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Role of moist processes in the trajectories of mid-latitude surface cyclones within idealized simulations.

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Recent studies suggest that it is the misrepresentation of moist processes within extratropical cyclones that is responsible for many forecast failures. The effect of the latent heat release intensifying perturbations has been demonstrated in numerous studies but its effect on the trajectory has been less extensively studied. Our objective is to systematically study the influence of wet processes on the trajectories of surface cyclones using idealized simulations of the MESO-NH non-hydrostatic mesoscale model.
The initial state of the simulations is defined as the sum of a zonal baroclinic jet and finite-amplitude synoptic-scale anomalies located to the south of the jet. Special attention is paid to identifying the dynamical processes acting on the motion of the surface cyclone along and across the jet. Two sets of initial conditions are introduced, one with a unique cyclonic anomaly near the surface, and another one with two cyclonic anomalies near the surface and tropopause in such a way that they interact baroclinically with each other. A first comparison is made between dry simulations having these two different initial conditions to see the impact of the upper-level anomaly in the motion of the surface cyclone. The second comparison is made between wet and dry simulations to study the influence of moist processes.
The difference between the different simulations is interpreted in terms of potential vorticity (PV). In all simulations, a dipolar PV anomaly which is composed of an upstream cyclone and a downstream anticyclone is formed near the tropopause and above the surface depression. Using a PV inversion algorithm, we show that the trajectories of the surface cyclone in the various experiments mainly depend on the intensity and orientation of the upper-level dipolar PV anomaly. The upper-level anticyclonic PV being more intense in the moist run than in the dry run, it more rapidly advects the surface cyclone poleward. The consequence is that the surface cyclone crosses the jet axis sooner in the moist run than in the dry run. The advection by the zonal jet being the same in the dry and moist experiments, the zonal displacements in the moist run differ from the dry run by two processes. One is the direct effect of latent heat release creating trends toward the east and the other is the advection by the upper-level anticyclone, which creates a more important westward tendency in the moist run. As these two tendencies act against each other, the zonal displacements are not significantly different between moist and dry runs.