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Continuous and in situ isotope measurements of atmospheric water vapor during a winter Arctic Vortex event

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The Arctic water cycle is undergoing pronounced change in the atmosphere, hydrosphere, and cryosphere. Reduced albedo due to declining sea ice extent is amplifying Arctic temperatures and atmospheric humidity, leading to complex seasonal patterns of synoptic climate, evaporation and precipitation. To better understand, quantify, and monitor these changes, in December 2017 we installed a new Picarro continuous water vapor analyzer at the Finnish Meteorological Institute's research station in Pallas-Yllästunturi National Park, 170 km north of the Arctic Circle. Here, we pair real-time (1 second) water vapor isotope measurements (δ18O, δ2H) with a suite of meteorological parameters – including air temperature, relative humidity, solar flux, wind speed and direction – as well as a Lagrangian moisture source diagnostic for isotopic fingerprinting of atmospheric transport pathways. Pallas vapor compositions range between -20 to -38 ‰ for δ18O and -140 to -300 ‰ for δ2H, and exhibit pronounced diurnal, weekly, monthly and seasonal fluctuations. We use the deuterium excess parameter (d-excess; δ2H$-$8.δ18O) to partition the water vapor flux from different moisture source regions across the Arctic and sub-Arctic. Of note is the observation that d-excess values oscillate substantially (> $\pm$20 ‰ and rapidly in response to shifting synoptic conditions and divergent storm tracks; for example, switching from vapor derived in the eastern Barents and Kara Seas to vapor from the North Atlantic or Greenland Sea, and these nuances are further explored in relation to sea ice coverage or lack thereof. Delineating these changes at such fine definition using our land-based system are key to reconciling how a changing Arctic system with reduced sea ice and divergent ocean temperatures are altering typical patterns of synoptic weather, for example the remarkable winter and spring snow conditions that blanketed much of northern Europe and North America in 2018.