

## ***Interactive comment on “In-situ observation of Asian pollution transported into the Arctic lowermost stratosphere” by A. Roiger et al.***

**Anonymous Referee #1**

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The paper of Roiger et al. presents a case study for transport of Asian pollution by a warm conveyor belt to the tropopause region and subsequent transport into the lowermost stratosphere. The authors use airborne in-situ data and trajectory calculations to prove their hypothesis about the origin of air and the dynamical history before the measurements. The paper is well written and presents some strong indications for the proposed transport history. All in all, the combinations of analyses are convincing and I recommend the paper for publications after minor changes and after the following points have been addressed.

The authors speculate, that troposphere to stratosphere exchange (TST) occurred during the travel of the air masses from the WCB to the measurement location rather than directly through the ascent. What are the reasons for this hypothesis, since the authors

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state, that most trajectories encountered  $PV > 2$  PVU just after the WCB. Is there any further evidence (see also below).

p.16271: l. 25 and following What is the reason to split the emission data in so many sub-clusters, doesn't this lead to inconsistencies?

p.16272: l. 13 and following What motivates a tracer removal after 20 days, since it strongly depends on the dynamics acting on the individual plume, how efficient the mixing with background is.

p.16273: l. 8: Are the LAGRANTO trajectories initialized along the flight track?

p.16274: l.24: replace 'connected' by 'associated'

p.16280, l.5ff: It is stated that 92% (of the 4.5%) intersected the 2 PVU tropopause. How long did they stay above 2PVU? Was there a criterion to check the time, which the air parcels spent in the stratosphere (to account for frequent reversible undulations around the dynamical tropopause)? What is the maximum PV of the air parcels?

p.16280, l.11: Isn't this a bit contradictive? The WCB is associated with the air streams ahead the surface cold front in the warm sector, which leads to the strongest uplift. This is generally not the cyclone center. Please clarify that statement.

p.16284, l.15: The reference to Plumb and Ko is only correct when looking at really long-lived tracers (long-lived with respect to the underlying transport processes). This is not the case here - especially CO is not covered by the prerequisites in Plumb and Ko.

p.16284, l.18: Ozone = 100 nmol/mol was selected as criterion and not determined from the data, I guess?

p.16286, l.7: The H<sub>2</sub>O ozone correlation - as stated correctly by the authors - is heavily affected by temperature. They interpret the deviating tropospheric correlation as dehydrated. Does this fit to the Lagrangian Cold point, which can be easily deduced from the trajectories?

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p.16286, l.25: Please specify: I guess the enhancements ratio ( $\Delta \text{CO}_2 / \Delta \text{CO}$ ) is meant. Are there any specific values for the CO/CO<sub>2</sub> ratio around? The simple occurrence of positive slopes does not necessarily indicate combustion, since positive slopes of both tracers can occur in normal 'background' conditions. Since this is most likely not the case here, a number would help here. Further, the NO and NO<sub>y</sub> data are correlated with ozone, but anti correlated with CO (see Fig.2). This does not support the conclusion, that strong pollution sources have affected the observations. How do correlations of CO versus NO (or NO<sub>z</sub> versus CO or ozone) look like?

p.16288, l.26: The authors suggest that most of the mixing happened during the travel of the air masses due to stirring and filamentation. How is the evolution of PV along the trajectories? Do they show a PV increase during their travel (e.g. a plot as in Figure 4, but for PV only for TST trajectories).

p.16290, l.27: The statement, that general statement that CO in the LMS exceeds 100 nmol/mol north of the polar jet is misleading. This can happen, but is a strong function of altitude relative to the tropopause - please rephrase.

Check the correct spelling of the reference: Wernli and Bourqui, 2002.

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