Geophysical Research Abstracts
Vol. 17, EGU2015-10421-1, 2015
EGU General Assembly 2015

Rare event simulation of the chaotic Lorenz 96 dynamical system

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The simulation of rare events is becoming increasingly important in the climate sciences. Several sessions are devoted to rare and extreme events at this meeting and the IPCC has devoted a special report to risk management of extreme events (SREX). Brute force simulation of rare events can however be very costly. To obtain satisfactory statistics on a 1/1000y event, one needs to perform simulations over several thousands of years.

Recently, a class of rare event simulation algorithms has been introduced that could yield significant increases in performance with respect to brute force simulations (see e.g. [1]). In these algorithms an ensemble of simulations is evolved in parallel, while at certain interaction times ensemble members are killed and cloned so as to have better statistics in the region of phase space that is relevant to the rare event of interest.

We will discuss the implementational issues and performance gains for these algorithms. We also present results on a first application of a rare event simulation algorithm to a toy model for chaos in the atmosphere, the Lorenz 96 model. We demonstrate that for the estimation of the histogram tail of the energy observable, the algorithm gives a significant error reduction. We will furthermore discuss first results and an outlook on the application of rare event simulation algorithms to study blocking atmospheric circulation and heat wave events in the PlaSim climate model [2].

[1] Del Moral, P. & Garnier, J. Genealogical particle analysis of rare events. The Annals of Applied Probability 15, 2496–2534 (2005).
[2] http://www.mi.uni-hamburg.de/Planet-Simul.216.0.html