Evaluation of the uWRF performance in Hong Kong with UCPs derived based on WUDAPT/NUDAPT dataset and the guidance for implementation

Michael Mau Fung Wong[1], Jimmy Chi Hung Fung[2], Jason Ching[3], Jason Wai Po Tse[1], Peter Pak Shing Yeung[2], Chao Ren[4], Wang Ren[4]

[1] Environmental Science Programs, School of Science, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong

[2] Division of Environment, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong

[3] Institute for the Environment, University of North Carolina, Chapel Hill NC, USA

[4] School of Architecture, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong

ABSTRACT:

The uWRF (WRF BEP/BEM)[1] model has been widely used to study urban boundary layer physics over several major cities in the past decade. However, evaluation of its performance over Hong Kong or the PRD region is less discussed. One of the reasons is the lack of a complete UCPs (urban canopy parameters) dataset for the building morphology (NUDAPT)[2] in the Pearl River Delta (PRD) region. In recent years, the WUDAPT[3] approach provides an alternative estimation of the building morphology dimensions based on the satellite retrieved local climate zones (LCZs)[4]. WUDAPT provides a simple, open source means to generate required input data in uWRF modeling. In this study, the WUDAPT dataset is implemented in the uWRF modeling and its results are compared to the one driven by a data set for Hong Kong, where accurate building morphology database (NUDAPT-based) as standard baseline is available. The difference of the model output from these two approaches is quantified to provide insight on the ability of the satellite retrieved WUDAPT to mimic standard reference dataset in terms of uWRF simulation. We also perform sensitivity tests for different WUDAPT input data treatments to provide guidance for optimal data preprocessing regarding the WUDAPT dataset. Moreover, different sources of uncertainties would be discussed including: 1. Supervised classification, 2. Simplification of the urban canopy parameters distribution, 3. Dominant local climate zone vs. Subgrid Averaging approach, 4. Local knowledge of the urban canopy parameters vs. Default look-up table, 5. Model Bin Size in uWRF. For operational and scientific perspective, the performance of the uWRF model by different approaches would be quantified by comparison with surface temperature and wind speed observations. The impact of different urban morphology changes on the urban boundary layer structure would also be discussed.

Preliminary results show that different WUDAPT dataset preprocessing methods can induce significant difference in the uWRF simulated averaged vertical wind speed profiles over Hong Kong urban area (up to 70% throughout the urban roughness sublayer as in Figure 1) when compared to the NUDAPT case. This study helps to quantify and understand the different sources of uncertainties generated by WUDAPT dataset in uWRF application and could help to provide guidance on how to best implement the WUDAPT dataset in uWRF application when detail building morphology (NUDAPT) is not available. The results also show that with sub-grid averaging approach and local

expert judgement on UCPs for each LCZs (rather than the default look up table) results in excellent surface wind speed performance comparable to the NUDAPT case, where both of those are much better than the simpler NOAH bulk urban scheme. This suggests that with proper data preprocessing, WUDAPT is can provide a good estimation of UCPs in uWRF application when detail building morphology (NUDAPT) is not available.

REFERENCES:

1. Salamanca F, Krpo A, Martilli A, Clappier A. A new building energy model coupled with an urban canopy parameterization for urban climate simulations-part I. formulation, verification, and sensitivity analysis of the model. *Theoretical and applied climatology*. 2010;99(3-4):331-344.
2. Ching J, Brown M, Burian S, et al. National urban database and access portal tool, NUDAPT. 2009.
3. Ching J, See L, Mills G, et al. WUDAPT: Facilitating advanced urban canopy modeling for weather, climate and air quality applications. 2014.
4. Stewart ID, Oke TR. Local climate zones for urban temperature studies. *Bull Amer Meteor Soc*. 2012;93(12):1879-1900.

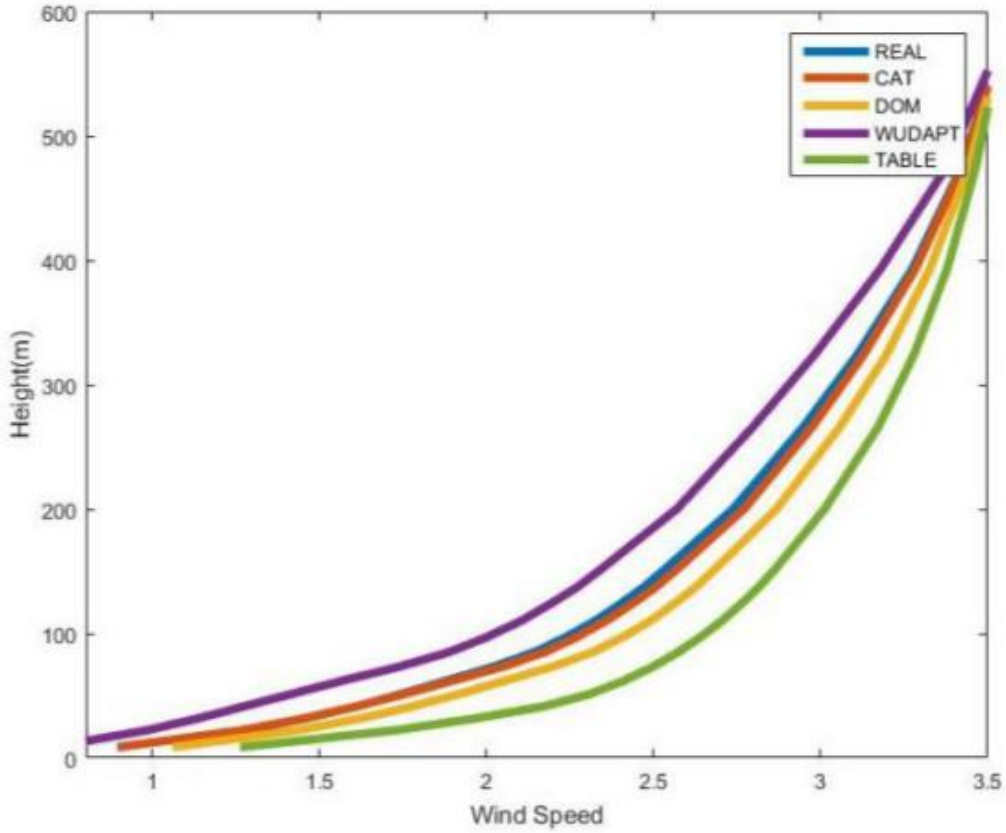

Figure 1. uWRF simulated wind speed with NUDAPT(real) and different WUDAPT cases.

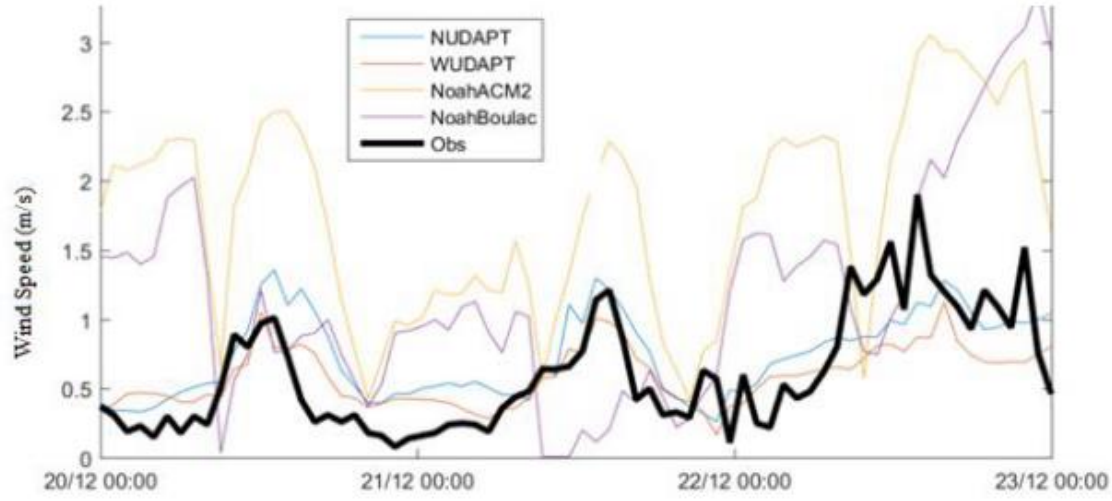

Figure 2. The performance of wind speed simulation for NUDAPT, WUDPAT and NOAH bulk scheme cases from 2010-12-20 to 2010-12-23 by comparison with observation data from urban station.