Characterization of Wetlands and Surface Freeze/Thaw in North America and Russia:

Completion of work from Phase 1

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Completion of work from Phase 1

• Develop methodology for forest-, wetlands- and freeze-thaw monitoring.
  • Algorithms for classification of landcover and landscape freeze/thaw state have matured, and their performance has been assessed over variable landcover and terrain.
  • New approaches to landcover classification as applied to boreal wetlands ecosystems characterization utilize a statistically-generated decision tree approach.
  • Methodologies for both wetlands classification and freeze/thaw state have gained maturity with JERS data sets. Work continues in application to PALSAR data.
  • Details of the methodologies and algorithms are provided in the publications related to this project.
The Europe and Eurasia mosaics were assembled by JRC and coverage spans the summer of 1998.

The Alaska mosaic was assembled by JPL and coverage spans the summer of 1998.
L-band Radar Imagery from JERS-1 Boreal Mapping Mission

Pass-to-Pass striping is prominent, pointing to possible calibration drifts and/or temporal scene variations
Wetlands Classification Methodology

- The Alaska radar mosaic is divided into 9 tiles, and each tile classified separately, with enough overlap to ensure consistency of class definitions.
- 100m resolution
- Example data layers for a tile:

Tile A5 DEM
Tile A5 open water
Tile A5 texture
Tile A5 acquisition date
Wetlands Classification Methodology

- Ground reference data set primarily from National Wetlands Inventory
- Nonwetlands classes from Alaska Geospatial Data Clearinghouse
Completed Wetlands Map of Alaska

Note: some of the smaller classes are not visible at the resolution of this figure
Classification Accuracy

- Referring to the image tiles identified on previous pages, the following table shows the classification error rate. The resulting accuracy is better than 88%.

<table>
<thead>
<tr>
<th>Tile Number</th>
<th>Training Pixels</th>
<th>Error Rate (%)</th>
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</thead>
<tbody>
<tr>
<td>A1</td>
<td>387059</td>
<td>3.72</td>
</tr>
<tr>
<td>A2</td>
<td>2120222</td>
<td>11.22</td>
</tr>
<tr>
<td>A3</td>
<td>124669</td>
<td>11.13</td>
</tr>
<tr>
<td>West A4</td>
<td>1835839</td>
<td>3.61</td>
</tr>
<tr>
<td>Mid A4/A5</td>
<td>1184311</td>
<td>20.16</td>
</tr>
<tr>
<td>East A5</td>
<td>822863</td>
<td>19.09</td>
</tr>
<tr>
<td>A6</td>
<td>440813</td>
<td>13.69</td>
</tr>
<tr>
<td>A7/A9</td>
<td>67612</td>
<td>13.20</td>
</tr>
<tr>
<td>A8</td>
<td>70160</td>
<td>30.56</td>
</tr>
<tr>
<td><strong>Overall Aggregated Error Rate</strong></td>
<td></td>
<td><strong>11.61</strong></td>
</tr>
</tbody>
</table>

Following results are based on pixel counts in classified image

<table>
<thead>
<tr>
<th>Wetland Type</th>
<th>Fraction of Total Wetlands (%)</th>
<th>Fraction of Total Area of AK (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergent, Palustrine</td>
<td>46.4</td>
<td>12.2</td>
</tr>
<tr>
<td>Scrub/Shrub, Palustrine</td>
<td>44.3</td>
<td>11.6</td>
</tr>
<tr>
<td>Forested, Palustrine</td>
<td>8.56</td>
<td>2.25</td>
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<tr>
<td>Emergent, Estuarine</td>
<td>0.78</td>
<td>0.21</td>
</tr>
<tr>
<td>All Other vegetated</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>Open water</td>
<td></td>
<td>3.7</td>
</tr>
<tr>
<td>Total (all wetlands)</td>
<td><strong>100.0</strong></td>
<td><strong>29.9</strong></td>
</tr>
</tbody>
</table>

- Approx. 26.3% of Alaska is vegetated wetlands
- Approx. 3.7% of Alaska is open water
- Total estimate of ~30% wetlands updates the 1980s figure (40-45%) derived through less rigorous means
Decadal change in wetlands: JERS/PALSAR
Yukon Delta, Alaska

Light green: emergent
Medium green: scrub/schrub.
This area does not have forested wetlands

JERS SAR: 1998
ALOS PALSAR: 2007
Wetland Characterization with MultiSensor Remote Sensing

Image Segmentation, Training data

Decision Tree Classifier

High Biomass Forest - 52%
Low Biomass Forest - 5%
High Vegetation Wetland - 13%
Low Vegetation Wetland - 18%
Low Vegetation Saturated Wetland - 6%
Open Water - 1%
Agriculture/Nonforest - 5%

Chaya Basin NEESPI Domain

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Alaska- Monthly 100m JERS-1 Mosaics for Assessment of Open Water Change

A USGS DEM of the entire state was used to mask out areas of complex topography where radar shadowing was confused as open water. Open water change analysis was performed across areas with monthly overlaps where water was in a liquid state.
Open Water Change - North Slope, Alaska

The top shows open water overlayed on the JERS image and the bottom shows open water change relative to June.

June 1998
July 1998
August 1998

More open water
Less open water
No change

Open Water Change Relative to June

<table>
<thead>
<tr>
<th></th>
<th>Dryer</th>
<th>Wetter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jul.</td>
<td>7.7%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Aug.</td>
<td>6.9%</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

Open water change
June/July
Open water change
June/August
Linkages

Wetland Parameterization

The VIC model

surface water extent

water table, soil temperature, NPP

Walter and Heimann methane model

methane flux by landscape position

Model vs. JPL open water product

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Change from day 100 to day 143 of 1995

JERS

Model

“saturated” water table above -40 cm

Change in Inundated Fraction

Change in "Saturated" Pixels

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Motivation and Objectives

Motivation:
The seasonal transition between predominantly frozen and non-frozen conditions occurs each year over more than 50 million km² of the global biosphere, profoundly affecting surface hydrology, meteorology and ecosystem processes.

The freeze/thaw (F/T) state variable from satellite microwave remote sensing provides a surrogate measure of landscape frozen/non-frozen conditions.

Global satellite microwave remote sensing records represent a potential long-term (>25-year) record of F/T state dynamics and related climate change impacts.

Objectives:
Construct a systematic, long-term Earth System Data Record of F/T state dynamics (F/T-ESDR) for all vegetation regions where seasonal frozen temperatures are a major constraint to ecosystem processes.

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JERS-1 L-band SAR landscape freeze-thaw classification

<table>
<thead>
<tr>
<th>Backscatter (dB)</th>
<th>17 Feb. (Day 48)</th>
<th>1 April (Day 91)</th>
<th>3 April (Day 93)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; -2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-4</td>
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<tr>
<td>-6</td>
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<td></td>
</tr>
<tr>
<td>-8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; -18</td>
<td></td>
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</tbody>
</table>

Frozen
Thawed
Water
Classified State

Day of Primary Thaw

SeaWinds
SSM/I

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Freeze/Thaw and Carbon Cycle Science

The satellite F/T signal corresponds with growing season timing and duration, influencing NPP and atmospheric CO₂ dynamics. The FT-ESDR will enable improved studies of cold temperature constraints to NPP and land-atmosphere C exchange.

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