REVIEW OF MANUSCRIPT No.: se-2010-5
AUTHORS: L.J. Barrows and V.J. Barrows
TITLE: "The Mechanics of Gravity-Driven Faulting"

The authors of this manuscript describe two mechanisms of earthquake faulting: Elastic rebound and gravity collapse mechanism. The former is widely well known and well accepted mechanism, and the latter is also known but few explored. Based on theoretical and simplified models, the authors make a qualitative comparison between these two mechanisms. The qualitative comparison is quite interesting and informative that I think it is relevant for publication. But the authors go further in their interpretation of this comparison. The overall understanding of this manuscript suggests that gravity collapse mechanism is the main responsible of earthquakes in nature, and elastic rebound is minimum or secondary. If the authors want to keep this message in the paper, they need to work more on it providing convincing arguments to prove it, principally with observations. But I think the paper can be presented in a more prudent way, highlighting that the consideration of gravitation energy change in the energy balance of earthquake can be important, as suggested by other studies (e.g., Chaos et al, 1995) in which gravitational energy change was observed in some earthquakes.

Major comments

-One of the main statements pointed out by the authors is that the decrease of gravitational potential energy (during the gravity collapse mechanism) produces an increase in elastic strain energy. This is ok for a theoretical model, as it was mathematically proved. But if we go to nature, and assuming that this mechanism prevail in earthquakes, we see that this mechanism is physically inconsistent. Earth does not sustain a long term built up of elastic energy. So this accumulated elastic energy will eventually be dissipated weather seismically or aseismically, in an elastic rebound manner (one point for the rebound theory).
As pointed out by Chaos et al (1995), some of the earthquake induced gravitational energy decrease, can turn into other forms of mechanical energy, such as back into gravitational energy in the process of crustal uplifting or mountain building. But they conclude that the primary energy effect of earthquakes is an overall transfer of gravitational energy into terrestrial heat.

Minor comments

- One of the main conclusions of the paper is that this seismic mechanism (slip in direct response to gravitational tectonic stress) is new. Actually it is not new. This idea have been already introduced earlier (e.g., Chaos et al, 1995)
-Gravity inducing earthquakes is actually well accepted. For example the cases of reservoirs inducing seismicity. In these problems, basically the mass of water in the reservoir alters the pressure in the rock which can trigger small earthquakes. It also appears in dams, construction of super-tall buildings and others that tend to pull the mass toward the interior of the earth. The models in Appendix A can nicely explain this seismicity.
- It is expected that horizontal displacement has no effect in the change of gravitational

energy, so it have to drops out from the equations.
- Elastic rebound is a robust model and widely accepted for several reasons: Elastic strain energy is stored by many ways (even due to gravity collapse), and needs to release; it provide a robust framework for understanding fault behaviour over multiple earthquake cycles; it is consistent with observations. The recent Chile earthquake (Mw.~8.8) is one of robust examples of elastic rebound mechanism that was predicted by Ruegg et al (2009).
- Equations 1to 9 are essentially the same equations as 10 to 19. The only difference is that the former set of equations is formulated for one degree of freedom (scalar form), and the latter set for multiple degrees of freedom (matrix form). I do not think it is necessary to show both. The author may decide of one of them. I would be favorable for the scalar form, since it is simpler.

References:

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- Ruegg, J.C., A. Rudloff, C. Vigny, R. Madariaga, J.B. de Chabalier, J. Campos, E. Kausel, S. Barrientos, D. Dimitrov (2009). Interseismic strain accumulation measured by GPS in the seismic gap between Constitución and Concepción in Chile. Physics of the Earth and Planetary Interiors 175 (2009) 78–85.