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熱フラックス偏差が短時間で台風強化に影響を与えるメカニズム
Short-time-scale typhoon intensification as a response to anomalous surface heat fluxes

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The typhoon often encounters small scale oceanic variabilities due to oceanic mesoscale warm eddies and warm western boundary currents. These features act to enhance heat fluxes at the sea surface [Lin et al. 2008, MWR]. According to the energy balance obtained from the theoretical framework, these oceanic factors can potentially have an impact on maximum tangential velocity [Emanuel et al. 2004, JAS; Lin et al. 2008, MWR].

One of the fundamental questions is how perturbations bring about changes in the maximum tangential velocity. Needless to say, diagnostic balance theory does not describe the time-dependent behavior of perturbations. Perhaps one may identify that adjustment processes in a gradient-wind balanced vortex explain the intensification, more specifically, changes in the central pressure field due to enhanced condensation capable of intensifying the vortex. However, Wu et al. (2006, JAS) showed perturbation-like inputs to the central pressure field are not likely to affect the subsequent maximum tangential velocity substantially. This is because the radius of the eyewall is typically smaller than the Rossby deformation radius.

In this study, we trace the sensitivity of maximum tangential velocity backward by using an adjoint model and evaluate the term balances to seek for the responsible physical processes. As a result of integration backwards to four minutes prior to the specified time, a dipole pattern appears in the sensitivity fields with respect to potential temperature and the mixing ratio of water vapor. A positive (negative) sensitivity is found inside (outside) the target region, which exhibits an increase of tangential velocity four minutes after the introduction of positive (negative) perturbations in potential temperature or in the mixing ratio of water vapor inside (outside) the target region. With further backward integration, the sensitivity signals reach down to the surface.

The term balance analysis indicates that the stronger inward motion is induced quite locally following the enhanced convective motion due to the changes in condensation and buoyancy forces. Then, stronger inward motion is quickly turned into the anomaly of tangential wind (that is, the intensification of maximum wind speed) since the timescale of conversion from radial velocity to tangential velocity is relevant to the inverse of the absolute vorticity in a near gradient wind balanced vortex. This short-timescale process is not associated with the changes in the central pressure field. See details in Ito et al.(2011, JAS). If the presentation time allows, we will further discuss the fact that a reduction in moist air supply in the exterior region of the typhoon can serve to strengthen the maximum tangential velocity.

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