Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 8, 5975-5995, 2008
www.atmos-chem-phys.net/8/5975/2008/

Effect of explicit urban land surface representation on the simulation of the 26 July 2005 heavy rain event over Mumbai, India

M. Lei[1], D. Niyogi[1], C. Kishtawal[2], R. A. Pielke Sr.[3], A. Beltrán-Przekurat[3], T. E. Nobis[3], and S. S. Vaidya[4]

[1]Purdue University, Department of Earth and Atmospheric Sciences and Department of Agronomy, West Lafayette, IN 47906, USA
[2]SAC/ISRO, Ahmedabad 380015, India
[3]University of Colorado at Boulder, CIRES, Boulder, CO 80309, USA
[4]Indian Institute of Tropical Meteorology, Homi Bhabha Road, Pune 411008, India

Abstract. We investigate whether explicit representation of the urban land surface improves the simulation of the record-breaking 24-h heavy rain event that occurred over Mumbai, India on 26 July 2005 as the event has been poorly simulated by operational weather forecasting models. We conducted experiments using the Regional Atmosphere modeling system (RAMS 4.3), coupled with and without explicit urban energy balance model-town energy budget (TEB) to study the role of urban land – atmosphere interactions in modulating the heavy rain event over the Indian monsoon region. The impact of including an explicit urban energy balance on surface thermodynamic, boundary layer, and circulation changes are analyzed. The results indicate that even for this synoptically active rainfall event, the vertical wind and precipitation are significantly influenced by heterogeneity in surface temperatures due to urbanization, and the effect is more significant during the storm initiation. Interestingly, precipitation in the upwind region of Mumbai city is increased in the simulation, possibly as a feedback from the sea breeze – urban landscape convergence. We find that even with the active monsoon, the representation of urbanization contributes to local heavy precipitation and mesoscale precipitation distribution over the Indian monsoon region. Additional experiments within a statistical dynamical framework show that an urban model by itself is not the dominant factor for the enhanced rainfall for a Mumbai heavy rain event; the combination of updated SST fields using Tropical Rainfall Measurement Mission (TRMM) data with the detailed representation of urban effects simulated by the TEB model created realistic gradients that successfully maintained the convergence zone over Mumbai. Further