Biogeosciences Discuss., 7, C1313–C1315, 2010
www.biogeosciences-discuss.net/7/C1313/2010/

Biogeosciences
Discussions

Interactive comment on "Hypoxia and cyanobacterial blooms are not natural features of the Baltic Sea" *by* L. Zillén and D. J. Conley

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Received and published: 8 June 2010

We do not neglect that physical forcing has an impact on the size of the hypoxic zone in the Baltic Sea. However, there are numerous of studies that focus on this topic. For example, it has been demonstrated that short-term trends in hypoxia during the modern era in the Baltic Sea are related to variations in salt water inflows from Kattegat, with less stratification and less hypoxia during "stagnation periods" (i.e. in the 1920/1930s, 1950/1960s and the 1980/1990s). During these "stagnation periods" the salt water inflows are reduced and the salinity of the Baltic Sea decreases by about 0.5 salinity units lower than the mean value (Meier & Kauker, 2003).

The aim of this manuscript is not to explore the physical forcing mechanisms on hypoxia but to put forward the hypothesis that humans may have impacted the Baltic

Sea environment on much longer time-scales than previously thought. We know that deforestation and agricultural expansion during the last two millennia has caused mobilization of nutrients through soil erosion and enhanced eutrophication of lakes in e.g. Sweden (Renberg et al. 2001), Denmark (Bradshaw et al. 2005) and Germany (Enters et al. 2006). Anthropogenic impacts have thus caused major shifts in freshwater systems in north Western Europe on much longer time-scales than just a few decades or centuries. If these systems were not pristine – how can hypoxia and cyanobacterial blooms in the Baltic Sea during the late Holocene be regarded as fully natural? We do agree that the estimates of organic N losses due to plowing new arable are more "guesstimates" rather than estimates. Some of these estimates will therefore be excluded in the revised manuscript and more effort will be invested to propose what could be done in the future to calculate more accurate and precise numbers.

In general the circulation in the Baltic Sea follows the topography in the basin. However, on top of this circulation there is a large variability due to surface wind-drift and stratification changes. There are at least two studies (Eiola & Stigebrandt, 1998; Nerheim & Stigebrandt, 2006) which shows a relative fast dispersion of tracer clouds, i.e. within a few months the tracer has spread from rivers in the north to the central and southern parts of the Baltic Proper. The pattern of spreading shows that much of the freshwater from the Gulfs of Bothnia and Finland passes the northwestern part of the Baltic proper, from where it spreads southward, in April and May mostly along the Swedish coast and later also along the east coast of Gotland in the middle of the Baltic Proper. This spreading pattern fits well with the spatial progress of the time for the start of the phytoplankton spring bloom (Eiola & Stigebrandt, 1998). Of course, parts of the nutrients are lost in the coastal zones, which utilize and processes nutrients from the watershed before they are transported to the open sea. In contrast, the lack of a nutrient source in a coastal area results in a net transport of nutrients from the open sea to the coast generating a negative load seen from a Baltic Sea perspective.

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Interactive comment on Biogeosciences Discuss., 7, 1783, 2010.