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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of planetary boundary layer turbulence on model climate and tracer transport" *by* E. L. McGrath-Spangler et al.

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Thank you for reading this manuscript and offering your comments. They have been addressed in the responses below.

This study shows the sensitivity of the algorithm to calculate the PBL depth in the climate-chemistry model GEOS-5. I found the article interesting, but as it is now written, it is submitted to the wrong journal. In my opinion, this article needs to be submitted to Geophysical Model Development or a similar journal. These journals aim at testing and developing parameterizations and their impact.

We submitted to ACP because this work builds off our previous work examining the diagnostic evaluation of PBL depth in GEOS-5 already published in ACP (McGrath-

Spangler and Molod, 2014) and because this manuscript is concerned with the transport and concentration of chemical constituents in the atmosphere.

McGrath-Spangler, E. L. and Molod, A.: Comparison of GEOS-5 AGCM planetary boundary layer depths computed with various definitions, Atmos. Chem. Phys., 14, 6717-6727, doi:10.5194/acp-14-6717-2014, 2014.

The article treats too many subjects and the reader is left with too many open questions. I would like to put three examples in which I think the authors should go deeper in their analysis in order to disentangle the impact of different planetary boundary depth calculations in their results. First, in section 3 there is a description on the differences of PBL depths due to the application of three different criteria method. Nothing is mentioned whether these differences lead to different surface fluxes and entrainment of warmer and drier air. At page 31636 it is mentioned that there are differences, but not quantitative explanation is given. A similar comments holds for the surface fluxes. In consequence, it is unclear the reasons of the different PBL calculations. Second, differences in the aerosol optical thickness (AOT) leads to a different vertical distribution of aerosol. Depending on the aerosol absorption and scattering characteristics, the vertical profiles of the thermodynamic variables can have relevant differences that can impact in the performance of the algorithm. In addition, it is also not discussed how the differences in AOT impact the surface forcing and therefore the estimation of parameter related to the turbulence parameterizations. Third, it is mentioned at the end of section 3 that the algorithm 3 leads to more marine low level clouds, that in turn modifies the surface and inversion conditions due to differences in radiation and turbulence conditions How do these interactions between physical parameterizations influence their findings?

At the beginning of section 3, we've added a discussion of the diurnal cycle of PBL depth differences among the three methods and a figure (Figure 1) showing the diurnal cycle averaged over northern Africa and tropical South America.

In section 3, we've added a discussion of the effect of the changes on sensible and latent heat fluxes (Figure 2), how they impact surface-atmosphere interactions, and the impact on boundary layer top entrainment.

The vertical redistribution of Saharan dust and its impact on temperature and radiation is discussed in Section 4. Specifically, the increase in atmospheric dust between 800 hPa and 500 hPa contributes to a warming due to an increase in shortwave radiation absorption. This shades the lower atmosphere and produces a cooling due to less absorption of shortwave radiation near the surface, creating an increase in lower tropospheric stability.

We've added a short discussion of the effect of increasing low-level clouds on longwave radiation and temperature and that these effects can modify the PBL to the end of Section 3.

In my opinion, if the authors want to submit again the article to Atmospheric Chemistry and Physics they need to analyse in depth one of the subject in order to understand how the different algorithm definition not only impacts the turbulence parameterizations, but also the other key processes related to it

Please see above for a more detailed description of the modifications we have made to the manuscript to address your concerns.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 31627, 2014.

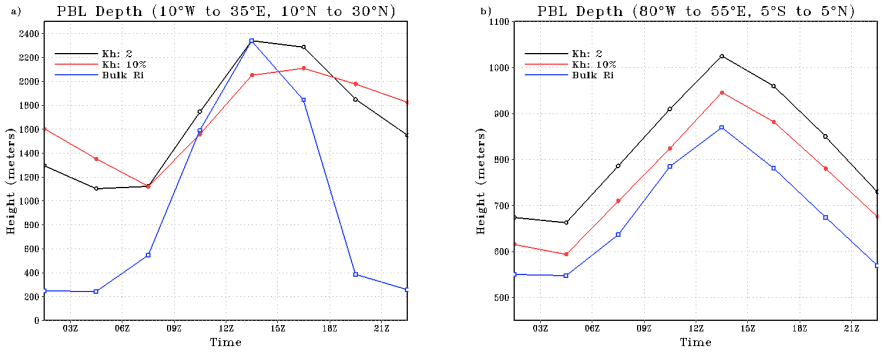

Fig. 1. Diurnal cycle of JJA mean PBL depth over northern Africa and tropical S. America

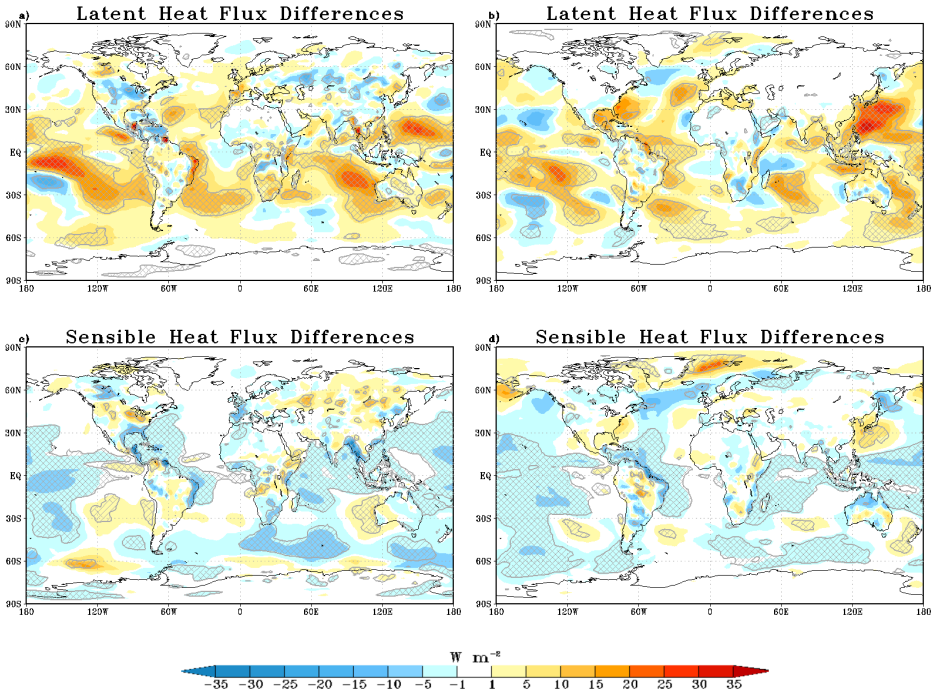

Fig. 2. Seasonal mean latent heat flux differences (Method 3 minus Method 2) for JJA a) and DJF b) and seasonal mean sensible heat flux differences for JJA c) and DJF d). Hatch marks represent significance.