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Influence of increasing carbon dioxide levels on stomatal conductance and surface air quality

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The levels of carbon dioxide in the atmosphere have increased from about 280 ppm in the pre-industrial era to 375 ppm in the year 2000, and are continuing to rise. This increase in carbon dioxide levels is mostly due to the burning of fossil fuels, with a smaller contribution from land-use changes. Carbon dioxide levels will continue to rise in the future unless substantial reductions in emissions are made. The global mean surface temperature is predicted to rise between 1.2 and 5.8 C by the year 2100.

An additional indirect impact of higher levels of carbon dioxide on surface trace gas concentrations occurs owing to reduced stomatal conductance. Stomata are small pores on the surface of leaves, which allow carbon dioxide to enter the leaf, where it may be assimilated by photosynthesis. As the carbon dioxide levels rise, the stomatal conductance will fall, as the stomata will not need to open as widely to allow sufficient carbon dioxide to enter the leaf for photosynthesis.

An important loss mechanism for many pollutants is dry deposition, which is the irreversible uptake of trace gases by the surface in the absence of precipitation. Trace gases may be dry deposited to the interior of leaves via the stomata. Hence, as the levels of carbon dioxide rise, the stomatal conductance will fall, and the surface concentrations of some trace gases will rise, as the loss rate due to dry deposition will fall. Results from model simulations using present-day and future climates were used to investigate the effect of increased carbon dioxide levels on stomatal conductance and surface air quality. Under larger levels of carbon dioxide, the surface ozone levels were found to increase in all four seasons, although the extent and magnitude of the increase was very different. No real change in the levels of nitrogen oxides or carbon monoxide was found.