Crossbreeding CMIP6 Earth System Model Features with an Emulator

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Improving future climate change projections with the MESMER emulator

What? Improving the sampling of the temperature projection phase space compared to the newly available Coupled Model Intercomparision Project phase six (CMIP6) ensemble.

Why? These projections serve as basis for global and regional assessments of future climate change. However, the projection phase space is only sparsely sampled by the CMIP6 ensemble (Earth System Models (ESMs) = computationally expensive -> limited number of runs available) + agreement with observations is not taken into account.

How? With the MESMER emulator.

(Beusch et al., 2020b)

MESMER mimics ESM-specific large initial-condition ensembles at a negligible computational cost

In Beusch et al. (2020a), we introduce the MODular Earth System Model Emulator (MESMER) with spatially resolved output. The idea is to generate such an emulator for each ESM of the CMIP6 ensemble. For a single ESM, this emulator is represented by a high-dimensional function. To avoid non-physical properties, we fix the ESM’s climate system state for a representative year (e.g., 1990) and only optimize the emulator’s parameters. Since climate models by definition contain a number of degrees of freedom that are not of direct interest (e.g., land surface and snow/ice processes), we fix their state to a common, observationally constrained state and only optimize the emulator’s parameters for the atmospheric component of the model.

(Beusch et al., 2020a)

Evaluating the global and regional temperature performance of ESMs

(Earth Observation Climate model)

(Fig. 2c from Beusch et al., 2020b)

Crossbreeding as a tool to avoid loss of information in observationally-constrained ESM ensembles

In Beusch et al. (2020b), we propose to «crossbreed» ESMs to retain the full suite of ESM features consistent with observations at both global and regional scales:

(Earth Observation Climate model)

Results are spatially diverse and inter-ESM uncertainty remains large

Conservative removal approach: grey ESMs excluded, i.e. the ones never consistent with observations (for details + «best estimate» approach see Beusch et al., 2020b)

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