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Atmospheric Measurement Techniques Discussions

Interactive comment on "Tropospheric ozone column retrieval from the Ozone Monitoring Instrument by means of a neural network algorithm" *by* P. Sellitto et al.

Anonymous Referee #1

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Review

Tropospheric ozone column retrieval from the Ozone Monitoring Instrument by means of a neural network algorithm

By Sellito et al.

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This paper describes the result of applying a Neural Network approach to UV-VIS spectral measurements from the OMI satellite to determine tropospheric ozone. Retriev-

ing tropospheric ozone from UV-VIS measurements is at the edge of what is possible both fundamentally but also instrument-wise. Hence, any information on what can be achieved is highly valuable and appreciated. The NN approach is a fundamentally different approach than more standard methodologies that have been developed over the last decade or so (residual methods, optimal estimation). It is therefore interesting and relevant to evaluate the results from the NN approach with those from other methods, which is presented in this paper.

The paper is well written, concise and well organized, and in general I have no major remarks or criticism with what is presented.

However, I have three more general comments which with probably just a little bit of effort could help improve the paper. Furthermore, there is a small list of minor issues and/or suggestions.

GENERAL COMMENTS

- Distribution of ozone sonde stations:

The ozone sonde locations used in this study are all from Northern Hemisphere mid-latitudes. The question arises whether or not campaign data from the Northern Hemisphere can be really considered a true "out of sample" test. After all, conditions in the Northern Hemisphere to some extent are similar: often a thick stratospheric ozone layer and lots of ozone variability – both chemically and dynamically – in the troposphere and in the stratosphere. Measurements from the tropics and the Southern Hemisphere provide quite different conditions. In the tropics stratospheric ozone is rather constant, and variability in tropospheric ozone occurs on longer timescales than outside of the tropics. Furthermore, the tropical tropopause is much higher and there are places where little to no tropospheric ozone is present (tropical Pacific). In the Southern Hemisphere one has to deal with ozone depleted stratospheric layers in the vicinity of Antarctica and in general a thinner stratosphere.

I do not think it is necessary to perform analysis for those regions in this study – the contents of this paper are sufficient to present a case for the NN as a proper functioning algorithm, but at some point comparison with data from the tropics and the Southern Hemisphere provides a highly interesting and probably more independent "out of sample" test. Hence, I would strongly recommend some discussion of such work in the "conclusions", for example as "future work". Could be done in a couple of sentences.

- Validation statistics and collocation criteria.

Selection criteria for what is considered a collocation of ozone sondes are missing, for example on page 4/5, paragraph 2.2/2.3. Please provide how a collocation is selected, i.e. within what spatial and temporal interval is a sonde measurement considered to be collocated with an OMI measurement. This is also important information that is lacking for the comparison with sonde measurements later in section 3.

Furthermore, it is unclear to what extent a change of the criteria improves the validation as presented in section three. Some information on this would be highly appreciated.

For example, it is stated in section 4.1 that the results appear to be insensitive to ozone enhancements in the upper troposphere. Although it is well known that the sensitivity of UV-VIS ozone profile retrievals for the upper troposphere is limited, such a difference could – in theory – also be the result of collocation issues, i.e. such enhancements may have a certain horizontal size but due to the collocation criteria the enhancement may be missed by OMI as it is not measuring at the geographical location where the enhancement occurs (think: a stratospheri-troposphere exchange event). If the results are robust (or not) with regard to the collocation criteria then that is an indication that this is not the case (or could be the case). Either way, it is valuable information.

- Vertical Sensitivity

The results clearly indicate that there is limited sensitivity to the lower troposphere or – my interpretation - to smaller changes in ozone throughout the troposphere. This is no

surprise, as correctly noted by the authors, since others using different methods have come the same conclusions.

However, this raises the particular question on how to actually use tropospheric ozone columns from the NN method. For other methods - residual methods or OE methods - it is possible to define a vertical sensitivity, either for the total ozone column used in residual methods or for the ozone profile, the so-called averaging kernel. When OMI tropospheric ozone measurements then are compared to other measurements or model data that vertical sensitivity should be taken into account – even though this is frequently and conveniently forgotten, in particular for the residual methods. Nevertheless, vertical sensitivity information is available.

The question thus becomes how to address this with NN data. I could not find it here, but some discussion on how to do that would be useful for potential users. I'm not even sure if it is possible within the NN framework, but that conclusion then is also relevant for potential users.

Please provide a short discussion of this issue.

MINOR COMMENTS

- Page 2, lines 19-20. Include reference to Shindell et al. [Science, 2009; "Improved attribution of climate forcing to emissions"]. This paper presented a different approach to estimating radiative forcing (emission based vs. the traditional abundance based) and does more justice to the complexity of trospheric chemistry in estimating radiative forcing and the role of tropospheric ozone.

- Page 2, line 21, about crop damage. There are quite a few official reports about future ozone and ozone damage, so adding a reference is recommended. The one below from 2008 is probably as good as any.

Ground-level ozone in the 21st century: future trends, impacts and policy implications. Chapter 8: Impacts of ozone on the environment, page 75-84. Science Policy report

15/08, October 2008, The Royal Society.

http://royalsociety.org/WorkArea/DownloadAsset.aspx?id=5484

Page 2, line 35. Start new paragraph after Levelt reference. Otherwise it is a very long paragraph.

Page 50-51. There is also an official OMI ozone profile OE profile retrieval algorithm. A reference here would be nice, but documentation in the form of reviewed paper is still lacking, I know informally that a paper is under review. Maybe a reference to the ATBD could be added, but I leave it up to the authors to decide. I'll keep a close eye to see if that paper gets accepted before publication of this paper, in which case I will notify the editor and provide a reference.

Page 3, line 66. change to "In this paper we present the OMI-TOC NN, a . . ."

Page 4/5, paragraph 2.2/2.3. I am missing something on the OMI row anomaly and if for the profile retrievals affected pixels are excluded. The row anomaly started halfway 2007, hence some part of the period considered here is affected. Providing a short explanation would do.

Page 5, line 160. Change to ". . . in e.g. Del Frate et al. (2002, 2005) and ..."

Page 10, line 235. Provide which type of cloud fraction information in the OMTO3 data is used (O2-O2 or Raman, but I think it is Raman).

Page 12, line 266-269. It is mentioned that statistics improve when extreme off-nadir positions are excluded from the comparison. This is an important piece of information, so I think the actual statistical numbers should be provided here.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 2491, 2011.