EARSeL Newsletter

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EARSeL Newsletter Editor
Keith McCloy, Department of Agroecology,
Danish Institute of Agricultural Sciences,
Post Boks 50, 8830 – Tjele, Denmark.
Tel: +45 89991824, +45 75802017
Fax: +45 89991200
Email: keith.mccloy@agrsci.dk

Editorial Assistance
EARSeL Secretariat, Gesine Boettcher,
C/o Institute of Photogrammetry and Geo-Information,
Nienburger Strasser, 1,
30167, Hannover, Germany.
Tel: +49 511 7622482
Fax: +49 511 7622483
Email: secretariat@earsel.org

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EARSeL Bureau

CHAIRMAN
Prof Rudi Goosens
Geography Department
University of Ghent, Krijgslaan 281
B-9000 Ghent, Belgium
Tel: +32 9 2644709
Fax: +32 9 2644985
Email: rudi.goossens@ugent.be

VICE-CHAIRMAN
Dr Rainer Reuter
Physics Department
Carl von Ossietzky University
D-2611 Oldenburg, Germany
Tel: +49 441 798 3522
Fax: +49 441 798 3201
Email: rainer.reuter@uni-oldenburg.de

SECRETARY-GENERAL
Dr Andre Marcal
CICGE/FCUP - University of Porto
DMA, Rua do Campo Alegre, 687
4169-007 Porto, Portugal,
Tel: +351 220100873
Fax: +351 220100809
Email: andre.marcal@fc.up.pt

TREASURER
Dr Lena Halounova
Remote Sensing Laboratory
Department of Mapping and Cartography
Faculty of Civil Engineering
Czech Technical University in Prague
Thakurova 7
166 29 Prague 6
Czech Republic
Tel: +420 22435 4952
Fax: +420 22435 5419
Email: lena.halounova@fsv.cvut.cz

OTHER COUNTRIES
Dr Mario Hernandez
Chief Remote Sensing
UNESCO/Natural Sciences Sector,
7 Place de Fontenoy
75532 Paris 07 SP
France
Tel: +33 1 45 68 14 44
Fax: +33 1 45 68 55 70
Email: ma.hernandez@unesco.org

Front Cover - It's all about beating the weather

EARSeL eProceedings 05(1), 42-50, 2006: Lars Gleitsmann and Martin Kappas
GLACIER MONITORING SURVEY FLIGHTS BELOW CLOUDS IN ALASKA, -OBLIQUE AERIAL PHOTOGRAPHY UTILISING DIGITAL MULTIPLE-IMAGE PHOTOGRAMMETRY METHODS TO COPE WITH ADVERSE WEATHER

In a subarctic high mountain environment under oceanic climate influence, weather is of paramount concern for any optical remote sensing approach.

The upper right image shows the typical weather conditions with clouds over the target, the Wolverine Glacier. Of course no photogrammetry from a position above the cloud cover can work under those common circumstances. Due to this, an aerial application of close range photogrammetry was tried, where an oblique-convergent (multiple image) approach is used, orbiting the target with a low and slow flying small aircraft under the clouds. The survey camera used here, handheld - out of the open cockpit window - is the well known and tried analogue Rollei 6008metric, a good choice for both cold weather flying and yielding high resolution with 7µm scan. The method works for targets of limited sizes, but cannot be applied for large acreage mapping or the like.

The lower left image shows a small section of a measurement image with red dots from the measurements (adjusted for print/ scale & visibility). The upper right shows the typical photogrammetric problem of the featureless snow and the possible measurements on the upper glacier. The lower right image finally shows a rawish DEM product of this glacier made from the aerial oblique images.

The full paper can be found under the following link:
http://las.physik.uni-oldenburg.de/eProceedings/vol05_1/05_1_gleitsmann1.html

1 EDITORIAL

On October 4th, 1957, Russia launched Sputnik 1, the first manmade satellite, into space from the Baikonur Cosmodrome in Kazakhstan. Coming at the height of the Cold War, the launching of Sputnik caught the West by surprise, and led to a wave of self-recriminations in the US, the beginning of the space race, and a movement to reform science education in the USA. Sputnik 1 (meaning fellow traveler or satellite in Russian) weighed 83 kg and carried two radio transmitters that operated for three weeks until their chemical batteries failed. Sputnik incinerated on re-entry into the earth's atmosphere on 3 January 1958.

Next year there will be extensive celebrations for the subsequent fifty years that man has been exploring and using space. Much of this exploration is related to the phenomenal changes that have occurred in our understanding of the cosmos in the last fifty years, with the latest developments in one aspect of this knowledge being reflected in the current information coming from space explorers such as the ESA Venus Express. Our understanding of the universe is still expanding at a phenomenal rate, very much because of the way that we have and are collecting data on the universe from space.

Other applications of space have come in the form of revolutionarily improved telecommunications around the globe, GPS, weather predictions and monitoring of the ozone hole to name but some of the more obvious benefits of space exploration and use to mankind. And these developments have had some spectacular spinoffs. We all know about Teflon, but the most spectacular must be the blossoming of the web. It is possible that the web could have come to fruition without satellite communications, but for those of us who remember telephone communications before satellite communications, this suggestion must create an air of scepticism.

We in EARSeL are vitally interested in most of these applications, either professionally or personally. However professionally we are also interested in the development of earth observation, clearly an area of professional activity that could only come into being with the availability of space image data. Some aspects of earth observation have become established as operational systems, whilst many still remain in the research and development arena. Of those that are operational, probably the most important is the impact that satellite image data has had on weather predictions. One can easily talk about pre and post satellite weather predictions as being like chalk and cheese. I can still remember the farmers in Australia using the barometer to decide whether they would sow or harvest the next day or not, the daily papers carried long term predictions of weather trends by the weather medicine men that existed at that time and the daily weather predictions on the radio were for the next day. We have progressed a long way from that situation, as Eberhard describes in his paper in this Newsletter.

To me the technical developments that have occurred since the advent of remote sensing are just as spectacular. We in EARSeL are also celebrating this fifty years in space, through articles in this newsletter that celebrate the successes that have come from this exploration, articles on the technological developments that have occurred and articles relating to the way forward with new applications. Towards this end, in this edition of the Newsletter you will find an article by Eberhard Parlow on how weather prediction has changed over the last fifty years. Neither Eberhard nor I are suggesting that all of these dramatic changes are due to remote sensing because they are clearly not, but the use of remotely sensed imagery, in conjunction with ground data and modelling work in computers, has formed the background to the revolution that we have seen in weather prediction over the last fifty years. And this revolution could only have taken place with space exploration in its different forms.

Nor have we come to the end of the revolution in developments that are occurring in our technological area. In saying this I am aware of the changes that Google Earth is bringing to the whole concept of viewing the earth. Before satellites, one could only envisage the earth as a whole in one's mind eye. Since then images of the earth have made the concept of Gaia reasonable to the science community and in an abstract way to the community at large. Google Earth is revolutionising this attitude, such that I believe that the boundary that we see in weather prediction (pre and post weather satellites) will come to pass in that the level of acceptance of satellite images will be quite different pre and post Google Earth. Pre Google remote sensing was kept in the domain of a specialist elite with their "big" pockets, sophisticated software and hardware. Post Google earth will see this group drowned in the interest and use of the data by the general community; school children, university students, and the general public in their weather maps, in their GPS controlled car navigation systems, in the maps that they access through the internet and that they view in their atlases, in the integration of images into the information they peruse in deciding on a holiday destination or the purchase of a business site or farm. These images will stop being an exotic extra and become an essential element in the suite of information that is used in making many different types of decisions.

I think that we are seeing the start of a truly geo-educated population, not just a geo-educated elite. And of course this is going to have huge implications for us as scientists and implementers in this technical area. So the future should hold more interest in the use of the data in ways that we have not even thought about, more funding opportunities, more data supply alternatives and also more competition. So, if you thought the first fifty years have been exciting, then just wait for the second fifty years.

Keith McCloy

2 NEWS FROM MEMBERS AND SPECIAL INTEREST GROUPS

2.1 NEW MEMBERS

GEMME - Georesources & Geo-Imaging Laboratory
Université de Liège
Sart Tilman - B52
4000 Liège, Belgium
EARSeL representatives: Prof. Eric Pirard, Dr. Fernando Caceres

I hope to receive an article on the activities within the GEMME laboratory for the next newsletter and I would like to welcome the members of GEMME into EARSeL.

LABORATOIRE de PLANETOLOGIE et GEODYNAMIQUE de NANTES (LPGN)

http://www.sciences.univ-nantes.fr/geol/UMR6112/

Studying Earth-like planets to better understand the Earth's dynamics

The research performed at LPGN aims at understanding the dynamics and evolution of the Earth and Earth-like planets. The LPGN is involved in most ESA (European Space Agency) missions devoted to the study of the solar system including Cassini-Huygens, MarsExpress and VenusExpress. Most of the researchers have a strong background in Earth Science and apply their skills to the study of other planets. Their research is funded by national research programs and they organize and participate to field trips and cruises in order to get the data necessary to understand the Earth's dynamics. The four main research themes are:

- Dynamics of continental surface
- Formation and evolution of oceanic lithosphere
- Internal dynamics of Earth-like planets
- Icy satellites

The scientific objectives have lead us to develop several capabilities including numerical modelling on massively parallel computers, high-pressure and low-temperature laboratory experiments, visible and near-infrared mapping using imaging spectrometry at different scales (laboratory, airborne, spaceborne), seismic network and development in space geophysics.

3 NEWS ITEMS

3.1 Meteorological satellites - A brief historical review

Many people have worked out a history of meteorological satellites in the past. This will be another attempt to compile in brief the fast developing and wide field of satellite remote sensing techniques in the field of meteorology. Doing that now for this issue of the EARSeL Newsletters is related to the 20th anniversary of EUMETSAT in 2006 and next year's celebration of 50 years in space since the launch of Sputnik 1.

As far as meteorological satellites are concerned it has a long history when TIROS 1, the first true weather satellite, was launched on April 1, 1960. But even before TIROS 1 was launched there was a great interest to predict tomorrow's weather and attempts were made to probe the atmosphere with all kinds of flying vehicles just like balloons and kites in the early 20th century. Due to the rapid development of the airplane technology during World War I new ways to obtain upper air observations were developed. After 1920 programmes of daily observations from sensors that were attached on the wings of the aircraft were initiated. In 1929, Robert Goddard launched a payload on a rocket that included meteorological instruments like a barometer and a thermometer as well as a camera. The origins of the meteorological satellite programme are often traced back to this effort.

Evolution of the Polar Orbiting Meteorological Satellites

History changed on October 4, 1957, when the Soviet Union successfully launched SPUTNIK 1. The world's first artificial satellite was about the size of a basketball, weighed only 83 kg, and took about 98 minutes to orbit the Earth on its elliptical path. The official scien¬tific mission of this first satellite was observation of ionosphere.

After this successful mission on the height of the Cold War the United States accelerated its programme to launch the first meteorological satellite TIROS-1 (Television Infrared Observational Satellite) on 1 April 1960. For the first time, complete pictures of the clouds associated with large weather systems could be made visible. The operational meteorological satellite programme evolved rapidly thereafter. A total of ten TIROS satellites were launched which carried vidicon camera systems for daytime visible imaging and passive infrared radiometers for sensing during both day and night. Some of the important steps in the TIROS programme are listed below:

- TIROS 8 had the first Automatic Picture Transmission (APT) equipment that allowed images to be sent back right after they were taken instead of having to be stored for later transmission. Eventually, APT pictures with reduced spatial resolution could be received on fairly simple ground stations anywhere in the world, even in university classrooms. Many of us have experienced this technology ourselves which made meteorological satellite data useable to a wide user community.
- The introduction of sun synchronous orbits, which meant that a satellite crossed the equator at the same local solar time each orbit - this allowed for the development of worldwide mosaics of satellite images and opened the door for a number of important scientific projects, including the World Climate Research Programme (WCRP).

Another series of US meteorological research satellites were the NIMBUS satellites designed to test atmospheric remote sensing systems and as a test bed for future operational polar orbiting instruments as major goals. With it, synoptic views of the Earth could be acquired which clearly showed weather patterns and pronounced geo¬logic and vegetation patterns. Seven NIMBUS spacecraft have been launched into near-polar, sun-synchronous orbits beginning with NIMBUS 1 on August 28, 1964 until NIMBUS 7, launched on October 1978. NIMBUS provided a number of science firsts and laid the foundation for satellite data use in 'Earth Applications Science' (meteorology, oceanography, hydrology, geology, geomorphology, geography, cartography, and agriculture). It can be pointed out that the roots of the Landsat programme can be traced directly back to NIMBUS series. Significant advances with this satellite series included routine global coverage. Based on these data jet streams, mid-tropospheric trough and ridge lines, and vorticity centres were readily located in the images. While the feasibility of using satellite imagery to locate and track tropical storms was recognized almost immediately, routine surveillance was assured and techniques to estimate hurricane intensity from satellites became a regular part of weather forecasting.

These experimental satellite series eventually carried a variety of sensors, evolving as technology and experience increased. Working together, NASA and the Environmental Science Services Administration ESSA stimulated improved designs. TIROS-1 through TIROS-X contained simple television cameras, while four of the ten satellites also included infrared sensors. Finally NASA and ESSA initiated the TIROS Operational System (TOS) with its first launch in 1966.

A further achievement during the 1970s was the Improved TOS (ITOS), which combined APT and global data collection/recording in each satellite. ITOS also introduced day/night acquisitions and a new series of Scanning Radiometers, which offered vastly improved data. Later, ITOS carried the Very High Resolution Radiometer (VHRR). As part of international weather data exchange, NOAA (National Oceanic and Atmospheric Administration) introduced the direct reception of VHRR data at no charge to ground stations built by an increasing number of users, beginning in 1972.

The latest generation of this series has been operational since 1978. TIROS-N (for TIROS – NOAA) and NOAA-7 through the latest NOAA-18 include the Advanced Very High Resolution Radiometer (AVHRR). The major advance introduced with this satellite series was the shift from an analogue data relay to a fully digital system. Data are digitized onboard the spacecraft before being transmitted to the Earth. Also the size and weight of the satellite has changed from under 300 kg with the ESSA series of satellites to over 1200 kg with the TIROS-N satellites. There has been one change in the TIROS-N with the addition of a second thermal infrared band to help in the correction for water vapour attenuation when computing sea surface temperatures (split window technique) and with all channels providing imagery at 1.1 km resolution at nadir. This long lasting and still ongoing history of NOAA–AVHRR imagery over several decades is now an important data source for time series analysis in continental to global scales for changes in the Earth's system due to anthropogenic impacts and the consequences of global climate change to our environment.

Another very important development made during these early years of satellite meteorology was the use of multi-spectral satellite imagery for vertical profiles of temperature, humidity and other trace gases. Meteorological observations from space are made through the electromagnetic radiation leaving the atmosphere. Outgoing radiation from Earth to space varies with wavelength for two reasons: (a) Planck function dependence on wavelength, and (b) absorption by atmospheric gases of differing mole¬cular structure (CO_2, H_2O, O_3...). Around absorbing bands of the constituent gases of the atmosphere, vertical profiles of atmospheric parameters can be derived. Sampling in the spectral region at the centre of the absorption band yields radiation from the upper levels of the atmosphere (e.g., radiation from below has already been absorbed by the atmospheric gas); sampling in spectral regions away from the centre of the absorption band yields radiation from successively lower levels of the atmos¬phere. With careful selection of spectral bands in and around an absorbing band, it was suggested that multi-spectral observations can yield information about the vertical structure of atmospheric temperature and moisture. The first temperature retrievals were accomplished with the Satellite Infrared Spectrometer (SIRS), a grating spectrometer aboard NIMBUS-3 in 1969. Comparison with radiosonde observed profiles showed that the satellite-derived temperature profiles were very representative overall, with detailed vertical features smoothed out.

One sustainable contribution of satellite meteorology to global change studies began with the Total Ozone Mapping Spectrometer (TOMS) onboard a NIMBUS-7 satellite launched in 1978. This NASA-developed instrument measures ozone indirectly by mapping ultraviolet light emitted by the Sun to that scattered from the Earth's atmosphere back to the satellite. The TOMS instrument has mapped in detail the global ozone distribution as well as the Antarctic ‘ozone hole’ which forms from September through November of each year. During its lifetime on Nimbus-7 (1978 – 1993) TOMS helped make ‘ozone’ and ‘ozone hole’ a common word through impressive images of the Antarctic Ozone Hole and became an important contribution to the first World Climate Conference held at WMO 1979 in Geneva. These satellite derived measurements of the terrestrial spectrum revealed details of water vapour, and ozone absorption bands never seen before. To guarantee long term daily mapping of the global distribution of the Earth's atmospheric ozone there was a continuation with TOMS aboard a Russian Meteor-3 satellite from 1992 – 1994 and onboard Earth Probe from 1996 – 2005. Today the OMI (Ozone Monitoring Instrument) will continue the TOMS record for total ozone and other atmospheric parameters related to ozone chemistry and climate. OMI is flying on the EOS Aura platform.

In Europe little has been achieved in the field of near-polar orbiting meteorological satellites during the last decades of the 20th century. During the 1980s, ESA had been planning to build an Earth Observation multi-disciplinary Polar Platform for flying by the end of the century. At some stage, it was decided that the instruments of meteorological operational nature would be better put together on a separate satellite, based on the polar platform design. After many delays the launch of this first European polar orbiting meteorological satellite was planned for July 17, 2006 from the Russian Baikonur launch site, but had to be called off due to technical reasons of the Soyuz’s ground segment. The launch is now planned for October 7, 2006.

With its launch METOP-1, Europe’s first operational polar-orbiting weather satellite, will replace one of two satellite services operated by NOAA. EUMETSAT, the European Organisation for the Exploitation of Meteorological Satellites, is committed to establish, maintain and exploit European operational systems of meteorological satellites and is responsible for the ground segment of METOP, developed by the European Space Agency ESA. EUMETSAT was founded in June 1986 and has celebrated its 20th anniversary on July 19, 2006. From an EARSeL point of view it is interesting that Prof. André Lebeau, first Vice-Chairman and from 1990 – 1994 Chairman of the EUMETSAT Council, was not only one of the founding fathers of EUMETSAT but also of EARSeL.

The United States has delivered meteorological data from polar orbit free of charge to users worldwide for almost 40 years. METOP represents Europe’s contribution to a new cooperative venture which will secure this weather data service for the next decades. The present plan is to launch three METOP satellites sequentially to maintain the service for at least 14 years. METOP will carry a set of 'heritage' instruments provided by the United States and a new generation of European instruments offering improved sensing capabilities to both meteorologists and climatologists. The new instruments will augment the accuracy of temperature and humidity measurements, and wind speed and wind direction measurements, especially over the ocean, and provide a more accurate profile of ozone in the atmosphere.

METOP will replace the morning orbit of NOAA satellites at the same local time (9.30 AM). NOAA will continue to operate its afternoon satellite service from a complementary orbit which follows a track at a local time of 2.30 PM.

Evolution of Geostationary Meteorological Satellites

Geostationary satellites, such as METEOSAT and its successor MSG, are fixed and provide direct images of nearly a quarter of the Earth's surface. They are particularly useful for imaging the rapidly changing atmosphere within minutes. Polar orbiting satellites, however, provide more detailed global coverage, but at longer time intervals. The geostationary orbit above the equator enables continuous surveillance of the weather.

On December 6, 1966 the first Applications Technology Satellite (ATS-1) was launched. ATS-1's spin scan cloud camera was capable of providing full disk visible images of the Earth and its cloud cover every 20 minutes. Meteorologists were surprised at the first views of global animations of clouds and cloud systems in motion. By the early 1970s ATS imagery was being used in operational forecast centres, with the first movie loops being used at the US National Severe Storm Forecast Centre (NSSFC) in the spring of 1972.

As with the polar programme, NASA research and development led to the operational geostationary satellite programme. The success of ATS in the meteorological arena led to NASA's development of the Synchronous Meteorological Satellite (SMS), an operational prototype dedicated to meteorology. SMS-1 was launched May 1974 and SMS-2 was launched February 1975: those satellites were positioned above the equator at 75° W and 135° W, which until today remain the nominal positions of the US eastern and western Geostationary Operational Environmental Satellites (GOES) which was first launched in 1975.

In 1977 the European Space Agency launched a geostationary METEOSAT, which provided visible imagery at 2.5 km spatial resolution, infrared window band imagery at 5 km spatial resolution, and also water vapour band imagery at 5 km spatial resolution. These new images in the water vapour band provided a very different view of the planet Earth. Upper tropospheric humidity and high cloud features dominate the image and indicate synoptic scale circulations. Three GOES and one METEOSAT were used as part of a Global Atmospheric Research Programme (GARP) in 1979 to define atmospheric circulations. Organized by the Committee on Space and Atmospheric Research (COSPAR), this was the first international experiment to use sa¬tel¬lites.

As imagery from polar orbiting satellites helped advance understanding of synoptic scale phenomena, imagery from geostationary satellites helped advance understanding of the mesoscale. Prior to the geostationary satellite the mesoscale was a 'data sparse' region. Meteorologists were forced to make inferences about mesoscale phenomena from macroscale observations. Today geostationary satellite imagery represent the equivalent of a 'reporting station' (up to every 1 km with visible data and up to every 3 km with infrared data) and hence shows features that are seldom detected by fixed observing sites. The clouds and cloud patterns in a satellite image provide a visualization of mesoscale meteorological processes. When imagery is viewed in animation, the movement, orientation, and development of important mesoscale features can be observed, adding a new dimension to mesoscale reasoning. Furthermore, animation provides observations of convective behaviour at temporal and spatial resolutions compatible with the scale of the mechanisms responsible for triggering deep and intense convective storms.

The first step in the development of a European meteorological satellite system occurred in 1968. The eight-nation European Space Research Organisation (ESRO), later to become the European Space Agency (ESA), received funding for studies of application satellites including weather satellites. Initially ESRO promoted the idea of an experimental polar-orbiting satellite project conceived by UK scientists. However, Prof. Pierre Morel, then Director of the French space agency Centre National d'Etudes Spatiales (CNES), was convinced that a geostationary satellite could provide essential data for weather forecasting, as well as providing the public with easily recognisable television pictures of the weather. This proposed METEOSAT project was redirected towards ESRO, but found little favour at first. The UK proposal had merit from a specific European weather forecasting perspective: the northern European (especially Nordic) countries lie near the edge of the view from a geostationary satellite, and considered that their needs were better met by a polar-orbiting satellite. On the other hand, METEOSAT was the more visionary idea, introducing the concept of a global system of geostationary platforms capable of observing the atmospheric circulation and weather around the equator in near real-time and in September 1972 ESRO officially adopted the METEOSAT programme.

The European history of success with geostationary meteorological satellites started with the launch of METEOSAT-1 on November 23, 1977 from Cape Canaveral. It reached its definitive position at 0° longitude over the Gulf of Guinea on December 7, 1977. A series of identical satellite followed with METEOSAT-2 in 1981 until METEOSAT-7 in 1997. From METEOSAT-2 on all satellites were launched from ESA's space port Kourou in French Guiana with Ariane rockets. All these satellites belonging to the so-called METEOSAT First Generation provide data 24 hours a day from three channels in the visible, infrared, and water vapour regions of the electromagnetic spectrum.

Satellites operated in space according to a schedule of overlapping time which means that it was always guaranteed that a back-up satellite was in orbit in case of failure of the operational one. This led to a situation that after the launch of MTEOSAT-7 it was decided to shift METEOSAT-5 to a position at 63 °E in early 1998 for being used in the international Indian Ocean Experiment (INDOEX). After the end of this experiment METEOSAT-5 continued to operate as what is now known as Indian Ocean Data Coverage (IODC) and fills since that time the gap of geostationary meteorological satellites over the Indian Ocean. Together with METEOSAT, GOES-W, GOES-E and the Japanese GMS this enables an observation of meteorological processes around the world except the polar regions.

On August 28, 2002 started a new era of European geostationary satellites with the successful launch of the first METEOSAT Second Generation Satellite (MSG-1) or METEO¬SAT-8. MSG-1 is a significantly enhanced follow-on system to the previous generation of METEOSAT through the 12 spectral bands (3 in the previous system) of its radiometer, the Spinning Enhanced Visible and InfraRed Imager (SEVIRI). Eight of the channels will be in the thermal infrared, providing among other information, permanent data about the temperatures of clouds, land and sea surfaces. One of the channels is called the High Resolution Visible (HRV) channel, and has a sampling distance at nadir of 1 km, as opposed to the 3 km resolution of the other visible channels. Using channels that absorb ozone, water vapour and carbon dioxide, MSG satellites will also allow meteorologists to analyse the characteristics of atmospheric air masses making it possible to reconstruct a three-dimen¬sional view of the atmosphere. The improved horizontal image resolution for the visible light spectral channel (1 km as opposed to 2.5 km on the previous system) and the full disc view every 15 minutes enables monitoring of rapidly evolving events. This supports the weather forecaster in the swift recognition and prediction of dangerous weather phenomena such as thunderstorms, heavy rain, snow, fog and explosive development of small but intense depressions, which can lead to devastating windstorms. This successful story of the European MSG satellites can be finished with the information, that on July 18, 2006, MSG-2 (now renamed to Meteosat-9) as the second out of four satellites, which guarantee for high resolution weather information over the next 18 years, arrived its orbit at 0° longitude. From this position Meteosat-9 becomes the official back-up satellite to Meteosat-8. The Meteosat-8 satellite remains, until further notice, the operational prime.

This brief historical report is not complete since there are many additional missions existing like CLOUDSAT, SeaWinds on ADEOS-II, QuickSCAT, the Tropical Rainfall Measuring Mission (TRMM) or all those meteorological/climatological instruments flying on ENVISAT like SCIAMACHY, MIPAS etc. Nevertheless, the report would not have been made possible without very much information provided from several sources on the internet. My thanks go namely to ESA, EUMETSAT, NASA, NOAA and numerous other web sites.

Eberhard Parlow,
Eberhard.Parlow@unibas.ch

3.2 NEWS FROM IFREMER

Dynamiques de l'Environnement Côtier
Centre de Brest – BP 70
F 29280 PLOUZANE

Remote sensing for coastal seabed habitat mapping

The research department Dyneco (Dynamiques de l'Environnement Côtier) at Ifremer, Centre de Brest, France embarked 4 years ago in mapping the seabed habitats of the coastal zone of France. The Rebent (Réseau benthique, http://www .rebent.org) project was first taylored to the region of Brittany by bringing together all the local actors in seabed mapping, marine biologists for the most part but also geophysicists and geographers from the regional scientific community and is now about to be extended to the whole coastline. In Brittany it became operational in 2003 and is currently delivering habitat maps. In 2004 a European component was added to it by way of the Mesh project (Mapping European Seabed Habitats – http://www. searchmesh.net/), a joint initiative funded by the Interreg North West programme of the EC.

The area under scope can schematically be divided into three domains: a) the subtidal zone, where only acoustics tools are effective, b) the intertidal zone, where remote sensing tools are also quite effective, c) the more challenging interface of shallow water where synergy of both types of techniques is being experimented.

Given the complexity of many inshore environments, mapping strategies were looked at, aiming at optimising habitat discrimination by combining various sources of remote sensing data (acoustic and remote sensing) and minimum ground truthing and sampling.

High resolution remote sensing techniques are of many kinds, some of them rather well established such as Spot 5 or aerial photography, others still being in an assessement phase such as Lidar.

Spot 5, currently featuring a full colour 10 metre resolution (marginally increased to 5 metres by panchromatic fusion) yields 100% coverage of the intertidal zone. It is mainly geared towards mapping the vegetal fraction, currently including seaweed belts (mostly fucoids) and saltmarshes. A robust index (actually a cover index derived from the well known NDVI) derived from previous Spot series provided satisfactory assessment of seaweed habitats and allowed for change detection. A mapping update frequency of 5-6 years was planned. The only severe constraint with satellite data is the recourse to programming the satellite so as to acquire spring low tide shots. However this constraint will be alleviated with the advent of the Pleiades constellation and its doubled revisit capability (planned 2008). At the present stage, a full coverage of the intertidal zone of Brittany is underway.

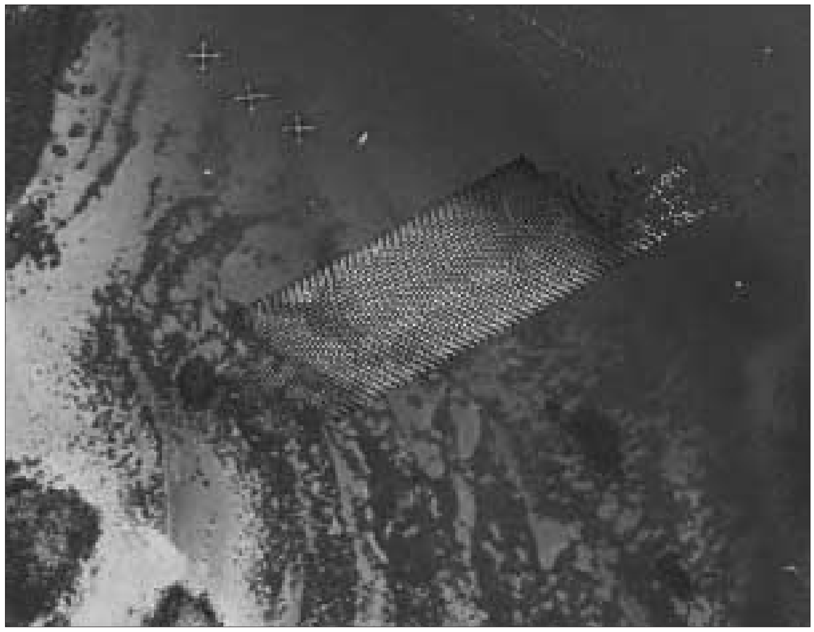
On a more local scale, specific priority sectors were selected (representing about 15% of the total coastal zone) that are to be mapped thoroughly on high scale (better than 1/25000). To achieve this, a combination of data was deemed necessary, with aerial photography (ortho-mosaics) forming the base layer. Whilst it represents the mapping reference onto which other data sources are mapped, its limited quality in terms of colours dynamics restricts its standalone use. Yet it proves quite efficient in e.g. seagrass mapping, where texture is more relevant than colour.

To complete aerial photography topographic Lidar surveys were run on several sites featuring more intricate habitats. This technique is now fully operational and well mastered by a number of contractors in Europe. The availability of elevation on 1 to 2 metre resolution DTMs with vertical accuracy of 15 cm highly enhanced the ability of interpreters to identify specific units or to interpolate on the basis of elevation of slope. Rather than elevation, the flooding frequency, obtained by inverting the tidal curve at any given location was shown to be most powerful in detecting ecological boundaries that are a result of seawater flooding time. This was reported in a paper at the Earsel SIG Coastal Zone meeting in June 2005 in Porto. The local variability of the elevation still needs to be looked at, as it could help identify particular habitats such as boulders. Aerial photography remains efficient to a few metres underwater at the most (referring to the typical clear waters of Brittany) to detect and map either seagrass or seaweed presence, unfortunately most of the time the lower limit of seagrass beds is blurred.

To overcome this, and more generally as we were seeking for a mapping tool not hindered by navigational constraints in rocky foreshores, hydrographic Lidar was tested recently with a twofold objective: a) to provide water depth in shallow waters where acoustic sensors (and platforms) are least effective, b) to yield bottom type information thanks to light backscatter waveform.

The results in terms of range detection are reported to be within the announced specifications (rms of 30-40 cm), which proves to be quite stisfactory for ecological purposes. Detection still currently occurs through 20 metres of water (Secchi disk of 5-7 metres), which potentially gives access to information on a whole unknown portion of our coastal seabed. Seagrass patches clearly appear on hydrographic Lidar DTMs, a very encouraging fact. Besides, measurement of backscatter has been reported feasible by some Canadian researchers. This was obtained by inverting the lightpath model along with the know-ledge of the depth to retrieve bottom type. These expectations remain to be tested on our sites for the detection of standing kelp and seagrass. As a matter of fact, it is expected that the presence of kelp will induce a signature on the wave form quite the same way land vegetation creates a double pulse on topographic Lidar. Such bottom detection would highly enhance the potential of the Lidar technique.

An intercalibration meeting in les Abers organised under the aegis of the Mesh project, Brittany, September 2005.

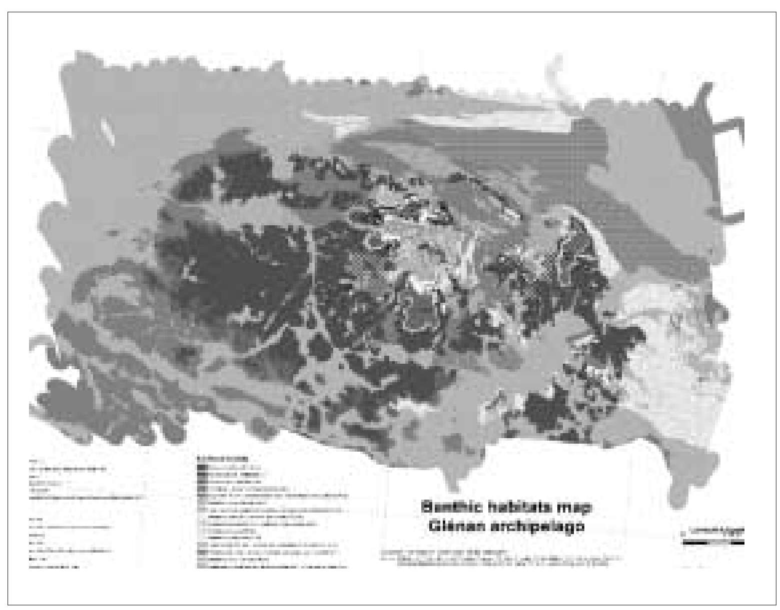


Zostera marina beds are visible on bathymetric Lidar (raw data as colored dots); background: ortho-photography on Les Abers, Brittany.

Finally it should be mentioned that hydrographic Lidar, as it uses green and infrared light beams is currently operated simultaneously in the two modes (topographic and hydrographic), hence potentially saving a topographic survey, at least in overlapping zones. However the latter mode being much more expensive than the former (typically three times), the surveying strategy needs to be thoroughly adapted to each particular coastal configuration.

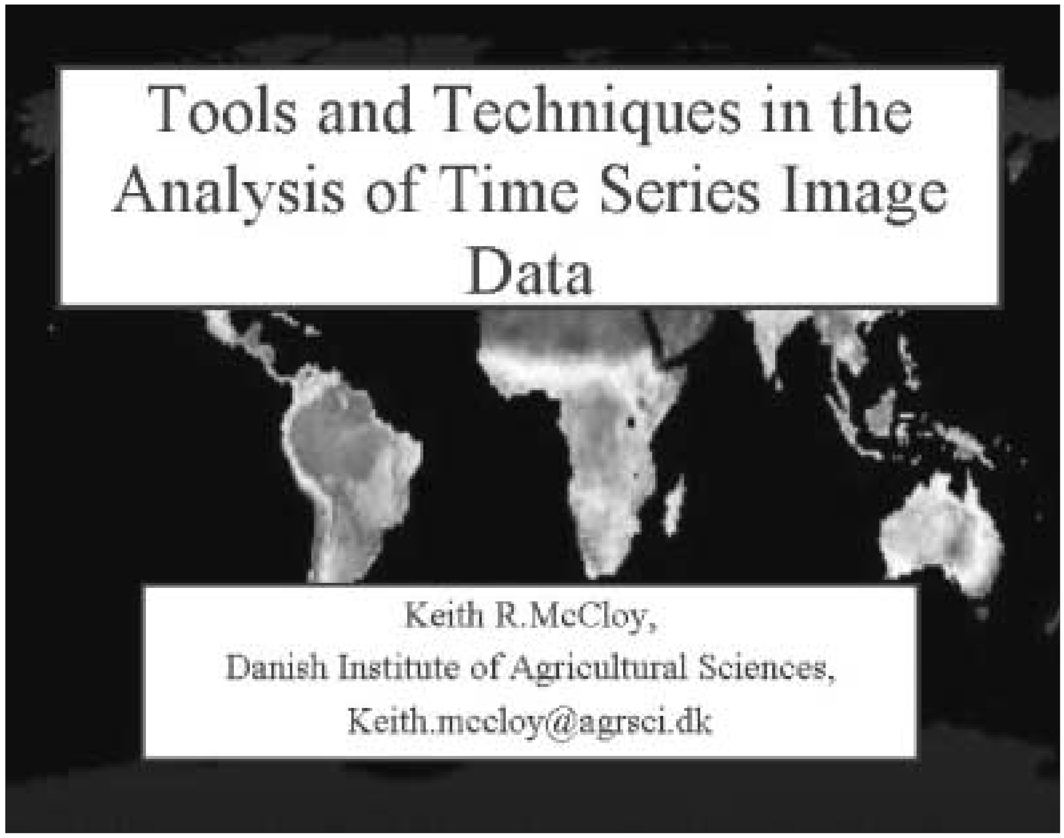
The Mesh project largely supports this methodological research. It is expected that a follow up project will draw on these advances to submit a wide scale mapping project for the shores of Europe in the framework of the FP7. If you're interested on seabed mapping, synergy of techniques, and wish to take part to prospects in this field please contact either Jacques Populus or any of the Mesh partners.

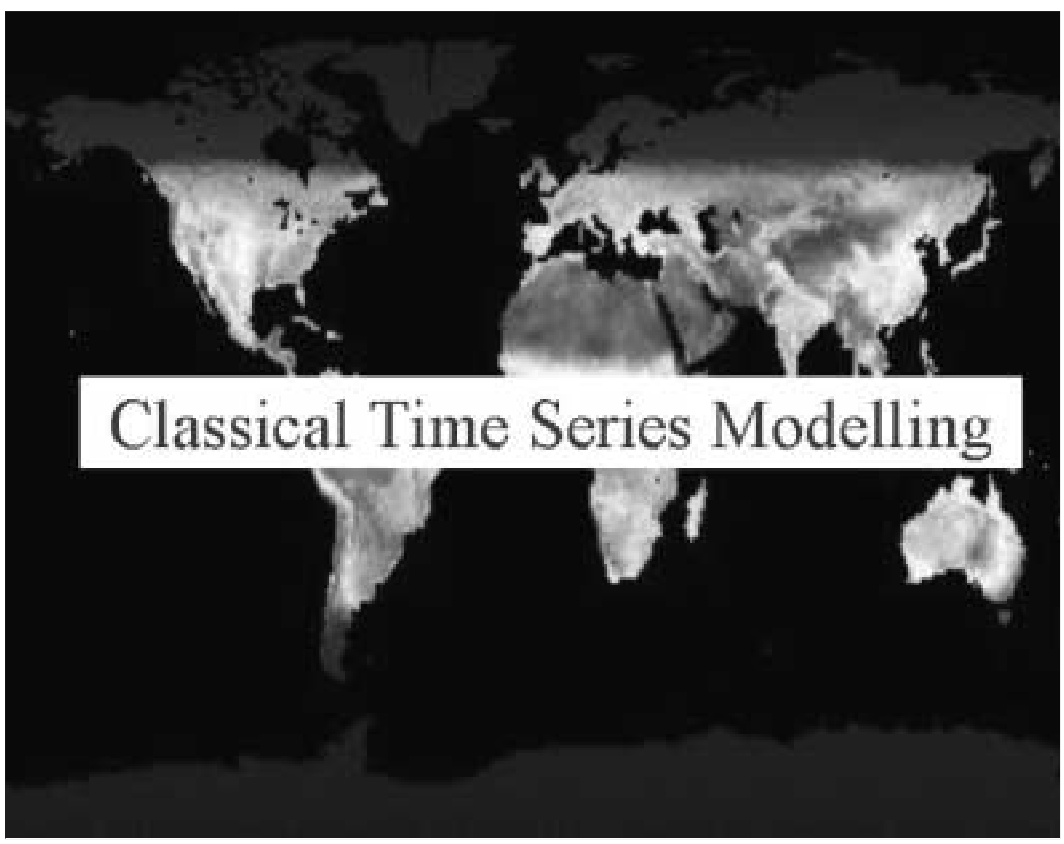
Jacques Populus
Dyneco/Vigies
jpopulus@ifremer.fr

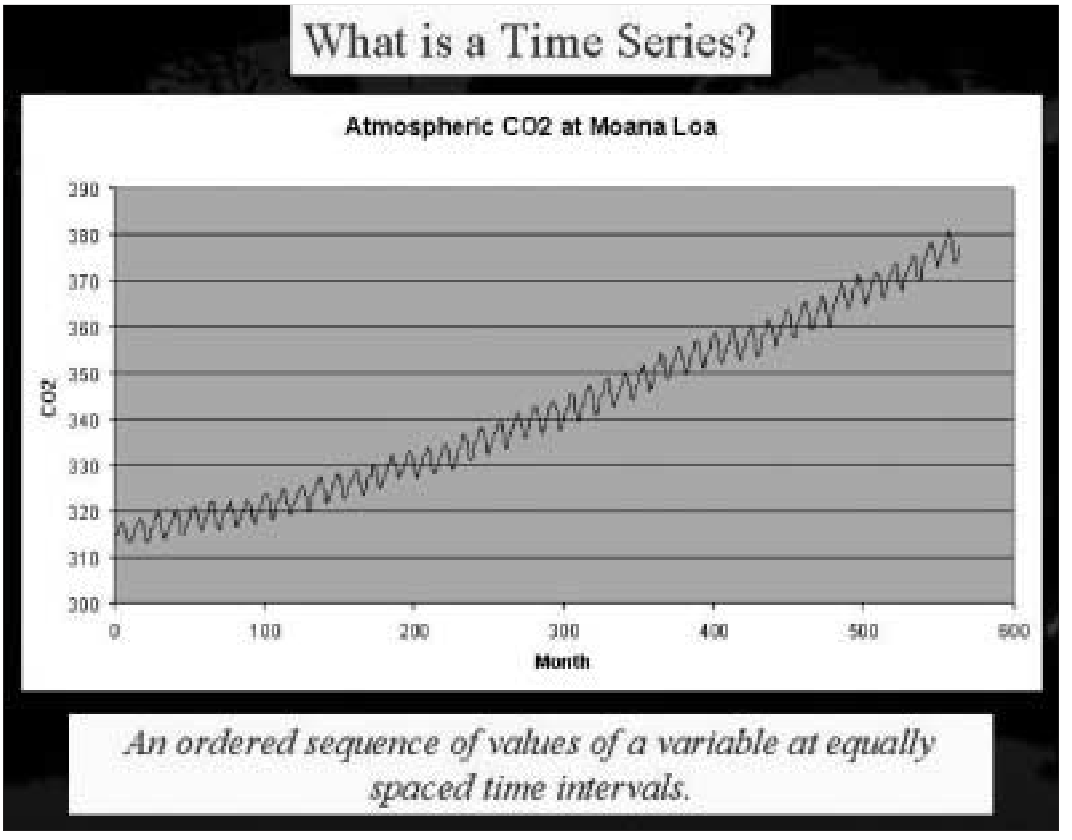


The habitat map of Glénan site, Brittany, resulting from combined interpretation of visible and acoustic remote sensing.

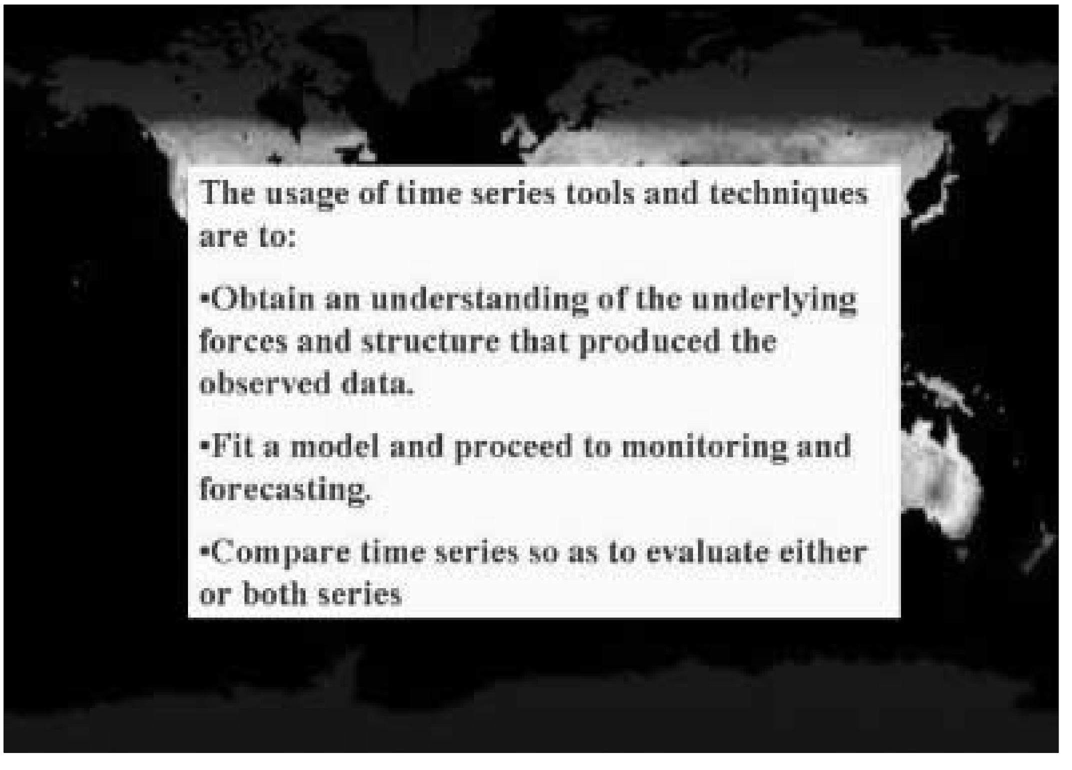
3.3 TUTORIAL ON TIME SERIES ANALYSIS



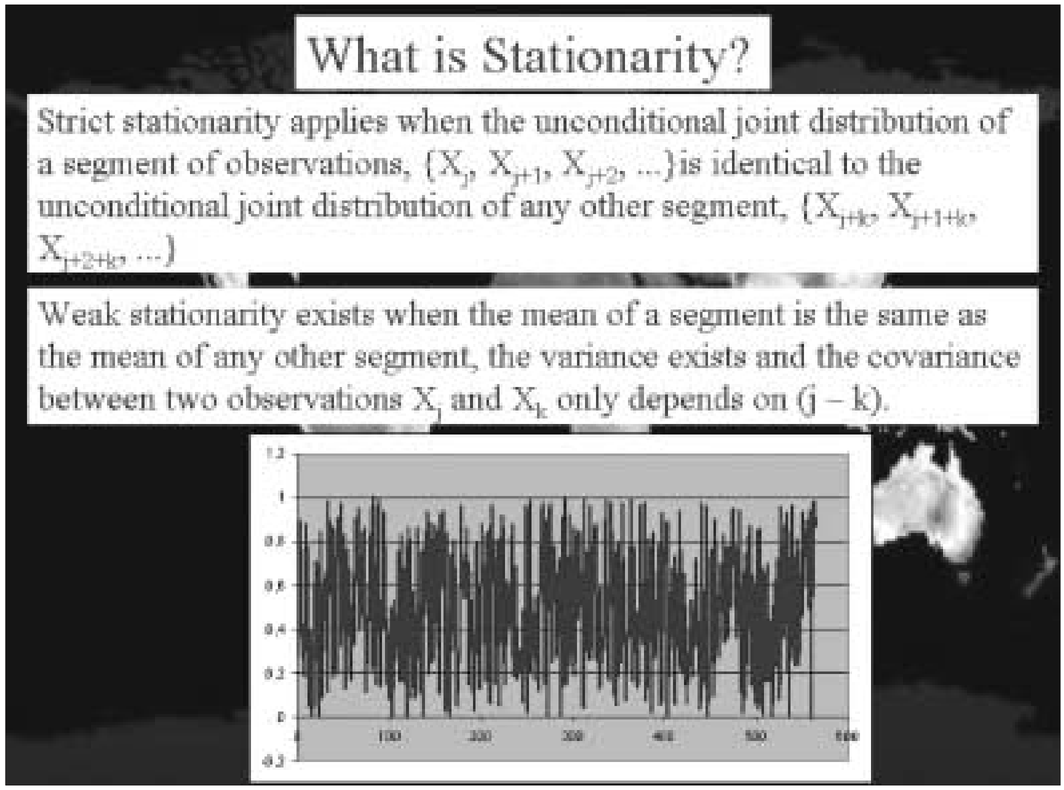




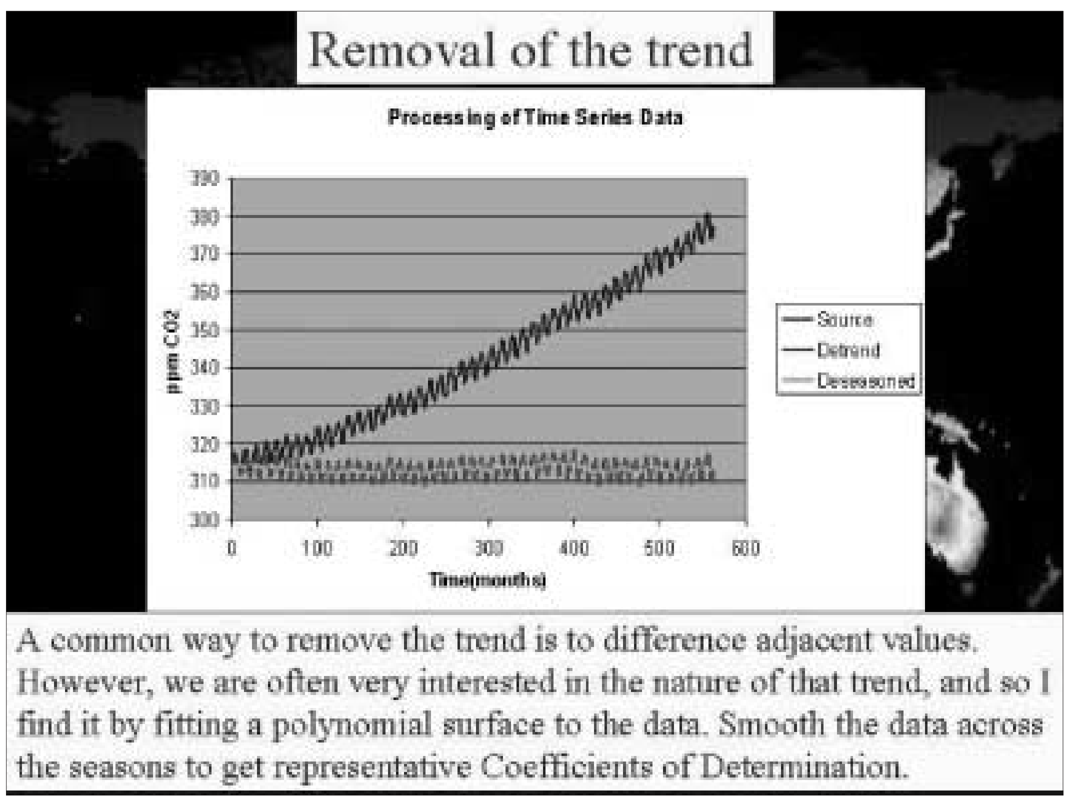
Definition of a time series using 47 years of atmospheric CO2 data at Moana Loa



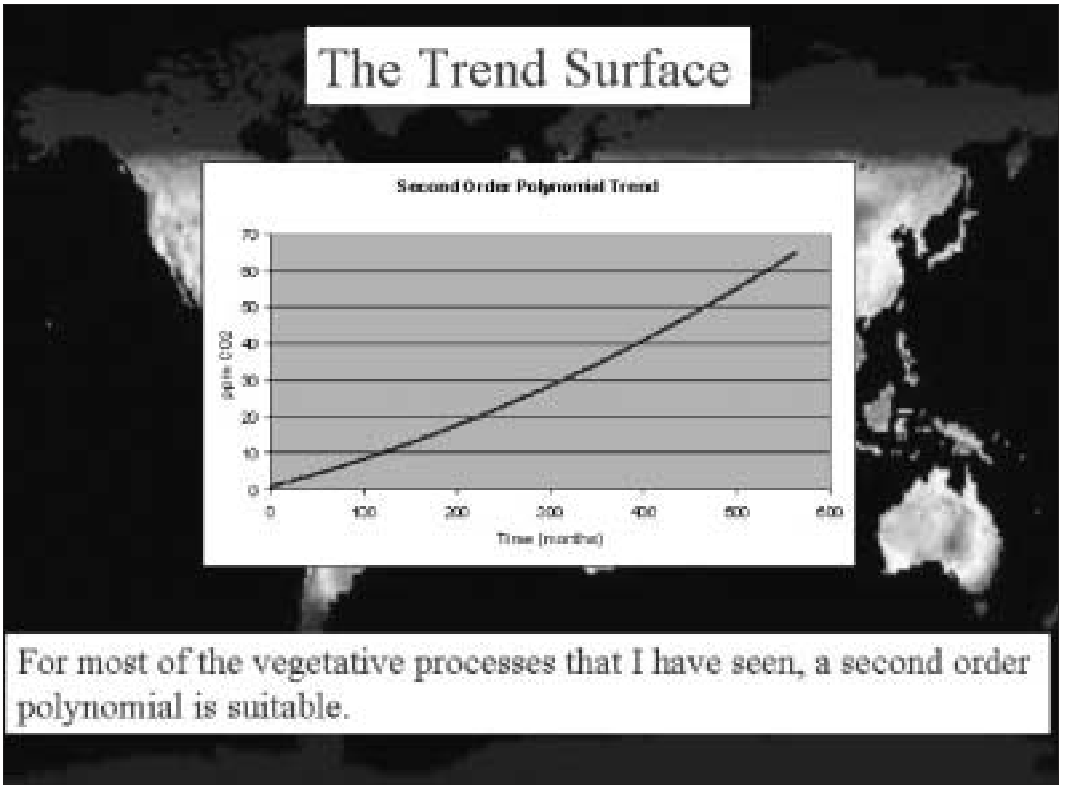
Use of Time Series Analysis Techniques



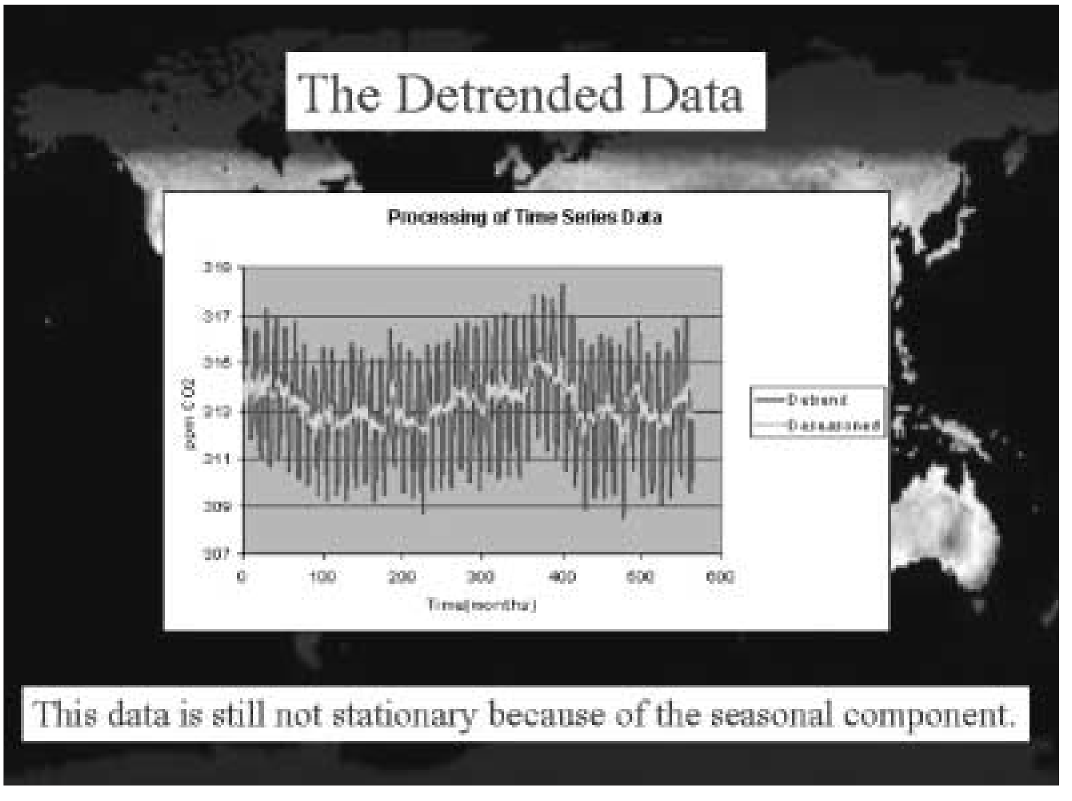
Stationarity defined.



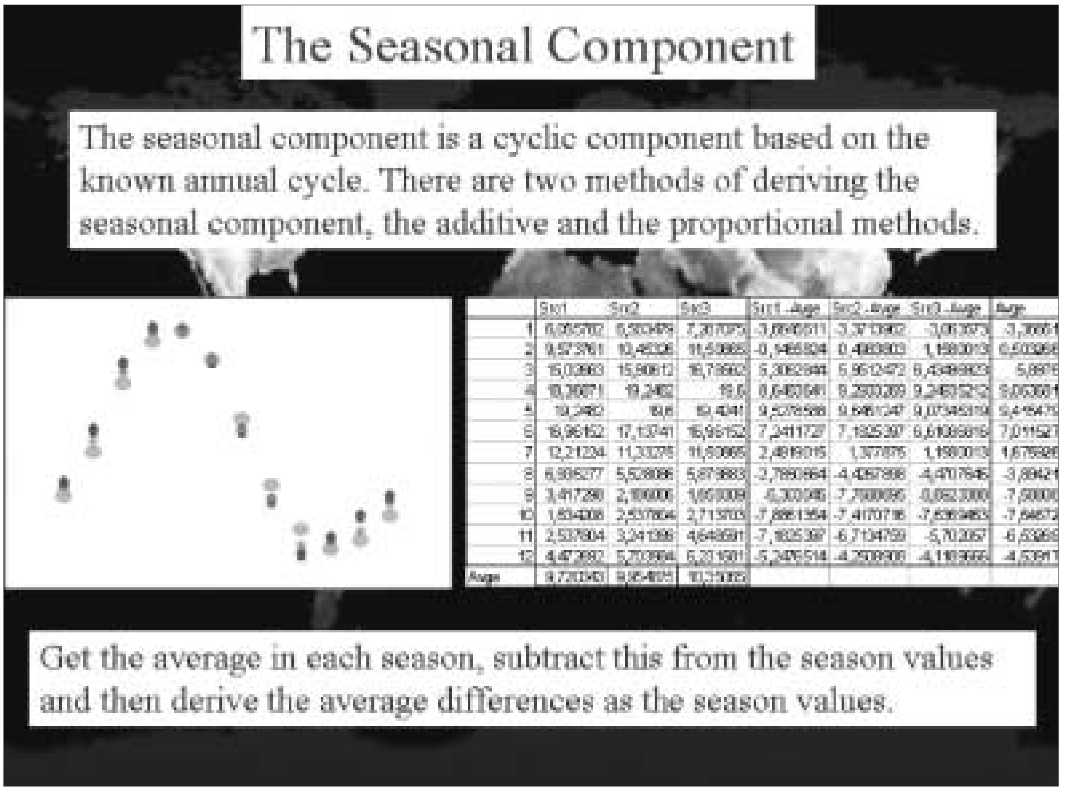
Removing the trend from the data. For vegetation I have found that a second order polynomial is adequate.



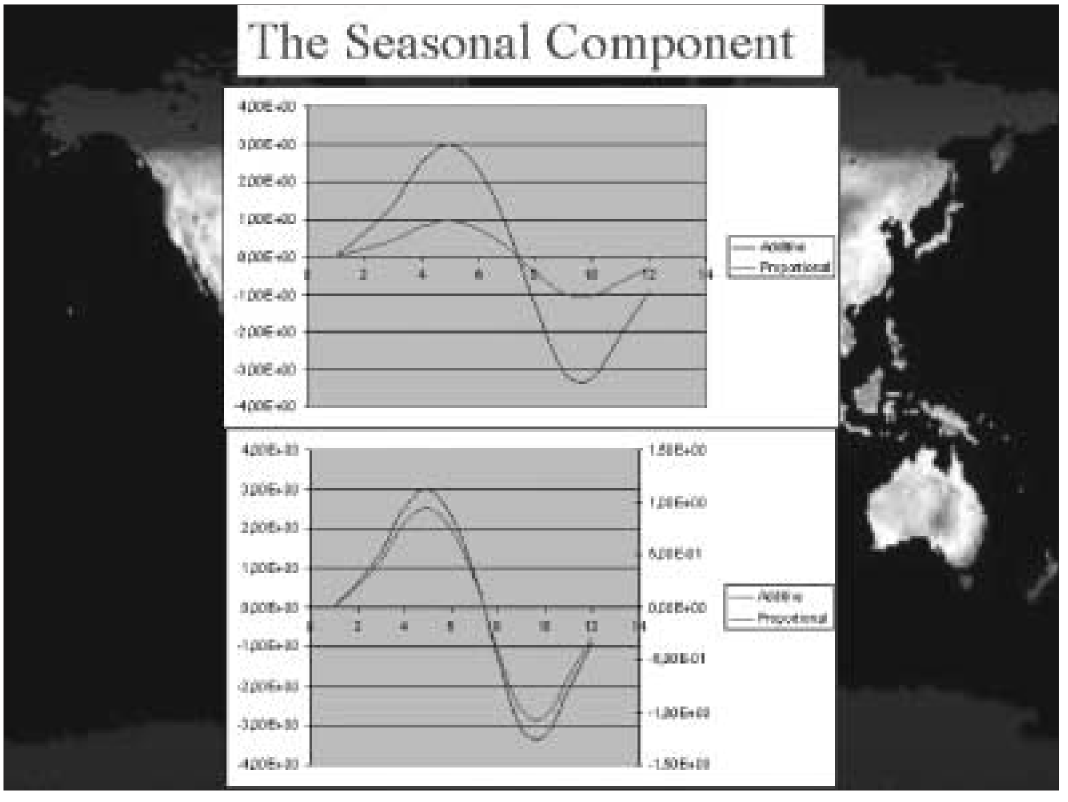
The trend surface for CO_2 at Mauna Loa in Hawaii.



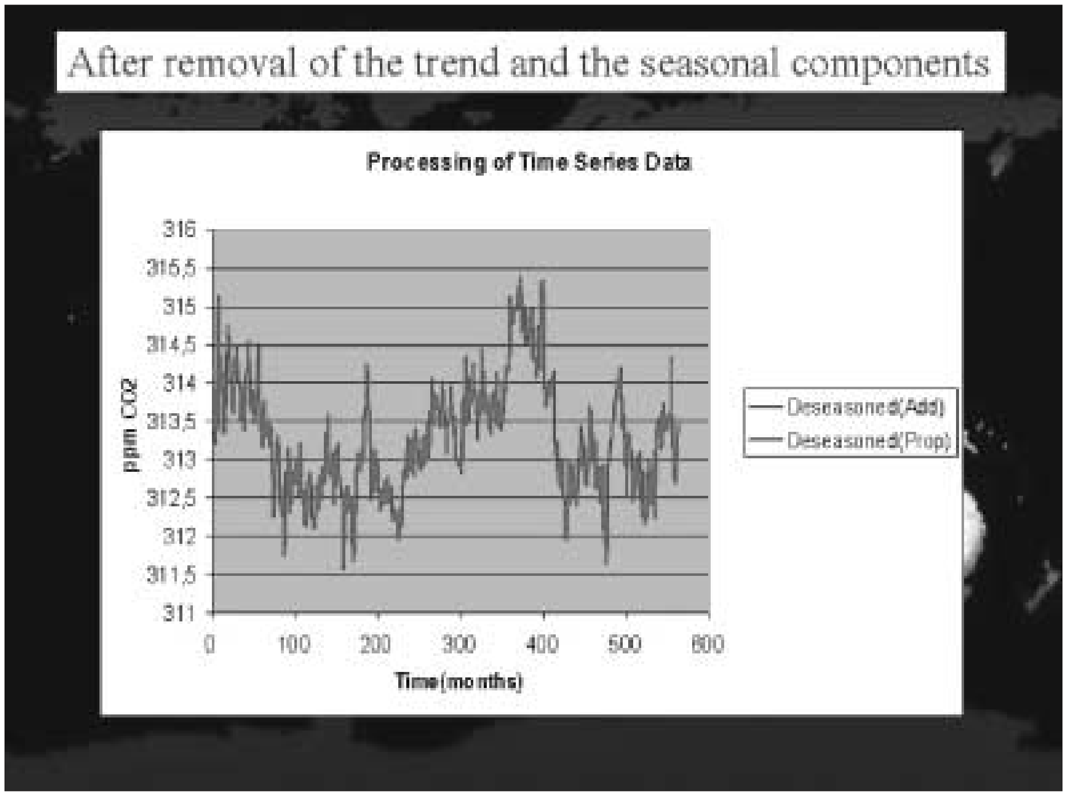
The data after removal of the trend. The strong seasonal component means that this data is still not stationary.



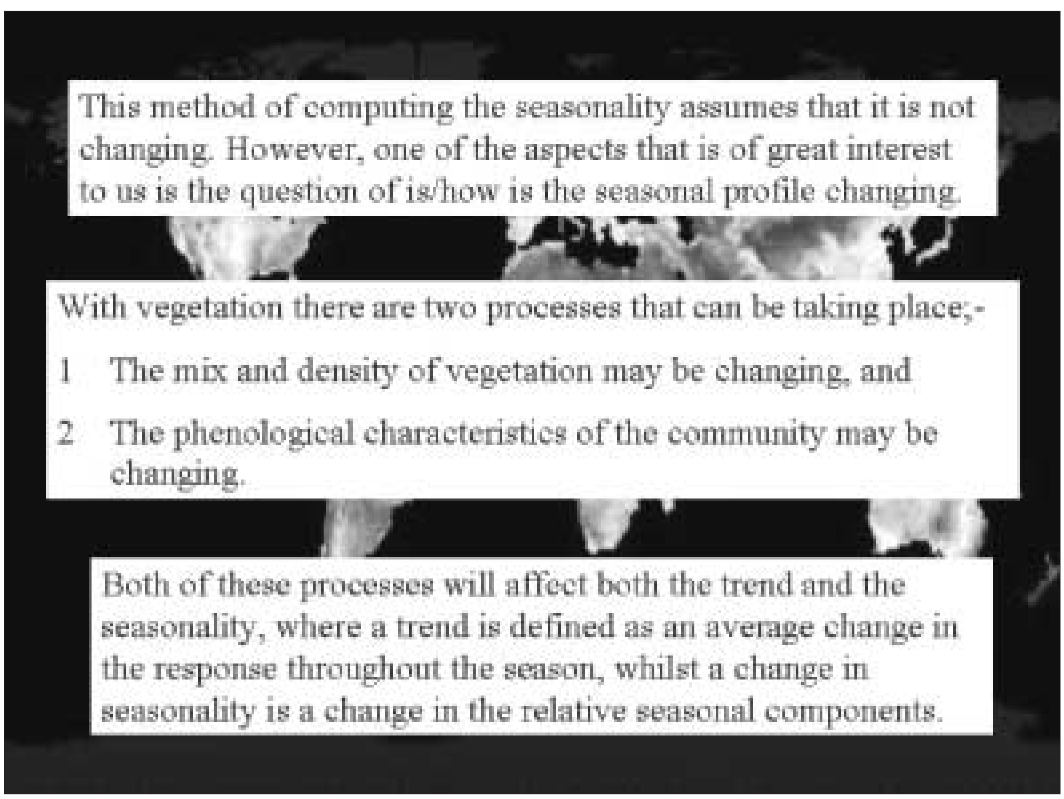
The classical way to remove the seasonal component.



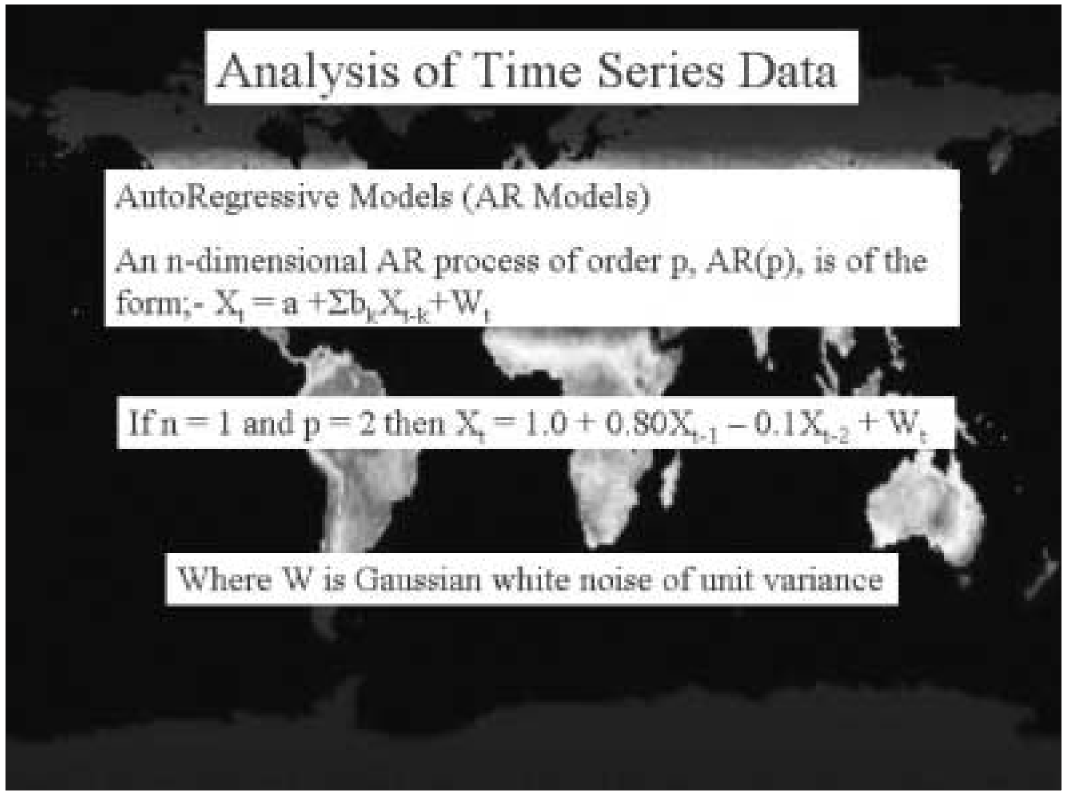
The seasonal components as derived by the additive and the proportional methods. The results are different, but usually very similar.



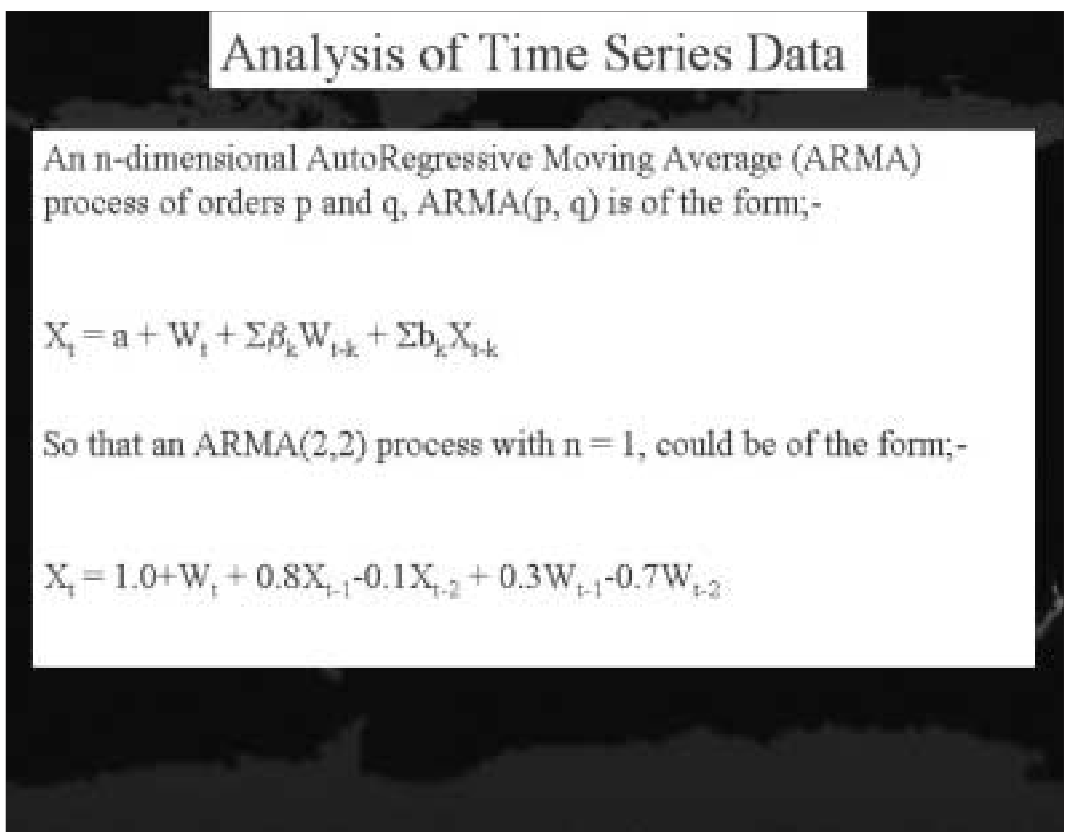
The data after removal of the trend and the seasonal component. The data may still contain cyclic and random components, as this data does.

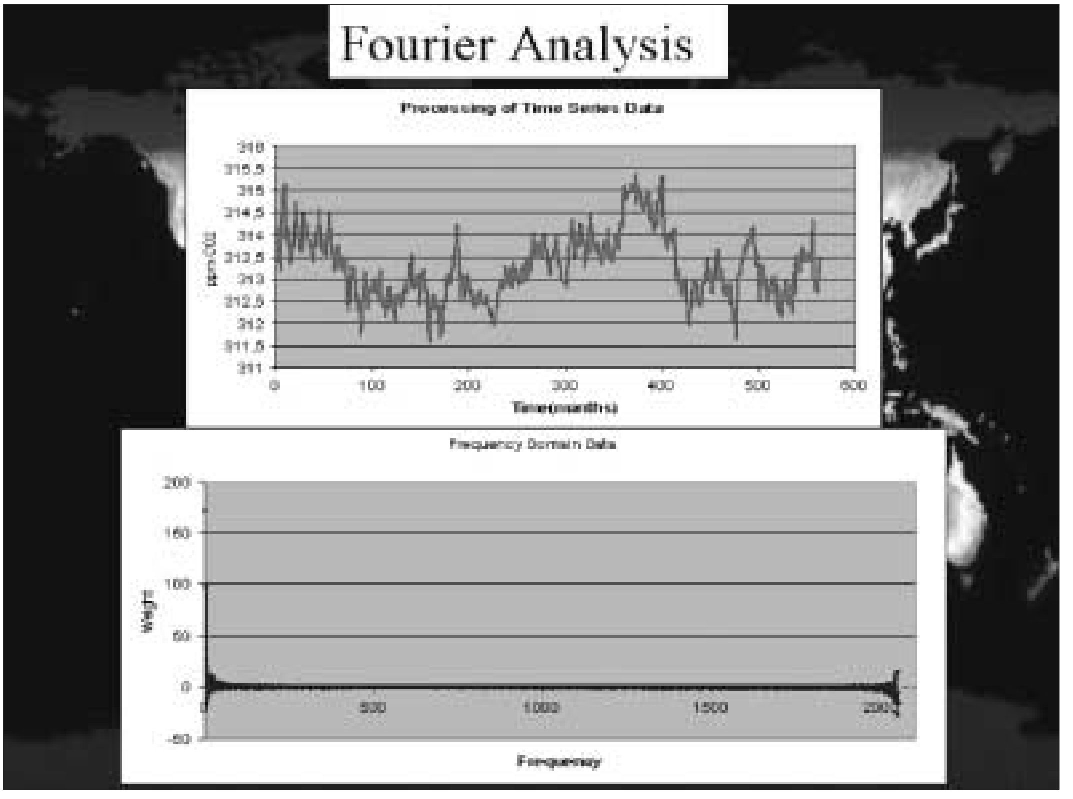


The problem with this classical approach, at least in relation to vegetation.

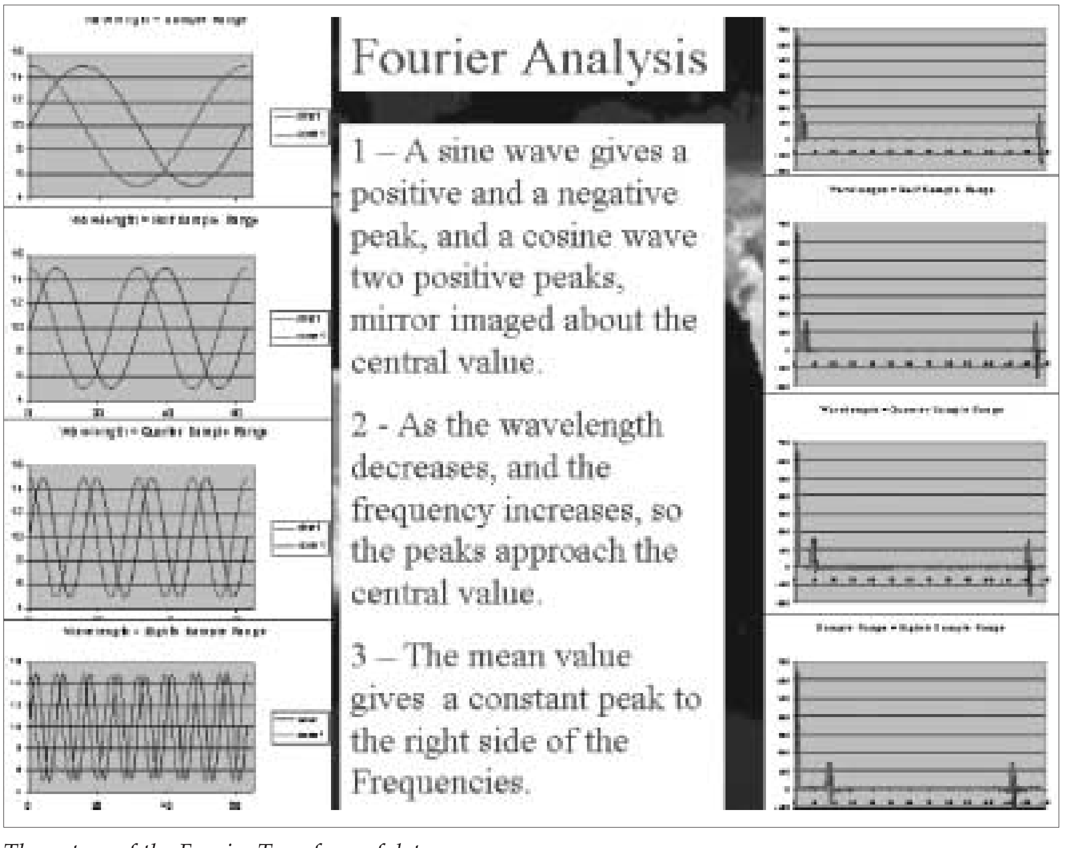


Once the data is stationary, then the classical approach is likely to involve AR or ARMA modelling. Whilst both can be very powerful, they involve a lot of experimental involvement of the researcher, something that we cannot do with image data. We need another solution.

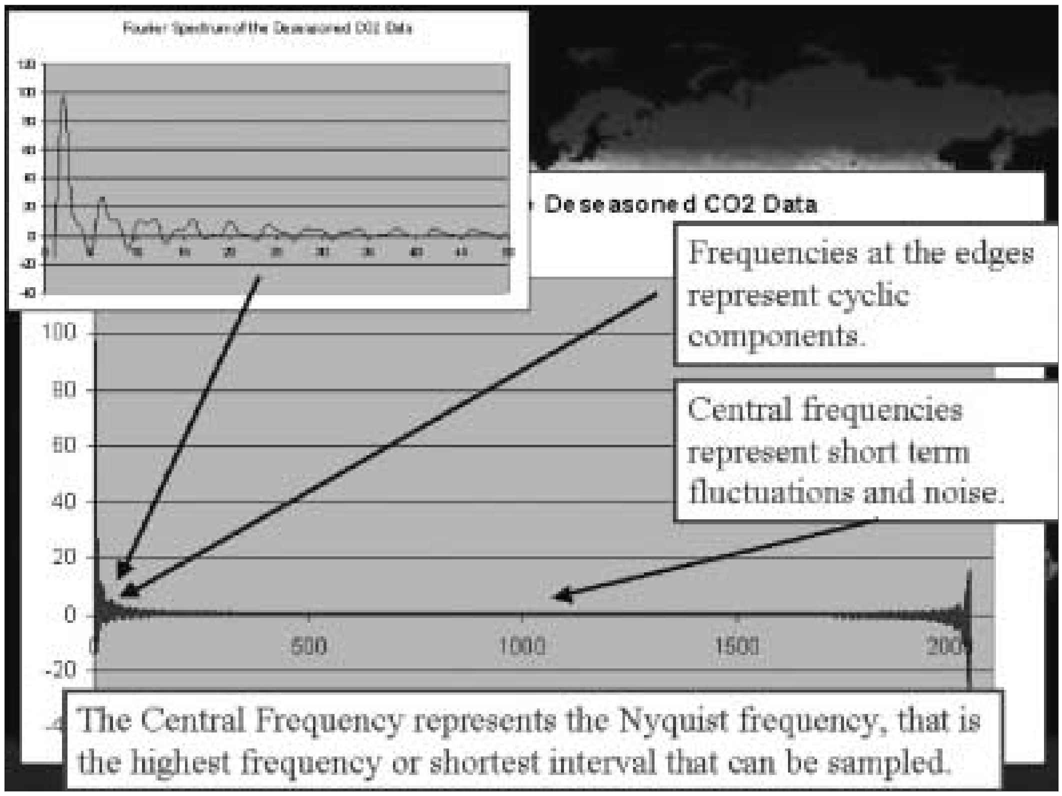




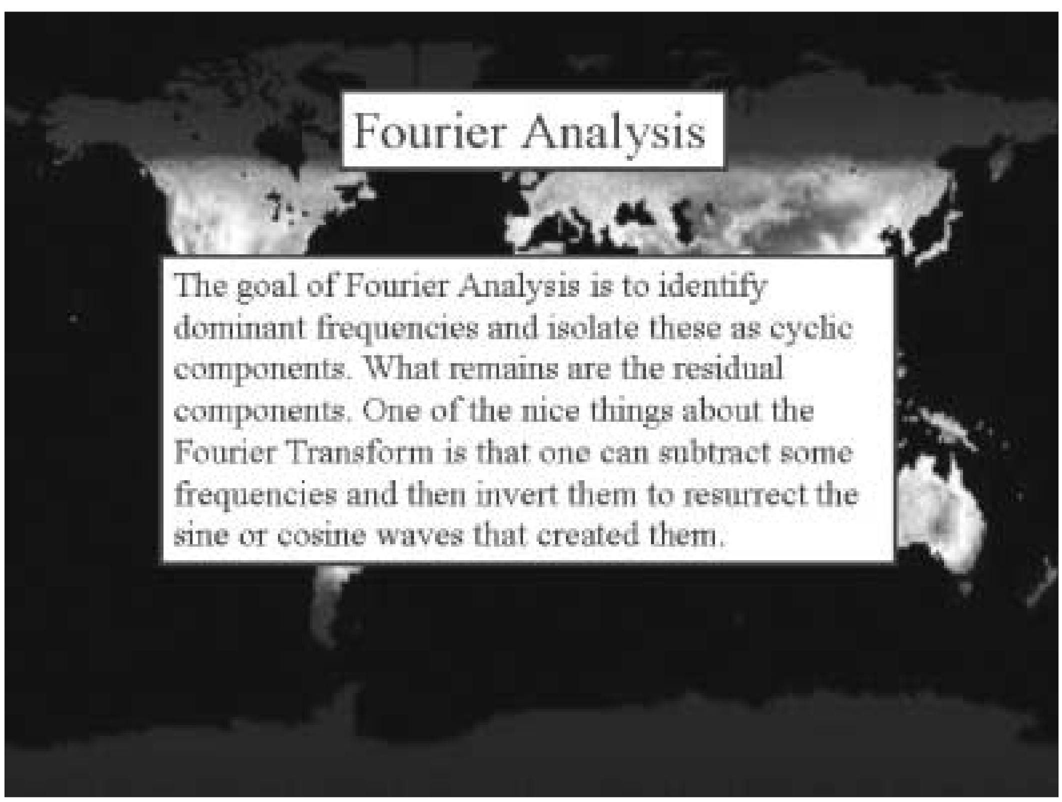
The way that I have been experimenting with is to derive the Fourier Transform of the data and filter this for selected frequencies.

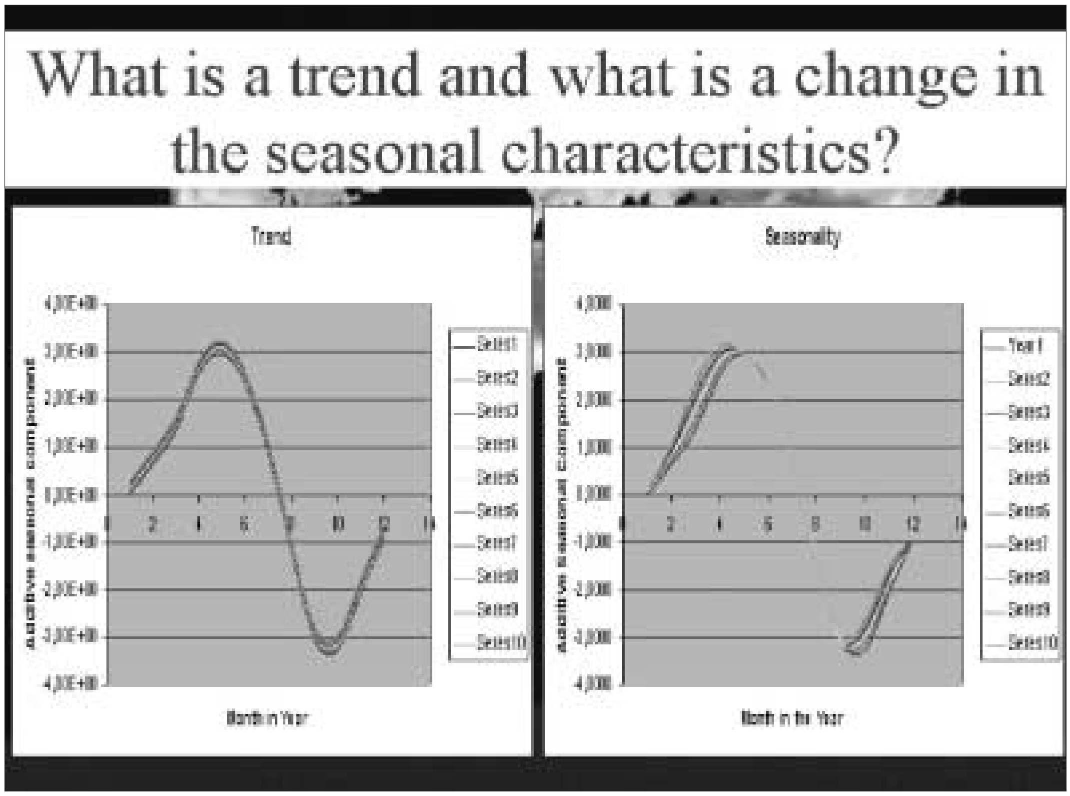


The nature of the Fourier Transform of data.



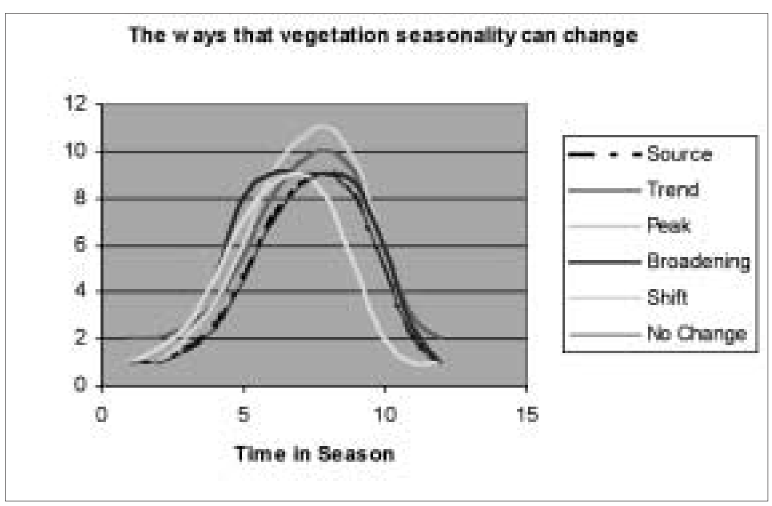
And some more on the characteristics of the Fourier transform of data.





Under certain circumstances a change in the phenology of the vegetation can be translated into a trend. The classical trend analysis thus can often mask what is actually happening to the vegetation.

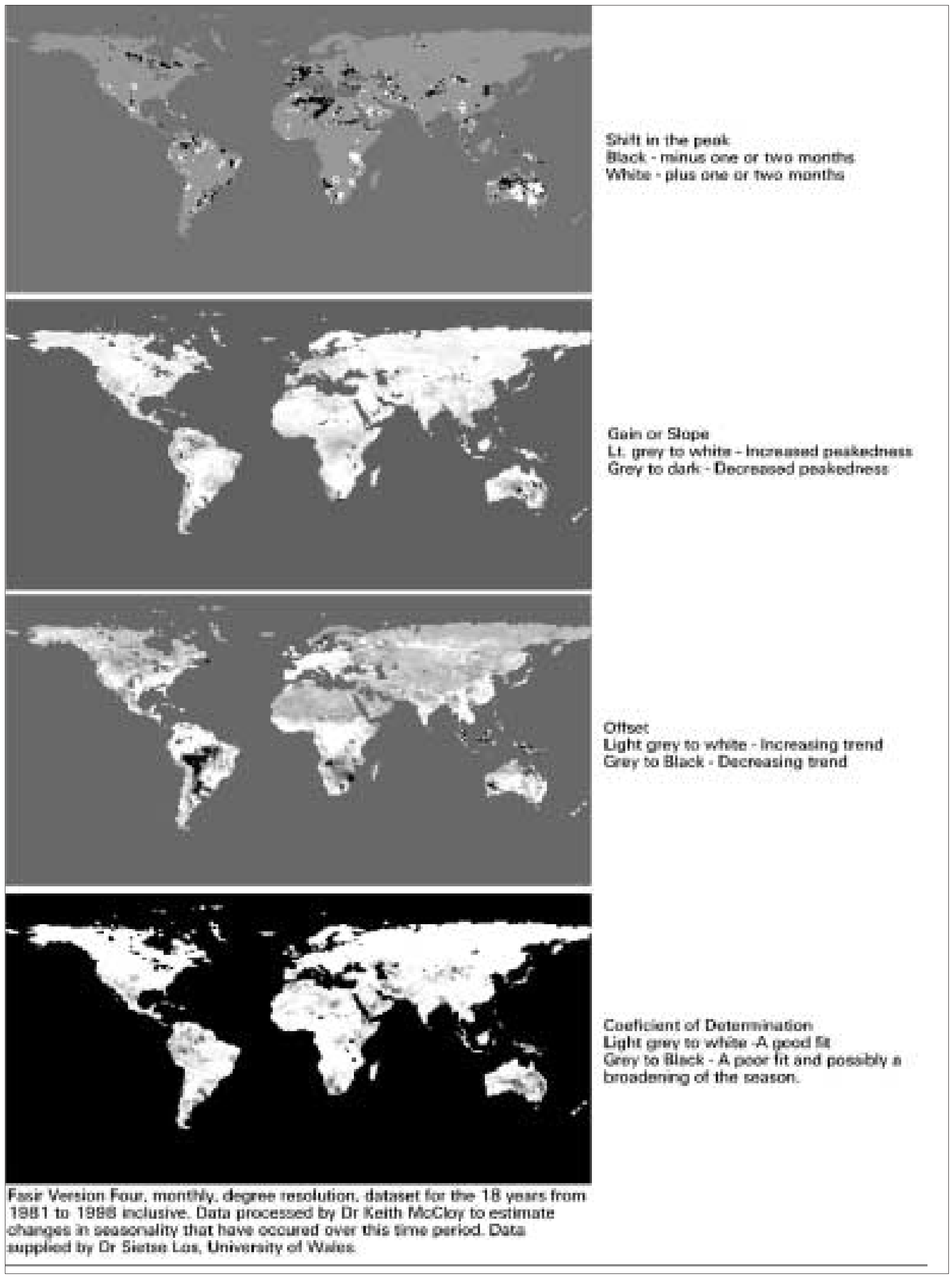
A trend is defined as a uniform change in the vegetation status throughout the year, whilst a change in seasonality occurs when there are differential changes within the season. There are different causes for a trend and a change in seasonality, and these can be expressed differently in their effect on the trend and the seasonal profile.



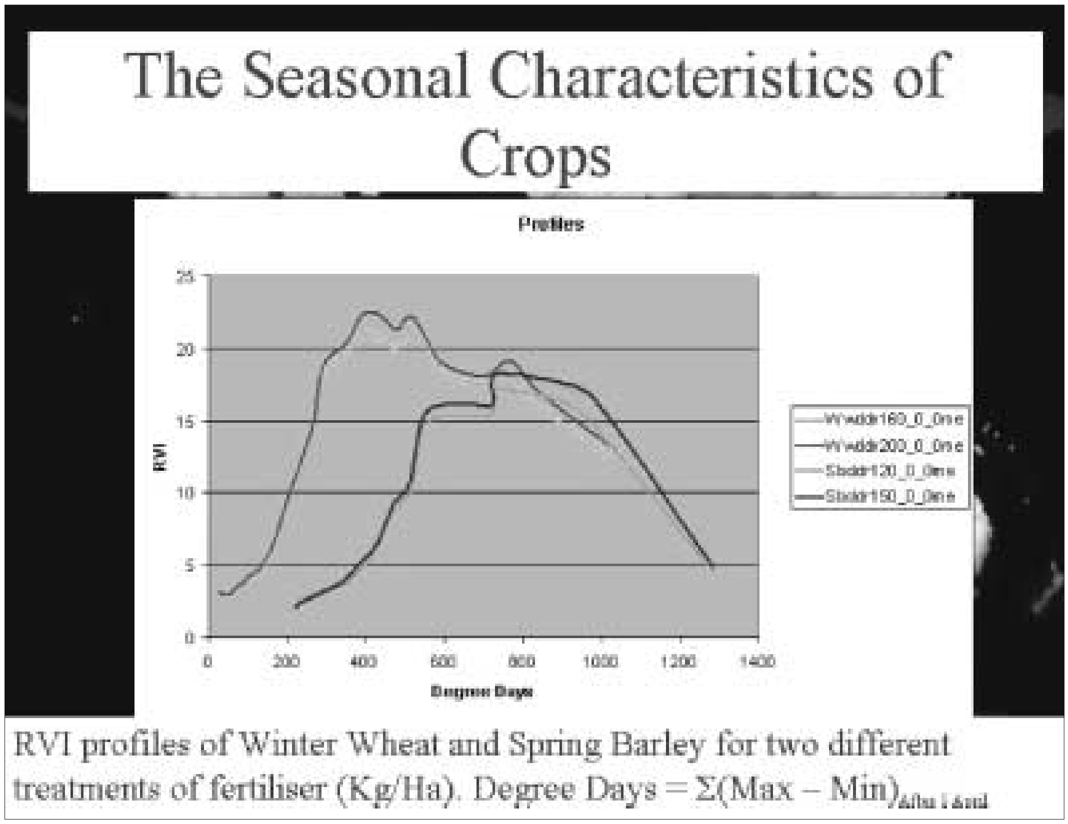
There are four ways that vegetation can change:-

1 A trend or a uniform change across the year,
2 A change in peakedness,
3 A broadening of the season, and
4 A shift in the peak of the season.

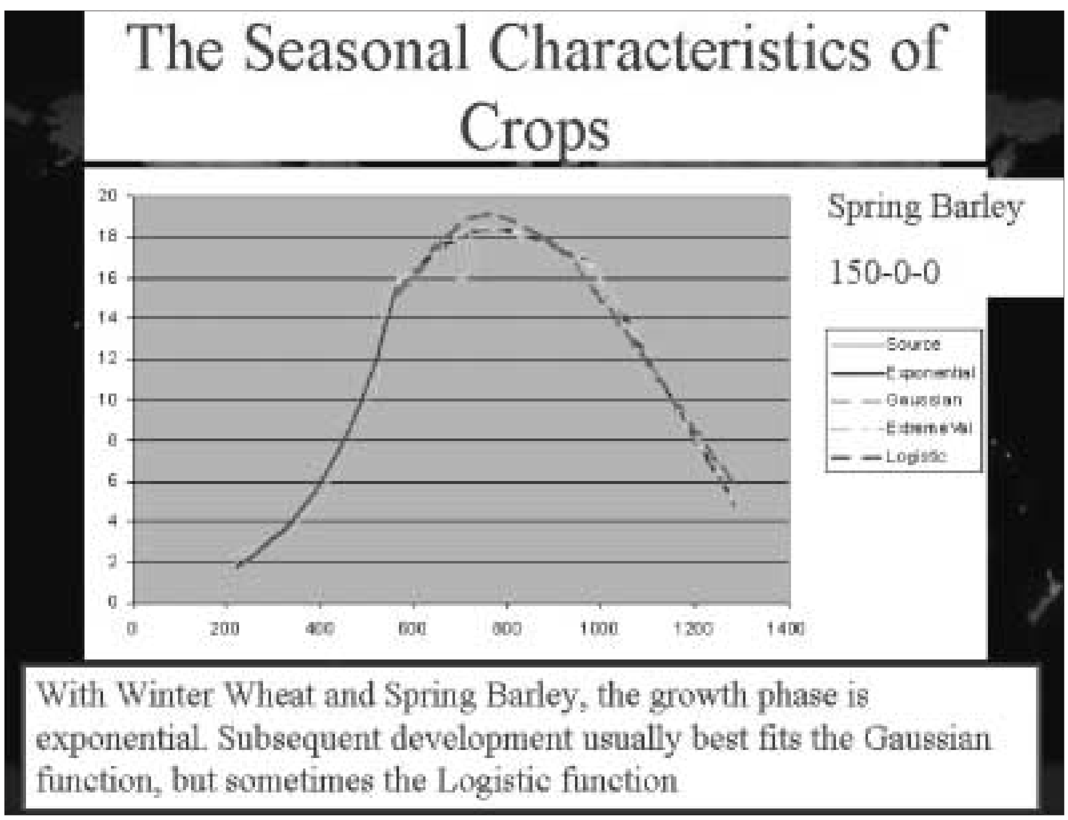
A trend can occur when the changes in temperature and rainfall allow increased growth throughout the year. A change in peakedness can occur when rainfall limited vegetation receives more rain, allowing more growth in the season, but any changes in temperature are not sufficient to enable growth out of the season. A change in the length of the growing season can occur when changes in temperature allow for a longer growing season and a shift in the peak can occur when changes in temperature allow the earlier growth of annuals that are genetically programmed to grow, flower, fruit and die.



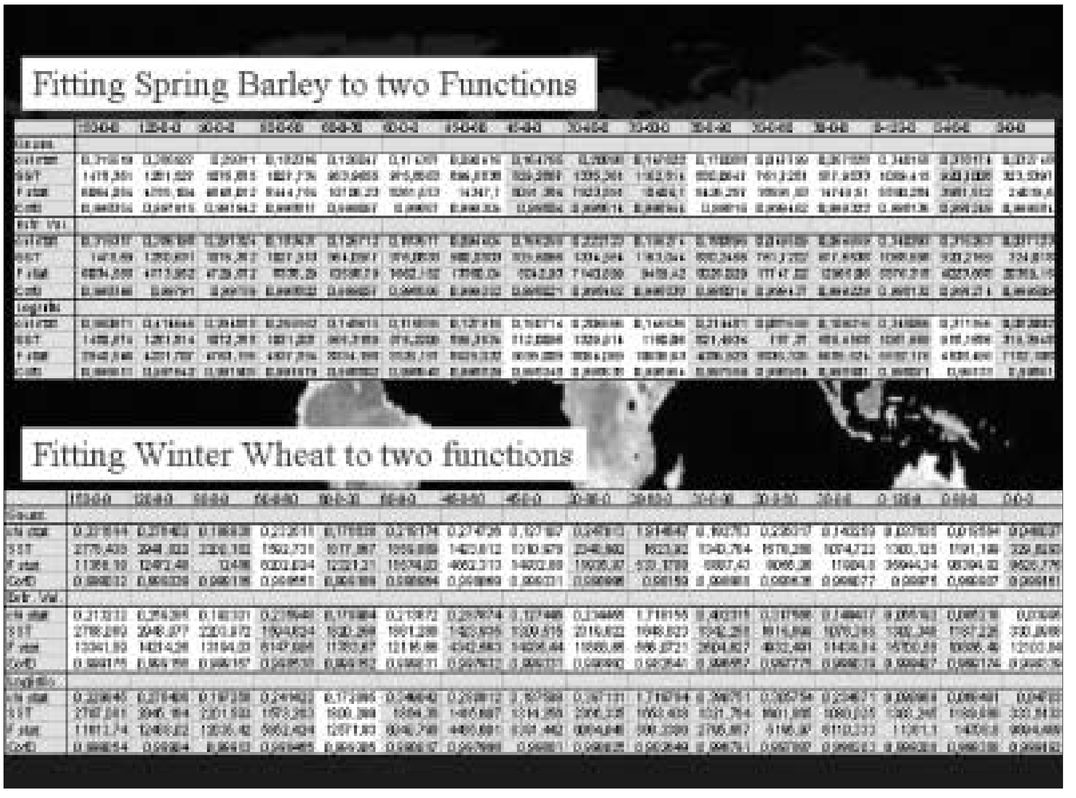
This figure shows shifts in the peak, changes in peakedness, trends and broadening for the vegetation around the globe using the Fasir V4 data set supplied by Dr Sietse Los of the University of Wales.



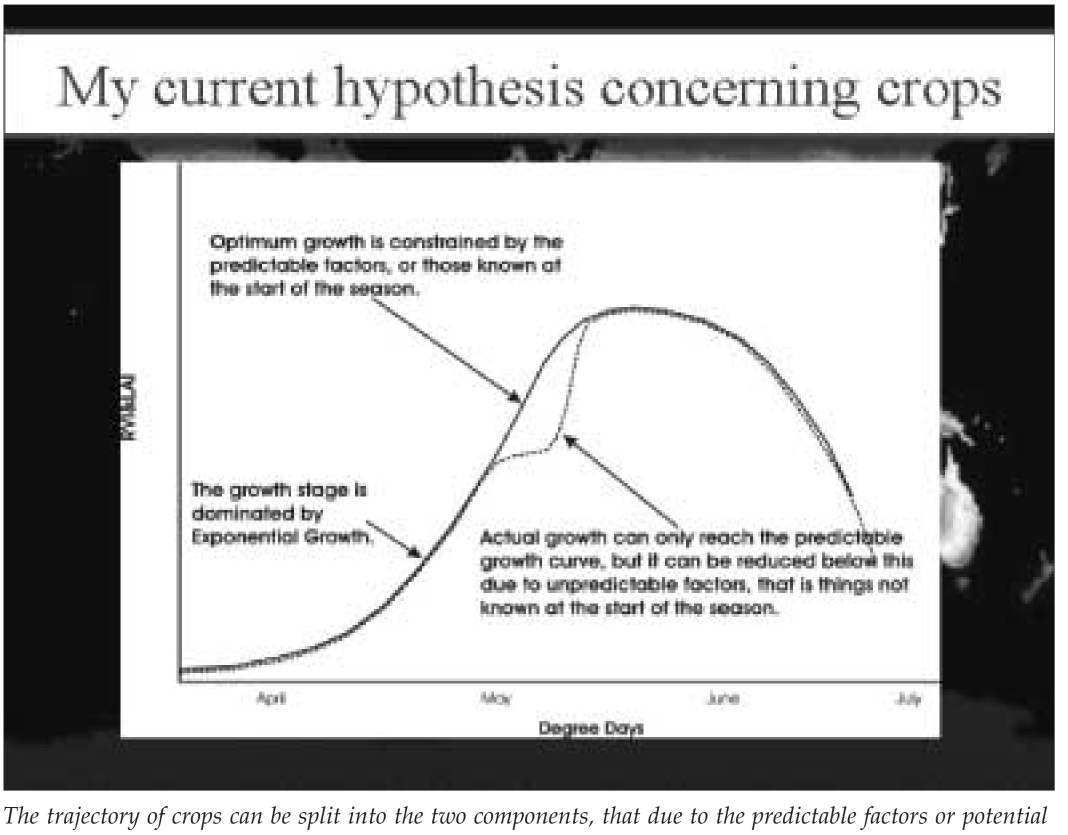
Let us further consider some of the seasonal characteristics of crops.



With crops, the envelope to the seasonal profile is best fitted using two functions; the exponential function for the growth phase and a peak function for the mature phase, such as the Gaussian model.



F Statistic values for the fitting of two functions to various fertiliser treatments of Winter Wheat and Spring Barley.



The trajectory of crops can be split into the two components, that due to the predictable factors or potential growth, and the reductions from this caused by the unpredictable factors, giving actual growth.

THE HYPOTHESIS

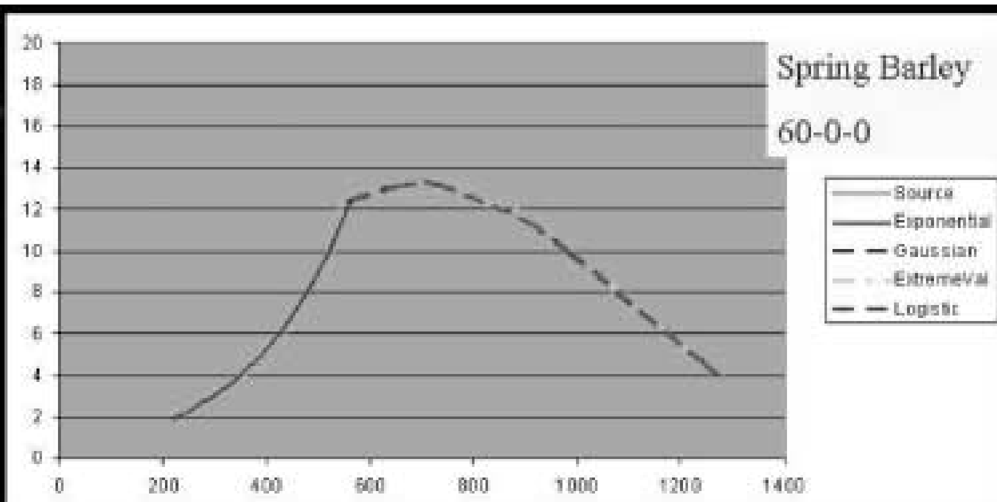
"Crops will attempt to grow up to the constraints imposed on them by the predictable factors, or those known in advance, but they will not achieve this due to the impact of the unpredictable factors during the season"

The predictable factors can be known and as such they can be modelled. **They represent potential growth.**

The unpredictable factors are not known in advance and as such they cannot be modelled accurately. **They result in actual growth.**

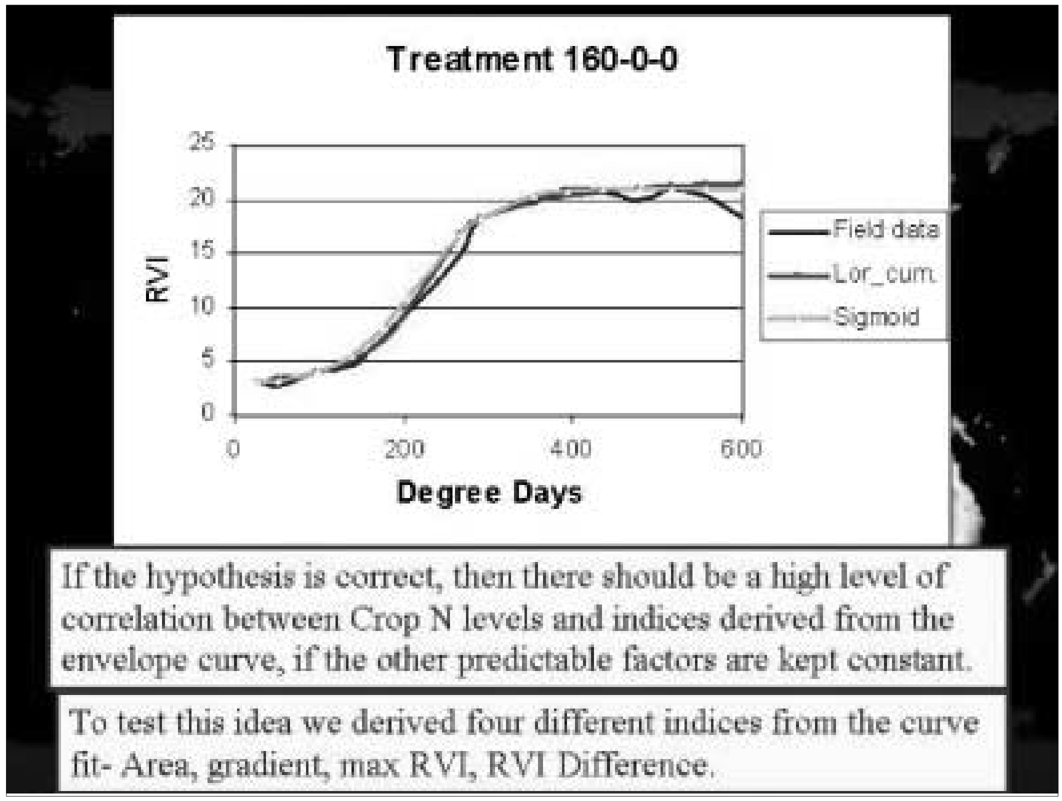
The predictable factors include soil, terrain, plant type, and average radiation.

The unpredictable factors include soil moisture deficit, disease and predation.

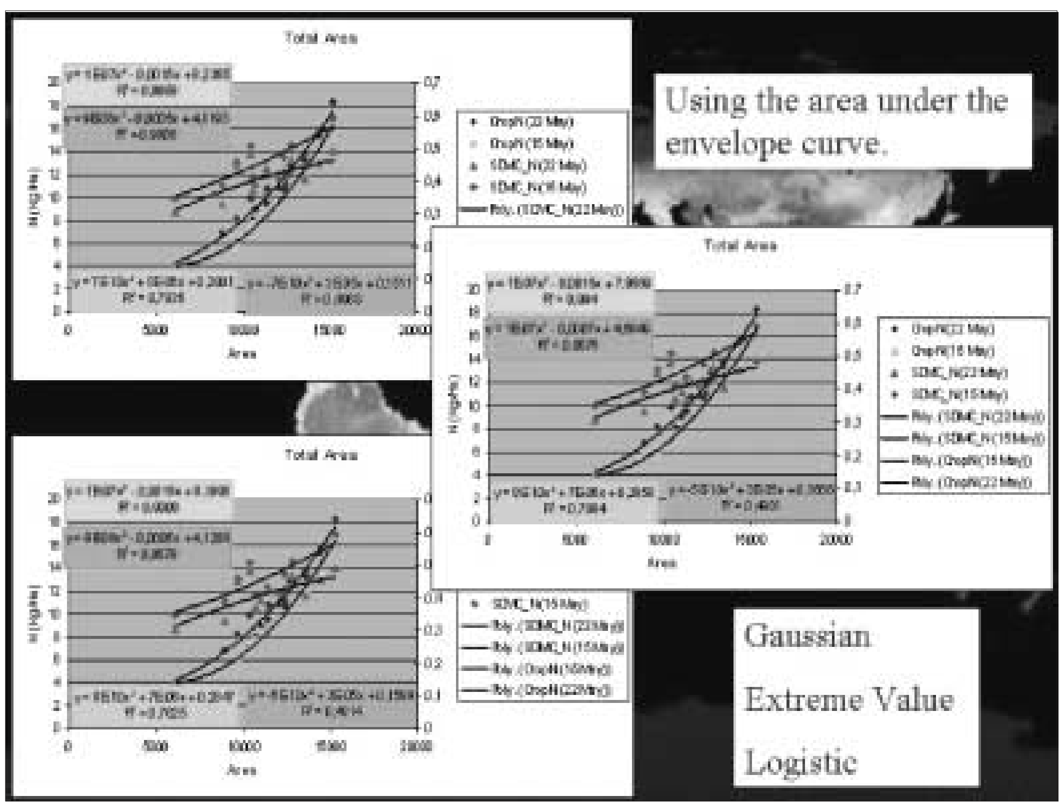


The envelope curve tells us about the integration of the predictable factors; if we know the status of all of them except one, then we can estimate that one, eg crop Nitrogen levels.

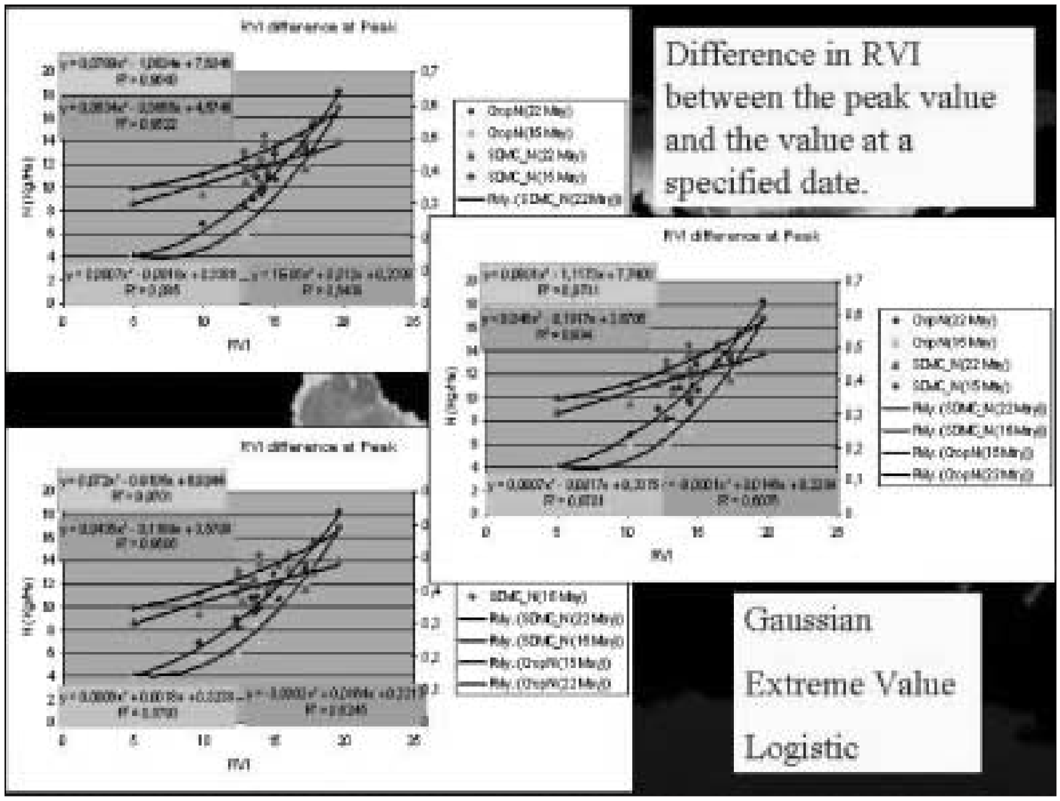
The difference between the envelope curve and the actual curve tells us about the integrated impact of the unpredictable factors; if we know that it is due to one factor then we can estimate its impact.

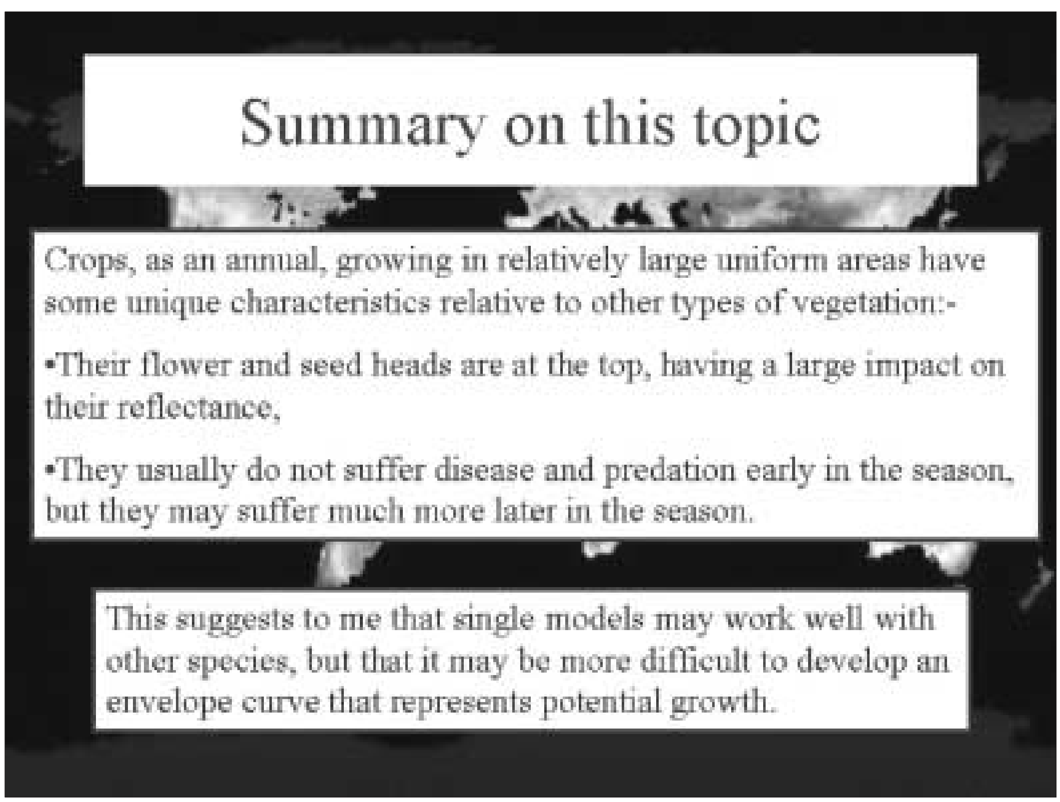


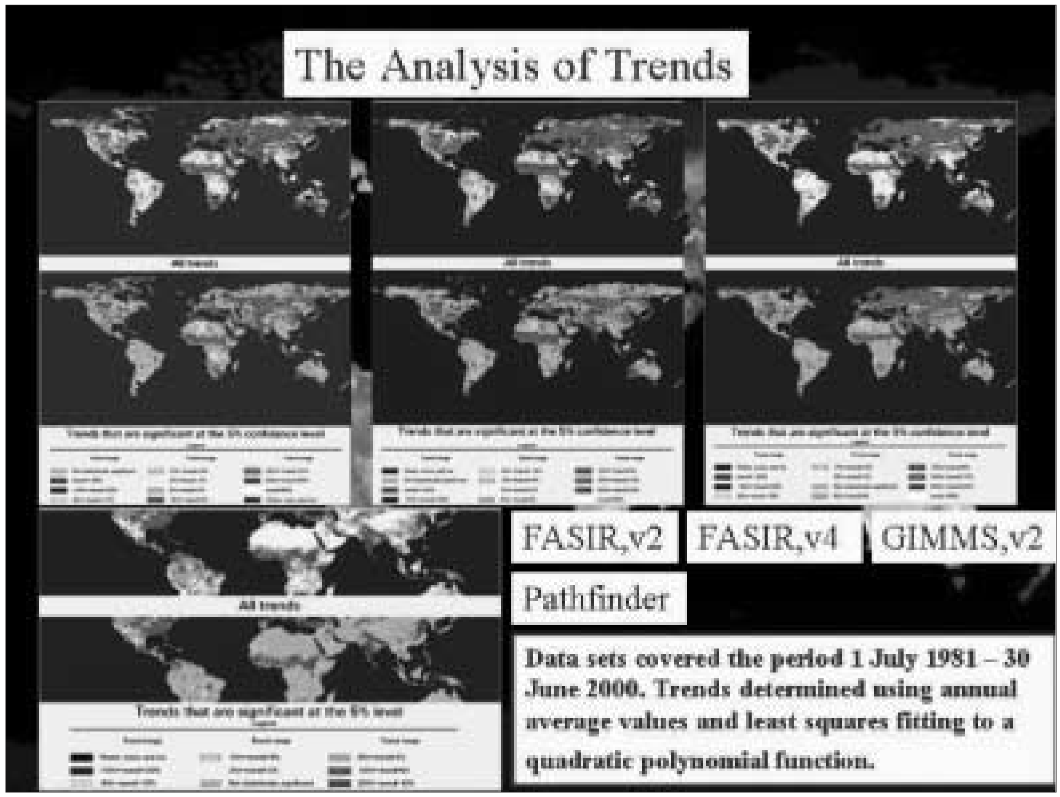
The actual data and its envelope fit, used to derive indices that are meant to be indicative of crop growth.



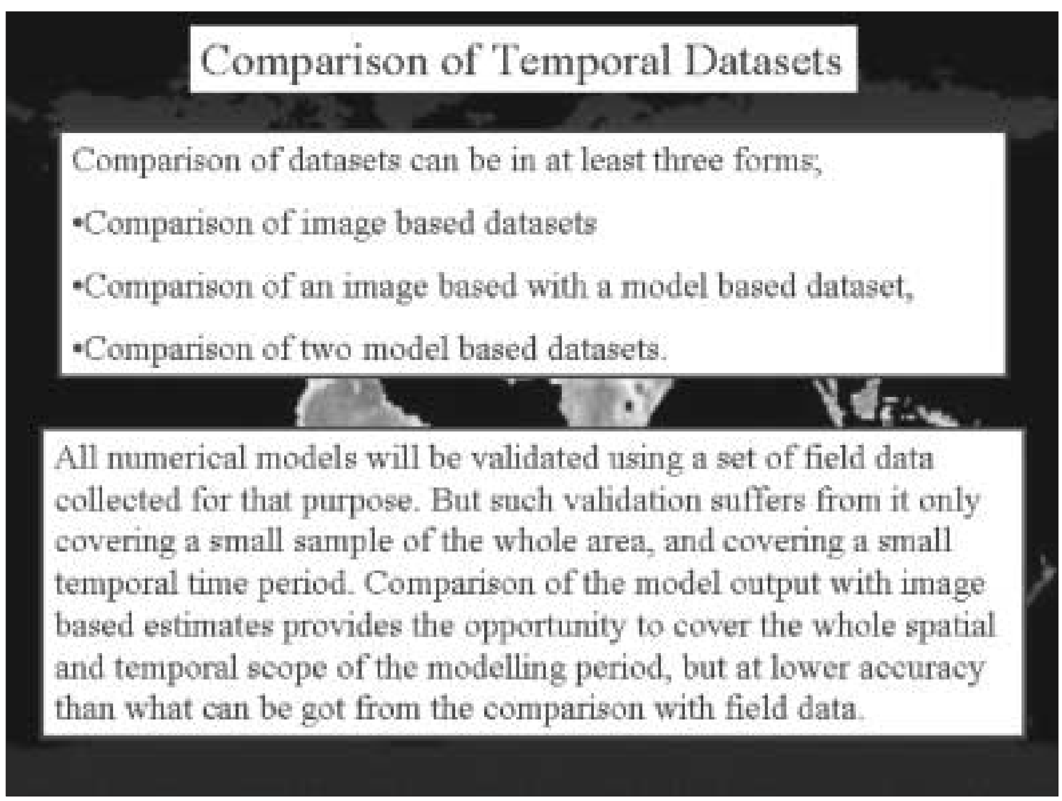
Regressions of some of these indices against Crop N content, where the plot data are all on the same soil type, so that the only predictable variable is variations in soil fertility, dominated by the application of fertiliser. For image data, where other predictable factors also can vary, then the correlation is not so good.


Difference in RVI between the peak value and the value at a specified date.
RVI difference at Peak
RVI
Gaussian
Extreme Value
Logistic

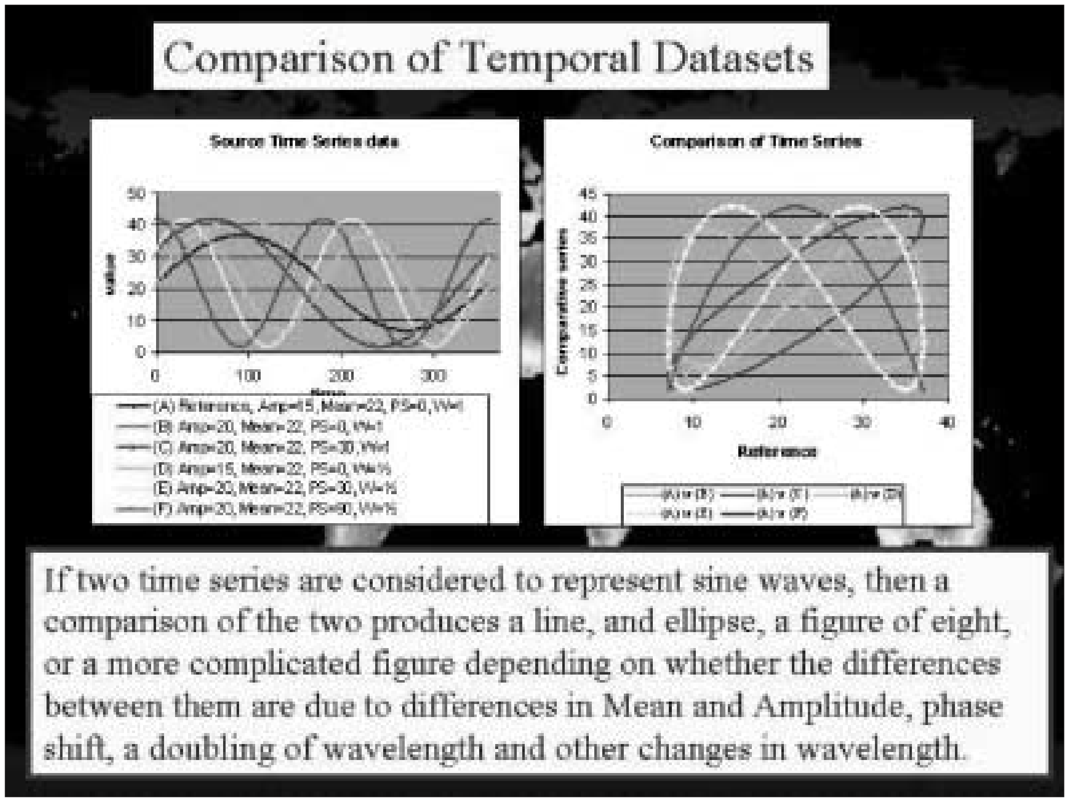

Summary on this topic
Crops, as an annual, growing in relatively large uniform areas have some unique characteristics relative to other types of vegetation:-
•Their flower and seed heads are at the top, having a large impact on their reflectance,
•They usually do not suffer disease and predation early in the season, but they may suffer much more later in the season.
This suggests to me that single models may work well with other species, but that it may be more difficult to develop an envelope curve that represents potential growth.



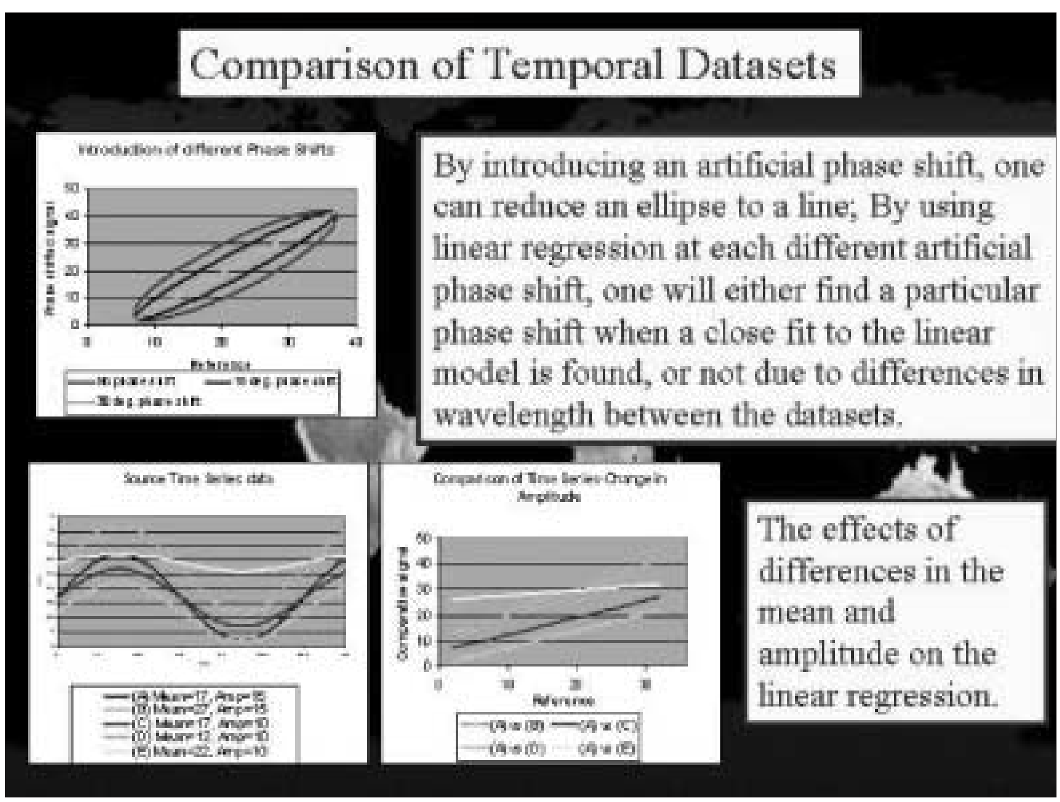
Analysis of trends in NDVI using four different long term global datasets based on AVHRR data all show an increasing trend. But this trend masks what is actually happening to the vegetation.

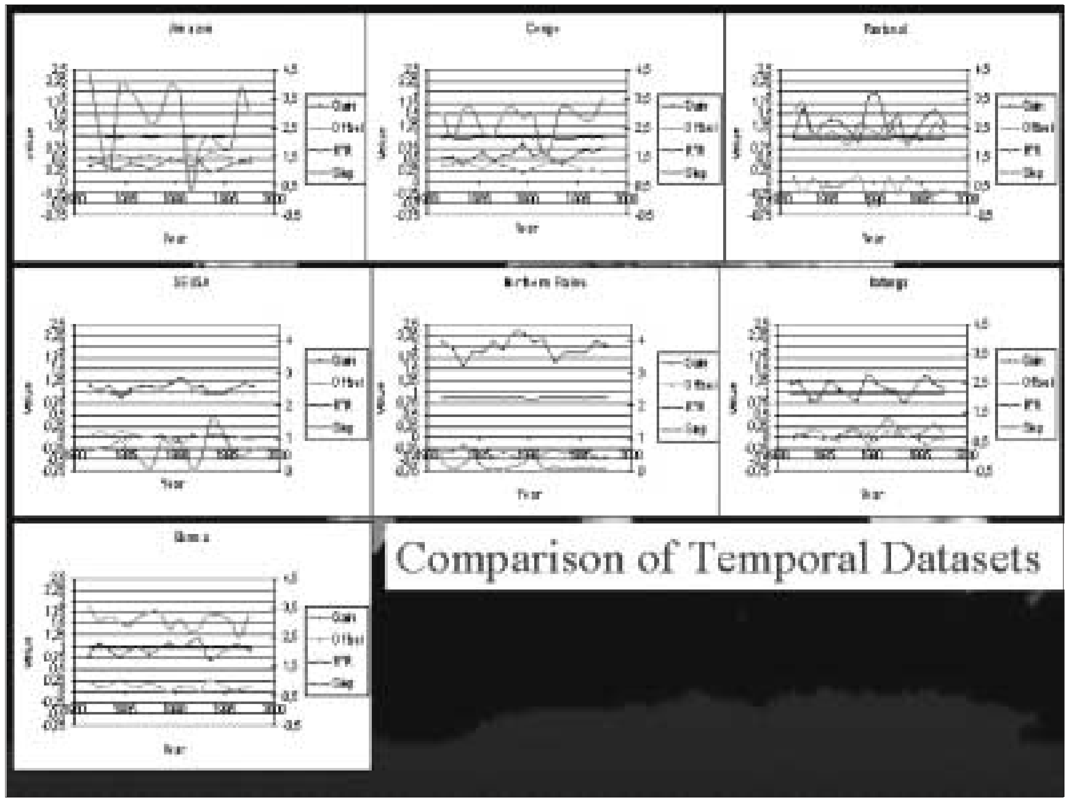


There is also the need to compare temporal datasets.

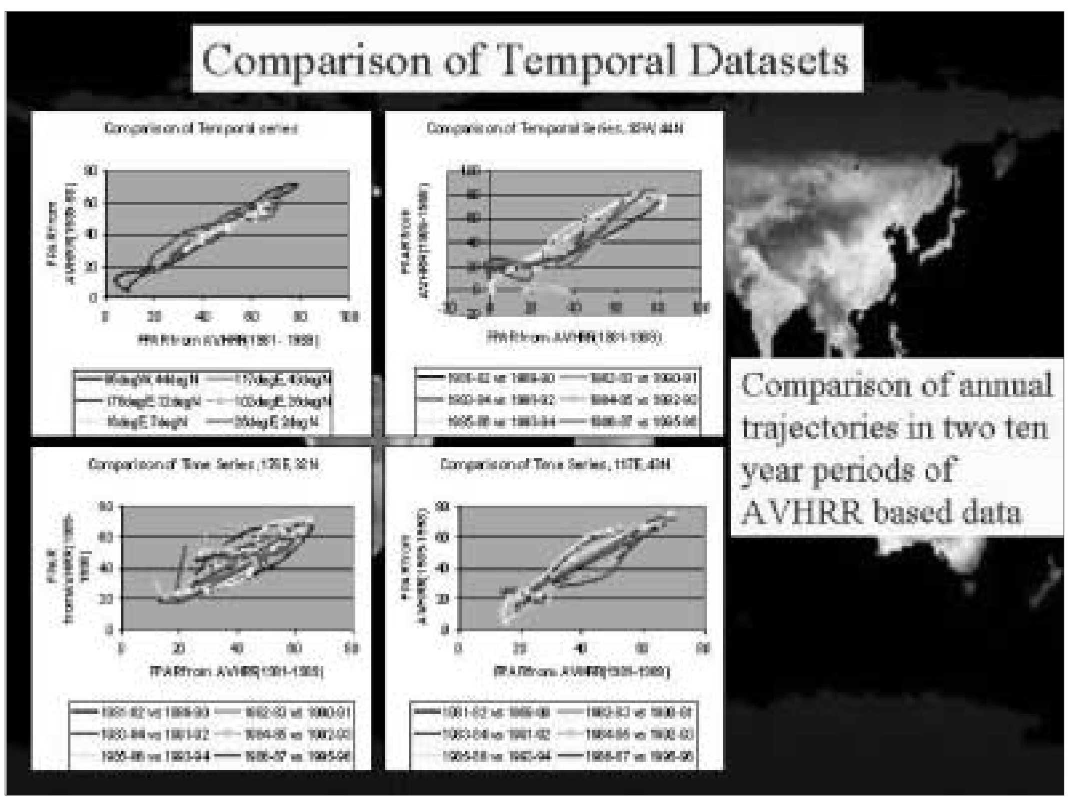


The theoretical basis for the method of comparison that I have developed.

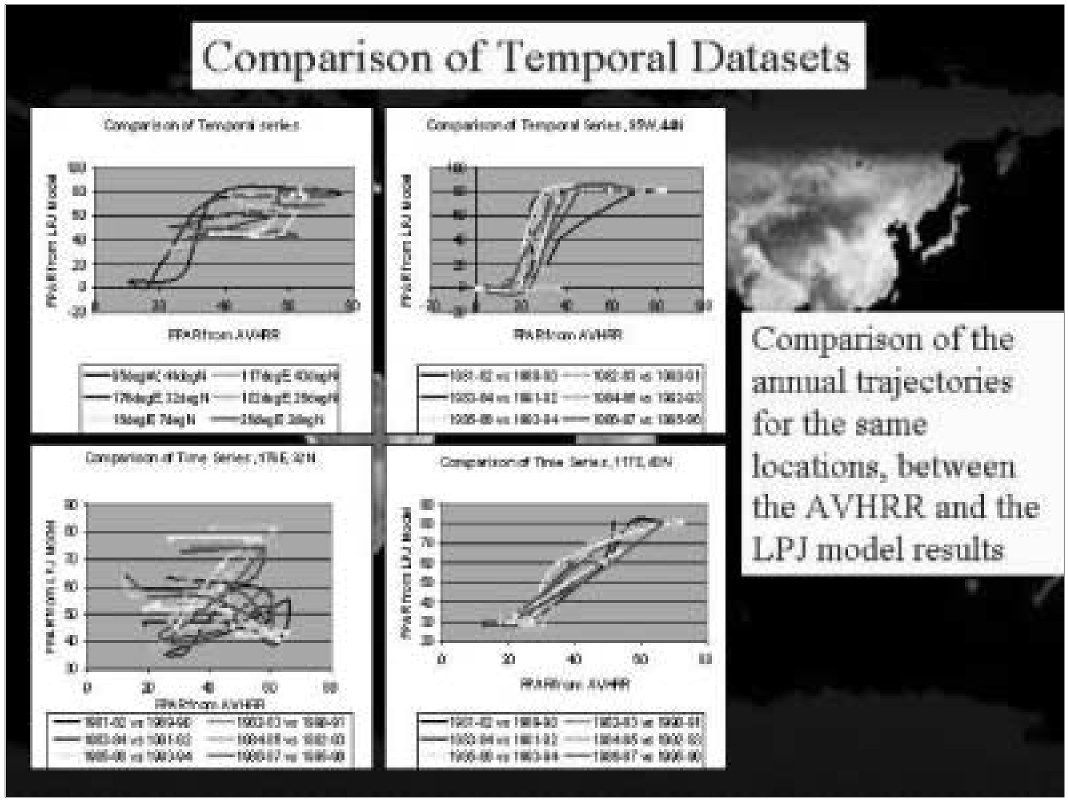




Changes in the shift, gain, offset and Coefficient of Determination for selected sites around the globe as derived from this comparison. The advantage of this approach is that the parameters all have a meaning in terms of the nature of the change that has occurred.



Comparison for four sites; the differences are due to the weather. Most of the sites are strongly linear.



Comparison for the same sites, between the AVHRR based data and the global vegetation process model estimate of vegetative status. The lack of linearity indicates a significant difference between the satellite based record and the model estimate of vegetative growth.

Keith McCloy, keith.mccloy@agrsci.dk

3.4 Workshop on the analysis of time series data at Bolzano

Program, Thursday, 7th June 2007

0900 – 1430 Registration
1430 – 1500 Coffee
1500 – 1700 Pre-processing of Image Data
1900 Workshop Dinner

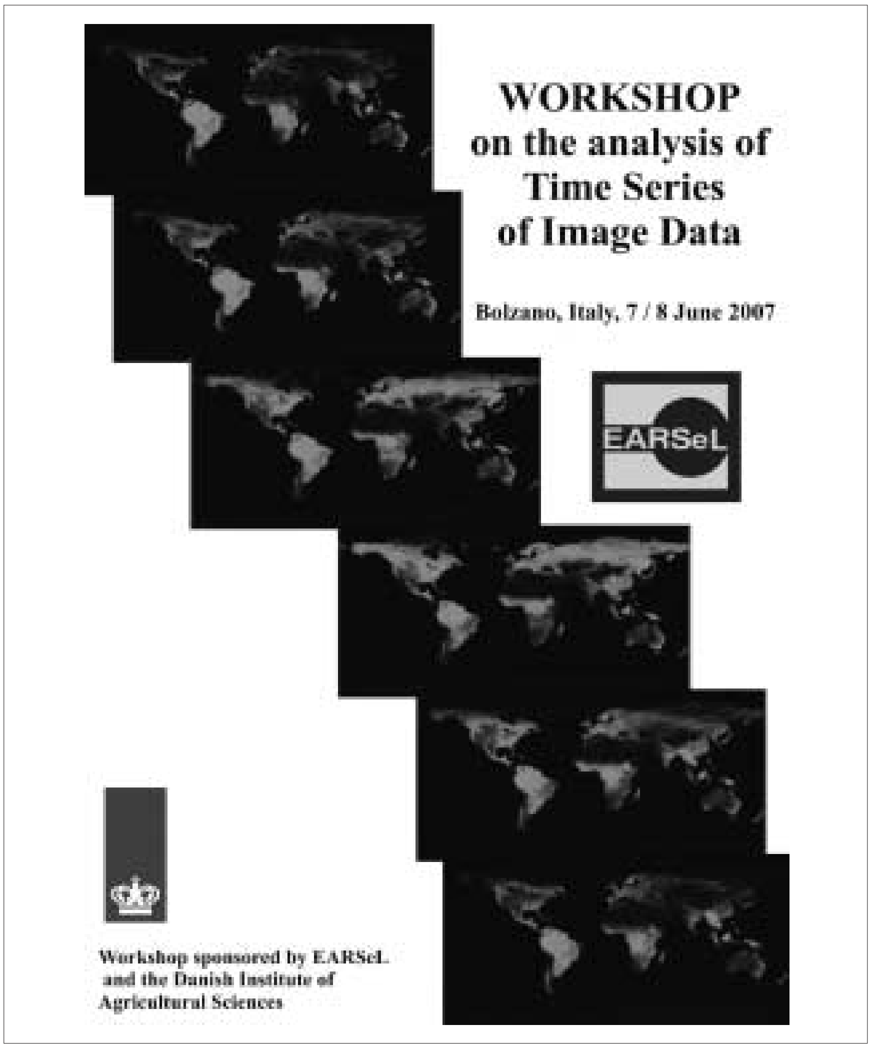
Program, Friday 8th June 2007

0830 – 1030 Classical Time Series Analysis
1030 – 1100 Coffee
1100 – 1200 The Analysis of Seasonality
1200 – 1300 Lunch
1300 – 1400 The Analysis of Seasonality – cont'd.
1400 – 1430 Coffee
1430 – 1630 Issues of dimensionality
1630 – 1700 Closing Session

The images shown are of NDVI in February, April, June, August, October and December 1982, Fasir dataset, supplied by Dr Sietse Los, University of Wales.

The purposes of the workshop are to:

- Discuss the issues and needs in the adequate pre-processing of image data so as to provide a consistent data set for temporal analysis and learn about some of the available time series datasets.
- Learn about the classical methods of time series analysis and consider how it may be adapted to the analysis of image data.
- Learn about the latest techniques in the analysis of seasonality and how to measure its changes in image data.
- Discuss issues of dimensionality (spatial, spectral, informational) in time series of image data and how to reduce this prob-

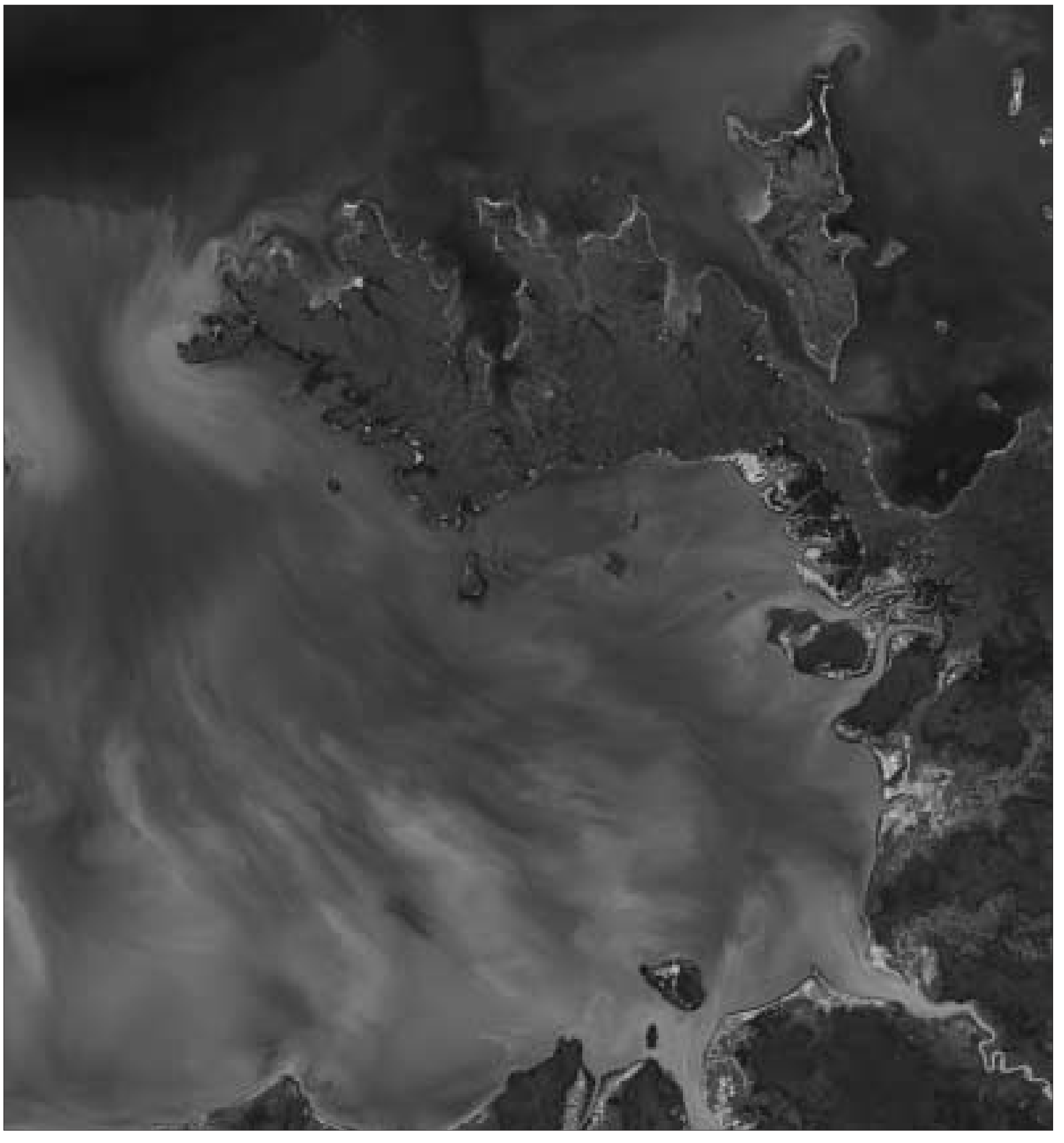


lem yet not remove information from the data.
- Provide attendees with the opportunity to display posters of their work during the workshop.

Registration for the workshop should be done through the EARSeL web page, www.earsel.org/welcome.html for the EARSeL Symposium.

3.5 Garig Gunak Barlu National Park, Australia

This is a Landsat image acquired on 30 July 2006 of the Garig Gunak Barlu National Park at the northern tip of Northern Territory, Australia. The park spans the whole of the peninsular and includes the surrounding waters of the Van Diemen Gulf and the Arafura Sea. Nearly the whole peninsula is Aboriginal land, and the park is managed as a sanctuary under the direction of traditional Aboriginal landowners. Diverse habitats—from coral reefs, to rainforests, to wetlands—are scattered across the park, which protects six different kinds of sea turtle and the largest wild herd of native Indonesian cattle, endangered in its native habitat. The Park is internationally important and was the first park in the world to be declared under the RAMSAR Convention because of it's significant wetlands.



A beach on Cobourg Peninsular.

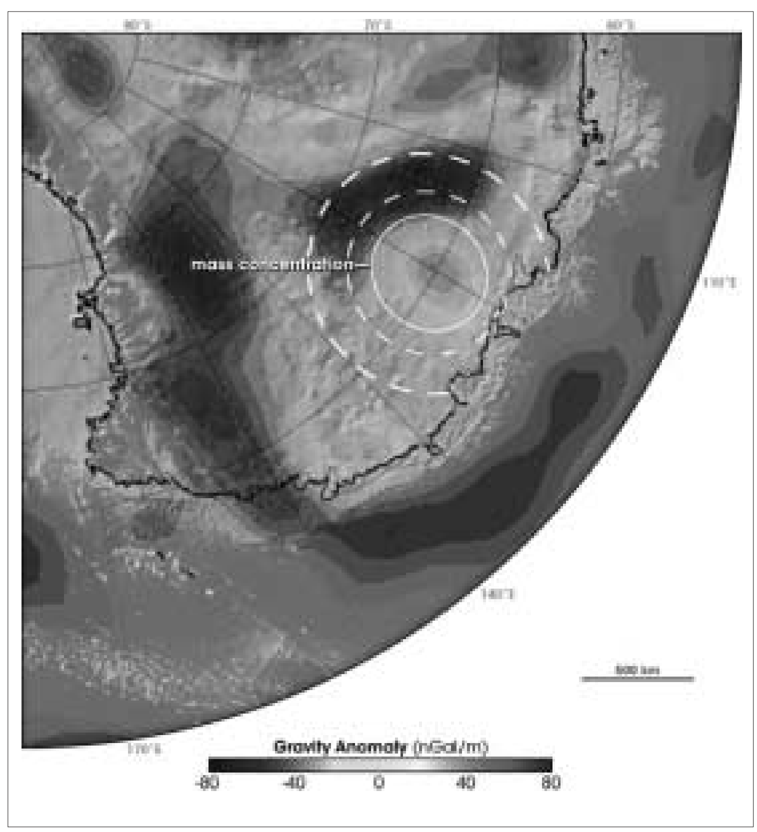
The peninsula is a narrow strip of land deeply carved by numerous bays, especially in the north, where white, sandy beaches create a bright perimeter. The southern coastline is dominated by mangrove forests, which appear deep green in the image, interspersed with sand and mudflats, exposed during the three metre low tidal zone, which appear white. The coastal waters are filled with sediment churned up by tides and stream outflow; the swirling sediment steaks the blue waters with white ribbons. The dominant vegetation type on the peninsula is open eucalyptus woodland. The openness of the woodland means that the peninsula isn't blanketed with green; the brownish colour of much of the landscape is from the dead herbaceous vegetation during the dry season (May to September) and exposed soil.

3.6 A gravity anomaly in Antarctica may be a meteor impact site

Launched on March 17, 2002, NASA's Gravity Recovery and Climate Experiment (GRACE) takes detailed measurements of Earth's gravity field from space. GRACE consists of two satellites that assess differences in Earth's gravity field by tracking tiny changes in their distance from each other. Areas on Earth with greater gravity—known as mass concentrations—pull the leading GRACE satellite away from the trailing satellite.

In June 2006, researchers at Ohio State University announced that GRACE had found a mass concentration under the ice in East Antarctica. This image shows GRACE's measurements of gravity, indicated in galileos. Areas with more intense gravity appear in red, and areas with less intense gravity appear in blue. Yellow and green show levels in between these extremes. Not far from the coast is a 320-kilometer-wide mass concentration, outlined in white. This spot attracted the researchers's attention.

The mass concentration GRACE detected indicates an area containing unusually dense material. Such mass concentrations can result from more than one cause. One possible explanation is an upwelling of volcanic rock from deep within Earth's crust. Ralph von Frese, a geology professor at Ohio State University, proposed that the mass concentration may have resulted from an asteroid impact.



The approximately circular mass concentration found by GRACE in Antarctica that is attracting a lot of attention as a possible meteor impact site.

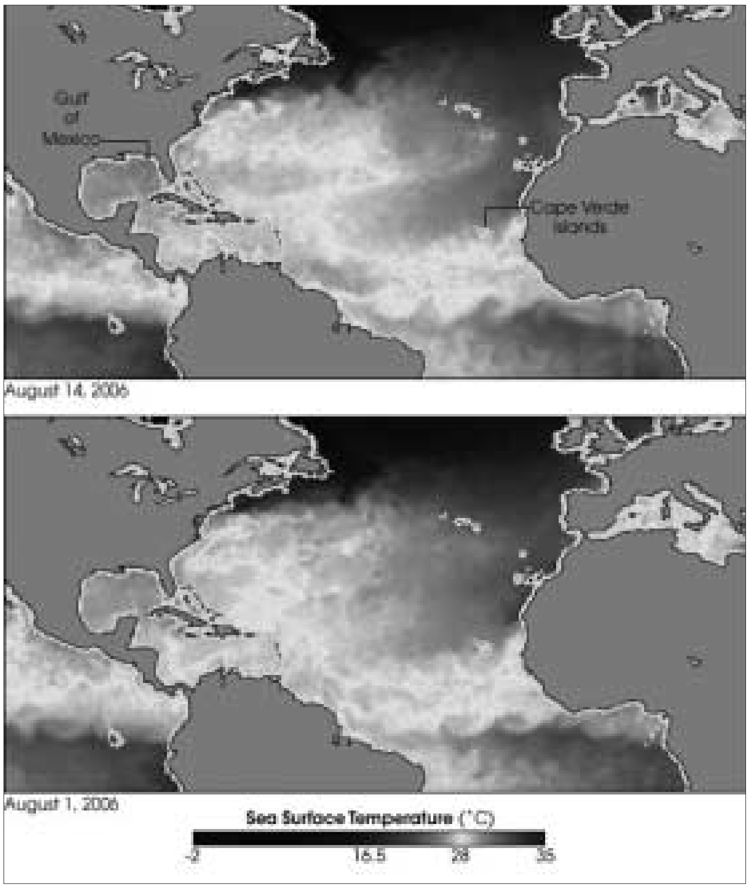
Approximately 251 million years ago, our planet experienced the worst extinction in its history. Called the Permo-Triassic extinction, this event was far more destructive than the extinction event 65 million years ago that ended the Age of the Dinosaurs. An asteroid impact is widely believed to have caused the dinosaur extinction, and a crater that dates to that time is located on the Yucatan Peninsula. Although multiple explanations have been proposed for the earlier, Permo-Triassic extinction, Von Frese supports the view that an asteroid impact caused it, too. According to Von Frese, the mass concentration GRACE detected in Antarctica could be the crater from an asteroid that triggered the Permo-Triassic extinction.

GRACE's discovery is just the first step in understanding this mass concentration. More clues can come from a visit to the site, as well as chemical analyses that provide a geologic age for the rocks in that area. If the rocks date to the same time as the Permo-Triassic extinction, GRACE may have made an important discovery about the history of life (and death) on Earth.
Source: http://earthobservatory.nasa. gov/Newsroom/NewImages/imagesphp3?img_id=17375

3.7 The risk of hurricanes in the USA is still above average this year

In early August, forecasters at the National Oceanic and Atmospheric Administration (NOAA) revised downward slightly their early-season predictions of the 2006 Atlantic hurricane season. Citing atmospheric and oceanic conditions less conducive to hurricane formation than they initially expected, the National Hurricane Center decreased its predictions of named storms (12-15 instead of 13-16), hurricanes (7-9 instead of 8-10), and major hurricanes (3-4 instead of 4-6). The revised prediction is still above-normal compared to the long-term average.

This pair of images from Japan's Advanced Microwave Scanning Radiometer for EOS Aqua satellite shows areas where sea surface temperatures were hurricane-ready on August 14, 2006 (top), and August 1 (bottom). Sea surface temperatures warmer than a threshold of about 28 degrees Celsius (about 82 degrees Fahrenheit) are one of the required ingredients for hurricanes to form. Areas where waters have reached the hurricane-ready threshold are yellow or red in these images, while areas where



Sea surface temperatures on 14th (top) and 1st (bottom) August waters are generally too cool to support hurricanes are blue. Coastal areas where temperatures were not measured are light gray.

The expanse of hurricane-ready water between Africa and the Gulf of Mexico grew over the two-week period. The color of the Gulf of Mexico became a deeper red, as well; any storms steered into the region would find ample warm water to keep them going. According to NOAA, although sea surface temperatures in the tropical Atlantic did not warm as much as originally forecasted, they are nevertheless still above long-term average conditions, which will likely contribute to above-average hurricane activity from August-October.

Among the other factors that NOAA expects to contribute to hurricane activity over the remainder of the 2006 season is a hurricane-favorable configuration of the African easterly jet, a strong easterly (from the east) wind in the middle levels of the atmosphere over West Africa. Waves of turbulence spin off this jet and head westward over the Atlantic; some of these easterly waves spawn hurricanes. Hurricanes that arise from African easterly waves are sometimes called "Cape Verde storms." In mid-August 2006, NASA, NOAA, university, and international scientists will converge on the Cape Verde Islands to conduct a major field research campaign to study these easterly waves. Using satellites, and ground- and aircraft-based instruments, the scientists will gather data that will help explain why some easterly waves intensify into hurricanes while others do not, as well as how and why the strength, location, and frequency of easterly waves change from year to year. Among the key questions is how dust sweeping over the Atlantic from the Sahara Desert influences hurricane formation.

Source: - http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17368

4 FUTURE EVENTS

4.1 ISPRS MID-CONGRESS SYMPOSIUM

The ISPRS Commission VII mid-congress symposium, 'Remote Sensing Applications for a Sustainable Future', will be held between 4-7 September 2006, Haifa, Israel. Tutorials and Workshops, will be held prior to the symposium.

For more details please contact: -
ISPRS8 [isprs8@geo.haifa.ac.il]

4.2 Atlantic Europe conference on remote imaging and spectroscopy

Preston, United Kingdom, 11-12 September 2006
www.uclan.ac.uk/aecris
Funded by ERDF (European Regional Development Fund), endorsed by IAPR (The International Association for Pattern Recognition), and sponsored by 8 organisations in Europe, the conference provides a venue in the Atlantic area of Europe for presenting the current development, as well as networking and sharing experiences, with academics/engineers/researchers/scientists/specialists both in the region and in the rest of the world, on all aspects of sensing technologies, processing methodologies and applications related to remote imaging and spectroscopy.

The conference programme will include presentation sessions, poster sessions, demonstration of interactive and immersive stereoscopic visualisation, and social events. There will be best paper and poster awards. The conference language is English.

Prospective authors are invited to email an abstract (less than 300 words) of the proposed paper by email before 26 April 2006 to the Technical Chair, Dr. Matuszewski B J at bmatuszewski1@uclan.ac.uk.

Important Dates
Deadline for submission of abstract: 26 April 2006
Notification of acceptance (oral or poster): 15 May 2006
Submission of full paper for publication in conference proceedings: 21 July 2006

A poster is attached to provide further information and we look forward to receiving abstract from you and your colleagues.

Dr. Phil Holifield (Organising Chair)
Tel: 01772 893168
Fax: 01772 892901
Email: pholifield@uclan.ac.uk

4.3 Ninth international symposium on high mountain remote sensing cartography

The symposium will be held in Graz, Austria, from 14-22 September 2006. Call for abstracts is open until 31 January, 2006. For more details please visit http://www.kfunigraz.ac.at/geowww/hmrsc/hmrsc_9/

4.4 2nd workshop on landuse and land-cover

EARSeL Special Interest Group on LAND USE AND LAND COVER, will hold their second workshop in Bonn, from 28 – 30 September 2006.
For more details please contact: -

www.zfl.uni-bonn.de

4.5 Second Goettingen GIS and remote sensing days

The theme of the 2nd Göttingen GIS & Remote Sensing Days is 'Global Change Issues in Developing and Emerging Countries'. The meeting will beheld between 4th – 6th October 2006. For more details please contact: -

GGRS@uni-goettingen.de
URL: http://www.ggrs.uni-goettingen.de

4.6 27th EARSeL symposium, Bolzano, Italy

The 27th EARSeL Symposium will be held in June 2007 in Bolzano, Italy. Registration through the EARSeL Home Page.

5 WEB ADDRESSES

If you know of other good e-sites for news and information, data or advice that you wish to share with your colleagues, please let me know as I will publish those that are relevant in future editions of the newsletter.

5.1 Electronic news sources

Genacs GMES e-news
This E-News is published by the GENACS Consortium – GENACS is a 6th FP Specific Support Action funded by the European Commission/Directorate General Enterprise and Industry. The views expressed in this E-News are those of the authors and do not necessarily represent those of the European Commission or of the European Space Agency.

You can subscribe or unsubscribe to this E-News, see www.gmes.info and go to the Newsletter Section, menu item 'How to subscribe'. Contact: info@gmes.info

The GENACS E-NEWS covers the commonly distributed material from ESA, EU and other sources.

EO-Portal
The Earth Observation Portal provides a news service on al aspects of Earth Observation. You can register to have their e-news sent you through their web page at: http://www.eoportal.org/?=newsl20

NASA News
NASA distributes information about their activities as wel as those of supporting sci-

entists. You can have notification of the latest edition of this sent automatically to you through their web page at: -
http://earthobservatory.nasa.gov/Study/

ESA Portal
ESA provide news from their web site;
http://www.esa.int/esaCP/index.html

You can subscribe to receive your preferred ESA news on a variety of topics by going to: www.esa.int/esaCP/subscribers.html

You can also get a lot of information on Earth Observation including copies of about 790 images of different parts of the globe at

www.esa.int/esaEO/index.html

ASPRS Guide to land imaging satellites
The latest version of the ASPRS Guide to land imaging satellites, is now available at www.asprs.org/news/satellites/.

This version provides the most recent information on land imaging satellites. It replaces a version, which was distributed at the most recent Pecora 16 Conference in Sioux Falls. If you have questions and/or comments, please contact Bill Stoney directly at mailto:Wstoney@mitretek.org.

SARTREK
The Radarsat – 2 Newsletter carries a lot of information about preparations for Radarsat 2, as well as information about other activities related more to the analysis of radar data per se, including software, training courses, and so forth. You can register to automatically get the newsletter by contacting: -

clientservices@mdacorporation.com

GIS development weekly
This weekly electronic newsletter carries stories on Remote Sensing and Photogrammetry as well as GIS stories. You can register through: -
www.gisdevelopment.net/ezine/index.htm

Newsletter, European association of remote sensing companies
Contains stories related to EARSC and web addresses to many activities related to Remote Sensing.
http://www.earsc.org/newsletter/

Imageworld
Contains information on events in the mapping and Remote Sensing area.
http://mailman.itu.dk/mailman/listinfo/imageworld

or, via email, send a message with subject or body 'help' to imageworld-request@itu.dk

5.2 Sources of image data

Spot image
This is the source for existing SPOT image data and for placing orders for new data acquisitions.
www.spotimage.fr/html/_167_.php

NASA earth observing system data gateway locations
This portal gives you access to information on most of the NASA and USGS datasets that are available. You can enter as a guest, or you can register.
http://redhook.gsfc.nasa.gov/~imswww/pub/imswelcome/imswwwsites.html

Euromap
Distributes Indian IRS satellite data. They have some electronic search facilities and they will conduct searches for free.
www.euromap.de/site/index.html

Satellite imaging corporation
Sells Quickbird, Ikonos and SPOT-5 image data. www.satimagingcorp.com/

USGS
The US Geological Survey Depository of image and map data held by the USGS.
http://edc.usgs.gov/

EURIMAGE
Sells Quickbird, Landsat, ESA, Radarsat and IRS data
www.eurimage.com/

5.3 General sources of information

Wim Bakker's page
Wim Bakker has gone to a considerable amount of trouble to compile a list of Web

sites that may be of interest to the Remote Sensing community.
www.itc.nl/~bakker/satellite.html

The NASA remote sensing data and information page
Contains a lot of information about remote sensing, data sources within NASA and some applications.
http://rsd.gsfc.nasa.gov/RemoteSensing.html

CIESIN Page
Summarises how CIESIN see the role of Remote Sensing in the management of the earth's resources and environment.
www.ciesin.org/TG/RS/RS-home.html

Back Cover - Alaska fieldwork

The composition of images illustrates the reality of the fieldwork of this project in south-central Alaska, in which cost-reduction is of paramount concern. Instead of the typical twin engine survey airplane the smaller single engine Cessna 185 on the upper left is used and flown by the project scientist. Also expensive helicopter charters are not used in this project, the small two-seater Piper Pa18 bush plane is being used to get a cheaper access to the study area (in this case the Knik Glacier). On the lower left, one of the many "aluminium foil –glued on a rock" ground control point markers is depicted, those are installed by the sole fieldworker after hiking from one of the thirteen natural bush plane landing sites, like gravel bars in the rivers, were the airplane could be landed. The map on the upper right shows the locations of the Wolverine Glacier (upper inset) and the Knik-Colony-and Lake George Glaciers area in the lower inset image. The main technical aspect of the study is to seek ways to survey pinpoint targets with high accuracy and less dependency on weather conditions in a cost-effective way, utilising already existing technology.

(all images by first author, also processing and enhancement of the used satellite images and map data, base map by DeLorme Inc.; satellite images therein by Global Land Cover Facility; GLCF)