Submission Title:

Dynamical mechanisms underlying the 2022/23 California flooding: Analysis with a stationary wave model

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Abstract

In late December 2022 and the first half of January 2023, much of California experienced an unprecedented series of atmospheric rivers that produced heavy rains and near-record flooding. Previous work shows that a chain of dynamical events contributed to the extreme precipitation, including the development of a Rossby wave (as a result of forcing linked to the MJO) that emerged from the Indian Ocean in mid-December, and the subsequent development of a persistent positive Pacific North American (PNA) pattern that ultimately directed moisture onto the US West Coast starting in late December. Here, we use a stationary wave model (SWM) to further elucidate the dynamical and thermodynamical processes that drove the aforementioned chain of events. The results reveal the following: 1) The mid-December Rossby wave was likely induced by vorticity stretching and advection in the middle East linked indirectly to the MJO, 2) The initial development of the PNA in late December was triggered by transient and stretching sources of vorticity in the Pacific that were themselves induced by the aforementioned Rossby wave, and 3) The PNA was maintained through mid-January in part by diabatic heating west of Hawaii that was associated with anomalous precipitation influenced by the PNA circulation anomalies, thus representing a feedback on the PNA. One key finding from the SWM analysis is the limited direct role of tropical heating for inducing any of the dynamical mechanisms related to the California extreme event.