OPERATIONAL FORECAST OF THUNDERSTORMS OVER PIEMONTE REGION: A SIMULATION OF PAST CASES, USING DIFFERENT WEATHER FORECASTER'S OUTPUT.

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(Dated: 26 August 2011)

I. INTRODUCTION

Heavy thunderstorm forecasting is one of the hardest challenges for weather forecasters, especially over a complex terrain like the Alpine Area. There are relatively few works that verify subjective thunderstorm forecasts (Giaiotti et. al, 2001, Kowaleski et al., 2010), with a wide range of results.

In operational contests, it often happens to waver between an alarmist approach and a softer forecast that could lead to missed alarms; the link with forecast end-users (e.g. civil protection) is another factor that could influence the forecaster behaviour in spreading alarms.

In this work, after having selected 10 significant past cases, we attempted to simulate the operational forecasting framework and to invite ARPA Piemonte forecasters to achieve some thunderstorm forecasts (omitting the date) with some light changes to the operational environments. The aim of the work is to look for the effective added value in thunderstorm forecasting of various instruments (Global model, Small-Scale model, Post-Processing procedures) and of the forecasters themselves.

II. THE SIMULATING FRAMEWORK

The ARPA Piemonte forecasters daily spread, beyond many other products, heavy thunderstorms warnings troughout the country. Piemonte is divided in alert areas and a warning (or not-warning) for every geographical area is issued every 24 hours. The warnings refer to the upcoming 48 hours. At the same time 6 hours QPF forecast for every alert area are issued, in terms of maximum and average precipitation.

The first step of the work was to choose ten past cases, selected between 2008, 2009, 2010 summers, particularly significant from an operational viewpoint (very heavy thunderstorms, large hail, small tornadoes, operational failures like false or missed alarms). The ARPA Piemonte forecasting framework is made up of a global meteorological model (ECMWF-IFS), a non hydrostatic local model (COSMO-I7), many post-processing procedures, some of them for thunderstorms forecasting, plus all the meteorological information and the models output available on the web (neglected in this work). Regarding the post-processing procedures, we considered one of this procedures (the most used by forecasters), based on COSMO-I7 K-Index and QPF values for every warning area. The exceeding of some statistically determined thresholds over an alert area leads to a warning signal.

The aim of the work was to simulate an operational environment making weather forecasters able to reformulate warnings and QPF for the ten previously selected cases, having omitted the date. Three slightly different simulation frameworks were created:

1. Only global model available (ECMWF-IFS)
2. Global Model + Local Model available (ECMWF-IFS + COSMO-I7 model)
3. Global Model + Local Model + Post-Processing available (ECMWF-IFS + COSMO-I7 + P-P)

An internal web page was set up: the forecasters, could chose a case to study, a simulating framework (among 1, 2, 3) and find the weather maps to issue the warnings and the maximum 6 hours QPF for the next 48 hours, over every geographical alert area. At the end of the study, every anonymous different forecast was collected and analyzed. We collected more than 100 forecasts, with an average of ten forecasts for every case study.

III. RESULTS AND CONCLUSIONS

1. Thunderstorms Warnings

Considering Heavy Thunderstorms warnings, the first key-point to note is the significant difference among the 3 different simulating frameworks, especially between the ECMWF-IFS-only simulations and the other ones. In detail, some considerations emerge:

- Around 55% of the simulations improved operational warnings issued at the time of the event;
- 46% of the ECMWF-IFS-only simulations improved operational warnings;
- 58% of the ECMWF-IFS + COSMO-I7 simulations improved operational warnings;
- 62% of the all instruments simulations improved operational warnings.

These percentages, at a glance, may decline the general reliability of the operational warnings, but we need to take into account another factor, namely the fact that 6 to 10 case studies were selected among the dramatical operational warning failures. We can notice however that these results show that better performances could be achieved at the time of the events.

Having a look to areal POD and ETS diagrams (Fig. 1), we can observe the differences among the three different simulation frameworks. The addition of the COSMO-I7 model leads to a pronounced growth of POD and ETS (with a parallel slight FAR increase, not shown here), while the Post-Processing addition causes another POD increase but not an ETS growth. This is due to the associated FAR increase: if we want to catch more thunderstorms, we have to deal with a major number of false alarms.

2. QPF

Analysing the forecasted maximum precipitation, the simulation frameworks are reduced to 2; this is due to the fact that Post-Processing doesn't provide QPF suggestions. The main results of the work are essentially two:

- Confronting MAE diagrams (Fig. 2.a) of the 2 frameworks (over the 11 Piemonte alert areas, named from A to L) versus the operational forecasts MAE, we observe that QPF underestimations are more likely than overestimations, except for ECMWF + COSMO-I7 forecasts, that show a better equilibrium between underestimation and overestimation.
- Confronting RMSE diagram (Fig 2.b) we note that simulations with ECMWF + COSMO-I7 models show better performances over many alert areas, while ECMWF-IFS-only simulations do not show significant and generalized improvements.

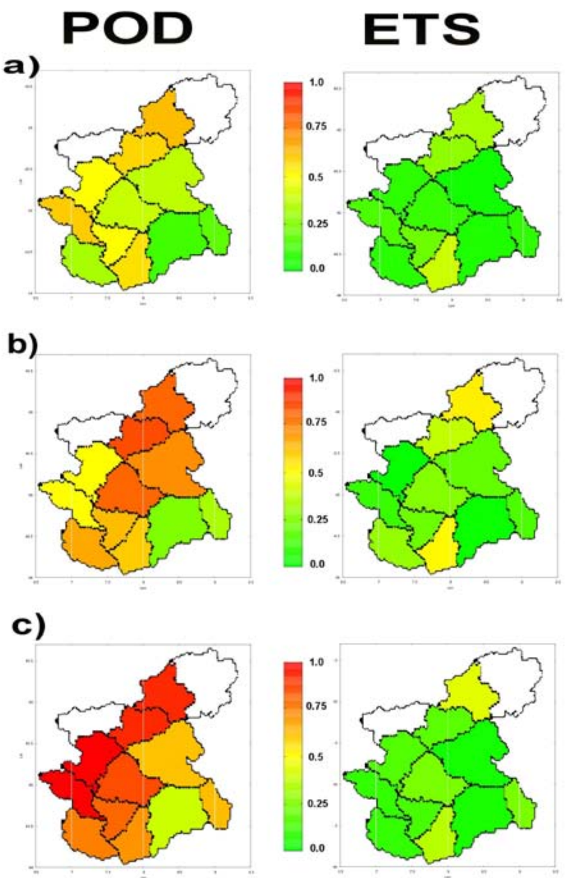

FIG. 1: POD and ETS of a)ECMWF-IFS-only Warnings; b)ECMWF-IFS + COSMO-I7 Warnings c)ECMWF-IFS + COSMO-I7 + Post-Processing Warnings.

In summary, we can state that:

- The operational use of COSMO-I7 model leads to a clear improvement of the thunderstorm forecasts, both in warning issue and in QPF.
- Post-Processing procedure leads to a further improvement of the POD, but with a FAR increase as side-effect; answering the question –What is the better forecast between COSMO-I7 based (lower POD and FAR) and Post-Processing based (higher POD and FAR)?- is not currently possible, because we need to perform a complex cost-loss analysis to proceed any further.
- Compared to operational forecasts (that were critical in some case studies, as pointed out before), the majority of the simulations showed better performances, especially the all-models ones. This could be imputed to two key factors: first, forecasters implied in these simulations were particularly careful and focused to thunderstorms forecasting. They expected that something unusual lead to the choice of these cases rather than others. The second observation is about the light contest of the simulations, definitely different from the stressing operational framework, especially in high potential risk forecasts, where operational forecasters are often in direct contact with end-users, the civil protection managers.
- Lastly, this work shows the potential of a different approach of verification, more related to model users (weather forecasters), not based upon *a posteriori* validation but structured on some pseudo-operational case study analysis.

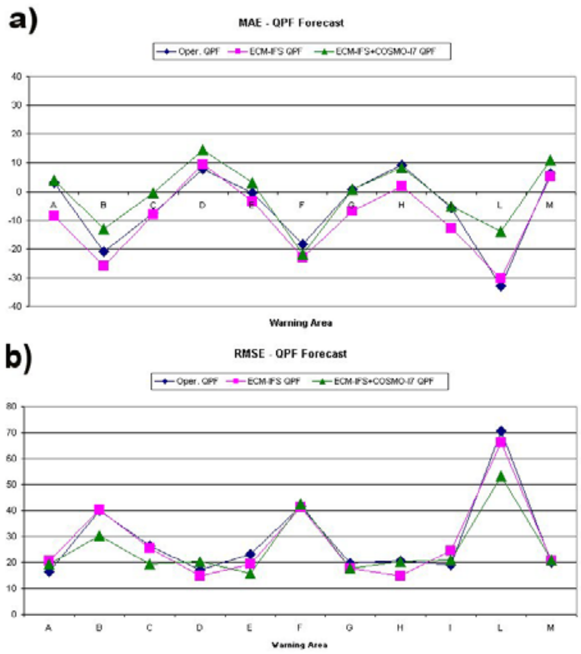

FIG. 2: MAE (a) and RMSE (b) of QPF forecast of operational forecasts (blue), ECMWF-IFS only forecasts (pink), ECMWF-IFS + COSMO-I7 forecasts (green) over every Piemonte alert area.

IV. ACKNOWLEDGMENTS

The author would like to thank all the colleagues, the ARPA Piemonte forecasters, who made this work possible with their operational and pseudo-operational simulations.

V. REFERENCES

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