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

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

Location-dependent biases

Location-independent biases
Dual ENS calibration tests

RAW operational (~18 km)
51 ENS members

RAW low resolution (~28 km)
201 ENS members

CALIBRATED DUAL ENS
Combinations
• (51,0)
• (40,40)
• (20,120)
• (10,160)
• (0,201)

CAL operational (5 km)
51 ENS members

CAL low resolution (5 km)
201 ENS members

CALIBRATION
Quantile mapping
- 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)
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)
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.
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)
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).
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.
PPT24 > 0.1 mm
1 day lead time
PPT24 > 10 mm
1 day lead time
PPT24 > 0.1 mm

5 day lead time

EFAS 5 km analysis
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.