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Merging information from multi-model flood projections in a hierarchical Bayesian framework

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Multi-model ensembles are becoming widely accepted for flood frequency change analysis. The use of multiple models results in large uncertainty around estimates of flood magnitudes, due to both uncertainty in model selection and natural variability of river flow. The challenge is therefore to extract the most meaningful signal from the multi-model predictions, accounting for both model quality and uncertainties in individual model estimates. The study demonstrates the potential of a recently proposed hierarchical Bayesian approach to combine information from multiple models. The approach facilitates explicit treatment of shared multi-model discrepancy as well as the probabilistic nature of the flood estimates, by treating the available models as a sample from a hypothetical complete (but unobserved) set of models. The advantages of the approach are: 1) to insure an adequate 'baseline' conditions with which to compare future changes; 2) to reduce flood estimate uncertainty; 3) to maximize use of statistical information in circumstances where multiple weak predictions individually lack power, but collectively provide meaningful information; 4) to adjust multi-model consistency criteria when model biases are large; and 5) to explicitly consider the influence of the (model performance) stationarity assumption. Moreover, the analysis indicates that reducing shared model discrepancy is the key to further reduction of uncertainty in the flood frequency analysis. The findings are of value regarding how conclusions about changing exposure to flooding are drawn, and to flood frequency change attribution studies.