TropiSAR, a SAR data acquisition campaign in French Guiana

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1. INTRODUCTION

The BIOMASS mission [1] was retained in January 2009 as one of the three candidates for the next Earth Explorer Core mission to go to phase A. BIOMASS will meet a pressing need for information on the carbon sinks and sources in the forests globally, which will be of essential value for climate modelling and policy adaptation, e.g. REDD. :

During phase 0, biomass retrieval algorithms have been developed and validated for the range of biomass up to 300 t/ha. The methods are based on combining SAR intensity and SAR Polarimetric interferometry (PolInSAR) which provide respectively estimates of biomass and canopy height. One of the important findings from the BIOSAR 2007 airborne campaign in boreal forest was that at P-band, the temporal coherence remains high after 20-30 days. The result indicates that forest height can be retrieved with good accuracy using interferometry at P-band at time interval compatible with a single radar concept in a repeat pass mode. Reversely, at L band, the lost of coherence after 20-30 days implies for example the use of two satellites for the height retrieval. : :

The questions which remain to be addressed in phase A concern the overall performance of the retrieval algorithms in tropical forests characterized by high biomass density (> 300 t/ha) and complex structure.

Among the actions recommended by ESAC to be undertaken during phase A, the following action is of utmost importance: to conduct flight campaigns particularly in high forest density regions to verify the robustness of the height and biomass retrieval algorithm. :

It is essential that BIOMASS could measure the biomass density in tropical forests, in order to estimate with accuracy this large component of the terrestrial carbon pool and the carbon sources generated by deforestation in the tropics. :

The TropiSAR experiment in French Guyana was proposed to provide feedbacks to ESA and CNES on the performances of a P-band SAR to measure biomass and canopy height of a tropical forest with high biomass density. :

Specifically, TropiSAR is designed for the following objectives:

- to provide measurements of temporal coherence at P- and L-band over tropical forests for time intervals compatible with spaceborne missions (typically 20-30 days)
- to assess performances of methods transforming P-Band SAR intensity and interferometric measurements into forest biomass and forest height.
- to assess uncertainties in in-situ methods for biomass estimates and tree allometry for tropical forests under considerations.

In this paper, the campaign is described and the first results are presented.

2. FOREST SITES

The Nouragues Research Station (4°05'N, 52°40'W), is located 120 km South of Cayenne, in the lowland rain forest of French Guiana [2]. The biomass level measured on the studied plots ranges between 300 and 520 T/ha.

The Paracou experimental site is located in a lowland tropical rain forest near Sinnamary, French Guiana (5o 18' N, 52o 55 'W) [3]. Tree census data are from a series of 15 permanent plots of 6.25 ha each in which all stems ≥ 10 cm DBH were mapped and regularly censused. The biomass over the sites was measured between 260 and 470 T/ha.

3. THE SETHI RADAR

The airborne system proposed for TropiSAR is the SETHI, a new generation SAR developed over the last three years, to be compatible with small/medium aircrafts for remote sensing applications.

SETHI combines two pods positioned under aircraft wings which are able to carry heavy and bulky payloads of different kinds ranging from VHF to Ku band and/or optical sensors with a wide range of acquisition geometries.

SETHI can be operated with 4 radar front-ends simultaneously together with two optical payloads. The first version of the system, tested in September 2007 includes P, L and X bands fully polarimetric SAR with potential for single pass interferometry at X band. P and L systems rely on fully digital signal generation. The new UHF-VHF system was tested in October 2008. The data recording system, inherited from RAMSES, allows up to four simultaneous channels with a maximum sampling frequency of 1.5 GHz, and a maximum data rate of 360MB/s for each recording channels. [4]

Band	Centre Frequency[MHz]	Bandwidth [MHz]	Polarimetry
UHF-VHF	225-475	250 MHz	Full
P	440	70 MHz	Full
L	1300	200 MHz	Full
X	9600	1200 MHz	Dual poll

3. THE CAMPAIGN ACQUISITIONS

Flight ID	Scenario	Date
Validation	Validation	10-août
Flight 1	Standard	12-août
Flight 2	Tomo-Nour	15-août
Flight 3	Standard	19-août
Flight 4	Tomo-Para	24-août
Flight 5	Standard	28-août
Flight 6	Standard	01-sept

Table 1 : Campaign acquisition flight schedule

The standard flight includes PolInSAR acquisitions over each main forest sites and two zero baseline acquisition to perform temporal decorrelation analysis. Each tomographic flight is dedicated to one main site over which 5 different baselines are acquired.

It was decided to fly vertical baselines rather than the usual horizontal baseline scenario. A vertical baseline has some major advantages compared to a horizontal one in an airborne configuration.

An intuitive way to look at it is to note that the sensitivity of the interferometric information is proportional to the difference in viewing angle (($\Delta\Theta$)). What happens when the incidence angle varies? For a horizontal base, $\Delta\Theta$ decreases quickly when the incidence angle changes because of two conjugate effects (orientation of the baseline and increased range). For vertical baseline, these two effects are opposite (the perpendicular baseline increases with increasing incidence angle, whereas the range increases) resulting in a less pronounced variation with range. This is illustrated in the following figure. The following baselines were flown : zero-baseline (temporal decorrelation analysis), 50ft, 100ft, 150ft, 200ft and 250ft

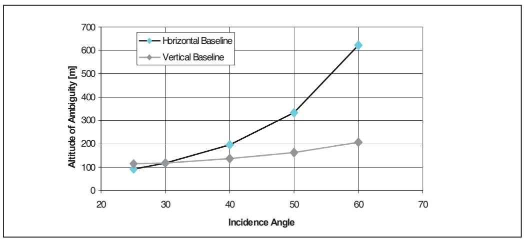

Figure 1 : Comparison between vertical and horizontal baseline and the altitude of ambiguity as a function of range.

5. FIRST RESULTS

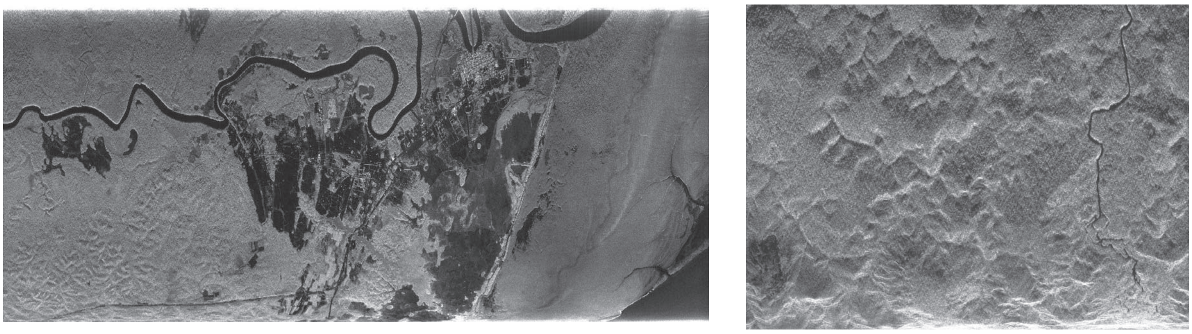

Figure 2 : P-HV image of the Paracou site and the Nouragues site

The Paracou site (Fig. 4) in along the Sinnamary river. The image is P band HV polarisation. The test site is on the lower left of the image. This Nouragues image (Fig 4) is also at P Band HV polarisation.

5. REFERENCES

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