

# Development of Earthquake Early Warning System using initial P waves

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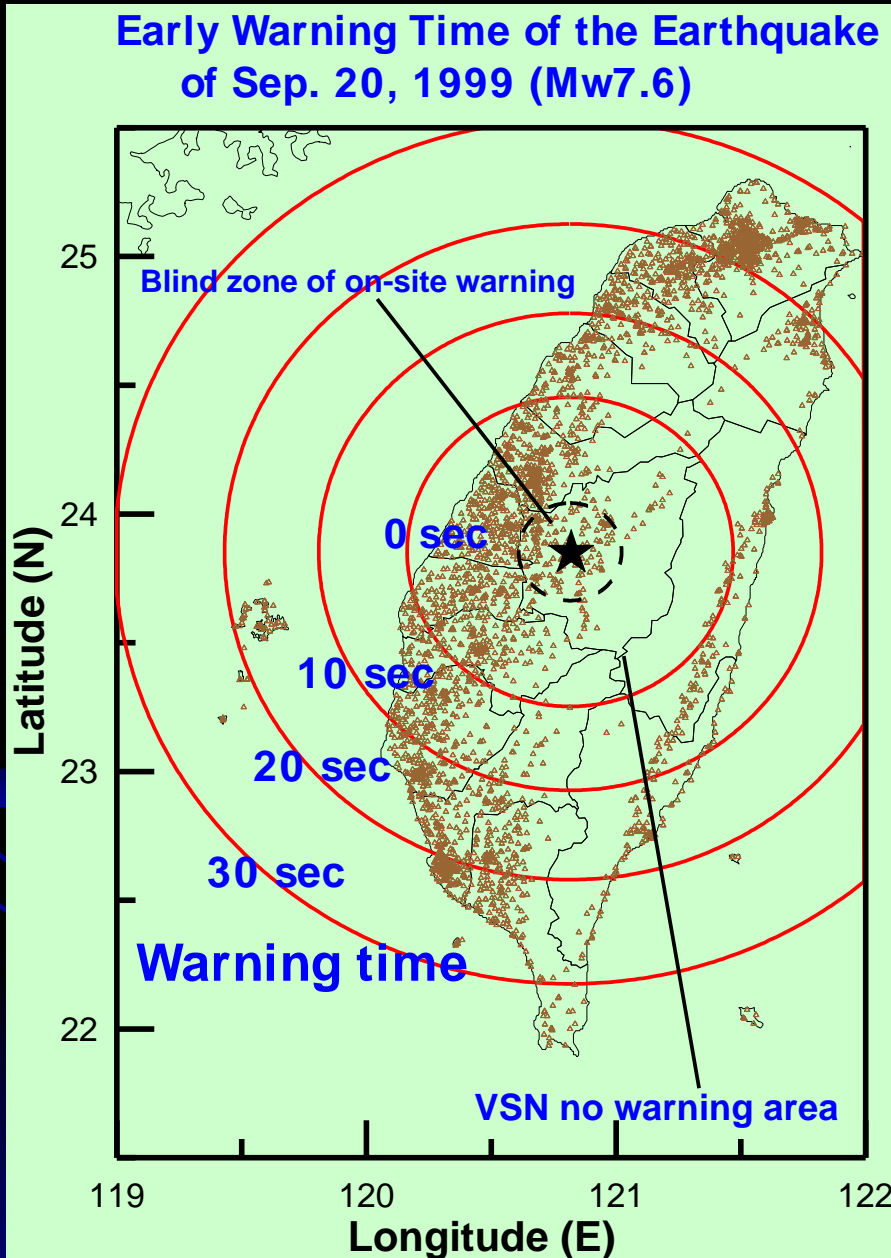


# Earthquake early warning (EEW)

- Before Strong Ground Motion
  - Earthquake Early Warning System
  - Predict Shaking
- Regional Warning & Onsite Warning



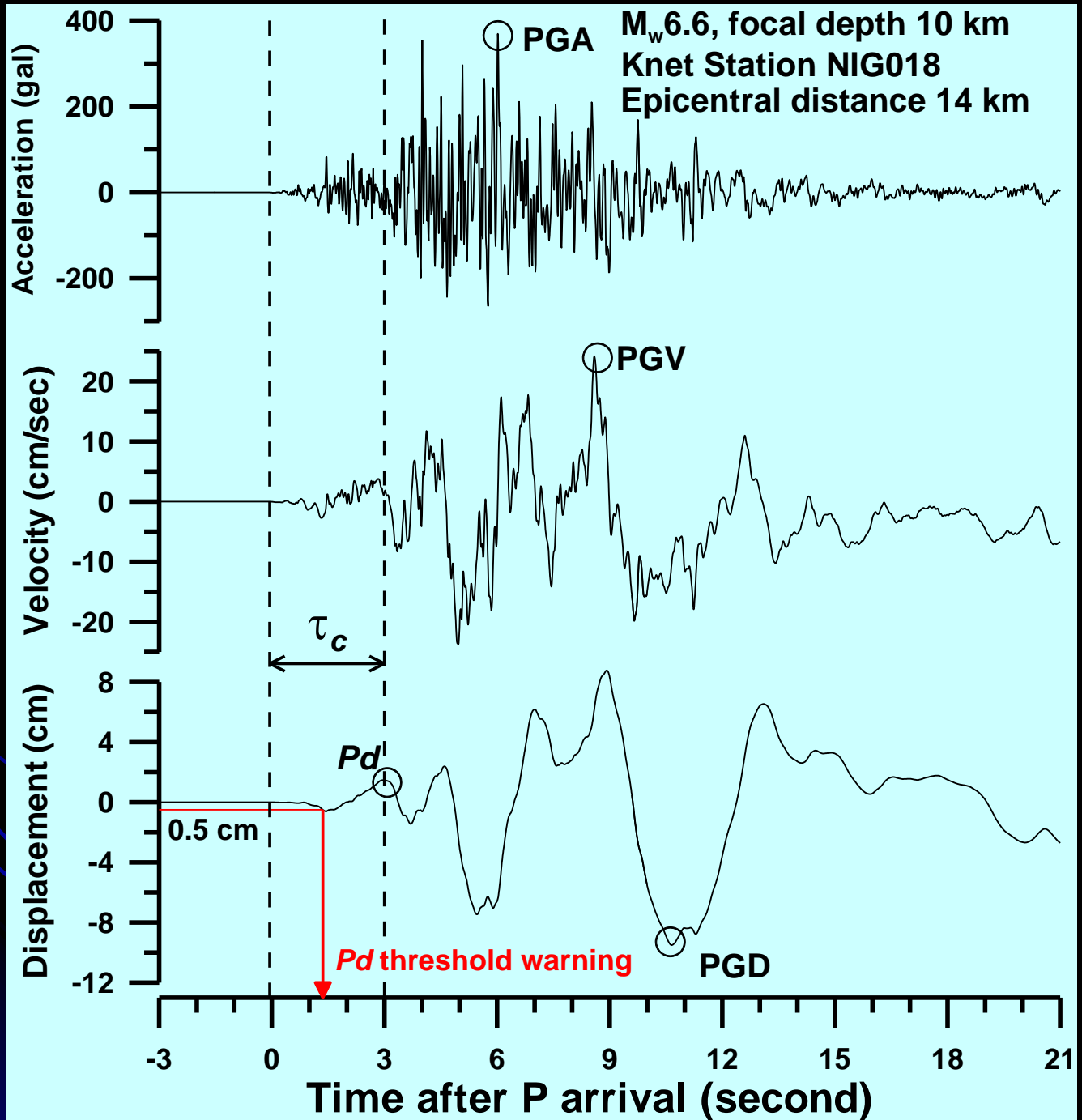
# Regional warning v.s. onsite warning

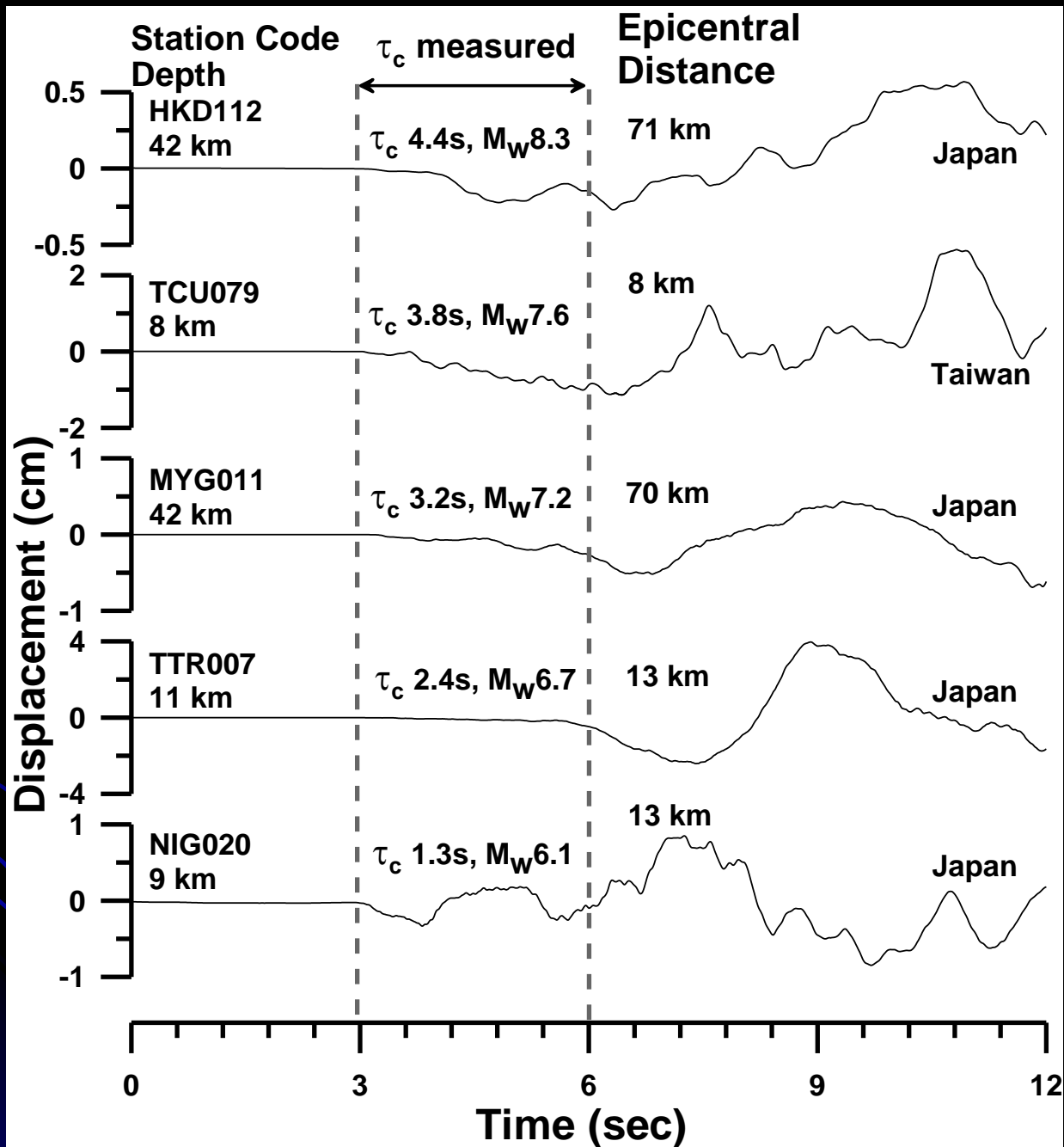


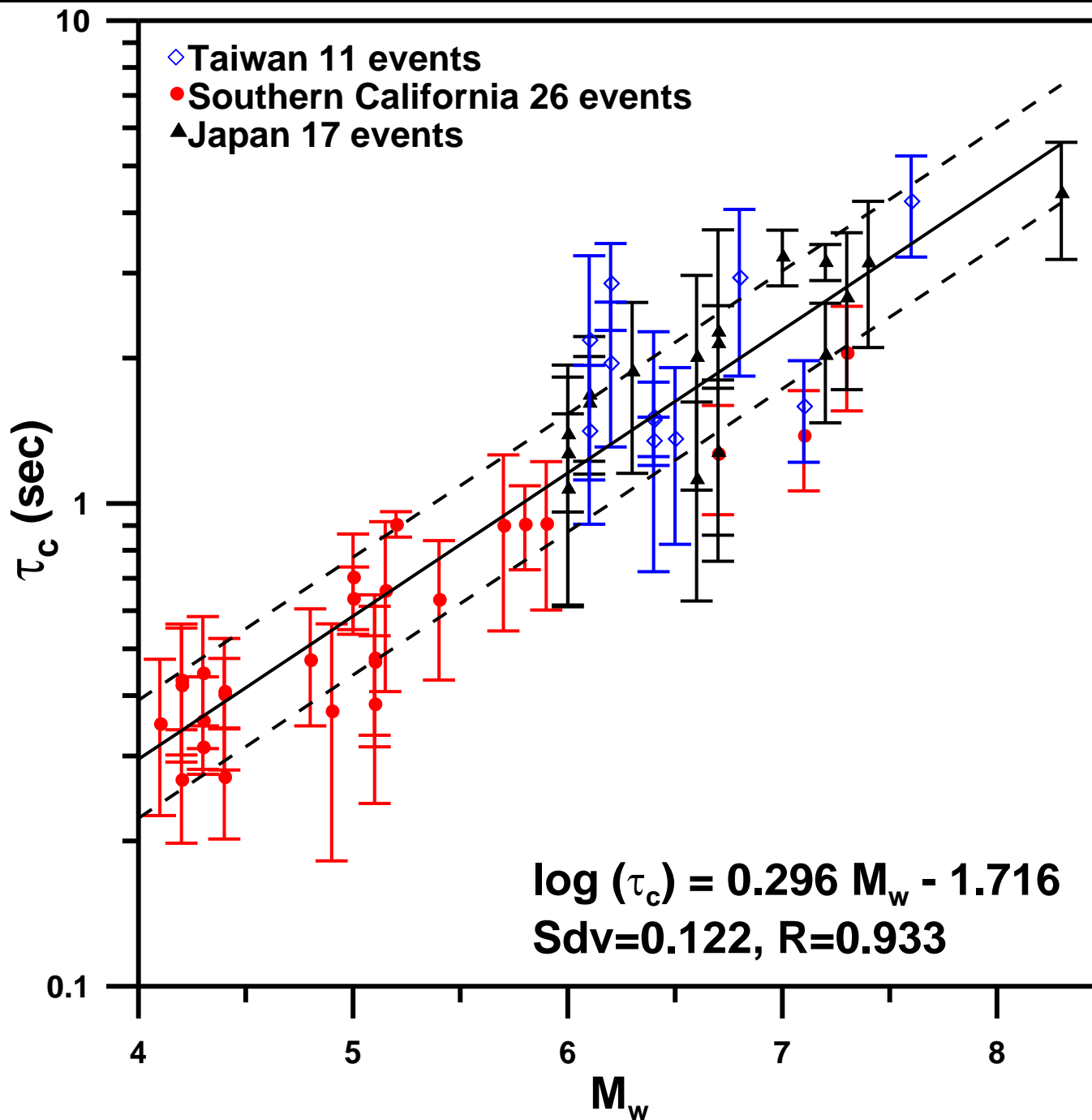
There is no warning time for VSN method within the distance 70 km from epicenter.

# $T_c$ & $P_d$ Methods

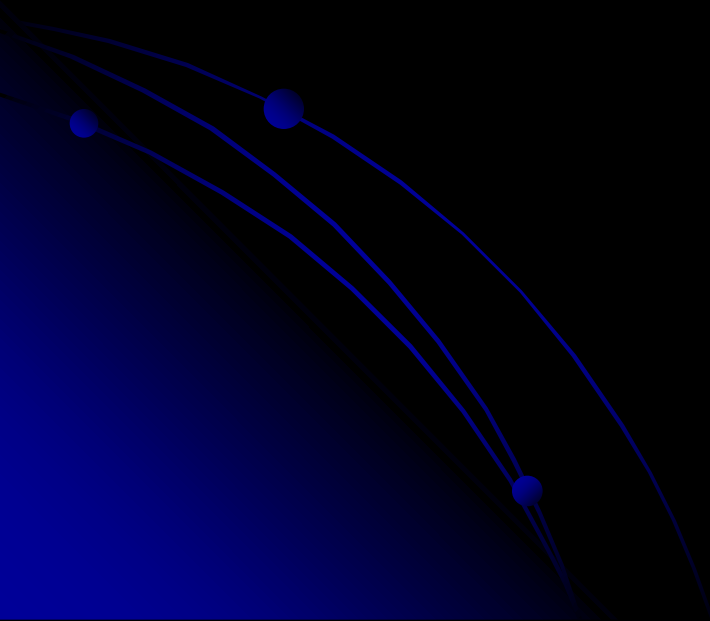
- $T_c$  average period parameter of the initial three seconds P waves
- $P_d$  0.075Hz high pass peak displacement amplitude of the initial three seconds P waves
- $T_c$  for magnitude determination
  - Kanamori (2005), Wu & Kanamori (2005A,2008a,b)
- $P_d$  for intensity estimation
  - Wu & Kanamori (2005B,2008a,b), Wu et al. (2007)
- $P_d$  for magnitude determination
  - Wu & Zhao (2006), Wu et al. (2007)



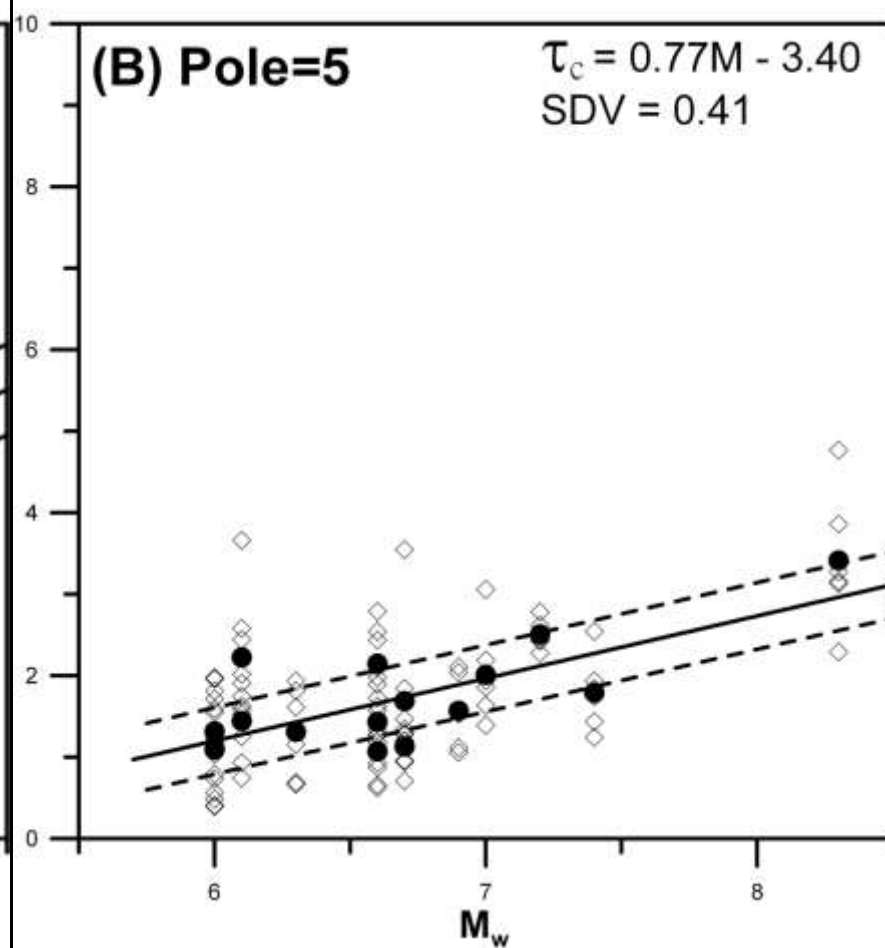
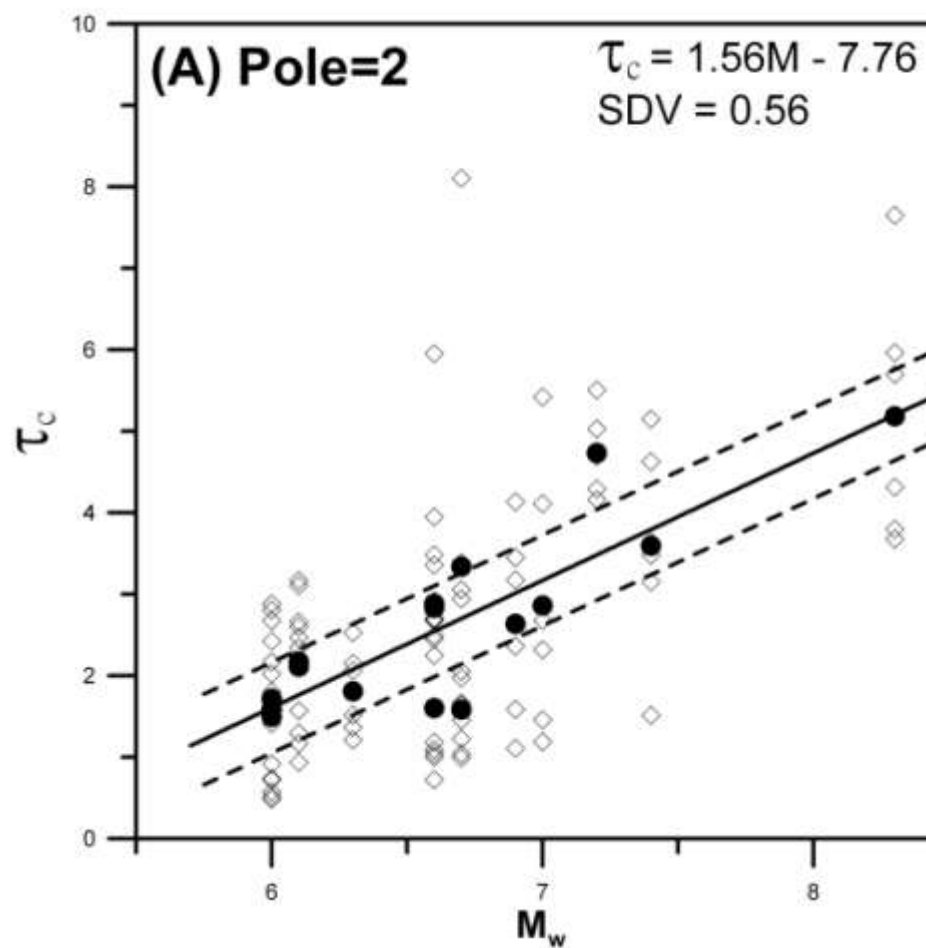


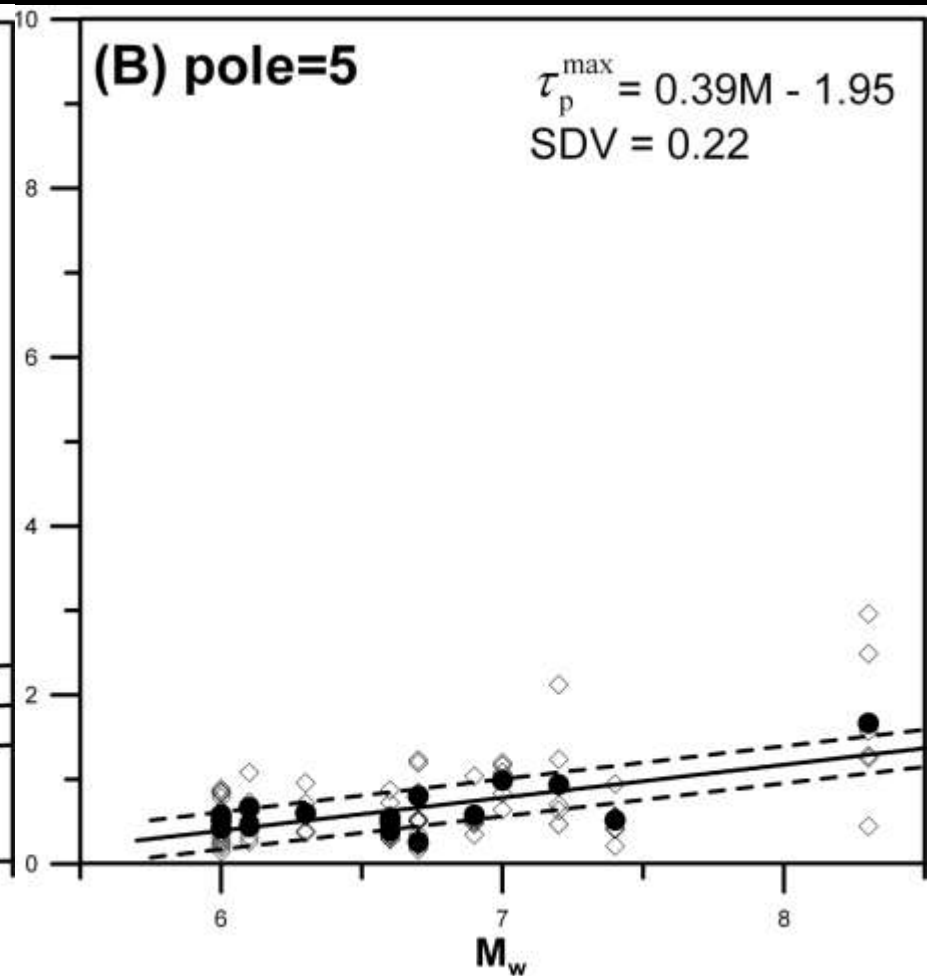
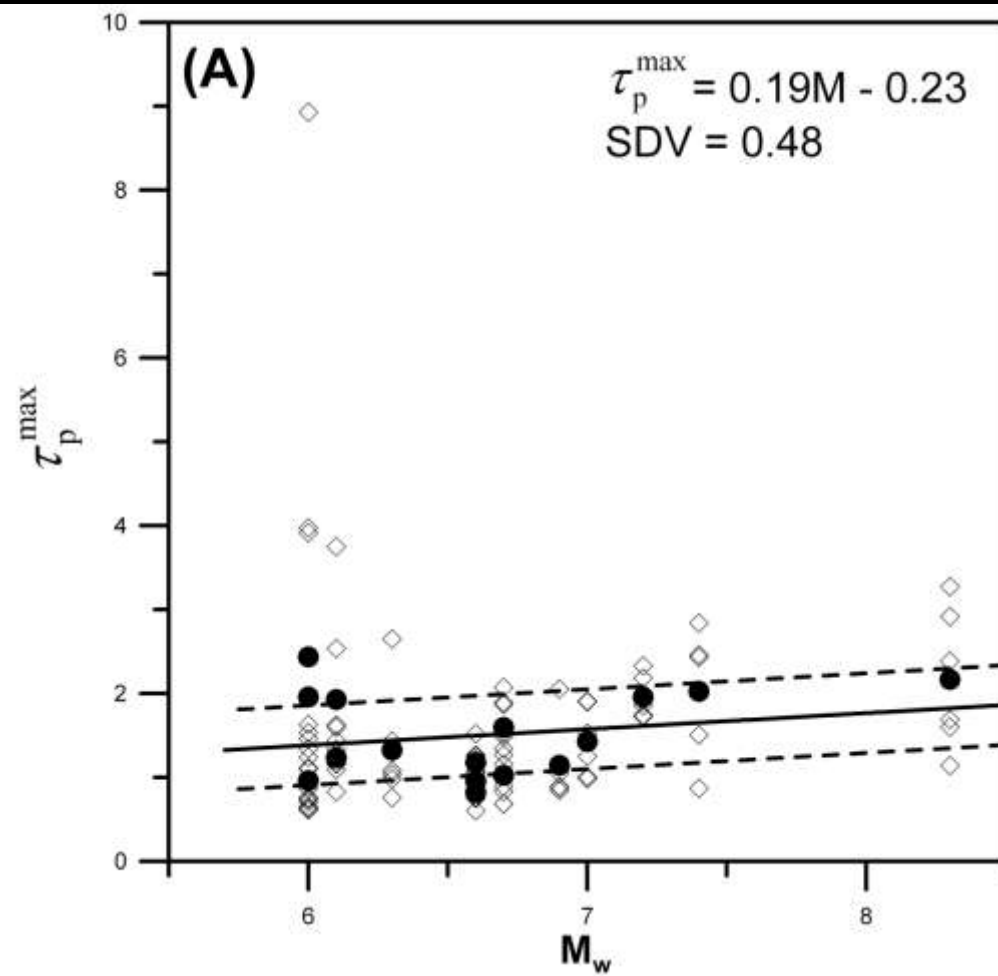


# Filter problem

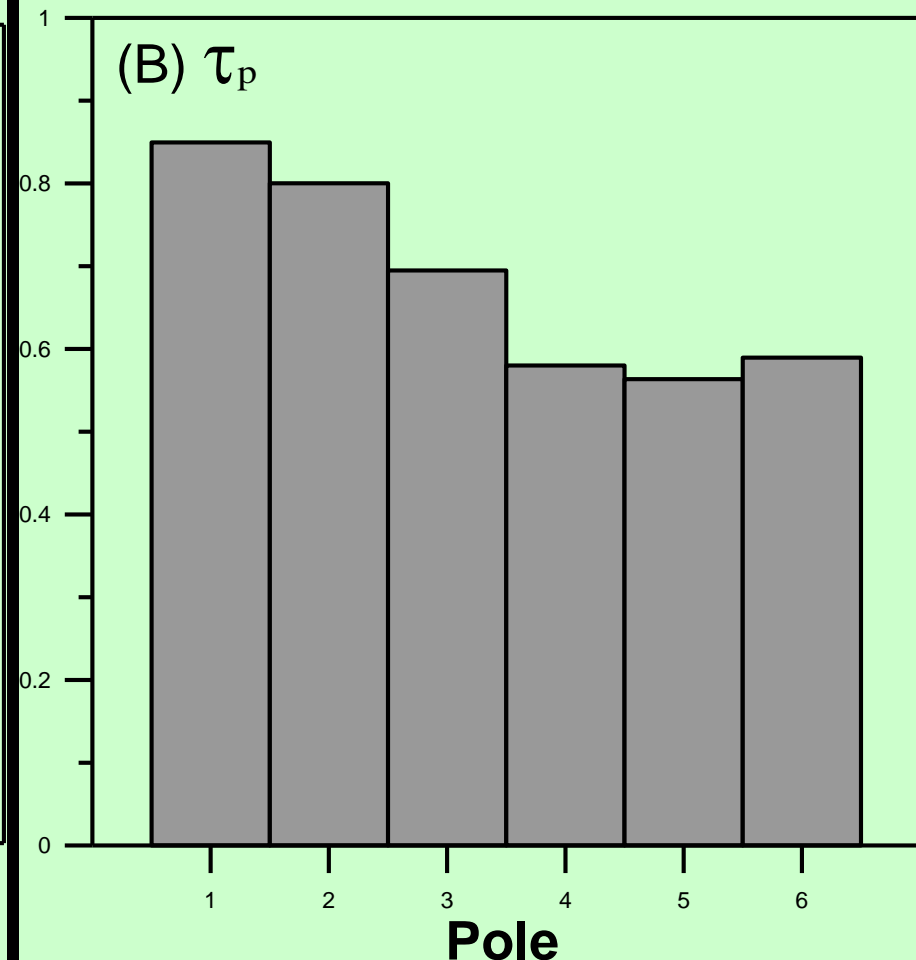
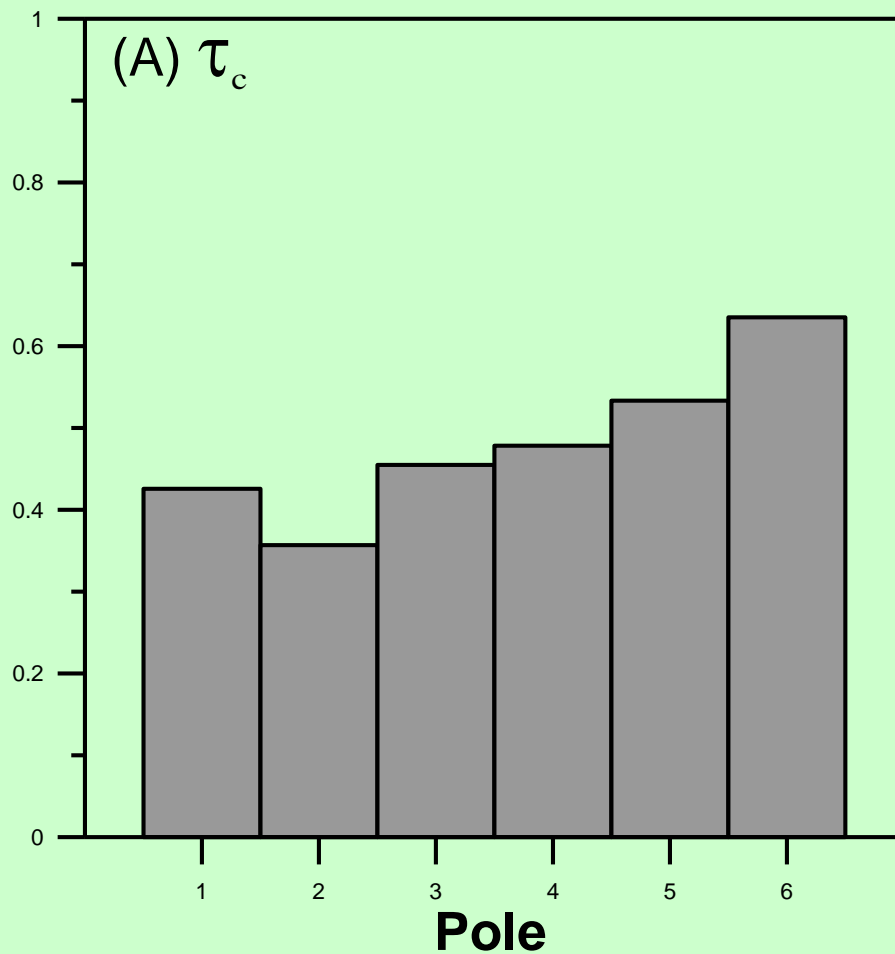






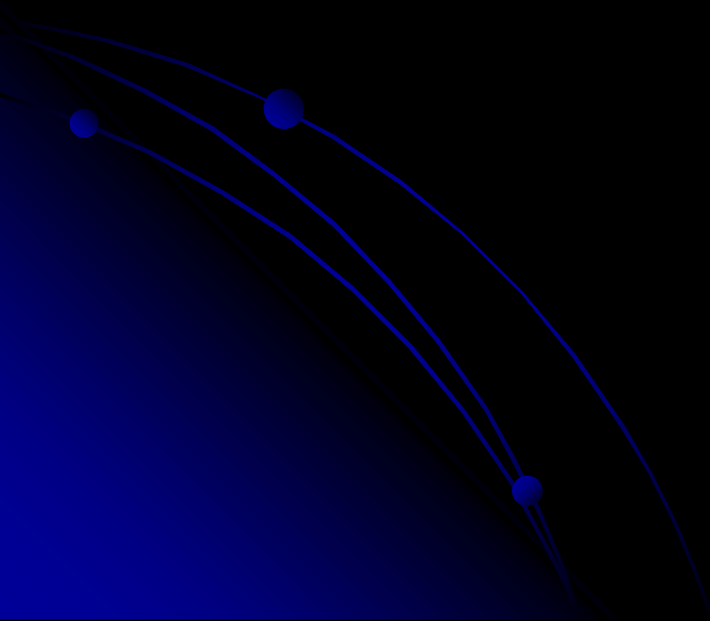


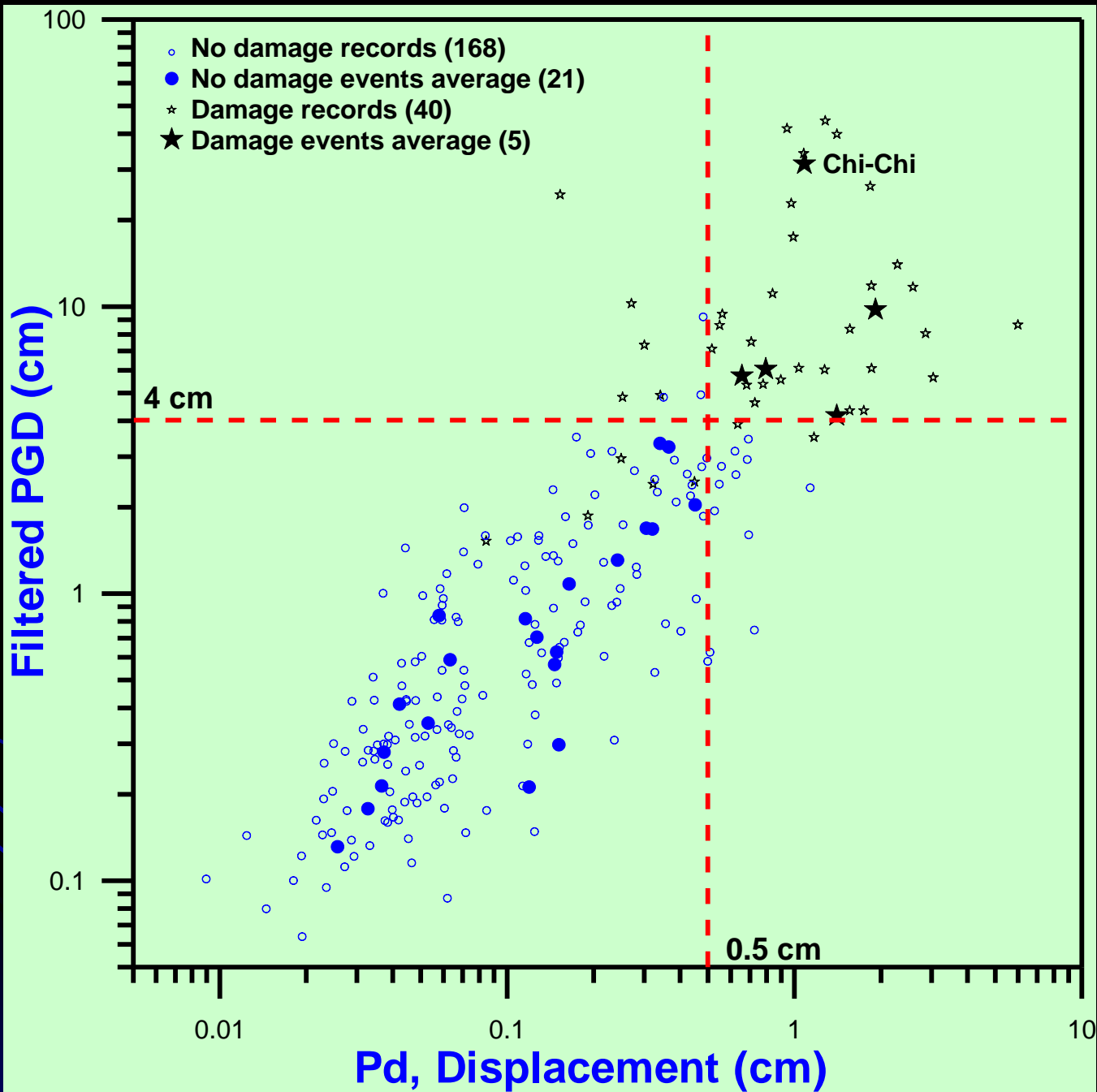
SDV of Error in  $M_w$  Determination

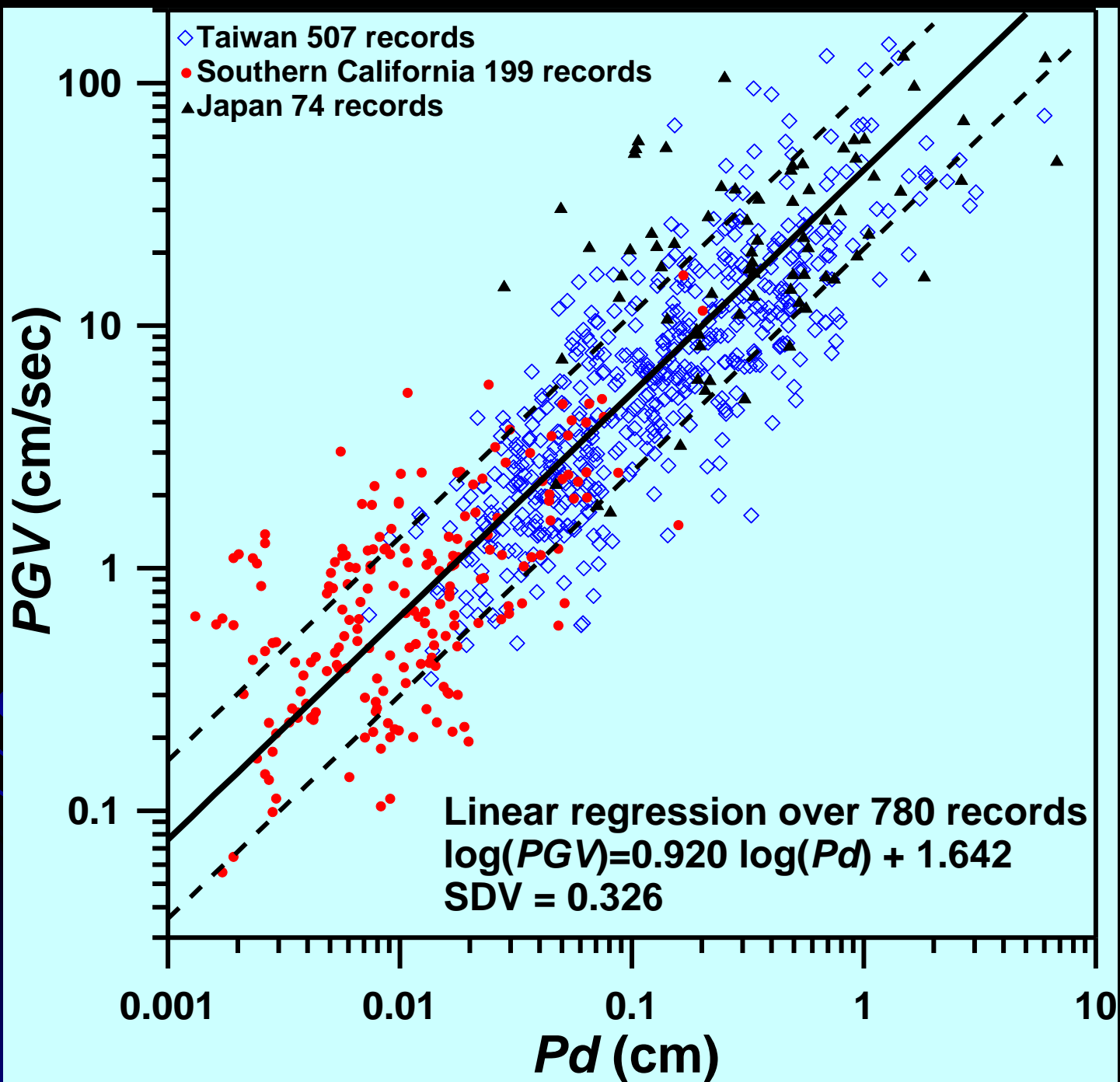


Std 0.27 for using both

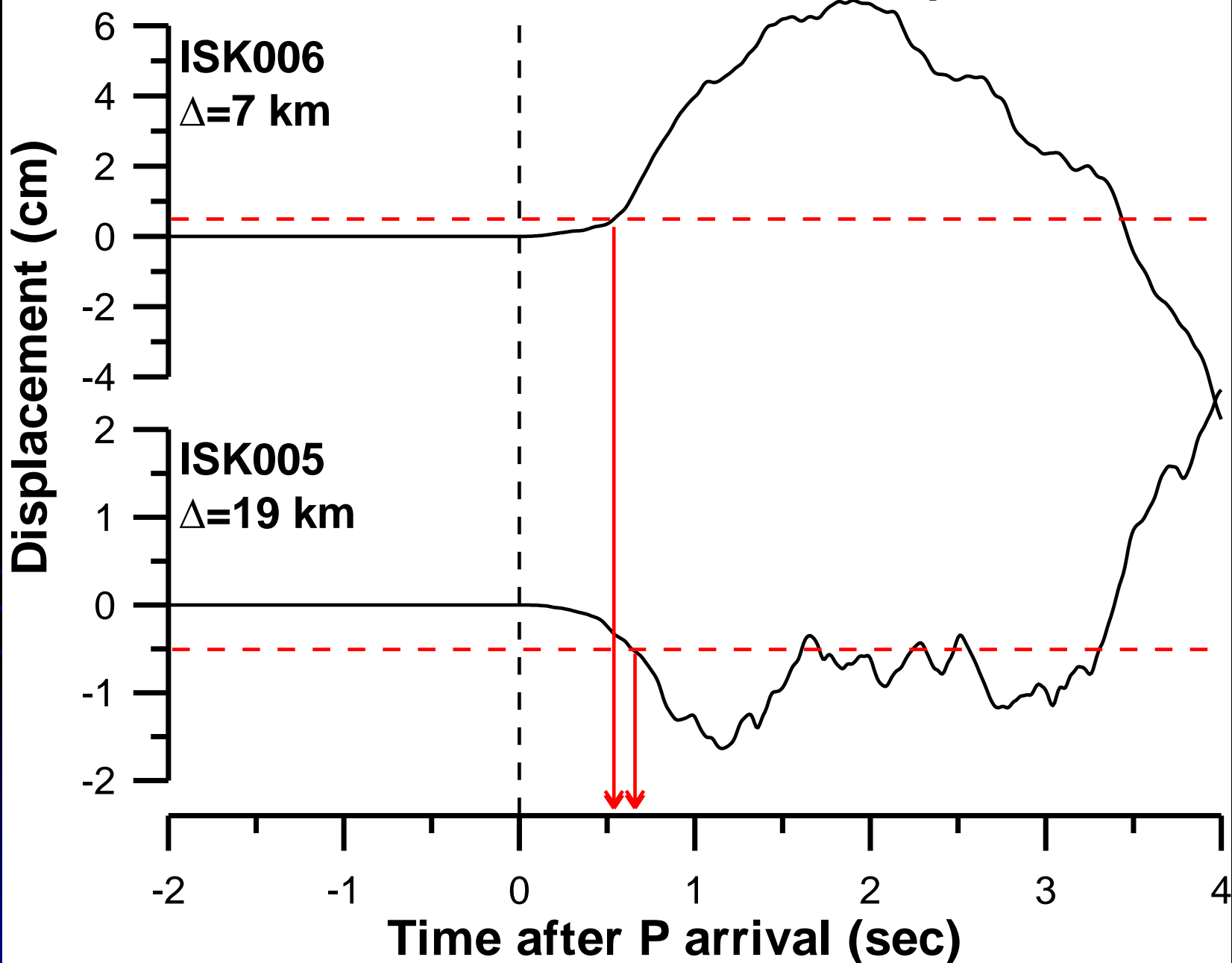
# Simple Pd for onsite EEW

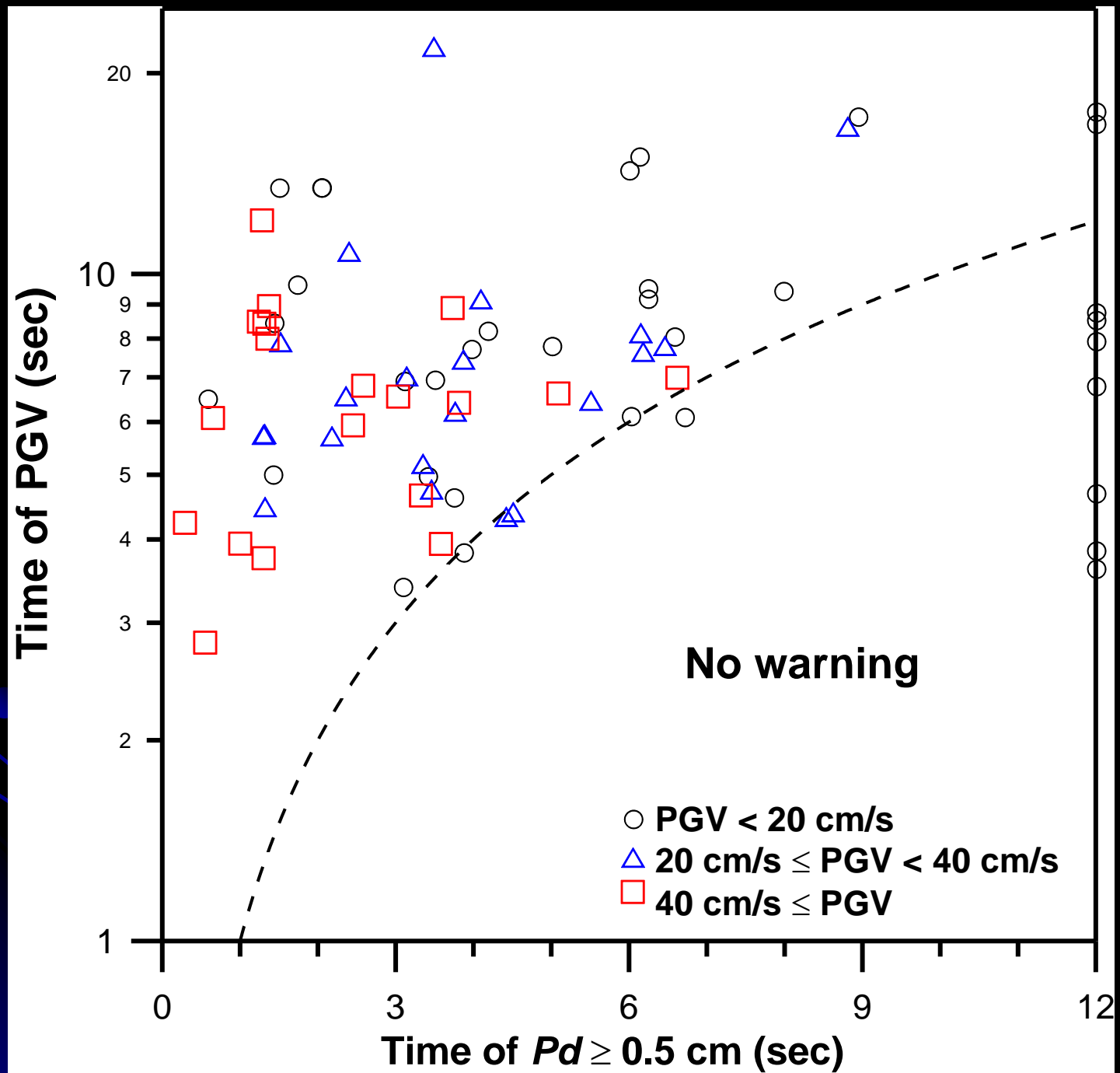






# 2007/03/25 Noto $M_w$ 6.7 earthquake



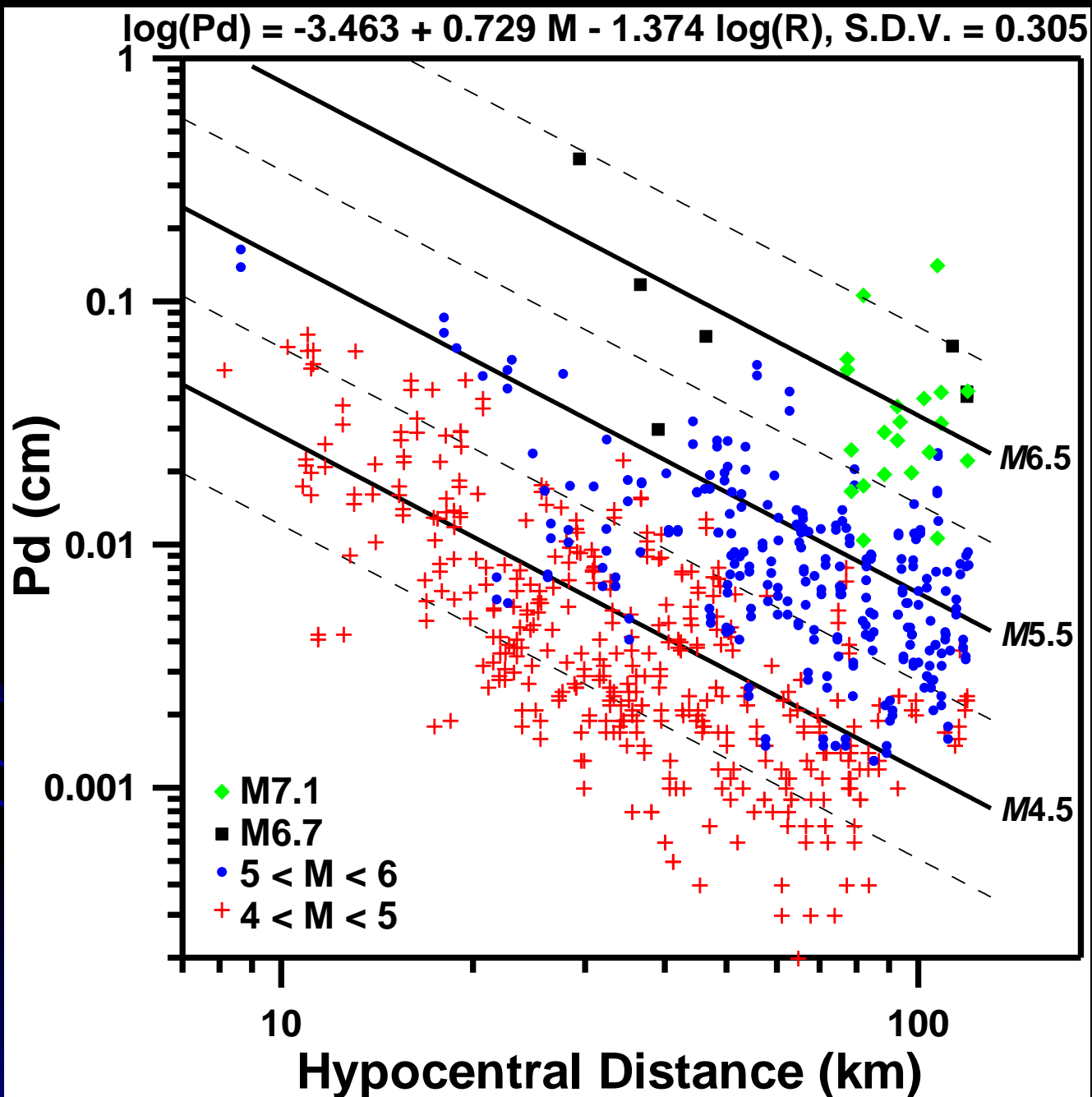


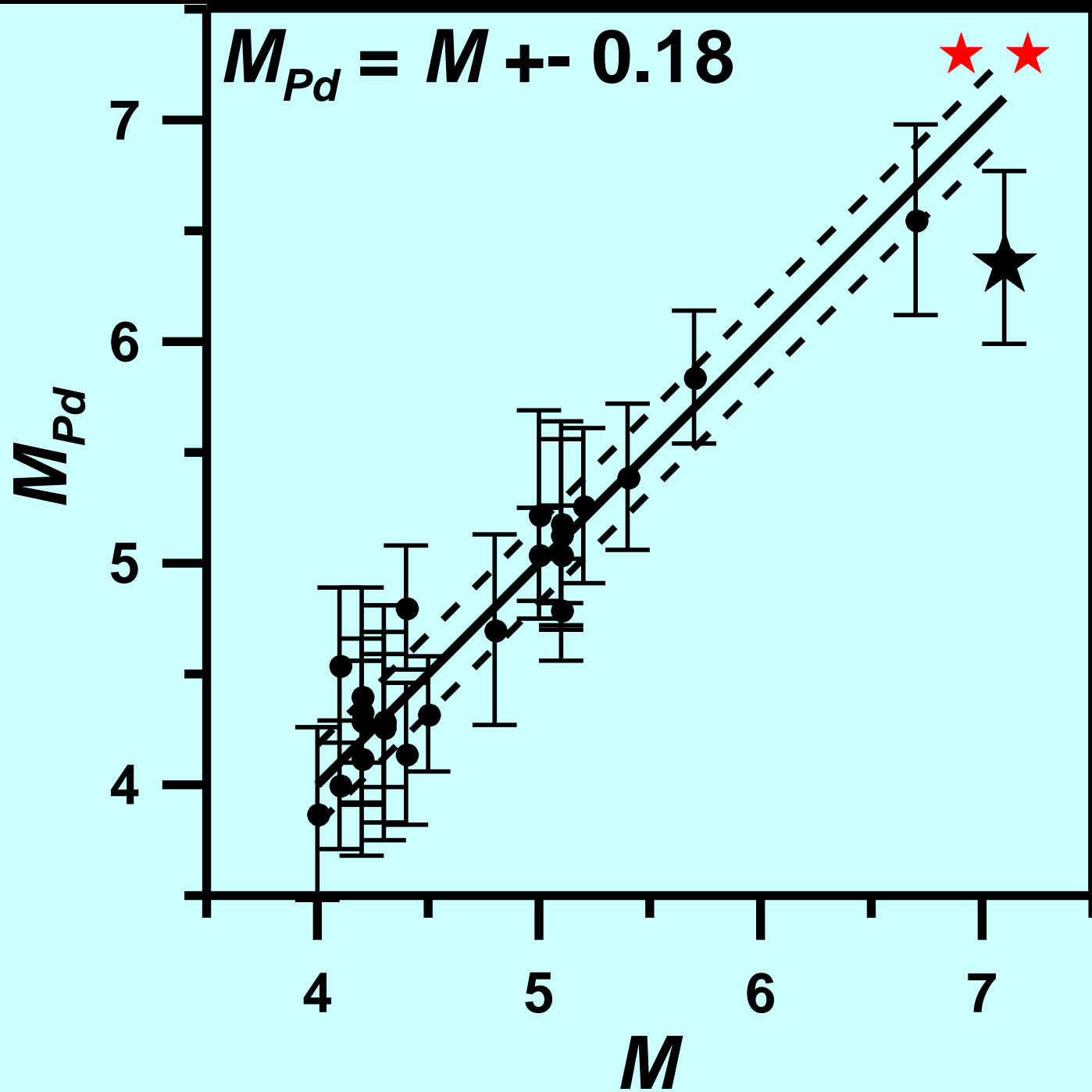


$P_d$  for regional EEW

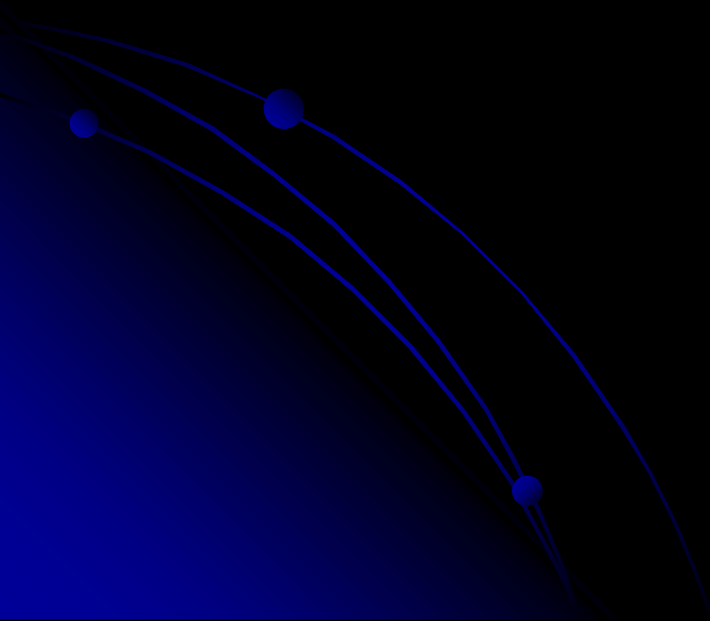


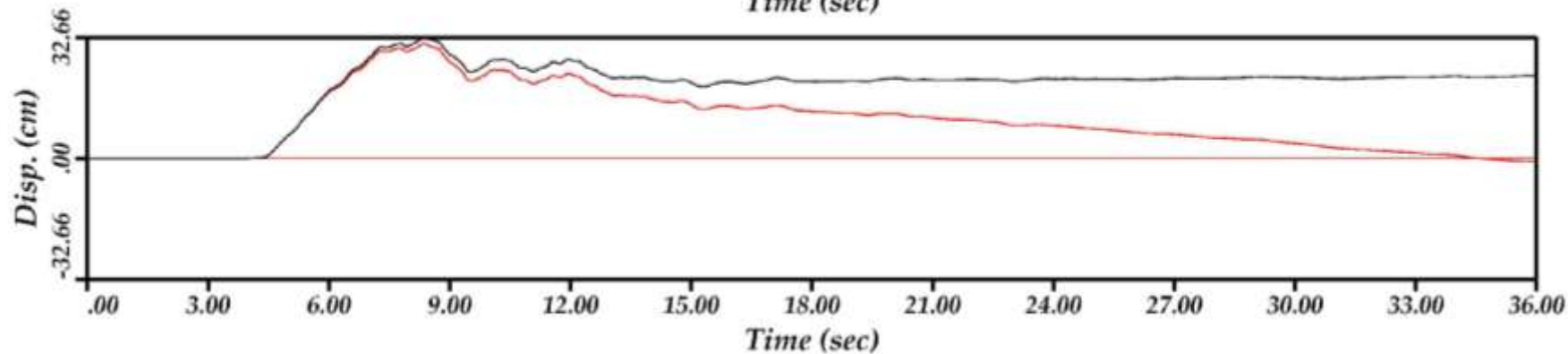
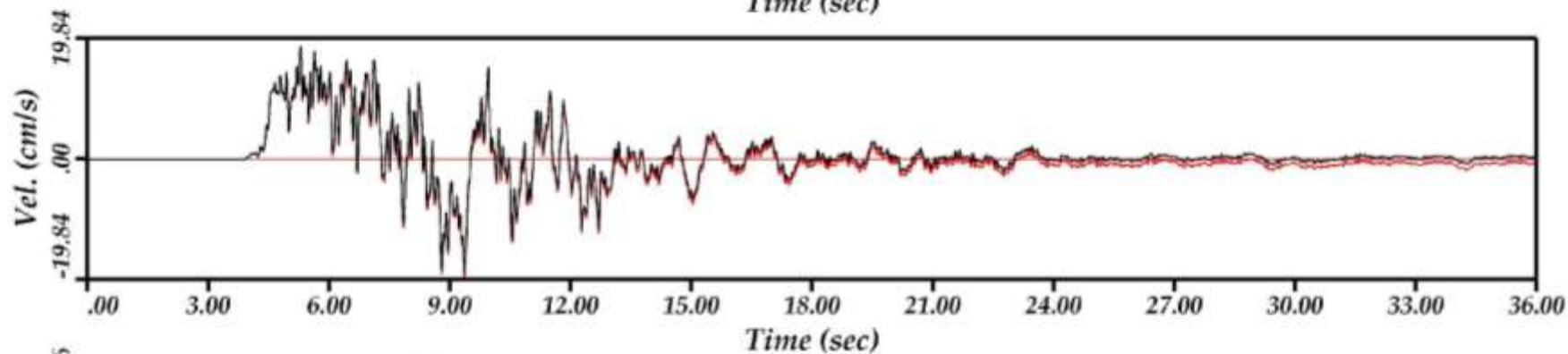
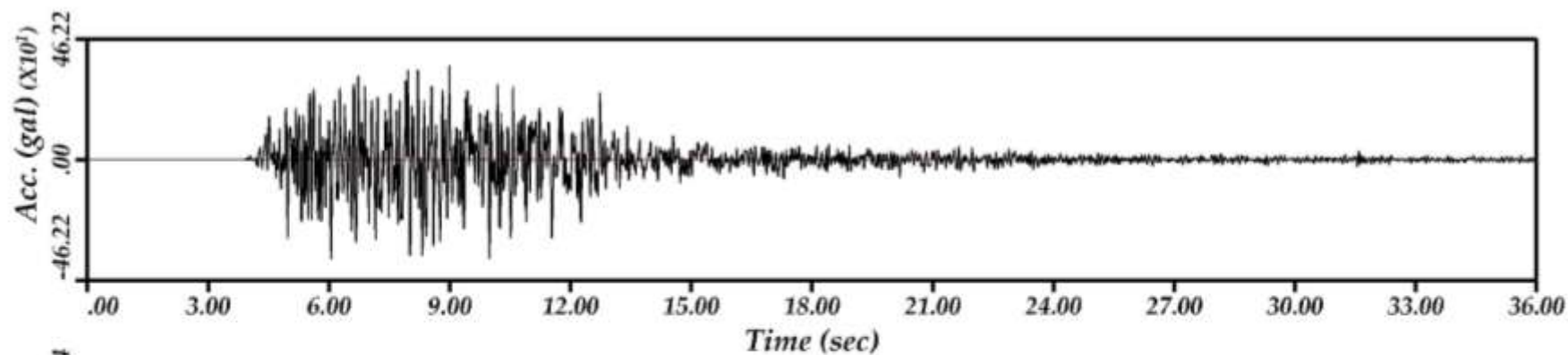
# Pd for magnitude determination



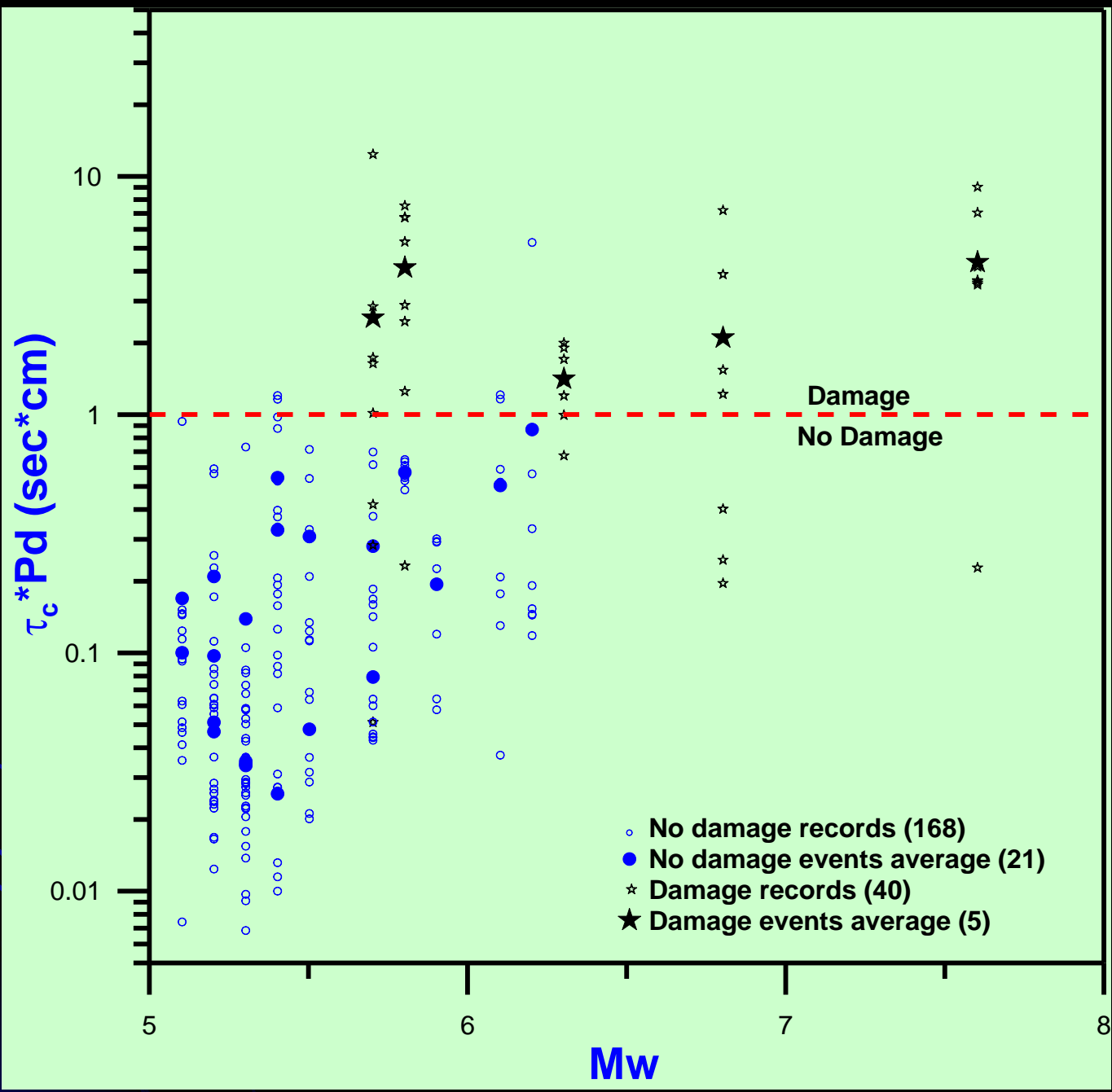


Near Source effect!

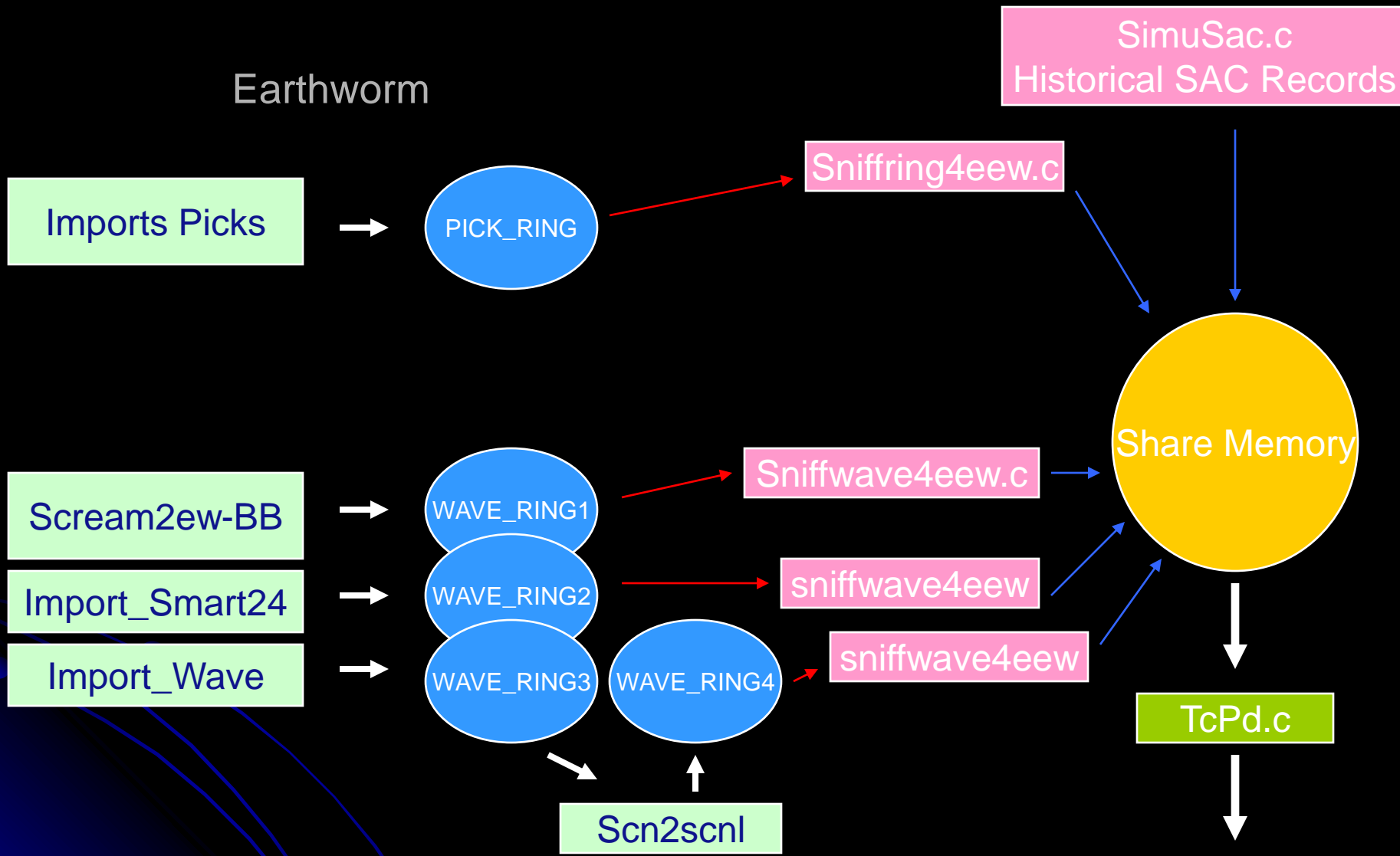




Filename=ISK0060703250942.UID, V Component Disp.= 21.79+- 1.11cm

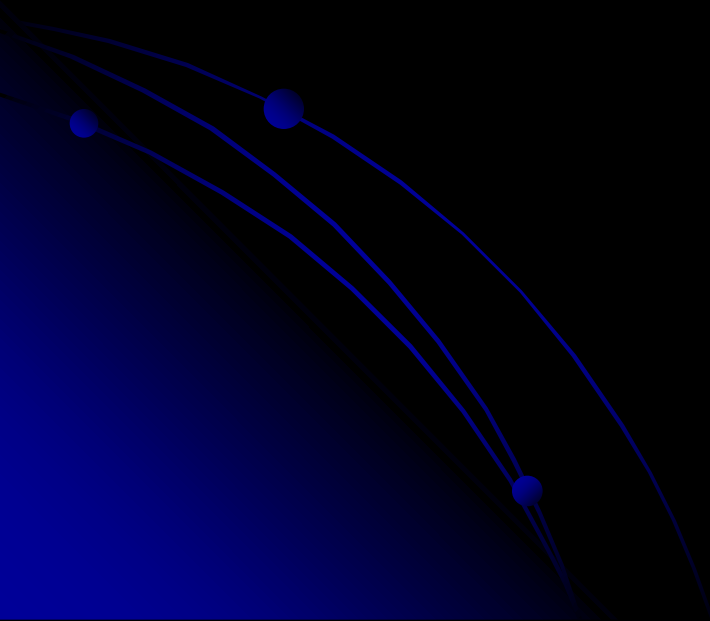


# Earthworm



Report 200808\_evts.txt

<b>Iwate earthquake</b>	<b>4 stations</b>	<b>7 stations</b>	<b>11 stations</b>
2008/06/14 08:43:45.36	<b>6.8 sec after</b>	<b>7.4 sec after</b>	<b>8.3 sec after</b>
Lat.=39.0298	38.9905	39.0804	39.0393
Long.=140.8807	140.8262	140.9413	140.8726
Depth =7.77 km	5.65 km	4.38 km	13.92km
JMA magnitude 7.2	Mpd=7.45	Mpd=7.10	Mpd=7.29
	Mtc=7.72	Mtc=7.53	Mtc=7.30





# Summary

- Parameters from initial three seconds P waves
  - Average period,  $\tau_c$  can be used for magnitude determination
  - $P_d$  can be used for predicting shaking intensity
  - $P_d$  and  $\tau_c$  can be used to identify damage event
  - 10 sec EEW is possible depends on telemetry, dense array in operation, and instrumentation.
  - Will be useful onsite type EEW system (structure control, chip manufacture, eyes surgical operation...)
  - This concept is testing in Taiwan, PWTC, and Kyoto Univ.

# Thanks to

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