Atmos. Chem. Phys. Discuss., 14, C2536–C2539, 2014
www.atmos-chem-phys-discuss.net/14/C2536/2014/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comparison of GEOS-5 AGCM planetary boundary layer depths computed with various definitions" *by* E. L. McGrath-Spangler and A. Molod

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Received and published: 19 May 2014

Anonymous Referee #2

General comments: This manuscript compared 7 different methods of defining the planetary boundary layer (PBL) depths in the GEOS-5 atmospheric general circulation model over land. It is very important to evaluate the PBL depths in models. However, there are some major issues in this manuscript. Please see comments below. Therefore, I recommend accepting this manuscript after major revisions.

Thank you for your time in reviewing this manuscript. We agree that it is important

to evaluate the PBL depth in models. Your concerns are addressed in the comments below.

Major comments:

1. The introduction didn't cover most the PBL depths comparison works. It only referred to 3 papers related to PBL depths.

We have expanded the introduction to include studies by Helmis et al. (2012), Hu et al. (2010), Nielsen-Gammon et al. (2008), and Seibert et al. (2000).

2. Regarding Method 5 and 6, I am not surprised at "In general, both local Richardson number methods (Methods 5 and 6) estimate PBL depths that are lower than the other methods throughout the diurnal cycle." There are many inversions near the surface or at the low level, especially at night or in winter. It didn't get much meaningful information based on these two methods according to your results. Maybe consider to remove these two methods or just compare one of them or write some words on these methods?

In the new manuscript, the discussion about Methods 5 and 6 is expanded to include mean and percentage differences between the methods as well as the characteristic that the differences are maximal during the afternoon.

3. There are some comparisons between model results and the radiosonde-based results. Based on my understanding, the PBL depths provided in Seidel et al. (2012) is for the period 1981-2005, while the model results in this manuscript is from 1990 to 2013. In lines 17-27 Page 6601, it is said the differences between the model and radiosonde estimates were just 100 m. I don't think it gave us some convincible information since they used different study period and the differences could be changed a lot if using another study period.

We've included this comparison to radiosondes because both the model simulated PBL depths and those estimated from the radiosonde profiles represent climatological

conditions and so provide an estimate of model uncertainty. The new manuscript acknowledges the difference in time period, but that both are climatological datasets in the subsection describing the radiosonde observations.

Specific comments:

1. In Section 2, please clarify the definition of the seasons used in this manuscript. In Figure 2, the “summer PBL depth” just popped out. Also, please describe briefly the observation results you used in this section.

We have moved our definition of summer and winter to section 2 and included a separate subsection within Section 2 describing the radiosonde observations.

2. Figure 2: It shows the four different climate classes. Why does the tropical forest show the annual result and others show the summer results? Additionally, please use the same scale of the y-axis and it would be easier to compare.

We show the annual result for the tropical rainforest because seasons near the equator are more dependent on precipitation than on temperature and there is no distinct summer or winter seasons. We have updated the figure to use the same y-axis for all four panels and explained why we show the annual mean diurnal cycle for the tropical rainforest.

3. Figure 3: You can’t say “...PBL height variability is explained by skin temperature” only based on some correlation test or some diagram. The variation of PBL depth is complicated.

We have reworded this and added a section explaining that variability exists that is not explained by temperature.

4. Figure 5: The error bars are barely seen.

We’ve increased the size of the error bars and extended them to three standard deviations.

5. Figure 7: The x, y axes’ labels are nearly overlapped with the values

This has been corrected.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 6589, 2014.