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## ***Interactive comment on “A PV-based determination of the transport barrier in the Asian summer monsoon anticyclone” by F. Ploeger et al.***

### **Anonymous Referee #2**

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This study introduces a creative way of applying potential vorticity (PV) gradients-based definition of the polar vortex edges in defining the Asian summer monsoon anticyclone transport barrier. As the authors emphasized in the manuscript, both the applications have some similarities and also dis-similarities. I think this PV gradients-based method of defining the transport barrier is thoughtfully applied and the results are convincing. However, I would have liked to see more fundamental aspects of this application. For instance, why the definition of the anticyclonic transport barrier is important and what kind of questions can we answer with this method that we haven't been able to answer in the past? What were the challenges that scientific community had in the past due to the lack of method the authors are now presenting? I think adding a little bit more details and context to the current form of presentation can potentially improve the

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scientific significance of this work.

Major Comments:

1. As previous studies have shown, Ertel's PV and long-lived tracer distributions are highly correlated in their spatial and temporal distributions inside the Asian monsoon anticyclone. I don't necessarily think the PV as a barrier but as a measure of confinement of the air masses within the anticyclone. This barrier is leaky and also has large variability, if it exists. The authors also have introduced three other variables to characterize the monsoon anticyclonic boundaries in section 2, which include, PV, circulation and stream function. With this in mind, the authors have to emphasize if it is possible to define a barrier over the monsoon region. Maybe there is no barrier? Why using PV gradients defining the transport barrier following Nash et al. (1996) over the monsoon region is applicable and what that means physically. Also, as the magnitude of PV is highly dependent on altitude, it will be useful to use MPV (modified PV) instead of PV and show how the results will change.

2. The 380 K isentropic surface can well be representing the dynamic variability of the Asian monsoon anticyclone in the tropics and subtropics. However, as shown in the previous studies, the transport processes near the Asian monsoon region are occurring in the thick layer instead of on a surface. In fact, 360 K can be a better representative of the Asian monsoon anticyclone itself (where both the jet streams act as a boundary, see Fig. 1). Even though the transport barrier defined in this study is most distinguishable at 380 K surface, I think it is important to emphasize how the entire monsoon system has rather a layered structure and the method used in this study is subjective to the PV values itself. For example, based on Fig. 13 one can probably define transport barriers at 370 and 390 K as well based on smaller PV gradients over different equivalent latitudes.

3. Defining polar vortex edges, as in the previous studies, can be useful in knowing polar vortex breakdown dates and so on. Then how is the definition of transport barrier

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in the Asian monsoon anticyclone based on PV gradients useful? For example, can this diagnostics be used in quantifying vertical transport from the upper troposphere to stratosphere or size of the anticyclone? Are the characteristics of the transport barrier affected by the convective activities in the lower troposphere and the strength of vertical and horizontal circulations near the monsoon region? I think the importance (and usefulness) of defining anticyclonic transport barrier based on PV gradients has to be emphasized in a broader context in relation with dynamical and chemical variabilities of the monsoon anticyclone and convection.

Minor Comments:

P1, L59 – is -> and is

P1, L60-67 – It should be mentioned that why those simple methods are problematic or unsatisfactory and also how it affects the results of various diagnostics (related to major comment # 1).

P1, L68 – What does ‘physically motivated’ mean?

P2, L93 – ‘We interpolated...’ -> What are the reasons for the horizontal interpolation and also what is the original grid of the ERA-interim data?

P2, L57 – in the monsoon -> in the monsoon anticyclone

P2, L150 – At the end of this paragraph, a brief comment about CLaMS CO and ozone reproducing climatology and/or observations will be helpful.

P3, L176 -> model and simulations -> model simulations and the satellite observations

P3, L202 – What are the boundaries of the Asian monsoon region here?

P3, L232 - -10E -> 10W?

P4, L320- 325 – This is an interesting point. As the anticyclone itself won’t disappear during this period, one can argue that this PV gradients-based method fails locating the

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transport barrier. Do the actual PV values and tracers maxima show clear boundary of the anticyclone during this period? Or the anticyclone is simply too weak to act as a transport barrier?

P5, L380-383 – Is there any possible explanation to this feature?

P5, L459 – Also, there is a possibility that the monsoon anticyclone is not as isolated as the polar vortex or the jet stream.

P6, L548-550 – More specific information about how this can be done?

P7, L685 – This citation year needs to be corrected from 2006 to 2007.

P9, Fig. 2c – The wind vectors are hard to see in this plot. Using slightly darker grey color should help. . P9, Fig. 4 – I have a feeling that the map projection underneath the PV contours is not correct. The secondary PV minimum on the left hand side should sit somewhere in the Middle East not over North America or Pacific (see Fig. 10 of Garny and Randel, 2013).

P14, Fig.11b – The crosses in this plot rather look like asterisks on top of filled circles, which make it harder to distinguish from the black diamonds. I would recommend using crosses or pluses in grey colors. Also related to this plot, I wonder why this method works the best in early July. If this method were going to be more practical, I would think it should work from the onset to the end of the summer monsoon.

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 10593, 2015.

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