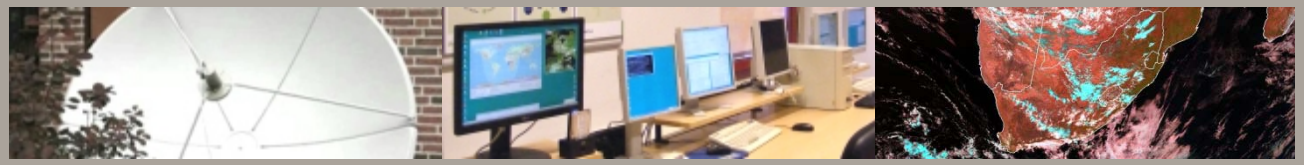
UNIVERSITY OF TWENTE.



GEO, GEONETCast and building a low cost ground receiving station

Ben Maathuis & Chris Mannaerts

Dept Water Resources

ITC-Enschede, The Netherlands

Layout of presentation

- Group on Earth Observation (GEO)
- Global EO System of Systems
- EUMETSAT's contribution to GEO: EUMETCast
- Services and data broadcasted
- Ground reception system components
- Data Management
- Concluding remarks

GEO: the Group on Earth Observations

An Intergovernmental Organization with 89 Member Countries, the European Commission and around 67 Participating Organizations

U.S. Department of State, Washington DC
July 31, 2003

GROUP ON EARTH OBSERVATIONS

GEO objectives

- Improve and coordinate earth (land & ocean) observation systems
- Provide easier and more open data access
- Foster use (science, applications) also through capacity building

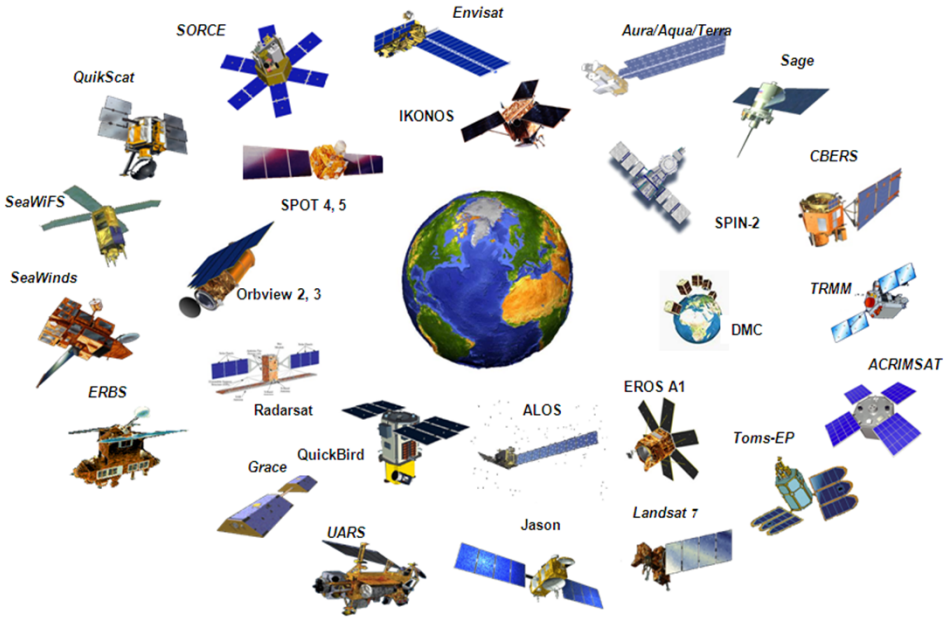
... to answer Society's need
for informed decision making

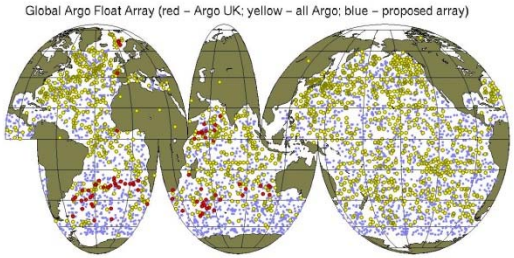
GOAL of GEO:

GEOSS: A Global, Coordinated, Comprehensive and Sustained System of Observing Systems

GEO open data access & sharing principles

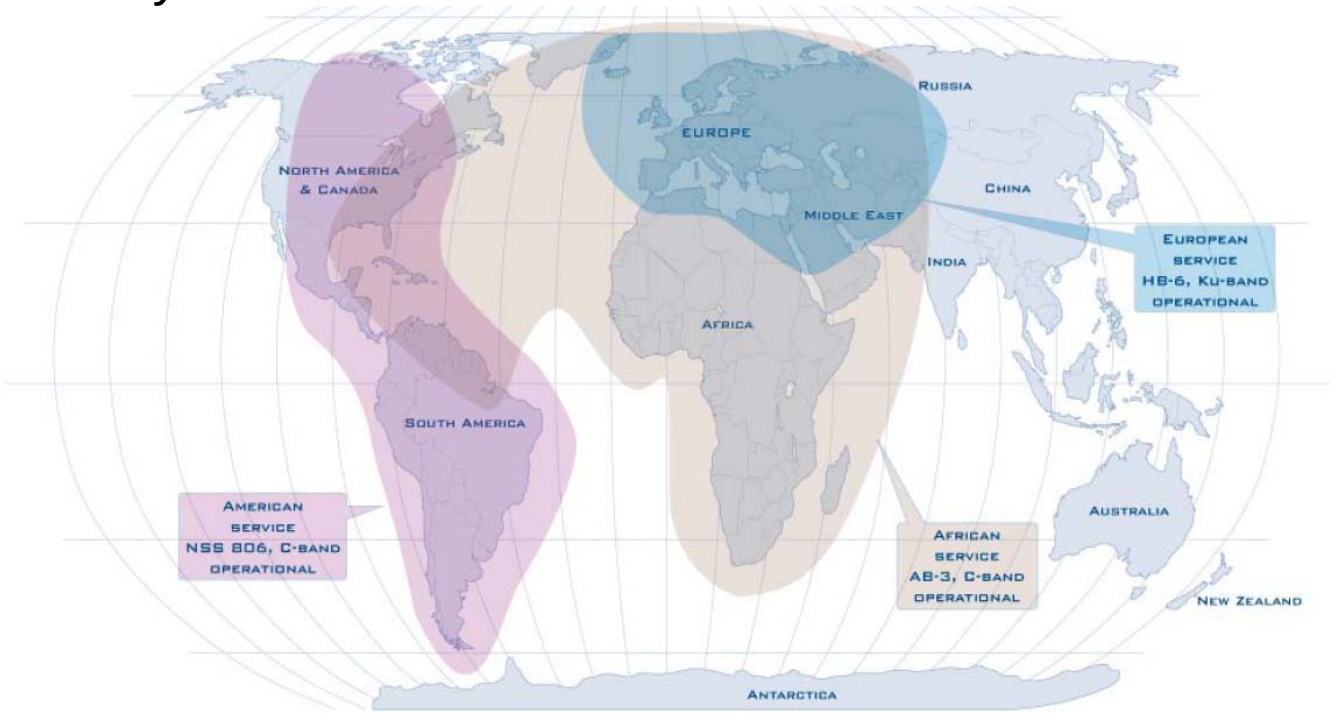
- Open Access & exchange of data (globally) from Airborne, Space based and *In Situ* Observation Systems
- Data and Products at Minimum Time delay and Minimum Cost
- Free of Charge or cost of reproduction for Research and Education





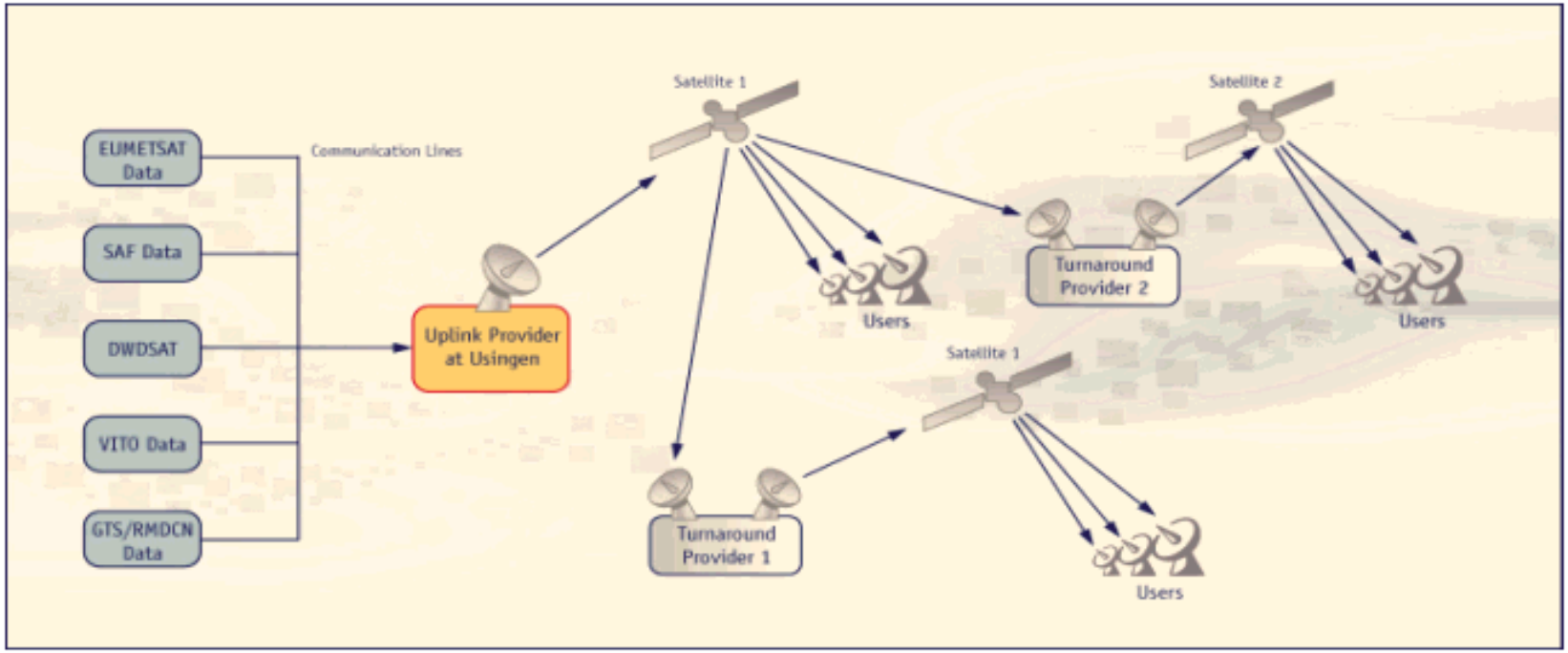
GEONETCast as backbone for data provision

GEONETCast provides free near real-time environmental and Earth observation data and derived products to a worldwide user community using a telecommunication satellite based data distribution system.



GEONETCast – system layout

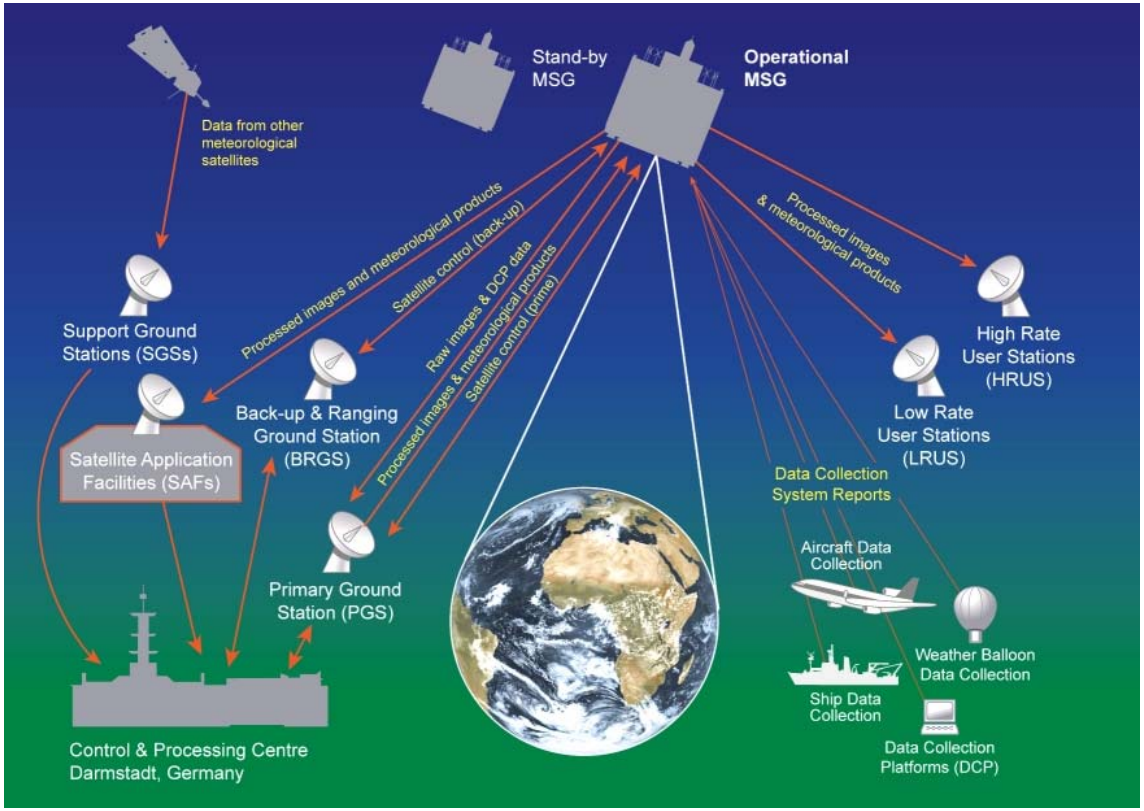
Layout of the GEONETCast telecommunication satellite based data distribution system



GEONETCast
Delivering Environmental Data to Users Worldwide

GEONETCast - Africa

Near real-time satellite image reception using a communication satellite based data distribution system, example MSG



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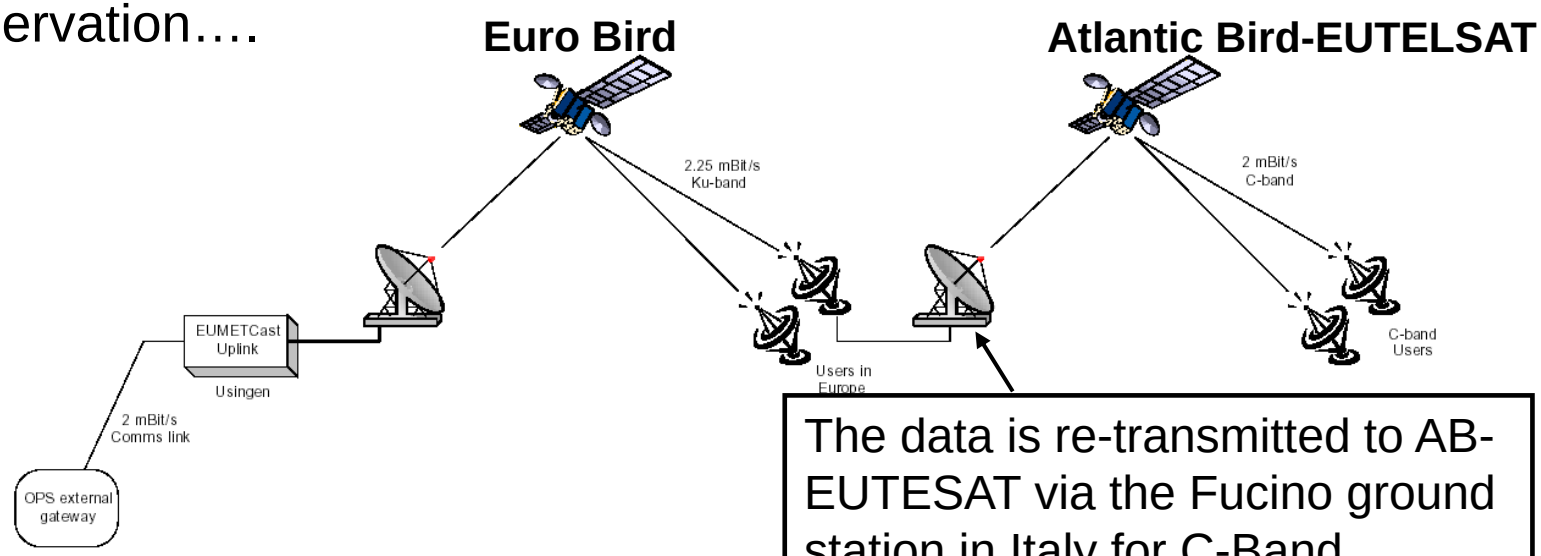
GEONETCast - Africa

After central ground processing at EUMETSAT, images in full resolution are transmitted in HRIT mode, within five minutes of observation….



The data is re-transmitted to AB-EUTESAT via the Fucino ground station in Italy for C-Band reception for African Users

Before the signal is received at a local ground receiving station it has traveled from MSG -> Darmstadt -> Usingen -> Eurobird -> Fucino -> AB-EUTELSAT -> Local Station (approximate distance is 5 * 36.000 km!!)

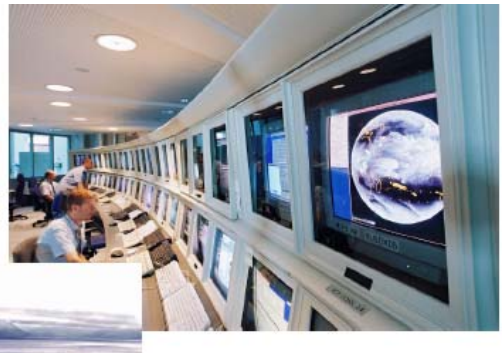


EUMETSAT

- Data and Services provided by EUMETSAT (The European Organisation for Exploitation of Meteorological Satellites):

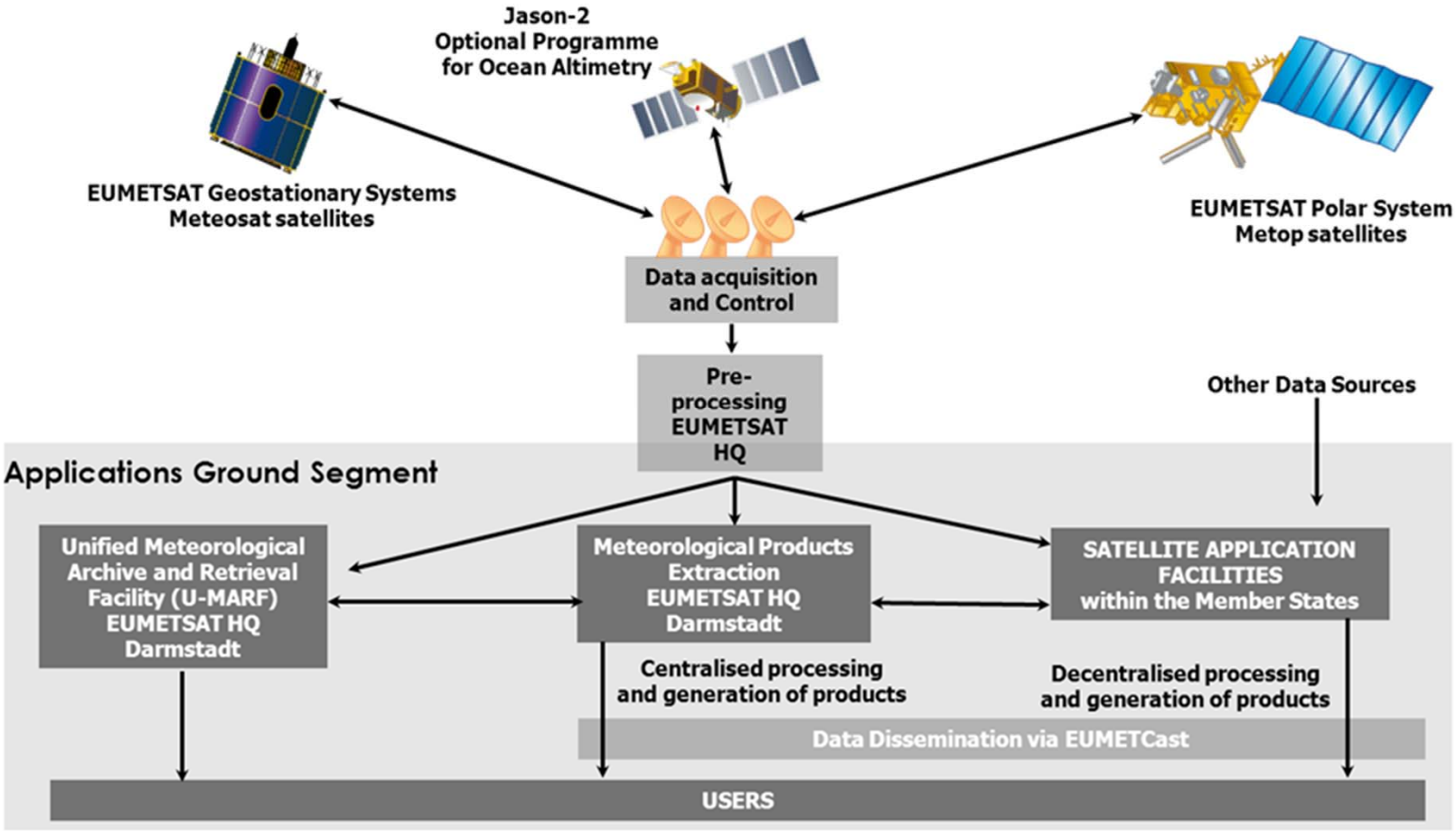
  Meteosat, Metop & Jason

- Goal: Maintain continuity and develop the operational meteorological and climate data services with adequate satellite and ground infrastructure, and associated user services

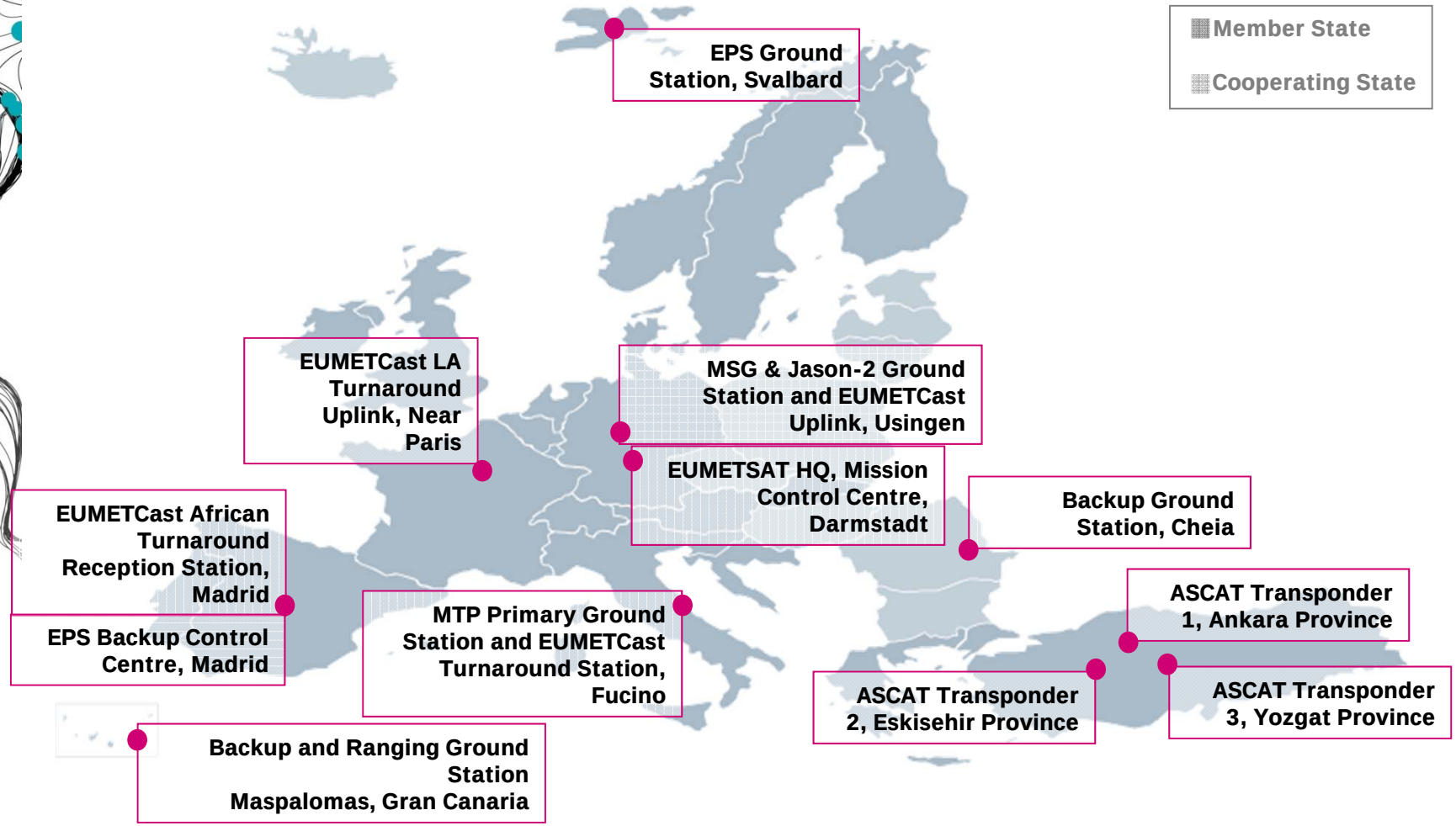




http://www.eumetsat.int

Overview of the EUMETSAT Ground Segment



EUMETSAT Ground Segment



EUMETSAT Ground Segment

Meteosat Antenna
Usingen, Germany

Meteosat Antenna
Fucino, Italy

Metop Antenna
Spitzbergen, Norway

Jason Antenna
Usingen, Germany

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EUMETSAT Ground Segment

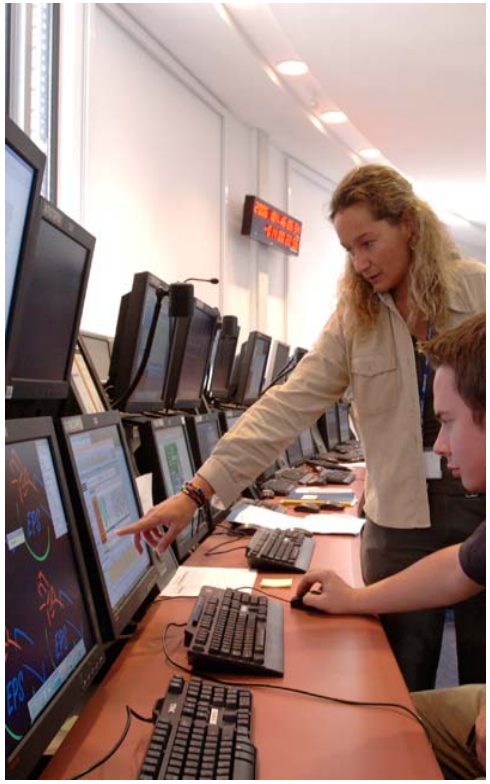
- The Metop Global Data Service comprises orbit dumps from both Svalbard and McMurdo ground stations.
- To improve data timeliness NASA's McMurdo ground station in Antarctica is used to collect the data from the first half of the satellite's orbit, in addition to the Svalbard ground station in the Arctic.
- For orbits where Metop will perform a dump over McMurdo, the timeliness of products will be significantly improved over current service requirements.

McMurdo Station, Ross Island (Antarctica)

EUMETSAT Control Centres

MTP Control Centre

MSG Control Centre



EPS Control Centre

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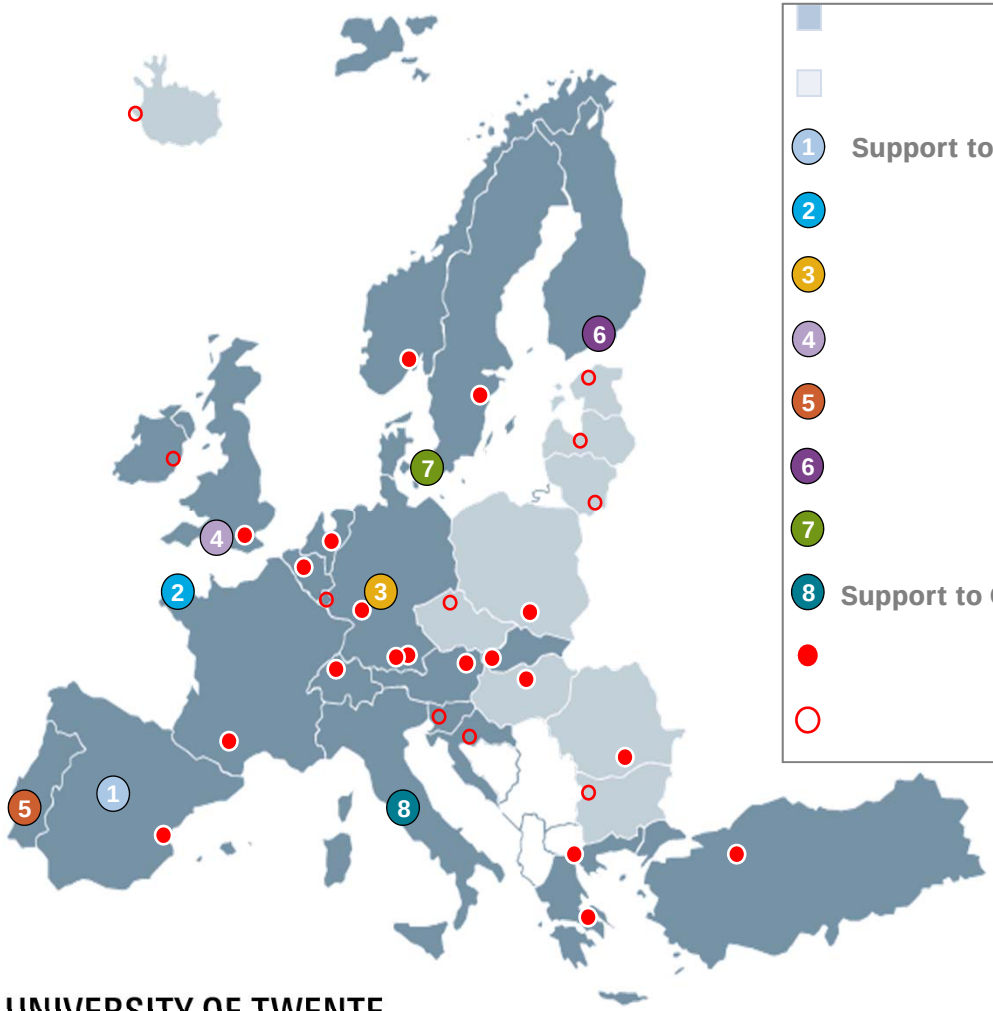
Satellite Application Facilities (SAFs) in Europe



- Member State
- Cooperating State
- 1 Support to Nowcasting and Very Short Range Forecasting
- 2 Ocean and Sea Ice
- 3 Climate Monitoring
- 4 Numerical Weather Prediction
- 5 Land Surface Analysis
- 6 Ozone and Atmospheric Chemistry Monitoring
- 7 GRAS Meteorology
- 8 Support to Operational Hydrology and Water Management
- SAF Consortium Member
- Additional Met Service Users

ITC

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GEONETCast services

EUMETCast	EUMETCast is the EUMETAT contribution to GEONETCast with coverage over **Europe, Africa and the Americas**. EUMETCast established since 2004 has over 2000 registered reception stations with over 1600 users already benefiting from the environmental data it provides.
CMACast	CMACast is the China Meteorological Administration's contribution to GEONETCast. CMACast utilises the AsiaSat 4 satellite to broadcast data and products to a user community in the **Asia Pacific region**.
GEONETCast-Americas	GEONETCast Americas is the Western Hemisphere component of GEONETCast, In 2007, the U.S. National Oceanic and Atmospheric Administration (NOAA) awarded a contract to enable expansion of GEONETCast into the **Americas**, and the service went operational in early 2008

GEONETCast
Delivering Environmental Data to Users Worldwide

Data disseminated through GEONETCast

- Space-based observations from the Meteosat, Metop, Jason-2, GOES, MT-SAT and FY2 satellites. At their most frequent, these data are delivered to users within five minutes of processing.
- MODIS level 1 and 2 products covering selective geographical regions.
- Numerical weather forecasts.
- In-situ observational data.
- Land application products covering Europe, Africa and South America.
- Global and regional marine meteorological and ocean surface products.
- Atmospheric chemistry products.

Data disseminated through GEONETCast

In addition, a wide range of third-party meteorological and environmental products are available on EUMETCast. The range includes:

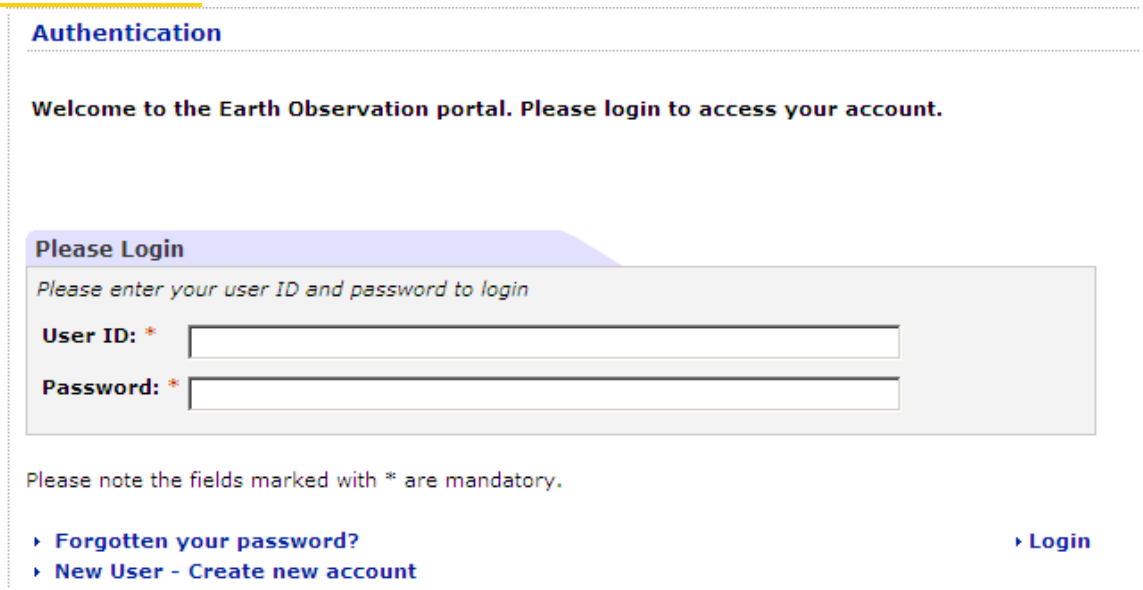
- Level 1 Satellite data (e.g. GOES-E & GOES-W, MTSAT, FY2D, aqua/terra MODIS)
- Meteorological products
- In-situ observational data
- Numerical weather forecasts
- Land application products covering Europe, Africa and South America
- Global and regional marine meteorological and ocean surface products

A comprehensive list of all products available on EUMETCast can be found on the **Product Navigator**.

PRODUCT NAVIGATOR
Collection Discovery Service

User Registration

- Users interested in receiving products and services delivered via GEONETCast should register with a GEONETCast network provider covering their geographical location. To register for the service provided by EUMETCast (EUMETCast-Europe, EUMETCast-Africa, EUMETCast-America) complete the online registration form
- https://eoportal.eumetsat.int



Atlantic Bird – EUTELSAT footprint & antenna size

Atlantic Bird 3 – EUTELSAT5 is situated at 5 degree West.
EUMETCast is available via one of the C-band transponders.

EIRP (dbW)	C-band
40	-
39	2.40
38	2.69
37	3.02
36	3.39
35	3.80
34	4.27
33	4.79

Coverage map showing EIRP contours and corresponding antenna sizes for AB -EUTELSAT C-band dBW footprint

EUTELSAT 5 West A C-band transponder settings

- http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/ReceptionStationSetup/index.html

C-band Transponder EUTELSAT™ 5 WEST A (5° W)

PARAMETER	VALUE
Name	EUTELSAT™ 5 WEST A
Transponder	C02
Down Link Frequency	3731.7570 MHz
Symbol Rate	11.963 MS/s
FEC	2/3
Polarisation	Circular Left Hand

Pointing your antenna

Satellite Finder / Dish Alignment Calculator with Google Maps

Your location: e.g. streetname, zip code, (lat, lon):

Modderdam Road Bellville 7535 Republic of South Africa | Go!

Most Popular Satellites in

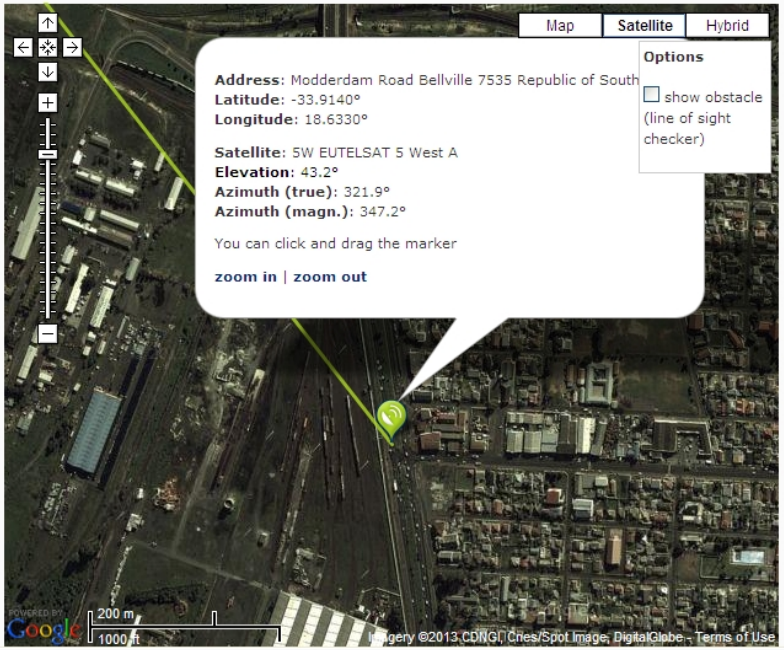
1. 68.5E INTELSAT 20 (IS-20) | INTELSAT 7 (IS-7)
2. 4.8E SIRIUS 4
3. 36E EUTELSAT 36A | EUTELSAT 36B
4. 7E EUTELSAT 7A
5. 66E INTELSAT 17

All Satellites | Motorized Systems | Multi-LNB Setups:

5W EUTELSAT 5 West A

All Satellites | Motorized Systems | Multi-LNB Setups:

5W EUTELSAT 5 West A



http://www.dishpointer.com/

Your Location	Satellite Data	Dish Setup Data
Latitude: -33.9140°	Name: 5W EUTELSAT 5 West A	Elevation: 43.2°
Longitude: 18.6330°	Distance: 37547km	Azimuth (true): 321.9°
		Azimuth (magn.): 347.2°
		LNB Skew [?]: -30.8°

Google EARTH

Ground receiving components

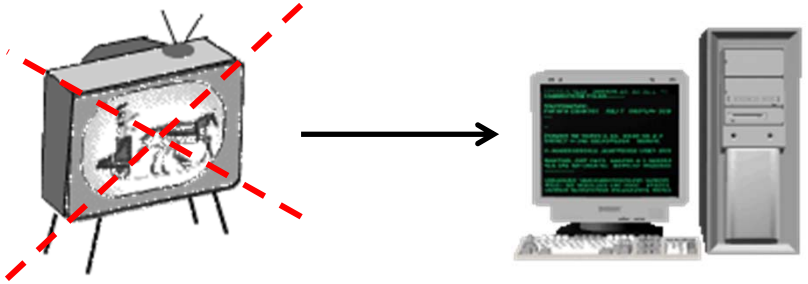
- **Satellite off-set or prime focus antenna**, with:
  - universal V/H LNB in C-band
  - circular polarisation feedhorn,
  - C-band LNB, bandpass filter recommended (in areas with radar interference)

Ground receiving components

- **Computer equipment needed**
  - 2 x PC with minimum 2.0 GHz Pentium™ IV; 1Gb RAM, 36Gb internal disk (or more, depending on storage required); USB port for EKU; 5 volt PCI bus (compatible with recommended DVB PCI card); 100/10 base Ethernet card (if required). Microsoft Internet Explorer (web browser) version 5.5, or later version, or Mozilla, or similar, Web browser, including JAVA RTE, (required for display of the TELLICAST monitoring information). Two PCs are recommended - one for the DVB acquisition and a second for processing applications.
  - EUMETSAT recommends setting up the EUMETCast PC as a receiving station and ftp or file server only and not to install and run other application software on this PC. Peaks in disk and bus usage could interrupt DVB data reception.

Ground receiving components

- **Digital Video Broadcasting** is the Digital Video Broadcasting Forward Error Correction (FEC) and demodulation standard for Satellite Television and dates from 1994, in its first release;
- The telecommunications providers supply the DVB multicast distribution. Encoded data/product files are transferred via a dedicated communications line from EUMETSAT to the uplink facility where they are transmitted to a geostationary communications satellite for broadcast to user receiving stations. Each receiving station decodes the signal and recreates the user data/products according to a defined directory and file name structure.



Reception of data channels via satellite transponder and not televisions channels

Ground receiving components

- **Digital Video Broadcasting Board**
  - DVB PCI Card (5 volts) - the following brands have been tested by EUMETSAT: TechniSat™ SkyStar2; BroadLogic™ V@box 2030; Hauppage WINTV (only older Technotrend based cards), Pentamedia™ Pent@Value Card, Technotrend budget and premium cards. DVB USB boxes:
  - DVB USB 1.1 boxes (up to 6 mbit/s only): Technisat™ SkyStar2 USB; Hauppage USB
  - DVB USB 2.0 boxes (> 20 mbit/s): TechnoTrend TT-connect S-2400; Dexatek DK-5702 I-TEK Sphere DVB-S
  - DVB Routers (LAN connectivity): IPricot IPR-S500 or other models

Ground receiving components

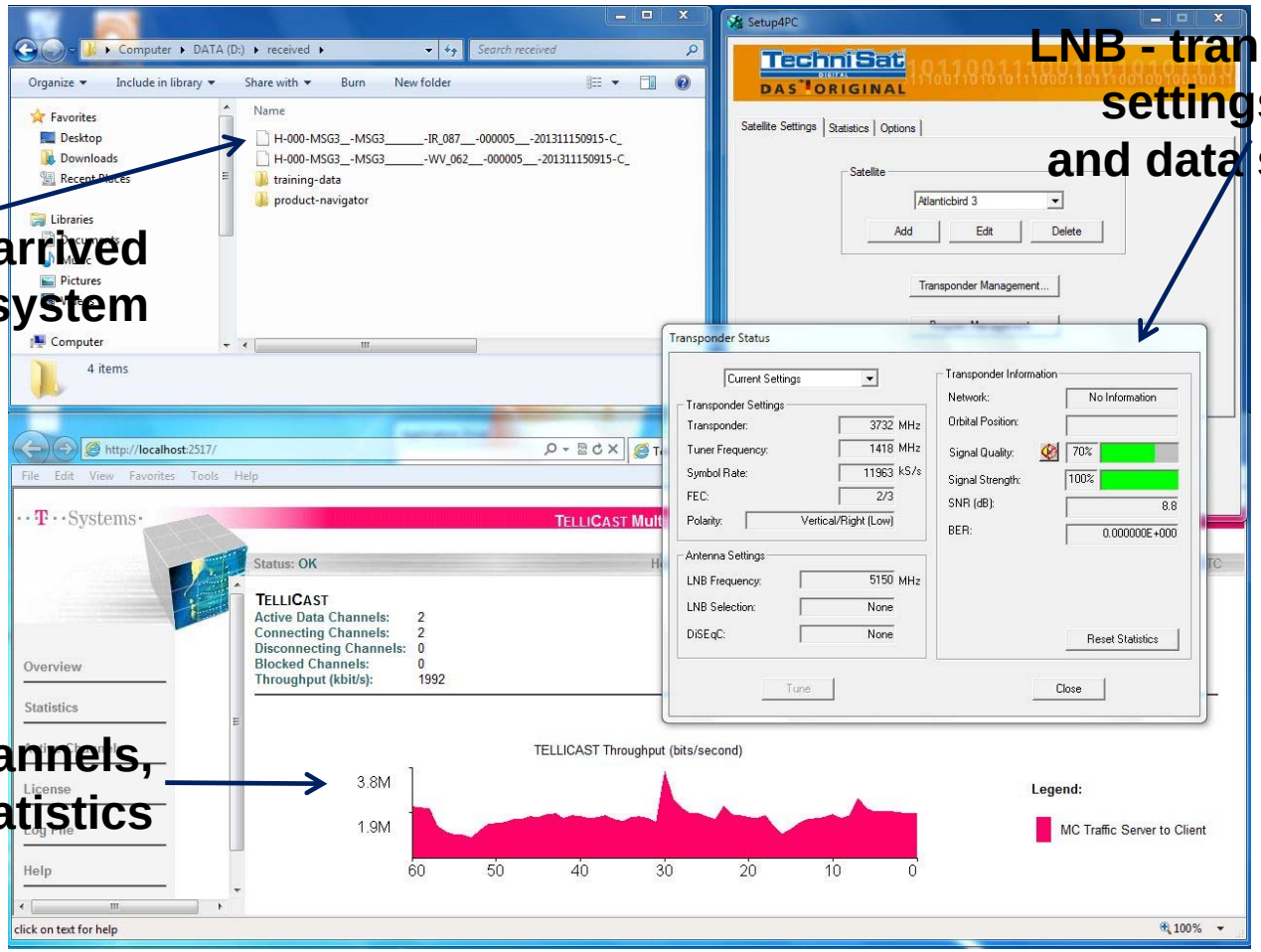
- **Communication Software needed**
  - EUMETCast Client Software - used in conjunction with a username/password to decrypt the DVB signal. EUMETSAT is the only supplier of this type of client software licence package.
- **USB EKU**
  - EUMETCast Key Unit (EKU) - used in association with the EUMETCast Client Software to access certain data services. The EKU is a USB device that controls the access to the multicast to allow only those stations fitted with the EKU to receive the restricted service. EUMETSAT is the sole supplier of the EKU and included in the delivery package is the EKU Run-time-Environment, for both MS Windows and Linux systems.

Operational ground receiving station

New files arrived on local system

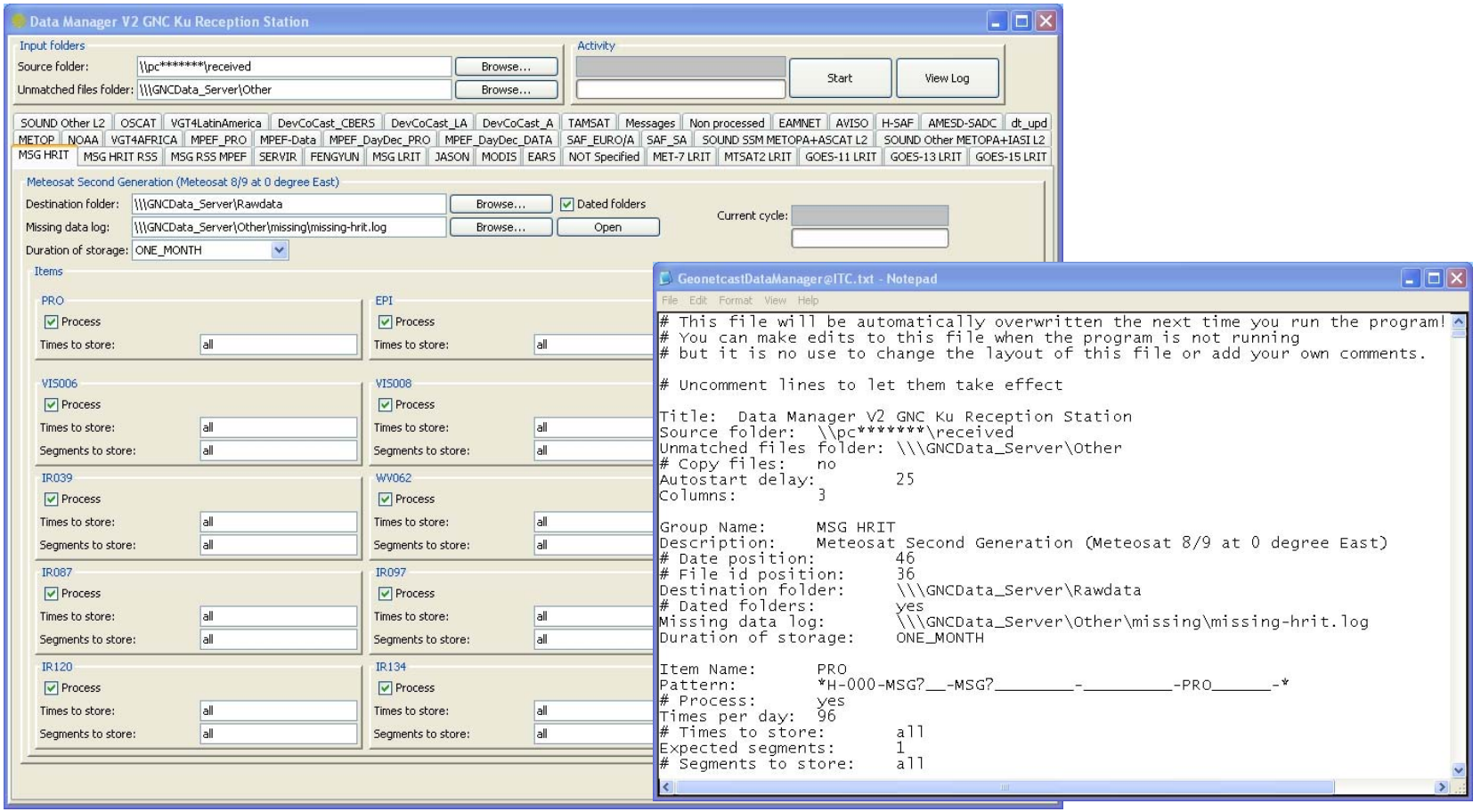
LNB - transponder settings, signal and data services

Monitor active channels, data load and statistics



Operational ground receiving station

Automated Data Management using the Data Manager



Menu as result from text file

Multicast channels and PIDs

Each service available on EUMETCast has been assigned a corresponding multicast channel and Packet Identifier (PID). In order to receive the service, the relevant PID must be added in the DVB Data Service software.

Current multicast channels and PIDs

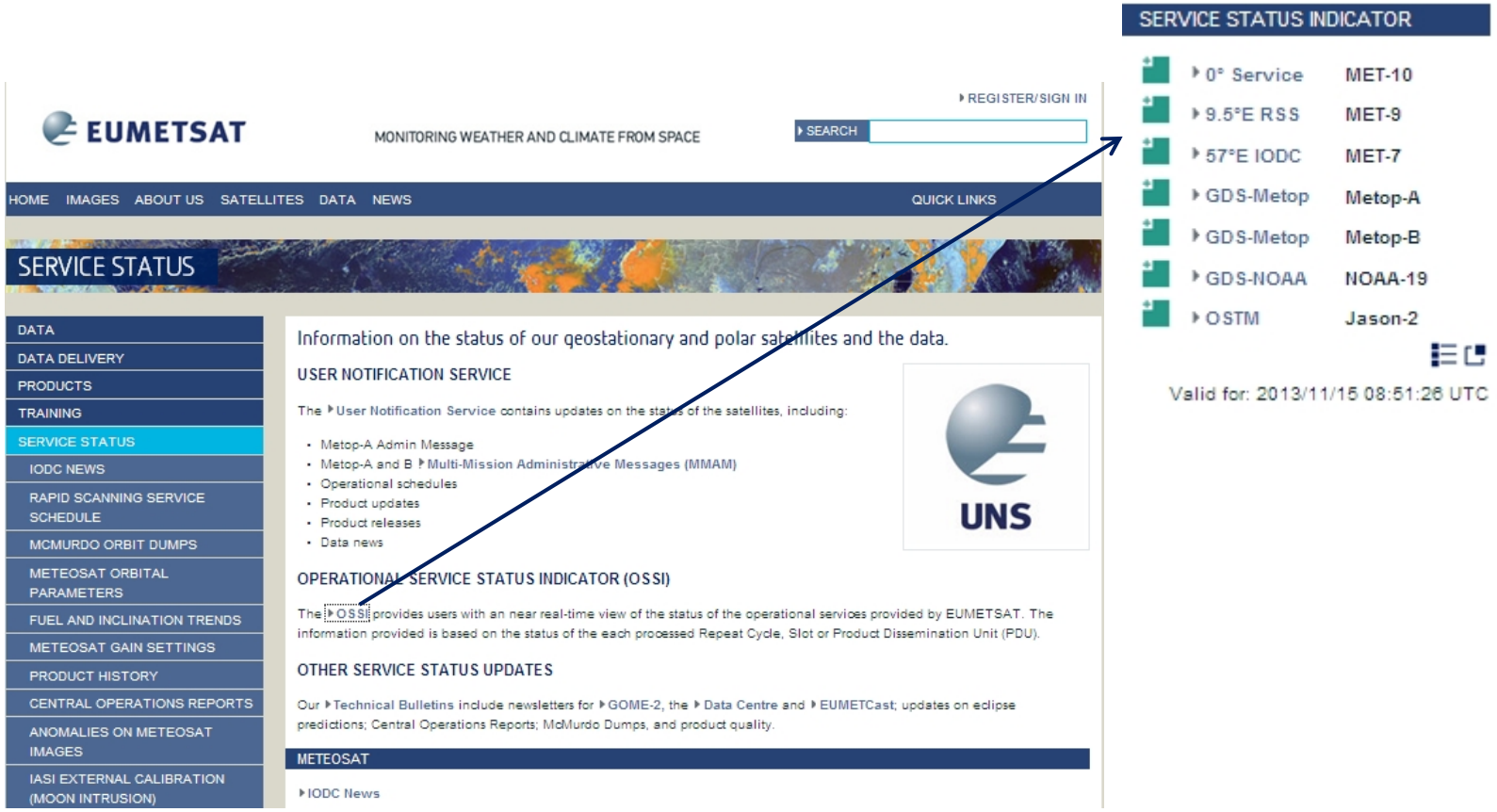
CHANNEL NAME	PID (DECIMAL) EUTELSAT 9A (FORMER EUROBIRD 9A)	PID (DECIMAL) EUTELSAT 5 WEST A (FORMER AB3)	PID (DECIMAL) SES-6 (FORMER NSS806)	MAX DATA RATE (KBPS)	REMARK
TSL Announcement Channel	100	100	1921	600	Announcement channel
EUMETSAT Data Channel 1	500	-	-	1501	EARS service
EUMETSAT Data Channel 2	300	300	1922	1600	Primary High Rate SEVIRI
EUMETSAT Data Channel 3	301	301	-	578	Multi-service Europe/Africa[1]
EUMETSAT Data Channel 4	500	-	-	2000	Multi-service Europe
EUMETSAT Data Channel 5	500	-	-	1420	Secondary High Rate SEVIRI
EUMETSAT Data Channel 6	500	-	-	340	Secondary Meteorological Products
EUMETSAT Data Channel 7	509	-	1923	240	Multi-service Europe/Americas[2]
EUMETSAT Data Channel 8	300	300	1922	240	Multi-service Europe/Africa/Americas

Part of the PID table

http://www.eumetsat.int/website/home/Data/DataDelivery/EUMETCast/ReceptionStationSetup/ChannelsandPIDs/index.html

User Notification of Service Status

http://www.eumetsat.int/website/home/Data/ServiceStatus/index.html?l=en



Also subscription is possible to the UNS

Opportunities of the Low-Cost Satellite Image Reception Station

Abeyou Wale, Essayas Kaba, Daniel Fuka, Ben Maathuis, Chris Mannaerts & Tammo Steenhuis

Introduction

In many countries throughout the world, the use of earth observation data for environmental or societal purposes still remains underexplored, in spite increasing earth observation (EO) data provision but sustainable development requires coordinated, comprehensive and sustained Earth observations for early warning and for effective decision making.
In March 2011, in collaboration with Tana Sub-Basin Office and ITC, the Netherlands (the GEONETCast Strategic Initiative) a low-cost GEONETCast satellite image reception station is established at Bahir Dar University (BDU).

Objective

The main objective of this poster is to describe the components and the opportunities of the established reception station, and in addition the received satellite image will be processed to see the spatial and temporal relationships of Normalized Difference Vegetation Index (NDVI) versus areal rainfall and Land Surface Temperature (LST) versus Evapotranspiration (ET) for the Lake Tana Basin.

Study area description

The study area, Lake Tana is the source of the Blue Nile River and has a total drainage area of approximately 15,000 km^2, of which the lake covers 3,060 km^2 at elevation 1,786 m amsl.

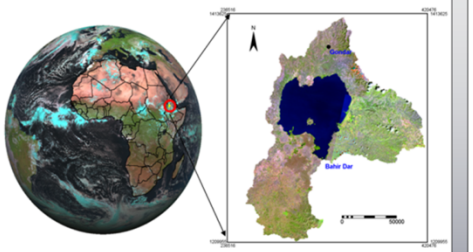


Figure- 1: Location of Lake Tana Basin north-west highlands of Ethiopia
(Left side first MSG satellite image received March 12, 2011 at 09:35 UTC and right Landsat 7 ETM+ satellite image of September 12, 1999)

Figure- 2: Hardware components of the reception station at BDU

System overview and opportunities

System overview

For Africa, the EUMETSAT AtlanticBird-3 carries the dissemination service. The reception station at Bahir Dar University comprises of a standard PC with Digital Video Broadcast (DVB) card inserted and C-band LNB, 2.4 meter diameter parabolic dish antenna. The reception station is fitted, next to the TechniSat SkyStar-2 DVB board, with Tellicast Client Software and the USB EUMETSAT Key Unit (EKU).

DVB card configuration software

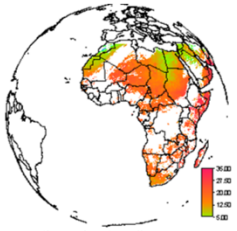
GEONETCast Toolbox plug-in for ILWIS

Opportunities of the reception station

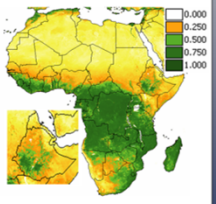
Some of the raw satellite images and processed products received by the GEONETCast ground reception station includes:
Meteosat Second Generation (MSG): Raw unprocessed data received every 15 minutes in 12 spectral bands from visible to infrared channel. All of them have a spatial resolution of 3 km except the high resolution visible which has 1 km resolution.
Satellite Application Facilities (SAFs): The LANDSAF disseminates high-quality geo- and bio-physical products :

Table 1: List of products available from LSA-SAF

SAF products	Spatial Resolution (km)
Albedo (1 per day)	3
Down-welling Short-wave and Long-wave Radiation (0.5 hr)	3
Land Surface Temperature (LST) (0.25 hr)	3
Fraction Vegetation Cover (FVC) (1 per day)	3
Leaf Area Index (LAI) (1 per day)	3
Evapotranspiration (ET) (0.5 hr)	3



Land Surface Temperature LST 2011/03/15 08:00 UTC



SPOT-VGT Normalized Difference Vegetation Index

Meteorological Product Extraction Facility (MPEF): is part of the MSG ground segment; its primary function is disseminating Meteorological Products:

Table-2: List of products available through MPEF

MPEF products	Spatial Resolution (km)
Atmospheric Motion Vectors (AMV) (1 hr)	BUFR file
Cloud Analysis Image (CLAI) (3 hr)	9
Cloud Mask (CLM) (0.25 hr)	3
Cloud Top Height (CTH) (1 hr)	9
Active Fire Monitoring (FIR) (0.25 hr)	Ascii table
Global Instability Index (GII) (0.25 hr)	BUFR file
Precipitation Estimate (MPE) (0.25 hr)	3
Clear Sky Radiance (CSR) (1 hr)	BUFR file
Tropospheric Humidity (TH) (3 hr)	BUFR file
Total Ozone (TOZ) (1 hr)	BUFR file

VGT4Africa: distributes vegetation data to Africa through EUMETCast every 10 day interval with 1 km spatial resolution. Some of the products available from VGT4Africa include Normalized Difference Vegetation Index (NDVI), Albedo (ALBQ), Fraction of surface covered by vegetation (FCOVER), Leaf Area Index (LAI), Normalized Difference Water Index (NDWI) and Vegetation Productivity Index (VPI).

Methodology

The spatial and temporal relationship between vegetation density and rainfall across Lake Tana Basin is captured by the decadal NDVI map collected from VGT4Africa for the year 2005, and daily rainfall data collected from six nearby stations for the same period.

The temporal relationship between LST and ET over the Lake Tana Basin is captured using SAF-data, archived by the reception station at hourly interval for March 15, 2011.

Result

The decadal NDVI map archived from VGT4Africa is aggregated to monthly NDVI using ILWIS software. The monthly areal rainfall of Lake Tana Basin is estimated by Thiessen polygon method using Bahir Dar, Gondar, Dangla, Addis Zemen, Enfranze and Debre Tabor stations. The result indicated a maximum NDVI in September (0.63) and minimum in April (0.23) and maximum and minimum rainfall of 392 mm and zero in July and December respectively for the study period.

Figure- 3: Rainfall Thiessen polygon map of the basin

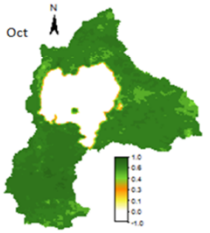
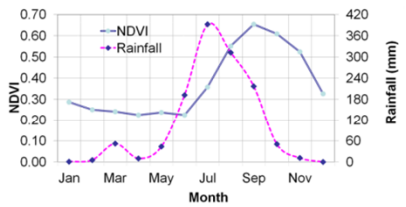
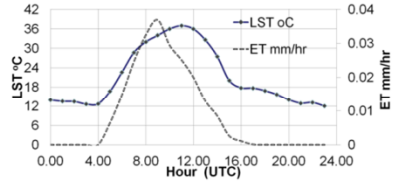


Figure- 3: NDVI map of Lake Tana Oct/2005



The correlation of areal monthly NDVI and rainfall on Lake Tana Basin for year 2005 is poor around 0.1, the analysis showed that for the study period NDVI responded slowly to precipitation by almost two month lag time. Satellite derived precipitation estimate, as provided by the MPE product, should be further explored.

Hourly LST and ET archived from the LSA-SAF for March 15, 2010 through the reception station was analyzed using the ILWIS software.



The analysis shows that, ET and LST are maximum at 9:00 UTC and 11:00 UTC respectively which a lag time of approximately two hours and they have a correlation of 0.8.

Conclusion

The low-cost GEONETCast ground reception system established at the Bahir Dar University, insures that with a minimum cost the possibility of collecting time series data's relevant for environmental, hydrological and meteorological monitoring. This archived data can be utilized for further research to obtain a better insight in the changing conditions of the environment and to assist the policy making process.

Low cost ground reception systems in Africa

Some of the antenna configuration at various locations in Africa

Satellite Dish installed at Makarere University, Kampala, Uganda

Satellite Dish installed at CGIS-NUR, Butare, Rwanda

Satellite Dish installed at RCMRD, Nairobi, Kenya

Others in Tunisia, Ethiopia, Ivory Coast, Ghana, Zimbabwe and South Africa; number of requests pending.

Low cost ground reception systems

Temporary setup at Africa-GIS conference in 2009

Ground receiving station used during "Open Days"

- "*Experiment in het Bos" – September 2011*

Ground reception infrastructure @ ITC

Both Ku and C-Band reception @ ITC

The ground reception infrastructure facilities at ITC

GEONETCast at ITC

- Keywords:
  - Not only GEONETCast Ku-reception over Europe;
  - Also GEONETCast reception over Africa, SE Asia and Latin America (C-Band);
  - New reception room developed to offer dedicated training on use of ground reception infrastructure hard - and software;
  - Check new services and develop new routines for relevant data sets –operate also manufacturer license;
  - Update "*DataManager*" configuration files for automated storage of (newly arrived) data in structured manner.

Concluding remarks

- Now low cost ground receiving station can be constructed, using off-the-shelf components;
- The free data contained in GNC is applicable for many applications related to land, ocean and atmosphere;
- The ITC/52N-communities can provide the necessary backstopping and will continue to develop relevant utilities for processing and analysis of the data streams.