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Continuous monitoring of surface water vapor isotopic composition at Neumayer-III station, East Antarctica

Saeid Bagheri Dastgerdi, Martin Werner, Jean-Louis Bonne, Melanie Behrens, Maria Hörhold, and Gerrit Lohmann

Alfred Wegener Institute (AWI), Paleoclimate Dynamics, Bremerhaven, Germany (saeid.bagheri@awi.de)

Understanding the processes influencing the stable water isotopic composition and variability of the atmospheric vapor under different climate conditions is essential for a more accurate interpretation of Antarctic ice core isotopic data as a temperature proxy. This can be achieved by a combination of direct observation of the isotopic composition of the water vapor and climate modeling simulations of the isotopic composition of Antarctic precipitation.
A Cavity Ring-Down Spectroscopy analyzer has been installed in January 2017 at the Neumayer-III station (on the Ekström ice shelf within the Weddell Sea) in Antarctica for high frequency continuous in situ observations of the water vapor isotopic composition. We present results of the first year-round observations (Feb 2017 - Feb 2018) of surface water vapor isotopic composition recorded at this location.
During the observational period, δ18O (δD) in water vapor changes in the range of -47 ‰ (-395 ‰) to -18 ‰ (-139 ‰). The seasonal cycle of δ18O (δD) has an amplitude of 9 ‰ (95 ‰). At the seasonal scale, δ18O and δD have a maximum in February and a minimum in July.
Co-variations of the water vapor isotopic composition with local meteorological parameters have been evaluated. δ18O and δD are very well correlated with each other (R=0.99) and they show a high correlation with temperature (R=0.86) and humidity (R=0.82). The relation between δ18O and temperature is δ18O [‰] =0.55 T [°C] – 25.06.
Observations have been compared with the simulated isotopic composition of vapor from ECHAM5-wiso, an atmospheric general circulation model (AGCM) equipped with water isotope diagnostics. The model correctly captures the seasonal and synoptic variability of δ18O and δD with a high correlation between observed and modeled values (respectively R=0.74 and R=0.75).
A wind analysis shows that our observations were influenced by winds originating from the east (55%), the south (15%) and south-west (13%). Less than 5% of all wind observations was related to the north, north-west, and west.
Moisture sources have been estimated for our observation period based on air masses dispersion simulations with the FLEXPART Lagrangian transport and dispersion model. Most of the moisture was transported to the station by cyclonic circulation patterns, with significant seasonal variations (dominant source from the north-west in spring, from the east in fall and from the west in winter). Contrary to the other seasons, an enhanced contribution of local moisture uptake in the coastal areas close to the station was observed in summer.