Anomalies of seismicity in space and time measured by the ETAS model and stress changes

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We first investigate the aftershock activity of the November 2006 great event of Ms8.3 at Chishima (Kuril) Islands based on the PDE hypocenter catalog determined by USGS together with the focal mechanism solutions from the Harvard catalog. The aftershocks are apparently separated into two spatial parts. The dominating mechanisms in the aftershock area of the western cluster are reverse faulting type similar to the mainshock mechanism while it is normal faulting type in the eastern cluster, which is consistent with triggering of the off-fault aftershocks in the outer rise. It is interesting that the off-fault aftershock activity in the eastern cluster is substantially higher than the proper aftershock activity in the western cluster. The b-values of the two clusters do not differ from each other.

It is not clear from the curve of the cumulative number of aftershocks against the ordinary time to examine whether or not any changes of the aftershock activity take place. Thus, we have fitted the ETAS model to the data for the whole aftershock sequence to find the significant change after a half month from the main event and also to find quiescence relative to the predicted rate during the second period of one month preceding the January event of Ms8.2. The space-time plot of the NW-SE cross-section against the transformed time by the predicted model shows the uniform distribution except for the eastern cluster after the change-point till the main event. We suspect that the sparseness (relative quiescence) in the eastern cluster may be due to precursory slips in the fault of the forthcoming January great event. This hypothesis can explain the phenomenon how the quiescence appeared in one part of the clusters but not seen in the other part due to the different receiver fault mechanism.

The seismic activity since September 2006 till the November great event of Ms8.3 was far extraordinary in the sense that the stationary ETAS model does not well fit to the data during the period. It is seen to be swarm or foreshock activity in the sense that the conspicuously largest earthquake as the main event was not occurred during the period. The b-values of this precursory activity is low (b=1.1) in comparison with that of aftershock activity of the November event (b=1.7). During this activity we see very low p-value (p=0.5) in the first half month, while high p-value (p=1.7) in the remaining period if we fit the ordinary ETAS model with the constant parameters for each of the periods. This indicates that the parameters of the ETAS model vary in time, especially the background $¥mu$-value, which suggests the stress-change due to the nucleation of the November great rupture.

References

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