Atmos. Chem. Phys. Discuss., 12, C8099–C8102, 2012
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Atmospheric Chemistry and Physics Discussions

ACPD

12, C8099–C8102, 2012

Interactive Comment

Interactive comment on "Simulating 3-D radiative transfer effects over the Sierra Nevada mountains using WRF" *by* Y. Gu et al.

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Received and published: 12 October 2012

This paper implemented a new surface solar radiation parameterization based on deviations between 3-D and conventional plane-parallel radiative transfer models into the WRF model to simulate the solar insolation over the mountain/snow areas of Sierra Nevada in the Western United States. It examines the impact of the spatial and temporal distribution and variation of surface solar fluxes on land-surface processes. In general, this paper is well written, the results are original and well presented. I recommend the publication of this paper after addressing the following minor comments.

Response: We appreciate Reviewer 2's constructive comments. Below are our specific responses to minor comments.

Minor Comments:

Figures: The map figures (1-5) are hard to visualize. It will be better to have maps of the bigger area, with the study region marked up and zoomed in.

Response: Following the reviewer's comments, we have added a new figure (Fig. 1) to illustrate the topography (Fig. 1b) and domain (Fig. 1a) used to derive the parameterization data, with the 80 sub-regions marked by 'x'. For Figs. 2-6 (Figs. 1-5 before), please see Fig. 1a for the map of the bigger area and Fig. 1b for the study region's topography.

Page 19902: Equation (1). What is the definition of Ct? Is it the related to the size of the mountains?

Response: The term Ct is referred to as the terrain configuration factor, defined as the area of surrounding mountains visible to the target point which determines the solar fluxes reflected to the target point from the surrounding mountains. The parameter Ct will affect the direct- and diffuse-reflected fluxes as well as the coupled flux induced by mountains. We have incorporated additional description regarding 'Ct' in the revision (page 5, lines 150-154).

Page 19903: Second paragraph. I think the authors also need to discuss the seasonal variation since it will affect the position of the Sun and thus the solar zenith angle μ.

Response: The solar flux at the top of the atmosphere is governed by the cosine of the solar zenith angle, μ0, which is defined by the latitude, time of year, and the solar declination angle and is therefore seasonally dependent. The variable that is used to represent the angular effect of the direct flux component in the parameterization is the cosine of the solar incident angle μi, which accounts for the solar zenith angle, μ0, mountain slope, and slope orientation. In the parameterization, we have used 7 μ0 ranging from 0.1 to 1. Once time of year is defined, μ0 can be computed from known mathematical expressions. We have included the preceding discussions in the text

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(page 8, lines 230-234).

Page 19910: first paragraph. I don't understand why higher elevations have a maximum reduction at 2pm, while at lower elevations the maximum reduction is at 10am or earlier? If it's caused by geometry, a more detailed explanation is needed.

Response: The maximum reduction of surface solar flux over higher elevations at 2 pm is probably due to the topographic characteristics of the Sierras, which have sharper cliffs over the northeast side of the mountains (see Fig. 1). Therefore, for higher elevations, a portion of the northern slopes will be shadowed even when the position of the Sun is at 2 pm, during which the available solar flux is near its maximum, leading to the maximum reduction of surface solar flux. When lower elevations are included, most of the lower mountain areas are visible to the Sun. Because the higher elevation region only constitutes a portion of the total area, reduction at 2 pm becomes smaller. Following the reviewer's comment, we have added more explanation in the revised manuscript (page 15, lines 383-395).

Page 19911: Is LSM defined in the previous text?

Response: Yes, LSM (Noah land-surface model) has been defined previously in the 1st paragraph of Section 3 (page 7, line 214).

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 19897, 2012.

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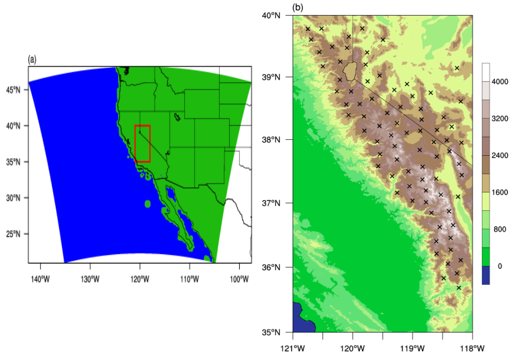

Fig. 1. (a) The domain of the western United States, where the red box denotes the study region over the Sierras. (b) The topography for the study region using the digital elevation model (DEM) at a resolution of 1 km. The scale on the right is in units of meter. The x's represent 80 sub-regions with a resolution of 20 km from which the parameterization data involving 3D radiative transfer was derived (Lee et al. 2011).

Fig. 1.

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