Urban Installation of Smog Reducing Materials

Team Number: SFHS3
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Project Title: Urban Installation of Smog Reducing Materials

Problem Definition

Air pollution is a major contributor to many detrimental health and environmental issues around the world. According to the World Health Organization (WHO), it is directly responsible for an estimated 2.4 million deaths annually. In fact, the most affected countries, such as China, can experience in excess of 4,000 casualties a day. Moreover, smog is a mixture of various greenhouse gases and is a known contributor to global warming. As such, companies worldwide have been creating materials aimed at passively reducing smog concentrations in urban environments. These smog-reducing materials have proved effective in diminishing smog almost instantly but at a step cost. TX Active Aria and similar products, for instance, can run six times the expense of ordinary cement. This price increase over ordinary products means it is not economically feasible to apply these products without first understanding where they will be most impactful.

Problem Solution

To lessen or entirely neutralize these effects, global companies are coming up with new ways, plans, and materials that can help reduce the smog in the air, including Titanium oxide bearing products. The Titanium oxide has been added to several construction materials such as concretes and paints designed to help fight smog in large urban and suburban areas. When these materials are exposed to sunlight, more specifically the ultraviolet rays (UV) within its spectrum, these particles act as a photocatalyst, using light to accelerate the breakdown of chemicals that make up smog. In a continuation of our simulation from last year, we will be looking at the most effective placement of these materials at various building elevations, ranging from sidewalks to rooftops. Over the course of this project, additional research will be conducted, including the acquisition of current data to update and improve our program. Among other subroutines, the variation in the amount of smog produced depending on the time of day and the effect of urban wind patterns, such as downdrafts and wind tunneling, on its dispersal will be integrated into the simulation. By doing this we can determine how effective the materials are at neutralizing smog in an urban setting when placed at distinct heights and combinations thereof. The model will be created in Netlogo 3D, to simulate the urban environment.

Progress to Date

This year's model is based upon the code submitted for the previous competition. As such, the current model shares many of the same variables and programs, including the diffusion and removal subroutines. These are unchanged and performing as they did in the previous model. The spread of smog is based on a uniform diffusion, in which each patch takes its total percent of smog and divides it by the number of adjacent patches plus one for itself. Smog removal, on the other hand, occurs when the patches representing Titanium Oxide, indicated by a white coloration in the simulation,set the smog percentages of neighboring air patches to zero. As urban areas with significant transportation and industrialization are more susceptible to smog and the problems it creates, the smog originates along the roadway and disperses outward.

There are deviations from the previous simulation, however. The current cityscape has been expanded and made more realistic in its reflection of an average city block. Both the width and length of our view has been increased, allowing the model to capture approximately 8 blocks and the roads in between them. The buildings have also been rescaled to reflect average dimensions and the varying arrangements thereof observed in cities. In our previous model, we had established that one patch was the equivalent of a 3x3x3 meter cube, or 27 cubic meters, but failed to apply that scaling to our buildings. Eventually, variations in smog production rates, sunlight, and wind will also be added. These changes are intended to increase the applicability of our simulation to the real world.

Expected Results

In our previous simulation, it was determined that the bottom application of Titanium oxide was the most effective placement for reducing smog in the more populous ground levels of the city, aside from more costly full coverage. With the introduction of sunlight and therefore shade, we may see significantly different results, as the bottom may not receive adequate lighting for the Titanium oxide to function at capacity. Additionally, downdrafts and wind tunneling may alter dispersal patterns causing greater concentrations of smog at these lower levels; however, variations in the rate of smog production throughout the day may serve as a mitigating factor. These fluctuations in production will limit the concentration of smog within the cityscape and may increase the impact of the peak processing hours of the Titanium oxide bearing structures.

We anticipate that the data collected could encourage urban planners to view these materials as a viable solution and increase their implementation. Given the wide range of product, this could include retrofitting with paint or new construction with concrete. This increased use would have the potential to dramatically reduce associated casualties and environmental impacts.

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