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Nonlinear Processes in Geophysics
Discussions

Interactive comment on "Evidence of a fluctuation theorem for the input of mechanical power to the ocean at the air-sea interface from satellite data" *by* Achim Wirth and Bertrand Chapron

Anonymous Referee #1

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General comments:

This study investigates empirically whether or not the time integrated input of mechanical power from the atmosphere to the ocean obeys a fluctuation theorem. If this were the case, observations of the very common case where momentum is transferred from the atmosphere to the ocean could be used to infer probabilities for the rare opposite case. The paper is overall well-written and easy to follow, even if the reader is not closely familiar with ocean dynamics or fluctuation theorems. The core idea is sufficiently interesting for publication in this journal and constitutes a natural next step after the first author's previous study of conceptual models (Wirth 2019). The results

appear to be somewhat inconclusive but this fact alone should not exclude the paper from publication. I am mainly concerned with the data analysis in section 5 which is not very clearly presented, both in terms of the methodology and the actual discussion and plots.

Specific comments:

p.4 l4-5 "fixed surface area" this is probably not very important but is the surface area actually fixed when the sea state can change over time? If you always consider fixed geographical regions, wouldn't calm conditions lead to a smaller surface area than rough seas?

p.2 l22 "the focus" please make it clear whose focus you mean (the focus of most current research?)

p.2 l33-34 "not only concerned with instantaneous values" if I understand correctly, eq. 3 doesn't refer to instantaneous values at all, right? In that case you should cut "only" here.

p.3 l30 please make it unambiguous that the limit of large tau relates to both conditions and not just (ii). Also this is the first instance where tau_0 occurs, please explain what this refers to.

p.5 l27f consider including a map of the world showing these four regions to give non-oceanographers at least some idea where they are located, how large they are and what factors might influence the different dynamics.

p.5 l27f do you have some idea how sensitive your results are to the specific choice of your domains?

p.6 l1 what exactly do you mean by "an interval that spans twice the mean value [...] from the origin"? 0 +/- 2*mean(E_tau) ? In that case why is zero not at the center of the left parts of Fig.1-4 ?

Figures 1-4: Please add axis labels to both parts of the figures. Then the captions of Fig. 2-4 don't need to repeat that of Fig.1, "as Fig.1 but for case XY" would be sufficient. Please give the unit of the averaging time as well.

p.6 l11you state that you will verify Eq. 3 in two steps so the reader expects these two to be addressed in order. It is however unclear to me which of the following two paragraphs is supposed to refer to which aspect (see further comments below).

p.6 l12 you claim that you "determine the slope" but that that slope is never actually shown or discussed directly. Why not fit lines to your curves and show us the estimated slopes (see comment below)? In that way we could also compare whether or not the slope differs between the regions which is hardly possible by comparing curves in different plots with different y-axes.

p.6 l13 you again mention tau_0, can you at least give some rough estimate how long that time-scale might be, relative to the length of your time series? Could this be inferred from the power-spectrum of the time-series?

p.6 18f "This indicates the existence of a large deviation principle" isn't it more important that this convergence is predicted by the FT? What is the relationship between the existence of an LD principle and a FT? Also is this the first or the second part of the verification mentioned above?

p.6 l19f "extension of the domains within ...", "extension of the western boundary current" please refer to the different regions by the acronyms you established before and also refer to the figures in which these results are shown.

p.7 l1f I'm not sure why you chose to quantify the linearity of your curves by this specially designed index. If I understand correctly, the scaled symmetry functions corresponding to long averaging times should be linear across the whole range of z-values. Why not simply fit a line via least squares to calculate the overall slope? Use Rˆ2 to get an idea of the goodness of fit and plot the slopes against tau to observe the conver-

gence behavior. I understand that the statistical interpretation in terms of confidence intervals is questionable but I don't see why your index is more appropriate. Unless I misunderstood your definition, there are many non-linear curves for which gamma=1.

p.8 l7 "extreme events are often key" of course extreme events in general are interesting but your framework doesn't describe just any kind of weather extreme but specifically unusually small (negative) values of atmosphere-ocean momentum transfer. Can you explain a bit more specifically why a rare event wherein the wind in the atmosphere is sped up by the ocean is of interest?

p.8 l9f I like this example, perhaps it would be even more illustrative if you put in actual numbers for tau? Say one month or one year? This, however raises the question how large tau has to be for the FT to hold ...

p.8 l12 "all averaging times" if I understand correctly, your FT only makes statements about long averaging times, right?

p.9 l3 "exp2 &4" please refer either to the figures or the abbreviations of the different regions in a consistent manner, the terms "expN" were never explicitly introduced.

p.9 l18 "guide the up and down-scaling" can you either give a reference for this claim or explain a little more how the FT could help with that?

Technical corrections:

p.2 l14: case mismatch between "the importance [...] is, [...] their imprint", please re-formulate

p.2 l17-18: the sentence with "can not be understood or modelled" is repeated verbatim, please cut or re-formulate.

p.2 l32: replace "i.e." by "e.g."

p.4 l7: replace "is" by "should be"

p.5 l6f “the production has been performed of ...” confusing sentence, do you mean “a near real-time data set, as well as a 24 year reanalysis, [...], have been produced” ?

p.5 l15 25 or 24 years ?

p.5 l20 “6h in time and 1/4° in space” this is repeated from the previous sentence.

p.5 l24 “, For” either change to lowercase or start a new sentence

p.5 l30 “from” instead of “form”

p.7 l5 “these cases” or “this case”

p.8 l1 “is a currently a hot topic” cut one of the “a”s

p.8 l9 “slope” instead of “slops”

p.9 l5-6 replace “to which” by “in which”

p.9 l14 “growth” instead of “grows” or write “its surface grows quadratically”

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