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Remote ship emission measurements of sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) from airborne platforms

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The combustion of fossil fuels gives rise to emissions of sulfur dioxide, and nitrogen oxides. The International Maritime Organization has ratified new conventions to reduce ship emissions of sulfur and nitrogen oxides (NO_x), which are predicted to exceed land based emissions by 2020. There is economic incitement to disobey the legislation and run with cheaper residual fuel containing high concentrations of sulfur.

As a mean to control ships remotely an optical remote sensing system to measure total emission of sulfur dioxide (SO_2) and nitrogen oxide (NO_2) from ship exhaust plumes has been developed in a Swedish national project. The system is based on Differential Optical Absorption Spectroscopy using reflected skylight on the water surface as light source. The emission measurements are carried out by conducting flight transects over and perpendicular to the exhaust plume of the ships. A spectrometer is recording spectra with the telescope pointed at 30° angle from the horizon. The mass column of SO_2 and NO_2 in the light path of each spectrum is retrieved and the column values obtained when measuring across the ship plume are summed up. The resulting total mass across the plume is further multiplied with the apparent wind to obtain the total emission in kg/h. The optical system is part of a larger system, denoted IGPS (Identification of Gross Polluting Ships) which will be further described.

The system was operated from a CASA-212 airplane during 2008 around the Swedish coast and from a Dauphin helicopter on the North Sea in an EU campaign 2009. In this presentation the results from these measurements will be shown. The uncertainty is estimated to be in the range 40-60% with the largest error sources corresponding to the uncertainty in the optical path due to multiple scattering and influence of waves.