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# Rainfall distribution is the main driver of runoff under future CO2-concentration in a temperate deciduous forest

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Reduced stomatal conductance under elevated CO2 results in increased soil moisture, provided all other factors remain constant. Whether this results in increased runoff critically depends on the interaction of rainfall patterns, soil water storage capacity and plant responses. To test the sensitivity of runoff to these parameters under elevated CO2, we combine transpiration and soil moisture data from the Swiss Canopy Crane (SCC) FACE experiment with 104 years of daily precipitation data from an adjacent weather station to drive a three-layer bucket model (mean yearly precipitation 794 mm). The model adequately predicts the water budget of a temperate deciduous forest and runoff from a nearby gauging station. A simulation run over all 104 years based on sap flow responses resulted in only 5.5 mm (2.9 %) increased ecosystem runoff under elevated CO2. Out of the 37986 days (1.1.1901 to 31.12.2004), only 576 days produce higher runoff under in the elevated CO2 scenario. Only 1 out of 17 years produces a CO2-signal greater than 20 mma-1, which mostly depends on a few single days when runoff under elevated CO2 exceeds runoff under ambient conditions. The maximum signal for a double pre-industrial CO2-concentration under the past century daily rainfall regime is an additional runoff of 46 mm (year 1938). More than half of all years produce a signal of less than 5 mma-1, because trees consume the 'extra' moisture during prolonged dry weather.

Increased runoff under elevated CO2 is 9 times more sensitive to variations in rain pattern than to the applied reduction in transpiration under elevated CO2. Thus the key driver of increased runoff under future CO2-concentration is the day by day rainfall pattern.

We argue that increased runoff due to a first-order plant physiological CO2-effect will be very small (<3 %) in the landscape dominated by temperate deciduous forests, and will hardly increase flooding risk in forest catchments. It is likely that these results are equally valid for other ecosystems, as all underlying processes on which our argument is based remain the same. Monthly rainfall sums are unsuitable to realistically model such CO2 effects.