MISTRAL project and a new tool for flash flood forecast in Italy

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ECMWF

MISTRAL
Meteo Italian Supercomputing Portal

MISTRAL project

PARTNERS

1

EUROPEAN PROJECT

Project funded under the Connecting Europe Facility (CEF) – Telecommunication Sector Programme of the **European Union** and started on 1 October 2018.

2

GOAL

The **GOAL** of the MISTRAL portal is to facilitate and foster the **re-use of the datasets** **by the** **weather** **community**, as well as by its cross-area communities, to provide added value services through the use of **HPC resources**, turning it into the level of new business opportunities.

1

ECMWF ROLE

Exploit CINECA supercomputer facilities to combine the most skilful aspects of two **6-h precipitation forecasts**:

1. **ecPoint Rainfall** product from IFS ENS (ECMWF)
2. **COSMO-2I EPS 2.2 km** resolution + **new post-processing** method

Motivation

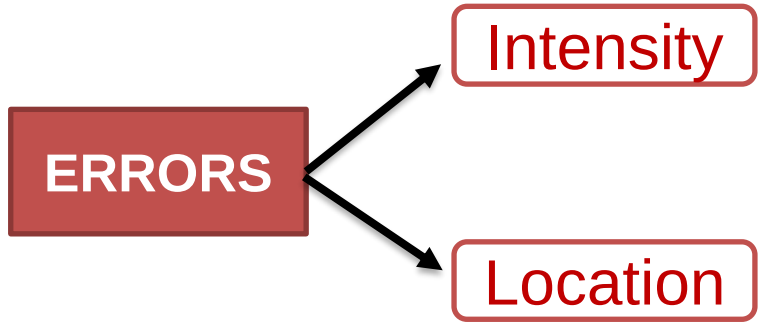
Weather forecasts can present **large errors** because they are calculated for grid boxes in large regions, not for points.

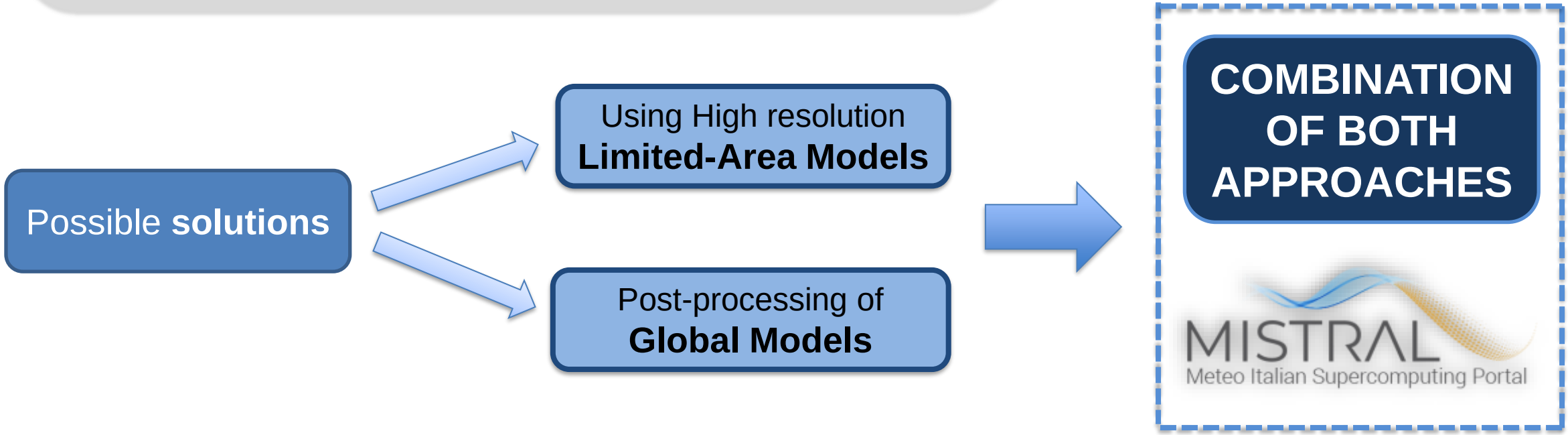
↓

Larger errors in localized convection rather than for large-scale precipitation

↓

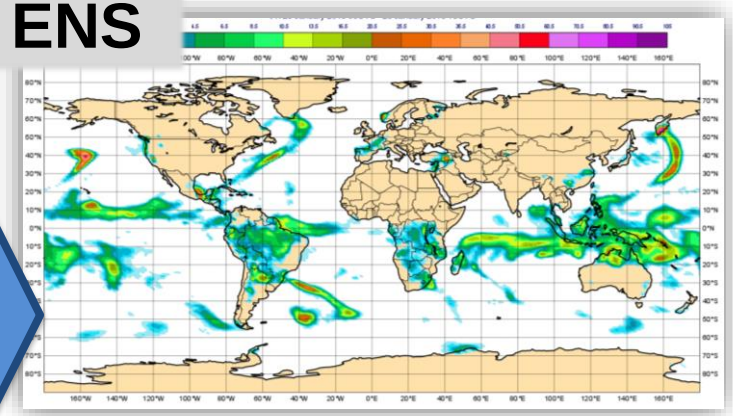
Limitations in FLASH FLOOD predictions





Workflow for 6-h precipitation forecast

Global ECMWF ENS

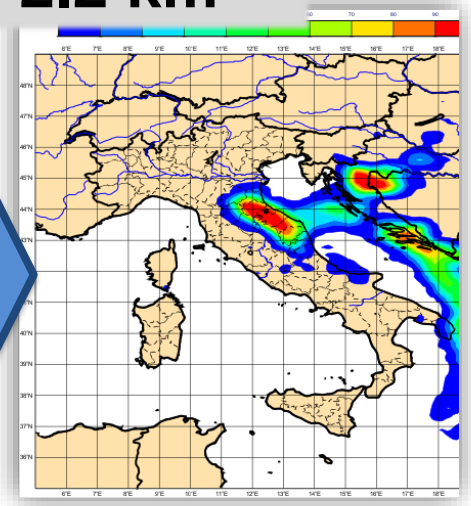


ecPoint post-processing

ecPoint Rainfall 6-h

ecPoint Rainfall 6-h cropped and interpolated to COSMO grid

COSMO-2I-EPS 2.2 km



scale-selective neighbourhood post-processing

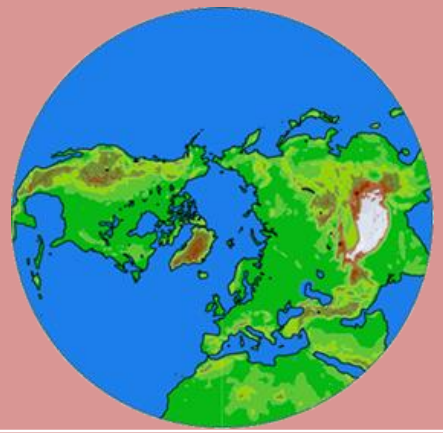
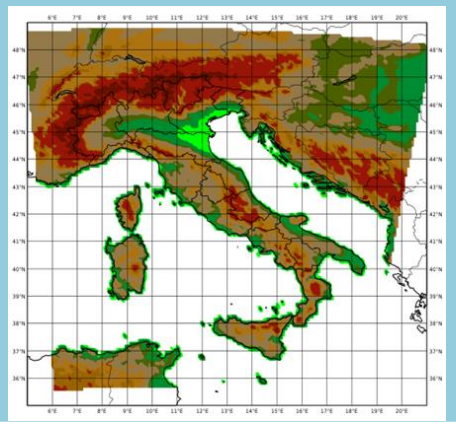
COSMO post-processed

LEAD-TIME WEIGHTED BLENDING

COSMO post-processed
+ ecPoint Rainfall post-processed
blended for Italy and surroundings

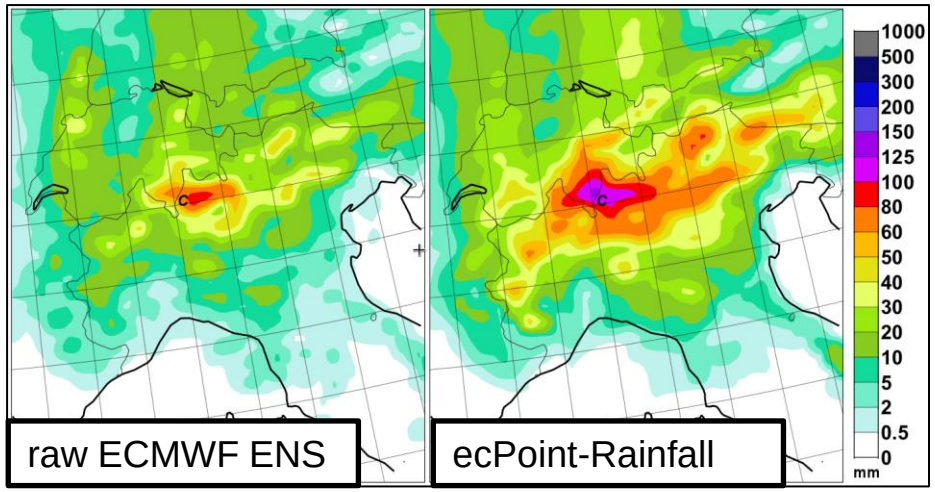
Skilful 6-h probabilistic forecast

The raw ensemble systems: **ECMWF ENS**, **COSMO-2I-EPS**

MAIN FEATURES \ ENSEMBLE SYSTEMS	**ECMWF ENS** (global)	**COSMO-2I-EPS** (LAM used in Mistral project)
Integration domain		
Horizontal resolution (km)	18	2.2
Vertical resolution (ML)	91	65
Forecast range	240h (138h)	51h
Initial conditions	Ens 4Dvar + SVs	ETKF
Boundary conditions	/	COSMO-ME-EPS
Type of convection	Parameterized convection	Explicit convection
Ensemble size	50+1	20
Starting times (UTC)	00, 12 (06, 18)	21

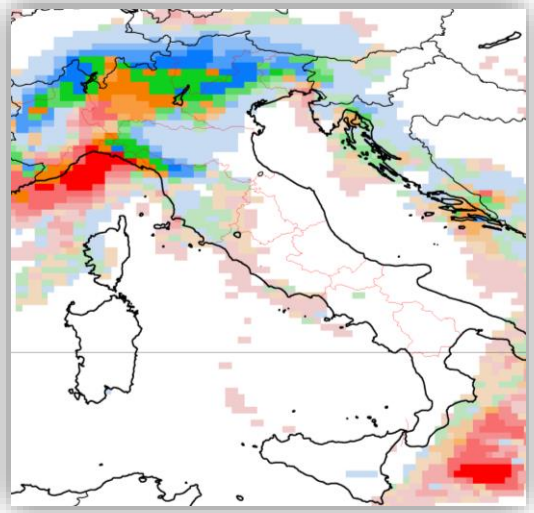
6h ecPoint-Rainfall post-processing

*99th **percentile** 6-h precipitation*



- A **statistical post-processing** system, that aims to **correct for physical aspects of rainfall generation** that are not well represented in the NWP model and that relate closely to error sources for point-based verification.

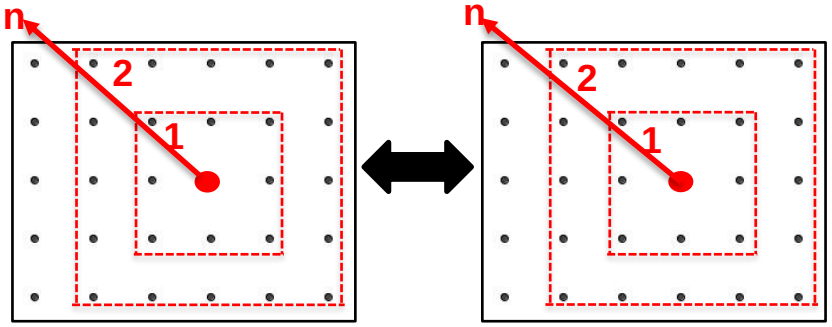
-sub-grid variability & gridscale biases are corrected for, both based on **"gridbox weather types";**



***Weather types** for a day/lead time/ensemble member*

scale-selective neighborhood method

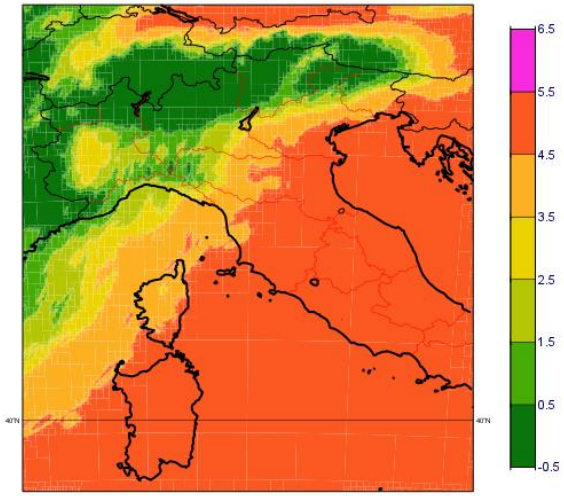
Blake et al. (WEA, 2018)
Dey et al. (QJRMS 2016a, 2016b)



- compensate for there being **insufficient** limited area model **ensemble members.**

- It can **retain** at the finest scales **rainfall signal**s when it is in **good agreement** between all the ensemble members (reliable at those scales): orographically-forced rainfall.

- It also can **spread out** the information from nearby gridboxes when we have scattered showers or some discrepancy in time or space of the arrival of a front



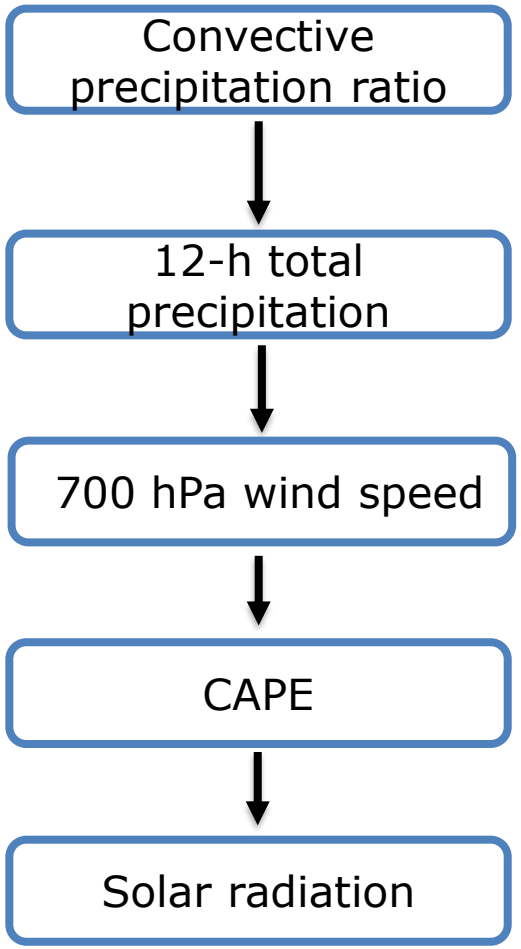
***Scale agreement** for a day/lead time for COSMO-2I-EPS*

At each grid-point, **SA** is the spatial scale at which 2 ensemble members are deemed "sufficiently" similar.

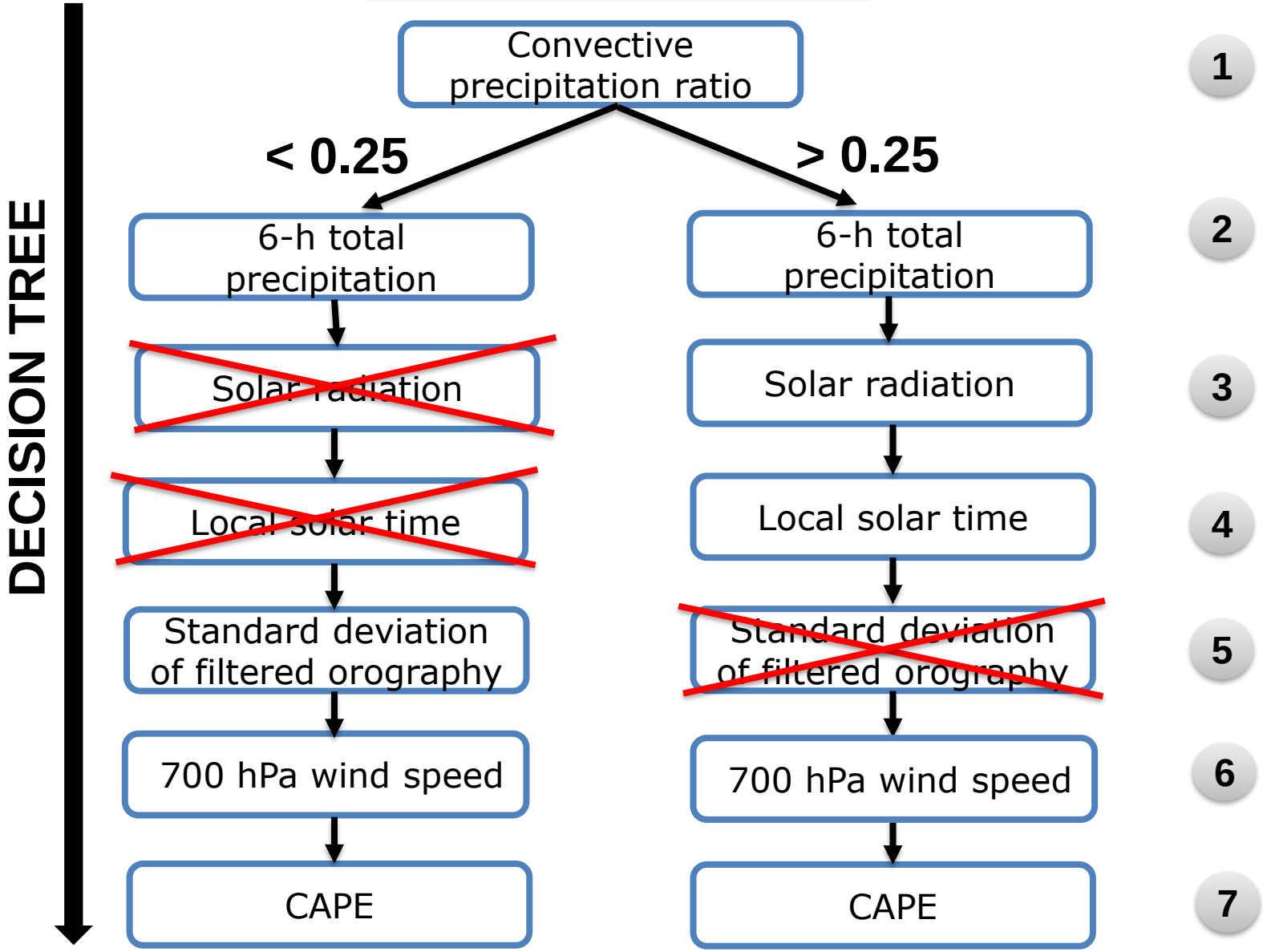
PREDICTORS

NEW!

ecPoint Rainfall 12-h



ecPoint Rainfall 6-h

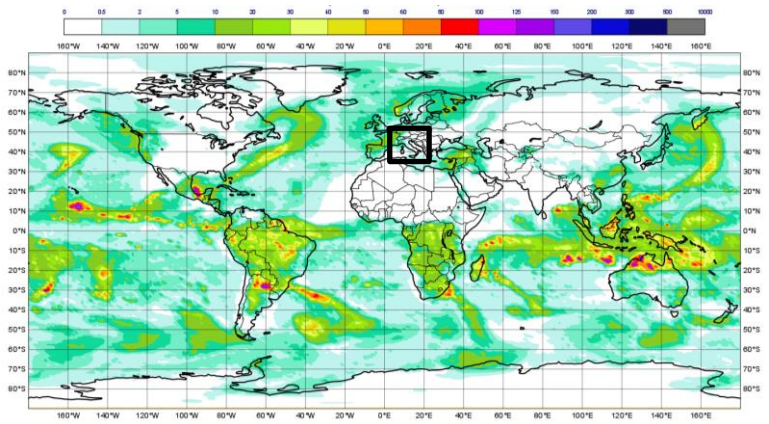


COSMO and ecPoint 6-h Rainfall blending

Combine the **most skilful aspects of the two systems** after applying different post-processings.

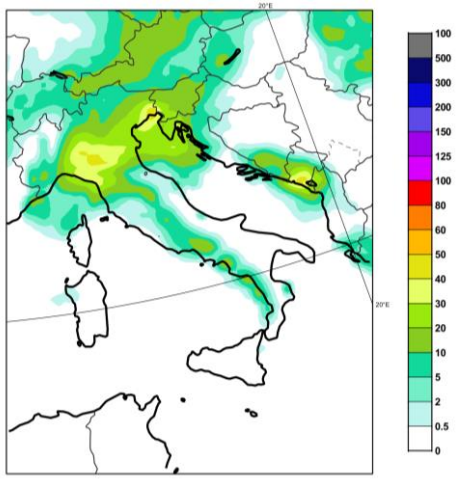
- All using the **CINECA supercomputer**.
- The final product will comprise **percentiles** (1, 2,..99) and **probabilities of exceeding** specific precipitation thresholds, for each COSMO gridbox.
- Lead times up to **48 h (the blending**) and **240 h** for the **ecPoint** Rainfall 6-h.

THE WEIGHTS OF EACH SYSTEM IN THE BLENDING WILL BE LEAD-TIME DEPENDANT



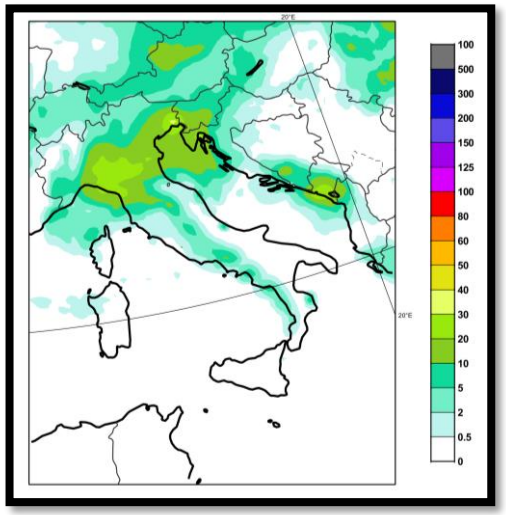
ecPoint Rainfall 6-h Global

+



COSMO-2I EPS post-processed rainfall 6-h

=



ecPoint + COSMO post-processing rainfall 6-h for Italy and surroundings

MISTRAL Maps Attributions & Licenses Privacy Participate Sign in Sign up

PARAMETERS

FIELDS:

pe pr

1 10 25 50 70 75 80 90 95 99

RUN:

00

RESOLUTION (Km):

2.2

From 0 to 48h: 2.2 km
From 48h to 240h (day 10): 18 km

AREA:

Italy
Italy
Northern Italy
Central Italy
Southern Italy

6h precipitation percentiles (mm): perc 90 | 00 | 2.2 Km | Italy

From 0 to 48h: blending of ecPoint-Rainfall and COSMO-2I-EPS post-processed
From 48h to 240h (day 10): only ecPoint-Rainfall is available

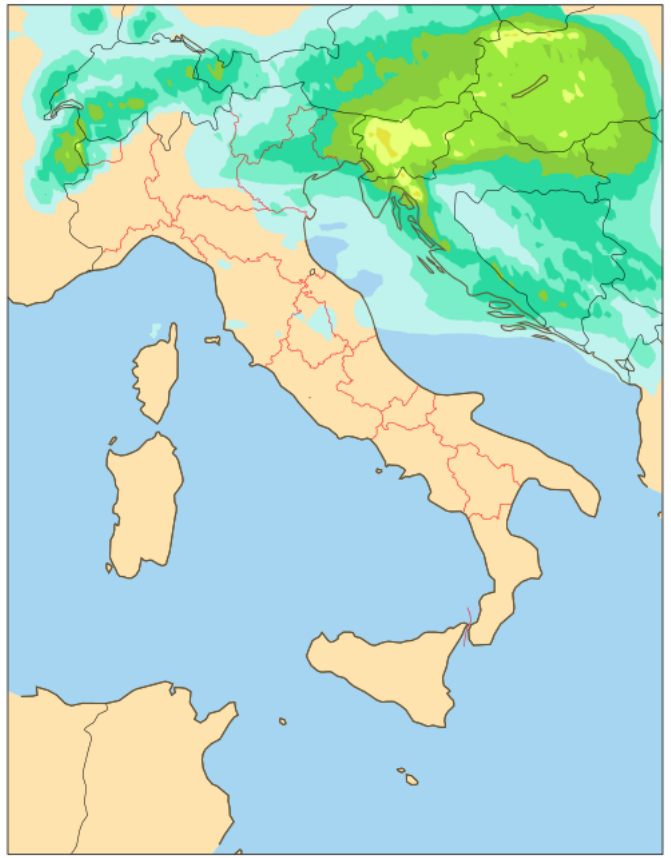
Forecast model: **Italy Flash Flood** - Reference date: **2021-05-17** - Run: **00**

Plot pre-defined:

- **Probabilities** of exceeding some precipitation threshold
- **Percentiles**

Different pre-defined areas

Select a specific forecast lead time or “play” a sequence of all lead times



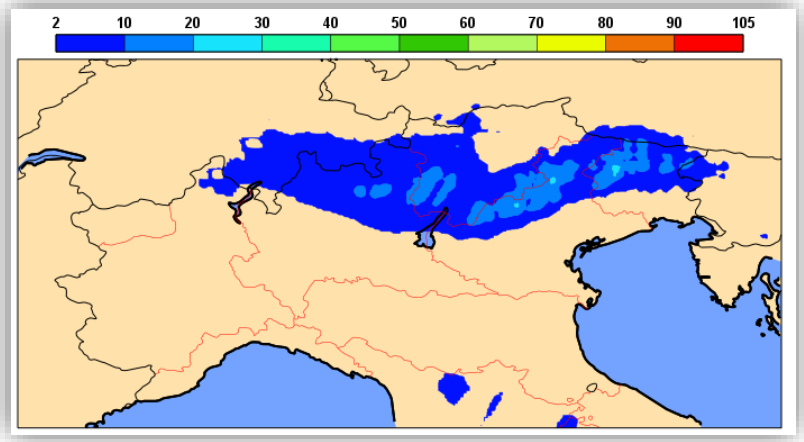
2021-05-17 06:00 (UTC)

+6h

© MISTRAL

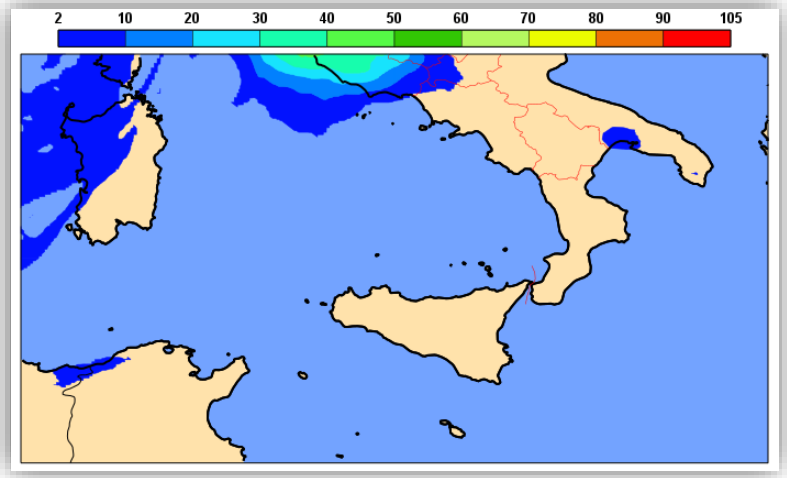
https://meteohub.mistralportal.it/app/datasets

Areas

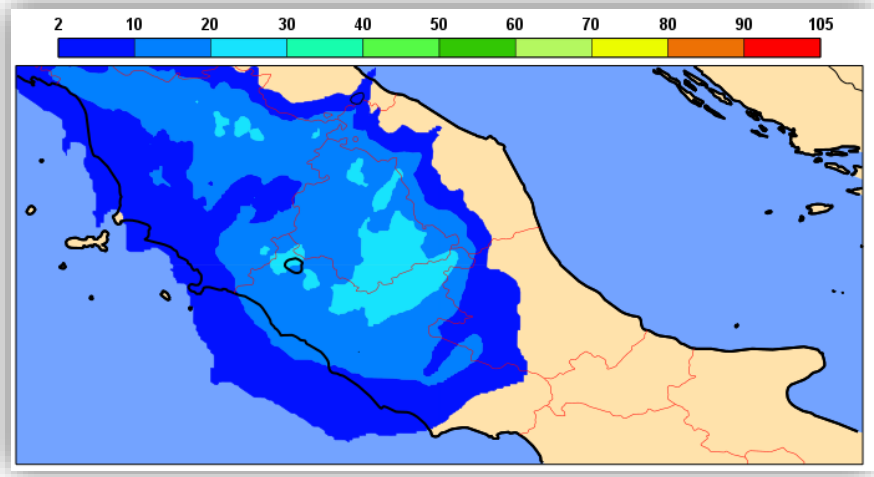


North Italy

COSMO-2I-EPS area



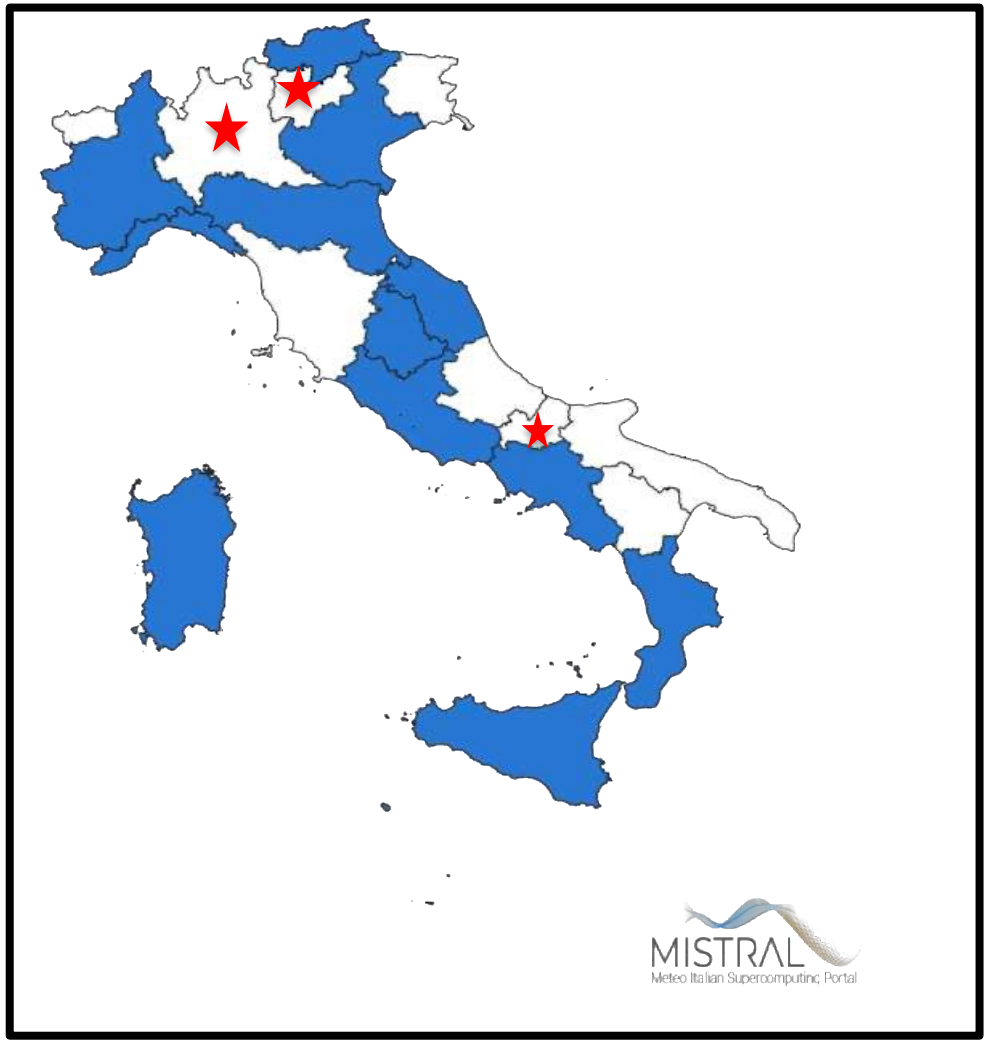
South Italy



Central Italy

Regions included in the observations integration data

1 Campania
2 Calabria
3 Emilia Romagna
4 Lazio
5 Liguria
6 **Lombardia** ★
7 Marche
8 **Molise** ★
9 Piemonte
10 Sardegna
11 Veneto
12 Sicilia
13 Umbria
Provincia di Bolzano
Provincia di Trento ★



Flash flood events

in the north-west of Italy

between 2 and 3 October 2020

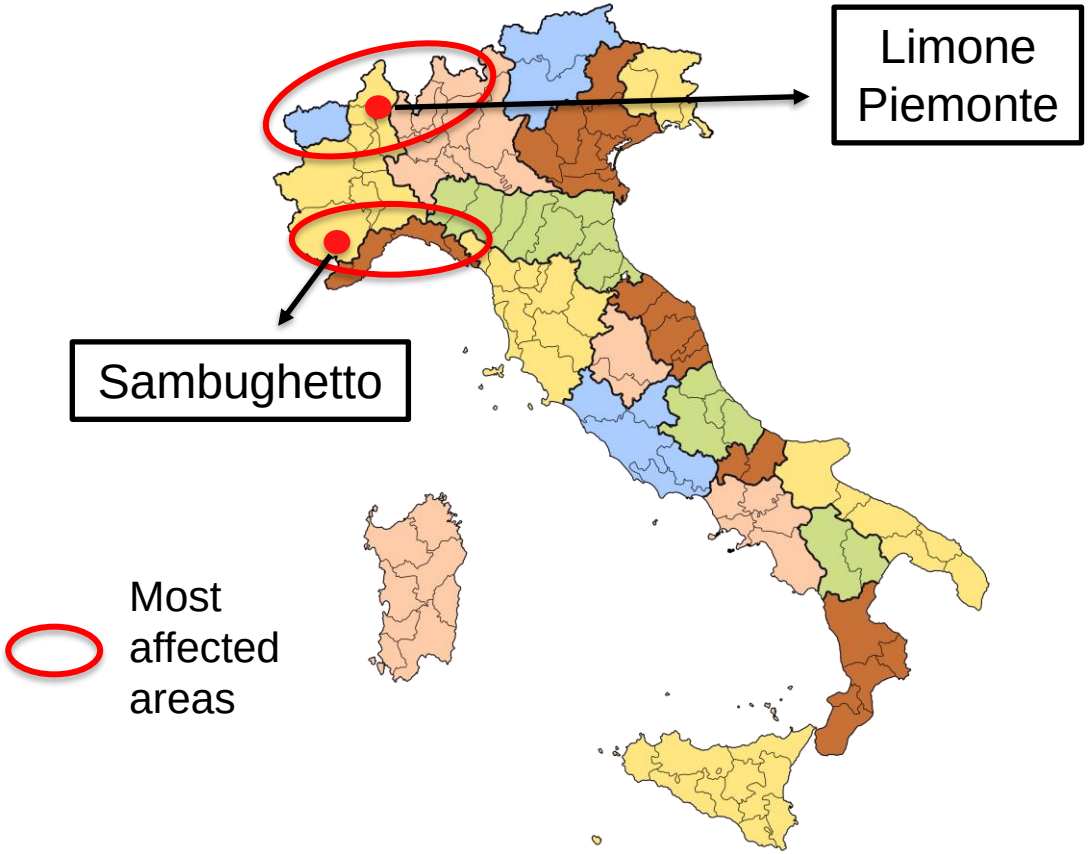
Analysis of the Mistral Flash-flood forecast products

Between the

2 and **3** of **October 2020**

the north-west of Italy was subject to record

precipitations and subsequent **flash floods**



3 October - **Data from Arpa Piemonte**

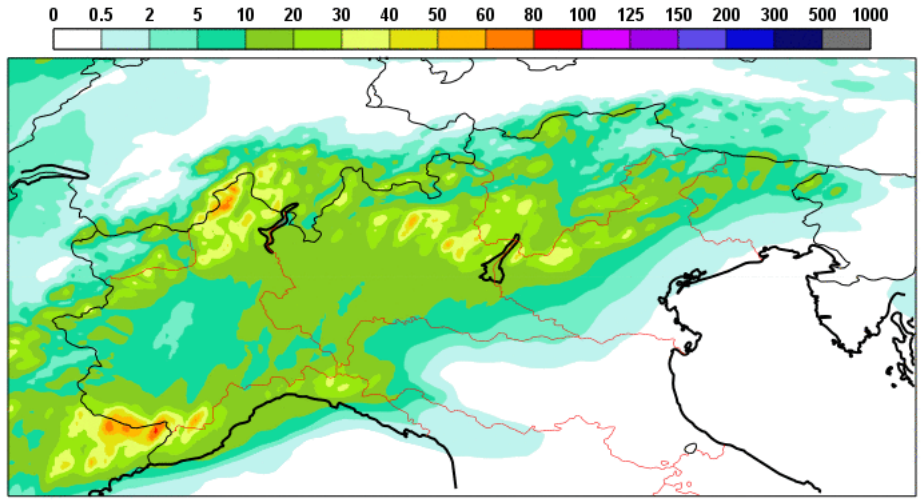
Cumulative rainfall in the last **24 hours**

- Sambughetto (VB) 630 mm
- Limone Piemonte (CN) 580 mm

Flash flood product: percentiles in 6h. North Italy
Base time: 2 Oct 2020 00 UTC

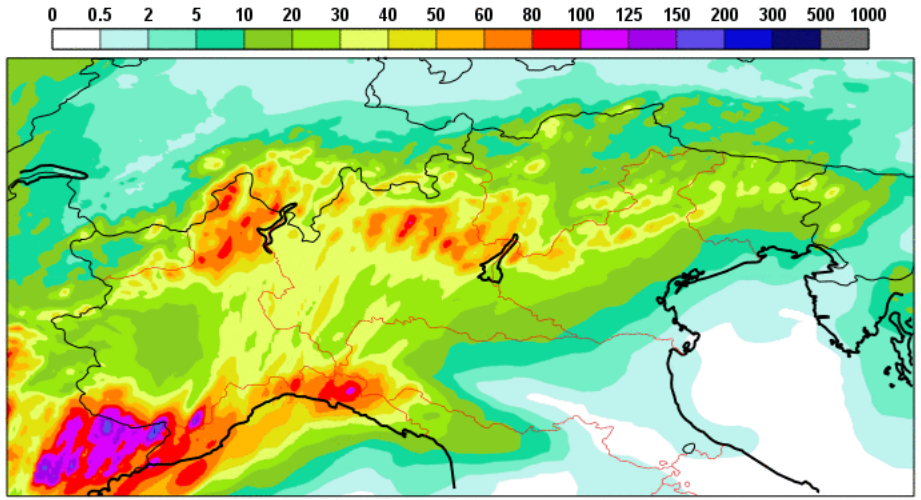
2 Oct 2020 12 UTC T+6-12h

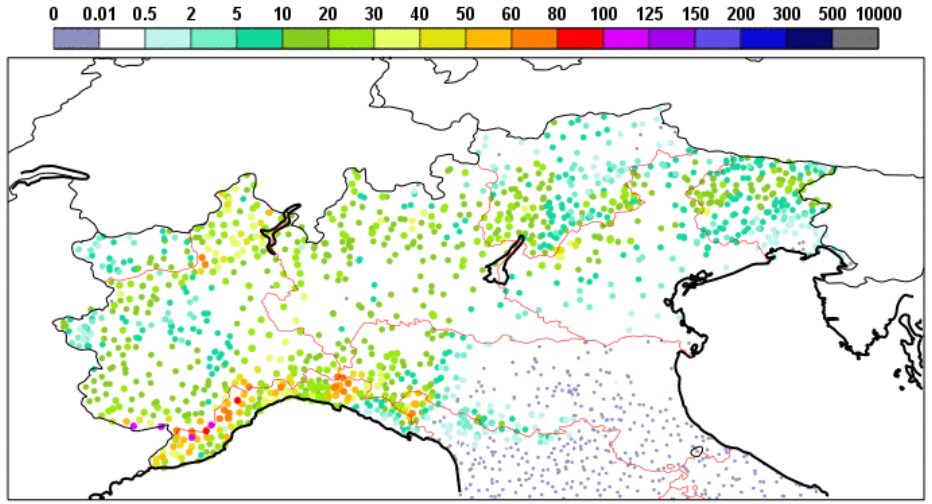
P50 (mm)



2 Oct 2020 12 UTC T+6-12h

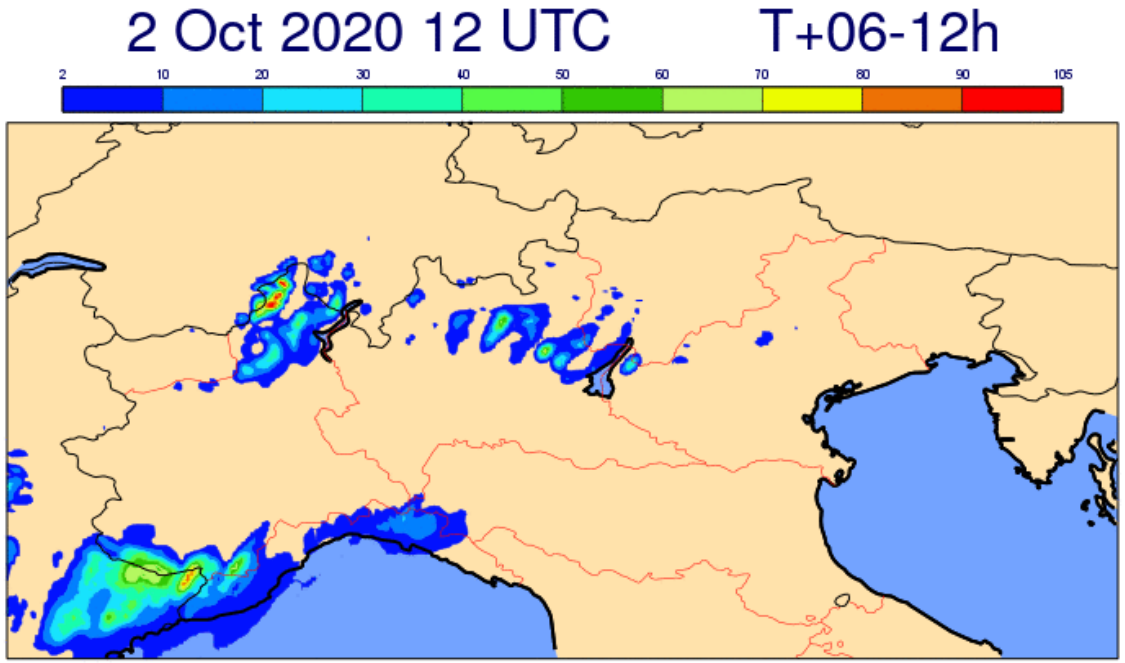
P99 (mm)



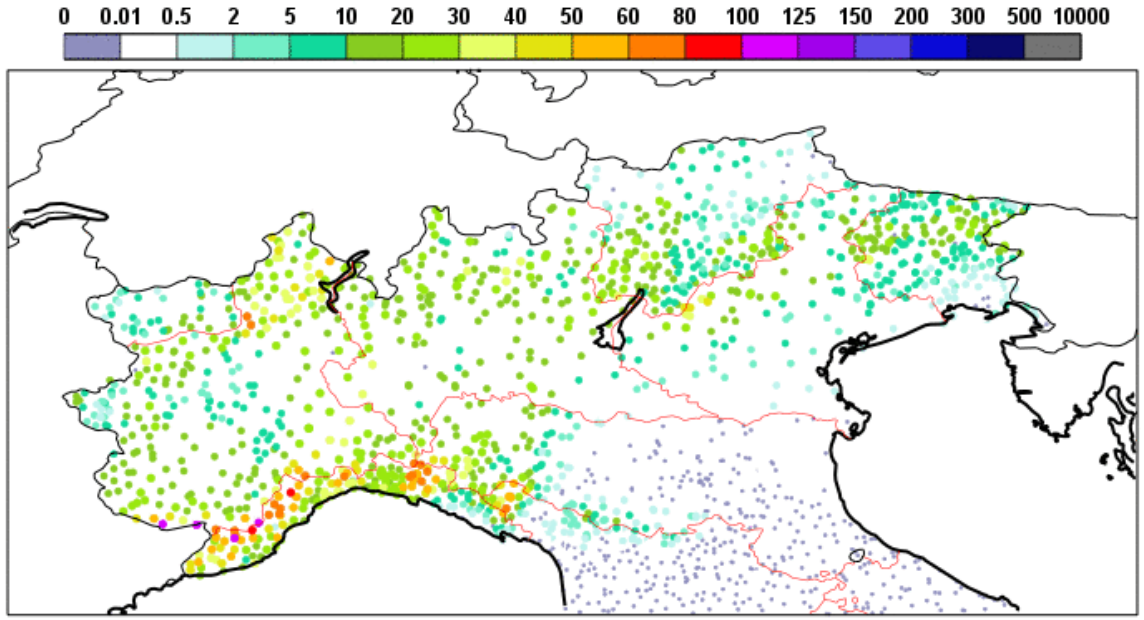


Observations

Flash flood product: Probabilities > 50mm/6h. North Italy
Base time: 2 Oct 2020 00 UTC

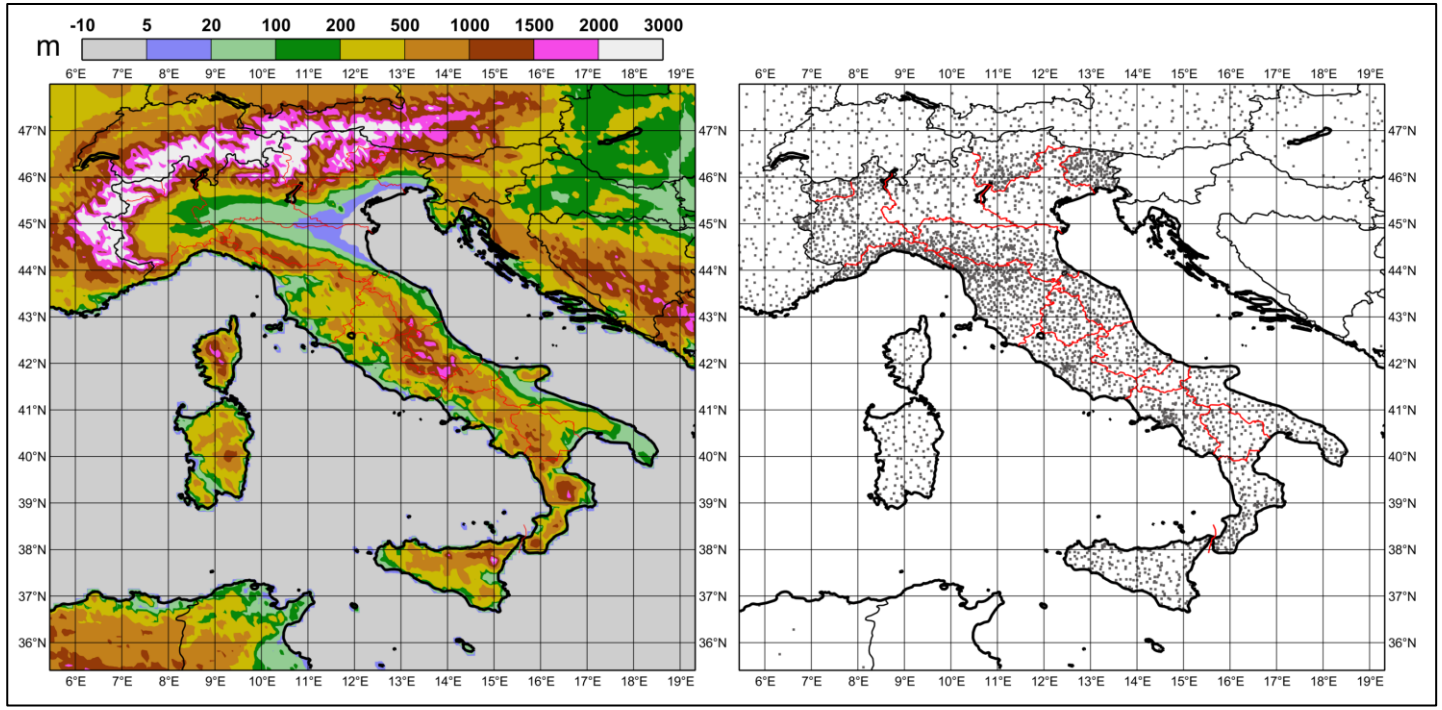


Observations



Verification

- variable: 6h precipitation;
- **period: 01/02/2019 - 31/01/2020;**
- region: 35-48N, 6-19E (Italy and surroundings);
- **obs: synop + Non-GTS regional network (~ 4000 stations per day);**
- time steps: 0-6, 6-12, …, 42-48h;
- thresholds: 0.2, 1, 5, 10, 20, 30, 50 mm/6h;
- products: **COSMO-raw** **COSMO-post** **ENS raw** **ecPoint6h** **merge product**
- scores: ROC area, BSreliab, …
- method: nearest neighbour

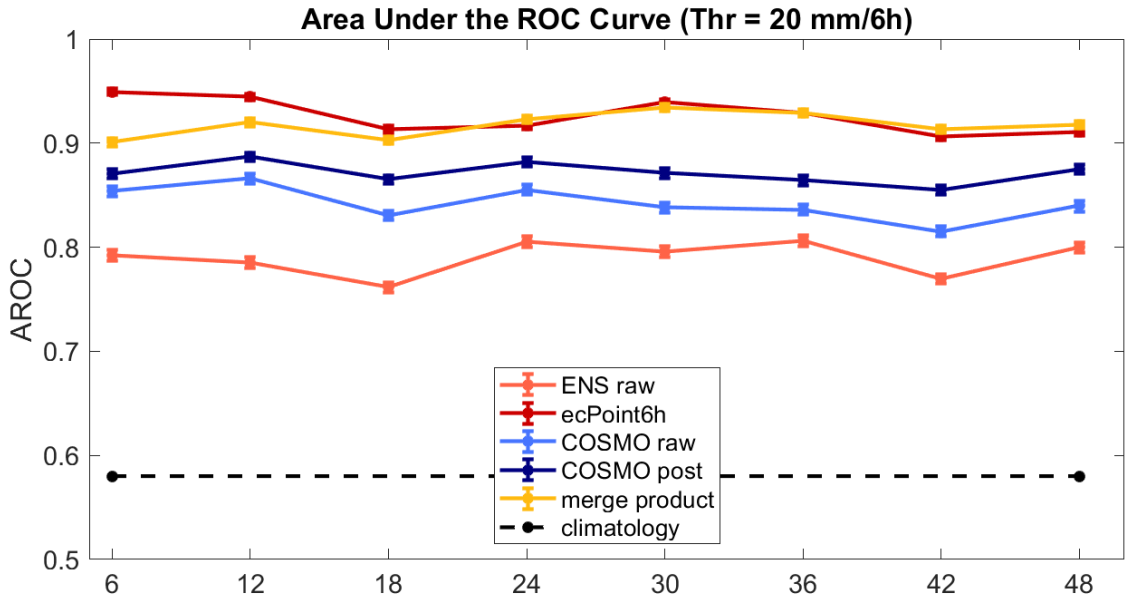


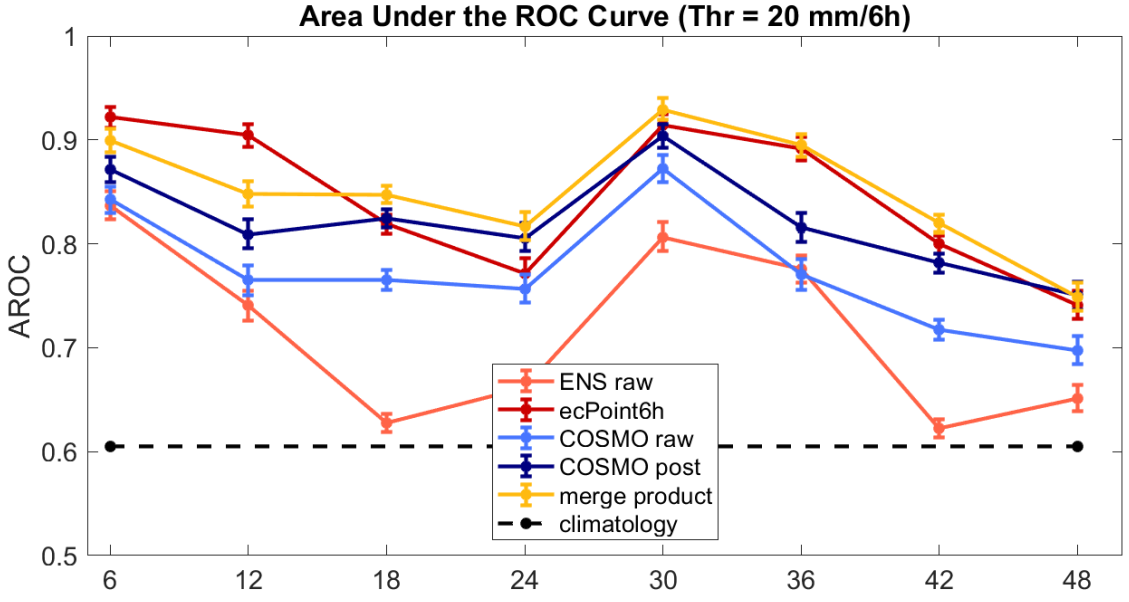
ALL SEASONS 1 YEAR

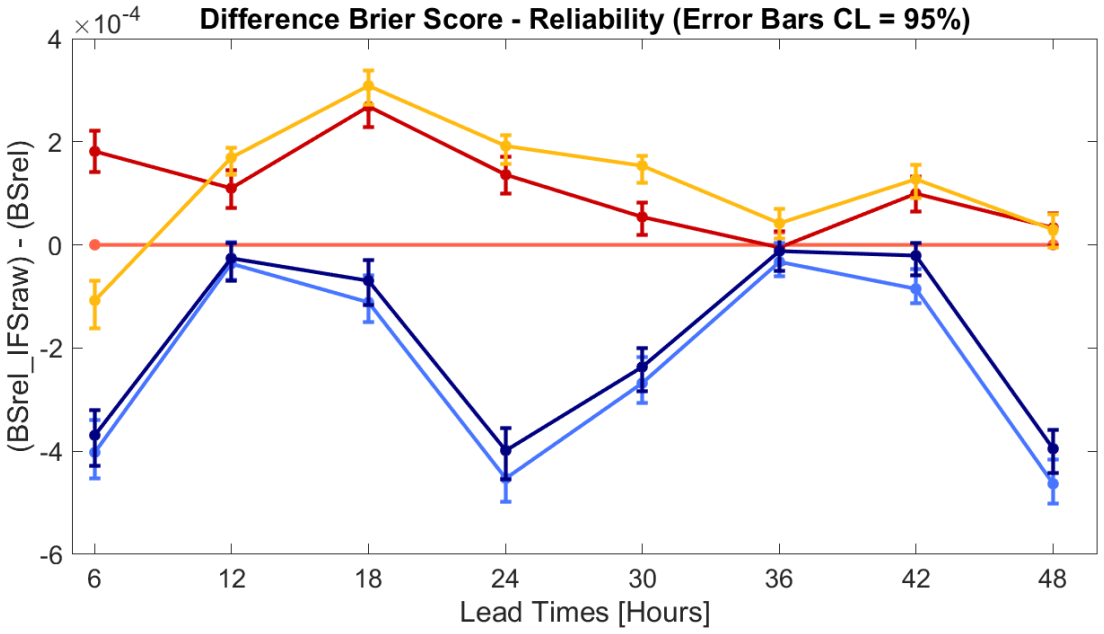
Verification

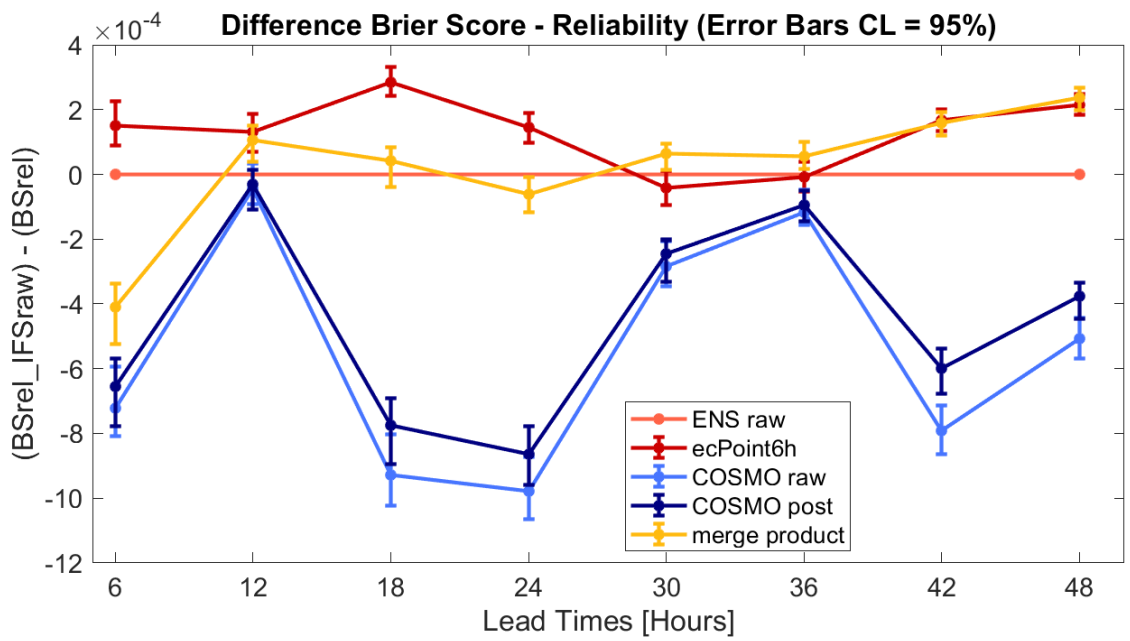
SUMMER

- "Normalised" Reliability component of the Brier Score
- Threshold: 20 mm/6h; cases: ~ 3300









better

Farther reading

MISTRAL flash floods use case

Products description and interpretation
https://www.mistralportal.it/italy-flash-flood/

ecPoint

ecPoint-calibrate software is open source:
https://github.com/esowc/ecPoint-Calibrate

more on ecPoint:
http://tiny.cc/ecPoint-seminar

ecPoint paper:
https://arxiv.org/abs/2003.14397 (a revised version will be published soon in *Communications Earth and Environment.)*

scale-selective neighborhood method

References:

Blake, B.T., Carley, J.R., Alcott, T.I., Jankov, I., Pyle, M.E., Perfater, S.E. and Albright B (2018), An Adaptive Approach for the Calculation of Ensemble Gridpoint Probabilities. Wea. Forecasting, 33: 1063–1080. https://doi.org/10.1175/WAF-D-18-0035.1

Dey, S.R.A., Roberts, N.M., Plant, R.S. and Migliorini, S. (2016a), A new method for the characterization and verification of local spatial predictability for convective-scale ensembles. Q.J.R. Meteorol. Soc., 142: 1982-1996. doi:10.1002/qj.2792

Dey, S.R.A., Plant, R.S., Roberts, N.M. and Migliorini, S. (2016b), Assessing spatial precipitation uncertainties in a convective-scale ensemble. Q.J.R. Meteorol. Soc., 142: 2935-2948. doi:10.1002/qj.289

CONCLUSIONS

- Development and operational implementation of “COSMO post”, based on a scale-selective neighbour post-processing of COSMO-2I-EPS;
- Development and operational implementation of a global ecPoint-Rainfall 6h.
- The merging of COSMO post with ecPoint6h provides promising results as for the prediction of flash floods over Italy, specially in summer period, when flash floods are more likely to occur.
- Forecast products displayed on an operational basis on MISTRAL Portal: https://meteohub.hpc.cineca.it

Work in progress

- improve documentation;
- think about more sophisticated ways of blending (season related?);

Quick tour to meteo-hub portal
https://meteohub.mistralportal.it/app/datasets

ECMWF

Thanks for your attention!!!