

Interactive comment on “A fully Automated Dobson Sun Spectrophotometer for total column ozone and Umkehr measurements” by René Stübi et al.

Anonymous Referee #1

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General Comments

The authors describe an automated system for operating the Dobson spectrophotometer, which, despite its age, is still very widely used around the world for high-quality ground-based measurements of stratospheric ozone. The system described in the manuscript presents a large number of advantages and might be very attractive to Dobson operators in many countries. The authors should be commended for their effort to document the system in this manner, and in my view the manuscript is very welcome in AMT, subject to some minor revisions.

My only substantial comment on the manuscript is that in several places, the authors

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could do better to explain how they reach their conclusions. At times, the authors seem to implicitly assume that the reader already knows what they are talking about, and a reader outside the Dobson community or even one not familiar with the Arosa Dobson station might have difficulty following the logic. One example is the list of benefits of the so-called "rotating cabin" (page 6), but a more serious one is that in several places it is stated that the automation leads to a higher "quality" of data, and that this will facilitate improved understanding of various Dobson issues, without much explanation to the reader of why this is.

One other point to raise is that, from my understanding of the system, it is not possible to make zenith observations during the daytime while operating automatically – is that correct? This seems to be a significant limitation of the system, compared to standard manual operation. This point should be clarified or discussed.

Specific comments

Page 2

Line 2 "state of the ozone layer" would be better wording

Lines 2-3 Reword this whole sentence please

Lines 3-6 I would say the main point is that the calibration drifts during the time the satellite is in orbit

Line 6 – I don't understand what the authors mean by "developed over 50 years" – the instruments or the networks? People typically date the "Dobson network" to 1957, but sometimes much earlier.

Line 9 Why do you cite Pawson et al. (the 2014 WMO Ozone Assessment) and not the corresponding chapter from 2018? The 2018 assessment is cited in general but no specific chapters are referred to.

Line 10 "to" should be "with"

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Lines 12-14 This statement is confusing because you start with wavelengths below 300 nm which you say are "almost completely absorbed" but then finish with saying the ozone column controls UV intensity at ground level – the reader should understand what wavelength range you're talking about and distinguish between UV-B and UV-C.

Line 17 I think this statement understates the age of a lot of the Dobsons in the network – many of the very old ones are still being operated, not just instruments made before the year 2000. (<http://www.o3soft.eu/dobsonweb/instruments.html>)

Lines 28-33 This is all interesting but I don't see that it's relevant. (You should still provide the references for the reader who wants to know more about the history of Arosa though).

Page 3

Line 1 – "strengthening" should be "strengthen"

Lines 2-3 Was there any reason to think either that extra measurements would be beneficial, or that operator influence was having a non-negligible effect on the measurements?

Lines 5-8 It sounds though it is not possible to automatically perform DS/ZB or DS/ZC pairs of observations as is the practice at many stations, or to choose to take zenith observations during the day if DS is not possible for a time?

Page 4

Line 3 – I think you really need a diagram of your own, showing the components of the Dobson that will be referred to in the rest of the manuscript.

Line 4 "direct sun" – not necessarily, in the case of Umkehr or zenith observations.

Line 9 Just "Dobson" will do from now on, for the first mention you could give his initials.

Line 19 Moeini et al. 2019 seems a strange reference for the basic Dobson equation.

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Line 22 The reader might not understand why these coefficients are based on properties of the primary reference instrument.

Line 26 I would prefer you give at least one more equation showing how the formula looks for four wavelengths rather than just one, so the reader can follow why the aerosol term is so small.

Line 27 If you are going to give these values, you should explain (very briefly) how you measured them particularly since the measurement of slit widths has been receiving a lot of attention in the Dobson community in recent years.

Line 34 "allows to estimate" – please re-word.

Page 5

Line 1 If you say "at" sunrise or sunset the reader may have the impression it is a single measurement at that one moment, rather than over a period of time.

Line 4 Figure 4 is not the clearest diagram to explain the Umkehr effect but it's good enough I suppose.

Line 5 "is" should be "are"

Page 6

Lines 4-8 You definitely need to explain this better. It would be very difficult for the reader to see why a "rotating cabin" would lead to these four improvements, especially the first two which might seem completely unrelated. What was the situation before the introduction of the cabin?

Lines 9-12 I don't see the relevance of this information?

Lines 15-16 I would like to see just a little bit more information about the earlier partial automation. What does "not conclusive" mean here?

Line 20 "table" should "tables"

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Line 23 insert "from", ie "protrudes from the roof"

Lines 23 The quartz dome is not widely used around the Dobson network and needs a little bit of explanation, particularly about why you believe it does not interfere with the measurement.

Page 7

Line 3 Why only 20 measurements?

Lines 4-9 You need to explain the reasoning here – why does the automation extend the valid mu range of the Dobson?

Lines 10-15 I really like the fact that you set out clearly a list of the five rotational axes.

Page 8

Lines 1-8 This is probably a question more for the editorial team – I question the usefulness of including links to commercial websites. These will probably change within a few years. Specific information that appears on the website now is not guaranteed to still be there tomorrow.

Lines 1-5 How do you know that the tracking of the sun is sufficiently accurate? (I see some discussion of this point later on).

Page 12

(Figure 4) The CD is more variable from point-to-point and interestingly, also has larger rises and falls than the AD and AC during the short-term variations. Would you like to comment on that?

Lines 11-12 It sounds like a person has to be at the site quite early in the morning to change from Umkehr to Direct Sun mode? This is disappointing from a pragmatic viewpoint because it reduces some of the benefit of automation.

Lines 10-12 Are you also performing sunset Umkehers?

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Page 14

Lines 3-11 Are the results of the lamp tests over a long period of time able to be presented by the software in a user-friendly way? This would be extremely helpful, eg if you could track the lamp tests over a year or in between two calibrations.

Lines 25-30 This addresses the question I asked a couple of pages ago about the accuracy of the sun tracking. It sound like the check is not automatically scheduled but set into action by the operator? Are there any criteria for how close it needs to be? (The peak of the curve on the azimuth plot in figure 7 is quite wide). If the instrument levelling is not quite right of course the tracking might be correct at certain times but not others.

Page 16 Line 3 G.M.B. Dobson not G.W. I don't hesitate to say I believe Dobson would consider your S-curves to be very "nice".

Page 17

Line 4 It's not clear how automating the "old" instruments extends their lifetimes? Do you mean just that they will be cheaper to operate, or something more?

Line 7 It's not clear how automating the instruments improves the measurement "quality". Especially in the "discussion" section you should expand on this point.

Lines 9-10 Similarly, you need to explain how automating the instruments will help address these longstanding issues.

Page 18

Line 6 Correct the spelling of "Komhyr"

Lines 13 "his" should be "its"

Page 19

Lines 4-5 This sentence is not very clear. Isn't the point the high-temporal-resolution,

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not the +/- 1 DU? Is it useful to be able to follow these small-scale variations?

Lines 5-7 I think you could make it clearer to the reader why the housekeeping data would facilitate further understanding as you claim.

One question many readers would be interested in is what are the advantages and disadvantages of the automated Dobson system compared to a Brewer? (You might consider this to be out of scope for the current work, however).

Page 20

Line 2 Albrecht is a strange choice – it's more about the policy issues of the Montreal Protocol

Line 5 I think you could do better here. The link only goes to the EURAMET page.

Page 22

Line 1 Did you mean to refer to a particular chapter or chapters of the 2018 Ozone Assessment?

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