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The stable isotope signal of atmospheric water vapour in Sydney, Australia

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The stable isotopic composition of atmospheric water vapour is related to the hydrological processes that occur along the back trajectory of an air mass, including evaporation at the moisture source, atmospheric mixing and precipitation. Incorporation of stable water isotopes into weather and climate prediction models therefore has the potential to aid in their evaluation, calibration and improvement, but this requires the availability of continuous time series of isotope data to compare with isotopically-enabled simulations. We present an analysis of a 15-month high resolution time series of atmospheric water vapour stable isotope measurements at a site near Sydney, Australia. The deuterium isotope exhibits a large amount of variability (-60 to -180 per mille), reflecting the range of weather conditions encountered at this near-coastal measurement site. Using collocated meteorological and surface radon measurements, together with back trajectory analysis, we investigate major processes that contribute to variability in the stable isotope value of water vapour in the Sydney region. The analysis indicates that the lowest isotope values are generally associated with cold fronts passing over the Sydney region. When a cold front passes over or near the measurement site, the deuterium isotope value can be observed to change by up to 100 per mille within the space of a few hours. In addition, cold frontal passages with contrasting moisture source and precipitation histories exhibit systematic differences in water vapour stable isotope signals as they pass over Sydney. On the other hand, higher and more slowly changing isotope values are generally associated with anticyclonic conditions. From this study it is clear that the variations in the stable isotope values are strongly influenced by the hydrological history of air parcels at a synoptic scale.