

## ***Interactive comment on “The role of building models in the evaluation of heat-related risks” by O. Buchin et al.***

### **Anonymous Referee #1**

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#### General comments

This paper addresses an important topic – the role of indoor overheating on population mortality during hot weather, and addressed the issue in a novel way. This work is particularly relevant due to the predicted changes in climate, including an increase in extreme heat events, and the changes in the housing stock due to energy-efficient retrofit policies.

Due to the importance of the topic, I recommend publication, however I have a number of reservations. Firstly, the modelling work has examined only a single dwelling type, and has broadly generalised this across the entire housing stock, although I recognise that this is a proof-of-concept study. We know that different dwelling types have

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varying overheating risks, and there is little background information provided to justify the selection of the dwelling (some info on the prevalence of the building type would be useful, for example). There seems to be little consideration for occupant behaviour and ventilation during the modelling process, both of which can have significant influences on indoor temperature, and in the majority of cases building occupants can be expected to take some action to counter high indoor temperatures such as opening windows.

The development of models based on the EnergyPlus simulation – presumably to enable real-time risk estimation – ignores many modelling approaches that have been shown to have a good correlation to EnergyPlus models, such as NeuralNetwork models. The assumption of linearity between indoor and outdoor temperatures is tenuous, as buildings are transient, dynamic systems. Finally, a mention of the role of Urban Heat Islands in potential risk would be beneficial, for example the paper by Gabriel and Endlicher (Urban and rural mortality rates during heat waves in Berlin and Brandenburg, Germany, Environmental Pollution, 2011). The paper would also benefit from more of a review of existing studies where heat-related mortality has been predicted based on housing or urban characteristics.

#### Specific comments

Abstract Line 1. I would say they are generally based on outdoor climates. However, some models (for example Wolf and MacGregor, as well as the ones referenced in the paper) have developed risk indices which account for dwelling types

Pg 7622 line 20. Heat waves have definitions that vary according to different bodies. Heat events which may not be categorised as heatwaves may also cause mortality risk to increase. Please consider changing heat waves to ‘heat events’.

Pg 7624 line 24 Can you please reference PMV and UTCI

Pg 7625 Equation 3. These variables need to be defined

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Pg 7625 Line 5 – proportional above the temperature threshold?

Pg 7625 Line 6 It is not immediately clear what is meant by retardation effects in this context. Does this refer to prior weather conditions? Or prior indoor temperatures?

Pg 7625 Line 20. Indoor contributions to temperature due to internal gains (from, for example, occupant metabolism, hot water supply, and electrical equipment) may also contribute to indoor overheating, independent of weather conditions.

Pg 7625 Line 21 Please clarify what is meant by night recreation

Pg 7626 Line 6 Please clarify what is meant by 'exposition parameter'. Is this a parameter to describe exposure?

Pg 7626. Equation 6. While it can be inferred from the following paragraph, it would be helpful if you could explain the variables  $N_{out}$  and  $N$ . If one were to define  $N_{out}$  and  $N$ , would it account for the lag-behaviour of a population spending time in both outdoor and indoor locations, or is it largely nominal? Is there an argument for having exposure inside non-domestic buildings accounted for?

Pg 7627 line 10. Occupant behaviour in response to high internal temperatures (for example the opening of windows) and preceding weather conditions (alongside varying thermal mass within the building fabric storing heat energy from previous hot or cold days) will also lead to non-linear relationships between indoor and outdoor temperature. The assumption of linearity is tenuous.

Pg 7628 EN 15251 refers to comfort thresholds, and has a linear relationship to running mean temperature. Comfort thresholds do not easily transfer to mortality risk, as defined by increased risk above temperature thresholds, as it accounts for occupant adaptation over a period of hot outdoor weather, and it is generally presented as a number of percentage of hours exceeding comfort thresholds (which will be highly non-linear with outdoor temperatures – please see Mavrogianni et al, 2014, The impact of occupancy patterns, occupant-controlled ventilation and shading on indoor overheating

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ing risk in domestic environments, Building and Environment). It is not clear how the linear relationship between comfort temperature thresholds and outdoor temperatures, as detailed in EN 15251, supports a linear relationship between outdoor and indoor absolute temperature.

Pg 7628 Line 13 Representing a building as a box model leads to the assumption that the sources of heat gains are located in the same zone as the occupant exposed, or that the heat will be evenly transferred throughout the dwelling. Please justify this.

Pg 7628 line 18. Ventilation is very important for reducing overheating risk. I understand if this was ignored in the physical building model, but it is important to know whether it was included in the EnergyPlus model.

Pg 7629 – Parameterization data. Was ventilation included in the EP model? Without even a nominal air change rate, the overheating risk is likely to be very high indeed. What was the reason for the choice of storey of the dwelling, given that a number of studies have shown top-floor flats have amongst the greatest overheating risk of all dwelling types? This model is representative of a single dwelling type, yet is applied using population mortality data.

7633 Line 13 – please define/clarify SD

Pg7633 Line 21 – Do you mean example rather than exemplary?

Pg7633 Line 22 – it is unclear until you look at the figure that the calculation has been done for individuals over 65 – this should be mentioned in the text, ideally in the methodology. Where did the mortality data come from? It is possible you would see a stronger association with an older age group.

Pg 7634 Line 9 – Is this the mean number across the population aged over 65?

Pg 7636 Line 2 – there is more recent data for London, and other locations. Please see, e.g.: Armstrong et al, Association of mortality with high temperatures in a temperature climate: England and Wales, 2010, JECH Gasparrini et al, The effect of high

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temperatures on cause-specific mortality in England and Wales, *Occ and Env Med*, 2012

Technical corrections

Please check the entire document for spelling and nomenclature. I believe lag should be used in the place of retardation, example in the case of exemplary.

pg 7627 line 15 – empirical

pg 7628 line 2 relationship

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Interactive comment on *Nat. Hazards Earth Syst. Sci. Discuss.*, 2, 7621, 2014.

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