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Ecohydrology of boreal forests: scaling up challenges and opportunities

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Despite being one of the most extensive ecosystems at the global scale, our understanding of watershed transpiration (T, mm d-1) in boreal forests is limited compared to temperate or tropical forests. In northern Sweden, Pinus silvestris, and Picea abies are two of the most representative species in terms of timber production. These two species cover large areas of boreal forests, and contribute to most of the watershed T. However, despite the long history of forest management in Sweden, there are various questions that remain to be answered regarding the hydrological contributions of these species. For example, what is the relative importance of transpiration compared to other water loss pathways in boreal forests? Are both species contributing equally to the amount of water that is being lost back to the atmosphere? What are the environmental drivers influencing the amount of water loss via T and how do they change during the course of the growing season? With the increasing development of thermometric methods to estimate sap flow at the tree level, it is possible to answer some of these questions. However, sap flow methods are often limited by sample size and studies covering periods of time extensive enough to make reasonable inferences of the annual transpiration trends are thus rare. Additionally, scaling up from the tree to the watershed level is limited by site-specific effects that might override species effects. In this study, we deployed a total of 150 heat dissipation sensors, to monitor a total of 60 trees, 30 Pinus silvestris, and 30 Picea abies) in a boreal forest in northern Sweden. We monitored all trees during a three-year period 2015-2018, and recorded data every 30 minutes during the entire calendar year (365 days). Our main overarching goal was to explore the challenges associated in the scaling up process from the tree to the watershed level. Additionally, we set to answer some of the fundamental questions previously described, regarding the hydrology of these two dominant species, with the goal to incorporate their hydrological traits into forest management practices.