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Satellite Measurements of Formaldehyde from Shipping Emissions

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This study presents the first satellite measurements of formaldehyde (HCHO) linked to shipping emissions as derived from observations made by the Global Ozone Monitoring Experiment (GOME) instrument. Launched on the ERS-2 satellite in April 1995, GOME has performed continuous operations over 8 years providing global observations of different trace gases. In this way, long term satellite observations provide unique opportunities for the identifications of trace gas sources.

We analyzed enhanced HCHO tropospheric columns from shipping emissions over the Indian Ocean between Sri Lanka and Sumatra. This region offers good conditions for plume detection with the GOME instrument as all ship tracks follow a single narrow track in the same east-west direction than used for the GOME pixel scanning. The HCHO signal alone is weak but could be clearly seen in the high-pass filtered data. The line of enhanced HCHO in the Indian Ocean as seen in the 7-year composite of cloud free GOME observations clearly coincides with the distinct ship track corridor from Sri Lanka to Indonesia. From the observed HCHO column densities we estimate the direct and indirect HCHO emissions from shipping. The observed mean HCHO column enhancement over this shipping route is about 2.0×10^{15} molec/cm^2.

The observed HCHO pattern also agrees qualitatively well with results from the atmospheric model ECHAM5/MESSy. However, the modelled HCHO values over the ship corridor are two times lower than in the GOME high-pass filtered data. This might indicate that the used emission inventories are too low and/or that the in-plume chemistry taking place at the narrow path of the shipping lanes are not well represented from the rather coarse model resolution. The effect of ship emissions on the rather pristine marine boundary layer is evident from the models as well as from satellite HCHO observations, making HCHO to a marker of the NMHC-reactivity. Although the ship emissions are not a major source of HCHO globally, this study has shown that they can be detected and measured with a satellite-based instrument (GOME). GOME II (launched onboard METOP in October 2006) with improved spatial resolution might even allow the detection of further ship tracks. Ship emission have already been detected for other trace gases like NO_2 and other studies show an increase of the ship emissions over the last years and a further increase for the coming years.