



Apogee Instruments Infrared Radiometers Temperature Free-Air Controlled Enhancement (T-FACE)

This type of experiment applies a heating treatment to open-field plant canopies, simulating models of future warmer conditions. Dr. Bruce Kimball of the Arid-Land Agricultural Research Center and colleagues design and operate such experiments. In 2005 they developed a proportional-integrative-derivative control system for controlling the rise in temperatures. Apogee Infrared Radiometers provided the data on control and heated plot temperatures.

Dr. Kimball and his colleagues have developed hexagonal arrays of infrared heaters that produce uniform warming across 3-meter-diameter plots. The degree of warming is maintained using the proportional-integrative-derivative control system for controlling the rise in temperatures. Apogee Infrared Radiometers (housed in a white PVC pipe radiation shield in the photo) sense the canopy temperatures of the heated plots as well as unheated reference plots, which are used by dataloggers to modulate the output of the heaters.

Similar infrared warming experimentation using this design and Apogee Infrared Radiometer sensors are also underway in Haibei, Qinghai, China; Cheyenne, WY; Ely and Cloquet, MN; Urbana, IL; Lexington, KY, and several other places around the world.

Reference Article

Kimball, B. A., 2005. Theory and performance of an infrared heater for ecosystem warming. *Global Change Biology*, 11(11):2041-2056.

Kimball BA, Conley MM, Wang S, Lin X, Luo C, Morgan J, Smith D (2008) Infrared heater arrays for warming ecosystem field plots. *Global Change Biology* 14, 309-320.

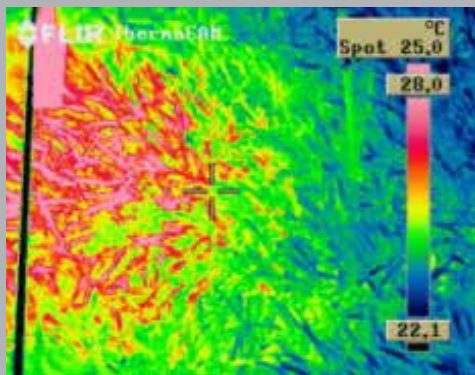


Image: Thermal image of the distribution of warming from Mor FTE infrared heater deployed at nadir over 95-cm-tall Sudan grass. The heater is the pink rectangle in the upper left of the image.



Image: Wheat warmed by infrared heaters is headed sooner in the "Hot Serial Cereal" experiment conducted by dr. Bruce A. Kimball and colleagues at the USDA-ARS Arid-Land Agricultural Research Center and the University of Arizona at Maricopa, Arizona.

Application Summary

Summary

Simulating models of future warmer conditions by applying a heat treatment to open-field plant canopies. Apogee infrared radiometers provide the data and control the heated plot temperatures.

Apogee Sensors Used

Infrared Radiometerd

Contributor

Dr. Bruce Kimball of the Arid-Land Agricultural Research Center

Location

Nebraska



'Mor FTE' infrared heater deployed at an angle of 45° from horizontal and of 30° with respect to the suspension cable.