

Interactive comment on “Can we explain the trends in European ozone levels?” by J. E. Jonson et al.

Anonymous Referee #3

Received and published: 2 September 2005

The paper discusses a few elements that are connected to understanding the trends of tropospheric ozone. The subject is highly relevant, both from a scientific point of view as well as from a policy perspective. Scientifically, there are various aspects that need further clarification, such as the development of background ozone (background from a European point of view). At some locations it is reported increasing, whereas other data suggest no increase or even decreases. Also it is unclear how these developments relate to emission changes in other continents. A second aspect that needs more attention is whether or not the observed changes in European ozone concentrations as a result of the significant emission changes that have occurred over the last 10-20 years are in line with the modelled changes. This is relevant to future policies.

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

Key in this study is the EMEP model which has been used to address changes in ozone. This model is very well suited to study ozone in Europe as it is one of the scientific foundations of the European ozone policy, and since it stands out as a scientific sound model as is proven in recent model inter-comparison studies. Since the EMEP model is fed by long-time series of meteorological fields and emissions it has the potential to model the ozone concentrations in Europe over a long time span.

The strong features of the EMEP model could be exploited to study in particular the effects of changes in the European ozone precursor emissions, and to address the problem of inter-annual variability. The latter is, quite rightly, recognised by the authors as a serious problem in assessing the trends in the measurements. It is therefore remarkable that the model is used to address a topic for which the model is much less suited, that is the background ozone. The background ozone in the model is constructed by imposing boundary conditions which are chosen to follow the (sparse) measurements at the boundary as good as possible. Although the approach of representing the background in this way is certainly defensible, it is obviously a weaker element (scientifically) in the ozone simulation than the meteorological processes and the emission processes.

There are a few other difficulties with “boundary conditions” in this paper. It may be assumed that the boundary conditions at the Atlantic border follow quite nicely the measured ozone in that region, but the validity of the boundary conditions at the other boundaries remains unclear. Moreover, the differences between the two sets of boundary conditions (Ref versus AvgBC) are not clear. Is it a few ppb? Is it in line with the trend in background ozone as discussed in the other sections of the paper? In order to evaluate and understand the model results this sort of information should be given.

Structure and presentation The paper seems to be a mixture of an overview paper and a paper discussing own results. There is a rather long introduction before the model is introduced and in the discussion (chapter 6) the emphasis is more on literature than on own results. This itself is not a problem, but since the discussion of own results is

[Full Screen / Esc](#)[Print Version](#)[Interactive Discussion](#)[Discussion Paper](#)

hardly put in the context of other studies, it makes the impression of two separate story lines and that is rather confusing. What is the message of the paper? The discussion at the end of the paper is of the same nature as the introduction. We cannot expect to have solved all the problems in understanding the trends, but one might expect to see where this study (the model runs) has contributed in improvement at one place or another. This is missing, so it is not obvious what we have learnt. Can we estimate how much the trend in background ozone and the trend due to emissions contribute to for instance winter time ozone trends in Europe? That would be interesting to see in the discussion.

The results are presented and discussed in a rather condensed way, possibly due to a lack of room. By selecting only a few items (for instance by dropping the high ozone events, and the NO₂) and economising on the rather long first sections room is created to discuss the results in somewhat more detail. In order to distinguish between the effects of background ozone and emissions sites should be selected that bear strong marks of either one of them. For instance, North Scandinavian sites can be used to discuss the effects of the background, and central European sites to see more of the emission effects. Wintertime and summertime trends at a selection of sites can then be discussed in the light of relative contributions from background and emission changes. It is recommended to focus in more detail on a few aspects of trends (for instance winter mean ozone) and to avoid short and general discussions on all aspects of trends.

Detailed comments (line by line)

p.5958 line 9 Climatological ozone etc Ę: The Ref. BC (which is the normal mode of operation) suggests that there is inter-annual variability in the ozone boundary conditions. So, this is not a climatological data set.

p. 5958, line 19. Such a trend Ę The abstract is good, but this is a strange sentence to finish with. Can be left out.

P. 5959, line 5. The anticipated effect Ę. are.. (shouldn't this be is??)

P. 5959, line 9. Inter-annual variations in ozone making it difficult to identify trends: True, but in the last couple of years methods (regression models, selection trees) have been developed and applied to account for the meteorological variability in the ozone data. For various sites corrected trends are available.

p. 5960, line 1. Why are the CO emissions in the US increasing? It is a very remarkable anomaly.

p. 5960, line 3. Increases in ship emissions. How much do ship emissions increase (in absolute numbers) compared to the decrease of country emissions? Averaged over the European domain, the ship emissions are still a relatively small factor.

p. 5963, line 18-20. The difference Ę section 6. The discussion is repeated in section 6, but without new insights. The model results don't seem to have affected the outcomes of the discussion much. See also comments under "structure and presentation".

p. 5964, line 10-14 This paragraph on seasonal cycles is a loose element in the whole paper. Can be left out.

p. 5965, line 28. Relatively smaller. Not: relatively small?

p. 5966, end of section 5. It is a rather long section on calculated trends in the literature. What is the message? What do we know and what do we not know? What is relevant in relation to this study and to the choice of the model runs?

p. 5966 line 17..28. The explanation of the boundary conditions is not very clear. The inter-annual variability (and consequently any trend therein) of Mace Head are imposed on the 3D climatological data set of Logan. Is that correct for the other boundaries? Does it represent the variations and trends that is underpinning the long-term data of sites like Hohenpeissenberg? There are indications that ozone at the eastern boundary has decreased, see the downward trend of ozone in the Caucasian mountains since 1989. And what about the boundary conditions of other species, like CO, SO₄, NO₂ etc??

[Full Screen / Esc](#)[Print Version](#)[Interactive Discussion](#)[Discussion Paper](#)

p. 5967 section 5.2 Why compare NO₂ modelled data (and not NO_x data) if there is a comparison with NO_x emissions? Trends of measured NO₂ in Scandinavian background sites are partly affected by changes in the background, whereas interior sites in Germany reflect better the changes in emissions. Why put them together in one plot, instead of discussing two individual sites in Germany and Norway?

The problem of inter-annual variability which also affects NO₂ at background sites can be addressed by the model. The model should be able to indicate how much the NO₂ varies as a result of long-term differences in the meteorological fields!!

p. 5967, line 23 This is probably due to Etc. strange conclusion and hard to understand. At clean background sites the contribution of European NO_x emissions is of the same order as the NO₂ background. This effect is more pronounced in the summer, and probably the emission effects are then small compared to the variations in the background NO₂.

p.5968, line 7-10. Why are the years 1991-1994 missing?

p.5968, line 11-13. The appearance of inter-annual variability also exists in ensembles of sites (as can be seen in the graphs). The arguments of choosing a large ensemble seem questionable.

p.5968, line 18-19. If the model is reproducing the inter-annual variability so well, it should be used for studying the variability!! For instance: what is variability and what is a trend?

p.5969, line 3-4. Do I understand correctly that the base run comprises the meteorological fields of 2002 and the boundary conditions of 1990? Are the BC's given on a monthly basis or on a hourly basis? Why not use the 2002 BC's instead of an average BC? That avoids the problem of having to multiply with 2 as latter pointed out in the discussion.

p. 5969, line 23-27. The fact that reductions are not seen in an ensemble demonstrates

[Full Screen / Esc](#)[Print Version](#)[Interactive Discussion](#)[Discussion Paper](#)

the drawback of using an ensemble. Select individual stations in different parts of Europe to show the effects you are after.

p.5970 winter section The model results indicate that emission changes have contributed not more than 1 ppb increase in Scandinavia, Scotland and Ireland, whereas changes in the boundary conditions are responsible for 3-4 ppb. If this is discussed in relation to the measurements, it would convey important information!

p. 5971, section 5.4.5 and p. 5972, line 3-6 As in the previous comment: try to make the conclusions more quantitative, and relate them to typical background areas and to areas stronger affected by European emissions (Germany).

p.5972, line 7. Make a distinction between summer mean and summer episodes.

p. 5972, line 27. What is meant with “here”? Does it mean: in Asia, ozone and ozone precursors? . ?

Concluding, I suggest that the article focuses more on 1-2 aspects of ozone trends, and tries to make quantitative conclusions (background versus European contributions). It will help if the presentation discusses individual “example” sites instead of ensembles. Furthermore, a more elaborated connection with monitored time series can help clarifying the trends. And in particular, trends of sites which have extended trend documentation.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 5957, 2005.

[Full Screen / Esc](#)[Print Version](#)[Interactive Discussion](#)[Discussion Paper](#)