COSMO-CZ-EPS – FIRST EVALUATION

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I. INTRODUCTION

One of the main challenges for numerical weather prediction (NWP) is still recognized as quantitative precipitation forecasting. Several national and international weather centres, like the European Centre for Medium-Range Weather Forecasts (ECMWF), the Canadian Meteorological Centre (CMC), the National Centers for Environmental Prediction (NCEP) and the UK Meteorological Office, provide valuable operational ensemble prediction at a global scale (Buizza et al., 2007). In addition to them, many limited-area ensemble prediction systems have been recently developed, either in research or in operational mode, so as to address the need of detailing high-impact weather forecasts at higher and higher resolution and to provide more reliable forecasts than achievable with a single deterministic forecast (Iversen et al, 2011).

The COSMO-CZ-ENS is running at an Institute of Atmospheric Physics Czech Academy of Sciences with high resolution and using lateral, initial and boundary conditions from COSMO-LEPS ans COSMO-SREPS. The description of the ensemble and its first evaluation is presented in the next paragraphs.

II. ENSEMBLE SETUP AND DATA

II.I COSMO MODEL

The single ensemble runs are computed by COSMO model which is a non-hydrostatic and fully compressible model formulated in advection form (Baldauf et al., 2011). The model was integrated over the area covering the domain of Czech Republic (Fig. 1), which comprises 281 by 211 grid points with a horizontal resolution of 2.8 km and 50 vertical levels. The model was integrated with a time step of 30 s. The parametrization of deep convection was switched off and only the parametrization of shallow convection was included. The model setting is the same setting as in the COSMO-CZ runs (Sokol and Zacharov, 2012; Sokol 2011).

II.II COSMO-CZ-ENS

The COSMO-CZ-ENS was previously planned to run on initial, lateral and boundary (IC+LBC) from COSMO-SREPS (Marsigli, 2009). The former SREPS was driven by three different global NWP models with perturbe physicall settings. However, there was a strong dependence of the SREPS on the given global model and the dependence of the physical parametrization disturbances was significantly smaller than the difference in a driving model (dependence on boundary conditions). For this reason the number of the ensemble members was decreased to three members. Each member is now run with another glogal model IC+LBCs (GFS, GME and IFS).

COSMO–LEPS is the mesoscale limited-area ensemble of the COSMO Consortium, developed by ARPA–SIMC, running since 2002 (Montani et al., 2011). The ensemble is based on 16 runs of the COSMO model with 7 km horizontal resolution, on a domain covering central and southern Europe and 40 levels in the vertical. The ensemble is generated as a downscaling of the global ECMWF EPS. An ensemble reduction technique (Molteni et al., 2001) is applied to select members of the EPS for nesting the COSMO model. The members of EPS runs are grouped into 16 clusters on the basis of the similarity of some mid and lower tropospheric fields. One representative member is selected for each cluster to provide IC+LBCs of the COSMO run.

Together, SREPS and LEPS are providing IC+LBCs for 19 COSMO runs with 2.8km resolution creating the final COSMO-CZ-ENS. The domain of this ensemble is shown on the Figure 1, the domain contains 281x211 g.p.

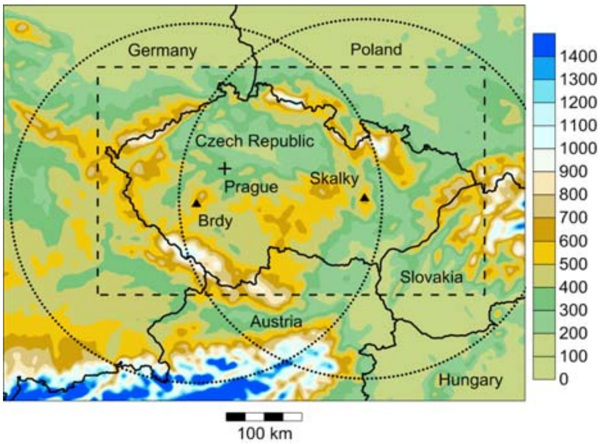

FIG. 1: The model domain of COSMO-CZ-ENS with topography above sea level in m (see legend). The positions of the Brdy and Skalky radars (black triangles), the borders of Prague and the areas covered by the radar data (dotted circles) are marked. The rectangle (dashed lines) shows the verification domain.

II.III PERIOD AND VERIFICATION DATA

The COSMO-CZ-ENS was verified on the period coverring July 2012. There was a heavy precipitation in the in the first half of this period and the second part was drier with some afternoon showers. In this article we have verified only the 12h precipitation totals from 1200-2400UTC.

The radar data were obtained from the CZRAD network (Novák, 2007). The positions of both radars are shown in Fig. 1. To determine the verification rainfall values, we applied the MERGE product (Šálek and Novák, 2008), which adjusts the radar data with gauge measurements, as described by Sokol and Zacharov (2011). The MERGE data were interpolated into the COSMO model grid.

III. VERIFICATION

The COSMO-CZ-ENS was verified on the period coverring July 2012. First, we used a Talagrand diagram (Rank histogram) to look into distribution of the ensemble precipitation values and their spread. It is a useful for determination of the reliability of ensemble forecasts and for diagnosing errors in its mean and spread (Hamill, 2001). This method checks where the verifying observation usually falls with respect to the ensemble forecast data arranged in increasing order at each grid point. The diagram on Figure 2 was constructed from 12h precipitation totals on the whole verification period. The diagam shows a bias where the ensemble underpredicts the precipitation totals. The bias is markable also in the mean error at Figure 3. It is clear, that the mean error is increasing with mean measured precipitation. There are only two days, where the ensemble overpredicts the 12h precipitation totals – 11th and 13th July. There is also a lot of spread in the mean error of the ensemble members espetially in cases with high mean error.

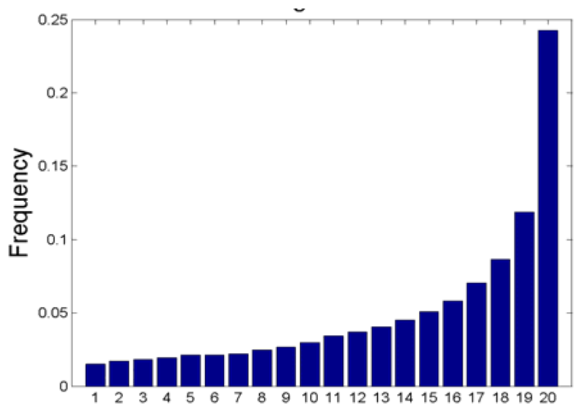

FIG. 2: Talagrand diagram of COSMO-CZ-ENS 12h precipitation totals (1200-2400UTC) for 1st – 31st July 2012.

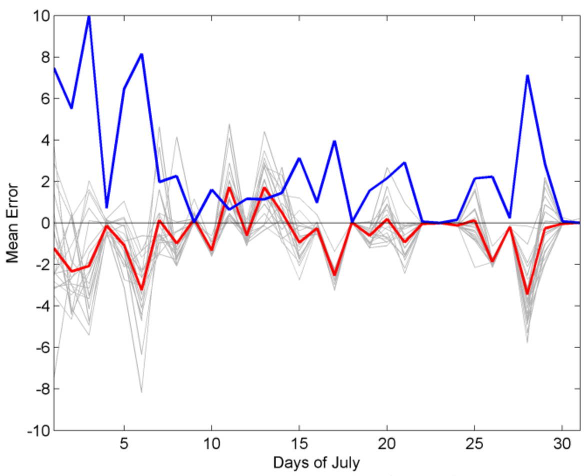

FIG. 3: Mean Error (model - radar) for 1st – 31st July 2012 in mm/12h. The red curve represents the mean error over the ensemble and the gray lines represent the error of ensemble members. The blue curve represents the mean precipitation over the verification domain.

The SAL verification measure provides a three-component, feature-based quality measure, where the components quantify the quality of the forecast in terms of its structure (S), amplitude (A), and location (L) (Wernli et al., 2008). The SAL technique is an object-based method that separately identifies precipitation objects within the domains of the observed and forecasted precipitation fields. However, one-to-one matching is not requested between the identified objects in the observed and simulated precipitation fields. The SAL technique depends on the precipitation threshold because a given threshold selects the objects in the precipitation fields. We are using both the absolute and relative thresholds for the object selection. The absolute thresholds are suitable for verifying the forecast e.g. for high precipitation event leading to flash floods. The relative thresholds are suitable for comparing forecasts of events with different measured precipitation totals. We used the absolute threshold 20mm/12h. The relative threshold was computed as a 95% percentile of all grid point with nonzero measured precipitation divided by factor 5.

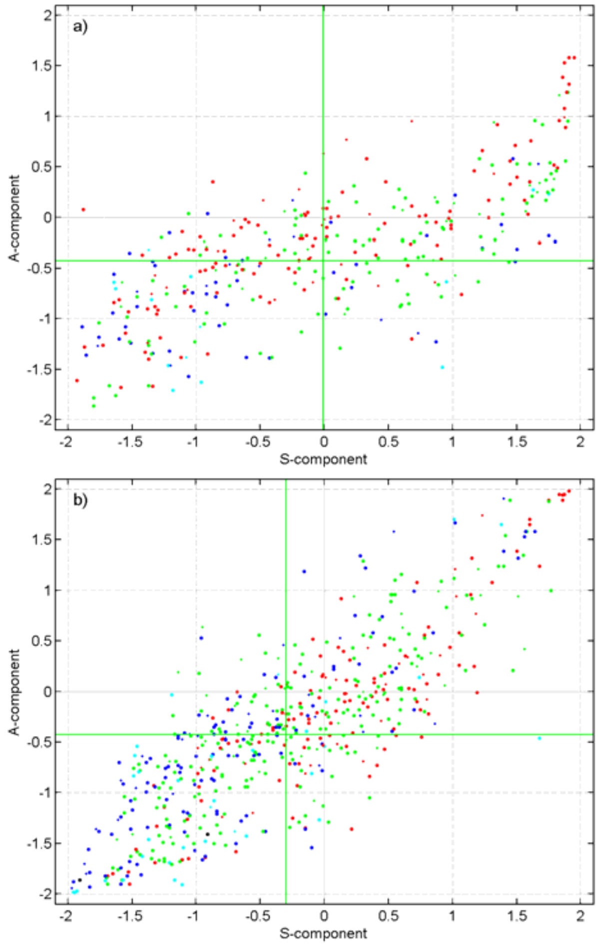

FIG. 4: SAL verification results for a) threshold 20mm/12h and b) relative threshold R5 (see text for explanation). Single forecasts are represented by marks, whose colours show the magnitude of the L parameter (red: L≤0.2, green: 0.2<L≤0.4, blue: 0.4<L≤0.6, cyan: 0.6<L≤1, and black: 1<L). The crossed lines depict the median values of S and A components, and their colours correspond to the mean value of L.

The result of SAL verification is shown on the Figure 4. The Figure 4b has more points marking the single forecast than the Figure 4a, because the absolute threshold 20mm/12h was not found in all forecasts. The results shows, that the structure of all forecasts is quite good in mean especially for 20mm threshold. The relative threshold shows spatially narrower structures than the absolute threshold. There is also a bias detected for both thresholds in A component. The location component shows good results comparable for both thresholds.

IV. RESULTS AND OUTLOOK

COSMO-CZ-EPS – 19 members were computed for the period of July 2012. The ensemble forecasts over the period showed a bias, the ensemble underforecast the mean precipitation. It has to be taken into account in the next work. The ensemble was able to forecast the first part of the period with heavy precipitation.

In the next work the spread of the ensemble will be studied. It will include main characteristics as geopotential and temperature at standard pressure levels (850hPa, 500hPa). The spread of the precipitation forecast will be studied by appropriate modern verification techniques.

V. ACKNOWLEDGMENTS

The authors want to thank to Dr. Chiara Marsigli for COSMO-SREPS data providing and useful advices and comments, Dr. Andrea Montani for COSMO-LEPS data providing, DWD for COSMO model code providing, CHMI, for radar data providing, gauge-adjusted radar product MERGE and Computing and Information centre of Czech Technical University, for supercomputer facilities providing.

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