Atmos. Chem. Phys. Discuss., 15, C1155–C1157, 2015
www.atmos-chem-phys-discuss.net/15/C1155/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Stratosphere–troposphere exchange (STE) in the vicinity of North Atlantic cyclones" *by* P. Reutter et al.

Anonymous Referee #2

Received and published: 27 March 2015

This is a promising paper that focuses on quantifying the two-way stratosphere-troposphere exchange (STE) that occurs in the vicinity of extratropical cyclones in the North Atlantic. Using ERA-Interim reanalysis data, the analysis makes use of a documented cyclone identification and tracking algorithm and a method of identifying trajectories that cross the dynamic tropopause. The results focus on evaluating the STE during three phases (deepening, mature and decaying) of the extratropical cyclone lifecycle and attempts to quantify the transport in both the troposphere-to-stratosphere (TST) and the stratosphere-to-troposphere (STT) direction. While the goal to quantify the STE in the vicinity of an extratropical cyclone is a good one, I believe the analysis

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does not fully reach the desired goal. My concerns are mainly in reference to aspects of the methodology that may result in a misrepresentation of the dominant direction of the STE in the vicinity of the cyclone. To the authors' credit, they do note that there are caveats to their analysis, but I think more needs to be done to address these caveats.

Major comments: 1) The attribution of STE to a specific cyclone is made in reference to the location of the sea level pressure minimum. In the case study analysis presented in Sect. 3.1, it is noted that according to the methodology used in this study, the STT identified to the northwest of the surface cyclone center was not associated with the cyclone. However, as the authors note, it is well known that developing baroclinic waves (e.g., cyclones in their deepening phase) have westward tilts with height. The notch and anticyclonic curvature in the tropopause level potential vorticity structure to the northwest of the cyclone center, in the vicinity of the identified STT, is directly associated with the dynamic and thermodynamic processes that occur within the cyclone. Very few synoptic meteorologists would consider this region as 'not associated with the cyclone'. By not representing STE in regions like this one (immediately to the northwest or west of the cyclone center) the results of the climatology misrepresent the total STE values in the vicinity of deepening cyclone. In particular, I think that in the deepening (baroclinic) phase that the STT that should be attributed to a cyclone is vastly underrepresented by the analysis, therefore also calling the results comparing TST to STT in the various phases of the cyclone lifecycle also into question.

To the authors' credit, they to note that their analysis can be considered a conservative estimate of STE. However, I think that a discussion and perhaps analysis of how sensitive this method of diagnosing STE in the vicinity of cyclones is to the definition of cyclone area would be valuable in adding credibility to the analysis. Otherwise, it might be worth focusing the analysis on the portion of the cyclone lifecycle in which the upper-level and lower-level cyclone features are co-located and vertically stacked (i.e., the barotropic – mature and decaying – phases of the cyclone lifecycle).

Minor comments: 1) The introduction contains a very thorough review of STE research,

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but seems more appropriate for a review paper or thesis length manuscript. Perhaps this review can be shortened, doing so would provide 'space' for the recommended analysis/discussion mentioned above.

Typos: P2540 L1: "date" should be "data" P2548 L27: The 's' should be removed before 445 P2548 L28: "the the average" should be "the average" P2554 L17: "muss flux" should be "mass flux"

Figures: Fig. 2: It is hard to see the southern end point of the cross section line. Which 320 K PV contour does the red line represent? Figs 9 & 10: What are the values that correspond to the color fills? Perhaps the gray line could be thicker.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 2535, 2015.