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High dimensional decision dilemmas in climate models

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Abstract. An important source of uncertainty in climate models is linked to the calibration of model parameters. Interest in systematic and automated parameter optimization procedures stems from the desire to improve the model climatology and to quantify the average sensitivity associated with potential changes in the climate system. Building upon on the smoothness of the response of an atmospheric circulation model (AGCM) to changes of four adjustable parameters, Neelin et al. (2010) used a quadratic metamodel to objectively calibrate the AGCM. The metamodel accurately estimates global spatial averages of common fields of climatic interest, from precipitation, to low and high level winds, from temperature at various levels to sea level pressure and geopotential height, while providing a computationally cheap strategy to explore the influence of parameter settings. Here, guided by the metamodel, the ambiguities or dilemmas related to the decision making process in relation to model sensitivity and optimization are examined. Simulations of current climate are subject to considerable regional-scale biases. Those biases may vary substantially depending on the climate variable considered, and/or on the performance metric adopted. Common dilemmas are associated with model revisions yielding improvement in one field or regional pattern or season, but degradation in another, or improvement in the model climatology but degradation in the interannual variability representation. Challenges are posed to the modeler by the high dimensionality of the model output fields and by the large number of adjustable parameters. The use of the metamodel in the optimization strategy helps visualize trade-offs at a regional level, e.g., how mismatches between sensitivity and error spatial fields yield regional errors under minimization of global objective functions.

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