Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07604, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07604
EGU General Assembly 2008

Review of three-dimensional biogeochemical/ecological modelling of a coastal region

A. Moll, J. Pätsch and W. Kühn

Institut für Meereskunde (IfM), Universität Hamburg (ZMAW), Bundesstr. 53, D-20146 Hamburg, Germany (moll@ifm.uni-hamburg.de)

The state-of-the-art in modelling the marine ecosystem of the greater North Sea (North-east Atlantic: 47°-62°N and 12°W - 12°E) is reviewed, providing an overview especially about three-dimensional models that describe and predict how the marine ecosystem of the greater North Sea functions and how concentrations and fluxes of biologically important elements vary in space and time, throughout the shelf and over years, in response to physical forcing. Three-dimensional models will be presented, characterizing the complexity of the models, by comparing their resolution in time and space, and the resolution of the trophic structure by discussing the number and kind of state variables and of the processes relating these state variables to each other. Important findings by model simulations have either confirmed existing knowledge derived from field work or have given new insight into the functioning of the North Sea system in shallow and deep areas: the temporal and spatial development and magnitude of primary production, its spreading from the coasts to the north-west over the open North Sea, its mechanisms of limitation, the functioning of the pelagic small food web and of the benthic web, the mechanisms of nutrient regeneration, the effects of riverine and atmospheric nutrient inputs causing eutrophication of coastal waters, the extent of eutrophication in the North Sea, and the budgets for nitrogen, phosphorus, and silicon. The models have provided consistent distributions and dynamics of the lower trophic levels on their regional, annual and decadal scales which cannot be derived to this degree of coverage by observations. The state-of-the-art in validation of these models shows that several of the models were able to reproduce observations of the state variables correctly within an order of magnitude, but all models are not capable of

reproducing every simulated state variable in the range of observations. Comparison of results from different models with datasets is evaluated according to the different spatial and temporal scales, for which data were available, namely for regional distributions, annual cycles, long-term developments and events. The higher the trophic level the greater was the discrepancy with the data. Problems still exist in determining the necessary complexity of the model ecosystem. More complexity in the model does not necessarily improve the simulations. Most of the models still need to be evaluated more intensively for their predictive potential to be judged. They have not yet been tested to a degree which is possible today using the various existing datasets from the northwest European shelf seas. Common datasets for the necessary annual cycles of forcing functions are needed. Four examples from the Northwest European Shelf (mainly the North Sea) depict the impact of external exchange across boundaries using the model system ECOHAM. First the question "Is the North Sea a source or a sink of nitrogen for the adjacent North Atlantic" will be investigated using a nitrogen budget (including the Ocean-Shelf Exchange) for the years 1995/1996. Under certain meteorological conditions the source of dissolved inorganic nitrogen can transmute into a sink. The second example covers Atmosphere-Ocean Exchange of nitrogen and carbon. Benthic denitrification causes the export of di-nitrogen into the atmosphere while the largest import represents the atmospheric deposition of oxidised and reduced nitrogen compounds. Biologically linked with these nutrient-related fluxes is the air-sea exchange of CO2, one of the essential mechanisms of the carbon shelf pump. The third example concerns the Land-to-Ocean Flux of water, carbon and nutrients in terms of continental river loads and their effects. These sources exhibit high interannual and seasonal variability which could not be fully explained until now. Water-Sediment Exchange is the last example. A high-resolution early-diagenesis model for the North Sea sediments has been coupled with ECOHAM to quantify the processes in the coupled sediment-water system from the sea surface to a sediment depth of 11 cm focussing on the processes in the sediments of the North Sea. With the coupled model the daily benthic fluxes of POC, oxygen, nitrate, phosphate, and sulphate at the sediment-water interface for the whole North Sea area have been determined.