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On the connection among components of carbon cycling and water mass parameters in the East Siberian Arctic Shelf: The First Quantitative Assessment.

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The East Siberian Arctic Shelf (ESAS), the widest and shallowest ocean shelf in the world, is an important region for producing and processing organic matter before the material is transported into the Arctic Ocean. Up to 100% of the total organic carbon (TOC) in the ESAS surface sediments is terrestrial by origin (TOCterr). TOCterr flux in the ESAS integrates riverine and coastal erosion signals, transforming TOCterr to carbon dioxide and other components within the land-shelf-atmosphere system. Degradation of eroded organic carbon produces a decrease in values of pH (causing ocean acidification) and dissolved oxygen, while producing an increase in the partial pressure of carbon dioxide (pCO2), total CO2 (TCO2), and nutrients (Semiletov, 1999; Semiletov et al., 2007; Anderson et al., 2009). Ongoing warming causes thawing of the permafrost underlying a majority of arctic river watersheds and more than 80% of the ESAS area; this process could accelerate river discharge, carbon losses from soils, involvement of old carbon in the modern carbon cycle, and the mobilization of previously-originated methane (CH4) that is currently stored within seabed deposits (Shakhova and Semiletov, 2009). Given current and predicted dramatic Arctic climate changes, baseline measurements are critical to elucidating Arctic carbon cycle feedback processes, predicting climate response, and understanding the likely ecological changes in the oligotrophic ESAS under future warmer (ice-free) climate scenarios. Here we present the first quantitative assessment of the connection among the components of carbon cycling and water mass parameters in the ESAS. Our results are based on a complex biogeochemical study performed by our group during 1997-2007. A strong regional correlation ($\sim$0.96) was found between the dissolved organic carbon (DOC) concentration and colored dissolved organic matter (CDOM) fluorescence measured in situ using the WETStar fluorometer, and between the "filtered" particulate material (PM) and the turbidity ($\sim$0.95) measured in situ using the OBS-3. These correlations allow us to accurately calculate DOC and PM distributions and their dynamics in the ESAS over recent years. We have found a correlation between the integrated storage (calculated according Shakhova et al., 2005) of components of the carbon cycle (dissolved CO2, CH4, dissolved inorganic carbon (DIC), DOC) and water mass parameters (salinity, PM concentration, and others) in the summer of 2003 vs. 2004 in connection with the atmospheric circulation patterns. We have found that both CO2 and PM integrated storage were increased in 2004 vs. 2003, while the integrated salinity and DIC were decreased; these results indicate an increase in the fresh water (FW) burden and probably in rates of coastal erosion (assuming the "erosional" origin of PM). In different years a significant correlation was found among values of DOC and POC vs. salinity, pCO2 vs. DOC/CDOM, and other parameters. We have shown that CDOM can be used as a conservative tracer to follow the transport and fate of FW across the Arctic shelf through a combination of remote sensing and field observations. That complex approach can be used to quantitatively monitor the overall changes in the ESAS; the ESAS integrates changing FW and geochemical response throughout the vast Siberian watersheds.

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