TS5.1Seismic analysis and geodetic modelling: multi-disciplinary approach to problem-solving
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Fault stressing in the overriding plate due to megathrust coupling along the Nankai trough, Japan

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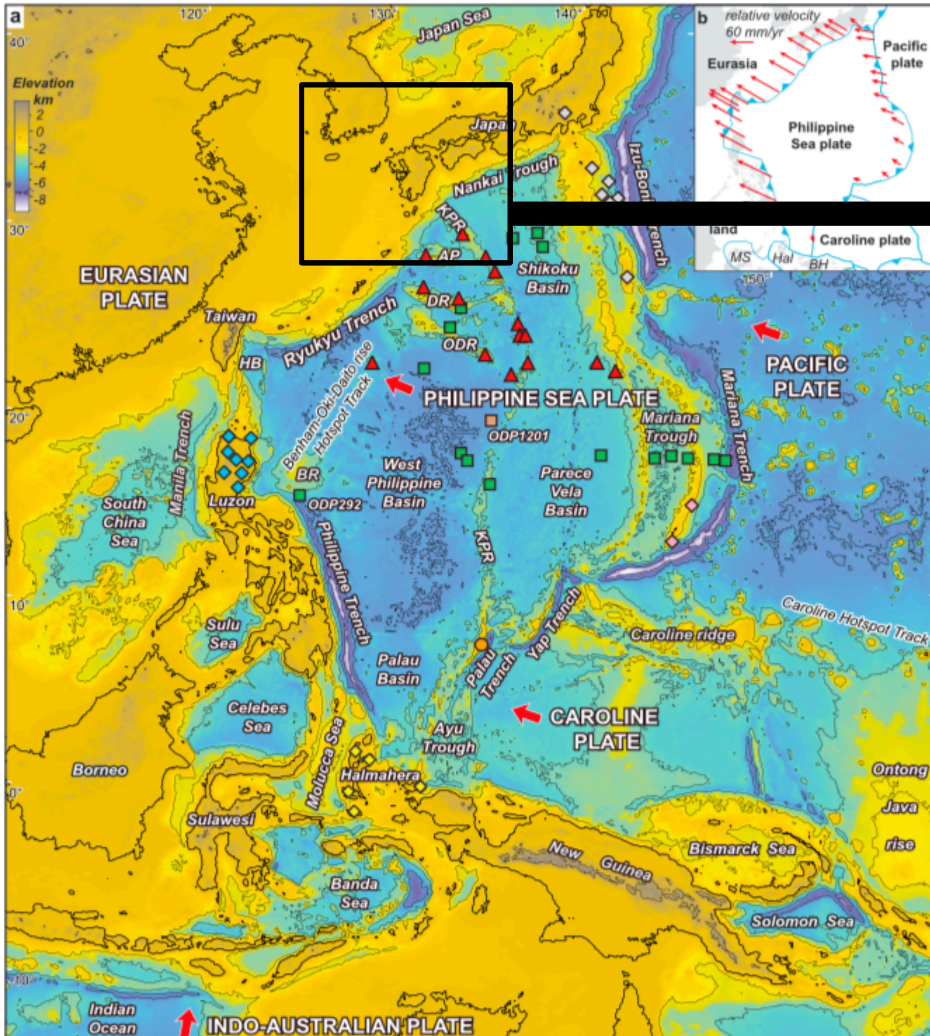
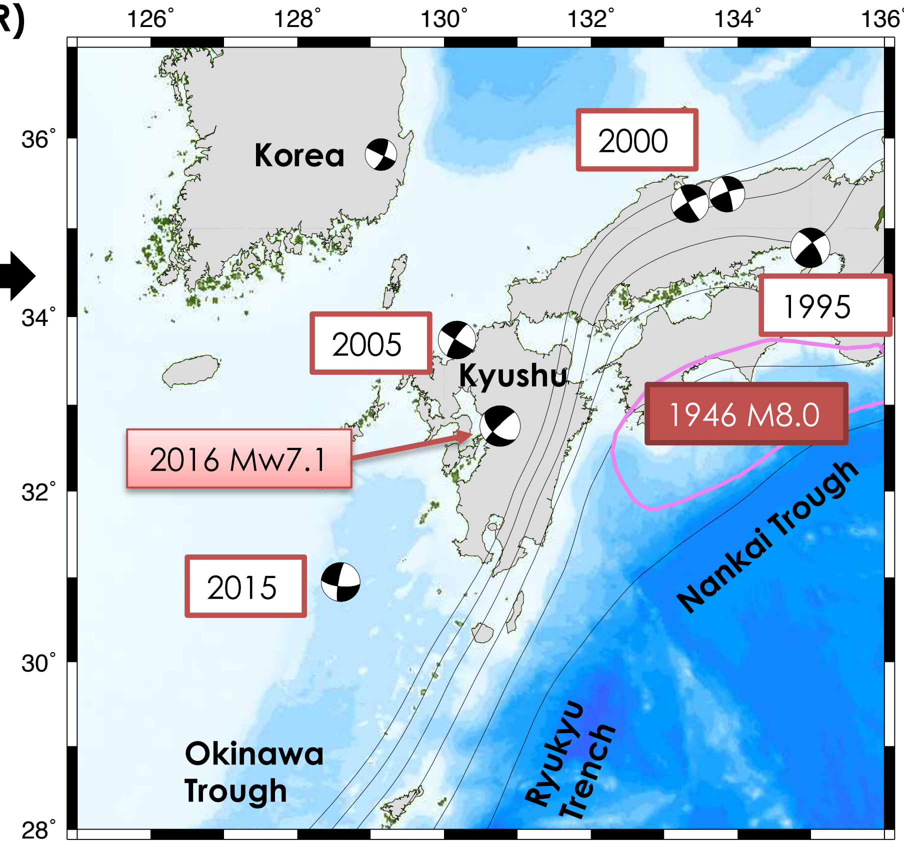
Recent inland earthquakes around SW Japan

Tectonics around Philippine Sea (Wu et al., 2016, JGR)

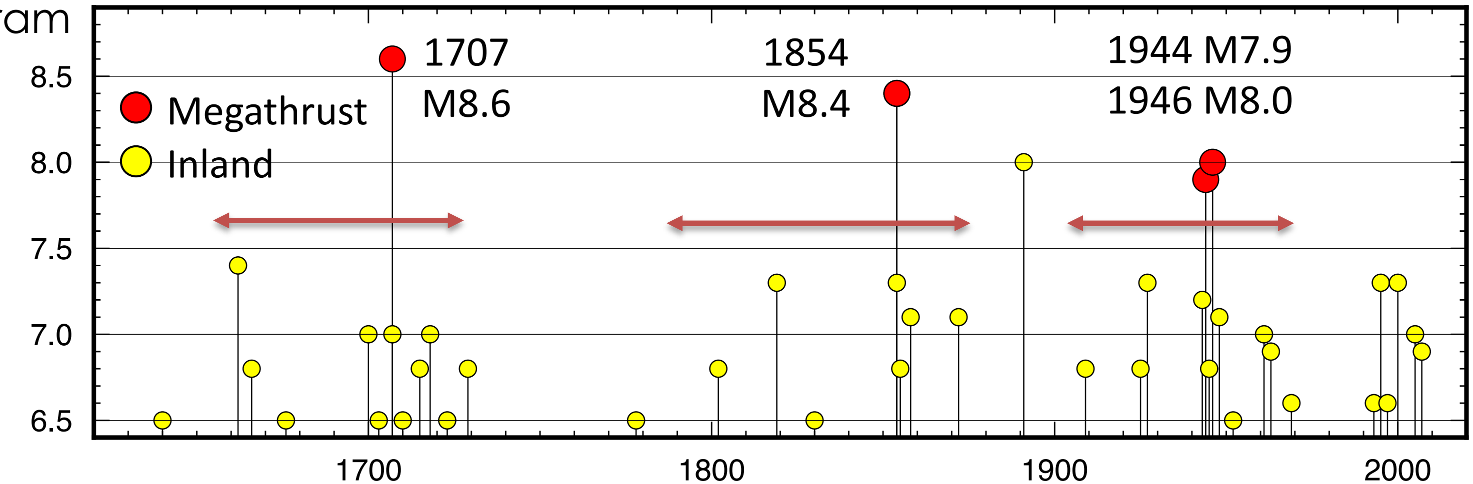




Active seismic activity of ~M7, especially around Kyushu since 1995

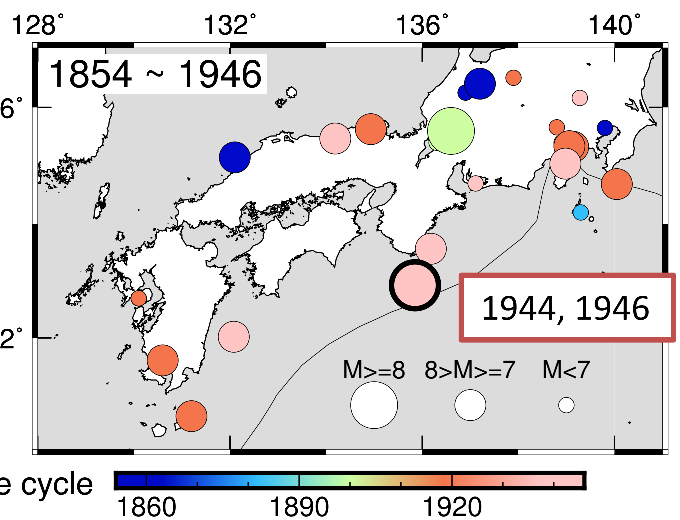
Inland earthquakes due to Nankai megathrust

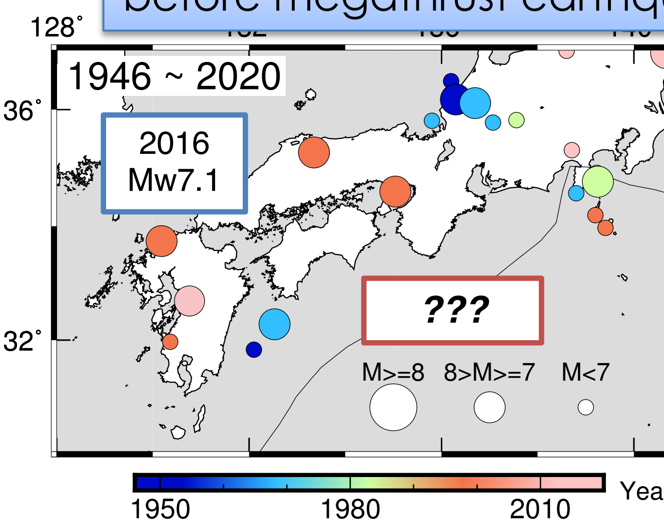
M-T diagram



Inland earthquakes tend to occur before megathrust earthquakes

Map View





Time in earthquake cycle

Data from historical documents (Utsu, 1990, 2002, 2004) http://iisee.kenken.go.jp/utsu/index_eng.html

Motivation of this study

- **Inland source faults are activated by the Nankai megathrust coupling? How the Ryukyu trench contributes?**

Methods

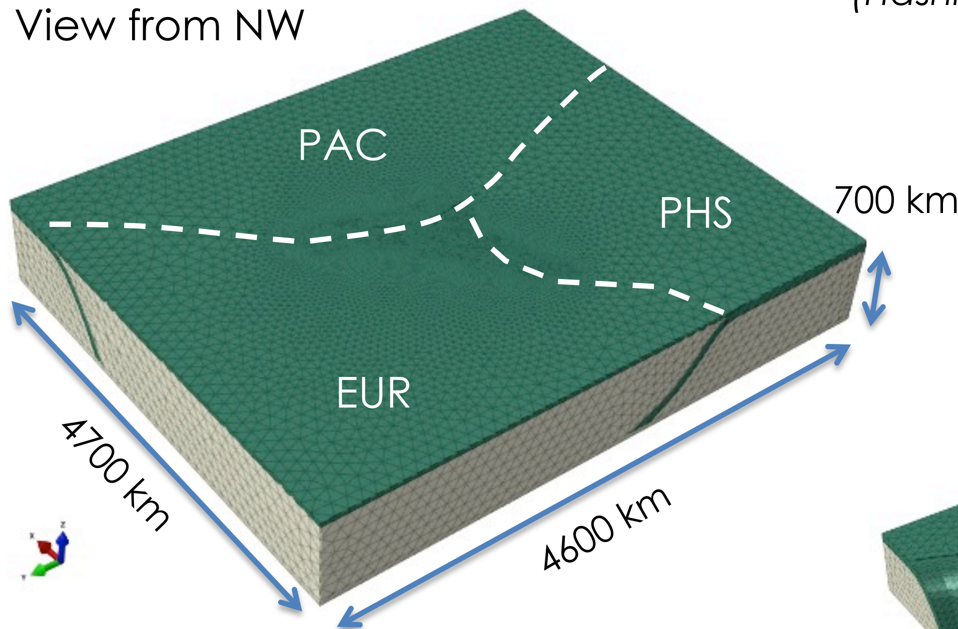
- **Calculate the stressing rate on source faults by the interplate coupling using 3-D finite element model**
- **interplate coupling under the Ryukyu-Nankai trenches is constrained by the GPS data**

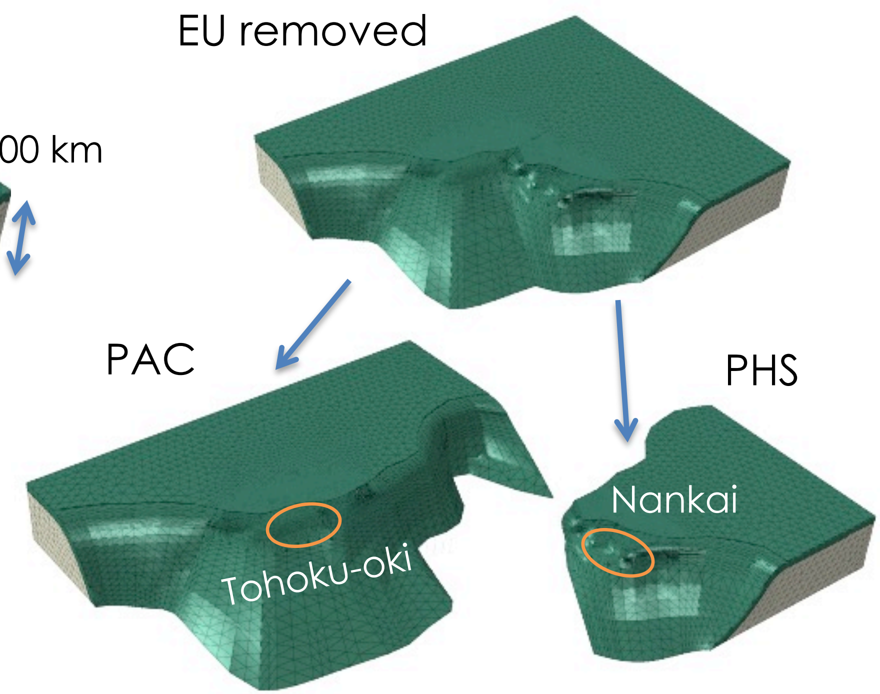
→ ***This method can be used to determine the inland fault going close to rupture***

3D FEM around the Japanese islands

(Hashima et al., 2016, EPS; Freed et al., 2017, EPSL)

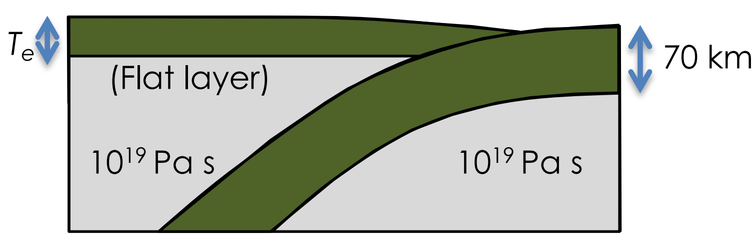
View from NW





Viscoelastic effect of asthenosphere

(Li et al., 2015, 2018; Noda et al., 2018)



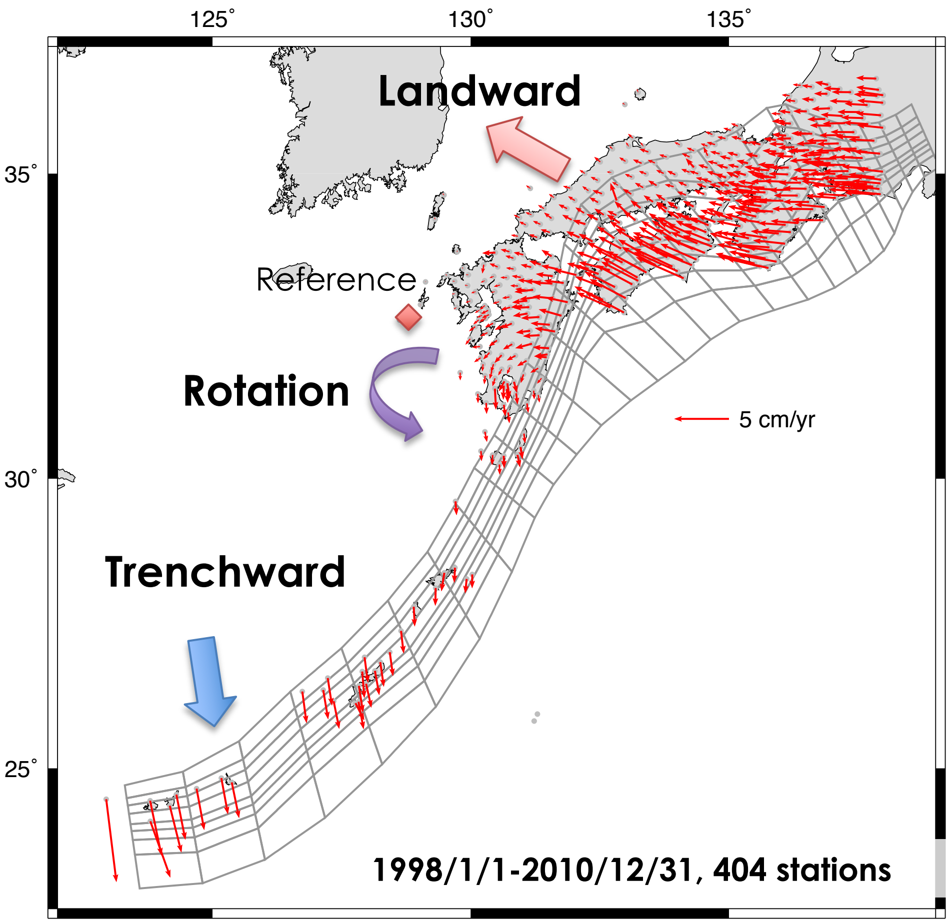
Elastic thickness T_e is critical to deformation
We examine cases of <u>T_e = 30, 50, and 80 km</u>

- Plate interface geometry based on *Nakajima & Hasegawa (2006), Hayes et al. (2012), etc.*
- 1000,000 Elements with the size of 5–100 km

**We use solution at t = 100 yr (perfectly relaxed)*

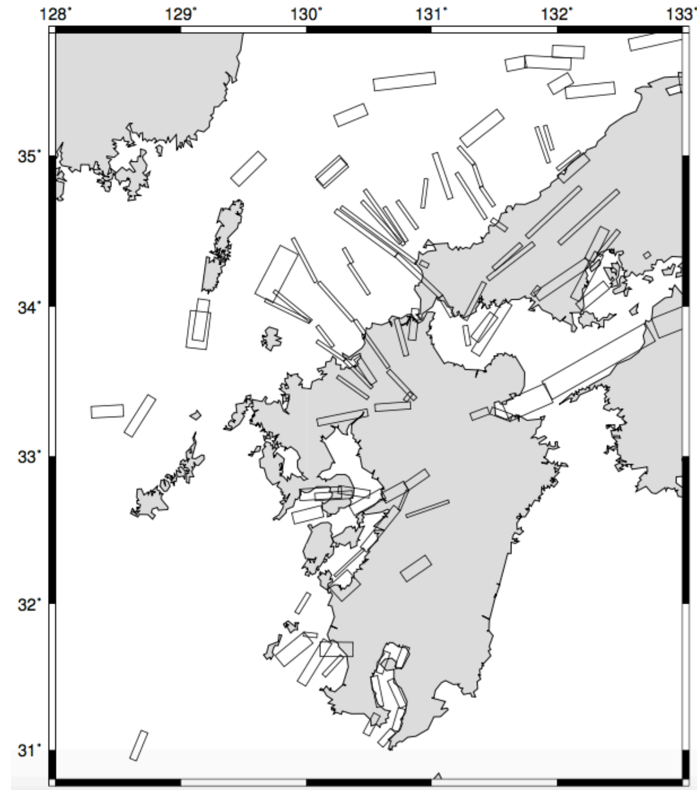
GPS Data and inland fault model

GPS data (from GSI of Japan)



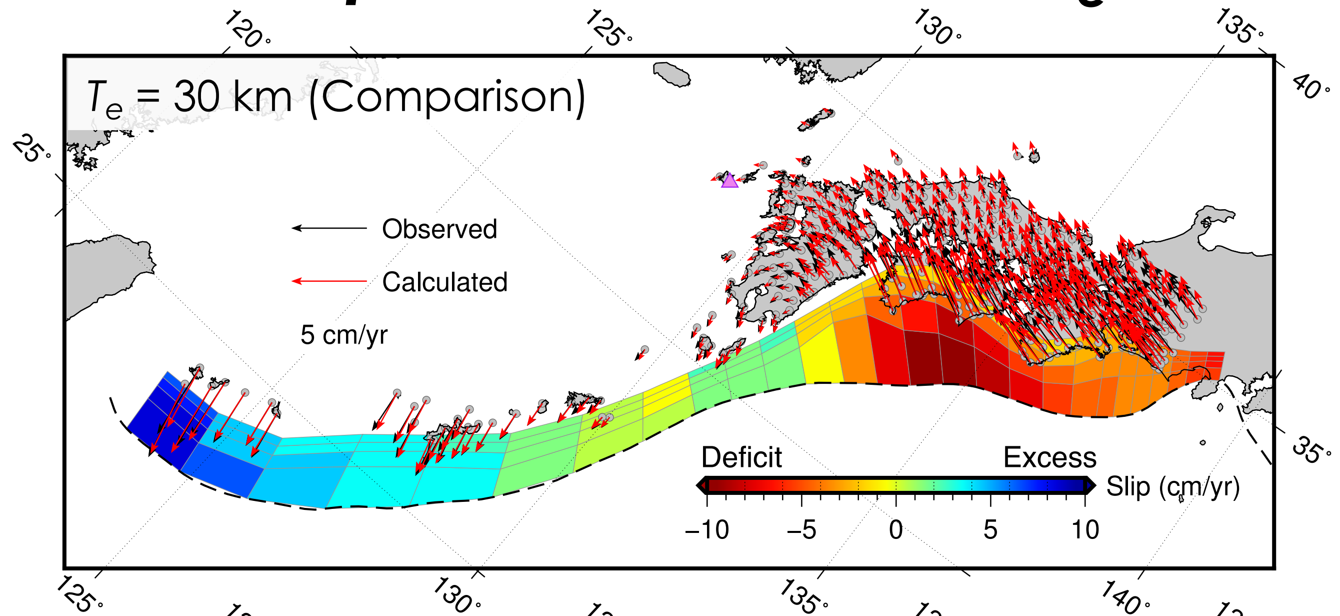
- Plate interface divided into 8×27 Patches
- Slip response is computed for each patch for inversion

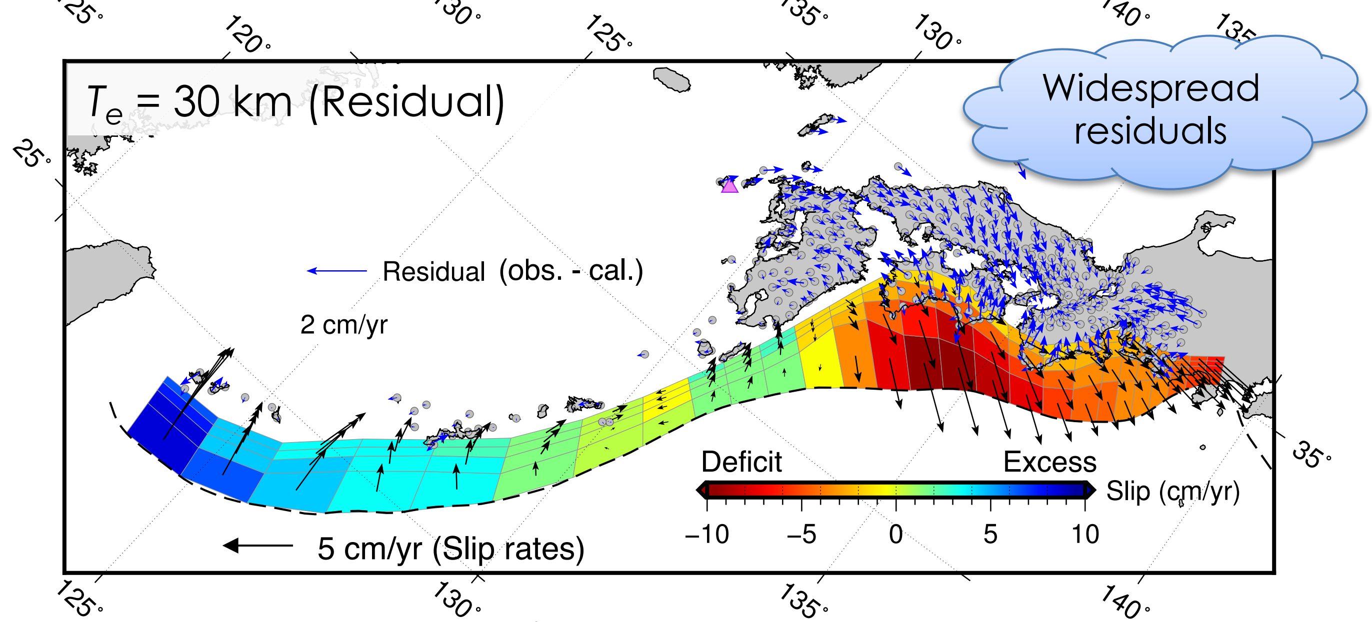
Source fault model



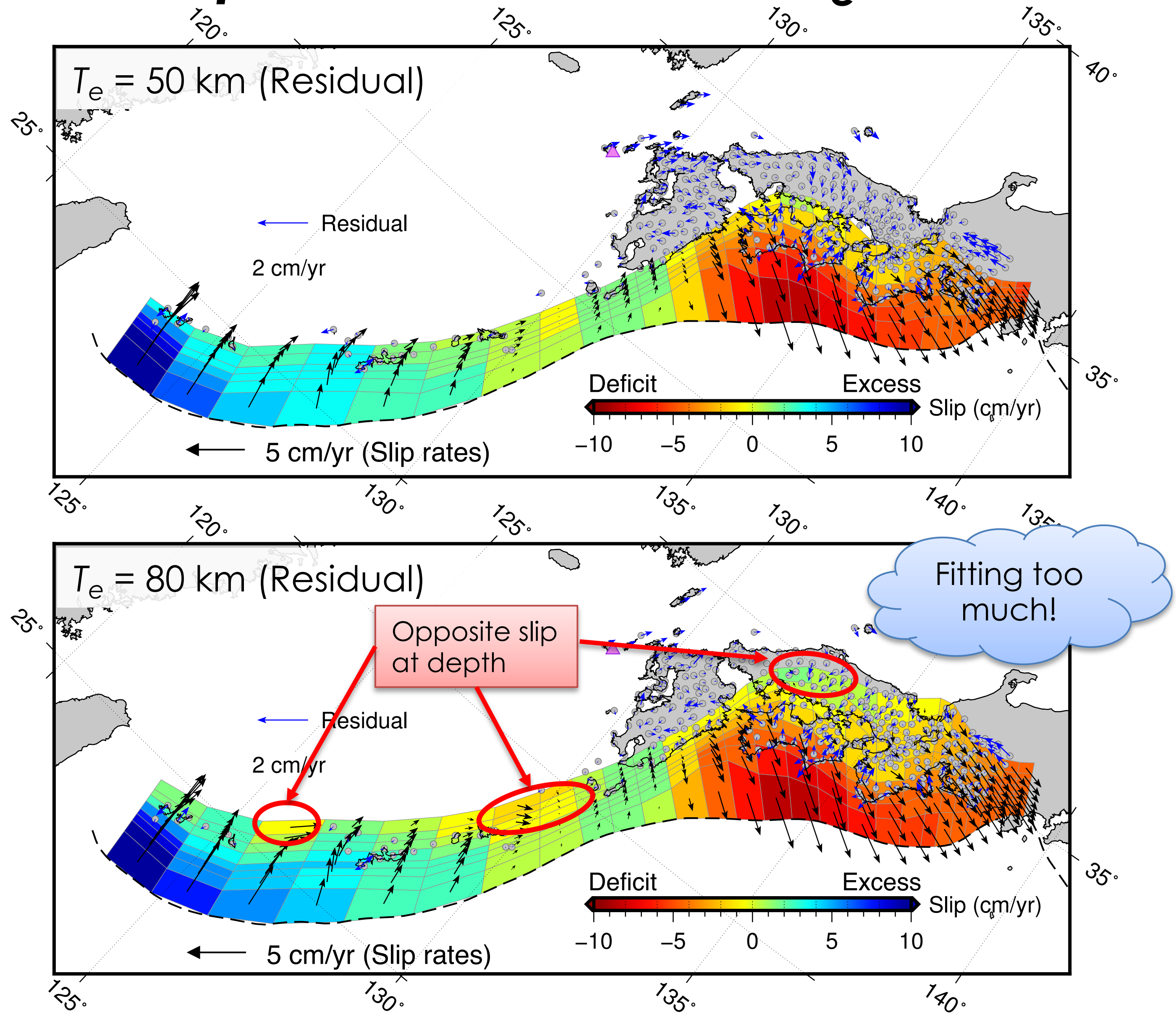
Slip angle is estimated to be the optimum direction by regional stress field (Terakawa & Matsu'ura, 2010)

Results of slip-rate inversion for T_e = 30 km



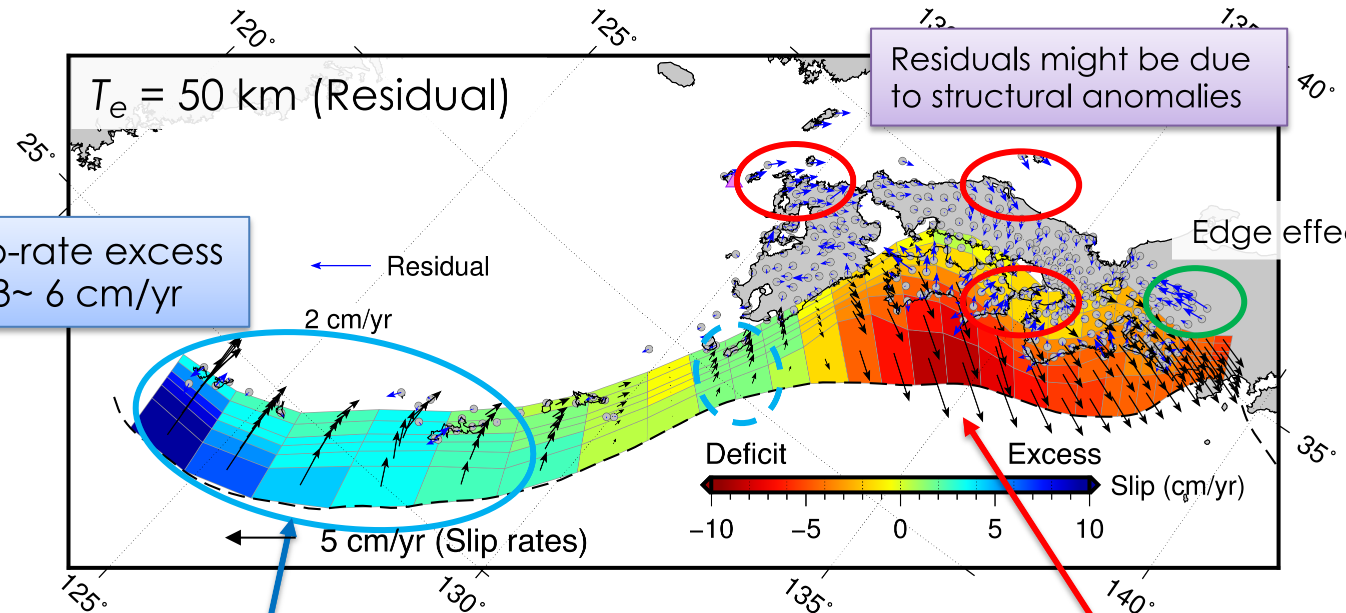


Results of slip-rate inversion for T_e = 50 & 80 km



The optimum model (T_e = 50 km)

Slip-rate excess
3~ 6 cm/yr



Residuals might be due to structural anomalies

Edge effect

Direction of slip-rate excess is deviated from the EUR-PHS relative motion, which represents different characteristics from relative plate motion

Related to slab rollback?

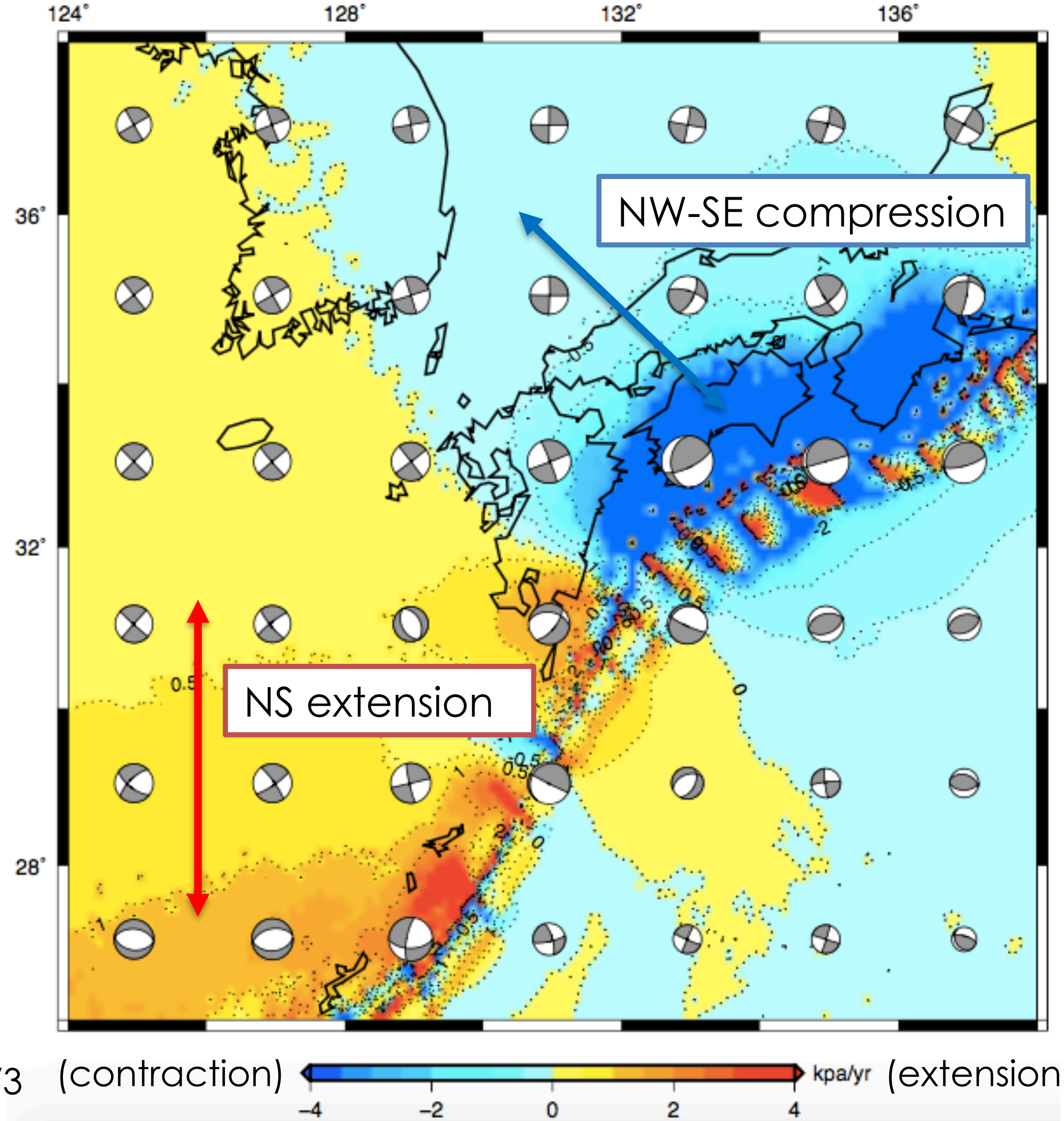
Slip-rate deficit ~ 8 cm/yr
(Interplate locking)

Consistent with previous studies (e.g. Ito et al., 1999; Yokota et al., 2016; Noda et al., 2018)

Intra-plate stressing rate for optimum model

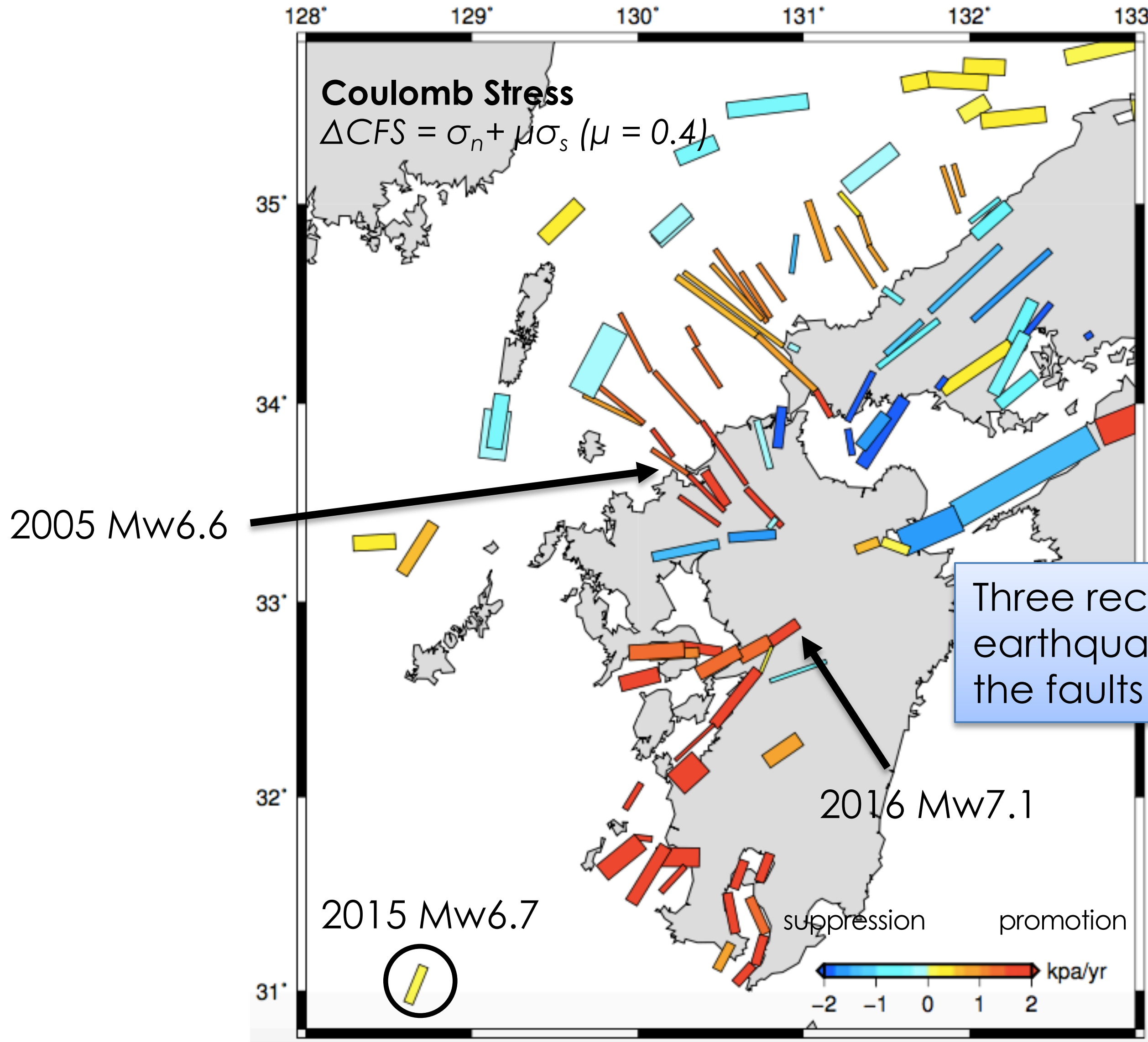
Stress at depth of 10 km

T_e = 50 km



$(\sigma_{11} + \sigma_{22} + \sigma_{33})/3$

Coulomb stress rates on inland faults



Three recent ~M7 earthquakes occurred on the faults of positive ΔCFF

Summary

- **Using 3-D FEM, we inverted GPS data in the Ryukyu-SW Japan arcs to obtain slip-rate excess/deficit under the Ryukyu-Nankai trenches**
  - **Slip-rate excess under the Ryukyu trench might be due to slab rollback**
  - **Slip rates under the Ryukyu trench is critical to the deformation on the Kyushu island, junction of the Ryukyu-SW Japan arcs**

- **Using slip-rate distribution, we computed stressing rate on the inland faults. In particular, source faults of the recent ~M7 earthquakes shows positive Coulomb stressing rates**

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