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Primary and secondary effects of climate variability on carbon and water exchange in a managed subalpine Eucalyptus forest.

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Climate variability and change, ecosystem disturbance and land management operate over a large range of temporal and spatial scales and lead to variability in carbon and water fluxes. Diagnosing the climate controls over these fluxes is not simple but key to improving prediction and understanding of water and carbon cycle–climate interactions.
We use a novel technique to investigate the variability of the fluxes from daily to multiannual timescales. We rank direct controlling factors of climate on water use and carbon uptake (changes in radiation, temperature, humidity) and indirect factors (disturbance triggered by changes in climate conditions). Direct climate impacts depend on the time scale under consideration but are generally strongest on the annual time scale.
To investigate the spatio-temporal variability caused by disturbance we use NDVI and albedo. They provide information on status and dynamics of the vegetation and we find that the whole area within Bago State Forest that was classified as native Eucalyptus forest (305.05 km2) was affected by a disturbance by insect attack. This disturbance affected tree species differently, led to a reduced photosynthetically active leaf area, reduced canopy conductance and hence photosynthetic capacity. The reduced net carbon uptake of the trees was evident as reduced biomass increment and increased mortality was observed. Net ecosystem exchange measurements at the Tumbarumba flux tower indicate that the ecosystem turned from a generally strong carbon sink to a source. We further find that the coherence between albedo and carbon and water exchange is strong on annual and multi-annual time scales. At a multi-annual time scale, carbon and water fluxes are coherent with the multivariate El Niño index.