Geophysical Research Abstracts
Vol. 18, EGU2016-2760, 2016
EGU General Assembly 2016

Application of identified sensitive physical parameters in reducing the uncertainty of numerical simulation

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An important source of uncertainty, which then causes further uncertainty in numerical simulations, is that residing in the parameters describing physical processes in numerical models. There are many physical parameters in numerical models in the atmospheric and oceanic sciences, and it would cost a great deal to reduce uncertainties in all physical parameters. Therefore, finding a subset of these parameters, which are relatively more sensitive and important parameters, and reducing the errors in the physical parameters in this subset would be a far more efficient way to reduce the uncertainties involved in simulations. In this context, we present a new approach based on the conditional nonlinear optimal perturbation related to parameter (CNOP-P) method. The approach provides a framework to ascertain the subset of those relatively more sensitive and important parameters among the physical parameters. The Lund–Potsdam–Jena (LPJ) dynamical global vegetation model was utilized to test the validity of the new approach. The results imply that nonlinear interactions among parameters play a key role in the uncertainty of numerical simulations in arid and semi-arid regions of China compared to those in northern, northeastern and southern China. The uncertainties in the numerical simulations were reduced considerably by reducing the errors of the subset of relatively more sensitive and important parameters. The results demonstrate that our approach not only offers a new route to identify relatively more sensitive and important physical parameters but also that it is viable to then apply “target observations” to reduce the uncertainties in model parameters.