Can Absence of Multiple Teleconnection Patterns Lead to Trends in Hydrologic Signals?

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Abstract. Several studies have reported that total precipitation is increasing across the United States with most of the increase coming from a positive trend in the upper tail of the daily precipitation distribution. Other studies have found that low and moderate, but not flood, flows are also increasing across much of the United States.

We analyzed trends in annual 7-day low, average and high flows along with seasonal precipitation that is averaged over individual basins. Our findings suggest that statistically significant trends in both fall precipitation and 7-day low flow are found in a large percentage of the basins in the upper Mississippi and Great Lakes regions of the country. By estimating trends in precipitation at the spatial scale of individual basins, we are able to offer a simple explanation for the apparent paradox of lack of trends in high flows. At the spatial scale of individual basins, precipitation is increasing during the fall but not during the spring, the season when high flows are generally observed. The increase in fall precipitation appears to result in an increase in the low flows while the lack of trends in precipitation in spring explains the lack of widespread trends in the high flows.

Our understanding of interannual and longer scale variations in fall climate remains limited because few previous studies have focused primarily on fall. We demonstrate that the secular trend component in national precipitation is statistically significant and spatially coherent over a large area in the interior of the country. We also present evidence that decadal variations in precipitation became large and strongly coherent across much of the interior of the country after 1950, the same period when the largest increases in precipitation are observed.

We will demonstrate that fall precipitation regimes across the United States experienced a sharp increase during the 1950s that has continued throughout the rest of the century. Using linear regression, univariate and multivariate spectral analysis, we will present evidence that nationally, regionally and locally, fall precipitation has increased dramatically on secular, decadal and quasi-biennial timescales. A key finding of this study is that the decadal variations in precipitation become strongly coherent across much of the interior of the country after 1950. Another interesting result is that the decadal and quasi-biennial signals in precipitation are strongly phase-locked during the fall. We will argue that the lack of dominant influences of multiple teleconnection patterns on fall precipitation makes the identification of trends possible.