Mean-Flow Changes by Typhoon-Generated Gravity Waves and Their Effects on the Typhoon

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As convection associated with the typhoon has been recognized as a significant source of atmospheric gravity waves, characteristics of typhoon-generated gravity waves (TGWs) have been examined through the observational and numerical modeling (e.g., Kim et al. 2009) studies. In the previous studies on TGWs, it was found that significant momentum is deposited into the upper troposphere and lower stratosphere by the critical-level filtering and damping of TGWs. Since the vertical wind shear is a crucial factor in the development and intensity of the typhoon (e.g., DeMaria 1996), this momentum deposition and resultant change of the background wind are expected to affect the development and maintenance of the typhoon. However, there haven't been no proper studies to examine the impact of TGWs on the typhoon itself. As the first step to investigate effects of TGWs on the typhoon dynamics, we simulate gravity waves generated by Typhoon Saomai (2006) using the Weather Research and Forecasting (WRF) model and examine the effects of TGWs on the mean flow. Simulation is performed with a horizontal grid spacing of 3 km in the moving frame, which follows the typhoon. The possible effect of TGWs on the background wind is investigated by calculating the momentum flux of TGWs. The results show that the momentum fluxes have positive values in the upper troposphere and stratosphere and decrease considerably between z = 15 and z = 17 km. The magnitude of gravity wave drag at z = 17 km varies with time between -3.15 and 12 m s^{-1}/day and temporally-averaged magnitude of wave drag has a value between -0.08 and 1.83 m s^{-1}/day depending on the typhoon-evolution stage. The estimated effect of TGWs on the background wind in the upper troposphere and lower stratosphere is a deceleration of the easterly flow. This estimation can be used to understand the influence of TGWs on the typhoon development.

Keywords: Typhoon; Gravity waves; Momentum flux; Numerical Modeling; Vertical wind shear

References

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