K&C Phase 4 – Final Report

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

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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 Carbon cycle science, the GEO initiative for global agricultural monitoring (GEOGLAM & JECAM) and Environmental Conservation as it applies to permanent land cover conversion.
NISAR Development: Ecosystems

- Biomass
- Inundation
- Disturbance
- 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.
L-band coverage from ALOS-1

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

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

8 cross-pol scenes
21 co-pol scenes
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

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
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.
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

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!!
Post-KC proposal

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

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- **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 Experiment (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-2 data sets being analyzed for the ABoVE region
• Use as proxy time-series for NISAR