

Review of “Correction of the Observatoire Haute Provence electrochemical concentration cell (ECC) ozonesonde 1991-2023 data record”

After a careful homogenization effort of the OHP ozonesonde record, as described in Ancellet et al. (2022), the OHP team proposes an additional correction for anomalous low ozone records in the 2002-2007 time period. As those low ozone partial pressures in this period coincide with low internal pump temperatures during this period, a correction method that linearly increases the pump temperatures with height is proposed. This method is then evaluated making use of co-located lidar and MLS overpass stratospheric ozone profile measurements and of the total column ozone amounts retrieved from a collocated SAOZ instrument.

General comments

I want to congratulate the authors with their very detailed and careful assessment of their dataset and the identification of the origin of anomalous ozone partial pressure time records in their high-quality dataset. Clearly, also taking the basic ozonesonde conversion formula (1) at hand, there is clear relationship between the low pump temperatures and low ozone partial pressures recorded in the 2002-2007 period.

1. However, and here I second the other reviewer, there could/should be done more analysis to rule out potential causes and seek to find an explanation for this anomalous behaviour: a temperature measurement, with a thermistor, is a fairly easy measurement and large errors on precision or large uncertainties are rather impossible. In other words, the measurement of the pump temperature is right and cannot be off so much compared to earlier and later periods. So, the only possible explanation for those much lower pump temperature measurements is a change in the environmental conditions of the measurement. Here, different causes might be thought of:
 - change of the thermistor location. This happened in July 2007. I'll come back to this later.
 - change of batteries for the pump motor (e.g. from water-activated batteries to Lithium/Alkaline batteries). For instance, the water-activated batteries released much more heat than Lithium or Alkaline batteries
 - change of the position of the pump motor batteries (e.g. in the separate battery compartment of the Styrofoam box or inside the Styrofoam box itself)
 - change of the isolation properties of the Styrofoam box
 - change of the performance of the pump itself (e.g. higher pump currents, higher pump friction, heating up the box more)
 - ...

The authors therefore could/should analyze their metadata records and try to determine any coincidences with the beginning and end of the 2002-2007 period. In this respect, it would also be very helpful to provide some additional plots:

- The ozonesonde serial numbers versus time
- The ECC pump flow rates versus time

- The mean vertical profile of both the measured and O3S-DQA corrected (see Ancellet et al., 2022 and my point 4) internal pump temperatures for the three periods. This information is to some extent provided in Fig. 3 (is it the measured or corrected internal pump temperature?), but I guess that a mean vertical temperature profile would give more information if the anomalous low temperatures in period 2 are arising at all vertical levels or from some typical altitudes onwards. Of course, period 3 might be further split in subperiods, so that the number of years for each period does not differ too much.
2. In addition to the direct (mathematical) impact of lower pump temperatures on the ozone partial pressure values through Eq. (1), there is also an indirect impact. As the ECC cell temperatures are typically around 5 to 10 °C lower than the measured pump temperatures (with the 5°C more typical for SPC ozonesondes, and the 10°C applying for En-Sci ozonesondes), as measured in simulation chamber tests with ozonesondes, the lower pump temperatures in the 2002-2007 period might be associated with ozonesonde cells with frozen solutions (cell temperature close to 0°C). In such cases, the chemical reactions inside the cells will be less efficient or slow down, and as a consequence much lower currents will be generated. In the Uccle station, I could identify this feature quite regularly in the upper parts of the ozone profile when the En-Sci ECC (measured) pump temperatures drop to below 10°C or lower (despite active heating). However, at OHP, from your table 1 and Fig. 4, it seems that during the anomalous period 2 (2002-2007), higher cell currents are measured at 25 km compared to the periods before and thereafter. I found this rather surprising and this argues against the hypothesis of frozen solutions during this period 2. Can you therefore more extend on this analysis and also look at e.g. other altitude levels? It would also be interesting to produce some mean vertical profiles of pump temperature, ozone partial pressure, and cell current for (the) different periods to analyze in greater detail the hypothesis of frozen solutions (relation between pump temperature close to 10°C from given altitudes & cell current and/or ozone partial pressure drops from that given altitude as well?).
 3. As shortly mentioned earlier in point 1., the impact of the lower ECC pump flow rates on the lower ozone partial pressures in period 2 should be discussed and highlighted as well. As shown in Fig. 4b, the pump flow rates (or better: times to pump 100 ml of air, t_{100}) are lower in the 2002-2007 compared to the periods before and therefore. From Eq. (1), it follows immediately that those lower t_{100} s ($\phi_{p} = 100/t_{100}$) will result in lower ozone partial pressures as well. This effect also contributes to the low ozone anomalies in 2002-2007. So, the anomalous low ozone partial pressures seem to be caused by a combination of effects.
 4. Please, be also more specific on the different pump temperatures used throughout the paper. I could identify the following ones:
 - the measured pump temperature: measured value by the thermistor
 - the O3S-DQA corrected internal pump temperature: here, please specify which corrections have been applied. I guess that, before 2007, you used Equations [E-D-3A/B/C] and [E-3-15] (or [E-D-6] & [E-D-7]) and only [E-3-15] after 2007, where the equation numbers refer to those from the WMO-GAW N°268 document

(<https://library.wmo.int/idurl/4/57720>). Please, also clearly mention that those corrections will increase the measured pump temperature, and that due to the pump temperature sensor location change in 2007, the O3S-DQA corrected pump temperatures before that date will be increased by values around 8°C compared to the O3S-DQA corrected pump temperatures after that date, which would resolve part of the biases between the measured pump temperatures before and after 2007.

- The calculated pump temperatures using the lidar ozone concentrations (used in Table 2)
- The corrected ECC pump temperatures (Eq. 3).

Clearly describe those different pump temperatures and you might even use different symbols for them. Also, specify for every figure which pump temperature is shown. For instance, it is not clear to me if the “ECC temperatures” in Figs. 3, 4, 5a are the measured pump temperatures or the O3S-DQA corrected internal pump temperatures!

5. I would also be very cautious about the terminology used for the proposed correction method. You “correct the ECC pump temperature” in the 2002-2007 period, but the measured pump temperatures are not wrong! These are truly measured values. What you ultimately correct for, are the anomalous low ozone partial pressure values, and you do this by increasing or even “manipulating” the pump temperatures. But, under (too) low pump temperature regimes, the conversion efficiency of the chemical reactions will change, possibly giving too low measured cell currents (to be investigated further). Therefore, physically, the conversion efficiency coefficients should be altered for the 2002-2007 period, and not the pump temperatures. I do not disapprove your pragmatic approach by increasing the pump temperatures, but I would merely call it an empirical correction and not necessarily a “pump temperature correction”. In this sense, you might introduce an extra correction factor in Eq. 1.

Minor comments

- Line 9: I guess you are referring to the ECC pump flow rate trend, instead of the ECC pump motor speed (which is expressed as rotations per minute or RPM).
- Line 41: add “in OHP” after “The ECC ozonesondes have been used”
- Line 56: how many ozonesonde profiles are discarded based on the normalization factor limit? And did you not apply a lower limit for the normalization factor? Why only an upper limit? So, you also do not consider ozonesonde profiles with lower burst altitudes? What is the criterion?
- Caption Table 1: specify that those values are taken at 25 km. It should however be instructive to also see some values at other altitudes.