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Relevance of hydro-climatic change projection and monitoring for assessment of water cycle changes in the Arctic

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Rapid changes to the Arctic hydrological cycle challenge both our process understanding and our ability to find appropriate adaptation strategies. We have investigated the relevance and accuracy development of climate change projections for assessment of water cycle changes in major Arctic drainage basins. Results show relatively good agreement of climate model projections with observed temperature changes, but high model inaccuracy relative to available observation data for precipitation changes. Direct observations further show systematically larger (smaller) runoff than precipitation increases (decreases). This result is partly attributable to uncertainties and systematic bias in precipitation observations, but still indicates that some of the observed increase in Arctic river runoff is due to water storage changes, for example melting permafrost and/or groundwater storage changes, within the drainage basins. Such causes of runoff change affect sea level, in addition to ocean salinity, and inland water resources, ecosystems and infrastructure. Process-based hydrological modeling and observations, which can resolve changes in evapotranspiration, and groundwater and permafrost storage at and below river basin scales, are needed in order to accurately interpret and translate climate-driven precipitation changes to changes in freshwater cycling and runoff. In contrast to this need, our results show that the density of Arctic runoff monitoring has become increasingly biased and less relevant by decreasing most and being lowest in river basins with the largest expected climatic changes.