THE LIMITED–AREA ENSEMBLE PREDICTION SYSTEM COSMO–LEPS

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The forecast of localised and severe weather events is still a challenging problem. The key role played by mesoscale and orographic–related processes can seriously limit the predictability of intense and localised events. Although the use of high–resolution limited–area models (LAMs) has improved the short–range prediction of locally intense events, it is sometimes difficult to forecast accurately their space–time evolution for ranges longer than 48 hours. Thanks to ensemble prediction systems (EPSs), many weather centres, and ECMWF among them, have given more and more emphasis to the probabilistic approach. Regarding the use of limited–area models within ensemble systems, ARPA-SMR developed LEPS, a Limited–area Ensemble Prediction System. Out of a "super–ensemble" of 153 elements of three consecutive operational ECMWF EPS runs, five clusters are identified and, for each of them, a cluster representative member (RM) is chosen. Each of such RMs provides both initial and boundary conditions for a LAM integration, generating in this way a small–size, high–resolution ensemble. The LEPS methodology allows to combine the benefits of the probabilistic approach (a set of different evolution scenarios is provided to the forecaster) with the high–resolution detail of the LAM integrations, with a limited computational investment (Marsigli et al., 2001, *Quart. J. Roy. Meteor. Soc.*, **127**, 2095–2115; Molteni et al., 2001, *Quart. J. Roy. Meteor. Soc.*, **127**, 2069–2094; Montani et al., 2001, *Nonlin. Proc. Geophys.*, **8**, 387–399). In the quoted references it has been shown that, over a number of test cases and for several forecast ranges (48–120 hours), LEPS performs better than EPS concerning the quantitative forecast of intense precipitation, as well as the geographical localisation of the regions most likely affected by the events. Following the encouraging results of an early experimental phase, the generation of an "experimental–operational" limited–area ensemble prediction system, the COSMO–LEPS project, has recently started on the ECMWF computer system under the auspices of COSMO. COSMO (COnsortium for Small–scale MOdelling, www.cosmo–model.org) is a consortium involving Germany, Italy, Switzerland, Greece and Poland on the developement of the limited–area non–hydrostatic model Lokal Modell (LM). COSMO–LEPS aims therefore at the development and pre–operational test of a "short to medium–range" (48–120 hours) probabilistic forecasting system using a LAM over a comparatively large domain (see fig. 1), covering all countries involved in COSMO. Thanks

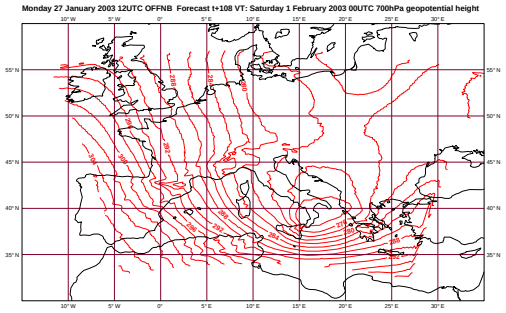

Figure 1: Operational COSMO–LEPS domain.

to the experience gained during the early experimental phase, it was decided to set–up the suite as follows:

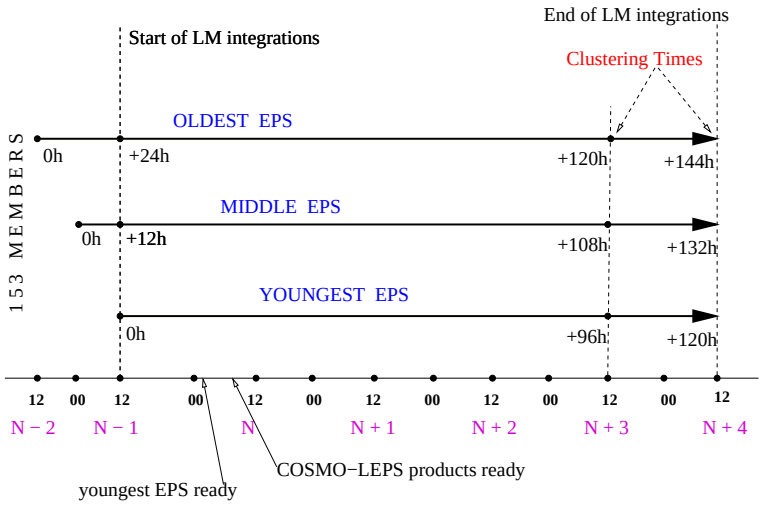

Figure 2: Details of COSMO–LEPS suite.

- three successive 12–hour–lagged EPS runs (started at 12 UTC of day *N–2*, at 00 and 12 UTC of day *N–1*) are grouped together so as to generate a 153–member super–ensemble; (see fig. 2);
- a hierarchical cluster analysis is performed on the 153 members so as to group all elements into 5 clusters (of different populations); the clustering variables are Z, U, V and Q (specific humidity) at three pressure levels (500, 700, 850 hPa) and at two forecast times (fc+96 and fc+120 for the "youngest" EPS); the cluster domain covers the region 30N–60N, 20W–40E;
- within each cluster, one representative member (RM) is selected according to the following criteria: the RM is that element closest to the members of its own clusters and most distant from the members of the other clusters; distances are calculated using the same variables and the same metric used in the cluster analysis; hence, 5 RMs are selected;
- each RM provides initial and boundary conditions for the integrations with LM, which is run 5 times for 120 hours, always starting at 12UTC of day *N–1* and ending at 12UTC of day $N + 4$;
- the LM has a horizontal resolution $\Delta x \simeq 10$ km, 32 vertical levels and the time–step used for the integrations is 60 sec;
- probability maps based on LM runs are generated by assigning to each LM integration a weight proportional to the population of the cluster from which the RM (providing initial and boundary conditions) was selected; deterministic products (that is, the 5 LM scenarios in terms of surface and upper–level fields) are also produced;
- LM grib–files are disseminated to the COSMO community for evaluation;

COSMO–LEPS products are usually available by 9UTC of day *N*, well in time to be evaluated by operational forecasters. COSMO–LEPS dissemination started during November 2002 and, at the time of writing (March 2003), the system is still being tested to assess its usefulness in met–ops rooms, particularly in terms of the assistance given to forecasters in cases of extreme events. An objective probabilistic verification of the system is also being carried on.