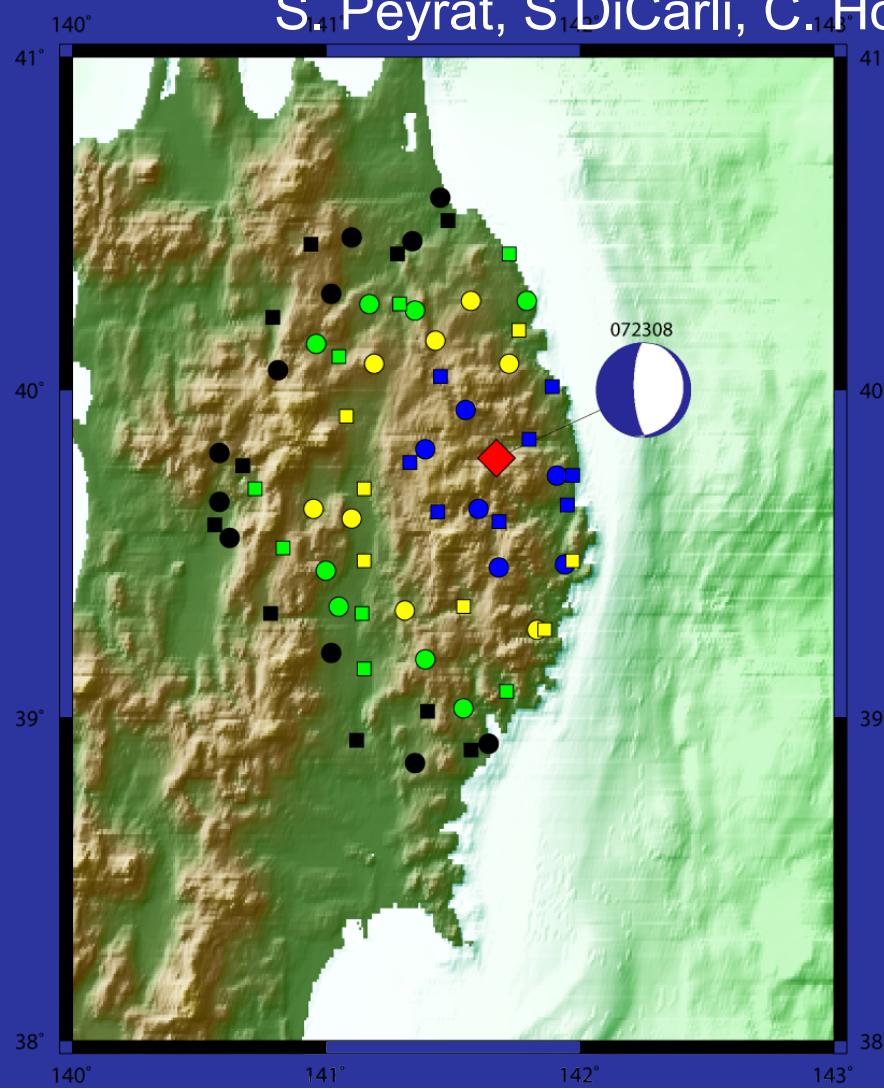


Dynamic inversion of intermediate depth earthquakes and Brune's model

Sergio Ruiz (U. of Chile) and R. Madariaga (ENS)

In collaboration with

S. Peyrat, S. DiCarli, C. Holden, V. Cruz, J. J. Diaz



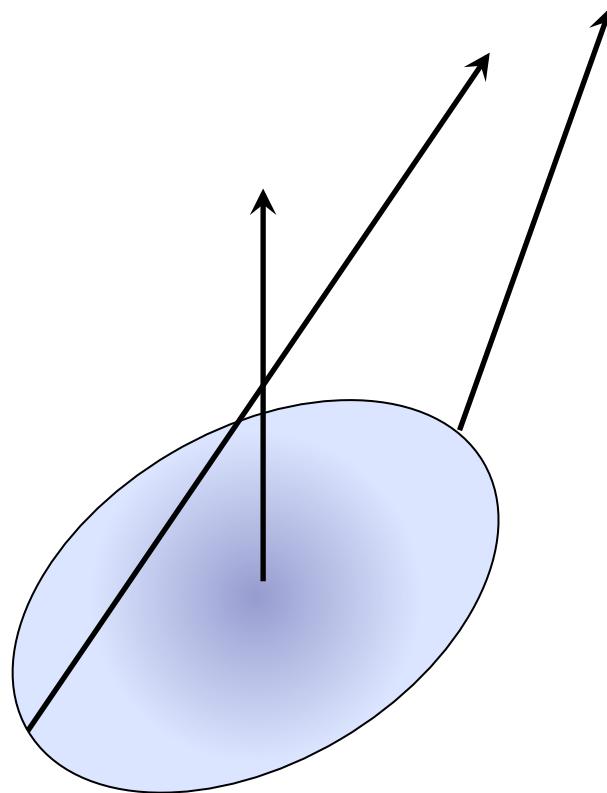
Northern Iwate intermediate depth
earthquake

23 July 2008 M_w=6.9

Suzuki et al , BSSA, 2009

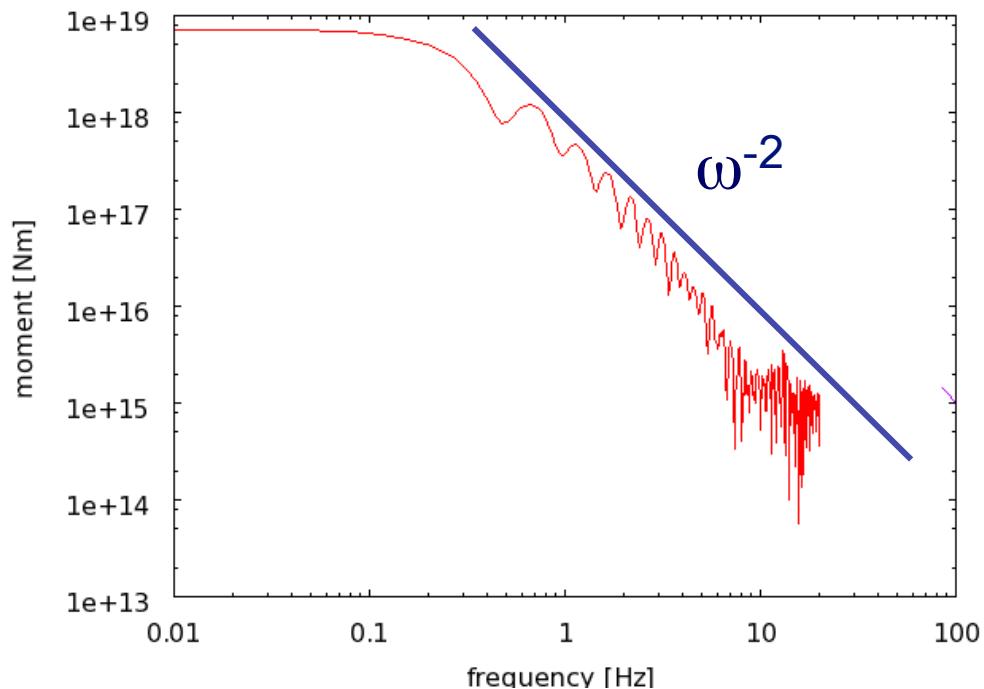
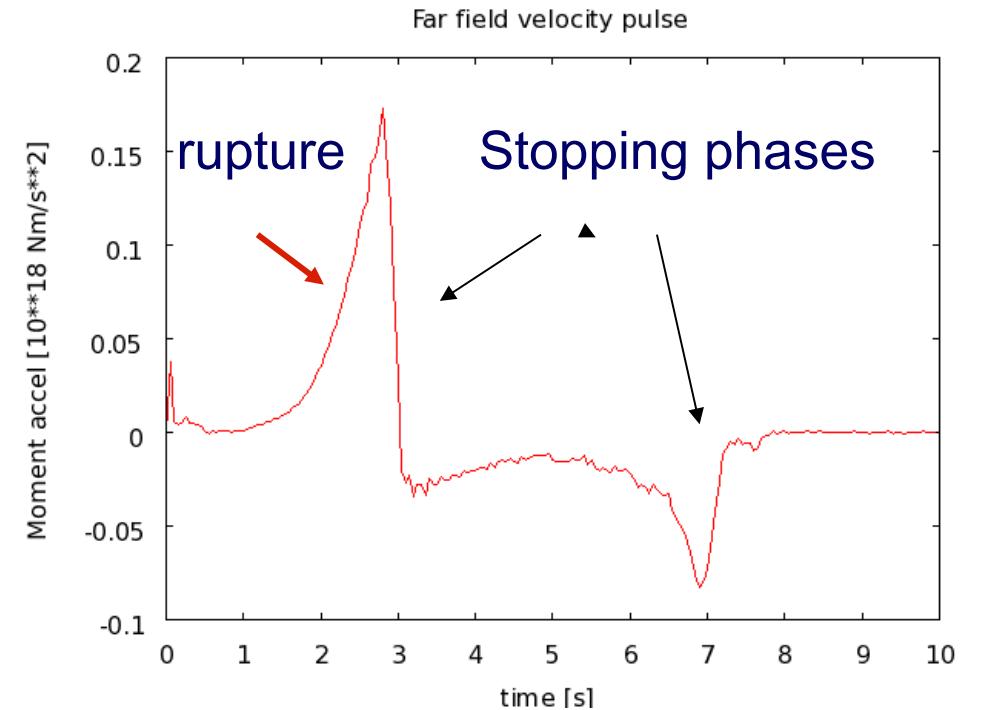
Ruiz, Madariaga, GRL, 2011

Far field radiation from circular crack

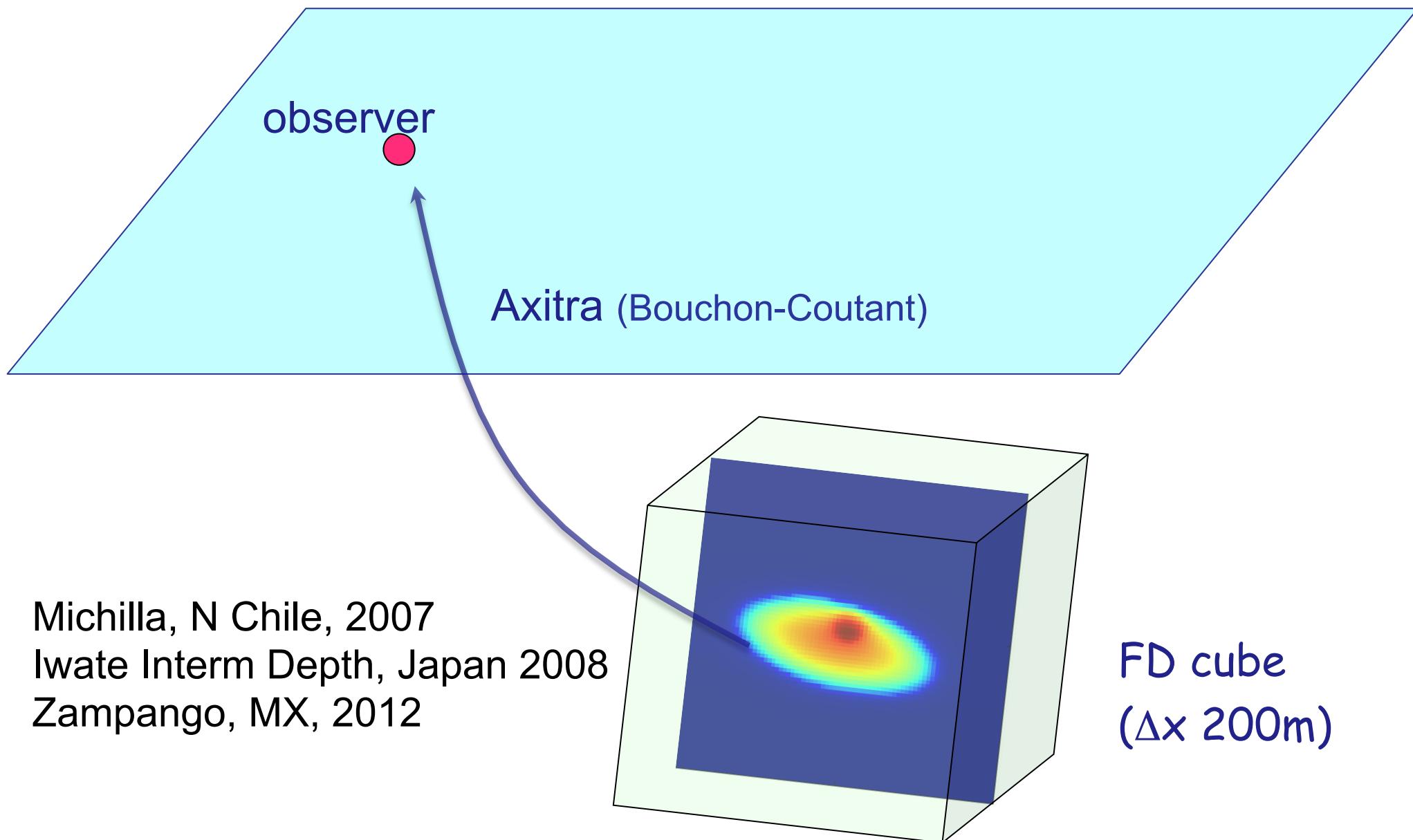


Corner frequency

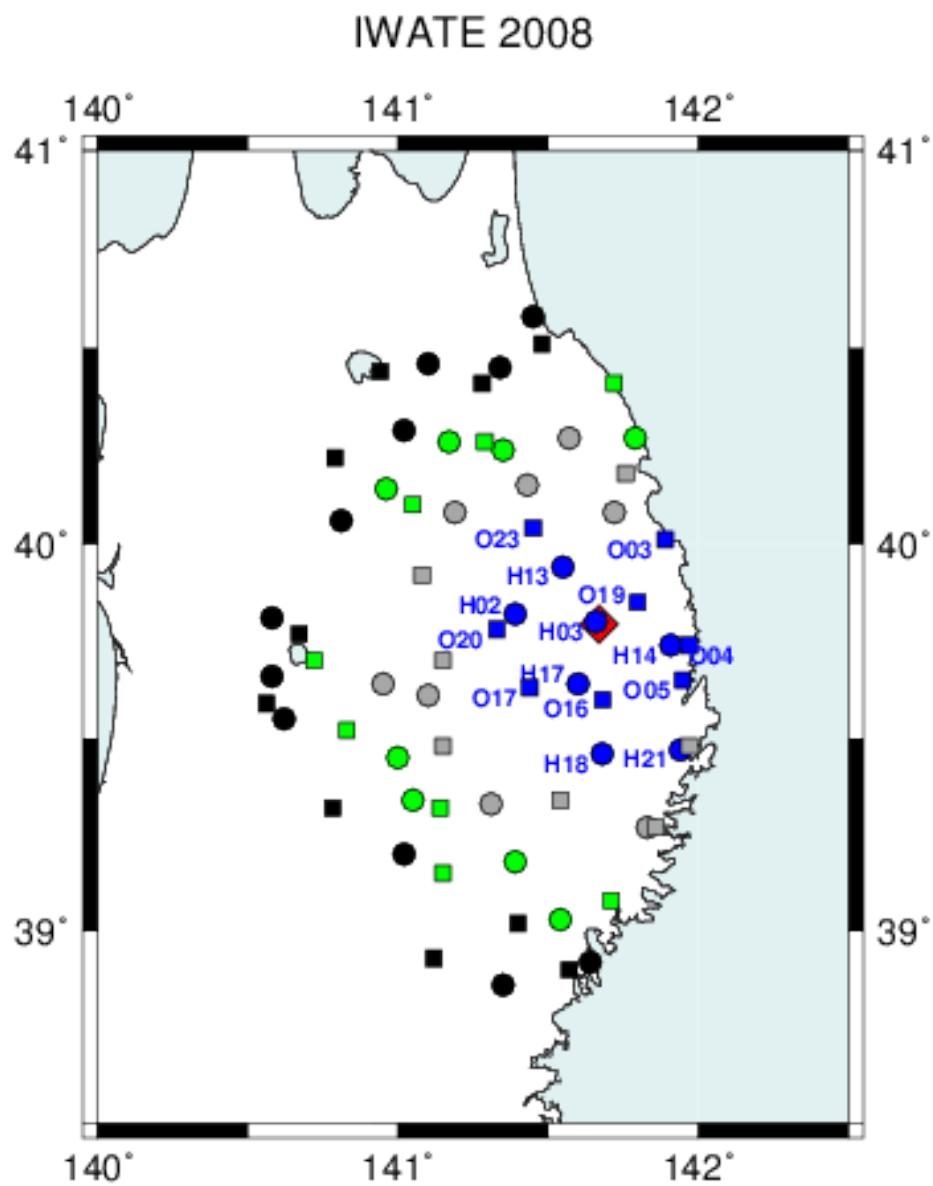
Determined by seismic
efficiency



Dynamic Forward problem



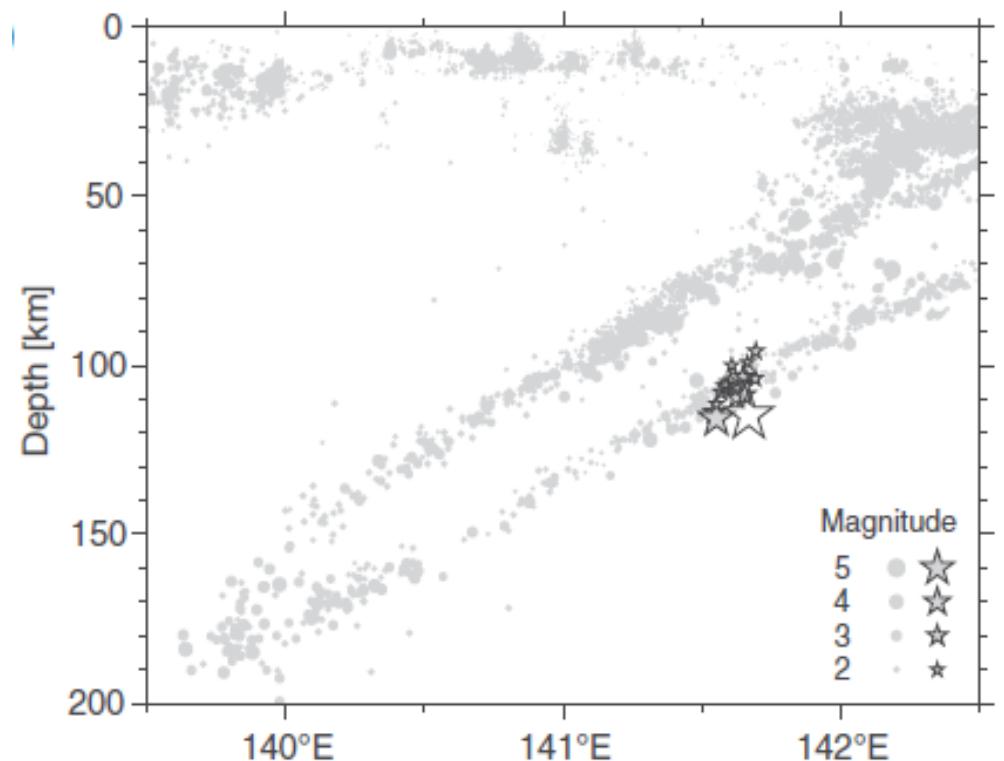
The 2008 intermediate depth Iwate earthquake



Iwate-ken Engan-hokubu

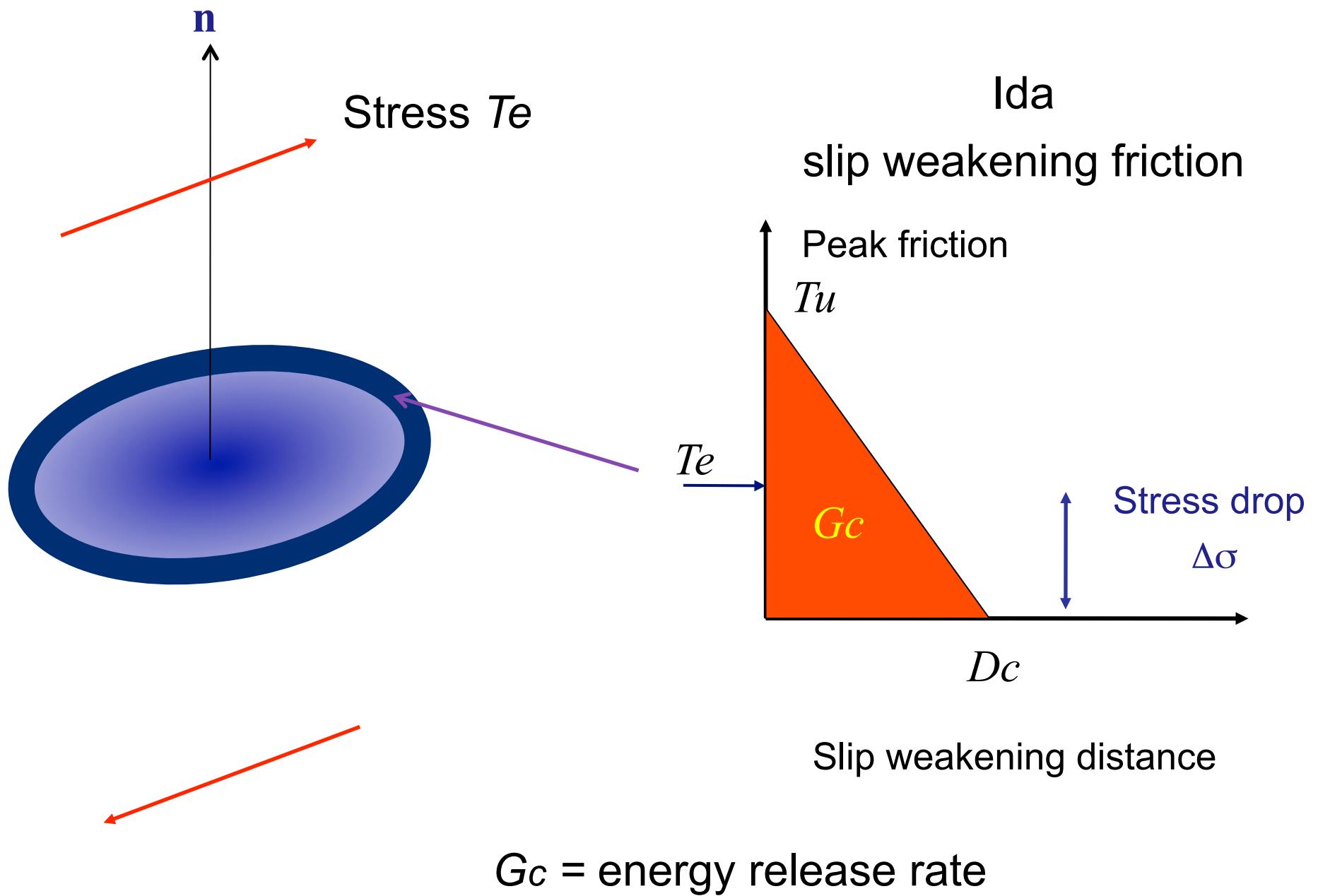
23 July 2008 at 15:26 GMT

$M_0 = 2.8 \times 10^{19} \text{ Nm}$ $M_w = 6.9$



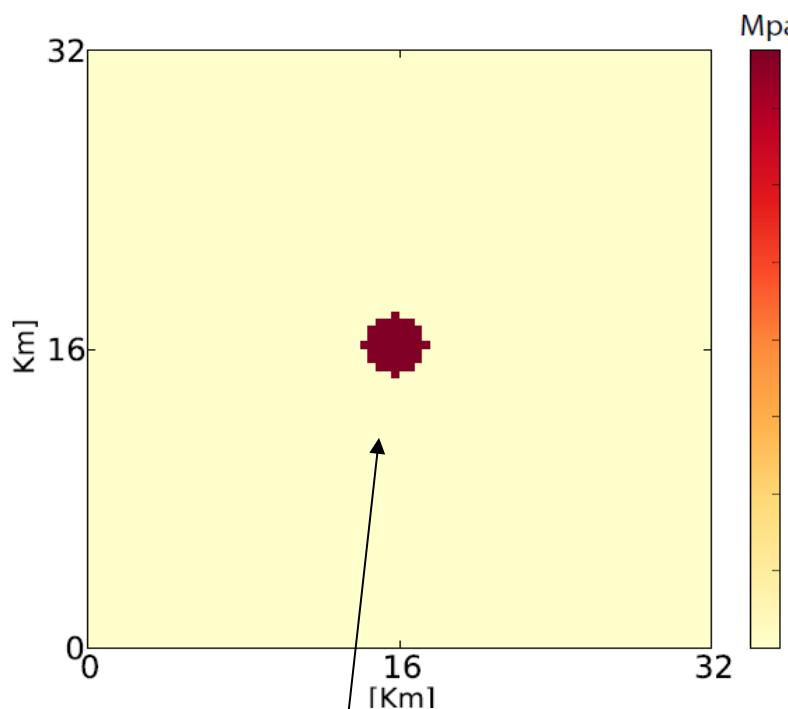
From Suzuki, Aoi and Sekiguchi, BSSA, 2009

Forward problem : Spontaneous crack model



Parameters for the inversion of a barrier model

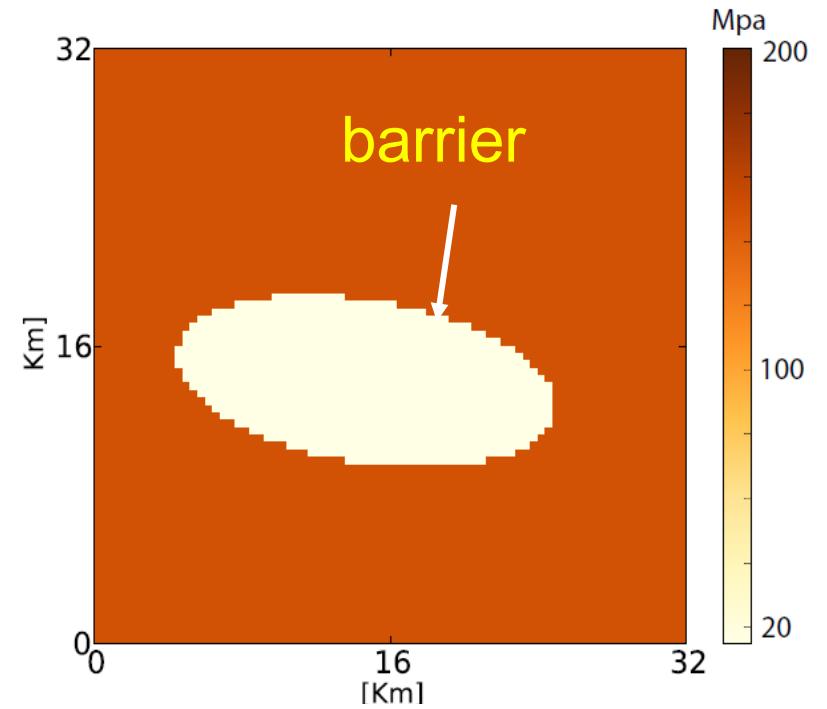
Applied stress



Te Applied stress

Asperity radius and value at peak

Rupture resistance



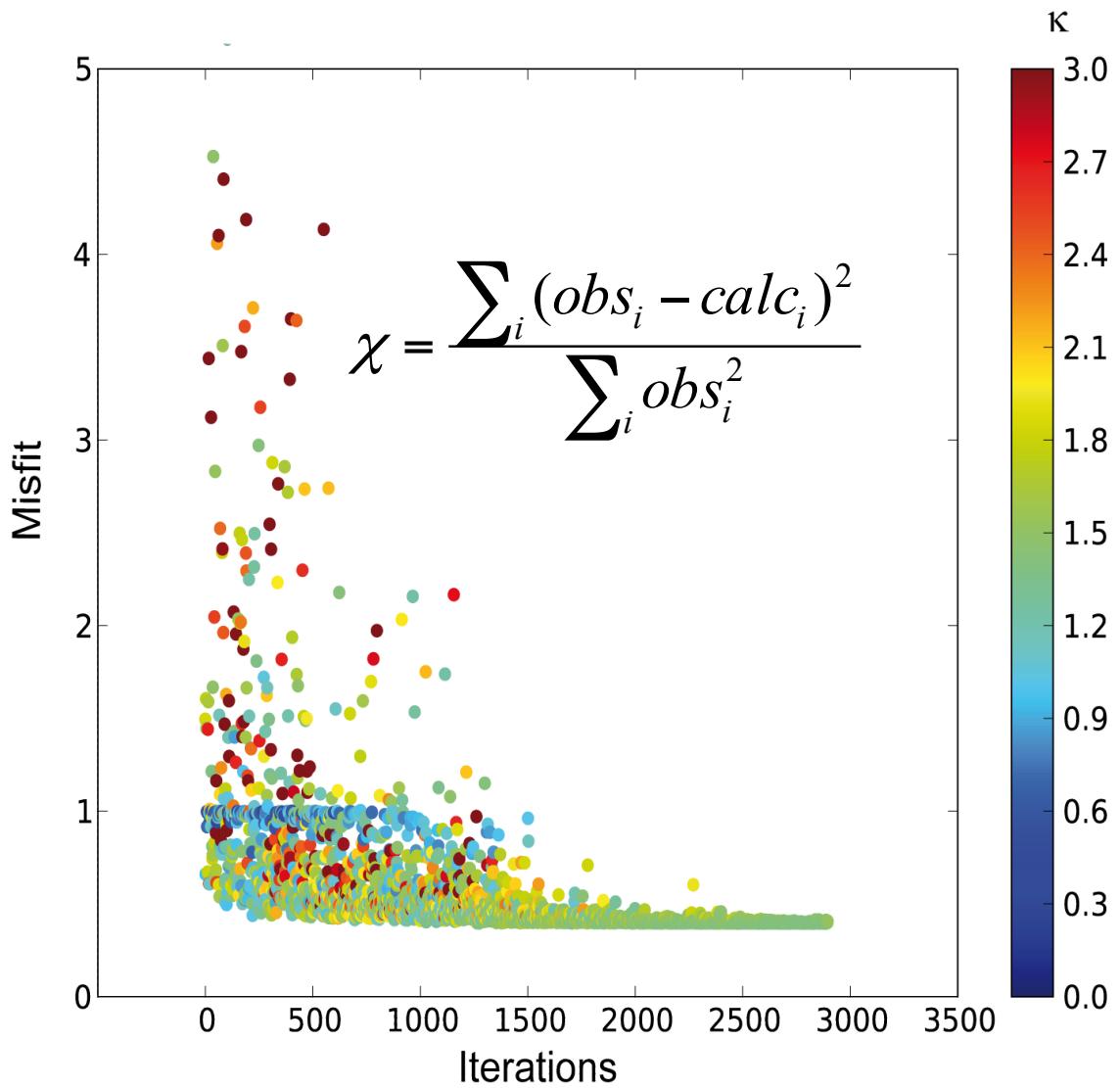
Friction

Tu Dc

geometry a, b , ϕ , x_0 , y_0

Dynamic inversion

Convergence of the NA algorithm



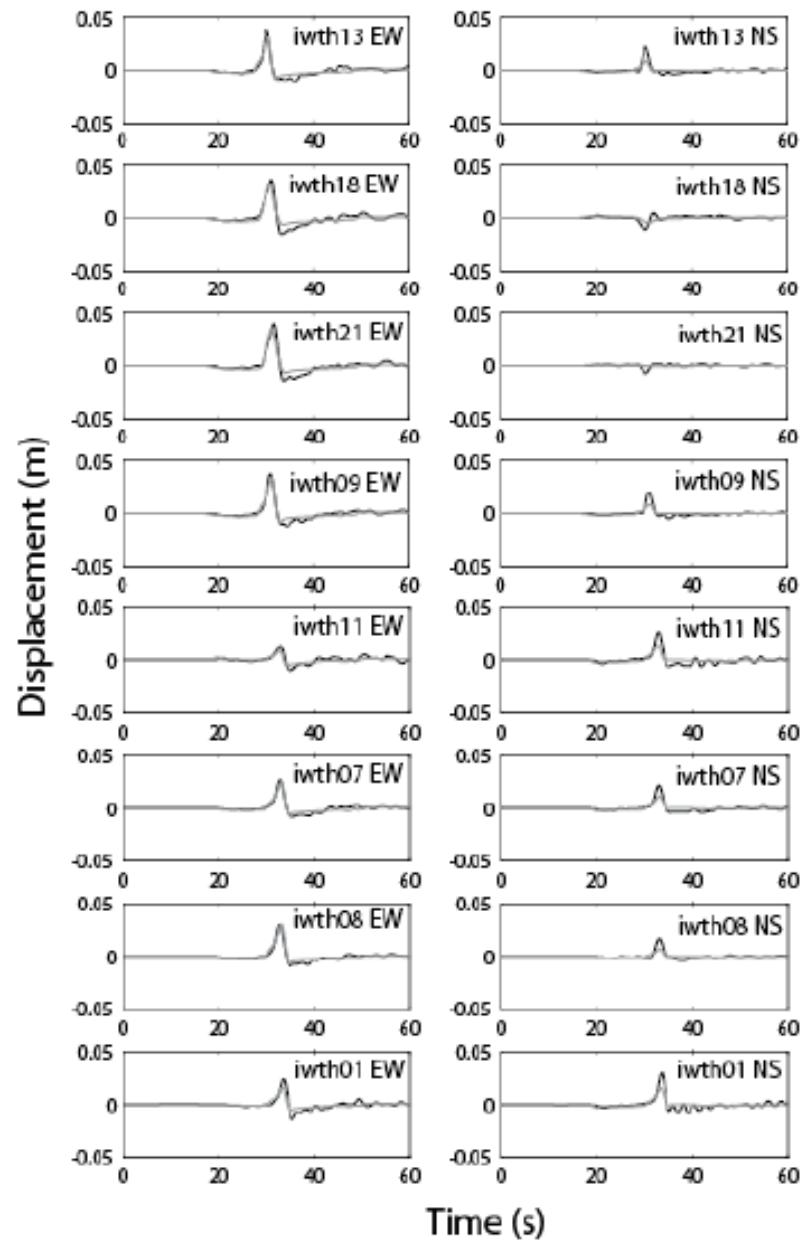
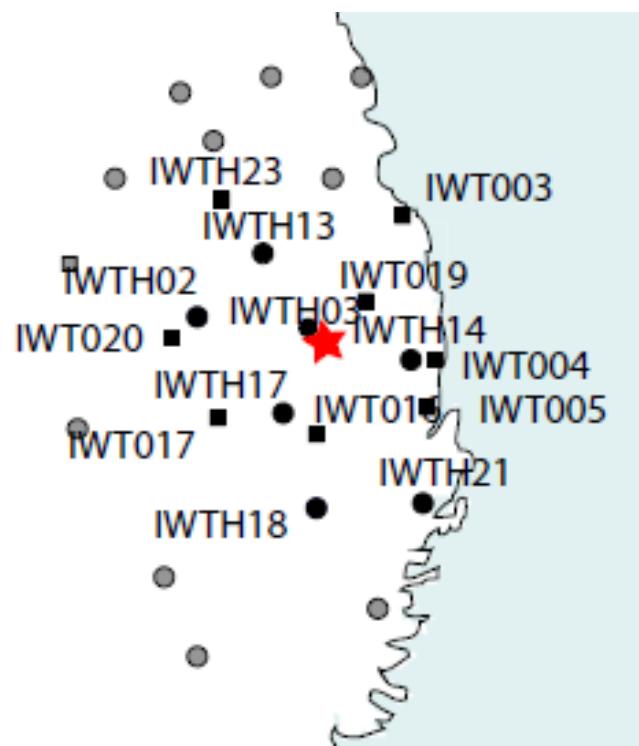
$$\kappa = \frac{T_e^2}{\mu} \frac{b}{T_u D_c}$$

$$\kappa = 1.3$$

$$\chi = 0.39$$

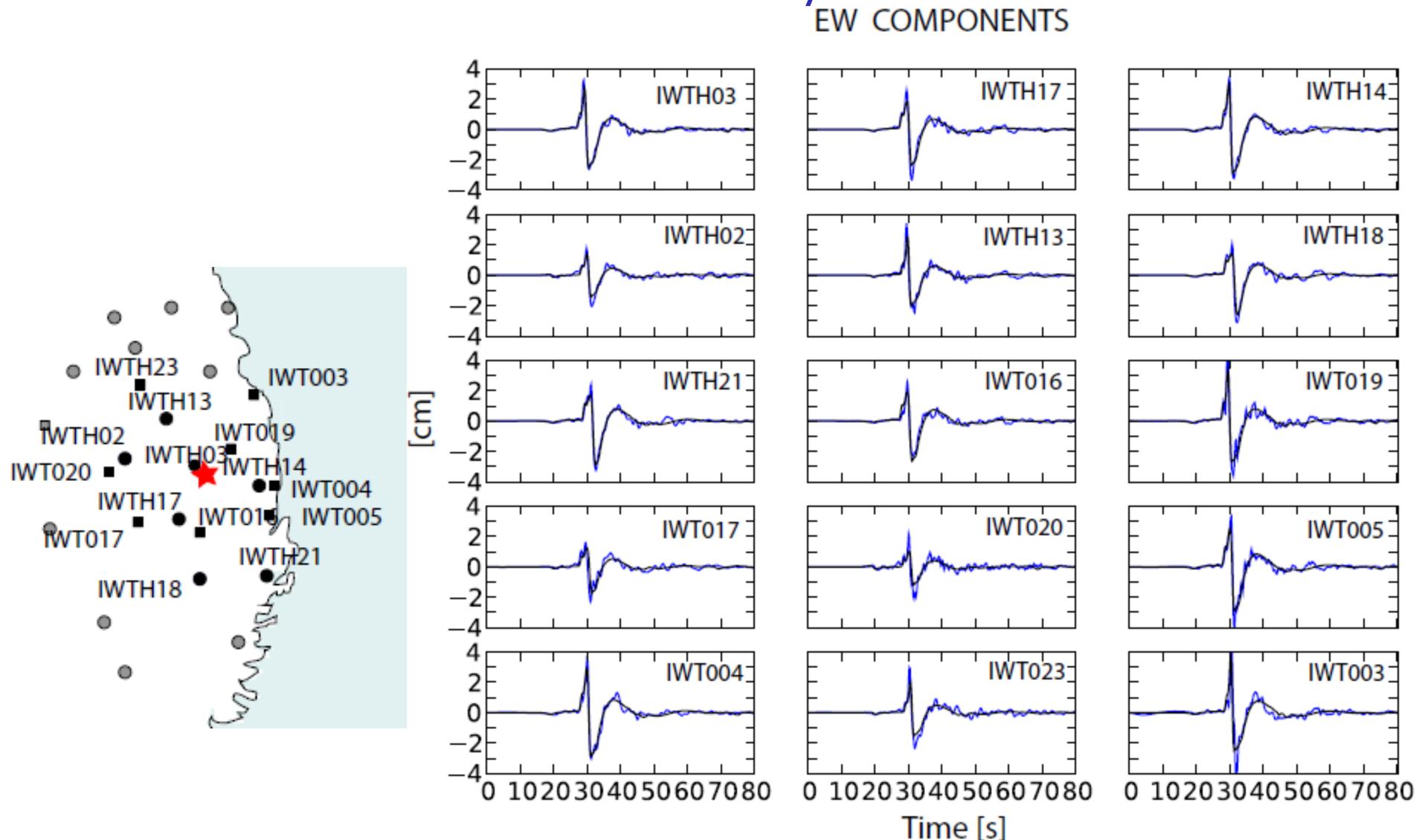
Inversion of the Iwate intermediate depth EQ 2008

Displacement fits



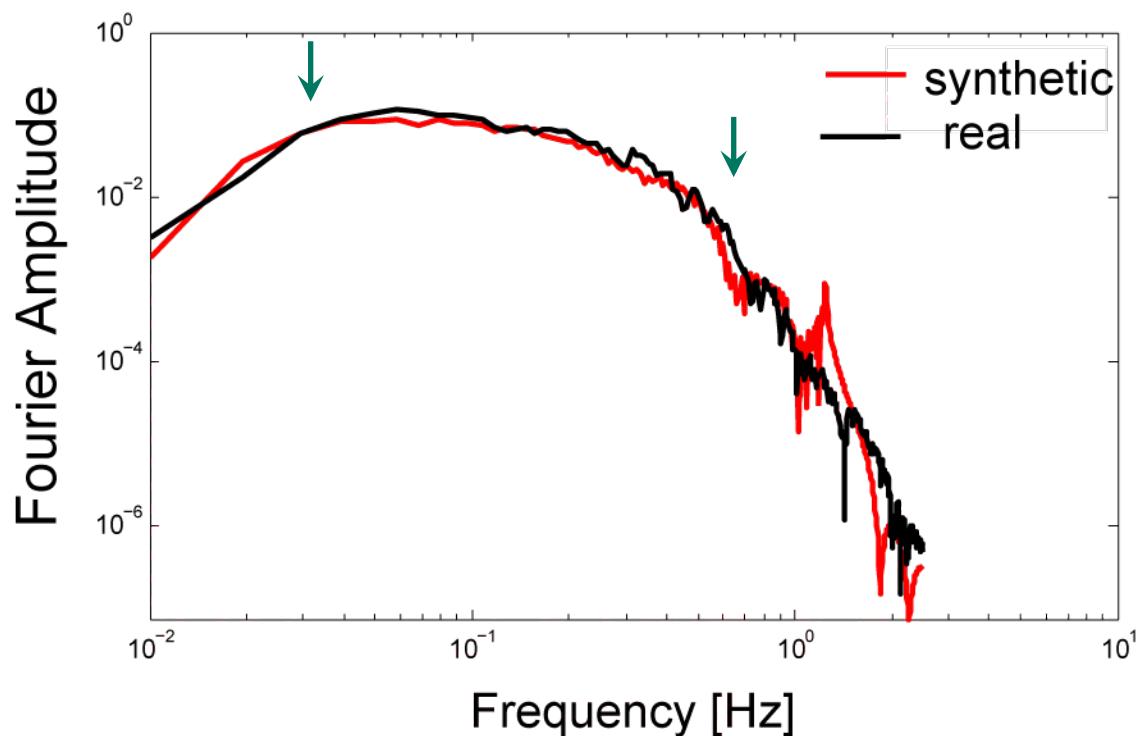
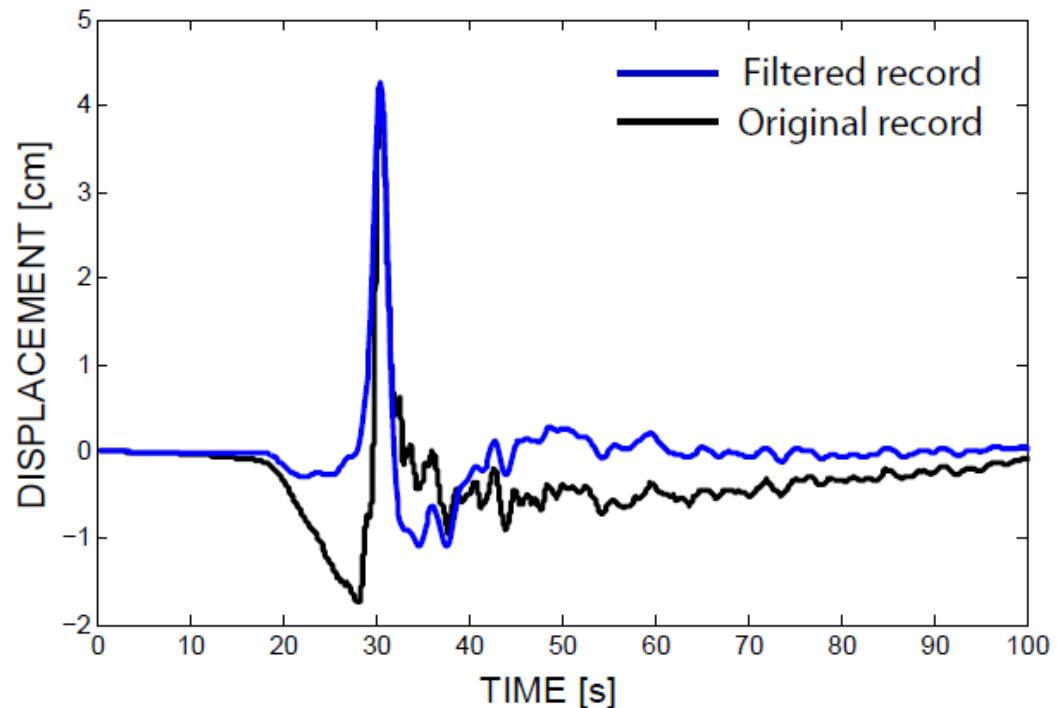
Inversion of the Iwate intermediate depth EQ 2008

Fit of the records in velocity



Northern Iwate EQ 2008

Spectral resolution
Band pass 0.02-0.5 Hz



Inversion of the Northern Iwate intermediate EQ

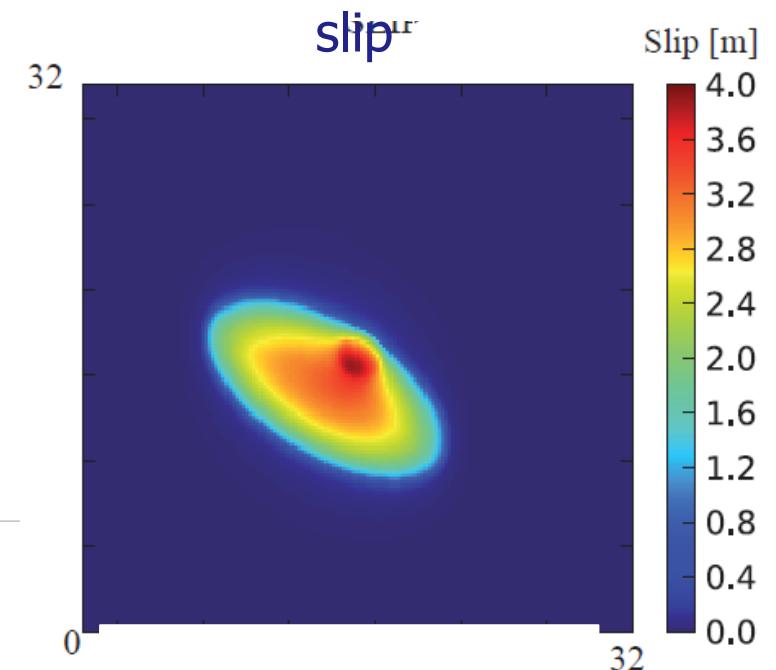
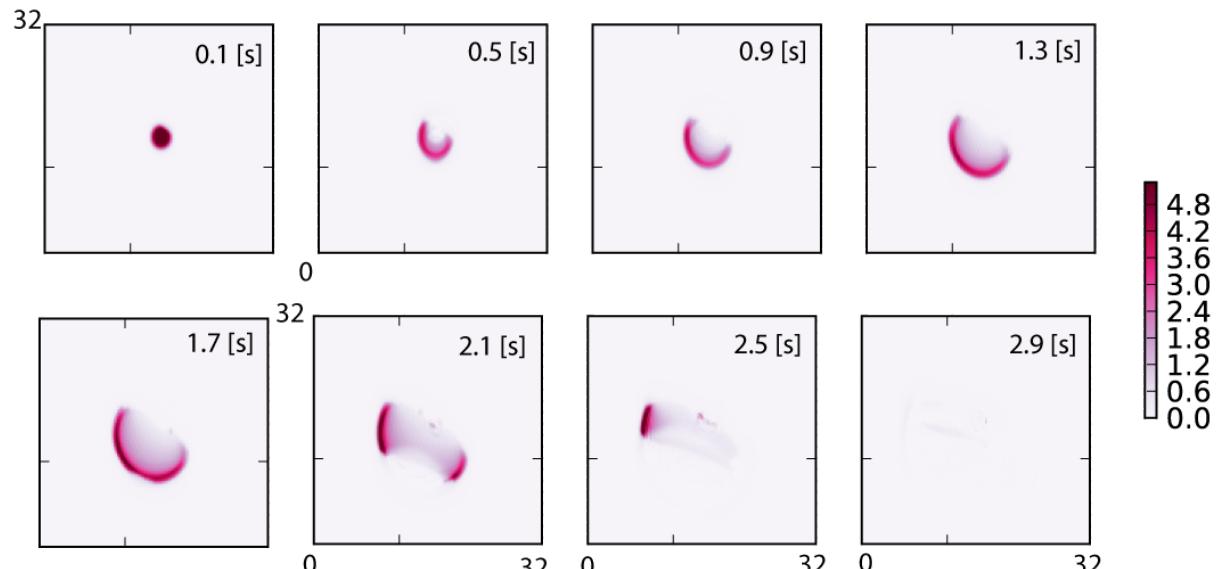
$T_e = 34 \text{ MPa}$

$D_c = 1 \text{ m}$

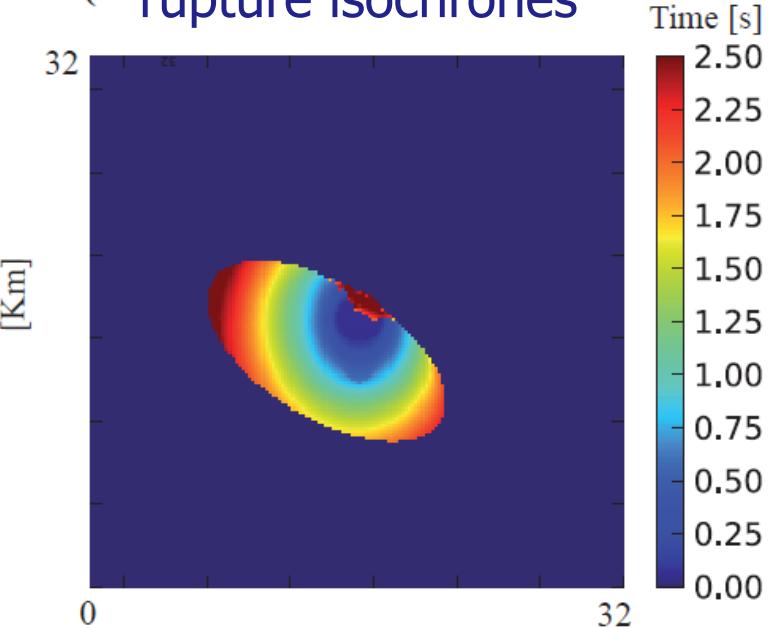
$G_c = 28 \text{ MJ/m}^2$

Peak velocity 5.5 m/s

Slip rate snapshots

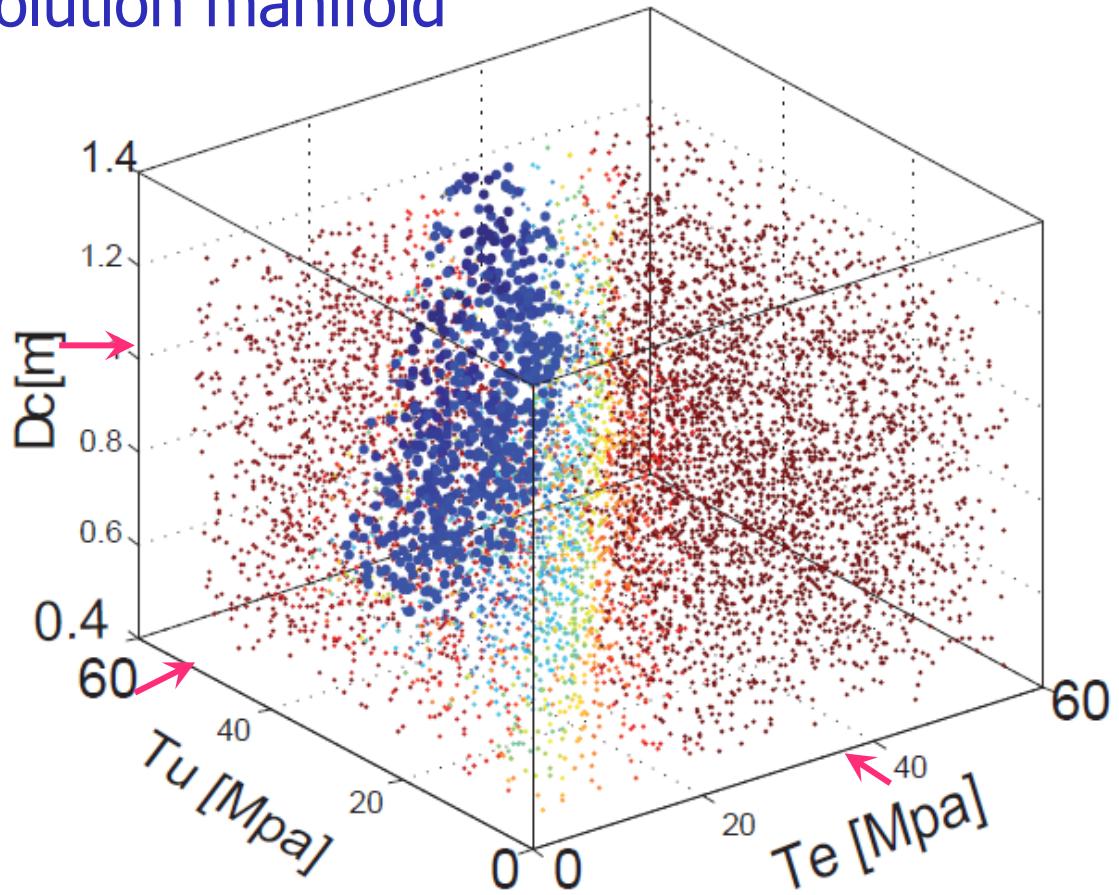


rupture isochrones

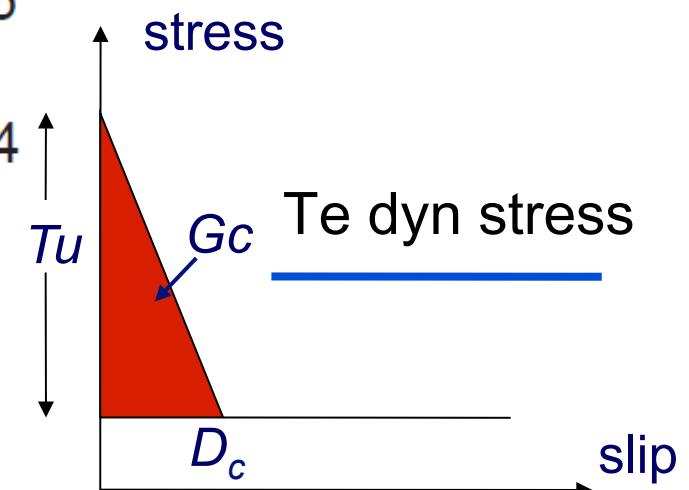
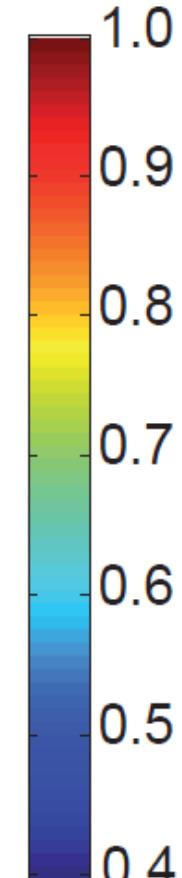


Study of resolution by Monte Carlo

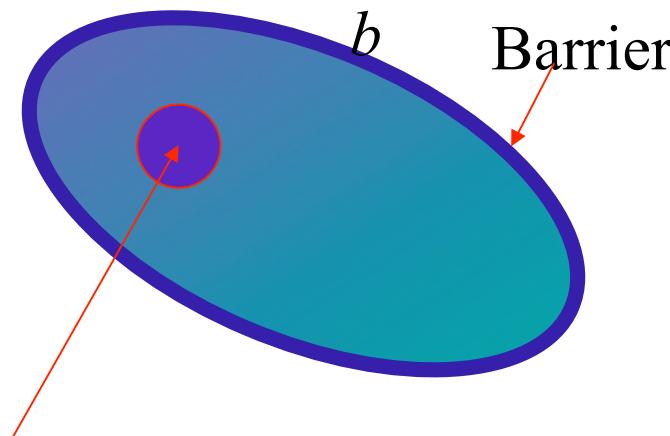
Solution manifold



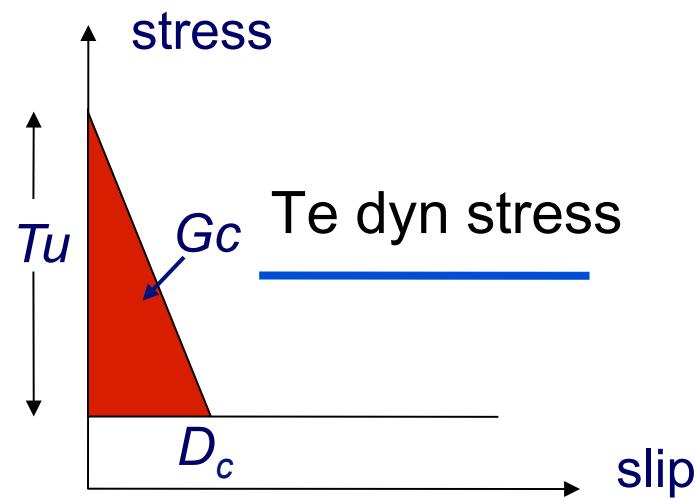
Misfit



Dynamic parameters are not independent

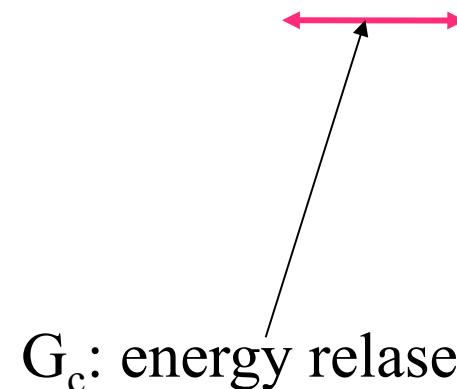


Initial patch radius R



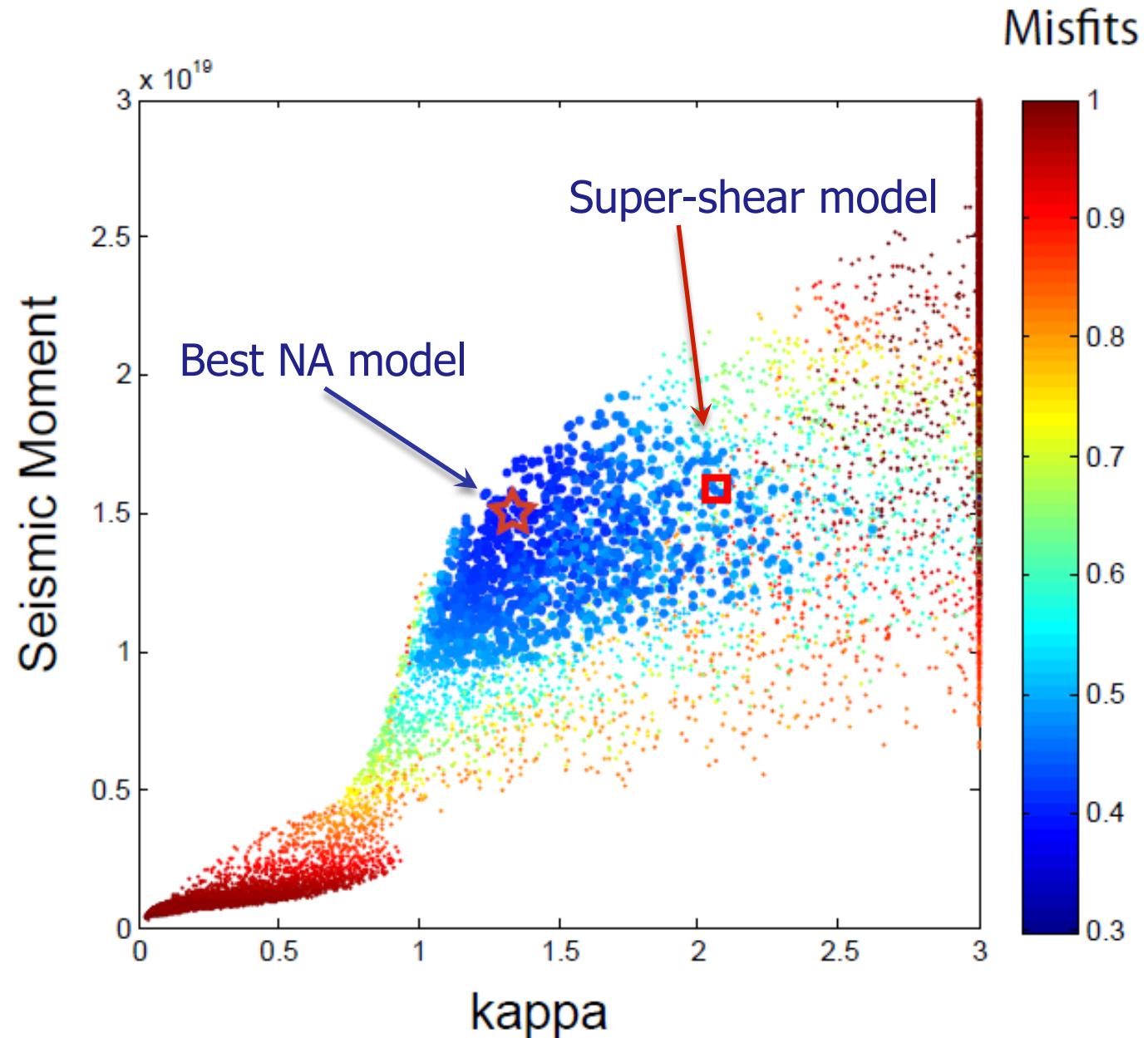
Stress drop fault size

$$K = \frac{T_e^2}{\mu} \frac{b}{G_c}$$

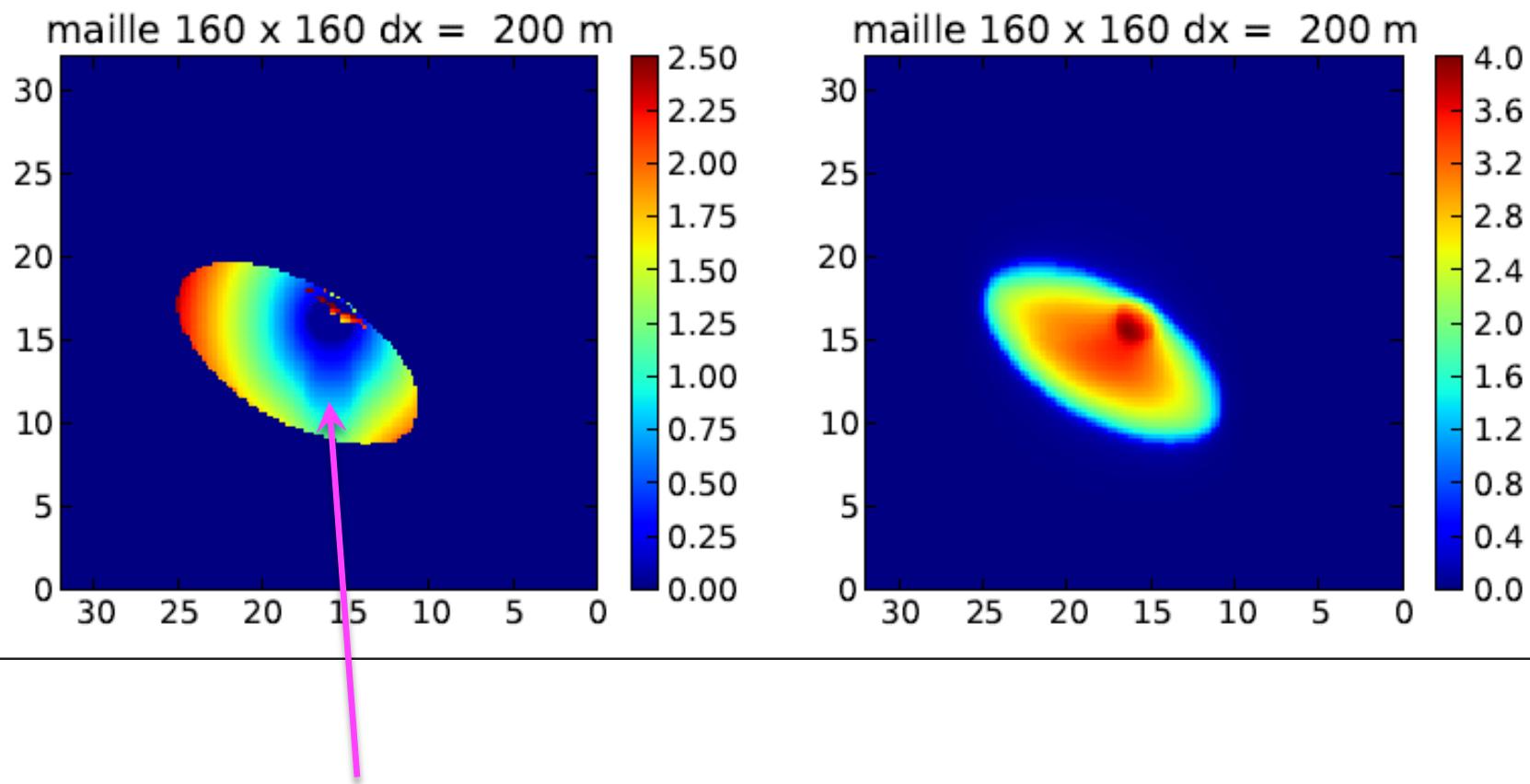


G_c : energy release rate

The underlying parameterisation



A super-shear model



Super shear « ear »

Conclusions

- Dynamic inversion is possible now
- Needs very well recorded earthquakes (special circumstances)
- Friction law can not be determined from seismic data alone,
only G_c can be determined
- Dynamic similarity parameter κ controls solutions

Projets:

1. Modélisation séisme du 25 Mars 2012 Constitucion, Chile (Ruiz et al)
2. Inversion dynamique (???)
3. Modélisation d'un ou plusieurs Kink (Soumaya)
4. Interaction rupture surface libre (Hok ANR Flash Japon)
5. Inversion à « plus haute » fréquence (Ruiz)
6. Relocalisation des répliques du séisme de Maule 2010 (Amaya)
7. Inversion de thrusts au Japon à partir du cGPS (Axitra vs Okada)

8. Migration vers le Nord du Chili (ANR Debate + Conicyt)