

Comments on npg-2020-31

The article considered influence of extreme events modeled by Lévy flight on global thermohaline circulation stability. The authors adopted the three deterministic quantitative tools: mean first passage time, escape probability and stochastic basin of attraction to character the stability of the strong THC state and the weak THC state. In my own opinion, the manuscript is clearly structured and organized. However, some points should be considered in the manuscript.

1) In the work, the symbol V has two different meanings. One is the volume in Figure 1, the other is the potential function on Page 5.

2) In stochastic differential equation (9), you can add the initial condition $Y_0 = y_0$. On the second line from the bottom of Page 7, the generator should be $\lim_{t \rightarrow 0} \frac{\mathbb{E}u(y_t) - u(y_0)}{t}$.

3) In the manuscript, the authors adopted the α -stable non-Gaussian Lévy noise to model the extreme events? Can you give the comparison between the Brownian motion and Lévy flight?

4) In equation (4), what is the definition of I ?

5) In Section 2.1.5, what is the definition of $p_i(y)$, m , M ? Could you represent the definition of stochastic basin of attraction to the one-dimensional case since that the escape boundary only has two direction in the one-dimension. The work "Y. Zheng, L. Serdukova, J. Duan, J. Kurths, Transitions in a genetic transcriptional regulatory system under Lévy motion, Sci. Rep. 6 (2016) 29274." also introduces the stochastic basin of attraction, which can be added to the references.

6) In the manuscript, the authors show the three concepts, mean residence time, first passage probability and stochastic basin of attraction to perform the stability analysis. Could you show us how to solve the nonlocal equations (14) (15) and (17)?