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Remobilization and degradation of Myostah Island (Laptev Sea), as part of the collapsing Arctic coastal ice complex

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The Eurasian Arctic, and particularly the East-Siberian Arctic Shelves (ESAS; Laptev, East Siberian and Chuckchi Seas), is expected to be one of the most sensitive ecosystems for global warming effects on large-scale C dynamics. The main reason is that climate models forecast the largest warming trends on Earth for the Eurasian Arctic with 4-7 ºC increases by the end of the 21^{st} century [1]. Besides, it is estimated that about 45% of the global terrestrial detrital C pool is held in the pan-Artic taiga and tundra as soil and peat, much in permafrost, alone matching the total amount held as CO_2 in the atmosphere [2]. Furthermore, the drainage basins of the Arctic rivers store large amounts of organic matter (OM), accounting for 25-33% or the entire global soil reservoir of OM [3].

Hence, the ESAS may be particularly sensitive to global warming effects on large-scale C dynamics. However, there is a paucity of detailed studies on C processes particularly in the dynamic land-ocean interface region of the ESAS. The few available assessments suggest, based on very little data, that coastal erosion is delivering as much OC to the ESAS as all the great Russian-Arctic rivers combined [4, 5]. However, presently there is no information about the fate of the OM derived from coastal erosion once it enters the shelf [5].

Accelerated coastal erosion of what is believed to be Pleistocene Ice Complexes is brought on by a combination of thermal collapse, sea-level rise and enhanced wave fetch from loss of coastal sea-ice cover [2, 5]. One of the most significant examples of this destructive geological process in the ESAS is Myostah Island, located in the SE Laptev Sea. The erosion evolution of this island has been observed over the past decade by Dr. Semiletov´s group, which has estimated a retreat rate up to 20m during a few summer days.

This investigation focuses on remobilization of OM from massive coastal erosion in the ESAS, seeking to address whether the eroded old C is subject to degradation. To this end, samples from Myostah Island collected in 2006 along several "erosion transects", spanning relieves with ranges of approximately 25 m from the shallow active peat layer on the plateau to the relief bottom near the sea surface. Dried, ground and decarbonated samples were subjected to TOC and ^{14}C quantification. Automatic lid chambers (Licor 8100) were used to estimate CO_2 fluxes on-site, at different locations on and around the island. Samples are also being analyzed for molecular-level compositional indications of degradation status.

Preliminary results registered larger CO_2 fluxes on the island soil and nearby shallow waters (close to 5 μM m^{-2} sec^{-1}), compared to those measured on the Sphagnum dominated tundra at the continental coast (0.1-1.1 μM m^{-2} sec^{-1}), indicating biodegradation of thawing-eroding coastal ice complex. The presence of older OC in the lower parts of the island (F_m as low as 0.01) suggests that nearly fossil C forms (>35,000 years) could be remobilized and thus bioavailable to be degraded to CO_2. Given the higher exposure of the lower sites of the island to the wave impact and coastal erosion, the OC remobilization is facilitated, making it potentially available for biodegradation. This would mean that as a consequence of the global warming, old forms of C stored for thousands of years, could be reintroduced in the short-term C cycle, producing greenhouse C forms, which in turn would trigger further temperature increase.

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