

Hydroinnova

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Observing soil moisture at the field scale

The Cosmic-Ray Probe fills a huge gap in the spatial scale of soil moisture observations. Conventional methods operate at small scales and require manual insertion of probes into the soil, which is often impractical due to the presence of roots and rocks. Furthermore point-scale data can poorly represent the wider moisture field due to the notorious heterogeneity of soils. On the other hand, satellite remote sensing shows promise for large scales, but with a footprint of ~40 km and penetration depth of only a few centimeters, practical applications are limited. The Cosmic-Ray Probe is ideal for observations at the scale of a small watershed, hydrologic model element or agricultural plot.

How it works

The cosmic-ray probe is completely passive, taking advantage of:

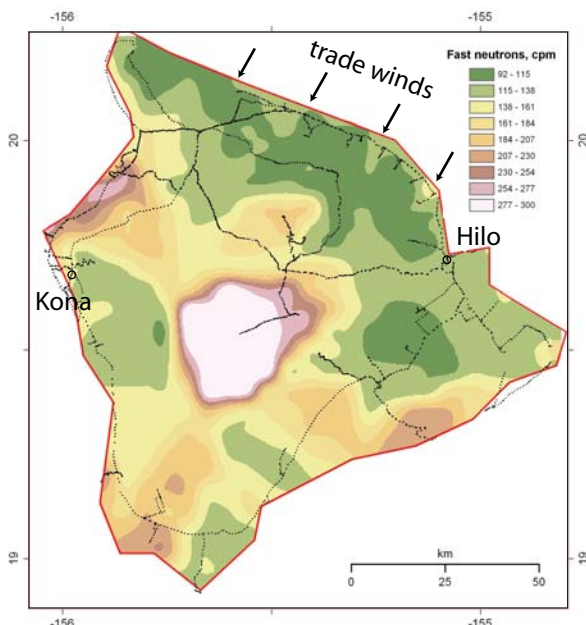
- (1) the presence of background cosmic-ray neutrons at earth's surface;
- (2) the unique ability of hydrogen to moderate neutrons; and
- (3) the large mean free path for neutron collisions in air.

Advantages:

- Non-invasive and non-contact.
- Insensitive to soil salinity, bulk density, or texture.
- Small data streams (meaning inexpensive telemetry).
- Entirely passive.
- Can be powered with solar panels.
- Spatial scale covering 40 ha (100 acres).

Applications

There are numerous applications for soil moisture measurements, including drought monitoring, irrigation scheduling, hillslope stability analysis, flash flood forecasting and water supply management. Soil moisture is also increasingly used in numerical weather and climate models.



Soil wetness map derived from a mobile cosmic-ray probe survey conducted in 2010 on the Island of Hawaii. Darker shades indicate wetter soil.

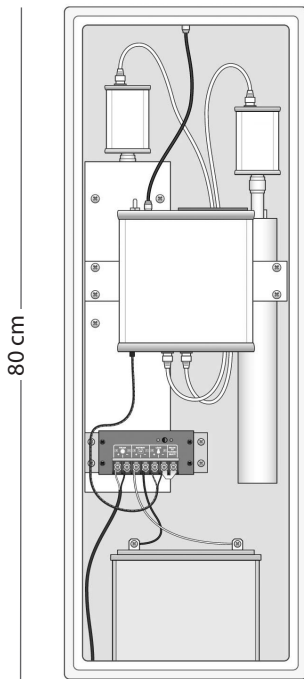
Our customers

Hydroinnova provides fully equipped soil moisture monitoring systems for continental and regional scale sensor networks. Our biggest customers are universities and government agencies in the US, China, Germany, UK and Australia.

The future

We are currently developing a mobile soil moisture monitoring tool that can be mounted on a motor vehicle. This will provide a unique capability for obtaining moisture across transects spanning tens to thousands of kilometers.

We are also developing monitoring systems that will help improve the irrigation efficiency. The 40 ha (100 acre) footprint for our technique makes it a perfect size for monitoring moisture conditions for center-pivot irrigated crops. We expect the agricultural market to grow in the near future as pumping costs and commodity prices both continue to increase.

**CRS-1000**

The system

The Cosmic-Ray Probe is typically purchased as complete data acquisition system that includes a data logger with integrated satellite or GSM cellular modem. Data are stored on a removable secure-digital (SD) card and backed up to an internal mini-SD card.

Programming the logger

Programming is easy and can be accomplished by changing parameters on a text file stored on the removable SD card. This can be done using any common available SD card reader. Alternatively, the data logger can be interfaced directly by using a USB cable and free terminal emulator software.

Remote data link

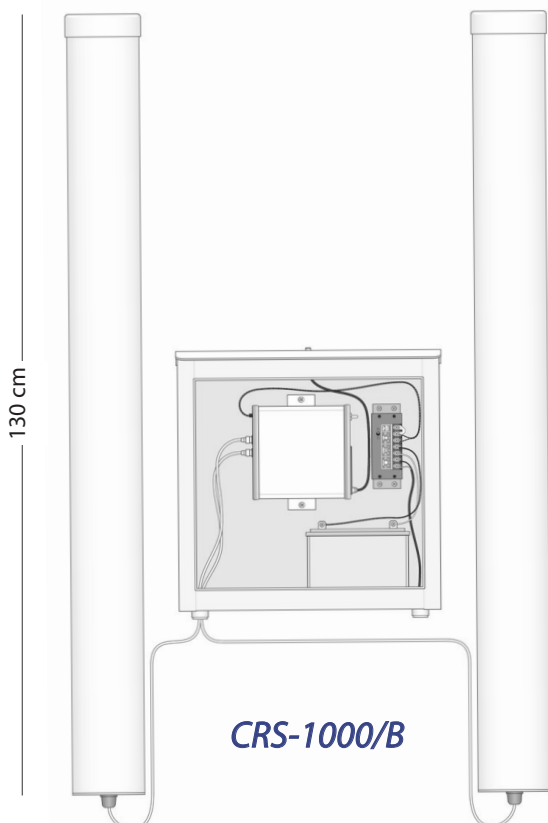
Turn-key options are available for retrieving data via *Iridium* satellite or GSM cellular modem. With Iridium satellite customers gain complete global coverage at affordable rates. Data are emailed to customers from the *Iridium* server as frequently as every one hour. An option for sending remote commands to the data logger via *Iridium* or GSM modem will soon be available.

Data base and web services

Data received via remote data link can be displayed and plotted in near real time on a password-protected web page. Data can also be accessed directly from a MySQL data base. Please let us know how we can support your data management needs.

Ancillary measurements

Standard measurements include external barometric pressure and internal temperature and relative humidity. Analog and digital inputs will support a variety of common sensors including rain gauges, pressure gauges and some invasive soil moisture probes. Please contact us regarding the compatibility of specific sensors.

**CRS-1000/B**

Data logger specifications

Power requirements

- 6 to 26 V DC.
- typical current drain ~150 mA @ 12V.

Analog inputs

- 4 Single-Ended inputs, 0 to 5V range.
- 2.5 V resolution (21 bits).

Analog outputs

- 4 independent 16 bit DAC outputs, 0 to 5V.
- 0.08 mV resolution.

Digital I/O ports

- 4 TTL ports, can be input, output, or counter.

Relays

- 4 solid-state, rated for 30 Volts DC @ 1.2A.

Internal temperature/relative humidity sensor

- RH accuracy ~ 3%.
- Temp accuracy ~ 1 deg.

Barometric pressure Sensor

- 0.1 mbar resolution.

Switched Regulated Power Outputs,

- 5V and 12V.

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