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Evaluating the global health impact of inter-continental transport of sulfate aerosol

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We evaluate the impact of domestic concentrations and inter-continental transport of sulfate aerosols on global health including infant ($<$1year old) and adult ($>$30years old) premature mortality. We tag sulfur emissions from ten continental regions and simulate inter-continental transport of sulfate aerosols with diameters less than 10μm (PM10) and 2.5μm (PM2.5) from 1997 to 2003, using a global coupled chemistry-aerosol model (MOZART-2) driven with NCEP/NCAR reanalysis meteorology. The simulated sulfate concentrations in general agree within a factor 2 with the observations, except that the model tends to overestimate sulfate over a few places in Europe (EU) and Southeast Asia (SE). We superimpose the gridded distribution of global population on the distribution of surface concentrations to calculate the population weighted (P-W) sulfate concentrations. We find that average sulfate exposure is highest in East Asia (EA, PM10: 12.9μg·m^{-3}, PM2.5: 11.4μg·m^{-3}) and lowest in Australia (AU, PM10: 1.8 μg·m^{-3}, PM2.5: 1.6 μg·m^{-3}). Global annual infant and adult premature mortalities due to sulfate exposure are estimated to be nearly 0.14 and 0.85 million, respectively. While most of these deaths are caused by local emissions, nearly 17,000 infant and 60,000 adult deaths are associated with inter-continental transport of sulfate aerosol. We find that the sulfur emissions from EU and the Middle East (ME) are associated with the largest foreign health impacts (23,000 deaths by EU emissions; 18,000 deaths by ME emissions), with infant deaths accounting for 25-30% of total premature mortalities. Nearly 16,000 deaths in Africa (AF) and 15,000 deaths in India (IN) are caused by inter-continental transport of aerosols. In addition, we find that inter-continental transport of sulfate aerosols causes $\sim$700 deaths in North America (NA) and $\sim$7,000 deaths in EU each year, with infant deaths accounting for 3.6% and 2.3% of these deaths, respectively. In order to compare the relative importance of for-

eign emissions and estimate the health impact from future changes in emissions, we define an "influence potential" (IP) which measures the P-W human exposure from a unit of SO_2 emissions from a particular region. We find that emissions from the ME and EU have the largest potential to influence populations in surrounding regions. By comparing the domestic and foreign IP for SO_2 emissions, we find that a regional agreement among East Asian countries, and an inter-regional agreement among EU, ME, the former Soviet Union (FSU) and North AF regions to control sulfur emissions could benefit public health in these regions.