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

Potential vorticity budget of typhoon Nari (2001) at Landfall

2011 - 11 - 30 (Wed.)
15:00 - 16:30
308, Mathematics Research Center Building (ori. New Math. Bldg.)

A moist nonhydrostatic potential vorticity (PV) budget with virtual potential temperature as the thermodynamic variable is conducted in this study to investigate the PV evolution of Typhoon Nari (2001) from its oceanic stage to landfall stage over the northern Taiwan. Budget calculations are based on the MM5 model output (control simulation) with high spatial resolution (2-km horizontal grid size). Two additional sensitivity experiments, by removing the Taiwan topography and replacing the Taiwan island with the ocean condition, respectively, are performed to examine the effect of Taiwan's topography and the ocean surface fluxes on PV evolution. When Nari was over ocean, its PV distribution exhibited the typical feature of a mature TC. After landfall, its eyewall was contracted and convection was further intensified by Taiwan topography. PV was redistributed cyclonically with the vortex tangential flow and entered the inner core with the radial inflow. The low-level PV generated by sensible heat fluxes and latent heat release was transported upward through the vertical advection. Latent heating accounted for major PV generation in lower levels during the oceanic and early landfall stage, and acted as a major PV sink at middle-to-upper levels. The moist nonhydrostatic PV, which may be more appropriate for landfalling TCs over a rugged terrain such as the Taiwan Island, produced a latent-heating PV generation term with a peak magnitude of 450 PVU/hr, twice of that (~210 PVU/hr) of the dry hydrostatic PV (using potential temperature as the thermodynamic variable). Surface friction was a PV sink term. Eddy mixing, on the other hand, could be either PV source or sink term, depending on the PV distribution and convection intensity. The

no-Taiwan-terrain sensitivity experiment showed that the existence of Taiwan topography could enhance the surface friction and vertical eddy mixing, intensifying PV by releasing more latent heat with stronger convection. Turning off ocean surface fluxes would cause the dissipation of PV ring. The asymmetric latent heating in the no-terrain run near the land-sea interface resulted in the formation of a new PV ring, and this new PV ring became more polygonal over ocean. This asymmetric PV phenomenon might cause the typhoon center to move in a trochoidal manner afterward.