PROCESSING HRIT MSG DATA WITH METEOSATLIB FOR ARPA-SIMC REAL TIME OPERATIONAL APPLICATIONS

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Abstract

In this work we introduce the Meteosatlib software (see http://meteosatlib.sourceforge.net) and how it is used by Arpa Emilia-Romagna Hydro-Meteo-Climate Service (ARPA-SIMC) to manage real time HRIT MSG data to support operational forecaster activities.

Meteosatlib is a suite of libraries, tools and GDAL plugins to read and write Meteosat images in several formats. Meteosatlib works on any Linux or unix-like system. GDAL stands for Geospatial Data Abstraction Library (see http://www.gdal.org/) and is an open source access library for raster geospatial data formats. The GDAL plugin has been specifically developed by ARPA-SIMC to allow the library to be used by a wide range of existing tools.

Here we describe the library with its capabilities and potential applications. We also describe the whole ARPA-SIMC satellite operational chain, which produces, via Meteosatlib, data to support forecast activities, single channel information, combination of different channels for the implementation of RGB products (i.e. Airmass, Natural Colours, etc.) and also the visualization of Eumetsat SAFNWC data (i.e. Cloud type, Cloud Mask, etc) and geolocated maps.

Meteosatlib is available and redistributable as free/open source software, with a GPL license. Its functions can be accessed from C++, Python or any other language with GDAL bindings, as well as from command line tools or interactive applications. This flexibility makes it the ideal component of processing chains for real time data.

INTRODUCTION

ARPA-SIMC requirements for satellite data operational activities are driven by forecasters and data management needs.

Forecasters require real time data, with automatic visualization and also with the additional capability to customize the products, in terms of graphic options (various projections, superimposition of geographic layers, etc.) and development of new products.

With regards to data management, operational procedures in ARPA-SIMC are typically hosted on GNU/Linux systems and placed in an internally developed software framework aimed to centralize monitoring and logging of all batch processing. License issues are also a concern, Open Source software is preferred both as a local institutional choice and by governmental directives to public services (section 68 of the Italian Digital Administrator Code).

Most of the available software for satellite data manipulation does not fit with these requirements, because they are mainly developed for research use and case studies analysis. Additionally, many of

them are not fully customizable by the user and have Graphic User Interfaces that cannot easily be integrated in operational procedures.

METEOSATLIB SOFTWARE

For the reasons mentioned above, ARPA-SIMC relies on the software Meteosatlib to generate the operational satellite products.

Meteosatlib is a suite of libraries, tools and GDAL plugins to read and write Meteosat data in several formats. It works on any Linux or unix-like system with a C++ compiler and it supports MSG HRIT/LRIT data. In particular the GDAL plugin has been specifically developed by ARPA-SIMC to allow the library to manipulate the MSG satellite data via GDAL.

GDAL stands for Geospatial Data Abstraction Library (http://www.gdal.org/) and it is an open source access library for raster geospatial data formats. It provides tools to work with raster images, with functions such as reprojection, geolocation and format conversion. Further it has bindings in a large number of programming languages (C, C++, Python, R, Java and more) and it is a de-facto standard used by a wide range of existing software.

Thanks to the plugin, GDAL is extended to:

- read data in HRIT/LRIT, GRIB, SAF HDF5 and some NetCDF based formats, plus the GDAL already supported formats (see gdalinfo --formats for a list of all the supported formats). Note that the library at the moment is tested only for HRIT/LRIT of Eumetsat MSG satellites;
- write data in GRIB, and some NetCDF based formats, plus GDAL supported formats;
- annotate the datasets with satellite-specific metadata (i.e. the name of the sensor, the channel number etc);
- compute the reflectance for visible and near-infrared channels on HRIT/LRIT datasets. For details about the calculations, especially in NIR, refer to [1],[2].

Thus with Meteosatlib (and its GDAL plugin) is possible to precisely correlate every pixel with its geographical coordinates, display and reproject images, extract image subareas, add shape files, perform numerical data elaboration (i.e. the computation of the Normalized Difference Vegetation Index [3], see Figure 1), create RGB composite images, load directly HRIT datasets in GDAL-enabled geospatial applications (like QGIS or GRASS) and convert data for a wide range of applications.
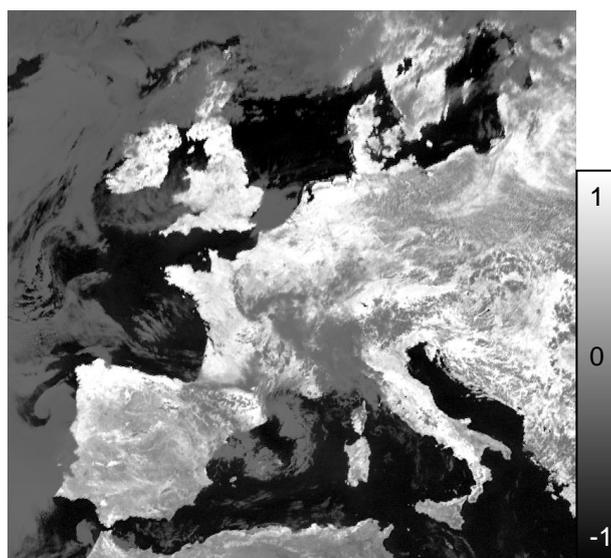

Figure 1: **Normalized Difference Vegetation Index (NDVI) map of 18/08/2013 at 10:00 UTC.**

The software package can be downloaded at http://meteosatlib.sourceforge.net/.

Note that no decryption is performed, files are expected to be already decrypted by using the EUMETSAT key unit or to be transmitted already in clear form. Moreover due to Eumetsat licensing, Meteosatlib cannot include the PublicDecompWT.zip HRIT decompression library. This software has to be downloaded separately from Eumetsat website and put in a dedicated directory before Meteosatlib is built.

SIMPLE COMMAND LINE EXAMPLES

Once the library is installed, the following command line tools are immediately available:

the **msat** command can manipulate satellite data to visualize (the --*display* option performs contrast stretching automatically), create an image (png, jpg etc), select a sub-area in pixels or lat-lon coordinates, view the contents of the file and convert the data in many formats (i.e. GRIB or GeoTiff).

It is also possible to directly visualize the reflectance field for the VIS and NIR channels, that is computed on the fly by the C++ source code of Meteosatlib.

An example of creation of a space view map for HRV channel over a selected area (displayed in Figure 2), is obtained by the following line command:

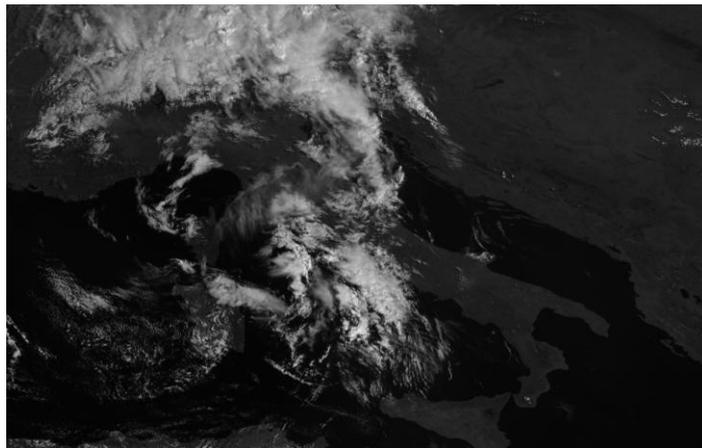msat --png --Area="37,49,5,20" H:MSG3:HRV:201308090900.

Figure 2: **High Resolution Channel image of 09/08/2013 at 09:00 UTC in space view projection.**

In the following example the previous dataset, shown in Figure 2, is visualized in a lat-lon projection over the same selected area (Figure 3), by using the following line command:

gdalwarp -t_srs "+proj=latlong" -te 5 37 20 49 -of Gtiff H:MSG3:HRV:201308090900 hrv.tiff,

where **gdalwarp** is an image mosaicing, reprojection and warping utility provided by GDAL and it allows to choose the favourite projection and the output formats.
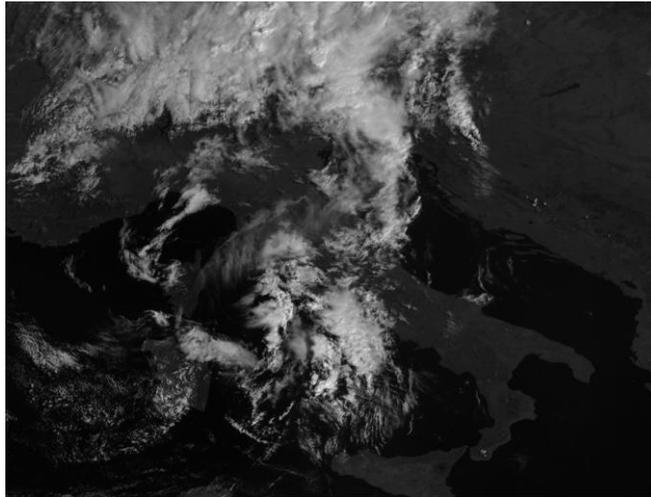
Figure 3: **High Resolution Channel image of 09/08/2013 at 09:00 UTC in lat-lon projection.**

ARPA-SIMC OPERATIONAL CHAIN

In the ARPA-SIMC operational chain, Meteosat satellite data are received by a PDUS station, then decrypted and sent to a linux workstation. Before every elaborations, only segments related to european area are kept to make the procedures faster. Finally the operational products are generated via Meteosatlib.

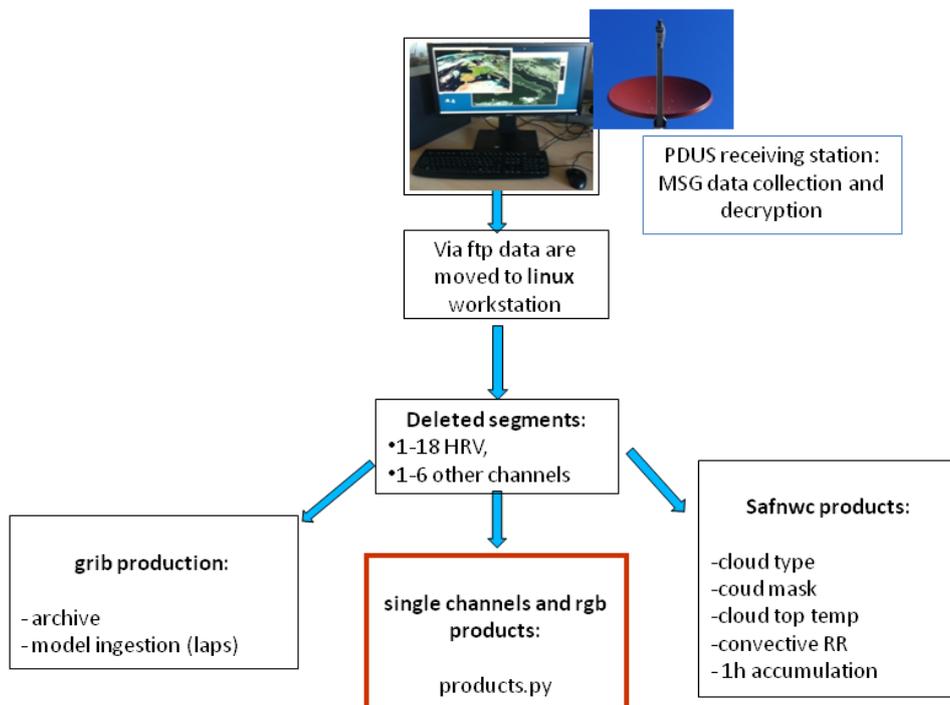In Figure 4 a simple schema of the satellite data operational chain is presented.

Figure 4: **The operational chain at ARPA-SIMC to manage satellite data.**

To support forecast activities several satellite products are provided via a Python+SciPy script (*products.py)*. This script can be found in the Meteosatlib sources (example/products) and it generates the following satellite products, according to Eumetsat guidelines [4]:

- single channel information (HRV, VIS0.6, IR1.6, IR3.9, IR3.9r, WV6.2, WV7.3 and IR 10.8);
- combination of different channels for the implementation of RGB products (Airmass, Day solar, Natural Colours, Dust, Day Microphysical, Convective Storms etc), with addiction and difference of channels and gamma function computation;
- other products as "enhanced IR" (adding a colour palette) or "HRV-lower resolution channels" (with a combination of different resolution channels).

The production time for all the products listed above is about 25 seconds for every satellite scan on a 64 bit Fedora 16 system running on a dual-core Intel Xeon@3GHz.

Further down the operational chain, satellite data are converted to GRIB for archiving and ingestion into the LAPS (Local Analysis Prediction System) model. The visualization of Eumetsat SAFNWC products (i.e. Cloud type) is also performed via Meteosatlib.

The following images (Figures 5-8) show some examples of the operational maps provided by the operational suite.
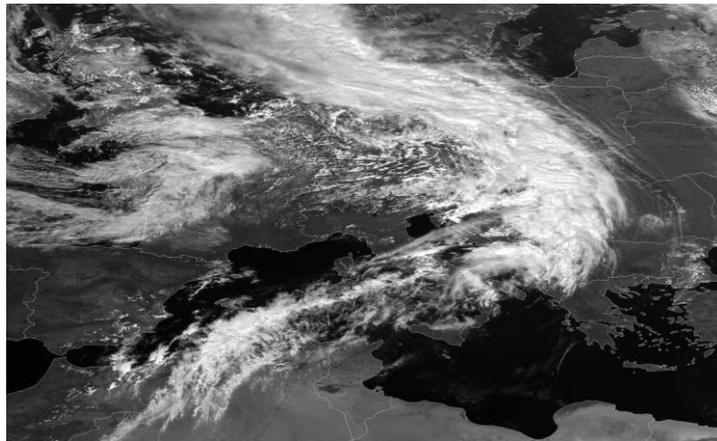

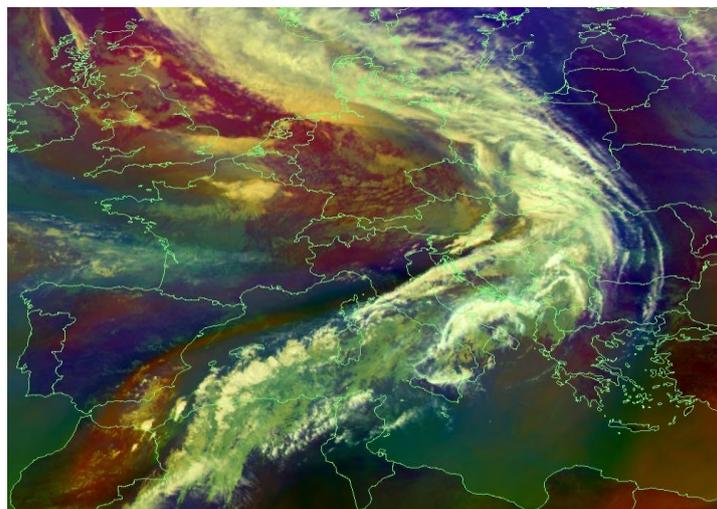*Figure 5:* **High Resolution Visible image in the European area at 09/09/2013, 11:00 UTC.**

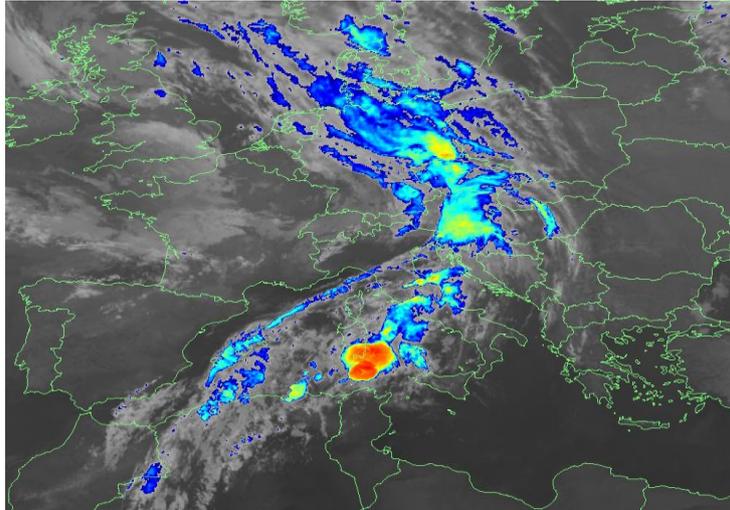*Figure 6: Airmass* **product in the European area at 09/09/2013, 11:00 UTC.**

Figure 7: Enhanced InfraRed **product in the European area at 09/09/2013, 03:45 UTC**
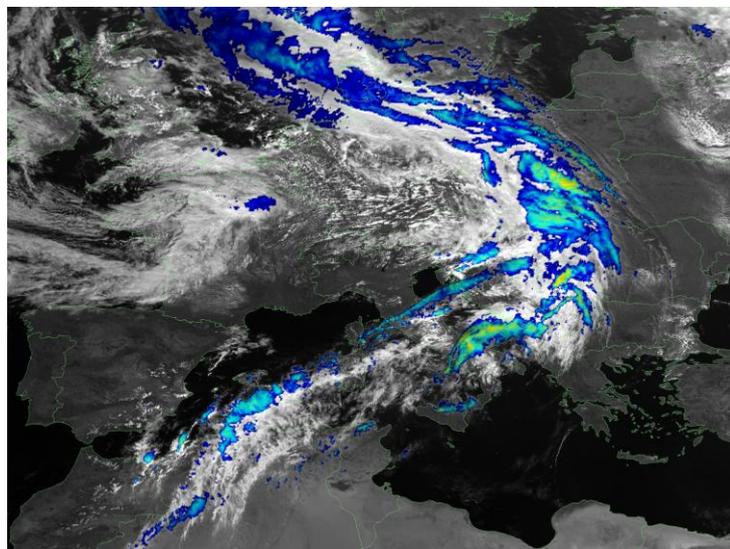

Figure 8: HRV-Enhanced InfraRed **product in the European area at 09/09/2013, 11:00 UTC**

CONCLUSIONS

Meteosatlib is a useful tool that can be installed on operational Linux Servers to manipulate raw satellite data, ingesting them in GDAL, developing meteorological products and finally creating geolocated maps.

The main advantages of this software is that it allows to efficiently and rapidly manage satellite information, so that can be particularly suitable for real time data. It is also readily available, since it is freely downloadable and modifiable as Free/Open Source, with a GPL license.

Another peculiar feature of the tool is that, starting from the compressed raw satellite data, the library performs an internal calibration to directly obtain the reflectance dataset. For all these reasons ARPA-SIMC relies on this tool to produce the operational satellite products.

The software can be downloaded at http://meteosatlib.sourceforge.net/todownload and has a dedicated mailing list at https://lists.sourceforge.net/lists/listinfo/meteosatlib-info.

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