Water vapour and precipitation isotope measurements from different platforms during the IGP campaign, Iceland, in 2018 connect evaporation sources to precipitation sinks

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Iceland-Greenland Sea

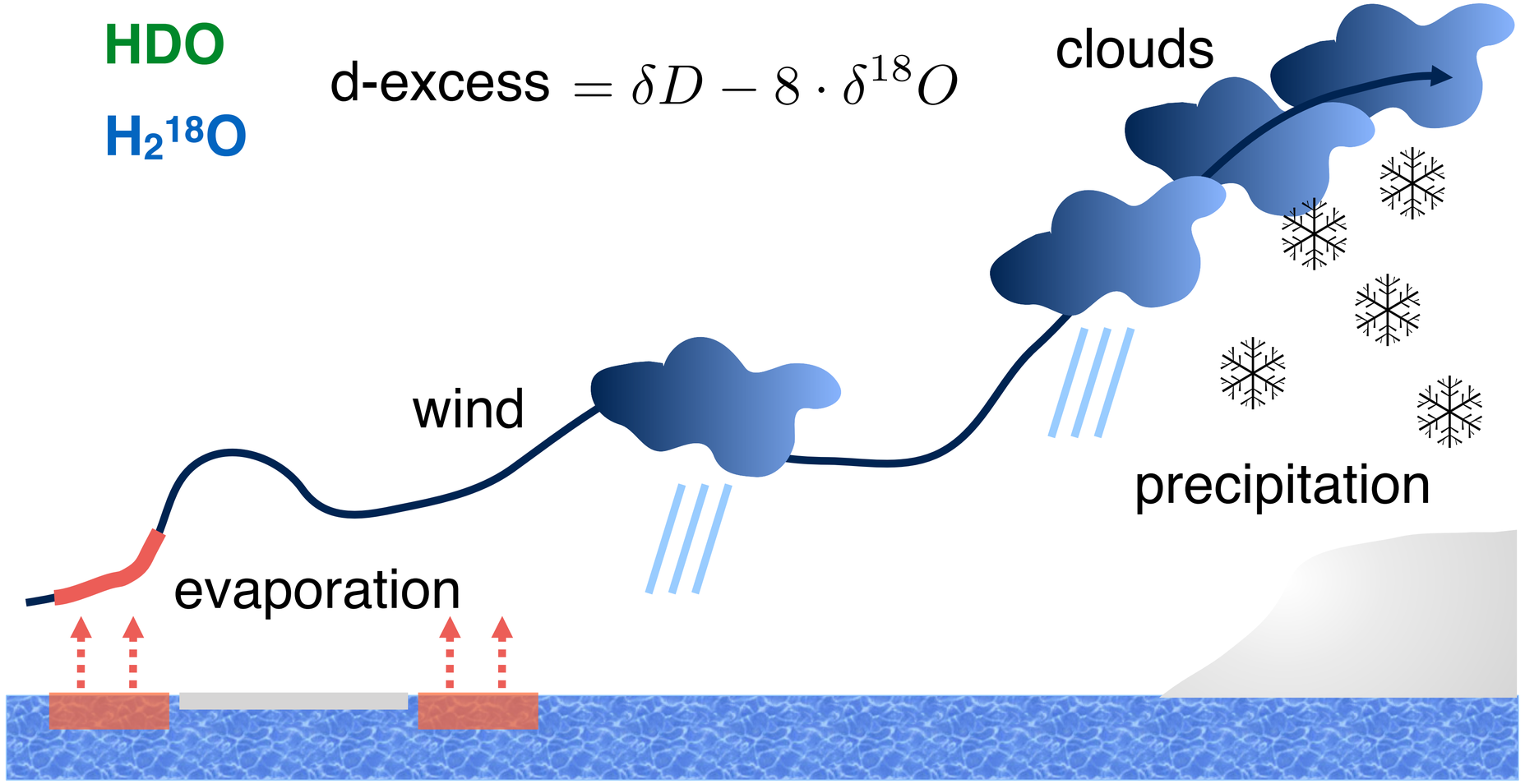
Akureyri

Husavik

HDO

$H_2{}^{18}O$

d-excess $= \delta D - 8 \cdot \delta^{18}O$



Stable water isotopes undergo fractionation during phase changes. $H_2{}^{18}O$, and HDO have lower vapour pressures and condense preferentially, leading to depletion in the atmosphere. The d-excess signals evaporation conditions, with **high d-excess indicating intense evaporation**

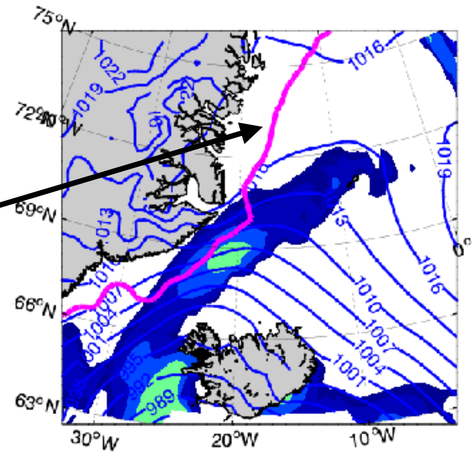
During cold-air outbreaks, essentially dry air acquires water vapour from the surface. When transported south towards Iceland, precipitation processes set in, creating **a local water cycle** that can be **probed for water isotope composition on a regional scale**

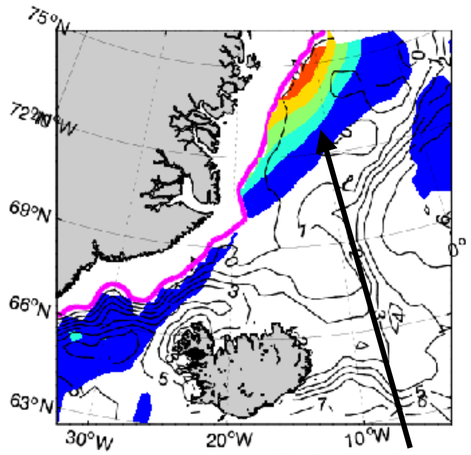
SLP and total P

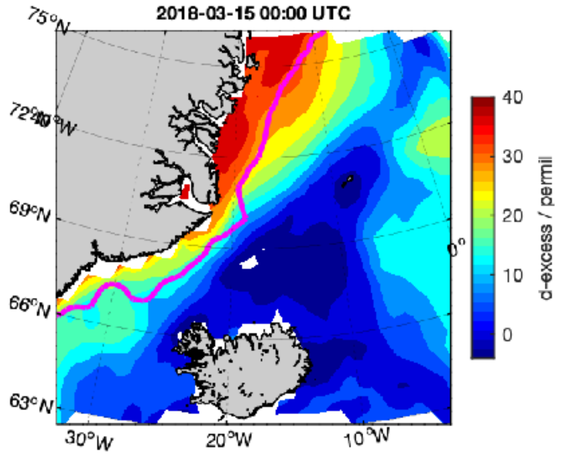
CAO index & SST

d-excess proxy (Pfahl and Sodemann, 2014)

sea ice boundary



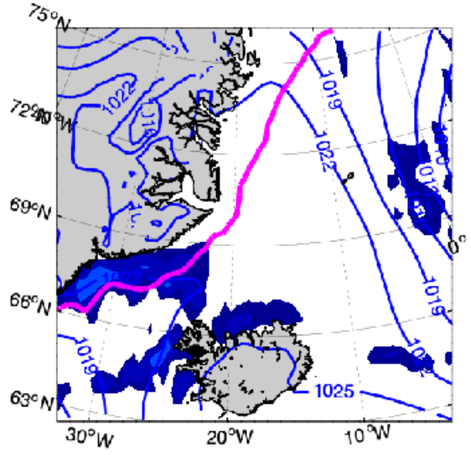


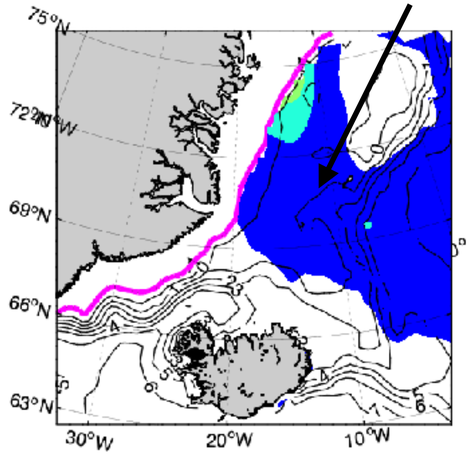


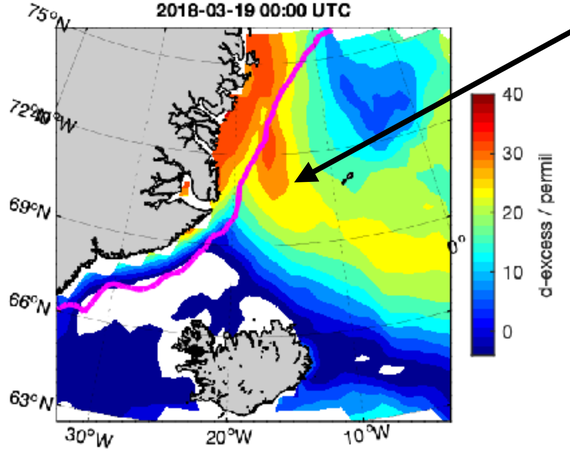
15 Mar 2018

CAO forming

high d-excess in CAO area



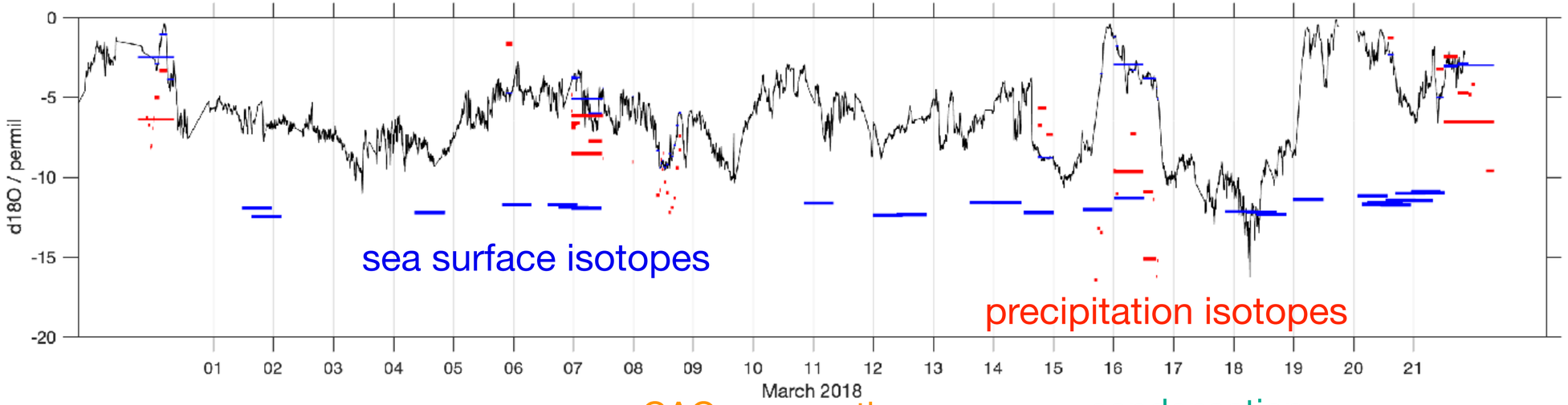




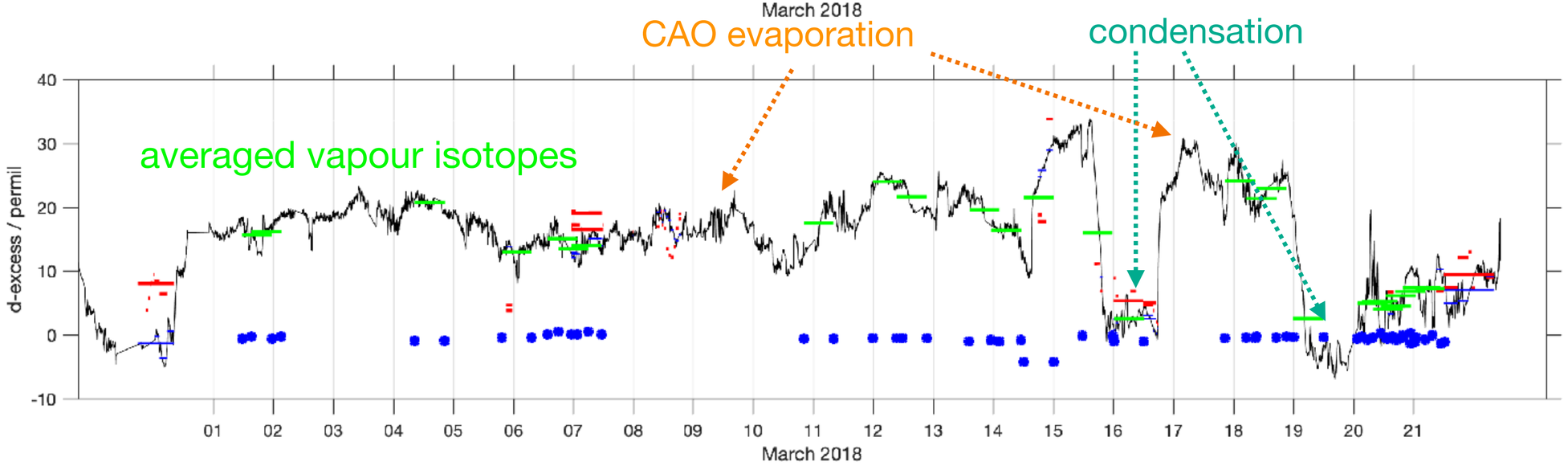
19 Mar 2018

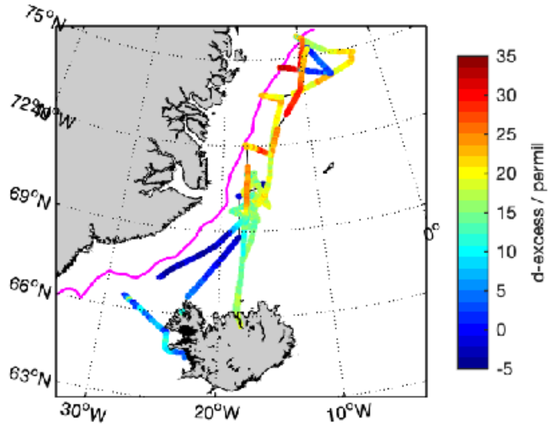
The overall weather situation during the IGP campaign in Feb/Mar 2018 was characterized by a strong anticyclone over Greenland, leading to repeated CAO with preciptiation in Iceland. Towards end of March weather became more variable, with intermittent strong CAO conditions, in particular during 15-19 March.

Vapour isotope measurements on the ship R/V Alliance during Leg 2 in the Iceland-Greenland Sea show substantial variability, as the ship was reached by different airmasses when travelling along the sea-ice boundary.



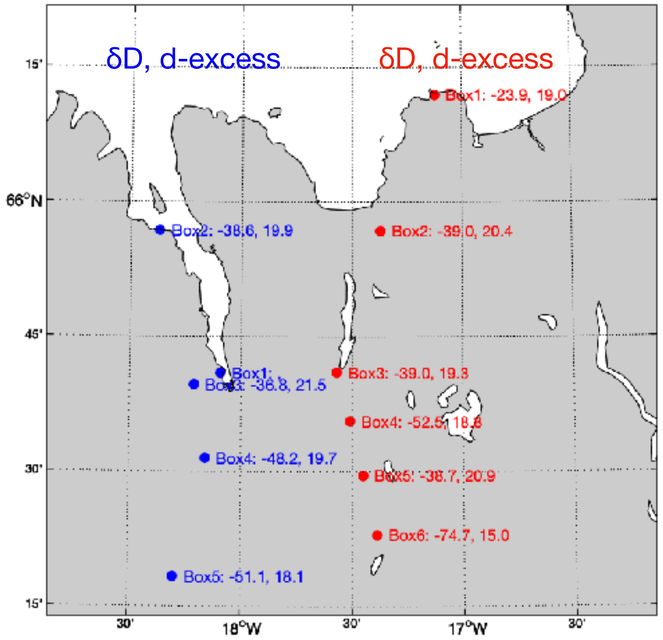
equilibrium vapour of sea surface and precipitation isotopes shows that the vapour measurements on the ship are rarely in equilibrium with local ocean water, and only sometimes during precipitation events

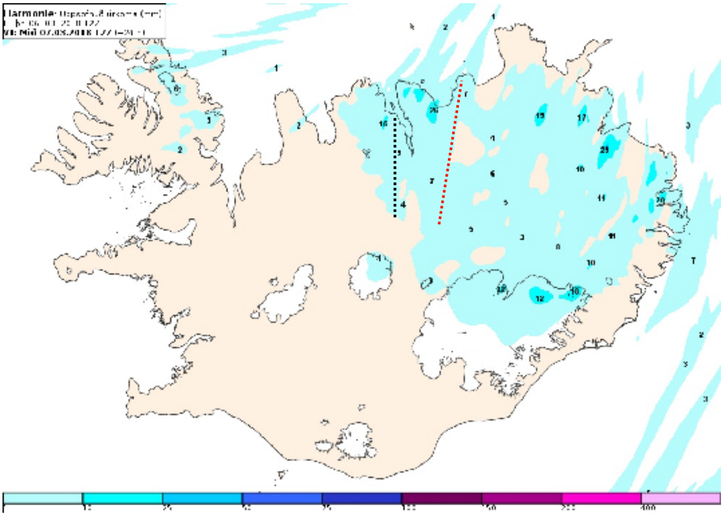




High d-excess values indicate strong kinetic fractionation regime during in the CAO period, also underlined by the deviation from surface water d-excess. Averaged vapour during precipitation shows match in d-excess, corresponding to alterations between northerly air associated with evaporation, and sourtherly airmasses leading to condensation.

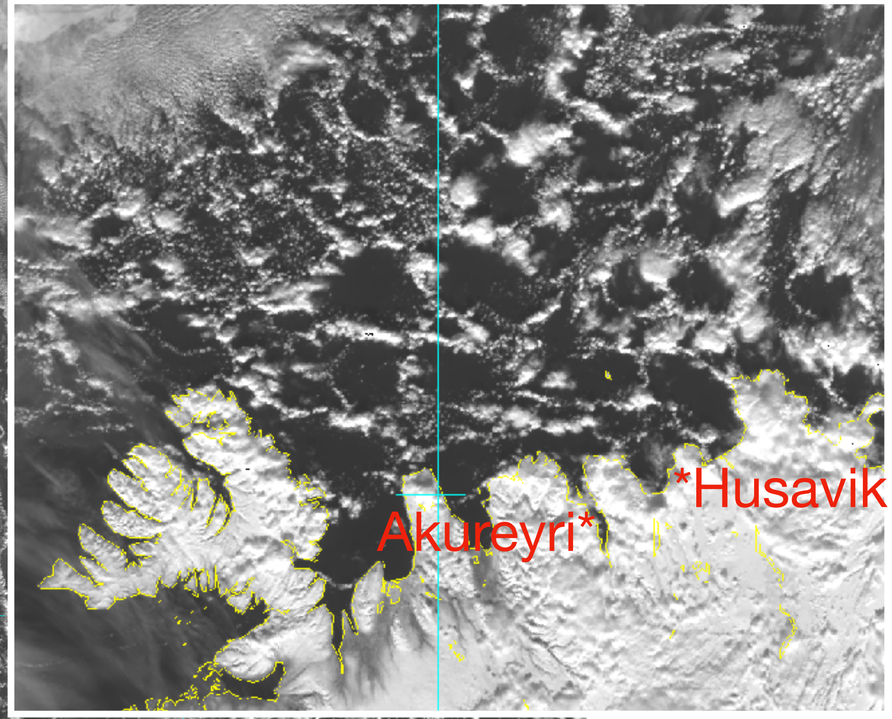
2018-03-07





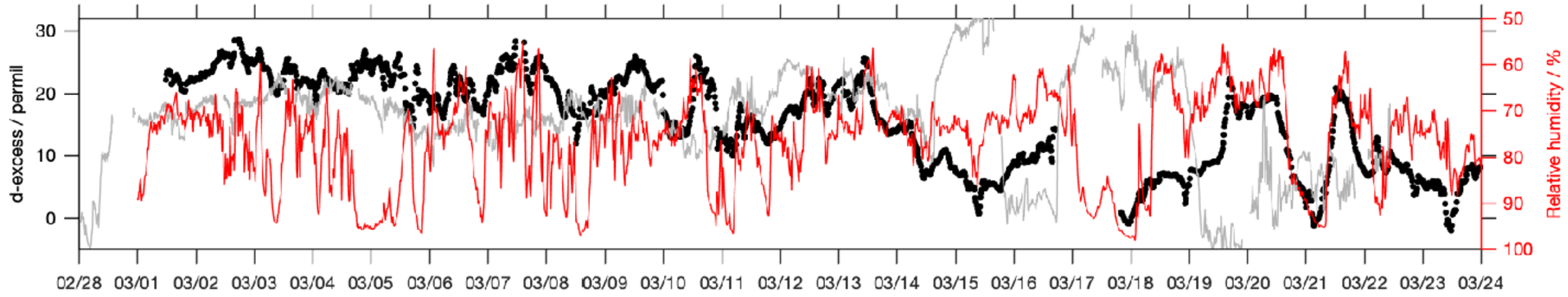
07-08 Mar 2018

CAO air caused frequent snow showers at the coast of northern Iceland. Snow was sampled at high frequency along two transects, and in high resolution at Akureyri, in addition to vapour measurements at Husavik and aircraft observations from Akureyri

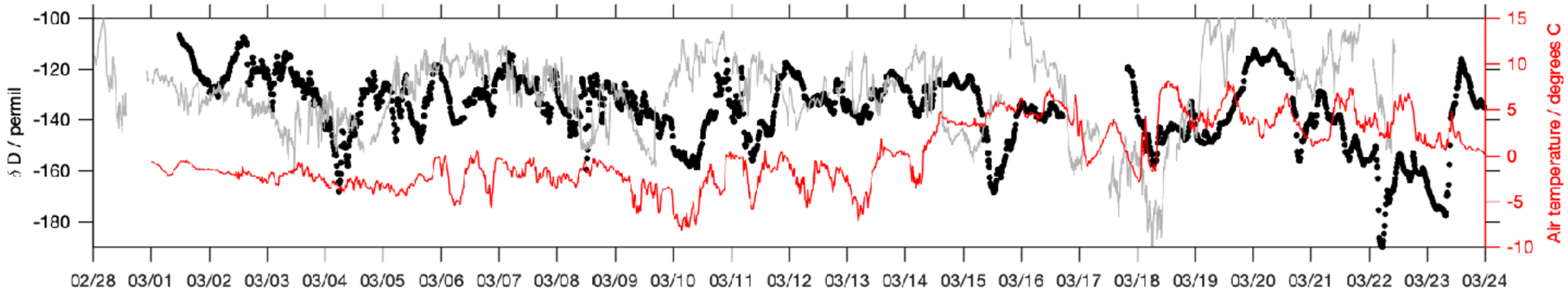


CAO airmass transport

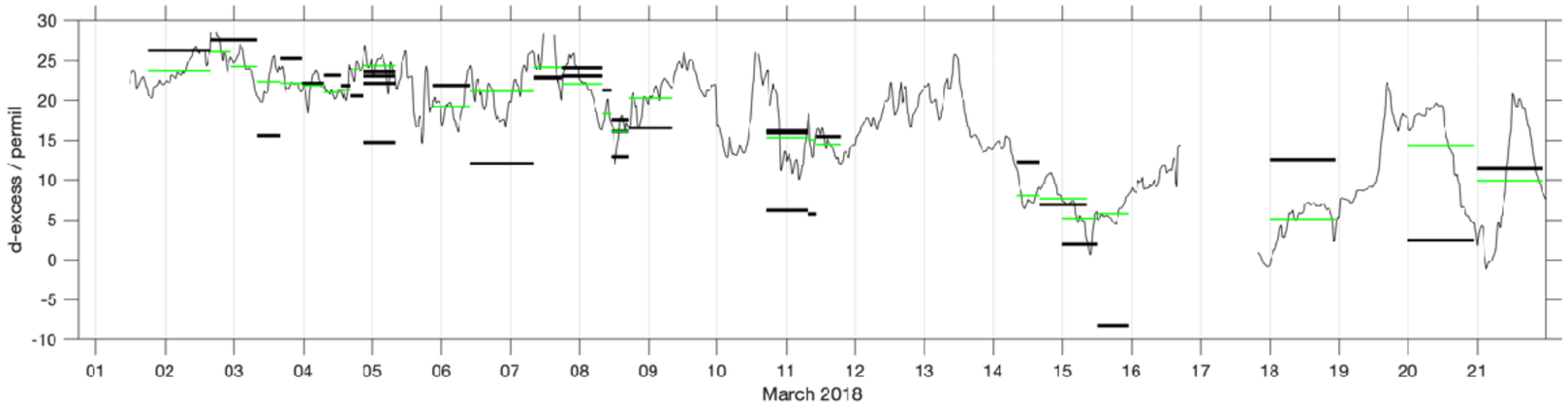
The snowfall event on 7-8 March shows d-excess values in line with vapour composition from the ship , except for the most high-elevation sites



d-excess in Husavik vapour and Alliance vapour with Husavik RH



δD in Husavik vapour and Alliance vapour with air temperature



d-excess in Akureyri precipitation and Husavik vapour

Time series of vapour isotope measurements and meteorology in Husavik shows d-excess varying in agreement with the ship measurements, but with temporal offsets due to different locations. Precipitation isotopes are more depleted than implied by the vapour measurements at Husavik (not shown), but follow the d-excess pattern of the vapour time series (bottom panel).

Conclusions

1. CAO situations during IGP set up **local water cycle** between Iceland-Greenland-Seas and Iceland, studied with isotope measurements from ship, aircraft and precipitation

2. Ship-based and station-based d-excess show coherent variation, depending on dominance of **either evaporation or condensation**

3. Water isotope observations from IGP will be useful for **isotope-enabled model validation.**