Operational implementation of regional ensemble forecasts

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The forecast of localised and severe weather events (e.g. heavy rainfall, strong winds, cold temperature anomalies) is still nowadays a challenging problem, despite the more and more careful detection of precursors, developments and mature phase of this kind of events. Many weather centres have given more and more emphasis to the probabilistic approach, which enable to estimate the predictability of the atmospheric flow and assess the reliability of the deterministic forecast beyond the very short range. As to the use of limited–area models (LAMs), ARPA–SMR developed the Limited–area Ensemble Prediction System (LEPS). By means of a clustering–selection technique, ECMWF EPS members are first grouped into five clusters, then a Representative Member (RM) is selected within each cluster (Marsigli et al., 2001). The RMs provide both initial and boundary conditions for the integrations with a limited–area model, which is run five times (once per RM), so generating a small–size high–resolution ensemble for forecast ranges up to 120 hours. Hence, the typical probabilistic products (e.g. probability maps for rainfall rates or wind intensity exceeding particular thresholds) are produced on the basis of the information provided by the LAM integrations, each run being weighted according to the population of the cluster where the RM is selected. LEPS has been shown to perform better than EPS over a number of test cases and for forecast ranges between 48 and 120 hours (Montani et al., 2003a) in terms of estimate of precipitation intensity as well as in the detection of the regions most likely affected by heavy rain. These encouraging results opened the way to the experimental production of limited–area ensemble forecasts on a daily basis, the COSMO–LEPS project, which has recently started within the COSMO framework (COnsortium for Small–scale MOdelling; the members of the Consortium are Germany, Greece, Italy, Poland and Switzerland). This project aims to generate "short to medium–range" (48–120 hours) probabilistic predictions of severe weather events (based on the non–hydrostatic regional model Lokal Modell – LM) over a domain covering all countries involved in COSMO. An "experimental–operational" COSMO–LEPS suite (following the methodology described in Montani et al., 2003b) was set–up so as to produce probabilistic forecasts, based on LM nested on a selection of ECMWF EPS members.

As an example of COSMO–LEPS performance, we present the behaviour of the system for a heavy precipitation event occurred in November 2002 in Northern Italy. During the 24–hour period ending at 12UTC of 25 November 2002, rainfall values exceeding 100 mm/day were recorded all over the southern Alpine area, the highest amounts being observed in North-eastern Italy (above 150 mm/day). This caused widespread flooding as well as the overflow of several lakes in northern Italy. The main COSMO–LEPS product consists in combining the 5 LM deterministic runs using weights proportional to the population of the cluster where the RM providing initial and boundary conditions was selected. This enables the generation of probability maps on the basis of LM forecasts. For this case study, Fig. 1 shows the probability forecast (120–hour range) of 1–day rainfall exceeding 4 different thresholds: 20, 50, 100 and 150 mm. As to the two lowest thresholds (top–row panels), it can be noticed that all regions actually affected by the flood are highlighted as locations of heavy rainfall, with probability above 90% over North–western

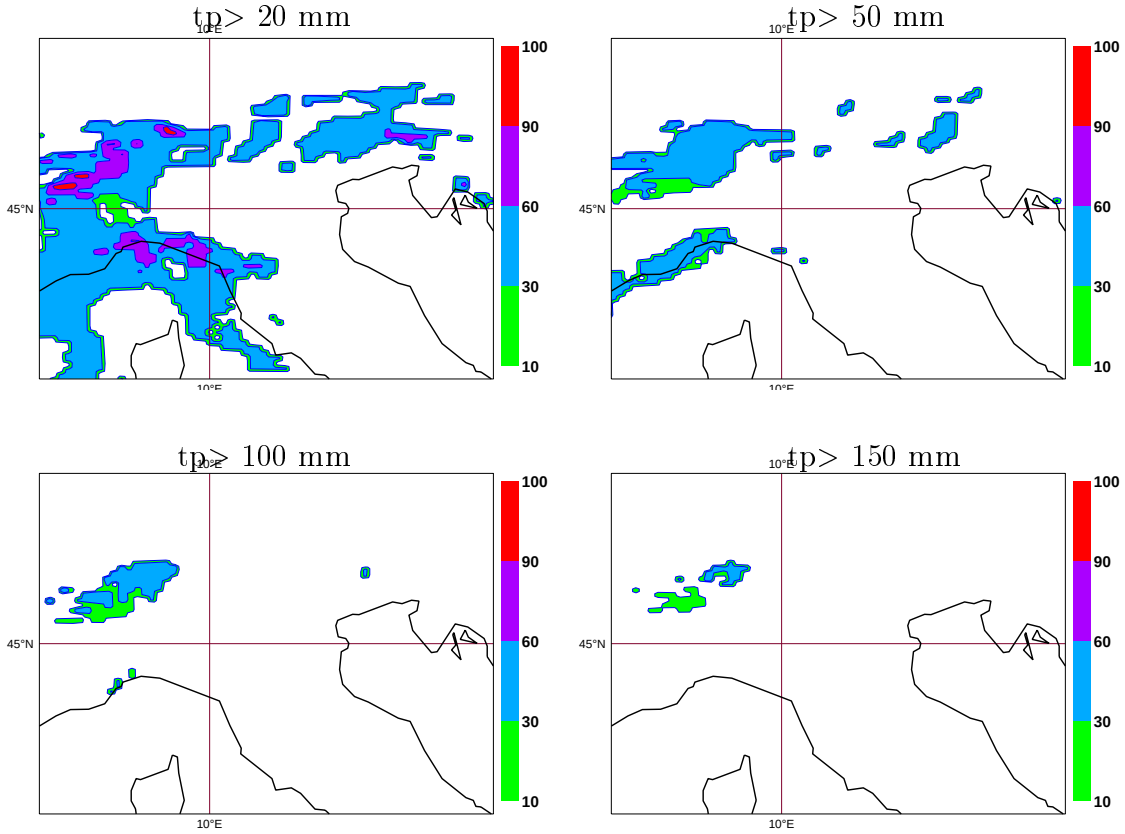

Figure 1: Probability maps of 24–hour rainfall exceeding 20 (top–left panel), 50 (top–right), 100 (bottom–left) and 150 mm (bottom–right) for COSMO–LEPS runs starting at 12UTC of 20 November 2002 (120–hour range). Contour intervals: 10%, 30%, 60%, 90%.

Italy for the 20 mm threshold. At the two highest thresholds (bottom–row panels), only the signal over north–western Italy "survives", with a probability of rainfall above 150 mm between 30% and 60%. Therefore, already at the 5–day range, the possibility of a intense and localised weather event over Northern Italy is highlighted, thus giving the possibility to issue preliminary warning to be either confirmed or dismissed on the basis of more recent forecasts. In these months, the experimental–operational part of COSMO–LEPS project is being accomplished. Deterministic and probability products based on LM are generated on a daily basis and disseminated to the meteorological services taking part to the COSMO consortium. The forecast accuracy of the products is being examined on the basis of several objective scores, which will evaluate both ability and shortcoming of the COSMO–LEPS system in a comprehensive way.

References

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