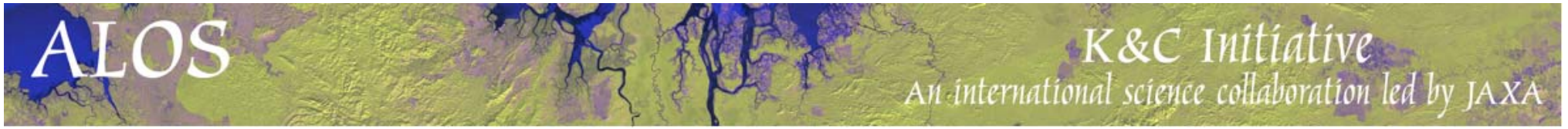

Extension Phase Proposal

Regional-scale wetlands and freeze/thaw mapping with ALOS PALSAR

Objective: Development of a global-scale Earth science data record of inundated wetlands using PALSAR dual pol and SCANSAR data sets.

Approach: We will employ techniques established during our initial K&C project, extending these efforts to development of a systematically develop coherent mapping of wetlands ecosystems.

Related K&C projects: This work dovetails with mosaicking tasks proposed by Bruce Chapman and incorporates work by Laura Hess (Tropical Wetlands).

Deliverables: Maps of inundated wetlands focusing on regions of SCANSAR mosaics for each repeat interval for each region.

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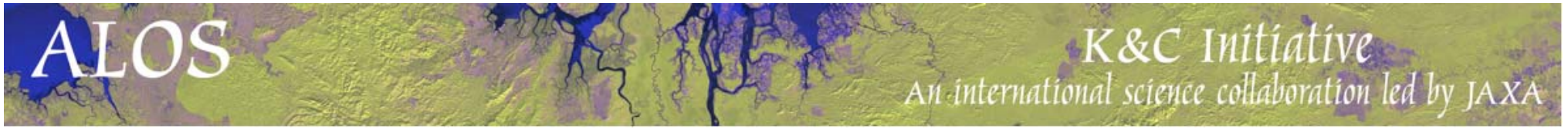
An Inundated Wetlands Earth System Data Record: Global Monitoring of Wetland Extent and Dynamics

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)
Lisa Rebelo
(International Water Management Institute)
Martti Hallikainen
(Helsinki University of Technology)

Components of the Inundated Wetlands Earth System Data Record

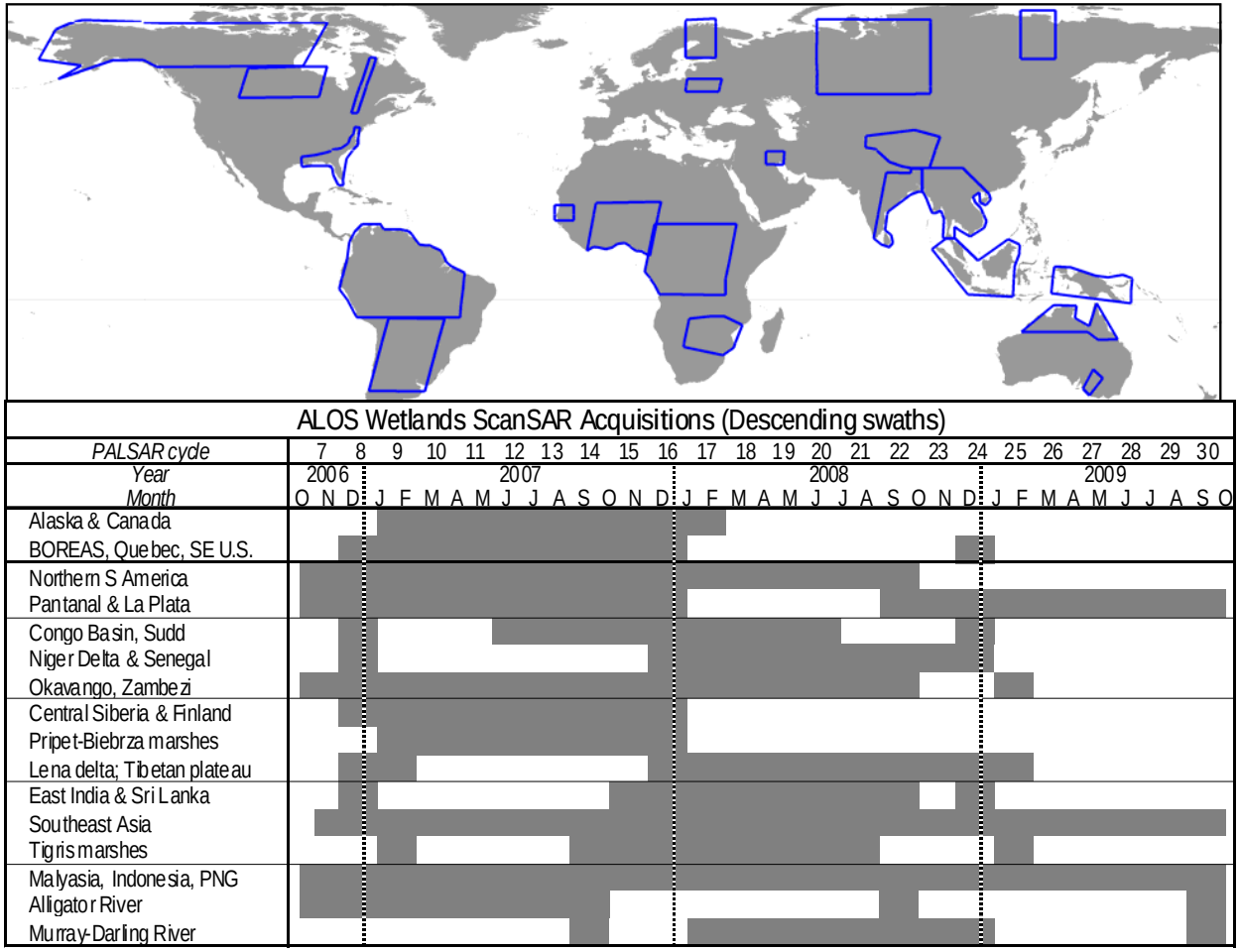
I. Regional inundated wetlands data sets from Synthetic Aperture Radar (SAR)
- Spatial coverage: Major global wetland regions, 100m resolution
- Temporal coverage: 1-2 year time series at 17-to-46 day intervals during 2006-2009 † ‡
- Retrospective 1990's-era from archived JERS data covering Alaska, Canada, Amazon
1. Wetland extent (maximum inundatal 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 (SSMI, ERS scatterometer, AVHRR, AMSR-E, MODIS, QuikSCAT)
- 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.

- 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



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Milestone chart for mosaicking

Acitivity by quarter	Year 1				Year 2				Year 3				Year 4				Year 5			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Data Acquisition and Assembly																				
a. Prototype mosaics (ScanSAR and Dual Pol)																				
a. Dual Polarization PALSAR Mosaic for ScanSAR regions of North and South America																				
b. Mosaics of S. America ScanSAR data																				
c. Mosaics of N. America ScanSAR data																				
d. Dual polarization PALSAR mosaic for scanSAR regions of Africa and S.E. Asia																				
e. Mosaics of Africa ScanSAR data																				
f. All other Dual polarization mosaics																				
g. All remaining ScanSAR mosaics																				

The schedule of deliverables follows the mosaicking schedule at left and presented in the Chapman K&C proposal.

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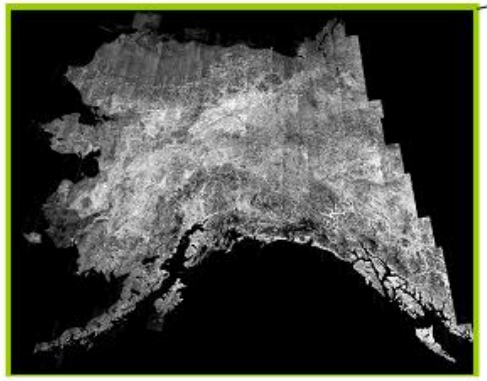
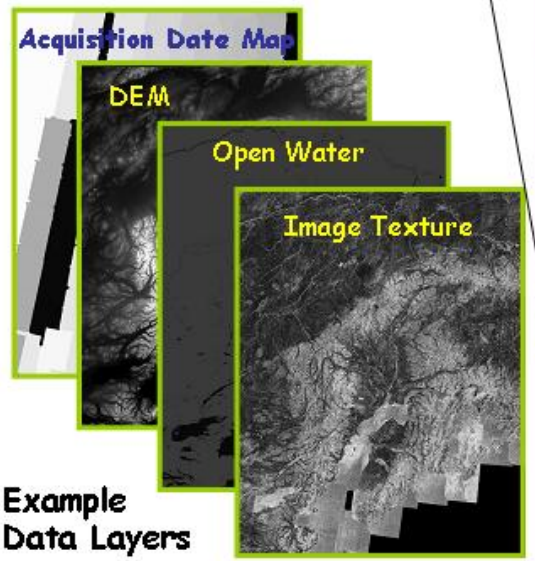
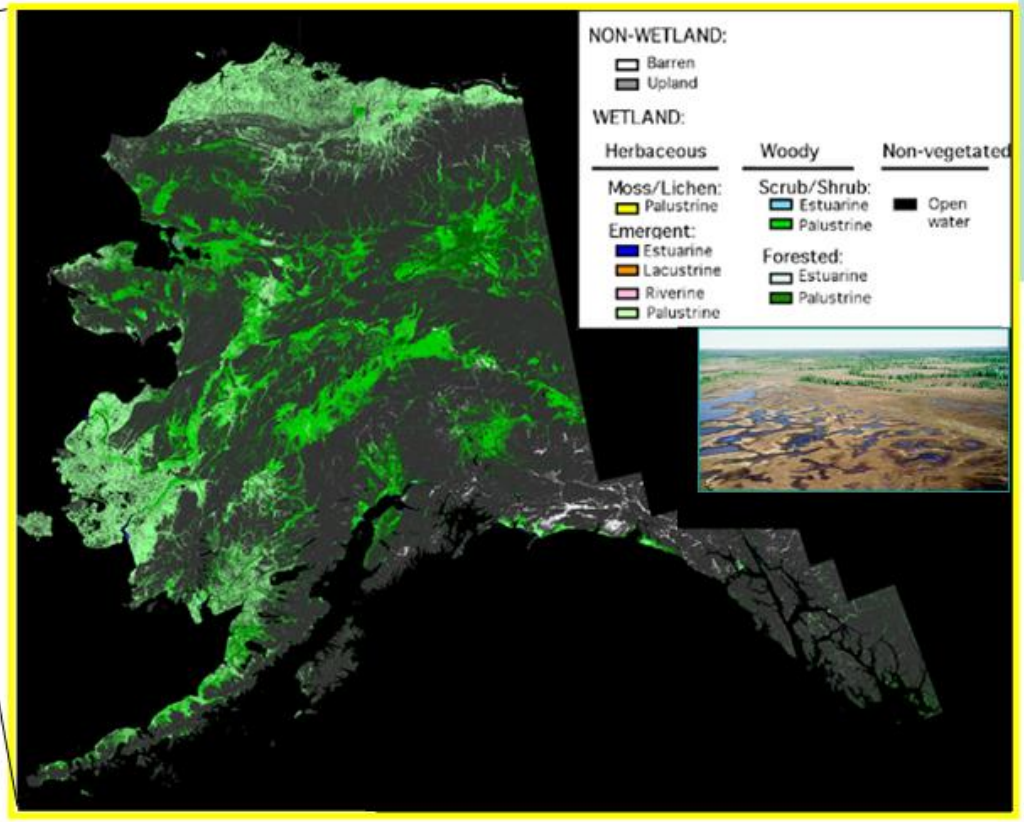
Alaska Wetlands Map from Satellite L-Band Synthetic Aperture Radar



JERS-1 SAR Mosaic



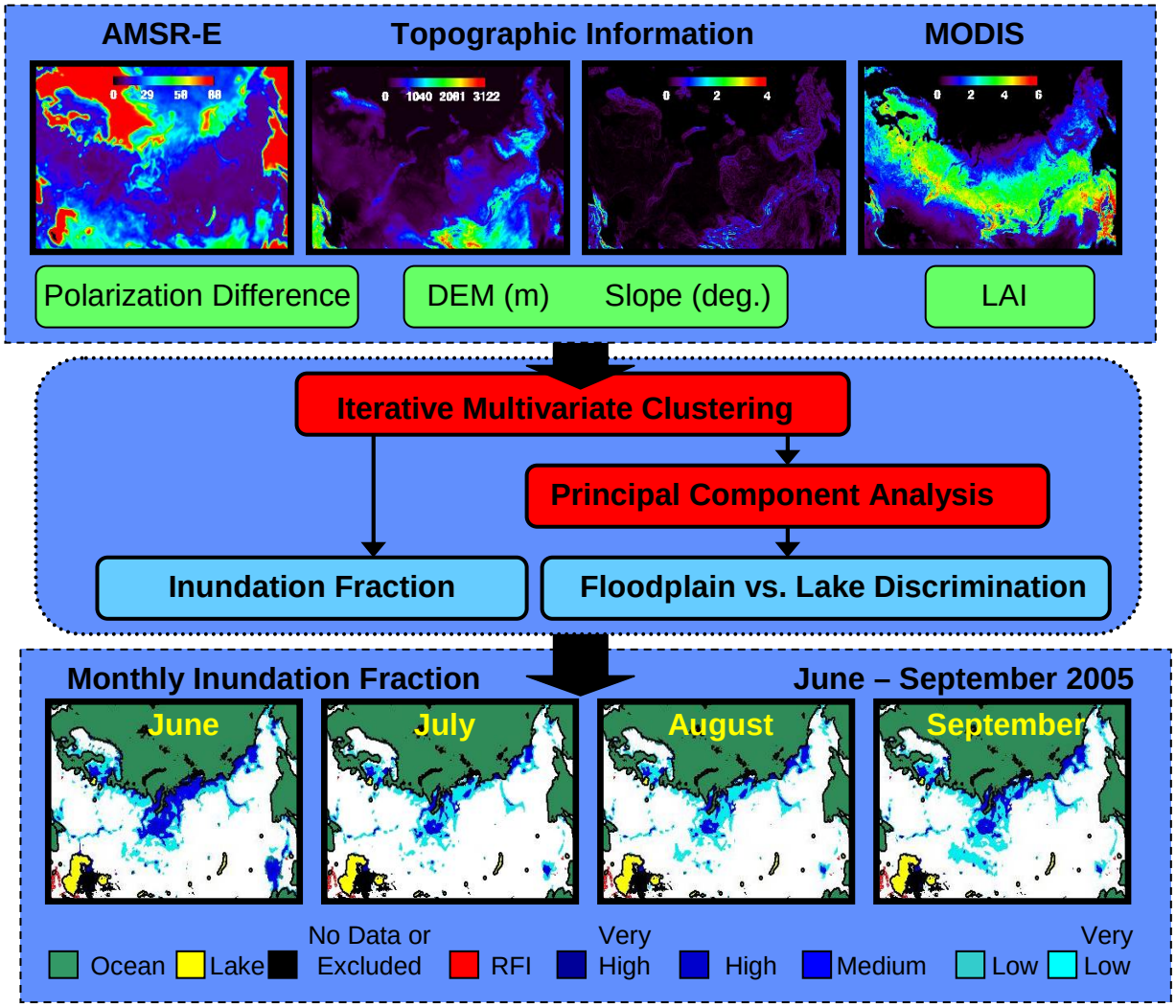
Example Data Layers



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.

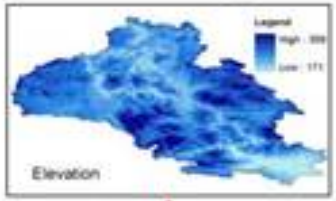
Whitcomb, Moghaddam, McDonald, Kellndorfer, and Podest, Canadian Journal of Remote Sensing, 2008 (accepted)

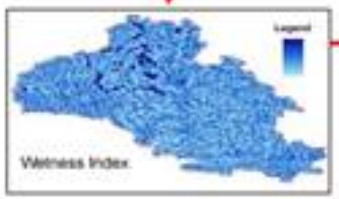
Inundation Monitoring with AMSR-E and MODIS



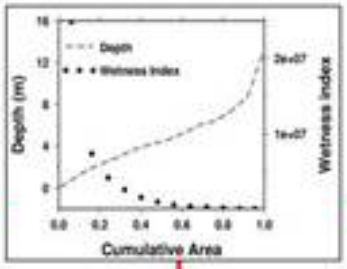
Construct for derivation of monthly inundation data sets, showing example products for the NEESPI domain. Algorithm input data sets include AMSR-E brightness temperature and polarization difference, topography, and MODIS-based leaf area index (LAI). An iterative unsupervised multivariate clustering approach 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

Linkages

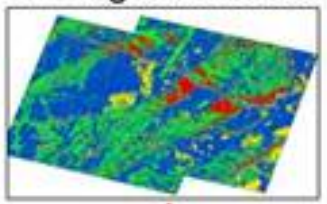


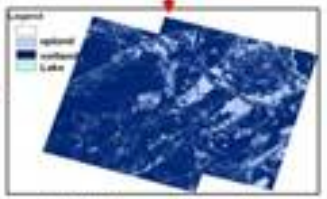


Wetland Parameterization



JPL Vegetation Class



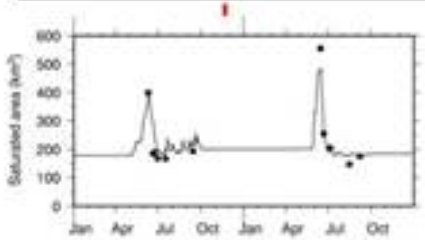


Wetland Mask

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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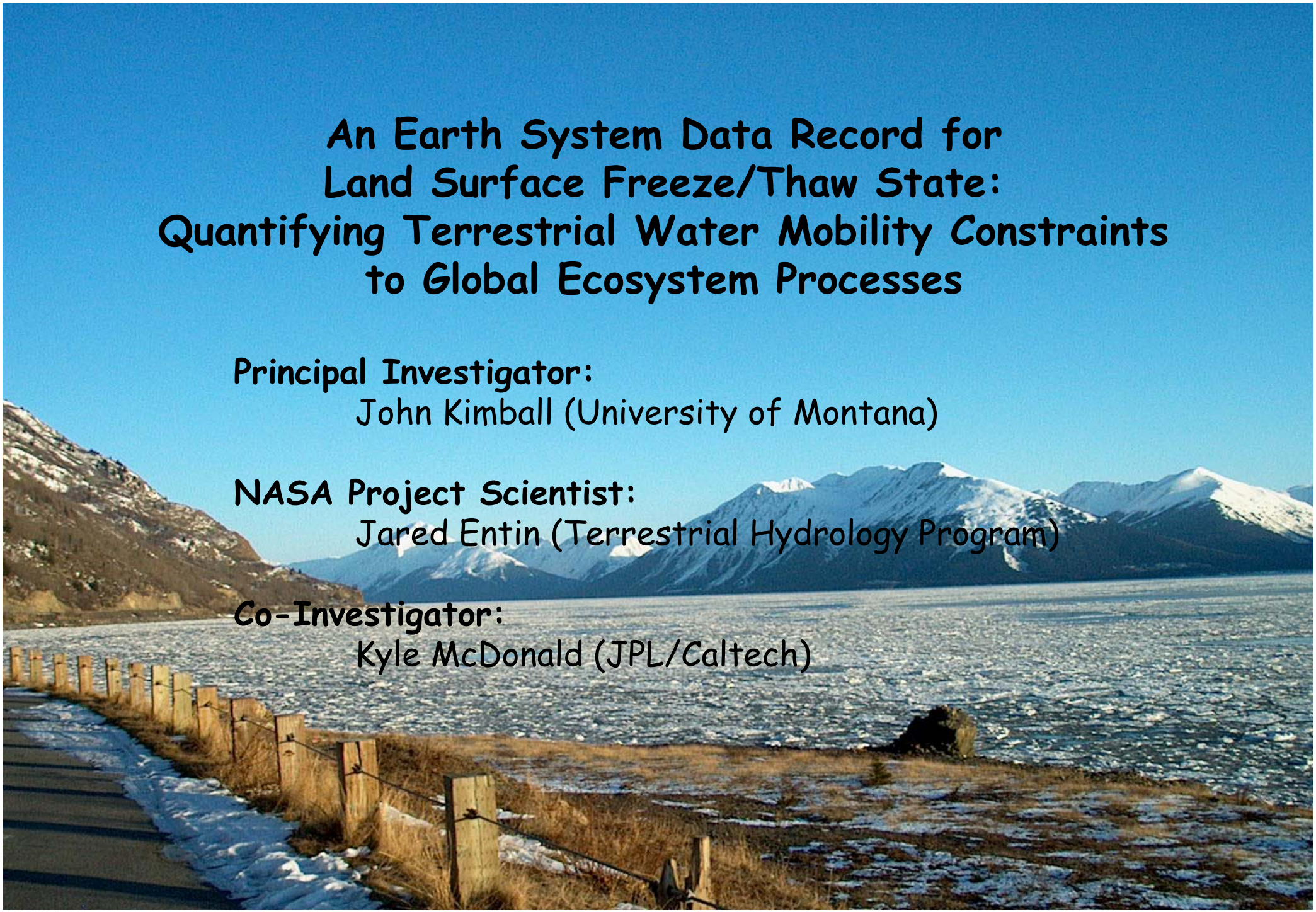


An Earth System Data Record for Land Surface Freeze/Thaw State: Quantifying Terrestrial Water Mobility Constraints to Global Ecosystem Processes

Principal Investigator:
John Kimball (University of Montana)

NASA Project Scientist:
Jared Entin (Terrestrial Hydrology Program)

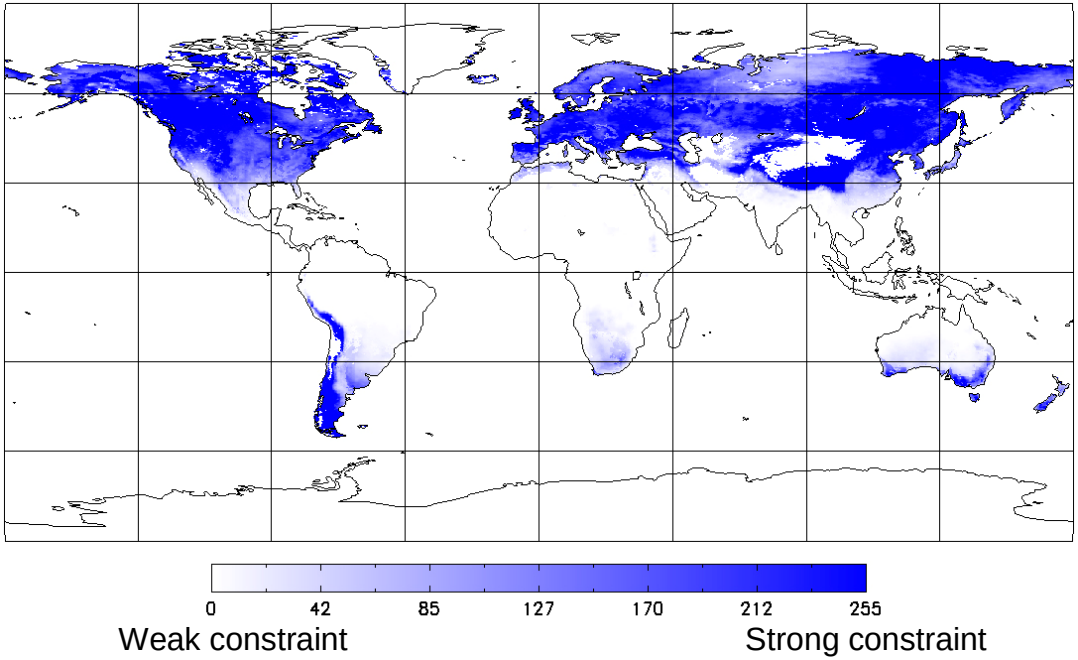
Co-Investigator:
Kyle McDonald (JPL/Caltech)

ALOS

K&C Initiative

An international science collaboration led by JAXA

Global Extent of Cold Temperature Constraints To MODIS Annual Productivity



Low temperatures constrain annual gross primary production (GPP) over 65 percent of the global vegetated area, as indicated by the EOS MODIS (MOD17) Production Efficiency Model time series (2000-2007). The F/T-ESDR will encompass global vegetated areas where seasonal frozen temperatures are limiting to biological processes including plant photosynthesis.

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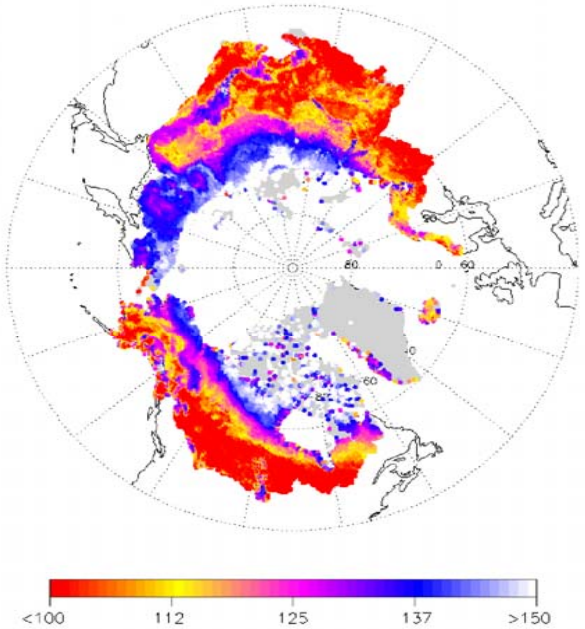
NASA

ALOS

K&C Initiative
An international science collaboration led by JAXA

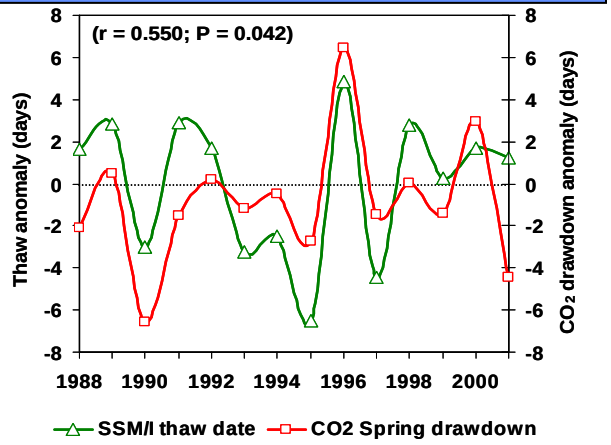
Freeze/Thaw and Carbon Cycle Science

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.

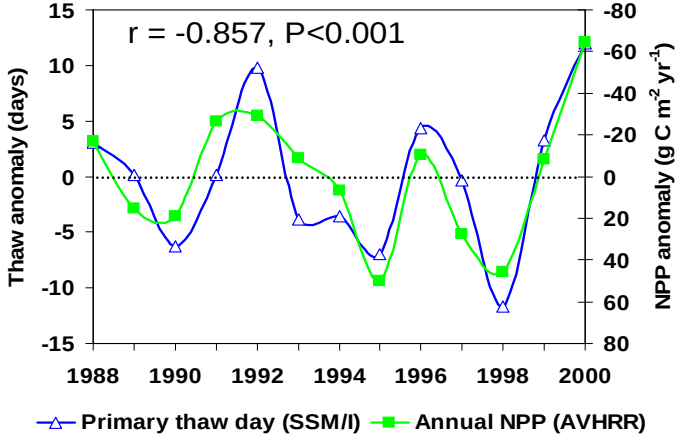


Mean Growing Season Onset
(SSM/I, 1988-2001)

SSM/I Thaw vs Spring Atmosphere CO_2 Anomalies



AK Spring Thaw vs NPP



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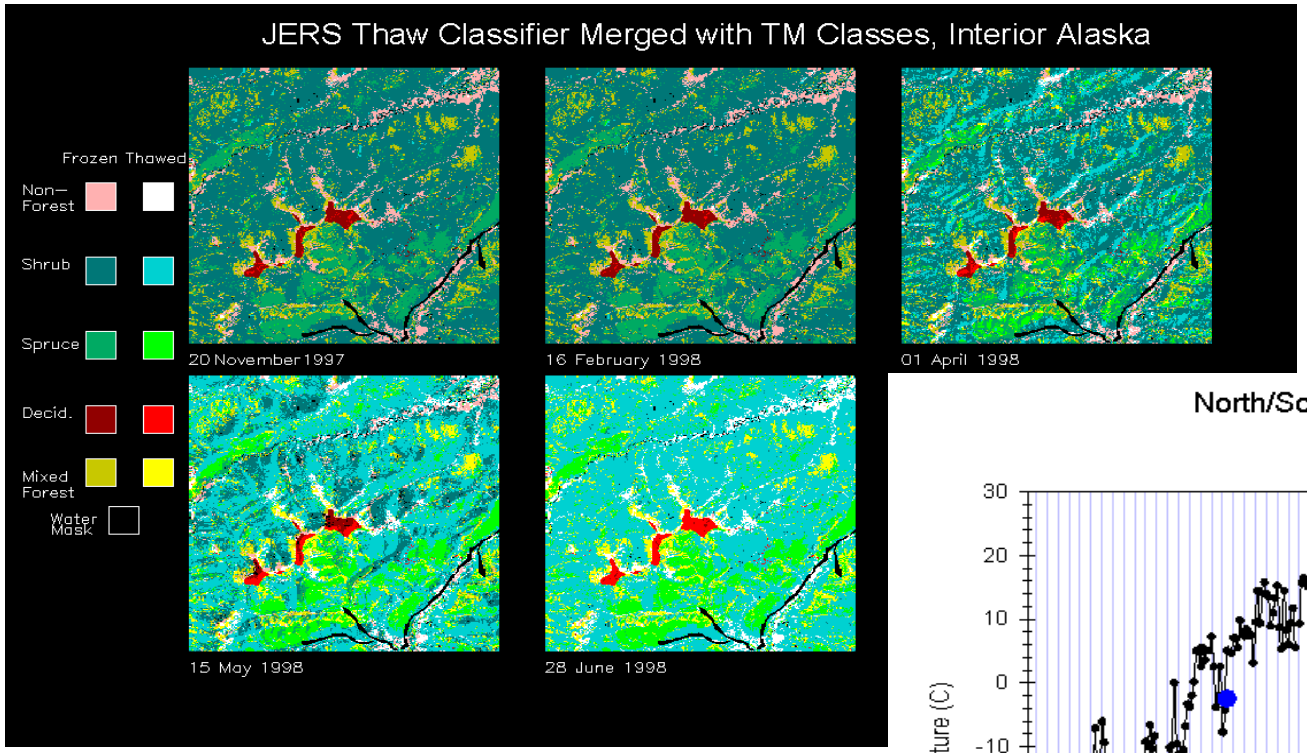
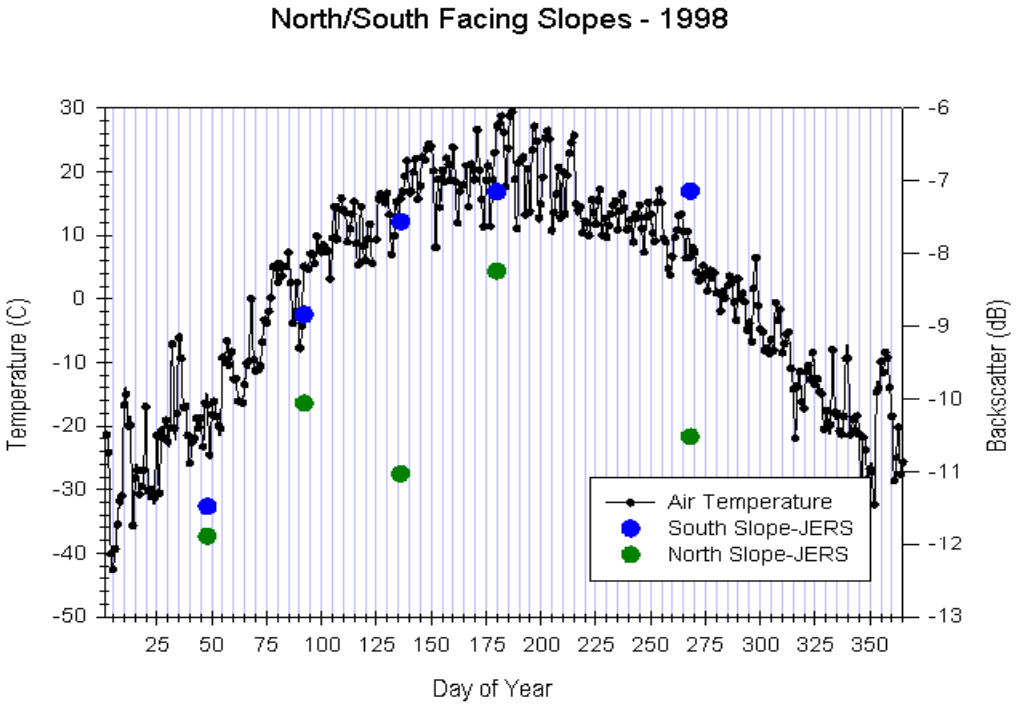
NASA

Freeze/Thaw: Enhancements



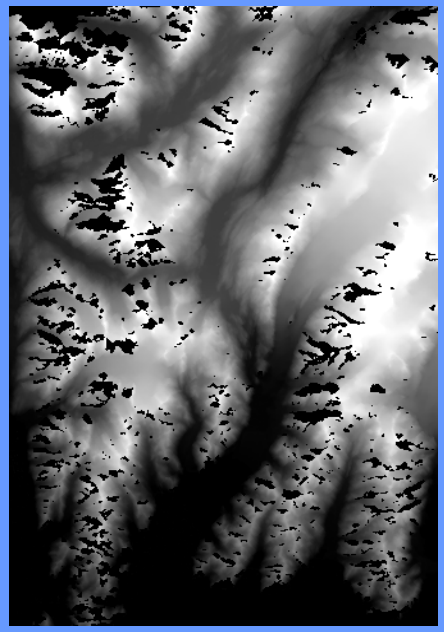


Merged Freeze/Thaw and Landcover

Freeze/Thaw: Complex Topography

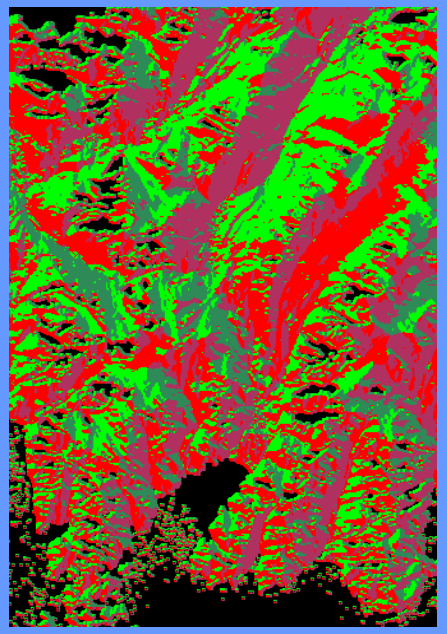
Elevation Map

0m - 500m
500m-1000m
1000m-1500m
1500m-1900m



SRTM DEM

Slope Aspect Map



Northwest
Northeast
Southeast
Southwest

Global Datasets for Constructing the FT-ESDR

- Global satellite microwave remote sensing records involve overlapping time series with multiple frequencies and polarizations spanning > 25-year record.

- The F/T sensitivity and temporal stability of these data is influenced by variable geometric/radiometric precision; variable spectral, spatial and temporal resolutions.

- Retrospective analyses of overlapping sensor records will produce a consistent and continuous F/T-ESDR with documented accuracy.

Remote sensing data sources enlisted in the F/T-ESDR

Instrument	Platform	Time Series	Features
SeaWinds Scatterometer	QuikSCAT	1999 - present	13.4 GHz; 25x37 km resolution; Swath (outer beam): 1800 km; Coverage 1-2 day repeat, global.
AMSR-E Radiometer	EOS	2002 – present	Frequencies: 6.925, 10.65, 18.7, 23.8, 36.5, 89.0 GHz; Resolutions (km): 75x43, 48x27, 27x16, 31x18, 14x8, 6x4; Incidence angle: 55 degrees; Swath: 1445 km; Coverage: 1-2 day repeat, global.
SSM/I Radiometer	DMSP platforms	1987 - present	Frequencies: 19.3, 22.2, 37.0, 85.5 GHz; Resolutions (km): 70x45, 60x40, 38x30, 16x14; Incidence angle: 53.1 degrees; Swath: 1400 km; Coverage: 1-2 day, global.
SMMR Radiometer	Nimbus-7	1978 - 1987	Frequencies: 6.6, 10.7, 18, 21, 37 GHz; Resolutions (km): 148x95, 91x59, 55x41, 46x30, 27x18; Incidence angle: 50.3 degrees; Coverage: 1-3 day, global.