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Long-Lead Forecasts of the Yearly Varying Annual Evolution of the Northern Hemisphere Stratospheric Polar Vortex

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Based on an elliptic orbit representation of the yearly varying annual cycles of the Northern Hemisphere stratospheric polar vortex (SPV) from 1979 to 2021, we develop a statistical model to predict the parameters of the SPV's elliptic orbit on a yearly basis. The predictors include indices describing the phase of key climate modes, such as ENSO and the quasi-biennial oscillation (QBO), as well as the initial state of the polar stratosphere, all derived from prior seasons. Our results demonstrate that the predicted annual SPV evolution, initialized on October 1, provides skillful forecasts with anomaly correlation skill exceeding 0.7 throughout the November-to-March period. In particular, our forecasts can accurately predict the timing and magnitude of peak vortex strength, the timing of the final warming, as well as providing insights into the sub-seasonal evolution of the vortex.