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Excitation of Rossby-wave trains associated with high-impact weather: optimal growth of forecast errors

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Singular vectors (SV) have been used at the Metorological Service of Canada (MSC) to analyze the influence of physical parametrizations and initial-time norms on the properties of unstable atmospheric disturbances in the Canadian Global Environmental Multiscale (GEM) model. There is evidence that Rossby wave-trains originating over the Western Pacific may significantly influence the middle- to long-range predictability of high impact weather over North America and beyond. In this study, SVs with appropriate norms and time scales are calculated to identify, at the time of excitation, the mechanisms that control the amplitude of Rossby-wave trains and the sensitivity of their forecasts to initial-condition error in cases of high-impact weather. Using global analysis data provided by the CMC, various events of long-lasting Rossby-wave trains are selected. In each case, SVs are calculated using an optimization time interval of 48h and a tangent linear version of the GEM model. At initial time, the global total-energy norm is used. For the final time, the same norm is used but over a restricted horizontal and vertical domain. Results obtained show that when the analysis is modified with the pseudo-inverse of the 48h forecast error in the SV subspace, the error in the non-linear forecast over the life of the wave train is significantly reduced. Results also suggest that this error reduction is correlated with the amplitude of the zonal wave packet envelope.