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Physics in Constraining Observational Data Biases and Investigating Climate Changes in Hydrological Cycle

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Observations and climate change projections have indicated a wetting trend in northern high latitudes and Arctic. It is therefore imperative to understand underlying causal mechanisms. However, large biases existing in observational data and climate model output bring a great challenge to identify physical processes behind the observed changes in climate. In this study, we employed fundamental physical principals and theory to correct and constrain biases in the reanalysis products and developed a mass-corrected, temporally homogeneous atmospheric moisture transport data from 1948-2008. By using this data, we found that enhancement of poleward atmospheric moisture transport (AMT) decisively contributes to increased Eurasian Arctic river discharges. Net AMT into the Eurasian Arctic river basins captures 98% of the gauged climatological river discharges. The trend of 2.6% net AMT increase per decade accounts well for the 1.8 per decade increase in gauged discharges, and also suggests an increase in underlying soil moisture. A radical shift of the atmospheric circulation pattern induced an unusually large AMT and warm surface in 2006-07 over Eurasia, resulting in the record high discharge. The result from this study has significant implications for better understanding Arctic climate system changes and its interplay with global climate system.