Synchronicity of heavy rainfall induced by atmospheric rivers over North America

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Do atmospheric rivers cause a specific pattern of synchonized heavy rainfall over North America?

DATA

- ERA5 daily estimates of precipitation, integrated water vapor transport, and meridional wind at 250 hPa, with 0.25° resolution, from 1979 to 2018.
- SIO-R1 catalog for land-falling ARs by Gershunov, et al., 2017.

METHODS

- 95-th percentile thresholds of the days exceeding 1 mm of rain.
- Complex networks based on event synchronization, with a dynamical coincidence interval of 5 days and a significance of 0.05.

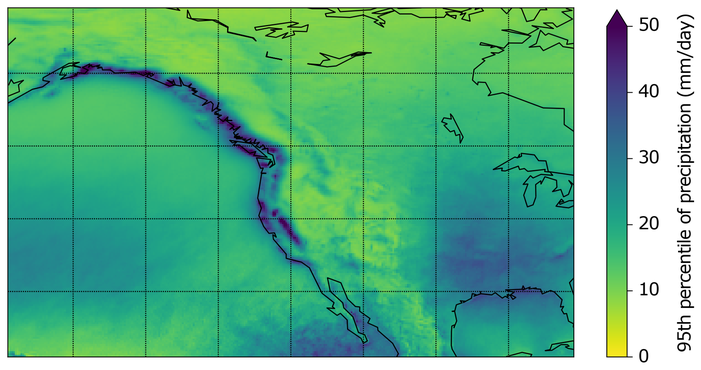

Fig 1. 95-th percentile thresholds of precipitation considering only wet days.

RESULTS

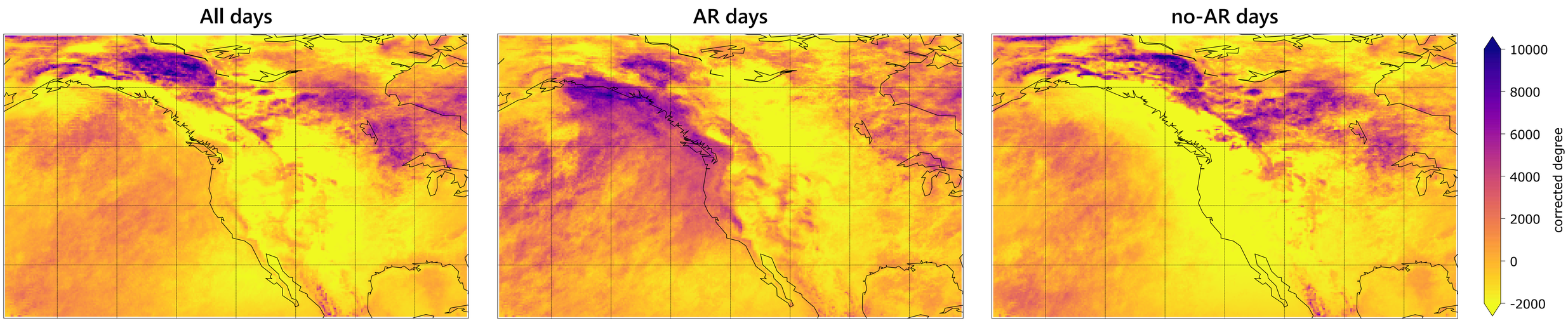

Fig 2. Corrected node degree of the complex networks representing the synchronization of heavy rainfall based on (l) all heavy rainfall events, (c) events coinciding with ARs, and (r) events not coinciding with ARs.

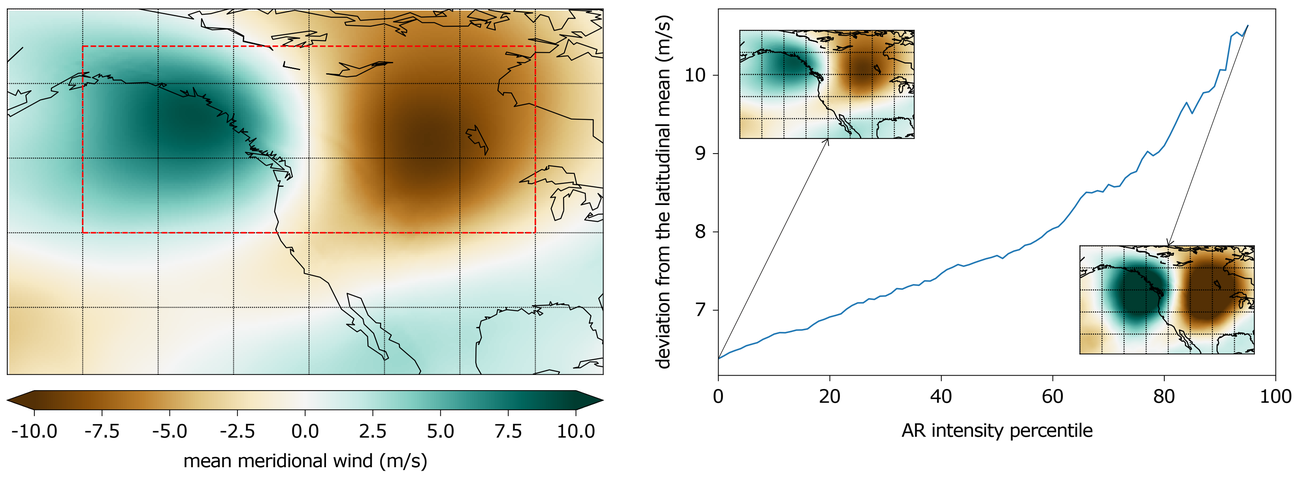

Fig 3. Scaling of the AR-related meridional wind pattern. (l) Mean meridional wind during AR days. (r) Spatially aggregated deviation of the meridional wind from the latitudinal mean over the red-dashed box.

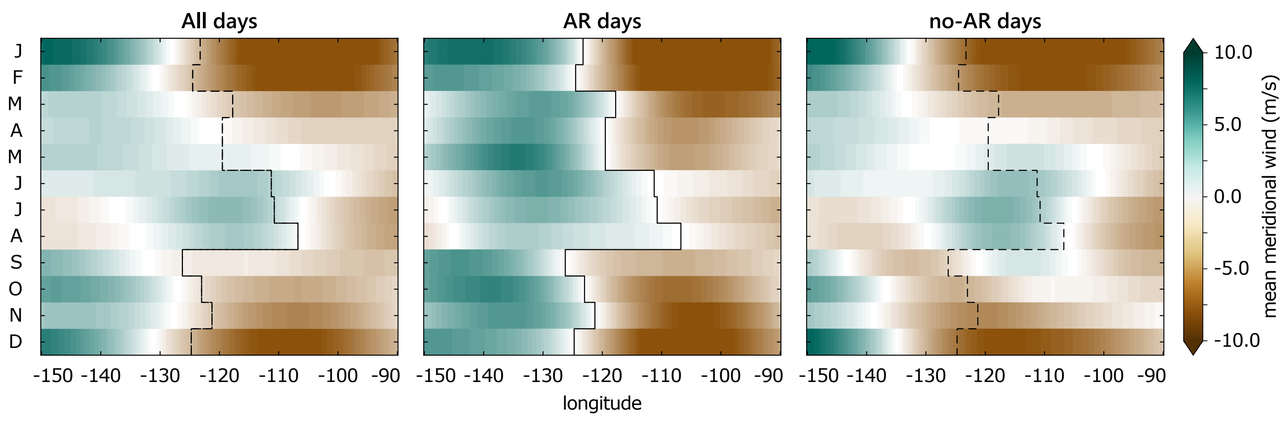

Fig 4. Latitudinal mean of the monthly meridional wind for (l) the whole time series, (c) periods with land-falling ARs, and (r) without landfalling ARs. The black line indicates the position of the ridge during AR days.

- Fig 2: There are two separate features hidden in the overall network. First, land-falling ARs cause an enhanced number of synchronized heavy rainfall events over the coastal and mountainous regions. Second, the three high-degree patches over Canada and the norther USA are associated with times with no land-falling ARs.
- Fig 3: During AR days, there is an atmospheric circulation pattern, with northward-directed winds over the Pacific and southward-directed winds over the North American continent, related to a cyclone-anticyclone pair. The magnitude of this pattern scales with the intensity of the ARs.
- Fig 4: ARs are located where the meridional wind speed is close to zero, right over the ridge of the circulation pattern. The longitudinal position of the ridge determines the occurence or absence of land-falling ARs over North America.

Atmospheric rivers cause a characteristic pattern of synchronized heavy rainfall over the Rocky mountains and the west coast of North America, and are associated with the magnitude and location of a robust upper-level circulation pattern.

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