

# 1. INTRODUCTION TO GEONETCAST AND THE DEVCOCAST PROJECT

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## 1.1. GEO and GEONETCast

The Group on Earth Observations (GEO), an intergovernmental organization, was established in May 2005. It calls for coordination of the Earth Observation systems of various countries, promotes the concept of establishing a Global Earth Observation System of Systems (GEOSS) that will yield a broad range of societal benefits, such as:

- reducing loss of life and property from natural and human-induced disasters;
- understanding environmental factors affecting human health and well-being;
- improving the management of energy resources;
- understanding, assessing, predicting, mitigating, and adapting to climate variability and change;
- improving water resource management through better understanding of the water cycle;
- improving weather information, forecasting and warning;
- improving the management and protection of terrestrial, coastal and marine ecosystems;
- supporting sustainable agriculture and combating desertification;
- and understanding, monitoring and conserving biodiversity.

As of 2011, GEO's Members include 86 Governments and the European Commission. In addition, 61 intergovernmental, international, and regional organizations with a mandate in Earth Observation or related issues have been recognized as Participating Organizations. Now, GEO has become the largest international organization in the field of Earth Observation. For further information on GEO consult: <http://www.earthobservations.org>.



*Figure 1.1 Opening ceremony of GEO at UN Headquarters in Washington DC*

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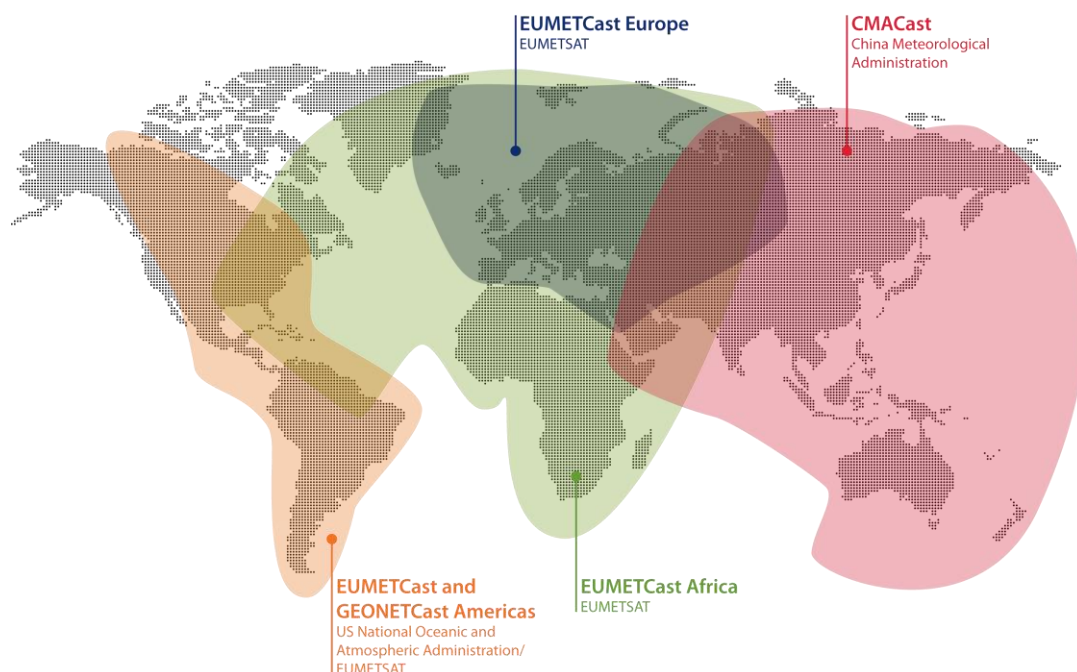
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One of the important GEO tasks is to promote sharing of Earth Observation (EO) data and remarkable developments have been achieved in this regard. One of these achievements is the development of GEONETCast, a global network of data dissemination systems based on satellite broadcast that shares environmental data and derived information products to a world-wide user community in near real-time. This unique GEONETCast network, part of the core GEOSS infrastructure, currently provides reliable, worldwide and low cost access to over 100 different Earth Observation (EO) images and products, from 35 providers around the world. The network consists of three regional broadcasts, and a fourth component, the Russian Mitra, is being added:

- EUMETCast: operated by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), covering Europe, Africa, parts of Asia and the Americas;
- CMACast: operated by the China Meteorological Administration (CMA), covering Asia and parts of the Pacific (a considerable upgrade of the formerly called FengYunCast);
- GEONETCast-Americas: operated by the US National Oceanic and Atmospheric Administration (NOAA), covering North, Central, and South America and the Caribbean.

The three main operators, NOAA, EUMETSAT and CMA, are referred to as GEONETCast Networking Centres (GNC). The coverage of GEONETCast is illustrated in Figure 1.2. The main providers of satellite data and derived products on GEONETCast are listed in the table 1.1.



**Figure 1.2 GEONETCast Coverage**

EUMETSAT and its network of Satellite Application Facilities (SAFs)	Meteosat (every 15 minutes), Jason and MetOp (per local satellite pass) satellite data Meteorological products for atmospheric, land and marine applications
NOAA	GOES and POES satellite data and NOAA-NESDIS products for atmospheric and marine applications
CMA	FengYun satellite data (FY 1/2/3)
VITO	Various products derived from SPOT-Vegetation for land applications.
ECMWF/ U.K. Met Office, Deutscher Wetterdienst, Météo-France	Observational and forecast products for atmospheric, marine and land applications

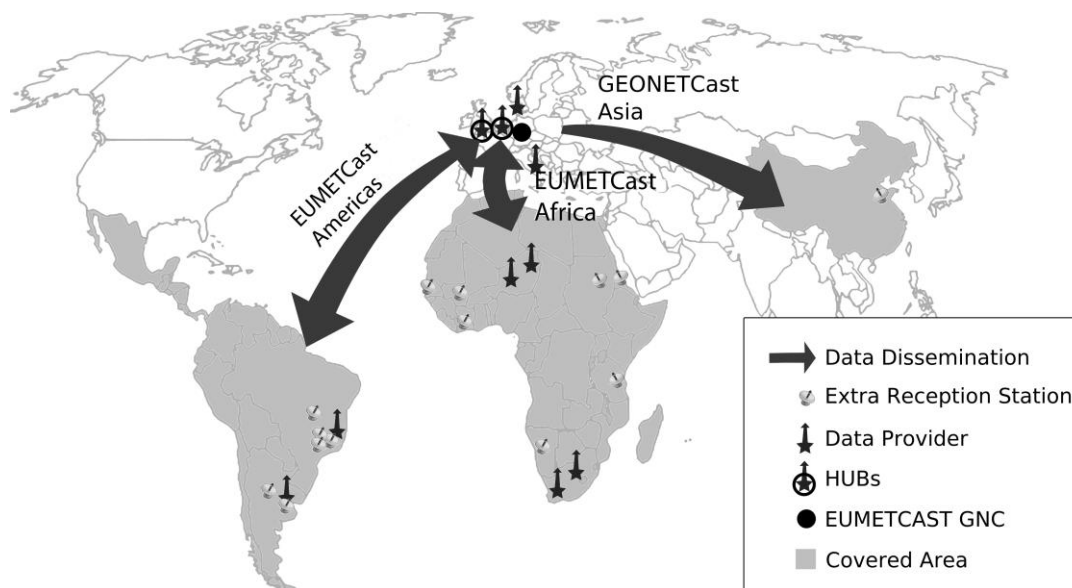
**Table 1.1 GEONETCast – main providers of satellite data and derived products**

An up to date listing of available products and data can be obtained by accessing the “Product Navigator” maintained by EUMETSAT, and is available directly from their home page (<http://www.eumetsat.int>).

## 1.2. The DevCoCast Project

### 1.2.1. Introduction

Many developing countries and emerging economies (China, Brazil) face serious environmental risks and need reliable access to accurate EO data and derived environmental information for their sustainable development. The **GEONETCast for and by Developing Countries Project (DevCoCast)**, funded by the European Community's 7th Framework Programme for Research and Technological Development (FP7), involves developing countries more closely in the GEONETCast initiative. DevCoCast uses GEONETCast to disseminate existing environmental added-value data (both in-situ and satellite-based) from various sources in Africa, South and Central America, Asia and Europe to a broad range of end-users in developing countries. To help organize (prioritize, schedule) the flow of products, DevCoCast establishes central hubs for marine and land data that seamlessly integrate into the GEONETCast network. At the same time, the network of satellite receivers is expanded in South America, as well as for marine research and desert locust control services in Africa and for a pilot GEONETCast data-exchange with China supporting marine information services.



*Figure 1.3 DevCoCast overview map*

More importantly, the actual use of the products by the growing user community is supported through training, building on and maintaining the existing networks and capacities. This is done across continents and for various application themes such as vegetation and agriculture, fires, floods, water resources, marine, weather and climate. The goal is to introduce and integrate GEONETCast and the EO products it offers into educational curricula, research, environmental monitoring and decision making processes, in support of sustainable development.

### 1.2.2. Advantages of using the GEONETCast broadcasting system

Though the majority of receivers are currently found in Europe and China, the broadcasting system is particularly useful in Developing Countries, where it can help to avoid the high cost of maintaining a reliable internet connections that are sufficient in capacity to carry large volume of Earth Observation products (e.g. outside of major cities). Other advantages are:

- The availability of low cost, off-the-shelf receiver equipment;
- The high reliability and data transfer rate;
- The wide variety of freely available images and products;
- The long-term commitment to maintain the infrastructure, in particular by EUMETSAT towards Africa;
- The constantly growing receiver network, the growing number of products and (Third Party) data providers.

With GEONETCast the users do not need to repeatedly build ground receiving stations for different satellites. The convenient one-stop solution allows the data from different providers to be broadcast through telecommunication satellites. Access to the data needs a reception terminal similar to a satellite TV or satellite internet receiver.

### 1.2.3. DevCoCast Partnership and the open network established

The DevCoCast project is coordinated by the Flemish Institute for Technological Research NV (VITO), Belgium. In addition to VITO, 14 other organizations from Africa (4), South America (4) and Europe (6) team up to make DevCoCast a success. To lead the project, VITO heads a Steering Group of nine partners, three from each involved continent. The collaborating organizations within DevCoCast are:

- Flemish Institute for Technological Research NV (VITO), Belgium
- African Centre of Meteorological Application for Development (ACMAD), Niger
- Regional Centre for Training and Operational Applications in Agro-meteorology and Hydrology (AGRHYMET), Niger
- Food Supply Agency of the Ministry of Agriculture (CONAB), Brazil
- Centre for Surveying and Assessment of Agriculture and Natural Resources (CREAN), Argentina
- Council for Scientific and Industrial Research – Meraka Institute (CSIR), South Africa
- Danish Meteorological Institute (DMI), Denmark
- European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), Germany
- National Institute for Space Research (INPE), Brazil
- National Institute of Agriculture Technology (INTA), Argentina
- University of Twente - Faculty of Geo-Information Science and Earth Observation (ITC), The Netherlands
- European Commission - DG Joint Research Centre - Institute for Environment and Sustainability (JRC), Italy
- Natural Environment Research Council - National Oceanography Centre Southampton (NOCS), United Kingdom
- Marine Research Institute - University of Cape Town (MRSU, UCT), South Africa
- Plymouth Marine Laboratory (PML), United Kingdom

Besides these full partners, 10 more organizations received a DevCoCast-funded satellite receiver, installed by (or with help from) the partners, and are in turn asked to show the impact of GEONETCast on their day-to-day work. These Associated Organizations include:

- Brazilian Agricultural Research Corporation (EMBRAPA), Centre for Satellite Monitoring (CNPQ), Brazil
- State University of Campinas, Faculty of Agricultural Engineering (FEAGRI), Brazil
- Four marine research institutes
  - University Cheikh Anta Diop, Laboratory for Training and Research in Geo-matics (LERG), Senegal
  - University of Dar es Salaam, Institute of Marine Sciences (IMS), Tanzania
  - Ministry of Fisheries and Marine Resources, National Marine Information and Research Centre (NatMIRC), Namibia
  - University of Ghana (UG)
- National locust control centres and offices of Mali (CNLCP), Sudan and Eritrea
- Jiangyin Marine Technology Co. Ltd. (JYMT), China

Even with this large partnership, the real network of organizations involved with or related to DevCoCast is much larger. It connects for instance to and helps to strengthen the EUMETCast network in Brazil (around 50 organizations), the AMESD network in Africa (all sub-Sahara National Meteorological Services and various other national environmental and agriculture ministries), the South Africa Fire Network (SAFNET) of fire fighters and managers, international organizations such as UN-FAO and many more existing networks of GEONETCast satellite receivers and users (e.g. FP7-Geoland2/FP6-VGT4Africa, ChloroGIN, FP6-YEOS), and training networks

(EUMETSAT, ITC). This means the user community now encompasses hundreds of EO experts. As an example, the network of users of the provided SPOT-VEGETATION data has grown from around 100 by the end of 2007 in Africa only (VGT4Africa final report, 2008) to over 300 now (in Africa and South America).

To make this possible, DevCoCast, from the start, built on existing networks and remains very open to support any organization willing to use GEONETCast, either as a provider of products or as a receiver/user.

#### **1.2.4. Methodology and project outcome**

The DevCoCast project has four core activities:

1. Sharing many EO products (some produced in Africa and South America) across the continents and even worldwide, using EUMETCast and a pilot GEONETCast data-exchange. This includes a review and harmonization of the products, aiming to simplify their use. For a product listing see also Appendix 1.
2. Extending the existing infrastructure with central land and ocean add-on nodes to the GEONETCast Networking Centre operated by EUMETSAT, set up to prioritize and schedule incoming EO products prior to sending them to EUMETSAT for broadcast. In addition, several satellite receiving stations are newly established or upgraded in Africa (7), South America (6) and China (1).
3. Capacity building by supporting and training users through various (international) workshops, help desks, stand-alone training packages, building on existing training networks.
4. Finally, building on and maintaining existing capacities and networks to integrate GEONETCast and the products it offers into everyday education, research, environmental monitoring and decision making applications.

With products being broadcasted from almost each of the ten product providers in DevCoCast (see Appendix 1), the land and marine hubs fully operational and nearly all receiving stations installed and functioning, the first two core activities are very near to completion. Several successful workshops, with more than 300 participants, have been organized using Open Source and freely available software to manage and process the data disseminated by GEONETCast. Training material is partially available and more is under development. This material, including this document, will be made freely available in various languages. The project has now reached the last and most important stage: to demonstrate the benefit and actual use of GEONETCast to the user community, across continents and for various application themes, hopefully ensuring more sustained use of GEONETCast in Africa, South America and South East Asia.

The start-up of the follow-on Europe-Africa Marine Network (EAMNET, FP7) ensures continuity, further capacity building and shows the successful uptake of GEONETCast for marine applications in Africa. The new (also FP7-funded) AGRICAB project, to start back-to-back with DevCoCast, further ensures continuation of use of GEONETCast data for land (agriculture, forestry) applications in Africa in the near future.

### **1.3. EUMETCast**

#### **1.3.1. Introduction**

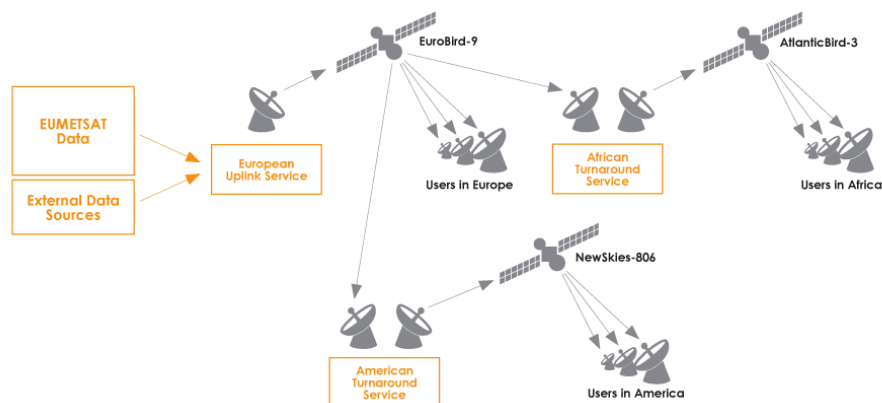
For the broadcast of the wide variety of DevCoCast products, from ten different sources to hundreds of receivers/users in particular in Africa, South America and China, the project builds on and extends the EUMETCast broadcast, operated by EUMETSAT and as such is one of the main components of GEONETCast. This includes:

- hiring dedicated broadcast bandwidth (the so-called DEVCOCAST-1 channel);
- updating the configuration of EUMETSAT's EUMETCast dissemination systems;
- adding data to the EUMETCast-CMACast data exchange for (demonstration) broadcast over China;
- and supporting the installation of new GEONETCast stations by providing advice and remote support to users when necessary.

EUMETCast system is a multicast system that uses standard Digital Video Broadcast (DVB) technology to transport data packets (IP datagrams) over a set of geostationary telecommunication satellites that are also used for satellite internet and satellite TV. This is done in a client/server system with the server side implemented at the EUMETCast

uplink site and the client side installed on the many individual EUMETCast reception stations. The components involved include:

- Data providers
- Service management
- Uplink service provider
- Turn around service provider
- Satellites
- Reception stations



**Figure 1.4 EUMETCast Architecture**

On the transmission side, EUMETSAT's own and externally provided products are transferred as files via a dedicated communications line from EUMETSAT to the uplink facility. The facility then encodes and transmits them to the communications satellite for broadcast (using a set of forward channels, not (yet) the return channels) to targeted user receiving stations. Each receiver decodes the signal and recreates the data/products. A single reception station thus can receive any combination of the data services provided on EUMETCast, in accordance with the relevant data policy and after registration to get the (usually free-of-charge) license to access the data/products.

### 1.3.2. Technical features of EUMETCast

In addition to the generic advantages of GEONETCast (see section 1.3), EUMETCast has the following features:

- Secure delivery allows multicasts to be targeted to a specific user or group of users thus supporting any required data policy;
- Handling of any file format, allowing the dissemination of a broad range of products;
- Use of DVB turnarounds allows easy extension of geographical coverage;
- Users are able to receive many data streams via one reception station using off-the-shelf (DVB) equipment
- An installed User base of over 1700 User stations;
- Highly scalable system architecture.

#### 1.3.2.1. Uplink, Turnaround and Data Providers

The Uplink service provider performs the following tasks:

- Receives all the data to be disseminated from all the data providers;
- Co-ordinates all the transmissions according to the service configuration;
- Encrypts the data according to the user dissemination configuration;
- Applies Forward Error Correction (FEC) to multicast data (FEC techniques transmit additional redundant information to enable the receivers to correct a certain amount of lost data, without requiring retransmission);
- Converts the files into Digital Video Broadcast (DVB);
- Broadcasts the signal using a commercial satellite;
- Receives the multicast data into a local reference reception station for service monitoring.

For EUMETCast, the multicast system provided by T-Systems GmbH, is based on a client/server system developed by Tellitec with the server side implemented at the EUMETCast uplink site in Usingen (Germany). The client side is installed on all the EUMETCast reception stations. There are a number of data providers, including EUMETSAT themselves, who deliver files to the uplink site via FTP over various communication lines.

The turnaround service provider receives the DVB signal from one satellite and retransmits it, without unpacking the DVB packets, to another satellite. Telespazio S.p.a. provides the C-band turnaround service for EUMETCast Africa from its uplink site in Fucino (Italy) and Globecast provides the C-band turnaround service for EUMETCast-Americas from its uplink facility in Paris (France).

### **1.3.2.2. Multicast to specific user(s) via Data File Encryption/Decryption**

The EUMETCast system allows files to be independently targeted towards a single user, or group of users, thus enabling secure control of access to the data at individual file and individual user level. The encryption of the data is performed by the EUMETCast uplink and decryption by the EUMETCast Client Software installed on the reception station. Most of the provided data or products are encrypted with user key (password) of the target user(s), making them only available after the user has registered to receive them and has been granted access (license, usually free-of-charge) in accordance with the Data Policy in play (e.g. EUMETSAT Data Policy for the EUMETSAT data and products). This requirement to register also gives the providers a clear view of the number of EUMETCast receiving stations registered for their products, thus promoting the sustained delivery. Registration can be done online using EUMETSATs "Earth Observation" Portal (available at: <http://www.eumetsat.int/Home/Main/DataAccess/EOPortal/index.html?l=en>).

To enable the corresponding decryption by the EUMETCast Client Software on the receiver side, the user's station will need to be equipped with a EUMETCast Key Unit (EKU). The EKU is connected simply via USB and EUMETSAT manages the distribution of the EKU devices to registered users.

### **1.3.2.3. Service Management and Service Directories**

The service configuration management is done by EUMETSAT, who provides the service configuration (bandwidth, users, dissemination parameters, etc.) to the DVB uplink provider. Management of the satellite transponder bandwidth capacity available to EUMETCast is achieved with channels and by the use of a priority scheme.

The DVB multicast management software adapts the uplink stream according to the relative priorities of the data waiting to be transmitted on a particular channel.

The EUMETCast interface is based on a concept called 'Service Directories', entry points into which the data to be multicast are transferred. To organize the flow, each service directory is associated with a distribution list, which identifies all the EUMETCast users entitled to receive the data transferred to the directory. The service directory structure is also used to allocate bandwidth characteristics to a particular set of products or directories.

### **1.3.2.4. Telecommunication Satellites**

The satellites used by the uplink providers to relay the EUMETCast multicast form part of the Eutelsat and New Skies satellite fleet:

- EURO-BIRD™ 9 (located at 9° East) delivers 20 fully operational Ku-band transponders supplying coverage across Europe, North Africa and the Middle East. Under the current arrangements provided by the uplink provider, EUMETCast is available via one of the Ku-band transponders;
- ATLANTIC BIRD™ 3 (located at 5° West) carries a Ku/C-band payload of 45 transponders (35 Ku-band, 10 C-band) with European, African and western Asia coverage. Under the current arrangements provided by the Africa turnaround provider, EUMETCast is available via one of the C-band transponders;
- NSS-806 (located at 40.5° West) is providing an optimum view of South America while also reaching the Iberian peninsula, the Canary Islands, Western Europe and much of Eastern Europe. Its tailored, high-powered hemispheric beam provides simultaneous coverage of both Europe and the Americas, with virtually complete coverage of North, Central and South America. EUMETCast is available via one of the C-band transponders.

The agreements with the satellite and turnaround providers are renewed through a fixed procurement procedure, which may cause changes to the satellite being used. But this is not frequent, as the agreements span multiple years typically.

#### **1.3.2.5. High reliability through Network supervision**

Reference reception stations are used to monitor the status of the system. There are reference reception stations at each data provider, the uplink service provider and on every turnaround service provider. Each data provider is responsible for the end-to-end monitoring of its own data. EUMETSAT monitors the end-to-end service relative to the data provided by EUMETSAT.

#### **1.3.3. EUMETCast user station**

A single reception station can potentially receive all the data being transmitted from one communication satellite (one broadcast beam), independent of the data provider(s).

##### **1.3.3.1. Reception Station components**

Based on EUMETSAT's substantial tests and user experiences, a typical EUMETCast reception station comprises:

- a standard PC with either DVB card inserted or a DVB router connected (e.g. via USB)
- a satellite prime focus or off-set antenna fitted with
  - a digital universal V/H LNB for Ku-band (EUMETCast-Europe),
  - a circular polarization feed horn, band pass filter (in areas with radar interference) and special LNB for C-band (EUMETCast-Africa or –Americas).
- EUMETCast Client Software and in most instances the EUMETCast Key Unit (EKU) are also required to decode and decrypt the DVB signal.

It is recommended to set up two PCs – one for DVB reception (and FTP/file serving to the network) and the other for processing. As peaks in hard disk and bus usage could interrupt DVB data reception, it is recommended that no processing or visualization of the data, not even unpacking of compressed files, is performed on the dedicated reception PC. The second PC can accommodate those.

Minimum PC requirements are listed as: 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). Furthermore EUMETSAT provides a step-by-step guide provided in the EUMETCast Technical Description (EUM TD 15, 2004 and 2010). Also consult this document for an up-to-date list of tested PC and DVB card configurations.

The cost of EUMETCast reception stations is kept to a minimum by utilizing industry open standards to the maximum extent possible, thus allowing the use of off-the-shelf equipment, available from satellite TV and/or satellite internet providers. In addition to the above front-end equipment, EUMETCast Client Software and EKU, data processing/visualization software is often required depending on the actual application and user's needs, making it a flexible solution. Unless the user already has suitable processing software, DevCoCast recommends the use of freely available software such as ILWIS and the GEONETCast Toolbox (see section 1.5).

##### **1.3.3.2. EUMETCast Key Unit and Client Software**

EUMETSAT provides the EUMETCast Client Software (TELLICAST) and the EUMETCast Key Unit (EKU) required to decrypt the DVB signal, in the case of the Client Software, and to facilitate access to the licensed or restricted services in the case of the EKU. They are provided together as a USB dongle and a CDROM, which together form the EUMETCast Package. This EUMETCast Package is available to all registered users and includes:

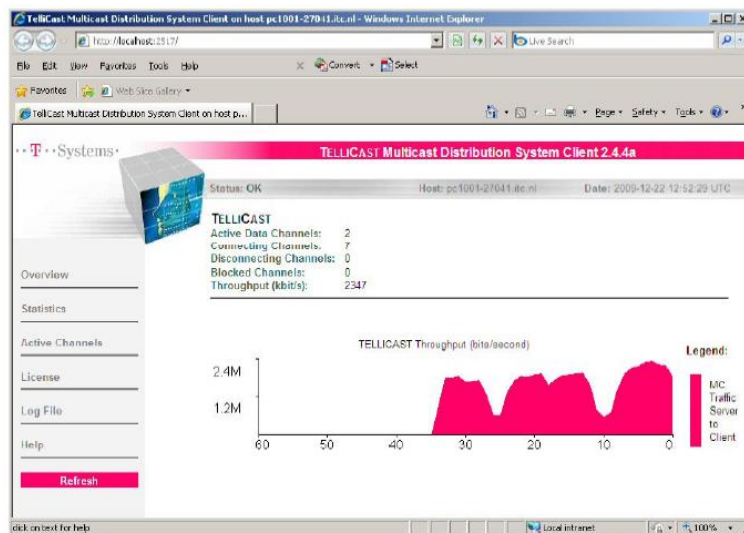


- The latest version of the EUMETCast Client Software (TELLICAST);
- ECU Run-Time-Environment, available for both MS Windows and Linux systems;
- A selection of DVB card driver software;
- Documentation, trouble shooting notes, readme files, Tellicast license notes, etc.

The EUMETCast Client Software is available for both MS Windows and Linux systems and performs the following processes:

- Decryption of data based on a key code;
- Error correction and management of received files.

As the current EUMETCast operates a TELLICAST server, the TELLICAST client software is mandatory. Per computer on which the software is installed, a license fee is charged. A single license fee is included in the price of the software CDROM (currently 60 EUR). The software installation procedure can be performed and when prompted the username and password have to be entered which are provided by EUMETSAT.



*Figure 1.5 Tellicast client software window*

The EUMETCast Key Unit (EKU) is the USB device used in conjunction with the EUMETCast Client Software to provide reception of services that require separate registration, licensing and/or have restricted access. The current cost of a single EKU is 40 EUR. EUMETSAT is the sole supplier of the EKU's and included in the delivery package is the ECU Run-Time-Environment software, for both MS Windows and Linux systems.



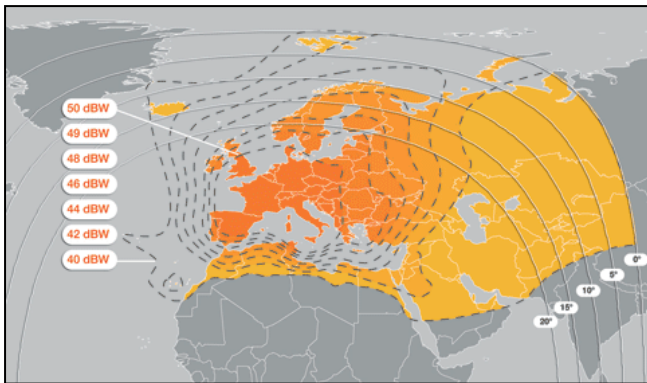
*Figure 1.6 The EUMETSAT Key Unit*

### 1.3.3.3. Antenna size, pointing and satellite parameters

Antenna size depends on the location where the ground receiving station is installed and the frequency band (Ku, C) used. Further information is provided in table 1.2, followed by the satellite footprints and reception parameters. For pointing the antenna use can be made of the dish pointing utility available at: <http://www.dishpointer.com/>. Websites like <http://www.satsig.net/africa/vsat-installers-africa.htm> and [EUMETSAT manufacturer list](#) can help locate local installers.

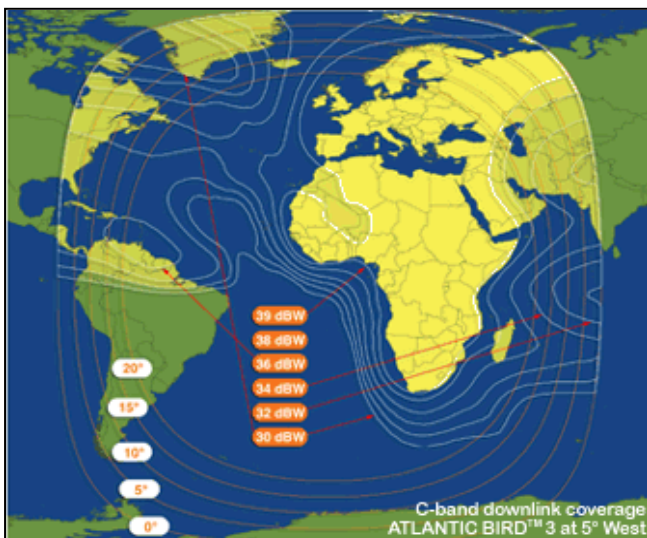
Band	Location	Antenna Size
Europe (Ku-band)	within the "core" geographical footprint of the spacecraft, the area bounded by the 50 dBW contour depicted in the EUROBIRD™ 9. Footprint, see figure 1.7	120cm or smaller (non-professional users 85 cm)
Europe (Ku-band)	within the "extended" geographical coverage (remote European islands, Turkey East of Ankara and Eastern European countries)	1.8m or larger
Africa (C-band)	within the "core" geographical footprint , the area bounded by the inner contour depicted in the Atlantic™ Bird 3 Footprint, see figure 1.8	2.4m or larger
Africa (C-band)	within the "extended" geographical coverage (e.g. Madagascar, La Reunion, Mauritius and parts of North America)	3.7m or larger
South America (C-band)	within the area bounded by the 39 dBW contour depicted in the NSS806 graphic Footprint, see figure 1.9	2.4m or larger
South America (C-band)	smaller antennas may be sufficient, depending upon individual location, for details for your location, contact the EUMETSAT User Service ( <a href="mailto:ops@eumetsat.int">ops@eumetsat.int</a> )	1.8m or larger

**Table 1.2 Antenna dimensions for various regions**



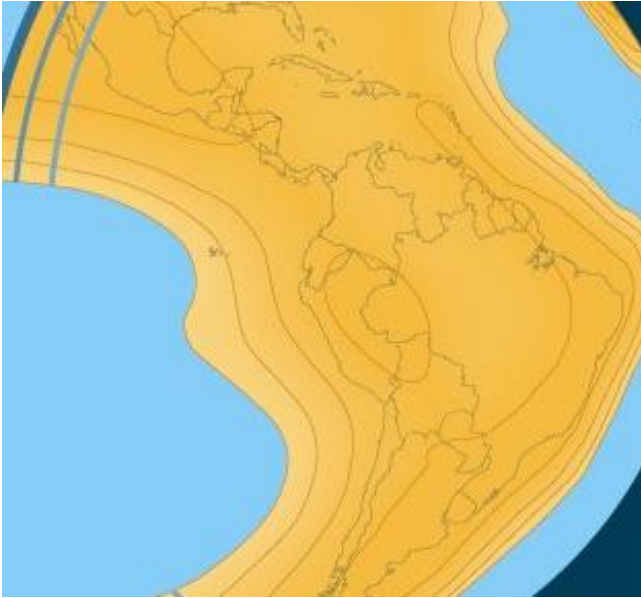
**Figure 1.7 Eurobird 9 coverage and satellite transponder settings**

Ku-band Transponder EUROBIRD™ 9	
Parameter	Value
Name	EUROBIRD™ 9
Transponder	TP63
Down Link Frequency	11976.82 MHz
Symbol Rate	27500 kS/s
FEC	3/4
Polarization	Horizontal



**Figure 1.8 Atlantic Bird 3 coverage and satellite transponder setting**

C-band Transponder Atlantic Bird™	
Parameter	Value
Name	Atlantic Bird™ 3
Transponder	C02
Down Link Frequency	3731.7570 MHz
Symbol Rate	11.963 MS/s
FEC	2/3
Polarization	Circular Left Hand



*Figure 1.9 NSS-806 South America coverage and satellite transponder settings*

South America - C-band NSS806	
Parameter	Value
Name	NSS806
Transponder	22A
Down Link Frequency	3.803 GHz
Symbol Rate	27.500 MS/s
FEC	3/4
Polarization	Circular Left Hand

The plots assume that antennas are correctly pointed, the LNB and reception equipment is state of the art and the cables are not too long or low loss ones are used. Smaller antennas (e.g. used for TV reception) will still provide good reception at fair weather conditions, but will increasingly suffer under rain and snow. For widely used 60 cm antennas, subtract 2.5 dB from the link margin for 80 cm antennas, and check if it still provides a positive margin.

#### **1.3.4. EUMETCast configuration for DevCoCast flow**

Normally, the files from data providers like those in DevCoCast are transferred via FTP/INTERNET to the EUMETSAT Operations Internet Server (OIS), an FTP server located at EUMETSAT in Darmstadt. EUMETSAT then further processes and/or transfers the uploaded products either to the uplink site in Usingen (Germany), where they are converted into a DVB (Digital Video Broadcast) Multicast data stream and transmitted via EUMETCast, or via RMDCN/internet networks for data-exchanges with other GEONETCast components (e.g. to CMA for the China broadcast).

In the context of DevCoCast, only the products from DMI (Denmark) are sent to CMA in China for a pilot broadcast. All other products are added to EUMETCast, on a channel that is available in the entire EUMETCast footprint (EUMETCast-Europe, EUMETCast-Africa and EUMETCast-Americas).

The products from INPE (Brazil) are thus disseminated via EUMETCast, as part of the DevCoCast service, by first pushing them via FTP from INPE to EUMETSAT, who in turn pushes them to the DVB uplink server for EUMETCast dissemination on Ku-band, C-band Americas (main users for these data) and C-band Africa.

For the remaining eight Product Providers in Africa, South America and Europe, including VITO and PML themselves, the operation interfaces are between EUMETSAT on one side and the land hub at Flemish Institute of Technological Research NV (VITO) and marine hub at Plymouth Marine Laboratory (PML) on the other. These hubs are explained in the next section.

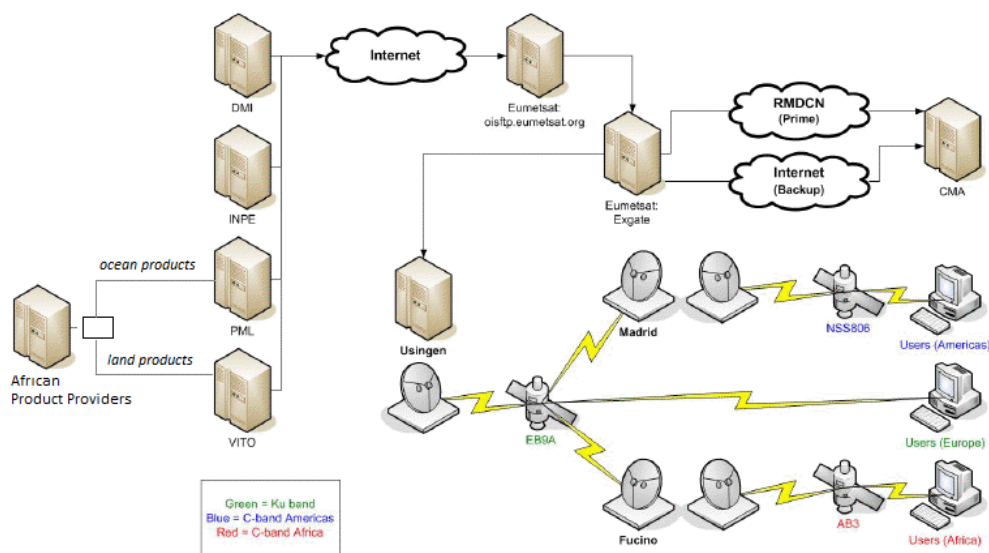


Figure 1.10 DevCoCast data provision and dissemination overview

#### 1.4. Extending the broadcast infrastructure: the DevCoCast hubs

The land and marine hub systems are intermediary data gathering nodes, servers running bespoke software for the controlled dissemination of satellite imagery and derived information. Though designed and developed within DevCoCast, they integrate nicely with the rest of the GEONETCast (in particular EUMETCast) infrastructure, acting as (optional) add-ons to EUMETSAT as the main GEONETCast Networking Centre. Hence, they can easily be re-used and extended for handling the flow of additional products.

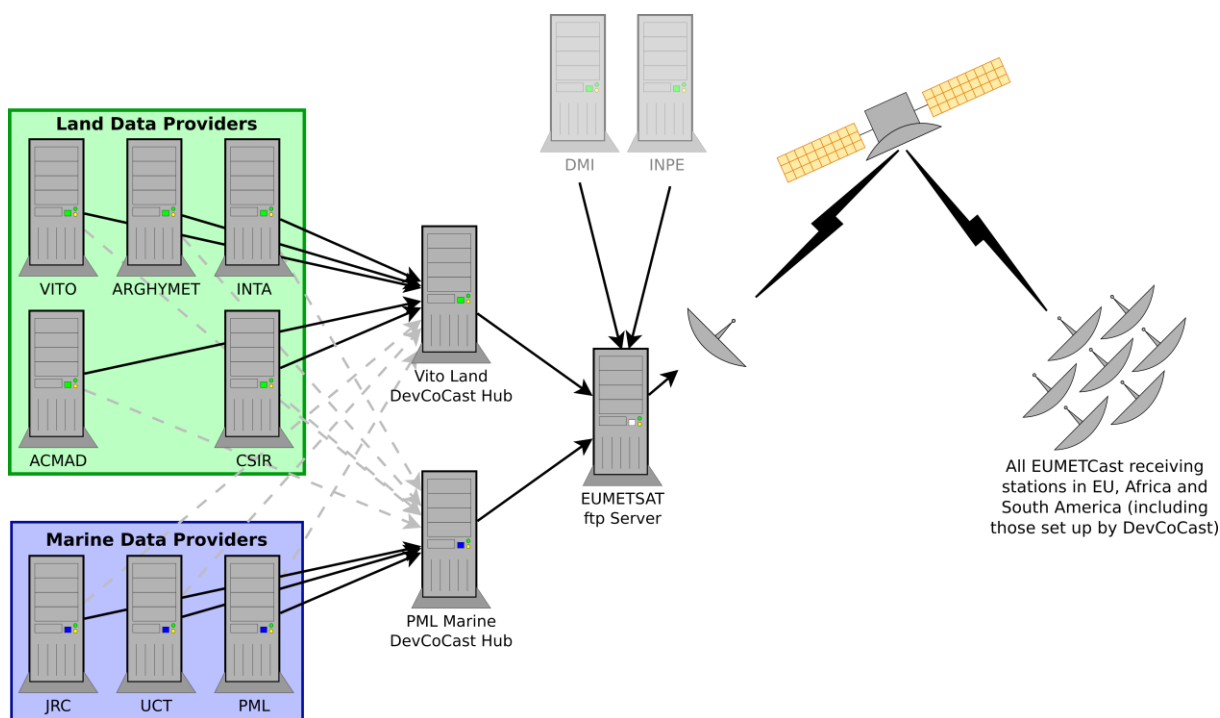
The DevCoCast hub systems help to gather the flow of diverse "land" and "ocean" thematic products from various providers, including some originating in Africa and South America. They then pass these products on to EUMETSAT for the EUMETCast broadcast, scheduling them according to priorities and available bandwidth. The hubs' main purposes are thus:

- To channel the products via the Land and Marine hubs (running at VITO and PML respectively), simplifying the steps in the transport of products from the providers to the broadcast systems at EUMETSAT;
- To extend GEONETCast with additional providers and products, covering additional application themes (notably beyond meteorology) and relevant with respect to the GEO Societal Benefit Areas.

From a data provider's point of view, they have a single point of contact in the relevant hub that has domain-specific knowledge of the products, that has extensive experience in interacting with EUMETSAT's GNC operations and can assist with product format adjustments, product flow monitoring and queries.

From EUMETSAT's perspective, they have a single "DevCoCast" interface with each of the hubs, who have specific knowledge of the products, expected frequency and of EUMETSAT's procedures, rather than many interfaces with many providers.

From the hub's own point of view, they can assure appropriate flow control for DevCoCast through a simple but robust system, with routine monitoring, prioritisation, flow smoothing/ordering and with fail-over redundancy. In fact, the hubs are designed to be able to take over from one another, e.g. in case of downtime. Though this take over does not occur often, the hubs do share the same configuration and logging and can thus be seen (from EUMETSAT and product provider perspectives) as mirror copies, with VITO hub dealing nominally with land, and rarely with ocean and vice-versa for PML hub.



*Figure 1.11 Overview of DevCoCast data providers, hubs and EUMETSAT transmission*

#### 1.4.1. Features of the hubs

The core purpose of the DevCoCast hub is to collect data from multiple providers and send it to EUMETSAT in a controlled and effective manner. The main features of the hub are as follows:

- Bandwidth control: in total, per provider and per product priority
- Prioritisation
- High resilience
  - Redundancy (hubs back up one another)
  - Retransmission prevention
- Extensive monitoring
  - Detailed transmission logging
  - Integration with Nagios (an open source computer and network monitoring solution)
  - Transmission graphing via external scripts
- Flexible and extensible system
  - Per product destination selection, allowing products to be dispatched to alternative systems during testing/trial phases
  - Possibility of multiple hubs on a single server
  - Generic processing trigger, allowing customised processing on individual products (e.g. additional compression or filename standardisation)

##### 1.4.1.1. Bandwidth control

A key role of the hub is to limit the amount of data transmitted in a given time. This is vital; the DevCoCast project have a certain amount of bandwidth through EUMETSAT and cannot exceed it. It is also important to ensure that the EUMETSAT servers are not flooded with large bursts of data - another role of the hubs is to spread the transmissions out over time.

The first goal is achieved by setting, managing and keeping to constraints (potentially per provider, per product type and per priority level). The second goal, smoothing, is achieved by spreading available bandwidth linearly throughout

set periods (typically 3 hour or 1 day) and accumulating it in a pool such that a product is only transmitted when sufficient unused bandwidth has accumulated.

The hubs also perform some tests on filenames and data contents (checksum) to ensure that data files are not transmitted multiple times due to errors in the systems of a data provider or hub.

#### **1.4.1.2. Prioritisation**

Not all of the data travelling through the hub are equally urgent. Products with high timeliness (for example event-driven imagery, such as imagery covering a fire) needs to be broadcast more urgently than monthly or weekly summary products. Another role of the hub is to ensure that the highest priority data are sent first.

There are 5 different priority levels:

- Very Low (e.g. less than monthly data)
- Low (e.g. monthly summaries)
- Medium (e.g. weekly products)
- High (e.g. near-real time ocean products / daily land products)
- Very High (e.g. event driven, like near-real time fire products)

These priority levels are assigned depending on the project objectives and the characteristics of the data.

#### **1.4.1.3. Seamless integration**

As described above, the hubs integrate into the main GEONETCast system. The hub operators (PML and VITO) ensure that the relevant EUMETSAT procedures are followed, assisting EO product providers in meeting operational broadcast requirements (metadata, test and trial broadcasts, user announcements, etc) more easily and flexibly, and assisting EUMETSAT in dealing with a growing number of product providers, particularly in thematic areas they are less familiar with.

#### **1.4.1.4. Redundancy**

In the event of a problem (scheduled maintenance or unscheduled outage), each hub can operate as a backup for the other. So, if the PML Marine hub is affected by a local outage then the ocean data providers can switch (potentially automatically) to the VITO Land hub. As both hubs run the same configuration, the outage and changeover can be transparent to the data provider, to EUMETSAT and to end users. The hubs routinely share information on transmitted products every 15 minutes, so retransmissions are unlikely and limited to a small window of time.

#### **1.4.1.5. Basic hub operation**

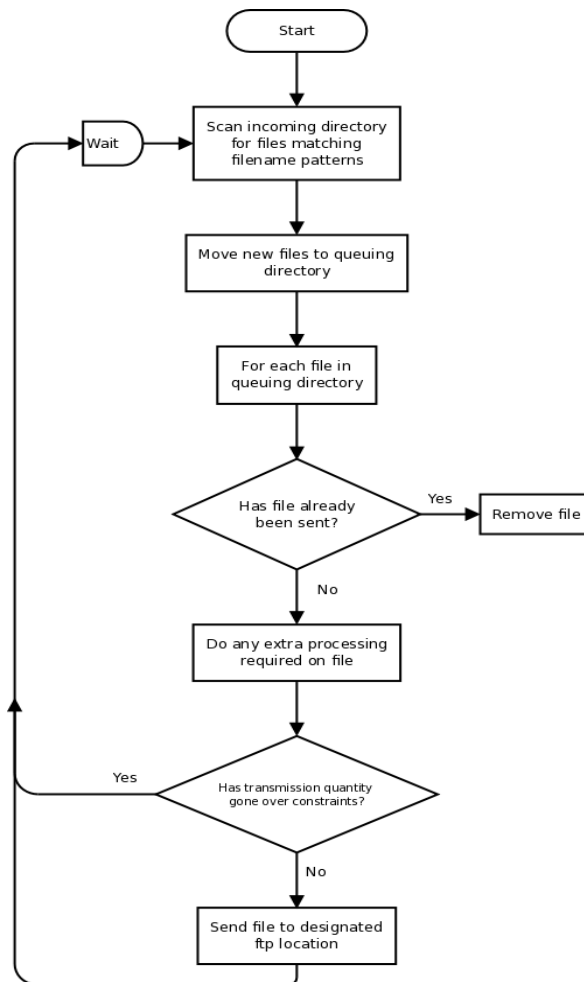
Providers upload EO data and information products via FTP to the relevant hub, using filenames according to a pre-defined format. Once a file arrives at a DevCoCast hub, it is recognised by the filename, prioritised, potentially reformatted (renaming, compression, etc) and, once sufficient bandwidth is available and all the constraints released, transmitted on to EUMETSAT.

The files are prioritised primarily according to the time sensitivity of the data. At a set interval ( $\approx 5$  mins) the hub tries to send all of the files in priority order, starting with the highest priority. The hub also balances the reservation of bandwidth for expected high-priority products against gradually redistributing unused bandwidth from higher to lower priority products over the accounting period.

Different amounts of bandwidth can be set aside for each priority, enabling to finely tune how much data for each priority will be sent at a given time. The hubs can also set available bandwidth differently per provider to ensure that no one provider monopolises the DevCoCast bandwidth.

Some files may require extra processing or standardisation. This can be done simply on the hub, which is capable of running arbitrary processing on any file as it arrives. All that is needed on the hub is a copy of the Linux compatible script/executable file to run.

The operation of the hub is simple, yet robust; a high level description of the routines implemented can be seen in the flowchart in figure 1.12.



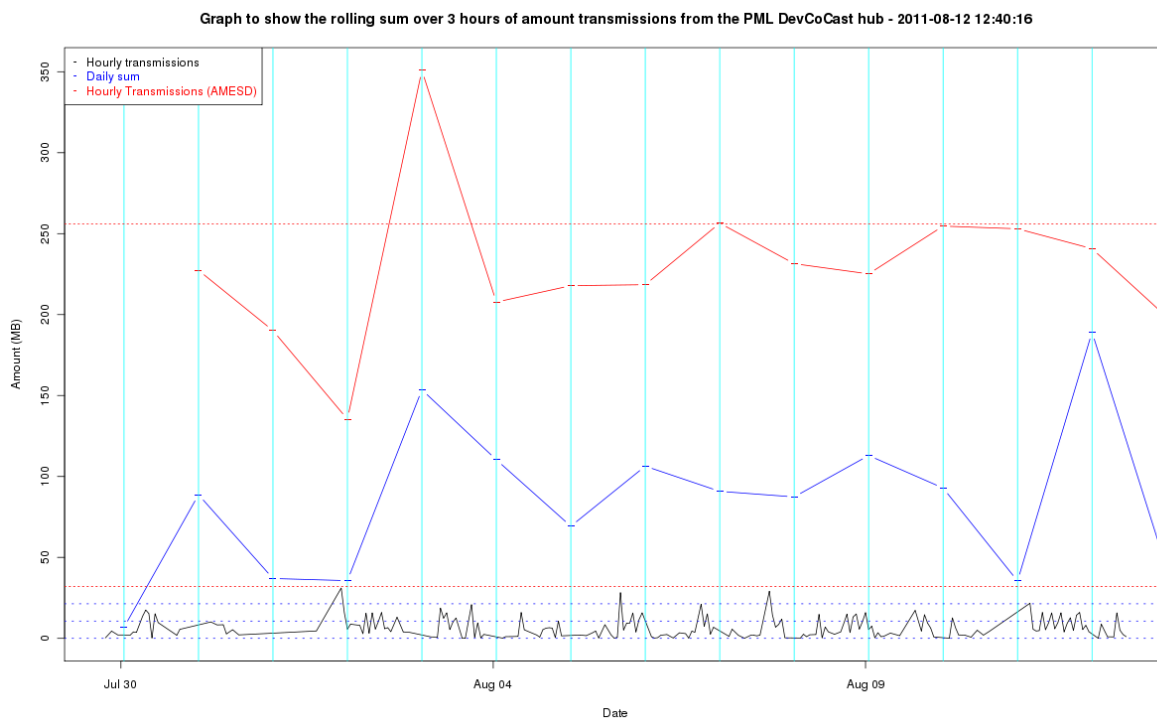
*Figure 1.12 High level description of the hub's operation*

Once it has been determined that the file will fit within the bandwidth allocation, it is transmitted to EUMETSAT via FTP. EUMETSAT has multiple service directories, each with a specific use. This is not apparent to the end user, as EUMETSAT is grouping data together into channels for onward broadcast.

#### 1.4.1.6. Hub monitoring

The hubs provide detailed logging of transmitted products and actions taken. This allows for detailed debugging or tracing of a product through the system. These logs are also summarised in graphs showing overall flow rates for monitoring of the DevCoCast system (see Figure 1.13 for an example).

Finally, scripts exist to integrate the hubs with Nagios, an open source monitoring solution, such that alerts can be sent to operators when problems (such as the hub losing network connectivity) or potential problems (such as unexpectedly low numbers of products for a particular provider) occur.



*Figure 1.13 Plot of DevCoCast Marine Hub transmissions over several days*

## 1.5. Free and open source software

To keep the barriers to using GEONETCast and the shared data as low as possible, the DevCoCast team further develops and promotes (e.g. in demonstrations at forums and conferences) the use of free and/or open source software for processing and visualizing of the provided data. This includes provider-specific software, such as VITO's "VGTEExtract" (available at: <http://www.devcocast.eu>) for integrating SPOT-VEGETATION data into the users' commonly used GIS or Remote Sensing (RS) software. In addition, a comprehensive set of tools – the GEONETCast toolbox - was developed as extension to the open version of "ILWIS" (available at: <http://www.52north.org/communities/earth-observation>). This software can import and manage the wide variety of GEONETCast data and at the same time links to a free, generic GIS and RS package (ILWIS, available at: <http://www.52north.org/communities/ilwis>). For this reason, it has also been used (and improved) extensively for DevCoCast and related training activities (workshops, training material development).

Of course, the DevCoCast team remains open and also supports users who prefer the software they are used to, as long as it meets their needs. But recent evidence has shown an increasing adoption of free software by key users, such as the African National Meteo Services (UFA9 Report, 2010).

### 1.5.1. Data Manager Software

Once a local ground receiving station has been installed and configured the satellite and environmental data that is (re-) broadcasted via communication satellites can be received and stored on a storage device. Since the data is continuously received through GEONETCast (24h each day, 7 days per week), the "GEONETCast Data Manager" data management system has been developed to manage the data streams more automatically. This utility can be easily configured using a simple ascii text file. No programming experience is required to update the configuration file to cope with the changing data stream. The Data Manager Software can be used as a standalone and can be downloaded from: <http://52north.org/communities/earth-observation/data-manager-software>.



### 1.5.2. ILWIS Open

ILWIS OPEN 3.7 (or a more recent version) integrates image, vector and thematic data in one unique and powerful desktop package. It delivers a wide range of features including import/export, digitizing, editing, analysis and display of data, as well as production of quality maps. Key features are:

- Integrated raster and vector design
- Import and export of widely used data formats
- On-screen and tablet digitizing
- Comprehensive set of image processing tools
- Orthophoto, image georeferencing, transformation and mosaicing
- Advanced modeling and spatial data analysis
- 3D visualization with interactive editing for optimal view findings
- Rich projection and coordinate system library
- Geo-statistical analyses, with Kriging for improved interpolation
- Production and visualization of stereo image pairs
- Spatial Multiple Criteria Evaluation
- Web Mapping Services
- Surface Energy Balances

ILWIS can be used as a standalone package and can be downloaded from: <http://52north.org/communities/ilwis/download>. From here also various other training materials are available. Latin American users can also consult <http://www.ilwis.org/> for additional information.

### 1.5.3. GEONETCast Toolbox Software

The GEONETCast Toolbox is an ILWIS 3.7 Open (or a more recent version) plug-in. It enables easy access to and management of GEONETCast data (various satellite and environmental data and/or resulting products) and supports their subsequent, efficient geospatial processing with ILWIS 3.7 Open or other Geographic Information Systems. The GEONETCast Toolbox ZIP can be used as an ILWIS plug-in and downloaded from: <http://52north.org/downloads/earth-observation/GEONETCast/toolbox>. An installation, configuration and user guide is also available, including exercises based on a variety of sample data disseminated through GEONETCast. Further information is also provided on the ITC-GEONETCast pages (<http://www.itc.nl/Pub/WRS/WRS-GEONETCast>).

## 1.6. Scope of this manual

With the regular sharing of Earth Observation products in place, project focus has shifted to the use and added value of the shared products. In this chapter of the manual, the EUMETCast broadcast, DevCoCast hub and satellite reception infrastructure, as well as the used free and open source software are briefly introduced. More information on those can be found in separate documents posted on various web sites, the links to these sites are provided in the References section.

The next chapters of this manual describe various applications using data from the GEONETCast data stream, in conjunction with collected local information from Africa and Latin America. The application examples presented are developed in collaboration with local thematic experts during (among others) a two weeks advanced DevCoCast training workshop and demonstrate the potentials of using the information provided for environmental assessment.

The applications described are based on real world examples and can be used as standalone study and exercise cases that demonstrate the added value of GEONETCast for environmental assessment. All exercises are based on ILWIS Open, version 3.7.2, which is freely available. Sample data for the exercises can be obtained on DVD and downloaded (<http://www.itc.nl/Pub/WRS/WRS-GEONETCast/Application-manual.html> and <http://www.devcoCast.eu/>). Users are encouraged to submit their comments, feedback and/or additional exercises to ITC via the Earth Observation Community at 52North.org (<http://52north.org/communities/earth-observation/community-contact>).

## REFERENCES

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VGT4Africa Final report (2008): Final Publishable Activity Report of VGT4Africa project, revision 1, 10 February 2008, [http://www.vgt4africa.org/PublicDocuments/VGT4AFRICA\\_Final\\_Activity\\_Report\\_v4.pdf](http://www.vgt4africa.org/PublicDocuments/VGT4AFRICA_Final_Activity_Report_v4.pdf), VITO, Mol, Belgium

UFA9 Report (2010): Report from the 9<sup>th</sup> EUMETSAT User Forum in Africa, EUMETSAT, Darmstadt, Germany, [http://www.eumetsat.int/Home/Main/AboutEUMETSAT/InternationalRelations/Africa/SP\\_1226315310036?l=en](http://www.eumetsat.int/Home/Main/AboutEUMETSAT/InternationalRelations/Africa/SP_1226315310036?l=en)  
[n](#)

<http://www.earthobservations.org/geonetcast.shtml>

<http://www.devcoCast.eu/ViewContent.do?pageId=125>

<http://www.eumetsat.int/Home/Main/DataAccess/EUMETCast/index.htm?l=en>

<http://www.itc.nl/Pub/WRS/WRS-GEONETCast>

<http://52north.org/communities/earth-observation/getting-started-with-geonetcast-toolbox>

<http://www.vito.be/VITO/EN/HomepageAdmin/Home/WetenschappelijkOnderzoek/Aardobservatie/DevCoCast.htm>

<http://www.eumetsat.int/Home/Main/DataProducts/ProductNavigator/index.htm>

## Appendix 1 Products Listing from VITO Land and PML Marine hubs

### Land hub products for dissemination through EUMETCast.

Product acronym	Full product name	Filename OIS In	Filename EXGate Out	Format Out	Compressed Size and type	Products Frequency	Generation Time (UTC)
VITO							
NDVI	Normalised Difference Vegetation Index - South America	V2KRNS10_YYYYMMDD_NDVI_S-America.ZIP	V2KRNS10_YYYYMMDD_NDVI_S-America.ZIP	Zip archive	~25Mb	1st, 11th and 21st of each month	~1-5 days later
NDWI	Normalised Difference Water Index - South America	g2_BIOPAR_NDWI_YYYYMMDD000_S-America_VGT_V0.2.zip	g2_BIOPAR_NDWI_YYYYMMDD000_S-America_VGT_V0.2.zip	Zip archive	~20 Mb	1st, 11th and 21st of each month	~1-5 days later
DMP	Dry Matter Productivity - South America	g2_BIOPAR_DMP_YYYYMMDD0000_S-America_VGT_V0.1.zip	g2_BIOPAR_DMP_YYYYMMDD0000_S-America_VGT_V0.1.zip	Zip archive	~35 Mb	1st, 11th and 21st of each month	~1-5 days later
LOC	Desert Locust Products	MCD_GreenArea_YYYYMMDD_[Eritrea Mali N-Sudan].zip	MCD_GreenArea_YYYYMMDD_[Eritrea Mali N-Sudan].zip	Zip archive	~1-4Mb	1st, 11th and 21st of each month	~1-5 days later
CSIR							
FFDI	McArthur Forest Fire Danger Index	CSIR_FFDI_YYYYMMDD1200.txt	CSIR_FFDI_YYYYMMDD1200.txt	ASCII	242Kb	Daily	12:00
LFDI	Lowveld Fire Danger Index	CSIR_LFDI_YYYYMMDD1200.txt	CSIR_LFDI_YYYYMMDD1200.txt	ASCII	242Kb	Daily	12:00
INTA							
ANOMNDVI	Anomaly of Normalised Difference Vegetation Index Map - South America	INTA_HRPT_Vegetation_Index_Anomaly_YYYYMM-K.gif [K = Dekad = 1,2,3]	INTA_HRPT_Vegetation_Index_Anomaly_YYYYMM-K.gif [K = Dekad = 1,2,3]	Gif	~240 Kb	1st, 11th and 21st of each month	~1-5 days later
FDI	Fire Danger Index - South America	INTA_NOAA_AVHRR_18_19_Fire_Risk_YYYYMM-K.gif K = Dekad = 1,2,3]	INTA_NOAA_AVHRR_18_19_Fire_Risk_YYYYMM-K.gif K = Dekad = 1,2,3]	Gif	~ 300 Kb	1st, 11th and 21st of each month	~1-5 days later

NDVIM	Normalised Difference Vegetation Index Map - South America	INTA_HRPT_Vegetation_Index_YYYYMM-K.gif K = Dekad = 1,2,3]	INTA_HRPT_Vegetation_Index_YYYYMM-K.gif K = Dekad = 1,2,3]	Gif	~260 Kb	1st, 11th and 21st of each month	~1-5 days later
ETR	Real Evapotranspiration - South America	INTA_NOAA_AVHRR_Evapotranspiration_YYYYMM-K.gif K = Dekad = 1,2,3]	INTA_NOAA_AVHRR_Evapotranspiration_YYYYMM-K.gif K = Dekad = 1,2,3]	Gif	~500 Kb	1st, 11th and 21st of each month	~1-5 days later

**Marine products for dissemination through EUMETCast.**

Product acronym	Full product name	Filename OIS In	Filename EXGate Out	Format Out	Compressed Size and type	Products Frequency	Generation Time (UTC)
PML							
PMLAFR	Near real time ocean product – Africa	PML_<pml_area>_MODIS_sst_nrt_YY YMMDDHHMMSS.nc.bz2 PML_<pml_area>_MERIS_oc_nrt_YY YMMDDHHMMSS.nc.bz2 (see)	PML_<pml_area>_MODIS_sst_nrt_YY YMMDDHHMMSS.nc.bz2 PML_<pml_area>_MERIS_oc_nrt_YY YMMDDHHMMSS.nc.bz2	NetCDFv3	Bzip2	24 per day	Various
PMLBRA	Near real time ocean product – Brazil	PML_Brazil_MERIS_oc_nrt_<passtime>.nc.bz2	PML_Brazil_MERIS_oc_nrt_<passtime>.nc.bz2	NetCDFv3	Bzip2	1 per day	Various
TBC	Refined ocean Products	PML_<pml_area>_MODIS_sst_refined_<passtime>.nc.bz2 PML_<pml_area>_MERIS_oc_refined_<passtime>.nc.bz2	PML_<pml_area>_MODIS_sst_refined_<passtime>.nc.bz2 PML_<pml_area>_MERIS_oc_refined_<passtime>.nc.bz2	NetCDFv3	Bzip2	1 per day	TBC
UCT							
AQUA:O CPUCT	Level 3 Ocean Product	UCT_<uct_area>_MODIS_chlora_YYY YMMDD.nc.bz2 UCT_<uct_area>_MODIS_Kd490_YY YMMDD.nc.bz2 UCT_<uct_area>_MODIS_nflh_YYYY MMDD.nc.bz2 UCT_<uct_area>_MODIS_sst_YYYY MMDD.nc.bz2	UCT_<uct_area>_MODIS_chlora_YY YMMDD.nc.bz2 UCT_<uct_area>_MODIS_Kd490_YY YMMDD.nc.bz2 UCT_<uct_area>_MODIS_nflh_YYY YMMDD.nc.bz2 UCT_<uct_area>_MODIS_sst_YYYY MMDD.nc.bz2	NetCDFv3	40-2000K b bzip2	1 per day per area	Various
ENVISAT:OCPUCT	Level 3 Ocean Product	UCT_<uct_area>_MERIS_algal1_YYY YMMDD.nc.bz2 UCT_<uct_area>_MERIS_algal2_YYY YMMDD.nc.bz2 UCT_<uct_area>_MERIS_totalsusp_YY YMMDD.nc.bz2 UCT_<uct_area>_MERIS_yellowsubs_YYYYMMDD.nc.bz2	UCT_<uct_area>_MERIS_algal1_YY YMMDD.nc.bz2 UCT_<uct_area>_MERIS_algal2_YY YMMDD.nc.bz2 UCT_<uct_area>_MERIS_totalsusp_YYYYMMDD.nc.bz2 UCT_<uct_area>_MERIS_yellowsubs_YYYYMMDD.nc.bz2	NetCDFv3	40-2000K b bzip2	1 per day per area	Various
JRC							
JRC	Level 4 Ocean Product	TBD, but currently AYYYYJJJJYYYYJJJ_<product>_AMIS.nc.bz2	TBD	Ascii	5-7MB bzip2	Monthly	after end of month

<PML\_area>=Algeria, Egypt, EMadagascar, Ghana, Libya, Mozambique, NEMadagascar, NMorocco, RedSea, SierraLeone, or SMorocco

<UCT\_area>= Angola, CotedIvoire, ESAfrica, Guinea, Mauritania, MChannel, Namibia, Nigeria, NSomalia, Senegal, SSAfrica, SSomalia, Tanzania, or WSAfrica