SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	2015
Project Title:	Short-Range Ensemble Prediction System
Computer Project Account:	**SP** ITLEKF
Principal Investigator(s):	Lucio Torrisi
Affiliation:	CNMCA - Italian Met. Service
Name of ECMWF scientist(s) collaborating to the project (if applicable)	Francesca Marcucci
Start date of the project:	2015
Expected end date:	2017

Computer resources allocated/used for the current year and the previous one
(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	0	0	6000000	0
Data storage capacity	(Gbytes)		0		0

Summary of project objectives
(10 lines max)

The goal of this project is to improve the existing short-range ensemble prediction system, based on the Ensemble Kalman Filter (EnKF) approach (CNMCA-LETKF [1] [2]) for the data assimilation component (estimation of the initial conditions) and the COSMO regional model (www.cosmo-model.org) for the prognostic one, in the framework of a comprehensive plan for development of a new set of tools for the probabilistic forecast.

Summary of problems encountered (if any)
(20 lines max)

No real problem was encountered, neither technical nor conceptual.
Because a mistake, the BU reserved to Italy have been used instead of those one allocated for the project.

Summary of results of the current year (from July of previous year to June of current year)
This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

The CNMCA-LETKF data assimilation system is operationally used since june 2011 to initialize the high-resolution non-hydrostatic model COSMO integrated over the Mediterranean-European region (named COSMO-ME). The atmospheric short-range ensemble prediction system (COSMO-ME EPS) based on the LETKF system and the COSMO model is under testing at CNMCA since july 2013.
During the first year of the project, the almost two year (2013-2014) of forecast data have been analyzed, in order to evaluate the performances of the ensemble and the possibility of further improvements.
First of all a few statistical scores have been developed and applied in order to evaluate the usefulness of the COSMO-ME EPS forecast system in term of sharpness, bias and skill.
Rank histogram, spread-skill relationship and continuous rank probability scores have been chosen as best candidates for a first investigation. Scores are computed for temperature, wind and relative humidity over pressure levels and for pressure, wind, temperature and precipitation for the surface.
Ensemble forecast at different steps have been compared with respect to observations from synop station as well as with the ECMWF IFS analysis fields.
Following Hamill et al. [3] the observation error is accounted in the computation of the scores.
The spread skill relationship has been computed following the method proposed in Whang and Bishop [4], results show that the ensemble has on average a good spread-skill behavior with respect to IFS analysis, but is slightly under-dispersive when compared to observations for some forecast steps. In Fig.1 the spread-skill results for temperature and wind are shown respectively at 500 hPa and 700 hPa.

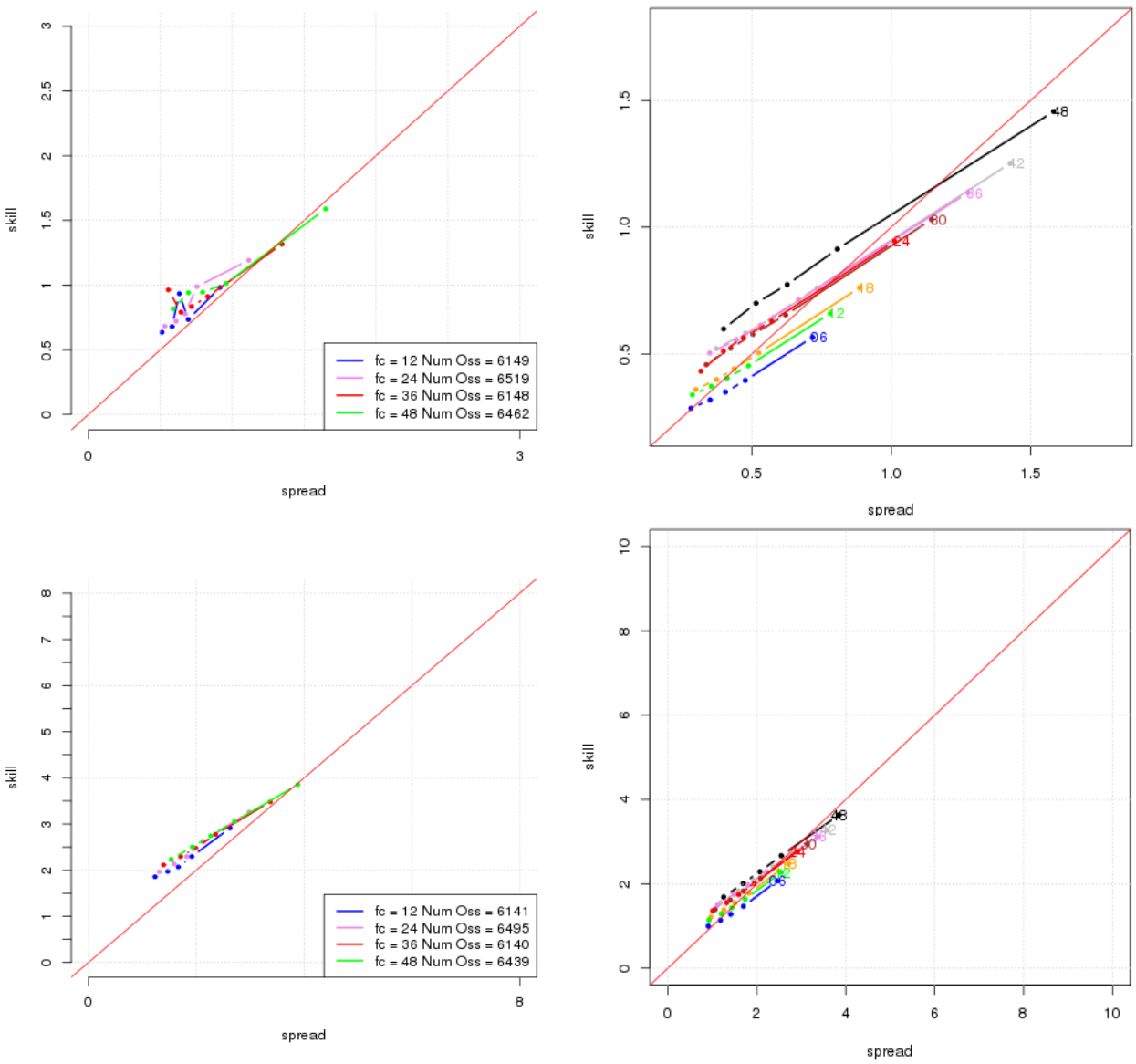

Fig.1 left panels show temperature at 500 hPa (top) and u-wind component at 700 hPa (down) spread-skill binned relationship for all the forecast steps (in different colors) with respect to synop observation. Right panel shows same results with respect to IFS analysis.

Looking at the rank histogram the under-dispersion of the COSMO-ME EPS after second day of forecast is confirmed in particular for the temperature and wind component (Fig.2).

The continuous rank probability score (CRPS) has been computed following method proposed in Hersbach [5], as shown in Fig.3 the value of CRPS increase with the forecast time step for all variables as expected, but low values indicate that the system is satisfactorily working.

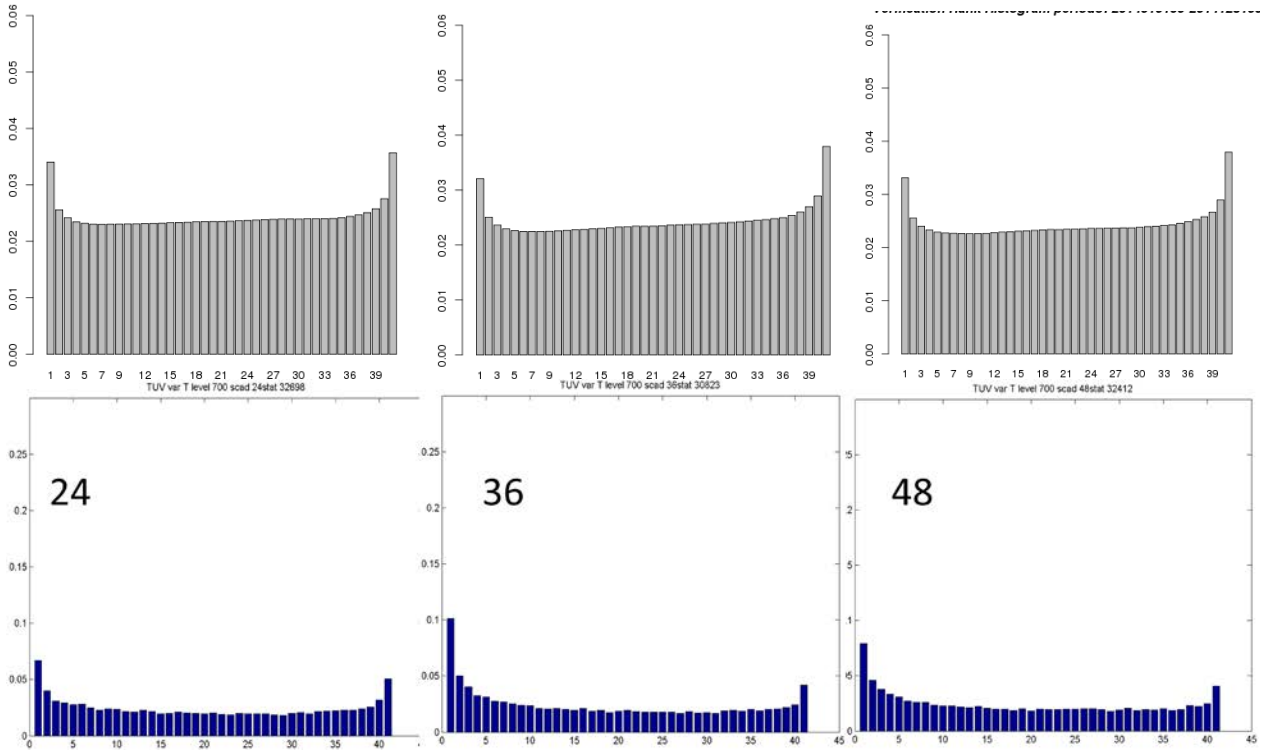

Fig.2 Rank histogram computed with respect to IFS analysis (top) and synop observation (down) for u-wind component at 700 hPa for different forecast step (24h, 36h and 48h from left to right)

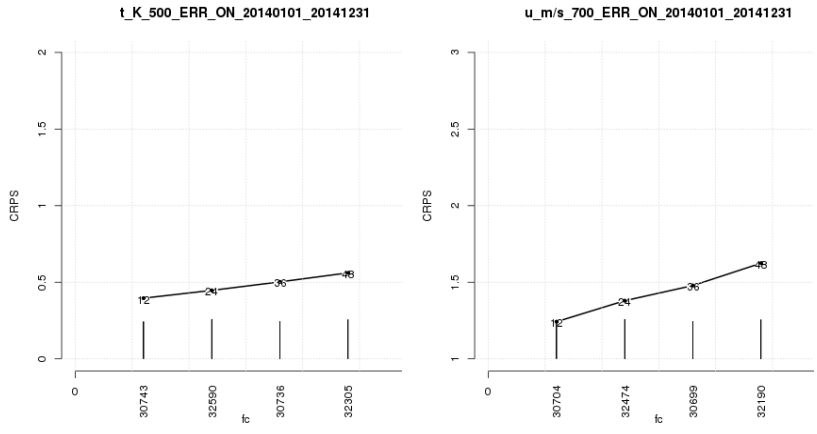

Fig.3 (from left to right) CRPS for temperature at 500 hPa and u-wind component at 700 hPa for different 12, 24, 36 and 48h forecast steps.

List of publications/reports from the project with complete references

[1] Bonavita M, Torrisi L, Marcucci F. 2008. The ensemble Kalman filter in an operational regional NWP system: Preliminary results with real observations. *Q. J. R. Meteorol. Soc.* 134: 1733-1744.
[2] Bonavita M, Torrisi L, Marcucci F. 2010. Ensemble data assimilation with the CNMCA regional forecasting system. *Q. J. R. Meteorol. Soc.* 136: 132-145.
[3] Thomas M. Hamill, 2001: Interpretation of Rank Histograms for Verifying Ensemble Forecasts. Mon. Wea. Rev., 129, 550–560.
[4] Wang, X., and C. H. Bishop, 2003: A comparison of breeding and ensemble transform Kalman filter ensemble forecast schemes. J. Atmos. Sci., 60, 1140-1158.
[5] Hersbach, H. 2000 Decomposition of the continuous ranked probability score for ensemble prediction systems. Weather and Forecasting, 15, 559–570

Summary of plans for the continuation of the project

(10 lines max)

Plans for the continuation of the project comprise a further investigation of the COSMO-ME EPS performances in term of resolution, reliability and accuracy by the implementation and computation of new scores (brier score, brier skill score, roc area etc) and the use of the Italian high-resolution precipitation observations.
Different calibration methods will be also investigated in order to correct the bias of the existing ensemble and the derived uncertainty information, providing to our forecasters the best possible support for specific operational applications.