Anonymous Referee #1

Overview

This paper proposes a method to estimate the error covariances of ozone-sensitive Infrared Atmospheric Sounding Interferometer (IASI) channels and to evaluate their impact on the ozone analyses in the MOdèle de Chime Atmospherique à Grande Echelle (MOCAGE) chemistry transport model. A set of 280 channels between 980 and 1100 cm^{-1} is used for this study. The author chose to diagnose his observation-error covariance matrix (**R**) using the method of ***Desroziers et al. 2005***, which allows the estimation of inter-channel error covariances. Different 3D-Var data assimilation experiments are performed to provide ozone analyses that have been compared to independent data (ozone-sondes, the Microwave Limb Sounder (MLS) and the Ozone Monitoring Instrument (OMI)).

General Comments

Overall, the paper is well structured. The improvement in the quality of the figures is noticeable. This study deals with an interesting and in progress subject, which is data assimilation in chemistry transport models. The comparisons between observation-errors according to surface types and between day and night are interesting. However, a guideline is missing. What is the main objective of this paper? To diagnose an **R**-matrix or to improve ozone analyses using a diagnosed R-matrix?

Then, I understand that it is long and expensive to carry out these experiments but I wonder about the significance of an experiment of one month. It would have been beneficial to continue these experiments over 2 months, as well as over two distinct periods (summer and winter). In addition, this paper lacks a discussion about the bias correction that may be needed for ozone-sensitive channels. A comparison with the work of ***Han and McNally, 2010*** would have been relevant.

Finally, it is useful and important to refer to previous studies, however the constant reference to the work of ***Emili et al. 2019*** is over-exploited. This paper would benefit from providing all the technical information required for a good understanding of the characteristics of the experiments. I will provide you some specific comments on this in the following.

Specific Comments

Title: I think it is important to specify in the title, that this work is carried out in a chemistry transport model.

P1, L6: « … between 980 and 1100 cm^{-1} » I suggest adding that this spectral range includes ozone-sensitive channels and atmospheric window channels.

P1, L11: « The computational cost … » This sentence is useless without explanation. I suggest you delete it or add a short comment.

P2, L30: « … impact on analysis accuracy. » Specify that this is the impact on the ozone analysis.

P3, L2: There are more recent studies on the same subject that you can reference:
Weston et al. 2014, Borman et al. 2016, Tabeart et al. 2020, Coopmann et al. 2020

P3, L29: « … the radiative transfer model RTTOV » Most recent reference to the work of *Saunders et al. 2018*.

P3, L31: « …Starting from an atmospheric … » Specify that RTTOV requires a vertical temperature and humidity profile.

P4, L6: What about other chemical variables (CO_2, CH_4, CO, N_2O, SO_2)? Do you use reference profiles? Which coefficient file do you take into account?

P3, L17: Indeed, the observation-error variances and observation-error covariances plays a fundamental role in the data assimilation process. In addition, background-errors are also very important in this process. For the purpose of consistency, It is required, at least, to show the background-error variances or background-error error standard deviation, as well as, the background-error correlations matrix.

P3, L19: « as a percentage of the observation values. » What does this percentage look like?

P3, L22: Are there other variables included in the control vector?

P5, Table 1: Can you provide more information about the ozone background?

P5, L15: « … co-located land mask … » Wouldn't it be the "Land Sea Mask" instead?

P5, L16: In this case, from which satellite platform are IASI observations extracted? MetopA, B, C?

P6, L20: Another reference to *Emili et al. 2019* … It would be very useful to summarize the configuration of the experiments in a table.

P6, L27: Can you compare these ozone background-error standard deviation with other values used in recent research?

P7, L11: On what criteria were these channels identified as sensitive to water vapor?

P8, L18 to L28: This paragraph is complicated to follow and it is a pity because it is important for the next step. I suggest you summarize the different configurations in a table.

P10, Figure 2: Correlation matrices can vary between -1.0 and 1.0. I expected to see negative correlations between some channels in the atmospheric window and some ozone-sensitive channels. Why not represent the matrix between -1.0 and 1.0, centered on white at zero?

P12, Figure 5: Same remark as above about the color scale.

P12, L8: The naming of the experiments is not appropriate because one could confuse Control and Reference. I would suggest **RdiagExp** instead of ~~**RefExp**~~.

P14, L4: It would be useful to explain the physical link between skin temperature and ozone in the assimilation of infrared observations. Is there any consideration of inter-variable background-error correlations between O_3 and T_{skin}?

P14, Figure 7: There is also increase in difference on land using **RfullExp**, mainly in Africa and South America. This can be related to the differences in observation-errors depending on the surface...
In addition, there are too many pixels on the map. It would be interesting to average by box in order to better exploit the information provided by this Figure.

P17, L15 to L17: This paragraph is not clear... Where does this third estimate come from? It does not seem to me to have seen any explanation for it before. If this is the case, it is not explicit and needs to be clarified.

Conclusions: I find that there is a lack of discussion about:

IASI channels between 1000 and 1070 cm^{-1} are mainly sensitive to ozone above 100 hPa, which poses the challenge of using other observations for a complete analysis of ozone over the entire atmospheric column...

Similarly, the high sensitivity of the ozone channels raises the problem of the amount of information remaining after a cloud detection...

Finally, work on background-errors is significant for the distribution of ozone increments...

Technical Corrections

P1, L4: « Modèle de Chimie Atmosphéri**que** à Grande Échelle »

Throughout the paper: I suggest « **Chemistry Transport Model** » instead of « Chemical transport model »

P1, L5: « … already adopted in numerical weather prediction centers » This is not the case for all centers, « … already adopted in **some** numerical weather prediction centers »

Throughout the paper: Beware of the systematic use of « Furthermore ». Vary the adverbs.

P2, L8: « … to construct a realistic **picture** of the … » The term « picture » is not appropriate, I suggest changing the word.

P2, L22: « …uncorrelated, **some** Numerical Weather Prediction … »

P2, L31: « … evaluate their impact on the **ozone** analysis accuracy »

P3, L19: « …. MOCAGE is ~~fed with~~ **forced by** meteorological … »

P5, L5: « … the polar-orbiting satellite Metop-A**, B and C** launched … »

P6, L24: « The **ozone** forecast-**error** standard deviation … »

P6, L27: « The **ozone** background-**error** standard deviation … »

P7, L1: « The **ozone** background-**error** covariance matrix … »

P9, L12: « … we present the **diagnosed** correlation matrix … »

Throughout the paper: Be careful to capitalize the words « Figure »

P14, L16: « … to converge after a ~~certain~~ number of iterations »

Throughout the paper: Write rather with dashes « observation-errors, background-errors , ozone-sensitive, … »

P15, L22: « … encountered in these regions **in** the stratosphere … »