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Comparative measurements for detection of ship emissions

Kai Krause (1), Folkard Wittrock (1), John P. Burrows (1), Denis Pöhler (2), Stefan Schmitt (2), Andreas Weigelt (3), and Stefan Schmolke (3)

(1) University of Bremen, Institute of Environmental Physics, Physics of the Oceans and the Atmosphere, Germany (kakrau@iup.physik.uni-bremen.de), (2) Heidelberg University, Institute of Environmental Physics, (3) Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency)

Ship emissions are an important source of trace gases and particles like CO, CO_2, NO_x (NO + NO_2), SO_2, VOCs, PM and black carbon. To analyze ship emissions a bunch of different instruments have been set up in Wedel close to the port of Hamburg which is the busiest in Germany and number three in Europe. This activity is part of the project MeSmarT (Measurements of shipping emissions in the troposphere, www.mesmart.de).
Three of the instruments used in this study are DOAS-type (Differential Optical Absorption Spectroscopy): two different Open Path-DOAS and one MAX-DOAS. Two commercial in-situ measurement systems, meteorological instruments and an AIS-decoder are complementing the measurement site. One of the Long Path-DOAS systems is a newly developed prototype specifically designed to measure ship emissions and is currently tested in Wedel, while the other one serves as a reference system. The light path of all the DOAS systems cross the Elbe river and thus allows to detect the plumes of passing ships. The prototype system has been set up in October 2018, while the reference Open Path system was set up in April 2018. MAX-DOAS and in-situ systems are already running for several years.
This study focuses on the time series of NO_2 and SO_2. Differences between the instruments are discussed in detail, taking into account meteorological conditions, photochemistry and radiative transfer. SO_2/NO_2 ratios are investigated focusing on the question, whether this information can be used to monitor the sulfur content of shipping fuel.