Impacts of leaf wetness on forest carbon cycle under air pollution

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Tropospheric ozone impairs forest productivity and causes stomatal sluggishness, i.e., a delay in stomatal responses to fluctuating stimuli, which can change the carbon and water balance of forests. Nevertheless, this effect is not included in the current land surface model. In this study, we examine the effects of ozone-induced stomatal sluggishness on carbon assimilation and transpiration of temperate deciduous forests in the Northern Hemisphere by combining a multi-layer land surface model (SOLVEG) and a global atmospheric chemistry model. SOLVEG considers the processes of changes in the maximum rate of carboxylation (V_{cmax}) and the stomatal conductance (g_s) due to ozone uptake by leaves depending on canopy wetness level. The results demonstrate that ozone-induced stomatal sluggishness decrease water use efficiency, i.e., the ratio of net carbon assimilation to transpiration, of temperate deciduous forests at high ozone concentration areas. However, this effect was small in the regions with long wet spell of forest canopy due to high annual rainfall frequency, indicating that the ozone effect on forests also depends on canopy wetness period. Since wet spell in Asian region is expected to become shorter in future climate scenario, ozone-induced stomatal sluggishness and net carbon assimilation decline enhanced by long dry period under severe air pollution may change water and carbon cycle of forest ecosystems.

Keywords: Forest carbon cycle, Air pollution, Canopy wetness

