Researchers find the link between human activity and shifting weather patterns in western North America

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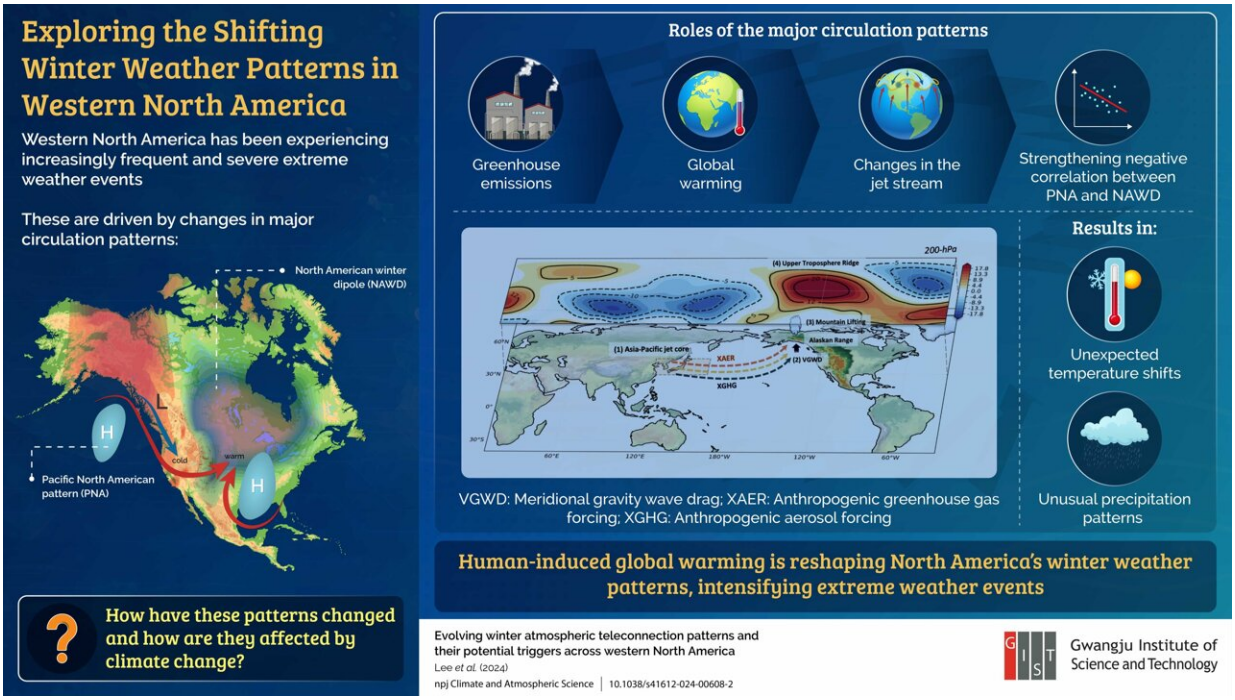


This study explores the impact of human-induced climate change on Northern Hemisphere winter weather, highlighting the dominant role of specific teleconnection patterns and the influence of greenhouse gas emissions. Credit: Jin-Ho Yoon from GIST

Western North America seems to be experiencing more extreme weather

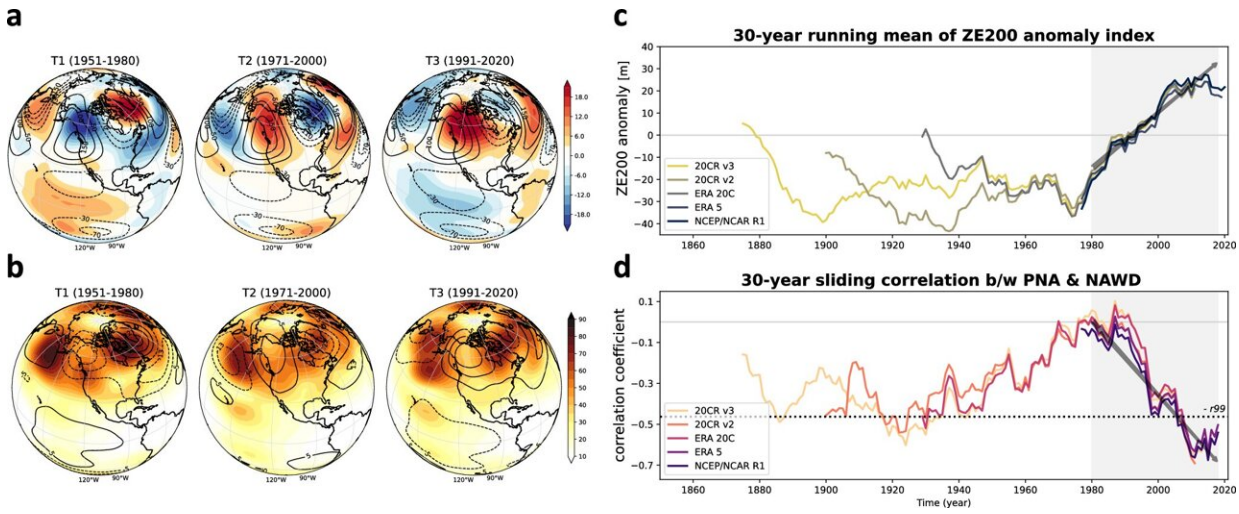
events more frequently. From scorching droughts to torrential floods, the climate is changing rapidly, with no signs of slowing down. From 2011 to 2015, California and neighboring states experienced extended periods of drought, while 2017 saw heavy rains trigger catastrophic floods.

These events are linked to specific weather patterns. The atmosphere is like a network of interconnected pathways that determine how weather systems move and interact across the globe.

In the Northern Hemisphere, there are three such major teleconnection patterns that affect winter conditions: the Pacific North American pattern (PNA), the North Atlantic Oscillation (NAO), and the North American winter dipole (NAWD). However, the understanding of how these patterns change over time and their connection to climate change remains limited.

To better understand this phenomenon, a group of scientists led by Professor of Earth Sciences and Environmental Engineering Jin-Ho Yoon and including Ph.D. student Jueun Lee from the Gwangju Institute of Science and Technology recently conducted a study to examine the reasons behind changes in these patterns. Their findings have been published in *npj Climate and Atmospheric Science* on 7 March 2024.

The scientists employed a sophisticated Community Earth System model that there is a regular influence of the NAWD for over 70 years (1951–2020), which is in contrast with the fluctuating influence from PNA and minor impacts from NAO. Furthermore, in recent years, there has been a strengthening negative correlation between the PNA and the NAWD: as one exhibits a positive phase, the other tends to exhibit a negative phase.



Variation of the ZE200 during the northern winter (DJF) season and comparison with the corresponding correlation between PNA and NAWD. Credit: *npj Climate and Atmospheric Science* (2024). DOI: 10.1038/s41612-024-00608-2

"This projected intensification of large-scale atmospheric circulation in a warming climate is expected to likely escalate extreme hydroclimatic events in mid-latitude regions like California near western North America," explains Dr. Yoon.

The weather system is like a network of dominos, where one piece can trigger a chain reaction and set off a series of unforeseen events. Using extensive models and numerical simulations, the scientists deduced that these changes in how the PNA and the NAWD interact can be traced back to variations in the jet stream, a band-like flow of air high up in the atmosphere. As the climate warms, the jet stream changes, influencing patterns such as the PNA and the NAWD.

The study notably shows that greenhouse gas emissions play a significant role in driving the shifts. "Climate models consider a range of factors affecting the atmosphere, including changes in greenhouse gas

concentrations resulting from human activities. By running simulations with and without the influence of greenhouse gases, we can compare the results and see how they differ," explains Dr. Yoon.

The scientists observed an association between higher greenhouse gas levels and the variations in the jet stream: the gases drive the northward drift of the Asia-Pacific jet core. Aided by mountain-related lifting over the Alaskan Range, contributing to the formation of potent high-pressure systems in the vicinity. This phenomenon strengthens the winter stationary wave throughout western North America.

Simply put, the study shows that the rise in temperatures caused by greenhouse gases is changing how air moves in the atmosphere. This, in turn, affects the weather patterns that influence winter conditions in western North America and contribute to recent more frequent extreme weather events. This research thus highlights the urgent need to address climate change.

More information: Jueun Lee et al, Evolving winter atmospheric teleconnection patterns and their potential triggers across western North America, *npj Climate and Atmospheric Science* (2024). DOI: 10.1038/s41612-024-00608-2

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