Lake Victoria: Satellite Based Nowcasting

Doc.No. : EUM/MET/DOC/12/0499
Issue : v1 Draft
Date : 26 September 2012
WBS :

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1 INTRODUCTION

This document describes the available satellite observations, products, prospective products and tools to support the nowcasting of nocturnal severe weather over Lake Victoria.

2 METEOSAT SECOND GENERATION (MSG)

The backbone of the satellite based nowcasting system in this region is the Meteosat Second Generation (MSG) satellite with its main imaging instrument SEVIRI (Spinning Enhanced Visible and Infrared Imager).

2.1 Instrument Characteristics

MSG is located in a geostationary orbit over the 0 deg meridian. This service is currently provided by Meteosat-9, but will in the near future (early 2013) be taken over by Meteosat-10, the latest model of the same series of satellites

MSG scans the full Earth disk from south to north every 15 minutes, in a total of 12 spectral channels. 8 of the channels are located in the infrared part of the spectrum, i.e. also provide useful data at night. The spatial sampling distance is 3 km (1 km for the high resolution visible channel) at the subsatellite point.

Figure 1 shows the entire MSG field of view and specifically marks the Lake Victoria region, which is seen under a viewing angle of ~ 35 deg.

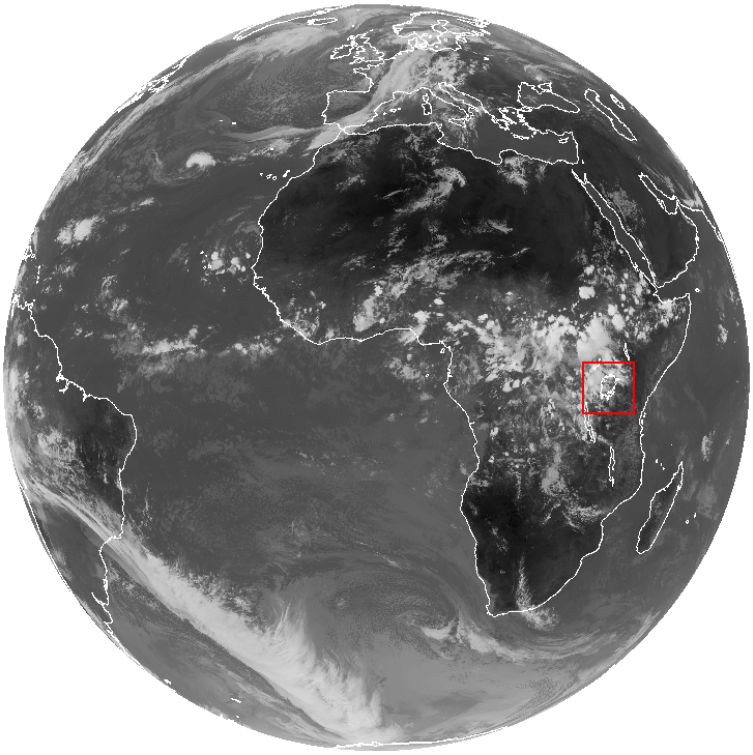

Figure 1: Field of view of the MSG satellite (shown here is the channel in the infrared window region), red box denotes the Lake Victoria region

Table 1 lists the available MSG channels.

Channel	Centre [µm]	Range[µm]
VIS 0.6	0.635	0.56 - 0.71
VIS 0.8	0.81	0.74 - 0.88
NIR 1.6	1.6	1.50 - 1.78
IR 3.9	3.92	3.48 - 4.36
WV 6.2	6.25	5.35 - 7.15
WV 7.3	7.35	6.85 - 7.85
IR 8.7	8.70	8.30 - 9.10
IR 9.7	9.66	9.38 - 9.94
IR 10.8	10.8	9.80 - 11.80
IR 12.0	12.0	11.00 - 13.00
IR 13.4	13.4	12.40 - 14.40
HRV		0.5 - 0.9

Table 1: MSG SEVIRI spectral channels.

2.2 Data Dissemination

MSG data (and many other datasets, including model fields etc.) are disseminated to users via EUMETCast. EUMETCast is based on the DVB technology and uses commercial television satellites. Figure 2 gives a system overview, while Figure 3 shows the coverage for the respective EUMETCast beams.

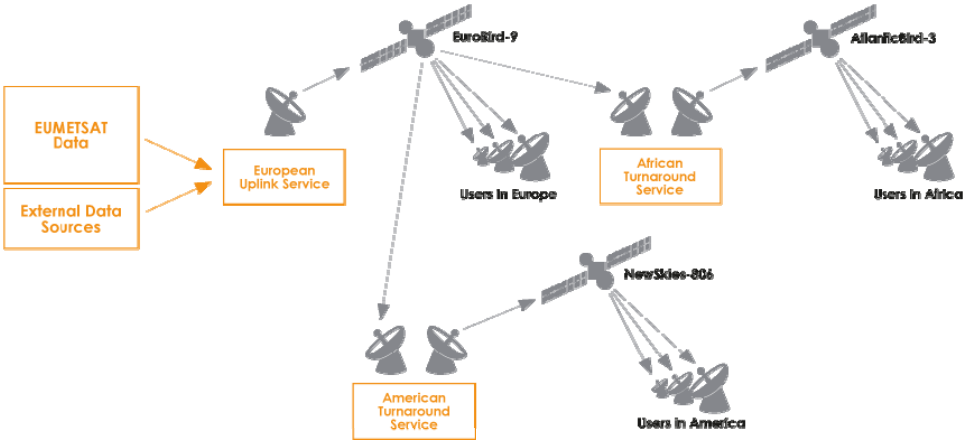

Figure 2: Overview over the EUMETCast dissemination system.

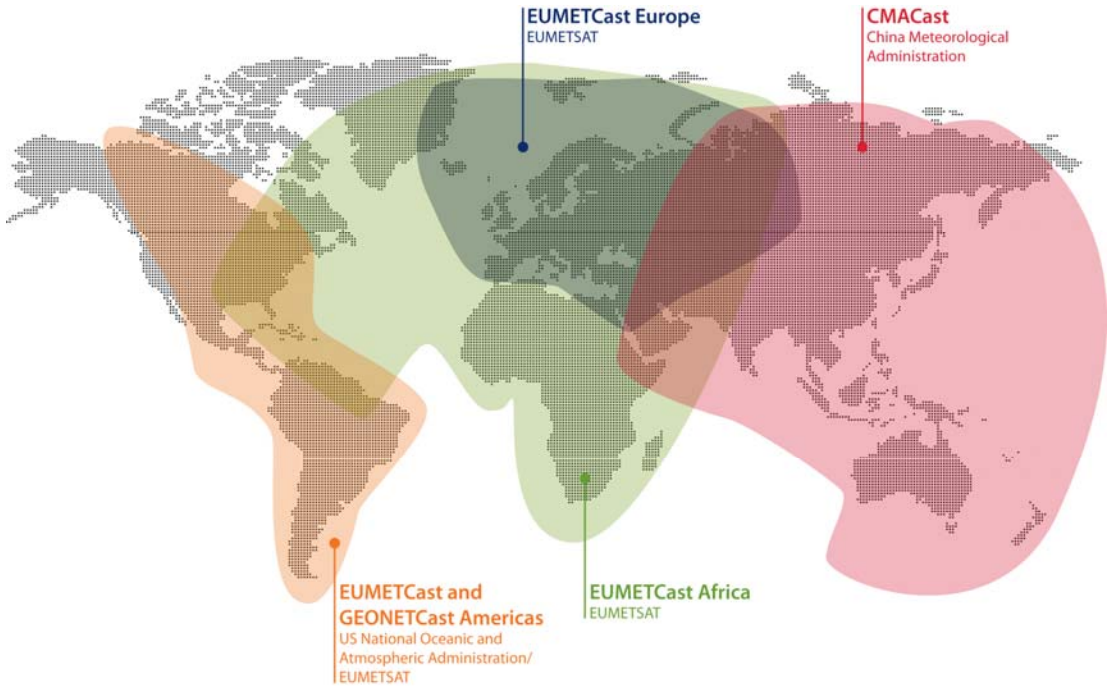

Figure 3: EUMETCast coverage (Europe, Africa, America)

EUMETCast Africa is provided by the C-band coverage of the satellite Atlantic Bird 3.

Users can gain access to EUMETCast through a registration process with EUMETSAT.

It should be noted that only certain datasets are available on the respective Europe / Africa / America EUMETCast beams, full information on data availability is given by the Product Navigator on the EUMETSAT web site wwww.eumetsat.int. Data content on the respective beams can be changed on user request to EUMETSAT.

African countries are equipped with EUMETCast reception stations (antenna, PC, encryption key) and attached visualisation systems (mostly PUMA and Synergie stations).

2.3 Satellite Training

EUMETSAT performs regular satellite training courses, together with the WMO Training Centres in Nairobi, Niamey and Pretoria. Training courses can be classroom courses, training for the trainers or some computer based training through dedicated training modules.

The main aim of this training has been to familiarise users with the information content of MSG data, i.e. to fully understand the spectral characteristics of the SEVIRI channels, to use the data in some kind of visual combinations (e.g. channel differences, RGBs) to detect and highlight certain features of interest (convective cloud tops, dust storms etc.). Most of the training aimed at a better visual usage of the MSG data (in terms of images).

3 SATELLITE PRODUCTS

A number of quantitative meteorological parameters are extracted from the MSG observations, partially at the EUMETSAT Central Facilities, and partially at the EUMETSAT Satellite Application Facilities (SAFs). (For more detail on the SAF concept, please refer to the EUMETSAT web site).

The centrally extracted parameters are mainly aimed at assimilation in Numerical Weather Prediction Models (e.g. clear sky radiances, atmospheric motion vectors), and are less (or not at all) suited for any Nowcasting process. The only exception here is the so-called GII product (Global Instability Indices) which provides, every 15 minutes, information on the static stability of the atmosphere (in terms of e.g. Listed Index or K-Index) together with information on the total precipitable water content and the precipitable water content in three atmospheric layers (low, medium, high). This information is provided for every cloud free 3 by 3 pixel group, i.e. on a spatial scale of ~10 km. The GII product is available on EUMETCast Africa.

3.1 SAF Products

One SAF is dedicated to products concerning nowcasting and very short-range Forecasting (Satellite Applciation Facility in Support to Nowcasting and Very Short-Range Forecasting, or short NWC-SAF, see www.nwcsaf.org).

Other than the other SAFs, the NWC-SAF does not directly provide any products, but it provides a software package, to be installed and run locally, which then extracts the respective meteorological products. As many of these products do not only rely on the satellite data alone but also need model fields as additional input, the basic idea behind this setup was that every user can run the software on his own (meso-scale) model data.

The MSG NWC-SAF software produces the following products:

1. Cloud Mask (pixel based information whether the pixel is cloudy, cloud-free or partially cloudy)
2. Cloud Type (pixel based cloud classification)
3. Cloud Top Temperature and Height (pixel based)
4. Precipitating Clouds (delineation of precipitating and not-precipitating clouds)
5. Convective Rainfall Rate (pixel based quantitative rainfall estimate)
6. Rapid Development Thunderstorms (mature thunderstorm identification – cells, movement)
7. Total and layer precipitable water content
8. Atmospheric Stability (pixel based stability indices)
9. Air Mass Analysis (air mass classification, delineation)
10. Automatic Satellite Image Interpretation (in terms of conceptual models)
11. High Resolution Winds (Atmospheric Motion Vectors derived from a number of channels)

Note that products #7 and #8 and conceptually the same as the respective central product (GII), mentioned above.

3.2 Prospective Future Products

Together with the scientific community, notably in the framework of the US preparation to the GOES-R programme, a number of interesting nowcasting product algorithms were developed and (to some extent) tested on MSG data.

The products comprise:

1. NearCasts, provided by University of Wisconsin/Madison (UW)
2. Convective Cloud Top Cooling, provided by University of Wisconsin/Madison (UW)
3. Detection of Overshooting Tops, provided by University of Wisconsin/Madison (UW)
4. Detection of Convective Initiation, provided by University of Alabama/Huntsville (UAH)

Attached to this document are the two proposals from UW and UAH, detailing the product algorithms and expected results, together with some cost estimates.

4 EPORT

ePort is a browser-based functionality, developed in the framework of the EUMETSAT training project EUMETRAIN, which allows the combination of a number of satellite images and image composites with derived products and numerical model fields. An example of its functionality can be found at http://eumetrain.org/eport.html. Figure 4 shows an example

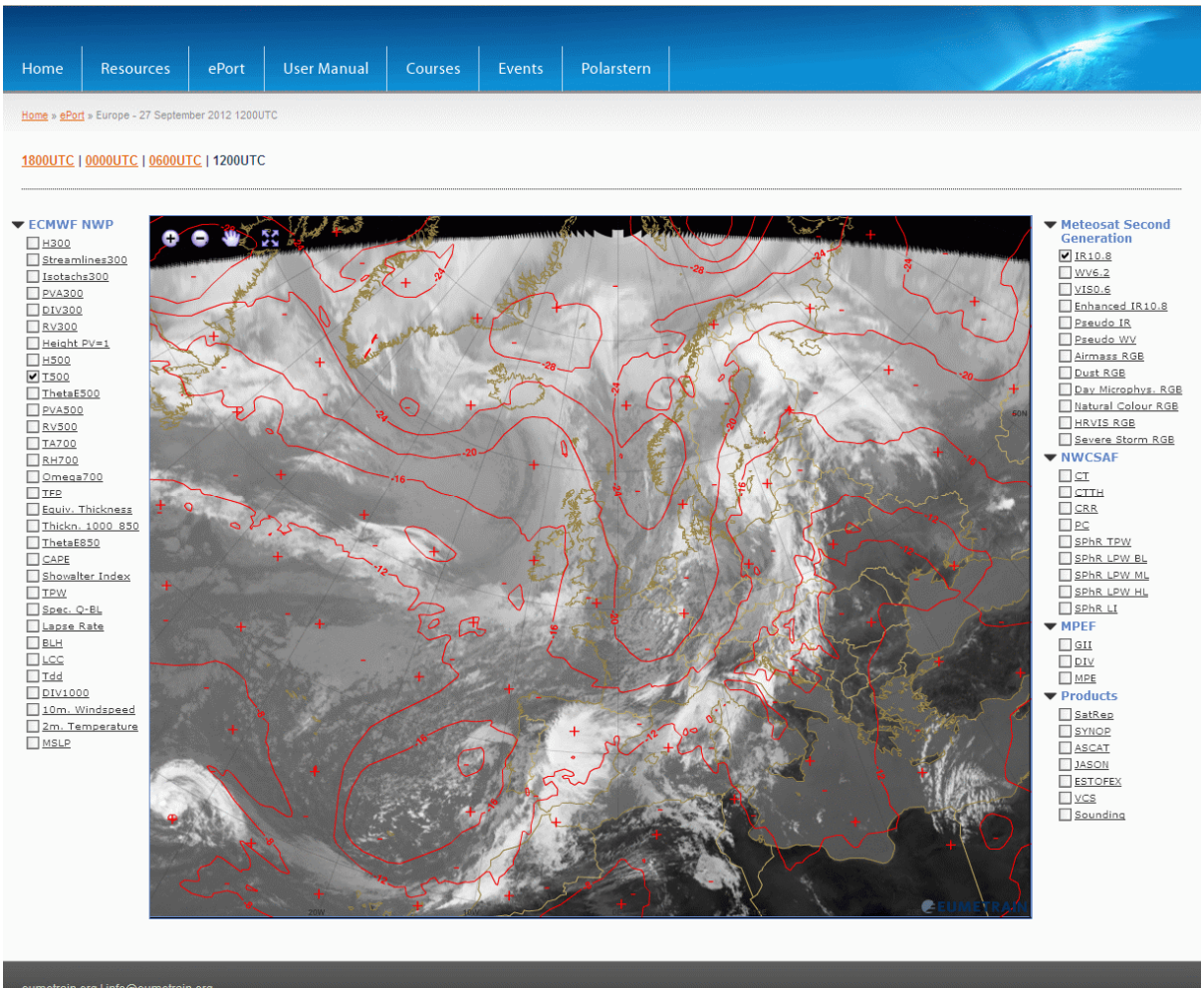

Figure 4: Example of an eport view (for the Euopean sector): Columns on the right show a number of satellite images and products, on the left some model fields. Ticked in this particular view are the MSG 10.8 µm image with the 500 hPa (model) temperature overlaid.

This original EUMETRAIN eport is structured such that the individual images are stored in a central archive, located on the web server, i.e. eport users would need (good) internet access in order to use the functionality. However, an alternative system is feasible, based on the same browser approach, where the files (images) are stored locally. The Met Office is currently supporting the necessary technical changes that need to be done to the eport software in order to run it locally.

It could well be envisaged that the necessary background images are produced at a central server (e.g. located at the Met Office), and the images are then transmitted via EUMETCast to the local African user stations and then accessed locally form there. eport would additionally offer the functionality to get other products, e.g. the ones described in section 3.2, to the users, where the necessary visualisation would be automatically available. In this scenario, a very easy access also to new products would be available.