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Sensitivity of the likelihood function for climate system parameters to assumptions about the historical radiative forcing

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Several studies have identified likelihood functions for the value of pertinent climate system properties, namely climate sensitivity (CS), vertical ocean heat diffusivity (OHD), and sulphate aerosol cooling (SAC), from a comparison of model simulations with the temperature record of the 20th century. Obviously, such estimates will depend on assumptions about the historical radiative forcing trajectory, which itself is very uncertain - not only due to our limited knowledge about the sulphate cooling, but also about contributions from black and organic carbon as well as solar and volcanic forcing.

In the work presented here, we investigate the sensitivity of the joint likelihood function for CS, OHD, and SAC to various scenarios for the historical radiative forcing (excluding SAC) from the literature. The scenario approach is in some sense complementary to a second approach, which parameterizes the remaining forcing uncertainty in order to process it in a Monte Carlo type analysis. Due to the large number of uncertain parameters, the latter approach usually has to assume independence between the various forcing parameters, while in the former approach the uncertainty has been grouped around a limited number of scenarios.

We use an efficient energy balance model with 1-D diffusive ocean to scan the profile of the 3-dimensional likelihood function. The likelihood for the model parameters is estimated by assuming that the residual between model response and instrumental SST record constitutes an AR(1) process after removal of the ENSO signal. We will investigate which features of the likelihood function are robust under the various forcing scenarios, and which are not.