# THE 20090-2010 UAVSAR CAMPAIGN TO MAP VEGETATION 3D STRUCTURE AND BIOMASS

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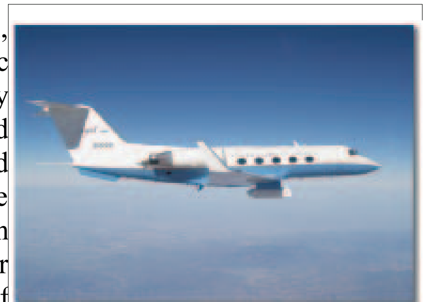
*Figure 1: UAVSAR L-band system mounted below a GIII aircraft*

We present the results of the 2009-2010 UAVSAR campaigns over boreal, temperate and tropical forests. UAVSAR is a new L-band fully polarimetric synthetic aperture radar (inSAR) capable of repeat pass interferometry (Figure 1)[1]. Our objective is to estimate vegetation 3D structure and biomass using polarimetric backscatter, repeat-pass inSAR, lidar and ancillary data (e.g. land cover maps, climate and weather data). The campaign was designed to inform the upcoming NASA's DESDynI mission [2] which involves a lidar and radar sensor. Data was collected over temperate forests of New Hampshire, Maine and California, boreal forests of Québec (Figure 2) and tropical forests of Costa Rica. The radar swath is 20km and data collection ran between 100 and 185km long. Each site was chosen to cover at least one National Park and an experimental forest, providing pristine and managed forests with a wealth of historical data. During the UAVSAR campaign, we also collected airborne lidar data using LVIS (Laser Vegetation Imaging System)[3] in addition to field (tree height, Diameter at Breast Height (DBH), crown size and species composition) and weather data (precipitation and wind).

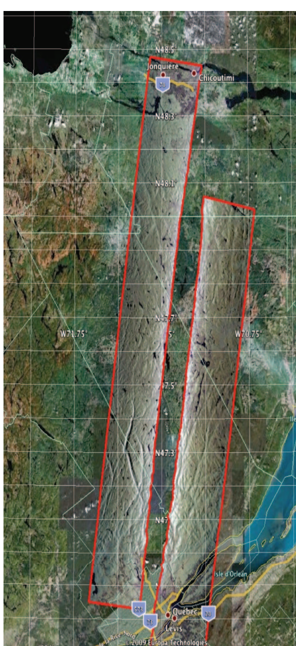
*Figure 2: UAVSAR data over the Québec (Laurentians) site. Each line is 20km wide and 185km long.*

The UAVSAR data was processed at JPL within a few weeks of the flights. In this presentation, we first describe the incidence angle radiometric calibration procedure for the polarimetric backscatter data. In the case of UAVSAR, the incidence angle varies from 20 to 70º from close to far range. Both topography and forest reflectivity patterns must be removed before estimating biomass at the landscape scale. We used incidence angle and facet models to correct for topographic effect and show a reduction of the small scale residuals with the latter [4]. The residuals are due to the low resolution digital elevation models used in the topographic corrections. In terms of the vegetation reflectivity pattern, we found it was specific to land cover type and differed greatly for each polarization (Figure 3). Thus we used land cover specific calibration curves to calibrate the backscatter data. Curves were compiled for all sites to provide a set of "universal" calibrations that can be applied to any UAVSAR image given a the land cover type is known from ancillary data. Calibrated data is shown for the Main site in Figure 4.

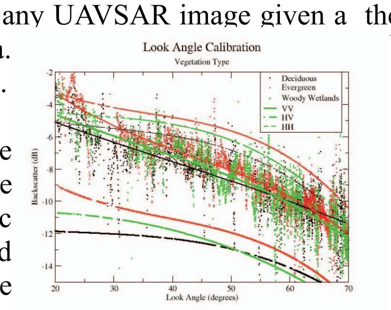

*Figure 3: L-band radar reflectivity pattern for 3 land cover types. The point data is for VV polarization and the fits are for each polarizations.*

Variations in weather (precipitation and wind) induce changes in radar backscattering properties of the canopy and in particular the interferometric correlation [5]. This reduces inSAR coherence and therefore height measurement accuracy. The UAVSAR campaigns was designed to quantify the impact of these so-called temporal changes on the inSAR measurement in order to apply the polInSAR method [6]. To achieve this, UAVSAR collected data several times over each site within a 2 weeks period in order to obtain a set of temporal intervals.

Weather data was collected during the entire flight campaign and used to identify spatial pattern of change in the radar data. Over each site, we flew 2 pairs of flights: one with zero baseline and one with 65m perpendicular baseline. The zero baseline is relatively free of volumetric decorrelation thus isolating the impact of temporal decorrelation on the radar signal. The temporal decorrelation is then used to correct the polinSAR height inversion algorithm. Although we did not find any significant impact on the radar backscatter level, the impact of wind and precipitation can be distinguished by spatial patterns of lower coherence.

We use LVIS (Lidar Vegetation Imaging System) and Land Cover maps to assess the impact of weather as a function of vegetation structure and estimate spatial variations of microwave extinction (Figure 6). The quantile metrics (Drake et al., 2002) were used to estimate canopy density layers as a function of height and microwave extinction for polINSAR inversion and to guide the polinSAR inversion. Field data was used to calibrate and validate the UAVSAR maps.

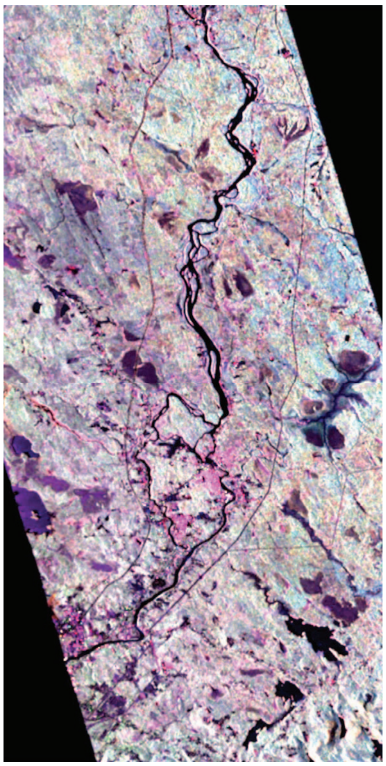

*Figure 4: Calibrate UAVSAR backscatter image (RGB composite) for HH, HV and VV polarization over the Maine site.*

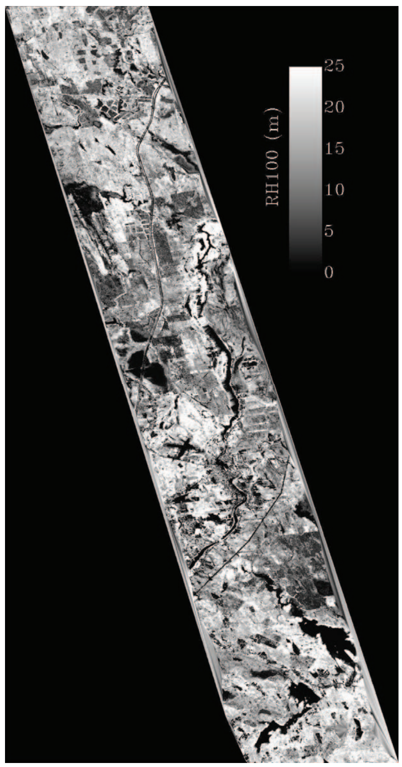


*Figure 5: LVIS canopy height estimation.*

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