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Simulation of the eThekweni Heat Island in South Africa

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ABSTRACT

The study evaluates the performance of the Conformal-Cubic Atmospheric Model (CCAM) when simulating an urban heat island (UHI) over the City of eThekweni, located along the southeast coast of South Africa. The CCAM model is applied at a grid length of 1 km on the panel with eThekweni, in a stretched grid mode. The CCAM is coupled to the urban climate model (UCM) called the Australian Town Energy Budget (ATEB). The ATEB incorporates measured urban parameters including building characteristics, emissions, and albedo. The ATEB incorporates the landcover boundary conditions obtained from the Moderate Resolution Imaging Spectro-radiometer (MODIS) satellite. The CCAM configuration applied realistically captured the orientation of the city and landcover types. Simulations of meteorological variables such as temperatures and longwave radiation reproduced the spatial distribution and intensity of the UHI. Results shows that the UHI is stronger during summer and weaker in all other seasons. The UHI developed because of natural factors (i.e., distribution of longwave radiation) and human factors (i.e., urban expansion, an increase in anthropogenic emissions, and additional heating). Due to the city's location along the coast, the UHI simulation could be weakened by atmospheric circulations resulting from land and sea breezes. Mitigation methods such as applying reflective paints and re-vegetation of the city may increase albedo and latent heat fluxes but reduce the sensible heat fluxes and weakens the UHI. However, the UHI may not be completely eliminated since natural factors emissions constantly influence its development.

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