地球物理学报 2008 51 (3): 715～726 ISSN: 0001-5733 CN: 11-2074/P

城市冠层结构热力效应对城市热岛形成及强度影响的模拟研究

周荣卫[1,2],蒋维楣[1],何晓凤[1,2]

1 南京大学大气科学系,南京 210093;2 国家气候中心，北京 100081

收稿日期 2007-8-14 修回日期 2008-2-29 网络版发布日期 2008-5-17 接受日期

摘要 本文在城市边界层预报模式中耦合了一个单层冠层模式，此模式能够体现城市冠层结构和人为热源对城市热岛的共同作用.通过传统平板模式和城市冠层模式的模拟结果与自动气象站观测资料对比发现，耦合了城市冠层模式的模拟结果与观测资料更为吻合，尤其能够较好地模拟出城市地区夜间地面的气温变化情况.
对北京城市区域的模拟结果进行分析，白家庄地区冠层建筑物使得城市地区气温白天下降，夜晚上升，不考虑人为热源作用时，城市冠层使得白家庄站地面气温白天最低下降2.5℃，夜间气温最大升高为4.7℃.针对模拟区域较小的理想算例模拟结果分析表明，城市冠层模式能够很好地模拟城市地区地表能量平衡关系，体现城市冠层对长短波辐射的封截以及热量存储能力，全天平均净辐射通量由传统模式的43.38 W/m^{2}变为84.19 W/m^2，热存储通量白天最大值为278.04 W/m^2，夜晚最大释放热存储通量为160.35 W/m^2.冠层建筑物和人为热源对夜间城市热岛强度的贡献分别为70.65%和29.35%.城市冠层建筑物对夜间城市热岛的形成起决定性作用.

关键词 城市边界层 预报模式 城市冠层 热岛强度

分类号 P463

DOI:

Numerical simulation of the impacts of the thermal effects of urban canopy structure on the formation and the intensity of the urban heat island

ZHOU Rong-Wei[1,2], JIANG Wei-Mei[1], HE Xiao-Feng[1,2]

1 Department of Atmospheric Science, Nanjing University, Nanjing 210093, China;2 National Climate Center, Beijing 100081, China

Received 2007-8-14 Revised 2008-2-29 Online 2008-5-17 Accepted

Abstract A single-layer urban canopy model is incorporated into the urban boundary prognostic model. The simulation results of the model are commonly affected by the urban canopy structure and the anthropogenic heat flux. The conclusions are drawn by the comparisons between the simulation results of the traditional slab model, the incorporated model and the observations of the automatic weather stations: the simulated surface temperature of incorporated model is better than that of the slab model and in more reasonable agreement with the observations, especially in the nighttime.
The results of the surface temperature are compared and analyzed between the slab model and the incorporated model at Baijiazhuang station. The results are as followings: the surface temperature is descend mostly by 2.5℃ at daytime and is ascended mostly by 4.7℃ at nighttime only with the effect of the urban canopy.
The results of the surface energy budgets indicate that the urban canopy model can well describe the urban canopy surface energy balance relationship, the short wave radiation trapping effect and the heat storage capability. The daily average net radiation flux is 84.19 W/m^2, while it is 43.38 W/m^2 in the slab model. The maximum heat storage is 278.04 W/m^2 at daytime, and the maximum releasing heat storage is 160.35 W/m^2 at night. The contributions of canopy structure and the anthropogenic heat flux to the intensity of nocturnal urban heat island are 70.65% and 29.35%, respectively. So the urban structure plays a fateful role in the formation of the nocturnal urban heat island.

Key words Urban boundary Prognostic model Urban canopy Intensity of urban heat island

通讯作者:
周荣卫 zhourongwei@yahoo.com.cn
作者个人主页: 周荣卫[1;2];蒋维楣[1];何晓凤[1;2]