

CONDITIONAL EMULATORS FOR PARAMETER TUNING IN EARTH SCIENCE SIMULATIONS

Vadim Zinchenko

Master Program for Polar and Marine Sciences POMOR, 050406 Ecology and environmental management

Supervisors:

Prof. Dr. Johanna Baehr, Universität Hamburg

Dr. David Greenberg, Helmholtz-Zentrum Hereon

Prof. Dr. Tatyana Belonenko, St. Petersburg State University

Simulators combine physical and empirical knowledge, making them powerful tools for understanding and predicting the behavior of the Earth system. Their large system sizes, chaotic dynamics and interactions across multiple spatial and temporal scales make them extremely complex. In order to use them effectively for forecasting, their physical parameters must be tuned. Parameter tuning is widely recognized as a challenging task, made even more difficult by the fact that gradients of simulator outputs with respect to these parameters are typically unavailable.

Here we show how neural networks can be used to construct conditional emulators that calculate parameter gradients. We demonstrate the application of our approach on the chaotic Lorenz '96 model by training emulators on simulations with diverse parameter settings. We show that these conditional emulators can be used to estimate unknown simulator parameters from noisy observations of the simulated system.

We also introduce a new approach to deal with long sequences of observations, which is particularly challenging when performing parameter tuning on chaotic systems. It based on splitting these long observations into smaller chunks. We carried out systematic experiments to examine the effect of noise level, observation sequence length and the strength of external forcing on the accuracy of parameter tuning.