

# **New and Improved Data Logging and Collection System for Atmospheric Radiation Measurement Climate Research Facility, Tropical Western Pacific, and North Slope of Alaska Sky Radiation, Ground Radiation, and MET Systems**

*M.T. Ritsche, D.J. Holdridge  
Environmental Research Division, Argonne National Laboratory  
Argonne, IL*

*R. Pearson  
Australian Bureau of Meteorology  
Darwin, NT Australia*

## **Background**

Aging systems and technological advances mandated changes to the data collection systems at the Atmospheric Radiation Measurement (ARM) Program's Tropical Western Pacific (TWP) and North Slope of Alaska (NSA) ARM Climate Research Facility (ACRF) sites. Key reasons for the upgrade include the following:

- Achieve consistency across all ACRF sites for easy data use and operational maintenance.
- Minimize the need for a single mentor requiring specialized knowledge and training.
- Provide local access to real-time data for operational support, intensive operational period (IOP) support, and public relations.
- Eliminate problems with physical packaging (condensation, connectors, etc.).
- Increase flexibility in programming and control of the data logger.

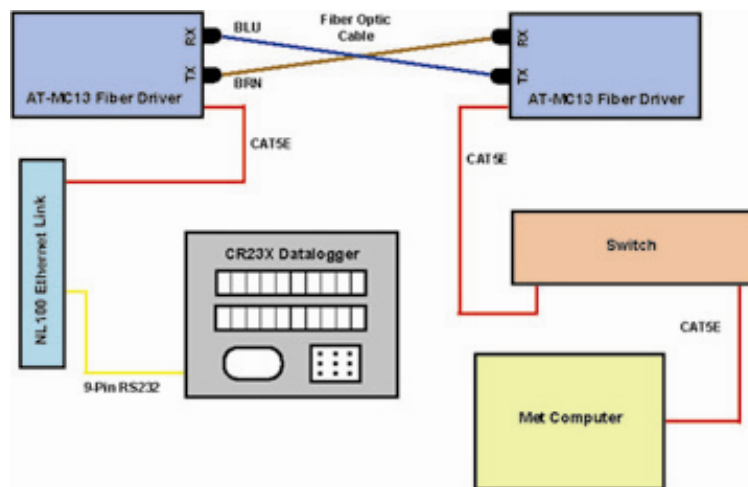
The TWP ACRF site has used Coastal Environmental Systems, Inc., ZENO<sup>®</sup> 3200 data loggers to collect data from the sky radiation (SKYRAD), ground radiation (GNDRAD), and surface meteorology (SMET) systems. Housing of the ZENO loggers (and some sensors) in a pressurized aluminum canister made access difficult and time consuming. The canisters also had problems with grounding, leaking and cracked connectors, blocked barometric pressure ports, and difficulty in shipping. Desirable qualities, such as interchangeability between the SKYRAD and GNDRAD loggers-canisters, were to be retained and extended to the SMET system. Programming limitations of the ZENO logger did not permit conditional statements, and communication with it was difficult and time consuming (Figure 1).



**Figure 1.** Aluminum canister housing installed at a TWP field site (left), and the canister housing disassembled to reveal the ZENO<sup>®</sup> 3200 data logger (black box) and internal wiring (right).

The NSA ACRF site's SKYRAD and GNDRAD systems used the same ZENO logger-canister collection system as the TWP sites. Similar problems were occurring at the NSA sites, and in addition connectors were breaking in the extreme cold. The surface meteorological collection system used a desktop personal computer (PC) operating on a Windows NT platform and employed National Instruments Bridgeview software for data collection and display. The manufacturer discontinued Bridgeview, and support for it dwindled. The communication peripherals used by the Bridgeview collection system began to fail regularly, and data collection efficiency was dropping.

Campbell Scientific, Inc., CR23X data loggers housed in easily accessible fiberglass enclosures were selected to replace the ZENO logger-canister-Bridgeview collection systems. An on-site ARM Core-PC using Campbell Scientific's LoggerNet software polls the data loggers (Figure 2).



**Figure 2.** Schematic diagram depicting the network used to retrieve data from the Campbell Scientific, Inc., CR23X data logger.

## Components

### Computer

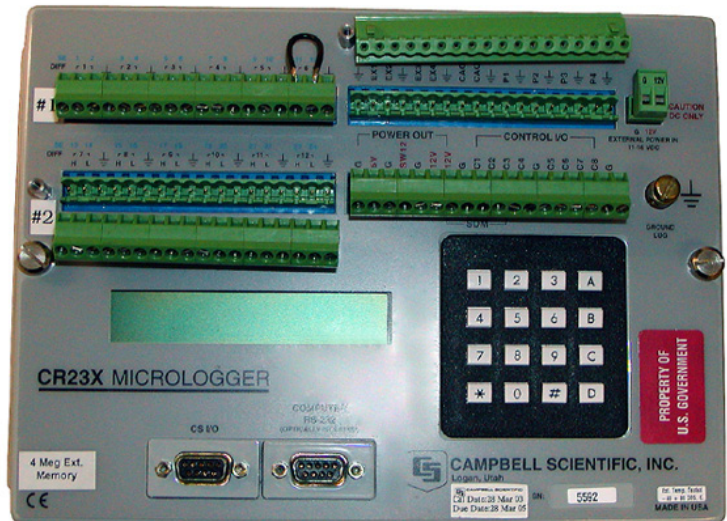
The PC used is a Dell Optiplex GX270 Small Form Factor with a 15-in. flat-panel monitor. The Small Form Factor was chosen for its small footprint, which is a requirement at the ACRF NSA and TWP sites because operating space is limited. The PC contains a Celeron 2.00- GHz processor, 400- MHz front side bus, and 128-KB cache processor. It has 512 MB of double data rate (DDR) non-Error Correction Code (ECC) Synchronous Dynamic Random-Access Memory (SDRAM) and an Integrated Dynamic Video Memory Technology (DVMT) video card. The hard drive is an 80-GB Enhanced Integrated Device Electronics (EIDE) 7200-rpm drive. The PC also has internal Dell business audio speakers, an integrated Intel Gigabit (10/100/1000) network interface card, and an 8x DVD-ROM. The operating system installed on the PC is Microsoft Windows XP Professional using NTFS (New Technology File System). The PC is configured to conform to the ARM Core-PC standards and is set to automatically restart and logon after any power disruption, eliminating the need for human intervention.

### Media Converter

Allied Telesyn International Corp. AT-MC13 media converters are used to convert the serial data from the CR23X through the NL100 serial server to fiber optics. This conversion achieves a 2-km-maximum network operating distance. One media converter is located in the data logger enclosure, and a second is inside the building at each location. The media converters operate at 10-Mbps and feature half- and full-duplex operation. The media converters also have a switch to configure the twisted-pair port on the media converter as either MDI or MDI-X, eliminating the need for crossover cables regardless of the type of network device connected to the unit. The media converters also have a fiber link test switch to permit testing of the fiber optic connection even if the twisted-pair port is not connected.

### Data Logger

A Campbell Scientific CR23X data logger is used to acquire and process the data collected from the various sensors. The data are sent from the CR23X to the PC upon request. All CR23X data loggers include a 4-MB extended memory option allowing the storage of over 2 million data points; this is a suitable backup in the event of a communication outage. The data loggers used at the NSA sites have an extended temperature option, giving them a valid operating temperature range of  $-40^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$ , while the data loggers used at the TWP sites have the default operating temperature range of  $-25^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . All CR23X data loggers have been modified so that the input-output connectors are removable. This permits quick connecting and disconnecting for easy data logger replacement without removal or reconnection of the sensor cables (Figure 3).



**Figure 3.** Field installation of the Campbell Scientific, Inc., CR23X data logger and peripherals for the GNDRAD system at Darwin Australia TWP site (left). Removable connectors on the CR23X data logger make for simplified logger change outs (right).

## LoggerNet

Campbell Scientific, Inc., LoggerNet software on each collector PC manages the CR23X data loggers. LoggerNet allows the setup, configuration, and retrieval of data from a network of Campbell Scientific data loggers and also allows sharing of data over an Ethernet communications network. LoggerNet uses advanced “client-server” architecture. The server software program runs in the background, handling all data logger communications. The server also stores the data and provides information to manage the data logger network. Client software programs in LoggerNet are used to create data logger programs, view and graph data, verify communications on the network, and run other software or tasks.

## Data Collection, Displays, and Remote Access

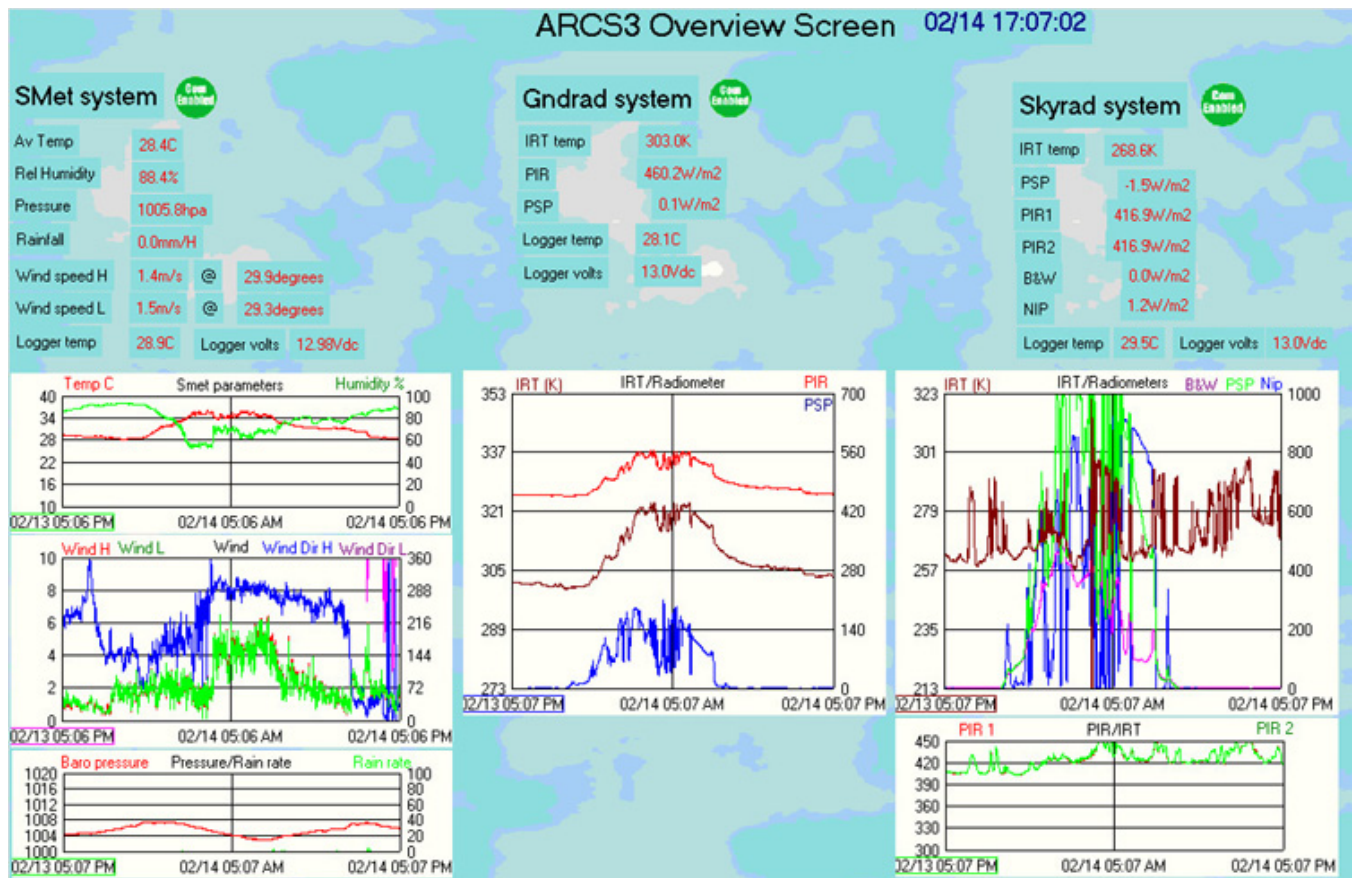
### Perl Script

The data collected from the logger are placed in a unique file on each PC that is appended after each collection interval. The continual growth of the file poses a problem, because the Data Collection System requires hourly files. To create hourly files, a Perl script is installed on each collector PC to handle the output data file created by the LoggerNet software. The script is scheduled to run separately

for each system (SKYRAD, GNDRAD, MET) once each hour. Task Manager client software in LoggerNet controls the execution of the script. The script creates uniquely named hourly files according to ACRF protocols and naming conventions and places the files in separate folders from which the Data Collection System can access, collect, and delete them via FTP software.

## Overview Screen

The systems that used the ZENO loggers did not have local displays allowing technicians or observers at the sites to view or monitor instrument status. The replacement systems required real-time data access and display to facilitate operational maintenance, to support IOPs, and for public relations. Client software in LoggerNet called Real-Time Monitoring and Control (RTMC) allows users to create and run graphical screens to display real-time data being collected from the data loggers. The current displays show historical data, so that technicians can determine whether failures of any components or sensors have occurred when no staff is present. Visual alarms are set to inform local personnel of communication failures (Figure 4).



**Figure 4.** Example of the overview screen from the Campbell Scientific, Inc., Real-Time Monitoring and Control customized display.

## **Remote Access**

Remote Administrator (RAdmin) software provides remote access allowing mentors, technicians, and selected users of the various systems to log onto the PC and view the data; download/upload files; or modify the computer, displays, logger programs, etc., as if they were sitting in front of the PC. RAdmin also allows a remote user to view the computer screen without taking control of the computer itself. This capability greatly enhances the speed of repairs and troubleshooting.

## **Benefits**

- Increased data collection efficiency.
- Decreased downtime of system components and sensors.
- Remote access to local systems for better coordination between local technicians and off-site support personnel.
- Increased flexibility for future upgrades and additional sensors.
- Increased flexibility and control of the data logger program.
- Increased interchangeability between systems due to identical main components in all systems.
- Decreased need for logistic support and spares.
- Increased support from the manufacturer.
- Decreased time for TWP radiometer change-out from 2 weeks to 2 days.

## **Acknowledgments**

This work was supported by the U. S. Department of Energy, Office of Science, Office of Biological and Environmental Research, Climate Change Research Division, under contract W 31 109-Eng-38, as part of the Atmospheric Radiation Measurement Program.