

Seismic hazard assessment in Taiwan: Insights from historical seismicity and radar interferometry analyses

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In memory of

Prof. Jacques Angelier
(1947-2010)

Acknowledgements:

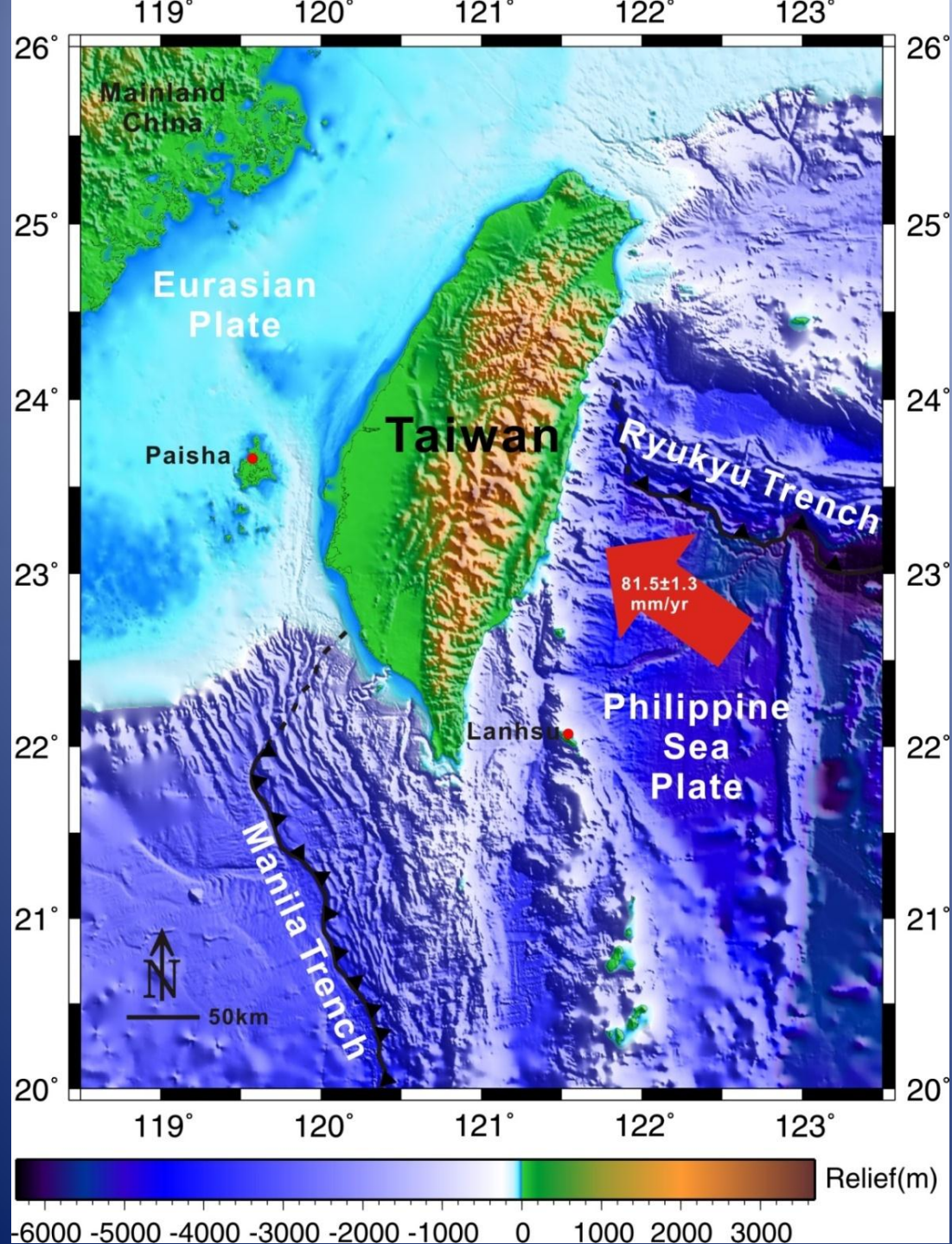
Chung-Pai Chang, Françoise Courboux, Yvonne Font,
Shu-Kun Hsu, Jyr-Ching Hu, Kuo-Fong Ma, Lionel Siame,

John Suppe

&

Nicole Bethoux





Tectonic framework of Taiwan

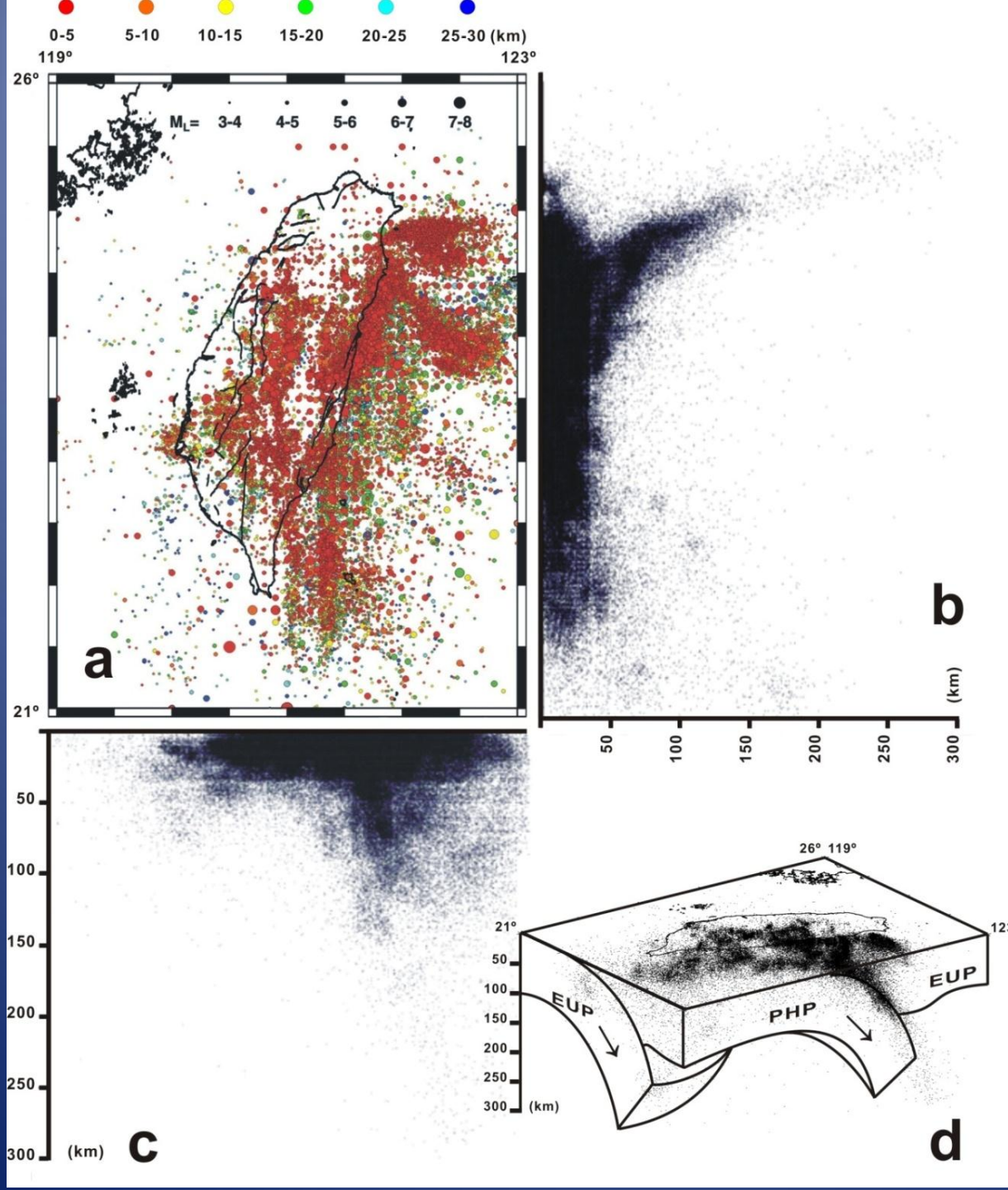
(Ng et al., 2009)

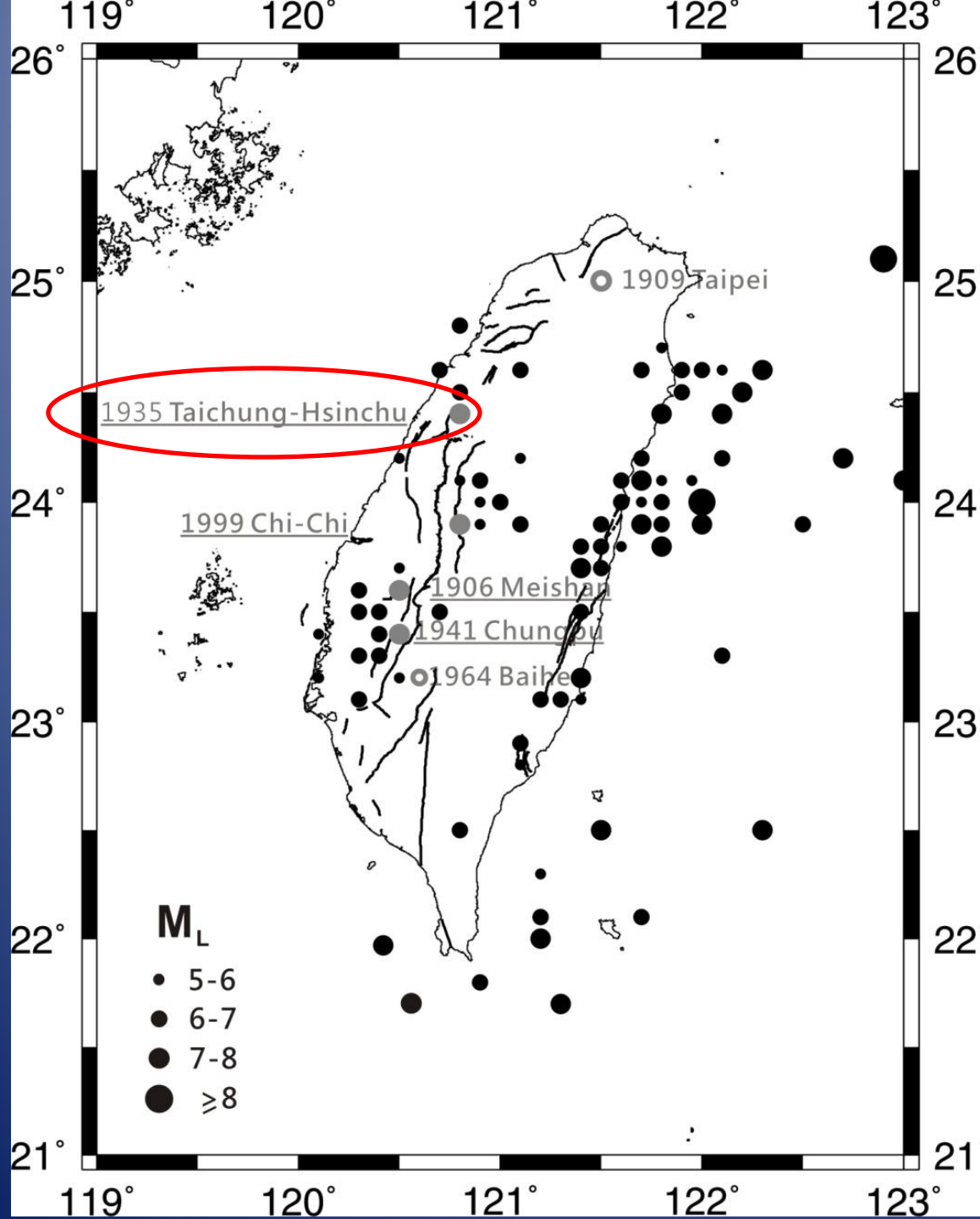
Topographic-bathymetric background map made using GMT software (Wessel and Smith, 1998)

Distribution of earthquakes 1900-2006 $M_L \geq 3$

(Ng et al., 2009)

Source of seismic data:
Central Weather Bureau





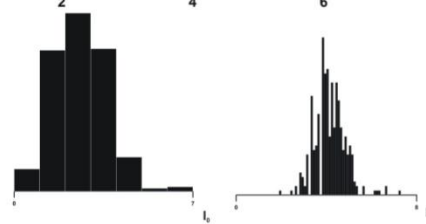
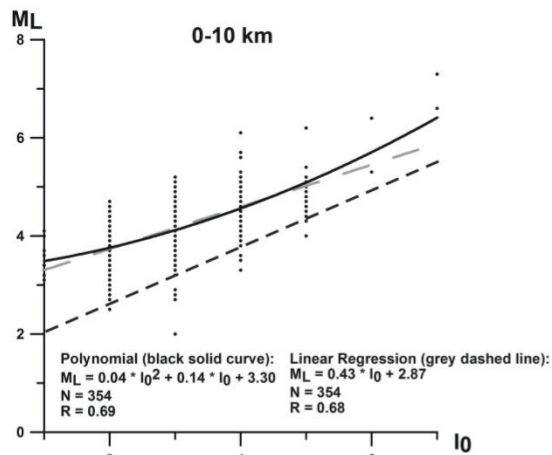
**Epicentres
of
destructive
earthquakes
M_L ≥ 5
1900-2006**

(Ng et al., 2009)

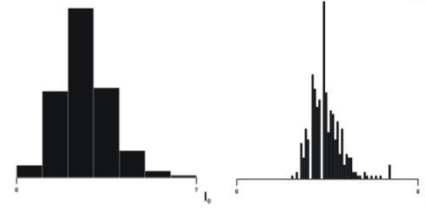
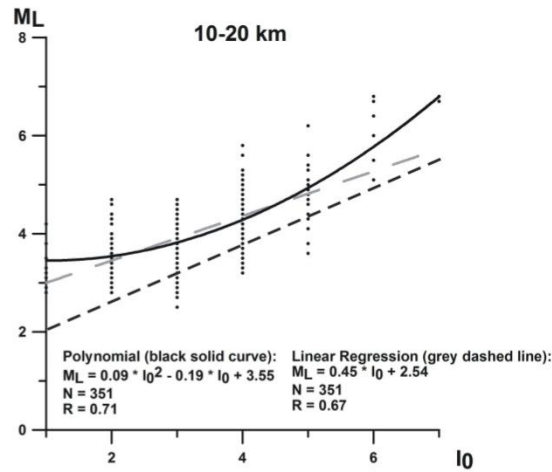
Source of seismic data:
Central Weather Bureau

Relationships between local magnitudes & maximum intensities

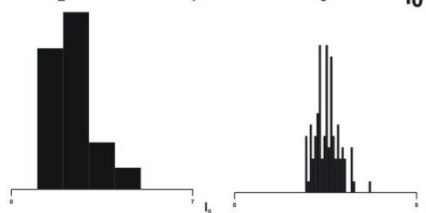
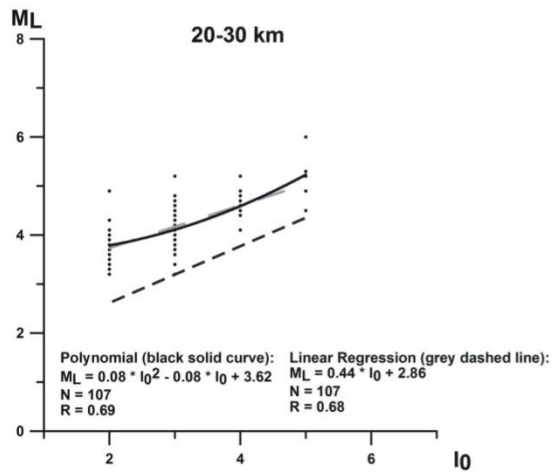
(Ng et al., 2009)



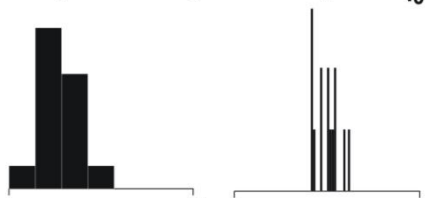
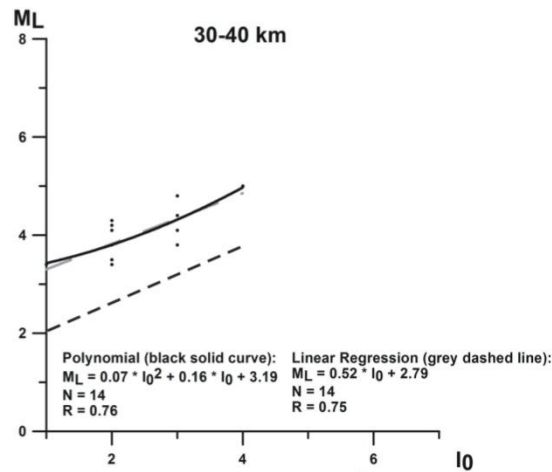
a



b



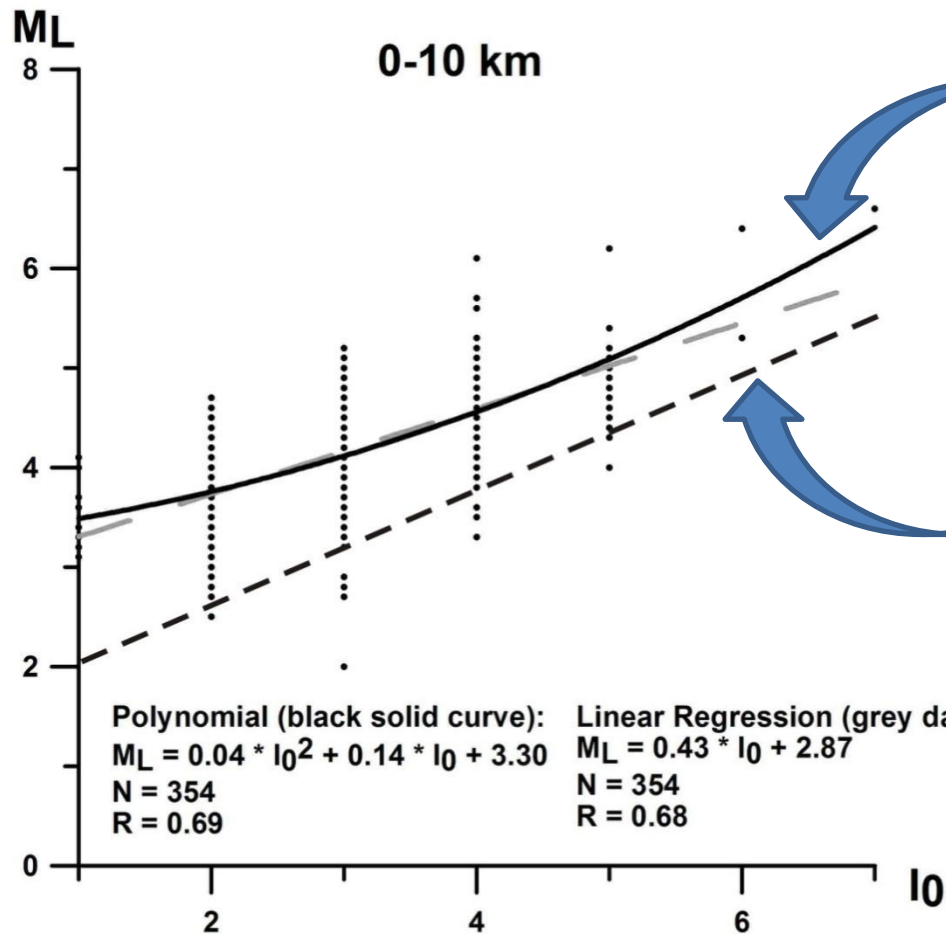
c



d

Source of seismic data:
Central Weather Bureau

a)

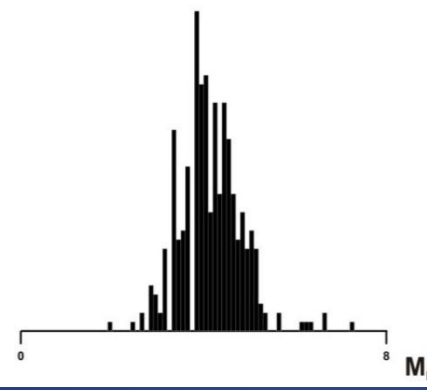
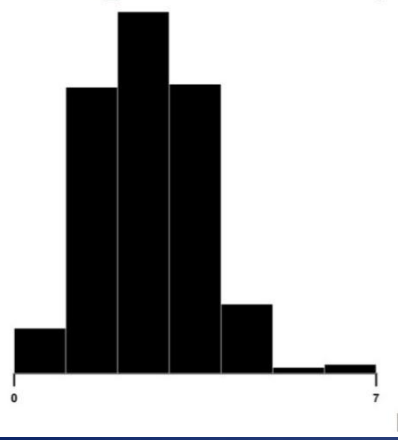


Polynomial function of degree 2
Linear regression
Black solid line:

$$M = 0.58I_0 + 1.5,$$

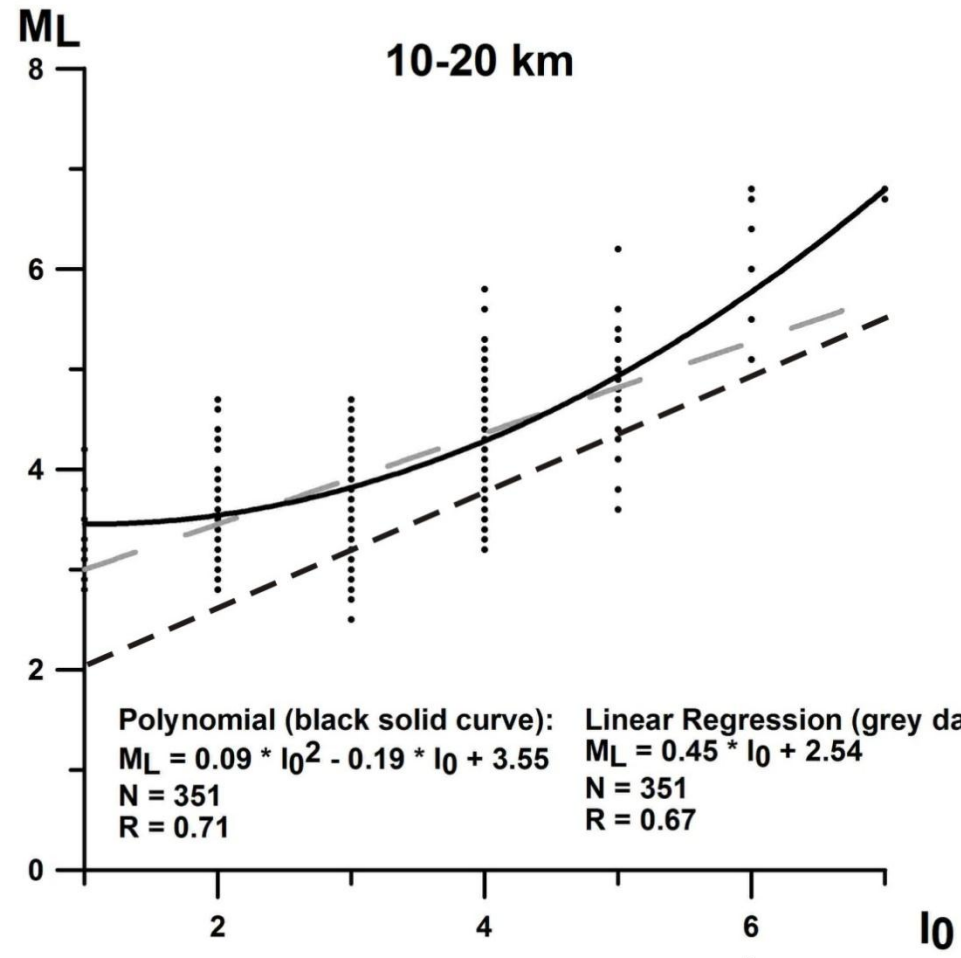
previously provided by Lee et al.
(1976)

(Ng et al., 2009)



Source of seismic data:
Central Weather Bureau

b)

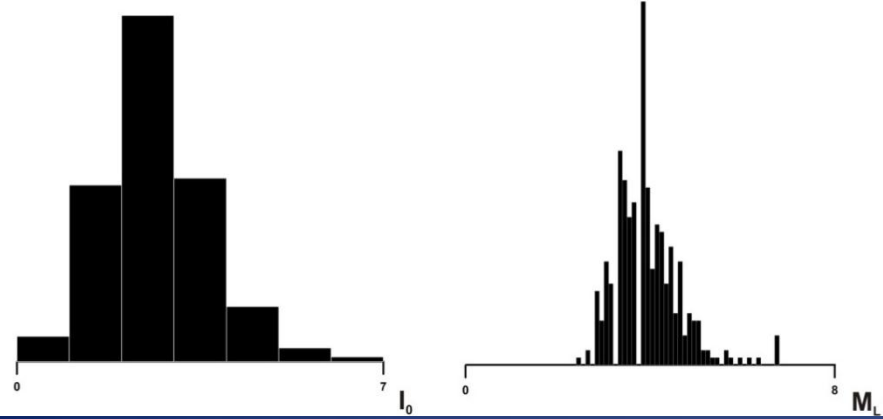


Black short dashed line:

$$M = 0.58I_0 + 1.5,$$

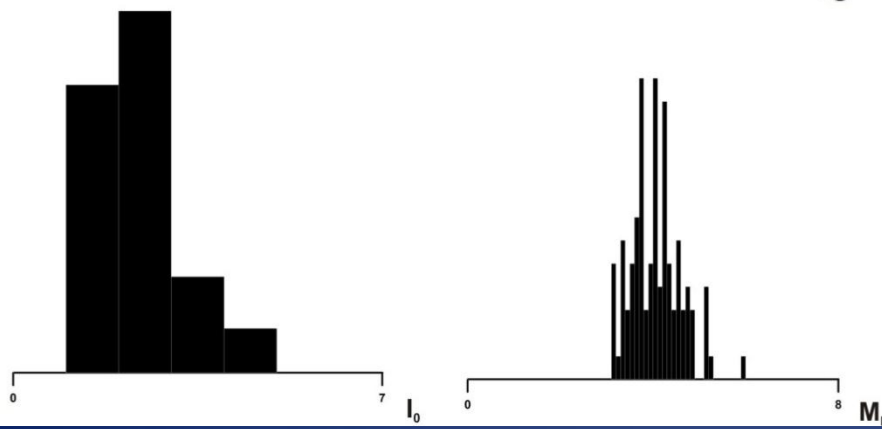
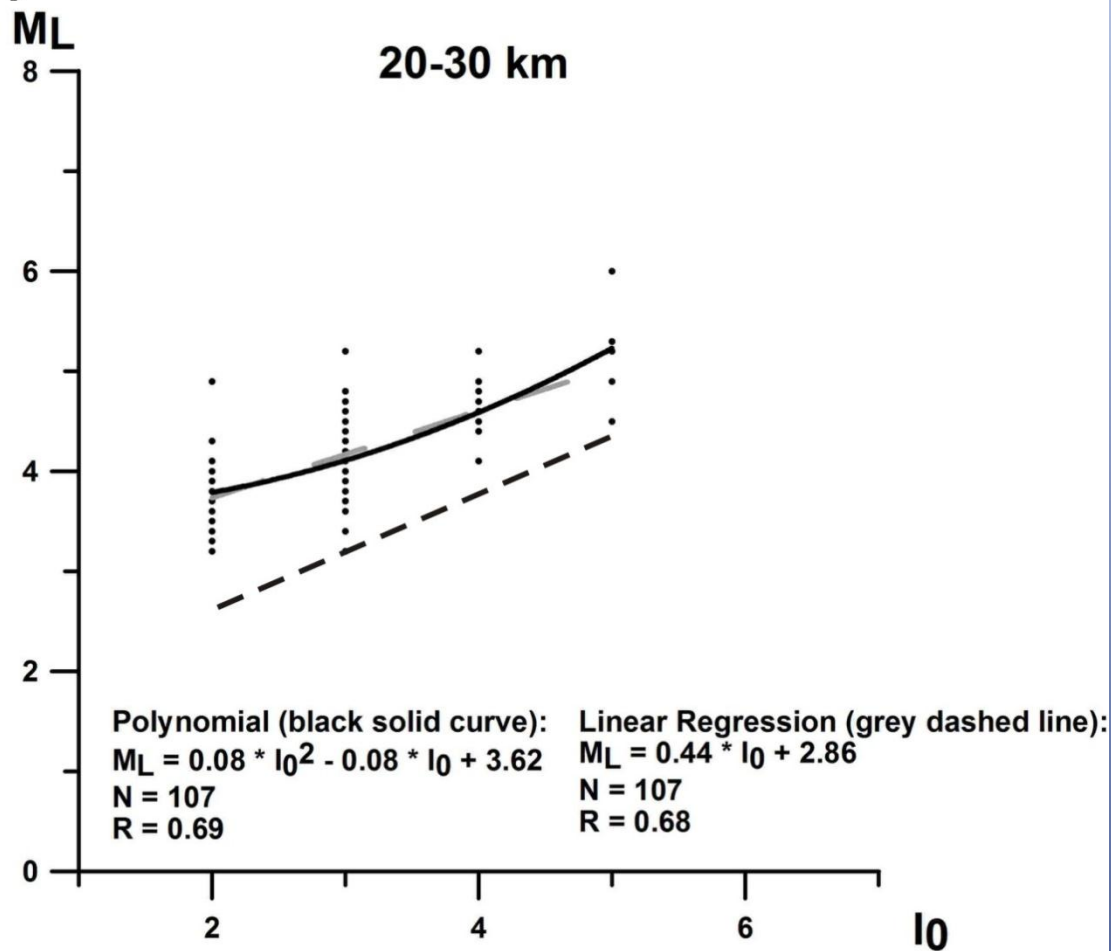
previously provided by Lee et al. (1976)

(Ng et al., 2009)



Source of seismic data:
Central Weather Bureau

c)



Black short dashed line:

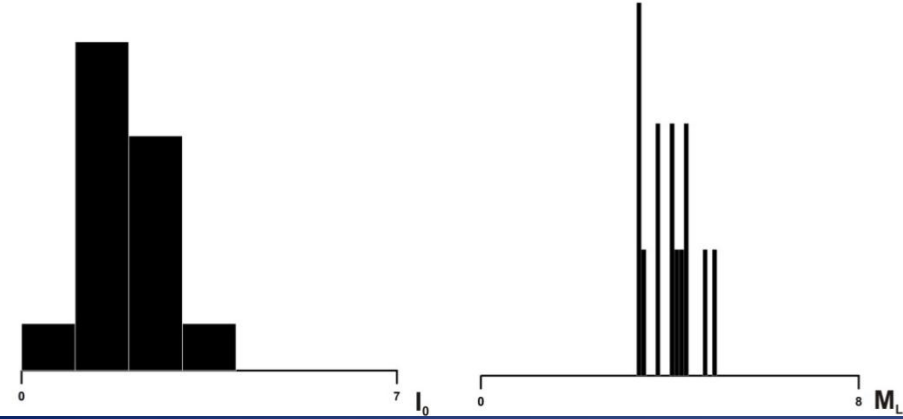
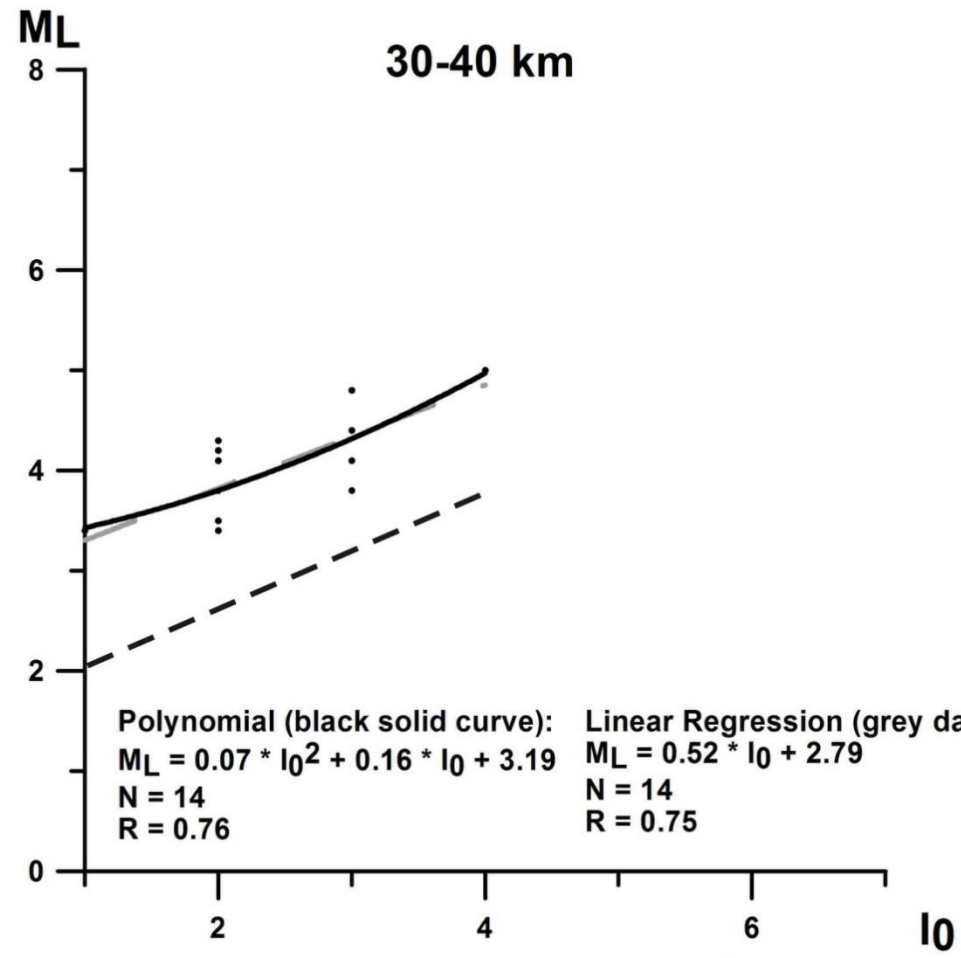
$$M = 0.58I_0 + 1.5,$$

previously provided by Lee et al.
(1976)

(Ng et al., 2009)

Source of seismic data:
Central Weather Bureau

d)



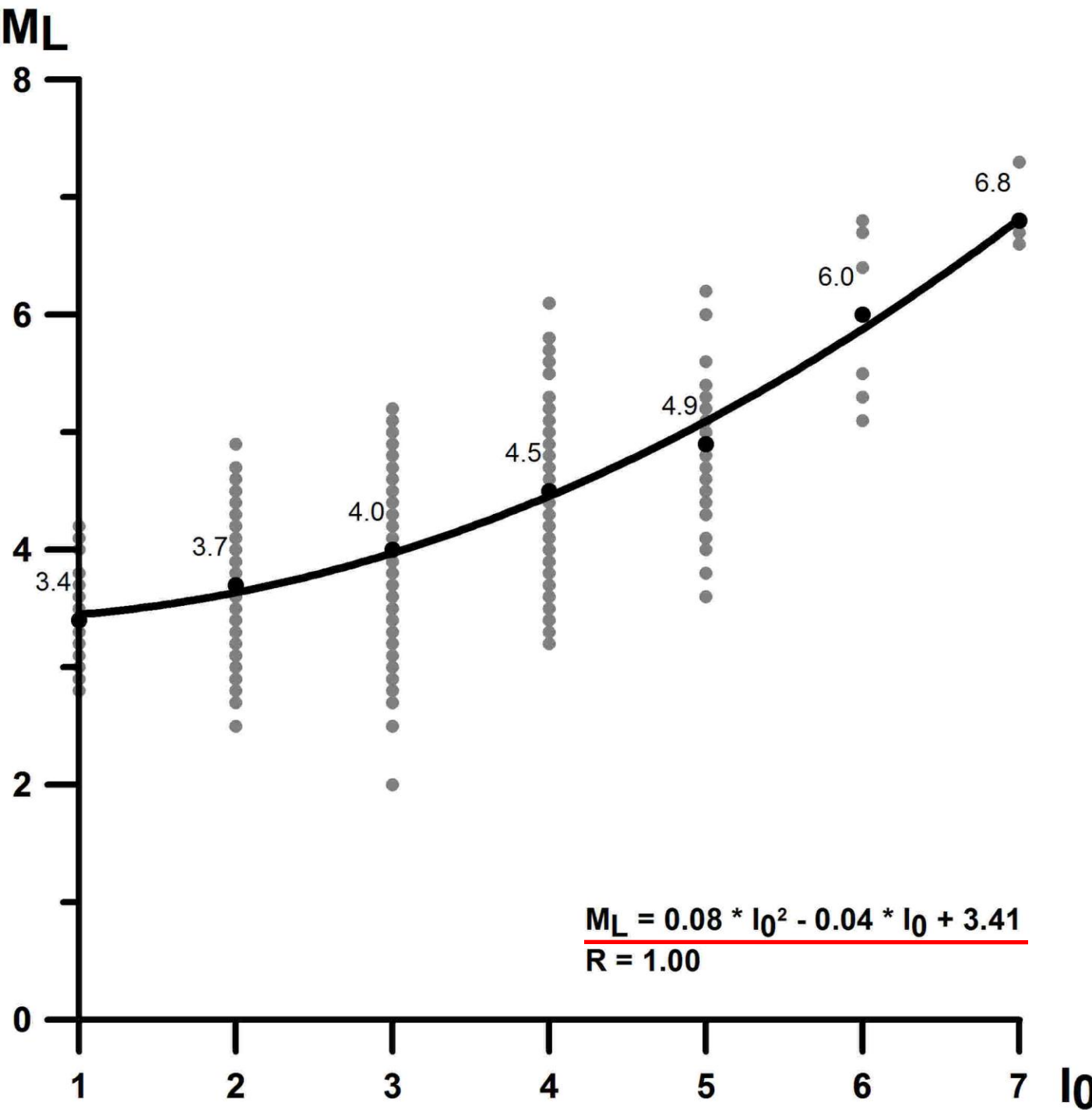
Black short dashed line:

$$M = 0.58I_0 + 1.5,$$

previously provided by Lee et al. (1976)

(Ng et al., 2009)

Source of seismic data:
Central Weather Bureau



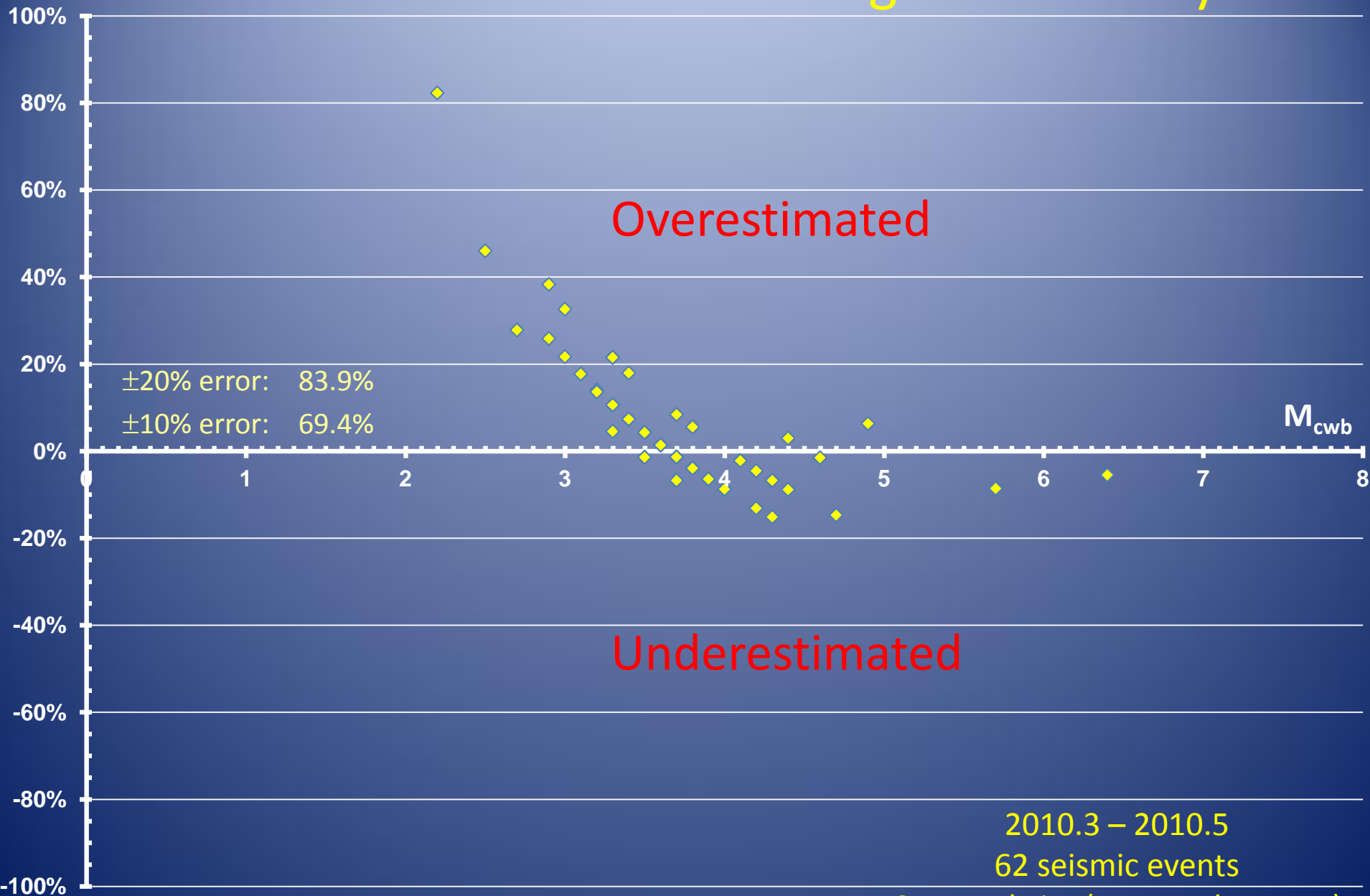
Derived
empirical
relation

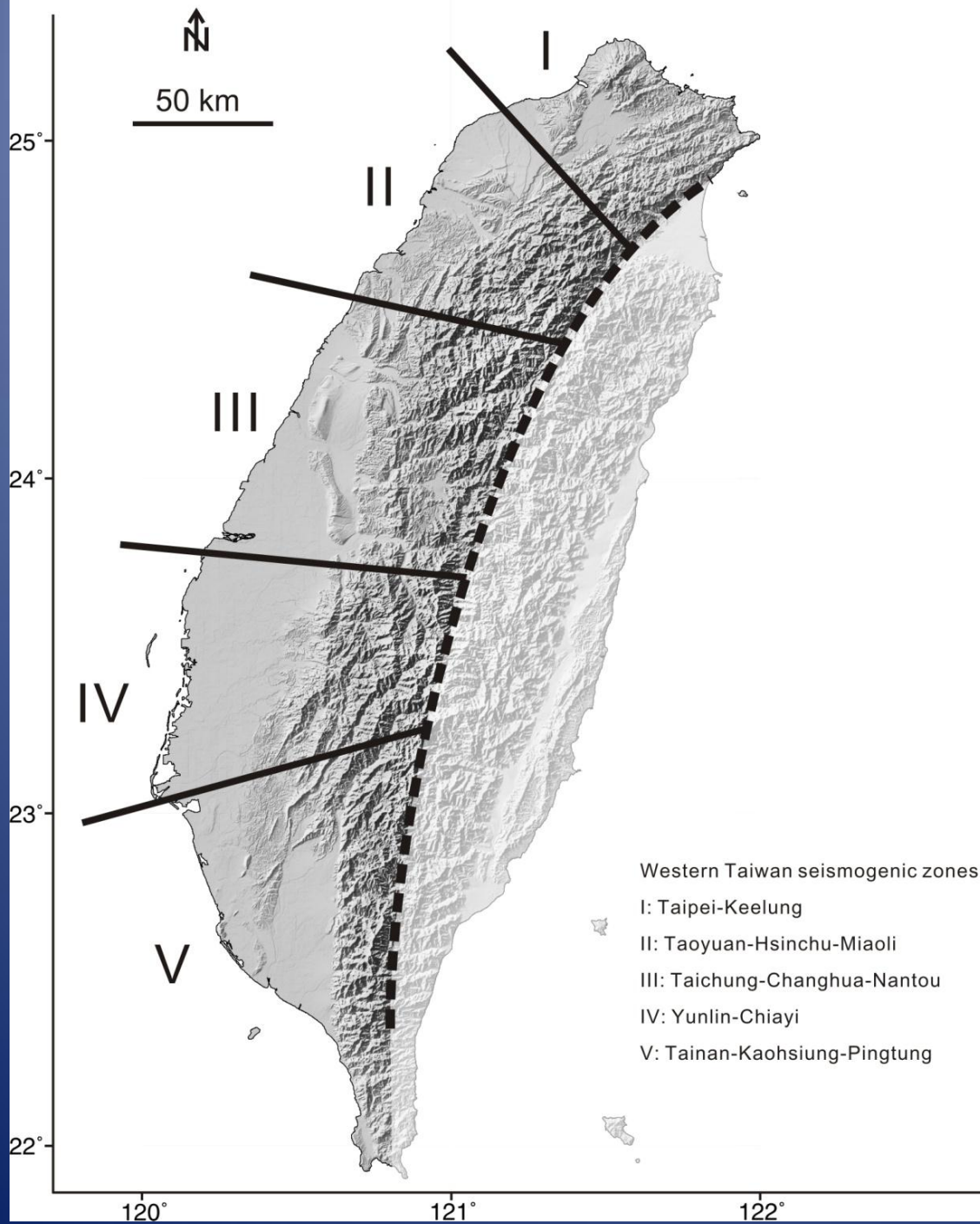
(Ng et al., 2009)

Source of seismic data:
Central Weather Bureau

Percentage Error Analysis

$$\left[\frac{M_{\text{est}} - M_{\text{cwb}}}{M_{\text{cwb}}} \right] * 100\%$$



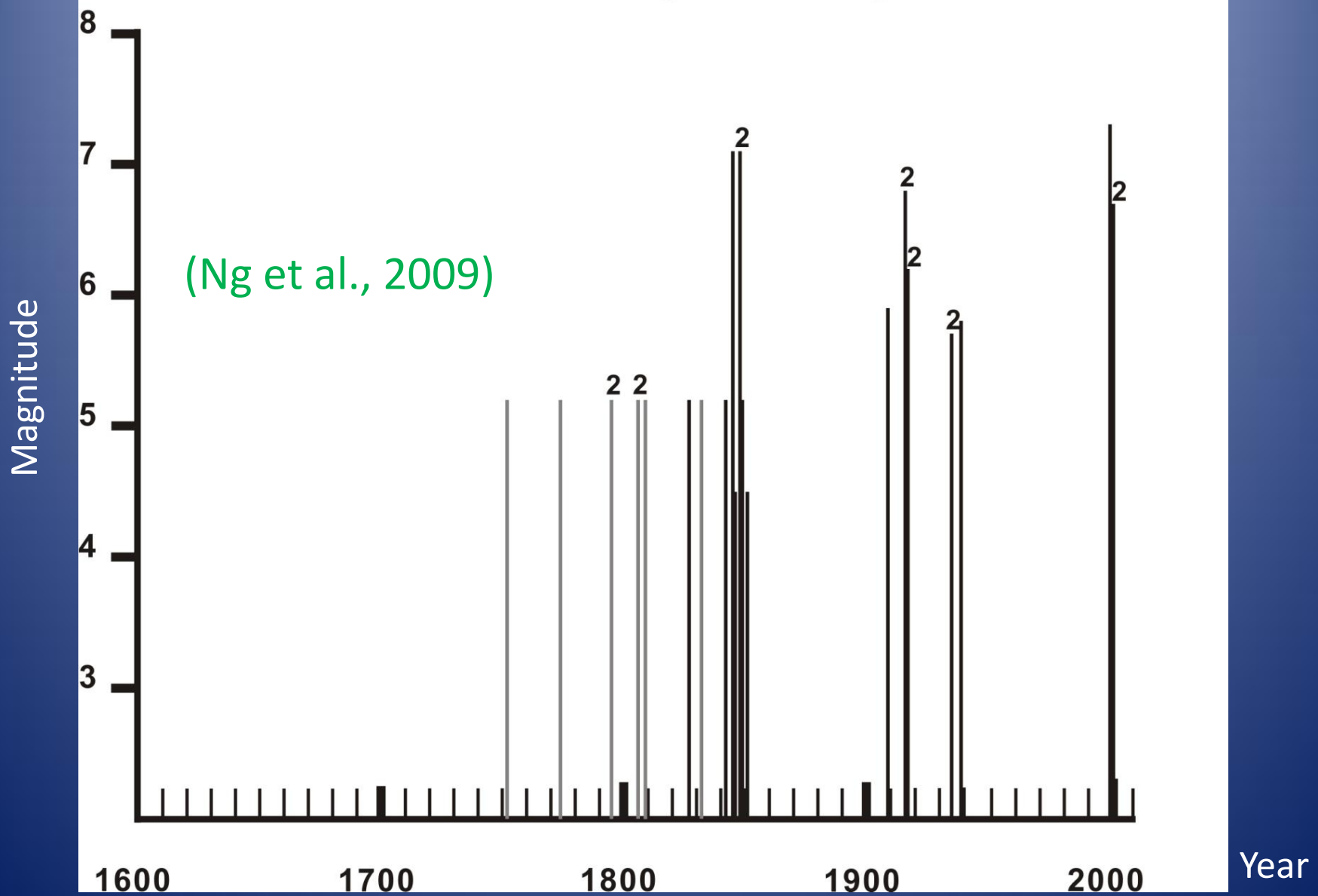


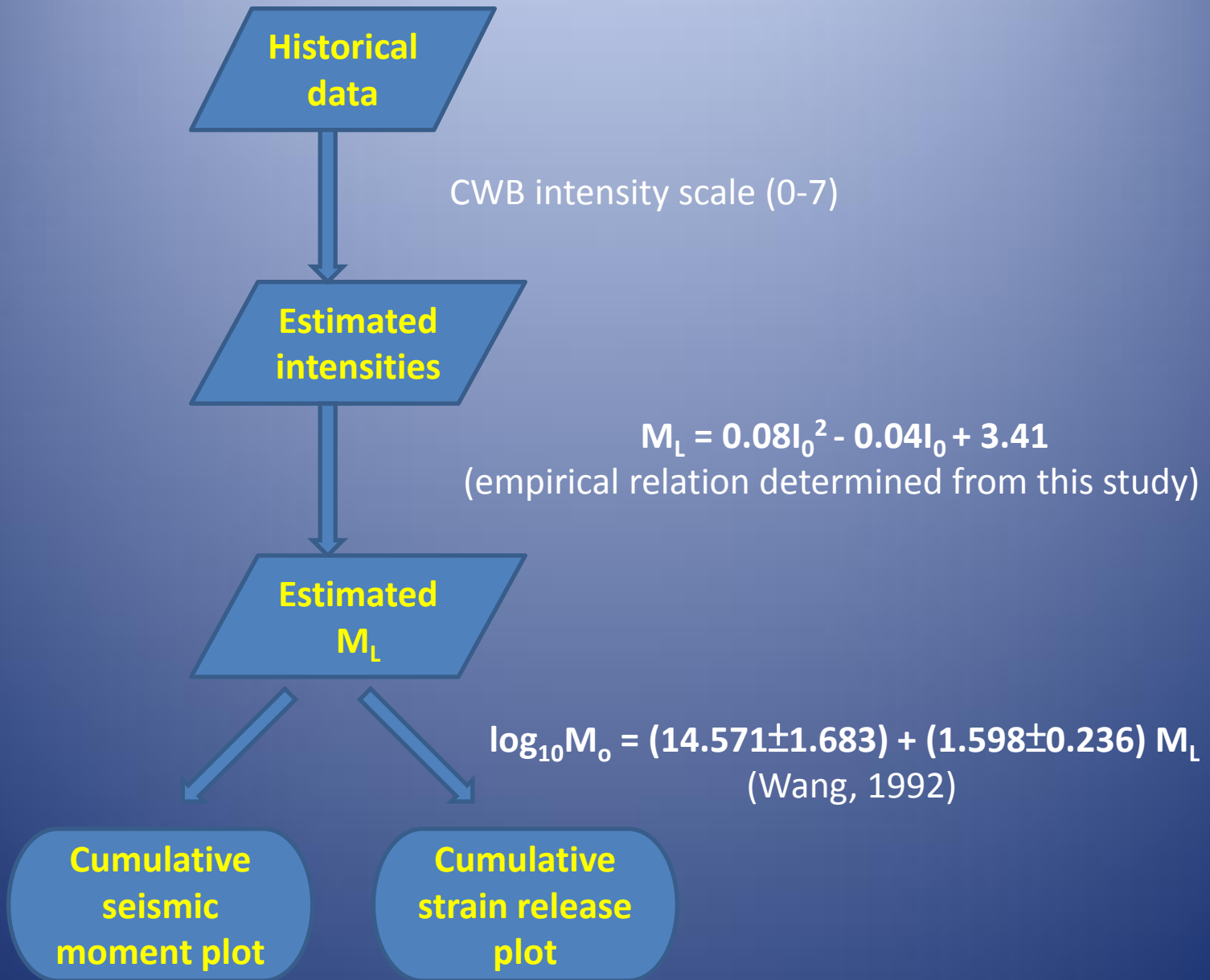
Five seismogenic zones in western Taiwan

(Ng et al., 2009)

a) A non-cumulative representation of earthquake magnitude as ordinates

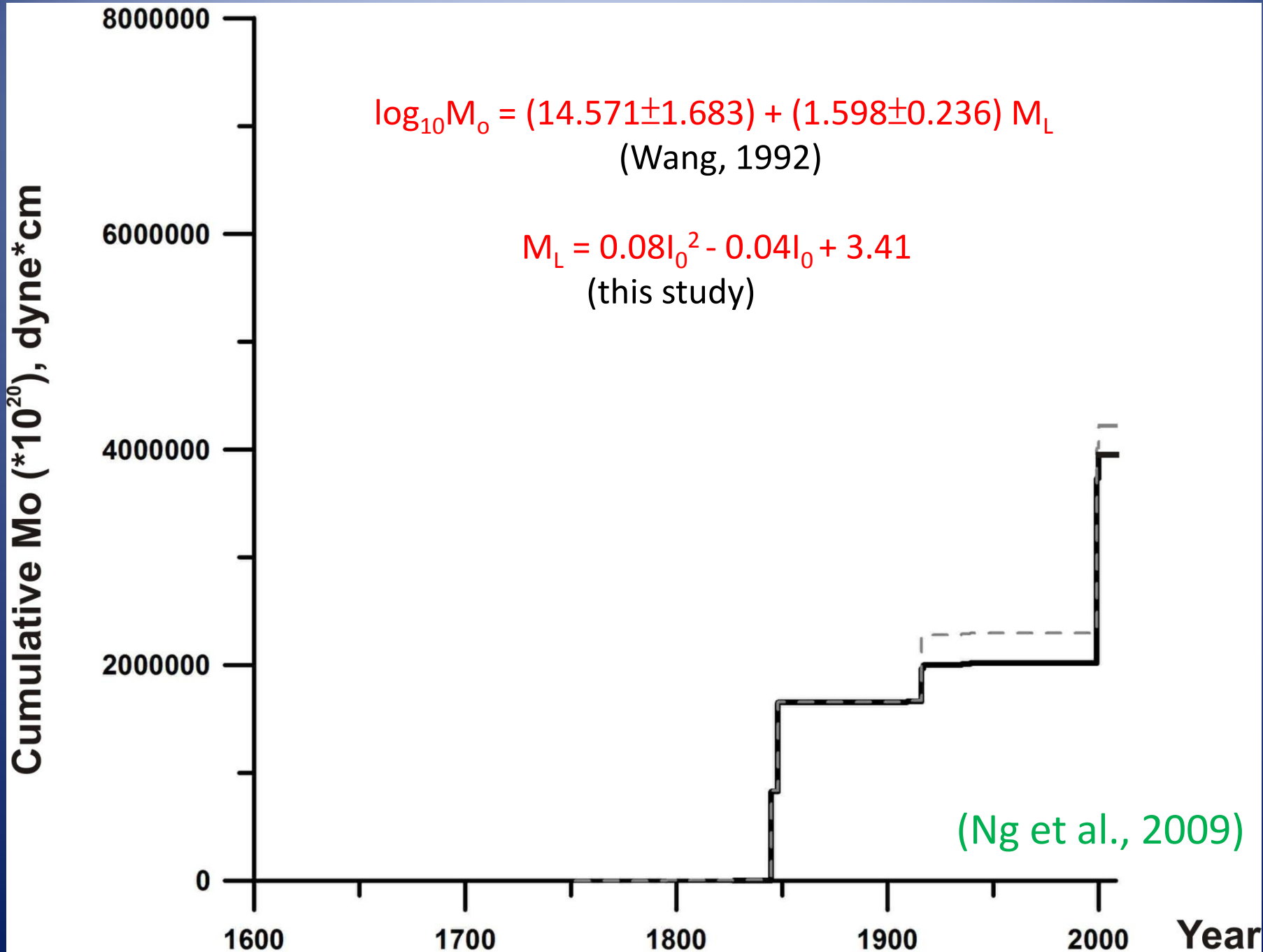
Zone III ~ Taichung-Changhua-Nantou



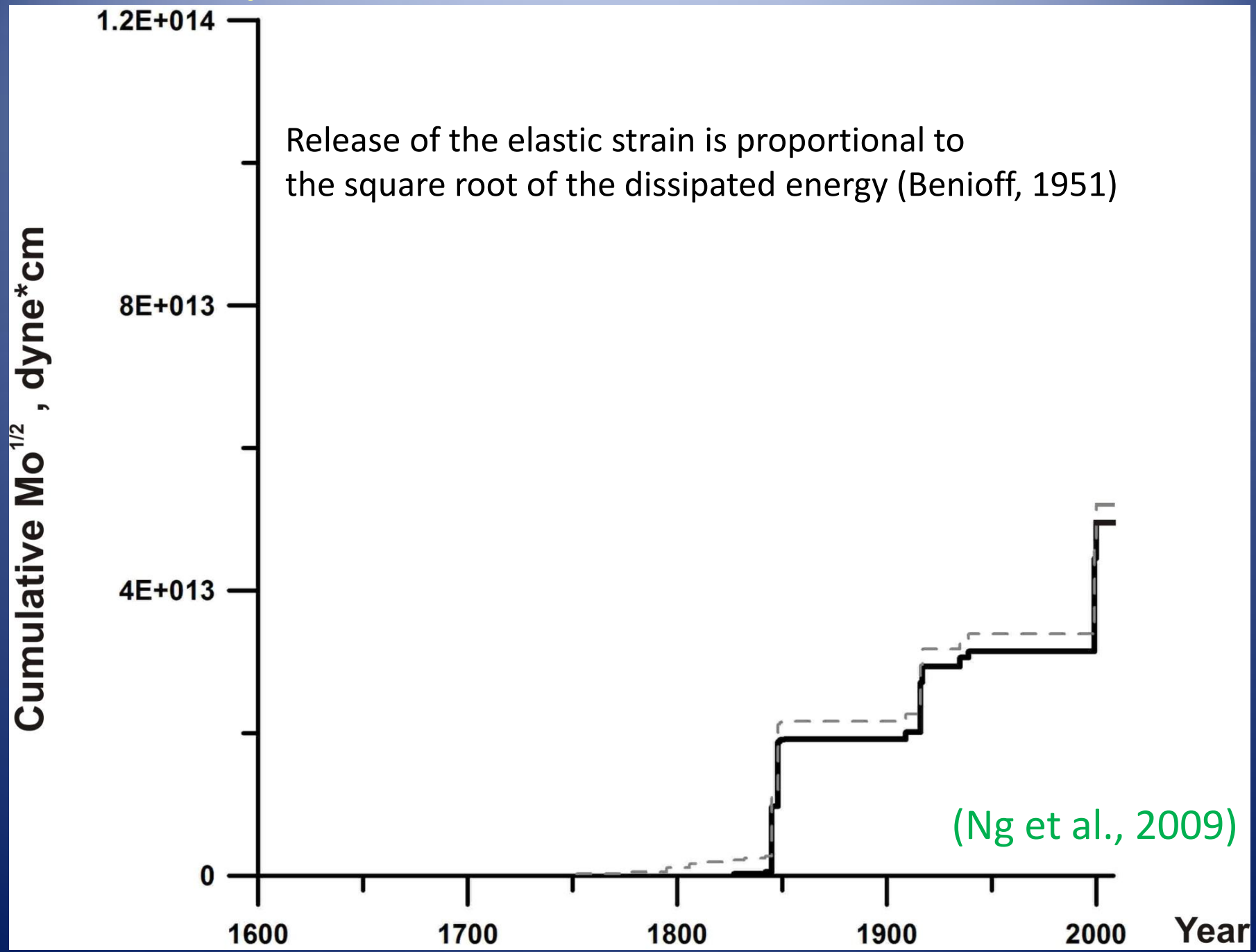


Schematic flowchart showing how to obtain cumulative plots

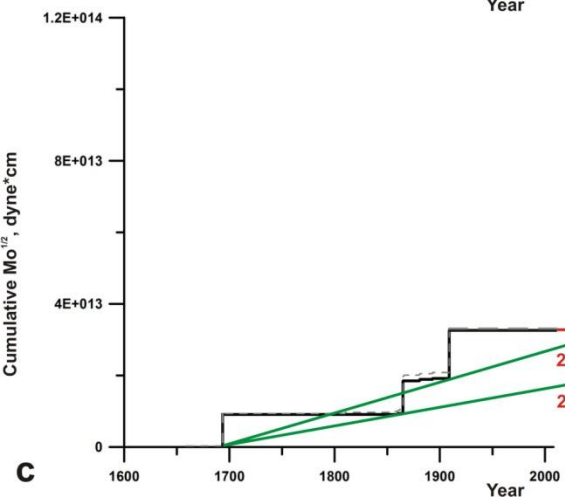
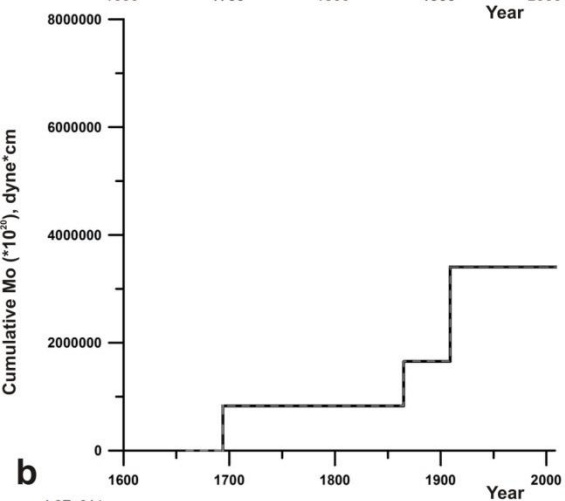
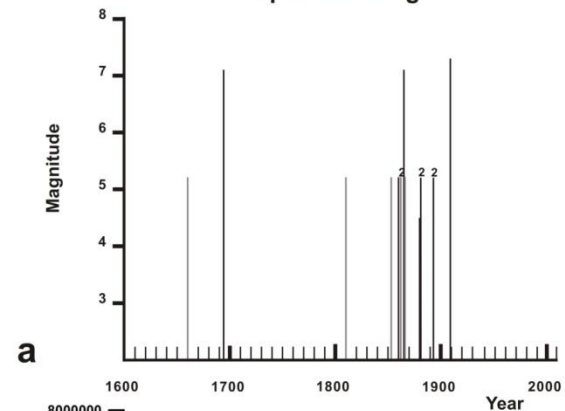
b) A cumulative representation of earthquake energy, seismic moment plot



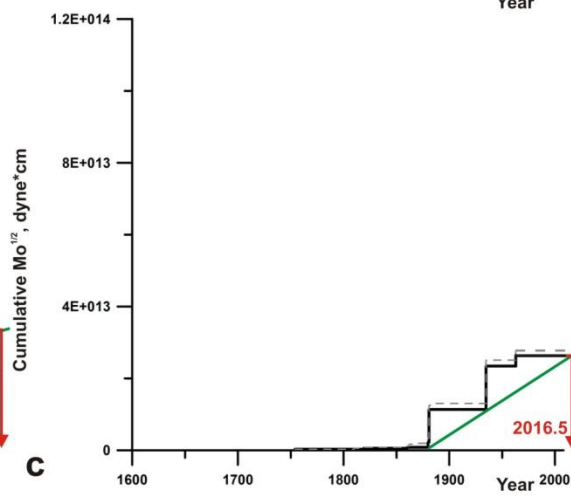
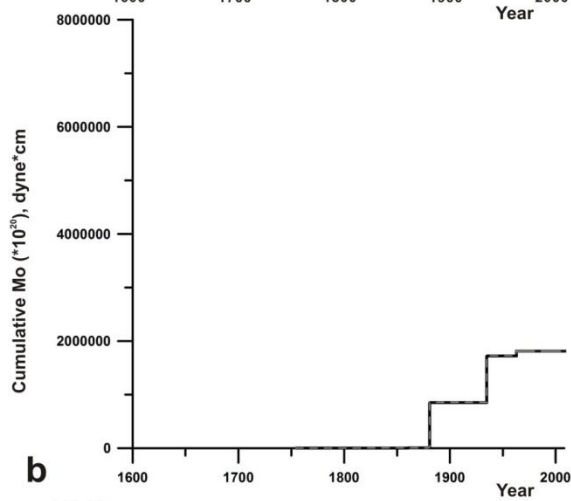
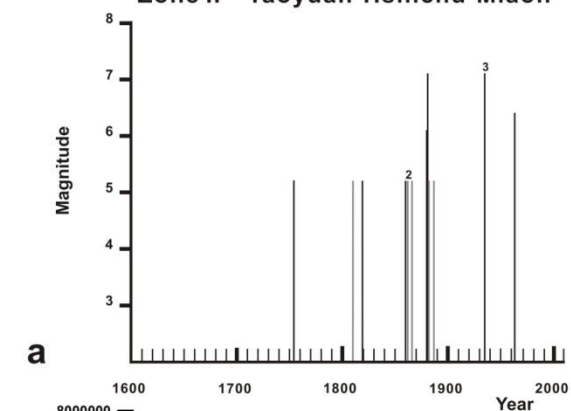
c) A cumulative representation of seismic strain release



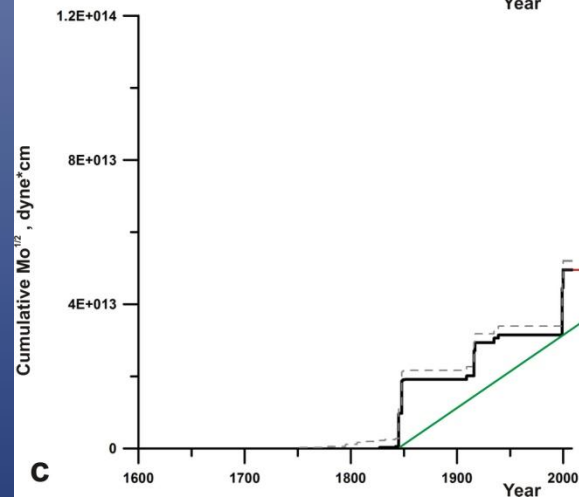
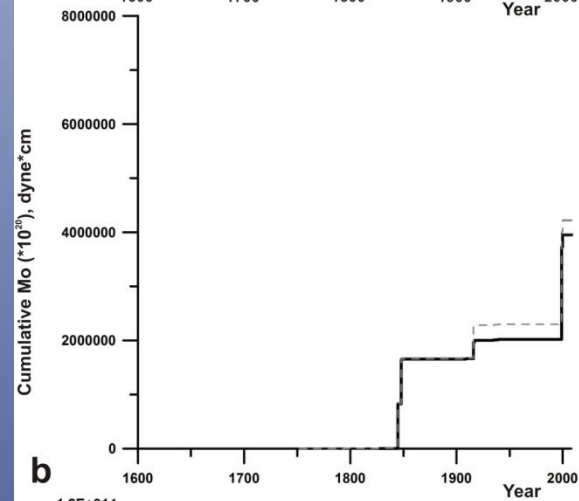
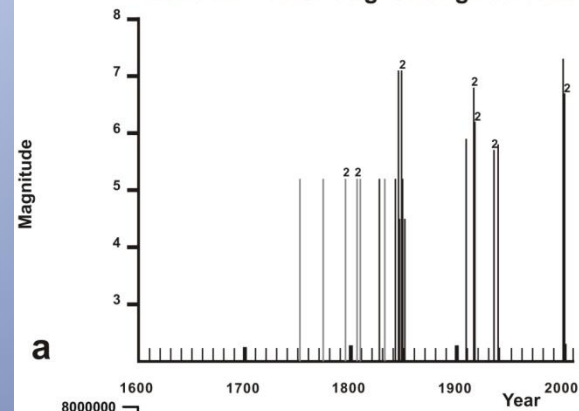
Zone I ~ Taipei-Keelung



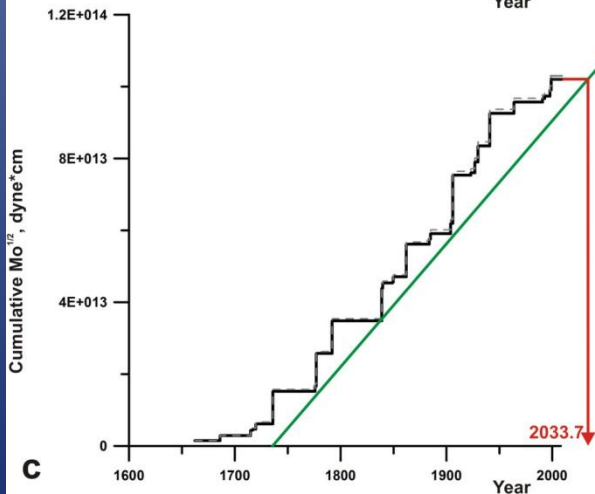
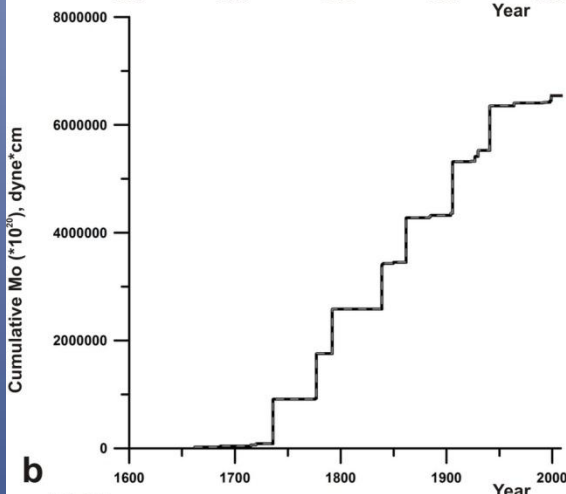
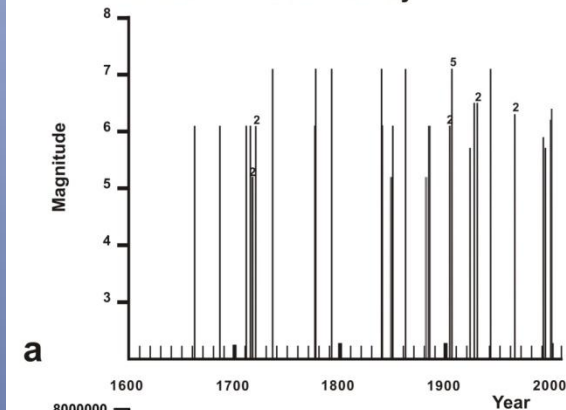
Zone II ~ Taoyuan-Hsinchu-Miaoli



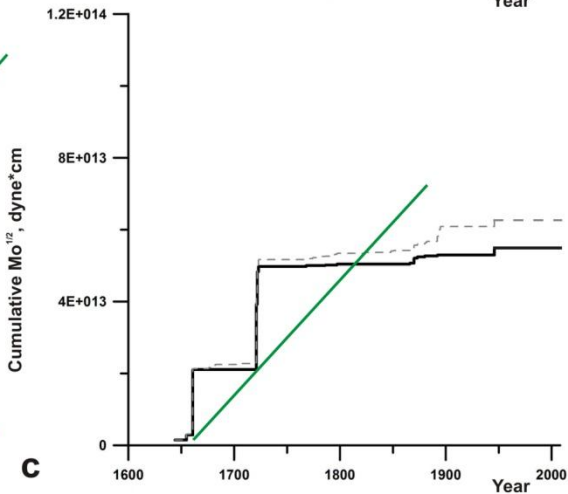
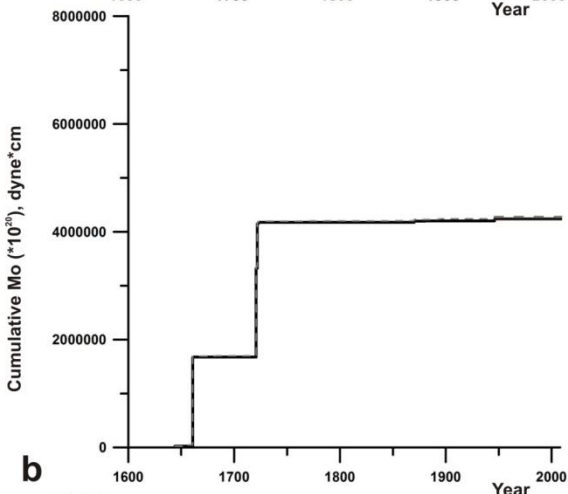
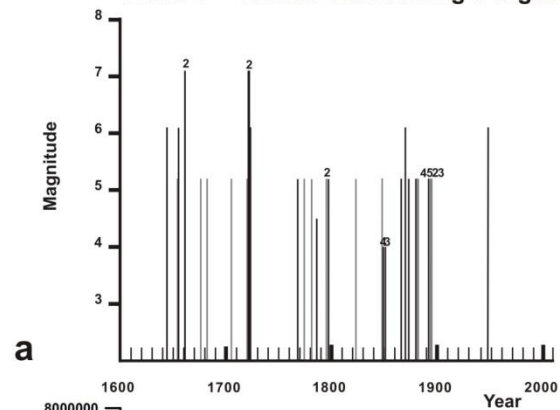
Zone III ~ Taichung-Changhua-Nantou



Zone IV ~ Yunlin-Chiayi



Zone V ~ Tainan-Kaohsiung-Pingtung



Earthquake cycle in Western Taiwan: Insights from historical seismicity (summary)

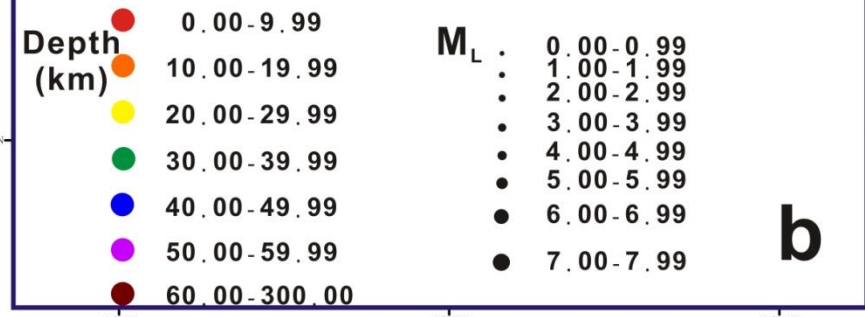
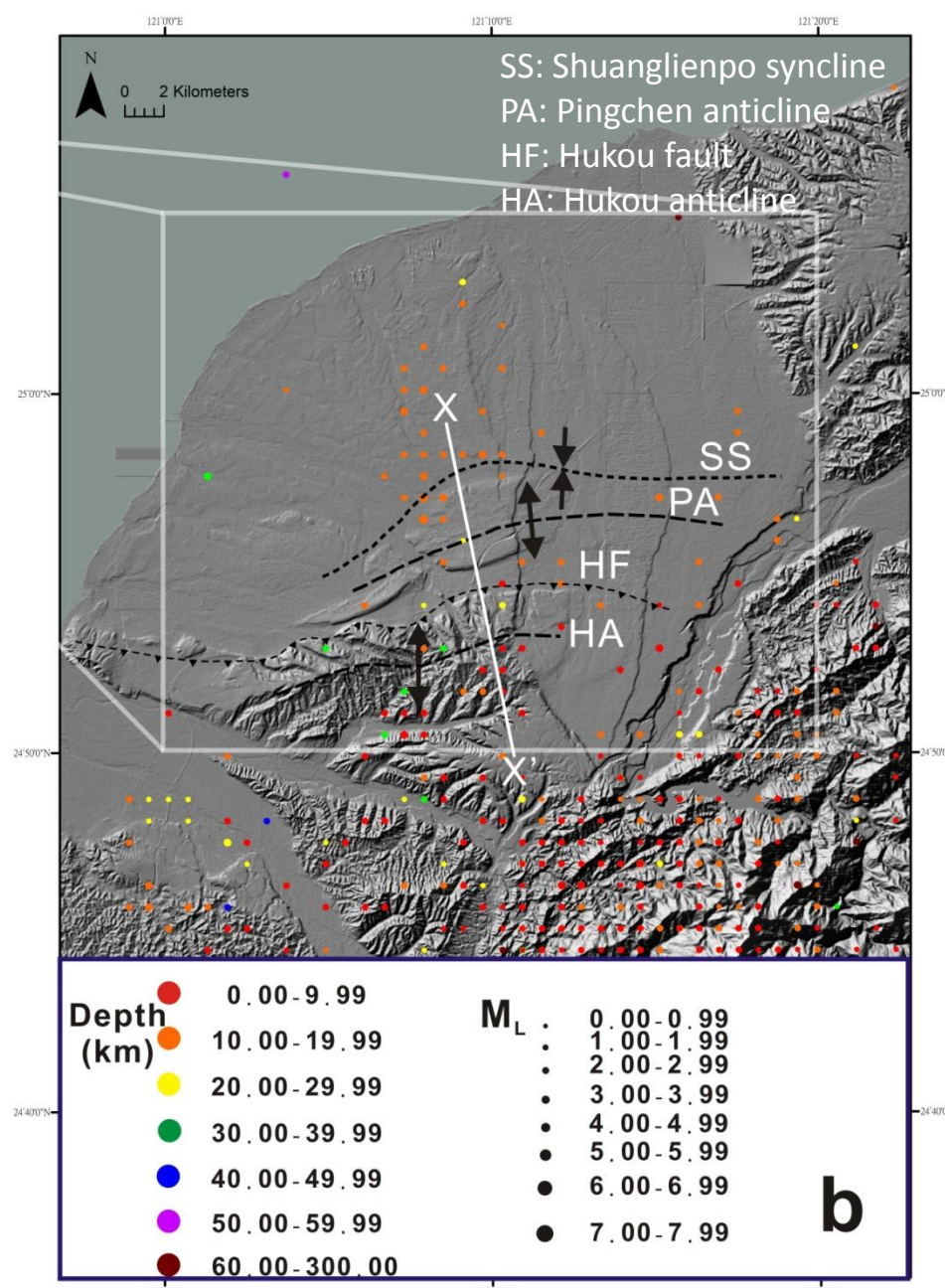
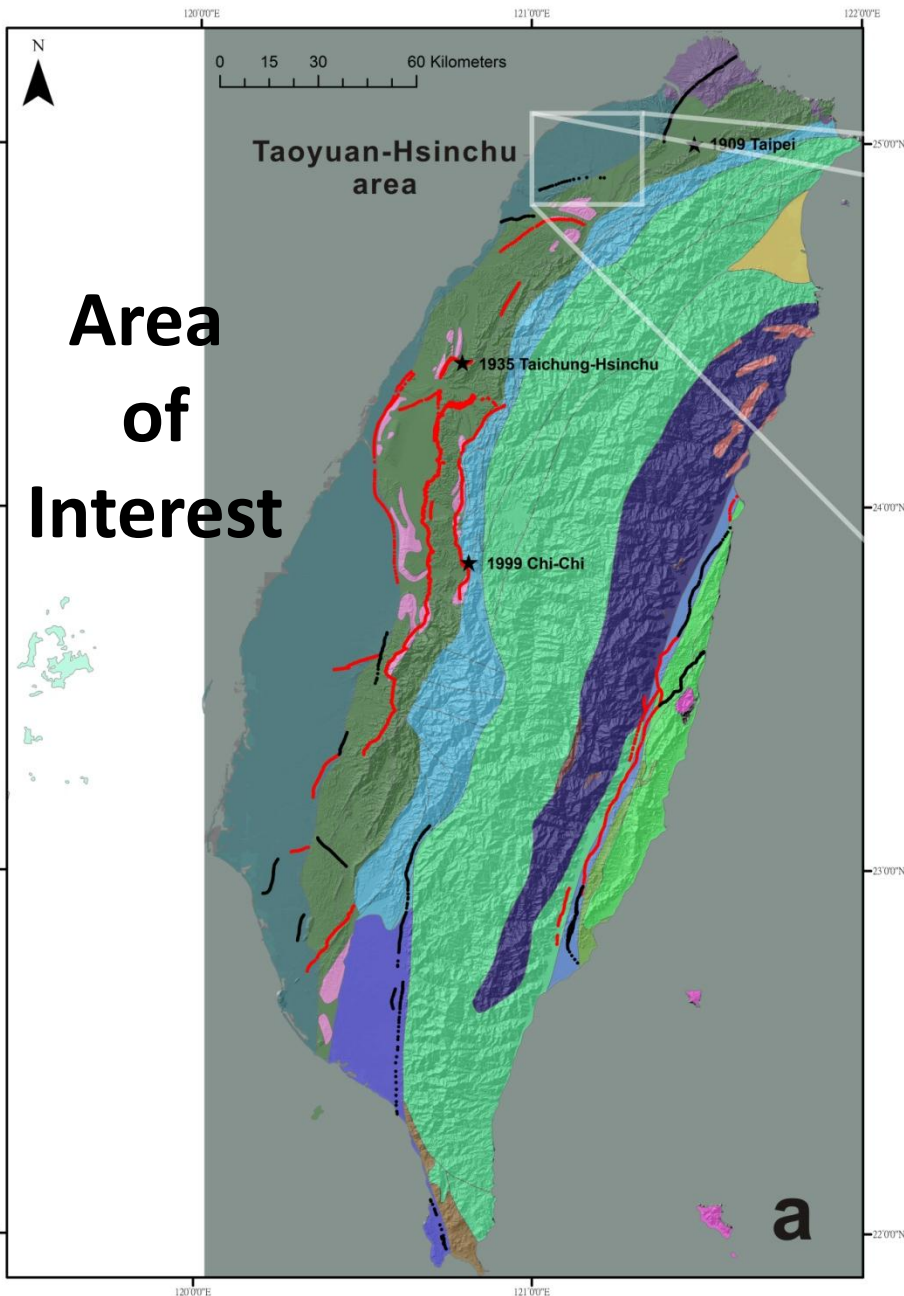
Purpose: To evaluate the seismic cycle, that is, the recurrence time interval of major earthquake events in Western Taiwan.

Problem: To reconcile the historical information of the 17th, 18th and 19th centuries, which is essentially qualitative, with the abundant and accurate information of more recent instrumental period.

Tactic: We address the problem of intensity-magnitude relationships, to evaluate the relative importance of old and recent and give them appropriate weight in total record.

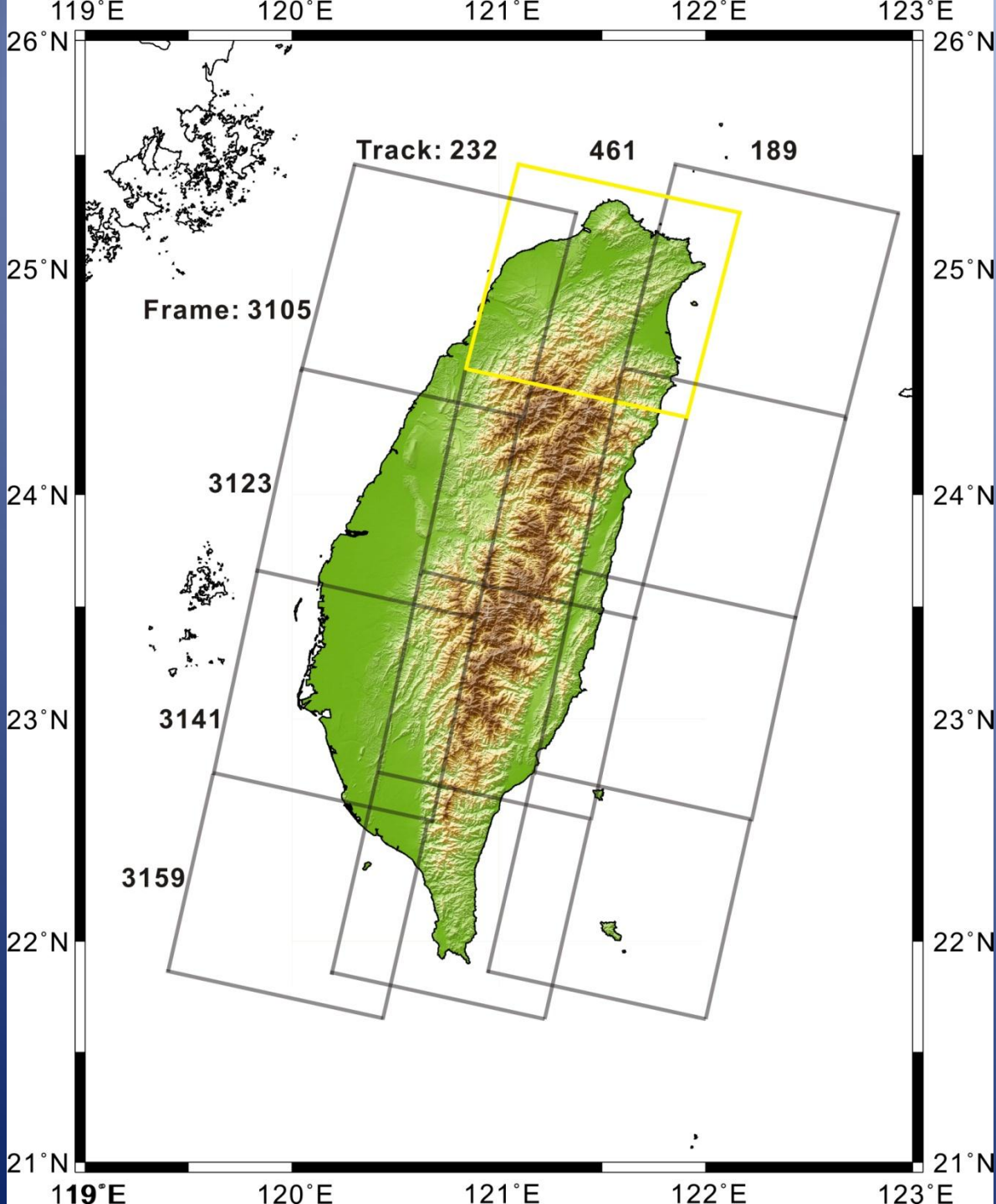
Validation: Percentage error analysis is performed to test the reliability of our derived empirical relationship:

$$M_L = 0.08I_0^2 - 0.04I_0 + 3.41$$

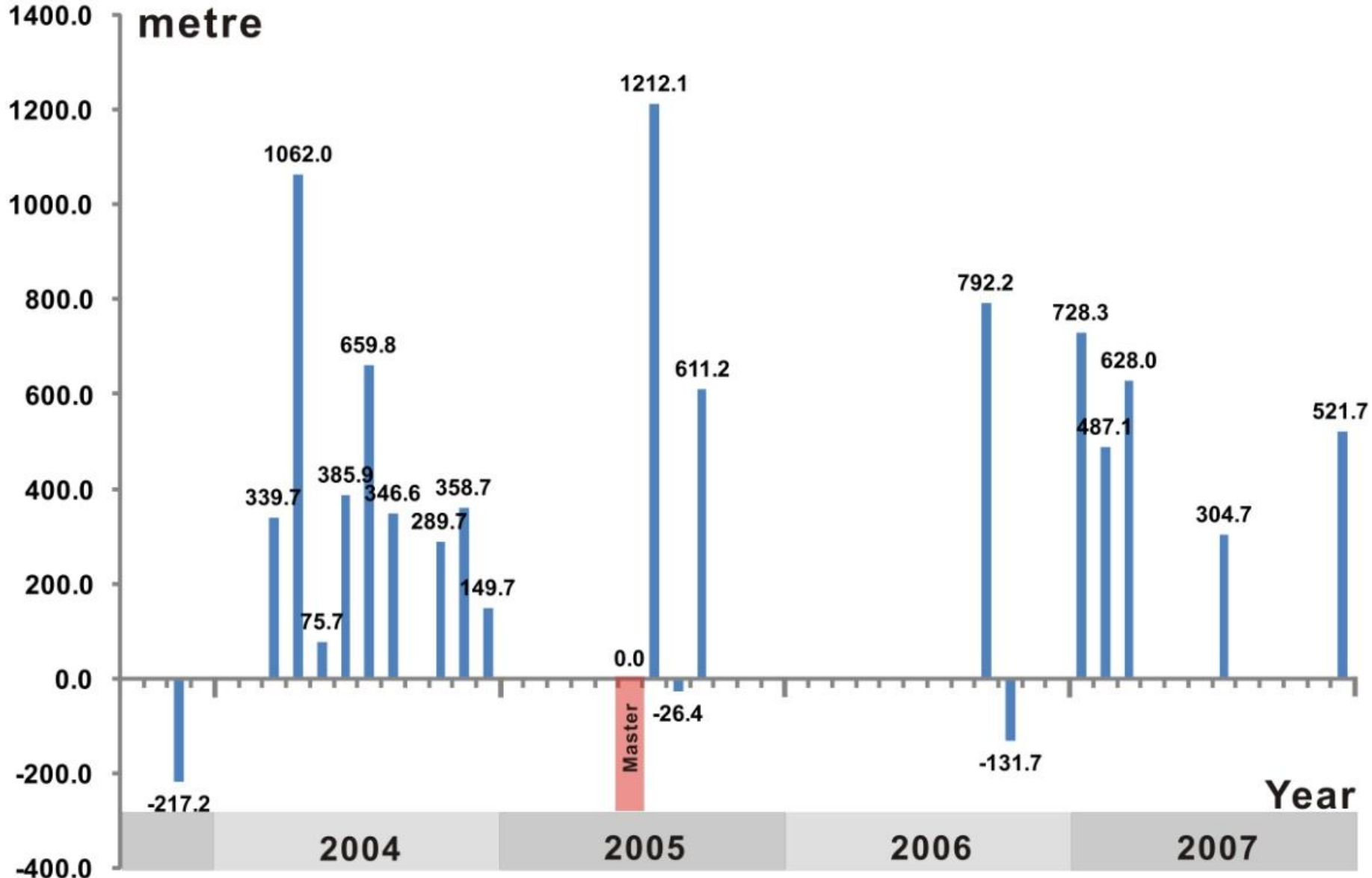


Relocated seismicity 1991-2009

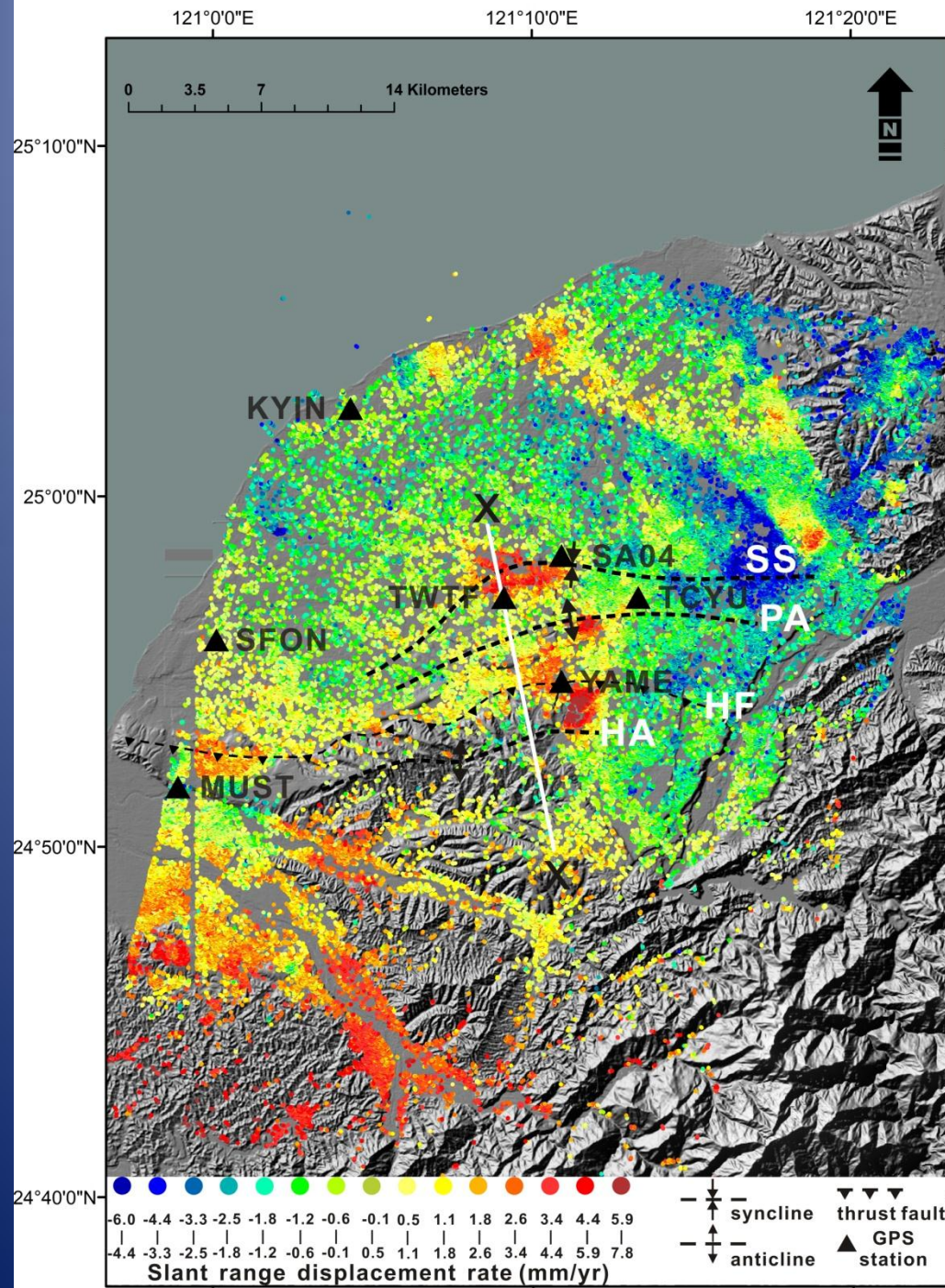
obtained from Prof. Wu



Coverage Map of Envisat Satellite



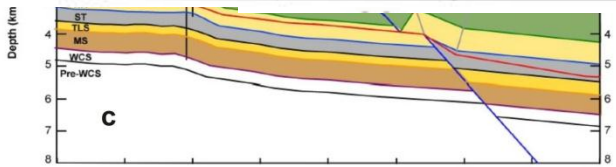
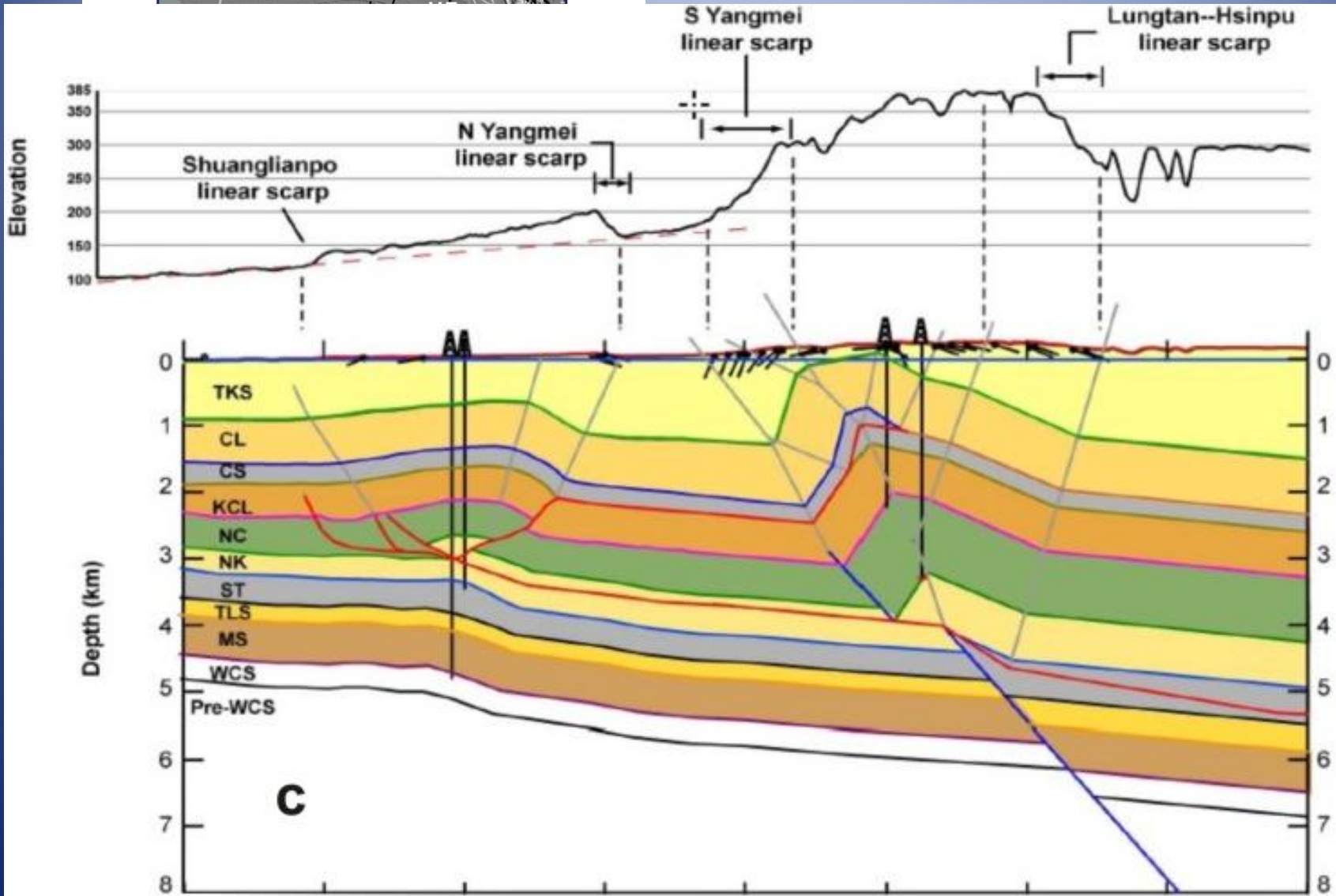
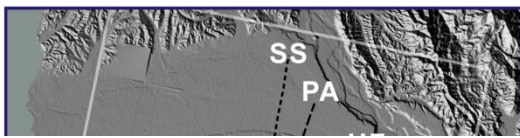
Temporal distribution of perpendicular baselines (B_{\perp}) with values of twenty-one Envisat images



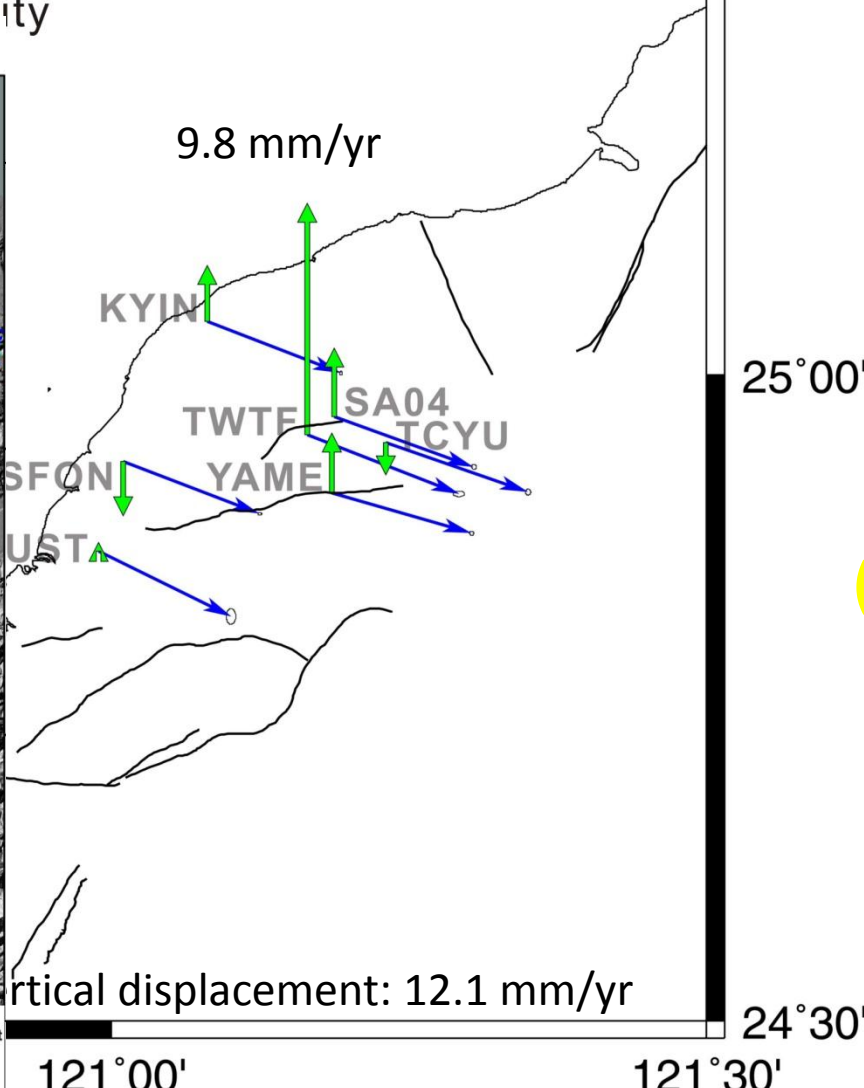
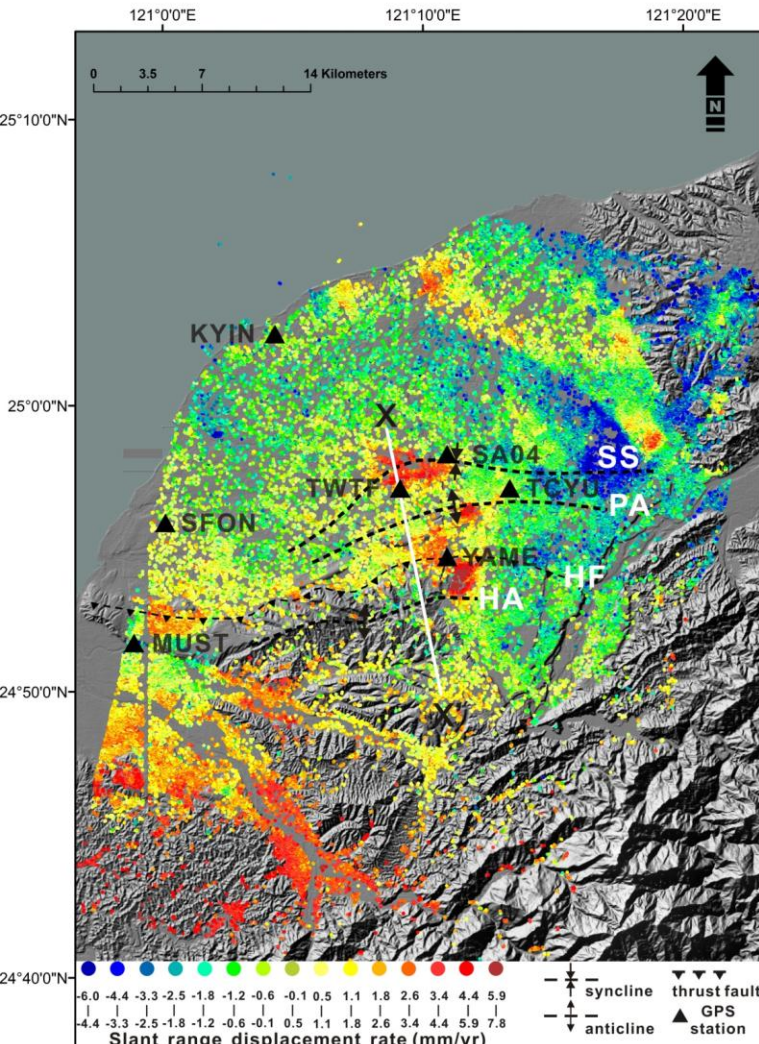
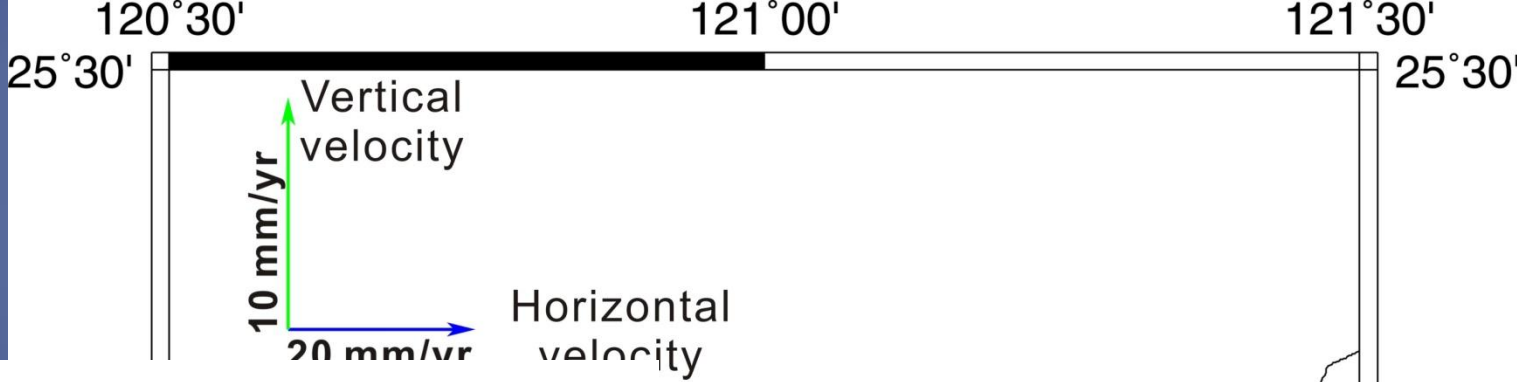
PSI Mean Velocity

Relative SRD: 13.8 mm/yr
(Nov. 2003 ~ Dec. 2007)

PSI Interpretation



(C) is adapted after Wang (2003)



Velocity Field of Seven Taiwan CGPS (2006-2009)

25°30'

Principal strain rate



EXT.



CONT.

2.0 μ strain/year

25°00'

Dilatation Rate



-4 -3 -2 -1 0 1 2 3 4

μ strain/year

24°30'

120°30'

121°00'

121°30'

**Strain
Rate**

(1995-2006)

Campaign-mode GPS
data from CGS

Neotectonics of growth blind fault system in Taoyuan-Hsinchu area, northwestern Taiwan revealed by InSAR persistent scatterers

(Summary)

Purpose: To evaluate recent tectonic activity in the Taoyuan-Hsinchu area as a direct consequence of the previous historical study.

Problem: To acquire suitable SAR (satellite) images for study. Miaoli area should be covered in this study, unfortunately, only Taoyuan-Hsinchu area can be investigated using PSI.

Thank You