Flood event in 1994 over Piedmont region: high resolution forecast with the COSMO model

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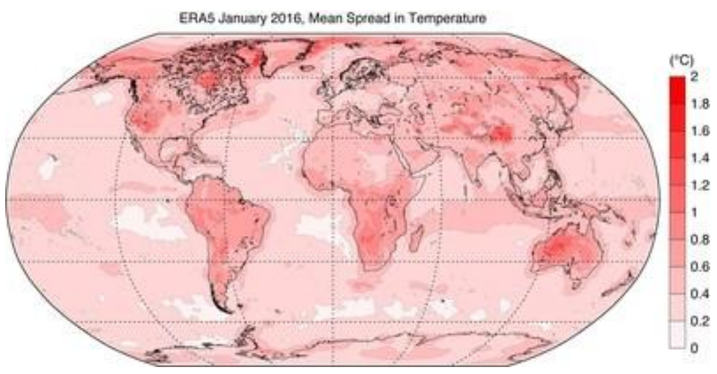
In the first days of November 1994, Piedmont was hit by a disastrous flood. The persistence of a wide depression over Western Europe caused heavy rains over large part of Piedmont region from 4 to 7 November 1994. The strong confluence of the surface south-easterly flow and of the upper-level southerly current caused exceptional rainfall peaks over the Maritime Alps and the north-west sector of the region. Rainfall led to large floods along the rivers and numerous landslides that were responsible for considerable damages and, unfortunately, numerous victims.
The 25th anniversary of the flood event of November 1994 in Piedmont was an opportunity to assess the progresses made in meteorological modelling during these years and what remains to be done.

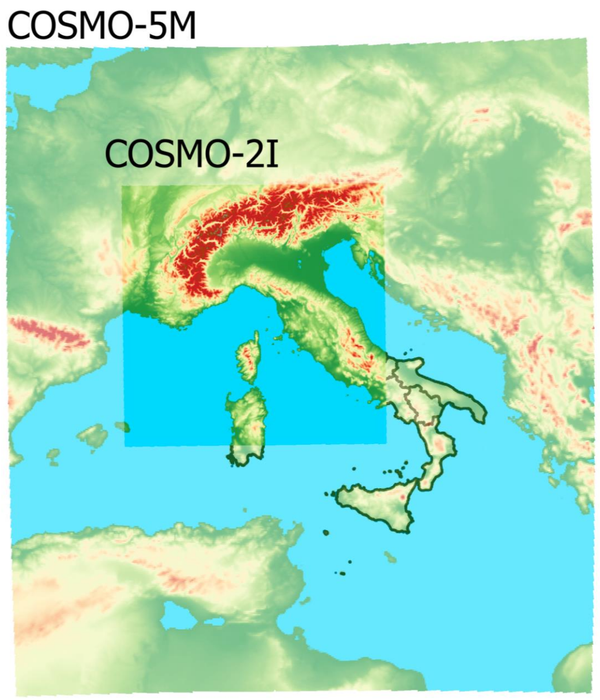
Methods

The scope of this work is to investigate the behavior of the **Italian operational model COSMO** in forecasting past extreme events. Thanks to the availability of ECMWF's new set of reanalysis and reforecast dedicated to this major flood, a set of experiments was produced using different initial and boundary conditions:

- COSMO runs at 5km resolution (COSMO-5M), forced by the IFS reanalysis at grid spacing of 18 km (experiment 3738), from 3 November 1994 00UTC to 7 November 1994 00UTC and COSMO runs at 2.2 km (COSMO-2I) with initial and boundary conditions provided by COSMO-5M
- COSMO-5M runs, forced by the IFS HRES reforecast at grid spacing of 9 km (experiment h9zy), from 4 November 1994 up to +48h and COSMO-2I runs nested into COSMO-5M

The ECMW's new experiments were driven by the new **climate reanalysis dataset ERA5**, covering the period 1950 to present and being developed through the Copernicus Climate Change Service (C3S). ERA5 HRES data were produced using 4D-Var data assimilation in cycle "cy41r2" of ECMWF's IFS, with 137 vertical levels and 31 km horizontal resolution.

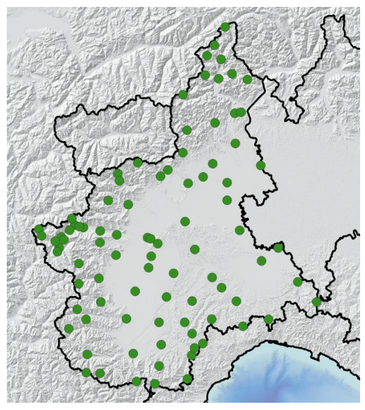




Although the event was mainly advective and orography-driven, a simple sensitivity test on the parameterization of convection has been performed. In COSMO-2I the deep convection was resolved and the shallow convection was:

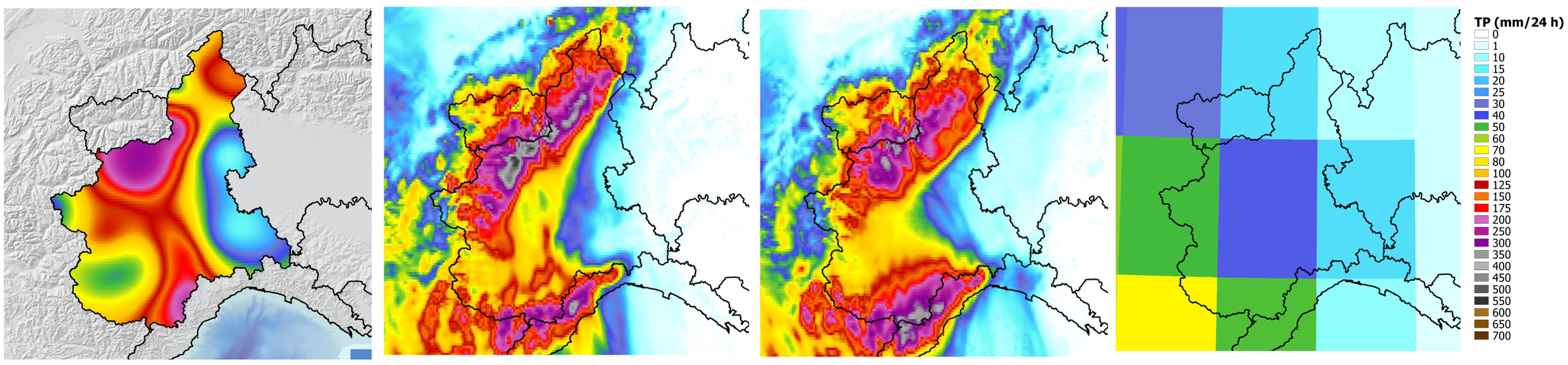
1. parameterized by the (default) **Tiedtke** scheme
2. parameterized by the (optional) **Bechtold** scheme
3. resolved (**no convection** parameterization)

The model outputs have been evaluated by visually comparing the precipitation maps with the spatial rainfall distribution estimated, using the Kriging interpolation technique, from the measurements provided by the meteorological network available at that time (figure in the right).

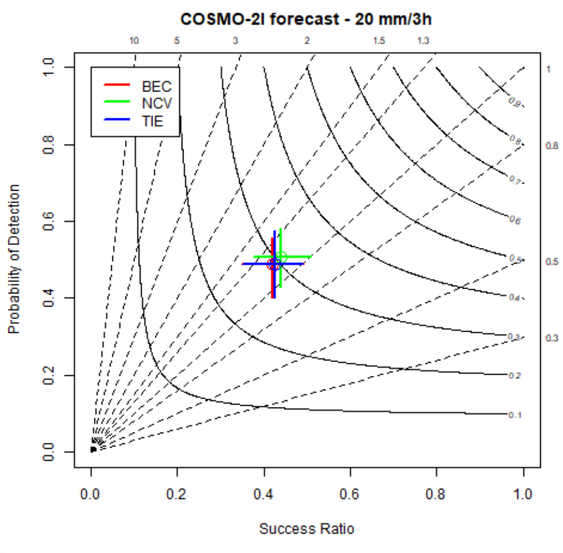


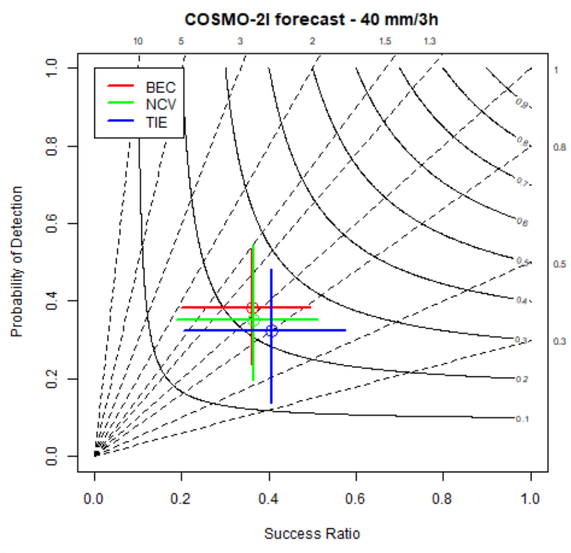
Results

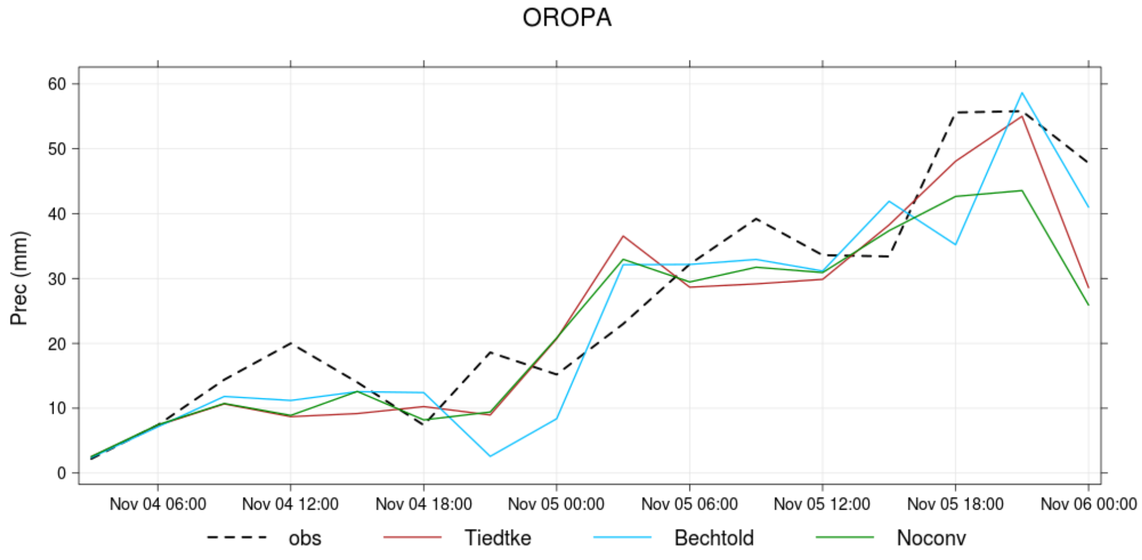
The figures below show the 24-hours rainfall on 5 November 1994 respectively from observations, COSMO-2I reanalysis, COSMO-2I forecast and IFS forecast available at that time, when the cycle "cy11r7" (horizontal resolution equivalent to 60/80 km approximately) was in operation. COSMO-I2 correctly reproduces the precipitation pattern, even though there is a slightly overestimation in the north part and a slight underestimation over the south plains. The original IFS forecast indicated intense precipitation over the reliefs, especially in the southwest, but the progress made in meteorological modeling since then is evident.



In addition, a quantitative assessment of the model was conducted by producing performance diagrams for different rainfall thresholds and by comparing the rainfall evolution over time at the stations where the largest amount of precipitation has been recorded (n the figure on the right Oropa, in the north-western part of Piedmont). The diagrams show a worsening of the model performance for higher precipitation thresholds, whereas the Bechtold pattern seems to have a better behavior.







References

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[2] Copernicus Climate Change Service (C3S), ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate, Copernicus Climate Change Service Climate Data Store (CDS), date of access. https://cds.climate.copernicus.eu/cdsapp#!/home

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