Multiscale Arctic Landscape Characterization

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Classify, assign properties to, and parameterize processes across the Arctic landscape

Bio-hydro-geomorphic units
Lakes, Drained Thaw Lake Basins, Interstitial Areas

Polygons, channels, other features
Synthesize in-situ and geophysical data with LiDAR and high res satellite data

Electromagnetic Data

Ground Penetrating Radar

Electrical Resistance Tomography

Hubbard et al., 2012

Liquid water content at 7-10 cm depth: Variations across an 8 m transect @ site C

Hubbard et al., 2012
Develop methods to enable the spatial and temporal distribution and evaluation of key properties and processes—Spatial distribution of polygon types and properties from LiDAR and regional multi-spectral data.
Spatial distribution of polygon types and properties using LiDAR

Gangodagamage et al. in prep

Optimized wavelet transformed LIDAR data

Use values of geomorphic properties to identify poly boundaries and poly types

Close polygons using triangulation, redundant edge removal and edge connection
Data assimilation for model domain classification and characterization

Gangodagamage et al. submitted
Creating grids from Polygonal ground characteristics

Topographic statistics

Size/geometry statistics

Coming soon: Subsurface statistics with Hubbard et al.
Spatial distribution of polygon types and properties from regional multi-spectral data (Skurikhin et al in prep)

Segmentation of water bodies including ice wedges, troughs, pond-like polygons, lakes, rivers, by Unsupervised Clustering and Level Sets

Original Image (WorldView-2)

- 8 original bands:
  - Coastal Blue (400-450 nm)
  - Blue (450-510 nm)
  - Green (510-580 nm)
  - Yellow (585-625 nm)
  - Red (630-690 nm)
  - Red-Edge (705-745 nm)
  - NIR1 (770-895 nm)
  - NIR2 (860-1040 nm)

- 2 feature maps:
  - NDVI = (NIRs-Red)/(NIR1+Red)
  - NDWI = (CoastalBlue-NIR2)/(CoastalBlue+NIR2)

k-means clustering of 8 bands + 2 feature maps to produce seed “water-like” regions

Extract seeds, candidate “water-like”-regions, to initialize segmentation

Compute additional feature map to perform segmentation

Segmentation by Level Set Evolution

Segmented “water-like” regions shown in white

multi-scale wavelets filtering of Red-Edge band to produce energy-based feature map
Segmented “water-like” regions

White color for:
- ice wedges
- troughs
- pond-like polygons
- lakes and river

Illustration of the segmentation results:
- Contours (in red) outlining boundaries between foreground and background

troughs

ridges

Polygon-ponds
Histogram of Equivalent Diameter

6,134 polygons. Bin Size = 0.8 meter

diameter, meters (bin centers)

percentage
Evaluation data sets: dynamic spatial distribution of standing water to evaluate model predictions

Use Genie to extract all inundated areas from WV2 data (Jul. 21, 2010) Chen et al. in prep

Inundated Area Extracted Using Genie

8838 ha, 26% of land area

Inundated Area Excluding Existing Lakes and Rivers

2321 ha, 7% of land area
Perform a series of numerical experiments to test key hypotheses about climate warming impacts and feedbacks.
Land cover clusters (Barrow region)

Barrow area subimage (shown in Red/Green/Blue)

9x9 pixel patch
20 clusters
Land cover clusters (Barrow region)

Barrow area subimage (shown in NIR2/RedEdge/Yellow)

7x7 pixel patch
20 clusters
Future work

- Exploit multiscale/multiresolution analysis tool
- Pre-condition the learning toward features of interest using band index
  - E.g., NDVI, NDWI, NDSI, NHFD
- Learn fusion dictionaries with Lidar data
- Develop quantitative performance metrics
- Explore land cover change detection in MSI