Nonlin. Processes Geophys. Discuss., 2, C130–C133, 2015
www.nonlin-processes-geophys-discuss.net/2/C130/2015/

Nonlinear Processes in Geophysics
Discussions
Open Access

Interactive comment on "Stress states and moment rates of a two-asperity fault in the presence of viscoelastic relaxation" *by* M. Dragoni and E. Lorenzano

M. Dragoni and E. Lorenzano

michele.dragoni@unibo.it

Received and published: 27 April 2015

[a4,12pt]article lineno

Response to an Anonymous Referee's Comment

M. Dragoni and E. Lorenzano

Dipartimento di Fisica e Astronomia, Alma Mater Studiorum Università di Bologna, Viale Carlo Berti Pichat 8, 40127 Bologna, Italy

We thank the Anonymous Referee for his comments on the first version of our paper. He considers some points that we discuss in the following.

(a) The hypothesis that asperities have equal areas is made for the sake of simplicity. The equations of motion were written according to this hypothesis and relaxing it would introduce an additional parameter. In many earthquakes, asperities have similar areas and assuming that they are equal is a reasonable approximation. The dynamics of a fault with two asperities of different areas will be the subject of future work.

(b) The parameters ϵ and β are independent of each other. If we call f_{s1} and f_{d1} the static and the dynamic frictions of asperity 1, respectively, and f_{s2} and f_{d2} the static

and the dynamic frictions of asperity 2, we define

$$\epsilon = \frac{f_{d1}}{f_{s1}} = \frac{f_{d2}}{f_{s2}} \tag{1}$$

Hence we have $0 < \epsilon < 1$. On the other hand, β is the ratio between frictions of the two asperities:

$$\beta = \frac{f_{s2}}{f_{s1}} = \frac{f_{d2}}{f_{d1}} \tag{2}$$

Since we define asperity 1 as the one having the higher friction, it is always $0 < \beta < 1$, independently of the value of ϵ.

(c) According to the model, events involving the simultaneous failure of asperities can take place only from particular subsets of states of the system: at the beginning of an earthquake, these subsets are the regions R_1 or R_2 shown in Fig. 4. There is observational evidence that asperities can slip simultaneously: an example is the 2010 Maule earthquake, for which a phase of simultaneous slip of two asperities is reported by Delouis et al. (2010).

(d) We applied the model to the 1964 Alaska earthquake for a number of reasons. First, the earthquake was due to the failure of two distinct asperities. Secondly, being a large-size event, it was followed by remarkable post-seismic deformation. Finally, more

than 50 years have elapsed since the earthquake, allowing such a deformation to be observed over a sufficiently long period of time.

(e) In fact, the velocity of the Pacific Plate relative to the North American Plate at the Alaska/Aleutian Trench increases gradually from the northeast to the southwest (DeMets and Dixon 1999; Cohen and Freymueller, 2004). However, the difference between the area of Prince William Sound and the area of Kodiak Island is small, in the order of few mm per year, and can be reasonably neglected.

References

Cohen, S.C. and Freymueller, J.T.: Crustal Deformation in the Southcentral Alaska Subduction Zone, Advances in Geophysics, 47, 1-63, 2004.
Delouis, B., Nocquet, J.-M. and Vallée M.: Slip distribution of the February 27, 2010 Mw = 8.8 Maule earthquake, central Chile, from static and high-rate GPS, InSAR, and broadband teleseismic data, Geophys. Res. Lett., 37, L17305, doi:10.1029/2010GL043899, 2010.
DeMets, C. and Dixon, T.H.: New kinematic models for Pacific-Â–North America motion from 3 Ma to present. Part 1. Evidence for steady motion and biases in the NUVEL1-A model. Geophys. Res. Lett. 26, 1921Â—1924, 1999.