Dissolved organic matter properties in arctic coastal waters are strongly influenced by fluxes from permafrost coasts and by local meteorology

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Under future climate change scenarios, Arctic coastal waters are believed to receive higher terrestrial organic matter (OM) fluxes. Permafrost carbon is increasingly mobilized upon thaw from rivers draining permafrost terrain and from eroding permafrost coasts. Once received, the coastal waters are the transformation zone for terrestrial OM, although quantities, especially those of dissolved organic matter (DOM) released by coastal erosion, are largely unknown. This nearshore zone plays a crucial role in Arctic biogeochemical cycling, as here the released material is destined to be

1. mineralized into greenhouse gases,
2. incorporated into marine primary production,
3. buried in nearshore sediments or
4. transported offshore.

In this presentation, we show data on DOM quantities in surface water in the nearshore zone of the southern Beaufort Sea from two consecutive summer seasons under different meteorological conditions. Colored dissolved organic matter (cDOM) properties help to differentiate the terrestrial from the marine DOM component. Figure 1 shows DOC concentrations and salinities for 23 and 24 days in the summer seasons of 2013 and 2014, respectively. DOC concentrations in the nearshore zone of the southern Beaufort Sea vary between about 1.5 and 5 mg C L^{-1}. In the Lena River Delta, bay water, river water, and permafrost meltwater creeks yielded similar values between 5.8 and 5.9 mg C L^{-1} (Dubinenkov et al., 2015). Similarly, Fritz et al. (2015) found DOC concentrations in ice wedges between 1.6 and 28.6 mg C L^{-1}.

In 2013, the first half of July was characterized by low salinity between 8 and 15 psu and high DOC concentrations of 3.5 to 5 mg C L-1. Then, a sudden change in water properties occurred after a major storm which lasted for at least 2 days. This storm led to strongly decreased DOC (1.5 to 2.5 mg C L^{-1}) concentration and increasing salinity (14 to 28 psu) in surface water, probably due to upwelling In 2014, a more stable situation in both salinity and DOC prevailed, with relatively high salinity (23 to 29 psu) and low DOC concentration (1.5 to 2.5 mg C L^{-1}). This pattern was due to rather windy and wavy conditions throughout the whole season. The water column in 2014 was likely well-mixed and DOC-poor because saline waters have probably been transported from the offshore to the nearshore.

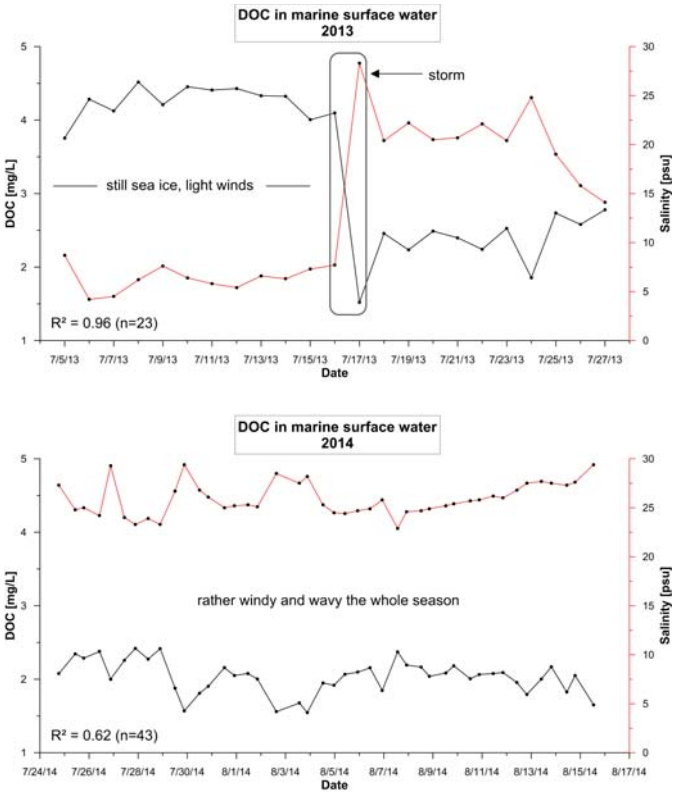

Figure 1: Dissolved organic carbon (DOC) and salinity of marine surface water in the southern Beaufort Sea (Canada) in 2013 and 2014. Correlation coefficient shows the relation between DOC and salinity. Major meteorological conditions are indicated.

We recognized a significant negative correlation between DOC and salinity, independent from varying meteorological conditions. In general, this suggests a conservative mixing between DOC derived from terrestrial/permafrost runoff and marine DOC. The low salinity in July 2013 was probably due to prolonged sea-ice presence in the sampled area. This leads to the assumption that DOC also originates from melting sea ice. Quantitatively more important will be terrestrial runoff which is relatively rich in DOC. A stable stratification in the nearshore zone and calm weather conditions will increase the influence of terrestrial-derived DOM. The strength of the terrestrial influence can be estimated by salinity measures as they directly correlate with DOC concentrations; the lower the salinity the stronger the terrestrial influence.

We conclude that the terrestrial imprint of coastal erosion on DOM concentrations in the nearshore zone is significant. We see that DOC concentrations are significantly elevated also compared to riverine input in front of river mouths and deltas. Meteorological conditions play a major role for the strength of the terrestrial DOM signal, which can vary on short timescales. Our approach is different from ship-based oceanography because we study DOM that is directly derived from thawing permafrost coasts, explicitly excluding rivers. When qualifying DOM origin from permafrost landscapes apart from rivers we have to take into consideration the different DOM mobilization pathways.

1. Surface runoff and near-surface groundwater flow mainly drain and flush the active layer.
2. Melting ground ice releases DOM.
3. Ground ice meltwater leaches DOM from sedimentary OM upon permafrost thaw on land.
4. DOM is leached from sedimentary OM upon contact with sea water.

The latter three will mobilize old OM which is believed to be highly bioavailable (see Vonk et al., 2013a, b).

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