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Predictability of Extreme Events in a Nonlinear Stochastic-Dynamical Model

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We evaluate the ability of reduced order models to reproduce the extreme event and predictability characteristics of high-dimensional dynamical systems. A nonlinear model is used which contains key features of comprehensive climate models. First, we demonstrate that the systematic stochastic mode reduction strategy leads to reduced order models with the same extreme value characteristics as the full dynamical models for a wide range of time scale separations. Second, we find that extreme events in these models follow a Generalized Pareto Distribution with a negative shape parameter; thus extreme events are bounded in this model. Third, we find that a precursor approach has good forecast skill of extreme events. We then find that the reduced stochastic models capture the predictive skill of extreme events of the full dynamical models well. We also find that the larger the extreme events the better predictable they are. Our results suggest that systematic reduced order models can be used for the modelling and statistical prediction of weather and climate related extreme events and possibly in other areas of science and engineering too.