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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Stratosphere-troposphere exchange in a summertime extratropical low: analysis" *by* J. Brioude et al.

Anonymous Referee #1

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The paper presents an interesting case study of stratosphere-to-troposphere exchange in a summertime extratropical low by using the reverse domain filling technique (RDF) and backward trajectories to explain unexpected features in observed tracer measurements. Using forward trajectories, the STE events were shown to be irreversible. The value of such a case study lies beside the presentation of a new data set in its use for validation of weather forecast models such as ECMWF or of dynamical processes in chemistry transport models. However, some issues have to be addressed and the structure of the manuscript improved before publication is recommended.

Specific comments:

Major points:

1) Corresponding to the ECMWF PV-analysis in Figure 10a, the air masses of flight section 3 originate in the lowermost stratosphere. The measured values of around 200 ppbv O_3 and 70 ppbv CO are not unusual for this region around 20 K above the tropopause at mid-latitudes (Pan et al., JGR 2004; Hoor et al., ACP 2004). If understood correctly, the discussion about the supposed discrepancy between origin of air masses and tracer mixing ratios of flight section 3 arises from the RDF calculation which attributes tropospheric origin to the air masses. The question is therefore whether we trust the RDF or not. The discussion on P12481 L8-28 might be rendered unnecessary (see also next comment).

2) P12481 L8-28: It seems somehow arbitrary to pick out one specific vertical cross section along the backward trajectories and to start a RDF analysis from this position in a second step. Mixing in other locations along the back trajectories might be missed which produces errors in the interpretation. Please discuss this possibility. A more obvious approach would be to start the RDF calculation from a grid box encompassing the flight track and to determine the air masses processed by the WCB in this box. Eventually, the air parcels surrounding flight section 3 exhibit a more stratospheric character than the ones surrounding flight sections 1 and 2. An error in the starting location of the back trajectories then could have caused flight section 3 to be (wrongly) attributed to the troposphere. The very low O_3 and CO mixing ratios in flight sections 1 and 2 further might be explained by the specific origin of the air parcels, i.e. from the maritime lowermost troposphere in the subtropical region where both species are known to exhibit low mixing ratios (McMillan, JGR 1997). Please check this possibility by calculating 10 day backward trajectories.

3) The structure and readability of the paper should be improved by splitting Section 3 into a method section and a result section. The method section should present the cal-

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culation of the back trajectories and the RDF technique. Clarify if the trajectories used for the RDF technique were also calculated with Lagranto and specify further the used ECMWF fields. The new result section further might be organized in two subsections corresponding to the two separate flights.

Minor points:

4) The used measurement techniques for O_3 and CO, the precision and the accuracy of the measurements should be mentioned in the MOZAIC observation section. The concept of the MOZAIC program should also be explained shortly.

5) A similar study to the present analysis had been carried out by Bethan et al. (JGR 1998). Please include a reference to this work and discuss its relevance for the here presented paper.

6) Please clarify if PV or rPV is depicted in Figure 5 lowest panel. If it is rPV change axis and caption notation and also change the notation of the pressure to rP.

7) Suggestion: The accurate localization of the different air flows in the here discussed split front is expected to be a difficult task for the ECMWF model. Therefore, it would be interesting to analyze ECMWF winds interpolated onto the flight path and to compare it to measured wind directions and speeds. This evaluation would yield further information about how much we can trust the calculated back trajectories.

Technical comments:

Please improve the used language and check the document for typos. The following list might not be complete.

Several pages and lines: 'With regards' is used at the end of letters → use 'with regard to'.

Also change 'interpretated' to 'interpreted' on different pages.

P12467 L7: ...recent study *of* individual CTMs...

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P12467 L20: suggestion: use 'Hereafter' rather than 'Heretofore'

P12467 L25: ...the dynamical coherence of operational *global-scale* analyses...

P12468 L9: Which technique? Improve or remove sentence.

P12468 L22: Reconstruct sentence: 'The synoptic setting involves the baroclinic development of a mid-latitude cyclone on 16-17 over the *East* Coast of the United States...'

P12468 L28: Remove 'to landing': *During descent to New York City...*

P12468 L229: To my knowledge, a sentence cannot start with 'while' if there is no subset.

P12474 L3 and abstract: *Lagrangian* instead of lagrangian

P12474 L16: ...and 5 hPa *in* the vertical...

P12476 L21: A strong sensitivity *to* the initialization...

Title Section 3.3: *Reconstructed*...

P12478 L25: *mesoscale*...

P12478 L27: ...*reaching down* to 350 hPa...

P12485 L24: ...midlatitude cyclones...

P12486 L16: change Fisher to *Fischer*

P12486 L22 and L26: change echange to *exchange*

P12487 L22: *Schoeberl*

Figure caption 2: Suggestion to explain abbreviations or refer to text for further information.

Figure caption 4: Denote x-axis with 'RH(%), O_3 (ppbv)' and remove last sentence 'The

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scale for...'

Figure caption 5: ...Aircraft path is shown *in* Fig. 7 ...

Figure caption 9: Indicate integration time of the RDF reconstruction.

Figure 1 or 2: Suggestion adding flight tracks.

Figure 5: Please show the timeseries of CO instead of using the coloring. This allows better comparison between the two tracers and eventually reveals an expected anti-correlation in the stratospheric parts of the flight.

Figure 6: Denote x- and y-axis with CO (ppbv) and O_3 (ppbv), respectively.

Figure 8,9,10,11,12,13: Use larger font-sizes for the colorbars and label them with PV.

Figure 7: Suggestion to denote the two black lines i.e. the different locations at which the cross sections are taken with Roman numbers I and II and label them correspondingly in Figs. 11 and 12.

Figure 10: Please label flight section 3.

Figure 13: Group S2 is not labeled in the figure and it is not clear if the white shaded regions are supposed to indicate groups S2 and S3. Improve figure caption.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 12465, 2005.