The maximum likelihood climate change for global warming under the influence of greenhouse effect and Levy noise

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An abrupt climatic transition could be triggered by a single extreme event, and an alpha-stable non-Gaussian Levy noise is regarded as a type of noise to generate such extreme events. In contrast with the classic Gaussian noise, a comprehensive approach of the most probable transition path for systems under alpha-stable Levy noise is still lacking. We develop here a probabilistic framework, based on the nonlocal Fokker-Planck equation, to investigate the maximum likelihood climate change for an energy balance system under the influence of greenhouse effect and Levy fluctuations. We find that a period of the cold climate state can be interrupted by a sharp shift to the warmer one due to larger noise jumps with low frequency. Additionally, the climate change for warming 1.5 degree under an enhanced greenhouse effect generates a step-like growth process. These results provide important insights into the underlying mechanisms of abrupt climate transitions triggered by a Levy process.