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Open-source data loggers and sensors for field research

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Over the past 6 years, we have developed – at an accelerating pace – data loggers and sensors for field research, with a focus on hydrology, glaciology, and geomorphology. Users can access all of our continually-updated code and schematics online at https://github.com/NorthernWidget/. Here we summarize the present state of our work. We have developed two new ALog-series (Arduino-compatible) data loggers: The BottleLogger v3.0, which is low-power for standalone applications while being powered by primary (e.g,. AA alkaline) batteries, and the TLog v1.0, which supports telemetry to form monitoring networks. Both can store up to 32 GB of data on SD cards, are outfitted with 16-bit analog-digital coverters, have high-precision real-time clocks, and can receive input voltages (fuse-protected) between 2.5 and 12V; the TLog is additionally outfitted with a GNSS receiver and a radio transceiver. The ALog-series data loggers currently support sensors for full weather stations, glacier ablation stations, temperature probes, stream gauges, and other specialized instruments. In addition to the hardware, we have developed the “ALog” firmware library. This Arduino-compatible C++ library combines the core utilities required to run a data logger and an expandable array of sensor interface functions into a single programming interface. To the user, this interface provides one-line function calls to sensors and a simple set of set-up options in which logging interval and file names can be chosen. The Alog library may also be used with a generic Arduino board. In order to add data logger functionality to exiting Arduino products, we have developed the "ALog Shield". The shield, or add-on board, adds SD card storage, screw terminals, and precise timekeeping to popular Arduino hardware, further reducing the cost of entry for those who already own Arduino products. In addition to data loggers, we have developed open-source sensors. These include (1) a pressure and temperature sensor, (2) a low-cost solar radiation sensor that uses wavelength-dependent light intensity sensors, and (3) a general-purpose instrumentation amplifier whose gain can be changed on the fly. The pressure sensor may be used in the open air, surface water, and groundwater wells up to 100 m deep. It is built around a MEMS pressure transducer that is commonly used for dive computers. Development and testing of new instruments is ongoing, with the goal of expanding the reach of scientific field data collection through open-source technology.