
Response to Referee #2

RE: Comprehensive evaluation of typical planetary boundary layer (PBL) parameterization schemes in China. Part I: Understanding expressiveness of schemes for different regions from the mechanism perspective

Author(s): Wenxing Jia et al.

This manuscript comprehensively evaluates the performance of four typical boundary layer parameterization schemes (YSU, ACM2, BL and MYJ) over four months (January, April, July and October) in five key regions (NCP, YRD, PRD, SB and NS regions) of China, starting from the mechanism of the parameterization schemes to the optimal solution of the parameterization schemes, and answering almost all the answers that current model users want to know in terms of PBL parameterization schemes. The whole manuscript focuses on the near-surface meteorological parameters in the PBL, including 2-m temperature, 2-m relative humidity, 10-m wind speed and direction, vertical structures of the PBL, PBL height, and turbulence diffusion coefficient, analyzes the reasons for the differences between different PBL parameterization schemes, discusses the differences between PBL parameterization schemes and observations, and gives suggestions for the optimal solutions of PBL parameterization schemes. I do have some comments, which I believe should be addressed before the manuscript is considered for publication:

Thank you for your positive comments and valuable suggestions to improve the quality of our manuscript. Based on these comments and suggestions, we have made careful modifications to our pervious draft, and the detailed point-by-point responses are listed below.

Specific comments:

1. The abstract section is a bit too long, the article is rich in content and there are many results to show, so you need to take it and streamline the abstract.

Re1: Revised as suggested.

2. Why these four boundary layer parameterization schemes were chosen, and whether the corresponding explanatory notes can be given in the appropriate places?

Re2: There are three categories of PBL parameterization schemes, nonlocal, local and hybrid. Considering that each category of parameterization schemes should be covered, for each category, a typical parameterization scheme in that category is selected.

3. What was the basis for the selection of sounding sites in each region?

Re3: Four sounding stations have been selected for each region, including different underlying surface conditions as much as possible.

4. The second part of the manuscript should describe the topographical and regional characteristics of the five regions and why they were chosen.

Re4: Revised as suggested.

5. The analysis of this part of L423-498 is very clear, but the part of L499-522 is a little bit messy and needs to be reorganized, therefore, there is a leading sentence to make the idea clearer.

Re5: Revised as suggested.

6. In the section 3.4, are there any observations of turbulent diffusion for the relevant comparison work?

Re6: Currently, observations of turbulent diffusion are still scarce, especially for multilayer turbulence observations throughout the vertical direction within the PBL.

7. In fact, there are many articles about PBL parameterization schemes, most of them are more or less the same. This manuscript has analyzed and evaluated the PBL parameterization scheme very comprehensively, which is of great reference to the readers. Could you add a paragraph at the end of the manuscript with thoughts and suggestions on the PBL parameterization scheme?

Re7: Revised as suggested. "The PBL parameterization scheme, as the most critical parameterization process within the PBL in the model, has been well proposed and

developed by previous generations, but the development has been slower in recent years, few new theories have been proposed and almost no new schemes have been put into the model or the existing schemes have rarely been improved. Most of the previous studies have evaluated the PBL parameterization scheme, but many of them focus on a particular case in a certain region and lack of universality. This study makes up for this deficiency and provides a comprehensive discussion on the evaluation and uncertainty analysis of the PBL parameterization scheme, hoping to give some reference to the model users. The future development of the PBL parameterization scheme needs to start from the theoretical mechanism, go deeper into the PBL parameterization scheme, and have a deeper understanding of the PBL parameterization, even if it is only for one scheme, or the improvement of one parameter. And for China's self-developed GRAPES model, the introduction and improvement of PBL parameterization schemes need to be selected, rather than a brain to write all the schemes, in fact, many schemes are almost not measured and used.”

Minor issues:

1. Table 1, A near surface layer parameterization scheme is missing, because MYJ can only couple Eta near surface layer scheme.

Re1: Revised as suggested.

2. L258, “Rib” should be changed to “Rib_{cr}”.

Re2: Revised as suggested.

3. L331-334, Eq. (13a), Eq. (13b) and Eq. (13c) switch the order and correspond to the previous ones.

Re3: Revised as suggested.

4. L391, “structure” should be changed to “structures”.

Re4: Revised as suggested.

5. L400, “orange dots” should be changed to “purple dots” in Figure 1.

Re5: Revised as suggested.

6. L449-451, The formula of HFX should be given out.

Re6: Revised as suggested.

7. L506, here, should also include a part of Shandong Province, “Hebei province” should be changed to “Hebei and Shandong provinces”.

Re7: Revised as suggested.

8. L523-524, this sentence needs to be rewritten.

Re8: Revised as suggested.

9. L560-561, according to Figures 2-6 and supplement, this conclusion should be directed especially to winter, i.e., October and January.

Re9: Revised as suggested.

10. L614, “WS10” should be changed to “WS₁₀”.

Re10: Revised as suggested.

11. L816, “planetary boundary layer height” should be deleted.

Re11: Revised as suggested.

12. L819, here, it is not these two equations, it should be equations (15) and (16).

Re12: Revised as suggested.

13. L822, “Eq. 29” should be changed to “Eq. (15)”.

Re13: Revised as suggested.

14. L837-839, what is the reason for the PBLH simulated by the BL scheme is better than the other three schemes, and the poor simulation results of the MYJ scheme?

Re14: This is because the BL scheme calculates the PBLH by the virtual potential temperature method, and the model gives the best simulation results for temperature.

15. L872, “turbulent diffusion coefficient” should be deleted.

Re15: Revised as suggested.

16. L875, “structure” should be changed to “structures”.

Re16: Revised as suggested.

17. L888, lack of figure citation, and figure 18 is only for the NCP region.

Re17: Revised as suggested.

18. L904-928, Add some references as supporting notes.

Re18: Revised as suggested.

19. L935-942, the “SCB” in Figure 19 should be changed to “SB”.

Re19: Revised as suggested.

20. L1021, “planetary boundary layer” should be changed to “PBL”.

Re20: Revised as suggested.

21. L1073, “vertical distribution of PBL” should be changed to “PBL vertical structures”.

Re21: Revised as suggested.

22. There are more figures, which need to be provided in high resolution (especially Figure 19), as well as double-checking the figure title of each figure.

Re22: Revised as suggested.

23. The citation format of references in the manuscript needs to be standardized, especially in the introduction.

Re23: Revised as suggested.