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Improving tree carbon use efficiency for climate-adapted more productive forests (iCUE-Forest)

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The rate at which forests take up atmospheric CO_2 is critical with regard to their potential to mitigate climate change as well as their value for wood production. The allocation of carbon fixed through photosynthesis into biomass is crucially dependent on tree carbon use efficiency (CUE), which is determined by gross primary production (GPP) and plant respiration (Ra) via the relation CUE=(GPP-Ra)/GPP. The effect of future climate on CUE is unclear due to the unknown response of plant respiration to more severe increases in temperature. This motivates assessing spatial patterns in CUE across climatic gradients with marked temperature variations.

Within the ”Improving tree carbon use efficiency for climate-adapted more productive forests” (iCUE-Forest) project, we aim to develop novel data-driven estimates of plant respiration, net primary production (NPP=GPP-Ra) and tree CUE covering the northern hemisphere boreal and temperate forests. These will be based on recent satellite-driven maps of tree living biomass, databases of N concentration measurements in tree compartments (leaves, stem/branches, roots) and the relationships between respiration rates and tissue N concentrations and temperature. Such estimates will enable the detection of spatial relationships between CUE and environmental conditions and facilitate the parameterization of dynamic global vegetation models which allow predicting the change in CUE in response to future climate and forest management.

Here we will present an extensive database of N concentration measurements in tree stems/branches and roots that we have compiled in addition to data available mainly for leaves from databases like TRY. More than 5000 measurements have been collected from the literature covering all common boreal and temperate tree species. Currently, we are exploring how the variation in tissue N concentrations is influenced by climate and tree species. Subsequently, we apply the derived tree-level relationships between tissue N concentrations and underlying drivers in combination with tree species distribution maps and estimates of tree compartment biomass

based on satellite remote sensing products. In this way, we will derive novel estimates of the spatial distribution of N content in northern boreal and temperate forests that will in turn be used to assess CUE variations.