Spatio-Temporal Sensitivity of MODIS Land Surface Temperature Anomalies Indicates High Potential for Large-Scale Land Cover Change Detection in Permafrost Landscapes

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Motivation

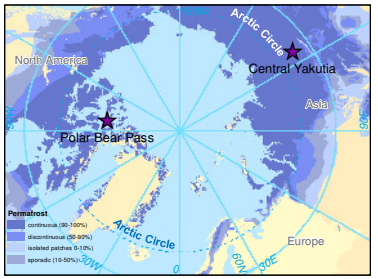
The accelerated warming of the Arctic climate may alter the surface energy balance locally and regionally of which a changing land surface temperature (LST) is a key indicator. Modelling current and anticipated changes of the surface energy balance requires an understanding of the spatio-temporal interactions between LST and land cover.

Goals

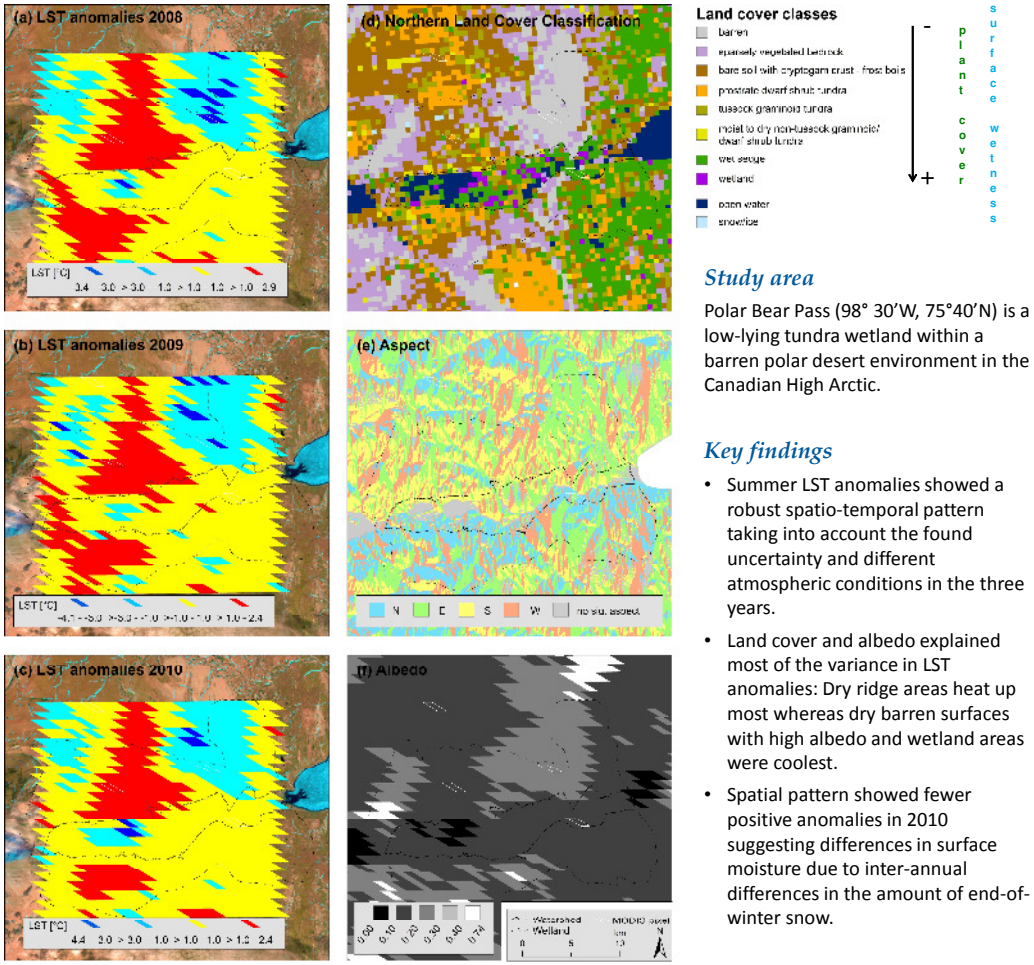
(1) Assess the accuracy of MODIS LST V5 1 km level 3 product
(2) Investigate MODIS LST spatio-temporal sensitivity to land cover properties

Data & Methods

- Spatial LST anomalies were calcuated as the difference between mean daily LST for each pixel and the daily regional mean of the study area.
- LST anomalies of summer periods were averaged for all scenes with regional means larger than 5˚C at Bathurst Island (with 19 to 28 observations per pixel) and 10°C in Central Yakutia (with 11 to 65 observations per pixel).



Land surface temperature anomalies at Polar Bear Pass, Bathurst Island (CA)



Study area

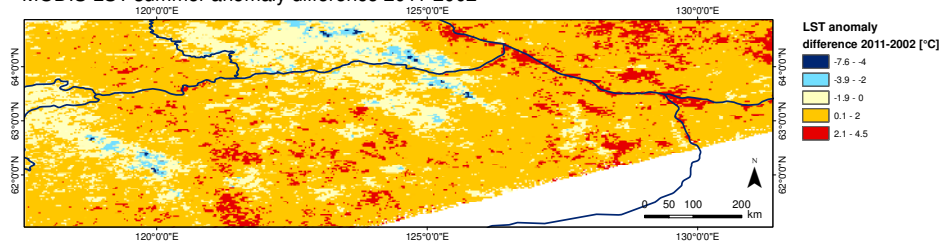
Polar Bear Pass (98° 30'W, 75°40'N) is a low-lying tundra wetland within a barren polar desert environment in the Canadian High Arctic.

Key findings

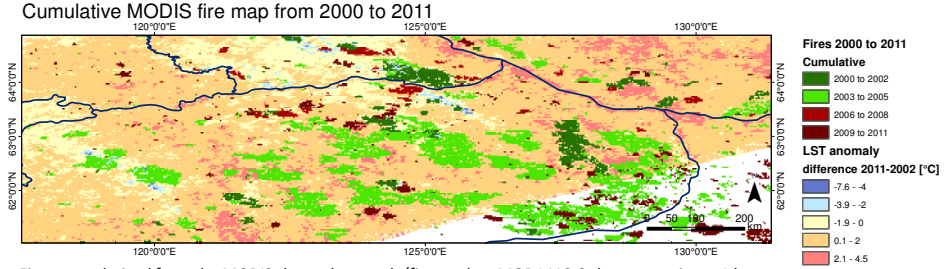
- Summer LST anomalies showed a robust spatio-temporal pattern taking into account the found uncertainty and different atmospheric conditions in the three years.
- Land cover and albedo explained most of the variance in LST anomalies: Dry ridge areas heat up most whereas dry barren surfaces with high albedo and wetland areas were coolest.
- Spatial pattern showed fewer positive anomalies in 2010 suggesting differences in surface moisture due to inter-annual differences in the amount of end-of-winter snow.

Land surface temperature anomalies in Central Yakutia, Siberia (RU)

MODIS LST summer anomaly difference 2011-2002



Cumulative MODIS fire map from 2000 to 2011



Fires were derived from the MODIS thermal anomaly/fire product MOD14A2 8-day composite at 1 km resolution.

Study area

The investigated region in Central Yakutia is characterized by a thermokarst landscape, with thermokarst lakes, thermokarst valleys, and alases on deep, continuous permafrost dominated by larches.

Key findings

- Between 2002 and 2011 the region showed strong differences of LST anomalies ranging from -7.6 °C to 4.5°C.
- Changes in LST anomaly patterns could be linked to occurrence and age of fires in the taiga zone.

Outlook

- **Presented summer MODIS LST anomalies can serve as a baseline** against which to evaluate past and future changes in land surface properties with regard to the surface energy balance.
- A multi-sensor approach combining MODIS LST measurements in conjunction with other MODIS products (NDVI, albedo, fire, snow) and high-resolution optical and radar imagery promises to be an effective tool for a **dynamic, process-based ecosystem monitoring scheme.**

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