Aerosol size distribution response to anthropogenically driven historical changes in biogenic secondary organic aerosol formation

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Emissions of biological volatile organic compounds (BVOC) have changed in the past millennium due to changes in land use, temperature and CO_2 concentrations. A recent model reconstruction of BVOC emissions over the past millennium predicted the changes in the three dominant secondary organic aerosol (SOA) producing BVOC classes (isoprene, monoterpenes and sesquiterpenes). The reconstruction predicted that in global averages isoprene emissions have decreased (land-use changes to crop/grazing land dominate the reduction), while monoterpene and sesquiterpene emissions have increased (temperature increases dominate the increases); however, all three show both increases and decreases in certain regions due to competition between the various influencing factors. These BVOC changes have largely been anthropogenic in nature, and land-use change was shown to have the most dramatic effect by decreasing isoprene emissions.

We use these modeled estimates of these three dominant BVOC classes' emissions from the years 1000 to 2000 to test the effect of anthropogenic changes to BVOC emissions on SOA formation and global aerosol size distributions using the GEOS-Chem-TOMAS global aerosol microphysics model. With anthropogenic emissions (e.g. SO_2, NOx, primary aerosols) held at present day values and BVOC emissions changed from year 1000 to year 2000 values, decreases in the number concentration of particles of size $D_p > 80$ nm (N80) of >25% in year 2000 relative to year 1000 were predicted in regions with extensive land-use changes since year 1000. This change in N80 was predominately driven by a shift towards crop/grazing land that produces less BVOC than the natural vegetation. Similar sensitivities to year 1000 vs. year 2000 BVOC emissions exist when anthropogenic emissions are turned off. This large decrease in N80 could be a largely overlooked and important anthropogenic aerosol effect on regional climates.