SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year 2019-2020

Project Title: Improvement of a convection-permitting Ensemble Prediction System over Italy

Computer Project Account: SPITEPS

Principal Investigator(s): Lucio Torrisi

Affiliation: COMET (Operational Center for Meteorology) - Italian Air Force Met. Service

Name of ECMWF scientist(s) collaborating to the project (if applicable)
Francesca Marcucci (COMET)
Marco Alemanno (COMET)
Riccardo Scatamacchia (COMET)

Start date of the project: 1st jan 2019

Expected end date: 31 dec 2021

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)	9500000	9500000	9500000	0
Data storage capacity	(Gbytes)	5000	2000	5000	0

Summary of project objectives (10 lines max)

The goal of this study is to improve the convection permitting ensemble prediction system COSMO-IT EPS, over the Italian domain, based on the Ensemble Kalman Filter (EnKF) approach for the data assimilation component (estimation of the initial conditions) and the COSMO regional model (www.cosmo-model.org) for the prognostic one. The outputs of this system could then be used to generate new probabilistic products for aeronautical support, taking advantage also of the developed tools for fog and thunderstorm prediction developed in the framework of the EUMETNET SRNWP-EPS-II Project

Summary of problems encountered (10 lines max)

No real problem was encountered, neither technical nor conceptual.

Summary of plans for the continuation of the project (10 lines max)

Plans for the continuation of the project envisage:

- sensitivity test of the system using different parameterizations of the shallow convection in COSMO model (Tiedtke versus Becthold scheme)
- use of most recent ECMWF-EPS data in COSMO-IT LETKF and EPS
- increase EnKF analysis update to 1 hour
- application of the EUMETNET SRNWP-EPS tool for severe events detection to the outputs of COSMO-IT models (deterministic and ensemble).

List of publications/reports from the project with complete references

None

Summary of results

A data assimilation algorithm based on the LETKF approach (KENDA system, Schraff C. et al., 2016) has been implemented and tested in the COMET NWP suite in realistic conditions to initialize the COSMO model over the Italian domain (COSMO-IT).

The high-resolution KENDA- LETKF analysis as been realized with a 40 members ensemble plus a deterministic member, having a 0.02° grid spacing (~2.2 km) and 65 vertical levels, 3hour data assimilation cycle and BCs from operational COSMO-ME EPS.
The same set of observations used in the operational data stream for the nudging analysis of the COSMO-IT model has been assimilated. The observational dataset comprises radiosonde ascents (RAOB), surface pressure observations from land and sea stations (SYNOP, SHIP, BUOY), manual and automatic aircraft observations and wind profilers. An a-posteriori perspective has been assumed as regards the treatment of random model error. We use a combination of additive and adaptively-varying multiplicative covariance inflation techniques. Model uncertainty representation through a stochastic physics scheme (Buizza et al, 1999; Palmer et al, 2009) has been also implemented in the prognostic model. Sea surface temperature perturbations derived from randomly selected, scaled consecutive analysis differences has been daily inserted together with stochastic soil moisture perturbations.

The LETKF deterministic analysis performance has been evaluated in comparison with the observation nudging over of a past dataset (from 04 Nov 2017 to 22 Jan 2018). The EnKF-based assimilation cycle has proved to be of superior quality with respect to the currently operational scheme. Results are shown in the plots below.

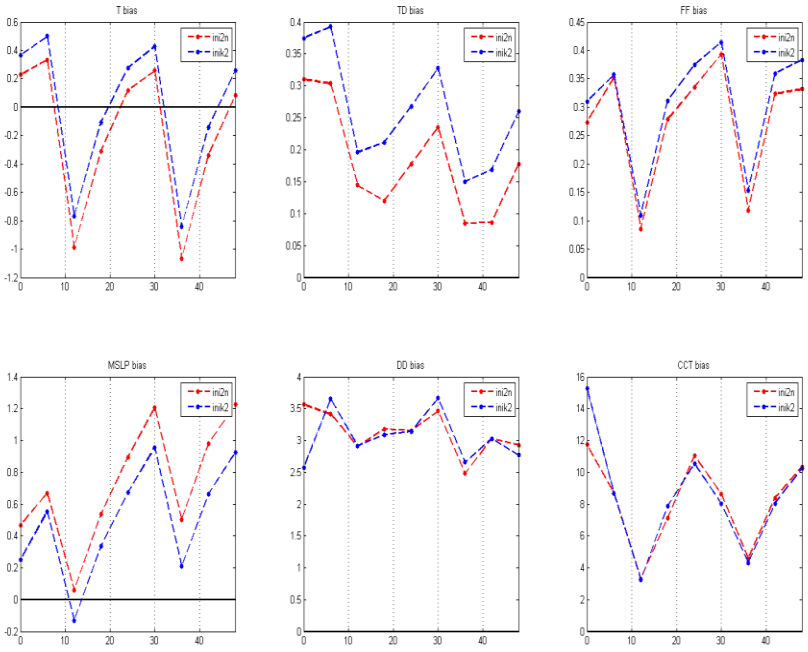

Fig.1 Surface verification with respect to observations from synop stations (over Italy) of COSMO-IT (00UTC run) forecasts initialized by kenda-letkf (BLUE) and by nudging (RED) assimilation. From top left to right bottom bias for 2m-temperature, 2m-dew point, 10m wind intensity, mean sea level pressure, 10m wind direction and total cloud coverage.

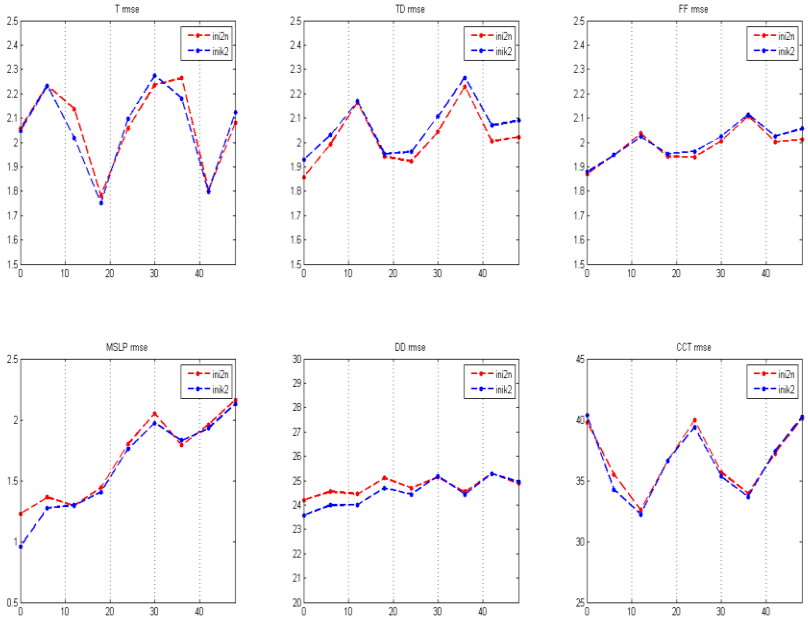

Fig.2 Surface verification with respect to observations from synop stations (over Italy) of COSMO-IT (00UTC run) forecasts initialized by kenda-letkf (BLUE) and nudging (RED) assimilation. From top left to right bottom rmse for 2m-temperature, 2m-dew point, 10m wind intensity, mean sea level pressure, 10m wind direction and total cloud coverage.

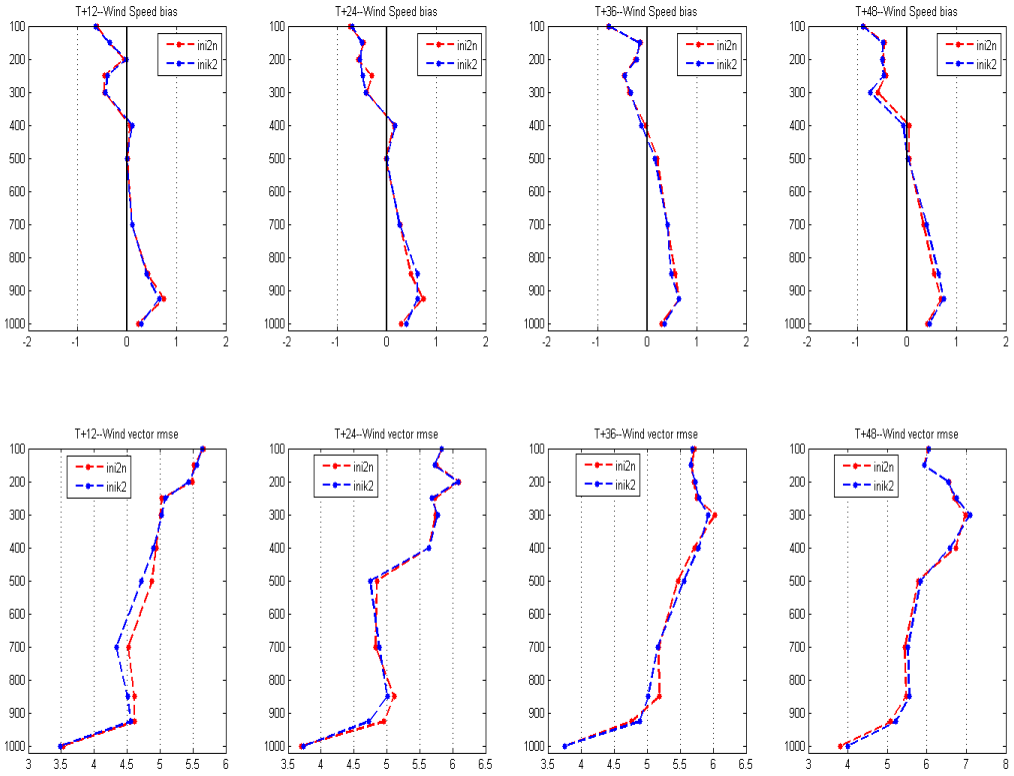

Fig.3 Upper level verification with respect to radiosondes observations (over Italy) of COSMO-IT (00UTC run) forecasts initialized by kenda-letkf (BLUE) and nudging (RED) assimilation. Top panels: wind speed bias for different forecast steps (from T+12 left to T+48 right).
Bottom panels: wind vector rmse for different forecast steps (from T+12 left to T+48 right).

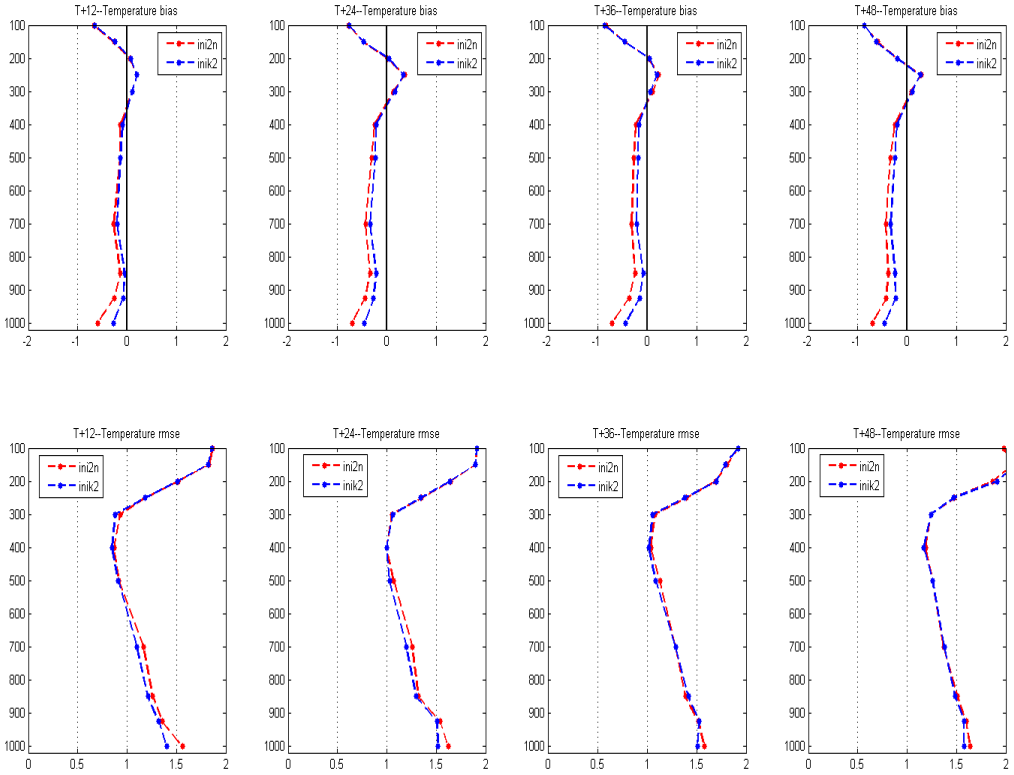

Fig.4 Upper level verification with respect to radiosondes observations (over Italy) of COSMO-IT (00UTC run) forecasts initialized by kenda-letkf (BLUE) and nudging (RED) assimilation. Top panels: Temperature bias for different forecast steps (from T+12 left to T+48 right).
Bottom panels: Temperature rmse for different forecast steps (from T+12 left to T+48 right).

Along with the evaluation of LETKF analysis performances with respect to a nudging scheme, a COSMO-IT EPS system has been implemented. The COSMO model is integrated 20 times on the same domain of the COSMO-IT system with a grid spacing of 2.2 km, 576x701 grid points/layer and 65 vertical levels. The initial conditions are taken from the high resolution KENDA-LETKF system and the lateral boundaries conditions are derived from the COSMO-ME EPS fields.
Few test cases of typical summer convection over Italy has been investigated to underlines the advantage of the use of a convection permitting EPS. Probabilistic maps have been produced for both ensembles (COSMO-IT EPS and COSMO-ME EPS) to allow forecasters evaluation.
Results are shown for the case of 27th august 2019 (Fig.5). Probability maps of 6 hours cumulated precipitation for low thresholds (greater than 0.2 mm, yes/not precipitation event) are similar for the two EPS, but COSMO-IT EPS gives a signal also for higher threshold (10 mm). The forecast precipitation pattern is good even if the probability values are low (<=40%). For many cases, a similar behaviour has been found, consequently, forecasters can use this product to get information about deep convection.

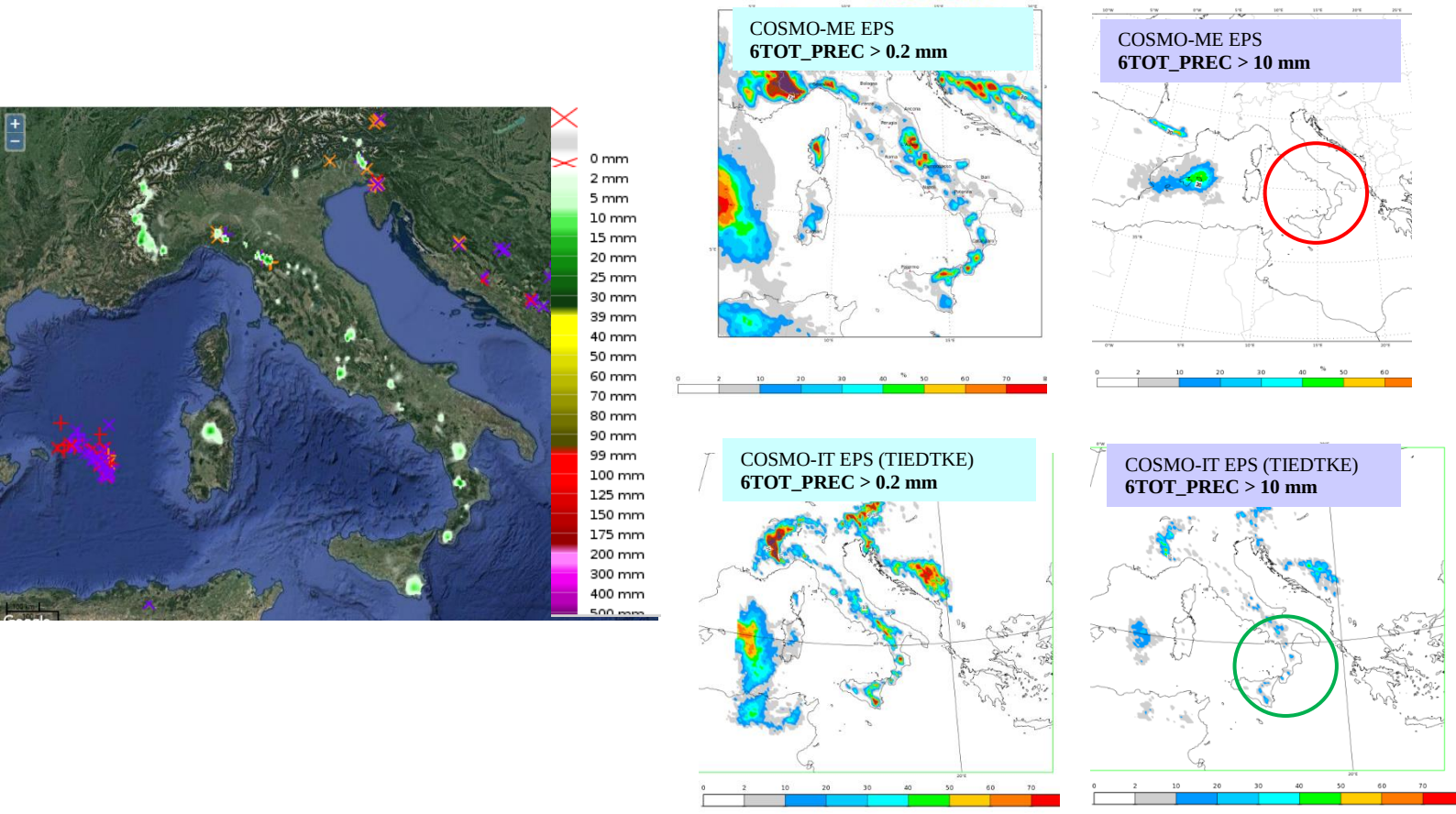

Fig. 5: Left: Radar and Lighting (red/purple crosses) maps for 6 hour cumulated precipitation (12-18 UTC) of 27th august 2019.
Top-Right: COSMO-ME EPS probability maps of 6 hours cumulated precipitation greater than 0.2 mm (left) and 10 mm (right).
Bottom-Right: COSMO-IT EPS probability maps of 6 hours cumulated precipitation greater than 0.2 mm (left) and 10 mm (right)