CRC for Water Sensitive Cities

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

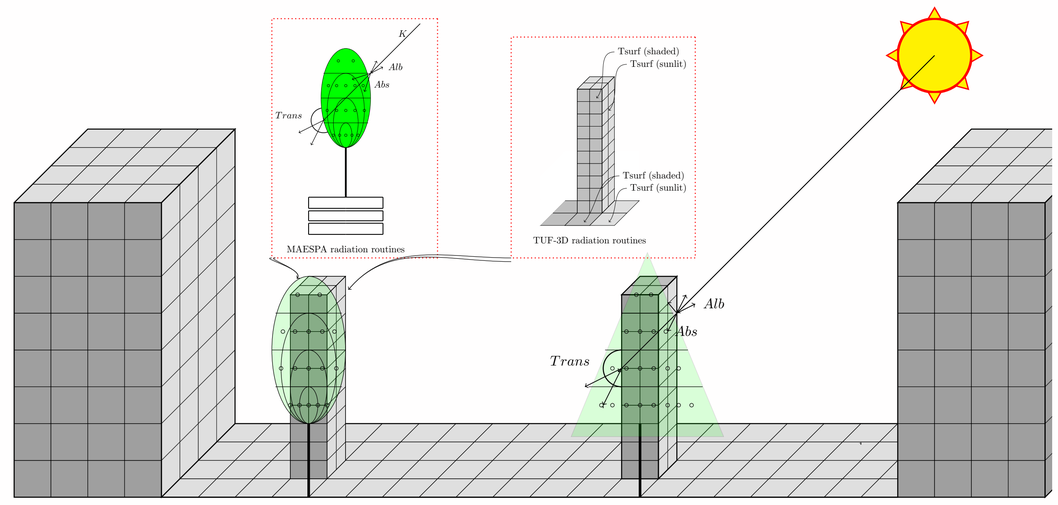
An urban micro-climate model for assessing impacts of Water Sensitive Urban Design

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 (TUF-3D/MAESPA) provides parameters of air temperature, radiant temperatures, wind, and humidity at a suitable scale to assess HTC 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.

Modifications to TUF-3D radiation modelling

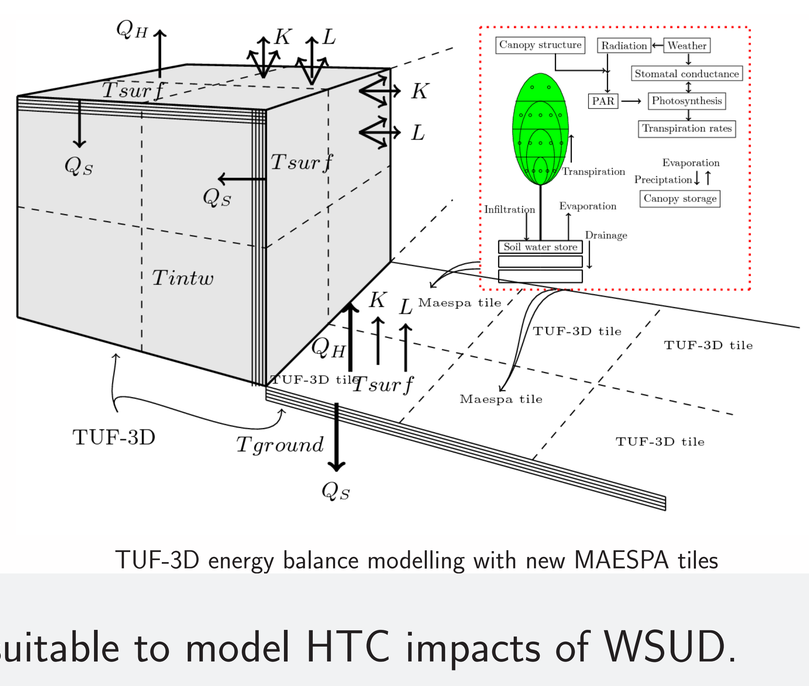
- Modifications allow TUF-3D to resolve urban canyon radiation flux movement using placeholder vegetation structures which call MAESPA vegetation absorption, transmission, and reflection routines.
- TUF-3D/MAESPA uses cube shaped structures (as TUF-3D uses to represent buildings) to represent vegetation. These cubes store the surface properties and states and interact with the rest of the TUF-3D domain.
- The vegetation's true shape is represented in MAESPA and calls underlying MAESPA routines to calculate the vegetation's interactions with the urban canyon and radiation movement.



Integration of MAESPA tree model into the TUF-3D model radiation fluxes routines

Tiling MAESPA within TUF-3D

- Using a novel approach, MAESPA tiles replaces TUF-3D ground surfaces with vegetated MAESPA surfaces and use MAESPA's photosynthesis and water cycle routines to modify TUF-3D's energy balance calculations.
- Each embedded MAESPA surface calculates a full 3 dimensional tree or tree stand (along with associated soil and movement of water within the stand) and feeds results back to TUF-3D ground surface energy balances.



TUF-3D energy balance modelling with new MAESPA tiles

Conclusions

- Integration of MAESPA tree model into TUF-3D creates a tool suitable to model HTC impacts of WSUD.
- Future work on TUF-3D/MAESPA:
  - Completion of modifications
  - Full validation testing
  - Running comprehensive set of WSUD scenarios

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