Hydrography and nutrient concentrations in years of contrasting sea ice conditions in the Atlantic inflow region north of Svalbard

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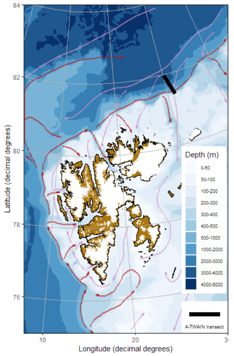

Figure 1: The study region. The transect location is marked by the black line.

In brief:

- late summer repeat transects for hydrography, nutrients and chlorophyll a at 81.5N, 31E across the Atlantic Water inflow to the Arctic
- large interannual variability in all parameters but close relationship between nutrient availability in late summer, stratification, and Atlantic Water layer depth
- varibility steered by sea ice conditions in the months preceding the sampling and subsequent bloom development

What we did:

- cruises in Sep 2012, 2013, 2015, 2017 to the area north of Svalbard CTD transect and water sampling for chlorophyll a, nitrate/nitrite, phosphate, silicate from the shelf to the deep basin
- additional data from satellite: sea ice concentration from AMSR-2 (Spreen et al., 2008) and near-surface chlorophyll a concentration from MODIS (NASA 2014)

What we found so far:

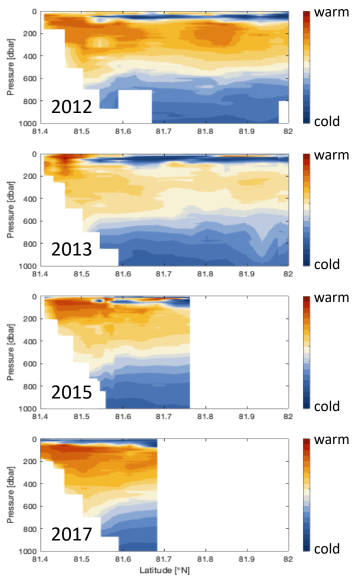

Figure 2: Conservative temperature in the upper 1000 m.

Polar Surface Water (PSW; σ_0<27.7) overlaying Atlantic Water (AW; 27.7<σ_0<27.97 and T>2) and modified AW (T<2), and intermediate and deep water masses (σ_0>27.97) below.

In most years, especially in 2013, warm water reaches from the AW layer to the surface. By contrast, in 2017 PSW is cold and caps off the AW layer below.

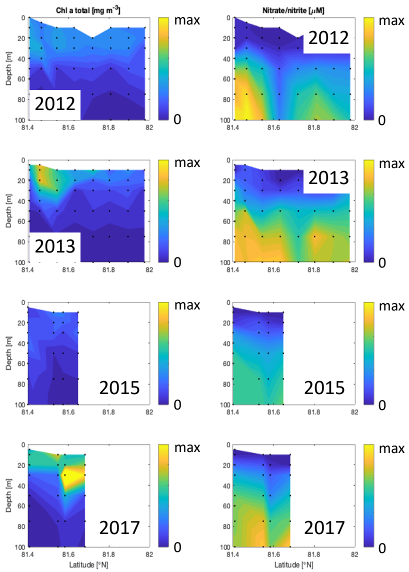

Figure 3: Chlorophyll a (Chl a; left) and nitrate&nitrite concentrations (N; right) in the upper 100 m.*

Chl a is confined to the upper 50 m with highest values in 2017 followed by 2013 (Figure 3).

Nutrients are depleted or near-depleted in the surface corresponding to late summer, post productive period conditions.

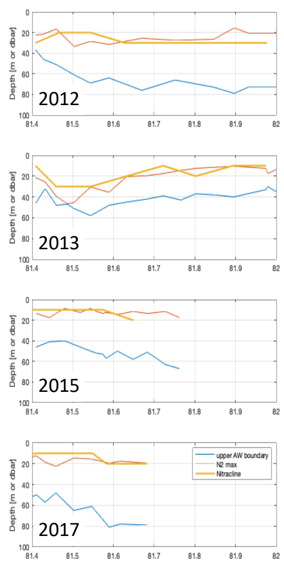

Figure 4: Depth of the nitracline (gradient in N>0.1μM m-1), the maximum in buoyancy frequency N², and the upper limit of AW.*

The nitracline is closely linked to stratification and to the depth of the AW layer (Figure 4). In all years, depth of the upper boundary of AW increases towards north except for 2013.

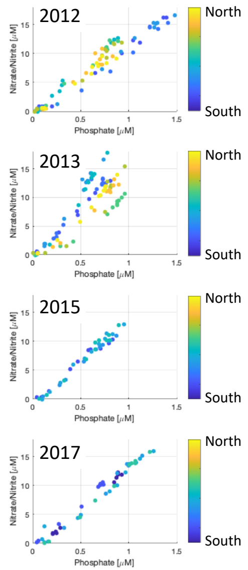

Figure 5: N:P ratio by latitude.

N:P ratios mostly in range expected for AW dominated Arctic regions (Figure 5). Si:N however increases significantly in deeper water masses.

2013 represents a big outlier in N:P ratio due to higher N* and lower phosphate concentrations than in the other years

What we speculate is happening:

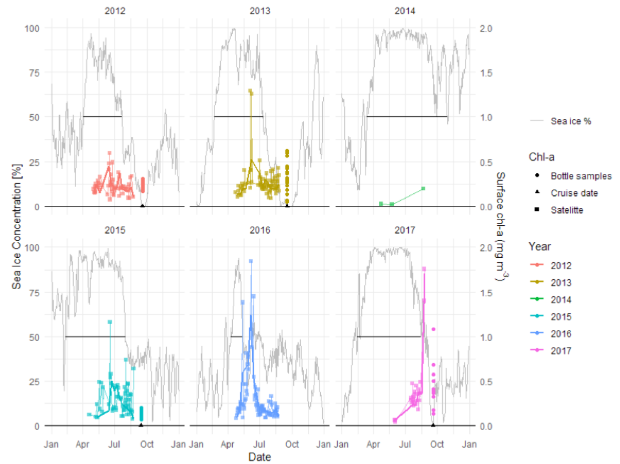

Figure 6: Average sea ice concentration north of Svalbard (80-84 N, 10-35 E) and cal a concentration along the transect for 2012-2017.

- resupply of nutrients to the surface layer from deeper water masses is effectively hindered by stratification; shallower AW helps replenishment
- extent and timing of the phytoplankton bloom is governed by the sea ice cover (Figure 6): extensive sea ice and late retreat delays the bloom (e.g. 2017) or prevents it (e.g. 2014)
- stratification is also influenced by summer sea ice development: extensive ice cover and fast melt promotes cold PSW layer and strong stratification (e.g. 2017); little sea ice or early retreat allows for warmer PSW and weaker stratification (e.g. 2012 & 2013).

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