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Stable C and O isotope signals of drought in Mediterranean pines

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As proxies for stomatal control of transpiration and soil water sources we analyzed stable 13C and 18O isotopes in tree rings of the dominant Mediterranean conifer species Pinus halepensis (its subspecies brutia found in the Eastern Mediterranean) on the Island of Samos (Greece). Data covered the last 30 years of the 20th century and included one of the driest periods on record. Drought clearly reduced 13C discrimination (Δ) and δ18O tree-ring signatures, interpreted as reduced leaf/needle stomatal conductance during late spring growth, as well as increased utilization of water from deeper soil layers. Water supply of pines (and thus tree growth) under chronic drought depended on rainfall infiltration into deeper soil layers, supplied even from precipitation of multiple years prior to and including the current year of growth. Declining δ18O signals with increasing drought suggest that the less 18O-enriched top soil water was taken up by trees during the main growing period (spring and fall) in dry years because growth did not extend into late spring/early summer due to early top soil moisture exhaustion. Uptake of less enriched 18O water from deeper soil layers further enhanced this trend. These isotope signals illustrate multi-year integration periods of drought effects and that severe drought may not leave a fingerprint because of a lack of assimilation and tissue formation under such severe stress.