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Generative Adversarial Modeling of Tropical Precipitation and the Intertropical Convergence Zone

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In this study we evaluate the use of generative adversarial networks (GANs) to model satellite-based estimates of precipitation conditioned on reanalysis temperature, humidity, wind, and surface latent heat flux. We are interested in the climatology of precipitation and modeling it in terms of atmospheric state variables, in contrast to a weather forecast or precipitation nowcast perspective. We consider a hierarchy of models in terms of complexity, including simple baselines, generalized linear models, gradient boosted decision trees, pointwise GANs and deep convolutional GANs. To gain further insight into the models we apply methods for analyzing machine learning models, including model explainability, ablation studies, and a diverse set of metrics for pointwise and distributional differences, including information theory based metrics. We find that generative models significantly outperform baseline models on metrics based on the distribution of predictions, particularly in capturing the extremes of the distributions. Overall, a deep convolutional model achieves the highest accuracy. We also find that the relative importance of atmospheric variables and of their interactions vary considerably among the different models considered.