Abstract

Estimation of methane emissions from high-latitude wetlands and changes that may occur in a warming climate is an important component of projections of global warming, due to the strength of methane as a greenhouse gas and the substantial fraction of global methane emissions that come from high latitudes. Efforts to monitor high-latitude methane emissions are hampered by the sparseness of in situ data at high latitudes, and in Northern Europe in particular. While biogeochemical modeling can provide estimates of methane emissions in areas where in situ measurements are scarce, the lack of in situ measurements makes it difficult to calibrate and constrain these models. However, remote sensing products based on synthetic aperture radar can be used to calibrate or constrain biogeochemical models in these regions at high resolution over multiple seasons have recently become available. We compare multi-temporal remotely-sensed estimates of saturated soil extent and inundation from the ALOS/Phased Array L-band sensor to simulations from our modeling framework (consisting of the Variable Infiltration Capacity macroscale hydraulic model (VIC), extended to include carbon cycling and coupled to a methane emissions model) of these quantities at multiple points in time over two growing seasons (2005 and 2007) for various locations in the West Siberian Lowlands. We assess the accuracy and precision of the model parameterization of water table distribution and examine the interannual variability of simulated inundation and methane emissions for the period 1948-2007.

1. Modeling Approach

1.1 Land Surface Hydrology Model

A macroscale hydro-meteorological model is used to simulate the wetness index (Wet Index) from SRTM3 DEM. Topography is supplied by the SRTM 30m UTM DEM. For comparison with simulations, and to calibrating the modeling framework, we have classified 10 m/70m PALSAR imagery from the region panel (b) acquired in the summers of 2000-01. Classes of topographic noticeable bare soil, sparse and saturated/submerged land with emergent vegetation (listed as "wetland" in the legend in panel (b)). To explore the water table parameterization, we have selected 6 regions of interest (ROI) shown on an airborne survey in panels (a) and (b).

1.2 Methane Model

The Methane Model is a two-box model which simulates local scale methane emissions and transport of methane by diffusion, ebullition, and through plants modeled explicitly. Methane production occurs in the aquatic soil, the bottom of the soil column due to the soil water table, and methane production is rate controlled by soil temperature and salinity from VIC. Methane oxidation also taken into account.

2. Study Domain

2.1 Study Domain

Study domain is Siberian Lowlands. We assess the accuracy and precision of the model parameterization of water table distribution and examine the interannual variability of simulated inundation and methane emissions for the period 1948-2007.

3. Evaluating the Lateral Distribution of Inundation

3.1 Inundation

Inundation is the area of time varying inundated fraction (wetland pixels only) in each ROI. Inundation is the area of time varying inundated fraction (wetland pixels only) in each ROI. For each ROI, we computed the inundated fraction for a range of threshold wetness index at the threshold value for all grid cell's pixels. For each ROI, we aggregated the remote sensing observations to a two-step process: Step 1 is described here; step 2 is described in section 4.

4. Calibrating the Vertical Distribution of Water Table

For each ROI, we use the model parameterizations for the VIC hydraulic model to simulate the vertical distribution of water table. We calculated the simulated water table depths at high resolution over multiple seasons have recently become available. We compare multi-temporal remotely-sensed estimates of saturated soil extent and inundation from the ALOS/Phased Array L-band sensor to simulations from our modeling framework (consisting of the Variable Infiltration Capacity macroscale hydraulic model (VIC), extended to include carbon cycling and coupled to a methane emissions model) of these quantities at multiple points in time over two growing seasons (2005 and 2007) for various locations in the West Siberian Lowlands. We assess the accuracy and precision of the model parameterization of water table distribution and examine the interannual variability of simulated inundation and methane emissions for the period 1948-2007.

5. Interannual Variability

5.1 Interannual Variability

We are using our modeling framework as a resolution of 10km-celled grid and evaluate pattern and trends to calibrate the inundated fraction in our modeling framework in panels (a) and (b). Inundation is the area of time varying inundated fraction (wetland pixels only) in each ROI. Inundation is the area of time varying inundated fraction (wetland pixels only) in each ROI. For each ROI, we aggregated the remote sensing observations to a two-step process: Step 1 is described here; step 2 is described in section 4.

6. Spatial Variability of Inundation and Methane Emissions

6.1 Spatial Variability of Inundation and Methane Emissions

Spatial variability of inundation and methane emissions is an important component of projections of global warming, due to the strength of methane as a greenhouse gas and the substantial fraction of global methane emissions that come from high latitudes. Efforts to monitor high-latitude methane emissions are hampered by the sparseness of in situ data at high latitudes, and in Northern Europe in particular. While biogeochemical modeling can provide estimates of methane emissions in areas where in situ measurements are scarce, the lack of in situ measurements makes it difficult to calibrate and constrain these models. However, remote sensing products based on synthetic aperture radar can be used to calibrate or constrain biogeochemical models in these regions at high resolution over multiple seasons have recently become available. We compare multi-temporal remotely-sensed estimates of saturated soil extent and inundation from the ALOS/Phased Array L-band sensor to simulations from our modeling framework (consisting of the Variable Infiltration Capacity macroscale hydraulic model (VIC), extended to include carbon cycling and coupled to a methane emissions model) of these quantities at multiple points in time over two growing seasons (2005 and 2007) for various locations in the West Siberian Lowlands. We assess the accuracy and precision of the model parameterization of water table distribution and examine the interannual variability of simulated inundation and methane emissions for the period 1948-2007.

7. Conclusions and Future Work

7.1 Conclusions

The TOPMODEL approach was used to simulate the distribution of inundation, offering a relatively inexpensive method for increasing the accuracy of methane emissions estimates from these large-scale models. This method combines the results of this study with those from other regions to develop a comprehensive estimate of methane emissions from high-latitude wetlands. The TOPMODEL approach was used to simulate the distribution of inundation, offering a relatively inexpensive method for increasing the accuracy of methane emissions estimates from these large-scale models. This method combines the results of this study with those from other regions to develop a comprehensive estimate of methane emissions from high-latitude wetlands. This method combines the results of this study with those from other regions to develop a comprehensive estimate of methane emissions from high-latitude wetlands.

7.2 Future Work

Future work includes developing an approach to simulate the distribution of inundation, offering a relatively inexpensive method for increasing the accuracy of methane emissions estimates from these large-scale models. The approach combines the results of this study with those from other regions to develop a comprehensive estimate of methane emissions from high-latitude wetlands. This method combines the results of this study with those from other regions to develop a comprehensive estimate of methane emissions from high-latitude wetlands. This method combines the results of this study with those from other regions to develop a comprehensive estimate of methane emissions from high-latitude wetlands.