THE INFLUENCE OF NORTH PACIFIC ATMOSPHERIC CIRCULATION ON STREAMFLOW IN THE WEST

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ABSTRACT

The annual cycle and non-seasonal variability of streamflow over a network of stations in western North America and Hawaii is studied in terms of atmospheric forcing elements. The phase lag between the annual cycle of streamflow and precipitation varies considerably over this network, as does the persistence of monthly streamflow anomalies. This lag effect appears to be largely a function of the relative amount of snow laid down in a particular basin. In addition to the rather strong annual cycle that exists in mean streamflow and its variance at most of the stations, there is also a distinct annual cycle in the autocorrelation of streamflow anomalies that is related to the interplay between the temperature and precipitation annual cycles; of particular importance is the existence of stored water in the form of a snow pack.

In the West, much of the streamflow and its variability occurs during December to August from precipitation during the winter. The seasonal anomaly of streamflow between December and August is modestly well-related to anomalous winter mean atmospheric circulation over the North Pacific. Along the West Coast, the circulation pattern responsible for positive streamflow anomalies is a broad scale pattern of low pressure (SLP) centered several hundred kilometers to the west, south of the Aleutian Islands. For basins in the interior, there are remote SLP anomaly teleconnections over the central North Pacific, as well as weak local negative SLP abinakues. A useful index of the broad scale circulation over the North Pacific and its relationship to streamflow is a regional average SLP anomaly over the Central North Pacific (CNP); this is well-correlated with the familiar Pacific/North American pattern (PNA) index, and to some extent, with the Southern Oscillation Index (SOI). These large scale indices are correlated at modest levels over quite distinct regional zones of the streamflow network. These patterns can be interpreted as the variations in the strength and position of the mean North Pacific storm track as it enters North America.

Streamflow anomalies leave fairly well-defined spatial anomaly features of several hundred kilometer scale, but the remote teleconnections

over this network are quite weak. One teleconnection that does appear to be a rather reliable tendency is for anomalous stremflow in the Hawaiian Islands with the same sign as anomalous streamflow in the interior West/Northwest. From the series of data available, it appears that there may be an asymmetry in the spatial pattern of positive vs. negative streamflow anomalies in the Southwest United States: dry patterns have been larger and more spatially coherent than wet patterns, with dry patterns tending to span the region from California into Utah and Colorado, while wet patterns in either the western or eastern part of this domain are more regionally confined.

Although the record available is at most about one century in length, it is clear that there exist spatially coherent streamflow fluctuations that persist for several years. These appear to be associated with several year shifts in the atmospheric circulation features.