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Does the Madden-Julian Oscillation influence wintertime atmospheric rivers and snowpack in the Sierra Nevada?

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The relationships between the Madden-Julian Oscillation (MJO), activities of atmospheric rivers (ARs), and resulting snowpack accumulation in the Sierra Nevada, California are analyzed based on 13 years of observations for water years 1998-2010 inclusive. AR activity, as measured by the number of high-impact ARs, mean per event snow water equivalent (SWE) changes, and the cumulative SWE changes, is shown to be significantly augmented when MJO is active over the far western tropical Pacific (phase 6 on the Wheeler-Hendon diagram). The timing of high-impact ARs (early- vs. late-winter occurrences) also appears to be regulated by the MJO. Total snow accumulation in the Sierra Nevada (i.e., AR and non-AR accumulation combined) is most significantly increased when MJO convection is active over the eastern Indian Ocean (phase 3), and reduced when MJO convection is active over the Western Hemisphere (phase 8), with the magnitude of the daily anomaly being roughly half the cold-season mean daily snow accumulation over many snow sensor sites. The positive (negative) SWE anomaly is accompanied by cold (warm) surface air temperature (SAT) anomaly and onshore (offshore) water vapor flux anomaly. The contrasting SAT anomaly patterns associated with MJO phases 3 and 8, revealed by the in situ observations, are more realistically represented in satellite retrievals from the Atmospheric Infrared Sounder than in the European Centre for Medium-Range Weather Forecasts Interim reanalysis.