

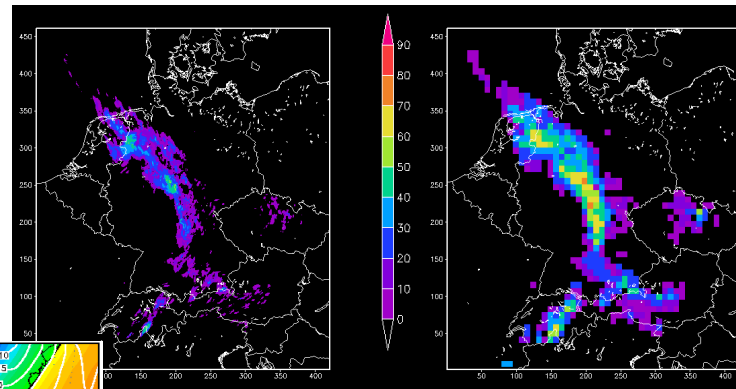
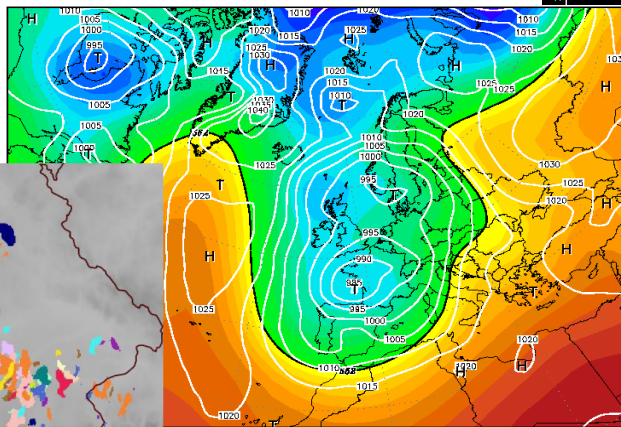
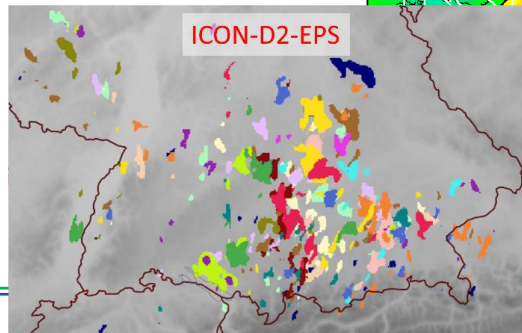
Ensemble forecasts with limited-area models: the challenge of the high resolution

Chiara Marsigli

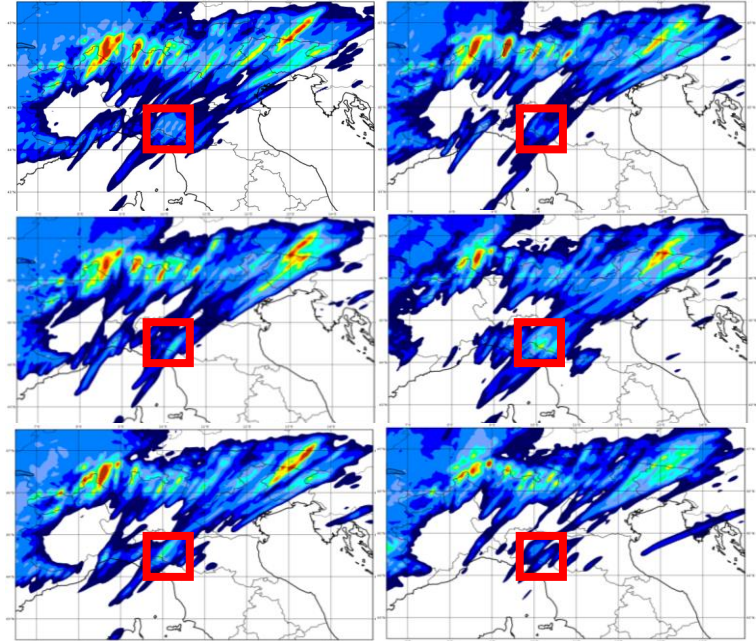
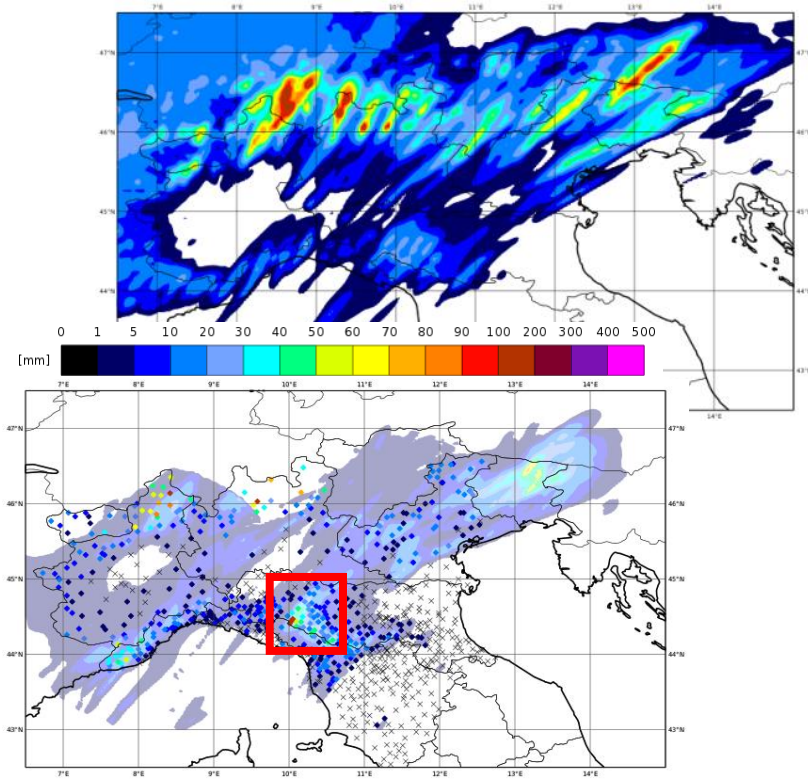
Deutscher Wetterdienst (DWD), Germany
Hydro-Meteo-Climate Service (SIMC) of Arpae Emilia-Romagna, Italy

Christoph Gebhardt (DWD)
Virginia Poli, Maria Stefania Tesini, Tommaso Diomede, Thomas Gastaldo (Arpae)

- Spatio-temporal detail
- Uncertainty in the details



Why high resolution needs ensembles?

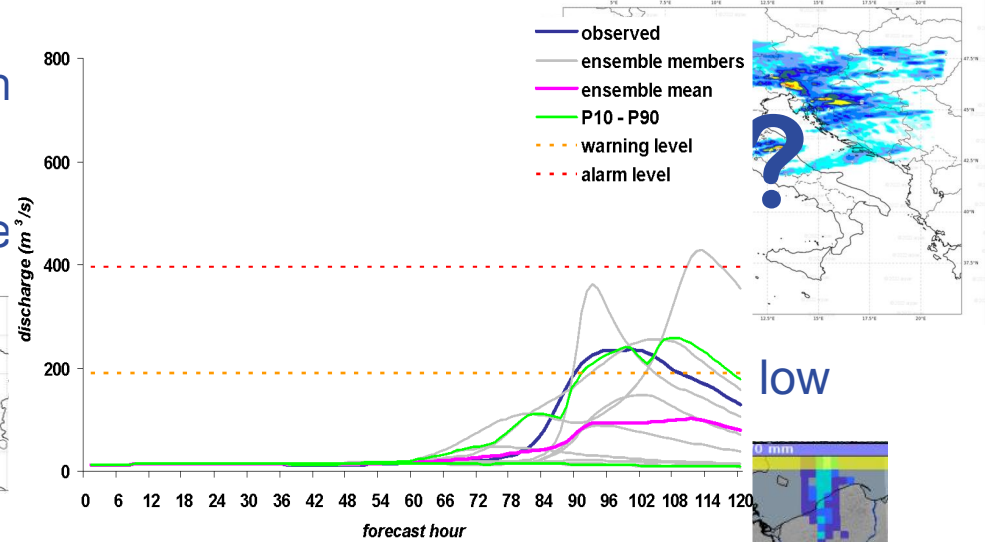
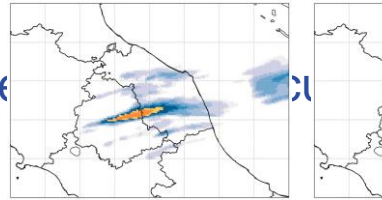


→ To increase the confidence in the

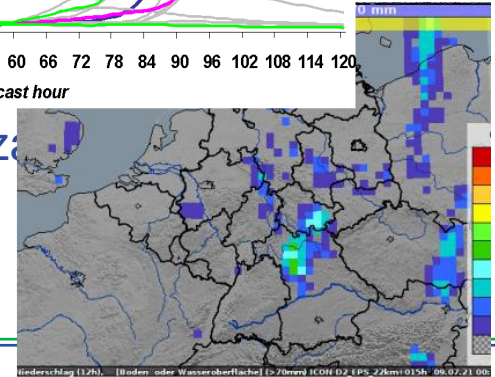
→ To indicate an uncertainty in the

→ To indicate the probability

→ To generate an uncertainty cascade by driving hazards



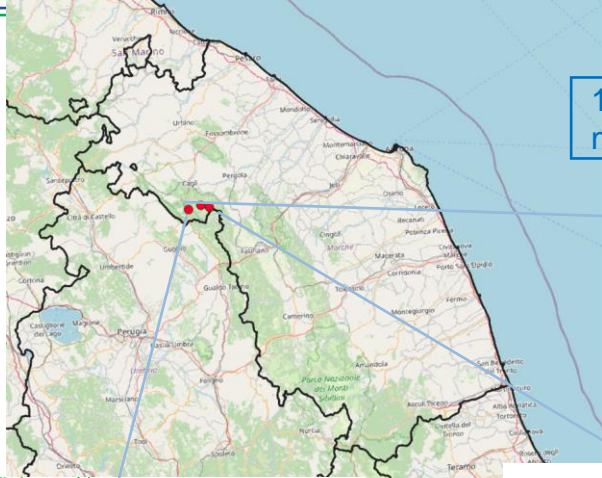
low



- To increase the confidence in the deterministic forecast
- To indicate an uncertainty in the spatial location of the phenomenon
- To indicate the possible occurrence of severe weather, even if with low probability
- To generate an uncertainty cascade by driving hazard/impact models

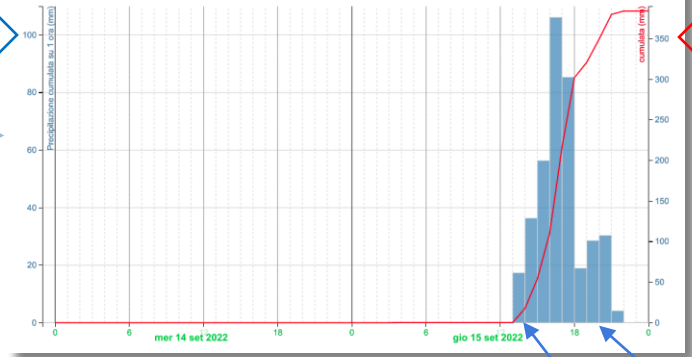
Marche region event

Observed
 precipitation
 15.09.2022



ultimo dato: 0.2 mm
 ore: 00:00 **UIG**
 di: ven 16 set 2022

100 mm



bacino: CESANO - METAURO
 sottobacino: non disponibile
 quota sensore: 1446 m s.l.m.

350 mm

Cantiano - Precipitazione cumulata su 1 ora

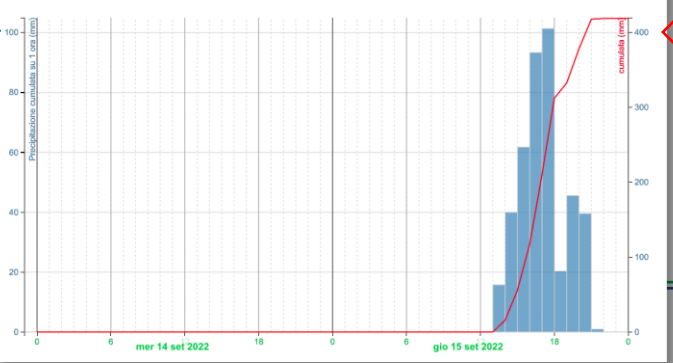
ultimo dato: 0.0 mm
 ore: 00:00 **UIG**
 di: ven 16 set 2022

100 mm

bacino: METAURO
 sottobacino: non disponibile
 quota sensore: 396 m s.l.m.

ultimo dato: 0.0 mm
 ore: 00:00 **UIG**
 di: ven 16 set 2022

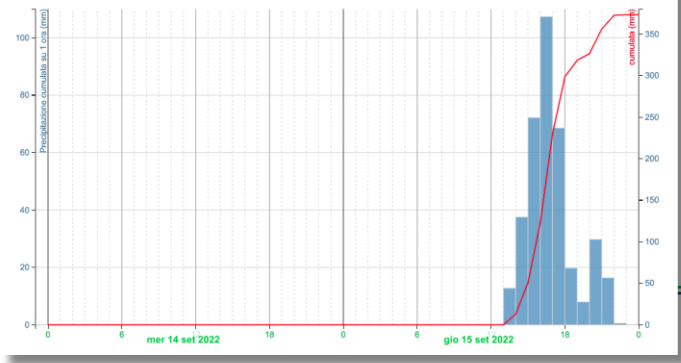
400 mm

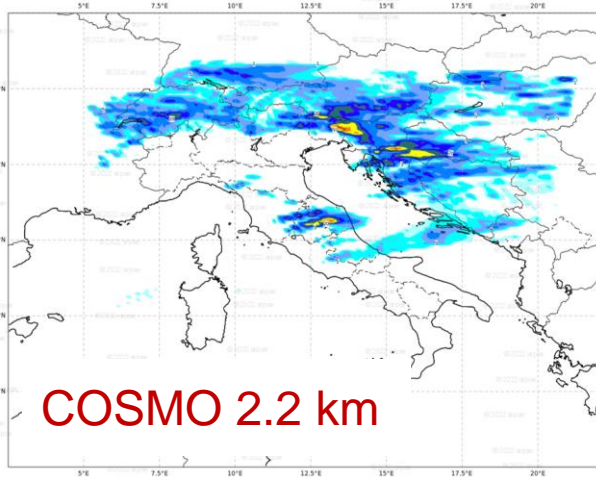
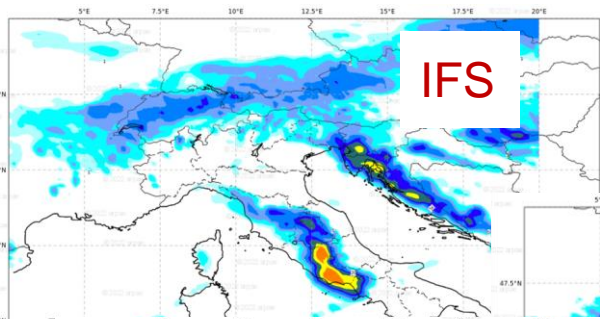


Fonte Avelliana - Precipitazione cumulata su 1 ora

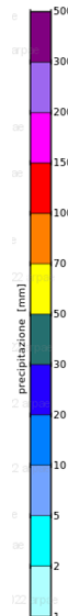
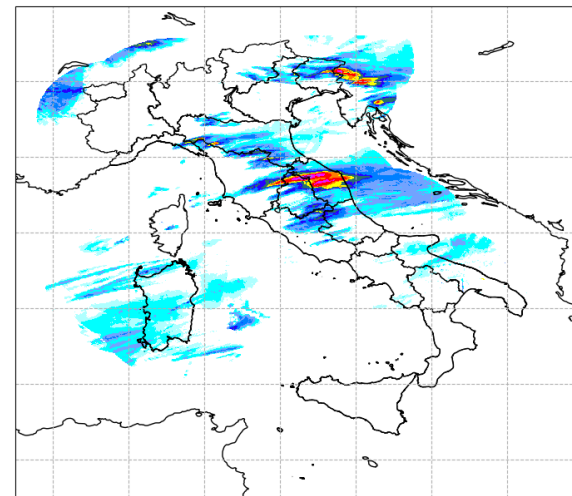
bacino: CESANO
 sottobacino: non disponibile
 quota sensore: 690 m s.l.m.

12 18

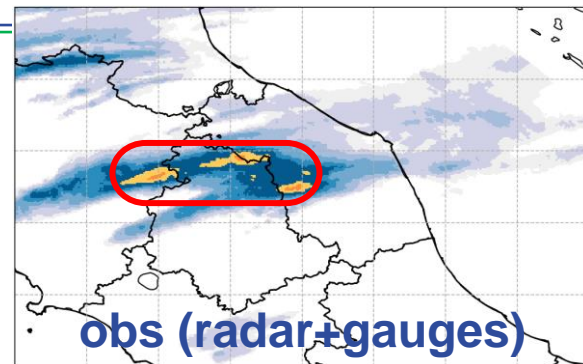




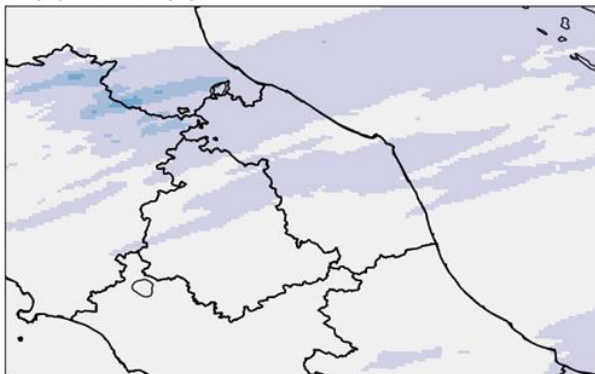
15.09.2022 12-24 UTC



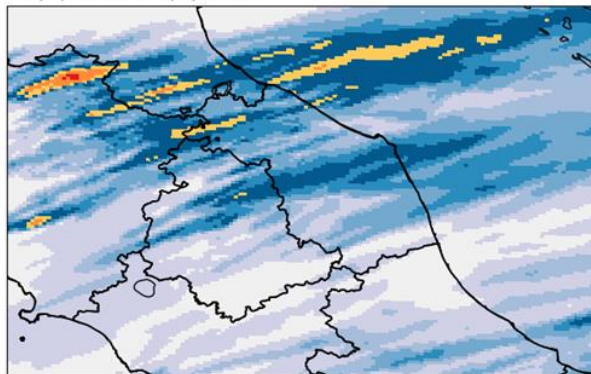
run 14/09/2022, 21 UTC
VT: 15/09/2022 12-15 UTC



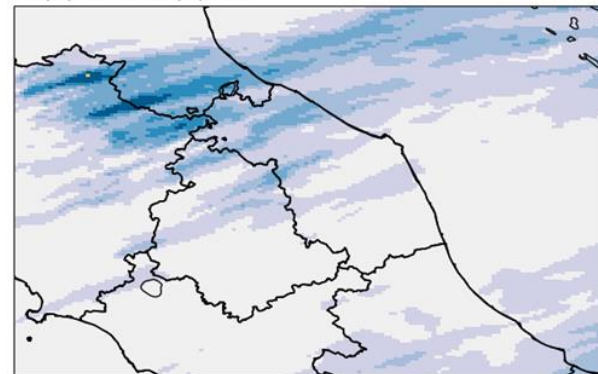
Mean precipitation
2022/09/15 12:00 - 2022/09/15 15:00



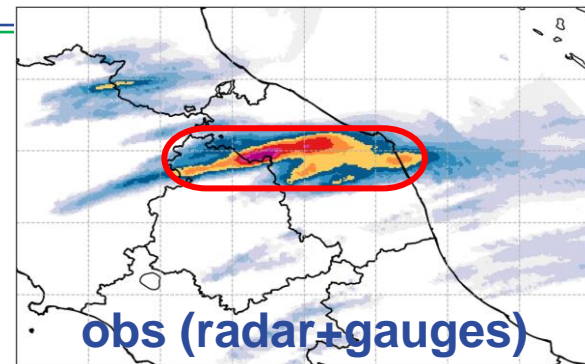
Maximum precipitation
2022/09/15 12:00 - 2022/09/15 15:00



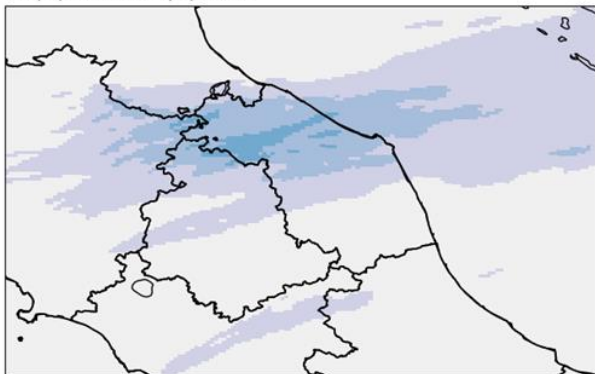
90th percentile precipitation
2022/09/15 12:00 - 2022/09/15 15:00



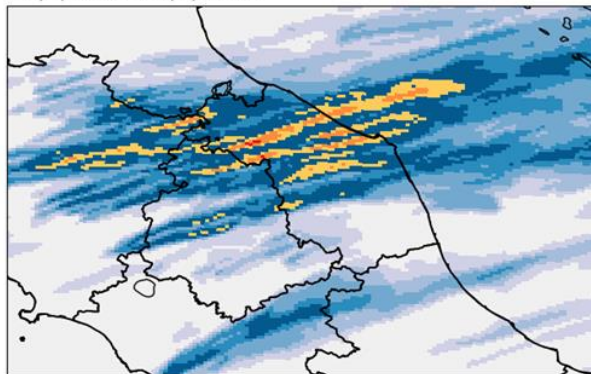
run 14/09/2022, 21 UTC
VT: 15/09/2022 15-18 UTC



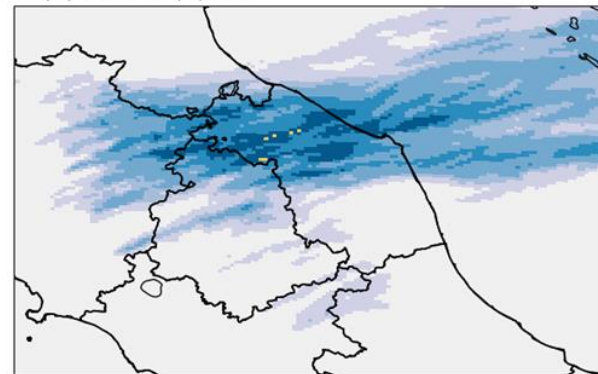
Mean precipitation
2022/09/15 15:00 - 2022/09/15 18:00



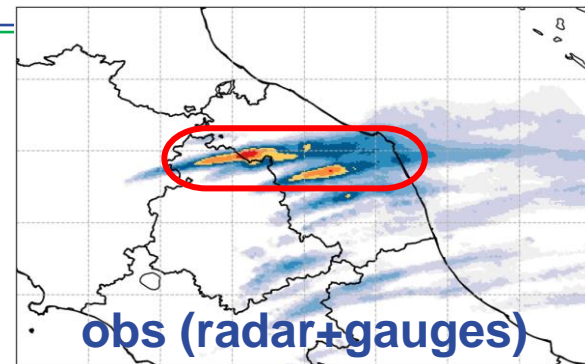
Maximum precipitation
2022/09/15 15:00 - 2022/09/15 18:00



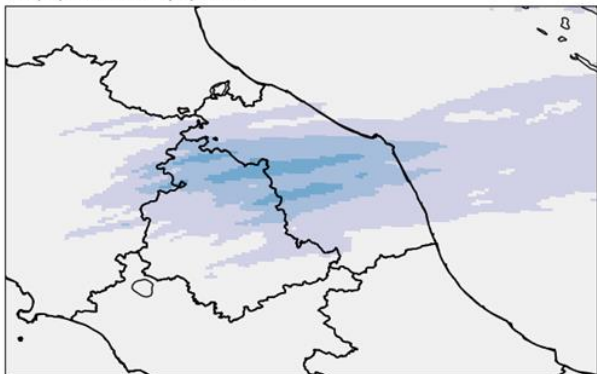
90th percentile precipitation
2022/09/15 15:00 - 2022/09/15 18:00



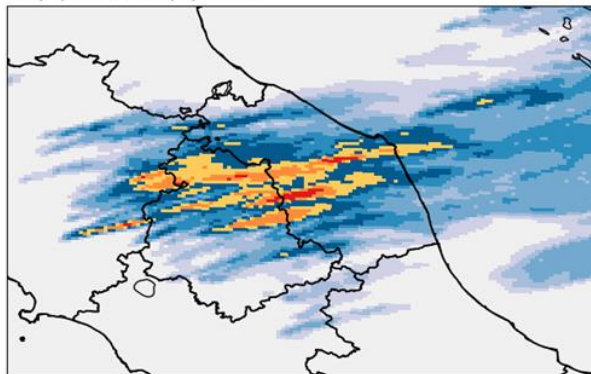
run 14/09/2022, 21 UTC
 VT: 15/09/2022 **18-21** UTC



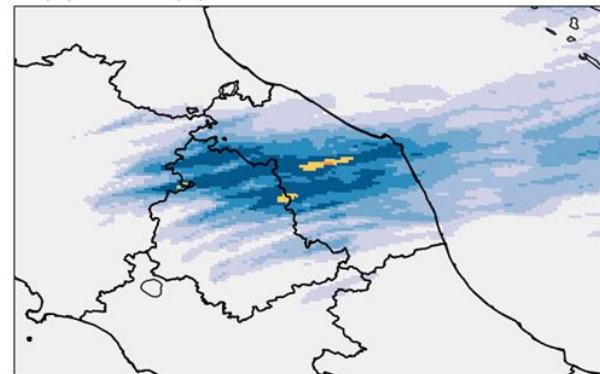
Mean precipitation
 2022/09/15 18:00 - 2022/09/15 21:00

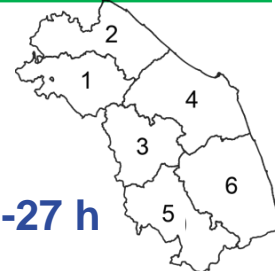
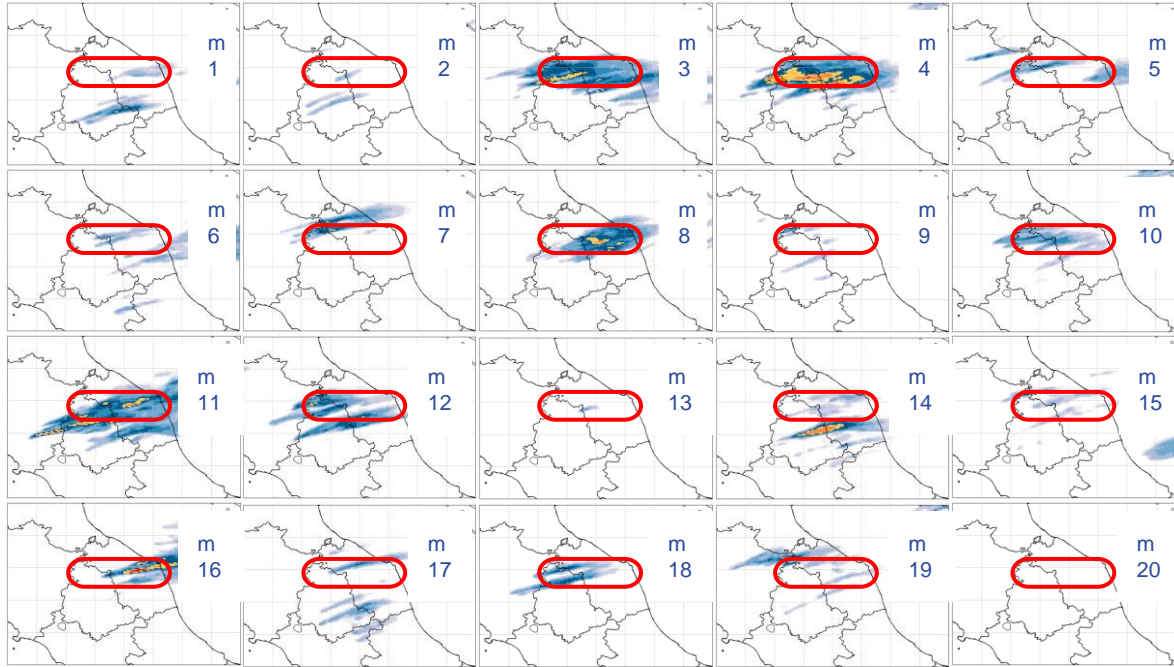


Maximum precipitation
 2022/09/15 18:00 - 2022/09/15 21:00

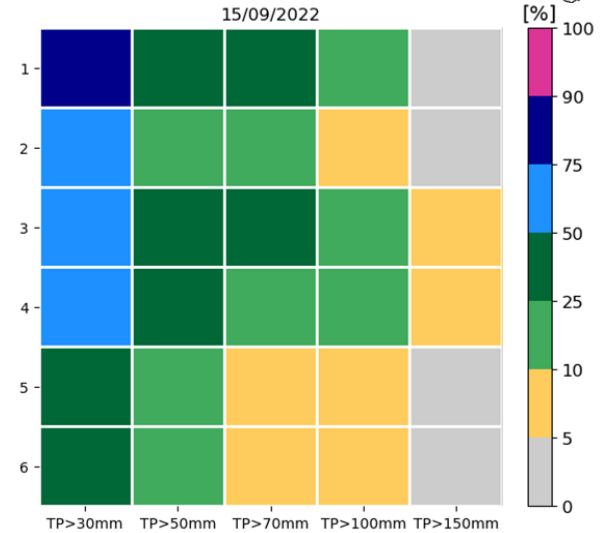


90th percentile precipitation
 2022/09/15 18:00 - 2022/09/15 21:00



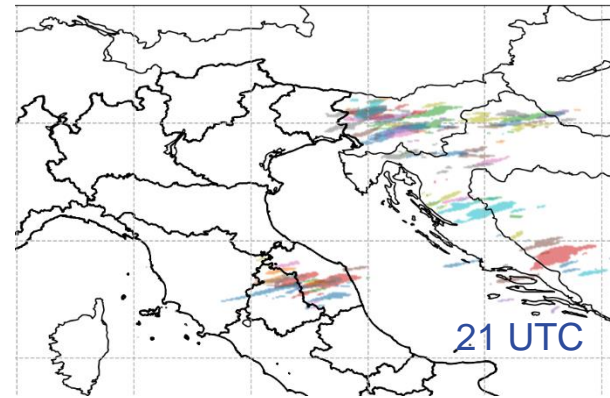
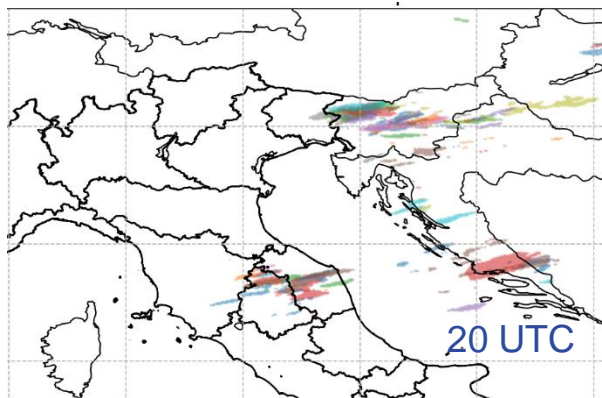
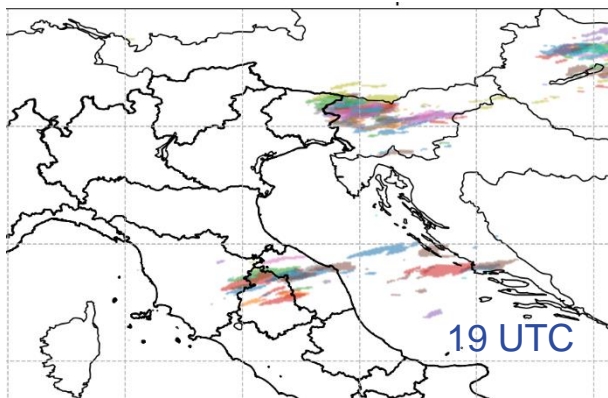
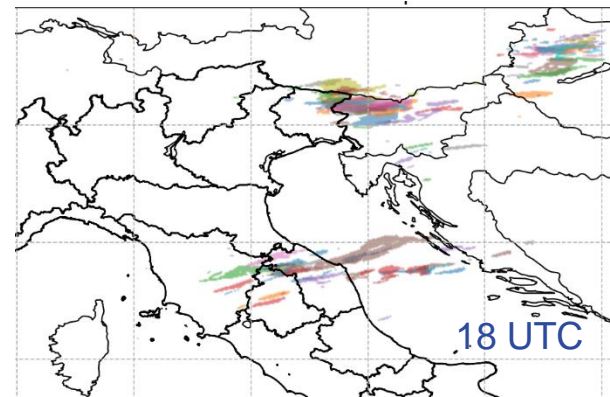
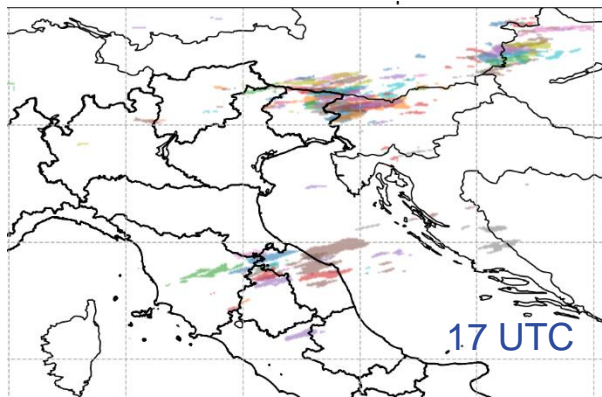
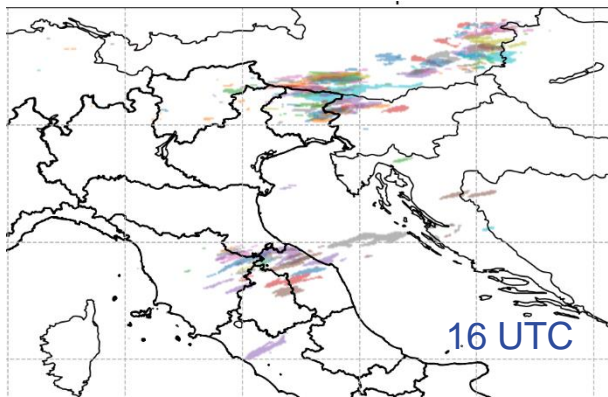


fc range: + 3-27 h



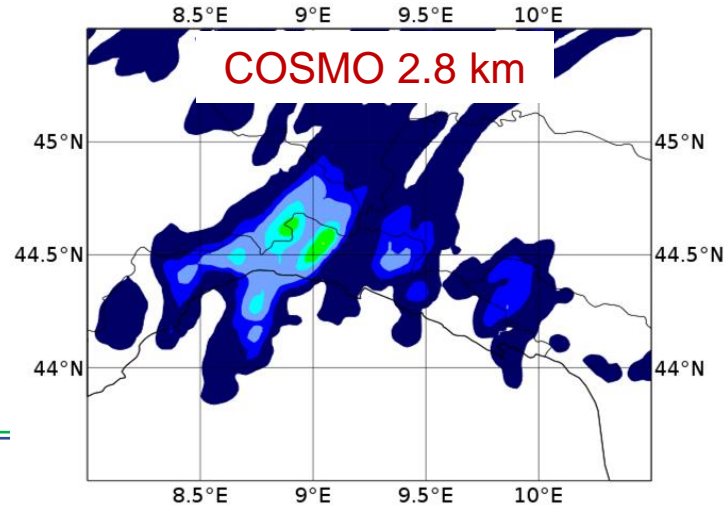
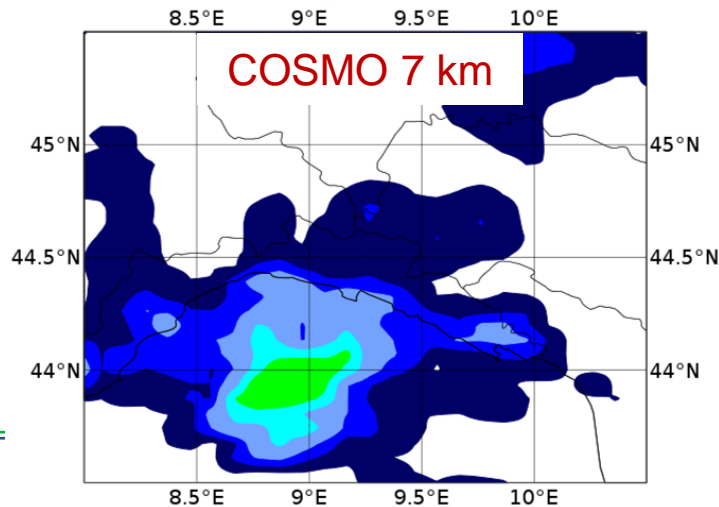
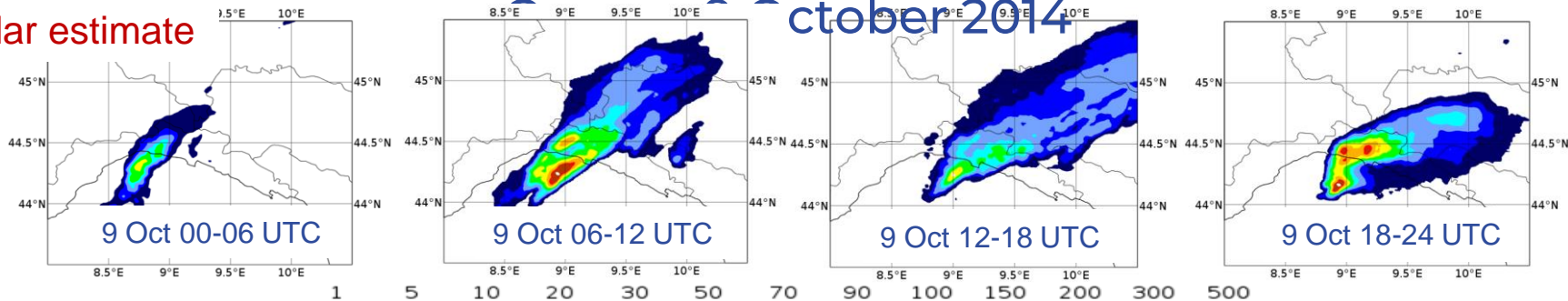
Scenarios: paintball plots

hourly TP > 20 mm



radar estimate

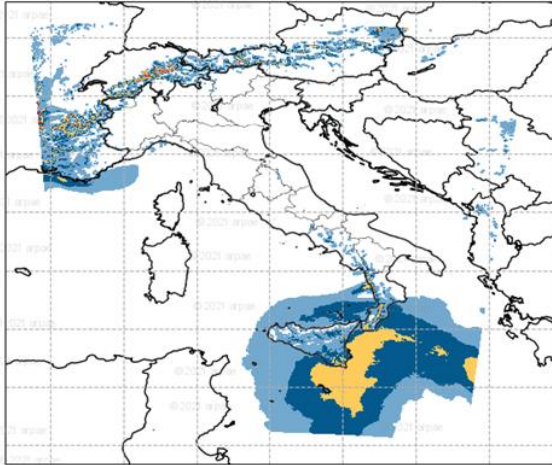
October 2014



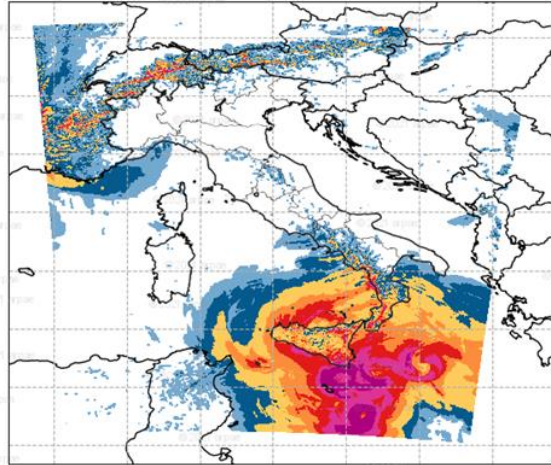
- To increase the confidence in the deterministic forecast
- To indicate an uncertainty in the spatial location of the phenomenon
- To indicate the possible occurrence of severe weather, even if with low probability
- To generate an uncertainty cascade by driving hazard/impact models

COSMO-2I-EPS - 10m gusts

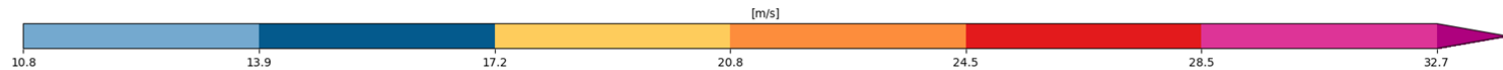
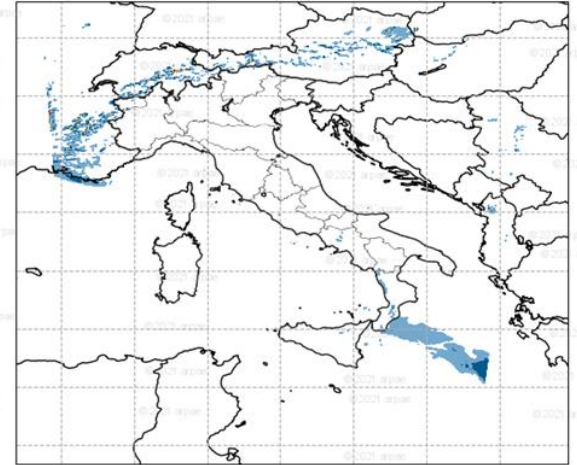
ensemble mean



ensemble maximum



ensemble minimum



The maximum permits to visualise the spatial uncertainty in the prediction of the cyclone

- To increase the confidence in the deterministic forecast
- To indicate an uncertainty in the spatial location of the phenomenon
- To indicate the possible occurrence of severe weather, even if with low probability
- To generate an uncertainty cascade by driving hazard/impact models

Q4

When convection is satisfactorily forecasted by at least one member, how many members typically support this forecast? In other words, is it typically forecasted by only one or a very few members, while many members have no precipitation at all? Or is it forecasted by several members, which maybe show only (small) differences in the localization of the cells and in the timing?

One of very few members

The eastern storms were forecast by
only a few members

Several members

Case 18 June 2012; good fraction of
members although it was an isolated cluster

One of very few members

Case 22 June 2012

One of very few members

Tornado event.

In general, it depends on the region and time

One of very few members

Case 8 July 2012.

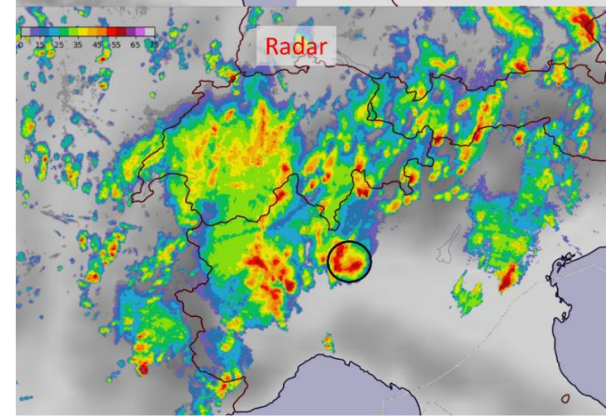
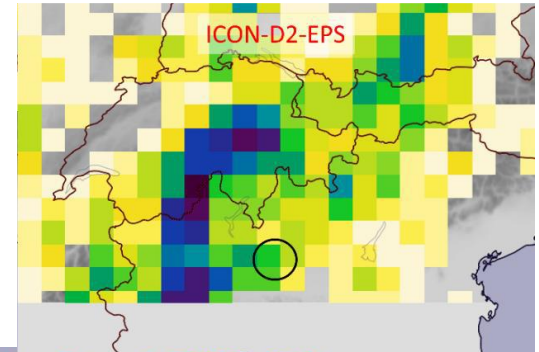
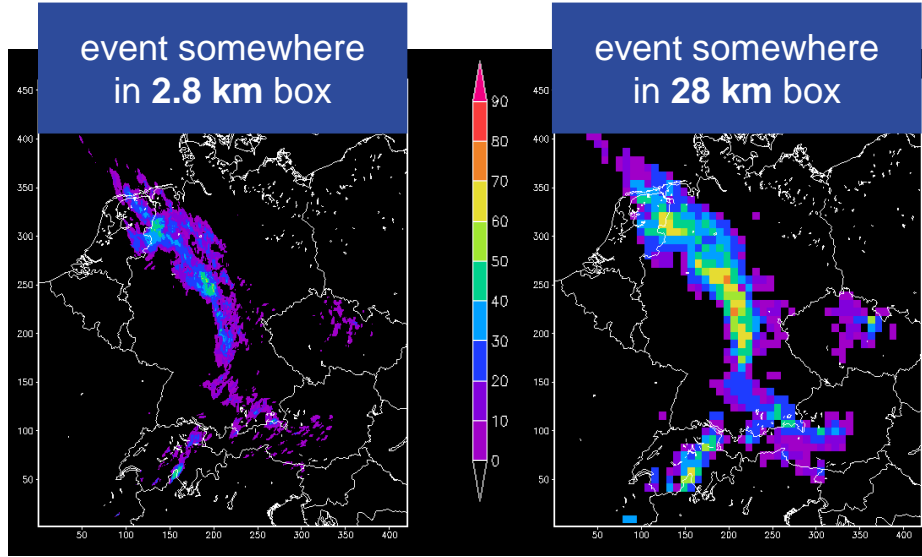
Two storms not forecasted by ICON-D2. ICON-D2-EPS forecasted them with 1-2 members only



ESSL Testbed

ESSL, Pucik and Groenemeijer

Models are able to forecast areas of convective storms, but not the location, structure, and movement of the specific individual thunderstorms within the area of activity

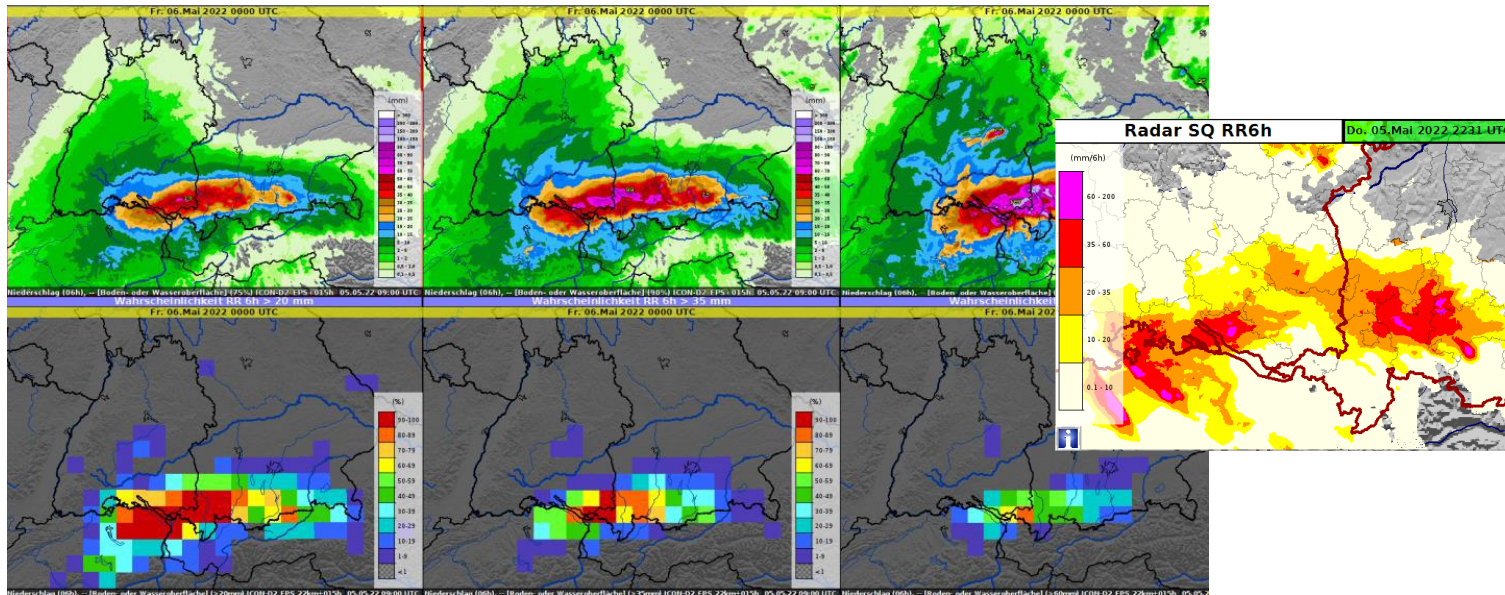


Upscaled probabilities provide a more realistic depiction of the regions of higher interest. Not upscaled probabilities have quite low values and do not highlight some regions.

median

70th percentile

90th percentile



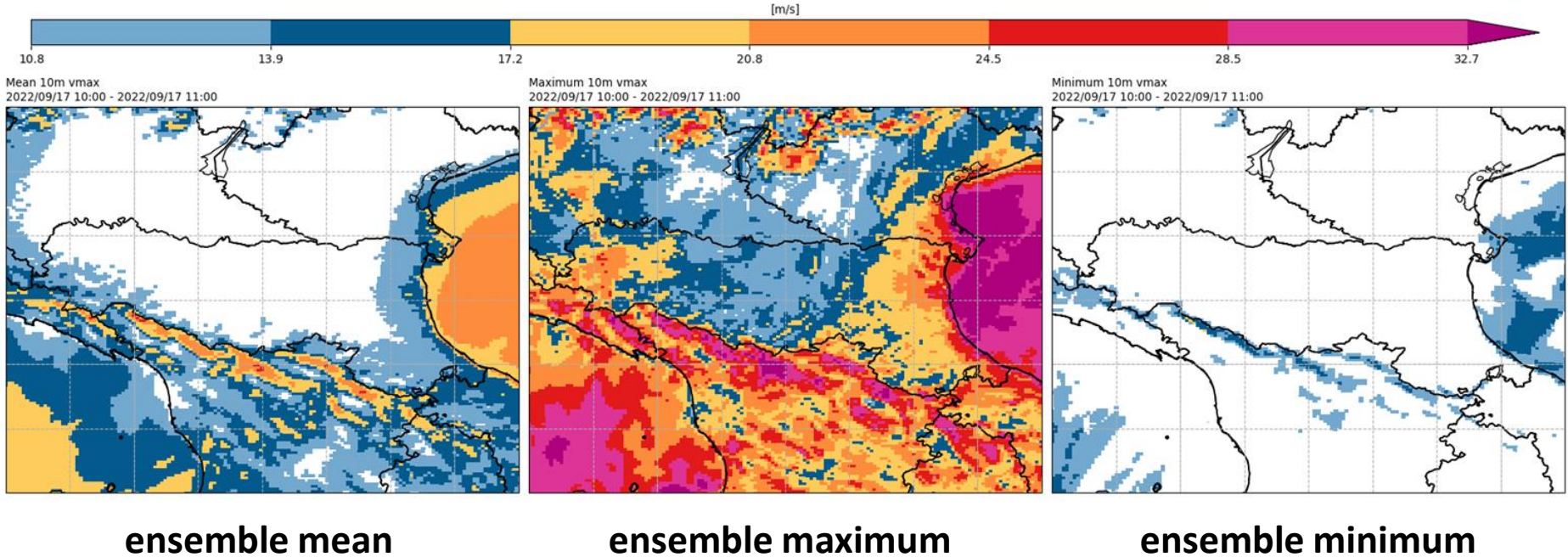
TP 6h > 20 mm

TP 6h > 35 mm

TP 6h > 60 mm

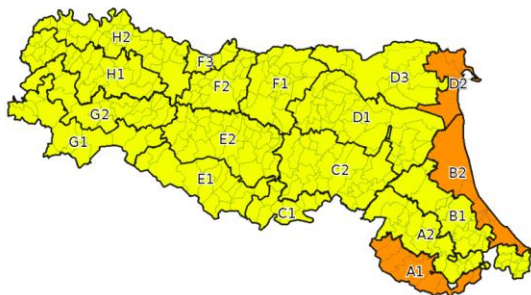
DWD, forecasting office

COSMO-2I-EPS - 10m gusts



DOCUMENTO N.	DATA EMISSIONE	INIZIO VALIDITA'	FINE VALIDITA'
063/2022	16/09/2022 12:13	16/09/2022 12:00	18/09/2022 00:00

dalle ore 00:00 di sabato 17/09/2022



ZONE DI ALLERTA:

- A1: Montagna romagnola (FC, RN)
- A2: Alta collina romagnola (RA, FC, RN)
- B1: Bassa collina e pianura romagnola (RA, FC, RN)
- B2: Costa romagnola (RA, FC, RN)
- C1: Montagna bolognese (BO)
- C2: Collina bolognese (BO, RA)
- D1: Pianura bolognese (BO, FE, RA)
- D2: Costa ferrarese (FE)
- D3: Pianura ferrarese (FE)
- E1: Montagna emiliana centrale (PR, RE, MO)
- E2: Collina emiliana centrale (PR, RE, MO)
- F1: Pianura modenese (RE, MO)
- F2: Pianura reggiana (RE)
- F3: Pianura reggiana di Po (PR, RE)
- G1: Montagna piacentino-parmense (PC, PR)
- G2: Alta collina piacentino-parmense (PC, PR)
- H1: Bassa collina piacentino-parmense (PC, PR)
- H2: Pianura piacentino-parmense (PC, PR)

	CRITICITA' IDRAULICA	CRITICITA' IDROGEOLOGICA	CRITICITA' PER TEMPORALI	VENTO	TEMPERATURE ESTREME	NEVE	PIOGGIA CHE GELA	STATO DEL MARE	CRITICITA' COSTIERA
A1	VERDE	GIALLO	GIALLO	ARANCIONE	VERDE				
A2	VERDE	GIALLO	GIALLO	GIALLO	VERDE				
B1	VERDE	GIALLO	GIALLO	GIALLO	VERDE				
B2	VERDE	GIALLO	GIALLO	ARANCIONE	VERDE			GIALLO	GIALLO
C1	VERDE	GIALLO	GIALLO	GIALLO	VERDE				
C2	VERDE	GIALLO	GIALLO	GIALLO	VERDE				
D1	GIALLO	VERDE	GIALLO	GIALLO	VERDE				
D2	VERDE	VERDE	GIALLO	ARANCIONE	VERDE			GIALLO	GIALLO
D3	VERDE	VERDE	GIALLO	GIALLO	VERDE				
E1	VERDE	GIALLO	GIALLO	GIALLO	VERDE				
E2	VERDE	GIALLO	GIALLO	VERDE	VERDE				
F1	VERDE	VERDE	GIALLO	VERDE	VERDE				
F2	VERDE	VERDE	GIALLO	VERDE	VERDE				
F3	VERDE	VERDE	GIALLO	VERDE	VERDE				
G1	VERDE	VERDE	GIALLO	GIALLO	VERDE				
G2	VERDE	VERDE	GIALLO	VERDE	VERDE				
H1	VERDE	VERDE	GIALLO	VERDE	VERDE				
H2	VERDE	VERDE	GIALLO	VERDE	VERDE				

Strong wind

Bora – 17.09.2022

Home > Ravenna > Cronaca > Nave da crociera in bali...

Nave da crociera in balia del vento

La bora spezza gli ormeggi, evitata la collisione con la scogliera



Home > Cronaca > Ironman Cervia, cancell...

Ironman Cervia, cancellata la gara di sabato per maltempo. Domenica si fa

La 'lunga distanza' non si terrà a causa dell'allerta meteo



RAVENNATODAY



Redazione
 17 settembre 2022 14:01



Burrasca e venti oltre i 100 km orari: strade chiuse, traghetto fermo e mareggiata nel Ravennate

Diverse strade sono chiuse per la caduta di alberi, mentre a Lido di Savio si è registrato un evento di ingressione marina



FORLITODAY



Redazione
 17 settembre 2022 10:59



CRONACA

Bora tempestosa e pioggia battente: alberi caduti, cancellato il Memorial Pantani

L'ondata di maltempo, con tanto di allerta meteo gialla e arancione da parte della protezione civile, è arrivata puntuale dalle prime ore di sabato ha colpito tutta la Romagna

L'ondata di maltempo, con tanto di allerta meteo gialla e arancione da parte della protezione civile, è arrivata puntuale dalle prime ore di sabato ha colpito tutta la Romagna



CESENATODAY



Redazione
 17 settembre 2022 10:59



CRONACA

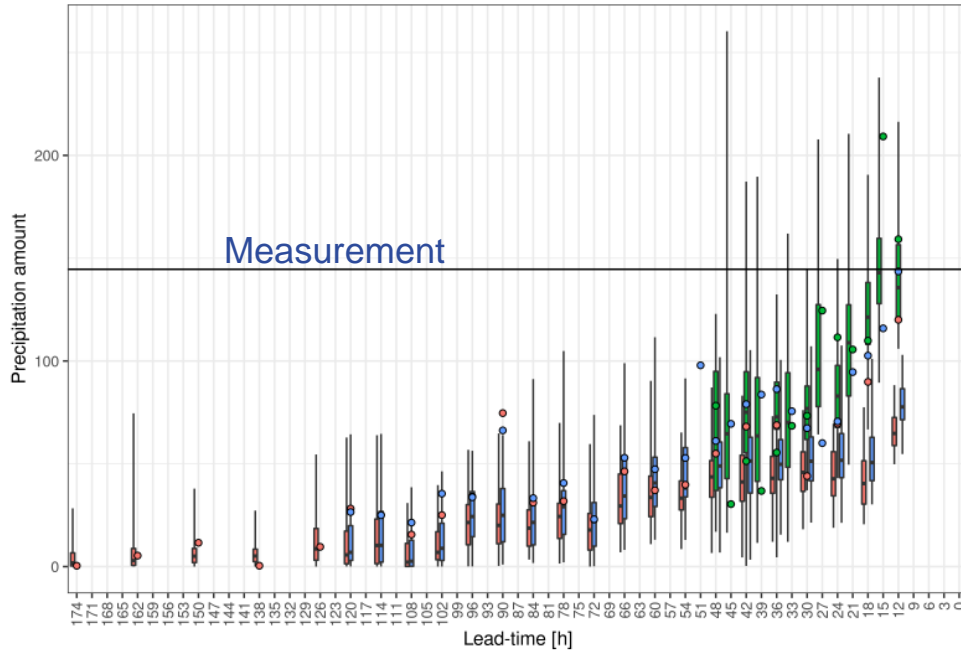
Il maltempo picchia forte su tutta la Romagna: alberi caduti, allagamenti e danni

L'ondata di maltempo, con tanto di allerta meteo gialla e arancione da parte della protezione civile, è arrivata puntuale dalle prime ore di sabato ha colpito tutta la Romagna



- To increase the confidence in the deterministic forecast
- To indicate an uncertainty in the spatial location of the phenomenon
- To indicate the possible occurrence of severe weather, even if with low probability
- To generate an uncertainty cascade by driving hazard/impact models

Predictability Diagram for 2021-07-14 18 UTC
 Station: NRW Max.
 Variable: RR_12h (144.6)



ICON-EPS global 40 km

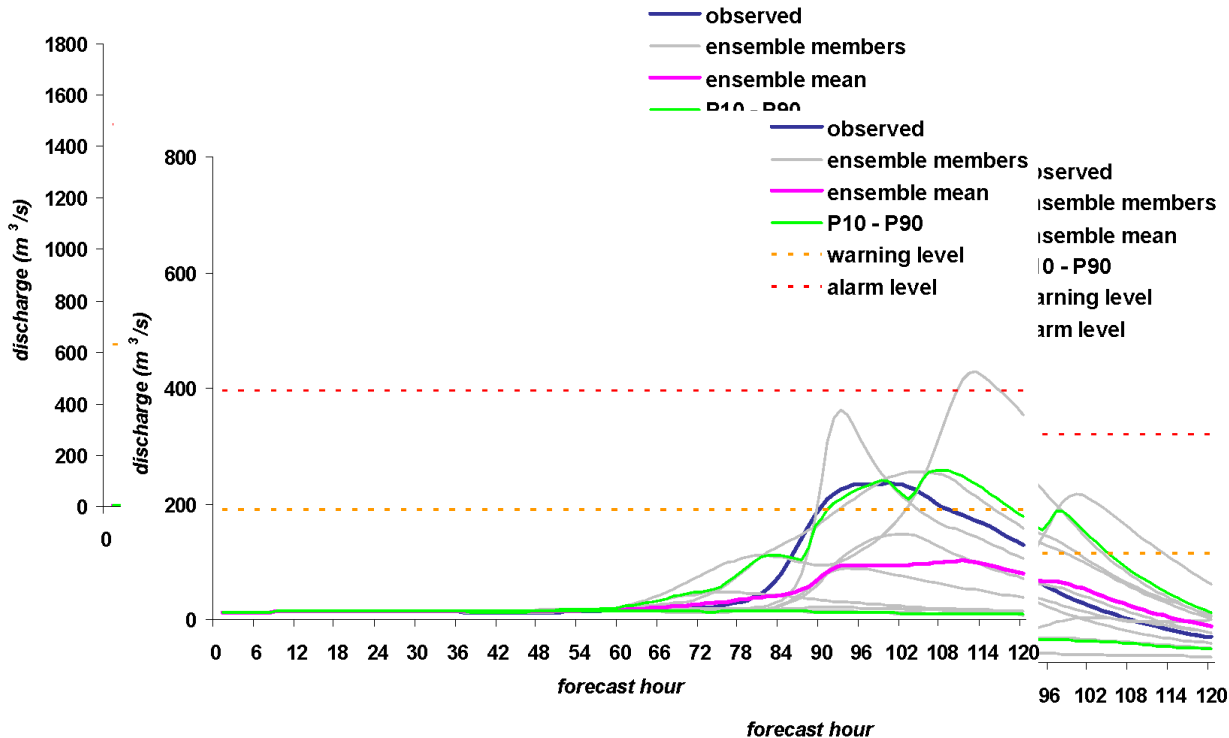
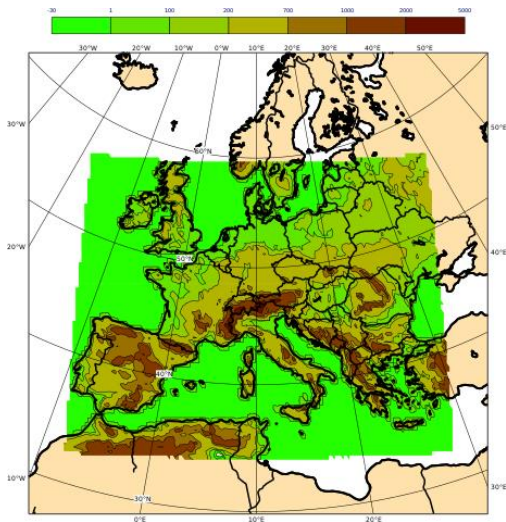
ICON-D2-EPS 2 km

ICON-EU-EPS 20 km

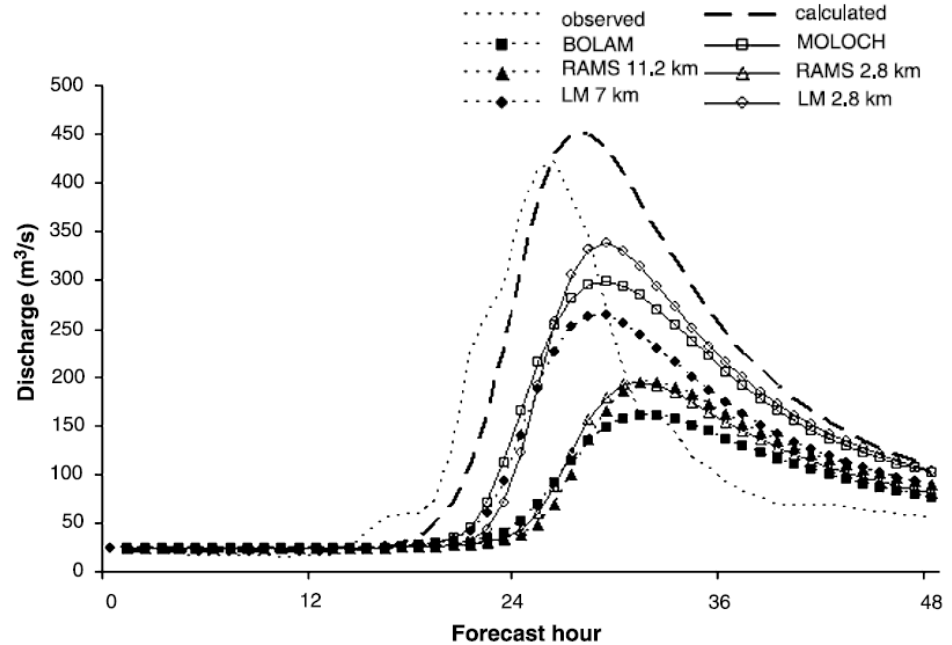
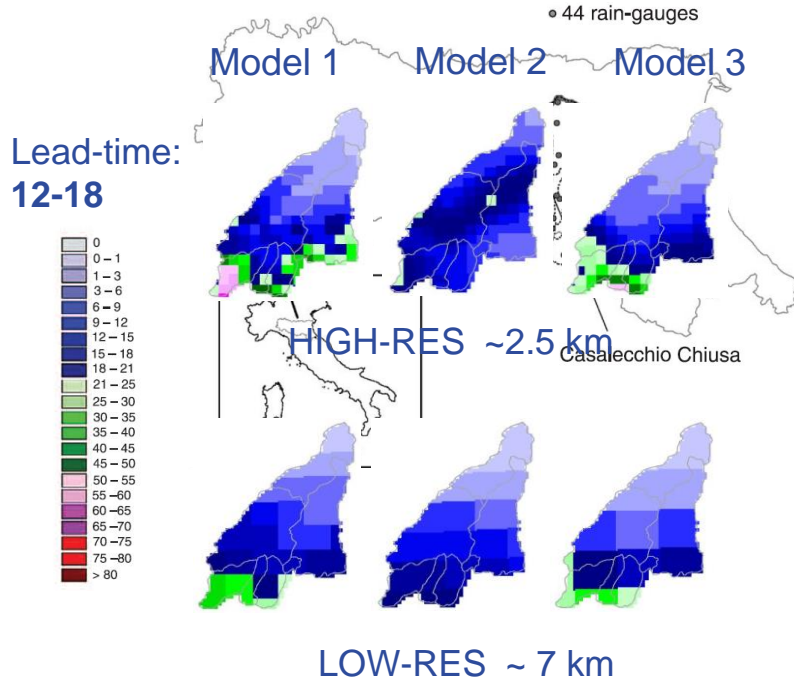
Model
 ICON
 ICON-D2
 ICON-EU

Felix Fundel, DWD

COSMO-LEPS



Tommaso Diomede, Arpae

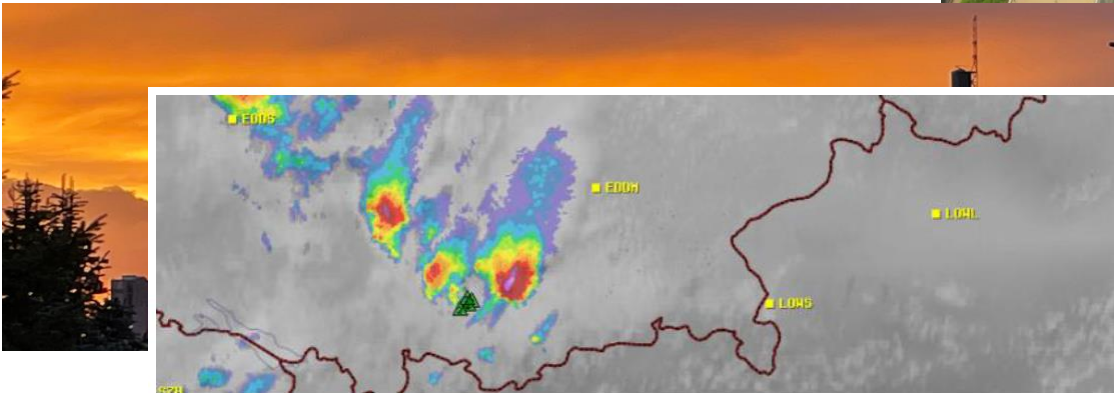
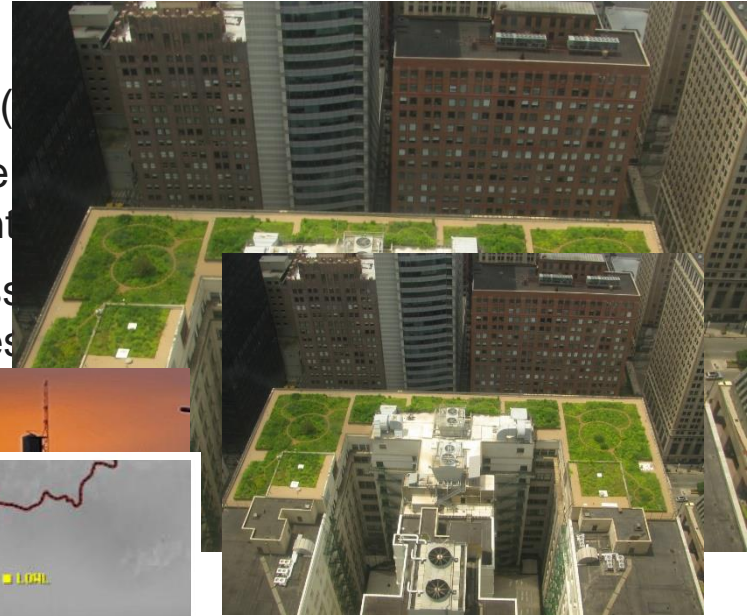


Diomede, Davolio, Marsigli et al., 2008: „Discharge predictions based on multi-model precipitation forecasts“

- To increase the confidence in the deterministic forecast
- To indicate an uncertainty in the spatial location of the phenomenon
- To indicate the possible occurrence of severe weather even if with low probability
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- **Concluding remarks**

The rooftop concept

- epistemic (or knowledge-based) vs aleatoric (or knowledge-free)
- *epistemic uncertainty*: aspects relevant to the process that are not sufficiently well known to be represented by a model
- *intrinsic uncertainty*: inherent to some processes and has an aleatoric character. This is the case for processes that are highly localized

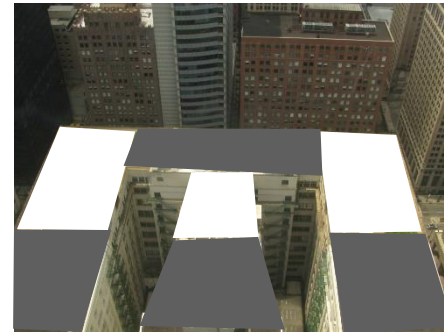
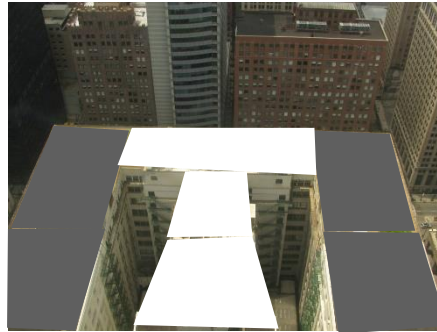
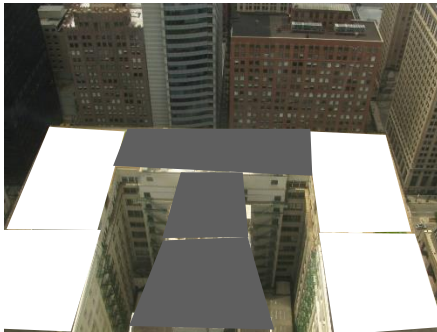


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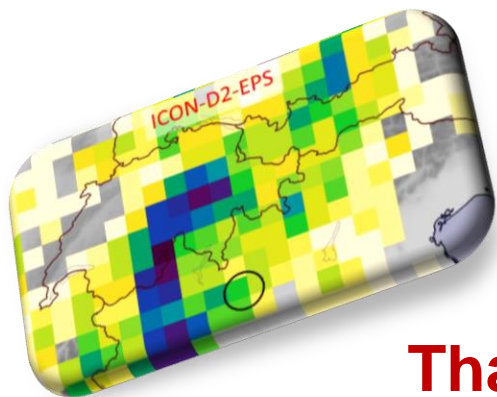
The rooftop concept

Going to higher resolution:

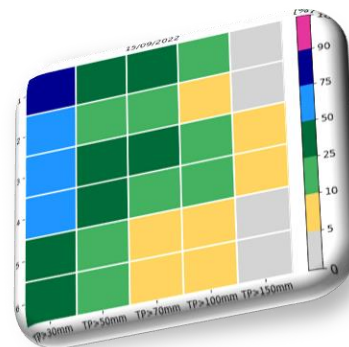
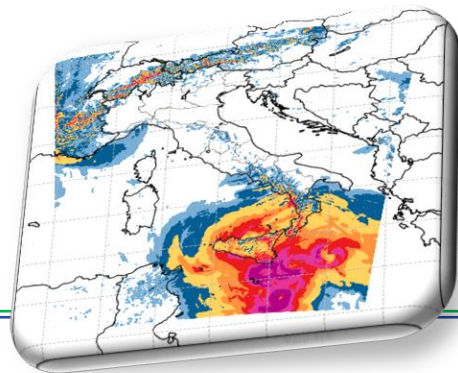
- some parametrized processes are resolved -> some uncertainties become known
- new processes are parametrised -> new uncertainties show up
- **ensembles are needed!**



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Thank you for your attention!

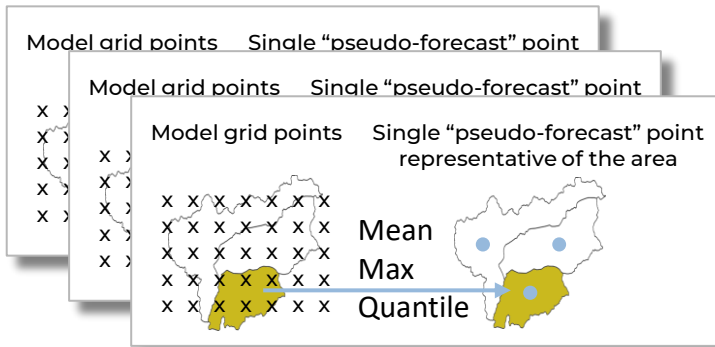
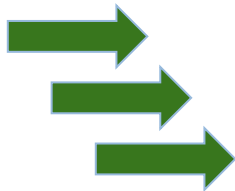
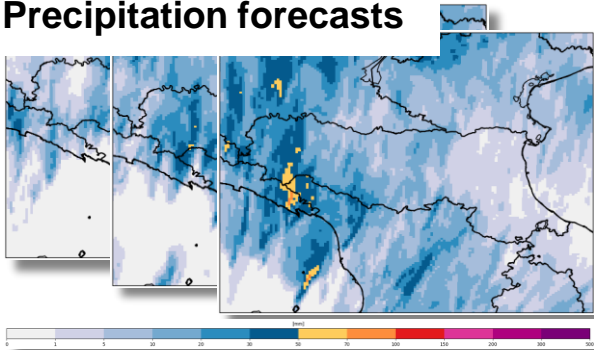


- Most reliable scenario (ensemble mean)
- Possible alternative scenarios (clusters)
- Worst case (extremes)
- Pseudo-deterministic scenarios, from the ensemble members distribution (median, percentiles)
- Probability of occurrence of selected events (probability maps)
- Estimate of the forecast uncertainty (spread, diversity)
- "Best" scenario (is it possible to select the best member on the basis of updated base observations?)

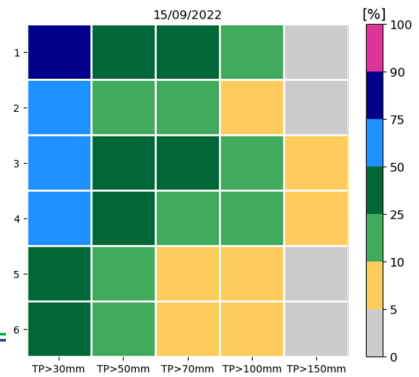
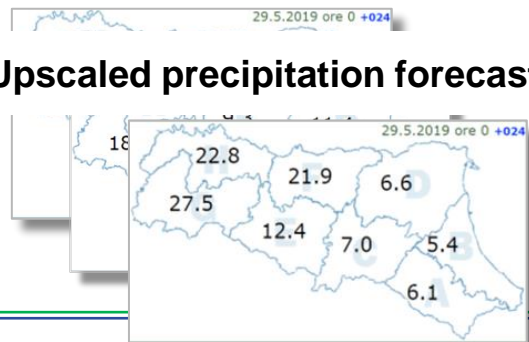
PROBABILITY that the areal average/maximum TP exceeds a threshold:

probability maps of the areal mean/maximum precipitation

Precipitation forecasts

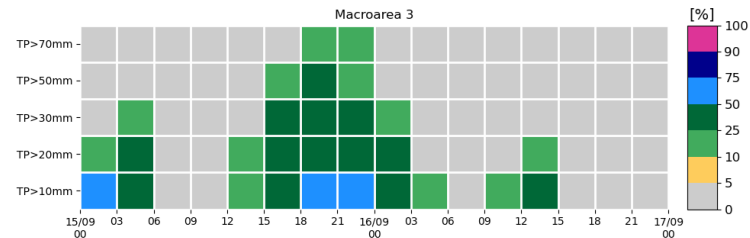
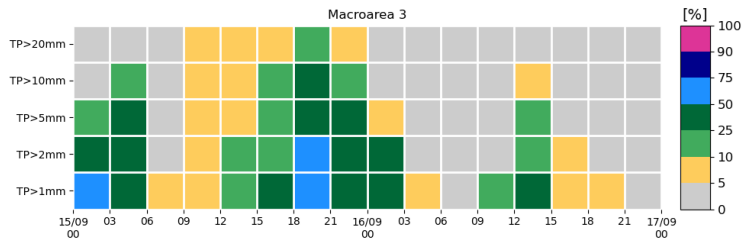
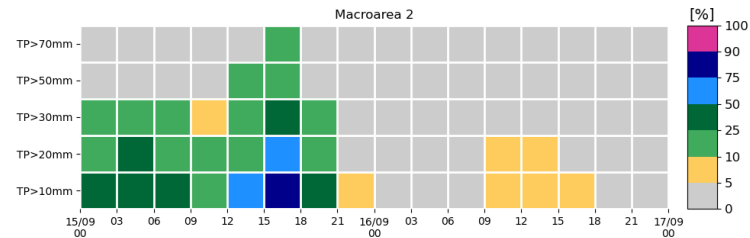
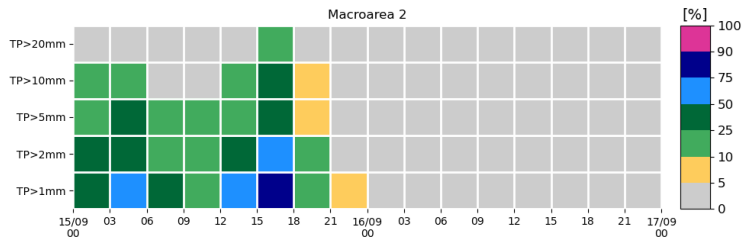
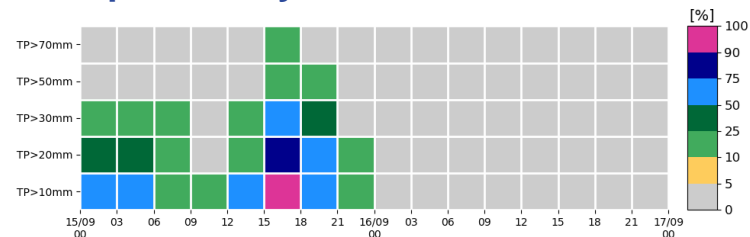
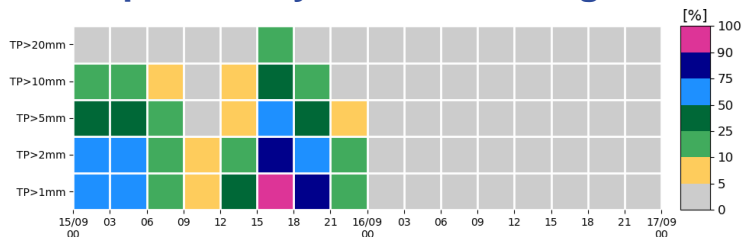


Upscaled precipitation forecasts



probability for areal average

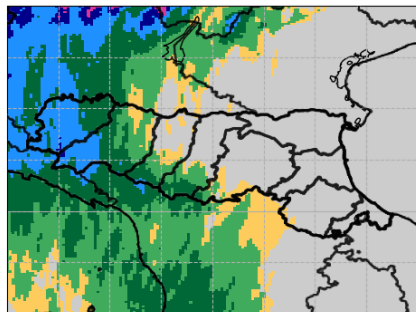
probability for areal maximum



Maximum PROBABILITY wherever in an area that TP exceeds a threshold:

maximum of the probability over the alert areas

Probability of TP>10 mm



Model grid points



Single "pseudo-forecast" point
representative of the area

Mean
Max
Quantile

