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Observed changes in land-climate interactions over Australia

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Satellite and on-ground observations over Australia were analysed and compared with output from land surface models to investigate changes in the interaction between atmosphere, water cycle and vegetation. Observations included top soil water content and vegetation vigour derived from passive microwave satellite observations since 1979, remotely sensed gravity anomalies (indicative of changes in soil water and groundwater storage) since 2002, and evapotranspiration estimates derived by fusing on-ground and different types of satellite observations since 1992, along with climate and hydrometric records over several decades.
Changes were assessed in the context of natural variability, ocean circulation and climate trends using statistical methods and land surface models. The observations show underlying trends of reduced water availability in eastern Australia and increases in northern Australia. Much of the superimposed inter-annual variation is explained by ENSO patterns. Gravity anomalies and hydrometric data emphasise the extent to which soil and groundwater stores in southeast Australia have been depleted in recent years.
Regional rainfall changes explain most of the observed patterns and trends in water cycle components, and by and large, land surface models driven by climate records reproduce these. Furthermore, most GCMs predict trends in rainfall and evapotranspiration drivers that are broadly consistent with those that have occurred over the last years. However, some additional feedbacks between climate, water cycle and land cover appear to exist. In particular, satellite observations show large scale changes in land cover condition in response to changed water availability, and possibly CO2 concentrations, that are not sufficiently reproduced by existing land surface models.