Review of egusphere-2026-228: “The impact of orography on the troposphere-to-stratosphere transport during a typhoon event in the tropics” by M. Martina et al.

The study by Martina et al. addresses the question of how orography may foster the transport of air masses from the troposphere into the stratosphere in the vicinity of a typhoon during landfall. To investigate this, the authors analyze output from a limited-area WRF model simulation, along with data from the FLEXPART dispersion model, which is driven by WRF meteorology. A novel algorithm is introduced to help identify air masses that cross the lapse-rate and cold-point tropopause in the tropics. Combined with so-called “clock tracers,” this approach allows the authors to characterize intrusions in terms of location and residence time.

Using their diagnostics, they identify hotspots of air mass intrusion, which are often located near surface orography. Close to the typhoon center, intrusions are deeper, and air masses remain above the lapse-rate or cold-point tropopause for longer periods. In hotspots farther from the center, the picture differs slightly: air masses cross the tropopause (either lapse-rate or cold-point) multiple times, resulting in shorter residence times above the respective tropopause and shallower intrusions. Since this behavior is primarily observed over orographic regions — and given that the tropopause region is characterized by dynamic instability — the authors conclude that orography-induced gravity waves play a major role in this phenomenon.

The topic of stratosphere–troposphere exchange, despite having been studied for a long time, remains of significant importance. In particular, transient phenomena driving this exchange are still poorly understood or have received little attention — often because they are difficult to observe or simulate. For these reasons, I recommend this manuscript for publication after minor revisions. The topic fits well within the scope of *ACP*. The manuscript is well written, clearly states its objectives, and follows a logical storyline. The figures are of high quality, and I appreciate the paper’s focused approach and concise presentation. I have only a few minor comments, which the authors may wish to consider before final publication.

Minor comments (in order of appearance)

L48 “...models and observations (Kunkel et al., 2014), but…” : In Kunkel et al. (2014) only results from idealized model simulations are shown. So here the observational reference is missing here.

L60: What is the vertical grid spacing of the WRF simulation, especially in the UTLS?

L112: Can you please include the criterion for the LRT detection here? I guess it is the one with 2K/km and the 2 km thick layer above? And also Lapse Rate Tropopause; why are the words capitalized?

L149: Can the OGWs be more specifically shown, e.g., using a cross section through the region of the OGWs. And more importantly: the connection of these OGW should be made more clearly to the low Ri values shown in Fig. 6. I would value it, if this connection would be shown in more detail in the manuscript; in the current version it might not be too obvious for many reader to see the OGW signals.

L158/159: Upper Troposphere–Lower Stratosphere => upper troposphere-lower stratosphere

L184: The first discussion around the secondary intrusion and the concept of multiple tropopause crossing is very much like the transit time concept used by

Wernli, H., and M.Bourqui, A Lagrangian “1-year climatology” of (deep) cross-tropopause exchange in the extratropical Northern Hemisphere, J. Geophys. Res., 107(D2), doi:10.1029/2001JD000812, 2002.

Bourqui, M. S.: Stratosphere-troposphere exchange from the Lagrangian perspective: a case study and method sensitivities, Atmos. Chem. Phys., 6, 2651–2670, https://doi.org/10.5194/acp-6-2651-2006, 2006.

L187ff (the discussion around Figure 5): Can you more clearly state what the difference is between Figures 5a and 5b and between Figures 5c and 5d, especially in the figure itself by using a title or in the figure caption? From the text I get: 5a, 5c are for intrusions into the TTL and 5b, 5d are for intrusions into the stratosphere?

Figure 5: When looking at Figure 5 I wondered whether you have the data for each trajectory available from the FLEXPART-WRF simulation and more specifically:

(1) Are any other quantities available along the trajectories? Especially, quantities which would help to show the presence of OGWs? Or to highlight the dynamic instability, in lines 133/134 it is stated that the Richardson number, the TKE and the Brunt-Vaisala frequency are available.

(2) If OGWs play a role I would expect to see some undulations in the trajectories? Is this the case here? If so, where? If not, why?

L275 (and L139): I tried to follow the given link (https://github.com/MassiMart/FLEXPART-WRF_AirIntrusions.git) and it gave me a http 404 error. I only can reach https://github.com/MassiMart, maybe the repository is still private? And also the asset made available when submitting this review was expired.