METEOSAT
SECOND GENERATION
A Satellite for Europe

Lawrence Harris

Europe may not have been first into space but when we orbited the geostationary Meteosat satellite we took our own giant leap.

Ariane 513 Vol 155 - ATLANTIC BIRD™ 1 - MSG 1 - 28 août 2002

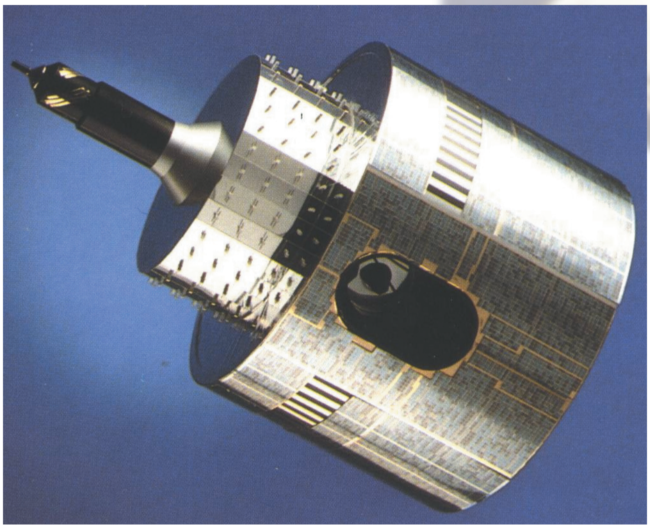
It all started with...

The first experimental weather satellite – TIROS-1 - had been launched by the USA into low earth orbit on 1 April 1960. At some 700km above the Earth in an approximately polar orbit, it spun at 12 revolutions per minute and produced images composed of lines at 500 pixels/line. For the first time meteorologists could actually see the distribution of weather systems over the surface of the Earth and no longer had to rely on inferences from widely scattered conventional observations.

America also pioneered the first geostationary weather satellite when NASA launched the experimental ATS-I satellite on 7 December 1966. This was a combined communication / meteorological satellite - the first of a series. It carried two meteorological experiments that provided half-hourly, full earth-disc images at a resolution of 3.2km, and also transmitted weather facsimile (WEFAX) data. During its twelve year life span, ATS-I provided useful data for several years.

The story of METEOSAT really began during the 1970s when the European Space Agency (ESA) procured METEOSAT-1. This was finally launched at 0135UTC on 23 November 1977. I remember the day of the announcement because upon returning from duty on night-shift satellite operations as part of my involvement within the UK space science programme, I was intrigued to hear about it on television, just before crawling into bed. METEOSAT-1 continued operations for two years before a radiometer fault terminated the imaging service. METEOSAT-2 was identical to its predecessor and was also procured, launched on 19 June 1981, and operated by ESA. By the mid-1980s I had assembled my own Meteosat reception system at home and was able to receive, record and display Meteosat-2 images. I am almost certain that I still have some of these stored on audio cassette tape – waiting for a rainy day and oodles of time for them to be replayed….. METEOSAT-3 followed, launched on 15 June 1988.

Fig 1: Meteosat – image © EUMETSAT 2004



METEOSAT-4 was the first in a series of improved versions of METEOSATs that included enhanced on-board battery storage, full redundancy of imager channels, higher data rate to the ground station, and the ability to operate the new Meteorological Data Distribution service. METEOSAT-4 was launched on 6 March 1989, becoming EUMETSAT's first operational satellite following the transfer of operations from ESA. After a few months of operations, a problem arose - erroneous grey levels (called "fish") - which at times rendered image rectification impossible. The problem was found to lay with the synchronisation and imaging chain (SIC) electronics; these controlled image taking and processing. Image processing software was produced to detect and correct grey levels, if fewer than about 2000 fish were present in a full disc image. It was therefore possible to operate Meteosat-4 successfully until Meteosat-5 took over in 1994.

METEOSAT-5 was launched on 2 March 1991. As with the previous satellite, Meteosat-5 was also found to suffer from imaging problems, but this time caused by a rotating lens in the cold part of the optical assembly. Vibrations during launch had probably loosened a crimp holding the lens in place in the optics barrel, allowing it to slowly rotate during the radiometer's periodic stepping and retrace motions. As a result, the path of radiation reaching the detector varied by a small amount, but enough to affect the grey levels, producing bands across visible images. It proved possible to produce detection software to compensate for the effect, so the satellite still remains usable and is currently located above longitude 63° east for the Indian Ocean Experiment (INDOEX).

METEOSAT-6 was launched on 20 November 1993. As with the previous satellite, Meteosat-6 showed a malfunction of the radiometer, though not due to a rotating lens. It was found that infrared and water vapour imagery suffered brightness variations within or between images, on a timescale of anything from minutes to hours. Sophisticated software was developed during 1994-5 which corrected for the problem, and it was able to take on the role of stand-by satellite in late 1995, some two years after launch. In June 1998 it was employed to support the Mesoscale Alpine Programme (MAP) special observing period. During 2000 it started the Rapid Scanning Service trials, becoming operational the following year. These scans continue today and the images are also available on EUMETCast – see later.

METEOSAT-7 was launched on 2 September 1997 as the last satellite of the Meteosat Transition Programme (the transition from the original Meteosat Operational Programme to the Meteosat Second Generation that was scheduled for launch in later years). The satellite became operational at 0° as soon as post-launch commissioning was completed.

WEFAX and Primary Data – decades of reliability...

Image data from the Meteosat series has been disseminated using internationally standardised frequency transmissions reserved for the geostationary weather satellites. The main modes accessed by the huge number of amateurs, in addition to many professionals, were the WEFAX (weather facsimile) on 1691MHz, and PDUS (Primary Data User Station) frequencies on 1694.5MHz. WEFAX was designed as an image transmission system for use by low-cost user stations. That objective was achieved. WEFAX user stations have been installed in most countries around the world – WEFAX being available directly from several other geostationary satellites. The system is used by professional meteorologists in smaller establishments, as well as by universities, schools, and private individuals. It requires a small dish or multi-element yagi, together with a good quality pre-amplifier and a WEFAX receiver. Primary Data was mostly used by professionals until MSG-1 became available. It requires an antenna at least 1.8m diameter, together with a specialist PDUS receiver and high quality pre-amplifier. Very few amateurs set up PDUS systems, though I eventually joined their ranks in the days before encryption.

So why Meteosat Second Generation?...

Given that the Meteosat series of satellites was highly successful for so many years (despite the inevitable hiccups), some might ask why a new design was needed? Anyone thinking along those lines might also consider why – given that 405 lines black-and-white television was so successful, why go to 625; and equivalently, why ever move on if your current product is successful? The answer of course is that throughout the history of technology, we have seen that new ideas are developed by technologists and engineers as quickly as new electronic products become available. Engineers then develop ways of making things work better, or more efficiently, or do more in the same time. Continuing to use older technology for a moderate period is reasonable – especially when thousands of users all over the hemisphere have invested in equipment to take advantage of the facility – but one must not lose sight of the reason for which the facility exists in the first place. The primary objective of Meteosat is to support operational weather forecasting. This is increasingly requiring more data and a greater spectrum of data with which to feed the ever more complex computer models that emulate earth's atmosphere. These models try to predict – as accurately as possible – how the weather will behave during the next few hours, few days, and even few weeks.

Meteosat Second Generation (or Meteosat-8 as we now know it) was designed to do far more than aid weather forecasters in their efforts to predict weather more accurately and for longer periods in the future. The satellite was jointly developed with the European Space Agency (ESA) and manufactured by a consortium led by ALCATEL. The newly designed satellites (the MSG series) are spin-stabilised and perform full-disc scans of the Earth, like their predecessors. However, MSG has far more sophisticated equipment than its predecessor, including the new SEVERI unit that produces MSG's 12 spectral channels with their repeat cycle of only 15 minutes (instead of 30 minutes as before). MSG therefore provides 20 times the information of the previous Meteosat systems. Each of the 12 channels offers a different perspective of the Earth, and different combinations of channels can be used for novel meteorological products.

Fig 2: MSG-1 prior to launch - – image © EUMETSAT 2002
Fig 3: Launch of MSG-1 – image © EUMETSAT 2002

On 28 August 2002, MSG-1 was launched. To the relief of all concerned, launch was successful and injection into transfer orbit was performed by Arianespace. The European Space Operations Centre (ESOC) controlled MSG-1, and through several motor firings, placed it into geosynchronous orbit where they controlled it until handover to EUMETSAT in late September. Commissioning then began.

Commissioning Tasks...

Several jobs had to be completed after launch and before normal operations could be started; they included the following:

1: determine the functionality and performance of the MSG System, including the satellite, after launch;
2: to verify the MSG-1 satellite and system requirements;
3: to determine the calibration factors and operating parameters;
4: to tune algorithms for image and meteorological product processing;
5: to validate the end user requirements;
6: to prepare the system for routine operations.

On 25 September, the satellite was officially handed over by ESOC to EUMETSAT, and commissioning started the same day. The platform's data handling and radio frequency functional and performance tests were successfully verified. Commissioning was divided into two phases - Phase A and Phase B. Phase A focused on testing the satellite in-orbit, and a first version of the ground segment that relied on a temporary solution for image processing. Considerable progress was made during Phase A, despite occasional difficult circumstances. The Geostationary Earth Radiation Budget (GERB) experiment, Interim Image Processing System (IIPS) Imaging, and Image, Calibration & Product Dry-runs were tested. These were completed – and then in the silence of space - there was a failure on 17 October. Testing and commissioning came to a standstill as gradually, the significance of the failure was realised.

A Solid State Power Amplifier (SSPA-C) – an essential part of the data downlink - had failed. Although operational conditions of the satellite were nominal, it still led to an automatic payload switch-off. All attempts to restart the SSPA failed so commissioning was suspended while an enquiry board started investigations. A new satellite configuration was set up to allow the future transmission of images to the ground station whilst minimising the risk of another SSPA failure. SEVERI – the Spinning Enhanced Visible and Infra-red Imager – is the instrument that produces the set of 12 spectral images every 15 minutes. Commissioning activities resumed on 26 November 2002 using the revised data transmission configuration. After a progressive, very careful activation of SEVIRI on 27 November 2002, the first image was taken on 28 November and disseminated live in EUMETSAT's foyer. It was well centred, showing the quality of the flight dynamics predictions and the accuracy of the default SEVIRI parameters.

Based on their knowledge of the nature of the failure, it was clear that the HRIT (High Rate Information Transfer) and LRIT (Low Rate Information Transfer) mission of MSG-1 could not be activated. Let us look at these new formats.

HRIT and LRIT – image data for a new generation...

The new digital formats High Rate Information Transmission and Low Rate Information Transmission were approved at a Coordination Group for Meteorological Satellites (CGMS) meeting. HRIT requires significantly more expensive technology - larger dishes and higher frequencies - to accommodate the large increase in data transmission flow. LRIT would effectively become the amateur's only entry into Meteosat Second Generation image reception –

but there were still new requirements: much larger dishes and considerably more expensive electronics. By the time of launch of MSG-1 it was difficult to identify a vendor that could provide a viable reception system, though several appeared to be doing some level of development work. The decision to not disseminate HRIT or LRIT from MSG-1 was inevitable, given the new circumstances – but what alternative was there?

EUMETCast...

In fact, EUMETSAT already had a basic meteorological data distribution service called EUMETCast, in which a commercial telecommunications satellite was used to broadcast data to a group of specialist users via standard Digital Video Broadcasting (DVB) technology. This digital television transponder system had been set up in November 2002 using the HotBird satellite to provide a data retransmission service called EARS (EUMETSAT ATOVS Retransmission Service) – where ATOVS is the Advanced Tiros Operational Vertical Sounder data. With an eye to the future, the decision was taken to expand EUMETCast to include selected data from MSG-1.

Fig 4: An overview of EUMETCast – image © EUMETSAT 2004

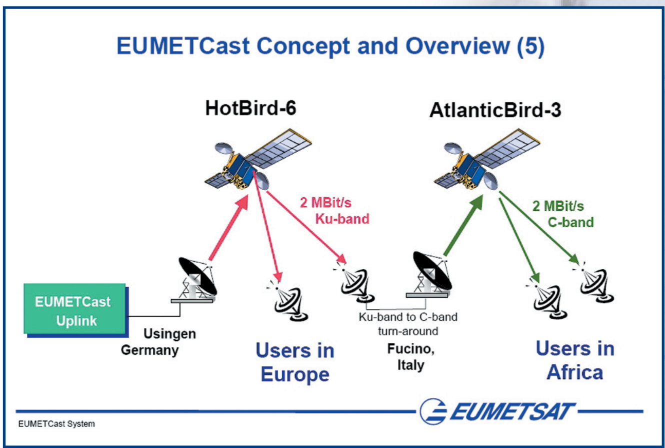


Figure 4 – a graphic provided by EUMETSAT – illustrates the wide area of coverage available to users across Europe and Africa from HotBird-6 and AtlanticBird-3. The Ku band (satellite television) transmissions at 2Mbits/s originate as the EUMETCast uplink and are received across Europe. In Italy, the Fucino station takes this same transmission and converts it to C-band that is transmitted to AtlanticBird-3. This then transmits in C-band to African users.

Reception of the EUMETCast service on HotBird-6 requires little more than setting up a standard satellite television system using a relatively small dish, low noise block, receiver and computer. The computer forms the analytical tool that takes the specific digital stream available from the satellite – when correctly set up – and, using suitable software, decodes it. Permission is required to decode the data, and it is encrypted for security. Decryption requires an individual password and a physical dongle that slots into a USB port on the decoding computer. From EUMETSAT's point of view, EUMETCast is a fully secure, mass data transmission system that is able to permit or prevent access to any type of transmitted data on an individual basis.

The announcement that MSG-1 imagery was going to be routed through EUMETCast sent shock waves through the amateur community – shock waves mostly of delight! Suddenly the future had changed from being close to an expensive impossibility into an economical means of obtaining professional quality data at near-nominal cost. Not only was LRIT going to be included in the EUMETCast data flow, but also HRIT – previously unavailable to amateurs due to the near impossibility of obtaining planning permission to install the giant dish required for good reception – even if you could actually buy the receiver!

A trial period commenced in April 2003 during which the EUMETCast data stream was progressively enhanced with new additions – and a hundred or so amateurs and others set up off-the-shelf satellite television systems and applied for permission to decode the data. The need for decoding software became a necessity; some of those already involved in the satellite data decoding business, whether amateur or professional, examined the requirements and produced various levels of software. The most common problem experienced by amateurs was probably that of the initial setting up of the installation software and the files that held data, such as the password and the codes required to identify the image files. To help solve these problems, various user groups were set up, and the EUMETSAT Operations staff provided a help facility – ever ready to give advice.

EUMETCast – hardware requirements...

From the results carefully logged by a hundred or more amateurs, and from EUMETSAT's official notices, as published in their documentation, the following hardware requirements can be referred to:

Reception computer – two are officially recommended: one for reception and one for decoding. Many users are successfully using higher specification PC computers to combine the tasks on a dedicated machine.
A DVB-PCI card or separate USB receiver.
Satellite offset antenna with a digital V/H LNB.
EUMETCast client software.
EUMETCast Key Unit.
Processing – display software.

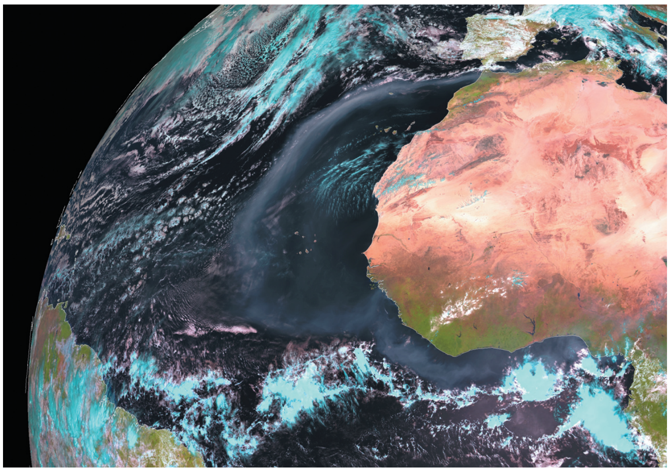
During the last two years, EUMETCast has been received by increasing numbers of amateurs. The relative simplicity of the necessary receiving equipment, combined with EUMETSAT's ease of reconfiguring EUMETCast for a wider role in disseminating meteorological data to a European-wide audience was ensuring its future. The data is fully controllable through the use of a small dongle (officially known as the EUMETCast Key Unit (EKU) and the EUMETCast client software. This persuaded EUMETSAT that the system should be expanded. HRIT and LRIT data was added to the stream, and during the following several months, EUMETSAT advised trial users that new data was to be added in due course. Under the label of Foreign Satellite Data came the three GOES satellites (GOES-east, GOES-west and GOES-9). Meteosat-5 and even Meteosat-7 were added, the latter effectively making redundant many PDUS receivers! To keep up with the data flow, formal permission had to be obtained to decode some of the Meteosat-7 data. Meteosat-6 rapid scan service images were also included in the flow. In December 2003 EUMETCast was declared "baseline dissemination for Meteosat-8 and future Meteosat satellites", implying that the new system would be operating for several years. EUMETCast was also transmitted in C-band from the Atlantic Bird-3 satellite located at 5° west longitude. C-band reception requires a 1.8 – 2.4m antenna, plus suitable electronics and receiver.

By the end of the EUMETCast trial, the number of reception systems and registered users had increased considerably and new data had been added. Some of the new data – such as the polar ice coverage - had mostly never been seen by amateurs. The success of EUMETCast in delivering meteorological data to its target audience was recognised, with future plans being made to include data from Metop – the new, yet-to-be-launched polar satellite.

Selected images Illustrating some of the Special Features of Meteosat-8

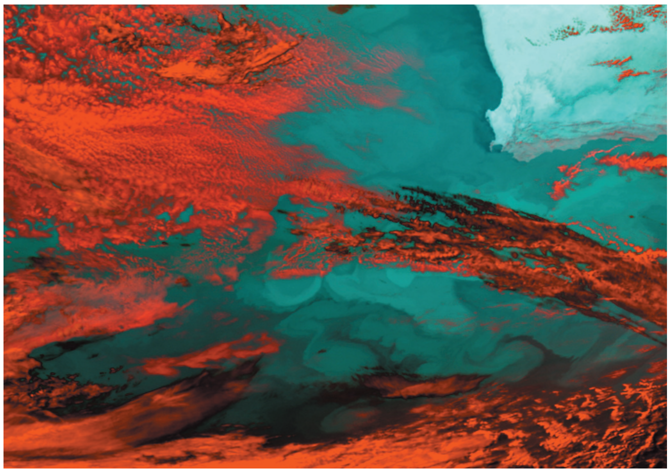
(numbers, where given, are the channels used for red, green and blue)

Fig 5: Sahara dust 6 March 2004 – image © EUMETSAT 2004



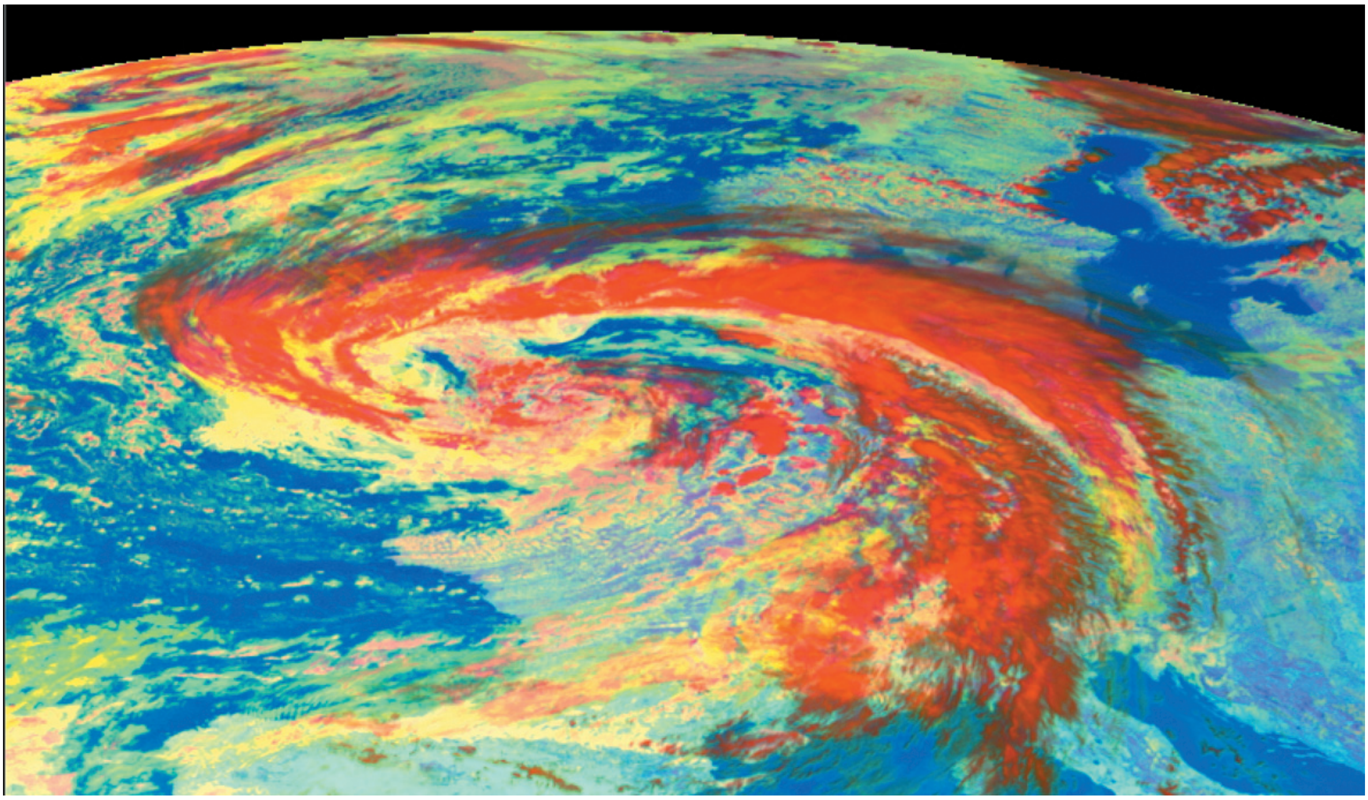
Every year strong winds blowing over the Sahara desert lift hundreds of millions of tons of dust high into the sky over North Africa. Depending on the season, the dust may be blown across the Mediterranean Sea into Europe or over the Atlantic Ocean. Although carried aloft by trade winds, the heavier particles quickly drop back to earth. Those that survive the journey across the oceans are a hundred times smaller than the diameter of the finest human hair. The dust often reaches the western hemisphere, where it fertilises bromeliads in Brazil, dirties windshields across the continents and causes brilliant red sunsets across the American southwest. The dust normally arrives in the Caribbean by mid- June, and disappears until autumn.

Fig 7: 3 May 2004 Ocean eddies in the South Atlantic © EUMETSAT 2004



The area south of Africa is of particular interest to oceanographers. Warm, less saline water from the Indian basin encounters the cooler, saltier water of the Atlantic. Rings and filaments of Indian Ocean water periodically enter the Atlantic via the Agulhas Current which flows to the southwest along the southeastern coast of southern Africa. The input of Indian Ocean water into the South Atlantic may be important to ocean circulation and dynamics within the Atlantic basin, and to the circulation of saline water in the oceans as a whole. Indian Ocean water (warm, high sea level) enters the South Atlantic in filaments and rings, south of Africa. These features migrate into the South Atlantic Ocean, where they alter the heat and salt balance of the surrounding water. The exchange of water between the Indian and Atlantic basins at their boundary south of Africa is currently being studied within a project called 'Agulhas-South Atlantic Thermohaline Transport Experiment' (ASTTEX).

Fig 6: 23 June 2004 Storm Yasna over Europe © EUMETSAT 2004



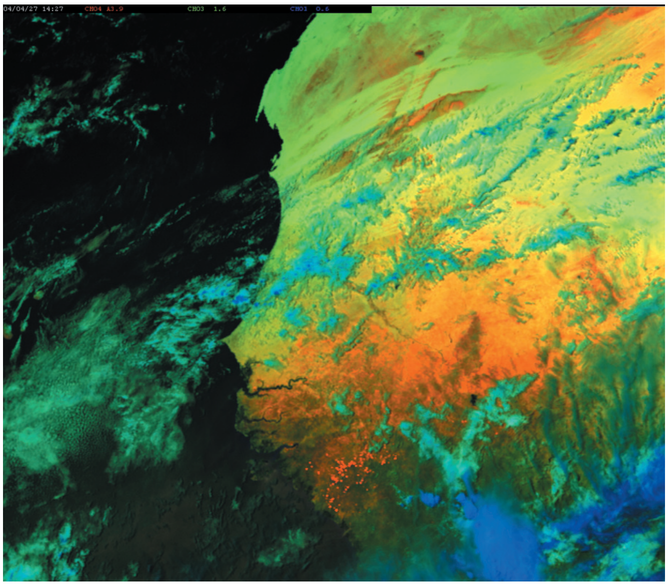


Fig 8: 27 April, 2004 Fires over Guinea, west Africa – image © EUMETSAT 2004

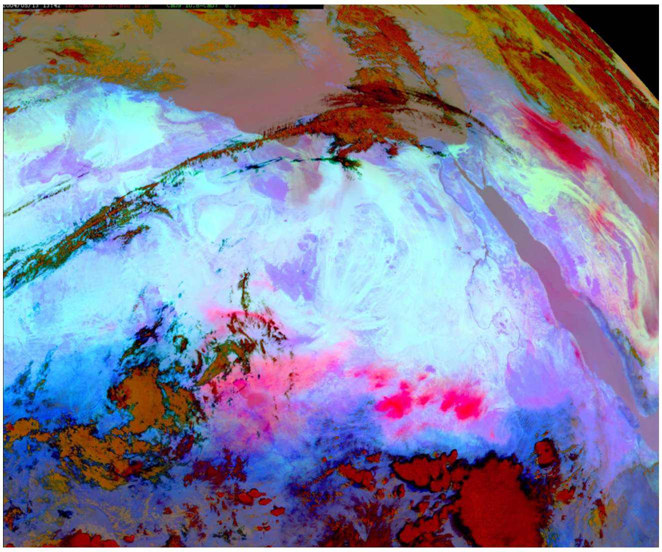


Fig 9: Large dust storms over Sudan, Libya and the Middle East © EUMETSAT 2004

On 13 May 2004, Meteosat-8 recorded five major dust storms within a satellite field of view of about 1200 x 900 pixels; one over Libya, one over Iraq, one over Saudi Arabia, one over Iran and several smaller ones over Sudan. The dust storms over Iraq and Saudi Arabia are related to strong post-frontal north-westerly winds. This situation, which typically persists for 24 - 36 hours and occurs 2 - 3 times a month, is called Shamal (from the arabic for "north"). These dust storms also severely affected the Darfur region in Sudan. Meteosat-8, with its capability to observe wildfires and dust storms in the whole area at a frequency of 15 minutes, plays an essential role in helping the United Nations to coordinate their humanitarian aid activities.

Between 4 and 14 December 2004, an anticyclonic system over central Europe, with a strong low-level temperature inversion caused widely spread fog with low-level stratus over Germany, France, UK and many other countries. Many valleys and low-altitude areas were shrouded in fog for many days, while mountain areas enjoyed sunny weather with relatively high temperatures. This weather situation lasted until 15 December 2004 when a cold front from the north-west finally led to a change of air masses over Central Europe.

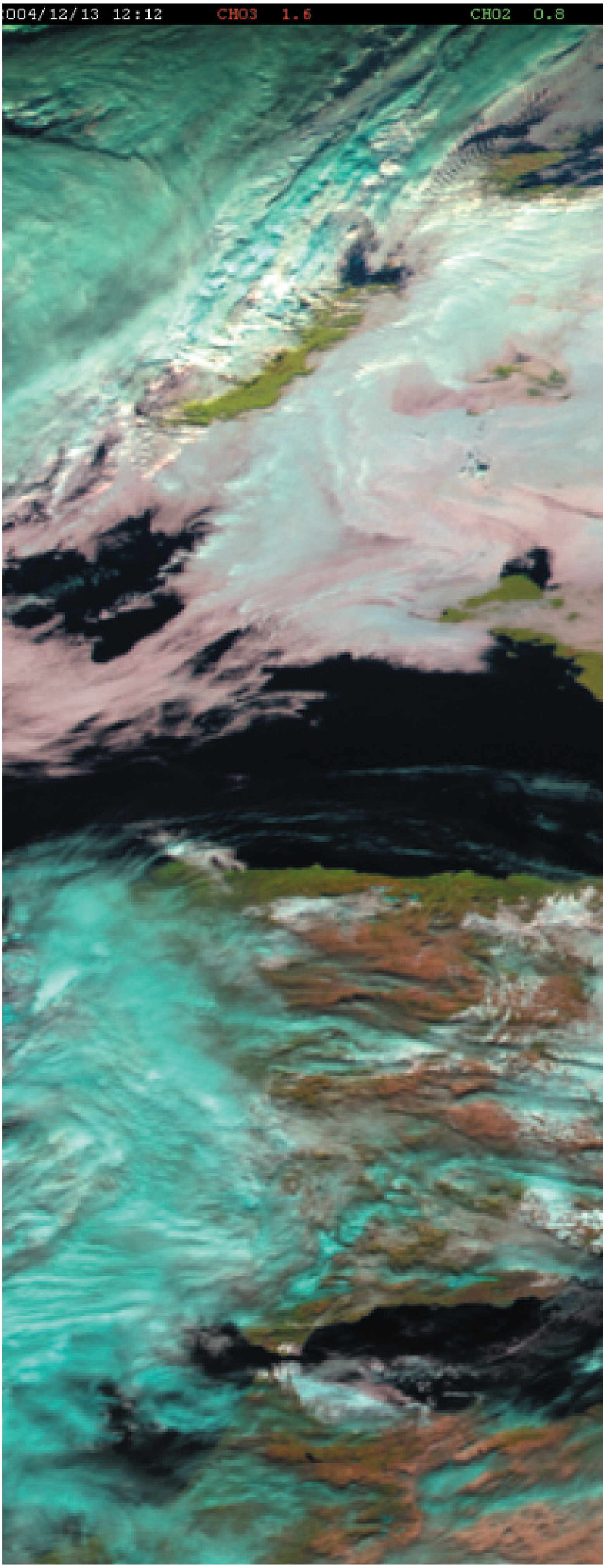
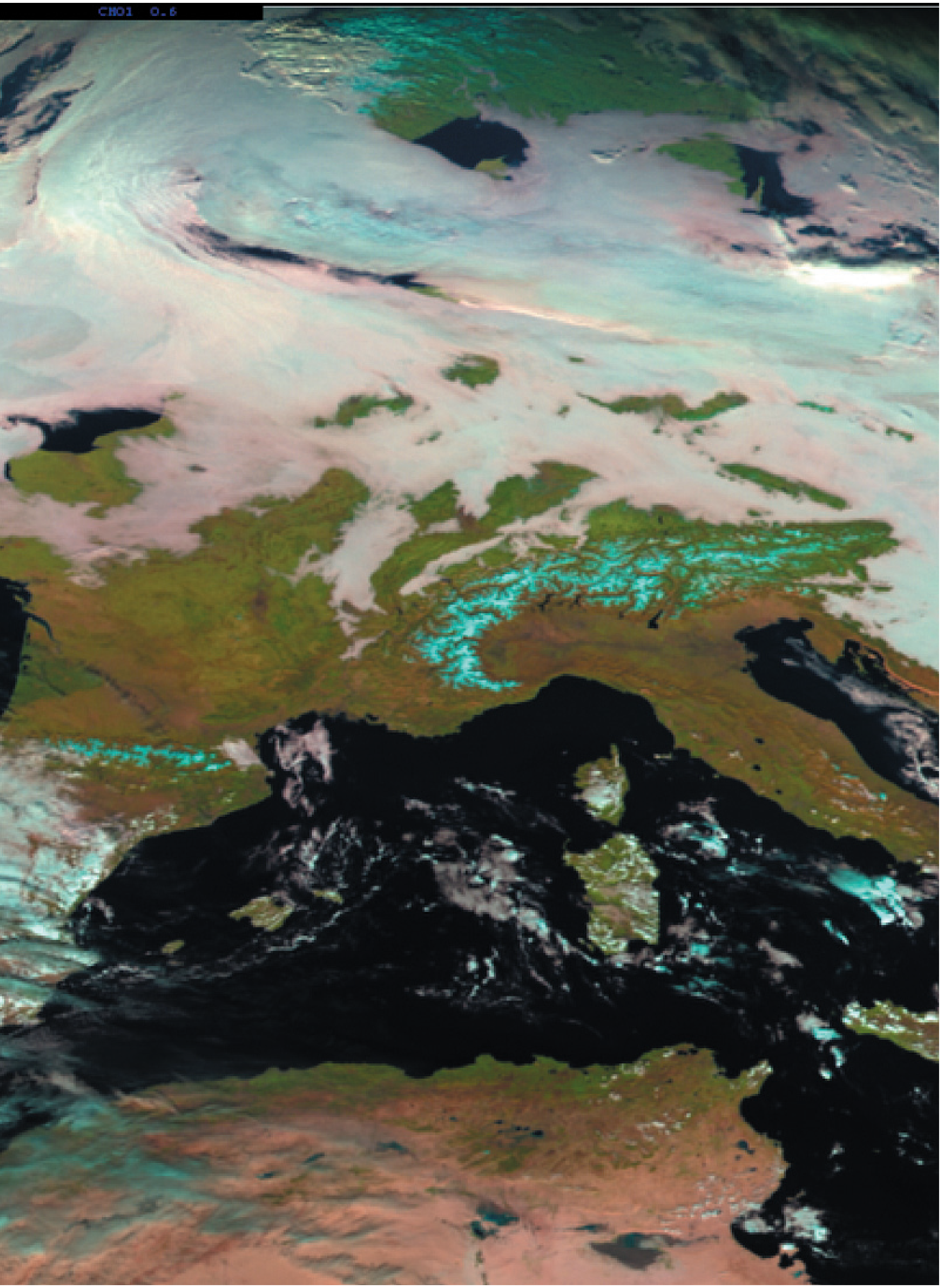
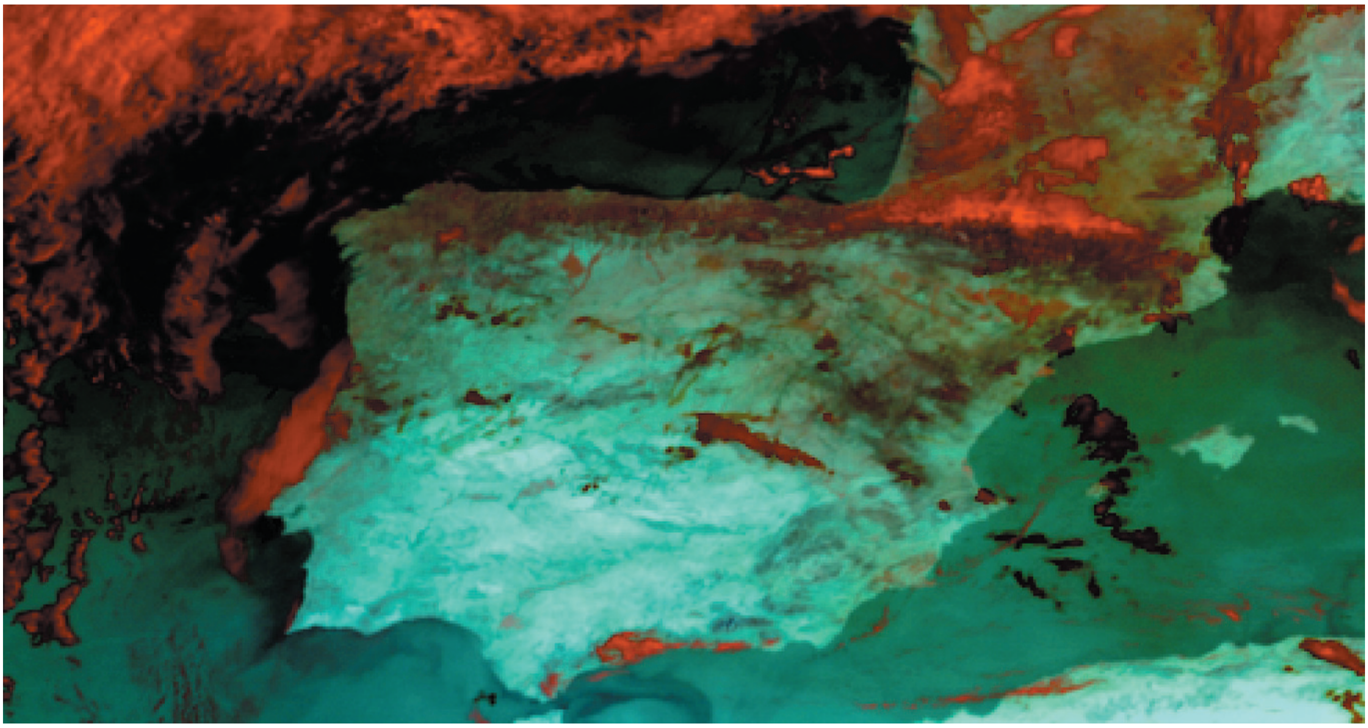
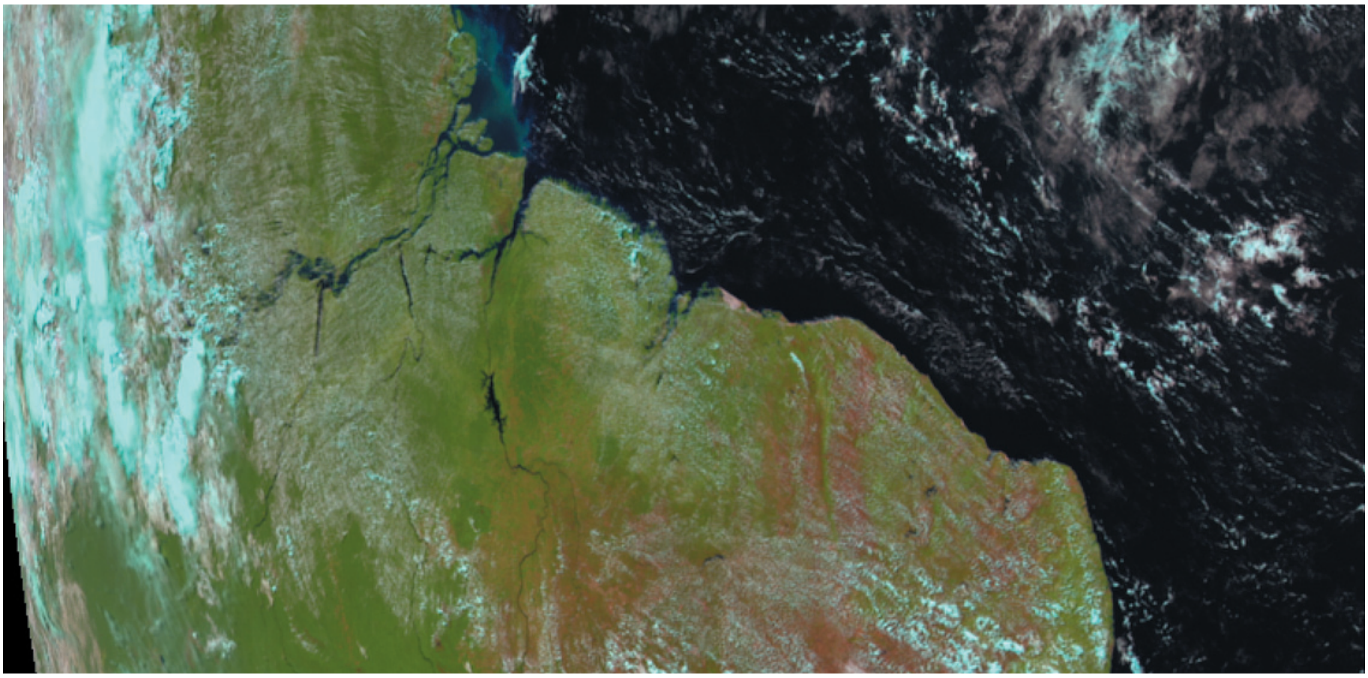


Fig 10: 13 December 2004 using rgb (03 02 01) Fog over Europe – image © EUMETSAT 2004


CH01 0.6





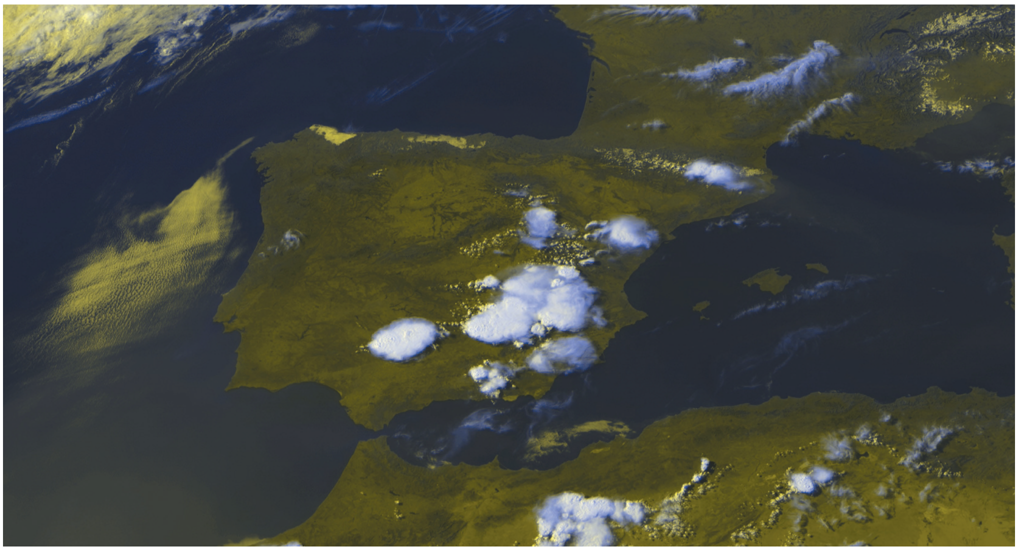


Fig 11: 30 July 2004 Ocean eddies in the western Mediterranean image © EUMETSAT 2004

Fig 12: 6 July 2004 Sedimentation in the Amazon basin image © EUMETSAT 2004

Fig 13: 29 June 2004 Severe thunderstorms over Spain and Morocco – image © EUMETSAT 2004

MSG Software

DB1 Lite from Timestep

By Dave Cawley

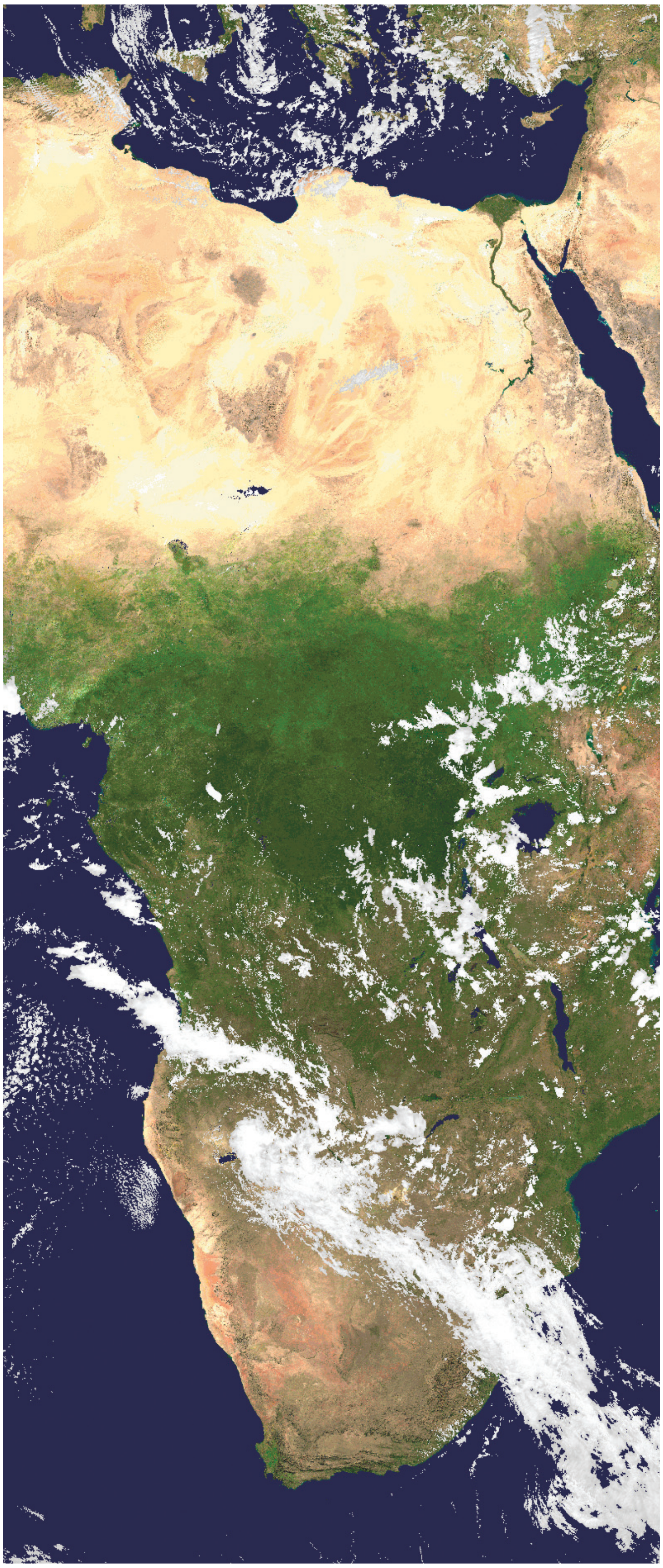


Fig 1: A re- projected 3 band colour image

Overview

This is more of an appetite-wetter than a full review of the Timestep DB1 lite software. The manual for the software comprises 105 pages and covers the multitude of functions available. What really matters is what the images look like and how easy they are to obtain. Microsoft Word has maybe over 1,000 functions, but most users use only a few, but maybe each user uses a different few.

It's the same with DB1 Lite, a lot of users simply want automatic animation from the HRV high resolution visible sensor, and to do this only requires clicking on the "Image Viewer" icon, and then on "Short Cut" button 4, nothing else, just two mouse clicks including running the program. It is that simple.

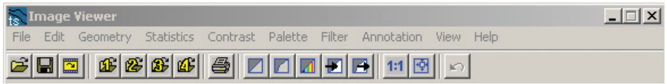


Fig 2: The simple menu bar

When Meteosat WEFAX was rumoured to be replaced by a bold new standard LRIT and HRIT, Timestep immediately started work on new software to take both image standards, hence the X for anything in XRIT. Work on a new 1691.0MHz receiver started and the prototype was shown at many shows and meetings. As we all know the final power amplifier on the satellite failed and an alternative, and in some ways, more attractive method of dissemination was found, via the commercial TV satellite, Hotbird 6.

Timestep had accumulated many professional friends in the satellite industry over many years and had exhibited throughout the World. In fact many high end professional systems installed in government departments and several dozen War Ships, actually had Timestep receivers buried deep inside racks of equipment. One of the founders of weather satellite technology, Feedback Instruments, actually used a OEM version of PROsat II, only in the Info Panel would you find the giveaway, the names of Dave Cawley and Peter Arnold. Conversely Timestep's own professional HRPT system proudly sports the ultimate Quorum receiver. The days of a dozen different people displaying Weather Satellite technology at NOAA Conferences and at the Dayton Hamfest have long gone, there is only a small handful of manufacturers left in the World, and co-operation is the name of the game.

After a recent Military co-operation with TS Technology Services Space and Defence Division, where Timestep provided the hardware and TS provided the software, a deal was struck to commission a "Lite" version of the commercial "DB1" software especially for MSG Hotbird reception and display. Whilst you may not get the level of technical support and configurability of the full £5,000 package, you would be hard pushed to notice the difference !

Getting Started

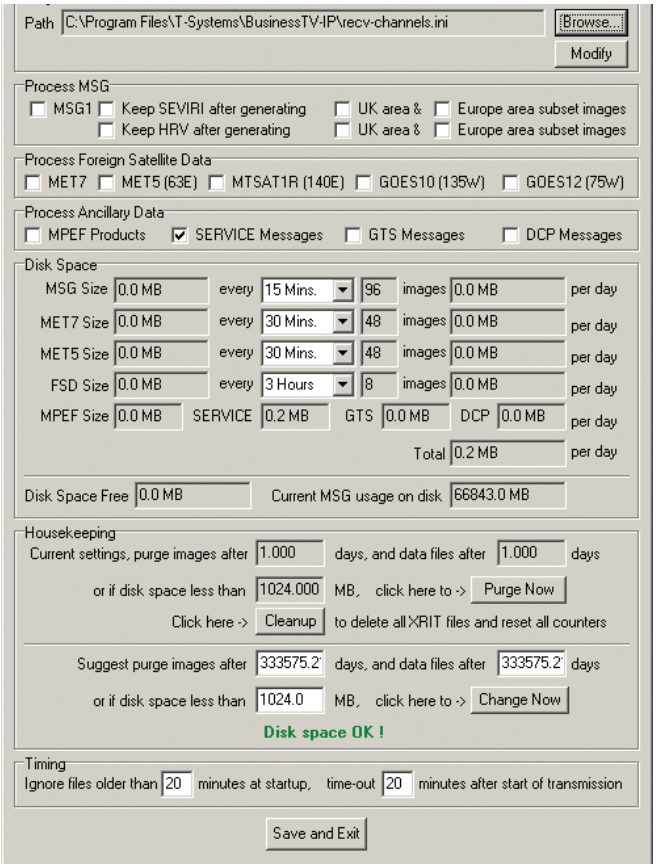
You will need the Eumetsat software, and for those worried by form filling, for a small fee Timestep can do this for you. Assuming you have that software running, the DB1 Lite installs the same as any professional Microsoft software, that is by an Install Shield that does everything for you, simply and quickly !

Then it is just a matter of waiting for some images to be received and pressing the "Short Cut" button. It is easy, if not easier than the original PROsat II software. One click to load the software, another click to animate, nothing more. If that is all you want to do, and let's be honest most of us only dream of animating near HRPT quality images automatically every 15 minutes, so two buttons it is then !

Browse through the images presented in this article, most were created with no more than three mouse clicks.

Assuming you have not installed anything, then you really need to read the manual, however here is a simple list of things to do. Remember if you took the option of purchasing the complete system from Timestep, you will only need plug the dish in, everything, including all the paperwork, will already be done for you, and you will not have to follow this procedure at all. I recommend getting a satellite TV installer to put the dish up for you, this won't cost as much as you think and will get you started very quickly.

1) Disable the firewall (Control Panel, Security Centre, scroll down to bottom of window, Windows Firewall, OFF, OK.. Then on right of window, Change the way Security Centre alerts me, untick all, OK. Scroll down to bottom of window, Automatic Updates, turn off automatic updates, apply, OK.



2) Uninstall any anti-virus software
3) Turn off power monitor, screen saver, un-hide inactive icons
4) Install the receiver drivers (turn PC off, plug in receiver, switch PC on, put in CD)
5) Install the TV view program to ensure you are receiving a good Hotbird signal (boot CD)
6) Configure for EUMETCast (add "MSG": 10853Mhz: 27,500: PID 100 300 301 500)
7) Install the EUMETCast software (D:\Windows\EUMETCast_client/t-systems-setup.exe: put in username and password)
8) Install the EUMETCast Key (run rte-3-51 from CD: plug in dongle: check Data Channels)
9) Install the TE Satellite Viewer program (run install from CD)
10) Install the TE Satellite Viewer dongle (plug in dongle: at prompt load driver from CD)
11) Start Control processing program, (only needs doing once)
12) Set up and watch the weather using the TE Weather Satellite viewer
13) Sit back and relax

Simple, yes it is, if you do it properly. The first window you will get is insert image 3 this will be ticked in all the right places, you need do nothing, but you can see the flexibility it offers for advanced usage.

The "Short Cut" buttons will allow you to open the latest full disk image, the latest Europe image, to animate visible, and animate infrared. These buttons can be defined for other uses by you at a later time should you have special requirements.

The colour overlays are from the Blue Marble imagery provided by courtesy of the NASA Earth Observation team http://earthobservatory.nasa.gov which were taken from cloud free Aqua/Terra images.

There is an additional blue/green background.

Serious forecasters will want the original black and white imagery which can be displayed with median contrast stretches on-the-fly.

Image Processing

Here the old adage of a picture being worth a thousand words was never truer. The images here give you a taste of the processing available.

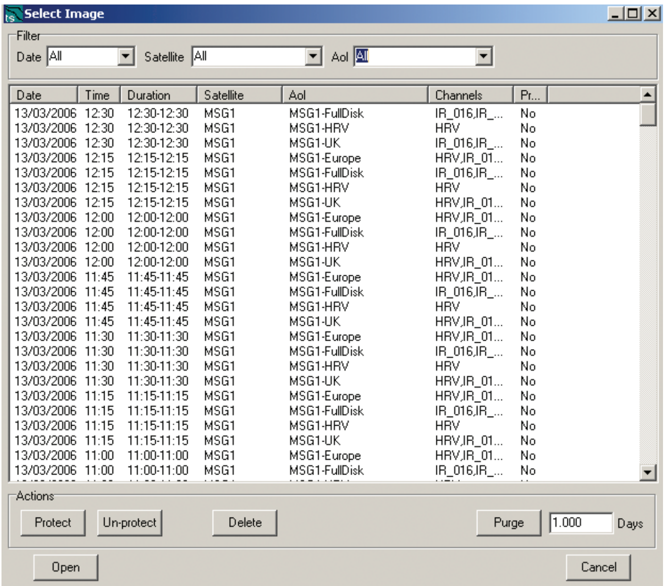


Figure 1

Opening the file list gives this screen, images are filed and identified very easily. Unwanted images may be set to purge at your defined time.

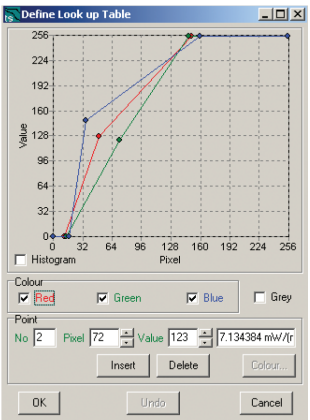


Figure 2

Here we can define the RGB look up table in an easy graphical format. Each channel can have its own user defined curve and absolute values set. In reality a lot of the functions like this can be carried out automatically.

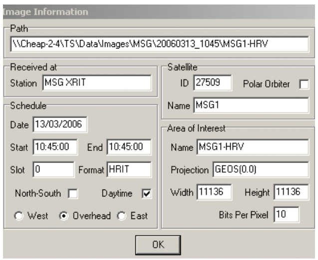


Figure 3

The Image Information can be easily identified with this option box, image size and pixel depth are easily evaluated.

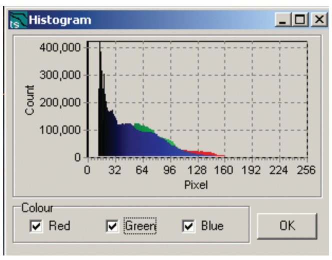


Figure 4

A histogram of the colour information can be easily viewed. This shows the frequency of pixels occurring and their values.

Figure 5

A scatter plot of any two channels can be viewed as well as individual mouse pointer pixel information. A wealth of information can be retrieved with this function, any two channels can be compared.

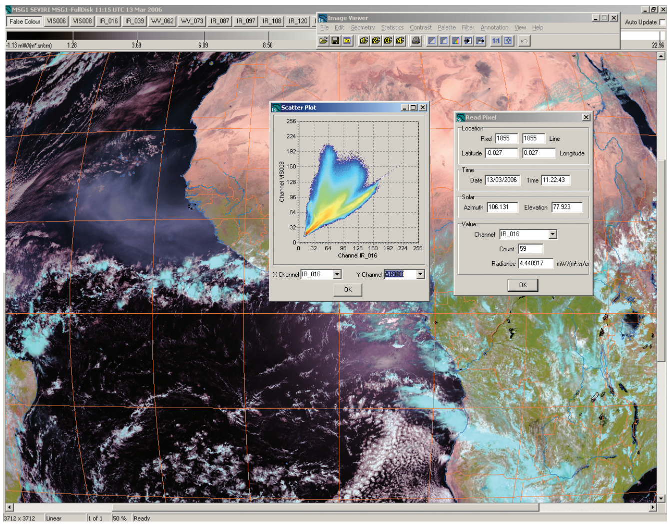
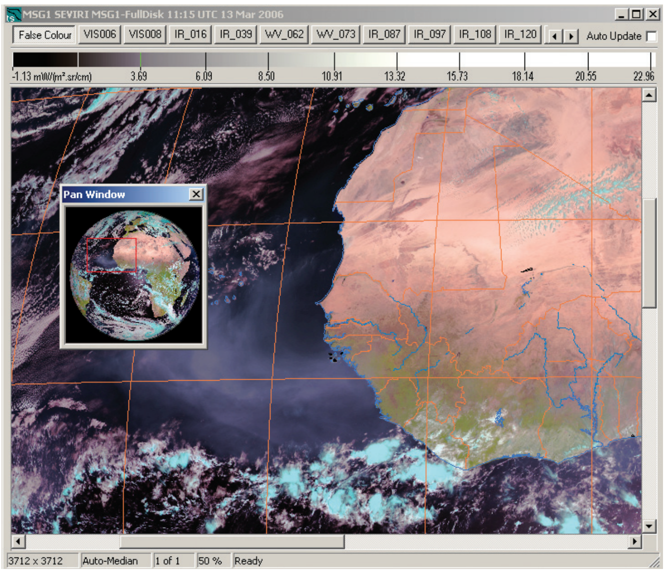
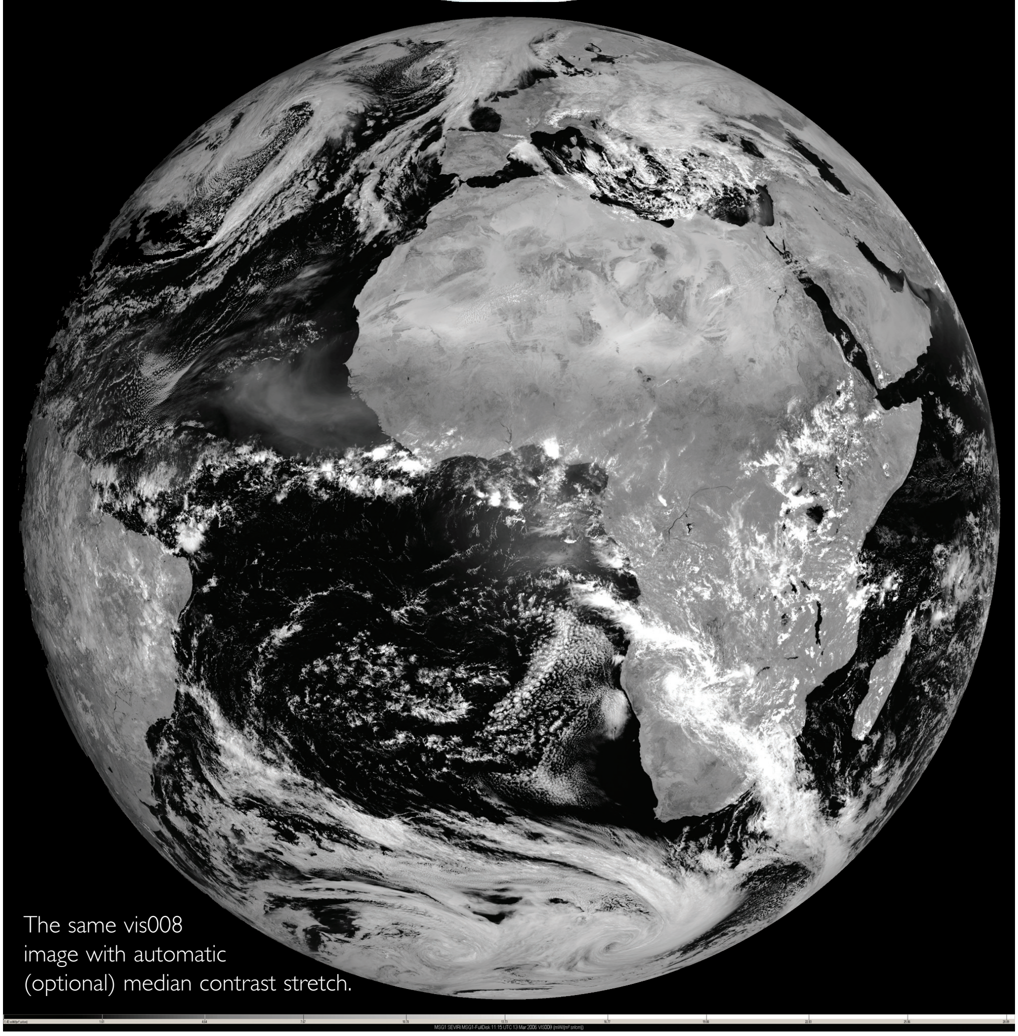


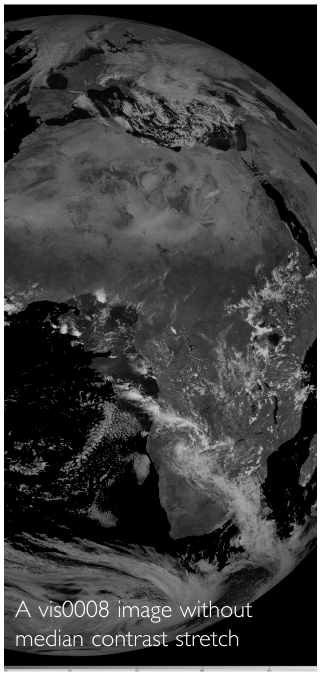
Figure 6

You can pan and zoom with any magnification, either by the scroll bars or by the zoom box as shown here. The zoom box can be selected in simple increments or in any value you like. Picking up the box on the small image will pan the large image.




The MODIS overlay


The same vis008 image with automatic (optional) median contrast stretch.


A vis0008 image without median contrast stretch

There are so many ways that MSG can be used, from detecting sandstorms in Africa to determining if it's OK to cut your lawn. These images should be an inspiration to move up from APT/WEFAX to MSG. Members are invited to send in their MSG images for publication.