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Definitions

Geosci. Model Dev., 7, 1609-1619, 2014
www.geosci-model-dev.net/7/1609/2014/
doi:10.5194/gmd-7-1609-2014

Limiting the parameter space in the Carbon Cycle Data Assimilation System (CCDAS)

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Abstract. Terrestrial ecosystem models are employed to calculate the sources and sinks of carbon dioxide between land and atmosphere. These models may be heavily parameterised. Where reliable estimates are unavailable for a parameter, it remains highly uncertain; uncertainty of parameters can substantially contribute to overall model output uncertainty. This paper builds on the work of the terrestrial Carbon Cycle Data Assimilation System (CCDAS), which, here, assimilates atmospheric CO_2 concentrations to optimise 19 parameters of the underlying terrestrial ecosystem model (Biosphere Energy Transfer and Hydrology scheme, BETHY). Previous experiments have shown that the identified minimum may contain non-physical parameter values. One way to combat this problem is to use constrained optimisation and so avoid the optimiser searching non-physical regions. Another technique is to use penalty terms in the cost function, which are added when the optimisation searches outside of a specified region. The use of parameter transformations is a further method of avoiding this problem, where the optimisation is carried out in a transformed parameter space, thus ensuring that the optimal parameters at the minimum are in the physical domain. We compare these different methods of achieving meaningful parameter values, finding that the parameter transformation method shows consistent results and that the other two provide no useful results.

Citation: Kemp, S., Scholze, M., Ziehn, T., and Kaminski, T.: Limiting the parameter space in the Carbon Cycle Data Assimilation System (CCDAS), Geosci. Model Dev., 7, 1609-1619, doi:10.5194/gmd-7-1609-2014, 2014.

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Published on 20 Jan 2014

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