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{Climate Data Assimilation using inverse modelling: Application to the Carbon Cycle}

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Concern about the uncertainty on the current and future behaviour of the terrestrial carbon cycle has stimulated the research community to build complex observing systems for the terrestrial carbon cycle. These observations are of many forms and are made either at a point or with detailed spatial coverage. Improving our understanding requires incorporating these measurements into underlying modelling frameworks. This has led to the adoption of assimilation techniques widely used in numerical weather prediction to this inherently climatic problem. The difficulties are substantially different however since the underlying models of the terrestrial biosphere are much less developed than their meteorological counterparts. Thus there are uncertainties both on the underlying model and the observation operators in this climate assimilation problem. Here we present a comparison of two assimilation systems which differ only in the choice of observation operator. The relevant observations are of atmospheric concentration so the observation operator is an atmospheric transport model that links carbon fluxes to atmospheric concentrations.

The assimilation system CCDAS (Carbon Cycle Data Assimilation System) is built around the terrestrial biosphere model BETHY (Biosphere Energy Transfer Hydrology) and we attach this to efficient representations of the TM2 and TM3 transport models. After presenting the basic formalism we show the impact of the choice of observation operator on the implied function of the terrestrial biosphere, particularly tracing the impact of different seasonality of transport.