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Impact of large-scale climate on streamflow in New England

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Recent studies have identified a number of changes in the hydroclimatology of north-east USA over the last three or four decades. Many of these are concerned with reduced snow and ice storage during winter and earlier release of meltwater into the regional river network in spring. Snow- and ice-melt forms a vital component of the annual hydrograph of many New England rivers, due to the upland and montane source areas of the majority of these rivers. A number of investigators have proposed that the coincidental tendency of the North Atlantic Oscillation (NAO) towards a more positive state is intrinsically linked to these changes in meltwater dynamics, but little process based investigation of this hypothesised link has taken place. A more complete understanding of the nature and presence of a chain of causality linking these two trends is necessary both to explain these recent hydroclimatic variations and to assess how predicted climatic change may impact water resources in this topographically diverse region.

This paper seeks to address this research gap by identifying the climatic processes controlling high and low monthly streamflow across New England, and thus whether conditions associated with high and low streamflow can be linked with variation in the NAO. This is achieved through a composite analysis of a range of climatic variables under high and low streamflow conditions between 1958-2001, using data from the ERA-40 reanalysis and the USGS Hydro-Climatic Data Network. It is hoped that such an approach will yield greater information on the nature of large-scale climatic forcing of streamflow compared to a correlation-based approach. Statistically significant and physically consistent differences are found between high and low streamflow in a number of climatic variables. Surface temperature and atmospheric thickness, for

example, are shown to be positively associated with streamflow (mainly in winter), as are geopotential height and humidity. Wind speed is negatively associated with streamflow. The differences between the high and low flow composites are also consistent with a positive relationship between the NAO and regional streamflow, allowing the construction of a conceptual model of the process chain linking these variables.