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The role of the Pacific Decadal Oscillation and ocean-atmosphere interactions in driving United States heatwaves

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Heatwaves can have devastating impact on society and reliable early warnings at several weeks lead time are needed. Heatwaves are often associated with quasi-stationary Rossby waves, which interact with sea surface temperature (SST). Previous studies showed that north-Pacific SST can provide long-lead predictability for eastern U.S. temperature, moderated by an atmospheric Rossby wave. The exact mechanisms, however, are not well understood. Here we analyze Rossby waves associated with heatwaves in western and eastern US. Causal inference analyses reveal that both waves are characterized by positive ocean-atmosphere feedbacks at synoptic timescales, amplifying the waves. However, this positive feedback on short timescales is not the causal mechanism that leads to a long-lead SST signal. Only the eastern US shows a long-lead causal link from SSTs to the Rossby wave. We show that the long-lead SST signal derives from low-frequency PDO variability, providing the source of eastern US temperature predictability. We use this improved physical understanding to identify more reliable long-lead predictions. When, at the onset of summer, the Pacific is in a pronounced PDO phase, the SST signal is expected to persist throughout summer. These summers are characterized by a stronger ocean-boundary forcing, thereby more than doubling the eastern US temperature forecast skill, providing a temporary window of enhanced predictability.