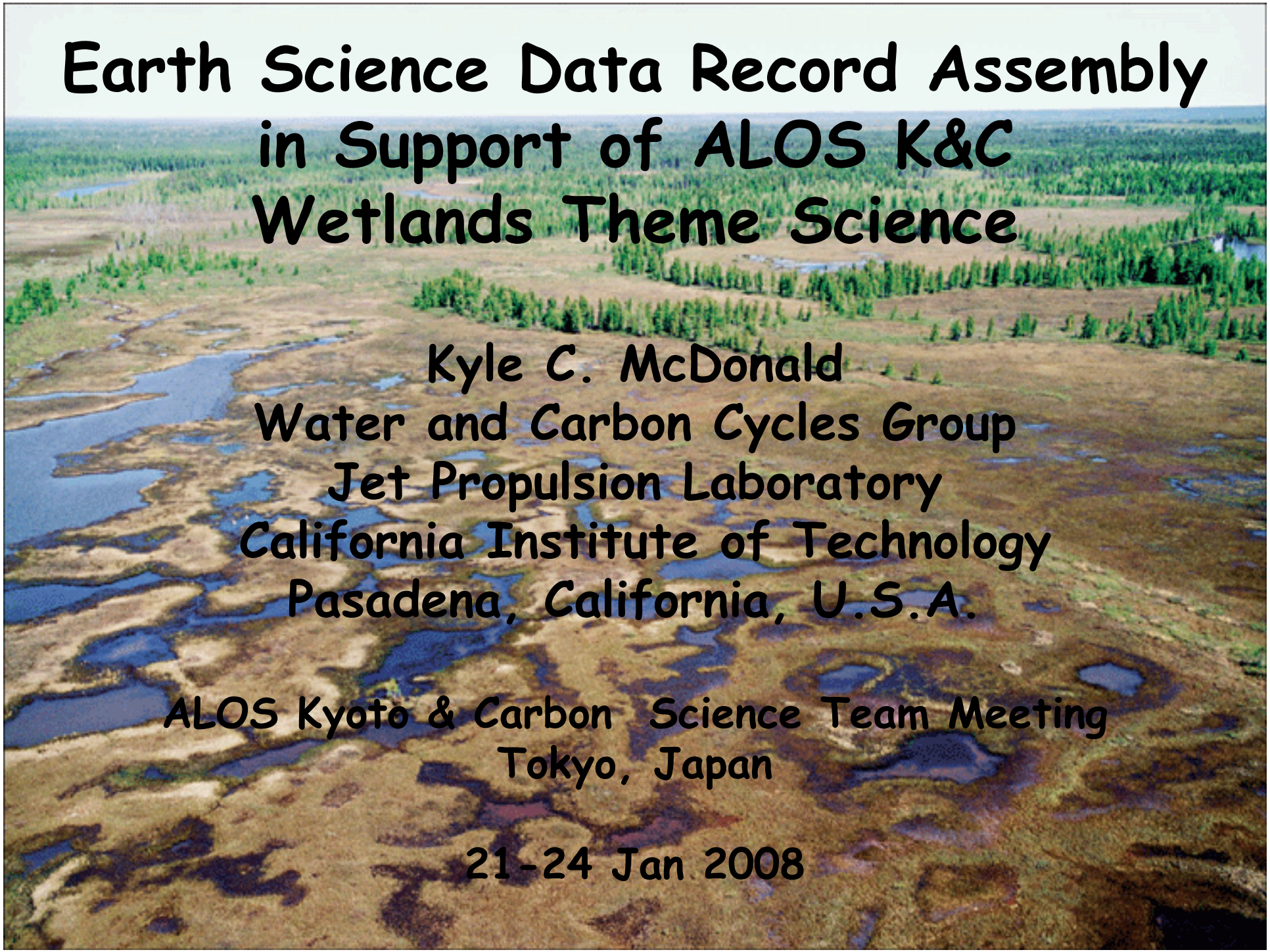


Earth Science Data Record Assembly in Support of ALOS K&C Wetlands Theme Science

Kyle C. McDonald
Water and Carbon Cycles Group
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California, U.S.A.

ALOS Kyoto & Carbon Science Team Meeting
Tokyo, Japan

21-24 Jan 2008

An Inundated Wetlands Earth System Data Record: Global Monitoring of Wetland Extent and Dynamics

Objective: Development of a data set to facilitate global and regional studies of the role of inundated wetlands in studies of climate, biogeochemistry, hydrology, and biodiversity.

An Earth System Data Record for Land Surface Freeze/Thaw State: Quantifying Terrestrial Water Mobility Constraints to Global Ecosystem Processes

Objective: Construction of a consistent, systematic long-term global record of land surface freeze/thaw state dynamics for all vegetated regions where low temperatures are a major constraint to ecosystem processes.

An Inundated Wetlands Earth System Data Record: Global Monitoring of Wetland Extent and Dynamics

Principal Investigator: Kyle McDonald (JPL/Caltech)

NASA Project Scientist: Diane Wickland (Terrestrial Ecology Program)

Project Members:
Bruce Chapman (JPL/Caltech)
Laura Hess (University of California, Santa Barbara)
John Kimball (University of Montana)
Elaine Matthews, (NASA/GISS)
Mahta Moghaddam (The University of Michigan)

Collaborators:
Catherine Prigent (LERMA - France)
Ake Rosenqvist (JRC- Italy)
Masanobu Shimada (EORC-JAXA – Japan)
Wenjun Chen (Canadian Centre for Remote Sensing
Nick Davidson (Ramsar)
Max Finlayson
(International Water Management Institute)
Martti Hallikainen
(Helsinki University of Technology)

Components of the Inundated Wetlands Earth System Data Record

I. Regional inundated wetlands data sets from Synthetic Aperture Radar (SAR)
- Spatial coverage: Major global wetland regions, 100m resolution
- Temporal coverage: 1-2 year time series at 17-to-46 day intervals during 2006-2009 † ‡
- Retrospective 1990's-era from archived JERS data covering Alaska, Canada, Amazon
1. Wetland extent (maximum inundatable area, including water bodies).
2. Wetland vegetation type (Non-vegetated, Herbaceous, Shrub, Woodland, Forest).
3. Inundation state (Flooded, Non-flooded; 17-46 day intervals) ‡
4. Annual inundation duration

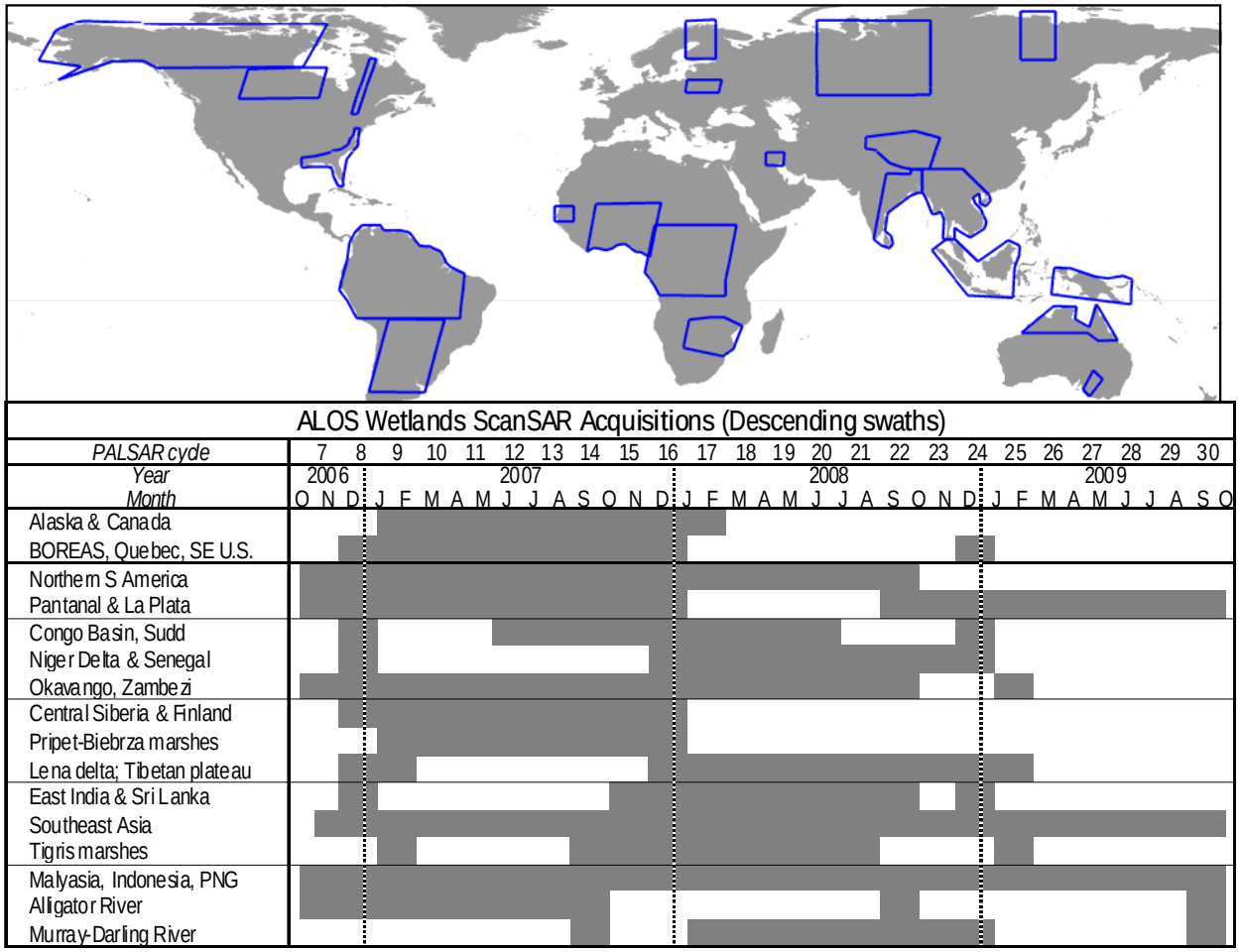
II. Global monthly inundation data sets derived from multiple satellite data sources
- Spatial coverage: Global, 25 km resolution
- Temporal coverage: Monthly monitoring with annual summaries, 1992-2009 †
1. Globally gridded (0.25º) monthly inundated area fraction
2. Globally gridded (0.25º) annual inundation duration

† The domain of the 25-km and 100-m data sets excludes permanently frozen regions and seasonally frozen landscapes during the frozen season, although data from frozen seasons is used to improve classification accuracy.

‡ PALSAR ScanSAR mode has 46-day exact repeat orbit with 17-day sub-cycles.

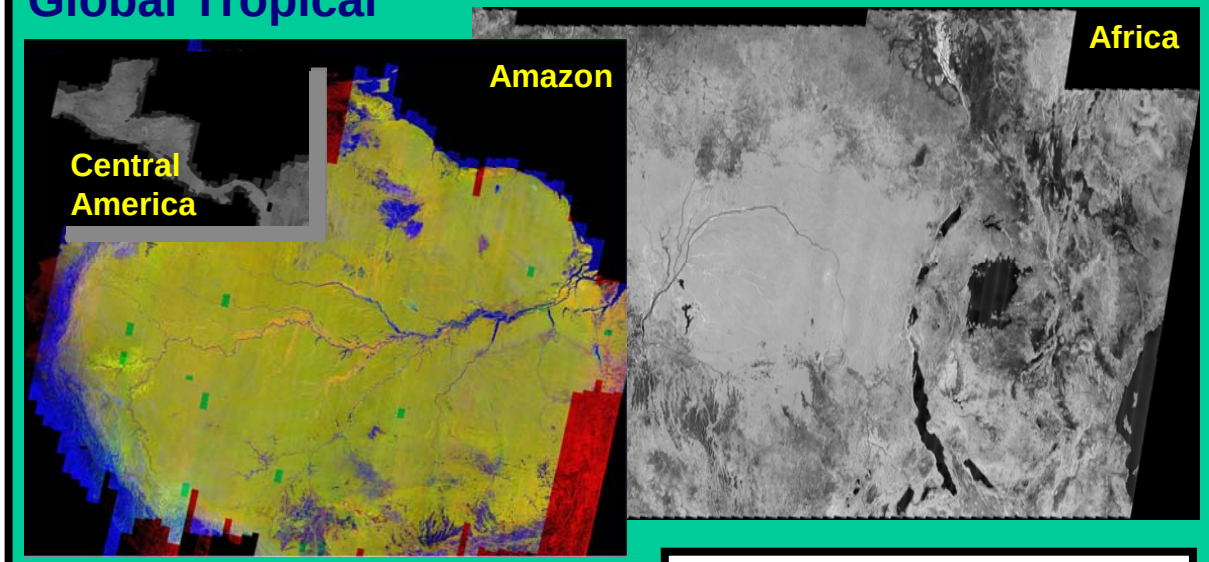
PALSAR Regional Coverage: ScanSAR regions

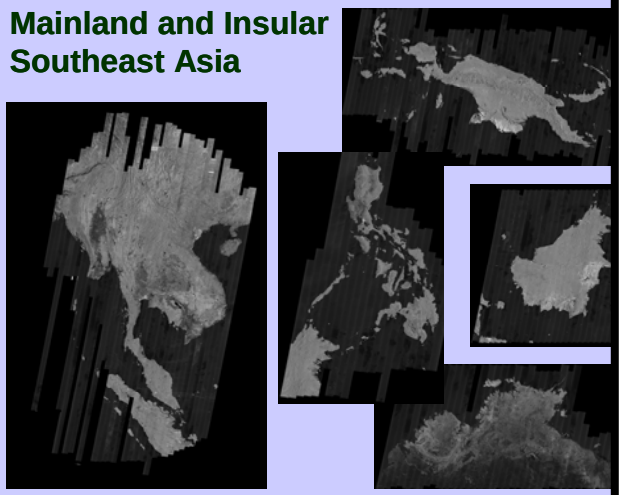
- Inundated wetland area (swath-by-swath)
- Principal wetland vegetation classes (non-vegetated, herbaceous, shrub, woodland, forest),
- Seasonally based summary products describing timing and extent of wetland inundation
- Production is phased according to K&C acquisitions



Global Boreal and Rain Forest Mapping Projects: JERS-1 Synthetic Aperture Radar Image Mosaics

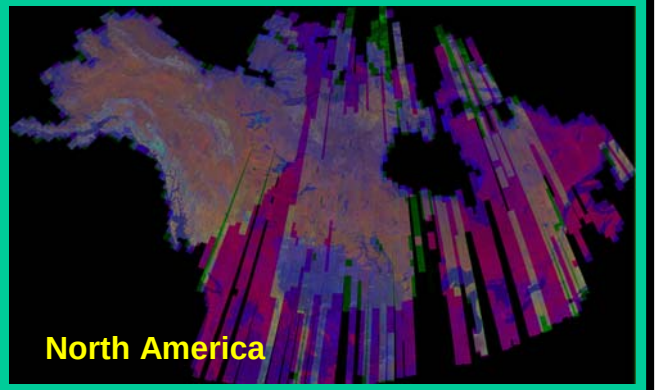
Global Tropical

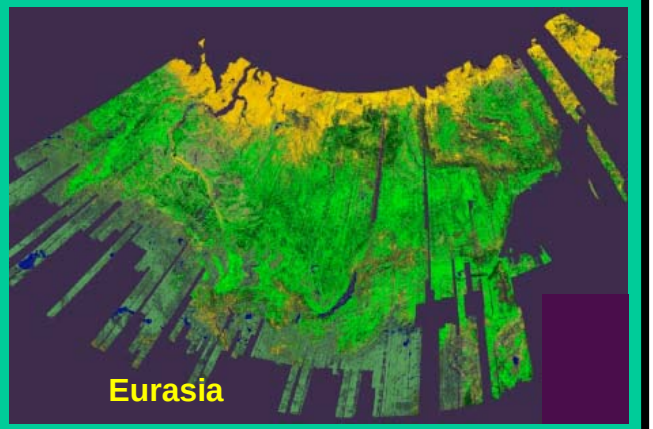




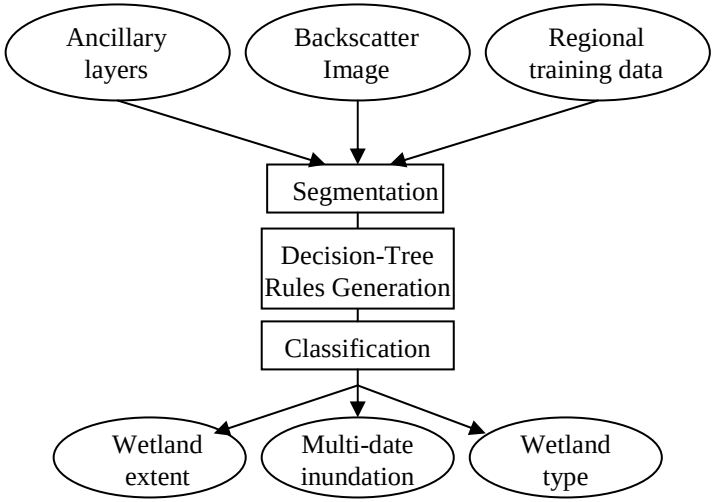
Examples of regional and continental-scale JERS-1 backscatter image mosaics assembled under the Global Boreal Forest and Rain Forest Mapping Projects. The JERS-1 SAR constitutes a pathfinder mission for application of satellite-borne SAR for mapping global wetlands. **We will build on experience and techniques established utilizing these data sets in developing our global-scale inundated wetlands ESDR.**

Global Boreal



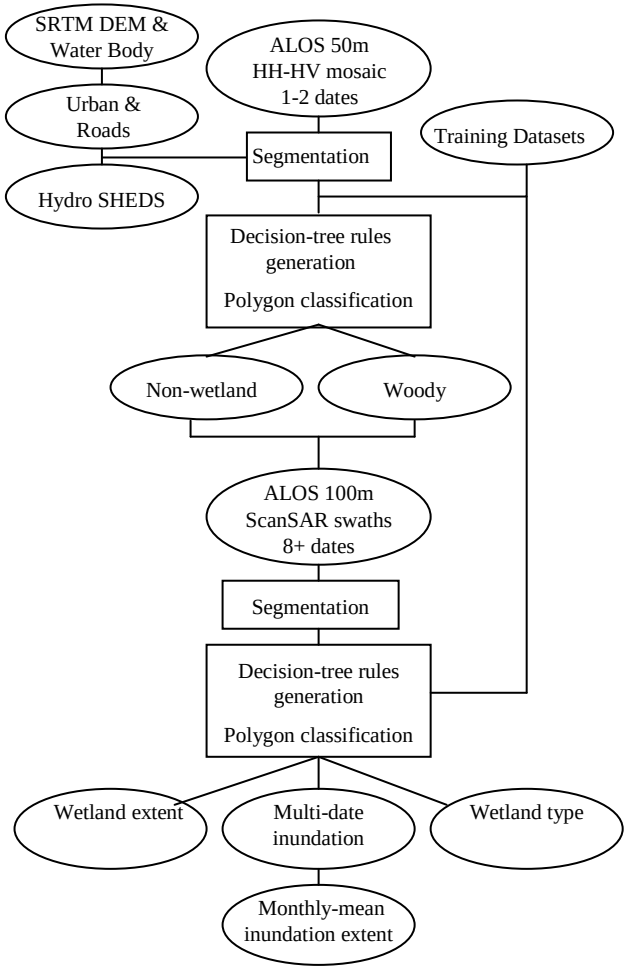


Regional inundated wetlands data sets from Synthetic Aperture Radar (SAR): Algorithms



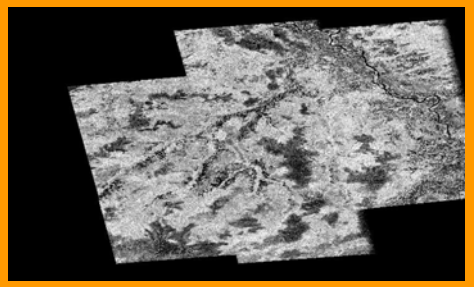
Baseline Algorithm

Algorithm for classification of L-band SAR imagery into 100-meter resolution inundated wetlands data sets. The SAR classification algorithm employs object-oriented image segmentation and statistically-based decision tree classification. This construct follows directly from our previous work on mapping of tropical and boreal wetlands with JERS SAR imagery.



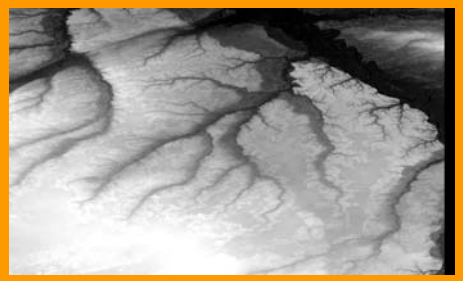
Enhanced Algorithm

Chaya Basin

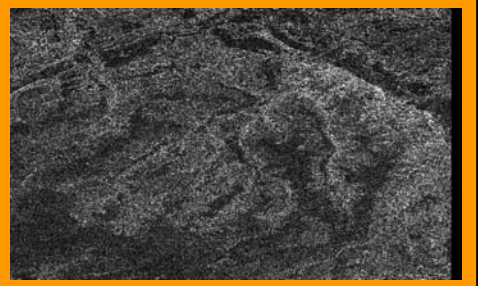


Palsar

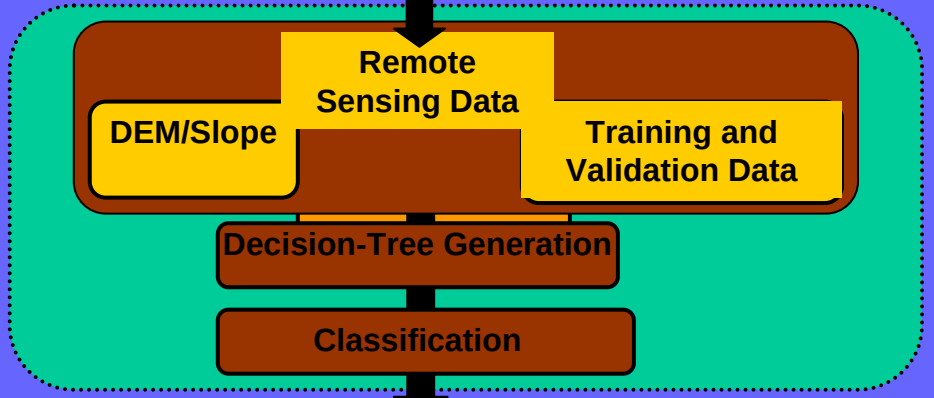
Landsat



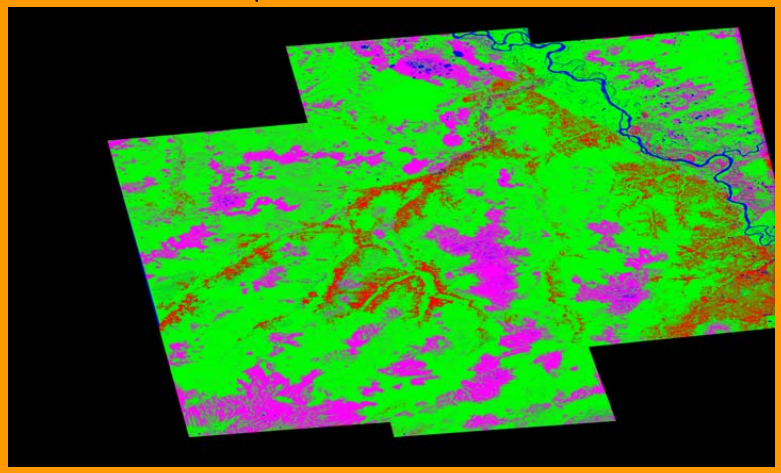
DEM



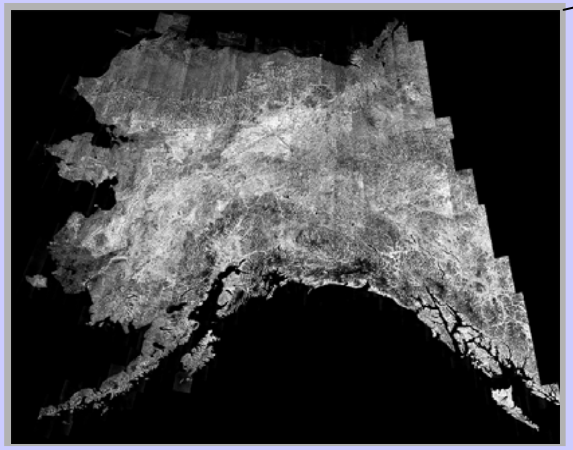
Slope



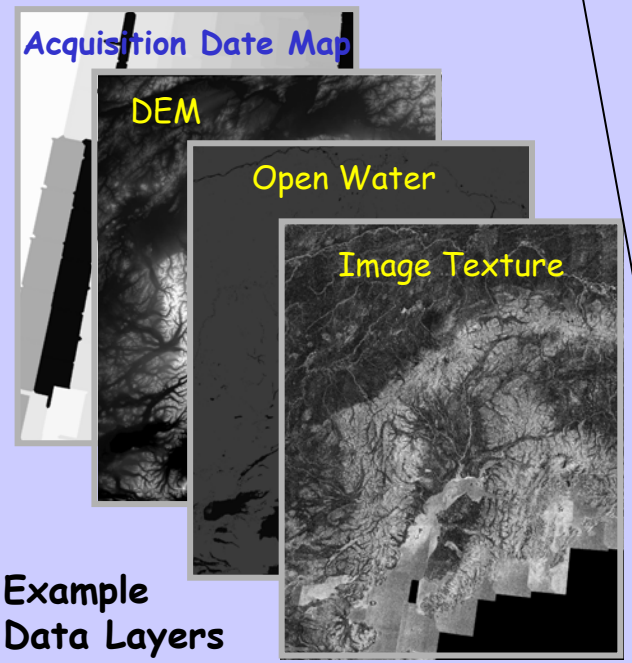
- Wetland
- Open Water
- Agriculture
- Low Biomass non-wetland
- High Biomass non-wetland



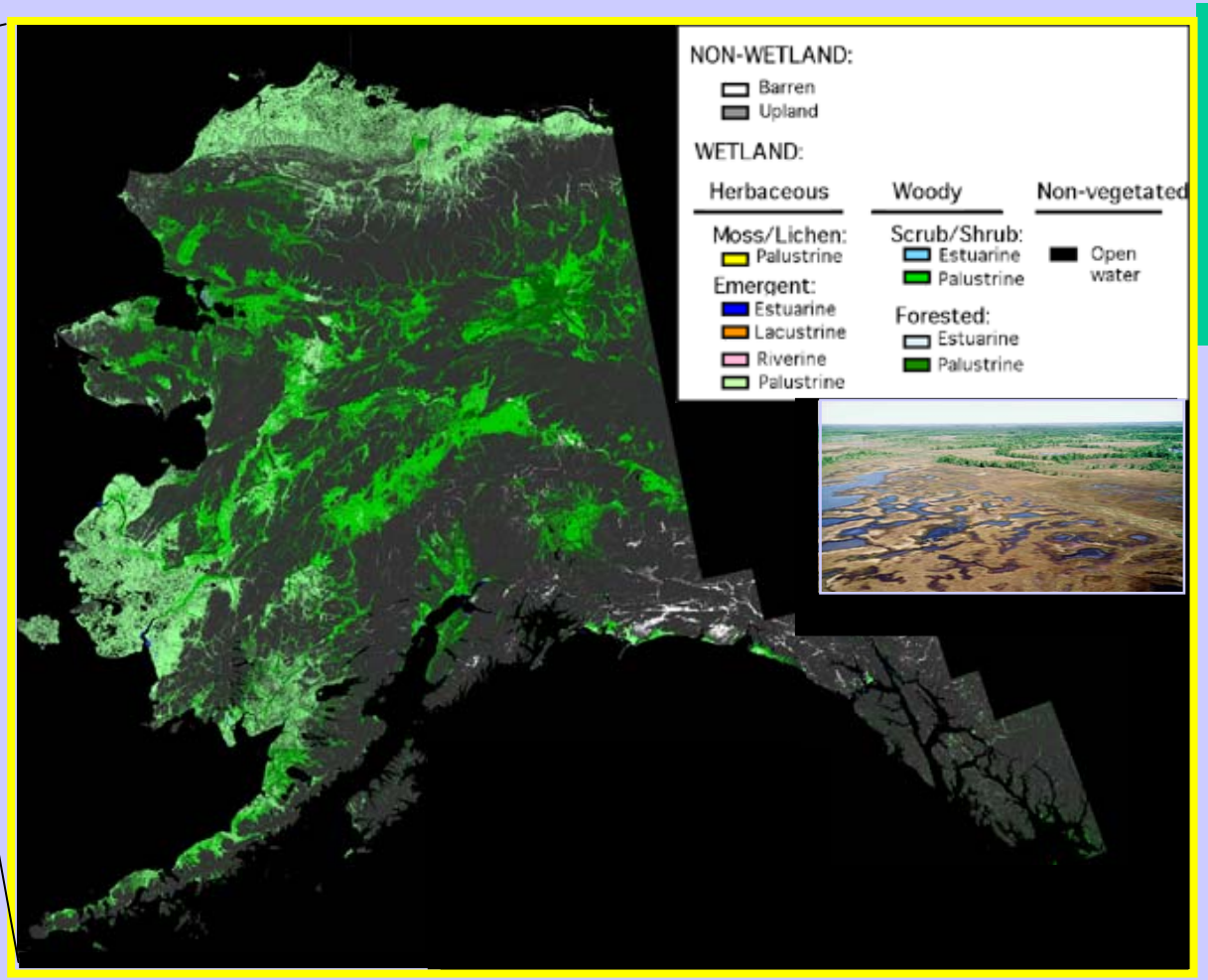
Alaska Wetlands Map from Satellite L-Band Synthetic Aperture Radar



JERS-1 SAR Mosaic



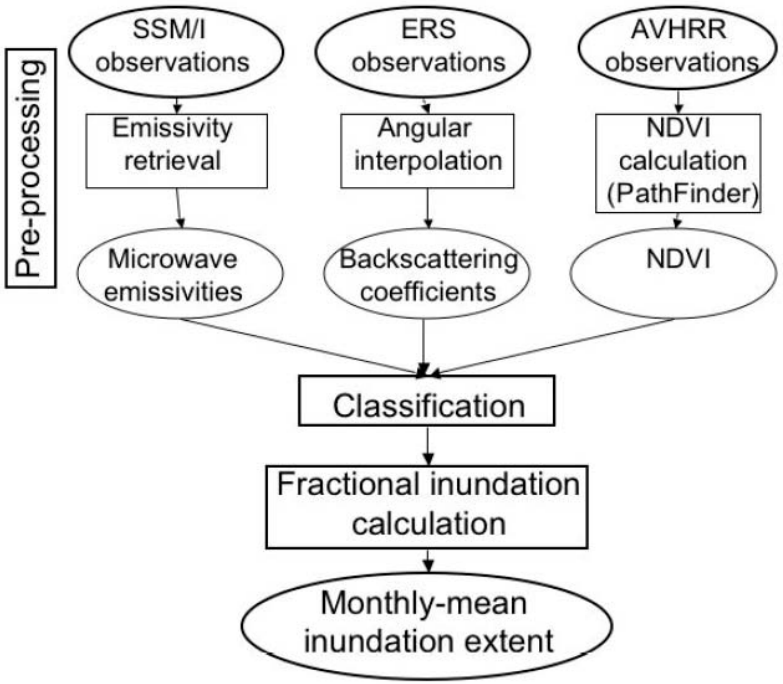
Example Data Layers

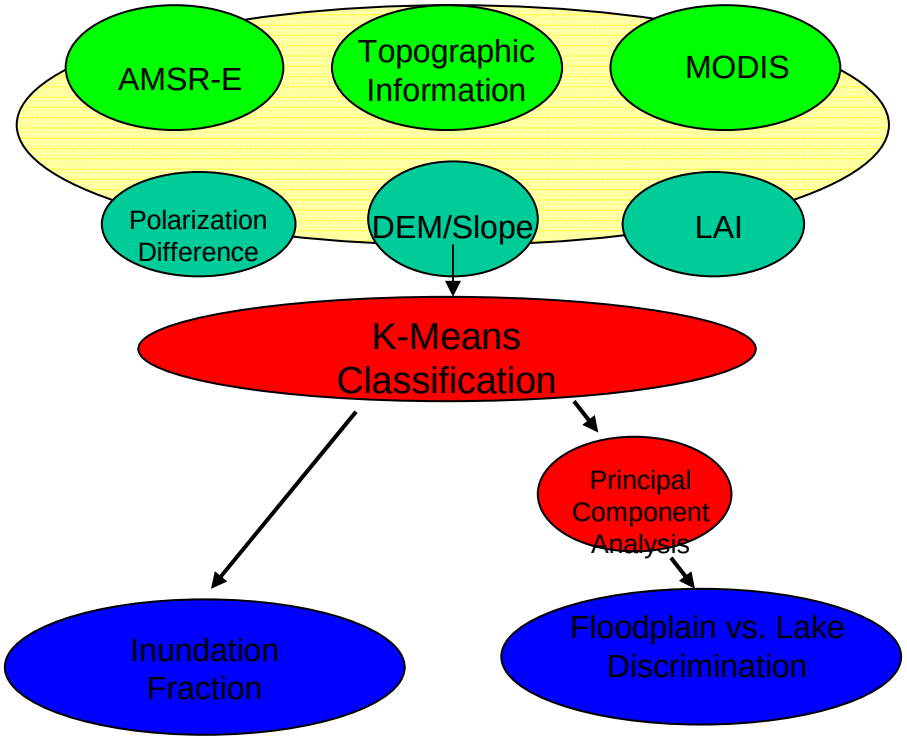


A 100-meter resolution wetlands map of Alaska has been developed using JERS-1 SAR imagery. A statistically based decision tree classification scheme was applied using multiple data layers to develop the regional-scale map. Data layers employed include maps of wetlands ground reference data, DEM, JERS SAR-based open water maps, SAR acquisition date, and image texture.

Whitcomb, Moghaddam, McDonald, Kellndorfer, and Podest, 2007 (in review)

Global monthly inundation data sets derived from multiple satellite data sources: Algorithm



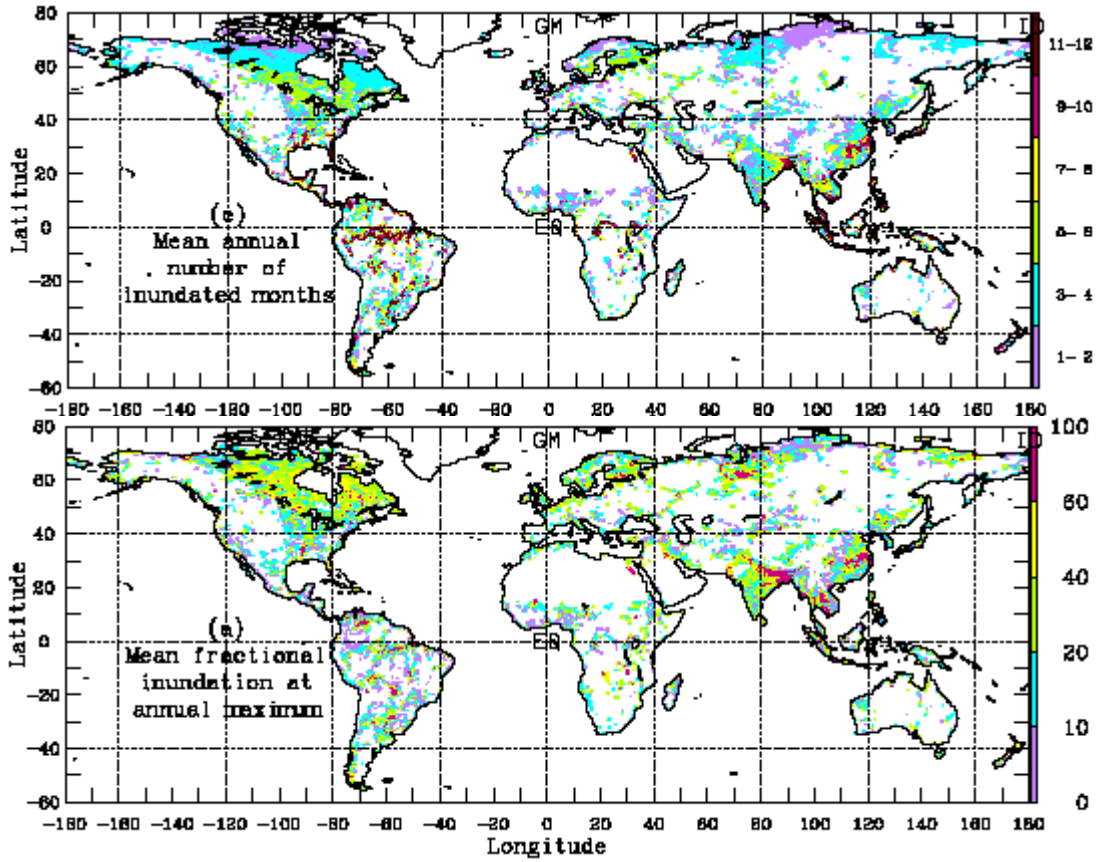


Legacy Algorithm

Algorithm Utilizing Contemporary Sources

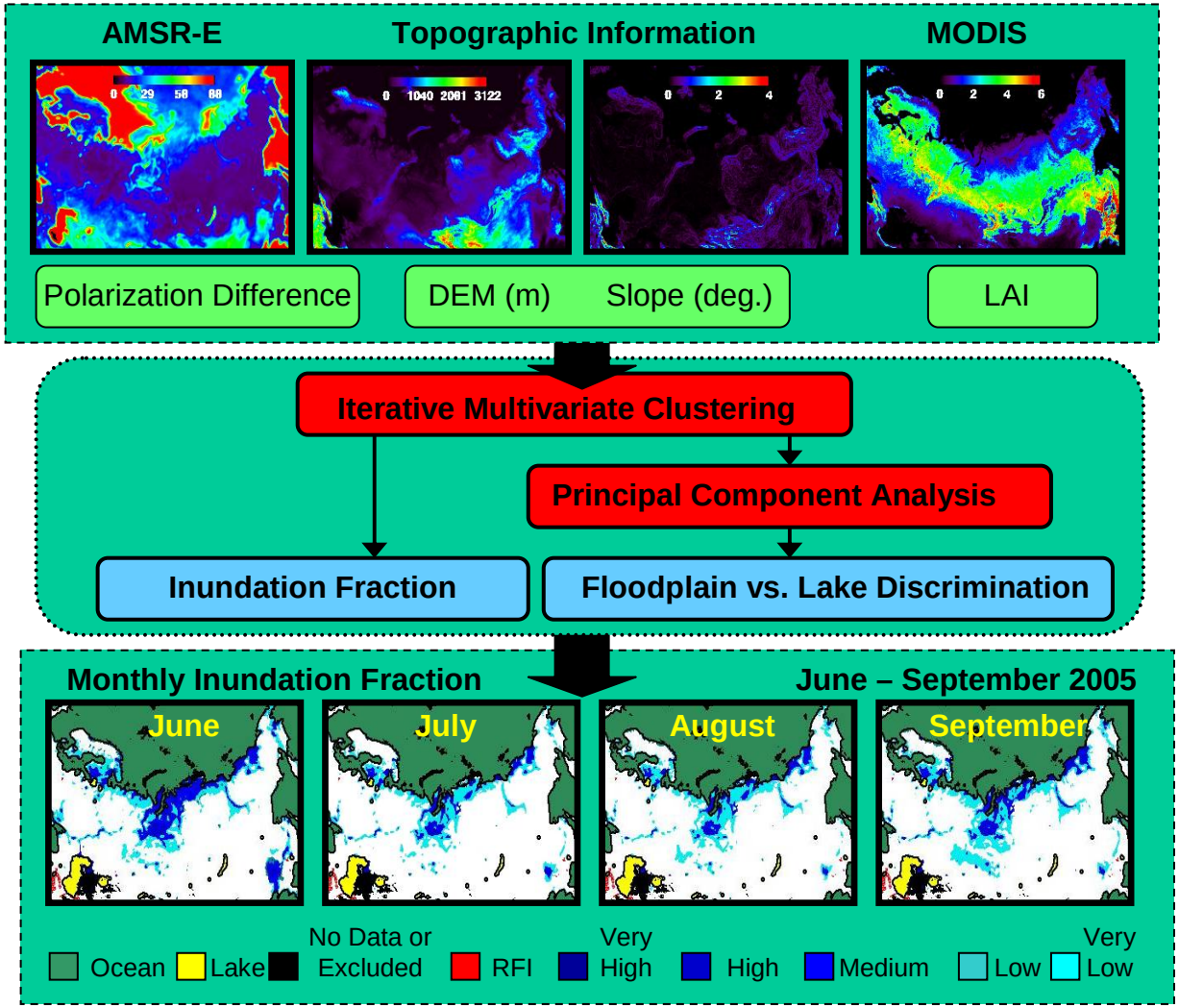
Algorithm construct for derivation of monthly inundated area fraction data sets. Monthly inundated area fraction employs data from multiple satellites to derive estimates of wetland extent.

Global monthly inundation data sets: Legacy Algorthm

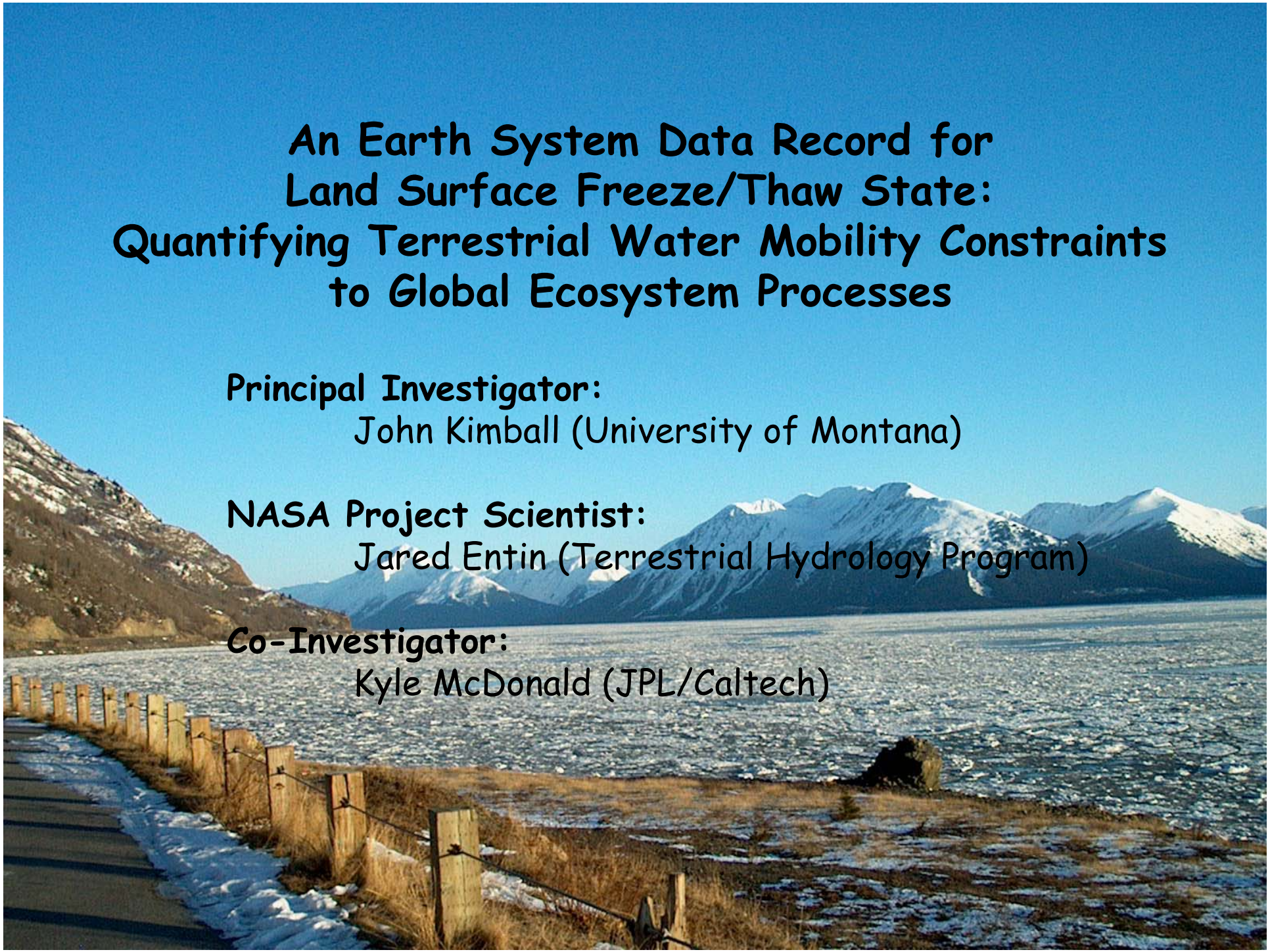


Global mapping of (top) the annual mean number of inundation months from 1993 through 2000, and (bottom) mean fractional inundation at the annual maximum inundation over this same time period, as inferred from multiple satellite sources (Prigent et al., 2007). These data sets indicate the global extent of potential wetland regions. We will incorporate the 100m SAR-based data sets of wetland features to validate and quantify the accuracy of these lower-resolution data sets to ensure consistency within the ESDR components.

Global monthly inundation data sets: Contemporary Data Sources



Construct for derivation of monthly inundation data sets, showing example products for the NEESPI domain. Algorithm input data sets include AMSR-E brightness temperature and polarization difference, topography, and MODIS-based leaf area index (LAI). An iterative unsupervised multivariate clustering approach is employed to identify potential inundated areas and the corresponding inundation fraction, and principal component analysis applied to differentiate critical features within the inundated regions. The derived data sets show monthly mean relative inundated area fraction. The algorithm is applied globally and shown here for the NEESPI region. **We will use high resolution (~100m) data sets derived from PALSAR to quantify the inundation area fraction provided by this scheme, and to validate the algorithm performance. These products will be merged within our process modeling construct to assess the process model performance for contemporary timeframes (2002 onward).**



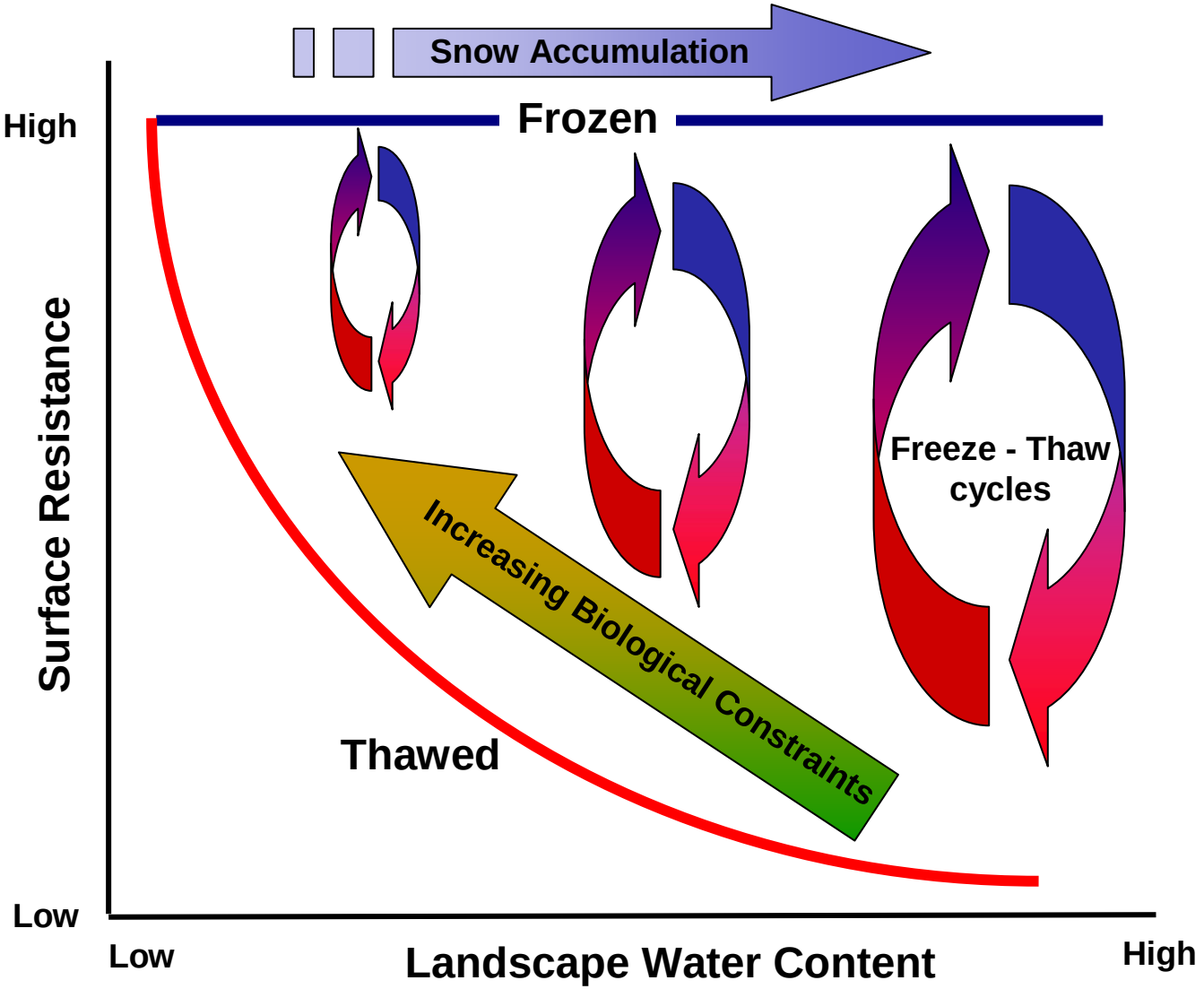
An Earth System Data Record for Land Surface Freeze/Thaw State: Quantifying Terrestrial Water Mobility Constraints to Global Ecosystem Processes

Principal Investigator:
John Kimball (University of Montana)

NASA Project Scientist:
Jared Entin (Terrestrial Hydrology Program)

Co-Investigator:
Kyle McDonald (JPL/Caltech)

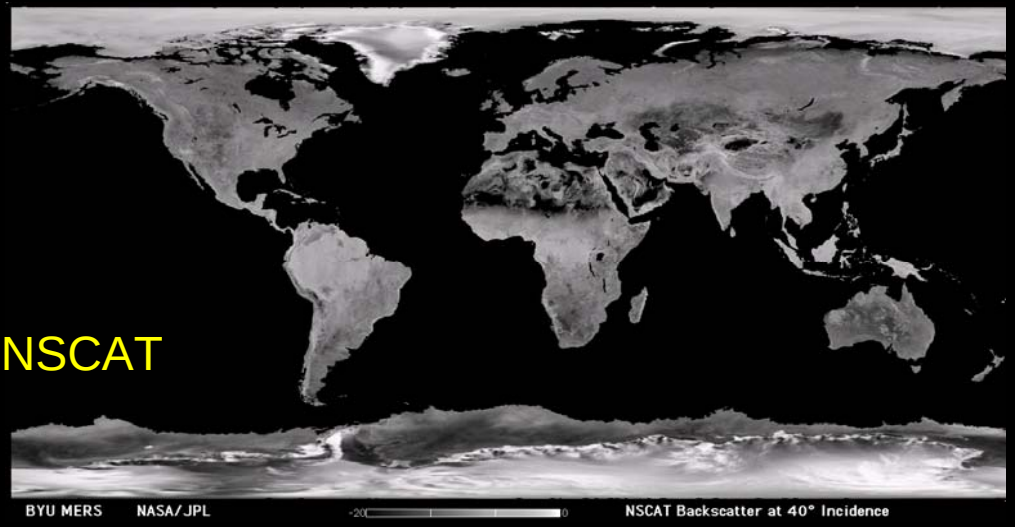
Terrestrial Water Mobility Constraints to Ecosystem Processes



Conceptualization of the relationship between landscape water content and the bulk surface resistance to land-atmosphere latent energy and water exchange, vegetation productivity and sequestration of atmospheric CO_2. Decreasing water content imposes increasing constraints to CO_2 exchange, as do seasonal and episodic freezing. Accumulation of snow during cold seasons allows for increased water availability (high water content) for growth processes after snow melt and landscape thaw.

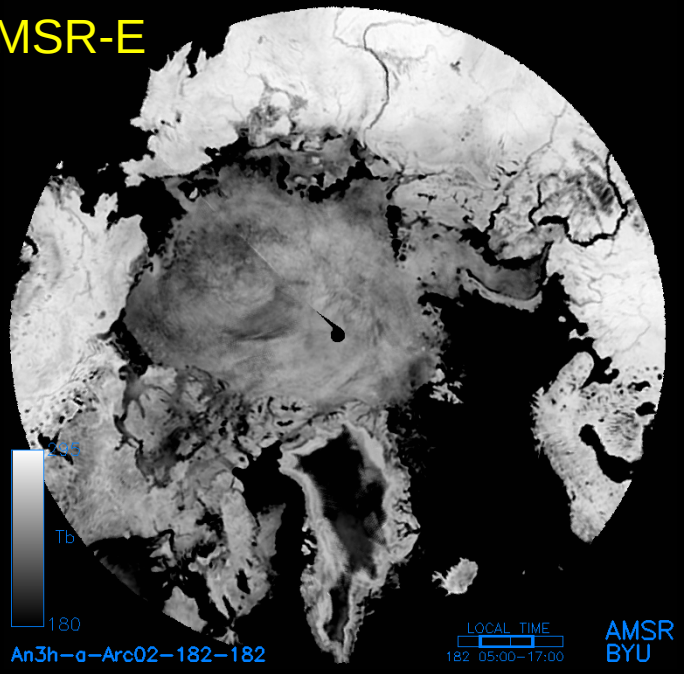
Global Data Sets: Active and Passive Sensors

NSCAT



The global land and cryosphere as observed by the NASA Scatterometer (NSCAT).

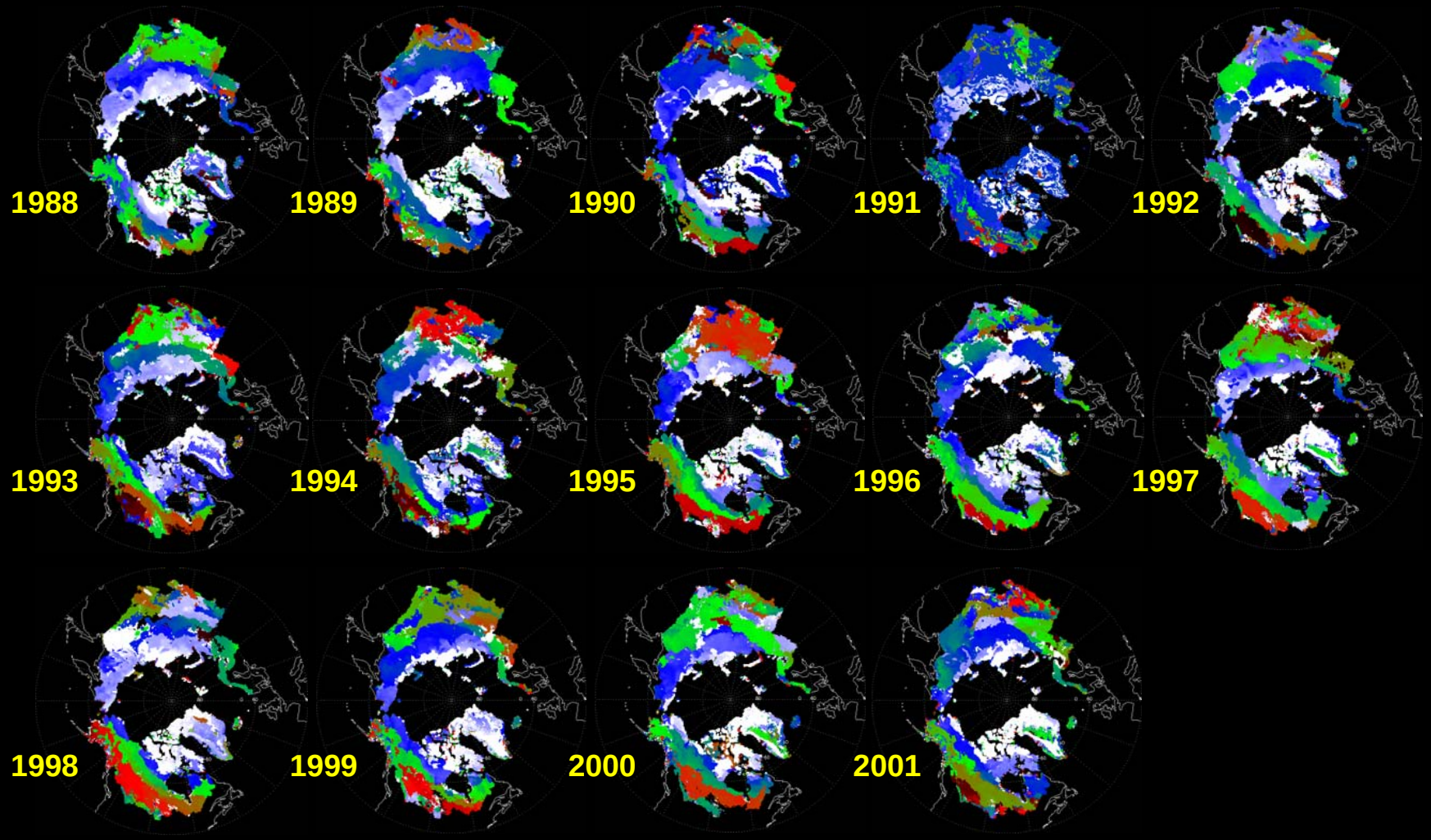
AMSR-E

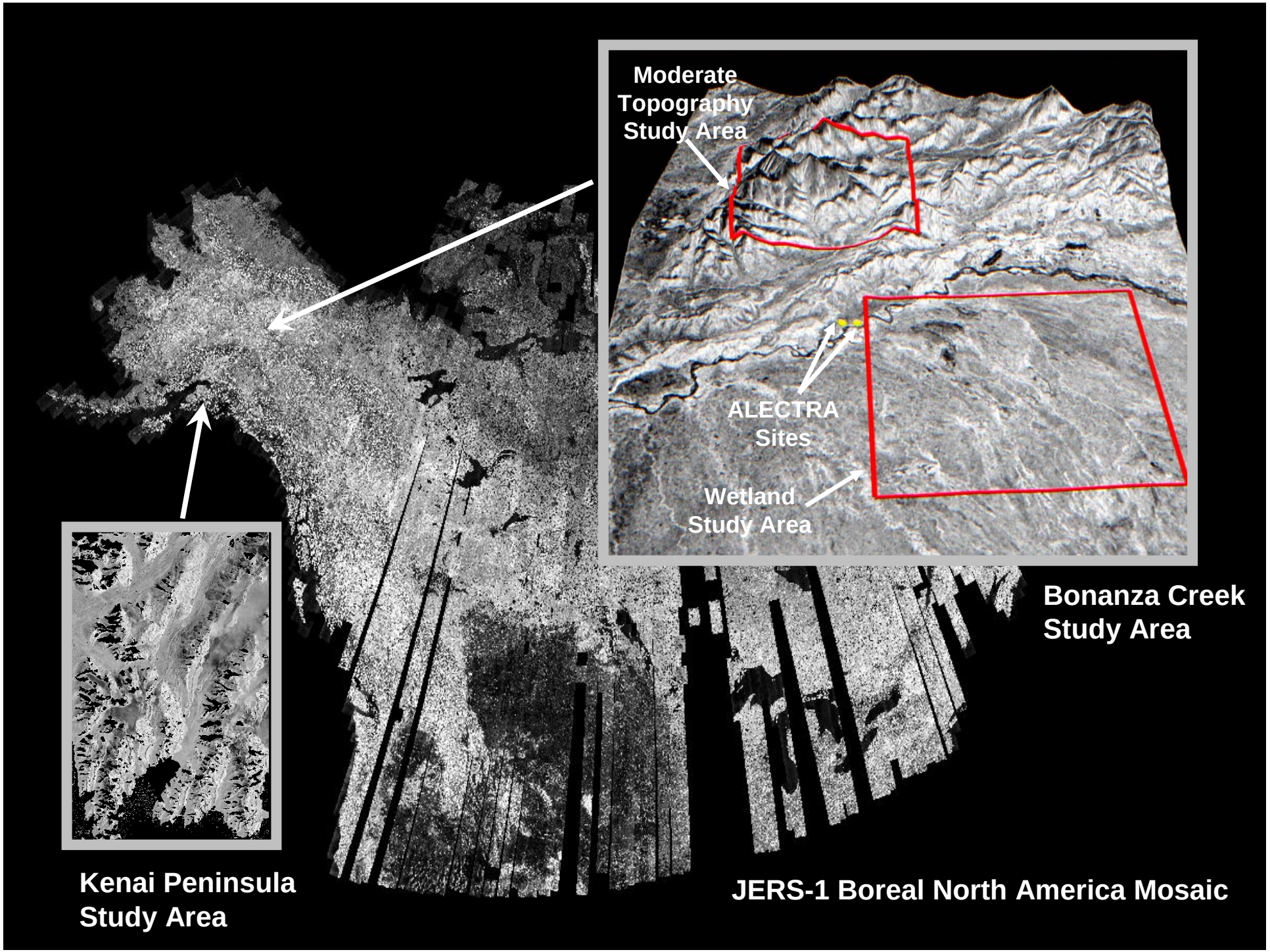


North polar view with the AMSR-E radiometer. Data shown are from the H-polarized 19 GHz channel, and were acquired on July 2, 2002.

Courtesy of NASA/JPL-Caltech and the Scatterometer Climate Record Pathfinder project, Microwave Earth Remote Sensing Lab, Brigham Young University.

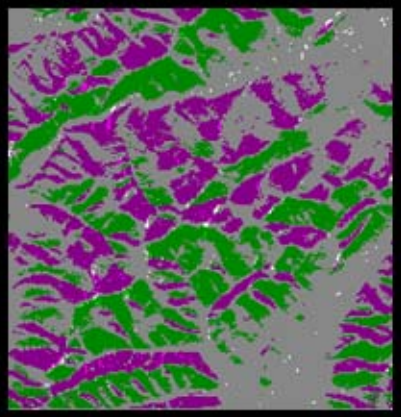
Pan-Arctic Growing Season observed with SSM/I



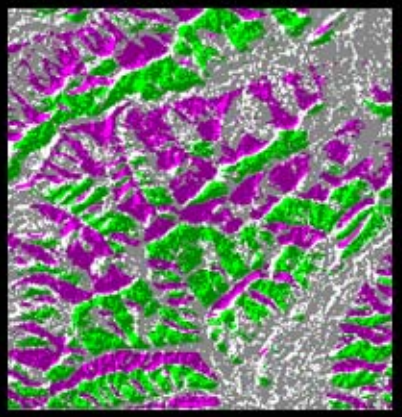

Moderate
Topography
Study Area
ALECTRA
Sites
Wetland
Study Area
Bonanza Creek
Study Area
Kenai Peninsula
Study Area
JERS-1 Boreal North America Mosaic


Bonanza Creek Experimental Forest, Alaska

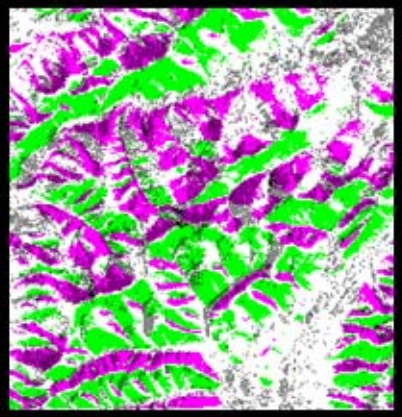
Thaw State Classifier Integrated with Landscape Topography
Bonanza Creek Experimental Forest, Alaska



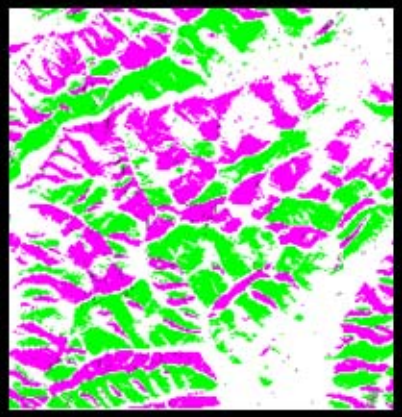
16 Feb 1998



1 April 1998



15 May 1998



28 June 1998

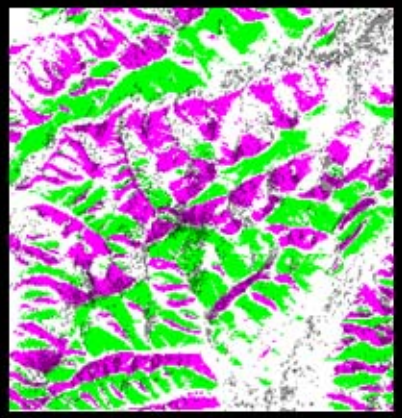
25 km

Frozen Thawed

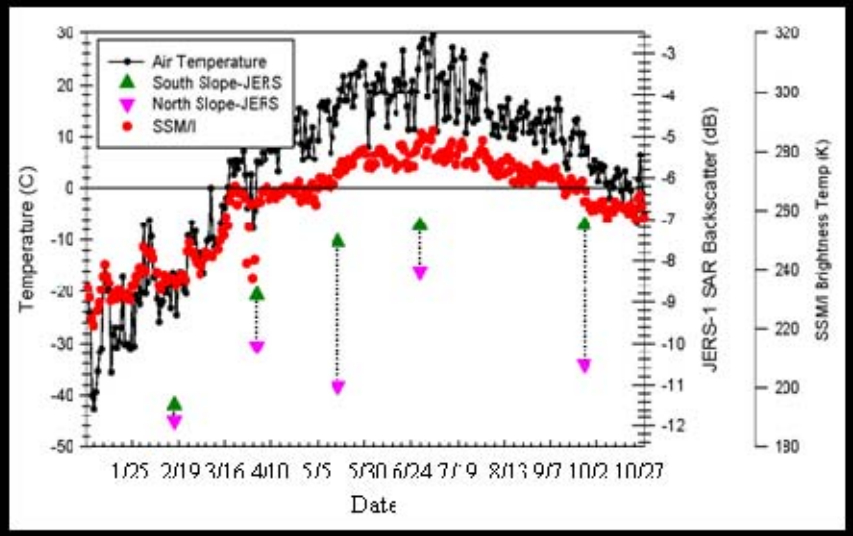
South Facing Slope

North Facing Slope

Flat/ Other



24 Sept 1998



NUMERICAL TERRADYNAMIC SIMULATION GROUP

College of Forestry
The University of Montana

- Home
- Mission
- Publications
- Personnel
- Courses

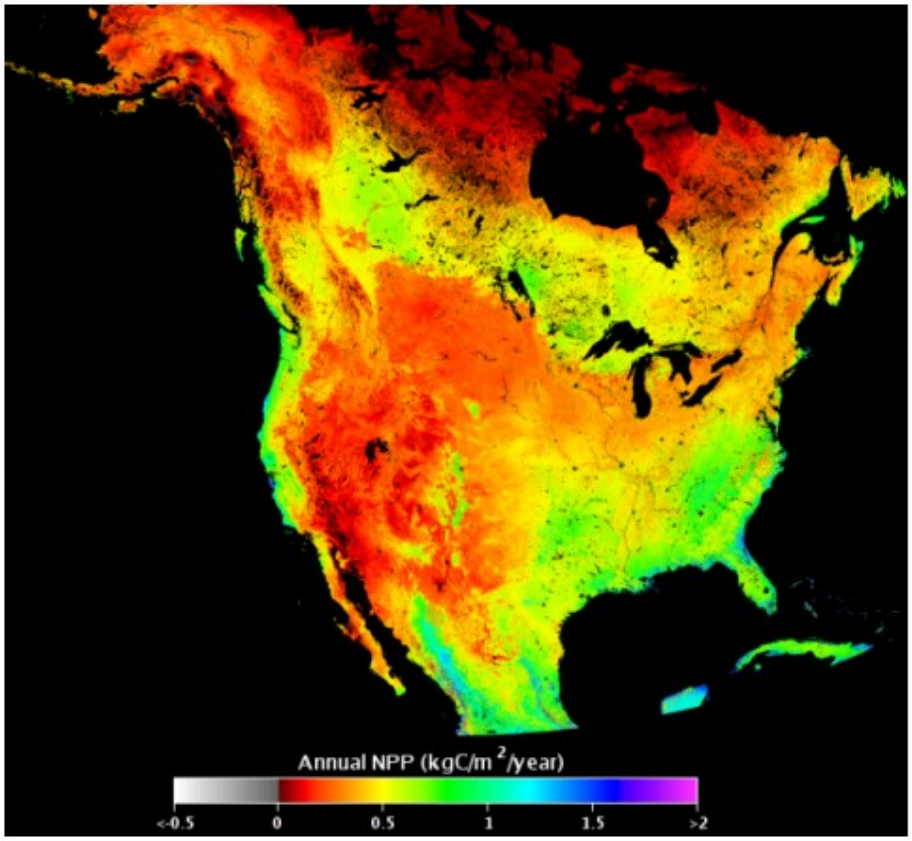
- MODIS
- Ecological Forecasting (TOPS)
- Ecosystem Modeling
- Bioclimatology
- Projects

- Terra Room Schedule
- FTP site
- Graphics and Animations
- Models to Download
- Links

- The National Center for Landscape & Fire Analysis

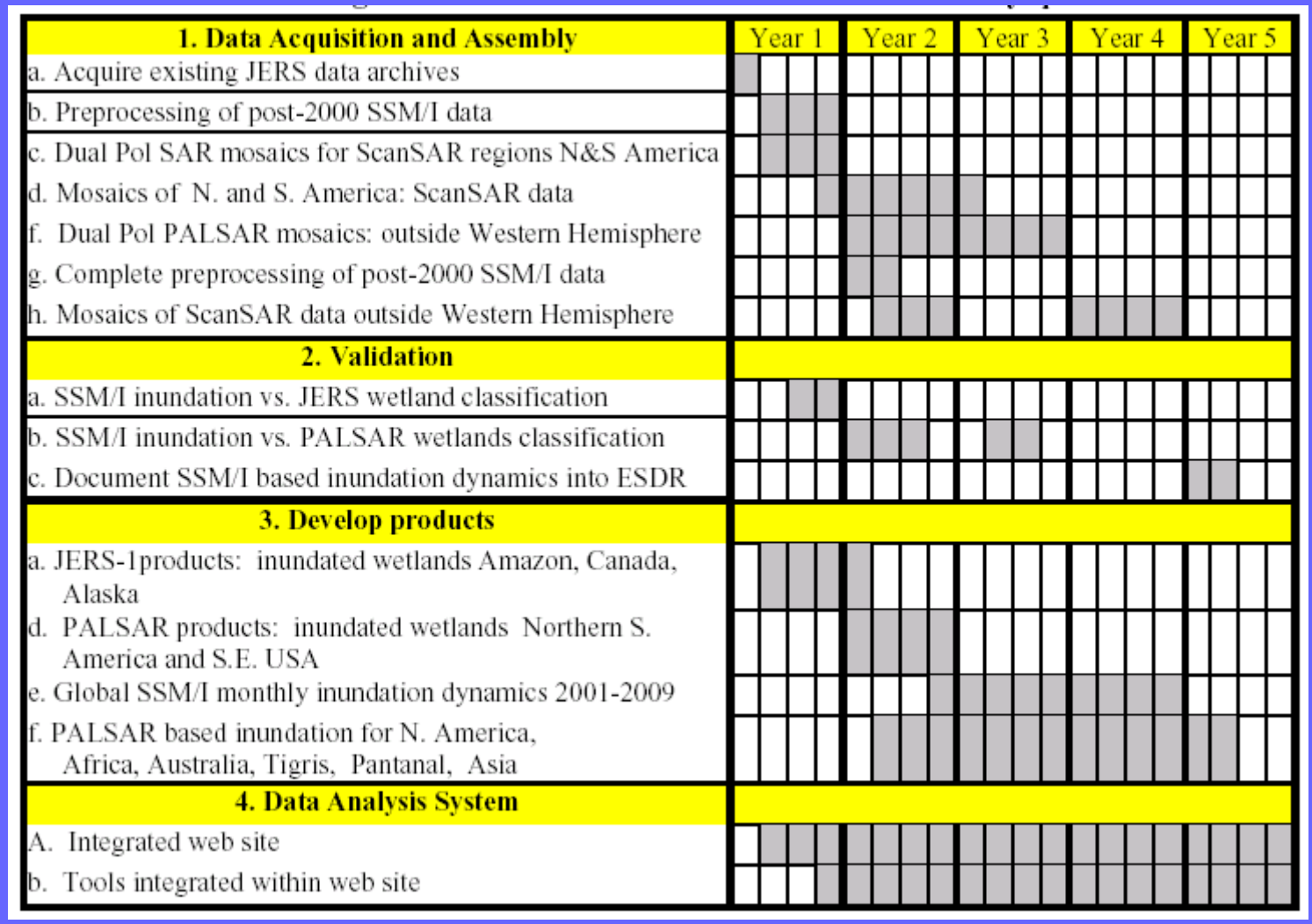
Principal Investigator: Steven W. Running
Faculty and Research Associates: Ramakrishna R. Nemani, Peter E. Thornton, Kenlo Nishida
Director of Software Development: Joseph M. Glassy

The NASA Earth Observing System is a $7.3 billion program planning satellite-based earth monitoring for 15 years, and is the heart of global change science for the United States. The central sensor on board the Terra Satellite Platform is the Moderate Resolution Imaging Spectroradiometer (MODIS picture). Terra was successfully launched on December 16, 1999, and a second MODIS-based satellite, Aqua, was launched May 4, 2002.



The University of Montana is the only Forestry School in the country with a member on the EOS science team. Our responsibility is to provide computer programs to use this new satellite data to calculate global photosynthesis and evapotranspiration for all terrestrial biomes. We envision the EOS satellite to provide a dramatic improvement in our ability to accurately monitor global ecological conditions. Large scale climate shifts, deforestation, desertification, pollution damage, crop conditions, glacial retreats, flooding, wildfires and urbanization are examples of the types of earth system monitoring planned. Currently, as we work on these software products, we are using Montana as a testbed for this advanced satellite technology.

Integrated Master Schedule



Some Issues

- **Some re-scope is under consideration**
  - Wetlands
    - JERS efforts and associated cross-product harmonization
    - PALSAR work may be scaled back in some less significant regions
  - Freeze/Thaw
    - Timing of product delivery and SMMR products.

- **Data Distribution**
  - Identify DAAC for archiving
    - likely ASF
  - NASA requests making the backscatter data generally available
    - Mosaics?
    - K&C data and ASF

- **ESIP Federation membership**
  - Probably not necessary but we can pursue this if desired

- **Review board**
  - Wetlands
  - Freeze/Thaw