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Modeling the Northern eddy-driven jet stream position and wind speed variability with stochastic coupled non-linear lattices

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On a synoptic time scale, the northern mid-latitudes weather is dominated by the influence of the eddy-driven jet stream and its variability. The usually zonal jet can become mostly meridional during so-called blocking events, increasing the persistence of cyclonic and anticyclonic structures and therefore triggering extremes of temperature or precipitations. During those events, the jet takes unusual latitudinal positions, either northerly or southerly of its mean position. Previous research proposed theoretically derived 1D models of the jet stream to represent the dynamics of such events. Here, we take a data-driven approach using ERA5 reanalysis data over the period 1979-2019 to investigate the variability of the eddy-driven jet latitudinal position and wind speed variability. We show that shifts of the jet latitudinal position occur on a daily time scale and are preceded by a strong decrease of the jet zonal wind speed 2-3 days prior to the shift. We also show that the dynamics of the jet zonal wind speed can be modelled by a non-linear oscillator with stochastic perturbations. We combine those two results to propose a simple 1D model capable of representing the statistics and dynamics of blocking events of the eddy-driven jet stream. The model is based on two stochastic coupled non-linear lattices representing the jet latitudinal position and zonal wind speed. Our model is able to reproduce temporal and spatial characteristics of the jet and we highlight a potential link between the propagation of solitary waves along the jet and the occurrence of blocking events.