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Robust Extremes in Chaotic Geophysical Flows

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A chaotic deterministic system is said to exhibit robust extremes under an observable when the associated extreme value statistics depend smoothly on the system's control parameters. Such robustness can be exploited to enhance the precision and accuracy of statistical estimators of extreme value distributions. It is conjectured here that robust chaos is sufficient for robust extremes. This is demonstrated for 1D Lorenz maps and illustrated numerically for the Lorenz63 flow, derived from the Rayleigh equations for convection in a fluid layer between two plates. Robustness of extremes can be used for the rigorous definition of trends in the extremes of geophysical flows. This is shown for the extremes of the total energy in a simplified two-layer baroclinic model, which display a scaling of power-law type with respect to the baroclinic forcing.