

## Human Emissions Drive the Pacific Decadal Oscillation

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### Abstract

The Pacific Decadal Oscillation (PDO) - the leading mode of climate variability driving long-term changes in the Pacific Ocean and surrounding continents - is thought to be generated by naturally occurring processes. Here, we show that instead, during the 20<sup>th</sup> century, the PDO was driven by variations in human emissions of aerosols and greenhouse gases. Several large suites of climate model simulations shows that mid-twentieth century aerosol emissions drove cooling in the North Pacific with similar timing and spatial pattern to the observed PDO. By the late 20<sup>th</sup> century, greenhouse gases replaced aerosols as the dominant forcing. This revelation allows us attribute PDO impacts – including the ongoing drought in the southwestern United States – to human activity. This was previously undiscovered because climate models underestimate the regional influence of external forcing, particularly from aerosols. Addressing this issue in climate models offers a direct path towards extending the predictability horizon of the PDO, as well as producing accurate attribution of regional climate changes.