TITLE	**INFRARED HEATER SYSTEM FOR WARMING TROPICAL FOREST UNDERSTORY PLANTS AND SOILS**
PUBLICATION TYPE	Journal Article
YEAR	2018
AUTHORS	Bruce A. Kimball, Aura M. Alonso-Rodríguez, Molly A. Cavaleri, Sasha C. Reed, Grizelle González, and Tana E. Wood
JOURNAL	Ecology and Evolution
VOLUME	8
PAGINATION	1932-1944
KEY WORDS	climate change, global warming, heater array, infrared warming, proportional integrative derivative control, trees
ABSTRACT	The response of tropical forests to global warming is one of the largest uncertainties in predicting the future carbon balance of Earth. To determine the likely effects of elevated temperatures on tropical forest understory plants and soils, as well as other ecosystems, an infrared (IR) heater system was developed to provide in situ warming for the Tropical Responses to Altered Climate Experiment (TRACE) in the Luquillo Experimental Forest in Puerto Rico. Three replicates heated 4- m- diameter plots were warmed to maintain a 4°C increase in understory vegetation compared to three un-heated control plots, as sensed by IR thermometers. The equipment was larger than any used previously and was subjected to challenges different from those of many temperate ecosystem warming systems, including frequent power surges and outages, high humidity, heavy rains, hurricanes, saturated clayey soils, and steep slopes. The system was able to maintain the target 4.0°C increase in hourly average vegetation temperatures to within ± 0.1°C. The vegetation was heterogeneous and on a 21° slope, which decreased uniformity of the warming treatment on the plots; yet, the green leaves were fairly uniformly warmed, and there was little difference among 0–10 cm depth soil temperatures at the plot centers, edges, and midway between. Soil temperatures at the 40–50 cm depth increased about 3°C compared to the controls after a month of warming. As expected, the soil in the heated plots dried faster than that of the control plots, but the average soil moisture remained adequate for the plants. The TRACE heating system produced an adequately uniform warming precisely controlled down to at least 50- cm soil depth, thereby creating a treatment that allows for assessing mechanistic responses of tropical plants and soil to warming, with applicability to other ecosystems. No physical obstacles

	to scaling the approach to taller vegetation (i.e., trees) and larger plots were observed.
LINK	https://doi.org/10.1002/ece3.3780