

## ***Interactive comment on “Residual circulation trajectories and transit times into the extratropical lowermost stratosphere” by T. Birner and H. Bönisch***

**Anonymous Referee #3**

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### General comments

This study investigates backward trajectories along the stratospheric residual circulation from a 3-yr simulation of CMAM. The authors examine the transit times and aspect ratio associated with the trajectories to argue for a clear separation of the shallow branch (driven by synoptic waves) of the residual circulation from the deep branch (driven by planetary waves). Whereas a few questions would need to be clarified (as described in Specific comments), overall this study has been reasonably well done in terms of the theme, method, and presentation. It will be a good contribution to characterize the separation of the two branches using the trajectory calculations, since such a

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separation remains relatively unexplored. I recommend that this paper can be accepted after the questions are resolved (which will be categorized into “minor revisions”).

### Specific comments

1. Clear separation between the shallow and deep branches The authors repeatedly argue for a clear separation between the shallow and deep branches of the residual circulation as summarized in l. 20 of Abstract (p. 16838). The results certainly show spatial changes of the properties of the residual circulation supporting the existence of the two branches, but I wonder how the two can be separated. The phrase “clear separation” seems to imply that the two can be separated in an objective manner. Such an objective separation will be possible if there is some “node” or “bimodality” of a property (or properties) of the residual circulation, but the examined spatial changes largely seem continuous and the present descriptions lack such discussions.

2. Seasonality The discussions of the seasonal cycle of the transit times, aspect ratio, and mass flux of the trajectories (Section 3.3, and Fig. 5) seem to leave some difficulty in interpretation to my understanding, since the transit times are longer than a season or even a year in extratropical latitudes. For example, the right panels of Fig. 5 plot the aspect ratio and mass flux for MAM and SON as functions of latitude. Here, I assume that the plots are averages for backward trajectories that are started from days (with the 5-day interval) within each season. The transit times to the extratropical lower stratosphere are longer than a year poleward of about 60N/S in the representative annual mean (Fig. 3, left). Therefore, even though the plots in Fig. 5 are labeled as those for the two seasons, the results each reflect the time-dependent residual circulation for the associated transit times that are longer than a year in the extratropical latitudes. I wonder how useful/straightforward it is for the authors to argue for the seasonal changes and/or season-specific features from such results. Similar difficulties will also exist in Figs. 6-9, which plot seasonal changes through the year.

Technical corrections The followings suggest possible minor changes.

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3. The comma will be a period (l. 10, p. 16844).

4. It will be better to add "(not shown)" at the end of l. 18, p. 16844 and l. 20, p. 16845.

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