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Interactive comment on "Jarzynski equality and Crooks relation for local models of air-sea interaction" *by* Achim Wirth and Florian Lemarié

Anonymous Referee #1

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Authors analyze the applicability of Jarzynski equality and Crooks relation, (taken from non-equilibrium statistical mechanics) in local air-sea models, subjected both to Coriolis force and a time-varying external forcing protocol. Authors show the quite ample range of situations in which those relations apply. Authors present their results in a sequence of models of increasing complexity, first analytical, then numerical models, in a rigorous and pedagogical form.

The manuscript is suitable for publication in ESD after the correction of some minor remarks.

Pg 2, line 31. When speaking about betaD, explain better its meaning and how it can be obtained. In the present context betaD is the inverse a temperature of a turbulent kinetic energy. Include a statement here explaining that. What should be the equivalent

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to entropy in the present context?

Pg 5, line 2. The external forcing in the ocean equations vanishes. Why? By hypothesis? Explain.

Pg 8 Note in the text that, since the Coriolis force is orthogonal to the speed vector, it does not interfere neither in the work nor in the heat.

Pg. 9 line 1, BetaG is the variation of free energy: G(B)-G(A). In order to be consistent, should the free energy be defined as G(A)=G(A)-G(infinity) ? The state infinity is ambiguous and must be avoided or carefully defined. Clarify please. Solve other cases where free energy or variation of free energy is misused (e.g. pg. 15, line 22).

Pg 9, Eqs. 25,27 say which are the dependent variables of Q (e.g. Q(0,infinity)).

Pg. 11 line 4. The parameter R must be defined here. Normally, according to Wirth (2019), the parameter R measures the strength of the delta-correlated fluctuating force, taken as a white noise process. Include that expression here (See eq. 40).

Pg. 14 In the rhs of Eq. 46, the second term must be multiplied by T

Pg. 16, Eqs. 56 and 61, u_I (∞)=F_0 T since F_0 is an acceleration. Please verify the consistency of physical dimensions.

Pg. 19, line 16. The upper bound of the time interval can be smaller than the lower bound for j=3,.... Please check.

Pg. 21, lines 11-12. Authors say 'probability for a forward event with work smaller than the free energy ïĄĎG is non negligible, the equivalent of such events in thermal processes are related to as "violations of the second law of thermodynamics".' Could you give a number for that probability.

Fig. 5 is never referred in the text. Include its discussion.

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2020.