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Biomass recovery after fires dominates the carbon sink of boreal forests over the last three decades

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Wildfires are an integral part of boreal forest dynamics. Understanding the carbon loss/recovery associated with fires is crucial to assess the stability of these slow-growing forests. Yet, the carbon balance from fires and post-fire forest recovery remain uncertain at the biome scale due to the lack of spatial details about rates of forest regrowth. Here, we quantify carbon losses from fire emissions and gains from post-fire regrowth using high spatial-resolution satellite data and a bookkeeping model. We combined a 35-year long record of burned area from the Landsat satellites since 1985 with local biomass-age regrowth curves derived from high-resolution satellite-based above ground biomass (AGB) datasets. We found that forests in Eurasia tend to recover faster and reach higher biomass levels than those in North America. Young forests recovering from post-1985 wildfires produced a carbon sink of 652±200 TgC during the period 1985 to 2020. The additional recovery of older secondary forests that burned before 1985 further adds a cumulative sink of 1659±346 TgC. Comparatively, old-growth forests that did not burn accumulated 930±233 TgC during the period 1985-2020. This result shows 71% of the contemporary carbon sink in AGB is contributed by recovery from fires. After accounting for fire emissions each year and for the slow decay of coarse woody debris after burning, the net AGB

carbon sink in boreal forests is 2108±234 TgC during 1985-2020. This study provides the first spatially explicit aboveground observation-based carbon budget of boreal forests and provides insights on the key factors that will control its future evolution.