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The truth is out there: measured, calculated and modelled benthic fluxes.

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In a modern Earth science there is a great importance of understanding the processes, forming the benthic fluxes as one of element sources or sinks to or from the water body, which affects the elements balance in the water system. There are several ways to assess benthic fluxes and here we try to compare the results obtained by chamber experiments, calculated from porewater distributions and simulated with model.

Benthic fluxes of dissolved elements (oxygen, nitrogen species, phosphate, silicate, alkalinity, iron and manganese species) were studied in the Baltic and Black Seas from 2000 to 2005. Fluxes were measured in situ using chamber incubations (Jch) and at the same time sediment cores were collected to assess the porewater distribution at different depths to calculate diffusive fluxes (Jpw). Model study was carried out with benthic-pelagic biogeochemical model BROM (O-N-P-Si-C-S-Mn-Fe redox model). It was applied to simulate biogeochemical structure of the water column and upper sediment and to assess the vertical fluxes (Jmd).

By the behaviour at the water-sediment interface all studied elements can be divided into three groups: (1) elements which benthic fluxes are determined by the concentrations gradient only (Si, Mn), (2) elements which fluxes depend on redox conditions in the bottom water (Fe, PO4, NH4), and (3) elements which fluxes are strongly connected with organic matter fate (O_2, Alk, NH4). For the first group it was found that measured fluxes are always higher than calculated diffusive fluxes ($1.5<Jch/Jpw<5$) that could indicate undervaluation of total flux. In this case bioturbation, bioirrigation and advection should be taken into account. For the second group measured fluxes can be both much lower (practically absent) and much higher than calculated diffusive fluxes ($0.01<Jch/Jpw<100$). It means that at changing redox conditions some processes in the bottom water and/or on the sediment surface (oxidation, adsorption, particles dissolution, etc.) are faster than diffusion and play an important role in the benthic flux formation for these elements. For the third group measured fluxes could be often overestimated, especially for coastal shallow stations, up to 50%, because of intensive decomposition of OM and/or organisms respiration in the isolated bottom water.

Values of benthic fluxes obtained by the BROM model are within the range of magnitudes measured by chamber experiments and calculated from porewater distributions ($Jpw < Jmd < Jch$). Using the model it is possible estimate the influence of bioturbation on elements exchange at water-sediment interface. Model has a high resolution in the upper sediment (0.1 mm) that gives the advantage of a more accurate calculation of diffusive fluxes especially for redox dependent elements. Model results showed that in 50 cm above the sediment vertical fluxes are changing largely while in chamber experiments they are averaged.

As a result, each of the methods has its disadvantages and the main facing us question is – which value should be taken for calculation the balance?

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