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Interpretable Deep Learning for Probabilistic MJO Prediction

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The Madden–Julian Oscillation (MJO) is the dominant source of sub-seasonal variability in the tropics. It consists of an Eastward moving region of enhanced convection coupled to changes in zonal winds. It is not possible to predict the precise evolution of the MJO, so subseasonal forecasts are generally probabilistic. Ideally the spread of the forecast probability distribution would vary from day to day depending on the instantaneous predictability of the MJO. Operational subseasonal forecasting models do not have this property. We present a deep convolutional neural network that produces skilful state-dependent probabilistic MJO forecasts. This statistical model accounts for intrinsic chaotic uncertainty by predicting the standard deviation about the mean, and model uncertainty using a Monte-Carlo dropout approach. Interpretation of the mean forecasts from the neural network highlights known MJO mechanisms, providing confidence in the model, while interpretation of the predicted uncertainty indicates new physical mechanisms governing MJO predictability.