Slow slip and tectonic tremor episodes on south-central Alaska megathrust

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We jointly investigate aseismic slip transients and tremor activity in south-central Alaska, where only independent studies of either process have been carried out. Near the eastern downdip edge of the Mw 9.2 1964 Prince Williams earthquake rupture, years-long slow slip events (SSEs) have been observed by continuous Global Positioning System (GPS) measurements below the lower and upper Cook Inlet. Kinematic modeling of the 2009 - 2013 SSE below the upper Cook Inlet suggests cumulative transient slip of up to 55 cm, for an equivalent moment magnitude Mw = 7.6. During this 5-year transient event, tectonic tremors were co-located with the inferred aseismic slip zone and occurred in weeks-long bursts of events. A transient deformation event is observed in the GPS time series spanning a tremor burst in September 2010. This Mw = 6.9 subevent ruptured a ~100 km-long section of the subduction thrust. The time-dependent modeling of its slip shows that it migrated along strike with tremor at speeds of ~8 km/day and with slip rates of ~ 3 mm/day. During this subevent, 9 % of the total moment of the 5-year transient event was released in 1.4 % of its duration, showing that slip rates were highly variable. To complement the detailed analysis of this single event, we decomposed the GPS time series relative to tremor times during the 5-year transient event. GPS site velocities were on average 3 to 6 times higher during tremor bursts than in between, suggesting that slip pulses are generally associated with tremor bursts. This inference is strengthened by the decomposition of the GPS time series after the 5-year-long deformation event, when tremor bursts continued to occur. Our results show that the plate interface is being loaded in between the short-duration events, and slips at times of tremor bursts. We discuss two end-member models to explain the 5-year-long transient deformation event. It could either represent a cluster of short-term events or it could be the sum of short-term ETS events in the tremor zone and a smooth long-term slip event located updip.

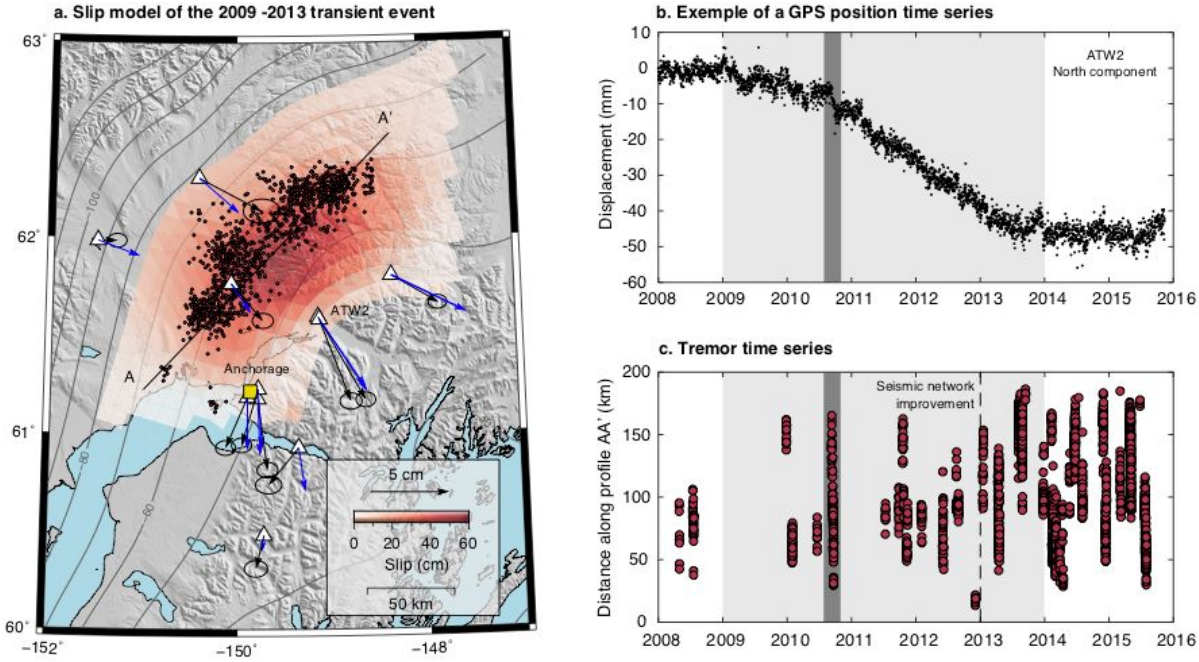

Figure: Geodetic and seismic observations of the 2009 - 2013 transient event. (a) Total static slip amplitude of the transient event and tremor locations from 2008 to 2016. GPS stations are indicated by white triangles. The total GPS-measured offset is shown by the black arrows tipped with 1-sigma confidence ellipses, and the model prediction by the blue arrows. (b) North component of the position time series of GPS station ATW2 from 2008 to 2016. The light gray rectangle indicates the duration of the 5-year transient. The darker gray bar highlight the 2010 September sub-event studied in details in section 3.2. (c) Tremor time series projected along the profile AA' shown in a.