

## ***Interactive comment on “Thermodynamics, maximum power, and the dynamics of preferential river flow structures on continents” by A. Kleidon et al.***

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We thank Kyungrock Paik for his thoughtful and constructive comments. In the following, we respond to each of his points. The individual points are taken from the review and listed in the following in *italic*, with our response following in plain text.

**comment 1:** *There are notations which may not be familiar with HESS readers. For example, we are familiar with  $Q$  for water flux (volumetric). This paper uses mass flux of water and expressed it as  $J$ . Further, authors use notations such as  $J^p$ ,  $J^{pe}$ , and  $J^{ke}$ . These  $J$  series have different physical dimensions (mass flux, energy, etc.) which*

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*can confuse readers. In particular, the superscripts of  $p$ ,  $pe$ , and  $ke$  look like exponents. These notations make readers to spend additional effort to read the paper. Authors also use  $\tau_s$  for the time scale. Actually  $\tau$  has been very widely used notation for the shear stress, and so this could be also confusing (especially because the authors are dealing with sediment transport in the context). I would suggest the authors reconsidering the choice of notations.*

We agree with the reviewer that the choice of notations is possibly uncommon. The motivation for introducing a different, more general scheme of notation is that there is only a limited set of letters available, and these quite often have different meanings in different fields. For instance,  $Q$  is used for water flux in hydrology, but used for heat content in thermodynamics. We have chosen a terminology here that is used in thermodynamics and used a notation that denote *all* fluxes by the letter  $J$ , with the index indicating the type of flux it refers to. With this, we achieve that at least within the manuscript the notation is consistent. Since the other reviewers did not specifically spell out this to be a problem, we decided to stay with the notation of the submitted manuscript.

**comment 2:** *Title: I assume the title ending with ‘continents’ could be better suited for the context if it ends with ‘continental scale’.*

We have followed the reviewer’s suggestion and altered the title.

**comment 3:** *P7319, Line 8: It would be good to add another reference of Paik and Kumar (2010) next to Phillips (2010).*

Yes, this reference is very adequate and is added in the revision.

**comment 4:** *P7320, Line 9: Not clear what ‘these proposed principles’ mean in this sentence. I suggest revising this as ‘these maximization principles’, ‘these minimization principles’, or ‘these maximization/minimization principles’.*

Agreed. We added the suggested text to the manuscript.

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**comment 5:** P7335, Line 1: The expression for the root should start with  $\Delta\phi^{1/2}$  (which should be consistent with expressions on the line 5 of the same page).

Agreed, the equation was corrected.

**comment 6:** P7335, Line 4: Authors may wish to check whether they want to say  $F_{w,d} \gg 2J_{w,in}\Delta\phi^{1/2}$  instead of  $F_{w,d} \gg 0$ .

Agreed, the equation was improved.

**comment 7:** P7335, Line 5: Please revise the expression here because it is not clear whether  $N_d$  and  $\Delta\phi$  are denominators.

The equation was clarified.

**comment 8:** P7336, Lines 17-18: I am not sure whether the authors can call  $L/\tau_s$  as the 'settling velocity'. There have been previous studies that scaled the settling velocity. Authors may want to check them and if necessary, it may be better to call the quantity  $L/\tau_s$  as a different name.

We followed the recommendation and altered the description of the velocity to avoid confusion.

**comment 9:** P7337, Line 12: I recommend insert 'kinetic energy' between 'exported' and 'by' for clarity.

done.

**comment 10:** P7339, Line 19: In eq. (38),  $D_{w,o}$  on LHS also appears on RHS. How does this eq. work?

The definition of the parameter  $D_{w,0}$  (with index "0") was moved closer to the equation so that it is clearer that  $D_{w,o}$  and  $D_{w,0}$  are two different terms.

**comment 11:** P7340: Lines 16-22: The monotonic decrease of optimal channel number along with increasing rainfall suggested by eq. (44) may need to be stated cau-

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*tiously because it has been studied that the 'drainage density' is not following monotonic function of precipitation. For example, check Gregory (1976). Authors may need to cite relevant references.*

This comment was also made in the review by Hubert Savenije. We corrected the corresponding paragraph.

**comment 12:** Section 4.3: There are many references that deal with the steady-state condition. Some of the key references are summarized in Paik (2011) (pages 686-687) and so authors can check them easily. In particular, the authors' model 3 is similar with the model of Ahnert (1970) (full reference given in Paik (2011)), and so they may wish to check the reference. I suggest authors citing appropriate references about the steady-state condition.

We have added references to the steady-state assumption in section 4.3 (to also address the point raised in review 1.)

**comment 12:** Figure 1: This figure contains fundamental assumptions on tectonic mechanisms which may bring arguments. I would be more careful in stating the four steps. I wonder whether we really need Figure 1 for this paper. If this figure is not critically necessary, authors may consider removing this figure. Figure 1a: I don't think  $\Delta Z_c$  is defined in the paper.

We agree, and Greg Tucker made a similar point (although he found it useful). So we kept the figure and altered it by removing the first part of the figure. A more quantitative evaluation of the potential energy changes during the states that were displayed is added in the Appendix.

**comment 13:** Figure 2: What does  $M$  stand for here?

The  $M$  stands for motor, or engine (a symbol used in electrical engineering). We added this description to the caption.

**comment 14:** Figure 4, 5, 6: Please show the units on the y-axis.

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The units were added to the axes.

**comment 15:** *Figure 4, 6: Are these figures drawn from an example? Then please describe.*

The sample values for creating these Figures were added to the text.

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