed into my medium specification *Dell* computer. The software was the *ESA Beam VI-SAT* package supplied to me free of charge by ESRIN.

I used channels 9 (red), 10 (green) and 4 (blue) to colour the raw image and highlight features present in it. I am still on a learning curve here: with 15 channels to choose from, applying colour by combining red, green and blue, together with different brightnesses can produce a mind boggling number of possibilities.

I was attracted to this image for a number of reasons. The island of Madagascar is not a superficial or ephemeral island but, geologically, a splinter of the African continental plate which split away some 135 million years ago and drifted away from mainland Africa now lying 250 miles to the east in the Indian Ocean. Madagascar is approximately 1000 miles long and 300 miles wide. Mountains run longitudinally along the island from north to south, and these generate climate differences from east to west. The eastern side of the island is exposed to the moist southeast trade winds while the west, being in a rain shadow, hence experiences a drier climate.

Just over a year ago, I visited the north of the island for a few days and had the privilege of seeing wild lemurs, together with other wild life. As a result of this visit I have become more sensitive to some of the issues that the island is facing: principally, the consequences of deforestation and subsequent surface erosion. The consequences of erosion can be seen on the satellite image, with westerly flowing rivers carrying their heavy sediment loads, together with extensive surface deposits, along their flood plains.

The island of Madagascar is a country named the *Malagasy Republic*, and has been a little more newsworthy recently than in the past. I have followed BBC programmes presented by David Attenborough, where he has sensitively reported on the effect humans have had on this once lush and forested island. Little is reported of the island's history and its role in World War Two. The Japanese attempted a submarine invasion on the north of the island in an effort to establish a naval base. They failed, but with consequent loss of allied lives. I respectfully visited the commonwealth graves, numbering a few hundred, on the northern tip of the island.

A zoomed subset from this image forms the basis of this issue's *Quarterly Question*.



Quarterly Question No 31

My thanks to those members who responded to Quarterly Question 31. The question related to an image of a large lake or water reservoir in the USA. The image shown was one I

had received at home using my Envi-Ham system. Rather unusually, this image covered part of the USA slightly in contrast to most of my Envi-Ham high resolution FRS images which understandably tend to cover Europe and Africa. The other reason it caught my eye was because I will be visiting this part of the USA next March and will include a visit to the Hoover Dam and Grand Canyon.

The answer to the question was the image showed 'Lake Powell'. Anyone interested in following up this question should look up its *Wikipedia* entry, which gives two or three pages of interesting information. Interestingly, the satellite image within the *Wikipedia* entry is almost identical to the one published for this question.

I received correct answers from Francis Bream (UK), Christopher Bell (USA), Ken Barker (UK) and Elmar Bogels (Germany).

Here is the interesting reply to my question that I received from Francis Bream.

'At last one I know. This is Lake Powell, Arizona/Utah, which was created by the building of the Glen Canyon Dam on the Colorado River. It is upstream of the better-known Lake Meade-Hoover Dam and the Grand Canyon.'

'I visited it a few years ago, staying at Page, which is a small town descended from the construction camp used for the Dam. Incidentally, the equivalent for the Hoover Dam is Boulder City, a delightful little town at which to stay if, like me, you want to avoid Las Vegas.'

'It's a pity that Envi-Ham have stopped sending high-res North American images: the European, Middle and African ones which is all we now receive, although excellent, can be rather repetitive.'

Quarterly Question No 32

The Quarterly Question for this issue relates to the zoomed subset of the Envi-Ham image of Madagascar shown at the foot of the next page.

The question is straightforward: Name the river shown in the image.

I know we have had 'name the river' questions before but this one caught my eye because of the extensive flood plain deposits which are shown; these indicate some measure of the erosion taking place within this river's catchment area. As guidance note that this river is also shown on the wider view of Madagascar at the top of the same page.

Answers to me by January 29, 2012, which is the copy deadline for the next issue of *GEO Quarterly*.

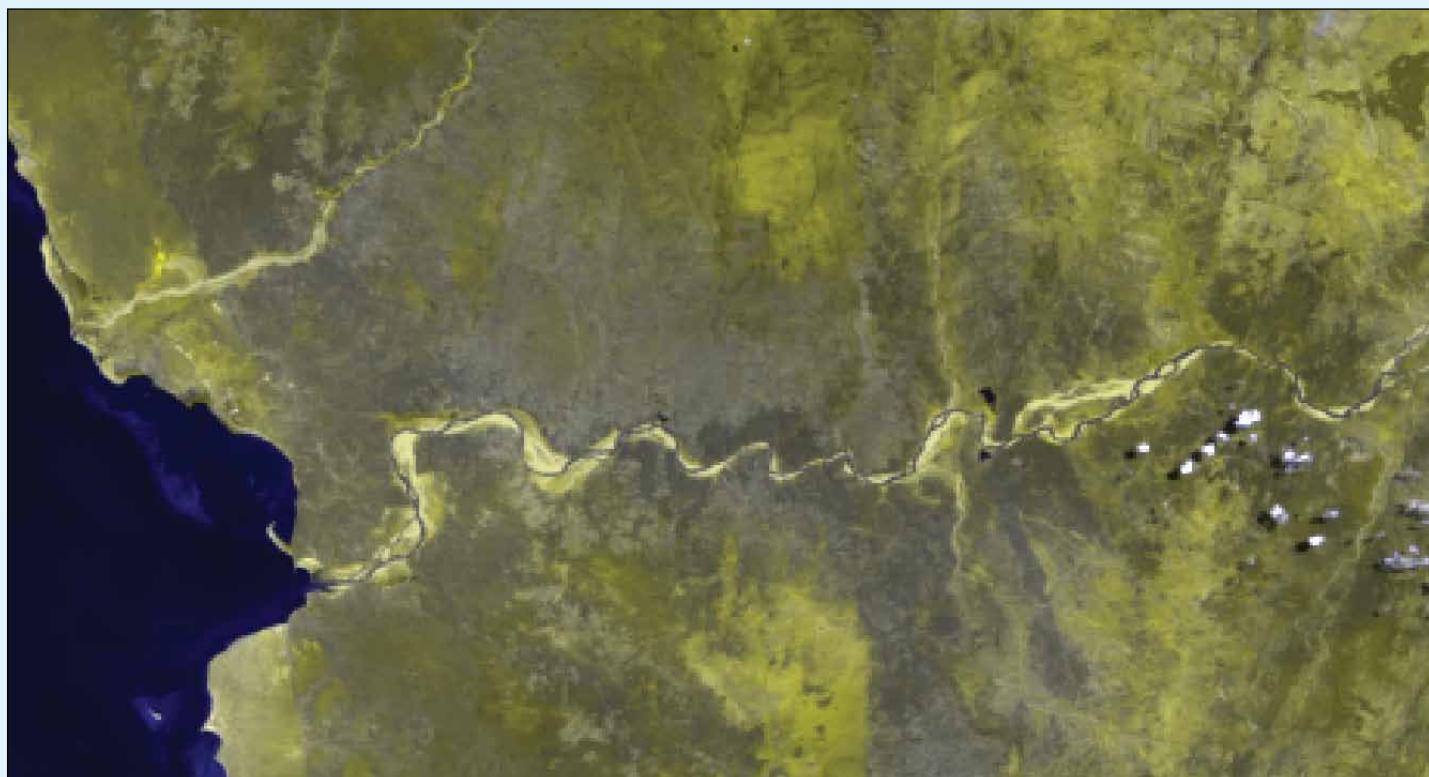
Please email replies to

francis@geo-web.org.uk

or mail them to my address, as shown on page 1 of this magazine. One winner will be picked at random, to whom I will send one or two postcards I collected while visiting Madagascar.



Southern Madagascar as imaged by Envisat on October 21, 2011
Image: ESA



Quarterly Question: Can you name this river in southwest Madagascar
Image: ESA

Successful Launch for NPP

NASA/NOAA



Following a year-long delay, the NASA/NOAA NPOESS Preparatory Project spacecraft (NPP) was successfully launched from Vandenberg Air Force Base, California in the early hours of October 28, 2011 to begin its Earth observation mission. This new satellite, lifted into orbit atop a United Launch Alliance Delta II rocket, will enable NOAA to continue issuing accurate forecasts and provide advance warning for severe weather, such as tornados, heat waves, floods, snowfall and wildfires.

The new satellite orbits Earth in a sun-synchronous polar orbit every 102 minutes at an altitude of 824 km, where it will capture data from the Earth's land, oceans, and atmosphere. These data are used by NOAA forecasters to detect the potential for dangerous weather conditions days—even several weeks—in advance. For example, data from current polar-orbiting satellites helped NOAA meteorologists to predict, five days in advance, the major snowstorms that struck the Atlantic Coast in February 2010 (the so-called *Snowmageddon*), and another which paralysed New York City in December that same year.

Unlike the currently operating NOAA satellites, NPP is actually a NASA mission, but NOAA will be responsible for feeding the data from the satellite's new, sophisticated instruments into the forecast models. The satellite data will be used to generate dozens of products, including cloud and vegetation cover measurements, ocean colour, and sea and land surface temperatures. NPP as the Bridge

NPP data will, in time, replace NOAA-19 as the prime 'afternoon' satellite. The afternoon orbit is especially important since some of the spacecraft's sensors work best in full daylight. NPP is also the bridge that will link NOAA's current constellation of polar orbiting satellites to the next generation of advanced spacecraft, the Joint Polar Satellite System (JPSS). Data from NPP, as is the case with all other US weather satellites, is processed and distributed from NOAA's Satellite Operations Facility in Suitland, Maryland to key users around the world, in particular NOAA's National Weather Service.

In addition to providing data for accurate weather forecasting, NPP will track ash plumes from volcanic eruptions, assist emergency responders to fight wildfires, help in the advance of climate science, accurately measure the quantity of Arctic sea ice, changes in the ozone hole, and monitor phytoplankton and other organisms in the oceans.



A Delta II rocket arcs across the sky carrying NASA's NPP spacecraft toward Earth Orbit
Image credit: NASA/Bill Ingalls



The NPP mission takes off from Vandenberg Air Force Base
Image: NASA/ULA



Preparing the NPP satellite in a clean room at Vandenberg Air Force Base
Image: Ball Aerospace

ESA Launches its first Galileo Satellites

John Tellick

Aboard a Soyuz VS01 flight operated by Arianespace (the first Russian space transport vehicle ever launched from Europe's Spaceport at Kourou in French Guiana), the first two satellites of Europe's Galileo global navigation system were successfully deployed into orbit on October 21 2011. All of the Soyuz stages performed perfectly and its Fregat-MT upper stage released the Galileo satellites into their 23 222 km altitude orbit 3 hours 49 minutes following liftoff.

A new site for Soyuz in French Guiana, operated by Arianespace, adds to the flexibility and competitiveness of Europe's fleet of launchers. Soyuz is a medium-size vehicle which complements ESA's own launchers: Ariane 5 which handles large payloads and the new Vega, planned to debut in 2012, which will lift smaller satellites.

Launching from close to the equator allows the European Soyuz to offer improved performance. When launched from Europe, Soyuz is capable of raising a payload of only 1.7 tonnes to the geostationary transfer orbit typically required by commercial telecommunications satellites: from Kourou, it can deliver payloads up to 3 tonnes.

What is Galileo?

Galileo is Europe's own global navigation satellite system, a €20 billion project currently being built by the European Union (EU) and European Space Agency (ESA) and named after the famous Italian astronomer Galileo Galilei. One of the political aims of Galileo is to provide a highly accurate, guaranteed global positioning service under civilian control, totally independent from the Russian GLONASS and US GPS systems, which can be disabled for commercial users in times of war or conflict. It will, however, be inter-operable with GPS and GLONASS.

By offering dual frequencies as standard, Galileo, which will be a free service, will deliver real-time positioning accuracy down to the metre range. Availability of the service will be guaranteed under all but the most extreme circumstances and users will be informed within seconds of any satellite failure, making it suitable for safety-critical applications such as guiding cars, running trains and landing aircraft.

These first two operational satellites are part of the In-Orbit Validation (IOV) phase that will see the Galileo system's space, ground and user segments extensively tested. Two more will follow in 2012. Once this In-Orbit Validation phase has been completed, additional satellites will be launched to reach Initial Operational Capability (IOC) around mid-decade. The range of services will be extended as the system builds up and it is the aim to reach full operational capability by 2019.

The satellites are currently under the control of a joint ESA and CNES French space agency team in Toulouse. After these initial operations they will be handed over to SpaceOpal, a joint company of the DLR German Aerospace Centre and Italy's Telespazio, to undergo 90 days of testing before being commissioned for the IOV phase.

The fully deployed Galileo system will consist of 30 satellites (27 operational and three active spares), positioned in three circular orbital planes at 23 222 km altitude, and inclined at 56° to the equator. When in operation, Galileo will use two ground operations centres, near Munich, Germany and in Fucino, Italy.

This launch represents a great deal to Europe and will position our continent as a world-class player in the strategic domain of satellite navigation, a domain with huge economic perspectives, according to Jean-Jacques Dordain,

Director General of ESA. This historic launch, aboard one of the legendary Soyuz craft that were used for Sputnik and Yuri Gagarin (the first Soyuz to be launched from a site outside Baikonur in Kazakhstan or Plesetsk in Russia), was the first of many from Kourou. It is a symbol of the cooperation between ESA and Russia, with a strong essential contribution from France, and also of the cooperation between ESA and the European Union. The launch consolidates Europe's pivotal role in space cooperation at the global level.



The Soyuz launch pad at Baikonur

Acknowledgement

ESA Media Relations Office

Reference

<http://www.esa.int/esaNA/galileo.html>



A variety of Soyuz launchers

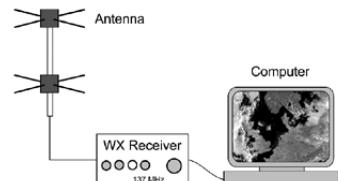


The First Soyuz launch from Kourou on October 21, 2011 - note the new launch pad gantry arrangements



The first two Galileo satellites separate from the Fregat-MT upper stage

An introduction to
APT Weather Satellite Reception
 Part 1 - General Overview



Ron Hahn

Reception of the APT satellites is not particularly difficult, but it does present some challenges to the budding weather enthusiast. There's an aerial to put up, a receiver to connect, and bits of software to configure. If you want daily (24/7) reception there are some additional considerations. None of these tasks is insurmountable for the amateur enthusiast, but some do present a bit of a challenge.

In order to receive the polar satellites you first need an outdoor aerial. Not just any aerial, but one capable of receiving the satellite signal with an azimuth (direction) of 0-360 degrees with an elevation (height) of 0-90 degrees. To visualise this, your aerial's view of the sky needs to be a bit like a sphere cut in half. The aerial wants to be able to see any point in this half-sphere. A directional aerial won't do here: you need something that is truly omnidirectional. The weather satellites have this problem too, so they use a specialised aerial called a quadrifilar helix (photo 1 below). For your receiving station you want to use a similar aerial, either home-constructed or commercially manufactured. In earlier times I used a home-made aerial, but, due to my proximity to the sea, I use a commercially manufactured aerial designed for marine environments (shown in photo 2 below).

In order to receive images as far north-south and east-west as possible, its necessary to mount the aerial as high up as possible, away from obstructions that will occlude the view to the horizon. I'm fortunate to have a receiving location here on the Rosslare peninsula where I'm on a bit of an elevation, with no real obstructions except Forth Mountain about 10 km

the west. My current aerial is elevated just above the chimney line of the house. This allows me to receive usable images starting as far south as Libya and as far north as Greenland, east to Uzbekistan and west to Newfoundland. To date I've been quite satisfied with this: Its the best reception coverage I've obtained anywhere I've lived in Ireland. If you're located in a valley with hills or mountains around, such as Killarney or Clonmel, then you won't get as wide a coverage area to your images.

With the aerial in position and the coaxial cable run into the house, it's now time to focus on the receiver. For APT satellite reception, you need a specialised receiver with a wide bandwidth (approximately 30-40 kHz) in the 137 MHz weather satellite band (just above the civil aircraft band). The receiver needs to be sensitive (able to receive weak signals), selective (able to reject strong adjacent signals) and able to receive on several discrete channels. When the satellite is low on the horizon, it's furthest point away from you, the signal is exceptionally weak.

The receiver needs to be able to 'hear' the satellite at these low elevations which is why you need good sensitivity. All the commercially available weather satellite receivers have exceptional sensitivity. The receiver also needs to be selective and reject interference from outside the 137 MHz frequency

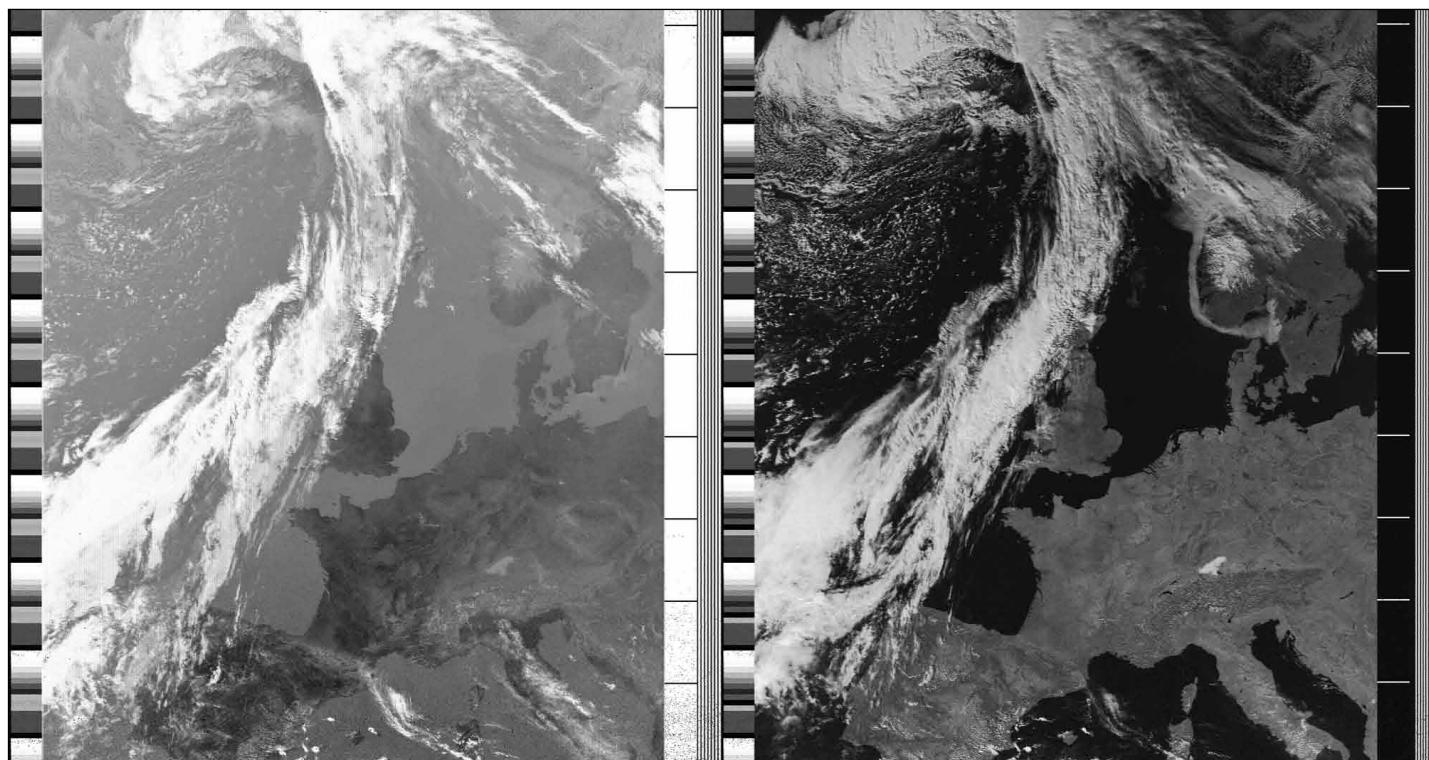


Figure 1 - This is a typical NOAA-19 image, acquired at 14.33 UT on September 30, 2011, showing both the infrared (left) and visible light images.

band. This is especially important in the UK, where high-powered pocket pager transmitters use frequencies that are adjacent to the weather satellite ones. Thankfully, we don't have to contend with this in Ireland.

The receiver also needs multiple channels as each satellite transmits on a different frequency. Ideally, the channel selection should be computer controlled, so that you can switch channels via software control. Once all these requirements are met you can form the basis of your automated receiving station.

I have used several receivers over the years, manufactured by *Hamtronics*, *TimeStep*, and, most recently, the *R2FX* receiver manufactured by Marius Rensen in Germany. This receiver does meet all the above requirements and has performed flawlessly in my location now for several years. It's small, about the size of a small transistor radio, of robust construction, and is powered by a 12 volt mains adapter. The actual receiver is shown in figure 3 below. It's not very exciting, just a few lamps on the front to show which channel is selected, and the signal strength (when receiving). It also supports diversity (twin-aerial) reception, but I've never used that feature. It is also capable of powering an aerial-mounted preamplifier for poor-signal applications. I don't use this feature either.

My processing workstation is a home-assembled *Intel Atom 330* computer running *Windows XP*. I'm a self-confessed low-power computer 'nut' so, since this is going to run 24/7, I wanted something that had adequate processing power but wasn't going to draw significant electric current or create noticeable levels of noise. The Atom CPU with a 'shoebox' style case fits the bill perfectly. It sits quietly on the shelf, running day in and day out. I've no keyboard, mouse, or display connected to it but use remote desktop control software to access it instead. As a lot of data is stored on this reception computer, I have an inexpensive RAID (Redundant Array of Inexpensive Discs) card installed with two 500 GB hard discs for data storage. It's a simple but effective setup for this application.

Now is a good time to talk about storage requirements. There are three types of files that have to be stored on your reception computer: WAV (audio) files of the actual received satellite signal, PNG (image) files decoded from the WAV file and JPG (JPEG) image files of the fully processed image. This works out at around 30 MB of storage, required per satellite pass, for all the files. Given that there are multiple satellite passes per day, the storage budget needs to accommodate several hundred MB of data growth per day. That works out at around a gigabyte a month for data storage (if you wish to keep them all). With my current hard drive that works out at less than one year of storage. I haven't reached that point yet with this computer but I plan to delete old imagery on a scheduled basis to keep things manageable. If the raw WAV and PNG files are retained, they can be re-processed at a later date by the processing software to reproduce the final images.

The reception/processing software is really the core of the satellite receiving station. It has a lot of work to do: track the satellites, control the receiver, record the image and process the raw image. I'll cover each of these in depth below.

The satellites that transmit APT are polar satellites (they circumnavigate the Earth over the poles). To make it more complicated, their orbit changes day by day. To accommodate this, you have to prepare satellite predictions that predict, via mathematical models, where the satellite will be in the sky at a point in time relevant to your receiving location. This is done using Keplerian elements, data files that the reception software uses to predict

exactly when the satellite comes into view of your station and can change to the proper channel to receive it. This is a core requirement of any automated receiving station. The Keplerian elements are constantly updated and the reception software can download them on a regular (~2 day) basis over the Internet.

As each satellite transmits on a different frequency, you need some sort of automatic channel selection. This is a by-product of the satellite predictions mentioned above. If you know which satellite is in view and what frequency it's transmitting on, you can set the channel on the receiver to the one corresponding with that satellite. My *R2FX* receiver has an RS-232 serial port on the back for just this purpose. It's connected to the processing computer with a standard RS-232 cable. The software 'knows' which satellite is in view and, via a serial command, sets the appropriate frequency in preparation of a pass. Almost all but the most basic weather satellite receivers support computer channel selection. Needless to say, this feature is essential if you want to create composite images from multiple satellite passes.

Once the appropriate channel has been selected, and everything is set up for recording a pass, the process of actually recording the satellite transmission can begin. What you want to accomplish here is to record the audio transmitted from the satellite and then post-process it. The receiving software takes the audio from the receiver and, through the built-in computer sound card, digitises it, and saves it to the hard disc as a WAV file. This contains the raw satellite data from which all your processing will be done. In order to do this, you need to decode the WAV file and build an image file from it (the PNG file mentioned earlier). But this is the first step in producing human-meaningful images.

The APT image consists of two frames, usually a visible light frame and an infrared or near-infrared frame. These images are transmitted as grey scale (black and white) images. By combining the information in these two frames and processing it through algorithms, you can produce false-colour images representing more of what you would expect to see.

Before moving on to processing the raw image, there is one other consideration that needs to be accommodated. You must set your computer clock accurately. Somewhere, you have to obtain accurate time information to discipline the receiving PC's clock. An NTP (Network Time Protocol) client does this job nicely. While *Windows XP* has a built-in time client, it isn't really designed for, or suitable for, high-precision timekeeping. In my receiving system I've disabled this client in favour of a *Windows XP* build of *ntpd*, the network time daemon. This provides much better time discipline of the PC's internal clock and helps to minimise some other image processing problems. The *ntpd* daemon quietly works in the background, comparing the local PC's clock with reference clocks out on the Internet. Timekeeping accuracy improves to the order of single-digit milliseconds. This is especially important for positioning the map overlays which you may later apply to your processed images.

Once you have your raw satellite image in PNG format, you can process it using a number of algorithms. These take the grey scale images and process them into false-colour images which lend themselves to human visualisation. This is a complete topic all in itself which I'll save for instalment 3 of this series.

I have an up-to-date web page that has current satellite imagery at

<HTTP://www.ei2jp.com>

The Ultimate Weather Satellite Enthusiast

Robert Moore gives a guided tour of his office

Here is a picture of my 'shack' (actually my study). Four PCs are visible in this picture. On the left, under the bench against the wall, is a *Dell Dimension 8300* which runs solely to receive *EUMETCast* data. The PC itself is probably above the specification needed for this task. It has no monitor or keyboard because I communicate with it via *UltraVNC* from my main processing computer, located at the left hand end of the table on the right.

The main processing PC is a *Dell Optiplex 745* which, when purchased, was a fairly high-end piece of kit. The *Optiplex* computers are designed to be capable of running continuously and have appropriately designed cooling arrangements. The processing PC handles all the data from the receiver PC and also serves as my daily workstation, with software for data-processing, Geographical Information System, *Photoshop* and, of course, writing. This is where I do my day job of research and writing. I also have software for programming radios and processing radio data, although I now do very little of either. I also have the full array of David Taylor's software and some others.

Two flat screens can be seen on the table. The left-hand screen is the working one but the 590 mm wide screen on the right gives me extra space for opening a range of applications simultaneously (very useful, for example, for viewing two or more documents at the same time). This screen also enables me to view very large—and sometimes spectacular—satellite images. I often have *MSG Animator* running an Atlantic IR animation on this screen while I'm working on the other one. I find this useful for making my own local medium-range weather forecasts. I also have paid-for access to UK rain radar on this PC.

There is nearly always something interesting offshore and often visible from the window. Thus, I have the *COAA Ship Plotter* on this PC and occasionally use it to identify some of the very wide variety of ships in the Mersey and the Irish Sea, which range from monster container ships to dredgers, cranes, tugs and the specialist vessels serving the gas platforms or building the wind farms. A large, tripod-mounted telescope in another room supplements this highly distracting facility.

Two further PCs can be seen under the table: the larger is a *Dell Optiplex 740* and the smaller is an *Optiplex 320*. I use *Windows Remote Desktop Connection* to



enable me to use a common keyboard and monitor for these two computers: the monitor can be seen on the edge of the right hand table. The *Optiplex 320* runs two programs: firstly *Timestep's WinHRPT* software for the reception of HRPT data from polar orbiting satellites (NOAA16 and NOAA19 at present) and secondly a very old version of *Mscan Meteo* to receive radio fax charts. These come through the *HF-150* receiver which is just visible at the top of the radio stack on the left of the photograph. This radio is quite old: my father used it until the early 90s and I have been running it 24/7 ever since, receiving Admiralty data from Northwood.

The *Optiplex 740* receives data via a UHF link from my weather station in the garden. These data are used to prepare monthly weather reports for the local secondary school and quarterly reports with commentary for our community newspaper. They are also reported on my weather station web site

http://www.robertsmoore.co.uk/carmel_weather.html

I recently deposited ten years of weather reports, illustrated with satellite images, with our county archives. The *Optiplex 740* PC is a bit of a sledgehammer to crack a nut so I also run *Basestation* and the *COAA Planeplotter* with an *SBS-1* receiver. *Planeplotter* enables me to share data and

I hope this is useful to the more avid plane enthusiasts because my geographical position in North Wales gives me coverage northeast of a line from Belfast to the Wash (and sometimes beyond).

All the PCs can talk to each other. Thus, interesting HRPT images from my *TimeStep* setup, for example, can be examined with *HRPT Reader* on my main PC and may be displayed on the wide screen.

Readers will appreciate that all these PCs, radios and other equipment, plus aerial and PC cables, make for a lot of wiring - with the potential for tangling and tripping. I have therefore installed trunking around the wall, just above table level, to carry wires and cables tidily and safely around the room.

How I ever do a day's work remains a mystery to me. The view out of the window can be very striking, especially when one can see Blackpool Tower and the Lake District hills. The bird-feeder outside my window is visited non-stop by a quite remarkable variety of birds. To add to these distractions, two cats compete for my chair and the loser usually tries to sleep on the keyboard.

In the next issue of GEO Quarterly I hope to tell you what I do with the satellite data I receive.



Lightning Detection and Weather



Esko Patäjä

I have always been keen to have my own lightning detection system. I have been looking at available systems on the market and almost purchased one, only for another with higher priorities to come along.

This spring, the local radio amateur club (Teemu OH6HGN) undertook activities to make a group order for lightning detection kits. The selection was for devices from *Blitzortung*. Thirty kits were ordered in total at a cost of €71 each. Additionally, of course, was the cost of station equipment like antennas, cables and so on. Today totally fifteen of these stations are on-line with the rest expected to follow next season (figure 1).

This article discusses lightning, four different hardware and software options available for displaying lightning on your own PC, how one of the groups went about implementing this, and how you can relate this lightning data to satellite images. My own system is described in detail.

Different Lightning Sensing Devices

While working with system I have been studying different lightning detection system and how they works. I have studied following systems.

- Blitzortung (my own station)
- Lightning Radar (invented by Frank Kooiman)
- Boltek
- Vaisala (a commercial system).

It is worth noting that some systems built by amateurs, like Blitzortung, in conjunction with *MyBlitzortung* software, are even more comprehensive than commercial systems.

Blitzortung

A lightning discharge emits energy over a wide range of radio frequencies. The most powerful emissions occur in the Very Low Frequency (VLF) range. VLF refers to radio frequencies in the range of 3 kHz to 30 kHz. In the case of *Blitzortung*, the lightning is detected by multiple stations and accuracy timing of stations. The system is based *Time of Arrival*, where the location of the lightning is based on the time differences between reception at each station as illustrated in figure 2.

My own station consists of the following elements: antenna, GPS, preamplifier and processor board. The antenna can be either a loop or ferrite rod type. The preamplifier amplifies the antenna signal, which is transmitted to the processor boards where data are send to the server for the calculation of strike positions.

Lightning data from each station is uploaded to a server where the exact location of each strike is calculated. Users can view the combined data from each lightning station on a web-based *Google Map* or by making their own services by PHP and showing data in their own web pages. In the latter case, raw data is downloaded from *Blitzortung*. Figure 4 shows a plot of lightning strikes over northern Germany and southern Sweden.

Lightning Radar

John Silver has written an article in *GEOQ 17* about this system, which was based on loop antennas angled at 90° (figure 5) and a VLF amplifier.

Output from the VLP amplifier was connected to a PC sound card.

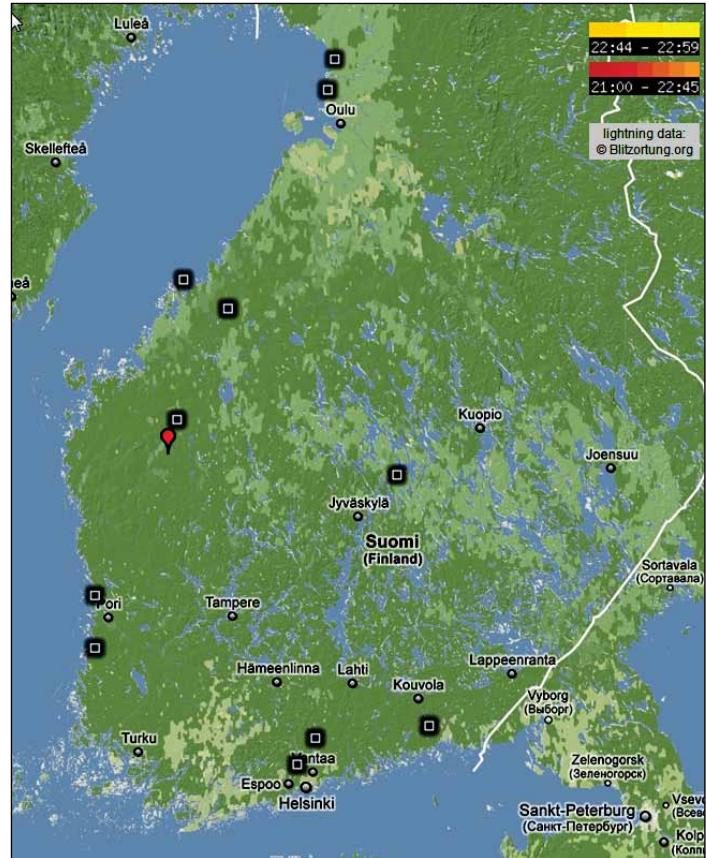


Figure 1 - Station locations in Finland

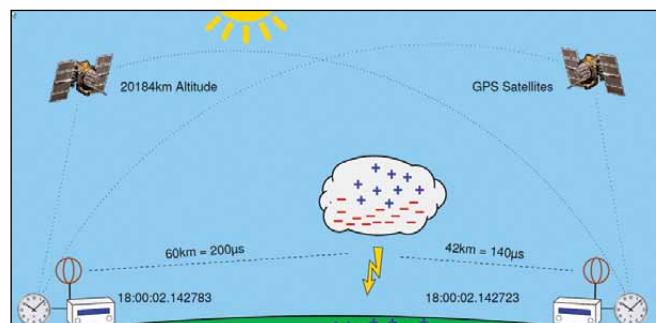


Figure 2 - The Principle of Lightning Detection
(c) Blitzortung

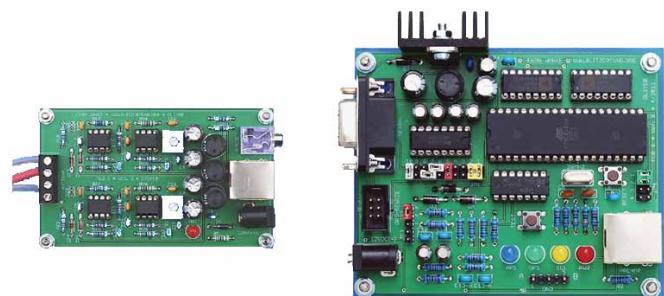


Figure 3 - Station Components: VLF Amplifier and Processor Board

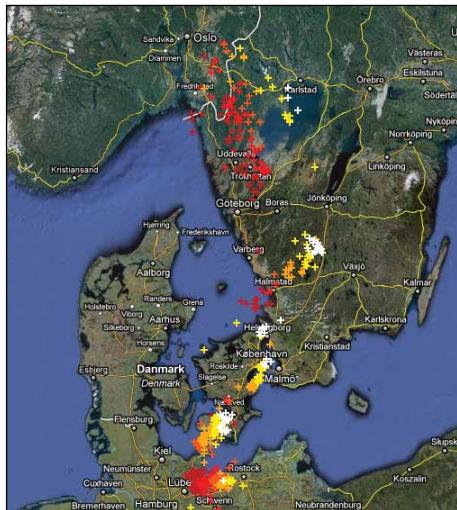


Figure 4 - Strikes over Germany and Sweden

Strike positions were calculated according to multiple station bearings to the signal. The *GEO Shop* sells these devices but, unfortunately there are no other stations available in Finland. Due to this reason this selection was not possible for me.

The Boltek Corporation System

The *Boltek* system is a factory manufactured product from Canada. It is widely used by amateurs specially in north America. It has also wide range of options and software, which is why it is also widely used commercially. The price for this system is around €1000, more expensive than a system built by an amateur.

The *LD-250* uses a small active antenna to receive the radio signals from lightning strikes. These signals are the crackling you hear on an AM radio during a thunderstorm. This direction-finding antenna is able to tell which direction the signal is coming from. The software then measures the strength of the received signals to estimate the distance to the strike. Special signal processing in software reduces the effects of strike-to-strike energy variations, thus providing more accurate distance information. There have been many questions on how one station detection system could work accurately, based on signal strength measurement. Detected signal strength can vary according to atmospheric conditions but *Boltek* claim that this has been solved by advanced signal processing (figures 6). Figure 7 shows the *Boltek* software in action.

The measuring accuracy of a *Boltek* station is not very good when using a single station.

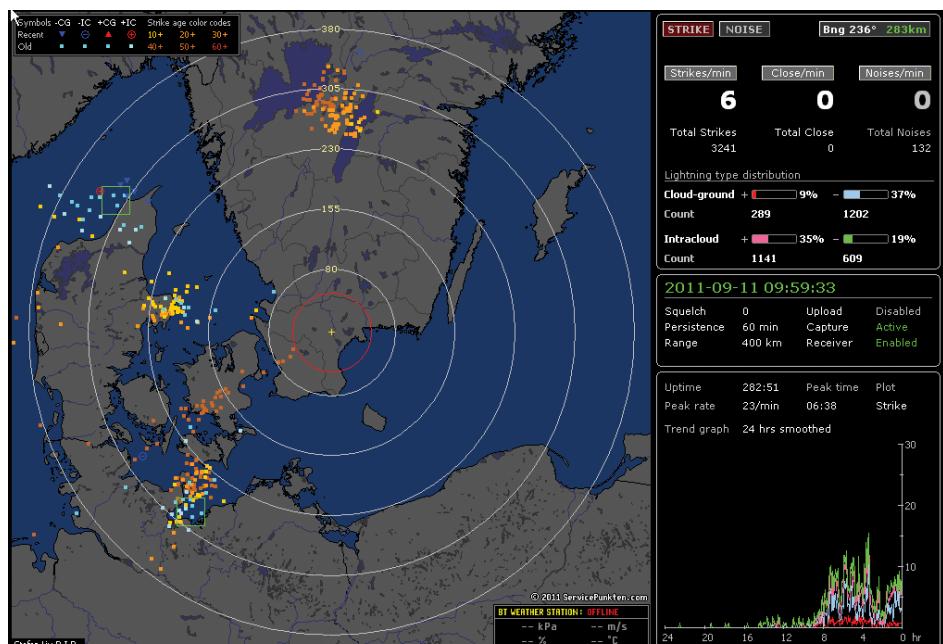
In real life, station measuring accuracy is improved because almost all stations share their data over the European *Strike Star* network, which provides more accurate, recalculated data to the users.



Figure 8



Figure 5 - Daniel Verschueren's loop antenna

Figure 6 - The *Boltek* strike sensing systemFigure 7 - *Boltek* strike sensing software display

Additionally to strike detection, *Boltek* also has atmospheric electric field measuring devices which are able to measure electric fields (kV/m) and display them on the computer screen. The *Atmospheric Electric Field* measuring device antenna from *Boltek* is shown in figure 8.

Figure 9a shows a typical atmospheric electric field when a thunderstorm is approaching: figure 9b shows the electric field pattern when the thunderstorm is directly overhead.

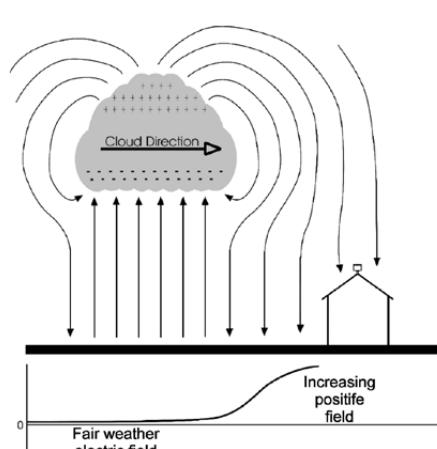


Figure 9a
The Increasing electric field as a thundercloud approaches

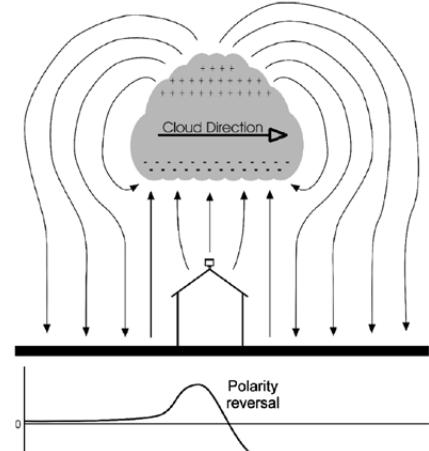


Figure 9b
The electric field changes polarity when a thundercloud is overhead

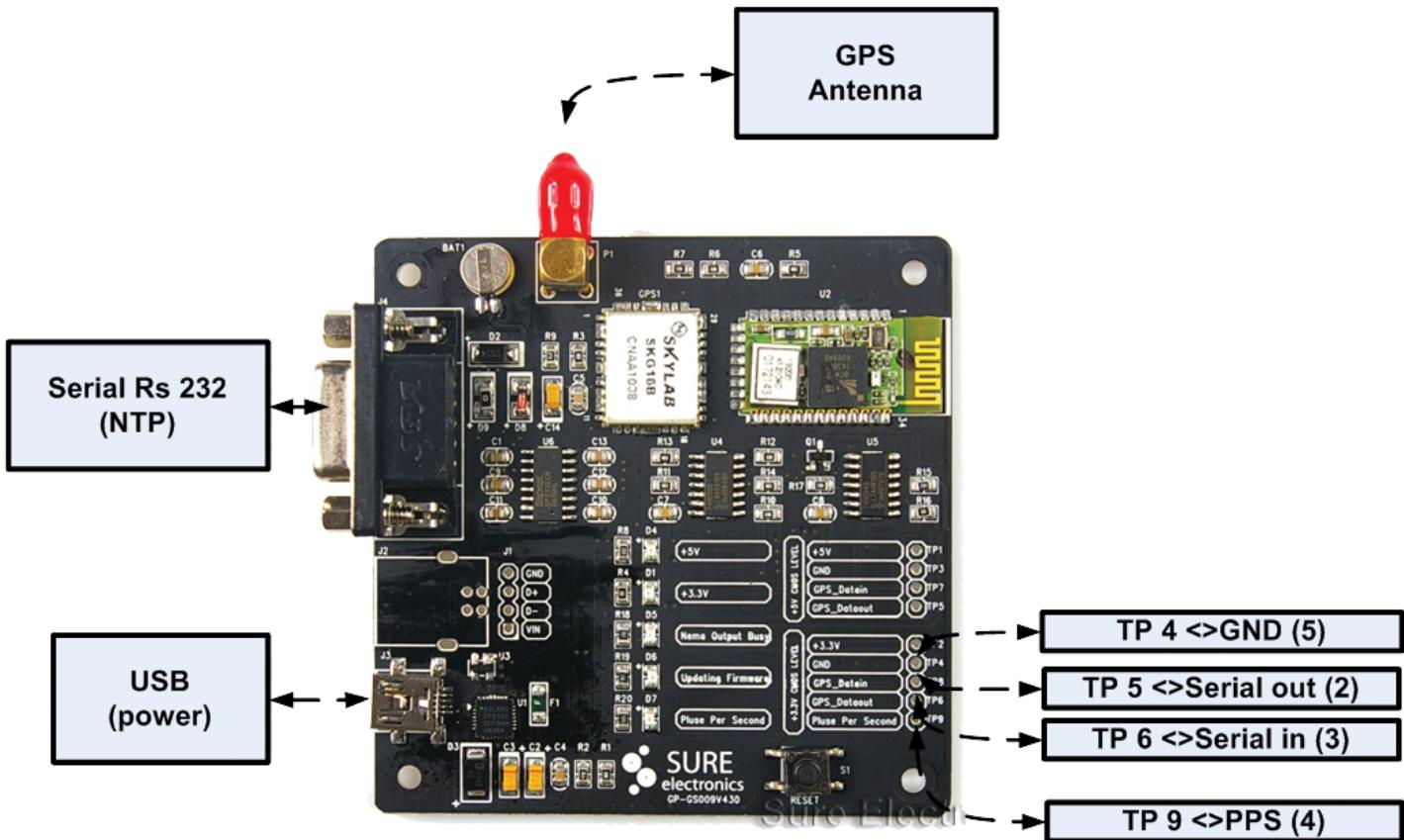


Figure 10 - TTL level connections to the Sure GPS Board

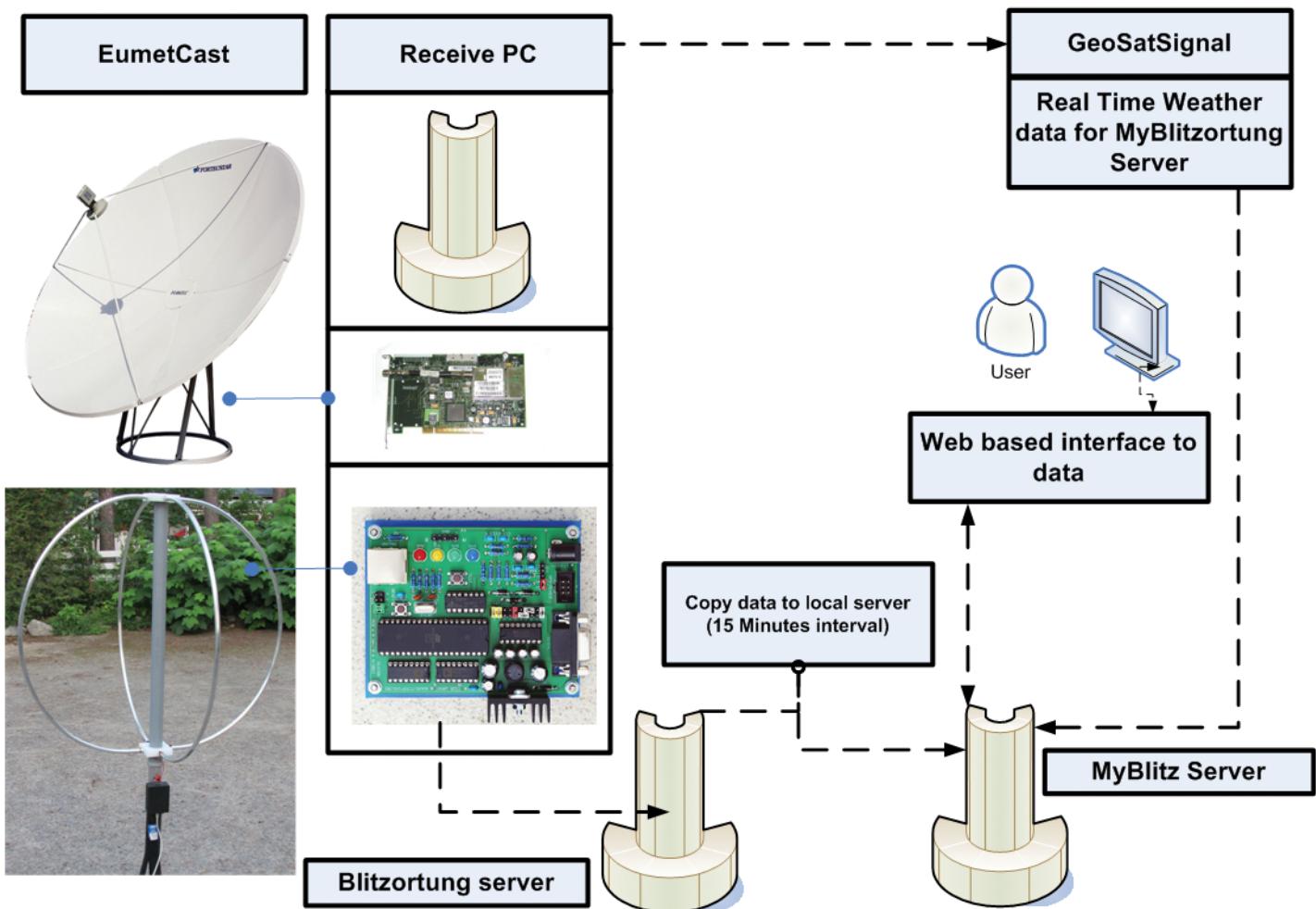
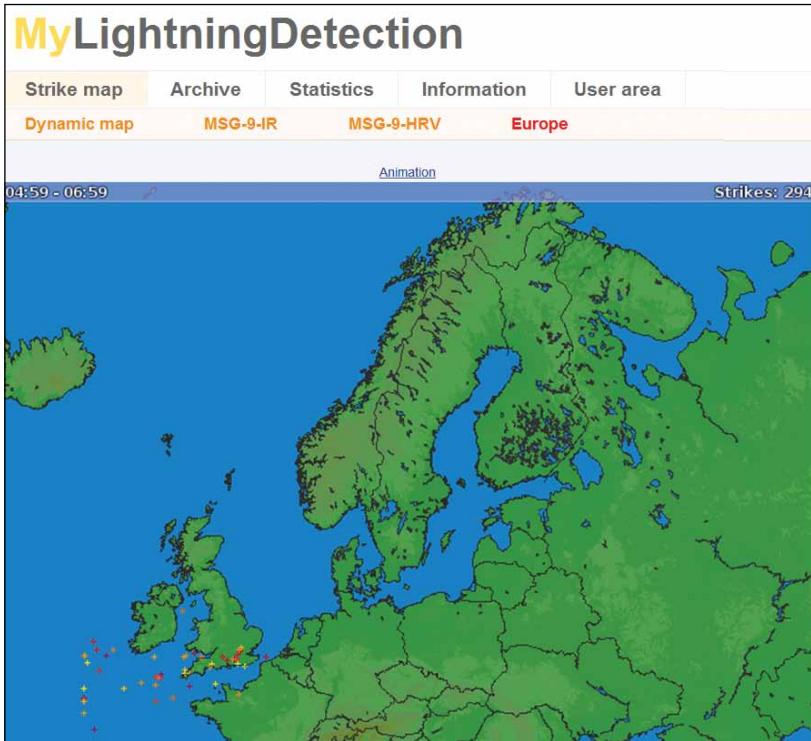


Figure 11 - Schematic of the Author's combined EUMETCast and Lightning Detection Station

Figure 14 - The main *MyBlitzortung* screen

(a free command line tool for retrieving files using HTTP, HTTPS and FTP, the most widely-used Internet protocols).

MyBlitzortung now offers multiple options for displaying this data, such as showing the lightning in local maps, in weather maps, making a lightning strike animation or listing station and signal statistics.

Figure 14 shows the main screen of the *MyBlitzortung* software, which has menus for accessing the different map and station statistic displays.

Figure 15 shows statistics from the detection range, which is amazingly large—several thousand kilometres. Figure 16 shows the lightning strikes as a function of direction. In figure 17, the deviation (accuracy) of the detected signals is shown. Deviation relates to the time difference between different stations detecting a lightning strike. The accuracy is remarkably good. Figure 18 is a log of strike activity over a 24 hour period.

I would like to thank the following for helping me to work on this project.

- Teemu (OH6HNG) for organising activities to get a group order for kits
- Petri (OH6FUB) who helped me to set up the WAMP server
- Terje Matisen and David J Taylor for helping me to configure Sure GPS board
- David J Taylor for helping me with software
- Tobias Volgnandt for extending *MyBlitzortung* for weather animations.

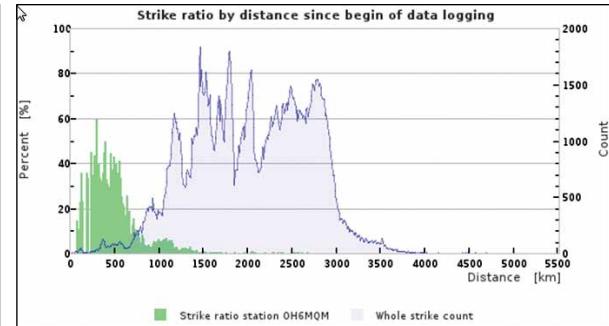
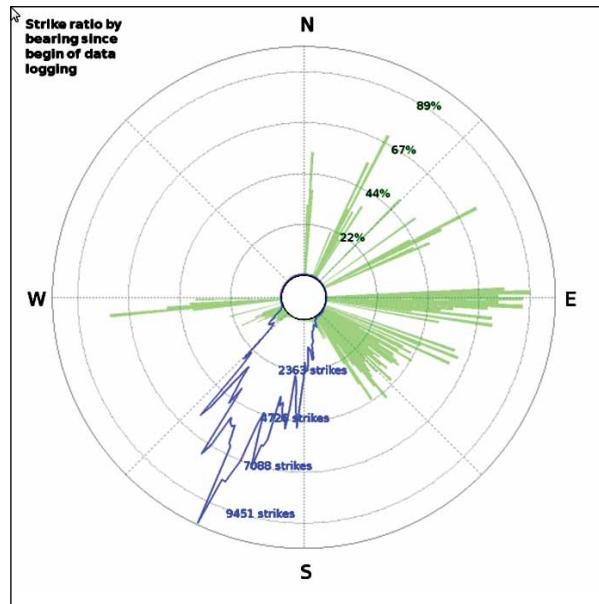
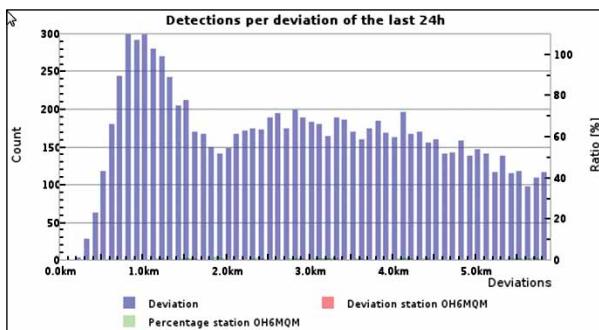
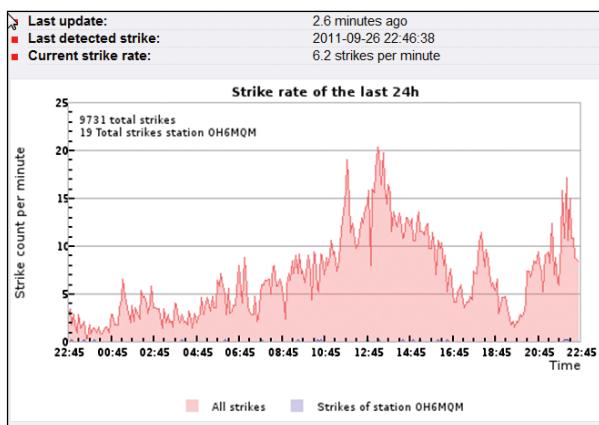
Further plans

The lightning season locally in Finland is over and I can only do further testing with data from the network. It is also amazing how I can still get some data from lightning from as far away as southern Italy. The distance is 2500–3000 km and the deviation, confirmed by other stations, is less than 3 km.

For the future, I will automate reception from polar orbiting satellites to update the latest images. There are good command line tools available from *SatSignal*, and I need to write some small additions to make that ready. I have also started collecting parts for an atmospheric electrical field strength measuring device. This will be excellent for local thunderstorms. The system that I plan to build is similar to the Boltek system, with a rotating wheel.

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- <http://members.home.nl/fkooiman/lightning/>
- <http://www.boltek.com/>
- <http://www.satsignal.eu/>

Figure 15
A log of strike ratio as a function of distanceFigure 16
A log of strike ratio as a function of bearingFigure 17
A log of detections per deviation during the previous 24 hoursFigure 18
A log of strike rate over the previous 24 hours

The Buddleja Effect

Francis Breame

Many readers use *EUMETCast* to receive an impressive variety of images and other meteorological data, some of which deal with vegetation coverage. Now I discover I can also use the service to determine how well my garden is growing!

Have a look at figure 1. This shows my received signal level over a few weeks, with a gradual decline followed by a sharp recovery, happening twice. In fact, this is caused by my buddleja shrub, which is very close to the line of sight of my *EUMETCast* dish. As gardeners will know, this plant grows very vigorously in all directions, so that I have regularly to prune a gap for the signal to get through (figure 2). Actually, it's surprising just how little vegetation is needed to produce substantial attenuation at Ku band. I wonder if there's scope to replace the buddleja with something with much smaller leaves? The buddleja is also known as the *Butterfly Bush*, so I suppose any rapid fluctuations in signal strength could be explained!

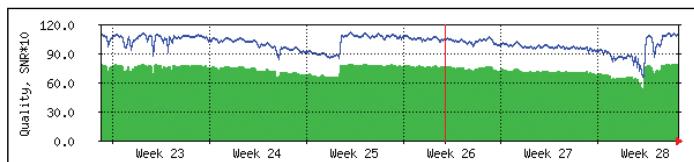


Figure 1 - Received *EUMETCast* signal level



Figure 2 - The author's *EUMETCast* dish



Figure 3 - A peacock butterfly feeding upon a buddleja bush

Possible Sighting of a Fallstreak Hole from Wisley

Francis Breame forwarded us the photograph below, which was taken by his friend, David Salter, while on a visit to RHS Wisley. Although no aeroplane was seen at the time, the corridor through the cloud does seem to tie in well with the fallstreak hole concept (see article on page 9), and a query to the Met Office elicited the response that the trail through the cloud could have been 'dissipated by an aircraft, probably in a stack, waiting to land at Heathrow'.



NPP, NiPPy and the Workhorse

Ed Murashie

This story is about the NPOESS Preparatory Project, its NPP weather satellite, its mascot NiPPy and the rocket called 'the Workhorse'. It begins with the technical details of each piece of the mission and ends with a tour of the rocket and satellite that is filled with little known facts. So feel free to skip ahead to the tour if the facts become overwhelming.

NPP [1] is the latest Earth observation satellite and should have already gained orbit as you read this. The acronym even has another within it (NASA loves those acronyms). NPOESS stands for the *National Polar-orbiting Operational Environmental Satellite*. Breaking the name down tells you what the satellite does. National comes from the original idea of combining the separate *Defense Department's Defense Meteorological Satellite Program* (DMSP) weather satellite, the *National Oceanic and Atmospheric Administration's* (NOAA) *Advanced TIROS-N* (ATN) satellite and NASA's Earth resources satellites.

If you have seen a picture of city lights from space, it was probably taken from a DMSP satellite. You may not have seen ATN's pictures but you have seen pictures from NOAA's other weather satellite, the *Geostationary Operational Environmental Satellite* (GOES), on nightly news weather reports. GOES does not let you see the polar regions or areas like Asia, Europe, Africa and Australia because it is in geostationary orbit around the equator whereas ATN is in an orbit that goes around the North and South Poles. NPP will be in a similar polar orbit, thus the word Polar-orbiting in the name. Operational comes from the data actually being used to predict the weather on a daily basis, as opposed to an experimental satellite. Environmental comes from the fact that the satellite not only takes pictures of the Earth, but also measures other factors like temperature, ozone, rain/snow and humidity, which help predict the weather. Preparatory Project comes from the original plan to use this satellite to test some of the new onboard instruments before deciding on their use in the follow on series, simply called NPOESS.

The U.S. Government wanted to save money by combining the DMSP and NOAA ATN satellite systems but it was decided in 2009 that they could not create a set of instruments that would cost effectively satisfy each organization's requirements and other political factors. Therefore, the NPOESS mission no longer exists and is being replaced with the Joint Polar Satellite System or JPSS. JPSS-1 is expected to launch in November 2016. Meanwhile, NPP

will fill the gap between the ATN satellites and JPSS-1. NPP is not just a weather satellite: its new mission is also to bridge between the ATN satellite and past Earth resource satellites like *Aqua* and *Terra*, which study even more environmental factors. Therefore, NPP is a NASA satellite although NOAA will make use of its operational data. Approximately six months after launch and checkout, NASA will turn the satellite over to NOAA for operations.

NPP's spacecraft bus is a modified version of Ball Aerospace and Technologies Corporation's BCP2000 bus [2] that has been used in other missions, including the environmental *CloudSat* and *ICESat*. The bus is designed for a five-year life and provides the propulsion, electrical power, communications, thermal control and mounting surfaces for the instruments. Propulsion and 3-axis attitude control keep the instruments pointed in the right direction and the satellite in its correct orbit. Power is provided by a single solar panel that generates 2700 watts. High-speed 300/10 Mbps X-band communication channels and 343 Gbit of storage provide links for both the on-board instruments and spacecraft. Attached to the surface of the BCP2000 bus are the five *Earth science instruments* [3]: VIIRS, CrIS, CERES, ATMS and OMPS.

VIIRS

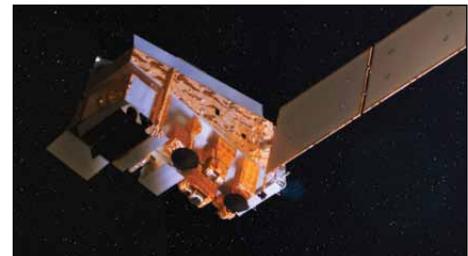
The *Visible Infrared Imaging Radiometer Suite* is built by Raytheon and measures the energy radiated from the Earth at infrared through visible light wavelengths. Infrared provides the thermal images during the day and night periods and visible during the day only. Its 22 channels provides 12-bit quantization (4096 shades of gray), two levels of gain and 750 metres resolution across the full scan line. This compares with ATN's AVHRR instrument with 5 channels, 10-bit quantization (1024 shades of gray) and 1.1 kilometre resolution (but only directly under the satellite).

CrIS

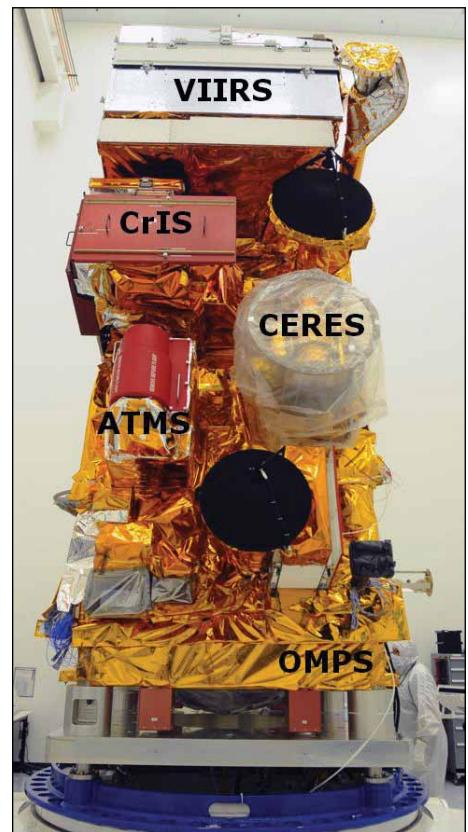
The *Cross-track Infrared Sounder* is built by ITT and provides high-resolution three-dimensional measurements of the atmosphere's temperature and moisture that will be used in weather forecasting. CrIS picks up and improves on the *Atmospheric Infrared Sounder* on the *Aqua* satellite.

CERES

The *Clouds and the Earth's Radiant Energy System* instrument built by Northrop Grumman Aerospace Systems measures the reflected sunlight and Earth's thermal radiation to determine the planet's



An artist's impression of NPP in orbit
Photo: NASA/GSFC



The Earth facing (Nadir) deck with the instruments.
The stored data black antenna is on the bottom
and the user data black antenna on the top
Photo credit Ball Aerospace

energy budget. The data will help in the understanding of periodic and long-term changes like El Nino. CERES is already flown on both the *Terra* and *Aqua* satellites.

ATMS

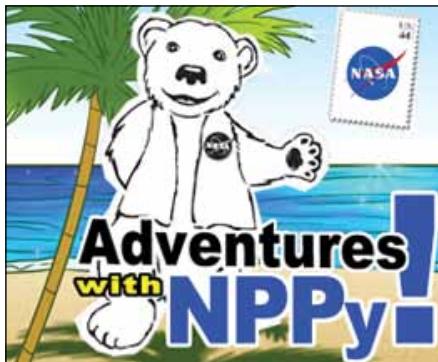
The *Advanced Technology Microwave Sounder* built by Northrop Grumman measures the atmospheric temperature and moisture using passive microwave energy. Microwaves can pass through clouds more readily than infrared energy and, therefore, the ATMS complements the CrIS. The ATMS is an improved instrument that combines several instruments that make up the AMSU flown on the ATN satellite.

OMPS

This is the Ozone Mapper Profiler Suite built by Ball Aerospace and Technologies Corporation, and measures the ozone layer at higher resolution than the SBUV/2s flying on ATNs. The cost of improvements in the satellite is manifested in a new data format [4] and a higher transmission frequency and data rate. A larger antenna and new receiver are required to receive the direct broadcast from the satellite. The new transmission frequency for the satellite is 7812 MHz and the combined data rate is 15 Mbps. This compares to ATN's 1698-1707 MHz frequency and 665 kbps data rate.

NiPPY

NPP is unique because it has its own mascot [5]. NiPPY is NPP's animated mascot who has his own video, in which he talks about the climate change which effects many species, including polar bears. He also talks about what he learned in school about the NPP satellite. You can help NiPPY spread the word by photographing him in various states and countries and posting your pictures on the NASA website.



The Delta II Launcher

In 2006, Boeing, with its Delta rockets and Lockheed Martin with their Atlas rockets, combined their launch vehicle business to form United Launch Alliance (ULA) so that they could compete better in the world launch services market. NPP gets a ride into space on board ULA's *Delta II* rocket [6].

More impressive than the Delta II's height (39 metres) and mass (231 872kg) is its tremendous success rate of 98.7% after 150 launches. The *Grail* mission, launched from Cape Canaveral Air Station in Florida in September of this year, was the 96th consecutive successful—and also the final—launch of a *Delta II* from Cape Canaveral (the first launch was on February 14, 1989).

The NPP mission will be the last scheduled launch of a *Delta II* from Vandenberg Air Force Station in California, although there are parts for five more (but without contracted launches). The first launch at Vandenberg was on November 4, 1995. The *Delta II* also is called the 'Workhorse' and the larger *Delta-IV* completes the Delta family.

Within the *Delta II* family are the 7300, 7400 and 7900 series, where the '3', '4' and

'9' refer to the number of graphite-epoxy motors (GEMs) attached to the first stage body. Each GEM is a metre in diameter, about 11 metres long, has a mass of 13 000 kg at launch and provides 500 kilo newtons (kN) of thrust; 63 seconds later, at burnout, the launcher's mass has fallen to just 1134 kg.

For the NPP mission, a *Delta II* powered by nine GEMs will be used, six of which are ground lit and three lit after the first six burn out. Because the latter three are air lit in a thinner atmosphere, the nozzles and overall length are slightly larger. The mass and orbit of the satellite are two of the factors that determine how much thrust is required and therefore how many GEMs are used. The 2.13 tonne NPP will be placed in a 824 kilometre orbit and therefore will be launched with a 7920-10 configuration where 9 GEMS will be used. The '2' in the configuration number refers to the use of an Aerojet AJ10-119K second stage and the '-10' refers to using a 10 foot diameter by 29.1 foot fairing to cover the satellite (3 x 8.9 metres). For complete information on the *Delta II*, please refer to the *Delta II Payload Planners Guide* [7].

The 1.5 billion dollar NPP satellite was successfully launched from *Space Launch Complex 2 West* (SLC-2W) at 2:48 am PDT on October 28, 2011. Just under one hour later, it separated from the *Delta II* [8]. NPP now circles the Earth once every 102 minutes in a 824 km sun-synchronous circular orbit at a 98° inclination over the poles. Ultimately, it will replace NOAA-19 as the primary afternoon satellite. Several spectacular videos showing the launch from a camera on board a *Delta II* can be found on YouTube [9].

Riding along as secondary payloads were cubesats, small satellites usually, 10-centimetre cubes weighting less than 1.5 kg, built using commercial parts. These included *AubieSat-1* from Auburn University [10], *DICE* from the University of Utah [11], *Explorer-1[Prime]* [12] from



P-POD on the left and two cubesats on the right.

Credit: NASA/KSC



Gravity Probe B at SLC 2-W is a *Delta II* 7920-10. The mobile service tower is to the left and the fixed umbilical tower is to the right of the rocket.

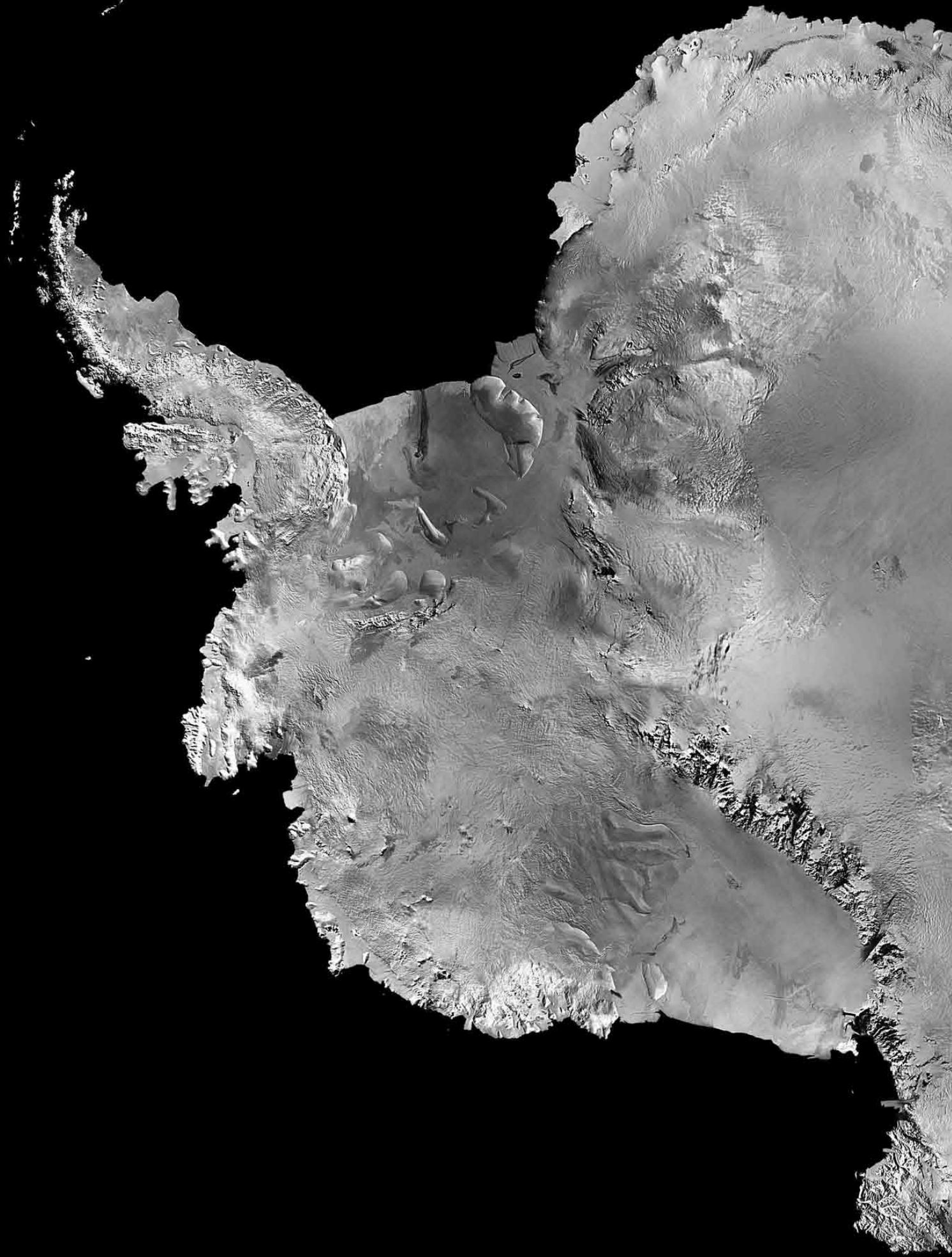
Credit: NASA/KSC

Montana State University, *M-Cubed* [13] and *RAX-2* [14] from the University of Michigan. The format was started and standardized by Cal Poly San Luis Obispo and Stanford University in 1999 [15]. These make for wonderful educational experiences at high schools and universities, and are also built by private companies. These left their P-POD launch tubes, in different orbits for their own specific purposes, approximately 39 minutes after NPP separation.

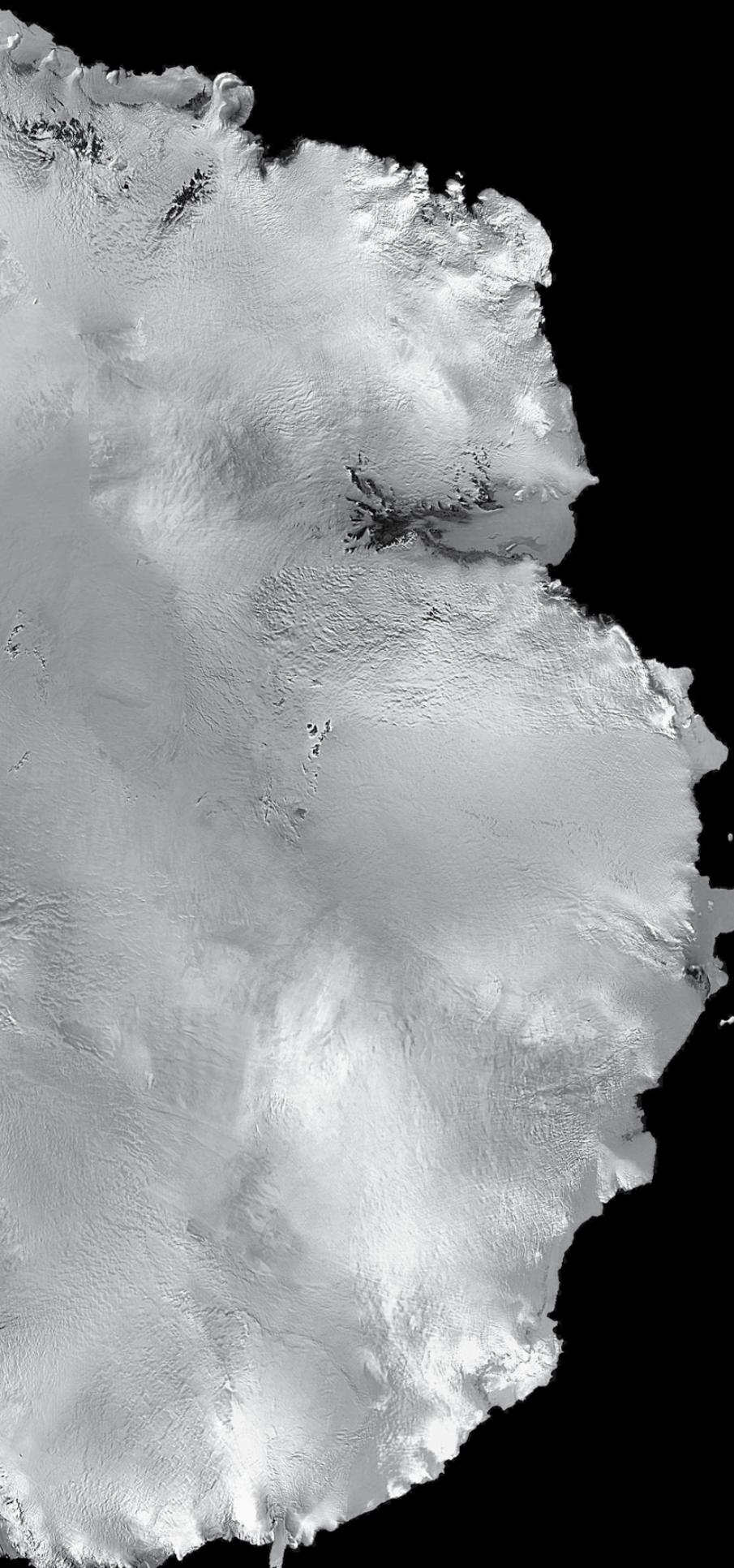
So as you can see the NPP mission involves many government facilities, private corporations and universities and will extend our Earth science data set as well as supply the data for future weather forecasts.

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Blue Marble image of Antarctica courtesy NASA



Spring Arrives in Antarctica

John Tellick

For the majority of *GEO Quarterly* readers, winter is fast approaching and it's time to dig out those woolly hats and gloves. But in the southern hemisphere the sun is returning, it's springtime, and the ice is starting to melt.

Antarctica is Earth's southernmost continent, encapsulating the South Pole. It is situated almost entirely south of the *Antarctic Circle*, surrounded by the Southern Ocean. With a surface area of fourteen million km², it is the fifth-largest continent in area. Only Europe and Australia are smaller. Indeed, Antarctica is nearly twice the size of Australia.

Some 98% of Antarctica is permanently covered by ice that averages at least 1.6 kilometres in depth. Overall, Antarctica is the coldest, driest, and windiest place on Earth and has the highest mean land elevation of all the continents. Antarctica is considered a desert, with an annual precipitation of only 200 mm along the coast and far less inland. The temperature in Antarctica has been recorded to fall as low as -89 °C. Here, although there are no permanent human residents, between one and five thousand personnel from many countries may be present throughout the year manning the research stations scattered across the continent.

Only cold-adapted organisms survive in Antarctica. These include many types of algae, bacteria, fungi and a few plants and also a few animal species such as mites, nematodes, penguins, seals and tardigrades (microscopic, water-dwelling, segmented animals with eight legs).

As many as 45 species of birds are known in Antarctica, including the Antarctic Skua, Giant Antarctic Petrel, Storm Petrel (which migrates here from the Arctic), Snow Petrel and Antarctic Fulmar. Only the seven species of penguin, however, are endemic.

Vegetation, where it occurs, includes about 150 lichens, 30 mosses, a few fungi and one liverwort. There are only two native vascular plants, the Antarctic hair grass and a cushion-forming pearlwort, which are found in small clumps near the western shore of the Antarctic Peninsula.

Although myths and speculation about a *Terra Australis* date back to antiquity, the first confirmed sighting of the continent is accepted to have occurred in 1820 by the Russian expedition of Fabian Gottlieb von Bellingshausen and Mikhail Lazarev. Antarctica remained largely neglected for the rest of the 19th century because of its hostile environment, lack of resources, and isolation. The Antarctic Treaty was signed in 1959 by 12 countries and to date, 47 nations are signatories. The treaty prohibits military activities, mineral mining and nuclear testing, but supports scientific research and protects the continent's ecozone.

Source: *Wikipedia*

FEEDBACK

Dear Mr Bell

I am writing on behalf of Midhurst, University of the Third Age (U3A) group to thank you for the talk you gave us yesterday on 'Viewing the Weather from Space'.

It was no wonder that you replied in answer to my enquiry that you weren't at all nervous before you started. You knew your subject inside out and just so obviously loved it, thus your knowledge and enthusiasm were infectious. I have to say that I left school at 16 having never studied science of any sort, so I didn't understand everything you said, but I was sitting near a lady who was listening to your every word with much appreciation—it was good to see.

What an interest for you to be able to download all those images and photographs, and how interesting to learn of the different ways it can be done. There was much food for thought during the afternoon. I've met several U3A members today and we all talked about what we learned from your talk: we all had different perspectives of course but good discussions have taken place and I'm sure that's what the U3A is all about—to liven up our thinking and broaden our horizons. That you did so on behalf of the Committee and all who were at the meeting yesterday, may I thank you very much for coming to talk to us and for sharing your knowledge with us.

Yours sincerely,
Sara Dodds, Secretary Midhurst U3A.

It's great to read this sort of letter. It's feedback like this that really makes everyone on the GEO Management Team feel that their efforts are worthwhile. Perhaps this will encourage more of our members to give talks to their local community groups and spread the word about GEO - (Editor).

Dear Francis,

I would be grateful if you would send me a copy of the EUMETSAT Presentation disc and I enclose postage stamps accordingly.

Once again, I enjoyed the latest edition of GEO. I am afraid that I cannot get to the shows anymore because of weakness in my arms and legs but I am still receiving APT.

I hope that you are well. Following GEO over the years I am aware of the enormous amount of work you have done to ensure its success.

Please give my best wishes to John Tellick,

The column for Readers' Letters, Queries and Discussion

Email: geoeditor@geo-web.org.uk

Les Hamilton and others who might remember me

Kind regards.
Yours sincerely,
Roland White.
Northampton.

Unseasonable Snow in NE of the USA

(Continued from page 28)

loss of electricity in Connecticut that was worse than the outages caused by Hurricane Irene.

From Maryland to Maine, it took several days to restore electricity after the snowfall ceased. The storm, dubbed *Snowtober* by news organisations, smashed record snowfall totals for October and worsened as it moved north. Communities in western Massachusetts were among the hardest hit with snowfall totals topping 68 cm in Plainfield, and 66 cm in nearby Windsor.

The storm was blamed for at least 11 deaths, and states of emergency were declared in New Jersey, Connecticut, Massachusetts and parts of New York.

There were flight delays in the region over the weekend, and commuter trains in Connecticut and New York were delayed or suspended because of downed trees and signal problems.

Roads, railways and airline flights were knocked out, and passengers on a JetBlue flight were stuck on a plane in Hartford, Connecticut, for more than seven hours on Saturday. Thirty-two shelters were open around the state, and volunteer fire departments were asked to allow people in for warmth and showers. At least four hospitals were relying on generators for power.

According to the Weather Service, this snowstorm crushed previous records, some dating back more than 100 years. October 29 was only the fourth snowy October day in New York's Central Park since record-keeping began 135 years ago.

Erratum

The top right image on page 21 of GEOQ 31 should have been captioned: 'European ATV Craft', and not 'Progress'.

A Kamchatkan Autumn

A NASA Earth Observatory Report

The typical satellite view of eastern Russia's Kamchatka Peninsula tends to be either white or green depending on the season. But on October 16, 2011, the Moderate Resolution Imaging Spectroradiometer (MODIS) carried by NASA's *Aqua* satellite captured this image (right) of a landscape in transition. The green of spring and summer has been replaced with the orange and tan tones of autumn: the high volcanic summits are already coated with fresh snow, presaging the winter to come. The autumn couloirs in the image serve to highlight the volcanic activity of this region.

Forming the northwestern segment of the Pacific *Ring of Fire*, Kamchatka contains more than 300 volcanoes, 29 of which are active. Vulcanism shaped Kamchatka, and its circular volcanic peaks are the most distinctive features in the image. Five active volcanoes are visible: *Shiveluch*, *Ushkovsky*, *Kliuchevskoi*, *Bezymianny*, and *Plosky Tolbackik*.

Shiveluch can be seen at top centre in the image with the other four volcanoes clustered in the lower left corner. Ranked amongst Kamchatka's largest and most active volcanoes, *Shiveluch* is the only one of these five showing obvious activity. A plume of ash and gas blows east from the summit, and recent lava flows cover the snow on the mountain's southeastern flank. On October 16, the Kamchatka Volcanic Eruption Response Team (KVERT) reported that a plume of volcanic gas and ash rose three kilometres above the volcano and drifted about 35 kilometres southeast. There were also reports hot avalanches at the volcano.

Both the plume and the volcanic debris on the ground are visible because of the season. If the image had been taken earlier in the year, before snow coated the volcano's slopes, the debris on the southeastern slope would have blended with older flows and it would have been difficult to identify new activity. If the image had been taken later in the year, when snow covers the entire peninsula, the ash plume would be difficult to see against a white background.

The snow also provides a clue that the other four volcanoes shown in the image have been quiet since it fell: the snow around them is pristine. KVERT reported lava flows at *Bezymianny*, but the other volcanoes had no activity in mid-October. The feature that resembles a plume east of the peaks is probably a cloud.

