Modelling the impact of inland shipping on ambient air quality: some questions

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Shipping is an important means of transport. Emissions from sea shipping are among the main global sources of air pollutants (e.g., Driesch *et al.* 2013). The role of inland shipping in this regard is less well known. Focus of this study is the impact of inland shipping on the air pollutants NO_2 and PM_{10} and some of the questions arising when modelling this. We concentrate on the German federal state North Rhine-Westphalia (NRW), and the river Rhine, one of the main water ways in Europe.

Considering that shipping on a major water way like the river Rhine accounts for similar emission loads as a heavily trafficked highway, it is obvious that it must be a focus of air quality investigations at least for adjacent areas. In NRW, shipping emissions contribute about 10 % of NO_x and 2 % of PM_{10} emissions.

Model results of the chemistry transport model EURAD for the share of different source groups to the regional background concentration are shown in Fig. 1. Inland shipping within NRW contributes up to 15% to the NO_2 and up to 11% to the PM_{10} background concentrations. It is not unlikely that shipping is also part of the share from long range transport.

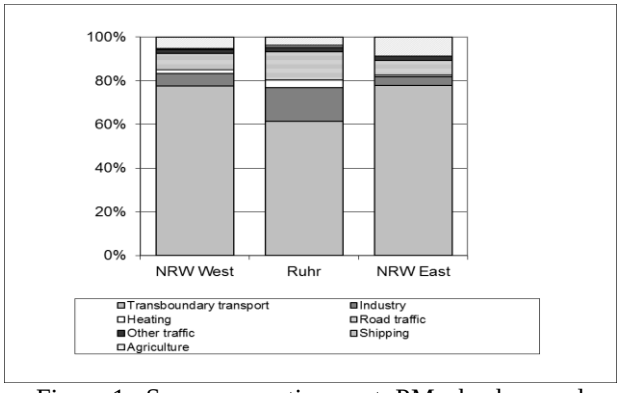

Figure 1. Source apportionment: PM_{10} background concentrations in different regions in NRW. EURAD model results.

When modelling shipping effects on a smaller scale, e.g., for air quality plans, questions arise. Figure 2 shows such model results of the contribution of the river Rhine to the PM_{10} concentration. Disregarding the effects of grid size resolution, emissions from shipping affect an area larger than the area affected by a typical heavily trafficked highway. This leads to the question if this is a modelling artefact. Compared to road vehicles, emissions from ships are generally higher above ground. Thus, it is probable that they can be transported farther. But how far? In order to answer this question we started a field experiment with passive samplers for NO_2 to identify the magnitude of the gradient in the shipping immission from the riverbank to the next residential area.

Other questions concern the effect of the water body on the wind and the impact of obstacles, e.g., the riverbank or buildings. In streets, air quality problems are mainly caused by road traffic in street canyons. The lack of ventilation leads to high concentrations of air pollutants. To analyse the effects for rivers, we carried out model simulations with a high resolution for a small section of the river Rhine, taking into account riverbanks as well as buildings on the shore. The model results show markedly less influence of buildings and riverbanks on the spread of the air pollutants compared to the effect of buildings on a street canyon. This may be due to the relation between the breadth of the river bed compared to the height of the obstacles and/or the different emission height.

Conclusion: Even though emission from shipping on a river is comparable to that from traffic on a busy street, modelling their impact on air quality shows marked differences and raises questions that need to be investigated.

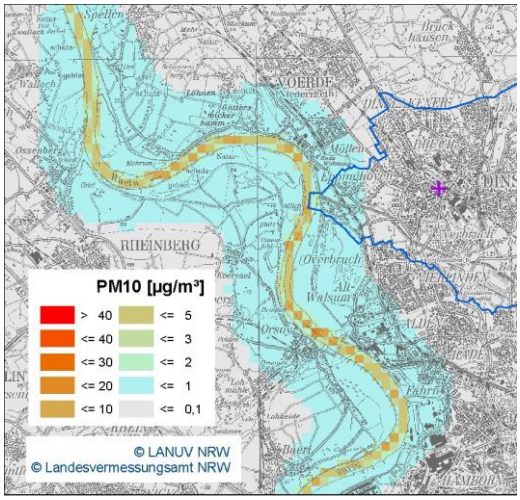

Figure 2. Modelled contribution of a section of the river Rhine to the PM_{10} immission load (annual average).

Driesch, J. M., Drewnick, F., Klimach, T., and Borrmann, S. (2013) *Atmos. Chem. Phys.*, **13**, 3603–3618