Origin of freshwater and polynya water in the Arctic Ocean halocline in summer 2007

With the aim of determining the origin of freshwater in the halocline, fractions of river water and sea-ice meltwater (or brine influence from sea-ice formation) as well as pacific derived waters are quantified by a combination of salinity and $\delta^{18}O$ and nutrients in the upper 150 m of the Central Arctic Ocean. Our study indicates which layers of the Arctic Ocean halocline are primarily influenced by sea-ice formation in coastal polynyas and which are primarily influenced by sea-ice formation over the open ocean. With the ongoing changes in sea-ice coverage in the Arctic Ocean it can be expected that these processes will change in the immediate future. Thus the relative contributions and the stratification of the halocline will change accordingly.

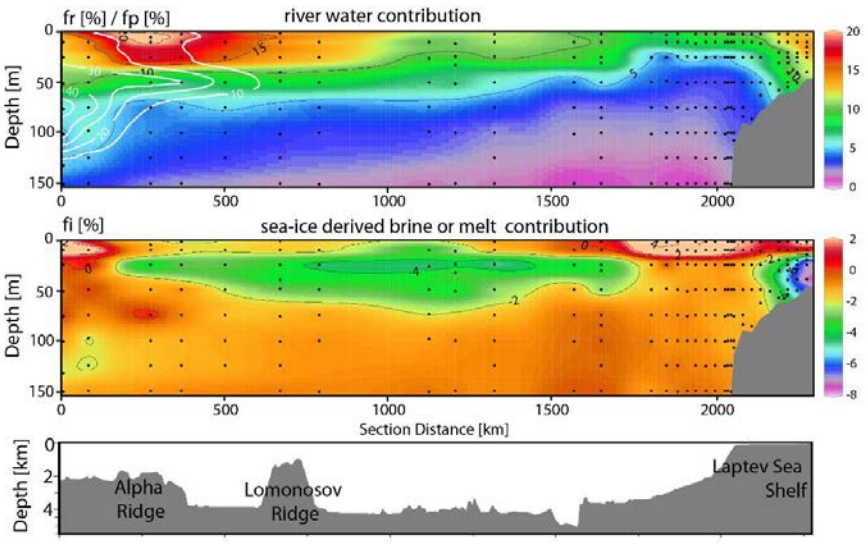

Fig.1: The section runs from the Laptev Sea shelf to the central Arctic Ocean and shows the fractions of river water (fr) and sea-ice melting (fi) or formation (neg. fi). In addition the contribution from Pacific-derived waters are shown (fp; white isolines). Figure is modified from Bauch et al. (2011) and is one of two sections taken parallel across the Transpolar Drift System (located at the position of the Lomonosov Ridge in 2007).

Only the Atlantic regime in the Eurasian Basin is dominated by net sea-ice melting. A pronounced signal of brines released during sea-ice formation is found over the Lomonosov Ridge at about 30 to 50 m water depth (see Fig. 1). This signal marks water transported from the Siberian shelf regions via the North Pole towards Fram Strait in the Transpolar Drift System. The geographic distinct definition and variation of this water mass signal indicates the rapid release and transport of shelf waters within the Transpolar Drift in discrete pulses. Using the ratio of brine signal and river water the maximum in brine influence seen in 2007 within the Transpolar Drift over the North Pole can be linked with a pulse of shelf waters released from the Laptev Sea likely in summer 2005.

The ratio of sea-ice derived brine influence and river water is roughly constant within each layer of the Arctic Ocean halocline (see Fig. 2). The correlation between brine influence and river water reveals two clusters that can be assigned to the two main mechanisms of sea-ice formation within the Arctic Ocean. Over the open ocean or in polynyas at the continental slope sea-ice formation results in a linear correlation between brine influence and river water at salinities of ~ 32 to 34. In coastal polynyas in the shallow regions of the Laptev Sea and southern Kara Sea, sea-ice formation transports river water into the shelf's bottom layer due to the close proximity to the river mouths. This process results in a second linear correlation between brine influence and river water at salinities of ~ 30 to 32.

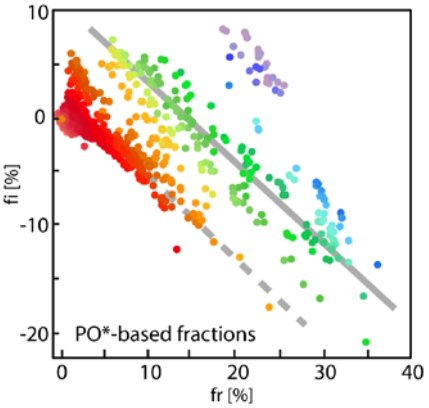

Fig.2: Property plot of river water (fr) and sea-ice (fi) fractions. The lines highlight the clusters formed by open ocean convection (stippled) and coastal polynyas (solid). Figure modified from Bauch et al. (2011).

Reference: Bauch, D., M. Rutgers van der Loeff, N. Andersen, S. Torres-Valdes, K. Bakker, and E. P. Abrahamsen (2011), Origin of freshwater and polynya water in the Arctic Ocean halocline in summer 2007, Progress in Oceanography, 482-495, doi:410.1016/j.pocean.2011.1007.1017

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