

Review of “Rain gauge aerodynamic design to minimise wind-induced bias in precipitation measurement”

Summary

This work proposed and tested modifications to a rain collector’s rim to minimize airflow perturbations due to its shape. The authors utilized CFD to test the performance of the proposed rain gauge design and tested a variety of inclination angles, rim thicknesses, rim widths, and collector areas under a range of wind speeds (1-20 m/s). The final proposed design appears to largely outperform the existing gauge designs it was compared against, with higher raindrop catch ratios across a wide range of drop sizes (0.25-8 mm). This finding holds true for liquid precipitation, but the existing design compared against performs better for smaller particles in solid precipitation. While the work itself is interesting, the writing needs improvement, and some critical details are unaddressed and should be resolved before publication.

Major Comments

- Overall, the writing style of the manuscript makes it difficult to follow.
 - The introduction, in particular, is quite dense and not all that clear. It is very difficult to follow in the current organization. After reading the introduction, I did not understand why a new rain gauge design is needed. The introduction discusses updrafts induced by non-aerodynamic rain gauge designs, but it does not discuss the impacts on collection efficiency.
 - The challenges in writing style made it difficult to understand the implications of the results. For example, in the abstract, the new design is simply reported as “better” than existing gauges without quantification.
- Given the focus on rim design, it is somewhat surprising that the manuscript largely avoids discussing splashing. Much work has gone into designing/redesigning the edges of hydrometeor collectors (e.g., the work done on the Parsivel2; Battaglia et al. 2010) to address this phenomenon. It is unclear to me whether the impacts from splashing are smaller than the impacts from an optimal rim design in the context of aerodynamics. I feel this needs to be addressed, either by contextualizing it with the literature or exploring it in the simulations. What percentage of the total hydrometeors in the Lagrangian Particle Tracking simulations hit the rim?
 - This is more confusing given that the “best” design was rejected at the start of Section 4 due to an increase in splashing expected.
- The gauge used for comparison switches between subsections. In Section 3.1, the Lambrecht rain[e]H3 is used; in Section 3.2, the EML SBS-500 is used. In Section 3.3, the AES Nipher gauge is used. Finally, in Section 4, we switch back to the EML SBS-500. This makes comparing the results extremely difficult, and the text does not clearly explain why the authors switched between these three gauges.
- The overcollection of large drops (e.g., Figure 5) seems like a bigger problem than the undercollection of small drops from a mass sense, but this is not addressed. How does the total collection of mass change between these designs? This is addressed in the discussion section, but

should be discussed earlier, especially since the over collection appears to be diminished when building together all of the individual parameters.

- The data availability statement is lacking. While the simulations may be too large to transfer (I cannot validate this as no size information is given), namelists/configuration files should be made publicly available. Further, I do not believe that, in the current form, the study is replicable as required by AMT policy, as the rain gauge design is not available as any sort of CAD file.

Minor Comments

- The particle model omits turbulence, which is an understandable choice. However, that makes the comparison against the AES Nipher gauge challenging, as the shield necessarily increases turbulence. This should be addressed in the manuscript.
- If the authors want to extend applications to solid precipitation, they should also mention/present results on how airflow may affect mixed precipitation or graupel, which will have different particle sizes and densities than liquid and snow.

Lines 33-37: be consistent with “see” and “see e.g.”

Lines 45-55: These two paragraphs are very difficult to understand.

Figure 1: The proposed rain gauge design is helpful, but there is no comparison to existing gauges. Readers would benefit from including a comparison figure to Fig 1 that compares existing gauge design(s) to the proposed design (Lambrecht cylindrical, EML inverted-conical, AES Nipher shielded gauge compared later in the paper)

Line 120: superscripts were dropped for cm^2

Line 153-154: it would be very helpful to label the angles here in the text (linking them to Fig 1)

Line 165: Why was only one inflow angle selected?

Line 180: How is the phase 1 OpenFOAM model connected to the LPT model in line 191? Is the LPT model entirely separate, or is this using the background conditions from the OpenFOAM model from phase 1?

Line 180: 5 m/s as a baseline is fine, but the phrasing of “is a common occurrence in the field” is a bit odd

Line 180: U_{ref} should be defined as *undisturbed* wind speed

Line 234: This is a different theta than before.

Figure 2: It would be very useful to have the angles written on the figure.

Line 197: What does it mean that the releasing positions were in regularly set grids? Are they populating every grid point?

Figure 3: The white bar on Figure 3b is extremely difficult to see.

Figure 10: this is extremely difficult to interpret. I cannot tell the difference between the triangles and circles.

Line 297: “Larger rims tend to produce lower separation layers and limited flow acceleration.” Figure 6 seems to show that smaller rims lead to lower separation layers and flow acceleration.

References: Gunn and Marshall 1958, Rasmussen et al. 1999 DOI links are broken, Nipher et al. 1878 DOI link leads to the wrong paper