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NON-LINEAR PARAMTER OPTIMISATION OF A TERRESTIAL BIOSPHERE MODEL USING ATM. CO2 OBSERVATIONS

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Various indirect methods suggest that much of the year-year variability in the growth-rate of atmospheric CO2 over the last two decades is attributable to variability in the net terrestrial flux. It is much less clear which processes are responsible for this terrestrial variability. In this talk we present results from a carbon cycle data assimilation system (CCDAS) in which the controlling parameters in a terrestrial carbon cycle model are inferred by nonlinear optimization based on the model's adjoint. Uncertainties in the parameters are inferred from observational and model uncertainties via the model's Hessian and then mapped forward on predicted quantities such as net CO2 fluxes to the atmosphere via the model's Jacobian. The adjoint, Hessian, and Jacobian are generated by automatic differentiation of the model's source code. The dataset is the set of extended CO2 concentration records from 41 observing sites. The model is able to fit the observations moderately well on a seasonal time scale and rather very well on an interannual time scale, although it slightly overpredicts the long-term growth rate. This occurs despite the increase in terrestrial uptake through the 1990s over the 1980s. The increase, in turn, occurs despite a reduction in net primary productivity and is hence caused by a larger decrease in soil respiration. It appears that the requirement to fit both the seasonal cycle and interannual dynamics in the CO2 record is a strong constraint on model formulation.