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DATA COLLECTION MODULE FOR IMPROVED MEASUREMENT OF MICROCLIMATES IN DENSE FOREST CANOPIES

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ABSTRACT. Forest canopy research is one of the more recent frontiers of scientific research. Many methods have been devised to obtain data from the treetops, including the use of canopy cranes. Access to regions beneath the canopy surface of dense forests, however, is restricted to canopy gaps large enough for passage of the crane gondola. Often the result is a reduced selection of sample sites and hence reduced randomization. The data collection module (DCM) described in this technical note provides a solution to eliminate most problems facing other means of canopy access, such as poles, for microclimate measurements. Examples of canopy photosynthetically active radiation gradients measured in a lowland tropical rain forest in northeastern Australia in 1999 illustrate the use of the data collection module under field conditions.

Key words: Australia, canopy crane, data collection module, forest, microclimate, tropical

TECHNICAL NOTE

Access into forest canopies is a difficult, arduous, and often dangerous practice (Parker et al. 1992, Moffett & Lowman 1995, Nadkarni 1995). The introduction of canopy cranes has simplified this process and allowed for greater safety and flexibility (Parker et al. 1992). According to Parker (1997), a tall construction crane could provide the horizontal coverage and stability for truly three-dimensional microclimate measurements; however, this application has not been reported. Accessing the canopy using a crane has some operational difficulties. In particular, where microclimate measurements are to be taken within dense forest canopies, the crane gondolas are too large to access the middle and lower regions of the canopy. Thus natural gaps are necessary to lower the gondola into the forest. This maneuver, which requires specific selection of sites, often makes randomization of microclimate measurements impossible. Access to readouts from meteorological sensors is difficult; and the long cables attached to the measuring equipment tend to get caught up in branches and vines (Parker et al. 1996).

These challenges can be overcome to a large extent by using the data collection module (DCM) developed in 1999 to investigate the three-dimensional distribution of forest microclimate parameters at the Australian Canopy Crane Research Facility in northeastern Australia. These parameters include wind speed, incoming solar radiation, photosynthetically active radiation, air temperature, and vapor pressure deficit. Turton et al. (1999) provide a detailed description of this rain forest site, including vegetation, soil, and climate.

During the first inspection of the canopy from the crane's gondola, opportunities to lower the gondola to a height of less than 5 m above the forest floor were few. This obstacle led to the concept of the data collection module (DCM) shown in FIGURE 1.

The DCM is a Plexiglas box that contains the digital readout displays for an anemometer, pyranometer, thermo-hygrometer, and quantum sensor. Respectively, these were a Skywatch® Meteos anemometer; a Solar Radiation Instruments (SRI 3) pyranometer; a Dick Smith Electronics Thermo-hygrometer Model 241/Y5189; and a Delta-T Devices, type QS Multimeter (×2) UNI-T Q1051. The anemometer, pyranometer, and quantum sensor all provide instant readouts of

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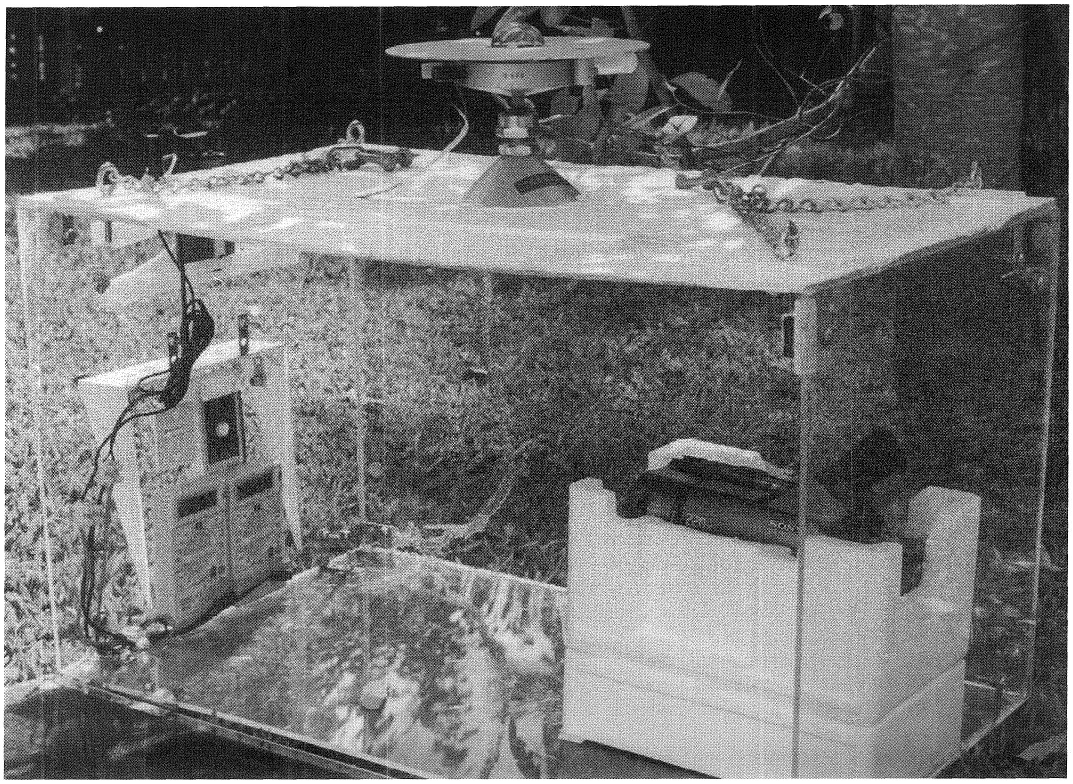
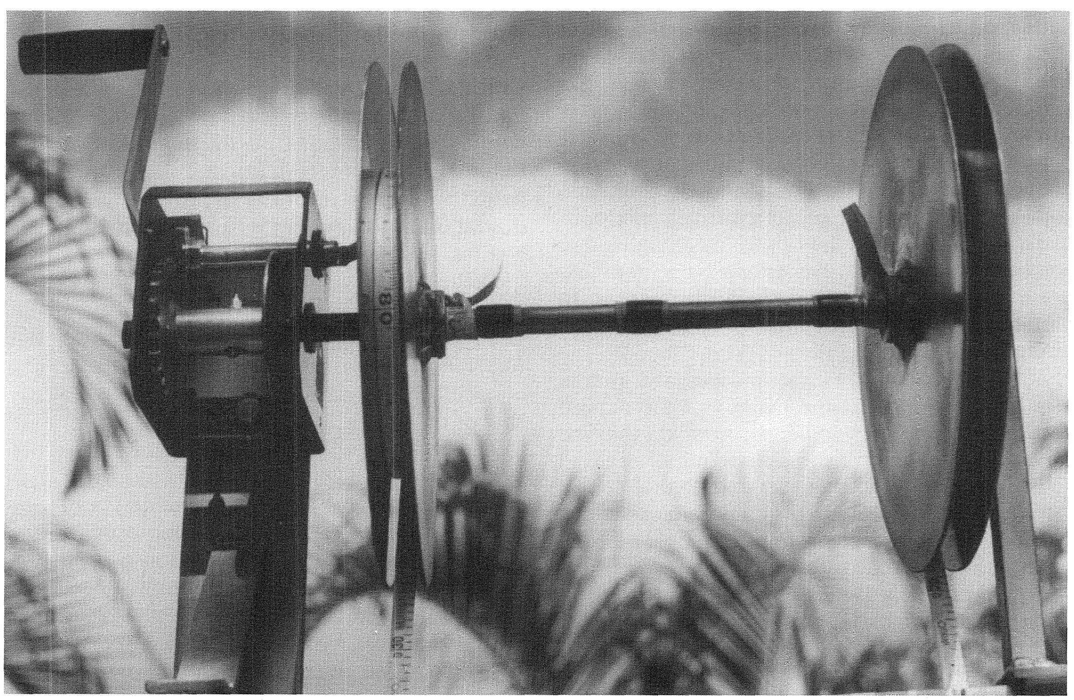


FIGURE 1. Data collection module (DCM), illustrating various microclimate instruments and their readout displays. The video camera is housed in a container in the bottom right hand corner of the Plexiglas container.



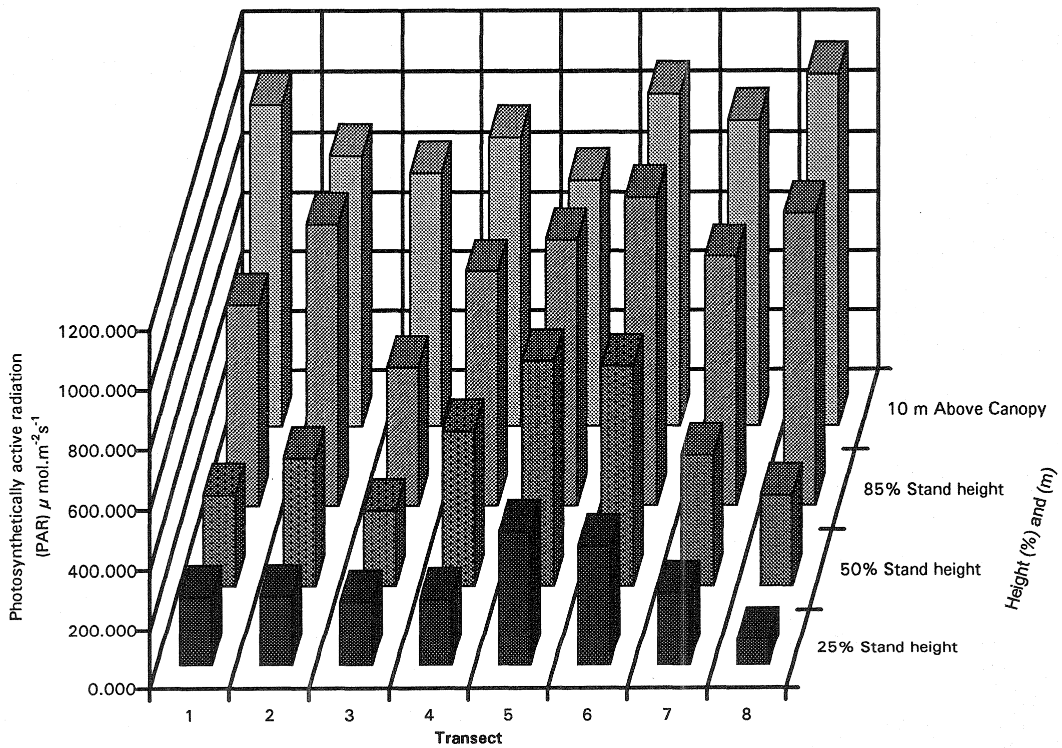


FIGURE 3. Example of eight vertical transects, in which photosynthetically active radiation (PAR) were measured, using the DCM system within and above a lowland tropical rain forest canopy at the Australian Canopy Crane Research Facility.

current weather conditions; but the thermo-hygrometer requires 1 minute to readjust to new conditions. These displays are continuously being filmed by a Sony Handycam TR511 at the opposite end of the DCM, allowing for replay at a convenient time. A Sony 12-hour lithium ion battery powers the camera, which has a long-play function that records over a 3-hour period. Thus, the tape only needs to be changed three times during a full 8-hour day of data collection.

The use of a video camera has several advantages over datalogger recordings. These include visual confirmation of site and location, which can be determined on playback of tapes; better communication with the camera at the time of data collection to provide additional information than with the use of a datalogger system; and visual confirmation of local weather conditions to exclude data gathered during rainfall, high wind squalls, or other meteorologically unsuitable periods for microclimate data collection.

The DCM measures 70 cm (long) by 40 cm (wide) by 40 cm (high), which is small enough to allow much greater flexibility with choice of access into the canopy. As the DCM is suspended below the gondola, interference from the gondola and the crane's jib is virtually eliminated. The small weight and overall size of the DCM increase maneuverability around branches. The top of the DCM is white to reduce build-up of heat inside the box, as the camera has a maximum operating temperature of ~45°C. The sides and bottom of the DCM remain transparent to allow sufficient light for filming the digital display. Inside the DCM, a 2-way radio is fixed in front of the camera's microphone to communicate location, time, and other information for later clarification of data output. The camera also has a continuous time display, which allows for double-checking to reduce potential data errors.

Two 50-m nylon tapes attach the DCM to a

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FIGURE 2. Winch system for lowering and raising the DCM within forest canopies.

custom-made mechanical winch. The winch is fixed to the side rail of the crane's gondola (FIGURE 2). This facilitates lowering of the module to predetermined heights within the canopy. The tapes, non-stretch at the DCM weight of 17 kg, attach to the module by two chains on either side (camera end and digital display end). This setup allows the module to remain as close to level as possible at all times during data collection.

The combination of the DCM and the winch system allows virtually unrestricted access to all areas of the forest canopy within the 1-ha circular area covered by the crane, thereby ensuring statistically robust (randomized) microclimate data measurements. FIGURE 3 presents an example of eight vertical transects in which photosynthetically active radiation (PAR) was measured, using the DCM system within and above a lowland tropical rain forest canopy at the Australian Canopy Crane Research Facility. Results of a comprehensive study that examined vertical canopy microclimate gradients at successive time intervals in the aftermath of Cyclone Rona at the crane site will be presented elsewhere.

Improvements of this system could be achieved in several ways. The winch system needs to be automated, as extended data collection periods require considerable strength to raise and lower the DCM. Use of smaller, more advanced cameras would reduce the dimensions and the weight of the data collection module. Design of a more compact data display panel would shorten the distance from display required by the camera to capture all instrument readouts. Finally, the shape of the DCM could be changed to a cylindrical form, which would provide reduced resistance to wind and thus reduced swing and possible damage to instruments.

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