**Atmospheric
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Discussions

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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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Anonymous Referee #1 General comments: This manuscript compared 7 methods to diagnose PBL depth in the GEOS-5 model. Such investigation is important for applications that use the PBL depth as input. However there are some deficiencies in its current form (see comments below). Thus I recommend major revision before it can be accepted for publication.

Thank you for taking the time to review this manuscript. We are glad to hear that you found this work important. We have addressed your concerns in the comments below.

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Major comments:

1. All the PBL depth diagnose methods are actually based on vertical profiles of variables such as potential temperature, wind, TKE etc. Vertical profiles of these variables describe/illustrate the boundary layer structure more clearly. So the comparison of those PBL depth diagnosed by different methods (e.g., Fig. 6) should be discussed with the aid of vertical profiles of those relevant variables. Good example are Fig. 3 of (Nielsen-Gammon et al., 2008), Fig. 1 of (Seibert et al., 2000)

An additional figure (new figure 6) has been added to the revised manuscript showing day and nighttime profiles of relevant variables and a discussion has been added concerning how they impact the PBL depth estimate.

2. Table 1 lists the PBL depth diagnose method for the model simulation. What is the method used to diagnose PBL depth based on radiosonde observations (particularly at night)? A separate section is needed in method section to describe the observations.

In the revised manuscript, a section on the radiosonde observations has been added to the methods section. The radiosonde observations were evaluated using the bulk Richardson number method (Method 4).

3. I would expect the nighttime PBL depth diagnosed by method 6 (Ricrit=0) is 0 in most places since there is always temperature inversion near the surface. I am a little surprised to see significant nighttime PBL depth from this method.

The minimum PBL depth obtained by the GEOS-5 AGCM coincides with the lowest model level at about 150 m. This has been added to the text in the revised manuscript.

4. Some of the text is repetitive from the figure captions, e.g., "The horizontal dashed lines indicate the PBL depth found using the total Kh (Method 1, Fig. 7a) and bulk Richardson number (Method 4, Fig. 7b).", which are unnecessary in the text.

Repetitive text has been removed.

Specific comments:

1. LN21, page 6593, The sentence of "estimates the PBL depth as the model level below that which Kh falls below" does not make sense.

This has been reworded in the revised manuscript.

2. "A spatial map of the JJA skin temperature (Fig. 3b) shows the same pattern as the PBL depth". This is not true for the Arabian Peninsula. Any reason why?

This is due to upslope winds opposing the overlying subsidence over the higher to-pography of the western part of the Arabian Peninsula. This has been added to the discussion in the revised manuscript.

3. "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." Please analyze vertical profiles of relevant variables such as potential temperature, wind, TKE, local Ri (pick up one time in the day and one at night)

We have updated Figure 7 (now figure 8) to include the vertical profile of wind speed. It also now includes both a daytime and nighttime profile.

4. "This has implications for estimating the shallow nocturnal boundary layer that has been shown to be relevant for constituent transport". This is not true for some air quality models that do not use the variable of PBL depth to compute transport of constituents. For these models, constituent mixing does not depend on the diagnosed PBL depth.

This has been reworded in the revised manuscript.

5. Many studies investigated/compared PBL depth diagnose method (e.g., (Helmis et al., 2012; Hu et al., 2010; Nielsen-Gammon et al., 2008)). They need to be better summarized in introduction.

The introduction has been expanded in the revised manuscript.

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References:

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