A Geostationary Weather Satellite Station

Part 1

The Case for Geostationary

by Douglas Deans

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Douglas Deans

In this article and the next I will be looking at the many uses and advantages of running an amateur geostationary weather satellite station, and perhaps encourage a few more polar enthusiasts to take the plunge. My experiences are based on EUMETSAT's Meteosat range of satellites (fig.1), but many of the points will equally apply to the satellites of other countries. The data being considered is the secondary analogue wefax data. Meteosat also provides primary digital data of significantly higher quality and resolution, and although some people have a Primary Data User Station (PDUS), decryption costs, large dish requirements and equipment costs tend to put it beyond the means of the average user.

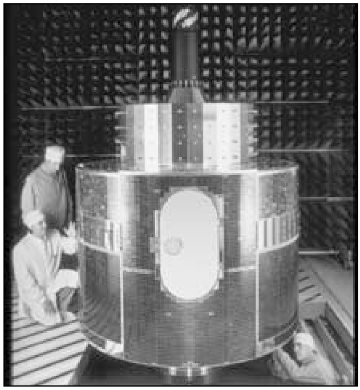


Fig.1 - Meteosat-6
Image courtesy EUMETSAT

Whilst there have always been excellent equipment and reception software available, the ability to further process the WEFAX images has been more limited. That has now changed with the release of David Taylor's GeoSatSignal suite of programs. Part 2 of this article will review this new software and the benefits and options it brings, even to those with their own stations and existing software.

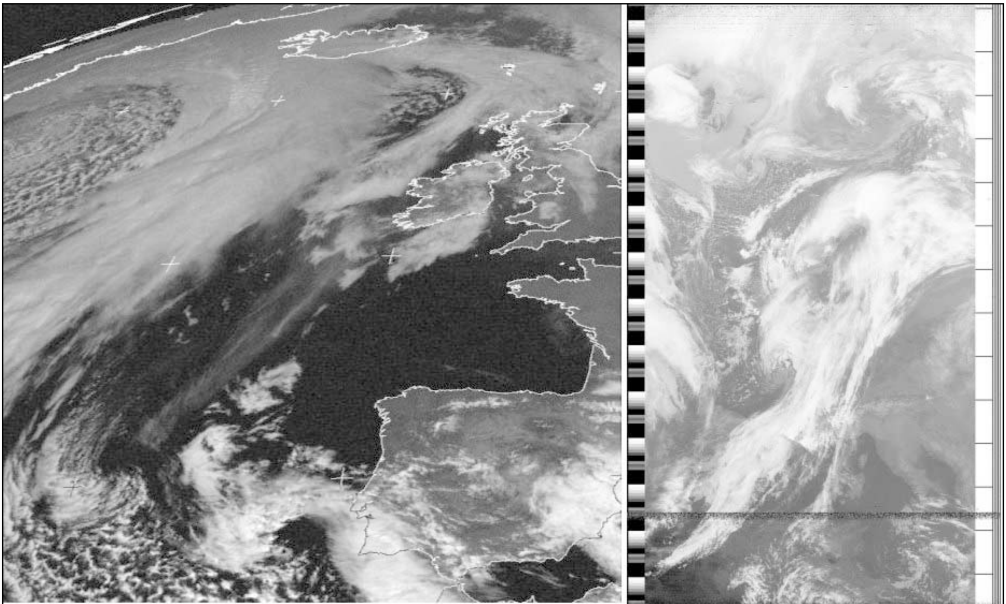
I have been receiving both geostationary and polar orbiting satellites for a long time and have always found the statistics for amateur weather satellite reception surprising. The most recent ones published by RIG for 2001 show that less than half of those receiving polar orbiting satellites have a station for geostationary WEFAX reception.

Why is this Surprising?

There are several reasons! Meteorologically there is a wealth of image data from Meteosat, with over 350 WEFAX images being disseminated each day. A number of these images are relayed from other geostationary satellites (America, Japan etc.), so there are few places in the world where it is not possible to monitor, analyse and even animate fascinating weather phenomena and conditions.

In addition, the rapidly declining options with polar APT are leaving long hours of inactivity each day for hobbyists and enthusiasts. In terms of value for money there is no contest, and that analysis will hold good irrespective of choosing the commercial or home-brew route for the station.

How many Journal articles, e-mails and frustrated telephone calls are there on the subject of APT interference? During 10 years of Meteosat reception I have never seen an image with terrestrial interference. Enjoy over two hundred images per day, each of the standard shown in fig.2(a), and none like fig.2(b).



(a) Meteosat **(b) Polar**

Fig.2 - Comparison between an interference-free Meteosat image, and a NOAA image showing the effects of terrestial interference.

A brief word regarding equipment which is well documented in other articles and advertisements. In contrast with 10 years ago there is now a much better range of equipment and software available to meet the needs of those looking for good quality and animation, but also for those wanting to enjoy reception at minimal cost. Systems more or less fall into two categories. There are those that use a dedicated receiver (approximately 1690 MHz) and those that convert the signal to 137 MHz to enable reception by a polar satellite receiver. The latter are known as downconverter systems.

The dedicated system normally comprises a dish (usually 90 cm) with horn and low noise amplifier, a Meteosat receiver, and the interface and software for the computer. The good news is that those already running a polar system such as Timestep's may well already possess both the interface and software designed to take in both polar and geostationary inputs and process the signals – a big cost saving.

The advantage of the downconverter route is obvious in that it can make use of an existing 137 MHz polar receiver, thus allowing the geostationary system to be added at minimal cost. The RIG/Timestep downconverter and active feed are examples of excellent value for money.

The choice is entirely down to your needs. If full automation and integration are important then purchase a commercial system. While you are away all day you can record and save all images of your choice, switch between geostationary and polar, select palettes and colours, choose and run animations, plus a multitude of other possibilities, all fully automated at the press of a button.

My own preference is the dedicated system. The scanning polar receiver is best left to do just that – scan. There are still enough surprises in the 137 MHz band, and these would be missed if the receiver were permanently tied up on one frequency with a downconverter signal.

What Does Meteosat Provide and What Use Can We make of its Data?

Meteosat, in common with all geostationary satellites, orbits at an altitude of approximately 35,800 kilometres, where its orbital speed exactly matches Earth's rotation. If we were to stand directly below Meteosat, and had better eyesight, it would appear to hover above us, despite the fact it is travelling at a speed in excess of 11,000 k.p.h.

From this altitude, the spacecraft views the entire disc of earth. However, because of the problem of image distortion in the higher latitudes, acceptable imagery is limited to the areas lying between 70°N and 70°S. Outwith these latitudes the angle is too oblique to provide useful imagery.

Meteosat-7 is stationed above 0° longitude, and the geographic extremities of its view are shown in fig.3. Meteosat's ability to remain stationary in relation to the Earth's surface, coupled with its view of the entire disc clearly provides geostationary satellites with unique advantages and exciting possibilities. A further requirement to satisfy true geostationary orbit is to be situated directly above the equator with an

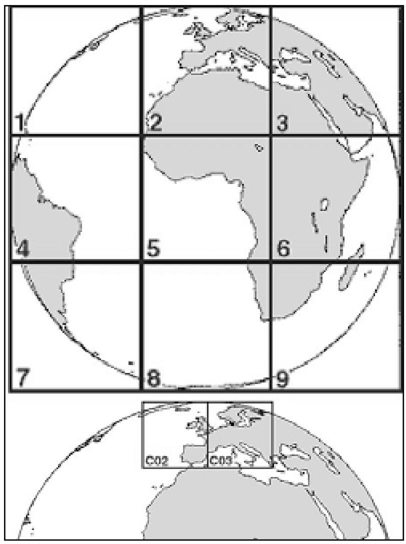


Fig.3 - Meteosat WEFAX sectors

orbital inclination of 0°. Any deviation from this inclination will give the satellite a north/south oscillation. Distance and position are important, and since the Earth, Moon and Sun are constantly 'tugging' at the craft, Meteosat carries hydrazine thrusters to adjust its position form time to time.

Meteosat scans the entire disc of the Earth in three wavelengths as it spins at 100 revolutions per minute, providing data in the visible (0.4-1.1 µm), water vapour (5.7-7.1 µm) and infra red (10.5-12.5 µm) wavelengths. Examples of these are shown in fig.4. The WEFAX images are transmitted in a sectored format, the full disc being divided into 9 sectors numbered as shown in fig.3. A dissemination schedule details the time of each transmission (including the HR digital formats).

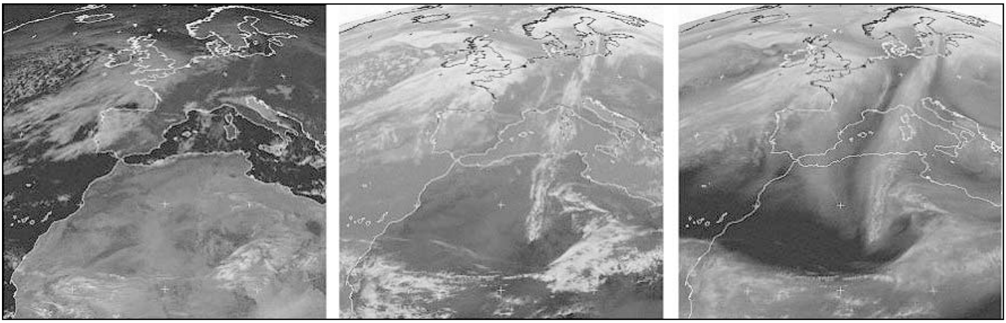


Fig.4 - Typical WEFAX images (left to right), visible, infrared and water vapour.

Three prefixes are used to identify the type of image, 'C' for visible, 'D' for infrared and 'E' for water vapour, with the numbers following the letters indicating the sector number.

During hours of acceptable illumination, higher resolution visible light close-ups (x2) of Europe (C02 and C03) are also transmitted.

What are Meteosat's Strengths and Benefits Over Polar Satellites?

The first, most obvious, and certainly most useful benefit is the ability to generate and animate a sequence of images. For example, there are 48 D2 images (fig.3) every day, and these can be combined into a superb animation extending over a number of days. Animations offer the opportunity to study and learn so much.

Examples are observing how a depression forms; viewing what happens to the upper level clouds in a warm front as they approach high pressure (a classic UK scenario); watching the results of moist south westerlies over the Pyrenees; investigating how a thunderstorm can develop from nothing, mushroom, moves and eventually dissipate; learn about world weather

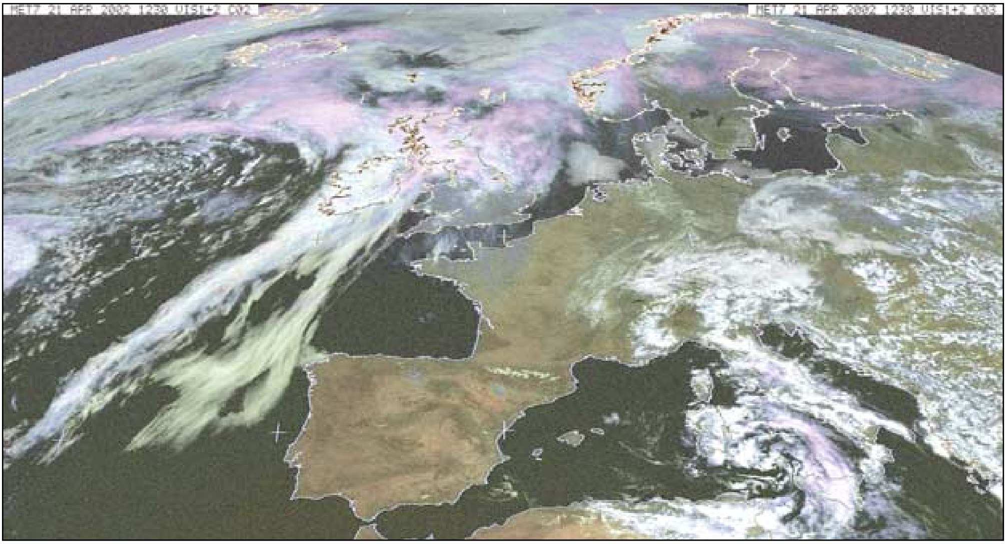
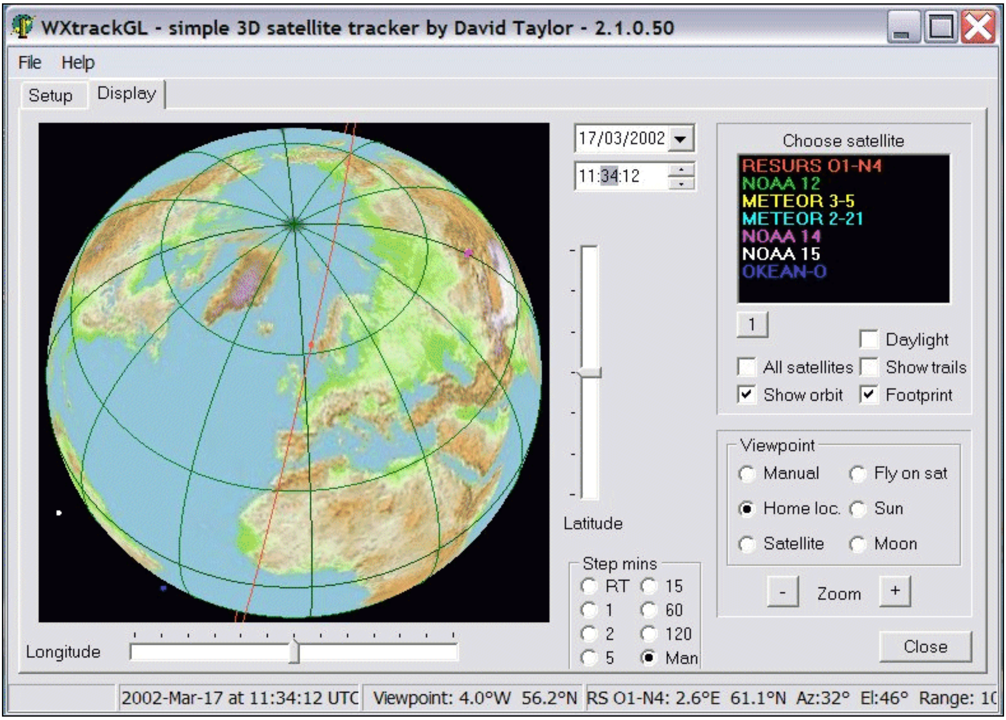


Fig.6 - Meteosat C02+C03 WEFAX brought to life by colour



David Taylor's WxsatGL program in operation (see Shareware Corner) movements and patterns by animating whole disc images. These are just a few examples, but the list is endless.

Current local imagery is important, but Meteosat provides the ability to view the bigger picture. Here in Scotland the next few days' weather is often being generated out in the Atlantic. Fig.5, a composite IR image (D1+D2+D3), shows a deepening depression in the North Atlantic, the effects of which were keenly felt about 36 hours later! Of course, animating such a composite provides even more information but more of that next time.

More to Look Out For

Meteosat provides the opportunity to view Nature's most notorious and dramatic storms generate, move, and dissipate. In particular, you can see the beginnings of tropical depressions, as thunderstorms move west over the Atlantic from the African Coast, then watch as these intensify into tropical storms and finally mature hurricanes. Can you predict these before the National Hurricane Centre does? Thanks to the relayed images, typhoons and tropical cyclones can also be studied and observed in the other Oceans of the world.

Water takes the longest to cool in the evening. Watch late afternoon thunderstorms form over Lake Victoria in East Africa demonstrating a wealth of meteorology.

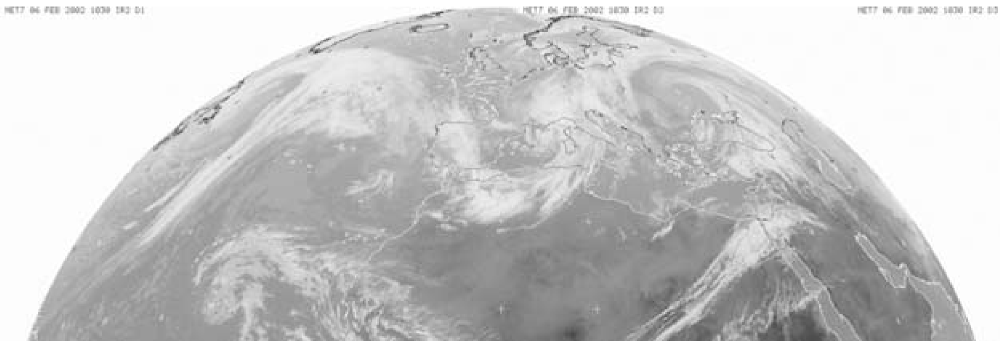


Fig.5 - A storm approaches Great Britain

This article has hopefully provided a brief insight into the many interesting and exciting images available from Meteosat and other geostationary satellites. It has not attempted in any way to explain technical aspects of the satellite. For those interested in this can I suggest some further reading.

- Satellite Project Handbook — Lawrence Harris
- Weather Satellite Handbook — Dr. Ralph E. Taggart
- The Meteosat System, parts 1,2 and 3 — Peter Wakelin/Eumetsat (RIG Journals 39,43 and 47)

In addition there are a wealth of web sites offering basic and in depth technical information. Some of the better known ones include :-

Eumetsat	:	***http://www.eumetsat.de/***
NOAA Satellites	:	***http://www.oso.noaa.gov/goes/***

For those looking for help in interpreting weather satellite imagery, there is in my opinion only one definitive book:

'Images in Weather Forecasting' by Bader, Forbes, Grant, Lilley and Waters.

This book is filled with extremely high-quality images and is of a standard suitable for meteorological students and forecasters. It is quite expensive, but is now available in paperback format. When I purchased it many years ago it was only available in hardback edition and cost £85 !

Although much can be done with the software provided with composite systems, serious image processing has relied on saved images being transferred to other image processing programmes such as Paint Shop Pro. Processing in this way can be a slow and laborious task, particularly with large quantities of daily images requiring different techniques.

All that is now a thing of the past with the release of David Taylor's GeoSatSignal software, which now offers a wide range of image manipulation and processing at the touch of a few buttons. GeoSatSignal will be discussed in part 2 of this article, along with an appraisal of what the future holds for geostationary meteorological satellites. But meantime, fig.6 provides a small taster of things to come.
