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Learning about climate sensitivity over time

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Although some features of climate change are known with relative certainty, many uncertainties in the climate science remain. The most important uncertainty pertains to the Climate Sensitivity (CS), i.e. the equilibrium increase in the global mean surface temperature that follows from a doubling of the atmospheric CO_2 concentration.
The marginal distribution of the CS can be estimated from the observational record of global mean surface temperatures and ocean heat uptake together with estimates of anthropogenic and natural radiative forcings. However, since the CS is statistically dependent on other uncertain factors, such as the uncertainty in the direct and indirect radiative forcing of aerosols, it is difficult to constrain the multivariate distribution from observations.

The primary aim with this presentation is to analyze how the joint distribution of the key parameters in an Upwelling Diffusion Energy Balance Model (UDEBM) changes over time as the observational record becomes longer using a Bayesian Markov Chain Monte Carlo approach. Natural variability is handled by removing the ENSO signal (from the surface temperature observations) and by treating the remaining natural variability as a first order autoregressive process. We analyze how the distributions of the CS, ocean mixing parameters and an aerosol forcing scaling factor change over time when using observations up to 1980, 1990, 2000 and 2010. By analyzing how the multivariate distribution changes as more observations become available we may say something about the learning about climate sensitivity from observations.

Our preliminary results shows that the marginal distribution for CS remains relatively unconstrained when using observations up to 2000, while the inclusion of observations up 2010 result in a more constrained estimate of the CS. However, a critical issue concerns the modeling of natural variability, that is, has the last ten years of observations been critical in narrowing down the uncertainty range for the CS or is the result (at least in part) an artifact of an underrepresentation of natural variability?