A low cost weather/situation monitor for wildland firefighter safety

Robert Kremens*, Jason Faulring, Andrew Gallagher
Rochester Institute of Technology
54 Lomb Memorial Drive
Rochester, NY 14623, U.S.A.
*Phone: 585.475.7286
*Email: kremens@cis.rit.edu

1. Introduction

.

Wildland fire behavior is governed by fuels, topography and weather. Rapid changes in weather conditions can lead to fire break-outs and dangerous rates of fire spread that can imperil both firefighters and firefighting activities. Investigation of firefighter accidents often shows that rapid temperature rises along with an accompanying decrease in relative humidity, combined with shifting or rapidly varying winds (especially in fine fuels) to be major factors during entrapments. Fire weather on major incidents is transmitted by RAWS weather systems, but often these systems are deployed far away from actual firefighting operations, and the weather data transmitted may not be relevant to a particular crew or division operation. What is more desirable is an inexpensive, portable easily deployed version of the RAWS system that can be deployed at the division or crew level. For prescribed fires, such an inexpensive weather station could provide an added margin of control during ignition operations without the need for a weather observer to be tied to a belt weather station.

We have designed and implemented a lightweight, portable data recorder (Kremens (2003)) that can simultaneously measure 10 or more parameters associated with fire behavior. These units presently cost less than (US2003)$300, and we are working on even lower cost units (US2003$100). A complete data recorder system configured as a weather station/fire data recorder consists of a weather vane/anemometer 'head', mounting mast, tripod, and data recorder/transmitter. (see Figure 1) The weight of the system is less than 8 kg, and two systems can easily be carried in a frame pack by a firefighter who is also carrying standard personal protective equipment, water and food. The units can be deployed in as little as 5 minutes, the majority of time being spent orienting and leveling the weather vane -anemometer sensing head.

2. Approach

The apparatus consists of two main components, a mast system and a data collection system. (see Figure 2). On the mast system are a wind speed and direction transducer, an infrared flux meter (to measure the radiant thermal flux from an approaching fire front) and a relative humidity/temperature sensor. The data collection system consists of a small waterproof enclosure housing electronics, battery and connectors for the mast sensors. Note that the device has the capability of accepting many more inputs than are currently deployed, if the need arises.

3. Preliminary results and discussion

The units were first deployed to monitor weather conditions within a fire front on a wildfire in Montana in July 2003 (Cooney Ridge Complex fire). This is an extreme application of the device, and we fully expected the weather sensing heads to be destroyed during fire front

passage. The sensors were placed in position in front of an advancing wildfire front about 45 minutes before fire passage. The fuel bed consisted of small shrubs that had overgrown medium sized (7-8 cm diameter) logging slash, interspersed with tall grasses and sub-alpine fir and Englemann spruce of 15 - 30 cm DBH.

Two packages were positioned roughly perpendicular to the expected advancing front. Other sensors were also positioned to measure total flux (radiant + convective) and to observe the fire behavior. (flame height and rate of spread), The data acquisition unit was buried about 10 cm beneath the soil surface which provided sufficient insulation to protect the electronics from the fire. In this deployment, the data was stored in the data logger, although the data could just as easily have been forwarded to a remote site by radio using voice or audio frequency shift keying telegraphy.

In Figure 4 we show the response of the wind direction and speed and air temperature and relative humidity in the 10 minutes immediately preceding and following the passage of an active fire front. The fire was approaching from the north and was advancing upslope at about 50 m/hr. We can see that the wind direction, which before the fire was light and variable, begins to point directly into the fire before passage of the fire front. The temperature rises and relative humidity falls precipitously during the fire, but recovers to pre-fire levels in about 2 hours after the fire front has passed. This information would be invaluable to firefighters and especially to prescribed burn or backfiring crews to assist in prediction of fire behavior.

4. References

Kremens, R., Faulring, J., Gallagher, A., Seema, A., Vodacek, A., 2003: Int. J. of Wildfire, **12**, 237-244.

Figure 1: A weather station/situation monitor deployed on a wildfire in Montana (Cooney Ridge Complex). The weather station is in the foreground; the other tripod mounts another experiment. The data logger is buried about 10 cm underground to protect it from the fire front.

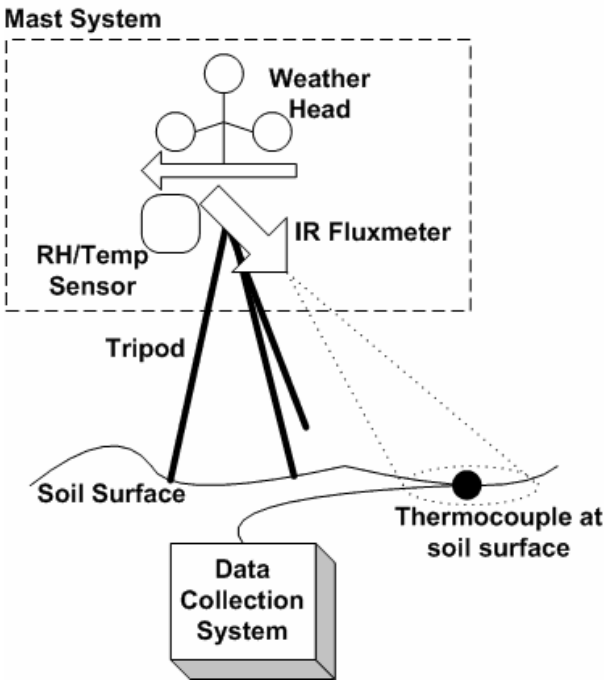

***Figure 2*:** An IR flux meter, relative humidity sensor, temperature sensor and wind vane (speed/direction) are mounted on a tripod about 2 m above the surface of the soil. ('mast package') The flux meter field-of-view is centered on a thermocouple that is in contact with the soil surface. The data from both sensors is logged as a time series by a buried 'data collection system'. Up to 3 additional sensor pairs and two additional thermocouples may be logged by a single logger.

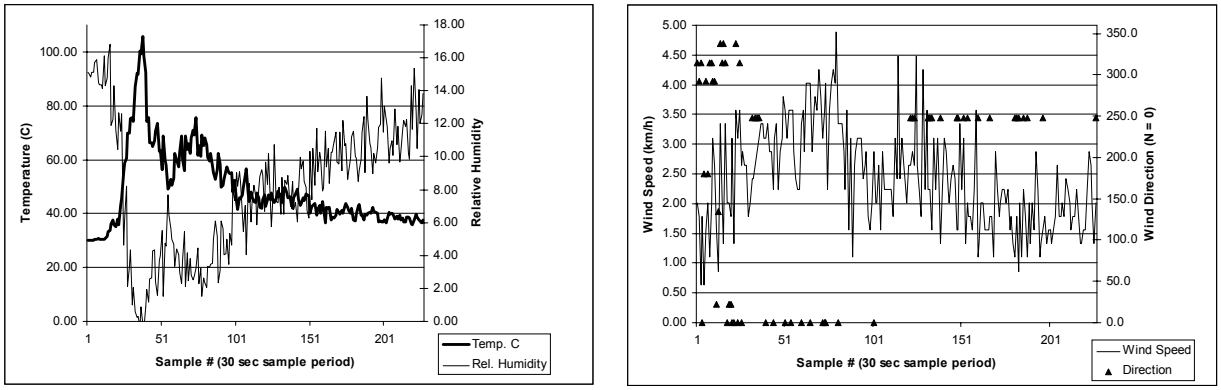

Figure 4: A plot of the relative humidity and air temperature (left) and wind speed and direction as a function of time (right)as a function of time. The wind direction changed from west to directly toward the fire (0^{o}) during the time of fire passage. The fire front passed the mast system at about sample 40. Note the precipitous drop in relative humidity and increase in temperature during fire front passage.