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Interactive comment on "Energy of plate tectonics calculation and projection" *by* N. H. Swedan

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Author follow-up comment to a comment of Referee #2

This follow-up is relative the following comment of Referee #2:

6) Fifth, plate tectonics is governed by mantle convection(that fact is ignored here),which occurs at rates that depend on the temperature difference between the mantle interior and the surface, which is ∼1400 degrees C – this means than a few degrees C of surface warming will make little difference to plate tectonic rates.

Author follow-up comment

Mantle convection is not ignored in the manuscript.

It is unclear what mantle convection this Referee is referring to. Interior mantle convection through the boundary layer is practically independent of surface warming and

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surface water temperature; it is a function of mantle temperature, which is constant. This is so stated in the manuscript on page 149 between lines 15 and 21, and the work presented in the manuscript is an agreement with this Referee's comment. The related convection heat transfer coefficient for this mantle convection (which is typically denoted by the letter, h, in the heat transfer literature) is constant even with changes of surface temperature. Please note that even though, h, is constant, the overall heat transfer coefficient between mantle and ocean is variable, because the thickness of the lithosphere is variable with the speed of the tectonic plates and the difference between the temperature of the mantle and the temperature of ocean floor is variable as well with climate change.

On the other hand, the upper mantle convection resulting from the closed loop motion of the tectonic plates, Qh, is variable with the speed of the tectonic cycle. An increase in surface water temperature raises the temperature of the ocean floor. The total temperature difference available between mantle and ocean floor decreases. This would accumulate heat in the earth's interior if not for the increase in the speed of the tectonic cycle. The energy that would have been accumulated is relived in the form of work, W, or the geological activities. This is explained on page 140 between lines 5 and 12.

If the total heat generated in the earth's interior is equal to Qg, the heat to land, Ql, is constant because, h, is constant and land thickness is constant. Ql$\approx$0.3Qg. The heat to ocean, Qo, is variable with the temperature of ocean floor, because the thickness of the lithosphere and the temperature of ocean floor are variable. Qo$\approx$0.69Qg. Please not that, Qo, is not the same as, Qc, used in the manuscript. Qc, or the heat rejected to the ocean by the tectonic engine is only a small fraction of Qo. The total energy balance follows:

Qg=Qo+Ql+W

If surface water temperature increases, the temperature of ocean floor increases and, Qo, decreases. But, W, increases such that the total Qo+Ql+W=Qg at all times. W

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is about equal to 0.01Qg. Vice versa, if surface water temperature decreases, Qo, increases and, W, decreases such that Qo+Ql+W=Qg at all times.

Interactive comment on Solid Earth Discuss., 5, 135, 2013.