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A revised carbon budget for the North Sea

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The 3-d coupled physical-biogeochemical model ECOHAM was applied to the Northwest European Shelf (47° 41‘ – 63° 53’ N, 15° 5’ W – 13° 55’ E) for the years 1993 – 1996. Carbon budgets were calculated for the years 1995 and 1996 for the inner shelf region, the North Sea (511,725 km2). The mid-nineties were chosen because they exhibit a shift from a very high North Atlantic Oscillation Index (NAOI) in winter, 1994/95, to an extremely low (negative) one in winter, 1995/96, with consequences for the North Sea system: During the first half of 1996, the observed mean SST was about 1° C lower than in 1995; in the southern part of the North Sea the difference was even larger. These observations could be reproduced by the model. Due to a different wind regime, the normally prevailing anti-clockwise circulation, also found in winter 1995, was replaced by more complicated patterns in winter 1996. Decreased precipitation over the drainage area of the continental rivers led to a reduction in the total (inorganic + organic) riverine carbon load to the North Sea from 476 Gmol C yr-1 in 1995 to 340 Gmol C yr-1 in 1996. In addition to these high loadings the North Sea took up 230 (1995) or 120 (1996) Gmol C yr-1 of CO2 from the atmosphere. Thus, the North Sea is a moderate sink for atmospheric CO2, with 0.45 and 0.23 mol C m-2 yr-1 for the two years. These results were obtained with boundary conditions which were derived from a climatological data set.

In a new simulation-run the boundary conditions were extracted year by year from a multi-decadal simulation of the global REMO-MPIOM-HAMOCC model of the Max-Planck-Institute of Meteorology in Hamburg. The results of the shelf model ECOHAM now exhibit much larger carbon fluxes than those driven with climatological boundary conditions: For 1995 the atmospheric CO2 uptake was as large as 1380 Gmol C yr-1 (̃2.7 mol C m-2 yr-1). These model results suggest the North Sea to be a strong sink for atmospheric CO2.