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Fluid Mechanics of Urban Environments

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The rapid urbanization of the Earth has led to highly populated cities that act as concentrated centers of anthropogenic stressors on the natural environment. The degradation of environmental quality due to such stressors, in turn, greatly impacts human behavior. Anthropogenic stressors largely originate as a result of coupling between man-made urban elements (i.e., networks of engineering and socio-economic infrastructures) and the environment, for which surrounding fluid motions play a key role. In recent years, research efforts have been directed at the understanding and modeling of fluid motions in urban areas, infrastructure dynamics and interactions thereof, with the hope of identifying environmental impacts of urbanization and complex outcomes (or "emergent properties") of nominally simple interactions between infrastructures and environment. Such consequences play an important role in determining the "resilience" of cities under anthropogenic stressors, defined as maintaining the structure and essential functions of an urbanity without regime shifts. Holistic integrated models that meld the dynamics of infrastructures and environment as well as "quality of life" attributes are becoming powerful decision-making tools with regard to sustainability of urban areas (continuance or even enhancement of socio-economic activities in harmony with the environment). The rudimentary forms of integrated models are beginning to take shape, augmented by comprehensive field studies and advanced measurement platforms to validate them. This presentation deals with the challenges of modeling urban atmosphere, subject to anthropogenic forcing. An important emergent property, the Urban Heat Island, and its role in determining resilience and sustainability of cities will be discussed based on the prediction of a coupled model.