Geophysical Research Abstracts
Vol. 16, EGU2014-4816, 2014
EGU General Assembly 2014

Predictability of extreme values in geophysical models

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Classical extreme value theory studies the occurrence of unlikely large events. Extreme value theory was originally developed for time series of near-independent random variables, but in the last decade the theory has been extended to the setting of chaotic, deterministic dynamical systems. In the latter context one studies the distribution of large values in a time series generated by evaluating a scalar observable along evolutions of the system.

We have studied the *finite-time predictability* of extreme values, such as convection, energy, and wind speeds, in three geophysical models. To that end we computed finite-time Lyapunov exponents (FTLEs) which measure the exponential growth rate of nearby trajectories over a finite time. In general, FTLEs strongly depend on the initial condition. We study whether initial conditions leading to extremes typically have a larger or smaller FTLE.

Our study clearly suggests that general statements about the predictability of extreme values are not possible: the predictability of extreme values depends on (1) the observable, (2) the attractor of the system, and (3) the prediction lead time.