Geophysical Research Abstracts
Vol. 21, EGU2019-5562, 2019
EGU General Assembly 2019
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Carbon flux from decomposing wood and its dependency on temperature, wood N2 fixation rate, moisture and fungal composition in a Norway spruce forest

Katja Rinne-Garmston (Rinne), Krista Peltoniemi, Janet Chen, Mikko Peltoniemi, Hannu Fritze, and Raisa Mäkipää

Natural Resources Institute Finland, Helsinki, Finland (katja.rinne-garmston@luke.fi)

Globally 40-70 Pg of carbon (C) are stored in coarse woody debris on forest floor. Climate change may reduce the function of this stock as a C sink in the future due to increasing temperature. However, current knowledge on the drivers of wood decomposition is inadequate for detailed predictions. To define the factors that control wood respiration rate of Norway spruce and to produce a model that adequately describes the decomposition process of this species as a function of time, we used an unprecedentedly diverse analytical approach, which included measurements of respiration, fungal community sequencing, N2 fixation rate, nifH copy number, 14C-dating as well as N%, δ13C and C% values of wood. Our results suggest that climate change will accelerate C flux from deadwood in boreal conditions, due to the observed strong temperature dependency of deadwood respiration. At the research site, the annual C flux from deadwood would increase by 27% from the current 117g C/kg wood with the projected climate warming (RCP4.5). The second most important control on respiration rate was the stage of wood decomposition; at early stages of decomposition low nitrogen content and low wood moisture limited fungal activity while reduced wood resource quality decreased the respiration rate at the final stages of decomposition. Wood decomposition process was best described by a Sigmoidal model, where after 116 years of wood decomposition mass loss of 95% was reached. Our results on deadwood decomposition are important for C budget calculations in ecosystem and climate change models. We observed for the first time that the temperature dependency of N2 fixation, which has a major role at providing N for wood-inhabiting fungi, was not constant but varied between wood density classes due to source supply and wood quality. This has significant consequences on projecting N2 fixation rates for deadwood in changing climate.