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Propagation of slow slip leading up to the 2011 Mw 9.0 Tohoku-Oki earthquake

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Many large earthquakes are preceded by one or more foreshocks, but it is unclear how these foreshocks relate to the nucleation process of the mainshock. On the basis of an earthquake catalog created using a waveform correlation technique, we identified two distinct sequences of foreshocks migrating at rates of 2-10 km/day along the trench axis toward the epicenter of the 2011 Mw 9.0 Tohoku-Oki earthquake. The time history of quasi-static slip along the plate interface, based on small repeating earthquakes that were part of the migrating seismicity, suggest that two sequences involved slow slip transients propagating toward the initial rupture point. The second sequence, which involved large slip rates, may have caused substantial stress loading, prompting the unstable dynamic rupture of the mainshock (Kato et al., 2012, Science).

Keywords: Tohoku-Oki earthquake, slow slip, migration, repeating earthquakes