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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "On the extraction of wind information from the assimilation of ozone profiles in Météo–France 4D-Var operational NWP suite" *by* N. Semane et al.

N. Semane et al.

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We thank the referee for his/her remarks. We will quote the comments of the referee and provide our reply below.

- Paper layout: "For the general meteorological community, I think the headline result is the fact that assimilating EOS MLS ozone data reduces lower stratospheric wind errors. However, this result (Figure 7) is stuck at the end of the paper almost as an afterthought! This result needs to be more prominent and the way to do this is to move Figure 7 ahead of Figures 5 and 6 and to discuss the wind errors prior to the DFS and error variance reduction diagnostics. These diagnostics are a very useful way of deducing the impact of the EOS MLS ozone data, but this analysis should

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appear after the key results (ie Figures 4 and 7). Other parts of the paper (eg the abstract) also need to be changed to reflect the reorganisation of the paper."

≻≻ **The paper has been reorganised as suggested by the referee.**

- pp 16479-16480 (a) "Since the EOS MLS data are highly effective at constraining ozone analyses in the lower stratosphere, and the ozone photochemical lifetime is long here, it makes sense to perform another experiment where the MOCAGE step is missed out all together and the 6 hr forecasts are produced using ARPEGE only. This would test out the hypothesis at the top of p 16480 that is doesn't matter whether MOCAGE or ARPEGE is used for background error calculation (and, by extension, the 6 hr forecasts). If the authors have already done this experiment, it may be useful to report the results of it in the paper. If not, it£s worth discussing in more detail exactly what extra MOCAGE gives you compared to ARPEGE in a 6 hr assimilation window (eg without MOCAGE is there drift within the 3 month experiment period?)"

≻≻ **The use of MOCAGE for the background initialisation at the beginning of each assimilation cycle is a key component of this study. This initialisation replaces the ARPEGE transported ozone field by more realistic values given the fact that the MOCAGE CTM takes into account many processes, which simulate more accurately the ozone evolution in comparison to the only advection process of the ARPEGE model. Moreover, the ARPEGE ozone transport scheme is not very robust, even in places where the photochemical lifetime is very important as the UTLS, in comparison to the MOCAGE transport scheme. Therefore, the ozone field of ARPEGE is updated after 6 hours of simulation in order to prevent its divergence.**

- pp 16479-16480 (b) The background error is calculated using 12 and 36 hour

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ARPEGE forecast differences. The hypothesis on p 16480 (see a) above) may actually be weak here, since Figure 1d shows that over a 24 hour period MOCAGE and ARPEGE fields differ by a relatively large amount (often over 10%) near the tropopause. It would be useful to recalculate the background errors using MOCAGE forecast differences and compare them with those calculated from ARPEGE forecast differences. What impact might this have on the results presented?

≻≻ **We agree that it would be useful to recalculate the background errors using the MOCAGE forecast differences and compare them with those calculated from the ARPEGE forecast differences. Now as the dynamical impact of the real ozone observations is found to be positive, the next step of this work will concentrate more on the optimal estimation of the background error covariance matrix, which should be based on the MOCAGE fields and not on the ARPEGE ones.**

-p 16480 l 15-18. Using an ozone climatology in the assimilation of HIRS 9 and AMSU 18 radiances may be problematic because this may lead to a degraded assimilation of these data, compared to the case where background ozone is used in the radiance assimilation. This is particularly important given that both channels have ozone Jacobians that peak in the UTLS, and since assimilating EOS MLS data seems to give a more accurate analysis in this region (see Figure 4: this Figure could be extended to plot departures of the Fortuin climatology from observations to confirm the above). Thus, using background rather than climatological ozone in the radiance assimilation could lead to even larger positive impacts of wind errors than those shown in Figure 7. Again, if the authors have already run an experiment like this, they should report the results from it in the paper. If not, the points raised above should be discussed.

≻≻**The primarily objective of this study is to examine how ozone data generate**

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wind increments. The main outcome of this work is the positive impact of these increments on the wind analyses and forecasts. The upcoming work will attempt to take the maximum advantage offered by the designed MOCAGE-ARPEGE assimilation system.

-p16481/Figure 4: The results shown are not surprising since the observations (ie EOS MLS) used to produce the plot are not independent, ie they are being assimilated by the system (at least, that is the impression given by the text). So this Figure only shows that the assimilation system is performing properly. To be more meaningful, Figure 4 needs to be repeated using independent observations (eg from ozonesondes).

≻≻**We agree that the use of independent observations will be more meaningful. This should be done in another study.**

-p16475, l 19-23: I think at least some of the papers listed (eg Holm et al) take the approach of directly specifying correlations between wind and ozone in the background error covariances. It should be mentioned that this approach has been used in many of the papers referred to, and clarified that in the study here, the ozone-wind relation-ship is represented differently, via the tracer transport equation (and its adjoint) and its evolution within the 4D-Var assimilation window.

≻≻**In order to meet the referee's suggestion, the first paragraph of section 2 has been modified as follows :**
Thanks to the 4D-Var assimilation process, ozone observations affect not only the analysis of the ozone field itself, but also the analysis of the wind field through the adjoint of the ozone advection model. In this study, the 4D-Var ozone-wind relationship within the assimilation window is, thus, investigated in

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an univariate approach in which the wind and ozone are only coupled via the tracer transport equation and not via the background error covariances.

-p16476 l 9 and l 14: "On the one hand" and "on the other hand" do not aid the clarity of the text here. The former should be deleted and the latter should be changed to "In addition".

≻≻**Done.**

-p 16476 l 21: I don't think you are attempting to "nearly" do anything! Better to rephrase this as "..in this study attempts to meet these requirements as closely as possible through.."

≻≻**Done.**

-p16477 Sect 2.1: Numerous other EOS MLS ozone assimilation studies have recently appeared and these should be referenced - Jackson (2007, QJRMS); Stajner et al (2008, JGR): Feng et al (2008, JGR)

≻≻**Done.**

-p16481 / Fig 4: More detail is needed in the discussion of these results: Why is northern hemisphere ozone overestimated? (I know a reference to El Amraoui et al is given but a summary of the relevance results from this paper should reappear here); why is southern hemisphere and tropical ozone below the 46 hPa level under-estimated?

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≻≻**The Northern hemisphere ozone overestimation appears to be linked to an overestimation of the equator to pole meridional circulation due to the meteorological forcing. A similar diagnostic has been made with the long-term ozone simulation in Clark et al. 2007, and in "age of the air" calculations with CTMs. The Southern hemisphere and tropical ozone underestimation (below the 46 hPa level) can be partly due to the meridional circulation. This study deals with the January-April period, which corresponds to a poleward meridional circulation in NH. Therefore, the CTM overestimates ozone in the NH and vice versa in the SH.**

-p16483, l7: Add "if" ("In fact, if it is assumed..")

≻≻**Done.**

References

Clark, H. L., Cathala, M.-L., Teyssèdre, H., Cammas, J.-P. and Peuch, V.-H. 2007 Cross-tropopause fluxes of ozone using assimilation of MOZAIC observations in a global CTM, *Tellus*, **59B,** 39–49.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 16473, 2008.