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A Strain Event Related to Aftershock Activity Following the 2003 Tokachi-oki Earthquake (8.0)

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On September 25, 2003 at 19:50 (UTC) a great thrust earthquake occurred off Tokachi (Tokachi-oki), the junction of the Kuril and the Japan trenches; many aftershocks were recorded. For aftershocks with magnitude >4.0, the dominant active period was from 25th September to 11th October. Almost all the aftershocks are thrust faults on the plate boundary. They did not occur in the large stress-drop zone, but surrounding the main shock (Ito et al., 2004). The pattern suggests that many aftershocks on the plate boundary were triggered by stress increase due to non-uniform rupture process of the main shock (Ito et al., 2004).A Sacks-Evertson borehole strain meter is located 105 km from the epicenter of the main shock at azimuth 300 degrees. The sensor is at a depth of 110m in a borehole at Urakawa Seismological Observatory (KMU) of Hokkaido University in the southern part of the Hidaka Mountains. The strain data showed rapid contraction during the period of high seismic activity with the strain data closely resembling the plot of cumulative number of aftershocks. This contraction was followed by slower expansion over a longer time interval. We examine possible mechanisms for the relation between the aftershock activity and the deformation changes observed during the beginning of the aftershock sequence.
Conclusion:
1. State-space modeling for decomposition with Non-Gaussian Noise and Jump process is used to isolate tidal signal, pressure and precipitation effect.
2. Two slow slip stages calculated using the formulation by Okada (1992) have been identified on the Pacific subduction plate beneath southern Hokkaido. Over long time intervals these patches are aseismic.
3. Unusually, there were no co-located small earthquakes during the slow slip events; rather the areas bounding the slow slip regions show enhanced seismic activity during the slip episodes.
4. The average slip for each stage was 50cm, which suggested that there must have been considerable long-term strain storage. The average slip on the adjacent main earthquake fault was about 3m, with a 5 m peak.
5. The model is based primarily on the strain transient but is in general agreement with the GPS data.

Keywords: 2003 Tokachi-oki earthquake, Volume strain record, Slow slip faulting, Aftershocks, State-space model, Signal decomposition