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Calibration of ECMWF precipitation forecasts in a dual resolution ensemble

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Uncertainties exist in numerical weather prediction (NWP) ensemble precipitation forecasts due to a combination of the imperfect knowledge of the initial atmospheric conditions, the chaotic nature of the atmosphere and because of the incorrect representation of physical processes by NWP models (e.g. coarse spatial resolution). As ensemble precipitation forecasts from a global forecast model are sometimes under-spread and not always valid at small scales, numerous post-processing techniques have been developed to statistically correct for biases in NWP output. These techniques usually compare a set of past model forecasts with observations in order to identify systematic relationships that can be used to correct the operational forecast. Additionally, computer resource availability is the main cause of the current limitation imposed on the horizontal resolution of ensemble systems, so another option to improve the forecast can be to increase the number of ensemble members at the expense of reducing their spatial resolution.

As part of ECMWF's contribution to the EU H2020 IMPREX (Improving PRedictions and management of hydrological Extremes) project, several experiments investigating the performance of non-calibrated and calibrated daily precipitation using two different ensemble forecast resolutions have been undertaken. Firstly, a quantile mapping procedure was applied to calibrate both ensemble systems, using 20 years of reforecasts and EFAS (European Flood Awareness System) 5 km gridded precipitation analysis for Europe; supplemental locations were chosen based on the similarity of precipitation climatology and terrain to increase the sample size. Five different ensemble combinations combining subsets of the 50-member operational ECMWF configuration (18 km grid) and an experimental 200-member low-resolution configuration (28 km grid) were tested. Each combination would have similar computational cost to the current operational ensemble.

The verification of the five ensemble combinations (calibrated and raw) was undertaken with daily EFAS precipitation across Europe for June, July and August in 2016 at 1, 3, 5, 7 and 10 days lead time. The CRPS, ROC, reliability, Brier Score, Quantile Score and Relative economic value were evaluated for different 24-hour precipitation thresholds. The verification shows that the most skilful combination is 40 ensemble members from the operational configuration and 40 from the low-resolution configuration. These results suggest that that this set-up combines the advantage of the high resolution forecast system with an improved the representation of the forecast distribution, especially useful for longer lead times. Finally, for all the lead times and combinations, the calibrated forecast increases not only the reliability but also the resolution of the raw forecast.