

The Mosaic Theme of the ALOS Kyoto and Carbon Project

Bruce Chapman
Jet Propulsion Laboratory, California Institute of Technology
bruce.chapman@jpl.nasa.gov

Introduction

The Japan Aerospace Exploration Agency (JAXA) Advanced Land Observing Satellite (ALOS) project includes the ALOS Kyoto and Carbon Initiative (ALOS K&C), begun in 2000 by the Earth Observation Research and Applications Centre (EORC) of JAXA – formerly known as NASDA. The charter of the ALOS K&C is to support explicit and implicit data and information needs raised by international environmental Conventions, Carbon Cycle Science and Conservation of the environment, focusing primarily on defining and optimizing the provision of data products and validated thematic information derived from in-situ and satellite sensor data, particularly on that acquired by the Phased Array L-band Synthetic Aperture Radar (PALSAR) on-board ALOS. The ALOS K&C will define, develop and validate thematic products derived primarily from ALOS PALSAR data that can be used to meet the required information needs. A key component of this work has been the development of a systematic data acquisition strategy for ALOS PALSAR that fits within the constraints imposed by the orbital and technical capabilities of the spacecraft and also ensures that adequate data will be collected to allow the required thematic output products to be developed on a timely basis. (Rosenqvist, 2008).

The K&C Initiative is based on the three coordinated themes relating to global biomes; Forests, Wetlands, Deserts and Semi-Arid Regions, and a fourth theme dealing with the generation of regional ALOS PALSAR mosaics. This paper will address this last theme: the mosaicking of ALOS PALSAR imagery.

One of the motivations of this theme lies in the historical context of the Global Rain Forest Mapping project (GRFM) in which JERS-1 imagery from selected forest areas around the globe (SE Asia, Amazon basin, Africa, Boreal North America) were calibrated and mosaicked for further scientific use by the scientific user community. The mosaic theme is therefore descended from the GRFM project, and will build upon the lessons learned from the GRFM project.

Since the GRFM project, there have been several technology enhancements that will make mosaic generation more straightforward: path processing of the image strips, reductions in cost of resources, improved position accuracy expected for ALOS, and the existence of a near global high resolution DEM (SRTM) for ortho-rectification and calibration. Calibration and gaps in coverage will continue to be issues.

There are two main objectives of mosaic theme: 1) Develop products to facilitate science product generation, and 2) Public presentation of the data to promote the project. For this first objective, the mosaic theme will generate intermediate products used in construction of ALOS K&C Initiative science products (such as wetland extent, change in deforestation, etc). The projection, format and season/cycle of acquisition will be optimized according to science objectives. These mosaics demonstrate that the calibration and geo-location are well understood, which is necessary for accurate development of the science products. For the second objective, this is probably best accomplished using KML files to enable the visualization of the

mosaics. This public visualization of the data will facilitate non-K&C research investigations. The mosaic products are an intermediate product rather than a science product, but these products facilitate many of the science products of the forest, wetlands, and desert and water themes.

Anticipated results

There are four products that will be produced through the mosaic theme of the ALOS K&C:

- 1) Path images. These are the JAXA/EORC produced image strips that are assembled into mosaics. They are suitable for independent image analysis as well.
- 2) ScanSAR mosaics. These are the mosaics made from the ScanSAR mode of operation. There is often dense multi-temporal coverage, and therefore multiple corresponding mosaics.
- 3) Dual and single polarization strip map mosaics. In most cases, there is one mosaic generated once per year for selected continental scale regions.
- 4) Browse mosaics. These will be generated shortly after acquisition with minimal corrections, and are not intended for science analysis.

NASA will be supporting this mosaicking activity through a project funded through the NASA MEaSURES program. The task, entitled “A Global Inundated Wetlands Earth Science Data Record (IW-ESDR)” is a five-year project lead by Kyle McDonald of JPL, and has the objective of producing a global inundated wetlands earth science data record. The remainder of this paper will address the activity that will be conducted through this program.

Methodology

The input data, in generally long (> 1000km) path image strips, will be geo-coded to the SRTM DEM. Any errors in geo-coding will be evaluated and corrected during the geo-coding process. The output imagery will be co-registered to the SRTM tiles that are freely available from NASA. The selection of which images are ‘on top’ will occur at the ‘stitching’ stage of processing, and will be determined by calibration issues, thematic issues related to the timing of each image, and available imagery. The data will remain (even at high latitude) in geographic projection (latitude/longitude) to simplify global data products, but alternate projections and pixel spacings will be supported depending on the needs of the science themes of the ALOS K&C.

There will also be made available online tools to facilitate user-customized mosaics. These online tools will enable users to produce customized thematic mosaics that are driven by specific scientific requirements.

There are difficult decisions that have to be made in generating a large scale continental scale mosaic, primary among them is ‘What image strips should be in the mosaic?’ when there is a choice of imagery; in particular, in overlap regions between image paths. ALOS PALSAR, and any high resolution sensor making global observations, do not produce ‘instantaneous’ snapshots, but in fact often have gaps in coverage, take months to acquire, and may vary temporally over a span of several years. Science objectives may necessitate combination of ascending and descending data takes, and data takes from different modes (i.e. ScanSAR and dual-polarization

modes). In the overlap regions, a decision must be made for the mosaic pixel: should it be an average of the overlap regions, or the choice selection of a pixel from a single image path. If averaging is not selected (which may be desirable, as otherwise the image statistics will vary with location and the number of overlapping images), imagery will be thrown out and not used. This drives the desire to make user customized mosaics, as different science objectives may have different requirements as to what each image pixel should contain. ‘Throwing out data’ is particularly an issue with the ScanSAR acquisitions, as the acquisition plan calls for 100% overlap (to accommodate possible acquisition losses)

Acknowledgements

Copyright 2008 California Institute of Technology. Government sponsorship acknowledged. This research is conducted under the agreement of the JAXA PI program (#86) through the Alaska SAR Facility, and the ALOS Kyoto and Carbon Cycle Initiative. Some of the research was conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

- Ahern, F., Janetos, A. and Langham, E. (1998). Global observations of forest cover: One component of CEOS’ integrated global observation strategy. Proceedings of the 27th International Symposium on Remote Sensing of Environment, Tromso, Norway.
- Chapman, B., Siqueira, P, and Freeman, A., ‘The JERS-1 Amazon Multi-Season Mapping Study (JAMMS): Observation Strategies and Data Characteristics, *International Journal of Remote Sensing*, Vol 23, No. 7, 10 April 2002, pp 1427-1446.
- Cihlar J., *et al.* (Eds.), 2001. *IGOS-P Carbon Cycle Observation Theme: Terrestrial and atmospheric components*. A report to IGOS-P by the Terrestrial Carbon Theme Team.
- De Grandi G.; Mayaux P.; Rauste Y.; Rosenqvist A.; Simard M. and Saatchi S. “The Global Rain Forest Mapping Project JERS-1 radar mosaic of tropical Africa - Development and product characterization aspects.” *IEEE Transactions on Geoscience and Remote Sensing*, 2000, vol. 38, No. 5, p. 2218-2233.
- Freeman, A., Chapman, B, and Siqueira, P, 2001, “The JERS-1 Amazon Multi-season Mapping Study: Science objectives and implications for future missions”, *International Journal of Remote Sensing*, Vol. 23, No. 7, April 10, 2002, pp1447-1461.
- Hess, L.L.; Melack,J.M.; Filoso, S.; Wang, Y. (1995). Delineation of inundated area and vegetation along the Amazon Floodplain with SIR-C synthetic aperture radar. *IEEE Transaction on Geoscience and Remote Sensing*. 33(4):896-903.
- Paillou Ph., A. Rosenqvist, T. Farr, 2003b. “Saharasar: A JERS-1 radar mosaic for subsurface geology mapping in East Sahara,” *Proceedings of IGARSS’03*, Toulouse, France, 2003.

- Rosenqvist, A., Shimada, M and Watanabe, M. *ALOS PALSAR: A pathfinder mission for global-scale monitoring of the environment*. IEEE Transactions on Geoscience and Remote Sensing, Vol. 45, No. 11, pp 3307-3316, Nov. 2007.
- Rosenqvist, A., Finlayson, M., Lowry, J. and Taylor, D. *The potential of long wavelength satellite borne radar to support implementation of the Ramsar Wetlands Convention*. Journal of Aquatic Conservation; Marine and Freshwater Ecosystems, Vol 17, 2007, pp 229-244.
- Rosenqvist, A., Milne A.K. and Zimmermann, R., 2003. Systematic Data Acquisitions - A Pre-requisite for Meaningful Biophysical Parameter Retrieval?. *IEEE Transactions on Geoscience and Remote Sensing*, Communication, Vol. 41, No. 7, pp.1709-1711.
- Rosenqvist, A. and Birkett C., 2002. Evaluation of the JERS-1 SAR mosaics for hydrological applications in the Congo river basin. *International Journal of Remote Sensing*, 2002, Vol. 23, No. 7, pp. 1283-1302.
- Rosenqvist A., Shimada M., Chapman B., Freeman A., De Grandi G., Saatchi S. and Rauste Y. The Global Rain Forest Mapping project - A review. *International Journal of Remote Sensing*, 2000, Vol. 21, No. 6&7, pp. 1375-1387.
- Rosenqvist A., Shimada M., Chapman B., Freeman A., De Grandi G.F., Saatchi S. and Rauste Y. The Global Rain Forest Mapping Project - A Review. *International Journal of Remote Sensing*, 2000, Vol. 21, No. 6&7, pp. 1375-1387
- Rosenqvist, A., *The ALOS Kyoto & Carbon Initiative Science Plan (v.3.0)*, JAXA, 2008.
- Shimada M. and O. Isoguchi. JERS-1 SAR Mosaics of Southeast Asia Using Calibrated Path Images. *International Journal of Remote Sensing*, Vol. 23 No.7, 2002.
- Siqueira, P., B. Chapman, and G. McGarragh, 2003, "The Creation and Interpretation of the Multiseason JERS-1 SAR Mosaic over South America", *Remote sensing of the Environment*, Vol. 87, 15 November 2003, pp389-403..
- Siqueira, P., S. Hensley, S. Shaffer, L. Hess, G. McGarragh, B. Chapman, and A. Freeman, "A Continental Scale Mosaic of the Amazon Basin Using JERS-1 SAR," *IEEE Trans. Geosci. Rem. Sens.*, November 2000.