

Feedbacks between Terrestrial Biosphere and Climate in the GFDL Dynamic Land /
Slab Ocean Climate Models

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The ability of the terrestrial biosphere to serve as a sink for fossil fuel CO₂ under changing climate is highly uncertain and critically depends on the magnitude of CO₂ fertilization by vegetation. Experimental evidence on the magnitude of the CO₂ fertilization effect from the laboratory and forest studies remains equivocal. Nutrient limitation, changes in plants' allocation strategies, adverse effects of climate change and air pollution could counteract beneficial effects of the increased CO₂ concentration on photosynthesis. We present an estimate of the long-term uncertainty range in terrestrial carbon storage due to uncertainty in CO₂ fertilization obtained with the GFDL coupled terrestrial biosphere -equilibrium climate model using a set of idealized experiments. In these experiments, the CO₂ is prescribed independently for the radiation code and for the biology. Using combinations of preindustrial, present day and twice present day values for CO₂, we estimate that the equilibrium response of terrestrial biosphere for a CO₂ doubling could vary from a source of about 100 PG C to a sink of about 130 PG C depending on the assumptions used for the CO₂ fertilization effect. The large spread in these values indicates that this uncertainty is very important and of the same magnitude as the climate response uncertainty due to clouds or oceanic heat uptake. Reducing uncertainty associated with the magnitude of the CO₂ fertilization is therefore of critical importance in improving confidence of climate change assessments.