Analysis of the Precipitation Detection Algorithm for the GEONOR T-200B Precipitation Gauge to Improve Accuracy

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Main Question

When is it necessary to de-ice an aircraft?

Fig. 1 (above) An aircraft being de-iced at Denver International Airport in Denver, Colorado.

Reason

Ice on an aircraft's wings can be dangerous. The ice increases air resistance which lowers the performance of the craft.

Solution

Sensors, like the GEONOR All-Weather Precipitation Gauge can be used to estimate the liquid water content of the precipitation falling around airports. This can help airport staff identify when it is necessary to de-ice the aircraft.

How It Works

- The GEONOR Gauge collects raw precipitation data very accurately.
- An algorithm is applied to the raw data to indicate that precipitation is falling in real time.
  - This is the algorithm that was analyzed in the study.
- The output of this algorithm is then used to determine if it is necessary to de-ice the planes or not.

Problem

Before it is used to indicate precipitation, the accuracy of the precipitation detection algorithm must be tested. In order to test the accuracy, another algorithm must be developed and perfected.

Research Objective

Create a truth algorithm to effectively evaluate the accuracy of the GEONOR T-200B All-Weather Precipitation Gauge for use as an indicator for when an aircraft need to be de-iced.

Method

Data was collected from four GEONOR All-Weather Precipitation Gauges located at NCAR's Marshall Test Facility in Boulder, CO over a four month period from 1 January 2014 to 30 April 2014.

- Visually locate possible errors in the Precipitation Detection Algorithm
  - Record timing, cause and other data for each error
  - Pinpoint patterns in the type and cause of the disagreements
- Manually Identify when a precipitation event occurred
  - Compare the detection algorithm to the manual detection to locate errors

Fig. 2 (above) A GEONOR T-200B All=Weather Precipitation Gauge can be used to measure the liquid water equivalences if frozen precipitation falling at airports.
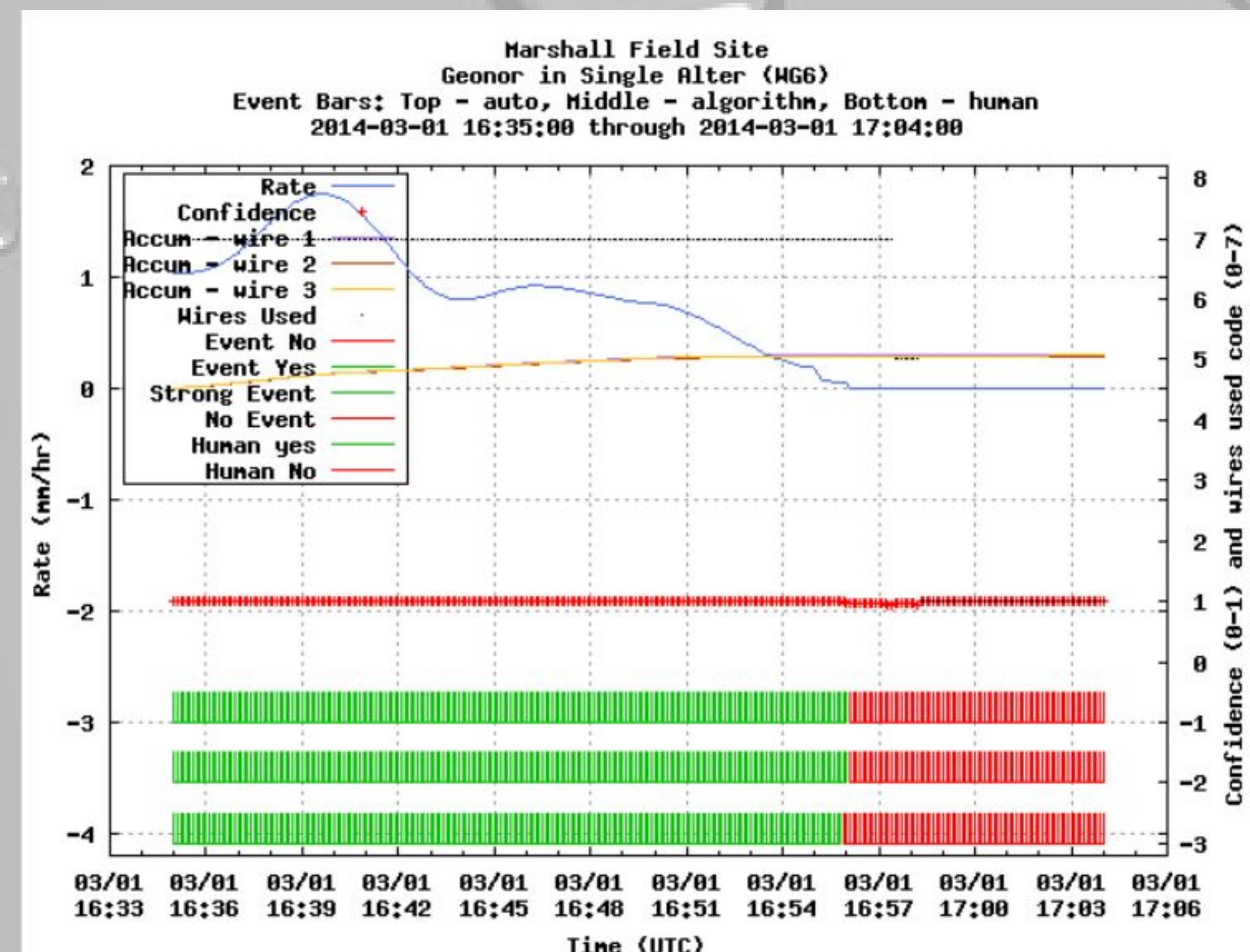

Fig. 3 (left) Graphical representations of the data produced by the precipitation detection algorithm were visually analyzed to pinpoint flaws in the detection. The red and green bars indicate whether a precipitation event is taking place or not. Green indicates that there is precipitation while red indicates there is not.

Results

- Two types of errors were most common
  1. The algorithm produced a false alarm for precipitation
     - This error was caused by external noise affecting the data collected by the gauge
  2. Precipitation was not detected by the algorithm
     - This error was caused by very light precipitation that was undetectable by the algorithm
- Errors were most likely to occur at the beginning and end of a precipitation event
- It was also common for the algorithm to produce errors when the collection environment was not ideal (outside noise affecting data, light precipitation, low accumulation rate, ect.)

Discussion

By analyzing the types of errors produced by the algorithm, we were able to conclude that it does need to be improved before it can be used for its intended purpose. Oftentimes, the algorithm produced a false alarm errors as the result of noisy data produced by the GEONOR Gauge.The algorithm misinterpreted this noise to indicate a precipitation event. To eliminate this error, the algorithm must be improved to include a check for noisy data. We also concluded that the false alarms indicated by the algorithm mainly occurred at the beginning and end of events. It is very difficult to eliminate these types of errors because when the detection threshold is raised, it may cause the algorithm to miss very light precipitation,which would lead to more errors. In order to avoid these types of errors without raising the detection threshold, the algorithm must be modified to account for errors at the beginning and end of events.