Grønlandshavet, tundraen og klimaforandringene

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Previously presented as:

Primary production in the Greenland Sea may decrease because of accelerated melting of tundra surrounding the Arctic Ocean

ASLO
summer meeting 2018, Victoria, British Colombia.
The beginning of the Story (2006):

In a mesocosm experiment in Ny Ålesund, Svalbard, we discovered unexpected consequences of increased availability of organic carbon.


Counterintuitive carbon-to-nutrient coupling in an Arctic pelagic ecosystem.

Nature 455, 387 – 390
Net accumulation of TOC in the enriched mesocosms.

Nutrients were added daily, in very small amounts.

Incipient mineral nutrient limitation

Sunlight: continuous.
The counterintuitive result
The counterintuitive result found in our experiments was that, when small doses of organic-C (as glucose) were added to our mesocosms, accumulation of total organic-C (TOC) was reduced.

Thingstad et al. 2007.

So, where in the world can one expect increased doses of organic carbon?
The Arctic Ocean receives increasing amounts of terrestrial organic material (This meeting, D. Colatriano, C. Lovejoy, et al.)

Figure 1 | Soil organic carbon maps. a, Soil organic carbon pool (kg C m\(^{-2}\)) contained in the 0–3 m depth interval of the northern circumpolar permafrost

Climate change and the permafrost carbon feedback

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Scenario
Melting of tundra exposes a huge reservoir of organic material, which may:
• Be mineralized and release CO$_2$ (Schuur et al. 2015, previous slide)
• Be leached into the runoff to the ocean.

Freshwater runoff into the Arctic Ocean is increasing. (Bruce J. Peterson, Robert M. Holmes, James W. McClelland et al. 2002. Increasing River Discharge to the Arctic Ocean. Science 298, 2171-2173).

Rainer M. W. Amon et al. measured DOC at several latitudes along the East Greenland Current, and they showed elevated concentrations of DOC in the current compared to the Greenland Sea waters. (J. Geophys. Res. Oceans 108, 2003).

EGC: East Greenland Current.
NAC: North Atlantic Current.
WSC: West Spitsbergen Current.
O: Ob.
Y: Yenitseij.
L: Lena.
M: Mackensie.
The expeditions showed **similar pattern**, 10 years apart.
Bacterial production rate along 75ºN (µmol C l⁻¹ d⁻¹).

When the Greenland Sea water mixes with the East Greenland Sea Current water, bacterial production is profoundly stimulated.

Possible reason:
The specialized Arctic microbes seem to lack the capacity to easily mineralize the recalcitrant leftovers from the terrestrial output of the tundra.

There is an emerging understanding of the differences in the “meta – omics” of procaryotes in time and space revealed at the present meeting of ASLO.

Metabolic diversity seem to be a local phenomenon, Arctic Ocean bacteria can differently specialized compared to their colleagues from the south.
Primary production, modelled on satellite sensed data.

**Fig. 8.** Timecourses of annual net primary production as a function of distance from the East Greenland Current (dotted line). Area 1 covers approximately the current, and area 4 covers the area with the highest maximal average chlorophyll concentration.

The increase in annual net primary productivity during the life time of the MODIS registrations was **weaker at the East Greenland Current** than in the Greenland Sea.
Conclusion 1

Bacterial production rates at the edge of the East Greenland Current are stimulated by organic material carried out of the Arctic Ocean.

Comment:
Other work has shown that the Arctic Ocean excess of organic material is mostly of terrestrial origin.
Conclusion 2

Primary production rates are negatively influenced by the increased bacterial production along the edge of the Greenland Sea Current.

Conclusion 3.

Increased melting of tundra will lead to decreased primary production along the edge of the Greenland Sea Current.
Conclusion 4

Increased melting of tundra will lead to decreased total production along the edge of the Greenland Sea Current (if the mechanism presented in Thingstad T.F. et al., 2008. Counterintuitive carbon-to-nutrient coupling in an Arctic pelagic ecosystem. Nature 455, 387 – 390 is applicable).

I say it, so it must be so (Bob Dylan, Modern Times, 2006)