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	2017
Project Title:	Development of a perturbation strategy for convection-permitting ensemble forecasting over Italy
Computer Project Account:	spitconv
Principal Investigator(s):	Chiara Marsigli
Affiliation:	Arpae SIMC, Bologna, Italy
Name of ECMWF scientist(s) collaborating to the project (if applicable)	……………………………………………………….…… ……………………………………………………….……
Start date of the project:	01/01/2016
Expected end date:	31/12/2018

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)	3,000,000	2,657,616	3,000,000	623,182
Data storage capacity	(Gbytes)	200	500	200	100

Summary of project objectives

(10 lines max)

The aim of this project is to develop a complete perturbation strategy for the convention-permitting ensemble over Italy based on the COSMO model (COSMO-IT-EPS). This project represents the third step of a work which has been performed thanks to previous the SPITCONV Special Project (2010-2012 and 2013-2015).

The third phase (2016-2018, this SP) is aimed at:

1) further developing the use of the LETKF scheme for providing perturbed Initial Conditions to the ensemble

2) testing the combination of the different perturbations which are being developed in COSMO (physics and soil).

The tests for the system further developments and upgrades will be carried out on ECMWF resources, thanks to this SP and to Italian resources.

Summary of problems encountered (if any)

(20 lines max)

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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

Summary.

During this reporting period (second half of 2016 and first half of 2017) the work has focused on further testing KENDA for providing Initial Conditions to the COSMO-IT-EPS ensemble and to further testing the physics perturbations in the COSMO model:

- test of KENDA with COSMO-ME-EPS Boundary Conditions
- test of COSMO-IT-EPS ensemble with KENDA IC
- test of the inflation methodology.

Set-up of the experiments.

Using mainly Italian resources, the COSMO-IT-EPS ensemble has been run for a long period (October 2015), a period of intense precipitation over Italy. For this period, Initial and Boundary Conditions were provided by COSMO-ME-EPS, the operational ensemble at 10 km run by COMET (Italian Air Force Meteorological Service). The ensemble was run at 2.8 km.

In order to complement this experiment, it was run also KENDA on the same period, in order to test the impact of KENDA Initial Conditions on this ensemble set-up.

The KENDA set-up was as follows:

- 3-hourly cycles
- COSMO model run at 2.8 km, 50 levels

- BCs for the KENDA cycle provided by COSMO-ME-EPS (also ICs for the cold start)
- adaptive localization, inflation by RTPP
- assimilation of conventional observation only

The runs have covered to periods of the testing one: 5th to 11th October 2015 and 26th to 31st October 2015.

Then, the COSMO-IT-EPS ensemble has been runs using these KENDA analyses as Initial Conditions.

In this case the ensemble has been run with no physics perturbations. Boundary Conditions were provided by COSMO-ME-EPS, as in the runs without KENDA analyses.

In addition to these runs, some complementary runs have been performed using the SBU provided by the SPITCONV project.

KENDA, which meanwhile has been implemented by Arpae as operational suite on the CINECA supercomputing system, as part of the COSMO-LAMI operational chain, has a horizontal resolution of 2.2 km, and 65 vertical levels. Therefore more recent tests have been performed with this model resolution.

In particular, it has been tested the inflation method. Two methodologies are available, implemented already in the KENDA code: RTPP (Relaxation To Prior Perturbations) and RTPS (Relaxation to Prior Spread).

Two runs of KENDA have therefore been performed, with the two different inflation methodologies, over the period 8-10 October 2014. Boundary Conditions have been provided from the ECMWF ENS, since COSMO-ME-EPS was not available for that period.

Evaluation of the results.

The impact of the Initial Conditions derived from KENDA in the COSMO-IT-EPS ensemble is reported for 2 cases, the 10th and the 28th of October 2015.

In the first event, a case of intense precipitation over Central Italy and the Tyrrhenian Sea, the area mean precipitation as estimated by the Italian radar network was overestimated by the ensemble members, especially in the first hours of the forecast (see Figure 1). For a proper comparison, both the radar and the model values are considered only over land.

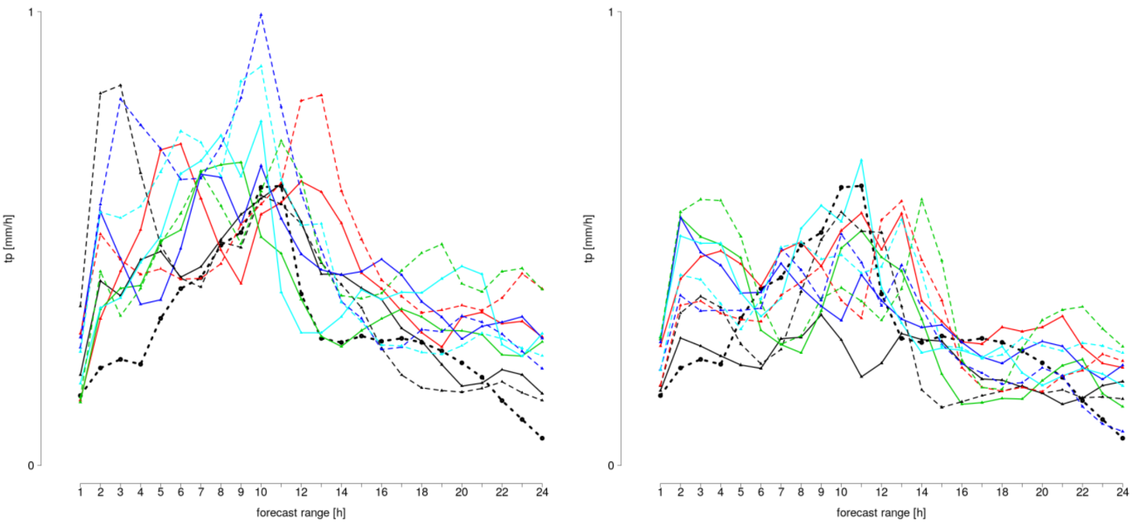
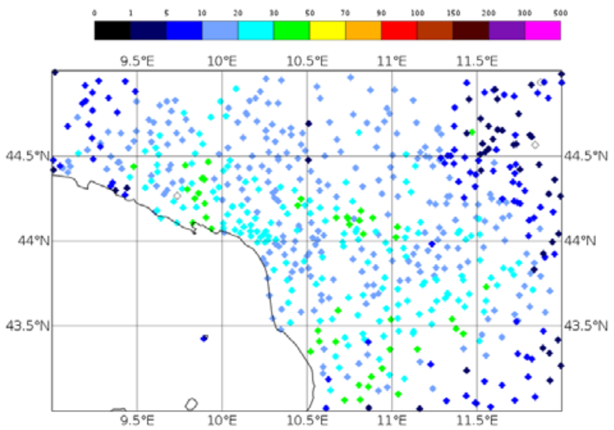


Figure 1. Area mean precipitation (only over land) for the 10th October event. The precipitation estimated by the Italian radar network is represented as black dashed line, the precipitation forecasted by the 10 ensemble members is represented as coloured lines.

By using as Initial Conditions for COSMO-IT-EPS the first 10 analyses produced by the KENDA assimilation, the area mean precipitation forecasted by the members is improved, reducing the overestimate of the first hours, while retaining a correct amount, as a whole, for the most intense precipitation.

The second event took place on the 28th of October, when heavy precipitation interested Liguria and Tuscany regions.



In this case, the precipitation at the beginning of the event was underestimated by the ensemble (see Figure 2), and the Initial Conditions provided by KENDA are not able to improve the forecast in the first hours. In order to address the problem of the underestimation of the precipitation, it is probably crucial to assimilate also the 3d reflectivities from the radar volumes, which is the next major step to be done in the KENDA implementation at Arpae.

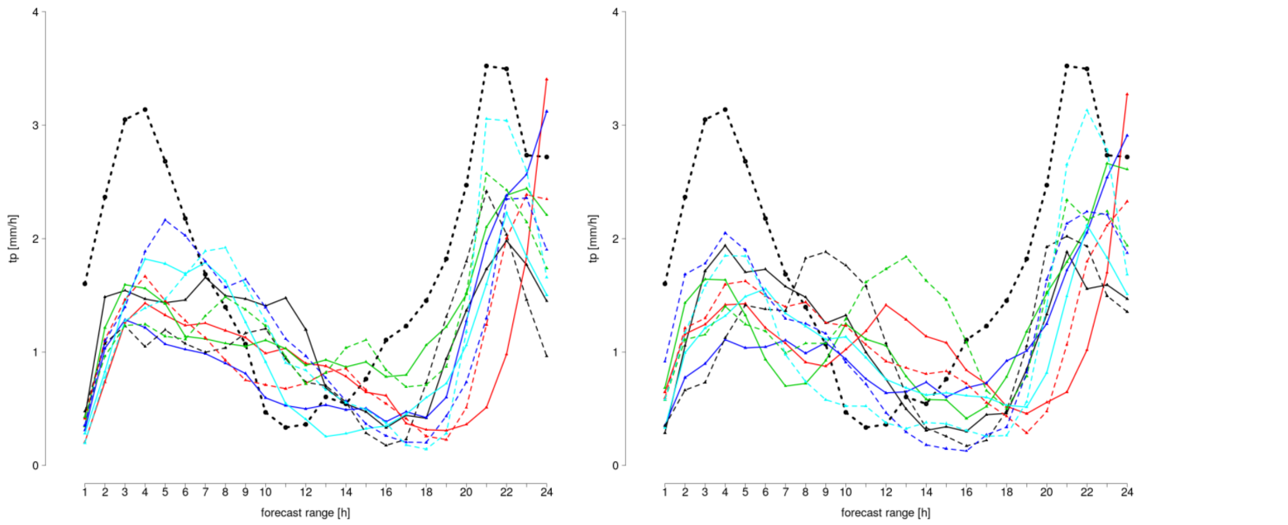


Figure 2. Area mean precipitation (only over land) for the 28th October event. The precipitation estimated by the Italian radar network is represented as black dashed line, the precipitation forecasted by the 10 ensemble members is represented as coloured lines.

In order to check the role played by the KENDA-derived Initial Conditions on the ensemble, the spectra of the perturbation fields have been also studied.

In Figure 3 the spectra of the perturbations of the initial conditions for the temperature at the first model level are shown for all the members of the ensemble, for the control configuration (left), where the ICs are obtained by downscaling the driving ensemble, and for the experimental configuration (right), where ICs are derived from the first 10 KENDA analyses.

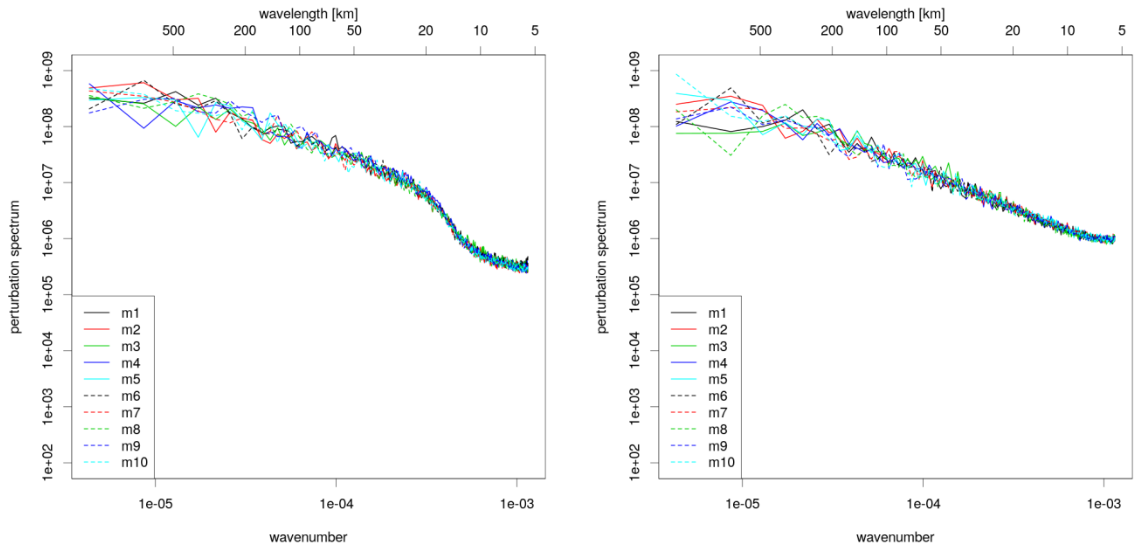


Figure 3. Spectra of the perturbations of temperature at the first model level for all the 10 ensemble members, both for the control configuration (ICs from downscaling of the driving ensemble, left panel) and for the experimental configuration (ICs from KENDA, right panel).

The impact of the KENDA analyses is evident in the fact that the KENDA derived Initial Conditions (right) have more signal at the small scales, below 20 km (double of the nominal resolution of the driving ensemble), showing that they have structures also at these small scales, while when the downscaled ICs are used (left) the perturbations do not interest the small scales.

In order to give an idea of the behavior of the perturbations with integration time, in Figure 4 the spectra of the perturbations for the 10 ensemble members are plotted for the initial time of the ensemble integrations (left column) and for the +1h (middle column) and +2h (right colum) forecast range. It is evident that, with the proceeding of the integration, the small scale are “filled” by the model, and the perturbations reach these scales also in the CTRL ensemble. Nevertheless it is also evident that the perturbations are “richer” and more spread when the ensemble is initialized with KENDA analyses.

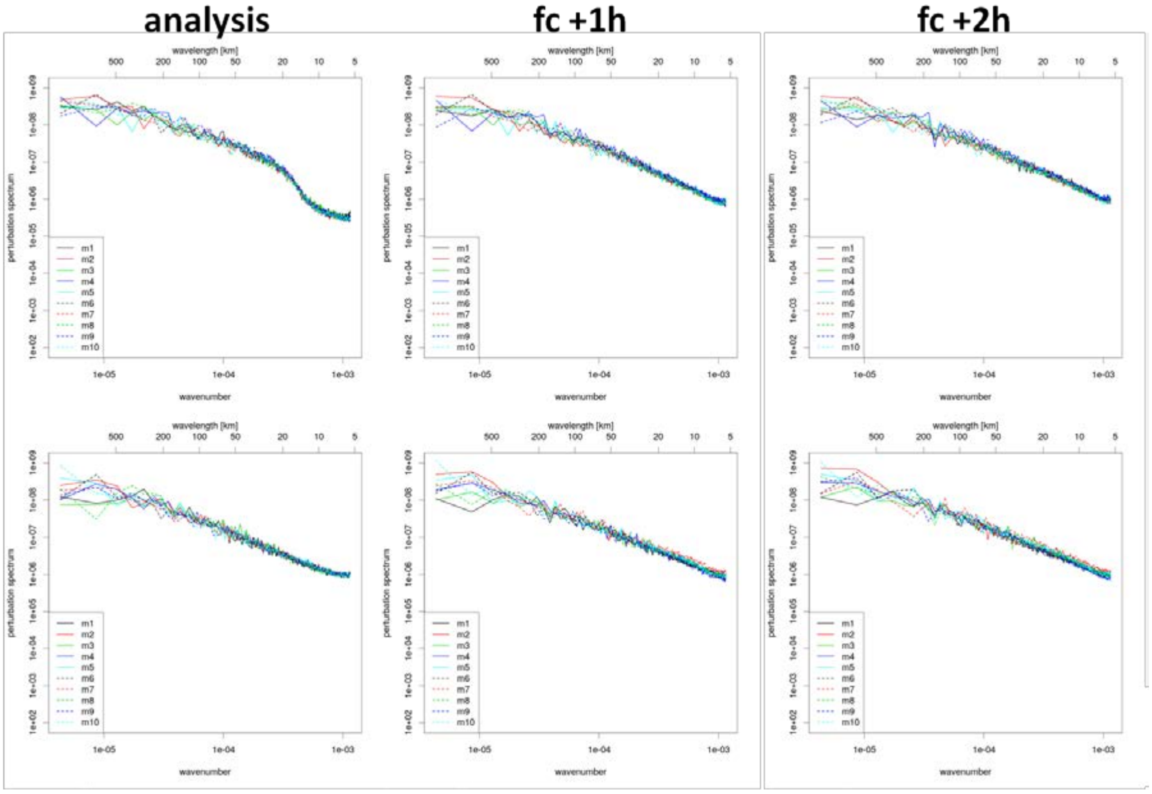


Figure 4. Spectra of the perturbations of temperature at the first model level for all the 10 ensemble members, both for the control configuration (top row) and for the experimental configuration (bottom row).

List of publications/reports from the project with complete references

Summary of plans for the continuation of the project

(10 lines max)

In the next period all the test will be performed with the new KENDA/COSMO-IT-EPS configuration (2.2 km hor. res., 65 levels, BCs from COSMO-ME-EPS).

In particular, the KENDA analyses will be used as initial conditions to the run of COSMO-IT-EPS, for periods including cases of thunderstorms. In KENDA the inflation methodology will be further addressed, also including an additive climatological B-matrix.
Then, the work on model perturbation will also continue, by considering the perturbation of more parameters of the physical schemes (new schemes/parameters coming from the ICON model) in agreement with the developments of the COSMO Consortium, where a new Priority Project on this topic is starting at the beginning of 2018.