AGU PUBLICATIONS

Geophysical Research Letters

Supporting Information for

Moisture Sources of Precipitation in the Great Lakes Region: Climatology and Recent Changes

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Method to calculate precipitation quantile and its corresponding moisture sources

A long-term GLR precipitation distribution is firstly formed based on multiple years of daily mean precipitation intensity over the GLR. Then the 25th and 75th percentile is obtained from this precipitation distribution and serve as threshold to define the weak and strong GLR precipitation days. Then each daily precipitation will be categorized into weak (<25th percentile) or strong GLR precipitation day (>75th percentile) based on the long-term GLR annual precipitation historical record. Two composites of precipitation days are obtained. Then we count the number of days that fall in the weak or strong composite in the warm or cold season for each year, respectively. The long-term mean is then calculated for the cold and warm season for each composite, as shown in Figure 3a & Figure 3d.

For each day in GLR, we know the fraction of rain that originates from the 12 source regions based on DRM. Therefore, the corresponding moisture contributions from the 12 source regions for the strong and weak composite can be obtained by averaging across all days in each composite, which is shown in Figure 3b-3c, 3e-3f.

Definition of column-integrated moisture weighted mean wind.

Here is how the moisture weighted zonal (U) and meridional (V) winds are formulated:

$$U = \frac{\int_{Ps}^{Pt} qudP}{\int_{Ps}^{Pt} qdP} \tag{1}$$

$$V = \frac{\int_{Ps}^{Pt} qvdP}{\int_{Ps}^{Pt} qdP} \tag{2}$$

Where q is specific humidity, u and v are wind speed at different pressure levels, q is specific humidity, P_s is surface pressure, P_t is pressure at the top of atmosphere.

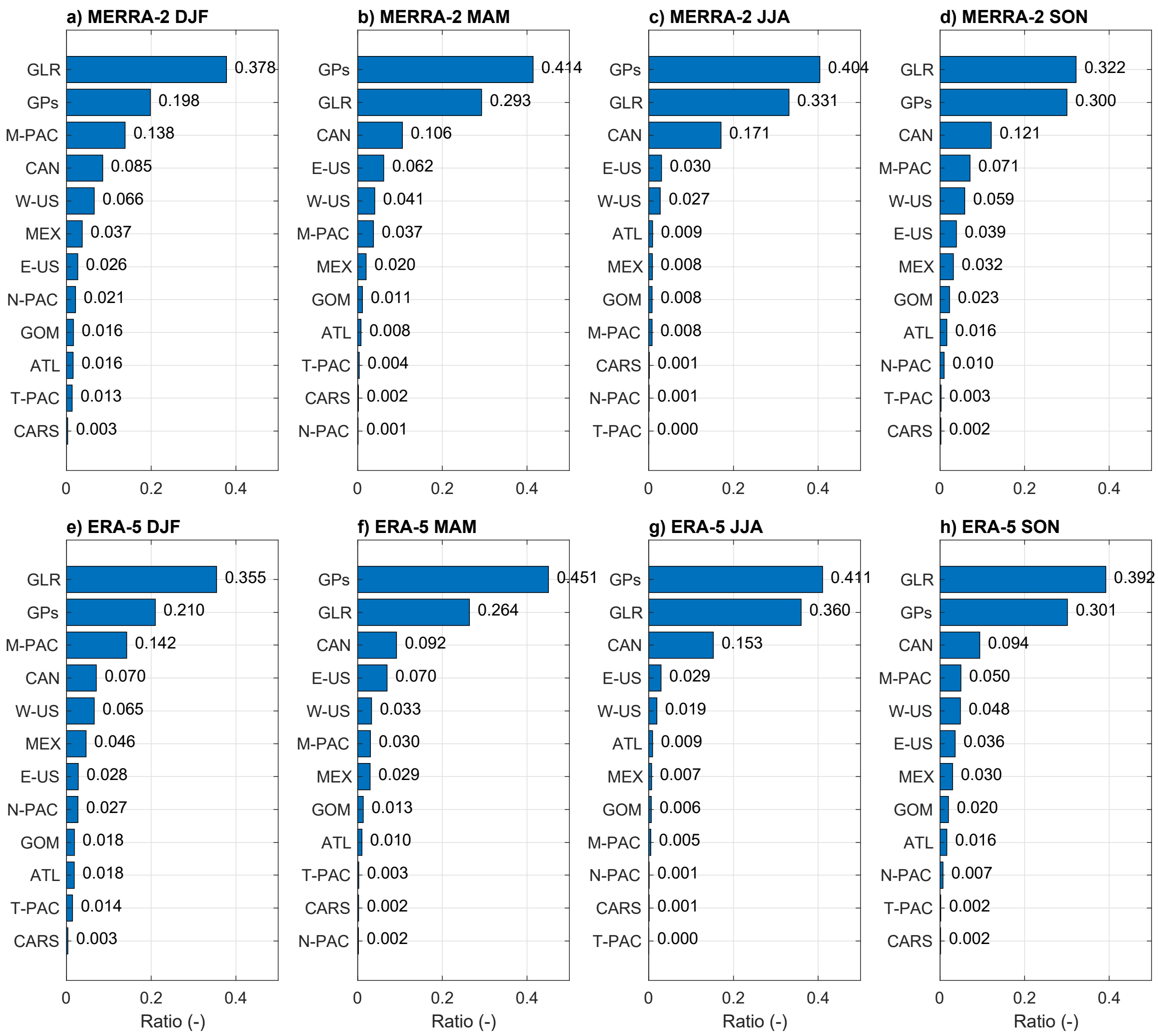

Figure s1: Seasonal contribution to the GLR precipitation from different moisture source regions and two reanalysis products.

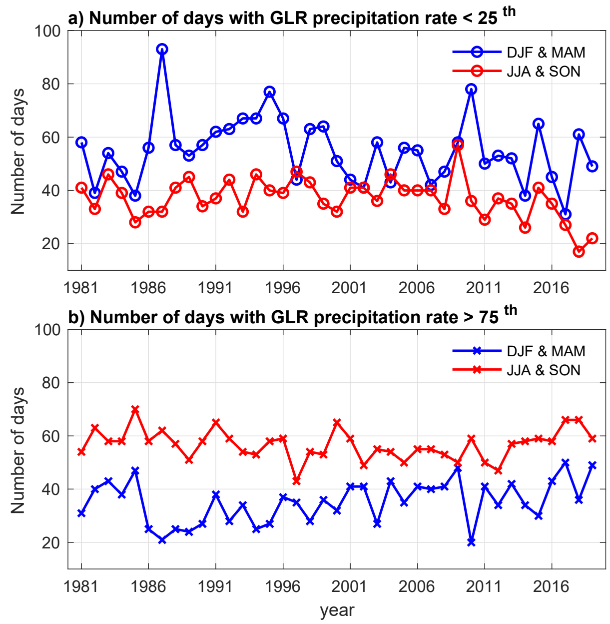

Figure S2: Number of days with GLR precipitation rate less than 25th and greater than 75th percentile of its long-term record in the warm (June-November) and cold season (December-May).

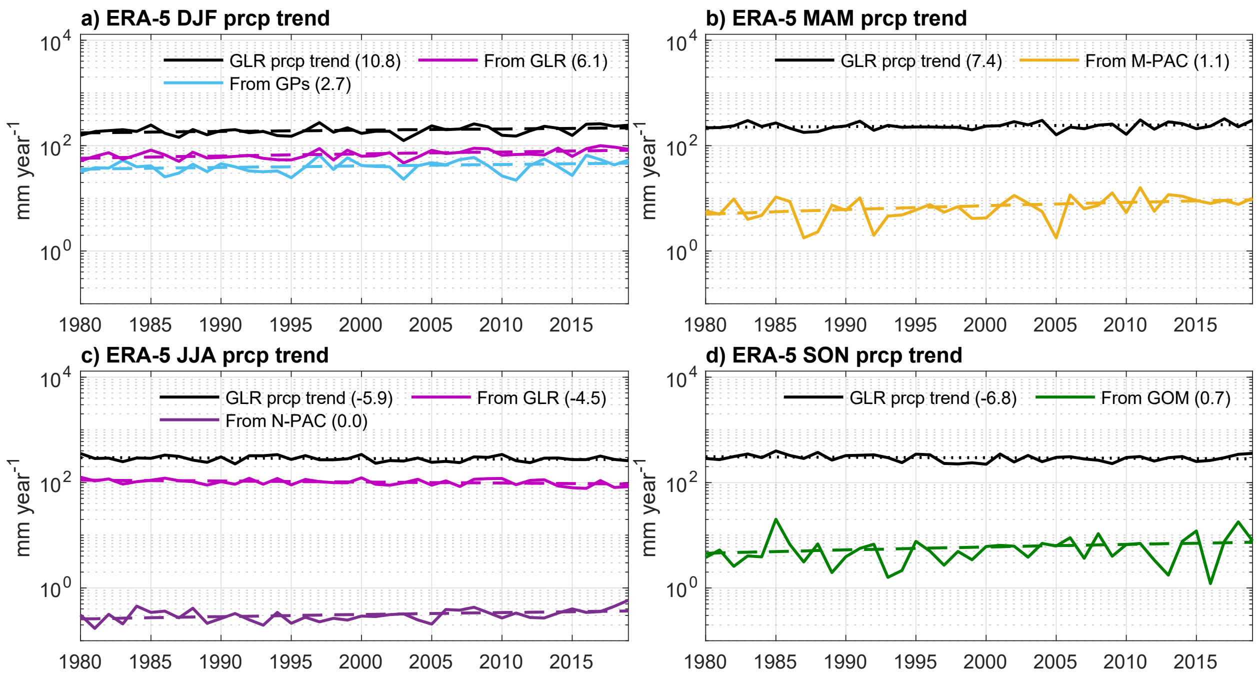

Figure S3: Long-term trend for seasonal precipitation using ERA-5 and contribution from its source regions. Only source regions with statistically significant trend ($p < 0.05$) are shown. Dash line indicates statistically significant trend using the Mann-Kendall test at 0.05 significance level.

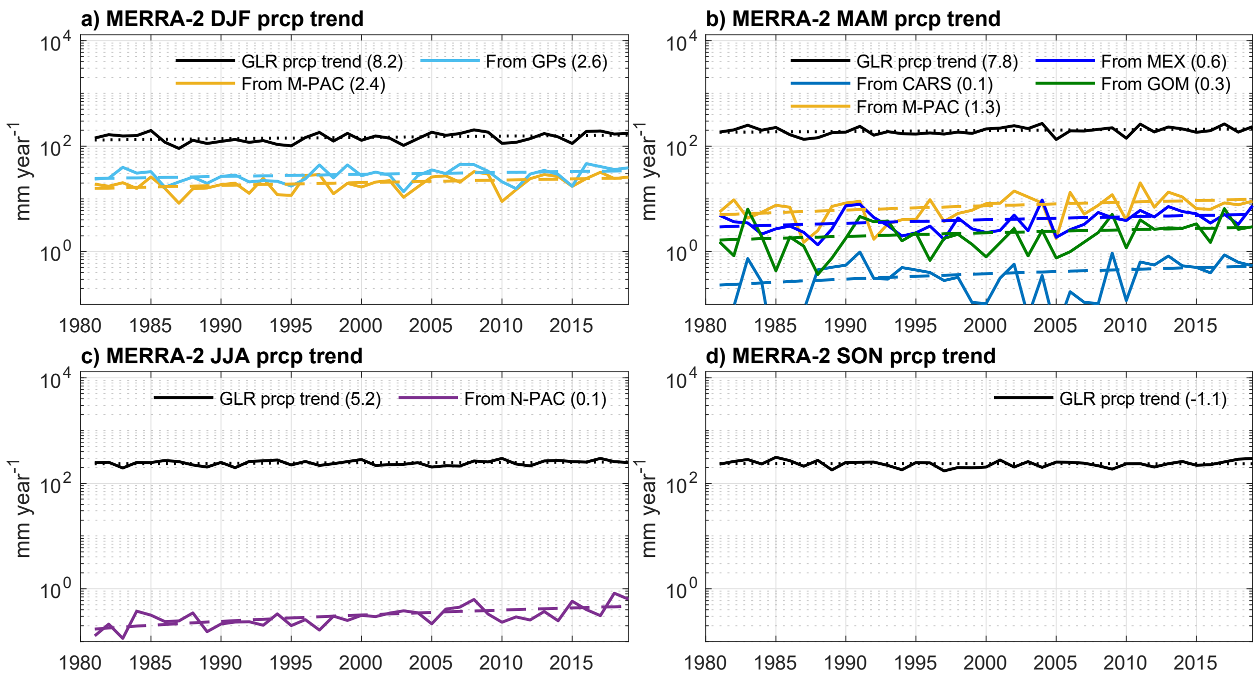

Figure S4: Similar to Figure S3 but using MERRA-2 data.

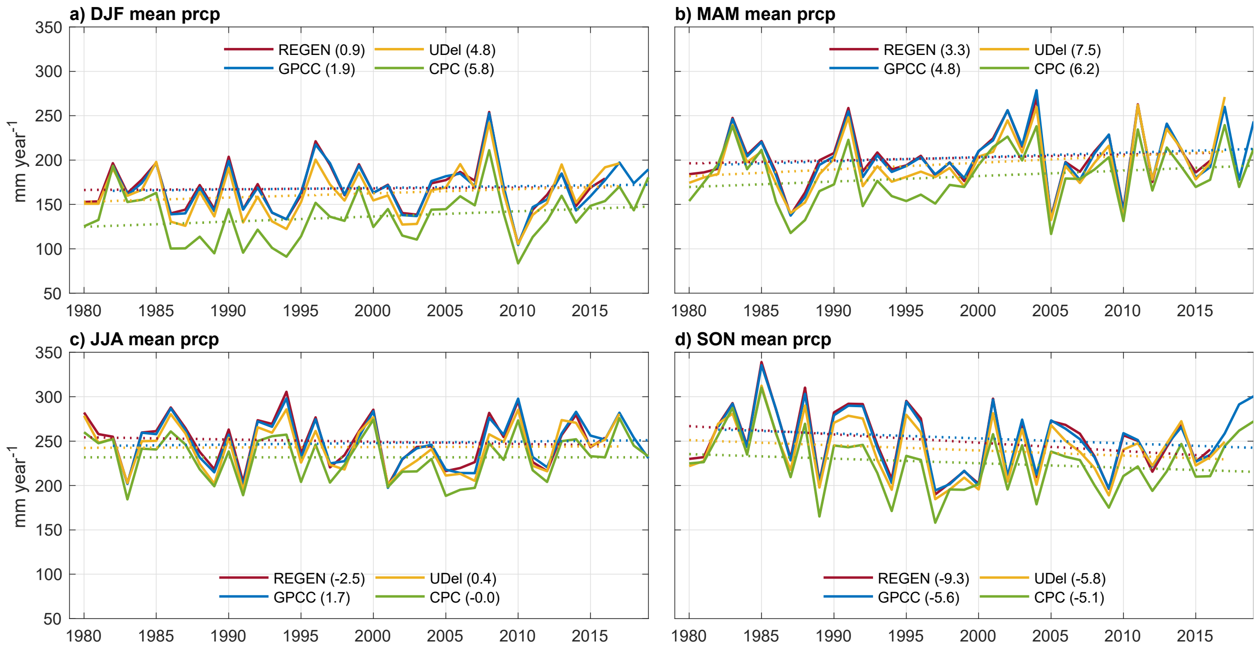

Figure S5: Long-term trend of seasonal precipitation in the reference datasets. Dotted lines indicate that the long-term trend is not statistically significant using the Mann-Kendall test at 0.05 significance level.

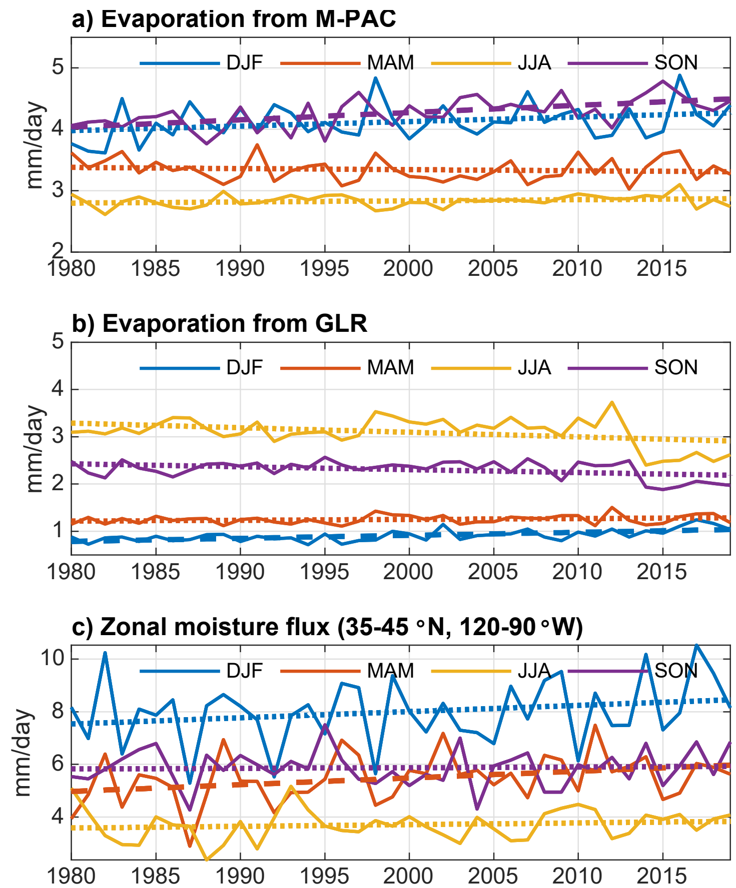

Figure S6: Long-term trend in evaporation over the M-PAC and zonal moisture flux over the moisture transport belt (35–45°N, 120–90°W) from the M-PAC to the GLR. Dash line indicates statistically significant trend using the Mann-Kendall test at 0.05 significance level. Dotted lines indicate that the long-term trend is not statistically significant using the Mann-Kendall test at 0.05 significance level.