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Vertical nutrient fluxes, turbulence and the distribution of chlorophyll a in the north-eastern North Sea

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During summer the northern North Sea is characterized by nutrient rich bottom water masses and nutrient poor surface layers. This explains the distribution of chlorophyll a in the water column where a subsurface maximum, referred to as the deep chlorophyll maximum (DCM), often is present during the growth season. Vertical transport of nutrients between bottom water masses and the well lit surface layer stimulates phytoplankton growth and this generally explains the location of the DCM. However, a more specific understanding of the interplay between vertical transports, nutrient fluxes and phytoplankton abundance is required for identifying the nature of the vertical transport processes, e.g the role of advection versus vertical turbulent diffusion or the role of localized mixing associated with mesoscale eddies. We present results from the VERMIX study in the north-eastern North Sea where nutrients, chlorophyll a and turbulence profiles were measured along five north-south directed transects in July 2016. A high-resolution sampling program, with horizontal distances of 1-10 km between CTD-stations, resolved the horizontal gradients of chlorophyll a across the steep bottom slope from the relatively shallow central North Sea ($\sim$50-80 m) towards the deep Norwegian Trench (>700 m). Low oxygen concentrations in the bottom water masses above the slope indicated enhanced biological production where vertical mixing would stimulate phytoplankton growth around the DCM. Measurements of variable fluorescence (Fv/Fm) showed elevated values in the DCM which demonstrates a higher potential for electron transport in the Photosystem II in the phytoplankton cells, i.e. an indication of nutrient-rich conditions favorable for phytoplankton production. Profiles of the vertical shear and microstructure of temperature and salinity were measured by a VMP-250 turbulence profiler and the vertical diffusion of nutrients was calculated from the estimated vertical turbulent diffusivity and the distributions of nutrients. Results from the five transects and two time-series stations, where vertical profiles were made at hourly intervals, showed that vertical mixing processes above the slope increased the vertical transport of nutrients significantly and mixing above the slope can explain the hydrographic features and the distribution of the DCM in the area.