Geophysical Research Abstracts
Vol. 14, EGU2012-8375-1, 2012
EGU General Assembly 2012

Remobilization of old carbon from coastal and subsea permafrost in the Siberian Arctic

J. E. Vonk (1), L. Sánchez-García (1), B. E. van Dongen (1), V. Alling (1), D. Kosmach (2), A. Charkin (2), I. P. Semiletov (2,3), O. V. Dudarev (2), N. Shakhova (2,3), P. Roos (4), T. I. Eglinton (5), A. Andersson (1), and Ö. Gustafsson (1)

(1) Department of Applied Environmental Science (ITM) and the Bert Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden, (2) Pacific Oceanological Institute, Russian Academy of Sciences, Vladivostok, Russia, (3) International Arctic Research Center, University of Alaska, Fairbanks, USA, (4) Risø National Laboratory for Sustainable Energy, Roskilde, Denmark, (5) Geological Institute, ETH-Zürich, Zürich, Switzerland

Destabilization of permafrost is one of the few mechanisms that can redistribute significant amounts of carbon among the Earth's reservoirs within this century, contributing to the build-up of greenhouse gases and potentially enhancing global warming. Ancient Ice Complex (IC) deposits in the Siberian Arctic and shallow subsea permafrost on the East Siberian Arctic Shelf (ESAS) are two large pools of permafrost carbon, yet their vulnerabilities toward thawing and decomposition are scarcely investigated. Recent Arctic warming is stronger than predicted by several degrees, and is specifically pronounced over the coastal ESAS region. This makes it particularly urgent to improve our understanding of permafrost carbon-climate links in this relatively inaccessible region.

To evaluate the role of ancient IC permafrost carbon in the contemporary ESAS carbon cycle, we adopted an inverse approach based on deducing the contribution of IC deposits to carbon accumulating on the wide ESAS shelf. Based on extensive ship-based expeditions on this region, >200 sediments were analyzed to obtain a shelf-wide coverage. A dual-carbon isotopic (δ13C and Δ14C) mixing model, solved with a Monte Carlo simulation strategy to account for end-member uncertainties, was applied to solve the relative contributions from IC, plankton detritus and a riverborne terrestrial component. The fractional contribution from IC deposits was then combined with the radiochronologically-constrained sediment accumulation flux to derive the shelf-wide re-sequestration flux of old carbon from permafrost. Furthermore, to evaluate the degradation prior to delivery into coastal waters, we performed an investigation along coastal slopes of Muostakh, an island in the southeastern Laptev Sea that is disappearing due to erosion of up to 20 m per year. Bulk carbon contents, as well as molecular and isotopic compositions of IC-OC were assessed in conjunction with in situ CO_2 evasion fluxes to evaluate the degradation prior to delivery into coastal waters.

Here we show that carbon is extensively released from these IC deposits of the ESAS, with ca. 65% escaping to the atmosphere as CO_2 and the rest being re-sequestered in shelf sediments. Our modeled, dual-carbon isotopic approach suggests that 43$\pm$10 Tg of old carbon is activated annually from coastal permafrost, an order of magnitude higher than previous studies. Thermal collapse and erosion of these carbon-rich Pleistocene coastline and seafloor deposits may accelerate with Arctic amplification of climate warming.