Atmospheric
Measurement
Techniques

Discussions

Interactive comment on "Estimation of the error covariance matrix for IASI radiances and its impact on ozone analyses" *by* Mohammad El Aabaribaoune et al.

Anonymous Referee #2

Received and published: 28 September 2020

This manuscript describes the estimation of errors and inter-channel error correlations in ozone and surface sensitive IASI observations. The estimated covariance matrix is then used when assimilating IASI radiances in the MOdèle de Chime Atmospherique à Grande Echelle chemical transport model. Accounting for correlated error in chemical transport models is a new and interesting area of research and the authors show benefit from using the new IASI error covariance matrix. There are some issues that need to be addressed, which I have outlined below.

General comments:

The authors present IASI error correlations for different surface types and for land/night.

I thought these results were interesting, but these matrices were not used in any of the assimilation experiments presented. I would welcome a discussion on why the separate treatment of the land/sea covariance matrices did not yield significant results. Otherwise I think the land/sea and day/night results could be cut.

The correlation matrices that are plotted show very strong inter-channel error correlations and almost look singular. What are the final condition numbers of the reconditioned covariance matrices? It seems that reconditioning was only used to correct negative eigenvalues, which could result in a nearly singular matrix. In fact I was surprised that the use of these matrices lead to a faster convergence of the minimization algorithm. What is the minimization algorithm, and does it include a preconditioner that depends on R?

Radiance bias correction is important in the assimilation of IASI channels that are sensitive to the surface and ozone. Was bias correction used and if so, what method? If not, were significant biases observed in the IASI observations?

The assimilation experiments were run for a 1 month period. Is this long enough to quantify the significance?

Are SBUV observations available for assimilation or validation of results?

The quality of English language should be improved before accepting this manuscript.

There are several incorrectly cited works and the references need to be carefully checked.

Specific comments:

P2 L4 and P5 L5, IASI is on Metop-A, B and C. But only Metop-A was available during the period of this study.

P2 L16 Other references exist that discuss sources of IR error and error correlations. Representivity errors can also contribute to inter-channel error correlations.

P2 L23 Campbell et al 2017 is another study to cite here.

P2 L31 Is the main objective to study the impact on ozone analysis accuracy? Also I think it is worth mentioning here that this is within the framework of a CTM.

P3 L1 There are numerous other studies that could be cited here.

P4 L22 Does the control vector include any other variables?

P5 L16. A brief discussion of channel selection is warranted. The abstract mentions that 280 channels are used, but this is worth restating here.

P6 L21 What observations are being assimilated? Assimilating observations from OMI, SBUV or ozonesondes could help anchor the bias correction of IASI ozone channels.

P7 L18 Change "missing" to "absence." Is there a better justification for this assumption?

P8 L1 There are many other references that should be cited in addition to Stewart et al, 2009. In addition, there have been a few theoretical studies on the Desroziers method that could be cited here.

P8 L8 How many days of data were used in the computation? How many days of data were used for the re-estimations?

P8 L9 The term "positive definite" is typically not used when discussing asymmetric matrices. A symmetric matrix is positive definite if and only if all of its eigenvalues are positive. I suggest that you instead discuss the eigenvalues after the matrix is made symmetric.

P8 L14 Citing Van Loan seems out of place here. Is there a specific page number? This again is an incorrect citation, Gene Golub was another author of this textbook. I believe this method was used in Weston et al 2014 and in Tabeart et al, 2020b, so these might be better references.

P8 L22 Positive definite- was the re-estimated matrix symmetric?

Figure 1- Please state in the caption what the "previous studies" are.

Figure 2, 5- I do not trust the tick labels on the x and y axes. In Figure 1, there seems to be a gap in channels between 1010 and 1020 cm-1. If the ticks on Figure 2 are linear then the plotting program might be interpolating the covariances between 1010-1020 cm-1, or the tick labels could be wrong. I know that Matlab for example does not label ticks correctly by default when making matrix plots like these. Also, in the caption, "statistics of Desroziers" would read better as "Desroziers method" or "Desroziers diagnostic"

Figure 5- Anti-correlations likely exist over land. I suggest changing the colorbar scale to include negative values.

P13 L7 Suggest to specify in this sentence that this is an ozone analysis.

P13 L14 Why is the reduction important?

P15 L10-14. I do not understand this discussion. What is the "estimation?" Why did the minimization fail to converge when using the "first estimation" but not the "second estimation?"

P15 L20 Why does a reduction of ozone in the analysis imply a better fit to OMI?

Figures 9 and 10, in the captions it would be helpful to state that negative values indicate an improvement in fit relative to ControlExp. Is it possible to remove the empty space in Figure 10? What is meant by "divided by the average profile of radiosoundings?"

P20 L16 Specify that ozone is added/reduced in the analysis.

P20 L17 "The total column also. . ." This sentence can be omitted. Isn't the total column result the validation against OMI mentioned in the next sentence?

Technical comments:

The work from Desroziers is not cited correctly. It is from 2005, not 2006. Weston et al. is cited incorrectly as well, this paper is from 2014.

Throughout the article, ozone is written as O3, when it should be O_3 with the 3 in the subscript.

P1 L22 Change "Remote sounding from satellites is" to "Remote soundings from satellites are"

P2 L1 Change "monitoring atmospheric gases, a large" to "monitoring of atmospheric gases. A large"

P2 L10 Should "Recent studies" be "A recent study" instead?

P2 L26 Remove (Weston et al 2013) from this sentence. All of the studies mentioned above show this result.

P2 L29 "(increase of the errors...)" The errors of what?

P3 L3 and other places. This should read "Desroziers method", not "Desroziers statistics"

P3 L7 Why not mention Section 5 in this paragraph?

P4 L10 "aerosols" should be singular.

P4 L18 What data file do you mean? I don't see one defined.

P4 L23 "evaluate the impact of the estimated observation error" and the error covariances, correct?

P4 L26 Change "reminded" to "given"

P6 L13 Change this sentence to "...carried by a radiosonde continuously transmitting measurements as it ascends."

P6 L26 Change "found out" to "found"

P7 L26 Change "radiative transfer may" to "radiative transfer model may" and "statistics of error from the instruments" to "error statistics from instrument"

P7 L29 The second term in the expected value should be a vector transpose.

P8 L7 "(with a standard..." there is no closing parenthesis

P8 L12 Change "assumed" to "applied"

P8 L15 Change "An other" to "Another"

P8 L 20 Change "The resulted standard deviation was greater than the one" to "The resulting standard deviations were greater than those"

P9 L 22 Figure 3 shows standard deviations, not differences.

P14 L1-2 These two sentences are unnecessary

P15 L25 This sentence should be a part of the previous paragraph.

_____