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Detecting a direct carbon dioxide effect on plants in continental river runoff

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Large-scale runoff has increased over many regions during the 20th century despite more intensive human water consumption. Possible reasons for the increase include climate change and variability, land use change such as deforestation, "solar dimming" due to increases in atmospheric aerosols, and the direct effect of atmospheric carbon dioxide on plant leaf stomatal apertures and therefore transpiration. All these mechanisms have the potential to affect precipitation and/or evaporation and thereby modify runoff. We force the mechanistic land-surface model MOSES with the Climate Research Unit climate data of the 20th Century. Here we apply optimal finger-printing statistical techniques to attribute observation-based runoff changes into contributions due to these factors. Climate, aerosols and direct carbon dioxide-stomatal effects all significantly modify the modelled continental scale runoff. The model successfully captures the climate-driven inter-annual runoff variability, but 20th century climate alone is not sufficient to explain the runoff trends in the latter part of the century. We find that the remaining spatial and temporal trends in runoff are consistent with a suppression of transpiration due to carbon dioxide-induced stomatal closure.