LCLUC year 1 task report – May 2001

Title: The Development of a Fine Resolution, Continental Scale Forest Monitoring System Using SAR imagery

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Abstract

A variety of sensors and international partnerships are required to globally monitor forest cover and forest cover change. While Synthetic Aperture Radar (SAR) has a well defined role in the global observing strategy (providing coverage over persistently cloudy areas), there are many integration issues that have never been executed in an operational environment; for instance, reconciling SAR/AVHRR/Landsat classification schemes. In addition, prior SAR land cover mapping projects, such as the Global Rain Forest Mapping Project (GRFM), have been research activities rather than operational systems.

We have begun to prototype the development of a fine resolution forest monitoring system using SAR imagery applicable to continental scale regions that could become operational in the NASDA ALOS PALSAR era beginning in 2003. This end-to-end processing system incorporating commercial off the shelf software would consist of the following elements: level 0 signal processing, calibration, geo-referencing, classification, and mosaicking to a resolution as fine as 30 meters. Using NASDA JERS-1 SAR imagery, this prototype development will deliver fine resolution, calibrated, continental scale image and classification mosaics of sub-tropical regions in Africa and South America, areas currently undergoing rapid changes in land cover. The JERS-1 SAR between 1993 and 1996 acquired data of these regions, but much of this imagery was never processed.

The land cover classification will include the classification of flooded vegetation areas, as well as land cover types compatible with coarse resolution and other fine resolution land cover products. This prototype data set will allow an unprecedented snapshot of the state of forest cover currently unobtainable over perpetually cloudy regions in African and South American sub-tropical areas. An important component of this work will be the utilization of the data products in partnership with individuals and institutions from South America and Africa. The development of the processing system will be accomplished in close cooperation with the National Space Development Agency of Japan (NASDA). The key technology this task incorporates will demonstrate inexpensive but efficient processing architectures for continental scale mapping activities.

Keywords:

1) Research Fields : land cover classification, image processing
2) Geographic Area/Biome : South America, Humid tropical forest, wetlands
3) Remote Sensing : SAR, radars
4) Methods/scales : regional scale, data info systems

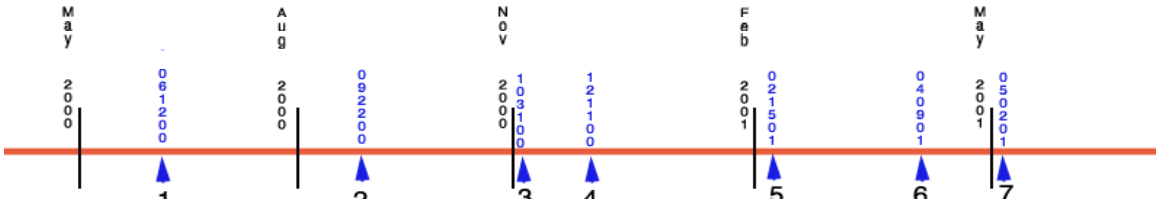
Questions, Goals, Approaches

The primary deliverable of this task is a baseline land cover map for forested areas South of the Global Rain Forest Mapping (GRFM) Project coverage areas in South America and Africa. Changes in land cover are occurring in these areas, but some areas in particular are difficult to monitor due to cloud cover. The proportion of social science used in this study is 0.0%. Our activity is concentrated on the development of operational forest monitoring techniques, rather than the causes and consequences of land cover and land use change. The GOFC theme is 100% of this task.

Our approach is to develop a prototype operational processing system that produces mosaicked imagery and classifications of forested areas south of the GRFM coverage in South America and Africa. After the data is mosaicked and a classification performed, it will be possible to compare with data from other complementary sensors. In order to prototype what will be possible once SRTM DEM data is available, we have interpolated the global GTOPO30 dataset to a similar pixel spacing, and experimented with visualization of the combined data set.

In this first year of this task, our goal has been to 1) develop the processing infrastructure to process level 0 JERS-1 SAR, 2) define the protocols for transmission of data to JPL by NASDA EORC, and 3) begin processing data.

First year schedule:



Milestones:
1 – funding received at JPL
2 – LCLUC meeting
3 – test data received at JPL from NASDA EORC
4 – procurement for processing software completed
5 – modifications of processing software completed
6 - ASF proposal submitted
7 - 4 initial tracks processed

Figure 1 shows one quarter of a track (~14,000 sq km) (RSP 233) at three different resolutions that has been processed of an area over southern Africa, using the Gamma MSP processor at JPL.

We are still evaluating the calibration of the SAR processor. When this is completed, we will make a mosaic of a large region in southern Africa, and produce a simple classification. Based on these results, we will commence operational processing of data from South America (and other regions of Africa). We have found that the data may be more easily interpreted when compared with a simulated SAR image generated from a DEM (i.e. The GTOPO30 global 1km dataset) The DEM also allows for new visualizations of the data, such as shown in figure 2.

Narrative statement of progress in study

The first year of this task included the procurement of processing software from a foreign company, which required over 3 months for approval. In addition, the vendor (Gamma Remote Sensing, Switzerland) had to make some modifications to the MSP software to handle the data format from the EORC, which required another 2 months to implement. The NASDA EORC is obtaining copies of all the JERS-1 SAR data from the NASDA EOC, but this is occurring more slowly that expected. Because of this, we have had to request data based not on site priority but on data availability. In order to reduce the near-term load on the EORC of our requests, we have also submitted a data-only proposal to the Alaska SAR facility, which received most of the downlinks of JERS-1 SAR data acquired of South America. This will also initiate the ingestion of JERS-1 SAR raw signal data into the ASF level 0 archive. As a result of these actions, we expect to be able to successfully acquire JERS-1 SAR data in a timely fashion over the forested regions south of the GRFM coverage in South America and Africa, as described in our task plan.

We have currently received unprocessed SAR data covering almost 3 million square kilometers over forested areas in South America and Southern Africa. The full resolution of this data set is 12.5 meters, but for the purposes of this project, it will be re-sampled at the Landsat pixel spacing of 28.5. 4 long tracks over Africa have been processed to full resolution (over 80 images) for the purposes of testing the software.
We hosted Eileen Helmer of the USFS International Institute for Tropical Forestry and Vijay Datadin of the Iwokrama Forest Reserve in Guyana for two weeks in February to explore future collaboration possibilities. Based on this meeting, we are working on a forestry application paper, and pursuing multiple future remote sensing data collections over the Iwokrama forest using ASTER, SRTM, GEOSAR, AIRSAR, and other sensors.

New findings: -

New potential:

- The use of simulated SAR images generated from the DEM will assist in visualization and interpretation of the imagery.
- Collaboration with USFS IITF and Iwokrama Forest Reserve in Guyana
- ALOS research proposal (data only) for regular imaging of the South American continent (beginning 2003) was approved.

New products:

- CDROM of GRFM data from South America has been completed.

Conclusions

The first year of this task has been devoted as planned to development of the system for processing SAR imagery from the JERS-1 satellite. In the next year of this task, we will begin producing mosaics of multiple image tracks over southern Africa and southern South America, leading to full coverage by the end of this task of forested regions in these areas. In addition, we will develop simple land cover classifications based upon the mosaicked SAR imagery and ancillary products.

Several of us (Bruce Chapman, Ake Rosenqvist, Masanobu Shimada, Frank DeGrandi, and Laura Hess) are members of the science advisory panel for the ALOS Kyoto and Carbon cycle initiative, for which a dedicated observation strategy for monitoring changes in land cover using ALOS is the prime objective. Under this program, and through our approved data-only research proposals, beginning in 2003, data will be available to continue (at a substantially enhanced level) periodic continental-to-global scale SAR imaging of forested areas.

Accepted Journal Papers:

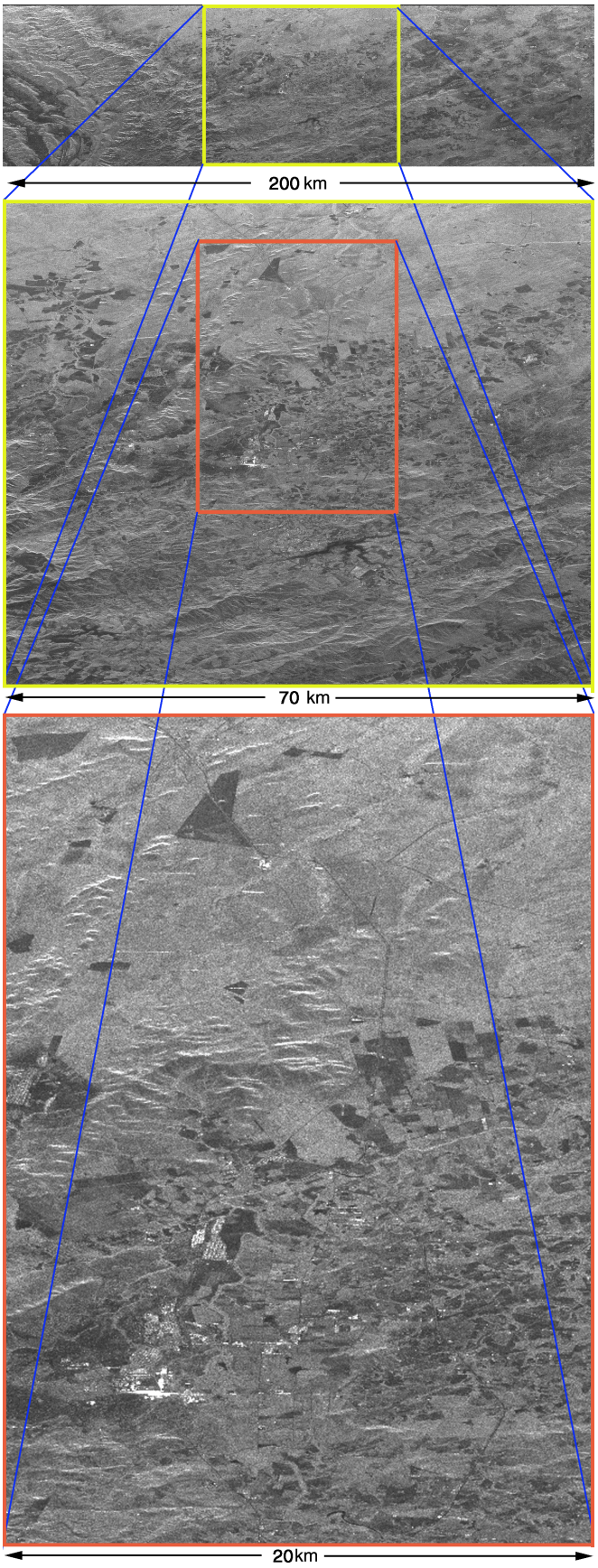
Chapman, Bruce, Paul Siqueira, and Tony Freeman, 2001, "The JERS Amazon Multi-Season Mapping Study (JAMMS) : Observation strategies and data characteristics", special GRFM issue of IJRS.

Freeman, Tony, Bruce Chapman, and Paul Siqueira, 2001, "The JERS Amazon Multi-Season Mapping Study (JAMMS) : Science Objectives and implications for future missions", special GRFM issue of IJRS.

Published Journal Papers:

Siqueira, Paul, Scott Hensley, Scott Shaffer, Laura Hess, Greg Mcgarragh, Bruce Chapman, and Tony Freeman "A continental scale mosaic of the Amazon basin using jers-1 SAR", , IEEE Geosci and Rem. Sensing, November, 2000.

Figures



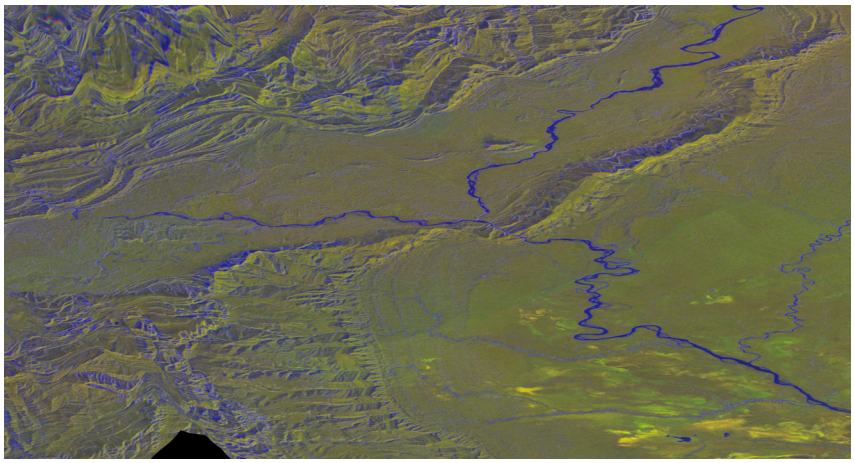


Figure 2: Visualization of radar imagery using GTOPO30 DEM.

Figure 1: One quarter of one JERS-1 SAR track over southern Africa