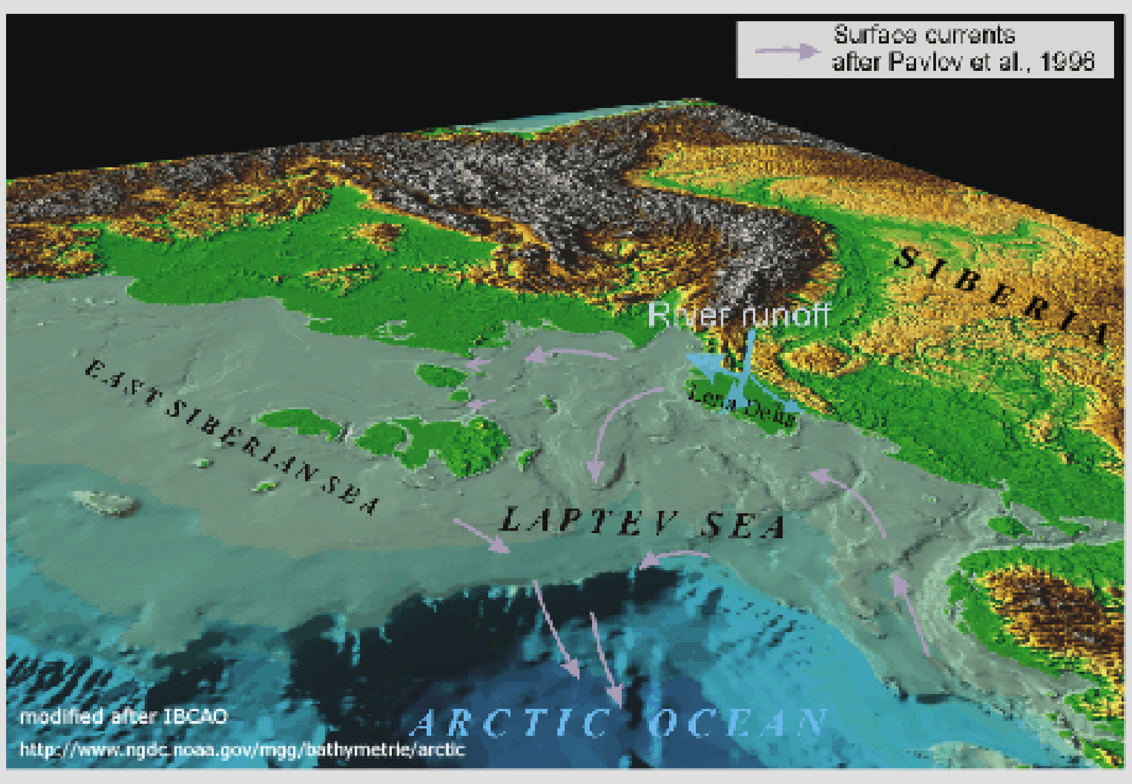
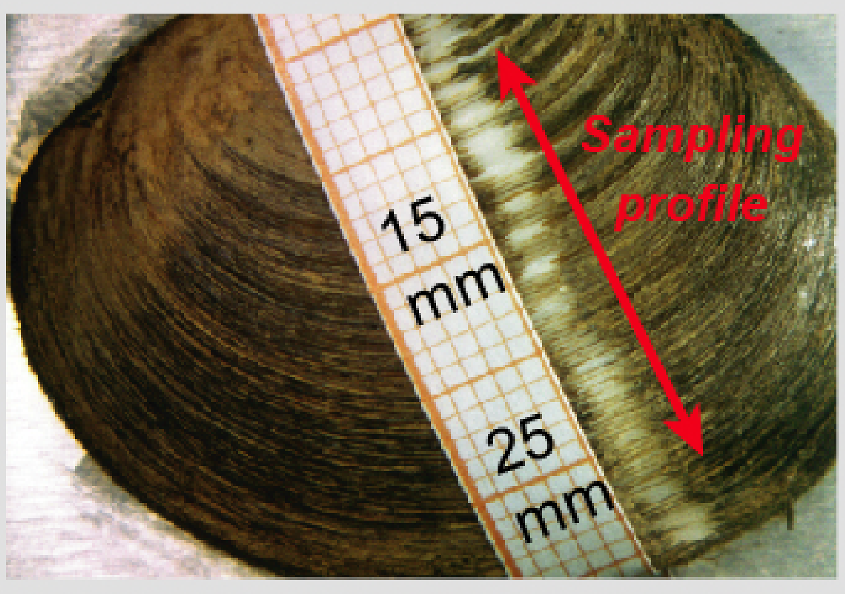
Hydrological Change in Arctic Land – Shelf Connection
Records on Annual Timescales

Introduction

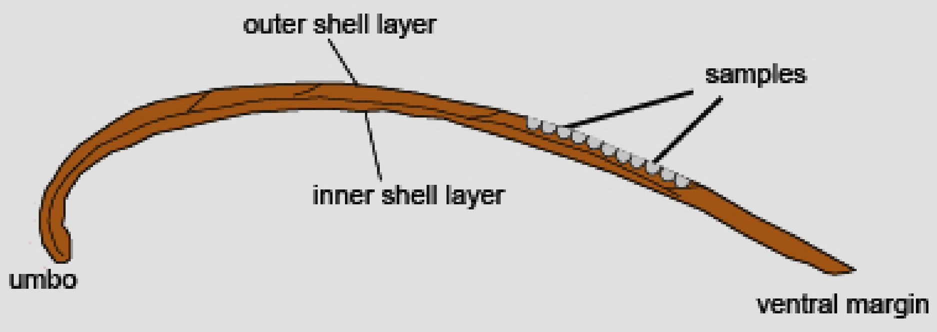


The Laptev Sea, one of the key areas for the formation of arctic surface and intermediate water, is influenced by large freshwater input, discharged mainly by the Lena River. This runoff is subjected to strong seasonal and annual variations. The aim of our work is to reconstruct the variations of hydrographical changes on different timescales, as they are embedded in carbonate shells of living and fossil bivalves.

Tool



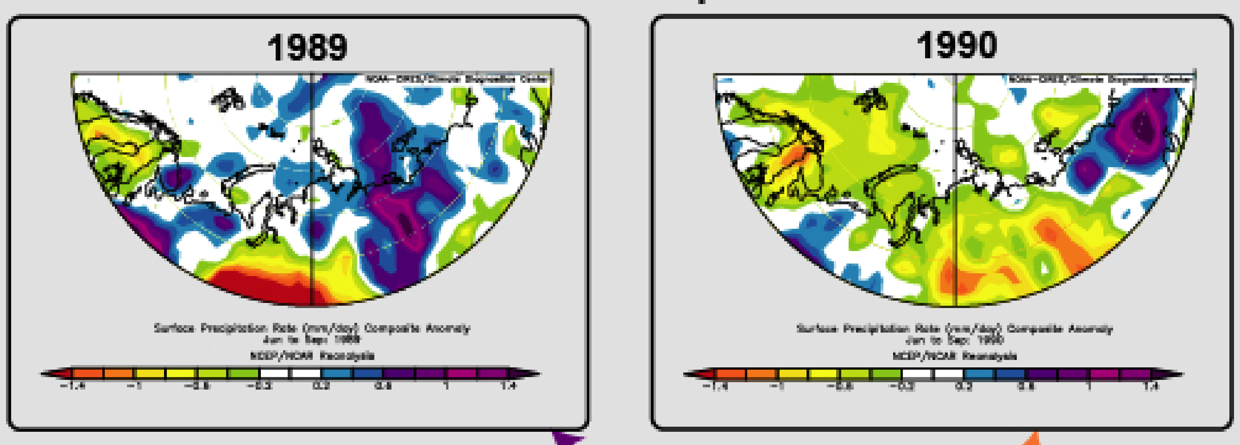
$\delta^{18}O$-profile of *Astarte borealis* (sampling interval 0.2 – 0.3 mm)

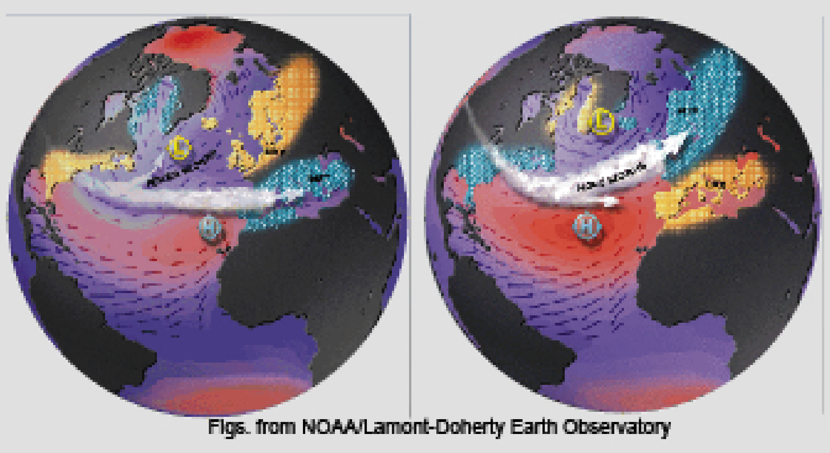


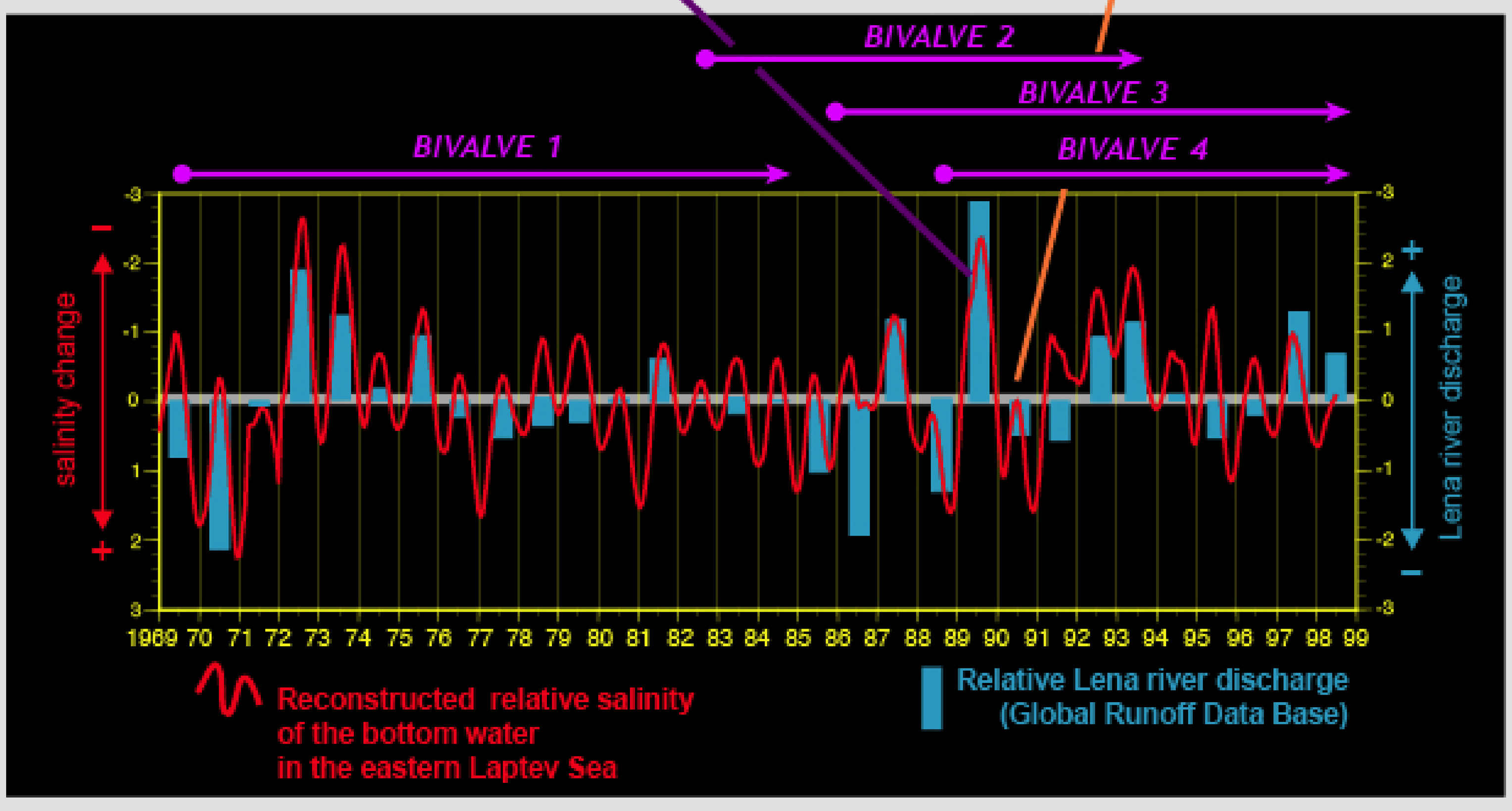
Individual carbonate powder samples (>15 µg) were millcut sequentially from the aragonitic outer shell layer. The detailed sampling along the axis of maximum growth provides an isotopic record of environmental changes during the life of the bivalves.

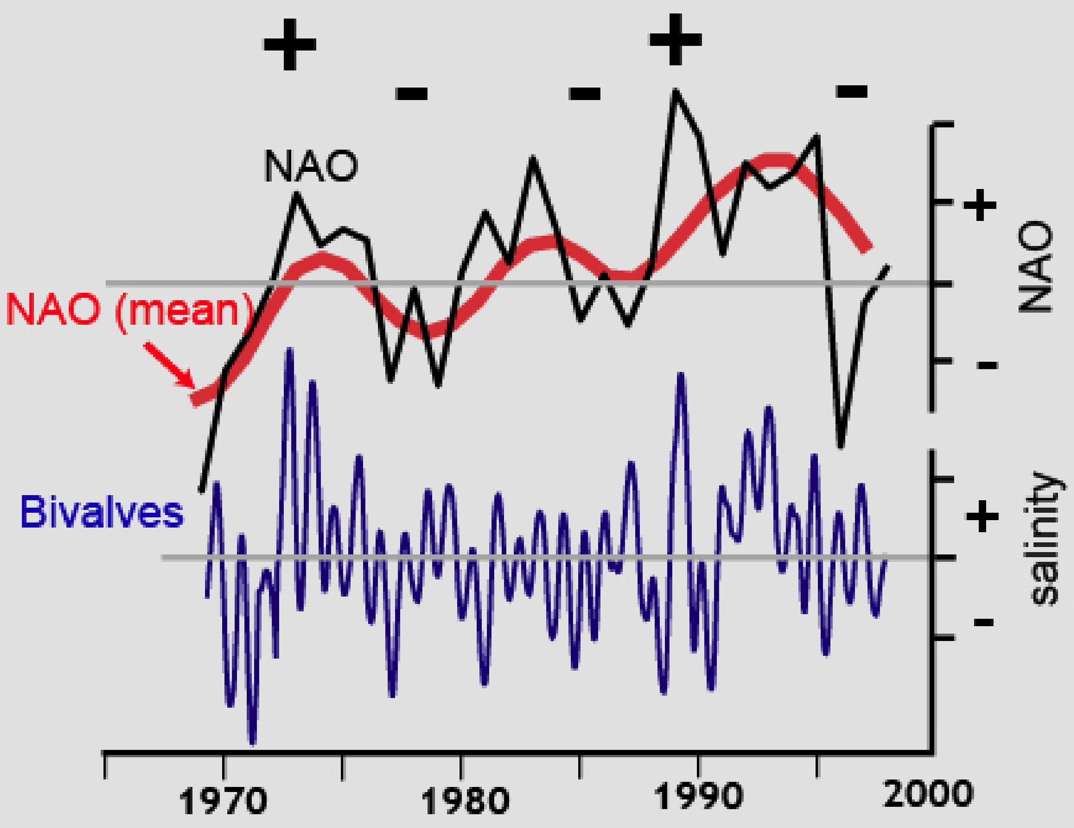
Annual & Subdecadal Changes

Precipitation Rate Anomaly
Jun - Sep





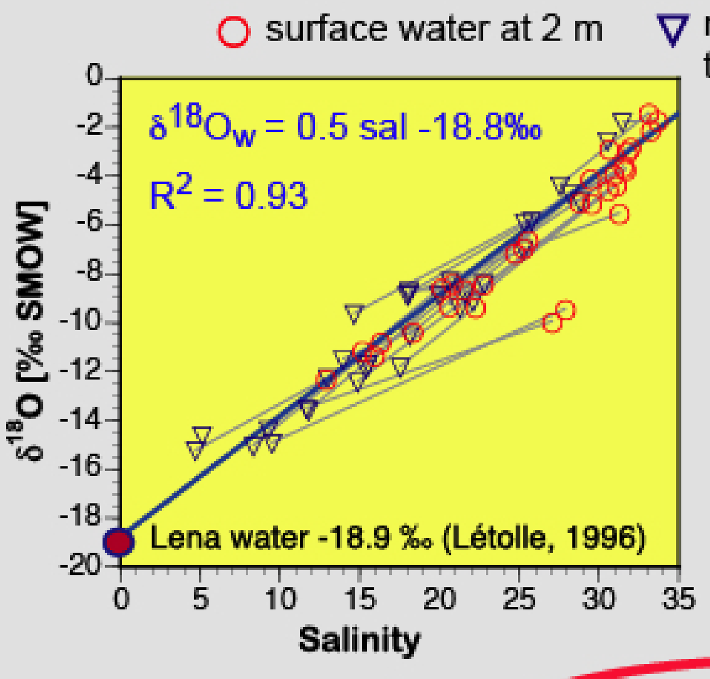




By normalizing the $\delta^{18}O$ records of four bivalve specimens collected alive in different years from the Laptev Sea a stacked record from 1969 to 1998 of the relative salinity changes of the bottom water in the eastern Laptev Sea is reconstructed and shows a good correspondences of the bivalves' record to the variability of the annual lena river discharge into the Laptev Sea. Additionally a sensibility of the bivalves' record to Northern Hemisphere circulation patterns like the North Atlantic Oscillation (NAO) is shown.

$\delta^{18}O$

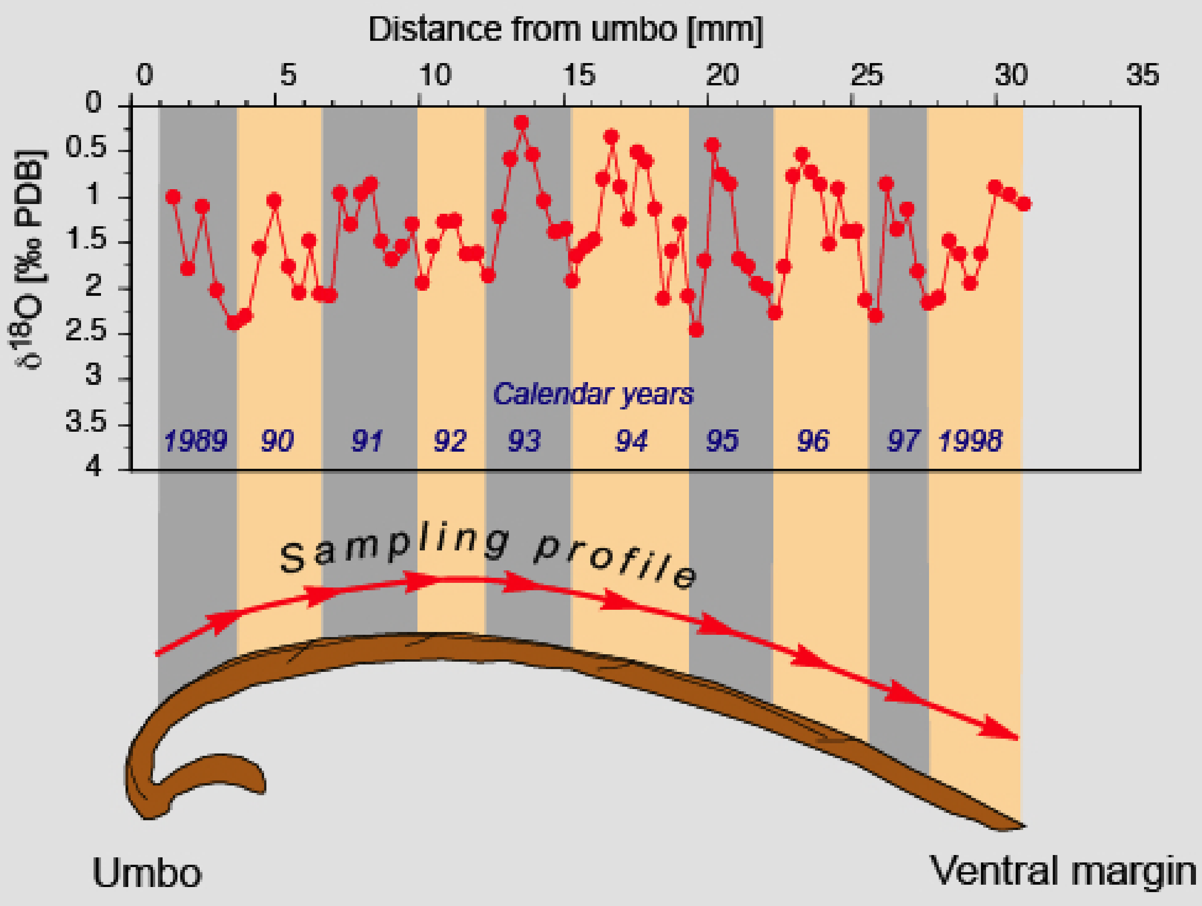
$\delta^{18}O$ of the Laptev Sea waters



Linear correlation of $\delta^{18}O_W$ to salinity documents the mixing between riverine freshwater and seawater. The $\delta^{18}O_W$ can be described by a salinity- related term:

$$\delta^{18}O_{W[SMOW]} = 0.5\ sal - 18.8\ ‰$$

$\delta^{18}O$ of the bivalves' carbonate



$$\delta^{18}O_{Bivalve} = 4.65 - 0.21\ T + \delta^{18}O_{water}$$ (Grossman & Ku, 1986)

$$\delta^{18}O_{Bivalve} = 4.65 - 0.21\ T + (S*0.50 - 18.8‰) - 0.2‰$$

$\delta^{18}O_{Bivalve}$ variability = seasonal changes → freshwater

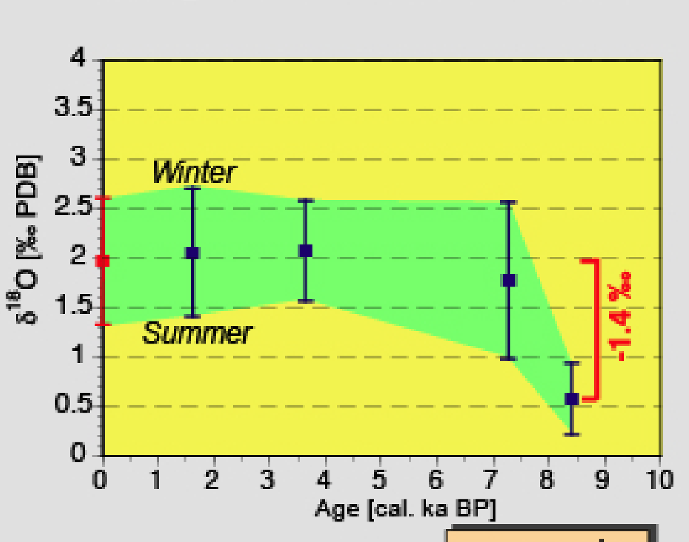
light $\delta^{18}O_{Bivalve}$ = freshwater input = summer

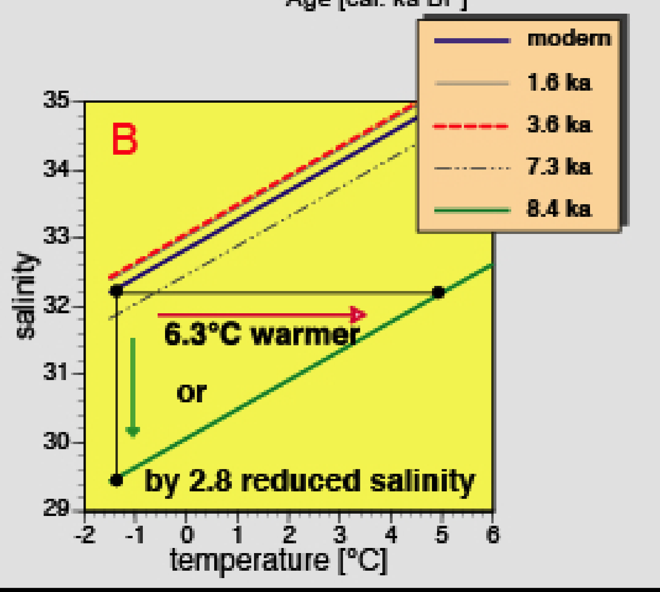
heavy $\delta^{18}O_{Bivalve}$ = no freshwater input = winter

Within-shell $\delta^{18}O$ variations are related to salinity and temperature changes. Becasue the bottom water temperature in the Laptev Sea remains relatively constant between -1,2 and -1,6°C and thus exerts a negligible influence on the oxygen isotope variations the main forcing factor of within-shell isotopic variations is the isotopic composition of the water and thus salinity.

Holocene Changes

Long-term reconstruction

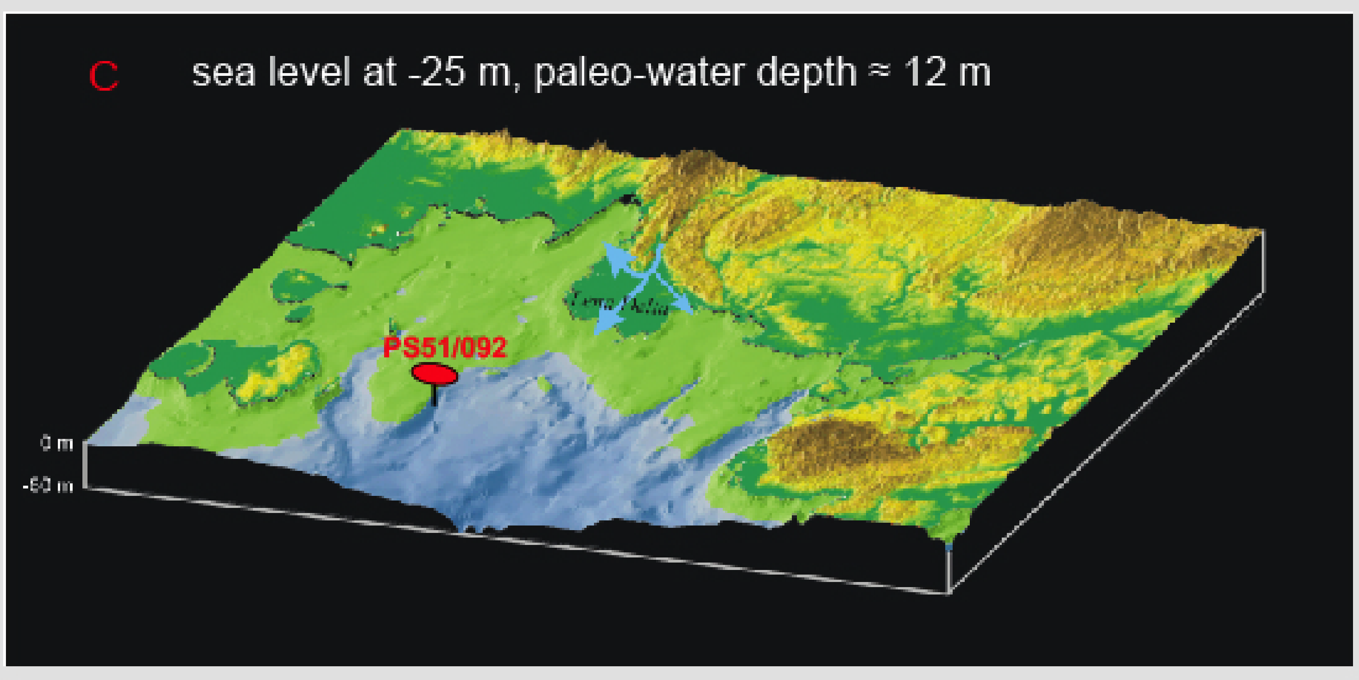




Given the usefulness of isotope profiles of modern bivalves for the reconstruction of salinity changes in the bottom water, fossil, radiocarbon-dated, bivalves from sediment core PS51/92-12 were analyzed. They show the hydrographical settings and changes during snap-shots of the transgressional history of the eastern Laptev Sea shelf.

Fig. A) shows the mean and the interannual range of the $\delta^{18}O$ signal in a modern (red) and four fossil bivalves. Comparing the modern mean $\delta^{18}O$ value with the mean at 8.4 ka an offset of -1,4‰ is recognizable. This difference is the effect of less saline and/or warmer bottom water at this site before 8400 years (Fig. B).

Scenario at 8.4 ka



According to the reconstruction of inundation of the Laptev Sea shelf (Bauch et al. 2001), sea level at 8.4 ka was about ~25 m lower than today. At that time site 92 was located close to the coastline and the bottom water was under the direct influence of warm and less saline riverine water.

References:
Mueller-Lupp T., Erlenkeuser H. and Bauch H.A. (2003), *Boreas*, 32 (2), 292-303.
Bauch H.A., Mueller-Lupp T. et al. (2001), *Global and Planetary Change*, 31 (1-4), 125-139.
Mueller-Lupp T., Bauch H.A. and Erlenkeuser H. (2004), *Quaternary Research*, 61 (1), 32-41.
Mueller-Lupp T. and Bauch H.A. (2005), *Global and Planetary Change*, 48 (1-3)179-190.

Acknowledgements
The study is part of the German-Russian Cooperation Project "Laptev-Sea System 2000". Research funds were provided by the German Ministry of Science and Technology.