Slow earthquakes under Unalaska and Akutan Islands in the Alaska-Aleutian subduction zone using mini seismic arrays

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The coupled phenomena of tremor, LFEs and episodic slow slip events (SSEs) may represent a mode of failure for a transition zone between a locked and continuously creeping fault [Shelly et al., 2006]. Existing literature shows that LFEs comprise at least a portion of tremor [Shelly et al., 2007a, 2007b], and Shelly et al. (2006) shows strong evidence that the LFEs occur on the plate interface, coincident with the inferred zone of slow slip. Thus study LFEs helps us have a better understanding of the coupled phenomena of tremor, LFEs and SSEs. LFEs are difficult to be detected due to their inherently low signal-to-noise ratios. It becomes more challenging in Alaska-Aleutian subduction zone, because of the harsh weather conditions, the limited land and seismic station coverage, and the interference of the volcanic activities.

In this study, we used the beamforming network response method [Frank et al., 2014], to detect and locate non-volcanic tremor and LFE templates during the two-month data recorded by the mini seismic array that installed in the summer of 2012 by Abhijit Ghosh, in collaboration with United States Geological Survey. During the time period, the array detected tremor activity of 1.3 hours per day on average, which is ~5 times more than a visual detection using the existing Alaska Volcano Observatory network. We used a beam backprojection method to automatically scan the array data for tremor activity [Ghosh et al., 2009]. The LFE templates detected are used to detect more LFEs over the two-month period using the match filter method. Using the two templates detected, hundreds of additional LFEs are detected and their location matches with tremor locations obtained by beam backprojection method (Figure 1). They located in the eastern edge of the 1957 M8.6 and west of the 1938 Mw8.2 megathrust rupture zone (Figure 2). Another seismic array has been deployed last summer (2014) and two more arrays will be installed this coming summer (2015). The limitation of seismic station coverage will get greatly improved with the 3 arrays running simultaneously, and we will be able to detect much more tremor and LFEs and have better control of their locations. This also helps us better understand the mechanism of tremors, study the stress transfer in the subduction zone due to slow earthquakes and have a better idea of the spatiotemporal distribution of the slow earthquakes in this region.

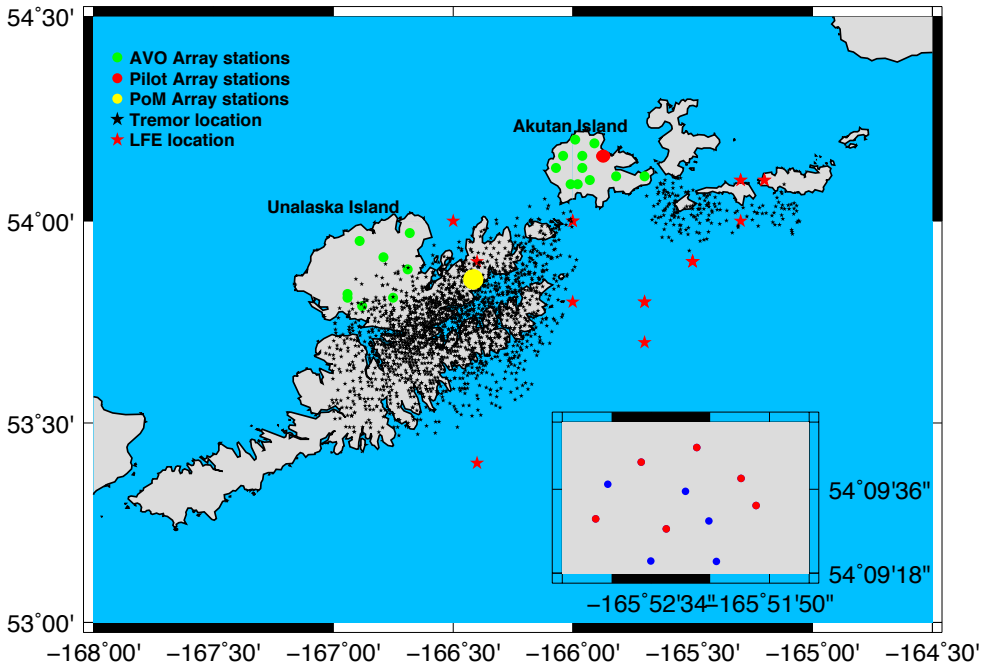

Figure 1. Two-month data Tremor and LFE templates distributions. The insert figure shows the Pilot Array stations.

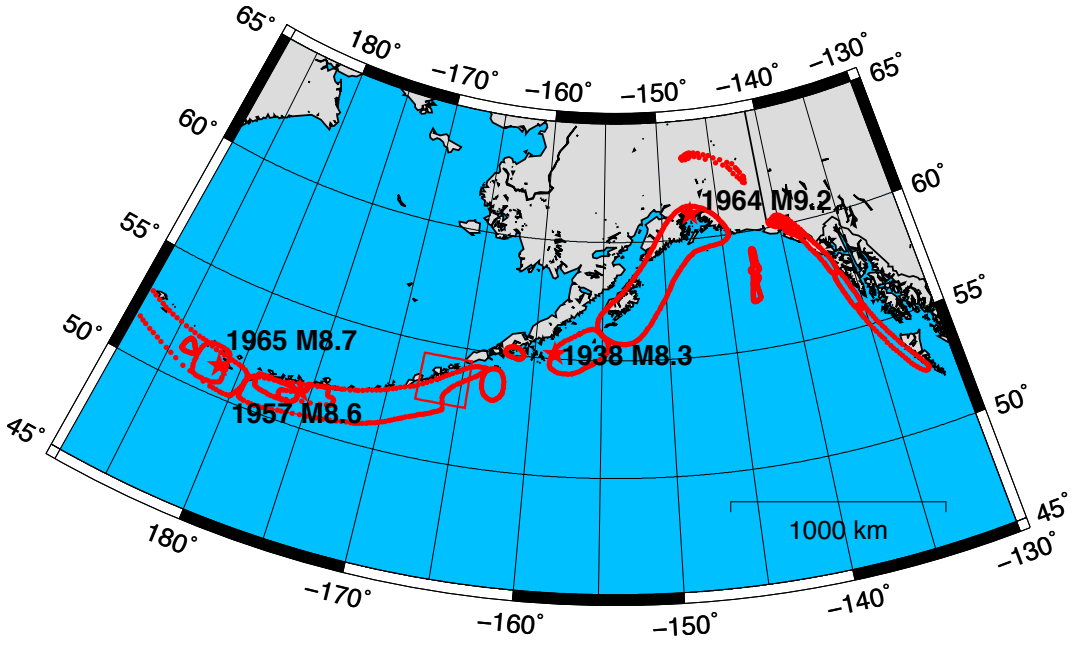

Figure 2. Rupture zone for the large earthquakes happened in Alaska Aleutian subduction zone. The red box shows our study area.