FACULTY OF GEO-INFORMATION SCIENCE
AND EARTH OBSERVATION

ITC

WATER AND FOOD SECURITY-ETHIOPIA TOOLBOX

INSTALLATION, CONFIGURATION AND USER GUIDE OF THE WFS - ETHIOPIA TOOLBOX PLUG-IN FOR ILWIS 3.7.2

XML version 1.0

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Acknowledgement

After the announcement by EUMETSAT in 2004 that data from the SEVIRI instrument (on-board of the Meteosat 2nd generation or MSG satellite) would become freely available for education and research, an initiative was launched at ITC, to enable to receive and process the data from this instrument in near real time for use in education and capacity building worldwide. Also through the efforts of the Group on Earth Observation (GEO), many more datasets became rapidly available by means of their global earth observation data dissemination system – “GEONETCast”, used now by several space agencies (EUMETSAT, NOAA, CMA) as their global data distribution system.

The GEONETCast data dissemination system can be used for a variety of meteorological and environmental near real time applications. Within the framework of a dedicated project on early warning for food security in the Horn of East Africa and Ethiopia in particular, a dedicated toolbox, called the “Water and Food Security-Ethiopia Toolbox”, was developed as a plug-in of the generic remote sensing and GIS freeware and open source package ILWIS.

The ILWIS open source software community as well as the more recently established Earth Observation Community are hosted by our cooperation partner “52North.org”. All software and toolbox utilities can be freely obtained and 52North is thanked for their continuing support.

This development would not have been possible without the support from various organizations. EUMETSAT’s support has been instrumental. Technical or logistical questions, requests for trial data or contacts with data providers where handled promptly and efficiently. Utilities developed by EUMETSAT could be used, such as the Product Navigator. User Services and ops@eumetsat.int were instrumental in providing licenses to new users in Ethiopia, specifically for the regional offices of the National Meteorological Agency (NMA), Early Warning and Response Directorate of the Ministry of Agriculture (DRMFSS) and the World Food Programme (WFP) – Ethiopia country office, who all were keen to embark on using “GEONETCast” and our ILWIS open source RS and GIS technology.

The ITC Directorate has also been instrumental in supporting this development throughout the years. Next to their continuing support to the Capacity Building component of GEO, they allocated resources for this capacity development initiative, including setting up antennas, providing data storage capacity and day to day management of the ITC data receiving centre and training facilities.

The collaboration within different projects and partners from Ethiopia was instrumental. The inputs from the NMA, DRMFSS and WFP have been taken as a guide for the development of the various routines available in this dedicated toolbox. The experiences gained during training activities and short capacity building workshops conducted in Ethiopia and Africa have also been used to ensure that the utilities developed can be easily implemented by the growing Ethiopian User Community.

An important driver behind the development of this WFS-Ethiopia toolbox is the subsequent use of processed GEONETCast data, for further analysis using the Livelihood, Early Assessment & Protection (LEAP) software of WFP to increase food security among the most vulnerable communities in Ethiopia and maybe the world.

Ben Maathuis and Chris Mannaerts, September 2012

List of acronyms and abbreviations

52North	52°North Initiative for Geospatial Open Source Software
AMESD	African Monitoring of the Environment for Sustainable Development
AMV	Atmospheric Motion Vector
AVHRR	Advanced Very High Resolution Radiometer
BDMS	Botswana Department of Meteorological Services
BEAM	Basic ERS and ENVISAT AATSR and MERIS Toolbox
BILKO	Software package for learning and teaching remote sensing image analysis skills
BRAT	Basic Radar Altimetry Toolbox
BUFR	Binary Universal Form for the Representation of meteorological data
CBERS	Chinese Brazilian Earth Resources Satellite
CCD	Charge Coupled Device
CHC	CBERS CCD and HRC composite product
CLAI	Cloud Analysis Image
CMA	Chinese Meteorological Agency
CSIR	Council for Scientific and Industrial Research, South Africa
CTH	Cloud Top Height
DDS	Data Dissemination System
DevCoCast	GEONETCast for and by Developing Countries
DMP	Dry Matter Productivity
DN	Digital Number
DOS	Disk Operating System
DRMFSS	Disaster Risk Management and Food Security Sector
DSLF	Down welling Surface Long-wave radiation Flux
DSSF	Down welling Surface Short-wave radiation Flux
DVB	Digital Video Broadcast
EAMNET	European African Marine Network
ECMWF	European Centre for Medium-Range Weather Forecasts
ENVISAT	Environmental Satellite
ESA	European Space Agency
ET	Evapotranspiration
EUMETCast	A satellite based data dissemination of various (mainly satellite based) data covering Europe and Africa
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
FTP	File Transfer Protocol
FVC-FCOVER	Fraction of Vegetation Cover
GDAL	Geospatial Data Abstraction Library
GEO	Group on Earth Observation
GEONETCast	A global network of satellite based data dissemination systems
GEOSS	Global Earth Observation System of Systems
GNC	GEONETCast
GRIB	Gridded Binary data format
GTS	Global Telecommunication System
GUI	Graphical User Interface
HRIT	High Rate Image Transmission
HRV	High Resolution Visible
ICAO	International Civil Aviation Organization
ILWIS	Integrated Land and Water Information System
INPE	Instituto Nacional de Pesquisas Espaciais, Brazil
ITC-UT	Faculty of Geo-Information Science and Earth Observation, University of Twente
IR	Infra-Red
LAI	Leaf Area Index
LEAP	Livelihood, Early Assessment, Protection
LSA	Land Surface Analysis
LST	Land Surface Temperature
MDD	Meteorological Data Dissemination

METAR	Meteorological Aerodrome Report (amongst others!)
METOP	Meteorological Operational satellite programme
MODIS	Moderate Resolution Imaging Spectrometer
MPE	Multi sensor Precipitation Estimate
MPEF	Meteorological Product Extraction Facility
MSG	Meteosat Second Generation
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NIR	Near Infra-Red
NMA	National Meteorological Agency
NOAA	National Oceanic and Atmospheric Administration
PML	Plymouth Marine Laboratory
PHENOKS	Phenology Key Stages
R	A language and environment for statistical computing and graphics
RFS	Rainfall Satellite
RGB	Red – Green – Blue colour assignment
RSS	Rapid Scanning Service
SADC	Southern African Development Community
SAF	Satellite Application Facilities
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SPOT	Système Probatoire d’Observation de la Terre ou Satellite Pour l’Observation de la Terre
SWB	Small Water Bodies
TAF	Terminal Aerodrome Forecast
TAMSAT	Tropical Applications of Meteorology using Satellite data and ground-based observations
TIR	Thermal Infra-Red
VGT-extract	Software tool developed by VITO to import products derived from the Vegetation instrument
VGTinstrument	Vegetation instrument onboard of SPOT
VIS	Visible
VITO	Flemish Institute for Scientific Research
VPI	Vegetation Production Indicator
UTC	Universal Time Coordinated
WFP	World Food Programme
WFS-E	Water and Food Security – Ethiopia
WMO	World Meteorological Organization
WV	Water Vapour
XML	Extensible Markup Language

RELEASE NOTES

Following comments have to be taken into consideration with respect to the release of this Water and Food Security – Ethiopia Toolbox, XML version 1.0:

1. This is the first (β) release and currently under testing by the Ethiopian User Community. Utmost care was taken to ensure appropriate operation of the routines developed but at this stage some defects might still be included and should be reported to the corresponding author to be included in a new release;
2. No liability can be accepted for use of the WFS-Ethiopia Toolbox by the toolbox developers;
3. In order to maintain a simple toolbox structure only a limited number of products can be processed. The type and number of products for which processing routines have been developed are resulting from discussions between ITC and the Ethiopian stakeholders: National Meteorological Agency (NMA), Early Warning and Response Directorate of the Ministry of Agriculture (DRMFSS) and the World Food Programme (WFP) – Ethiopia country office;
4. Some of the routines, like “Generic LEAP import – export” are under development. Also the way currently TAF (Terminal Aerodrome Forecast) messages are processed need further improvement as the actual forecast information is not yet included;
5. When using the WFS-Ethiopia Toolbox you agree and comply with the conditions of the software utilities used as well as the terms and conditions stipulated by EUMETSAT for the use of the data delivered by means of GEONETCast and EUMETCast.

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1. GENERAL INSTALLATION AND CONFIGURATION INSTRUCTIONS

1.1 INTRODUCTION

Follow the instructions provided below to install ILWIS Version 3.7.2, the WFS-Ethiopia Toolbox and a number of other free software utilities, in order to work with the data provided via EUMETCast - GEONETCast. Read the instructions provided below carefully and proceed with the installation of the various utilities. In case you want to use the WFS-Ethiopia Toolbox, be aware that at this moment it is not running under LINUX-Ubuntu. Furthermore this WFS-Ethiopia Toolbox version is not downwards compatible; you need to use at least the latest ILWIS Version 3.7.2.

1.1.1 *ILWIS*

Available from: http://52north.org/

From this location select the navigation tab: "*Downloads*" or directly select "http://52North.org/downloads/ILWIS". Select the latest (multiple file) ILWIS372 version ("*ILWIS 3.07.02*") and download the ZIP file(s), save the file(s) in a temporary directory on your hard disk. Unzip the file and run the ILWIS setup. When you intend to use the WFS-Ethiopia Toolbox **do not install ILWIS372 under the default installation directory "C:\Program Files"** as this might cause problems with respect to administration rights (especially under Windows 7) when creating temporary files and because the toolbox is utilizing DOS batch routines, which can be affected by the space in the directory name "*Program Files*". Select as your installation "*drive:\directory*" a location where you have the proper administrative rights (e.g. "*D:\ILWIS372*"). In the "*ILWIS372*" directory a shortcut to the "*ILWIS.exe*" can be created, you can copy this shortcut to the desktop of your system.

Please take into consideration, straight from the start, the following golden rules when using ILWIS:

- ***Don't use spaces in (sub-) directory or file names, instead use underscores;***
- ***Do not only use numbers as file names;***
- ***Do not work in multiple output directories;***
- ***Start ILWIS, navigate to your working directory and close ILWIS. Open ILWIS again to ensure that your current working directory is also the actual ILWIS working directory.***

1.1.2 *WFS-Ethiopia Toolbox*

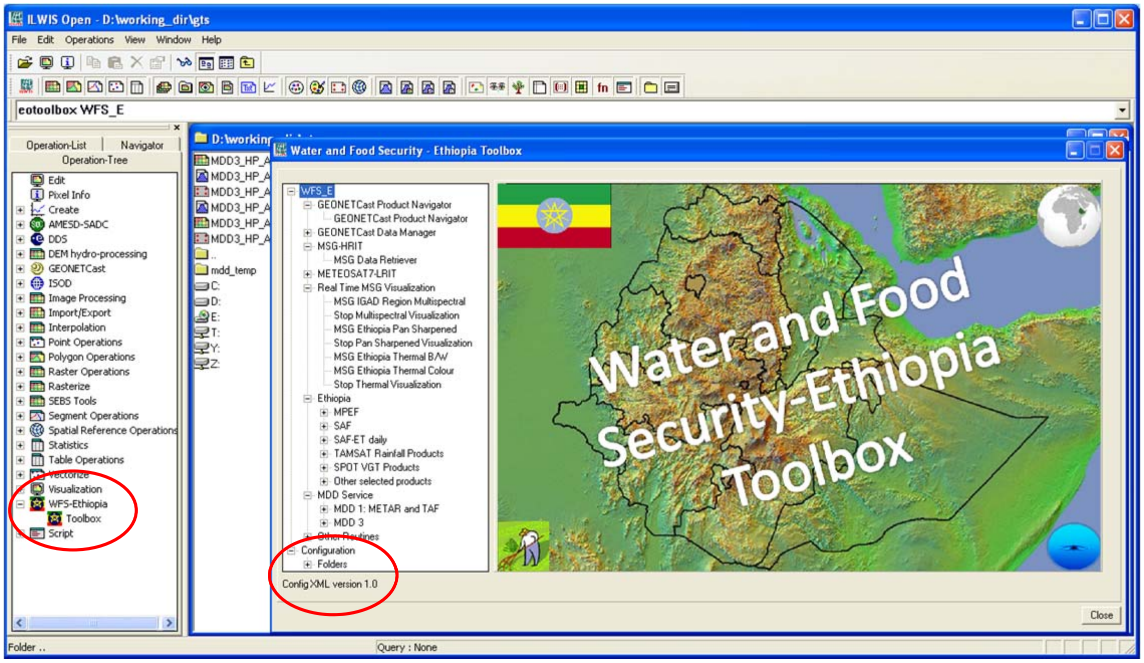
Available from: http://52north.org/

To download the *WFS-Ethiopia Toolbox* from the 52North website: Select from the 52north.org website the navigation tab: "*Earth Observation*". Additional information is provided over there as well as the link to the download area. You can also directly download the Toolbox from http://52north.org/downloads/earth-observation, select "*WFS-Ethiopia*". Download the Zip file: "*52n-eo-WFS-E-toolbox-1.0*" available over there and store it in a temporary directory. Eventually download other resources provided over there.

After the download is completed, copy this ZIP file in the ILWIS sub-directory "\Extensions". *There is no need to unzip the file! ILWIS automatically detects the ZIP file in this directory then unzips the file and installs the plug-in when a new instance of ILWIS is started*. *Afterwards the ZIP file is deleted in this sub-directory!*

Start ILWIS and in the Operation-Tree of ILWIS the "WFS-Ethiopia" tab will appear (see also figure 1.1). Double click the "WFS-Ethiopia" tab and the subsequent "Toolbox" tab and various (sub) menu items are now at your disposal. These options can be used to import several image and data sources that are disseminated via EUMETCast-GEONETCast, a system that uses digital video broadcast (DVB) to deliver environmental data worldwide. Over 60 image and product processing routines, relevant for Water and Food Security Analysis for Ethiopia, are currently supported. As the GEONETCast dissemination system is constantly developing, keep checking the ITC website (http://www.itc.nl/Pub/ WRS/WRS-GEONETCast) or the "*Earth Observation*" community webpage at http://52north.org, for new (toolbox) developments. Modifications and added functionality for the WFS-Ethiopia Toolbox are made available here on an ad hoc basis, so check if you are working with the latest version. The XML configuration number, currently 1.0, is given on the lower left hand portion of the WFS-Ethiopia Toolbox opening screen.

Figure 1.1: The WFS-Ethiopia Toolbox main and sub menu structure under ILWIS372



Close ILWIS as you might need to install additional utilities. Check if you have already installed the Java runtime environment, IrfanView, BUFRtool, BUFRdisplay and METAR-Weather. If this is not or partially the case, use the links below and follow the additional installation instructions.

1.1.3 *Java Runtime Environment*

Available from: http://www.java.com/en/download/index.jsp

Some WFS-Ethiopia Toolbox routines make use of JAVA. If your system does not have the JAVA Runtime Environment installed already, move to the website indicated above, select the “Free Java Download” button and install it. Accept the License Agreement to start and complete the installation (using default settings).

1.1.4 *IrfanView*

Available from: http://www.irfanview.com/

For some data visualizations that do not require import into an ILWIS data format, use is made of IrfanView. Download the setup executable and save it in a temporary directory on your hard disk.

After the download has been completed run the setup, there is no need to create shortcuts, use the option: “For all users” and select the default Installation folder. Click “Next” three times, just use the default settings, “Don’t install Google Desktop Search”, click “Next” two times and after the installation has been completed, press “Done”.

An instance of IrfanView can be started to check if the installation has been successful, the program can stopped.

1.1.5 *BUFRtool*

Available from: http://www.northern-lighthouse.com/cipher/bufrtool.html

This utility is used to import BUFR encoded data and is called from within batch routines operated from the DOS command prompt. On the webpage given above, select: "*Note the conditions of use*". After accepting conditions of use, select: "*Download zipped MS Windows version of BUFRtool 5.0*" (or newer version if available).

Download the zip file to a temporary directory and unzip the file in this directory. Move to the directory created during the unzip procedure, e.g. bufrtool-5.0 and copy the file "bufrtool.exe" from the BUFRtool sub-directory "/BIN" to the ILWIS directory under:

Drive:*ilwis_dir*\Extensions\WFS_E-Toolbox\util

(note that "Drive:\" is the disk drive and the "*ilwis_dir*\" is the ILWIS directory where ILWIS was installed during the first step, see chapter 1.2).

Copy also from the BUFRtool directory the whole sub-directory "\Tables" into the ILWIS directory:

Drive:*ilwis_dir*\Extensions\WFS_E-Toolbox\util

The "\Util" directory now should have a sub-directory "\Tables" containing the so called BUFR tables (htm files, from A to F, numbered 7-14, and some other htm files).

1.1.6 *BUFRdisplay*

Available from: http://www.elnath.org.uk/

On this webpage, under "BUFR File Support Software", select "*BUFRdisplay*" and download the BUFRdisplay utility and eventually also the User Guide. Store the BUFRdisplay_v???.zip file in a local temporary directory. Copy the zipped file into your ILWIS directory under "\Extensions\WFS_E-Toolbox\util\bufrdisplay" and unzip the BUFRdisplay_v???.zip in this sub-directory. This utility facilitates quick visualization of (multiple) EUMETCast-GEONETCast disseminated BUFR encoded files for various products. The BUFRtool (see Chapter 1.1.5) is used to import selected BUFR encoded data into ILWIS format for subsequent analysis. Using the software means that you agree and comply to the conditions of use of the software.

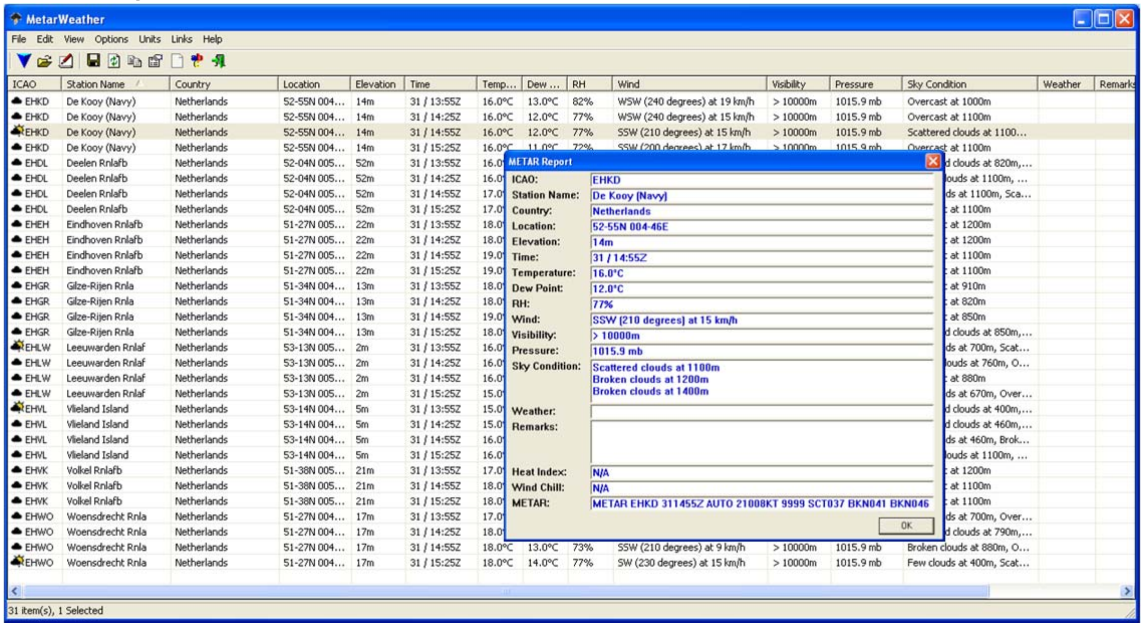
1.1.7 *METAR-Weather*

Available from: http://www.nirsoft.net/utils/mweather.html

To quickly visualize METAR and TAF information use is made of a freeware tool called "METAR-Weather" (currently use is made of MetarWeather version 1.70, Copyright (c) 2003 - 2011 by Nir Sofer). The Metar-Weather utility decodes METAR weather reports from around the world, and displays them in a simple weather report table. You can save the weather report into text, HTML or KML files. Metar-Weather can decode METAR reports from a text file, or download the latest reports directly from the Internet. Within the Toolbox the utility is used to display the METAR and TAF messages (for TAF only the first line of the message) disseminated through the Meteorological Data Dissemination (MDD) System, the MDD-1 service of GEONETCast, see also figure 1.2.

At the bottom of the webpage indicated above use the link: "*Download MetarWeather in Zip File*". Save the utility to your local disk unzip the file and copy the utility "Mweather.exe" into your ILWIS sub-directory: "Extensions\WFS_E-Toolbox\util\mweather". You can double click on "*mweather.exe*" to see if the application works, subsequently close it.

Figure 1.2: The METAR Weather Viewer with MDD-1 data from the Netherlands

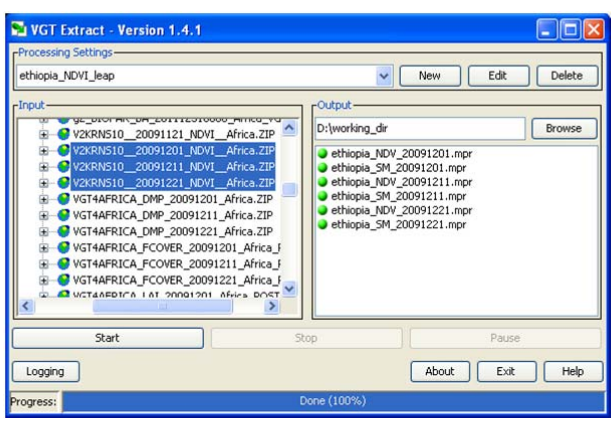


1.1.8 *VGTExtract*

Available from: http://www.agricab.info/software/Pages/VGTExtract.aspx

The VGTExtract tool is a simple, user-friendly free tool originally made by VITO and is used to simplify and automate the integration of basic and derived SPOT-VEGETATION products in a variety of GIS and Remote Sensing end-user software for further analysis, post-processing or visualization. VGTExtract searches for VGT products in a given directory and its sub-directories. For each event of a product found, VGTExtract is automatically uncompressing the product and performs the reformatting into ILWIS format, applying product calibration coefficients and extracts the Region of Interest defined by LEAP for Ethiopia. It is advised to select the VGTExtract version containing Virtual Machine (VM) and install the package directly on your “C:\” or “D:\” drive in the directory “VGTExtract”, otherwise the default installation settings can be used. After installation copy the whole “VGTExtract directory into the ILWIS sub-directory \Extensions\WFS_E-Toolbox\util. Advantage of the use of VGTExtract is the quick retrieval of time series of VGT products. In the VGT import application shown in figure 1.3 all instances of the VGT-NDVI data is retrieved according to the “Processing Settings” of the configuration file “ethiopia_NDVI_LEAP”.

Figure 1.3 Import of VGT-NDVI using predefined Processing Settings for Ethiopia



1.1.9 ***Concluding remarks***

With ILWIS, the Water and Food Security - Ethiopia Toolbox plug-in and the other necessary utility-software installed you still need to continue with the WFS-Ethiopia Toolbox configuration settings which are further described in the next chapter.

Note that also use can be made of other freeware utilities for pre or post processing of the data, such as BILKO, BRAT, satellite tracking software, VISAT-BEAM, etc. Links to these resources are provided in appendices. For other "EO" community freeware utilities developed, like the "GEONETCast Toolbox", the "AMESD-SADC Toolbox" and the "*In Situ* and Online Data Toolbox", see also the references provided in the appendices. Using the various software utilities means that you agree and comply with the conditions of use of these software tools.

1.2 CONFIGURATION OF THE DATA STREAM USING THE GEONETCAST DATA MANAGER

1.2.1 *Introduction*

Once having installed and configured a local GEONETCast ground receiving station the satellite and environmental data that is (re-) broadcasted via communication satellites can be received and stored on a storage device (server). As the data is received on a 24 hr – 7 days a week basis, the "GEONETCast Data Manager", a data management system, has been developed that can be easily configured using a simple ascii text file. How to prepare or modify this ascii configuration file and to run the Data Manager is described below. This section is of special relevance to the system administrator operating the ground receiving station. On the 52north.org website (the navigation tab: "Earth Observation") also a recent ascii "GEONETCast Data Manager" configuration file is available, so new users don't need to start from scratch constructing the ascii file. Within the GEONETCast toolbox an ascii configuration file, fine-tuned for Ethiopia, is also available.

1.2.2 *General design considerations for development of the GEONETCast Data Manager*

The GEONETCast Data Manager is a software application for Windows / Linux written in Java that - in short – examines computer files, and transfers them to a proper location, based on filename-patterns. It was developed at ITC (http://www.itc.nl).

The primary purpose for developing this application is to organize the large amount of data files received on a GEONETCast receiving station (a computer with a Digital Video Broadcast (DVB) card connected to a satellite dish, configured to receive the EUMETCast – GEONETCast data. The data that is received on the EUMETCast - GEONETCast receiving station must be transferred to computer storage that is independent of the receiving station's disk storage before users can access it. Users are not allowed to work directly with the data on the receiving station, because it should perform its primary task undisturbed, which is to be available all the time for storing the files captured by the (DVB) card.

Main objectives of the GEONETCast Data Manager application:

- To organize all files in the "incoming" folder of the EUMETCast – GEONETCast receiving station, according to "rules" defined by the local system administrator.
- To detect and log "missing files". The application can be fed with knowledge about the files that are expected from a certain category (e.g. for MSG-HRV this would be 24 segments every 15 minutes). The "missing files" log is very helpful when users need to check data consistency prior to time-series analysis.
- Be extremely reliable to work continuously, 24 hours per day, 7 days per week, preferably unattended for several months, because if the application stops working unexpectedly (and nobody is available to solve the problem), after a couple of days, the files accumulated in the "incoming" folder on the EUMETCast - GEONETCast receiving station is likely to reach the maximum available disk capacity.
- Cause as little as possible disturbance to the EUMETCast – GEONETCast receiving station (lightweight activity), or otherwise the station will be too busy and occasionally miss the reception of files (fail to store some of the files captured by the DVB card).
- It must be easy to restore the configuration of the GEONETCast Data Manager after a software or hardware crash or a power failure, even by non-experts, as the local system administrator may not be available at all times.
- The GEONETCast Data Manager must be able to process a large number of files in a single folder at one time. Therefore it must be able to handle all files that have been accumulated in the "incoming" folder in case the application has not worked for a couple of days. This can be more than a million files!

- The type of files that the GEONETCast Data Manager can process must not be fixed to a specific type (e.g. satellite images). Therefore the application will only depend on the fact that EUMETCast files have specific filename-patterns. With this, the process of detecting a file's category can be kept lightweight, as the file does not need to be opened.
- The “rules” with which files are organized are kept simple in the initial implementation (transfer files to a new location, delete after a certain time period, delete immediately or keep forever, ignore specific files, etc.), which is sufficient for the primary objective of the application. However, it is not difficult to extend their capability if such demand exists.
- The system administrator must be able to easily adapt the configuration file, so that new data that is broadcasted can be easily handled, as the EUMETCast-GEONETCast system is further developing and it is expected that in the future more data will be broadcasted.
- The system manager should be able to fine-tune the storage of the data that is received to be tailored for a specific organization. Given the data load it is impossible to store all of the data. Each organization will have its own specific data storage requirements!

The GEONETCast Data Manager can run without problems on the EUMETCast-GEONETCast receiving station, but can also run on another computer, as long as all necessary folders can be accessed through the network connection. Note that the (sub-) directories assigned to store the various data files can be created manually prior to starting the Data Manager or can be automatically generated according to the directory names specified in the ascii configuration file.

1.2.3 *The GEONETCast Data Manager - “Rules”*

The local EUMETCast-GEONETCast system administrator creates the file-processing rules. This is initially done by editing a text-file (the configuration file that is used by the GEONETCast Data Manager). At a later stage, the rules are fine-tuned in the user-interface of the GEONETCast Data Manager. This was done to keep the user-interface simple and understandable. For example, file patterns or expected frequency of a category of files must be changed in the configuration file, using a text-editor. However, the destination location or the duration of storage of a category of files is changed in the user-interface, because it is considered a "last-minute" change: the administrator may frequently change his mind about this.

The user-interface of the GEONETCast Data Manager adapts itself to the rules that are defined. Rules are organized in “groups” and “items”. Each group becomes a tab, and each item becomes a box within a tab.

1.2.4 *Configuring the GEONETCast Data Manager*

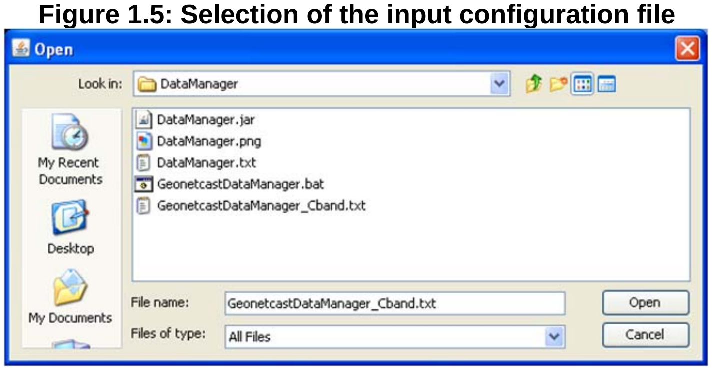
Open ILWIS and from the Operation-Tree select the “*WFS-Ethiopia*” and the “*Toolbox*” tab. Subsequently select the option “GEONETCast Data Manager” (see also the figure 1.4 below) and start the “Data Manager” by pressing the “*Start Data Manager*” button.

Once the GEONETCast Data Manager is activated an input configuration file needs to be specified as indicated in figure 1.5. A sample configuration file that is used at ITC for the C-Band EUMETCast broadcasting is provided. Select the file “*GeonetcastDataManager_Cband.txt*” and a menu will appear on the screen. A menu sample is shown in figure 1.6.

Figure 1.4: Location of the GEONETCast Data Manager in the WFS-Ethiopia Toolbox menu

Note that this utility only needs to be configured by the system manager-administrator to ensure that the data which is required by the organization – institute is properly stored and can be accessed by the other users within the organization – institute. There is no need to start the application as an instance of the GEONETCast Data Manager might already be running by the system administrator.

Figure 1.5: Selection of the input configuration file



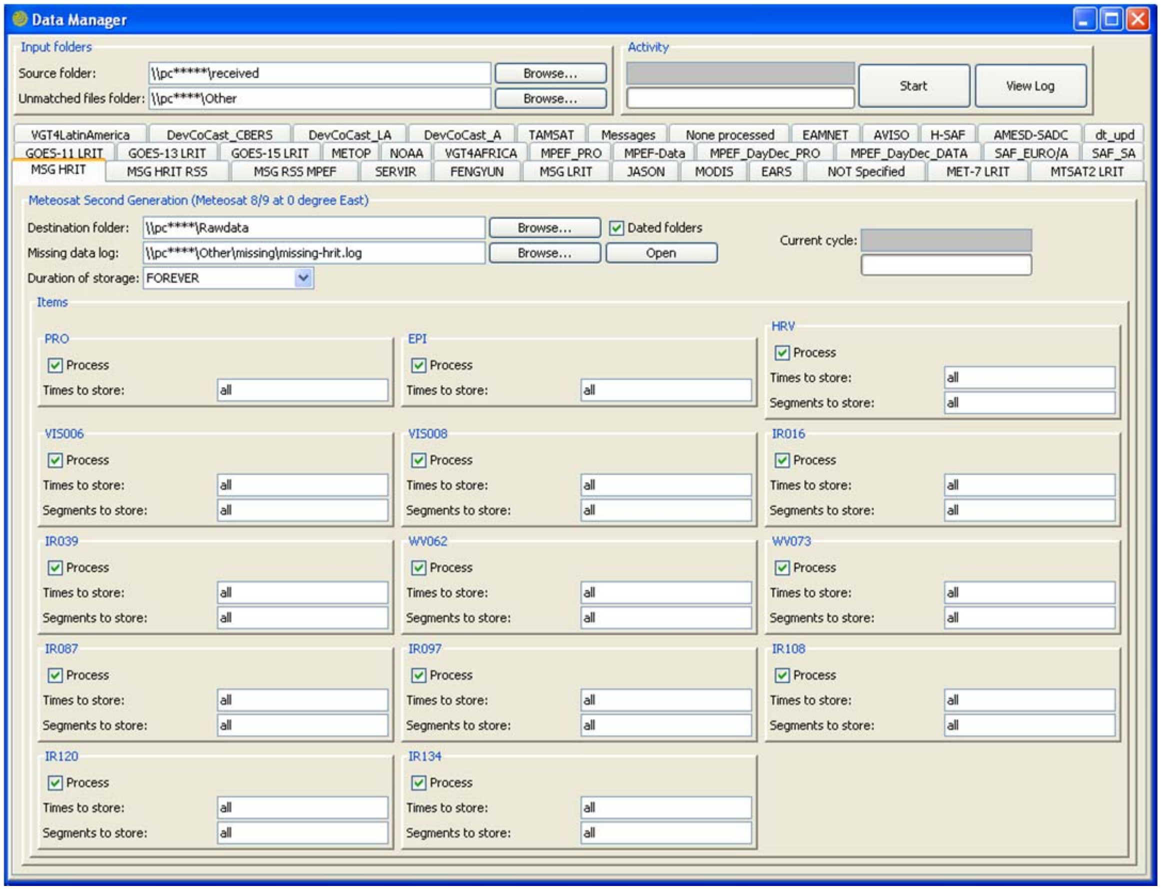
The menu that subsequently appears is based upon the settings that are provided in the “GeonetcastDataManager_Cband.txt” file. Examine the various tabs (“groups”) and look at the “items” within each of these groups (once more: don’t start the application!).

The User Interface allows the system administrator to define the “Source folder”, the directory where the newly incoming data arrive on the ground receiving station; the “Destination folder” is used to store the newly arrived data on the archiving system.

A location for the “Missing Data log” can be specified if for each “Item” the number of “Times per day” is specified (see also figure 1.7). Also “Duration of storage” can be interactively defined and how the data is stored, e.g. by a date formatted folder structure, activating the “Dated folders” option.

This configuration file can also be opened using a text editor and can be modified according to the specific need of the user. The Data Manager can be closed by clicking the closing button in the top-right corner.

Figure 1.6: The GEONETCast Data Manager, showing the menu as defined by the ascii file GeonetcastDataManager_Cband.txt



Use the Windows Explorer, move to the ILWIS directory and move to the following sub-directory: \Extensions\WFS_E-Toolbox\DataManager.

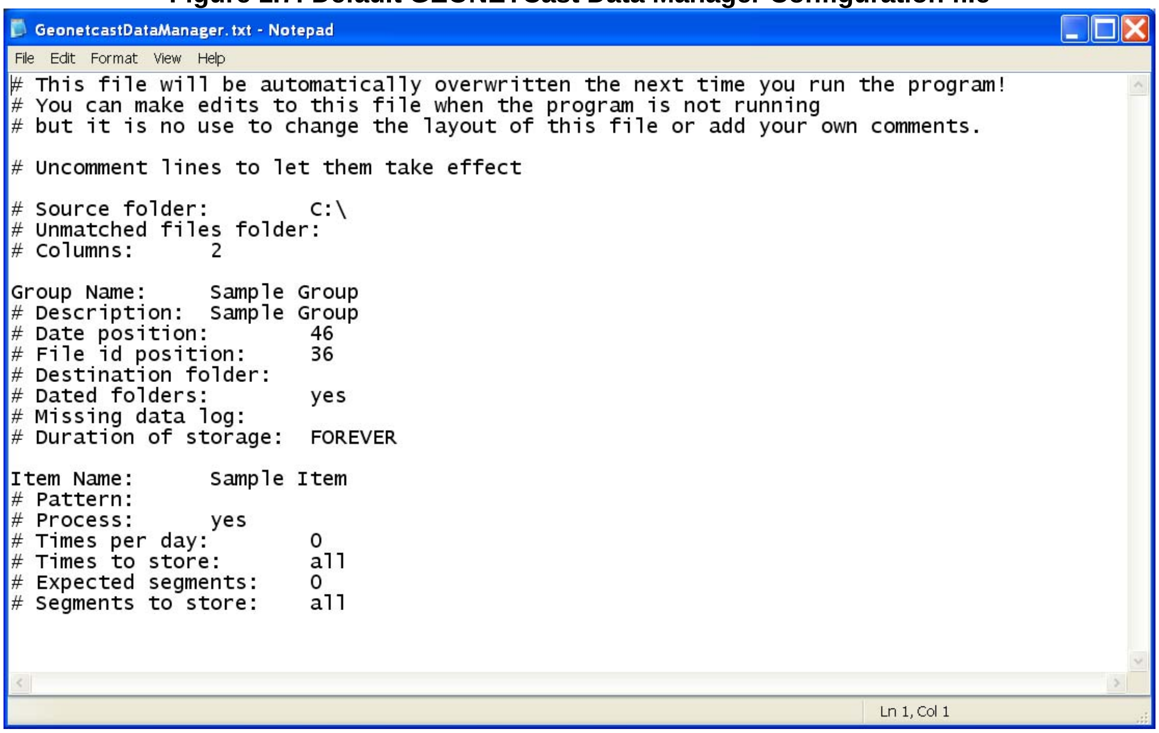
Select the file “DataManager.txt”, double click the file to open it using Notepad. This file is the default file that can be used to build your own data storage configuration file (see also figure 1.7).

As indicated in the application description before (chapter 1.2.3 GEONETCast Data Manager - “Rules”) you are able by adapting the “Group Name” and “Item Name” to modify the menu that will be generated subsequently when starting the application using the modified configuration file, which should be saved using a different name (else it will be overwritten when a new instance of the Data Manager is started using the default “DataManager.txt” file). To ensure that the changes are implemented when a new event of the Data Manager is started the lines should be uncommented to let them take effect.

The GEONETCast Data Manager can also be used as a stand-alone application. All required files are situated in the ILWIS sub-directory \Extensions\WFS_E-Toolbox\DataManager. This sub-directory can be copied to the appropriate system with JAVA installed and the “DataManager.jar” can be directly started from there as well, also using LINUX.

Having the capability to easily adapt the menu and therefore also the storage of the incoming data stream any new modifications resulting from adaptations of the EUMETCast-GEONETCast system can be easily incorporated without the need to wait for software updates. This is important as the system will further develop and broadcast more satellite and environmental data. Using simple copy and paste options the text file can be configured according to the need of the user, the system manager-administrator does not need to have any programming experience to do these types of manipulations.

Figure 1.7: Default GEONETCast Data Manager Configuration file



GeonetcastDataManager.txt - Notepad

```
# This file will be automatically overwritten the next time you run the program!
# You can make edits to this file when the program is not running
# but it is no use to change the layout of this file or add your own comments.

# Uncomment lines to let them take effect

# Source folder:        C:\
# Unmatched files folder:
# Columns:      2

Group Name:     Sample Group
# Description:  Sample Group
# Date position:        46
# File id position:     36
# Destination folder:
# Dated folders:        yes
# Missing data log:
# Duration of storage:  FOREVER

Item Name:      Sample Item
# Pattern:
# Process:      yes
# Times per day:        0
# Times to store:       all
# Expected segments:    0
# Segments to store:    all
```

Ln 1, Col 1

Note that any data which is not assigned by the rules specified is stored in the Directory assigned under the “Unmatched File Folder”. If this Directory is regularly checked the new data that has arrived can be easily captured in a set of new “rules” and stored if required relevant or deleted.

Carefully check the content of the text file “*GeonetcastDataManager_Cband.txt*” using Notepad to see how at ITC (for C-band reception) the full range of data broadcasted via GEONETCast is configured / handled and which data is stored (for various durations). Check also the various “Group and Item names”, “Pattern” and “Source and Destination folder” used.

In the toolbox XML version 1.0 wildcard characters * and ? are allowed in the filename pattern (thus not full regular expressions). Expected pattern examples are:

H-000-MSG2__-MSG2________-HRV______-
*g2_BIOPAR*Africa* or *g2_BIOPAR*America*

The last example shows that the generic part of the centre of the file name string is maintained but the data for Africa and America can still be separated and moved to other folders. These wildcard options provide more flexibility to define the filename patterns.

Note that new GEONETCast users can use this configuration file to get them going and adapt it to their local circumstances (using copy, paste and delete!). On the http://52north.org website (navigation tab: “Earth Observation”) also a recent ascii “GEONETCast Data Manager” configuration file is available, which can be downloaded and used/modified.

1.2.5 *Making the GEONETCast data available within the organisation*

The data that is received via EUMETCast-GEONETCast is commonly stored on a file server that can be accessed by all users within the organization according to the Data Manager settings described above. When using the “GeonetcastDataManager_Cband.txt” configuration file, two directories are relevant:

- GEONETCast_MSG_HRIT; a year, month, day formatted directory structure, which is storing the High Rate Image Transmitted data of Meteosat Second Generation (full spatial, spectral and temporal resolution data of MSG);
- GEONETCast_other; including a number of sub-directories as well as (undefined) data that might reside in the root of this directory, which still needs to be defined by new “rules”.

The directory “GEONETCast_other” is configured to contain all the other data, except the MSG HRIT data from the receiving computer, using the settings as specified by the GEONETCast Data Manager’s configuration file and is stored in various sub-directories in this archiving folder. Some relevant sub-directories in this folder are:

- LRIT: Low Rate Image Transmitted satellite image data from Geostationary satellites (such as Meteosat-7);
- METOP: Data from the various instruments onboard of METOP, like the ASCAT instrument;
- MPEF: Secondary Meteorological Products with high temporal resolution (AMV, GII, CLM, CLAI), note that the directory is “date-formatted”;
- MPEF_DayDek: Secondary Meteorological Products with low temporal resolution (daily NDVI and decadal NDVI products from MSG);
- SAF: Satellite Application Facility data (e.g. surface radiation budget, bio-geophysical parameters, sea surface temperature);
- MODIS: MODIS global products like fires and chlorophyll;
- VGT4Africa: Dekadal processed data derived from SPOT Vegetation Instrument, like NDVI, NDWI, DMP, etc, for Africa;
- DevCoCast: Products produced by the DevCoCast-AGRICAB partners (CSIR, PML, INPE) for Africa;
- EAMNET: Various marine products for several regions in Africa;
- TAMSAT: Dekadal and monthly rainfall and rainfall anomaly products over the African continent;
- AMESD-SADC: Products for the Southern African Region related to Agriculture, Drought, Fires and Long Range Forecasting. This service also contains the ABBA-MSG fire product.

To get easy access to the data, as it is stored on a “distant” file server, it is convenient to map these directories as a Network Drive using the Windows Explorer Tools option.

When using WINDOWS XP, open Windows Explorer, from the Menu, select Tools and Map Network Drive. Specify a Drive letter, select the shared network folder from Windows and browse to the target folder. If you have configured your system using the “GeonetcastDataManager_Cband.txt” file, specify two network mappings, one for the folder “GEONETCast_MSG_HRIT” (e.g. as drive Z:\) and one for the folder “GEONETCast_other” (e.g. drive Y:\).

When using WINDOWS-7 open Windows Explorer and from the left hand menu, right click with the mouse on the icon “Network” and select from the context sensitive menu the option: “Map Network Drive..”, and proceed as indicated above.

These settings will vary for different locations. You have to consult the system manager to get the details of how the data is stored in the archive. Note that there are differences with respect to the type of data disseminated by Ku and C-Band services and a certain organization might not have requested all the services that are disseminated by EUMETCast-GEONETCast.

1.2.6 *Product information and other services*

To get an idea of what is currently disseminated using the various services, browse to the Product Navigator from EUMETSAT, available at: http://navigator.eumetsat.int/. From here select: “*Extended Search*”. Under Dissemination, select EUMETCast Europe / Africa / Americas, GEONETCast Americas or CMACast and press the Search button. Also the total number of products that are operationally broadcasted is indicated.

Note that the AMESD-SADC service using the GEONETCast data dissemination system has become operational during second half of 2011. Some of the products contained in their Services (Agriculture, Drought, Fire and Long Range Forecasting) might also be relevant for Ethiopia. In case further information is required the Botswana Department of Meteorological Services (BDMS) can be contacted. ABBA-MSG fire sample data, which also cover the Ethiopian region, can be also be downloaded from their FTP server:

Host Server:	168.167.37.249
User Name:	sadcuser
Password:	sadcuser

A separate AMESD-SADC toolbox is developed and is also hosted by the “Earth Observation” community at http://52north.org. Further information on this toolbox can also be obtained from Farai Maxwell Marumbwa, Thematic Expert of the AMESD-SADC Thema Action (email: maxmarumbwa@gmail.com) who is the principal developer.

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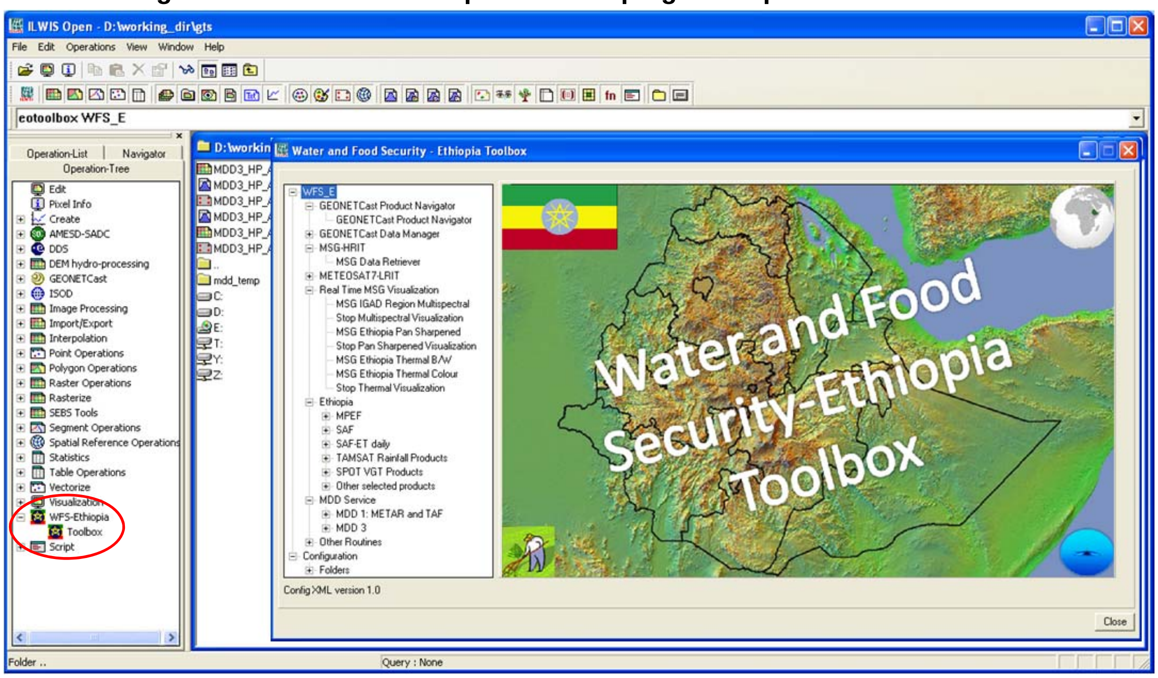
2. OVERVIEW OF THE WFS-ETHIOPIA TOOLBOX ARCHITECTURE

2.1 INTRODUCTION

This is the first version of the Water and Food Security - Ethiopia Toolbox. It is developed as a plug-in under ILWIS 3.7.2 but can also be used as a plug-in under ILWIS 3.8,provided that the appropriate EO-Toolbox.dll is loaded. The general installation instructions are described before. Note that this Toolbox version is not ILWIS downward compatible; in such a case download the latest ILWIS 3.7.2 version from http://52north.org.

The main objective of the Toolbox is to allow the user, who operates a EUMETCast – GEONETCast ground receiving station to easily manage the incoming data stream and to import the data into a common freeware GIS-RS environment for further analysis, in this case using the functionality of ILWIS version 3.7.2 or higher. This toolbox version allows import of various data sources relevant for water and food security analysis for Ethiopia through a Graphical User Interface (GUI). Here the toolbox architecture is described into more detail. Once the toolbox is installed and ILWIS is newly started the "WFS-Ethiopia Toolbox" should appear as a menu item under the ILWIS Operation Tree (see figure 2.1).

Figure 2.1: The WFS-Ethiopia Toolbox plug-in Graphical User Interface

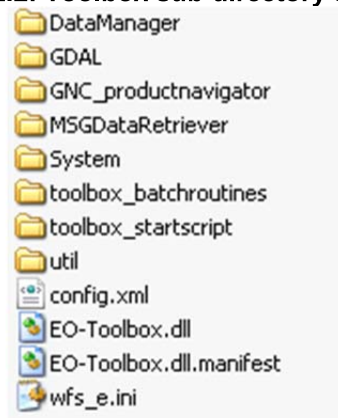


2.2 STRUCTURE OF THE WFS-ETHIOPIA TOOLBOX

To operate the WFS-Ethiopia Toolbox, the file ""*52n-eo-WFS-E-toolbox-1.0*.zip" is copied under the ILWIS sub-directory \Extensions. Once a new event of ILWIS372 is started this ZIP file is extracted and the content is stored in the sub-directory \WFS_E-Toolbox within the same \Extensions sub-directory. Within the WFS_E–Toolbox sub-directory a number of other sub-directories appear (see figure 2.2).

The folder *DataManager* contains the "Geonetcast Data Manager", a utility that allows automated archiving of the newly incoming data. This application requires the Java Runtime Environment. It is advised to run this utility as a stand-alone application if operated on a ground receiving station as it should be operated continuous. This utility is described in chapter 1.2 and also operates under LINUX.

Figure 2.2: Toolbox sub-directory structure



The folder *GDAL* (Geospatial Data Abstraction Library) contains a translator library for raster geospatial data formats that is released under an X/MIT style Open Source license by the Open Source Geospatial Foundation (http://www.gdal.org).

The folder *GNC_productnavigator* contains the utilities to open the GNC Product Navigator disseminated via EUMETCast-GEONETCast. This folder appears in the "*Received*" folder of the Ground receiving station. This folder can be copied to the archiving system to make it available to the users. As the Product Navigator is regularly updated it is advised to update it frequently so the end user is using the latest version (see also http://www.eumetsat.int/Home/Main/Access_to_Data/ProductNavigator/index.htm).

A Scheduled Task can be created in Windows by the system administrator. This task is executed automatically at the given system clock time, preferably to be invoked once a day. This task subsequently runs a batch file, which should have the following command lines:

```
@echo off
xcopy /s /i /r /y \\pc\received\product-navigator y:\product-navigator
```

where:

\\pc\received\product-navigator	the receiving computer \ directory
y:\product-navigator	the output directory on the archive

The folder *MSGDataRetriever* contains the utility that allows import of the HRIT MSG 8 and 9 Level 1.5 data. This utility can also be used as stand-alone. Further information is provided in chapter 2.5.

The folder *System* is storing the ILWIS service objects. Service objects are used by data objects; they contain accessories required by data objects besides the data itself. Upon installation of the toolbox, these objects are copied to the main ILWIS directory \System.

The folder *Toolbox_batchroutines* provides the batch files that are used to execute most of the actual operations. These files can be opened and modified using a text editor. Currently approximate 60 routines are available for accessing the various images and data products in the EUMETCast-GEONETCast data stream relevant for water and food security analysis for Ethiopia. Further information is provided in chapter 2.7.

The folder *\Toolbox_startscript* is having various sub-directories containing ILWIS scripts. Upon selection of an import routine, from the WFS-Ethiopia toolbox User Interface (GUI) a script is called and this script subsequently calls a batch file which executes the operation. The scripts can also be opened and modified using ILWIS. Further information is provided in chapter 2.6.

In the root of the *\Util* folder ILWIS service objects are stored, like lookup tables, georeferences, domains, etc. Furthermore a number of executables are stored here that are used by various toolbox batch routines, such as the bufrtool.exe, which should be copied into this folder. The folder is containing a number of sub-directories:

- The sub-directory *\Maps* is containing various segment maps of Ethiopia and a segment-polygon file of all countries of the world and for Africa, a land mask for Africa (zipped) as well as a number of map views.
- The sub-directory *\MSG_time* contains the time stamps needed for the MSG real time visualization.
- A sub-directory \Tables should be available here as well, note that this has to be copied there by yourself (see also chapter 1.1.5).
- The sub-directory \Bufrdisplay is used to store the "Bufrdisplay" executable (bufrdisplay.exe), see also chapter 1.1.6. The utility should be downloaded yourself and copied into this folder. The program can be accessed from the menu under the option "*Other Routines*" >> "*Generic BUFR data visualization*".
- The folder \Julian_Day contains two tables showing the Julian day number for normal and leap years and the actual calendar date. The tables can be accessed from the menu under the option "*Other Routines*" >> "*Display Julian Day tables*".
- The folder \MWeather is used to store "MWeather.exe" (see also chapter 1.1.7), a utility to quickly decode METAR and TAF messages. The program can be accessed from the menu under the option "*MDD Service*" >> "*MDD 1: METAR and TAF*". After creation of a METAR-TAF file for a certain country the "*Display METAR TAF data*" option is used to start MWeather.exe and the information contained in the file created can be displayed.
- The folder \VGT_config is containing the configuration files used by VGTExtract to import the VGT data and includes the geographic window settings for Ethiopia as defined by LEAP as well as the data transformation settings for a number of products (scaling and offset) and format transformation into ILWIS, see also chapter 1.1.8. This routine can be started from the menu using the options "*Other Routines*" >> "*Import VGT products Ethiopia*".

The file "*config.xml*" contains the WFS-Ethiopia Toolbox GUI menu structure. This file can be edited using a text editor. In case the user wants to add new routines, this XML file can be adapted and modified. The resulting GUI menu will be adapted accordingly when a new instance of the Toolbox is started. This allows users that do not have programming experiences to adapt the toolbox to their own preferences. A more detailed description is provided below in chapter 2.3.

The file "*wfs_e.ini*" contains the settings of the input and output directories for each "folderid" that is defined in the "config.xml". This file is storing the settings as defined from the Toolbox menu options: "*Configuration*" >> "*Folders*". Further information on the input and output folder settings is provided in chapter 2.4. The "xml" and "ini" files can be opened and edited with Notepad or Wordpad.

The file "*EO-Toolbox.dll*" contains the layout of the User Interface of the WFS-Ethiopia Toolbox and generates the full ILWIS command string that executes the script, batch file and defines and passes the parameters that are used, like the time stamp, input drive, input directory, output drive, output directory, ILWIS directory, etc. Up to 9 parameters are used to execute a Toolbox operation. Note that for ILWIS38 another EO-Toolbox.dll has to be used, this DLL can be downloaded from the Earth Observation Community download area (http://52north.org) and copied into the ILWIS sub-directory \Extensions\WFS_E-Toolbox. The existing DLL can be replaced.

The file "*EO-Toolbox.dll.manifest*" is used by the operating system for certification of the appropriate DLL.

2.3 STRUCTURE OF THE CONFIG.XML

One of the main criteria during the development of this utility was to make the toolbox as open as possible, allowing persons with no programming background to make modifications in case new sensor data - products become available as the EUMETCast-GEONETCast data stream will further evolve-change. As indicated before, all scripts and batch routines used can be adapted by the user. Next to this, the user can also modify the menu of the Toolbox GUI. The file that generates the user interface, "config.xml", can be opened using a text editor.

The structure of the file is kept as simple as possible. The "Level" is defining the main (Level1) and sub menu structure (Level2 – Level"*N*"). For the "Level value=" a menu name can be defined. Within a certain level a "Product value=" can be specified, which will generate the name of the respective (sub) menu.

The string starting with "Product value=" contains mostly a number of other items, like "*script*", "*format*", "*type*", "*folderid*" and "*comment*".

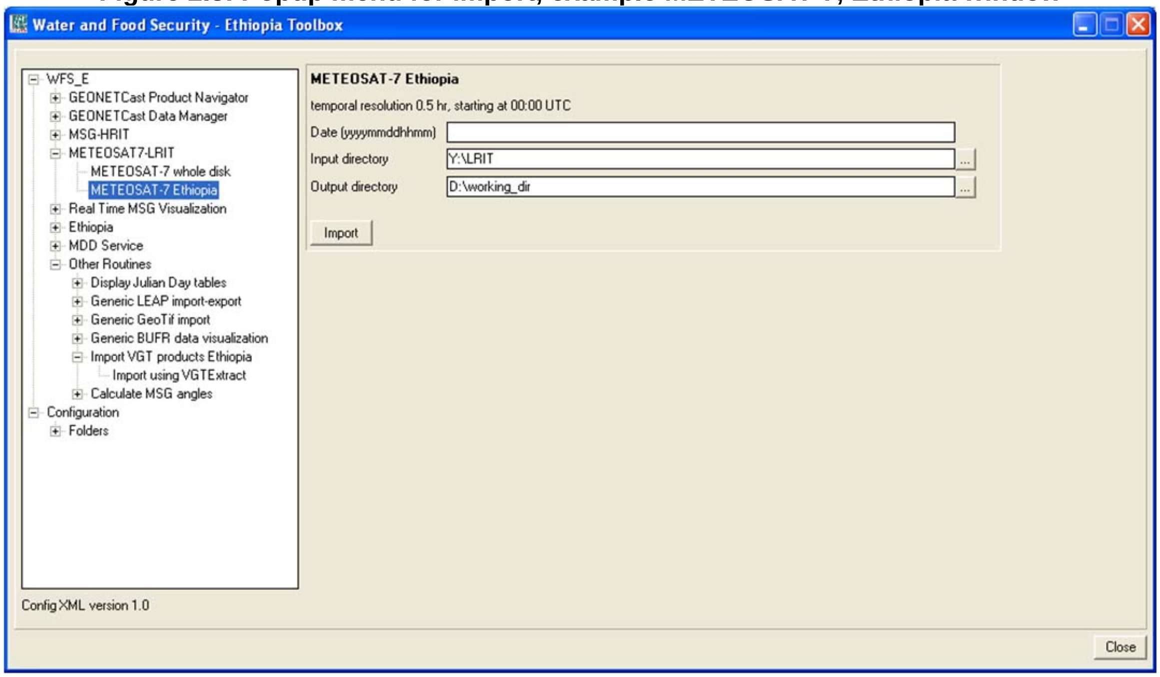
- *Script*. The item script defines the sub-directory were the respective ILWIS script is located and the name of the script that should be executed;
- *Format*. The text string that can be entered here will appear in the popup window when importing a certain image or product. It is used to ensure that e.g. the appropriate "time stamp" is entered on the user interface (see the "Date" on figure 2.3). For the various images and products these can have a different formats, in the example of figure 2.3 the "Date" stamp expected should have the format "yyyymmddhhmm" (y=year, m=month, d=day, h=hour and m=minute);
- Type. This is the only part of the toolbox that does not allow user modification without programming experiences. Various forms, that generate the pop-up windows are available within the "EO-Toolbox.dll" and are called by their specific names given. These forms generate the appearance of the popup windows when importing a specific product. The popup menu that is given in figure 2.3 is generated from a "type" called: "ymdhm". In case another pop-up window is required don't hesitate to send an email to the corresponding author;
- *Folderid*. This item generates a folder item in the "wfs_e.ini" file. From the main Toolbox menu, Configuration and Folders option, this Folder item is now available and can now be further specified by defining the appropriate input and output directories. As example a "folderid" of "MPEF-highres" is given. When opening the "wfs_e.ini" file, using a text editor, an item [MPEF-highres] is added and the input and output folders can now be specified here as well by providing the relevant directory names, like:

  ```
  [MPEF-highres]
  InputFolder=Y:\mpef\2012\07\27
  OutputFolder=D:\working_dir
  ```

  Make use of a text editor (using find and replace) to quickly change the output directory for all "OutputFolder" settings in the "wfs_e.ini";
- *Comment*. Additional information (one line of text) can be provided in the popup menu to notify the user on any specific information that might be relevant. In figure 2.3 a comment string is added showing the temporal resolution of the METEOSAT-7 data and the starting time stamp of the images in UTC;

- *Id*. This item is currently under development; here you can specify keywords that can be used for a search.

Figure 2.3: Popup menu for import, example METEOSAT-7, Ethiopia window



The first few lines of the config.xml are:

1: <WFS_E>
2: <Version id="1.0" finder="false"/>
3: <UIInfo icon="ethiopia" menu="WFS-Ethiopia..Toolbox" title="Water and Food Security - Ethiopia Toolbox"/>
4: <Path value="Extensions\WFS_E-Toolbox" inifile="wfs_e.ini"/>

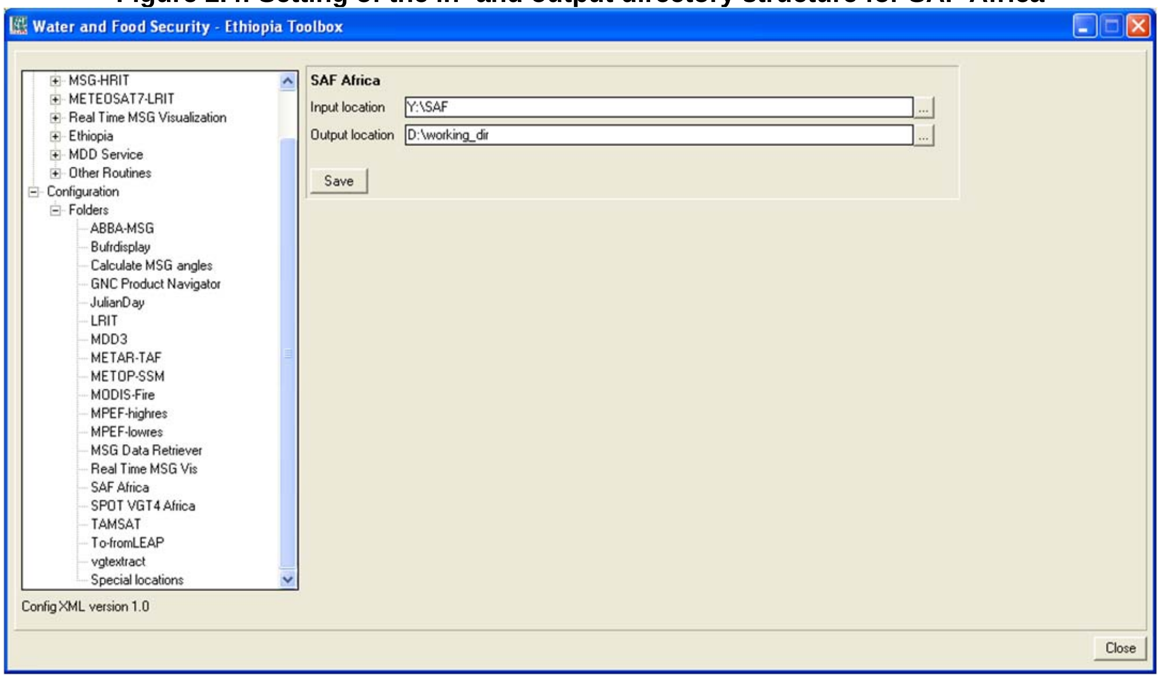
Line 1 provides the link to the plug-in and the menu name, note that this is also the last line of the XML. Line 2 provides the opportunity to indicate a version number, useful if modifications are done to the original XML. The version number is also shown in the main WFS-Ethiopia Toolbox menu, in the lower left hand corner (see also figure 2.3). The "*Finder*" is a utility under development, allowing a search using keywords. The "*UIInfo Icon*" in line 3 refers to the toolbox logo used in the ILWIS Operation Tree, the "*menu*" provides the name, the ".." indicates that the menu consists of two levels, and the heading used in the toolbox user interface is defined by the "*title*". In Line 4 the "*path*" defines the location of the toolbox in ILWIS and the "*inifile*" here refers to the "wfs_e.*ini*" file, which provides the links to the input and output directories. Note that between lines 3 and 4 there can be an entry "RemoteServer…". This is an internal (ITC) item at this moment.

After changes are made to the config.xml the file should be saved and a new instance of the Toolbox should be started, showing the adaptations. Before modifying the file first make a backup!

2.4 GENERAL GEONETCAST TOOLBOX CONFIGURATION - FOLDER SETTINGS

For you to conveniently work with the WFS-Ethiopia Toolbox the data sources (on your local area network) and the local system output (working) directories need to be defined. From the main WFS-Ethiopia Toolbox menu, select "*Configuration*" and the sub-menu "*Folders*". In figure 2.4 below the in- and output directory for the SAF Africa is used as example ("*Y*" is the "local area network drive" and "*D*" is the local system hard disk). Note that use can be made of a "Network Mapping" as described in chapter 1.2.5. Furthermore note that some input folders can be date formatted according to the specifications of the local system administrator. These directories are having a year, month and day structure. See the "MPEF-highres" folder settings in chapter 2.3 as an example.

Figure 2.4: Setting of the in- and output directory structure for SAF Africa



Configure the input directory "Folders" according to the settings given by the local system configuration. Note that if your system administrator has provided you with an updated configuration file used for the GEONETCast Data Manager, all relevant settings can be obtained from there! It might not be necessary to specify all folders as some of the data services are not received by the local ground reception infrastructure. There is a "Special locations" folder to select the location and programme-executable. Currently the location of "IrfanView" and "i_view32.exe" (or newer version) needs to be specified, as this freeware utility is used for visualization of pictures that are not transformed into an ILWIS data format. Make sure that this folder and executable are always correctly specified.

2.5 CONFIGURING THE DATA SOURCE OF THE MSG DATA RETRIEVER

The data source folder for the MSG Data Retriever can be specified from the main WFS-Ethiopia Toolbox menu, select "*Configuration*" and the sub-menu "*Folders*". Select the Folder "*MSG Data Retriever*" and specify the input location and press "*Save*".

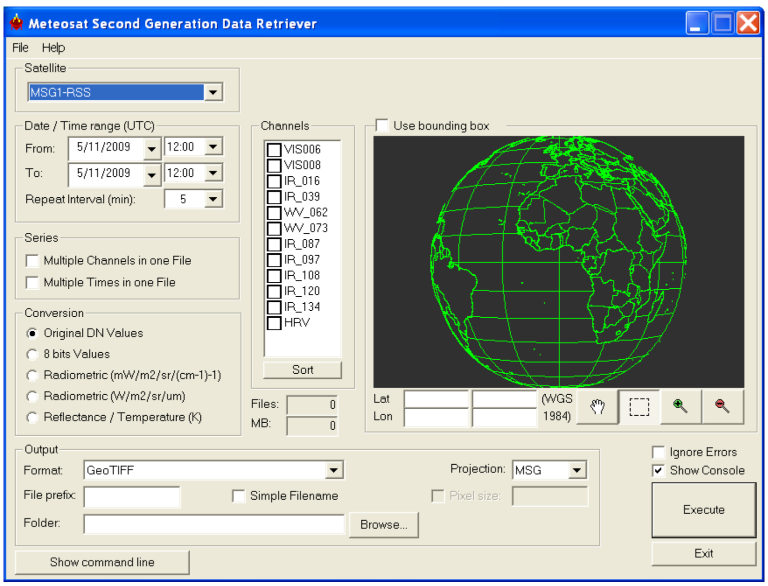
For advanced data source(s) configuration settings open the "*MSG HRIT*" tab and activate the "*MSG Data Retriever*" option in the WFS-Ethiopia Toolbox. The Meteosat Second Generation Data Retriever (MSG Data Retriever) window appears. This utility is a tool for converting raw

Meteosat Second Generation (MSG) SERVIRI Level 1.5 files into a known raster-GIS or raster image file format. The MSG Data Retriever is used to extract the HRIT data recorded by MSG 8 and 9 (also referred to as MSG1 and MSG2 respectively prior to being declared operational).

Note that the MSG-HRIT data is licensed and therefore parts of MSG Data Retriever are licensed. Using the software means that you agree and comply to the conditions of use of the software as specified in the document provided under the main menu "*Help*" function. See here: "*Limitation of use of MSG Data Retriever*". See also figure 2.5 below.

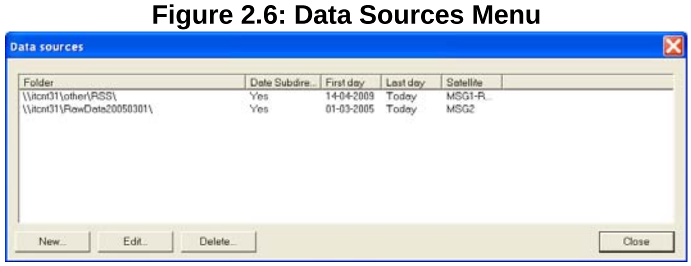
In the Satellite dropdown list, situated in the top left portion of the MSG Data Retriever window MSG1-RSS and MSG2 can be specified. These settings refer to MSG 8, the so-called Rapid Scanning Service (MSG1-RSS) situated at 9.5 degree East (scanning the northern 1/3 portion of the field of view of MSG at 5 minutes temporal intervals) and to the regular MSG 9 (MSG2) situated at 0 degree (scanning the whole field of view of MSG at 15 minutes temporal intervals).

Figure 2.5: Meteosat Second Generation Data Retriever



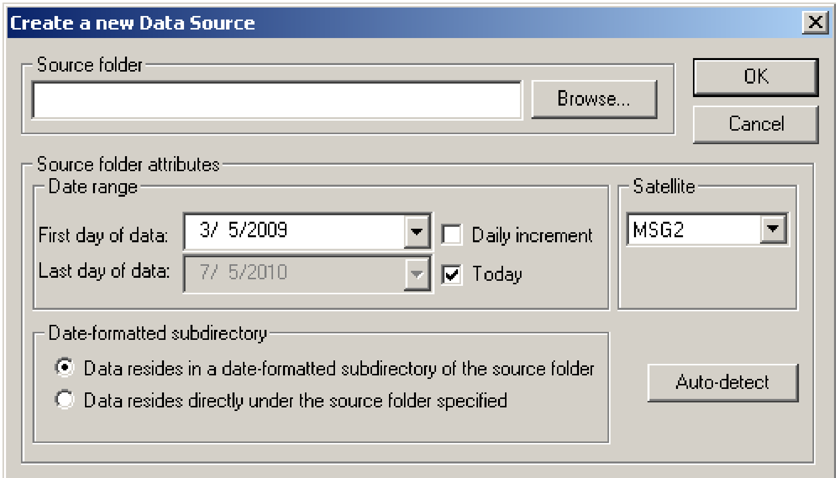
The advanced settings of the data sources of this HRIT data stream have to be configured separately. To configure the appropriate data source for the MSG2 satellite, select from the top left menu, the "*File*" Option and open the "*Data Sources*" menu.

Figure 2.6: Data Sources Menu



In this submenu delete any folder that might appear, select "*New*". In the "*Create a new data source*" menu, browse to your "*drive:\folder*" that contains the raw MSG-HRIT data (see also figure 2.7). See also the description given in chapter 1.2.5 if a new network mapping has to be created.

Figure 2.7: Create a new HRIT MSG2 data source folder



When the source folder is provided, the "*First day of data*" should be specified. The "*Last day of data*" can be obtained using the option "*Auto-detect*" situated at the lower right portion of the "Create a new Data Source" Window. When using the "*Auto-detect*" option this is automatically detected. If "Last day of data" equals the current day it will automatically keep updating the "Last day of data" to be the present date.

If the data source is correctly specified the settings can be accepted by pressing "OK". Note that when using the settings of the GeonetcastDataManager_Cband.txt (as discussed in chapter 1.2.4) use is made of a date-formatted sub-directory structure (each day a new sub directory is created storing the MSG-HRIT data of that specific day). In this case the option "Data resides in a date-formatted subdirectory of the source folder" is activated. In case all the MSG2-HRIT data is situated directly under a source folder the other option can be activated ("Data is situated directly under a source folder specified").

In a similar way also the source folder for the "MSG1-RSS" satellite (METEOSAT-8, Rapid Scanning Service) can be specified. The help function in the main MSG Data Retriever Window is providing additional information on the functionality offered by this utility. Note that RSS data is not provided via C-band reception (in Africa).

2.6 STRUCTURE OF THE ILWIS GEONETCAST TOOLBOX SCRIPTS

Most of the ILWIS scripts, situated within various sub-directories in the folder *Toolbox_startscript*, contain a single line which is identical. You can open ILWIS, use the "Navigator" to move to the sub-directory \Toolbox_startscript\Ethiopia\MPEF and double click with the mouse on a script to open it. You can close the script editor. Below an example is given of an Atmospheric Motion Vector (AMV) import routine (situated in the same sub-directory *toolbox_startscript\ Ethiopia\MPEF*):

!%7\Extensions\WFS_E-Toolbox\toolbox_batchroutines\MPEF_eth_amv_import.bat %1 %2 %3 %4 %5 %6 %7 %8

The command line starts with: ! This syntax (!) instructs ILWIS to start an external application. The application that should be started is situated in *"%7\Extensions\WFS_E-Toolbox\toolbox_batchroutines*" and called "*MPEF_eth_amv_import.bat*". This is a DOS batch routine which should be executed. The parameters required to execute the batch routine are given as %1 to %8:

%1	Longfilename	remark: the time stamp entered for the specific product
%2	InputDrive	remark: input data drive, can also be a network mapping
%3	InputDir	remark: input data directory
%4	OutputDrive	remark: output data drive
%5	OutputDir	remark: output data directory
%6	GdalDir	remark: location of GDAL directory within toolbox
%7	IlwDir	remark: location of the ILWIS directory
%8	UtilDir	remark: location of the Util directory within toolbox

A number of these parameters are generated by the "EO-Toolbox.dll", such as "GdalDir", "IlwDir" and "UtilDir" as these are fixed locations within the toolbox. Other parameters require user interaction, such as "longfilename", "InputDrive", "InputDir", "OutputDrive", "OutputDir", as these change based on the user preferences. These parameters can be interactively provided in the popup menu when importing an image or product, see e.g. figure 2.3 above and the Date field provides the "Longfilename", input and output directory for the "InputDrive", "InputDir", "OutputDrive" and "OutputDir" respectively.

When pressing the "Import" button of the popup menu (see again figure 2.3) a command line is generated which is executed by ILWIS. Using the script example above of importing an Atmospheric Motion Vector (AMV) map, the following command line is generated and executed:

!C:\ilwis372\Extensions\WFS_E-Toolbox\toolbox_batchroutines\MPEF_eth_amv_import.bat 201207021145 Y: MPEF\2012\07\02 D: GNC_out C:\ilwis372\Extensions\WFS_E-Toolbox \GDAL\bin C:\ilwis372 C:\ilwis372\Extensions\WFS_E-Toolbox\util

The parameters are now defined as follows:

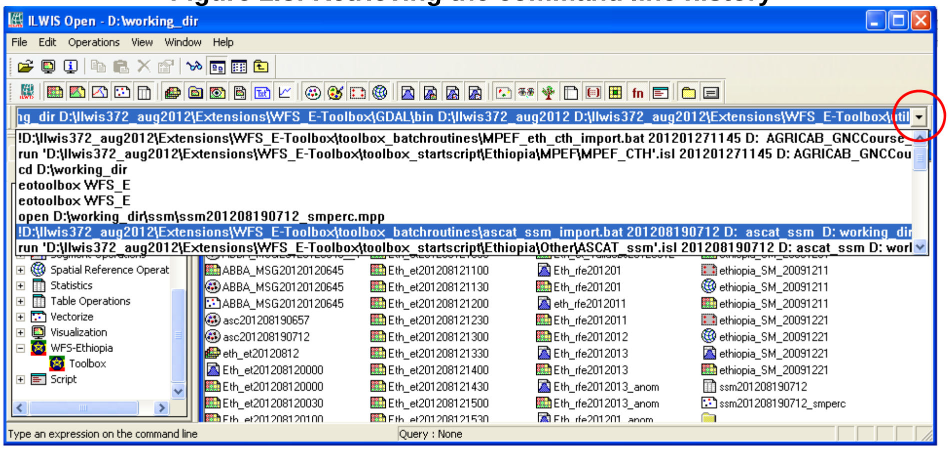
%1	Longfilename	201207021145
%2	InputDrive	Y:
%3	InputDir	MPEF\2012\07\02
%4	OutputDrive	D:
%5	OutputDir	GNC_out
%6	GdalDir	C:\ilwis372\Extensions\WFS_E-Toolbox\GDAL\bin
%7	IlwDir	C:\ilwis372
%8	UtilDir	C:\ilwis372\Extensions\WFS_E-Toolbox\util

Now with all parameters set the batch file "*MPEF_eth_amv_import.bat*", situated in the ILWIS sub-directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines\ can be executed. Starting the command with the !, ILWIS knows it has to execute an external command, given the fact that the extension is ".bat", the Windows Command Line Interpreter (CMD.exe) knows it has to execute this file using the Batch command line processor.

For a number of visualization routines "IrfanView" is used. In these cases an additional parameter is defined as %9, called "IrfanViewDir". This parameter defines the location of the IrfanView directory and executable. It can be specified under the "Configuration", "Folders" and "Special locations" options from the WFS-Ethiopia Toolbox User Interface. Sometimes (e.g. for the MODIS global products) %9 is used for the Julian day or for the METOP Soil Moisture product %9 is used for the orbit number.

The command line history can be retrieved pressing the drop down arrow at the right hand part of the command line in the main ILWIS menu.

Figure 2.8: Retrieving the command line history



2.7 STRUCTURE OF THE ILWIS WFS-ETHIOPIA TOOLBOX BATCH ROUTINES

As is the case with the ILWIS scripts, also most of the batch files follow a similar structure. These files are located in the sub-directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines. As an example a MPEF Cloud Top Height import routine (MPEF_eth_cth_import.bat) is given below.

The first 9 lines (see line numbers) are giving some remarks. Lines start with the "echo" command, which allows, or turns off (echo off) the display of messages in the command line window, see also figure 2.9. Note that an "echo." creates an empty line in the command line window. From line 10 to line 18 in the batch file, the parameters are passed, originating from the ILWIS script, to the batch file using the "SET" command. This command displays, sets, or removes Windows Environment Variables. Once these parameters are known the actual import routine can start. Special attention should be given to lines 10 and 11. The time stamp is defined as longfilename1 and is set in line 10. In line 11 this time stamp is used, starting from position 0, for 12 characters. In this case if a time stamp is used, like 201007021145 (as yyyymmddhhmm), the whole time stamp will be set as "shortfilename1", as this has a length of 12 characters. This allows flexibility in selections of portions of strings, but does not have any influence for this specific import routine, here longfilename and shortfilename1 are the same.

Lines 19 to 21 ensure that the application moves to the appropriate output directory. Line 22 displays the selected output directory in the command line window (see again figure 2.9). The items "echo." in lines 23 and 24 creates two empty lines in the command line window (see again figure 2.9). Line 25 sets the display of subsequent messages off.

In line 26 a check is performed if the input file exists, if this file does not exist the batch routine jumps to the section starting with ":MESSAGE". If the input file exists line 27 is displayed in the command line window, followed by 2 empty lines and then jumps to the start of the actual import routine, which begins at the ":START" section (line 30).

If the input file does not exist (in line 26) the batch routine jumps to line 31 ":MESSAGE", the section below (lines 32 to 36) are displayed, see also figure 2.9. In line 37 a "pause" command is used and the user has to press <enter> in order to continue. Once this is done the "GOTO END" command in line 38 causes the routine to jump to line 57.

If the data is located in the specified input drive-directory, line 40 copies the requested input data, using the appropriate time stamp, note %shortfilename1%. Images and products can consist of more than one file / segment. In line 40 note the portion of the file name string "__-00000?__". Using the "?" allows copying all segments of the same time stamp. To reconstruct the image or product the various segments have to be merged. This is done in line 41 (using the utility "joinmsg.exe") and a new output file is created, file format is GRIB. This file is renamed in line 42, to obtain a shorter filename and is imported into ILWIS format in line 43, using GDAL_translate.exe.

Once the file is in ILWIS format, ILWIS is executed from the command prompt in lines 44 to 47 (ilwis.exe –C) and a number of map calculations (lines 44 and 45) and map resampling to the Ethiopian window (lines 46 and 47) are performed. Lines 48 – 56 are deleting the files that have become obsolete.

Line 57 marks the ":END" section. With or without the required input data line 58 is always executed, this line closes instances of ILWIS which have started using this batch routine.

Start of batch file listing: MPEF_eth_cth_import.bat

```
------------------------------------------------------------------------------------------------------------------------------------
1:@echo off
2: echo Cloud Top Height import routine
3: echo The output-prefix: Eth_v  is a value map
4: echo The output prefix: Eth_c  is a class map, using elevclass.dom
5: echo The value map can be displayed using a PSEUDO Representation
6: echo Data is resampled to cover the Ethiopian region
7: echo Use is made of the Ethiopia 1km Lat-Lon projection
8: echo.
9: echo.

10: set longfilename=%1
11: set shortfilename1=%longfilename:~0,12%
12: set InputDrive=%2
13: set InputDir=%3
14: set OutputDrive=%4
15: set OutputDir=%5
16: set gdalDir=%6
17: set IlwDir=%7
18: set UtilDir=%8

19: cd\
20: %OutputDrive%
21: cd %OutputDir%

22: echo your current working directory = %OutputDrive%\%OutputDir%
23: echo.
24: echo.

25: echo off
```

26: if not exist %InputDrive%\%InputDir%\"L-000-MSG2__-MPEF________-CTH______-00000?___-%shortfilename1%-__*.*" goto MESSAGE

27: echo The file(s) %InputDrive%\%InputDir%\"L-000-MSG2__-MPEF________-CTH______-00000?___-%shortfilename1%-__*.*" will be copied to your current working directory
28: echo.
29: echo.

30: GOTO START

31: :MESSAGE
32: echo The input file was not found.
33: echo Check your directory and date stamp settings
34: echo Your current date stamp used is %shortfilename1%
35: echo Check also if the data exists on your input directory - archive
36: echo Note the temporal resolution of your data

37: pause

38: GOTO END

39: :START

40: copy %InputDrive%\%InputDir%\"L-000-MSG2__-MPEF________-CTH______-00000?___-%shortfilename1%-__*.*"

41: "%UtilDir%\joinmsg.exe" "L-000-MSG2__-MPEF________-CTH______-000001___-%shortfilename1%-__" %OutputDrive%\%OutputDir%\

42: rename "l-000-msg2__-mpef________-cth______-000001___-%shortfilename1%-__.grib" CTH%shortfilename1%.grib

43: "%gdalDir%\gdal_translate" -of ILWIS CTH%shortfilename1%.grib tCTH%shortfilename1%

44: "%IlwDir%\ilwis.exe" -C %OutputDrive%\%OutputDir%\vCTH%shortfilename1%.mpr{dom=value;vr=-100000.00:1000000.00:0.01}:=iff(%OutputDrive%\%OutputDir%\tCTH%shortfilename1%_band_1 ne 9999,%OutputDrive%\%OutputDir%\tCTH%shortfilename1%_band_1,?);

45: "%IlwDir%\ilwis.exe" -C %OutputDrive%\%OutputDir%\cCTH%shortfilename1%.mpr{dom='%UtilDir%\elevclass'}:=MapSlicing(%OutputDrive%\%OutputDir%\vCTH%shortfilename1%.mpr,'%UtilDir%\elevclass');

46: "%IlwDir%\ilwis.exe" -C %OutputDrive%\%OutputDir%\Eth_vCTH%shortfilename1%.mpr{dom=value;vr=-100000.00:100000.00:0.01}:=MapResample(%OutputDrive%\%OutputDir%\vCTH%shortfilename1%, ethiopia_1km.grf,nearest)

47: "%IlwDir%\ilwis.exe" -C %OutputDrive%\%OutputDir%\Eth_cCTH%shortfilename1%.mpr{dom='%UtilDir%\clai'}:= MapResample(%OutputDrive%\%OutputDir%\cCTH%shortfilename1%, ethiopia_1km.grf,nearest)

48: del "tCTH%shortfilename1%".mp*
49: del "tCTH%shortfilename1%".csy
50: del "tCTH%shortfilename1%".grf
51: del tCTH%shortfilename1%.aux.xml
52: del "tCTH%shortfilename1%_band*".mp*
53: del CTH%shortfilename1%.grib
54: del "L-000-MSG2__-MPEF________-CTH______-00000?___-%shortfilename1%-__*.*"
55: del cCTH%shortfilename1%.mp*
56: del vCTH%shortfilename1%.mp*

57: :END

58: "%IlwDir%\ilwis.exe" -C closeall

End of Batch file listing.

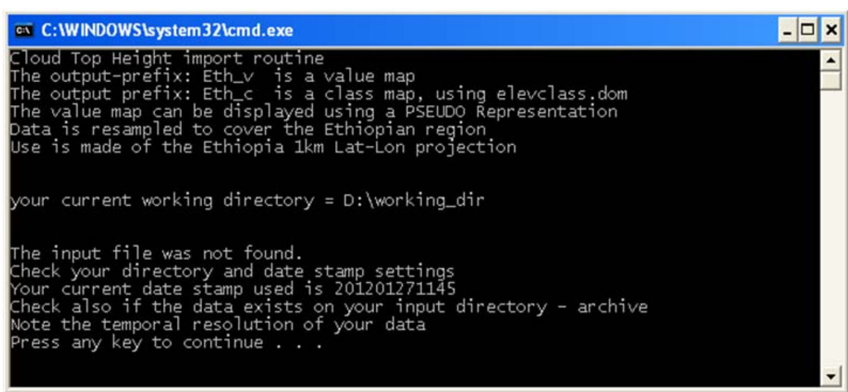
Although the content of the batch files can vary significantly, the sequence of activities is mostly the same:

- Some remarks are given at the start of the batch file
- Setting of the environment variables, passing over the parameters from the ILWIS scripts
- Check if input data is available, if not go to the end of the batch routine
- Copy the original data to a local disk
- Import of the data into ILWIS format
- Execute various ILWIS routines from the command prompt
- Delete obsolete files
- Close ILWIS tasks created by the batch routine

Note that all batch routines show a command line window. Relevant information is contained in these windows. It is advised that the content of these windows is critically checked while waiting for the batch routine to finish. The batch files can be opened using a text editor. The name of the batch file executed can be obtained from the ILWIS command line string as given in chapter 2.6 and figure 2.8.

In the example given in the batch file listing a date stamp should have been entered as “201001271145”. The actual time stamp used is “201201271145” which is resulting in the fact that the input data cannot be found and the routine, after pressing <enter> is aborted. Carefully inspect the date stamp and directory settings as indicated in the command line interpreter window as given in the figure below.

Figure 2.9: Resulting message when entering wrong date-time stamp



When appropriate, “quotation marks” are used to specify the location of a ‘directory\executable’ as well as for the input GEONETCast original file names to ensure that batch routines keep working if encountered spaces in (sub-) directory names and to copy input files with the complex file names. To ensure proper operation of the batch routines stick to the golden rules as given in chapter 1.1.1.

2.8 CHANGES AND MODIFICATIONS

As the EUMETCast-GEONETCast data stream is changing-evolving the user has the capability to easily modify or create new import routines and subsequently change the graphical user interface. For all these actions no programming experiences are required. New lines can be added in the “config.xml” file, and using the option “folderid” a new entry is created in the “wfs_e.ini” file. When opening a new instance of the WFS-Ethiopia Toolbox GUI, these changes are incorporated and using the option “Configuration” and “Folders” the appropriate input and output directories can be specified. A new script can be made, which in turn is executing a new batch file, to be created by the user. There are over 60 batch files already and portions of these files can be used as example to create new ones.

It is advised to keep track of the changes using the XML version number. This version number can be modified in the “config.xml” file as well. The version number used for creation of this document is config.xml version 1.0.

2.9 ADVANCED USE

If certain operations have to be repeated on a continuous basis, e.g. import of a certain data type, e.g. for which basically only the time stamp has to be modified, it is advised to copy the command line string that is generated through the graphical user interface, available from the command line, in the main menu of ILWIS (see also figure 2.8), to the WINDOWS command line interpreter (CMD.exe). Move to your working directory; paste the command line string in the command line interpreter window. Delete the “!” from the start of the string and execute the expression. Within the string the date stamp can be easily modified.

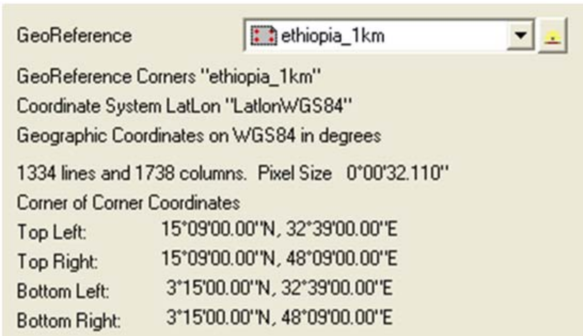
Also from the main menu of ILWIS, the command line history can be checked. Select the appropriate string generated through the graphical user interface, modify the time stamp and execute the expression again.

2.10 THE REGION OF INTEREST: ETHIOPIA

Given the dimensions of Ethiopia various UTM zones do exist in the country and therefore the data for the Ethiopia ROI routines, available from the WFS-Ethiopia Toolbox under the sub menu “Ethiopia” are resampled to Latitude-Longitude, using the WGS84 Ellipsoid and Datum. The georeference used is “ethiopia_1km.grf” and is available in the “Util” sub-directory. Coordinates of the selected window correspond with those from LEAP and are (in Degree.Decimals): MinX=32.65, MinY=3.25, MaxX=48.15 and MaxY=15.15. The corner of the corner pixel is used (not the centre!). For resampling use is made of a nearest neighbour resampling method.

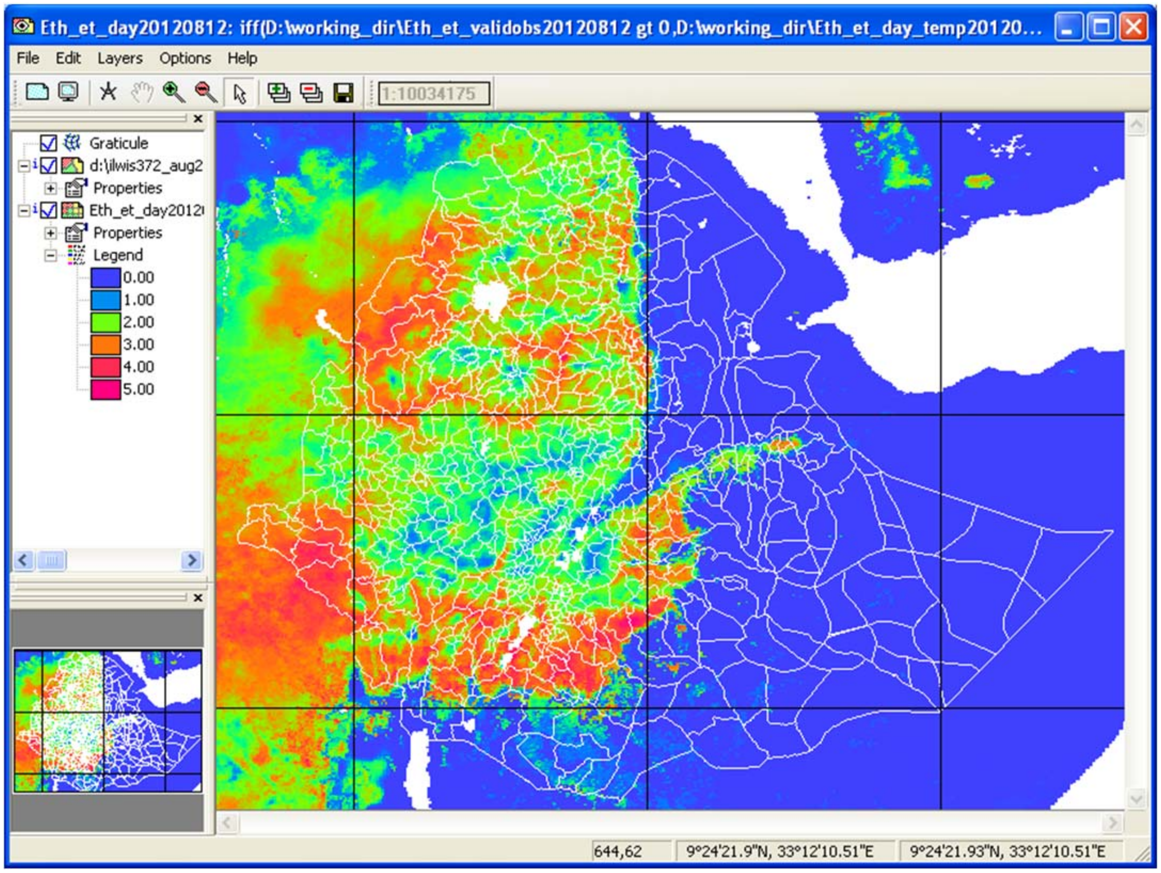
Given the fact that at the equator one degree can be approximated by 112 km (1/112), a pixel size of 0.008928571429 degree or 0º0’32.14’’ represents 1 km. Here a pixel size of 0.00891829689 degree (X or Longitude, approximately 998.849 metres) and 0.00892053973 degree (Y or Latitude, approximately 999.101 metres) or 0º0’32.11’’ is used. A pixel therefore approximately represents 0.998km^2. Further details are presented in figure 2.10 and a map example is given in figure 2.11.

Figure 2.10: Region of Interest details for Ethiopia



If another projection is required (e.g. UTM), the user can create one using the generic ILWIS functionality and modify the command "MapResample" (see batch file listing, lines 46 and 47 of chapter 2.7) and replace "Ethiopia_1km.grf" with the new target georeference.

Figure 2.11: Ethiopia ROI showing 24 hour accumulated ET, woreda boundaries and 5 degree interval graticule



2.11 CONCLUDING REMARK

With all the configuration settings provided you are now ready to utilize the Water and Food Security-Ethiopia Toolbox and explore the selected (real time) data that is delivered via DVB broadcast. The WFS-Ethiopia Toolbox under ILWIS is able to import and process a multitude of data types delivered via EUMETCast-GEONETCast, but it depends on the service channels activated which data is actually received at the various ground receiving stations. Furthermore the National Meteorological Agency has access to the MDD service, which is restricted to other users. Check the services actually received by contacting the local ground receiving system administrator.

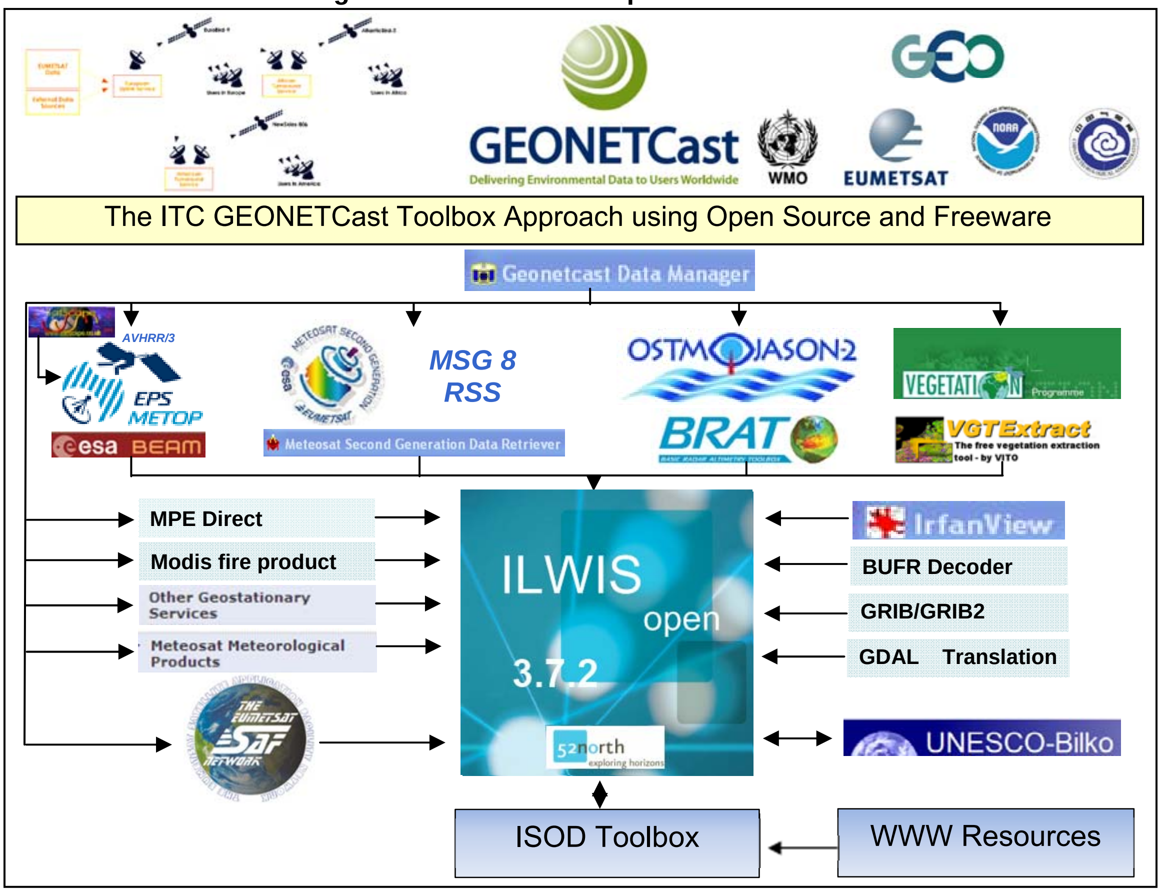
Further information can also be found on the EO-portal at EUMETSAT (http://www.eumetsat.int/Home/Main/DataAccess/EOPortal/index.htm?l=en). Your system administrator has access to the services received and can login to this portal using the provided username and password. Using the "Edit/View Service Subscriptions" tab it is possible to apply for new services. Your system administrator should check the account of your organization on a regular basis to see if new services offered are of interest, in such case these services can be requested – activated and these will be received at the ground receiving station after the application has been processed by EUMETSAT.

3. EXPLORING THE GEONETCAST DATA STREAM USING THE WATER AND FOOD SECURITY-ETHIOPIA TOOLBOX

3.1 INTRODUCTION

The WFS-Ethiopia Toolbox provides an open and flexible integrated solution to manage the EUMETCast-GEONETCast data stream, import of the various image types and data products and bring them together in a common GIS and RS environment for further processing. This approach is further elaborated upon in figure 3.1.

Figure 3.1: Overall concept of the Toolbox



The data disseminated by EUMETCast-GEONETCast is consisting of various formats. Over time a number of utilities have been developed at ITC to be able to import these data types. Also other existing freeware utilities are used and have been integrated in the toolbox, such as BUFR and GRIB (2) decoders. Also use can be made of other available software routines, such as BEAM, for pre-processing. In that case import routines are available to seamless transfer the data into an ILWIS data format, e.g. using the option “Generic GEOTiff import”. Appendix 1 is providing the links to these utilities.

Last but not least attention was given to use data that is made freely available through the World Wide Web. A separate toolbox (In Situ and Online Data Toolbox) is available to incorporate relevant (*in situ*) environmental and forecasting information in this manner, extending the functionality beyond the EUMETCast-GEONETCast direct reception. To be able to use this toolbox internet connectivity is required. The data is automatically retrieved and pre-processed.

3.2 THE WFS-ETHIOPIA TOOLBOX FUNCTIONALITY (CONFIG XML VERSION 1.0)

Below a short description with instructions to import the data / run a utility is provided of the main menu items that are available in the WFS-Ethiopia Toolbox, XML version 1.0. The sequence followed is identical to the menu structure as given in figure 1.1.

3.2.1 *GEONETCast Product Navigator*

The Product Navigator is developed and maintained by EUMETSAT. Updates are disseminated via EUMETCast-GEONETCast and can be found at the \Received data folder on the ground receiving station. A regular windows scheduled task should be created to copy the files from this directory to a central archive, so users always work with the latest version. The location of this utility should be specified using the options “Configuration” and “Folders”. If this is done the button “Start GNC Product Navigator” can be pressed and a web browser is opened showing the details of the GEONETCast data stream. All kind of selection criteria can be applied to find the data that might be of interest to the various users. This is a good starting point to discover the data that is currently disseminated through the African dissemination service.

3.2.2 *GEONETCast Data Manager*

This utility allows the system administrator to transfer the newly incoming data on the ground receiving station to a central archive based on all kind of rules and decisions. This utility generates a menu based on an ascii text file. This file can be modified and adapted using a text editor if new data has arrived or if the organization wants to maintain only a certain portion of the full data stream. This utility is described into more detail in chapter 1.2. Note that Java is required to run this application.

Having selected from the menu the “Geonetcast Data Manager” the utility can be activated by pressing the “Start Data Manager” button and subsequently select the appropriate text file (*.txt) and the menu will appear. As indicated before it is advised to run this utility as a stand-alone, only to be operated by the local system administrator.

3.2.3 *MSG-HRIT, MSG Data Retriever*

MSG-1 was launched on the 28th of August 2002 and after a testing period commenced routine operations on the 29th of January 2004. Then the satellite was renamed to Meteosat-8. On the 21st of December 2005, as a backup of Meteosat-8, MSG-2 was successfully launched and is currently operational. This will ensure continuous satellite observations for the next decade. MSG-3 has been launched on 05 July 2012 and is currently under commissioning. The advanced SEVIRI radiometer on-board the MSG series of geostationary satellites enables the Earth to be scanned in 12 spectral channels from visible to thermal infrared (including water vapour, ozone and carbon dioxide channels). The specifications of SEVIRI have been chosen carefully to match operational requirements. Each of the 12 channels (table 3.1) has one or more specific applications in mind, either when used alone or in conjunction with data from other channels. Each has a well-established heritage, ensuring that their characteristics are well understood so that the data can be used on an operational basis. The actual instrument includes a primary mirror with a diameter of 51 cm and infrared detectors. The raw images are generated through a combination of an east-west scan obtained from the spinning of the entire satellite at 100 revolutions per minute, together with a stepping of a telescope mirror from south to north after each scan line. The spatial resolution of the SEVIRI instrument has been slightly increased (at intervals of 3 km) compared to its predecessors, the High Resolution Visible (HVR) channel even has a sampling distance interval of just 1 km.

Table 3.1: SEVIRI channels and their applications

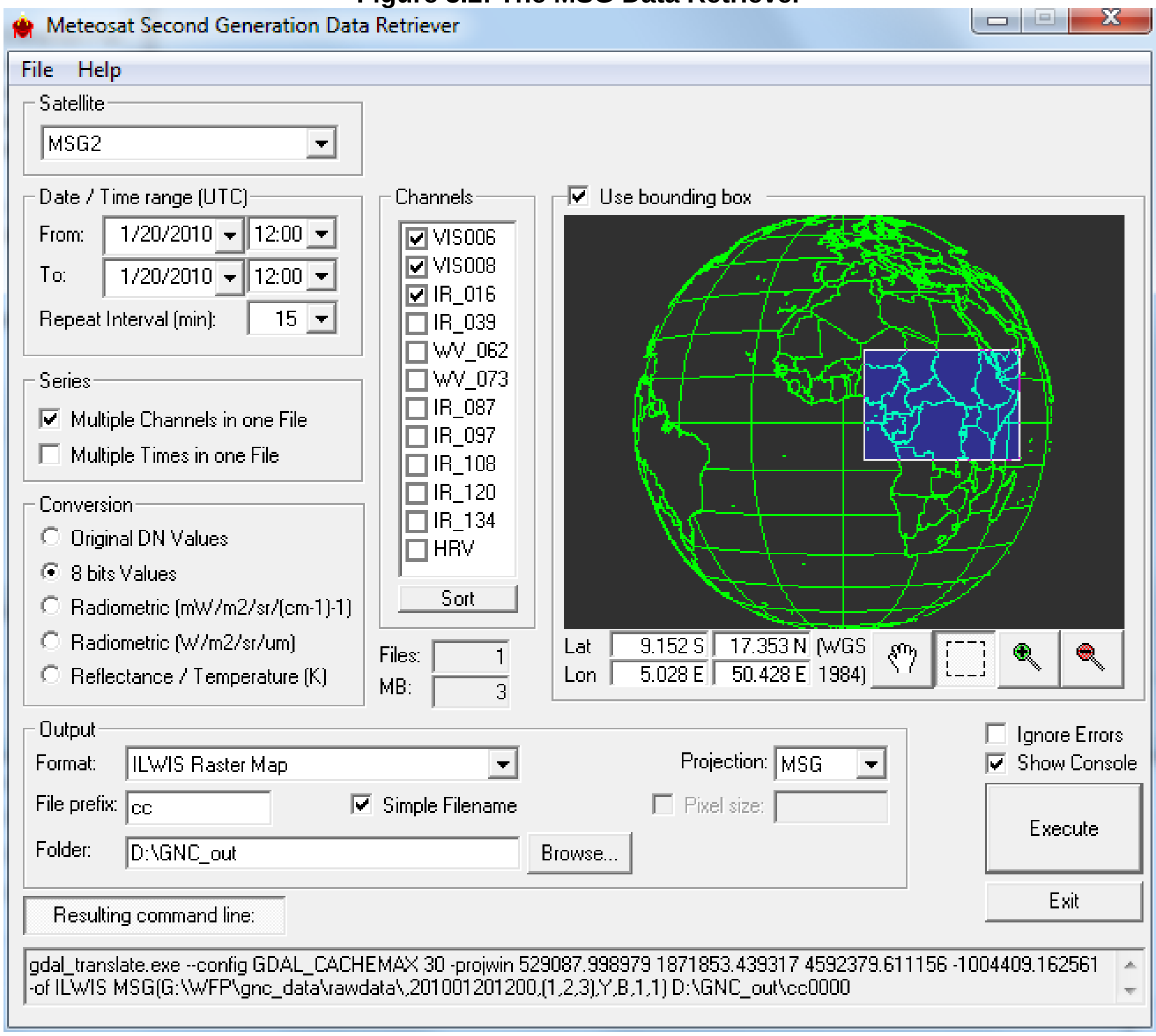
Band	Center	Min	Max	Nadir Res	Row x Cols	Repetition	Application
1	0.635	0.56	0.71	3000	3712 x 3712	15	Surface, clouds, windfield
2	0.81	0.74	0.88	3000	3712 x 3712	15	Surface, clouds, windfield
3	1.64	1.5	1.78	3000	3712 x 3712	15	Surface, cloud phase
4	3.9	3.48	4.36	3000	3712 x 3712	15	Surface, clouds, windfield
5	6.25	5.35	7.15	3000	3712 x 3712	15	Water vapor, high level clouds, atmospheric instability
6	7.35	6.85	7.85	3000	3712 x 3712	15	Water vapor, atmospheric instability
7	8.7	8.3	9.1	3000	3712 x 3712	15	Surface, clouds, atmospheric instability
8	9.66	9.38	9.94	3000	3712 x 3712	15	Ozone
9	10.8	9.8	11.8	3000	3712 x 3712	15	Surface, clouds, windfield, atmospheric instability
10	12	1100	13	3000	3712 x 3712	15	Surface, clouds, atmospheric instability
11	13.4	12.4	14.4	3000	3712 x 3712	15	Cirrus cloud heights, atmospheric instability
12	-	0.4	1.1	1000	11136 x 7700	15	Surface, clouds

The problem with the MSG data is that the file format is not standard. None of the commonly used remote sensing packages is able to open or process the raw compressed images. Therefore a driver was developed for reading the images in the Geospatial Data Abstraction Library (GDAL, http://www.gdal.org). GDAL is a translation library for raster geospatial data formats that is released under an MIT style Open Source license. All source code is in C++, and great effort is put into keeping the code platform-independent. Drivers for writing files in popular RS formats (e.g. ENVI, ERDAS, ILWIS, GeoTiff) but also picture formats like JPEG, GIF and BMP have already been implemented by the community, so appending a driver for reading MSG image files to this driver was seen as the most appropriate solution.

An algorithm developed is correctly re-composing the images from the multiple compressed data files / segments. According to the provided documentation the algorithm must take care of scan direction, image compression, bit-depth, image size and proper alignment of the image strips of the high resolution band. A second algorithm developed performs the radiometric calibration using the relevant header / footer (PRO / EPI) parameters and applying appropriate formulas that calculate the resulting pixel values into the required unit. A third algorithm determines the geo-location of each pixel. Automatic geo-location has the advantage that no manual steps are needed to transform the images to a known projection. This utility can be used to import the recordings from the SEVIRI instrument onboard METEOSAT 8, the so called Rapid Scanning Service, and METOSAT 9, covering the whole footprint.

The command-line utilities that come with GDAL facilitate the use of the library to transform MSG images into widely applied RS data formats. The GDAL version used supports 25 output formats in the library. In-house experiences with these command-line utilities revealed that composing such a command-line string is an error-prone process (given the many options available). Therefore a Microsoft Windows based user-interface was developed that generates the necessary command-line syntax (figure 3.2). The user only needs to express the “query” by making appropriate choices using checkboxes, radio buttons, list boxes, selection of area of interest, etc. Through the user interface all relevant parameters can be adjusted and a time series can be easily constructed. The user interface facilitates retrieval of original DN values (10 bit-depth), compressed DN values to 8 bit-depth, Top of Atmosphere radiances in 2 different units (W/m2/sr/um or mW/m2/sr/cm-1)-1), computation of Top of Atmosphere reflectance for the visible channels or Top of Atmosphere temperature (in Kelvin) for the thermal channels. The geometric precision is within a pixel for the low resolution bands and Geographic coordinates and UTM projection conversion is possible (a pixel size dimension has to be entered).

Figure 3.2: The MSG Data Retriever



For more flexibility, with the option “Show Command Line” the corresponding command-line string for performing a certain import is revealed. This string can then be copied into a batch file which can be executed or called from within an ILWIS script in order to perform similar imports multiple times in a semi-automated manner. The GDAL-driver and windows based Data Retriever interface facilitate easy geometric and radiometric calibrated data retrieval of MSG into e.g. ILWIS format.

The MSG Data Retriever can be invoked when pressing the button “Start MSG Data Retriever” Using the option “File”, “Data Sources” the linkage can be established to the central archive, where the data is stored. Multiple data sources can be configured. More details on the configuration of the data sources can be found in chapter 2.5.

When METEOSAT-10 is declared operational, the Data Retriever will be adapted to allow import of the SEVERI data recorded by this satellite as well.

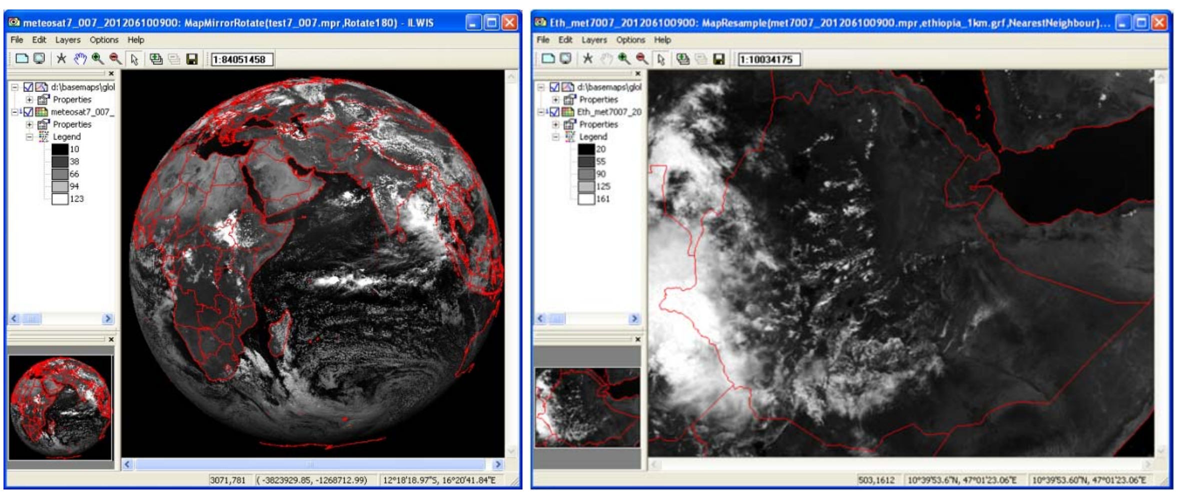
3.2.4 *METEOSAT 7-LRIT*

Under this menu a number of utilities are present facilitating the import of the data recorded by the METEOSAT 7 geostationary satellite, situated over the Indian Ocean (at 57 degree East). Using the Low Rate Image Transmission the full temporal resolution is not available. Currently the following import routines are supported: METEOSAT 7 full disk and METEOSAT 7 Ethiopian window. The data from the visible (007), water vapour (064) and thermal channels (115) are imported as byte images.

The temporal resolution is indicated and the starting time of an image in UTC on a daily basis in the comment line from the menu. For the “Date” stamp a 12 digit format is required, resembling the yearmonthdayhourminute of the image to be imported. All channels of a selected satellite are imported during the import operation. From the main WFS-Ethiopia Toolbox menu, using the options “Configuration” and “Folders”, the input and output directories can be specified.

The batch routines can be found under the ILWIS directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines and the batch filename convention used for the Meteosat 7 is LRIT_**.bat*. An example of the results of the import routines are given in figure 3.4 for the visible 007 channel recorded at 09:00 UTC on 20120610.

Figure 3.4: Example of METEOSAT 7 import, full disk and Ethiopian window



3.2.5 *Real Time MSG Visualization*

Utilities are developed to automatically import a number of spectral channels (and band combinations) derived from the SEVIRI instrument. Once a real time visualization routine is selected and the appropriate input and output directories are specified, the utility automatically starts at a given system clock time, scheduled in such a way to ensure that the last recorded images have arrived at the ground reception station. The task is automatically repeated every 15 minutes, in sync with the temporal resolution of MSG. The current real time applications available are “IGAD Region Multispectral”, “MSG Ethiopia Pan Sharpened”, “MSG Ethiopia Thermal B/W” and “MSG Ethiopia Thermal Colour”.

The utility starts a Windows Scheduled Task event. Once this is done, ILWIS can be closed as it will automatically run from the command prompt. To stop (and remove the Scheduled Task), the option “Stop …… Visualization” (‘…..’ stands for “Multispectral”, “Pan Sharpened” or “Thermal”) and subsequently the “Stop” button can be selected. This needs to be confirmed with “Y”.

The procedure for automatic visualization is further explained below using as example the "MSG IGAD Region Multispectral" option from the toolbox menu. Note that the other visualization routines work in a similar manner. When starting the routine "MSG IGAD Region Multispectral" a batch file "ini_IGAD.bat" is executed, situated within the ILWIS sub directory \Extensions\WFS_E-Toolbox\toolbox_ startscript\RealtimeMSGVisualization\AfricaIGADWindow. This batch file sets a number of input parameters (like the in- and output drive\directory and the directory location of executables needed). It furthermore creates a Scheduled Task. In this example when a new event of a Scheduled Task is started an new file "st_msgIGAD.bat" is created. This file is stored in the same ILWIS sub-directory and the syntax line creating the Scheduled Task is given below:

schtasks /create /sc minute /mo 15 /st 08:01:00 /tn "MSG_visual" /tr %4Extensions\WFS_E-Toolbox\toolbox_startscript\RealtimeMSGVisualization\AfricaIGADWindow\st_msgIGAD.bat

where:

schtasks	Windows Scheduled Tasks application (schtasks /? is the help function)
/create	Create a scheduled task
/sc	Specifies the schedule frequency
/mo	Modifier, for more refined task tuning, as "/sc" is defined as "Minute", "/mo" provides a repeat interval of 15 minutes
/st	Starting time, note this is your system time
/tn	Name that uniquely identifies the task
/tr	Task name, the batch file which is subsequently executed, containing the full path (here %4 defines the ILWIS directory)

The result is that a new Scheduled Task, named "MSG_visual" is created, which now executes a batch file ("st_msgIGAD.bat") every 15 minutes, starting from 08:01 hr (local time).Note that the file "ini_IGAD.bat" can be modified if e.g. another starting time is required.

The applications access the newly arrived raw MSG data (at the end of the each scan) which is stored on a network resource. A dated folder structure is assumed here (see also chapter 2.5 and figure 2.7). Note that a password might be required when running under Windows XP; this is normally your system login password.

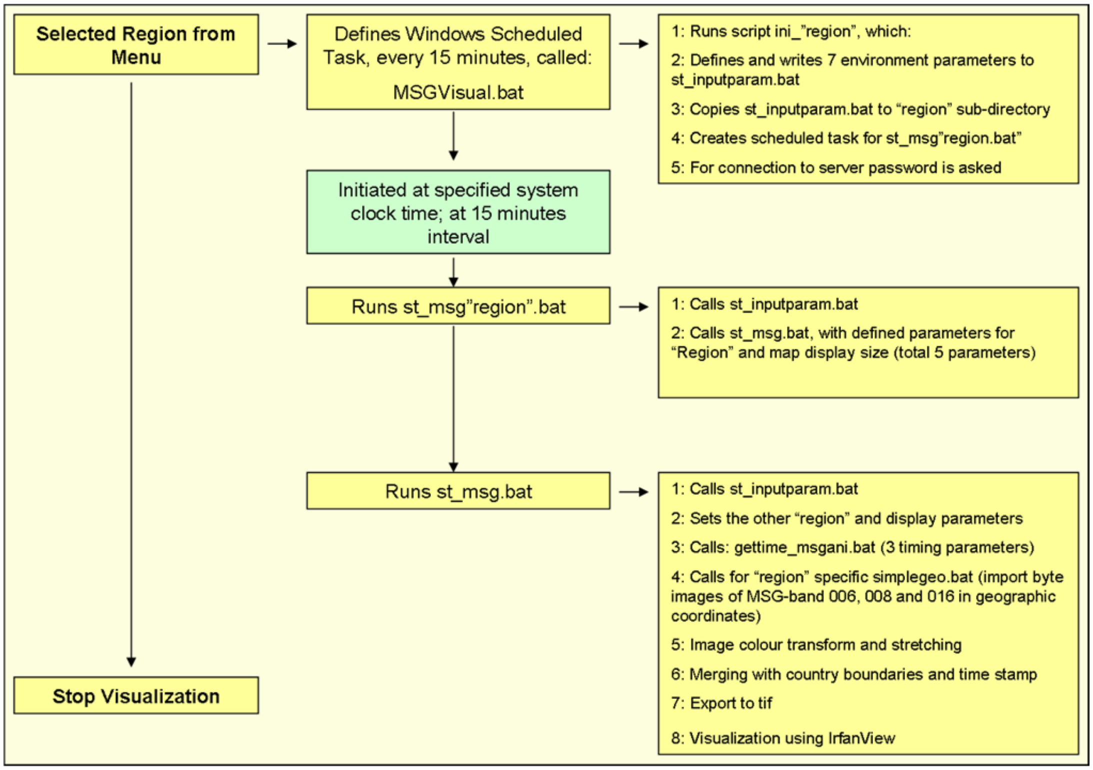
Each of the utilities run a (similar) sequence of batch files for each routine selected, which are located in the ILWIS sub-directory "\Extensions\WFP_E-Toolbox\toolbox_startscript\Realtime MSGVisualization". The sequence of batch routines is specified into more detail in figure 3.5. In this example "Region" refers to the IGAD window. The final image shown on the screen is visualized using IrfanView.

The link to the IrfanView directory\executable has to be properly specified in the main WFS-Ethiopia Toolbox menu, using the options "Configuration", "Folders" and "Special locations". Once a number of import sequences have passed the user can click with the left mouse button on the last displayed image (to activate the image display window) and use the scroll bar on the mouse to interactively move to the previous images and back to the last imported time interval.

The time stamp displayed on the upper left hand portion of the image is referring to the end of scan time for the whole field of view of MSG-9. The actual time when the northern most part of the Ethiopian window is scanned by MSG is approximately 07:30 minutes after the start of scan time. So from the equator till about 15 degree north latitude the actual time when the region is recorded is about 06:00 to 07:30 minutes after start of scan time respectively.

To get the appropriate end of scan time stamp in local time (but still applicable for the whole field of view of MSG) the system "date and time settings" should adhere to the appropriate time zone setting. It is advised to configure your system time stamp in a "HH:mm:ss" format, check your system "Region and Language" settings. The screen resolution to display the images should preferably be 1280 by 1024 pixels.

Figure 3.5: Layout of the various components for Real Time MSG visualization



Currently four automated visualization routines are supported. The "IGAD Region Multispectral" option displays a natural colour transformed composite covering the IGAD region, using the VIS006, VIS008 and IR_016 channels of the SEVIRI instrument. This visualization is only suitable for daytime conditions. The option "MSG Ethiopia Pan Sharpened" shows the Ethiopian window, resampled to approximately 1 km^2 pixel resolution. Next to the VIS006, VIS008 and IR_016 channels of the SEVIRI instrument also the HRV channel is incorporated and a pan sharpening approach is included after which a natural colour transformation is performed. Again this visualization is only relevant for daytime conditions. Using the HRV channel shows greater details, especially with respect to cloud occurrences. The HRV channel is moving according to the position of the sun, therefore after 14:00 UTC this routine starts showing a HRV gap from the east!

The "MSG Ethiopia Thermal B/W" imports and resamples the SEVIRI IR_108 channel over the Ethiopian region. The data is imported as Temperature (Kelvin). The output image is using an inversed 'gray-scale' lookup table (using the routine "st_msg_thermal_bw.bat"). The "MSG Ethiopia Thermal Colour" (using the routine "st_msg_thermal_c.bat") is displaying the colder clouds in a colour scheme.

For both the thermal channel visualization routines, the imported data is transformed into Temperature. To obtain an inverse representation a coefficient of 400 is used from which the actual imported pixel values are subtracted (400-actual). Assume a non-clouded pixel with a Top of Atmosphere (ToA) temperature of 310 Kelvin (K) this algorithm will result in an output pixel value of 90. Now assume a cloud pixel with a top of the cloud temperature of 190 K, this will result in an output pixel value of 210. The resulting data range is mostly in the range of 0-255 (byte range), and if an inverted gray scale lookup table is used the white toned pixels now represent the cold clouds and the dark gray areas represent the non-clouded land and water surfaces. No stretch function is applied!

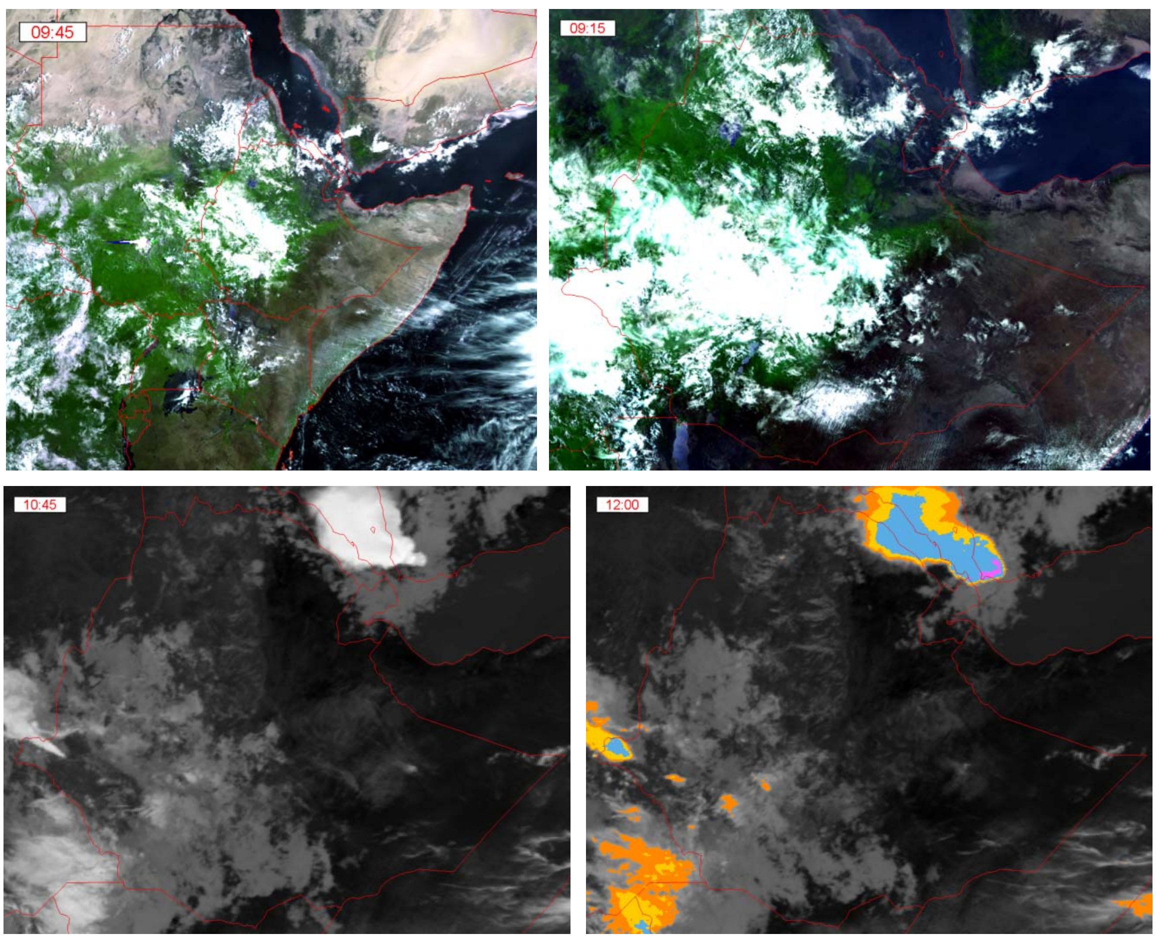
The same approach (using also a coefficient of 400) has been used for the coloured thermal image visualization routine. Thresholds are defined and the pixels falling in these threshold ranges are subsequently colour coded. The threshold actual temperature range and colour coding is given in table 3.2.

Table 3.2: Thermal thresholds applied for temperature ranges and colour coding used

Thresholds (Kelvin)	Gray scale values	Colour code (R,G,B)	Resulting colour
> 235	Inverted Gray scaling is applied for values less than 165		
220 - 235	165 - 180	255,136,0	orange
205 - 220	180 - 195	255,203,1	yellow
190 - 205	195 - 210	89,173,228	blue
< 190	> 210	255,93,255	pink

Within the batch file "st_msg_thermal_c.bat" an ILWIS MAPCALC "color" operation is executed to create the output map "ccTOA_Tinverse%workingtime%.mpr", assigning the class ranges to the specified output colours. If more classes or different colour are required this expression can be modified to suit the need of the user.

Figure 3.6: MSG-IGAD, MSG Pan Sharpened and MSG Thermal visualization examples



If at a given moment required input files cannot be retrieved (from the archive) due to whatever reason the application stops the import of that given time event. A command box will appear on the screen. To continue press <enter> and check what the problem could be why you are not able to import the latest images!

From the main WFS-Ethiopia Toolbox menu, using the options “Configuration” and “Folders”, the input “Real Time MSG VIS” and output directories can be specified. Also check the input folder settings for the folder “MSG Data Retriever”.

A small modification is still required to cope with a date change while the application is active. An error occurs when a new day is starting. In Windows 7 more scheduled task utilities are available compared to Windows XP. It is always possible to fine-tune the scheduled task if you create one yourself. If this is done it is advised to first create a scheduled task from the toolbox menu (to ensure that an appropriate inputparam.bat and st_msg*.bat file is created in the ILWIS sub-directories contained in \Extensions\WFS_E-Toolbox\toolbox_startscript\RealtimeMSGVisualization\. Check the scheduled task which is created to determine which batch file is executed (look at the properties). The task can be deleted and you can create one yourself specifying the appropriate batch file when defining a “New Action”. For purpose of downward compatibility (e.g. with Windows XP) only limited Scheduled Tasks functionality has been used when creating the Visualization tasks. If working with Windows 7 a “/du” option (specifying the duration, not supported by Windows XP) can be included and the time (in hh:mm) the visualization should be running can be included in the “schtasks /create” example as given above. To get further information on the various options type “schtasks /?” in the command line interpreter window (cmd.exe).

The output images are stored within the specified output drive\directory. The file name format is “ccyyyymmddhhmmhhmm.tif”. The first “hhmm” instance refers to the start of scan time in UTC, the second “hhmm” represents the local end of scan time (of the whole field of view of MSG) in hours and minutes, using a 24 hour format. Using IrfanView, and selecting the appropriate series of images, an animation can be easily created and can be saved as an executable (*.exe). The created slideshow can be visualized just by double clicking the file using your mouse.

3.2.6 *Ethiopia*

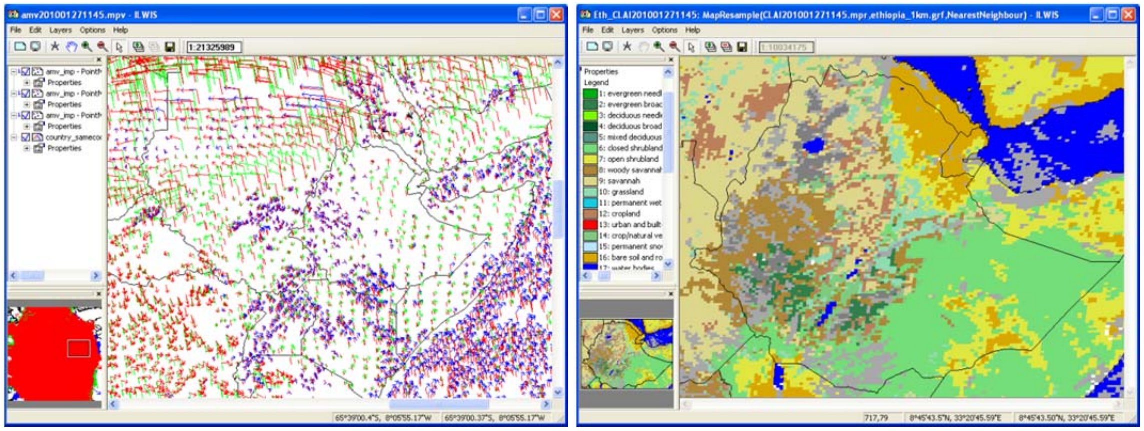
The majority of the import routines under this menu option extract the data for the Ethiopian window. Details on the map resampling procedure and georeference are provided in chapter 2.10.

3.2.6.1 Meteorological Product Extraction Facility (MPEF)

The MPEF is a part of the MSG Ground Segment; its primary function is the generation of Meteorological Products from the Level 1.5 SEVIRI image data supplied by the Image Processing Facility (IMPF). The products are then quality controlled and encoded prior to being passed to the Data Acquisition and Dissemination Facility (DADF) for delivery to users.

Under this heading a number of routines are available to import the various products that are generated by the MPEF at EUMETSAT. For the “High Temporal Resolution MPEF Products” the time stamp required here should adhere to: yearmonthdayhourminute (12 digits). The temporal resolution changes for the various products; it is indicated in the comment line of the menu as well as the time of the first product generated on a given day. From the main WFS-Ethiopia Toolbox menu, using the options “Configuration” and “Folders”, the input “MPEF_highres” and output directories can be specified. These products are generated using the full disk of MSG, currently METEOSAT 9. Import of the following products is supported: Atmospheric Motion Vectors (AMV), Cloud Analysis (CLA), Cloud Analysis Image (CLAI), Cloud Mask (CLM), Cloud Top Height (CTH), Fire-Grid (FIRG), Global Instability Index (GII), Multi Sensor Precipitation Estimate – Geostationary (MPEG), Clear Sky Radiances (CSR), Tropospheric Humidity (TH) and Total Ozone (TOZ). Note that some of the import routines create multiple output files, like the GII which creates the following output maps: K-Index, Parcel Lifted Index (to 500 hPa), Precipitable Water (kg m-2), KO-Index and Maximum Buoyancy. Some example import results for the AMV and CLAI are given in figure 3.7.

Figure 3.7: MPEF Atmospheric Motion Vectors and Cloud Analysis Image products



Recently also data with lower temporal resolution are generated by MPEF, such as a daily and dekadal NDVI. Import routines are available to process this information; the routines are situated under the sub menu “Low Temporal Resolution MPEF Products”, the input data directory is specified as “MPEF_lowres”, using the options “Configuration” and “Folders”. Only the “yyyymmdd” timestamp is required as for these products the “hhmm” timestamp is always “1200”. For the NDVD the day timestamp is 10, 20 or last day of the month, for each of the respective dakades. For both NDVI and NDVD the maximum, minimum and mean is extracted, use can be made of the Representation “NDVI1” for visualization.

All batch routines can be found under the ILWIS directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines and the batch filename convention used for the products is *MPEF_eth_”abbreviation”_import.bat* (where “*abbreviation”* stand for product type).

3.2.6.2 Satellite Application Facilities (SAF)

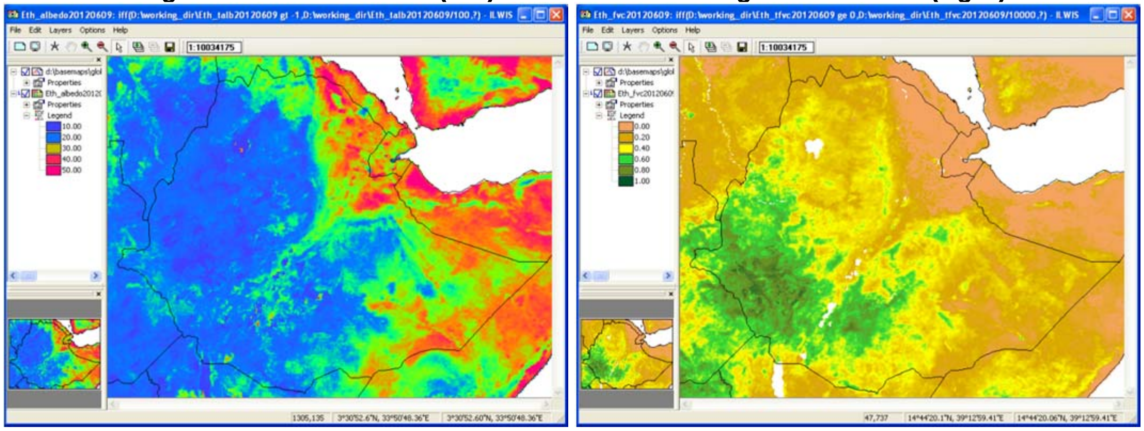
Satellite Application Facilities (SAFs) are specialised development and processing centres within the EUMETSAT Applications Ground Segment. Utilising specialised expertise in Member States, they complement the production of standard meteorological products derived from satellite data at EUMETSATs Central Facilities.

The routines available here are produced by the Satellite Application Facility (SAF) on Land Surface Analysis (LSA). The following products are supported: Albedo, Down-welling Surface Long-wave Radiation Flux (DSLF), Down-welling Surface Short-wave Radiation Flux (DSSF), Land Surface Temperature (LST), Evapotranspiration (ET), Fraction of Absorbed Photosythetically Active Radiation (FAPAR), Fraction of Vegetation Cover (FVC) and Leaf Area Index (LAI).

The import routines available allow import of the various products. The time stamp required here should adhere to: yearmonthday (8 digits) or yearmonthdayhourminutes (12 digits) as the temporal resolution changes for the various products; it is indicated in the comment line of the menu as well as the time of the first product generated on a given day in case of multiple products on a daily basis. From the main WFS-Ethiopia Toolbox menu, using the options “Configuration” and “Folders”, the input and output directories can be specified. Some product examples are given in figure 3.8. For visualization of the imported products standard look-up tables are available as “Representations” (lai, fapar, fvc, pseudo, etc).

All batch routines can be found under the ILWIS directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines and the batch filename convention used for the products is *LSASAF_eth_”abbreviation”import.bat* (where “*abbreviation”* stand for product type).

Figure 3.8: SAF Albedo (left) and Fraction of Vegetation Cover (right)



3.2.6.3 SAF – Evapotranspiration Daily

In order to obtain a daily total Evapotranspiration map, the 48 half hourly events of the SAF ET product are imported using a batch looping procedure. After all events are processed, the sum is calculated for each input pixel and a total ET in mm over a 24 hour period is obtained. Another map calculated is showing the number of valid observations, for some events during the day the ET cannot be derived and a no-data or undefined is returned. This map is useful to see if the sum ET is underestimated for some of the pixels!

The routine first checks if all 48 events are copied to your local system, if this is not the case a message is given and the missing files should be created (e.g. by coping and pasting previous or next time stamp event). The routine continues only if 48 events are available. An example of the result of this routine is given in figure 2.11.

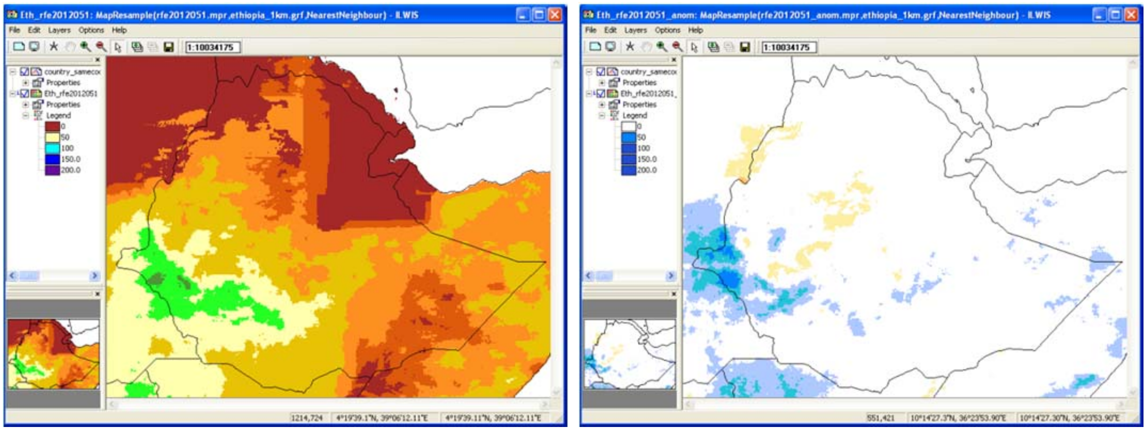
The batch routines can be found under the ILWIS directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines and the batch filename convention used for this routine is "*LSASAF_eth_ET_sta.bat*" and *"LSASAF_eth_ET_loop.bat".* The *sta.bat starts the procedure and executes for all 48 events the *loop.bat. If all 48 products are processed the *sta.bat creates an ILWIS maplist and performs the required calculations.

3.2.6.4 TAMSAT Rainfall Products

Within the GEONETCast data stream also non-meteorological organizations contribute. An example is the rainfall product for Africa, produced by the TAMSAT group from the University of Reading (UK) which are producing ten-daily (dekadal) and monthly rainfall estimates and anomalies derived from Meteosat Thermal Infra-Red (TIR) channels based on the recognition of storm clouds and calibration against ground-based rain gauge data. Using this set of import routines the 10 day accumulated RFE rainfall product can be imported as well as a monthly accumulated rainfall product, which is the sum of the 3 dekadal rainfall products for a given month. Furthermore a decadal anomaly and monthly anomaly rainfall product can be imported. Note that the "Date" stamp required format is: yyyymmdek (which stands for yearmonthdekade), dekades are number 1 to 3 for the dekadal products and yyyymm (which stands for yearmonth) for the monthly products. As from the 1st dekade of March 2011 the file format has changed, the import routines developed for import of the various TAMSAT rainfall (and anomaly) products can be applied to process the post March 2011products. If older data is required check the routines available from the ISOD Toolbox.

From the main WFS-Ethiopia Toolbox menu, using the options “Configuration” and “Folders”, the input TAMSAT and output directories can be specified. Standard representations for the various TAMSAT products for visualization are available, their names are starting with “rfe_*. An example is provided in figure 3.9.

Figure 3.9: Dekadal TAMSAT rainfall and rainfall anomaly (using climatology from 2000 - 2009) maps from 1st dekade of May 2012



All batch routines can be found under the ILWIS directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines and the batch filename convention used for the products is *TAMSATRFE_eth_”abbreviation”.bat* (where “*abbreviation”* stand for product type).

3.2.6.5 SPOT VGT Products

Based on recordings of the Vegetation Instrument on-board SPOT, three monthly 10 day synthesis products are produced and disseminated of Africa. Table 3.3 below provides a summary of the main SPOT VGT Africa product import routines available within the GEONETCast data stream for which import routines are available.

The SPOT VGT products are a dekadal product, in order to import the various products the “Date” format here should be specified as: yyyymmdekdek, where dek stand for dekade. There are three dekades, specified as 01, 11 and 21, for the first 10 days, the second series of 10 days and the remaining days for the last decade of the month respectively. To import a product for the second decade of May 2012, the “Date” stamp to be entered should be: “20120511”. Note that for the BA product another dekade timestamp convention (yyyymmdd) is used: 10, 20 or last day of the month for the first, second and last dekade of the month respectively. For visualization of the imported products standard look-up tables are available as “Representations” (ndvi1, lai, fapar, ndwi, pseudo, etc).

The BA, PHENOKS and PHENOMAX products provides upon import a map value comprising of 5 digits. The first two digits represent the years that have passed since 1980. The remaining / last 3 digits are indicating the Julian Day number when the BA, phenological key stage or phenological maximum NDVI was detected. Use can be made of the Julian Day tables (see chapter 3.2.8.1) to transform the Julian Day into calendar day. As example a map value of “31223” should be interpreted as: year = 31 (1980 + 31 = 2011), Julian Day 223, which yields as result: 11 August 2011 (2011 is no leap year!).

All batch routines can be found under the ILWIS directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines and the batch filename convention used for the products from

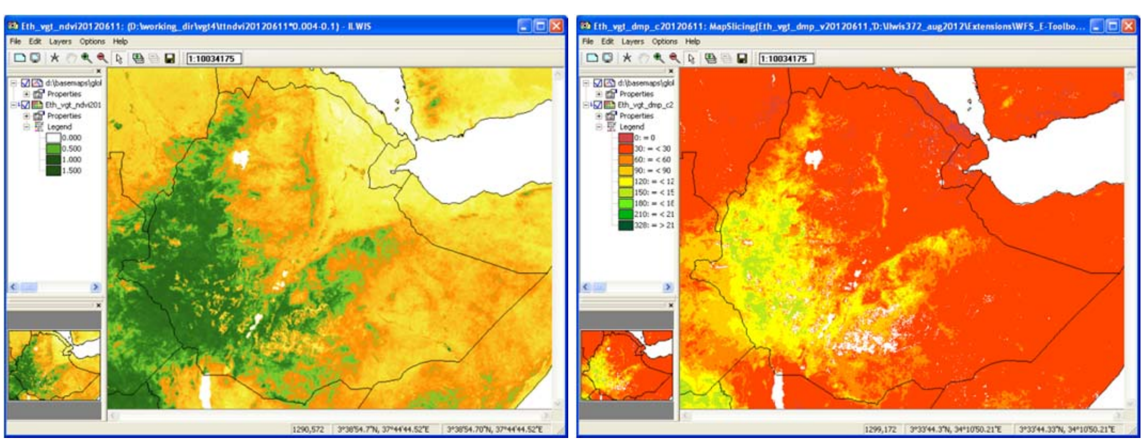
Africa is: *VGT4_eth_"abbreviation"import.bat*. Note that the abbreviation refers to the product names indicated in table 3.3.

Table 3.3: SPOT VGT Africa product details

Name product	**Abbreviation**	**Files created upon import (most file names end with: *yyyymmdekdek*)**	**Calibration coefficients used**
Burnt Area	BA	Eth_vgt_bayyyymmdd	number of years since 1980, followed by mmdd
Dry Matter Productivity	DMP	Eth_vgt_dmp_**v**yyyymmdekdek Eth_vgt_dmp_**c**yyyymmdekdek	* 0.01 Class map
Fraction of Surface covered by Vegetation	FCOVER	Eth_vgt_fcoveryyyymmdekdek	* 0.004
Leaf Area Index	LAI	Eth_vgt_laiyyyymmdekdek	* 0.033333333 * 0.005
Normalized Difference Vegetation Index	NDVI	Eth_vgt_ndviyyyymmdekdek Eth_vgt_ndviyyyymmdekdek_SM	*0.004-0.1 Bitwise encoded
Normalized Difference Water Index	NDWI	Eth_vgt_ndwiyyyymmdekdek	*0.008-1
Phenology Key Stages	PHENOKS	Eth_vgt_phhalfyyyymmdekdek Eth_vgt_phlengthyyyymmdekdek Eth_vgt_phstartyyyymmdekdek	number of dekads, since January 1st, 1980
Phenology Maximum NDVI	PHENOMAX	Eth_vgt_phmaxyyyymmdekdek Eth_vgt_phmaxvalyyyymmdekdek	number of dekads, since January 1st, 1980 *0.004-0.1
Small Water Bodies	SWB	Eth_vgt_swbyyyymmdekdek	Class map
Vegetation Productivity Indicator	VPI	Eth_vgt_vpi_**v**yyyymmdekdek Eth_vgt_vpi_**c**yyyymmdekdek	Value % Class map

A few examples of SPOT Vegetation products are provided in figure 3.10. Note that in chapter 3.2.8.5 another procedure is described to import, especially time series of a certain VGT product, using VGTExtract.

Figure 3.10 SPOT Vegetation NDVI (left) and Dry Matter Productivity (right)



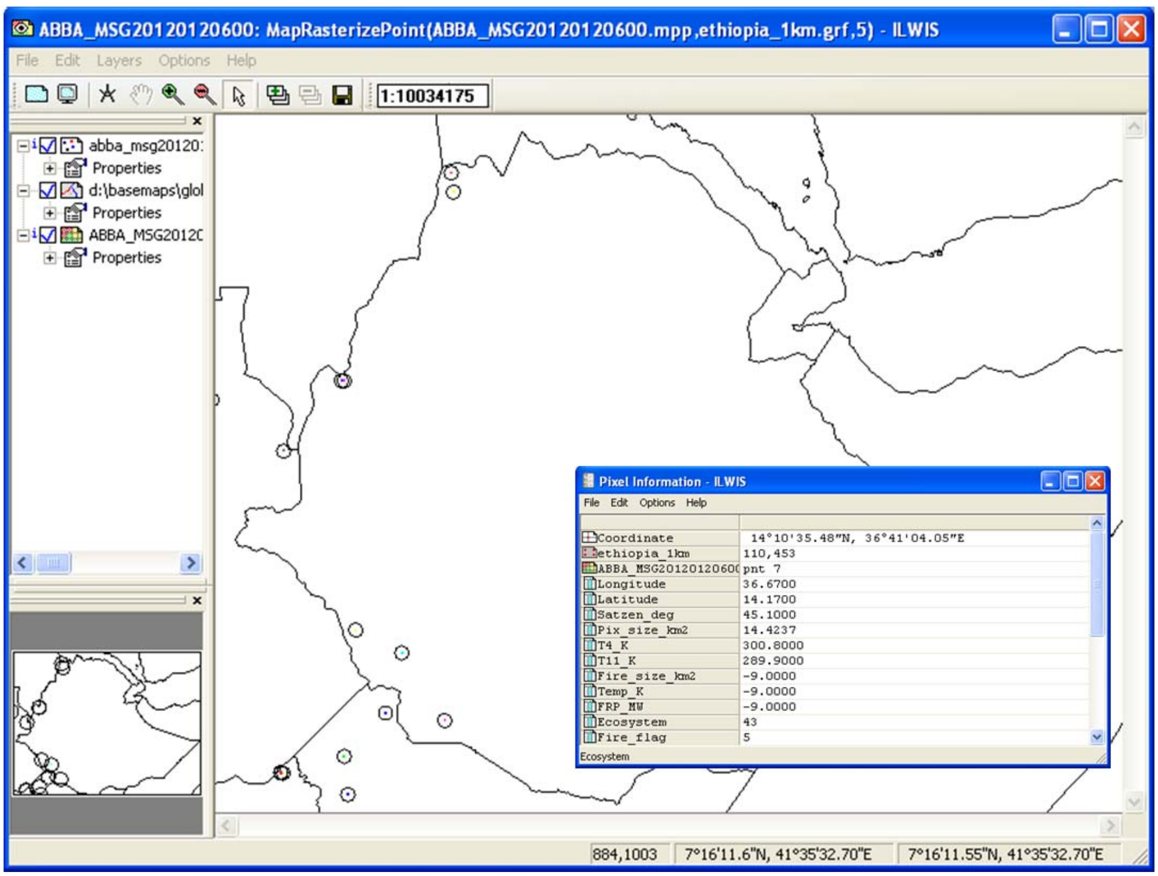
3.2.6.6 Other selected products

3.2.6.6.1 ABBA-MSG Fire Product

The Automated Biomass Burning Algorithm (ABBA) is using SEVIRI MSG, in full temporal resolution to capture active fires for the whole African continent. Further information of the processing routines is available at: http://cimss.ssec.wisc.edu/goes/burn/wfabba.html.

The input data directory is specified as "ABBA_MSG" and can be set using the options "Configuration" and "Folders". As input string a "yyyyjjjhhmm" timestamp is expected, note that "jjj" stand for Julian Day. After import of the file a point map is created and this map is resampled to the Ethiopian window. Both the raster map and point map can be displayed; additional information on the fires detected is stored in the attribute table. As example see figure 3.11.

Figure 3.11: ABBA-MSG fire product and associated attribute table



3.2.6.6.2 MODIS Aqua and Terra Fire product for a Julian Day

This is the most basic fire product in which active fires and other thermal anomalies, such as volcanoes, are identified using the Aqua and Terra instruments on the MODIS series of satellites. The product is covering an area of approximately 2340 by 2030 km in the across- and along-track directions, respectively (per file!).

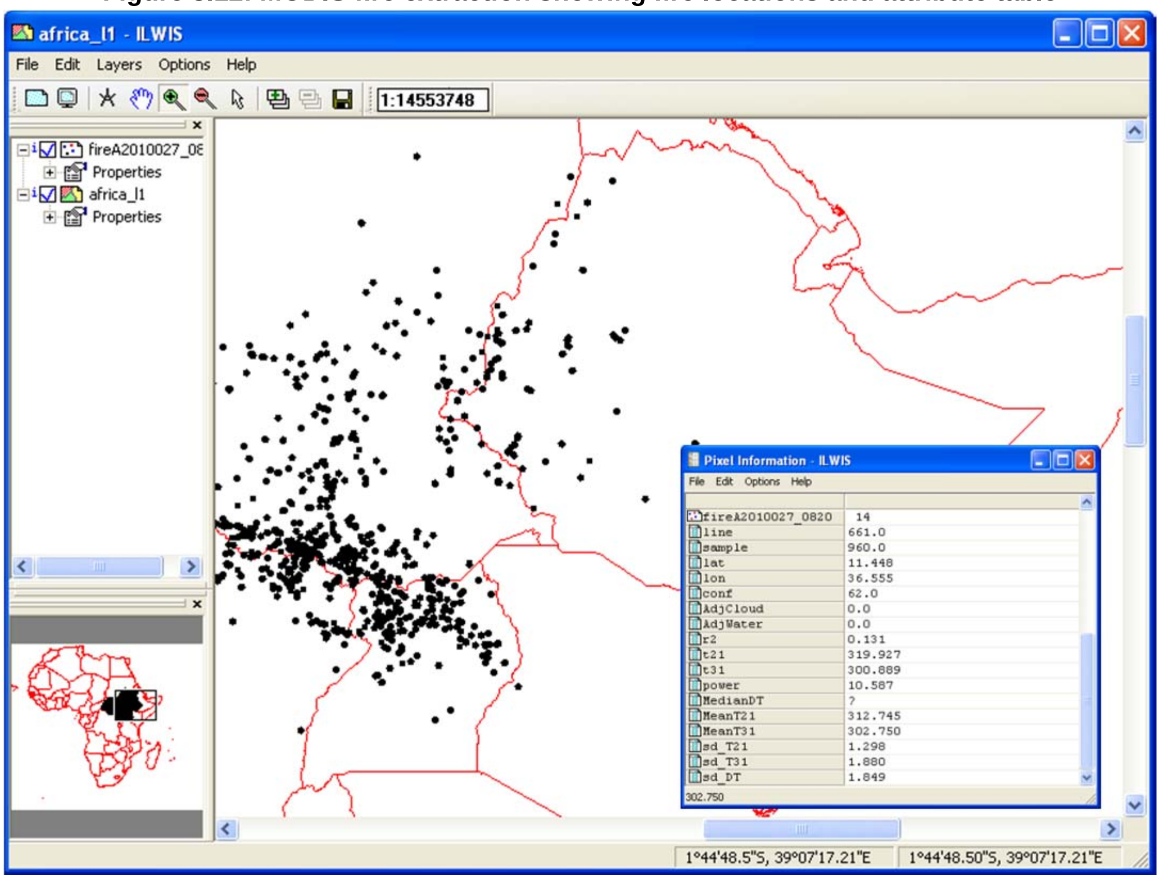
The imported files are accompanied by a fire-pixel table which provides radiometric and internal-algorithm information about each fire pixel detected within a granule (source:

http://navigator.eumetsat.int/). On a daily basis 270 files for the Aqua and Terra each, are disseminated. The import routine expects the year and Julian day number to be entered.

It is advised to first determine the overpass time of the instruments over the Region of Interest. This can be done by using a Satellite Orbit Tracking software package. See the appendices for freeware utilities available. Once a selection has been made of all the required files and copied into a dedicated input folder the routine retrieves all the files (using a looping procedure), if there are occurrences of fires, the information is extracted and a point file and associated table are created. These point files can be displayed over a map. An example is provided figure 3.12 showing MODIS fires displayed over a segment map of Africa, zooming in on Ethiopia.

From the main WFS-Ethiopia Toolbox menu, using the options "Configuration" and "Folders", under "MODIS-Fire" the input MODIS and output directories can be specified. The batch files used for the import of the MODIS fire product from Aqua and Terra all start with modis* and are situated in the ILWIS sub-directory \Extensions\WFS_E-Toolbox\toolbox_batchroutines.

Figure 3.12: MODIS fire extraction showing fire locations and attribute table



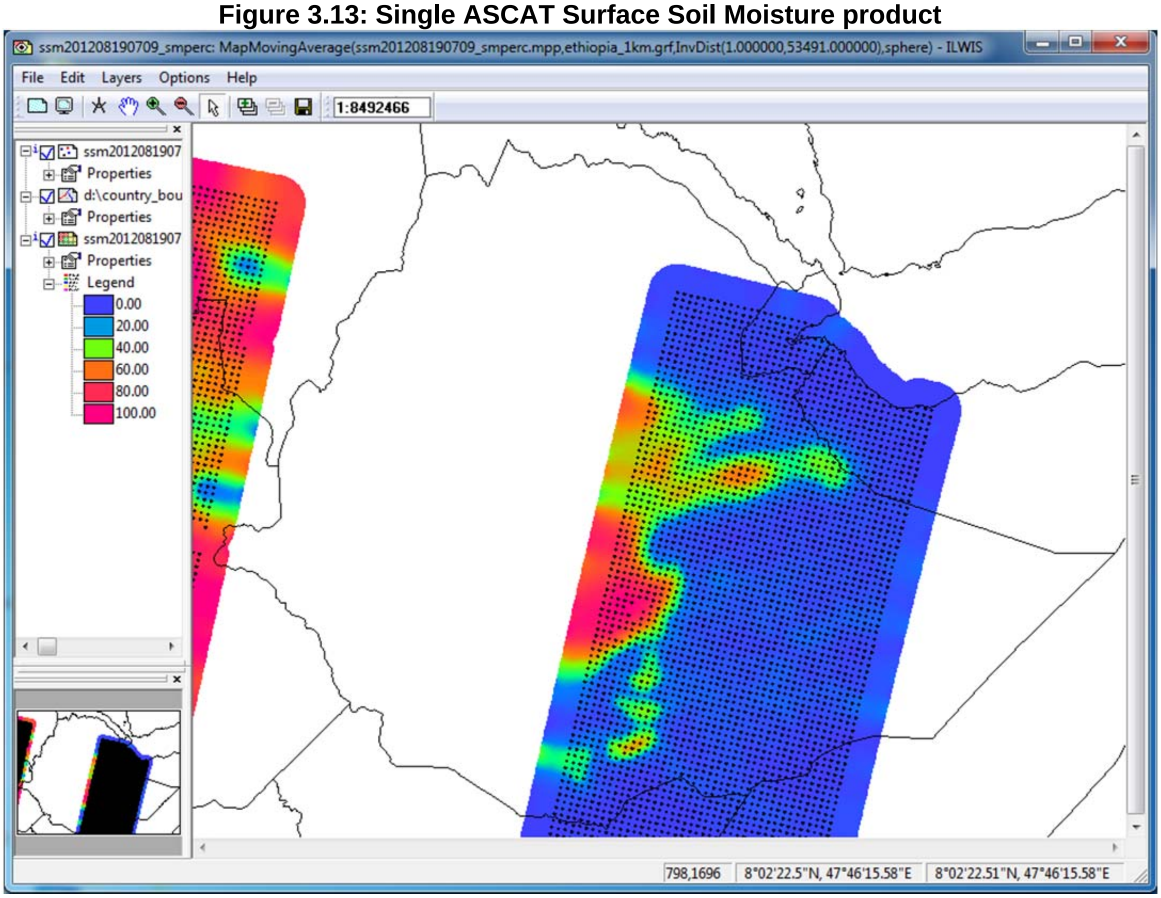
3.2.6.6.3 *ASCAT Surface Soil Moisture*

The METOP instrument is carrying various sensors. The products derived from the ASCAT instrument, the surface soil moisture and the ocean vector winds, are disseminated both via Ku and C band reception. For the Surface Soil Moisture product, with 12.5 km resolution, an import routine is available. For import of this product, next to the 12 digits time stamp (format=yyyymmddhhmm) also the orbit number is required. It is advised to check the raw data that is situated in the respective input directory to obtain the appropriate "Date" and "Orbit" stamp as it is related to the overpass time and orbit number. The link to this directory has to be specified in the main WFS-Ethiopia Toolbox menu, using the options “Configuration” and “Folders”, under “METOP-SSM”.

To select from the input directory the appropriate image for a specific region of interest, use can be made of Satellite Orbit Tracking freeware utilities (see Appendix 1 for some links). These utilities provide the possibility to retrieve the time of overpass of a given (polar) orbiting satellite. The filename convention for the METOP data indicates the start time of the recording; each file contains 3 minutes of observations.

Upon completion of the product import a point file and associated attribute table are created, the point map shows the surface soil moisture in percentage. An example is presented in figure 3.13, showing also the results of a moving average interpolation procedure.

Figure 3.13: Single ASCAT Surface Soil Moisture product



3.2.7 ***MDD Service***

The access to products contained within this service is restricted to National Meteorological Services and Partner Organizations. The Meteorological Data Dissemination (MDD) is a service primarily for the African members of the World Meteorological Organization (WMO). Members of the WMO coordinate the MDD content provision. It comprises observations, analyses and forecasts from major meteorological centres, including the Africa Limited Area Model Output (Africa LAM). There a four product types comprising the MDD service:

High Priority (within 15 minutes): MDD_1 (Nominal MDD) and MDD_2 (ACMAD)
Low Priority (within 2 hours): MDD_3 (Nominal MDD) and MDD_4 (ACMAD)

Within this version of the toolbox and based upon discussion with NMA attention was given to development of data retrieval procedures for the nominal MDD services, MDD_1 and MDD_3. First check if this service is activated for your EUMETCast-GEONETCast ground receiving station.

3.2.7.1 MDD-1 METAR and TAF

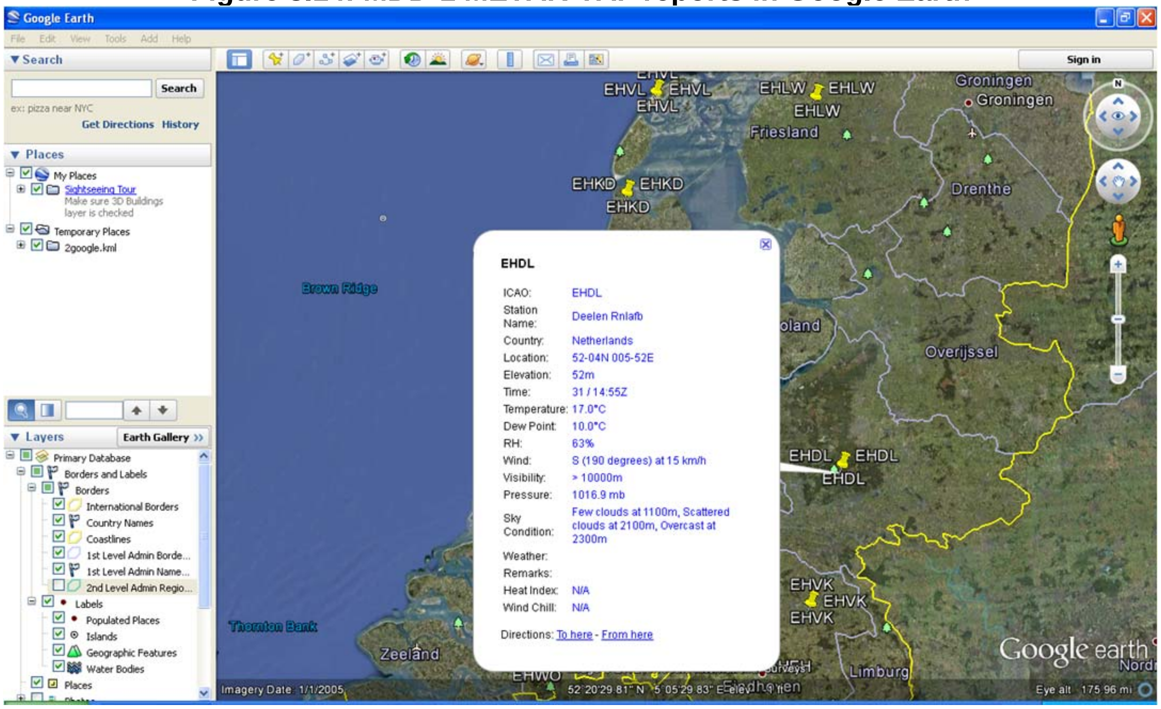
On a continuous basis MDD-1 files are disseminated. A single file contains multiple METAR and TAF messages. To extract only the messages for a specific country from a large collection of MDD-1 files the option “Create METAR-TAF for a country” has to be used. This operation filters all MDD-1 files in the input directory specified and extracts the messages only for the country specified. To operate the routine the 2 digit ICAO Location Indicator, specifying the country code (in capitals) has to be entered. Once the operation is completed an ascii file is created, called “metar_gts.txt” (by default). The information contained within the various MDD-1 messages for the selected country is now merged into this single output file and might contain several half hourly weather reports of the main airports situated within the country.

From the main WFS-Ethiopia Toolbox menu, using the options “Configuration” and “Folders”, under “METAR-TAF” the input MDD-1 and output directories can be specified and this is also the location where the “metar_gts.txt” will be stored. This file can be opened with a text editor. Note that at this moment for the TAF messages only the first part of the message is retrieved, forecasting information is not extracted.

This file can be used as input for the second routine: “Display METAR-TAF data” and press import. The freeware utility “MetarWeather” is appearing on your screen. From the menu, select “File” >> “Load METARs From File” and select the file “metar_gts.txt” and press “Open”. All messages now appear as a table; by double clicking on a record a METAR report form is shown. If all record in the table are selected (selected record turn blue), and the right mouse button is pressed, the context sensitive option “Save selected Items” and “Save as Type” “KML File – For Google Earth (*.kml)” can be selected, an appropriate output file name can be specified and the file can be saved.

Move to the output directory and double click with the mouse on the *.klm file created. Google Earth will start and zooms to the geographic extent covered by the kml file. A location displayed on the map can be selected and when clicking on a placemark the METAR report is shown. An example is presented in figure 3.14. Note that for the same location multiple METAR reports are available, each 30 minutes. For further details see also figure 1.2 which shows the MetarWeather table and report of the same MDD-1 files processed.

Figure 3.14: MDD-1 METAR-TAF reports in Google Earth



3.2.7.2 MDD-3

Also within the MDD-3 data stream on a continuous basis MDD-3 files are disseminated. A single file contains multiple GRIB formatted files. To extract only the relevant product from a large collection of MDD-3 files the option "Find Products in MDD messages" has to be used. This operation filters all MDD-3 files in the input directory specified and extracts the files which contain GRIB data for the product indicated. At this moment, based on wishes from the National Meteorological Organization (NMA) of Ethiopia a selected number of products can be processed, such as the Mean Sea Level Pressure, Geopotential Height at 500 hPa as well as winds (direction and speed) at different pressure levels.

From the main WFS-Ethiopia Toolbox menu, using the options "Configuration" and "Folders", under "MDD3" the input and output directories can be specified.

The codes expected for the routine "Find Products in MDD Messages" are for:

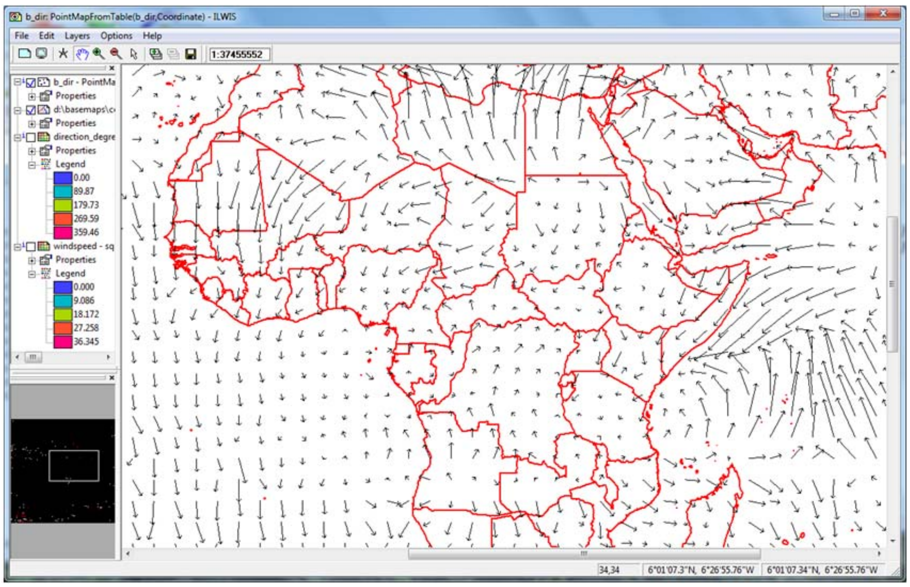
Mean Seal Level Pressure:	HPDA98		
Geopotential Height at 500 hPa:	HHDA50		
Winds at 200 hPa:	HUDA20	or	HVDA20
Winds at 500 hPa:	HUDA50	or	HVDA50
Winds at 700 hPa:	HUDA70	or	HVDA70
Winds at 850 hPa:	HUDA85	or	HVDA85

In the code example for the "Mean Sea Level Pressure" above note that "HP" is the code used for this product, "D" is the Area Designator (in this case from 0-90 N and 0-90 E, covering Ethiopia!), "A" indicates it is an analysis product and "98" is the pressure level. Further details are provided by ECMWF (http://www.ecmwf.int/products/additional/gts_headers.html). Note that for the wind products, in order to derive the wind direction and speed, both the u-wind ("HU") and v-wind ("VU") product are required.

Once the file which contains relevant product information is known, this file can be selected as input for the product retrieval routines. The individual windows are extracted (A, D, I, L) and merged into a single output file. The area covered is from 90 degree north to 90 degree south and from 90 degree west to 90 degree east. Note that the products have different spatial resolution, some are at 1 degree, others at 2.5 degree and there is a 1 degree Tropical Belt product, covering an area from 35 degree north to 35 degree south and from 90 west to 90 east. Here the respective area designators are E and H.

An example of the import of wind speed and wind direction (using 850 hPa U-wind and V-wind data) is given in figure 3.15.

Figure 3.15: MDD-3 import of winds product at 850 hPA



3.2.8 ***Other routines***

3.2.8.1 Display Julian Day Tables

As a number of products contained in the EUMETCast-GEONETCast data stream use the Julian Day convention two tables, one for normal and one for a leap year, can be retrieved under this menu option. Select the appropriate “Show Julian Day table” option, press “Import” and the conversion table from Julian to Calendar day is given. This table can be closed and the operation is stopped.

3.2.8.2 Generic LEAP import – export

To ensure compatibility with the LEAP software data format routines are available to import and export data from ILWIS to LEAP and vice versa. This routine has to be elaborated upon further.

3.2.8.3 Generic GeoTif import

To conveniently import some of the data in Geotif format this routine allows you to quickly transform the data format from TIF into ILWIS.

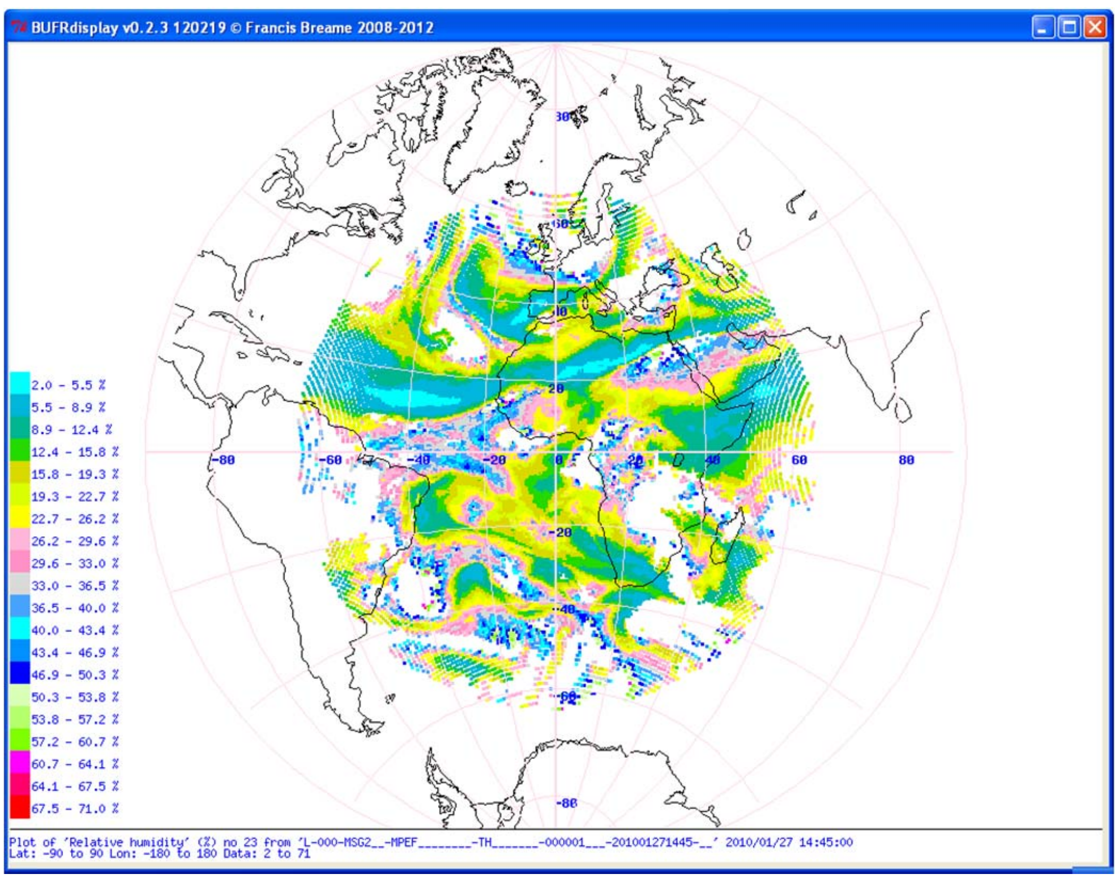
3.2.8.4 Generic BUFR data visualization

To visualize the various BUFR formatted products that are available in the EUMETCast-GEONETCast data stream you need to install the BUFRdisplay utility. See for installation instructions also chapter 1.1.6. From the main WFS-Ethiopia Toolbox menu, using the options “Configuration” and “Folders”, select “Bufrdisplay”. Browse to the appropriate data output directory. And press “Save” to store the settings. Note that Bufrdisplay is storing some temporary program files in the output directory, so ensure that you have the proper administration rights.

From the “WFS-E” and “Toolbox” main menu select the option “Other Routines” >> “Generic BUFR data Visualization” and “Show BUFR data using BUFRdisplay” sub menu items and if the output directory is properly assigned, press “Import”. In the Command Line Interpreter (CMD.exe) window, acknowledge the copyright of Francis Breame by pressing <enter> and the BUFRdisplay utility is opened. From the BUFRdisplay window select “File” and “Open”, navigate to the input data folder and select the appropriate file and press “Open”. Under the “Data Selection” window the required attributes need to be specified, like latitude, longitude and the data field. Once this is done activate the option “Input/decode data” and subsequently “Generate map”.

An example of a map showing the Tropospheric Humidity, in a stereographic projection is given in figure 3.16. Note that this utility is only used for visualization of (multiple) BUFR encoded products. Other routines within the toolbox can be used to convert the selected files into ILWIS data format.

Figure 3.16: Display of BUFR encoded data using BUFRDisplay



3.2.8.5 *Import VGT products Ethiopia*

To import time series of VGT product into ILWIS format, applying the product scaling and offset and extract the Ethiopian window only this routine can be used. It calls VGTExtract, copies the (product) configuration files into the relevant VGTExtract directories and when selecting your input and output directories and the “Product Settings” all VGT products are processed in a looping procedure. This is a very efficient way to import a large number of events for a single product. Note that you have to specify the relevant “Product Setting” for a given product before you “Start” the import routine.

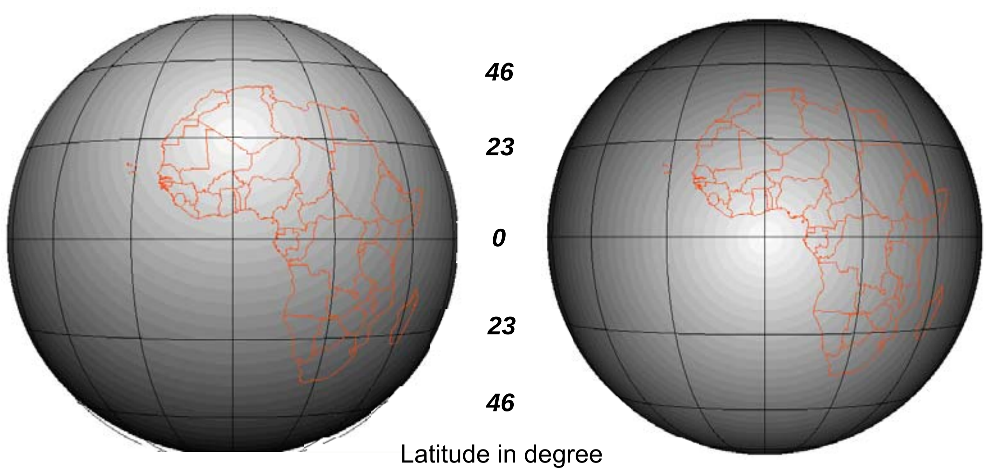
3.2.8.6 *Calculate MSG angles*

For many applications corrections to the pixels have to be applied based on satellite or sun azimuth and zenith angles. A Java applet has been created which allows computation of MSG satellite and sun azimuth and zenith angles based on date and time. This routine is called by an ILWIS script that allows the user to calculate the solar and MSG satellite solar / zenith angles for a certain time for the MSG field of view using a simple user interface. Note that the minutes are expressed in decimals, e.g. 30 minutes is 0.5.

This utility is using ILWIS scripts which are situated in the ILWIS sub-directory \Extensions\WFS_E-Toolbox\toolbox_startscript\angle. For the solar zenith angles also the sun elevation is calculated and the illumination conditions, as defined using thresholds from Meteo-France. The content of the scripts can be seen using ILWIS, using the Navigator option and move to the respective sub-directory. To open a script, double click the script using the left mouse button.

Once the Year, Month, Day and Time of day (in UTC) and output directory are specified the script can be started by pressing the “Create” button.

Figure 3.17: Example of Sun (for 21 June 2006, 12.00 UTC) and MSG satellite zenith angles (for 0°N latitude and 0°E longitude, left and right hand picture respectively)



3.2.9 ***Configuration and folder settings***

For you to conveniently work with the GEONETCast toolbox the data sources (on your local area network) and the local system output (working) directories need to be defined. From the main Water and Food Security-Ethiopia Toolbox menu, select “Configuration” and the sub-menu

"Folders". Further details have already been described in chapter 2.4. It is important to note that a "Folders" item can be set in the "config.xml", using the "folderid" option.

In general the input and output folders are set over here and are subsequently used in the various import routines to pre-set the input and output folders over there. This prevents the need to specify the folder specifications time and again! Note that external executables can be defined, using the folder "Special locations".

3.3 CONCLUDING REMARKS

The description provided is showing the capabilities of the various routines that are currently implemented under the WFS-Ethiopia Toolbox config XML version 1.0.

In case products or data is disseminated for which no import routines are available in this toolbox, chapter 2 is providing the necessary background information to add additional routines yourself. When you need assistance in building these scripts and batch routines don't hesitate to contact the corresponding author.

Chapter 4 contains a number of exercises that demonstrate the use of the data disseminated through GEONETCast. The Water and Food Security-Ethiopia Toolbox supports a number of import routines that have been selected as being most relevant. Other toolbox plug-ins can also be used if required. These can be obtained from http://52north.org, follow the tab provided under "Downloads", "Earth Observation". More information is also provided on the "EO" community pages (http://52north.org/communities/earth-observation/).

Appendix 1 is providing links to other freeware utilities that can be used in conjunction with ILWIS. Having an operational ground receiving station, together with these utilities, allows you to process a multitude of environmental information, delivered near real time and free of charge. You can also register for licensed services like AVISO at the EUMETSAT Earth Observation Portal.

Note that Appendix 2 is providing a description of how the sample and exercise data should be copied to / stored on your local system. Note that the sample and exercise data can also be downloaded from: ftp://ftp.itc.nl/pub/52n. Appendix 3 is providing further information to configure the data source(s) for the MSG Data Retriever. Appendix 4 provides additional information on the other freeware tools that can be downloaded from the "Earth Observation" community. In Appendix 5 some links are provided to other instruction and capacity building materials which have been developed over time and can be downloaded as well.

With all these free tools, utilities, manuals and sample data available new users should be able to become acquainted with the information currently delivered through satellite based communication systems as well as freely available relevant information which can be retrieved from internet resources.

This chapter provided further details on the capabilities and functionality of the Water and Food Security-Ethiopia Toolbox. The next chapter is focussing more on the use of the data, ensure that before you continue you download or copy the sample data to your local system (see also appendix 2 for further details). It is strongly advised to copy the directories directly on your system drive, don't hide it under a complex (sub-) directory structure as you will need to inspect the sub-directories containing the various data sources on a frequent basis!

4. EXERCISES USING DATA FROM GEONETCAST, APPLYING ILWIS AND THE WFS-ETHIOPIA TOOLBOX

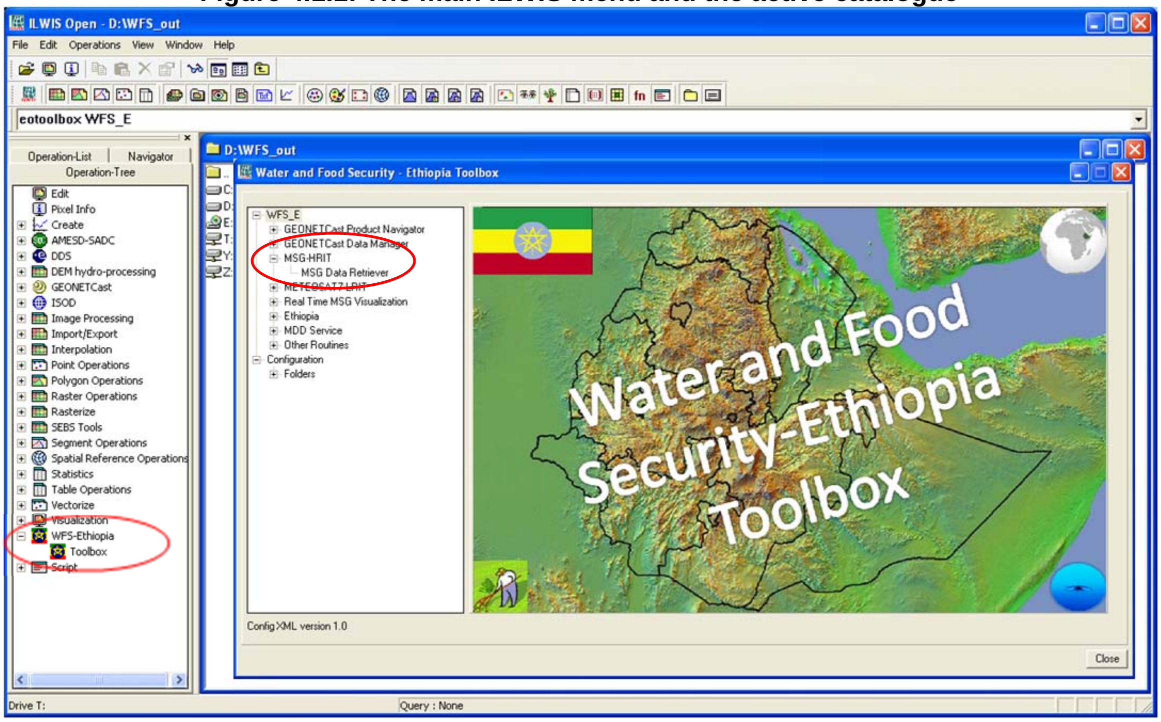
4.1 IMPORT AND VISUALIZATION OF DATA FROM MSG, METEOSAT-7 AND METOP.

Download the sample data directory obtained from the ITC FTP site (ftp://ftp.itc.nl/pub/52n/gnc_wfs/) to your hard disk or copy them from the DVD(s). Preferably use the sub-directory structure as indicated in Appendix 2. Copy the folder "*WFS_out*" on your D:\ drive. In case you are not familiar with ILWIS and want to practice some before you continue with these exercises, download from ftp://ftp.itc.nl/pub/52n/intro_exercises the exercise descriptions and exercise data, unzip the files and conduct the exercises as instructed. Here it is assumed that you have a basic Remote Sensing and GIS background.

4.1.1 *Data import and visualization from Meteosat Second Generation (MSG).*

Open ILWIS and use the Navigator to select the working directory. See also the ellipse indicated in the figure below pointing to the main menu items that will be used during this exercise. Note that in this figure the active working directory is "*D:\WFS_out*". Some ancillary files needed during the exercises are already located in this directory. Close ILWIS and open ILWIS again. It should now open in your working directory (D:\WFS_out). Please read once more (and adhere to) the golden rules when working with ILWIS as given in chapter 1.1.1.

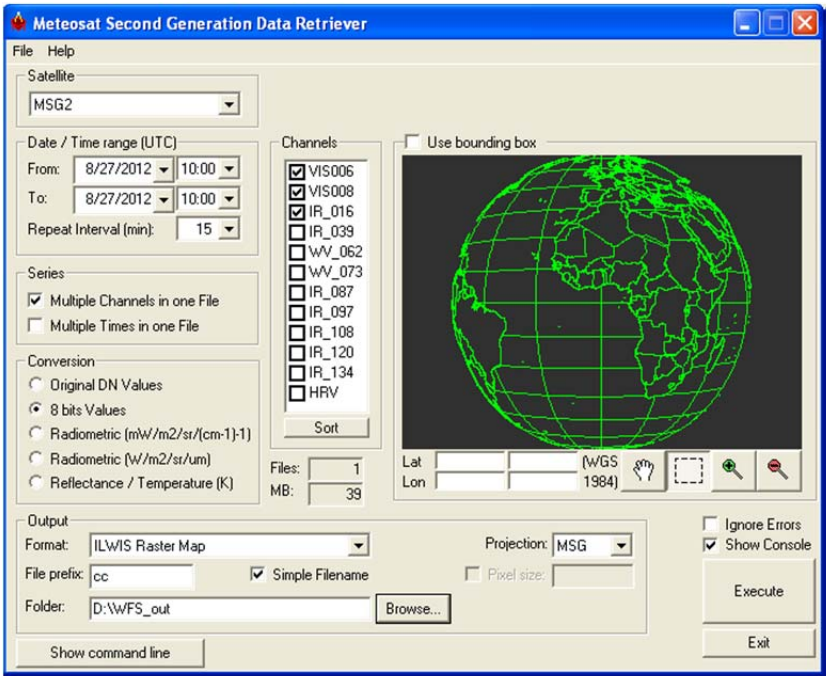
Figure 4.1.1: The main ILWIS menu and the active catalogue



In order to import data from MSG open the "*WFS-Ethiopia"* and *"Toolbox*" tabs from the main-menu and select "*MSG-HRIT*" and "*MSG Data Retriever*". The so-called MSG Data Retriever window will be activated which can be used to import the data recorded by MSG (currently MSG 8 and 9, MSG 10 will be added when declared operational). Specify the settings as indicated in figure 4.1.2, to import the 10:00 UTC image.

If you did not configure the "*Data Sources*" of the MSG Data Retriever consult chapter 2.5 as well as Appendix 3.

Figure 4.1.2: Selection and import of MSG channels using the Data Retriever

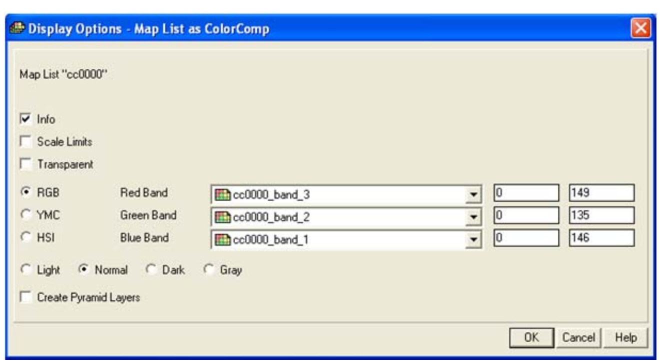


Note the following from these import settings: the "*Satellite*" selected is MSG2, which refers to Meteosat Second Generation – 9. The "*Date / Time Range*" is 8/27/2012 and 10:00 UTC respectively. The three channels that have been selected are often used to generate a Daytime Standard Colour Scheme composite. The multiple imported channels, converted to 8 bits, are stored as "*Multiple Channels in one File*" with a "*File Prefix*" cc and the option "*Simple Filename*" is activated. As output format an ILWIS Raster Map is selected and the appropriate "*Folder*" is selected to store the output data generated. The "*Projection*" MSG allows you to look at the data from a geostationary perspective and in this case the whole disk as recorded by MSG is selected.

After you have specified the appropriate settings, press "*Execute*" to conduct the import. Close the WFS-Ethiopia Toolbox window, note that in the tray bar the Meteosat Second Generation Data Retriever is still active, keep it as such as you will need during the next set of exercises.

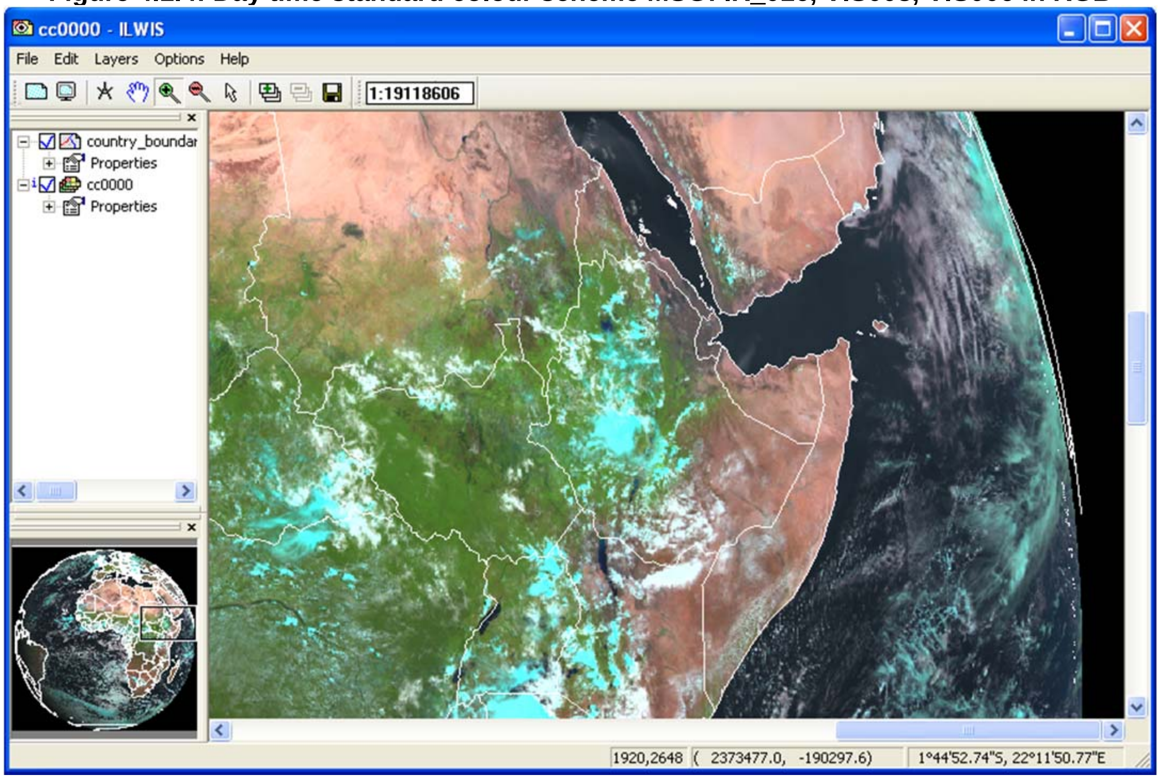
Upon completion of the import, select from the ILWIS main menu, the option "*Window*" and from the drop down menu "*Refresh F5*". To display the image double click the map list icon "*cc0000*" and in the Map List "cc0000" menu select the "*Open as ColorComposite*" option. Display the bands according to the assignment in the figure 4.1.3 below.

Figure 4.1.3: Band assignment for visualization



Note that using the "*Simple Filename*" option during import band_1 now represents VIS006, band_2 is VIS008 and band_3 is the IR_016 channel (see also figure 4.1.2). The default stretch function for each of the channels can be used and press "OK" to show the image. Figure 4.1.4 is showing a portion of the MSG disk over the Horn of Africa, using a similar colour assignment, for 8/27/2012 at 10:00 UTC. Note your local time!

Figure 4.1.4: Day time standard colour scheme MSG: IR_016, VIS008, VIS006 in RGB

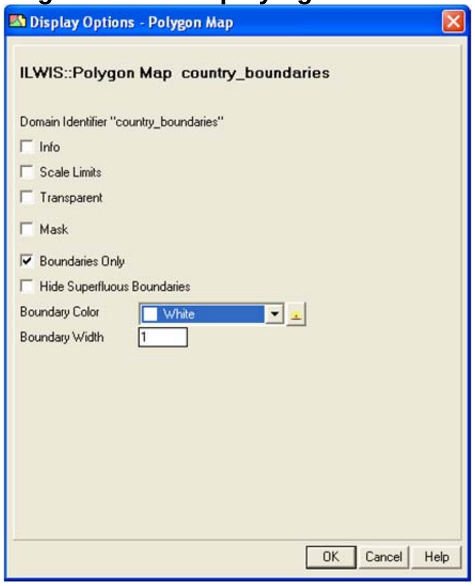


Check the features on the image, e.g. the water, (bare) land – vegetated surfaces and (various) clouds. Add to this image view also the country boundaries. In order to do so, select from the active map display window menu, the option "*Layers*", and "*Add Layer*", select an available segment or polygon map layer, e.g. "c*ountry_boundaries*". Note that when displaying a Polygon map, set the "*info*" option off, and to display only the boundaries, activate the option "*Boundaries Only*", you can also specify the "*Boundary Color*", select a white colour. See also figure 4.1.5.

With the vector layer active you can zoom to your area of interest, check the colour composite. Activate the "*Normal*" option from the active map display window. When you move the mouse cursor over the image and simultaneously press the left mouse button you can also see the values (note the unit: 8 bits values, see also the "*Conversion*" option as of figure 4.1.2) for RGB respectively.

Close all active layers when you have finished browsing through the colour composite.

Figure 4.1.5: Displaying vector data



Further online information about MSG can be obtained from:

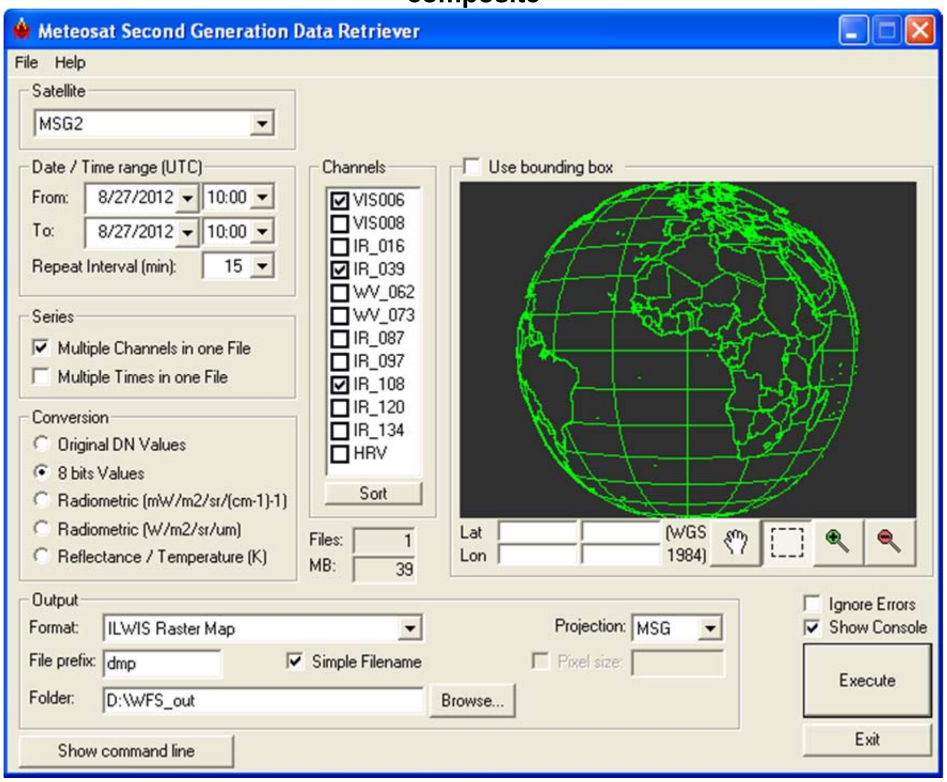
J. Schmetz, P. Pili, S Tjemkes, D. Just, J. Kerkmann, S. Rota, and A. Ratier (2002): An introduction to Meteosat Second Generation (MSG), available at:
http://journals.ametsoc.org/doi/pdf/10.1175/1520-0477%282002%29083%3C0977%3AAITMSG%3E2.3.CO%3B2

J. Schmid: The SEVIRI Instrument, available at:
http://www.eumetsat.int/groups/ops/documents/document/pdf_ten_msg_seviri_instrument.pdf

4.1.2 *Construct a Daytime Microphysical (DMP) Colour Scheme composite*

Activate once more the “*Meteosat Second Generation Data Retriever*”. Now specify for the “*Date / Time range UTC*” the same date as used for the previous exercise. The other settings are indicated in figure 4.1.6.

Figure 4.1.6: Import settings to construct Daytime Microphysical Colour Scheme composite



Upon completion of the import, select from the ILWIS main menu, the option “*Window*” and from the drop down menu “*Refresh F5*”. To display the new map list created, double click the map list called “*dmp0000*”, display band 1 (VIS006) as Red, band 2 (IR_039) as Green and Band 3 (IR_108) as Blue, use the default stretch options. Also display the country boundaries (info off and boundaries only) and zoom in as well. Figure 4.1.7 is showing this visualization (for the 10:00 UTC – part of MGS disk) of this MSG channel combination.

Note that this band combination can be used to determine in a qualitative manner some of the cloud properties. The VIS006 can be used to derive information about the optical thickness and the amount of cloud water and ice of the clouds, IR_039 can be used to get an idea of the particle size and the phase of the clouds (e.g. consisting of water vapour, small ice, large ice) and the IR_108 channel records the cloud top temperature.

Table 4.1 is showing the daytime convective development stages (I to IV) of clouds and the associated colouration that can be observed on a colour composite. When using this colour scheme for the respective MSG channels, note that an increasing Red colour contribution is an indication of larger visible reflectance; an increased Green colour contribution indicates smaller cloud top particles and with an increased Blue colour contribution the cloud tops are warmer.

Figure 4.1.7: Day Time Microphysical Colour Scheme, VIS006, IR_039 and IR_108 in RGB

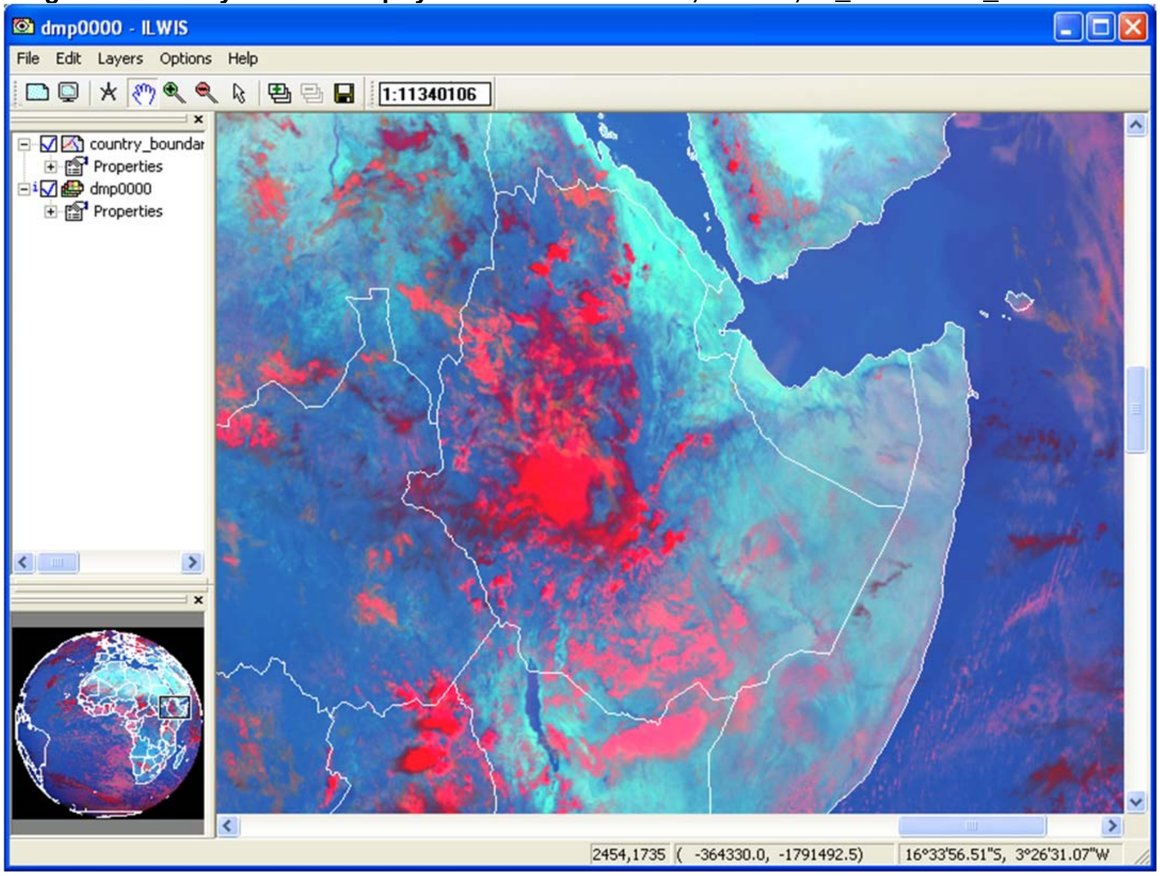
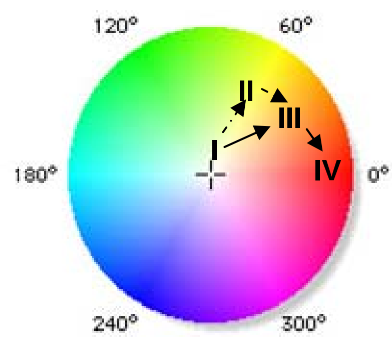


Table 4.1: Typical daytime convective development of clouds and related colour scheme

<table>
<tr><th></th><th>VIS006 (Red)</th><th>NIR016</th><th>IR_039 (Green)</th><th>IR_108 (Blue)</th><td rowspan="5">

Related colour scheme for various stages of convective development

Cb = Cumulonimbus</td></tr>
<tr><td>I. Very early stage
(low, warm water cloud)</td><td>White
opt thick</td><td>White
water</td><td>White
water</td><td>Light Grey
warm</td></tr>
<tr><td>II. First convection
(first convective towers)</td><td>White
opt thick</td><td>White
super cooled water</td><td>White
super cooled water</td><td>Dark Grey
cold</td></tr>
<tr><td>III. First icing
(transformation into Cb)</td><td>White
opt thick</td><td>Light Grey
small ice</td><td>Grey
small ice</td><td>Black
very cold</td></tr>
<tr><td>IV. Large icing
(Cb anvils)</td><td>White
opt thick</td><td>Dark Grey
large ice</td><td>Black
large ice</td><td>Black
very cold</td></tr>
</table>

Interaction of the solar radiation with clouds is presented in figures 4.1.8 and 4.1.9 for the various parts of the Electromagnetic Spectrum (EM). Figure 4.1.8 shows that at 1.6 μm (NIR) much more solar radiation is absorbed by the clouds than in the visible (VIS) part of the EM, ice absorbs even more strongly than water in the NIR. At 3.9 μm even more solar radiation is absorbed and here also ice is a stronger absorber compared to water. Figure 4.1.9 indicates the changes in reflectivity of snow clouds in the VIS and NIR part of the EM.

Figure 4.1.8: Absorption of water and ice by clouds for the various MSG channels (from: Daniel Rosenfeld, The Hebrew University of Jerusalem, HUJ)

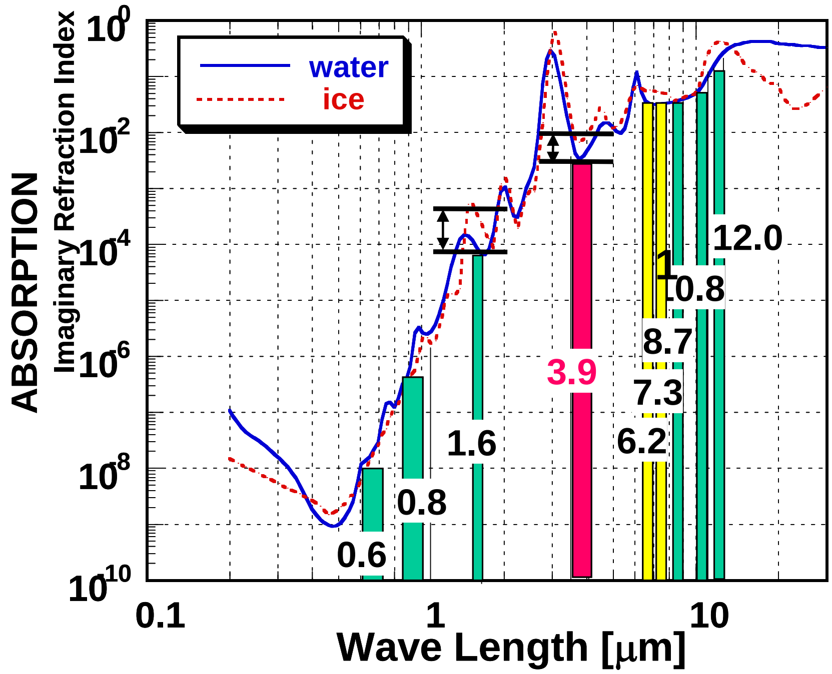
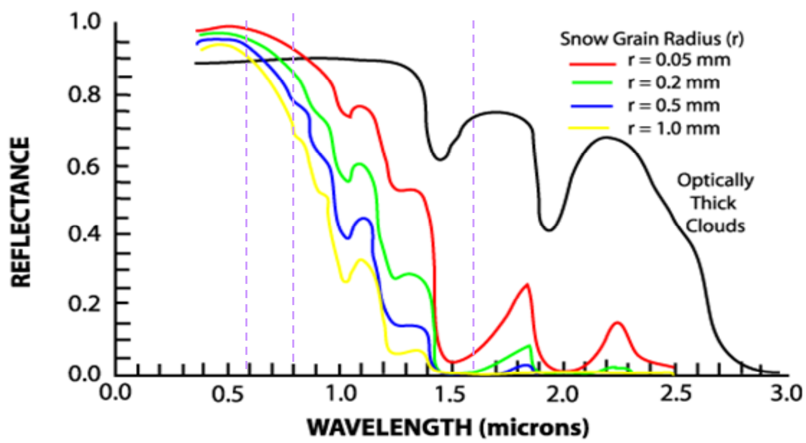


Figure 4.1.9: Different reflectivity of snow clouds at 0.6, 0.8 and 1.6 microns (from Rob Roebeling: Royal Netherlands Meteorological Institute, KNMI)

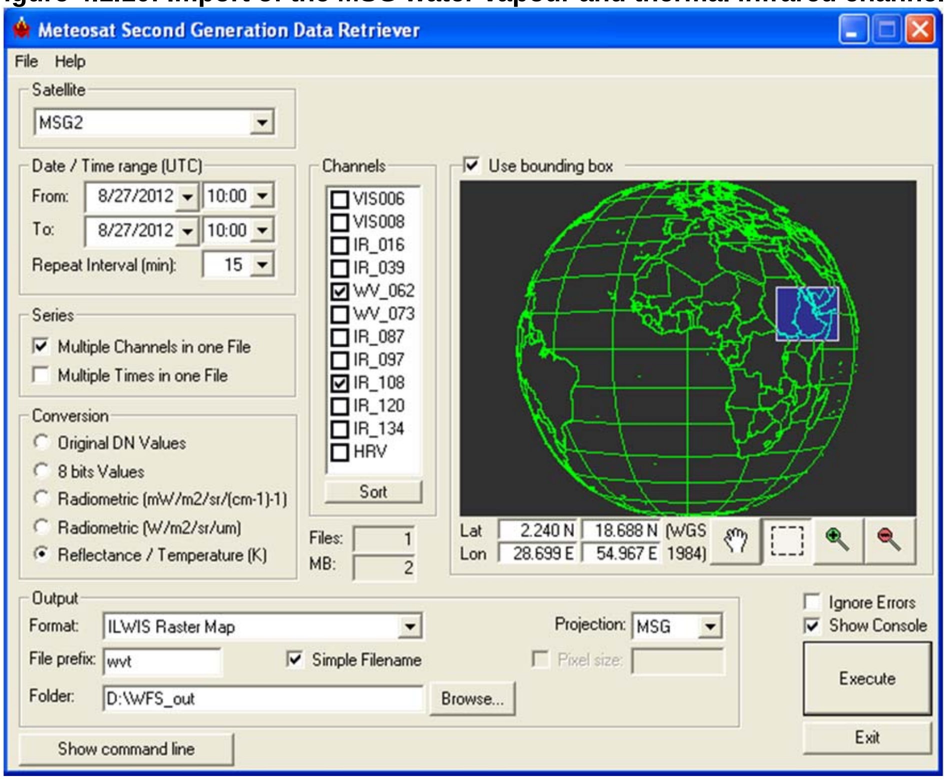


Explain using figures 4.1.8 and 4.1.9 why a daytime standard colour scheme (displayed as a colour composite, using as band assignments: IR_016, VIS008 and VIS006 in RGB) snow and ice clouds will have a cyan appearance and water clouds will be white (see also figure 4.1.4).

4.1.3 *The MSG water vapour (WV_062) and the Thermal (IR_108) channels*

MSG is recording the Visible to the Infrared region of the electromagnetic spectrum into a number of discrete channels. Import the WV_062 and the IR_108 channels for the same date / time as for the previous exercises and specify the other import options according to the specification given in figure 4.1.10.

Figure 4.1.10: Import of the MSG water vapour and thermal infrared channels



Note that the "*Conversion*" option used now is converting the WV and IR channels to Top of Atmosphere (TOA) brightness temperatures. The data is now converted to Kelvin; note the offset with Celsius of approximately 273. Also the window over Ethiopia has been added to select only a dedicated area. After the import is completed, refresh the catalogue, press with the left mouse button on the catalogue and press F5.

Display the imported image; from the ILWIS catalogue select the imported water vapour channel raster layer directly by double clicking on the file: "*wvt0000_band_1*", using as Representation "*Inverse*", and use default stretch values (note the minimum and maximum units of this image). Also put a vector layer showing the country boundaries on top (info off, boundaries only and boundary colour in red). The image should be comparable with the left image of figure 4.1.11.

Check the values of the image and also check the patterns. What can you observe? Do you see any features from the Earth surface on this water vapour image? What do the white toned areas represent (note also the Representation used)?

Also display the image "*wvt0000_band_2*" using an "*Inverse*" Representation. This is the thermal IR image and add also the country boundaries, in an identical manner as done for the previous image. The IR_108 image is also given in figure 4.1.11 on the right side. Also compare the values of this image and note especially the differences between the clouded (the bright white toned pixels on both images) and the non-clouded areas, like those over the eastern part of the Horn of Africa.

Figure 4.1.11: Imported WV channel (left) and TIR channel (right) for the same timestamp

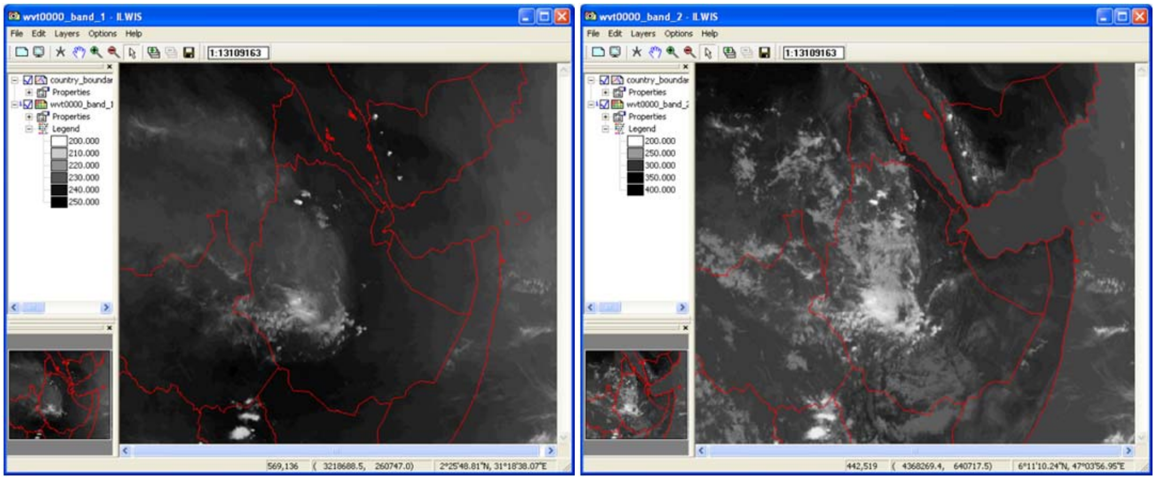
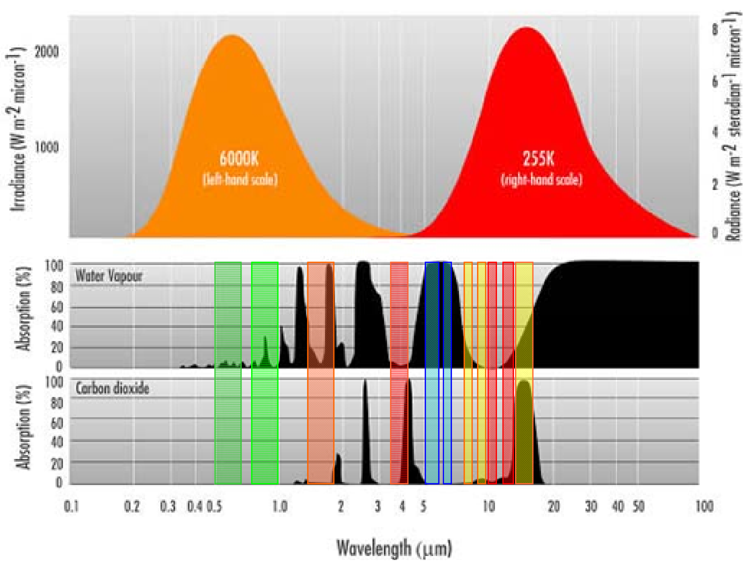
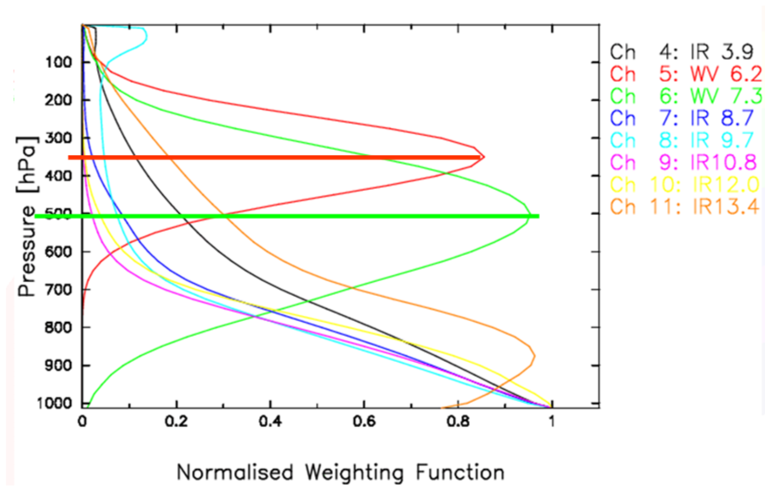


Figure 4.1.12: Irradiance and absorption for the various MSG channels (from: Rob Roebeling, Royal Netherlands Meteorological Institute, KNMI)



Note from figure 4.1.12 that the Water Vapour channels are strongly affected by absorption of the water vapour in the lower troposphere and therefore all radiation from the Earth itself is absorbed. The channels record the radiation that is emitted from certain layers within the troposphere. Therefore the water vapour channels are indicative of the water vapour content in the upper part of the troposphere. The maximum signal from WV_062 is at 350 hPa, and for WV_073 at 500 hPa (assuming normal pressure at sea level approximate elevation is at 8980 m and 5965 m amsl respectively), see also figure 4.1.13. If there would be no water vapour in the troposphere, radiation from far below can reach the satellite (source: Veronika Zwatz-Meise, ZAMG, available at: http://oiswww.eumetsat.org/WEBOPS/msg_interpretation/PowerPoints/Channels/WVguide.ppt#283,1,Introduction into the Absorption Channels). The IR_108 channel has its maximum contribution from the ground surface. Note the effect of the carbon dioxide absorption in the IR_134 channel.

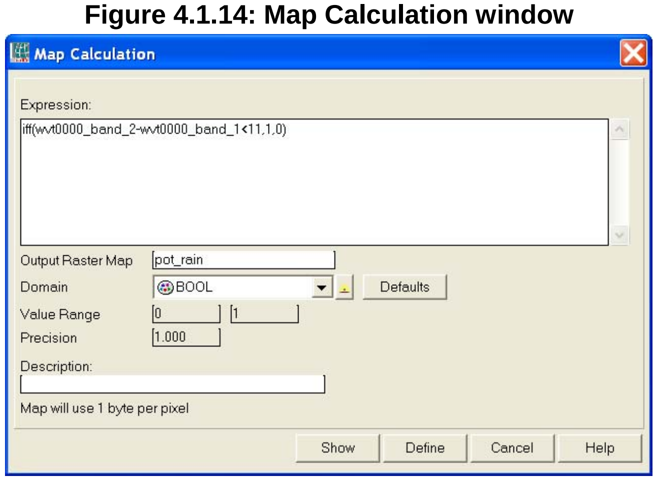
Figure 4.1.13: Contributions to Water Vapour and IR channels



The thermal channel records the emitted energy from the Earth surface itself. Based on a classification using MSG channel 108 and 062, applying a threshold on the temperature difference of less than 11 Kelvin (an empirically determined threshold by Kidder, et al, 2005) an approximation of the clouds that have a high likelihood of precipitation can be obtained (see also: Kidder, S., Kankiewicz, J.A., Eis, K. (2005): Meteosat Second Generation cloud algorithms for use in AFWA. In: BACIMO 2005, Monterey, CA.).

To calculate the potential precipitating clouds select from the ILWIS main menu the option "*Raster Operations*" and from the drop down menu "*Map Calculation*". Type the indicated algorithm as indicated in figure 4.1.14 in the Expression window, specify an output map, select as Domain "*Bool*" and execute the command by pressing "*Show*".

Figure 4.1.14: Map Calculation window



Display the map "*pot_rain*" calculated, for the "*True Color*" select "*Blue*" and for the "*False Color*" select "*White*". Also add the country boundary layer, using the options, no info, boundaries only and as boundary colour black.

Open in a new map window the map list showing the Daytime Microphysical Colour Scheme (dmp0000) and display band 1 (VIS006) as Red, band 2 (IR_039) as Green and Band 3 (IR_108) as Blue, use the default stretch options. Zoom in to cover approximately the same area. When you compare both maps what can you conclude?

4.1.4 *Multi temporal data import, processing and analysis*

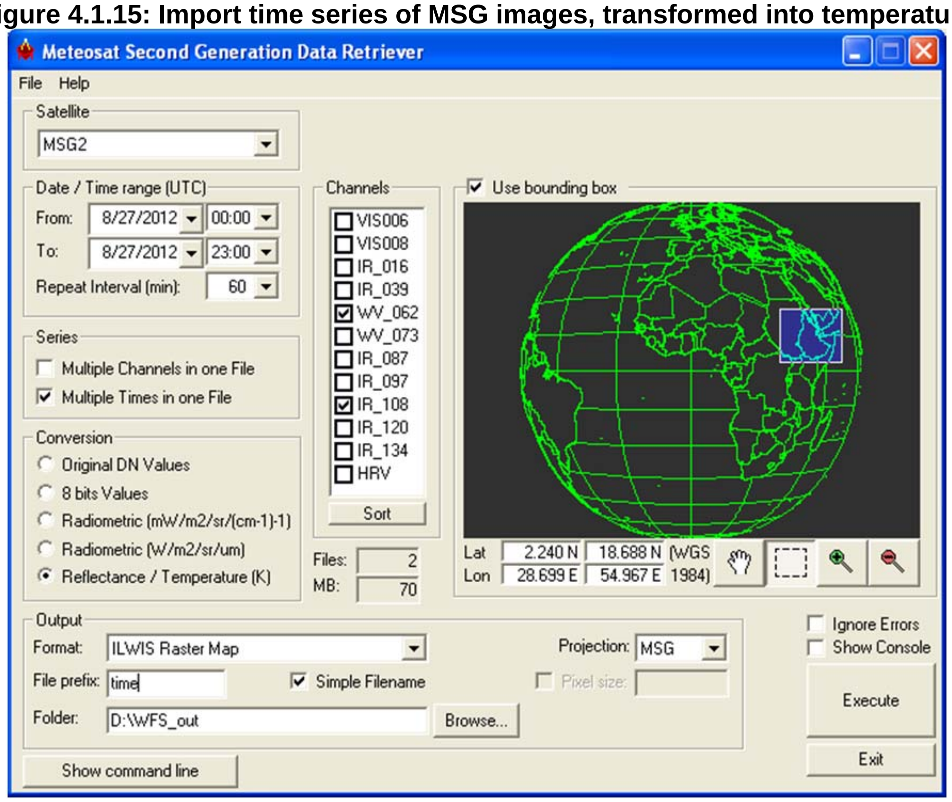
Within ILWIS 3.7.2 additional tools are at your disposal to perform dedicated analysis using time series of e.g. Meteosat-9 data. To deal with multi temporal image files ILWIS utilizes the concept of a map list, identical to the way a colour composite is handled. This list provides the temporal reference to a sequence of individual files in a time series. An algorithm can be entered through the command line and is executed for all of the maps in the map list. This map list can be created if in the Data Retriever the option: "*multiple times in one file*" is selected to create the co-registered image stack.

The map list can be visualized using an animation, by right clicking the map list icon, Visualization / as Slide Show; the user can define the image refresh rate and select a suitable colour representation and stretch in the Display Options.

Most of the regular Map calculation statements can be applied to map lists as well, making this a very powerful tool for time series data analysis.

In order to import a time series of data from MSG open the "*WFS-Ethiopia"* and *"Toolbox*" tabs from the main-menu and select "*MSG-HRIT*" and "*MSG Data Retriever*". You are now going to import the same bands as used during the previous exercise, but now an image for each hour. Specify the import settings as given in the figure below and execute the import. Given the time needed for import otherwise, here a subset of the field of view is selected; also try to select a subset, covering e.g. the Horn of Africa region. Note the "*Date / Time Range*" and "*Repeat Interval*" settings!

Figure 4.1.15: Import time series of MSG images, transformed into temperature



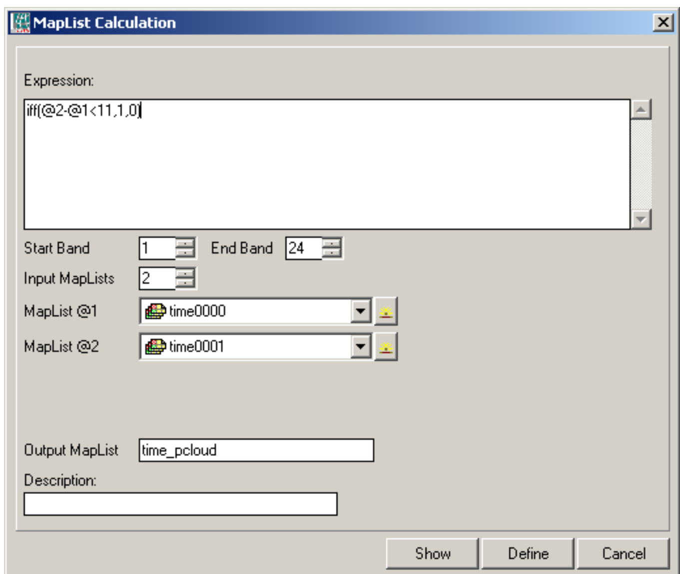
Upon completion of the import, select from the ILWIS main menu, the option "*Window*" and from the drop down menu "*Refresh F5*". To display the map list as an animated sequence double click the map list icon "*time0000*" and in the Map List "*time0000*" menu select the "*Open as SlideShow*" option. Use as Representation "*Inverse*", the other display options can be kept default, press "*OK*" twice. Note that the map list is containing 24 maps; each map represents one hour starting from 08/27/2012 at 00:00hr to 23:00hr. Furthermore, note that the map list "*time0000*" represents the WV_062 channel and the map list "*time0001*" represents the IR_108 channel.

Press the left mouse button over the active map window to see the values of the image, note that you look here at the temperature (unit in Kelvin). Also put a vector layer showing the country boundaries on top (info off, boundaries only and boundary colour in red).

Also display the map list "*time0001*" as an animated sequence to see for example the development of the clouds during this 24 hr period, with one hour intervals. Also put a vector layer showing the country boundaries on top (info off, boundaries only and boundary colour in red).

To calculate the potential precipitating clouds from this map list, select from the ILWIS main menu the option "*Raster Operations*" and from the drop down menu "*Map List Calculation*". Type the algorithm as indicated in figure 4.1.16: "*iff(@2-@1<11,1,0)*", in the Expression window, specify the appropriate Map Lists (time0000 is the WV; time0001 is the IR, as @1 and @2 respectively) and specify an output map list. Execute the command by pressing "*Show*".

Figure 4.1.16: MapList Calculation window



Note that a map list is defined by the "@" symbol. The syntax of the expression is the same as that of figure 4.1.14!

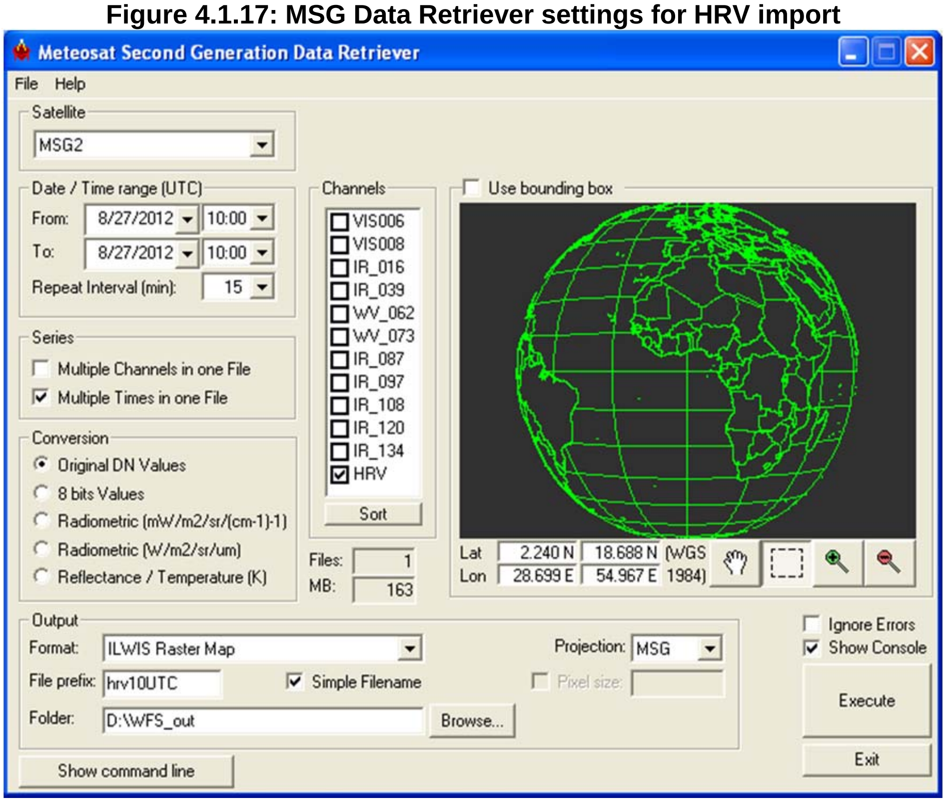
Upon completion of the calculation display the map list "*time_pcloud*" using an "*Inverse*" Representation. Also put a vector layer showing the country boundaries on top (info off, boundaries only and boundary colour in red). Note that the potential precipitating clouds have been assigned 1 and the background is 0.

4.1.5 *Import of the HRV channel*

One of the channels on MSG is the so-called High Resolution Visible channel. This is a broadband channel, recording the electromagnetic spectrum from 0.4 – 1.1 µm, with a sub-satellite spatial resolution of 1 km. Its primary use is with respect to surface and clouds (see also table 3.1).

In order to import a HRV image from MSG open the "*WFS-Ethiopia" and "Toolbox*" tabs from the main-menu and select "*MSG-HRIT*" and "*MSG Data Retriever*". Specify the settings as given in the figure below. Note that the data is now imported as 10 bit, data range from 0 to 1023.

Figure 4.1.17: MSG Data Retriever settings for HRV import

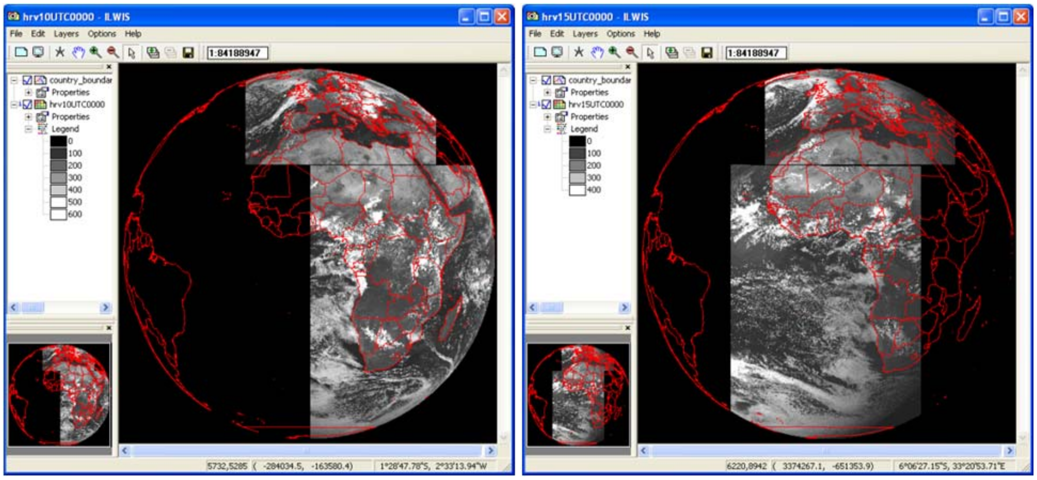


Upon Completion of the import double click the imported image "*hrv10UTC0000*", as Representation use "Gray" and press Show to see the image. Also put a vector layer showing the country boundaries on top (info off, boundaries only and boundary colour in red). Note that the image does not completely cover Africa and there is no coverage of western Africa at this UTC time selected. Zoom to the African region: from the active map window, select "Options" and "No Zoom" to see the image in the full resolution. Note that when another time is selected the southern part of the HRV image will move westward. Specify as Date / Time Range "*15:00*", use as File prefix "*hrv15UTC*" and conduct the import again. Your results should resemble those given in figure 4.1.18

Why can we use a "Gray" Representation here instead of an "Inverse" Representation?

As a general remark: Always consider carefully how to represent your images or data retrieved from GEONETCast (or in general), a wrong Representation can be misleading!

Figure 4.1.18: Imported HRV image at 10:00 UTC (left) and 15:00 UTC (right)



Note that till 13:45 UTC the eastern part of Africa is still fully covered, at 14:00 the eastern most part of the Horn of Africa is excluded and subsequently the southern MSG window moves over to cover the western part of Africa at 15:00 UTC.

In chapter 4.10 an additional exercise, using data from MSG, is presented. As this exercise can only be conducted when operating a real time reception system it cannot be provided as a generic exercise here. It might however be useful to browse through the exercise description though to note the functionality of the "*Real Time MSG Visualization*" options available from the WFS-Ethiopia Toolbox menu.

4.1.6 *Geostationary LRIT, example of Meteosat 7*

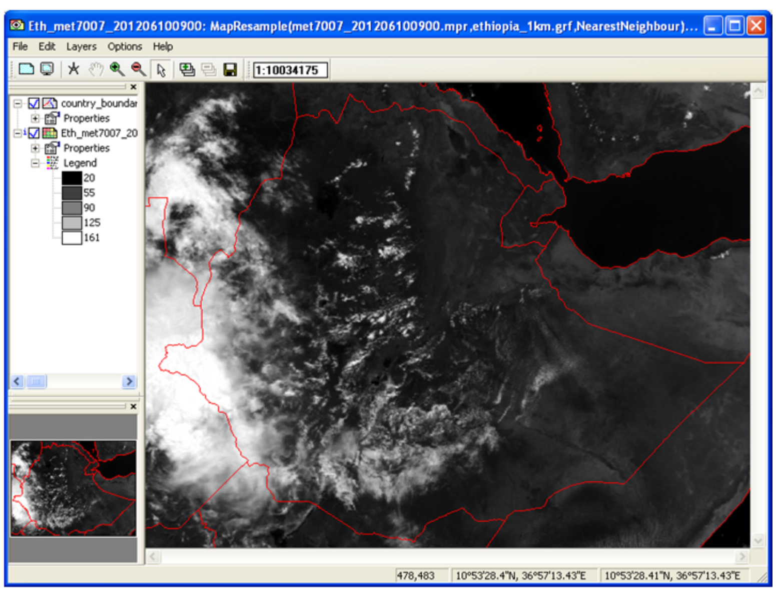
Before starting to import the Meteosat 7 LRIT images that are available in the GEONETCast data stream you need to check the settings of the directories that contain the raw data. From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*LRIT*". Browse to the appropriate data input and output locations and in the case of LRIT note that the data is stored in the directory "*D:\WFS_exercisedata\LRIT"*, where "*D:*" is the designated hard disk drive location). Here as output location "*D:\WFS_out*" is used.

From the "*WFS-Ethiopia Toolbox*" main-menu select "*METEOSAT 7-LRIT*" and "*METEOSAT 7 – whole disk*". Specify the appropriate time stamp according to the format required, e.g "*201206100900*". Also note if the input and output directories are correctly defined. You can select as UTC time 0900; an image is available and for most of the disk it is day time!

Note that during execution of the import routine a command line window is appearing. Always carefully check the content of this window. In case a time stamp is not entered properly, or data cannot be retrieved from a given input directory an error message is given and you have to press <enter> to proceed.

After the import is completed, update your ILWIS catalogue (Refresh F5) and note the file names of the newly imported images, e.g. meteosat7, followed by channel ID, year, month, day and time in UTC. Display the "*meteosat7_007_**" (*=yyyymmddhhmm) image, use as Representation "*Gray*", also add the country boundaries. Check the full coverage of Meteosat-7 and how Ethiopia is positioned. Now select from the menu "*METEOSAT 7-LRIT*" >> "*METEOSAT 7 – Ethiopia*". Specify the same time stamp according to the format required, "*201206100900*" and press "*Import*". Display the newly imported image "*Eth_met7007_201206100900*", using as Representation "*gray*", also add the country boundaries in red. The results obtained should resemble those of figure 4.1.21. Note the image values (8 bits).

Figure 4.1.21: Meteosat 7 image resampled to Ethiopia window of 201206100900



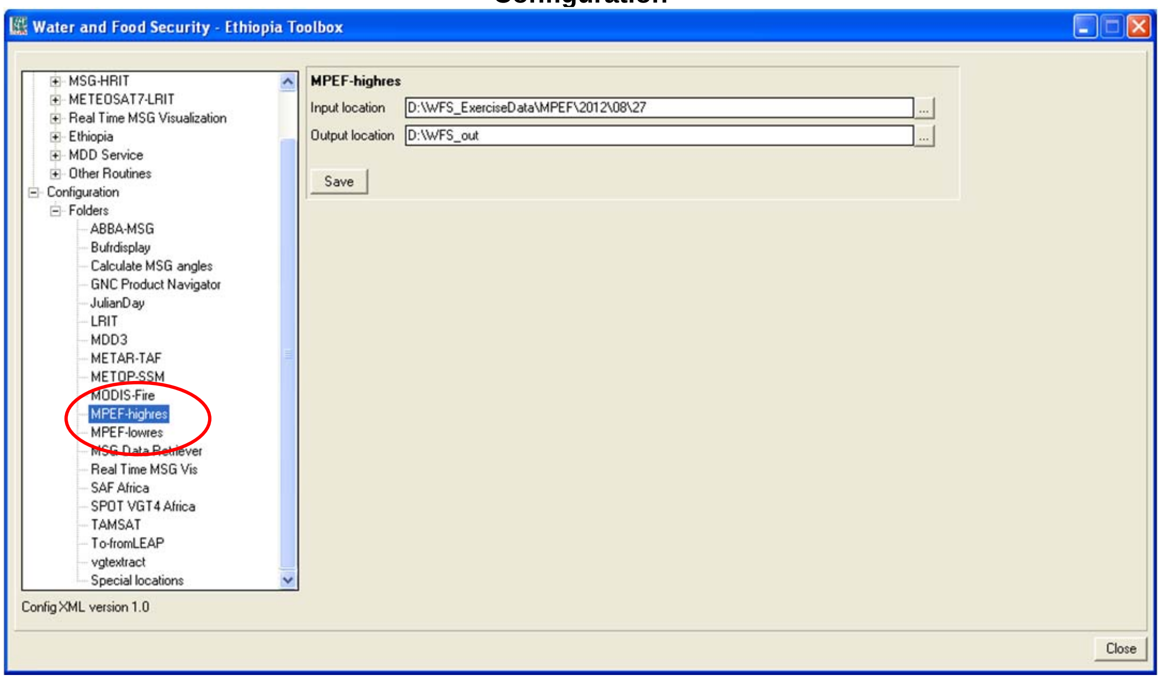
Display also the other spectral channels, like the 064 and 115 channels. For these thermal channels an "*Inverse*" Representation can be used. Before you continue close all active layers.

4.2 ETHIOPIA - IMPORT PRODUCTS FROM THE METEOROLOGICAL PRODUCT EXTRACTION FACILITY (MPEF)

4.2.1 *Import and processing of MPEF high temporal resolution data*

Before starting to import the various other data types that are available in the GEONETCast data stream you need to check the settings of the directories that contain the raw data. From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*MPEF_highres*". Browse to the appropriate data input and output locations and in the case of MPEF note that the data is stored in a year-month-day specific directory (here "*D:\WFS_exercisedata\MPEF\2012\08\27*", where "*D:*" is the designated hard disk drive location). Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings. See also the figure below.

Figure 4.2.1: Input and output directory specification using the Toolbox Folder Configuration

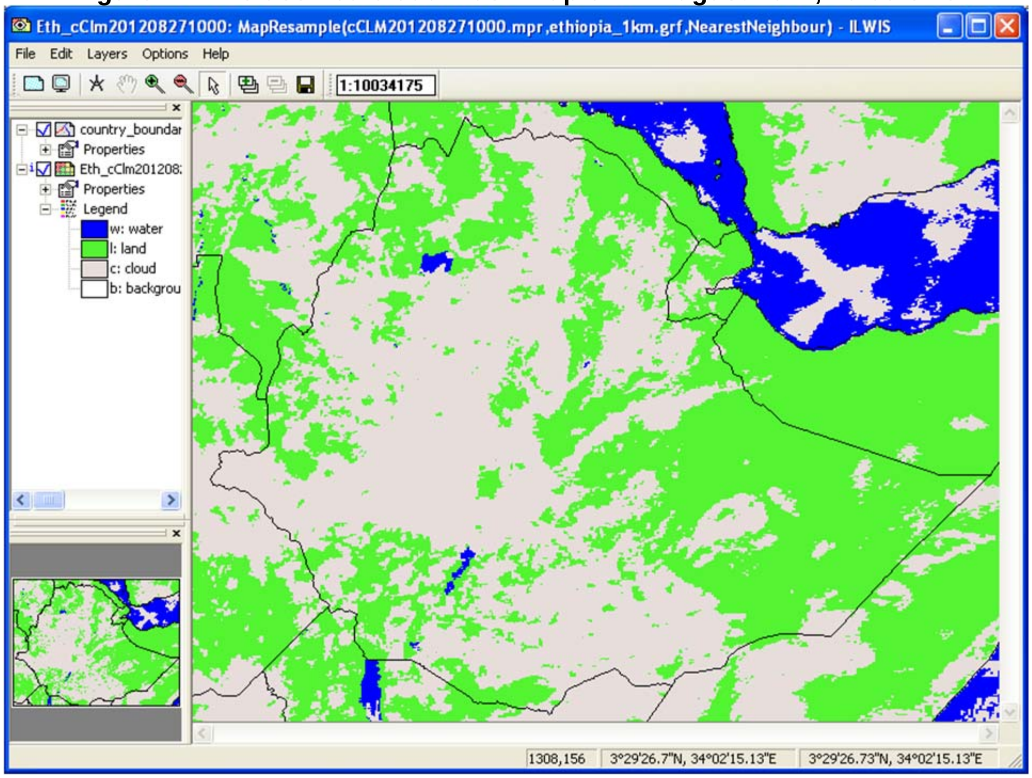


From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*MPEF*" >> "*High Temporal Resolution MPEF Products*" >> "*MPEF CLM*" to import the Cloud Mask (CLM). Select for the "*Date*" the identical time as used when importing the MSG images, in this case 201208271000. Specify this time stamp according to the format required in the "*Date*" field ("*yyyymmddhhmm*" is in this case "*201208271000*"). Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

As is the case with most routines under the menu item "Ethiopia" the data is resampled to the Ethiopian Region of Interest. Note that details of the RoI are given in chapter 2.10.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note that two new files have been created: "*Eth_cCLM**" and "*Eth_vCLM**" (*=yyyymmddhhmm), a classified cloud mask map and a value respectively. Open both maps and check their values or class names. A cloud mask class map is also given in figure 4.2.2.

Figure 4.2.2: Classified cloud mask map of 27 August 2012, 10:00 UTC



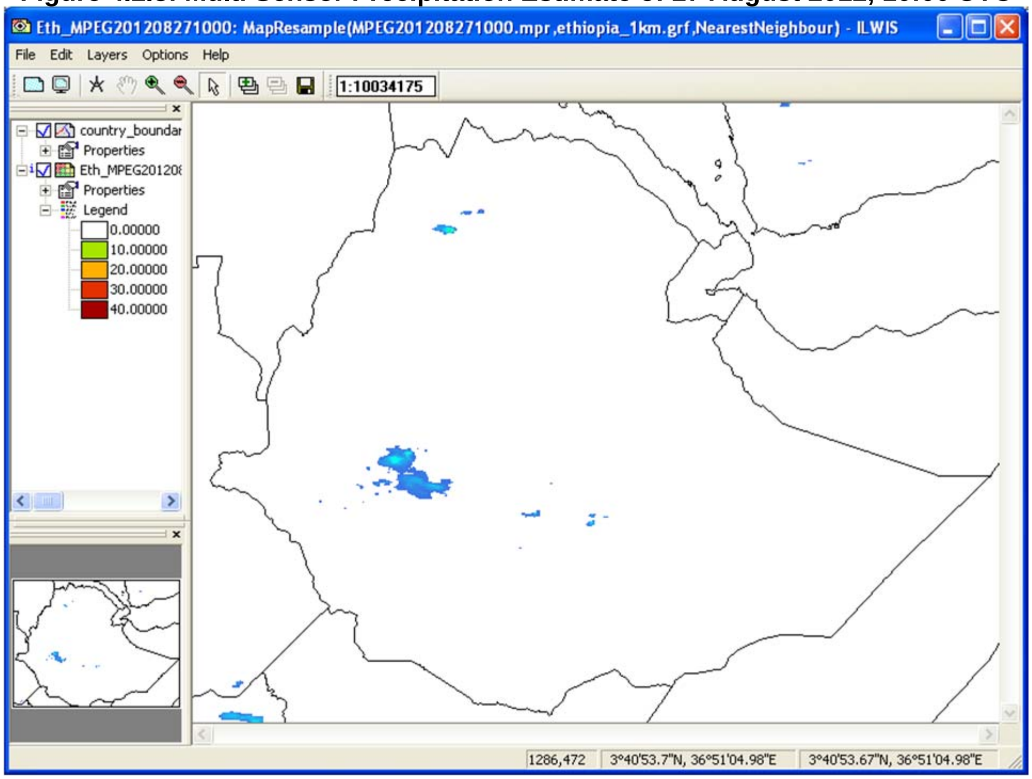
Close all active layers before you continue.

The Multi-Sensor Precipitation Estimate (MPE) product consists of the near-real-time rain rates in mm/hr for each Meteosat image in original pixel resolution. The algorithm is based on the combination of polar orbiting microwave measurements and thermal images recorded by the Meteosat IR-108 channel by a so-called blending technique. The MPE is most suitable for convective precipitation (source: http://www.eumetsat.int/Home/Main/DataProducts/ProductNavigator/index.htm?l=en).

From the "*WFS-Ethiopia" and "Toolbox*" main menu select "*Ethiopia*" >> "*MPEF*" >> "*High Temporal Resolution MPEF Products*" >> "*MPEF MPEG*" to import the Multi-sensor Precipitation Estimate (MPEG) product. Select for the "*Date*" the identical time as used when importing the Cloud Mask: "*201208271000*". Specify this time stamp according to the format required in the "*Date*" field. Also check if the input directory (note that this can be date specific!) and output directory are correctly defined. Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5"*) and note the file that has been created: Eth_MPEG* (*=yyyymmddhhmm). Display this map, using as Representation "*mpe_single*", also add the country boundaries (no info, boundaries only using a black colour). Check the values obtained, note that these are in mm/hr. The results obtained should resemble those of figure 4.2.3.

Figure 4.2.3: Multi Sensor Precipitation Estimate of 27 August 2012, 10:00 UTC

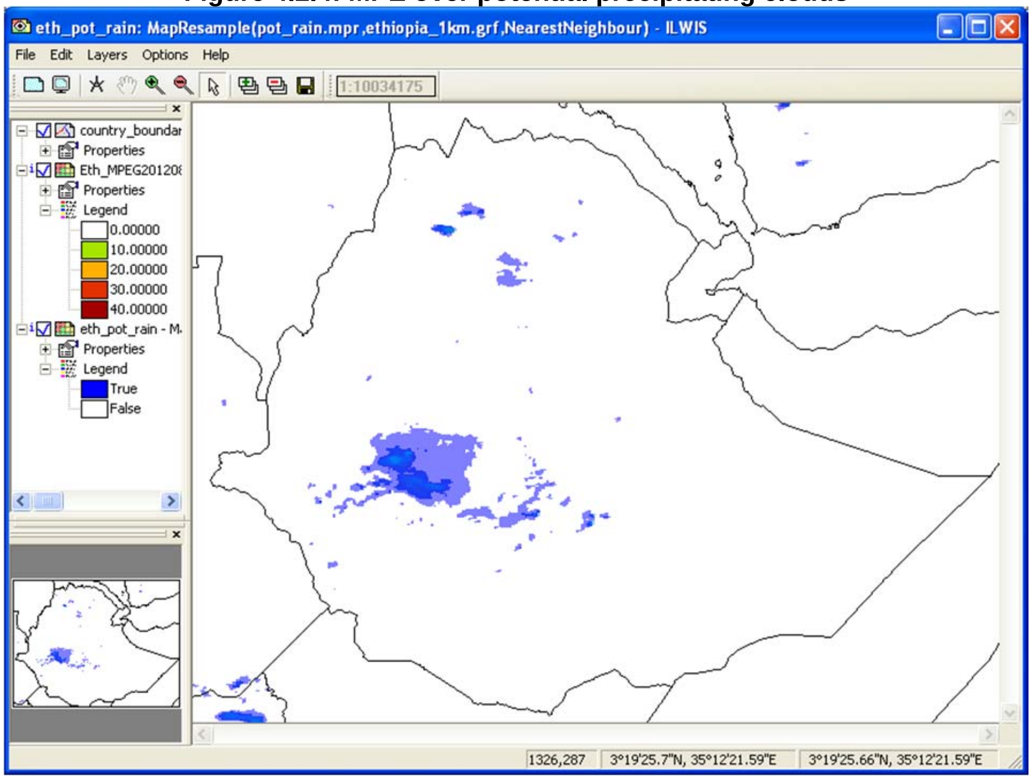


Display also the map that you calculated before showing the potential rainfall areas, called "*pot_rain*" and the cloud mask created before. What can you observe when comparing the maps?

The map "pot_rain" is based upon the MSG projection and shows a different geometry, check the country boundaries. In order to make a better comparison the map "pot_rain" can be resampled. From the main ILWIS menu, select the option "*Operations*" >> "*Spatial Reference Operations*" >> "*Raster*" >> "*Resample*", use as input raster map "*pot_rain*", specify as output map "*eth_pot_rain*" and as Georeference select "*ethiopia_1km*", press "*Show*". Display the map using as True Color "*blue*" and as False Color "*white*". From the map window press the "*Add Layer*" icon and add the map "*Eth_MPEG201208271000",* in the display options of this raster map, activate the option "*Transparent*", use default transparency, as Representation use "*mpe_single*" and press "*OK*". The results should look like in Figure 4.2.4 (note that the transparency does not always work, depending on your graphic board). Move the mouse cursor over the screen while keeping the left mouse button pressed. Note the rainfall intensities.

Note that for resampling use is made of the nearest neighbour resampling method, actual map values have not changed, only their "geographic" position! It can be noted that the threshold used to calculate the potential rain field is resulting in an overestimation. Modifying the threshold could yield better "regional" results. You can try to calculate the potential rain field once more using a smaller threshold using a similar methodology is described above (see figure 4.1.14).

Figure 4.2.4: MPE over potential precipitating clouds



From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*MPEF*" >> "*High Temporal Resolution MPEF Products*" >> "*MPEF CLAI*" to import the Cloud Analysis product. Select for the "*Date*" the appropriate time stamp, here use is made of the data for 27 August 2012 and as time step 1145 UTC is entered. Specify the time stamp according to the format required in the "*Date*" field. Also note if the input directory (this can be date specific!) and output directory is correctly defined. Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note the file that has been created: "*Eth_CLAI**" (*=yyyymmddhhmm). Display this map, using the default "*Representation*" "*CLAI*", also add the country boundaries (no info, boundaries only using a black colour). Check the classes obtained, note that these are obtained from the CLAI product description. Furthermore you will observe a more 'blocky' appearance of the pixels, this is due to the fact that the initial resolution of this product is 3 by 3 MSG pixels! Your results should resemble those of figure 4.2.5A (left), close the map when finished.

Note that for 27 August 2012 more MPEF products are available, you can check this MPEF sub-directory. You can import a number of these products. In order to import them, select the appropriate time stamp according to the format required in the "*Date*" field (e.g. for AMV: "*201208271145*", for CTH: "*201208271145*"; note that a value and a class map is generated, for FIRG: "*201208271145*"). In order to visualize the AMV products, select the so called map view icon  for the respective imported products e.g. "*amv201208271145*". To display the CTH value map a "*Pseudo*" representation can be used, for other maps use the default representation. Your results should resemble those of figure 4.2.5A (right) and 4.2.5B, close all active maps when finished. For the FIRG visualization add also the point map created (having the same name), use a point size of 3.

Figure 4.2.5A: Imported products from MPEF: CLAI (left) and CTH (right)

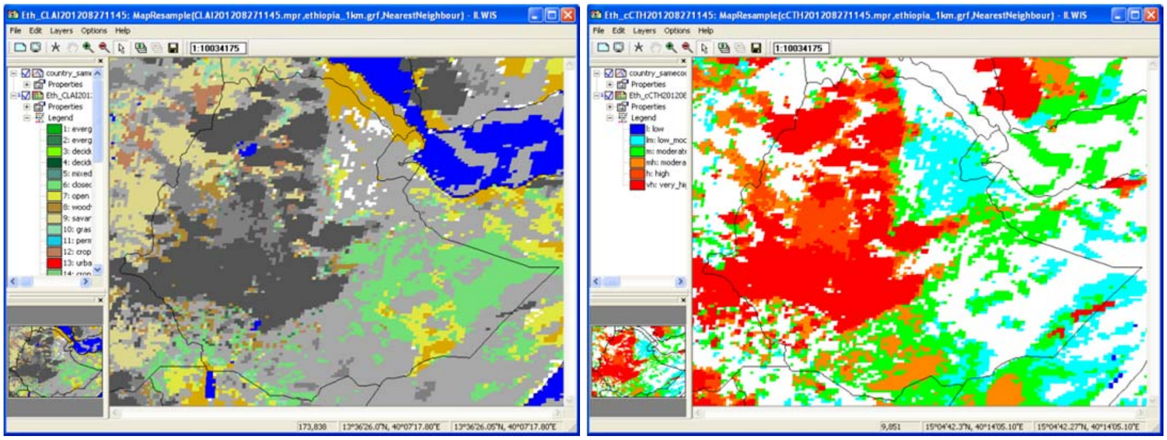
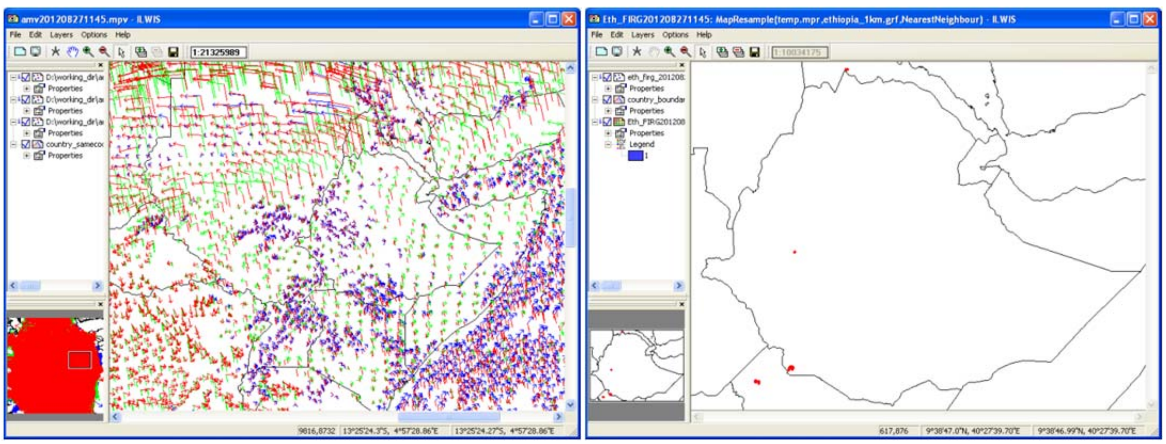


Figure 4.2.5B: Imported products from MPEF: AMV (left) and FIRG (right)



4.2.2 *Import and processing of MPEF low temporal resolution data*

From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*MPEF_lowres*". Browse to the appropriate data input and output locations and in case of MPEF_lowres note that the data is not stored in a year-month-day specific directory (here "*D:\WFS_ExerciseData\MPEF_DayDek*", where "*D:*" is the designated hard disk drive location). Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings.

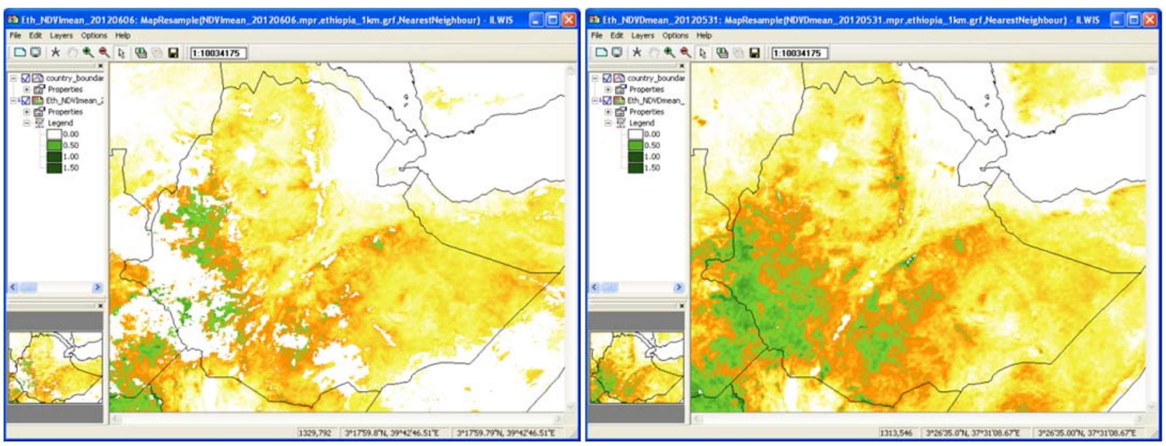
From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*MPEF*" >> "*Low Temporal Resolution MPEF Products*" >> "*MPEF NDVI*" to import the Daily NDVI based on MSG. Specify for the "*Date*" field a yyyymmdd timestamp like "*20120606*". Note that there is 1 product on a daily basis, the hhmm is always 1200 and is therefore not used. Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note that three new files have been created: Eth_NDVImax_*, Eth_NDVImean_* and Eth_NDVImin* (*=yyyymmdd), the daily maximum, mean and minimum NDVI of the various MGS observations respectively. Open the maps, using as Representation "*NDVI1*" and check their values. The daily NDVImean map of 20120606 is also given in figure 4.2.6 (left).

From the “*WFS-Ethiopia”* and *“Toolbox*” main menu select “*Ethiopia*” >> “*MPEF*” >> “*Low Temporal Resolution MPEF Products*” >> “*MPEF NDVD*” to import the Dekadal NDVI based on MSG. Select to import the last dekade of May 2012 as the “*Date*” stamp “20120531” (note for the 1st and second dekade of each month this is always 10 and 20 respectively, for the last dekade of the month this is always the last day of the respective month!). Specify this time stamp according to the format required in the “*Date*” field (“*yyyymmdd)* and in this case is “*20120531*”. Note that there are 3 products per month, the hhmm is always 1200 and is not used. Press “*Import*” to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select “*Window*” and “*Refresh F5”*) and note that three new files have been created: Eth_NDVDmax_*, Eth_NDVDmean_* and Eth_NDVDmin_* (*=yyyymmdd), the dekadal maximum, mean and minimum NDVI of the various daily MGS NDVI observations for that specific dekade. Open the maps, using as Representation “*NDVI1*” and check their values. The NDVDmean map of the last dekade of May 2012 is also given in figure 4.2.6 (right). Note the reduction of cloud contamination when comparing the daily and dekadal NDVI.

Figure 4.2.6: MPEF NDVI day and dekadal map



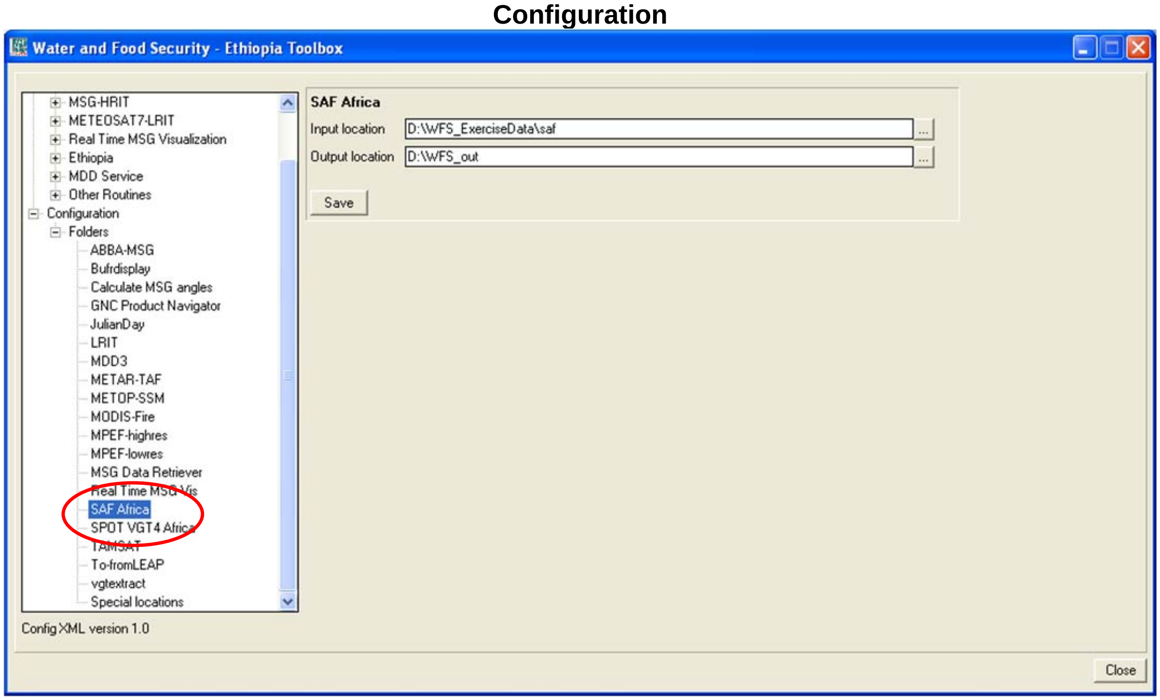
More information on MPEF and the algorithms used can be found in the document: “*MSG Meteorological Products Extraction Facility Algorithm Specification Document” (*EUM/MSG/SPE/ 022)*,* available at: www.eumetsat.int/groups/ops/documents/document/PDF_TEN_SPE_04022_MSG_MPEF.pdf

4.3 ETHIOPIA - IMPORT PRODUCTS FROM THE SATELLITE APPLICATION FACILITY

4.3.1 *Import and processing of LSA SAF data for Ethiopia*

Before starting to import the various other data types that are available in the GEONETCast data stream you need to check the settings of the directories that contain the raw data. From the "*WFS_Ethiopia*" and "*Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*SAF Africa*". Browse to the appropriate data input and output locations and in this case the SAF data is stored in the directory: "*D:\WFS_ExerciseData\SAF*" (where "*D:*" is the designated hard disk drive location). Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings. See also the figure below.

Figure 4.3.1: Input and output directory specification using the Toolbox Folder Configuration



4.3.2 *Surface Albedo (Albedo)*

Land surface albedo is a key variable for characterising the energy balance in the coupled soil-vegetation-atmosphere system. The albedo quantifies the part of the energy that is absorbed and transformed into heat and latent fluxes. Owing to strong feedback effects the knowledge of albedo is important for determining weather conditions at the atmospheric boundary layer. Climate sensitivity studies with Global Circulation Models have confirmed the unsteady nature of the energy balance with respect to small changes in surface albedo. Other domains of applications are in hydro-meteorology, agro-meteorology and environment related studies (source: http://landsaf.meteo.pt/).

From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*SAF*" >> "*Albedo*" to import the Surface Albedo product. Select for the "*Date*" the appropriate time stamp, here use is made of the data for 10 June 2012. Specify the time stamp according to the format required in the "*Date*" field (e.g. "*20120610*"). Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note the file that has been created: "*Eth_albedo**"

(*=yyyymmdd). Display this map, using as Representation "*Pseudo*", also add the country boundaries (no info, boundaries only using a black colour). Check the values obtained, note that these are in percentage. Your results should resemble those of figure 4.3.2A (left), close the map when finished.

4.3.3 *Down-welling surface short-wave and long-wave radiation fluxes*

The down-welling surface short-wave radiation flux (DSSF) refers to the radiative energy in the wavelength interval [0.3µm, 4.0µm] reaching the Earth's surface per time and surface unit. It essentially depends on the solar zenith angle, on cloud coverage, and to a lesser extent on atmospheric absorption and surface albedo. DSSF fields are crucial for a wide number of applications involving scientific domains like weather forecast, hydrology, climate, agriculture and environment-related studies. In numerical weather prediction and general circulation models of the atmosphere, satellite-derived DSSF estimates can either be used as a control variable or as a substitute to surface radiation measurement networks. Down-welling Surface Long-wave Radiation Flux (DSLF) is the result of atmospheric absorption, emission and scattering within the entire atmospheric column and may be defined as the thermal irradiance reaching the surface in the thermal infrared spectrum (4-100µm). In clear sky situations DSLF depends on the vertical profiles of temperature and gaseous absorbers (primarily the water-vapour followed by CO2, and others of smaller importance like O3, CH4, N2O and CFCs). However, DSLF is determined by the radiation that originates from a shallow layer close to the surface (about one third being emitted by the lowest 10 meters and 80% by the 500-meter layer). The cloud contribution mainly occurs in the atmospheric window (8-13µm) and mainly depends on cloud base properties (height, temperature and emissivity). DSLF is directly related to the greenhouse effect and its monitoring has an important role in climate change studies. Other applications include meteorology (land applications) and Hydrology (source: http://landsaf.meteo.pt/).

As an example of these fluxes, from the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*SAF*" and "*DSSF*" to import the down-welling surface short-wave radiation flux product. Select for the "*Date*" the appropriate time stamp, here use is made of the data for 11 June 2012 and as time step "*1200*" UTC is entered. Specify the time stamp according to the format required in the "*Date*" field (e.g. "*201206111200*"). Also note if the input directory and output directory is correctly defined. Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note the file that has been created: "*Eth_dssf**" (*=yyyymmddhhmm). Display this map, using as Representation "*Pseudo*", also add the country boundaries (no info, boundaries only using a black colour). Check the values obtained, note that the map unit is W/m^2. Your results should resemble those of figure 4.3.2A (right), close the map when finished.

4.3.4 *Land Surface Temperature (LST)*

Land Surface Temperature (LST) is the radiative skin temperature over land. LST plays an important role in the physics of land surface as it is involved in the processes of energy and water exchange with the atmosphere. LST is useful for the scientific community, namely for those dealing with meteorological and climate models. Accurate values of LST are also of special interest in a wide range of areas related to land surface processes, including meteorology, hydrology, agro meteorology, climatology and environmental studies (source: http://landsaf.meteo.pt/).

From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*SAF*" >> "*LST*" to import the Land Surface Temperature product. Select for the "*Date*" the appropriate time stamp, here use is made of the data for 11 June 2012 and as time step "*1200*" UTC is entered. Specify the time stamp according to the format required in the "*Date*" field (e.g. "*201206111200*"). Also note if the input directory and output directory is correctly defined. Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note the file that has been created: "*Eth_lst**" (*=yyyymmddhhmm). Display this map, using as Representation "*Pseudo*", also add the country boundaries (no info, boundaries only using a black colour). Check the values obtained, note that the temperature is in Celsius. Your results should resemble those of figure 4.3.2B (left), close the map when finished.

4.3.5 *Evapotranspiration (ET)*

Evapotranspiration (ET) accounts for the flux of water evaporated at the Earth-atmosphere interface (from soil, water bodies and interception) and transpired by vegetation through stomata in its leaves as a consequence of photosynthetic processes. ET is an important component of the water cycle and it is associated with the latent heat flux (LE), a key link between the energy and water cycles. In other words, LE represents the energy needed for the ET process. Evaluating energy fluxes at the Earth surface is of great importance in many disciplines like weather forecasting, global climate monitoring, water management, agriculture and ecology. This product currently is in an operational status (source: http://landsaf.meteo.pt/). From the LSA SAF archive also a daily ET product can be obtained.

From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*SAF*" >> "*ET*" to import the Evapotranspiration product. Select for the "*Date*" the appropriate time stamp, here use is made of the data for 11 June 2012 and as time step "*1200*" UTC is entered. Specify the time stamp according to the format required in the "*Date*" field (e.g. "*201206111200*"). Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note the file that has been created: "*Eth_et**" (*=yyyymmddhhmm). Display this map, using as Representation "*Pseudo*", also add the country boundaries (no info, boundaries only using a black colour). Check the values obtained, note that the ET is in mm/hr. Your results should resemble those of figure 4.3.2B (right), close the map when finished.

Figure 4.3.2A: Imported products from the LSA SAF: Albedo (left) and DSSF (right)

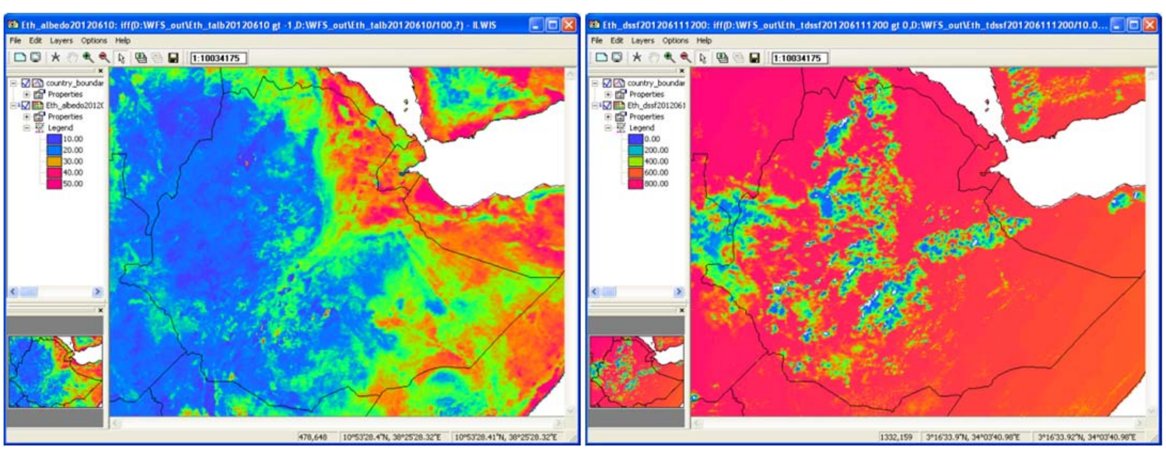
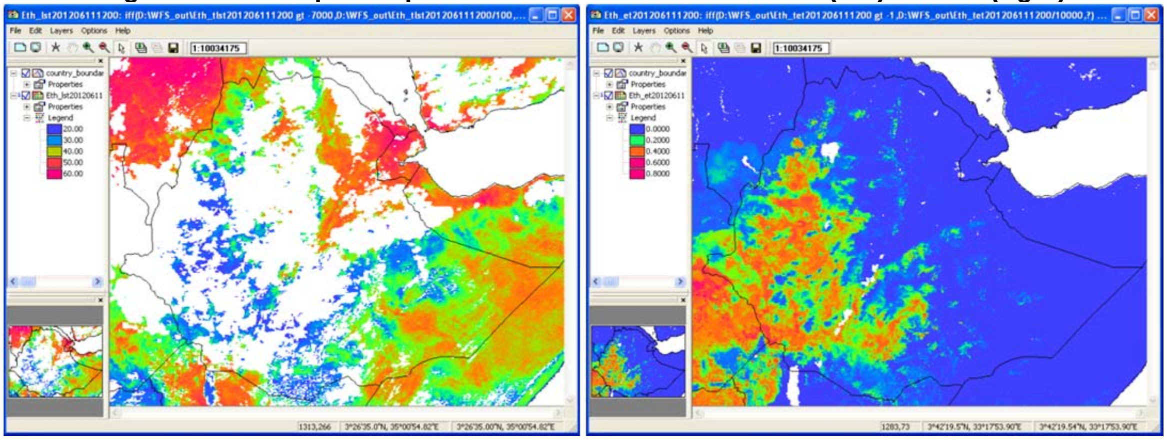


Figure 4.3.2B: Imported products from the LSA SAF: LST (left) and ET (right)



You will now continue to import a number of Vegetation Parameters that are generated once a day by the LSA SAF, using the data collected by the SEVIRI instrument on board of MSG.

4.3.6 *Fraction of Vegetation Cover (FVC)*

The FVC product is currently generated daily at the full spatial resolution of the MSG-SEVIRI instrument, and will be later provided on a 10-days and monthly basis. The product is based on the three short-wave channels (VIS 0.6µm, NIR 0.8µm, SWIR 1.6µm) using as input the k0 parameter of a parametric BRDF (Bi-directional Reflectance Distribution Function) model (Roujean et al. 1992). The k0 parameter (normalized reflectance) provides cloud-free observations over the SEVIRI disk based on an iterative scheme with a characteristic time scale of five days. The FVC product is expressed in the range from 0 % to 100 %. It is corrected from uncertainty derived of the view/sun angles and also the anisotropy effects of surface's reflectance in the SEVIRI image. The FVC product includes routine quality check and error estimates. The product will be validated in order to define the product uncertainties over a range of global conditions studies (source: http://landsaf.meteo.pt/).

From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select "*Ethiopia*" >> "*SAF*" >> "*FVC*" to import the Fraction of Vegetation Cover product. Select for the "*Date*" the appropriate time stamp, here use is made of the data for 10 June 2012. The "hhmm" time step (always 0000 UTC) is not required as the product is generated once a day. Specify the time stamp according to the format required in the "*Date*" field (e.g. "*20120610*"). Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note the file that has been created: "*Eth_fvc**" (*=yyyymmdd). Display this map, using as Representation "*fvc*", also add the country boundaries (no info, boundaries only using a black colour). Check the values obtained, note that these are in percentage (0 to 1 represents 0 to 100 percent). Your results should resemble those of figure 4.3.3A, close the map when finished.

4.3.7 *Leaf Area Index (LAI)*

Leaf Area Index (LAI) is a dimensionless variable [m2/m2], which defines an important structural property of a plant canopy. LAI is defined as one half the total leaf area per unit ground area (Chen and Black, 1992). It provides complementary information to the FVC, accounting for the surface of leaves contained in a vertical column normalized by its cross-sectional area. It defines thus the area of green vegetation that interacts with solar radiation determining the remote sensing signal, and represents the size of the interface between the vegetation canopy and the atmosphere for energy and mass exchanges. LAI is thus a necessary input for Numerical

Weather Prediction (NWP), regional and global climate modelling, weather forecasting and global change monitoring. Besides, the LAI is relevant for Land Biosphere Applications such as agriculture and forestry, environmental management and land use, hydrology, natural hazards monitoring and management, vegetation-soil dynamics monitoring and drought conditions studies (source: http://landsaf.meteo.pt/).

From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*SAF*" >> "*LAI*" to import the Leaf Area Index product. Select for the "*Date*" the appropriate time stamp, note that the product is generated once a day. Specify the time stamp according to the format required in the "*Date*" field (e.g. "*20120610*"). Press "*Import*" to start the import. Note that during import a command window is activated, have also a look at what is displayed in this window.

After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note the file that has been created: "*Eth_lai**" (*=yyyymmdd). Display this map, using as Representation "*lai_saf*", also add the country boundaries (no info, boundaries only using a black colour). Check the values obtained, note these are m^2/m^2. Your results should resemble those of figure 4.3.3B, close the map when finished.

4.3.8 *Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)*

Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) defines the fraction of PAR (400-700 nm) absorbed by the green parts of the canopy, and thus expresses the canopy's energy absorption capacity. FAPAR depends both on canopy structure, leaf and soil optical properties and irradiance conditions. FAPAR has been recognized as one of the fundamental terrestrial state variables in the context of the global change sciences (Steering Committee for GCOS, 2003; Gobron et al., 2006). It is a key variable in models assessing vegetation primary productivity and, more generally, in carbon cycle models implementing up-to-date land surfaces process schemes. Besides, FAPAR is an indicator of the health of vegetation. FAPAR is generally well correlated with the LAI, the more for healthy fully developed vegetation canopies studies (source: http://landsaf.meteo.pt/).

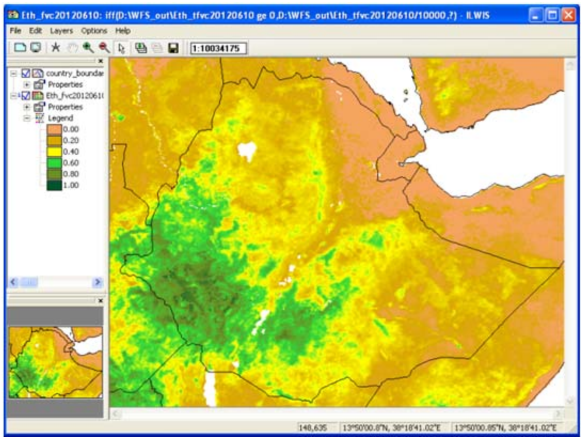
From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select "*Ethiopia*" >> "*SAF*" >> "*FAPAR*" to import the Fraction of Absorbed Photosynthetically Active Radiation product. Select for the "*Date*" the appropriate time stamp, here use is made of the data for 10 June 2012, note that the product is generated once a day. Specify the time stamp according to the format required in the "*Date*" field (e.g. "*20120610*"). Press "*Import*" to start the import. Check during import the command window which is activated and also have a look at information displayed in this window.

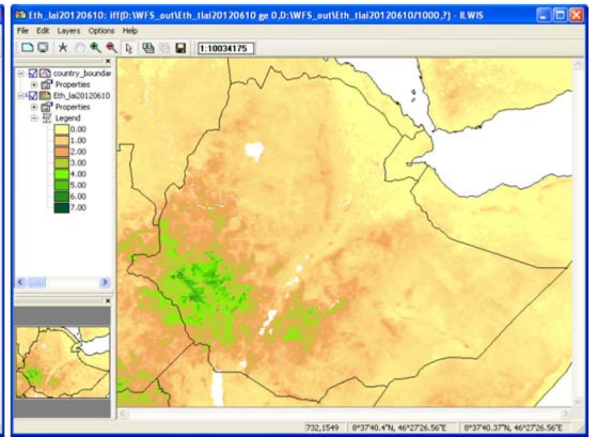
After completion of the import, update the ILWIS catalogue (from the main ILWIS menu, select "*Window*" and "*Refresh F5*") and note the file that has been created: "*Eth_fapar**" (*=yyyymmdd). Display this map, using as Representation "*fapar*", also add the country boundaries (no info, boundaries only using a black colour). Check the values obtained, note that the FAPAR unit is in percentage, 0 to 1, 1=100 percent. Your results should resemble those of figure 4.3.3C, close all open maps when finished.

Figure 4.3.3: LSA SAF vegetation products Fraction of Vegetation Cover (FVC), Leaf Area Index (LAI) and (Fraction of Absorbed Photosynthetically Active Radiation FAPAR)

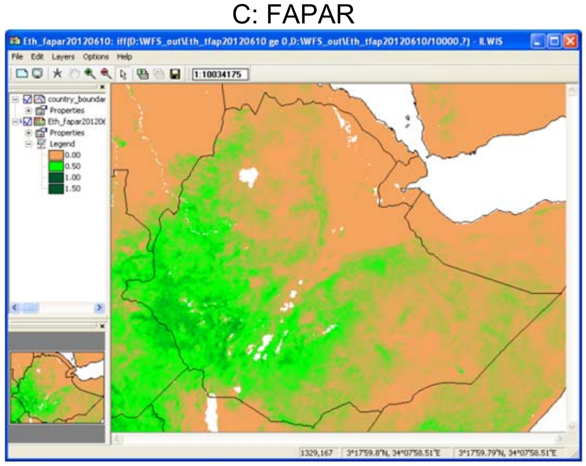
A: FVC

B: LAI





C: FAPAR



Before you continue, close all active map windows. Eventually close ILWIS to continue with the other exercises at a later stage.

Note that a lot of additional online information is provided with respect to the products that are used here, check the LSA-SAF webpages, available at: http://landsaf.meteo.pt/.

4.4 ETHIOPIA – CREATE DAILY ET MAP

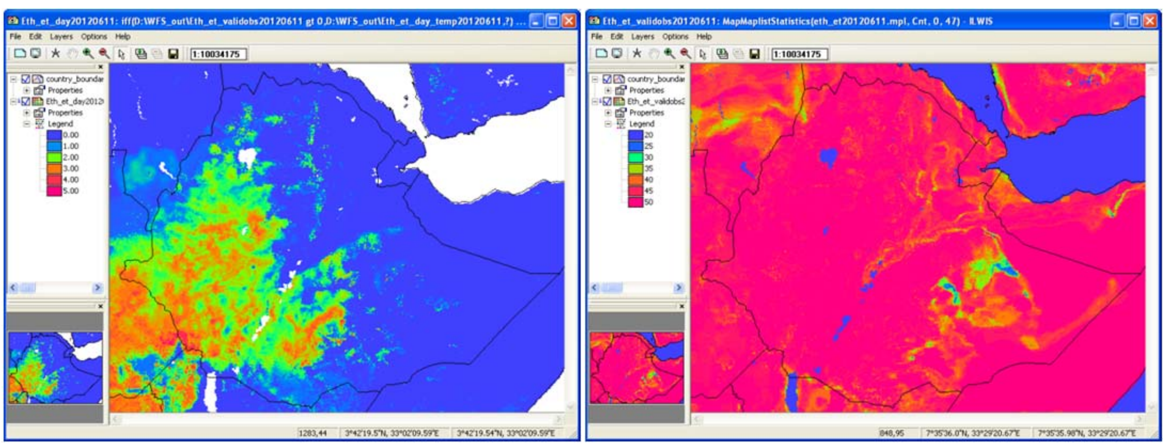
As could be noted from the previous exercise when importing the SAF data, some products are aggregated at daily level and other products are produced at 15 or 30 minutes temporal intervals. This is also the case with the Evapotranspiration (ET) product. To obtain a daily product for the ET all 30 minutes products over a 24 hour period (from 00:00 to 23:30 UTC) can be summed and the total ET can be calculated. To optimize this routine a batch looping procedure is used which copies all ET products for a certain day (48 products) and subsequently imports the data, creates an ILWIS map list and performs a number of map list statistics functions, like sum (to obtain the total ET) and count (to obtain the number of valid observations).

Before you continue, check the settings of the directories that contain the raw data. From the "*WFS_Ethiopia" and "Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*SAF Africa*". Browse to the appropriate data input and output locations and in this case the SAF ET data is stored in directory: "*D:\WFS_ExerciseData\SAF*" (where "*D:*" is the designated hard disk drive location). Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings.

From the WFS-Ethiopia Toolbox menu, select "*Ethiopia*" >> "*SAF-ET daily*" >> "*SAF_ET daily*", specify the appropriate Date stamp (in yyyymmdd format), here you can enter "*20120611*" and press import. After import has started a command line interpreter windows shows the progress of the import routine, note the time stamp. After import of all 48 events is completed ILWIS calculates the required aggregate statistics. Wait until the routine has finished and then open the newly created map ""*Eth_et_day20120611*", use a "*Pseudo*" Representation. Browse with the mouse, keeping the left mouse button pressed over the map display to see the ET values.

Right click with the mouse on the map "*Eth_et_validobs20120611*" and from the context sensitive menu select the option "*Statistics*" >> "*Histogram*" and press "*Show*". As can be seen from this histogram more than 85 % of the region has 40 or more valid observations, about 10 % has 0 valid observations (these are open water bodies or the ocean), so about 5 % of the observations are having a risk of underestimation of the ET. Close the histogram and display the map "*Eth_et_validobs20120611*" using a "*Pseudo*" Representation, stretch the map from 22 (min) to 48 (max) to see the spatial distribution. Your results should resemble those given in figure 4.4.1.

Figure 4.4.1: Daily ET and number of valid observations for 20120611



Note that all maps that have been imported and the map list are also available. Open the Map List "*eth_et20120611*" by double clicking with the left mouse button on the file name, note once more the different icon , belonging to a map list. Note the content of the map list, ET maps from 1 to 48 represent the 48 half hourly events of 11 June 2012. To display the map list, select as visualization option "*Open as Slide Show*", by clicking on the icon in the map list display window. For the "*Display Options*" select as Representation "*Pseudo*" and press "*OK*", for the new window showing more "*Display Options*", like "*Refresh rate*", the defaults can be accepted, continue by pressing OK.

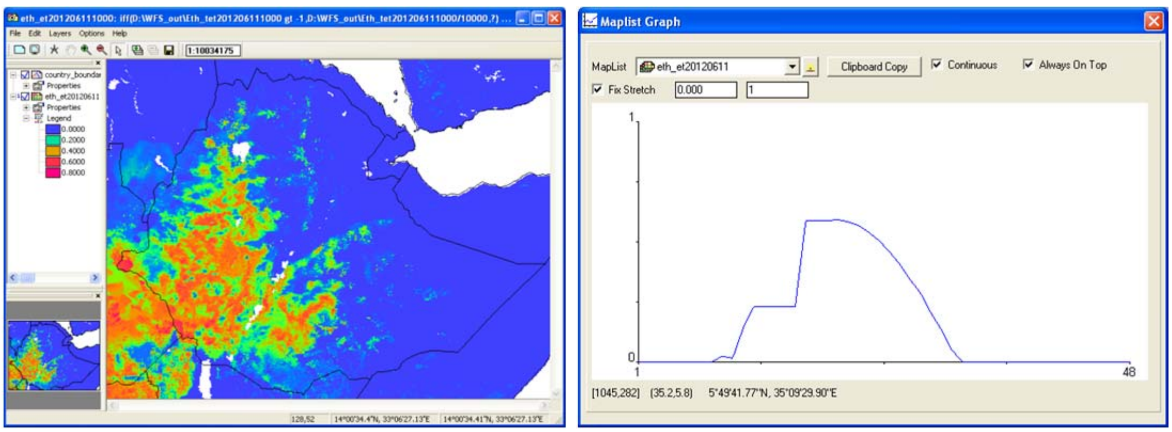
Visually inspect the changes that have occurred over the day, also note the occurrence of the "not a value"/ undefined pixels. After you have inspected the map list, close the map list display window.

Open the map list "*eth_et20120611*" once more and now select the layer "*eth_et201206111000*", double click on this layer with the left mouse button and as Representation select "*Pseudo*", press "*OK*" to display the map showing the ET at 10:00 UTC. Now from the ILWIS main menu, select:

"*Operations*" >> "*Statistics*" >> "*MapList*" >> "*MapList Graph*". Select as "*MapList*" "*eth_et20120611*". Activate the option: "Fix Stretch", select as minimum "*0"* and as maximum "*1"*. Also activate the options "*Continuous*" and "*Always On Top*". Note that the X-axis of the graph represents the time, here the time steps from 00:00 to 23:30 UTC and the Y axis is the ET, in mm/hr! Move the mouse cursor over the map "*eth_et201206111000*" (it might have disappeared under the main ILWIS window!) and check the corresponding ET values in the graph for a given pixel over the daily time range, in this case for 11 June 2012. Your results should resemble those of figure 4.4.2. Undefined pixels (not having a value) are represented by a dashed red line.

Note that with the "*Clipboard Copy*" option the time stack for a certain pixel can be copied to clipboard to be pasted into a spread sheet. In order to do so it is necessary to uncheck the option "*Continuous*" and click in the map on the desired location. The coordinate information / row-column number is provided in the Map List Graph window in the lower left hand corner.

Figure 4.4.2: ET map of 20120611 at 10:00 UTC (left) and the map list graph for the whole day for a selected pixel location (right)



Close all active map windows before you continue and open once more the map "*eth_et20120611"* using a *"Pseudo"* Representation. From the menu of the map "*eth_et20120611*", select "*Layer*", "*Add Layer*" and select the point map "*my_observations*", press "*OK*" twice to display the point map over the ET map. Check the location of the points.

From the main ILWIS menu, select "*Operations*" >> "*Point Operations*" >> "*Pointmap cross*". As Pointmap use "*my_observations*", as Map List use "*eth_et20120611*" and as Output Point Map specify: "*ET_locations*". A new point file "*ET_locations*" is created, but more important is the new table created. Open the table "*ET_locations*" and check the content. Note that for every point location you have the ET values for each of the 48 events in the map list. This can be very handy if you want to link your data with ground based observations. When you right click with the mouse on the table "*ET_locations*", select "Table Operations" >> "Transpose Table" and specify a new table name. After the operation has completed open this new table and check the content once more and take note of the record order in the transposed table!

Before you continue close all active windows, apart from the main ILWIS window. Eventually you can delete some of the obsolete files that have been created during previous exercises.

4.5 ETHIOPIA - TAMSAT 10 DAY AND MONTHLY RAINFALL PRODUCT

The TAMSAT *R*ain*F*all *E*stimate (RFE) for Africa are ten-daily (dekadal) and monthly rainfall estimates and anomalies derived from Meteosat Thermal Infra-Red (TIR) channels based on the recognition of storm clouds and calibration against ground-based rain gauge data are currently disseminated via GEONETCast.

From the “*WFS-Ethiopia”* and *“Toolbox*” main menu select the option “*Configuration*” and “*Folder*” and select “*TAMSAT*”. Browse to the appropriate data input and output locations and in the case of the TAMSAT rainfall products note that the data is stored in “*D:\WFS_exercisedata\TAMSAT”*, where “*D:*” is the designated hard disk drive location. Here as output location “*D:\WFS_out*” is used. Press “*Save*” to store the settings.

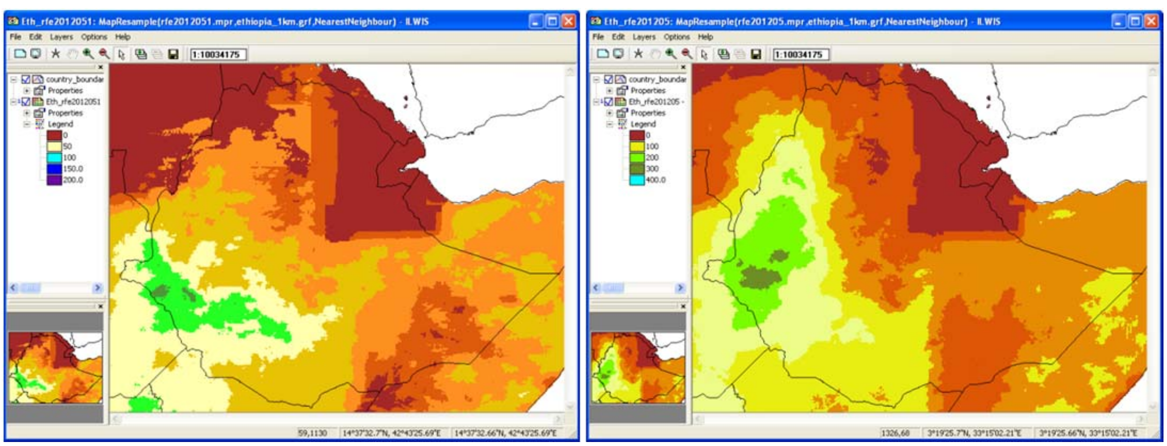
In order to import the dekadal RFE, from the “*WFS-Ethiopia*” and “*Toolbox*” main menu select the option “*Ethiopia*” >> “*TAMSAT Rainfall Products*” >> “*TAMSAT 10 day Accumulated Rainfall Ethiopia*”.

Import the dekadal rainfall map for the first dekade of May 2012, enter “*2012051*“. Note the format that is required for the Date stamp (yyyymmdek).

After the import is completed open the file “*Eth_rfe2012051”*, use as Representation “*rfe_dec*”. Add the country boundary vector file “*country_boundaries*”, no info and boundaries only, use a black colour for the boundaries.

Conduct the import of the other 2 dekades of May 2012 (“*2012052*” and “*2012053*”) and optionally calculate the total monthly precipitation by adding the three decadal maps to obtain the total monthly precipitation (in mm!). Display this map using as Representation “*rfe_month*”. Browse with the left mouse button pressed over the map and note the values. Note that you can also use the “*TAMSAT monthly Accumulated Rainfall Ethiopia*” import option available under “*Ethiopia*” >> “*TAMSAT Rainfall Products*”. As “*Date*” format yyyymm is expected, so enter for Date: “*201205”*. Conduct the import and display the map “*Eth_rfe20125*” using as Representation “*rfe_month*”. The RFE map of the first decade of May 2012 (right) and of the month of May 2012 (left) is also given in figure 4.5.1.

Figure 4.5.1: RFE map of the first decade of May 2012 and of the month of May 2012



Compare your own calculated monthly RFE with the TAMSAT monthly RFE product; you can calculate the difference by subtracting the monthly precipitation maps.

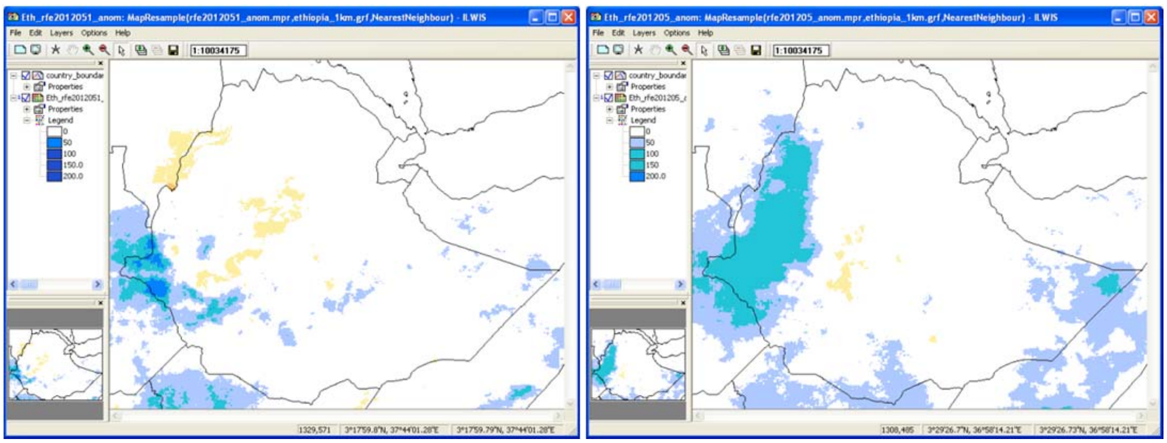
TAMSAT is also providing anomaly maps, using short term (10 years) climatology (from 2000-2009). In order to import the anomaly RFE for the 1st decade of May 2012, select from the “*WFS-Ethiopia*” and “*Toolbox*” main menu the option under “*Ethiopia*” >> “*TAMSAT Rainfall Products*” >> “*TAMSAT 10 day accumulated rainfall anomaly Ethiopia*”.

Import the dekadal anomaly rainfall map for the first dekade of May 2012, enter “*2012051*“. Note the format that is required for the Date stamp (yyyymmdek).

After the import is completed open the file “*Eth_rfe2012051_anom”*, use as Representation “*rfe_anom_dec*”. Add the country boundary vector file “*country_boundaries*”, no info and boundaries only, use a black colour for the boundaries.

Repeat above procedure, but now select the import option “*TAMSAT monthly accumulated rainfall anomaly Ethiopia*” and as Date stamp specify “*201205*” and press “*Import*”. After the import is completed open the file “*Eth_rfe201205_anom”*, use as Representation “*rfe_anom_month*”. Add the country boundary vector file “*country_boundaries*”, no info and boundaries only, use a black colour for the boundaries. Your results should be identical to those given in figure 4.5.2.

Figure 4.5.2: RFE anomaly map for 1st decade May 2012 (left) and the month of May 2012 (right)



As a general remark note that the legend classes in the left hand ILWIS map window do not properly reflect - represent your data range. It is advised to always check the map values using the mouse, keeping the left mouse button pressed. You can also consult the histogram.

4.6 ETHIOPIA - IMPORT PRODUCTS FROM THE SPOT VEGETATION INSTRUMENT

4.6.1 *Import of a 10-day NDVI product from VGT Africa*

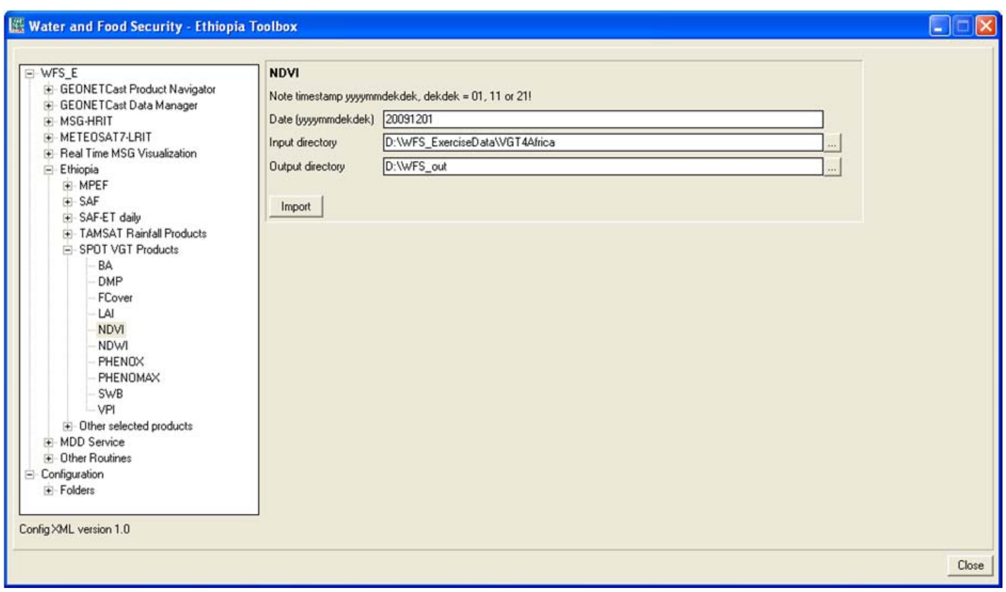
The LSA SAF is also producing products related to Vegetation Parameters. These products are based on the MSG-SEVIRI instrument and are generated on a daily basis. The products you are going to work with now are based on the SPOT Vegetation instrument and are 10-day aggregated products. Further information is provided in the VGT User Guide (see http://www.agricab.info/software/Pages/VGTExtract.aspx) and you can have access to the historical data using the following link: http://free.vgt.vito.be/.

Before starting to import the various products that are available in the GEONETCast data stream derived from the SPOT Vegetation Instrument you need to check the settings of the directories that contain the raw data. From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*SPOT VGT 4 Africa*". Browse to the appropriate data input and output locations and in the case of VGT4Africa products note that the data is stored in the directory "*D:\WFS_exercisedata\VGT4Africa*", where "*D:*" is the designated hard disk drive location. Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings.

Note that the VGT Africa products are a dekadal product, in order to import the various products the "*Date*" format here should be specified as: yyyymmdekdek, where dek stand for dekade. There are three dekades, specified as 01, 11 and 21, for the first 10 days, the second series of 10 days and the remaining days for the last dekade of the month respectively, so 20100121 as "Date" should be interpreted as: year = 2010, month = January, dekade = 21 (third decade of the month).

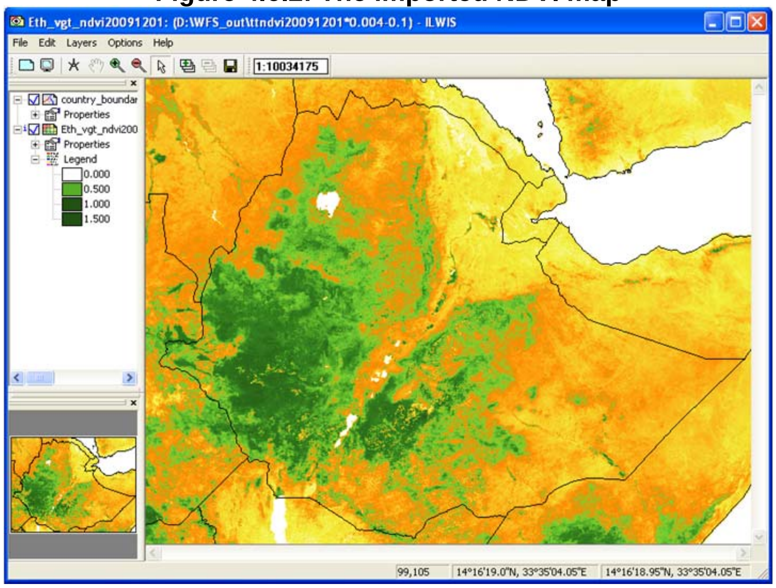
Consult the "*Vegetation for Africa User Manual*" and check the S10-NDVI product description (pp.97-105). The document can be downloaded from the online address provided above. For the exercise use is made of the 20091201 S-10 NDVI. From the "*WFS-Ethiopia*" and "*Toolbox*" menu select "*Ethiopia*" >> "*SPOT VGT Products*" >> "*NDVI*". To import the VGT4Africa NDVI map for Ethiopia, see also the specifications of figure 4.6.1. Also check the command line window information during the import.

Figure 4.6.1: VGT4Africa NDVI import window



Upon completion of the import select the imported NDVI map, here "*Eth_vgt_ndvi20091201*", display the map using as Representation "*NDVI1*". See also figure 4.6.2. Move the mouse while keeping the left mouse button pressed over the active map display window. Note the scaling and offset values used in the heading of the active map display window (see also table 3.3). Also display the country boundaries (no info! and boundaries only).

Figure 4.6.2: The imported NDVI map



In a similar way the other products disseminated via VGT4Africa can be imported. Continue to import a few other products, e.g the Leaf Area Index (LAI), the Fraction of Vegetation Cover (FCOVER) and PHENOKS. Use the same date / decade for these products as the NDVI map imported previously. In order to conduct the import select from the "*WFS-Ethiopia*" and "*Toolbox*" menu "*Ethiopia*" >> "*SPOT VGT Products*" and subsequently the required import routine for the product you want to import (BA, LAI, FCover, PHENOX, etc). Use the appropriate Representations for the products, e.g. for the NDVI:"*NDVI1*", for the FCover: "*fvc*", for the LAI: "*lai*" and for BA as well as the PHENOKS products (phstart, phhalf, phlength) a "*Pseudo*" Representation can be used. Note that for some classified products standard lookup tables are available, like for the classified DMP and VPI products. Consult again table 3.3 providing the information on the file names created for the various products and the calibration coefficients that are applied upon import. Also take notice of the information provided in the command line window when an import routine is executed, additional relevant information is presented there as well.

Note that for the BA product the file name convention is different. Here a yyyymmdd time stamp is required like 10, 20 or last day of the month as "dd" format. The map values of the BA, PHENOKS (phstart and phhalf) and PHENOMAX (Eth_vgt_phmaxyyyymmdekdek) represent as first 2 digits the number of years that have passed since 1980 and are followed by 3 digits indicating the Julian Day. The PHENOKS phlength product indicates the length of the growing season in dekades and the PHENOMAX maximum NDVI product (Eth_vgt_phmaxval) gives the maximum NDVI value. Check once more the description as provided in chapter 3.2.6.5 and see also a graphical representation given in figure 4.6.3 (source VGT4Africa User Manual, page 184) how season length is defined using the NDVI, also showing phstart (start of season), phhalf (half senescence) and maximum NDVI (phenomax).

Further information on the products can be obtained in the relevant sections of the "*VGT4Africa User Manual*". Upon completion of the import check the values of the maps created. The results should resemble those of figure 4.6.4. You can also import the other VGT products, such as the Dry Matter Productivity, Normalized Difference Water Index, Small Water Bodies and the

Vegetation Production Indicator. For the NDVI product also the status map is extracted. How to use and incorporate the status map will be treated in the next section.

Figure 4.6.3: Start, half senescence and length of season derived from NDVI time series

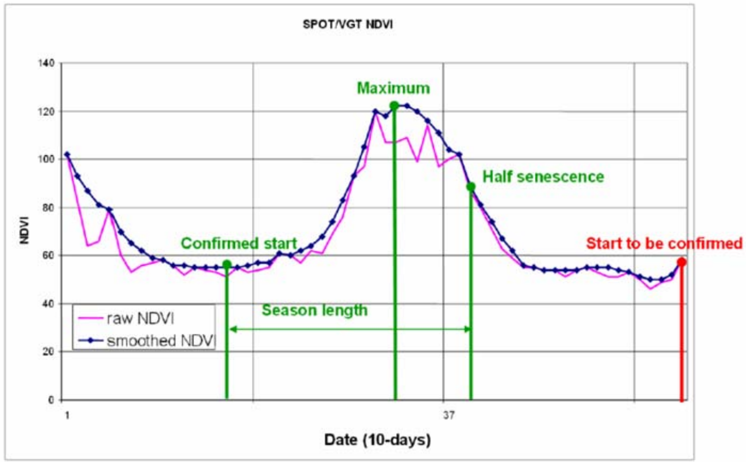
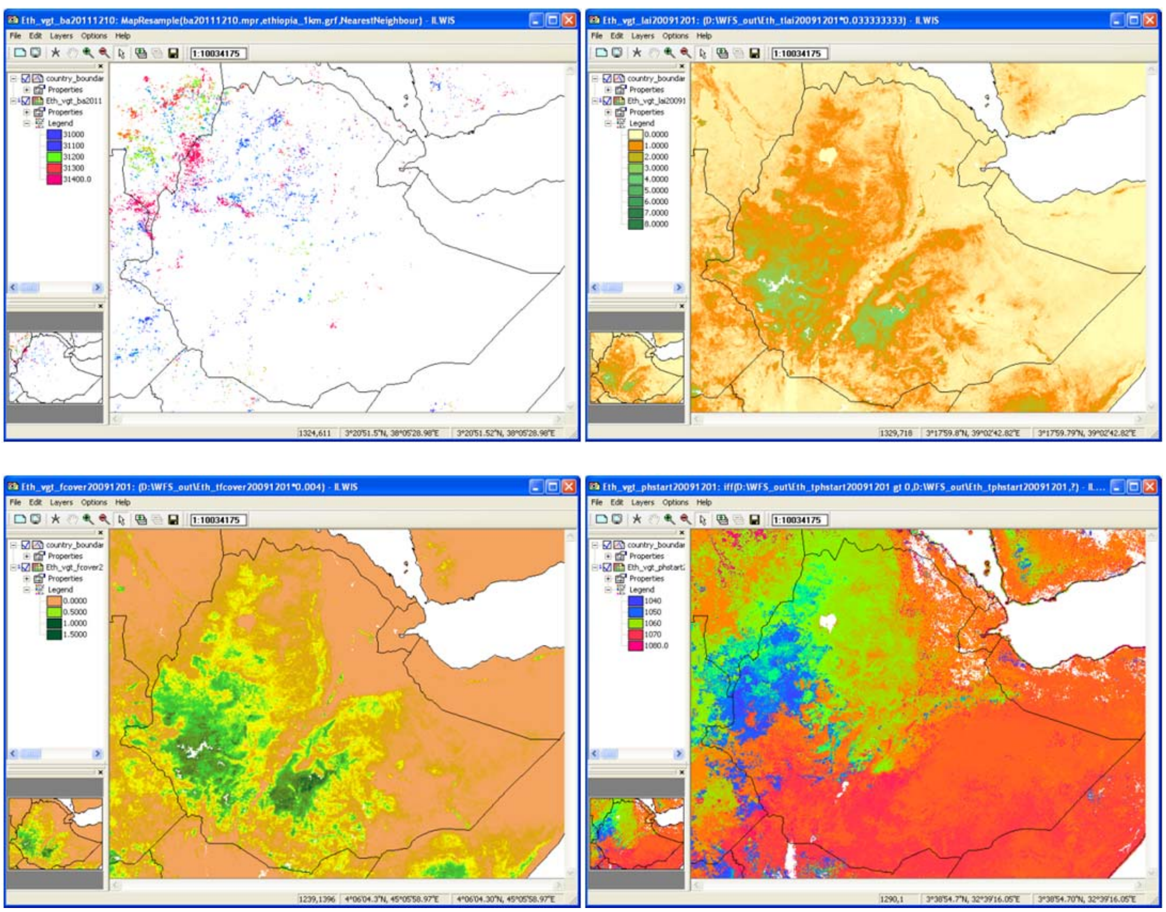
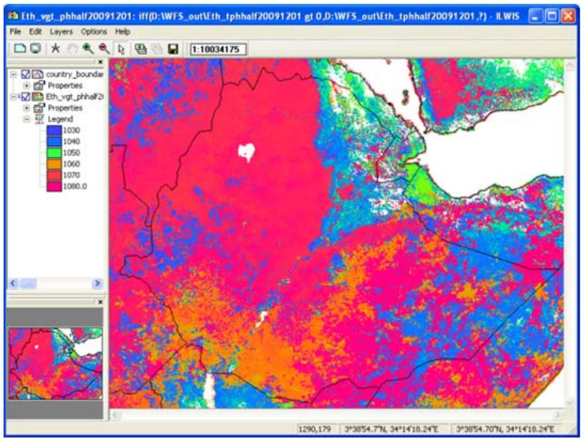
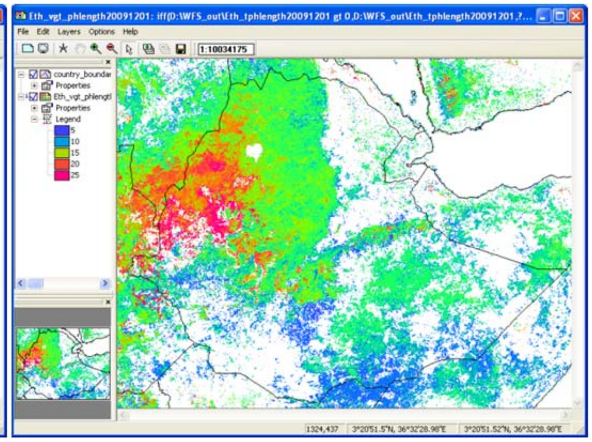


Figure 4.6.4: Imported BA (from 20111210), LAI, FCOVER and PHENOKS (phstart, phhalf and phlength) VGT4Africa products of 20091201







4.6.2 *VGT Africa NDVI correction using Status Map*

Some of the VGT4Africa products come with a status map which can be used to filter the values on their quality. Display the NDVI Status Map, using as Representation "*Gray*", which was created when importing the NDVI map ("Eth_vgt_ndvi20091201"), having the same name as the NDVI map but with a file name extension *"_SM*". Check the values of this map as well. Note that a byte range is used for this map. The status map needs to be interpreted on a bitwise basis. The status map flag filter matrix for the NDVI product is shown in figure 4.6.5.

Figure 4.6.5: The NDVI Status Map flag filter matrix

Bit Sequence								Meaning
X	X	X	X	X	X	0	0	Clear (cloud-free) pixel
X	X	X	X	X	X	0	1	Shadow detected
X	X	X	X	X	X	1	0	Shadow/cloud detection is uncertain
X	X	X	X	X	X	1	1	Cloud detected
X	X	X	X	X	0	X	X	No ice/snow
X	X	X	X	X	1	X	X	Ice/snow detected
X	X	X	X	0	X	X	X	Sea/water pixel
X	X	X	X	1	X	X	X	Land pixel
X	X	X	0	X	X	X	X	Bad radiometric quality of SWIR band (interpolated value)
X	X	X	1	X	X	X	X	Good radiometric quality of SWIR band
X	X	0	X	X	X	X	X	Bad radiometric quality of NIR band (interpolated value)
X	X	1	X	X	X	X	X	Good radiometric quality of NIR band
X	0	X	X	X	X	X	X	Bad radiometric quality of red band (interpolated value)
X	1	X	X	X	X	X	X	Good radiometric quality of red band
0	X	X	X	X	X	X	X	Bad radiometric quality of blue band (interpolated value)
1	X	X	X	X	X	X	X	Good radiometric quality of blue band

The bit position of the Status Map (in byte format) generated needs to be interpreted from right to left (under Bit Sequence):

7	6	5	4	3	2	1	0
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

The red circles in figure 4.6.5 define the criteria that can be used to select only the good NDVI quality pixels for further analysis:

Clear (cloud-free) pixel	bit sequence position 0 (2^0)	flag = 0
Clear (cloud-free) pixel	bit sequence position 1 (2^1)	flag = 0
Land pixel:	bit sequence position 3 (2^3)	flag = 1
Good radiometric quality of NIR band:	bit sequence position 5 (2^5)	flag = 1
Good radiometric quality of red band:	bit sequence position 6 (2^6)	flag = 1

To address this, the following bit pattern sequence applies: X ***1 1*** X ***1*** X ***0 0*** , at the 0^{th}, 1^{st}, 3^{rd},5^{th} and 6^{th} position in the bit sequence (from right to left!). Note that the “X” position is not indicating a relevant flag in the case of this NDVI product.

To test if the bits at these positions are according to the selection criteria the DIV and MOD operators in ILWIS can be used:

DIV: The integer division operator divides two integers and returns the integer quotient, i.e. *a* DIV *b*. (248 DIV 8 = 31,   246 DIV 8 = 30)

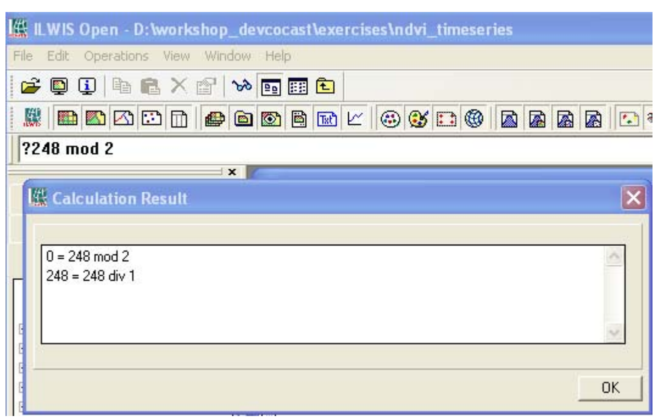
MOD: The modulus operator returns the remainder of *a* divided by *b*, i.e. *a* MOD *b*. (10 MOD 3 = 1, 11 MOD 5 =1)

Assuming we have an output Status Map pixel value of 248. To test whether for this pixel the flag value at the first bit position (0^{th} position) is 0, the pixel value is divided by the corresponding power of 2, in this case 1, as 1 is being the result of 2^0. Type the following command on the ILWIS command line in the main ILWIS menu (see also figure 4.6.6):

?248 DIV 1,

press <enter> and you will see as output value 248

Figure 4.6.6: the DIV and MOD operators from the ILWIS command line



Now the MOD operator is used to check if there is any remainder if divided by 2 (as a bit can only consist of a 0 or a 1):

?248 MOD 2

A value of 0 is returned as there is no remainder if divided by 2. Note that with the “?” prior to the expression the ILWIS command line can be used as a pocket calculator

To test whether for this pixel value the second position is 0, the pixel value is divided by the corresponding power of 2, in this case 2, as 2 is being the result of 2^1:

248 DIV 2 = 124
124 MOD 2 = 0

To test whether for this pixel value the fourth position is 1, the pixel value is divided by the corresponding power of 2, in this case 8, as 8 is being the result of 2^3:

248 DIV 8 = 31
31 MOD 2 = 1 (as the remainder of the division by 2 is 1)

To check this for the 5th (2^5 = 32) and 6th (2^6 = 64) position the procedure is identical:

248 DIV 32 = 7	7 MOD 2 = 1
248 DIV 64 = 3	3 MOD 2 = 1

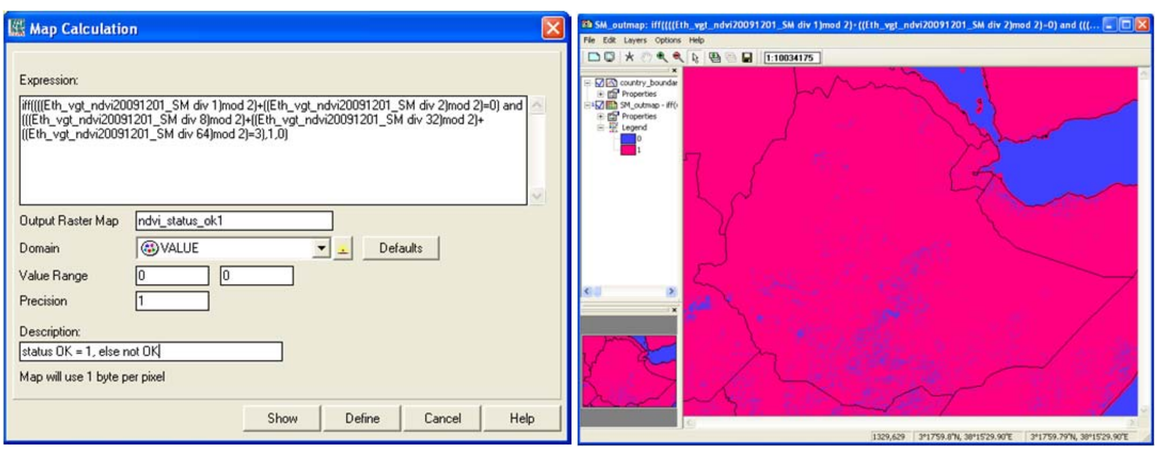
In the example of a pixel value in the status map of 248, for the 0th,1st, 3rd, 5th and 6th position are 0, 0, 1, 1 and 1 respectively. They are meeting the above indicated selection criteria. Check it yourself using as Status Map flag value: 232 and think of the "?" in front of the expression if the ILWIS command line calculator option is used.

A sample ILWIS "*map calculation*" statement to extract the 5 selection criteria from the bit sequence positions is:

outmap:=iff((((*ndvi_sm* div 1)mod 2)+((*ndvi_sm* div 2)mod 2)=0) and (((*ndvi_sm* div 8)mod 2)+((*ndvi_sm* div 32)mod 2)+((*ndvi_sm* div 64)mod 2)=3),1,0)

Note that: "*outmap"* = the output map and "*ndvi_sm* "= the status map that belongs to the NDVI map. To use this expression open from the main ILWIS menu the "*Operations*" item and select from the drop down menu "*Raster Operations*" menu and subsequently "*Map Calculation*". Enter the appropriate expression; here "*Eth_vgt_ndvi20091201_SM*" is used as status map. The other settings are specified in figure 4.4.6 as well as the output map generated, using "*Pseudo*" Representation for visualization of the map.

Figure 4.4.6: Map Calculation expression to extract the relevant NDVI flags (left) and resulting output map (right)



The output map has two values, 0: "<u>not meeting the selection criteria</u>", and 1: "<u>meets all criteria</u>". This map can now be used to retain only those values in the NDVI map that meet the selection criteria.

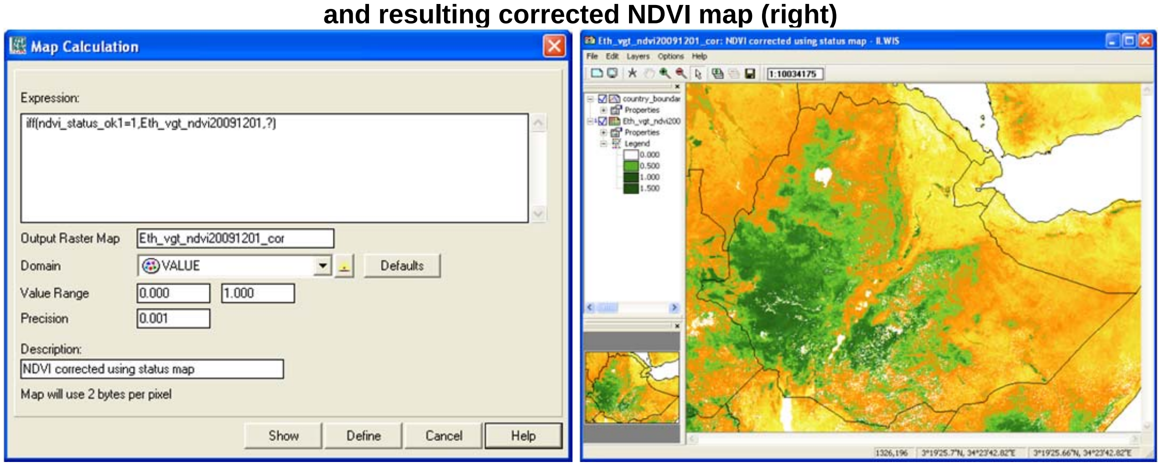
In order to derive the NDVI map for only those areas that have passes the quality assessment, open from the main ILWIS menu the "*Operations*" item and select from the drop down menu "*Raster Operations*" and subsequently "*Map Calculation*". Enter the appropriate expression:

iff(ndvi_status_ok1=1,Eth_vgt_ndvi20091201,?)

Specify as output map: "*Eth_vgt_ndvi20091201_cor*", "*domain*": "*Value*" and "*Range*" from 0 to 1, "*precision*": 0.001

Display the resulting corrected NDVI map as well as the status map using the appropriate Representations. Note that in the expression a "*?*" is used, this results in "*not_a_value*" or undefined areas for those pixels that do not meet the status criteria (which have been assigned 0 in the status map). If you compare your results with the status map you will see that the blue coloured pixels over land are now undefined (check the map value and you will see a "?" returned for these areas), for those pixels that have been assigned 1 in the status map the NDVI value is assigned. Your results should resemble those given in figure 4.4.7.

Figure 4.4.7: Map calculation to correct the NDVI map using the flagged status map (left) and resulting corrected NDVI map (right)



Some of the other VGT4Africa also have a status map. Currently only for the NDVI product the status map is extracted. The procedure how this is done can be seen from the batch file that is used for the import of this VGT4Africa NDVI product. To check the batch file use the Explorer, browse to the ILWIS directory and move to the following sub directory: *Extensions\WFS_E-Toolbox\toolbox_batchroutines*. In this sub-directory look for the file: "*VGT4_eth_ndviimport.bat*". Right click the mouse button over this filename and select "edit" to see the content of this batch routine. The necessary commands can be extracted from here and added to the other batch import routines if for these products the Status Map needs to be processed as well.

Note that the DIV and MOD operator expression used need to be changed when other status maps are being used, as the flag settings are different. Consult the VGT4Africa User Manual for further details on the other status maps.

4.6.3 ***Deriving statistical information, aggregated per Woreda***

Display once more the "*Eth_vgt_ndvi20091201_cor"* map created during the previous exercise, using as Representation "*NDVI1*". Now add to this map the polygon map "woredas. To do so open from the active map display window menu the option "*Layers*" and from the context sensitive menu "*Add Layer*", leave the option "*Info*" active and display "*Boundaries only*". Activate the "*Normal*" option from the active map display window. When you move the mouse cursor over the polygon map and simultaneously press the left mouse button you can see the values, here the woreda codes from the vector layer.

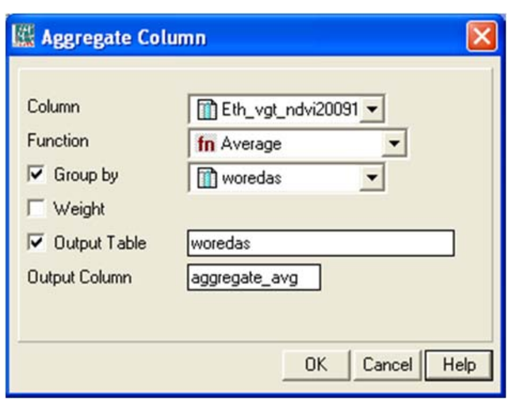
From the active map display window select from the menu "*File*" and from the drop down menu select "*Open Pixel Information*". Move the mouse cursor over the vector layer and check the changing values in the Pixel Information table. After having checked the table content for the different woredas, close all active layers.

The next step is to convert the Polygon map "woredas" to a Raster format, using the georeference of the Ethiopian window used. Open from the main ILWIS menu "*Operations*", subsequently "*Rasterize*" and "*Polygon to Raster*". Select as polygon map: "*woredas*" and as output map you can specify the same name: "*woredas*" (a new raster layer will be obtained) and select the georeference that belongs to the Ethiopian window, in this case: "*Ethiopia_1km*". When the polygon to raster conversion is completed, press "*OK"* to show the raster map of the woredas. Move the mouse cursor over the map and check the values. Once more open from the active map display window the menu item "*File*" and from the drop down menu select "*Open Pixel Information*". Check the relationship between the map and the table.

Now you can cross both maps. Open from the main ILWIS menu "*Operations*", subsequently "*Raster Operations*" and "*Cross*". Specify as first map: "*woredas*" and as second map the NDVI map: "*Eth_*vgt*_ndvi20091201_cor*". Specify as output cross table: "*woredas_ndvi*", all other options can be left as default, like "*Ignore Undefined*" and don't "*Create an Output Map*". Execute the map crossing by pressing "*Show*". After the crossing is completed the cross table will appear on your screen. Check the content of the table.

Note that for the column "woredas" in the cross table the left alignment of the numbers, these are identifiers (ID's) and not values! Select from the Table menu the option: "*Columns*" and from the drop down menu: "*Aggregation*". Specify other settings according to figure 4.4.8 and press "*OK*" to calculate the average NDVI per woreda. Note that a new column in the output table: "*woredas*" is being created by this operation.

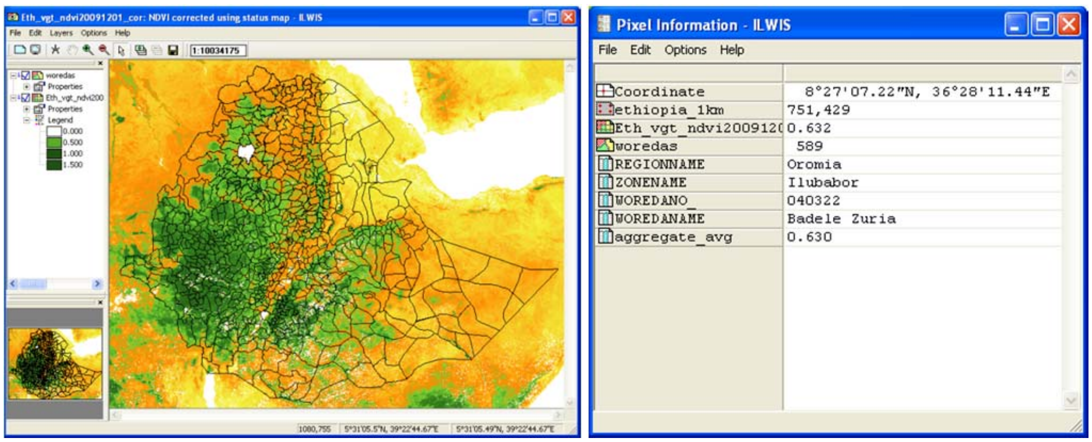
Figure 4.4.8: Create new output column table with aggregated statistics, grouped per woreda, using the function average for the NDVI



Close the cross table “*woredas_ndvi*” and open the table called: “*woredas*”, which belongs to the raster map “woredas” and check all the values in this table. Note once more that a new column has been added in this table according to the aggregated information from the cross table, called “*aggregate_avg*”.

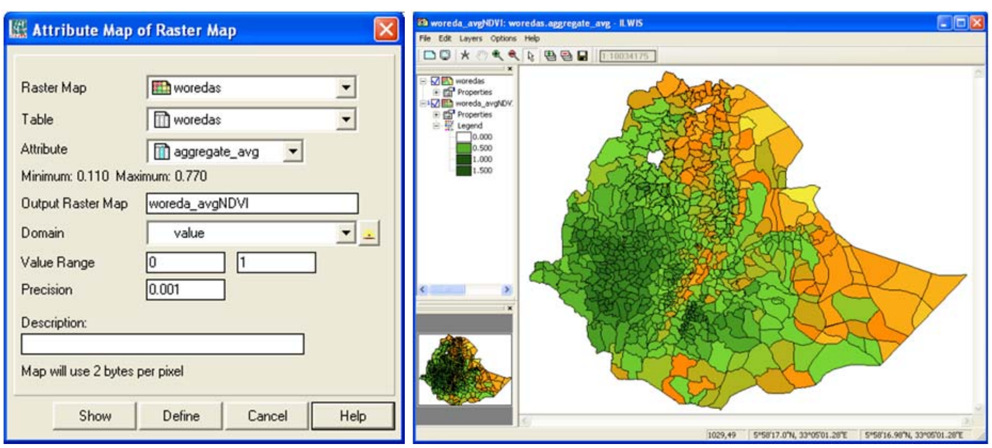
Display the sub map “*Eth_*vgt*_ndvi20091201_cor*” and add the polygon layer “*woredas*”, select boundaries only. Open from the active map display window “*File*” and “*Open Pixel Information*”. Inspect your results. They should resemble those of Figure 4.4.9.

Figure 4.4.9: NDVI map of Ethiopia and aggregated statistics appended to map table



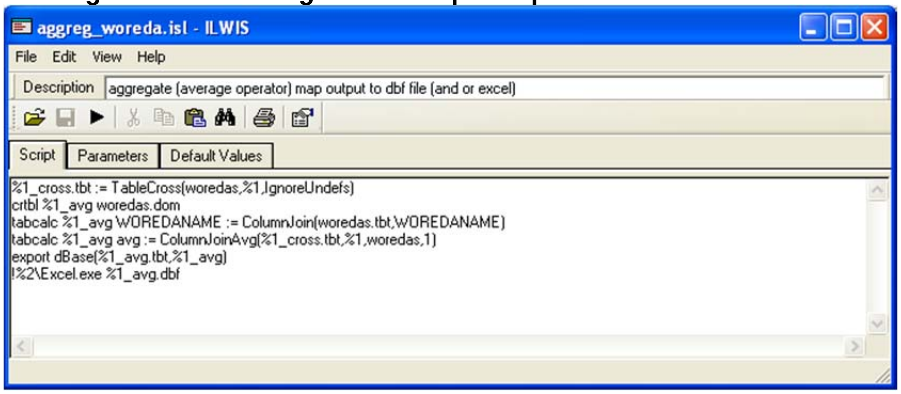
The woredas raster map can now be reclassified to see the spatial distribution of the averaged NDVI for each woreda. Right click with the mouse on the raster map “*woredas*”, select from the context sensitive menu “*Raster Operations*” >> “*Attribute Map*”, provide the information as given in the left hand figure below and press “*Show*” to execute the operation. Display the new map created “*woreda_agvNDVI*”, using as Representation “*NDVI1*”. Your results should resemble those of figure 4.4.10.

Figure 4.4.10: Average NDVI per woreda



The operations conducted above might require further analysis of the data in a spread sheet, like in Microsoft Excel. The table “woredas” can be manually exported to dBase DBF format and used in Excel. The whole procedure can also be automated when using ILWIS scripting language. An example script is provided here, open the script “*aggreg_woreda*” and check the content. See also figure 4.4.11.

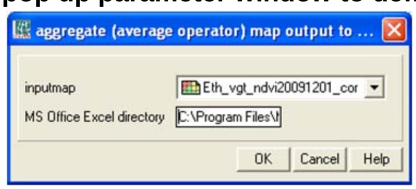
Figure 4.4.11: Using ILWIS scripts to perform certain routines



Note that line 1 is creating the cross table, line 2 is creating a new table, line 3 is creating a new column ("Woredaname") from the initial ILWIS table, line 4 is creating a new column and is calculating the average, line 5 exports this table to dBase and line 6 starts Excel and shows the newly created table.

Here two parameters (%1 and %2) are used, for the first one the input map needs to be specified, the second parameter specifies the location of Excel on your system. Open the "*Parameters*" tab to see how these are specified and when starting the script the user has to enter the required input in a new pop up window as given in the figure below. This has the advantage that the script does not need to be modified, even if other input maps are used.

Figure 4.4.12: The pop up parameter window to define the script input



Press the ▶"*Run script*" icon and specify as input map "*Eth_vgt_ndvi20091201_cor*" and furthermore specify the directory location of Excel.exe on your system (e.g. C:\Program Files\Microsoft Office\Office14) and press "*OK*" to execute the script. The new table created will be shown in Excel, check the content of the table.

More applications using data disseminated through GEONETCast in conjunction with local observations, utilizing the processing and analysis capability of ILWIS is provided in the "*DevCoCast Application Manual*". This resource is available online at: http://www.itc.nl/Pub/WRS/WRS-GEONETCast/Application-manual.html, including exercise descriptions and sample data. So if you want to learn more take a look at these resources as well.

4.7 ETHIOPIA - IMPORT OF OTHER SELECTED PRODUCTS.

Within the GEONETCast-EUMETCast data stream, various other near real time products are produced. In collaboration with the National Meteorological Agency, Ministry of Agriculture (Early Warning and Response Directorate) and the World Food Programme, Ethiopia office a few products have been selected and import routines have been developed. Here attention is given to fire products which also cover Ethiopia (from MSG and MODIS) and surface soil moisture derived from the ASCAT instrument on board of METOP. The exercises below elaborate into more detail how this data can be incorporated.

4.7.1 *Import ABBA – MSG fire product*

Currently within the AMESD-SADC service on GEONETCast there is a fire product, the so called Automated Biomass Burning Algorithm (ABBA) product, showing the MSG Active Fires captured for whole Africa. Further information can be obtained from http://cimss.ssec.wisc.edu/goes/burn/wfabba.html. Fire locations are provided as well as additional fire characteristics, like instantaneous fire size, fire temperature and fire radiative power. Upon extraction of the product it is provided as tabular information.

Before starting to import the ABBA fire product that is available in the GEONETCast data stream you need to check the settings of the directories that contain the raw data. From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*ABBA-MSG*". Browse to the appropriate data input and output locations and in the case of these fire products note that the data is stored in the directory "*D:\WFS_exercisedata\ABBA_MSG"*, where "*D:*" is the designated hard disk drive location. Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings.

In order to import this type of fire information, from the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "*Ethiopia*" >> "*Other selected products*" >> "*ABBA-MSG Fire product*". To import a fire product for 20120120715, enter "*20120120715* "on the Date stamp and press "*Import*". Note the format that is required for the Date stamp as here Julian Day is used (yyyyjjjhhmm).

After the import is completed open the raster map "*ABBA_MSG20120120715"*, use the default Representation. Add the country boundary vector file "*country_boundaries*", no info and boundaries only, use a black colour for the boundaries. Also add the point map having the same name, using the default display settings. From the menu of the active map display, select "*File*" >> "*Open Pixel Information*" and move your cursor over a fire pixel and note the content of the pixel information window over that fire location. Eventually zoom in on the map, as example see also figure 3.11.

4.7.2 *Import multiple MODIS Aqua and Terra Fire Products*

This is the most basic fire product in which active fires and other thermal anomalies, such as volcanoes, are identified. The Level 2 product is defined in the MODIS orbit geometry covering (per image) an area of approximately 2340 by 2030 km in the across- and along-track directions, respectively. It is used to generate all of the higher-level fire products, and contains the following components:

- an active fire mask that flags fires and other relevant pixels (e.g. cloud);
- a pixel-level quality assurance (QA) image that includes 19 bits of QA information about each pixel;
- a fire-pixel table which provides 19 separate pieces of radiometric and internal-algorithm information about each fire pixel detected within a granule;
- extensive mandatory and product-specific metadata;

- a grid-related data layer to simplify production of the Climate Modeling Grid (CMG) fire product.

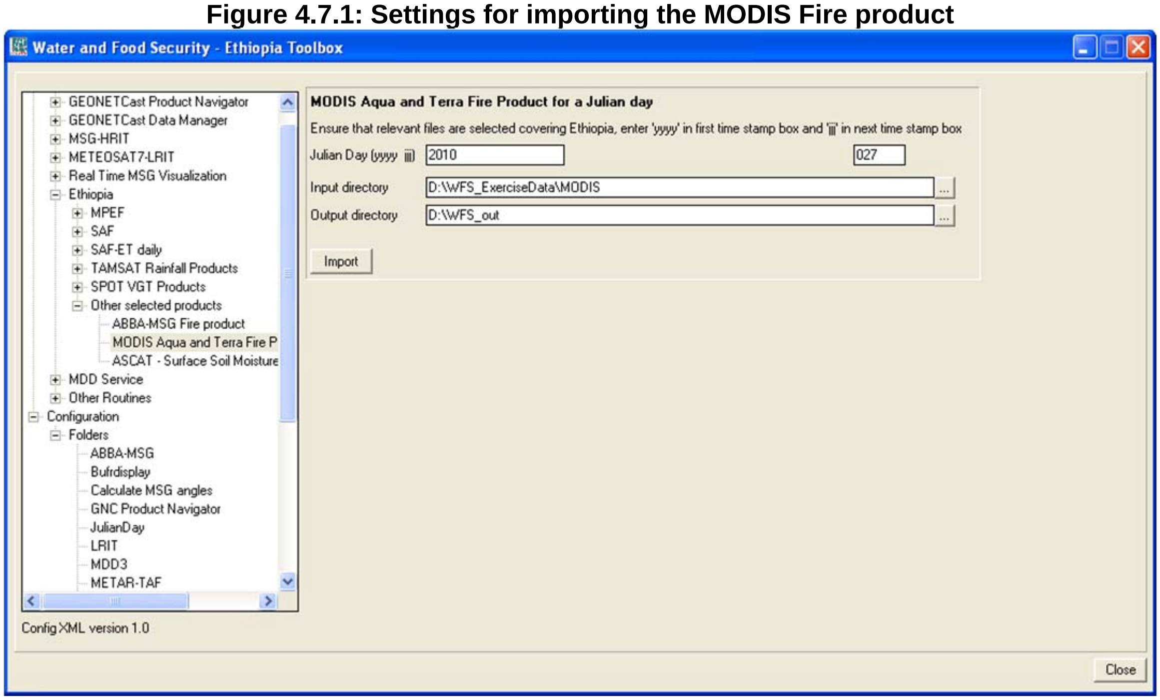
Product-specific metadata within the Level 2 fire product includes the number of cloud, water, non-fire, fire, unknown, and other pixels occurring within a granule to simplify identification of granules containing fire activity (source: Geonetcast Product Navigator).

Keep in mind that the MODIS Terra is passing over the equator during the morning and evening, the Aqua is having an afternoon and night time overpass (local time). As this MODIS Fire Product is a global product 2 * 270 files are generated which need to be processed on a daily basis to cover the whole globe. Here we only want to select a certain area and therefore only those MODIS Terra and Aqua fire products that are recorded over Ethiopia have to be selected for a certain Julian day. To conduct such a selection use can be made of Satellite Orbit Tracking software utilities, see also Appendix 1.

Before starting to import the MODIS fire products that are available in the GEONETCast data stream you need to check the settings of the directories that contain the raw data. From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*MODIS-Fire*". Browse to the appropriate data input and output locations and in the case of these MODIS products note that the data is stored in the directory "*D:\WFS_exercisedata\ MODIS"*, where "*D:*" is the designated hard disk drive location. Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings.

In the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "Ethiopia" >> "Other selected products" >> "*MODIS Aqua and Terra Fire Product for a Julian Day*". Having relevant files covering Ethiopia in the input sub-directory (here the sub-directory "*MODIS*" is used), you can start the import of the multiple MODIS fire files. Specify the appropriate year ("*2010*") and Julian day number ("*027*") and press "*Import*". See also the figure below. The import will start and processes all files, for those that contain fires, the vector files will be retrieved and transformed into a point map with associated table. Also check the command line window information during the import. Wait until the import has finished and refresh the catalogue of your working directory.

Figure 4.7.1: Settings for importing the MODIS Fire product



After the import has been completed open the vector file "*country_boundaries*", no info and boundaries only, use a red colour for the boundaries. Now with the left mouse button select the first imported fire point maps (fireA* and fireP*, *=yyyyjjj_hhmm) (MODIS-P = AQUA, MODIS-A = TERRA) and drag it to the active map display window, press "*OK*" to accept the default display options. You can start with the point map "*FireA2010027_0820*". Repeat the procedure for a number of other point maps in the catalogue and note the area covered and the time stamp. Zoom to the Ethiopian region to see the spatial distribution of the fires. Also open one of the associated tables belonging to a point map, from the menu of the active map display, select "*File*" >> "*Open Pixel Information*" and move your cursor over a fire pixel and note the content of the pixel information window over that fire location. Your results should resemble those as of figure 3.12 (when using the point map 'FireA2010027_0820').

4.7.3 ***ASCAT Surface Soil Moisture processing***

The Surface Soil Moisture L2 product is derived from the Advanced SCATterometer (ASCAT) data and given in swath geometry. This product provides an estimate of the water saturation of the 5 cm topsoil layer, in relative units between 0 and 100 [%]. The algorithm used to derive this parameter is based on a linear relationship of soil moisture and scatterometer backscatter and uses change detection techniques to eliminate the contributions of vegetation, land cover and surface topography, considered invariant from year to year. Seasonal vegetation effects are modeled by exploiting the multiple viewing capabilities of ASCAT. The processor has been developed by the Institute of Photogrammetry and Remote Sensing of the Vienna University of Technology (source: GEONETCast Product Navigator). The import routine available here supports the import of the product that is available in 12.5 km point sampling distance. Further information is provided in the ASCAT Product Guide, available at: http://oiswww.eumetsat.org/WEBOPS/eps-pg/ASCAT/ASCAT-PG-index.htm.

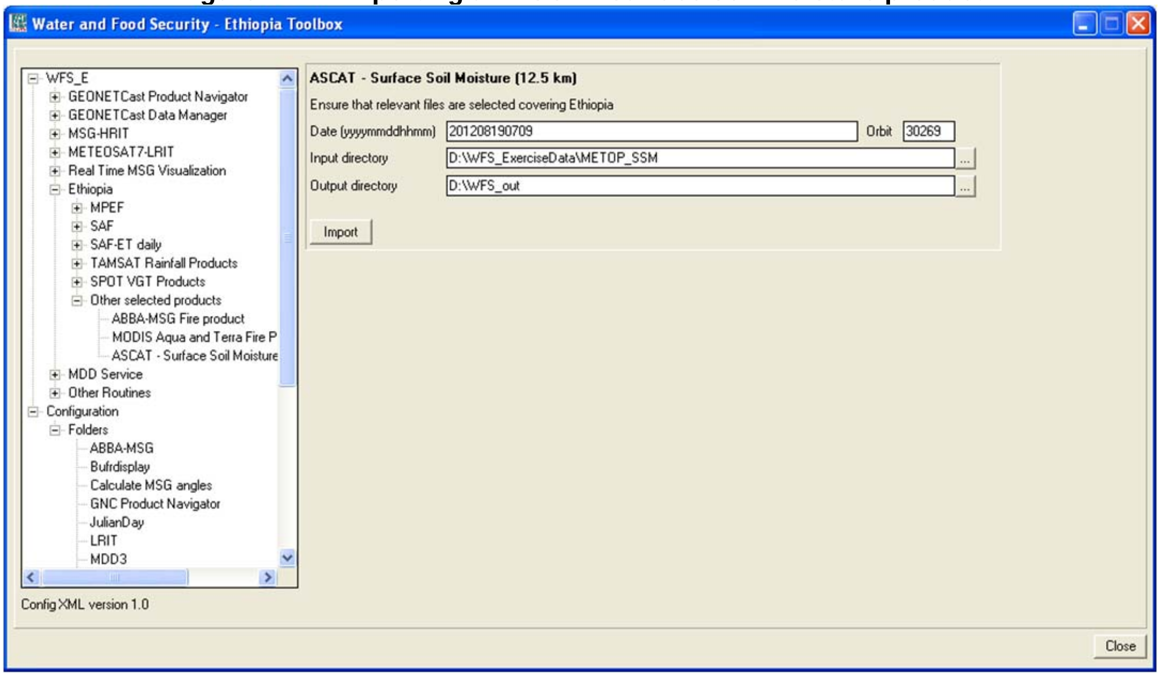
Before starting to import the ASCAT surface soil moisture products that are available in the GEONETCast data stream you need to check the settings of the directories that contain the raw data. From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*METOP-SSM*". Browse to the appropriate data input and output locations and in the case of these ASCAT products note that the data is stored in the directory "*D:\WFS_exercisedata\METOP_SSM*", where "*D:*" is the designated hard disk drive location. Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings.

It should be noted that nearly 500 products are available on a daily basis as it is a global product. Starting point of the process is to make a selection of the relevant products covering the area of interest. Use can be made of Satellite Orbit Tracking software utilities, see Appendix 1.

In the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "Ethiopia" >> "Other selected products" >> "*ASCAT - Surface Soil Moisture (12.5 km)*". Note the specifications from figure 4.7.2 below and conduct the import, by pressing "*Import*".

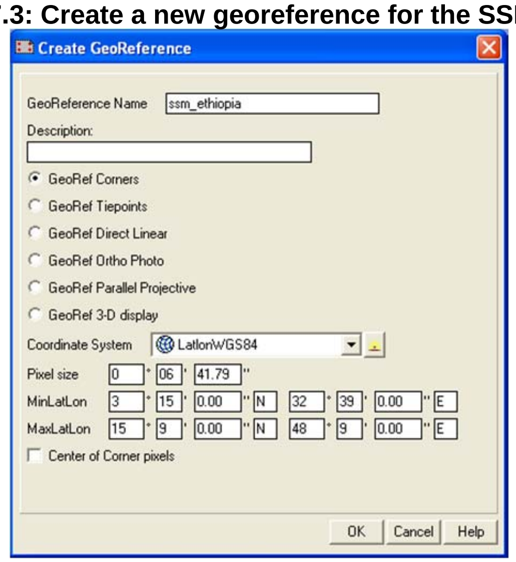
After the import has been completed, refresh the ILWIS catalogue. Note that two new files have been created, a point map "*ssm201208190709_smperc*" and the associated table "*ssm201208190709*". First open the table "*ssm201208190709*" and inspect the content. Note that the column "SM_Perc" has been used to create the point map, close the table when finished. Display the point map "*ssm201208190709_smperc*" using the default display settings and press "*OK*". Display also the "*country_boundaries*" and use a red boundary colour. Zoom in over one of the recorded strips, e.g. over the central-eastern part of Ethiopia and keep the left mouse button pressed to check the point values. From the active map display window activate the option "Measure Distance", by clicking on the icon and check yourself the distance between the centers of the sampling points, both along and across track.

Figure 4.7.2: Importing an ASCAT surface soil moisture product



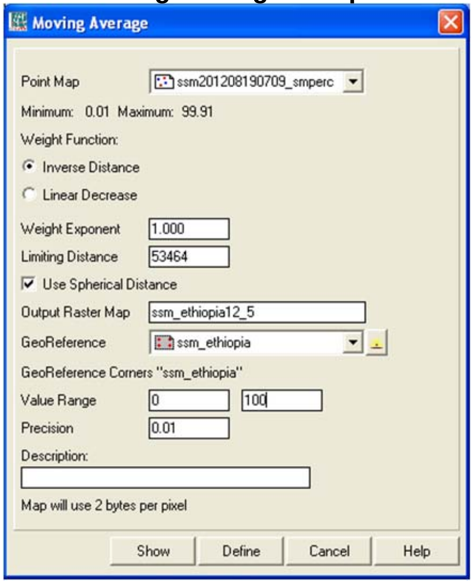
This point map can be used for interpolation. As the point sampling distance of the product is 12.5 km it does not make sense to resample it to 1 km using the "Ethiopia_1km" georeference. A new georeference can be created which can be used for the purpose of interpolation. Assuming that 1 degree at the equator is 112 km, 12.5 km represents 0.111607142 decimal degree or 0º6'41.79''. From the main ILWIS menu, select the options "*File*" >> "*Create*" >> "*Georeference*" and specify the settings as given in figure 4.7.3. Here we are using the coordinate boundaries for the "Ethiopia" window, but apply a different pixel size (which is more in line with the product resolution!). Press "*OK*" when all parameters are entered to create this new georeference.

Figure 4.7.3: Create a new georeference for the SSM product



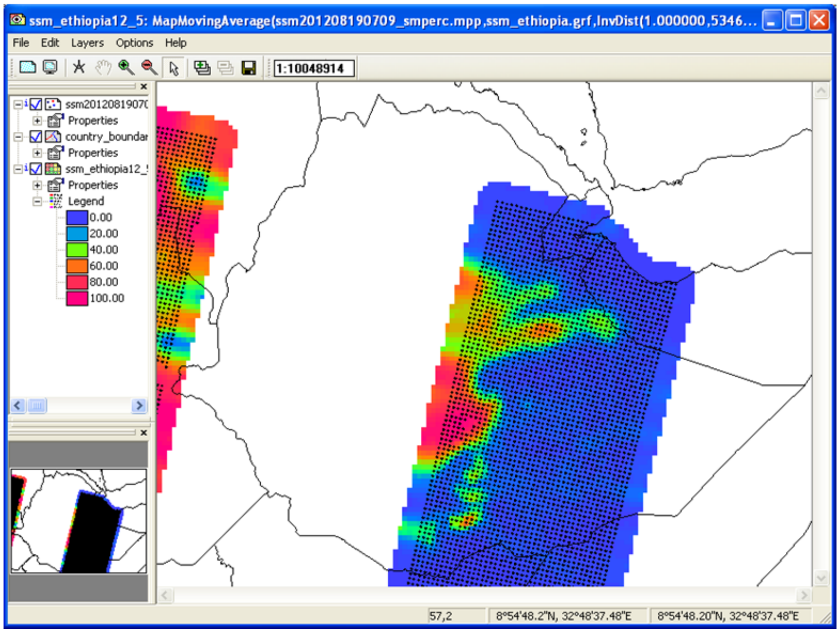
Now from the main ILWIS menu, select the options "*Operations*" >> "*Interpolation*" >> "*Point Interpolation*" >> "*Moving Average*". Specify the settings as given in figure 4.7.4 and press "*Show*".

Figure 4.7.4: Moving Average Interpolation settings



Wait until the interpolation procedure has finished and display the resulting raster map, here specified as "*ssm_ethiopia12_5*", using as Representation "*Pseudo*" and add the "*country_boundaries*". Note that for the interpolation a Spherical Distance is used as here the georeference used is having geographic coordinates. Also add the point map, in the point map display window use the button "*Symbol*", now uncheck the "*Stretch*" option, as point size use 2 and as fill colour select "*Black*". Press "*OK*" to show this point map. Check the values of the map using Pixel Information. Your results should resemble those given in figure 4.7.5.

Figure 4.7.5: Interpolated Surface Soil Moisture Map, using a moving average method



4.8 METEOROLOGICAL DATA DISSEMINATION SERVICE

As stated already in chapter 3, the data disseminated by this service is restricted to National Meteorological Services and their Partner Organizations. Import routines have been developed in collaboration with the National Meteorological Agency (NMA) of Ethiopia to allow access to this data stream, especially for the regional NMA offices. Based on their preferences a number of import routines are developed and these are elaborated upon below.

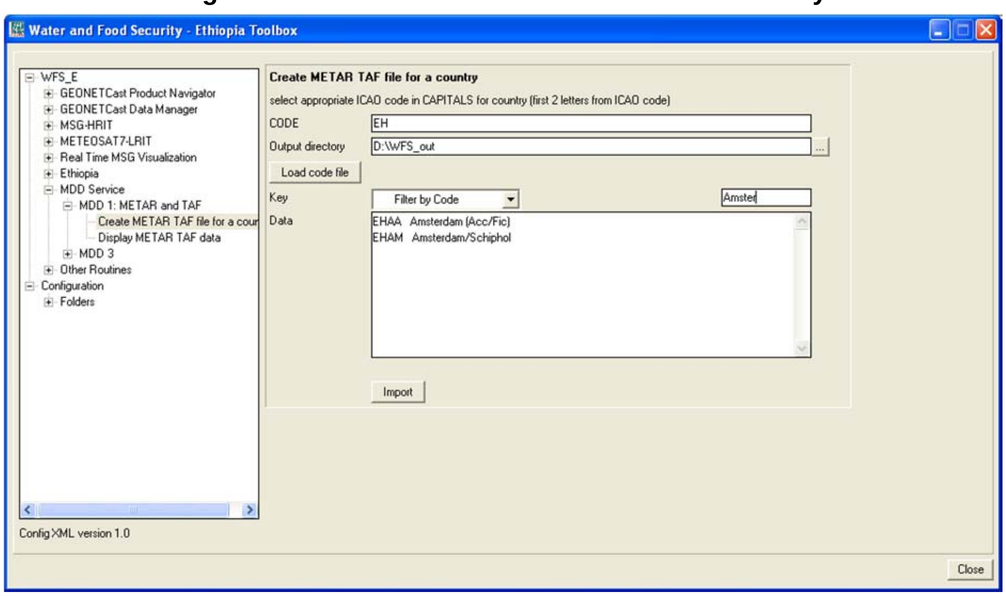
4.8.1 *Nominal MDD – 1 Service*

The nominal MDD1 data provide METAR and TAF messages for the major airports in the world. On a continuous basis these coded messages are received and use is made here of a freeware utility, called "MetarWeather", for decoding and report generation. The procedure adopted is consisting of two steps. First from all messages that have been received, those messages covering a country are retrieved and the messages are stored in a new file in the specified output directory. Once this file is available these messages are loaded in "MetarWeather" for visualization of the content and generation of the reports.

Before starting to import the METAR and TAF products that are available in the GEONETCast data stream derived from the Meteorological Data Dissemination Service you need to check the settings of the directories that contain the raw data. From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*METAR-TAF*". Browse to the appropriate data input and output locations and in the case of the MDD1 products note that the data is stored in the directory "*D:\WFS_exercisedata\MDD\MDD1"*, where "*D:*" is the designated hard disk drive location. Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings.

In order to import the MDD1 messages, from the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "*MDD Service*" >> "*MDD1: METAR and TAF*" >> "*Create METAR TAF file for a country*". In the subsequent menu the country code needs to be specified according to the ICAO naming convention. The option "*Load code file*" can be used to get country codes by typing the name of a city / airport for the respective country, see figure 4.8.1 as an example for the Netherlands. The country code here is "EH" and should be entered under the CODE field.

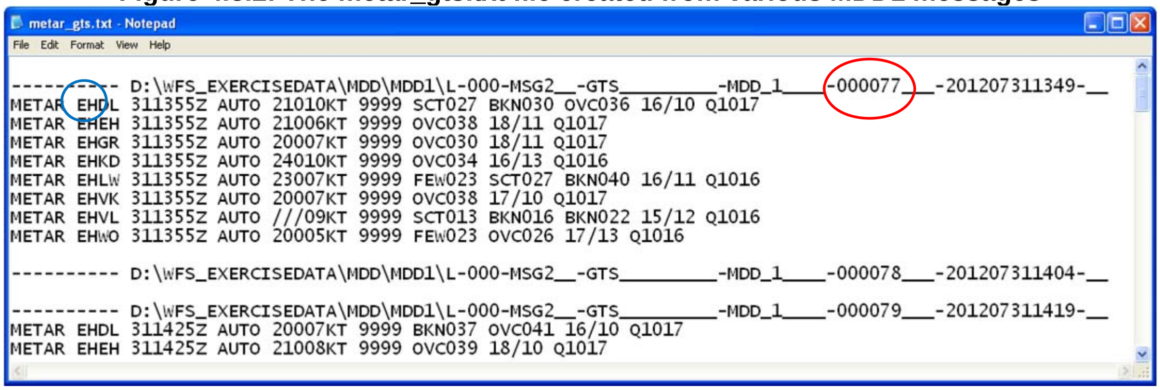
Figure 4.8.1: Create a METAR-TAF file for a country



After the appropriate code has been obtained (note it should be provided in Capitals), the routine checks the content of all MDD1 messages stored in the specified input directory and creates a new file in the specified output directory, called “*metar_gts.txt*”.

Press “Import” and after the routine has finished, use your Windows Explorer, navigate to the output directory, double click with the mouse on the file “*metar_gts.txt*” to take note of the content. An example of such a file is provided in figure 4.8.2.

Figure 4.8.2: The metar_gts.txt file created from various MDD1 messages



```
metar_gts.txt - Notepad
File  Edit  Format  View  Help

---------- D:\WFS_EXERCISEDATA\MDD\MDD1\L-000-MSG2__-GTS_________-MDD_1____-000077___-201207311349-__
METAR EHDL 311355Z AUTO 21010KT 9999 SCT027 BKN030 OVC036 16/10 Q1017
METAR EHEH 311355Z AUTO 21006KT 9999 OVC038 18/11 Q1017
METAR EHGR 311355Z AUTO 20007KT 9999 OVC030 18/11 Q1017
METAR EHKD 311355Z AUTO 24010KT 9999 OVC034 16/13 Q1016
METAR EHLW 311355Z AUTO 23007KT 9999 FEW023 SCT027 BKN040 16/11 Q1016
METAR EHVK 311355Z AUTO 20007KT 9999 OVC038 17/10 Q1017
METAR EHVL 311355Z AUTO ///09KT 9999 SCT013 BKN016 BKN022 15/12 Q1016
METAR EHWO 311355Z AUTO 20005KT 9999 FEW023 OVC026 17/13 Q1016

---------- D:\WFS_EXERCISEDATA\MDD\MDD1\L-000-MSG2__-GTS_________-MDD_1____-000078___-201207311404-__

---------- D:\WFS_EXERCISEDATA\MDD\MDD1\L-000-MSG2__-GTS_________-MDD_1____-000079___-201207311419-__
METAR EHDL 311425Z AUTO 20007KT 9999 BKN037 OVC041 16/10 Q1017
METAR EHEH 311425Z AUTO 21008KT 9999 OVC039 18/10 Q1017
```

As can be seen from this file, MDD1 message number 77 (see red ellipse) is containing messages for the ICAO code used (see blue circle), message number 78 is not containing valid information and message 79 has again relevant reports, etc.

For transformation of the METAR and TAF coding used into a more ‘readable’ output use is made of MetarWeather. From the “*WFS-Ethiopia*” and “*Toolbox*” main menu select the option “*MDD Service*” >> “*MDD1: METAR and TAF*” >> “*Display METAR TAF data*”. When pressing “Import” the utility is opened. Select from the menu “*File*” >> “*Load METARs From File*”, browse to your output directory and select the file “*metar_gts.txt*” and press “*Open*”. A table containing the data is now provided; double clicking on a record shows the METAR Report for that specific location. As example see also figure 1.2. Close the “MetarWeather” application before you continue.

4.8.2 *Nominal MDD – 3 Service*

Before starting to import the MDD3 products that are available in the GEONETCast data stream derived from the Meteorological Data Dissemination Service you need to check the settings of the directories that contain the raw data. From the “*WFS-Ethiopia*” and “*Toolbox*” main menu select the option “*Configuration*” and “*Folder*” and select “*MDD3*”. Browse to the appropriate data input and output locations and in the case of the MDD3 products note that the data is stored in the directory “*D:\WFS_ExerciseData\MDD\MDD3*”, where “*D:*” is the designated hard disk drive location. Here as output location “*D:\WFS_out*” is used. Press “*Save*” to store the settings.

In order to import the MDD3 selected products, from the “*WFS-Ethiopia*” and “*Toolbox*” main menu select the option “*MDD Service*” >> “MDD3” >> “*Find products in MDD messages*”. As is the case with the MDD1 service a large number of messages are provided for MDD3 on a daily basis as well. For this service the products are stored in GRIB format and a single message is containing multiple GRIB files (in different resolutions, 1 and 2.5 degree). In order to find the message that contains the product required all messages are filtered on their product code. The codes expected for the routine “*Find Products in MDD Messages*” are for:

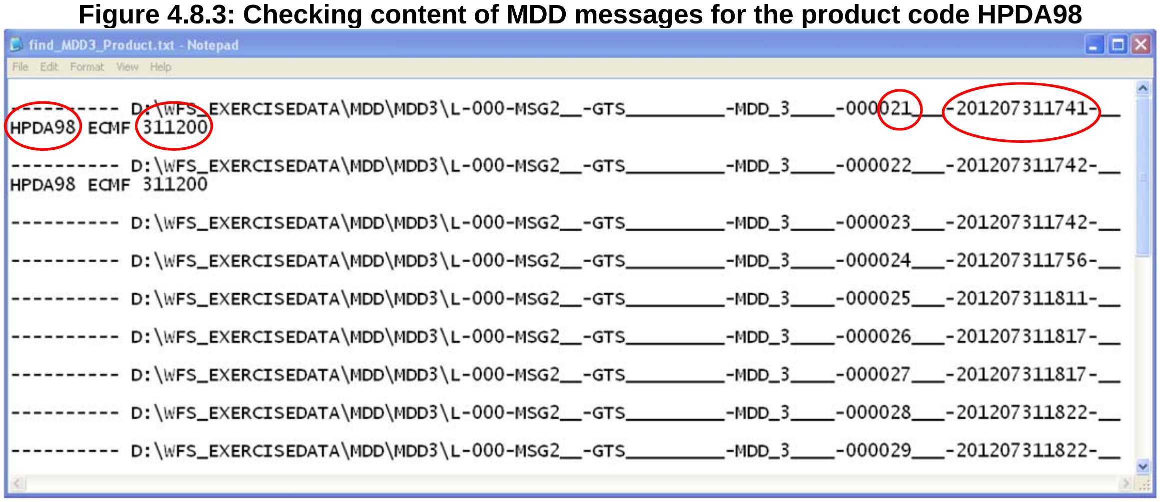
Mean Seal Level Pressure:	HPDA98		
Geopotential Height at 500 hPa:	HHDA50		
Winds at 200 hPa:	HUDA20	or	HVDA20

Winds at 500 hPa:	HUDA50	or	HVDA50
Winds at 700 hPa:	HUDA70	or	HVDA70
Winds at 850 hPa:	HUDA85	or	HVDA85

For MSL Pressure Analysis the “*HP*” indicates the type of product, the “*D*” defines the area, this is the area designator (here from 0-90 north latitude and 0-90 east longitude), the “*A*” stands for analysis and “*98*” defines the pressure level.

Enter the appropriate Product Code in the "*Date*" field, note it is case sensitive. A new file is created in the specified output directory: “*find_MDD3_Product.txt*” and can is opened with Notepad. Now you can select the message containing the product of interest. In the example given in figure 4.8.3 as Product Code “*HPDA98*” is used and based on the available data in the exercise MDD3 directory two messages (21 and 22) contain information on this MDD product. Note also the time stamp of the file and the day-time of issue (day 31 at 1200 UTC).

Figure 4.8.3: Checking content of MDD messages for the product code HPDA98



```
find_MDD3_Product.txt - Notepad
File  Edit  Format  View  Help

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000021___-201207311741-__
HPDA98 ECMF 311200

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000022___-201207311742-__
HPDA98 ECMF 311200

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000023___-201207311742-__

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000024___-201207311756-__

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000025___-201207311811-__

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000026___-201207311817-__

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000027___-201207311817-__

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000028___-201207311822-__

---------- D:\WFS_EXERCISEDATA\MDD\MDD3\L-000-MSG2__-GTS_________-MDD_3____-000029___-201207311822-__
```

Note that this file is stored in your specified output directory; you can use your Windows Explorer, navigate to the specified output directory and double click on the file “*find_MDD3_Product.txt*”.

Now from the “*WFS-Ethiopia*” and “*Toolbox*” main menu select the option “*MDD Service*” >> “*MDD3*” >> “*MSL Pressure*”. Specify your settings according to the figure 4.8.4 below. Note that you have to enter the selected product time stamp (in a yyyymmddhhmm format) in the first box and the message number in the next one. The Julian Day annotation is not relevant here and will be adapted in a next version of this toolbox! Press “*Import*” to execute the routine.

From the file “*find_MDD3_Product.txt*” it is observed that also message 22 is containing MSL Pressure Analysis data. As described before the data comes with different resolutions and spatial extent. The routine checks, based on the file size, the corresponding resolution and executes the appropriate import routine.

After the import routine has completed, open the map “*MDD3_HP_L_Analysis98_201207311741_021*” and display the map using a “*Pseudo*” Representation. Add also the “*country_boundaries*” vector file. Note the file name convention used here: “*HP*” is type of product, “*L*” refers to the 2.5 degree (Low) resolution, followed by the date-time stamp and the message number. Other resolution designators are “*H*” for 1 degree (High) spatial resolution and “*TB*” for the Tropical Belt product coverage. Note the unit of the map, hPa!

Import also MDD3 message number 23 of 201207311742 and after import has completed display this map the map “*MDD3_HP_H_Analysis98_201207311742_022*” and add the “*country_* *boundaries*". Note this is a high resolution (1 degree) product. Your results should resemble those of figure 4.8.5.

Figure 4.8.4: MDD3 product import window for the MSL Pressure product

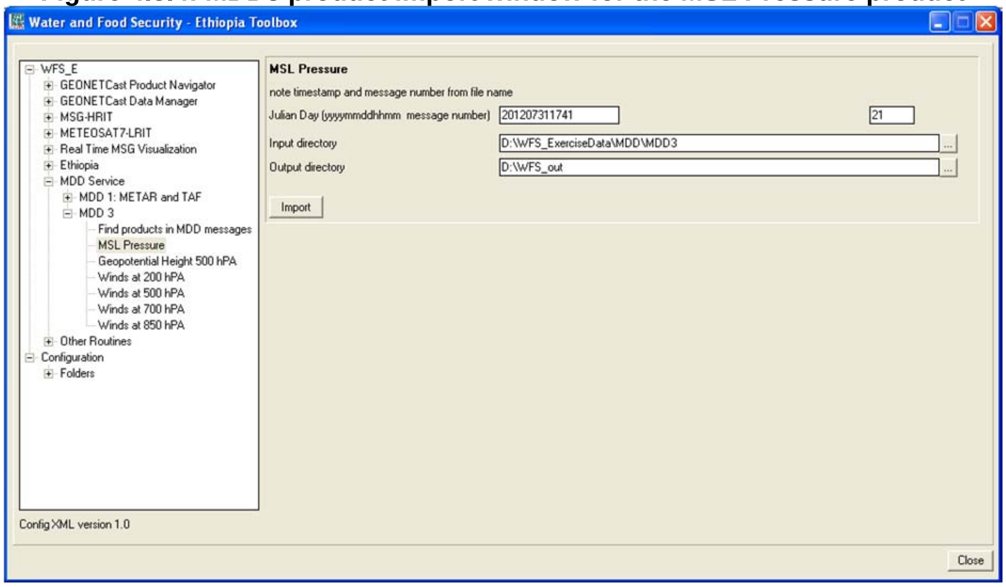
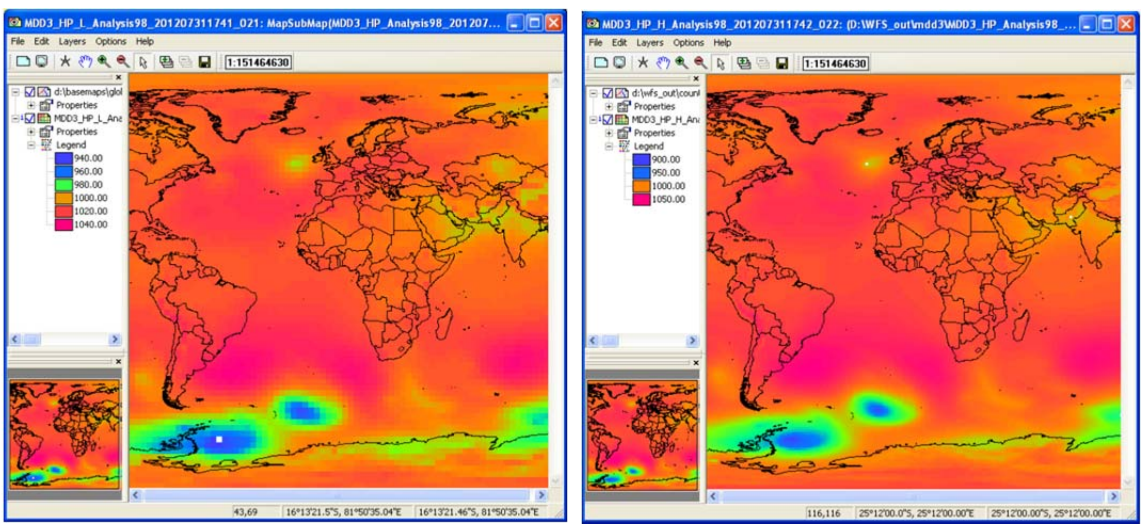


Figure 4.8.5: Import results of MDD3 MSL L (left) and H (right) products



Try some of the other MDD product import routines; the same procedures should be applied. First check which messages contain valid data for the product you want to import, subsequently conduct the import routine.

4.9 SOME SELECTED OTHER ROUTINES

4.9.1 *Import and Export to LEAP*

A generic import routine is available to import all data from the LEAP archive into an ILWIS format. All LEAP data is in a so called IDA (Image Display and Analysis) format. For a more technical description of the data formats used in LEAP consult the LEAP User Manual (Chapter 12, pp 85-98). The image and data archive available in LEAP is stored in the sub-directory \Images. Various other sub-directories can be accessed from here. Also the sub-directory \Msk can be of interest as it is storing some relevant agricultural masks (like areas for Belg, Meher).

To import and convert data into ILWIS format some sample data from the LEAP archive (NDVI from METEOSAT and Rain from TAMSAT) is contained in the exercise data for demonstration purpose. From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*From-LEAP*". Browse to the appropriate data output directory. Here as output location "*D:\WFS_out*" is used.

From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Other Routines*" >> "*Generic LEAP import-export*" and "*Import from LEAP*" sub menu items and if the output directory is properly assigned, select the image "*NDVI_2010_1_1*" as your Date stamp and press "*Import*". When the import has completed, refresh the ILWIS catalogue and display the newly imported map "*NDVI_2010_1_1*", using as Representation "*Pseudo*". Note that the data is in byte format, it still has to be rescaled to represent actual NDVI values. Add the vector map "*country_boundaries*", no info and boundaries only, colour "*Black*". Each of the products used in LEAP, in order to obey to the byte range, is using a different scaling. These scaling factors should still be applied! Note that the data is resampled (nearest neighbour) to the "Ethiopia_1km" georeference as the original data is having different spatial resolutions.

Repeat the procedure, now using as input "*Rain_2005_5_1*", display the map using a "*Pseudo*" Representation.

For export to LEAP currently an intermediate step is used. Data is not transformed directly to LEAP but to GeoTif. Further decisions on the data scaling have to be taken to directly export it to IDA format and these have to be developed in conjunction with the LEAP software developer. Two routines are currently supported, export of the daily ET product and also the TAMSAT dekadal rainfall export. For the TAMSAT product no scaling is used (assuming no dekade with more rainfall than 250 mm) and for the ET export a scaling is used of 25, assuming that the actual sum ET is not more than 10 mm/day. No data is represented by a value of 254.

From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*To-LEAP*". Specify the appropriate data input and output directories. Here as input folder "*D:\WFS_out*" is used. As output folder use "*D:\WFS_out\ToLEAP*"

From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Other Routines*" >> "*Generic LEAP import-export*" and "*Export SAF_ET_day to LEAP*" sub menu items and if the input and output directories are properly assigned, select the image "*Eth_et_day20120611*" (created before, see also chapter 4.4) and press "*Import*".

To check your results, use your Windows Explorer, navigate to the output folder specified and right click on the file "*Eth_et_day20120611.tif*", select "*Preview*" and the file will be displayed.

You can repeat the procedure for the other export routine "*Export TAMSAT_RFE_dek to LEAP*", now select as input file "*Eth_rfe2012051"* (created before, see also chapter 4.5) and press "*Import*".

To check your results, use your Windows Explorer, navigate to the output folder specified and right click on the file "*Eth_rfe2012051.tif*", select "*Preview*" and the file will be displayed. Note that the ILWIS files are not deleted from the output directory; you have to do it yourself. Here the output directory is defined differently from the input directory but if the same directory is used for both input and output this would result in deleting files that might be of use later!

4.9.2 *Generic BUFR data visualization*

Before starting to visualize the various BUFR formatted products that are available in the EUMETCast-GEONETCast data stream you need to install the BUFRdisplay utility. See for installation instructions also chapter 1.1.6.

From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*Bufrdisplay*". Browse to the appropriate data output directory. Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings. Note that BUFRdisplay is storing some temporary program files in the output directory, so ensure that you have the proper administration rights.

From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Other Routines*" >> "*Generic BUFR data Visualization*" and "*Show BUFR data using BUFRdisplay*" sub menu items and if the output directory is properly assigned, press "*Import*". In the Command Line Interpreter (CMD.exe) window, acknowledge the copyright of Francis Breame by pressing <*enter*> and the BUFRdisplay utility is opened.

From the BUFRdisplay window select "*File*" and "*Open*", navigate to the folder D:\WFS_exercisedata\MPEF\2012\08\27 and select the file: "*L-000-MSG2__-MPEF________-AMV______-000001___-201208270045-__*" and press "*Open*". Check the various attributes that are contained within this Atmospheric Motion Vector (AMV) BUFR file under the "Data Selection" window. Note that to display the AMV data the following attributes need to be specified:

for the Latitude field:	12 Latitude (high accuracy)
for the Longitude field:	13 Longitude (high accuracy)
for Data field:	18 Wind Speed

Make sure that under the "*Options*" section the option: "*Plot Vector Mode*" is activated

now for Vector Direction field: 17 Wind Direction

Now enter these values for the respective fields situated directly below the Data Attribute window: for Latitude field type "*12*", for the Longitude field type "*13*", for Data field type "*18*" and for Vector Direction field type "*17*" respectively. Note the values and the time stamp given. When the appropriate attributes are provided, press under "Actions" the option "*Input/decode data*" (situated on the mid-right hand side of the BUFRdisplay window). See also figure 4.9.1. After the data is decoded select again from the "Actions" the option "*Generate Map*" and the map window with the AMV's are displayed. Close the map and from the lower right hand part of the BUFRdisplay window select the option "*Zoom*" and enlarge the zoom factor to "*5*" by moving the slide bar to the right hand side using the mouse and activate the option "*Show countries*". Press the option "*Generate Map*" again. Now use the slide bars at the right hand side and lower part of the map display window to navigate over the map. Close the map once more.

Select from the lower left hand part of the BUFRdisplay window the option "Projection" and now specify as projection "Stereographic", and press the option "*Generate Map*" again. Your results should resemble those presented in figure 4.9.2.

Figure 4.9.1: BUFRdisplay main window using the settings to display AMV data

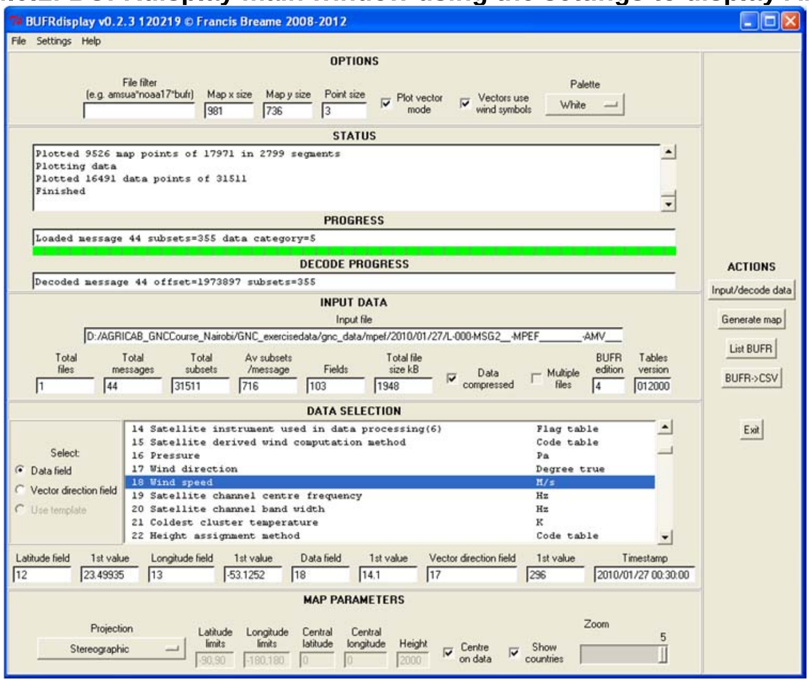
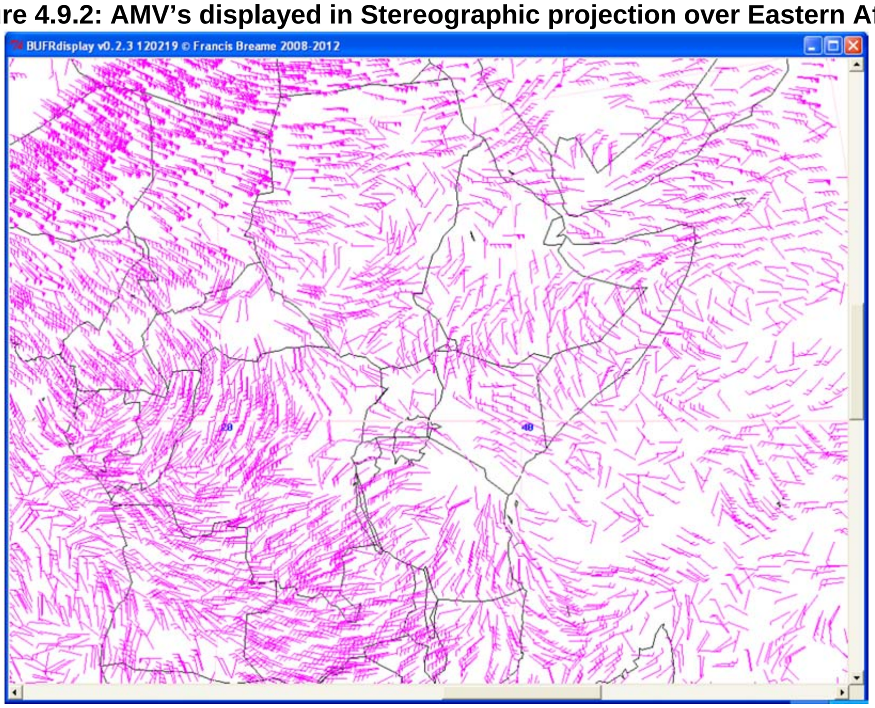


Figure 4.9.2: AMV's displayed in Stereographic projection over Eastern Africa



After visualization close the map and to close BUFRdisplay, select from the menu "*File*" and "*Exit*". Repeat the procedure and use as input the Tropospheric Humidity data, available from the same directory. Select as input file: "*L-000-MSG2__-MPEF________-TH_______-000001___-201001270245-__*" and as for Latitude field type "*14*", for the Longitude field type "*15*", for Data field type "*31*". Press under "Actions" the option "*Input/decode data*" and "*Generate Map*" respectively. Note the map displayed. Close BUFRdisplay. Also consult the BUFRdisplay user guide for a more detailed description of the functionality of this utility.

4.9.3 *Import VGT products from Ethiopia using VGTExtract*

To effectively import a longer time series of a certain VGT product use can be made of VGTExtract. See installation instructions in chapter 1.1.8 and check if the “VGTExtract” directory has been created under your ILWIS sub-directory Extensions\WFS_E-Toolbox\util\. If this is not the case install the package and copy the directory (note that as directory name VGTExtract is expected) into the “Util” sub-directory!

Note that various dedicated product configuration files, contained within the WFS-Ethiopia Toolbox are copied into the respective VGTExtract directories; therefore no administrative restrictions are allowed to access the VGTExtract directory and this is the reason why it has to be copied under ILWIS.

From the “*WFS-Ethiopia”* and *“Toolbox*” main menu select the option “*Configuration*” and “*Folder*” and select “*VGTExtract*”. Browse to the appropriate data output directory. Here as output location “*D:\WFS_out*” is used. Press “*Save*” to store the settings.

From the “*WFS-Ethiopia”* and *“Toolbox*” main menu select the option “*Other Routines*” >> “*Import VGT Products Ethiopia*” >> “*Import using VGTExtract*” and press “Import”. The VGTExtract utilityis opened and select under the “*Processing Settings*” the type of product you want to import, e.g. “Ethiopia_NDVI_leap”, specify the appropriate input and output folders. Here as input folder “*D:\WFS_exercisedata\VGT4Africa”* can be used and as output folder “*D:\WFS_out*” can be specified. In the input window all products from VGT are listed, select the NDVI products from December 2009 and press “*Start”* to conduct the import (see also figure 1.3). Note that the output file name convention for the NDVI product used is “*Ethiopia_NDV_yyyymmdekdek*”. The selected files are imported, converted to ILWIS format and the calibration coefficients are applied as well as the creation of a subset according to the specifications of LEAP. Note that also the status mask is imported.

Upon completion refresh the catalogue and display the new NDVI maps of Ethiopia created. Use as Representation “*NDVI1*”.

In a similar manner other products can be quickly imported, note that you have to select the appropriate “*Processing Settings*” relevant for the type of product you want to import.

Note that some post processing steps might still be required after the products have been imported. To quickly perform this task, create a map list, add all products and perform the required computations!

Press “*Exit*” to abort the application

4.10 ADDITIONAL EXERCISES

4.10.1 *Real Time MSG Visualization*

Given the timing and amount of data required to perform these routines they can only be done when having access to the HRIT MSG data stream using a ground receiving station. Have once more a careful look at Chapter 3.2.5 and study the sequence of routines which are executed as described in figure 3.5.

The real time visualization routines expect access to the archive; this can best be achieved by making a network mapping to where the new arriving MSG-HRIT data is stored. Note that given the large amount of MSG files disseminated on a daily basis to effectively store all the data a Year-Month-Day directory structure is commonly used. This structure is expected to run the visualization routines and is automatically recognized and does not need to be defined and therefore only the main directory, containing this dated folder structure has to be specified as a mapped network drive. From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" and "*Folder*" and select "*Real Time MSG Vis*". Browse to the appropriate data input directory and select your mapped network drive. Here as output location "*D:\WFS_out*" is used. Press "*Save*" to store the settings. Note that use is made of IrfanView to display the final image created, check once more from the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Configuration*" >> "*Folder*" >> "*Special locations*" if the location of IrfanView directory and executable is correctly specified.

From the "*WFS-Ethiopia"* and *"Toolbox*" main menu select the option "*Real Time MSG Visualization*" >> "*MSG IGAD Region Multispectral*". Check the input and output directories and press "Import". If working under XP enter your password, this is not required when working under Windows-7. In principle you can now close ILWIS as all operations are now executed from a scheduled task created and will automatically start (every 15 minutes –in sync with the temporal resolution of MSG) at a given system clock time (1 minute after the end of scan time). The scheduled task created will execute the newly created file "*st_MSGIGAD.bat*", stored in the ILWIS sub-directory: '\Extensions\WFS_E-Toolbox\toolbox_startscript\RealtimeMSGVisualization\AfricaIGADWindow'.

The batch file listing of "*st_MSGIGAD.bat" is given below.*

Start of listing

```
set st_inputdrive=Z:
set st_outputdrive=D:
set st_outputpath=WFS_out
set st_ilwdir=D:\Ilwis372\
set st_utildir=D:\Ilwis372\Extensions\WFS_E-Toolbox\util
set st_irfanviewdir="C:\Program Files\IrfanView\i_view32.exe"


call "%st_ilwdir%Extensions\WFS_E-Toolbox\toolbox_startscript\RealtimeMSGVisualization\st_msg.bat"
AfricaIGADWindow 452 50 100 100
```

End of listing

Every time this batch file is executed, first the relevant parameters are set so the subsequent utilities can make use of these settings. At the end another batch file "*st_msg.bat*" is executed having 5 parameters. The first one, "AfricaIGADWindow" is referring to the sub-directory containing other batch files which are required for this routine, the other 4 parameters are used by IrfanView to display the final image on the screen: 452 and 50 are the starting column and line on the screen respectively, 100 and 100 are used to resize the image, in this case the image is displayed with a resize factor of 100 %, so no resizing is applied in this case! These parameters are subsequently applied in the batch file "*st_msg.bat*" which is executing the actual import using a number of other batch routines. You can check the content of the file "*st_msg.bat*" situated in the ILWIS sub-directory 'Extensions\WFS_E-Toolbox\toolbox_startscript\RealtimeMSG Visualization'. Use your Windows Explorer, navigate to this sub-directory, right click with the mouse on the file and select "*Edit*" from the context sensitive menu.

The whole procedure is quite complex, take some time to study the various files used to create this automated image visualization.

There are more routines for automated visualization. Before you start a new one, Stop the "*MSG IGAD Region Multispectral*" scheduled task which is running by using the option from the menu "*Stop Multispectral Visualization*".

4.10.2 ***Multi temporal data import using a batch looping procedure***

To import all necessary data to do a time series analysis using the WFS-Ethiopia Toolbox menu can be cumbersome. Check the content of the sub-directory "*D:\WFS_out\multi_ET*" using your Windows Explorer. This sub-directory is consisting of 2 batch files, multi_ET_start.bat and multi_ET_loop.bat. The content of these batch files is also provided in figure 4.8.1 and 4.8.2.

Figure 4.10.1: Batch file 1, starting the multi temporal import routine

multi_ET_start.bat - Notepad

File Edit Format View Help

```
@echo off
rem from command line = multi_ET_start.bat data_dir ilwis_dir working_dir

echo set ilwdir=%2>inputparam.bat
echo set workdir=%3>>inputparam.bat

copy "%1\S-LSA_-HDF5_LSASAF_MSG_ET_NAfr_*"

for %%j in (*S-LSA_-HDF5_LSASAF_MSG_ET_NAfr_*) do "%2\Extensions\WFS_E-Toolbox\util\7z.exe" e %%j

del S-LSA_-HDF5_LSASAF_MSG_ET_NAfr_*.bz2


for %%j in (*S-LSA_-HDF5_LSASAF_MSG_ET_NAfr_*) do cmd /c multi_ET_loop.bat %%j

echo.
echo.
echo You have succesfully completed this multi temporal import
echo It is better to devote some time to construction of these import routines
echo as they can save a lot of time on data pre-processing
echo THIS TIME CAN BE USED FOR OTHER SOCIAL ACTIVITIES!
```

This batch routine provides at the beginning, after the rem (remark) in line 2 how the batch file should be executed. It is expecting 3 parameters to execute the batch file: the data directory, the ILWIS directory and the working directory. Parameter 2 and 3 are stored in a new batch file that is created (parameter.bat). Subsequently the required input data is copied from the data directory specified. Next all data is unzipped using 7Z.exe (note the "for" and "do" expression) and the original zipped files are being deleted in the next command line. After this all remaining unzipped files are used as input for the second batch file (multi_ET_loop.bat) which is executed. The "cmd /c" is included to ensure that after all computations are finalized by the second batch file the process continues in the starting batch file. At the end a number of lines are displayed and the content is provided here.

The second batch file is given in figure 4.10.2. Note that for visualization purpose use is made here of the option "Word Wrap" of Notepad, actually if you edit this batch file using Notepad you will see the expressions as single lines!

For each event which is meeting the file string criteria from the start_batch file the loop_batch file is executed. As we are working here with ET images having a 30 minutes temporal resolution and when processing a full day of data, the loop_batch should be executed 48 times. Each ET input file is processed. From the file name the timestamp is extracted (having 12 digits), it is set as shortfilename1 and is displayed in the command line window. Then the parameter file, created by the batch_start, which defines the ILWIS directory and Working directory is called and the directories are set. These are needed by the next three lines. Here the actual import of the data is done. Gdal_translate extracts the ET layer from the HDF file and transforms it into an ILWIS format, the next line sets the georeference, taken from the Toolbox \Util subdirectory and finally a map calculation is performed to transform the data into the appropriate unit (here mm/hr). The obsolete files are then being deleted. Note that ILWIS is executed from the command prompt!

Figure 4.10.2: Batch file 2, importing the data

```
multi_ET_loop.bat - Notepad
File  Edit  Format  View  Help
@echo off
echo  ET North African window in mm/hr
rem: sample file name = S-LSA_-HDF5_LSASAF_MSG_ET_NAfr_201206110000


set longfilename=%1
set shortfilename1=%longfilename:~31,12%

echo.
echo Current time stamp processed = %shortfilename1%
echo.

call inputparam.bat


"%ilwdir%\Extensions\WFS_E-Toolbox\GDAL\bin\gdal_translate.exe" -of ilwis hdf5:"S-LSA_-
HDF5_LSASAF_MSG_ET_NAfr_%shortfilename1%"://ET nafr_%shortfilename1%


"%ilwdir%\ilwis.exe" -C setgrf %workdir%\nafr_%shortfilename1%.mpr "%ilwdir%\Extensions\WFS_E-
Toolbox\util"\lst_north


"%ilwdir%\ilwis.exe" -C %workdir%\et_nafr%shortfilename1%.mpr{dom=value;vr=0.0000:10.0000:0.0001}:=iff
(%workdir%\nafr_%shortfilename1% gt -1,%workdir%\nafr_%shortfilename1%/10000,?)


del S-LSA_-HDF5_LSASAF_MSG_ET_NAfr_%shortfilename1%
del nafr_%shortfilename1%.aux.xml
del nafr_%shortfilename1%.mp*
del nafr_%shortfilename1%.csy
```

Now activate the Windows "*Start*" menu and select "*Run*". You are going to use the Windows "command.exe" utility to run the batch files and in order to activate this type "*cmd*" and press "*OK*". In the new command window that appears navigate to your active working directory, here D:\WFS_out\multi_ET is assumed and execute the ET import by typing the name of the start_batch and the three parameters on the command line (see also figure 4.8.3) and press enter. Note that the settings on your system most likely are different; substitute these with the correct (sub-) directory names. For the commands (followed by <enter>) to navigate to your working directory and other DOS command syntax, see also figure 4.8.3. Note the space between the batch file and the parameters!

Figure 4.10.3: Starting the batch processing from a CMD window

```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Maathuis>d:

D:\>cd WFS_out

D:\WFS_out>cd multi_ET

D:\WFS_out\multi_ET>multi_ET_start.bat D:\WFS_ExerciseData\SAF D:\Ilwis372_aug20
12 d:\wfs_out\multi_et
```

After the batch routines have started, keep following the messages displayed in the command line window, each time you will be notified that a new time step is being processed. When the batch routine has finished, navigate ILWIS to the "*\multi_ET*" sub-directory. You will note that all 48 files are now available as raster maps. From the main ILWIS menu, select "*File*", "*Create*" and select "*Map List*". Select all 48 files in the left hand column and press ">" to move them to the right hand column. Specify an appropriate out map list name, e.g. "*et20120611*". Double click on the newly created map list and use the "*Display as Slide Show*" option, select as "*Representation*" "*Pseudo*" and press "*OK*" twice to start the display of the animated sequence.

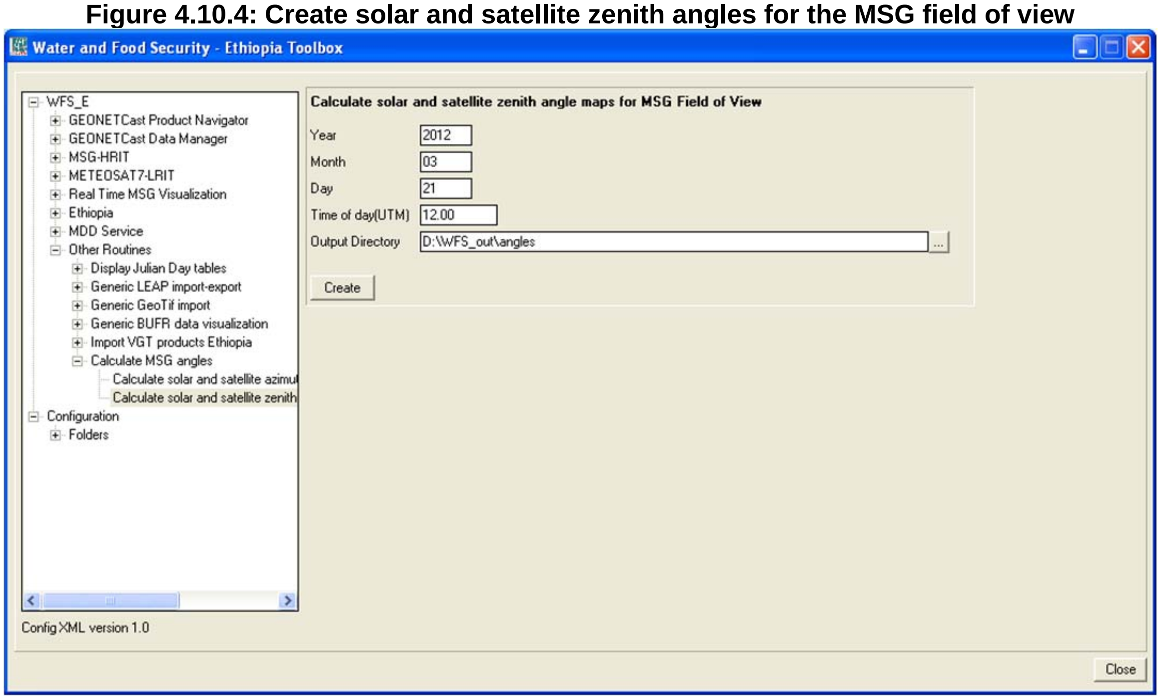
You have noted that the images cover the full northern African continent. In order to select only your region of interest, right click with the mouse the map list "et20120611", select the option "*Spatial Reference Operations*" >> "*Resample*". In the Resample Map window specify as resampling method "*nearest neighbour*", as output raster map "*et_res20120611*" and select as GeoReference "*Ethiopia_1km*", leave the other options as default and press "*Show*". Wait until the resampling process is completed and display the newly created map list as an animated sequence. Navigate back to the main working directory, here "*D:\WFS_out*", before you continue.

4.10.3 *Calculate MSG and solar zenith – azimuth angles for Ethiopia*

In order to derive the satellite viewing and solar angles select from the "*WFS-Ethiopia*" and "*Toolbox*" main menu the option "*Configuration*" and "*Folder*" and select "*Calculate MSG angles*". Browse to the appropriate data output directory. Here as output location "*D:\WFS_out\angles*" is used. Press "*Save*" to store the settings. Use the ILWIS Navigator to move to this sub-directory.

From the "*WFS-Ethiopia*" and "*Toolbox*" main menu select the option "*Other Routines*" >> "*Calculate MSG angles*" >> "*Calculate solar and satellite zenith angle maps for the MSG Field of View*" and specify the settings as given in the figure below for 21 March 2012 at 12:00 UTC, when the sun is above the equator and press "*Create*".

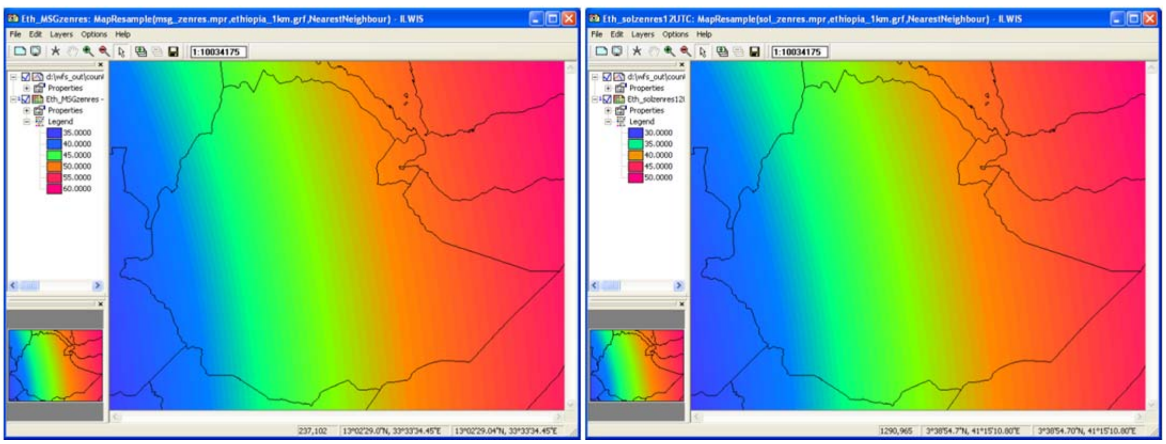
Figure 4.10.4: Create solar and satellite zenith angles for the MSG field of view



When the operation has completed, open the maps "*msg_zenres*" and "*sol_zenres*". Note that also other maps are being created like "*illum_condition*" and "*sun_elev*". Most maps can be displayed using a "*Pseudo*" Representation, as the "*illum_condition*" is a classified map, use the default Representation. From the active map window select the option “Layers” >> “Add Graticule” you can keep using a default Graticule distance of 20 degree and press “OK”. Move the mouse, keeping the left mouse button pressed, over the map and inspect the values representing the respective angles. Also the secant of the MSG and sun angle are calculated, open the files “*sec_msgzen*” and “*sec_solzen*”, use again a “*Pseudo*” Representation.

In order to obtain the angles for the Ethiopia region of interest, select for example the map “*msg_zenres*”, right click with the mouse on the map name and from the context sensitive menu select the option “*Spatial Reference Operations*” >> “*Resample*”. As resampling method select “*Nearest Neighbour*”, as output map “*Eth_MSGzenres*” and as Georeference “*Ethiopia_1km*”, leave the rest as default, press “*Show*” and press “*OK*” to display the map, using a “*Pseudo*” Representation. Add the country boundaries and inspect the values. Repeat the procedure and use as input “*sol_zenres*”, to resample the solar zenith angle to the Ethiopia georeference. Your results should resemble those of figure 4.10.5. Note that also the azimuth angles of the sun and satellite can be derived using the other option from the menu.

Figure 4.10.5: MSG (left) and solar angles (right) for 20120312 at 12:00 UTC



Note that in this case the angles look quite similar, MSG is situated over the equator at 0 degree and at this given moment the sun is also situated over the equator and furthermore a 12:00 UTC time stamp was used.

4.10.4 ***Import of METOP AVHRR/3***

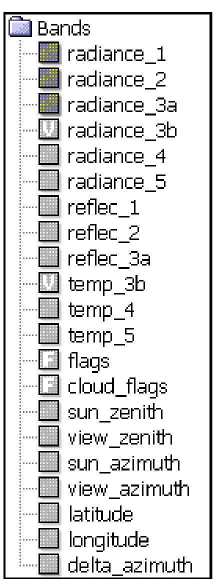
The images collected by the AVHRR/3 sensor on METOP is not disseminated via the GEONETCast C-band turn around services (e.g. to Africa or Latin America). It can be obtained from the archive at EUMETSAT (http://archive.eumetsat.int/umarf/, you can continue as Guest and Login). To get an idea of the images an example is included here. The table below shows the spectral channels of the AVHRR/3 sensor on METOP. It has six channels (three visible and three infra-red) but only five channels are used at a given time. Channel 3 is the visible channel recording during daytime and the infra-red channel is used at night time.

Table 4.1: AVHRR/3 spectral channel details and their primary use

Channel	Spectral Bandpass (micrometers)	Primary Use
1 (Visible)	0.580 - 0.68	Daytime cloud/surface mapping
2 (Near IR)	0.725 - 1.00	Surface water delineation, ice and snow melt
3A (Near IR)	1.580 - 1.64	Snow / ice discrimination
3B (IR-Window)	3.550 - 3.93	Sea surface temperature, night time cloud mapping
4 (IR-Window)	10.300 - 11.3	Sea surface temperature, day and night cloud mapping
5 (IR-Window)	11.500 - 12.5	Sea surface temperature, day and night cloud mapping

Pre-processing of the data is done using VISAT-BEAM. This process is not described here, see Appendix 1. The data is having geographic coordinates, using the WGS72 Datum and for resampling a Nearest Neighbour method is used and the output format selected is GeoTif.

If not already active, open ILWIS and navigate to the sub-directory "D:\WFS_out\metop". From the "*WFS-Ethiopia"* and *"Toolbox*" tabs select the menu item "*Other Routines*" >> "*Generic GeoTif Import*" >> "*GeoTif raster import*". Select as input file, from your sample data directory (*D:\WFS_exercisedata\METOP_Africa)* the file: "*AVHR_xxx_1B_M02_20120608065803Z_20120608070103Z_N_O_20120608073751Z_reprojected.tif*".



As output file name specify: "AVHRR_Eth". Note that as output an ILWIS map list is created, consisting of 21 bands. These band numbers refer to legend given in the left hand figure. Refresh your ILWIS catalogue after the import is completed.

For correct interpretation one needs to know if it is a day or night time image given the fact that the recording using channel 3 differs during day or night. This can be derived from the file name, as the recording time in UTC is given; see the year-month-day-hour-minutes-seconds notation. This imported image was recorded, starting from "*201206080658*" to "*201206080701*". Being a day time image, band 3A, recording the NIR, is the channel used. Therefore in the imported image the "radiance_3b" (imported as "*AVHRR_Eth_band_4*") does not contain valid data!

To create a colour composite, double click the map list icon of "*AVHRR_Eth*", in the map list select the option "*Open as ColorComposite*" and select for Red: "*AVHRR_Eth_band_3*", for Green: "*AVHRR_Eth_band_2*" and for Blue: "*AVHRR_Eth_band_1*". Leave the default stretch values; note that the data values represent radiances! Press "*OK*" to see the image. Also put the vector layer showing the "*country_boundaries*" on top (info off, boundaries only and boundary colour in white). Navigate back to the main working directory to select this file!

Once more create a colour composite, double click the map list icon of "*AVHRR_Eth*", in the map list select the option "*Open as ColorComposite*" and select for Red: "*AVHRR_Eth_band_9*", for Green: "*AVHRR_Eth_band_8*" and for Blue: "*AVHRR_Eth_band_7*". Leave the default stretch values. What do the band values now represent? Carefully study the legend provided above!

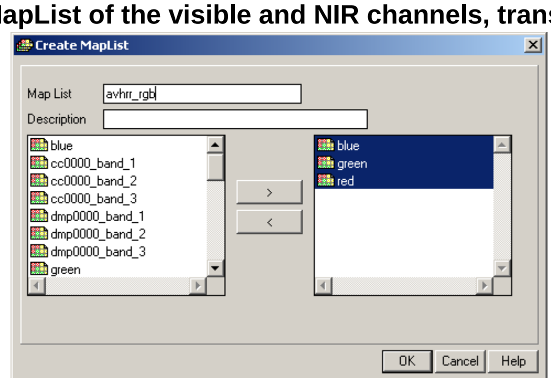
Press "*OK*" to see the image. Also put the vector layer showing the "*country_boundaries*" on top (info off, boundaries only and boundary colour in white). In order to create a better quality colour composite the selected bands need to be stretched.

To overcome a small bug in this ILWIS version an adaptation to the properties of the images has to be performed, else calculation of the histogram takes ages! From the ILWIS catalogue, right click using the mouse the "*AVHRR_Eth_band_9*" image, select "*Properties*" and the option "*Change Value range...*", now change the Precision to "*0.001*", press "*OK*" twice. Repeat this procedure for the "*AVHRR_Eth_band_8*" and "*AVHRR_Eth_band_7*" images.

From the ILWIS catalogue, right click using the mouse the "*AVHRR_Eth_band_9*" image, from the context sensitive menu, select "*Image Processing*" and "*Stretch*", specify as Output Raster Map: "*Red*", all other options can be kept as default. Press "*Show*", note that the data is now transformed into a byte image. Close the image once you have inspected the results. Repeat the same procedure for the bands "*AVHRR_Eth_band_8*" and "*AVHRR_Eth_band_7*" and specify "*Green*" and "*Blue*" as output maps respectively.

Now create a new map list of the 3 newly created images, Red, Green and Blue respectively. In order to do so, select from the ILWIS main menu, the option "*File*" >> "*Create*" >> "*Map List*" and select the image called "*Blue*", press the > sign in the middle of the window to move this layer to the right hand side. Repeat this procedure for the "Green" and "Red" images. Specify an appropriate Map List file name, e.g. "*avhrr_RGB*" (see also the figure below).

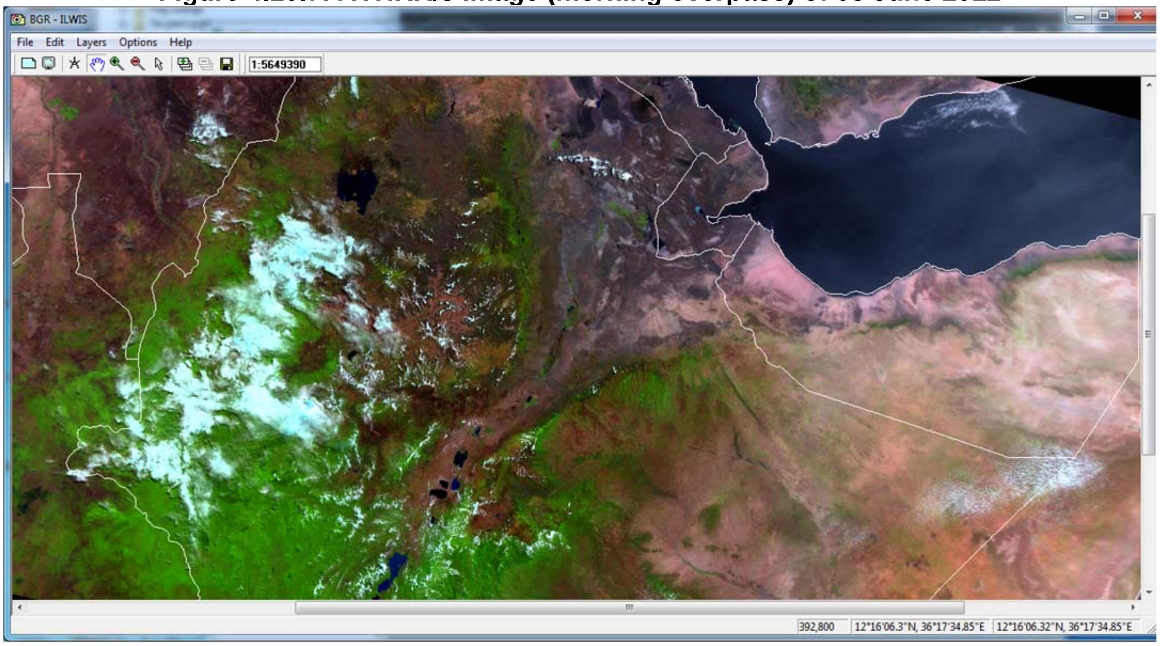
Figure 4.10.6: Create MapList of the visible and NIR channels, transformed to byte images



Press "*OK*" to store this map list. In the ILWIS catalogue double click the map list icon "*avhrr_RGB*", select the option "*Open as ColorComposite*" and select the appropriate bands for the colour assignment. Press "*OK*" to see the image. Also put the vector layer showing the country boundaries on top (info off, boundaries only and boundary colour in white). Your results should represent those of figure 4.10.7 showing a portion of the Horn of Africa.

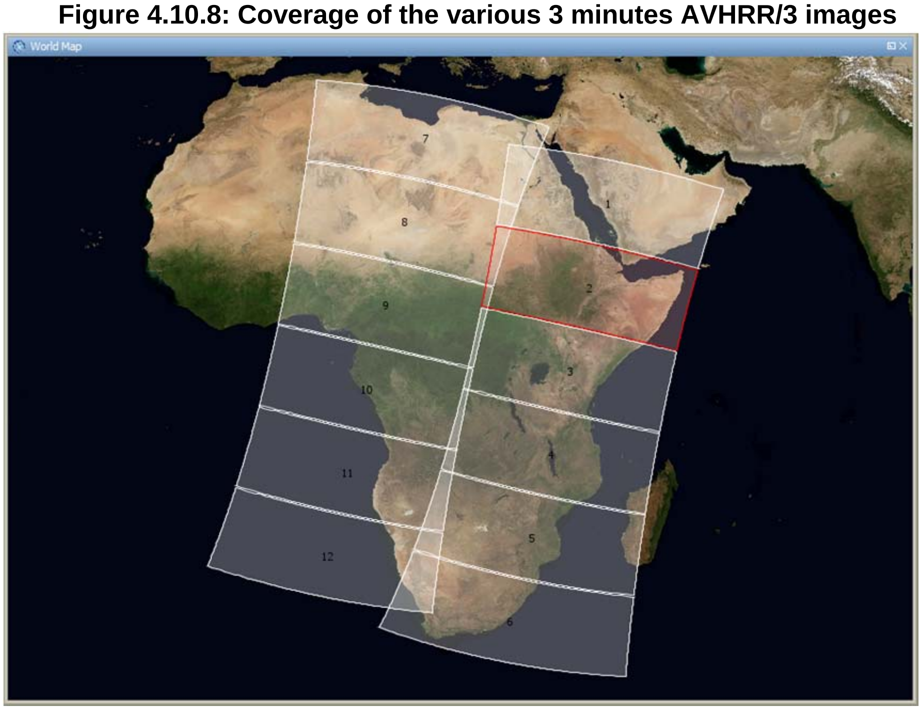
Display also a thermal channel (e.g. band "*AVHRR_Eth_band_12*", but first change the properties as described above!), using as Representation "*Inverse*" and keep the default stretch limits. In the active map window, roam the mouse over the map and keep the left mouse button pressed. What do the values indicate and which channel of the AVHRR instrument is now displayed?

Figure 4.10.7: AVHRR/3 image (morning overpass) of 08 June 2012



The other images in the sub-directory \METOP_Africa are also recorded over Africa. Each of the images covers a recording time of 3 minutes. If interested you can import these as well, using BEAM-VISAT and have a look at it. Note that the AVHRR instrument covers most of the Central and Eastern regions of Africa in 2 overpasses of 15 to 18 minutes of scanning each. METOP records the morning and evening overpasses (local time!). The coverage of the available images is given below. Note that this will change when METOP-B is launched, currently planned to be launched during the second half of 2012.

Figure 4.10.8: Coverage of the various 3 minutes AVHRR/3 images



Source image in figure 4.10.8: Beam-Visat World Map

APPENDICES

Appendix 1: Other freeware utilities that can be used in conjunction with ILWIS3.7.2

For Jason-2 Data:
Basic Radar Altimetry Toolbox is available at: http://www.altimetry.info/html/data/toolbox_en.html or http://earth.esa.int/brat/html/data/toolbox_en.html

For SPOT-Vegetation data:
New version of the VGTExtract software. This new version is 1.4. With additional output format: ILWIS (.mpr)

Windows, with JAVA integrated:
http://www.vgt4africa.org/VGTExtract/Windows/VM/setupVGTExtract_VM.exe
Windows version, without JAVA (JAVA should already be installed)
http://www.vgt4africa.org/VGTExtract/Windows/NoVM/setupVGTExtract_NoVM.exe

Linux, without JAVA
http://www.vgt4africa.org/VGTExtract/Linux/NoVM/setupVGTExtract_NoVM.bin
Linux, with JAVA
http://www.vgt4africa.org/VGTExtract/Linux/VM/setupVGTExtract_VM.bin

For METOP-AVHRR/3 Data:
VISAT-BEAM, with the Metop-AVHRR/3 import plug-in (version 1.3):

Home page BEAM:
http://www.brockmann-consult.de/beam/
Downloads of BEAM:
http://www.brockmann-consult.de/beam/downloads.html
Download of METOP AVHRR Level-1b Product Reader
http://www.brockmann-consult.de/beam-wiki/display/BEAM/Plug-ins

For Satellite Position Prediction software:
SATSCAPE is a satellite tracking program for Windows
http://www.satscape.info

WXTRACK: developed by David Taylor:
http://www.satsignal.eu/software/wxtrack.htm#DownloadWXtrack

For more Marine Applications and Processing:
BILKO, supported by UNESCO, BILKO is available from homepage:
http://www.noc.soton.ac.uk/bilko/

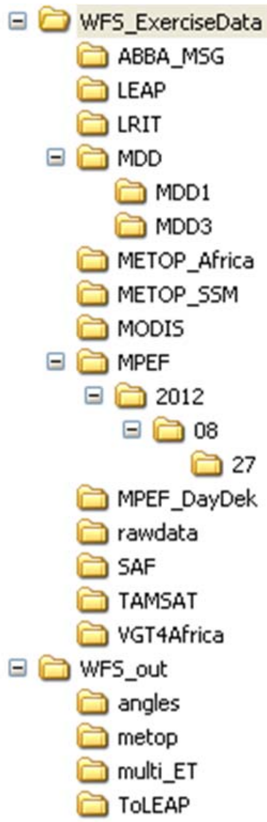
For visualization and export of BUFR encoded data:
For quick visualization of (multiple) BUFR encoded files in the GEONETCast data stream, developed by Francis Breame
http://www.vf0123.btinternet.co.uk/ or http://www.elnath.org.uk/

For statistical computing:
R is a language and environment for statistical computing and graphics and is available from the R-Project homepage.
http://www.r-project.org/

Appendix 2: Structure of the sample data on DVD(s) and from the ITC FTP site

In the figure below the directory structure is provided to execute the exercises. In the exercise description provided in chapter 4 the "*WFS_ExerciseData*" directory is assumed to be available on the "*D:*" drive of your local system. Copy the data accordingly. The working directory used for the exercise is "*WFS_out*", this directory and appropriate data should also be copied onto your local system "*D:*" drive.

Figure: Directory structure for the exercises on the root of the D:\ drive



From the ITC FTP site (ftp://ftp.itc.nl/pub/52n/wfs_exercisedata) the data can also be obtained. Download the files and ensure that the same directory structure is obtained as indicated above. Note that some zipped files are large; you need appropriate bandwidth to download the files. If this is not the case you can request a set of DVD's by sending an email to the corresponding author.

Note the golden rules when working with ILWIS and the toolbox plug-in as given in chapter 1.1.1 and take these into consideration if you want to deviate from the default directory installation instructions provided over here.

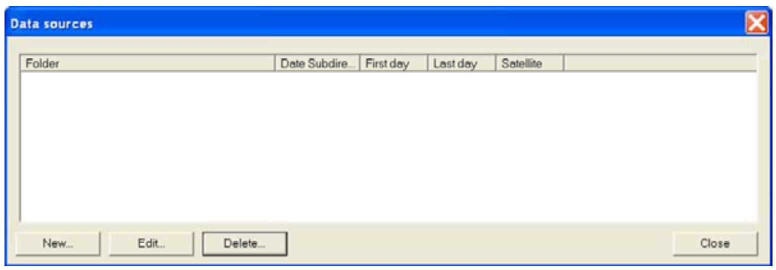
Appendix 3: MSG Data Retriever settings for exercise 4.1

Follow the steps to set the appropriate source folder location for the MSG sample data provided for exercise 4.1.

Open from the WFS-Ethiopia and Toolbox menu the MSG-HRIT and MSG Data Retriever options. Click the button "*Start MSG Data Retriever*".

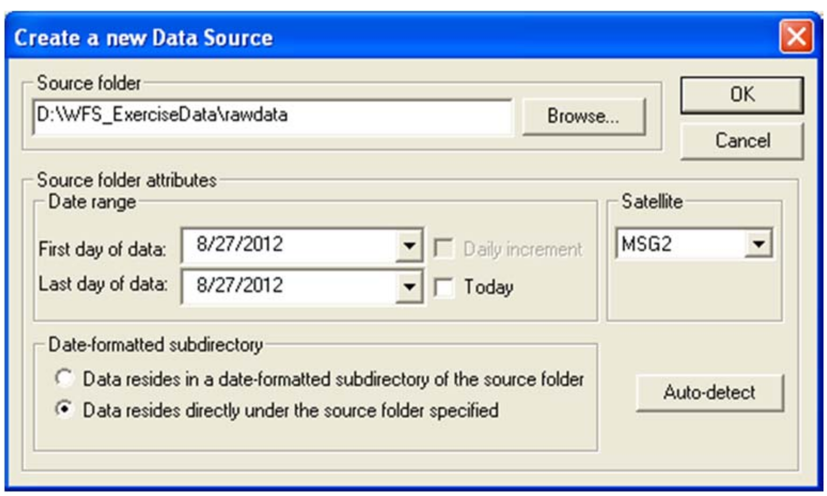
From the Data Retriever Menu, select the option "*File*" and from the popup menu the option "*Data Sources..*" The data sources menu is opened; see also figure 1. In case there are already data source folders specified delete these, using the "*Delete*" button.

Figure 1: Data source folder specification



To define the appropriate data source for the MSG-HRIT sample data provided, press the "*Create*" button, to create a new data source. Use the browse button and move to the appropriate folder. Enter the specifications as given in figure 2.

Figure 2: Create a new source folder to specify the location of the MSG-HRIT sample data



Please note that the data is directly residing under the source folder, not in a date formatted structure. Only a few sample images are provided. When pressing the "*Auto-detect*" button, the "*Last day of data*" will be assigned as: 8/27/2012

Appendix 4: Other utilities available at the EO Community web pages at 52North.org

Various other software utilities have been developed over time are released via the 52North.org web portal, through the Earth Observation Community, available at: http://52north.org/communities/earth-observation/overview. A short overview of the freely available ILWIS plug-ins is presented below. Also dedicated ILWIS scripts are available to import the Culture MERIS and METOP AVHRR-S10 data (under data bases) as well as various documents and useful links.

ILWIS plug-ins to handle free Environmental data sources

Current data dissemination systems, like GEONETCast and the ESA DDS provide free, near real-time Environmental and Earth Observation data together with derived products to a worldwide user community. The environmental data is delivered on a global scale via communication satellites. Next to this, a multitude of environmental relevant data is residing in online archives. To integrate this information toolbox plug-ins have been developed, also dealing with specific geographic regions only upon user request, like the AMESD-SADC Toolbox and the Water and Food Security Toolbox for Ethiopia (which is under development).

The toolbox plug-ins, coupled with the existing ILWIS processing utilities, facilitate easy integration of large amounts of environmental data into various applications related to weather, atmosphere, oceans, land, vegetation, water and environment.

General Key Features:

- open design and easy user configuration
- GEONETCast and ESA-DDS data management system for dedicated storage of data

Features GEONETCast Toolbox Version 1.3

- import routines for various satellites, Meteorological Product Extraction facility (MPEF), Satellite Application Facilities (SAF's), Chinese Meteorological Administration and 3rd party data providers such as TAMSAT, DevCoCast, MODIS, SPOT Vegetation
- integration of METOP-AVHRR and JASON-2 data
- export routines to BILKO and R
- calculation of solar and MSG zenith and azimuth angles
- real time METEOSAT Second Generation visualization

Features ESA DDS Toolbox Version 1.1

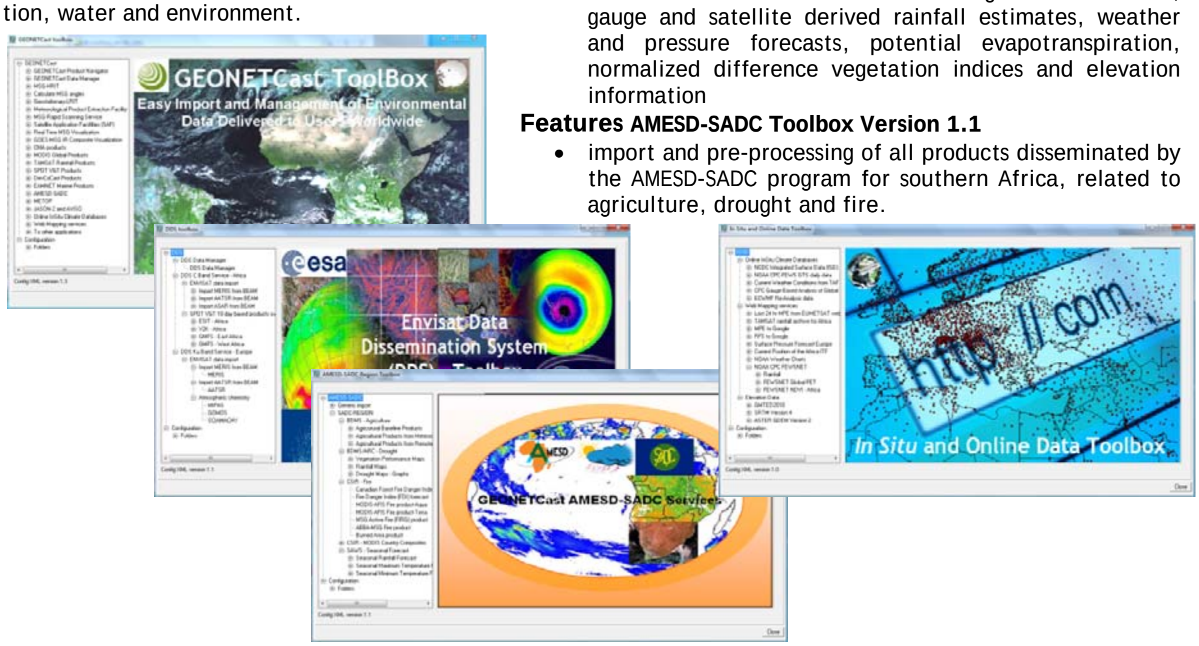
- processing routines for Ku- and C-band reception
- import of Global Monitoring for Food Security data

Features ISOD Toolbox Version 1.0

- retrieval and import of data from various free online archives related to in situ climatological observations, gauge and satellite derived rainfall estimates, weather and pressure forecasts, potential evapotranspiration, normalized difference vegetation indices and elevation information

Features AMESD-SADC Toolbox Version 1.1

- import and pre-processing of all products disseminated by the AMESD-SADC program for southern Africa, related to agriculture, drought and fire.



Appendix 5: Utilities available at the ITC GEONETCast web pages

For access to the Capacity Building utilities use can be made of the information and documents posted on: http://www.itc.nl/Pub/WRS/WRS-GEONETCast. Various documents are presented here providing further information on data dissemination systems providing a multitude of free environmental information, without the need for internet access but using a local ground receiving station for reception of the data.

For more advanced use of the environmental information in ILWIS use can be made of the so-called "GEONETCast-DevCoCast Application manual", providing various exercises, including description, exercise data and power point presentation. Also other training materials are available from the ILWIS community at http://52North.org as well as from http://www.itc.nl/ilwis/downloads/ilwis33.asp, check the left hand "*Documentation*" and "*Applications*" tabs.