Loosening of the interplate coupling in the focal region of the anticipated Tokai earthquake induced by the 2000 seismo-volcanic event in the northern Izu Islands

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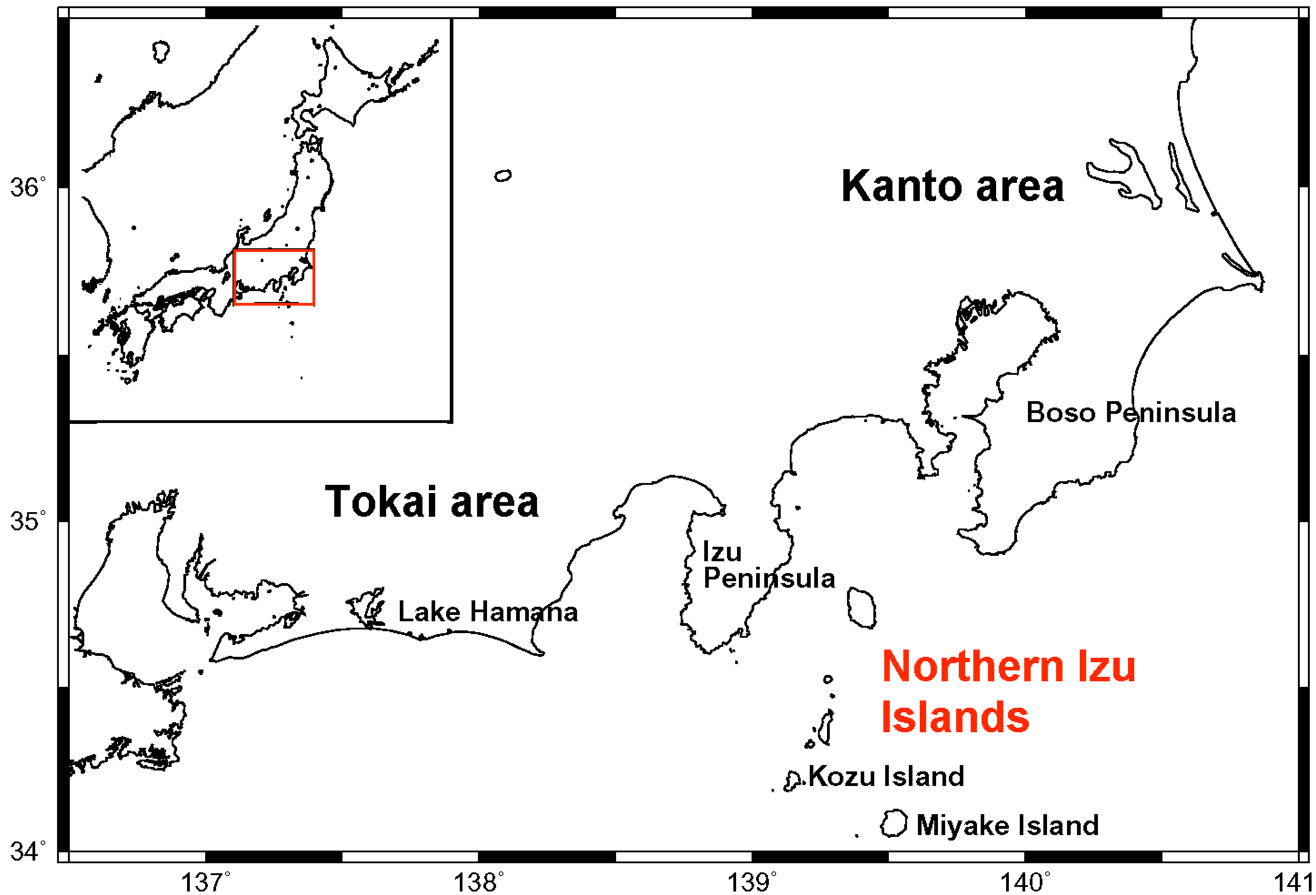
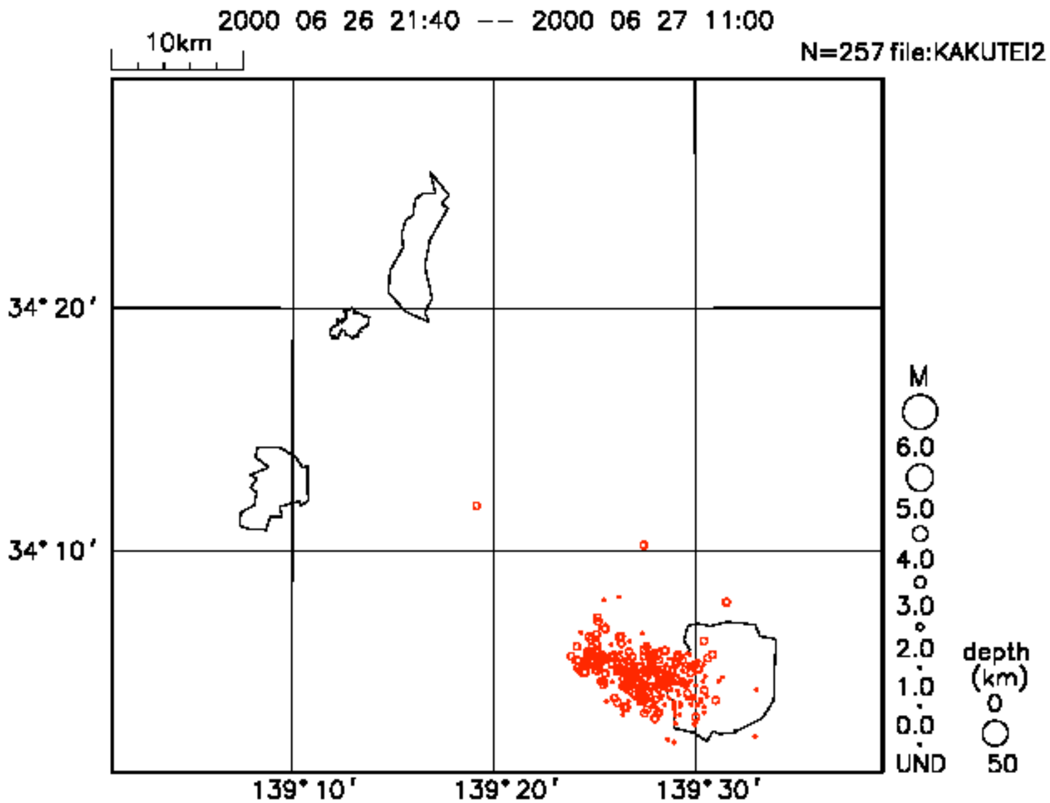
- Crustal deformation at and after the 2000 northern Izu seismo-volcanic event
- Source model for the crustal deformation
- Implication of the crustal deformation

Proposal: The 2000 northern Izu seismo-volcanic event brought about weakening of the interplate coupling in the Tokai region and that eventually triggered the slow slip near Lake Hamana.



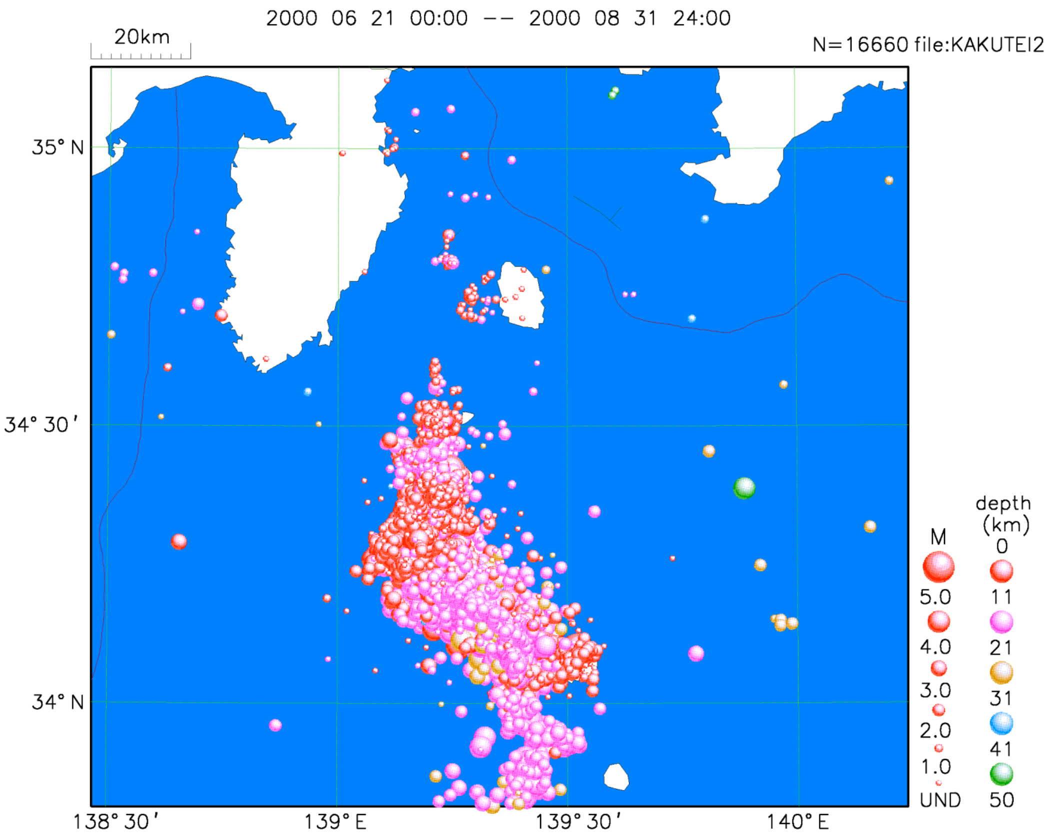
We first outline seismo-volcanic activity of the northern Izu Islands in 2000.

This is a map showing locations of the northern Izu Islands, Kanto, and the Tokai area.



A swarm activity began on 26th June 2000 in Miyake Island.
The active area soon moved to the west of the Island.

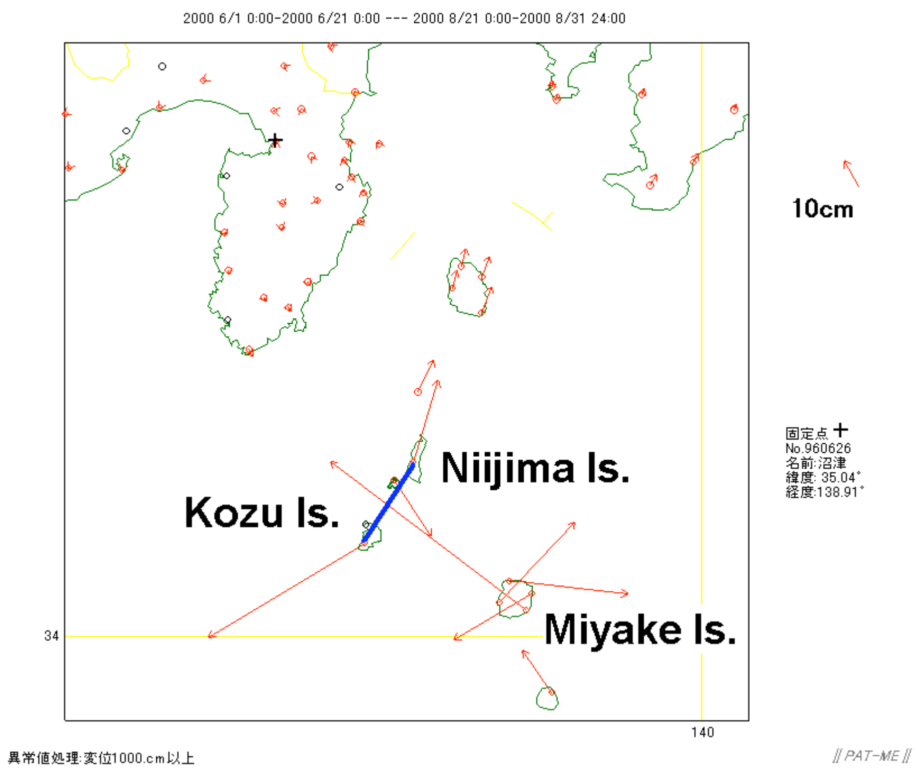
Swarm earthquakes were distributed in the sea region between Miyake and Kozu Islands.
The expansion of the source area is considered to have been caused by a dyke intrusion of magma.

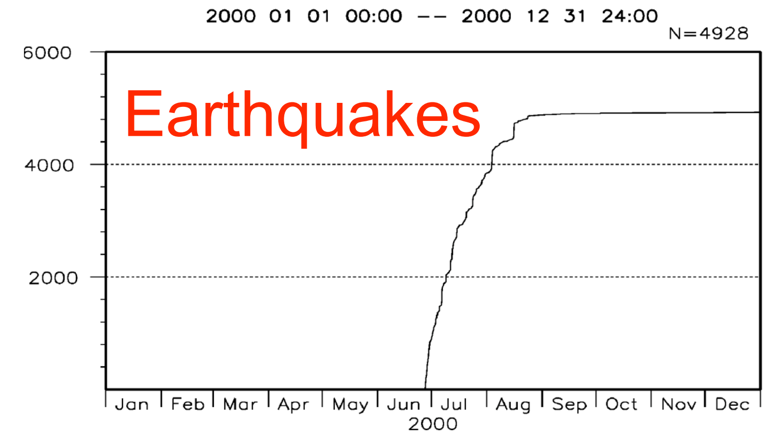


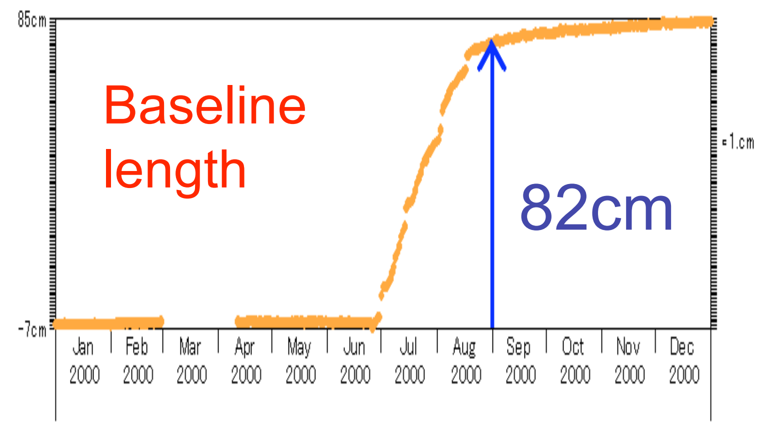
The swarm activity became the largest one ever observed in Japan. It includes more than 40 earthquakes with M5 or larger and 5 earthquakes with M6 or larger.

The most active period ended in the middle of August.

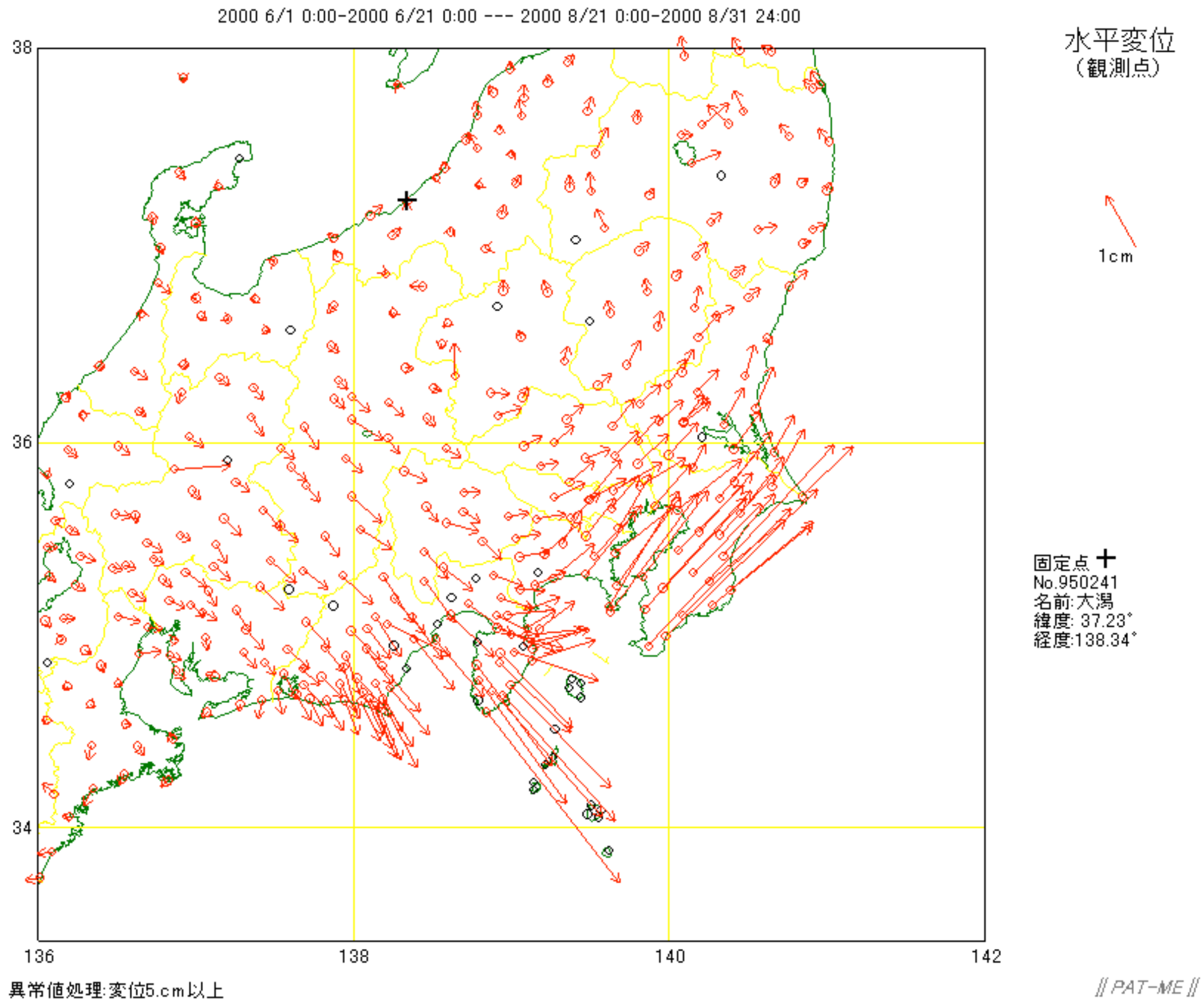
A volcano in Miyake Island repeated summit eruption several times from mid July through early September



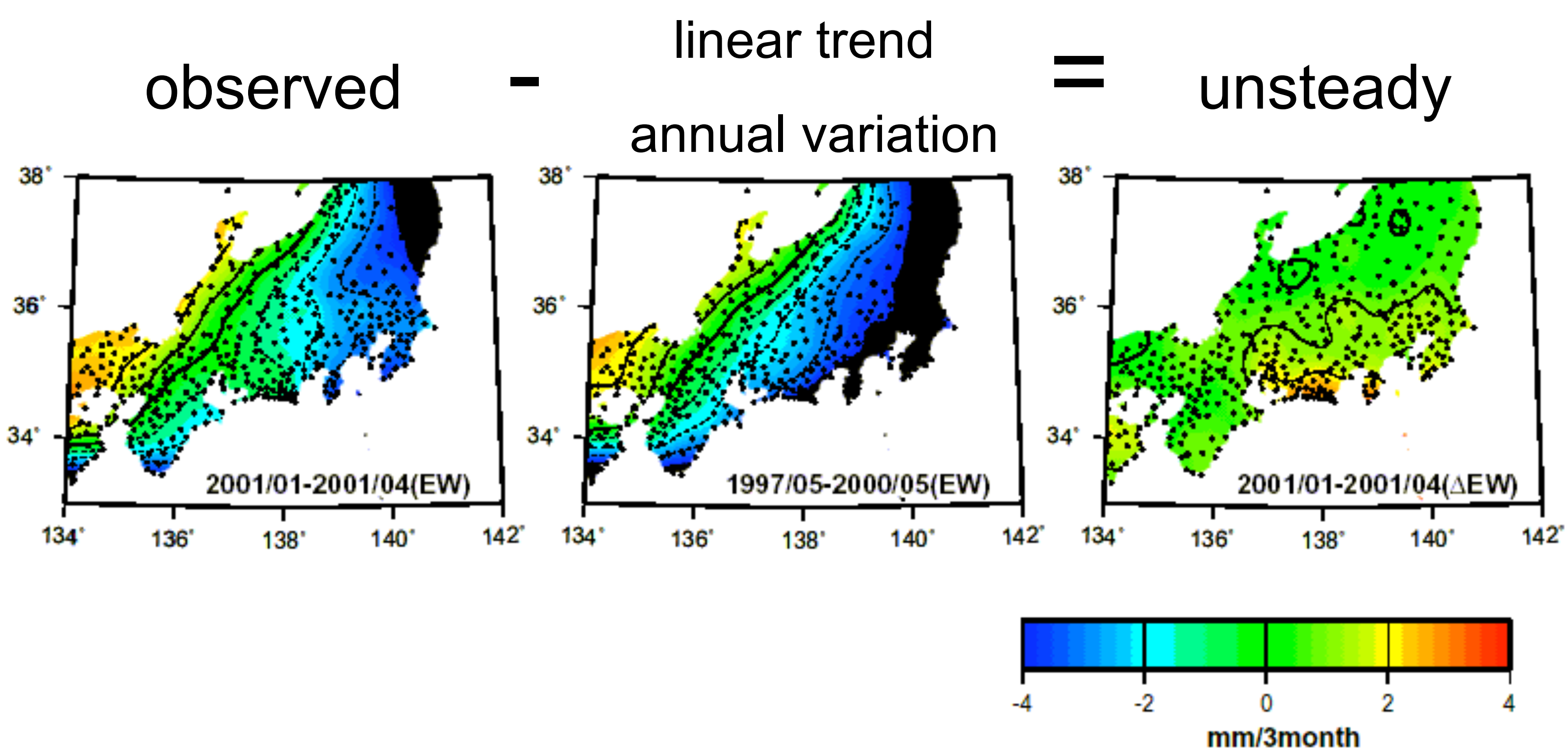




Remarkable crustal deformation was observed during the activity.
The right panel shows change in the distance between Niijima and Kozu Islands.
The interval was extended 82 cm in two months till the end of August.

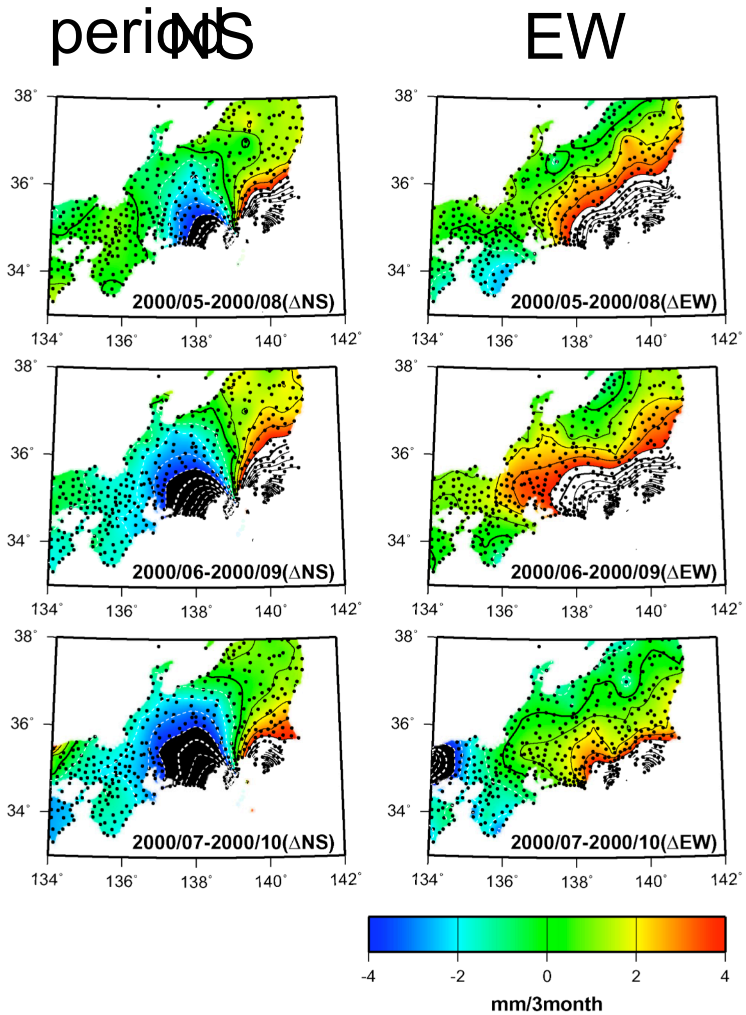


The crustal deformation that accompanied this event extended from southern Kanto to Tokai and Chubu district.



Smoothed displacements using a GMT tool.
We subtracted a linear trend and annual variations.
We use this method from now on.

Transient deformation in each three-month period



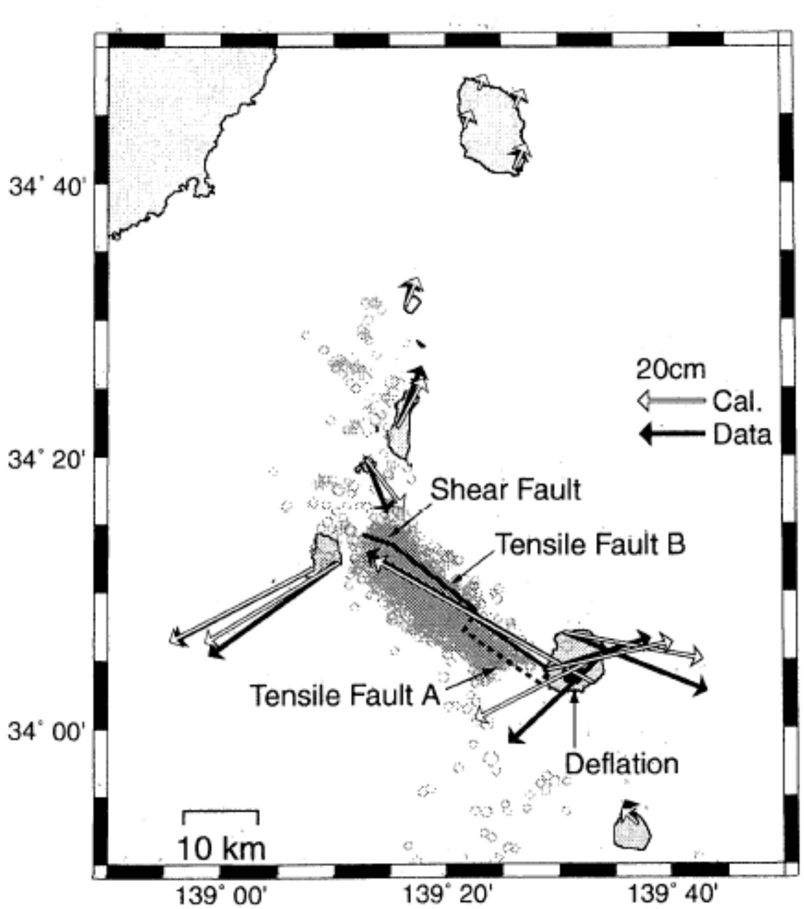
May - August

June - September

July - October

In Tokai and Chubu, transient crustal deformation was extended further to the north in the latest period from July through October. But such an expansion of the area was not seen in Kanto.

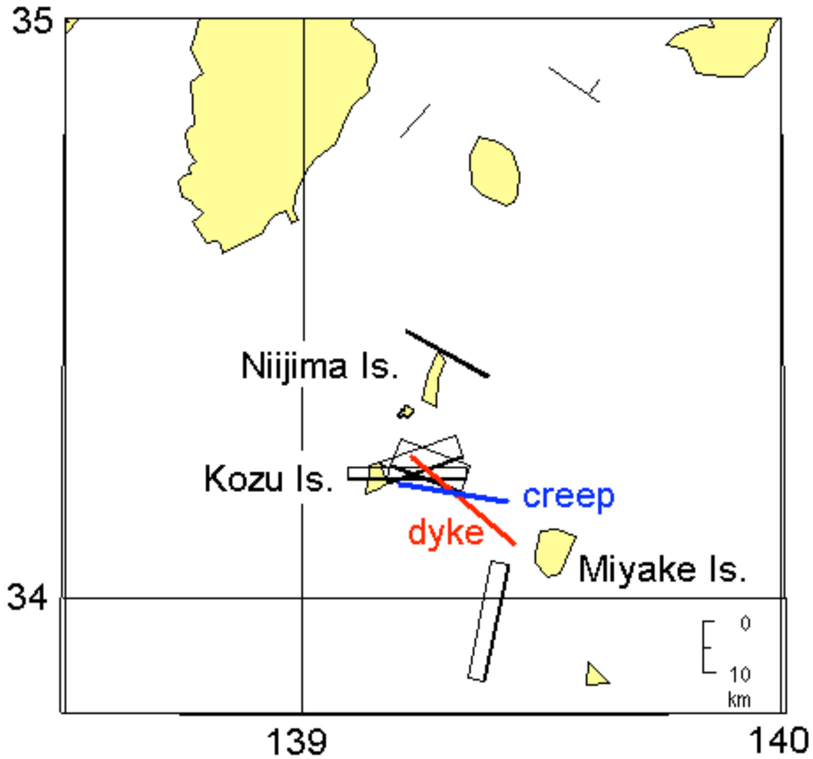
Sources of the crustal deformation of northern Izu Islands

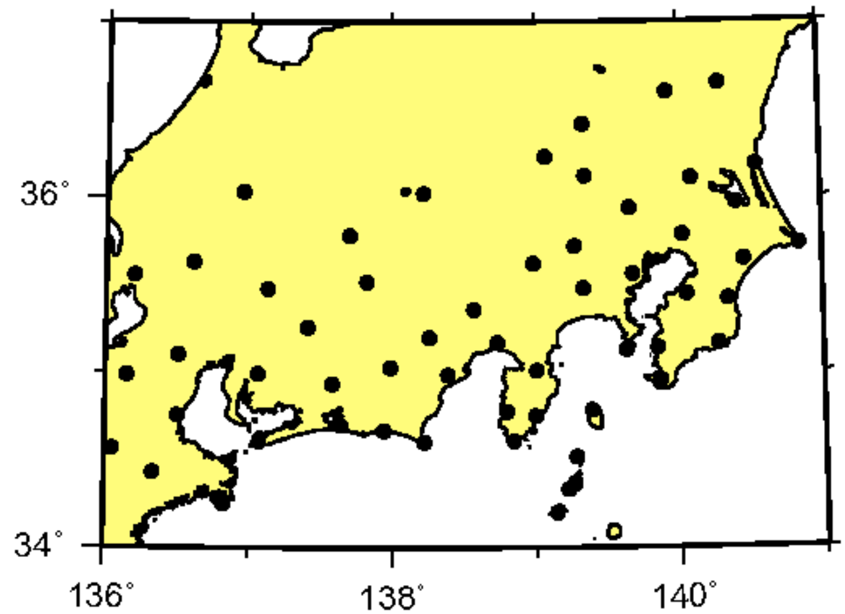


Nishimura (2001) proposed a source model to explain the crustal deformation around northern Izu islands.

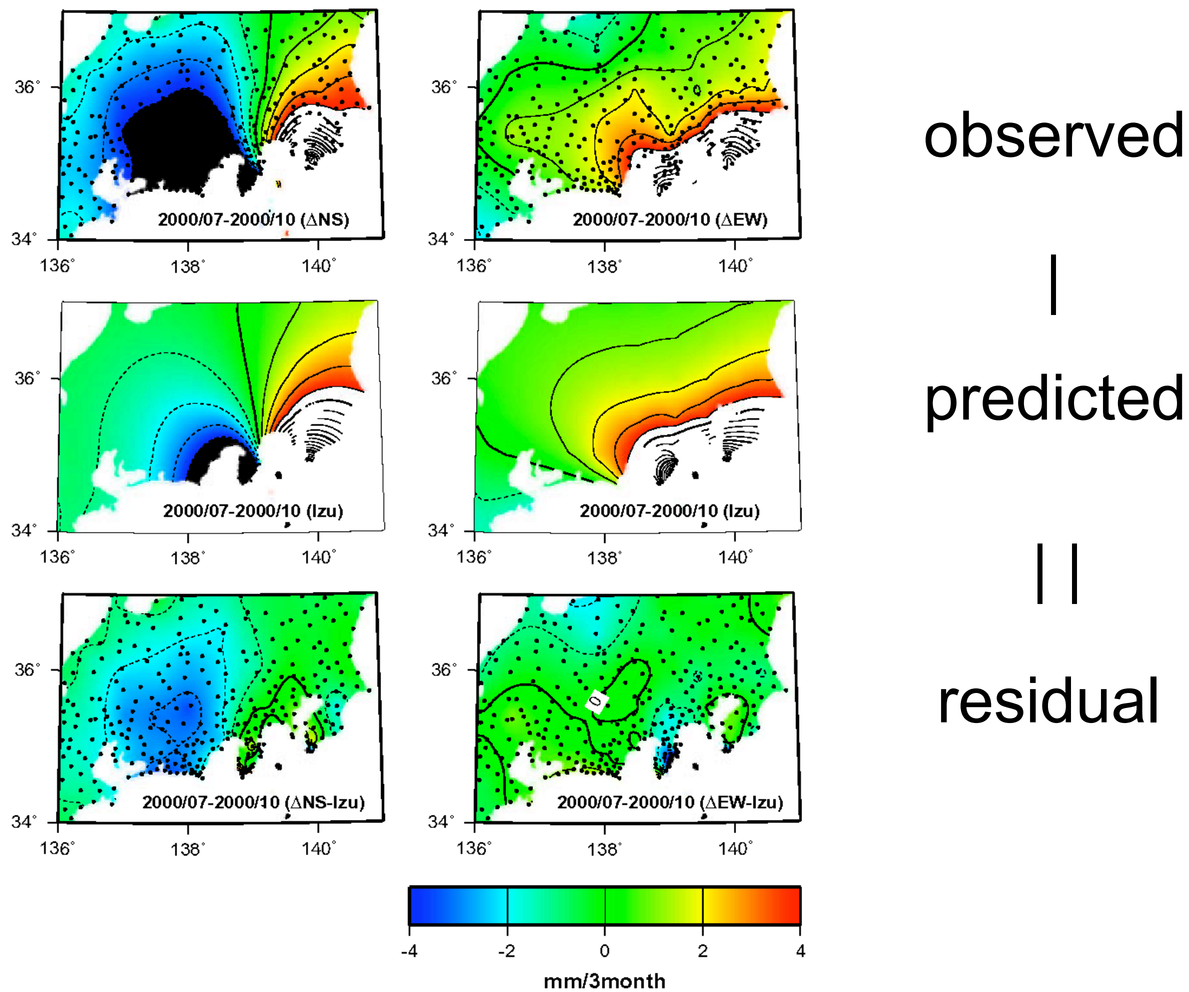
The source model explains crustal deformation around the northern Izu Islands fairly well, but it fails to explain crustal deformation in a broader area from Kanto to Tokai.

spherical contraction, two dykes, a creep like shear fault, and the main five earthquakes



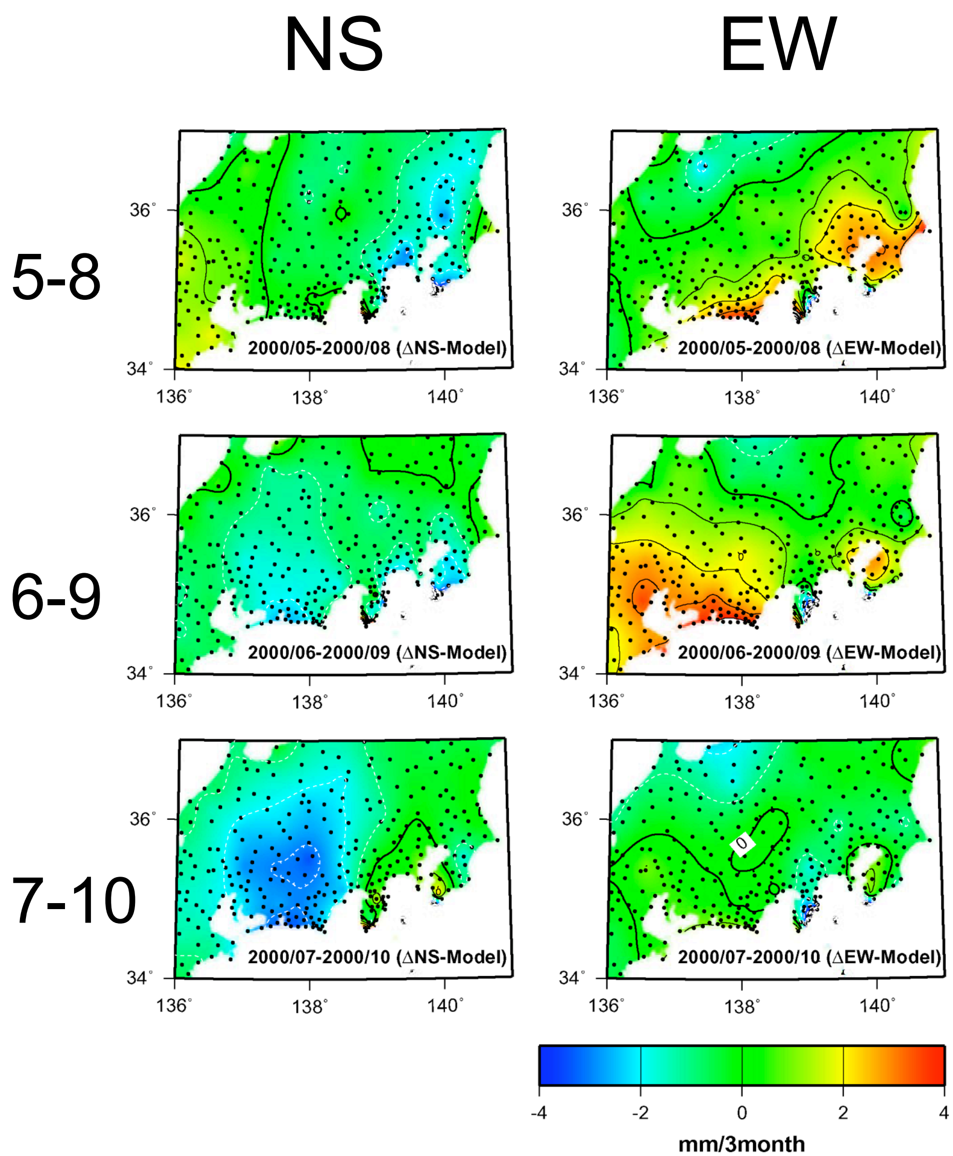


Basing on a similar model, but using GPS data in a broader area, we obtained optimum source parameters for the displacement fields in each three-month period of the early, middle and later stage of the event .



The optimum source model explains crustal deformation in Kanto very well.

But noticeable residual southward displacements remain in the Tokai and the surrounding region.



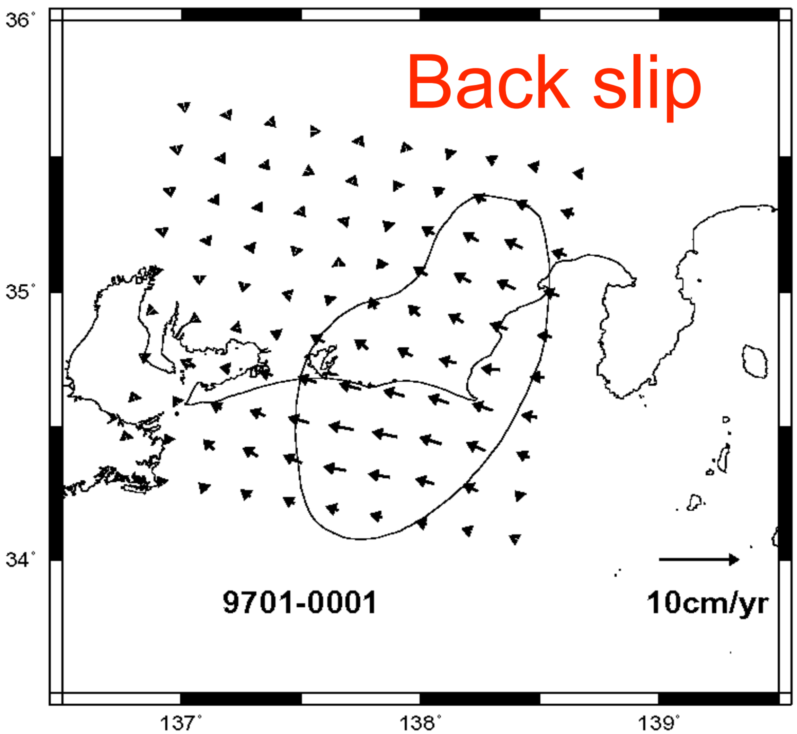
The residual displacement to the east is remarkable in the middle period and that to the south is conspicuous in the Tokai and the surrounding regions.

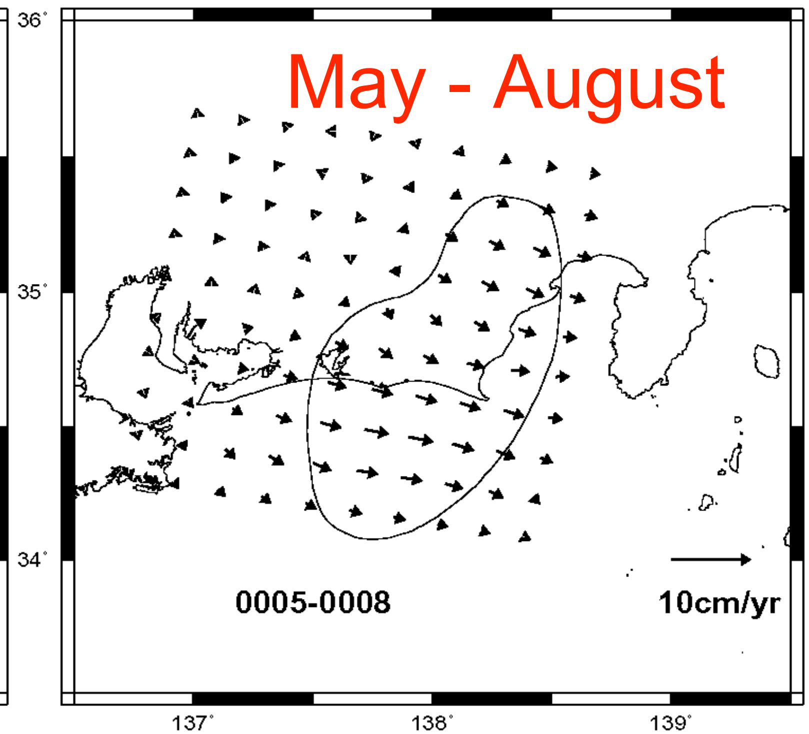
It is impossible to explain those residuals by any sources set in the northern Izu Islands region.

Because they were confined only in the Tokai and the surrounding regions.

We propose that the residual displacements were produced by weakening of the interplate coupling in the Tokai region.

Suspension of the back slip



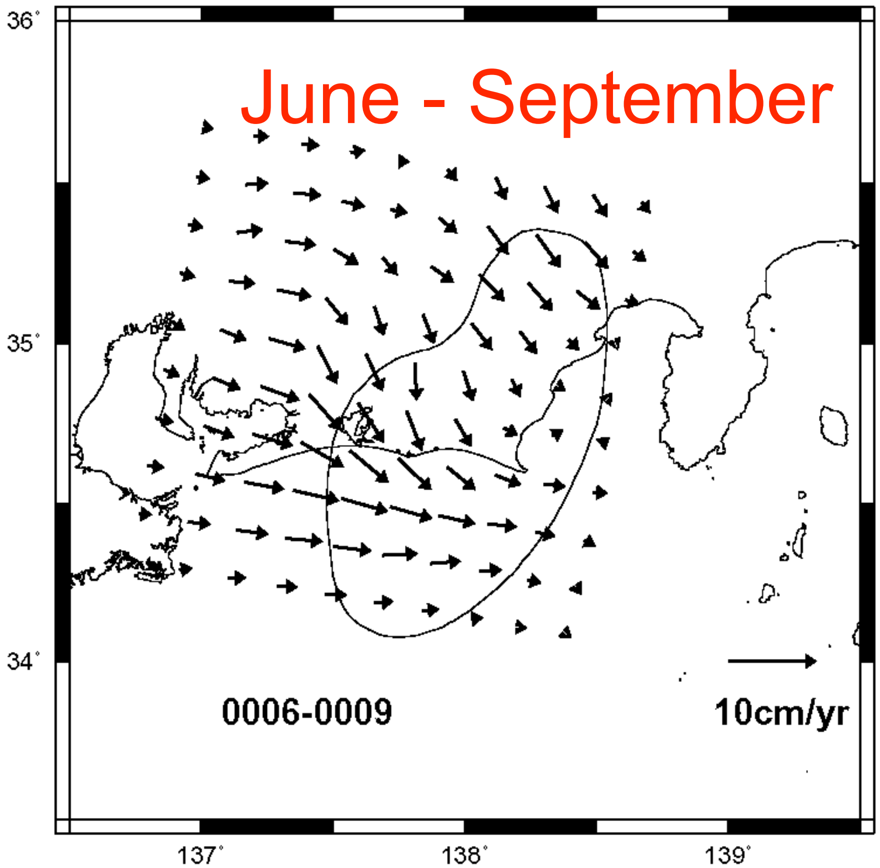


Distribution of back slips per year in the steady state

Apparent slips on the plate interface to explain the residual displacement.

The apparent slips are just the reverse of the back slips corresponding to the rate in three-month period. It means the suspension of the steady back

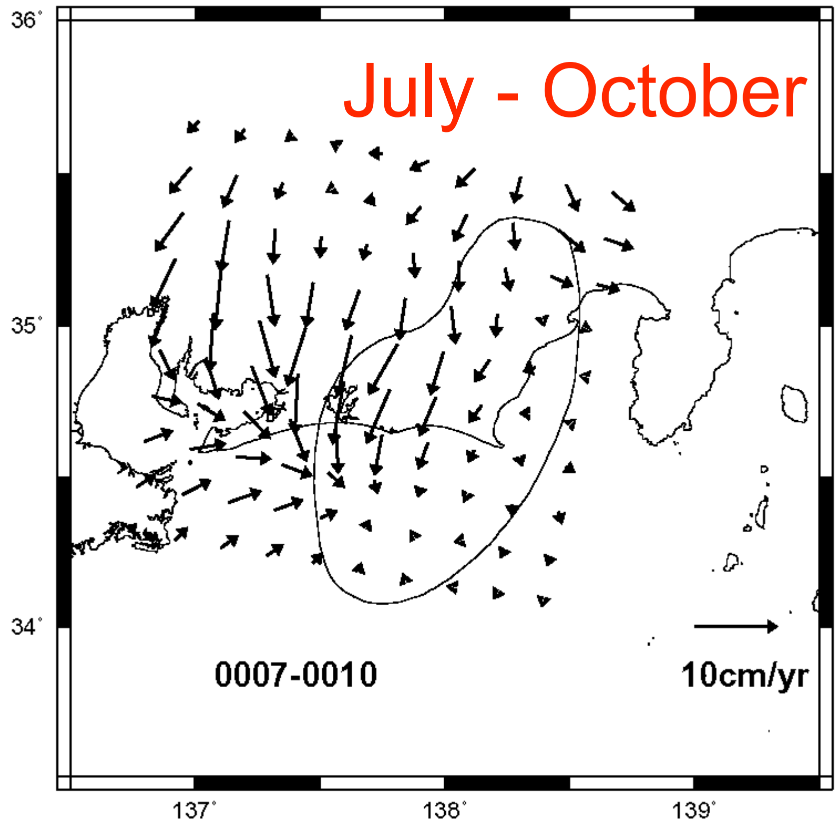
For the period of June to September



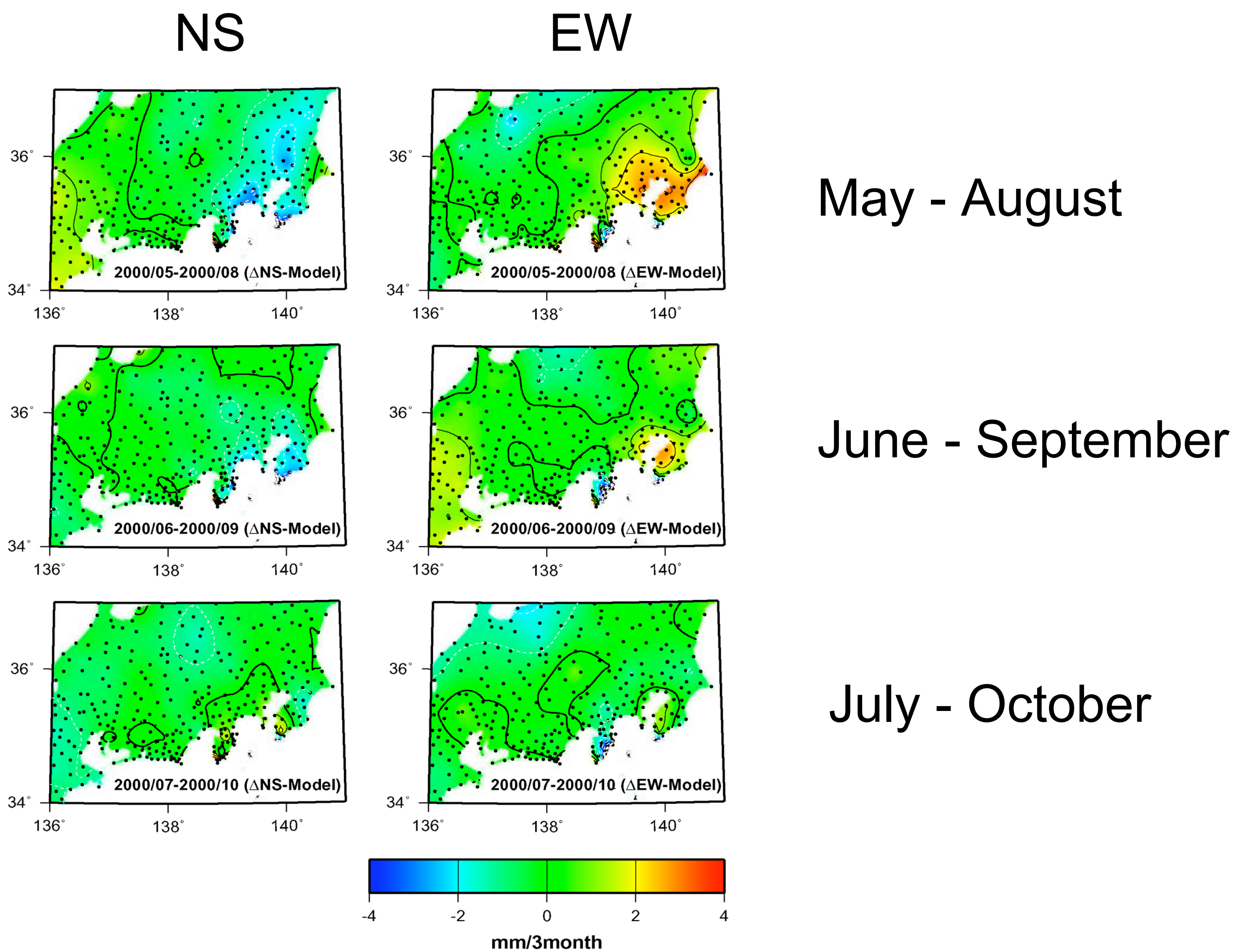
The residual cannot be explained by a slow slip equivalent to the steady back slip.
This figure is apparent slips on the plate interface obtained by inversion analysis to explain residual displacements.

The apparent slips near Lake Hamana exceed quantity of back slips in magnitude in the steady state.
It indicate that a net forward slip had already started during the period of the event.

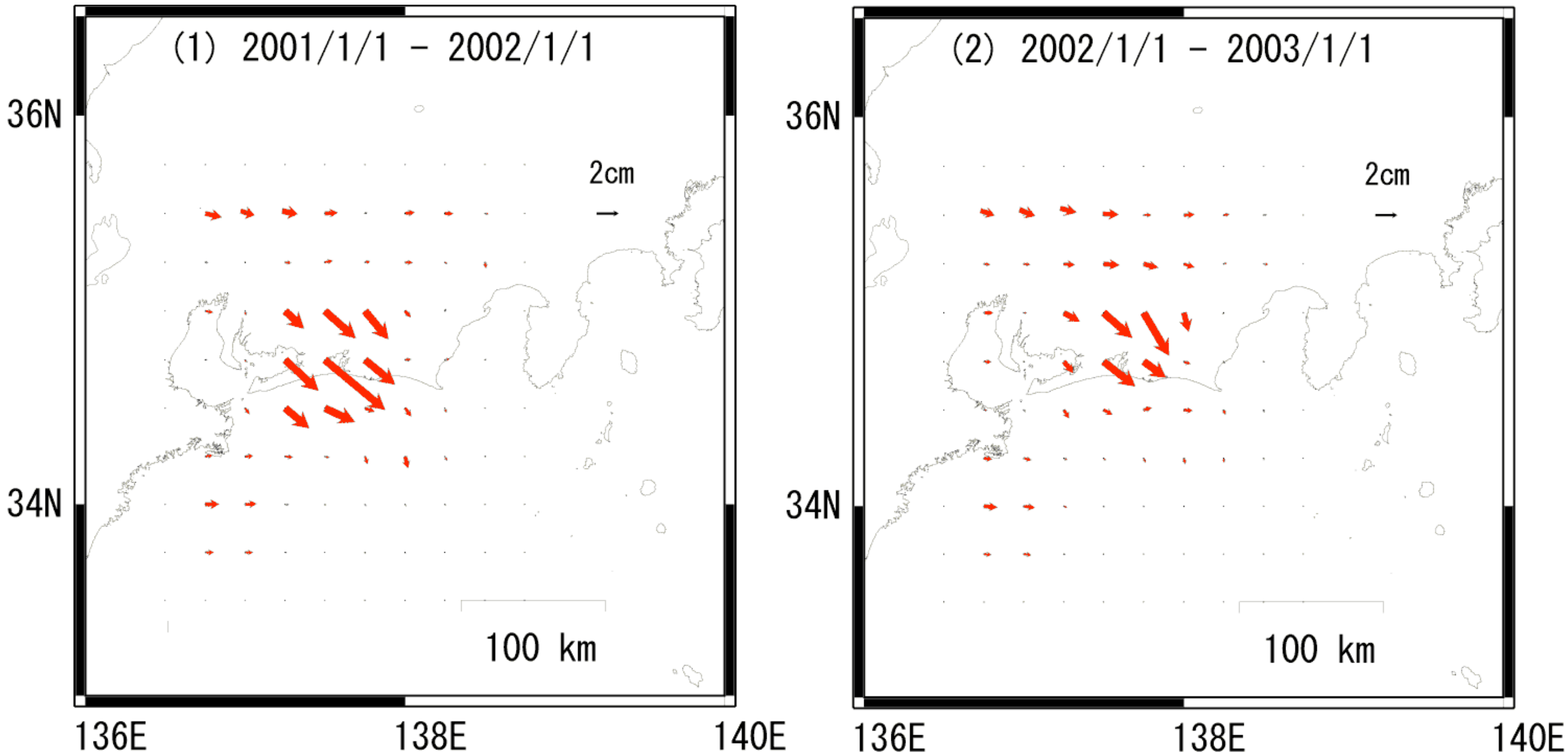
For the period of July to October



Slow slip near Lake Hamana is continued.
On the other hand, slow slip of the east side of the source region resumes.

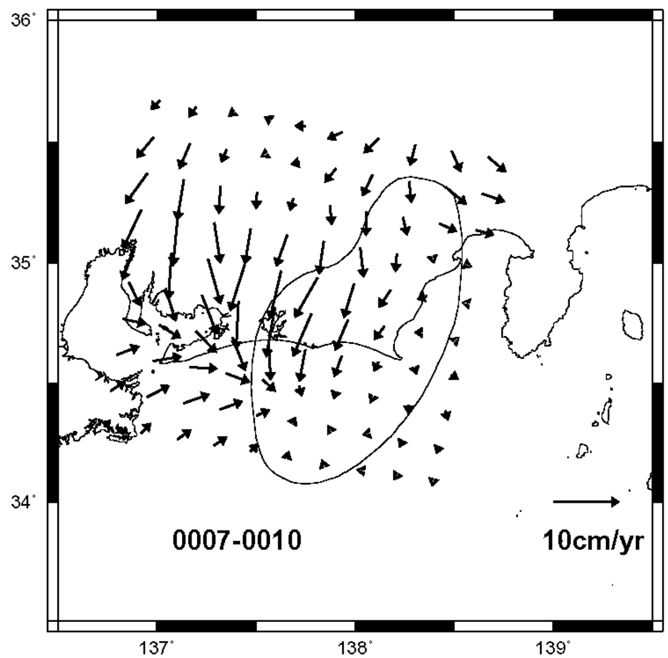


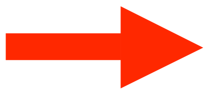
By considering the slow slips on the plate boundary, the residuals can be explained well.

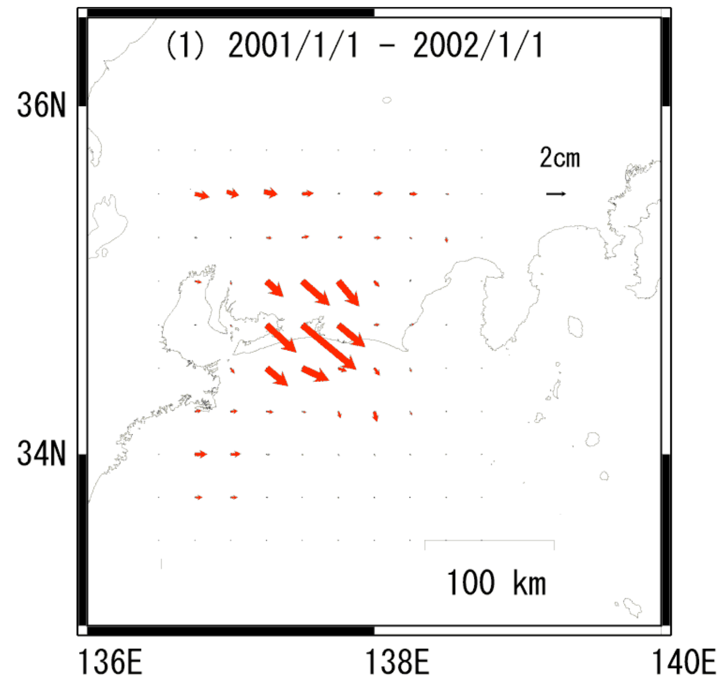


(figures from GSI home page)

Ozawa (2002) pointed out that the Tokai slow slip on the plate boundary near Lake Hamana started in October 2000.







Weakening of the interplate coupling beneath the Tokai region preceded the Tokai slow slip.

The slip started in the second half period of the 2000 northern Izu Islands event.

Summary

- Crustal deformation in a broad area from Kanto to Tokai associated with the 2000 northern Izu Islands event was investigated.
- Our model that incorporates weakening of the interplate coupling explains very well the displacement fields in the Tokai and the surrounding regions during the event.
- The Tokai slow slip is shown to have started in the second half of the event as a consequence of the weakening of the interplate coupling.

We are grateful to the Geographical Survey Institute (GSI) of Japan for providing the GPS data.