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Terrestrial organic carbon in the Arctic East Siberian land-shelf system

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The continental shelf of the East Siberia Sea (ESS) is the widest and shallowest in the World Ocean, yet it is the least explored.. The wide shelf acts as an important region for production and processing of organic matter before the material is transported into the Arctic Ocean. We focus our attention on the coastal zone, where processes of interaction between the local shelf waters (influenced strongly by fluvial and coastal erosion input) and Pacific-derived waters are most pronounced. These are among the first reliable hydrological and geochemical data reported for the ESS from the Dmitry Laptev Strait to the Long Strait, and they reveal novel insights about interaction between Pacific water and local shelf water. Using both historical water data and data from our cruises (2000, 2003, 2004), we divide the ESS into two specific areas: the *Western area*, influenced strongly by Lena River input, and the *Eastern area*, under direct influence of Pacific-derived water. We also used the stable $\delta^{13}C_{org}$ and $\delta^{15}N_{org}$ isotopes to detect the sediment geochemical boundary (or "*geochemical* FZ") between Pacific "marine-derived sediments" and "terrestrial derived sediments" which can be considered to reflect the long-term (on a scale of 10^2years) position of the most westward extension of Pacific water. It is supposed that the cyclonic circulation regime (using definition by Proshutinsky and Johnson, 1993) dominated on a scale of hundreds of years, while over the last 50-70 years the anti-cyclonic mode of circulation has dominated. The spatial *trends of $\delta^{13}C_{org}$ in the bottom sediment can be used to quantitatively estimate the contribution of terrestrial organic matter* (CTOM) to the ESS sediment west and east of the geochemical FZ. Following Walsh at al. (1989), the amount of OC derived from terrestrial end-member $\delta^{13}C_{ter}$ (terrestrial C) can be calculated from the data as

CTOM (%) = (δ^{13}Ño - $\delta^{13}\tilde{N}_{mar}$) x 100 / ($\delta^{13}\tilde{N}_{ter} - \delta^{13}\tilde{N}_{mar}$),

where “o”, “mar”, and “ter” refer to the ?^{13}C values of observed, marine, and terrestrial sediment. If we take the two end members to be a $\delta^{13}\tilde{N}_{ter}$ of -27, typical of higher plants, and a $\delta^{13}\tilde{N}_{mar}$ of –21, typical of phytoplankton. Calculations indicate that there is a significant amount of terrestrial OC stored within sediments, especially in the near shore zone most strongly influenced by coastal erosion: between the Dmitry Laptev Strait and the Kolyma mouth, the OC is almost all of terrestrial origin (from 81% to 100%, mean CTOM = 93%). In contrast, the sediments underneath transformed Pacific – origin water (the Eastern area) are almost half of marine origin.

Eroded carbon vs riverine carbon. Geochemical survey made along the Lena river stream in different summer months of 1998, 1999, and 2003 shows that a major portion of particulate material (PM) is settled down in the delta channels. The Quartz/Feldspar (Q/FS) ratios in the Western and Eastern ESS areas are the same (Q/FS=0.26), while the Q/FS ratios typical for the Lena solid discharge are 10 times higher; Q/FS ratios range between 2 and 2.3. This evidence indicates a hitherto *neglected direct influence of Lena transport of PM into the ESS.* The PM data obtained in the Dmitry Laptev Strait where the river PM signal is negligible show that “new production” is formed from the old terrigenous carbon with a typical terrestrial signal of $\delta^{13}\tilde{N}_{ter} < $ -26.5. Thus the river OM discharge has probably no direct influence on marine productivity, while coastal erosion and consequent degradation of “fresh” old terrestrial organics play a significant role in biogeochemical processes especially in the Western area of the East-Siberian Sea where coastal retreat is highest. *Significant amount of old eroded carbon is transformed in CO_2form while it is traveling across the tidal/surge zone*. This statement is supported by recent (September 2006) direct measurements of CO_2 efflux into the atmosphere across the highly eroded Muostakh Island (Laptev Sea) including the coastal zone