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Plant responses double the impact of CO_2-induced climate change on simulated future runoff

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In addition to radiative forcing, increasing atmospheric CO_2 concentrations also force the climate system through direct effects on plant physiology. Plant stomata generally open less under higher CO_2 concentrations, directly reducing the flux of moisture from the surface to the atmosphere through transpiration. Reduced transpiration leaves more water at the land surface, causing increased runoff due to the physiological impact of rising CO_2 on vegetation. Here we show that in a large ensemble of doubled-CO_2 climate model simulations, the response of runoff to a given increase in precipitation is approximately twice as large when this physiological forcing is included. This reveals a difficulty in the use of radiative forcing as a basis for metrics of climate change. While Global Warming Potentials may allow comparison of effects on global mean temperature, they do not provide an accurate comparison of impacts on the water cycle. We introduce the concepts of Hydrological Efficacy and the Global Wetting Potential as metrics through which to compare the relative effects of different forcing agents on hydrology.