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Observation of water and carbon flux decoupling at the landscape scale

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High air temperature events are often accompanied by reduced precipitation leading to drought in forests and agricultural ecosystems. Water stress can reduce photosynthesis under those circumstances through stomatal limitations and, hence, a close coupling between photosynthesis and transpiration is maintained. But high temperature can also directly cause photosynthetic inhibition in the leaves through a series of biochemical mechanisms. Something that has large been neglected when considering environmental stress effects at the landscape scale. This paper reports data on regional carbon flux measurements made in South-West of France in early summer 2005 showing a strong decoupling between carbon and water vapour fluxes over a large forested region, during a short duration episode of high temperature. For this, aircraft observations are combined with ground eddy covariance data to show that biochemical limitations caused by high temperatures were occurring at the landscape scale. Where the vegetation is not specifically acclimated to heat stress, short duration high temperature episodes can actually cause a substantial decrease in carbon uptake of terrestrial ecosystems, even in the absence of drought. This has implications for current and future climates, as any future increase in the frequency of this type of events, as predicted by the IPCC scenarios and the more recent climate simulation experiments, will likely affect the terrestrial carbon cycle similarly to what prolonged heatwaves and severe droughts will do.