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Influence of oceanic biota on carbon dioxide flux at atmosphere-ocean interface

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In this study, starting with model of Nefedova and Tarko [1995], we investigate the carbon cycle dynamics using mathematical modelling. In our model [Glushkov *et al.*, 2003], the CO₂ global turnover of the ocean (its surface is ice-free) is divided into 28 latitudinal belts with 5° width. The typical vertical ocean stratification includes: a) the upper quasi-uniform (or mixed) layer (UQL), b) the layer of temperature's sudden change (seasonal thermocline), c) the main thermocline, and d) the deep-sea layer (DL). It is supposed that the water between 40 S and 40 N goes slowly up and at the high latitudes goes slowly down; the water movement is from equator to pole in the UQL and has reverse direction in the DL. The vertically uniform atmosphere is divided into same zones as the ocean. The model variables are the molar concentration of non-organic carbon in each ocean block and carbon content as CO₂ in each atmospheric zone. The model time step is one month.

The seasonal dynamics of global carbon cycle is described with system of 112 non-linear common differential equations. The model considers the activity of ocean biota as both the rate of organic substance production in the UQL and the rate of organic substance decay in the UQL, thermocline, and DL. The system of equations is numerically integrated using the four-order Runge-Kutta method with prescribed initial conditions.

Our main results are follows. First, the maximal partial pressure of carbon dioxide dissolved in the UQL is registered at equator whereas the minimal values of this variable are observed at the polar ocean, where, moreover, the strongly pronounced annual variations occur. Other essential distinction of polar ocean consists in the largest differences between the results obtained with and without taking into account the oceanic biota. Next, the tropical ocean is the source of CO₂ for the atmosphere whereas in the polar regions the carbon dioxide flows from the atmosphere into the ocean. At that, owing to the oceanic the carbon dioxide exchange at the atmosphere-ocean interface increase somewhat towards the flux from the atmosphere. Finally, our model estimation of the adaptation time on the human economic activities for global climate system show that if the ocean biota is taken into account, this time may be significantly decreased.

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