Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2019-225-AC1, 2019

Geoscientific Model Development Discussions

Interactive comment on "An urban ecohydrological model to quantify the effect of vegetation on urban climate and hydrology (UTC v1.0)" *by* Naika Meili et al.

Naika Meili et al.

meili@ifu.baug.ethz.ch

Received and published: 29 November 2019

We thank the reviewer for his/her time, precise summary, and positive evaluation of the manuscript.

Specific referee comments and author replies:

1. Abstract: Line 9: It is stated here that the model calculates all urban hydrological fluxes. However, as mentioned in the model limitations section, snow hydrology is not accounted for. So this statement should be modified.

Yes, correct, we have modified the statement in the abstract to clarify that snow hydrol-

Printer-friendly version

Discussion paper

ogy is not included in the model yet (Line 9).

2. Line 52: Change "Reasearch" to "Research".

Corrected.

3. Line 55: CLM doesn't have an explicit representation of short ground vegetation in the urban canyon. Rather it has a generic pervious canyon floor whose soil column supports evaporation.

Yes, indeed, thank you for the clarification. We have removed CLM from the list of models with short ground vegetation.

4. Line 101: Is the model restricted to an hourly time step for any reason or is it flexible enough to accommodate finer time steps. For example, meteorological forcing data may be available at $\frac{1}{2}$ or $\frac{1}{4}$ hour time steps. Solution of soil moisture equations and conductive fluxes may benefit from a finer time step.

The code has been modified to accommodate shorter time steps (e.g. $\frac{1}{2}$ or $\frac{1}{4}$ h) if the meteorological forcing data are available. The soil moisture equations are internally solved at a much finer time step though, determined by an ordinary differential equation solver based on a modified Rosenbrock formula of order 2 (ode23s, Shampine and Reichelt, 1997) to ensure numerical stability. We have clarified this now in the manuscript (Line 100-102) and in Sect. "6.2 Vadose zone dynamics" in the TRM.

5. Line 173: This seems to imply that the interior building temperature is not a function of the conductive fluxes through the roof and walls and thus ignores external factors such as solar and longwave radiation impinging on roofs and walls and the transfer of that heat to building interior. Is this a reasonable assumption? Have the limitations of this assumption been explored in the cited paper (de Munck et al. 2018)? There is some reference as to the importance of this in lines 599-601, but there is no quantitative assessment of this offered.

In the current set-up, the interior building temperature is not a prognostic variable and, hence, it is not dependent on the conductive heat flux. We believe that this simplification is reasonable as building interiors are often heated or cooled when a certain temperature threshold is exceeded. In other words, inhabitants define the internal temperature, but not the amount of energy invested in cooling or heating (which is also a by-product of the UT&C model), as in the model. Furthermore, in mild-climates or in the Spring and Fall, occupants can open windows, thereby somehow setting the interior building temperature equal to the exterior air temperature or forcing air temperature. However, the conductive heat flux is a function of all external factors (e.g., shortwave and longwave radiation) affecting the surface temperature of the roof and walls. Additionally, the conductive heat flux is a function of the interior building temperature which can influence exterior temperature. For example, the heating of building interiors in winter can influence building facade temperatures and therefore, canyon air temperature. De Munck et al. (2018) did not further explore the limitation of fixing internal building temperature. Hence, we have now performed a sensitivity analysis for interior building temperature in Singapore where air-conditioning of building interiors is common (see TRM Sect. 5). We varied the interior building temperature and analysed the change in the air temperature at canyon reference height, and the canyon energy fluxes, if (A) the energy used for cooling is not re-emitted to the canyon air, and the energy used for cooling the building envelope is re-emitted to the canyon air with an air-conditioning coefficient of performance which is infinite (efficiency of 1) in (B), and 2.5 (De Munck et al. 2018) in (C). The air temperature at canyon reference height, the location where anthropogenic heat is emitted, increases with decreasing building temperature in the case of re-emitted anthropogenic heat. This re-emission of anthropogenic heat increases the sensible heat flux which corresponds to the increase in heat emissions caused by air-conditioning of building interiors. The further feedback of this increase in sensible heat on the forcing temperature and, therefore, urban canopy air temperature can only be analysed through a coupling with a mesoscale meteorological model.

We have clarified this now in Sect. 5 “Anthropogenic heat flux” of the TRM.

Printer-friendly version

Discussion paper

6. Table 1: Generally, “u” and “v” are used to describe the wind components. Suggest changing “Velocity u” to “Wind Velocity w”.

We have changed “Velocity u” to “Wind speed U”.

7. Line 560: Suggest changing “the here reported relative humidity increase” to “the relative humidity increase reported here”.

Changed.

8. Line 575: Change “fraiming” to “framing”. Or change to “helps to define reasonable expectations”.

Changed.

9. Line 618: Change “explicitely” to “explicitly”.

Changed.

10. Supplement, Line 1011: What is meant by “canyon calculation height”? Is this the height at which the air temperature calculated? Aren’t there two heights calculated?

Yes, the air temperature and humidity are calculated at two heights within the urban canyon: 1) at 2 m canyon height and 2) at canyon reference height, which is the sum of the zero-plane displacement height of the canyon and the canyon roughness length (ddisp,can + z0,m,can).

We have chosen to add the anthropogenic heat at the canyon reference height. However, this could be modified depending on the exact emission location of the anthropogenic heat. The anthropogenic heat could be added at 2 m canyon height, at canyon reference height, and at roof level, or could be partitioned among these different locations.

We have now clarified in the TRM that, in the current model set up, anthropogenic heat is added at the canyon reference height (=ddisp,can + z0,m,can). Modification in TRM

Line 1005.

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-225, 2019.

Printer-friendly version

Discussion paper