4.046 Numeric modeling of plant ozone exposure and its effect on atmospheric CO2 in China.

Early Career Scientist

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Abstract:

Tropospheric ozone (O_3) is known to damage leaf photosynthesis through oxidizing plant cells. In consequence, carbon uptake by land ecosystem is suppressed and more carbon dioxide (CO_2) accumulates in the atmosphere. Recent studies have assessed the effect of O_3 on plant primary productivity and carbon storage, but the potential impact on atmospheric CO_2 concentrations has not been quantified. Here, we use the regional climate model (RegCM4) coupled with a terrestrial biosphere model (YIBs) to estimate the effect of plant O_3 exposure on atmospheric CO_2 in China. Results from experiments considering O_3 damage compared to simulations without O_3 effects show a considerable reduction (0.55 Pg C) in gross primary productivity (GPP), with a maximum of about 2.5 Pg C in summer. At the same time, O_3 increases land ecosystem CO_2 flux by a regional mean 0.29 Pg C due to the inhibited carbon sequestration. The effects of O_3 on CO_2 flux are strongest in east and central China, frequently suffer from high levels of O_3. Furthermore, we find a significant increase in atmospheric CO_2 concentrations as tropospheric O_3 damages plant productivity. The increases in CO_2 are much more evident in spring and summer, since plants grow vigorously in these period. The maximum increase in CO2 concentration reaches about 12 ppm in Sichuan Basin and North China Plain. Our assessment indicates that the tropospheric O_3 has a detrimental impact on plant CO_2 uptake and leads to an indirect increase in atmospheric CO_2 concentrations, and should be taken into account in future carbon cycling and climate modeling.