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Interactive comment

# *Interactive comment on* "A new method to correct the ECC ozone sonde time response and its implications for "background current" and pump efficiency" *by* Holger Vömel et al.

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I have read through this paper manuscript as well as the two referee reports with great interest. I think that this is indeed a very interesting and important paper. I have some comments, which are written below.

(1) The "time lag correction" for the fast reaction pathway

Although the Introduction has extensive discussion on the "background current" issue and the proposed, appropriate treatment for the slow reaction pathway, large changes/improvements are actually seen by applying the "time lag correction" for the



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Discussion paper

fast reaction pathway, i.e., in Figures 5, 6, 9, and 11. In particular, we see large changes with opposite signs in the lower stratosphere and in the upper stratosphere due to the opposite signs in the average vertical gradient of ozone. In Figure 9, the effects of the time lag correction are seen also at the edges of tropical tropospheric ozone enhanced layers. In Figure 10, at the first ∼400 meters from the surface, it seems to me that the large changes are again due to this time lag correction.

Therefore, I think that a review on this time lag correction needs to be made also in the Introduction. I strongly believe that the Section 4 of Imai et al. (JGR, 2013) (I am a coauthor of this paper) is one of the appropriate and very useful references for this purpose. This Imai et al. paper explains the mathematics of the time lag correction procedure, and shows the effects of this correction on worldwide ozonesonde sounding data in the stratosphere. Their example of ascent vs. (much faster) descent comparison in a tropical sounding would also be useful to understand the effects. The results in Figure 10 (bottom left for 15N-15S) of their paper agree quite well with what is shown in Figure 11 (as well as Figure 6) of this Voemel et al. manuscript (note the difference in the definition of the difference (the variable for the x axis)).

To my knowledge, the paper by Imai et al. was the first to explicitly show the effects of this response time issue in ozonesonde data, but Referee #2 noted, "This (i.e., the time lag of the fast reaction pathway) has been known and sometimes corrected since the 1980s. Maybe add one or two of these old references?" . . . I am also interested in those old papers.

We (Masato Shiotani, Naohiro Manago, and myself) wanted to write a follow-on paper on this ozonesonde response time issue using JOSIE data, but we found that the temporal resolution of currently available JOSIE data is not enough high for quantitative analysis. Some of our preliminary results were presented in the SPARC General Assembly (Kyoto, Japan) in 2018 and in other meetings.

(2) The method and the terminology

I totally agree with the two referees that the mathematics need major revisions. All the symbols should be clearly defined. In addition, I also would like to emphasize that all the legends in the figures should be carefully revised, so that the same terminology, as will be re-defined in the Method section, is used; the legends in different figures are currently not consistent and thus are a source of confusion.

Below, let me write my understanding of the Method after reading through the Application . . . and Discussion sections.

For the conventional data processing, the cell current corresponding to the ambient ozone concentration, I_a (t), is calculated as:

I_a (t) = I_m (t) – I_bc

where I_m (t) is measured cell current, and I_bc is the "background current" which is usually treated as a constant. (However, in practice, the conventional "pump efficiency coefficient" (as a function of ambient pressure) has a component which depends on the buffered KI solution recipe, thus, in a sense, providing part of information on the slow response pathway, though it might have been incorrect anyway.)

For the proposed data processing in this paper, the measured cell current I_m (t) is assumed to be a summation of two components as:

I_m (t) = I_f (t) + I_s (t)

where I_f (t) is due to the fast reaction pathway, and I_s (t) is due to the slow reaction pathway. I_s (t) is, roughly speaking (as I still do not fully understand), assumed to have two components, the "steady state bias" depending on the buffer (and evaluated by VD2010) and the delayed and integrated response with a time scale of ∼25 minutes.

First, I_s (t) is evaluated based on the results by VD2010 and by other considerations. In this process, the "post-preparation current" might or might not be used. Then, we obtain I_f (t) = I_m (t) – I_s (t).

I_a (t) is then obtained from I_f (t) by applying the “time lag correction” with the time scale of ∼20 seconds. (I would like to note that the smoothing with the Gaussian filter used by the authors is not conceptually essential, but practically necessary, because noises in the original data can be amplified when the time lag correction is applied. Thus, separating this from the discussion of the concept may be good for the readers. Also, the “Fast reaction, smoothed” line in Figure 9 might not be essential for that figure.)

Please correct me if my understanding of the Method is not correct.

Again, in the paper, including the figure legends, please use exactly the same words (or even the defined symbol) for the same variable.

Written by Masatomo Fujiwara

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Imai, K., M. Fujiwara, Y. Inai, N. Manago, M. Suzuki, T. Sano, C. Mitsuda, Y. Naito, F. Hasebe, T. Koide, and M. Shiotani (2013), Comparison of ozone profiles between Superconducting Submillimeter-Wave Limb-Emission Sounder and worldwide ozonesonde measurements, Journal of Geophysical Research, 118(22), 12755-12765, doi: 10.1002/2013JD021094.

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