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Atmospheric Measurement Techniques Discussions

Interactive comment on "Upper tropospheric CH_4 and N_2O retrievals from MetOp/IASI within the project MUSICA" *by* Omaira E. García et al.

Anonymous Referee #3

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The paper written by Garcia et al. entitled "Upper tropospheric CH4 and N2O retrievals from MetOp/IASI within the project MUSICA" shows the retrivals of CH4 and N2O using the MUSICA methodology, which is based in Optimal Estimation (alas Rodgers 2000). It is an interesting paper showing how to perform retrievals of these two species for infrared hyperspectral instruments (IASI). There are not many of these kind of retrievals, and a new one based in OE, where uncertainties can be traced back very well, is very welcome. The paper deserves to be published. I would strongly encourage the authors to polish the paper and publish it.

There are a few minor corrections to be done, mainly due to the convoluted way of explaining the subject. Explanations should be made in short sentences, explaining the details. The sentences should come one after the other following a smooth reasoning

and deduction process.

There is also one major correction dealing with what is called in the paper "combined retrieval". It looks as if (difficult to know because I could not follow the explanations well enough, see minor corrections above) two retrievals are done one after the other using exactly the same measurements. This is something that should be totally avoided in OE. Looking at the final uncertainty of the retrievals, Sr, in OE, it is Srˆ{-1} = Kˆ{T} Seˆ{-1} K + Saˆ{-1} where Se is the measurement uncertainty covariance matrix and Sa the background uncertainty covariance matrix, and K is the Jacobian. It can easily be seen that Sr ends up being smaller than Sa. For example, for a simple 1D case, if Kˆ{T} Seˆ{-1} = 1 and Sa= 1 then Sr = 0.5. If we now apply OE to the same measurents using this retrieval as a new background (now Sa would be 0.5), we obtain a new Sr=0.333. Much smaller than the correct value obtained initially (0.5). This is because the background or a priori should be information that is completely independent of the measurements, otherwise we are making a big mistake using the OE theory. Because of this, it should be clarified if the "combined retrieval" is this kind of incorrect double OE retrieval or something else.

More especifically:

- Page 4 line 7 insert , - Intro: the biggest greenhouse gas is water vapour. The biggest greenhouse gas which produces climate forcing is CO2. Please include "as climate forcing gases" in this sentence about greenhouse gases. - First paragraph of section 2.4 is not clear. What is exactly s_epsilon, and S_epsilon,p? A priori and posteriori error covariance matrices? What is p, a trace gas, eg, ch4, ... Perhaps a small introduction to OE using tge cost function formula, which is known by everybody, would clarify the notation at the beggining. - Swach should probably be swath

- Section 2.4 is written for a person who already knows the música retrieval. This is not a good way to engage readers. It should be written starting from basic or theory (Rodgers). Perhaps an equation showing what is minimized (cost function) would add

clarity to the notation used. Likewise, the exact tikonov regularization could be written in a formula - Page 7 line 15. It is well known A changes with profiles. No need to say first we assume linearity and then say it is not true. Jump directly into non-linearity and then, if needed, approximate it to something more or less linear - Last paragraph page 7 very confusing

- Section 3. It is not clear when you do the combined retrieval if you are doing the retrieval twice with the same measurements. Please explain clearly. If this is the case, care should be taken not to use the same measurements twice. Otherwise we will estimate a much smaller error than the real value. See comments about this above. - Section 3.3 confusing - Eq 9 not well explained, probably because combined retrieval not well explained

- Section 4.2. usually time/space collocation windows are chosen with a criteria of little variability in this window. Is this the case here? Is this justified by any paper? If not, why is this particular collocation window chosen ? Reference? - Section 8 line 5 one before last paragraph. Again, combined retrieval seems to mean retrieving the same quatinty with the same measurements using oe. You will get a wrong error covariance matrix like this.

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