CRC for
Water Sensitive Cities

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Program B - Water Sensitive Urbanism
Project B3 Water Sensitive Urban Design and Urban Micro-climate

VTUF-3D: An urban micro-climate model to assess temperature moderation from increased vegetation and water in urban canyons

Introduction

- Assessing positive climatic impacts on human thermal comfort (HTC) of Water Sensitive Urban Design (WSUD), through associated increases in vegetation and water in urban areas, requires a suitable modelling tool
- Observation studies have shown that increased tree cover is effective in promoting positive HTC in urban areas (White et al., 2012).
- Modelling HTC at a microscale must fully account for both physical and physiological properties of vegetation, as well as the full soil/plant/atmosphere water cycle. No models were found which fulfilled this requirement.
- The TUF-3D model (Krayenhoff and Voogt, 2007) was modified in a novel way to tile the MAESPA tree model (Duursma and Medlyn, 2012) within the TUF-3D urban canyon and calculate vegetation radiation transmission.
- The modified model, VTUF-3D, provides parameters of air temperature, surface temperatures, wind, and humidity at a suitable scale to assess HTC (measured by UTCI) in urban canyon simulations.
- This tool can be used to determine optimal positioning of vegetation to maximize the impact, as well as determining the climate response of each tree and its relative value in urban canyons.

Validations of VTUF-3D

- Validations compared modelled results to flux observations in Preston (Coutts et al., 2007), HTC observations in Melbourne (White et al., 2012), and Tsfc and UTCI in Lincoln Square, Melbourne (Motazedian, 2015) and found to broadly reproduce their spatial and temporal variations.
- Ongoing model development aims to further increase predictive accuracy.

Modelling Preston vegetation scenarios with VTUF-3D

- 4 scenarios for Preston (Figure 1) (configurations, Figure 3) of 0% trees, 50% trees, existing 100% Preston tree canopy cover, and 200% trees.
- UTCI (averaged at 0m height, Figure 2) maximum variations of 0.9°C between no tree scenario and 200% trees
- 200% trees scenario gives 0.3°C UTCI reduction over existing 100% Preston tree canopy

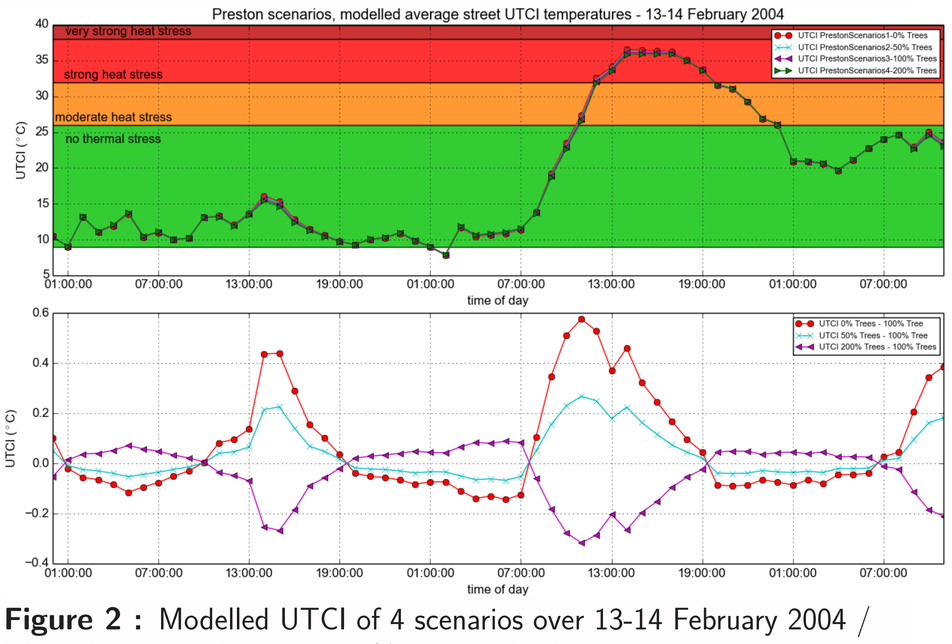

Figure 2 : Modelled UTCI of 4 scenarios over 13-14 February 2004 / UTCI differences between 200% trees and other scenarios

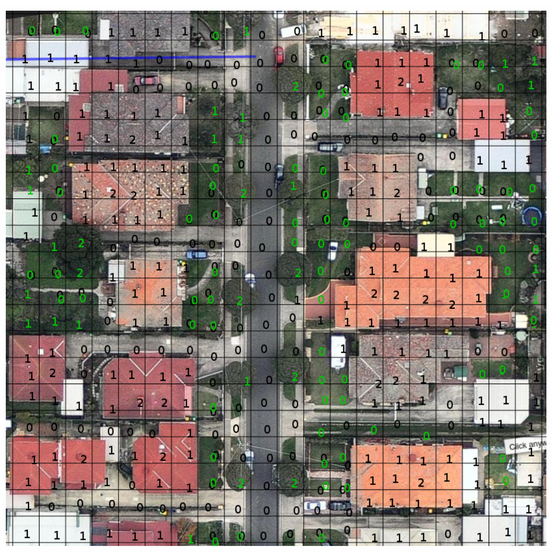

Figure 1 : Modelled Preston street

Figure 3 : Preston 0%, 50%, 100%, 200% trees configuration (top)/UTCI at 0m height at 14 Feb 2004 1400 (below)

Conclusions

- Integration of MAESPA and TUF-3D into VTUF-3D creates a tool suitable to model human thermal comfort impacts of WSUD.
- Modelling shows UTCI temperature reductions of 0.3°C to 0.9°C between varying tree cover scenarios.
- Future work includes furuther model refinement for added accuracy and running comprehensive sets of WSUD scenarios to further quantify HTC impacts of WSUD

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