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Interactive comment on "Analysis of water vapor LIDAR measurements during the MAP campaign: evidence of sub-structures of stratospheric intrusions" *by* P. D'Aulerio et al.

P. D'Aulerio et al.

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Major comments:

1. Accordingly with the remarks of both reviewers, we changed and (hopefully) clarified the structure of the section 3. The differences between the present and the last version are not detailed here, because large number of corrections has been included Some of the references are conserved in the new version, in particular Pierrehumbert, 1998 and Methven et al., 2003, that are important references in field of the water vapor simulations.

2. Although there is not a dramatic difference between the two cases, these present

some appreciable differentiations in the evolution of the tracers and in the folding structure. In the first case, a two fold structure is evident. The dry layer A seems to conserve well the water vapor concentration, trace of the upper level origin, (but this is not case of the Potential Vorticity, decreasing from 3.6 PVU to less than 1 PVU along the trajectory). The shallow layer B, as shown in the cross section and confirmed from the tracer values (both in PV and water vapor), is more similar to a filament detached from the primary fold than a part of a reversible system. In the second case, only the lower layer B has a direct relationship with the intrusion and the values of PV and water vapor could be significant of a mixing (also if this is not sufficient to determinate this), although this appears still connected to the principal intrusion (as remarked by the first reviewer). Further, the second case represents a convincing proof of the validity of LTR method. In fact, a better quantitative and qualitative representation of the measured distribution is produced respect to the first case that suffers for a greater dispersion of trajectories. For these motivations we consider relevant to retain both case studies

3. The site of radiosoundings launch, (Milano-Linate) is south-east from lidar site and we interpret the discrepancy lidar-radiosonde (qualitatively corresponding to a shift of 3 hours) as a combined effect of stirring and east-ward displacement. The first Linate radiosounding starts at 17.30 (about 3 hours before the lidar observation) and the only layer shown in the plot (between 3-8km), corresponds to the primary fold, the same that generates the layer (B) in the lidar data. The second and upper level tongue (A on the lidar plot) appears in the radiosounding of midnight. At the same time the tongue B is rather completely dissipated above the lidar site. We simulated time evolution of water vapor at the coordinate 45.5°N and 9.5°E (closer to Milano Linate), by the same method than Fig. 1. This confirmed the differences detected in the two measurements. We could provide these images if requested.

4. The lidar measurements between 8 November at 22.00 and 9 November at 2.00 UT show a decrease of water vapor content above 5km. The corresponding back-trajectories show a common geographical origin of air particles ending at different al-

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titudes (between 5 and 8 km). For sake of clarity we consider not necessary includes these figures in the paper, but we accordingly modified the text. We could provide the corresponding figures if requested.

5. The table 1 and 2 have been removed

6. We had chosen to present the cross section at 15.00 UT (about 5 hours before the beginning of the lidar observations) because as highlighted in the text, the model, at the temporal stage of the lidar measurement, well reproduces the upper dry layer (A), but not the shallow one (B). Besides, the main purpose for showing these cross sections is not the validation of the simulation, but the support to the interpretation of data. Therefore, the cross section at 15.00 gives the best representation of the context of the measurement, clearly highlighting the presence of a double structure and the relationship between the shallow and lower filament with the intrusion. We add the simulation at 20.00 UT. As can be observed, the lower layer is still identified but this appears reproduced with much less accuracy, especially in PV, with respect to the previous stage. The comparison between the two figures can also clarify the evolution of the fold with the time.

7. The time runs from right to left in Fig. 3, Fig. 5, Fig.4, Fig. 6, as required

Minor comments:

The text has been modified accordingly with the reviewer comments 1-3, 5-8

2. p.8328 l. 8 the text is modified following your request. The expression “breakout phase” is replaced with “stage of dissipation”

4. In the new version we provide three references on cyclogenesis effect, giving some hint (Rossa et al., 2000; Browing et al., 1995; Vaughan and Worthington, 2000)

7. p 8331 l. the following sentence is added to clarify the data properties “In the data processing, a time integration is performed and a 7-points rectangular smoothing is applied on the vertical above 6000 m, with the effect of reducing the vertical resolution

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from 75m to 525m.

8. p.8334 l. 13 “its breaking phase” is replaced with “the stage of dissipation”

9 we changed the expression “average fall speed” in fact, we agree with the reviewer remark: the use of this expression can lead to a misleading since “fall” is meaning of pure vertical descent due to gravity effect. The descent speed observed by lidar (in eulerian frame) is the result of the transport of sloping filaments.

10. We agree that the term “dehydration” is not appropriate for the phenomena described. We designate the presence of dry air with values of water vapor concentration lower than the usual as dryness. Corrections in the new version are included in the detailed list

11 p.8336 l.10 this is due to the symmetry of the streamer, that is “meridionally elongated”. As is observable also from figure 4, fixing latitude and altitude, at different longitudes, we obtain completely different characteristic. Take a similar range in longitude, means to average different kind of trajectories with an effect of “smoothing” the horizontal gradient.

12 An erroneous attribution of the time of the simulated profile was done in Fig.3: this is actually at 1.00 UT and accordingly modified on the figure caption

13 The expression “vertical speed “ is replaced by “apparent lowering speed” (see comment 9). In this case we refer to the rate of change of the lidar profile, in order to compare the same property on the LRT reconstruction

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Interactive comment on Atmos. Chem. Phys. Discuss., 4, 8327, 2004.