K&C Phase 4 – Status report

Use of short-period ALOS-2 observations for vegetation characterization and classification

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A Quick Notice

- Since 2015, The Alaska Satellite Facility has been processing ALOS-1 data into a Radiometric Terrain Correction (RTC) Product to remove geometric and radiometric distortion due to topography.
- Data is accessible by getting a simple account at the NASA DAAC.
- Data can be browsed using the GUI, or accessed through the API.
- Sentinel-1A data also being distributed. SAOCOM to be distributed post-launch.
- Data distributed in 12.5 m and 30 m GeoTIFF format.
- Coregistered DEM and incidence angle map also available.
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,
2. regions in South America where ground validation data is available and
3. agricultural regions in the US and elsewhere

- 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 will be done for forested and bare-surface regions over the geographic areas detailed above

- Develop a methodology for using time series observations over short-repeat periods (14 days) for the characterization of agriculture and inundated regions, for the geographic areas detailed above.

This work supports 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.
Forest Stand Height (FSH) Estimation

- Use of Repeat Pass Interferometry and Temporal Decorrelation to estimate tree height
- Have used the ALOS data archive to identify scene pairs with maximum correlation
- Algorithms have been automated to:
  - go through an archive
  - identify scenes with maximum correlation
  - include ground validation (e.g. vegetation height from lidar)
  - automate the mosaicking process
- Dominant error sources are non-height related sources of temporal decorrelation
  - e.g. Forest degradation, Deforestation and Tilling
\[ \gamma_{obs} = \gamma_{SNR} \cdot \gamma_{vol} \cdot \gamma_{temporal} \cdot \gamma_{geom} \Rightarrow \gamma_{v&t} \approx \frac{\gamma_{obs}}{\gamma_{SNR} \gamma_{geom}} \propto (h_v)^{-1} \]

Algorithm

- SAR image #1
- SAR image #2
- Interferogram
- Correct for geometric decorrelation, thermal noise decorrelation and correlation sampling bias
- Coupled correlation due to volume scattering and temporal changes
- Temporal change parameters \( S_{scene}, C_{scene} \)
- Estimated forest height
- Sinc inversion model with Gauss-Newton algorithm
- Ground validation forest height
Some Examples

LVIS  
SAR backscatter power  
InSAR phase  
InSAR correlation magnitude
Improved resolution over ICESAT
Automated Approach for Mosaicking

**Article**

An automatic mosaicking algorithm for the generation of a large-scale forest height map using spaceborne repeat-pass InSAR correlation magnitude

Yang Lei ¹, and Paul Siqueira ¹*
Application of mosaicking
Disturbance monitoring

Difference between external measure and FSH estimation used to identify likely regions of disturbance
In July 2015, USAID sponsored a two-week study tour to the University of Massachusetts for training and interaction on ecosystems applications of SAR.

Inputs from UMass and Applied GeoSolutions.

Attendees were from ISRO, FSI and Iora Ecological Solutions.

Connection has been fostered by ALOS K&C Meetings and this work.
ALOS-2 FBD Temporal Decorrelation Studies in Northeastern US

Ascending (36_900)
17 Sept 2014
26 Nov 2014: 5(30m)
04 Feb 2015: 5(17m)
08 July 2015: 11(150m)

Descending (139_2710)
07 June 2015
21 June 2015: 1(240m)
14 day repeat interferogram – June 2015
240 m baseline ($kz = 0.24$)
June time period indicates a greening of the landscape, which leads to large temporal decorrelation.
What next: Explore the Quad-pol data in the Northeastern US


Goal: process the data and compare with ground validation sites in Massachusetts, New Hampshire and Maine
Other K&C Related News

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- There will be a number of instruments on board and measurements are intended to be made on an hourly basis over a 50m length, throughout the year, daytime and nighttime.
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A radar on the tram

- A signal would travel a distance, hit groups of trees, and then bounce back to the tram.
- Since the target shape is relatively constant over time, the dominant signature would be of the moisture flow in the trees.
- Radar signals, such as those discussed here, would travel several kilometers.
- The tram path would be used to create a two-dimensional image of these changes over time.
Tram: The Movie
Airborne SAR Development

- Ka-band (35 GHz) and S-band (3.5 GHz)
- Cessna 206 Aircraft
- Both frequencies work well independently
- Currently working on a two-frequency InSAR
Data from the UMass Systems

- Working on systematizing the system so that data can be requested and processed for modest cost (~$0.50/ha; 50¥/ha)
- Ideal for collecting time series of
  - reflectivity
  - polarimetry
  - interferometry
  - differential penetration depth

Google Earth

35 GHz Diff. Topo.
Data sharing & Deliverables

Data from the tram and airborne observations over the Harvard Forest in Western Massachusetts as processing algorithms mature

Analysis of short-repeat period (14 days) and quad-pol data in Northeastern US to be presented at future K&C meetings