Episodic tremor and slip at the Japan Trench before the 2011 Tohoku earthquake: Implications for understanding shallow megathrust processes at the NZ focus site

Yoshihiro Ito (Tohoku University, Japan)

GeoPRISMS Planning Workshop for New Zealand
Apr. 15–Apr. 17 2013, Wellington

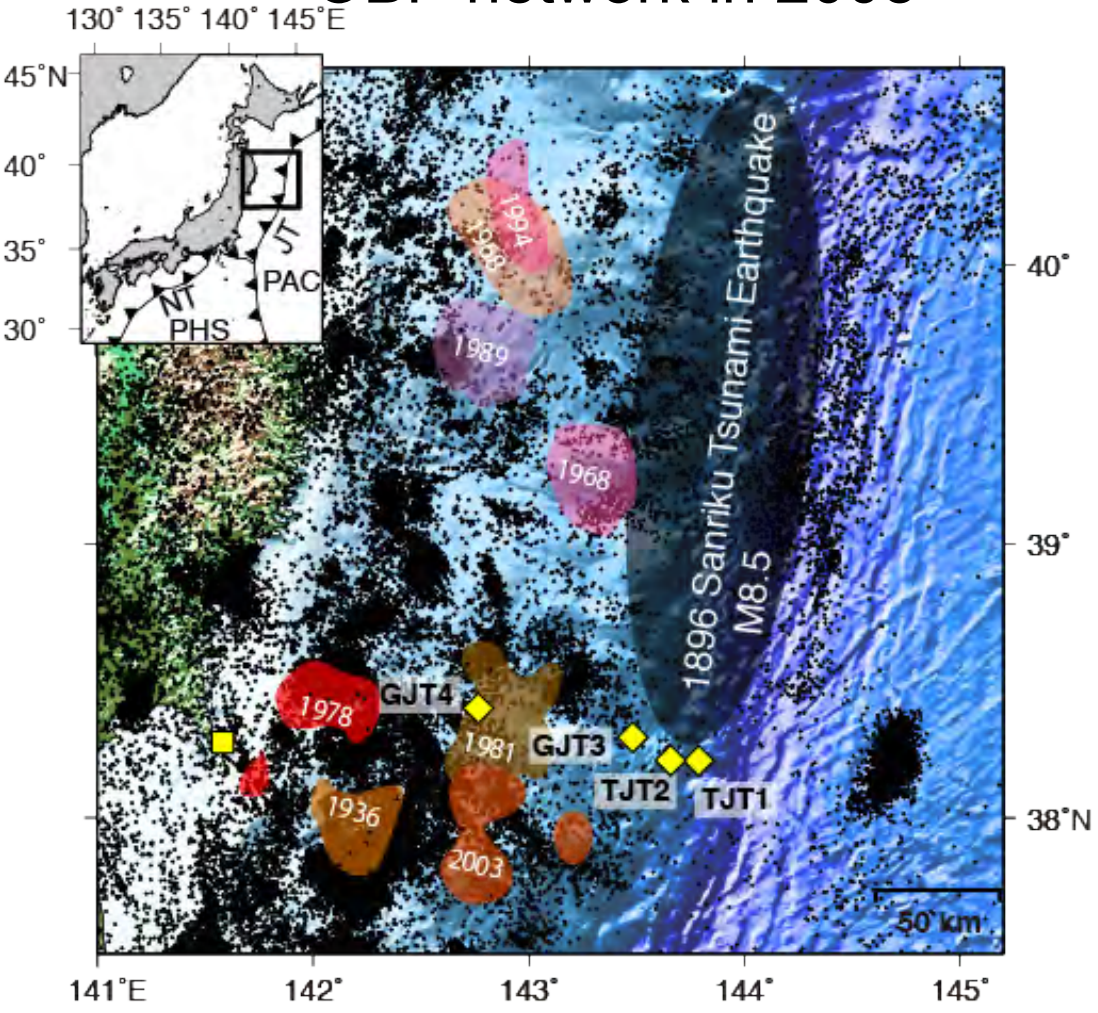
Episodic tremor and slip at the Japan Trench before the 2011 Tohoku earthquake: Implications for understanding shallow megathrust processes at the NZ focus site

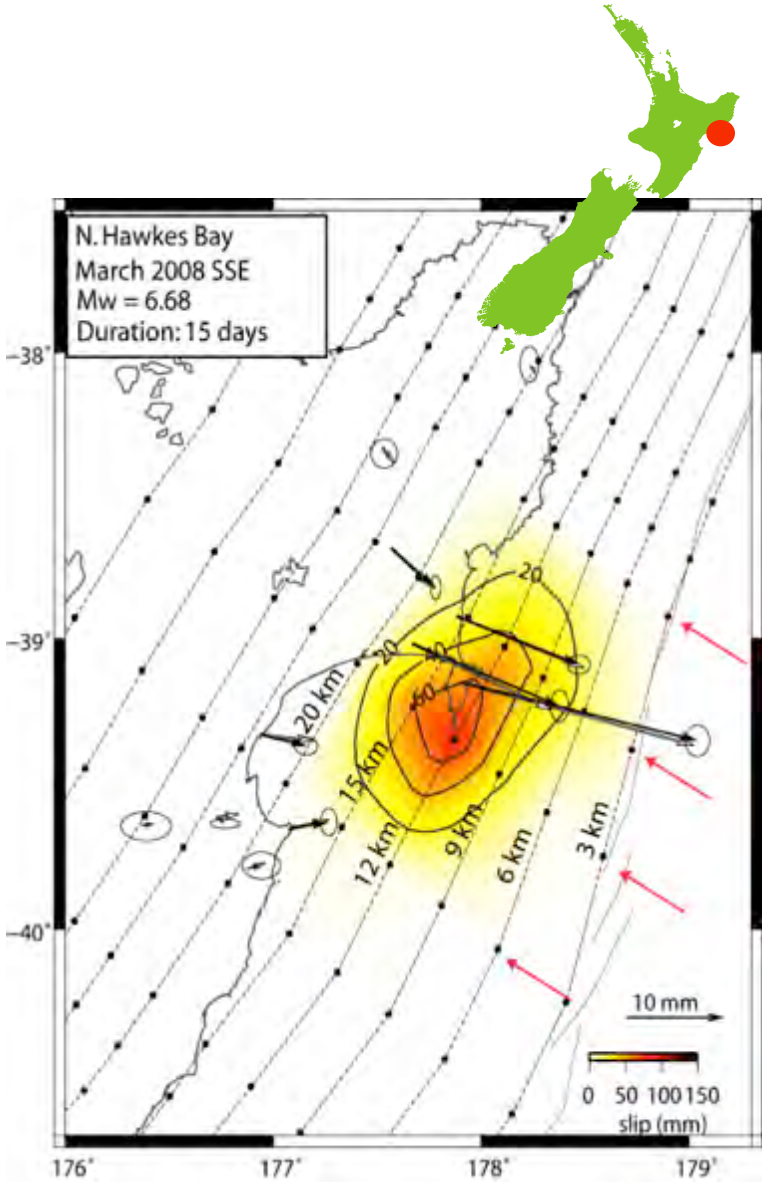
Yoshihiro Ito (Tohoku University, Japan)

GeoPRISMS Planning Workshop for New Zealand
Apr. 15–Apr. 17 2013, Wellington

Two focus sites: Tohoku vs.. Hikurangi

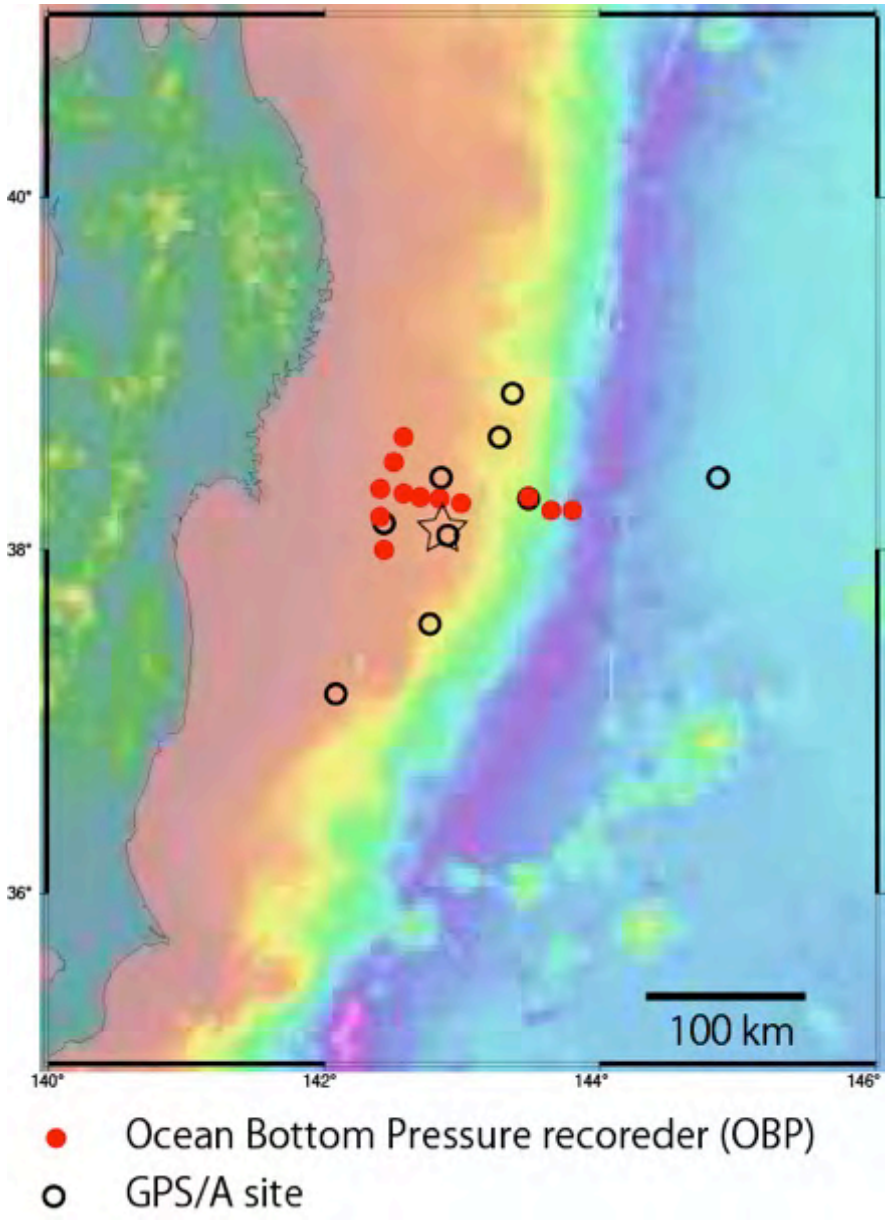
Seismicity before 2011
OBP network in 2008





Wallace and Beavan, 2010, JGR

GPS/A and OBP sites just before the 2011 Tohoku event



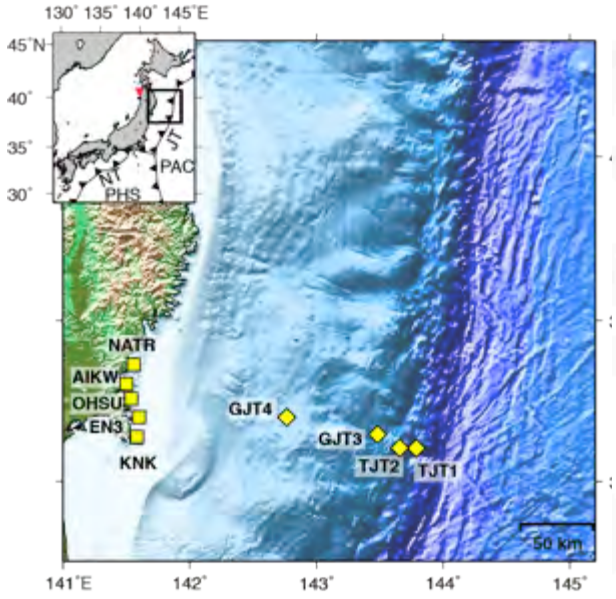
GPS/A:

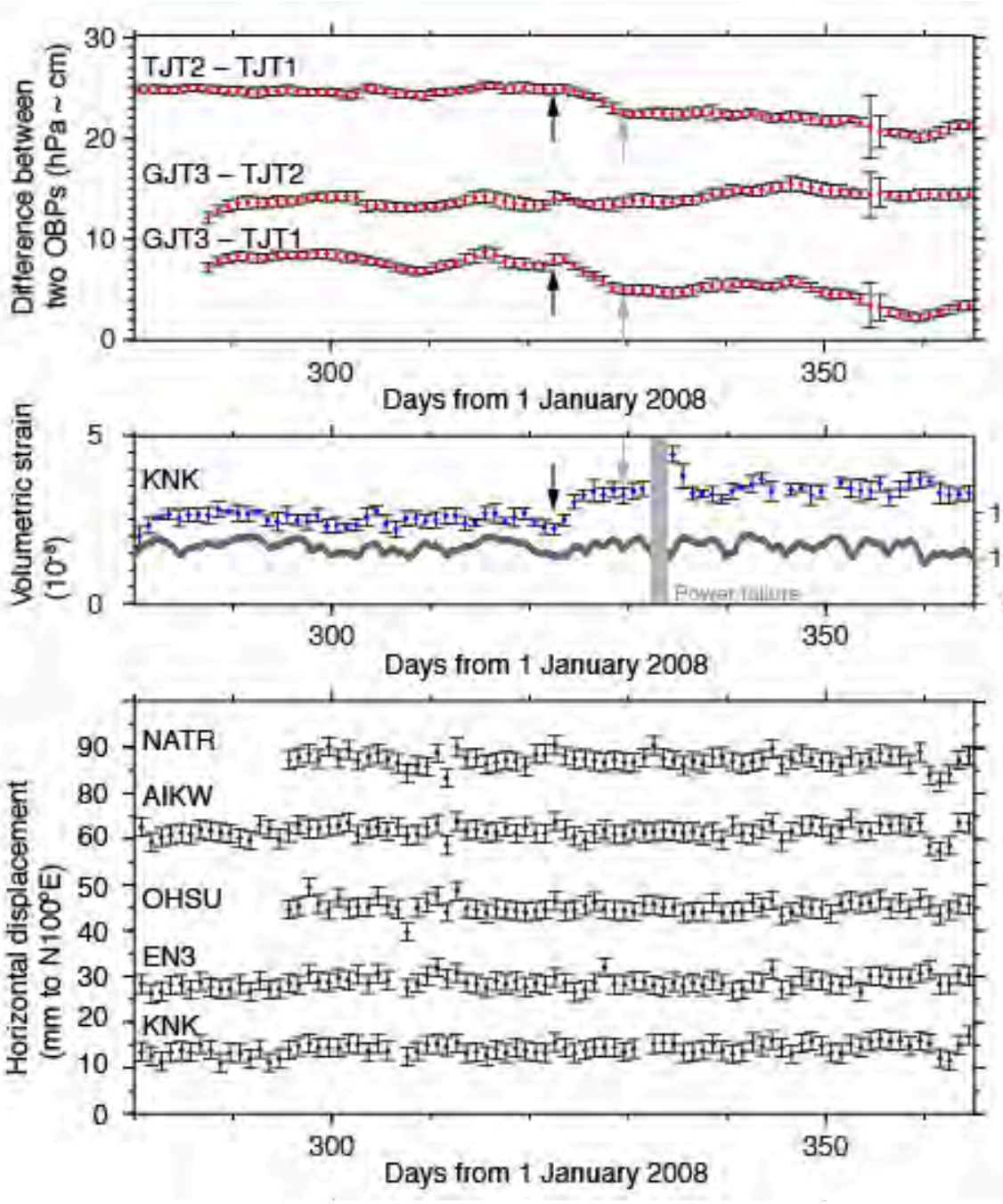
- Coseismic slip
  Sato et al., *Science* 2011
  Kido et al., *GRL* 2011
- Post seismic slip
  Iinuma et al, in prep.

OBP:

- Coseismic slip
  Ito et al., *GRL* 2011
  Iinuma et al., *JGR* 2012
- Slow slip event
  Ito et al., *Tectonophysics,* in press.

OBP diff,
On-shore strainmeter
& GPS data

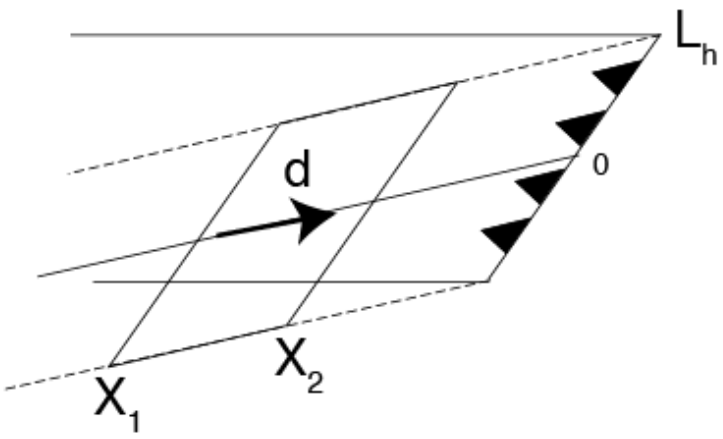




Constraints on a fault estimation

- Minimum χ^2 value calculated from the observed and predicted relative vertical deformations between two OBPs
- Predicted volumetric strain change consistent with the observation.
- Predicted horizontal displacement trenchward at the coast line less than 3 mm, based on observation error of the baseline measurement of the GPS network.

Fault parameter's estimation

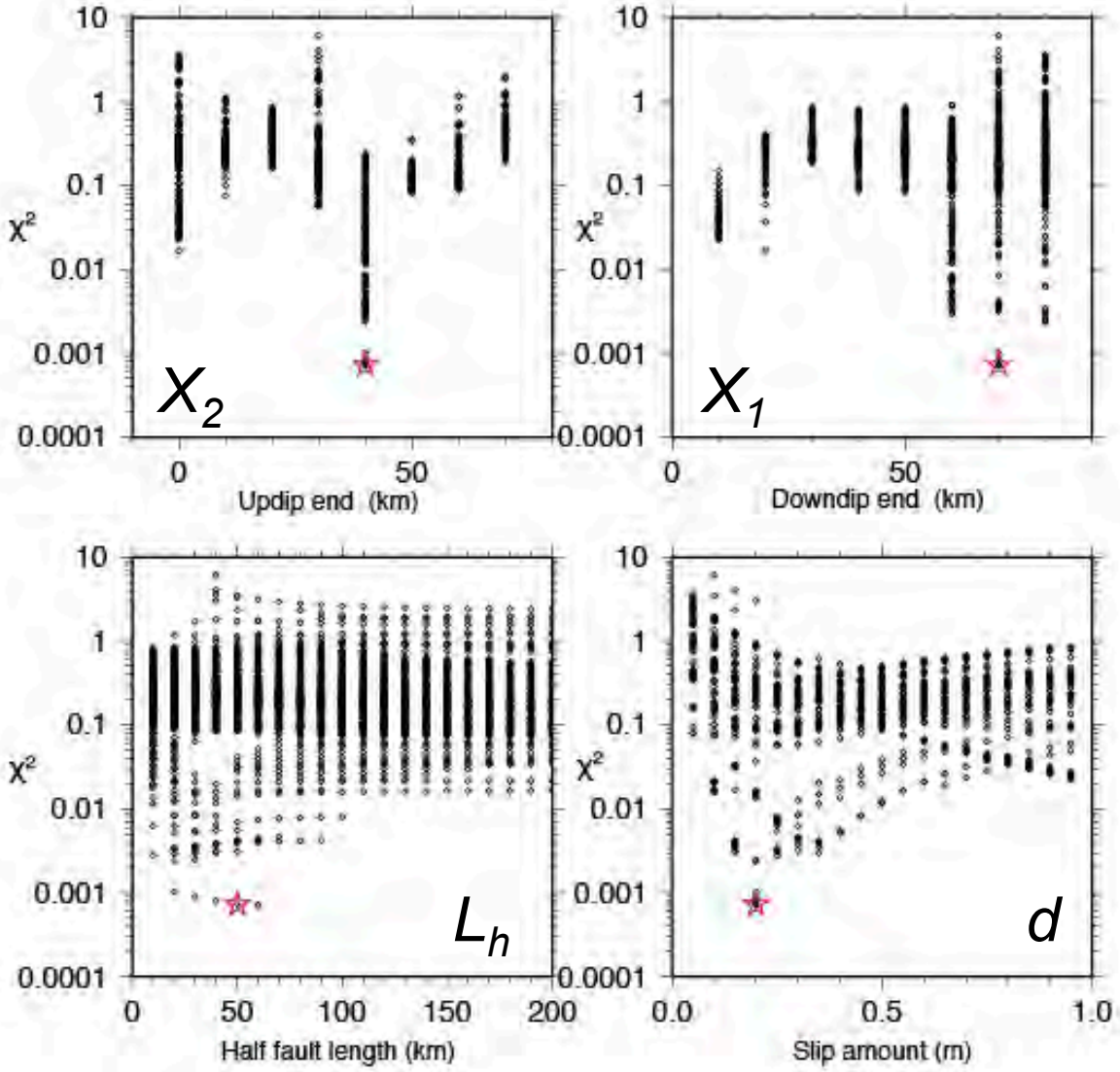


***X*$_1$: Distance to downdip limit from the trench**

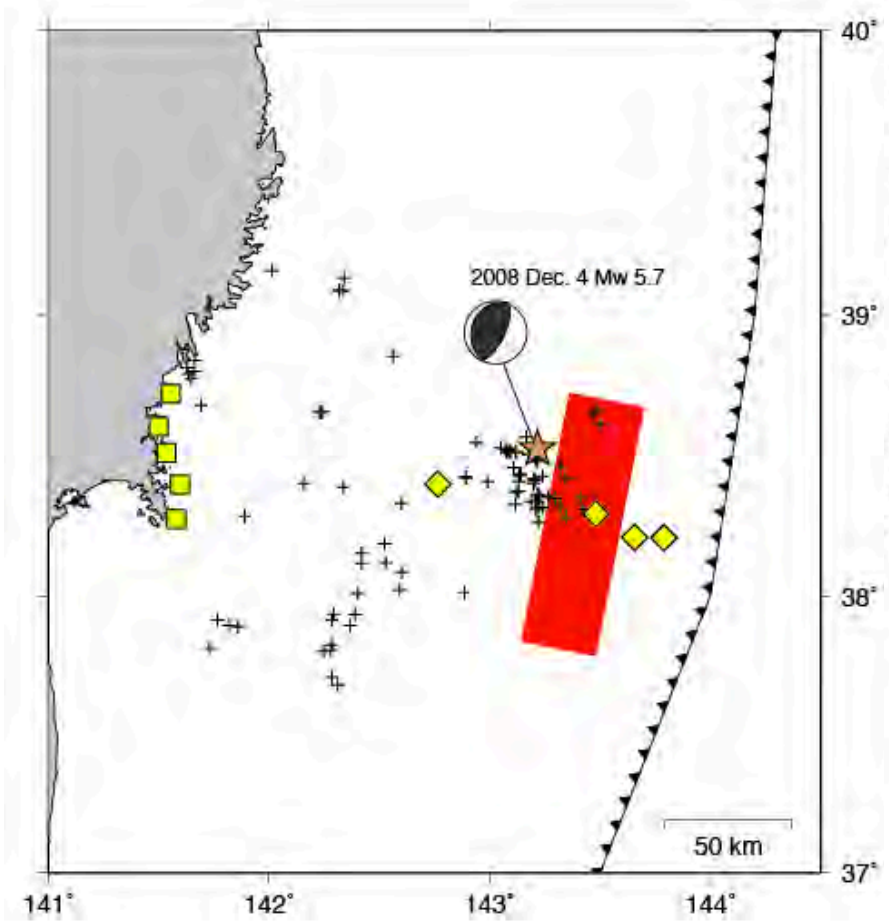
***X*$_2$: Distance to updip limit from the trench**

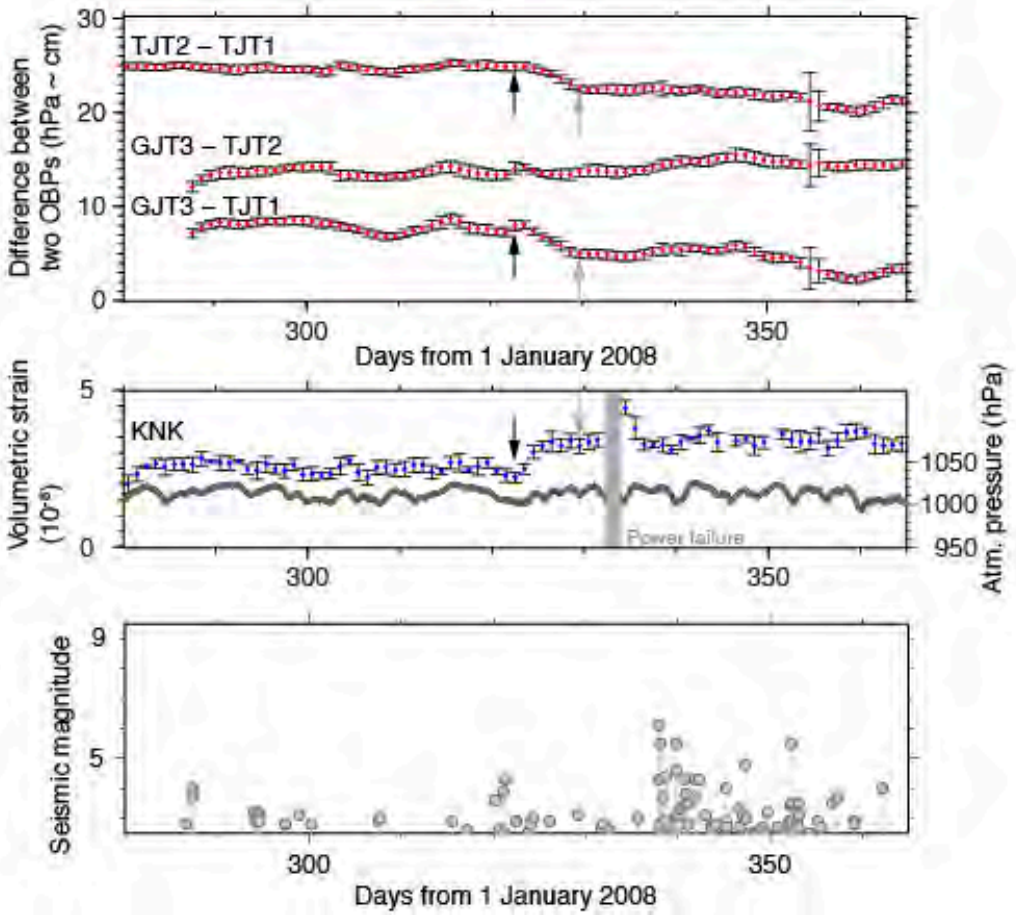
***L*$_h$: Half length of fault**

***d*: Slip amount**



The 2008 slow slip event & induced seismicity

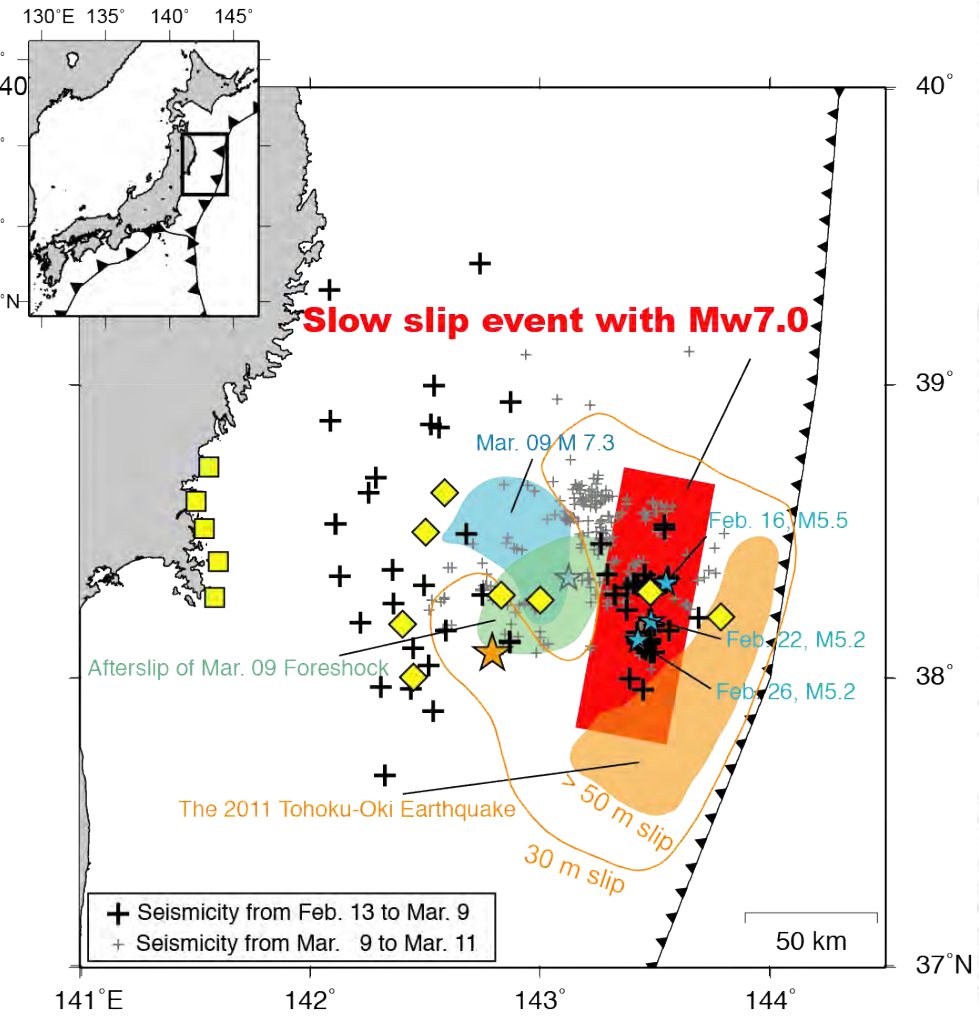


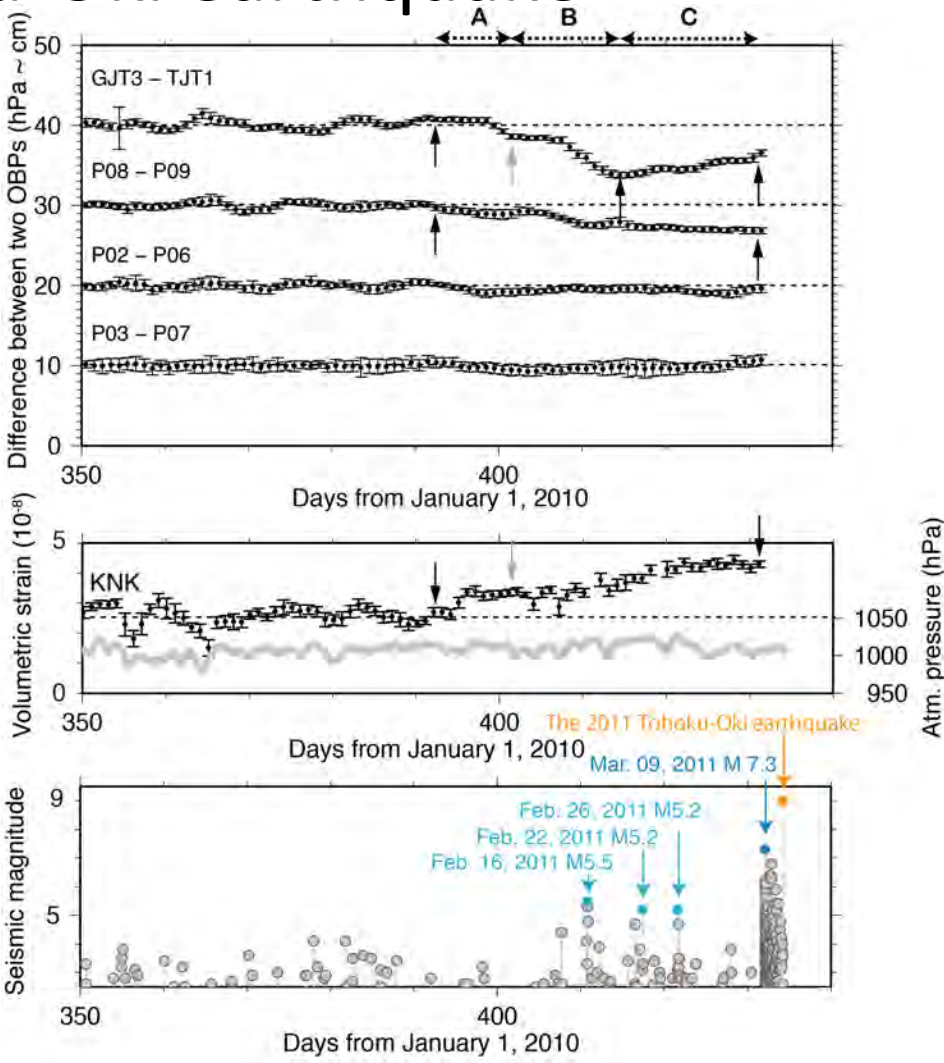


Fault size: 30 × 100 km
Slip amount: 0.2 m
Duration: ~20 days
Seismic moment: 1.8×10^{19} Nm (M_W 6.8)

Ito et al., (Tectonophysics, in press)

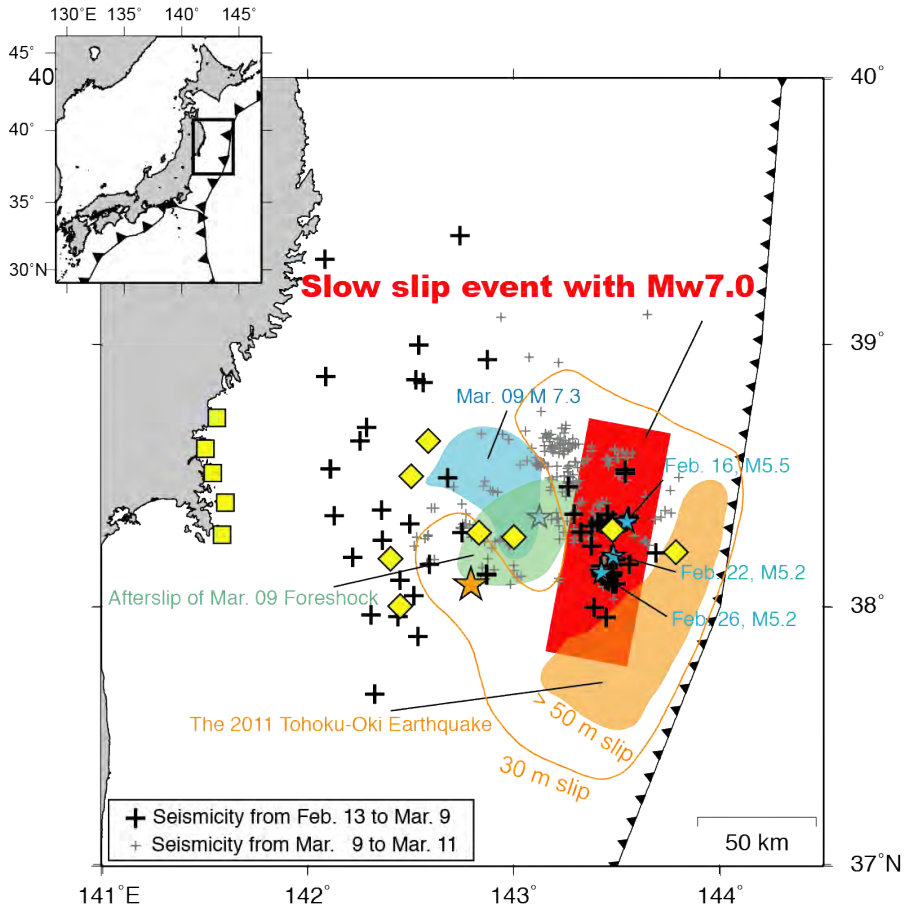
The 2011 slow slip event & the 2011 Tohoku-Oki earthquake

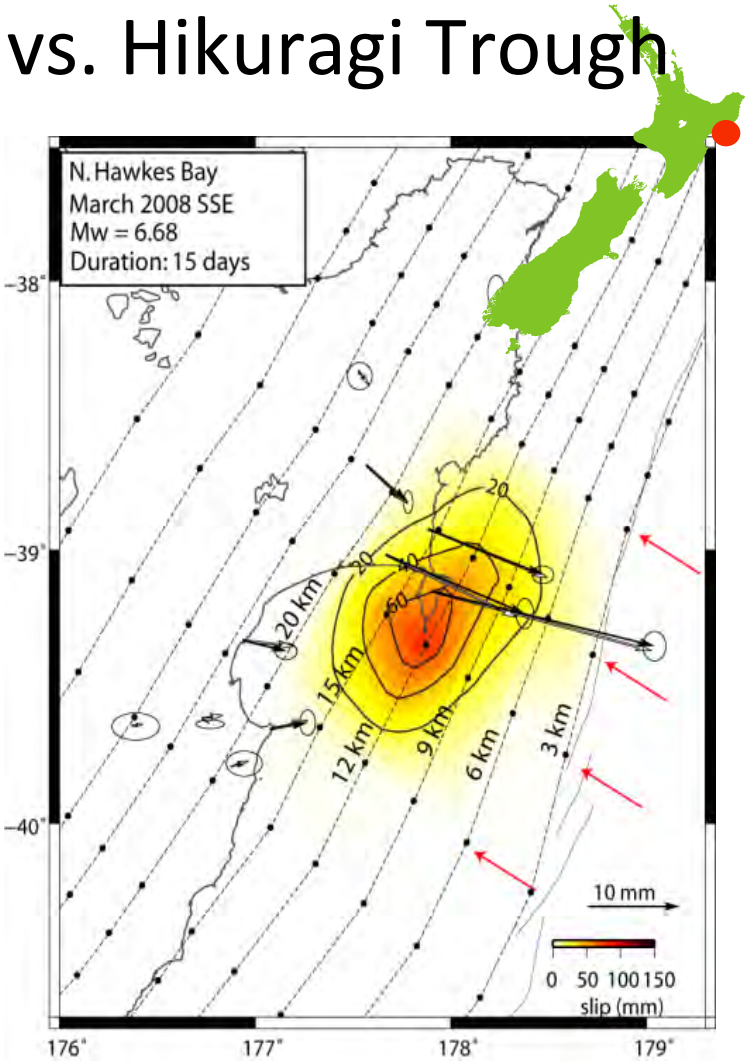




Fault size: 35 km × 100 km
Slip amount: 0.4 m
Duration: ~40 days
Seismic moment: 3.6×10^{19} Nm (M_W 7.0)

Slow slips in Japan Trench vs. Hikuragi Trough





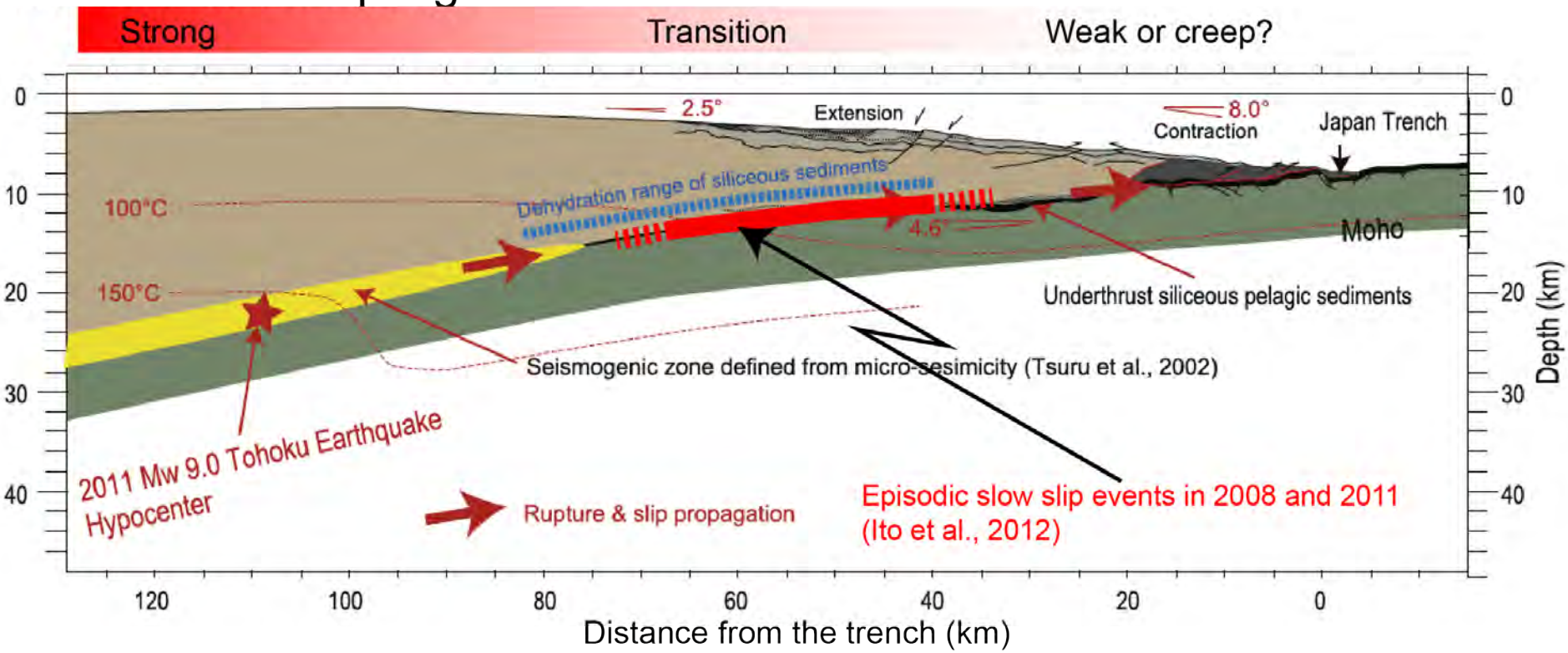
Slow slip	Japan Trench	Hikurangi Trough
Fault Depth	10–20 km	5–20 km
Mw	6.8–7.0	6.5–6.7
Duration	20–40 days	15–35 days

Wallace and Beavan, 2010, JGR

Slow slip in transition zone between strong couple to aseismic creep ?

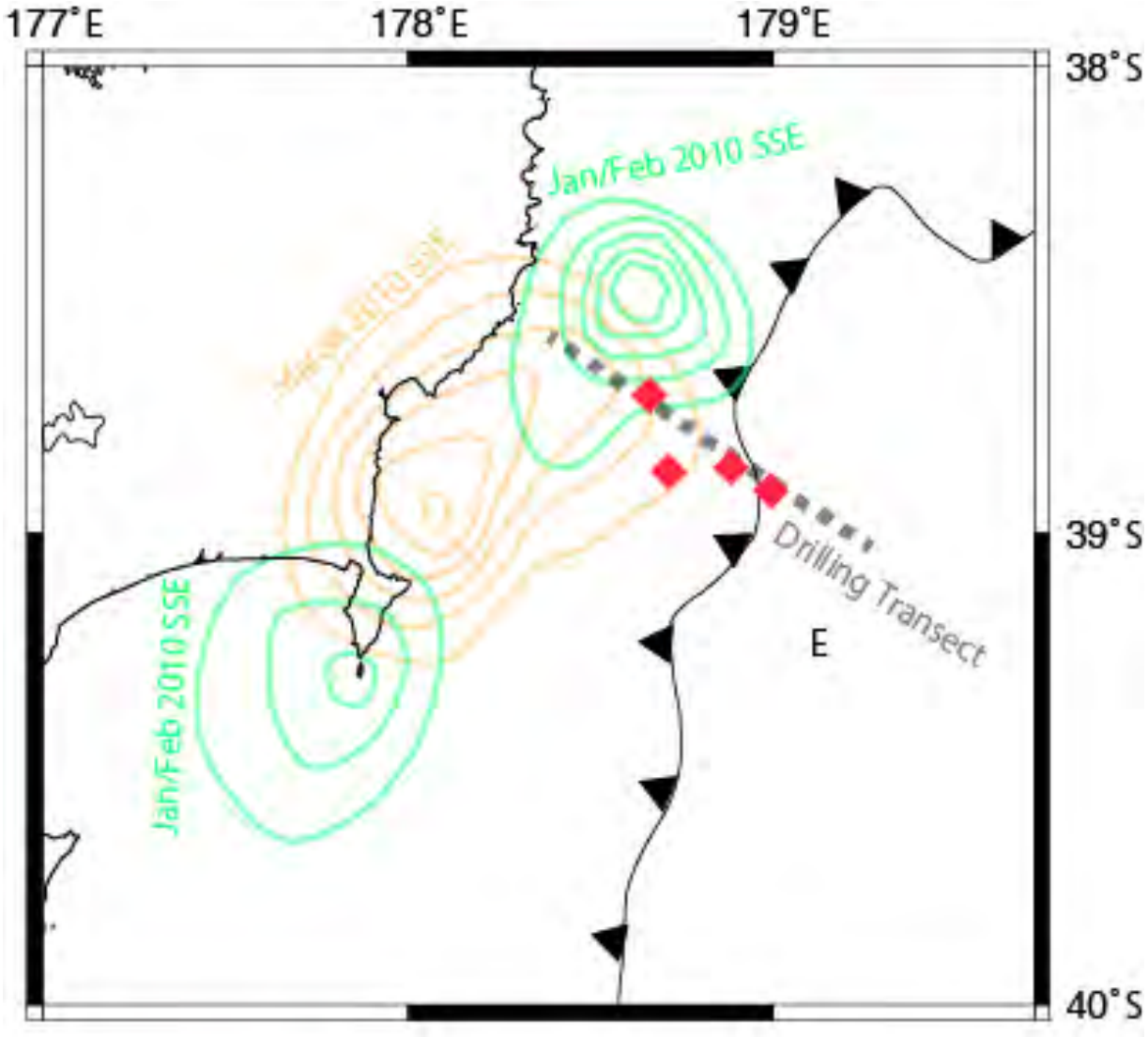
Coseismic slip on the megathrust event (Iinuma et al., 2012)

Interseismic coupling



Modified after Kimura et al. (EPSL, 2011)

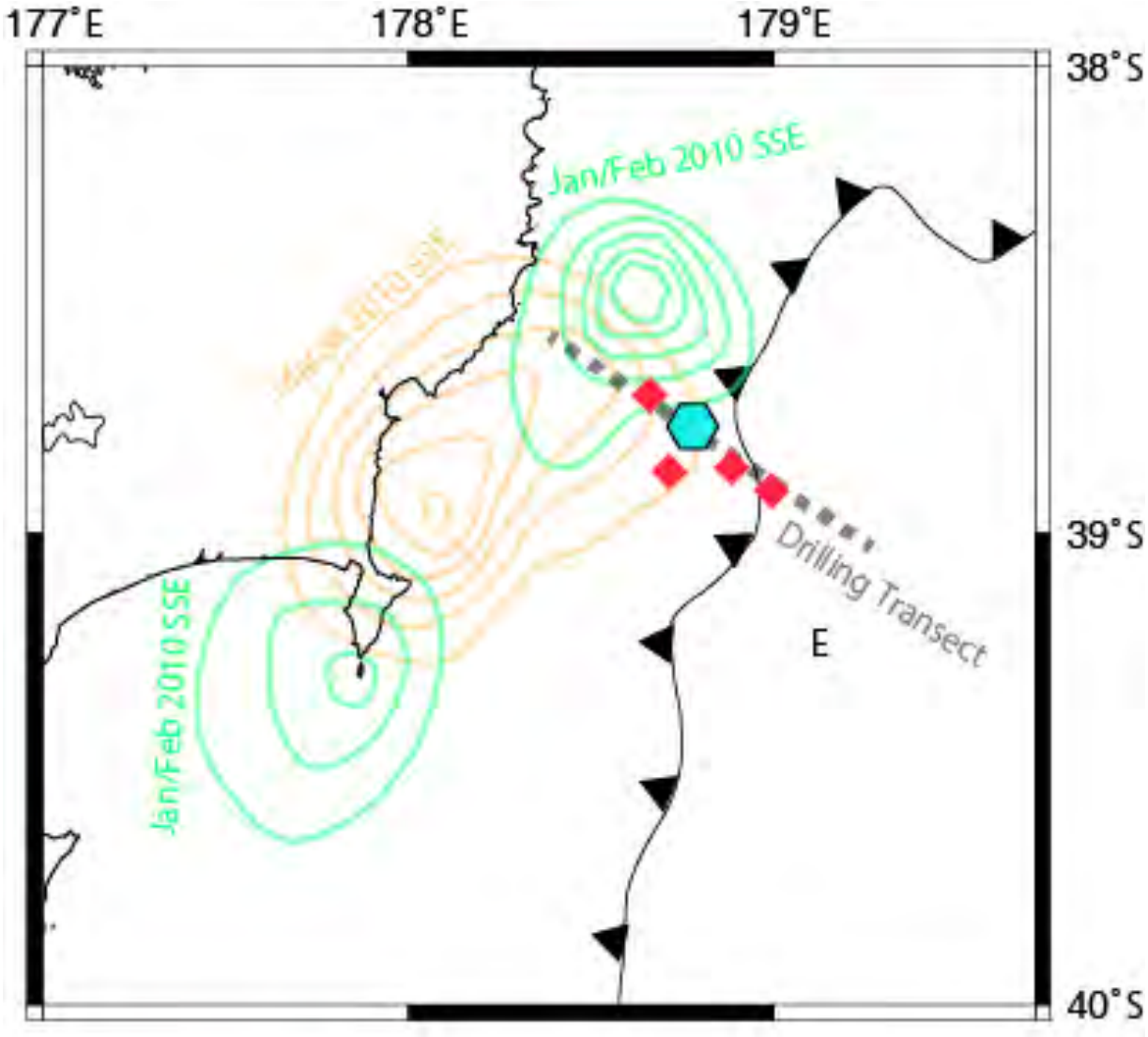
Overview of OBP observation in Hikurangi



OBP deployment:
March 14th 2013
~

Main target:
Updip limit of SSE

Planning GPS-Acoustic observation By Kido, Wang, and Chadwell

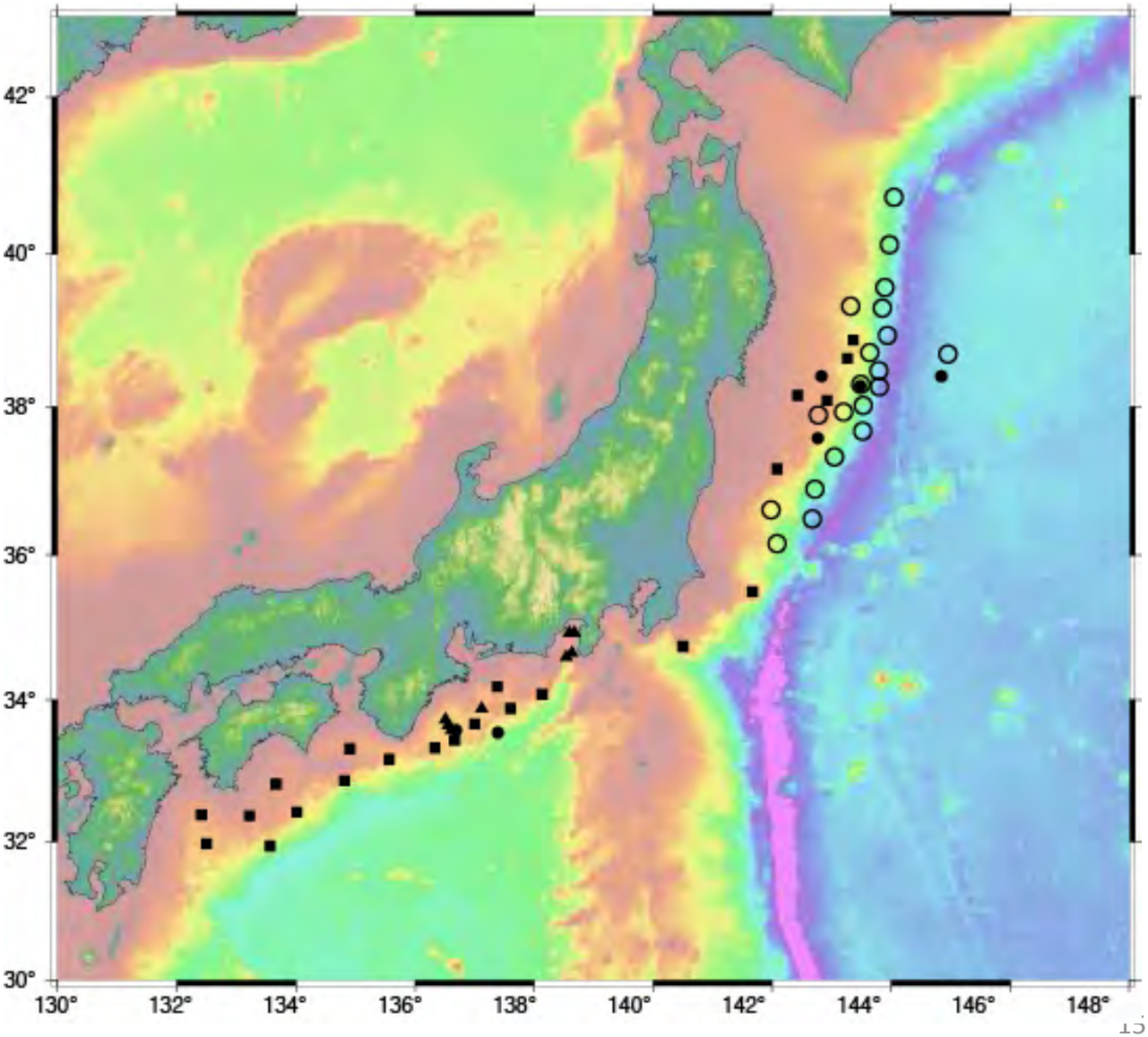


GPS/A deployment:
2014 ?

Main target:
Seismic coupling near the trough

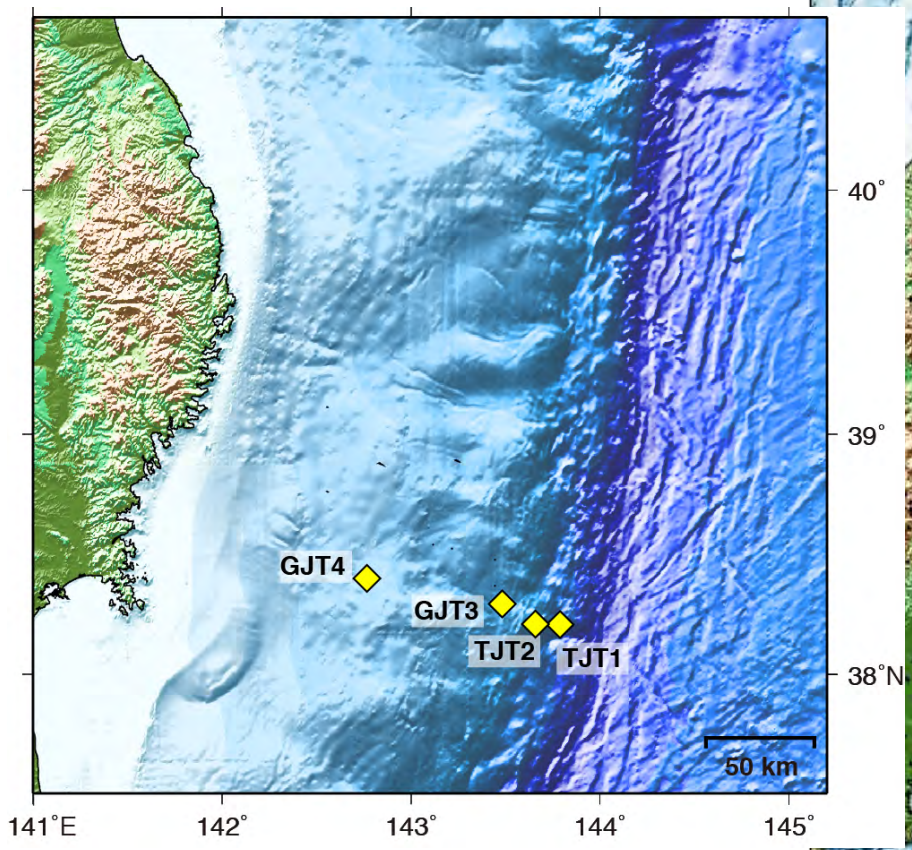
Appendix

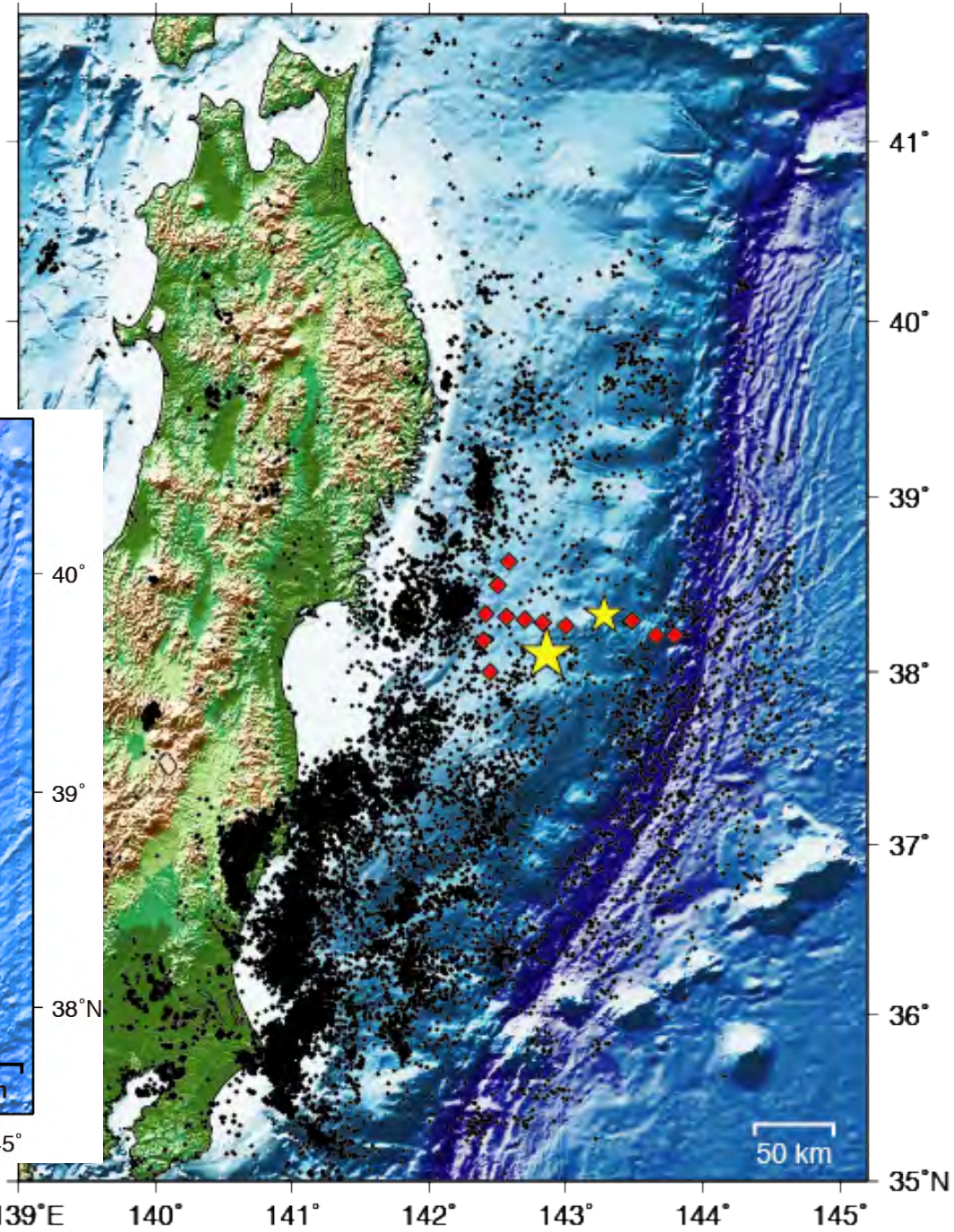
All GPS/A sites after the 2011 event



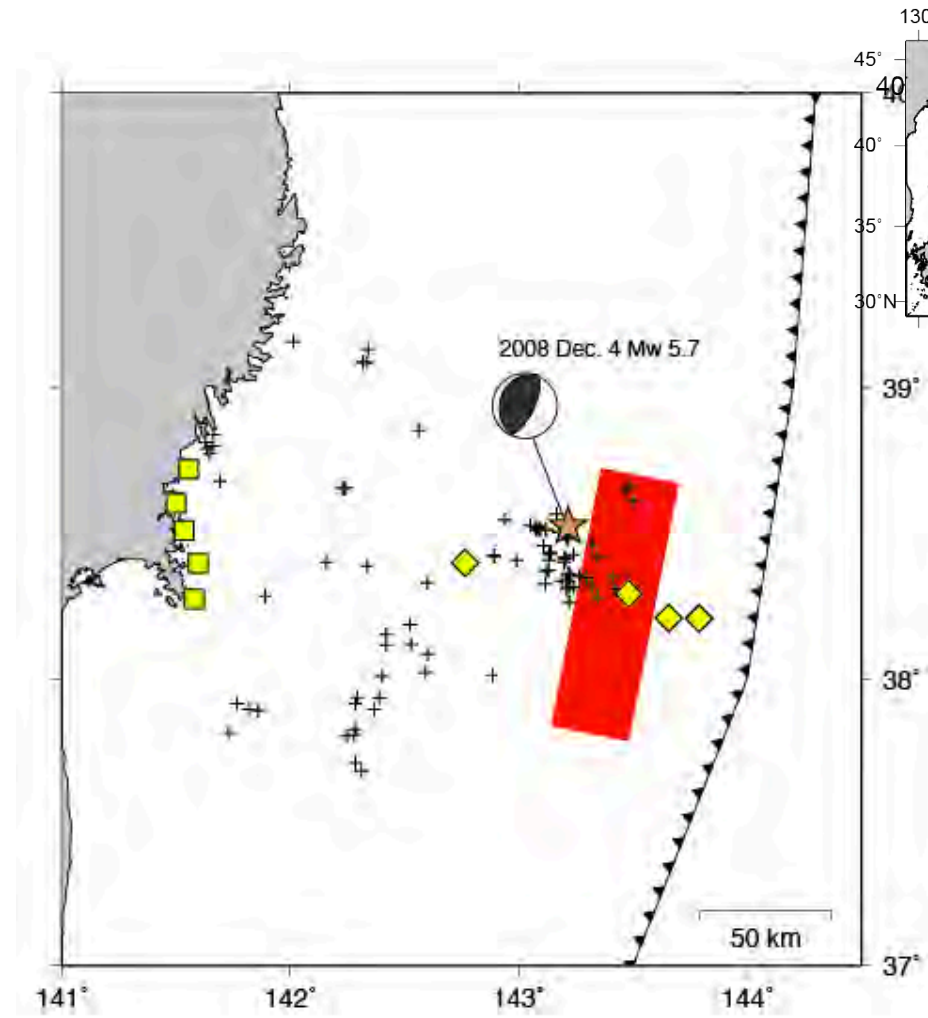
OBP observation for SSE in Japan Trench Since 2008

OBP network established from 2008

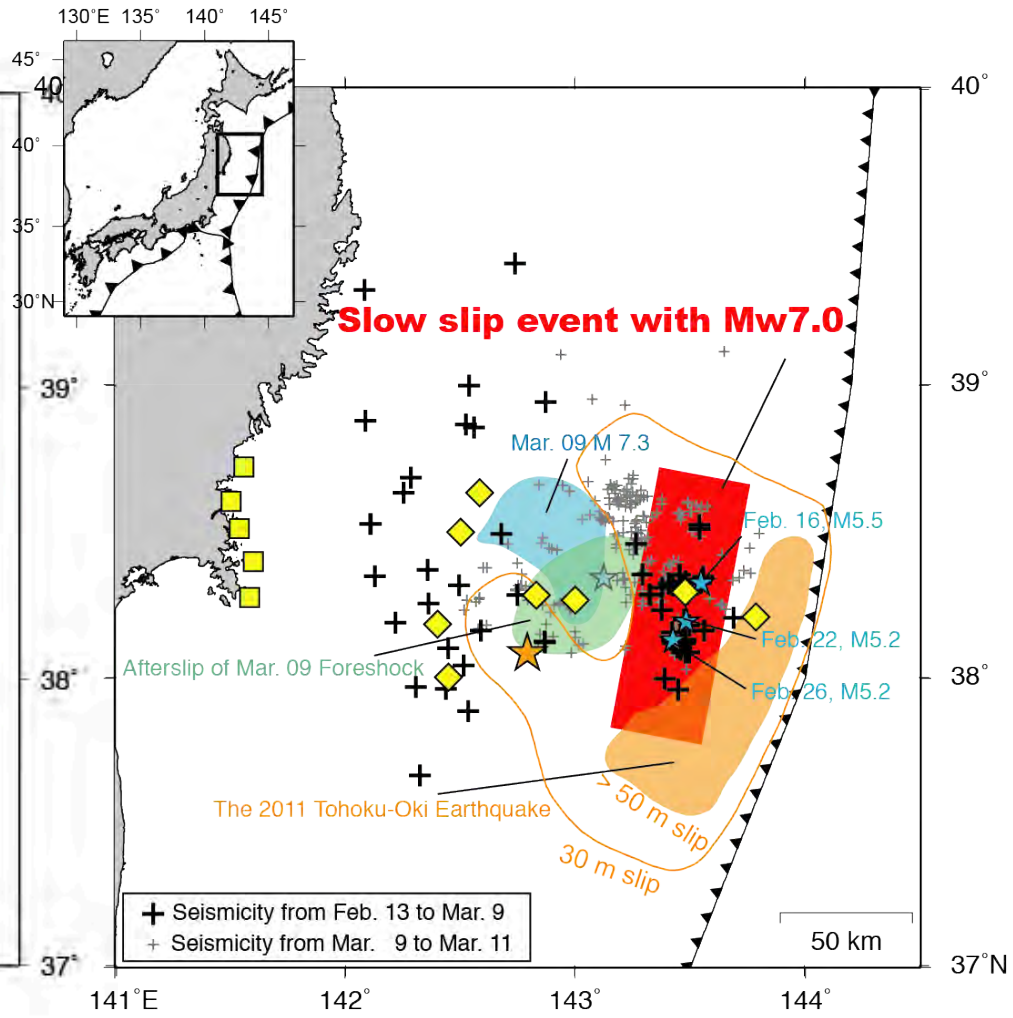




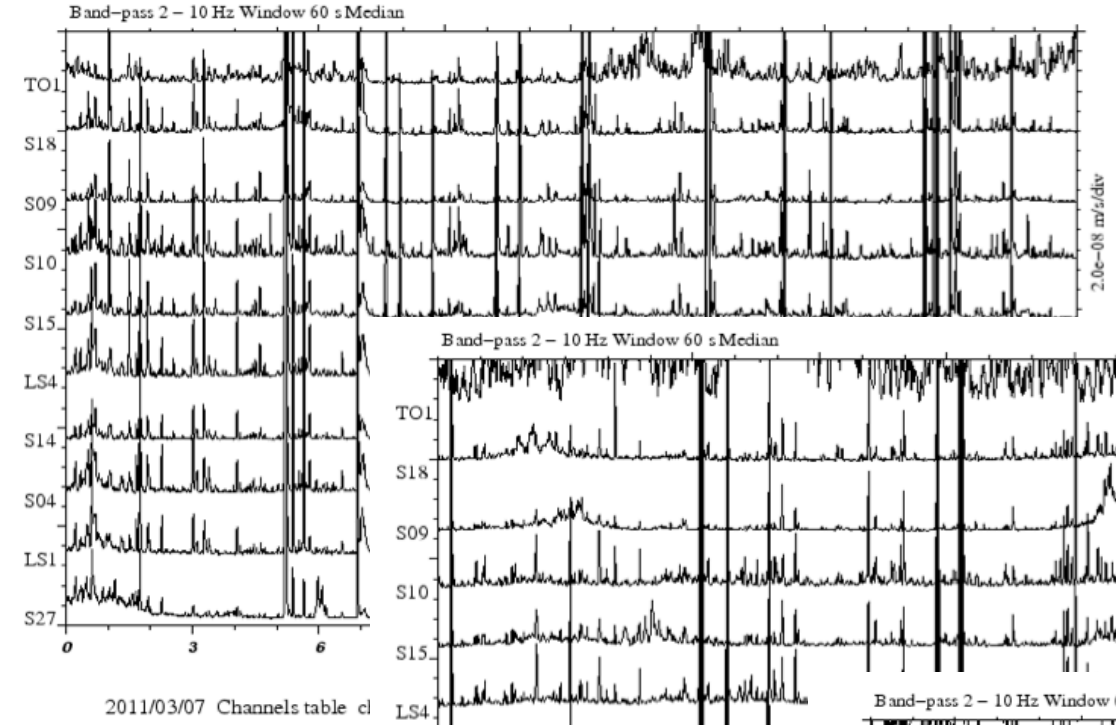
The 2008 & 2011 slow slip events



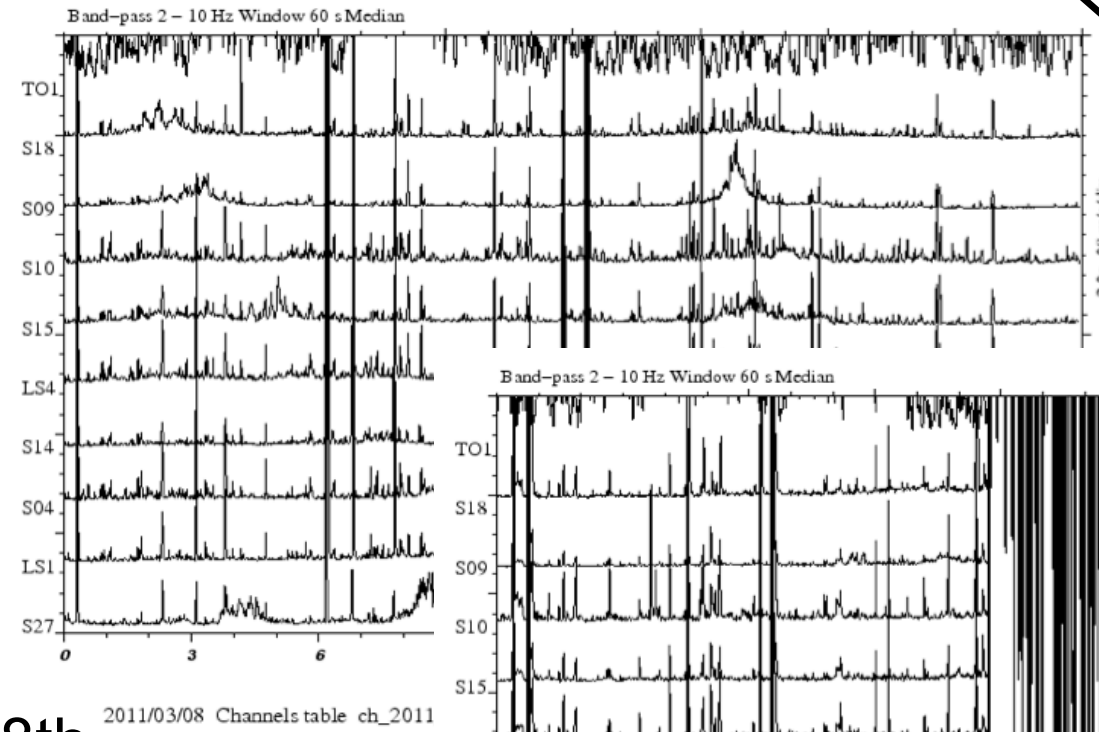
Fault size: 30 × 100 km
Slip amount: 0.2 m
Duration: ~20 days
Seismic moment: 1.8×10^{19} Nm (M_W 6.8)



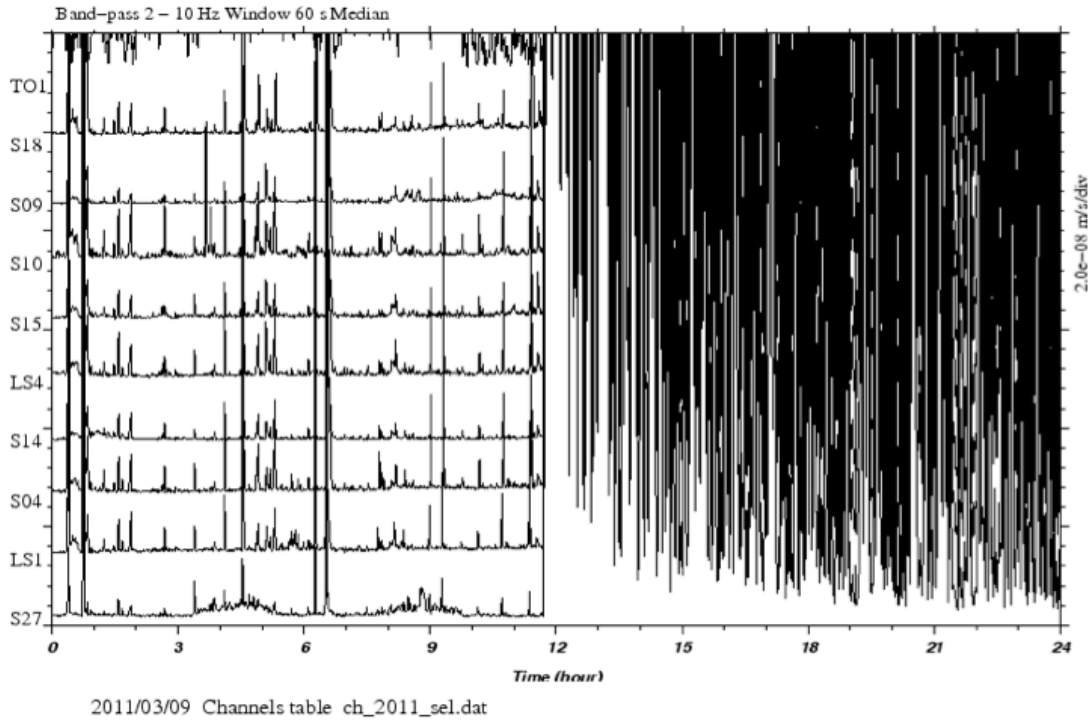
Fault size: 35 km × 100 km
Slip amount: 0.4 m
Duration: ~40 days
Seismic moment: 3.6×10^{19} Nm (M_W 7.0)



March 7th



March 8th



March 9th