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Atmospheric Chemistry and Physics Discussions

Interactive comment on "High resolution assimilation of IASI ozone data with a global CTM" *by* B. Pajot et al.

Anonymous Referee #1

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Review:

High resolution assimilation of IASI ozone data with a global CTM

by B. Pajot, S. Massart, D. Cariolle, A. Piacentini, O. Pannekoucke, W. A. Lahoz, C. Clerbaux, P. F. Coheur, and D. Hurtmans

The paper is a technical study that compares ozone model simulations and assimilation experiments of MLS and IASI retrievals at two horizontal resolutions (T42 and T170). The authors use the MOCAGE CTM, which applies the Cariolle- Parameterisation for the ozone chemistry and apply a 4D-VAR data assimilation technique as implemented in the Valentia assimilation system. The assimilated observations are aggregated to super-observations at the two model resolutions. Model and assimilation experiments

are carried out for one month (September 2008) and are validated against ozone sondes, OMI total column retrievals and the ozone analyses of ERA interim.

The title of the paper might benefit from a revision because (i) it does not mention the assimilated MLS data, (ii) the term “global CTM” implies that a multi-species chemical mechanism is applied and (iii) the term “high resolution” is relative.

The study is thoroughly carried out and includes some interesting aspects on the constructions of super-observations and the scale dependency of the background-error specification. However, it does not contain enough scientifically interesting results within the scope of ACP.

General comments:

The motivation for the construction of the combined MLS and IASI data sets remains unclear. Why is a combination of the two data sets needed and why is beneficial? How does the assimilation of either MLS and IASI compare to assimilation the combined data set.

The Coriolle chemical scheme has proven to be very useful for the simulation of stratospheric ozone chemistry in assimilation systems. It should be noted that it is based on the relaxation to modelled 2D climatological temperature and ozone fields, which are of low resolution. This means that the study can not really explore the rather interesting aspect of the scale-dependency of the chemical conversion, in particular during the ozone hole formation. The “scale” of the applied linear scheme is the same in the T42 and the T170 experiments and it is genuine resolution is probably even coarser then T42.

Since the study does not apply a full chemistry scheme, the model resolution can not be compared in a fair way to CTMs with a more less complex chemistry scheme. The model resolution should be compared to applications of simplified schemes for instance at operational NWP centres (e.g NCEP, ECMWF, UKMO). The horizontal resolution of

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these application is higher than T170 in most cases. In this respect, the term “high resolution” seems to be an exaggeration.

The methodology to combine the IASI and the MLS data needs to be better explained. Is the combined data set a partial column data set (as MLS) or a total column data set (as MLS). If the IASI data are bias-corrected according to the MLS data, how big is this correction. How are IASI’s total column observations corrected against the MLS partial columns. Is the aggregation to the T42 and T170 resolution done before or after the merge of the MLS and IASI data. Since IASI and MLS represent different horizontal resolutions, what is the effective resolution and the observation error of the combined data set.

Differences in the modelled ozone total columns fields with different model resolution (Ml vs. Mh) are attributed only to differences in the vertical velocity. It should be better explained why the authors come to this conclusion. Convection or numerical aspects of the advection scheme could also play a role. Further, it has to be better explained how the vertical velocities for the T42 experiment were derived from ERAI in a consistent way.

The resolution dependency of the background error statistics and the observation error statistics is a vital point for the validity of the study. It seems that the background error standard deviation is considered to be the same for the T42 and T170 experiment, i.e. it is interpolated from values derived for a 2x2 grid. What is the motivation for this? The background errors statistics should be model-resolution dependent.

The construction of super-observations by averaging observation over a given area will change the observation error statistics. The random observation error of the super observations should be smaller than the one of the individual observations. The differences in the random and representativeness error will depend on the variability of the observation within the averaging area. Has this been taken into account? More detail on this is needed to better understand the impact of the technical averaging procedure

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to the T42 and T170 grid. An alternative approach to the averaging of the observation is to randomly pick one observation. The differences between the two approaches should be discussed.

The validation of the model and assimilation result for only one month seems too short. What was the motivation to choose this period? The comparison against ozone sondes and OMI is useful. It should be specified, which ozone sondes were used. I am not so sure what can be learnt from the comparison with the ERA interim data set apart from a simple sanity check. Both ERA-interim and the MOCAGE system are similar in the horizontal resolution, the chemical scheme (Cariolle) and the assimilation technique (incremental 4d-VAR) and both assimilate MLS.

Using the IASI data as total columns without the application of averaging kernels seems to be a missed opportunity. In particular, the tropospheric signal of the IASI data could have been exploited in a better way. It is complementary to the MLS data which provide a more a stratospheric profile.

Specific comments:

P 29358

l 11 The tropospheric columns of MLS have a big error and its use is not recommended.

L 23 If it so difficult to combine the data why combine them?

P 29359

L 13 MOCAGE of this study does not use a full chemistry scheme – please add references for applications with simplified schemes (Geer et al. 2007)

L 27 The coupled chemistry assimilation system at ECMWF (using the full chemistry scheme of MOZART-3) has a resolution of about 1.1° and finer (TL159 and TL255) The system was applied for multi sensor ozone assimilation during the period August-December 2008 (Flemming et al. 2011, ACP)

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P 29361

L 4 What is the vertical resolution and the model top? How is convective transport modelled?

P 29363

L 3 It would be very interesting to quantify the impact of the assimilation of the IASI data with and without AK for the low resolution to get a feeling of the importance of this simplification.

P 29364

L 20 The reduced grid has 512 longitude points only near the equator

P 29366

L 14 What is the motivation of this choice of stations. Please provide better information on which stations were used.

L 23 This sort of stratification seems not justified if only 11 stations were used (mainly in the SH)

P 29367

L 9 Provide more information on the processing of the meteorological fields for the T42 and T170 runs. Is it simply a truncation of the spectral fields? How are the vertical wind fields obtained?

L 17 see the general comment

P 29372

L 18 Why does this threshold does not depend on the resolution?

P 29373

L5 Since the consistency measure deteriorates if no IASI data are available, does it

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mean that the error measures of MLS is not correctly specified ?

P 29375

L 2 “significant” = is this based on a statistical test

L 26 Please clarify how the vertical winds are obtained and if they are consistent with the horizontal winds, or simply interpolated from the ERAI vertical winds? How is convection treated in the model?

P 29376

L 1 The title of this is section is confusing – please mention that Ahl and All will be compared, i.e. the impact of the resolution of the model and not the observations.

P 29379

L 25 The following paragraph is not clear. OMI has been assimilated in ERAI.

P 29380

L 1 Why is Ahh treated in a separate section ?

L 18 The length scale is the correlation length of background (model) error. It should reflect the resolution of the model and not the resolution of the observations.

Figures:

Please avoid the comment “see text for details” in the figure captions. Try to say what the values mean (improvement etc.)

Figure 9 Should be complemented with a figure of the biases

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