An Unmanned Aerial Vehicle Sampling Platform for Atmospheric Water Vapor Isotopes in Polar Environments

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Abstract: Above polar ice sheets, atmospheric water vapor exchange occurs across the planetary boundary layer (PBL). This exchange is largely unconstrained, and has substantial implications for modeling and remote sensing of the polar hydrologic cycle. Efforts to characterize the exchange face logistical challenges due to extreme weather conditions, low humidity, and the remoteness of ice sheet field camps. Here, we present an Unmanned Aerial Vehicle (UAV) sampling platform capable of measuring atmospheric water vapor and water isotopes in extreme polar environments. This system was deployed to the East Greenland Ice-core Project (EastGRIP) camp in northeast Greenland during summer 2019. Six sampling flight missions were completed. This represents the largest such data retrieval ever above an ice sheet. With a suite of atmospheric measurements onboard the UAV (temperature, humidity, and water isotopes) we determine the height of the PBL and document significant gradients in water isotopes. The UAV-isotope data had internal repeatability in δD and $\delta^{18}O$ of 2.8 ‰ and 0.45 ‰, respectively, and was compared to concomitant sampled independent EastGRIP tower-isotope data. Based on these results, we present improvements to the UAV-isotope platform to be utilized in future polar field campaigns. The system is designed to be readily adaptable to other fields of study, such as carbon cycle gases.