ISOARC project: From source to sink - Monitoring the isotopic fingerprints of Arctic moisture

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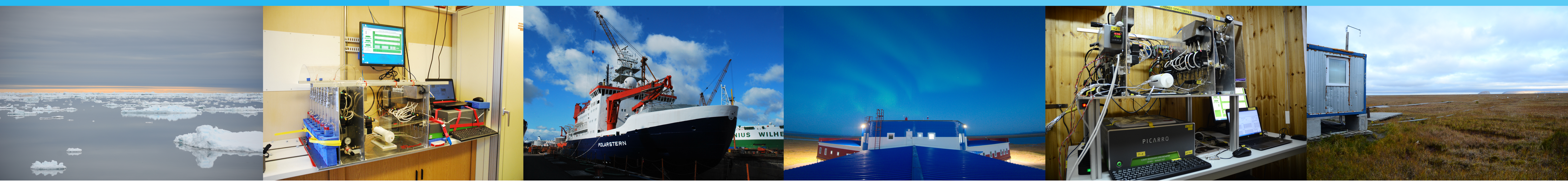


Introduction

In recent years, a new generation of analyzers (CRDS) has been used to develop an observing network of the isotopic composition of atmospheric water vapour ($\delta^{18}O$, δD, leading to d-excess = $\delta D - 8.\delta^{18}O$) in the Arctic, aiming at documenting the isotopic fingerprint of the hydrological cycle [Bonne et al. 2015, Steen-Larsen et al. 2013, 2015]. The interest of observations at the moisture sources also lead to regular ship based measurements in the Atlantic realm [Benetti et al. 2017].
To identify the eastern Arctic moisture sources, two analyzers are continuously operating since July 2015 on-board Polarstern research vessel (close to the evaporation sources) and in the ground station of Samoylov (Lena delta, 72°22'N, 126°29'E).

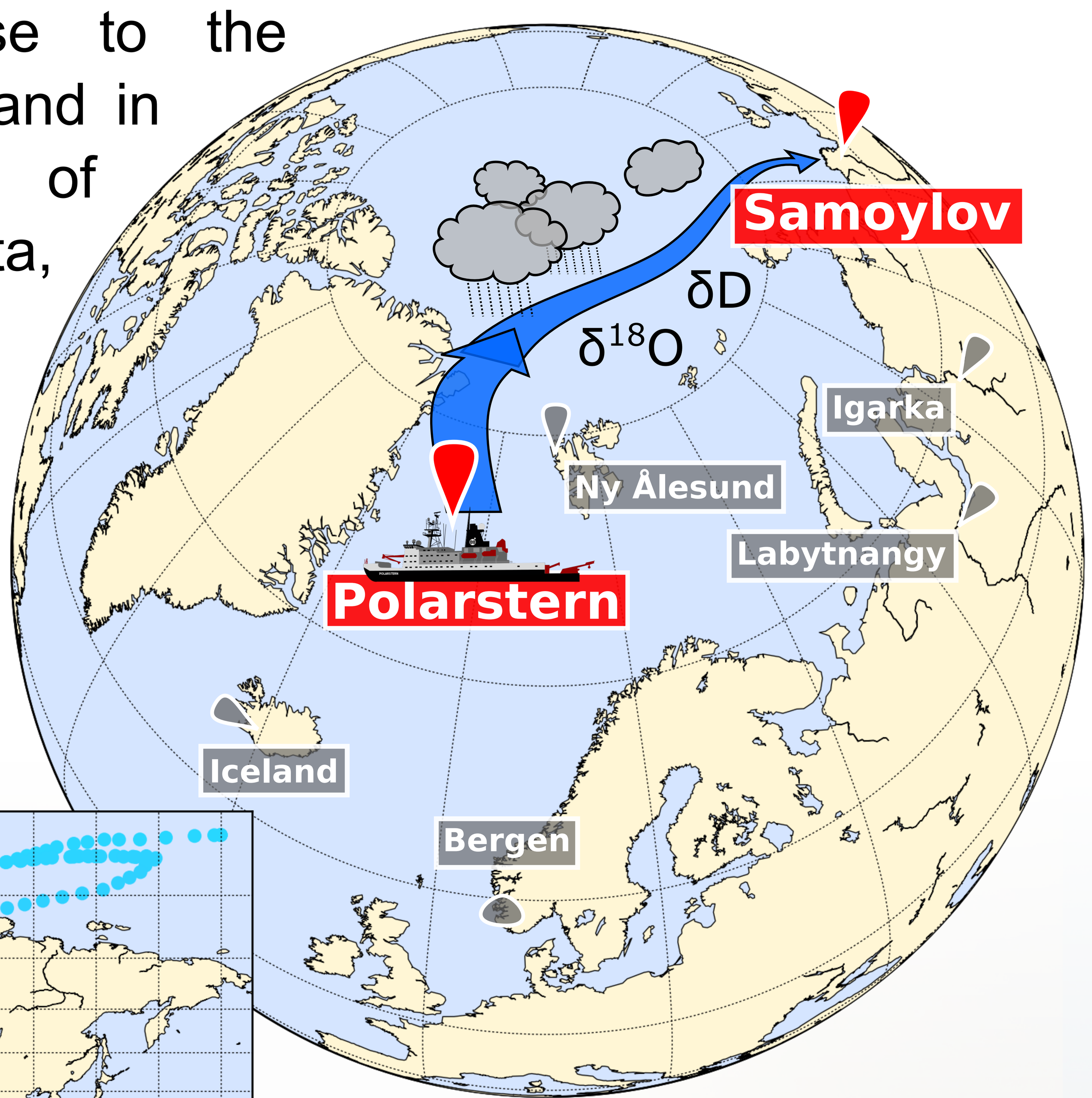


Fig.1 (right): Concept of the ISOARC project, with the current Arctic network of vapour isotopic analyzers.

Polarstern

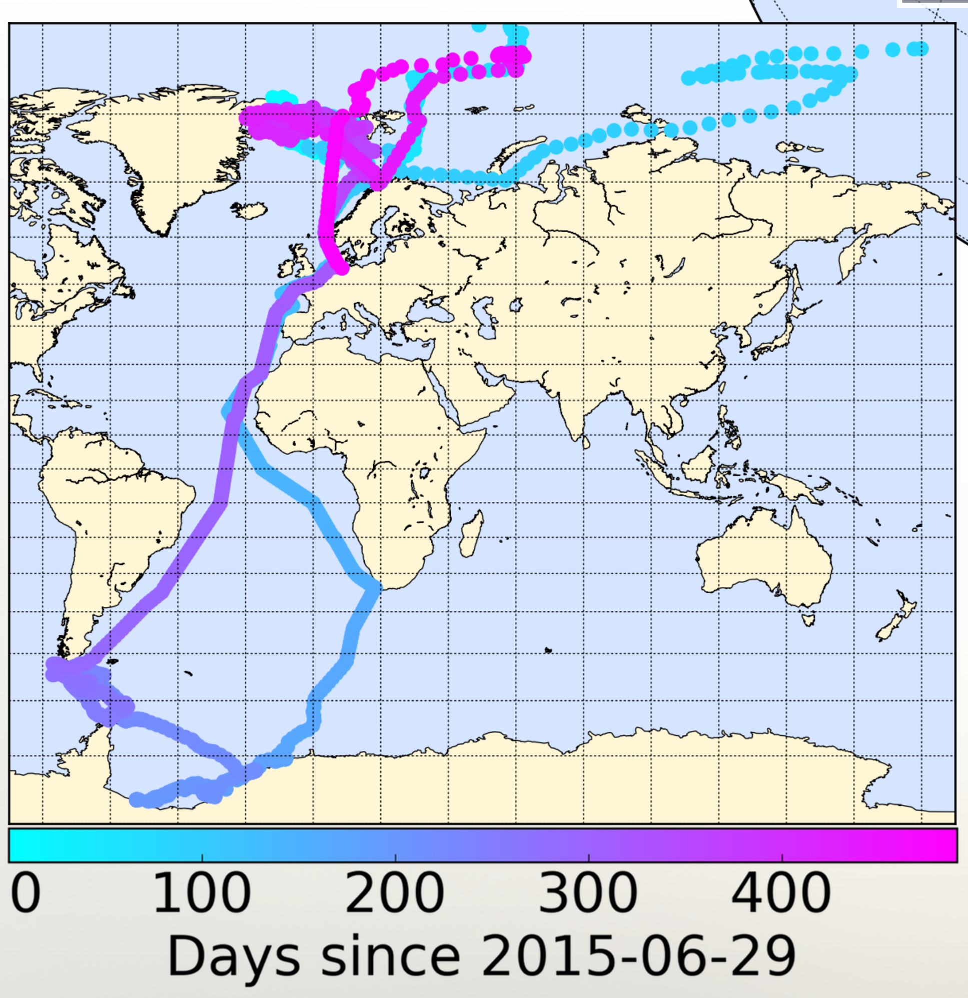


Fig.2 (left): Map of Polarstern positions at 6 hours interval from 07-2015 to 11-2016.

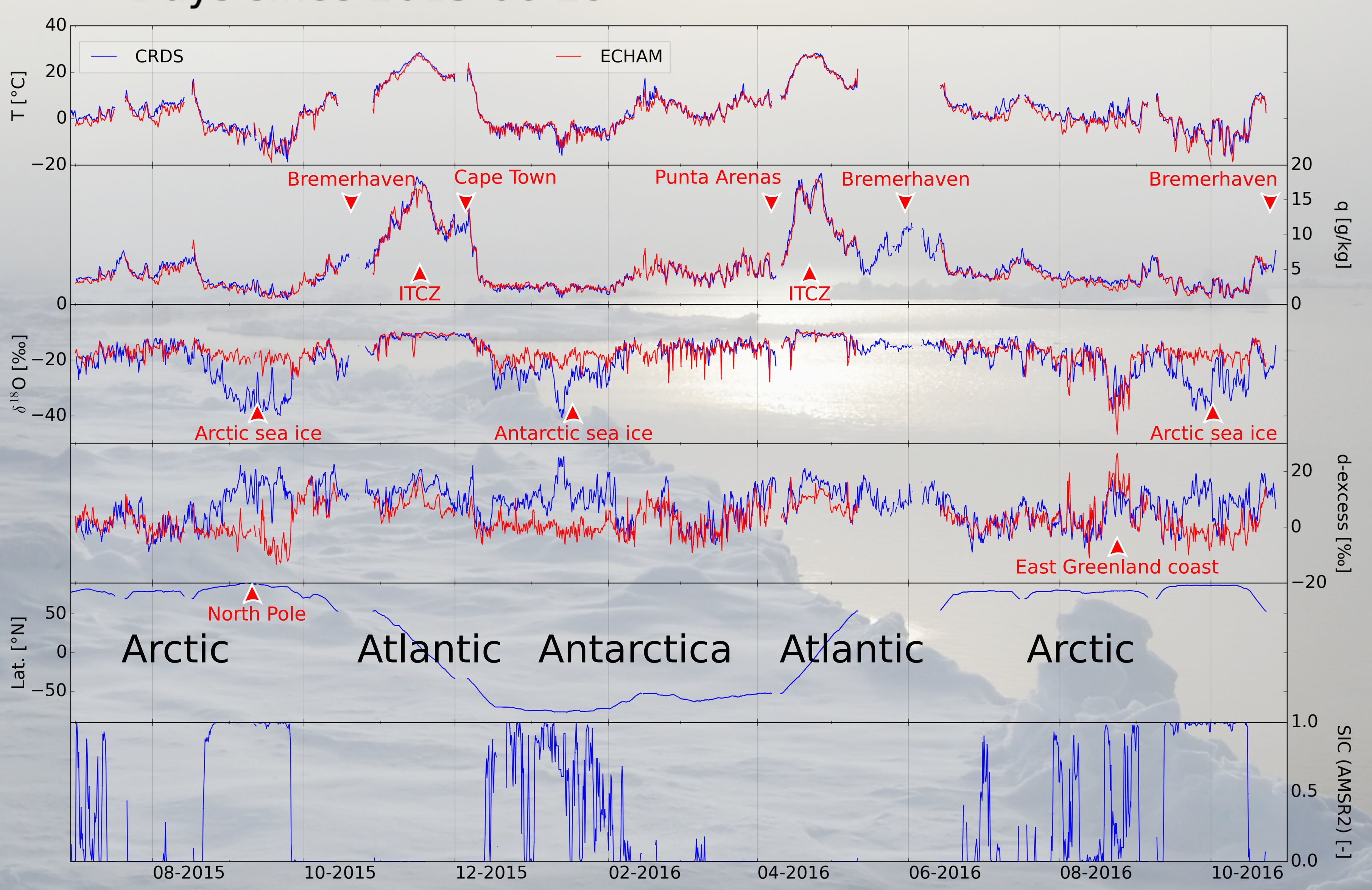
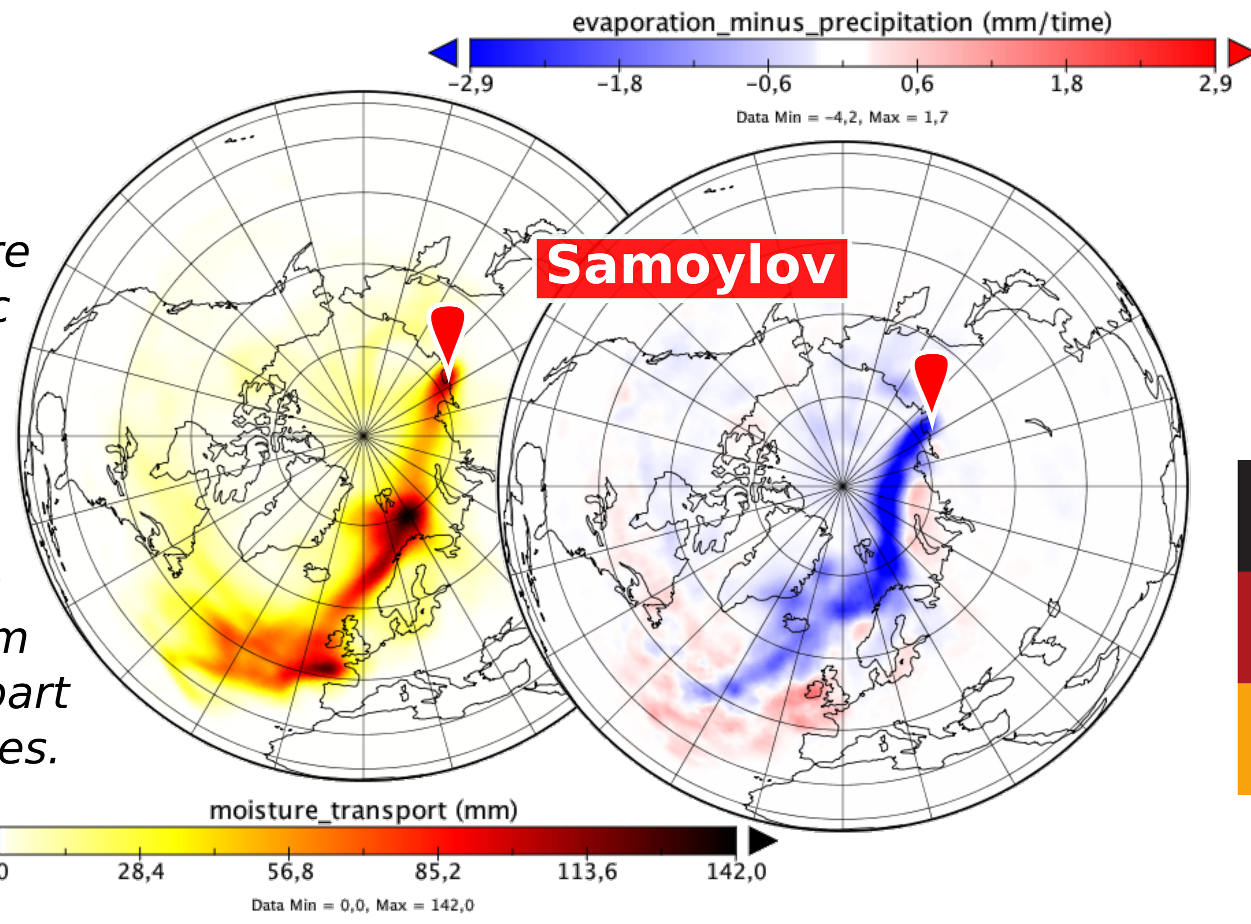


Fig.3: Polarstern observations (blue) and colocated ECHAM5-wiso model outputs (red) from 07-2015 to 11-2016 at 6 hours resolution. Downwards: temperature, specific humidity, $\delta^{18}O$, d-excess, latitude, local sea ice cover.

Samoylov

Fig.4: Simulated moisture transport over the Arctic Ocean towards Samoylov on 2015-09-30: amount of transported moisture (left) and evaporation minus precipitation (right), estimated from modelled 10-days Flexpart Lagrangian backtrajectories.



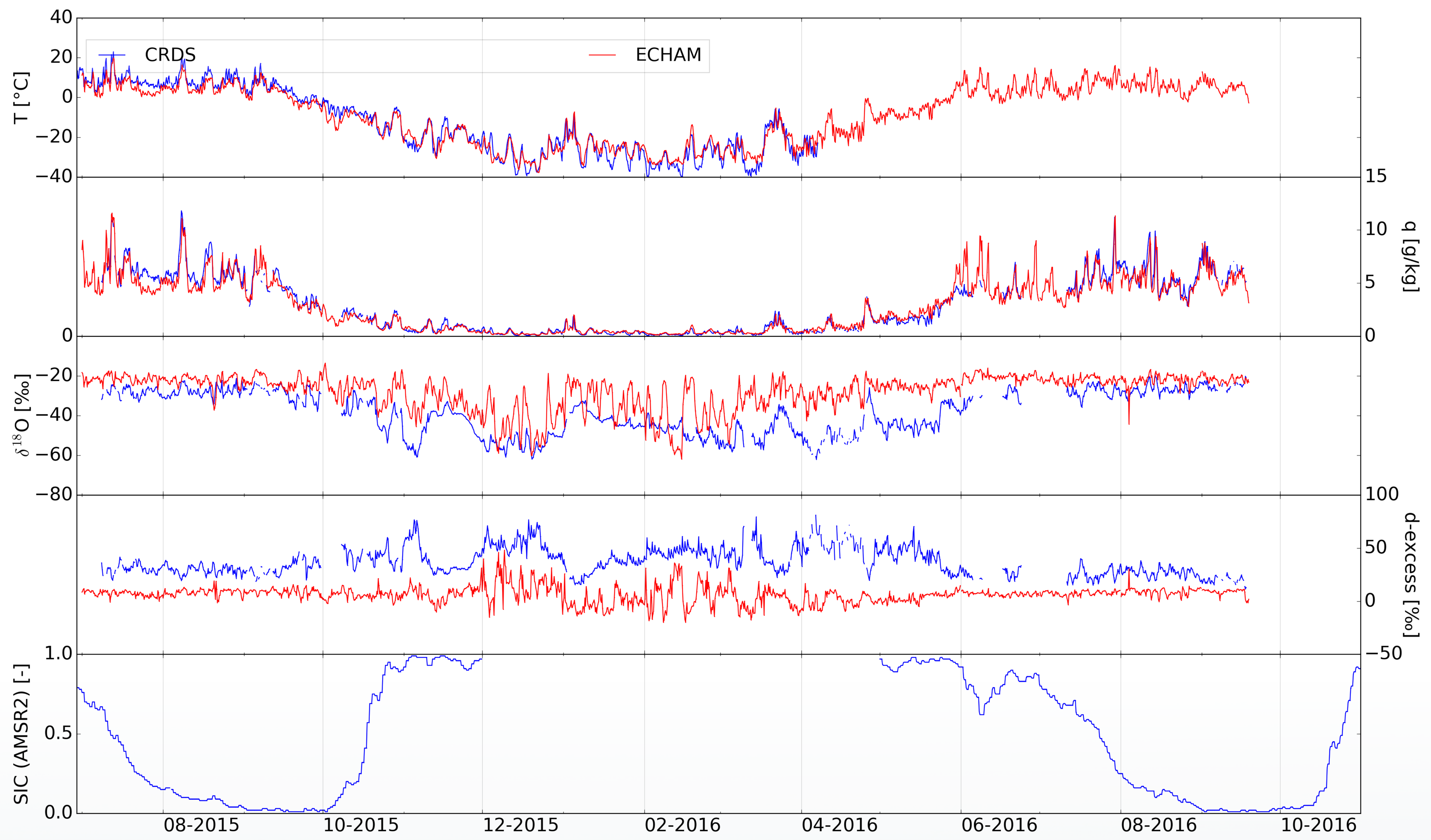


Fig.5: Samoylov 6-hours averaged observations (blue) & ECHAM5-wiso model outputs (red) from 07-2015 to 11-2016. Downwards: temperature, specific humidity, $\delta^{18}O$, d-excess, sea ice cover (at 500 km from Samoylov).

Summary and perspectives

Our studies have demonstrated the ability to measure vapour isotopic composition in a wide range of humidity values, from polar to tropical regions. Humidity is following temperatures to the first order.
The most depleted isotopic values are observed over sea ice from Polarstern and in Arctic winter in Samoylov. Isotopic values are more depleted in Samoylov than above the open ocean, showing the impact of atmospheric transport.
ECHAM5-wiso model correctly simulates humidity and temperature from both observational datasets. The vapour isotopic composition is well reproduced above the open ocean at every latitude, but needs to be improved at sea ice (Fig. 3).
At Samoylov station (Fig. 4), which is also influenced by continental air masses and local moisture sources, generally higher biases are seen, especially in spring. These maybe linked to snow melt and continental recycling (ice break-up).
Different Arctic records (Fig.1) could be combined to track vapour along atmospheric transport patterns [as in Bonne et al. 2015]. The measurements performed in a station in the Arctic region will help differentiating between long-distance vapour transport and local moisture contributions.

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