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Leaf respiration rates are increased by warm season as well as by elevated temperature treatment in Eucalyptus globulus

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Plant leaf respiration is one of the major CO_2 fluxes between terrestrial biosphere and the atmosphere, and its responses to elevated CO_2 and temperature thus have important implications for the carbon cycle and rate on ongoing climate change. Non-photorespiratory leaf respiration is reduced in light, Rlight, compared with the rate in the dark, Rdark. It is therefore important to consider both Rlight and Rdark when estimating the exchange of CO_2 between the biosphere and the atmosphere, during current and future climates.

This study was conducted at the Hawkesbury Forest Experiment, HFE, in Richmond, NSW, Australia. Trees of Tasmanian Blue Gum (Eucalyptus globulus Labill.) were exposed in whole tree chambers (WTC) to a complete factorial combination of ambient and elevated temperature and CO_2 (+3 °C and +240 ppm CO_2, respectively). The measurements of Rlight and Rdark were made in 2011 after 9 - 15 months exposure in the WTCs. The measurements were made in March (after the year's hottest months) and October (after the coldest period). Rlight was determined at four temperatures ranging between 20 and 40 °C on attached leaves using a portable gas exchange system (LI-6400XT). Rdark was measured at 20-40 °C in October and at 25 °C in March. Rdark was measured after dark acclimation for at least 30 min and Rlight was determined from the intersection of the photosynthetic CO_2 responses measured at three different light intensities using the Laisk metod.

Trees grown in elevated temperature had a considerably higher Rdark (+53% across all measurement temperatures in October). However, Rlight did not respond significantly to either CO_2 or temperature. In October, the Rlight to Rdark ratio indicated an overall light inhibition of respiration of 31% across all temperatures and in March the light inhibition was 22 % at 25 °C. The seasonal comparisons showed that both Rlight and Rdark were considerably higher after the warm compared to cold season, especially when measured at high temperature.

These results points out the importance to account for Rlight as well as seasonal thermal respiratory acclimation when improving predictions of the carbon exchange between tree canopies and the atmosphere. If not taking light inhibition into account, leaf respiration is being overestimated and if not taking the seasonal acclimation into account the errors are potentially very large.