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Estimating plant respiration in boreal and temperate forests using a satellite remote sensing biomass product

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Our understanding of the global carbon cycle is hampered by missing spatial details and global estimates of plant respiration. Consequently, at large spatial scales it is highly uncertain how plant respiration, net primary production (NPP) and carbon use efficiency (CUE) are responding to climate change. Maintenance respiration, as an integral part of plant respiration, depends both on temperature and plant biomass, or more precisely plant nitrogen. Since nitrogen content varies between plant compartments (stem, branches, roots, leaves), information on the spatial variation in biomass of these compartments is required. Spatially continuous estimates of stem, branch, root, and leaf biomass covering the entire northern boreal and temperate forests have been derived by combining information from satellite radar remote sensing and forest inventory databases. In addition, spatial estimates are required for the functionally important sapwood biomass, since sapwood (= living tissue, unlike heartwood) contributes to plant respiration. Recently we have separated sapwood from total stem biomass, which has been facilitated by the collection and application of extensive forest inventory data on sapwood proportions for common tree species. Our novel spatial estimates of tree biomass in individual compartments, in concert with high-resolution temperature data and plant trait data on the nitrogen content per dry mass and on the relation between stem respiration rate and nitrogen content, provide the basis for data-driven high-resolution maps of plant respiration. Identifying the relationships between plant respiration and climate at large spatial scales will improve our understanding of how climate shapes the carbon balance and wood productivity of boreal and temperate forest ecosystems. This knowledge will also be critical for evaluating and improving the representation of plant respiration and its response to climate change in global vegetation models.