Assimilation of Tower and Satellite-Based Observations for Improved Estimation of Methane Fluxes over Northern Eurasia

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Abstract
Changes in greenhouse gas emissions such as methane and carbon dioxide from high-latitude wetlands have important implications for global warming, due to the large amounts of carbon stored in high-latitude soils and high greenhouse warming potential of methane. As much as 1/3 of global natural methane emissions come from high latitudes. Efforts to monitor high-latitude greenhouse gas emissions are hampered by the sparseness of in-situ observations at high latitudes, especially in Northern Eurasia. One promising approach is to assimilate spatially sparse tower- and satellite-based observations into large-scale process-based models. In addition, because methane fluxes are sensitive to hydrologic variables such as inundation, passive microwavesatellite observations of surface water can also be assimilated. Here we apply an ensemble Kalman smoother to distribute, and soil carbon content.

1. Modeling Approach

2. Model Calibration

3. Observations

4. State Variables & Update Strategy

5. Conclusions and Future Work

Conclusions
Simulated methane fluxes are plausible (magnitude, spatial distribution)
Both allow adjustment of inundated area and methane fluxes to match observations of CH4
Neither is well-constrained
Updating water table distribution avoids consequences such as water budget errors and helps us constrain the characteristics of the distribution
But may compensate for errors in soil moisture content

Updating Strategy
We must update all cells on emissions trajectories that reached the observation location
Use Ensemble Kalman Smoother to account for convoluted with time

State Variables
Soil moisture vs. water table distribution

Both allow adjustment of inundated area and methane fluxes to match observations of CH4
Neither is well-constrained

Methane fluxes are very sensitive to these variables
Data assimilation can help us monitor and constrain these variables (in addition to methane fluxes themselves)

Status
Linked VIC/CTM model is undergoing testing now

Future Work
Set up Ensemble Kalman Smoother framework
Assess effectiveness of data assimilation in:
Improving methane flux estimates
Constraining hydrologic state variables