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# ***Interactive comment on “Measurements and modelling of ozone in the Mediterranean MBL: an investigation of the importance of ship emissions to local ozone production” by I. M. Hedgecock et al.***

**I. M. Hedgecock et al.**

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## **1 Reply to Referee #2**

We thank the referee for their useful and thought provoking comments. Below is our reply, point by point, to the referee's concerns:

*The manuscript continues with a description of the measurement campaigns, where an*

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overview table with the different periods and lengths of the campaigns would be useful to have.

We have included a table (the new table 1) with the campaign dates and the start and finish ports and a general description of the area where the campaign took place.

*In the model description section it is not very clear, if an in-plume chemistry approach for ship emissions is used or not. This should be clarified, also to better understand the differences in the simulation results with and without ship emissions.*

We didn't use an in-plume chemistry scheme, we interpolated the EMEP emissions directly in the model as stated in section 3.3. We have added a statement to make this clear and shortened somewhat section 3.2.1 as suggested.

*In the model results sections the five tables with statistical analysis for the model evaluation are not convincing enough for the overall evaluation of the model results. For example it is not distinguished between day and night-time ozone concentrations or minimum and maximum ozone concentration. This would help to clarify if background ozone concentrations or peak ozone concentrations during daytime are modified. As already mentioned by the authors on page 16575, short time fluctuations are not captured this way, nor are day- and night-time variabilities resolved. I strongly recommend to reduce the number of statistical tables for model evaluation and to show instead meaningful figures e.g. scatter plots or time series. This way a better overview over the different campaigns and years might be achieved for the interested reader.*

We have included time series plots and which includes a scatterplot inset in the corner. These are the new figures 3, 4 and 5. We have added a brief summary of the results of comparing modelled and observed means, maximum and minimum O<sub>3</sub> concentrations in the section describing the model results.

We have also added a new figure (the new figure 9), which shows the difference

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between the maximum O<sub>3</sub> concentrations in the No\_Ships and Tot\_Emiss simulations, for the 2003 simulation. The 2003 campaign covered more of the Mediterranean than any of the other campaigns and so gives a broader picture of where the differences are greatest.

*The selection of different years and dates shown in figures 4-8 needs to be motivated, as it remains unclear if these are representative or random results.*

Figures 4 and 5 are simply representative of just about all the simulations, for figures 6 and 7 which illustrate the vertical profile of the impact of ship emissions on the O<sub>3</sub> concentration for the two emission scenarios, the Med-Oceanor 2003 campaign was chosen because it was the most wide-ranging of the cruise routes, as stated on page 16576.

*In the current version of the manuscript, the reader is a bit lost as it is not easy to have the different campaigns and length of campaigns in mind with the statistical tables and description in the text only. As suggested we have added a table of the dates with a brief description of the route.*

*The results of a more detailed evaluation should be taken into account in the conclusions as well.*

The Conclusions have been rewritten.

*The author tends to use pretty long sentences throughout the manuscript. In most cases, those can be easily divided into two sentences. I recommend to do so as this will facilitate the reading of the manuscript greatly.*

The manuscript has been revised and all the longer sentences shortened, we have addressed the points of ambiguity highlighted by both referees.

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Specific remarks:

- title: please avoid abbreviations like MBL
- page 16560, line 24: delete 'in'
- page 16561, line 18, delete 'of the'
- page 16562, section 2 Measurements: a table with an overview of the campaigns and observations including the period might be helpful to add
- page 16563, line 1: 'in addition to' instead of 'as well as'
- page 16563, line 4: 'started' instead of 'took'
- page 16566, line 19: delete `chem_in_opt = 0`, this is technical information unimportant for the reader
- page 16567, line 25: please indicate more clear if the ship plume parametrisation is used or not, if not section 3.2.1 should be considerably shortened. This is also important to understand section 4.3.
- page 16567, line 27: delete 'the applying'
- page 16569, section 4.1 Model validation: please add illustrations of e.g. scatter diagrams or time series to replace a few of the statistical tables and to illustrate the model evaluation results in a more detailed way
- page 16573, lines 26-29: not shown, scatter plots or time series should be presented
- page 16573, line 28: delete 'to'
- page 16574, section 4.2: This paragraph clearly illustrates that with the statistical means of temporal averages most of the instantaneous differences are smoothed out. A focus should be put on peak ozone concentration as these may be expected to contribute most to the increase of daily average ozone levels.
- Fig. 4-7: As the differences in high- and low-level emissions simulations are so small, only one scenario should be shown. This way, Fig. 6 and 7 can be combined in one figure.
- page 16576, section 4.3: The selection of the results for the years 2005 in Fig. 4, 2006 in Fig. 5 and 2003 in Fig. 6 and 7, and one day in 2000 in Fig. 8 should be



motivated. It is not clear why these years or exact dates have been selected. Are they representative or not?

Fig. 8 caption: the caption needs clarifications as it is not clear what is meant with 'the standard is met', does is mean ozone concentrations below or above 120 ppbv?

Fig. 9 missing.

Where the text has not been changed from the original we have amended the wording as suggested by the referee. The additional table and figures suggested by the referee have been added, and figures 6 and 7 have been combined into a single figure (the new figure 9, also the previous figures 4 and 5 have been combined (the new figure 7). An extra figure illustrating the difference in the the maximum value of the O<sub>3</sub> concentration between the simulations with and without ship emissions, has been added (new figure 8). We have changed figures 8 and 9 and now show the O<sub>3</sub> concentration differences between the simulations with and without ships emissions along the route of the measurement campaigns, as referee #1 suggested that extrapolating to the whole of the domain was not reasonable. The new figure (figure 10 in the revised manuscript) shows the 120  $\mu\text{g m}^{-3}$  limit (roughly 61 ppb), and illustrates that during the campaign there are a number of days in which the simulations suggest that emissions from shipping make the difference between remaining below or not. We have added comments to the captions to make it clear if the periods / years shown were chosen to be representative or for a specific reason (as in the case of the original figures 6 and 7). We do not understand why the referee did not receive figure 9.

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