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Boreal Inundation Mapping with SMAP Radiometer Data for Methane Studies

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Inundation and consequent anoxic condition induce methane release, which is one of the most potent greenhouse gases. Boreal regions contain large amounts of organic carbon, which is a potentially major methane emission source under climatic warming conditions. Boreal wetlands in particular are one of the largest sources of uncertainties in global methane budget. Wetland spatial extent together with the gas release rate remains highly unknown. Characterization of the existing inundation database is poor, because of the inundation under clouds and dense vegetation. In this work, the inundation extent is derived using brightness temperature data acquired by the L-band Soil Moisture Active Passive (SMAP) satellite, which offers the L-band capabilities to penetrate clouds and vegetation at 3-day revisit.

The fidelity of the SMAP watermask is assessed as a first step in this investigation by comparing with the following data sets: 3-m resolution maps derived using Radarsat synthetic aperture radar (SAR) data in northern Canada and multi-sensor climatology over Siberia. Because Radarsat coverages are limited despite its high spatial resolution, at the time and location where Radarsats are not available, we also compare with 3-km resolution SMAP SAR data that are concurrent with the SMAP radiometer data globally until July 2015.

Inundation extents were derived with Radarsat, SMAP SAR, and SMAP radiometer over the 60 km x 60km area at Peace Athabasca Delta (PAD), Canada on 6 days in spring and summer 2015. The SMAP SAR results match the locations of Radarsat waterbodies. However, the SMAP SAR underestimates the water extent, mainly over mixed pixels that have subpixel land presence. The threshold value (-3 dB) applied to the SMAP SAR was determined previously over the global domain. The threshold is dependent on the type of local landcover within a mixed pixel. Further analysis is needed to locally optimize the threshold.

The SMAP radiometer water fraction over Peace Athabasca Delta varies from 0% to 25% spatially, which corresponds well with the waterbodies identified by Radarsat. To quantify the agreement, the SMAP radiometer data will be resampled to center itself within the study domain in the future.

West Siberia is one of the areas of significant methane exchance but the current estimates of the exchange differ by several times depending on the methodology. The radiometer-based SMAP water extent shows the consistent seasonality compared with the climatology (Global Inundation Extent from Multi-Satellites, GIEMS). SMAP's water extent appears more realistic in winter than shown by GIEMS: even in winter there are unfrozen wetlands identified by SMAP, which is plausible considering that the southern boundary of West Siberia is at 50°N.

The watermask produced with the global SMAP radiometer data will be applied to the bottom-up numerical model for methane release run at Purdue university, to experiment its impact on methane exchange.