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Reliability of structurally different perturbed physics and climate model ensembles

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Reliabilities of state-of-the-art climate model ensembles, multi-model ensembles (MMEs) and three structurally different perturbed physics ensembles (PPEs) are investigated by ranking histogram approach (Annan and Hargreaves 2010). Our analysis reveals that in the MMEs, climate variables we investigated are reliable (i.e. observation can be regarded as a member of ensemble). On the other hand, in the PPEs, reliability depends on ensembles and variables. In general, mean state and historical trend of surface air temperature, and mean state of precipitation are reliable in the PPEs. However, variables related to model dynamics, such as sea level pressure or clear-sky shortwave radiation, are not reliable. This is probably because in PPEs, only uncertain physical parameters mainly related to cloud are perturbed but dynamical parameter are not perturbed, and thus PPEs cannot cover wide range of dynamics in the models. We also show biases which are common to all the MMEs and PPEs from the global map of rank of observation. In addition, interestingly, model ensembles with reliable shortwave and longwave cloud radiative effect, whose changes under global warming are responsible for the spread in CS, have ranges of CS consistent with studies published in the literature (about 2-5K). On the other hand, model ensembles with relatively high (about 4-10K) or relatively low (about 2-3K) CS does not have reliable performance of cloud radiative effects. This result gives us more confident in the spread of CS in the studies published in the literature.

Reference

Annan and Hargreaves 2010, Reliability of the CMIP3 ensemble. Geophys Res Lett 37:L02703. doi:10.1029/2009GL041994