Doctoral Thesis Proposal: *Analysis and characterization of the effect of 3D forest structure fragmentation on fire behavior and biodiversity parameters using multi-scale LiDAR*

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Abstract: The determination of the maximum entropy using LiDAR (Light Detection and Ranging) data could improve the characterization of the structure, the modeling of the above-ground biomass, and the forest combustibility. Structural complexity is an essential morphological feature of ecosystems, complementary to others such as canopy height or vegetation cover (Fahey et al., 2019; Schneider et al., 2017; Valbuena et al., 2020), relevant for various ecological processes such as nutrient cycling, carbon sequestration and interactions between species (Lent and Looking, 2017; Lindenmayer et al., 2000; McElhinny et al., 2005). On the other hand, the analysis of forest structure is important for biomass estimation and carbon balance studies, elaboration of forest inventories, forecasting the dynamics of forest mass combustibility, and for the elaboration of wildfire risk and fire behavior models (Crespo-Peremarch, 2020). However, there is a lack of consensus on the most appropriate methods to measure the impact of the structural complexity of ecosystems (Lexerød and Eid, 2006; Neumann and Starlinger, 2001), and information is still lacking on the relationship between the metrics extracted from LiDAR and above-ground biomass, and on how predictive models are affected by different forest structures (Drake et al., 2003; Knapp et al., 2020).

The methodologies for the study of entropy and the estimation of forest variables using LiDAR data already have a certain development (Ammaturo et al., 2021; Andersen et al., 2005; Erdody and Moskal, 2010). However, there are several aspects that must be reviewed and studied, defining the objectives of this thesis, which aims to scale a study in different types of forests globally. In this thesis, the use of different types of LiDAR data (discrete, full-waveform) at different scales (satellite, aerial, UAV: unmanned aerial vehicle, terrestrial) will be analyzed for the characterization of forest structure fragmentation in three-dimensional space by means of the use of indicators and metrics derived from them, studying the effect of fragmentation on (i) fire behavior through simulations of real scenarios, and (ii) on descriptive parameters of biodiversity. Different types of forests will be analyzed globally, with special emphasis on the identification and characterization of the different vertical strata (sub-canopy, understory, etc.) at different work scales, depending on the type of sensor with which the data is collected and its characteristics, e.g., point clouds, waveforms, voxels (Crespo-Peremarch et al., 2016; Hermosilla et al., 2014).

Available Means: The thesis plan will be carried out with the support and financing of the Center for Earth Observation Sciences (CEOS), the University of Alberta (Canada) and the company LiDAR Latinoamerica, SpA, and will be developed within the framework of the project “Mapping 3D spectral and structural analysis of Mediterranean fuel for fire behavior modeling” (FireMode, ref. PID2020-117808RB-C21), funded by the *Agencia Estatal de Investigación* from Spain (09/01/2021 – 08/31/2024).

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