



Evaluating Digital Meters for Fire Weather Observations

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In the past few years, digital meters that read temperature, relative humidity, and windspeed have been developed and marketed. The Missoula Technology and Development Center (MTDC) obtained eight of these instruments to see whether a digital unit could replace the sling psychrometer and anemometer in the belt weather kit commonly used by wildland firefighters. Fire crews are already using a few digital units with limited success. Some of the units currently being used are the Amprobe digital psychrometer and the Extech humidity/temperature pen.

Changes in weather are important to wildland firefighters. A digital unit must be very accurate. In some types of fuels, a humidity drop of 2 percentage points could significantly alter the way a fire burns. The unit must also be easy to use. Crews on the fireline may take temperature readings every half hour during the peak burning period.

For years the sling psychrometer and anemometer have been used for taking weather observations. However, the sling psychrometer is slow and the anemometer in the belt weather kit is not very precise. This Tech Tip will compare the accuracy of new digital products to the psychrometer and anemometer in the belt weather kit.

A suitable replacement for the sling psychrometer must be easy to use, accurate, and relatively compact. These criteria were used to evaluate six of the eight digital meters. The remaining two meters (Extech heavy-duty thermo-anemometer and hygro thermometer) have

data logging capabilities. They both come with personal-computer software that can be used to construct graphs of temperature, relative humidity, and windspeed after the data have been downloaded. These two meters were tested for their accuracy, their ability to produce simple, accurate graphs, and their relative ease of use.



Test Methods

The humidity and temperature functions were tested against a standard sling psychrometer. Weather was taken with the sling psychrometer while digital psychrometers were taking readings of humidity and temperature. The temperature given by the sling psychrometer during testing was 45 °F and the humidity was 53 percent.

The digital units were tested against these readings.

Three of the units were equipped with anemometers. They were tested with a fixed wind source for consistency rather than for accuracy. Accuracy is very hard to test without a controlled setting. All of the anemometers gave readings within 0.10 m.p.h. of each other. The problem with any anemometer is positioning the unit so it will get an accurate wind-speed reading. The gauge should be perpendicular to the wind direction. Determining the exact direction of the wind is difficult. Human error can be a factor when using any handheld anemometer.



Digital Meters Tested

Extech Model 4465CF Humidity and Temperature Meter

This unit (Figure 1) is simple to operate, but does not appear to be very durable. It is made of hard plastic and metal and comes in a protective plastic case. The switches that control this unit are self-explanatory and are simple to operate. The unit reads temperature in either degrees Celsius or Fahrenheit.



Figure 1—Extech Model 4465CF humidity and temperature meter.

When the unit was tested against the sling psychrometer, the temperature was only 2.8 degrees high. The relative humidity was 6.5 percentage points low. This model costs \$159.

Extech Model 445580 Humidity and Temperature Pen

This was the smallest and the least-expensive Extech unit we tested (Figure 2). It is small enough to fit in a shirt pocket. It is simple to operate, with automatic temperature and humidity readings. It has a minimum

and maximum function for both temperature and humidity. A *Hold* button keeps the reading on the screen from changing.

When the pen was tested against the sling psychrometer, the temperatures were nearly identical. The humidity reading was about 11 percentage points low. This model costs about \$60.

Kestrel 2000—This unit (Figure 3) is small with a hard plastic case. It floats and is water resistant. It has two buttons: a *Mode* button and an *On/Off* button. The *Mode* button switches between maximum and average wind-speed readings and temperature readings. The temperature reading is displayed only in degrees Fahrenheit. When it was tested against the sling psychrometer, the Kestrel gave the same temperatures. The anemometer function was consistent with our control windspeed. This unit costs \$119.

Kestrel 3000—This model (Figure 4) is small with a hard plastic case. Like the Kestrel 2000, it floats and is water resistant. The Kestrel 3000 has humidity functions and



Figure 2—Extech Model 445580 humidity and temperature meter.

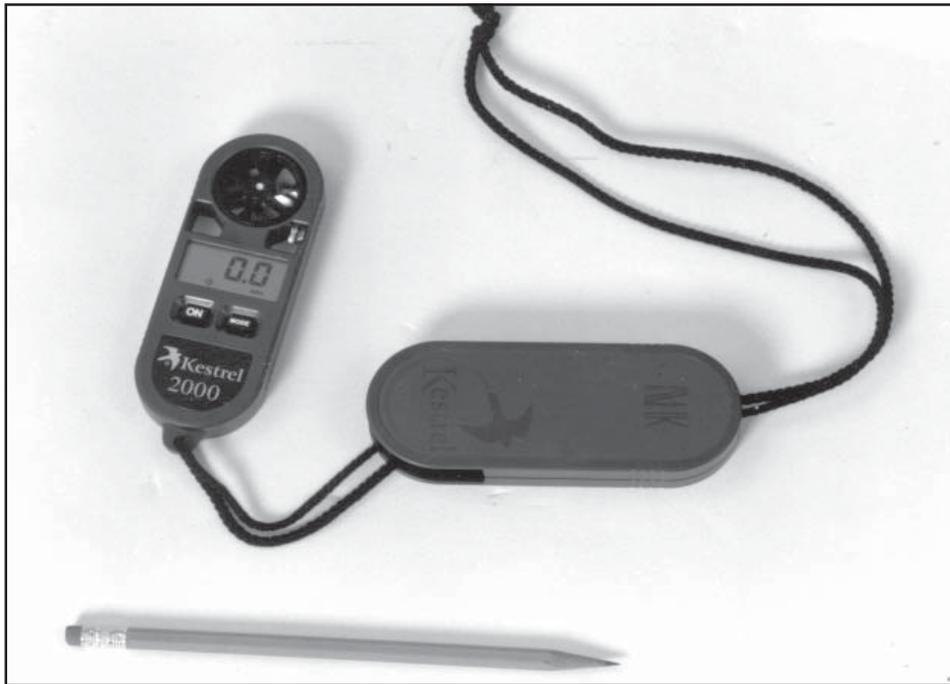


Figure 3—The Kestrel 2000 digital thermometer and anemometer.



Figure 4—The Kestrel 3000 digital thermometer, anemometer, and hygrometer.

reads dew point, heat index, and wind chill, along with temperature and wind speed. It has two buttons *Mode* and *On/Off*. It reads temperature in degrees Celsius and Fahrenheit. It reads wind speed in Beaufort Force, knots, kilometers per hour, miles per hour, meters per second, and feet per minute.

When this unit was tested against the sling psychrometer, it gave the same temperature. The humidity reading was 4 percentage points low. This model costs \$169.

Davis Instruments' Turbometer—This digital anemometer (Figure 5) is small and durable. It runs on four AAA batteries. Because it doesn't have an auto power-off function, the batteries could be discharged unintentionally. It gives readings in knots, meters per second, and miles per hour. The Turbometer is simple to operate. It has one slide switch that turns it on and selects the desired units of measurement. The Turbometer's readings were consistent with the control wind speed. This model costs \$159.

Amprobe Model THWD-1 Digital Psychrometer—The Amprobe (Figure 6) has been used by wildland firefighters with mixed results. It is small and fairly simple to operate. It will read temperature in both degrees Celsius and Fahrenheit. It has an auto power-off function to save battery life. A hold function keeps the reading on the screen from changing. The unit has minimum and maximum readings for both temperature and humidity. This unit also gives a dew point and wet-bulb reading.

The mixed success of the Amprobe has been due to its accuracy. When it was tested against the standard sling psychrometer, the temperature was about 1.7 degrees high and the humidity was about 12 percentage points low. This unit costs \$100.

Extech Models 407412 and 407445 Heavy-Duty Hygro/Thermo-Anemometers and Hygro Thermometers—These two units were the most complicated to operate. They work exactly the same except for the anemometer function on Model 407412 (Figure 7). Each has a humidity probe that plugs into the top of the unit. The thermo-anemometer has a wind speed probe that plugs into the same port as the humidity



Figure 5—Davis Instruments' Turbometer.



Figure 6—Amprobe Model THWD-1 digital psychrometer.

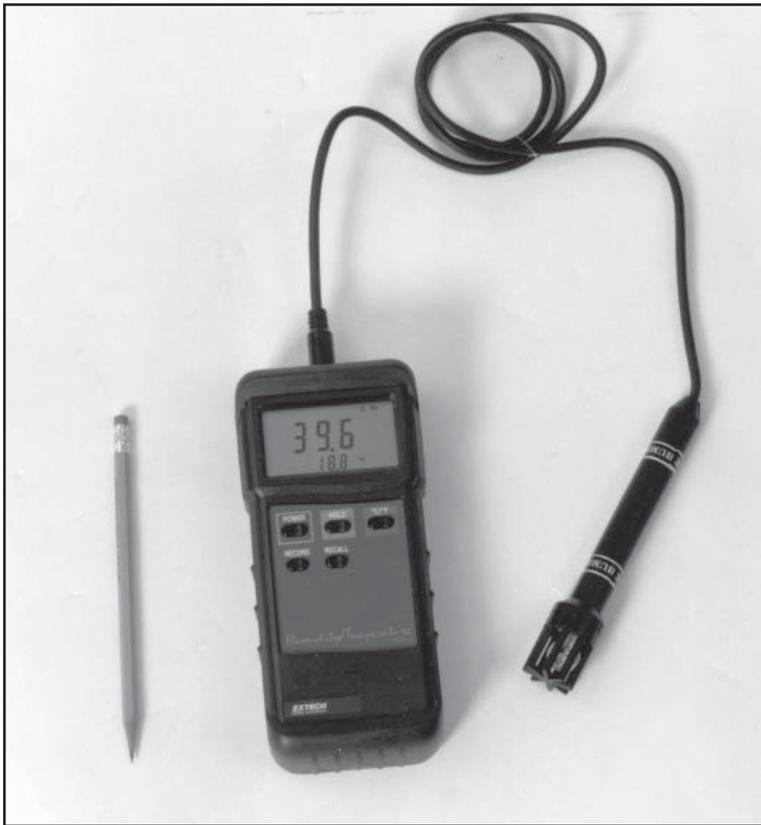


Figure 7—Extech Model 407412 heavy-duty hygro/thermo-anemometer and hygrometer.

probe. Both meters come with data logging capabilities. Both units display the current reading. Neither unit will display the data that have been logged into the data logging module. This information can only be viewed after it has been downloaded to a computer. Data can be downloaded directly to a computer or stored in an Extech data logging module (Model 380340) and then downloaded later. Figure 8 shows the Extech Model 407445, the heavy-duty hygro/thermo-anemometer with the data logging module. The information stored in it is downloaded in a series of readings that can be applied to a spreadsheet program and graphed. Obtaining a good graph of the data takes knowledge of a spreadsheet program.



Figure 8—Extech Model 407445 data logging module.

Initially, the data points are downloaded from the data logging module into the downloading program on a PC (this program must be ordered with the meters). The data must be saved and opened in a text-only format. Then the data must be arranged so they will transfer correctly to a spreadsheet. After this has been done, the data can be opened and graphed in a spreadsheet program (Figure 9).

Each unit comes with clear, simple instructions that need to be read carefully. The default temperature display is in degrees Celsius, but it can be changed to Fahrenheit. The hygro/thermo-anemometer will display windspeed readings in meters per second, kilometers per hour, feet per minute, knots, or miles per hour.

When the units were tested against the sling psychrometer, their temperature readings were 4 degrees high and their humidity readings were 6.5 percentage points low.

These units seem to be durable, but they become slightly cumbersome when outfitted with the attachments needed to operate them properly. Each probe has a 4-foot cord. Extech advised attaching the probe and cord to the unit with a rubber band when working in the field. This works well, but makes the unit bulky. To use the data logging module, another unit and cord are needed. In a wildland fire setting someone who wasn't moving around and had free time would have to set the unit up. Once the data logging system is set up, it is difficult to move. The Extech Model 407412 costs \$299, and the Model 407445 costs \$199.

Extech has a technical-services department that can provide assistance.

Results

Table 1 displays the results of tests on eight models of digital temperature and humidity meters. The anemometers were tested for consistency rather than accuracy, so their results were not included.

Conclusions

Eight digital temperature, humidity, and windspeed meters were tested for accuracy. The level of accuracy needed in particular fire situations depends on the type of fuel in which the fire is burning. For years, firefighters have used the belt weather kit for all weather measurements. Now that other options exist, firefighters need to be aware of the new digital instruments and their accuracy.

Manufacturer's Addresses

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Waltham, MA 02154-1020
Phone: 781-890-7440

Davis Instruments Corp.
3465 Diablo Avenue
Hayward, CA 94545
Phone: 510-732-9229

Kestrel Wind/Weather Instruments
104 West Fifteenth Street
Chester, PA 19013
Phone: 610-447-1555

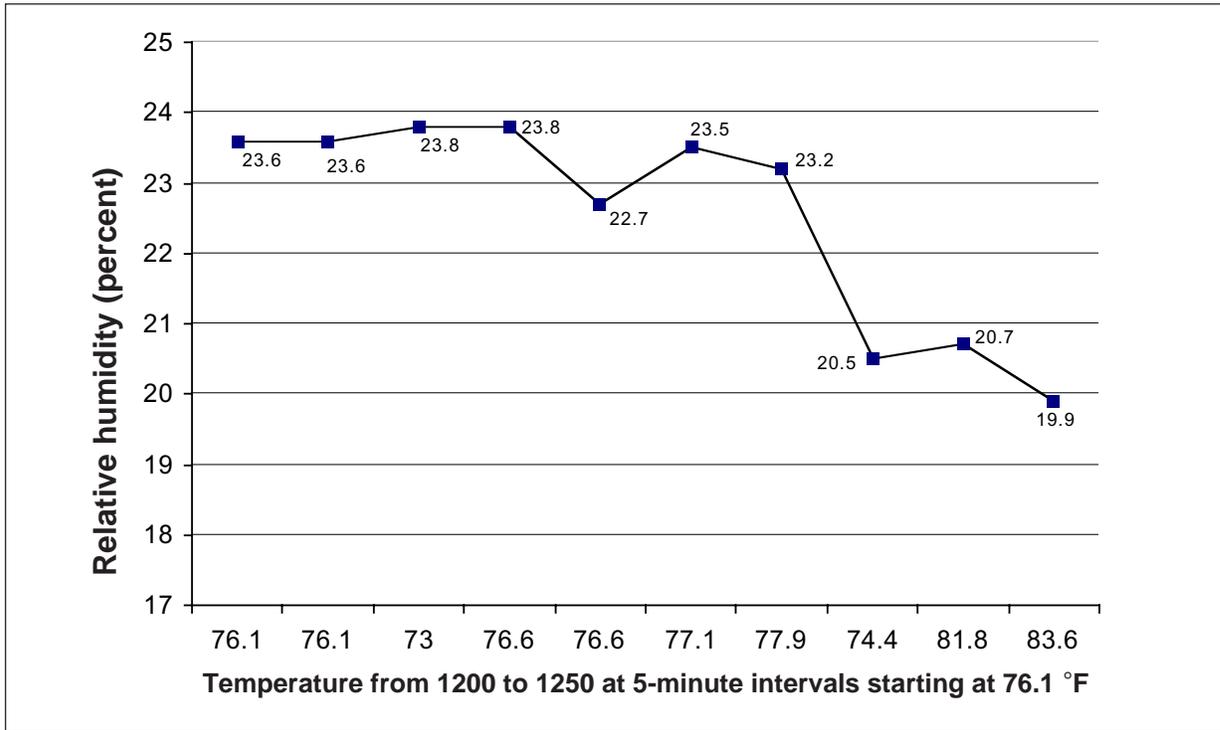


Figure 9—Data loggers can display temperatures and relative humidities like on this graph of a warm spring day in Western Montana.

Table 1—Test results of relative humidity (RH) and temperature (°F) readings for eight digital meters.

| Item | Weight (ounces) | Accuracy ^a | Cost in dollars (may vary) | Function | Size (inches) |
|---------------------------|-----------------|-----------------------|----------------------------|---------------------------|------------------|
| Extech Model 407412 | 12.0 | +5 °F, -6.5% RH | 299 | Psychrometer , anemometer | 7.1 x 2.8 x 1.3 |
| Extech Model 407445 | 18.0 | +4 8 °F, -6.5% RH | 199 | Psychrometer | 7.0 x 2.9 x 1.3 |
| Extech Model 4465CF | 7.0 | +2 8 °F, -6.5% RH | 159 | Psychrometer | 10.6 x 2.7 x 1.0 |
| Extech Model 445580 | 2.3 | +0.5 °F, -11% RH | 55 | Psychrometer | 5.7 x 1.2 x 1.0 |
| Kestrel 2000 ^b | 2.3 | +0.1 °F | 1,190 | Anemometer , ther mometer | 4.8 x 1.7 x 0.6 |
| Kestrel 3000 | 2.3 | +0.1 °F, -4% RH | 169 | Anemometer , psychrometer | 4.8 x 1.7 x 0.6 |
| Turbometer ^b | 8.0 | NA. | 159 | Anemometer | 4.5 x 2.5 x 1.0 |
| Amprobe Psychrometer | 8.0 | +1.7 °F, -12.2% RH | 100 | Psychrometer | 0.8 x 1.9 x 6.7 |

^a – These units were tested against a temperature of 45 °F and a relative humidity of 53 percent.

^b – These units do not give humidity readings .

About the Authors

Greg Lemon is a program assistant for MTDC and a forestry technician for the Lolo National Forest. He spent 3 years working on a district fire crew and 1 year working on the La Grande Hotshots for the Wallowa-Whitman National Forest in La Grande, OR. Greg is majoring in English at Eastern Oregon University.

Dick Mangan has been Program Leader for Fire, Aviation, and Residues at MTDC since 1989. Before coming to the Center, he spent more than 20 years working on Ranger Districts and National Forests in Oregon and

Washington, participating in the full range of wildland fire activities. He serves on the National Wildfire Coordinating Group (NWCG) Fire Equipment and Safety and Health Working Teams and is chairperson of the National Fire Protection Association (NFPA) 1977 Technical Committee for Wildland Fire Personal Protective Clothing and Equipment. Dick remains active in the field, representing MTDC on fire-entrapment investigations and serving as Operations Section Chief on a National Type I Overhead Team.

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