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Parameter Optimization in an atmospheric GCM using the Simultaneous Perturbation Stochastic Approximation (SPSA) technique

Reema Agarwal, Armin Köhl, and Detlef Stammer

Institut für Meeresforschung, Center für Erdsystemforschung und Nachhaltigkeit (CEN), University of Hamburg, Bundesstraße 53, D-20146 Hamburg

We present an application of a multivariate parameter optimization technique to a global primitive equation Atmospheric GCM. The technique is based upon the Simultaneous Perturbation Stochastic Approximation (SPSA) algorithm, in which gradients of the objective function are approximated. This technique has some advantages over other optimization procedures (such as Green's function or the Adjoint methods) like robustness to noise in the objective function and ability to find the actual minimum in case of multiple minima. Another useful feature of the technique is its simplicity and cost effectiveness. The atmospheric GCM used is the coarse resolution PLAnet SIMulator (PLASIM). In order to identify the parameters to be used in the optimization procedure, a series of sensitivity experiments with 12 different parameters was performed and subsequently 5 parameters related to cloud radiation parameterization to which the GCM was highly sensitive were finally selected. The optimization technique is applied and the selected parameters were simultaneously tuned and tested for a period of 1-year GCM integrations. The performance of the technique is judged by the behavior of model's cost function, which includes temperature, precipitation, humidity and flux contributions. The method is found to be useful for reducing the model's cost function against both identical twin data as well as ECMWF ERA-40 reanalysis data.