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Historical anthropogenic radiative forcing of changes in biogenic secondary aerosol

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Human activities have lead to changes in the energy balance of the Earth and the global climate. Changes in atmospheric aerosols are the second largest contributor to climate change after greenhouse gases since 1750 A.D. Land-use practices and other environmental drivers have caused changes in the emission of biogenic volatile organic compounds (BVOCs) and secondary organic aerosol (SOA) well before 1750 A.D, possibly causing climate effects through aerosol-radiation and aerosol-cloud interactions. Two numerical emission models LPJ-GUESS and MEGAN were used to quantify the changes in aerosol forming BVOC emissions in the past millennium. A chemical transport model of the atmosphere (GEOS-Chem-TOMAS) was driven with those BVOC emissions to quantify the effects on radiation caused by millennial changes in SOA.

We found that global isoprene emissions decreased after 1800 A.D. by about 12% - 15%. This decrease was dominated by losses of natural vegetation, whereas monoterpene and sesquiterpene emissions increased by about 2% - 10%, driven mostly by rising surface air temperatures. From 1000 A.D. to 1800 A.D, isoprene, monoterpene and sesquiterpene emissions decline by 3% - 8% driven by both, natural vegetation losses, and the moderate global cooling between the medieval climate anomaly and the little ice age. The millennial reduction in BVOC emissions lead to a 0.5% to 2% reduction in climatically relevant aerosol particles (> 80 nm) and cause a direct radiative forcing between +0.02 W/m^2 and +0.07 W/m^2, and an indirect radiative forcing between -0.02 W/m^2 and +0.02 W/m^2.