Calibration in ECMWF

24-h precipitation in dual ENS resolution forecast

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Why we should apply a calibration to the ensemble forecast?

- **Raw precipitation forecasts are less useful than they could be because**:
  - Imperfections in the prediction system.
  - Location-dependent and location-independent biases in the forecast
  - Biases may also differ between light and heavy precipitation events (i.e. overforecasting light precipitation and underforecasting the heavier)

- For these reasons, statistical postprocessing is often applied.
  - The method applied here is **quantile mapping**. (keep the spatial distribution of the field)

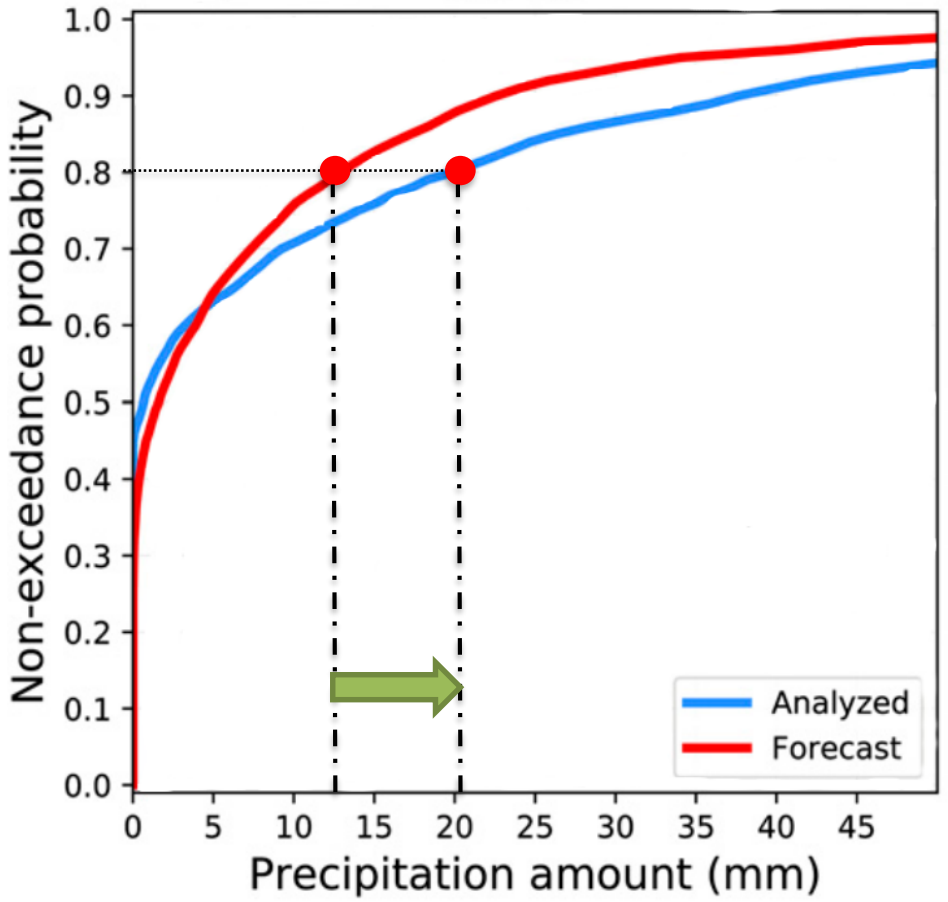


Figure adapted from Hamill et al. (2017)

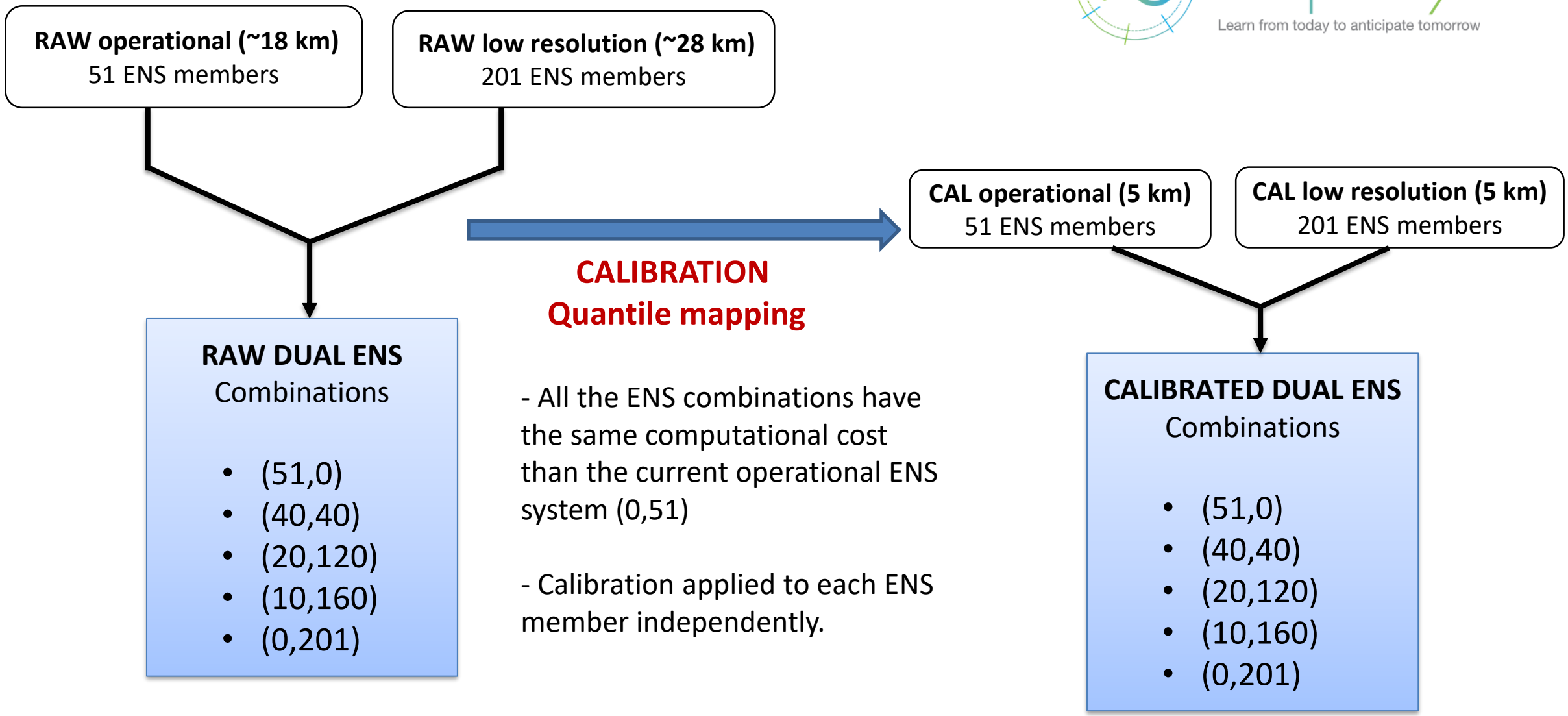
Quantile mapping applied in ECMWF 24h-h precipitation

DATABASES	ECMWF experiment
Observation/ analysis database	• EFAS (European Flood Awareness System) 24h precipitation 5 km analysis • **20 years** from 1996 to 2015
Supplemental locations	• 50 supplemental locations for each grid point. • Based on *Hamill et al. (2017).* • Applied to 20 years of EFAS 5km precipitation analysis
Reforecast database for quantile mapping	• Re-forecast interpolated to 5 km. • 50 supplemental locations. • **20 years x 9 runs x 50 sup.loc x 1 cf = 9000 samples**
Climatology database for quantile mapping	• EFAS 24h precipitation • **50 sup.loc x 20 years x 9 runs = 9000 samples**

Location-dependent biases

Location-independent biases

Dual ENS calibration tests



- All the ENS combinations have the same computational cost than the current operational ENS system (0,51)

- Calibration applied to each ENS member independently.

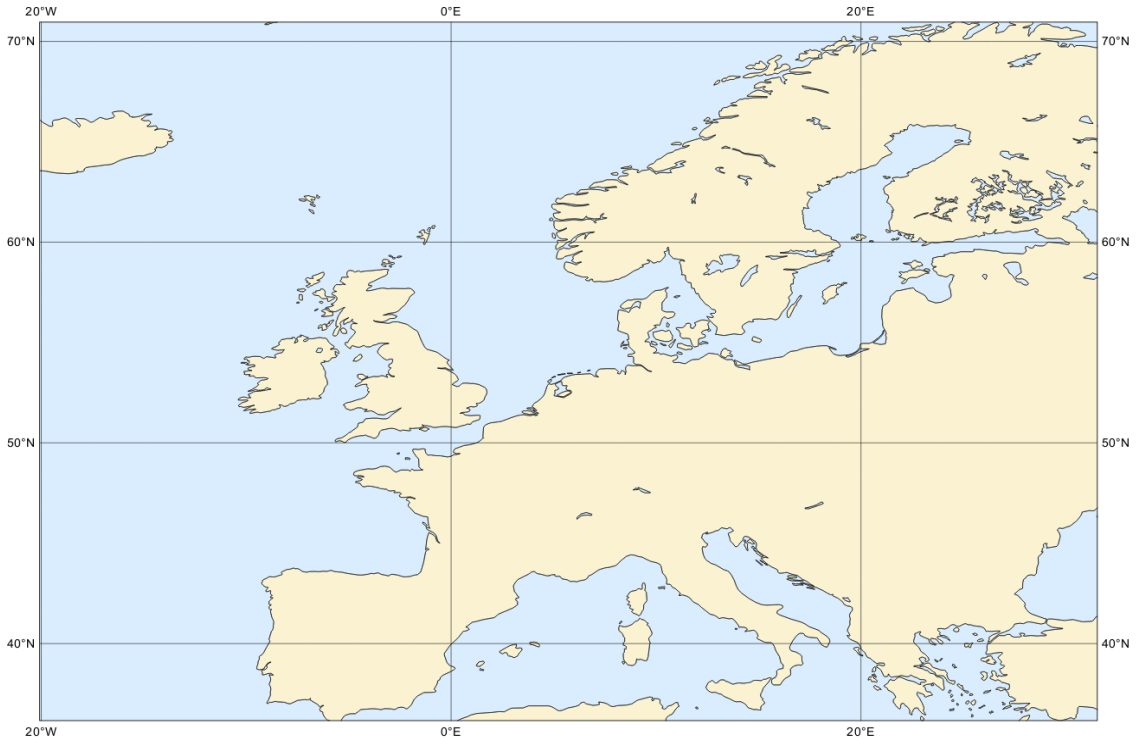
VERIFICATION

- 24h total precipitation June, July and August 2016 across **Europe**

- **EFAS 24h precipitation** at SYNOP locations.

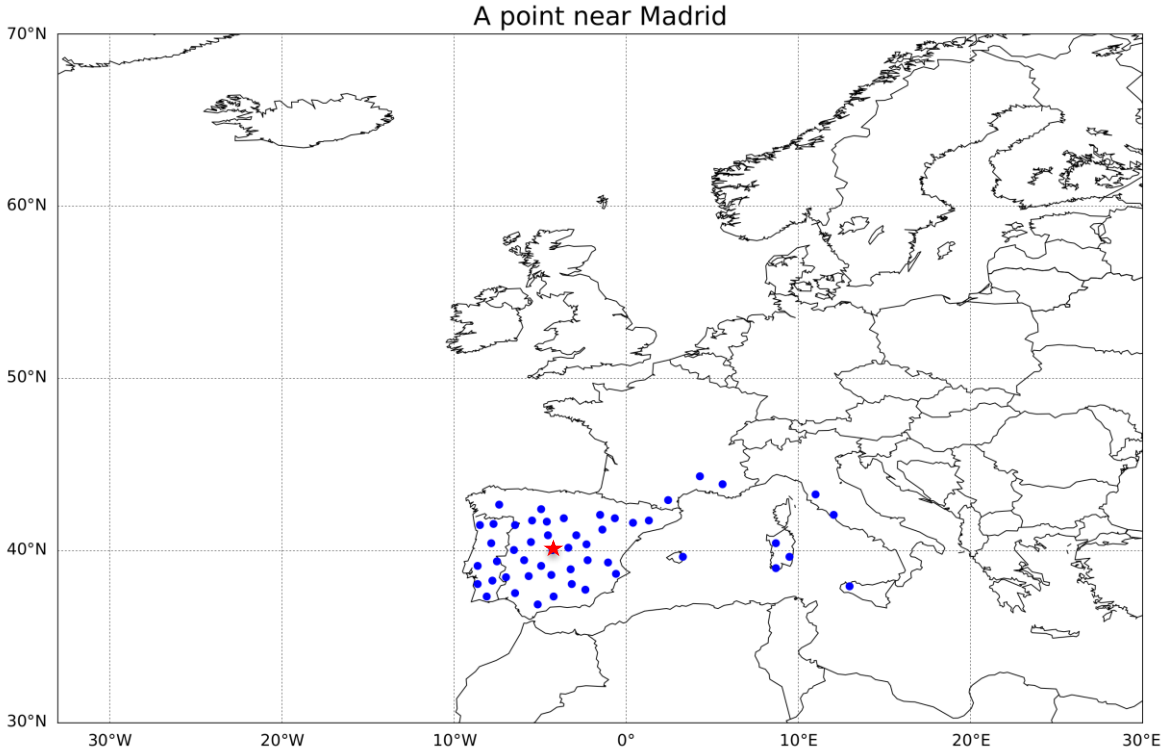
- Lead times **day 1 ,3, 5, 7 and 10**

- Verify the ENS combinations **(0,201), (10,160), (20,120), (40,40) and (51,0)**

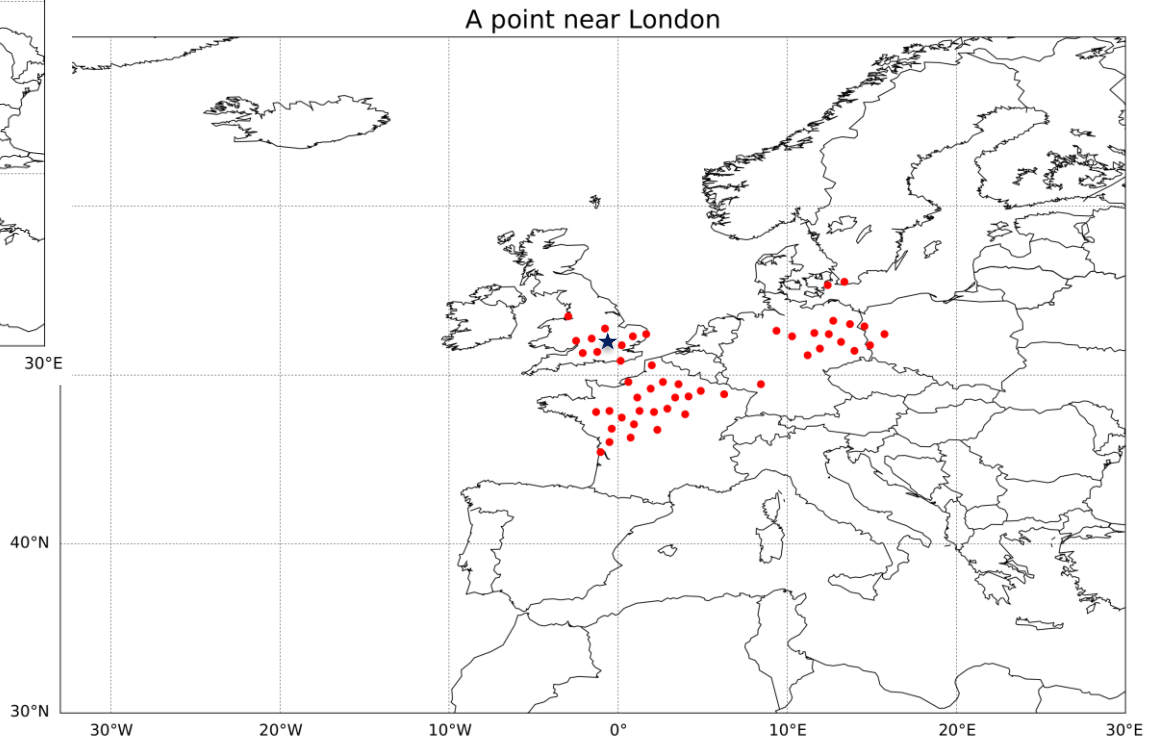


STUDY AREA

Supplemental locations (based on the method from *Hamill et al. (2017)*

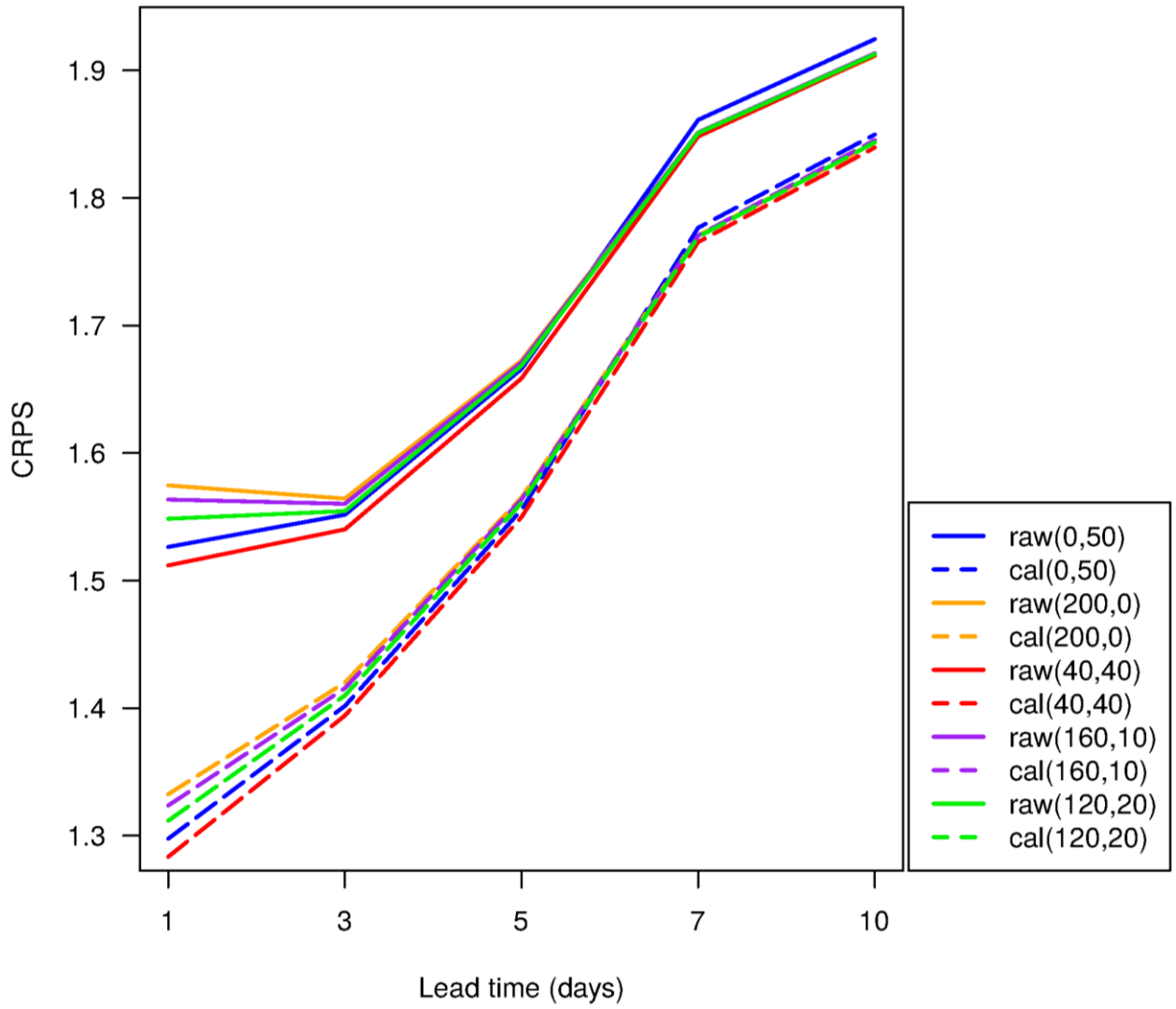


- To increase the training sample size for the quantile mapping.
- Reduce the systematic bias and location-dependant biases from a specific grid point.



- Based on common terrain and weather features:
  - 24-h Precipitation CDFs
  - Terrain heights
  - Geography (terrain facet)

VERIFICATION



CRPS

- Better CRPS for all lead times and all ENS combinations, most significant in shorter lead times.
- (0, 51) and (40,40) are the best combinations, in both, RAW and CALIBRATED forecasts.
- Quite similar score values for all the combinations at lead times equal or longer than 5 days.

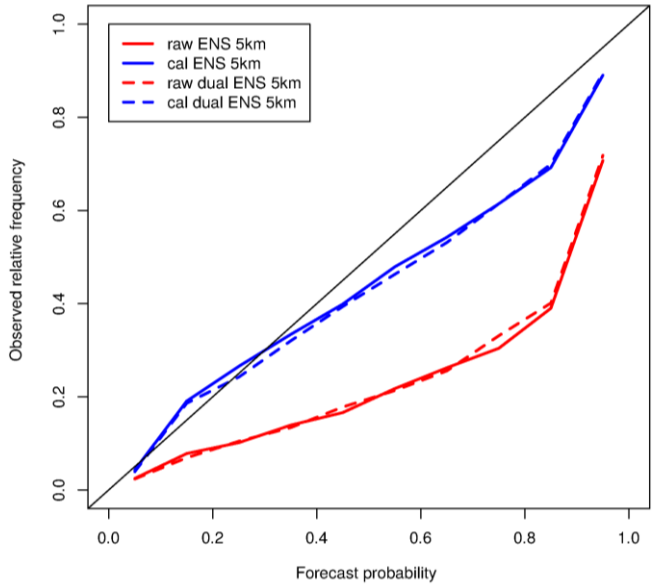
VERIFICATION

Reliability

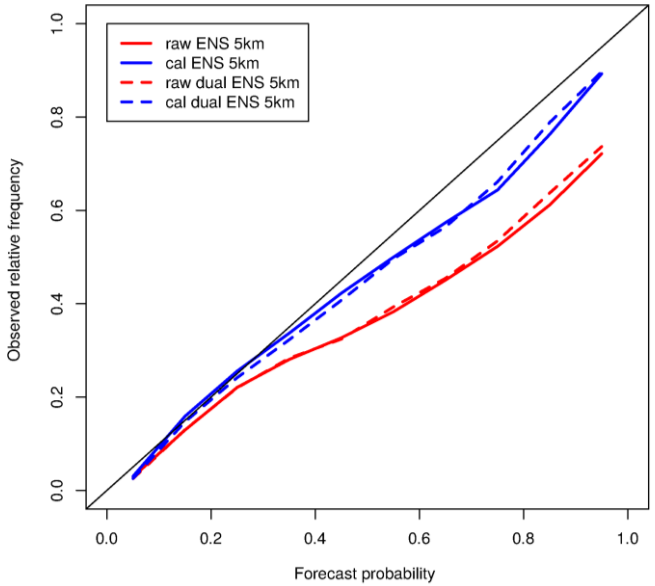
- Reliability improves after the calibration at least up to day 10 lead time and different PPT24 thresholds.

- Similar results in the current operational ENS system (0,51) than the dual ensemble combinations (i.e. 40,40)

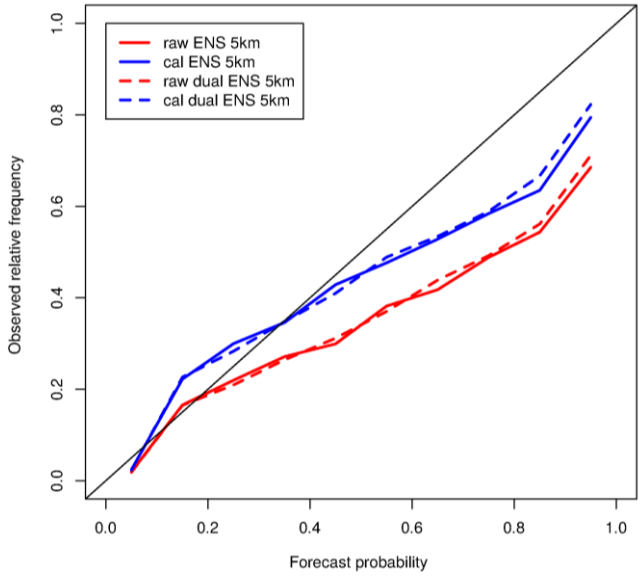
Day 1 PPT24>0.1 mm



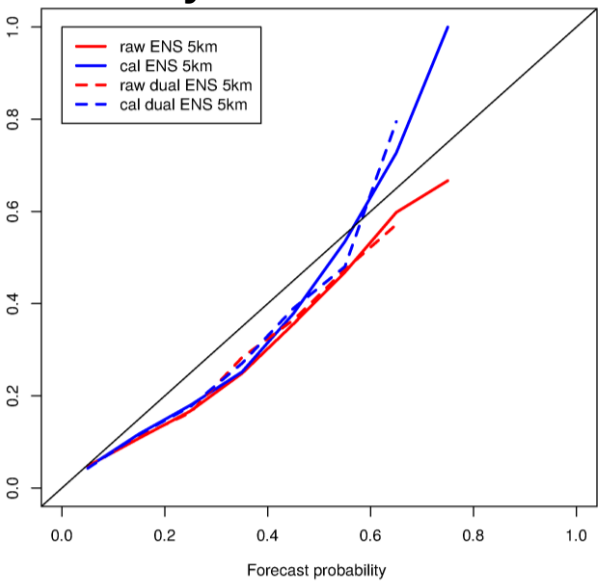
Day 10 PPT24>0.1 mm



Day 1 PPT24>10 mm



Day 10 PPT24>10 mm

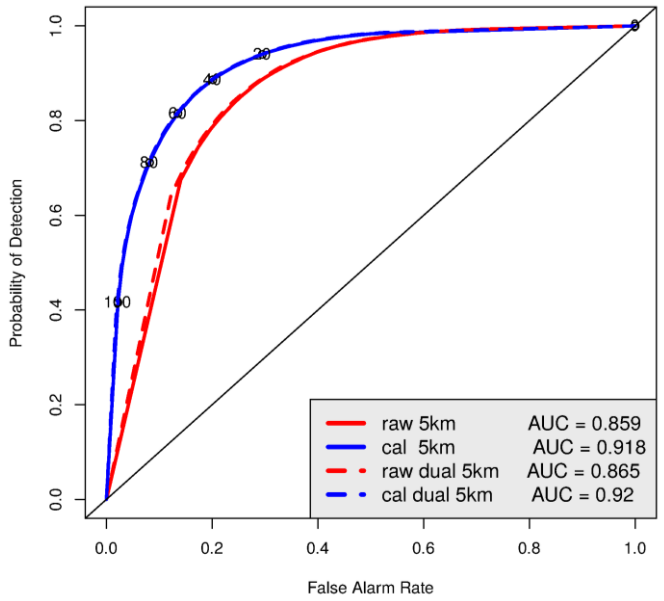


VERIFICATION

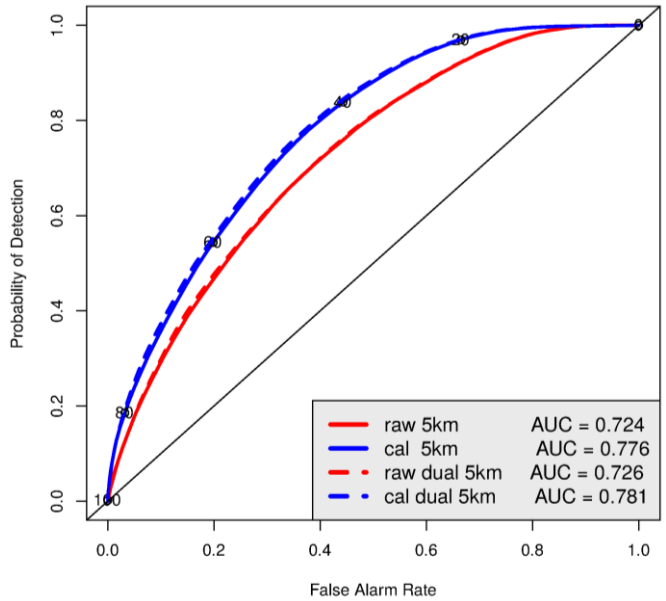
ROC curves

- Forecast skill improves after the calibration at least up to day 10 lead time and different PPT24 thresholds.
- Similar results in the current operational system (0,51) than the dual ensemble combinations (i.e. 40,40).

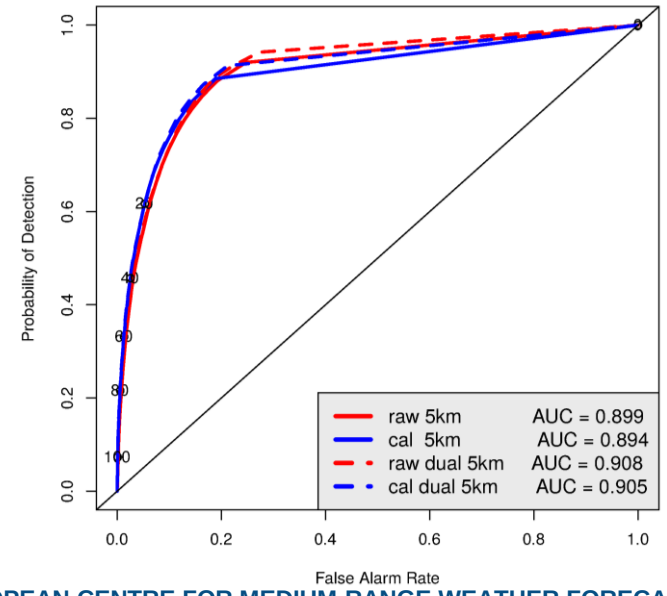
Day 1 PPT24>0.1 mm



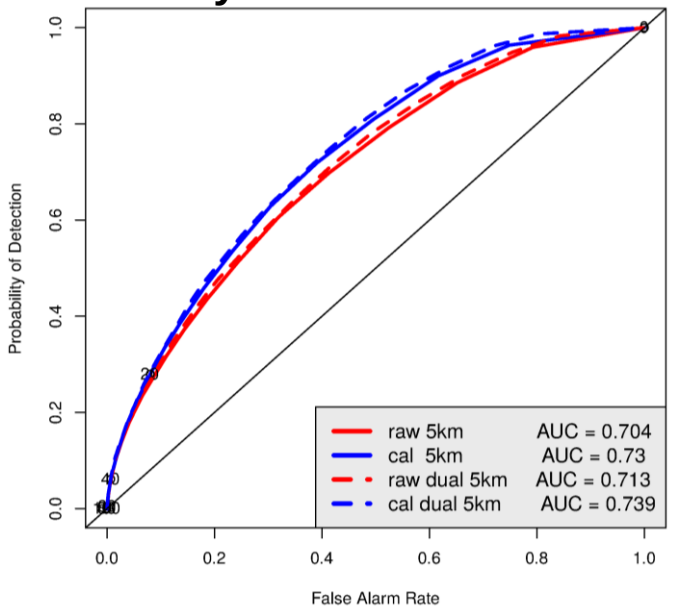
Day 10 PPT24>0.1 mm



Day 1 PPT24>10 mm



Day 10 PPT24>10 mm

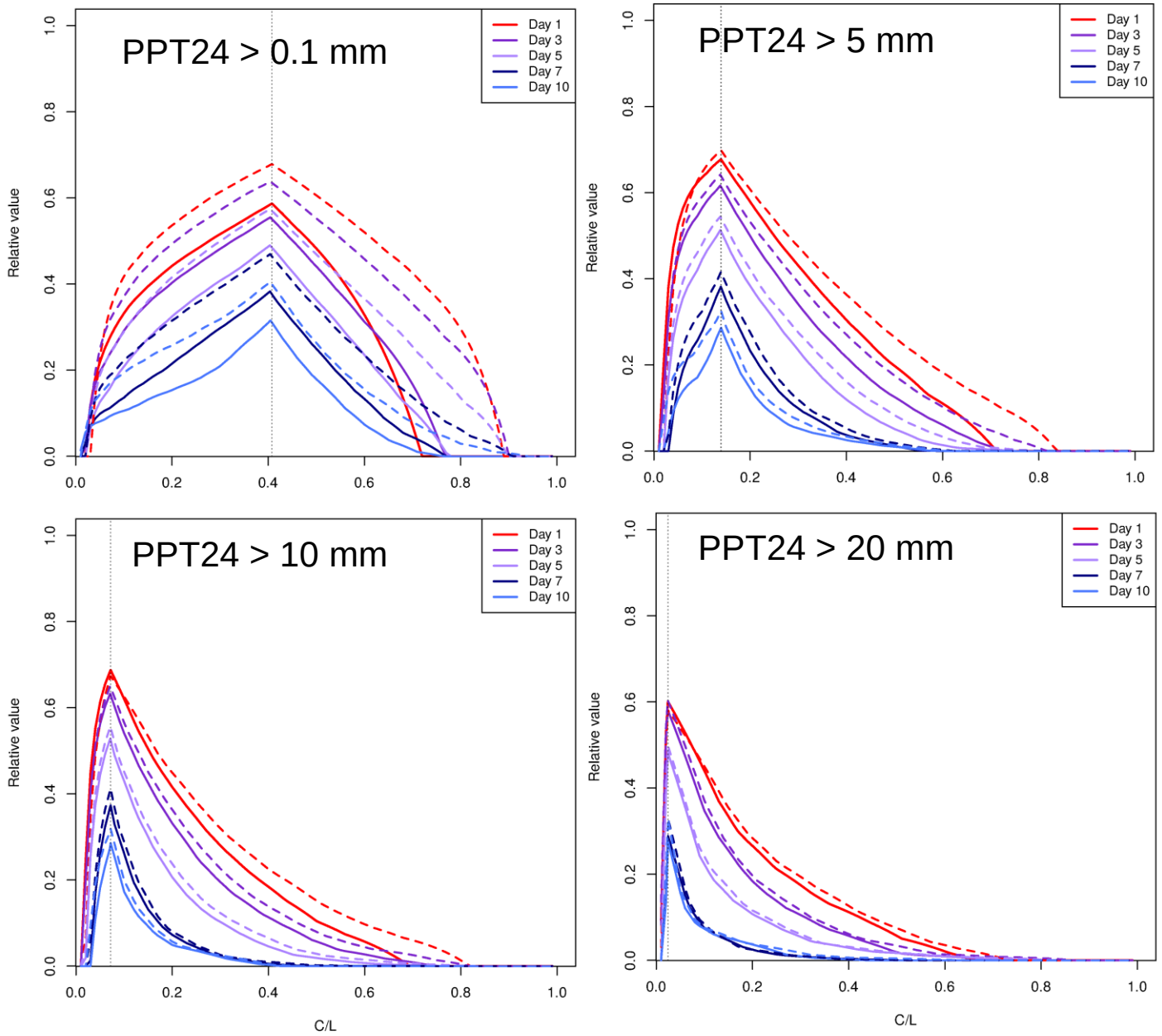


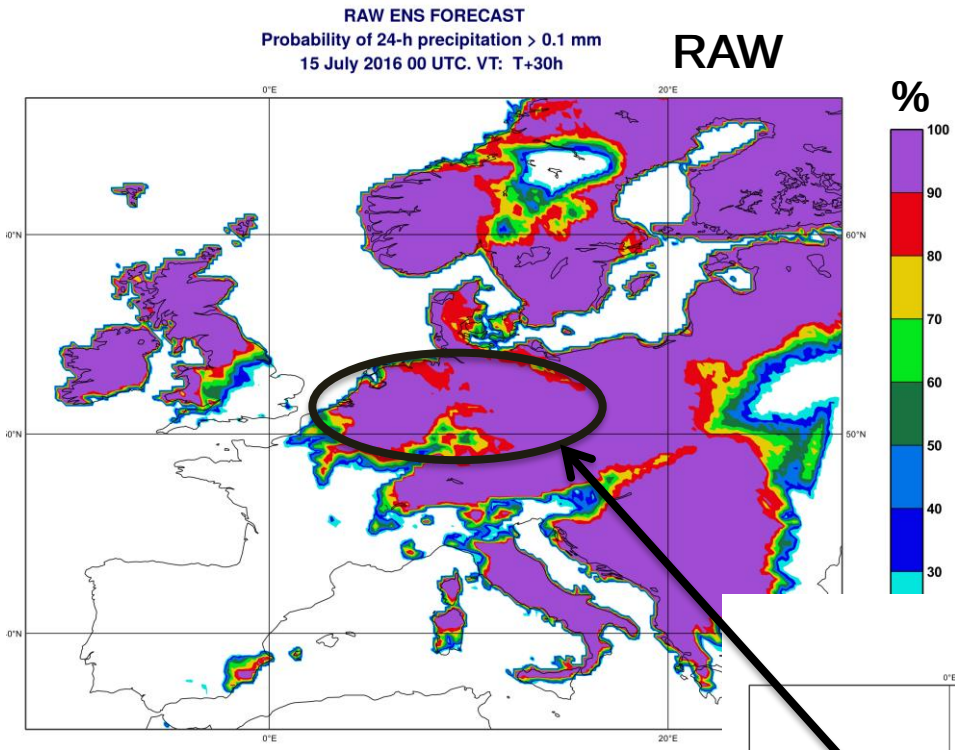
VERIFICATION

Relative economic value

- Higher relative economic value in the calibrated forecast than in the raw forecast, at least up to 5 mm threshold and for all the lead times.

- A greater number of users with different C/L can benefit from the calibrated forecast, compared to the raw forecast.

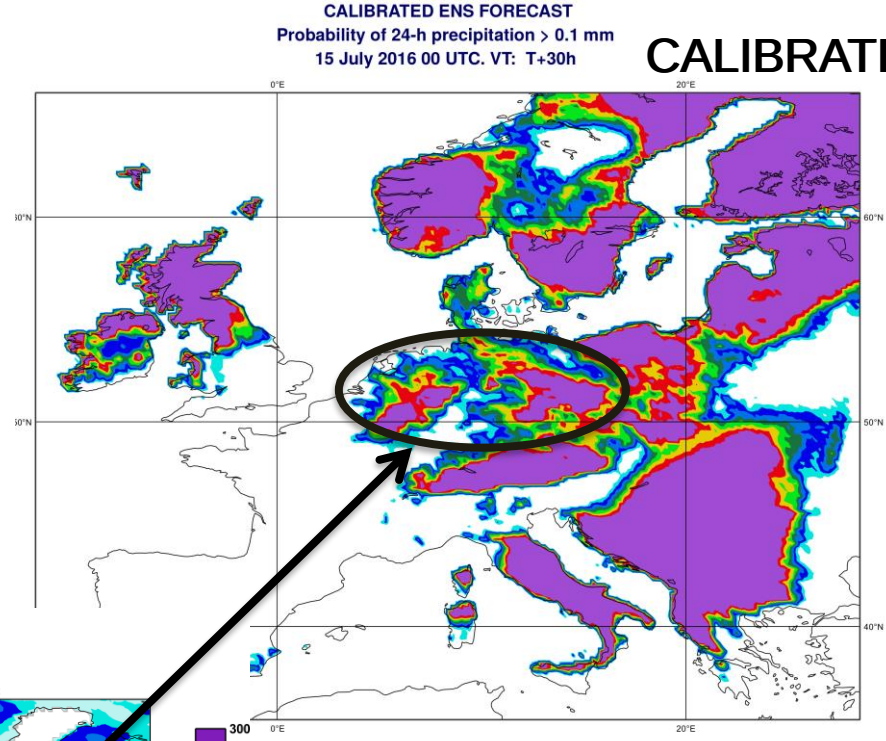




RAW

%

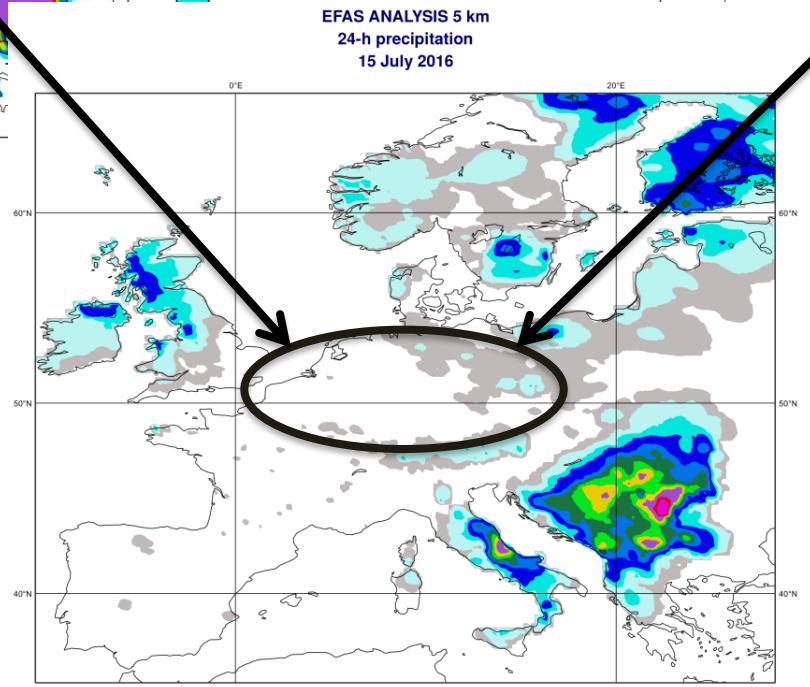
100 90 80 70 60 50 40 30



CALIBRATED

%

100 90 80 70 60 50 40 30 20 10



300 150 100 80 60 50 40 30 20 10 5 1 0.1

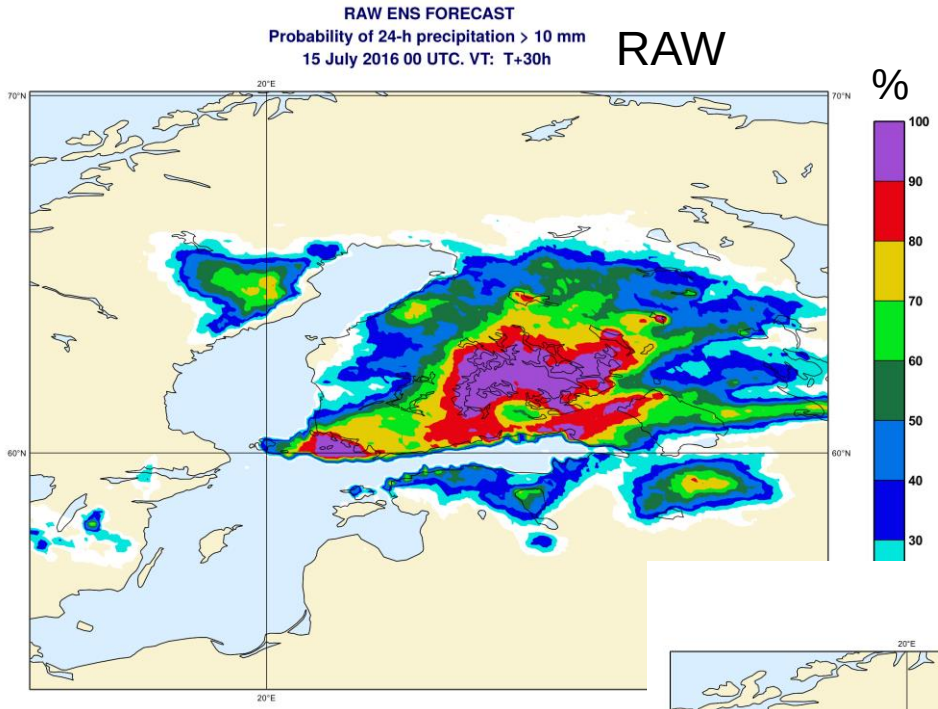
mm

EFAS 5 km analysis

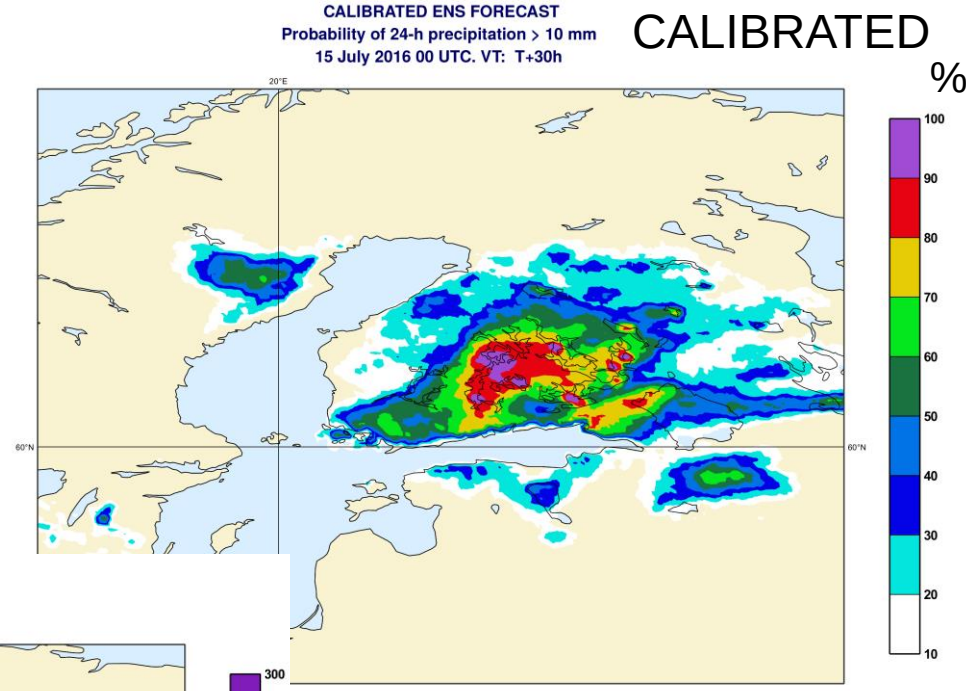
PPT24 > 0.1 mm

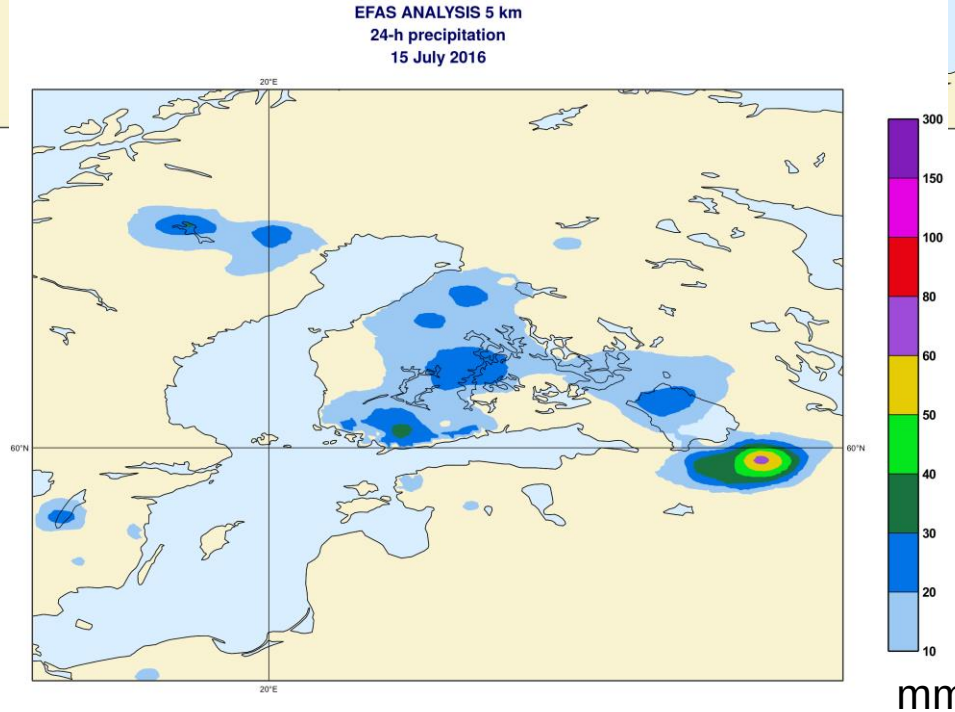
1 day lead time

RAW



CALIBRATED



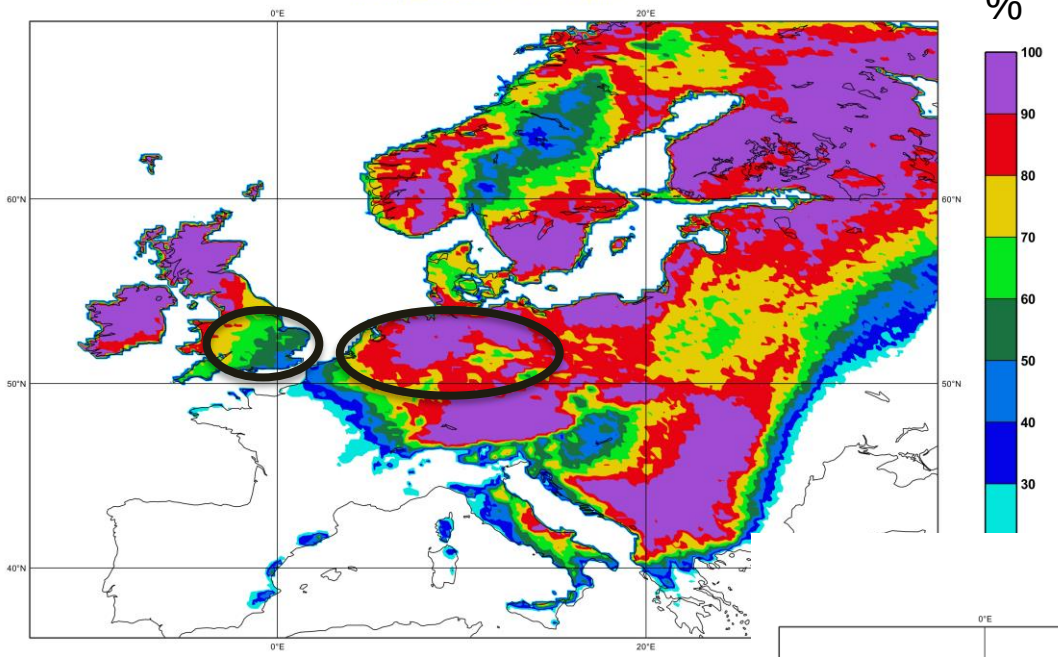


PPT24 > 10 mm

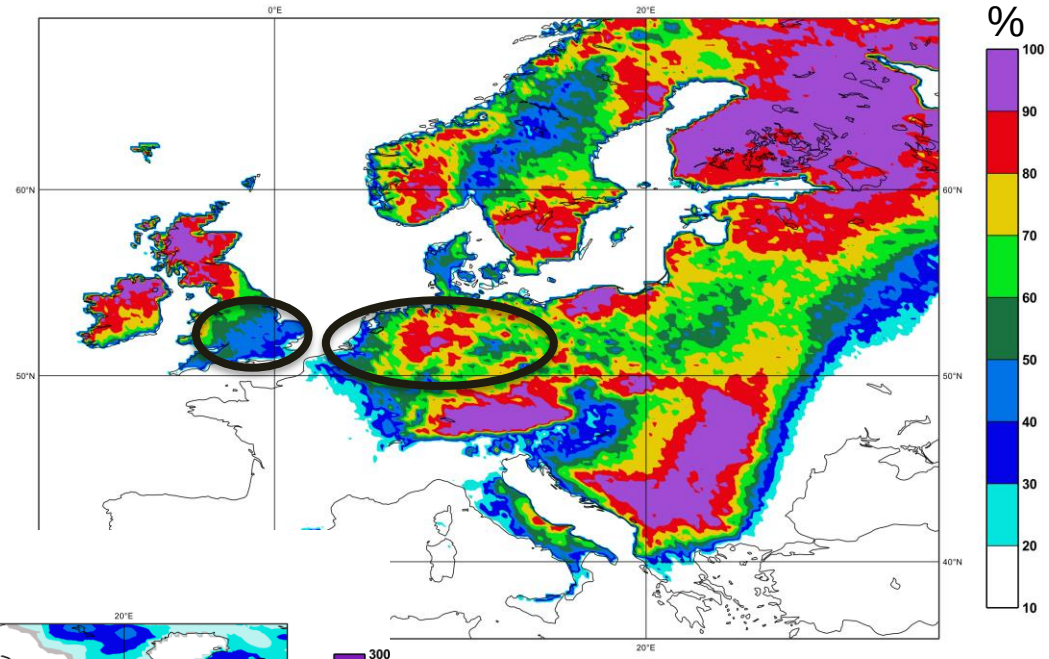
1 day lead time

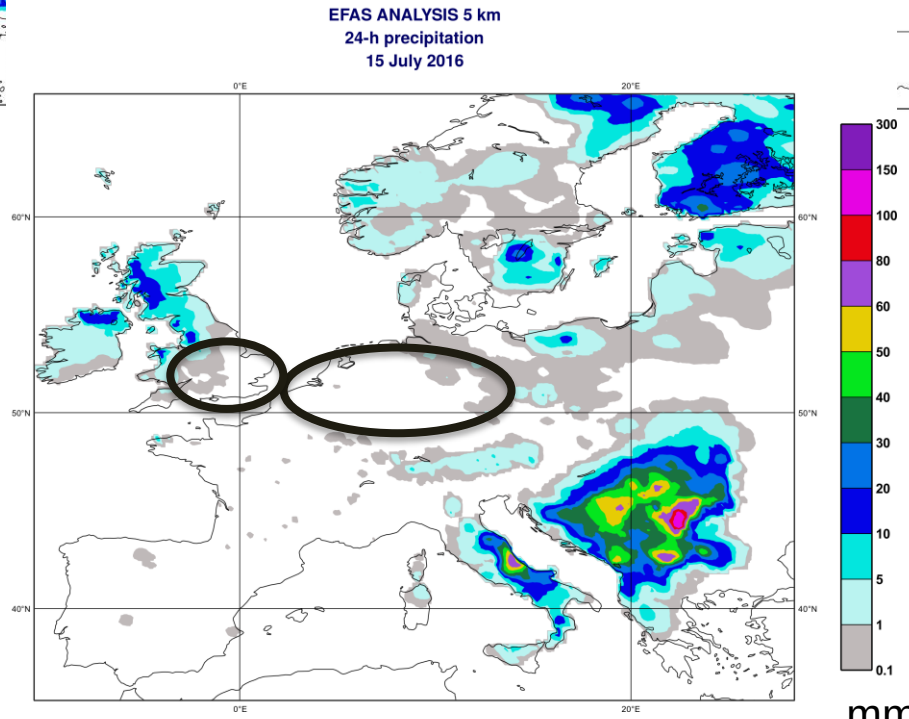
EFAS 5 km analysis

RAW



CALIBRATED





EFAS 5 km analysis

PPT24 > 0.1 mm

5 day lead time

CONCLUSIONS

- For all lead times and combinations, the calibrated forecast has better and resolution
- This calibration especially improves the forecast of low 24-h precipitation thresholds
- CRPS score shows that the most skilful combination is (40,40); however, the scores are similar to operational system.
- All the combinations have similar values in terms of reliability, skill or relative economic value.