Diagnosis of Errors in UFS Medium-Range Forecasts of Atmospheric Rivers

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We will present a case study to demonstrate the power of the diabatic potential vorticity (PV) perspective in diagnosing error sources in UFS medium-range forecasts of wintertime atmospheric rivers (ARs). We will show that the ‘‘forecast minus analysis’’ PV pattern on a cross-tropopause isentropic surface in the extratropics can reveal characteristic features of PV forecast errors and how these features relate to the forecast model’s uncertainties in simulating the complex sequence of multiscale interactions between the dynamics of Rossby waves at the tropopause and latent heating in the ARs associated with warm conveyor belts. The case study focuses on using both GFS and ERA5 analyses to diagnose PV errors in forecasts from the Atmospheric River Analysis and Forecast System (AR-AFS), a newly developed UFS application, for a wintertime heavy precipitation event along the US West Coast. We will use the results from the case study to illustrate that the challenge in medium-range AR-related weather forecasts lies in probabilistically predicting Rossby wave dynamics while accounting for stochastic feedback from diabatic effects at smaller scales. It will be shown that the diabatic PV perspective provides a conceptually robust and practically useful method of diagnosing and understanding the multiscale error dynamics of medium-range AR forecasts from NWP models.