Operation of Three Collocated Hotplate Precipitation Sensors

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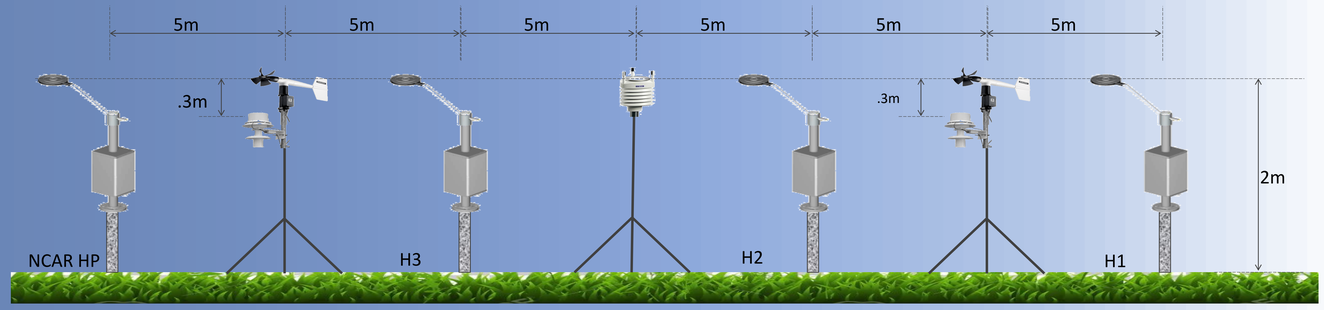
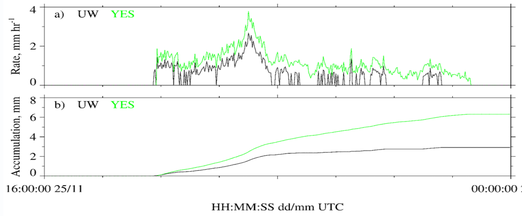
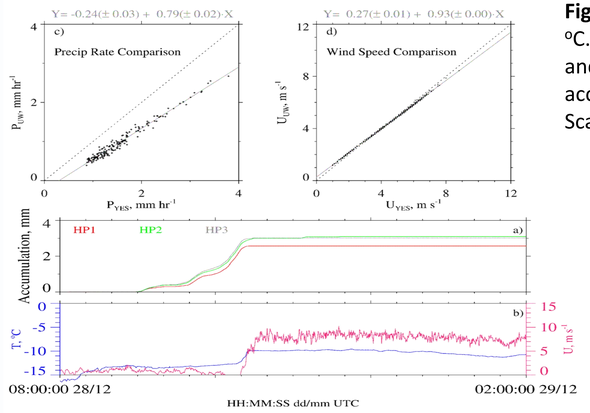
One primary advantage of the hotplate precipitation sensor, relative to weighing gauges, is the hotplate does not become obstructed with accumulated snowfall. Additionally, wind speed derived using a hotplate is not affected by accumulated rime or snow, this being a common problem for rotating and ultrasonic anemometers. Here, we report on winter and spring precipitation rates measured by three collocated hotplate sensors. At our measurement site (Laramie, Wyoming), the daytime wind speed is 5 to 10 m/s and rates seldom exceed 10 mm/hr (liquid equivalent). Three hotplate sensors were calibrated following the procedure described in Zelasko et al. (2018). Calculated rates are based on a previously described algorithm (Zelasko et al. 2018; the UW algorithm). Wind speeds are based on a soon-to-be-reported wind speed calibration and algorithm. Before field deployment, we conducted indoor (unventilated) tests where we challenge a hotplate to a range of reference rate rates. Relative to the reference, the manufacturer's proprietary algorithm (the YES algorithm) overestimates the reference rate by 10%. This bias is discussed in Zelasko et al. (2018). Based on the UW algorithm, there is good agreement with the reference rate. Analysis of several snowfall events shows the YES algorithm overestimates the UW algorithm by 10 to 40%. Wind speeds output by the YES algorithm, and the UW algorithm, are in good agreement. As such, the snowfall rate discrepancy does not appear to be attributable to differing values for the wind-speed-dependent particle catch efficiency. We attribute the snowfall discrepancy to differences between how the UW and YES algorithms calibrate and compute a hotplate's energy budget.



Bibliography

Zelasko, N., et al., Hotplate Precipitation Gauge Calibrations and Field Measurements, Atmos. Meas. Tech., 11, 441-458, https://doi.org/10.5194/amt-11-441-2018, 2018





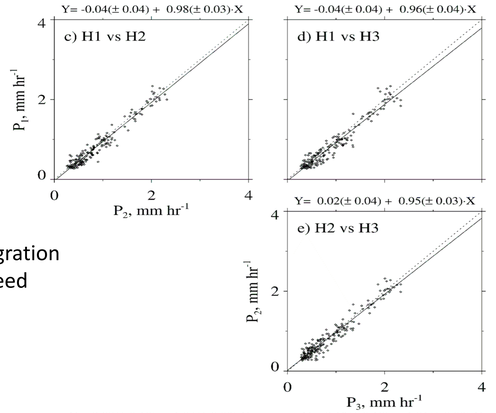
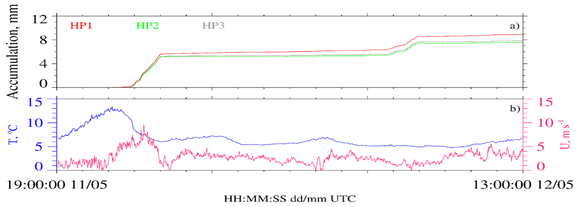


Fig. 1 – Snow event with <U> = 5 m s^{-1} and <T> = -4 °C. a) Comparison of liquid equivalent rates from UW and YES algorithms. b) Liquid equivalent accumulations calculated by integration of rates. c) Scatterplot of rates. d) Scatterplot of wind speeds.

Fig. 2 – Snow event. a) Accumulations calculated by integration of rate from UW algorithm. b) Temperature and wind speed from R.M. Young systems. c, d, e) Comparison of liquid equivalent rates from three hotplates (UW algorithm).



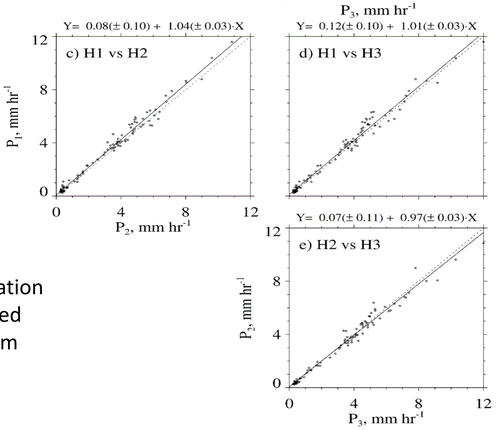


Fig. 3 – Rain event. a) Accumulations calculated by integration of rate from UW algorithm. b) Temperature and wind speed from R.M. Young systems. c, d, e) Comparison of rates from three hotplates (UW algorithm).

Take-Home Points

- ❑ In snow, YES-derived liquid equivalent rates are 10 to 40 % larger than UW rates (Fig. 1c)
- ❑ YES-derived rates exceed reference rate and UW-derived rate by 10% (See Abstract)
- ❑ UW- and YES-derived wind speeds are in good agreement (Fig. 1d)

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