Large-scale Circulation Context for Atmospheric Rivers: Influence of Subseasonal Winter Teleconnections

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Background

- Prevalent in winter months
- Poleward transfer of water vapor
- "Filaments" of integrated water vapor
  (Newell & Zhu, 1998)
- Occasional features in mid-latitude cyclones, where moisture is drawn in from the low-level jet in front of the cold front (warm sector)

Methods

- Processed the AR database: defined grid cells containing an AR as having a value of 1 and grid cells without an AR as having a value of 0
- Re-binned MERRA-2 and ERA-Interim variables (including AR database) to 5-day time steps (pentads)
- Computed climatological averages and anomalies for each pentad (1980-2007)
- Defined a Niño3.4 index using the area-averaged sea surface temperature anomalies (120W-170W and -55-55)
- Constrained each variable to span only the winter months – December, January, and February
- Regressed (lead/lag) the AR shapes, 850mb Heights, precipitation, and U/V fluxes of integrated water vapor onto the 7 principal components (each representing a different teleconnection) and calculated Niño3.4 index
- Analyzed the dynamics of the regressions with the greatest AR impact on the west coast of the US

Conclusion / Summary

Teleconnections are anomalous circulation patterns in our atmosphere, changing the distribution of AR landfalls and regional precipitation patterns. The west coast of the US typically receives a majority of their annual rainfall in the winter months due to the increase in moisture fluxes. The Niño3.4 index is critical as:

- Positive (El Niño) phase
  - Low pressure brings SW winds to the west coast, bringing moisture-rich air to the region
  - More landfalling ARs
  - Moisture fluxes are weaker than those for other teleconnection patterns

North Pacific Oscillation – Western Pacific (NPO-WP)

- Positive phase
  - Increased moisture flux due to tightening gradient (simultaneous and +1) in 850mb heights from Aleutian high pressure system
  - Increase in dry winds coming from the west coast and Pacific northwest
  - Fewer AR landfalls on west coast from moisture divergence

Pacific North American Pattern (PNA)

- Positive phase
  - Increased moisture flux due to tightening gradient (-1 and simultaneous) in 850mb heights
  - High pressure system south of the Aleutian Islands
  - Fluctuations are higher in this teleconnection pattern by nearly twice the magnitude of those in the NPO-WP pattern
  - SW winds bring moisture from the western Pacific to central Pacific and coastal, mountainous regions of the Pacific northwest
  - Northern winds bring dry air to most of the west coast

References


Acknowledgements

We would like to thank Dr. Stephen Baxter of the Climate Prediction Center for updating the CFSR principal components and giving us access to the dataset. We would also like to thank Dr. Tim Canty for the advice he has given towards this project and his dedication to guiding students through the scientific process.