Forecast of High-Impact Weather over Italy: performance of global and limited-area ensemble prediction systems

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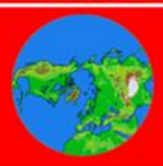
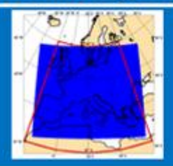
Motivation and purpose of the work

- **Motivation:** the forecast of "High-Impact Weather" (HIW) events with high spatio-temporal detail still suffers from severe limitation because HIW horizontal dimensions are too small to be explicitly resolved by state-of-art Numerical Weather Prediction (NWP) ensemble systems.
- The **main purpose** of this study is to assess the performance of a newly developed high-resolution ensemble prediction system for a number of HIW events. It is planned to compare its performance against two state-of-art ensemble prediction systems, both running on an operational basis.

The ensemble forecast systems

ENSEMBLE SYSTEM / MAIN TECHNICAL FEATURE	ECMWF ENS (European Centre for Medium-range Weather Forecast ENSemble prediction system)	COSMO-LEPS (Consortium for Small-scale Modelling Limited-area Ensemble Prediction Systems)	COSMO-2I-EPS
Integration domain			
Horizontal resolution (km)	18	7	2,2
Vertical resolution (Model level)	91	40	65
Forecast range (hours)	240	132	48
Type of model	Hydrostatic model	Non-Hydrostatic model	Non-Hydrostatic model
Type of convection	Parameterized convection	Parameterized convection	Explicit convection
Ensemble size	51	16	10
Starting times (UTC)	00, 06, 12, 18	00, 12	00

Description of experiment

Due to the limited availability of COSMO-2I-EPS, the intercomparison is performed on the period from 20 to 27 June 2016, starting at **00 UTC** and with a forecast range of **48 hours** (post-processing frequency every 6 hours).

The systems are compared over the **Italian region**

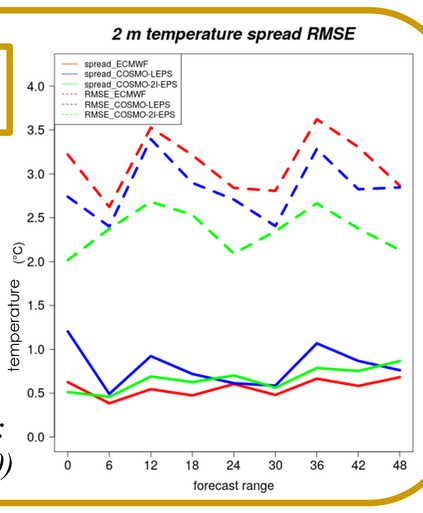
Italian domain
Latitude: 35N-48N
Longitude: 6E-19E

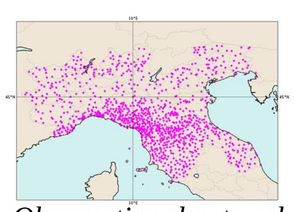
Performance of the ensemble systems: ECMWF ENS, COSMO-LEPS, COSMO-2I-EPS

- **Root Mean Square Error (RMSE)** of the ensemble mean measure the distance between the forecast mean and observations.
- **Spread (SPRD)** is calculated by measuring the deviation of ensemble forecasts from their mean.

In a perfect ensemble forecast the ensemble spread should match the RMSE of the ensemble mean over the same period.

2-m TEMPERATURE

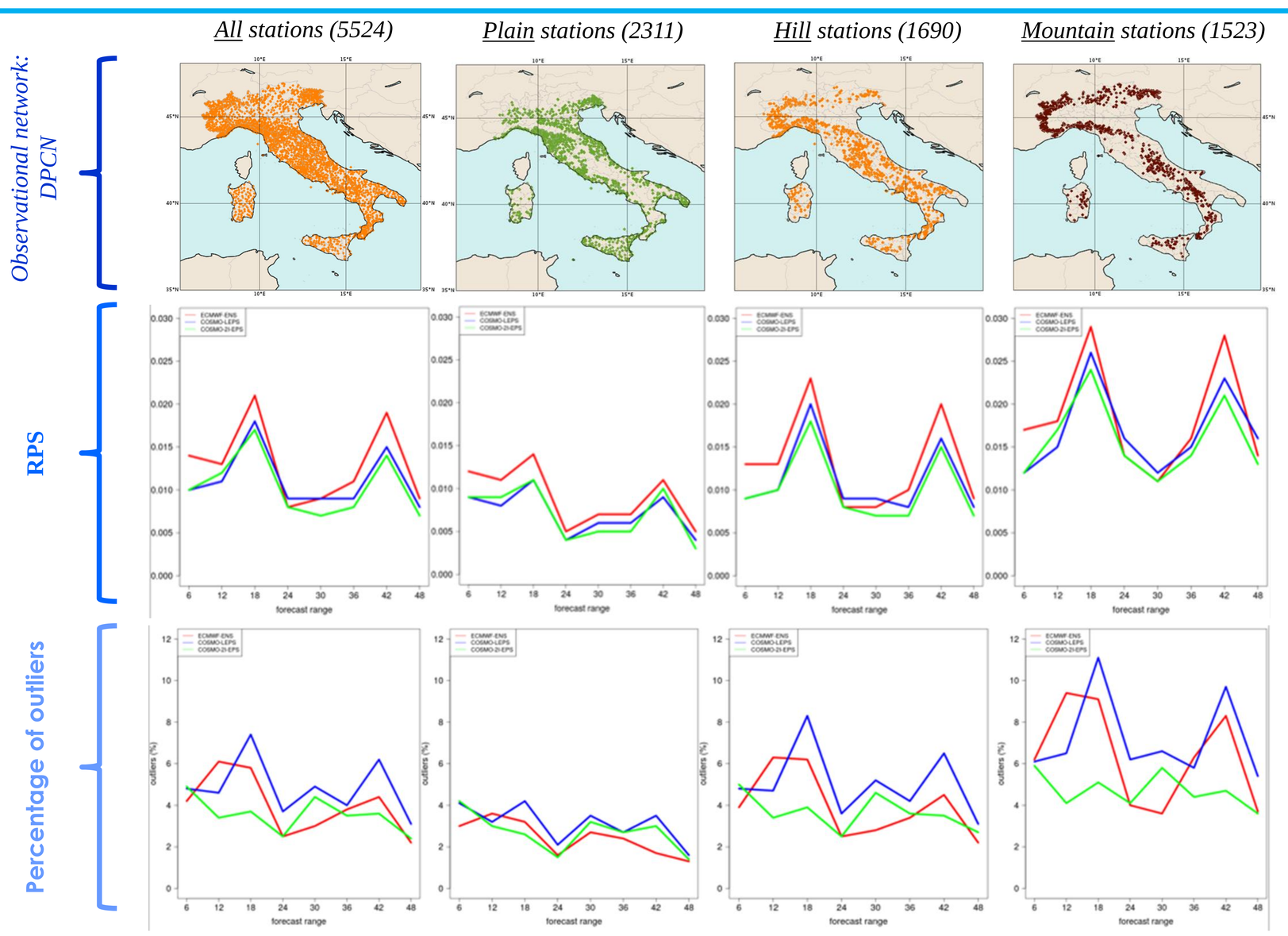




Observational network: regional station (≈ 1000)

- **Ranked Probability Score (RPS)** is an extension of the RMSE to the probabilistic world and to the multi-category events. RPS ϵ (0, 1); the lower the RPS, the better the ensemble system.
- **The percentage of outliers** is computed as the fraction of points of the domain where the observed value lies outside the minimum or maximum forecast value.

6-h TOTAL PRECIPITATION



Conclusions and plans

Geopotential height (not shown) and 2-m temperature

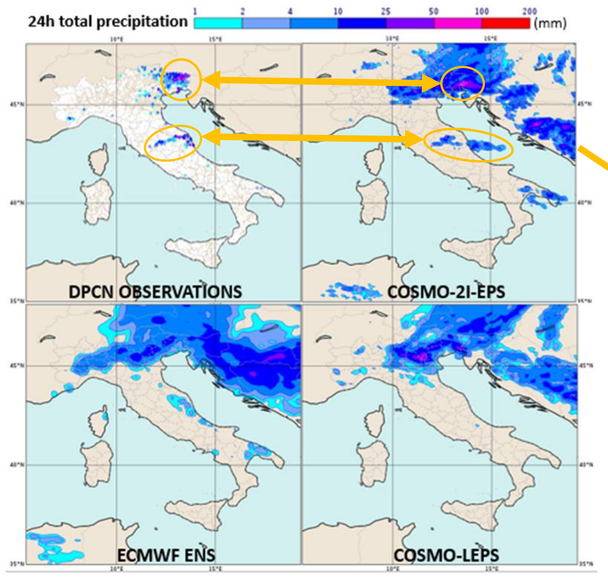
- ✓ There is a marked under-dispersion by all the investigated ensemble systems;
- ✓ The limited-area ensemble systems have a higher ability to describe more sources of uncertainty.

6-h total precipitation

- ✓ COSMO-2I-EPS has the best performance, regardless the altitude of the stations;
- ✓ The performance of the systems tend to worsen with the altitude, also enhancing the diurnal cicle.

The added value of high resolution in the convection-permitting ensembles plays a crucial role in the probabilistic prediction of atmospheric fields, especially at low levels.

Extend the verification period and use other methodologies to verify precipitation (such as bilinear interpolation and boxes).



Maps of total precipitation cumulated over 24 hours for 27 June 2016

The precipitation predicted by COSMO-2I-EPS is the one closest to the observations both for distribution and intensity

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