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Heterotrophic bacterioplankton control on organic and inorganic carbon cycle in stratified and non-stratified lakes of NW Russia

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Lakes of boreal zone regulate the fate of dissolved carbon, nutrients and trace metals during their transport from the watershed to the ocean. Study of primary production – mineralization processes in the context of carbon biogeochemical cycle allows determination of the rate and mechanisms of phytoplankton biomass production and its degradation via aquatic heterotrophic bacteria. In particular, comparative study of vertical distribution of Dissolved Organic Carbon (DOC) in stratified and non-stratified lakes allows establishing the link between biological and chemical aspects of the carbon cycle which, in turns, determines an environmental stability and recovering potential of the entire ecosystem.

In order to better understand the biogeochemical mechanisms that control dissolved organic and inorganic carbon migration in surface boreal waters, we studied in 2007-2009 two strongly stratified lakes (15-20 m deep) and two shallow lakes (2-4 m deep) in the Arkhangelsk region (NW Russia, White Sea basin). We conducted natural experiments of the lake water incubation for measurements of the intensity of production/mineralization processes and we determined vertical concentration of DOC during four basic hydrological seasons (winter and summer stratification, and spring and autumn lake overturn). Our seasonal studies of production/mineralization processes demonstrated high intensity of organic matter formation during summer period and significant retard of these processes during winter stagnation. During spring period, there is a strong increase of bacterial destruction of the allochtonous organic matter that is being delivered to the lake via terrigenous input. During autumn overturn, there is a decrease of the activity of phytoplankton, and the degradation of dead biomass by active bacterial community. Organic matter destruction processes are the most active in Svyatoe lake, whereas in the Beloe lake, the rate of organic matter production is significantly higher than its bacterial degradation, and in the Maselgskoe lake the aerobic mineralization plays insignificant role. Seasonally-stratified lake Svyatoe demonstrates systematic decrease of DOC concentration from the surface to the bottom horizon during summer and winter stagnation, whereas lake Maselgskoe exhibits an increase of DOC in the bottom horizons during winter stratification. During the autumn and spring overturn, we observe rather constant concentration of DOC due to well mixing of the water masses and low activity of the phytoplankton community. Results of the present work allow the evaluation of biotic and abitioc components of the biogeochemical cycle of carbon in small stratified and non-stratified lakes of the Arctic Ocean basin. They allow quantification of the direct link between the processes of primary production/heterotrophic bacteria mineralization and vertical profile of organic and inorganic carbon concentration.