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	2016
Project Title:	Short-Range Ensemble Prediction System
Computer Project Account:	**SP** ITLEKF
Principal Investigator(s):	Lucio Torrisi
Affiliation:	COMET - Italian Air Force Operational Met. Center
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)	6000000	100%	8000000	0
Data storage capacity	(Gbytes)				

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 (COMET-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.

Summary of results of the current year (from July of previous year to June of current year)

The atmospheric short-range ensemble prediction system (COSMO-ME EPS) based on the CNMCA-LETKF analysis and the COSMO model is running operationally at the Italian Air Force Meteorological Service (pre-operational since July 2013).

The relevant characteristics of the atmospheric COSMO-ME EPS are:

- Domain and resolution: COSMO model is integrated 40 times on the same domain of the CNMCA-LETKF system.
- IC and BC: initial conditions are derived from the CNMCA-LETKF system; lateral boundaries conditions are from the most recent IFS deterministic run perturbed using ECMWF-EPS.
- Model error: stochastics physics perturbation tendencies.
- Forecast range: 72 hours at 00/12 UTC.

During the second year of the project, one year (2014) forecast data have been analyzed, in order to evaluate COSMO-ME EPS precipitation forecast performances, using the Italian high-resolution precipitation observations. In particular the usefulness of the COSMO-ME EPS forecast system in term of sharpness, bias and skill has been investigated looking at rank histogram, spread-skill relationship [3] and continuous rank probability scores [4]. Following Hamill et al. [5] the observation error is accounted in the computation of the scores.

Precipitation forecasts (above 0.1 mm) from 6 hours to 48 hours have been averaged on a 4x4 grid box and compared to the observed values from the high resolution Italian rain gauges.
Looking at the results it can be outlined that the rank histogram and spread-skill relationship confirm the under-dispersion of the COSMO-ME for all forecast steps and the CRPS follows the behaviour of the spread-error as expected (fig 1,2).

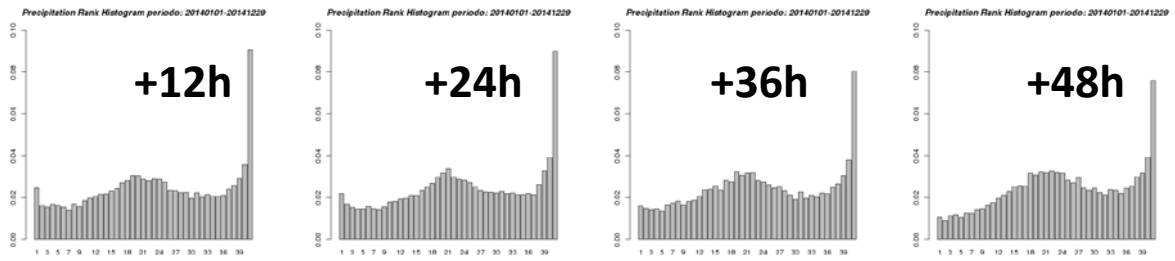

Fig.1 Rank histogram computed with respect high resolution precipitation for different forecast step (12h,24h, 36h and 48h from left to right).

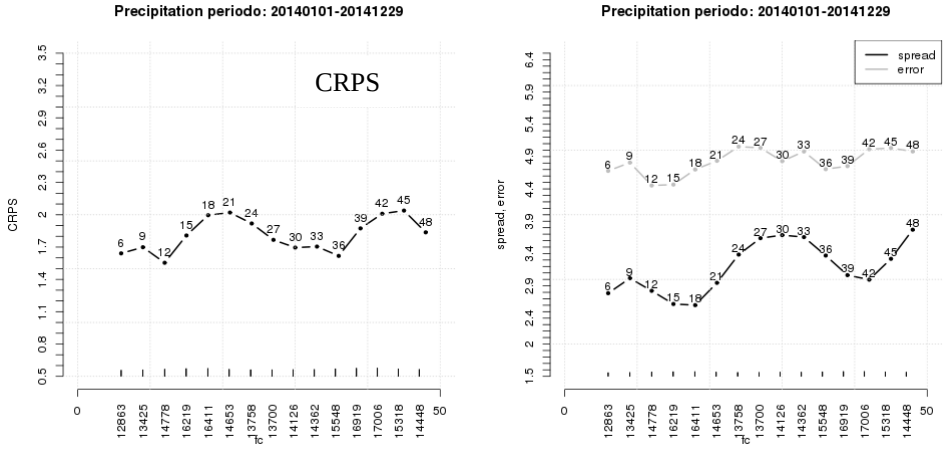

Fig.2 CRPS and spread-skill precipitation above 0.1 mm for different forecast steps.

In addition resolution, reliability and accuracy of the ensemble, for different precipitation thresholds, have been evaluated by the implementation and computation of new scores: brier score and brier skill score (fig 3).

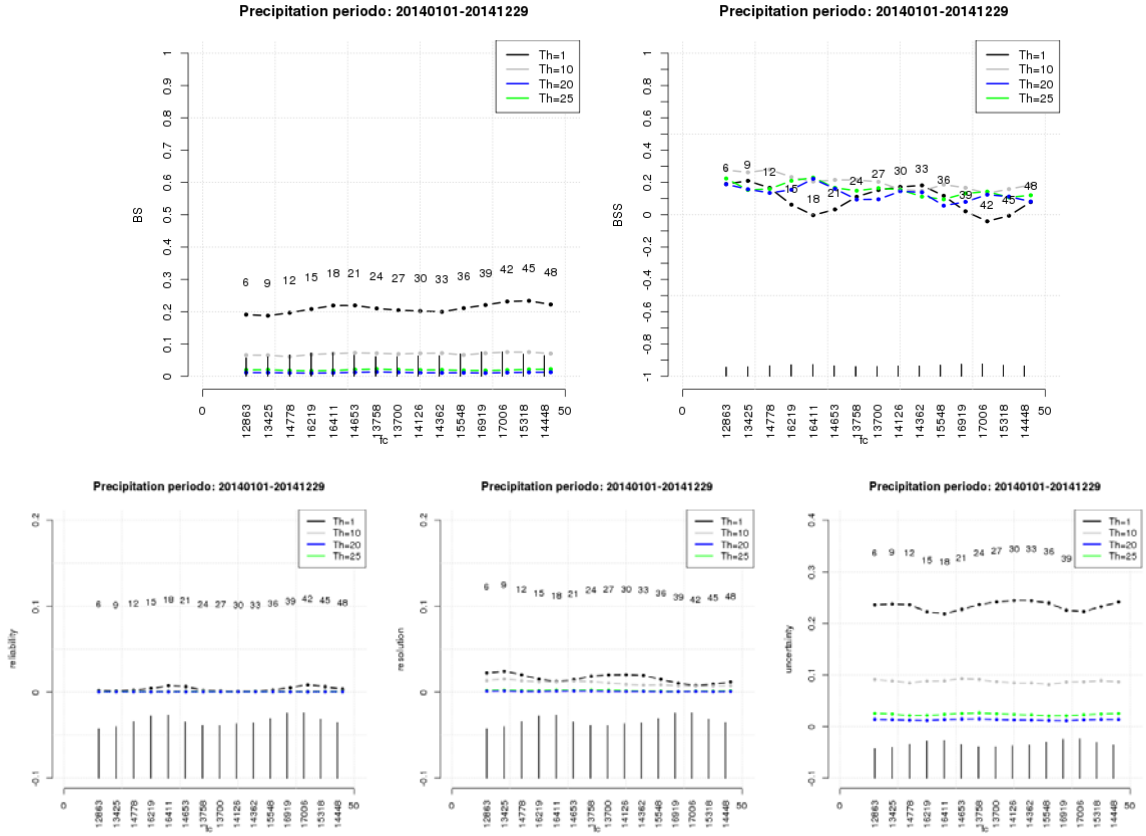

Fig.3 (top) Brie Score (left) and Brier Skill Score (right) for different threshold and forecast step. (bottom) From left to right reliability, resolution e uncertainty components of the Brier Score for different threshold and forecast step.

Performances of the COSMO-ME EPS system have been also evaluated with respect to the COSMO-LEPS system in term of spread-skill relationship and Brier Score. Similar behaviour can be observed even if the domain are different (fig 4).

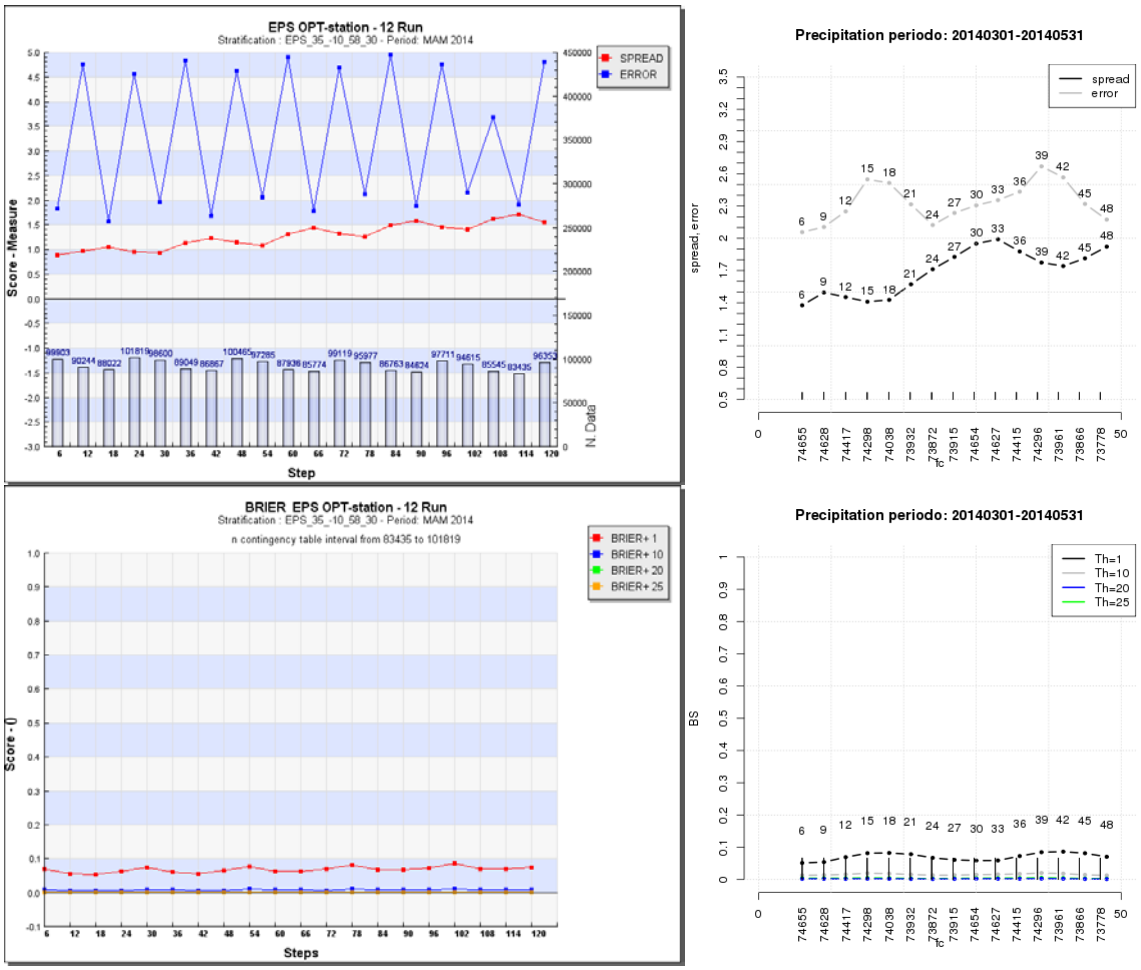

Fig.3 Comparison between COSMO-ME EPS (right panels) and COSMO-LEPS (left panels), in termo of spread-skill relationship (top) and Brier Score (bottom).

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] 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.
[4] Hersbach, H. 2000 Decomposition of the continuous ranked probability score for ensemble prediction systems. Weather and Forecasting, 15, 559–570
[5] Thomas M. Hamill, 2001: Interpretation of Rank Histograms for Verifying Ensemble Forecasts. Mon. Wea. Rev., 129, 550–560.

Summary of plans for the continuation of the project

(10 lines max)

Plans for the last year of the project comprise implementation and test of different calibration methods, 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.