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# The impact of resolution on the $O_x$-$HO_x$-$NO_x$ chemistry of ship plumes

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Ship emissions constitute a significant fraction of total anthropogenic emissions of $NO_x$. However, their inclusion in global atmospheric chemistry transport model causes these models to calculate unrealistically high concentrations of $O_3$ and $NO_x$ in the marine boundary layer. It has been suggested that the coarse resolution of such models coupled to the non-linear nature of the model chemistry leads to this overestimate however this has not been systematically investigate.

In order to investigate this hypothesis a high resolution chemical transport model of the marine boundary layer based on winds from a LEM which can be systematically degraded to lower and lower resolution.

Our simulations show that the OH concentration, $NO_x$ lifetime and ozone production efficiency of the model change by 8%, 32% and 31% respectively between the highest and lowest resolution simulations. Interpolating to the resolution of a typical global composition transport model (CTM, $5^\circ \times 5^\circ$), suggests that a CTM overestimates OH, $NO_x$ lifetime and ozone production efficiency due to ship $NO_x$ by approximately 15%, 55% and 59% respectively. Thus, the failure of CTMs to simulate ship plumes efficiently is likely due to the combined impact of coarse resolution and non-linear $O_x$-$HO_x$-$NO_x$ chemistry. These results are significant for the assessment and forecasting of the climate impact of ship $NO_x$ and indicate that at current global model resolutions ship plume emissions in CTMs, need to be suitably parameterized.