

Interannual Variability of the Cyclonic Activity along the U.S. Pacific Coast: Influences on the Characteristics of Winter Precipitation in the Western U.S



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Background – importance of cyclones for the western U.S. winter precipitation

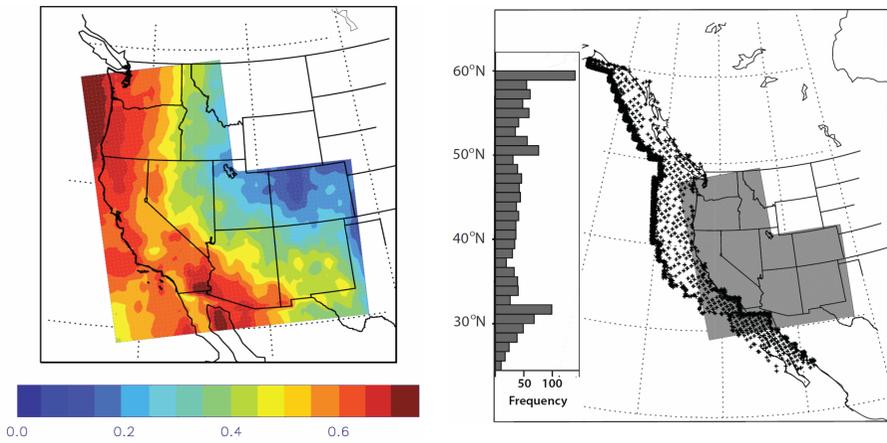


Fig. 1 Ratio of the cyclone-induced precipitation amount to the total winter precipitation in the western U.S. Contour interval is 0.05.

Fig. 2 Distribution of the locations of the coastal cyclones (“+”) and the histogram of their frequency across latitudes in 27 winters (DJF, 1979/80-2005/06).

Interannual variability of the coastal cyclonic activity and the winter precipitation

Definition of the Cyclonic Activity Function (CAF)
CAF = CAF (latitude, winter)

- Calculated as the accumulated intensity (e.g., 1000mb geostrophic relative vorticity) of all the coastal cyclones in a winter in each 1° latitude interval from 26°N to 52°N.

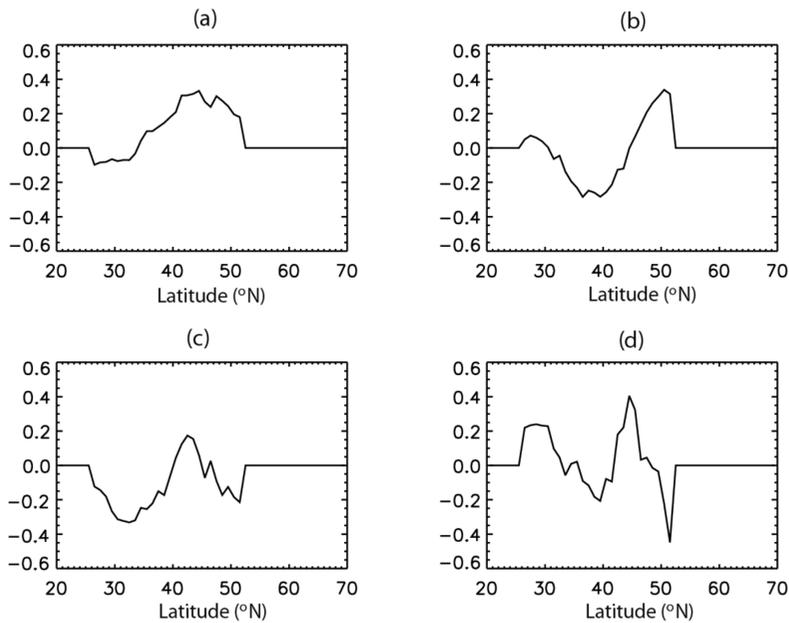


Fig. 3 EOF1 (a), EOF2 (b), EOF3 (c), and EOF4 (d) of the CAF. The analysis is based on objectively identified cyclone tracks derived from the NCEP/NCAR Reanalysis for 27 winters (1979/80-2005/06).

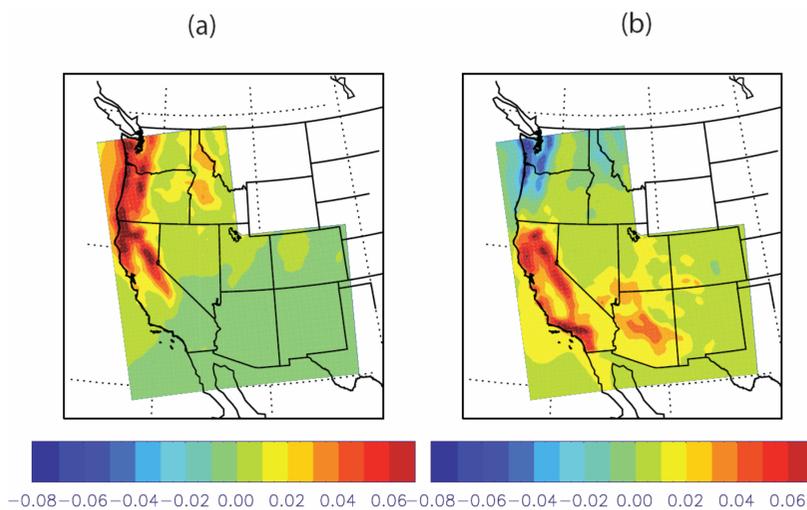


Fig. 4 EOF1 (a) and EOF2 (b) of the western U.S. winter precipitation. Contour interval is 0.02. Based on the North American Regional Reanalysis (NARR) for the period 1979/80-2005/06.

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Influences of the variability of cyclonic activity on the winter total and extreme precipitation

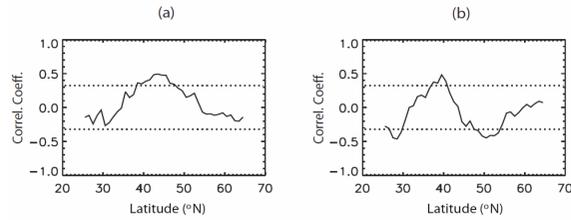


Fig. 5 Distribution of the correlation coefficients between the CLF and PCPRECIP1 (a), PCPRECIP2 (b). Dashed lines indicate the 95% significance level.

Table 1. Correlation between PCs of the winter precipitation and PCs of the CAF. Bolds are statistically significant at the 95% level.

CC	PC _{PRECIP1}	PC _{PRECIP2}
PC _{CAF1}	0.50	-0.08
PC _{CAF2}	-0.07	-0.53
PC _{CAF3}	0.03	0.18
PC _{CAF4}	0.11	-0.35

● Composite analysis based on the five largest +/- values of the PCs of the CAF

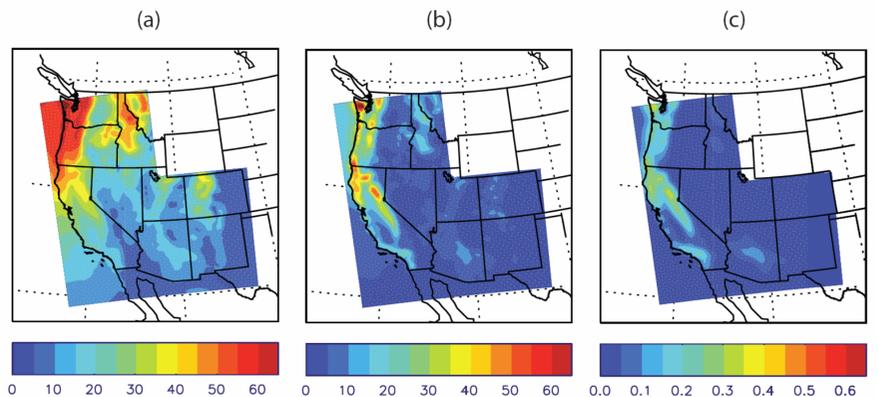


Fig. 6 Average number of rainy days per winter (a), 95th percentile of the daily rain rate (b) and the average probability of precipitation being heavy given a rainy day (c) in 27 winters.

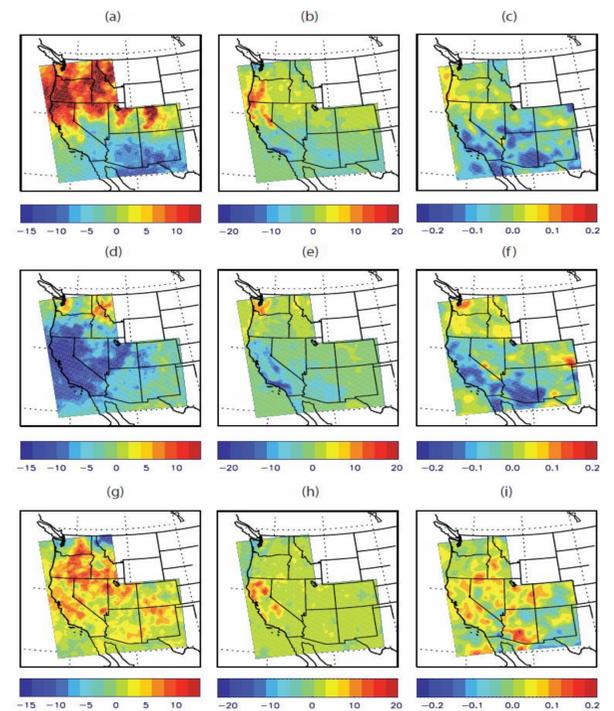


Fig. 7 Differences of the number of rainy days per winter (a), the 95th percentile of the daily rain rate (b) and the heavy rain probability (c) between PC1+ and PC1- winters. (d)-(f) and (g)-(i) are the same as (a)-(c) except for the differences between PC2+ and PC2- winters and between PC3+ and PC3- winters, respectively.

Linkages between the CAF and teleconnection patterns

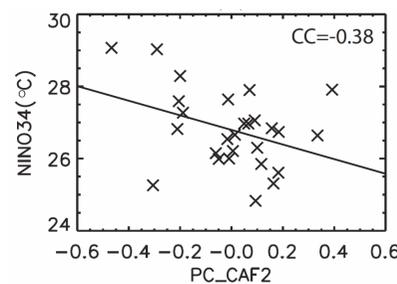


Fig. 8 Scatter plot of NINO3.4 SST with PC_{CAF2}. ‘CC’s stands for correlation coefficients.

Table 2. Correlation between PCs of the CAF and DJF averaged indices of PNA, TNH, AO and NP. Bolds are statistically significant at the 95% level.

	PC _{CAF1}	PC _{CAF2}	PC _{CAF3}	PC _{CAF4}
PNA	0.11	-0.31	0.36	0.13
TNH	-0.17	0.59	-0.05	-0.06
AO	-0.29	-0.11	-0.47	-0.21
NP	0.00	0.29	-0.50	-0.19

Conclusion

- Interannual variability of the western U.S. winter precipitation is largely determined by the principal variability of the coastal cyclones, i.e., EOF1 (EOF2) of the CAF is responsible for the EOF1 (EOF2) of the winter precipitation.
- EOF2s of both the CAF and precipitation are significantly linked to the ENSO (TNH) variability, indicating that ENSO affects the southwestern U.S. winter precipitation partly through modulating the coastal cyclonic activity across latitudes. EOF3 of the CAF is closely tied to the AO and NP variability.
- The above (below) normal precipitation associated with different phases of the CAF EOFs is caused by 1) the increase (decrease) of the total number of rainy days in a winter and 2) the increase (decrease) of the extremeness of the precipitation.