1.003 Unexpected air quality feedback chains from implementation of green infrastructure in urban environments: a Kansas City case study.

Early Career Scientist

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Abstract:

Field and numerical studies have demonstrated the benefits of green infrastructure (GI) implementation on lowering daytime temperature in urban environments due to shading and the role of evaporation and transpiration. Studies have also shown that through changes in dry deposition and atmospheric dispersion, the GI implementation could also reduce surface air pollutants and improve human health. However, few studies have systematically analyzed the feedback chains between atmospheric dynamic and chemical processes that are triggered by changes in the urban vegetation coverage. While lower temperatures could reduce the intensity of chemical reactions and subsequently secondary air pollutant formation (O_3 and secondary organic aerosols), the reduced ventilation of surface emissions in a stabler planetary boundary layer (PBL) resulting from the cooling, could potentially increase near-surface concentration of precursor species for

O_3 and particulate air pollutants ($PM_{2.5}$).
We use the state-of-the-art WRF-CMAQ coupled model to simulate the likely effects of a GI implementation strategy in Kansas City, MO/KS on regional meteorology and air quality changes. Two different land surface schemes (Pleim-Xiu and Noah) were implemented to characterize the differences in response estimated by different land surface schemes. A full year simulation was conducted for both the base case and GI scenario. Though the estimated magnitudes of the changes were different, both configurations showed consistently cooler surface temperatures and lower PBL heights in downtown areas. The CMAQ then predicted $PM_{2.5}$ increases, arising mostly from the primary components, across the domain due to the decreased PBL. O_3 changes are complicated as a combination of competing effects from increased dry deposition, increased NO_X titration and decreased chemical reduction interact non-linearly. These results highlight the region-specific non-linear process feedback chains that must be accounted for in assessing the likely air quality benefits and dis-benefits associated with GI implementation.