Reviewer 2:

This study systematically examines the impact of buildings on downward surface solar fluxes over Beijing by using a 3-D radiation parameterization that accounts for 3-D building structures versus the conventional plane-parallel scheme. Results show that the downward surface solar flux deviations between the two schemes are 1–10 Wm-2 at 800-m grid resolution. However, flux deviations are much smaller at 4-km resolution because the pairs of positive-negative flux deviations on different sides of buildings offset each other. Diurnal variations of flux deviations and contribution of individual flux components (e.g. direct flux, diffuse flux, etc.) are also analyzed. Further sensitivity experiments show that atmospheric aerosols can evidently reduce the magnitude of flux deviations while the surface albedo generally has a rather moderate impact. The results imply that the building effect on downward surface solar fluxes can play a crucial role in fine-resolution atmospheric models with grid spacing of 1 m – 1 km.

The subject is interesting, the paper is well written and the results are useful for urbanscale and meso-scale modeling applications. In fact I have two minor comments only:

Response: We thank the reviewer for two useful comments to improve the presentation of the text. In the following, the original comments are in black, while our responses are in blue.

1. The authors mainly compare the surface downward solar fluxes simulated by 3-D radiation parameterization and plane-parallel schemes. What about the difference between those simulated by 3-D radiation parameterization and by single- or multiple layer urban canopy scheme? Some discussion about this would be helpful given that urban canopy schemes are widely used in urban climate applications.

Response: We appreciate the reviewer's valuable comment. The 3-D radiation parameterization used in this study and urban canopy schemes used in many previous urban climate studies investigate the building effect on solar radiation with different methods. The present 3-D radiation parameterization was developed on the basis of a 3-D Monte Carlo photon tracing approach through which we parameterize downward surface solar fluxes by means of grid-average topographic information to reproduce flux results in order to optimize the computational burden involving 3-D Monte Carlo photon tracing calculations. In urban canopy schemes, the radiative transfer equation was first established using simplified, evenly spaced buildings. The average building geometry parameters (e.g., building height, building width, street width, etc.) are subsequently calculated for each model grid and used in radiative transfer calculations (Chen et al. 2011; Grimmond et al., 2010; Kusaka and Kimura, 2004; Martilli et al., 2002).

The present 3-D radiation parameterization and the commonly used urban canopy schemes both have their strengths. The 3-D radiation parameterization treats individual flux components (i.e., the direct, diffuse, direct-reflected, diffuse-reflected, and coupled fluxes) separately taking into account the distinct feature of different flux components. However, the diffuse, diffuse-reflected, and coupled fluxes are usually oversimplified in urban canopy schemes (e.g. isotropic radiation is assumed). Besides, the 3-D radiation parameterization directly relates surface solar fluxes to "real" (rather than simplified) topographic data, resulting in the realistic spatiotemporal distribution of solar fluxes. Some advantages of urban canopy schemes include a more detailed treatment of building geometrical features as well as the partitioning of total fluxes at roof, wall, and road to facilitate computations of the energy exchange at building domain.

It would be interesting to compare solar fluxes simulated by 3-D radiation parameterization and by single- or multiple layer urban canopy schemes. Such a comparison, however, would involve substantial and collaborative efforts, resources, as well as the coordination with scientists who have already developed an urban canopy scheme. We submit that such a comparison appears to be beyond the purview of the present study. We will be pleased to work on a future paper if the reviewer could enlighten us to the opportunity for collaborative work.

We have added the discussions above in the revised manuscript (from Page 13 Line 22 to Page 14 Line 26 of the revised manuscript).

References:

Chen, F., Kusaka, H., Bornstein, R., et al.: The integrated wrf/urban modelling system: Development, evaluation, and applications to urban environmental problems, Int J Climatol, 31, 273-288, 10.1002/joc.2158, 2011.

Grimmond, C. S. B., Blackett, M., Best, M. J., et al.: The international urban energy balance models comparison project: First results from phase 1, J Appl Meteorol Clim, 49, 1268-1292, 10.1175/2010JAMC2354.1, 2010.

Kusaka, H., and Kimura, F.: Coupling a single-layer urban canopy model with a simple atmospheric model: Impact on urban heat island simulation for an idealized case, J Meteorol Soc Jpn, 82, 67-80, Doi 10.2151/Jmsj.82.67, 2004.

Martilli, A., Clappier, A., and Rotach, M. W.: An urban surface exchange parameterisation for mesoscale models, Bound-Lay Meteorol, 104, 261-304, 10.1023/a:1016099921195, 2002.

2. In the 3-D radiation parameterization scheme, solar radiative fluxes can be categorized into five components (i.e. direct flux, diffuse flux, and so on) according to photon path. I am wondering whether it is possible to partition the total flux into individual components at roof, wall, and road, which are variables that can be used to calculate the canopy temperature and overall energy exchange between urban surface and atmosphere.

Response: We thank the reviewer for this valuable comment. For each model grid, the 3-D radiation parameterization used in this study can partition total fluxes into five components (i.e., the direct, diffuse, direct-reflected, diffuse-reflected, and coupled fluxes) according to photon path. However, it is difficult to partition total fluxes into components at roof, wall, and road since the 3-D radiation parameterization does not resolve complex building geometrical parameters. If the roof or road occupies a model grid, then it's possible to get different components of the fluxes for roof or road; otherwise the partitioning will be very difficult. We have described this limitation in the revised manuscript (Page 14 Line 23-26 of the revised manuscript).