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Implementation, modification and testing of the Building Energy Parameterization Scheme (BEP) in the Climate Local Model

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The Building Energy Parameterization scheme (BEP) was implemented in the mesoscale Climate Local Model (CLM) in order to improve model performance in weather and climate simulations for urban areas. Furthermore, modifications were introduced in BEP's radiation scheme: (1) closure of the radiative energy balance and (2) the radiative interactions of roofs with other urban canyon surface elements such as walls, roads and roofs. In order to achieve this, the street canyon element on which BEP is based was extended from one road and two rows of buildings on either side to include an additional road and row of buildings.

In the original BEP, the energy of the incoming radiation from the mesoscale model is generally not conserved, with residuals in the radiation balance of approximately 10 % depending on the urban morphology. Sensitivity tests show that the radiative interactions of roofs with other urban surfaces have potentially a significant effect on the simulated urban canyon albedo, surface temperatures and subsequently on the long and short wave radiation balances and meteorological fields. Depending on the canyon geometry, in particular the height distribution of buildings, differences in the effective urban surface radiation temperature of more than 2.4 K were simulated between the original and the modified BEP versions.

The coupled CLM BEP model was first tested for the city of Berlin, Germany. An algorithm was developed that computes BEP input parameters for each model grid cell based on a 3d building model that covers the entire city of Berlin (CityGML format; >460000 buildings). It is shown that the application of BEP significantly improved the quality of the simulations and enabled CLM to simulate characteristics of the urban surface energy balance and subsequently the urban heat island effect.