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Vorticity Development in Saturated Moist Air Based on MPV-Q*

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In this paper, the vorticity development theory based on the view of potential vorticity-diabatic heating (PV-Q) in dry air or unsaturated air is extended to saturated air. Then, the vorticity development theory from the view of moist potential vorticity-diabatic heating (MPV-Q*) is established and applied to practical case analyses.MPV-Q* has considered the complete diabatic heating, with the latent heat (LH) included in the expression of MPV, and the sensible heating and radiative heating (SRH) included in Q*. Based on MPV-Q*, the equation of vertical vorticity development frame is derived from the Lagrangian viewpoint. Then, the contributions of the individual change of convective stability , the individual change of MPV and the individual change of MPV_2 (the horizontal component of moist potential vorticity) to the development of vertical vorticity are studied, and the influence of spatial non-uniform distribution of Q* on the development of vortex movement is clarified. This theory has been applied to analyze the characteristics and mechanism of a low vortex development during its eastward movement in the first heavy rain episode in the Yangtze-Huaihe region of China in 2016. The results show that the more convective neutrality the atmospheric stratification tends to be, the more favorable it is for the vortex development. The individual change of MPV is caused by Q* The non-uniform distribution of Q*in the horizontal and vertical directions causes the non-uniform distribution of MPV individual changes. Considering the convective stability of the atmospheric stratification, the effect of Q*on the development of vortices can be divided into four situations. When the atmospheric stratification is convective instability (stability), the increase (decrease) of MPV_2 will lead to the development of vertical vorticity.