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Significance of the Autumn Bloom within the Seasonal Cycle of Primary Production in a Temperate Continental Shelf Sea

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Autumnal phytoplankton blooms are considered characteristic features of the seasonal cycle of primary productivity in most temperate and subpolar oceans. While observations of their occurrence and strength have been documented extensively, their significance within the seasonal cycle of primary production is not well quantified.

Our aim is to establish the role the autumn bloom plays within the seasonal cycle and estimate its contribution to the annual primary production of a temperate continental shelf. In particular, we will illustrate that the autumn bloom has the potential to be as productive as the well-studied summer sub-surface chlorophyll maximum (SCM) and the capacity to significantly contribute to the drawdown of atmospheric CO_2. We do this by combining long-term, high resolution observations of water column structure, meteorological forcing, nitrate and chlorophyll fluorescence over the entire seasonal cycle observed in a temperate shelf sea.

We present a new series of continuous measurements spanning 17 months (March 2014 - July 2015), which were collected in a temperate shelf sea on the North West European Shelf. A long-term mooring array recorded full depth vertical density structure, dynamics and meteorological data as well as surface chlorophyll fluorescence biomass and inorganic nutrient data over a full seasonal cycle at a station 120 km north-east from the continental shelf break. Eight process cruises supplied additional full depth profiles of chlorophyll fluorescence biomass and macronutrients.

The breakdown of stratification in 2014 commenced in early October due to increased winds compared to summer months, and a predominantly negative net heat flux (the ocean lost heat to the overlying atmosphere). Vertical mixing in autumn not only transformed the vertical density structure but also the vertical structure of chlorophyll biomass and surface nutrients. The SCM became eroded and instead a vertically homogeneous profile of chlorophyll biomass established itself above the pycnocline. This increased mixing also led to replenishment of surface nutrients and drove enhanced growth, which was almost 4 times stronger than observed during the summer months: We find an increase in depth integrated chlorophyll biomass of $\sim$50 mg m^{-2} in autumn 2014 compared to values of $\sim$20 mg m^{-2} during the summers of 2014 and 2015.