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Geoscientific
Model Development
Discussions

Interactive comment on "Development and evaluation of a building energy model integrated in the TEB scheme" *by* B. Bueno et al.

Anonymous Referee #1

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Bueno et al.'s paper is well thought out, makes important contributions, is well written and thoughtfully concise. Substantial revisions pertain mostly to providing the reader with the context necessary to interpret the importance of the work.

The scientific significance of the paper is rated "good". There are definitely substantial contributions to urban and possibly global climate models as well as models such as EnergyPlus. EnergyPlus' sophistication could be improved through the adoption of some of the methods used in Bueno et al.'s work, especially those methods relating to "real' air conditioning systems. The "excellent" rating is withheld on the suspicion that urban waste heat from HVAC systems are a relatively minor contribution to climate systems and even to the urban heat island (UHI) effect. It is strongly recommended that this paper include a sentence (or lengthier discussion as appropriate) on the relative

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magnitude of the impact of waste HVAC heat to these phenomena (global climate, local climate, and UHI effects) to that these suspicions can be confirmed or refuted. There is also a technical issue related to the discussion of the importance of waste HVAC heat to the UHI effect, which will be discussed below.

The scientific quality is also rated as “good”. The methods used are valid (pending discussion of a potential technical issue with the “f” terms in equation 2, discussed below) and the statistics used to present results, such as MBE and RMSE are valid statistics for discussing the model’s ability to make predictions. Again, with some context missing, however, it is difficult to say whether the results of the BEM-TEB model can lead to significant results. For example, a RMSE of 13.31 W/m2 seems like a great deal of error given an average value of 50.16 W/m2. Is it or is it a mundane, acceptable error given the context? A comment in the text on the answer to this question would be appreciated. It may be a simple answer, for this and other statistics presented, but without comment it seems as though the authors are dodging the question. Without context, an “excellent” rating cannot be given. There are several assumptions made by BEM-TEB, as there are with any model, and most assumptions given in this paper are reasonable, intelligent, practical, and well-described.

The scientific reproducibility is rated as “excellent”. The authors have taken pains throughout the paper and appendices to provide the reader with the equations used.

The presentation is rated as “excellent”. The concision is particularly appreciated and the text is very easy to understand. There are very few errors in language. Figures are well used and appropriate to communication of the paper’s important points. The paper’s structure and logic are thoughtful of the reader and arguments are well-made.

Specific comment on content:

p. 2978: Equation 2 is as follows:

Vbld*(rho)*Cp*(dTin/dt) = ...+Qig*(1-frd)*(1-flat)+...

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But the terms frd and flat are defined as fractions of Qig. Presumably, there's some fraction remaining, fr, after radiant and latent heat are accounted for, and

Qig = a*(frd+flat+fr)

and

frd + flat + fr = 1

fr = 1 - frd - flat

It would seem that

Qig*(1-frd)*(1-flat) = Qig*fr = Qig*(1 - frd - flat)

But it follows from the above that

Qig*fr = Qig*(1-frd-flat)

Thus

Qigfr is not equal to Qig*(1 - frd)*(1 - flat)

Is this an error in the manuscript? If the formula is correct as written in the manuscript, the terms should be more clearly defined in the text.

p. 2980: The claim regarding a value of 0.77*SHGC requires a reference or data to make it credible.

p. 2984: The assumption that supply air humidity is equal to mixing humidity needs qualification. Is this a reasonable assumption? Is it one frequently made by others? If it is wrong, how is that likely to affect results?

p. 2984: The term "Qexch,cool" is not clear. Is the heat exchanged between the system and the building a net exchange in this case? Much of the heat forced out of the building by the cooling system is heat that originated outside the building. If it is a net exchange, then would it not be equal to zero, with QHVAC,cool accounting for the

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gains from the air conditioner's operation? If it is not a net exchange, then it seems Qwaste,cool might be double counting some heat. Or does QHVAC,cool account only for non-HVAC internal gains? The term requires more clarification.

p. 2987: Again, some context of qualifying comment is required. The sentence, "Positive values of MBE indicate an over-prediction of the cooling and heating energy demand calculated by the SM with respect to the energy demand calculated by the DM." leaves the reader wondering, "so what?" Is the magnitude of the over-prediction acceptable?

p. 2989: How does the reader know that the first building performs more regularly than building 2? Why is that the case? Some qualification there would be useful, even if it is just a reference to a table or figure.

p. 2993: Where do the coefficients A1, B1, etc. in Appendix A2 come from? How were they arrive at and why are they valid?

Technical Issues

p. 2974: The term "real" as applied to real air conditioning systems seems inappropriate. BEM-TEB cannot model "real" air conditioners under true operating conditions, but rather makes fewer assumptions than does EnergyPlus. The air conditioner models still assume that air conditioners follow theoretical equations, which they may do fairly well in test conditions, but will not do in real applications. It is suggested that this term be re-thought and this part of the discussion merely mention that BEM-TEB allows for previously unavailable sophistication in the modeling of air conditioners.

p. 2975: This technical issue is the UHI-related one alluded to in the general comments above. Saying, "HVAC systems are responsible for waste heat emissions that contribute to the increase in air temperature observed in urban areas with respect to their undeveloped rural surroundings (Sailor, 2010). This phenomenon, known as the urban heat island (UHI)..." makes it seem as if the "phenomenon" being referred to

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is the increase in urban temperatures, but, as written, the paper allows for much ambiguity as to whether the phenomenon being referred to is this observed temperature increase or the contribution of HVAC systems to UHI. This ambiguity may lead some to believe the HVAC's contribution to UHI is the sole cause of UHI, which is far from true. Rather than saying "This phenomenon" the paper should effectively say, "This increased temperature, to which waste heat from HVAC systems contributes X%, is known as the UHI." This change would clear up the ambiguity in the writing, as well as provide the context recommended above.

p. 2795: In "Masson et al., 2002", TEB stands for Town Energy Balance. In this paper it is given as Town Energy Budget. This difference may be an intentional change and not an error at all, but may deserve the attention of the authors.

p. 2976: The first paragraph in section 2.1 should have an additional sentence or sentences briefly reiterating the value of BEM's objective. The objective is clear, but it would be worth quickly restating the motivation.

p. 2984: In the last sentences of section 2.6.4, the word "supply" (and conjugations) is used in two senses (a figure provided to the model and "supply" air). Perhaps "provided" would be better in uses such as "supplied by the user" to avoid confusion between the different senses of the word.

p. 2988: "averaged on" looks like it should be "averaged over".

p. 2992: Is Uref in the final sentence of appendix A1 meant to read Uurb?

p. 3005: Figure 4's caption should tell the reader what the meaning of the figure is. Why is the figure of interest to the reader? What should the reader be looking for in the figure? The same is true for Figures 2, 5, 6, 7, 8, 9 and 10.

Interactive comment on Geosci. Model Dev. Discuss., 4, 2973, 2011.