Geophysical Research Abstracts
Vol. 13, EGU2011-12830-1, 2011
EGU General Assembly 2011
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Managing radiative forcing from sulfate and black carbon

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While many new geo-engineering options have recently entered into the public debate over mitigating future climate change through policy intervention, air pollution control policies also have an effect on radiative forcing. Currently controlled due to their impact on public health, black carbon and sulfate have a mixed impact on atmospheric radiative forcing. Black carbon emissions absorb incoming solar radiation and contribute to a significant warming of the atmosphere while sulfate aerosols scatter incoming solar radiation and mitigate atmospheric warming. However, given that these short-lived climate forcers come from a variety of regionally disperse sources and have specific emission location impacts, it is computationally expensive to determine the best mitigation option using a coupled climate-chemistry model.

To reduce the computational load for evaluating multiple emission mitigation options, we have developed a rapid evaluation tool for estimating the global radiative forcing from emissions of short-lived climate forcers. Radiative forcing sensitivities from the GEOS-Chem/LIDORT adjoint model are used to estimate the global radiative forcing from present-day emissions of short lived climate forcers. Future emission scenarios of these pollutants under a greenhouse gas policy consistent with the RCP4.5 scenario and current air quality policies were evaluated for their effect on global radiative forcing. Under proposed carbon limits, additional reductions in sulfate are expected in the US as energy sources switch away from coal to less carbon intensive fuels. To compensate for this reduction in cooling particles, additional reductions in warming particles such as black carbon or greenhouse gases will be needed. By incorporating radiative forcing sensitivities into the energy system market model, MARKAL, we identify emission control strategies which may offset the reductions in sulfate.