Impact of Sulfur Regulations of Shipping Fuels on Coastal Air Quality

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MeSmaRt project
• “Measurements of Shipping Emissions in the Marine Troposphere” – a project coordinated by the University of Bremen with support of the German Federal Maritime and Hydrographic Agency (BSH) and the Helmholtz Zentrum Geesthacht
• Aims: – Measure ship emissions in the marine environment, comparison with satellite and model data – Investigate their impact on the atmospheric boundary layer – Development of a concept for controlling ship emissions
• Operational area: German Bight and Baltic Sea
• Stationary measurement sites:
  - NHU: 46° to navigation channel in the mouth of Elbe

Measured slant column densities of NOx and SO2
• Slant column densities of NOx and SO2 measured on Neuwerk on Wednesday, 23 July 2014 in 0° elevation (left): High and short ship emission peaks, enhanced coastal background pollution in the morning
• NOx Peaks in azimuthal viewing directions show movement direction of ship (right)

Daily means: Comparison of MAX-DOAS with in-situ volume mixing ratios
• Good agreement in progression of curves
• In-situ values systematically higher → expected, because MAX-DOAS averages over long light path and plumes usually never cover the whole light path → peak heights are usually underestimated

Mean VMR depending on wind direction
• Red curve: before 1 January 2015
• Blue curve: after 1 January 2015
• Blue sector: Wind from open North Sea, shipping is the only source
• Green sector: Wind from the coastline, air mass contains shipping emissions as well as land-based air pollution (traffic, industry, ...)

Impact of land-based pollution on air quality in the German Bight
• All NOx measurements (solid line): Clearly visible diurnal (left) and weekly cycle (right)
• Ship traffic should not depend on weekday and hour of day ⇒ it has to be road traffic emissions from land
• Only wind from open North Sea (darker): Cycle varies, significantly lower values
• Although Neuwerk is 8 km away from the coast, land-based air pollution strongly influences air quality on the island

Conclusions
• MAX-DOAS can measure emission peaks from single ships as well as background pollution
• NOx: No regulations ⇒ no change in emission
• SO2: Allowed fuel sulfur content dropped from 1.0 % to 0.1 % (MARPOL, ZF/7 Annex VI) ⇒ significantly lower SO2 emissions, especially from the open North Sea sector
• High NOx concentrations 10 to 15 km away from our instruments
• In-situ device cannot see plumes

Further information: visit www.mesmart.de and www.iup.uni-bremen.de/doas/

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Selected references

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