City scale wind profile map for understanding distribution of urban air pollutants' levels and responding to severe weather events like wind stagnation and smog

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Abstract

Fast movement of air brings with it more than fresh air and clearing away stagnant pollutants, it also packs energy that either could be harnessed or which may be damaging to buildings such as in a tropical storm. Given the high density of buildings in a city where narrow corridors funnel air flow at high speed, understanding the relative wind speeds between different streets in a city, especially in the central business district where tall buildings are closely packed, is of special importance. Why? From the environmental protection perspective, the highly reflective surfaces of a city together with heat emissions from cars and air conditioners of buildings meant that the urban heating effect known as urban heat island is important. Wind is the dominant form of outdoor cooling for ameliorating the effects of urban heat island, but need exists for knowing the wind profile map within and outside of the central business district for improving urban planning and redevelopment to help cater to impending greater warming from accelerating climate change. Specifically, in regions with poor air flow or weaker winds or both, future town planning would call for wider streets to help reduce the concentration of heat and improve air circulation. Similarly, air pollutants such as ozone, particulates and nitrous oxides are also trapped between tall buildings in a city and the only recourse for reducing such a buildup comes from periodic channeling of pollutants to a bigger body of air outside of the concentration zone. Experience from smog episodes in London and New Delhi informs city air pollution experts on the dangers of stagnant air on continuous accumulation of air pollutants to dangerous levels. Thus, knowing the areas most affected by stagnant air through a city scale wind profile map built from a collection of readings from street level anemometer and wind vane data together with particulate collectors and gas sensors, all electronically fed to a real-time database at the city level would alert city authorities and environmental protection and health agencies of local pollution events. Such granular understanding allows immediate issuance of local district level warnings of severe air pollutant (such as from carbon particulates) as well as forming a body of knowledge in pinpointing high risk areas requiring gentrification as well as providing insights useful for designing the urban cityscape in urban renewal. But, on the flip side, the wind velocity profile map would also be useful in understanding how strong winds funnel through tall closely separated buildings in a city; thus, providing an independent source of data that complements wind tunnel simulations on present and projected city landscape conditions. Such information would help urban planners decide on possible areas where buildings need to be buttressed in

view of stronger winds from tropical storms seeded by warming seas, as well as identify areas in building codes requiring strengthening and a city layout (taking into account building separation distance) with greater resilience against sustained strong winds. Thus, casting the glance now and into the future, investment in a street level system of wind velocity and air quality measurement stations collectively wired to a real-time central database would yield enormous benefits for informing areas with poor air circulation and heighten pollution as well as sections of the city such as the central business district likely to be worse sufferers of strong wind episodes through the wind funneling effect in between tall buildings. From providing forecast of district level pollution episodes and possible strong heat to informing future city planning and tightening of building codes in anticipation of strong winds due to greater temperature differentials induced by unabated climate change, wind velocity profile maps are a necessity tool for urban town and city planning.

Keywords: wind velocity profile, smog, urban heat island, reflection, air pollutants, stagnant air, building codes, funneling effect,

Subject areas: atmospheric chemistry, atmospheric physics, environmental engineering, environmental science,

Conflicts of interest

The author declares no conflicts of interest.

Author's contribution

The author thought about the possibility in which a wind profile map of a city would help inform its wind energy potential, but realise that the same map could also be used to understand the distribution of various air pollutants in the city with critical information on the "dead zones" requiring special attention particularly in the context of smog. On the other hand, areas with strong winds also point to the use of more stringent building codes to safeguard buildings against the damaging effect of strong winds from tropical storms funneling into a "wind funnel" such as the central business district of a city. He wrote the manuscript.

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