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Ecosystem carbon partitioning: aboveground net primary productivity correlates with the root carbon input in different land use types of Southern Alps

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Terrestrial plant carbon partitioning to above- and below-ground compartments can be better understood by integrating studies on biomass allocation and estimates of root carbon input based on the use of stable isotopes. These experiments are essential to model ecosystem's metabolism and predict the effects of global change on carbon cycling. Using in-growth soil cores in conjunction with the 13C natural abundance method we quantified net plant-derived root carbon input into the soil, which has been pointed out as the main unaccounted NPP (net primary productivity) component. Four land use types located in the Trentino Region (northern Italy) and representing a range of aboveground net primary productivity (ANPP) values (155-868 gC m-2 y-1) were investigated: conifer forest, apple orchard, vineyard and grassland. Cores, filled with soil of a known C4 isotopic signature were inserted at 18 sampling points for each site and left in place for twelve months. After extraction, cores were analysed for %C and d13C, which were used to calculate the proportion of new plant-derived root C input by applying a mass balance equation. The GPP (gross primary productivity) of each ecosystem was determined by the eddy covariance technique whereas ANPP was quantified with a repeated inventory approach. We found a strong and significant relationship ($R2 = 0.93$; $p=0.03$) between ANPP and the fraction of GPP transferred to the soil as root C input across the investigated sites. This percentage varied between 10 and 25% of GPP with the grassland having the lowest value and the apple orchard the highest. Mechanistic ecosystem carbon balance models could benefit from this general relationship since ANPP is routinely and easily measured at many sites. This result also suggests that by quantifying site-specific ANPP, root carbon input can be reliably estimated, as opposed to using arbitrary root/shoot ratios which may under- or over-estimate C partitioning.