Slip inversion on the creeping thrust fault using geodetic data and repeating earthquakes

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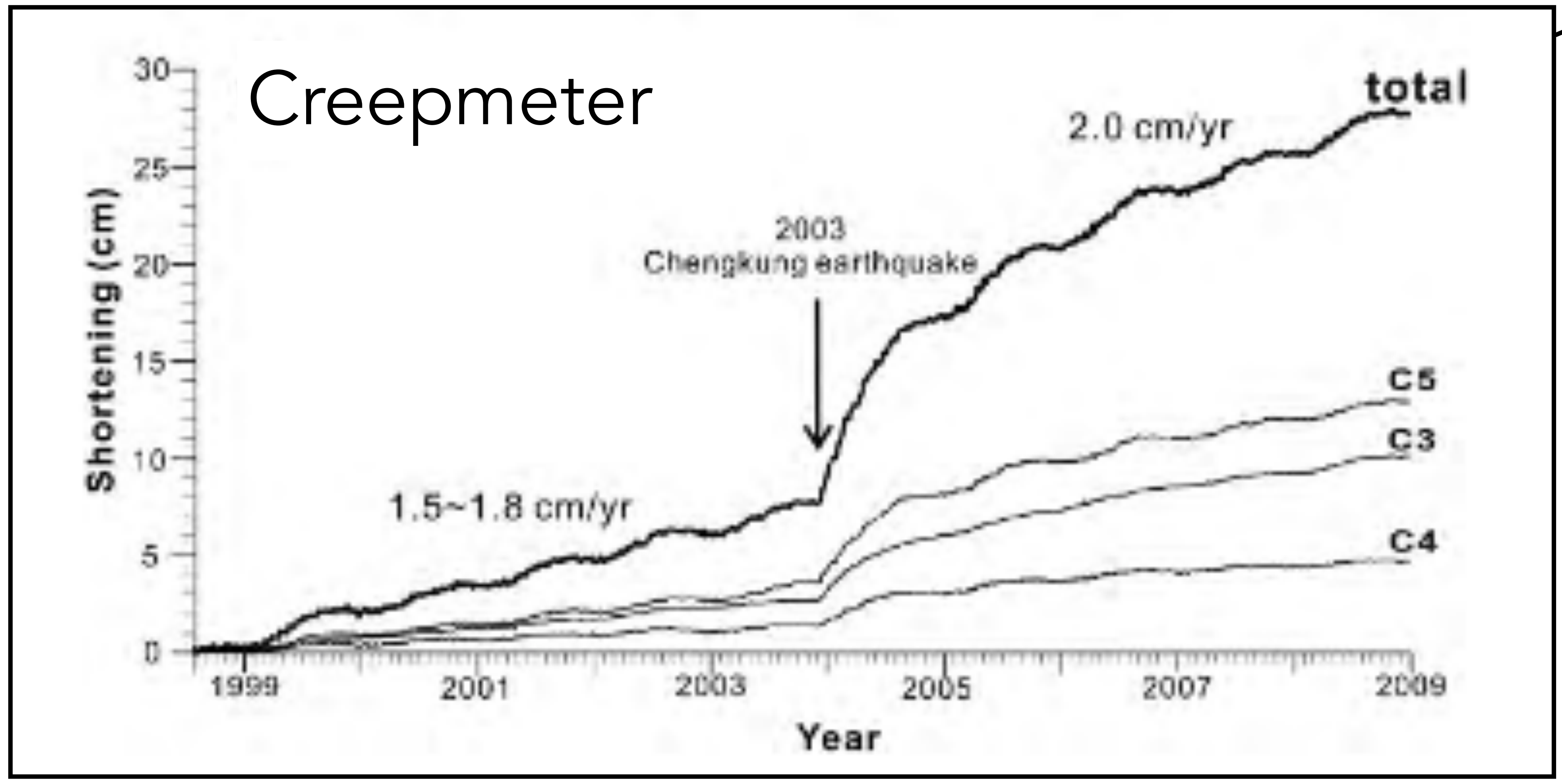
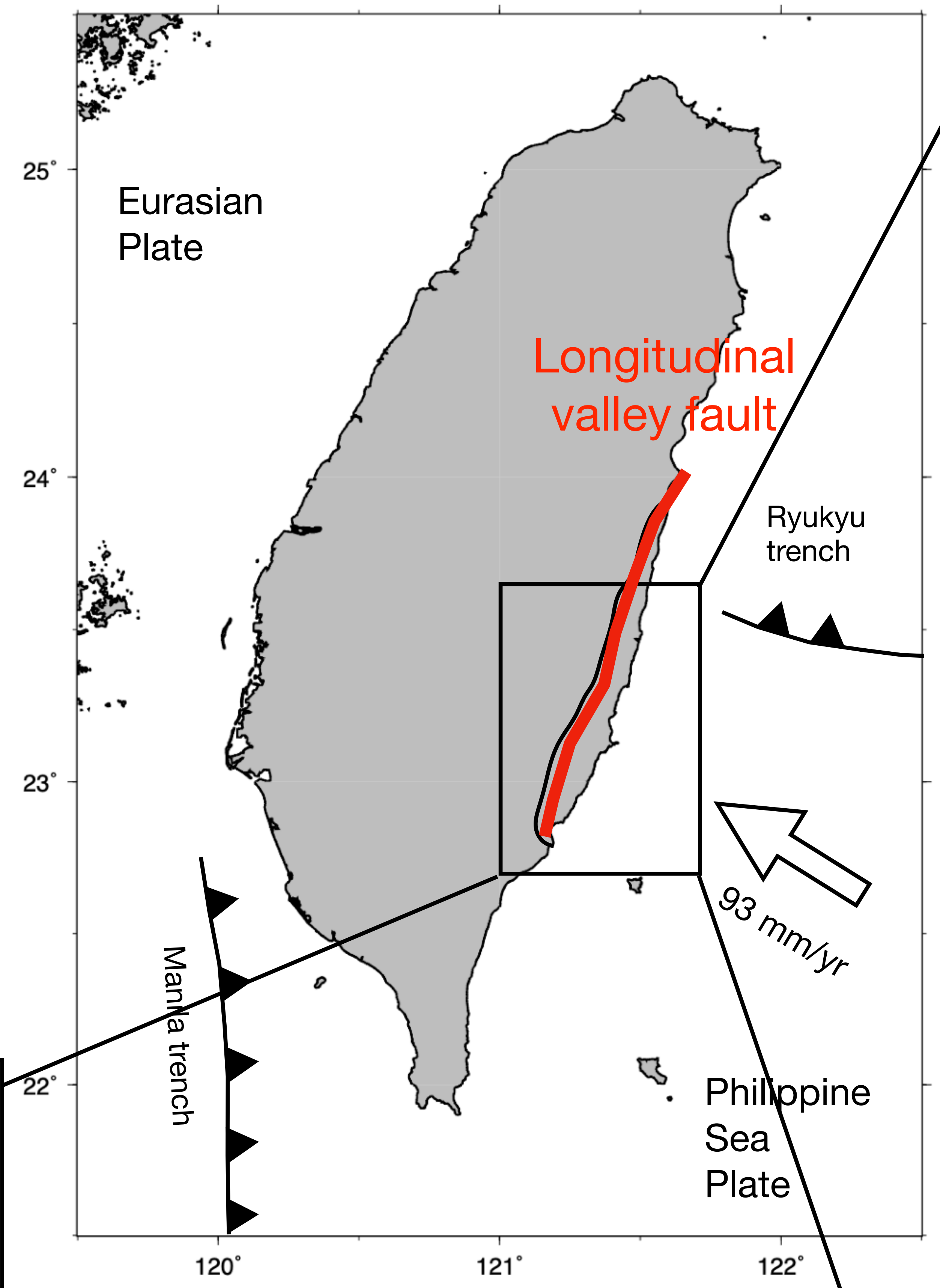
Chihshang fault - what do we know so far ?

South segment of the plate boundary between the Philippine Sea plate and the Eurasian plate (Longitudinal valley fault)

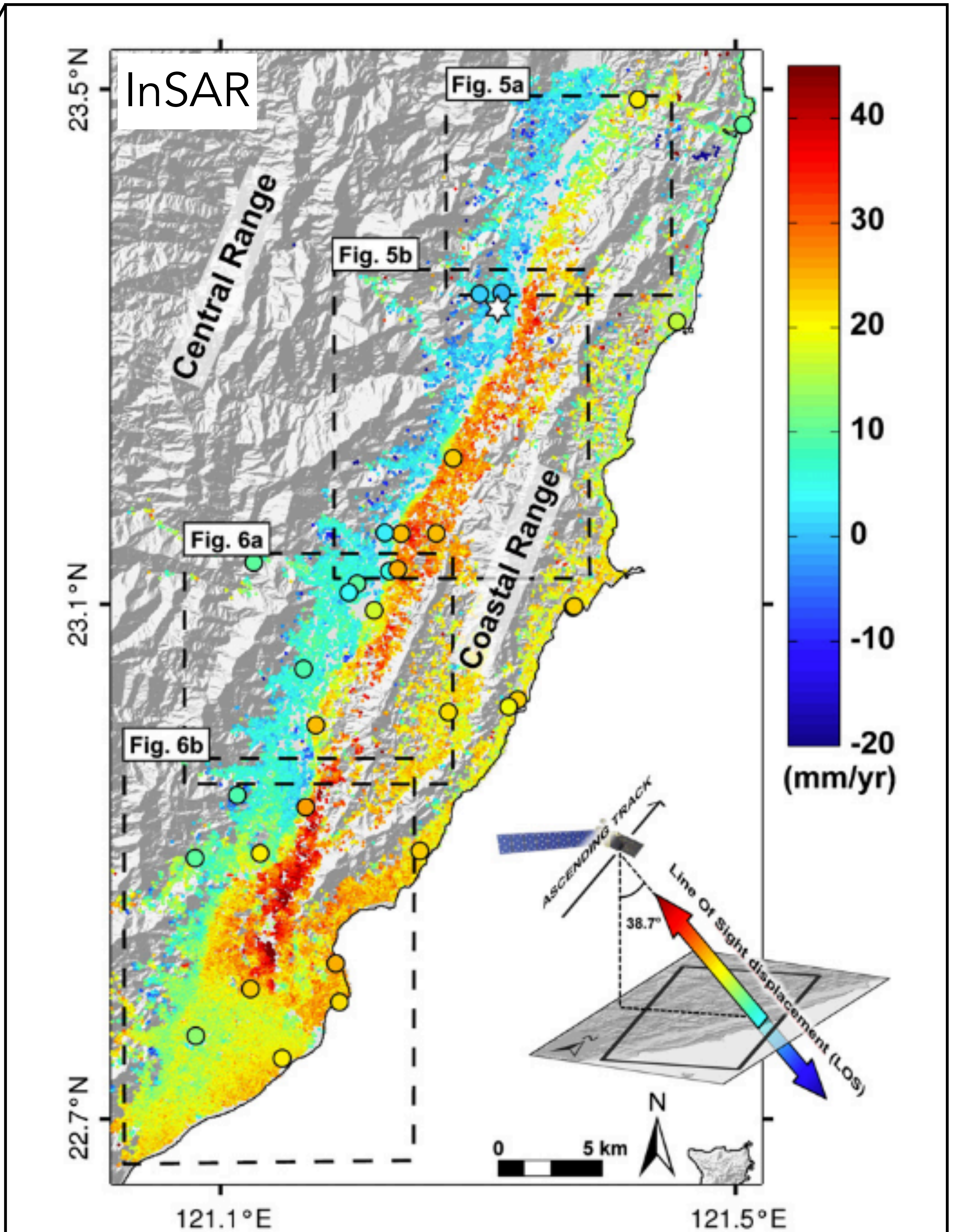
Rapid surface creeping of 2 - 4 cm/yr is observed.

Coupling map shows Chihshang fault is mostly creeping





Mu et al., 2011



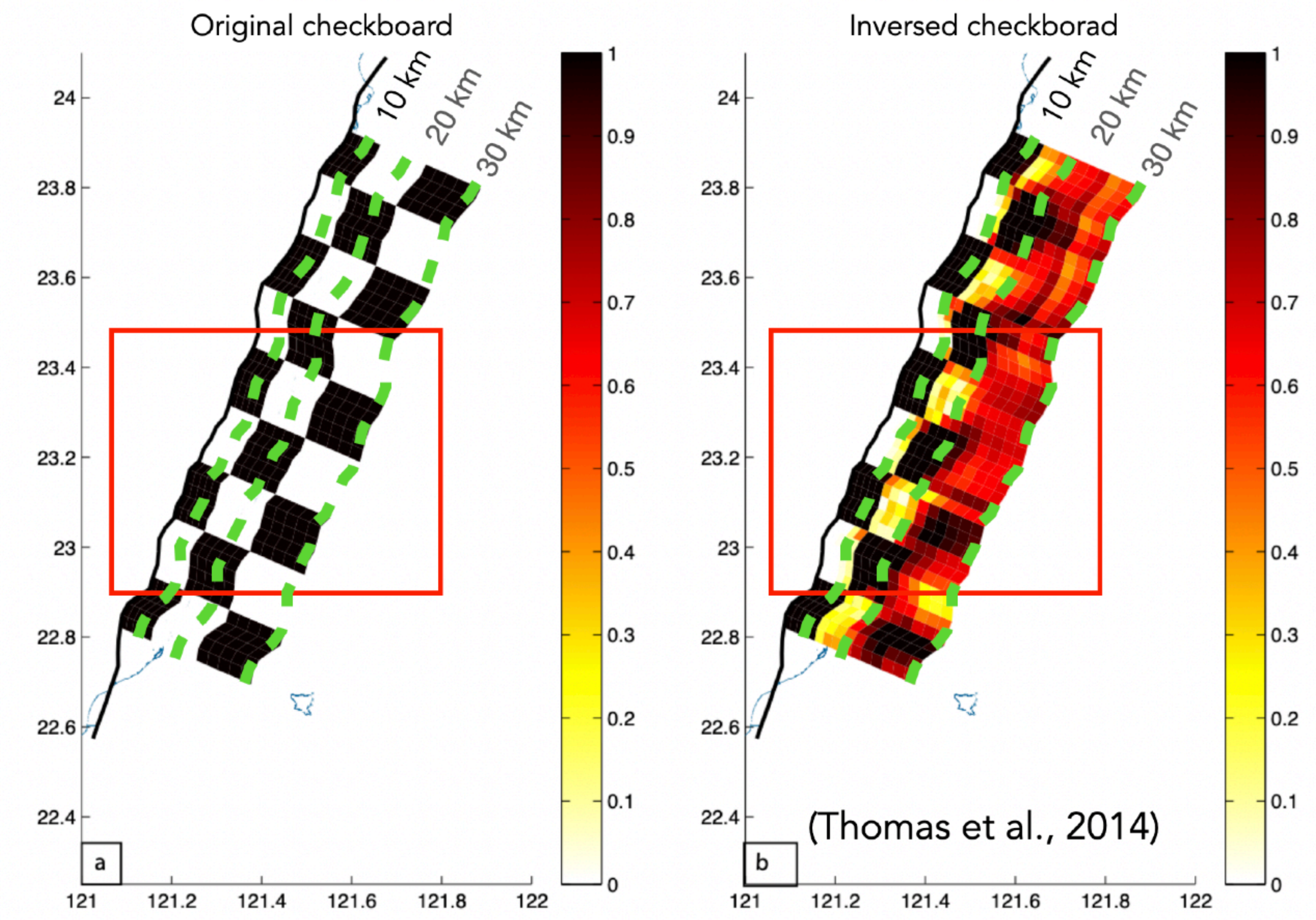
Champenois et al ., 2012

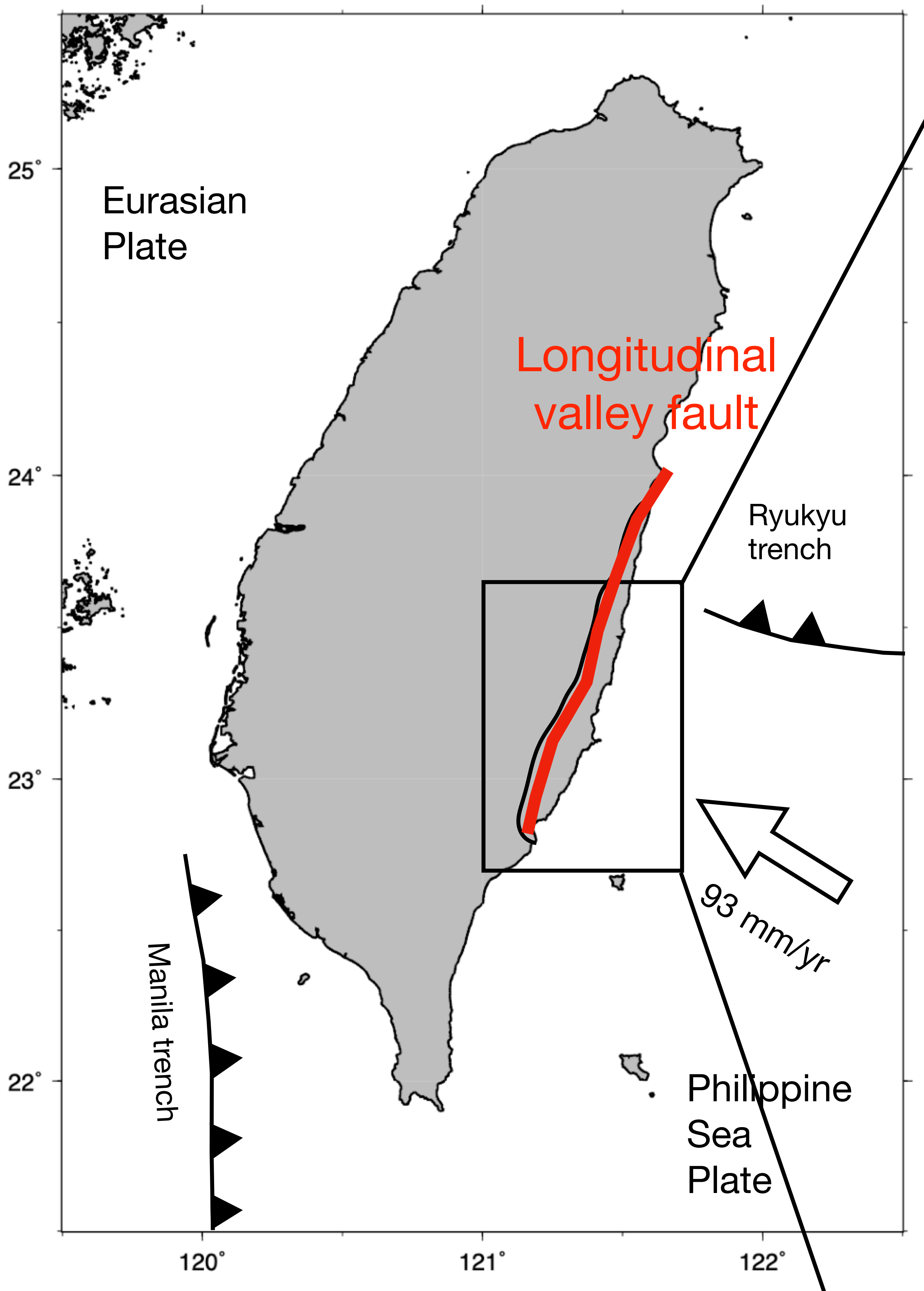
Chihshang fault - what do we know so far ?

The spatial distribution of creeping section at Chihshang fault is well-coincided with the previously found repeaters and earthquake swarms

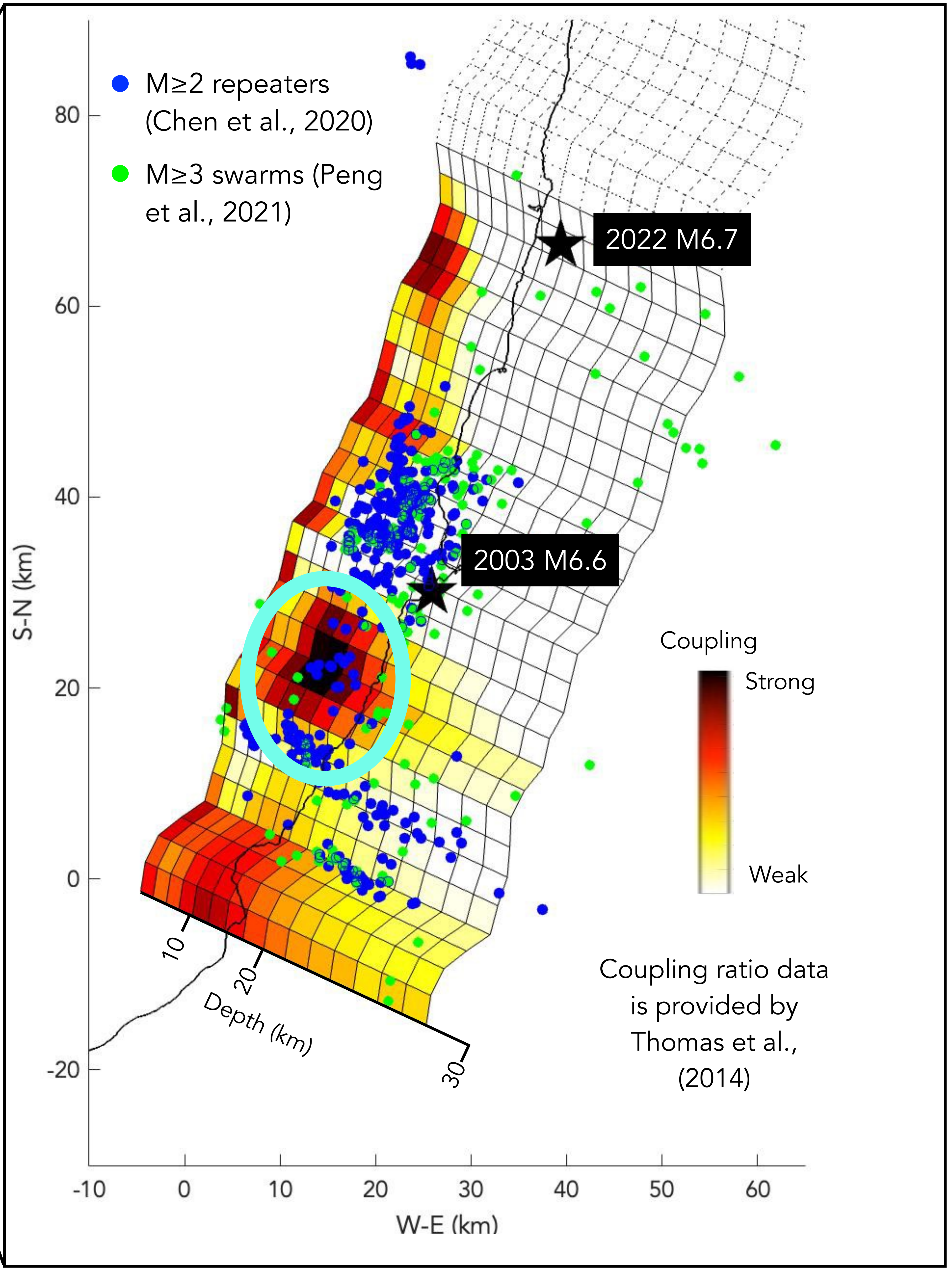
But it can not well-explained the mechanism of two most recent M≥6 events.

Less model resolution at depth below 10 km

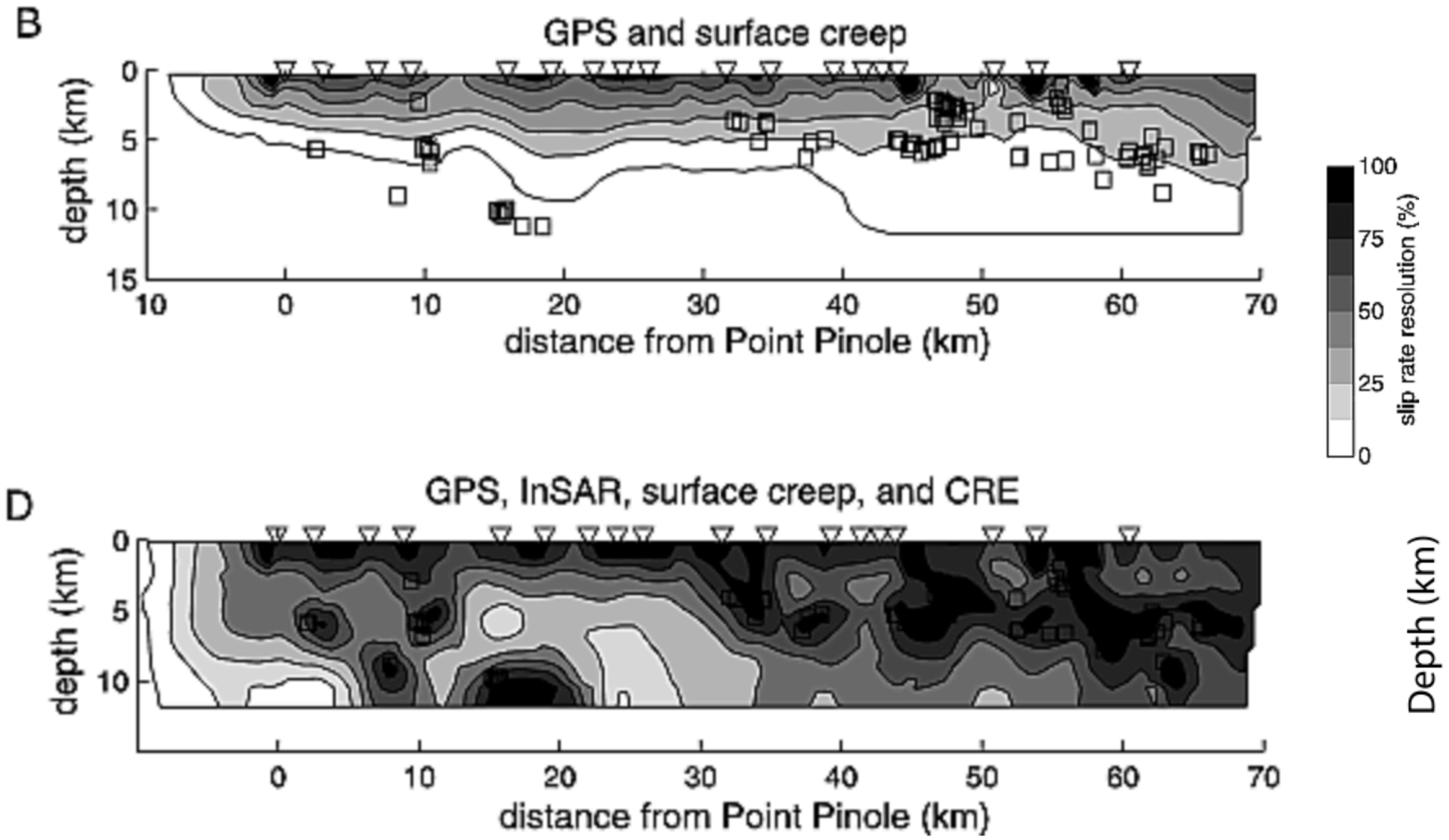




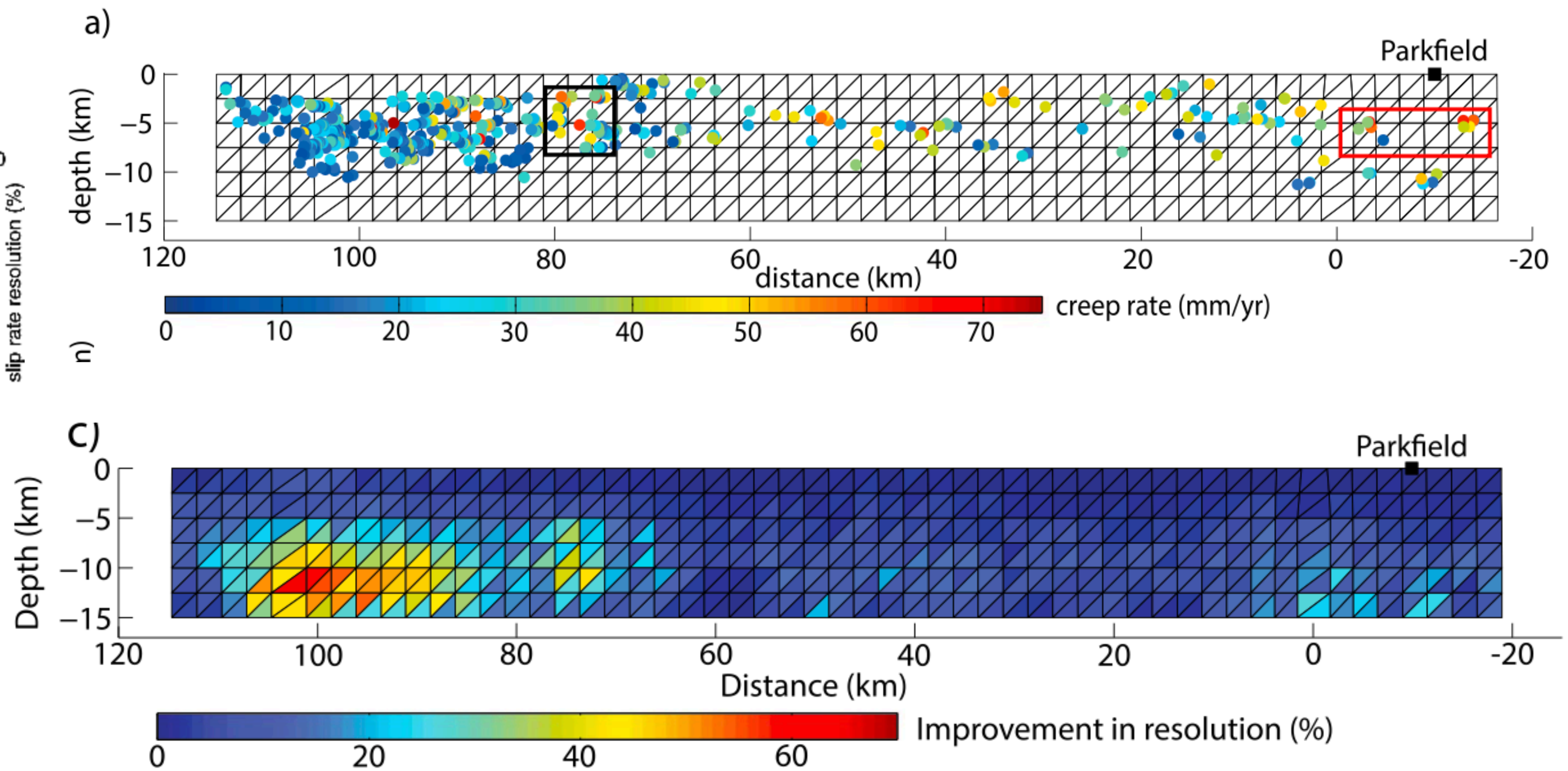
Interseismic coupling map



Intergrade slip at depth with repeating earthquake data can improve the resolution at depth (at least where the repeater occurred)



(Schmidt et al., 2005)



(Khoshmanesh et al., 2015)

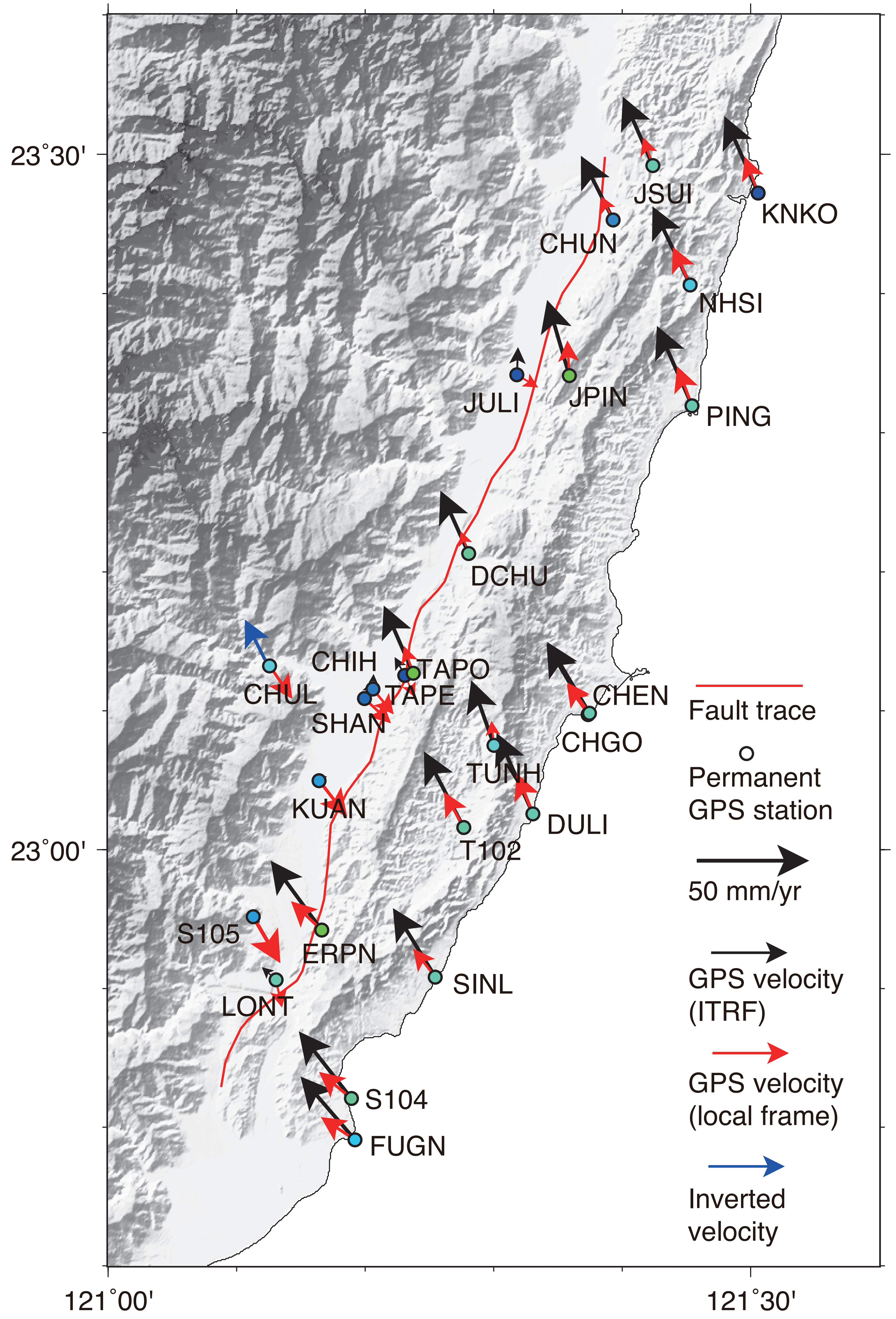
Objectives

How much the joint inversion enhances our understanding of aseismic and seismic faulting?

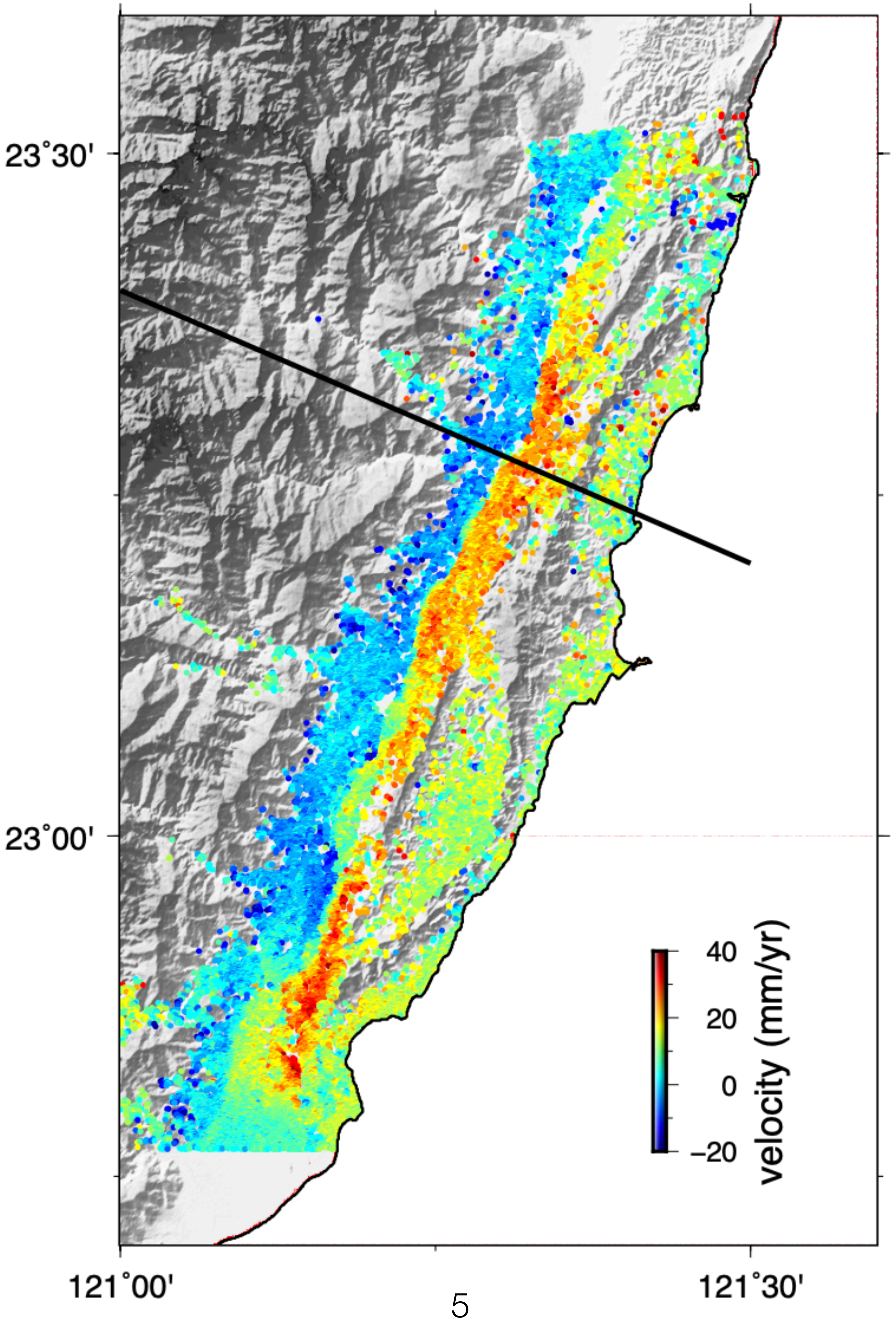
And with the regional seismicity development in time, how much this study contributes to seismic hazard estimates on the fault?

Data

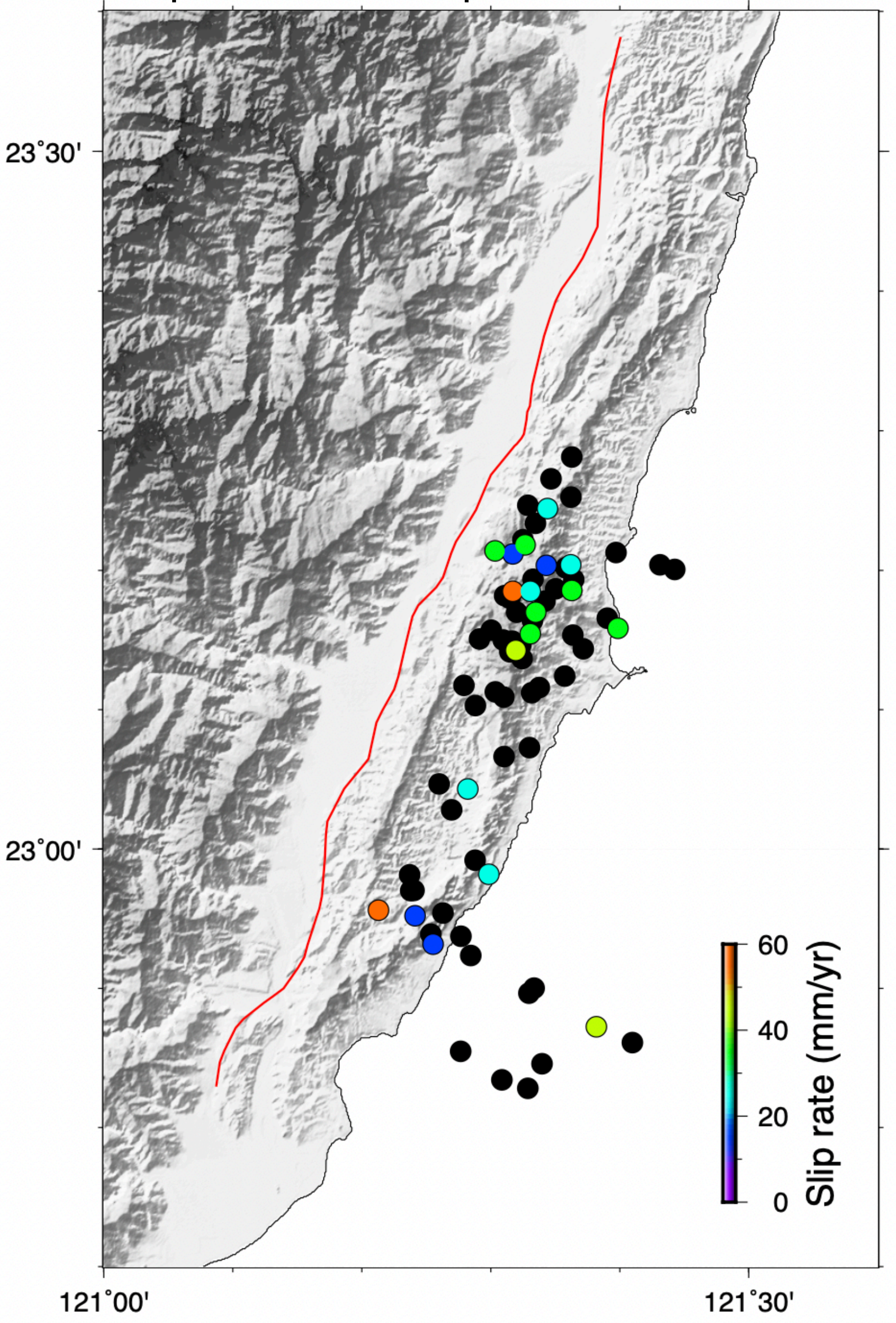
GPS (GPS lab)



InSAR (Thomas et al., 2014)

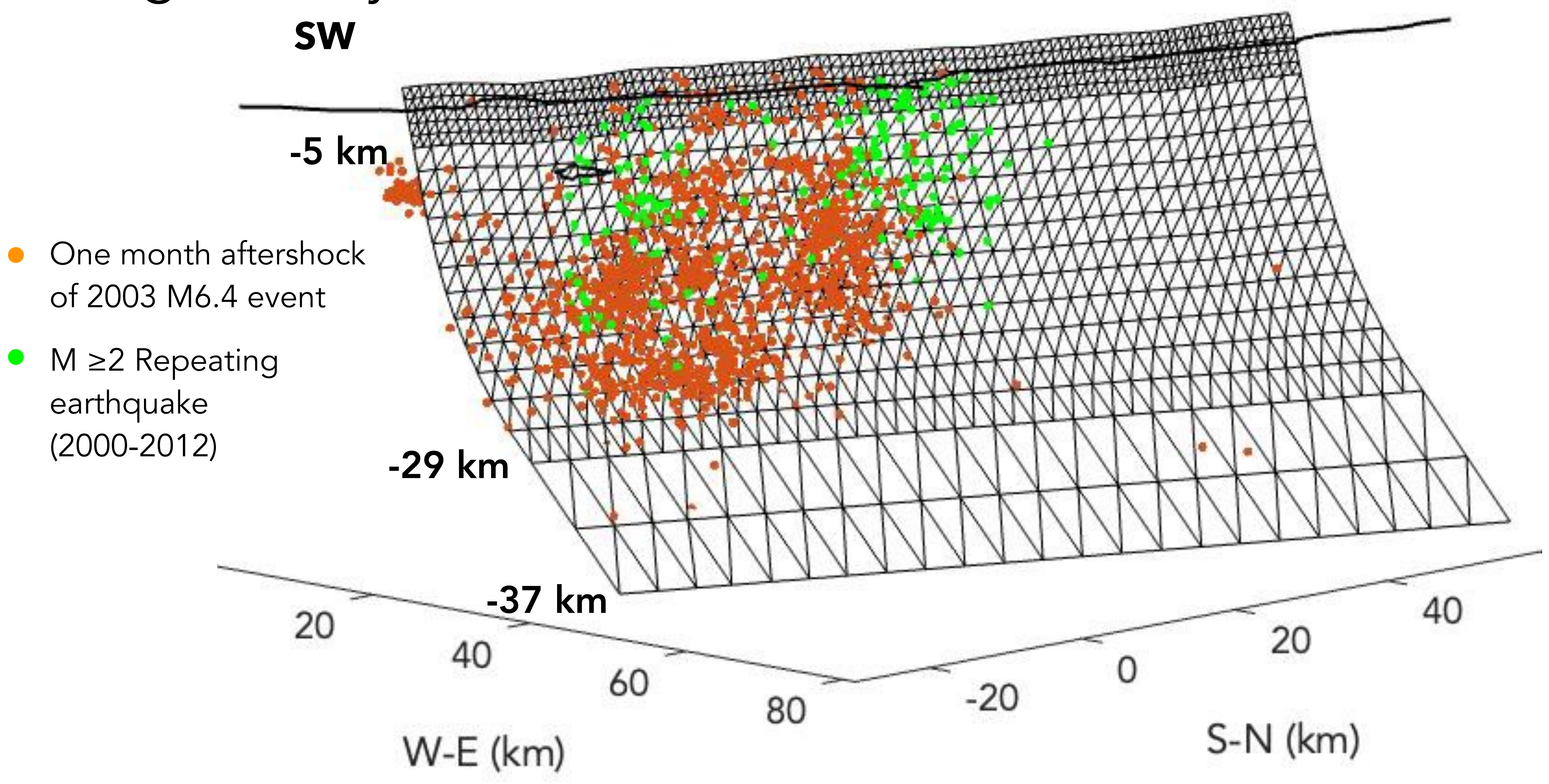


Repeating sequence (Chen et al., 2020)



Modelling slip at depth

Fault geometry



Linear inversion d = G x m

$$\begin{bmatrix} d_{GPS} \\ d_{InSAR} \\ d_{RES} \end{bmatrix} = \begin{bmatrix} G_{GPS} & G_{vector} & 0 \\ G_{InSAR} & 0 & G_{ramp} \\ G_{RES} & 0 & 0 \end{bmatrix} \begin{bmatrix} m_{slip} \\ m_{vector} \\ m_{ramp} \end{bmatrix}$$

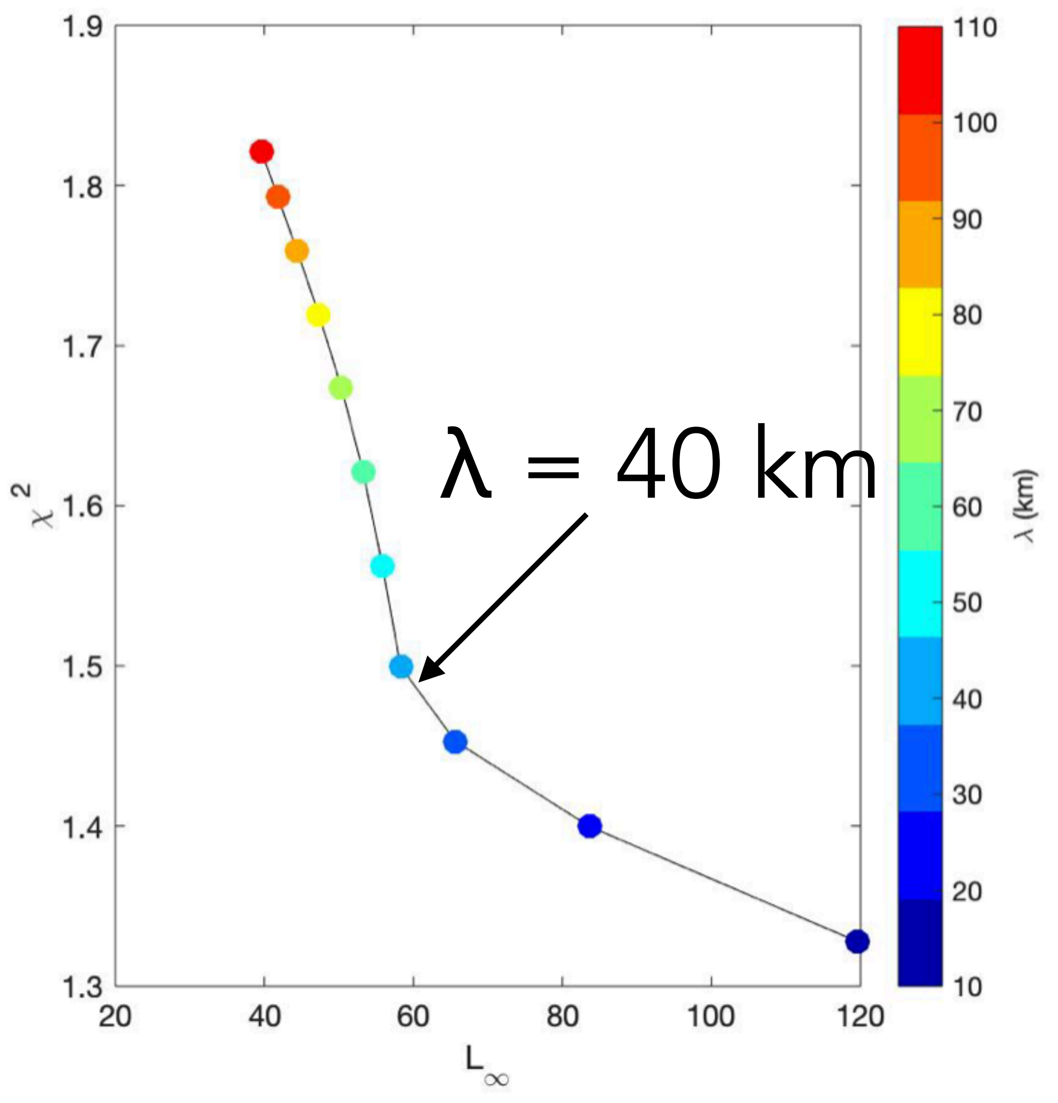
Linear problems (Tarantola, 2005)
Regularization method (Radiguat et al., 2011)

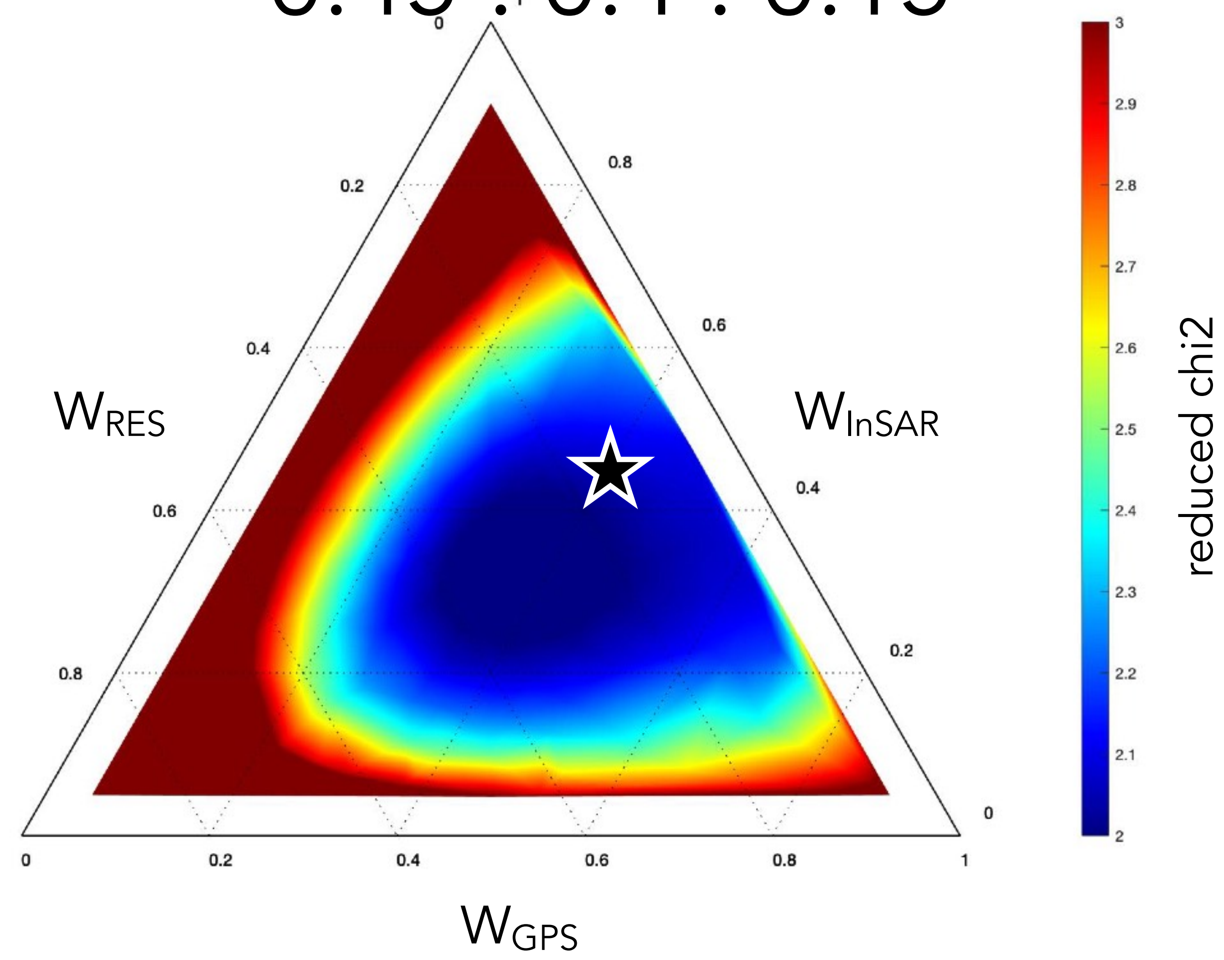
$W_{InSASR} : W_{GPS} : W_{RES} = 0.45 : 0.4 : 0.15$

Coast function

$$(Gm - d)^t C_d^{-1} (Gm - d) + (m - m_0)^t C_m^{-1} (m - m_0)$$

$$C_d = (w_i \sigma_d)^2 \qquad C_m(k,l) = \left(\sigma_m \frac{\lambda_0}{\lambda}\right)^2 e^{\left(\frac{-d(k,l)}{\lambda}\right)}$$





W_i : weighting between dataset
λ : spatial smoothing

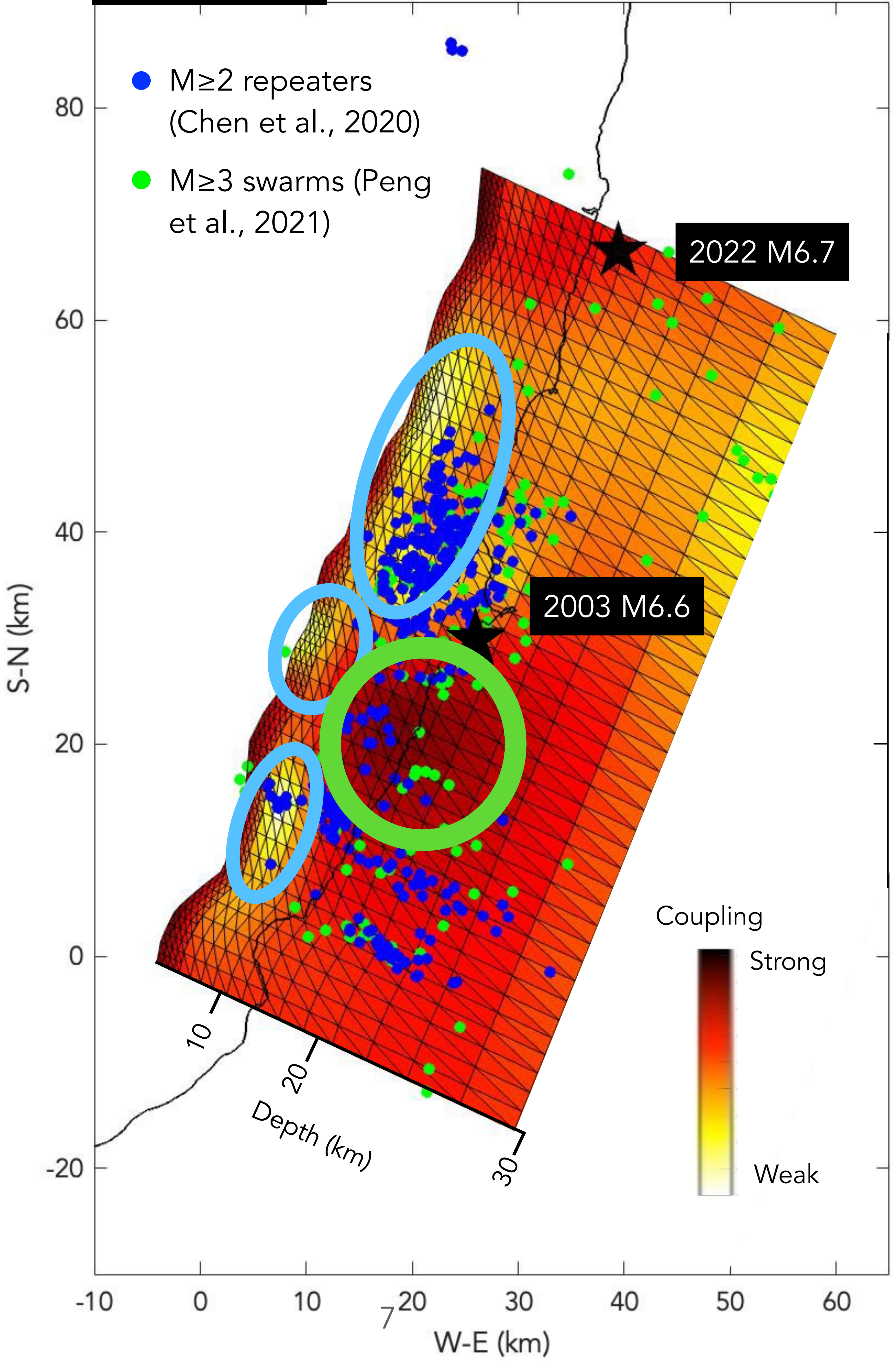
Result - Interseismic coupling

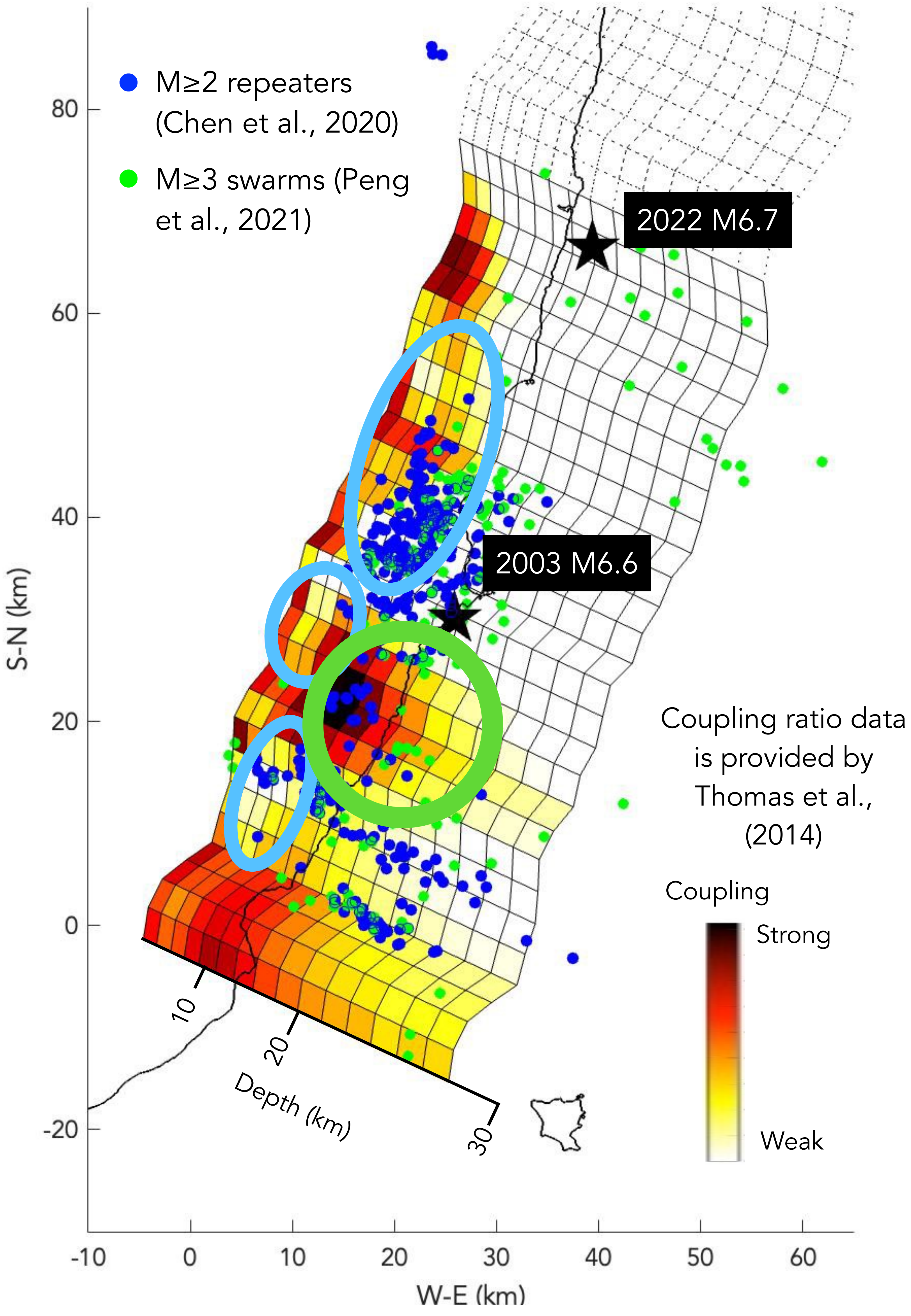
Similar distribution at depth below 10 km

Higher coupling at depth below 10 km

Two recent M≥6 events occurred at strong coupled area

This study

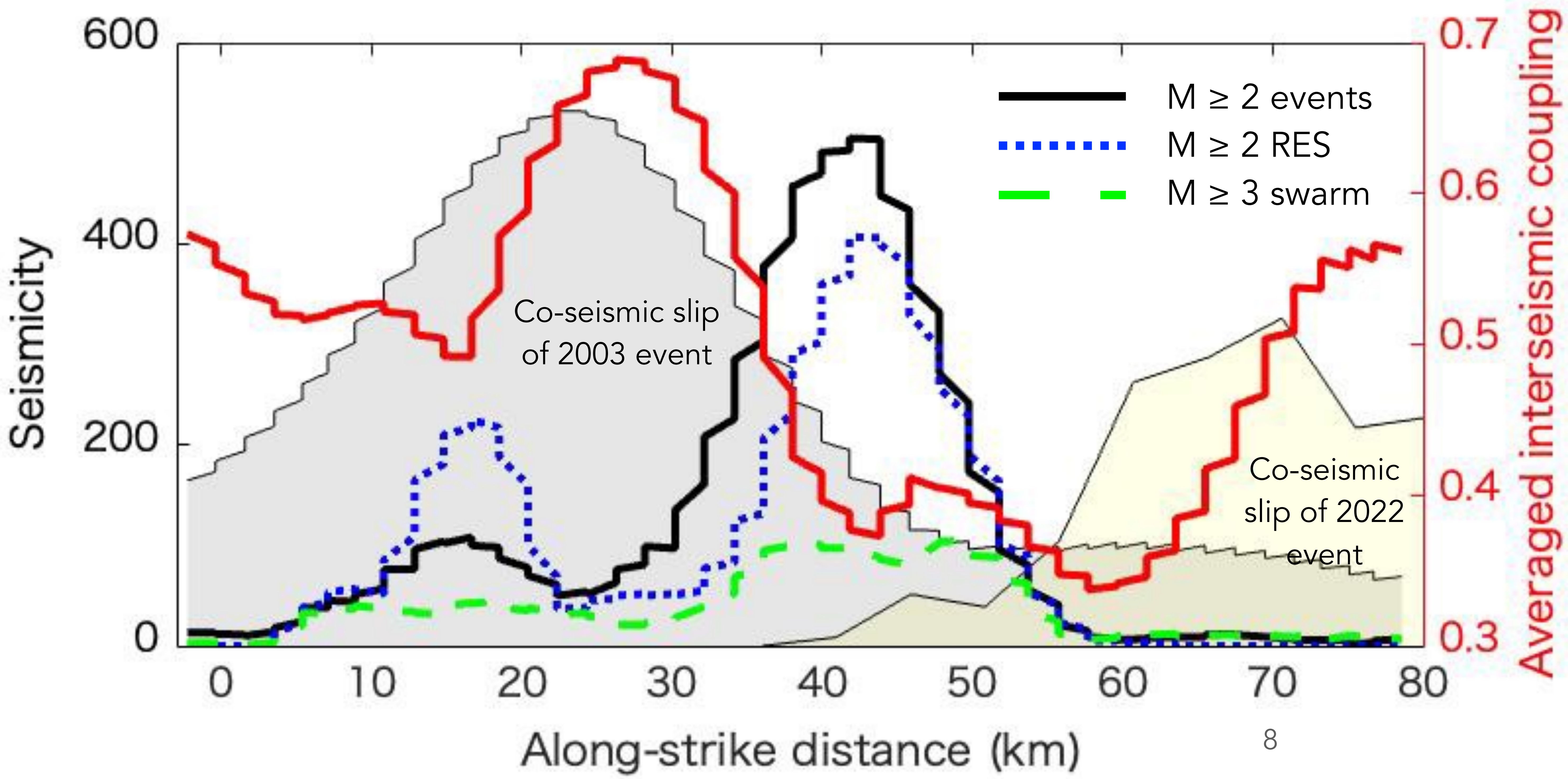


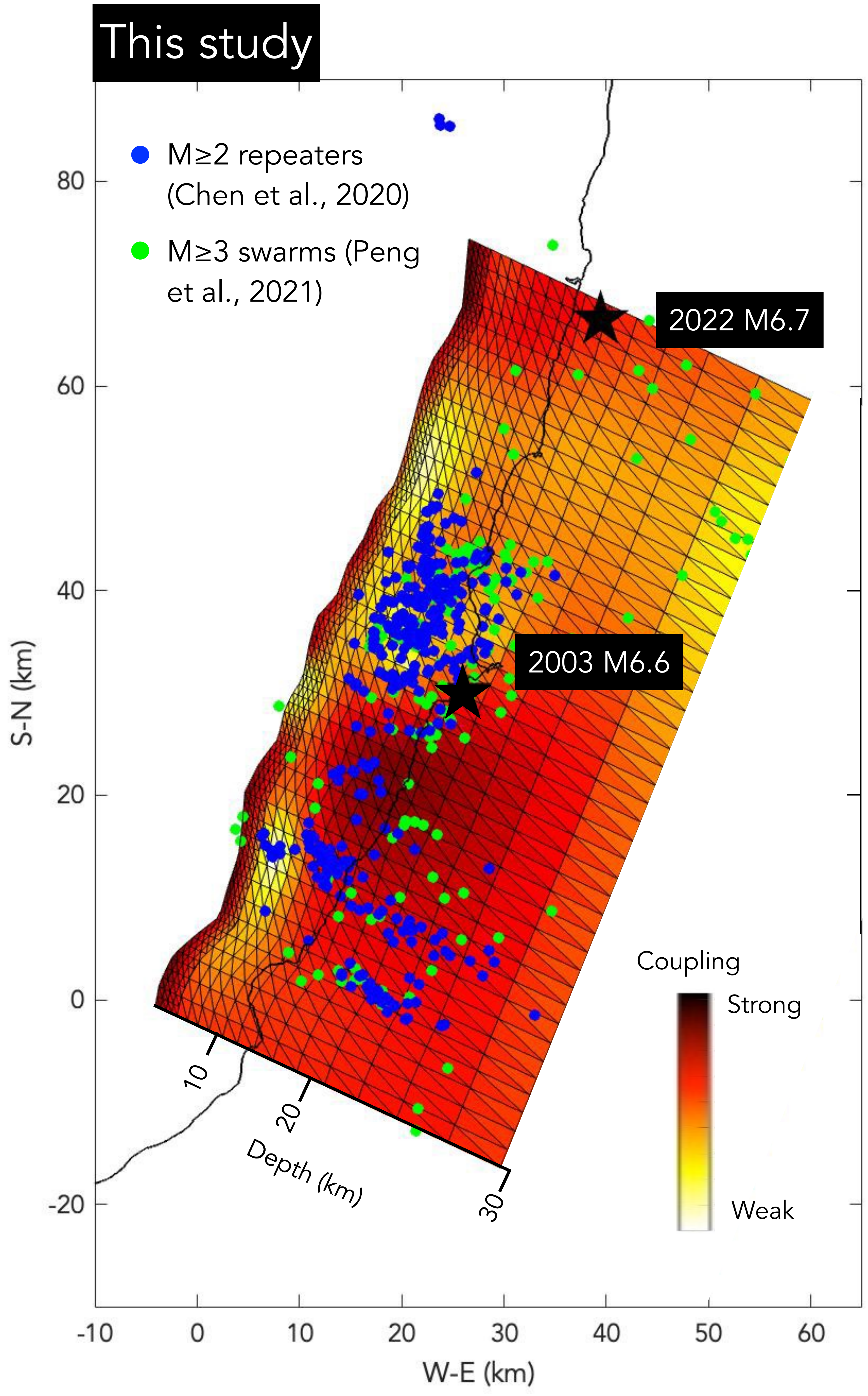


Result - Interseismic coupling

The spatial variation of seismicity in general, shows an anti-correlation with that of the interseismic coupling.

In higher coupling areas however, seismicity patterns are distinct from those with weak coupling.





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