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# Exploring the role of lags and legacies in the productivity of Australian ecosystems

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The vegetation's response to climate change is a major source of uncertainty in terrestrial biosphere model (TBM) projections. Constraining carbon cycle feedbacks to climate change requires improving our understanding of both the direct plant physiological responses to global change, as well as the role of legacy effects (e.g. reductions in plant growth, damage to the plant's hydraulic transport system), that drive multi-timescale feedbacks. In particular, the role of these legacy effects - both the timescale and strength of the memory effect - have been largely overlooked in the development of model hypotheses. This is despite the knowledge that plant responses to climatic drivers occur across multiple time scales (seconds to decades), with the impact of climate extremes (e.g. drought) resonating for many years. Using data from 13 eddy covariance sites, covering two rainfall gradients in Australia, in combination with a hierarchical Bayesian model, we characterised the timescales of influence of antecedent drivers on fluxes of net carbon exchange and evapotranspiration. Using our data assimilation approach we were able to partition the influence of ecological memory into both biological and environmental components. Overall, we found that the importance of ecological memory to antecedent conditions increased as water availability declines. Our results therefore underline the importance of capturing legacy effects in TBMs used to project responses in water limited ecosystems.