

Interactive comment on “A multi-model analysis of vertical ozone profiles” by J. E. Jonson et al.

Anonymous Referee #1

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The paper intends to quantify intercontinental transport of ozone using the output of 7 numerical models. In this approach the emissions of the individual continents of the northern hemisphere are reduced by 20%. The particle dispersion model FLEXPART is applied for comparison with the model results and ozonesonde measurements were used to test the reliability of the numerical simulations. The presented results show a large spread of the amount of ozone transported from one to another continent when comparing the individual models whereas the averaged reductions are comparatively small (also compared to the spread of the individual models). TF HAP (Task force on Hemispheric of Air Pollution) aims to provide scientific information for policy makers. This information is usually based on ensembles (simple averages) of a large number of numerical simulations, which show to be more consistent with an ozonesonde climatology than (some) individual numerical simulations. From this observation an “empirical modeler law” is deduced, namely that ensemble averages describe the real world in

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a more appropriate way than individual models. Indeed, every model design has its strengths and weaknesses, but when the averages fit better to an ozone climatology this does not necessarily mean that the postulated “empirical modeler law” is also correct to describe the effect of continental ozone precursor emission reductions which is the basic target of the TF HTAP. In my view the paper provides a first but not completely satisfactory step for model evaluation; the correlations between ozonesonde measurements at different levels and numerical simulations (using the output of 12 numerical models) concerning individual days are unexpectedly poor for some models; the paper also illustrates basic difficulties to validate such models and it is therefore appropriate to stress the need for further model validation as mentioned in the last sentence of the Abstract. Probably the comparison of other trace gases than ozone should be included in model validation as well. I think, it would be worth to consider to adopt the concept successfully developed and used in the stratospheric modeling community namely to grade the individual models rather than to calculate ensemble means without any weighting.

Abstract 1. Line 16: I suggest to replace “As a result ...” by “This possibly explains that statistical relationships between models and ozone sonde measurements strongly depend on the individual models being unexpectedly poor for some the models” (I don’t believe that paper deals with surface measurements) 2. I recommend to add on line 25: Intercontinental transport of ozone is finally determined based on differences in model ensemble calculations ...

Introduction 3. I suggest to add (possibly in line 23, p. 26098), that the numerical experiments include a 20% reduction of the emissions of every continent (indeed, this information is provided in Section 3 again, but I think it is important to mention this fact in the introduction). 4. Line 2-4, p. 26101: “...it is “virtually impossible” trace the ozone pollution ... back to any specific source using measurements alone ...”: If you only look on ozone measurements (at least from one single receptor site) this is true, but this does not necessarily mean “... that rather it will contribute to a hemispheric

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“cloud of ozone””: I think, studies e.g. of Huntrieser et al., “Intercontinental air pollution transport from North America to Europe: Experimental evidence from airborne measurements and surface observations”, *Journal of Geophys. Res.*, 2005 clearly show, that such continental plumes exist in the free troposphere and they can be found by measurements and therefore I don’t believe, that it is appropriate to write “they rather will contribute to a cloud of ozone” – I suggest to add the reference and rewording this sentence, I don’t completely understand the exact message of the sentence. Do you mean the “cloud of ozone” in numerical simulations or in reality ? 5. Line 20 on p. 26101: ... also provides information ...

Ozone sonde measurements 6. Line 19 on p. 26101:... the ozone sonde data originate (I think, the “s” is not necessary) 7. Line 11 on page 26102: At (not as) Goose Bay ... 8. Line19/20 on p. 26102: I think, the sentence should be: the measurements were generally within 2% near surface increasing to 4-5% close to tropopause where vertical ozone gradients are large

Model results 9. Line 7, p 26105: Are sigma-values of the individual simulations used to describe the “range” of the model results ? Please specify 10. Remark: to line 10 on p. 26106: The seasonal averages in winter and spring for most models are well within 20% : However, effects of ozone precursor reductions in one continent is predicted to yield much smaller ozone reductions in the neighboring continents than 20% 11. Line 2 on page 26107: ... the trans continental contributions “are large”. Large compared to what ? To the 20% range found for agreement between ozonesonde and models described in point 9 ? 12. Line 12, p. 26107, in the sentence starting with: “Even though ...”: I suggest to add: Even though the seasonal differences between “ensemble model means” and ozone sondes are moderate 13. Line 9, p. 26109: sentence starting with “In the lower troposphere ...”: Please provide evidence for the statement of “some tendency” that for the models with high resolution to capture some of this effect: this is not evident for me when looking at the presented material. 14. Line 10, p. 26110: Figures 8d and e show (no s) 15. Line 13, p. 26111: For tropospheric

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ozone there is a marked difference attributed to contributions from North America extending to western Europe: Is this not an internal inconsistency to line 2-4 of p. 26101 (see comment 4), where you argue that it is “virtually impossible to trace the ozone pollution back ... as they rather will contribute to a hemispheric “cloud of ozone””? 16. Line 23, p. 26111: The spread is “relatively” large. Relative to what ? I think, when looking on the ozone concentration attributed to intercontinental transport in the individual models the differences amount to a factor of two according to Fig. 10b. 17. Line 8 on page 26112: I think, the Pacific rim itself is not a major ozone precursor emission area, but the polluted air has been possibly previously advected from the Asian continent.

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