Seasonal variability and fluxes of nitrate in the surface waters over the Arctic shelf slope

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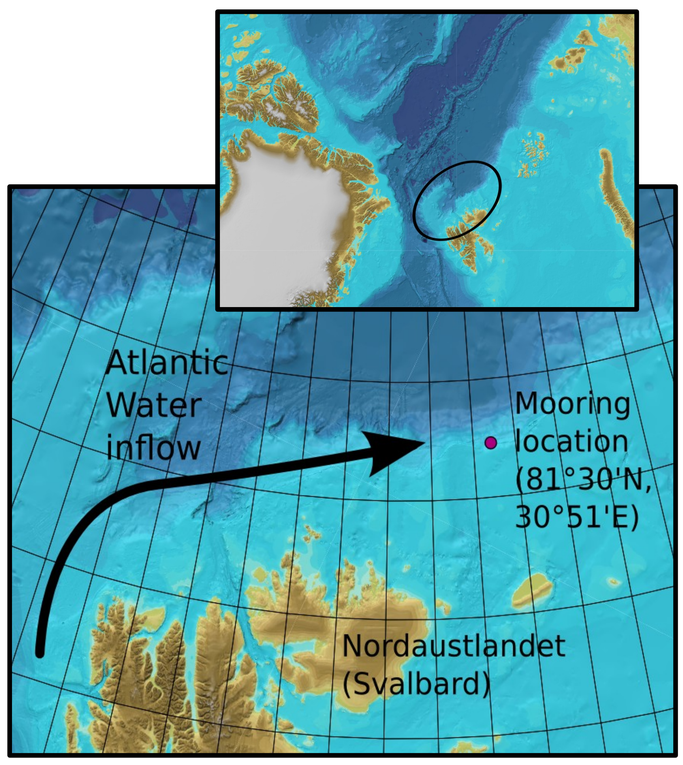
Background

Understanding the present state and possible future scenarios of Arctic Ocean primary productivity has been hampered by the scarcity of year-round nutrient measurements. Here, the first year-long moored timeseries of near-surface nitrate concentrations in the Eastern Arctic, together with hydrography, currents and chlorophyll-a fluorescence, is reported from the shelf slope north-east of Svalbard.

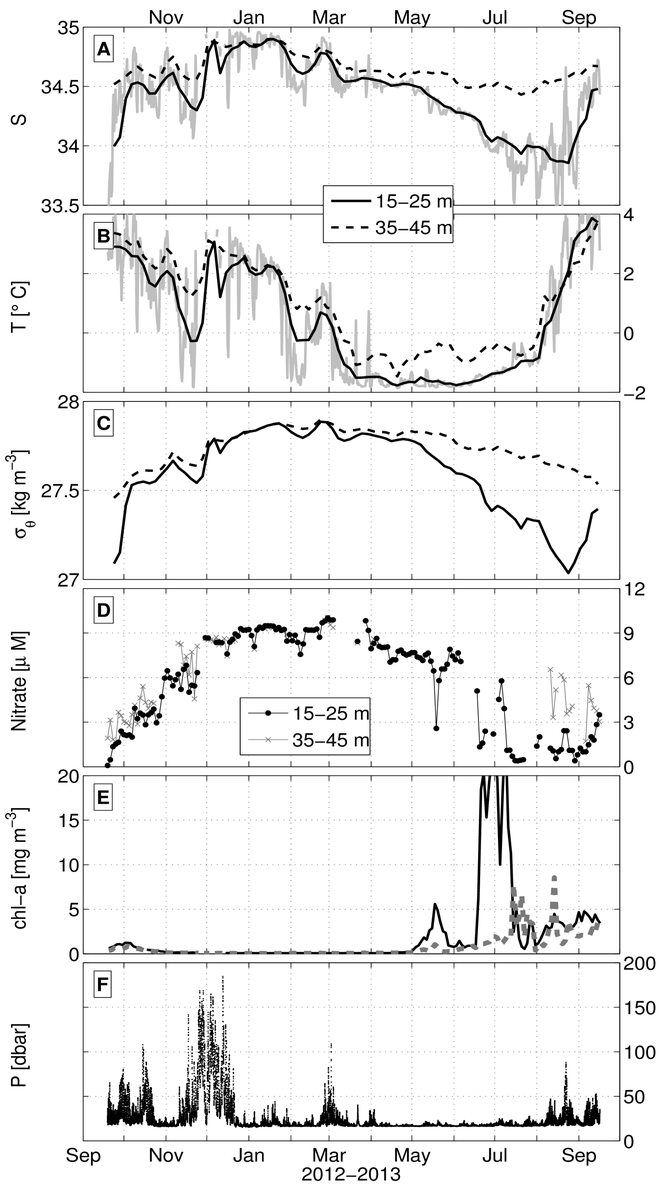
Nutrient-rich Atlantic Water (AW) flows into the Arctic Ocean through Fram Strait and eastward along the shelf break, and supplies the surface water with nutrients. Quantifying the nitrate dynamics helps understanding the implications for productivity patterns in an area with large reductions in ice extent in recent decades.

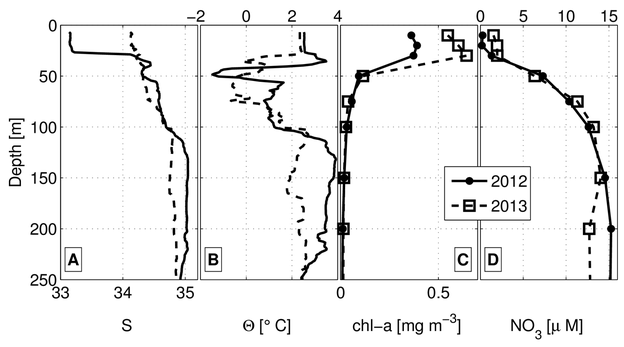
Data Set

- Mooring at 800 m water depth, part of the A-TWAIN project, logged from Sep 2012 to Sep 2013
- 2 SeaCATs moored at 20 and 40 m depth (conductivity, temperature, pressure, chl-a fluorescence)
- Nitrate sonde (SAtlantic ISUS) moored at 21 m depth
- Up-looking ADCP covering the surface 90 m
- Ship-based hydrographic stations at the mooring location in Sep 2012 and 2013, with bottle samples of nutrients and chl-a



Results: Mooring Time Series and September Profiles

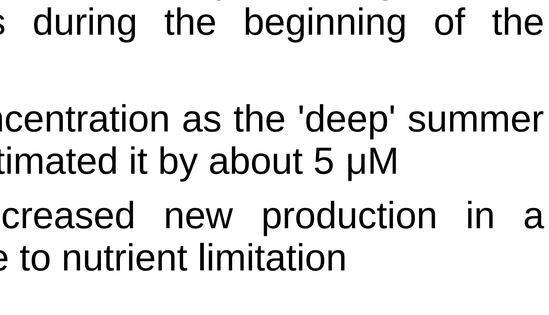




- September profiles show nitrate-depleted mixed layer of 25 m depth, pycnocline extending to ca. 50 m
- Seasonal salinity and temperature cycle dominated by freshening (ice melt)
- Maximum nitrate concentration of 10 µM reached during March
- Spring bloom triggered nitrate drawdown starting in June
- Temporal variability in nitrate during the productive season indication spatial patchiness

Vertical Nitrate Fluxes and Estimated New Production

- Vertical movement of the mooring between 20-200 m depth allowed to infer vertical profiles of nitrate through fall/winter 2012
- Nitrate gradient eroded when stratification vanished (Dec 2012)



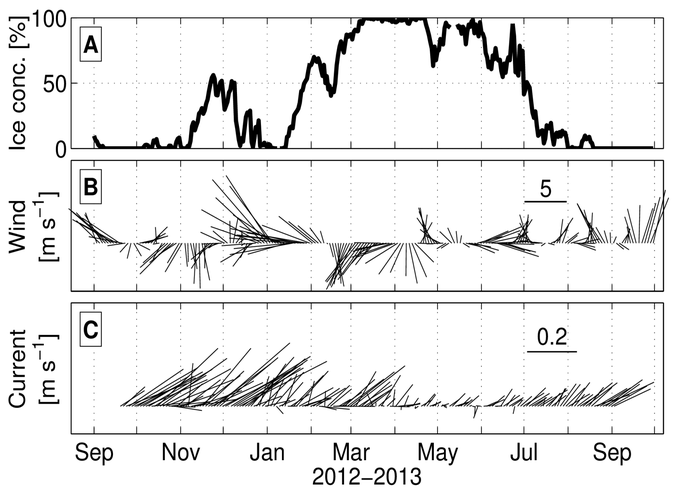
Monthly profiles of nitrate and density through fall/winter 2012

- Closing the budget yields upward nitrate flux of 2.5 mmol/m²/d during fall/winter 2012 in the AW inflow area upstream of the mooring (with vanishing nitrate uptake and small nitrification term during that time)
- Annual new production estimated from nitrate drawdown 31 g C/m²

Conclusions

- AW important to break down stratification and resupply surface layer with nitrate during fall
- Mooring location heavily influenced by inflowing AW, but large spatial patchiness during the beginning of the productive season
- Estimating the winter concentration as the 'deep' summer value would have overestimated it by about 5 µM
- Limited potential for increased new production in a scenario with less ice due to nutrient limitation

Ice, wind and currents



- Steady near-surface inflow of AW along the shelf break in spite of varying winds
- Along-shelf advection dominates over cross-shelf advection over the seasonal time scale
- Timing of bloom likely controlled by ice cover and strengthening stratification

Acknowledgments

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References

- Randelhoff, A., A. Sundfjord and M. Reigstad. Seasonal variability and fluxes of nitrate in the surface waters over the Arctic shelf slope. Under revision for Geophysical Research Letters

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