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Aboveground tree growth is a minor and decoupled fraction of boreal forest carbon input

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The boreal biome accounts for approximately one third of the terrestrial carbon (C) sink. However, estimates of its individual C pools remain uncertain and are often limited to specific points in time. Here, focusing on the southern edge of the boreal forest in central Canada, we quantified the magnitude and temporal dynamics of C allocation to aboveground tree growth at a mature black spruce (*Picea mariana*)-dominated forest stand in Saskatchewan. We reconstructed annual total live aboveground tree biomass increment (AGBi) using a biometric approach, i.e., species-specific allometry combined with forest stand characteristics and tree ring widths collected with a C-oriented sampling design. We explored the links between boreal tree growth and ecosystem C input by comparing AGBi with eddy-covariance-derived ecosystem C fluxes from 1999 to 2015. Mean AGBi at the study site was $71 \pm 7 \text{ g C m}^{-2}$ (1999–2015), which is only a minor fraction of gross ecosystem production (GEP; i.e., $\text{AGBi} / \text{GEP} \approx 9 \%$). Ecosystem C input and AGBi were decoupled, highlighting the potential role of direct sink limitations (temperature, water availability) on boreal tree wood formation. Moreover, C allocation to AGBi remained stable over time, with a temporal trend of near zero (-0.0001 yr^{-1} ; $p\text{-value}=0.775$), contrary to significant trends in GEP ($+5.72 \text{ g C m}^{-2} \text{ yr}^{-2}$; $p\text{-value}=0.02$) and ecosystem C use efficiency (i.e., NPP / GEP ; -0.0041 yr^{-1} , $p\text{-value}=0.007$). These findings highlight the importance of belowground tree C investments, together with the substantial contribution of understory, ground cover and soil to the boreal forest C balance. Our quantitative insights into the magnitude and temporal dynamics of aboveground boreal tree C

allocation offer additional observational constraints for terrestrial ecosystem models that, to date, are biased in converting C input to biomass, and can guide forest-management strategies for mitigating carbon dioxide emissions.