The potential value of multi-model ensembles

Working group report from ECMWF/WWRP/WCRP TIGGE/S2S workshop

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Craig Bishop, Martin Leutbecher, Dan Collins, Jim Goerss, Damien Specq, Nathalia Kohonen, Claire Barnes, Jessie Carmen, Gordon, Dan Rowlands, Nils Dorband, Jan Wandel, Jan Rajczak, Bill Lamberson

What happened

- Each participant discussed their view of advantages/disadvantages/issues associated with multi-model ensembles.
- The WG discussed 6 previously prepared issues/questions.

Relevant theory

- Independence:

If each forecast was equal to truth plus an error with variance σ^2 uncorrelated with all other members, then

$$\sigma^2_{MMM} = \frac{\sigma^2}{N}$$

- Ensemble size:

~30 members define the mean fairly well

~100 members define the variance fairly well

~500 members define the skewness

Questions considered

1. Multi-model ensemble forecasts superior or inferior and why?
2. Models constantly changing. What are judicious statistical post-processing approaches in such circumstances?
3. Value of centres making data available from the tests upon which the decision to revise forecast system was based before or at the same time the new model is released?
4. Value of managing forecast independence?
5. To what extent would individual model bias correction improve the utility of multi-model ensemble forecasting?
6. Value of multi-model ensemble increased if expressed in terms of event features (location, size, shape, intensity – as in TCs)

Recommendations

1. We recommend that NMHSs share their ensemble forecasts and make them available for research through publicly available data bases like TIGGE and S2S.
2. We also recommend that NMHSs make the beta runs and/or hindcasts associated with their decision to transition to their current model, publicly available.
3. Multi-model forecasting of parameters describing shape, position and intensity of common high impact events like cyclones avoids this smearing of fields.
4. **Promising research areas:**

a. Better weighting even though training data sets inevitably inadequate.

b. Synthesizing multi-model ensembles using clustering and advanced visualization techniques

c. Deriving multi-variate pdfs from multi-model ensembles where the members themselves are not equally likely.

d. Post-processing for important spatio-temporal features.

e. Recognize that the inter-model variance is a tool for predicting uncertainty and understanding and characterize model differences.

f. Explore how the much larger ensemble size of multi-model ensembles could be used to explore higher order moments, pre-emptive forecasting.

g. Blending models of differing resolutions through time; e.g. convection resolving to medium range to S2S to decadal – climate model.