THE ITC GEONETCAST TOOLBOX: A GEO CAPACITY BUILDING COMPONENT FOR EDUCATION AND TRAINING IN GLOBAL EARTH OBSERVATION & GEO INFORMATION PROVISION TO SOCIETY

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Abstract

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. The root cause is mainly a still inadequate generic knowledge to use remote sensing data and derive information products. The GEONETCast data dissemination system of GEOSS, the Global earth observation system of systems, is steadily working towards removing barriers for EO data access and use. Efficient processing and analysis tools, accessible by end-users, need to be urgently developed in order to exploit the full potential of this global data dissemination and information system. The ITC GEONETCast Toolbox, an open access earth observation data retrieval and application development environment is presented here. It can act as gap filler in the knowledge transfer chain from EO data providers to the local end-users in the different societal benefit areas of GEOSS.

Introduction

Use of real-time earth observation data in combination with other geospatial ground information to inform society and public has been used for many years by meteorological services for weather reporting and forecasting. Internet-based search engines and on-line communication media are also strongly contributing to an increased use of earth view, mapping and other geospatial end-user services. The Group on Earth Observation (GEO) is leading a worldwide effort to extend the use of near real time Earth Observation combined with in situ ground data to a broad array of societal benefit areas, including: climate, weather, water, health, energy, disasters, agriculture, biodiversity and ecosystems [4] as shown in Figure 1.
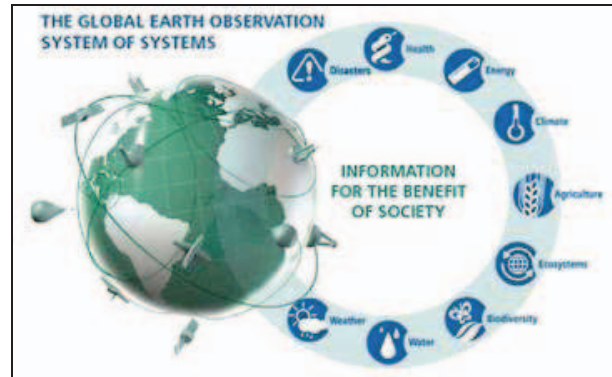

Figure 1: the vision for GEOSS

Geonetcast is the physical real time data dissemination backbone of GEOSS. Initially anchored on the data streams of the geostationary meteorological satellite constellation, it is now rapidly being extended with polar orbiting platforms and satellite datasets like global land cover vegetation products e.g. VEG4Africa [1], marine and ocean data e.g. Jason-2. It is as such conceived and designed to cover the full extend of the nine application areas of GEOSS. Geonetcast achieved global coverage by the end of 2008, with the Fenyun-2C geostationary satellite data with full Asia coverage becoming on-line in real-time mode.
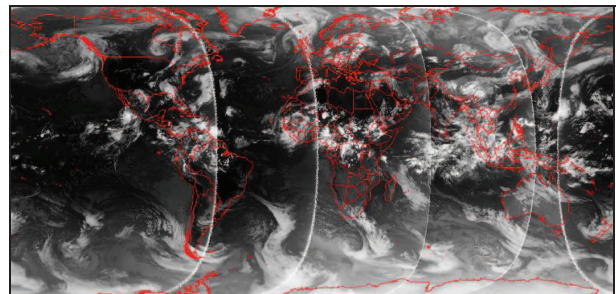

Figure 2: global composite view from Geonetcast

This low cost, real time environmental data and information delivery system is now currently globally operational. Figure 2 illustrates a recent global thermal band (10.8 µm) composite, processed from the geostationary satellite constellation (west to east: GOES-West; GOES-East, Meteosat-9, Meteosat-7, MTSAT-1R), received by the ITC mini disk reception station in Enschede, the Netherlands.

This global EO data transmission, when combined with low cost ground receiving infrastructure and application software tools, permits users anywhere in the world, also with limited means, to access EO data and other information sources. It is now extending beyond meteorological data stream use. The Geonetcast toolbox described here and developed by ITC with support of the 52North organization (www.52North.org) presents a low-cost option to process EO data relevant to a broad range of societal relevant applications in all societal benefit areas of GEOSS. Earlier (2008) versions of the Toolbox were also presented [7].

Toolbox components

As hardware, a low-cost digital satellite television data reception and PC-based storage system under a MS-Windows XP or Vista operation system is used, usable eventually also in remote areas, e.g. even without internet access. Global data reception is achieved through relay of EO satellite data via ground stations like e.g., EUMETcast near Darmstadt (Germany), to digital television broadcasting satellites like Eurobird, Atlantic Bird and others.
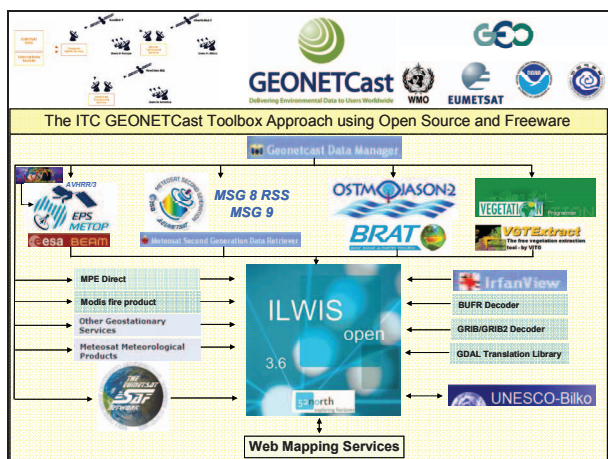

Figure 3: ITC GEONETCast Toolbox features

The software design principles of the toolbox were an easy operability, open source a/o freeware software components and an interface, adaptable by the users to

their own selected data streams, data analysis, processing needs and information dissemination requirements, like e.g. web mapping services. The toolbox setup and key features are shown in Figure 3.
The key features of the ITC Geonetcast Toolbox can be described as follows:

◊ Satellite data reception & archive
- Data reception via DVB antenna using EUMETCast / Geonetcast
- Global geographical coverage
- Selective archiving according user preferences e.g. satellite, data type, segment selection, time of storage, using an build-in data reception manager

◊ Near real-time image processing & applications
- ILWIS Open v.3.6 with full image analysis - GIS functionality with vector, raster, database, spatial modelling, dynamic visualization (see Figure 4)
- Build-in Meteosat MSG data browser and retriever
- Multiple data import and format routines (64) i.e. BUFR, GRIB, netCDF, GeoTIFF, NAS, HDF and other formats using Open GDAL geospatial data library libraries routines and freeware tools
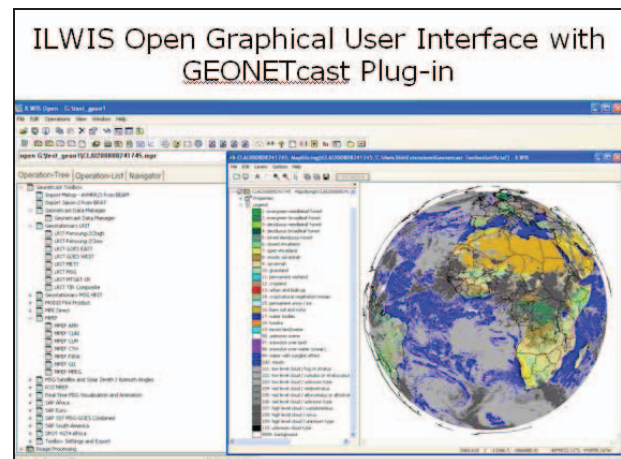- Toolbox sample library (with processing and example application development routines)

Figure 4: ILWIS Open v.3.6 GUI (52North)

◊ Visualization and web-based services
- Web-based client/server model using HTML and XML languages
- WMS or web mapping services client

For some EO sensor datasets e.g., METop and Jason-2, available open source or freeware data processing software's were used i.e., the ESA - BEAM METop reader plug-in [2] and the BRAT or Basic Radar

Altimetry Tool [3] for Jason-2 sea surface height data. After external pre-processing, METop and Jason-2 data can be analysed using the ILWIS Open Toolbox. Figure 4 further illustrates the easy to operate and user friendly ILWIS Open graphical user interface, tested and validated through several thousands of ITC course alumni and other users during recent years.

The current challenges and toolbox developments are geared towards: - coupling Earth Observation data streams to other components i.e., *in situ* data and terrestrial simulation and prediction models like hydrological (e.g. rainfall runoff, water quality) or environmental models (e.g. agro meteorology), or earth system simulation tools (e.g. carbon fluxes, land atmosphere interactions, etc.). Also the web-based services component is undergoing a continuous development i.e., web processing services and other internet based client/server developments.

GEONETCast Toolbox education & training initiatives and networks

Producing and providing scientifically sound and societal relevant geo information, derived for EO and in situ observations, to the public requires essential knowledge of EO datasets and system functionality. Education and training can contribute to empower large segments of society and persons to gain more scientific understanding, develop skills and build self reliance in creating and developing their own local or regional applications. The ITC Geonetcast toolbox permits numerous applications to be designed and implemented, for all GEOSS societal benefit areas [5].
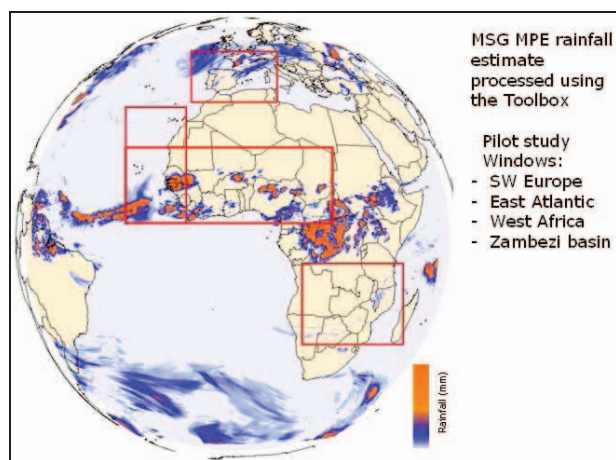

Figure 5: MSG Meteosat-9 precipitation estimate

As a practical show case of this, we just illustrate here the application potential by showing the recent

Geonetcast small group applications, created by students during a recent ITC MSc level regular 3-week training module in June 2009. Due to the majority of African, Middle East and European students in this module, the Meteosat MSG earth view window was chosen, as shown in Figure 5, illustrating also the chosen application regions. The small demonstration pilots developed by ITC MSc program students concerned the following topics:

- Rainfall outlook for the rainy season onset in the Sahel region (West Africa window)
- Tropical depression – cyclone monitoring during day and night-time (West Africa, East Atlantic)
- Relationships between MSG-derived SST (sea surface temperatures) and SeaWIFS chlorophyll-a concentrations (East Atlantic ocean window)
- Ground validation of MSG-MPE Multisensor precipitation estimates (SW Europe window)
- Now casting of thunderstorms using the MSG Global instability index (GII) over SW Europe
- Generating decadal ET (evapotranspiration) time series using the SEBS algorithm [9] and MSG and SPOT Vegetation data (Zambezi basin)
- Diurnal short term ET variability using MSG and SPOT Vegetation data (Zambezi basin)
- An automated procedure for deriving spatial and temporal satellite rainfall fields (Zambezi basin)
- Relationships between MSG rainfall estimates and vegetation variables from SPOT Vegetation instrument (West Africa window)
- Deriving a near real time GWSI (global water satisfaction index) using Geonetcast datasets

The students were requested to design and implement an automated application procedure for the above cases, taking into account calibration, validation and data uncertainty issues [6]. The list clearly illustrates the large potential of the Toolbox, also as a training engine for developing EO applications and user services. The Toolbox software and documentation is available from the ITC website, shown in Figure 6 at address www.itc.nl/departments/wrs/geonetcast [8].

Capacity building, ranging from scientific research, professional application building and operational use and maintenance of the Geonetcast integrated land and water information system are under continuous development, and is also implemented via a range of international projects. We can mention the EU FP7 DevCoCast project initiative [10].
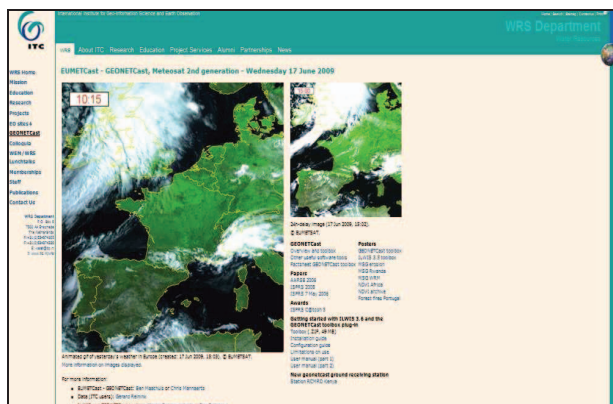
Figure 6: ITC GEONETCast website

Conclusions

The open data, tools and training access philosophy (low to non-restricted data access, open source, training and science support) and simple structure of the ITC GEONETCast Toolbox permits users of various natures (scientists, software application engineers, trainers and end-users) to adapt to toolbox components to their own needs and requirements. This permits ultimately the development of GEOSS applications <u>by</u> users themselves like e.g., African EO and Geo information providers a/o in cooperation with the international community. This approach stands in contrast to other (some although successful) international efforts or demonstration projects, produced <u>for</u> countries or regions like Africa by international projects.

The ITC Toolbox is undergoing continuous further development and extension with new items and components like new satellite data streams, exchange formats, application tools, coupling to terrestrial models (hydrological, environmental), data analysis and visualization tools and web-based communication services.

Capacity building support is being developed and is implemented currently using short training and workshop events and MSc degree embedded training modules. GEONETCast distance or e-learning initiatives are under development and testing and are planned to be operational early 2010. Research and component development is achieved using ITC staff in cooperation with PhD and postdoctoral researchers. ITC is taken a leading role here with several links to partners from the satellite agencies (EUMETSAT, CMA, ESA, INPE, CNES) value-added providers (VITO, JRC/EU, RCMRD) as well as other higher education institutions in Europe, Africa, Asia and America. The ITC GEONETCast Toolbox initiative will also be related to new EU FP7 funded support actions like GEONETCab, aiming at identifying best capacity building and earth observation user services in support of GEOSS. All these efforts will hopefully contribute to GEO, in order to achieve its ambitious societal goals set out in its 10-year (2005-2015) implementation plan.

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