SETHI, THE ONERA AIRBORNE SAR SENSOR, AND HIS LOW FREQUENCY CAPABILITY

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ABSTRACT

SETHI is the new airborne SAR system developed by the ONERA, the French Aerospace Lab. This system was developed according to the standard FAR25 applied to civil application. The main improvement compared to the previous ONERA airborne radar system RAMSES is that the antennas are located in two pods compatible with small aircrafts like the Falcon 20.

This new SAR system was designed to explore the science applications of radar remote sensing; it can operate over a wide range of frequency bands (P, L and X in its first version) and it has polarimetric and interferometric capabilities. The first improvement is the extension of the P band to the UHF/VHF band with a bandwidth of 235 MHz (from 225 MHz to 460 MHz – P band included). This low frequency sensor has full-polarimetric capabilities and the bandwith can be transmitted by sub-band to deal with electromagnetic interferences which are common in this spectrum domain.

This system can be operated simultaneously at three different bands, therefore, providing a way to explore the mutltifrequency (very high resolution at X-band and significant penetration using low frequency) without introducing uncertainties linked to changes between acquisitions.

The main challenge when operating and exploiting a SAR sensor is the radiometric and polarimetric calibration. In order to achieve this, we apply the standard calibration strategy elaborated during the RAMSES operations. This procedure has two main components: laboratory measurements and in-flight measurements. We start by characterizing the antenna patterns in the anechoic chamber and the calibration targets via simulation over the full half space or in the anechoic chamber whenever possible. Furthermore, for each campaign, we make laboratory tests of the full radar system during installation on the plane. The second component of our calibration procedure is in-flight calibration, with a dedicated flight over the calibration zone.

The UHF/VHF system validation campaign will take place in December 2008 to qualify this new component of the SETHI system, flown by itself and with the other radars.

The calibration area will be set around the Nîmes airport (south of France) and will include several reflectors (trihedral and dihedral) adapted to the different frequency bands: X, L and UHF/VHF. Most of the reflectors will be positioned along the swath, in the radial direction. However, to identify the azimuth performance, a few of them will be implemented in the azimuth direction. Three calibration flights are planned during a week; one of them is dedicated only to the UHF/VHF band while the two others will address the simultaneous operation of the three frequency bands available on SETHI.

After dataprocessing and analysis of the data acquired during this validation campaign, the antenna pattern, the radiometric and polarimetric calibration keys and their stability over time will be known for the different incidence angles identified for operation. All this information will be used for designing the next scientific acquisition campaign, and will allow us to refine our campaign procedure in which the different steps are the following:

- Design of the campaign: preparation of the waveforms (bands, mode, altitude, range, incidence angle, multiple bands…).
- Laboratory and ground test of each radar band during installation on the plane.
- One validation flight over calibration test site: including all the planned waveforms.
- Processing of the validation datasets and exploitation of the internal calibration tests: calibration keys and phase offsets for each mode.

- Data acquisition flights:
  - Install some corner reflectors on scene if possible
  - Process and calibrate datasets with validation flight information
  - Check the quality of the calibration

The first section of the paper will describe the airborne SAR system SETHI. Then the calibration campaign will be detailed in a second section: the calibration area with the correlated ground activity and the three flights with the different conditions of acquisition (flight track, incidence angle, temporal interval, waveform …). The final section will present the data analysis with a particular focus on the UHF/VHF band and a description of the radiometric and polarimetric calibration procedure.