**Lab Assignment 4. Measuring Precipitation**

**Objective**: Become familiar with the principles of precipitation measurement and operation of tipping bucket and snow depth sensors.

**Timeline: Feb. 6.** Take down weather station and make snow density measurements. **Feb. 8.**  Lab 4 prelab due. Lecture on measuring precipitation and begin Lab Assignment 4. **Feb. 13.** Turn in Lab 3 assignment. Continue Lab 4. **Feb. 20.** Turn in Lab 4 assignment.

**Before the Feb. 8 Lab Session**

1. You must complete the preliminary assignment for Lab 4 by 10 AM Feb. 8. That includes entering the snow density observations completed on Feb. 6.
2. **Read through the entire assignment so that you understand what is being required. Ask questions, if things don’t make sense.**

* Read through Chapter 4 section on measuring precipitation.
* The same program is used for both sensors. Look at the code in the prelab assignment: precip\_lab\_2012.cr1
* Participants will be broken into 6 groups. The groups will rotate through the two areas: tipping bucket and Judd Communications depth sensor.

1. **Area 1. TE 525 Tipping Bucket**
   * Reboot the laptop for this area. Create a folder on the netbook using your names
   * Make sure the precip\_lab\_2012.cr1 is on the desktop and copy it into your folder
   * Check battery voltage.
   * Use Loggernet to connect to the CR1000 and send the program.
   * Click on the Custom download option. Change the Collect Mode to “All the Data”
   * Change the File Mode to “Overwrite Existing File”
   * Select Change File Name and create a file in your folder
   * Select “Start Collection”
   * You should now be able to go and open that file with Wordpad or Notepad. Do so.
   * From LoggerNet, select from the Data tab: View Pro
   * From the File menu, select open and open the file you created
   * Highlight the Rain column and select Line graph. You’ll come back later and monitor your output.
   * At this point, you are ready to assess the accuracy of the tipping bucket rain gauge
   * Fill the cylinders or bottles with 150 ml of tap water. Pour very slowly the water into the bucket
   * Upon completing the calibration procedure, carefully remove the funnel. If there is still water left in the bucket, use the syringe to determine how many additional milliliters of water are needed to produce another tip of the bucket. In many cases, the amount of water needed will be two or three milliliters. Add the water slowly from the syringe, one milliliter at a time, allowing time for the water to drop into the bucket before adding the next milliliter of water. Count the number of milliliters of water as they are added, until the bucket tips.
   * Repeat a couple more times
   * *Question.* How do the number of tips compare to that expected from your calculations in the prelab?
   * *Question.*What might explain any discrepancies between the expected values and what was observed?
2. **Judd Communications depth sensor**

* Reboot the laptop for this area. Create a folder on the netbook using your names
* Copy the precip\_lab\_2010.cr1 from the Desktop into the folder on the laptop.
* Check battery voltage.
* Use Loggernet to connect to the CR1000 and send the program.
* Click on the Custom download option. Change the Collect Mode to “All the Data”
* Change the File Mode to “Overwrite Existing File”
* Select Change File Name and create a file in your folder
* Select “Start Collection”
* You should now be able to go and open that file with Wordpad or Notepad. Do so.
* From LoggerNet, select from the Data tab: View Pro
* From the File menu, select open and open the file you created
* Highlight the Depth column and select Line graph. You’ll come back later and monitor your output.
* At this point, you are ready to assess the accuracy of the depth sensor under varying conditions.
* Measure the distance from the sensor to the floor. Mark with tape the location immediately below the sensor. Using your results from the prelab, mark with tape the boundaries of the sensors viewing area based on the beamwidth of the sensor. Fill in the following table based on results collected from at least 3-4 observations for each case.
* *Question.* Fill in the following table assessing the accuracy of the sensor

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Observations | No objects in field of view | Large Cylinder directly under sensor | Large Cylinder halfway from sensor to beam width bounds | Large Cylinder at beam width bounds | Your choice |
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| 3 |  |  |  |  |  |

* *Question.* Loosen the depth sensor mount from the tower and measure the distance from the sensor to the floor for various depths. Collect several observations at each depth. Graph the data (x axis expected depth , y axis observed depth)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Observations | Temperature (C) from Judd sensor | Depth 1 | Depth 2 | Depth 3 | Depth 4 |
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| 3 |  |  |  |  |  |
| 4 |  |  |  |  |  |

* *Question.* Summarize the data collected on the accuracy of the depth sensor as a function of varying expected depth, wind speed, and different obstacles within the field of view.

**Project Report. Laboratory Assignment 4. Due Feb. 20. Must be submitted as a pdf into Canvas.**

**Your Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Group Member Names \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Restate the lab objective in your own words. Do not repeat verbatim.**

*Question 1*. As part of the assignment, you must complete the quiz for the COMET module: <http://www.meted.ucar.edu/hydro/precip_est/part1_measurement/>

This requires sending the quiz results to me. The steps for this will be reviewed in class. This will require quite a bit of time.

*Question 2.* How do the number of tips from the tipping bucket compare to that expected from your calculations in the prelab?

*Question 3.*What might explain any discrepancies between the expected values and what was observed from the tipping bucket?

*Questio 4.* Fill in the following table assessing the accuracy of the sensor

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Observations | No objects in field of view | Large Cylinder directly under sensor | Large Cylinder halfway from sensor to beam width bounds | Large Cylinder at beam width bounds | Your choice |
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| 3 |  |  |  |  |  |

*Question 5.* Loosen the depth sensor mount from the tower and measure the distance from the sensor to the floor for various depths. Collect several observations at each depth. Graph the data (x axis expected depth , y axis observed depth)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Observations | Temperature (C) from Judd sensor | Depth 1 | Depth 2 | Depth 3 | Depth 4 |
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |
| 3 |  |  |  |  |  |
| 4 |  |  |  |  |  |

*Question 6.* Summarize the data collected on the accuracy of the depth sensor as a function of varying expected depth, wind speed, and different obstacles within the field of view.