Diagnosis and Prognosis of Changes in Lake and Wetland Extent on the Regional Carbon Balance of Northern Eurasia

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Overarching Science Question:

How have changes in lake and wetland extent in northern Eurasia over the last half-century affected the region's carbon balance, and how are changes in lakes and wetlands over the regional likely to affect its carbon balance over the next century?

Specific Questions

- What areas within the region have been, and are most likely to be in the future, affected by changes in lake and wetland extent?
- How are ongoing changes in the tundra region (especially changes in permafrost active layer depth) affecting the dynamics of wetlands, and how are and will these changes affect the carbon balance of the region?
- How well can current sensors (MODIS, SAR) detect changes in wetland extent, and can high resolution SAR products be used to extend the rapid repeat cycle of lower resolution products like MODIS to provide information about seasonal and interannual variations in lake and wetland extent?

General approach:

Use high resolution remote sensing and in situ data to test and evaluate new lake and wetland, and permafrost dynamics models within the Variable Infiltration Capacity (VIC) macroscale hydrology model.

- The VIC model will then be linked (through collaborations with ongoing work at MPI-Hamburg and Jena with a dynamic terrestrial carbon model, and with a lake and wetland methane model.
- Evaluation will be performed with respect to large area estimates of carbon production and sequestration based on a combination of extrapolation of direct measurements, inverse modeling methods, and other modeling studies.
- Finally, we will attempt to reconstruct, using the extended VIC construct, the time history of terrestrial carbon and methane balances over the arctic Eurasia drainage, and, using a range of climate scenarios, to interpret how these balances might change over the next century.

Tasks

Task 1: Model improvements

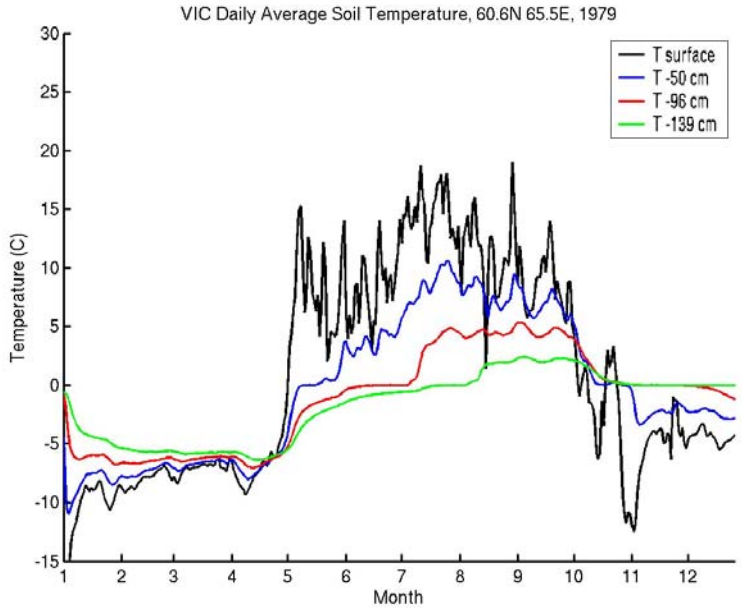
- Task 1a: VIC Lake and Wetlands model extensions
- Task 1b: Methane model extensions
- Task 1c: Integration of VIC in MPI VIC/BETHY/LPJ framework

Task 2: Data preparation and analysis

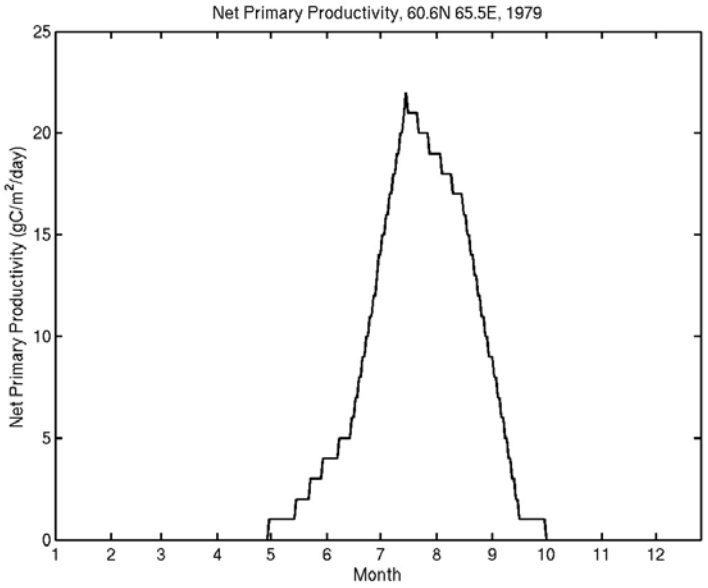
- Task 2a: In situ data
- Task 2b: Satellite data

Task 3: Model testing and evaluation

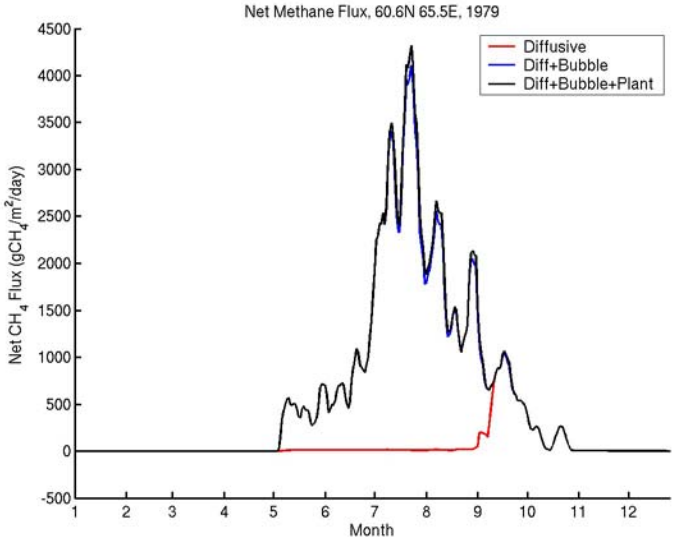
Task 4: Retrospective reconstruction of regional carbon balance



VIC daily average soil temperatures for the 100-km EASE grid cell centered at 60.6 N, 65.5 E, 1979



BETHY/LPJ net primary productivity for the 1-degree grid cell centered at 60.5 N, 65.5 E, 1979



Simulated methane fluxes for the 100-km EASE grid cell centered at 60.6 N, 65.5 E, 1979.

An integrated understanding of the terrestrial water and energy cycles across the NEESPI domain through observations and modeling

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Overarching Science Question:

How have changes in climate, landcover and water management in northern Eurasia over the last half-century affected the land surface hydrology and flood frequency, and what are the impacts at regional to continental scales?

Specific Questions

- To what extent can observed changes in seasonal discharge be attributed to land use change and water management versus climate variability?
- What are the effects of anthropogenic activities (water and land management) on water and energy fluxes across the NEESPI domain and how are they compounded by the presence of permafrost, snow and wetlands?
- How well can hydrologic processes related to permafrost, lake and wetland hydrology, and impacts from land cover change and water management be represented by our VIC LSM and how can it be improved through the synthesis of local field data and remote sensing observations?
- How does the hydroclimatology of the NEESPI region relate to continental and global water and energy cycle processes?

General approach:

Use land surface modeling, in combination with high resolution satellite-based land cover data and in-situ data provided by our Russian collaborators to assess the impact on the water and energy fluxes across the NEESPI domain from factors such as:

- climate variability and change;
- landscape variability and change that includes land cover, permafrost, snow extent, lakes and wetlands;
- and effects from anthropogenic activities such as water and and management.

TASKS

1: *Land surface model improvements*, related to high latitude hydrologic processes related to boreal and tundra landscapes using new tower, in-situ, river discharge and lake data.

2: *Data preparation and analysis*, related to in-situ field data and satellite data.

3: *Model testing and evaluation*, to assess the new high-latitude processes being incorporated in task 1.

4: *Retrospective reconstruction of regional water and energy balance* for the period 1950 to 2000 to evaluate the influence of land cover change on water and energy fluxes.

5: *Large-scale diagnostic and teleconnection studies*, which addresses the science question on how the hydroclimatology of the NEESPI region relates to continental and global water and energy cycle processes?