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Estimating forest biomass from medium and large footprint lidar data

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Forest covers play a tremendous role in the climate regulation and monitoring forest resources from regional to global scale is a major stake in the context of global warning. Biomass is a primary indication of carbon sequestration rate in forest ecosystems and has been identified as an Essential Climate Variable (ECV). Assessing forest biomass will improve our knowledge on carbon cycle and help to define efficient strategies for reducing human impact on climate change. Among remote sensing techniques used to monitor forests, lidar is one of the most promising technologies. It is based on the emission and reception of laser pulses and gives access to information on the whole vegetation column. In this study, we used a profiler fullwaveform lidar prototype (LAUVA) on-board an Ultra-Light Aircraft (ULA). The instrument was developed by the Commissariat à l'Énergie Atomique (CEA) and allows to acquire medium-footprint measurements in the ultra-violet (UV, 355 nm) wavelenght. In order to assess the capacity of this system to measure forest parameters and to open the way towards space-borne lidar systems dedicated to forest studies, we analysed data at two different scales. Parcels of maritime pines in the Landes forest (South-western France) were sampled by the lidar and raw data were analysed. Then, data were processed to simulate space-borne observations with a resolution similar to the one of Geoscience Laser Altimeter System (GLAS, IR, 1064 nm, NASA) on-board Ice, Cloud and land Elevation Satellite (ICESat, http://icesat.gsfc.nasa.gov/). We developed approaches to assess mean tree height and tree density for estimating aboveground biomass from medium footprint lidar measurements. To estimate aboveground biomass we used an allometric equation linking biomass and Diameter Breast Height (DBH). First mean tree heights were estimated by processing lidar waveforms and tree densities were derived from the spatial distribution of height measurements. Then, since the lidar does not give direct access to the tree DBH a relationship was established between field measured tree DBH and heights. It allowed estimating DBH from lidar derived tree heights. We obtained on the study area an aboveground biomass of 112 t.ha-1. This estimation was compared to reference biomass estimation calculated from field measurements, leading to an error of 9%. Large footprint lidar signals will be simulated from our medium footprint data and methods developed for processing GLAS data will be adapted in order to estimate biomass from these simulated signals. It will allow us to discuss 1) the impact of the change in footprint size on the accuracy of aboveground biomass estimation, 2) the reduction of signal to noise ratio within the forest structure, and 3) the dissipation along the optical path of the UV signal.