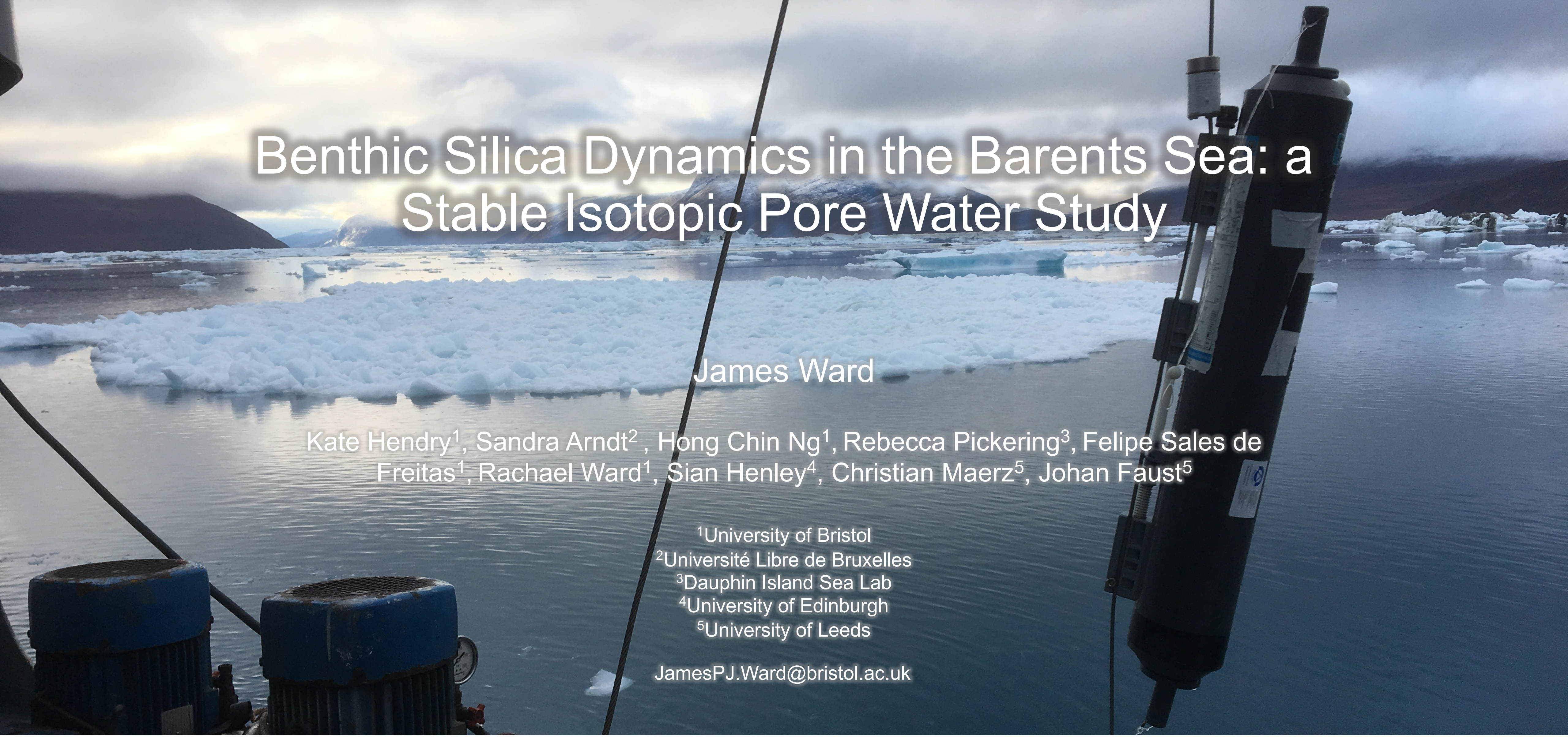

Benthic Silica Dynamics in the Barents Sea: a Stable Isotopic Pore Water Study

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Changing Arctic Ocean NERC

University of Bristol

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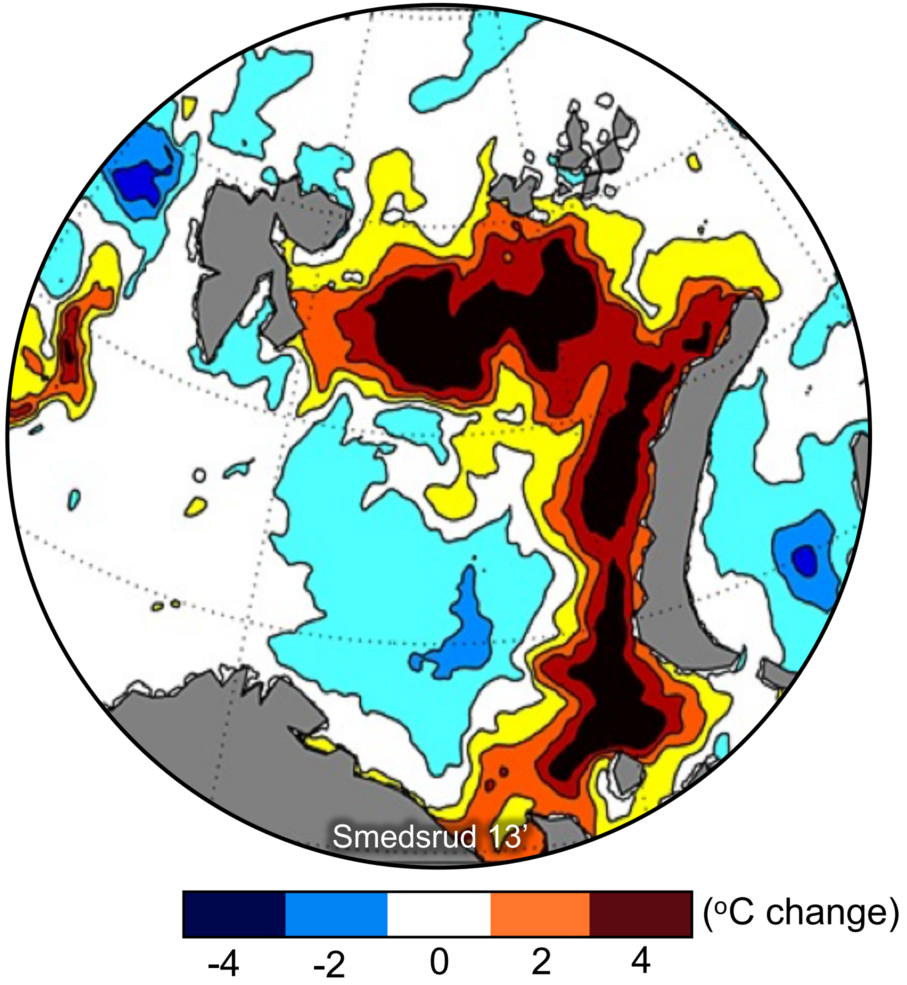
BOPP Bristol Oceans Past & Present

The Barents Sea

- 2050 model projection [1].
- Increase in Atlantic inflow rate and temperature.
- Rapid sea-ice loss and warming.



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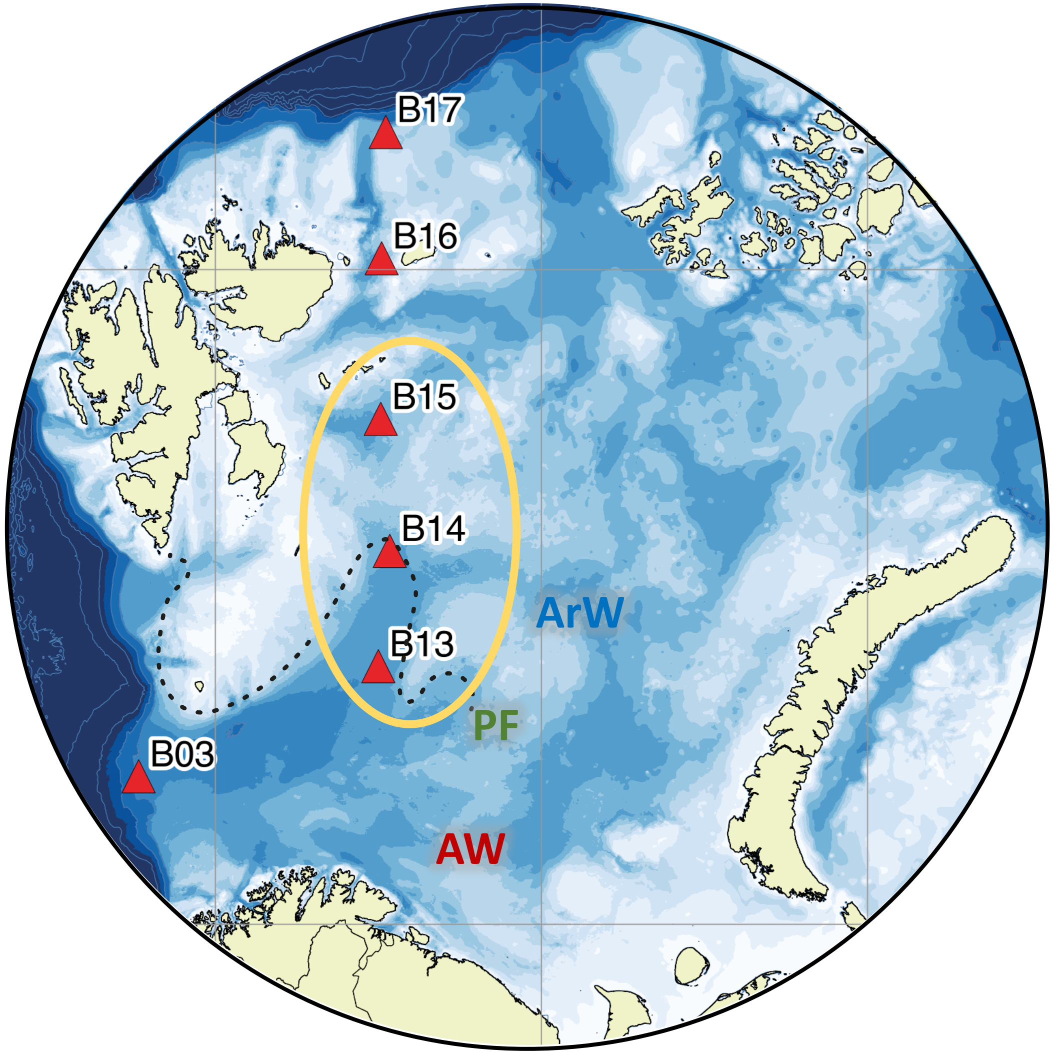
Changing Arctic Ocean Seafloor (ChAOS) Transect



- 30°E transect, three summer cruises in July 2017, 2018 and 2019.
- B13, B14 and B15 analysed for pore water silicic acid concentration (DSi) and stable isotopic composition ($\delta^{30}Si$).
- Sampling covers 3 main hydrographic domains:
    1. Seasonally ice-covered, nutrient poor Arctic Water of the north (**ArW**).
    2. Warmer, ice free, nutrient rich Atlantic Water of the south (**AW**).
    3. Oceanic polar front (dashed line) (**PF**).

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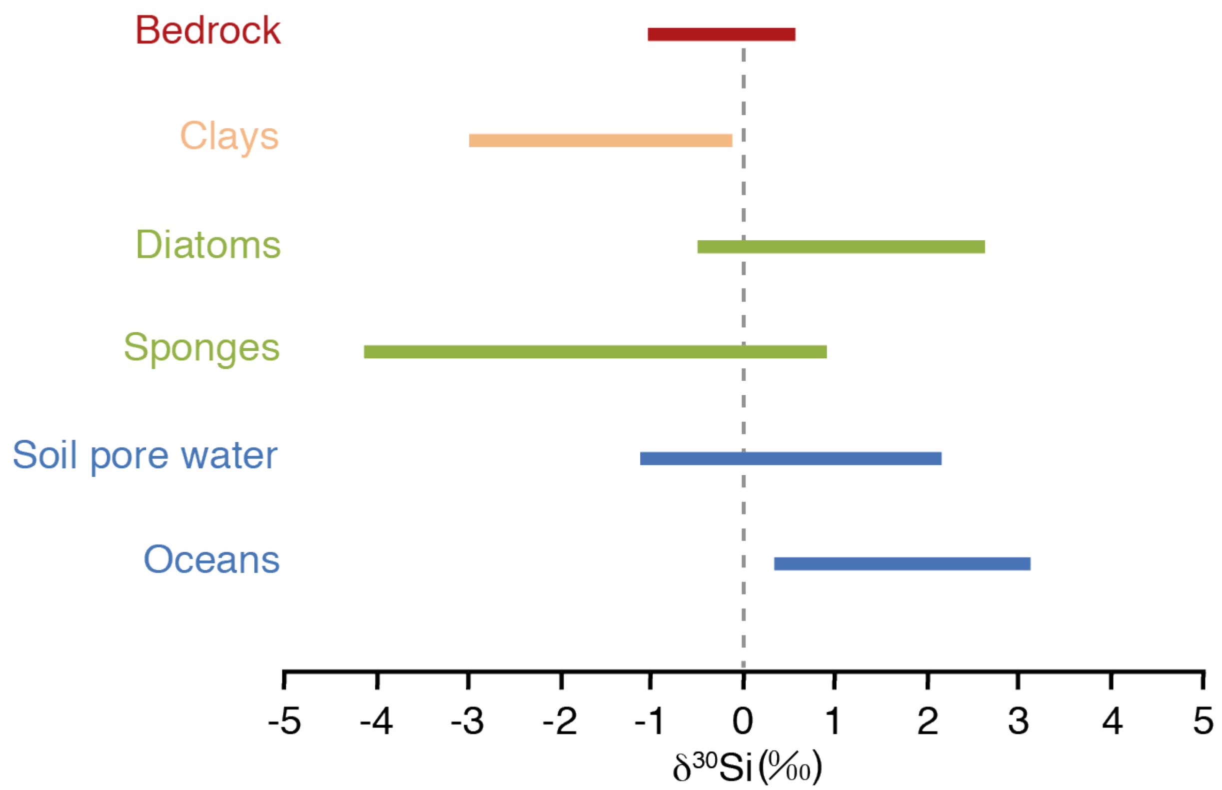
Silicon Isotopic Fractionation

- Precipitating clays take up ^{28}Si preferentially (ε -2 $^{0}/_{00}$) [2].
- ^{28}Si preferentially adsorbs onto Fe-(oxyhydr)oxides (ε -2 to -3 $^{0}/_{00}$) [3].
- Unweathered continental crust $\delta^{30}Si$ composition -0.5 to 0.5 $^{0}/_{00}$ [4].
- Diatoms preferentially take up ^{28}Si from surface waters (ε -1.1 $^{0}/_{00}$) [5]. Found to dissolve both with and without fractionation [6,7].

$$\delta^{30}Si = \left(\frac{\left({}^{30}Si/{}^{28}Si\right)_{sample}}{\left({}^{30}Si/{}^{28}Si\right)_{standard}} - 1 \right) \times 1000$$



Pore water sampling in 2017

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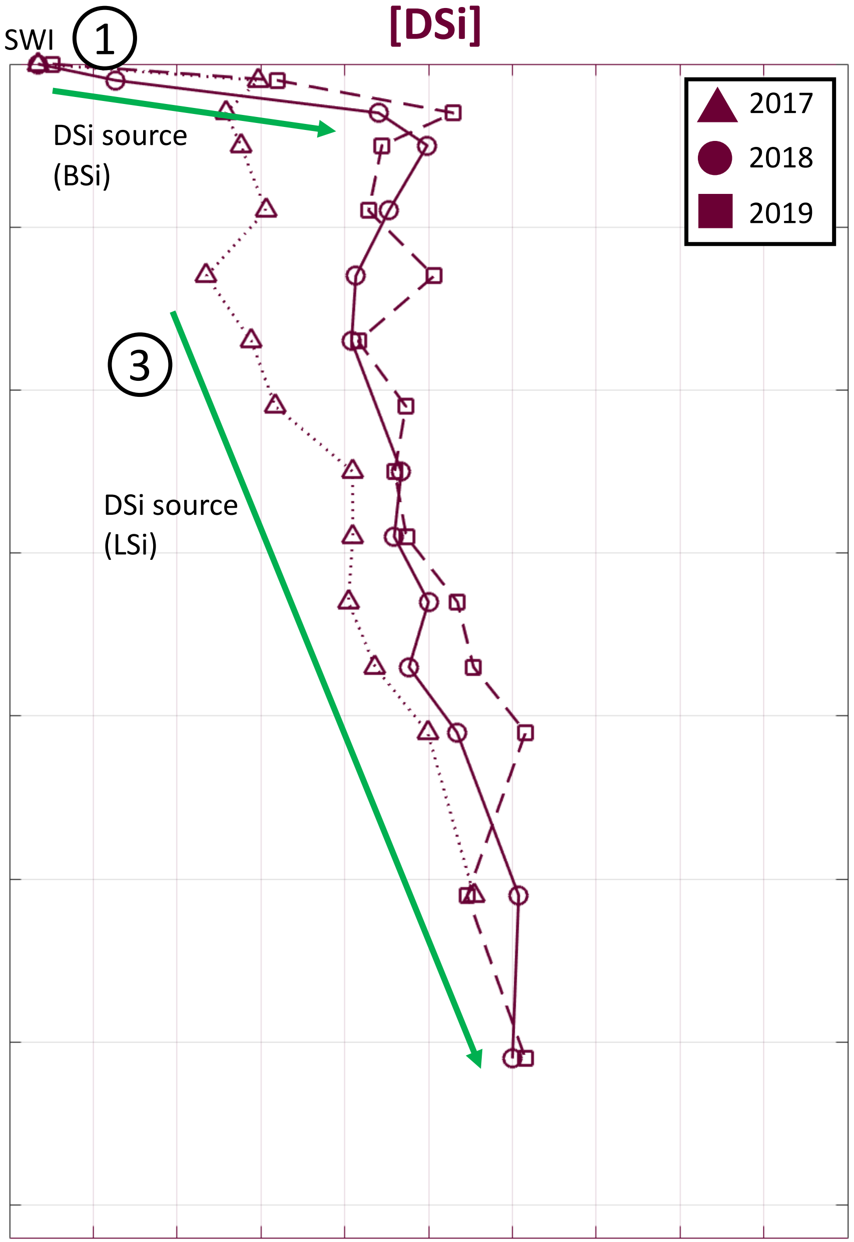
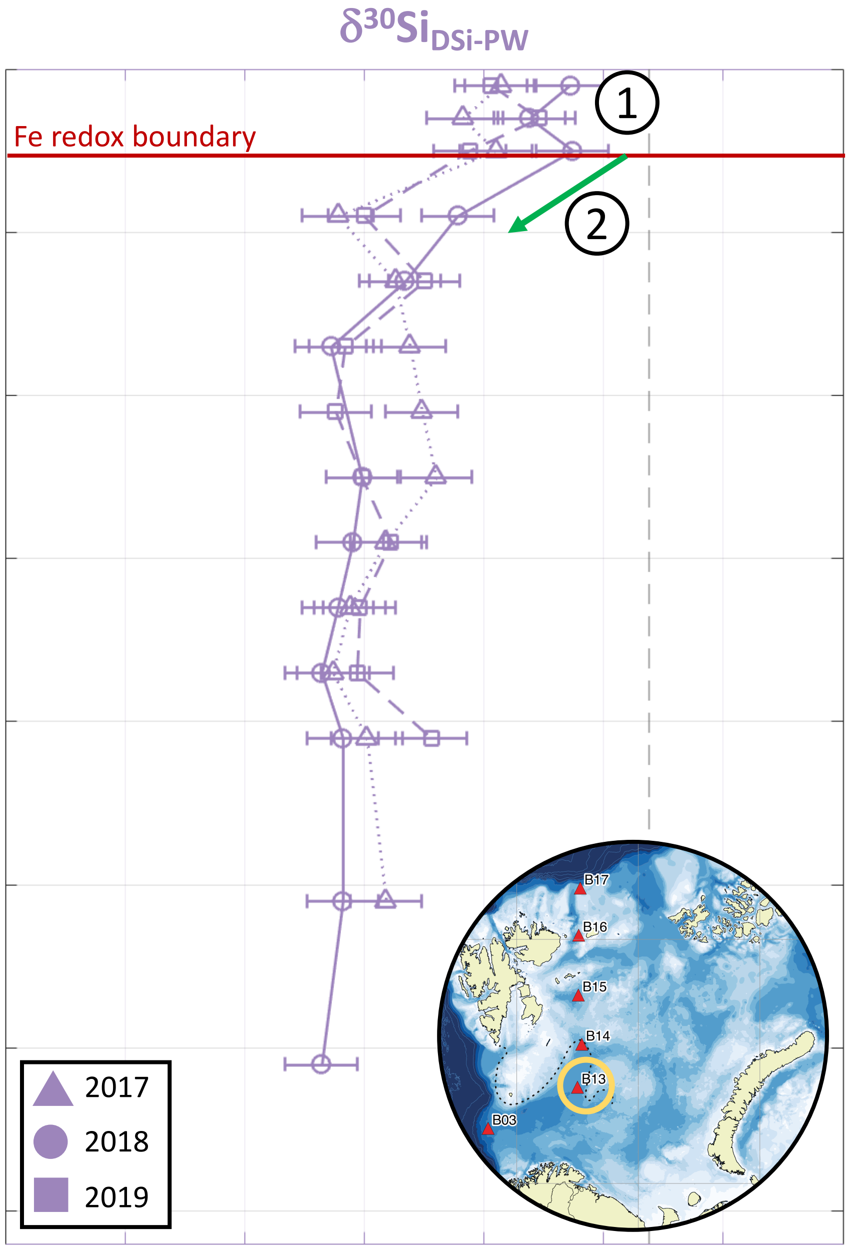
B13 (Atlantic)

SWI = Sediment-water interface





- Lighter composition with depth. DSi source enriched in ^{28}Si.

(1) Dissolution of opal (BSi) into undersaturated pore waters.

(2) Fe redox boundary. Fe(II) appears in solution indicating anoxic conditions. Coincides with a shift towards lighter $\delta^{30}Si_{DSi\text{-}PW}$.

^{28}Si preferentially adsorbs onto solid iron (oxyhydr)oxides. Released when the solid phase is reduced.

(3) Increase in DSi suggests a source. $\delta^{30}Si_{DSi\text{-}PW}$ consistent with terrigenous (LSi) material.

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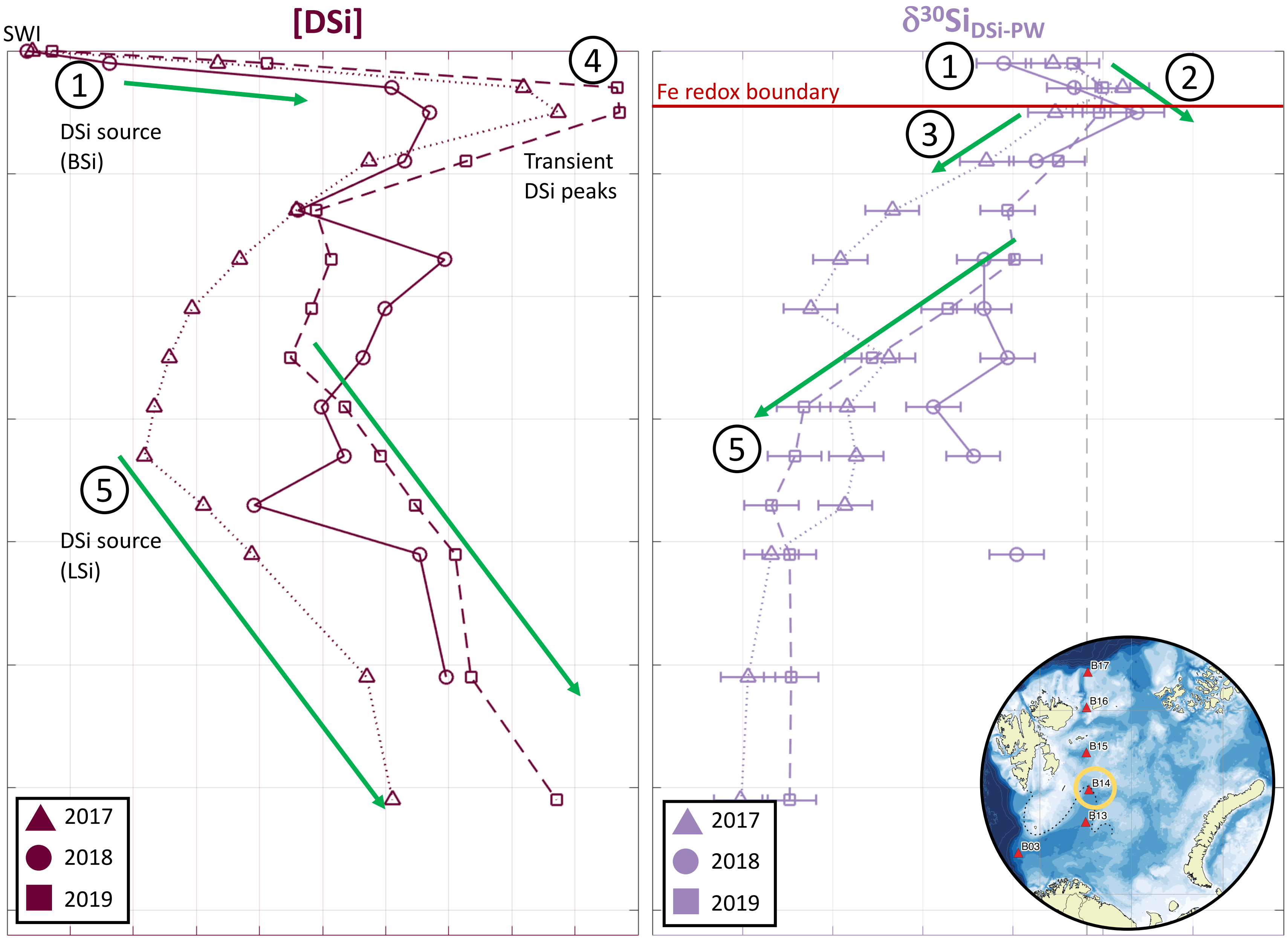
B14 (Polar Front)



1. Dissolution of opal (BSi).
2. Precipitation as DSi reaches authigenic mineral solubility. Uptake of ^{28}Si drives $\delta^{30}Si_{DSi-PW}$ up. Strongest evidence of precipitation across all sites but paradoxically with lightest $\delta^{30}Si_{DSi-PW}$.
3. Fe redox boundary- shift towards lighter $\delta^{30}Si_{DSi-PW}$.
4. DSi peaks in 2017 and 2019 superimposed on background profile represents seasonal influence of diatom bloom deposition. Earlier retreat of ice edge in 2018 so no peak sampled. Physical mixing at PF shown previously to increase export fluxes [8]. Non-steady state dynamic.
5. Increase in DSi at depth. Very light $\delta^{30}Si_{DSi-PW}$. Seems to overwrite the precipitation signal.

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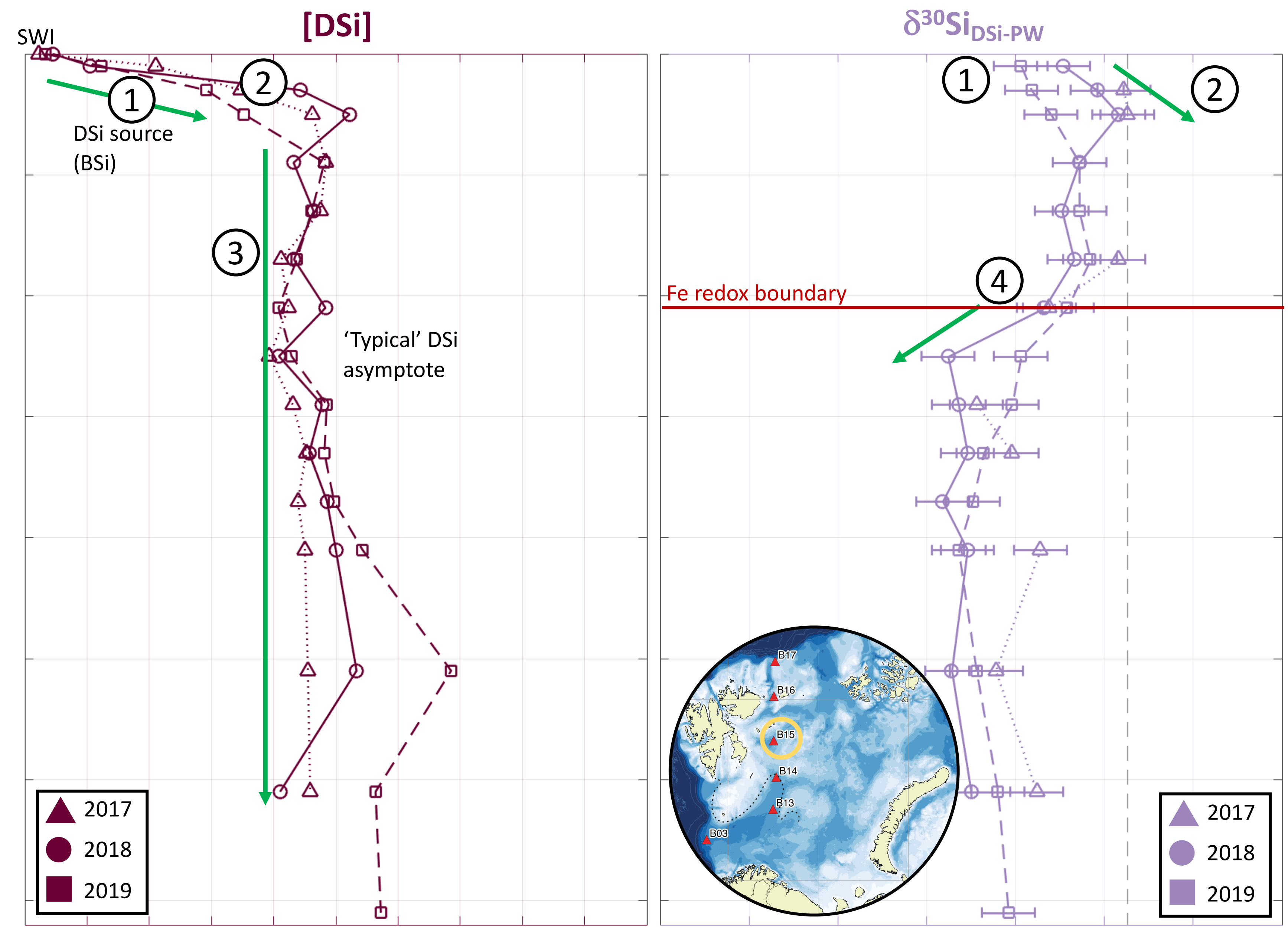
B15 (Arctic)



(1) Dissolution of opal (BSi).

(2) Precipitation as DSi reaches authigenic mineral solubility. Increased $\delta^{30}Si_{DSi-PW}$.

(3) Asymptote represents precipitation-dissolution balance.

(4) Fe redox boundary deeper at B15 (lower rates of organic matter reoxidation). Shift to lighter composition is accordingly deeper. Further evidence for influence of the iron cycle on early diagenesis of silica in the Barents Sea.

- Interannually and spatially less variable. Closer to a steady-state dynamic.

- Heavier than B13 and B14 at depth. Light source from solid iron reduction but possibly no additional LSi input.

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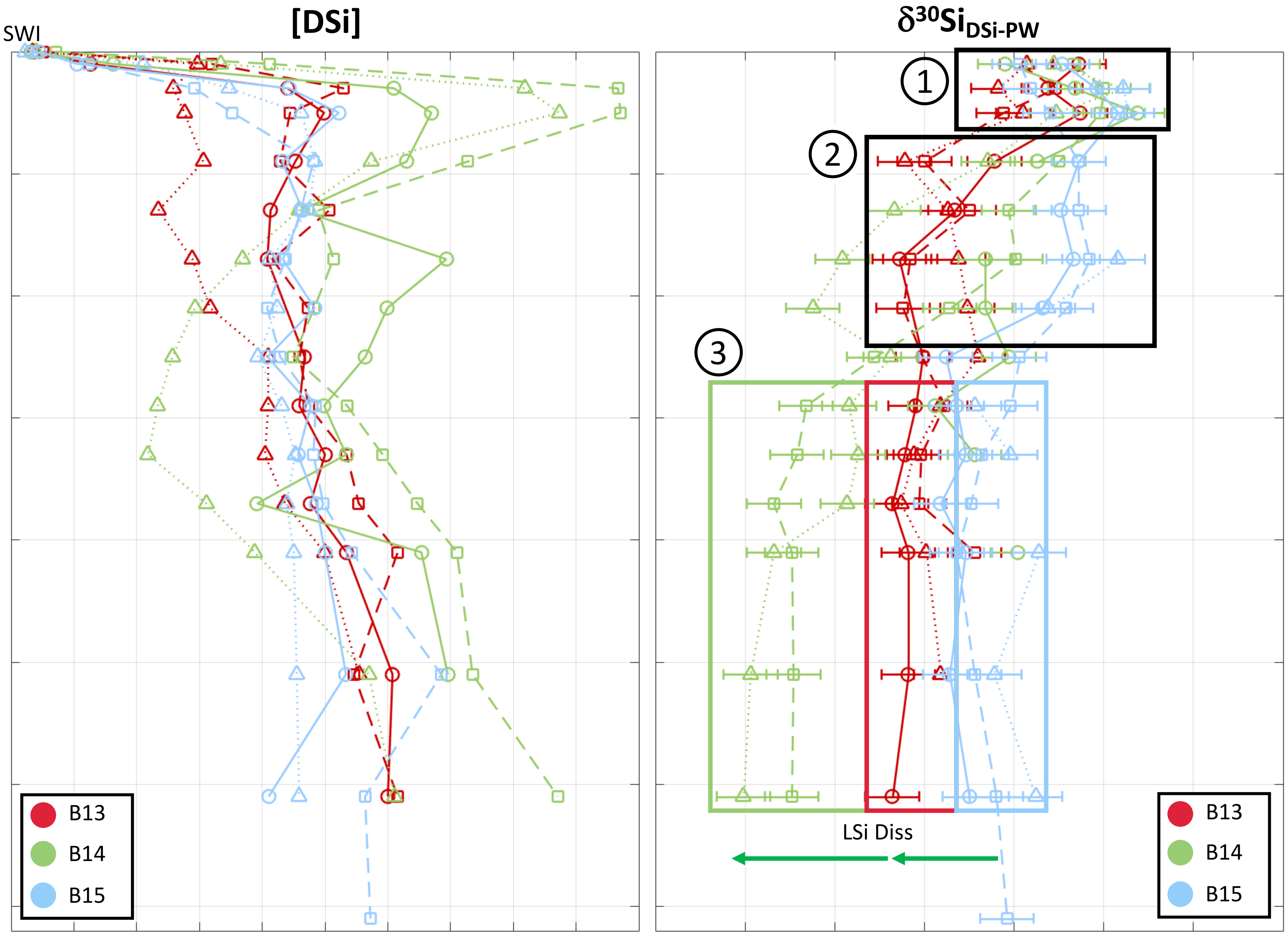
Site Intercomparison



1. Similar composition at surface across all sites. Dissolution of opal and precipitation of authigenic clays.

2. Divergence in $\delta^{30}Si_{DSi\text{-}PW}$ below Fe redox boundary of B13 and B14. B15 remains relatively enriched in ^{30}Si.

3. Below B15 redox boundary B13 and B15 $\delta^{30}Si_{DSi\text{-}PW}$ converge due to ^{28}Si release at B15, but B15 remains slightly heavier. Indicates an additional light source (LSi) at B14 and B13 to account for the difference. Increased precipitation at B15 unlikely to be the driver as pore water cation data suggests precipitation is strongest at B14 and similar at B13 and B15.

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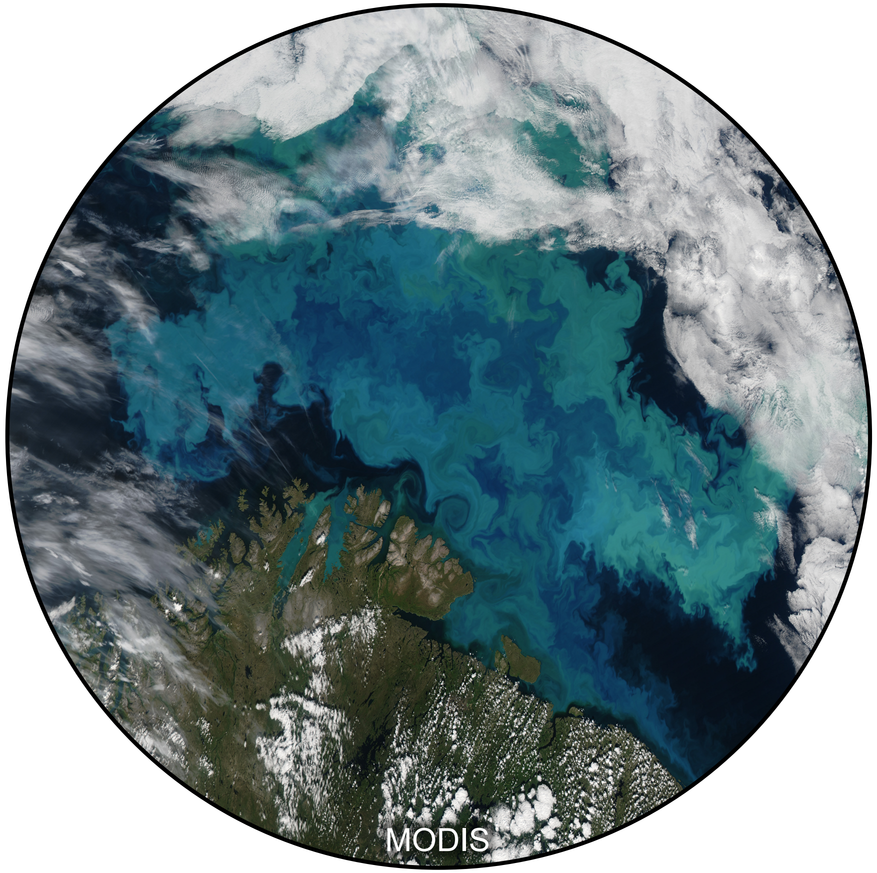
Take Home Messages

- Higher sediment BSi contents and mean fluxes measured in AW and PF sites suggest that over time atlantification could drive an overall increase in benthic DSi fluxes in the ArW zone.

- Evidence for a strong influence of the iron cycle on silica in Barents Sea sediments. There does not seem to be a consistent impact on DSi but isotopically there is a significant shift across the Fe redox boundary at all sites.

- Seasonal dynamics appear to strongly influence pore water DSi stocks here, which has long been debated [9, 10].

- In summary the benthic silica cycle here is driven by a complex balance of DSi release from three possible sources (**opal**, **lithogenic** and DSi **adsorbed** onto solid phase iron), as well as uptake by authigenic mineral precipitation. The balance of these processes varies between sites and only one site (B15) presents with a 'typical' asymptotic DSi profile.



Bloom in the southern Barents Sea

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