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

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**Introduction**

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 and climate modeling simulations of the water vapor isotopic composition of Antarctic precipitation.

**Method**

- 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.
- 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.
- Meteorological data of the Neumayer station is taken from PANGAEA data center.
- Moisture sources have been estimated over our observation period based on air masses dispersion simulations with FLEXPART model.

**Results**

- \(\delta^{18}O\) and \(D\) have a maximum in February and a minimum in July.
- \(\delta^{18}O\) and \(D\) 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 slope of the relation between \(\delta^{18}O\) and temperature is \(0.55 \, \text{‰} \, ^\circ \text{C}^{-1}\) (\(\delta^{18}O \, \text{[‰]} = 0.55 \times T \, [^\circ \text{C}] - 25.06\)).
- The ECHAM5-wiso model correctly captures the seasonal and synoptic variability of \(\delta^{18}O\) and \(D\) with a high correlation with observations (R=0.75).
- 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).
- 86% of warm events at the Neumayer station coincide with winds from east that bring more humidity from the ocean, form clouds and make \(\delta^{18}O\) richer. Cold events are associated with winds from south and southwest which bring the cold and dry air from East Antarctic Plateau to the station and make the sky clear. \(\delta^{18}O\) from the south is more depleted following the temperature.

**Conclusions**

We observe, model, and trace water vapor isotopes in Antarctica (at the Neumayer-III station).

- High correlation between \(\delta^{18}O\) & temperature
- High agreement between model & observations
  - Compared to observations, ECHAM5-wiso model can reproduce the synoptical and seasonal isotope and temperature variations, reliably.
- Seasonally different origins of the water vapor
  - The moisture sources of water vapor coming to the Neumayer station are seasonally different.
- Wind as an important driver
  - The value of \(\delta^{18}O\) and the relation between temperature and \(\delta^{18}O\) changes with the change of wind pattern.

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**Fig. 1.** Comparison of observations (blue) and simulated data (red) at the Neumayer station in Antarctica (Feb 2017 – Feb 2019). Downwards: temperature (Metrological & modeled), humidity, \(\delta^{18}O\), and d-excess.

**Fig. 2.** \(\delta^{18}O\) against temperature (Hourly average) in different seasons marked by colors during one year (Feb 2017-Feb 2018).

**Fig. 3.** Two dimensional frequency distribution of 10m wind (measured every minute) at Neumayer station during one year (2017).

**Fig. 4.** Simulated seasonal moisture transport towards Neumayer-III modelled by FLEXPART.