Geophysical Research Abstracts, Vol. 7, 09185, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09185

Earth System Model optimisation using Response Surface Modelling in the Grid-enabled GENIE framework

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Models frequently contain parameters that are poorly constrained by observations or are a product of simplification during model formulation. In the case of Earth System Models (ESMs), which typically comprise several earth system components more commonly modelled separately, there can be many such parameters. Consequently, with so many degrees of freedom it can be difficult to tune a model to observations in preparation for experiments.

The Grid-enabled GENIE framework provides an interface to a Design Search and Optimisation package which we exploit to adopt a Response Surface Modelling (RSM) approach to tune an ESM comprising a 3D ocean, sea-ice and a simplified 2D atmosphere (GENIE c-GOLDSTEIN). This approach uses a small (order 100) number of computationally-expensive simulations to sample multi-dimensional (order 12) parameter space with respect to a [model - observations] error function. These samples are pooled to generate a response surface (using a Kriging method) to estimate the behaviour of this error function across parameter space. By finding the minimum point on this surface, simulating at this point, and then adding the new simulation to the pool to regenerate the response surface, the error minimum is successively refined.

Further work evaluates the performance of this method by attempting to recover model parameters in twin studies. The consequences of the choice of error function (e.g. state variables versus fluxes) are also examined.