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Increased urban albedo for mitigation of climate-change's potential local impacts on urban meteorology and ground-level ozone

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Increased urban albedo via deployment of cool roofs, cool pavements, and other high-albedo surfaces (thus producing so called "cool cities"), has been shown in observational and modeling studies alike to have significant impacts in reducing cooling-energy use. Our mesoscale and meso-urban modeling studies also show that large-scale increases in urban albedo can have significant impacts on reducing precursor emissions (from anthropogenic and biogenic sources) and ozone formation in addition to reducing the emissions of greenhouse gases. These potential energy and environmental benefits of cool cities have led to an initial consideration of these strategies, often referred to as "heat-island mitigation measures", by regulatory agencies in the U.S. Cool cities can have multi-faceted positive impacts on the local environment via several direct and indirect pathways. From a climate-change perspective, increased urban albedo can have several potential benefits as well, e.g., negative radiative forcing, reduced energy-use-related emissions of greenhouse gases, particulate matter, and ozone precursors, local cooling, and slowing down the photochemical production of ozone. In this poster, the focus will be on the meteorological and ozone air-quality impacts of increased urban albedo. Our mesoscale and meso-urban modeling work to date suggests that the potential reductions in ground level ozone, as a result of implementing this strategy, would mitigate the anticipated increases due to the local effects of climate change. Temperature-wise, for example, various IPCC scenarios predict an increase generally in the range of 2-4K for California. Our modeling shows that cool cities can have an effect of about the same magnitude, i.e., a cooling of 1-3.5K, depending on synoptic conditions, urban characteristics, and surface modification scenarios. Our models also show that future-year 1-hour ozone peaks (in the 2050 - 2090 time frames) will likely increase by some 10 - 18 ppb, relative to present day, in regions such as Southern California and Sacramento, and that the potential impacts of increased urban albedo would be a reduction of between 8 and 15 ppb in those peaks. Thus a potential exists for use of cool cities and increased urban albedo as geo-engineering measures to locally mitigate the impacts of climate change. This potential will be explored further and evaluated more systematically in the near future. This poster will present results from our modeling of future-year IPCC scenarios' impacts on ground-level ozone and from mesoscale and meso-urban modeling of cool cities, with focus on increased urban albedo and its meteorological and air-quality benefits. The poster will evaluate and quantify the relative weights of the various direct and indirect pathways through which cool cities can mitigate the local effects of climate change. We will also present the approach, data, models, and methodologies used in developing these estimates, as well as limitations, needed research, and future directions. The deployability (potential for implementation) of high urban albedo will also be discussed. While the focus of this poster will be on California, we will also present other regions in the U.S. as well as estimates for potential world-wide benefits.