

Solid Earth Discuss., referee comment RC1
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Comment on se-2021-6

Bernd Schurr (Referee)

Referee comment on "Very early identification of a bimodal frictional behavior during the post-seismic phase of the 2015 M_w 8.3 Illapel, Chile, earthquake" by Cedric Twardzik et al., Solid Earth Discuss., <https://doi.org/10.5194/se-2021-6-RC1>, 2021

Twardzik and co-authors investigate the early, i.e. first 12 h of co-seismic deformation following the 2015 M_w 8.3 Illapel Chile earthquake. For this purpose they use 2 already published data sets: 1) 30 sec sampled position time series from 15 cont. GNSS sites earlier published by the authors (Twardzik et al. 2019) and 2 earthquake catalogs based on template matching to obtain high completeness even during the early phase of the aftershock sequence, published by others (Huang et al. and Frank et al. both 2017). The authors derive hourly displacements from the position time series and invert them for hourly afterslip maps. These are compared to aftershock catalogs to distinguish between seismic and aseismic deformation during the early post-seismic phase. They find that the cumulative afterslip during the first 12 h skirts around the lower end of co-seismic slip, a pattern that persists also during the later and longer post-seismic period. There are two main lobes north and south of the co-seismic slip region that behave differently. The northern patch apparently slips mostly aseismically, whereas for the southern patch moment release is dominated by aftershocks (incl. an $M_{7.1}$ and $M_{6.8}$ aftershock).

The manuscript is well written and well illustrated. I have only few minor points I comment in the following.

l.58 "seismic noise" – I think this is not really seismic noise but overwhelming signal, i.e. numerous often simultaneous aftershocks, that is causing problems to most detectors.

l.28: change "activity" to "deformation". I think there is a "itself" missing after "express".

l.49: change "highly" to "more"

l.89ff: "The cumulative surface displacements are calculated at every hour since the mainshock origin time by computing the average positions over a 1-hour time window

centered on the time of interest." Does cumulative refer here for cumulative during the one hour processed or cumulative since the main shock. I assume the earlier, but please clarify.

l.126: "yellow circles" should be "purple stars"?

l.129: There is a word missing after "second". Maybe "patch".

l.140ff: "When we look more closely, we see that some of the post-seismic slip might have penetrated inside the co-seismic rupture area (Figure 3)."

The general fuzziness of both co-seismic and post-seismic slip models makes this assertion difficult to maintain (and the authors actually relativize it later in the paragraph). In particular, different fault model used (simple plain slab like the authors or varying slab dip based on e.g. slab2.0) in the modeling will shift location of slip. To start interpreting this, at least the modeling set-up of co- and post-seismic slip should be the same.

l.186ff: "Our models show that post-seismic slip is now only observed north of the co-seismic rupture area and that the patch to the south has completely vanished." And also Figure 3 and Figure 6.

First of all, slip in Fig. 3 and 6 I assume is the slip during the respective hour, not the cumulative slip added up also from the previous hours (must be based on the amplitudes and the fact that some patches vanish). I don't understand why, if only the offsets of the 2 largest aftershocks are corrected (hour 1 and hour 5), all slip vanishes in the southern patch also during the other hours. Please explain.

Fig. S7.1: The second M6.8 aftershock occurs during hour 5 and clearly shows up as a step in the graphed moment. However a step in slip seems to occur mainly in hour 6? Is this an averaging effect?

l.197ff: Please elaborate in one or two sentences what this predicted acceleration phase signifies.

l.201ff: Please mention where the cited studies were based (Ecuador and Japan).

l.209: Change "rate-and-state law" to "rate-and-state friction law" here and everywhere else.

l.257: I wonder, are aftershocks anywhere actually operationally forecasted based on some models (maybe a citation would be good)? If so, I would assume that models have to be simple and robust. Here e.g. CFS would naturally predict aftershocks around the co-seismic rupture area, where they do occur, for the Illapel eqk and also for many other subduction zone earthquakes. I wonder, how realistic and it is to actually do the hindsight analysis outlined here in near real time and if it really adds value. Of course, this could be tested.

l.271ff: "Our additional finding is that the slip patterns that we observe after 12 hours persists over the first 2 months. When that is the case, information about very-early post-seismic slip can help to characterize longer-lasting post-seismic slip, which can prove to be useful to include for the forecast of aftershocks locations."

But can this really be generalized?