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Towards Effective Emissions of Ships in Global Models

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International shipping is one of the major transport sectors expecting to increase in the future. The Helmholtz-University Young Investigators Group SeaKLIM is investigating the impact of gaseous and particulate emission on climate. One important aspect is the chemical dilution of emissions in the near-field of a ship. Though ships emit their exhaust on a spatial scale of a few meters, current global models have grid sizes of a few hundred kilometers and are not capable to simulate the complex processes occurring during subgrid-scale plume dispersion.

In this study dispersion and chemical conversion of emissions in the near-field of a single ship are studied with two different modelling approaches to explore the differences between gradual dispersion and instantaneous dilution into a box with a size comparable to the large grid boxes of global models or satellite data. One approach instantaneously disperses the emissions on a large scale like a global model would do. The other starts with a small plume which is then continuously expanded while photochemistry is already running. Comparison between these two approaches shows that the neglect of plume expansion overestimates the ozone production up to a factor of 3, depending on emission strength and time. This indicates the necessity of correcting the way ship emissions are taken into account in global models. One possibility to account for these sub-grid processes in global models is the use of effective emissions. We present a method for calculating effective emissions. It is shown that the method is able to account for the neglect of sub-grid processes in global models for different emission times and emission strength.