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全球雲解像度モデルで再現された台風ライフサイクルの多重スケール相互作用
Multiscale Interactions on the Lifecycle of Tropical Cyclone simulated by Global Cloud-System Resolving Model

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The global cloud-system-resolving model, NICAM, successfully simulated the lifecycle of Tropical Storm (TS) Isobel that formed over the Timor Sea in the austral summer 2006. The multiscale interactions on the lifecycle of the simulated storm have been analyzed in this study as the large-scale and meso-scale aspects. The westerly wind burst accompanied by the onset of a Madden-Julian Oscillation (MJO) event over the Java Sea enhanced the cyclonic shear and convergence in the lower troposphere, providing the pre-conditioned large-scale environment for the genesis of Isobel. In the subsequent evolution, five stages are identified for the simulated Isobel, namely, the initial eddy, intensifying, temporary weakening, re-intensifying, and decaying stages.

At the initial eddy stage, small-/meso-scale cyclonic vortices (eddies) developed in the zonally-elongated rainband organized in a convergent shear-line in the lower troposphere over the sea north of Java. As the MJO propagated eastward, the cyclonic eddies moved southeastward with intensifying convective activities, showing the signal of cyclogenesis over the Timor Sea. As a result of multi-vortex interaction/merging in an environment with enhanced low-level cyclonic vorticity and weak vertical shear, a typical tropical cyclone structure developed, leading to the birth of Isobel (intensifying stage). An approaching subtropical high from the southwest exposed Isobel to a large-scale stretching deformation field with strong vertical shear. This change led to the development of asymmetric structure in the inner core of Isobel and interrupted its intensification, causing a temporary weakening (temporary weakening stage). As the vertical shear weakened and changed the direction in response to the upper-level northerlies, Isobel re-intensified in response to the reformation of its eyewall as a result of the inward spiraling rainband that was formed on the downshear left side (re-intensifying stage). Finally Isobel decayed due to the land effect as it approached the land and made landfall in northwest Australia (decaying stage).

A multiscale interaction associated with the genesis of Isobel has been investigated. It is clear that the large-scale cyclonic shear closely related to the WWB in the MJO provided a favorable condition for deep convection over the sea north of Java. The deep convection was accompanied by small-scale high low-level cyclonic potential vorticity with diameters less than 40 km, very similar to the so-called vortical hot towers discussed by previous studies (e.g., Montgomery et al. 2006). Isobel thus formed as a result of the following events: increased cyclonic shear due to the WWB, collective heating from the vortical hot towers, the merging and strengthening of low-level potential vorticity of the hot towers, and eventually the axisymmetrization of meso-scale features by the storm-scale low-level cyclonic circulation over the sea south of Java.