BLACK CARBON AS RADIATIVE FORCING – GLOBAL AND REGIONAL EFFECTS OF EMISSIONS AND POSSIBLE EMISSION REDUCTIONS

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Black carbon is among the most important short-lived climate pollutants (SLCP), alongside ozone and methane. Radiative forcing is often used as a measuring point for studying how various factors impact the climate, with positive values for warming and negative values for cooling factors. The best estimate for the current overall radiative forcing in comparison with the pre-industrial era is approximately 2.3 W/m2. The radiative forcing caused by black carbon is estimated to be 1.1 W/m2 while the greatest pollutant, carbon dioxide, causes a radiative forcing of around 1.7 W/m2. However, many sources of black carbon, such as biomass burning, also release climate-cooling aerosols in addition to black carbon. If the cooling factors are included, the effect of black carbon sources on radiative forcing is roughly 0.4 W/m2 according to the IPCC's latest report. However, the numbers are still uncertain.

The effects of black carbon on the climate can roughly be divided into three categories: (1) airborne black carbon that absorbs sunlight and warms the atmosphere (direct effect); (2) black carbon aerosols affect cloud properties and, through them, the climate (indirect effect); (3) black carbon that settles on snow and ice causes heating and early melting (effect on snow). The direct and indirect effects of airborne black carbon on the climate are at their greatest when insolation is high, and thus similar emissions have a more significant effect closer to the Equator than at higher latitudes. The effect is also stronger during the summer than in the winter. On the other hand, the effect that melting snow and ice have on the climate is primarily caused by wintertime emissions in northern and mountainous areas.

According to climate models, the climate effect of Finnish black carbon emissions is primarily caused by the early melting of snow and ice. Finland's share of the global black carbon effect on snow is up to one percent, while Finland's share of the direct and indirect effect is around a 0.1 percent. In terms of climate effect, emission reductions in Finland during the winter are considerably more effective as a mitigation measure than reductions during the summer. The seasonal difference is further increased by the minimal insolation during the winter which minimises the cooling effect of organic and sulphate aerosols produced together with black carbon emissions.

Small-scale wood burning is the largest source of black carbon emissions in Finland and accounts for roughly 50% of total emissions. Traffic and heavy machinery are another major source of emissions. In the next few decades, the emissions from traffic will decrease considerably due to strict emission regulations for diesel vehicles. On the other hand, there are currently no emission regulations for small-scale wood burning and emissions will not decrease without designated measures. These emissions could be reduced considerably through existing technical (more efficient ovens and heating boilers) and non-technical (user education) measures. The emissions from wood burning are a health hazard particularly in densely populated one-family house areas. Emission reductions directed towards suburban areas would be beneficial for both the climate and the health of the inhabitants.

RECOMMENDATIONS:

The Panel recommends the following measures to reduce black carbon emissions cost-efficiently while simultaneously limiting the health impact of black carbon aerosols:

1) Providing incentives for municipalities and regional authorities to organise information campaigns promoting clean wood burning and to produce general information regarding the effects of black carbon emissions and aerosol emissions produced by wood burning.
2) Finland supports the EU's Ecodesign Directive for local space heaters and small boilers, which is currently being prepared, and its ratification with sufficiently strict aerosol emission limits.
3) Developing a national device standard in the legislation of wood burning sauna stoves to reinforce the EU regulations for fireplaces by, for example, adapting the content of the stove standard to comply with the new requirements of the voluntary Joutsenmerkki, the official Nordic eco label.