Current USCRN Weighted Average Precipitation Calculation System – May 17, 2016

Since the U.S. Climate Reference Network (USCRN) measures the depth of precipitation using three separate load cells, converting the changes in depth to calculated precipitation during 5-minute intervals is a complex process. The Official Algorithm for Precipitation 2.0 (OAP 2.0) has been exhaustively tested for both real observations and for artificial light to strong precipitation test scenarios. This process is extensively described in the OAP 2.0 Description document. In addition, a small improvement was made in May 2016 to handle rare circumstances when poor quality data cause over-estimates of precipitation to occur. This software adjustment (in item 9 below) has now changed the active process to OAP 2.1. A brief summary is provided here with quality control range constants (Table) and a step-by-step description of the procedure to calculate precipitation.

Table. USCRN OAP 2.0 quality assurance (QA) system constants.

MIN_PRECIP	0.2 mm
DEPTH_RANGE_LOW	-15 mm
ROUNDING_THRESHOLD	0.05 mm
WETNESS_THRESHOLD	500
DELTA_THRESHOLD	0.5 mm
GIANTSTEP	25 mm

1). Check data logger door flag
- If flagged return no calculated precipitation

2). Evaluate wire weights
   a) Calculate wire weights as a function of the average delta variance
   b) Zero weights of wires having any depth below *DEPTH_RANGE_LOW* & recalculate wire weights
   c) Zero weights of wires with an anomalous initial depth change > *GIANTSTEP* (positive or negative) & recalculate wire weights [edge case]
   d) Normalize wire weights to 1

3). Verify more than one valid wire remains
- If two or more wires are weighted zero return no calculated precipitation

4). Determine Preliminary Precipitation
- Calculate precipitation as a weighted average of wire deltas

5). Set giant deltas to zero
- Sub-hourly periods with preliminary precipitation intensities greater than *GIANTSTEP* are set to zero as well as the following period. This occurs commonly with bucket emptying events when the data logger door is *not* opened and fluid (likely an antifreeze mixture) is added to the gauge. [edge case]

6). Zero dry periods
   a) Sub-hourly periods with un-flagged wetness observations greater than *WETNESS_THRESHOLD* are set to zero
   b) For periods with flagged wetness observations, sub-hourly precipitation is set to zero if either condition is true:
      i.   Any of the three wire deltas (for the sub-hourly period) is negative
      ii. Wire deltas are not within the *DELTA_THRESHOLD*

7). Remove negative deltas
   a) If the sum of total precipitation (negative and positive preliminary precipitation) is less than zero report no calculated precipitation
   b) Compute adjustment factor as the ratio of summed-total preliminary precipitation to summed-positive preliminary precipitation
   c) Set negative preliminary precipitation values to zero
   d) Apply adjustment factor to remaining positive precipitation values

8). Quantize (round) preliminary precipitation
   - If preliminary precipitation does not sum to *MIN_PRECIP* return no calculated precipitation
   a) Compute a running total of sub-hourly precipitation (referred to here as runningTotal)
   b) Round running total to nearest decimal place (referred to here as roundedSum)
   c) Replace initial two hours of roundedSum with calculated precipitation from the database
      - If the running total between database (initial two hours) and current hour are misaligned (a dip in accumulated precipitation) set the period of the dip to the previous sub-hourly period. [edge case]
   d) Set all preliminary precipitation values less than *MIN_PRECIP* to zero
   e) Add residual precipitation (runningTotal minus roundedSum) greater than the *ROUNDING_THRESHOLD* to a sub-hourly period exceeding *MIN_PRECIP*

9). Verify applied residual was added during a period of observed wetness
   - If not; shift residual forward in time to the next period of observed wetness (wetness observation less than *WETNESS_THRESHOLD*). If no wet periods exist within the current hour, residual precipitation is not applied. [edge case]
   - **OAP 2.1 Addition: The residual passed forward is limited to 0.3 mm or less.**

10). Check for gauge overflow
   - If any wire has an observed depth greater than gauge capacity no calculated precipitation is returned.