Efficiently modelling urban heat storage: an interface conduction scheme in an urban land surface model (aTEB v2.0)

Mathew J. Lipson[1], Melissa A. Hart[1], Marcus Thatcher[2]

[1]Climate Change Research Centre, UNSW and ARC Centre of Excellence for Climate System Science
[2]CSIRO Marine and Atmospheric Research, Aspendale, Australia

Correspondence to: M. Lipson (m.lipson@unsw.edu.au)

Summary
This document is the authors response to the Referee reviews and discussion of the manuscript:
http://www.geosci-model-dev-discuss.net/gmd-2016-240/

Page and line references (P# L#) are listed for original manuscript (in red with referee comments) and for the revised manuscript (in black with author response).

RC2: Anonymous Referee #2

This paper is concerned with the storage heat flux in areas with large thermal mass and multiple surface layers. It provides a really nice, through and useful analysis of the impact of where temperature nodes are in a layered system. My comments are very minor and easily addressed.

We thank Referee # 2 for these positive comments. The thoroughness of their review has improved the paper.

1) Notation is confusing for the storage heat flux as two sets of symbols are used for what should be the same (as the model is being evaluated against it- but is referred to differently between the model and observations

> *a. P1 L20 should be ΔQS (that notation throughout)*

P1 L20: We agree and have changed notation to ΔQ_S throughout.

> *b. P2 L23 - Δ changing notation – Infer that the Δ is related to the residual whereas in fact for both it should be the net change in all components of the system e.g. trees, air, as well as the built materials. The observational method of a residual difference is not related to Δ. The notation is confusing relative to the net change in storage – the authors could create a subscript to distinguish the two but refer to it with the same notation or refer to observed as RES (residual) as commonly done*

Revised P2 L24: In the original manuscript, we made a distinction between modelled net storage flux (Q_S) and observed net storage flux calculated as a residual (ΔQ_S). As noted the notation differs from established forms which has led to confusion, and on reflection is not necessary. We now refer only to ΔQ_S, meaning net storage heat flux density. Where a distinction is important, we note whether it is observed or modelled.

2) P2 L2 – there are multiple methods - so it is an additional method

Revised P2 L2: We have amended this sentence to make clear we are comparing a new alternative method with a well-established method.

3) P3 L5 – cite the original Grimmond et al. 1991

P3 L5: Done

4) P3 L12 – references should be in chronological order (throughout)

P3 L11: Done

5) P3 L29 – Homogenous – reference examples

Revised P3 L29: We have reworded sentence to make clearer the distinction between homogenous and composite materials, and updated other instances of "layered" materials to "composite" materials throughout. We have also changed '*some models use…*' in this line to '*modellers sometimes describe...*' to make a distinction that it is often a modellers choice to represent materials as homogenous (as opposed to being hardwired in a model). Lastly, we have moved the database descriptions (CLMU, SITE etc) to an Appendix for clearer flow of the article.

6) P4 L3 – Jackson et al. (date)

P14 L19: Done

7) P6 L1&2 – int – for the second R_{int}

P5 L9: Done

8) P6 L23 – for the respective time step?

P6 L23: Deleted lines 20-23 as they are not necessary and are confusing.

9) P8 L25 I assemblies or assemblages?

P10 L2: Assemblies, as an ordered group of components that work together, rather than an unordered assemblage.

10) P8 L24 – give accessible reference location

P10 L2: Done, referenced Fig. D.1

11) P9 line 2 – are representative of? The central tendency of ... later in sentence 'represent' or 'are for the ...'

P10 L9: Done, replaced "are representative of" with "represent".

12) P9/L18 – values have been multiplied by 100 % to be made a percent

P10 L24: We are unclear as to what change was required as the values on p9 are in the a 0-100% range.

13) P9 L19 – reword sentence

P10 L25: Done.

14) P10 – heading observational methods – some aspects have already been introduced, why this heading here? And why is the description of the model under observations?

Manuscript has been restructured per Referee #1 comments (see RC1 response). This section moved to P8 L16.

15) P11 L5 – net all-wave radiation

P8 L18: Done.

16) P11 L25 – notation now includes Δ

P11 L5: All Q_S now referred to as ΔQ_S, see response to 1b).

17) P12 L16 – define centred RMSE

P11 L29: Referenced Taylor (2001).

18) P14 top paragraph – consider work Salamanca, F., E.S. Krayenhoff, A. Martilli. 2009: On the derivation of material thermal properties representative of heterogeneous urban neighbourhoods, J. Appl. Meteorol. Climatol. 48, 1725-1732

P13 L15: The authors are aware of the interesting work by Salamanca et. al (2009), which considers various methods to aggregate material thermal properties (depth, conductivity and heat capacity) to give an overall homogenous material that is meant to be representative of patches of different urban materials. However, the current manuscript uses 'typically modelled' material thermal parameters sourced from previously published studies, and avoids creating new sets of thermal parameters. Therefore, the method described in Salamanca et. al (2009) was not considered relevant in this study.

19) P14 L21 enhance rather than benefit?

P13 L29: We feel in this case benefit is more appropriate, as enhance may suggests additional features, which is not the case.

20) Figure and Table caption in general need to be standalone so the material can be understood

Done, details below.

21) Appendix A –Tables A1 and A2 give references or basis for data sources here or indicate where these are given in the text. SITE, WRF uZE aTEB – need to be defined to

Done.

22) Figures 2 onwards – - units should have space between the dimensions. The extra headers should be removed (difference between talk and paper presentation)

Done

23) Figure 4 and 5 – give more details of types of conditions used

Done

24) Figure 6 – Caption is not complete enough to be stand alone. Need correct spacing on units W m^{-2} – - fix units within plots

Done

25) Figure 7 – Label Y axis

Done

We thank the reviewer for these valuable comments.