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We model the transportation of atmospheric and soil-based lead at the macro- and meso-scales to study its health effects on children in Jersey City, New Jersey. The Crank-Nicolson numerical approximation of the diffusion-advection partial differential equation in three spatial and one temporal dimension is used to calculate the concentration of atmospheric lead that had settled onto the surface of the soil, using as an initial condition a polynomial interpolation which considers lead that had accumulated from automobile exhaust and as a boundary condition the mean lead emissions from a nearby smelting plant. Considering the bioaccessibility and bioavailability of lead, a proportionality based on cumulative exposure over time, as measured by blood concentration, is used to determine the relative health risks. (Received September 17, 2012)