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History Matching for the tuning of coupled models: experiments on the Lorenz 96 model

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The process of relying on experience and intuition to find good sets of parameters, commonly referred to as "parameter tuning" keeps having a central role in the roadmaps followed by dozens of modeling groups involved in community efforts such as the Coupled Model Intercomparison Project (CMIP).

In this work, we study a tool from the Uncertainty Quantification community that started recently to draw attention in climate modeling: History Matching also referred to as "Iterative Refocussing". The core idea of History Matching is to run several simulations with different set of parameters and then use observed data to rule-out any parameter settings which are "implausible". Since climate simulation models are computationally heavy and do not allow testing every possible parameter setting, we employ an emulator that can be a cheap and accurate replacement. Here a machine learning algorithm, namely, Gaussian Process Regression is used for the emulating step. History Matching is then a good example where the recent advances in machine learning can be of high interest to climate modeling.

One objective of this study is to evaluate the potential for history matching to tune a climate system with multi-scale dynamics. By using a toy climate model, namely, the Lorenz 96 model, and producing experiments in perfect-model setting, we explore different types of applications of HM and highlight the strenghts and challenges of using such a technique.