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The response of vegetation to rising CO2 concentrations plays an important role in future changes in the hydrological cycle

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The effects of increasing CO2 concentrations on plant and carbon cycle have been extensively investigated; however, the effects of changes in plants on the hydrological cycle are still not fully understood. Increases in CO2 modify the stomatal conductance and water use of plants, which may have a considerable effect on the hydrological cycle. Using the carbon–climate feedback experiments from CMIP5, we estimated the responses of plants and hydrological cycle to rising CO2 concentrations to double of pre-industrial levels without climate change forcing. The mode results show that rising CO2 concentrations had a significant influence on the hydrological cycle by changing the evaporation and transpiration of plants and soils. The increases in the area covered by plant leaves result in the increases in vegetation evaporation. Besides, the physiological effects of stomatal closure were stronger than the opposite effects of changes in plant structure caused by the increases in LAI (leaf area index), which results in the decrease of transpiration. These two processes lead to overall decreases in evaporation, and then contribute to increases in soil moisture and total runoff. In the dry areas, the stronger increase in LAI caused the stronger increases in vegetation evaporation and then lead to the overall decreases in P − E (precipitation minus evaporation) and soil moisture. However, the soil moisture in sub-arid and wet areas would increase, and this may lead to the soil moisture deficit worse in the future in the dry areas. This study highlights the need to consider the different responses of plants and the hydrological cycle to rising CO2 in dry and wet areas in future water resources management, especially in water-limited areas.