NEW EYES IN THE SKY: CLOUD-FREE TROPICAL FOREST MONITORING FOR REDD WITH THE JAPANESE ADVANCED LAND OBSERVATION SATELLITE (ALOS)
New Eyes in the Sky: Cloud-Free Tropical Forest Monitoring for REDD with the Japanese Advanced Land Observing Satellite (ALOS)

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Executive Summary

As UNFCCC negotiations lead to a powerful new mechanism for compensating tropical countries for their nation-wide reductions of greenhouse gas emissions from deforestation and forest degradation (REDD), an important, re-occurring question is: “can we monitor forests?” Most of the world’s tropical forest countries still don’t have high quality maps of their forests for multiple reasons including chronic cloud cover, and the risk of being excluded from REDD. We report that pan-tropical monitoring of forests hidden by clouds will now be easier, thus strengthening existing global monitoring efforts. We present in this report two successful radar image mosaics of ALOS/PALSAR from a global dataset which was acquired between June and October of 2007. Regions in the Amazon (Xingu Basin, Mato Grosso, Brazil), Western Africa (Gabon and Equatorial Guinea) and Southeast Asia (Bali, Indonesia) were selected to be the focus of initial research to demonstrate ALOS as an important new monitoring tool to support REDD initiatives.

What do we see in the ALOS radar image mosaics?

Because radar sensors are “active” remote sensing systems (i.e., they transmit and receive their own microwave energy and thus complement “passive” optical sensors which measure reflected sunlight), radar images are always visual (i.e., in the visible spectrum) representations of microwave energy received at and recorded by the sensor. Single radar information channels are typically displayed as grayscale images. When interpreting a radar image it is a general rule of thumb that increasing brightness corresponds to a greater amount of energy recorded by the sensor. Applying this rule of thumb to the interpretation of vegetated regions in an ALOS/PALSAR image, areas with a greater amount of vegetation biomass of a given structural type will appear brighter due to the greater amount of energy scattered back to and recorded by the sensor. If multiple radar information channels are available, color images can be generated by assigning a combination of distinct radar information channels to each of the visible red, green, and blue (RGB) channels commonly used for display on computer monitors.

The radar image mosaics presented in this report (Figures 1 and 2) were each generated using two distinct PALSAR information channels: a) Image data derived from microwave energy that was both transmitted and received by the sensors and transmitted in the horizontal direction, i.e. parallel to Earth’s surface, and b) image data derived from microwave energy transmitted in the horizontal direction, but received in the vertical direction. The former case is referred to as HH-polarization while the latter case is HV-polarization. To create...
the RGB images included in this report, the HH information channel was assigned to red, HV was assigned
to green, and the difference between the two (HH-HV) was assigned to blue. Hence, green and yellow tones
correspond to instances where both HH and HV information channels have high energy returns e.g., over
forested and urban areas. Blue and magenta colors are generally found in non-forested areas, where the HH
polarized energy often exhibits a higher return from the surface than the HV polarized energy.

The ALOS/PALSAR Sensor and Imaging Modes

Since ALOS/PALSAR is based on phased-array L-Band antenna technology, the sensor can be operated in
various imaging modes referred to as fine-beam single-polarimetric (FBS), dual-polarimetric (FBD), fully
polarimetric (PLR), and wide-beam ScanSAR (WB). The latter mode allows for single-polarimetric image
acquisitions at a swath width of ~350 km at 100 m resolution. FBS and FBD imagery have a 70 km swath width
and resolutions of 10 m and 20 m, respectively. Additionally, the off-nadir look angle of the radar antenna
can be adjusted to target specific regions of interest, such as natural disasters, or to fill specific multi-temporal
acquisition needs.

The L-Band radar wavelength (~ 23 cm) has been shown in numerous studies to be particularly well suited for
forest mapping applications. This research is based on nearly three decades of airborne, satellite-borne and space
shuttle-based radar imaging missions, including the Japanese predecessor mission to ALOS, the Japanese Earth
Resources Satellite (JERS-1).

The ALOS/PALSAR Observation Strategy

In the interest of producing globally consistent radar image datasets of the type first generated during the
JERS-1 Global Rain Forest Mapping (GRFM) project of the mid-1990s, an international ALOS “Kyoto &
Carbon Science Team” was formed, and a dedicated observation strategy was developed to support global forest
monitoring needs (Figure 3). In a wall-to-wall manner, PALSAR data will be systematically collected in HH
(FBS and ScanSAR) and HH/HV mode to cover all of Earth’s land masses at least three times each year. The
observation strategy will be assessed and optimized after three years, and is likely to continue until the end
of the mission. Because of the excellent positional accuracy of ALOS and the availability of advanced image
processing methods, regional- to continental-scale image mosaics can readily be produced for any region that
has been systematically imaged by the PALSAR sensor.

Rosenqvist, A., Shimada, M and Watanabe, M. “ALOS PALSAR: A pathfinder mission for global-scale monitoring of the

Figure 1: Xingu Basin Watershed, Mato Grosso, Brazil. The radar image mosaic, is a composite of 116 individual scenes (400,000 km²)
acquired by the PALSAR sensor carried on board ALOS. The image acquisitions were made between June 8 and July 22, 2007. From the mosaic, Dr. Kellendörfer's group has generated
a preliminary land cover classification with emphasis on producing an accurate forest/nonforest map. In the forested areas, the sensitivity of the PALSAR data to
differences in aboveground biomass is also being investigated in collaboration with
the Amazon Institute of Environmental Research (IPAM).
Figure 2: Bali, Indonesia, host to the 2007 UNFCCC Conference of the Parties 13 (COP-13). The radar image mosaic is a composite of nine individual scenes (45,000 km²) acquired by the PALSAR sensor carried on board ALOS. The image acquisitions were made between September 9 and October 10, 2007.

Figure 3: Global observation strategy for various ALOS/PALSAR sensor modes (Source: JAXA/EORC).