



## Fine particles trap more heat in atmosphere than previously thought

**Fine particles in the air** produced by road transport trap more radiation in the earth's atmosphere than previously estimated, and therefore may contribute more to global warming than realised, according to new research. In contrast, the impact of particles from shipping appears to reflect more radiation than previously thought, whilst the effect of particles from aviation is comparatively small.

**Aerosols are fine particles** suspended in the air. Transportation emits aerosols of black carbon, organic carbon and sulphates which influence the amount of heat radiation that enters or leaves the atmosphere, otherwise known as radiative forcing. Black carbon tends to absorb the heat and keep it within the atmosphere, whilst sulphates tend to scatter the heat so that it leaves the atmosphere. As transportation is predicted to grow significantly in the next few decades, it is important to understand the effects of aerosols on radiative forcing.

Research funded through the EU QUANTIFY project<sup>1</sup> estimated the range of radiative forcing from the main transport aerosols of black carbon, organic carbon and sulphates for the whole transportation sector. It also investigated whether the mixing of different aerosols in the atmosphere would cause a change in properties.

When the effects of aerosols were totalled, all models indicated a 'positive' average radiative forcing for road transport, i.e. the overall impact of particles from road transport is to trap more heat than they reflect, contributing a warming effect to the atmosphere. Particles from shipping on the other hand have a 'negative' average forcing, i.e. they reflect more heat than they absorb and contribute an overall cooling effect. The emissions from aviation were much smaller and so their contribution to radiative forcing was small compared with other forms of transport.

Out of the three aerosols, black carbon contributed the most to radiative forcing produced by road transport. When black carbon mixes chemically with other aerosols the radiative forcing for the total aerosols ranges from 24.6 to 41.4 milliWatts per m<sup>2</sup> (the variation depends on the method of calculation). Whereas when the particles are assumed to retain their chemical properties the radiative forcing for total aerosols is nearly halved and ranges from 14.1 to 27.8 milliWatts per m<sup>2</sup>. The estimates for radiative forcing from road transport estimated in this study are much larger than previous predictions (3 +/- 11 milliWatt per m<sup>2</sup>).

For shipping the radiative forcing from all aerosols is negative. Shipping emissions contain large amounts of sulphates which have a strong negative effect, whilst the small contributions from organic carbon and black carbon tend to compensate for each other. The figures are hardly affected by assumptions about the mixing of aerosols and range from -29.7 to -22.5 milliWatts per m<sup>2</sup>. These estimates compare well with other studies.

The total radiative forcing for aviation is much smaller compared with the other two forms of transport. As sulphates and black carbon have opposite contributions, emissions of these aerosols cancel each other out. Assumptions about mixing have little impact: if the chemical properties of aerosols remain separate the radiative forcing is 0.1 to -1.1 milliWatts per m<sup>2</sup> and if aerosols mix so that their properties change then forcing is 0.3 to -1.0 milliWatts per m<sup>2</sup>.

1. QUANTIFY was supported by the European Commission under the Sixth Framework Programme under the theme 'Sustainable development, global change and ecosystems'. See: [www.pa.op.dlr.de/quantify/](http://www.pa.op.dlr.de/quantify/)

**Source:** Balkanski, Y., Myrhe, G., Gauss, M. *et al.* (2010). Direct radiative effect of aerosols emitted by transport: from road, shipping and aviation. *Atmospheric Chemistry and Physics Discussions*. 10: 1659-1691.

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