**Responses to reviewer #2' comments on gmd-2021-47**

The paper presents the development of a moving point source (MPS) model and compares it with two other common methods for evaluating the local dispersion of ship emissions, namely the line source model and the fixed point source model. The MPS was implemented as sub-grid module in the urban chemistry transport model EPISODE-CityChem to study the impact of ship emissions in numerical experiments with one and several ships, as well as in a real-world scenario in Singapore. The simulations are carefully done and the results properly discussed. MPS has a great potential when used together with AIS ship position data for real-time simulation of pollutant dispersion from ship emissions. The moving point source model is a valuable addition to the EPISODE model for assessing impacts of ship emissions on air concentrations and human health on local and city scale, allowing for more details on the spatial and temporal distribution. The comparison between MPS and the line source model reveals that differences between the two methods are more obvious for instantaneous concentrations than for longer averaging times (1 h), because the dispersion of single plumes released at different points along the same trajectory (line) becomes more homogeneous in space when longer time scales are considered. The real case did not reveal the clear benefits from using MPS, probably because the period of five hours was too short to cover different weather conditions, changes in the boundary layer structure or day/night variation. My suggestion is to include one more case that studies the role of different atmospheric stability conditions on the ship impact from the three emission models. Overall, I am in favor of publishing the paper after my specific comments below are sufficiently addressed.

Response:
The authors thank the reviewer for the valuable comments and suggestions. We have modified the manuscript, conducted more comparisons and run additional simulations to better present our results and conclusions. More details about the responses to the reviewer's comments are listed below (the reviewer's comments are in "blue" and the responses are in "black").

**Specific Comments:**

1.) The abstract should better reflect the results from the study and give quantitative information about the evaluation of the performance of MPS. In particular, the larger discrepancies between the emission source models for instantaneous than for averaged concentrations should be stated more clearly.

Response:
The authors thank the reviewer for this suggestion. In the revised paper, the abstract has been modified to better demonstrate the important results and conclusions from the simulations conducted in this paper.

2.) Is there any specific treatment when the plumes released from different virtual points during a simulation hour are crossing or overlapping each other? There should be some assumption about merging of the plume masses or other interaction between the individual plumes.

Response:
For one ship, an individual plume is emitted from each virtual point during each timestep, and it is then treated by using the Gaussian segmented plume model (SEGPLU) available in EPISODE. In each timestep, the parameters (such as size, location and so on) of each individual plume will be calculated, and then all mass of one plume will be merged into the Eulerian cells for further 3D convection-diffusion calculation, when its size grows to a predefined value ($\sigma y/dy=4$ or $\sigma z/dz=4$). The contributions of all existing plumes on sub-grid will then be calculated in each timestep as well. By using these methods, the contributions of

the plumes are estimated, even when they are crossing or overlapping each other. New material has been added to the revised paper in Pg. 5.

3.) Figure 4: what is causing the structures in the wind field?

Response:
In EPISODE, the build-in meteorological pre-processor code, MCWIND, is used to calculate the wind field in Singapore. In the calculation, the estimated wind speed and direction will be adjusted based on the local topographical conditions, so that the wind speed and direction are not always same in different locations as shown in Fig. 4. This has been mentioned in section "2.3.1 Simplified study" (pg. 7, line 173-174).

4.) In general, there is too little information about the plume rise algorithm. How is plume rise handled in the LS model?

Response:
As a default method used in EPISODE, the plume rise (due to buoyancy or momentum) was calculated based on Briggs's algorithms [Briggs 1969, 1971 and 1975], which consider the different atmospheric stability conditions (such as neutral-unstable and stable conditions). In the revised paper, new materials have been added (pg. 4, line 111-113) to mention this information. In addition, the default LS model in EPISODE-CityChem was designed for estimating the emission dispersion generated from cars, which emit emissions at 1m above ground. In our study, the LS model was modified to consider the plume rise estimated by Briggs algorithms as well.

5.) What is assumed about the ship building height and width, since they can influence the plume rise?

Response:
The ship building height (BH) and width (BW) are assumed to have different values for different ships. The building height is assumed to be 5 m below the ship chimney heights. Specifically, BH is 25 m and BW is 20 m for large ships (such as cargo, container), while BH and BW are both 5 m for small ships (such as pleasure, fishing). New materials have been added to the revised paper (pg. 9, line 193-195) to describe the building height and width for different ships.

In addition, an additional simulation was conducted to use different BH and BW values (20m BH and 15m BW for all kinds of ships) as well, and very similar results are found when compared to the ship building setups used in this study. The results for the sensitivity study can be found in the new Appendix C in the revised paper.

6.) Real case study, section 3.3: a longer simulation period could reveal discrepancies between MPS and the LS model. The differences between the two models are very small and based on the real case it is currently not possible to conclude that MPS performs better. It is suggested to show the average 2-D fields for the observation period, to analyze where the largest discrepancy between the models occur and to look at a time series in the place of largest impact from ships. Differences in hourly average NO2 concentrations can be noticed, for example when looking at the 2-D plots in Fig. 15 at 180 min simulation time, over the eastern part of the city. It may be considered to show 2-D maps of concentration differences, to make such details clearer.

Response:
The authors thank the reviewer for the suggestions. New figures (Fig. 18) showing the differences of overall concentration averages from MPS and LS simulations have been added in the revised paper. The figures (2D maps) showed that the biggest differences between two models are in the locations close to the ships

especially where large number of ships are located, while the differences are reduced to very small in the locations far away from the ships (such as the inland of Singapore, where observation stations are), due to the emission dilution and deposition. Additional figures (Fig. 18c and 18d) showing the time series of the emission concentrations at the location where the big differences exist were added to the revised paper as well, which once again support that the predicted results by the two models are quite different near the ships.

We also tried to conduct additional simulations to include different weather conditions and day/night variations, however, the results are still same to those in Figs. 17 and 18 that the MPS and LS results are still similar in the location of observation stations while large differences exist in the locations close to ships. Therefore, it is very hard to get the conclusions that the new MPS model will predict better than the LS model when compared to the measured data. However, the comparison between the MPS model and the measured data (Fig. 17) indicates that the new MPS model could reasonably predict the dispersion of shipping emissions. In addition, the simplified results and the 2D plots in the real cases also showed that the new MPS model is a more realistic representation of the emission source and allows for greater granulation of the emissions. Hence, the MPS model could be a useful addition or alternative for the environmental researcher to evaluate the dispersion of emissions generated by the moving ships. In the revised paper, the discussion in "3.3 Real case study" and the conclusion parts have been modified to better describe the results and conclusions drawn from this study.

**Technical Corrections**

7.) 10 line 20: emission and concentration are confused here.

Response:
The sentences have been modified in the revised paper to make it clearer.

8.) 18 line 328: mention that locations of observation stations are shown in Fig. 6.

Response:
In the revised paper, the sentence has been modified to indicate that the locations of the observation stations are shown in Fig. 6.

9.) 18 line 330: replace "may contributed from following aspects" by "may be attributed to the following aspects".

Response:
In the revised paper, the sentence has been modified as "may be attributed to the following aspects."

10.) 19 line 339: replace "very" by "vary".

Response:
In the revised paper, "very" has been replaced by "vary".

11.) Figure 15: MPS and LS model 2-D plots ought to have the same color scale to allow for a quantitative comparison. This also concerns the other 2-D plots, like Fig. 13 and Fig. 14.

Response:
In the revised paper, new figures with same color scale have been added to the revised paper for Figs. 13-15.