BOREALSCAT: A TOWER-BASED EXPERIMENT FOR FULLY POLARIMETRIC TOMOGRAPHIC IMAGING IN THE BOREAL FOREST AT P-, L- AND C- BAND

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The accuracy of forest parameter estimates using space-borne synthetic aperture radar (SAR) is affected by temporal changes, seasons, topography and environmental parameters such as wind and moisture in the forest under observation, among other effects. Significant temporal changes between acquisitions in repeat-pass SAR interferometry and tomography result in measurements where the structural information of the forest is not preserved [1]. A moving forest canopy due to strong winds can cause Doppler shifts during the integration time and moisture in forested areas introduce biases in parameter estimation models [2, 3]. In addition, these effects vary with incidence angle, polarization and throughout the vertical extent of the forest. These phenomena are of great concern for fulfilling the mission goals of BIOMASS, SAOCOM-CS, ALOS-2 and Sentinel-1. This calls for a better understanding of the polarimetric electromagnetic scattering mechanisms in forests at P- , L- and C-band in order to mitigate these effects in parameter estimation models.

Previous campaigns such as TropiSAR, TropiScat and AfriScat have studied temporal decorrelation at P- and L-band in the tropical forest sites in Paracou in French Guiana and Ankasa in Ghana [4, 5]. These studies have provided valuable information about scattering mechanisms in tropical forests throughout the vertical extent of the forest and suitable acquisition times for BIOMASS. But the conclusions of these studies cannot be extrapolated to boreal forests due to significant differences in forest structure and climate between the biomes. P- and L-band fully polarimetric SAR data with multiple temporal baselines was collected over hemi-/boreal forests during the BioSAR 2007, 2008 and 2010 campaigns, but the temporal baselines were few and on the order of months [6, 7, 8]. While this may be representative of some spaceborne SAR satellites, it is significantly longer than the revisit times for BIOMASS, Sentinel-1. A wider range of temporal resolutions was obtained during the TempoSAR 2008 and 2009 airborne campaigns, with temporal baselines as short as 10 minutes, revealing the strong contribution of wind in temporal decorrelation [9]. Although the temperate forest site in Traunstein used for the TempoSAR campaigns is more representative of boreal forests, the contributions from different heights within the forest could not be separated at temporal resolutions in the order of minutes.

A tower-based scatterometer experiment, BorealScat, has therefore been initiated in a forest area representative of boreal forests in Remningstorp, Sweden [10]. The 50-m high tower, equipped with an array of 30 antennas will provide fully polarimetric backscatter, Doppler and tomographic measurements at P- L- and C-band over timescales ranging from seconds to years. Meteorological and moisture sensors on and around the tower will provide the necessary ancillary data for performing the investigation. This will allow for a better understanding of how polarimetric radar measurements are affected by seasonal and weather effects throughout the vertical structure of boreal forests at P-, L- and C-band.

This paper will describe the experimental setup of the P- and L-band section of the BorealScat experiment, the calibration method, theoretical measures of tomographic performance and the first experimental results will be shown. The feasibility of range profiles and long-term tomographic imaging will be discussed. Finally, planned future work such as the C-band extension and a canopy attenuation experiment will be mentioned.

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