K&C Phase 4 – Final Report

Sensitivity of Vegetation and Agriculture Physical Characterization to Repeat-Pass ALOS Observations

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University of Massachusetts, Amherst

Science Team meeting #25
Tokyo, Japan, February 5-8, 2019

Project outline and objectives

To characterize the RCS (co- and cross-polarization) of stable and changing targets over time. These are important components for the development of segmentation and detection algorithms necessary for change detection and target identification.

These would be done over:

1. the northeastern US, (done)
2. regions in South America where ground validation data is available (done)
3. agricultural regions in the US and elsewhere (done)

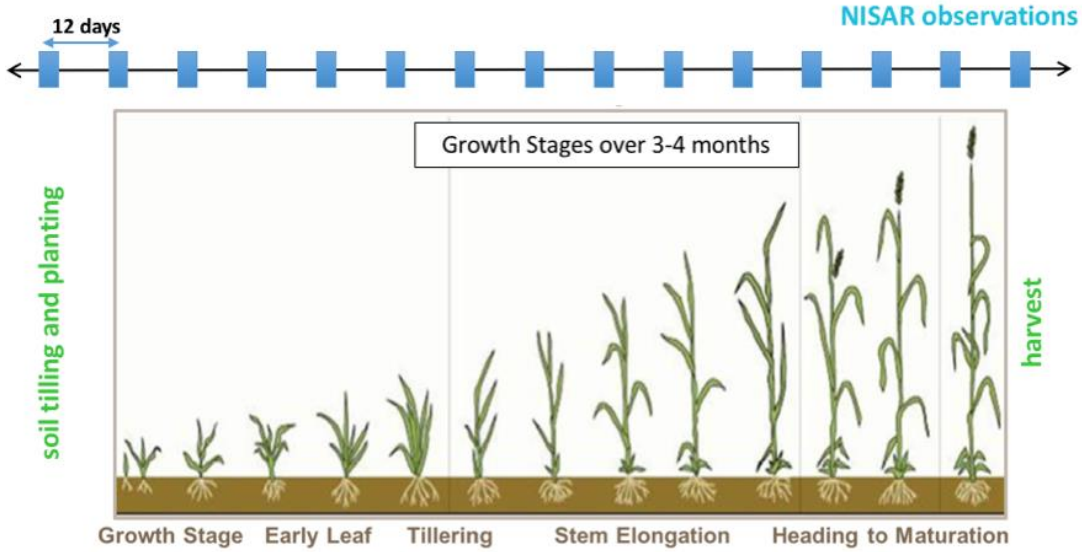
- To characterize temporal decorrelation related to interferometry; an important error source for deformation studies that the use of volumetric decorrelation for estimating forest vertical structure (especially for multi-baseline observations). This was done, but because of weather effects, the results were not promising as a reliable algorithm.
- Develop a methodology for using time series observations over short-repeat periods for the characterization of agriculture and inundated regions, for the geographic areas detailed above (done)

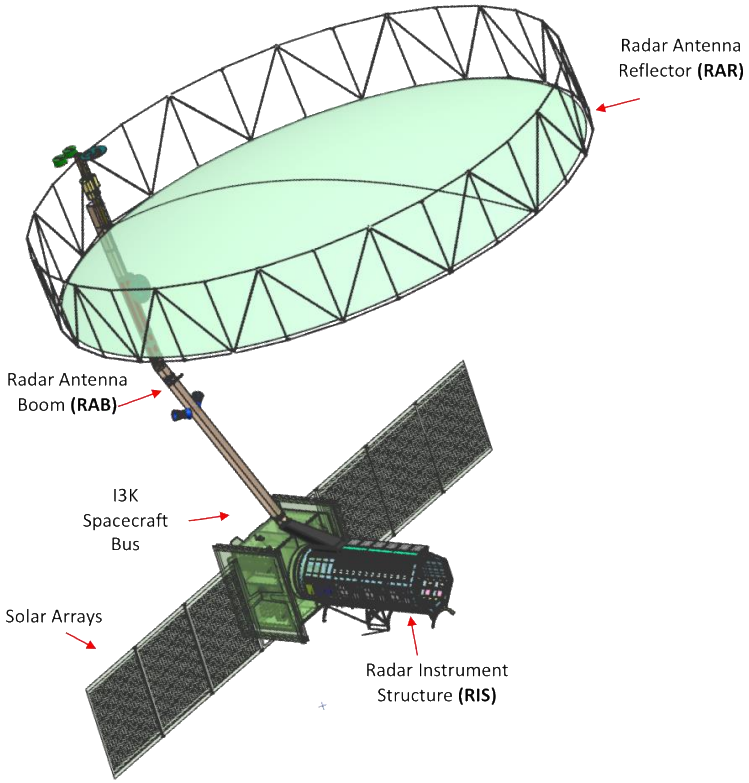
This work supported *the 4 K&C thematic drivers of* **C**arbon cycle science, the GEO initiative for global agricultural monitoring (GEOGLAM & JECAM) and Environmental **C**onservation as it applies to permanent land cover conversion.

NISAR Development: Ecosystems

- Biomass
- Disturbance
- Inundation
- Agriculture

Dense-time series of L-band data (dual-pol)



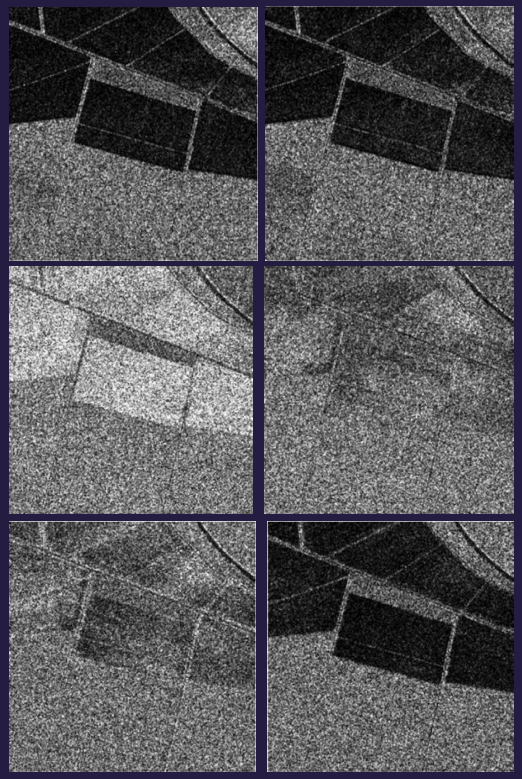


Results and significant findings

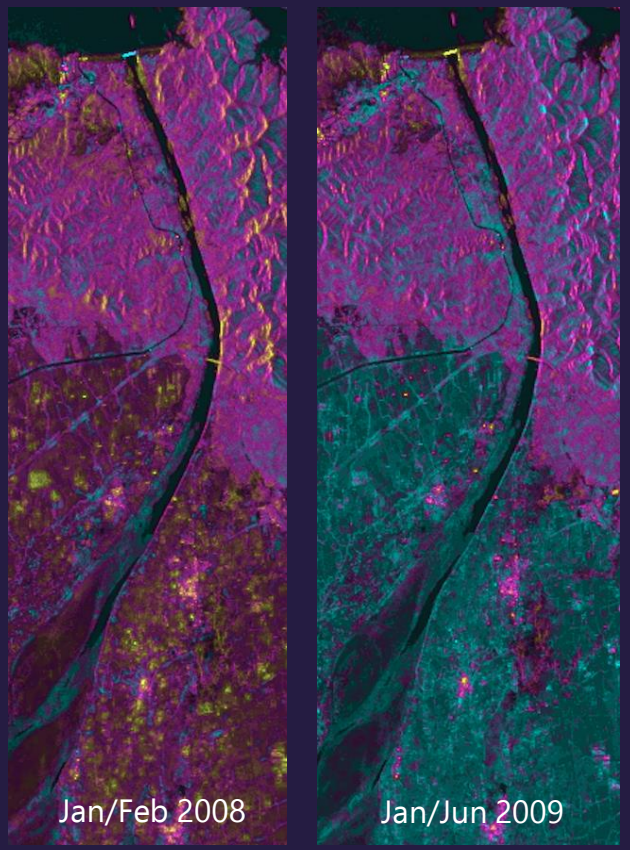
Phase A studies for agriculture
Methods for detecting agricultural activity

Regions of current agricultural activity detected by

1. changes in RCS signatures of HH, HV and HH/HV



2. interferometric correlation



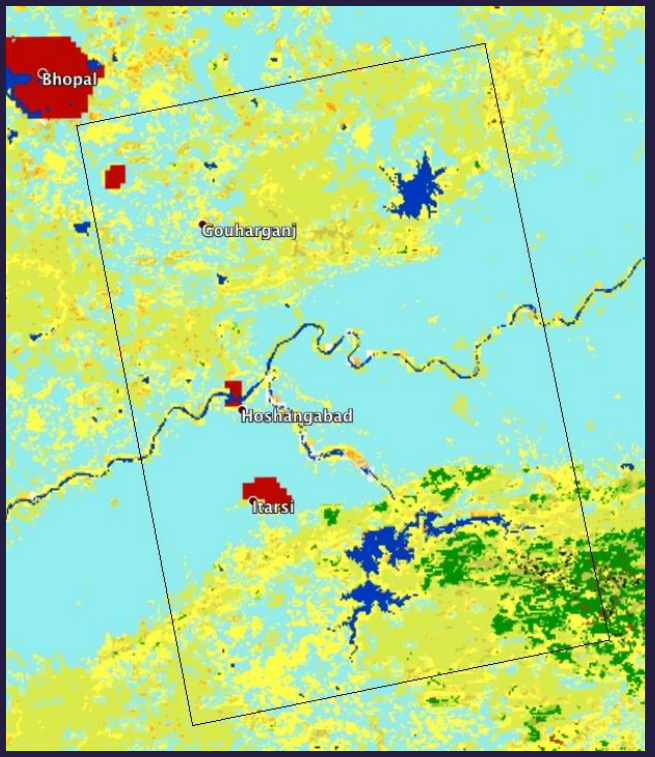
3. polarimetric signatures

SAR for Crop Area Determination
Madhya Pradesh Region in North-Central India

Region chosen because it has a combination of intensive/diverse agricultural activity, forested regions and urban settings.

map

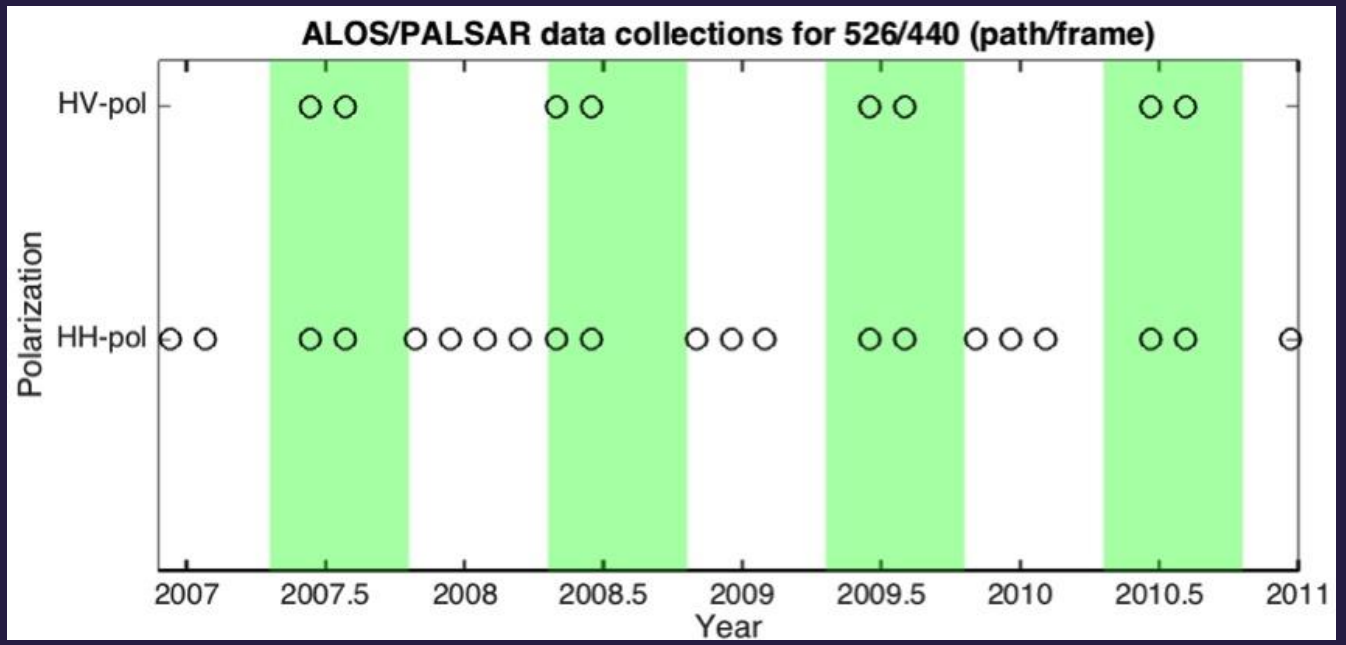
optical



GLOBCOVER

L-band coverage from ALOS-1

A four-year time series obtained from ALOS-1
2007 - 2011

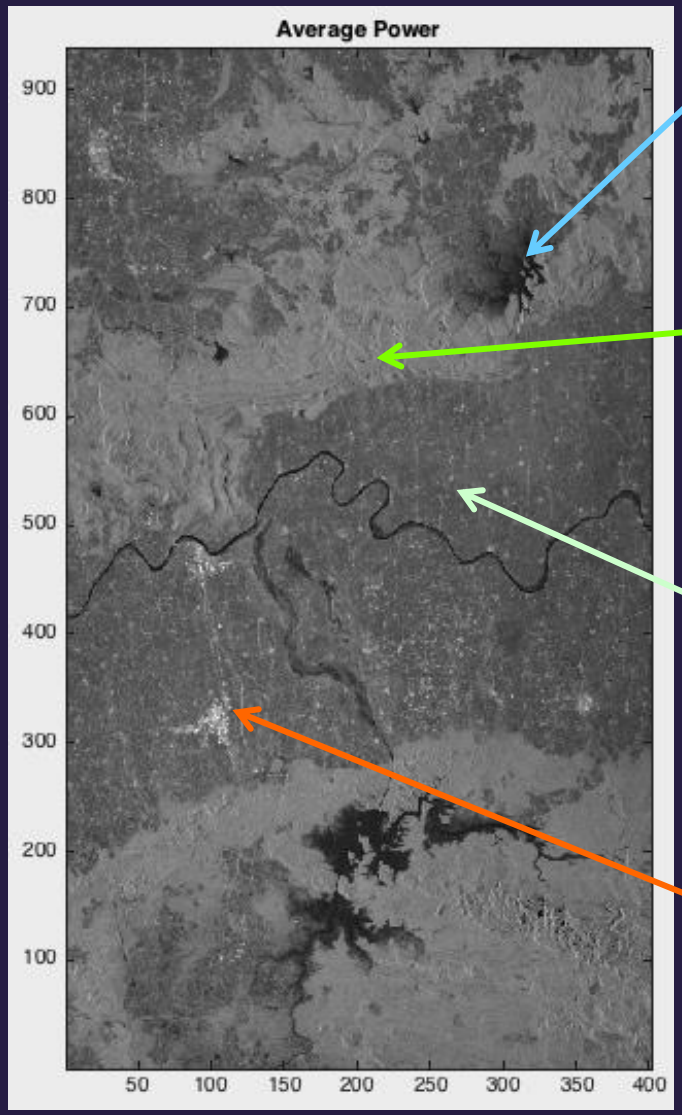


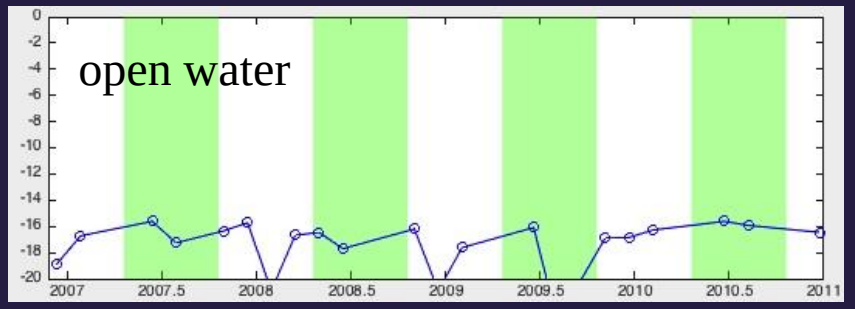
8 cross-pol scenes

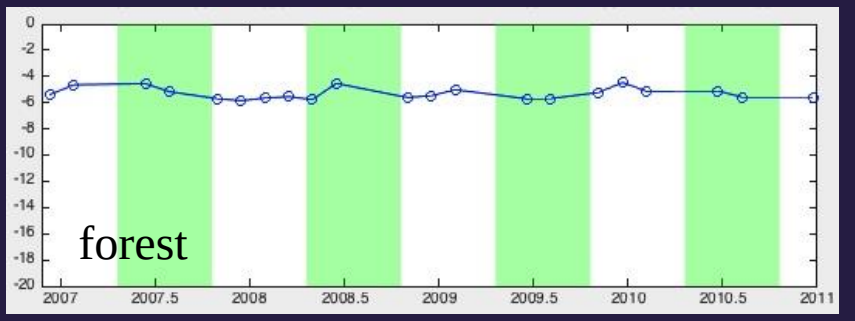
21 co-pol scenes

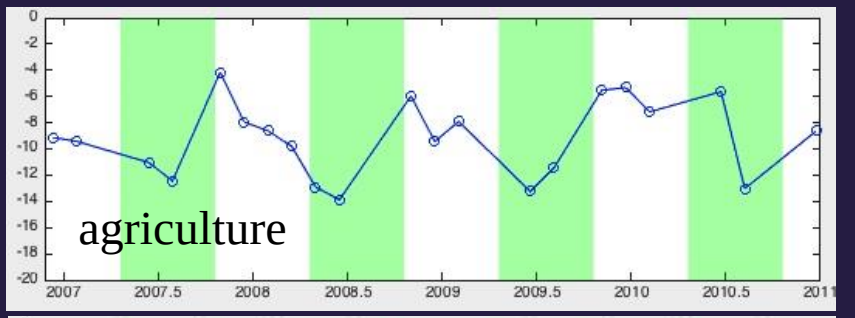
Colored bands indicate 6-month intervals centered around mid-year

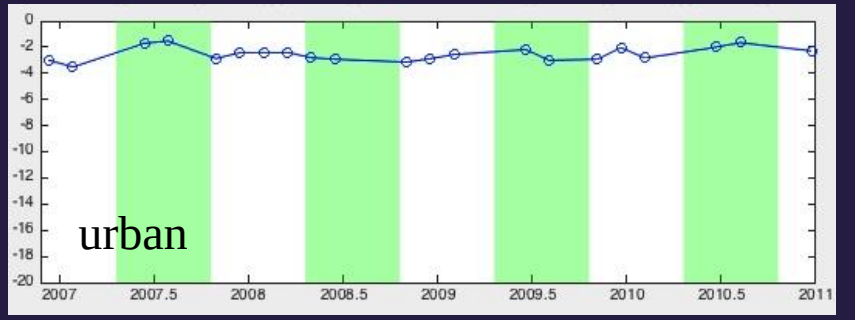
Radar signature changes over time









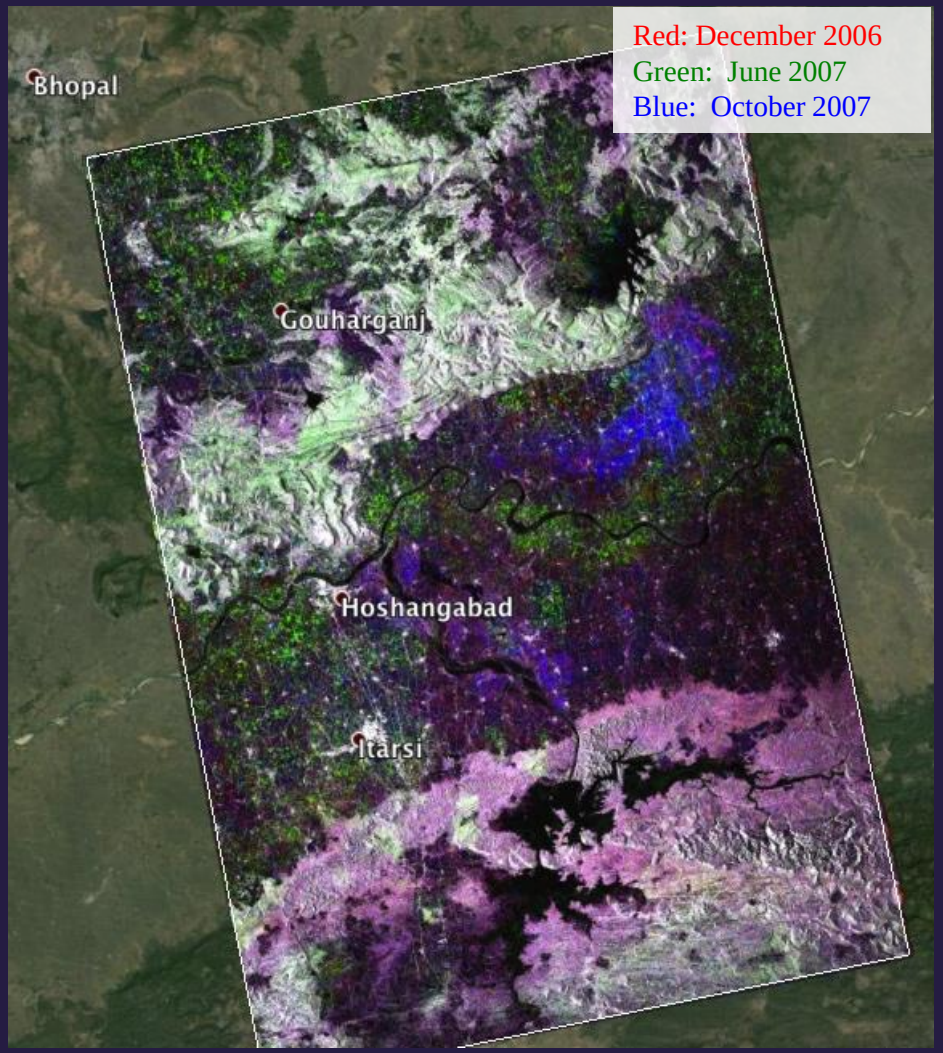


As an intensely managed landscape, agricultural fields are identified by the variation in radar signature (sensitive to structure of landcover) over time

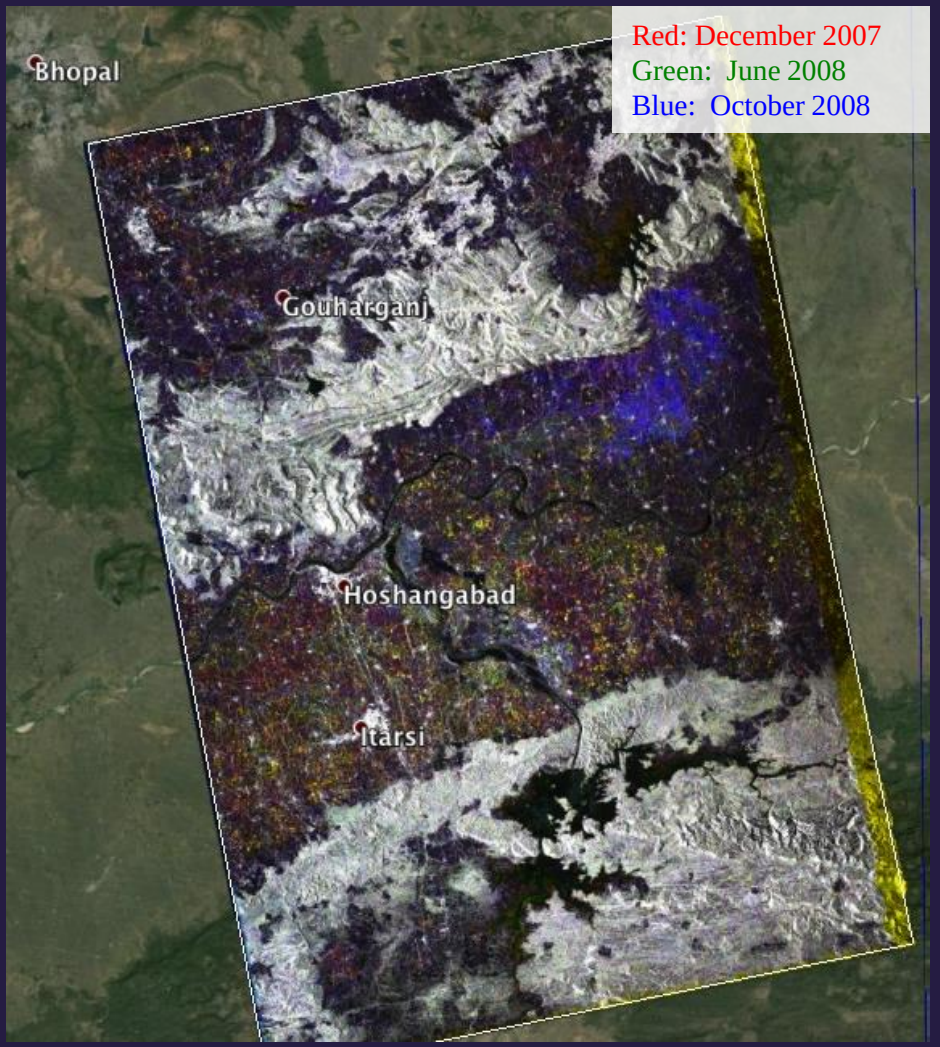
Methods for detecting agricultural activity

False color imagery year to year indicates variations that will complicate nominal approaches to classification

2007 time series

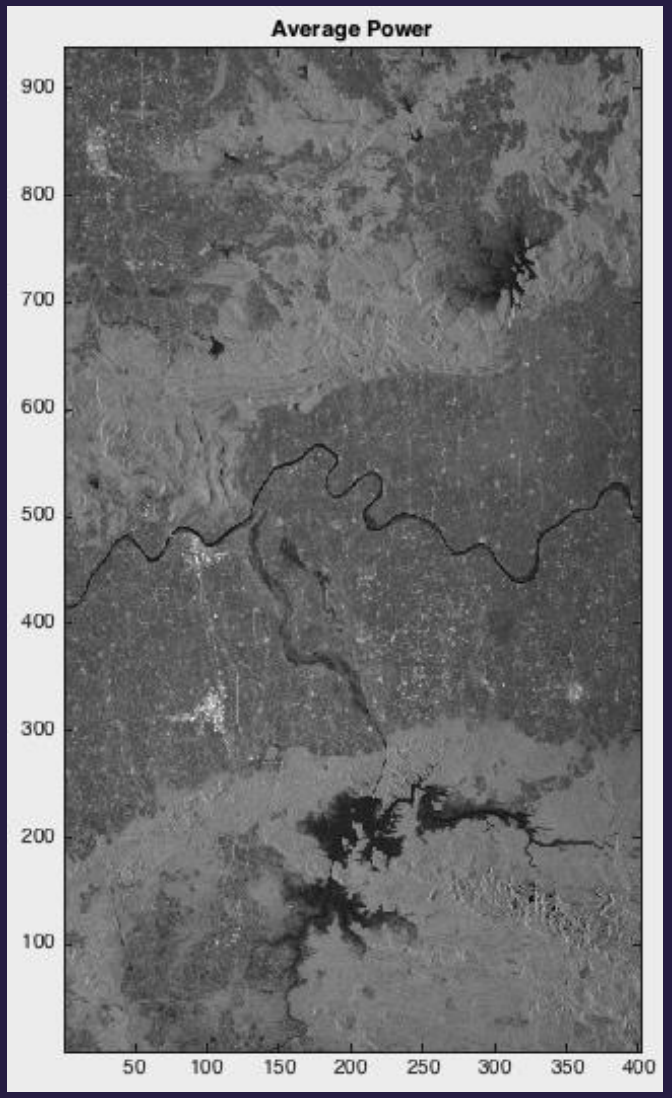


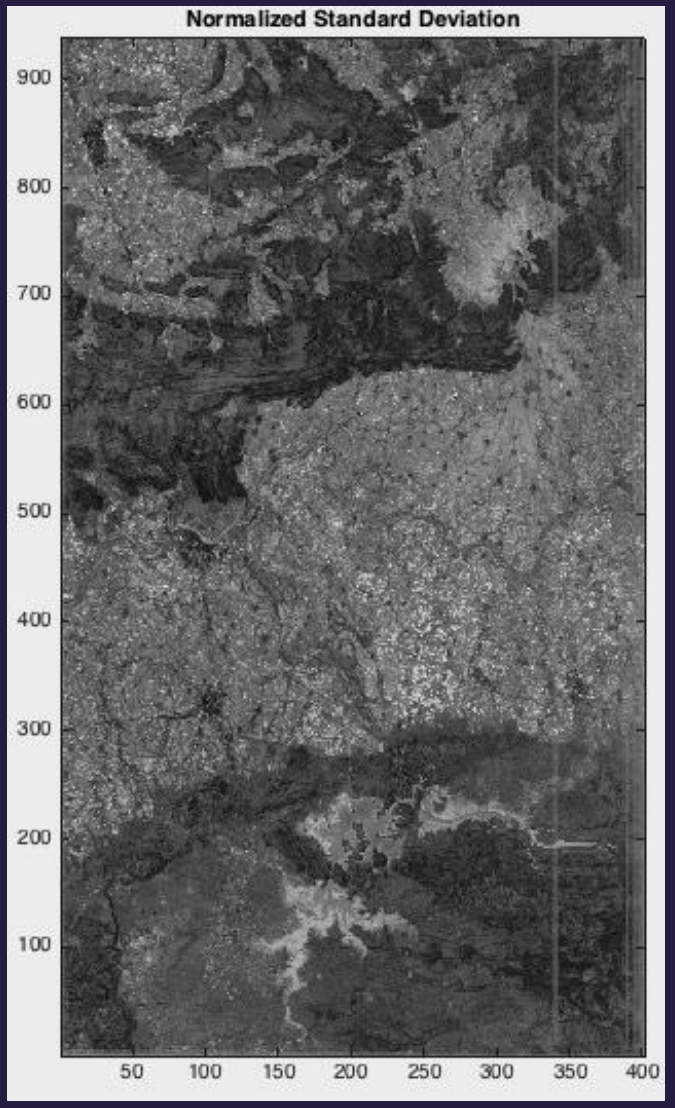
2008 time series



Methods for detecting agricultural activity

The Coefficient of Variation





Average power image used to identify general regions of landcover

Per-pixel standard deviation is a measure of the change over time

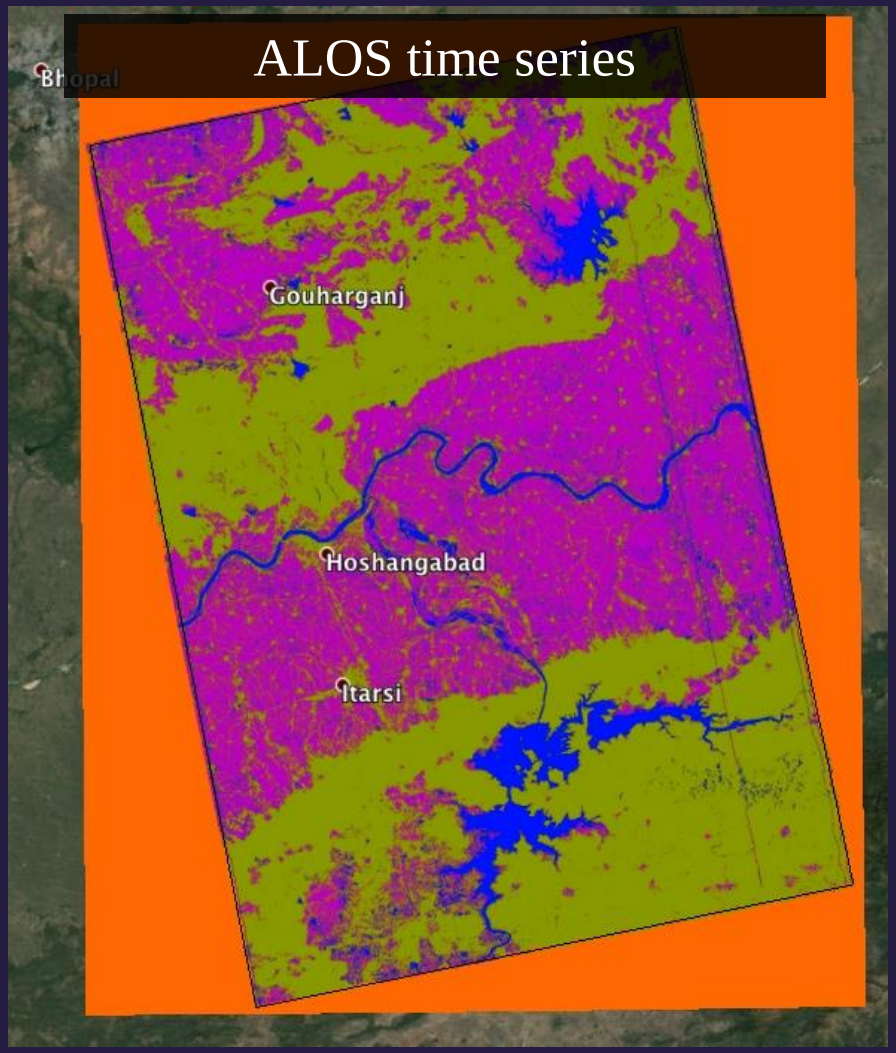
$$\text{metric} = \frac{\text{std. dev.}}{\text{mean}}$$

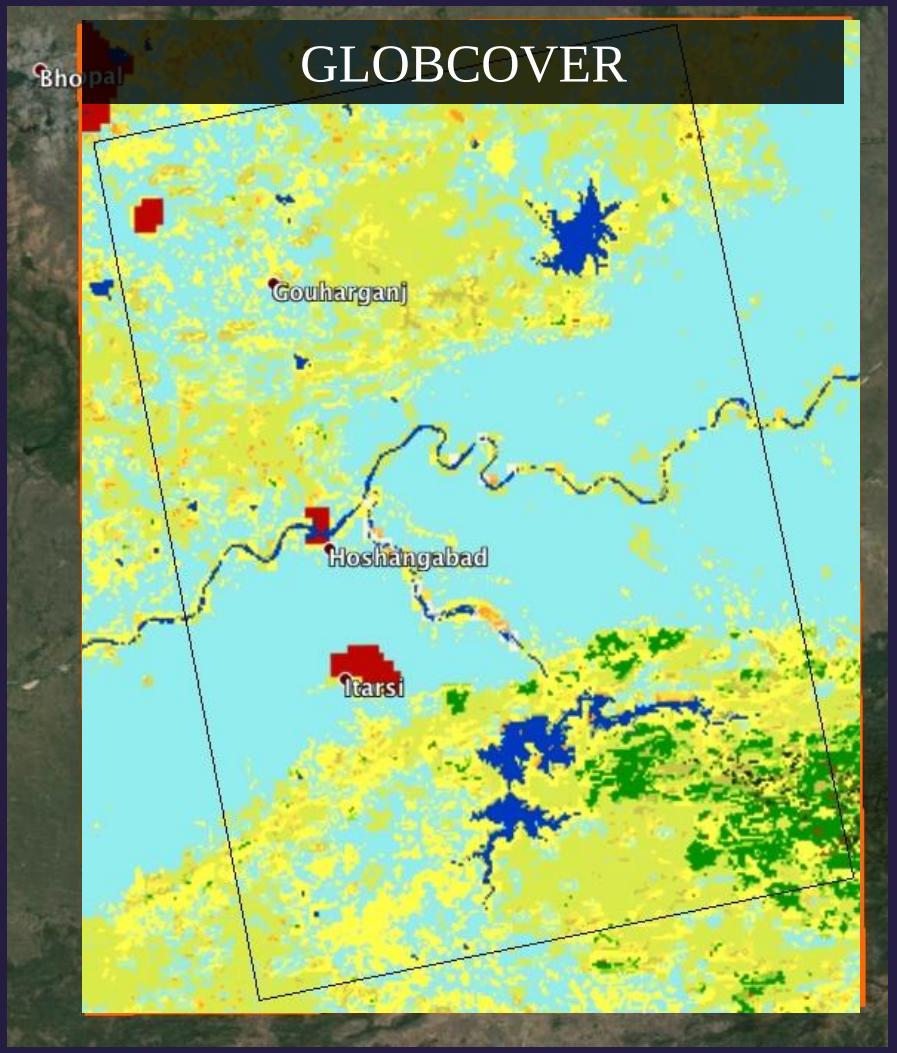
change metric highlights those areas where the image-to-image variation is unusually large

Methods for detecting agricultural activity

Coefficient of Variation

- Total classification accuracy, including errors in GLOBCOVER, are better than 80%.
- Noted accuracy in differentiating small developments and fixed structures (roads and towns) from agricultural landscapes





ALOS

JAXA

1

Remote Sensing of Environment 193 (2017) 216–224

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Use of time-series L-band UAVSAR data for the classification of agricultural fields in the San Joaquin Valley

Tracy Whelen, Paul Siqueira *

Department of Electrical and Computer Engineering, University of Massachusetts, Amherst, MA 01003, United States

Paper topic explores ALOS data collected over the US and shows that even a sporadic time-series can be used to identify crop and no - crop regions over a diverse set of regions across the US.

2

Int J Appl Earth Obs Geoinformation 67 (2018) 114–122

Contents lists available at ScienceDirect

Int J Appl Earth Obs Geoinformation

journal homepage: www.elsevier.com/locate/jag

Coefficient of variation for use in crop area classification across multiple climates

Tracy Whelen, Paul Siqueira*

3

REMOTE SENSING LETTERS, 2018
VOL. 9, NO. 5, 411–420
https://doi.org/10.1080/2150704X.2018.1430393

Taylor & Francis
Taylor & Francis Group

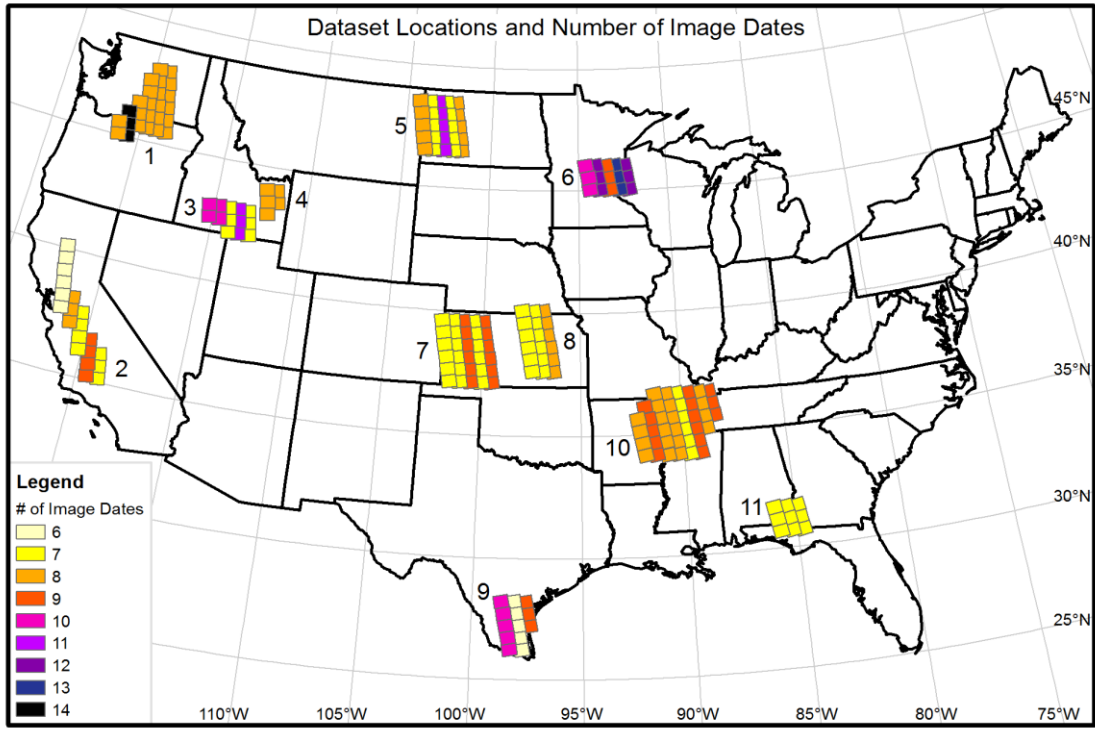
Check for updates

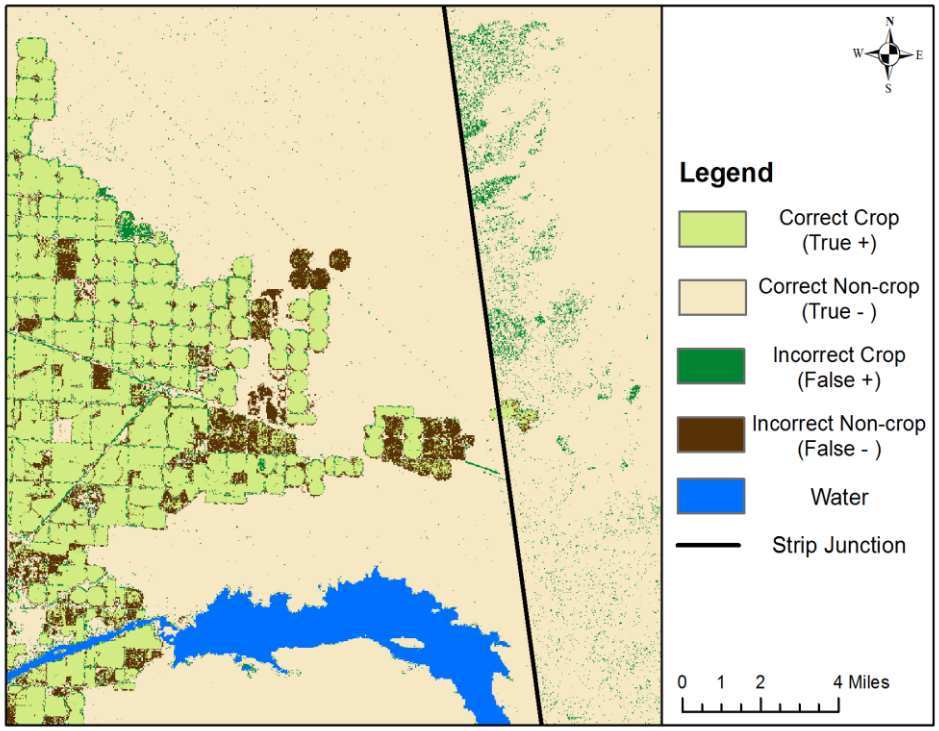
Time-series classification of Sentinel-1 agricultural data over North Dakota

Tracy Whelen and Paul Siqueira

Crop Area Determination

- Use coefficient of variation and a simple threshold to detect regions of land management
- ALOS-1 archive used to sample geographically disperse regions in the US where ground validation (USDA's CropScape) is available





Whelen, T. and P. Siqueira, "Coefficient of variation for use in crop area classification across multiple climates," Int. J. Appl. Earth. Obs. & Geoinf., 18 pp., 2018

Deliverables & Milestones

(and comments to JAXA)

- Coefficient of variation paper (RSE) in 2018
- Two other papers on related topics also published
  - * Repeat-pass UAVSAR in California's central valley
    - used for crop identification
  - * Sentinel-1 time-series used for crop classification
    - it is likely that an ALOS-2 or NISAR time-series could do similarly and even perform better
- Lack of consistent ALOS-1 or ALOS-2 data prevents use of long-term time series for creating global products from JAXA data.

PALSAR/PALSAR-2 data access

Please list the PALSAR/PALSAR-2 data you have requested and obtained

Data over central India, the US, and in the ABoVE domain.

Have you had sufficient data to complete your research (according to your K&C agreement)? Yes!!

For KC members who have submitted proposal for Post-KC

Post-KC proposal

L-band Sensitivity to Biomass and Landcover Structure in the ABoVE domain

Paul Siqueira
University of Massachusetts, Amherst
Curtis Woodcock, BU & Laura Borgeau-Chavez, MTRI

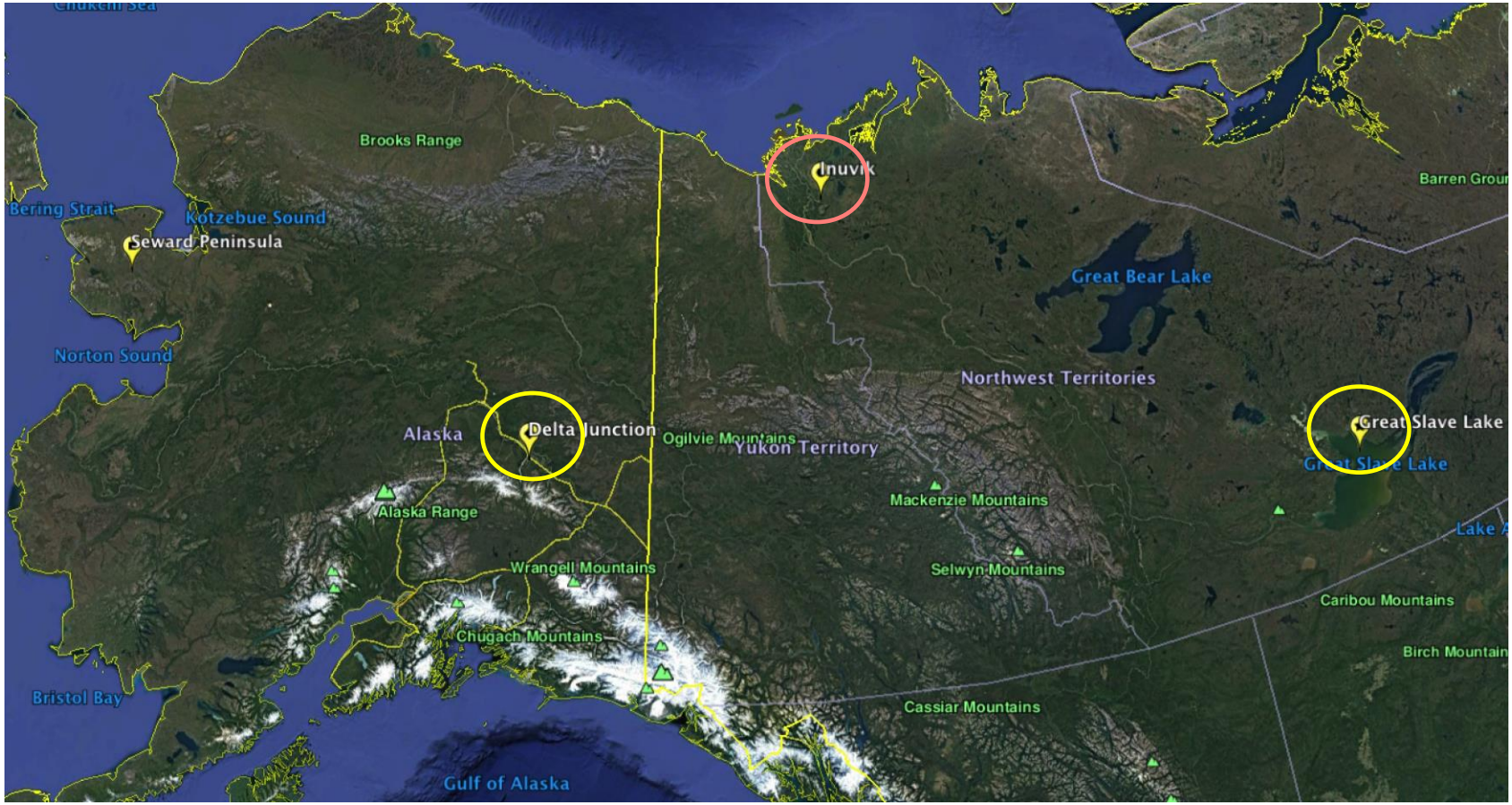
- Project objectives: study the estimation of biomass in the ABoVE domain. The region is complicated by low biomass and exposure of the radar signature to variations in soil moisture and roughness characteristics.
- Project area(s): Ecosystem characterization and carbon monitoring
- Satellite data requested from JAXA : ALOS-2 & MOLI (when available)
- Other data sources to be used: GEDI & UAVSAR
- Relevance to the 4 K&C thematic drivers: Carbon cycle science & Environmental Conservation
- Expected outcomes and deliverables: Map of landcover and biomass estimation over selected regions in the ABoVE domain.

ALOS-2 & ABoVE

- NASA is in the midst of the Arctic Boreal Vulnerability Experimeht (ABoVE) intended to study the ecologic consequences of climate change in the boreal region in Alaska and Canada
- Research focus areas on
  - Hydrology
  - Disturbance (fire, insect)
  - Disturbance History (biological succession)
  - Permafrost & Landscape effects
  - Habitat changes and effects on wildlife

Some study sites in ABoVE

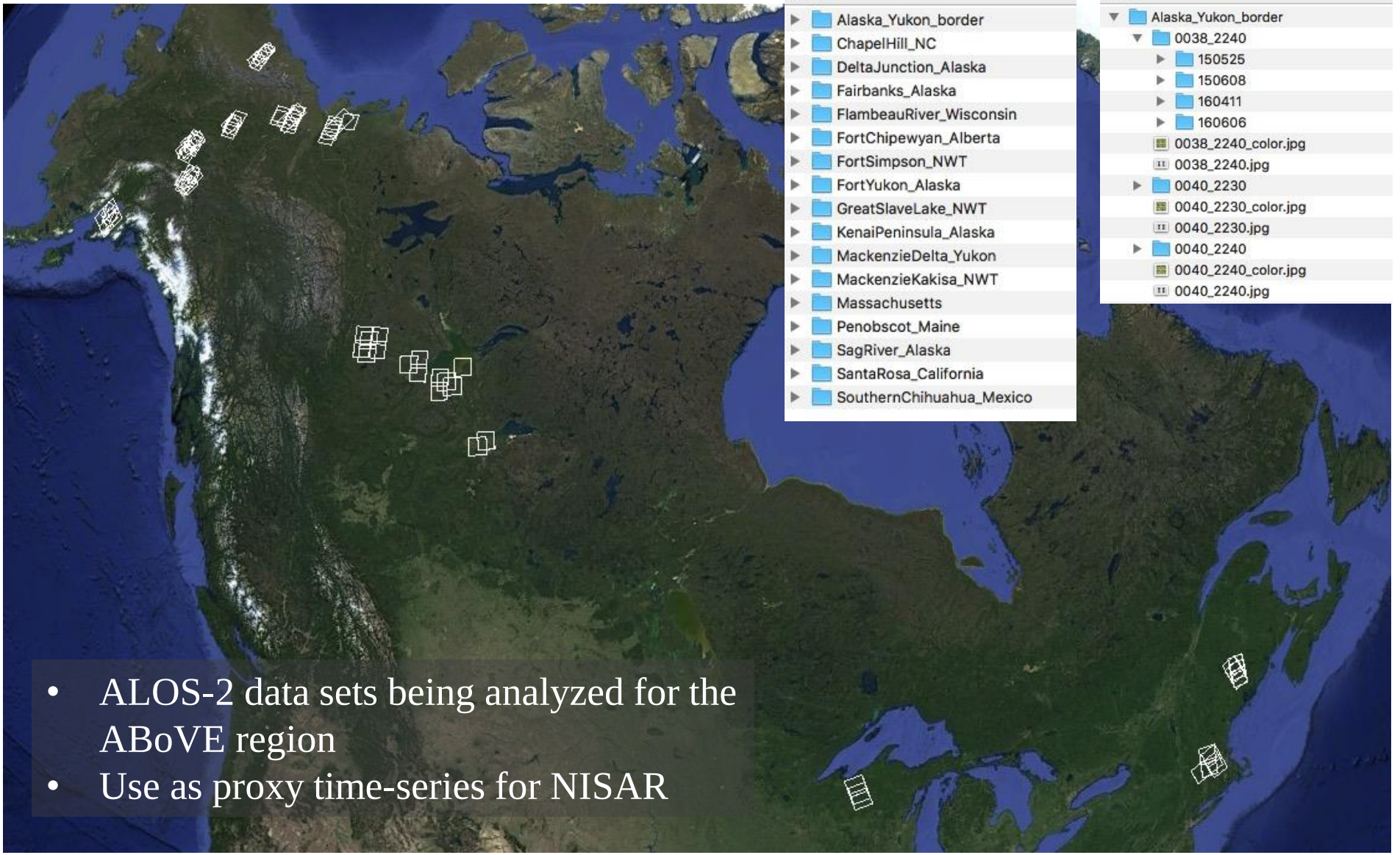
- Intensive air campaign in the ABoVE region in summer 2017
- Snow characterization at Inuvik in March 2018



ALOS

K&C Initiative

An international science collaboration led by JAXA



- ALOS-2 data sets being analyzed for the ABoVE region
- Use as proxy time-series for NISAR