THE SENSITIVITY OF ARCTIC SHELF SEAS TO VARIATIONS IN ENVIRONMENTAL FORCING: 10 YEARS OF PROGRESS IN UNDERSTANDING THE "LAPTEV SEA SYSTEM"

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Environmental forcing factors, i.e. atmospheric circulation, sea ice cover and river runoff, mainly affect the shallow water environment of the Laptev Sea in the Siberian Arctic. Especially the predominance of cyclonic or anticyclonic atmospheric circulation over the Arctic influences the current system of the Laptev Sea and the distribution of river runoff on the shelf. As a consequence also the transport of sediments and the sedimentation processes on the shelf are strongly affected by different regimes of atmospheric circulation and ice cover. New data show that this effect starts as soon as the Laptev Sea flaw polynya opens up during winter.

The modern depositional environment was probably established during the last phases of the Holocene transgression that reached the southern region of the Laptev Sea between ~ 7 ka and ~ 5 ka. The flooded areas now form large shoals that are covered by relict sandy sediments. Modern sediment deposition on the inner and central shelf is mainly connected to depressions in shelf topography. But even in a depression near the major outlet of the Lena River, the average sedimentation rate of the last 5 ka was not higher than 30 cm/ky.

New long-term measurements with bottom-moored instruments give strong evidence that modern shelf sediment transport is mainly connected to the N-S running submarine valleys on the shelf of the Laptev Sea. In the submarine valleys of the eastern Laptev Sea suspended sediments are transported within in a distinct bottom nepheloid layer which is strongly influenced by the prevailing atmospheric circulation and the ice cover. In the Eastern Lena Valley the main transport direction is towards the central and inner shelf. This transport system can explain the higher average sedimentation rates (40 – 70 cm/ky) at the southern end of the Lena Valley.

Geochemical and mineralogical signatures of surficial sediments in the Laptev Sea, the absence of a bottom nepheloid layer in the western Laptev Sea, and the hydrographic conditions let us arrive at the conclusion that the dominant source for surficial sediments in the central and outer shelf region is the riverine input of the Lena River. In the course of the spring freshet of the Lena River more than 50 percent of the annual input of suspended sediments enter the still ice-covered southeastern Laptev Sea. The suspended matter is laterally advected in an under-ice flow into the southeastern Laptev Sea. In the course of two weeks the material started to settle. During phases of strong atmospheric forcing the settled sediments are resuspended again and transported in the bottom nepheloid layer into the submarine valleys. Seafloor erosion of the shoals can also add significant amounts of sediments to the central and outer shelf region as they are influenced additionally by waves.

Based on the available data it can be assumed that the significant amounts of sediments that enter the Laptev Sea due to coastal erosion are trapped in a longshore transport system which prevents sediment transport towards the central shelf. Export of inner shelf sediments to the outer shelf area and the Arctic basin is mainly bound to the short period of the autumn freeze-up when new ice is formed in coastal and inner shelf areas. New data indicate that the atmospheric conditions during the first phase of the freeze-up -when the newly formed ice floes are still very mobile - control the incorporation of sediments into the ice cover and the export of "dirty" new ice into the Transpolar Drift System.

In general the seasonal variability of salinity and temperature in the region of the inner shelf is higher than the variability in the central and outer shelf region. This is mainly caused by fast ice which covers the inner shelf from October to the end of July. An examplary process is the supply of salt-enriched, cold brines which form during the growth of the ice. The low hydrodynamic forces under the ice cover allow the dense brines to accumulate in morphological depression. This process should have direct consequences for the stability of submarine permafrost on the inner shelf. Therefore climate-induced changes of the spatial and temporal distribution of the fast ice cover should have strong impact especially for the inner shelf environment and the submarine permafrost.