EMS Annual Meeting Abstracts
Vol. 13, EMS2016-5, 2016
16th EMS / 11th ECAC

WRF Model Evaluation for the Urban Heat Island Assessment

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The phenomenon of urban heat island has now been established as an unwanted outcome of urban growth across the world. Urban heat island has been known to effect regional atmospheric pollution, ecology, extreme weather events and climate change, energy consumption and human comfort. Numerical simulation of the urban heat island effect helps in increasing understanding of the phenomenon at region of interest, assessing major causative factors, and designing mitigation strategies. The present study attempts to utilize the Weather Research and Forecasting (WRF v3.5) model coupled with single layer urban canopy model (UCM) to simulate the urban heat island scenario in Delhi, the capital region of India. Urban heat island intensities (UHI) have been computed based on model estimated temperatures and further compared with in situ observations of city-wide field campaign carried out earlier. The estimated heat island intensities for different land use/land cover (LULC) have been compared with those derived from in situ and satellite observations. The model performs reasonably well for UHI estimation and is able to reproduce trend of UHI for urban areas. There is a significant improvement in model performance with inclusion of UCM which results in reduction in root mean-squared errors (RMSE) for temperatures from 1.63 °C (2.89 °C) to 1.13 °C (2.75 °C) for urban (non-urban) areas. Modification of LULC also improves performance for non-urban areas. High UHI zones and top 3 hotspots are captured well by the model. Study further attempts to explore the selection of reference site for determining urban heat island intensity. UHI has been computed with reference to two points viz. a minimum temperature site within and a rural spot outside the city to examine selection of reference point. UHIs with respect to a minimum temperature site in the city are in close agreement with those estimated with respect to rural area outside the city. Hence, if the LULC of the stations is correctly being represented in the model, reference point for UHI estimation can be chosen within the city. In conclusion, the study highlights the importance of appropriate representation of urban canopies and updated landuse-landcover for improving predictive capabilities of the mesoscale models.