

Snow depth distribution in canopy gaps over heterogeneous forest structure in the Central Pyrenees

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Abstract

This research analyses the snow depth distribution in canopy gaps across two plots in Central Pyrenees, to improve understanding of snow–forest and topography interactions. Snow depth maps, forest structure–canopy gap (FSCG) characteristics and topographic variables were generated by applying *Structure from Motion* algorithms (SfM) to images acquired from Unmanned Aerial Vehicles (UAVs). Six flights were conducted under different snowpack conditions in 2021, 2022 and 2023. Firstly, the snow depth database was analyzed in terms of the ratio between the radius of the canopy gap and the maximum height of the surrounding trees (r/h), in order to classify the gaps as *small-size*, *medium-size*, *large-size* or *open areas* at both sites independently. Then the Kendall correlation coefficients between the snow depth, FSCG and topographic variables were computed, and a Random Forest (RF) model for each survey day was implemented, to determine the influence of these variables for explaining snow depth patterns. The results demonstrate the high reliability of the UAV SfM photogrammetry approach for measuring snowpack dynamics at fine scale in canopy gaps and open areas. At site 1, the larger the r/h observed, the greater was the snow depth obtained. This pattern was not evident at site 2, which presented high variability related to the survey dates and categories, highlighting the relevance of topography for determining optimum snow accumulation in forested areas. *Slope* systematically exhibited a negative and significant correlation with snow depth, and was consistently the highest-ranked variable for explaining snow distribution at both sites according to the RF models. *Distance to the Canopy Edge* also presented high influence, especially at site 1. The findings suggest differences in the main drivers throughout each site and survey of the topographic and FSCG variables are needed to understand snow depth distribution over heterogeneous mountain forest domains.

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