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Geoscientific Model Development Discussions

Interactive comment on "Implementation of a roughness sublayer parameterization in the Weather Research and Forecasting model (WRF version 3.7.1) and its validation for regional climate simulations" *by* Junhong Lee et al.

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We thank all the reviewers for spending their valuable time to review our manuscdript. We are also happy to receive constructive comments of the reviewers and please check our reponses to your valuable comments below.

Technical Points:

1. With various z definitions, and d_0 and d_t, it is easy to be confused about what

reference height is being used. The authors should try to ensure consistency, such as when z is referenced and then d_t is introduced. Is z still relative to d_0 in that case when seen in later equations such as (4)-(5)?

Reply: As the reviewer pointed out, the coordinate systems between the original surface layer scheme and the RSL scheme proposed by Harman and Finnigan are different. For better understanding of these two different vertical coordinates, we added a figure to show differences of the two vertical coordinates. Please consider that we did coordinate transform from the RSL theory to the WRF surface layer scheme to couple the RSL model into the WRF. That is, z is defined as the distance from the conventional zero-plane displacement height (d_0) and therefore, $d_t(= h - d_0)$, distance between d_0 and canopy height (h) is matched to z at canopy top ($z = d_t$). For better clarification of this point, we revised our manuscript with additional schematic diagram.

2. Eq. (2). Using an infinite upper bound implies that the length scale in (3) is still below the lowest model level? If so, this needs to be made clear because it is not obvious what length scale (3) has.

Reply: About this issue, we want to cite the paragraph in Harman and Finnigan (2007): "the infinite upper bound in (3) indicates that the mixing layer eddies originate at the canopy top hence their influence on the wind speed profile should decrease with increasing height. Therefore the $z \to \infty$ limits of the wind speed profile with and without the roughness sublayer influence ($\hat{\phi_c} \equiv 1$) are equal." Accordingly, the upper bound is not related to the lowest model level and we revised our manuscript for better readability.

3. Eq. (4). This introduces f and does not define it as far as I can tell.

Reply: As the reviewer suggested, we added the definition of f in Appendix A, list of symbols and definitions.

4. The positions of d_0, d_t and h relative to each other may be helpful to visualize with a schematic, along with how z is defined.
Reply: As the reviewer suggested, we addd a schematic diagram to describe the coordinate system used in this study.

5. line 106. I believe this references Eq. (8) not (7).
Reply: This is our mistake and we corrected it.

6. line 109. g_a is introduced without being defined as far as I can tell. This is referred to as aerodynamic conductance but some may be more familiar with it as a surface exchange coefficient for temperature. Is it simply the heat flux divided by the temperature difference? This should be explained.
Reply: The reviewer pointed out, we revised the texts with more information on the definitions of aerodynamic conductances.

7. Table 1 shows a z_0, but this is probably only in the control experiment as z_0 is calculated by the new scheme.
Reply: As the reviewer suggested, we revised the manuscript to clarify this issue.

8. With the iterations required, does this add much to the cost of the scheme in computer time.
Reply: Based on our simulation, the YSL scheme increased the computing time by only 8%. We believe that our scheme is promising because of improvement of meteorology simulation described in our manuscript accordingly. We added this information into the revised manuscript.

9. Figure 3. In the idealized case, the control z_0 is 0.25 m. Here the figure shows a ratio of z_0/z_{0N}. What is z_{0N} so that we can compare it with 0.25 m?
Reply: z0N is the value of z_0 in neutral conditions simulated by the new RSL model and thus Figure 3 shows the dependency of the roughness length with L_c/L by normalizing it with the roughness length in neutral condition. As the reviewer suggested, we revised the texts to clarify the definition of z_{0N}.

10. Figure 5 is another place where it would have helped to know that the original displacement height is less than the canopy height because we see the CTL values end there
Reply: As the reviewer pointed out, z/h must be $\tilde{z}/h$ in this figure. We revised the Figures. We appreciate your support for our manuscript and thank you.

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