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Response of net community production to extreme meteorological conditions in spring/summer 2018

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The spring and summer period of 2018 has been recognized as a time of unpreceded meteorological conditions: severe droughts causing wildfires up to the Arctic range, close to maximum summer temperatures over parts of central and northern Europe, and integrated hours of sunshine during the productive period (March to August) up to 50% above the long-term mean. Over the central Baltic Sea, surface water temperatures were below average in late March, but then increased rapidly, caused by stable, calm and sunny conditions, resulting in late summer temperatures which are amongst the highest recorded so far.

These conditions had dramatic consequences on productivity in the central Baltic Sea, in particular with respect to the spring bloom, which becomes apparent by comparison with long-term observations.

The partial pressure of carbon dioxide (pCO_2) dropped down to 40μatm, and stayed below all earlier observations recorded on the ICOS VOS Finnmaid since 2003 over the period from mid April to mid July. Calculation of the inorganic carbon (DIC) removal in the surface layer reveals a dramatic drop in DIC, twice as high as usually observed. This is consistent with unusual high Chla concentrations and extremely high oxygen oversaturations of up to 170% in the surface layer in May, observed both on VOS Finnmaid and by an Argo Float deployed in the Baltic Sea since 2012. These data also show a strong restriction of the productivity to the upper layer ($\sim$10m). The excess productivity of the spring 2018 is mostly confined to the post-nitrate phase of the spring bloom, i.e. the period when inorganic nitrate is already depleted. However, results from HELCOM monitoring cruises in March, April and May suggest that the enhanced productivity in the surface layer was accompanied by a loss in inorganic nitrate down to 80m. A dominance of the late spring bloom phytoplankton by dinoflagellates (*Peridiniella catenata*) and, to a lesser extent, the ciliate *Mesodinium rubrum*, both reported to be able to migrate vertically through the water column, suggests vertical nutrient transport by the dominant autotrophic communities as the most likely explanation for these observations.

The hydrographical driver of the so far unprecedented productivity pattern appears to be the abrupt shoaling of the mixed layer from the halocline ($\sim$70m) to less than 20m over a period of less than 2 weeks due to extremely sunny and calm conditions, resulting in an unusual high unused nutrient pool below this depth after nitrate depletion in the surface layer. Later, during the summer period, the persistent high irradiation led to a prolonged cyanobacterial bloom, and in some areas, to the highest sea surface temperatures ever recorded.

Based on a combination of the data obtained on the VOS and by remote sensing, we assess the spatial extend of the unusual high spring surface productivity to be confined to the northern parts of the Baltic Proper, whereas the mid-summer cyanobacteria bloom covered almost the entire central Baltic Sea, reaching an areal extent of about 200.000km^2.