Nonlinear Processes
in Geophysics

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Discussions

Interactive comment on "Influence of extreme events modeled by Lévy flight on global thermohaline circulation stability" *by* Daniel Tesfay et al.

Anonymous Referee #2

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In this paper, the effect of α-stable Levy noise on the transitions of the Atlantic Meridional Overturning Circulation (MOC) is studied using a variant of the Stommel two-box model. While this is an interesting topic, the paper needs a major rewrite before it can be considered for publication again. Major issues are:

a. Many of the ocean/climate statements made are incorrect. A few examples are (just on first two pages):

Title: The model does not represent the global thermohaline circulation but the Atlantic

MOC.

l17: Tides are no part of the THC.
l27: There is no surplus of precipitation over evaporation at low latitudes, except in a small zone near the equator (ITCZ).

and a full list over the whole paper would fill at least a page.

b. There should be a justification that the variability in the freshwater forcing can be represented by an α-stable process. Here, the time scale considered is important: when focus is on Dansgaard-Oeschger (DO) events (e.g. Ditlevsen 1999), this is a different issue that when the stability of the present-day MOC is considered. As for the latter case, many observations and model results (reanalyses, CMIP6) are available for justification.

c. The new aspects in this paper, in relation to the one just published (Tesfay et al., 2020 in the reference list), should be clarified as the same model and same noise are investigated. The current paper surprisingly contains many more mistakes in formulation than in the published one, i.e.

l72: $\Delta\rho$ should be divided by ρ_0.
l99: β is no restoration 'tensility' but a ratio of a diffusive and a restoring time scale
l101: definition of μ^2 is wrong.
l105, 107: $dt \rightarrow d\tau$.
l129: the relation between the amplitude of dL_t and F is missing.
Fig. 6 contains no probability distributions as for each curve the integral is not 1.

so please correct all these (and many more).

d. The methodology in section 2.1 should be better explained and only provide well explained mathematical results with reference to the mathematical details. It appears now to have been copied from a mathematics paper with many symbols unexplained. At line 130, there is a reference to a 'Methods' section which is not there.

e. Section 3: I would suggest to split the results into two sections: (i) DO transitions. Connect the results to the Ditlevsen (1999) analysis and proposed noise structure. Can the α-stable noise better describe the transition behavior (as in the proxy data), than just Brownian noise? (ii) Present-day MOC. Is the transition probability of a MOC transition increased under climate change, when incorporating an α-stable process in the freshwater flux noise?

Improve also the interpretation of the results: in the present text, lines 209-210, lines 222-223, lines 267-268 and lines 277-281 make no sense.