



## Monitoring shipping emissions with MAX-DOAS measurements of reactive trace gases

Folkard Wittrock (1), Enno Peters (1), André Seyler (1), Lisa Kattner (1,2), Barbara Mathieu-Üffing (1,2), John P. Burrows (1), Maksym Chirkov (1), Andreas C. Meier (1), Andreas Richter (1), Anja Schönhardt (1), Stefan Schmolke (2), and Norbert Theobald (2)

(1) University of Bremen, Institute of Environmental Physics, Bremen, Germany (folkard@iup.physik.uni-bremen.de), (2) Federal Maritime and Hydrographic Agency (BSH), Hamburg, Germany

Air pollution from ships contributes to overall air quality problems and it has direct health effects on the population in particular in coastal regions, and in harbor cities. In order to reduce the emissions the International Maritime Organisation (IMO) have tightened the regulations for air pollution. E.g. Sulfur Emission Control Areas (SECA) have been introduced where the sulfur content of marine fuel is limited. However, up to now there is no regular monitoring system available to verify that ships are complying with the new regulations. Furthermore measurements of reactive trace gases in marine environments are in general sparse.

The project MeSMarT (Measurements of shipping emissions in the marine troposphere, [www.mesmart.de](http://www.mesmart.de)) has been established as a cooperation between the University of Bremen and the German Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency) with support of the Helmholtz Research Centre Geesthacht to estimate the influence of ship emissions on the chemistry of the atmospheric boundary layer and to establish a monitoring system for main shipping routes. Here we present MAX-DOAS observations of NO<sub>2</sub> and SO<sub>2</sub> carried out during ship campaigns in the North and Baltic Sea and from two permanent sites close to the Elbe river (Wedel, Germany) and on the island Neuwerk close to the mouths of Elbe and Weser river. Mixing ratios of both trace gases have been retrieved using different approaches (pure geometric and taking into account the radiative transfer) and compared to in situ and air borne observations (see Kattner et al., Monitoring shipping emissions with in-situ measurements of trace gases, and Meier et al., Airborne measurements of NO<sub>2</sub> shipping emissions using imaging DOAS) observations. Furthermore simple approaches have been used to calculate emission factors of NO<sub>x</sub> and SO<sub>2</sub> for single ships.