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History Matching for parameter tuning: the Lorenz96 model as a case study

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A major cause of earth system model discrepancies result from processes that are missed or are incorrectly represented in the model's equations. Despite the increasing number of collected observations, reducing parametric uncertainties is still an enourmous challenge.

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.

We investigate History Matching on a toy model: the two-layer Lorenz96, and share our findings about the challenges and opportunities of using this technique. We also discuss the use of this technique for realistic ocean models such as NEMO.