Young WISE Investigators Program 2017

Project Description

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Project topic: Micrometeorological Process over Urban Environments

Introduction:

Over 50% of the world's population lives in cities, many of which are hot, polluted, and expanding. The quickly developed urban area and the design of the surface impact local meteorology and climate, which affect building energy use and the comfort & health of urban residents. Understanding the micro meteorological process over urban environments is thus very important for mitigating urban atmospheric problems such as air pollution and the heat island effect.

The Earth's surface atmosphere extends some 100*km* in the vertical to the edge of outer space. Among this range, the lowest 1~2*km* (with the name atmospheric boundary layer, ABL) is where the Earth's surface is directly influenced by the surface fluxes of momentum, heat, and humidity. The ABL is important because this is the part we live in. To understand the physical processes in ABL, we need to investigate the behavior of the turbulent flow in this region.

Although the understanding of physical processes in ABL is now quite advanced, some complex processes are still unclear. For example, how does the atmospheric turbulence is evolved and what is the relationship between surface drag and the surface morphology, are still mysterious for the researchers all over the world. Compared with smooth surface and other relatively smooth surface, i.e. rural area surface, the near-surface wind flow velocity and turbulence profiles in urban areas are very different. These differences are very important considerations for pollution dispersion modelling and numerical weather prediction. In urban areas, the high-rise buildings and other infrastructures increase the roughness of the surface, and then more flow separations on obstacles are involved, which further modify the near surface flow field and promotes the vertical exchange of momentum between the surface and the atmosphere. More energy is dissipated with the increase of turbulence and more surface momentum fluxes (aerodynamic drag) are accumulated. The current project will focus on how to predict the aerodynamic drag of the turbulence over urban geometry, which is a fundamental parameter for the micrometeorological process.

Via the current project, the student will get the skills in the following areas,

(1) Fundamental knowledge of fluid mechanics.

(2) Fundamental knowledge of numerical approach, especially in Computational fluid mechanics.

(3) Fundamentals knowledge of turbulent flows.

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Name card:

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Publications and Proceedings:

Peer-Review Publications

Zhu, X., Iungo, G. V., Leonardi, S., & Anderson, W., 2016. Parametric Study of Urban-Like Topographic Statistical Moments Relevant to a Priori Modelling of Bulk Aerodynamic Parameters. *Boundary-Layer Meteorology*. doi:10.1007/s10546-016-0198-x.

Proceedings

Zhu X., Anderson W., 2016. Proceedings of American Physical Society, 69th Annual Meeting of the Division of Fluid Dynamics, Portland, OR.

Zhu X., Anderson W., 2016. Proceedings of American Meteorological Society, 22nd Symposium on Boundary Layers and Turbulence, Salt Lake City, UT.

Zhu X, Anderson W., 2015. Proceedings of American Physical Society, 68th Annual Meeting of Division of Fluid Dynamics, Boston, MA

Manuscripts in Preparation

Zhu, X., Anderson, W., 2017. Large eddy simulation study of turbulent flow over fractal-like urban landscape. *Physical Review Fluids*, (In Prep.)