A probabilistic approach to forecast the uncertainty with ensemble spread

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For most purposes the information gathered from an ensemble forecast is the ensemble mean and its uncertainty. The ensemble spread is commonly used as a measure of the uncertainty. We propose a method to assess whether the ensemble spread is a good measure of uncertainty and to bring forward an underlying spread-skill relationship.

Forecasting the uncertainty should be probabilistic of nature. This implies that, if only the ensemble spread is available, a probability density function (PDF) for the uncertainty forecast must be reconstructed based on one parameter. Different models are introduced for the composition of such PDFs and evaluated for different spread-error metrics. The uncertainty forecast can then be verified based on probabilistic skill scores.

For a perfectly reliable forecast the spread-error relationship is strongly heteroscedastic since the error can take a wide range of values, proportional to the ensemble spread. This makes a proper statistical assessment of the spread-skill relation intricate. However, it is shown that a logarithmic transformation of both spread and error allows for alleviating the heteroscedasticity. A linear regression analysis can then be performed to check whether the flow-dependent spread is a realistic indicator of the uncertainty and to what extent ensemble underdispersion or overdispersion depends on the ensemble spread.

The methods are tested on the ensemble forecast of wind and geopotential height of the European Centre of Medium-range forecasts (ECMWF) over Europe and Africa. A comparison is also made with spread-skill analysis based on binning methods.