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Study of Nonlinear Forcing Singular Vector on Tropical Cyclone predictability

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How to improve tropical cyclone (TC) intensity forecast skill is urgent, especially that of TC track forecast has been upgraded greatly during these several decades. Therefore, identifying the sources of TC intensity forecast errors is essential.
Nonlinear forcing singular vector (NFSV) accounts for the processes that are not explicitly or correctly described by the nonlinear model equations. Based upon the WRF-ARW and its adjoint model, this study uses NFSV to investigate the impacts of model errors on TC intensity forecasts, which is represented by minimum sea level pressure (MSLP). The results show that (1) model error is the important source for TC intensity forecast error, which is O (102) hPa for 1-2 day forecast generally; (2) the inaccurate description of model output to both potential temperature and the mixing ratio can lead to large TC intensity forecast errors; (3) above inaccurate descriptions firstly produce abnormal vertical motion, which cause abrupt variation of vertical eta coordinate within very short period, and finally lead to large MSLP forecast errors. These results infer that WRF-ARW model should be adjusted first for a more accurate TC intensity forecast.