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Contribution of flowering trees to urban atmospheric biogenic volatile organic compound emissions

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Emissions of biogenic volatile organic compounds (BVOC) from urban trees during and after blooming were measured during spring and early summer 2009 in Boulder, Colorado. Air samples were collected onto solid adsorbent cartridges from branch enclosures on the following trees: crabapple, horse chestnut, honey locust and hawthorn. These species constitute $\sim$65% of the insect-pollinated fraction of the flowering tree canopy (excluding catkin-producing trees) from the total street area managed by the City of Boulder. Samples were subsequently analyzed for C10 – C15 BVOC by thermal desorption and gas chromatography coupled to a flame ionization detector and a mass spectrometer (GC/FID/MS). Identified emissions and emission rates from these four tree species during the flowering phase were found to vary over a wide range. Monoterpene emissions were identified for honey locust, horse chestnut and hawthorn. Sesquiterpene emissions were observed in horse chestnut and hawthorn samples. Crabapple flowers were found to emit significant amounts of benzyl alcohol and benzaldehyde. Floral BVOC emissions were found to increase with temperature, generally exhibiting exponential temperature dependence. Changes in BVOC speciation during and after the flowering period were observed for every tree studied. Emission rates were significantly higher during the blooming compared to the vegetative state for crabapple and honey locust. Total normalized (30oC) monoterpene emissions from honey locust were 4.3 fold higher during flowering (5.26 μgC g-1h-1) than after flowering (1.23 μgC g-1h-1). The total normalized BVOC emission rate from crabapple (93 μgC g-1h-1) during the flowering period is of the same order as isoprene emissions from oak trees, which are among the highest BVOC emissions observed to date. These findings illustrate that during the relatively brief springtime flowering period, floral emissions constitute by far the most significant contribution to the BVOC flux from these tree species, some of which are leafless at this time. These experimental results were integrated into the MEGAN biogenic emission model and simulations were performed to estimate the contribution of floral BVOC emissions to the total urban BVOC flux during the spring flowering period. The floral BVOC emitted during this three-month simulation constitute eleven percent of the cumulative monoterpene flux for the Boulder urban area.