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Sensitivity study of PBL schemes and urban morphology parameters using the WRF-BEP+BEM model over a Mediterranean coastal city

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Cities house over 50% of the population, despite covering only 2% of the earth's surface area. With the increased urbanization, the impact of climate change in urban areas is seen as a major problem. In the case of the Mediterranean region, the increase in frequency, intensity and duration of extreme heat wave events supposes a significant risk for the population. These factors have raised the focus on understanding and modelling the impact of extreme heat events on cities and to improve the simulation of these events to investigate possible heat adaptation/mitigation measures to ameliorate urban temperatures. This study investigates the sensitivity of high-resolution mesoscale simulations of the Metropolitan Area of Barcelona (AMB) to different urban physical parametrizations for a heat wave event in order to improve urban atmospheric modelling of Mediterranean coastal cities and to reduce uncertainties. The simulations are conducted using the WRF model coupled to the Building Effect Parameterization and the Building Energy Model (BEP+BEM) at 1 km resolution. The physical aspects in WRF that are analysed are: 1) the refinement of urban morphological parameters; and 2) planetary boundary layer (PBL) scheme. The results show that the inclusion of more specific urban morphology does not suppose a better performance of the WRF simulation in comparison to the use of 11 urban land-use classes with averaged urban morphological parameters, although it reduces systematic errors on night-time near-surface temperatures, especially in urban green areas. The comparison between PBL schemes shows that this aspect has a significative influence in the simulation of potential temperature inside the PBL and on near-surface temperature and wind. Moreover, the impact of urbanization on the urban boundary layer (UBL) is determined for the AMB simulating a scenario with no urbanization inside the AMB (all urban areas are changed to croplands). Results show that urbanization not only changes near-surface temperatures, but it has a considerable reducing impact on sea and land-breezes, and an intensifying effect on the PBL height.