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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

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This paper builds on earlier published work by Dragoni and Santini (2012, 2014), developing a mathematical model for a fault with two asperities embedded within a viscoelastic shear zone. The model has a simplified description of the buildup of stress, rupture of the asperities, and stress redistribution as a result of earthquake ruptures. The basic setup of the model appears to be the same as in the earlier papers, although they emphasize different aspects of the model behavior.

The model is then applied to the case of the 1964 Alaska earthquake, and this is where a fundamental problem with the paper occurs. In equation (1), displacement of

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the viscoelastic shear zone loads one asperity while unloading the other. Although the direction of slip is not shown in any figure in this paper, this relationship implies that the direction of slip is along the line connecting the two asperities. Figure 1 of Dragoni and Santini (2012) and Dragoni and Santini (2014) clarify this. Thus the model is set up for the case of two along-strike asperities on a strike slip fault. This would be equivalent to two asperities on a thrust fault separated in the updip and downdip direction, but this is not the case for the Alaska 1964 earthquake. In fact, the two asperities in the Alaska 1964 case (and the thrust fault cases analyzed in the previous papers) are separated in the along-strike direction and slip in the system is in the dip direction, which means that displacement of the shear zone will load or unload both asperities with the same sign.

It is a bit beyond me to intuitively say how this will impact the findings of the paper, but every differential equation that depends in part on the relationship $F_2 = -Y - \alpha * Z$ (should be $+ \alpha * Z$ as in the relation for F_1) will change and thus have a different solution. It seems likely that the behavior of the system could change completely, although it might not be so extreme. But they need to set up the problem correctly for thrust faulting if they wish to apply the model to that case.

In section 4, it seems the model can generate 3-mode and higher (n -mode for $n > 2$) ruptures. If I understand the authors correctly, a 3 mode rupture would involve rupture of asperity 1 (only), followed by rupture of asperity 2 (only), followed by re-rupture of asperity 1, all in the same event. (The roles of the two asperities also could be reversed). Can the authors point to any real-world examples of an n -mode rupture for $n > 2$? I can't think of one.

The paper is also missing some more recent references for the 1964 earthquake: Slip models (Ichinose et al., 2007; Suito and Freymueller, 2009). Postseismic deformation models (Suito and Freymueller, 2009). No conclusions depend on this, but the authors should update. Both of these papers were in JGR.

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I found a few minor English edits, although overall the paper was written very clearly and in correct English.

p. 298, line 7, delete “the” after “which” p.298, line 24, add “that” after “earthquakes”
p.299, line 19, change “that” to “which” p.316, line 12, delete “the” at end of line.

Interactive comment on Nonlin. Processes Geophys. Discuss., 2, 297, 2015.

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