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Interactive comment on "Brewer spectrometer total ozone column measurements in Sodankylä" *by* T. Karppinen et al.

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Ref #1 1. Abstract line 1. Delete first 'The'.

Changed as suggested

2. Line 2 Suggest 'the signing of the Montreal Protocol'.

Changed as suggested

3. Line 3. '...since then to produce a high-quality, ozone time series now spanning 25 years.'

Changed as suggested

4. Line 4. 'The data have ...'

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Changed as suggested

5. Line 6. ‘Daily mean values calculated from the highest quality direct.,..’

Changed as suggested

6. Line 7. ‘...per day on clear days.’

calculated from the highest quality direct.,..

7. Line 12. ‘...oxygen molecules...’

removed atoms

8. Line 14. ‘...by the atmospheric circulation (e.g. Müller...’ Changed as suggested

9. Line 16. ‘...the atmosphere enabling...’

Changed as suggested

10. Line 16. ‘Excessive exposure to UV radiation...’

Changed as suggested

11. Line 17. ‘diseases of the eyes and skin for example (Lucas et al.,’

Changed as suggested

12. Line 18. ‘...having a negative influence on vegetation’

Changed as suggested

13. Line 19. ‘...out that the total ozone above...’

Changed as suggested

14. Line 21. ‘...significant the effect of chlorofluorocarbons...’

Changed " This showed how significant the effect the chlorofluorocarbons (CFC) had in reality for the total amount of ozone" to "This showed in reality how significant effect

chlorofluorocarbons (CFC) had on the total amount of ozone"

15. Line 26. Suggest: ‘The evolution of the global distribution of total ozone has been under...’

Changed as suggested

16. Line 28. Comma after ‘Protocol’

Changed as suggested

17. Line 29. ‘Sodankylä comprising both the Brewer measurements and regular ozone soundings starting in 1988.’

Changed as suggested

18. Line 30. ‘though ozone depletion is more pronounced and regular in the Antarctic the Arctic...’

Changed as suggested

19. Line 36. ‘...monitoring the evolution of the ozone layer...’

Changed as suggested

20. Line 38. ‘The FMI-ARC has been active in evaluating the effect of low solar elevation angles on Brewer measurements.’

Changed as suggested

21. Line 38. ‘These studies are important because Brewer #037 has been serving as a reference instrument for satellite validation...’

Changed as suggested

22. Line 41. ‘staffed station’ ???

meaning there is crew on the station evrey week day. Changed to "staffed"

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23. Line 45. ‘...data flow is briefly described...’

Changed as suggested

24. Line 46. ‘...presented along with the rules...’

Changed as suggested

25. Line 51. ‘The total ozone column...’

Changed as suggested

26. Line 53. ‘...still in the comparison phase...’ Changed as suggested

27. Line 60. ‘...from either of two internal...’

Changed as suggested

28. Line 60. ‘Direct radiation viewing angle is approximately 2 - 2.7 degrees (Kazadzis et al., 2005). I don’t know what this means and it is not grammatical.

What I meant to say was: "Field of view for the direct radiation measurement is approximately 2 - 2.7 degrees (Kazadzis et al., 2005)."

29. Line 63. ‘The grating can be rotated...’

Changed as suggested

30. Line 65. ‘The double monochromator has significantly less light coming from outside the desired wavelength band.’

Changed as suggested

31. Line 67. ‘...of a single exit slit, there is a slit mask with 8 different slit positions....’

changed as suggested

32. Line 71. ‘...depending slightly...’

changed as suggested

33. Line 72. '...325 nm for Brewer #037...365 nm for Brewer #214'

I am not sure what referee meant by this but changed to: "from 290 nm to 325 nm for ... from 286.5 nm to 365 nm for..."

34. Line 75. 'To accommodate large variations in the intensity throughout the day, a filter wheel quipped with set of neutral density filters...'

Changed "Due to high variability in the intensity along the day there is a filter wheel with set of wavelength neutral filters with different attenuations to choose from depending on the initial intensity check." to: "To accommodate large variations in the intensity throughout the day, there is a filter wheel equipped with a set of neutral density filters. The attenuation needed is determined on an initial intensity check."

35. Line 77. '...polarizer or a clear opening depending on the measurement mode.'

changed as suggested

36. Line 79. 'measure ozone with a Brewer instrument each suited to...'

changed as suggested

37. Line 80. 'The direct sun (ds) measurement is suited to clear sky conditions with a solar elevation angle...'

changed as suggested

38. Line 83. '...for a long period, focused moon...'

changed as suggested

39. Line 85. 'In the direct sun measurement...'

changed as suggested

40. Line 86. '...guided toward the entrance slit.'

changed as suggested

41. Line 87. '...input light to reduce the effect of slight misalignments.'

changed as suggested

42. Line 94. '...neutral density filter may be applied to control the maximum counting rate.'

changed as suggested

43. Line 95. 'subtracted from the intensities measured from the direct sunlight.'

changed as suggested

Sp. 44. Line 97. '...blocked by clouds, ...' Comma

changed as suggested

45. Line 99. '...neutral density filters...'

changed as suggested

46. Line 101. '...is fixed in the direction that rejects primary scattered light from the zenith (Brewer and Kerr, 1973, Muthama et al., 1995). Brewer, A.W., and J.B. Kerr, PAGEOPH, Vol. 106-108, 1973.

changed as suggested

47. Line 104. '...measure using light from the moon.'

changed as suggested

48. Line 115. '...changes on the ozone measurements...'

changed as suggested

49. Line 116. '...instrument's home institute against a well-calibrated...'

changed as suggested

50. Line 121. '...setting for ozone measurements...'

changed as suggested

51. Line 121. '...the differential absorption coefficient (??a).

changed "the absorption coefficient" to "the differential absorption coefficient"

52. Line 123. '...there was no ozone between...' The absolute absorption is pre-corrected for Rayleigh in the normal analysis.

changed as suggested

53. Line 135. 'The differential absorption coefficient is calculated ...absorption cross-section.

changed as suggested

54. Line 139. 'The neutral density filter wavelength...'

changed as suggested

55. Line 150. '...called the standard lamp,..'

changed as suggested

56. Line 152. '...the stepper motors...'

changed as suggested

57. Line 153. '...the stepper motors...'

changed as suggested

58. Line 156. 'The standard lamp is...'

changed as suggested

59. Line 163. '...measuring a 1000 W calibration lamp...'

changed as suggested

60. Line 164. '...calibration, before the instrument returns to the measurement site, the...'

changed as suggested

61. Line 185. 185 - 190 Some redundancy about defining IDEAS

I would like to keep these here because they are an essential part of data continuity control. However I removed lines 191-193 that were repetition of this chapter.

62. Line 194. '...to the World Ozone and Ultraviolet radiation Data Centre (WOUDC)...'

changed as suggested

63. Line 196. '...with software described...'

changed as suggested

64. Line 198. '...out by the human eye.'

changed as suggested

65. Line 201. '...Brewer data are sent...'

changed as suggested

66. Line 206. '...data include total counts...'

changed as suggested

67. Line 241. '...based on the Beer-Lambert-law..'

changed as suggested

68. Line 243. '...set of wavelength dependent...'

I found this part already as suggested

69. Line 149. Missing citation. '...the instrument designer (citation).'

Apparently this is based on Bates(1984)

70. Line 273. '...identical to that of the direct sun algorithm.'

changed as suggested

71. Line 278.The authors might wish to consult: Fioletov, V.E., C.A. McLinden, C.T. McElroy, and V. Savastiouk, New method for deriving total ozone from Brewer zenith sky observations, J. Geophys. Res., 116, D08301, doi:10.1029/2010JD015399, 2011.

I found this very interesting but not suitable for citing here as the Sodankylä coefficients are based on the earlier work by Muthama et al.

72. Line 303. '...thickness by the BrewerDobson...'

changed as suggested

73. Line 349. '...are, on average, very...'

changed as suggested

74. Line 354. '...other ground based...'

I found this already as suggested

Ref #2

Line 211: The description of the ozone retrieval algorithm of the brewer is described in detail. To avid any confusion to the readership, it would be good to distinguish between counts and photons, as this is not the same quantity in the Brewer spectrophotometer. In fact, a prescaler mounted directly on the photomultiplier reduces the photon rate by a factor of four by issuing one count for every four photon-events of the photomultiplier. This conversion from counts to photons is done explicitly in equation 1

(photons/sec=(Fi-F)*4/IT/(2*CY)), but should from then one be called photon count rate.

I changed the unit of count rate to (photons/second) and count rates from that on are referred as photon count rates.

Line 273: The moon is not a true grey body, but its reflection properties, especially in the UV show a marked spectral dependence which might affect the ozone retrieval when using the same calibration constants ETC) as for the sun mode. Can the authors comment on this and produce some validation data for the total ozone retrieved from lunar measurements (Rolo ref).

There are not too many studies on the matter and that is something to be noted for the Brewer user community, especially people operating high latitude Brewers. I wrote a new paragraph to be more specific about the fm measurements:

"For the moon measurements the algorithm is identical to the direct sun algorithm. However, the accuracy and consistency of these measurements are much lower than for the direct sun measurements as the intensities are much lower and the tracking has been found to be more difficult than 280 in the case of solar tracking. Also moon albedo could introduce a systematic error to the measurements. Lucke et al. (1976) reviewed some results on moon albedo showing either no wavelength dependency (Lebedinsky et al., 1967) or a linear dependency for the wavelength range used in the Brewer ozone retrieval. As the weighting coefficients in the algorithm have been chosen to disregard any absorption effects that are linear with wavelength, there should not be a remarkable difference 285 between focused moon and direct sun measurements. After comparing solar and lunar measurements Kerr (1989) concluded that the extraterrestrial constant (ETC) and the differential absorption coefficient (a) are the same for both measurement types"

Line 243 : The standard ozone algorithm uses 4 wavelengths (double ratio), not 5.

I thought it so that the first weighting coefficient is set to 0. To be more clear I added: "For ozone the coefficients are such that only four wavelengths (positions 3 to 5) are needed. "

Line 249: citation is missing.

added the citation

Please also note the supplement to this comment:
http://www.geosci-instrum-method-data-syst-discuss.net/gi-2015-41/gi-2015-41-AC1-supplement.pdf

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