

# Visualisation products using COSMO-LEPS: recent upgrades at Arpae-SIMC

**Andrea Montani**

D. Branchini, C. Marsigli, T. Paccagnella, A. Selvini, F. Siviero

*Arpae Emilia-Romagna Servizio IdroMeteoClima, Bologna, Italy*

UEF2018, ECMWF, 5-8 June 2018

# Outline

- Operational ensemble system COSMO-LEPS:
  - main features (what is old, what is new),
  - performance of the system,
  - future upgrades (towards 5 km, towards multi-physics).
- Development of COSMO-LEPS based visualization products:
  - products on COSMO website,
  - probabilistic wind roses,
  - “chessboard” maps for Emilia-Romagna region,
  - implementation of Italian “chessboard” for National Civil Protection.
- Conclusions and plans.

# About COSMO-LEPS

- **What is it?**

It is the Limited-area Ensemble Prediction System (LEPS), based on COSMO-model and implemented within COSMO (CONsortium for Small-scale Modelling, including Germany, Greece, Israel, Italy, Poland, Romania, Russia, Switzerland) implemented and maintained by Arpae-SIMC.

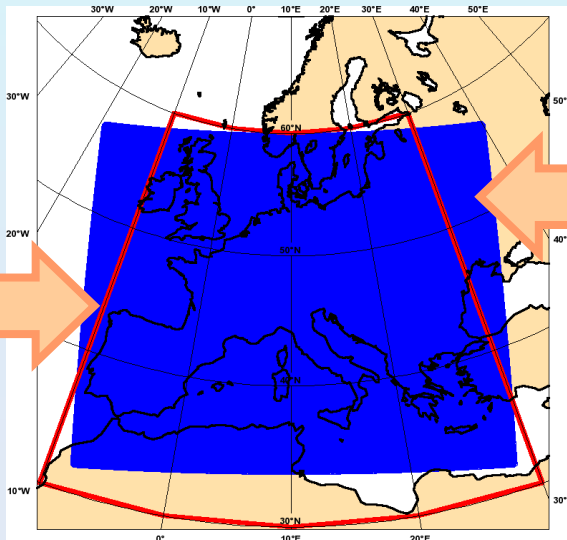
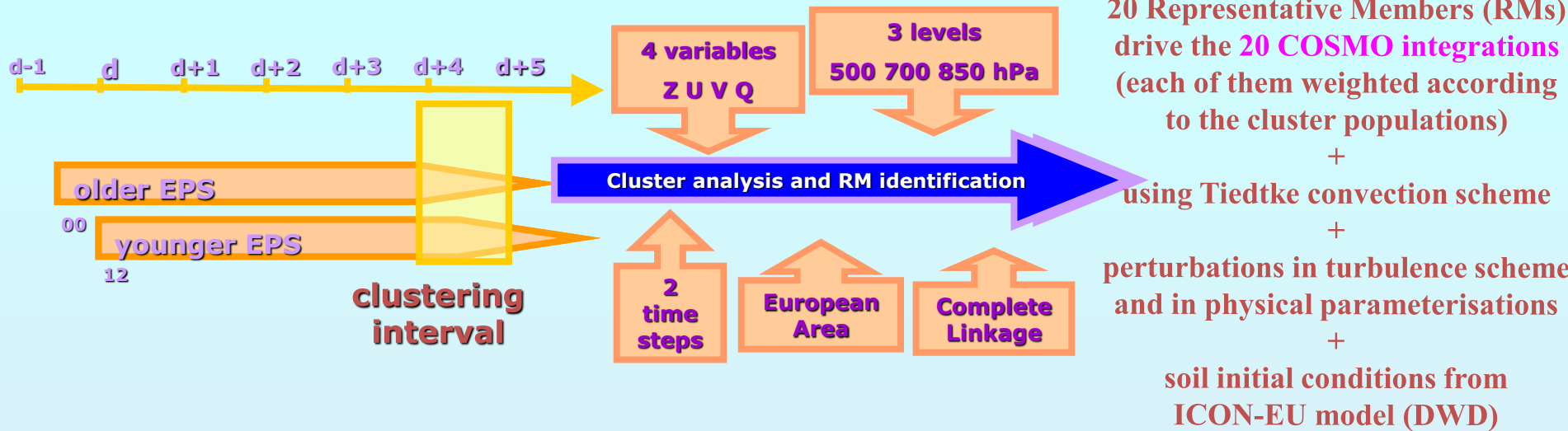
## **Why?**

COSMO-LEPS was developed to combine the advantages of global-model ensembles with the high-resolution details gained by the LAMs, so as to identify the possible occurrence of high-impact and localised weather events (heavy rainfall, strong winds, temperature anomalies, snowfall, ...).

**generation of COSMO-LEPS to improve the forecast of high-impact weather in the short and early-medium range (up to d+5).**

# COSMO-LEPS suite @ ECMWF: configuration “oper”

(operationally implemented on 5 November 2002 - the first in Europe)



**COSMO-LEPS**  
clustering  
area

**COSMO-LEPS**  
integration  
domain

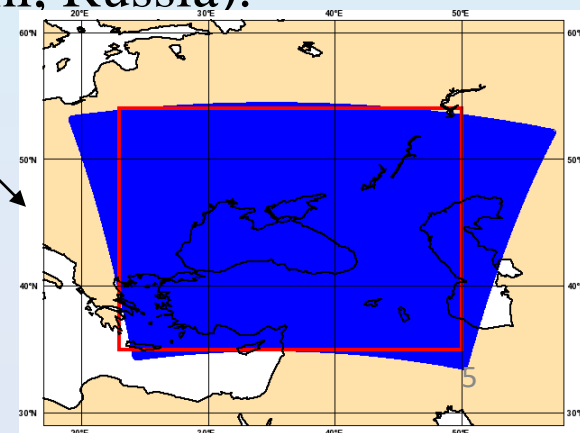
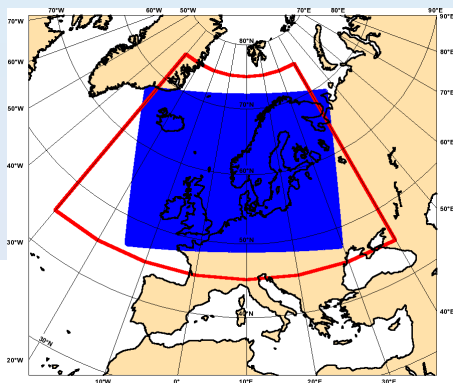
- The suite runs as a “time-critical application” managed by Arpaie-SIMC;
- The computer time (57 million BUs for 2018) provided by the COSMO partners which are ECMWF member states;
- $\Delta x \sim 7$  km; 40 ML; 2 runs per day (00 and 12UTC); fcst range: 132h;
- single precision since 1/12/2016 (20 runs in SP are cheaper than 16 runs in DP).

# Operational set-up

- 20 *perturbed* COSMO-model runs (ICs and 3-hourly BCs from 20 selected ENS members) to generate, “via weights”, probabilistic output; start at 00 and 12UTC;  $\Delta t = 132h$ .
- 1 *deterministic* run (ICs and 3-hourly BCs from ECMWF HRES) to “join” deterministic and probabilistic approaches; start at 00 and 12 UTC;  $\Delta t = 132h$ .

## Relocation

COSMO-LEPS was “cloned” e relocated over different regions in the framework of European Projects (FP6 Preview – WP Windstorms) and WMO Projects (FROST-2014 for the Winter Olympics in Sochi, Russia).



# Dissemination

COSMO-LEPS products are operationally disseminated towards:

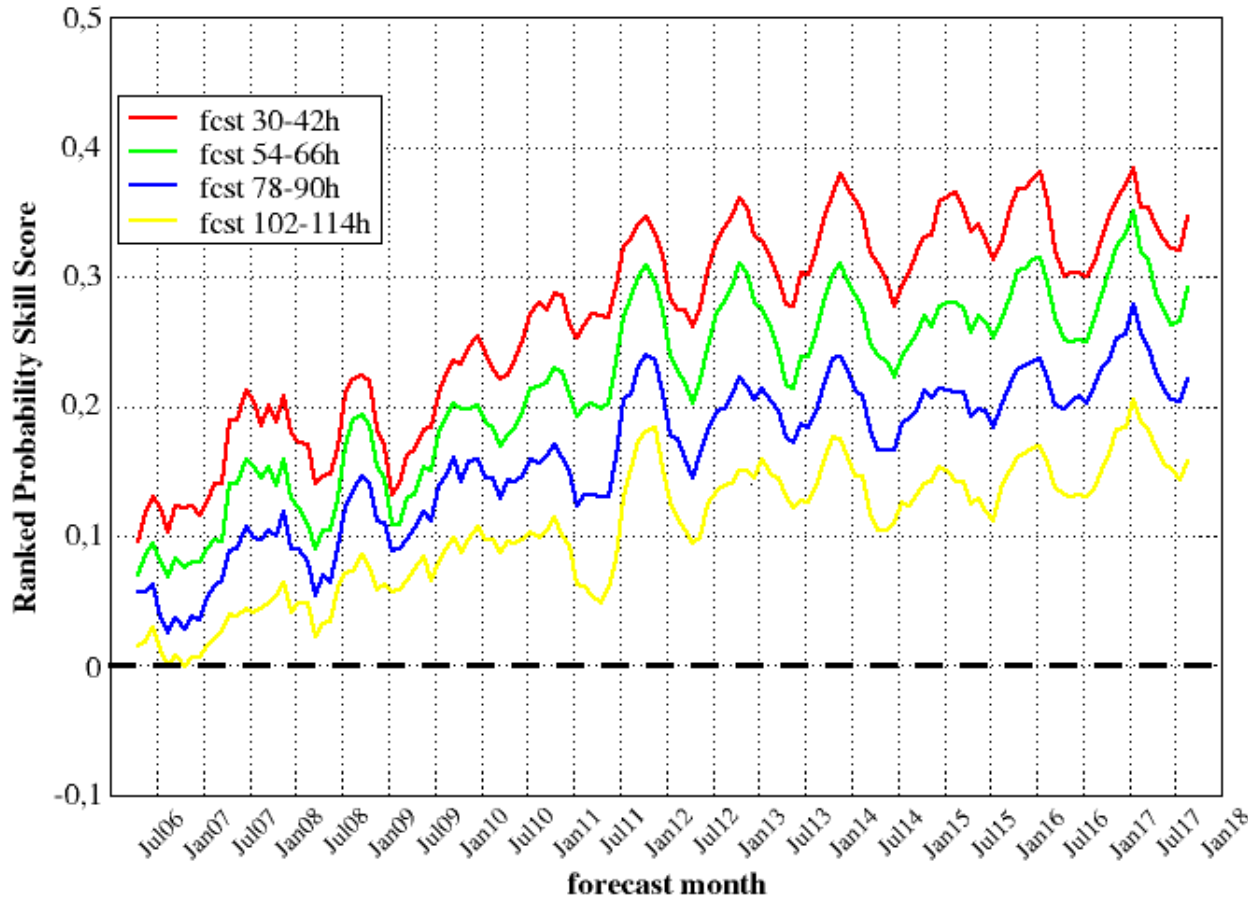
- COSMO countries,
- non-COSMO hydro-meteorological weather services,
- ECMWF (TIGGE-LAM, EFAS),
- private sector,
- .....

# Trends in precipitation forecast scores: RPSS

Monthly verification performed over the full integration domain (~1400 synop; NGP)

- Variable: 12h cumulated precipitation (thresholds: 1, 5, 10, 15, 25, 50 mm).
- Score: Ranked Probability Skill Score (RPSS), updated to November 2017.
- 6-month running mean.
- a good forecast system has  $RPSS > 0$ ; the higher, the better.

RPSS; 6M running mean; 12h cumulated precipitation; FULLDOM

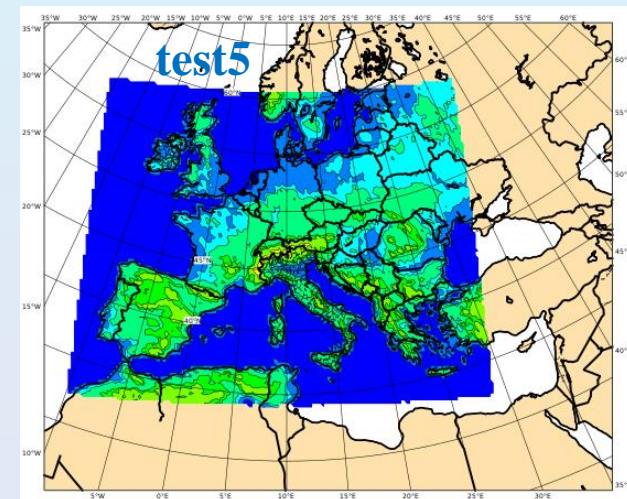
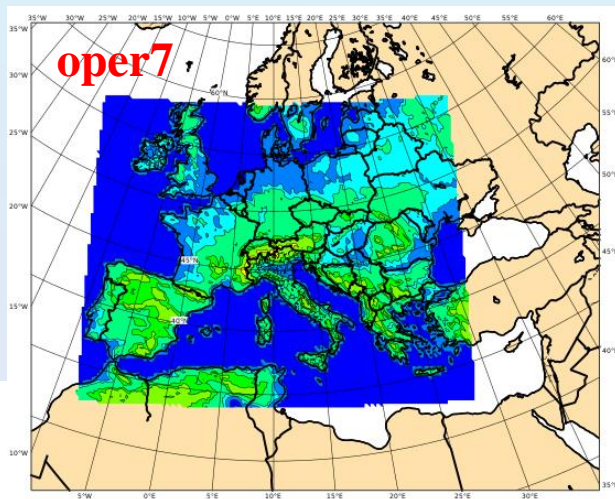


Positive trend for all forecast ranges, especially the longer ones ( — and — ).

# Planned upgrades

- In agreement with the Consortium strategies, we are assessing the sensitivity of COSMO-LEPS forecast skill to the use of different parameterisations of moist convection and to enhanced horizontal resolution.
- From 24/11 to 31/12/2017 and from 1/5 to 31/5/2018, in addition to **oper7** (COSMO-LEPS @ 7 km), we also ran a test configuration (only at 00UTC), denoted with **test5**.

	<b>oper7</b>	<b>test5</b>
convection scheme	Tiedtke	members 1-10 IFS-Bechtold members 11-20 Tiedtke
horizontal resolution	7 km	5 km
grid points	511 x 415 x 40	739 x 599 x 40
time step (s)	66	45



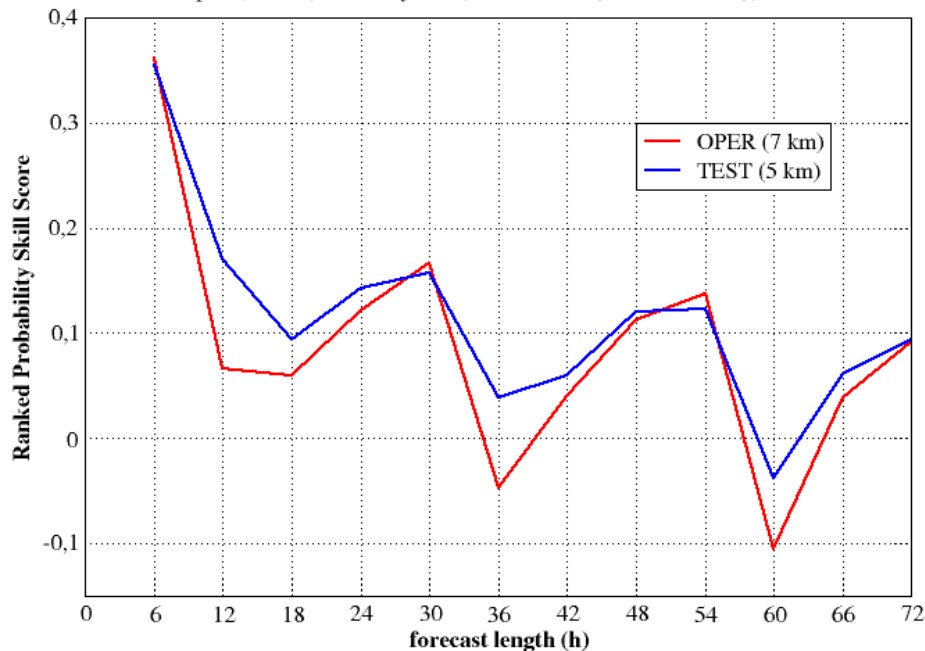


# May 2018 experimentation: **oper7** vs **test5**

- Variables: 6h cumulated precipitation (thresholds: 1, 5, 10, 15, 25, 50 mm) and 2-metre temperature.
- Scores: Ranked Probability Skill Score (RPSS), rmse, bias.

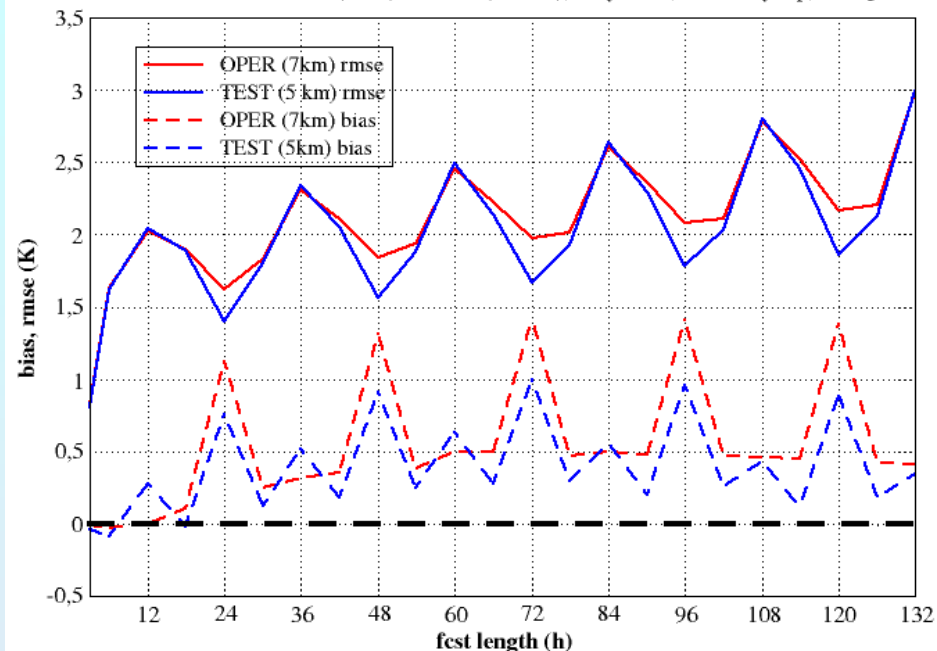
## tp06h

tp06h; RPSS; 1-30 May 2018; FULLDOM (~ 1610 stations); NGP



## t2m

T2M EnsembleMean rmse (solid) and bias (dashed); May 2018; ~ 1600 synop; corrQ=true



- Precipitation: clear daily cycle in the performance of the model; higher skill of **test5**, especially for day-time precipitation.
- Temperature: still positive bias at all forecast ranges (the model is too warm), but bias reduction at night-time in **test5**. Correspondingly, reduction of rmse.

# Outline

- Operational ensemble system COSMO-LEPS:
  - main features (what is old, what is new),
  - performance of the system,
  - future upgrades (towards 5 km, towards multi-physics).
- **Development of COSMO-LEPS based visualization products:**
  - products on COSMO website,
  - probabilistic wind roses,
  - “chessboard” maps for Emilia-Romagna region,
  - implementation of Italian “chessboard” for National Civil Protection.
- Conclusions and plans

# COSMO-LEPS on the public web:

Disseminate a set of static maps (jpg/png files) including:

- meteograms over a list of locations,
- probability maps for total precipitation, snowfall, temperature.

Meteograms were operationally implemented on 15 October 2017:

<http://www.cosmo-model.org/content/tasks/leps/boxgrams/default.htm>

The screenshot shows the website interface for COSMO-LEPS. The main header includes the COSMO logo and navigation tabs: Work Groups, Priority Projects, Priority Tasks, Model Management, Operational, and Home. The sidebar on the left contains a map and a menu with items: Organization, Model System, Documentation, COSMO Tasks, User Support, COSMO Places, COSMO LEPS Meteograms, Observations, Search, and Home. The main content area is titled 'LEPS Ensemble-Meteograms' and includes a sub-header 'Available Ensemble meteograms ENSEMBLE METEGRAMS (?) based on COSMO-LEPS for COSMO countries major cities. Each date shown is the analysis date. The forecast is up to 132 hours from the analysis.'

ATHENS	BERLIN	BERN	BOLOGNA	BUCHAREST	FRANKFURT	MOSCOW	ROMA	SALONIKA	TORINO
29/1/2018:00h	29/1/2018:00h	29/1/2018:00h	29/1/2018:00h	29/1/2018:00h	29/1/2018:00h	29/1/2018:00h	29/1/2018:00h	29/1/2018:00h	29/1/2018:00h
28/1/2018:12h	28/1/2018:12h	28/1/2018:12h	28/1/2018:12h	28/1/2018:12h	28/1/2018:12h	28/1/2018:12h	28/1/2018:12h	28/1/2018:12h	28/1/2018:12h
28/1/2018:00h	28/1/2018:00h	28/1/2018:00h	28/1/2018:00h	28/1/2018:00h	28/1/2018:00h	28/1/2018:00h	28/1/2018:00h	28/1/2018:00h	28/1/2018:00h

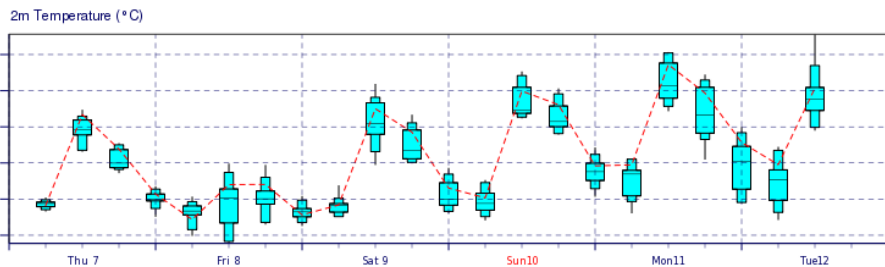
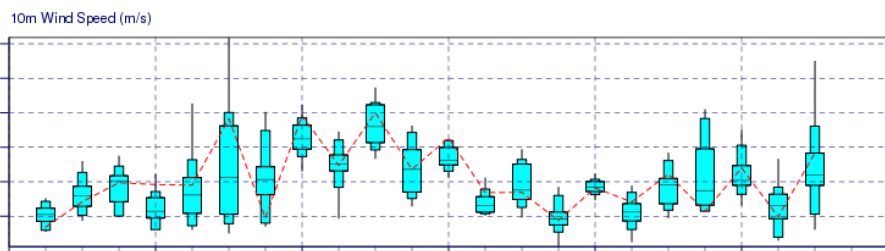
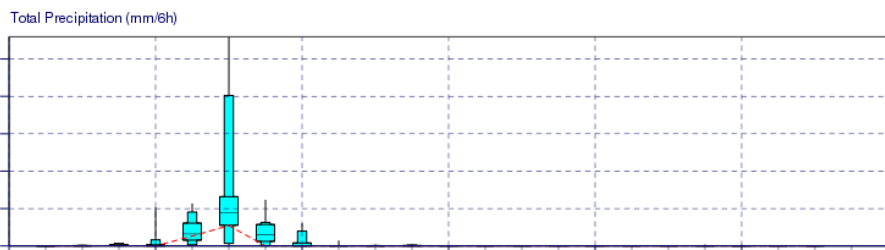
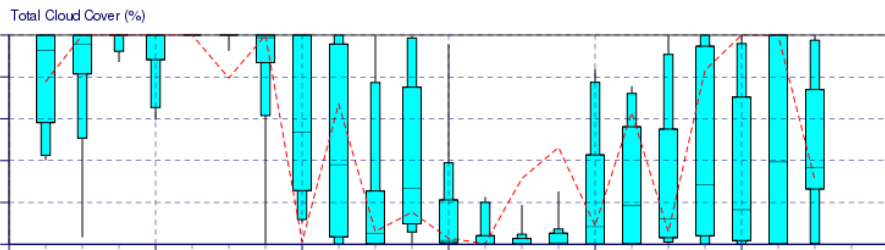
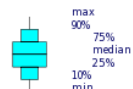
WARSAW	ZURICH
29/1/2018:00h	29/1/2018:00h
28/1/2018:12h	28/1/2018:12h
28/1/2018:00h	28/1/2018:00h

# COSMO-LEPS and the web: meteograms over Bologna and Frankfurt

COSMO-LEPS Meteogram

Bologna 44.53°N 11.3°E (ENS land point)

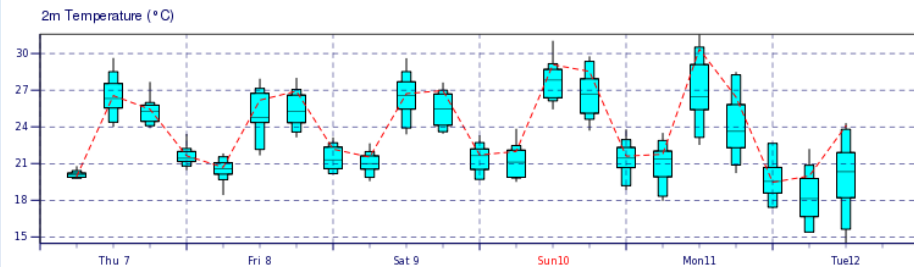
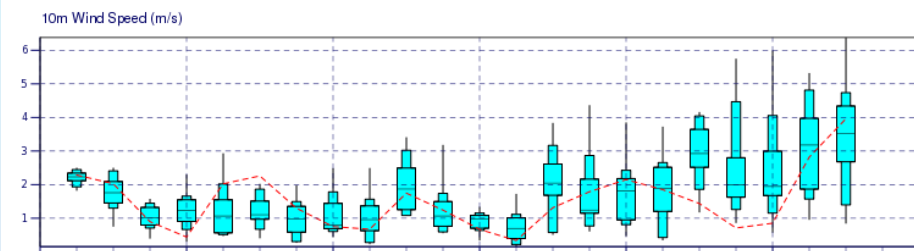
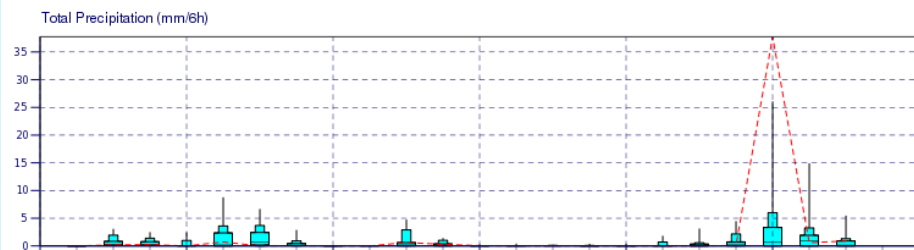
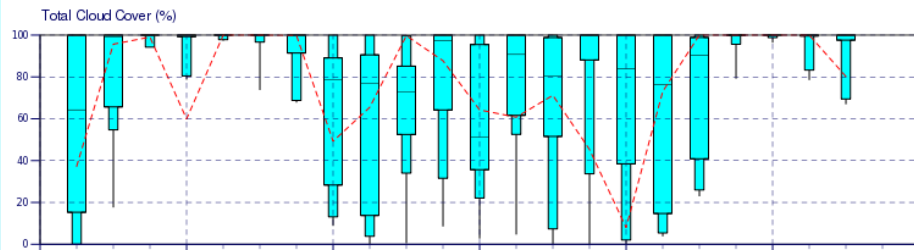
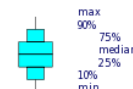
Deterministic run (red) and COSMO-LEPS Distribution - Thursday 7 June 2018 00 UTC



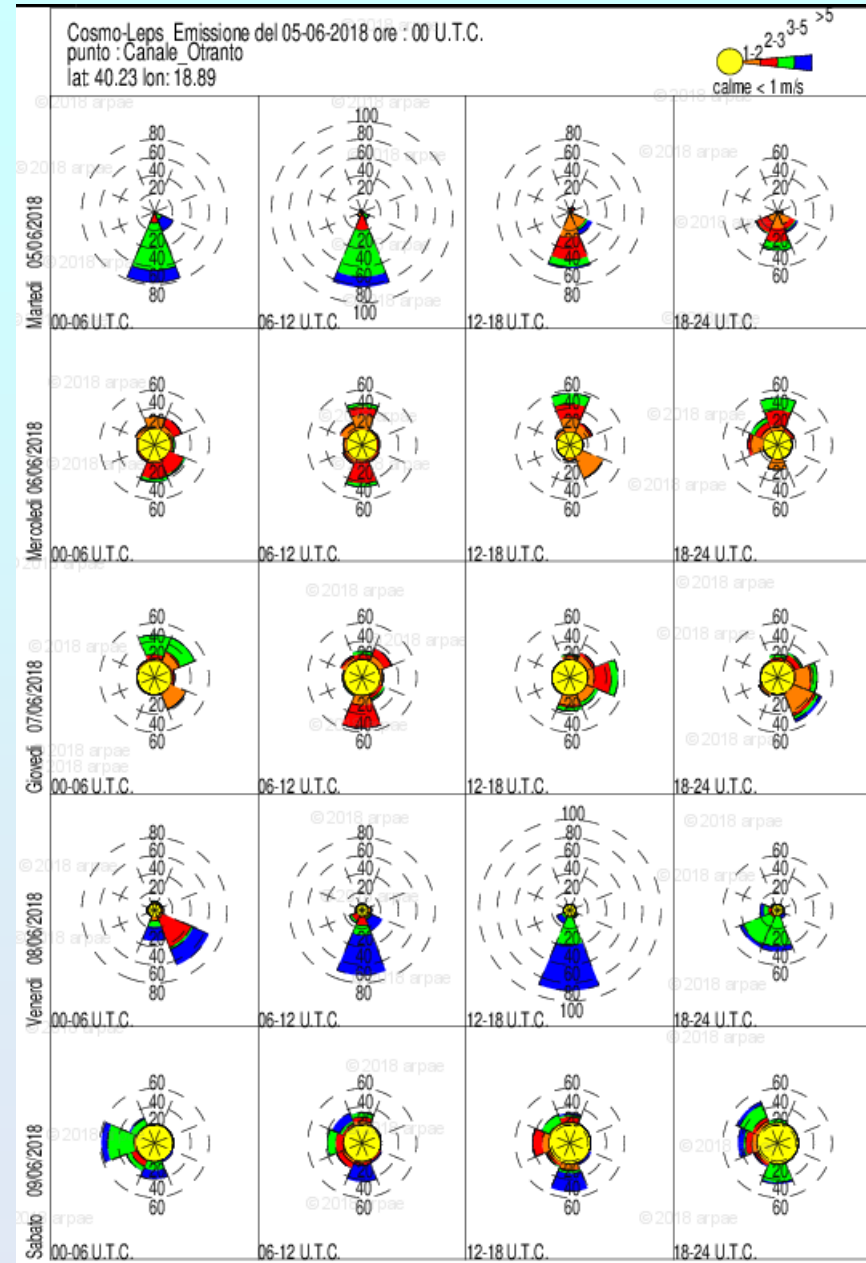
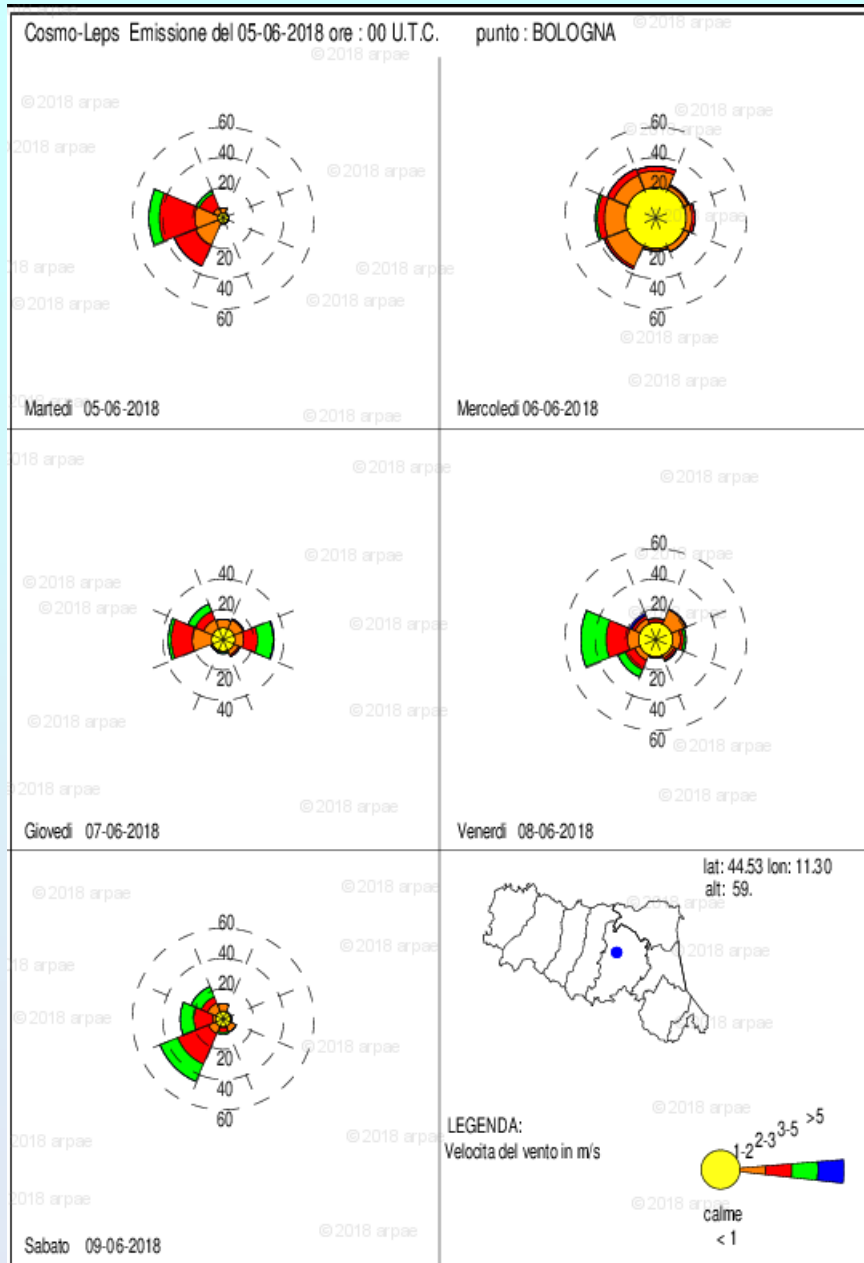
COSMO-LEPS Meteogram

Frankfurt 50.12°N 8.68°E (ENS land point)

Deterministic run (red) and COSMO-LEPS Distribution - Thursday 7 June 2018 00 UTC



# Probabilistic wind roses over fixed locations



# “Chessboard” over alert areas

- Divide Emilia-Romagna into 8 “homogeneous” alert areas (average size ~3000 km<sup>2</sup>, 60 grid points per area).
- For each COSMO-LEPS member, consider the corresponding areal means of 24-hour precipitation.
- Compute exceedance probabilities for pre-defined thresholds; colours “quantify” probabilities.

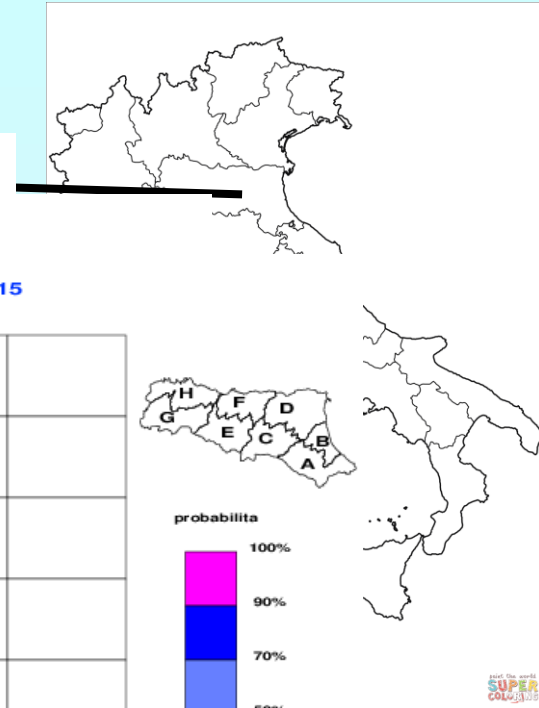
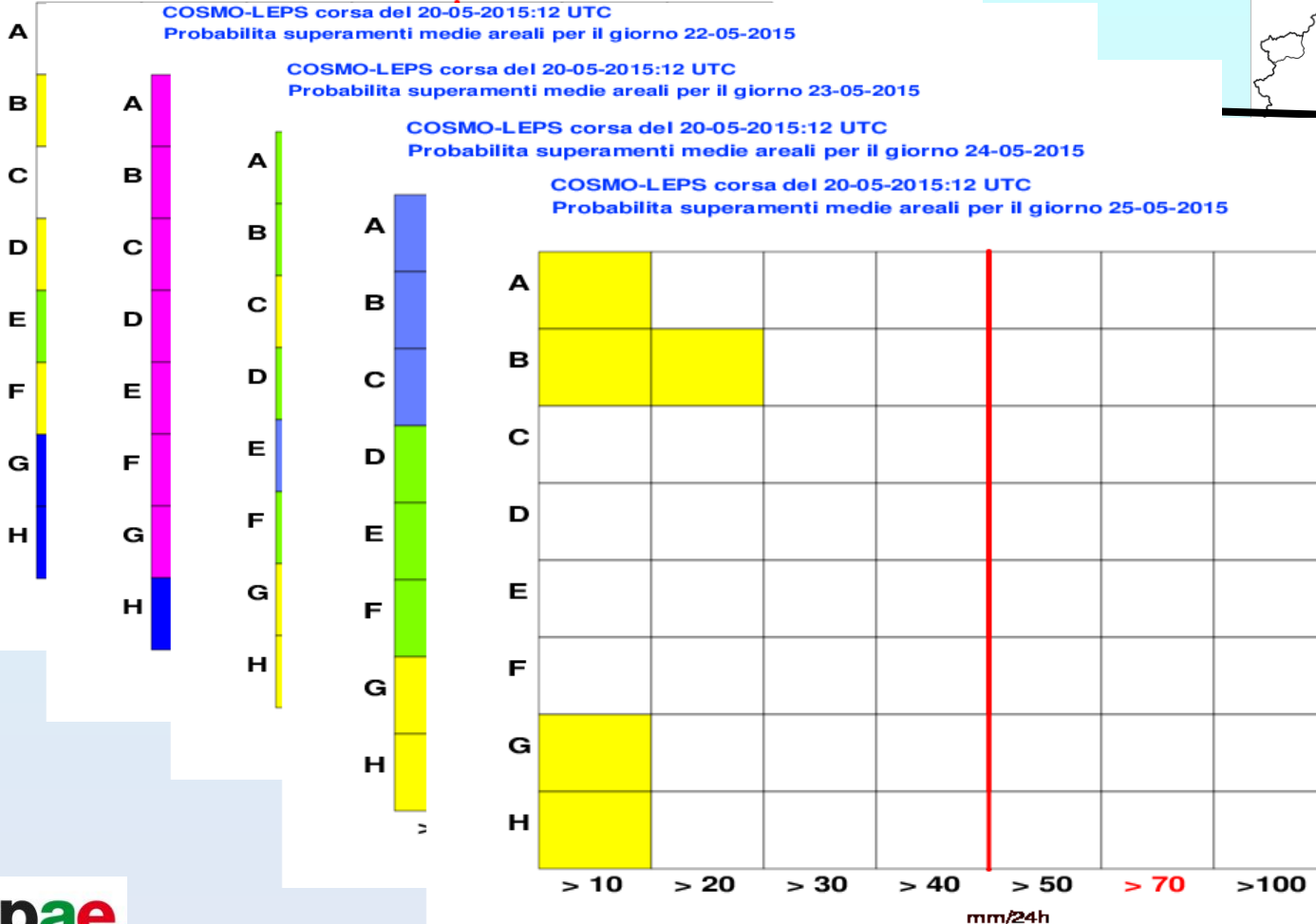
COSMO-LEPS corsa del 20-05-2015:12 UTC  
Probabilità superamenti medie areali per il giorno 21-05-2015

COSMO-LEPS corsa del 20-05-2015:12 UTC  
Probabilità superamenti medie areali per il giorno 22-05-2015

COSMO-LEPS corsa del 20-05-2015:12 UTC  
Probabilità superamenti medie areali per il giorno 23-05-2015

COSMO-LEPS corsa del 20-05-2015:12 UTC  
Probabilità superamenti medie areali per il giorno 24-05-2015

COSMO-LEPS corsa del 20-05-2015:12 UTC  
Probabilità superamenti medie areali per il giorno 25-05-2015



# Towards an Italian chessboard:

the only limit is ~~your imagination~~ my computer time!

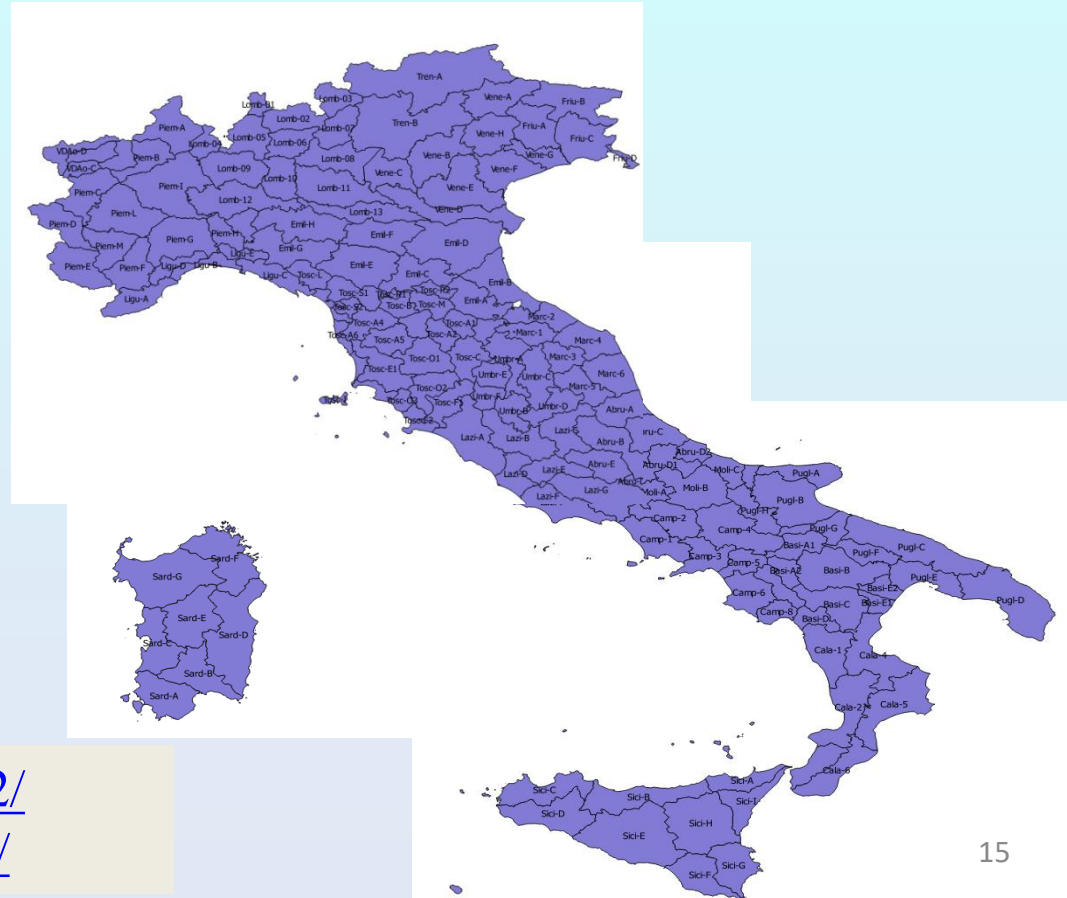
In Italy: 20 regions.....



but 156 alert areas, selected with different criteria by the different regions.

The smallest alert area: 193 km<sup>2</sup> (in Tuscany)

The largest alert area: 5670 km<sup>2</sup> (in Sicily)



<http://www.smr.arpa.emr.it/infomet2/>  
<https://simc.arpae.it/scacchieraitalia/>

# Conclusions

- COSMO-LEPS: well established product complementing ECMWF-ENS where high-spatial detail is required.
- Improved forecast skill of COSMO-LEPS throughout the years.
- Promising results by the increase of horizontal resolution (7 → 5 km) and the use of different parameterisations of moist convection (“multi-physics” approach).
- Probabilistic products are (at last!) considered and can support Civil Protection decisions.
- Italian chessboard: “optimal” solution would be to blend COSMO-LEPS and ENS products, but this is probably not appropriate with the present choice of alert areas.
- Keep on working with regional Civil Protection Agencies “to think ensemble” with them and develop customised products.



**Thanks for your attention!!!**