B33E-2127: Using Landsat to relate waterbody surface temperature to greenhouse gas emissions across a subarctic landscape

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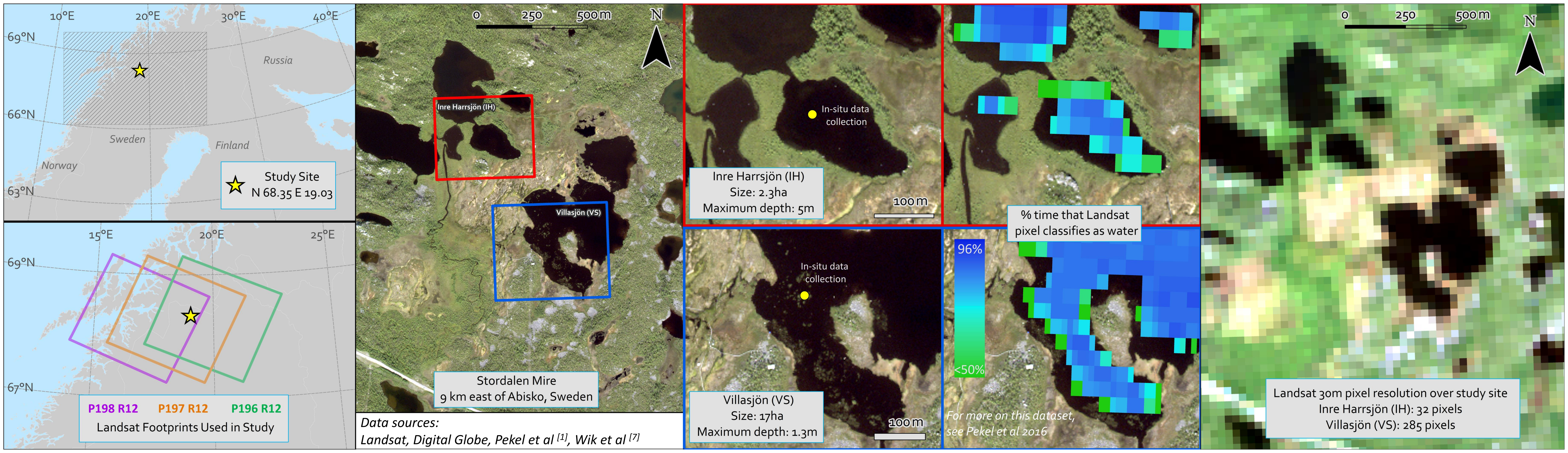
Overview

Small surface waterbodies in arctic and subarctic regions are responding to increased atmospheric temperatures. Warming of sediment within these water bodies during the growing season triggers methanogenesis which results in sediment bubbling or ebullition. However, recent history has seen more variability in the annual number of ice-off days; longer periods of thaw and warming temperatures increase the amount of methane in the atmosphere and provide a positive feedback to climate change. Understanding how these lakes and ponds are warming, and therefore emitting methane, requires in-situ temperature data which are difficult to collect and typically nonexistent for use in historical analysis. Using Landsat as a proxy for in-situ data is ideal because it is the longest running earth-observing satellite mission, with continuous operation since 1972. We compared Landsat-derived temperatures with 5 years of in-situ data collected from two waterbodies in northern Sweden and saw an overall strong positive correlation (ρ >0.87) between the two.

Study Site



Data sources:
Landsat, Digital Globe, Pekel et al [1], Wik et al [7]

Methods

- Scenes from Landsat 5 TM & Landsat 7 ETM+ were filtered by total cloud cover (<50%) between 2010-14
- Individual lake pixels were masked for clouds using Fmask[2,3]
- Atmospheric water vapor was obtained from the NCEP/NCAR Reanalysis Data [4]
- Landsat & water vapor were used to derive surface temperatures using a single-channel method [5,6]
- Results were compared with in-situ data (see Wik[7] for collection methods) using orthogonal regression analysis

References

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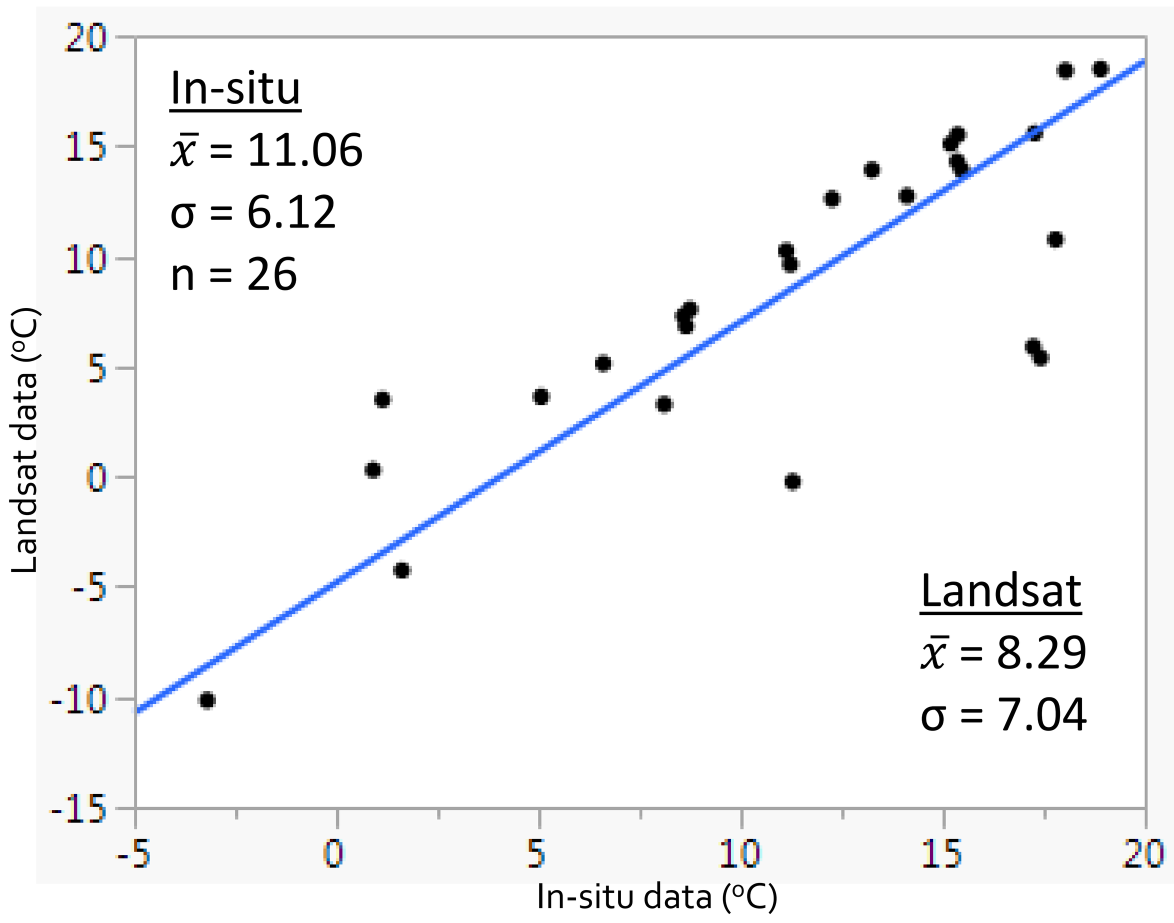
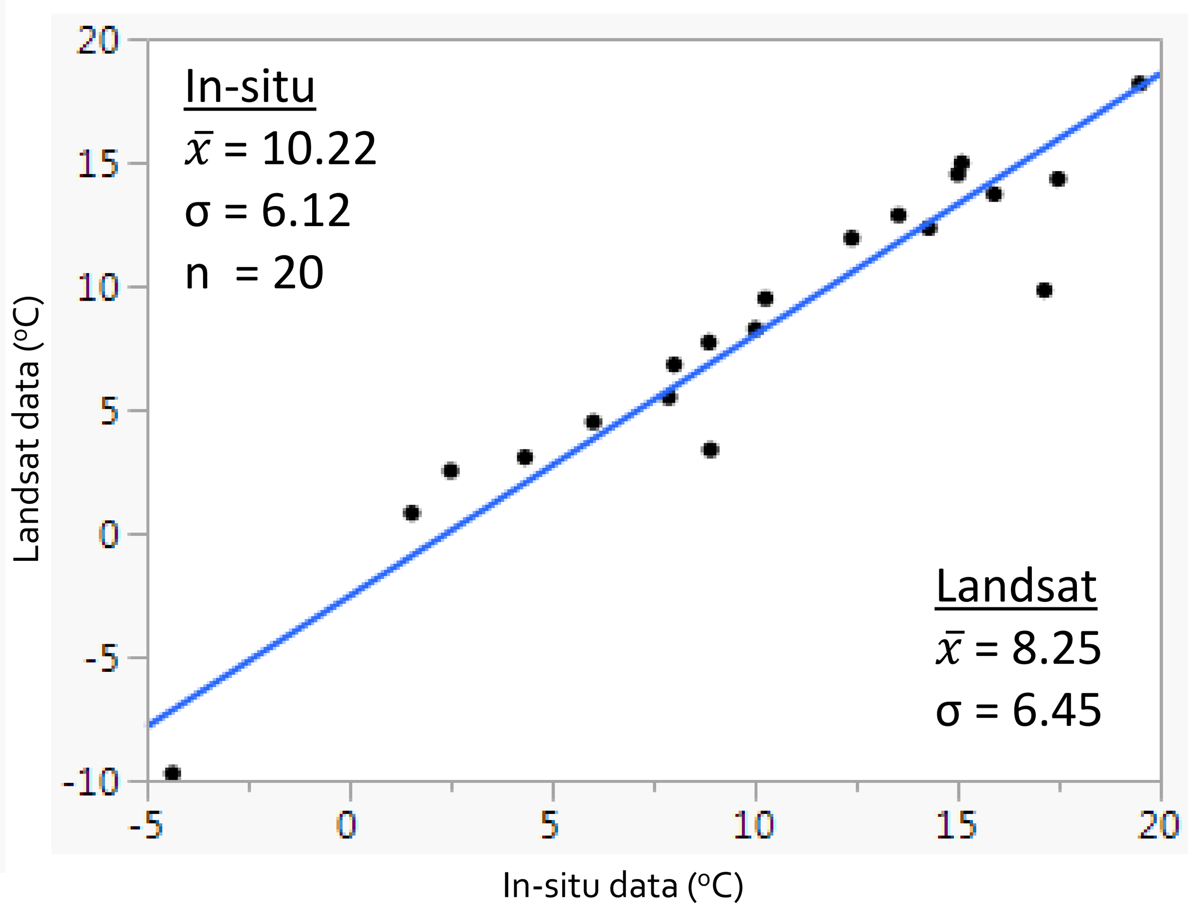
7. Wik, M., P.M. Crill, R.K. Varner, D. Bastviken. 2013. Multiyear measurements of ebullitive methane flux from three subarctic lakes, *J. Geophy. Res. Biogeo.*, doi:10.1002/jgrg.20103

Results & Conclusions



Lake IH
ρ = 0.829, m = 1.18



Lake VS
ρ = 0.953, m = 1.06

- Correlation was 0.829 (Lake IH), 0.953 (Lake VS), and 0.877 (both) to the in-situ data
- Landsat cloud masking needs improvement, removing many cold pixel outliers
- Larger lakes (more Landsat pixels) perform better (less mixed pixels)
- Single-channel method of surface temperature retrieval is an excellent proxy when historical data is absent

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