CAMPBELL SCIENTIFIC UPDATE

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The new GMON3, p. 3

Compatibility of Measurement Quality: The Key to a Successful NNoN

by Paul Campbell

During the past year, I have spent some time chairing the Organization/Business Models Working Group of the American Meteorological Society (AMS) ad hoc committee on the Nationwide Network of Networks (NNoN). One of the objectives of the ad hoc committee's work is to broaden the availability and use of mesoscale observations. As one contemplates this eventuality, the issues relating to measurement quality are immediately placed front and center.

When we hear the term "network" applied to multiple stations that have been deployed to measure environmental conditions, an important implication is that measurements at each station are made in a way to be comparable with similar measurements at other stations. If the accuracy of a given measurement has been assessed at one site, then it is preferred if like measurements at all sites within a network can be trusted to the same extent. Likewise, this would extend to similar parametric measurements across network boundaries if data from more than one network are combined for use in the same model or report. Another important implication is that time stamps from different dataloggers across the network are sufficiently synchronous for meaningful spatial data association.

The key to combining two or more mesoscale networks into a larger (virtual) network is compatibility of measurement quality. A network of networks at any scale is only achievable with the adoption of suitable metadata standards and the qualification of reasonably comparable data that is being consolidated. In the case of a NNoN, the AMS ad hoc committee is proposing the adoption of ISO Standard 19115-2 and SensorML, which standards are adequate to identify measurements with specifications, calibration, and maintenance information, even allowing for specific information pertaining to individual observations when necessary.

The operator of a network desiring to make observations available to other networks would make metadata available that allow potential users of the data to judge both temporal and spatial comparability. Users must be able to discover relevant observations, qualify their sources through the metadata, and ultimately perform reasonable quality control.

Data discovery, assessment of suitability, data exchange, and quality control of observations constitute process functions of the data recipient. A measurement network operator or provider must generate and maintain metadata, make the observations, and serve the data to the recipient. For the economic proposition of a NNoN to make sense, the cost of adopting and maintaining standards, data discovery, qualification, and exchange must be less than the cost of creating or expanding a uni-purpose measurement network. The cost of quality control might be the same with or without consolidation, with pros and cons that could be argued. The ultimate significance of a NNoN will be judged by the success of data exchange and satisfaction of data use by recipients.

It is likely that there will be reasonable economic benefits to a NNoN, especially to maximize the availability of high-cost observations to satisfy multiple uses. For routine observations that are low cost and easy to make, the appeal of a virtual network might be less, but even single-purpose measurement networks can benefit from vigilance in making quality measurements, maintaining metadata, and exercising reasonable quality control.

Campbell Scientific will continue to offer high-quality measurement systems able to satisfy the needs of individual environmental measurement networks with a view to accommodate the exchange of data between networks.

CAMPBELL SCIENTIFIC UPDATE

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New Snow Water Equivalency Sensor: GMON3

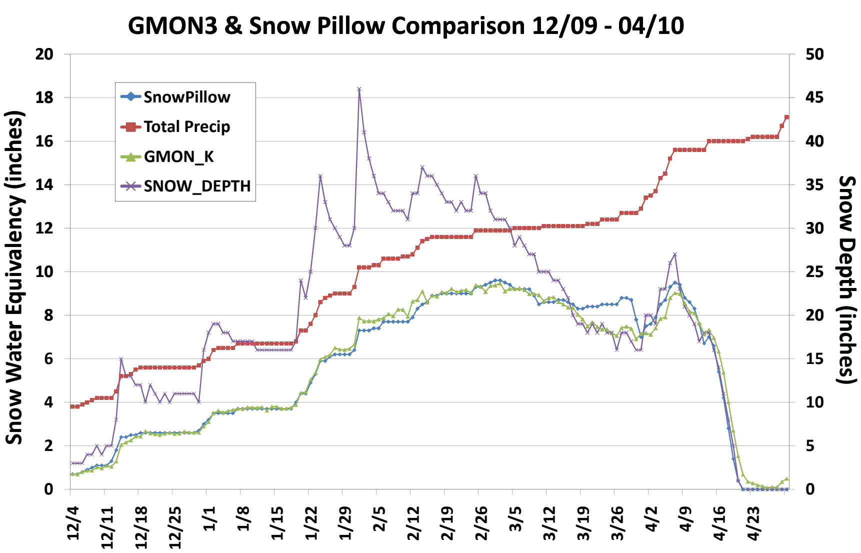
The GMON3 uses an innovative, non-contact method of measuring snow water equivalency (SWE) for any type of snow or ice. This new sensor offers a reliable alternative to snow pillows and other methods for monitoring SWE. Benefits of the GMON3 include measurements that cover a large surface area (approximately 1000 sq ft) and performance that is unaffected by adverse weather.

The GMON3 monitors gamma rays that are naturally emitted from the ground. An attenuation of the gamma-ray emissions occurs as snow accumulates. Snow with a higher water-content level causes a higher attenuation of the gamma-ray emissions, making it possible to calculate SWE from the gamma-ray measurements.

Snow pillows (a well-established technology for measuring SWE) use a radically different method for determining SWE. Snow pillows consist of bladders filled with antifreeze that is displaced as the weight of the snow accumulates on the bladder. A pressure transducer measures the pressure of this displacement, and from this measurement, SWE is calculated. The GMON3's method of measuring SWE avoids the hassles of using antifreeze.

In a recent side-by-side comparison, we verified that the GMON3's measurements are comparable to snow pillow measurements. From December 2009 to April 2010, a GMON3 and a snow pillow monitored SWE at Tony Grove, Utah. As the graph shows, the measurements correlated extremely well.

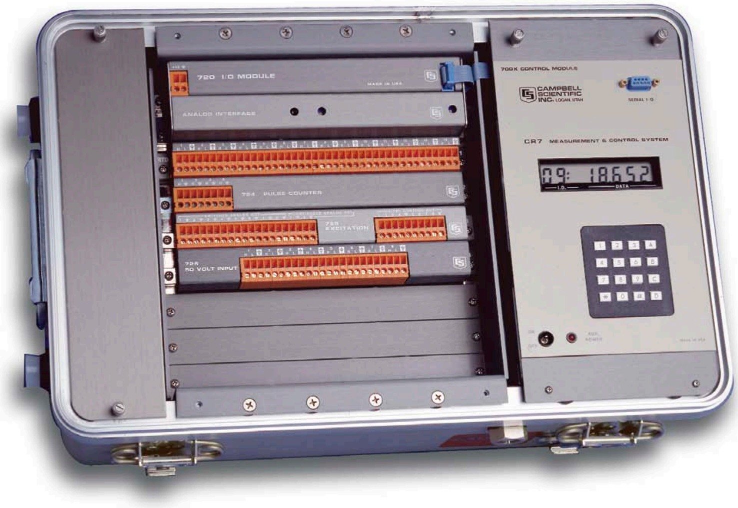
The GMON3 is manufactured by Campbell Scientific Canada. We look forward to the contributions the new sensor will make to future snow studies.



A comparison of the new GMON3 Snow Water Equivalency Sensor to a traditional snow pillow during the winter of 2009/2010 shows a strong correlation between the measurements of the two technologies.

Feature Article

The Exceptional 28-Year Career of the CR7



The year 1983 was memorable in many ways. McDonalds introduced Chicken McNuggets, Ronald Reagan announced his Star Wars plan for missile defense, and IBM released its IBM PC XT computer. At Campbell Scientific, we were proud of our newest datalogger release, the CR7 Measurement and Control System. Looking back 28 years later, the CR7 has lived a remarkably long life—especially for a piece of electronics equipment.

The CR7 was our first modular datalogger, allowing customers to select the number and type of I/O modules that matched their particular application. As such, it was well-suited for applications requiring a large number of channels. Like all of our dataloggers, its rugged design and construction has allowed it to be used in harsh environments around the world.

With its compact size and high-quality measurement capabilities, it quickly found a fit in automotive testing applications. Its first foray into this area happened in early 1983 in Kapuskasing, Ontario, Canada, the location of a General Motors cold-weather test track. A GM engineer was interested in seeing how the new CR7 datalogger could solve his vehicle testing needs. It didn't take long to show that the CR7 could withstand the extreme cold (subzero temperatures) and, as a small box on the seat of the car, provide more measurement functionality than a trailer full of their other measurement gear. Many CR7 systems are still in use in automotive applications.

Another aspect of the CR7 that made it a fit for many applications was its high-resolution measurement capability (to 50 nV). This was especially the case for thermocouple and strain measurements. Many thermocouple applications benefited from measurements that could be resolved to 0.001°C. Weighing lysimeters that used strain gauges to detect minute changes in the water content of soil plots also benefitted from these high-resolution measurements.

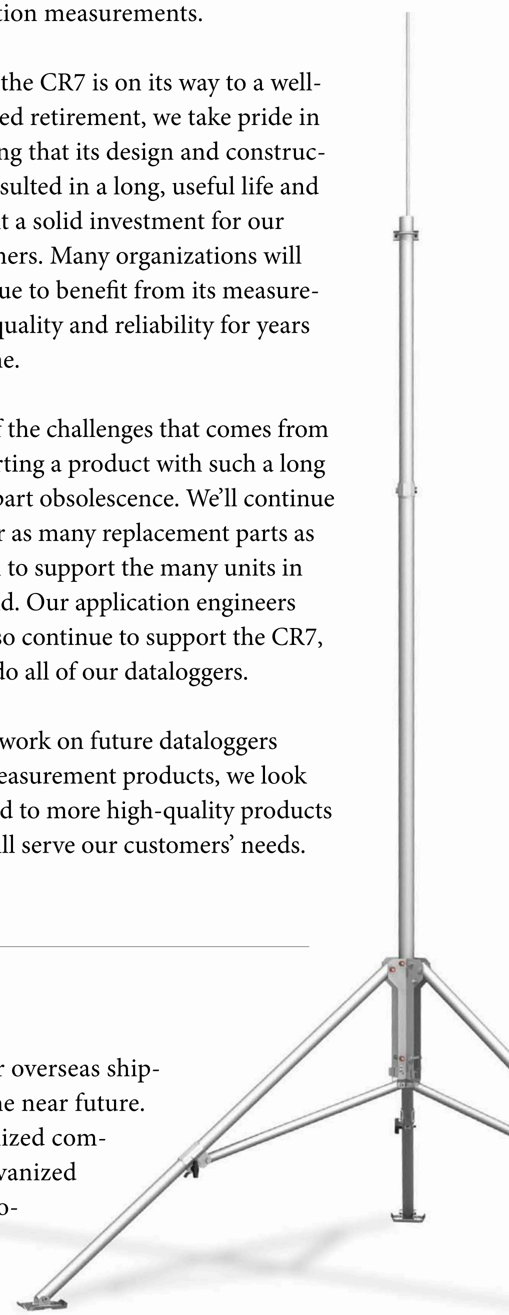
While the CR7 is on its way to a well-deserved retirement, we take pride in knowing that its design and construction resulted in a long, useful life and made it a solid investment for our customers. Many organizations will continue to benefit from its measurement quality and reliability for years to come.

One of the challenges that comes from supporting a product with such a long life is part obsolescence. We'll continue to offer as many replacement parts as we can to support the many units in the field. Our application engineers will also continue to support the CR7, as we do all of our dataloggers.

As we work on future dataloggers and measurement products, we look forward to more high-quality products that will serve our customers' needs.

New Product

A More Versatile Galvanized Tripod



We are pleased to announce the CM106, a new galvanized-steel tripod that replaces the CM6 and CM10. Height of the CM106's mast is adjustable from 7 to 10 ft. New features of the CM106 include the ability to mount a Campbell Scientific enclosure on either the leg base or the mast, and legs that can be individually adjusted without the use of tools. A guy kit is offered for sites that may experience high wind speeds.

The CM106K Tripod Kit for overseas shipments will be available in the near future. This kit contains the specialized components of the CM106. Galvanized pipe and other heavy components are purchased locally, greatly reducing overseas shipping costs.

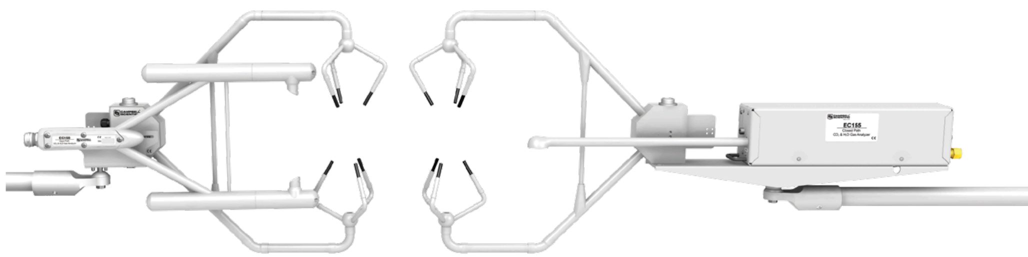
2010: The Year in Review

Campbell Scientific was busy on many fronts this past year. We met with customers and other experts at more than 65 trade shows and industry conferences in 2010. We introduced many innovative new products of our own, while also offering the best products from others in the industry. The company appointed a new vice president, installed a state-of-the-art solar energy system, and started construction on a new building. In the following paragraphs, we highlight our most significant accomplishments of 2010.

As we begin a new year, we continue our commitment to bring you the most versatile and reliable measurement and control systems possible. For more information about the items below, view the online version of this newsletter at www.campbellsci.com/newsletters.

2010: Products

Gas analyzers: We solidify our position as the leader in eddy-covariance systems with our own open- and closed-path gas analyzers (see right) for measuring H_2O and CO_2.



Wireless sensors: Our CWB100 base station combines with our CWS-series sensors to make wireless sensor networks for simple or complicated applications, saving time and money.

LNDB database software: To give you greater flexibility in managing your data, LNDB works with LoggerNet to easily insert your data into a relational database.

Smart power supplies: The PS200 and CH200 let users monitor battery status and enhance the safety of battery-power systems.

Downward-facing turbidity sensor: The newest member of our OBS line measures downward, avoiding obstacles around the sensor.

Soil-water content sensors: New sensors measure bulk electrical conductivity (EC) and soil temperature as well as soil water content with these sensors.

SIRCO water samplers: These precise, rugged systems take samples that better represent the solution being sampled, and operate faster and over longer distances.

High-accuracy pressure transducers: Our recently introduced CS450 and CS455 now have a high-accuracy option for even more demanding applications.

Heated rain gages: We added two heated rain gages that can measure heavy snowfall in near real time.

Freezing rain sensor: For situations where ice formation is a hazard, this sensor monitors and warns so rapid response can mitigate danger and damage.

2010: People

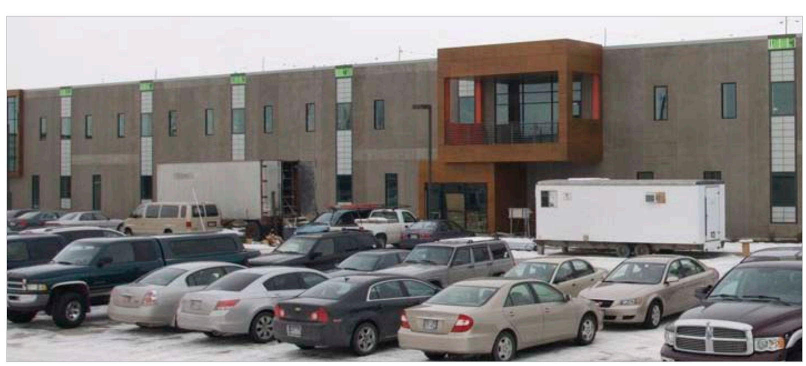
New VP: Joshua Campbell was appointed vice president of marketing and sales, bringing technical and business expertise to the position to keep Campbell Scientific strong and growing.

Campbells receive award: The College of Agriculture at Utah State University presented the Distinguished Service to Agriculture award to Paul and Paulette Campbell.

2010: Construction

New building: We broke ground in the spring on a 60,000-sq ft building at our headquarters in Logan, Utah. We will move into this production and office space in Spring 2011.

Solar power system: A 13-kW solar array and accompanying reference systems will enhance our renewable energy capabilities.



Case Study

Oceanography in the Gulf of Mexico

Recent events in the Gulf of Mexico—oil spill, red-tide algae blooms—have shown the need for real-time accessibility of oceanographic data for this region. Quick access to this information can show the extent of damage and help in planning responses. In response to this need, Florida State University (FSU) was asked to design a telemetry system that would retrieve oceanographic measurements from a tower located about 12 mi off shore.

The tower already hosted a weather station with various atmospheric instruments and a Campbell Scientific CR3000 datalogger. The CR3000 stored data from the sensors and then transmitted the data to shore via a radio modem. FSU had the task of integrating an existing group of oceanographic instruments on the ocean bottom to the datalogger and radio system on the tower.

Before this project was undertaken, each of the oceanographic instruments stored its data until divers could visit the site, uninstall the instruments, go to the surface and retrieve the data, and return the instruments to the bottom. Integrating the ocean-bottom sensors into the telemetry system on the tower would make a huge difference in the accessibility of this highly desirable information.

Eric Howarth, a biologist with FSU, was able to design a system in which a cable carries the data from the sensors, through a conduit secured to the ocean bottom, then up to the telemetry system high on the tower.

As the system now functions, the oceanographic intelligent sensors and sondes are mounted in a protective housing in water 66 ft deep and about 625 ft away from the tower. The instruments measure current speed and direction, wave height, water temperature, conductivity, pH, turbidity, and dissolved oxygen and nitrate.

The input from all of these different sensors is measured and stored by a CR1000 datalogger, as scheduled by on-site or remote onshore programming. The CR1000 passes the information to the existing CR3000, and the CR3000 transmits both the oceanographic data and the atmospheric data (from the sensors on the tower) via radio to an onshore site. The dataloggers' ability to communicate with each other, with sensors, and with other peripherals via PakBus® (our own protocol), Modbus, and RS-232 was a significant benefit to the project.

The integration of the oceanographic instruments with the telemetry system on the tower resulted in a reliable, low-power solution. This solution enables consistent flow of data from the underwater sensors, and remote control of measurement frequency and power supply.

New Product

New Four-Channel Relay Driver

Campbell Scientific's LR4 Four-Channel Latching Relay Module is ideal for locations where power is unreliable or needs to be conserved. Unlike traditional relays that must be continuously powered to keep their state, the new LR4 mechanically latches the relay's state, allowing power to be removed. The only way to change the state of a relay is to send a command to the LR4 or to press the manual toggle button. The LR4 is manufactured by Campbell Scientific Canada.

Case Study

Comparing Precipitation Gages in Korea

The Korean Meteorological Administration (KMA) is the governmental agency responsible for weather forecasting and managing meteorological data in South Korea. As part of this responsibility, the KMA runs networks with a total of about 500 weather stations. Among other sensors, the stations include precipitation gages and ranging sensors to measure snow depth.

In recent years, the KMA has been researching how to get better precipitation and snow depth data than they do with traditional tipping-bucket rain gages. As part of this research, the KMA compared and selected a variety of weight-sensing gauges, sonic-ranging sensors, and laser-ranging sensors manufactured by various companies all over the world.

The KMA also set up a new area for objectively testing and comparing sensor performance. Since the sensors' output signals are as varied as their manufacturers, the KMA needed dataloggers capable of reading any type of signal the sensors might send.

The KMA chose Campbell Scientific dataloggers because they can read all of the different signals that come from these sensors. Two CR3000 dataloggers and three CR1000 dataloggers are used to read analog voltages, as well as RS-232, RS-485, SDI-12, switch-closure pulse, and high-frequency pulse signals. The PakBus® network protocol is applied to reduce the number of communication lines between dataloggers and the data-collecting PC, which is 500 m away in the office.

One of the stations has a CR3000 and a CR1000 in the same enclosure. In this case, the CR1000 sends its data to the CR3000, which sends all the data to the PC. This allows for a single communication line, reducing costs and making management of the data easier because one file is generated from two loggers.

This project will benefit greatly from the compatibility and reliability of the dataloggers. The KMA is running this test through the winter and hopes the data will help them choose the best precipitation sensing equipment for their nationwide networks.

New Product

SG000 Strike Guard Lightning Detector

Campbell Scientific now offers the SG000 Strike Guard, an optical-coincidence lightning sensor. The SG000 detects cloud-to-cloud and cloud-to-ground lightning within a 20-mi radius. To prevent false alarms, the SG000 requires an optical signal to coincide with a magnetic-field-change signal before reporting lightning.

The SG000 is used in conjunction with our CS110 Electric Field Meter to create a complete lightning-threat measurement and analysis system. This system combines the advantages of two complementary lightning-warning technologies. The CS110 reports electric fields associated with local thunderstorm development—providing a warning prior to lightning strikes. The SG000 reports actual lightning strikes occurring at distances up to 20 mi—providing a comfortable warning time for incoming storms.

The SG000 and CS110 are typically mounted on the same tripod or pole. They communicate via a fiber-optic link (the FC100) that offers enhanced reliability in the lightning environment. The system's results can be displayed on the Internet and viewed on local and remote computers.

continued on p. 8

A150 Desiccated Case for Vented Cables

The A150 Desiccated Case allows our pressure transducers to connect to a CWS900 Wireless Sensor Interface (for use in a wireless sensor network) or to be connected to a prewired enclosure. A desiccated enclosure is necessary in these situations because pressure transducers need to be vented externally to allow equilibrium with the atmospheric pressure. This requirement prevents our pressure transducers from connecting directly to the CWS900 interface or a prewired enclosure.

The A150 has external vents and a port for routing the pressure transducer's vented cable. Inside the A150 is a terminal strip for splicing a continuation cable onto the end of the vented cable. The A150's continuation cable length is user specified and can terminate in pigtails, a prewired-enclosure connector, or a CWS900 connector.

SG000 Lightning Sensor continued from p. 7

The SG000 and CS110 can provide a robust lightning warning and detection system for a variety of applications. Outdoor spectator events such as ball games, golf tours, and soccer matches can use this system to protect players and fans. Public swimming pools and other outdoor venues would also benefit.

Additionally, the system is ideal for manufacturing facilities. For example, a system using the SG000 and CS110 is currently operating at Barrick Gold Corporation's Lagunas Norte mine in the highlands of Peru (a particularly lightning-prone region). The system warns of lightning danger, prompting evacuations that protect hundreds of workers. It then indicates when the danger has passed, allowing work to recommence as soon as possible.

Tips and Tricks: What's Your Initial Reaction?

Here's an easy way in CRBasic to initialize Public or Dim variables to something other than zero. By default, variables are set equal to zero when the datalogger program compiles.

```
Public Init1 = 1
Public InitArray(3) = {10, 20, 30} 'notice that
 'these are squiggly brackets
Public FlagInit As Boolean = true
Public StringInit as String * 20 = "String Data"
```

If the datalogger power cycles, these variables will return to the initialized values, unless the PreserveVariables instruction is used. To take advantage of variable initialization you'll need a recent operating system.

Remember that variables are not constants and therefore can be changed in a number of ways. Most often variables are changed under program control. For example, when taking measurements or doing calculations, the datalogger writes to a variable.

There are times, though, when you'd like to change a value on the fly (manually) such as resetting a counter or changing a multiplier or offset. As long as that value is declared as a variable, you can change it manually in several ways. The most common ways are via your software's Connect screen, and by using the keyboard display. RTMC also contains graphical components that allow you to toggle Boolean variables and set others.

Always a constant—never a variable,

Tip

Trade Show Calendar

Visit our website for training class schedules and additional listings.

January

NSAA Winter Conference	Snowbird, UT	18-20
TRB 90th Annual Meeting	Washington, DC	23-27
AMS Annual Meeting	Seattle, WA	23-27
Unified Wine & Grape Symposium	Sacramento, CA	26-27
AmeriFlux & NACP Meeting	New Orleans, LA	31-4

February

Distributech	San Diego, CA	1-3
World Ag Expo	Tulare, CA	8-10
Golf Industry Show	Orlando, FL	9-10

March

Rural Water of Utah	St. George, UT	1-3
GeoFrontiers 2011	Dallas, TX	13-16
USGS National Conference	Tampa, FL	28-1

April

Western Snow Conference	Spokane, WA	10-13

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