# Reply to referee's comments

First, the authors acknowledge the referees for their comments and suggestions.

Please note that changes are in red in the revised manuscript (acp-2010-262_manuscript_revised.pdf), and modified figures are enclosed in a separate file (acp-2010-262_figures_revised.pdf).

## Responses to Referee # 2

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| **Comment 1** | Uniformisation of the mapped data. To help the reader, I think polar maps as in Figure 3 should be used throughout, for example on Figure 4 and 5, with similar set of dates. The authors could show, in addition, a zoomed plot with MIMOSA, as a separate figure. |
| Reply | Following the referee's suggestion, figures 3-5 have been modified and rearranged so that the analysis of LS (475K) and US (700K) levels are uniform.<br>In the modified version we make use of $N_2O$, $O_3$ and APV maps for 4 days (5, 11, 16 and 17 April 2008) at both 475-K and 700-K isentropic levels.<br>Moreover, as suggested by the Referee, since the MIMOSA model is driven by ECMWF fields, the use of ECMWF data in Figure 4 is not necessary. In the revised version we removed Figure 4 and renumbed the figures accordingly.<br>See the modified figure file. |
| **Comment 2** | The authors present a careful analysis of their observations, but the discussion section would benefit in drawing analogies with known similar situations. In particular, similar contrasting transport in the low and mid stratosphere are found during summertime low ozone episodes at mid-high latitudes of both hemispheres (Orsolini et al, QJRMS, 2003; Jackson , cited, 2007). These would be opposite situations (polar air aloft and low latitude air below), but the analogy is worth to highlight. |
| Reply | In order to take into account this suggestion, the following paragraph has been added in subsection (3.2) :<br>In fact, Figure 3 illustrates … . *This finding is consistent with previous studies on meridional transport in the northern hemisphere. In fact, Orsolini et al. (2003) reported on a low-ozone pool of stratospheric air in the summer Arctic. By the use of ground-based and global datasets, together with trajectory modelling, they showed that the observed low-ozone event (occurred on July 2000) was dynamically driven, even though it was initially caused by active photochemistry* |

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| | *over Arctic. Moreover, Jackson (2007) reported on similar low-ozone events, but in the southern hemisphere, by assimilating EOS-MLS (Earth Observing System - Microwave Limb Sounder) observations in the Met Office data-assimilation system.* |
| **Comment 3** | Some information on the summer to winter transition and the autumn build-up of the vortex would be useful to show when in the seasonal cycle these measurements were taken. Perhaps in connection with Figure 2, to relate it to the O3 seasonal cycle. |
| Reply | The comment has been taken into account in the revised version: the 2nd paragraph of subsection 3.1 has been modified accordingly:<br><br>**" … Figure 2** *illustrates monthly climatological total ozone variations as derived from KER-SAOZ daily records, together with the 2008 SAOZ daily observations. The minimum of the annual ozone variation appears over KER by March and it is about 290 DU. It corresponds to the summer-to-winter transition in the southern hemisphere."* |
| **Comment 4** | The use of ECMWF data in Figure 4 is hardly necessary, or the authors should justify why it is used. The MIMOSA model is driven by ECMWF fields, and has been shown to reproduce filaments observed –more coarsely- in the ECMWF analyses. ECMWF ozone seems hardly necessary unless it is integrated more with Figure 2 and shown as in Figure 3,5. |
| Reply | We agree with the comment. The MIMOSA model is driven by ECMWF fields, the use of ECMWF data in Figure 4 is indeed not necessary. In the revised version we removed Figure 4 and renumbed the figures accordingly.<br><br>See the modified figure file. |
| **Minor Comments** | p5;l7. Specify "at that altitude"<br>> modified<br><br>p5;l35. The characteristics of the assimilation run, relevant for this study ought to be clarified a bit more. The MOCAGE CTM is said to be driven by Arpege. Is the GCM run in assimilation mode ? or is the CTM driven off-line rather by ECMWF analyses? Please clarify.<br>> In the revised version, the MOCAGE characteristics have been detailed. For more clarification, references have been added and subsection 2.2 (about MOCAGE assimilation) has been partially rewritten (3rd paragraph), as follows:<br><br>MOCAGE (MOdèle de Chimie Atmosphérique à Grande Echelle) is a 3D chemistry transport model *which covers the planetary boundary layer, the free troposphere, and the stratosphere. It provides a number of optional configurations with varying domain geometries and resolutions, as well as chemical and physical parameterization packages. It has the flexibility to use several chemical schemes for stratospheric and tropospheric studies. MOCAGE is used for several applications: operational chemical weather forecasting in Météo-France* (Dufour et al., 2004), *tropospheric as well as stratospheric* |

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| | *research studies* (e.g. Claeyman et al., 2010; Ricaud et al., 2009a,b), *and data assimilation research* (e.g. Cathala et al., 2003; Semane et al., 2007; El Amraoui et al., 2008a,b; Semane et al., 2009). *In this study, MOCAGE is forced dynamically by external wind and temperature fields from the ARPEGE model analyses, the global operational weather prediction of Météo–France* (Courtier et al. 1991). *The MOCAGE horizontal resolution used for this study is 2° both in latitude and longitude and the model uses a semi-Lagrangian transport scheme. It includes 47 hybrid (σ, P) levels from the surface up to 5 hPa, where σ = P/Ps; P and Ps are the pressure and the surface pressure, respectively. MOCAGE has a vertical resolution of about 800m in the vicinity of the tropopause and in the lower stratosphere.*<br><br>**Updated References**<br><br>*Cathala, M.-L., Pailleux, J., and Peuch, V. -H.: Improving chemical simulations of the upper troposphere – lower stratosphere with sequential assimilation of MOZAIC data, Tellus, 55B, 1–10, 2003.*<br>*Claeyman, M., Attié, J.-L., El Amraoui, L., Cariolle, D., Peuch, V.-H., Teyssèdre, H., Josse, B., Ricaud, P., Massart, S., Piacentini, A., Cammas, J.-P., Livesey, N. J., Pumphrey, H. C., and Edwards, D. P.: A linear CO chemistry parameterization in a chemistry-transport model: evaluation and application to data assimilation, Atmos. Chem. Phys., 10, 6097-6115, doi:10.5194/acp-10-6097-2010, 2010,*<br>*Dufour, A., Amodei, M., Ancellet, G., and Peuch, V.-H.: Observed and modelled "chemical weather" during ESCOMPTE, Atmos. Res., 74, 161–189, 2004.*<br>*Ricaud, P., Attié, J.-L., Teyssèdre, H., El Amraoui, L., Peuch, V.-H., Matricardi, M., and Schluessel, P.: Equatorial total column of nitrous oxide as measured by IASI on MetOp-A: implications for transport processes, Atmos. Chem. Phys., 9, 3947–3956, 2009a*<br>*Ricaud, P., Pommereau, J.-P., Attié, J.-L., Le Flochmoen, E., El Amraoui, L., Teyssèdre, H., Peuch, V.-H., Feng, W., and Chipperfield, M. P.: Equatorial transport as diagnosed from nitrous oxide variability, Atmos. Chem. Phys., 9, 8173–8188, 2009b,*<br>*Semane, N., Peuch, V.-H., El Amraoui, L., Bencherif, H., Massart, S., Cariolle, D., Attié, J.-L., and Abida, R.: An observed and analysed stratospheric ozone intrusion over the high Canadian Arctic UTLS region during the summer of 2003, Q. J. Roy. Meteor. Soc., 133(S2), 171–178, doi:10.1002/qj.141, 2007.*<br><br>p7; l5-11: section is long, could be simplified<br>> the section has been shortened as follows:<br>" *There are numerous ways to measure ozone in the atmosphere, but they fall broadly into two categories: measurements of total column ozone and measurements of the vertical profile of ozone. The column abundance of ozone can be derived from differential absorption measurements in the ultraviolet Huggins band, where ozone exhibits strong absorption features.* "<br><br>p7; l25; no need to mention a trend here. There is an increase in total ozone<br>> modified<br><br>p7; l30. Use of word "global" is misleading here (Same on p8;l13). "On the global" could be removed<br>> "on the global" is removed.<br><br>p8;l15. Remove "pretty good agreement". Give percent estimate<br>> modified: the expression " *we find a pretty good agreement* " is replaced by<br>" *we find less than 6% of discrepancy* "<br><br>p9;l8. Unclear sentence starting with "It can be seen: : :". Rather: "There are some filamentary structures extending from polar regions to the subtropics: : :" |

> modified: the section “ *It can also be seen from this plot that the polar ozone is not bordered to the polar region. There are some filamentary structures with large scale extensions up to subtropics* ” is replaced by

“ *There are some filamentary structures extending from polar regions to the subtropics* ”

Figure 2a,b should be combined in one, as there is much overlap.

> modified: Fig.2ab are now merged into one.

Figure 1. Hard to distinguish the curves corresponding to latitude bins 15-25S and 75-85S. Use colour, different symbol or thickness.

> modified: the 15-25S and 75-85S curves are depicted in colour