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www.geosci-model-dev.net/6/45/2013/
doi:10.5194/gmd-6-45-2013

11 Jan 2013

Quantifying the model structural error in carbon cycle data assimilation systems

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Received: 06 Jul 2012 – Published in Geosci. Model Dev. Discuss.: 14 Aug 2012
Revised: 21 Nov 2012 – Accepted: 26 Nov 2012 – Published: 11 Jan 2013

Abstract. This study explores the impact of the structural error of biosphere models when assimilating net ecosystem exchange (NEE) measurements or CO_2 concentration measurements to optimise uncertain model parameters within carbon cycle data assimilation systems (CCDASs). This error has been proven difficult to identify and is often neglected in the total uncertainty budget. We propose a simple method which is derived from the model-minus-observation mismatch statistics. This

diagnosis is applied to a state-of-the-art biogeochemical model using measurements of the net surface CO_2 flux at twelve sites located in temperate, deciduous, broadleaf forests. We find that the structural model error in the NEE space has a standard deviation of 1.5 to 1.7 gC m^{-2} d^{-1}, without a significant correlation structure beyond the lag of a few days, and a large spatial structure that can be approximated with an exponential decay of e-folding length of 500 km. In the space of concentrations, its characteristics are commensurate with the transport errors, both for surface air sample measurements and total column measurements. The inferred characteristics are confirmed by complementary optimality diagnostics performed after site-scale parameter optimisations.

Citation: Kuppel, S., Chevallier, F., and Peylin, P.: Quantifying the model structural error in carbon cycle data assimilation systems, Geosci. Model Dev., 6, 45-55, doi:10.5194/gmd-6-45-2013, 2013.