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Tuning a climate model ensemble (CLIMBER-2): comparing a range of approaches

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Climate model projections are inherently uncertain, and quantifying the uncertainty in a projection is almost as important as the projection itself. That is why ensembles of climate models have been increasingly used to produce climate forecasts: the spread of the ensemble projection is a measure for that uncertainty. The spread can then be reduced by selecting only models which satisfy observations - instrumental or proxy record. However, constructing an ensemble which satisfies the observational constraints (i.e. in which each ensemble member reproduces the observations within their uncertainty) is not trivial because of the large number of processes and parameters and the limited computer resources.

Here we will focus on a "perturbed physics ensemble", which consists in perturbing uncertain model parameters to generate the ensemble. In that work we use 20th century observations as constraints (global mean temperature: climatology and warming, ocean heat uptake, CFC etc...), but the same methods can be applied to paleoclimate proxies as well. We will compare a range of approaches with the climate model of intermediate complexity CLIMBER-2, from simple Monte Carlo sampling of model parameters (the best models are then selected or weighted ad-hoc) to more elaborate iterative methods where parameters are adjusted at each step and the ensemble slowly converges toward to the observations. Particular focus will be given to particle filters (e.g. Iterative Importance Sampling) and the iterative ensemble Kalman Filter. Procedures to extend these methods to paleoclimate applications will be discussed.