

***Interactive comment on* “Evaluation of tropospheric and stratospheric ozone trends over Western Europe from ground-based FTIR network observations” by C. Vigouroux et al.**

Anonymous Referee #1

Received and published: 21 April 2008

This paper by Vigouroux et al, "Evaluation of ozone tropospheric and stratospheric trends over Western Europe from ground-based FTIR network observations", is a reasonably well written account of European NDACC FTIR ground stations contribution to UFTIR. This network of stations analysed their high resolution IR spectra for O₃, reporting both total and partial columns. The FTIR data is then compared with sonde, brewer and lidar data, some collocated, as well as computing trends. The subsequent paper has many facets to it, including a multi-station comparison between a range of measurements, which are also spread spatially across latitudes and temporally over about 10 years. The analysis procedures also uses reasonably up to date analysis methods, although the need to have some consistency across all stations means that

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



some compromise on the methodology and approaches has led to larger errors than the most recent O₃ analysis work.

There seems to be reasonable consistency of the main results, in terms of the various studies that the authors compare their results to, with the exception of a few puzzling results, which may or may not be due to analysis issues. Some of these issues are discussed below. Generally the paper is well organised, clear, with appropriate use of tables and figures that are easy to read and interpret. The paper is therefore suitable for publication in ACP subject to some issues that need clarification, and a list of suggested changes to the text.

Main comments:

1. The abstract states that the retrievals for UFTIR have been optimised for a range of gases, including O₃ in this case, which is presumably one of the underlying tenants of the UFTIR project. Yet, the analysis procedures adopted by the 6 stations are not that consistent. The main driving forces of the DOFS in terms of obtaining partial columns with appropriate semi-independence, are the assumed SNR, the S_a a priori, the target gas a priori, wavenumber ranges, and instrument resolution. Assuming that the spectra have similar resolution, it would seem straightforward to adopt, for example, an agreed set of microwindows and interfering species. Sometimes code differences make choices tricky, but in this case both PROFITT and SFIT2 are quite capable of fitting the same microwindows and agreeing on which gases to fit, which to scale, and maybe which gases might be retrieved a profiles as well. Given this, referring to table 2, why were CO₂, C₂H₄, and more importantly the O₃ isotopes (really important for the 1000-1005 cm⁻¹ window) not fitted for all stations?
2. Section 2.2.2 Why did the water retrievals from Harestua fail? Was this a problem with the ILS, lack of knowledge of the a priori water vapour, or maybe the dynamic range of the water vapour?
3. Following on from point 1, why did the Zugspitze not use an S_a of 10%? It is under-

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

stood that using a realistic S_a is more physically reasonable, but this is not what all stations decided to do. Why did different stations choose different correlation lengths? The correlation lengths do affect the DOFS, in fact increasing the DOFS for small lengths of order 4-5 km. Given access to climatological data, these lengths can also be estimated. Is this what was done for each station or something more arbitrary?

4. On what basis were the SNR values chosen? Does this reflect the inherent noise in the spectra from each spectrometer?

5. Section 2.2.3. Neglecting phase error at Zugspitze and Jungfraujoch was done because the phase error was near zero presumably (line 8-9)? If so it is better to say that the asymmetrical ILS was neglected because it was not important; it might leave the impression that there is a source of error not accounted for.

6. Later in this section, lines 10 through 29, is a discussion on layering. The authors seem confused or uncertain about whether their layering scheme is "fairly independent", line 11, or more definitely "independent", line 28. What should be said here is that the layering scheme adopted in the study, based on the quantitative method of using a $\text{DOFS}=1.0$ criteria, results in 4 layers that are independent. Independent in the sense of using the optical analogy, referring to figure 2, that the averaging kernel functions are "resolved" at the half height point (0.5), with widths of about 8-10 km. You state the criteria you use for the layering, so explain that the independence of the layering is used on the basis of the resolution of the kernel functions, rather than a purely independent variable. This principle is, after all, nicely displayed in figure 2.

7. Section 2.4.3, line 5. The total random error comparison with the Kagawa et al work is particularly difficult since they used the 3 micron O_3 band. Only studies using the 10 micron band are really relevant here.

8. Section 3.1.2., page 5024. This is an interesting discussion of table 4 similarities and differences. In line 26-27, one obvious point not mentioned is why the Dobson at Harestua is so different to the one at Ny-Alsund? One could argue that the uv-

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

vis/FTIR bias is roughly consistent between these stations, or order 10%, but it's the Dobson results that change by nearly 8%. The Harestua bias is therefore present in the uv-vis comparison, but the Dobson bias is not so clear cut.

9. Section 3.2.1, page 5026, line 16. What does the value of 2×10^{17} molec cm⁻² exactly explain? Put this in the context of % differences, as a single absolute number might not mean a great deal to some readers.

10. Section 4.1, page 5028, lines 8,18. Careful with the numbers and descriptions; the biases are lower than approx 4% (actually 4.2 at Izana), and Lidar comparisons at Kiruna are very good or maybe even excellent, but not perfect (nothing is).

11. Section 4.2, page 5032. This is yet another interesting discussion of differences between stations, this time in the upper stratosphere, that appear to be at odds taken at face value. Why is the DOFS for the Zugspitze, 0.5, so different from the Jungfraujoch, 1.2, for this partial column? The SNR's are similar (217 compared with 200), so maybe the Sa diagonal elements above 25 km are very different? Are the O3 apriori profiles very different (US std 1976 compared with annual sondes)? One would think that if the Zugspitze is 0.5 then the retrievals will be influenced to a greater degree by the apriori, which in this case has zero trend anyway. Are the authors actually saying here that the Jungfraujoch did not see the low O3 columns in the 2003/2004 and 2004/2005 winters, but due to dynamics missed seeing these events? Can this be backed up by other observational evidence?

12. section 4.3. On the discussion of the Kiruna and Harestua trends in the 18-27 km range. The sonde results by Kivi et al, over the range 40-10 hPa, have a lower range of roughly 22 km, and not 18km. It is noted that in the lower stratosphere the trends from the FTIR data are lower, which actually might make the matter worse. Even so, were the nearby sondes to Kiruna and Harestua (listed in table 5) used in the Kivi et al study? Is it possible to look at trends just from those sondes?

13. Section 4.5. Similarly to the comments in 12 above, what does the sonde near

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

Harestua show for its' trend in the troposphere? What model input does the CTM2 model use in the simulations?

Minor changes/typos

14. Abstract, pg 5009, line 1. "... are discussed and compared with ..."

15. Introduction, pg 5010, line 13. "... hence to ozone depletion."

16. line 22-25; "Indeed, several authors ..., where the individual ..."

17. pg 5011, line 2. Suggest rewriting this sentence to reflect there are different ozone trends, not just "the ozone trend". Try instead; " ... FTIR measurements are very suitable for studying the vertical distribution of stratospheric ozone trends since they can provide independent measurements of three different"

18. line 5; "... greenhouse an surface air ..."

19. line 6; "... is therefore the subject ..."

20. line 9. "The other main source ..."

21. line 12. "...location, season, and altitude ..."

22. line 13. "..., the sign and magnitude of the ..."

23. line 14. "... of the observed ozone changes ..."

24. Section 2.1 pg 5012, line 18; "... performed over a wide ..."

25. section 2.2 pg 5013, line 9; "... agree to within 0.5%."

26. line 13; "... associated with the ..."

27. pg 5014, line 23; "This approach significantly reduces ..."

28. pg 5016, line 16; "Experience shows however, ..."

29. line 18, "to avoid this problem, ..."

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



30. line 20-24. Here one assumes the authors are speaking on behalf of all sites, and not just the Jungfraujoch, so the language just needs to be adjusted to reflect that the while test was done on Jungfraujoch data, the results are applicable to all stations. So suggest for line 20; "At the Jungfraujoch station, the latter approach was compared with the one ...". And for line 23-24; "Therefore, the latter option was adopted at almost all stations."

31. pg 5017, line 24, "...approximated by, the ideal..."

32. pg 5018, line 14-15. Since this sentence is an indicative list, I suggest simply finishing the list with a full stop, ie ", and the a priori covariance matrix S_a ."

33. line 28, "This means ... above 44 km contributes less than ..."

34. pg 5019, line 4, "...range over which ..."

35 line 14, " ...layer limits so that the DOFS is at least 1.0 in each ..."

36. pg 5021, line 5,8,11 "...associated with the ..."

37. pg 5022, line 5, "... error for the total column... work to be 5.9%."

38. line 11, "... parameters to this..."

39. line 12, "... into account baseline error, and ..."

40. line 23, "... compared with ..."

41. line 27, "... located 241 km and 43 km from ..."

42. line 28, "...data are from Dobson, ..."

43. pg 5023, line 15, "... estimated to be about 5.9%."

44. line 29, "Unfortunately, these latter comparisons suffer from poor numbers ..."

45. pg 5024, line 4, "...latitude, the STD ...error. One can even ..."

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

46. line 5, "...as the STD is ..."
47. line 21, "...maximum in the ozone partial column ..."
48. line 28, "...to downward..."
49. line 30, "At high ..., but this air remains in the stratosphere for several months, ..."
50. pg 5025, line 4, " ...we clearly see the difference between the ..."
51. line 9, "...present in the mid-latitude ..."
52. line 16, "...mean ozone partial column in the ground - ~ 3 km ..."
53. line 20, "Validation on a subset of ozone ..."
54. line 24, "...taken from NILUs..."
55. pg 5026, line 16, "... where S_x is ..."
56. pg 5027, line 20, " ...This confirms the result by ..."
57. pg 5028, line 21, "...Table 6, where we ..."
58. line 26, " ...are equivalent to 2 ..."
59. pg 5029, line, "...last decade total column ozone ..."
60. pg 5030, line 26, " obtained, nonetheless still ..."
61. pg 5031, line 19, "...are consistent, within their uncertainties, ..."
62. pg 5032, line 4, "... two years, at the Zugspitze (...), where ..."
63. line 16, "... , as noted by ..."
64. line 19, "... with a decrease in ODSs: ..."
65. pg 5034, line 1, "...way to the total ..."
66. pg 5034, line 23, "... observe a decrease ..., the authors do not consider an

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

Interactive
Comment

increase in deep convection is plausible."

67. line 29, "...care as the DOFS is less than 1 in ..."

68. pg 5035, line 7, "...stations, Jungfrauoch and Zugspitze, ..."

69. line 13, "contributes 50% ..."

70. line 17, "...was attributed substantially to the ...; similarly the Arctic stations probably contributed to the large positive ozone trend observed over the 1995-2005 period, in this layer, at the mid-latitude stations." 71. pg 5036, line 2, "...chose to give ..."

72. line 21, "...on the one hand..."

73. line 24, "This increase ..."

74. pg 5037, line 10, "... the last two decades, ..."

75. pg 5038, line 17, "...contribution from changes ..."

76. acknowledgements. "...support from the Helmholtz ..."

77. abid, "... providing accommodation for the ..."

78. abid, "... and the NILU Atmospheric ..."

79. pg 5055, fig 3, what is LOS?

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 5007, 2008.

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)