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On the role of multiple interactions in remote aftershock triggering: The Landers and the Hector Mine case studies

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I examine various properties of pre-mainshock and post-mainshock earthquake activities in remote sites that were triggered by two California earthquakes, the magnitude 7.1 Hector Mine earthquake and the magnitude 7.3 Landers earthquake. I define a new parameter, mainshock index, that quantifies the degree to which each aftershock is acting locally as a mainshock. Mainshock index greater than 1 is indicative of seismicity rate increase in the vicinity of the aftershock in question, suggesting that the effect of stress transfer from that aftershock to later aftershocks in that region is more important than that of the stress transfered from the mainshock and earlier aftershocks. I show that many of Landers aftershocks have a mainshock index greater than 1, and that the fraction of aftershocks with mainshock index greater than 1 increases with increasing aftershock magnitude. For example, the fraction of Landers aftershocks with mainshock index greater than 1 is $\approx 15\%$ for aftershocks of magnitude greater than 3, but $30-50\%$ for aftershocks with magnitude greater than 4. I present a time-space diagram for Hector Mine aftershock sequence, which suggests that this sequence is made up of several sub-sequences, and that the onset of activity migrated southward. I propose that delayed aftershocks occurring in remote sites are not directly triggered by the mainshock, but are instead secondary aftershocks triggered by previous aftershocks that are acting locally as mainshocks. Finally, I describe the results of quasi-static earthquake simulations that prove the viability of this mechanism.