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EUMETSAT Hydrological SAF
H05 product development at CNMCA

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Abstract

The knowledge of the effective precipitation at ground is a fundamental information both for weather forecasting and for the improvements of the precipitation products derived by post-processing of the satellite data.

In the framework of the Continuous Development and Operational Phase 2 (CDOP-2) of the EUMETSAT Hydrology SAF at the Italian Meteorological Service a series of research activities are ongoing, aiming to plan, realize, validate and test the future version of the accumulated precipitation at ground (H05) product.

The new algorithm performs a real-time statistical analysis system, based on a bias removal scheme using external sources of information (namely rain-gauges, weather radar, Numerical Weather Prediction short-term forecast) as independent estimates of the precipitation field.

Keywords: rain-gauge, weather radar, numerical weather prediction, spatial objective analysis, statistical post-processing, bias removal, remote sensing, satellite application facility, precipitation retrieval, hydrology, water management.

H05 product overview

Product H05 is based on precipitation intensity product generated by merging MW images from operational sun-synchronous satellites and IR images from geostationary satellites (i.e., either product PR-OBS-3 or PR-OBS-4), over the enlarged Euro-Mediterranean domain.

The main operational characteristics of H05 are summarized as follows.

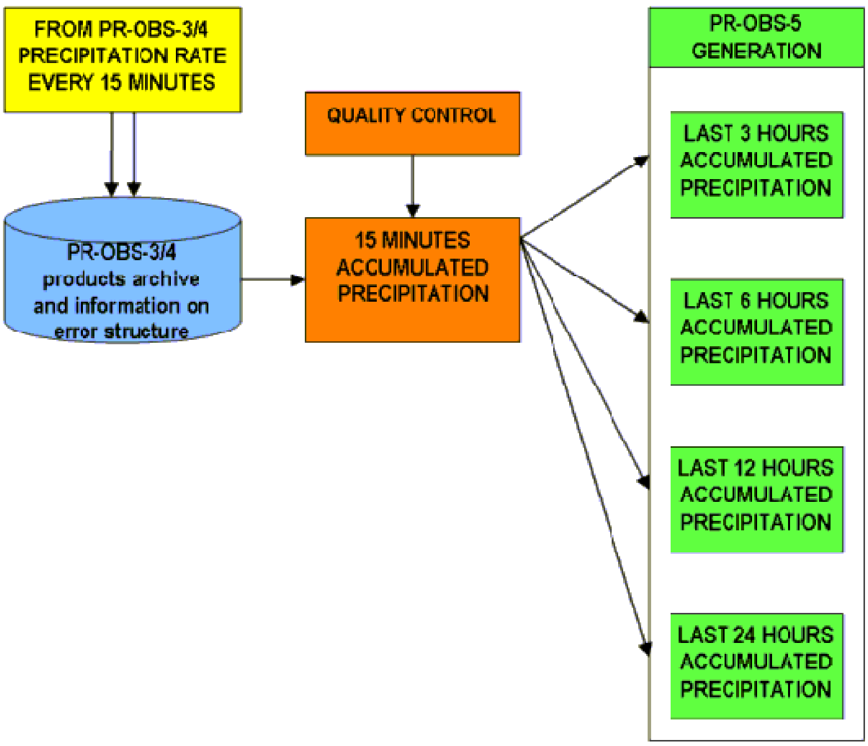
Horizontal resolution (Δx). The product is generated for each SEVIRI pixel. The SEVIRI IFOV is 4.8 km at nadir, and degrades moving away from nadir, becoming about 8 km in the H-SAF area. It is prudent to assume that the process leading to PR-OBS-3 hiddenly convolutes arrays of 3-4 SEVIRI neighbouring pixels, finally ending with Δx ~ 30 km. However, sampling is made at ~ 5 km intervals, consistent with the SEVIRI pixel over Europe.

Observing cycle (Δt). The product is generated every 3 hours, by integration over the previous 3, 6, 12 and 24 hours with respect to the reference time (i.e. nominal time). Moreover, with the recent upgrade to the current version (v2.1), a “rapid update” H05 output is generated hourly with 1 hour as time integration.

Timeliness (δ). Based on the user requirements, the product is processed within 15 minutes following the delivery of the parental product PR-OBS-3 (having 15' of timeliness after the reference time, i.e. the upper limit of the time integration process). The final timeliness required for H05 is therefore 30 minutes.

In the current version of H05 operational at CNMCA (v2.1), the base product (i.e. uncorrected) is derived by a simple time integration of product PR-OBS-3 (96 samples/day at 15-min intervals) over 1, 3, 6, 12 and 24 hours. The alternative accumulated precipitation product derived by use of PR-OBS-4 (“morphing”) is still not operational but it is easy to be implemented.

Static climatological thresholds are applied on the final products to avoid outliers (quality control).



Recent developments – rationale

Considering the design of the chain of the precipitation products, any improvement of the parental products of H05, in particular PR-OBS-3 affected by an evident bias towards the convective contribution to the precipitation estimate, would have a positive impact on the scores of H05.

Nevertheless, in order to improve the H05 product itself, the setup of the new version (v2.x) of the algorithm was designed, taking advantage of a series of dedicated research studies, exploited within the EUMETSAT HSAF Visiting Scientists Programme, and aiming to perform a two-steps approach:

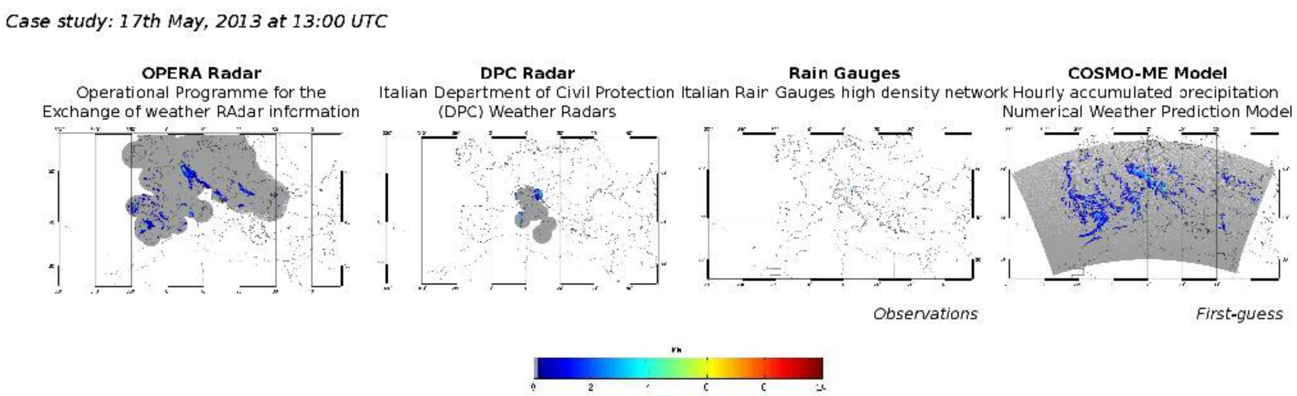
- firstly, the algorithm makes use of independent sources of information to take into account the real-time observed precipitation data from rain-gauges and weather radars, to realize the "combined observed precipitation field". Moreover, introducing a NWP very short-term forecast, acting as first-guess, it is possible to perform a real-time objective analysis system *(analysis step)*.
- Then, the H05 product is corrected in real-time by means of classical statistical techniques, using the accumulated precipitation analysis field as proxy *(correction step)*. In the current configuration, a simple bias removal algorithm has been chosen.

The analysis-correction algorithm is justified because literature studies have shown that the satellite precipitation estimates are most accurate during the warm season and a lower latitudes, where the rainfall is basically convective, whereas the quantitative precipitation forecast (QPF) by numerical weather prediction (NWP) model output is better than the satellite estimate during the cool season when non-convective precipitation is dominant. Moreover, the use of NWP precipitation field allows to minimize bias and random errors and to take implicitly into account the orographic forcing.

Analysis step – Data sources

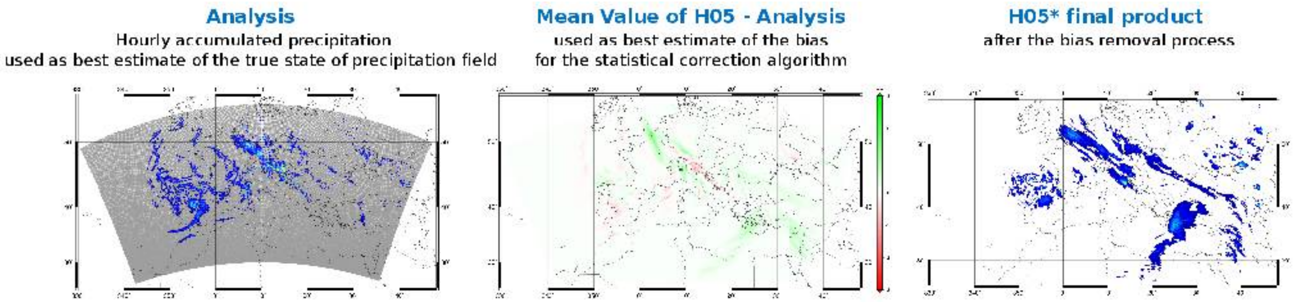
The hourly precipitation field analysis extended to the European domain incorporates the rain gauge data from the Department of Civil Protection (DPC) and radar data over Italy, as well as the EUMETNET-OPERA radar data and the NWP COSMO-ME model hourly accumulated precipitation forecast data on full domain. COSMO-ME is used as first guess, mapping all other sources of data to the model grid by means of standard interpolation techniques including kriging algorithm for rain gauges.

In the current operational configuration, all observed data used for analysis (rain gauges only, as the radar data are used in passive mode) are mapped on the model grid (779x401 pixels; spatial resolution 7 km). The analysis field is then interpolated to the H05 grid (SEVIRI grid, approximate resolution 4 km x 5 km). In the following figures an example of all data used in the analysis is shown.

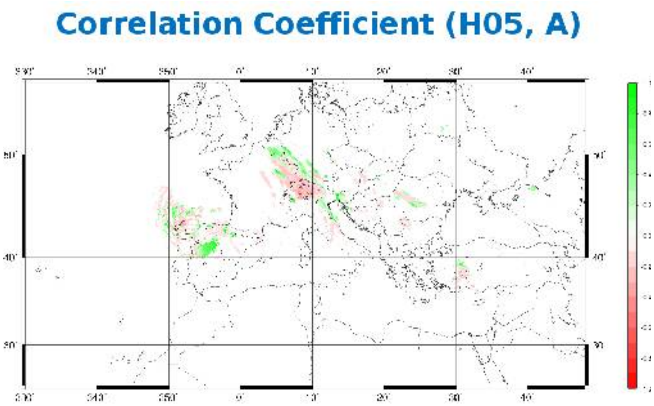


Correction Step - Methodology

In the correction step the mean error (or bias) between H05 and analysis data is computed. In the figure the bias plot for the 17th May case study is shown, obtained computing the difference for each grid point between H05 and analysis considering the last 12 hours for the statistics. A threshold on the correlation coefficient defines the dataset of the grid points to be corrected.



The linear correlation coefficient R between H05 operational product and analysis data was computed for each point, as shown below. From a theoretical point of view, The correlation coefficient pattern shows well-defined zones of positive and negative correlation that indicate, respectively, a good/bad geolocation of the patterns reproduced by H05 product with respect to the analysis ones. Moreover, the highest negative correlation generally indicates a temporal phase shift between the product and the analysis.



Conclusions

The results of the research activities performed at CNMCA demonstrate that the new statistical correction scheme for H05 product produces better estimates of precipitation field, in particular along the coastline, for the orographic enhanced precipitation and, in general, for the convective precipitation on the Mediterranean Sea. The more accurate location and intensity of the precipitation patterns clearly indicate that all sources of data contribute to the algorithm.

Current activities are mainly devoted to the optimization of the statistical processing system and to the delivery of the processing and quality flags for H05 product.

References

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