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Australian trees for the Australian Earth System Model

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Abstract: The Australian Earth system model (ACCESS-ESM) is used by the Australian research community to simulate past and future climate with interactive biogeochemistry (Ziehn et al., 2020). ACCESS-ESM simulations are used in a range of international programs including the World Climate Research Programme (WCRP) Coupled Model Intercomparison Project (CMIP). Vegetation plays a significant role in the Earth system as it mediates the cycling of carbon, water and energy with the atmosphere. In past versions of ACCESS-ESM, trees in Australia have been represented in the same way as trees in northern hemisphere temperate forests and tropical forests. However, Australian vegetation consists of a vast array of endemic species that differ from other forests around the globe, such as Eucalypts and arid-zone vegetation like Mulga, with adaptations to water deficits, nutrient poor soils and fire.

Here, we develop two new plant functional types (PFTs) for ACCESS-ESM to represent more ecologically relevant and realistic tree types in Australia. These represent structurally and functionally distinct tree types that broadly represent the evergreen trees found in mesic and xeric climate zones. The Australian mesic tree PFT represents generally tall, deep-rooted trees with relatively large, vertically oriented leaves, and are risk tolerant with higher biomass. The Australian xeric tree PFT represents generally shorter stature, shallow-rooted trees with relatively small, thick leaves and drought avoidant tendencies. Using the best available national data on plant traits from AusTraits (Falster et al., 2021) and other compilations alongside data on the spatial distribution of vegetation types (NVIS, 2017), we integrate these new PFTs into the latest model version (ACCESS-ESM1.6). Simulations are run in atmospherically coupled mode. We evaluate the impacts of these changes on Australian carbon and water cycling, with respect to the previous model version and key benchmarking datasets, and highlight the implications of the new representation of Australian vegetation on the climate.

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