Remote Sensing of Drained Thermokarst Lake Basin Successions

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Background

Thermokarst Lakes (TKL)
- TKL are important factors for northern hydrology, permafrost dynamics, and carbon cycling.
- TKL are abundant and highly dynamic landscape features of ground ice rich lowland regions in Alaska, N Siberia, and NW Canada.
- TKL provide important ecosystem services as habitats, hydrological feature, biogeochemical hotspots, and for surface energy budgets.

Drained Thermokarst Lake Basins (DTLB)
- DTLB are of different age are abundant and partially overlap each other, suggesting intense dynamics of lake formation and loss with complex carbon cycle histories (Grosse et al., 2013).
- LDMB successions patterns will help to constrain impacts of lake loss on hydrology, permafrost degradation, vegetation, carbon pools, and spectral land surface changes.
- RS helps characterizing DTLB

Objectives

- Determine recent and Holocene chronology of DTLB formation in the Paralic Terrane.
- Characterize the spectral, morphological, and functional properties of DTLB.
- Relate surface properties to succession dynamics and time since drainage for different DTLB types.

Approach

- Use RS imagery and accelerated mass spectrometry 14C dating to date lake drainage event.
- Derive spectral properties of DTLB with known age to investigate succession patterns and their impacts on land surface characteristics over time.

Results

- Types of drained thermokarst lake basins
- Processing Status
  - Lake extraction from 1950 USGS maps: semi-automated method established, several lake districts completed.
  - Super-temporal lake extraction and trend analysis from 1995-2015 Landsat: several lake districts completed.
- Albedo changes due to lake drainage

Field and Lab Methods

- 14C dating of peat layers indicative of post-drainage terrestrialization during the Holocene

Remote Sensing Methods

- RS helps characterizing DTLB
- Multi-temporal, multi-sensor approach delivers a comprehensive picture of DTLB and their impacts on land surface characteristics over time.

Conclusions

- Lake-rich landscapes in western Alaska are changing rapidly due to lake loss.
- Important lake drainage mechanisms are permafrost degradation around existing thermokarst lakes (lake expansion, talik growth), tapping by fluvial and coastal erosion, and gradual drying of shallow lakes.
- Multi-temporal, multi-sensor approach delivers a comprehensive picture of DTLB development over the last 65 years.
- Automated, super-temporal time series trend analysis with Landsat (and in the future also Sentinel-2) provides a fully scalable tool for region-wide DTLB characterization.
- More 14C dates are needed to compare modern with Holocene drainage rates.