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Australian rainfall isotope variability and its relationship with groundwater

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Rainfall stable isotope composition varies dramatically across the Australian continent. Using monthly deuterium and oxygen-18 data from 15 Global Network of Isotopes in Precipitation (GNIP), sites the underlying causes for the spatial and temporal variability have been investigated. Because of the island nature of Australia, moisture originates from the Indian Ocean to the west and the Pacific Ocean to the east, and is dominated by the monsoon and tropical cyclones to the north and frontal and low pressure systems to the south. Simple rainfall amount or temperature relationships don't explain what is observed over this low-elevation continent because of the huge spatial variability in moisture source and synoptic processes. However, latitude, elevation and continentality were found to have some influence on the isotopic average at the 15 sites. Using relationships developed with data from the 15 GNIP sites and additional data from higher elevation sites, an isoscape has been developed. This is used to investigate what drives groundwater recharge at a variety of locations across Australia. In many regions groundwater recharge can be linked isotopically to extreme high rainfall events such as tropical cyclones, east coast lows or major troughs which may occur on sub-annual or decadal time scales. For many inland sites, recharge from such events results from widespread flooding over hundreds or thousands of kilometers, introducing an evaporated signature to the groundwater, or one that reflects a different composition to local rainfall. In contrast, reliable seasonal rainfall from the monsoon in the north, or winter rainfall in the south west leads to groundwater signatures in alluvial, karst and fractured rock aquifers that reflect wet season averages. A better understanding of how these processes vary across the continent improves our ability to apply stable isotopes to trace groundwater recharge and ultimately provides valuable information for water resource managers to understand the sustainability of groundwater and connected surface water systems.