

# The influence of ship traffic emissions on the air concentrations of particulate matter

Preliminary estimate from EMEP/MSC-W  
under request of DG Environment  
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The contribution of ship traffic emissions to the air concentrations of secondary inorganic particles (nitrate and sulphate and ammonium) vary between 20-30% in most western European coastal areas. These results are a first rough estimate from the EMEP Eulerian model and should be validated further. It should also be mentioned that the EMEP Eulerian model generally underestimates the air concentrations of particulate matter although the underestimate is less pronounced for secondary inorganic particles. This means that the results presented here are more uncertain for PM10 than for secondary inorganic aerosols and PM2.5.

## Method

Concentrations of particulate matter in Europe have been calculated using the EMEP Eulerian acid deposition model and emissions reported by the Parties to the LRTAP convention for 1999. Secondary inorganic aerosol (SIA) concentrations have been derived from anthropogenic emissions of precursor gases. Emissions of  $SO_2$  and  $NO_x$  from ship traffic in the Atlantic ocean, the North Sea, the Baltic Sea, the Black Sea and the Mediterranean have been considered according to Lloyd's Register of Shipping. These emissions refer to 1990 and probably underestimate the 1999 level. Two sets of calculations have been carried out; with and without ship emissions. The contribution from ship traffic emissions to concentrations of secondary inorganic aerosols (SIA) have then been estimated as the difference between the concentrations in the results of the two calculations. Concentrations of primary particulate (PPM) have been calculated using a dedicated version of the EMEP Eulerian model and emission estimates for 1990 based on TNO data. Note that we do not have any explicit data from ship traffic for primary particulate emissions.

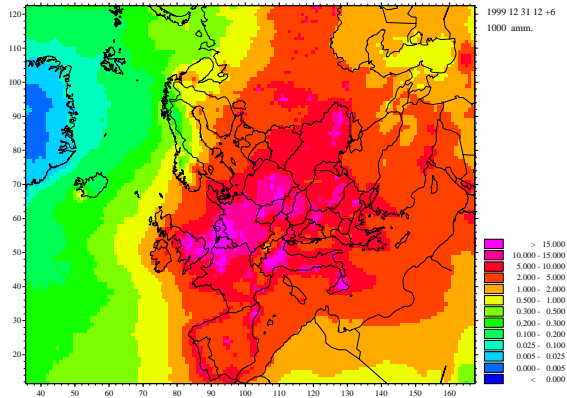
The sum of the calculated air concentrations of secondary inorganic aerosols (SIA) and primary particulate matter (PPM) are a first approximation to an-

thropogenic PM10 concentrations. Primary particulates contribute with approximately 20-30 % of the total modeled PM10 concentrations. It should be mentioned that secondary organic particles and particulate matter originating from natural sources are not included in this calculations. Thus we can expect that the calculated PM10 values presented here underestimate the actual PM10 air concentration values observed in Europe.

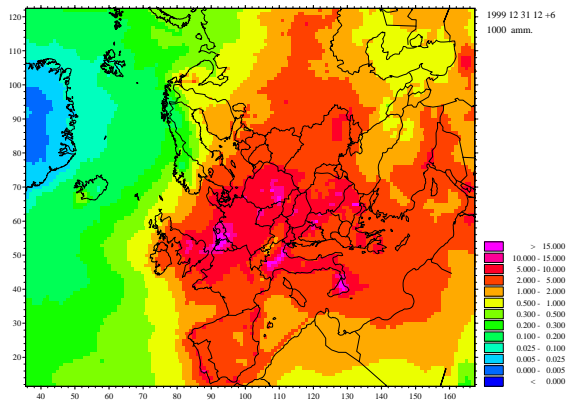
## Results and conclusions

In figure 1 maps of concentrations of total PM10 (as SIA + PPM), total SIA and SIA from international shipping are presented. Figure 2 show the contributions from ship traffic emissions to concentrations of SIA in percentage of the total PM and SIA concentrations. The contribution from ship emissions to the calculated concentrations of sulphate, nitrate and ammonium (SIA) can amount to 20-30% in most western European coastal areas. With the limitations mentioned above on the present PM10 calculations, these results indicate that international ship traffic emissions may be an important source to concentrations of PM10 in Europe, especially in coastal areas and areas dominated by long range transport. Ship traffic emissions appear to contribute with 5-10% of the calculated PM10 concentration in large parts of Great Britain, Portugal and Italy but with 10-20% in Denmark, Iceland, Norway and Sweden and more than 20% in remote areas in these countries.

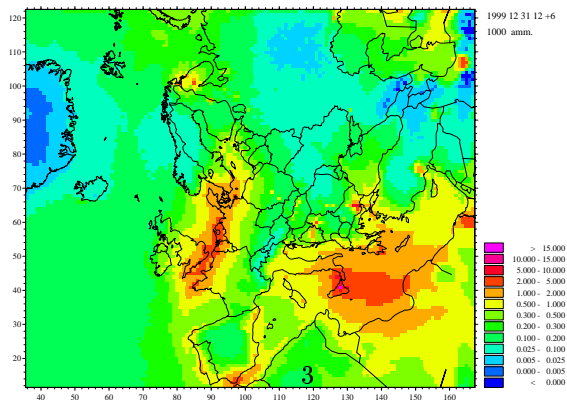
Only one year of meteorology (1999) have been used in this study. In order to diminish the uncertainties due to meteorological variations several years of meteorology should be applied. There are also considerable uncertainties in the estimated PPM concentrations, partly because PPM emissions are uncertain and PPM from ship emissions are not included and partly because the model generally underestimates the concentrations of PPM (see EMEP report 4/2001). Further work is envisaged in order to give reliable estimates on the magnitude of which ship traffic emissions contribute to PM concentrations in Europe.



(a) PM10

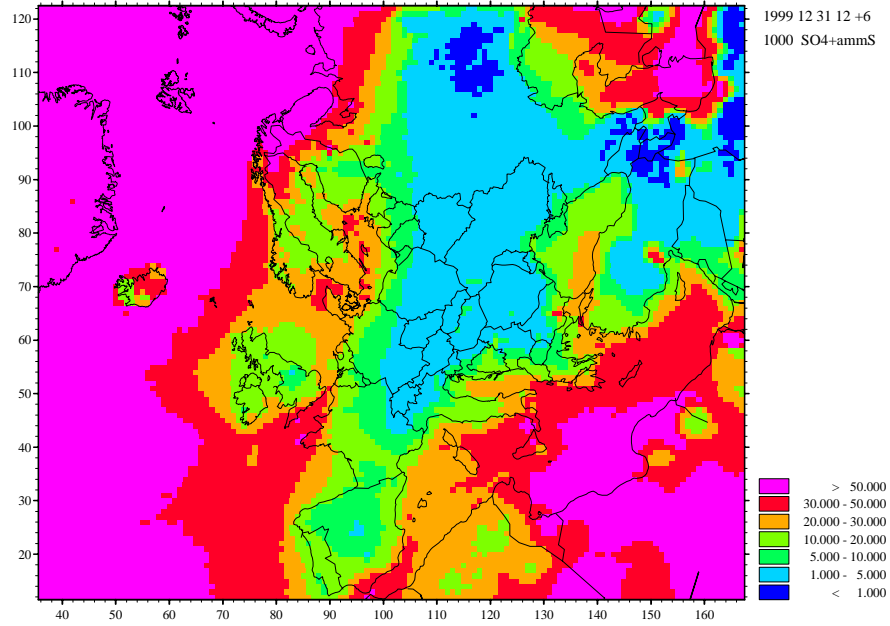


(b) Secondary inorganics (SIA)

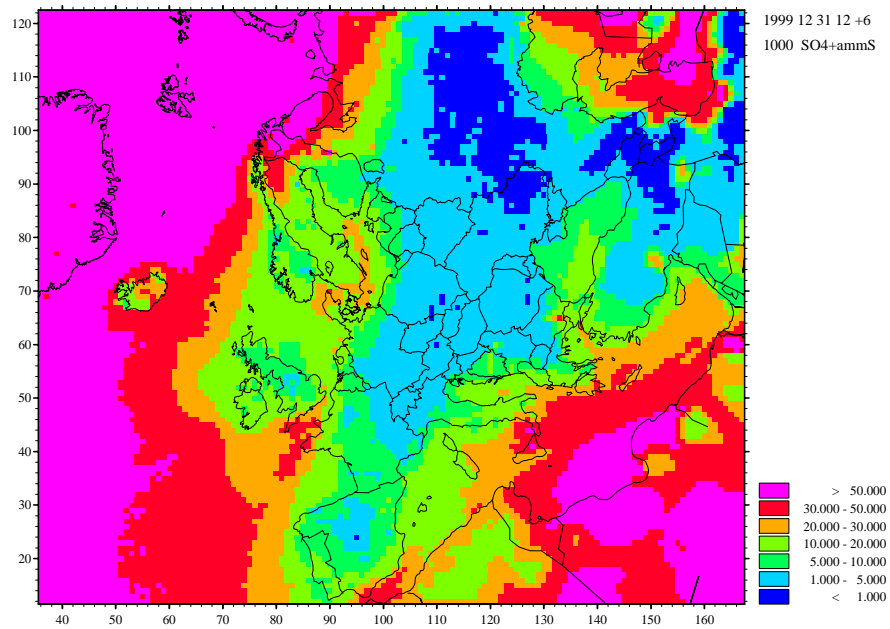


(c) Contribution to SIA from ship emissions

Figure 1: Particulate matter (PM) concentrations ( $\mu\text{g}/\text{m}^3$ ) in Europe, 1999



(a) Contribution from ship emissions to SIA



(b) Contribution from ship emissions to PM10

Figure 2: Contribution from ship traffic emissions (%) to concentrations of PM in Europe, 1999.