

## ***Interactive comment on “The Climatology of Brewer-Dobson Circulation and the Contribution of Gravity Waves” by Kaoru Sato and Soichiro Hirano***

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We are sorry that we could not submit this response soon because the first author did not find time (due to conferences and teaching).

We describe the reasons why we consider that our method can serve as an estimation for the true gravity wave drag. First, the stream functions attributed to GW contribution that were obtained from the four reanalyses have very similar structure. Thus, we think that the stream function obtained by our method reflects at least real dynamics in the atmosphere. Second, as discussed in Section 5, many of the characteristics found in the stream function are consistent with the characteristics of gravity waves known from

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previous studies using high-resolution observations and gravity-wave permitting GCM simulations. Third, the features observed in the "GW" stream function are consistent with the model study by Okamoto et al. (2011) referred to in AC1. As the reviewer said, it is true that increments include several sources other than GWs in the reanalysis, and we also understood it. Thus, we will carefully revise our manuscript and clarify the working hypothesis and its limitation of our analysis.

Abalos et al. (2015) showed that the spread among the nine estimates (three methods times three reanalysis data) of upward mass flux is large and about 40% for 70-10hPa (their Figure 6). However, they also noted that in general the differences are larger among the three estimates in each reanalysis than among the three reanalyses for each estimates. This is also clear in their Figure 6 above 70hPa. We consider that the difference between the direct estimate and the indirect estimate from the zonal momentum equation seen in Abalos et al's analysis is mainly due to a part of the GW drag that is not accurately expressed by the GW parameterizations. Note also that even in our analysis, as shown in Figures 10 and 11, the total upward mass fluxes obtained from directly estimated residual mean circulation using four reanalyses do not differ much. These facts suggest that the direct method using its definition gives a good estimation of  $w^*$  (or  $v^*$ ).

In contrast, the contribution of GWs to the upward mass flux shown also in Figures 11 and 12 largely depends on the reanalysis data. However, it should be noted that this quantity is quite sensitive to a slight difference in the stream function structure because the upward mass flux is calculated only using stream function values at two particular latitudes (i.e., turn-around latitudes). This point will be clearly discussed in the revised manuscript so as to avoid unnecessary confusion, if we are given the opportunity.

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