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THE ARCTIC ATMOSPHERIC WATER CYCLE: PAST AND FUTURE CHANGES AND THEIR IMPACTS

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We present a review on the atmospheric component of the Arctic freshwater system, including its interactions with the ocean, sea ice, land ice, snow, and terrestrial waters. The major physical processes in the Arctic atmospheric water cycle include large-scale moisture transports, evaporation, cloud formation, and precipitation. The estimates for moisture transport from lower latitudes to the Arctic as well as evaporation and precipitation in the Arctic will be reviewed.

Considering historical and ongoing changes over periods of at least a few decades in continental-scale areas, there seems to be a trend towards more wet conditions, but variable trends are detected when smaller regions and shorter time periods are analysed. Climate models capture the observed overall wetting trend but have problems in reproducing the regional details. The wetting is linked to the general warming trend, partly driven by anthropogenic forcing. Considering the rest of the 21st century, climate models project a robust increase in precipitation over the Arctic and mid-latitudes, related to warming and increased available moisture. If the clouds will contain more water, precipitation may increase even in regions where relative humidity and cloud coverage decrease.

The present knowledge on the impacts of changes in atmospheric water cycle on ocean and terrestrial freshwater budgets, mass balance sea ice and land ice, ecosystem dynamics, and water resources will be reviewed.

Major knowledge gaps in understanding of atmospheric moisture budget in the Arctic are related to sparcity (in space and time) of accurate observations as well as large errors and uncertainties atmospheric reanalyses and climate model results. The model errors are partly due to the complexity of physical processes in the Arctic atmosphere and its interactions with the Earth surface, including cloud-radiation-turbulence interactions and evaporation from drifting snow and spray droplets.