Multiscale urban modelling and WUDAPT

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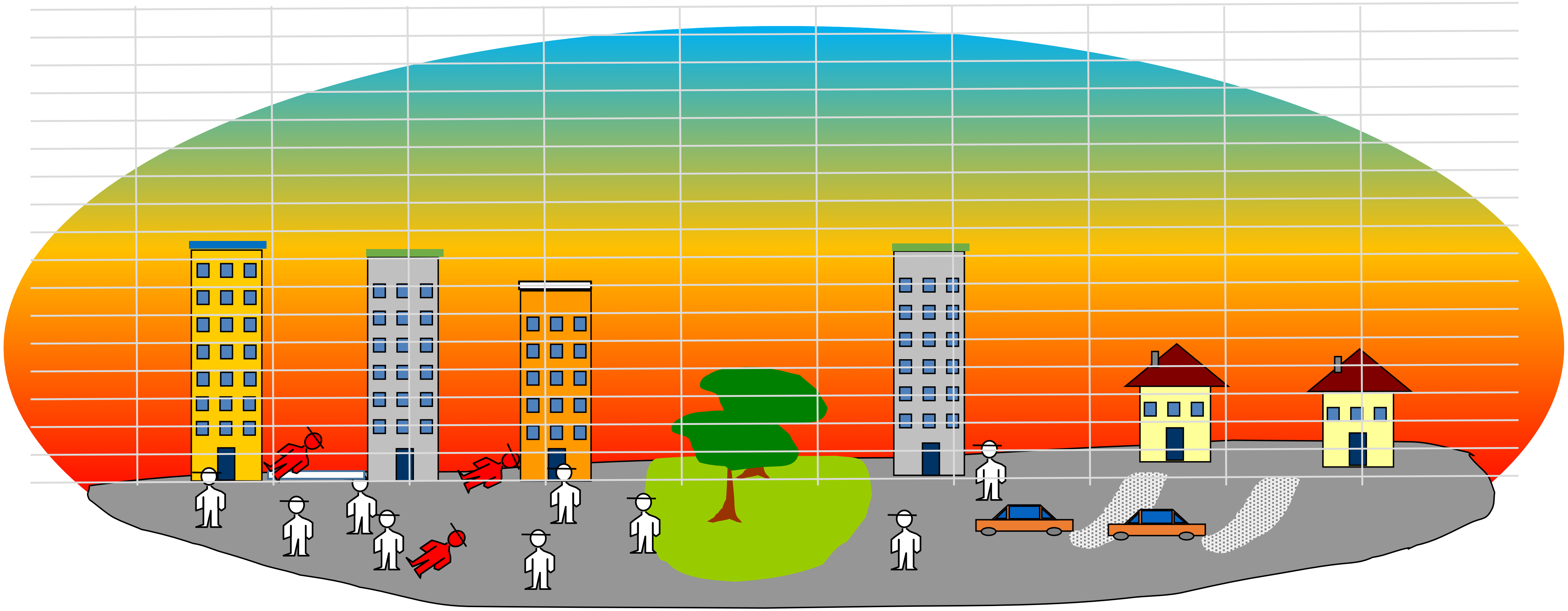
Spain



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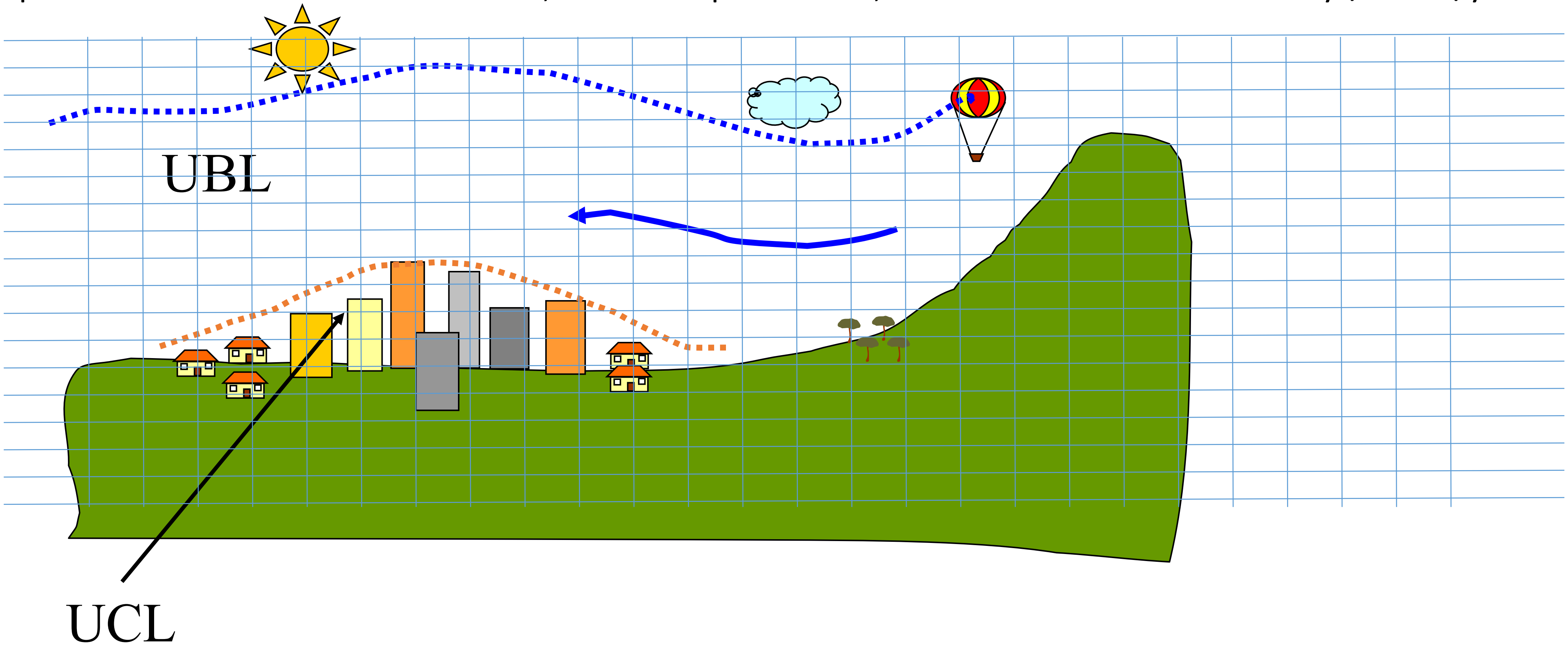
Traditionally ***mesoscale models*** have been the most common tool used to investigate urban climate

Spatial resolution of the order of 1km, domains up to 100km, simulation times of several days/weeks/years



At this resolution city cannot be resolved explicitly and its effect must be parametrized with so called ***Urban Canopy (UC) schemes*** embedded in mesoscale models.

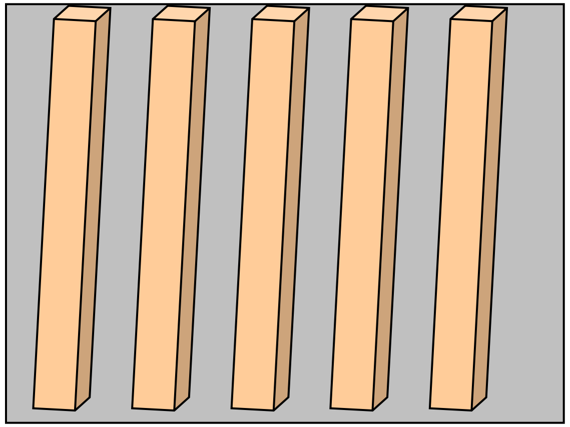
First, basic step of any UC scheme is the simplifcation of the urban surfaces

real

(?)

equivalent

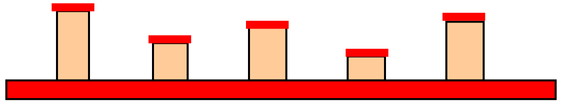
idealized



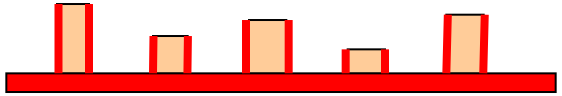
Advantage: every building behaves in the same way and also every street behaves in the same way. By computing the fluxes for one building and for one street, the fluxes for the whole grid cell can be easily estimated.

Thanks to the idealization of urban surfaces, cities are represented by few morphological parameters, namely:

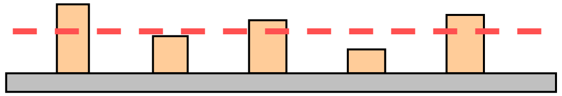
Plan area building density



Vertical area building density



Mean (and in some cases distribution) of building heights.



Where to get the morphological data?

NATIONAL URBAN DATABASE AND ACCESS PORTAL TOOL

BY JASON CHING, MICHAEL BROWN, STEVEN BURIAN, FEI CHEN, RON CIONCO, ADEL HANNA, TORRIN HULTGREN, TIMOTHY MCPHERSON, DAVID SAILOR, HAIDER TAHA, AND DAVID WILLIAMS

WUDAPT

An Urban Weather, Climate, and Environmental Modeling Infrastructure for the Anthropocene

J. CHING, G. MILLS, B. BECHTEL, L. SEE, J. FEDDEMA, X. WANG, C. REN, O. BROUSSE, A. MARTILLI, M. NEOPHYTOU, P. MOUZOURIDES, I. STEWART, A. HANNA, E. NG, M. FOLEY, P. ALEXANDER, D. ALIAGA, D. NIYOGI, A. SHREEVASTAVA, P. BHALACHANDRAN, V. MASSON, J. HIDALGO, J. FUNG, M. ANDRADE, A. BAKLANOV, W. DAI, G. MILCINSKI, M. DEMUZERE, N. BRUNSELL, M. PESARESI, S. MIAO, Q. MU, F. CHEN, AND N. THEEUWES

O. Brousse et al. / Urban Climate 17 (2016) 116–134

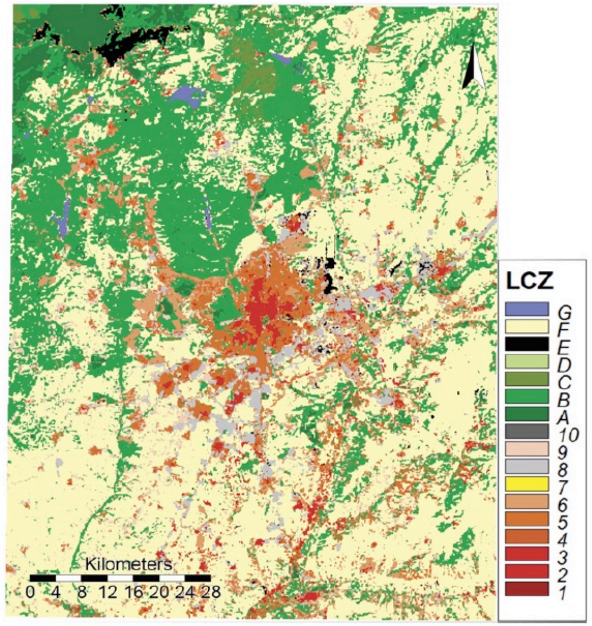
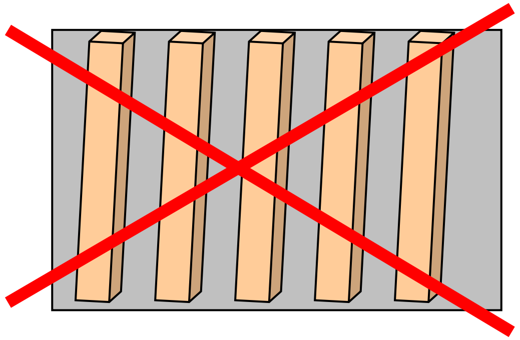


Fig. 1. Map of LCZs over Madrid using a Random Forest Classification.

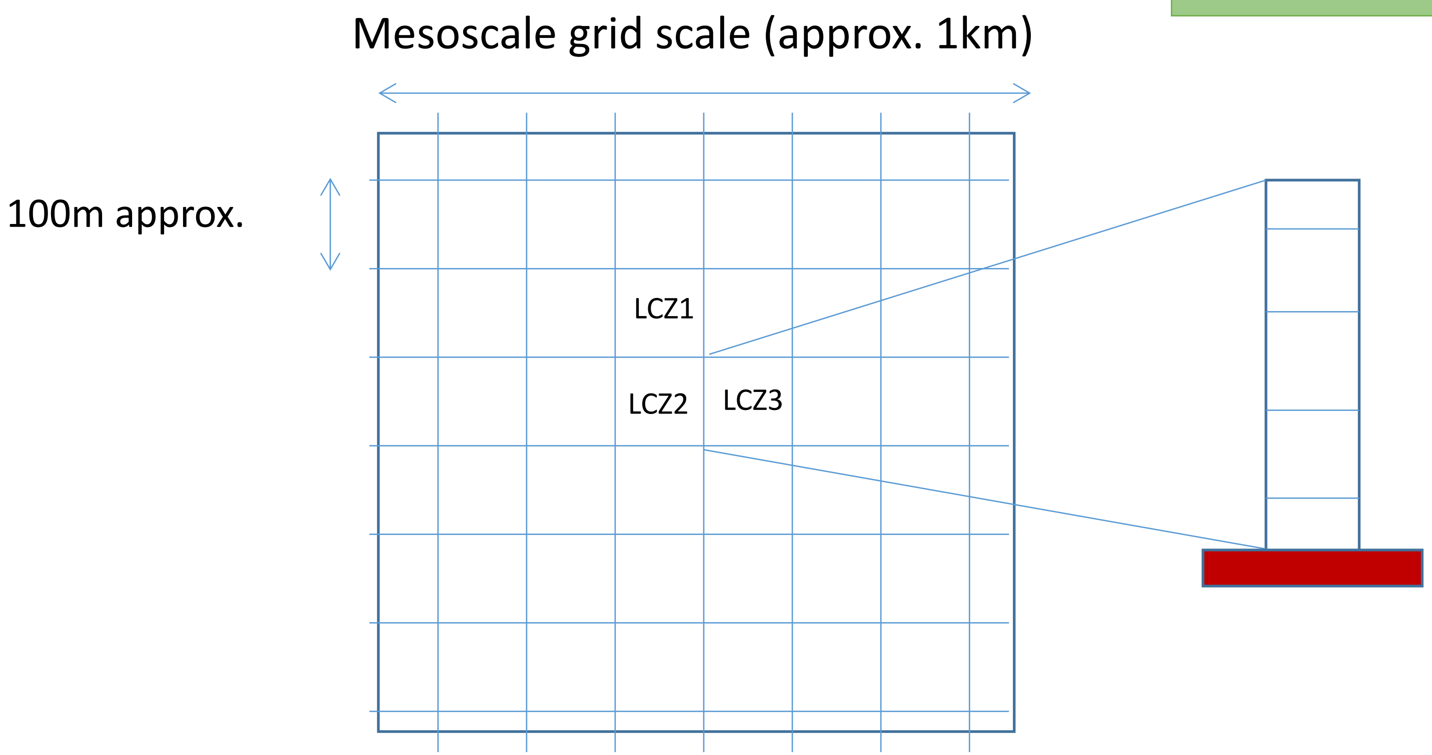
Today, the simplification of the urban surfaces is the main obstacle to progress.
With current computational power, ***<u>we can retain more details of the urban morphology and so better resolve smaller scales</u>***.



Several approaches are possible.

Simplest

Mosaic approach, and increase vertical resolution just for turbulent vertical transport.



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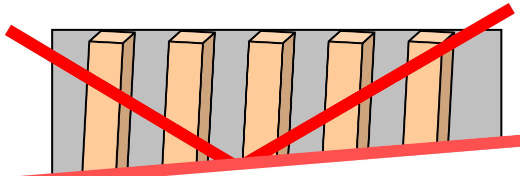
With current computational



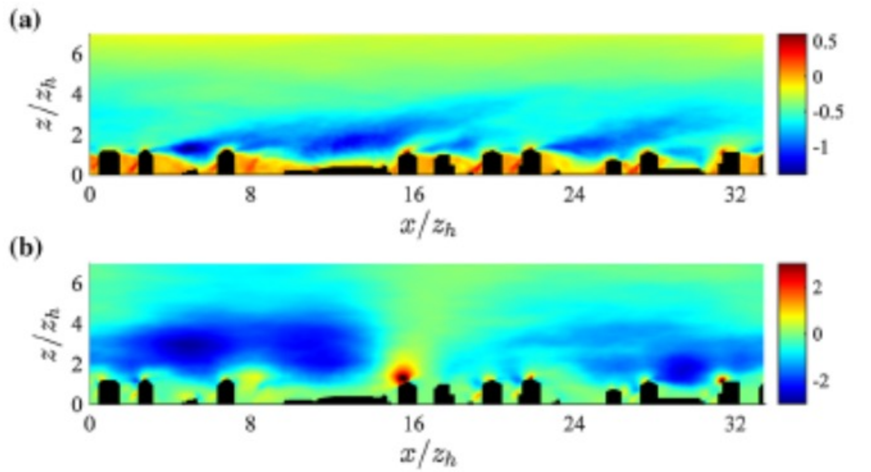
Change also from idealized 2D to 3D to better represent some US residential areas?

approach, and increase

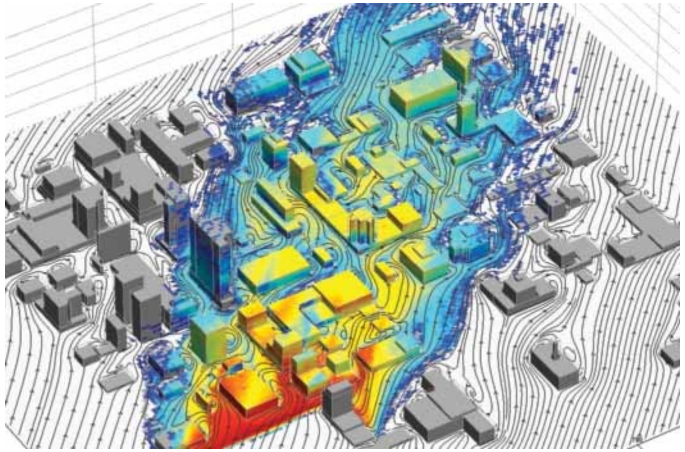
rt.

Intermediate

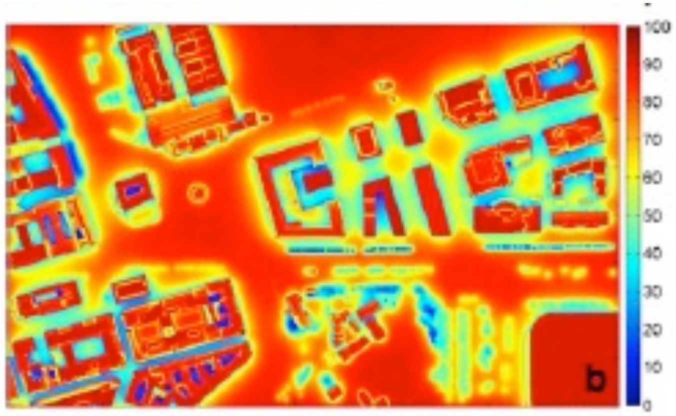
Integrate fast, and highly parameterized microscale models with radiation models in mesoscale.



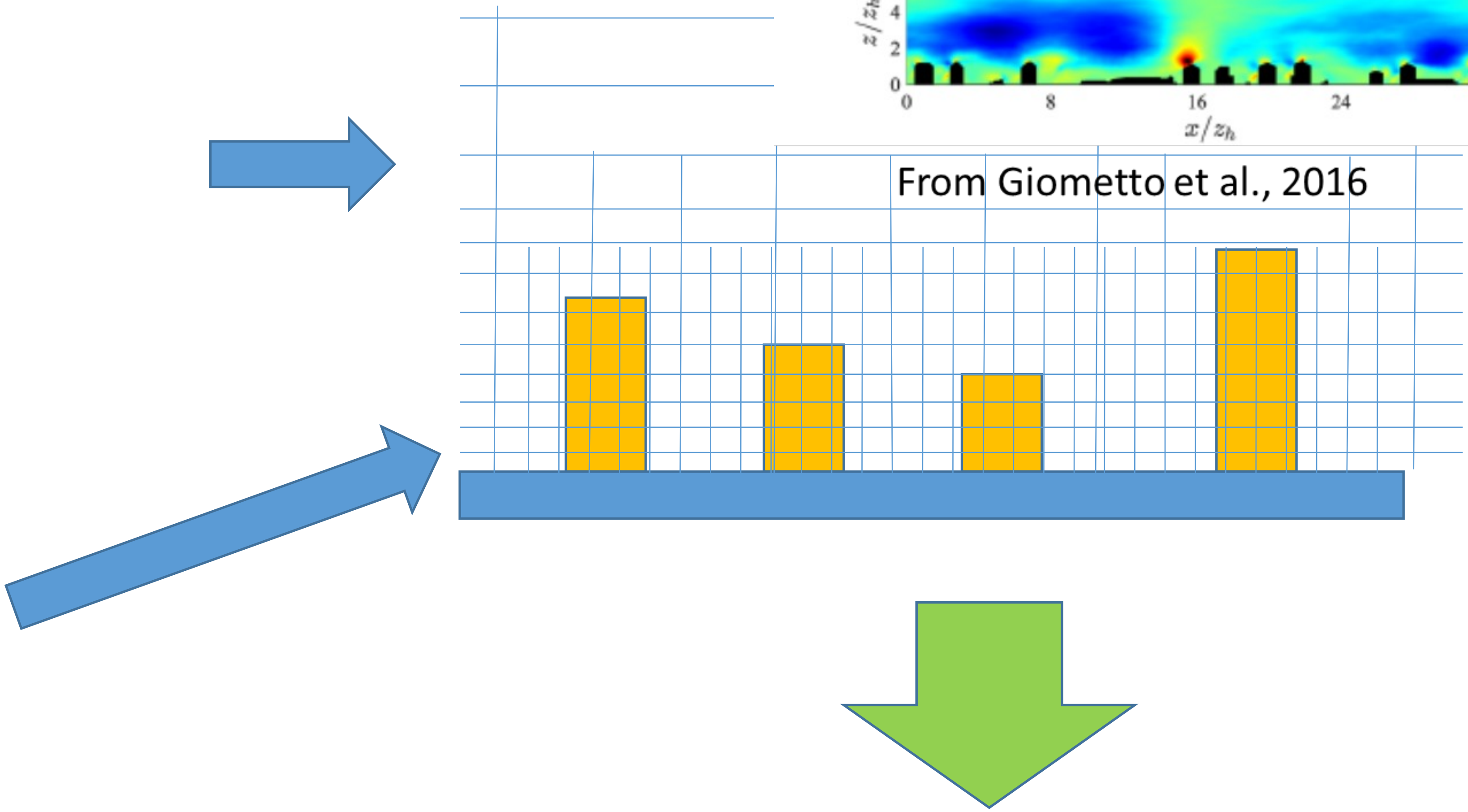
From Giometto et al., 2016



QUICUrb, M. J Brown



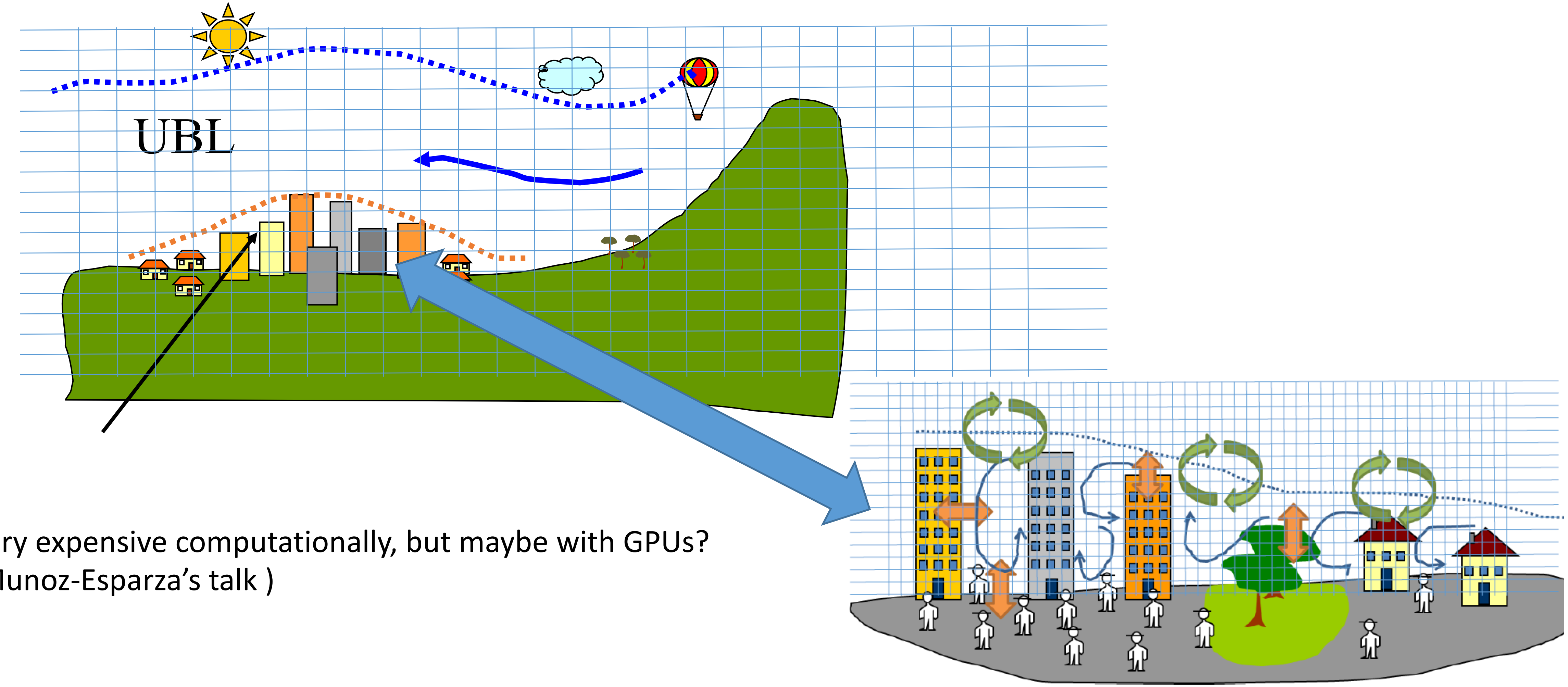
SOLWEIG, F. Linbdberg



Better representation of urban structure, better characterization of measures

Complex

Fully couple microscale CFD with Mesoscale model



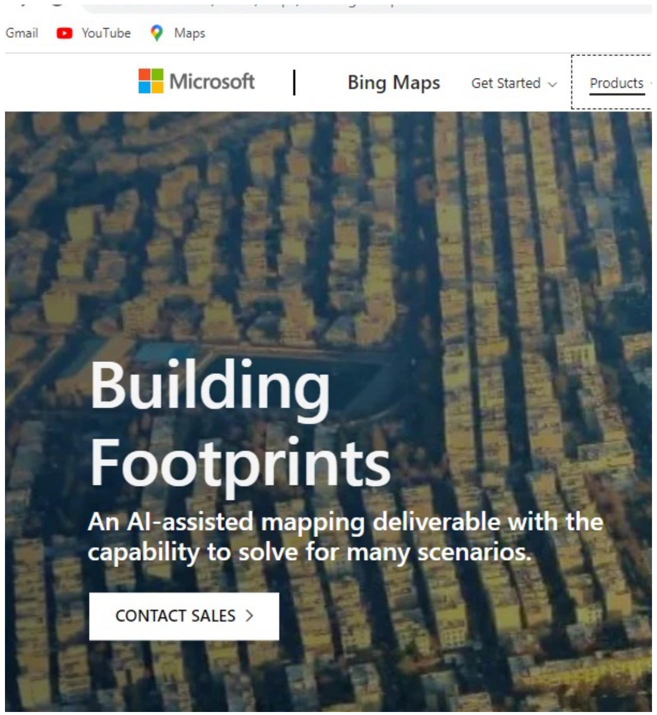
Very expensive computationally, but maybe with GPUs?
(Munoz-Esparza's talk)

Which data are needed?

LCZs probably not enough. More details on urban morphology are needed.

Possible sources, beyond city specific datasets

More global data available at high resolution



Globus effort (UT group)

Detailed morphology from Dan Aliaga, Purdue (?).

Continental to global scales

Diurnal interaction between urban expansion, climate change and adaptation in US cities

E. Scott Krayenhoff[1,2,3]*, Mohamed Moustaoui[1,4,5], Ashley M. Broadbent[1,2], Vishesh Gupta[1,2] and Matei Georgescu[1,2,4,5]*

ARTICLES NATURE CLIMATE CHANGE

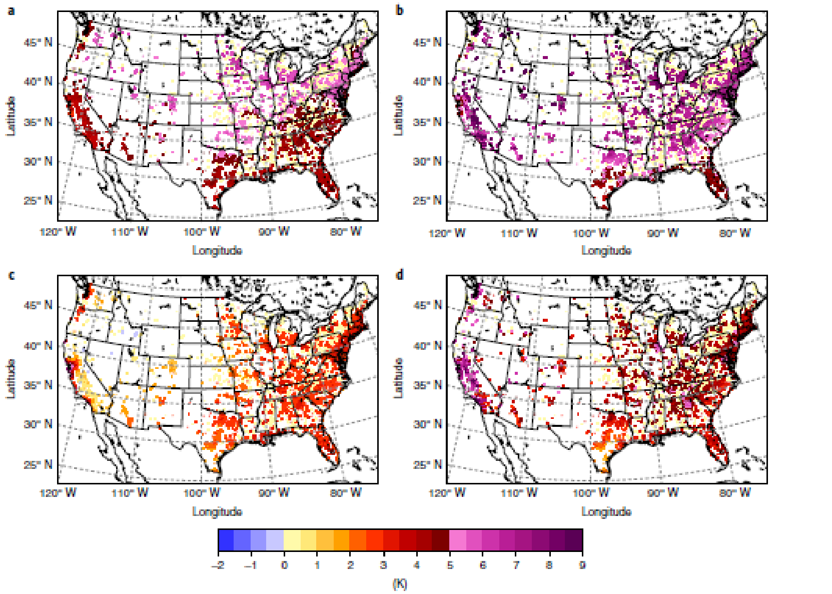


Fig. 1 | Summertime urban air temperature change resulting from the dynamically interactive combination of 90 years of projected urban expansion and climate change (2090–2099 compared with 2000–2009). The sum of the effects of climate change, urban expansion and their interaction is shown. The climate models that are dynamically downscaled and the associated scenarios are CESM RCP 8.5 (**a** and **b**) and GFDL RCP 8.5 (**c** and **d**) at 15:00 LMST (**a** and **c**) and 03:00 LMST (**b** and **d**). Each point represents a decadal mean June-July-August (JJA) subgrid near-surface urban temperature change within a 20 km × 20 km model grid square. Land areas displayed in white do not have projected A2 2100 urban expansion.

An Urban Parameterization for a Global Climate Model. Part I: Formulation and Evaluation for Two Cities

K. W. Oleson and G. B. Bonan
Climate and Global Dynamics Division, National Center for Atmospheric Research, Boulder, Colorado*

J. Feddema
Department of Geography, University of Kansas, Lawrence, Kansas

M. Vertenstein
Climate and Global Dynamics Division, National Center for Atmospheric Research, Boulder, Colorado*

C. S. B. Grimmond
Department of Geography, King's College, London, United Kingdom

Effects of white roofs on urban temperature in a global climate model

K. W. Oleson,[1] G. B. Bonan,[1] and J. Feddema[2]

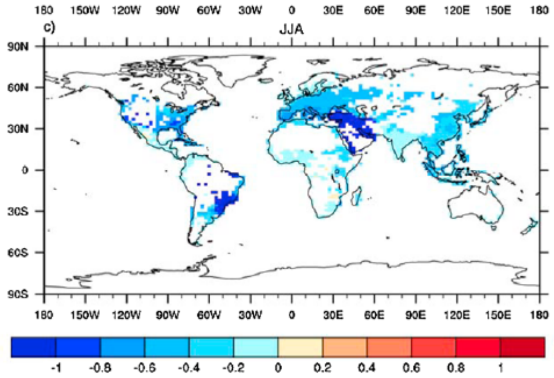
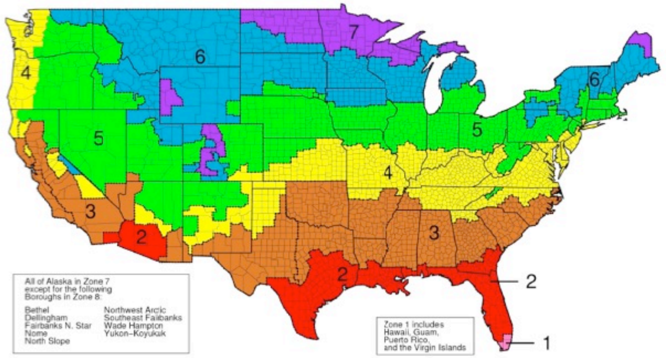


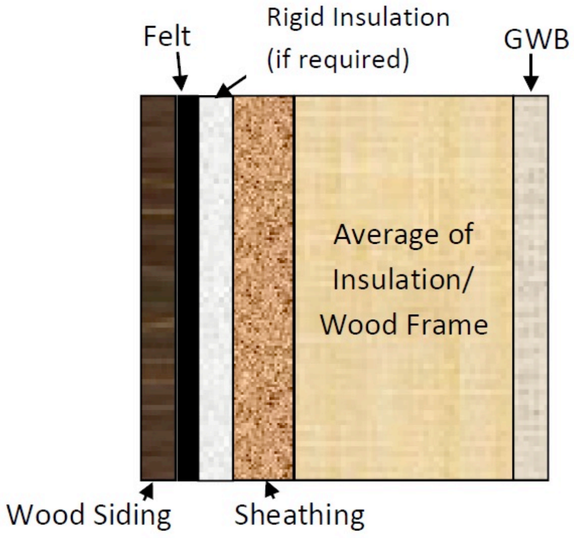
Figure 1. ALB minus CON simulations of urban minus rural air temperature for 1980–1999 climatology (°C) (a) annual (ANN), (b) December–February (DJF), (c) June–August (JJA). The urban temperature is the air temperature in the urban canopy layer. The rural temperature is the average 2-m air temperature of the "rural" surfaces (i.e., the vegetated and bare soil surfaces) in the grid cell. Land areas displayed in white are grid cells that have zero urban area in the model.

At this scale and resolution, LCZ are probably enough

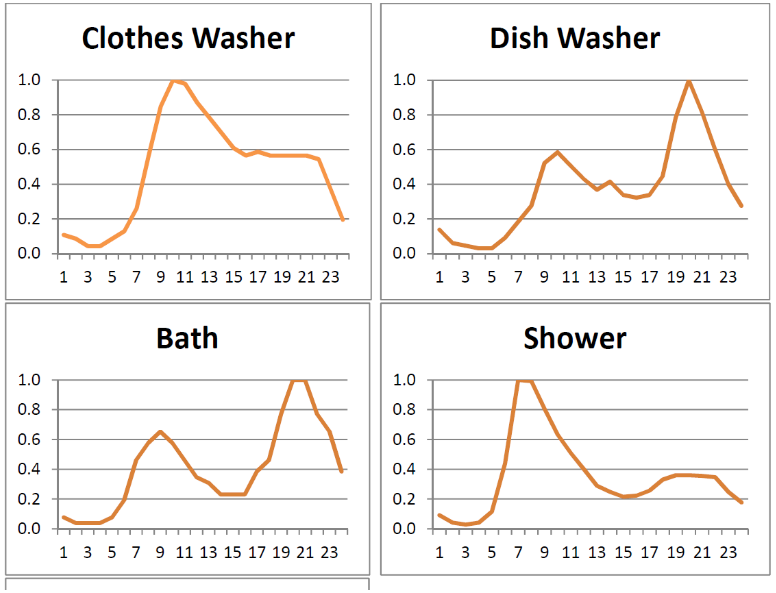
Integrate information from Building Energy/Indoor studies.

Thermal and optical properties of buildings





Heat generation inside the buildings from Building energy use



Many data exists and are freely available, for example from *EnergyPlus.* They need to be “translated” to units and framework needed in Urban Canopy Paramerizations.

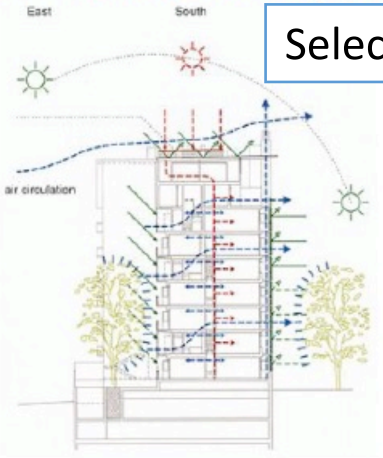
Strategies
How to characterize them from the point of view of models?

Green buildings

Street trees

Roof top solar panels

High performance materials, passive cooling, etc.



Selective emitters

Cool pavements

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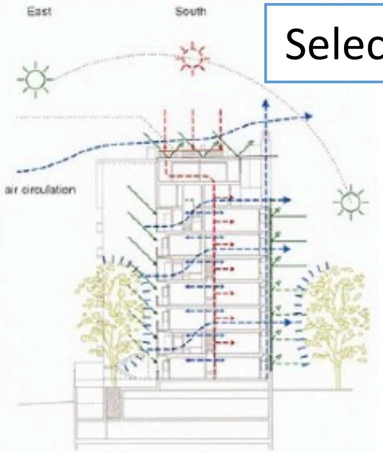

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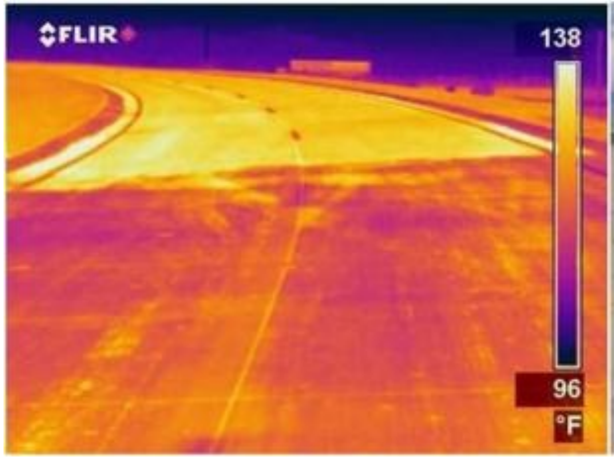
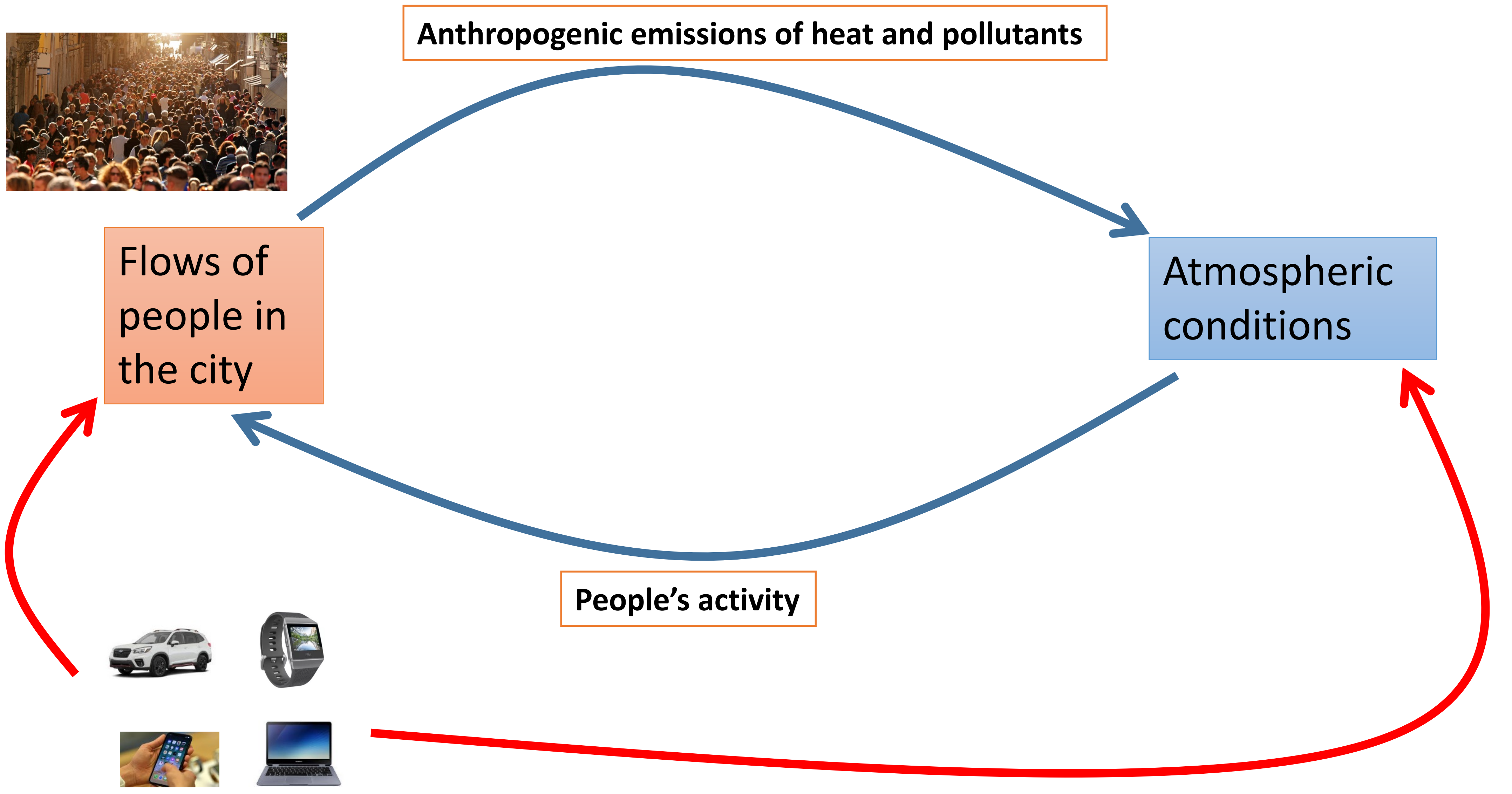
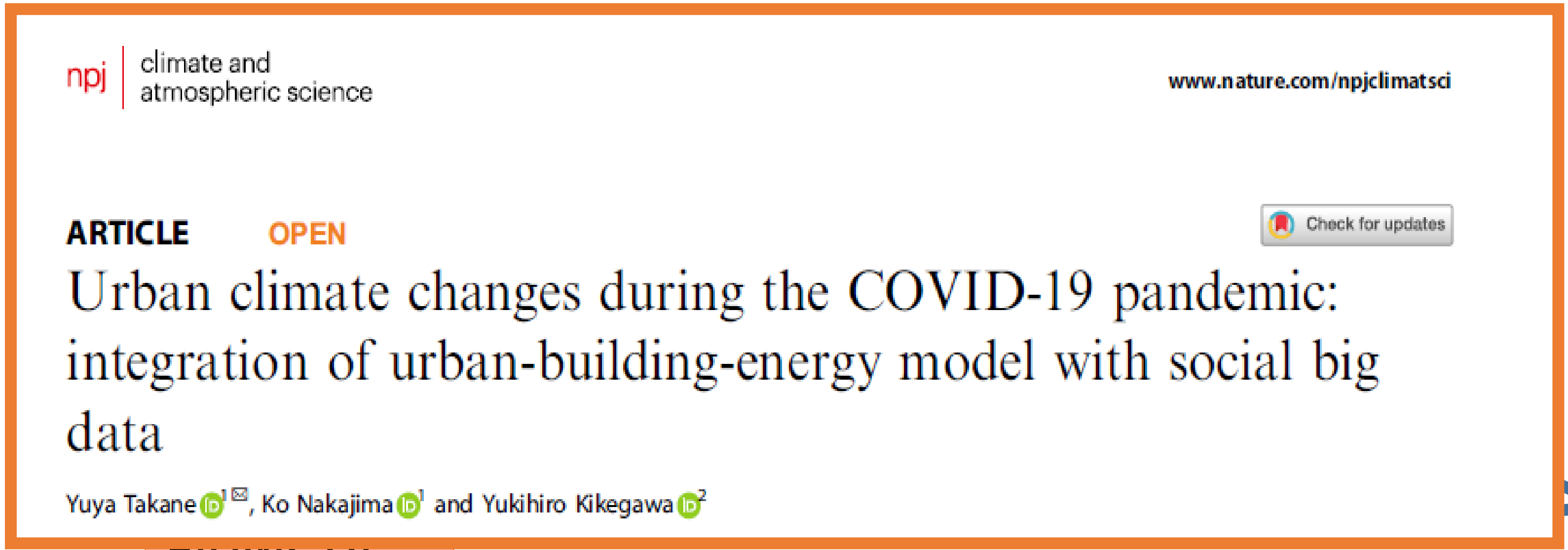


Links to models that can represent people movements and activities. Coupling with Agent-Based models (?).



New devices that can be used to monitor people movements and environmental variables activities. Coupling with Agent-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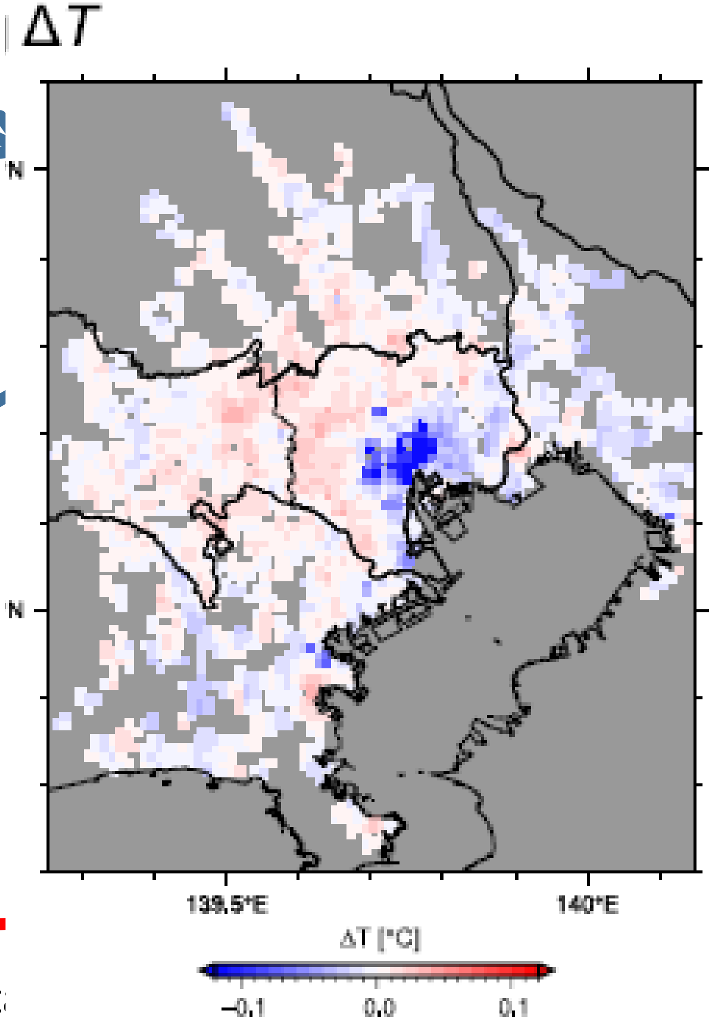
Check for updates

Urban climate changes during the COVID-19 pandemic: integration of urban-building-energy model with social big data

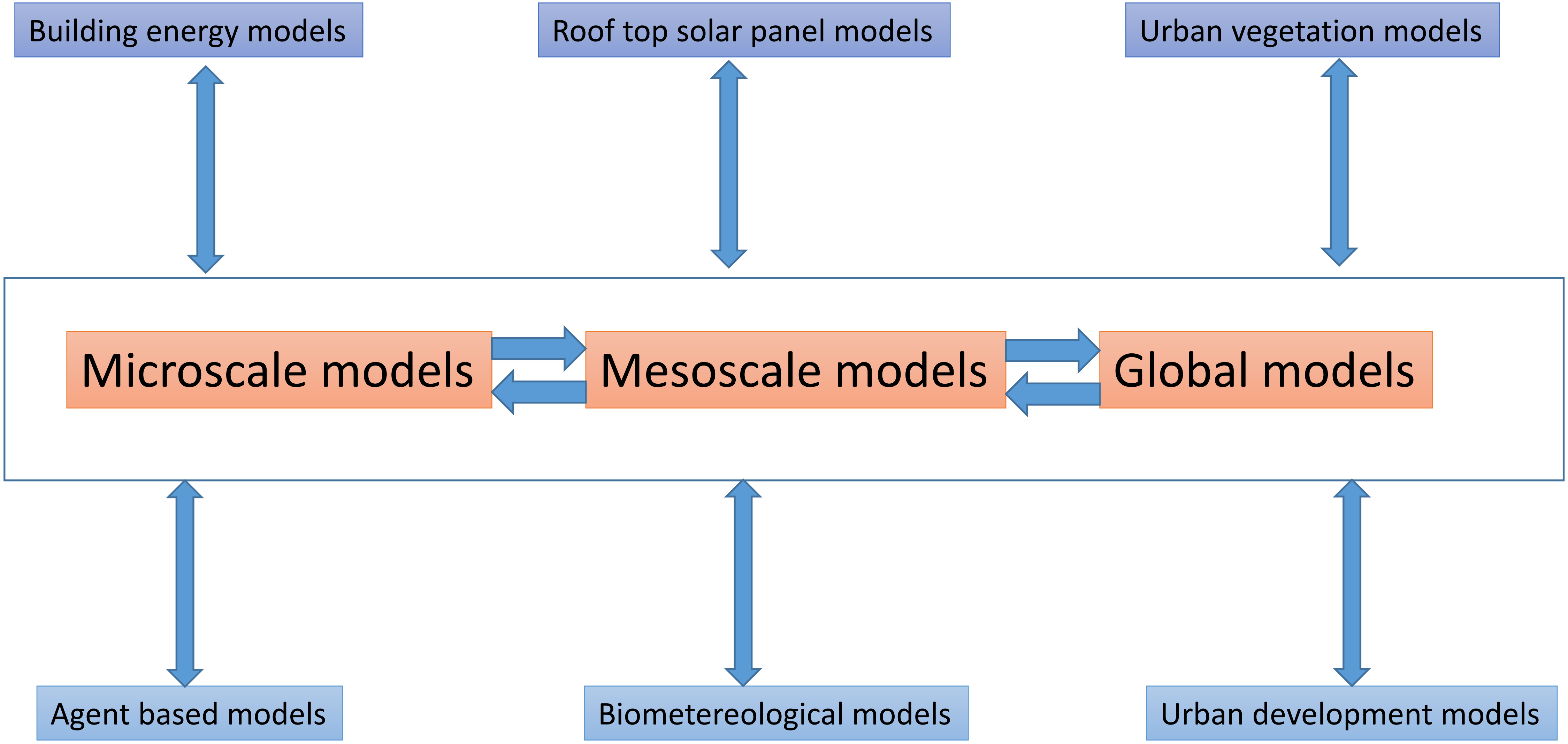
Yuya Takane[1]✉, Ko Nakajima[1] and Yukihiro Kikegawa[2]

Flows of people in the city

People's activity



New devices that can be used to monitor people movements and environment


Building energy models
Roof top solar panel models
Urban vegetation models
Microscale models
Mesoscale models
Global models
Agent based models
Biometereological models
Urban development models

Thank you