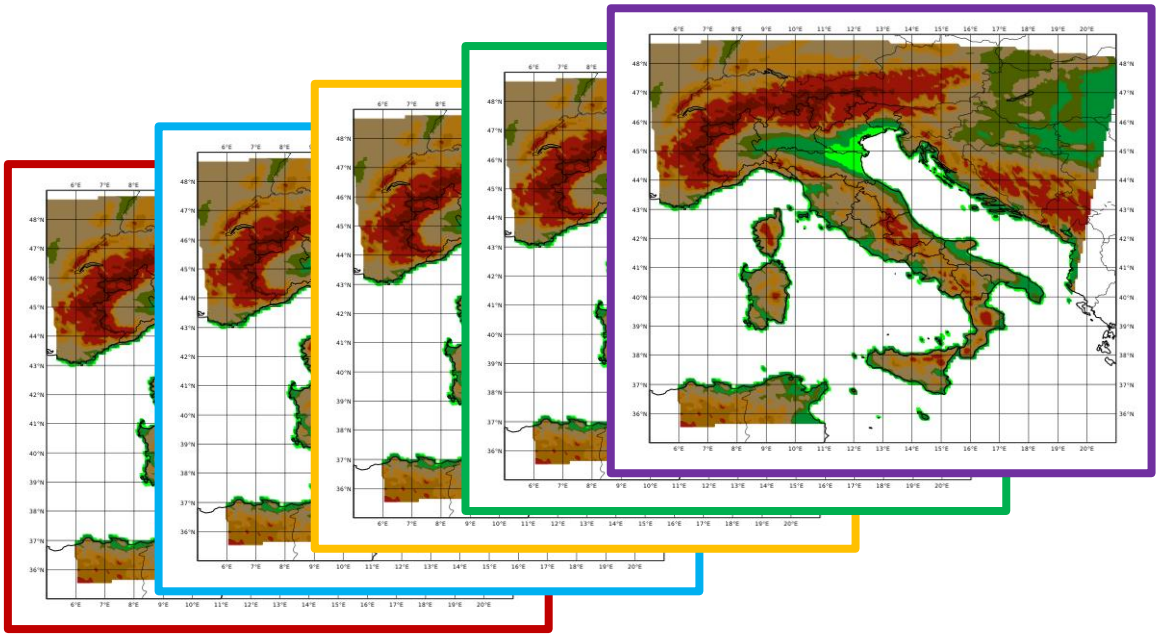
Prediction of thunderstorms with COSMO-2I-EPS

Chiara Marsigli, Maria Stefania Tesini, Davide Cesari, Andrea Montani, Tiziana Paccagnella

Arpae SIMC, Bologna, Italy

COSMO-2I-EPS: operational set-up

- COSMO 2.2 km, 65 levels
- 20 members
- BCs from the first 20 members of COSMO-ME-EPS
- ICs from KENDA (with LHN)
- No physics perturbations
- 1 run per day, 00 UTC, +48 h

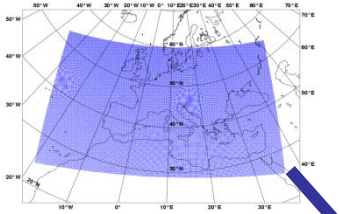


arpae
agenzia prevenzione ambiente energia emilia-romagna

CONSORTIUM FOR SMALL SCALE MODELING
COSMO

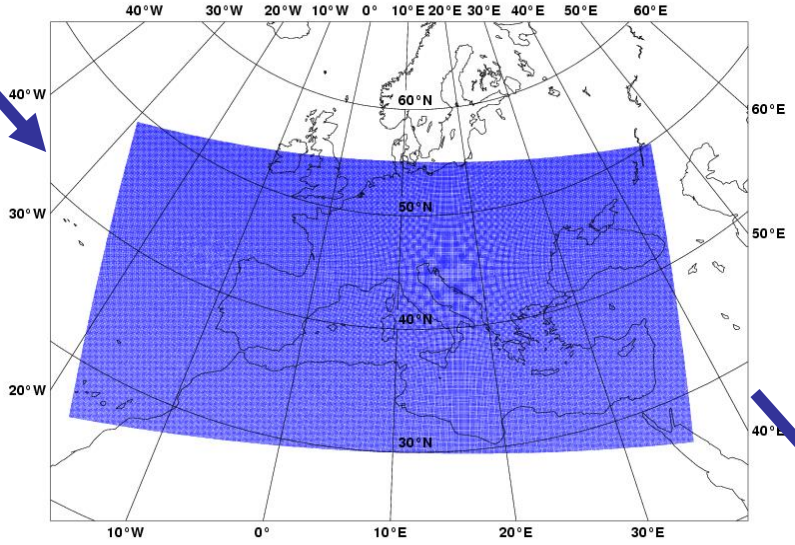
COSMO-2I-EPS: operational set-up

LETKF (COMET)



7 km

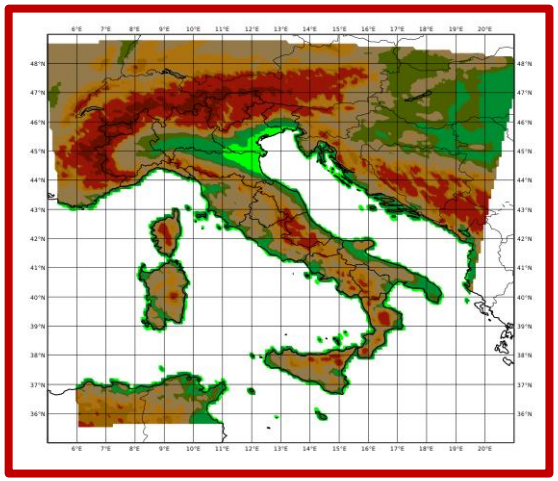
COSMO-ME-EPS (COMET)



7 km

2.2 km
explicit convection

COSMO-2I-EPS (Arpae)



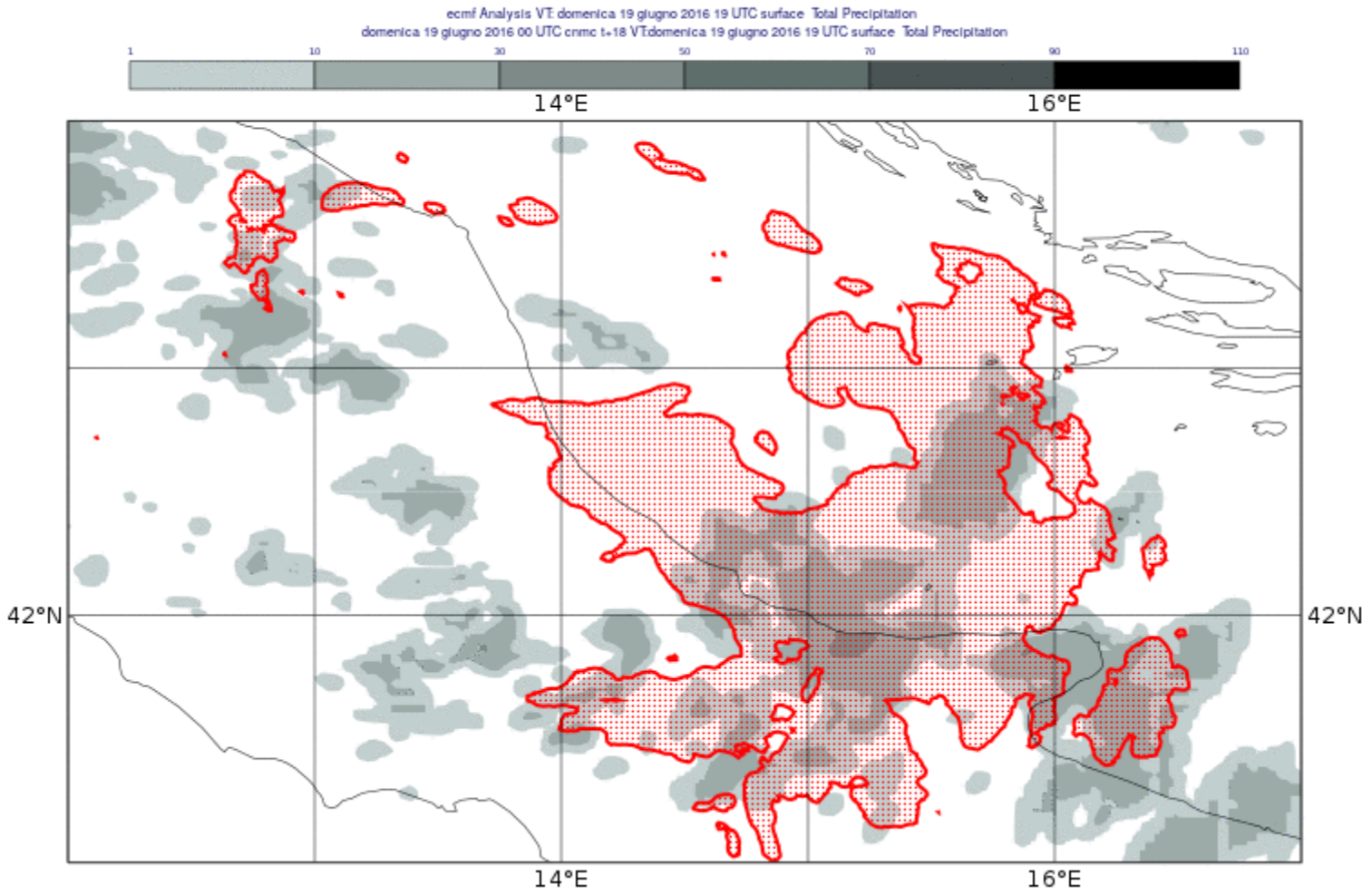
arpae
agenzia prevenzione ambiente energia emilia-romagna

CONSORTIUM FOR SMALL SCALE MODELING
COSMO

Testing the prediction of thunderstorms

- Run of the ensemble for a period in summer 2016 characterised by thunderstorms (19/06/2016 – 07/07/2016)
- 7 runs for days of rain and 7 runs for days of no rain
- Objective verification against precipitation estimated by the Italian radar composite corrected with raingauges (adjustement)
- Impact of ICs from KENDA analyses
- Verification of structures (SAL)
- Verification over civil protection warning areas:
  - using radar data
  - using lightning data

Identification of the thunderstorm predictors from the ensemble



Red areas: radar estimate (1mm)

Probability maps (5mm)

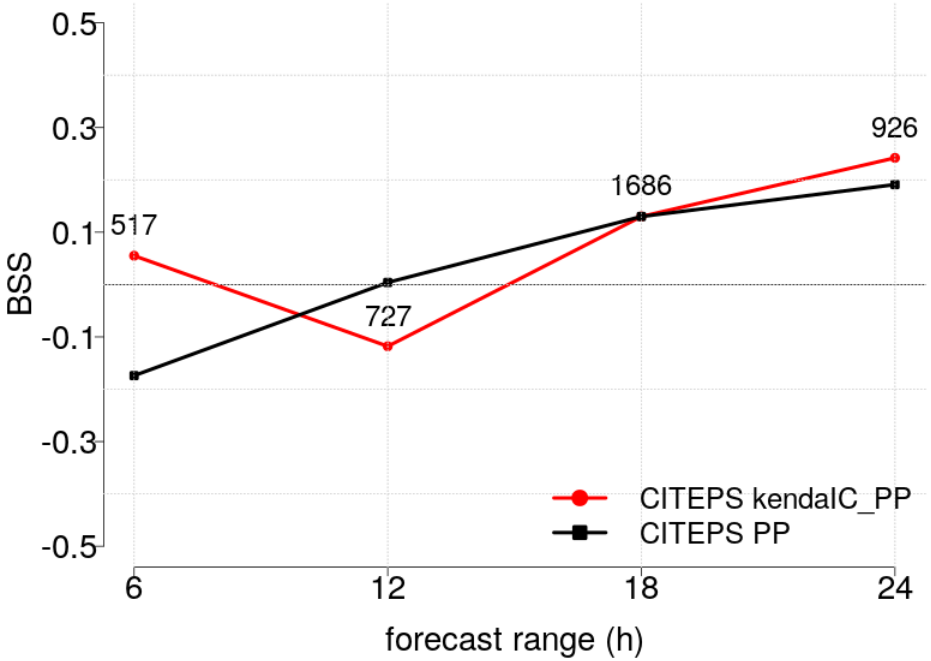
1 10 30 50 70 90 %

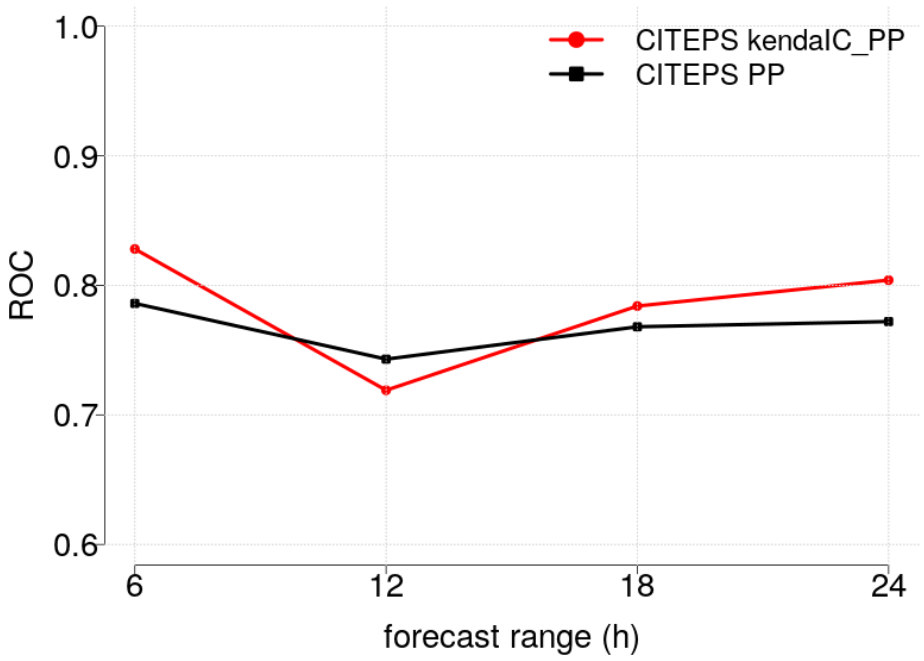
Verification of precipitation: quality of the ensemble forecasts

arpae
agenzia prevenzione ambiente energia emilia-romagna

Probabilistic scores

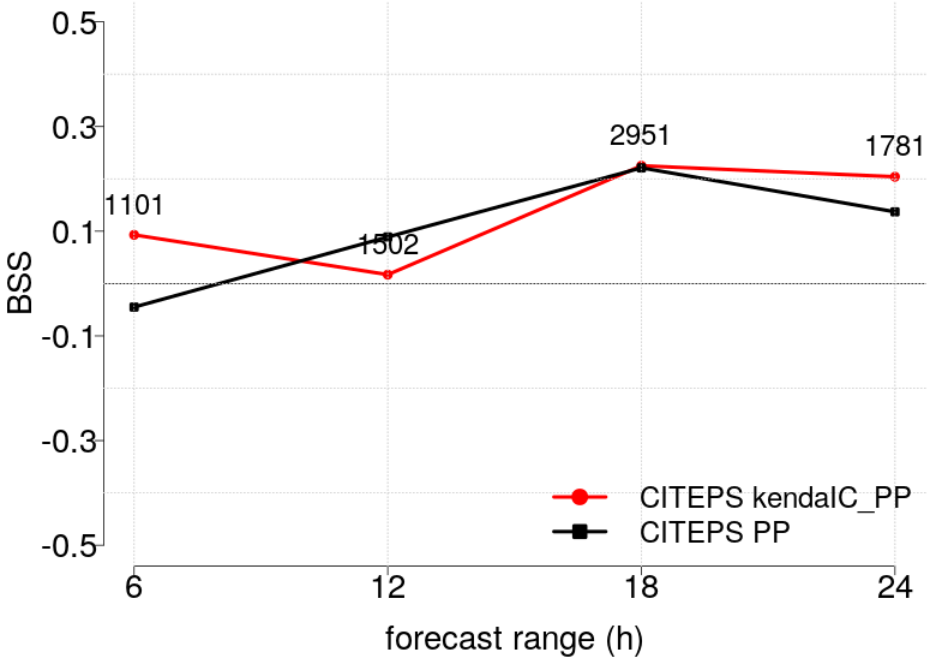
6h total precipitation vs radar estimate adjusted with rangauges average precipitation over boxes 02

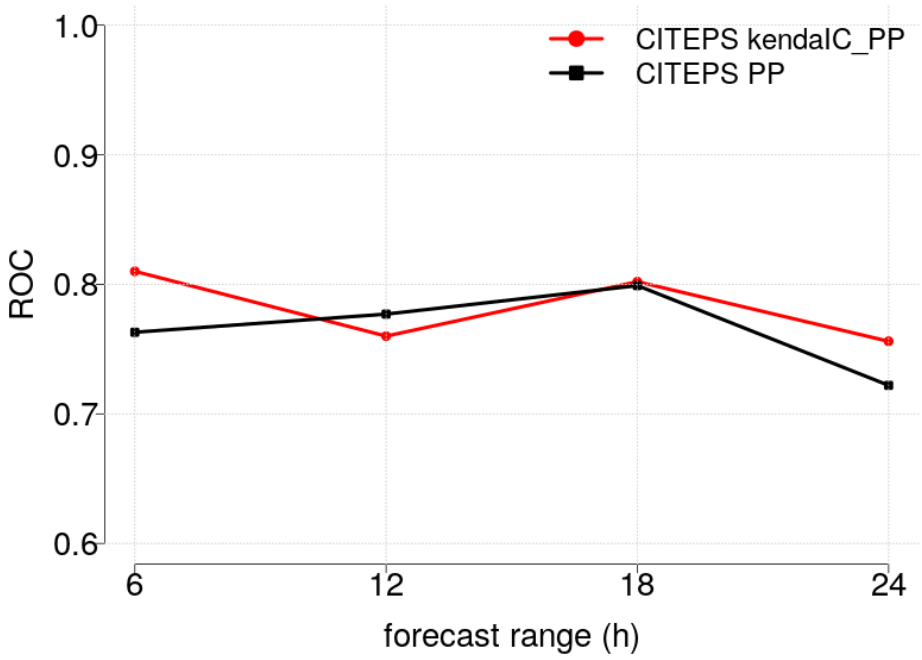




Probabilistic scores

6h total precipitation vs radar estimate adjusted with rangauges maximum precipitation over boxes 02



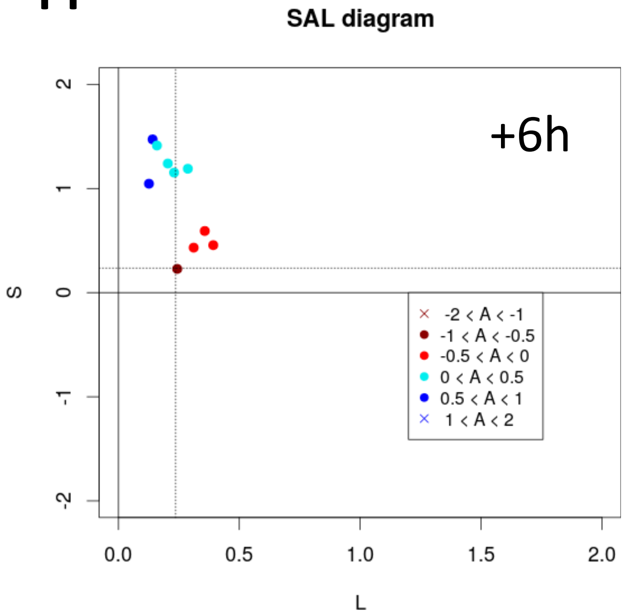


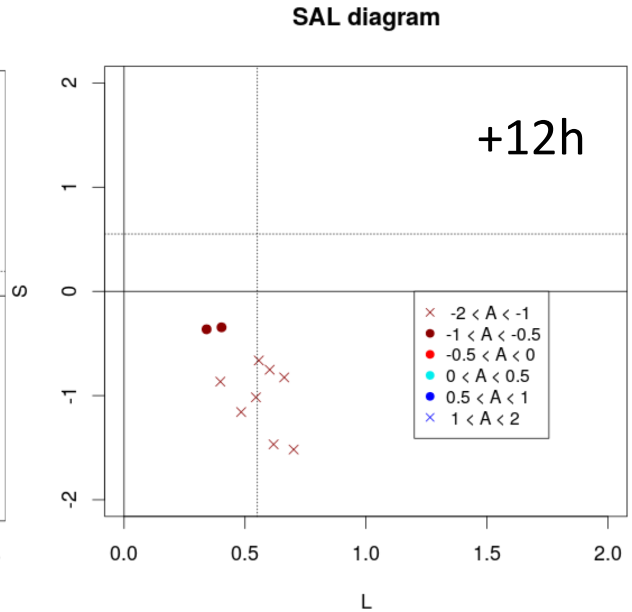
Verification of precipitation objects with SAL method

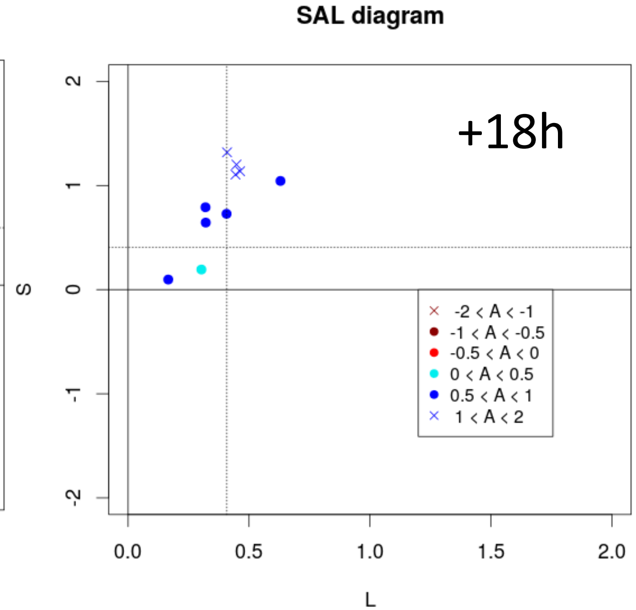
arpae
agenzia
prevenzione
ambiente energia
emilia-romagna

SAL method - radar adj – 25 June 2016

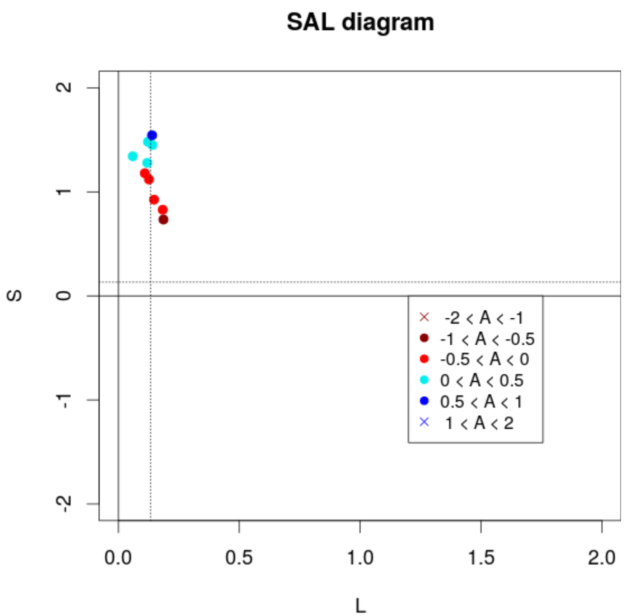
PP

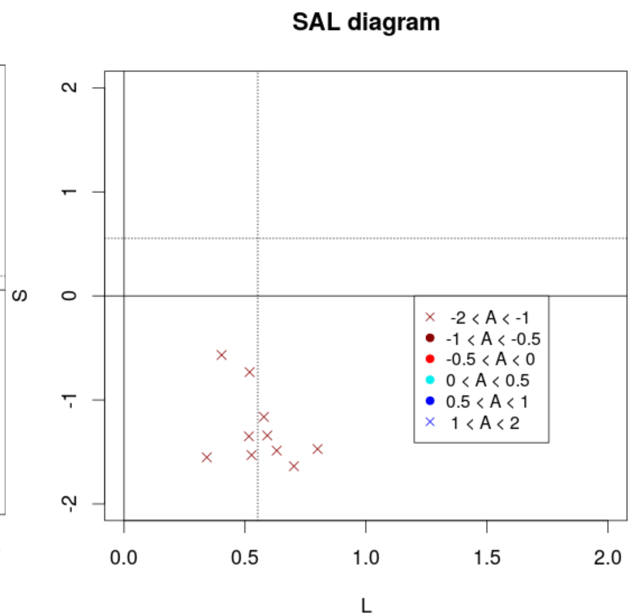


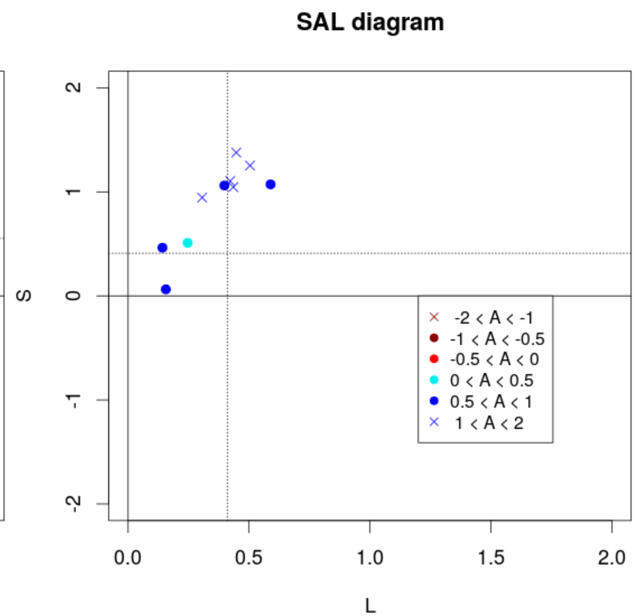




kenda IC PP

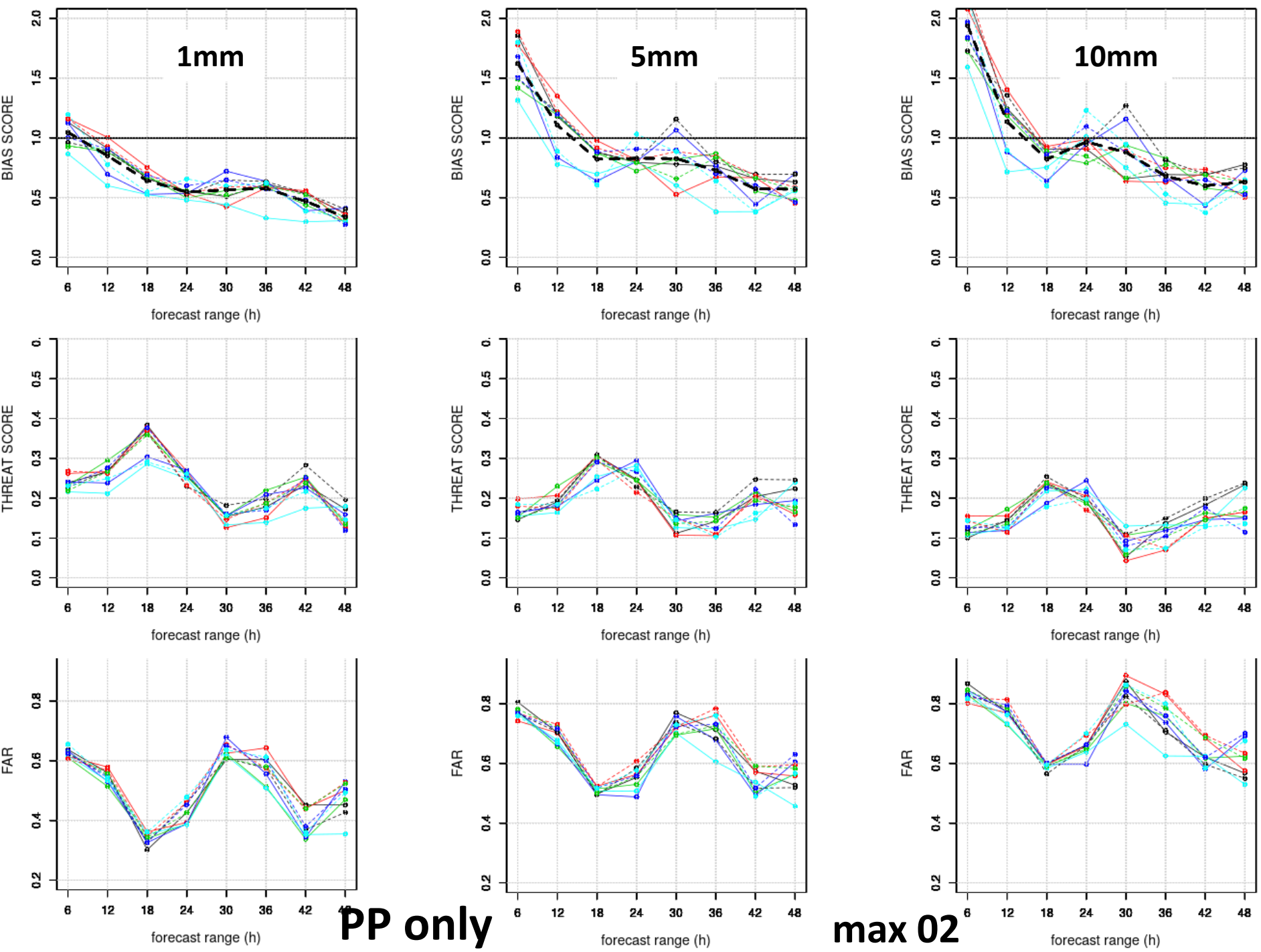


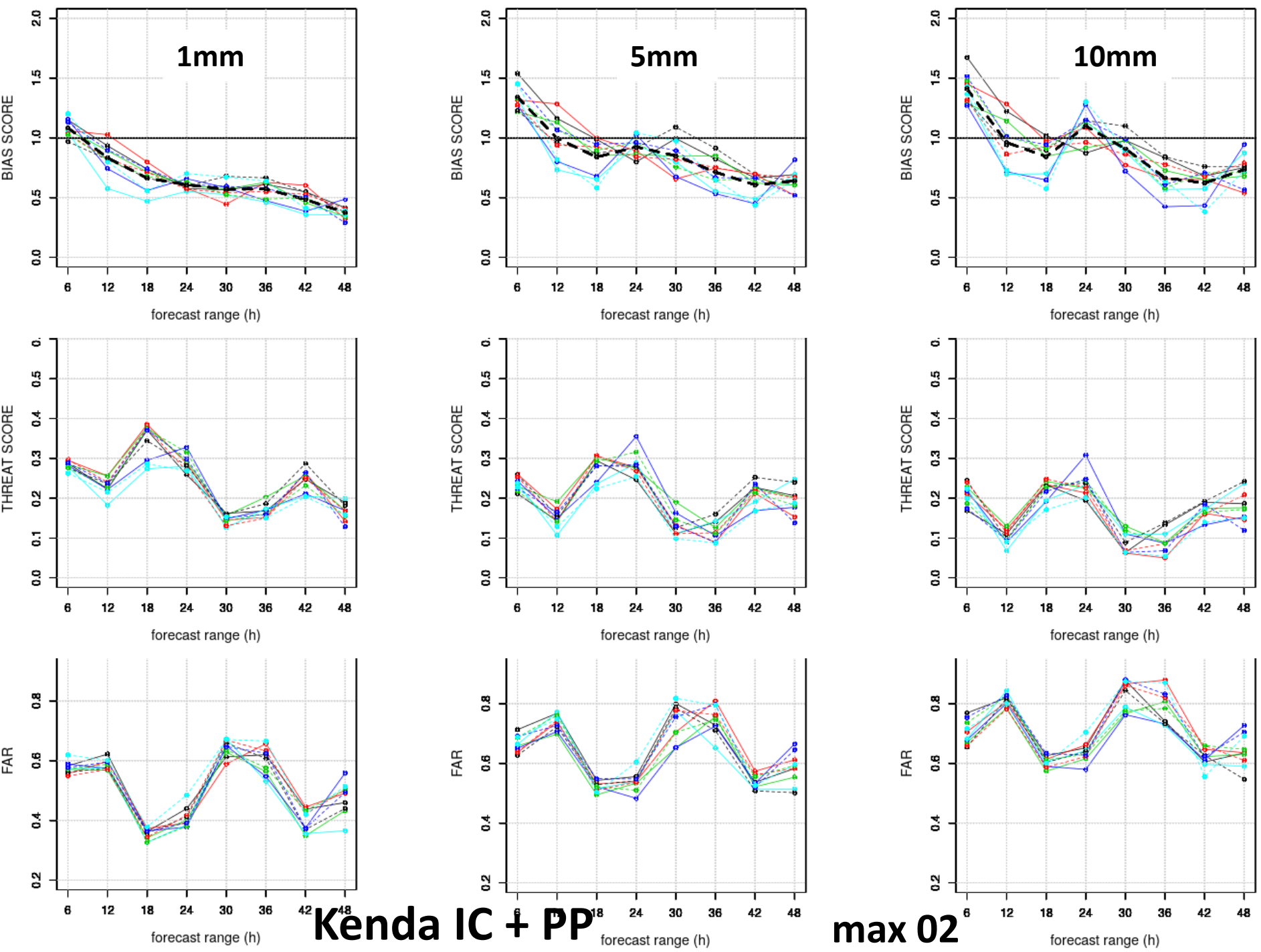




Verification of precipitation: quality of each ensemble member

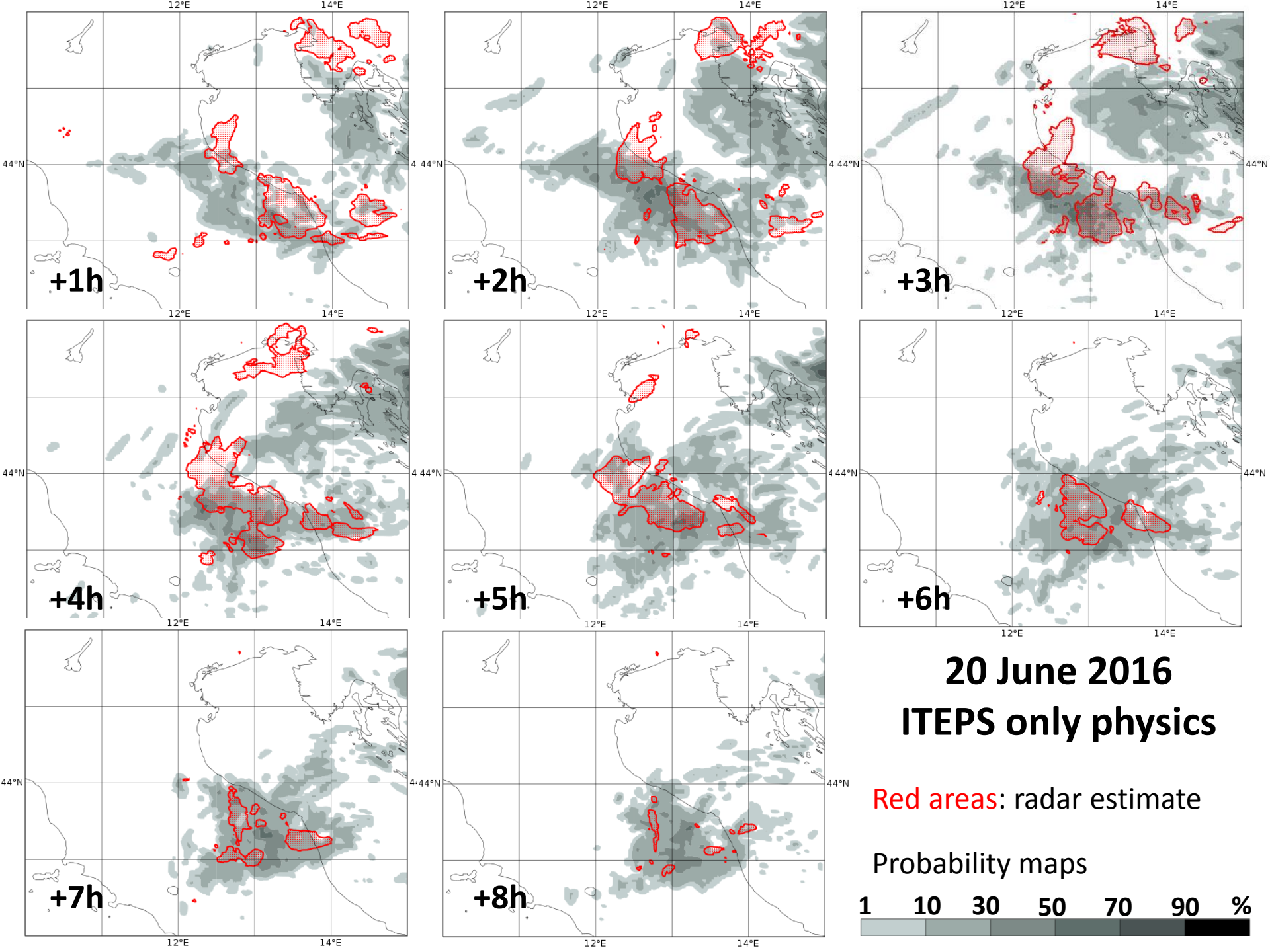
arpae
agenzia prevenzione ambiente energia emilia-romagna

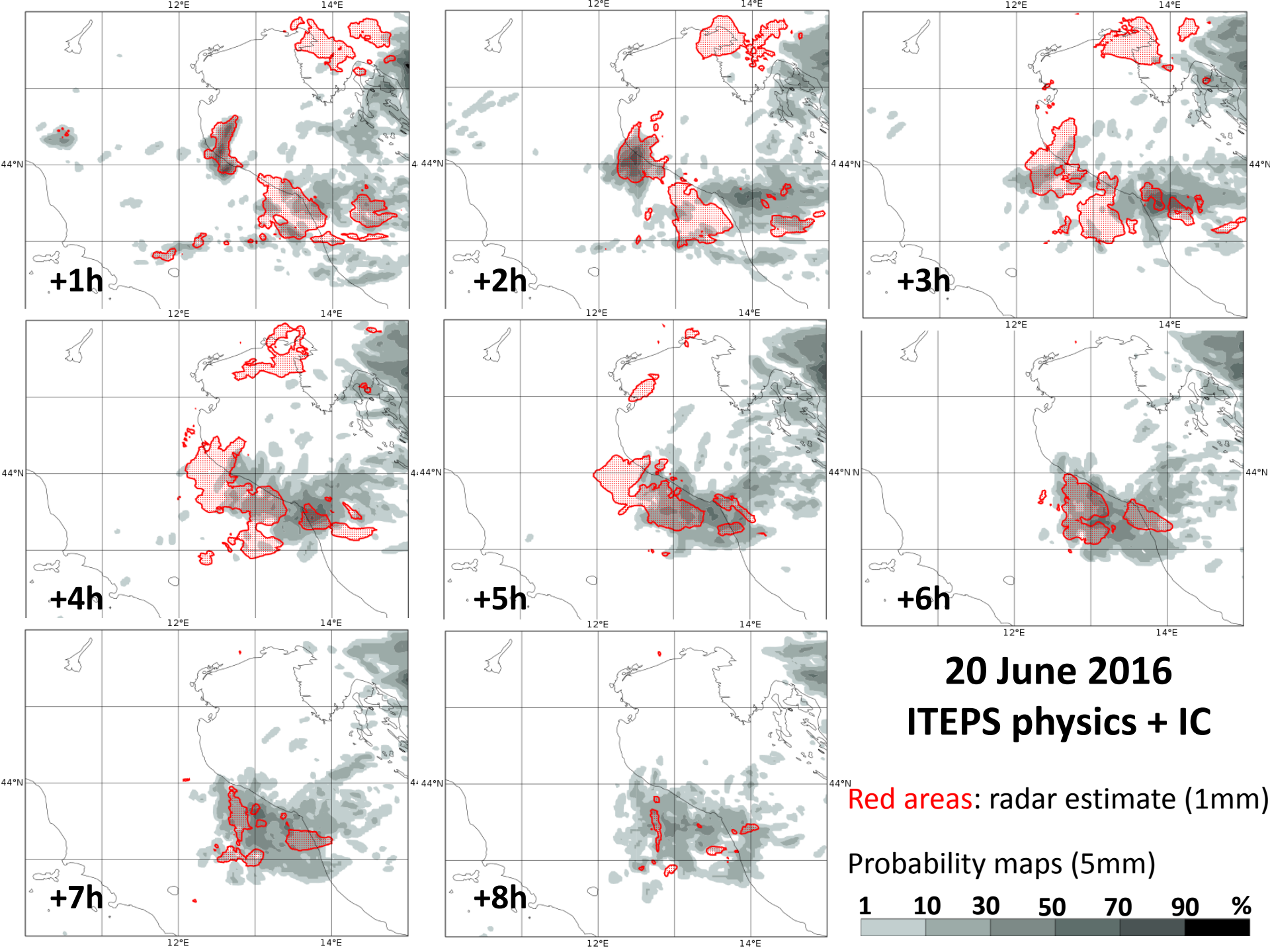

1mm
5mm
10mm
BIAS SCORE
THREAT SCORE
FAR
forecast range (h)
6
12
18
24
30
36
42
48
PP only
max 02

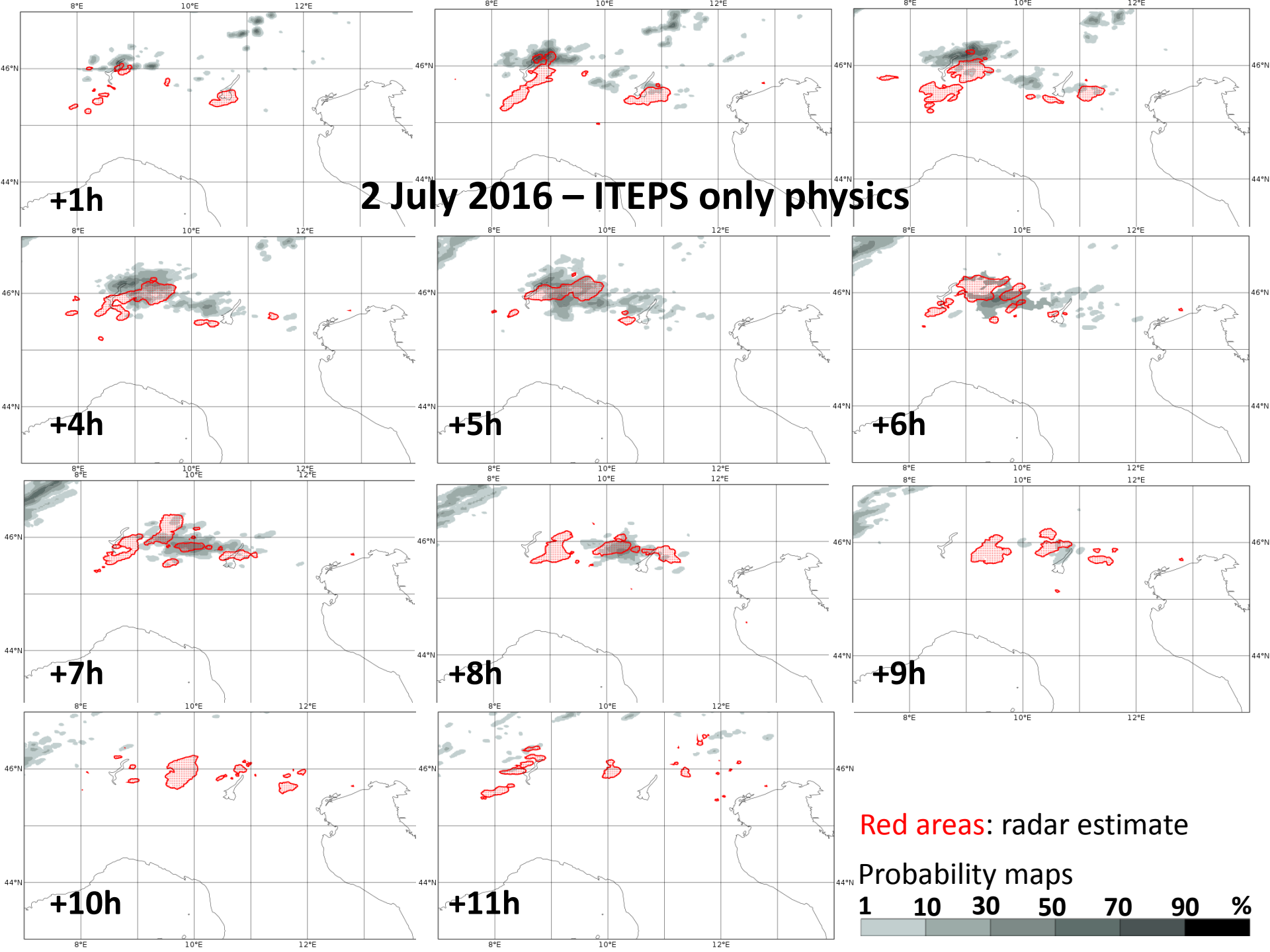

1mm
5mm
10mm
BIAS SCORE
THREAT SCORE
FAR
forecast range (h)
6
12
18
24
30
36
42
48
Kenda IC + PP
max 02

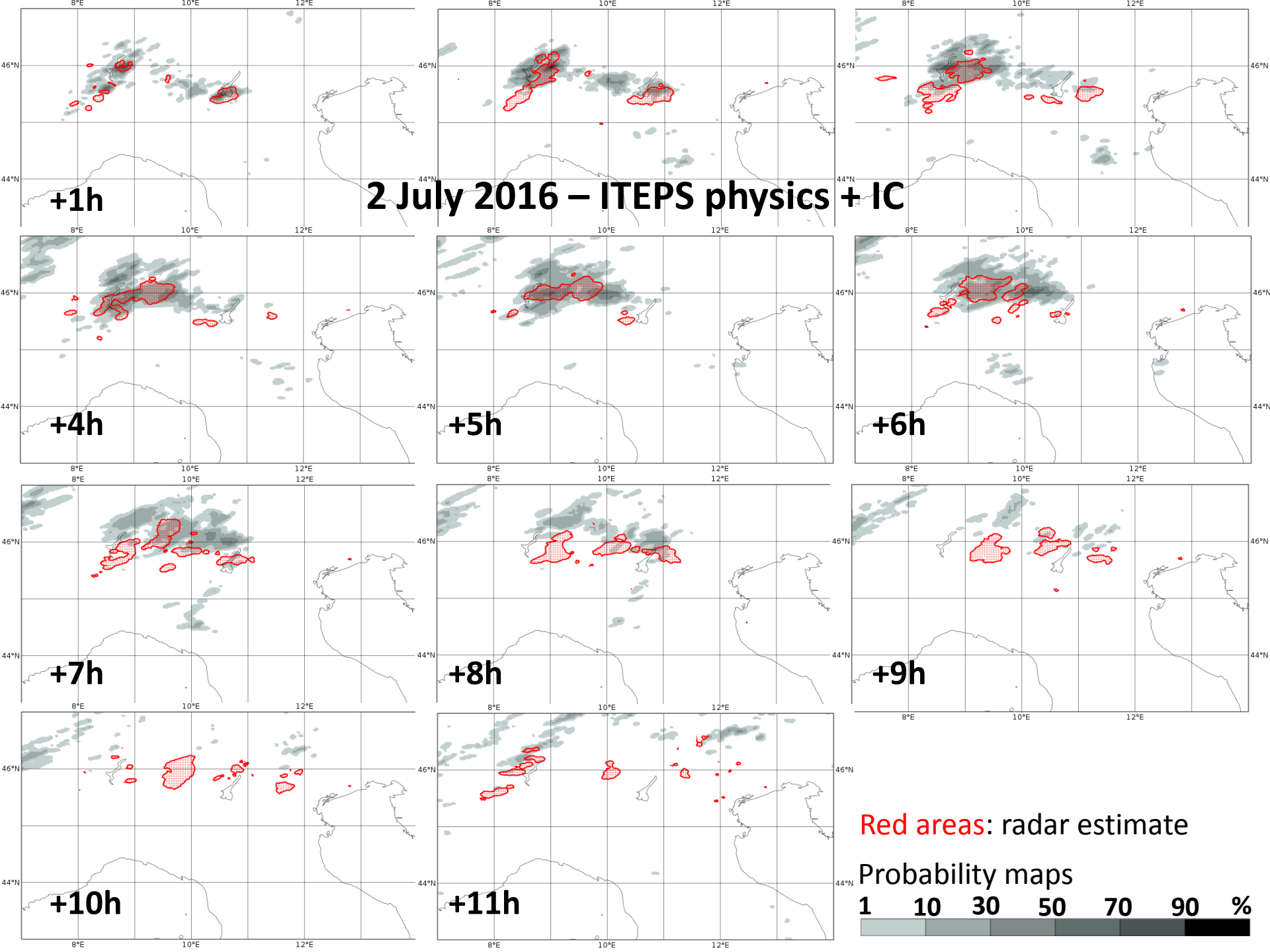
Impact of perturbed ICs from LETKF (subjective evaluation)

arpae
agenzia prevenzione ambiente energia emilia-romagna


12°E
14°E
44°N
+1h
+2h
+3h
+4h
+5h
+6h
+7h
+8h
20 June 2016
ITEPS only physics
Red areas: radar estimate
Probability maps
1 10 30 50 70 90 %


+1h
+2h
+3h
+4h
+5h
+6h
+7h
+8h
12°E
14°E
44°N
20 June 2016
ITEPS physics + IC
Red areas: radar estimate (1mm)
Probability maps (5mm)
1 10 30 50 70 90 %


2 July 2016 – ITEPS only physics
+1h
+4h
+5h
+6h
+7h
+8h
+9h
+10h
+11h
Red areas: radar estimate
Probability maps
1 10 30 50 70 90 %


2 July 2016 – ITEPS physics + IC
+1h
+4h
+5h
+6h
+7h
+8h
+9h
+10h
+11h
Red areas: radar estimate
Probability maps
1 10 30 50 70 90 %

Developing a method for verification on warning areas using radar data and lightning data

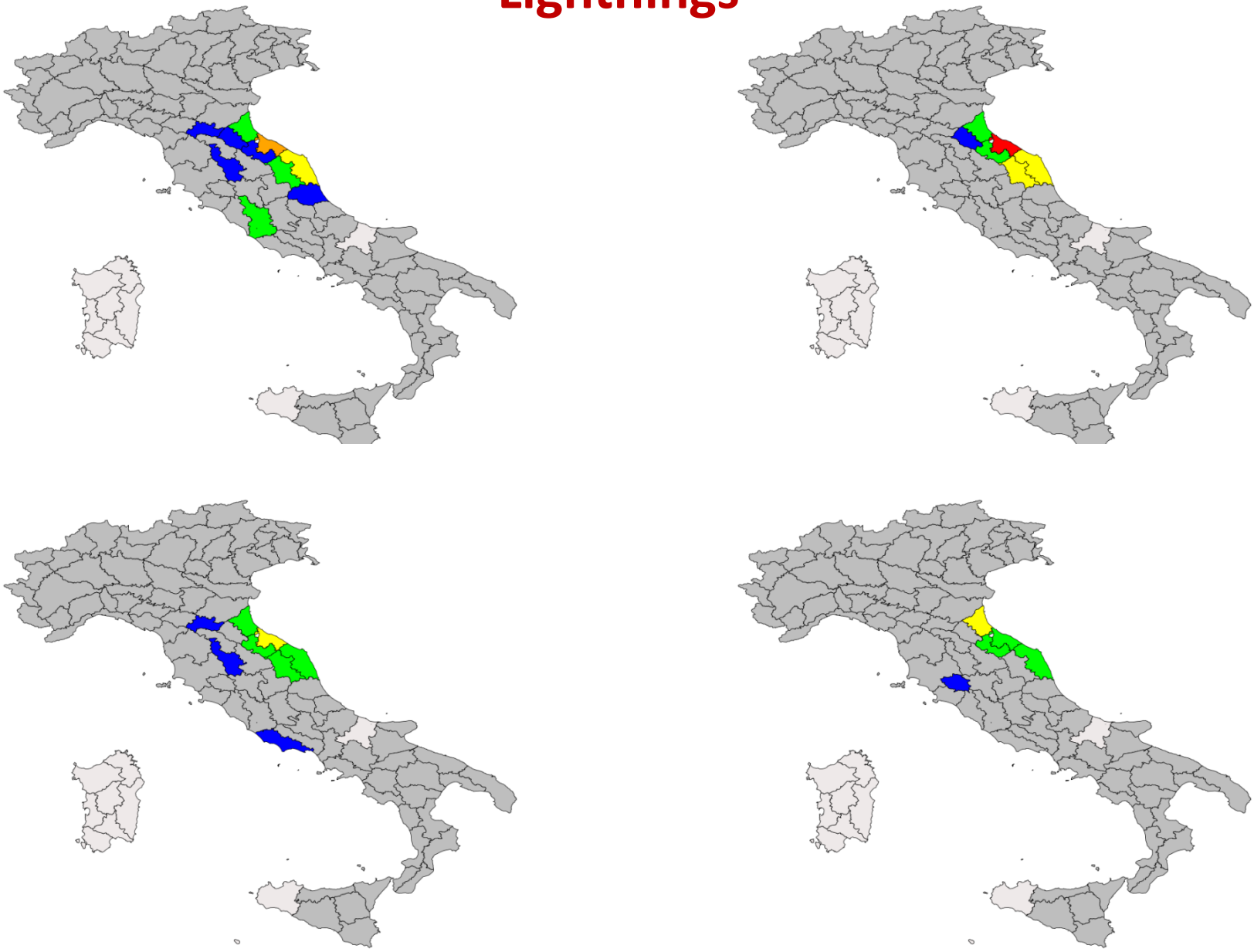
arpae
agenzia prevenzione ambiente energia emilia-romagna

Data and method

- Measures form a lightning network over Italy:
  - Number of lightnings
  - Maximum intensity recorded in the area
  - Spatialized over the warning areas, hourly
- Radar estimate of precipitation, raingauge adjusted
  - Spatialized over the warning areas, hourly
  - Average, maximum …
- Ensemble members
  - Precipitation forecasted over the warning areas, spatialized (average, maximum …)
  - Probabilities are computed, of precipitation exceeding a threshold (e.g. 1mm)

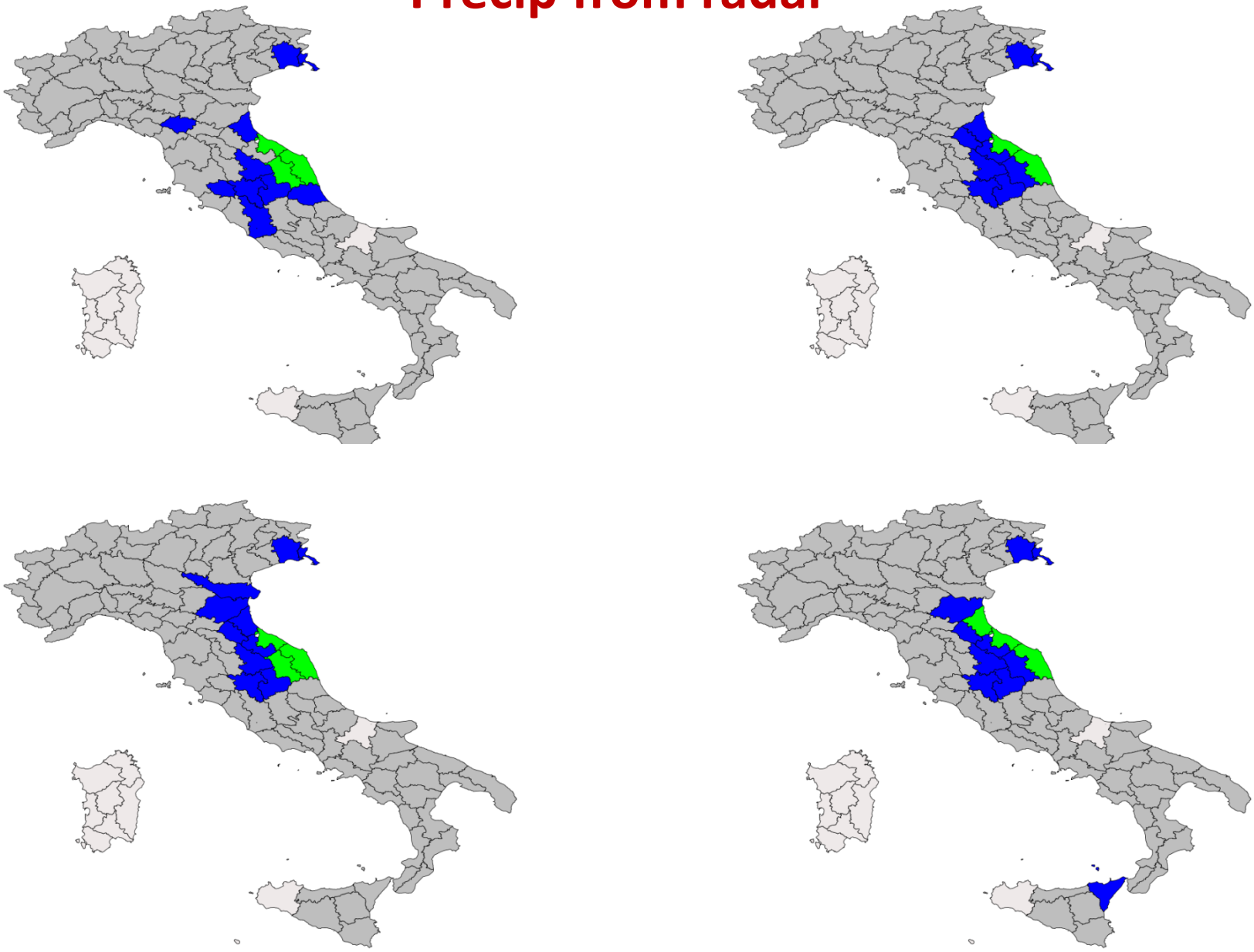
arpae
agenzia prevenzione ambiente energia emilia-romagna

Lightnings



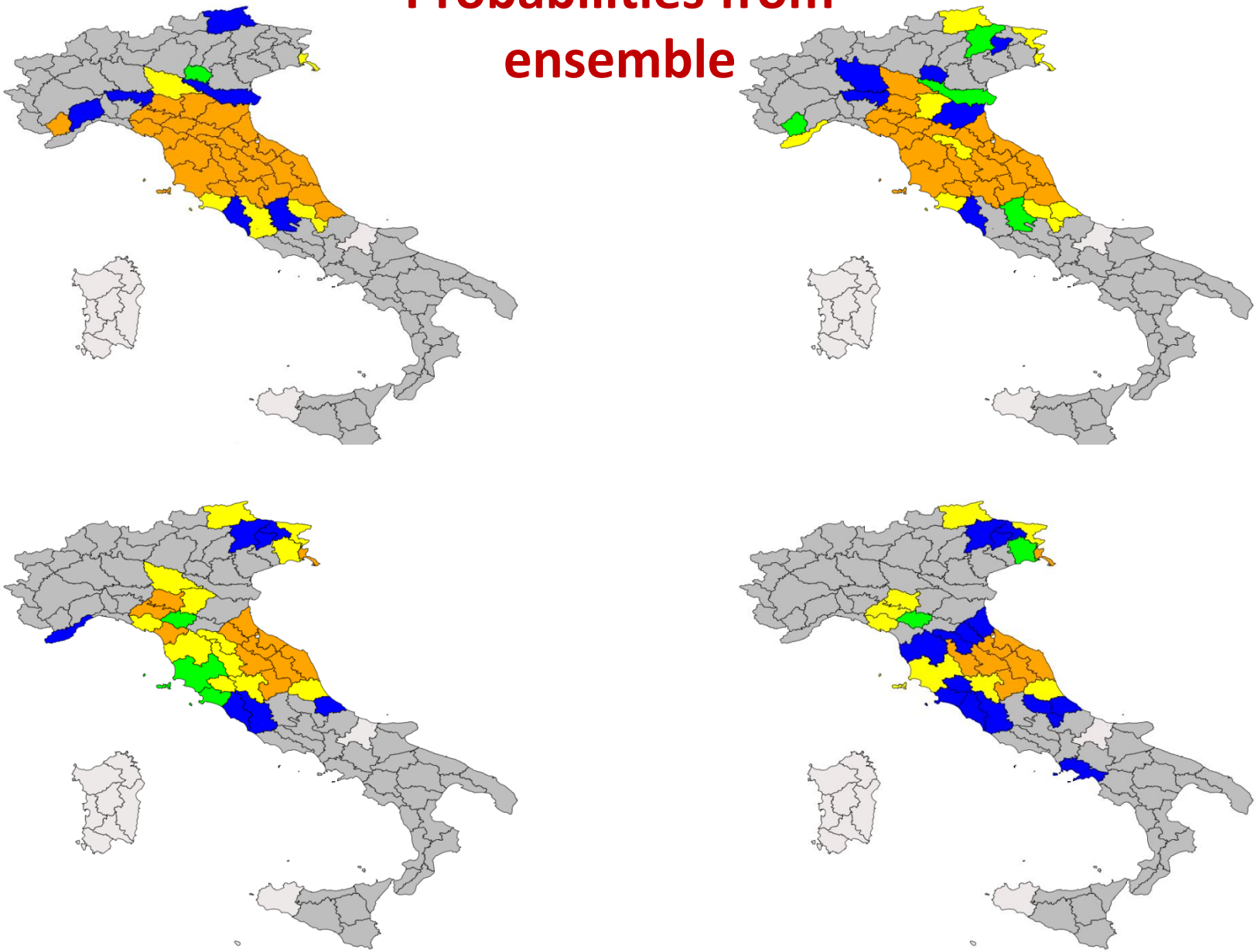
20.06.2016 – 01-04 UTC

Precip from radar



20.06.2016 – 01-04 UTC

Probabilities from ensemble

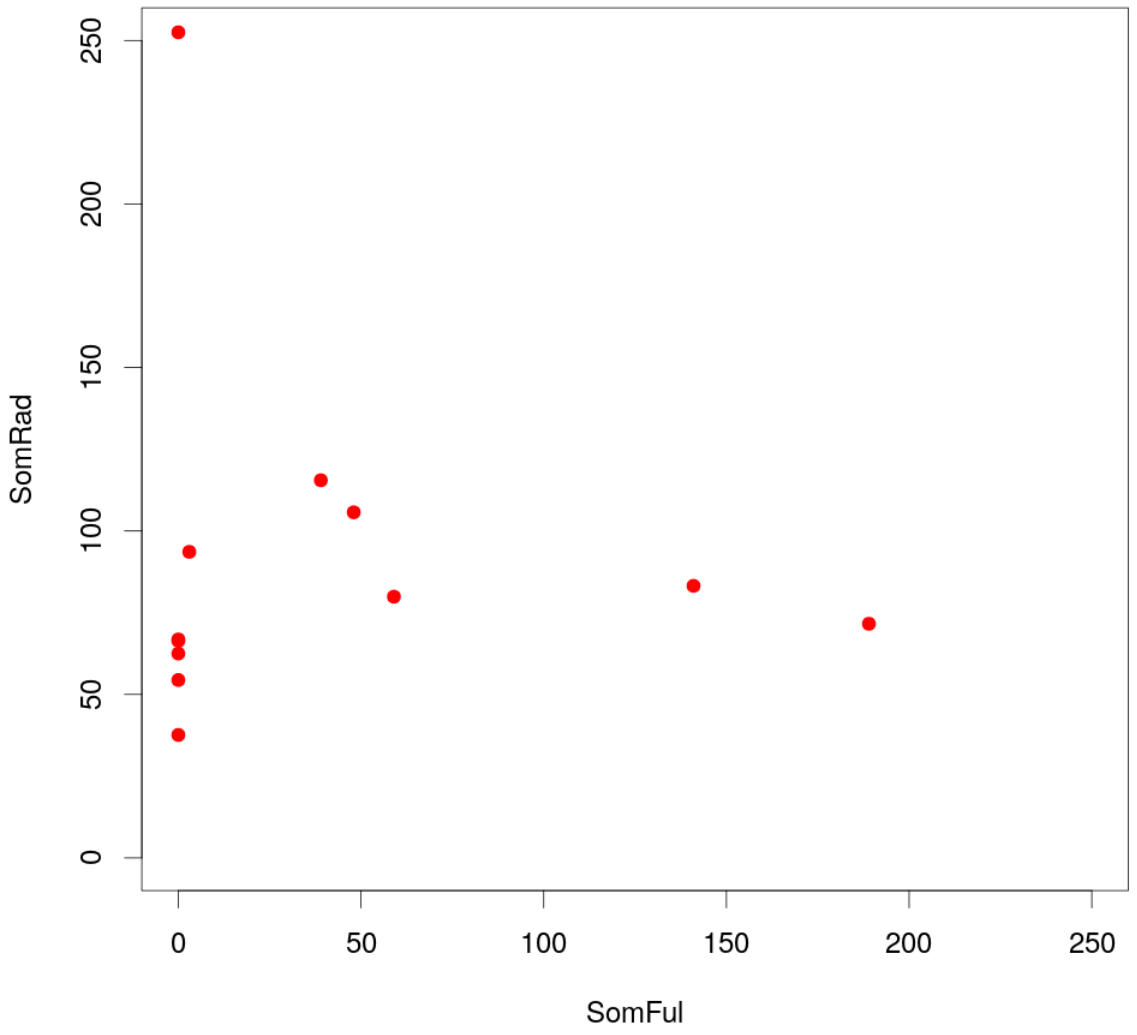


20.06.2016 – 01-04 UTC

Data and method – some questions

- Lightnings:
  - What measure should we use? How many lightnings are needed to "catch" a thunderstorm?
- Radar estimate of precipitation:
  - Which threshold indicate a "significant" precipitation? Likely different from the one of the model
- Ensemble:
  - Which threshold indicate a "significant" precipitation?
  - Use of average or maximum or a percentile?
  - How to spatialize probabilities? And which probability threshold should we use?

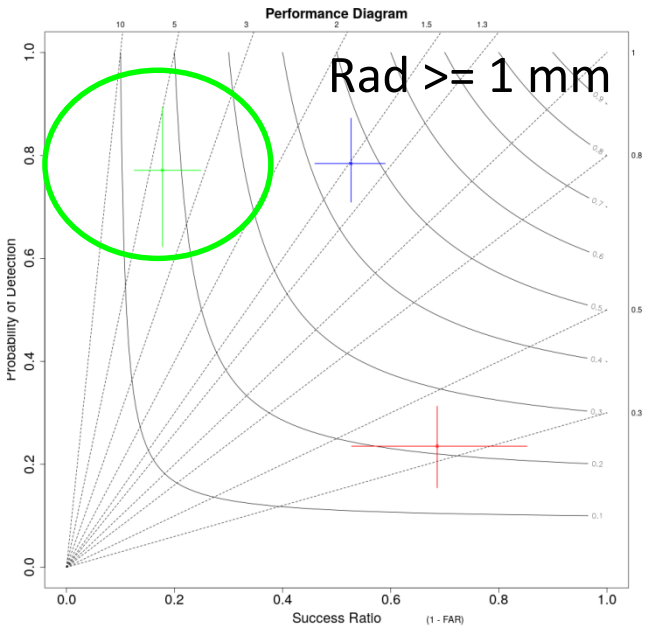
Scatter plot: radar - lightnings



20.06.2016

Example of performance diagram

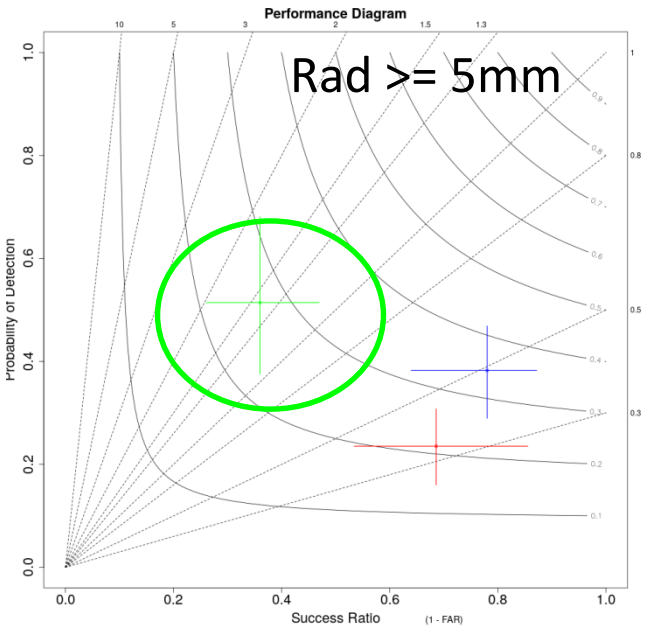
Prob >= 80%



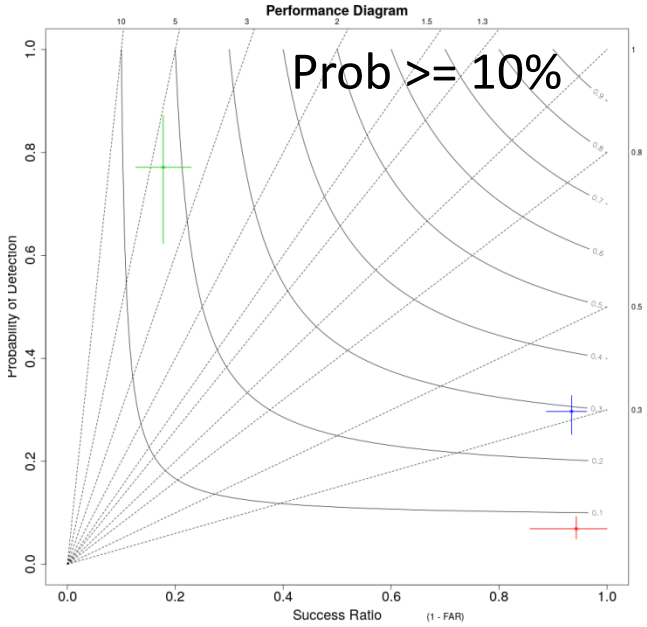
Ens. vs radar

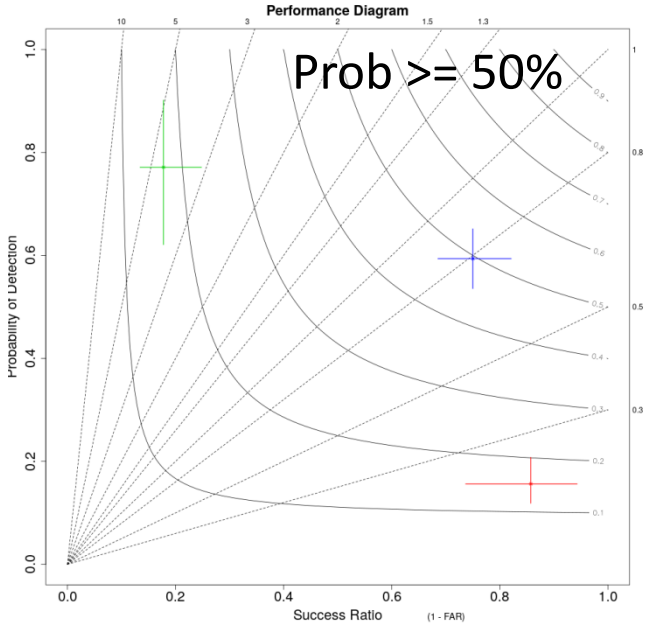
Ens. vs lightn

Radar vs lightn



Example of performance diagram

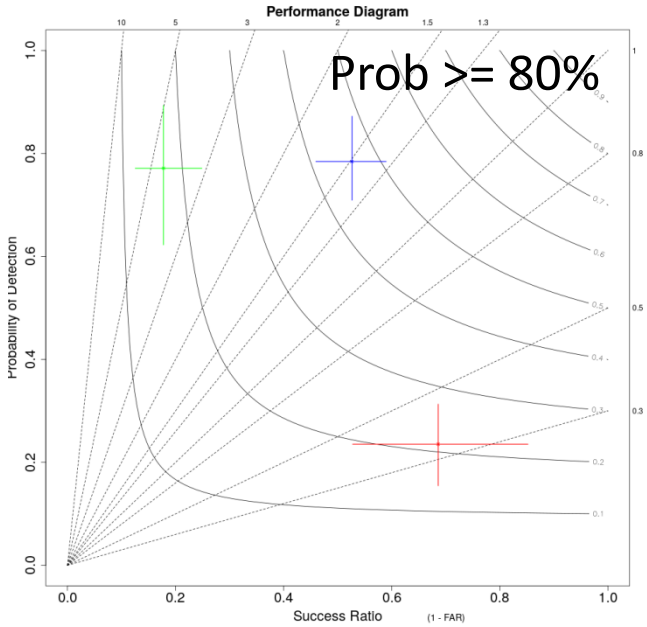


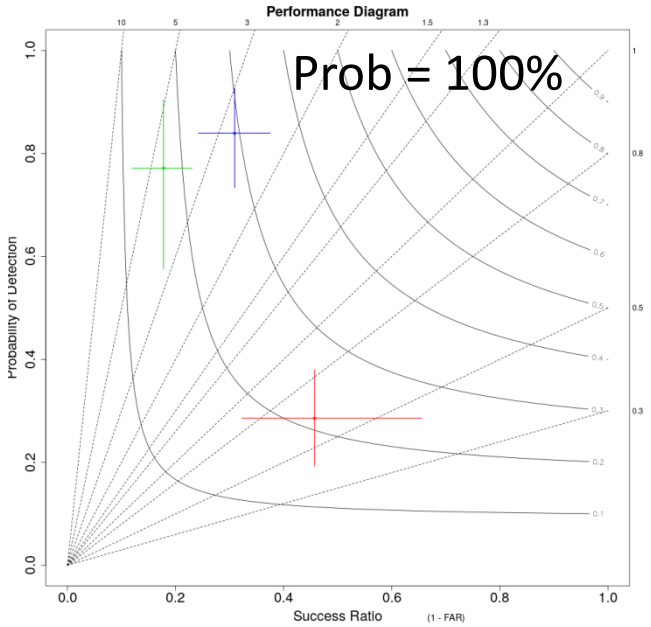


Ens. vs radar

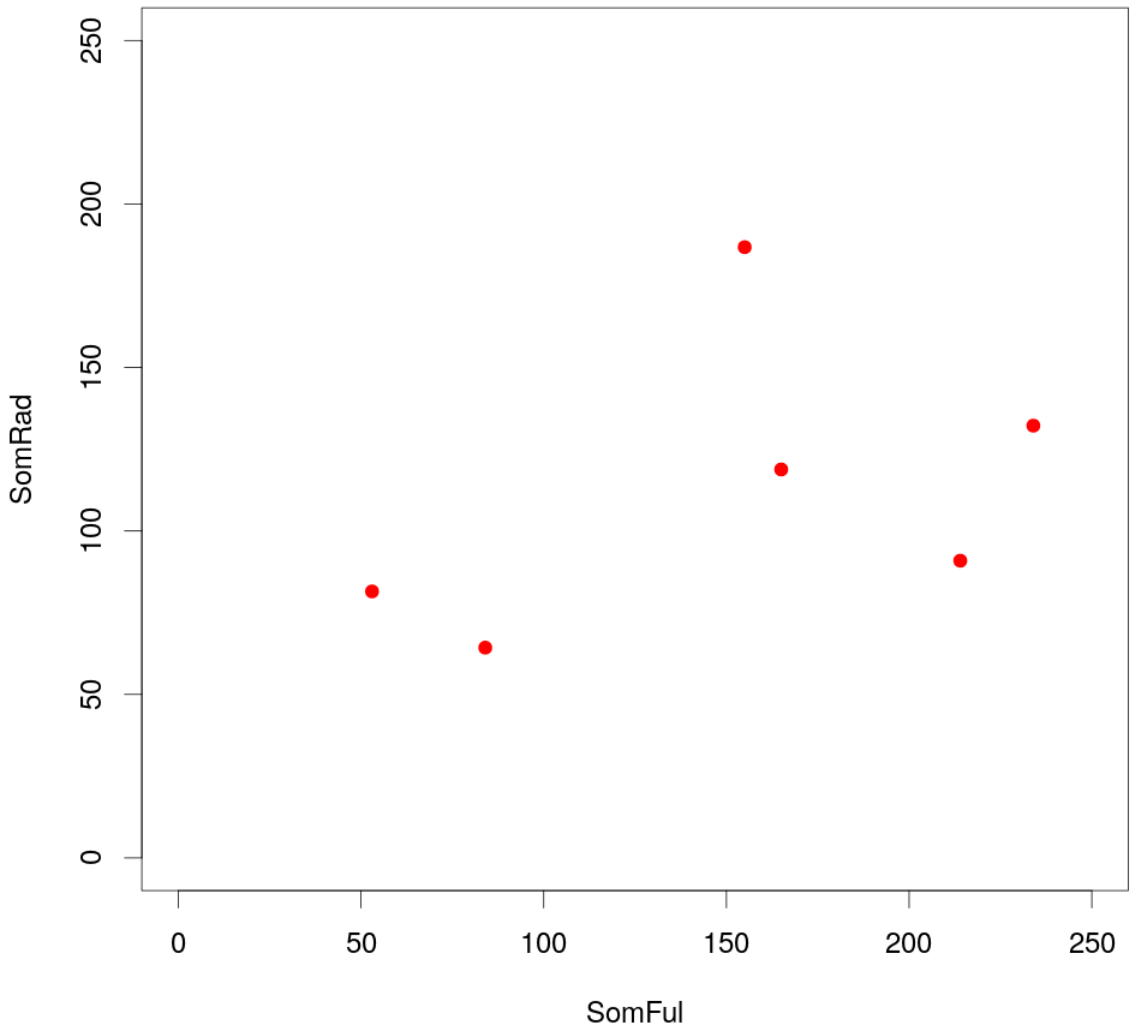
Ens. vs lightn

Radar vs lightn





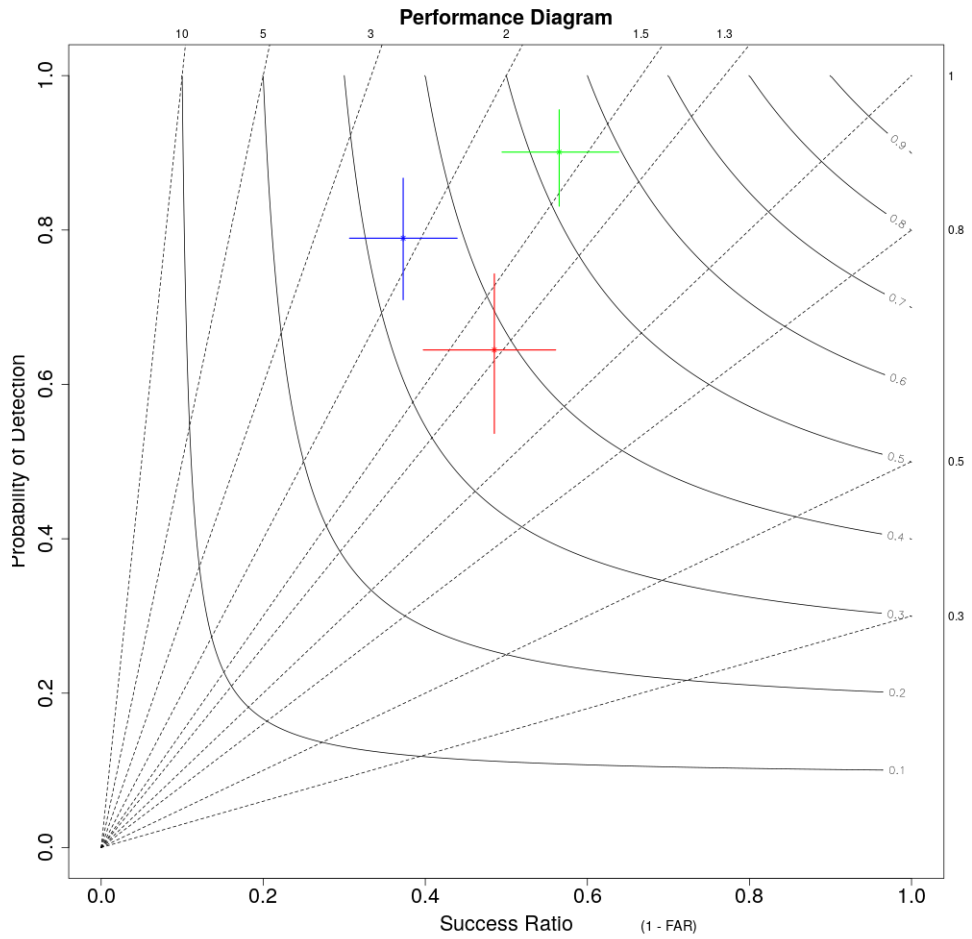
Scatter plot: radar - lightnings



02.07.2016

Example of performance diagram

Rad >= 1 mm Prob >= 80%



Ens. vs radar

Ens. vs lightn

Radar vs lightn

02.07.2016

Concluding remarks

- COSMO-2I-EPS is running as part of the operational chain of Arpae at CINECA but we are still not ready for operational usage (problems with DA and with timeliness)
- Forecass of thunderstorms on selected cases (experiments) shows encouraging result; positive impact of KENDA ICs
- new products for thunderstorms and fog

  => need to develop a suitable verification method
- Verification of precipitation against radar estimate

  => problem of the estimate

arpae
agenzia prevenzione ambiente energia emilia-romagna