

## **Global Sensitivity Analysis Using the Ultra-Low Resolution Energy Exascale Earth System Model**

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For decades, the Arctic has been warming at least twice as fast as the rest of the globe. As a first step towards quantifying parametric uncertainty in Arctic feedbacks, we perform a variance-based global sensitivity analysis (GSA) using a fully-coupled, ultra-low resolution (ULR) configuration of version 1 of the Department of Energy's Energy Exascale Earth System Model (E3SMv1). The study randomly draws 139 realizations of ten model parameters spanning three E3SMv1 components, which are used to generate 75-year long projections of future climate using a fixed pre-industrial forcing. We quantify the sensitivity of six Arctic-focused quantities of interest (QOIs) 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 sea ice status and the larger Arctic climate. We also use our GP emulator to predict the response of varying each variable when the impact of other parameters are averaged out. These results allow one to assess the non-linearity of a parameter's impact on a QOI and investigate the presence of local minima encountered during the spin-up tuning process. Our study confirms the necessity of performing global analyses involving fully-coupled climate models, and motivates follow-on investigations involving the ULR model.