2011 Special Program: Two-Phase Flow, Interface Flow and Related Phenomena

Multi-scale modeling of the atmosphere - Toward unification of the general circulation and cloud-resolving models

2011 - 09 - 21 (Wed.)
15:00 - 17:00
308, Mathematics Research Center Building (ori. New Math. Bldg.)

As far as the representation of deep moist convection is concerned, only two kinds of model physics are used at present: highly parameterized as in the conventional general circulation models (GCMs) and explicitly simulated as in the cloud-resolving models (CRMs). Ideally, these two kinds of model physics should be unified so that a continuous transition of model physics from one kind to the other takes place as the resolution changes. In this talk, we will introduce the newly developed unified parameterization so that the physical parameterizations of a GCM converge to a global CRM as the horizontal resolution is refined. The key for this unified parameterization to succeed is to eliminate the assumption that convective clouds occupy only a small fraction of the grid size which is commonly used in the convectional parameterization of the GCM.

As the horizontal resolution of the numerical models approaches cloud-resolving simulations, one of the difficult challenges is to handle the lower boundary as steep or as irregular as the surface topography. Most atmospheric models introduce the effect of surface topography through the use of a terrain-following vertical coordinate. While such a coordinate can formally bypass problems in implementing the lower boundary condition over the terrain, it is well known that the error due to the use of such coordinates is a prominent source of errors in calculating the horizontal pressure gradient over steep mountains. In the second part of the talk, we will introduce the block mountain approach for the numerical models that can handle complex topography without artificial smoothing. Since the block mountain is fixed at the coordinate surface, the model grid won’t be distorted in dealing with steep slopes. Examples such as mountain waves and precipitation over complex terrain are presented to demonstrate this approach.