Special Program in Applied Mathematics and Applied Mechanics

3-D radiative transfer in complex topography.

2013 - 03 - 20 (Wed.)
15:00 - 17:00
308, Mathematics Research Center Building (ori. New Math. Bldg.)

Solar radiation received by the surface is strongly affected by complex terrain. However, this effect has not been accounted for in the contemporary weather and climate models, which assume that the lower boundary is horizontal and unobstructed. We have developed a parameterization to quantify the topography effect on the basis of 3-D Monte Carlo photon tracing program, which simulates interactions between solar beams and the surface over irregular mountains. The results show that deviations in downward solar radiation between a plane-parallel radiative transfer scheme and 3-D parameterization could be larger than 200 W/m2 at the sunward and shaded sides of mountains. Deviations due to reflections could be more than 100 W/m2 in snow-covered areas. It implies that the surface receives more solar energy than 1-D calculation, and more small-scale circulations could be triggered by differences in solar heating. We have incorporated the parameterization into Weather Research and Forecasting Model (WRF) to demonstrate the topography effect using the Sierra Nevada as a test bed. Our simulations show that this effect could result in a temperature increase of up to 1 degree on the sunward side.