Response to the Referee

We thank the Referee for the careful and constructive comments on our manuscript.
In the following, the format is:

Referee's comment

Our reply (revised text and place)

The line references in this response refer to the clean revised manuscript with all tracked changes accepted. A separate marked-up manuscript is provided to show all revisions.

Referee #2

The objective of this study is to enhance the urban canopy model with integreated building energy model SLUCM-BEM v1.0 to SLUCM-BEM v2.0 by adding a prognostic indoor air temperature instead of prescribing fixed values. This allows to better represent situations when there is neither heating nor air conditining, which considerably enhances the model's capability for simulations on global scale and for a variety of meteorological situations.

Another improvement is the consideration of air exchanges between indoor and outdoor. The model is evaluated for the simulation of building energy consumption in Tokyo Metropolitan Area and for the simulation of indoor air temperature for buildings situated in London. For the naturally ventilated London buildings, a large variety in the observed indoor temperature is found, which is likely due to different human behaviour.

An ensemble of SLUCM-BEM simulations with different ventilation rates is made to represent this variability. It is shown that the average SLUCM-BEM results correspond well with the averaged observations. A reduction of the positive bias in building energy consumption is found for Tokyo in both summer and winter seasons. The sensitivity of building energy consumption to outdoor air temperature is also improved for summer, but not for winter.

Similar accuracy for the outdoor air temperature is found for the Tokyo region when using the new model version. A sensitivity study is made to investigate the effect of air conditioning on indoor and outdoor near-surface air temperature for Tokyo. The results are coherent with other previous studies on this topic.

This is a well-written study presenting a relevant urban canopy model development that could be published after some revisions.

We thank the Referee for the positive and constructive assessment and for recognising the value of the prognostic indoor-temperature and indoor–outdoor air-exchange developments. We have revised the manuscript to clarify the scope of the sensible indoor formulation, the interpretation and limitations of the prescribed effective air-change rate, the simplified indoor longwave treatment, the heating/cooling control used in different climates, and the distinction between mathematical symbols and implementation names. We have also broadened the comparison beyond WRF-based frameworks, expanded the feature-by-feature comparison in Table 1 and streamlined Table 2, moved the full parameter and implementation tables to the Supplement, added a nomenclature, and revised the terminology, captions, and Summary. Several comments overlap with points raised by Referee #1; in those cases, we retain the corresponding revision and have strengthened it where Referee #2 requested additional clarification.

Major review points:

- Indoor humidity is not included in the new BEM. This is a drawback since it might influence indoor human thermal comfoort. It might be added and maybe the observation data for London also provide humidity.

We agree that indoor humidity is important for thermal comfort and for latent cooling/dehumidification loads. The v2.0 formulation evaluated in this paper was intentionally limited to the indoor sensible-energy balance and a prognostic representative indoor temperature. We have already implemented an indoor moisture-load calculation and prognostic indoor humidity in a subsequent development version beyond v2.0. That development also calculates indoor mean radiant temperature, globe temperature, and WBGT. However, incorporating those results into the present revision would require changing the model version, formulation, diagnostics, validation, figures, and conclusions, rather than making a local revision. We therefore retain the scope of the present paper as SLUCM+BEM v2.0 and state explicitly that the humidity and indoor thermal-comfort extensions will be evaluated and reported in a separate paper. The Southwark observations include relative humidity and provide a valuable basis for that separate evaluation.

Revised manuscript, lines 616–620:

> "SLUCM+BEM v2.0 presented and evaluated here solves the indoor sensible-energy balance and does not prognose indoor humidity or latent HAC loads (e.g. Kikegawa et al. 2003; Meili et al. 2025). A subsequent development version beyond v2.0 already includes an indoor moisture-load calculation and prognostic indoor humidity, together with indoor mean radiant temperature, globe temperature, and WBGT. Because these extensions require separate formulation and validation and would substantially change the scope and results of the present paper, they will be reported separately."

- Ventilation seems to be a fixed mechanical ventilation. In reality, there might also be infiltration (air exchange due to tiny holes in the building envelope) or natural ventilation due to window opening. Please discuss that this is not considered. Infiltration might vary depending on the meteorological conditions (e.g. wind speed), which makes the model using a constant ventilation rate different from reality, especially for older, less airtight buildings.

We agree with the underlying concern, while clarifying that the term is not intended to represent mechanical ventilation alone. It is a prescribed effective total indoor–outdoor air-change rate assigned to the representative indoor volume. Thus, it may represent the aggregate effect of outdoor-air introduction, envelope leakage, and window opening, but these pathways are not diagnosed separately. The rate does not vary dynamically with wind speed, indoor–outdoor buoyancy, airtightness, opening area, or occupant behaviour. For London, the vent-0 to vent-10 cases are therefore interpreted as an idealised ensemble spanning unresolved differences among dwellings, rather than as time-varying simulations of individual windows. We now state this explicitly in the formulation, evaluation, and limitations.

Revised manuscript, lines 247–253:

> "where n_{air} is the prescribed effective indoor–outdoor air-change rate (h^{-1}; input name: VENT_RATE, Supplementary Tables S2 and S3). It represents the total air exchange assigned to the representative indoor volume and is not restricted to mechanical ventilation. For the Tokyo HAC simulations, n_{air} = 0.5 h^{-1} was used for the two residential categories, consistent with the minimum continuous-ventilation requirement in the Japanese Building Standards Act sick-house guidance, and n_{air} = 1.7 h^{-1} was used for business/commercial buildings following the standard CM-BEM office setting (5.0 m^3 m^{-2} h^{-1} divided by a 3.0 m floor height). In v2.0, this prescribed rate does not separately or dynamically diagnose envelope infiltration, window-opening ventilation, or their dependence on wind speed and indoor–outdoor buoyancy."

Revised manuscript, lines 254–256:

> "For the London evaluation, the vent-0 to vent-10 experiments should therefore be interpreted as an idealised ensemble of prescribed effective air-change rates, spanning unresolved differences among dwellings in window opening, airtightness, and other air-exchange pathways, rather than as time-varying simulations of individual window operation."

Revised manuscript, lines 625–627:

> "The effective air-change rate is prescribed. SLUCM+BEM v2.0 does not dynamically separate mechanical ventilation, envelope infiltration, and window opening, or represent their wind-speed and buoyancy dependence. This limitation is particularly relevant for older and less airtight buildings."

- A potentially questionable method is employed for the internal thermal infrared exchanges (Equations 16 and 17). It is assumed that the infrared radiative exchange takes place between the interior surfaces and the interior air. However, most of the infrared radiation will not be exchanged with the indoor air, but with the other interior surfaces. So it would be more precise to adopt a radiosity approach for the interior infrared exchanges. The uncertainty from the approach adopted in the present study might be low in most cases since the indoor air temperature will be quite close to the interior surface temperatures, but the potential uncertainty should be mentioned or investigated. L193 is also highly questionable. Equation (18) looks like the linearised Stefan Boltzmann equation. So ew should not be the thermal conductivity of air (but the emissivity) and sigma not the dynamic viscosity of air (but the Stefan Boltzmann constant).

We agree that the original explanation was ambiguous and that the definitions following Eq. (18) were incorrect. This point directly overlaps with a comment from Referee #1. In our response to

Referee #1, we explained in detail that the underlying BEM formulation first expresses indoor-enclosure longwave exchange using Gebhart radiation-absorption coefficients, which account for emission, absorption, reflection, and exchange among indoor surfaces. Under the subsequent BOX-model approximation, indoor structures, furniture, and inner surfaces are represented by the common representative indoor thermal state T_{in}, and the enclosure exchange is reduced to an effective linearised net exchange between each innermost envelope surface and T_{in}.

We have retained a concise and self-contained explanation of this formulation in Sect. 2.1.2. Thus, Eqs. (16)–(18) should not be interpreted as radiation from the envelope surfaces to a black indoor-air sink. At the same time, v2.0 does not solve an explicit multi-surface radiosity matrix or a separate prognostic floor-surface temperature. We now identify the conditions under which this approximation is expected to be most uncertain and state that comparison with an explicit multi-surface radiosity formulation is a future priority. We also corrected Eq. (18): $\varepsilon_s$is the indoor-side longwave emissivity of the relevant surface and $\sigma$is the Stefan–Boltzmann constant.

Revised manuscript, lines 228–241:

> "where ε_s is the indoor-side longwave emissivity of the corresponding surface, σ is the Stefan–Boltzmann constant (W m^{-2} K^{-4}), and T_{in} is the indoor temperature around which the longwave exchange is linearised. The radiative flux densities Q_{Rr} and Q_{Rw} in Eqs. (16) and (17) should be interpreted as effective linearised net longwave exchanges between the innermost roof/wall surface and the representative indoor thermal environment. In the underlying BEM formulation, the indoor-side longwave exchange is first written for an indoor enclosure using Gebhart radiation absorption coefficients, which account for emission, absorption, and reflection among indoor surfaces. The BOX-type BEM then assumes that indoor structures, furniture, and inner surfaces are represented by the indoor temperature T_{in}, while their heat storage is included in the effective indoor heat capacity Q_B. Under this BOX-model approximation, the detailed indoor surface-to-surface exchange is reduced to the effective forms represented by Eqs. (16) and (17). Thus, Eqs. (16) and (17) do not represent radiation to a black indoor-air sink, but an effective net exchange with the representative indoor thermal environment. The current implementation does not solve an explicit indoor radiosity matrix or a separate prognostic floor-surface temperature. The approximation is expected to be most uncertain when the indoor surfaces have large temperature contrasts or when the representative indoor state differs substantially from an individual surface temperature; an explicit radiosity/view-factor solution would be required to resolve those conditions in detail."

Revised manuscript, lines 621–624:

> "The indoor longwave exchange is represented by the simplified BOX-model treatment described in Section 2.1.2 rather than an explicit radiosity/view-factor matrix or a prognostic floor-surface temperature. Its uncertainty is expected to be greatest when indoor surfaces have large temperature contrasts; comparison with an explicit multi-surface radiosity model is a future priority."

- Table 1 seems to provide the state-of-the-art concerning the UCP-BEM models only as they are coupled to WRF. Please research also the developments of the UCP-BEM models that are not integrated in WRF.

Although the original Table 1 already included CLMU and UT&C-BEM, we agree that its framing was WRF-centred and omitted important developments. We retained all of the original feature-by-feature comparison rows and added UCLEM and DCEP-BEM. We also retained BEM-TEB in panel (a), because TEB, including its integrated BEM, has been coupled directly to WRF as WRF–TEB (Meyer et al., 2020). Panel (b) contains the distinct non-WRF or offline frameworks CLMU, UCLEM, DCEP-BEM, and UT&C-BEM.

Revised manuscript, lines 56–65:

> "BEM-TEB, the building-energy model integrated within the Town Energy Balance urban scheme; TEB is distributed within SURFEX and has also been coupled to WRF as WRF–TEB (Bueno et al., 2012; Schoetter et al., 2017; Meyer et al., 2020). Other non-WRF or offline developments include CLMU (Community Land Model Urban) in CESM (Oleson et al., 2008; Oleson and Feddema, 2020; Li et al., 2024b), UCLEM used with CCAM (Lipson et al., 2018), DCEP-BEM coupled with COSMO-CLM (Jin et al., 2021), and UT&C-BEM (Urban Tethys-Chloris-BEM) (Meili et al., 2020, 2025). Table 1 retains a feature-by-feature comparison of these frameworks, including building and traffic anthropogenic heat, internal heat gains, HAC energy, partial AC use, COP, windows, ventilation, indoor temperature, host model, and computational cost. The comparison is restricted to urban land-surface or canopy frameworks that represent building-energy feedbacks and does not include building-only tools such as EnergyPlus (Crawley et al., 2001), DASH (Capel-Timms et al., 2020), or BIPV Window (Chen et al., 2021)."

Revised manuscript, Table 1:

Table 1: Feature-by-feature comparison of urban canopy and building-energy parameterisations used in regional and global climate models. Panel (a) lists frameworks with a documented WRF coupling; panel (b) lists frameworks implemented in non-WRF host systems or offline/single-column modes.

(a) Frameworks with a documented WRF coupling

Feature	SLUCM	SLUCM+BEM v1.0[1]	SLUCM+BEM v2.0	BEP+BEM[2]	CM-BEM[3]	BEM-TEB[6]
Q_F from buildings	Prescribed (aggregate)	Dynamic	Dynamic	Dynamic	Dynamic	Dynamic
Q_F from traffic	Prescribed (aggregate)	Prescribed	Prescribed	–	Prescribed	Prescribed
Internal heat gain	–	Input	Input	Input	Input	Input
EC_{HAC}	–	Dynamic	Dynamic	Dynamic	Dynamic	Dynamic
Partial AC	–	Implemented	Implemented	–	Implemented	Implemented (2017 extension)
COP	–	Dynamic	Dynamic	Constant	Dynamic	Dynamic
Cooling tower	–	Implemented	Implemented	–	Implemented	–
Windows	–	–	–	Implemented	Implemented	Implemented
Ventilation	–	–	Implemented	Implemented	Implemented	Implemented
Indoor temperature	–	Prescribed	Dynamic	Dynamic	Dynamic	Dynamic
Weekday–weekend difference	–	–	–	–	Implemented	Implemented (2017 extension)
Atmospheric/host framework	WRF	WRF	WRF	WRF	WRF	SURFEX–TEB; WRF–TEB
Computational cost [–]*,[10]	1.0	1.0	1.0	2.3	1.7	0.8

(b) Frameworks in non-WRF host systems or offline/single-column models

Feature	CLMU[4,5]	UCLEM[7]	DCEP-BEM[8]	UT&C-BEM[9]
Q_F from buildings	Dynamic	Dynamic	Dynamic	Dynamic

Feature	CLMU[4,5]	UCLEM[7]	DCEP-BEM[8]	UT&C-BEM[9]
Q_F from traffic	Prescribed (base); dynamic (2026 extension)	Prescribed	–	–
Internal heat gain	–	Input	Input	Input
EC_{HAC}	Dynamic	Dynamic	Dynamic	Dynamic
Partial AC	Implemented (2024 extension)	Implemented (2019 extension)	–	Implemented (prescribed fraction)
COP	Constant	Dynamic	Not explicitly parameterised	Constant
Cooling tower	–	–	–	–
Windows	Implicit (bulk wall)	–	Implemented	Implemented
Ventilation	Implemented	Implemented (infiltration)	Implemented	Implemented
Indoor temperature	Dynamic	Dynamic	Dynamic	Dynamic
Weekday–weekend difference	–	–	–	–
Atmospheric/host framework	CESM/CTSM	CCAM; offline/SCM	COSMO-CLM	Offline/standalone
Computational cost [–]*,[10]	–	–	–	–

Note. "Prescribed" denotes an externally supplied flux; "Input", a parameter or schedule supplied to the BEM; "Dynamic", a quantity calculated from the evolving model state and prescribed controls; "Implemented", a process represented in the cited model version; "extension", a capability introduced after the core model publication; and "–", a process not represented or not explicitly documented. Abbreviations and model-specific qualifications are provided in Supplementary Table S2 and Supplementary Text S2.

[1]Takane et al. (2024); [2]Salamanca et al. (2010); [3]Kikegawa et al. (2003), Takane et al. (2017), and Nakajima et al. (2023); [4]Oleson and Feddema (2020); [5]Li et al. (2024b) and Sun et al. (2026a); [6]Bueno et al. (2012), Schoetter et al. (2017), and Meyer et al. (2020); [7]Lipson et al. (2018, 2019); [8]Jin et al. (2021); [9]Meili et al. (2020, 2025); [10]Kikegawa et al. (2025).

*Normalised computational time relative to SLUCM+BEM v2.0 under the WRF benchmark configuration described in Section 4.4; values are unavailable or not directly comparable for the other frameworks.

Revised manuscript, References:

"Lipson, M. J., Thatcher, M., Hart, M. A., and Pitman, A. J.: A building energy demand and urban land surface model, Quarterly Journal of the Royal Meteorological Society, 144, 1572–1590, https://doi.org/10.1002/qj.3317, 2018."

"Lipson, M. J., Thatcher, M., Hart, M. A., and Pitman, A. J.: Climate change impact on energy demand in building–urban–atmosphere simulations through the 21st century, Environmental Research Letters, 14, 125014, https://doi.org/10.1088/1748-9326/ab5aa5, 2019."

"Jin, L., Schubert, S., Fenner, D., Meier, F., and Schneider, C.: Integration of a Building Energy Model in an Urban Climate Model and its Application, Boundary-Layer Meteorology, 178, 249–281, https://doi.org/10.1007/s10546-020-00569-y, 2021."

"Schoetter, R., Masson, V., Bourgeois, A., Pellegrino, M., and Lévy, J.-P.: Parametrisation of the variety of human behaviour related to building energy consumption in the Town Energy Balance (SURFEX-TEB v. 8.2), Geoscientific Model Development, 10, 2801–2831, https://doi.org/10.5194/gmd-10-2801-2017, 2017."

"Meyer, D., Schoetter, R., Riechert, M., Verrelle, A., Tewari, M., Dudhia, J., Masson, V., van Reeuwijk, M., and Grimmond, C. S. B.: WRF–TEB: Implementation and Evaluation of the Coupled Weather Research and Forecasting (WRF) and Town Energy Balance (TEB) Model, Journal of Advances in Modeling Earth Systems, 12, e2019MS001961, https://doi.org/10.1029/2019MS001961, 2020."

Revised Supplement, Supplementary Text S2:

"Supplementary Text S2. Interpretation and scope of the entries in Table 1

In Table 1, "Partial AC" is classified as implemented only when the conditioned fraction of building floor area or indoor space can be specified. "Windows" denotes an explicit window element rather than an effective bulk-envelope treatment. "Cooling tower" denotes a treatment of cooling-tower or evaporative heat rejection, including a prescribed sensible/latent heat-rejection partition.

Core SLUCM: A single aggregate anthropogenic heat flux is prescribed; building and traffic components are not diagnosed separately.

BEM-TEB: BEM-TEB is the BEM integrated within TEB. TEB is distributed within SURFEX and has also been coupled to WRF as WRF–TEB; SURFEX is therefore treated as a host framework rather than as a separate BEM in Table 1. The cited BEM-TEB implementation permits water-condensed heat rejection but does not include an explicit cooling-tower submodel.

UCLEM: Partial AC was introduced in Lipson et al. (2019) as the prescribed fraction of indoor spaces with access to AC. The cited 2018 and 2019 versions do not distinguish weekday and weekend schedules.

CLMU: Explicit AC adoption was introduced by Li et al. (2024b), and interactive traffic heat was introduced by Sun et al. (2026a)."

- There is a mix of symbols rather mathematical (e.g. Tin) and symbols that are rather like model variables (e.g. TBLEND). I suggest unifying the nomenclature to use only mathematical symbols and following the typical nomenclature in the field.

We agree. The formulation now uses mathematical symbols consistently. Implementation and input names are retained only where needed for reproducibility. To avoid two tables with overlapping purposes, we removed the concise nomenclature table from the main text and retained one comprehensive nomenclature and symbol-to-implementation mapping as Supplementary Table S2.

Revised manuscript, lines 193–195:

"Mathematical symbols are used in the formulation below; Supplementary Table S2 provides the complete nomenclature and maps the mathematical symbols to implementation/input names. The calculation proceeds as follows (blue numbers in Fig. 1b):"

Revised manuscript, equations (1)–(7), (8), (10), (11), (12)–(14), (16), (17), (19), (20).

- Sometimes a double naming of variables seems to be employed. For example in L145: is AB_BUILD_RATIO = a in Equation (3)? In this cast it is confusing. Please use the same symbol at all places for a given variable.

We agree. Equation (3) now uses the descriptive mathematical symbols fab, f_{AC}, and r_{HAC} throughout the formulation. Their implementation/input names are listed only in Supplementary Table S2. This removes the previous simultaneous use of a, b, c and the input-table labels.

Revised manuscript, Eq. 3:

$$H_{out} = f_{cond} H_{in}. \tag{3}$$

Revised manuscript, lines 162–165:

> "where $f_{\mathrm{cond}} = (1 - f_{\mathrm{ab}}) f_{\mathrm{AC}} r_{\mathrm{HAC}}$, f_{ab} is the fraction of abandoned buildings, f_{AC} is the air-conditioned fraction of the total floor area, and r_{HAC} is the fraction of cooling or heating served by electric HAC. Their implementation/input names are AB_BUILD_RATIO, AC_FLOOR_RATIO, and AC_USAGE_RATIO_CL or AC_USAGE_RATIO_HT, respectively (Supplementary Table S2). Full parameter values used in the experiments are given in Supplementary Table S3."

- The lengthy Tables 3 and 5 with the parameter setting should be moved to an Appendix.

We agree. The full experimental parameter table and full WRF implementation table have been moved from the main manuscript to Supplementary Tables S3 and S4, respectively. The main text refers readers to the single comprehensive nomenclature in Supplementary Table S2 and to these full settings tables.

Revised manuscript, lines 328–329:

> "The complete parameter settings for the original SLUCM, SLUCM+BEM v1.0, and SLUCM+BEM v2.0 experiments are provided in Supplementary Table S3."

Revised manuscript, lines 542–545:

> "All scientific simulations presented in this paper used WRF v4.3.2, Noah-LSM, and Japan's National Land Numerical Information dataset with three urban categories. Figure 13 summarises the modified WRF modules and compatible options. Practical reproduction steps, the tested configurations, user settings, and modified source files are documented in Supplementary Text S1 and Supplementary Tables S1 and S4."

- A nomenclature could be added in the Appendix.

We agree. We added one comprehensive nomenclature in the Supplement rather than retaining overlapping main-text and supplementary tables. Supplementary Table S2 defines all mathematical symbols, units, and corresponding implementation/input names needed to read and reproduce the formulation.

Revised Supplement, Supplementary Table S2:

Supplementary Table S2. (a) Nomenclature and mapping between mathematical symbols and implementation or input names; and (b) abbreviations used in Table 1 and elsewhere in the manuscript.

(a) Mathematical symbols, definitions, units, and implementation/input names

Symbol	Definition	Unit	Implementation / input name
T_{in}	Representative indoor temperature of the BOX-type BEM	K	Tin_URB (prognostic output)
T_{set}	HAC thermostat threshold	K	TARGTEMP
T_{can}	Urban-canopy outdoor air temperature	K	TC_URB
$T_{r(N)}$	Innermost roof/ceiling temperature at layer N	K	TRL(N)
$T_{w(N)}$	Innermost wall temperature at layer N	K	TBL(N)
H_{in}	Total indoor sensible heat load for the unit-canyon building	W	HIN_URB2D / diagnostic
H_{out}	Indoor sensible load processed by HAC	W	internal diagnostic
Q_{FB}	Building anthropogenic heat flux returned outdoors	W m^{-2}	QFB_URB2D
Q_{FT}	Traffic anthropogenic heat flux	W m^{-2}	AH_TRAFFIC
EC_{HAC}	HAC electricity consumption per floor area	W floor-m^{-2}	ECAC_URB2D
n_{air}	Prescribed effective indoor–outdoor air-change rate	h^{-1}	VENT_RATE
f_{ab}	Fraction of abandoned buildings	–	AB_BUILD_RATIO
f_{AC}	Air-conditioned floor-area fraction	–	AC_FLOOR_RATIO
r_{HAC}	Fraction of cooling/heating served by electric HAC	–	AC_USAGE_RATIO_CL / AC_USAGE_RATIO_HT
h_C	Indoor convective heat-transfer coefficient	W m^{-2} K^{-1}	calculated
h_{Rr}, h_{Rw} (collectively h_{Rs})	Linearised indoor longwave heat-transfer coefficients	W m^{-2} K^{-1}	Calculated
λ_a	Thermal conductivity of air	W m^{-1} K^{-1}	temperature-dependent function of T_f
ν_a	Kinematic viscosity of air	m^2 s^{-1}	temperature-dependent function of T_f
α_a	Thermal diffusivity of air	m^2 s^{-1}	temperature-dependent function of T_f
ε_s, σ	Indoor-side surface emissivity and Stefan–Boltzmann constant	–; W m^{-2} K^{-4}	EPSR/EPSB; constant
Q_{Cr}, Q_{Cw}	Convective heat-flux densities at the innermost roof/ceiling and wall surfaces	W m^{-2}	calculated
Q_{Rr}, Q_{Rw}	Effective net longwave heat-flux densities at the innermost roof/ceiling and wall surfaces	W m^{-2}	calculated
Q_C, Q_R	Area-integrated indoor convective and longwave heat transfers for the unit-canyon building	W	calculated
Q_{VENT}	Sensible heat exchange associated with prescribed indoor–outdoor air exchange	W	calculated
Q_F	Total urban anthropogenic heat flux	W m^{-2}	QF_URB2D
COP	Heating/cooling coefficient of performance	–	COP / COPOPTION
V_{in}	Representative indoor volume per unit along-canyon length	m^3	$Z_R W_R$
A_f	Total floor area per unit along-canyon length	floor-m^2	$(Z_R/h_f)W_R$
A_{plan}	Canyon plan area represented per unit along-canyon length	m^2 per 1-m along-canyon length	$W_R + W_{road}$
W_R, W_{road}	Roof/building width and road width	m	WR / road-width parameter
Z_R, h_f	Building height and representative floor height	m	ZR; $h_f = 3.0$ m
Q_B	Total effective indoor heat capacity	J K^{-1}	calculated
R_M	Effective volumetric heat capacity of indoor materials and furniture	J m^{-3} K^{-1}	2.0×10^5
Gr; Pr; Ra; Nu	Grashof, Prandtl, Rayleigh, and Nusselt numbers	–	calculated
ρ_a, C_p	Air density and specific heat at constant pressure	kg m^{-3}; J kg^{-1} K^{-1}	WRF atmospheric state/constants

Symbol	Definition	Unit	Implementation / input name
$T_{w,set}, T_{r,set}$	Prescribed innermost wall and roof/ceiling boundary temperatures used in v1.0	K	TBLEND; TRLEND
H_{TRANS}	Conductive wall-and-roof contribution to the v1.0 indoor sensible heat load	W land-m^{-2}	HTRANS
h, r	Normalised building height and roof-width fractions in the SLUCM canyon geometry	–	HGT; R
$k_w,\ k_r$	Thermal conductivity of wall and roof materials	W m^{-1} K^{-1}	AKSB; AKSR
$\Delta z_{w(N)}$, $\Delta z_{r(N)}$	Thickness of wall and roof layers	m	DDZB(N); DDZR(N)
C_w, C_r	Volumetric heat capacity of wall and roof materials	J m^{-3} K^{-1}	CAPB; CAPR
qE	Sensible internal heat gain from equipment per floor area	W floor-m^{-2}	HSEQUIP_SCALE_FACTOR × HSEQUIP
$P\ \varphi P$	Product of peak occupant density and hourly occupancy fraction	person floor-m^{-2}	PERFLO
qhs	Sensible heat generation per person	W person^{-1}	HEAT_PERSON
f_{cond}	Conditioned fraction of the representative building, $(1 - f_{ab})\ f_{AC}\ r_{HAC}$	–	calculated
$H_{in,land}$	Indoor sensible heat load normalised by canyon plan area	W land-m^{-2}	Hin_land
V_{air}	Indoor–outdoor volumetric airflow rate for the unit-canyon building	m³ s^{-1}	airvol
Δt	Model time step	s	DELT
d_z	Characteristic length for indoor natural convection (representative floor height)	m	h_f = 3.0 m
$T_f; T_s$	Film temperature and relevant innermost roof/ceiling or wall surface temperature	K	calculated; T_f is converted to °C only for the air-property functions
g	Gravitational acceleration	m s^{-2}	GRAV / constant

Note for panel (a). Mathematical symbols are used in the main text. Implementation/input names are listed only to support reproducibility. A dash denotes that no direct user input is required.

(b) Abbreviations used in Table 1 and elsewhere in the manuscript

Abbreviation	Definition
AC	air conditioning
BEM	building energy model
BEP	building effect parameterisation
CCAM	Conformal Cubic Atmospheric Model
CESM	Community Earth System Model
CLMU	Community Land Model–Urban
CM	canopy model
COP	coefficient of performance
COSMO-CLM	Consortium for Small-scale Modeling model in Climate Limited-area Modelling mode
CTSM	Community Terrestrial Systems Model
DCEP	Double Canyon Effect Parametrisation
EC	electricity consumption
HAC	heating and air conditioning
QF	anthropogenic heat
SCM	single-column model
SLUCM	single-layer urban canopy model
SURFEX	Surface Externalisée
TEB	Town Energy Balance
UCLEM	Urban Climate and Energy Model
UT&C	Urban Tethys-Chloris
WRF	Weather Research and Forecasting model

Minor review points:

- Page 2, L36-37: This sentence seems not correct.

We agree that the Hokkaido sentence was not needed for the argument and was not sufficiently supported in this context. We deleted it.

- Page 2, L43-46: It seems not 100% clear what is Qf and what Qfb.

We agree. We now distinguish the total urban anthropogenic heat flux Q_F, the building component Q_{FB}, and the traffic component Q_{FT} at first use and use these definitions consistently thereafter.

Revised manuscript, lines 42–44:

> "Here, Q_{FB} denotes the building-related anthropogenic heat flux associated with HAC operation and other building energy use, whereas the total urban anthropogenic heat flux Q_F also includes non-building sources such as traffic (Q_{FT})."

- Page 2, L55: What means "official integration"?

We agree that "official integration" was ambiguous. We replaced it with the precise statement that BEP+BEM is distributed as one of the urban-physics options in WRF.

Revised manuscript, lines 54–56:

> "BEP+BEM (Building Effect Parameterization+Building Energy Model) is distributed as a WRF (Weather Research and Forecasting) urban-physics option (Salamanca et al., 2010; Skamarock et al., 2021)."

- Page 3, L63: use subscripts for Sup and Lup.

Corrected. We now use Sup and Lup with subscripts and have standardised the associated flux symbols.

Revised manuscript, lines 66–69:

"Takane et al.'s (2024) SLUCM+BEM v1.0 (Table 1) was developed for coupling to regional and global climate models. The standalone version reproduced observed upward shortwave and longwave radiation (S_{up} and L_{up}), sensible and latent heat fluxes (Q_H and Q_E), net all-wave radiation (Q_*), and the storage heat flux estimated as the residual $\Delta Q_S = Q_* + Q_F - (Q_H + Q_E)$ at Yoyogi, Tokyo, during July–August 2018 and January–February 2017 (Hirano et al., 2015; Sugawara et al., 2021; Takane et al., 2024)."

- Page 3, L63: the formula for the urban energy balance also includes the anthropogenic term (qant), which seems here neglected in the formula calculating the storage heat flux as a residual.

We agree. The residual storage heat flux is now written as ΔQS = Q* + QF − (QH + QE), explicitly including anthropogenic heat.

Revised manuscript, lines 66–69:

"Takane et al.'s (2024) SLUCM+BEM v1.0 (Table 1) was developed for coupling to regional and global climate models. The standalone version reproduced observed upward shortwave and longwave radiation (S_{up} and L_{up}), sensible and latent heat fluxes (Q_H and Q_E), net all-wave radiation (Q_*), and the storage heat flux estimated as the residual $\Delta Q_S = Q_* + Q_F - (Q_H + Q_E)$ at Yoyogi, Tokyo, during July–August 2018 and January–February 2017 (Hirano et al., 2015; Sugawara et al., 2021; Takane et al., 2024)."

- Based on the explanations on Page 3, L67, is not actually clear how SLUCM-BEM v1.0 works. How can the indoor wall and ceiling temperatures be equal to the heating and cooling setpoints. Can these two values be different? How is it decided which one is taken at which time? Or must heating and cooling setpoint be the same value in SLUCM-BEM v1.0?

We agree that the original description was unclear. In v1.0, the innermost wall and roof/ceiling boundary temperatures were both assigned the active HAC setpoint for the current mode. Cooling and heating setpoints may differ, and the active mode may be selected by the prescribed calendar schedule or by the outdoor-temperature-based control. Within a given active mode, however, the two indoor-side envelope boundary temperatures were assigned the same active setpoint. We now state this explicitly.

Revised manuscript, lines 143–147:

"Figure 1a shows a conceptual diagram of SLUCM+BEM v1.0. In v1.0, T_{in} was not prognostic. Instead, the innermost wall and roof/ceiling boundary temperature, denoted here by $T_{w,set}$ and $T_{r,set}$, were prescribed as the active HAC setpoint (their implementation names are listed in Supplementary Table S2). For a given heating or cooling mode, indoor-side boundary temperatures were assigned the same active setpoint. Heat transfer through the walls and roof (H_{TRANS}) was then calculated as follows:"

- Page 3, L75: Maybe better to use a mathematical symbol for "wall surface temperature"

We agree. The innermost wall surface temperature is now denoted by the mathematical symbol Tw,in in the explanatory text, and Tw(N) is used for the innermost prognostic wall layer in v2.0.

Revised manuscript, lines 77–82:

> "Issue 1 likely arises from the aforementioned assumption (Oleson and Feddema, 2020). It is improbable that indoor wall or ceiling surface temperatures equal the HAC setpoint throughout the summer and winter seasons. Specifically, during the cooling season (summer), the outdoor temperature is higher than the indoor temperature (T_{in}) for most periods. Consequently, heat flows from outdoors to indoors, leading to an indoor wall surface temperature $T_{\mathrm{w,in}} > T_{\mathrm{in}}$. In reality, AC is used to bring the T_{in} closer to the setpoint. However, v1.0 assumes the setpoint is the higher temperature of the interior wall surface, leading to an overestimation of EC. The opposite situation occurs in winter (heating season)."

- Page 4, Table 1: What is the difference between "prescribed" and "input"?

We agree that the distinction was unclear. Because these rows provide useful model-specific information, we retained them and clarified the terminology in the Table 1 note. "Prescribed" denotes a flux supplied directly to the urban model, whereas "Input" denotes a building-process parameter or schedule supplied to the building-energy calculation. This preserves the detailed feature-by-feature comparison requested by the Referee while removing the ambiguity.

Changes made in: Table 1 note:

> "Note. "Prescribed" denotes an externally supplied flux; "Input", a parameter or schedule supplied to the BEM; "Dynamic", a quantity calculated from the evolving model state and prescribed controls; "Implemented", a process represented in the cited model version; "extension", a capability introduced after the core model publication; and "–", a process not represented or not explicitly documented. Abbreviations and model-specific qualifications are provided in Supplementary Table S2 and Supplementary Text S2."

- Table 2 is quite difficult to read since it contains a lot of text.

We agree. We reduced Table 2 to five concise aspects and four columns, removed repetition, and retained only the principal v1.0 limitation, the v2.0 development, and the evidence presented in this study.

Revised manuscript, Table 2:

Table 2: Concise comparison of the principal differences between SLUCM+BEM v1.0 and v2.0 and the evidence presented in this study.

Aspect	**SLUCM+BEM v1.0**	**Development in v2.0**	**Evidence in this study**
Indoor thermal state	Indoor wall and roof/ceiling boundary temperatures fixed at the active HAC setpoint	Representative indoor temperature T_{in} is prognostic	Free-running London T_{in}: MAE 0.63–0.65 °C
Free-running and air exchange	No explicit indoor–outdoor air-exchange term; T_{in} unavailable when HAC was off	Prescribed effective air-change term enables HAC and no-HAC simulations	Ventilation ensemble spans much of the observed dwelling-to-dwelling range
Tokyo HAC electricity	Office-district EC was overestimated	Dynamic T_{in} and revised indoor load reduce the bias	Office MAE: 3.5 to 1.7 W floor-m^{-2} in summer; 2.1 to 1.5 W floor-m^{-2} in winter
Indoor–outdoor adaptation analysis	No consistent no-HAC indoor state	HAC use, building Q_{FB}, outdoor temperature, and T_{in} can be assessed together	No-HAC case: daytime Q_{FB} about 40 W m^{-2} lower, outdoor temperature about 0.2 °C lower on average, and daytime T_{in} more than 3 °C higher
Efficiency and portability	Low-cost WRF-coupled and standalone framework	Prognostic T_{in} added while retaining the same framework	WRF-coupled cost remains comparable to SLUCM and lower than BEP+BEM and CM-BEM in the reported benchmark

Note: HAC, heating and air conditioning; T_{in}, representative indoor temperature; EC, electricity consumption; Q_{FB}, building anthropogenic heat flux; MAE, mean absolute error; TMA, Tokyo metropolitan area.

- Page 6, L150: is it EC or Qfb which switches sign between summer and winter?

Thank you for identifying this ambiguity. ECHAC is defined as a non-negative electricity demand. QFB changes sign: it is positive during cooling, when heat is rejected outdoors, and negative during heat-pump heating, when heat is extracted from the outdoor environment.

Revised manuscript, lines 166–170:

> "Using the building-scale HAC-processed load H_{out}, the land-area-normalised indoor sensible load $H_{\text{in,land}}$, and the coefficient of performance (COP; Eq. 4 in Takane et al., 2024), EC_{HAC} and Q_{FB} were calculated at each time step as follows. The total represented floor area and canyon plan area per unit along-canyon length are $A_f = (Z_R/h_f)W_R$ and $A_{\text{plan}} = W_R + W_{\text{road}}$, respectively, and $H_{\text{in,land}} = H_{\text{in}}/A_{\text{plan}}$. Thus, EC_{HAC} is reported in

W floor-m^{-2}, whereas Q_{FB} is reported in W m^{-2}. EC_{HAC} is non-negative, while Q_{FB} is positive during cooling and negative during heat-pump heating."

- Page 7, L155: what is done in the tropical regions which do not have a summer or winter?

The model can control heating and cooling either by calendar month or by outdoor-air-temperature thresholds. The original statement that outdoor-temperature control is available was correct, but it did not explain the tropical case explicitly. We now state that, under temperature-based control, cooling operates whenever the simulated outdoor temperature exceeds the specified cooling threshold, independently of calendar month. Thus, a tropical application may use year-round temperature-based cooling rather than a summer/winter calendar.

Revised manuscript, lines 173–178:

> "The model can select heating and cooling either by calendar month or by outdoor-air-temperature thresholds. In the calendar-month configuration used here, the Northern Hemisphere used cooling from June to September and heating from November to March, with the periods reversed in the Southern Hemisphere. Under temperature-based control, the active mode is selected from the outdoor air temperature simulated by SLUCM/WRF; thus, in tropical regions cooling can operate whenever the outdoor temperature exceeds the specified cooling threshold, independently of calendar month."

- Figure 1: It might be better to redo this figure without explicitly hardcoding the number of layers to 4. Maybe just use a symbol for the number of layers and say in the caption that the default value is 4. The hardcoded number 4 is also appearing in some equations (e.g. 7 and 8).

We agree. The formulation now uses N for the number of roof and wall layers and N−1 for the adjacent layer. Eqs. (7), (8), (10), (11), (16), and (17) have been generalised accordingly. The caption states that N = 4 was used for the evaluated v2.0 configuration. The Fig. 1 artwork has been updated correspondingly before submission by replacing the explicit layer number 4 with N.

Revised manuscript, Fig. 1:

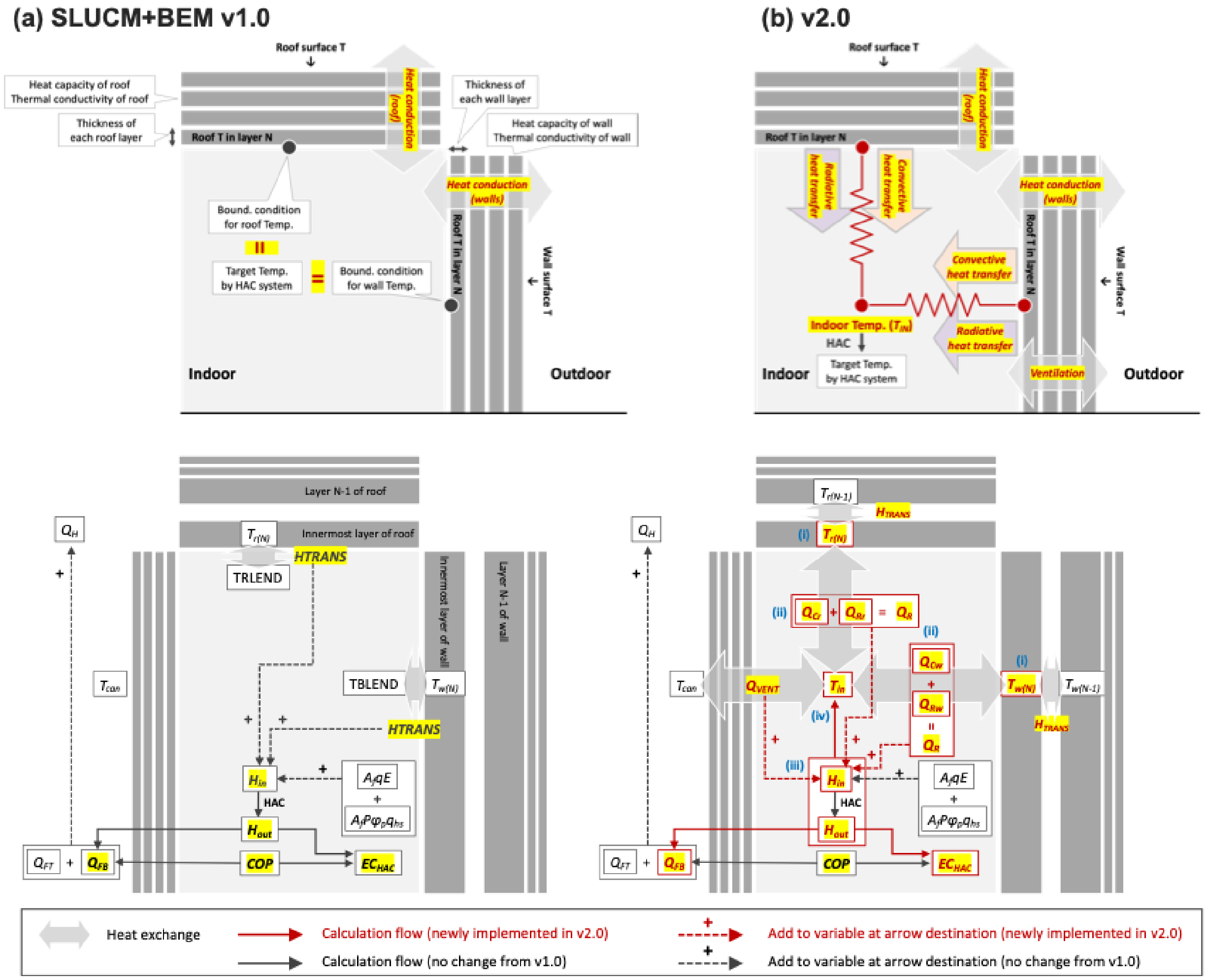

Figure 1: Top: schematic of the energy budgets for an urban canopy layer that includes buildings. The single-layer urban canopy model (SLUCM) coupled with building energy model (BEM) version (a) 1.0 and (b) 2.0. Dark red and yellow highlighting indicate variables simulated by SLUCM+BEM. The text in the callouts indicates original or newly introduced inputs to the WRF parameter table URBPARM.TBL. Bottom: flow-chart of BEM related variables for SLUCM+BEM (a) v1.0 and (b) v2.0. Dark red and yellow highlighting indicate variables simulated by SLUCM+BEM v2.0. The blue numbers (i)–(iv) correspond to those in section 2.1.2. N denotes the number of wall/roof layers; N = 4 was used in the evaluated v1.0 and v2.0 configuration.

- Page 9: There might be an issue in the Equations involving Qcr, Qrr, and so on. Since there is not the same roof area than wall area, must there not be factors converting the m² of walls/roofs into m² of built area?

We agree. This point was also raised by Referee #1 and is addressed by explicitly distinguishing surface heat-flux densities from area-integrated unit-canyon loads. The roof/ceiling fluxes are multiplied by W_R, the two wall fluxes by 2Z_R, and the resulting unit-canyon load is divided by W_R + W_road before coupling to WRF as a land-area-normalised flux.

Revised manuscript, Eqs. (9) and (15) and the explanatory paragraphs immediately following them:

"

$$Q_C = W_R Q_{Cr} + 2 Z_R Q_{Cw} \tag{9}$$

Here Q_C is the area-integrated convective heat transfer for a unit canyon building (W for a 1-m along-canyon length), whereas Q_{Cr} and Q_{Cw} are surface heat-flux densities (W m^{-2}). W_R and Z_R are the roof/building width and building height, respectively. Because SLUCM uses a two-dimensional street-canyon geometry, W_R represents the roof/ceiling area per unit along-canyon length and $2Z_R$ represents the total indoor wall area of the two canyon walls per unit along-canyon length. The factor 2 accounts for the two walls in the canyon cross-section.

$$Q_R = W_R Q_{Rr} + 2 Z_R Q_{Rw} \tag{15}$$

Here Q_R is the area-integrated radiative heat transfer (W), whereas Q_{Rr} and Q_{Rw} are surface heat-flux densities (W m^{-2}). These surface flux densities are defined as follows:"

- L185: which value is assumed for the thermal conductivity of air here? Is this a fixed value for laminar conditions?

Thank you for this question. The thermal conductivity of air, λ_a, is not assigned a fixed value. It is evaluated as a temperature-dependent function at the film temperature, defined as the mean of the relevant innermost surface temperature and the representative indoor temperature. For reference, $\lambda_a$is approximately $0.02570 \text{ W m}^{-1} \text{ K}^{-1}$at a film temperature of 20 °C.

The product $GrPr$in Eq. (12) is the Rayleigh number. Equation (12) already includes separate natural-convection correlations for the lower- and higher-Rayleigh-number ranges, with the transition at $GrPr = 10^9$. Therefore, the calculation is not restricted to the lower-Rayleigh-number branch, and no separate fixed "laminar" value of $\lambda_a$is used. We retained the existing forms of Eqs. (12)–(14), standardised the notation for the kinematic viscosity of air as ν_a, corrected "dynamic viscosity" to "kinematic viscosity", and added the above clarification after Eq. (14).

Revised manuscript, immediately following Eq. (14):

"

$$h_C = \begin{cases} 0.56 \dfrac{\lambda_a}{d_Z} (Gr\,Pr)^{0.25}, & Gr\,\mathrm{Pr} < 10^9, \\ 0.13 \dfrac{\lambda_a}{d_Z} (Gr\,Pr)^{0.33}, & Gr\,\mathrm{Pr} \geq 10^9 \end{cases} \tag{12}$$

$$Gr = \frac{2 {d_z}^3 g |T_s - T_{in}|}{{\nu_a}^2 (T_s + T_{in})} \tag{13}$$

$$Pr = \frac{\nu_a \rho_a C_p}{\lambda_a} \quad (14)$$

where $\lambda_a$is the thermal conductivity of air (W $\mathrm{m^{-1}\ K^{-1}}$); $d_z$is the representative length scale for indoor natural convection, taken as the representative floor height in the present implementation ($d_z = h_f = 3.0$ m); $Gr$is the Grashof number; $Pr$is the Prandtl number; $\nu_a$is the kinematic viscosity of air ($\mathrm{m^2\ s^{-1}}$); ρ_a and C_p are the air density and specific heat capacity, respectively; and $g$is gravitational acceleration. The product $GrPr$is the Rayleigh number. The air properties used in Eqs. (12)–(14), including $\lambda_a$and ν_a, are evaluated as temperature-dependent functions at the film temperature, defined as the mean of the relevant innermost surface temperature and T_{in}. At a film temperature of 20 °C, $\lambda_a \approx 0.02570\ \mathrm{W\,m^{-1}\,K^{-1}}$. Thus, $\lambda_a$is not prescribed as a fixed value. The two branches in Eq. (12) represent the lower- and higher-Rayleigh-number natural-convection regimes, so the calculation is not restricted to the lower-Rayleigh-number branch."

- L240 (and other instances in the manuscript): the names of the urban land cover classes (C, Rm, Rd) are not understandable.

We agree. The three categories are now introduced with their full meanings: low-density residential areas with detached dwellings (Rd), high-density residential areas with multi-unit dwellings (Rm), and business/commercial areas (BC). We use the full names at first occurrence and in the figure/table captions, and retain the short labels only after definition.

Revised manuscript, lines 305–308:

> "The urban grids were classified by dominant building use into low-density residential areas with detached dwellings (Rd), high-density residential areas with multi-unit dwellings (Rm), and business/commercial areas (BC), following Takane et al. (2022, 2024) and Nakajima et al. (2021, 2023) (Fig. 2a). These full names are used at first occurrence and in figure/table captions."

- L247-250: is it necessary to include these lengthy details on technical model options?

We agree. The detailed option list has been removed from the main formulation. The main text now directs users to Supplementary Text S1 and Supplementary Tables S1, S2, and S3 for controls, mappings, and parameter values.

Revised manuscript, lines 281–284:

> "The user-facing control and input settings for SLUCM+BEM v2.0 are documented in Supplementary Text S1 and Supplementary Table S1. The complete parameter values used in the Tokyo and London experiments are given in Supplementary Table S3, and the

complete mapping between mathematical symbols and implementation names is given in Supplementary Table S2."

- Figure 2: It is not necessary to use the numbers (31, ...) for the urban types. Please only use one meaningful name in the text and in the plot legend. In (b), the height label is colliding with the text.

We agree. The caption and manuscript terminology have been revised to use Rd, Rm, and BC with their full meanings and to omit the numerical WRF codes. Before submission, the Fig. 2 artwork has been updated to replace 31/32/33 in the legend with Rd/Rm/BC and to reposition the terrain-height colour bar/title so that it does not overlap the map text.

Revised manuscript, Fig. 2:

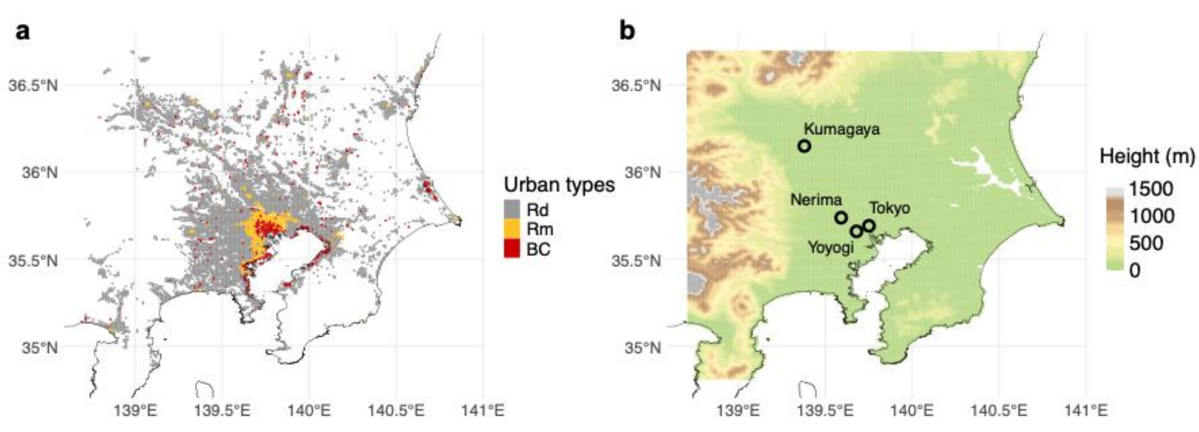

Figure 2: Study area of the online simulation. (a) Distribution of the three dominant building-use categories: low-density residential areas with detached dwellings (Rd; grey), high-density residential areas with multi-unit dwellings (Rm; yellow), and business/commercial areas (BC; red) in the Tokyo metropolitan area (TMA). (b) Terrain height within the study area. Open circles indicate the Tokyo, Nerima, Kumagaya, and Yoyogi evaluation sites.

- Figure 3: Why is there this double legend? This needs to be explained.

Thank you for pointing this out. The two blocks at the right of Fig. 3 are not duplicate legends; together they form a single LCZ legend arranged in two columns to accommodate all LCZ classes shown in the map. Each class is listed only once. We agree that this two-column arrangement was not sufficiently clear and have clarified it in the figure caption.

Revised manuscript, Fig. 3 caption:

"Figure 3: Study area of the offline simulation and local climate zone (LCZ) distribution in Greater London. The LCZ key at the right is a single legend arranged in two columns; the two columns together cover all LCZ classes shown in the map. White and black outlines indicate Greater London and Southwark, respectively."

- Section 2.3 -> metrics

We agree and changed the heading to "2.3 Evaluation metrics".

Revised manuscript, line 359:

"2.3 Evaluation metrics"

- L317: "it then decreased daily" -> is "daily" needed?

No. We deleted "daily".

Revised manuscript, lines 375–376:

"From 25 to 31 August, it then decreased to around 22 °C."

- Figure 5: The panels could be reorganised to make them larger, but still using only one page.

We agree. The figure has been reorganised into two rows and four columns on one page. The top row shows the full TMA, the bottom row shows central Tokyo, and the columns show observations, SLUCM+BEM v2.0, SLUCM+BEM v1.0, and CM-BEM. This removes unused vertical space and allows each map to be enlarged. The revised caption already reflects this panel order. The same treatment has been applied to Fig. 7.

Revised manuscript, Fig. 5 and 7:

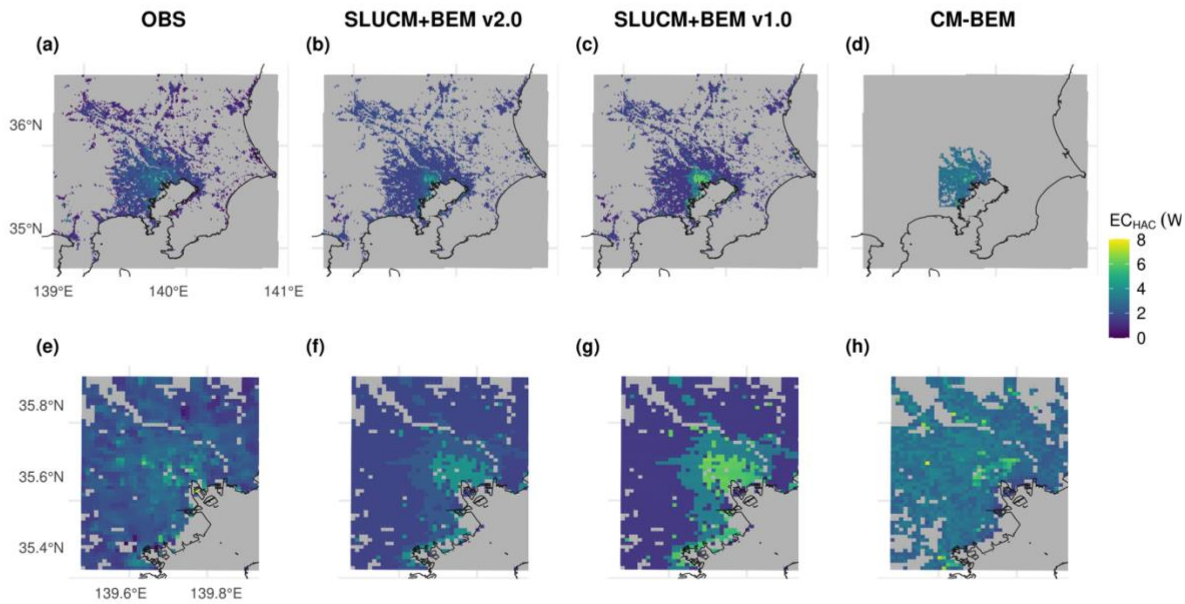

Figure 5: Weekday-mean summer electricity consumption for heating and air conditioning (ECHAC). The top row shows the Tokyo metropolitan area (TMA), and the bottom row shows central Tokyo. The columns show (a, e) observations, (b, f) SLUCM+BEM v2.0, (c, g) SLUCM+BEM v1.0, and (d, h) CM-BEM.

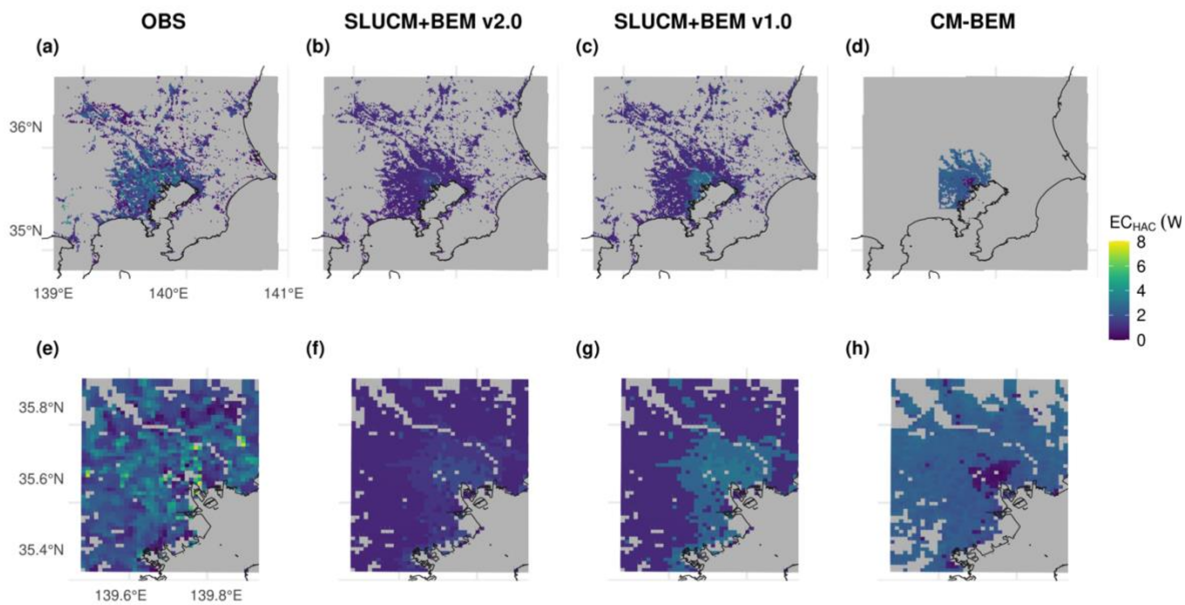

Figure 7: As in Fig. 5, but for winter.

- Figure 6: is it really "type of urban building" or better "type of urban land cover"? The legend also exceeds the plot.

We agree. We replaced “type of urban building” with “urban land-use category”. The Fig. 6 legend has been reduced and repositioned within or directly below the plotting area so that it no longer extends beyond the axes; the same treatment has also been applied to Fig. 8.

Revised manuscript, Fig. 6 and 8:

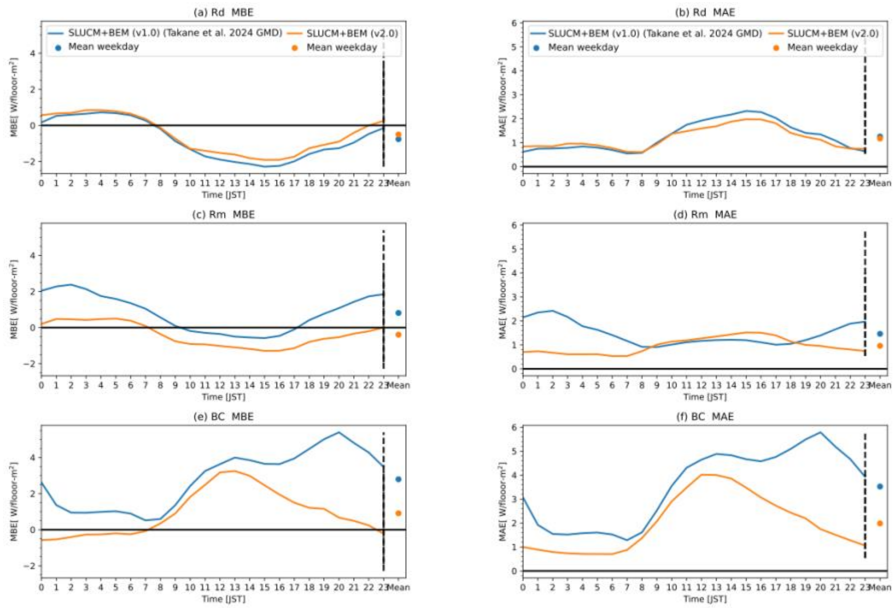

Figure 6: Diurnal changes in the MBE (left) and MAE (right) of EC_{HAC} for each urban land-use category ((a, b) Rd, (c, d) Rm and (e, f) BC), and the average of all grids from SLUCM+BEM v1.0 (blue line and circle) and v2.0 (orange line and circle) averaged over the summer season's weekdays.

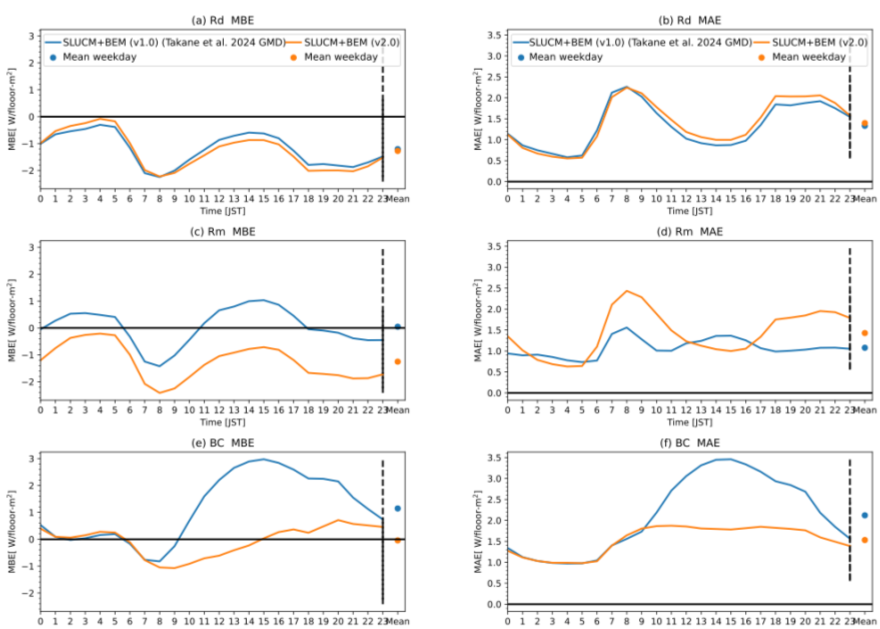

Figure 8: As in Fig. 6, but for winter.

- Figure 9: it is not necessary to repeat details like colours (given in the legend) in the plot caption.

We agree and removed the colour descriptions from the caption.

Revised manuscript, Fig. 9 caption:

> "Figure 9: Scatterplots of 2 m temperature and EC by HAC use (ECHAC) in Tokyo (BC), Kumagaya (Rm), and Nerima (Rd) at 14:00 LT in summer and winter, for SLUCM+BEM v1.0, SLUCM+BEM v2.0, and observations. Each panel shows daily values and a single linear regression. Plots with temperatures > 20°C represent the results for summer; those with temperatures < 20°C represent the results for winter."

- Table 4: is "verification" here the right word or should it be "evaluation metrics" or similar.

We agree and replaced "Verification" with "Evaluation statistics".

Revised manuscript, Table 3 caption:

> "Table 3: Evaluation statistics for the 2 m temperature simulated by the SLUCM and SLUCM+BEM models (v1.0 and v2.0) for the cooling and heating seasons (summer and winter) in Tokyo (BC), Kumagaya (Rm), and Nerima (Rd)."

- Figures 10 and 11: heat_load -> heat load

Corrected. The y-axis label is "Heat load", without an underscore.

Revised manuscript, Figure 10 and 11:

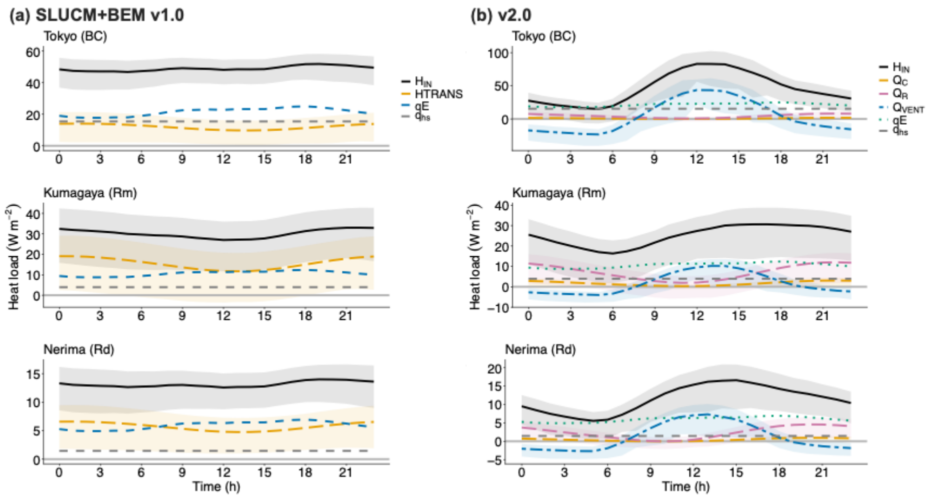

Figure 10: Diurnal changes in each component of indoor heat load H_{in} (Eqs. 2 and 21) in Tokyo (BC), Kumagaya (Rm), and Nerima (Rd; Fig. 2b) simulated by SLUCM+BEM (a) v1.0 and (b) v2.0 averaged seasonally over summer. Lines and ribbons indicate the simulated mean and 5th and 95th percentiles.

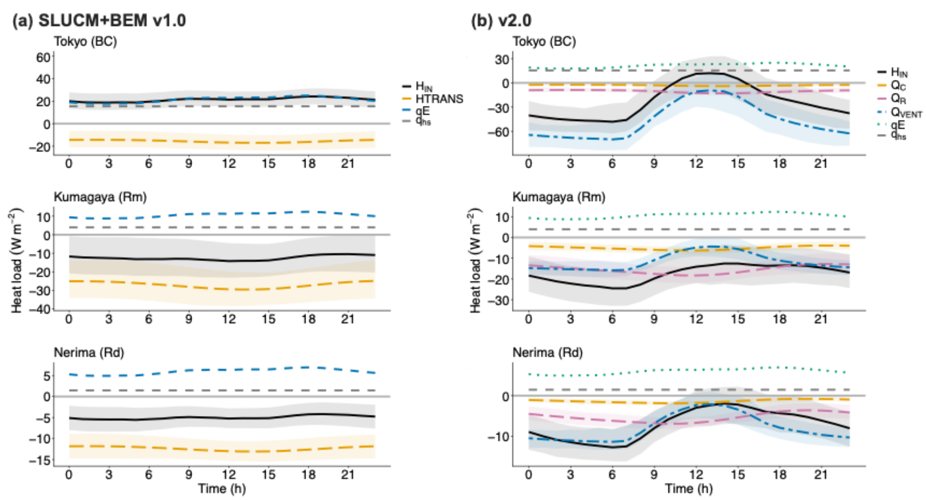

Figure 11: As described for Fig. 10, but showing results for winter.

- L469: the section 4.3 title needs to be reformulated.

We agree and changed the title to identify the WRF implementation, compatible configurations, and input data directly.

Revised manuscript, line 541:

"4.3 WRF implementation, compatible configurations, and input data"

- L553: The beginning of the summary might contain a short summary of the main developments and findings. Instead these are spread out in later parts of the summary.

We agree and made a limited revision to the opening of the Summary. The first paragraph now briefly identifies the two main developments and the principal London indoor-temperature, Tokyo EC, and outdoor-temperature findings. The subsequent paragraphs retain their existing order and provide the detailed results. To avoid repetition, the separate transition sentence beginning "To address these issues …" was deleted.

Revised manuscript, lines 635–638:

> "We have developed and released SLUCM+BEM v2.0, which introduces a prognostic representative indoor temperature and a prescribed indoor–outdoor air-exchange term while retaining the low computational cost of SLUCM. The principal evaluations show that v2.0 reproduces free-running indoor temperatures in London, reduces the overestimation of HAC-related EC in Tokyo office districts, and maintains outdoor-temperature accuracy comparable to v1.0."

We again thank the Referee for the careful and constructive assessment. We believe these revisions clarify the physical scope and limitations of SLUCM+BEM v2.0, improve nomenclature and reproducibility, broaden the comparison beyond WRF, and substantially improve the manuscript and Supplement.