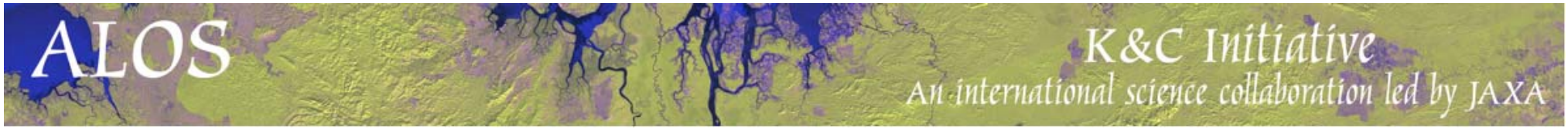

Characterization of Wetlands and Surface Freeze/Thaw in North America and Russia:

Completion of work from Phase 1

Kyle C. McDonald, Erika Podest, Bruce Chapman
Jet Propulsion Lab, California Institute of Technology

Mahta Moghaddam, Jane Whitcomb
The University of Michigan

Josef Kellndorfer
Woods Hole Research Center

John S. Kimball
University of Montana

Dennis Lettenmaier, Ted Bohn
University of Washingtom

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

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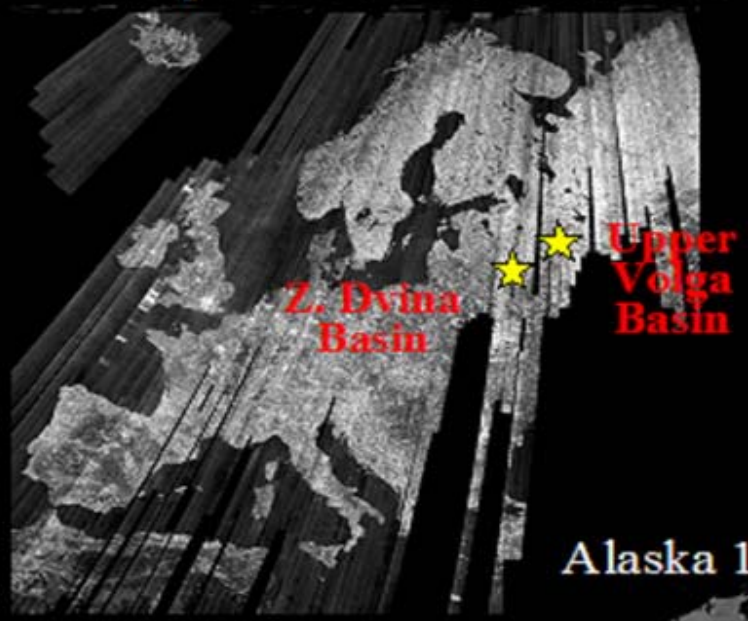
Jet Propulsion Lab
California Institute of Technology

ALOS

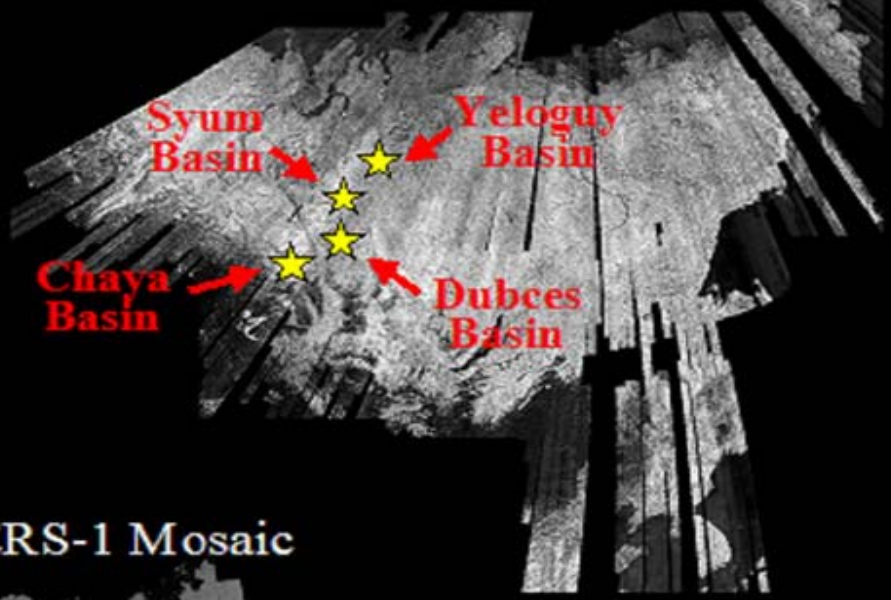
K&C Initiative

An international science collaboration led by JAXA

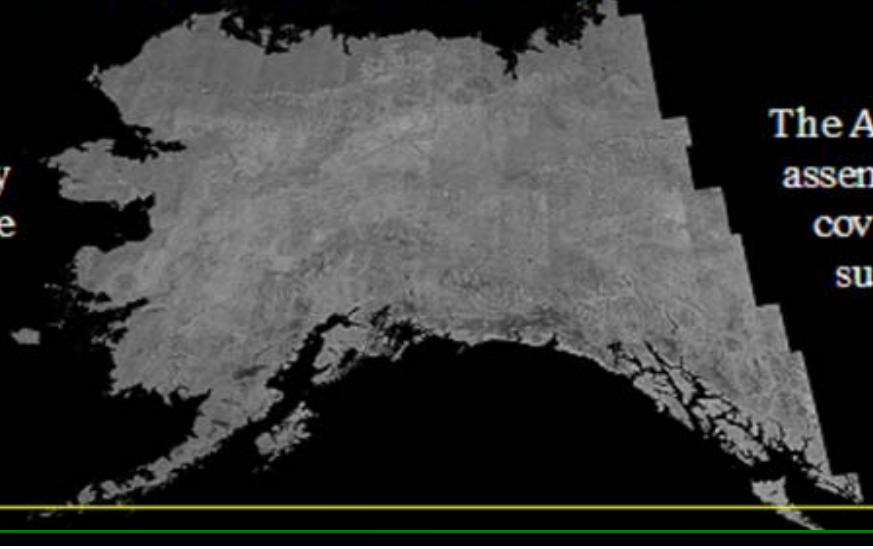
Europe 100m JERS-1 Mosaic



Eurasia 100m JERS-1 Mosaic



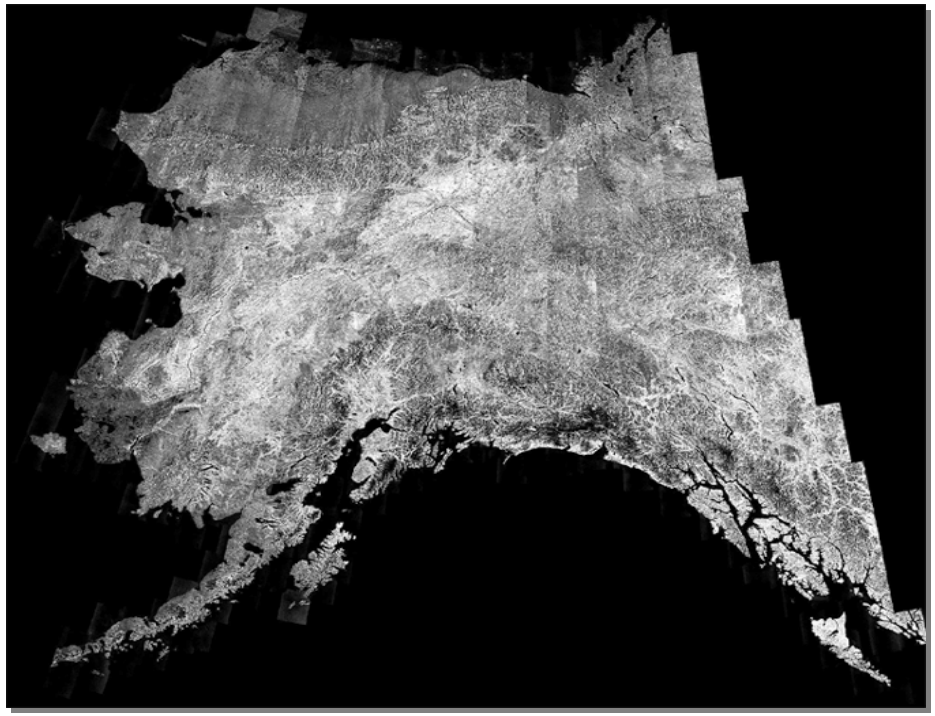
Alaska 100m JERS-1 Mosaic



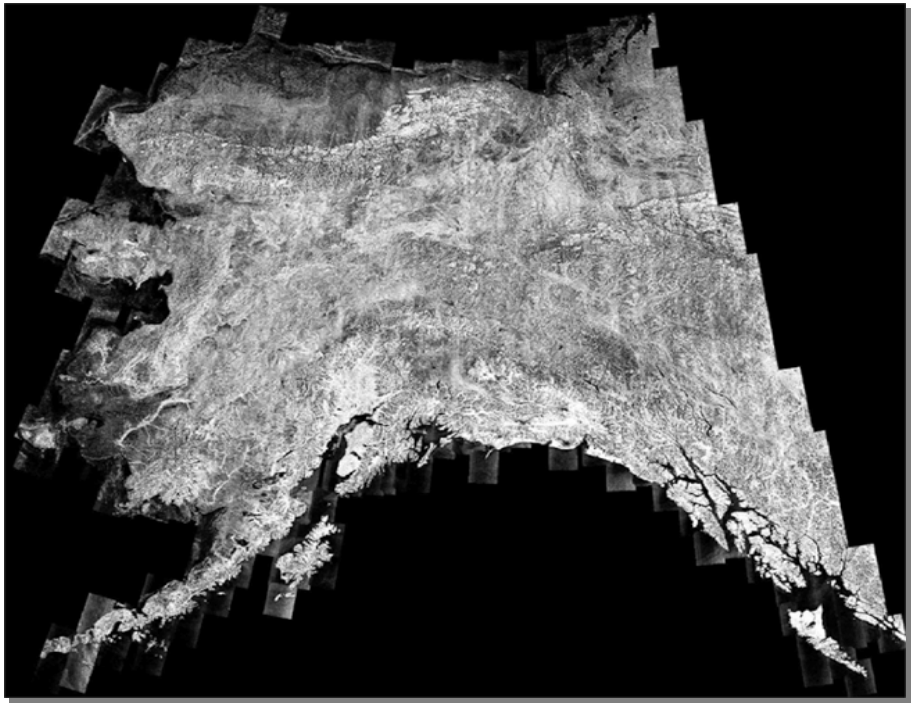
The Europe and Eurasia mosaics were assembled by JRC and coverage spans the summer of 1998.

The Alaska mosaic was assembled by JPL and coverage spans the summer of 1998

L-band Radar Imagery from JERS-1 Boreal Mapping Mission

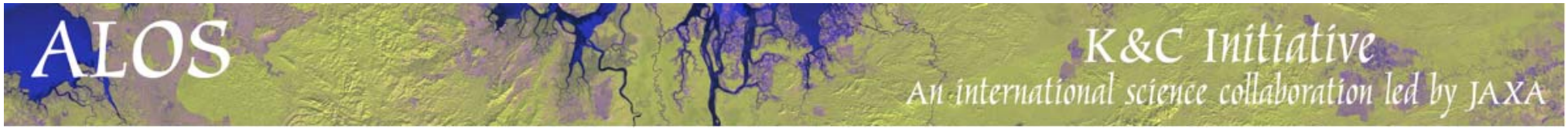


Summer

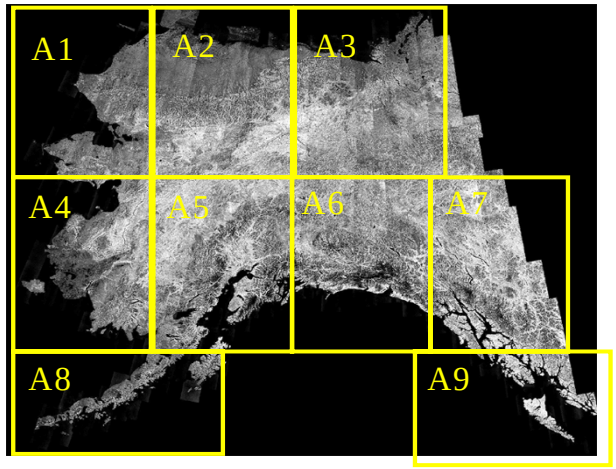


Winter

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

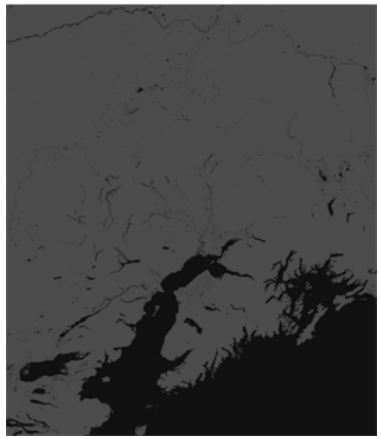


Wetlands Classification Methodology

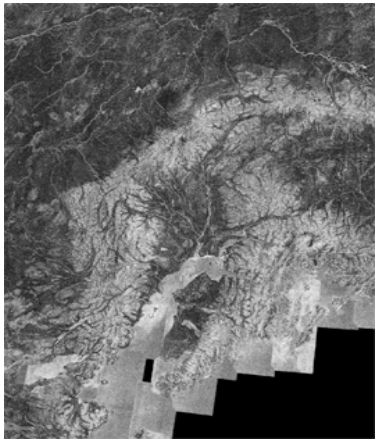


- **The Alaska radar mosaic is divided into 9 tiles, and each tile classified separately, with enough overlap to ensure consistency of class definitions**
- **100m resolution**
- **Example data layers for a tile:**

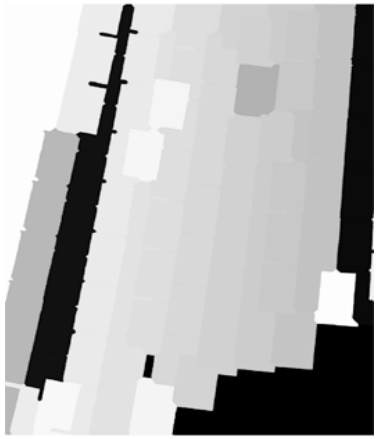
Tile A5 DEM



Tile A5 open water



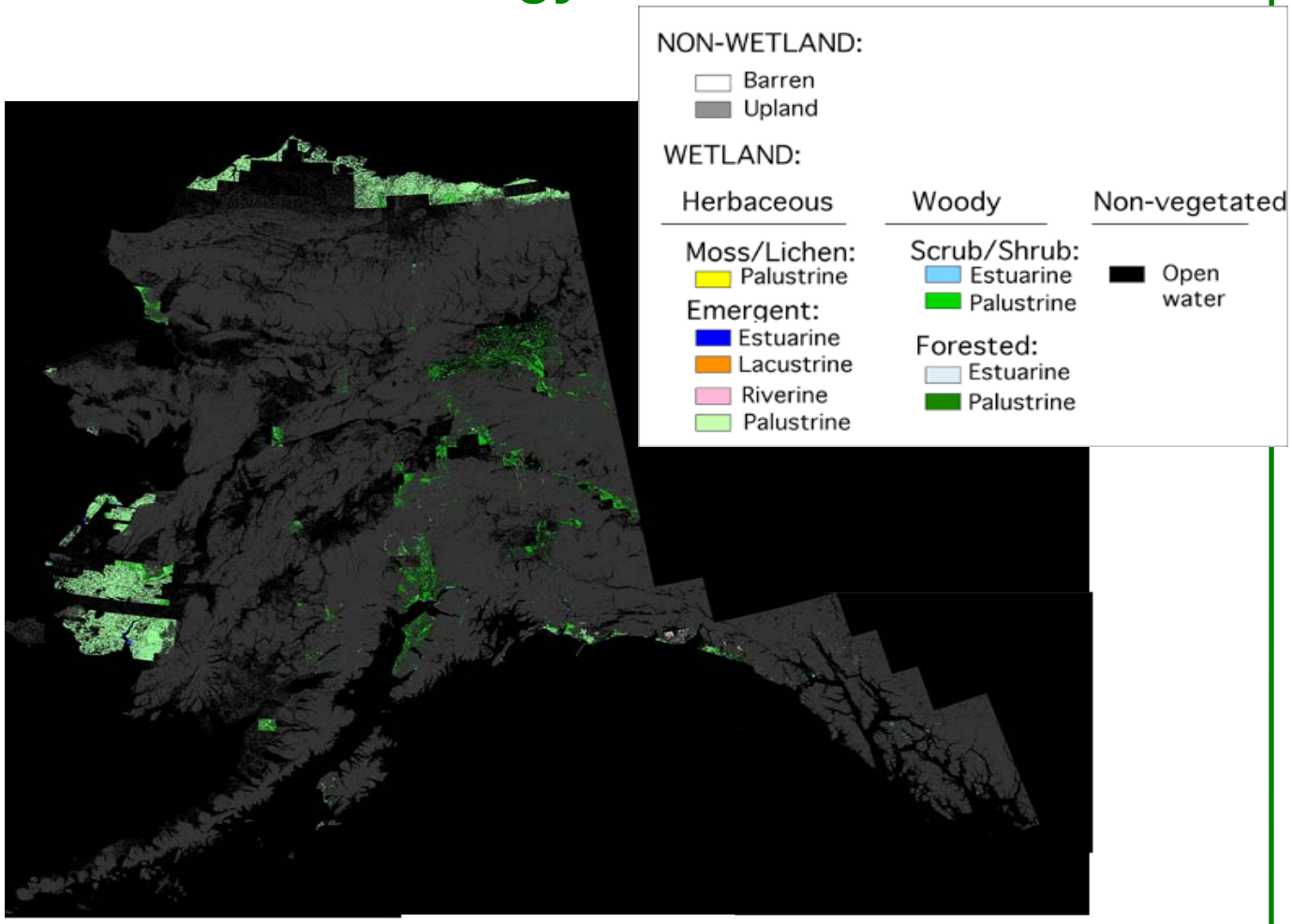
Tile A5 texture



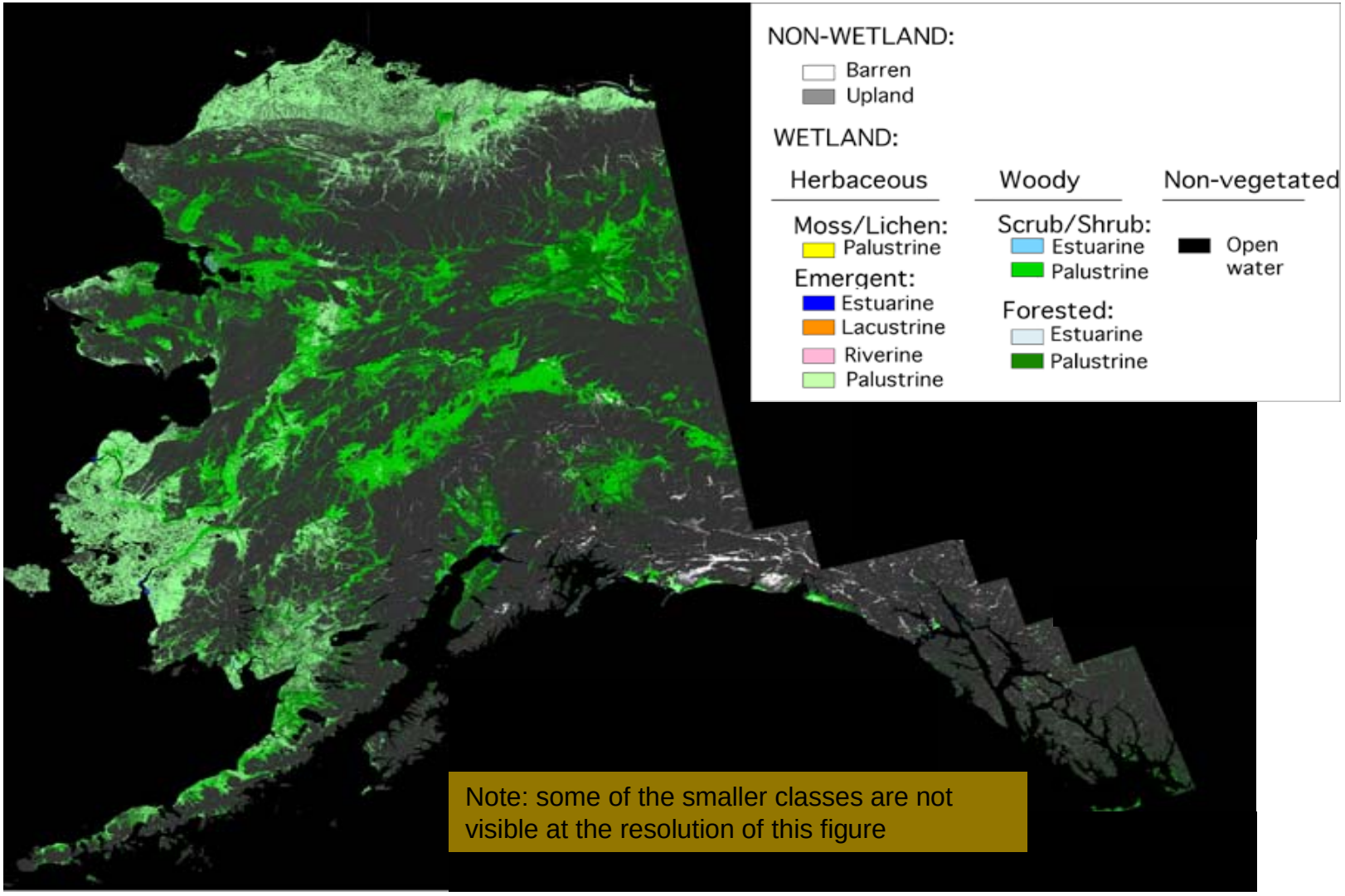
Tile A5 acquisition date

Wetlands Classification Methodology

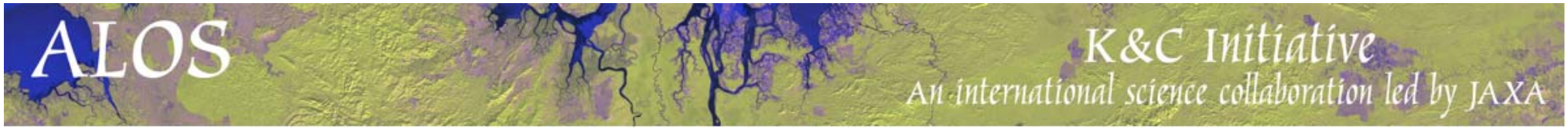
- **Ground reference data set primarily from National Wetlands Inventory**
- **Nonwetlands classes from Alaska Geospatial Data Clearinghouse**



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%.**

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

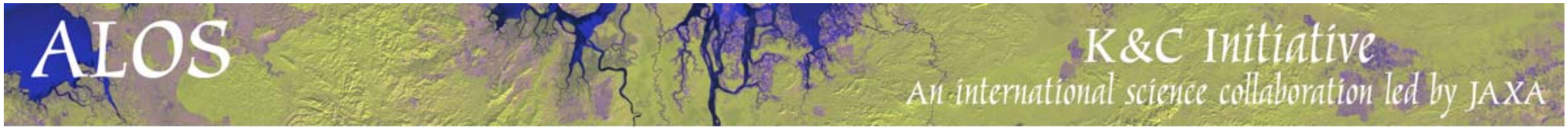
Ref.: J. Whitcomb, M. Moghaddam, K. McDonald, J. Kellndorfer, and E. Podest, “Mapping Wetlands of Alaska Using L-Band Radar Satellite Imagery,” in press.

Alaska Wetlands Tally

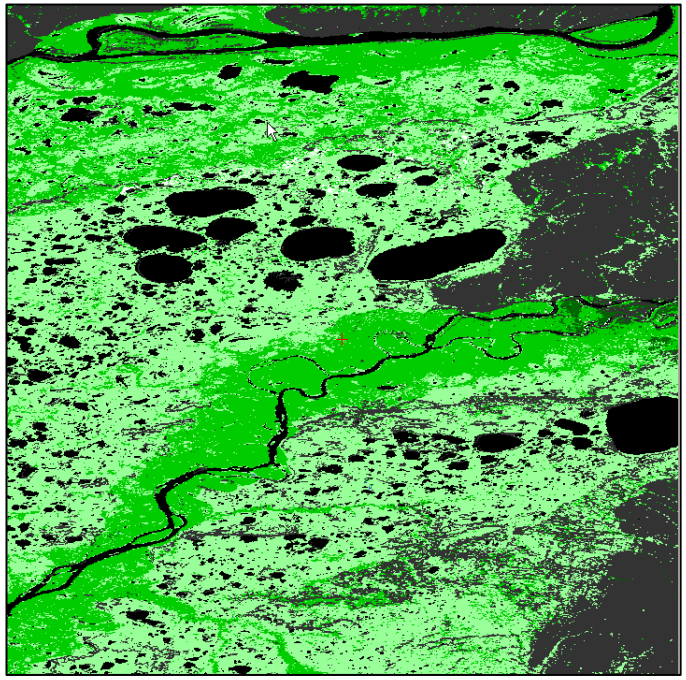
- **Following results are based on pixel counts in classified image**

Wetland Type	Fraction of Total Wetlands (%)	Fraction of Total Area of AK (%)
Emergent, Palustrine	46.4	12.2
Scrub/Shrub, Palustrine	44.3	11.6
Forested, Palustrine	8.56	2.25
Emergent, Estuarine	0.78	0.21
All Other vegetated	0.02	0.00
Open water		3.7
Total (all wetlands)	**100.0**	**29.9**

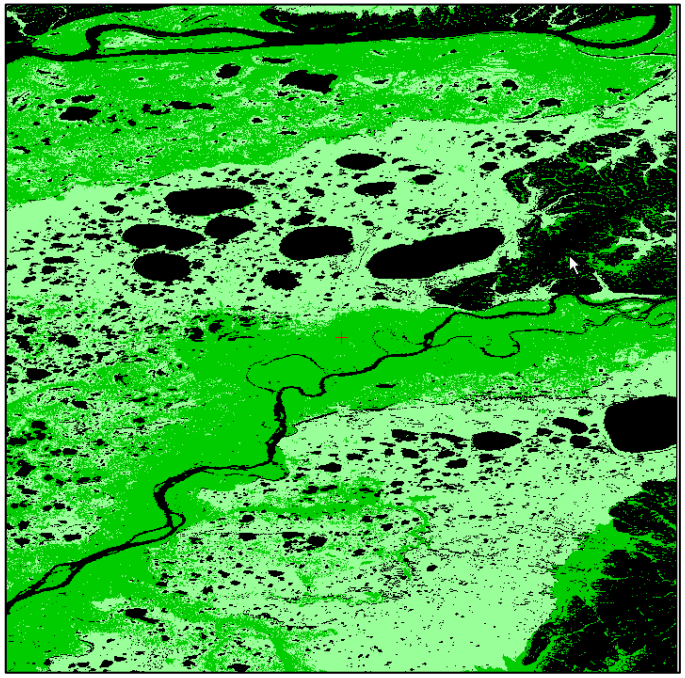
- **Approx. 26.3% of Alaska is vegetated wetlands**
- **Approx. 3.7% of Alaska is open water**
- **Total estimate of ~30% wetlands updates the 1980s figure (40-45%) derived through less rigorous means**



Decadal change in wetlands: JERS/PALSAR
Yukon Delta, Alaska



JERS SAR: 1998



ALOS PALSAR: 2007

Light green: emergent

Medium green: scrub/schrub.

This area does not have forested wetlands

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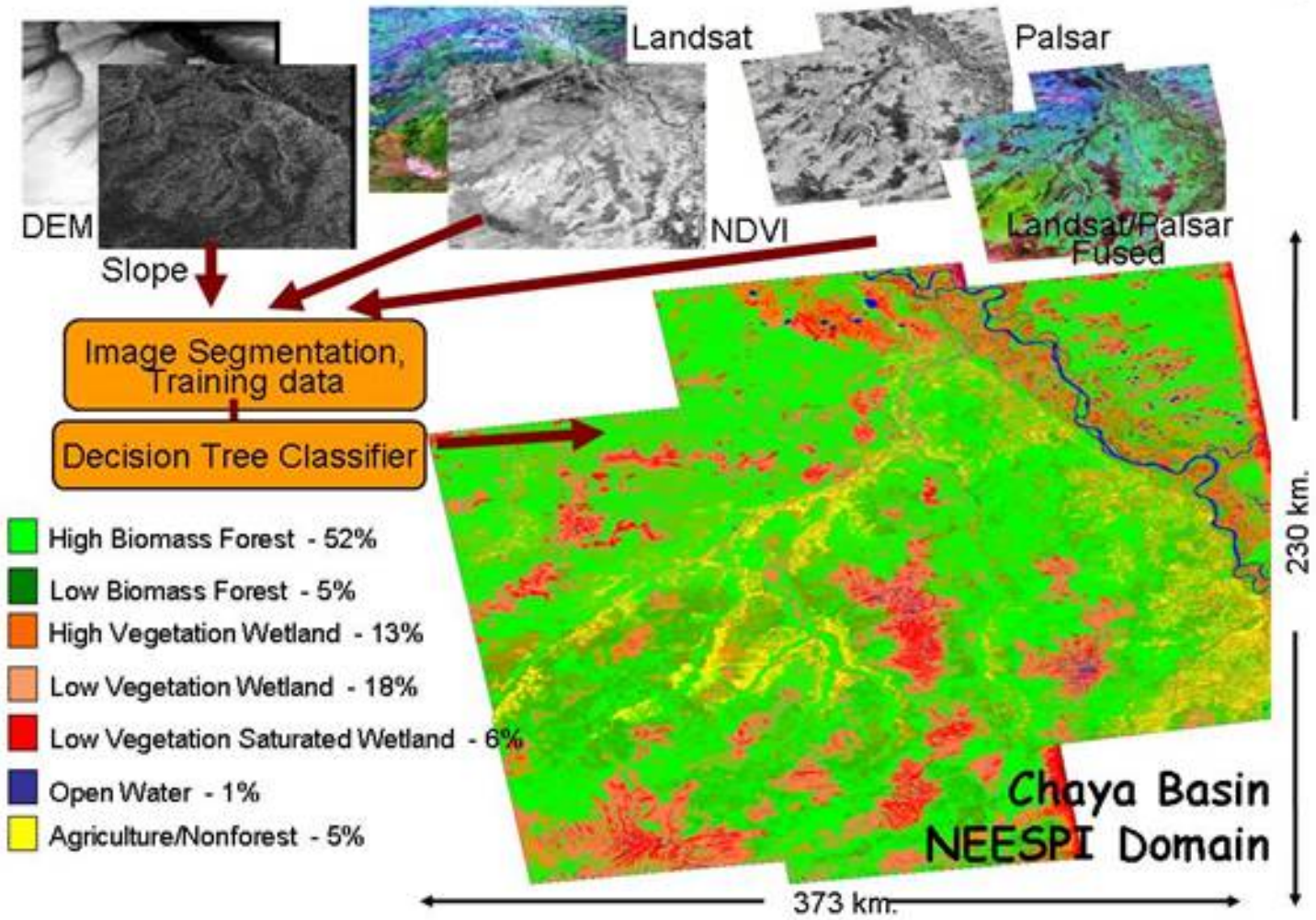
Wetland Characterization with MultiSensor Remote Sensing



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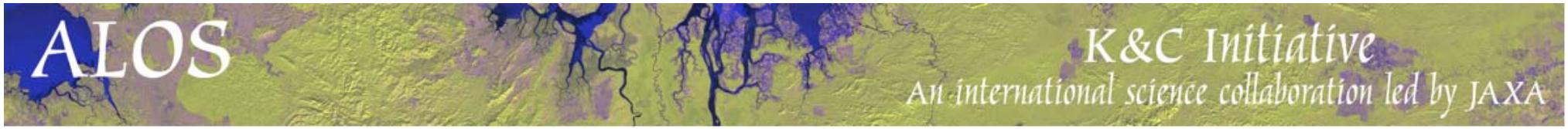
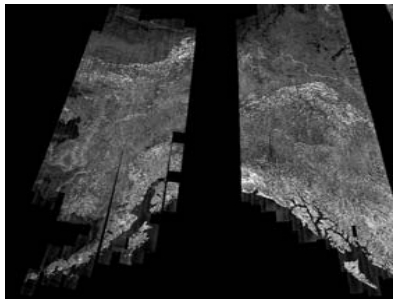
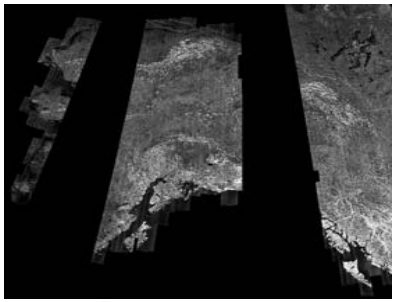
Jet Propulsion Lab
California Institute of Technology



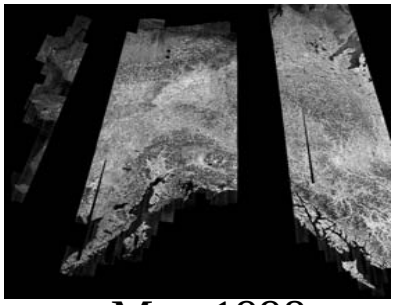
Alaska- Monthly 100m JERS-1 Mosaics for Assessment of Open Water Change


January 1998


February 1998


March 1998


April 1998

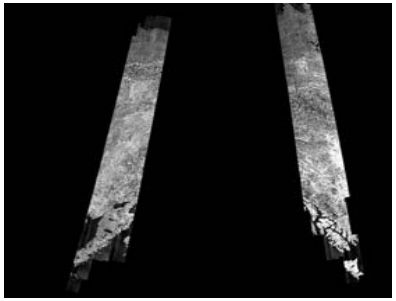

May 1998


June 1998


July 1998


August 1998

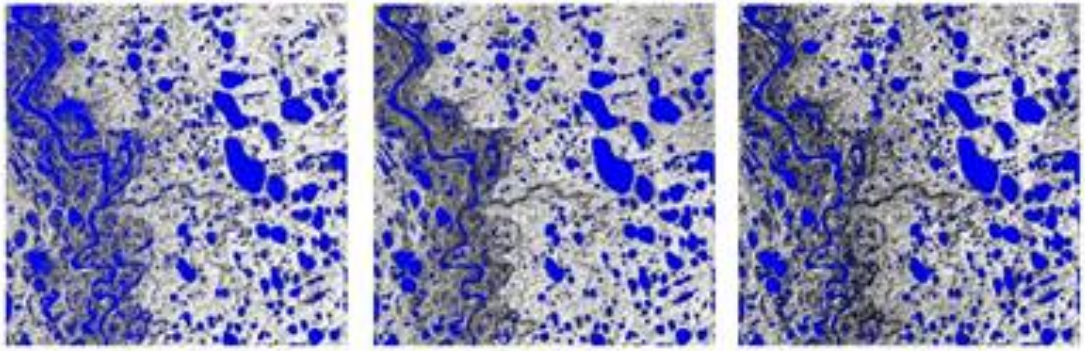

September 1998


October 1998

A USGS DEM of the entire state was used to mask out areas of complex topography were 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

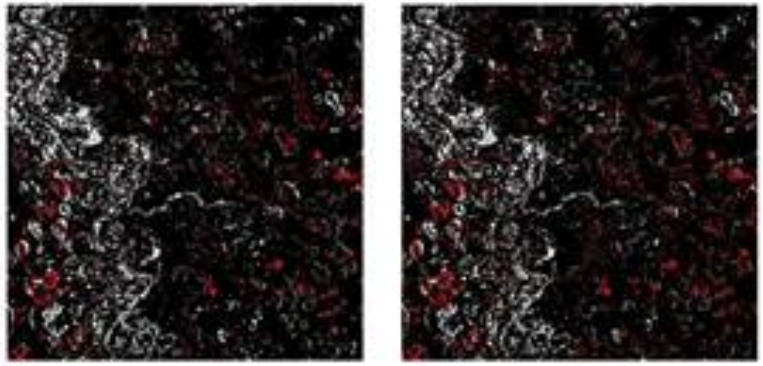
The top shows open water overlayed on the JERS image and the bottom shows open water change relative to June.



June 1998 July 1998 August 1998

More open water
Less open water
No change

40 km



Open water change June/July

Open water change June/August

Open Water Change Relative to June

	Dryer	Wetter
Jul.	7.7%	2.7%
Aug.	6.9%	3.2%

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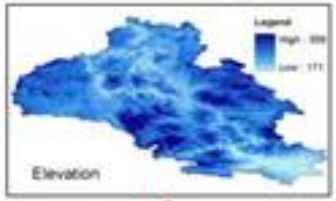
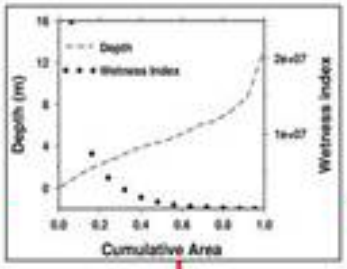
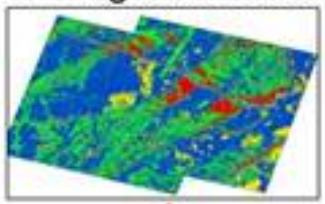
Linkages

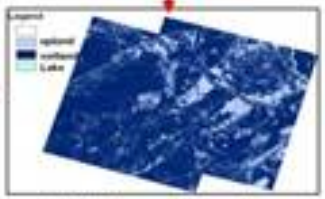


Wetland Parameterization



JPL Vegetation Class



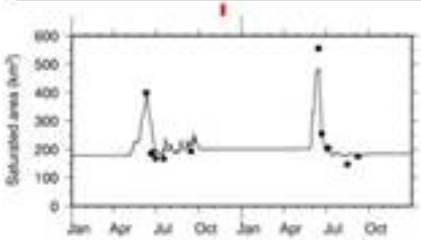


Wetland Mask

The VIC model

surface water extent

water table, soil temperature, NPP



Model vs. JPL open water product

Walter and Heimann methane model

methane flux by landscape position

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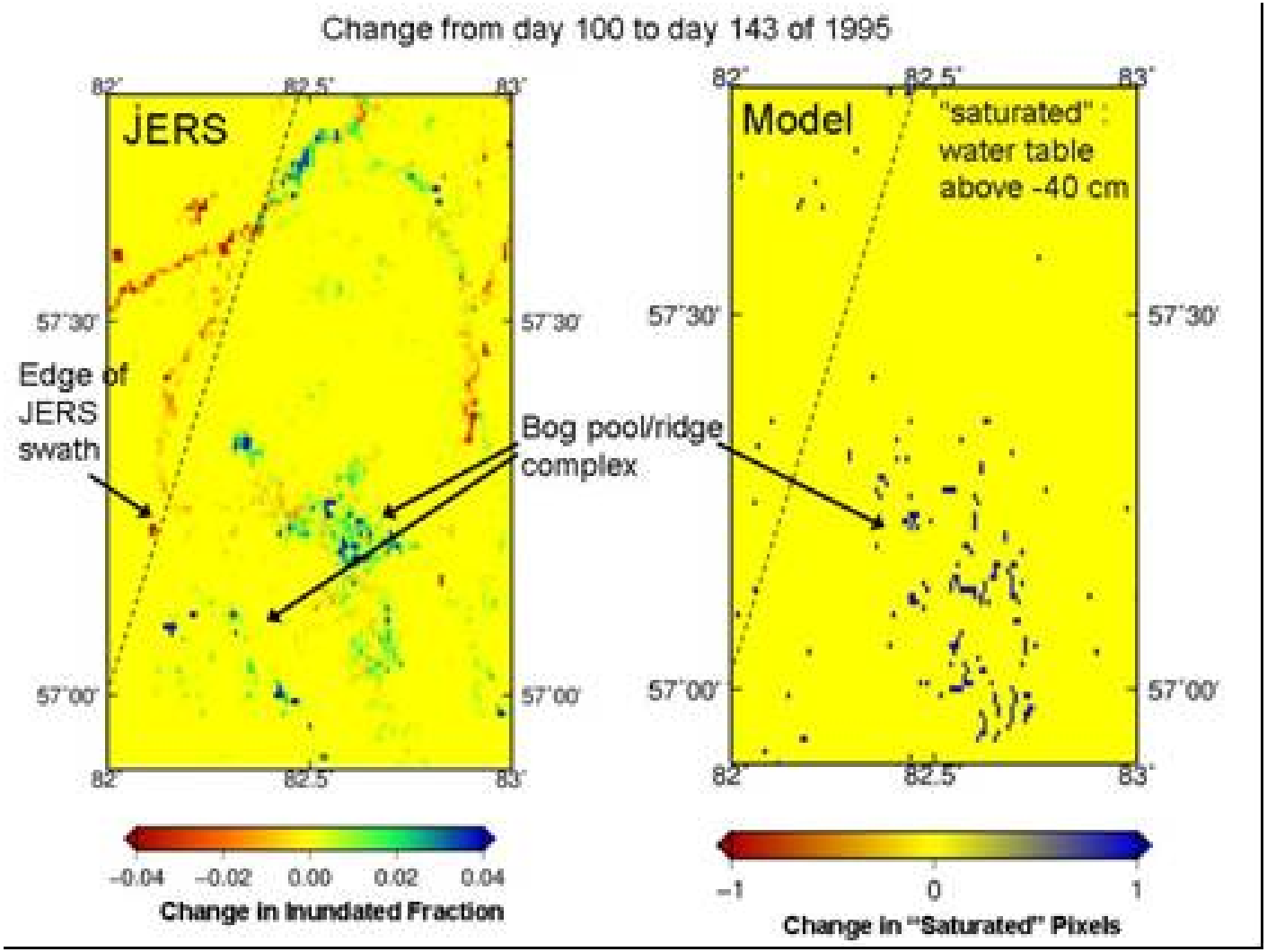

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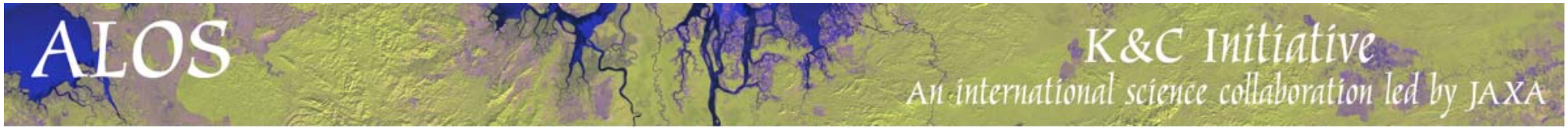


Motivation and Objectives

Motivation:

The seasonal transition between predominantly frozen and non-frozen conditions occurs each year over more than 50 million km^2 of the global biosphere, profoundly affecting surface hydrology, meteorology and ecosystem processes.

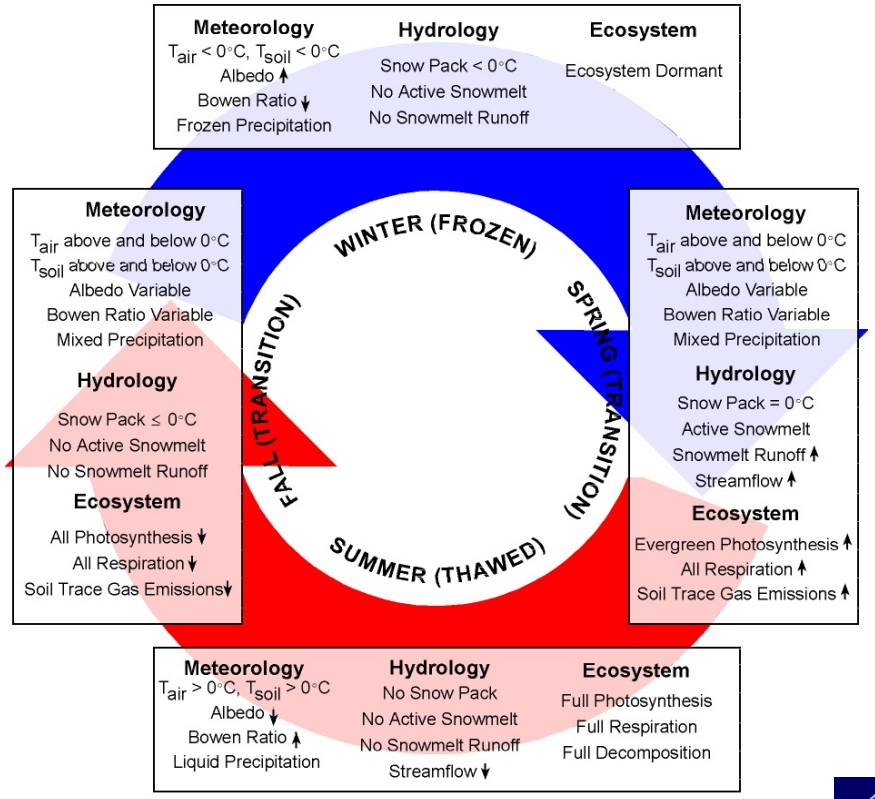
The freeze/thaw (F/T) state variable from satellite microwave remote sensing provides a surrogate measure of landscape frozen/non-frozen conditions.

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.

Conceptual Diagram of Biosphere Response to Seasonal F/T Cycles



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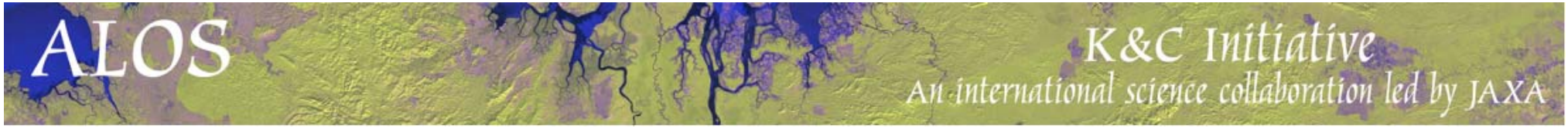
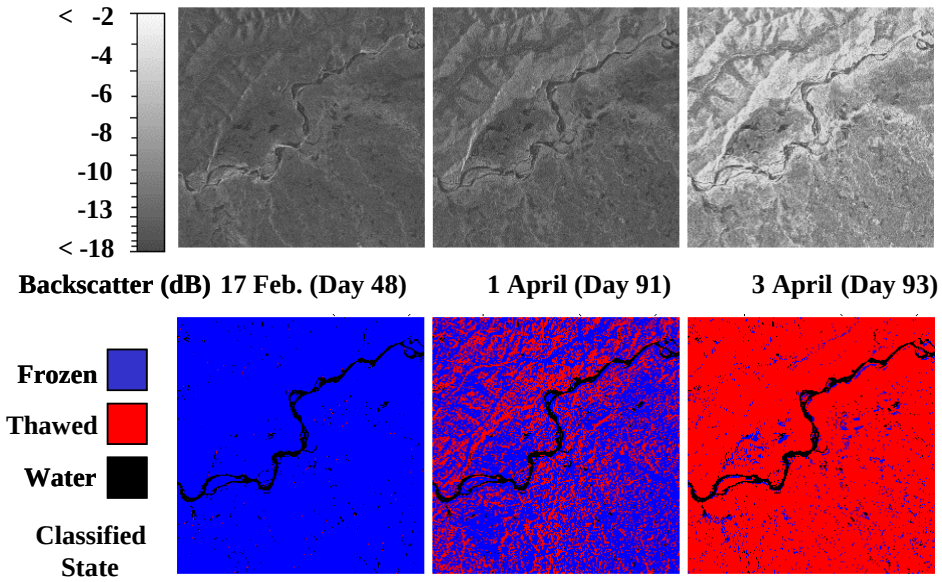
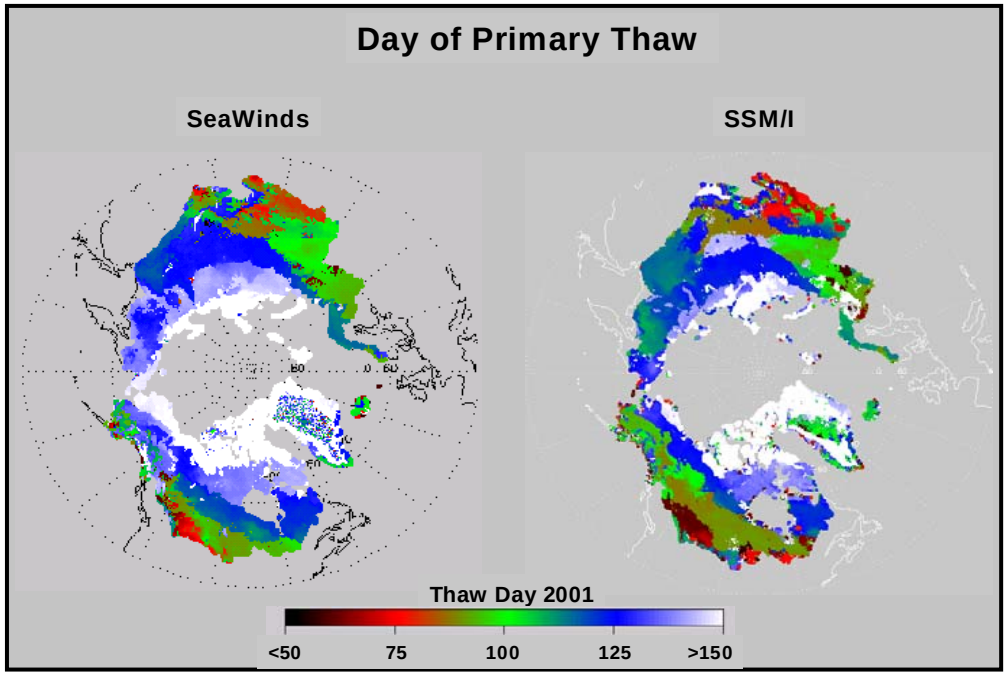


JERS -1 L-band SAR landscape freeze-thaw classification





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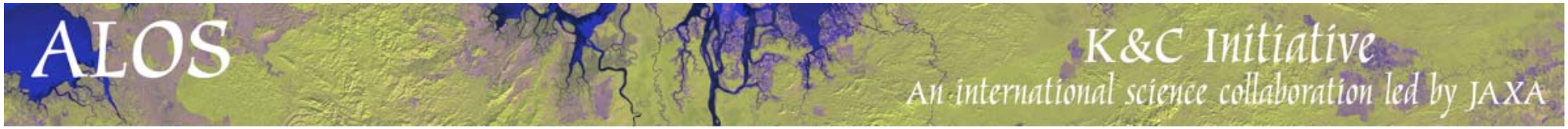
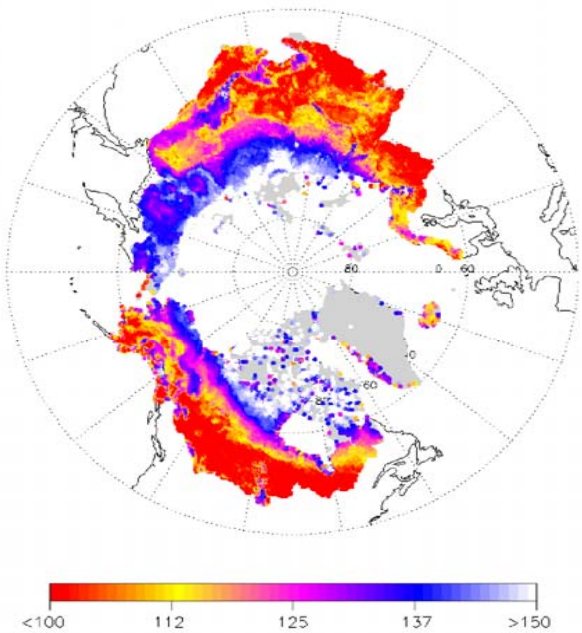


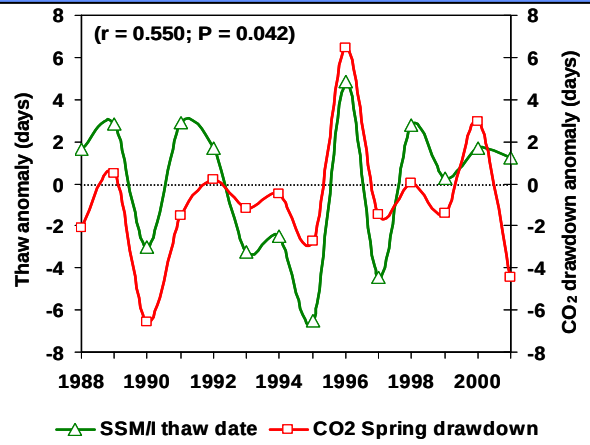
Freeze/Thaw and Carbon Cycle Science

The satellite F/T signal corresponds with growing season timing and duration, influencing NPP and atmospheric CO_2 dynamics. The FT-ESDR will enable improved studies of cold temperature constraints to NPP and land-atmosphere C exchange.

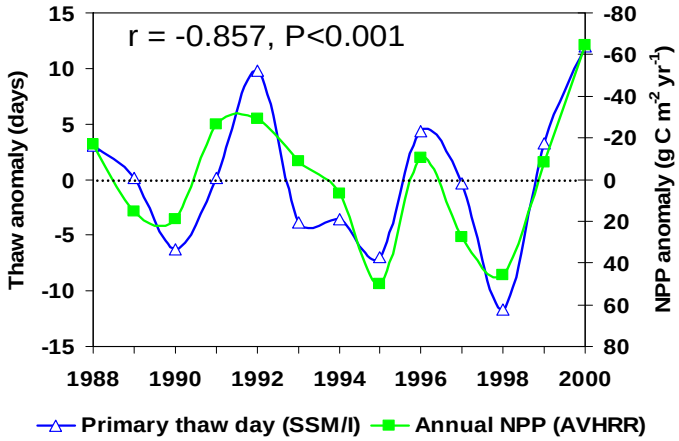


Mean Growing Season Onset
(SSM/I, 1988-2001)

SSM/I Thaw vs Spring Atmosphere CO_2 Anomalies



AK Spring Thaw vs NPP



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