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Trace Gas Flux Measurements on Samoylov Island, Lena Delta

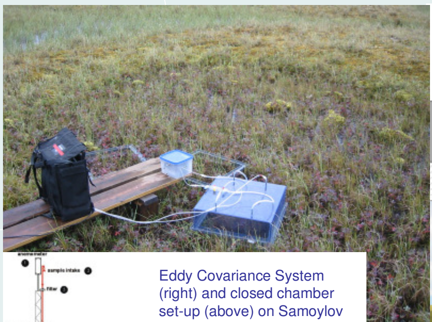
Introduction

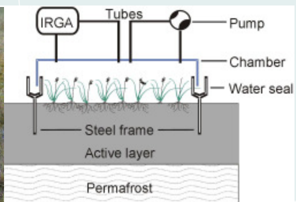
Arctic tundra ecosystems have been major carbon sinks throughout the Holocene. However, during the past decades high latitude environments have been observed to warm faster and to a greater extend than lower latitudes. It remains unclear whether this warming trend will cause tundra ecosystems to become a net carbon source or whether changes in the ecosystems, such as adaptation of microbial and plant communities and increased biomass production, will offset possible increased carbon emissions. In order to investigate and address this uncertainty, landscape scale measurements of carbon exchange are necessary in different arctic ecosystems.

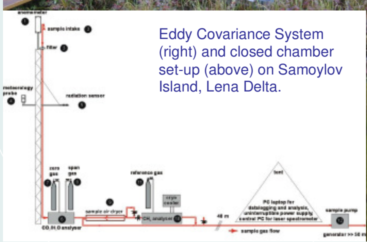
Above: Ice complex cliff in the Lena Delta; Right: Polygon breaking off Samoylov Island after ice wedge thawing, summer 2005.

Eddy Covariance and Chamber Measurements

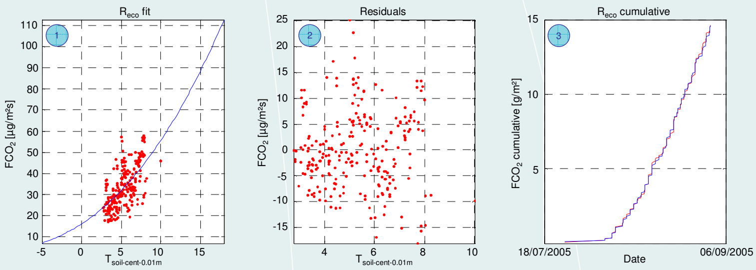
Within the joint Russian-German project "System Laptev Sea 2000" eddy covariance measurements of carbon dioxide, methane, and energy exchange were carried out during a period of 41 days in 2005 in northern Siberian wet polygonal tundra. For detailed understanding of the underlying biological and soil-physical processes, closed chamber flux measurements of both carbon dioxide and methane were also conducted during the same period. The study site was located in the zone of continuous permafrost on Samoylov Island in the southern part of the Lena River Delta. The area is characterized by arctic continental climate with very low temperatures and low precipitation. The mean annual temperature is -10.2℃ and the mean annual precipitation is 140 mm. Here, we present the first results from eddy covariance data.







Eddy Covariance System (right) and closed chamber set-up (above) on Samoylov Island, Lena Delta.



Empirical model for ecosystem respiration R_{eco} (PAR≤10µmol/m²s; R^2=0.39):

① Soil temperature in the polygon center at 0.01m depth fitted against ecosystem respiration R_{eco}.

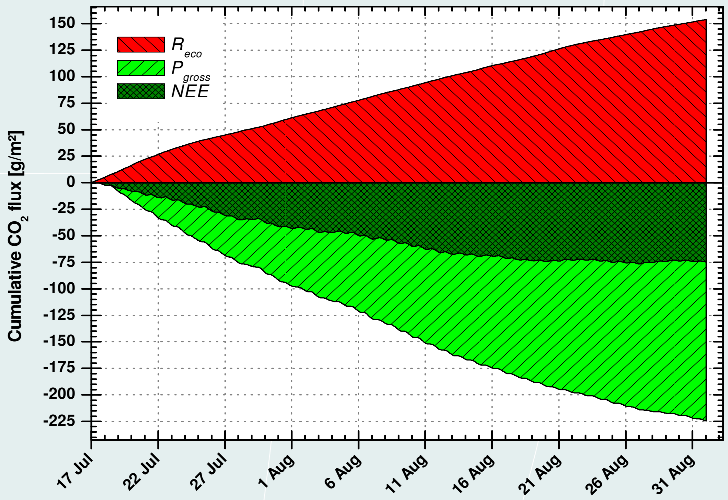
② Residuals

③ Cumulative R_{eco} (red = measured data; blue = modeled data)

First Results

Photosynthetically active radiation *PAR* and soil temperature $T_{soil\text{-}0.01}$ at 0.01 m depth were identified as the most important meteorological controls on carbon dioxide fluxes. Ecosystem respiration R_{eco} and canopy gross photosynthesis P_{gross} were estimated by empirical models derived from eddy covariance data.

The wet polygonal tundra on Samoylov Island was a net carbon dioxide sink during the measurement period in 2005. Total cumulative ecosystem respiration R_{eco} was estimated by the empirical model shown above to be 154 g/m². P_{gross} was estimated to be -225 g/m², and measured total cumulative *NEE* was -75 g/m².



Cumulative curves of CO_2 budget components during the measurement period in 2005. *NEE* is overlaid on R_{eco} and P_{gross}.

Outlook

In the next step we will identify predictors of methane fluxes in order to develop a model for gap-filling the CH_4 time series. Once total methane emissions have been determined, eddy covariance data will be compared to chamber-based flux data.

For seasonal carbon balance determination, the 2006 field season will include the entire growing period on Samoylov Island.

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