Geophysical Research Abstracts
Vol. 21, EGU2019-11221, 2019
EGU General Assembly 2019


# Comparing leaf temperature with measured and modeled canopy carbon and water fluxes during heat waves

Gerald Page (1), Youngil Kim (1), Yueyang Jiang (1), Bharat Rastogi (1), Sonia Wharton (2), John Kim (3), Hyojung Kwon (1), Beverly Law (1), and Christopher Still (1)

(1) Oregon State University, Corvallis, United States (gerald.page@oregonstate.edu), (2) Lawrence Livermore National Laboratory, Livermore, United States, (3) Pacific Northwest Research Station, USDA Forest Service, Corvallis, United States

Fluxes of carbon and water to and from the biosphere are mediated by leaf-level physiological processes that are sensitive to temperature. However, while air temperatures will increase in the future, it is less clear how leaf temperature will respond across species and ecosystems. In this experiment we compared the physiological response of an old-growth Douglas fir (Pseudotsuga menziesii) forest canopy (Wind River, 371 m a.s.l., 2338 mm precipitation) and a ponderosa pine (Pinus ponderosa) canopy (Metolius, 1255 m a.s.l., 536 mm precipitation) to a series of heatwaves during the 2015 growing season. Leaf temperatures (measured with a thermal infrared camera) and net ecosystem exchanges of carbon, as well as latent and sensible heat fluxes (measured by eddy-covariance flux towers) were compared before, during, and after five successive heatwaves in the Pacific Northwest, USA in the 2015 growing season. To better understand the sensitivity of ecosystem fluxes to heat waves, we employed the Ecosystem Demography model ED2.1 to simulate carbon and water fluxes across a range of heat wave conditions with varied timing, duration, and severity. Modeled results were then compared to empirical observations from 2015. Overall, the wetter Douglas fir forest was more sensitive to heatwaves than the drier ponderosa pine forest, with net carbon uptake early in the growing season reduced by each heatwave for the former forest type. Furthermore, three large heatwaves in June and July caused the Douglas fir forest to become a carbon source, whereas the ponderosa pine forest remained a carbon sink until the final heatwave at the end of July. The canopy of the ponderosa pine forest was also always closer to air temperature than Douglas fir. Douglas fir leaves remained on average 3.3 – 5.9 °C warmer than air during all five heatwaves, whereas ponderosa pine leaves started at an average daily maximum of 1.87 °C warmer than air and became progressively warmer for each subsequent heatwave, reaching an average daily maximum of 4.33 °C warmer than air by the end of July. The greatly elevated canopy temperatures of both forests also resulted in maximum leaf VPD values of 7.03 and 5.54 kPa for Douglas fir and ponderosa pine respectively, well above the values estimated from air temperature (5.65 and 4.50 kPa). Higher sensitivity of the Douglas fir forest to all five heatwaves may be explained by the higher daily maximum air temperatures compared to the ponderosa pine forest (seasonal maximum air temperatures of 37.2 and 33.0 °C respectively) and greater atmospheric coupling in the ponderosa pine canopy due to lower LAI and simpler canopy structure. Our study highlights the critical need for future work examining the consequences of extreme heat events on the growth and survival of forests in the Pacific Northwest, USA.