Large-Scale Influences on Atmospheric River Induced Extreme Precipitation Events Impacting the Coast of the State of Washington

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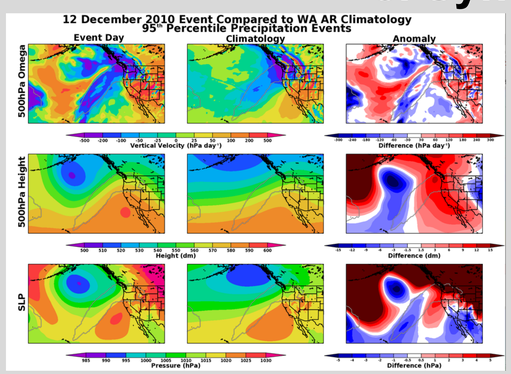
1. Background

- Atmospheric rivers (ARs) are elongated, narrow regions of enhanced water vapor transport
- ARs bring beneficial precipitation to the Western U.S coast during the winter months; however, extreme amounts can cause natural disasters
- **Goal:** Determine synoptic influences on and interannual and intraseasonal teleconnection relationships with AR induced extreme precipitation events

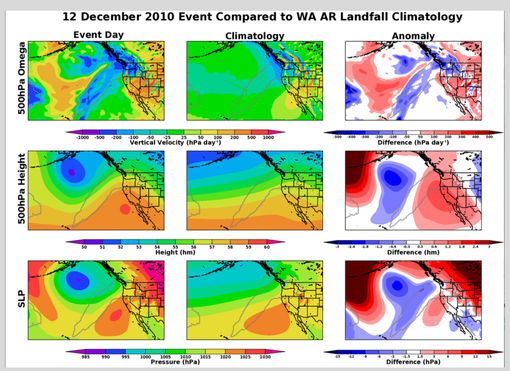
2. Technical Information

- Modern Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) (Gelaro et al. 2017)
- TempestExtremes AR detection algorithm used to detect ARs as regions of water vapor transport 250 kg m^{-1} s^{-1} above average (Ullrich and Zarzycki 2017)
- Nino 3.4 (ENSO), Madden Julian Oscillation (MJO), Pacific Decadal Oscillation (PDO), Pacific North American Pattern (PNA) daily and monthly indexes for the months of December, January, and February (DJF)
- Extreme events are defined as a day in which the precipitation exceeds the 95th percentile of daily precipitation and an AR is detected within the region

3. Synoptic Influences



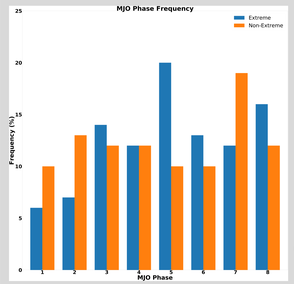
Extreme Events: 155

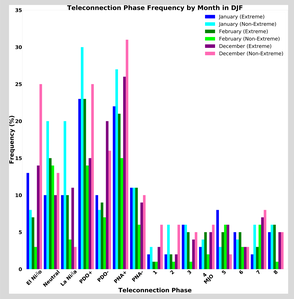


Non-Extreme Events: 1409

Figure 1 (left): Synoptic scale daily dynamics variables for an extreme event compared to mean extreme event synoptic conditions

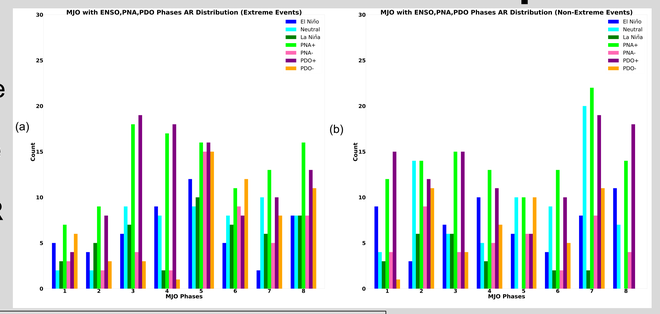
(right): Synoptic scale daily dynamics variables for an extreme event compared to mean non-extreme AR synoptic conditions





4. Teleconnection Relationships

Figure 2 (left): MJO phase frequency for extreme and non-extreme AR events



Extreme and Non-Extreme AR Events: 155
MJO Phase 5 Extreme AR Events: 31

Figure 3 (left): Frequencies of ENSO, PDO, PNA, MJO phases for extreme and non-extreme events in each DJF month

Figure 5 (right): MJO phase 5 extreme events composite for sea level pressure, 500hPa height, wind at 850hPa, 500hPa, and 250hPa

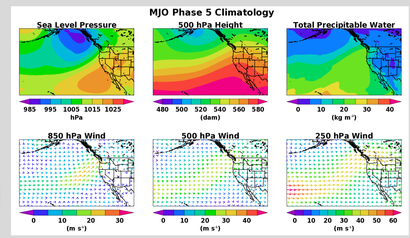


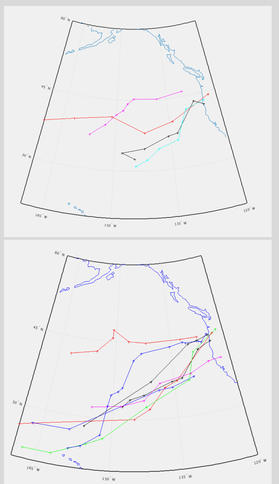
Figure 4 (left):
a) MJO, ENSO, PDO, PNA phase relationships for extreme events

b) MJO, ENSO, PDO, PNA phase relationships for non-extreme events

5. Conclusion and Future Work

Conclusion

- Southerly Aleutian Low, along with amplified troughing over Alaska and ridging over Western U.S., important for extreme precipitation events
- AR induced extreme events occur more frequently during phase 5 of the MJO than any other phase
- PDO and PNA influential interannually but PDO+ and PNA+ are most frequent among both event types
- ENSO less influential for extreme events. Similar frequencies of extreme events among phases



Future

- Assess tracks for all extreme and non-extreme ARs making landfall along the Washington coast
- Regionalize the Washington coast to better understand interannual and intraseasonal impacts on the region

Figure 6 (top): Tracks of ARs associated with non-extreme events
(bottom): Tracks of ARs associated with extreme events

References:

Gelaro, R., et al., 2017: The Modern-Era Retrospective Analysis for Research and Applications, version 2 (MERRA-2). *J. Climate*, **30**, 5419–5454

Ullrich, P. A. and C.M Zarzycki, 2017: TempestExtremes: a framework for scale-insensitive pointwise feature tracking on unstructured grids. *Geosci. Model Dev.*, **10**, 1069-1090

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