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	2020-2021
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	0	9500000	1348412.31
Data storage capacity	(Gbytes)	5000	0	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 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 the use of new observations (HSAF soil moisture and/or non conventional observations from regional networks) and evaluation of performances.

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 has been realized with a 40 members ensemble plus a deterministic member, having a 0.02° grid spacing (~2.2 km) and 65 vertical levels.
Recently, the assimilation cycle window has been reduced from 3 hours to 1 hour. The observational data-set comprises: synop (also non-GTS), ship, buoy, raob (also descent), pilot, wind profiler, airep, amdar, MODE-S, Meteosat AMV, metop scatt. winds, NOAA/Metop AMSUA/MHS and NPP ATMS radiances.
A set of analysis members (20 over 40) has been also used to initialize the COSMO-IT EPS system. 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 and boundary conditions (BCs) from the operational COSMO-ME EPS system.

Deterministic and ensemble forecasts of the COSMO-IT/COSMO-IT EPS models have been used as input to the application package developed in the framework of the EUMETNET SRNWP-EPS project to forecast severe weather events (hereafter referred to as “TSdetect” code). The tool uses a combination of instability/moisture index and trigger conditions to define favourable conditions for shower/thunderstorm development. To have an overall view, the outputs from different members can be combined together to produce the “most probable phenomenon” maps. Two different configurations of the COSMO model has been also compared in order to establish the better scheme for shallow convection (Tiedtke vs Becthold) to be used in the COSMO-IT EPS system. Results are shown (fig.1, Fig.2) for a single test case of 27th august 2019.

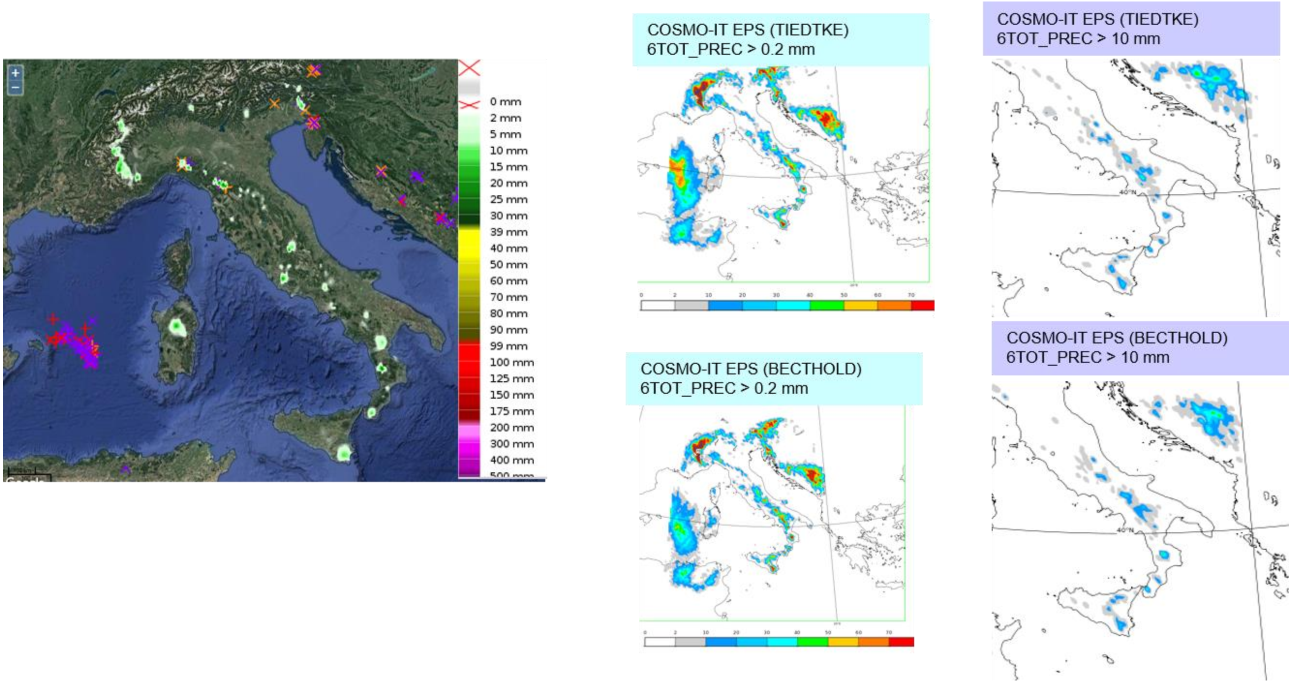

Fig. 1: Left: Radar and Lighting (red/purple crosses) maps for 6 hour cumulated precipitation (12- 18 UTC) of 27th august 2019. Top-Right: COSMO-IT EPS ("Tiedtke" scheme) probability maps of 6 hours cumulated precipitation greater than 0.2 mm (left) and 10 mm (right). Bottom-Right: COSMO-IT EPS ("Becthold" scheme) probability maps of 6 hours cumulated precipitation greater than 0.2 mm (left) and 10 mm (right).

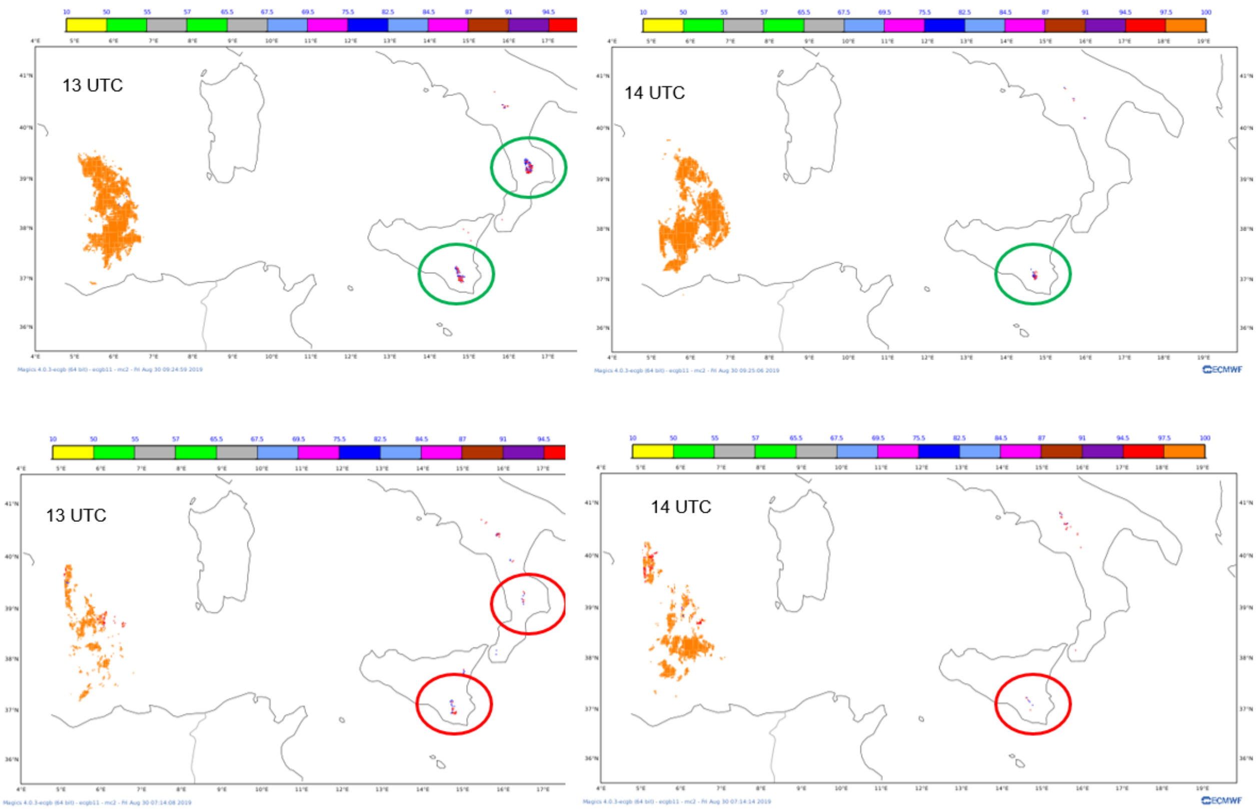

Fig.2: Outputs of the "TSdetect" tool applied to COSMO-IT EPS forecast (00UTC run of 27th august 2019), focus on convective precipitation over south Italy. Pictures show a synthetic output (most "probable phenomenon") obtained combining forecasts from the 20 eps-members. Detected phenomena are represented with different colors: orange (thunderstorm with hail), red (thunderstorm), blue (shower). Two different schemes for shallow convection parameterization are compared: "Becktold" scheme (top) and "Tiedke" scheme (bottom).

Even if probability maps of 6 hours cumulated precipitation (Fig. 1) for low thresholds (greater than 0.2 mm - yes/not precipitation event) and higher threshold (10 mm), are similar for the two EPS, the “Becthold” configuration seems to allow a better for detection of thunderstom with the TSdetect code (Fig.2). For other cases a similar behaviour has been found, consequently the Becthold scheme has been chosen for the operational configuration.

During last year, the impact of different BCs for the LETKF cycle has been also evaluated. In particular a comparison between COSMO-ME EPS BCs and ECMWF-EPS BCs has been performed over a long period (from December 2019 to may 2020). Performances have been evaluated with traditional forecast verification scores against synop observations and radiosonde data using the long deterministic run (initialized by the LETKF control member). Surface verifications (Fig.3, Fig. 4) show an improvement of TD and MSLP forecast skill using ECMWF-EPS BCs with respect to COSMO-ME EPS BCs (reduction of bias and RMSE for all forecast steps). A slight improvement on T2m and CLCT scores has also been observed.

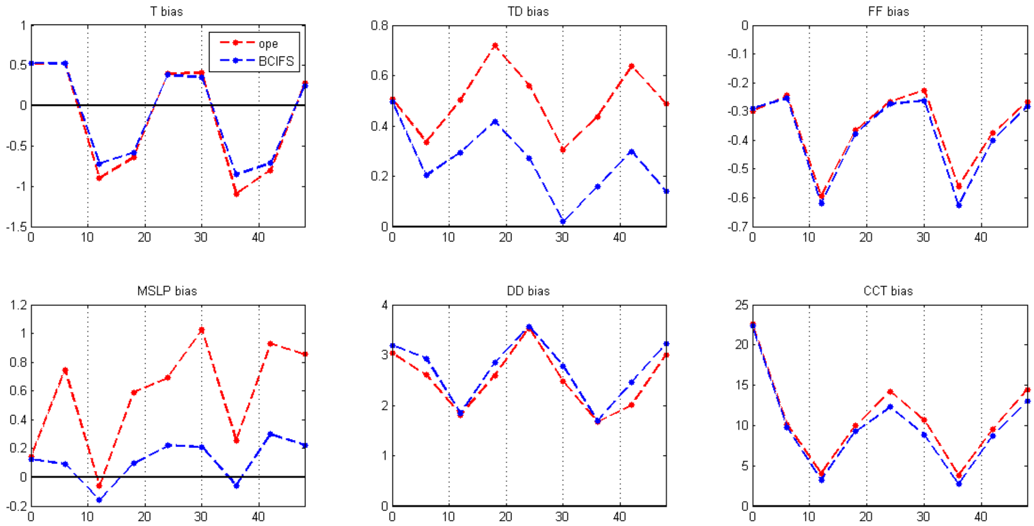

Fig.3: Mean Error score, as a function of forecast step, for (from left to right, top to bottom) 2m temperature, 2m dew point temperature, 10m wind speed , mean sea level pressure, 10 m wind direction, total cloud cover, computed for for COSMO-IT EPS forecast with BC from most recent ECMWF-EPS members (blue) and BC from COSMO-ME EPS members (red), using synop observations in the period 1st December 2019 – 9th may 2020.

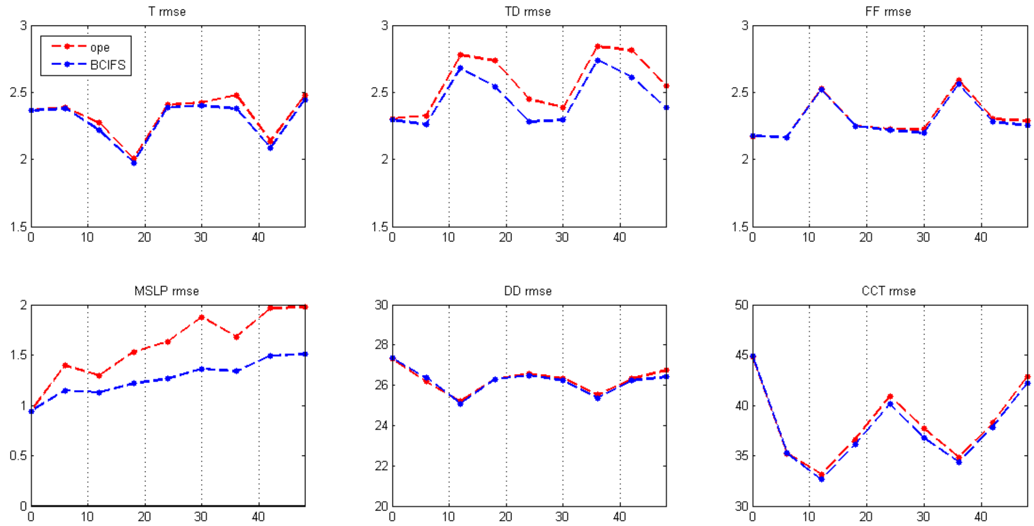

Fig.4 Root Mean Square Error (RMSE) score, as a function of forecast step, for (from left to right, top to bottom) 2m temperature, 2m dew point temperature, 10m wind speed , mean sea level pressure, 10 m wind direction, total cloud

cover, computed for COSMO-IT EPS forecast with BC from most recent ECMWF-EPS members (blue) and BC from COSMO-ME EPS members (red), using synop observations in the period 1st December 2019 – 9th may 2020.

Upper-air forecast verification scores against radiosonde data for the above cited period are shown in Fig.5, Fig.6 and Fig.7. For temperature, wind and humidity a substantial improvement is found throughout the whole column (reduction of both RMSE and BIAS for all forecast steps).
Given the evidence of a positive impact of using BC from most recent ECMWF-EPS members, this configuration became operational at the end of the year.

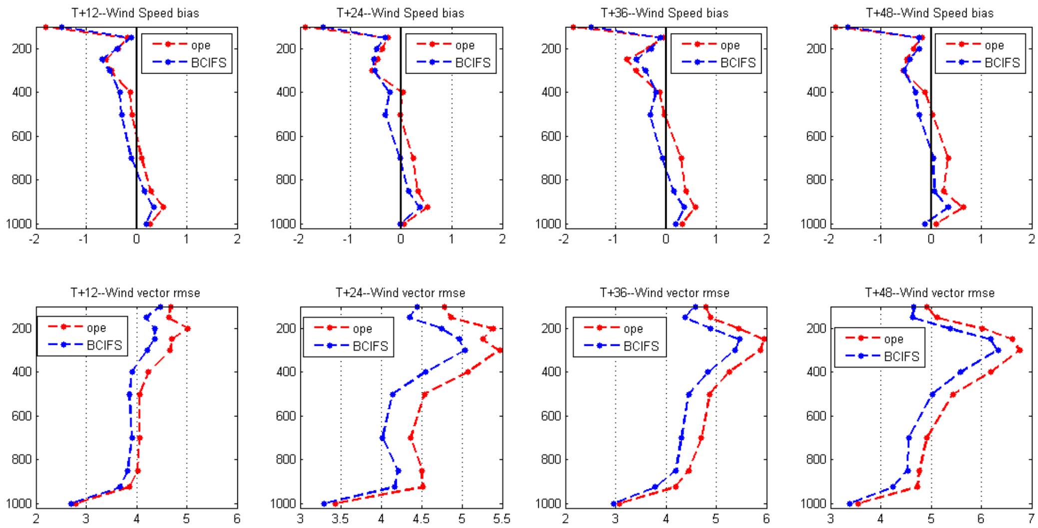

Fig.5 Wind speed mean Error (top) and wind vector Root Mean Square Error (bottom) vertical profiles for different forecast steps (from left to right: T+12h, T+24h, T+36h, T+48h), computed for COSMO-IT EPS forecast with BC from most recent ECMWF-EPS members (blue) and BC from COSMO-ME EPS members (red), using radiosonde observations in the period 1st December 2019 – 9th may 2020.

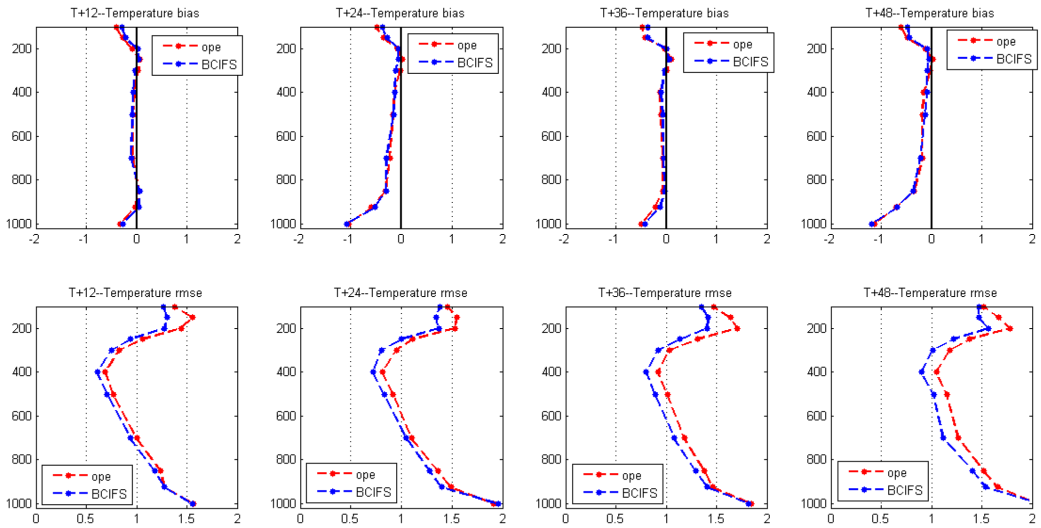

Fig.6 Mean Error (top) and Root Mean Square Error (bottom) vertical profiles of temperature for different forecast steps (from left to right: T+12h, T+24h, T+36h, T+48h), computed for COSMO-IT EPS forecast with BC from most recent ECMWF-EPS members (blue) and BC from COSMO-ME EPS members (red), using radiosonde observations in the period 1st December 2019 – 9th may 2020.

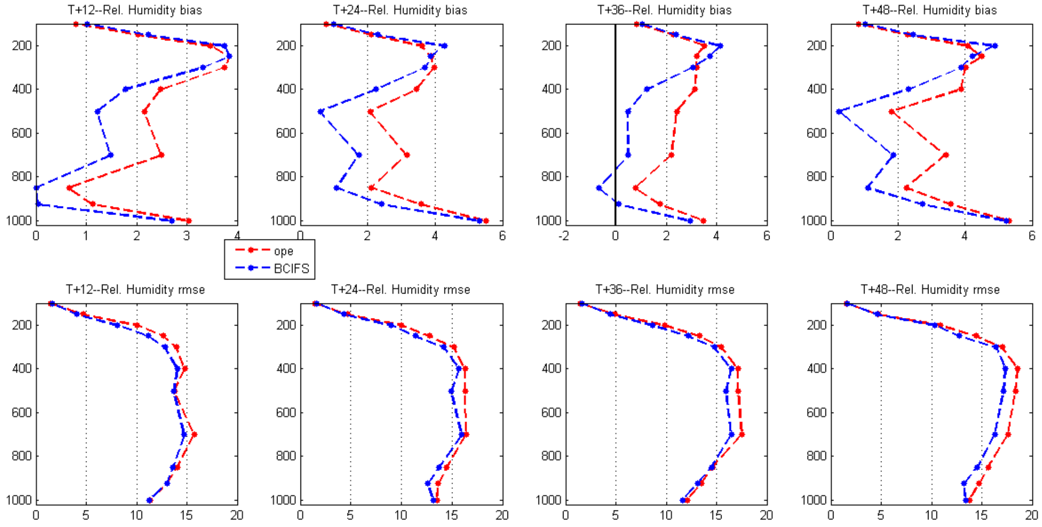

Fig.7 Mean Error (top) and Root Mean Square Error (bottom) vertical profiles of relative humidity for different forecast steps (from left to right: T+12h, T+24h, T+36h, T+48h), computed for COSMO-IT EPS forecast with BC from most recent ECMWF-EPS members (blue) and BC from COSMO-ME EPS members (red), using radiosonde observations in the period 1st December 2019 – 9th may 2020.

15 UTC