

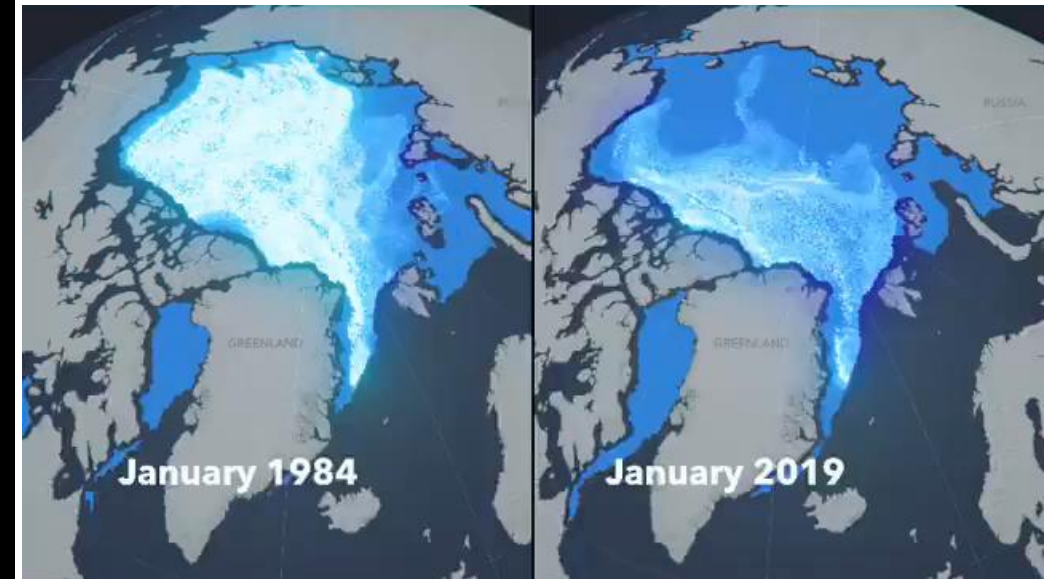
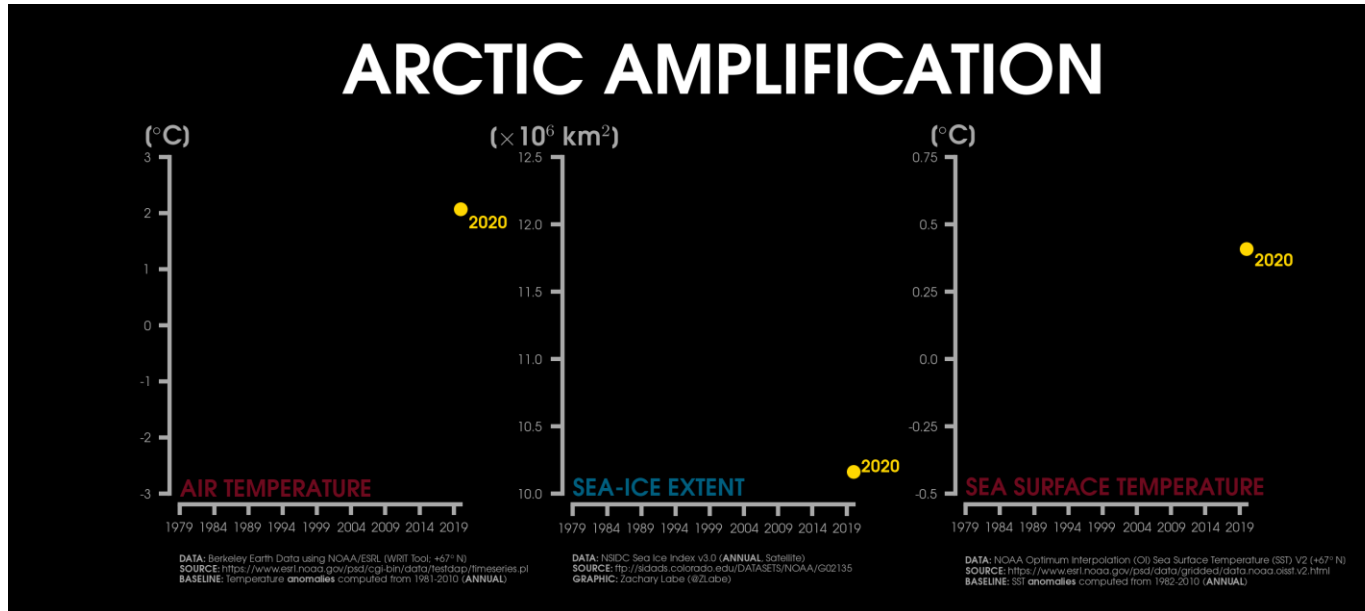
# Isotopic traits of the Arctic water cycle

Moein Mellat, Martin Werner, Camilla Brunello, Hanno Meyer



# Why Arctic?

Over the past four decades, surface air temperature (SAT) in the Arctic has increased by  $+1.7^{\circ}\text{C}$  (twice the global rate) and sea ice extent has decreased severely

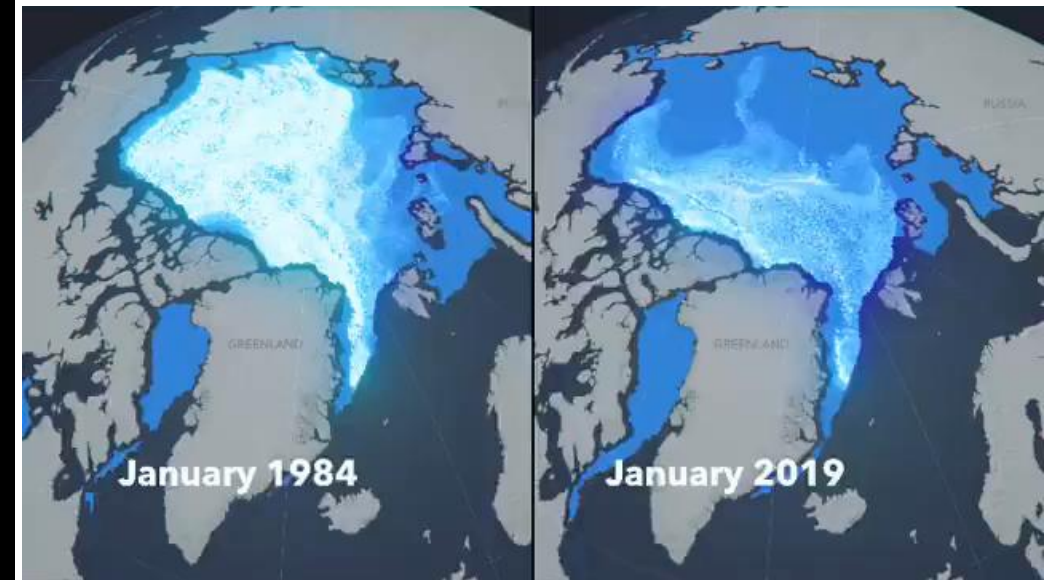
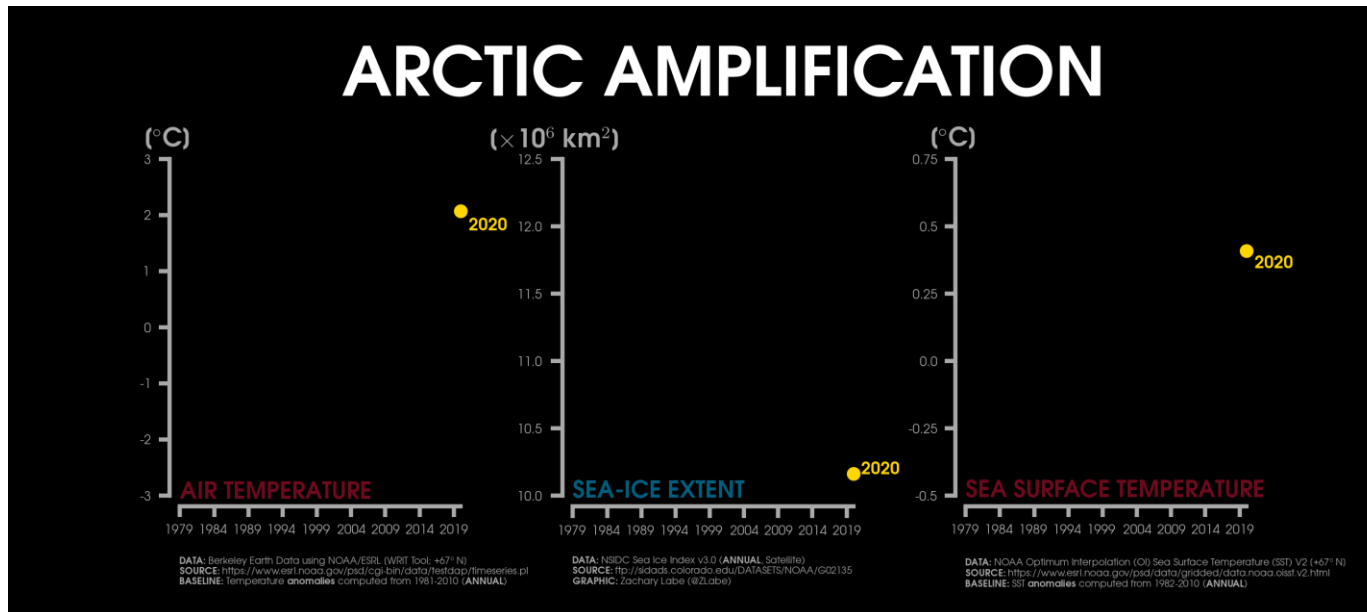


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# Why Arctic?

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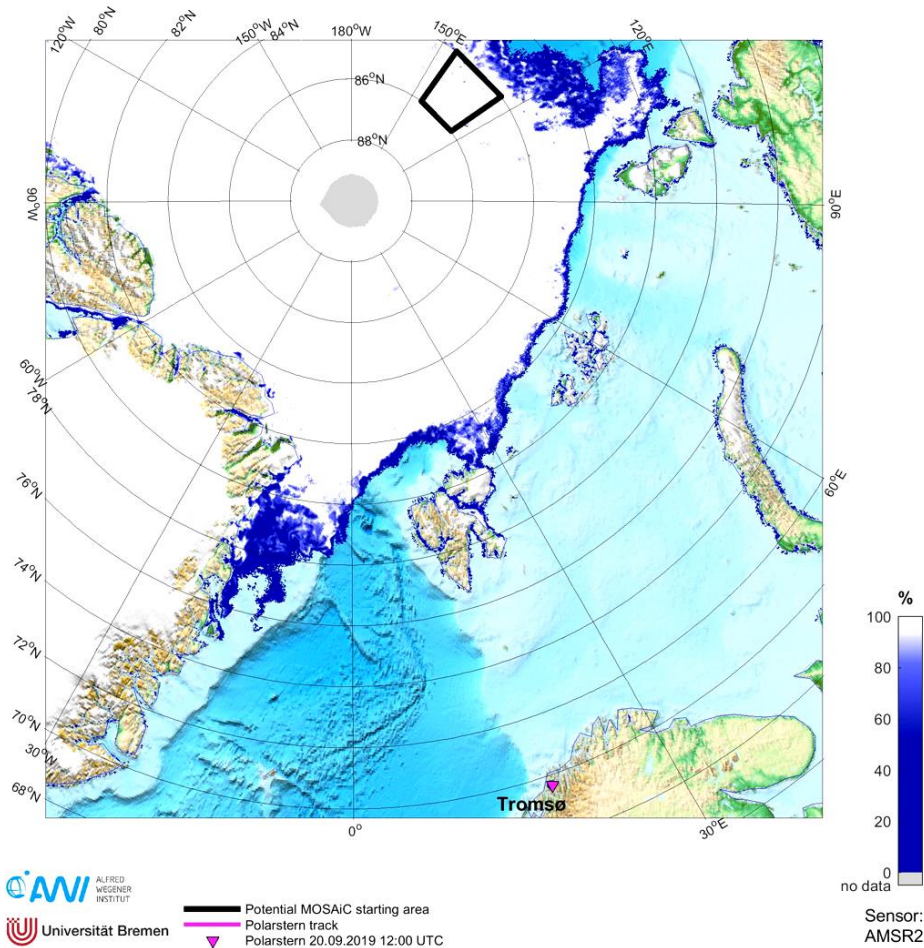
The challenge:  
Paucity of data!

# MOSAiC expedition



Sea ice concentration and ship position on 20.09.2019

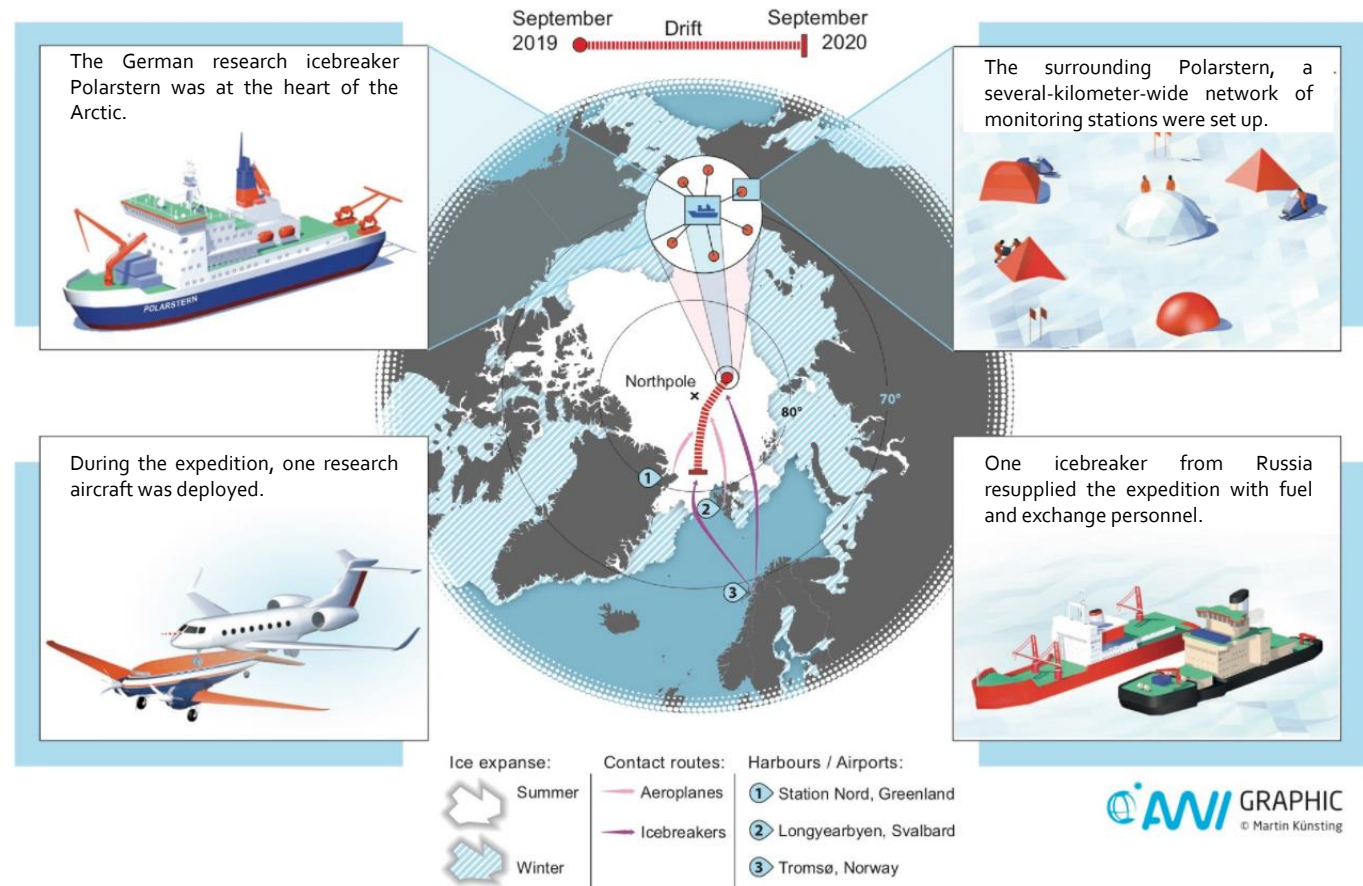
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Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAIC) expedition:

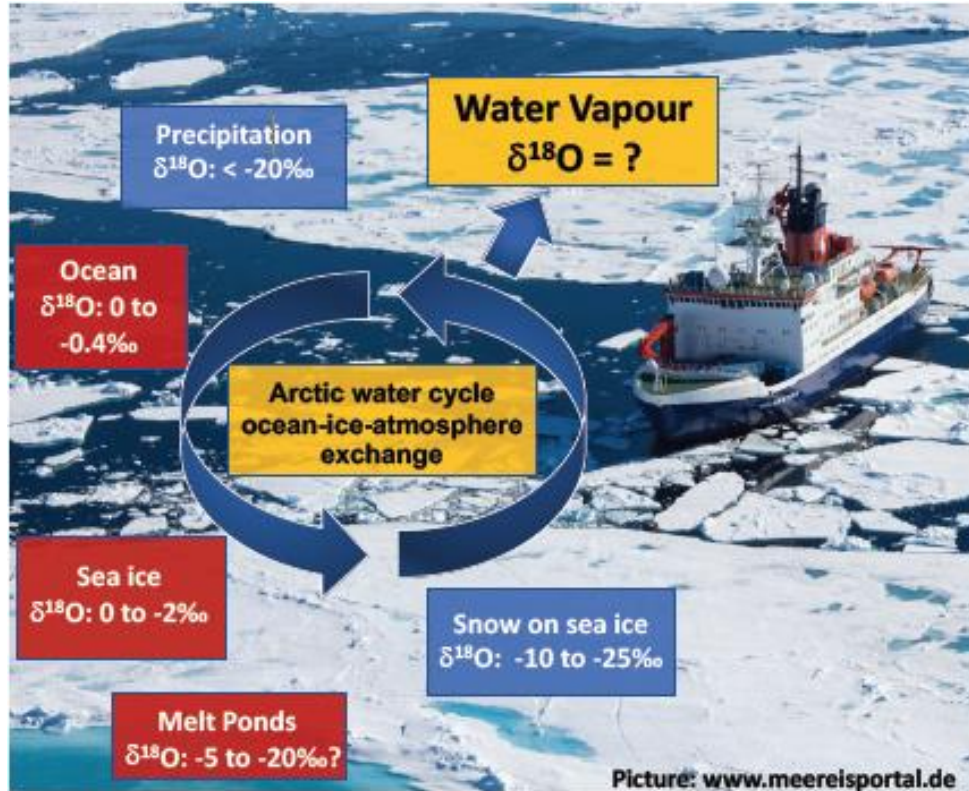
- An entire year trapped in ice (September 2019 to September 2020)
- The focus of MOSAIC lied on direct in-situ observations of the climate processes that couple the atmosphere, ocean, sea ice, biogeochemistry, and ecosystem



Universität Bremen



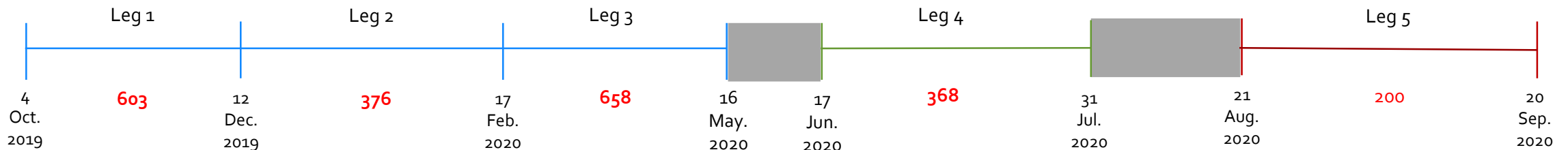
## Changes of water isotopes in Arctic Sea ice, Ocean, and atMosphere (CiASOM)



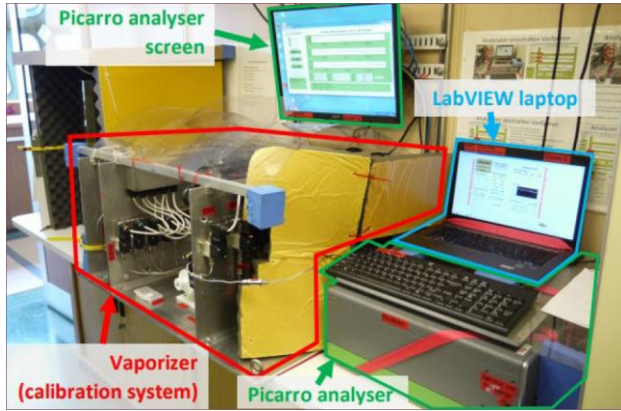
©CiASOM project plan

### Objectives of CiASOM:

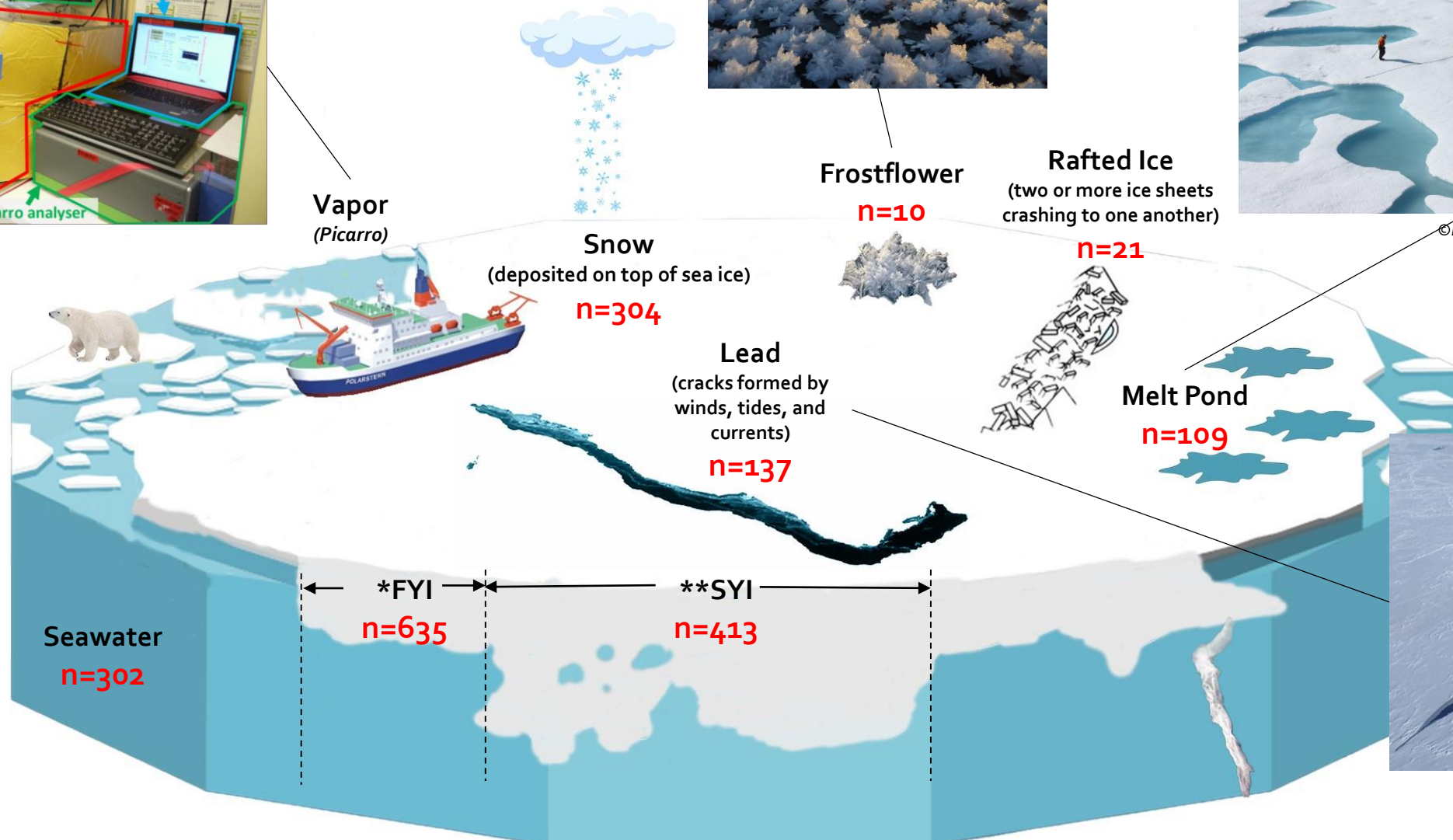
- First comprehensive description of isotopic composition of Arctic water cycle for a complete annual cycle (incl. understudied winter)
- Evaluation of key sea ice, ocean, and atmosphere exchange processes and their impact on Arctic water isotopes
- Imprint of sea ice conditions on the isotopic signature of Arctic water and its representation in coastal pan-Arctic stations



# Arctic water compartments

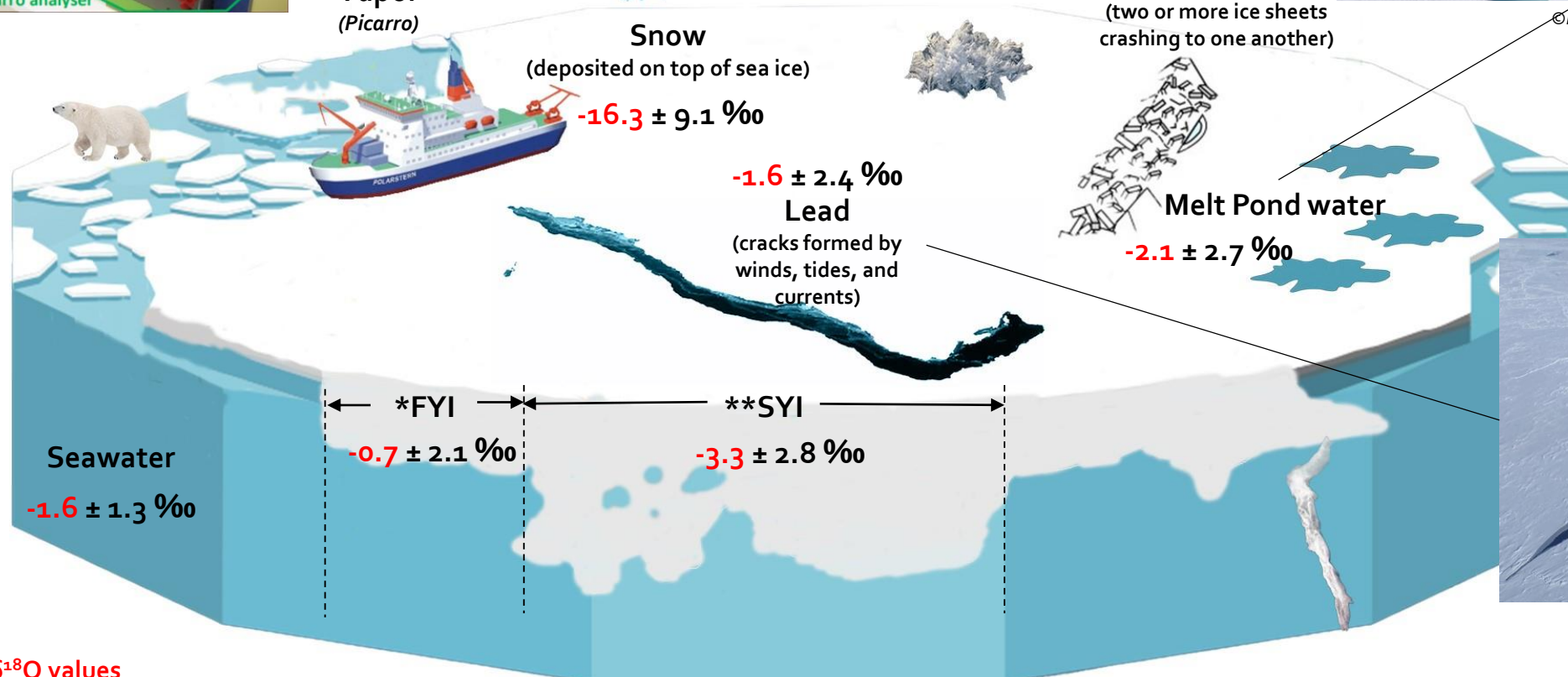
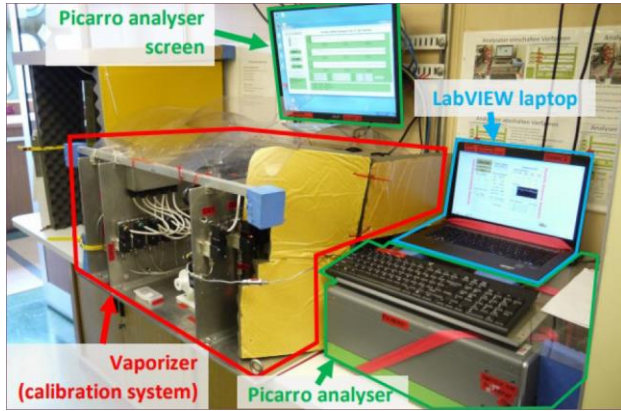


©NASA Goddard Space Flight Center

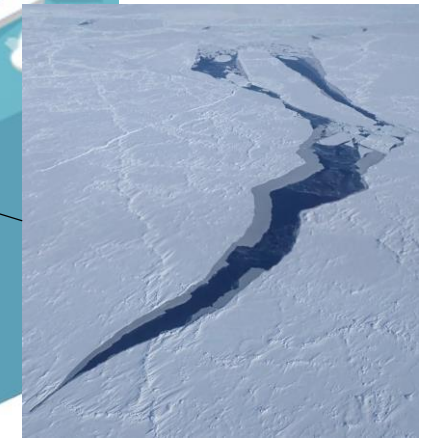


\*FYI = First Year Ice  
\*\*SYI = Second Year Ice

# Arctic water compartments



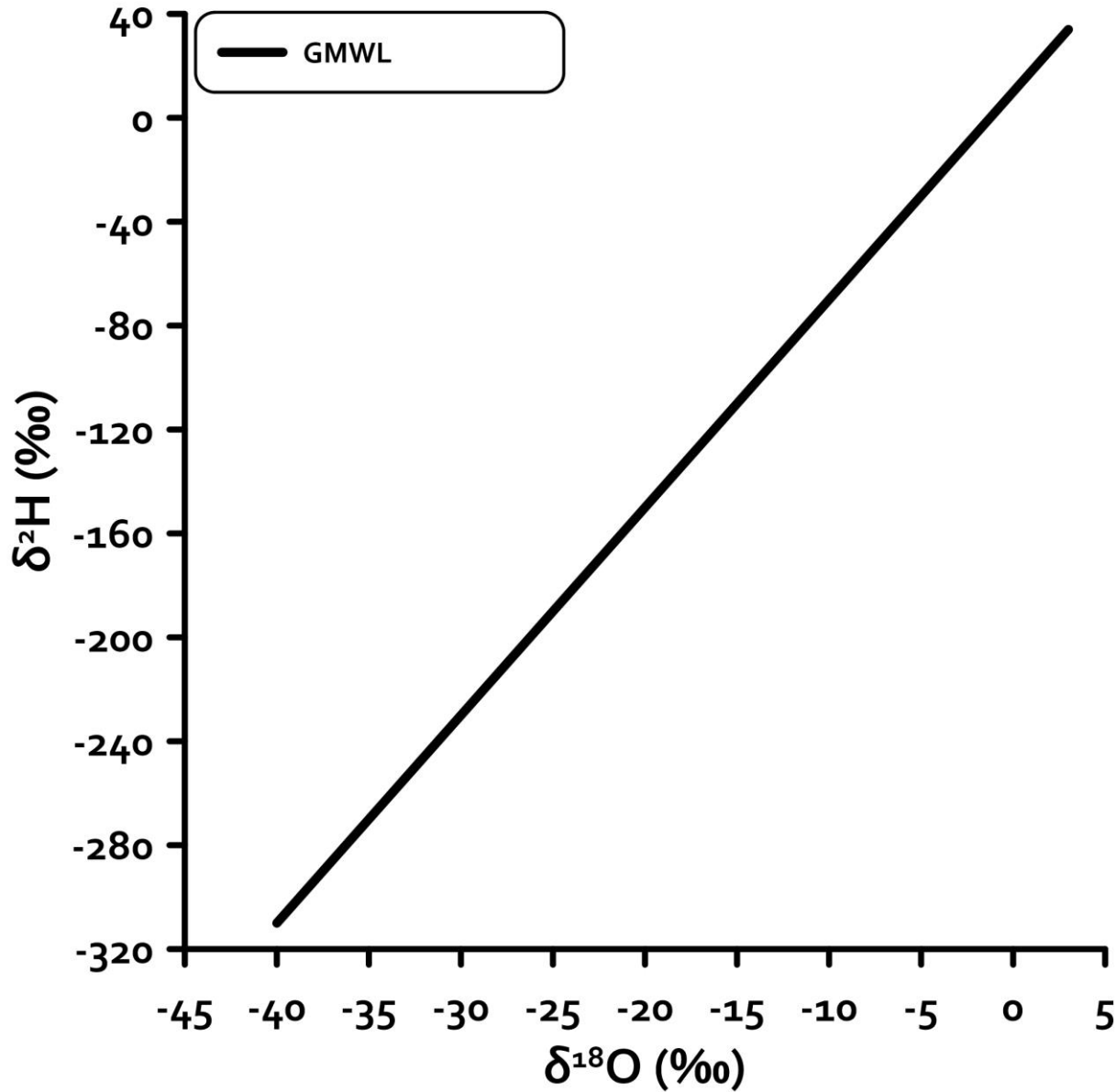
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\*Measured mean  $\delta^{18}\text{O}$  values

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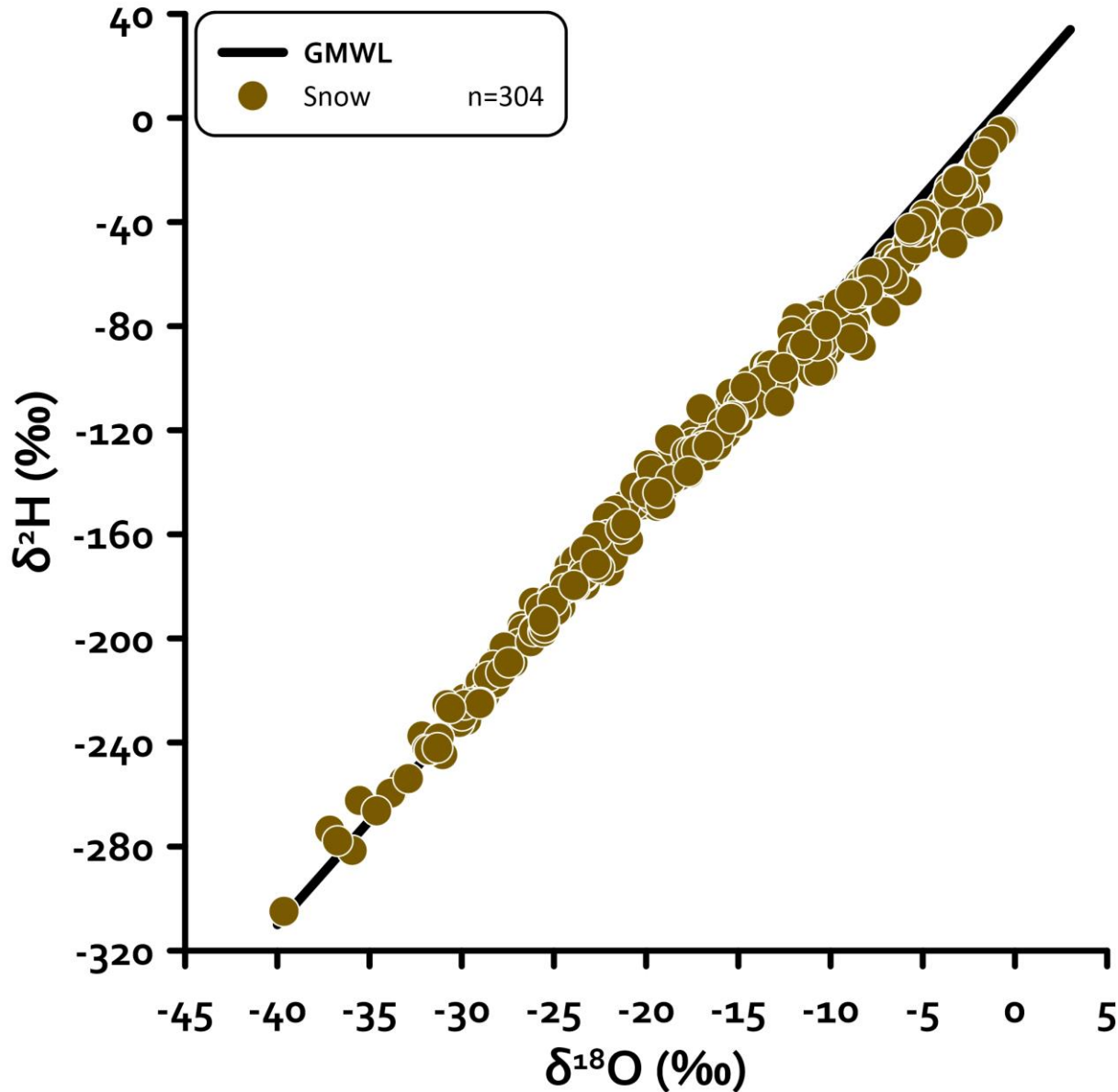
# Analytical results of discrete samples



- GMWL as a reference for co-isotope relationships

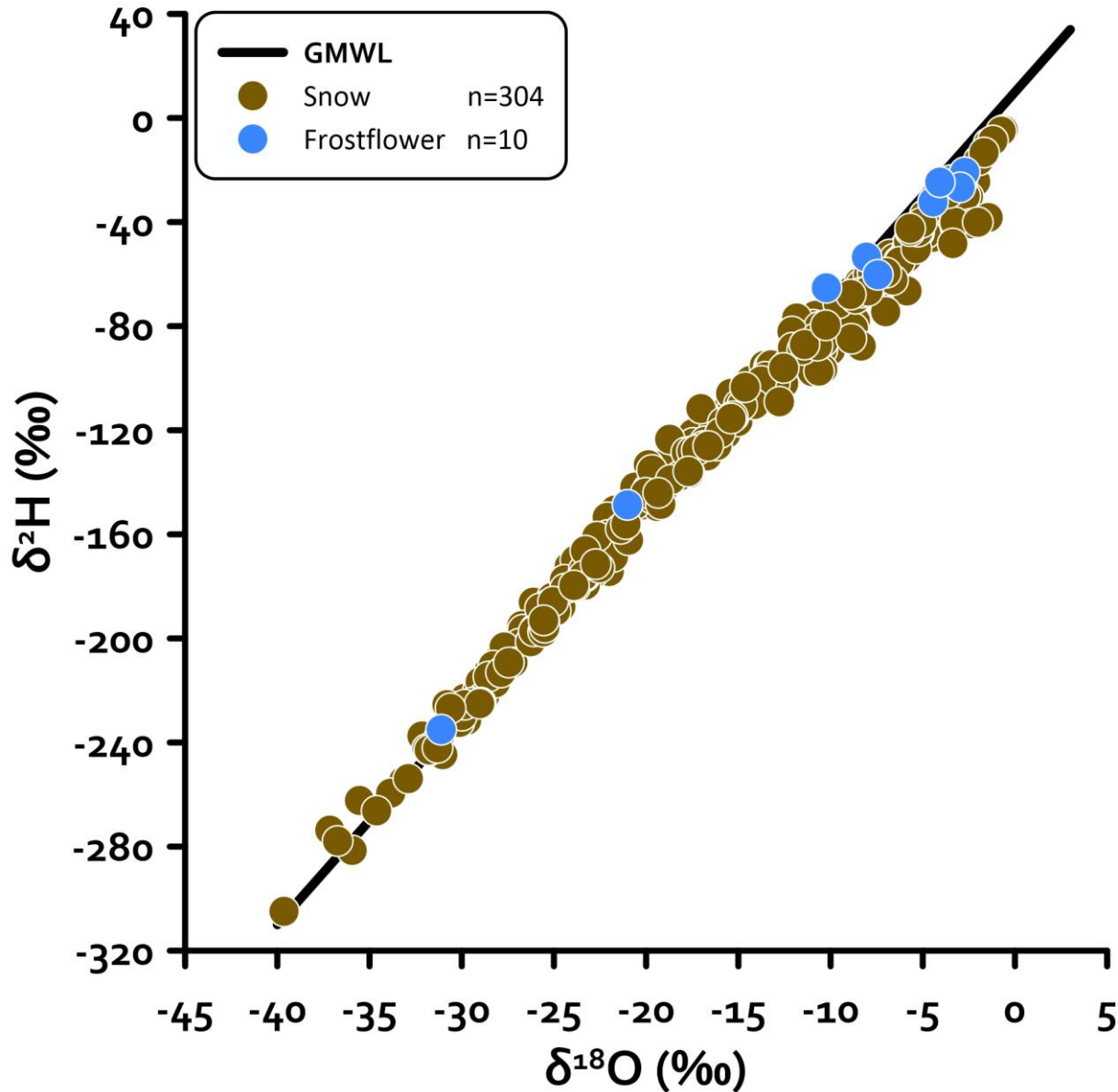


# Analytical results of discrete samples



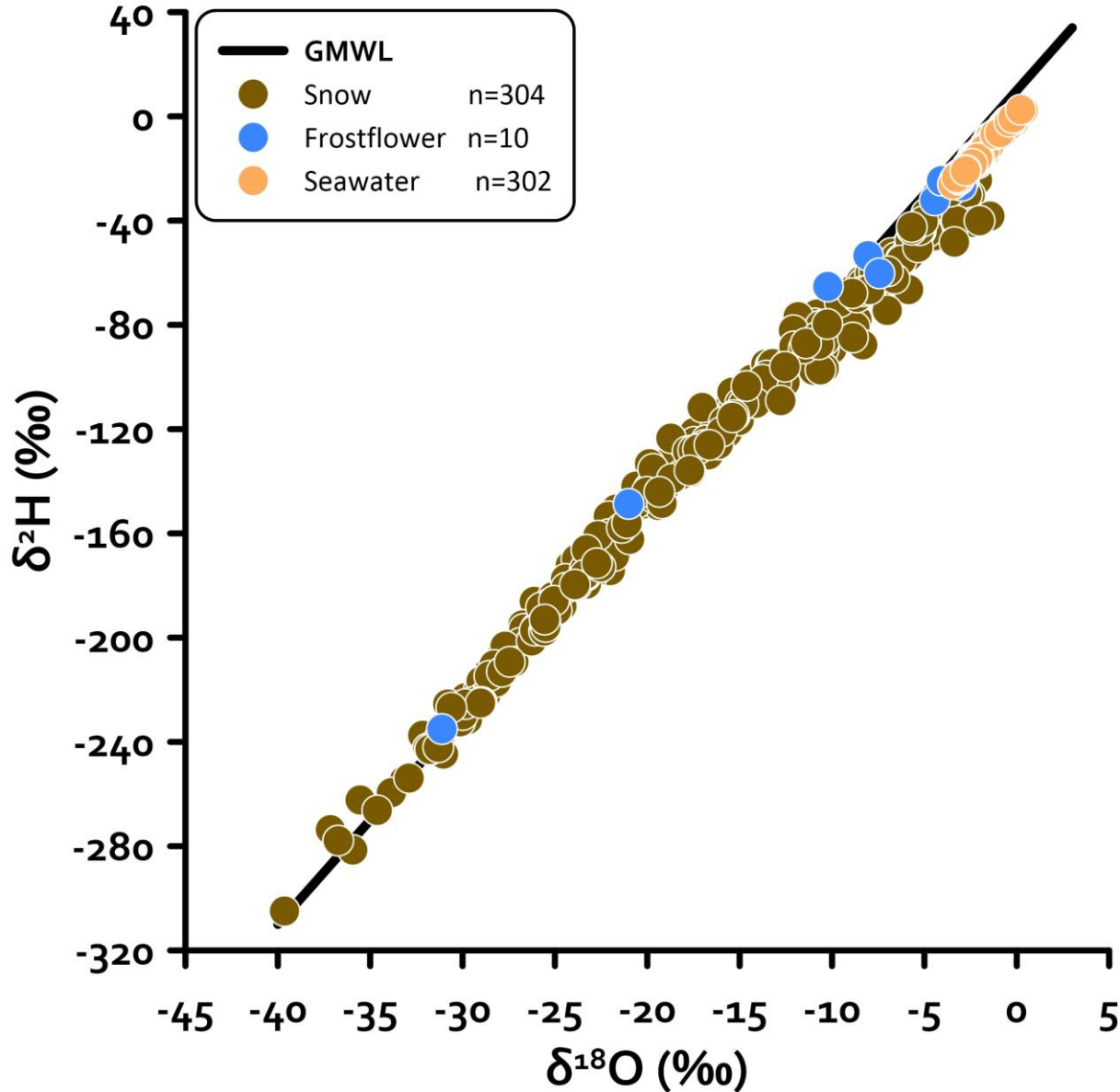
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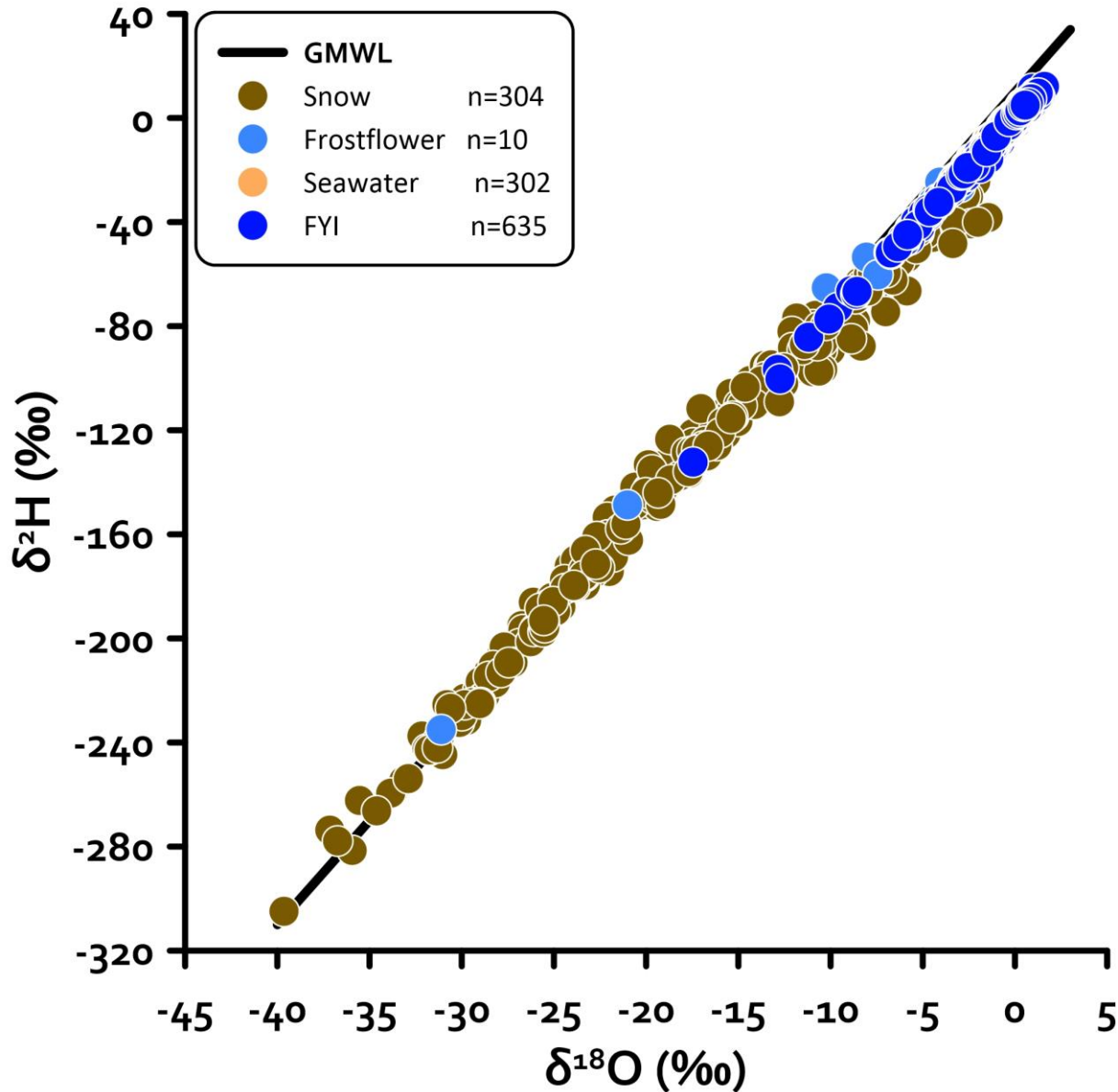
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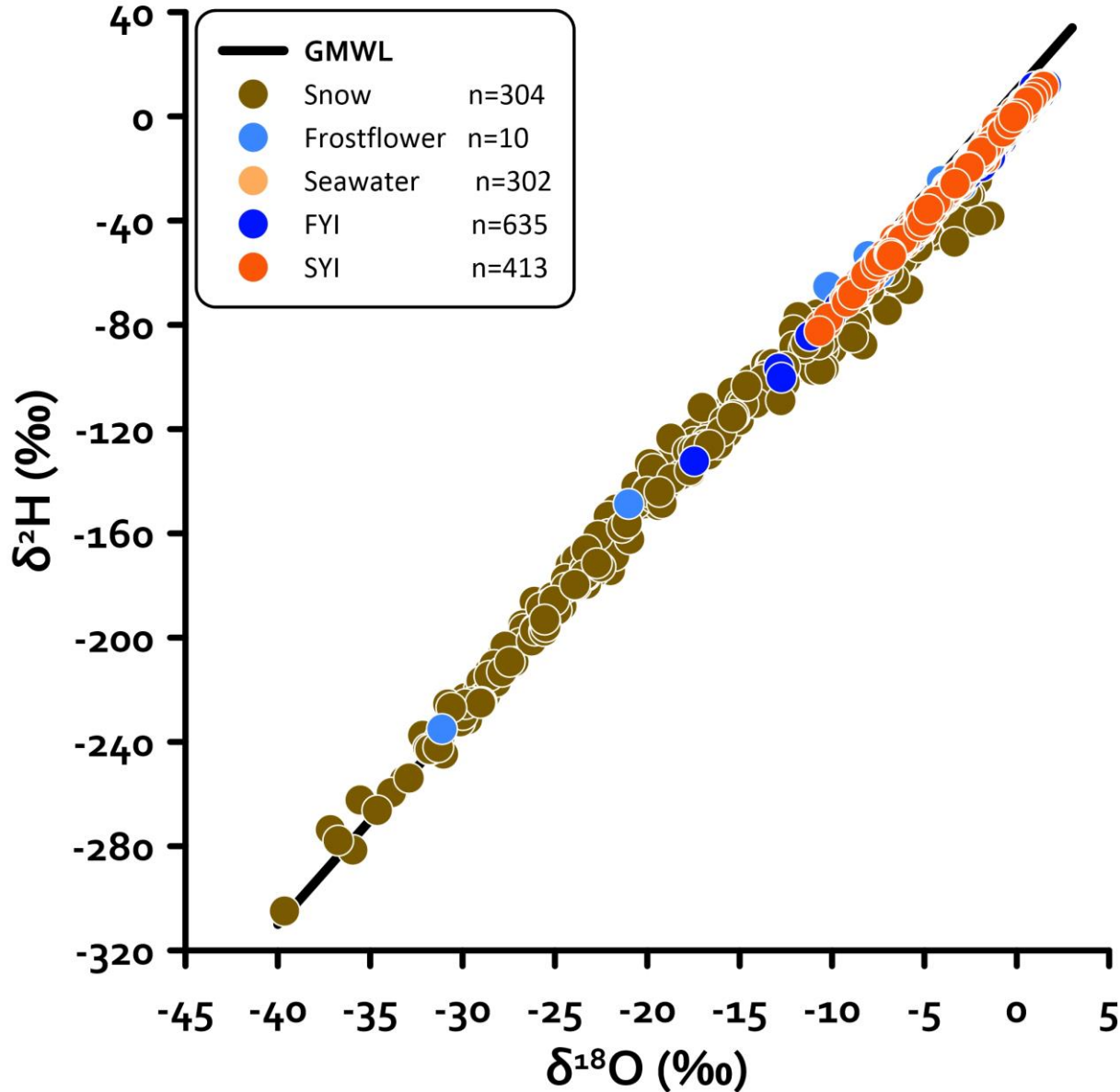
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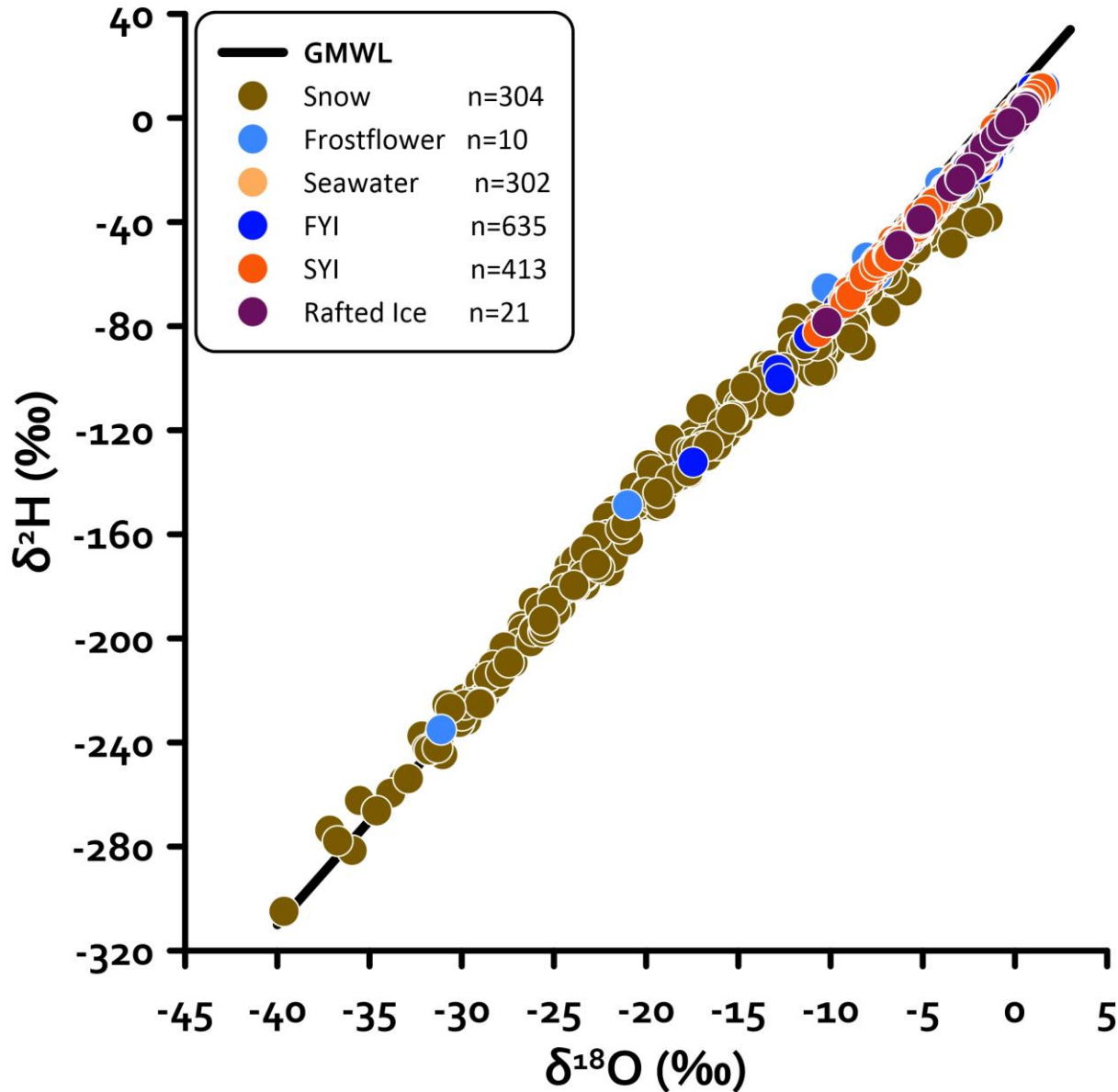
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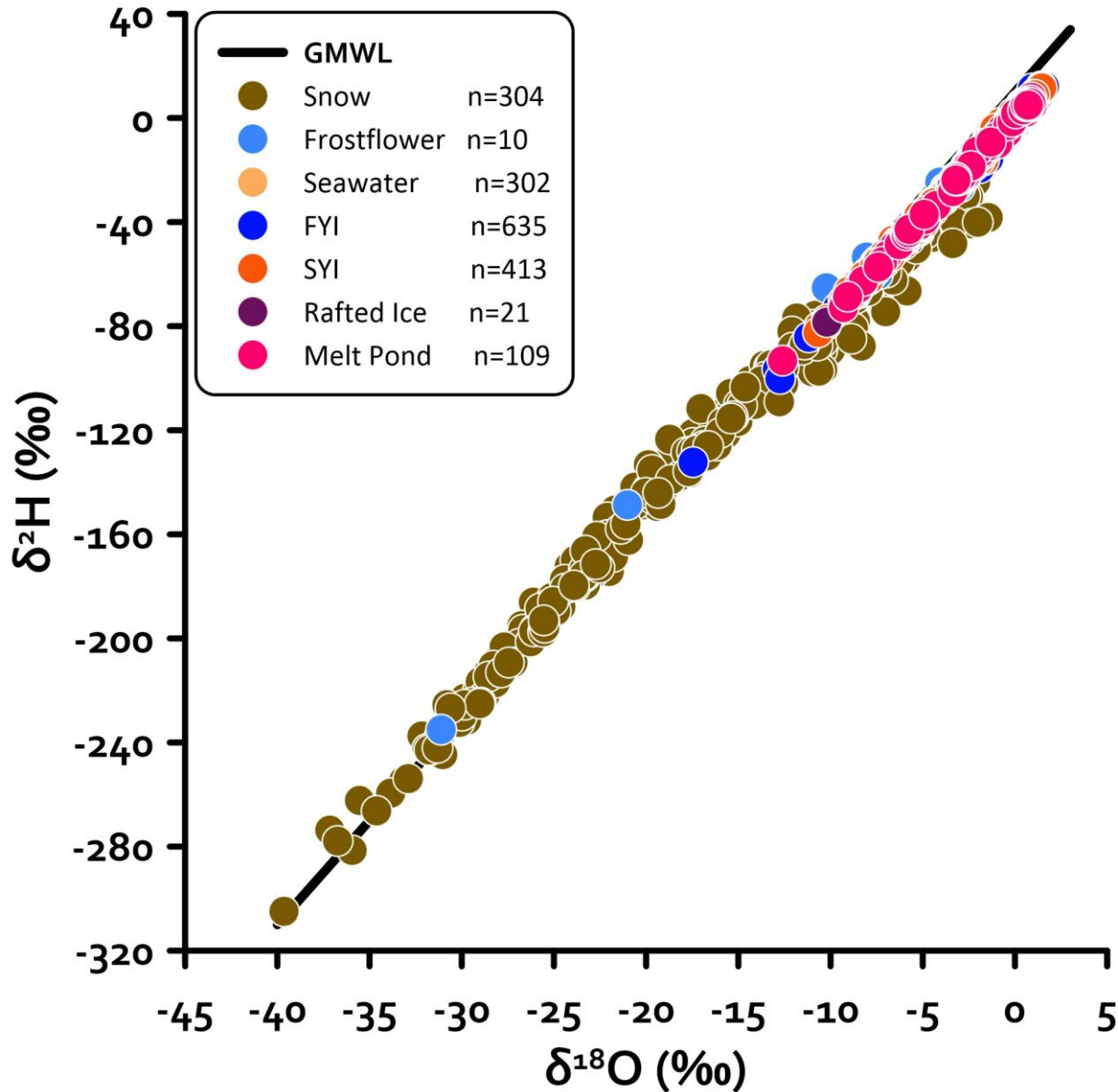
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- SYI on the upper side of the plot with low  $\delta^{18}\text{O}$  values down to -10‰

# Analytical results of discrete samples



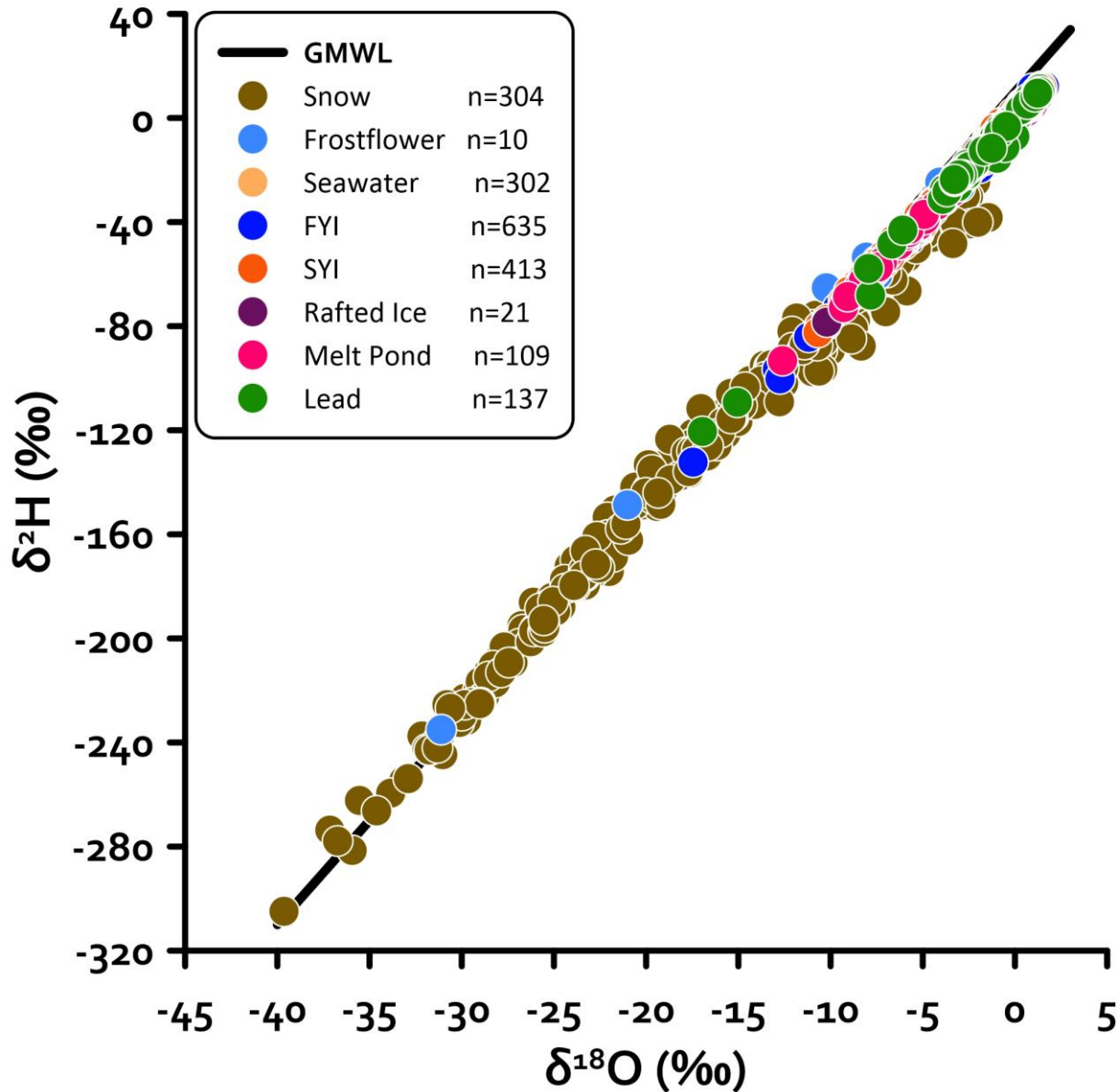
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- Melt water layer of ponds have wider range of more depleted isotope values compared to seawater

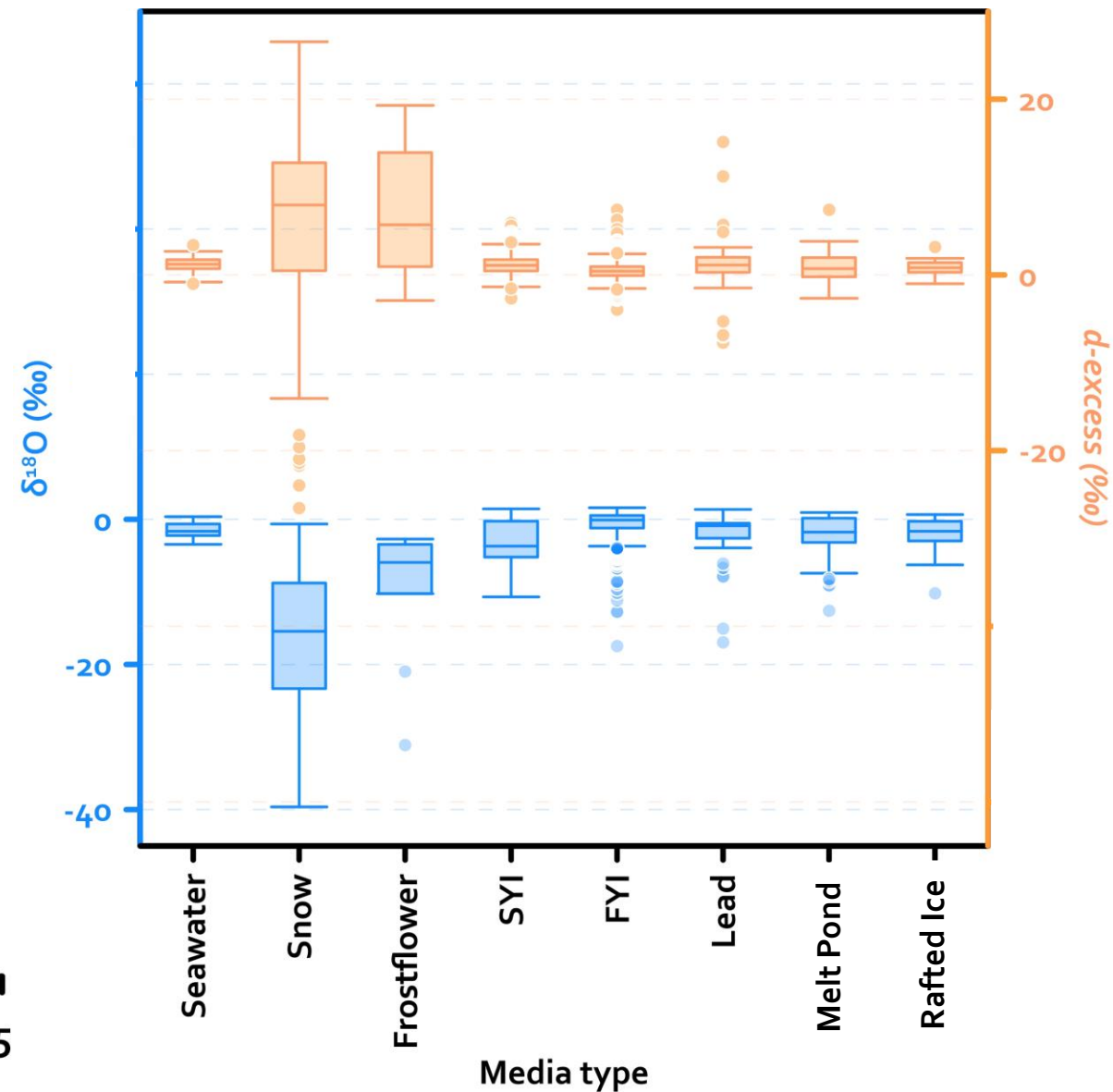
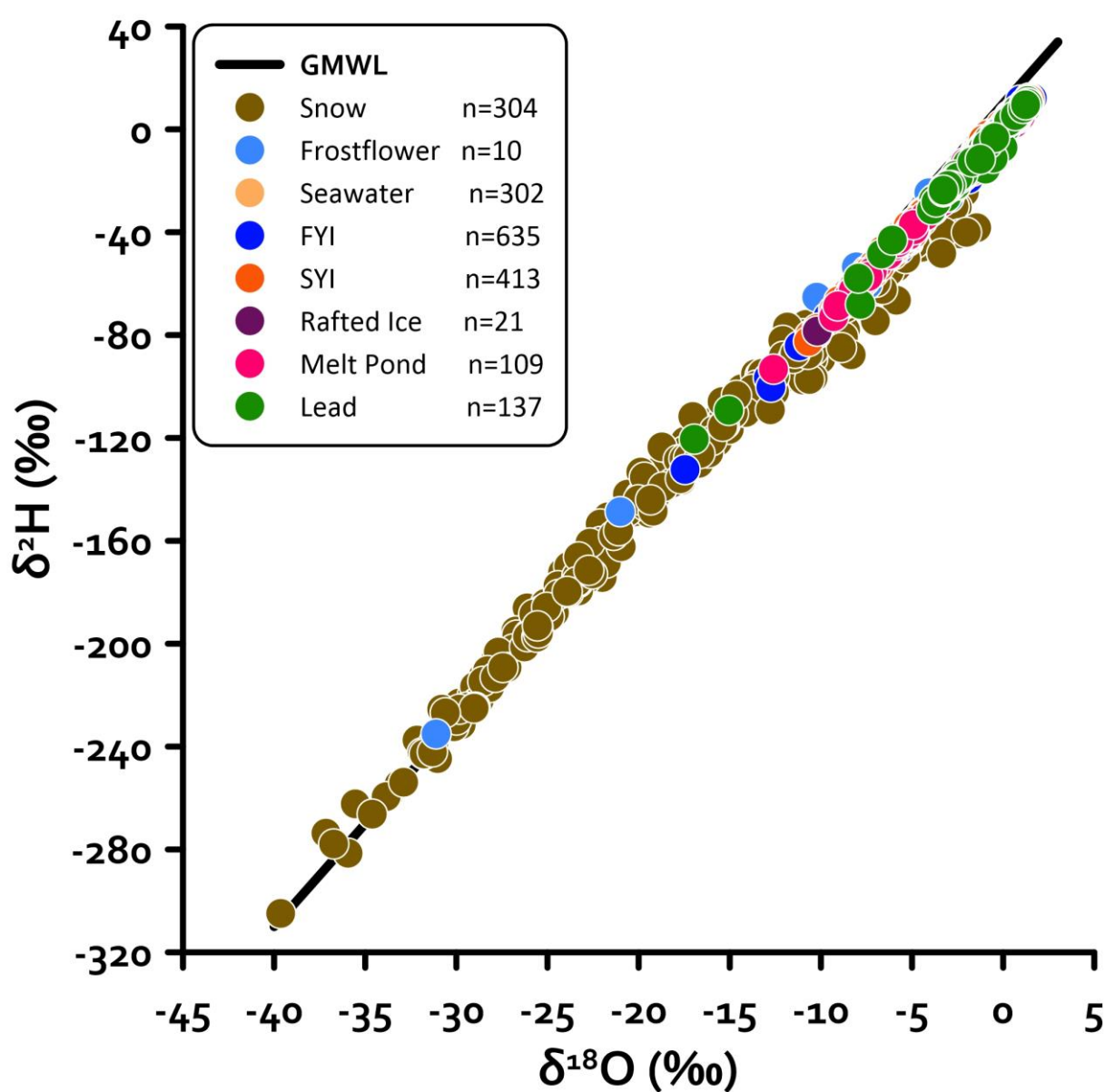
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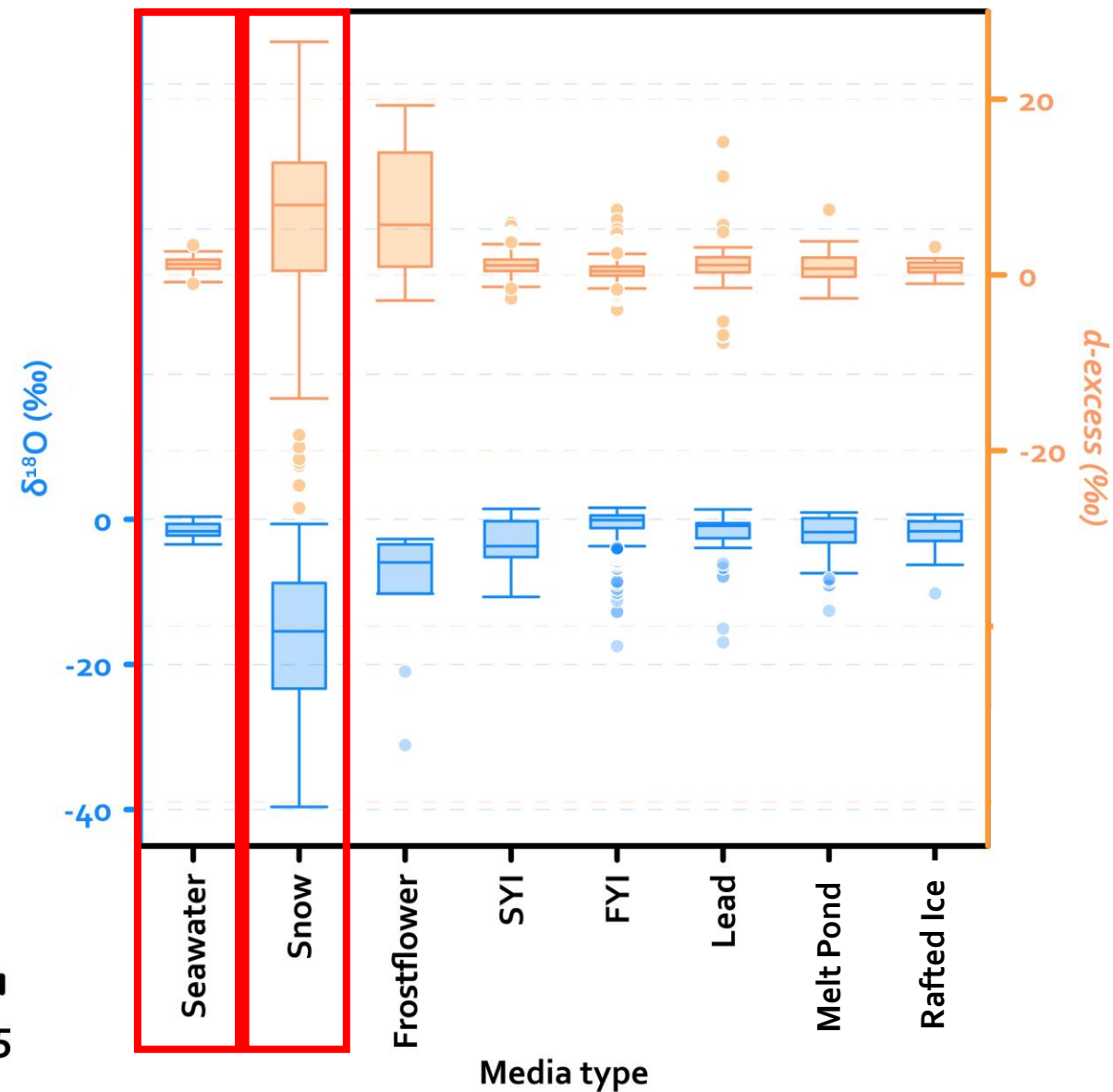
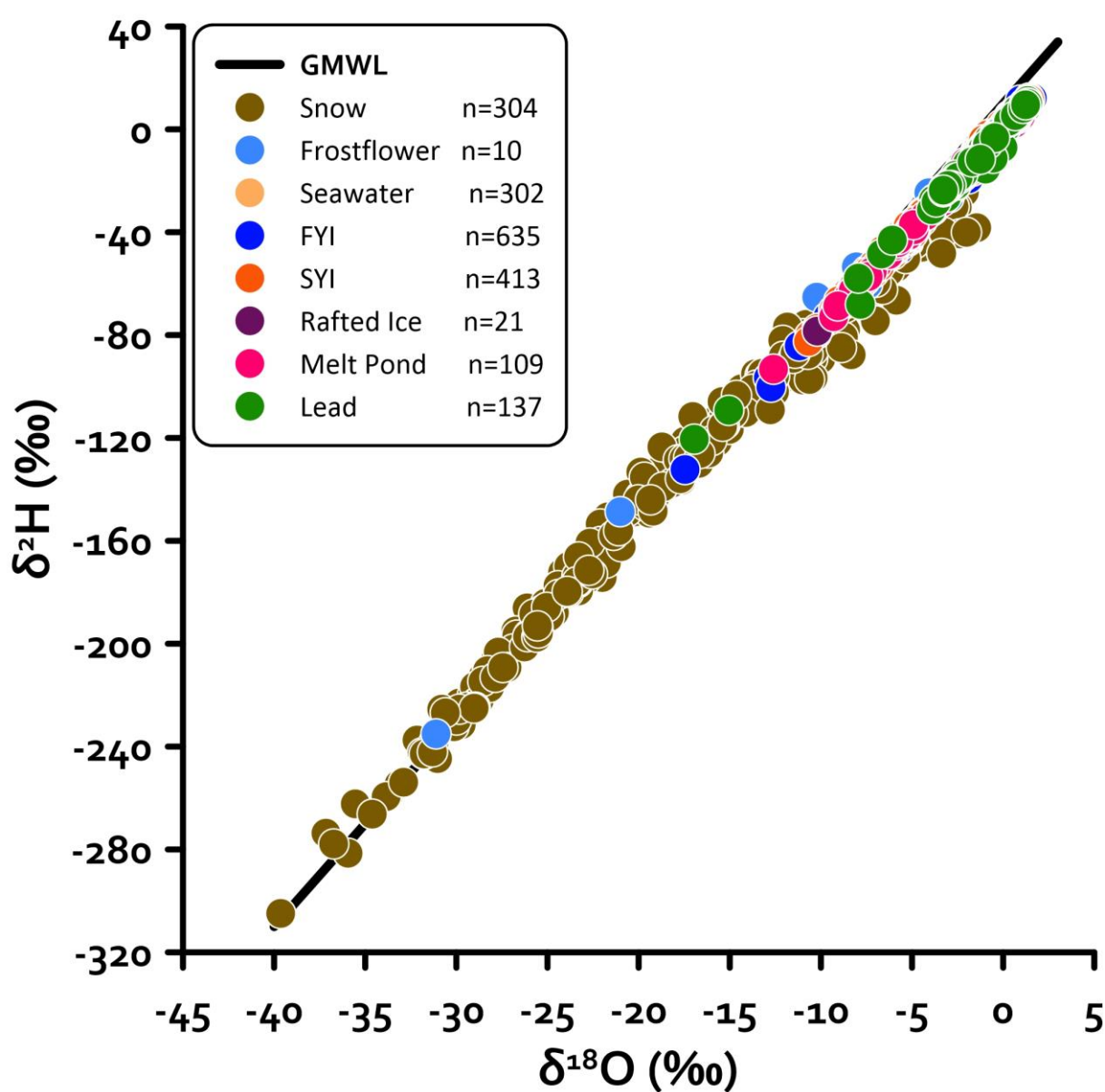
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- Rafted Ice isotopes plot over FYI and SYI
- Melt water layer of ponds have wider range of more depleted isotope values compared to seawater
- Lead plots mainly on the upper part of the line with a few samples with snow signature



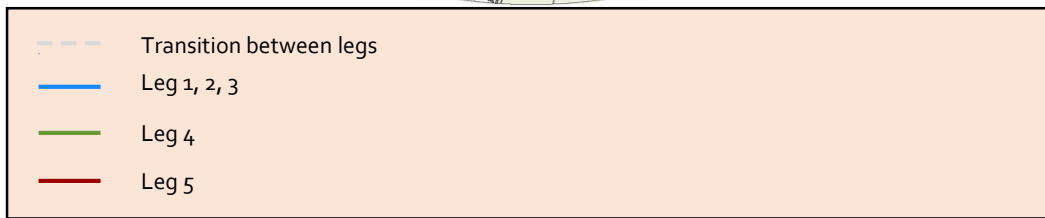
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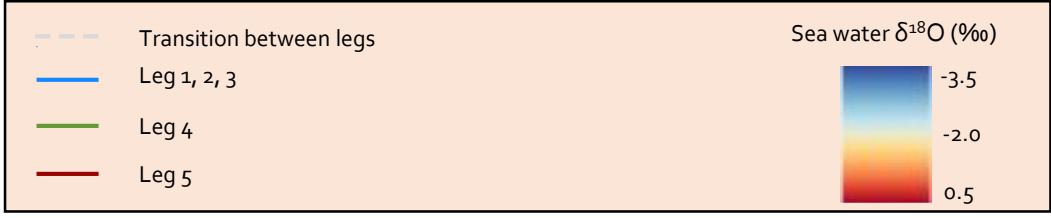
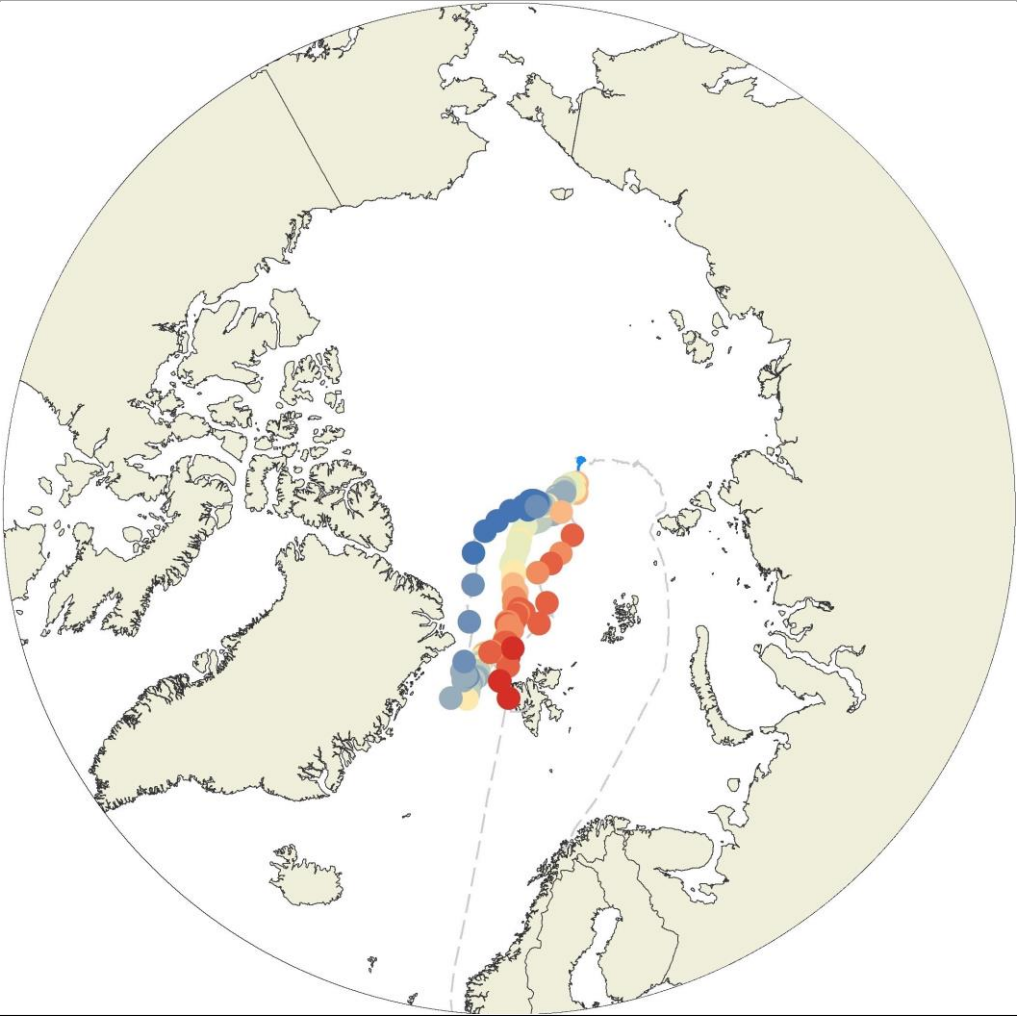
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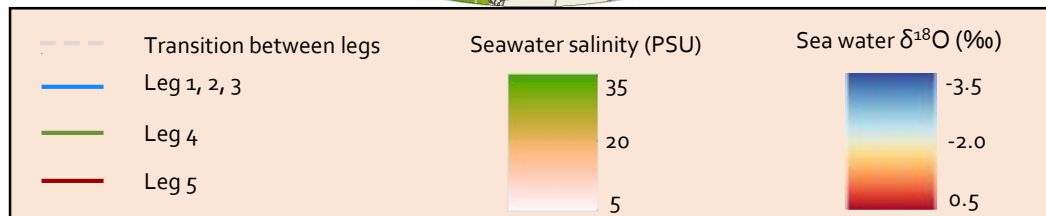
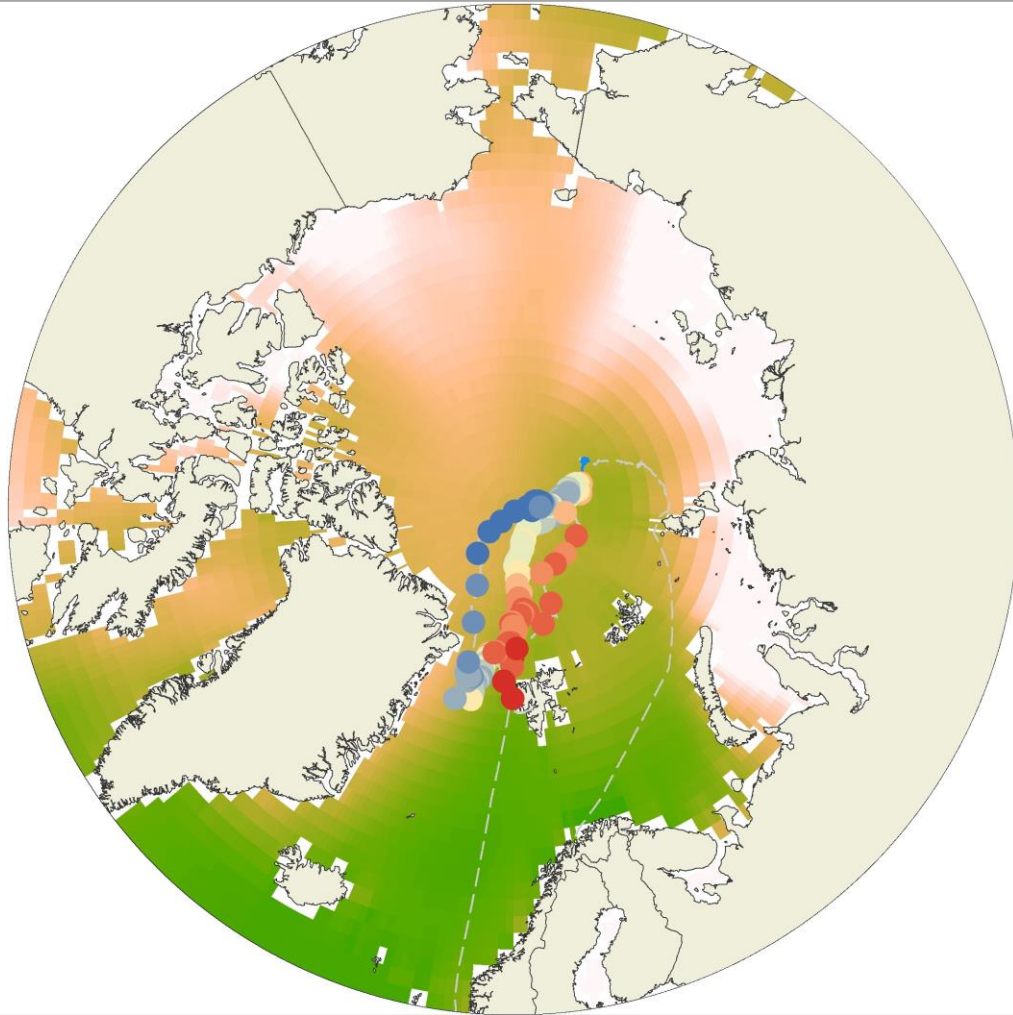
# MOSAiC track



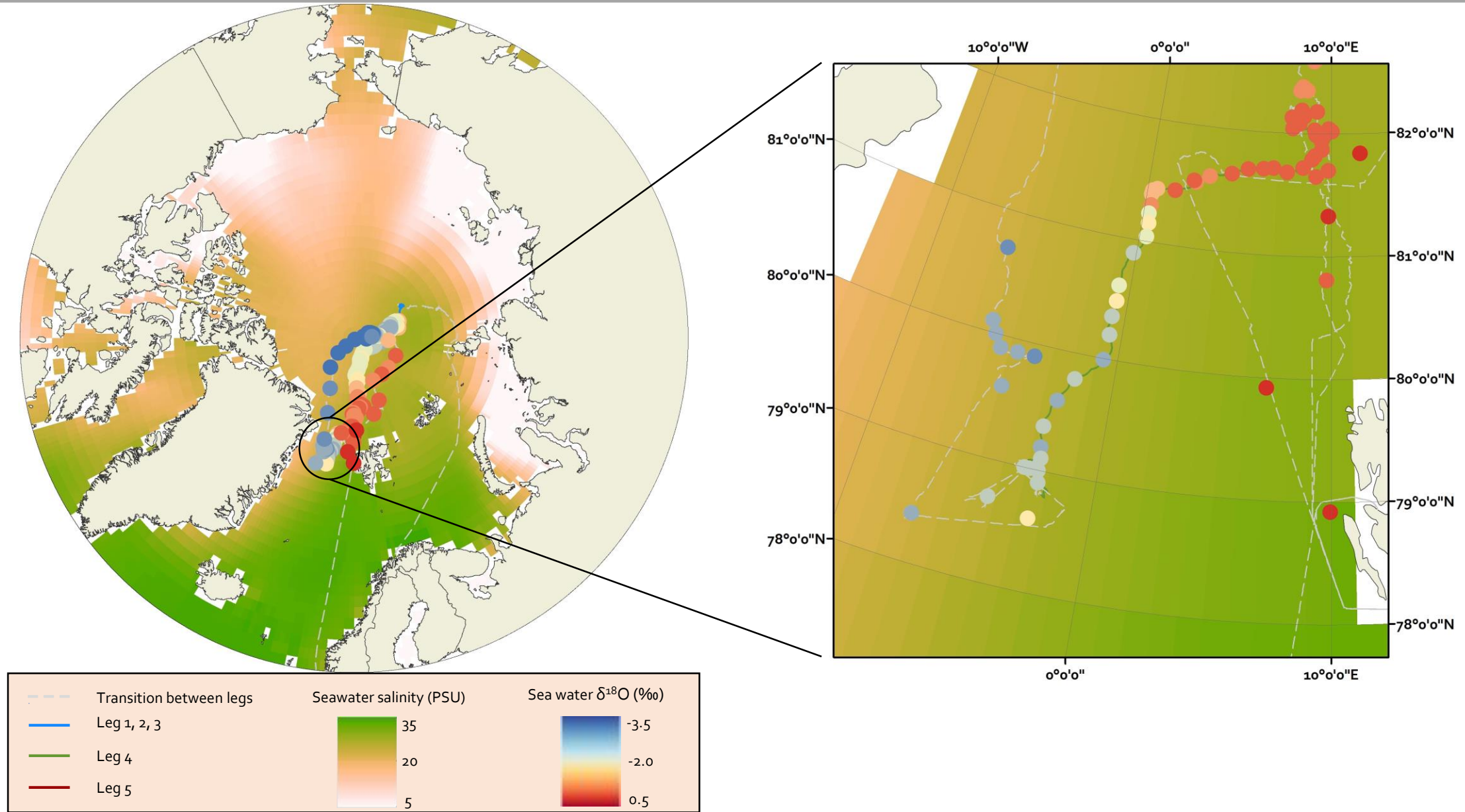
# Seawater $\delta^{18}\text{O}$ along the MOSAiC track



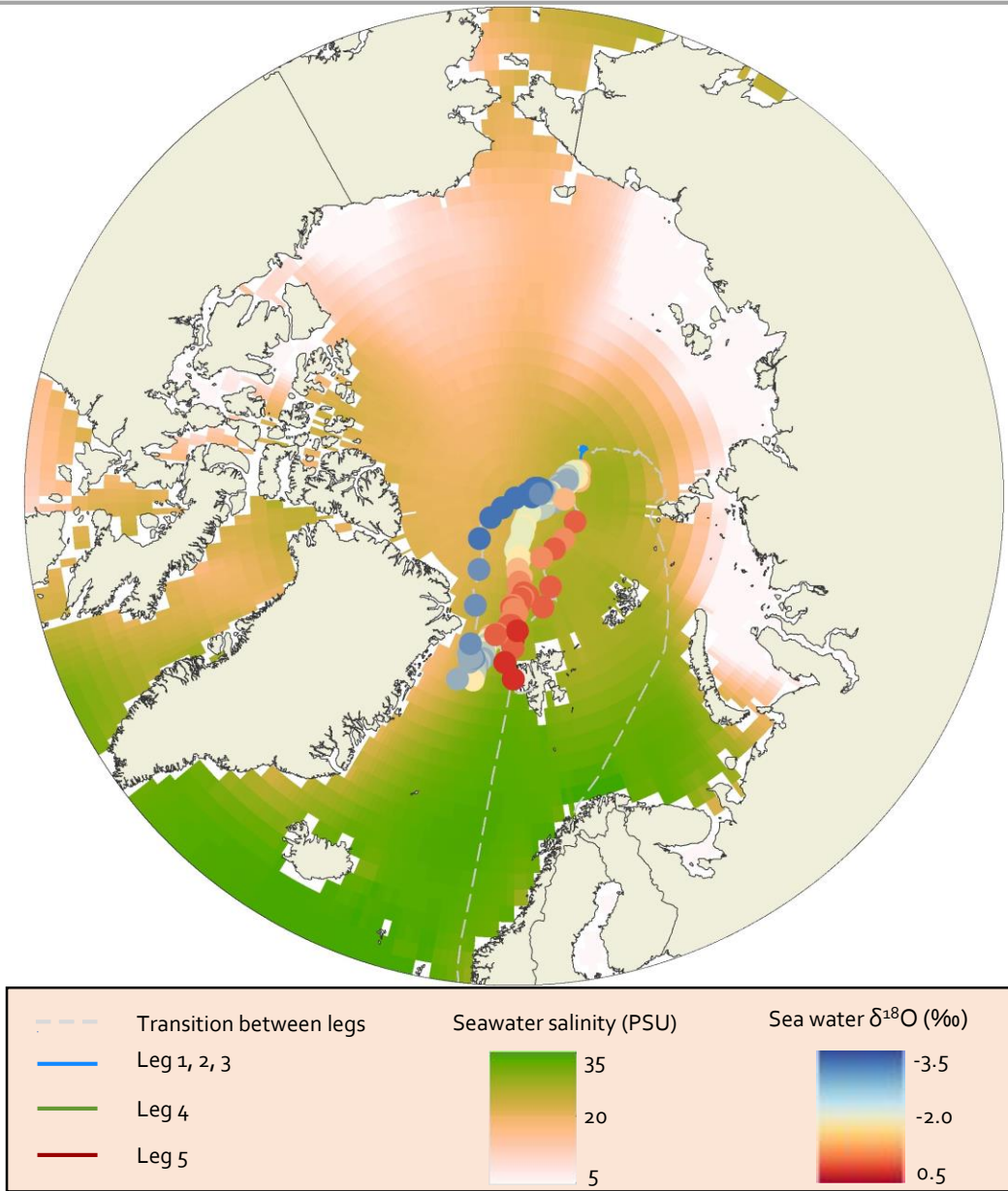
# Seawater $\delta^{18}\text{O}$ and Arctic water salinity



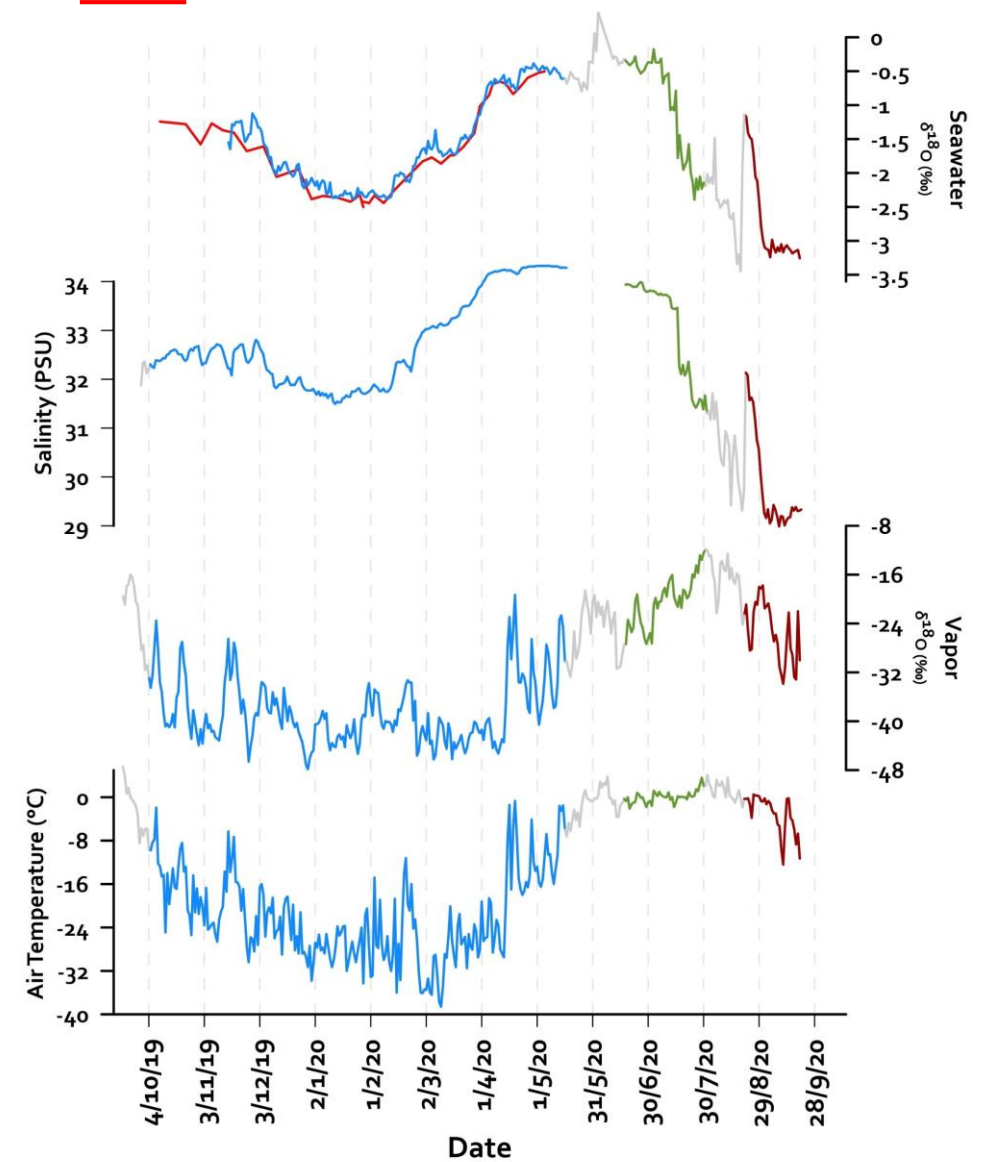
# Seawater $\delta^{18}\text{O}$ (Leg 4)



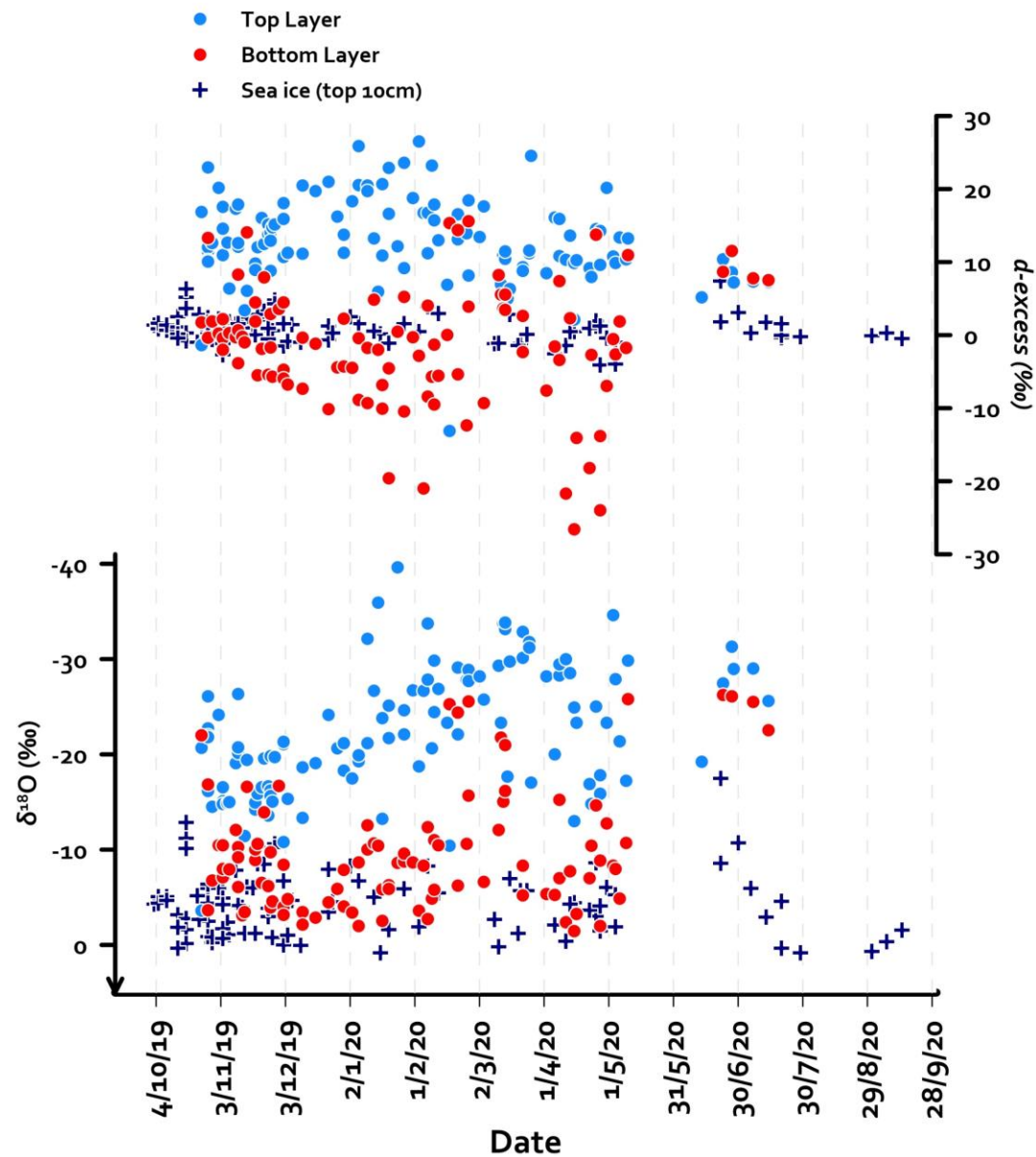
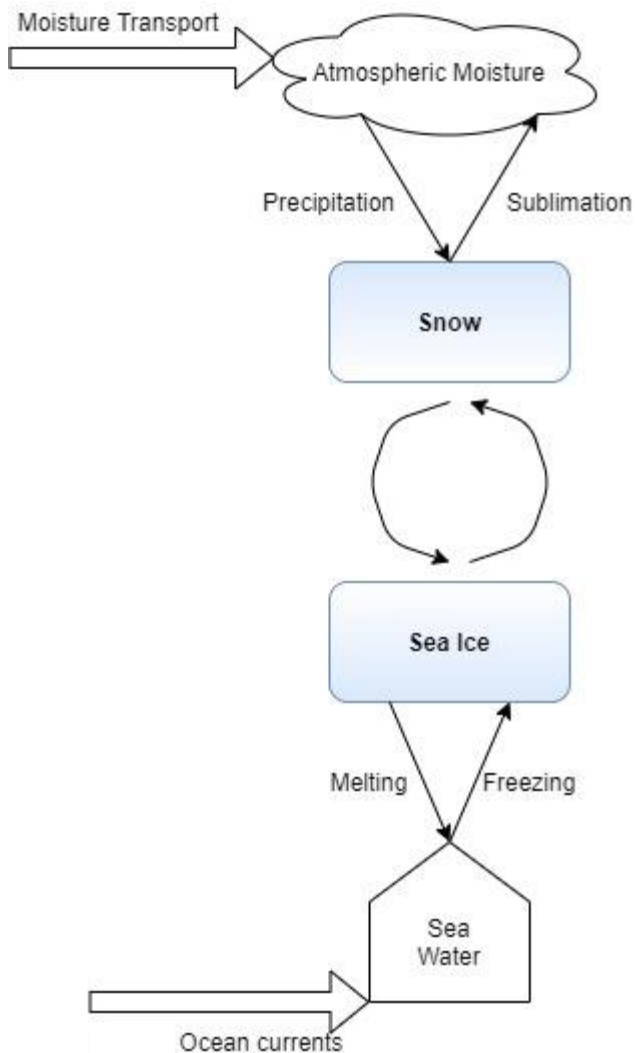
# Vapor and sea water isotopes in the mirror of air temperature and salinity



Lower resolution seawater sampling



# Snow-sea ice: vertical isotopic gradient



- The offset between top and bottom layers of snow: potential processes in play such as sublimation of deposited snow
- Mixture of bottom layer of snow with sea ice is more apparent from October to May



# Conclusions



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- MOSAiC expedition provided a unique opportunity to have a first-hand isotope dataset of different compartments forming the Arctic water cycle.
- Seawater isotopes get progressively depleted as Polarstern moves towards less saline water: what is the origin of this depleted water?
- Fresh snow layering on top of the sea ice displays a progressive enrichment from surface to bottom. Can we disentangle post-depositional metamorphic processes?

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Alessandra D'Angelo, Stefanie Arndt*

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Thank You!



# Seawater (Leg 5)

