IMPACT OF CO_2, CLIMATE AND O_3 ON FUTURE LAND-ATMOSPHERE CARBON EXCHANGE

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EXTENDED ABSTRACT

In this study we evaluate the individual and combined impacts of CO_2, climate and Ozone on future terrestrial carbon storage using the computationally efficient GCM analogue model coupled to the MOSES/TRIFFID land surface carbon cycle model. Ozone is modelled to have a significant detrimental effect on future plant productivity and hence terrestrial carbon storage, opposing the enhanced production and terrestrial carbon storage associated with elevated atmospheric CO_2 concentrations.

Near surface ozone concentrations are projected to increase significantly through the next century [*Prather et al.* 2001]. Plants are known to suffer ozone damage, which reduces both stomatal conductance and photosynthetic rates. Here we are primarily concerned with the possible impacts of tropospheric ozone changes on land carbon storage and plant net primary production. We use spatially explicit O_3 fields derived from the STOCHEM model [*Sanderson et al.* 2003], and climate change anomalies derived from HadCM3 via the GCM Analogue Model [*Huntingford and Cox* 2000], to drive the MOSES-TRIFFID land-surface scheme [*Cox et al* 2001] for the period 1860-2100.

Four simulations were conducted:

S1. CO_2 varying, O_3 fixed
S2. CO_2 varying, O_3 varying
S3. CO_2 varying, but plants seeing original CO_2 (i.e., no CO_2-fertilization), O_3 fixed
S4. CO_2 varying, but plants seeing original CO_2 (i.e., no CO_2-fertilization), O_3 varying

The difference between S1 and S2 gives the total ozone impact on the land carbon sink. The difference between S1 and S3 gives the CO_2 fertilization effect in the absence of O_3 effects, and the difference between S3 and gives the ozone impact without CO_2-induced stomatal closure. The idea is to show the interaction between CO_2 and O_3, with CO_2 most likely mitigating part of the ozone damage, and hence the need for simulations with O_3 and with and without CO_2-induced stomatal closure.

RESULTS

Although not as large as the individual effects of CO_2 and climate (T), O_3 has a significant detrimental effect on terrestrial C storage. Ozone is simulated to reduce the combined terrestrial cumulative sink due to climate change and plant physiological responses to elevated CO_2. Regions most affected are eastern North America, western Europe, South and South-East Asia, tropical Africa and South America.

This study highlights the large potential threat of elevated future O_3 on the ability of many terrestrial ecosystems to sequester carbon. Of particular concern is the impact of O_3 in densely populated temperate regions of eastern North America, Western Europe and East Asia which rely heavily on their agricultural production for supplying their nutritional requirements. Also tropical regions are particularly affected. Considering the projected sensitivity of tropical Amazonia to climate change [*Cox et al*. 2000], any further detrimental affect of a changing environment on plant productivity is of great concern.

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