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Probabilistic climate prediction with faulty models

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Recent attempts at probabilistic climate forecasting have generally ignored the issue of model inadequacy — that is, the residual model error that cannot be eliminated by parameter tuning but is due to fundamental mismatch between the model and the system which it aims to represent. However, the discrepancy between even an optimally-tuned model, and fields of climatological observations, is far greater than can be explained by observational error alone, and therefore model inadequacy should play an important (perhaps dominant) role in the estimation procedure. Strong constraint assimilation methods are sometimes represented as being synonymous with a "perfect model" assumption, and thus unsuitable for situations where model inadequacy is significant. We show here how strong constraint methods can in fact naturally account for some types of model inadequacy, and use the ensemble Kalman filter to generate a range of probabilistic ensembles based on a range of different assumptions and climate models.