Analyzing Accuracy of the Lufft WS600 in Remotely Measuring Precipitation Events

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Objective:

The purpose of this project is to determine the accuracy of precipitation rate measurements taken by the Lufft WS600 weather sensor. Data from the WS600 was compared to a GEONOR T-200b precipitation gauge in a Double Fenced Intercomparison Reference (DFIR) windshield, considered by many to be the standard reference for precipitation measurements. Previous research supported higher confidence in the WS600 in rain events than in snow events - Possibly due to the impacts of wind on falling snow.

Our research question: Can the WS600 be trusted as a reliable precipitation sensor for both rain and snow*?*

Measuring Precipitation:

Snow and rain measurement accuracy, especially in remote locations, can be difficult to obtain and quantify. Wind, blowing debris, and atmospheric particles can all have the capacity to interfere with instruments that are not being continuously compared to manual observations. Precipitation is an important environmental variable for:

- **Hydrological and weather forecasting**
- **Climate monitoring**
- **Ecological water cycling**
- **Aviation**

The Instruments:

Lufft WS600

- Precipitation measured with a vertically pointed 24 GHz Doppler radar
- Measured in real time
- Determines precipitation type by calculating differences in drop speed
- Lightweight, portable, cost effective

DFIR Windshield

- Double wind fence, to reduce impacts and inconsistencies from blowing precipitation
- Does not measure precipitation, but rather houses wind sensitive gauges
- Large, intensive construction, not easy to move

GEONOR T-200B

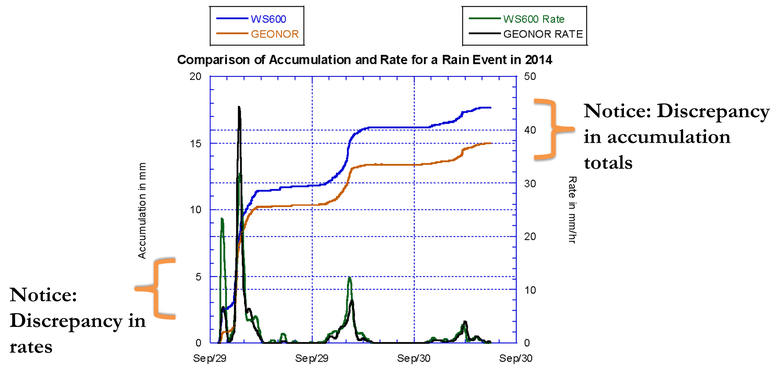
- Precipitation measured by 3 sensitive vibrating wires that detect changes in the weight of the catch bucket
- Measured in real time
- Usually surrounded by a DFIR shield
- Has an internal heater, and antifreeze to limit evaporation and snow build up

Test Site:

Front Range of the Rocky Mountains

- Marshall Field Site
  - located in Superior, Colorado
- Elevation 5,585 feet
- One of the largest meteorology field test sites in the world
- Isolated location on a mesa top free from over head obstacles

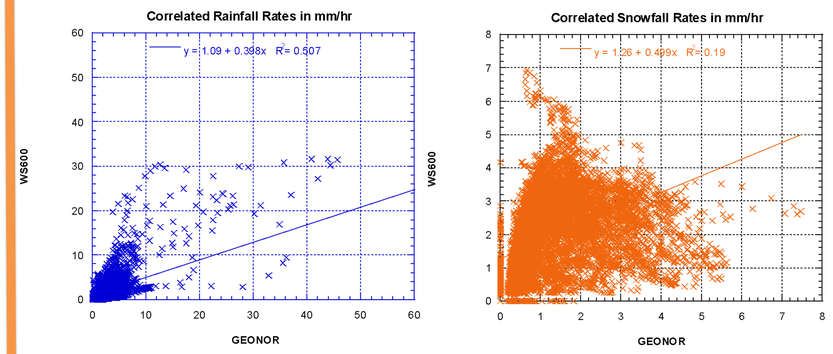
Methodology:



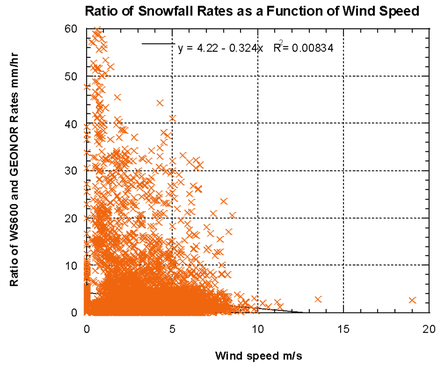
- We identified **long duration precipitation** (snow and rain) **events** from 2012-2016 from data gathered at the Marshall Field Site
  - Long duration events: 4+ hours for rain, 10+ hours for snow
  - 9 total rain events were evaluated; 12 total snow events were evaluated
- Events were selected to be **continuous and non-mixed (just rain or snow)**
- Raw accumulation data was pulled for each event and run through an algorithm that derived the 10-minute rates (intensities) – which were then compared for consistency and accuracy between instruments.

- **Why measure rate and not just accumulation?** Reporting rate allows for in situ, present weather analysis. Relying on accumulation totals reflects cumulative amounts; *Rate reflects how intense the precipitation in real time.*

Results:



- Neither type of precipitation event showed a strong correlation between instruments
  - Snow events: $R^2 = 0.19$
  - Rain events: $R^2 = 0.50$
- Based on the trend line equation, both types of precipitation events show a bias towards the WS600 instrument (y-intercept)



- No correlation was found when the ratio of snowfall rates between the WS600 and GEONOR were plotted as a function of wind speed
  - $R^2 = 0.008$

Conclusions:

- Based on our statistical analysis, and resulting lack of correlation between the precipitation rates of the Lufft WS600 and GENOR, we conclude that at this time **the Lufft is not accurate enough in its precipitation measurements to recommend for standalone commercial or scientific use.**
- As expected, there was higher confidence in measuring rain events compared to snow events.
  - **Our initial hypothesis that this was due to wind interfering with the less dense snow particles was not supported**

Further research questions:

- What other environmental variables (besides wind) could be impacting the accuracy of snowfall measurements?
- Why does the WS600 consistently overestimate precipitation events?
- Based on the degree of accuracy we reported, are there other applications this instrument could be used for currently?
- Since the Doppler radar is pointed vertically, it should not encounter topographical disturbances, but are there other atmospheric variables unaccounted for that could be contributing to increased radar refraction?

References:

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