Last updated: Nov 6, 2010 by M. Marinova

University Valley Campbell

In these notes: General description of the weather station, available sensors list and their locations, things to note and calibration calculations, wiring list for all sensors, how to download the weather station, and associated images.

General description:

Campbell: CR1000
Serial Number 28046
Program: UniversityValley_MetStation.CR1
Uploaded: Dec 2, 2009 8:50pm – logger set to local New Zealand time (an hour off from standard local sun time)
Deployed (outside, only air sensors): Dec 4, 2009 ~19:00
Ground temperature sensor deployed ~Dec 8, 2009
Deployed in its final location – with all sensors deployed: Dec. 10, ~3pm
Data fill days: 2492.79 days
Memory: 4,194,304 bytes
Scan interval: 30 min
Power: 5W solar panel and box contains two 40 Amp hour batteries connected in parallel
Location: S77° 51.729' E160° 42.606'; elevation: 1677m
Depth to permafrost at deployment location: 42cm
Permafrost cores were taken nearby.

Sensors & location description:

Above surface:

- Air T/RH (207) – about 1.2 m above ground
- Light (LI200X) – about 1.27 m above ground, mounted on top of T/RH grill
- Wind RM Young (05103) – about 1.08 m above ground; Note that the mast with the air T/RH and light sensors is to the west of the wind sensor.
- Hobo Air T/RH (Pro V2) – about 0.85 m above ground, on the same mast as the 207 T/RH probe. The sensor name is: UnivValley_WeatherStation_T_RH_AirTemp, sensor #2428137

Ground/below surface:

- T_surf (107)
- T_10cm (107)
- T_ice (107); depth as deployed: 42cm
- T_deep (107), depth as deployed: 7cm below ice-cemented ground = ~49cm total depth
- Water content TDR_{top} – intergrated top layer, put in at a 45° angle (= top 21cm) (TDR cs615, rods are 30cm long)
- Water content TDR20cm (TDR cs615); put in at a 30°angle. The "head" of the probe is at 20cm depth, with the bottommost reaches at 35cm depth (rod length = 30cm)
- Leaf wetness – surface (Leaf Wetness)
- Echo; deployment depth: 23cm
- Hobo T/RH surf (Pro V2); sensor name: UnivValley_WeatherStation_T_RH_surf, sensor #2429438

- Hobo T/RH 20cm (ProV2); depth at deployment: 20cm. sensor name: UnivValley_WeatherStation_T_RH_20cm, sensor #2429430
- Hobo T/RH ice (Pro V2); actual depth as deployed: 42cm; sensor name: UnivValley_WeatherStation_T_RH_Ice_Bound, sensor #2429433

In the above descriptions, ***ice*** is defined as the dry permafrost to ice-cemented ground boundary, and ***deep*** is defined as about 10cm into the ice-cemented permafrost.

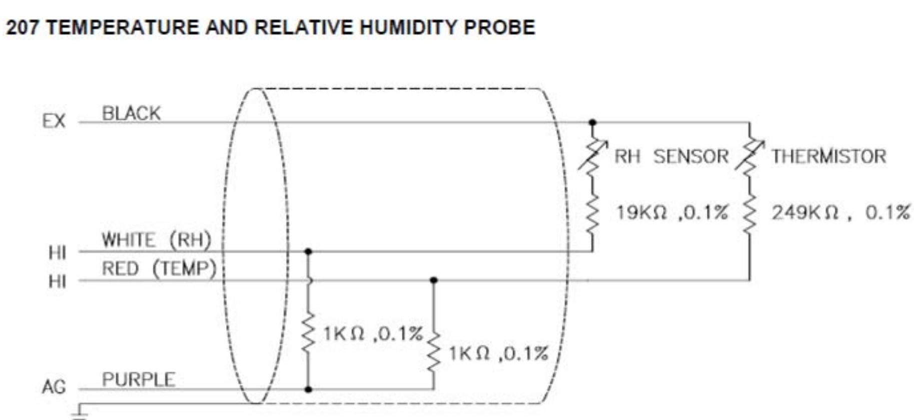
***Things to Note*:**

1. The uploaded Campbell CR1 program is modified from the shortcut program as follows:

- the 207 Temperature/Relative Humidity probe is programmed as a 107 temperature probe and a (humidity) half-bridge. The program is manually altered so that the 107 and the half bridge are excited by the same channel (see point 2 below for more info).
- Added the half-bridge for the Echo (this had to be done manually because ShortCut was insisting on using separate excitation channels for each half-bridge and was running out of excitation channels.)

2. ShortCut does not support the 207 air T/RH probe for the CR1000 sensor, therefore the 207 sensor is programmed as a 107 temperature probe and a half-bridge. (As an aside, we are still using a 207 probe instead of the HMP405 because the 207 has better response at very low temperatures, < -40°C.) Since we are using a manual half-bridge measurement for the humidity, we need to manually convert the recorded voltage to a humidity. Note that the Campbell records a *normalized* voltage output – normalized by the excitation voltage. The conversion from the normalized voltage that is recorded by Campbell to the corresponding humidity is given in University_Valley_Met_Station_Calibration.xls

The relative humidity calculation is as follows. When a half-bridge measurement is made by the Campbell, the output that is recorded is the voltage measured across the instrument *divided by* the excitation voltage (in this case 2.5 Volts). The diagram for the 207 probe (both T and RH sensors) is below.



A polynomial is used to convert from the measured voltage to relative humidity. Note that the input to the polynomial is a "relative" voltage, V_{rel}:

$$V_{rel} = 6000\left(\frac{V_s}{V_x}\right)$$

where V_s/V_x is the output recorded by Campbell, which is the measured voltage (V_s) normalized by the excitation voltage (V_x). The 6000 multiplication factor is just a scaling (as used in the Campbell manual). The temperature-independent relative humidity, RH_0, is then given by

$$RH_0 = C_0 + C_1 V_{rel} + C_2 V_{rel}^{\,2} + C_3 V_{rel}^{\,3} + C_4 V_{rel}^{\,4} + C_5 V_{rel}^{\,5}$$

The coefficients C_0 through C_5 are given below. The 207 manual provides further information on the accuracy of the polynomial fit to the actual sensor response.

TABLE 5. Polynomial Coefficients

Coefficient	Value
C_0	12.0843
C_1	0.952280
C_2	$-1.420342 \times 10^{-02}$
C_3	1.123239×10^{-04}
C_4	$-4.106548 \times 10^{-07}$
C_5	5.719691×10^{-10}

The relative humidity must be corrected for temperature, which is given by:

$$RH = RH_0 + 0.36(25 - T)$$

where T is the temperature in °C. This result is the relative humidity with respect to water. For the relative humidity with respect to ice, the following correction must be made when the temperature is below freezing (0°C):

$$RH_{ice} = \frac{RH}{1 + 0.0097T + 4.165\times 10^{-5} T^2}$$

The 207 probe manual provides further information on the accuracy of the measurement and the conversions.

Wiring as deployed in the field:

1st row
1H – 207 T/RH - red
1L – 207 T/RH – white
Ground – 207 T/RH – clear
2H – LI 200X - red
2L – LI 200X - black
Ground – LI 200X – clear and white
3H – 05103 - green
3L – T_surf 107 - red
Ground – T_surf 107 – purple & clear
4H – T_10cm 107 - red
4L – T_ice 107 - red
Ground – T_10cm – purple & clear

VX1/EX1 – T/RH 207 – black; T surf 107 - black; T10cm 107 - black; 05103 - blue
Ground – 05103 – white & clear & black
P1 – 05103 - red
Ground – T_ice 107 – white & purple

2nd row
5H – T_deep 107 - red
5L – TDR avg top cs605? - green
Ground – T_deep 107 – white & purple; TDR avg top - clear
6H – TDR_20cm - green
6L – Leaf wetness - red
Ground – TDR_20 cm clear; leaf wetness – purple & white
7H – Echo - red
7L – empty
Ground – Echo - shield
8H – empty
8L – empty
Ground - empty
VX2 – Echo - white
Ground – empty
VX3 – T_ice 107 – black; T_deep 107 - black; leaf wetness – black

3rd row
G – TDR avg top - black
5V – empty
G – TDR 20cm - black
SW12V – empty
G – empty
12V – TDR avg top – red; TDR 20cm - red
12V – empty
G – empty
C1 – TDR avg top - orange
C2 – TDR 20cm – orange
C3 – empty
C4 – empty
G – empty
C5 – empty/spare resistor
C6 – empty
C7 – Empty
C8 – empty
G – empty/spare resistor

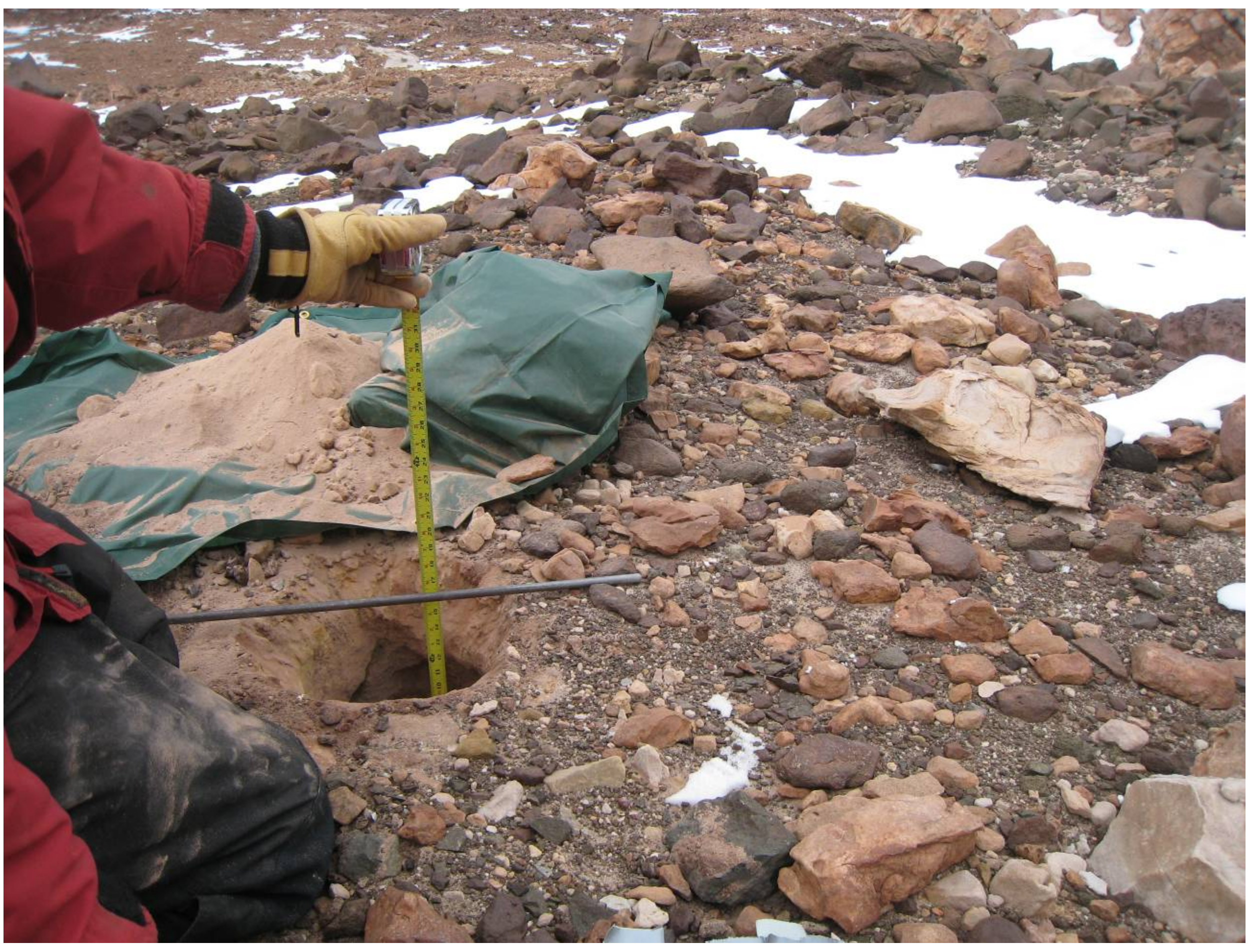
How to download the weather station:
If possible, use the Campbell USB connector. Connect the USB dongle to the Station. Wait for the red light on the dongle to stop flashing. When the flashing is done, all the data has been downloaded.

If a USB dongle is not available:

1. Install PC200W on your computer

2. If there is no serial port on the computer, get a Keyspan adapter working
3. When approaching the weather station, stay on its north side (towards the mouth of the valley, facing the snowpack) – the ground sensors are on the south side of the weather station!
4. The weather station box is closed by a clamp on either side of the box – be careful in opening the box since the solar panel wire runs from the box to the Campbell.
5. Attach the Keyspan/serial port to the top serial port input on the Campbell (the bottom serial port is used for the Campbell keypad).
6. Connect to the datalogger (top left icon on PC200W).
7. Collect the data – beware of the filename and possibly overwriting previous data. Note that even if you're not overwriting an old file, PC200W will warn you that you *may* be overwriting an old file.
8. To calibrate and plot the data, open *University_Valley_Met_Station_Calibration.xls.* Then open the weather station data file with Excel as well (using comma separated values). Paste the data into the *University_Valley_Met_Station_Calibraiton.xls* file **Data** sheet. Only the top 100 rows or so of data are calculated in the existing spreadsheet. In order for all the data to be calibrated and plotted, go to the **Calibrated University Vly Data** sheet, select the values in the bottom-most row, and drag the right, bottom corner down the spreadsheet until all the data is encompassed in the calculated section. ***No*** modifications are needed in the **DO NOT TOUCH – calculations** sheet!

Associated images

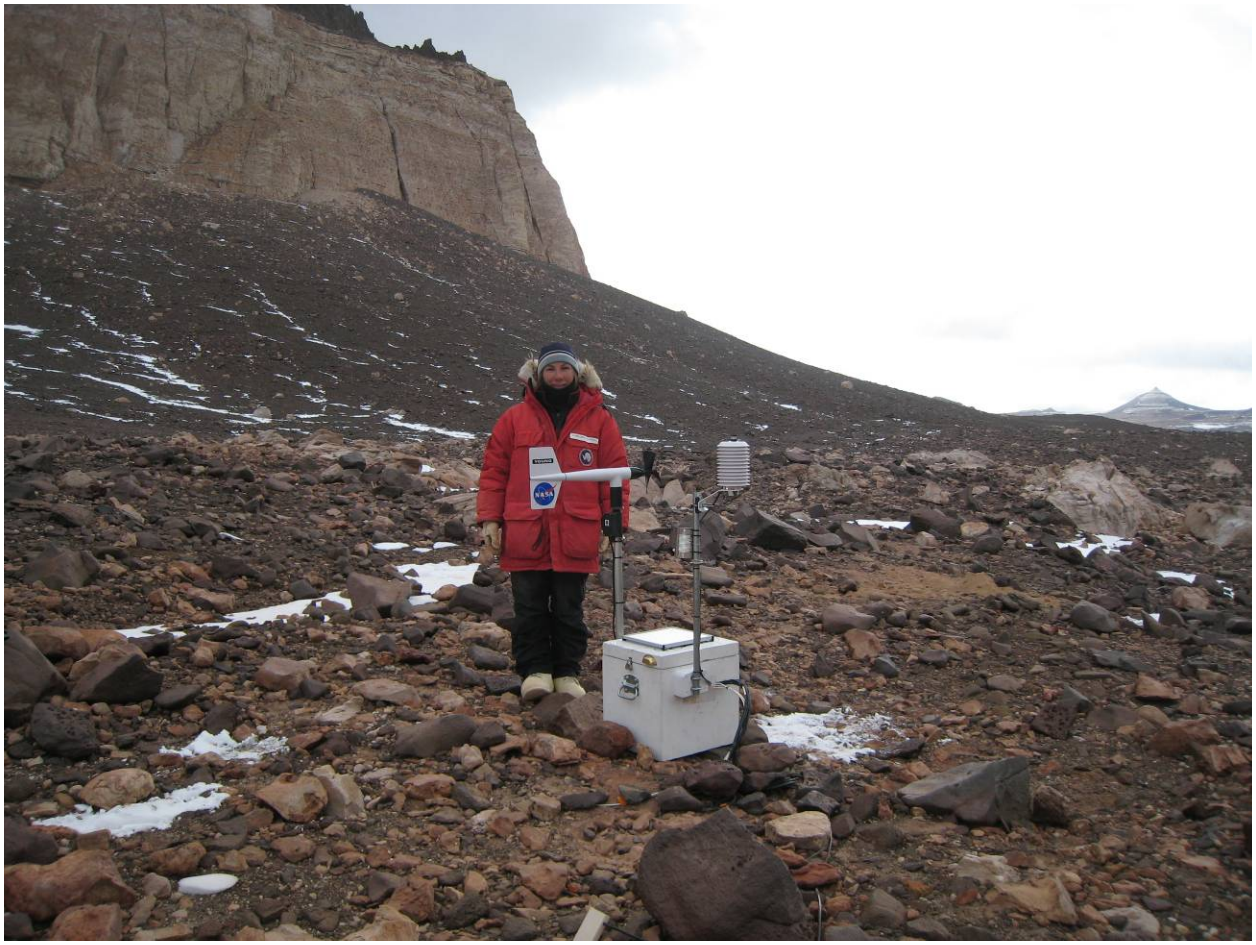


IMG_3593: Measuring the depth to the ice-cemented ground (with an inch scale…). The area to the right is where the surface instruments were deployed.

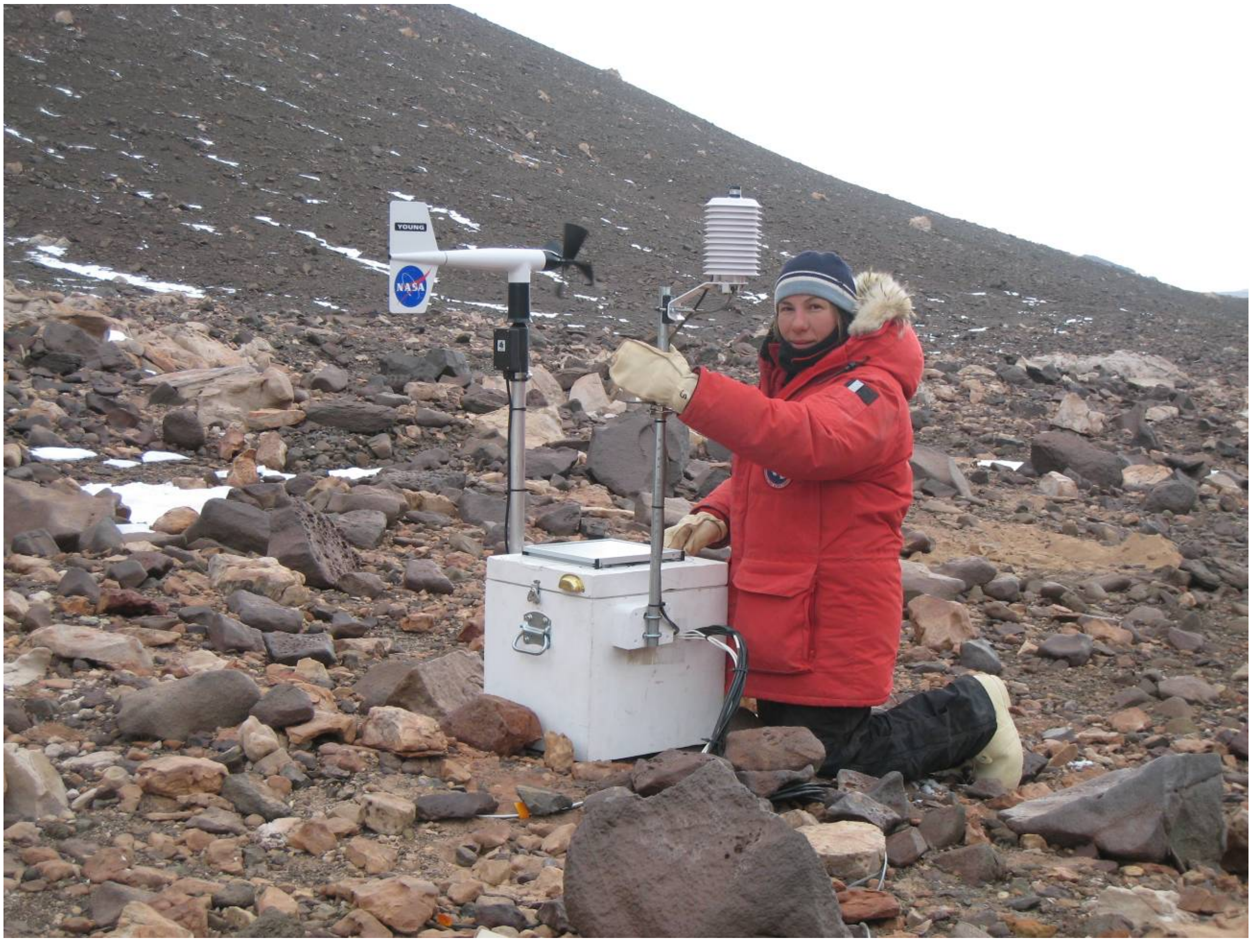
IMG_3594: Depth to ice-cemented ground ~16.5 inches = 42 cm.

IMG_3595: The lowest level of instruments were already inserted (in the ice-cemented ground and at the ice-cemented ground boundary) and the hole partially filled on. This is the second layer of instruments at ~20 cm. The Echo is inserted in this image, as well as the 20 cm T/RH Hobo. The metal ruler on the right is 15 cm

IMG_3596: Depth to the Echo sensor: 23 cm (9 inches). The regolith was pretty loose.



IMG_3597: All the sensors installed and the weather station is done! :) The sensors are located between the weather station and where the photographer (McKay) is standing.



IMG_3601: Close-up of the weather station. In the foreground you can see the cables for some of the sensors.