Protocols for the Measurement of Air Temperature and Relative Humidity

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1.0 INTRODUCTION

Air temperature and relative humidity (RH) are measured at climate monitoring stations operated by Alberta Agriculture and Forestry (AAF), and is an important aspect of climate monitoring and forecasting. Data from these stations, for example air temperature and RH, are used to develop maps and models which are integral to operations such as flood forecasting and crop insurance.

Regular maintenance and performance checks are required to keep these sensors functioning correctly to ensure the data are of high quality. There are many different kinds of temperature and humidity sensors installed in the AAF network, just as AAF operates many different kinds of field standards (Calibrated standard probe and display).

No official formal standard operating procedure (SOP) for the measurement of air temperature and RH has been written by the Government of Alberta in the past. Most knowledge has been passed on through demonstration, collaboration, and mentorship. Guidance was gained from the equipment manuals, as well as informal training from the vendor and other staff.

2.0 MEASUREMENT OF AIR TEMPERATURE AND RELATIVE HUMIDITY

Field standard checks are performed during station visits on air temperature and RH sensors using a calibrated field standard to insure the data being collected from theses sensors is accurate and the data being collected and stored in the archives is reliable.

2.1 Description of Field Units

There are many types of field units available to perform these tasks and practitioners use a diversity of commercially available meters. It is important that the meter chosen to measure air temperature and RH provides the levels of measurement and sensitivity aligned with the data requirements.

The acceptable standards used for temperature output is ± 0.50 °C and ± 5 % for RH. The station sensor is ideally tested with the standard probe immediately next to it, if at all possible, either inside the Stevenson Screen with the sensor (Figure 1), or in a similar gill shield directly next to the one installed at the station (Figure 2). Ideal conditions for a field check include a breeze and a continuous sky cover; calm conditions and changing cloud cover make it difficult to get a constant reading between the field standard and station's sensor.

Figure 1. Inside of Stevenson Screen: (A) Standard Probe (B) Station Sensor (C) Standard Display.

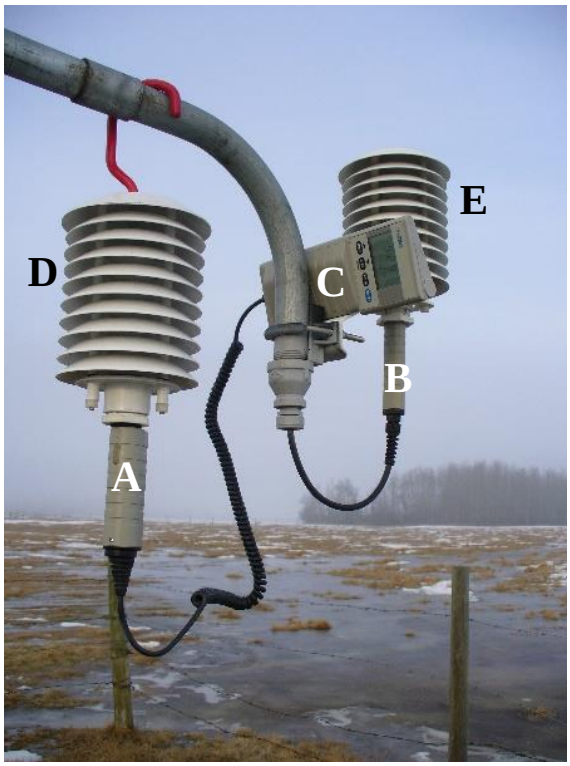

Figure 2. Station Sensor and Standard Probe Both in Gill Shields: (A) Standard Probe (B) Station Sensor (C) Standard Display (D) Mobile Gill Shield (E) Permanent Gill Shield.

If the sensor installed at the station is found to be out of range during this field check, it needs to be removed and replaced by the same type of sensor (ideally if available). This needs to be recorded and updated in the station inventory, and Quality Assurance/Quality Control Group within Agricultural Meteorology Unit needs to be notified to make the corrections to that specific output. As a general and historically practiced rule, the temperature and humidity readings are taken at the top of the hour. This is due to the fact that these parameters change rapidly throughout the day and the top of the hour time slot makes for the easier raw data comparison also aiding in eliminating the occurrence of repeat entries in the data. *[Note: Although preferred, top of the hour readings are not required if the logged reading at the time of standard check is also provided.]*

2.2 General Instruction

These following procedures are used when checking probe sensors that measure air temperature and/or RH as well as field standards used to spot check the same parameters.

- The air temperature and RH readings are checked in comparison with the field unit standard (calibrated standard probe and display). This is usually done at the beginning of the hour in conjunction with the stations raw data which is historically recorded at this time and can be used by data management personnel to make and apply corrections accordingly.
- The type of field standard used is the same or very similar to the sensor being checked. Each sensor has a varying response time and the standard being used to check the sensor should be the same or very similar in rate of response, especially in response time.
- Readings are taken with the standard in close proximity (within the same Stevenson screen as the sensor or directly beside the stations gill shield) to the station sensor to ensure accurate results. If the sensor is housed in a Stevenson Screen or gill shield the standard being used must also be in the same or similar apparatus (Figures 1 and 2).
- Ambient conditions should have a constant cloud cover and a breeze to obtain a stable reading.

- The reading is recorded and if it is not within the required specification ranges (± 0.5 °C and ± 5 % RH), it is removed, replaced and the data is sent to data management personnel to correct the outputs (See 2.2.1 Sensor Malfunctions in Humidity and Temperature Probe (HMP) Style Probes).
- The sensor may also be removed and replaced for routine maintenance according to its maintenance schedule which is part of the manufacturer recommendations, and available replacement inventory.

2.2.1 Sensor Malfunctions in HMP Style Probes

If the sensor is reading incorrectly (i.e. data do not fall within acceptable ranges measured by the standard):

- The HMP humidity and temperature probe head is removed from the field and brought back to the lab for a calibration check.
- First the necessary information is documented such as the model and serial number and inputted into the electronic calibration document.
- The head is connected to a probe interface which is wired to a calibrated CR10X on the lab test panel.
- The data from the HMP is recorded on the data logger and is manually checked and recorded in the electronic calibration document.
- The data from the HMP is compared to the calibration equipment and is evaluated in conjunction with acceptable variance in accordance with the manufactures guidelines.
- The HMP filter head is cleaned or replaced.
- The temperature is checked first; if the temperature sensor malfunctions, then the unit is sent to the vendor for repair/replacement. As a general practice, if a thermistor style temperature probe has more than one instance of erroneous readings, it should be sent in for replacement because these types of instruments can only be repaired by the manufacturer.
- After the temperature has been checked the RH is checked and adjusted by a technician in house if needed.
- A Performance Evaluation certificate is issued with the unit after it has passed the necessary criteria.

All calibration documentation is recorded and saved electronically and the sensors status is recorded into Provincial Stations as well as into inventory.

3.0 CALIBRATION PROCEDURES

These procedures have been developed specifically for equipment found within the Agriculture Climate and Drought Monitoring Network, variations of sensors and calibration equipment may differ but the basic check points and standard remain the same.

It is recommended that each HMP is field checked biannually and is calibration checked every 4 years or when the reading does not match the standard field unit (acceptable ranges: ± 0.5 °C for air temperature and ± 5 % for RH).

3.1 Calibration Equipment

The following procedures are to be used when calibrating HMP probe heads using a Sika (SIKA 2014) precision temperature calibrator and HMK15 humidity calibrator (Figure 3). These calibrations are carried out using a CR10X data logger to log the data:

- These techniques can also be used to calibration check various Field Standard Units.
- Calibrations have been successfully carried out on Standard Unit Models HMP45/HMI41 and HMP75/HM70.

- The limitations for accurate calibration checks depends on the type and dimensions of the field Unit, adjustments can be made but the calibration equipment is specific to the 45CF and 45C212 HMP models.
- A computer with serial port is required to run both the Loggernet for the CR10X logger and TPxxScan program for the Sika Temperature Calibrator.

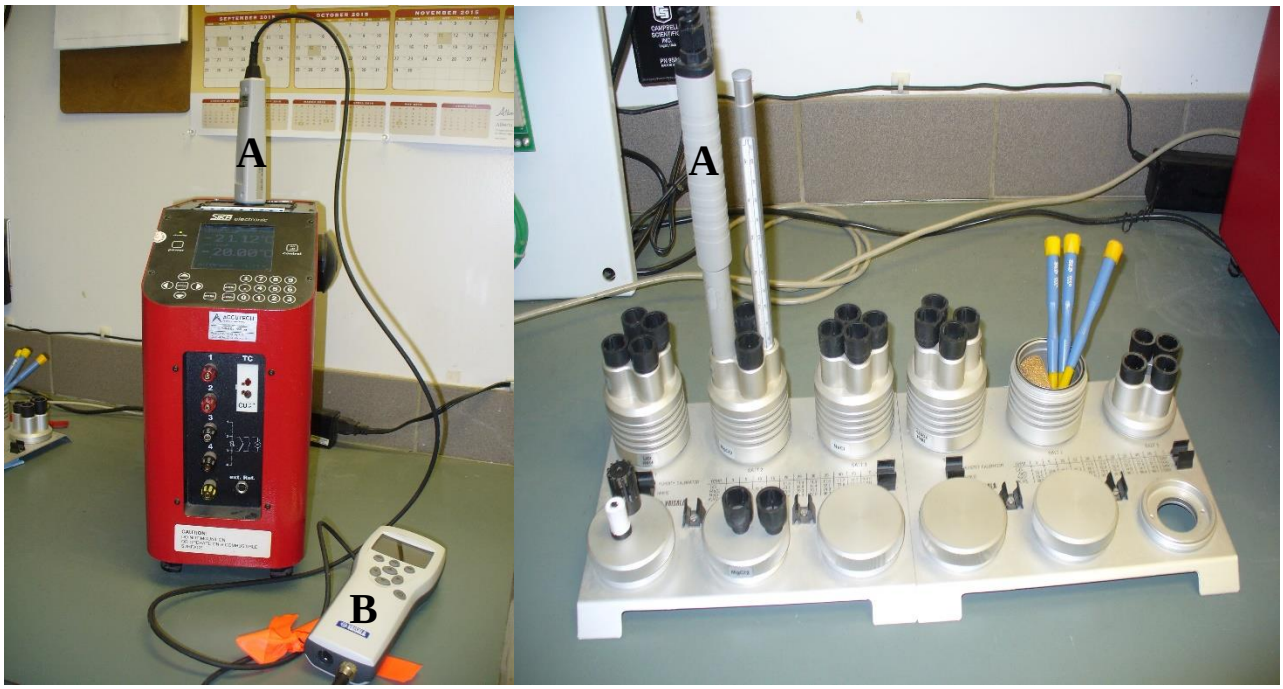

Figure 3. Sika Model Dry Block Temperature Calibration Chamber (Left) and Vaisala HMK15 Humidity Salts Chambers (Right): (A) HMP Probe (B) Display.

3.2 Temperature Calibration Check Procedure

The Sika precision temperature calibration unit is programmed with seven set temperatures (-30, -20, -10, 0, 10, 20, 30 in °C). Each temperature is held for fifteen minutes and the data is recorded by the CR10X data logger and spot checked manually by a technician. If the unit's output is within the acceptable range (± 0.5 °C), then the data is recorded on the performance evaluation certificate and then the RH is checked. If the temperatures are out of the acceptable range, the unit is sent out for repair or replacement.

- Connect the HMP to be tested to the test panel logger.
- Remove the filter from the HMP head and replace it with the gold filter cap and place into the Sika Calibration unit.
- Send the appropriate program for the HMP model being tested to the data logger (HMP45CF or HMP45C212).
- Disconnect the computer from the logger and connect a key pad to read out the HMP temperature from the logger.
- Connect the Sika calibration unit to the computer with the serial cable and turn the unit on.
- Open the TPxxScan program on the computer and click the ok button:
    - Select Program - Settings
    - In this menu select the C:\ folder -_LOCALdata - Sika - Test
- In the test unit column select Com port 1 and highlight the TP3800 and click the receive button, this will connect the Calibration unit to the computer.

- Now select the functions option in the main screen and the temperature steps option.
- Select the "Change test points" button and change the temperature interval to 10.000 and the number of steps to 7.
- Click the calculate button and the points to the right of the screen should change to -30, -20, -10, 0, 10, 20, 30.
- Now select "Ok" and "Yes" to save changes.
- Select the Start button on the left of the window.
- Select Start in the input test data window (information will be in German).
- The unit is now set to run the temperature step test, the HMP temperature values will need to be checked, recorded and accepted manually by a technician.
- All information is to be recorded in the ECD (electronic calibration document) including times and HMP readings from the Keypad display.
- A Performance evaluation certificate will be automatically generated with the information inputted into the ECD (electronic calibration document).
- Save the ECD to the internal shared drive.

3.3 Relative Humidity Calibration Procedure

The HMK15 humidity calibrator is used to check the RH output of the HMPs (Vaisala 2006). There are four chambers. Each of the four different salts has a known RH at room temperature: LiCl - 11.3 %, $MgCl_2$ - 33.1 %, NaCl - 75.5 %, K_2SO_4 - 97.3 %. The HMP sensor is left in each chamber for at least 15 minutes to stabilize before it is manually recorded by a technician, as well as being recorded by the CR10X data logger. If the sensor does not read in the acceptable variable range (± 5 %), it can be adjusted to acceptable standards. The before and after adjustment reading is recorded on the Performance Evaluation certificate.

- Connect the HMP to be tested to the test panel logger.
- Remove the filter from the head and set aside for cleaning if necessary.
- Send the appropriate program for the HMP model being tested to the data logger (HMP45CF or HMP45C212).
- Use Loggernet to display both the temperature and RH of the unit being tested.
- Insert the HMP head into the first salt chamber, as well as the calibration thermometer (they should both fit snugly into their respected cavity when the rubber stopper is removed).
- Allow for 15 minutes settling time before taking an RH reading, repeating for a total of three readings (15 minutes apart) in each chamber.
- Record all readings including the time, temperature and RH in the electronic calibration document.
- Clean and lightly grease the O-ring on the HMP if needed.
- A Performance evaluation certificate will be automatically generated with the information inputted into the ECD (electronic calibration document).
- Save the ECD to the internal shared drive.

4.0 ACKNOWLEDGEMENTS

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