Heterogeneous back-slip rate along the southern Kuril subduction zone obtained with the minimum solution norm constraint

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For back-slip inversion analyses, the smoothness constraint that assumes the back-slip distribution smoothly changing in space has been generally adapted. The smoothness constraint gives us a set of solutions which reproduces observed data and distributes as smooth as possible. It would overlook abrupt spatial changes of back-slip rate, although such distribution is a key for understanding heterogeneous stress accumulation on and around the plate interface. Another shortcoming of the smoothness constraint is that imaged slip tends to ooze out to unresolved area such as near the trench. We therefore applied another constraint called as the minimum solution norm constraint that estimates a set of solutions as short as possible, reproducing observed data.

Advantageous of this constraint are that (1) it properly reveals abrupt changes in space since a slip is not affected by surrounding slips and (2) slip does not appear on unresolved area because of length of solution tries to be short.

Using the minimum solution norm constraint, we imaged the back-slip rate distribution along the southern Kuril subduction zone from Sept.1998 to Aug. 2003. The estimated back-slip rate correlates with other geophysical observations rather than a result obtained with the smoothness constraint. For example, large back-slip zones almost overlap the rupture areas of the 1973 Nemuro-oki and 2003 Tokachi-oki earthquakes. The back-slip rate is consistent with a slip rate estimation derived from repeating earthquakes (Matsubara et al., 2005). We further discovered an important feature that the deeper part of the 2003 rupture area had already been uncoupled for several years before the 2003 Tokachi-oki earthquake. A seismic quiescence was also found over the uncoupled area during the same period (Katsumata et al., 2005). This coincidence indicates that the seismcity quieted down by stress releasing caused by a transition from couple to uncouple on the deeper part of the rupture area.