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Geoscientific Model Development Discussions

Interactive comment on "The Air-temperature Response to Green/blue-infrastructure Evaluation Tool (TARGET v1.0): an efficient and user-friendly model of city cooling" *by* Ashley M. Broadbent et al.

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General: This paper introduces a promising approach to modelling urban temperature which could allow planners and consultants to access first-order results with little input data or computation time relative to most other models. My main reservation is that the assumptions and simplifications adopted here make the approach unsuitable for modelling spatial variations in micro-scale thermal comfort, which can vary dramatically even when air temperature variations are quite modest. This because of exposure to radiation and localized airflow, neither of which the current approach models with

spatial precision.

Thank you for these comments.

The focus of the current version of TARGET (under review in this paper) is outdoor street-level air temperature, not human thermal comfort. We agree with the referee that TARGET cannot capture the micro-scale climate variations that influence human thermal comfort at the scale experienced by an individual. We will make sure that this statement is made clear in the introduction and conclusions of the amended manuscript; e.g. "TARGET calculates the average air temperature at street level in urban areas, but not does represent micro-scale variations in shading or wind flow at the human scale".

We believe that this spatially averaged approach still has great value to planners and policy-makers when evaluating blue/green infrastructure proposals.

Detailed: p7 lines 1-3 - "...walls and ground surfaces have similar longwave emission relative to the sky, and... solar radiation receipt can be approximated by SVF, on average. This simplification means that the model makes no distinction between lit and unlit buildings walls..." It also makes no distinction between lit and unlit ground surfaces, or pedestrians within an urban space. This should be noted as well. p12 lines 3-4 –

The referee is correct. We will add this comment to the amended manuscript. Thank you.

"Utop is estimated at the top of the UCL based on Uz using a logarithmic relationship." This seems to be problematic, because the constant flux layer in which a logarithmic wind profile can be found is separated from the UCL by a Roughness Sub-Layer. Extending the logarithmic profile downward through the RSL can lead to unrealistic wind speeds. This is significant because the canyon wind speed, and in turn the surface conductances and canyon air temperature itself, are based on Utop (as described in Eqs. 16-18).

Thank for this comment – we will clarify what Utop is and how it calculated in the amended manuscript, at P12L4:

“Utop is estimated at 3xH based on the observed wind speed (Uz) at a nearby observational site (ideally an airport) using a logarithmic relationship. Airports are relatively devoid of roughness elements and wind speed is typically measured at 10 m above the surface. As such, the assumption a logarithmic profile through the roughness sublayer (Masson, 2000) is imposed.”

We also note that at P6L19 we stated that: “Ideally, meteorological data should be representative of a nearby urban site” - this is incorrect - we will remove this sentence and encourage model users to take observations from a nearby airport.

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More detailed explanation:

Utop is not estimated at the top of the UCL, but rather is an estimate of wind speed at 3x the height of the tallest building in the domain. This will be clarified in the amended manuscript. We currently use a uniform Utop value for the whole domain.

Typically, urban canopy models are forced by “above canyon” wind speed (and other meteorological variables). However, above canyon data is almost never available to model users so we wanted to devise a simple and computationally inexpensive method to diagnose Utop from observed wind speed. Hence the use of a logarithmic profile. We also note that the assumption of a log profile through the roughness sublayer is used in other urban canopy models (e.g. TEB; Masson, 2000). In TARGET (an offline model), this simplification is necessary to ensure computation efficiency – as it avoids computationally expensive iterative methods for solving the above canyon wind speed.

We worked hard when building TARGET to balance computational efficiency and complete representation of physically realistic processes. This is one area where we had to simply the represented physics to achieve a computationally efficient outcome. We will point out that this approach will be more problematic when observed wind speed

(Uz) is taken from a low measurement height (e.g. below 10 m) and/or from a site with a high roughness length (e.g. > 0.5 m) in the limitations section.

Improvement of the Utop diagnoses, while maintaining computation efficiency, could be explored in future work.

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