P1.10 Improved Accuracy in Measuring Precipitation with the NERON Network in New England

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1. INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) established NOAA's Environmental Real-Time Observation Network (NERON) in 2004. NERON sites in New England use a GEONOR weighing gauge to record precipitation accumulation. The GEONOR gauge uses three vibrating wires to determine the amount of precipitation in the bucket. Quality assurance personnel in the NERON office currently employ two procedures to ensure the highest quality data possible from the GEONOR gauges: (1) data processing uses the latest U.S. Climate Reference Network (USCRN) algorithm (Baker et al. 2005) and (2) staff compare precipitation accumulation amounts from NERON sites to storm-total radar estimates and manual Cooperative Observer (COOP) reports on a daily basis.

2. AUTOMATED PROCESSING

The original NERON datalogger code used a first generation GEONOR algorithm developed for the USCRN to compute precipitation accumulation inside each station datalogger. The accumulation calculated by the datalogger was reported by the site for dissemination to users. Because sensitive vibrating wires were used, the GEONOR required a solid foundation. Limitations of the first-generation algorithm and numerous unstable foundations caused many reports of erroneous precipitation at New England NERON stations. Figure 1 illustrates a false precipitation problem associated with all three vibrating wires reporting noise. In other instances, false precipitation was calculated because of noise reported by just one of the wires.

During the summer and fall of 2006, personnel at the NERON Operations and Monitoring System worked with field technicians to download a much improved, second-generation logger program to the sites, which changed the way precipitation accumulation is calculated. Instead of calculating accumulation in the datalogger, sites now report each vibrating wire frequency and precipitation depth at five-minute resolution. During post-processing, the three vibrating wire depths are passed through an automated Quality Assurance (QA) system designed to flag those values that meet any of the following criteria: (1) exceed manufacturer specified ranges, (2) are not consistent with like instruments (e.g., vibrating wire data from one wire do not match the data from the other two wires at the site), (3) are coincident with a technician visit, or (4) are manually flagged as erroneous by QA personnel. The QA system used to process vibrating wire data is modeled after the Oklahoma Mesonet QA system described by Shafer et al. (2000) and Fiebrich and Crawford (2001).

For the data that pass the QA process, the second-generation GEONOR algorithm calculates an 'official' five-minute accumulation. At the time of this writing, the new algorithm has significantly reduced the number of false precipitation reports across the New England NERON network. To generate a baseline value for each wire, the algorithm averages the previous two hours of wire depth data. If precipitation or an out-of-range value is observed during those two hours, the amount of data used is shortened to include only the observations since the last precipitation or out-of-range report. Next, the algorithm checks if the vibrating wire depth increased within a certain range by comparing the new value to the baseline value. If the increase is between 0.20 and 25 mm, the increase is determined to be caused by precipitation and data from each wire are compared to that from the other two wires. If the inter-wire comparison determines the wires are within 0.20 mm of each other, all wires are used in the final calculation. If the wires disagree with each other, the algorithm performs a high precipitation rate test. If all wires are flagged by automated quality assurance or if all wires do not pass the precipitation algorithm tests, precipitation accumulation is flagged as "warning".

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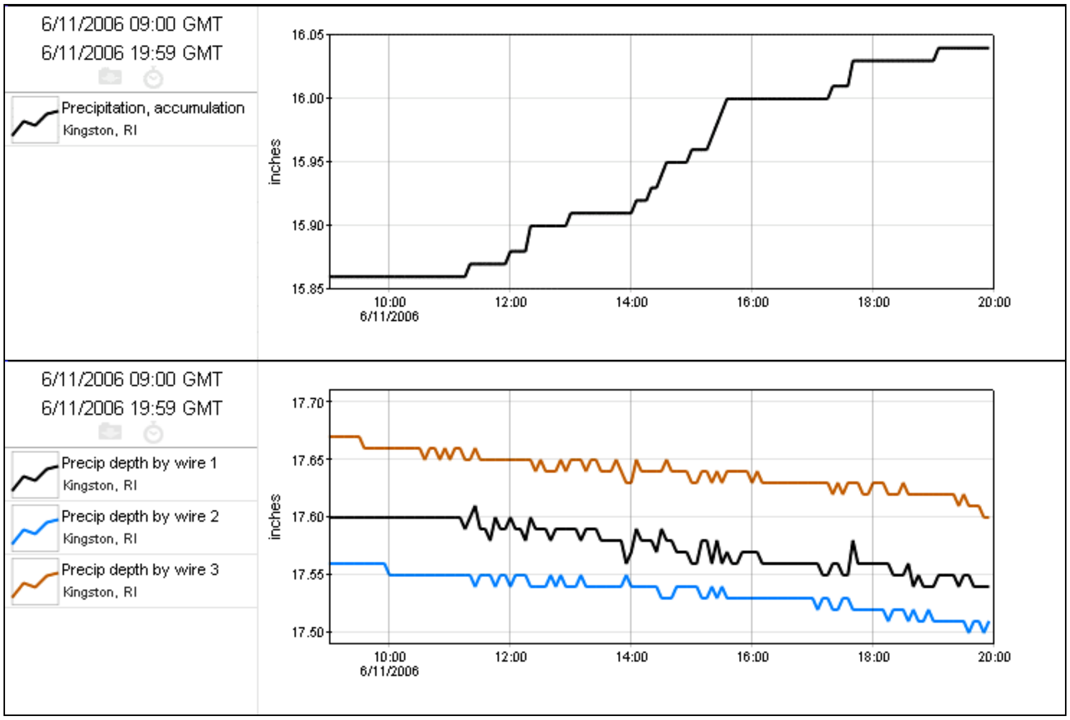

Figure 1: Time series plot of precipitation accumulation (top figure; inches) and vibrating wire depths (bottom figure; inches) for Kingston, RI using the first-generation GEONOR algorithm. Approximately 0.18 inches of false precipitation was reported during the period between 1200 – 1800 UTC on 11 June 2006 because of noise reported by the vibrating wires.

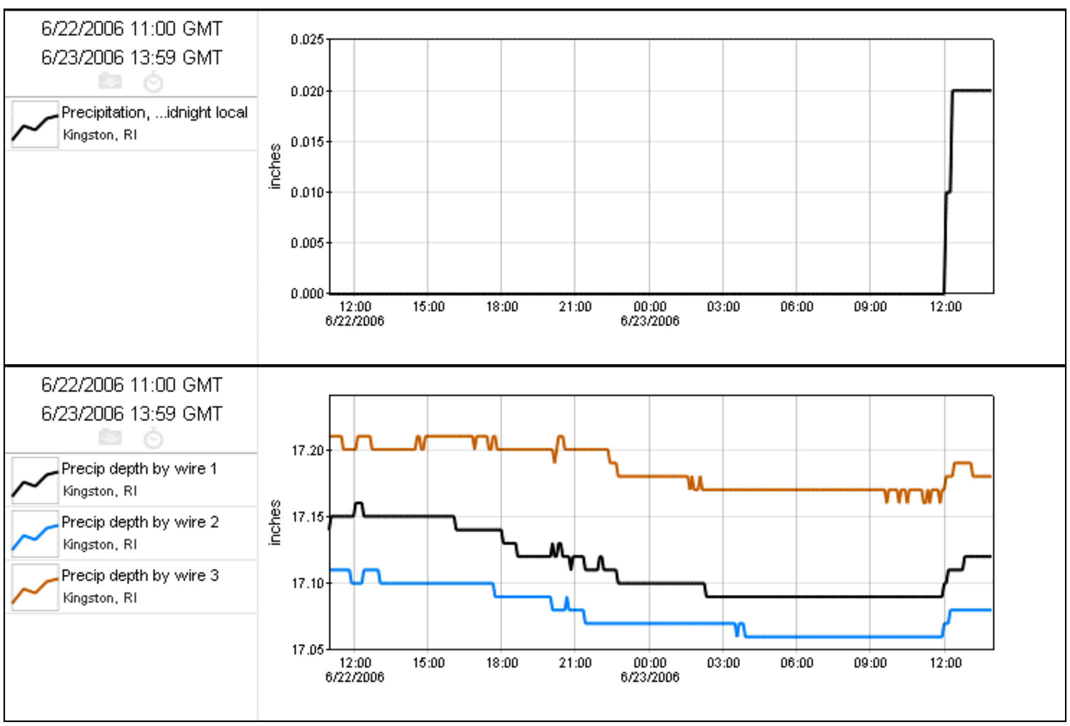

Figure 2: Time series plot of precipitation accumulation (top figure; inches) and vibrating wire depths (bottom figure; inches) for Kingston, RI using the second-generation GEONOR algorithm. Noise in the vibrating wires were not converted to precipitation accumulation until 1200 UTC on 23 June 2006 (i.e., which was when all three wires systematically indicated an increase in precipitation).

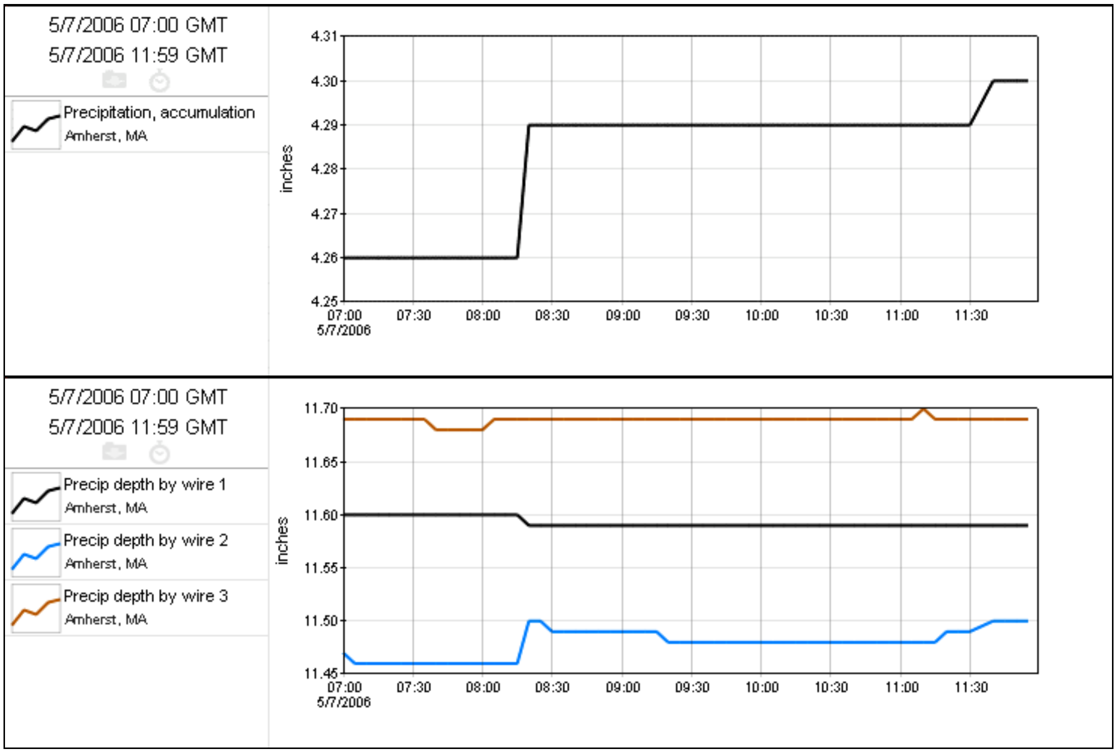

Figure 3: Time series plot of precipitation accumulation (top figure; inches) and vibrating wire depths (bottom figure; inches) for Amherst, MA using the first-generation GEONOR algorithm. Approximately 0.04 inches of false precipitation was reported between 0700 – 1200 UTC on 7 May 2006. The false precipitation resulted from noise reported by vibrating wire number 2 (blue line).

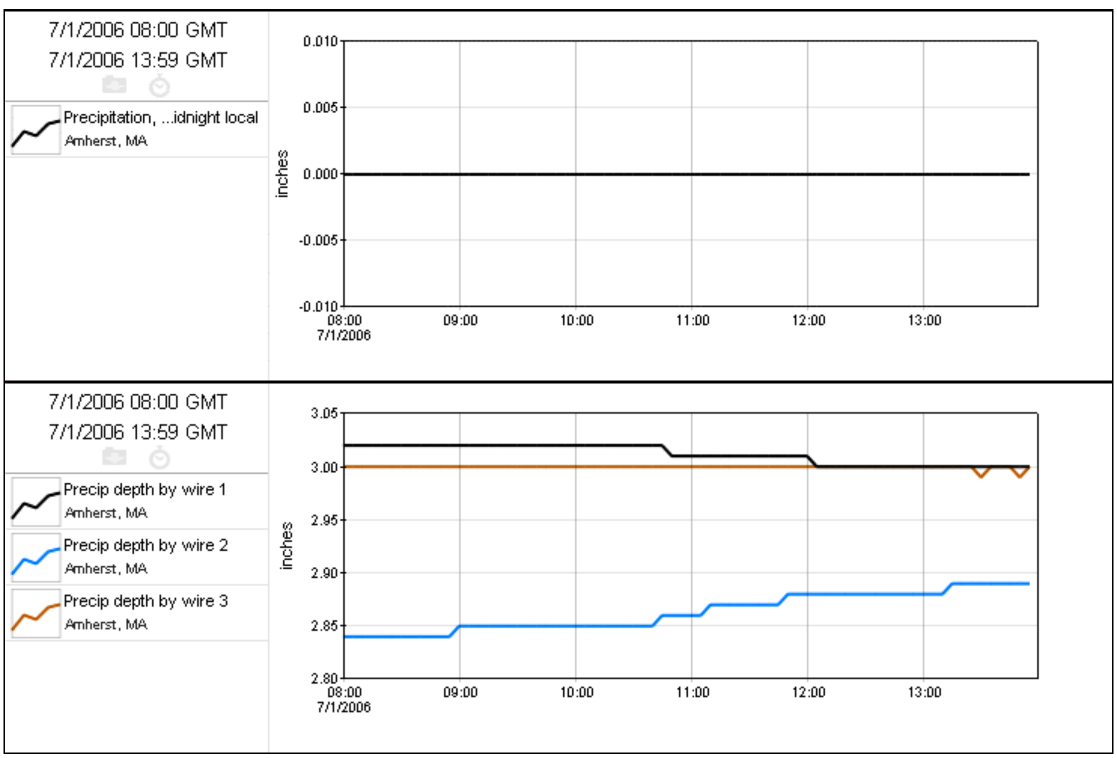

Figure 4: Time series plot of precipitation accumulation (top figure; inches) and vibrating wire depths (bottom figure; inches) for Amherst, MA using the second-generation GEONOR algorithm. Despite the fact that several increases were reported by vibrating wire number 2 (blue line), the calculated precipitation correctly calculated no rainfall.

Figures 1-4 exemplify the improvement in precipitation estimates using the new algorithm. Figure 1 shows a false precipitation event for Kingston, RI due to the first generation algorithm converting noise from all three wires into precipitation. Once the second generation algorithm was implemented (Figure 2), noise from the wires were not converted to precipitation. Similarly, Figure 3 shows false precipitation recorded at Amherst, MA due to a spurious increase in depth for vibrating wire 2. Since the new algorithm requires at least two wires report similar increases, noise from vibrating wire 2 were no longer converted to precipitation (Figure 4).

3. MANUAL QUALITY ASSURANCE

Because of the high spatial variability of precipitation patterns across a region, NERON staff complement the automated QA processing with a number of manual QA procedures (Martinez et al. 2004). Each day, NERON precipitation data are compared to storm total radar estimates. Software developed as part of the end-to-end QA system (Fiebrich et al. 2005) for the NERON program compares the gauge reports with radar estimates for each site. The software produces a map displaying the radar estimate, NERON gauge precipitation total, and radar image to allow QA personnel to view the data and identify potential gauge problems. Figure 5 shows an example of output from the radar QA program for a precipitation event that occurred during 12-13 August 2005. In the example, Brattleboro, VT (BBOV1) recorded 0.34 inches of precipitation. The Portland, ME radar (KGYX) estimated 0.30 inches of precipitation at the site (i.e., within 0.04 inches of what the gauge recorded). Although radar comparison provides a good spatial overview of precipitation accumulation, some areas tend to have limited or poor radar coverage.

To complement the radar analysis, nearby manual COOP observations are also used for rainfall comparisons. For near real-time comparison, daily hydrologic reports issued by each New England Weather Forecast Office are saved and used for comparison with NERON gauge reports. For data more than two months old, COOP monthly summaries are obtained from NOAA's National Climatic Data Center.

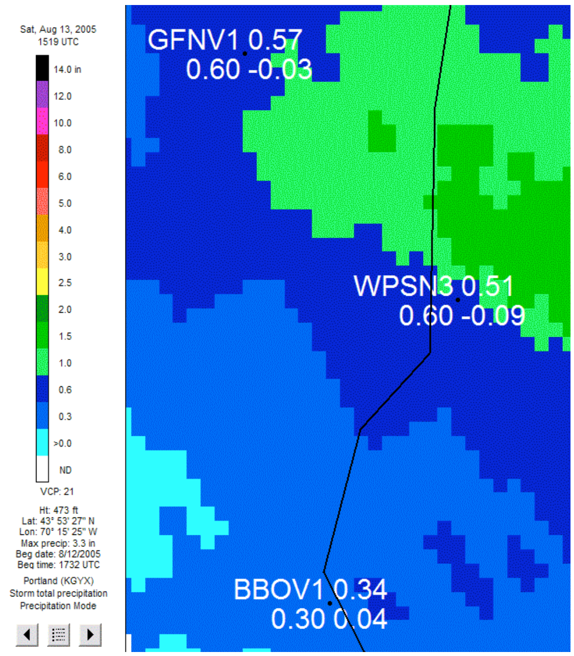

Figure 5: Radar QA output for a New England precipitation event during 12 August 2006 1732 UTC through 13 August 2006 1519 UTC. For each site, the map displays the station ID (upper left), amount of precipitation recorded by the site (inches; upper right), amount of precipitation estimated by radar (inches; lower left), and the difference between the radar estimate and the amount recorded by the site (inches; lower right).

4. SUMMARY

In summary, quality precipitation measurements are dependant on several factors. NERON users have found that the quality of precipitation data has improved notably since the vibrating wire data are now quality assured before being processed by the latest USCRN GEONOR algorithm. In addition, NERON staff have been able to monitor precipitation gauge problems successfully by manually comparing the data with radar estimates and nearby manual COOP reports. By combining these processes, NERON has significantly improved the accuracy of precipitation measured in New England.

5. REFERENCES

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