WORLD METEOROLOGICAL ORGANIZATION

CIMO/SPICE-IOC-4/Doc. 3(1)
(6.VI.2013)

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

ITEM: 3

INTERNATIONAL ORGANIZING COMMITTEE (IOC) FOR THE WMO SOLID PRECIPITATION INTERCOMPARISON EXPERIMENT (SPICE)
Fourth Session

Original: ENGLISH

Davos, Switzerland
17 – 21 June 2013

SITE REPORT FOR BRATT'S LAKE (CANADA)

(Submitted by Craig Smith)

Summary and purpose of document

This document provides site report of Bratt's Lake (Canada) for the 2012/2013 winter.

ACTION PROPOSED

The Meeting is invited to take this information into consideration when deciding on necessary modifications and clarifications on the overall set-up of the experiment and procedures to be followed to ensure best quality observations are collected on all sites and appropriate coordination and data transfer mechanisms are implemented.

Site Report: IOC-SPICE-4

Site: Bratt's Lake (Canada)

Date: June 17, 2013

1. Site layout

See Addendum 1

2. Configuration of references:

Covering: gauge used, heating (hardware, algorithm), sampling strategy, physical configuration (height, shields, etc):

Reference type	Gauge	heating	shield	Data sampling interval	Sampling strategy	Output interval	Height of the rim
R1							
R2	Geonor	USCRN	Alter	20 sec	Frequency	1 min	3m
R2	Geonor	unheated	Alter	1 min	Frequency	1 min	3m
R3	Geonor	USCRN	Alter	20 sec	Frequency	1 min	2m

3. Changes made during the season 12/13, if any.

No changes were made to the reference systems after Dec 14th, 2012. Although data is available from the systems back to Nov 1st, 2012, the R3 reference gauges did not fully come on-line until Dec 14th when the heaters were added. Note that a field calibration of approximately 500ml was made on March 27th starting at approximately 1930 UTC.

4. Issues: heating, data quality, vibrations, capping;

1)R2: a)VW2 intermittent depending on temperature. This problem is perennial but only occurs when Ta < -5 deg C and is VERY hard to diagnose. Even though efforts were made to change the system completely, the problem persists. b)VW3 is somewhat more noisy than VW1.

2)Geonor 1500mm gauge under test: This guage appears to have more noise than the other gauges operated at the site.

3)Freezing rain: there were occurrences of freezing rain at the site in early November. The heated gauges appear to have measured the events correctly but there are documented issues with the unheated sensors during these events.

4)Sample frequency: Because of the number of Geonor gauges being used at this site, and because of the reluctance to move away from frequency sampling of 1500 cycles, a 6 second sampling rate was not possible due to program time-out issues. For this reason, the 2012/2013 season was sampled every 20 seconds with output of the average occurring once per minute. A solution to this is being examined for the 2013/2014 season. Because communications on-site were limited by the use of digital cellular modems, it was decided not to try to keep the high frequency data but rather just collect the 1 minute data. A solution to this is also being examined.
5)Mast Vibration: all of the SPICE Geonor gauges at this site have shields attached to the pedestals as designed by Geonor. This may cause some additional vibration and noise in the signal but we were reluctant to engineer and re-install the wind shields at the site going into the winter collection season.
6)Instrumentation not installed: Due to the early onset of winter conditions at the site in mid- to late-October and due to the late delivery of some of the equipment from the manufacturers, not all of the equipment was installed at the site for the 2012/2013 season. The MRW500 precipitation gauges from Meteoservis in the Czech Republic were not installed. Other supplementary instruments, such as an optical disdrometer and the web camera, were also not installed prior to the 2012/2013 season. These instruments are planned for the 2013/2014 season.
7)Blowing snow: The site experienced a tremendous amount of blowing snow after mid February and throughout March and April. This was due to much higher than average snowfall during the winter combined with high wind speeds during events in February and March. It was observed that snow banked underneath and inside the West DFIR (with the unheated R2) and was more than 1m deep underneath many of the 2m gauges. Caution is required during analysis of this data.
8)Evaporation: as an experiment, we tried to use transmission fluid rather than motor oil on top of the bucket contents to prevent evaporation. We noticed increases amounts of evaporation in November due to this change. We expect to convert back to lighter weight motor oil to prevent this in the future.

5. Heating report:

i. Summary of configurations throughout the winter of 12/13:
   a. Hardware:
      i. The heated R2 and R3 Geonor references on site utilized the USCRN heating algorithm, adjusted for SPICE, using the USCRN style heater.
      ii. Each heater was powered with its own 12V power supply connected to an AC power source.
   b. software:
      i. upper limit temperature: +2 deg C (Ta and Rim)
      ii. lower limit temperature: -5 deg C
      iii. heating interval: 20 sec

iv. other factors considered: Rim temperature was logged at 1 minute resolution. Heating "switch control" was also logged at this resolution showing 1 when the heater was turned on at any time during the 1 minute period.

ii. Summary of changes made during the season: none after installation of R3 heaters on Dec 14, 2012.
iii. Effects noted: some analysis was performed to examine the advantage/disadvantage of heating gauges in a cold, dry environment. Some of the advantages were obvious while disadvantages, if any, were subtle. Some results shown in Addendum 2.
iv. Capping: some possible "clinging" of snow to unheated gauges, some definite delay in the measurement signal of unheated gauges during freezing rain events
v. Changes needed for the future: None required or anticipated at this site
vi. Provide pictures: web cam will go online before the 2013/2014 season
vii. Any other topic of challenge with impact on data, specific to your experience: none

6. *What has worked well;*

Overall, the site worked well this year with the exception of the issues noted above in Section 4. Trouble shooting was hampered in October and November due to some bad weather and a very early onset of winter. The site received at least 200% of normal snowfall this season so there should be some great data for intercomparison.

We found through experience that each gauge heater requires its own DC power supply (minimum 3A) to effectively operate the heaters. Because the pedestals each have their own AC power, this reduces the number of conductors leading back to the logger.

7. *What has not worked that well: lessons learned;*

Besides the issues noted in Section 4, it is unfortunate that some of the supplementary instrumentation, such as the optical disdrometer and the web camera, did not get installed before winter as these would have obviously aided analysis. Also, this was the first winter operating the site unmanned so this presented some maintenance challenges.

8. *Data available:*

i. # of days of data collected for each sensor on site: Since Dec 14, 2013—Heated R2, Unheated R2, R3 pair, Geonor 1500mm, Temp, RH, 2m Wind Speed and Direction, Surface Pressure, DRD11A precip detector. Since Nov 1, 2013—Heated R2, Unheated R2, R3 pair (heaters not turned on until Dec 14), Temp, 2m Wind Speed and Direction, Surface Pressure, DRD11A precip detector
ii. Data transmitted to NCAR: Daily data since Dec 14, 2013 includes Heated R2, Unheated R2, R3 pair, Geonor 1500mm, 2m Wind speed and Direction, 1.5m Temp/RH, Surface Pressure, 3m Wind speed (inside DFIR inner fence), rim temperatures, DRD11A precip detector voltage, Rim Heater On/Off
iii. Data QC'd: none
iv. Issues in data: March 27 calibration test (approx 25mm or 500ml) not removed

9. *Instruments under test: list, issues*

- Have you had problems with the instruments under test?
  - Geonor 1500mm gauge noisier than other Geonor gauges
- Have all instruments allocated to your site from Instrument Providers, been installed?
  - MRW500 Meteoservis gauges not installed
- Has the data been shared with the Instrument Providers?
  - Instrument providers have been notified of availability of data but none have expressed interest to date in receiving the data.
- Have any of them visited the site?
  - No

10. *Information on the Precipitation Detector(s) used;*

DRD11A

Instrument installed in late October above logger box location (see Addendum 1) at a height of approximately 3m. Cursory examination of the data suggests that the sensor is missing a substantial amount of precipitation occurrence. Much more analysis is required but it would appear that the sensor is not heating enough to melt and register cold, dry hydrometeors at low temperature and moderate to high wind speeds.

Thies and Parsivel optical disdrometers are planned for the site.

11. Commissioning:

- Date: Dec 14, 2013
- configuration at commissioning: nearly complete installation, missing some supplementary instrumentation and MRW500 precipitation gauges as notes above
- Availability of report: completion prior to meeting in Davos.

12. Results to date:

Although some Bratt's Lake data has been provided and used by the DAT team for noise analysis, the most significant analysis to date has been the work completed to examine the advantages/disadvantages of rim heating in this cold and dry environment. This analysis was accommodated with two similar DFIR-type wind fences each housing a Geonor T-200B, one heated and one non-heated. Preliminary results were presented at the 2013 CMOS/CGU/CWRA joint meeting in Saskatoon (May 26-30th) and summarized in Addendum 2.

13. Interaction Site manager and the IOC and Project team

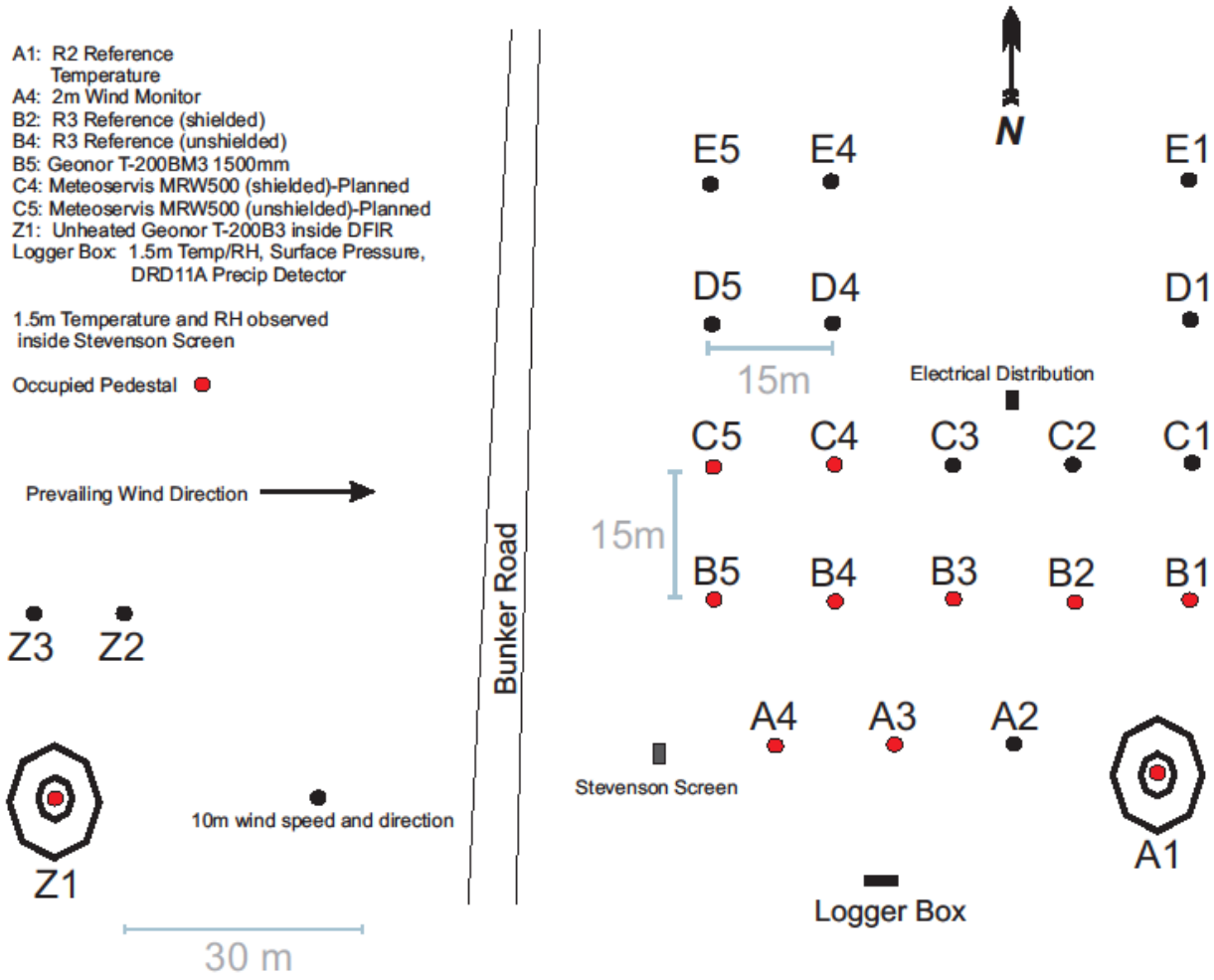
As site manager for the Bratt's Lake site, Craig Smith has been participating in most of the scheduled teleconferences and attended the last SPICE workshop in Boulder (June, 2012). He is also a member of the DAT.

14. Small things, big impacts?

One of our biggest regrets was not being able to operate the web camera at the site last winter. It was anticipated that the web camera would be extremely useful in identifying capping/icing/clinging events as well as potentially qualifying drifting and blowing snow events. Planning for the web cam was delayed for various reasons and could not be installed before the onset of winter but will be a great asset for the next accumulation season.

Addendum 1

Bratt's Lake Site Layout



Addendum 2

Summary of preliminary results of the advantages and disadvantages of gauge rim heating in a cold and dry environment

Project Summary:

As part of pre-SPICE and continuing into SPICE actual, two DFIR-type wind fences were used to intercompare two measurement methods relevant to designating a reference configuration for SPICE. As shown in the site diagram in Addendum 1, an unheated Geonor T-200B was operated at location Z1 on the west side of the intercomparison compound. A second heated Geonor was operated at A1 on the east side of the compound, separated by approximately 125m.

The study period for analysis is Nov 1 2012 to Feb 15 2013. Accumulations for the 2 gauges are shown in Figure 1 (Heated in red, Unheated in blue, and Heated minus Unheated in magenta). Twenty events were identified for closer examination and are shown overlain on the Heated accumulation line in green.

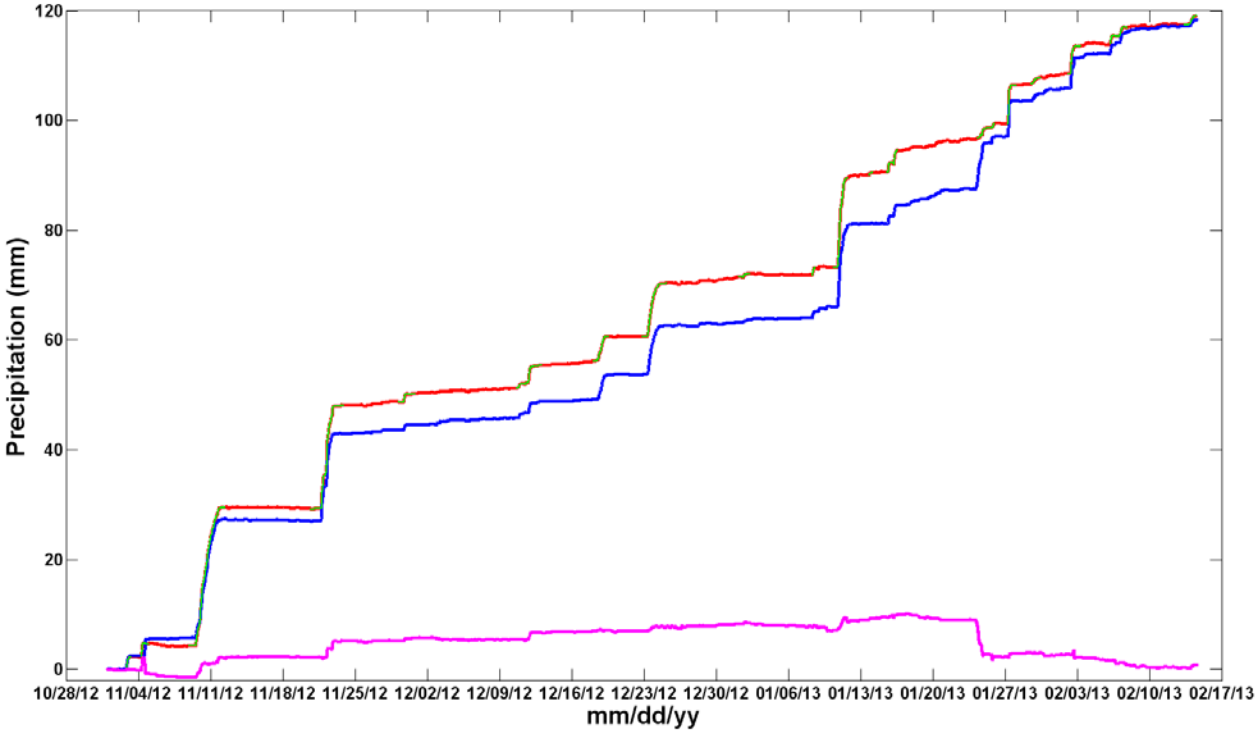


Figure 1: Zeroed accumulation for the Heated (red) and Unheated (blue) R2 reference gauges at Bratt's Lake from Nov 1 2012 through Feb 15 2013. Heated minus Unheated shown in magenta and 20 identified case studies marked in green.

At the end of this accumulation period on Feb 15th, the two gauges have accumulated almost exactly the same amount of precipitation. When the 20 events are accumulated (Figure 2, inset), the Heated gauge shows a catch of about 4% more than the Unheated gauge (even less if factoring in the March 27 field calibration information). However, as the magenta line shows, there are large differences in individual events and the difficulty is in determining the cause of these differences.

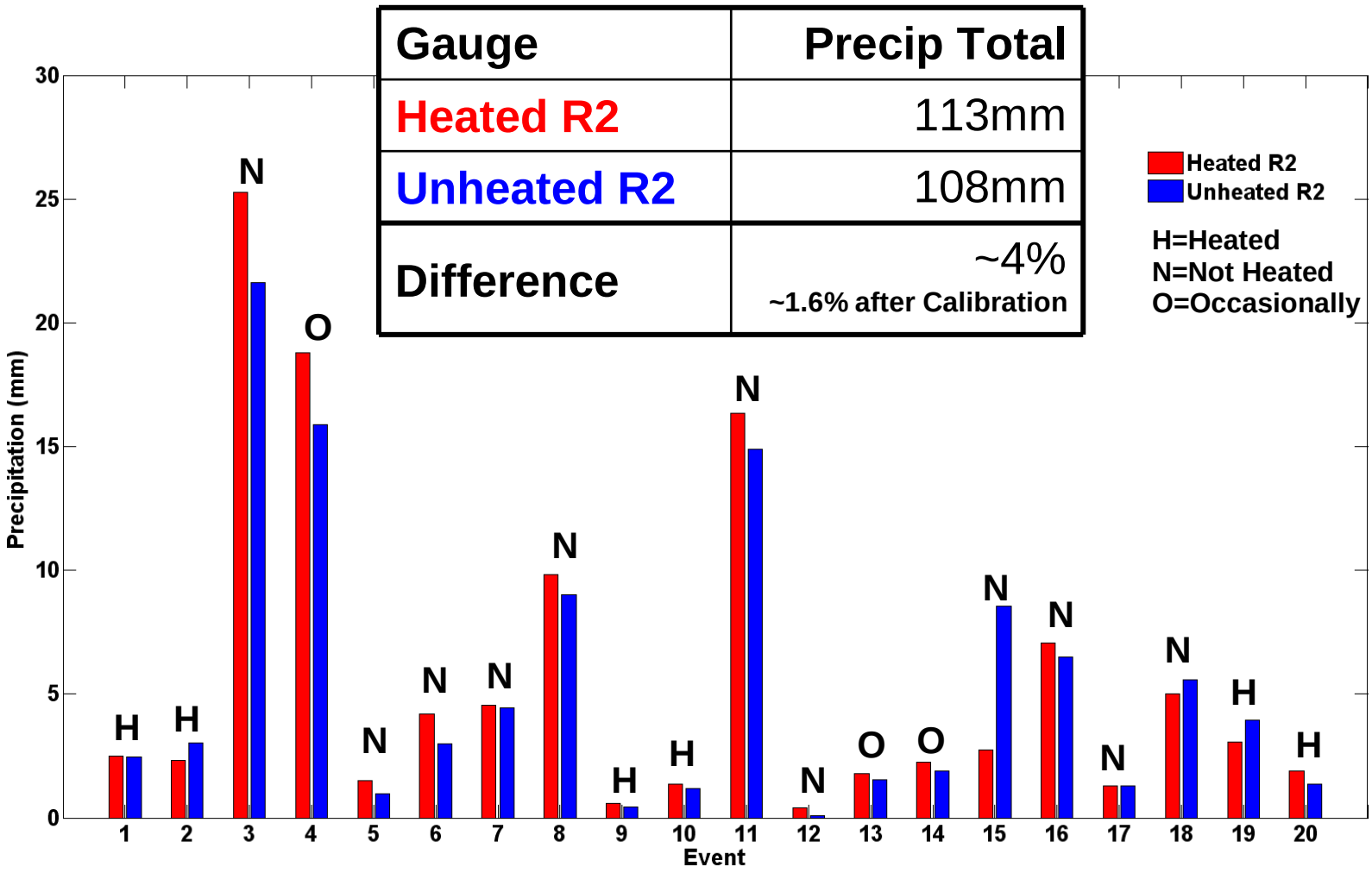


Figure 2: Event intercomparison.

When binned into heated and unheated events, some differences in catch become apparent. During heated events, the Heated gauge catches approximately 6% less than the Heated gauge but during non-heated events, catches about 5% more than the Unheated gauge. This only suggests that a closer analysis of the individual events is required for a proper assessment.

Case Studies:

Figure 3 shows event #1 which is a heated event with very little difference between the catch of the Heated and Unheated gauge. Wind speeds are low (< 4 m/s) and temperatures range from -4.0 to -1.5 deg C. Very little difference in the accumulations during this event suggests that the heater has very little impact on the catch of the gauges during these conditions. However, since temperatures are relatively mild, the snow hydrometeors likely had higher water content with faster fall speeds which would in turn reduce the possible negative impacts caused by heating.

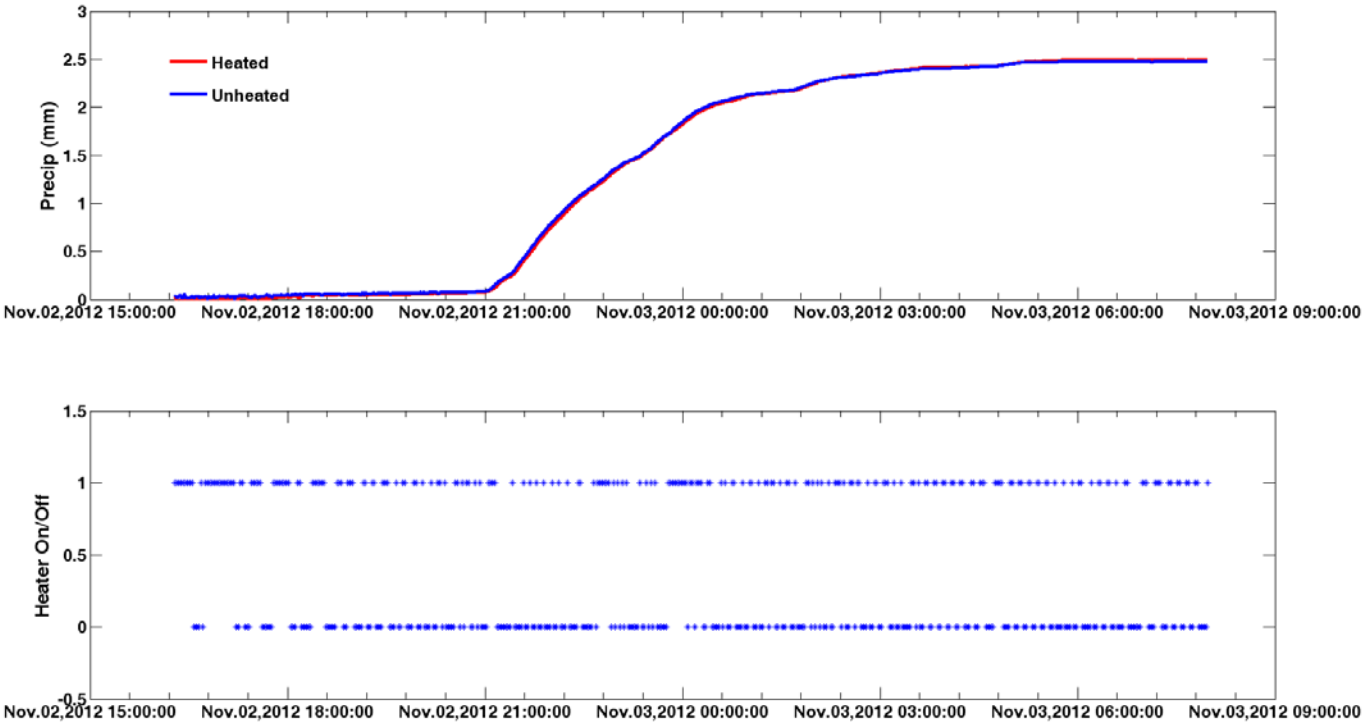


Figure 3: Event #1, Nov 2-3, 2012

Figure 4 shows event #2 that occurred November 4, 2012. This event included freezing rain (as observed at the Regina Airport, 30km NE of the site) and shows a definite advantage of rim heating during this type of event. The delay in response of the unheated gauge corresponds perfectly to the air temperature rising above 0 deg C and the subsequent melting of ice off of the unheated rim that then fell into the bucket. The question remains why the Unheated total at the end of the event is higher than the Heated total. Could evaporation or chimney effect cause this discrepancy between the Heated and Unheated gauges?

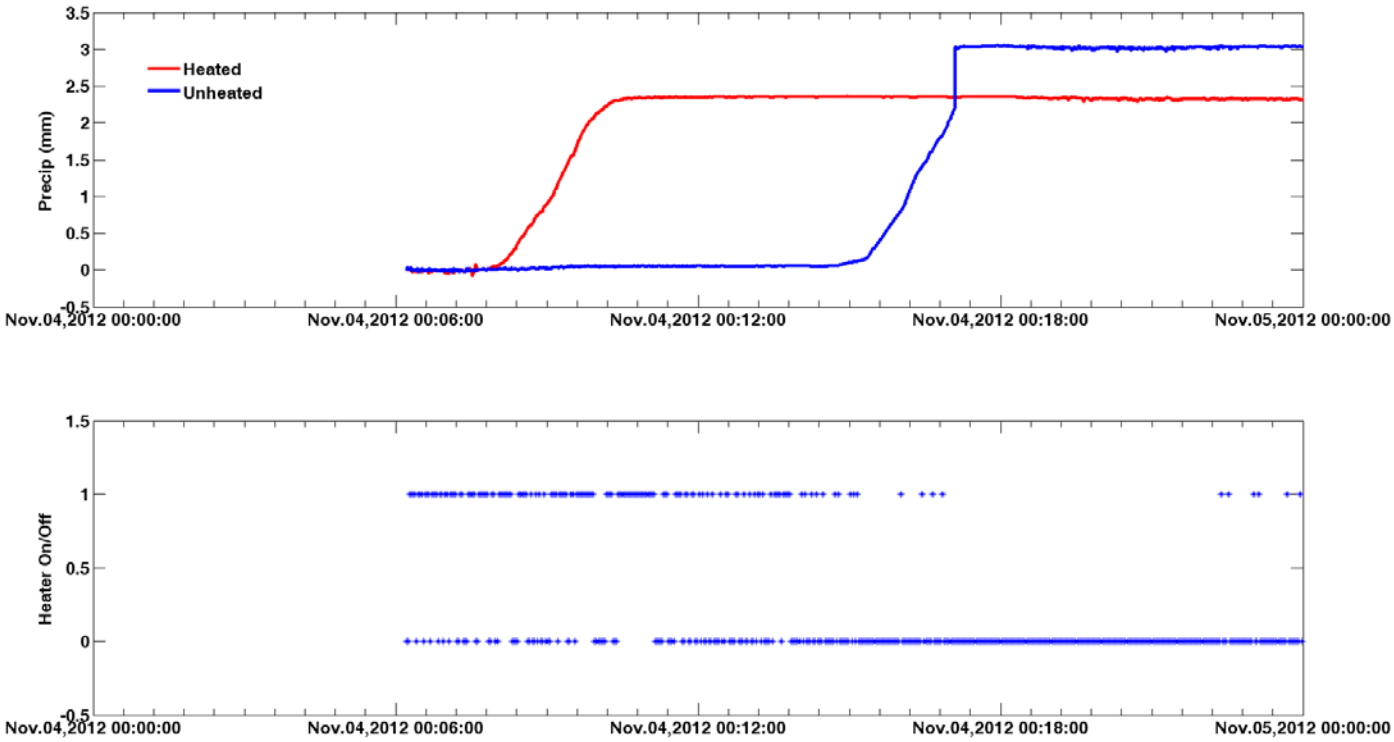


Figure 4: Event #2, Nov 4, 2012

Event #3 (Figure 5) is a non-heated event with relatively high wind speeds (up to 11 m/s at 2m) and lower temperatures (temperatures drop from -5 to -20 deg C during the event). The difference in catch between the Heated and Unheated gauge is not be caused by heating but more likely due to differences in catch related to small differences in wind bias and/or blowing snow. This illustrates the difficulty in isolating and assessing any errors that may be associated with heating.

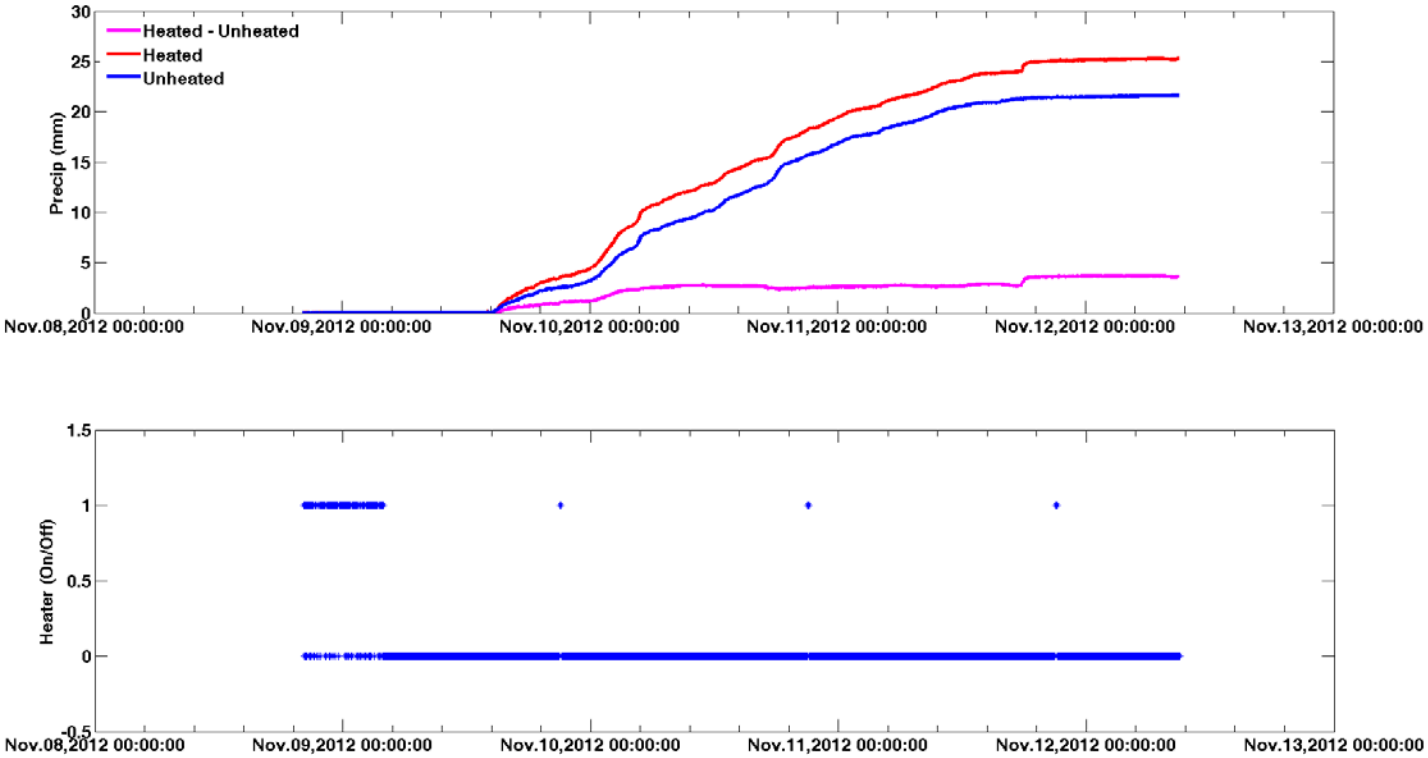


Figure 5: Event #3, Nov 9-12, 2012

Event #4 is shown in Figure 6. This is an occasionally heated event with only the heated sub-set of the event shown here. This event occurs Nov 21-22, 2012. Wind speed at 2m is relatively low varying from 0 to 4.5 m/s. Temperatures range from -6 to -1 deg C. Small differences can be seen in the collection of snow from the Heated and Unheated gauges that are likely not due to wind bias or blowing snow. The difference has a maximum of 7% (of the Heated gauge amount). Although it is difficult to determine if this is an impact of heating, the Unheated gauge does catch more snowfall than the Heated gauge although the difference is only 1% by the end of the event.

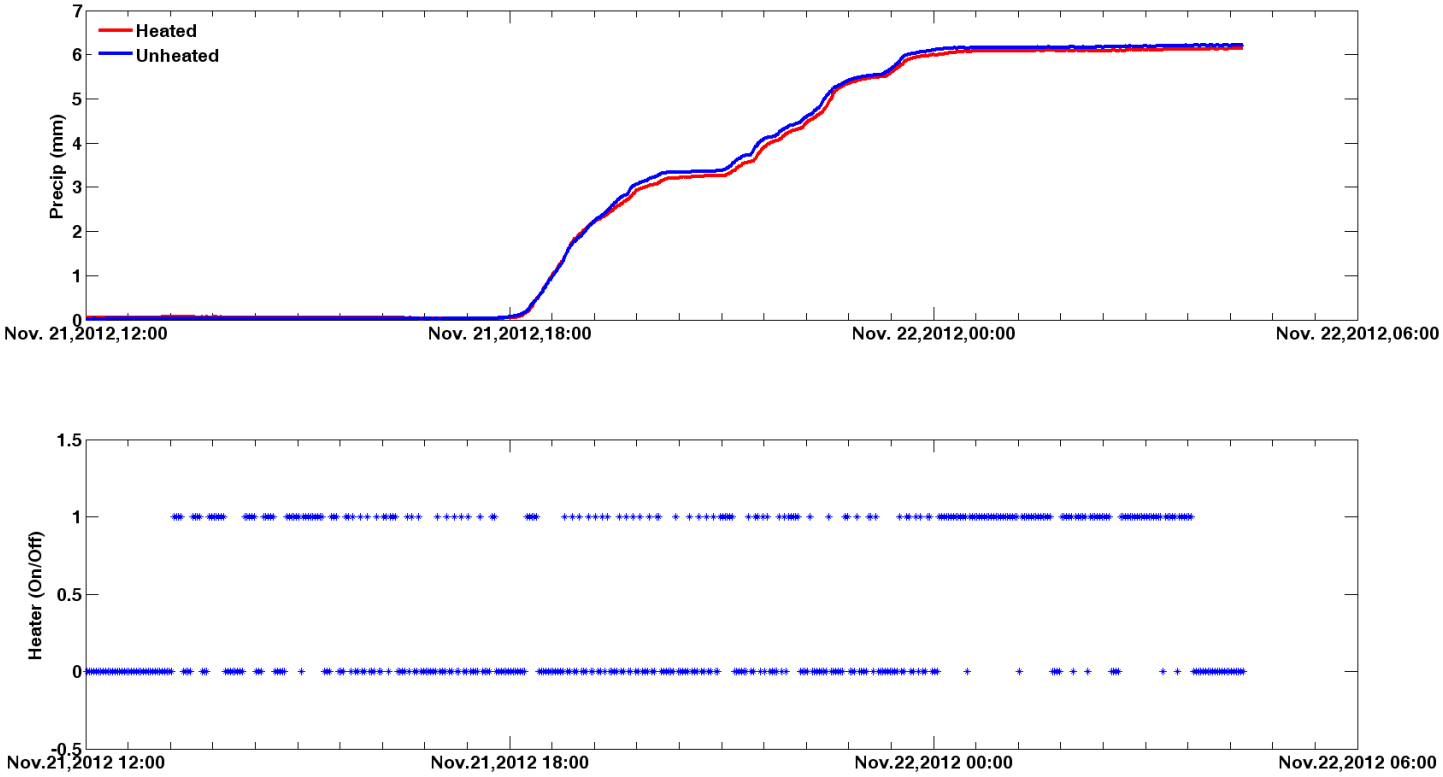


Figure 6: Event #4, Nov 21-22, 2012.

Conclusions:

Only the first 4 of the 20 events shown in Figure 2 are discussed briefly here and further analysis is obviously required. From the case studies shown, there are obvious advantages to heating precipitation gauges, even in this cold and dry environment. It is difficult to assess any negative influences that heating has on gauge catch since these negative influences are often masked by other factors that create more substantial bias, such as wind undercatch and blowing snow. However, negative impacts of heating, although likely small, can not be ruled out.