Ensemble design for sensitivity analyses using the Energy Exascale System Model (E3SM)

This talk will discuss ensemble design for sensitivity analyses using the U.S. Department of Energy's Energy Exascale Earth System Model (E3SM). We will present and discuss results from a variance-based global sensitivity analysis (GSA) using a fully-coupled, ultra-low resolution (ULR) configuration of version 1 of the E3SM (E3SMv1), performed as a first step towards quantifying parametric uncertainty in Arctic feedbacks. The study randomly draws 139 realizations of 10 model parameters spanning 3 E3SMv1 components, which are used to generate 75-year long projections of future climate with a fixed pre-industrial forcing. We quantify the sensitivity of 6 Arctic-focused quantities of interest to these parameters using main effect, total effect and Sobol sensitivity indices computed with a Gaussian process (GP) emulator. A sensitivity index-based ranking of model parameters shows that the atmospheric parameters in the CLUBB (Cloud Layers Unified by Binormals) scheme have significant impact on the Arctic climate. We also use our GP emulator to predict the response of varying each variable when the impact of other parameters is averaged out. Our study confirms the necessity of performing global analyses using fully-coupled climate models, and motivates follow-on studies involving the ULR model. Time-permitting, we will present some preliminary work involving ensemble design for a sensitivity study to understand the impacts of Stratospheric Aerosol Injection using the E3SM.