Carbon release from collapsing coastal permafrost in Arctic Siberia

August 30 2012

In this week's issue of *Nature* a study lead by Stockholm University, with collaborators from Russia, US, UK, Switzerland, Norway, Spain and Denmark, show that an ancient and large carbon pool held in a less-studied form of permafrost ("Yedoma") is thaw-released along the ~ 7000 kilometer desolate coast of northernmost Siberian Arctic.

The team found that the tens-of-thousands year old Yedoma carbon is rapidly converted to CO2 and that ten times more Yedoma carbon is released to the Arctic Ocean than previously estimated. Thermal collapse of the carbon-rich, permafrost-covered coasts may accelerate with warming of the Arctic climate.

Release to the atmosphere of carbon dioxide from thawing permafrost in the Arctic is identified as a positive feedback mechanism to climate warming. About half of the carbon pool in soils globally is held in frozen surficial permafrost in the Arctic (twice as much as in atmospheric CO2); the region is experiencing twice the global average of climate warming .

"Coastal Yedoma is likely more vulnerable towards carbon release than other permafrost bodies as it is not only subject to thermal collapse from above but also to enhanced wave and wind erosion of the Yedoma-dominated coast brought on by sea-level rise and longer ice-free seasons," explains Örjan Gustafsson, professor of biogeochemistry at Stockholm University and co-leader of the team with Igor Semiletov of the University of Alaska, Fairbanks and the Russian Academy of

Sciences.

The carbon-rich Ice-Complex permafrost structures (Yedoma) – rising along this Arctic coast are relict soils from the latest Ice Age, covering ~1 million km^2 (twice the area of Sweden). While satellite images reveal 1000s of kilometers of milky-cloudy waters along the Arctic coast, the Yedoma has remained understudied largely due to the region's inaccessibility.

Detailed chemical characterization of thaw-eroding Yedoma slopes of a disappearing island in SE Laptev Sea suggested rapid conversion of the old soils to carbon dioxide even before being washed into the sea. The compositional fingerprint of old organic carbon (7,000 to 10,000 years) found in marine bottom sediments revealed that erosional input from ancient coastal Yedoma was the dominant source of carbon, overwhelming input from marine sources and river-carried debris from inland vegetation and soils, on this, the World's largest coastal shelf sea.

While the present rate of carbon release from the NE Siberian coast is not substantially affecting the CO2 levels in the global atmosphere, the study, jointly lead-authored by Stockholm University PhD student Jorien Vonk (now at ETH-Zürich, Switzerland) and post-doc fellow Laura Sanchez (now at the Catalan Institute of Climate Sciences), demonstrates that the process is firmly underway.

This study adds to previous reports on extensive methane releases from collapsing subsea permafrost on the East Siberian Arctic Shelf (ESAS) published by the team. "In order to project the future trajectory of greenhouse gases in the atmosphere, it is important to study the interaction of a warming climate and releases from the enormous carbon pools held in coastal and subsea permafrost, as well as in methane hydrates, on the ESAS," says Gustafsson.

Thermal collapse and erosion of old permafrost masses along the 20-30 m steep and desolate Arctic coastline is an impressive phenomenon that is vividly illustrated in available images.

Provided by Stockholm University