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Simulating trends in 1970-2006 North Sea primary production with ECOHAM4

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Spatial and temporal patterns in annual primary production of the NW European shelf seas from 1970 to 2006 were simulated and especially analyzed for the North Sea (511.725 km2) according to driving mechanisms of North Atlantic inflow, sea surface temperature change, river nutrient loads and solar radiation patterns (NCEP). The three-dimensional coupled physical-biogeochemical model ECOHAM4 (Ecosystem Model, Hamburg, Version4) was applied to the Northwest European Shelf (47° 41' – 63° 53' N, 15° 5' W – 13° 55' E) for the years 1970 – 2006. The model forcing for this long-term simulation consists of annual atmospheric nitrogen deposition, monthly resolved carbon and nutrient concentrations at the open boundaries, daily river loads of nutrient and carbon species, and hourly resolved solar radiation. An extensive model validation of the hindcast was focussed on the annual nutrient and plankton cycles of different regions including the vertical resolution for a single year 2002 and 5-year blocks of observation. The regional production will be discussed according to observations tabulated regionally from the literature and comparison to other models (according to the OSPAR study).

For each year carbon and nitrogen budgets were calculated including the external transports and all internal process contributions, especially carbon production, nitroge-uptake and excess production. The North Sea primary production varies from 8.470 Gmol C yr-1 in 1996 to 10.100 Gmol C yr-1 in 1988. As a main driver for the annual production variability the nitrate river loads turned out. In the long-term trend analysis five maximum years correlate with the maximum annual nitrate loads in 1982, 1988, 1994, 1999, and 2003. There is a regional difference between the mean annual primary production of the southern North Sea with 236 gC m-2 yr-1 and that of the northern North Sea with 195 gC m-2 yr-1. The regions are separated mainly by the 50m depth contour. A possible correlation between river loadings and the non-diatom versus diatom production, as well as other drivers of climate variability as sea surface temperature, stratification, solar radiation, and inflow patterns were discussed.