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STATUS OF UPGRADE OF PRECIPITATION ESTIMATES FROM MSG

In addition to the operational rain rate retrievals using Meteosat data - the MPE method - EUMETSAT plans to provide at least offline installations of two further precipitation estimate schemes, the so-called CMORPH and the Hydroestimator. The aim is to closely monitor the performance of these various methods over the Meteosat field of view, especially over the African continent, to perform an evaluation with specialised partner organisations and to provide the information in a routine manner.

Status of Upgrade of Precipitation Estimates from MSG

1 INTRODUCTION

Both a reliable forecast of flash floods and estimates of the cumulative rainfall over several days up to a month can benefit from satellite observations. Although some dedicated rainfall measuring satellite missions exist, as e.g. the TRMM (Tropical Rainfall Measuring Mission, Kummerow et al., 1998), all these instruments fly on polar orbiters, so that their temporal coverage is by far not sufficient to capture all rainfall events.

Geostationary satellites are best suited to overcome the temporal sampling problem. These satellites, as also the Meteosat Second Generation (MSG) satellites, however, are only equipped with imaging instruments covering the visible and infrared spectral range. Numerous techniques to estimate precipitation based on these observations have been developed, whereby generally some relations between the IR-measured cloud top temperature with precipitation is assumed. Generally speaking, this assumption in itself is quite questionalble: It may hold reasonably well for high reaching, thick convective clouds, but e.g. not at all for high (cold) cirrus clouds, which are not precipitating at all.

It has since long been recognised that a blending of polar orbiter microwave data with geostationary infrared observations may be of value - Kuligowski (2002) gives a comprehensive review. Another option is the combination of infrared data with numerical weather prediction model fields, as e.g. the so-called Autoestimator, or in a slightly modified version, the Hydroestimator (Scofied and Kuligowski, 2003).

The following will shortly present the current EUMETSAT Multi-Sensor Precipitation Estimate, a possible upgrade of this method using the Climate Prediction Center morphing method (CMORPH) and the Hydroestimator. The EUMETSAT plans with respect to the latter two methods are summarised.

It is noted that the activity is part of the ongoing scientific cooperation between NOAA and EUMETSAT.

2 PRECIPITATION ESTIMATES

2.1 EUMETSAT's Multi-Sensor Precipitation Estimate (MPE)

The MPE algorithm combines the high temporal and relatively high spatial resolution of the geostationary Meteosat imager instrument with the high accuracy of rain rate retrievals of microwave sensors on polar orbiting satellites. In this special case, passive microwave data from the Special Sensor Microwave/Imager (SSM/I) instrument onboard DMSP satellites are used. The retrieval of rain rates from microwave data is based on well established algorithms (Ferraro, 1997). A statistical matching in temporal and geographical windows is performed with the aim to correlate the IR brightness temperatures to the microwave retrieved rain rates. The size of the time and space windows is selected to fit the scale of typical synoptic weather systems.

The assumption is used that cold clouds are more likely to produce precipitation than warmer clouds in the same synoptic system. The method thus reproduces the average rain rates according to the microwave measurements within the time and space window as well as the most likely spatial and temporal distribution of precipitation in the full Meteosat resolution.

The MPE algorithm generally follows the principles developed by Turk et al. (1999), although some simplifications have been introduced (Heinemann et al., 2002).

Originally developed for the IR channel of the first generation of Meteosats, the MPE is now also operational for the Meteosat Second Generation satellites Meteosat-8 and Meteosat-9, where it uses the IR10.8 channel information. The MPE is currently produced every 30 minutes over the Indian Ocean (Meteosat-7) and every 15 minutes (Meteosat-9). The data are available in GRIB2 format. In addition, graphical displays of the latest several days of MPE can be viewed on the EUMETSAT website (Fig. 1)

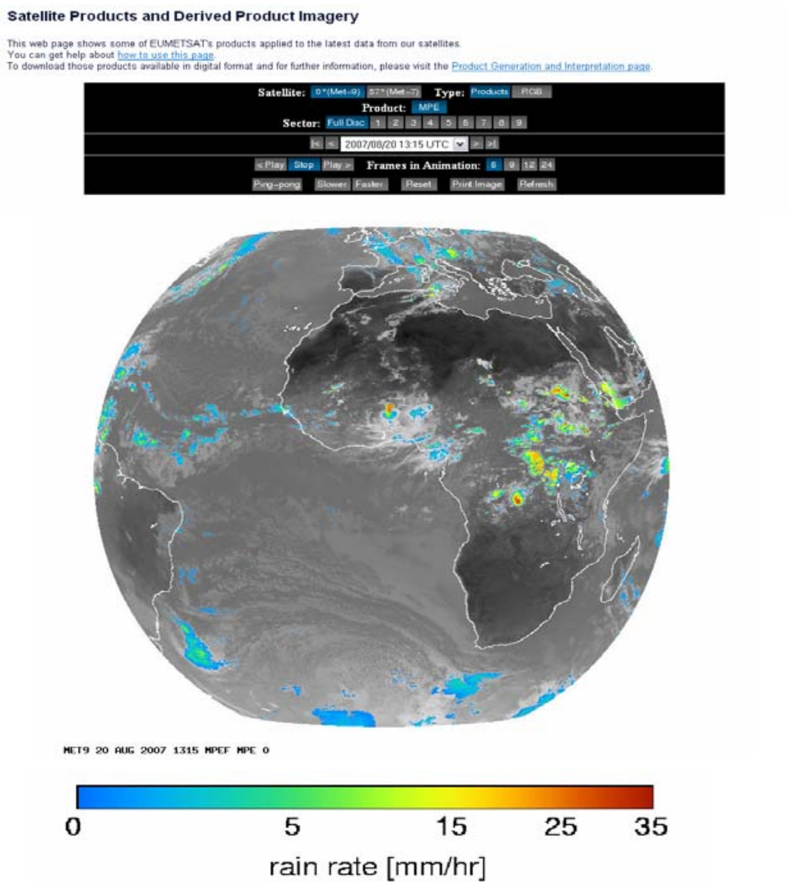

Fig.1: Screenshot of the MPE product on the EUMETSAT website. The visualisation offers both Meteosat-7 and Meteosat-9, views of static images or loops.

2.2 The CMORPH Method

CMORPH stands for Climate Prediction Center morphing method: Here, the infrared satellite data are used to generate atmospheric motion vectors from the 30 or 15 minute image repeat cycles. The precipitation fields, which are derived for a single microwave overpass, are then propagated in time using this motion or propagation information. This process yields spatially and temporally complete microwave-derived precipitation analyses, which are independent of the infrared temperatures field, i.e. no relation between cloud top temperature and precipitation is applied (Joyce et al., 2004).

This propagation can be done forward and backward in time, which leads to an even more reliable resolution. Fig. 2 shows an example.

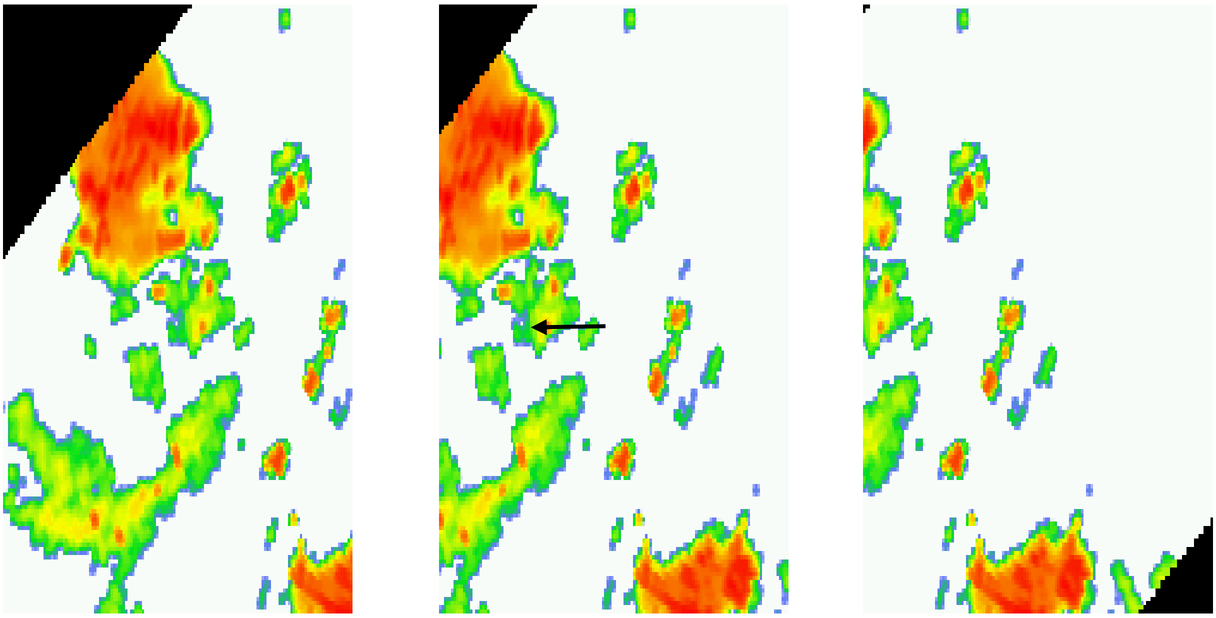

Figure 2: Estimated precipitation field during the microwave instrument overpass (centre) with one overlaid derived atmospheric motion vector. The propagation back in time by 2 hours yields the precipitation fields on the left picture, 2 hours forward in time the field on the right picture. An averaged forward and backward propagated field for the same time stamp would then be the final CMORPH result (figure courtesy A. Bozoglu, personal communication).

2.3 The Hydroestimator

A first version of NESDIS' automated rainfall estimate was called Autoestimator (Vicente et al., 1998). Rain rates are computed from IR window channel satellite observations, where the brightness temperatures are transferred to a rain rate using a static relation (Fig. 3).

The rain rates are then adjusted by the precipitable water, relative humidity, and the temperature in the level of neutral buoyancy, as forecasted by the Eta model. Also, the rain rates are blended with weather radar reflectivity data to screen out non-precipitating clouds. Especially this last point, the dependence on weather radar, was considered a significant problem, as a satellite product is usually most applicable for regions where radar and/or rain gauges are rare or even unavailable.

In response to this, the Hydroestimator was developed (Kuligowski, 2002), where precipitating clouds are identified from regionally coldest IR pixels. In addition, some of the adjustments using model fields were slightly modified.

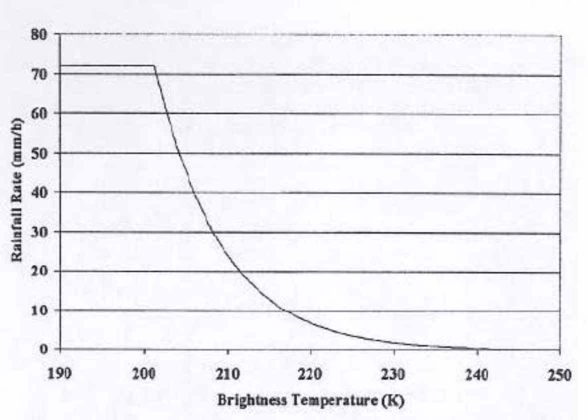

Fig. 3: Assumed relation between rain rate and IR window brightness temperature for the Autoestimator. The rain rate is capped at a maximum value of 72 mm/h. From: Scofield and Kuligowski, 2003.

3 EUMETSAT PLANS

In addition to the currently operational MPE algorithm, EUMETSAT plans to implement prototype versions of both CMORPH and the Hydroestimator. The aim is a long-term monitoring of the performance of each of these approaches within the Meteosat field of view. The focus is here on the African continent, as a satellite based precipitation estimate is most needed there. Better precipitation estimates will support relevant applications in those countries and will help deriving decision criteria for societal benefit areas like water management, agricultural meteorology, and health management. To gain confidence in these methods, dedicated comparison and validation studies are planned using data from especially African ground based rain gauge networks and available radar system, where ever possible.

It is noted that a first cooperation is already ongoing with the South African Weather Service, with a trial local installation of the Hydroestimator (for MSG data and the output of the South African regional model), which is supported by EUMETSAT.

These EUMETSAT activities can be considered as a contribution to the work on algorithm development and validation which is discussed in the International Precipitation Working Group (IPWG). Thereby further cooperation with other CGMS partner on precipitation estimates from geostationary and polar orbiting satellite systems is an important endeavour for EUMETSAT.

4. CONCLUSION

CGMS is invited to take note of EUMETSAT's activities in the area of quantitative precipitation estimates and of EUMETSAT plans in this respect.

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