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Changing Characteristics of Runoff and Freshwater Export From Watersheds Draining Northern Alaska

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The quantity and quality of river discharge in arctic regions is influenced by many processes including climate, watershed attributes and, increasingly, hydrological cycle intensification and permafrost thaw. We used a hydrological model to quantify baseline conditions and investigate the changing character of hydrological elements for Arctic watersheds between Point Barrow and just west of Mackenzie River over the period 1981-2010. The region annually exports 28.1 km^3 yr^{-1} of freshwater via river discharge, with 51.9% (14.6 km^3 yr^{-1}) coming collectively from the Colville, Kuparuk, and Sagavanirktok rivers. Our results point to significant ($p < 0.05$) increases (134-212% of average) in cold season discharge for several large North Slope rivers including the Colville and Kuparuk, and for the region as a whole. A significant increase in the proportion of subsurface runoff to total runoff is noted for the region and 24 of 42 study basins, with the change most prevalent across the northern foothills of the Brooks Range. Relatively large increases in simulated active-layer thickness suggest a physical connection between warming climate, permafrost degradation, and increasing subsurface flow to streams and rivers. A decline in terrestrial water storage is attributed to losses in soil ice that outweigh gains in soil liquid water storage. Over the 30 yr period the timing of peak spring (freshet) discharge shifts earlier by 4.5 days, though the time trend is only marginally ($p = 0.1$) significant. These changing characteristics of Arctic rivers have important implications for water, carbon, and nutrient cycling in coastal environments.