

Comment on amt-2021-434

Anonymous Referee #1

Referee comment on "3D trajectories and velocities of rainfall drops in a multifractal turbulent wind field" by Auguste Gires et al., Atmos. Meas. Tech. Discuss.,
<https://doi.org/10.5194/amt-2021-434-RC1>, 2022

The paper models the 3D trajectories and velocities of discrete raindrops accounting for corrections for raindrop oblateness. The paper is original and results are sound, but there are some comments that need clarification before the paper is accepted for publication.

Section 2.1 needs improvement mainly on the definition/description of some of the variables/equations. For instance, the wind is a vector and has 3 components, but the definition of v_{wind} does not say in which direction (is it in the 'z' direction?). What's "SA"? how did you come up with the equations shown in Lines 105 and lines 114 for MPA.

The force balance ($F_w = F_B + F_D$) is valid with the assumption that the particle reached terminal velocity and therefore any additional force due to acceleration is zero. Therefore, if the particle reached terminal velocity, should not dv/dt be equal to zero? However, Eq 1 shows that dv/dt is not zero. Could you please clarify? In addition, the force balance gives:

$$F_w = F_B + F_D$$

where F_w is the weight of particle, F_B buoyancy and F_D the drag. This equation leads to a well-known expression in fluid mechanics for the terminal velocity of a single particle given by:

$$v^2 = \frac{4 * D * g}{3 * C_D} \frac{(\rho_p - \rho_{\text{air}})}{\rho_{\text{air}}}$$

where ρ_p and ρ_{air} is the density of the particle and air respectively, C_D the drag coefficient, g gravity, D particle's diameter. So if the particle's velocity v is equal to $v_{rel} = v_{wind} - v_p$ in your notation (assuming v_{wind} is in the z direction), then any change in v_{wind} over time will affect v_{rel} and C_D (C_D is a function of Re and Re a function of v_{rel}). So it is unclear how you came up with your Equation 1 without including the time derivatives of C_D and v_{wind} . Perhaps I misunderstood something, but if you can elaborate please.

All the above does not account for raindrop breakup or aggregation and only applies for discrete particles that do not interact with each other. However, we know this is an important process in precipitation and this will affect v through the increase/decrease of D . Given the fact that you are using a more complex model to work out C_D and account for raindrop oblateness, what are the implications of breakup/aggregation in your results?

Section 3.1. Recommendation: to use a different variable for C_1 in Eq 7 to avoid confusion with ' c_1 ' in Eq 3.

Section 3.2 The real part ' Re ' might be confused with the Reynolds number ' Re '.

Eq 11. be consistent with the variable definition. is u_x , u_y and u_z the same as v_x , v_y and v_z in Figs 5 and 6?

From the conclusions, it is clear that wind effects are important especially during strong winds. However, it is unclear how to correct radar rainfall estimates on the ground to account for this. Perhaps the authors can elaborate further.

From a practical point of view, what's the difference in trajectories/displacements shown by this model and the one that assumes spherical particles (when computing C_D). Is the additional complexity in the modelling adding any value? I would like to see the differences in terms of displacements as well.

Spelling mistakes:

"equivolumic" (line 193), "withing a voxel" (line 272).