An urban surface scheme and derivation of its parameters

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The **multi-layer building energy parameterization** scheme (BEP) by Martilli et al. (2002) is currently implemented into the mesoscale weather and climate model CCLM to enhance its application to cities. CCLM operates on a latitude longitude grid with a rotated pole of grid sizes of at least 1 km^2. Consequently, BEP needs **effective urban morphology data** for that grid size to parametrize subgrid-scale effects.

1. Street Canyon model of BEP

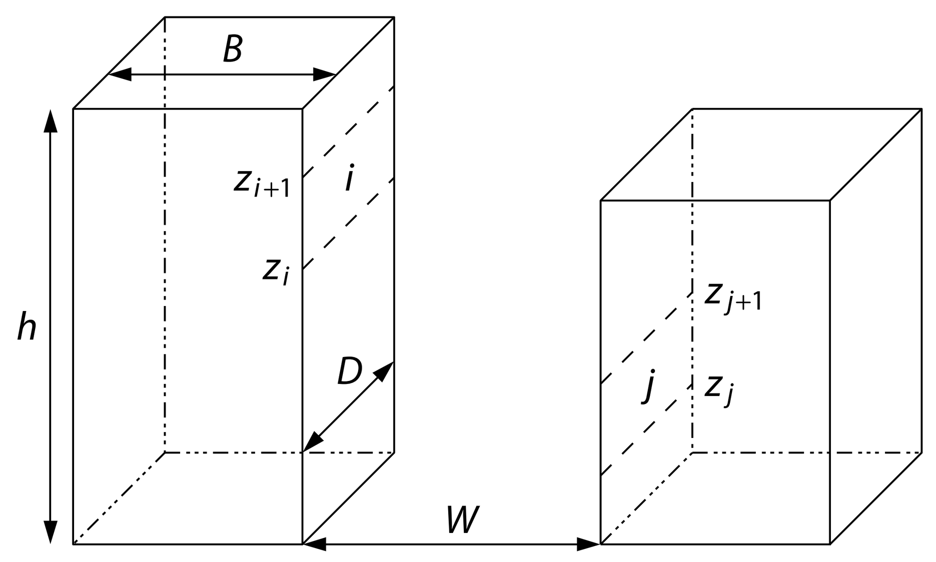

Figure 1: *building width B, street width W, canyon length D, probability $\gamma(h)$ of building height h; also: canyon angle χ relative to north-south direction, urban fraction F of a cell*

2. Derivation of urban parameters

Highly detailed urban building data in the CityGML format is available for Berlin (e.g. fig. 2) and can be used to **derive different urban input parameters for every grid cell**, which is described in the following keynotes:

canyon length *D* is defined by the model run parameters (grid size and street directions considered for the run) set by the user

urban fraction *F* is set to the impervious surface coverage of the cell (fig. 3); the only parameter which cannot be concluded from a building only CityGML data set

fraction cover of buildings A_B is given by the area of the building's ground surfaces (fig. 4)

building height probability $\gamma(h)$ (e.g. fig. 7) is determined by the distribution of building heights weighted by the respective ground area

canyon angle χ of a wall surface is defined by the normal of that surface projected onto the horizontal

street width *W* is calculated from the average distance to other wall surfaces which are visible to each other (fig. 5)

building width *B* (fig. 6) follows directly from the requirement that the total building and street surfaces of the simplified model equal that of the input data

The programme for this purpose is written in Java and uses the citygml4j library.

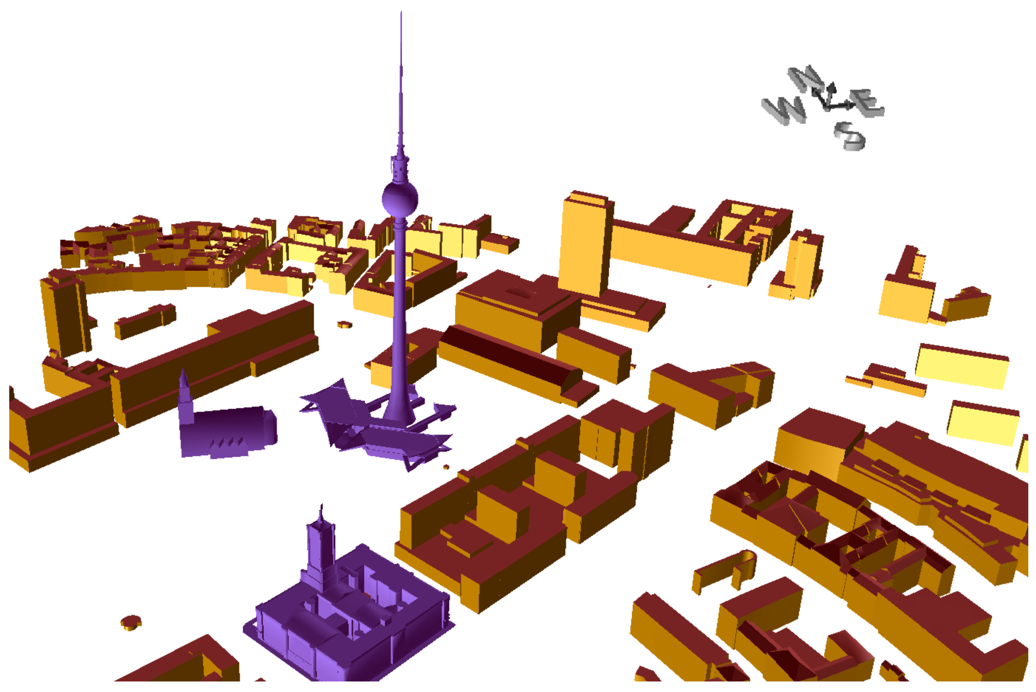

Figure 2: *Rendered example of the 3d data in CityGML LOD2 format used to derive the urban parameters: Berlin Alexanderplatz and the TV tower*

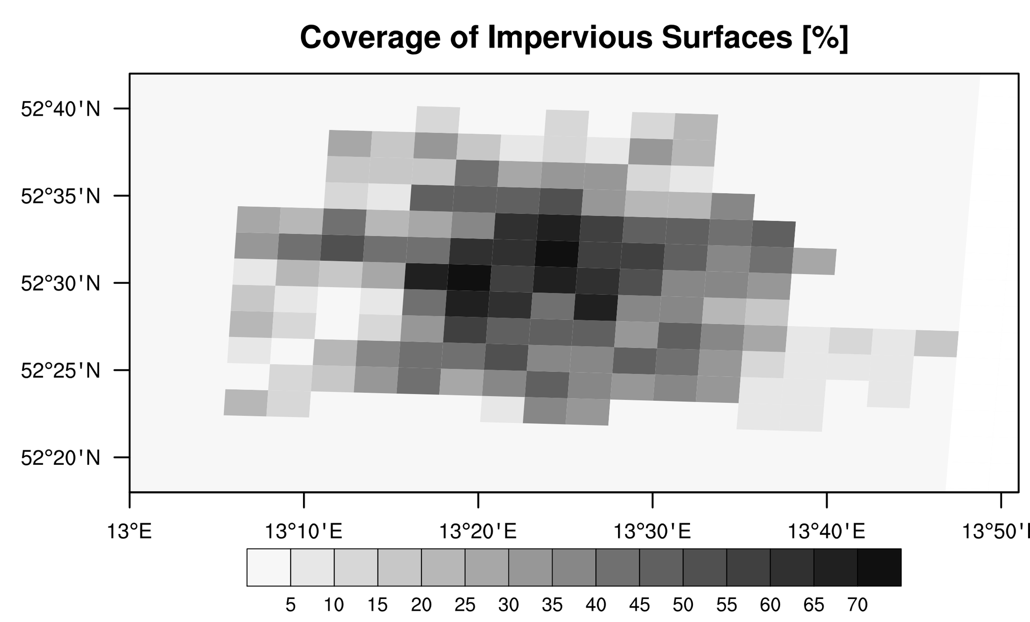

Figure 3: *Impervious surfaces coverage in Berlin. This value is used to define the urban fraction F.*

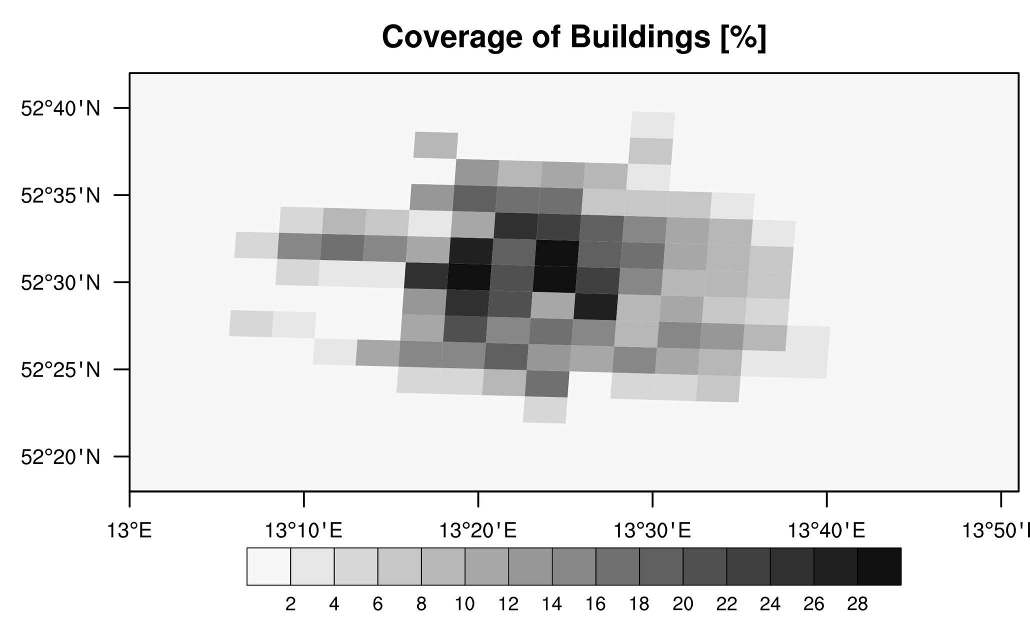

Figure 4: *Fraction of buildings A_B in Berlin defined by the ground surfaces of the buildings.*

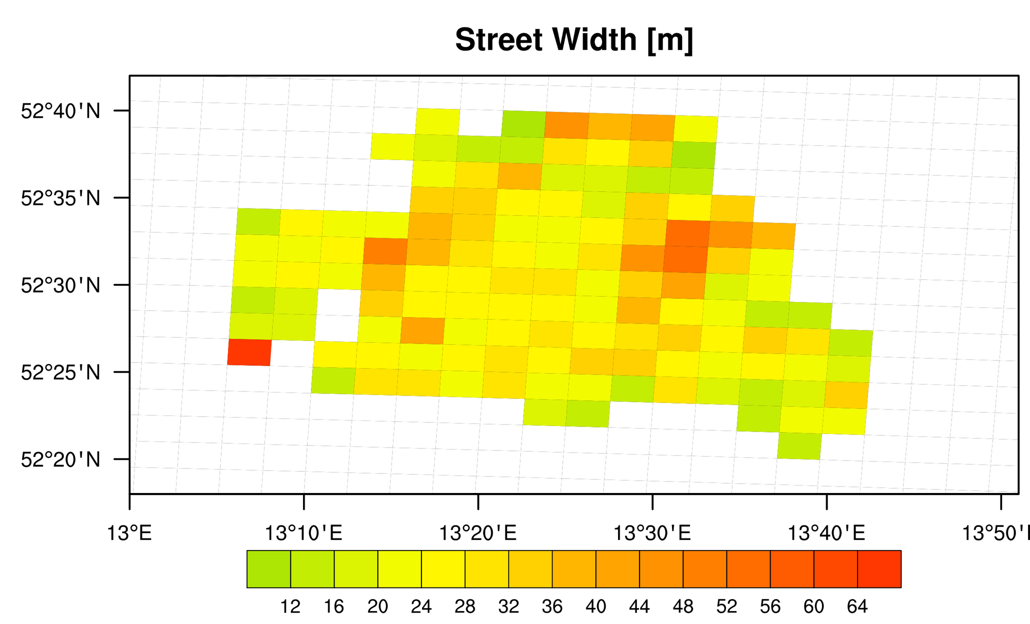

Figure 5: *Street width W for canyons with a north-south direction in Berlin calculated from the average distance of wall surfaces.*

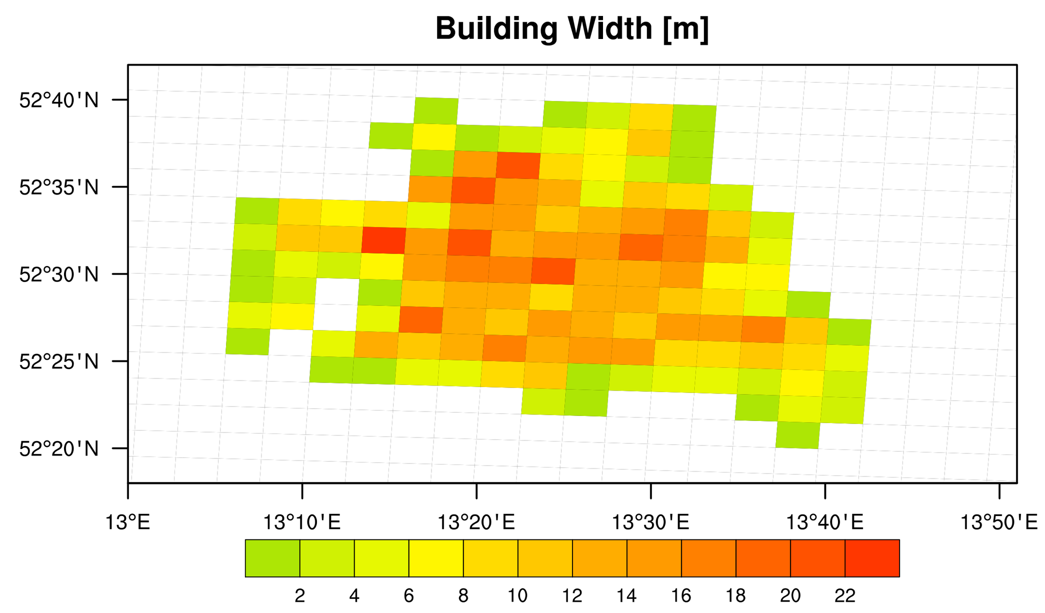

Figure 6: *Building width B for canyons with a north-south direction in Berlin calculated from $B = A_B W/(F - A_B)$.*

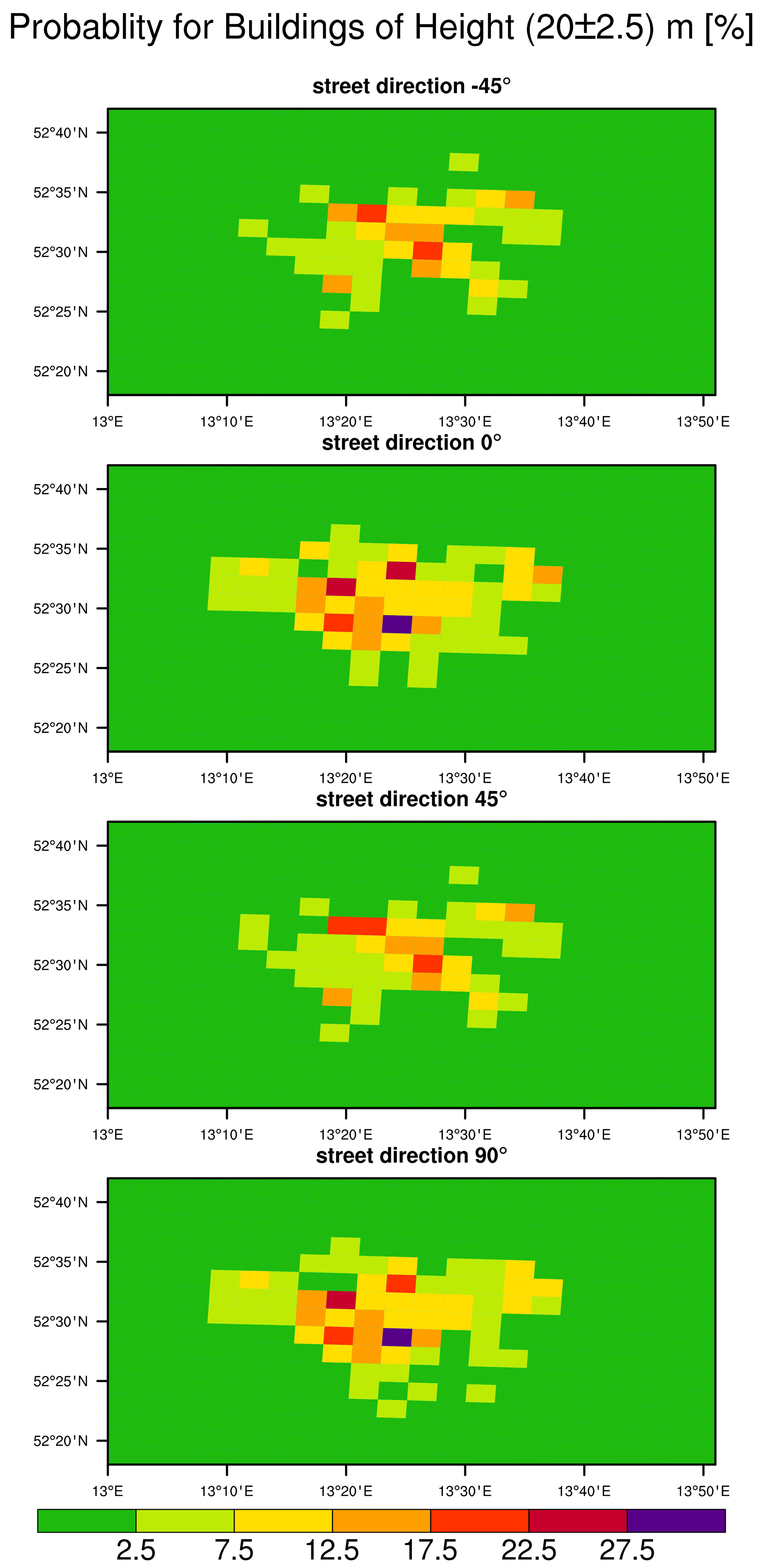

Figure 7: *Probability of buildings $\gamma(20\,\mathrm{m})$ to have a height (20 ± 2.5)m for different canyon angles relative to the north-south direction in Berlin. Note that distributions for angles which are 90° apart are similar.*

3. Acknowledgements