Regional and Sectoral Attributions of Aerosols: Potential Impacts of Emission Reductions

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We use the GISS GCM to explore the effects of eliminating aerosol emissions, first from particular regions and second from particular sectors. Our experiments include the major anthropogenic aerosol components: sulfate, black carbon and organic carbon. Our model includes state-of-the-art aerosol sources, sinks and radiative interaction; we assume a simple mass based scheme with externally mixed aerosols. Our anthropogenic emissions are based on scenarios from Bond et al. (2004) (for present-day carbonaceous aerosols), Streets et al. (2004) (for future carbonaceous aerosols), Van der Werf et al. (for biomass burning aerosols) and EDGAR version 2.3 for sulfur emissions.

In the regional experiments we seek answers to questions such as: If a region were to eliminate emission, how 'clean' would its surface air become? What would be the global implications? (i.e. How much do the regions retain vs export their pollution?) What are the climate impacts of emissions from each region? The 4 regions we examine are (*approximately*) North America, Europe, China and India. According to the model, surface level air is dominated by nearby regional sources. Thus, if a region reduces its emissions, surface level air quality response is highly significant. However, if we consider column-related quantities such as optical thickness, we find considerable export from some regions. For example, pollution emitted from India and China tends to loft to high altitudes and is therefore easily exported.

Our sectoral experiments aim to determine the potential benefits of targeting particular sectors globally. Since sectors vary in their fraction of absorbing and reflecting aerosol components, we may learn which sectors can best be targeted in order to reduce global warming. The sectors we consider are residential, biomass burning, power, industry, and transportation. Since black carbon emissions are strongest in the residential and transport sectors, these sectoral reductions are expected to offer a modest reduction to global warming. We show that in much of the world, organic carbon loads appear to be derived primarily from biomass burning and natural terpene emissions.

Our sectoral and regional experiments described so far make use of present-day emissions. We also perform aerosol simulations using 2 future SRES scenarios (A1b and B1) for the years 2030 and 2050 (Streets et al., 2004). We predict that the 'cleaner' alternative, the B1 scenario, would be less effective at combating global warming, since sulfate reductions exceed carbonaceous aerosol reductions.

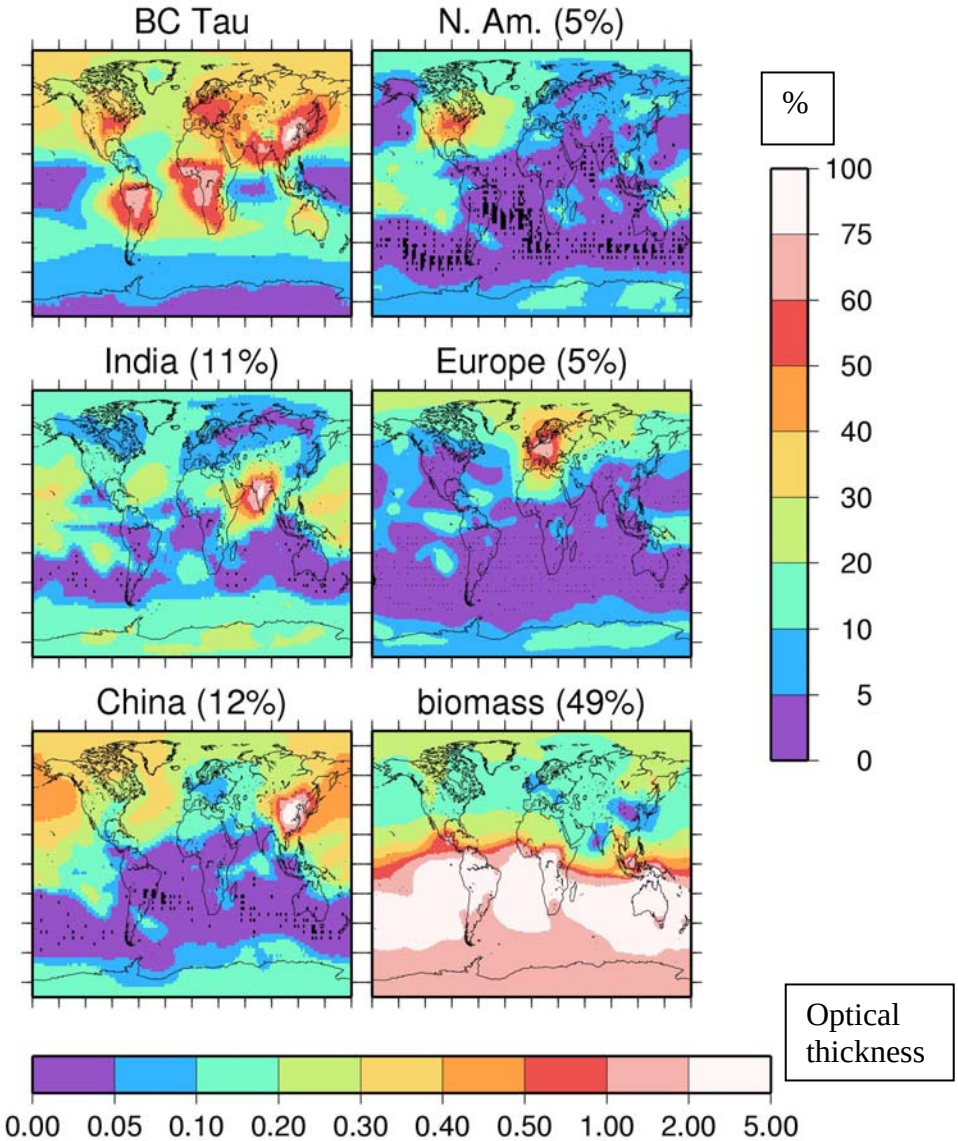

Figure caption. Annual mean black carbon optical thickness (upper left) and percent contributions from regions and from biomass burning.