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Estimating and understanding contemporary large-scale CO2 fluxes using 4D-Var for inverse transport modelling

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Knowledge of fluxes from terrestrial carbon reservoirs is currently uncertain. While the atmospheric burden and oceanic uptake of carbon are well understood, evidence points to a large land sink, equivalent in size to the atmospheric sink. However, neither the nature nor the location of this land reservoir is well known.

Atmospheric transport models, such as the CTM TOMCAT, predict the forward transport of carbon in the atmosphere by numerically solving tracer transport equations with respect to conditions based upon observed data. However, if an 'adjoint' to the CTM is created, it can be used to solve the inverse problem of investigating the nature of carbon sources and sinks using information about atmospheric carbon patterns i.e. inverse transport modelling.

Due to recent and imminent improvements in remote sensing of atmospheric CO2, there will soon be thorough high-resolution data available which can be used in order to constrain the results from inverse transport modelling. In this work we describe the creation of the adjoint of the TOMCAT CTM and its application to the inverse modeling of carbon fluxes. The inverse model is created through methods involving matrix inversion and iterative minimisation of a cost function involving surface carbon fluxes.