



Seismic network and earthquake rapid report in Taiwan

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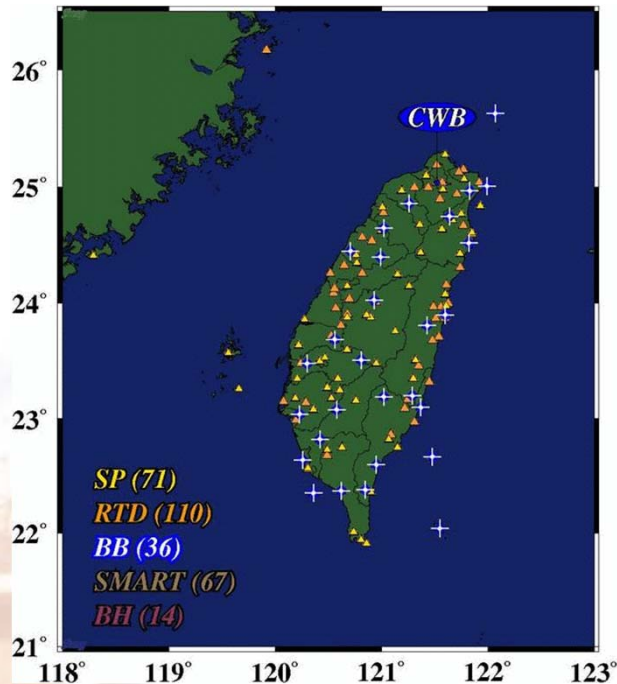
June 4, 2012

Seismic networks in operation



CWBSN

Central Weather Bureau
Seismic Network

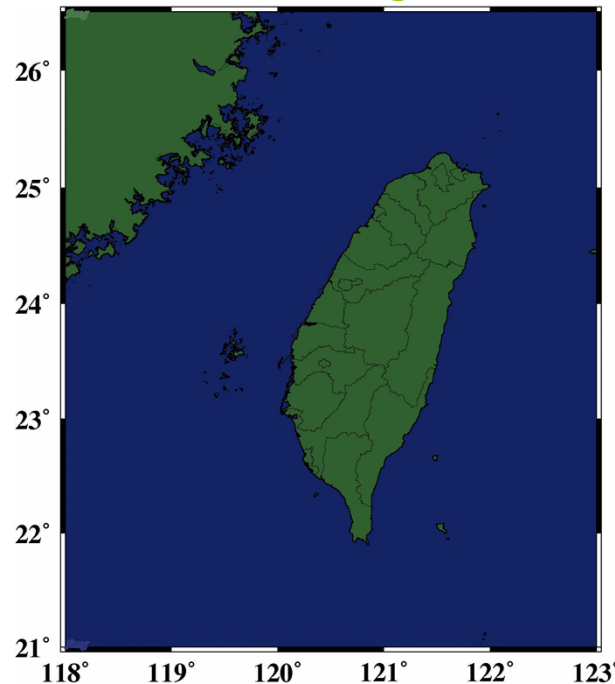


Tasks:

- ◆ Earthquake catalog
- ◆ Earthquake rapid notification and early warning
- ◆ Tsunami warning
- ◆ Seismological related research

TSMIP

Taiwan Strong Motion
Instrumentation Program network

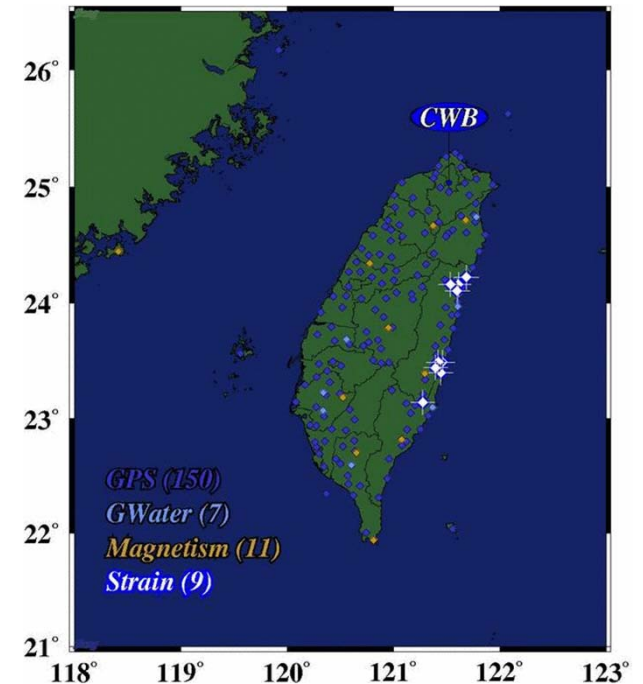


Tasks:

- ◆ Strong-motion database
- ◆ Strong-motion seismology research
- ◆ Earthquake engineering application

TGNS

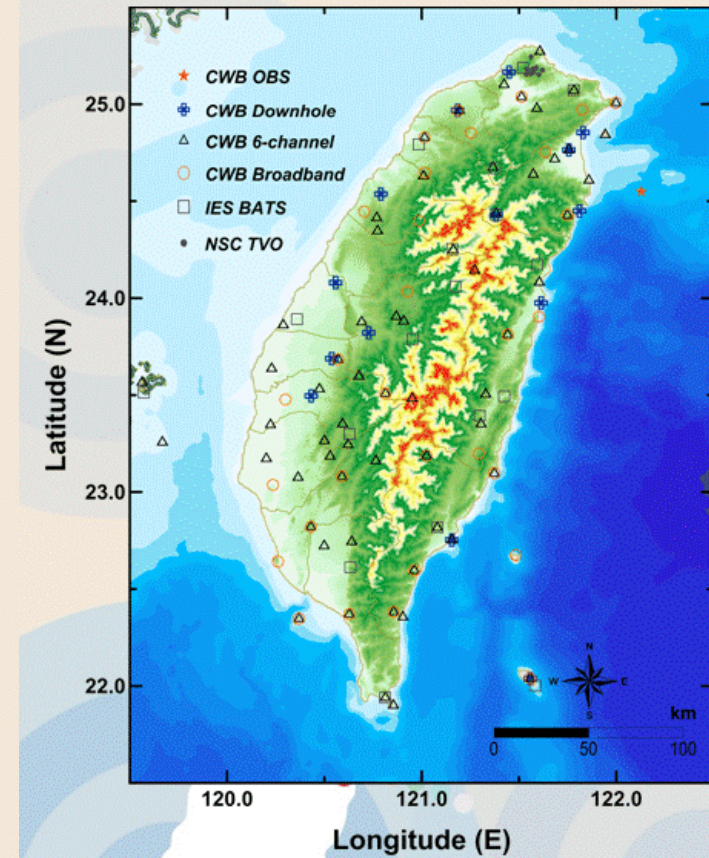
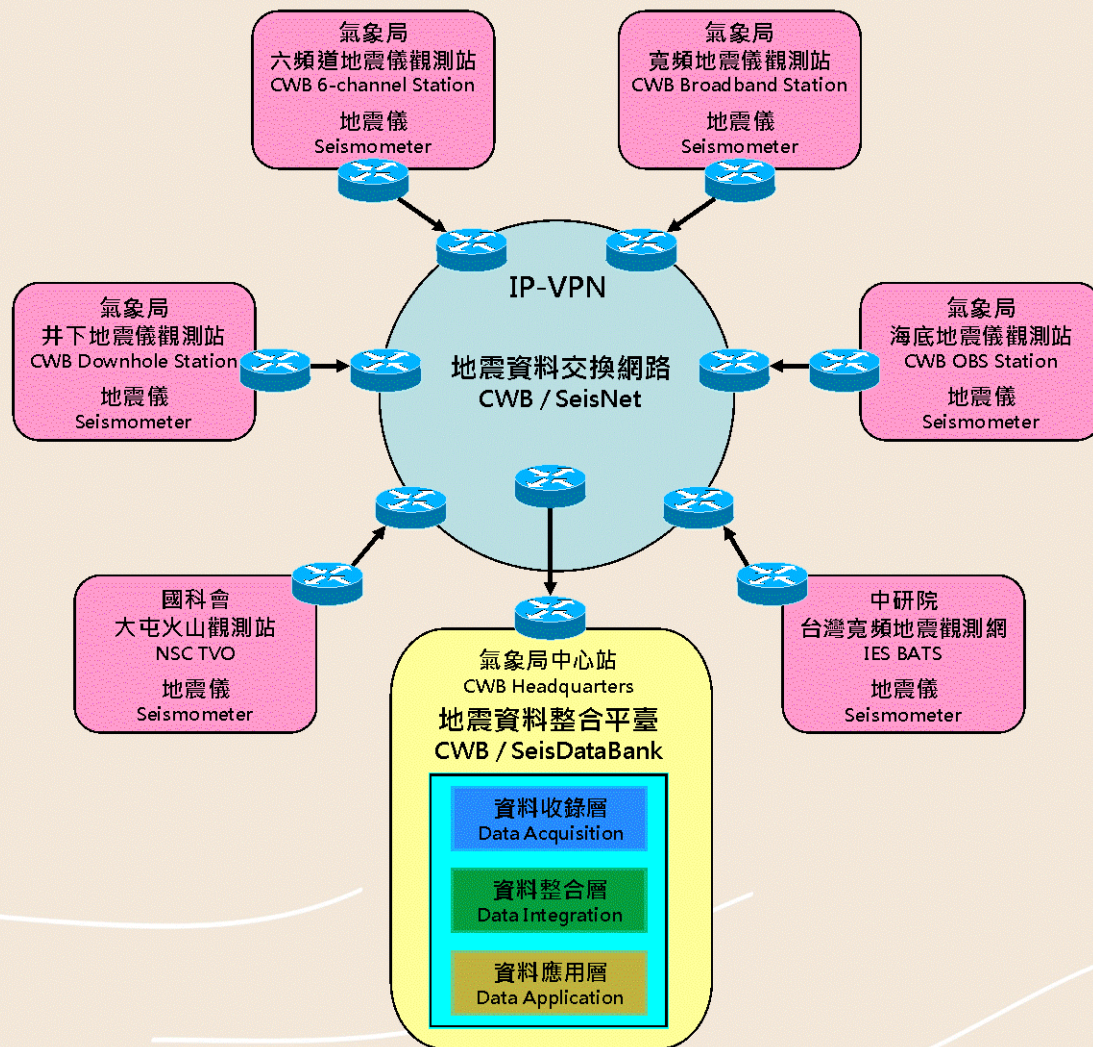
Taiwan Geophysical Network
for Seismology



Tasks:

- ◆ Geophysical database
- ◆ Earthquake precursor study
- ◆ Crustal deformation and active fault monitoring

CWBSN framework

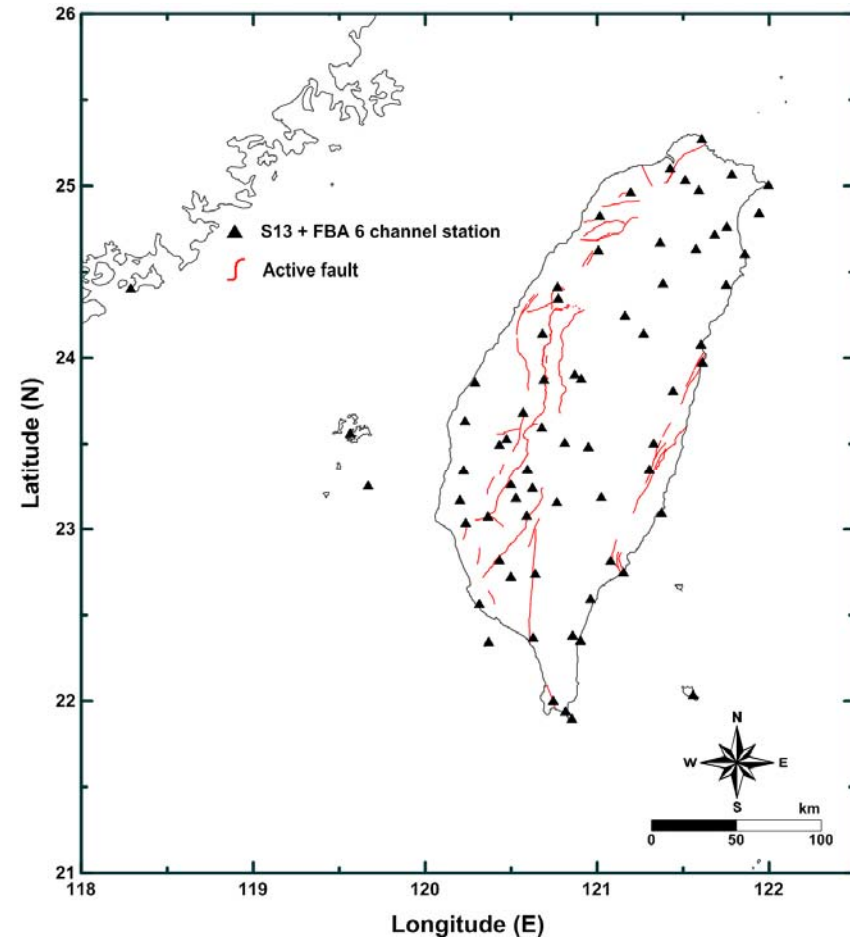


137stations totally



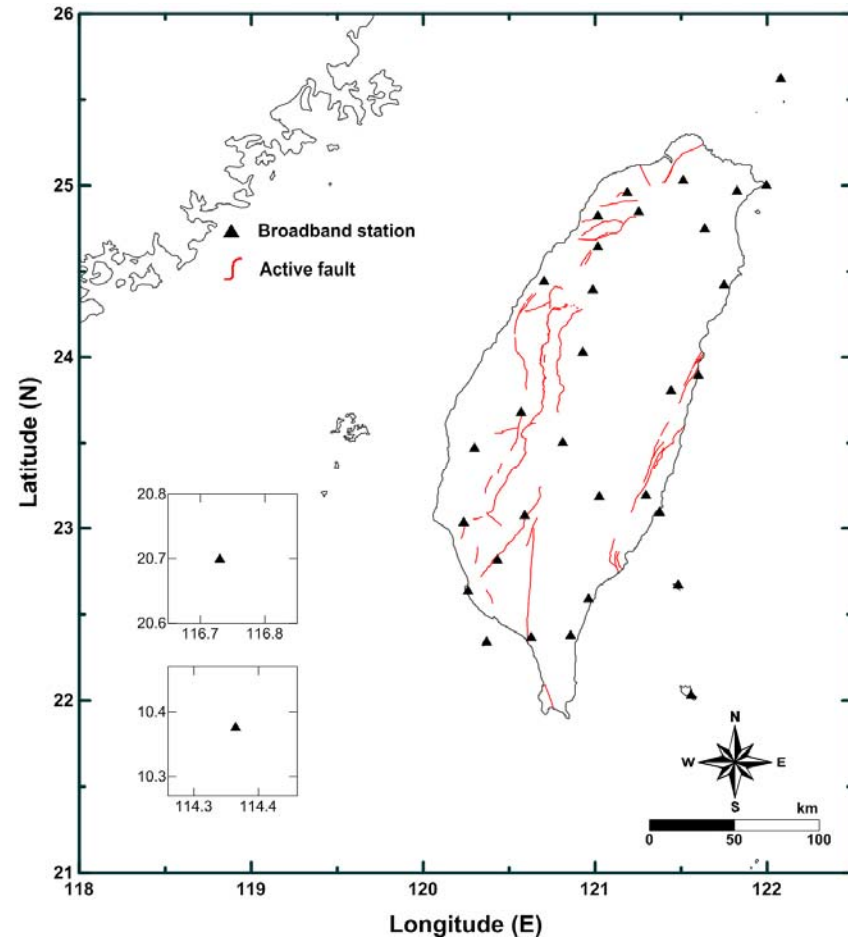
6-channel station

- ◆ Integrate and upgrade all of Taiwan's short-period stations in 1991. Add strong-motion seismometers in stations in 1995.
- ◆ The main seismic stations for earthquake observation in Taiwan for the past 20 years.
- ◆ Totally upgrade the resolution to 24 bits in 2012.
- ◆ 69 stations established.



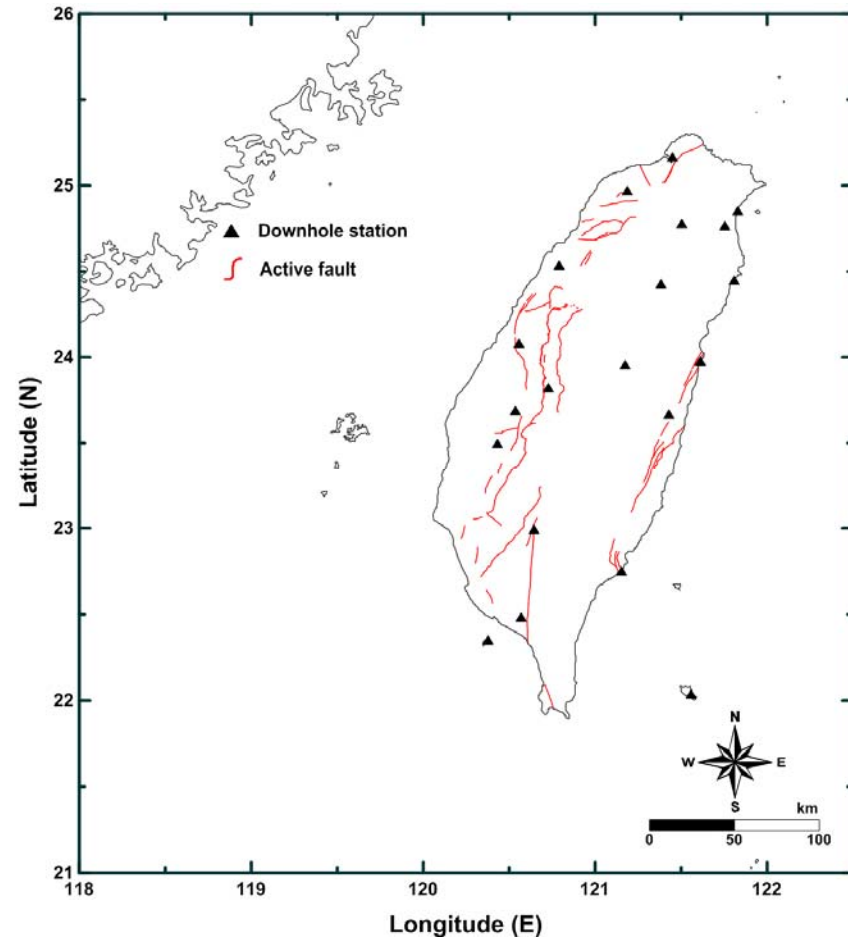
Broadband station

- ◆ Start to build the stations and install broadband seismometers in 2001.
- ◆ High quality and resolution data are acquired for seismological related research.
- ◆ 33 stations established.

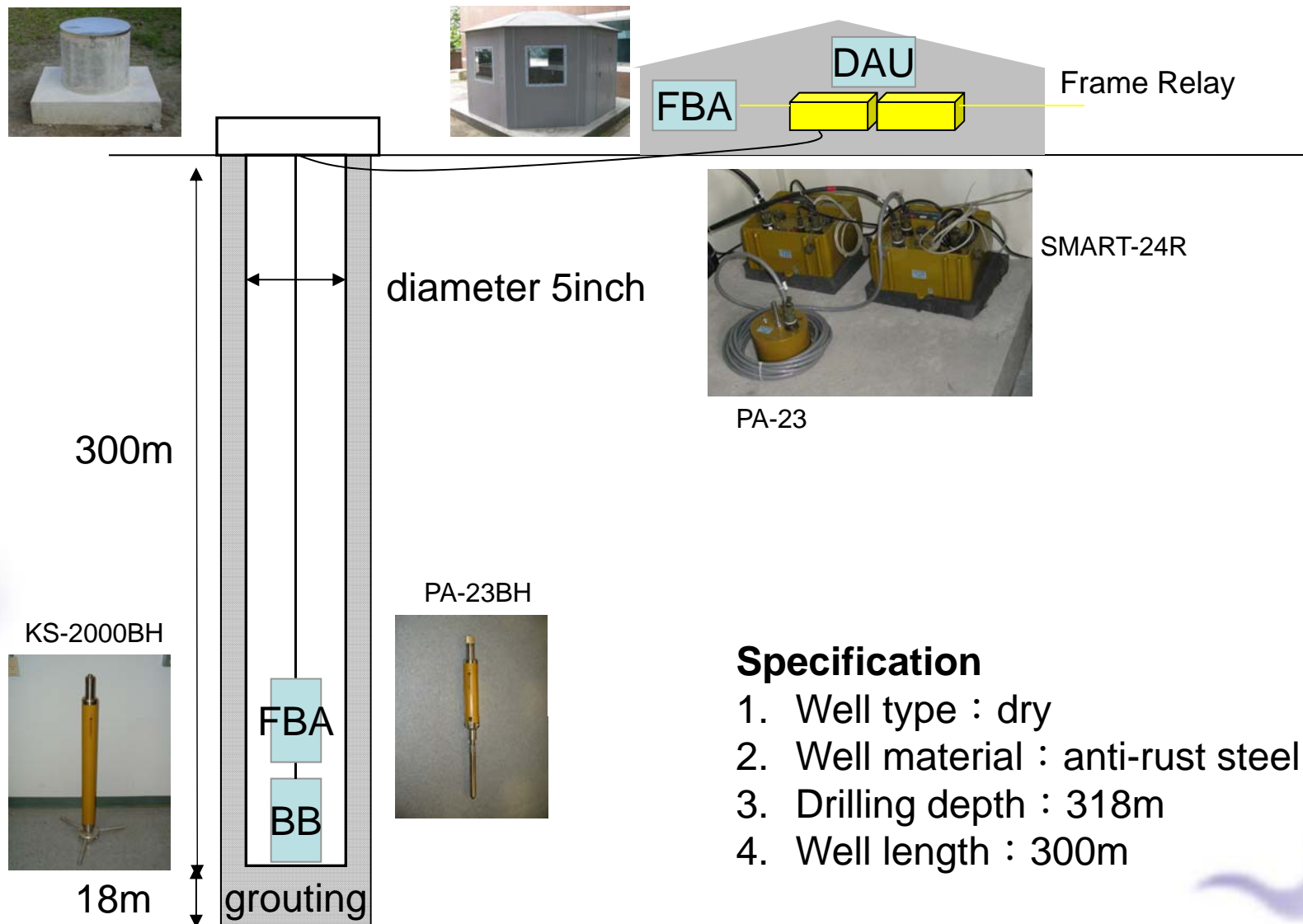


Downhole station

- ◆ Start to build the stations in 2007 in order to establish the next generation of seismic station in Taiwan.
- ◆ Borehole depth is set to 300 meter.
- ◆ 3 seismometers are installed in a station, include 1 borehole broadband sensor, 1 borehole FBA sensor, and 1 surface FBA sensor.
- ◆ 20 stations established, and plan to build 70 stations totally for the next few years.



Downhole station framework

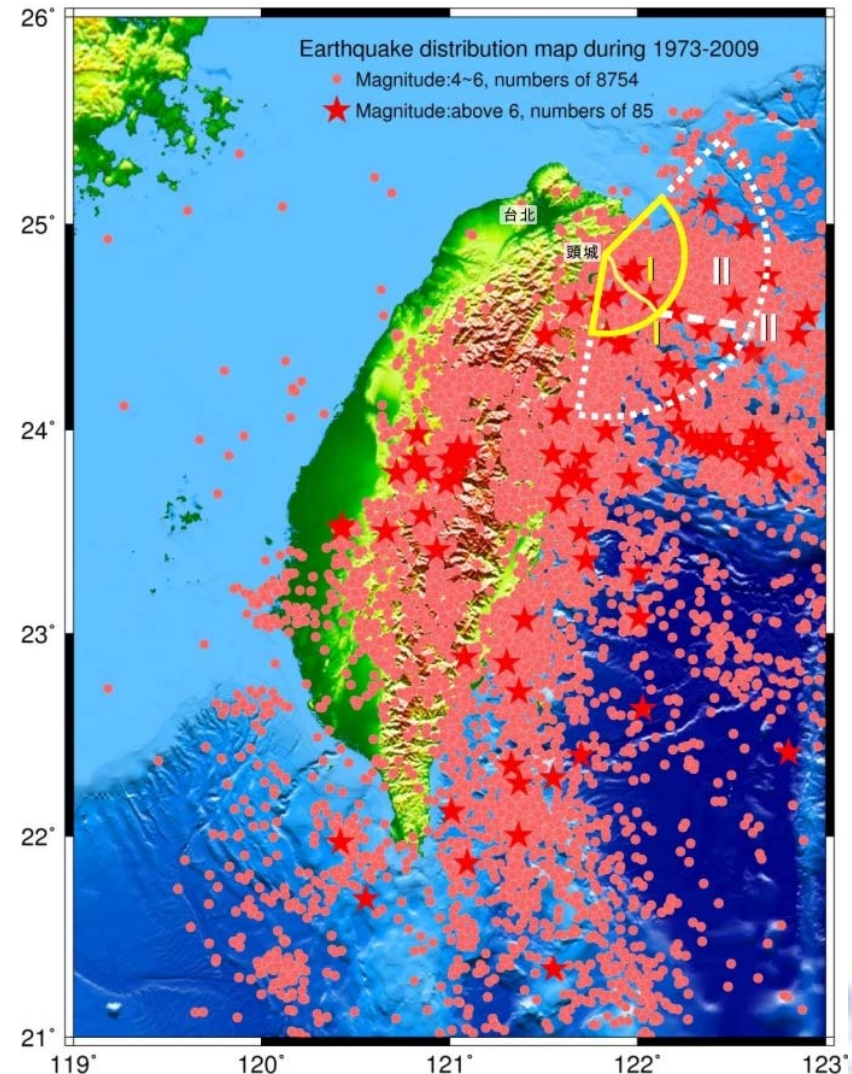


Specification

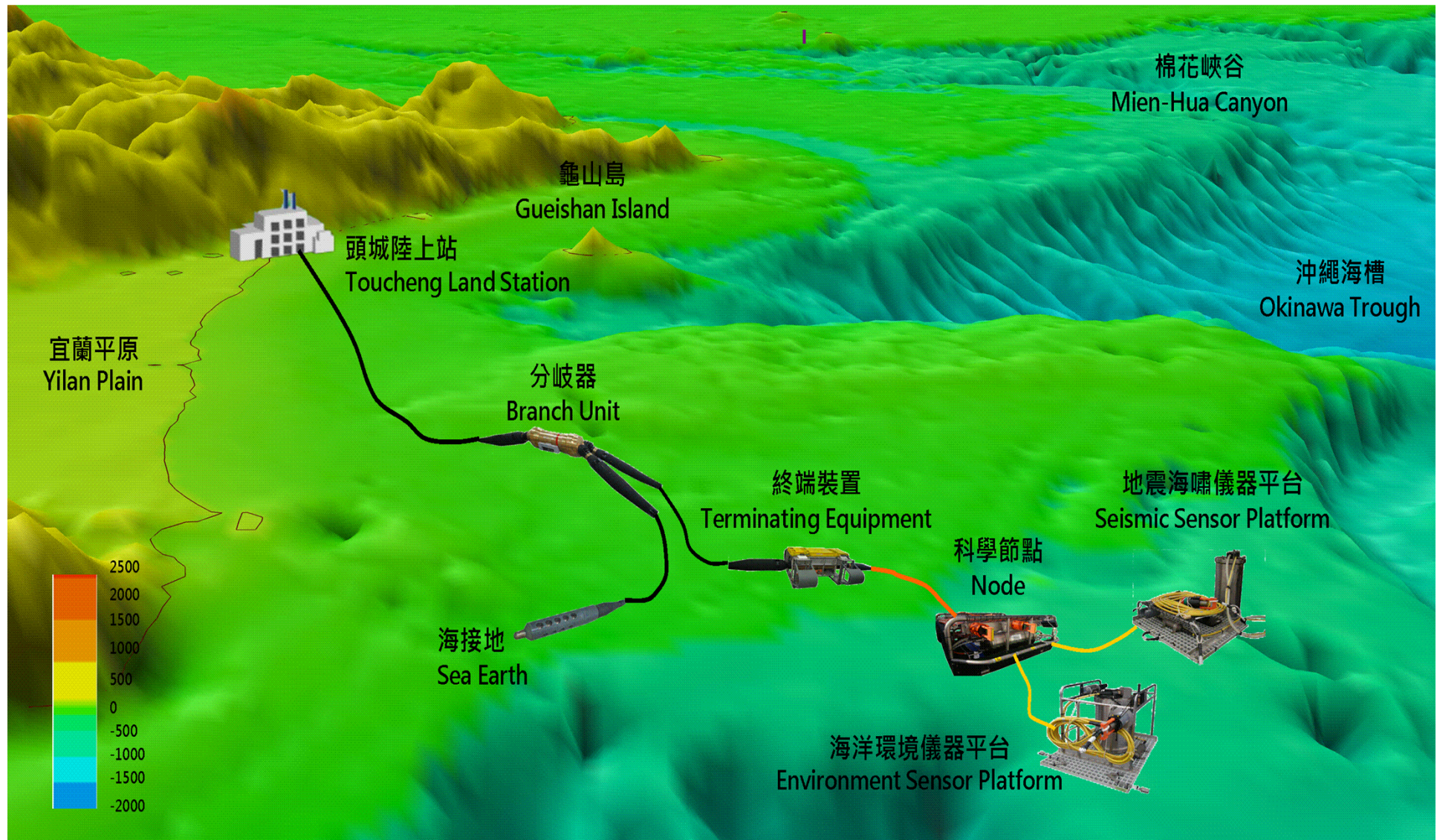
1. Well type : dry
2. Well material : anti-rust steel
3. Drilling depth : 318m
4. Well length : 300m

OBS station

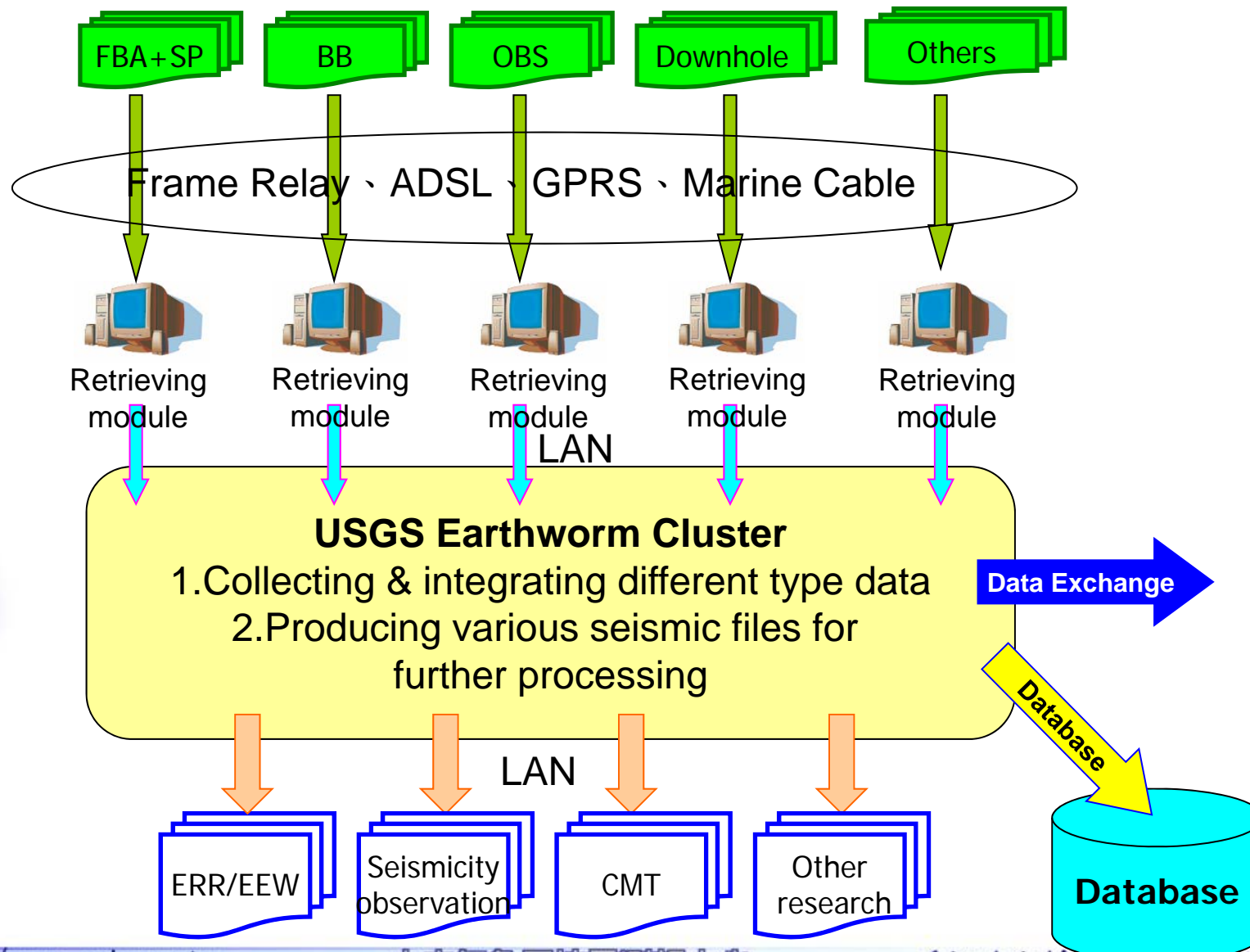
- ◆ 1 cable based OBS station is constructed off northeastern Taiwan in 2011 to improve the capabilities of earthquake monitoring.
- ◆ Cable laid from Toucheng, Yilan county. The cable length is about 45 km, and the water depth of station is about 300 meter.
- ◆ 1 broadband sensor and 1 FBA sensor are installed.
- ◆ Plan to extend the cable length and add more OBS in the future.



OBS system framework

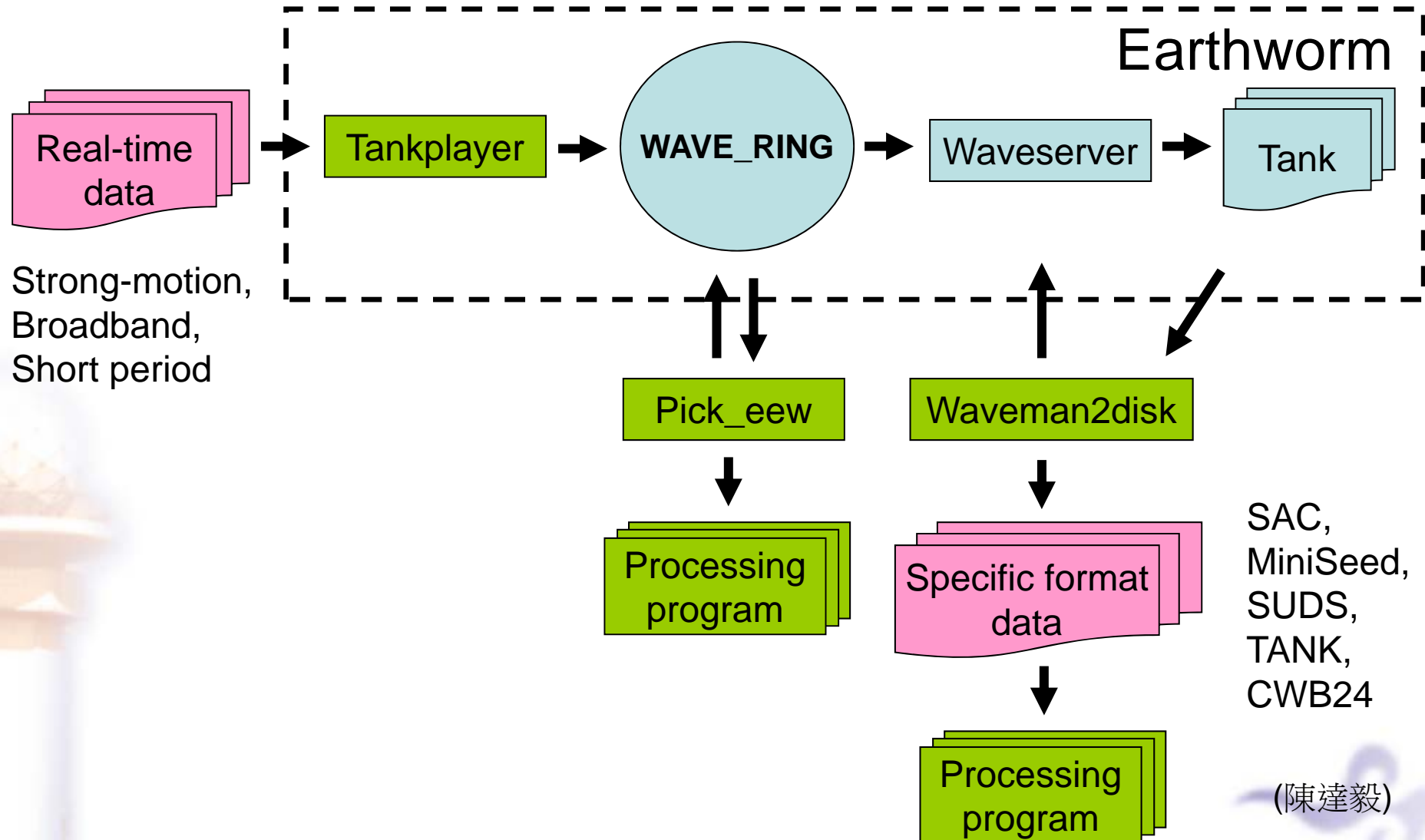


Integrated data processing platform





Real-time data integration



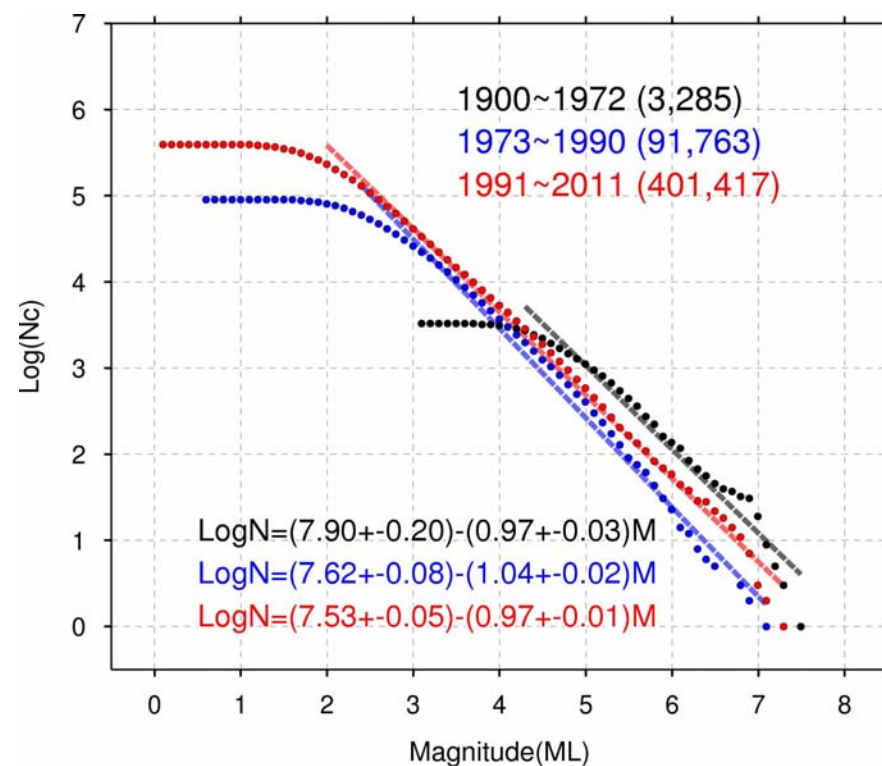
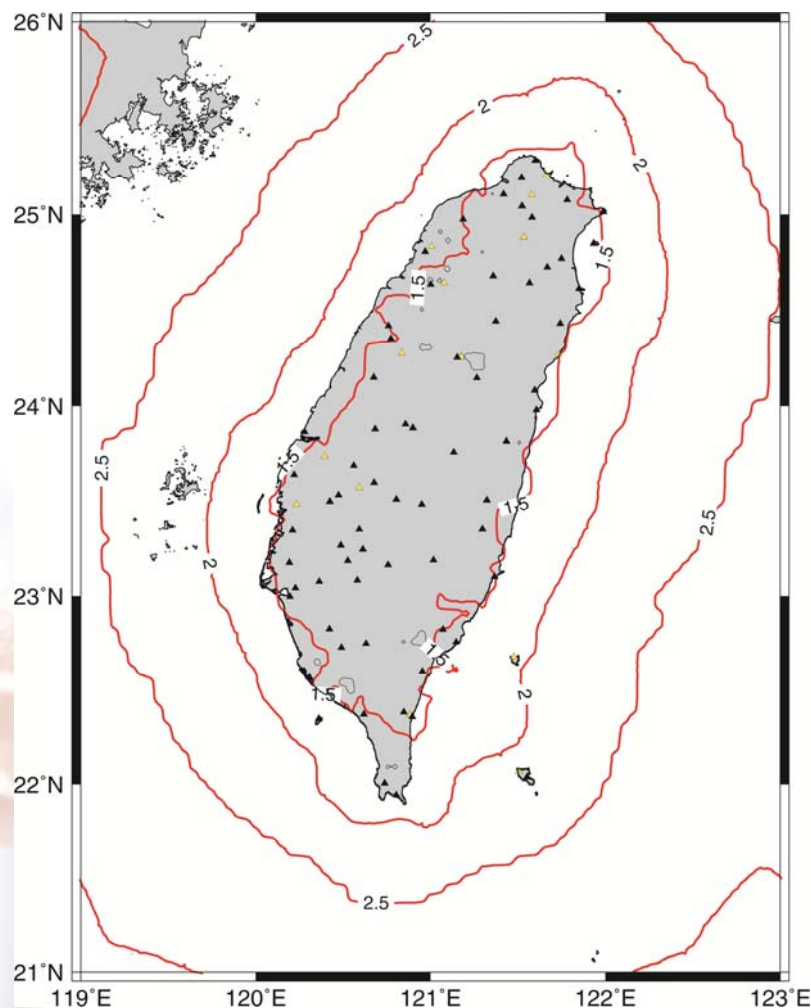


Main tasks in operation

- Earthquake catalog publish
- Earthquake rapid reporting
- Earthquake early warning

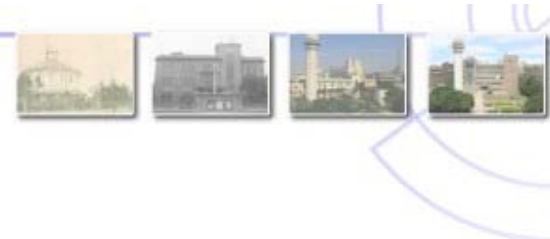


Magnitude of completeness



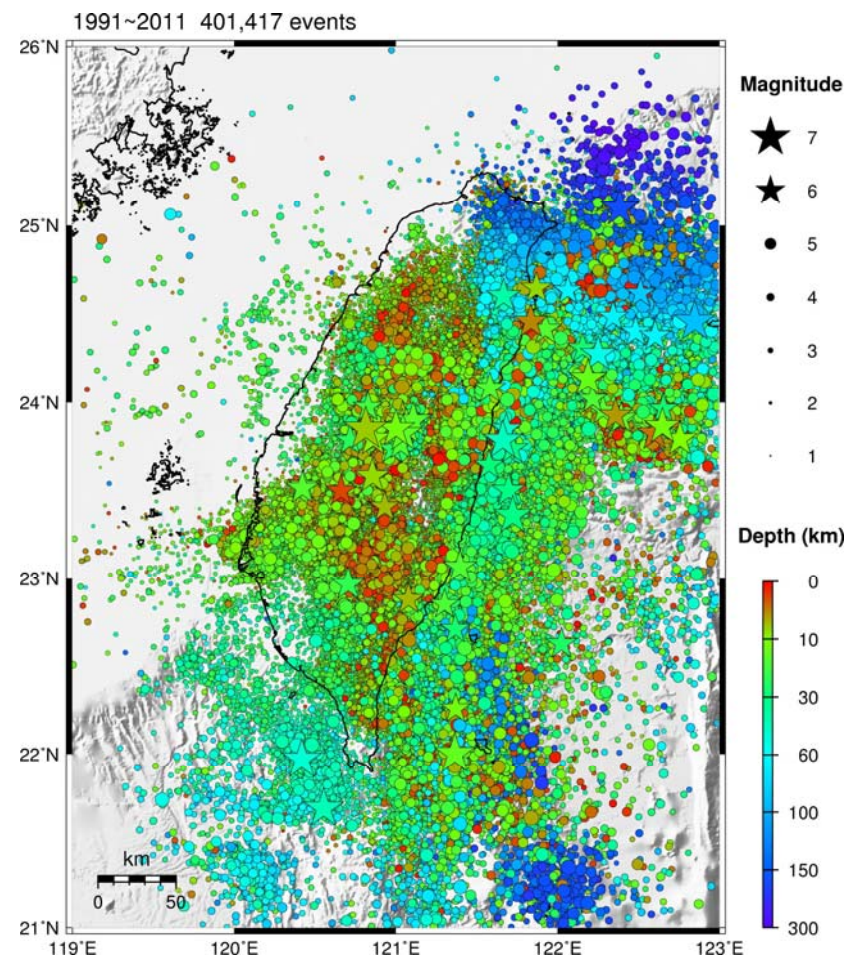
Frequency-Magnitude distribution

(張建興)



Taiwan earthquake catalog

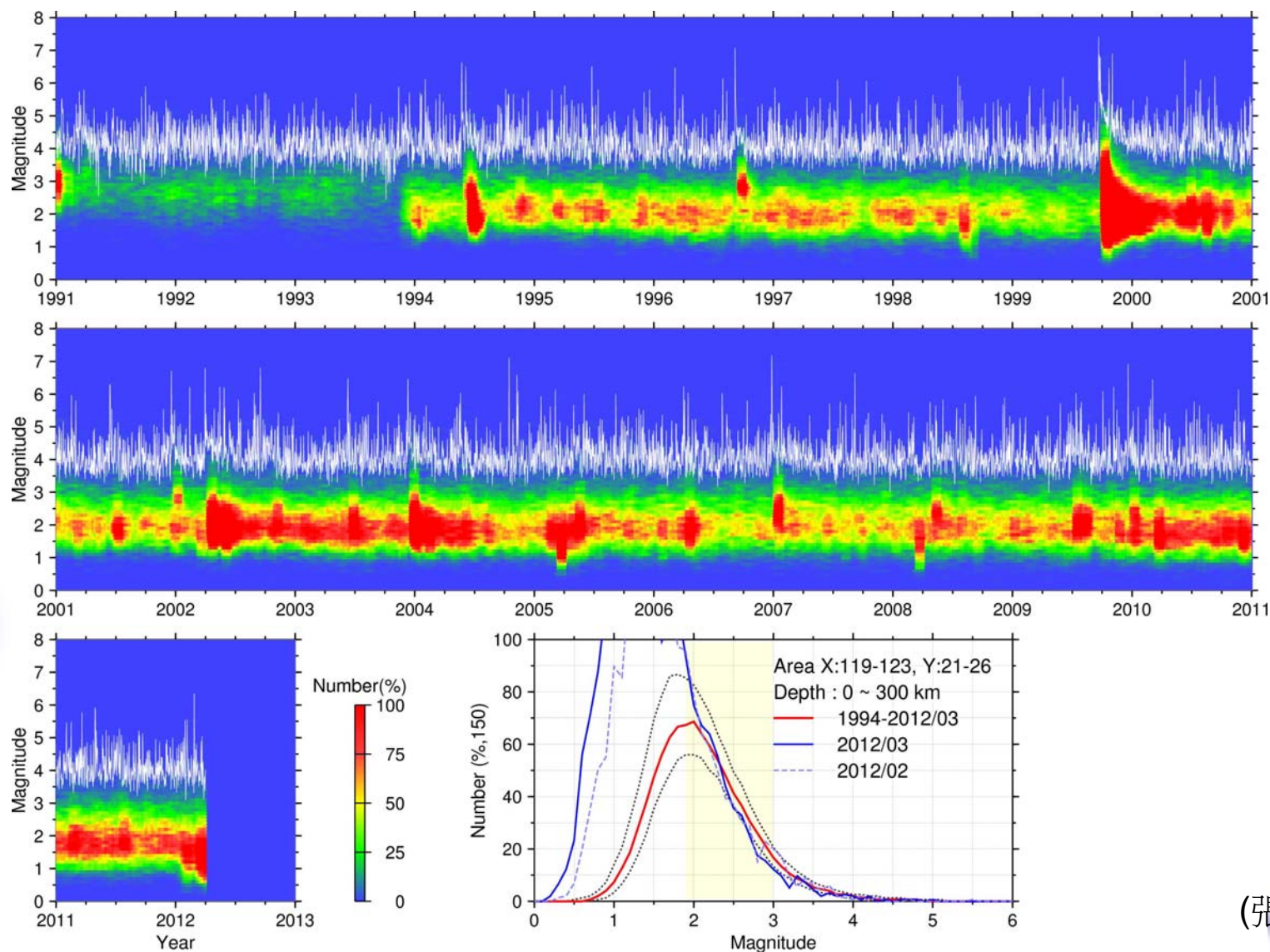
Year	Events No.	P arrivals	S arrivals	Polarity No.
1991	4,933	63,157	30,970	27,422
1992	4,520	68,506	31,070	18,208
1993	5,446	79,527	47,576	18,425
1994	17,961	192,383	104,225	26,706
1995	14,802	175,651	99,449	25,312
1996	16,977	185,054	113,905	26,030
1997	15,649	169,447	118,730	22,215
1998	14,981	161,639	118,532	25,967
1999	49,928	505,205	416,231	57,158
2000	24,322	285,274	226,274	34,617
2001	16,244	190,932	150,666	20,681
2002	28,097	321,470	264,770	27,800
2003	25,450	298,656	231,963	34,605
2004	21,783	248,736	196,195	28,951
2005	22,093	246,968	199,986	30,189
2006	18,059	239,893	192,543	23,264
2007	16,422	227,420	179,663	21,343
2008	18,388	237,813	190,235	23,862
2009	20,359	265,019	207,240	28,057
2010	23,207	277,067	238,736	27,170
2011	21,796	251,787	223,648	26,791
Totally	401,417	4,691,604	3,582,607	574,773



(張建興)



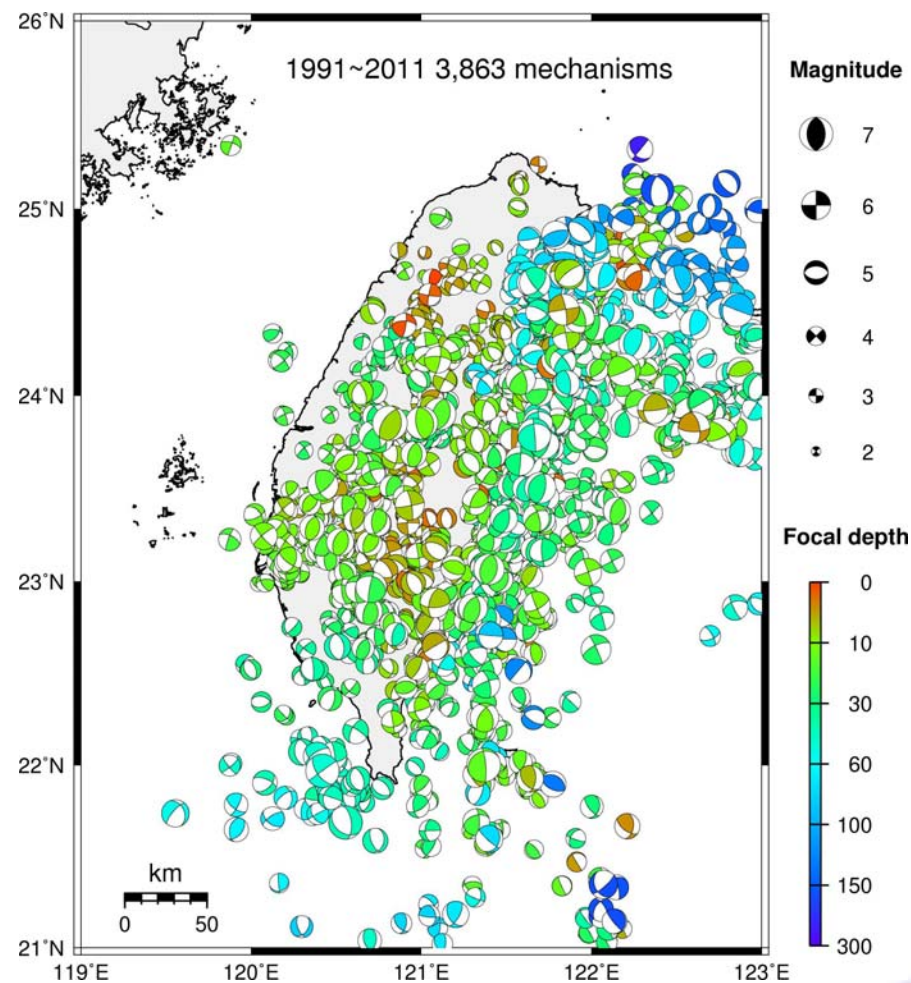
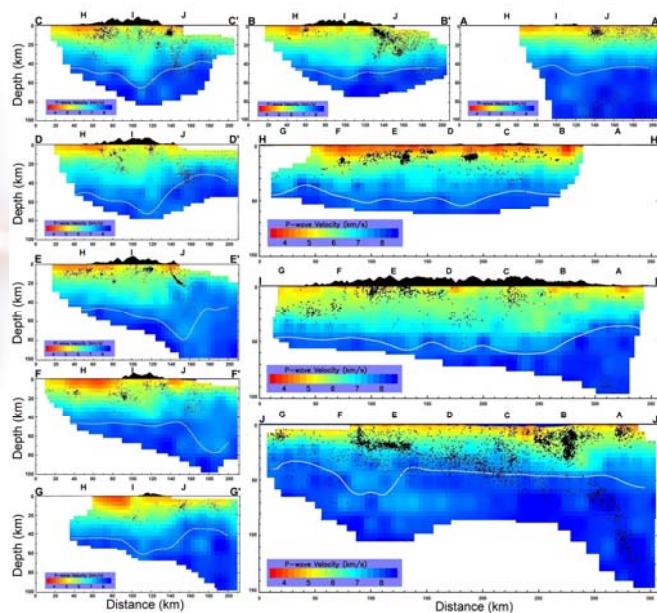
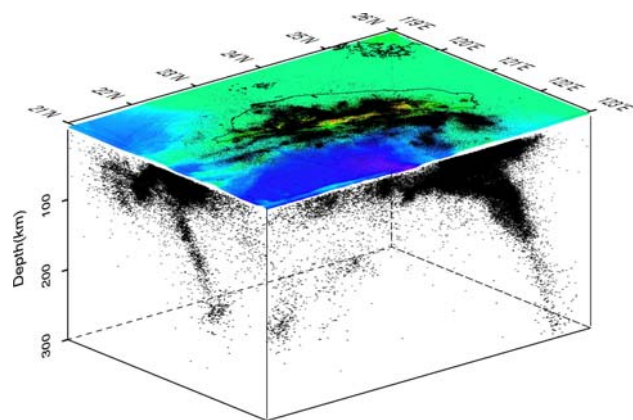
Seismicity observation



(張建興)



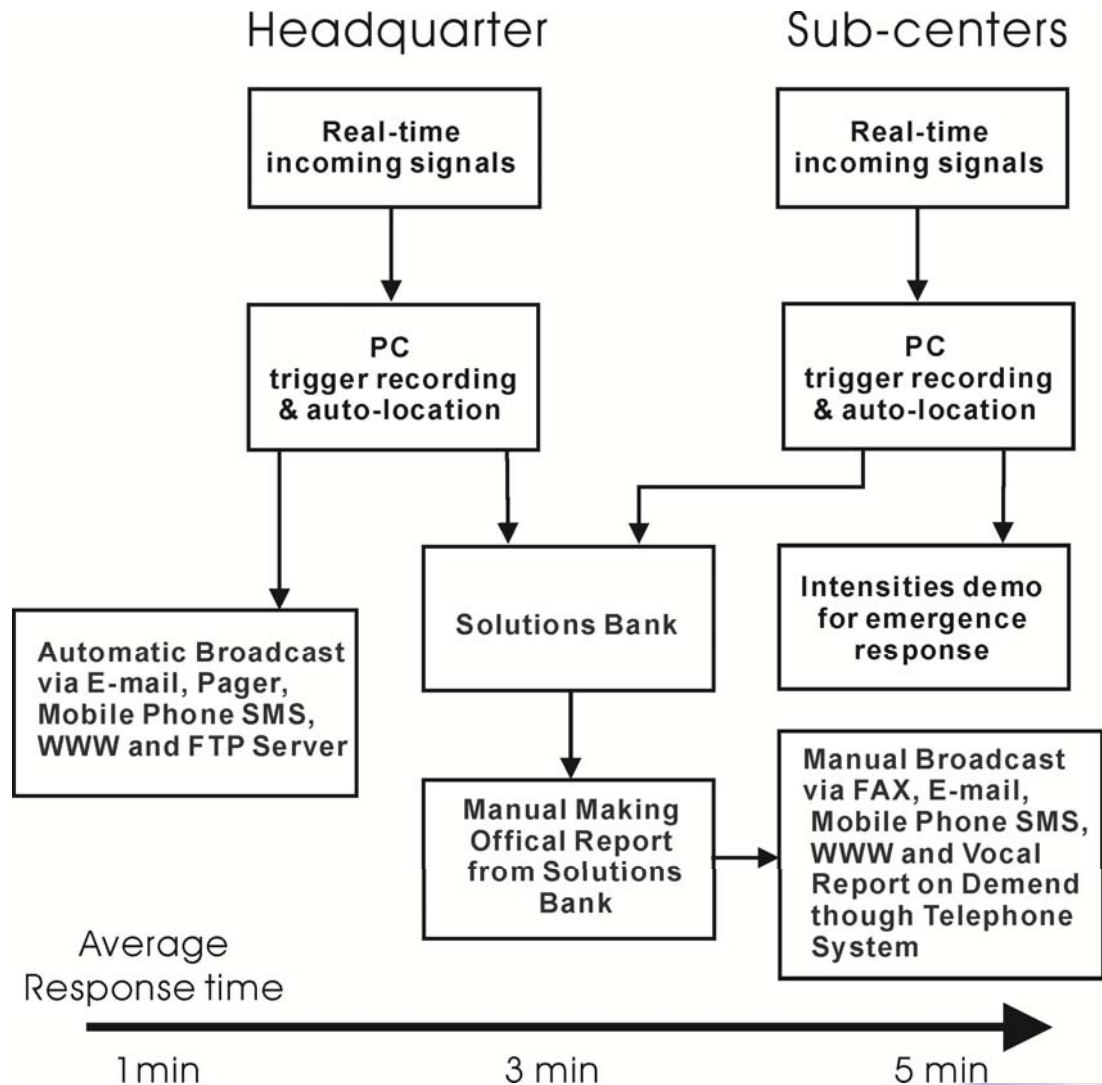
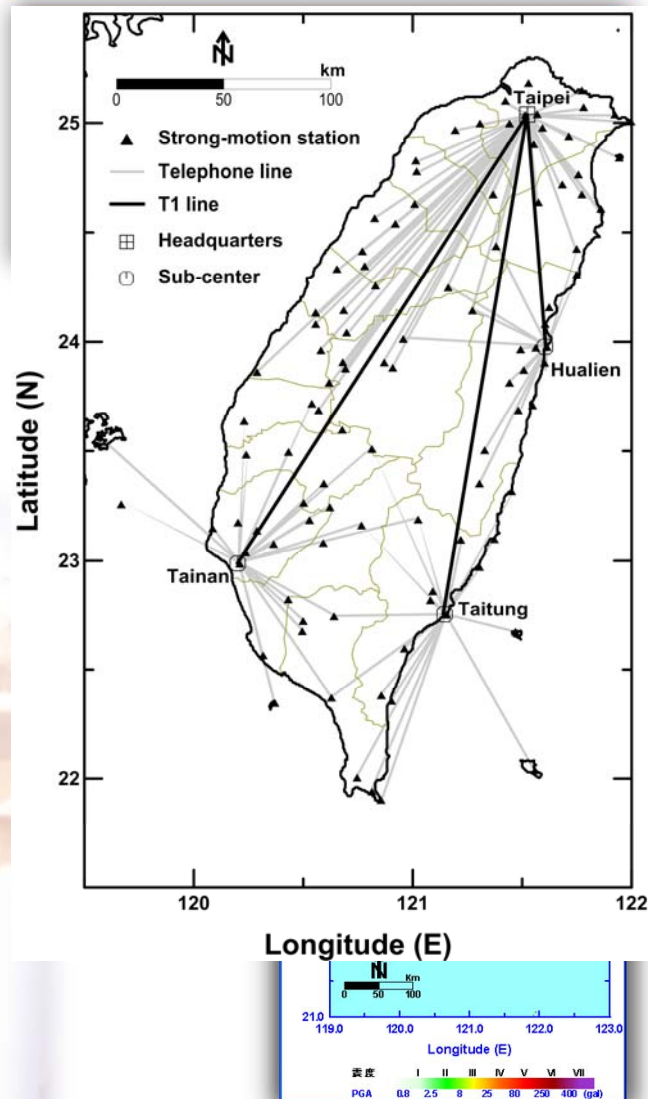
Seismogenic structure study



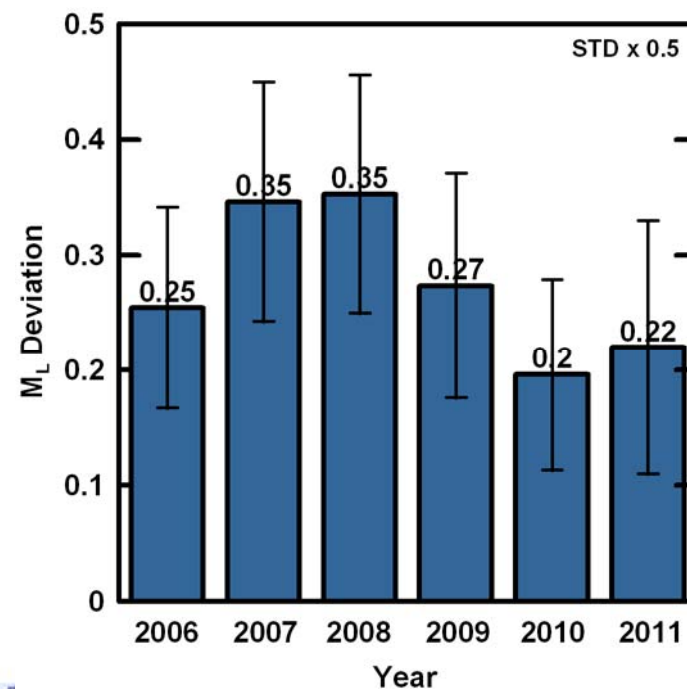
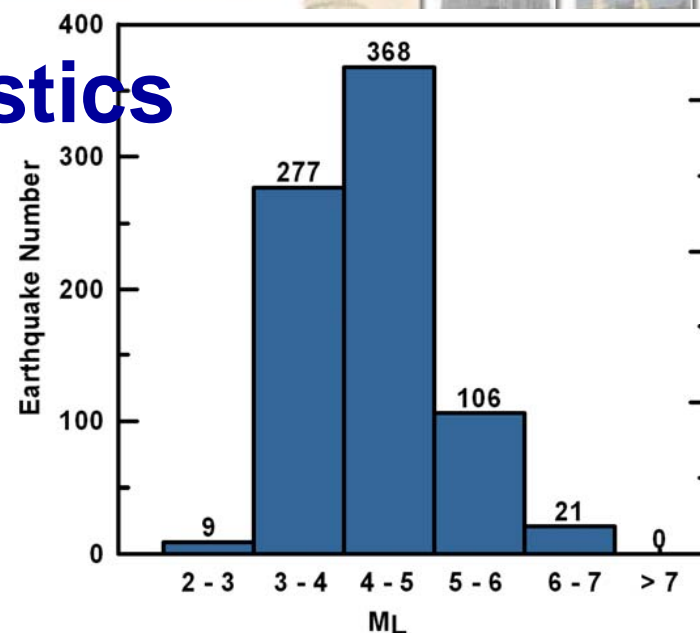
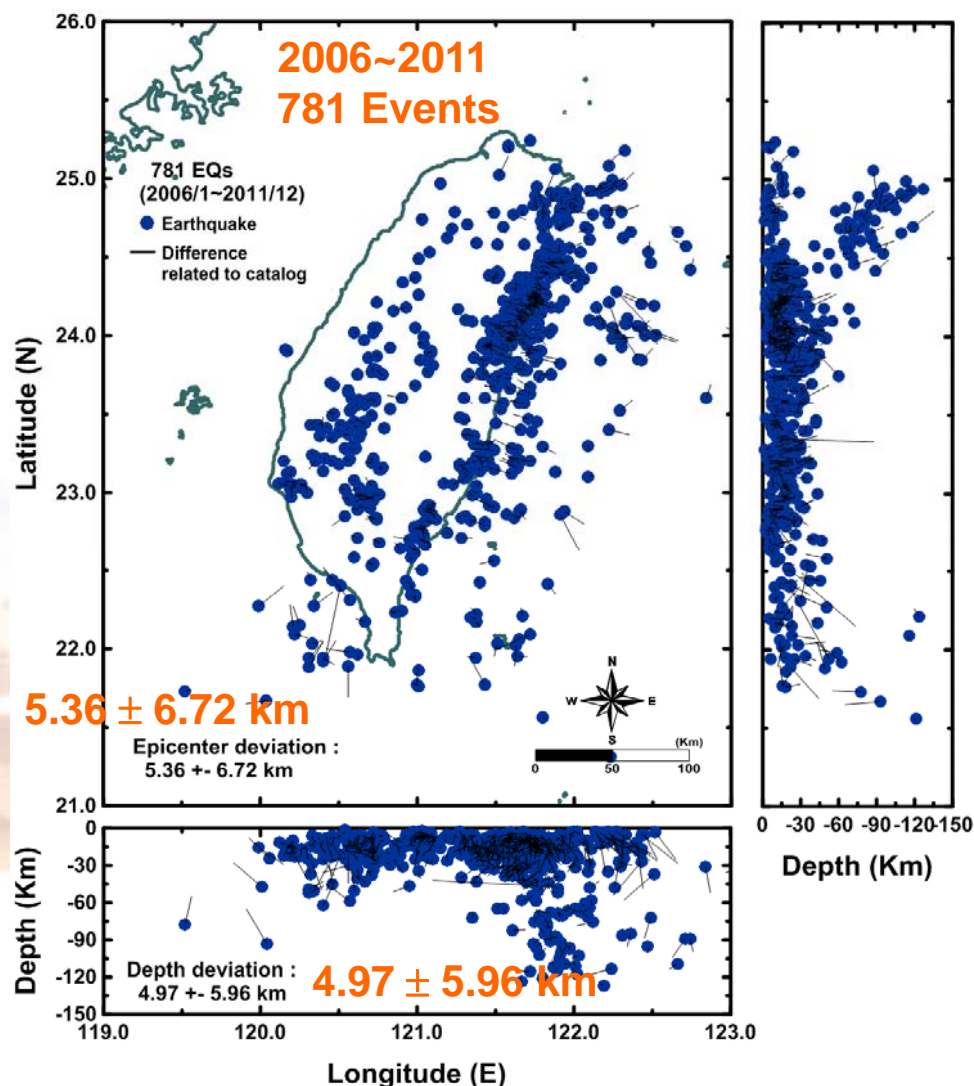
(張建興)

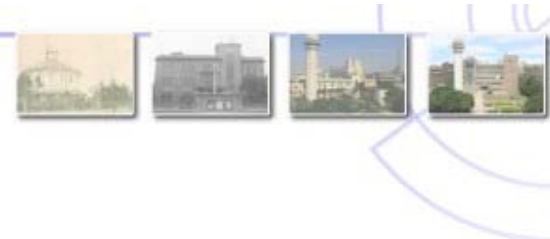


Earthquake rapid notification



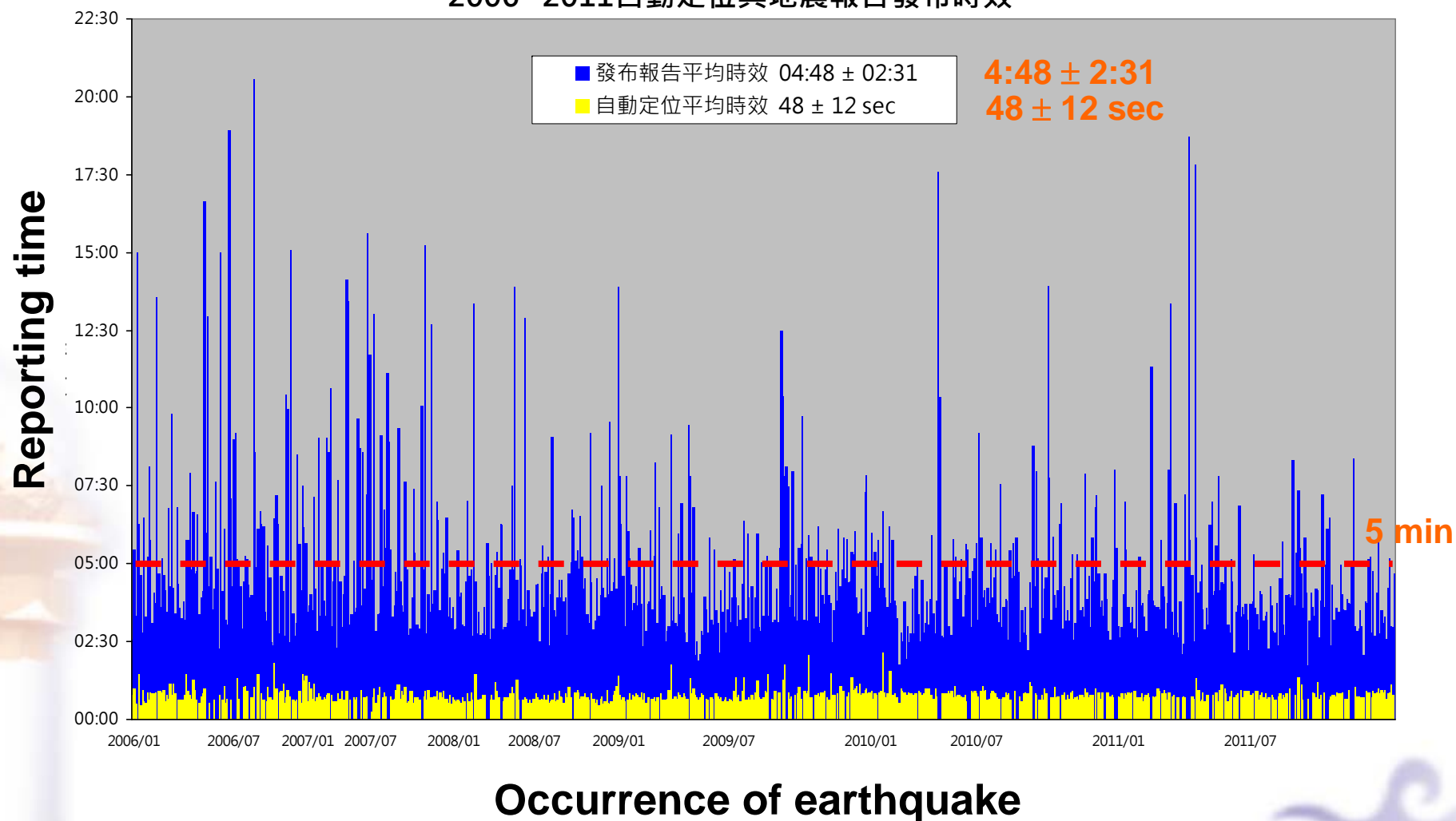
Earthquake report statistics





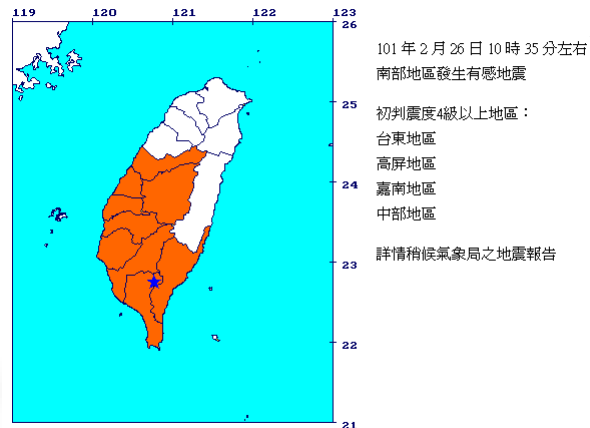
Reporting time

2006~2011自動定位與地震報告發布時效

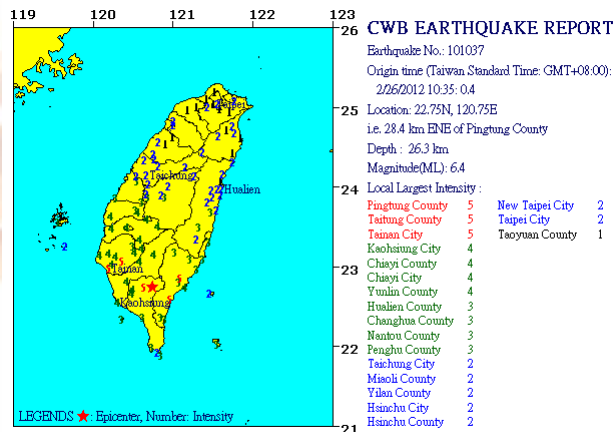




Example (Wutai earthquake)



101年2月26日10時35分左右
南部地區發生有感地震
初判震度4級以上地區：
台東地區
高屏地區
嘉南地區
中部地區
詳情請候氣象局之地震報告



CWB EARTHQUAKE REPORT
Earthquake No.: 101037
Origin time (Taiwan Standard Time: GMT+08:00):
2062012 10:35:04
Location: 22.75N, 120.75E
i.e. 28.4 km ENE of Pingtung County
Depth: 26.3 km
Magnitude(ML): 6.4
Local Largest Intensity:
Pingtung County 5 New Taipei City 2
Taichung County 5 Taipei City 2
Taizhen City 5 Taoyuan County 1
Kaohsiung City 4
Chiayi County 4
Chiayi City 4
Yulin County 4
Hualien County 3
Changhua County 3
Nantou County 3
Penghu County 3
Tainan City 2
Miaoli County 2
Yilan County 2
Hsinchu City 2
Hsinchu County 2

LEGENDS ★ Epicenter, Number: Intensity

Eq.

February 26, 2012
M6.4 Wutai earthquake

>Automatic earthquake report

→ 50 sec

Seismic Intensity map / Location of the earthquake

>Mobile phone text message

→ 59 sec

>E-mail

→ 59 sec

>Confirmed earthquake report

→ 03:59

>Mobile phone text message

→ 04:00

>Web server

→ 04:00

>Phone inquiries

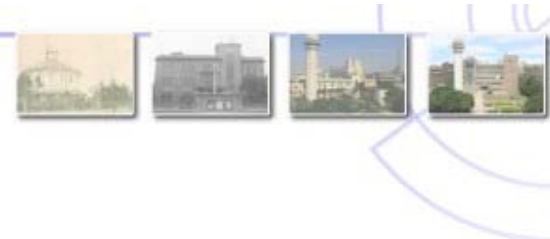
→ 04:00

>FAX

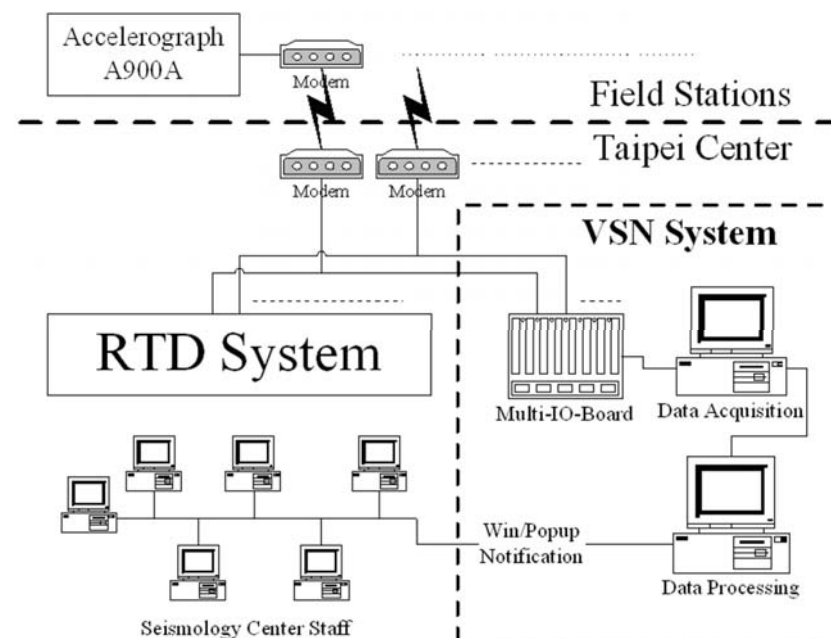
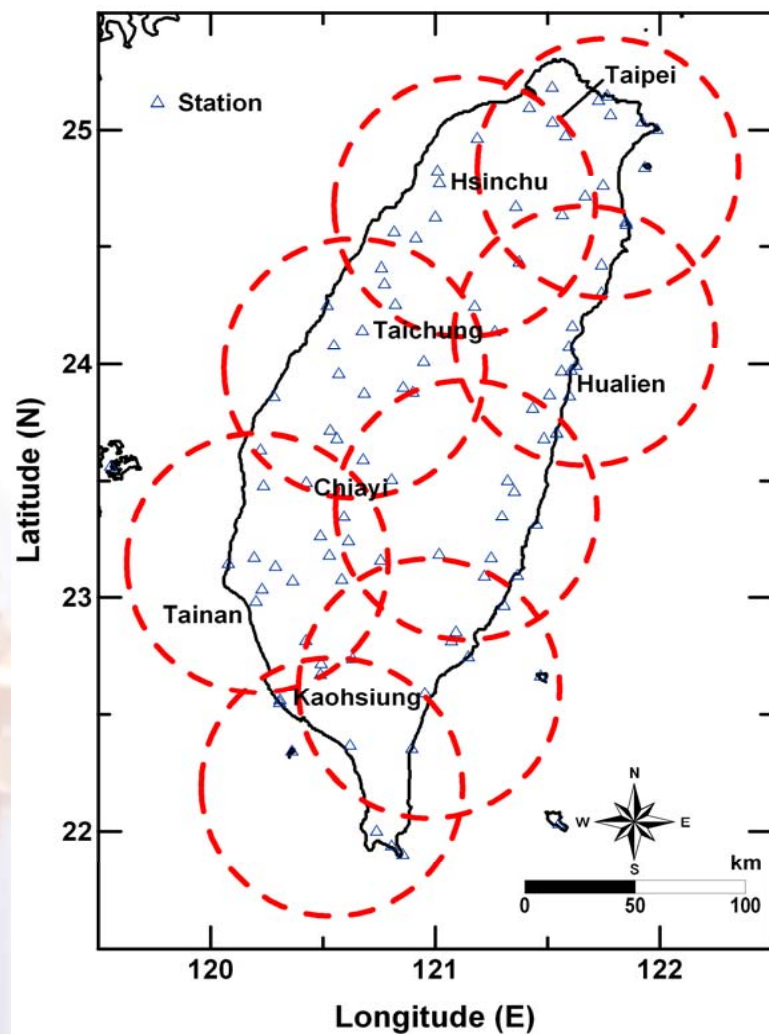
→ 04:00

>TV channels

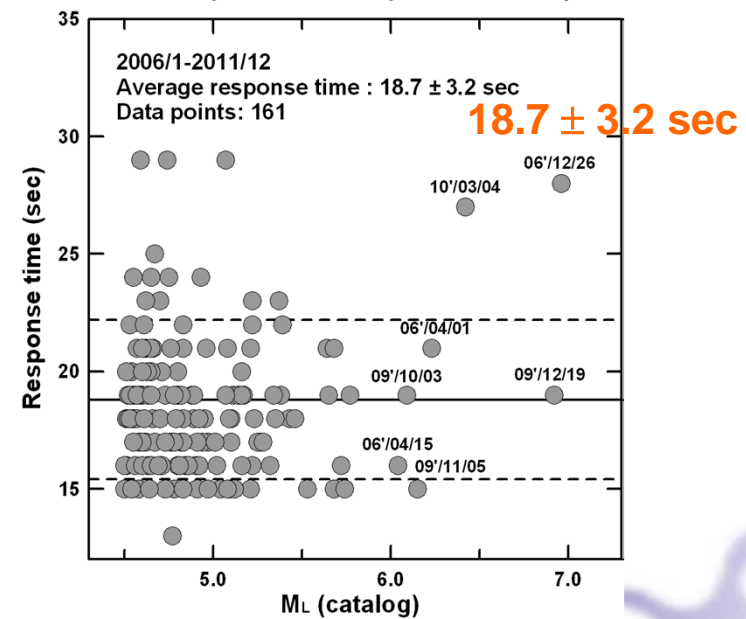
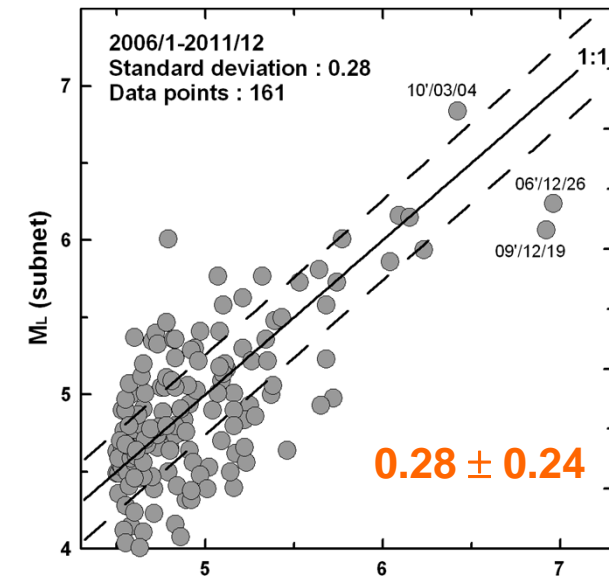
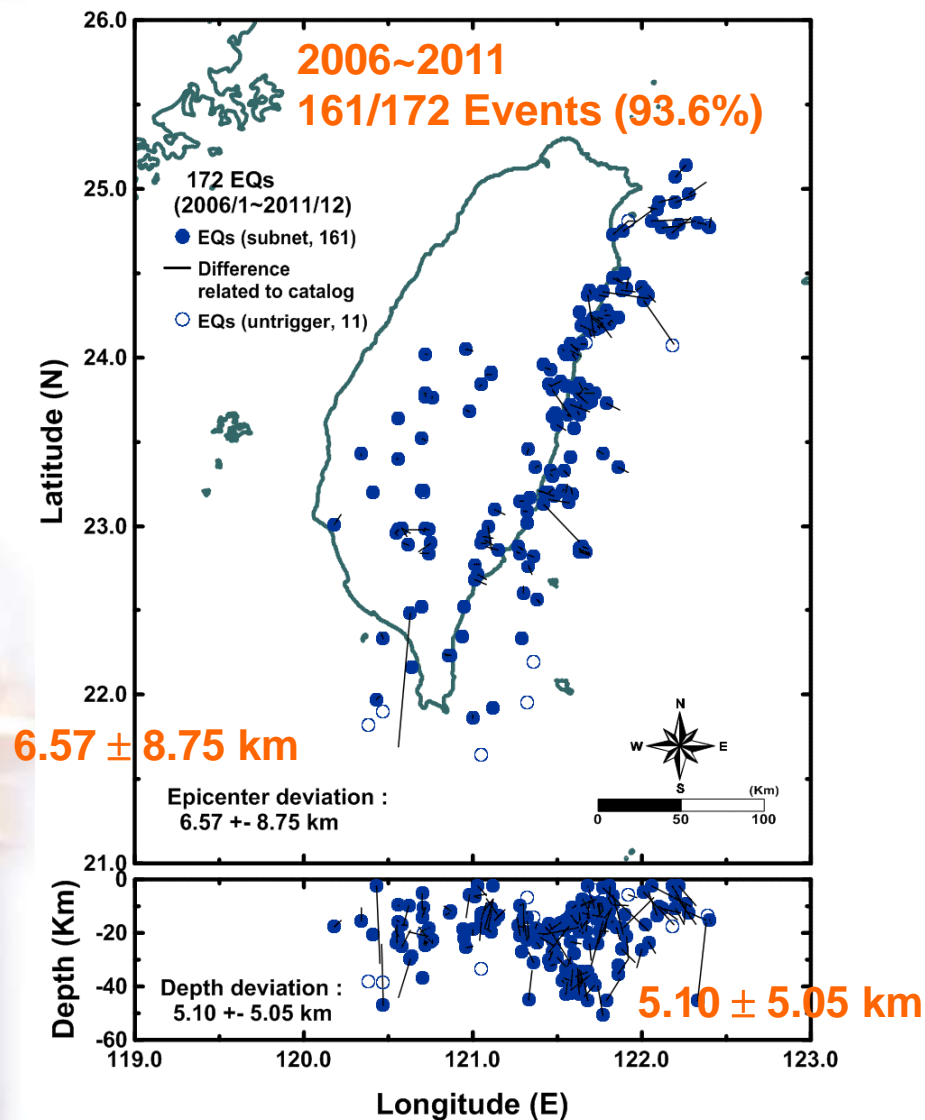
→ 05:08



Virtual Sub-Network for EEW

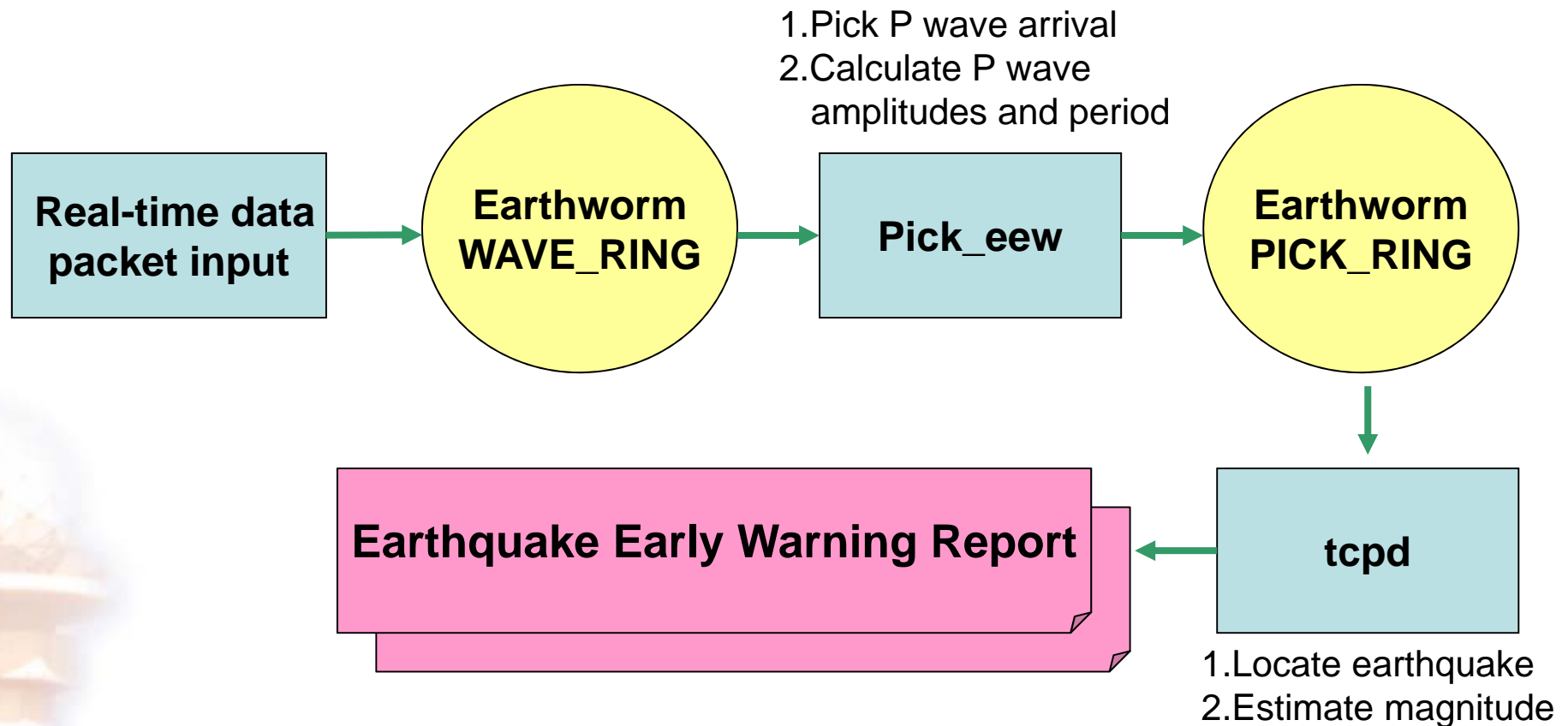


EEW Capability





Advanced EEW procedure developed



$$M_{\tau_c} = 4.218 * \log_{10}(\tau_c) + 6.166$$

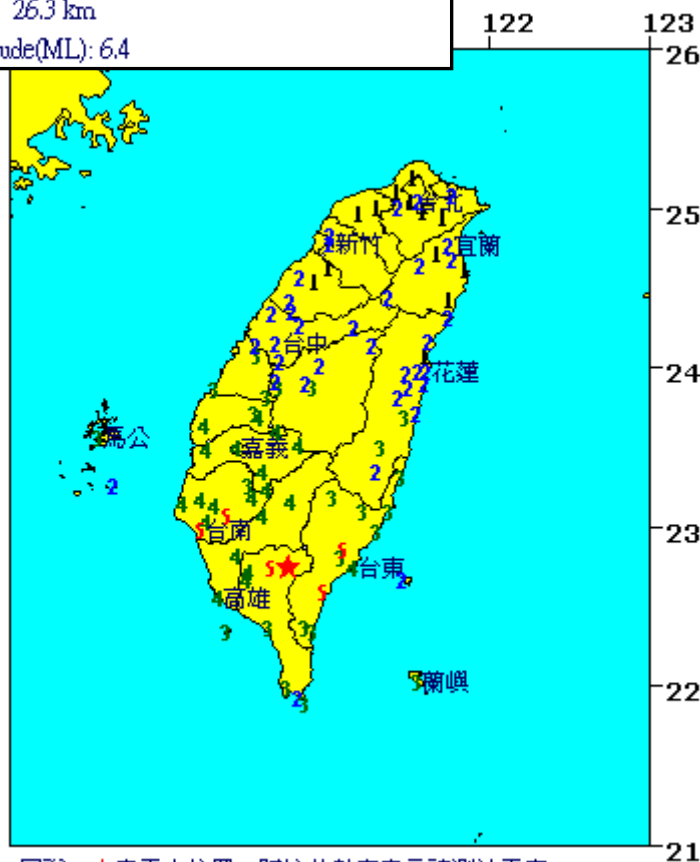
(Wu et al., 2010)

$$M_{Pd} = 3.905 + 2.198 * \log_{10}(Pd) + 2.703 * \log_{10}(R) \quad (\text{Hsiao et al., 2010})$$

(陳達毅)

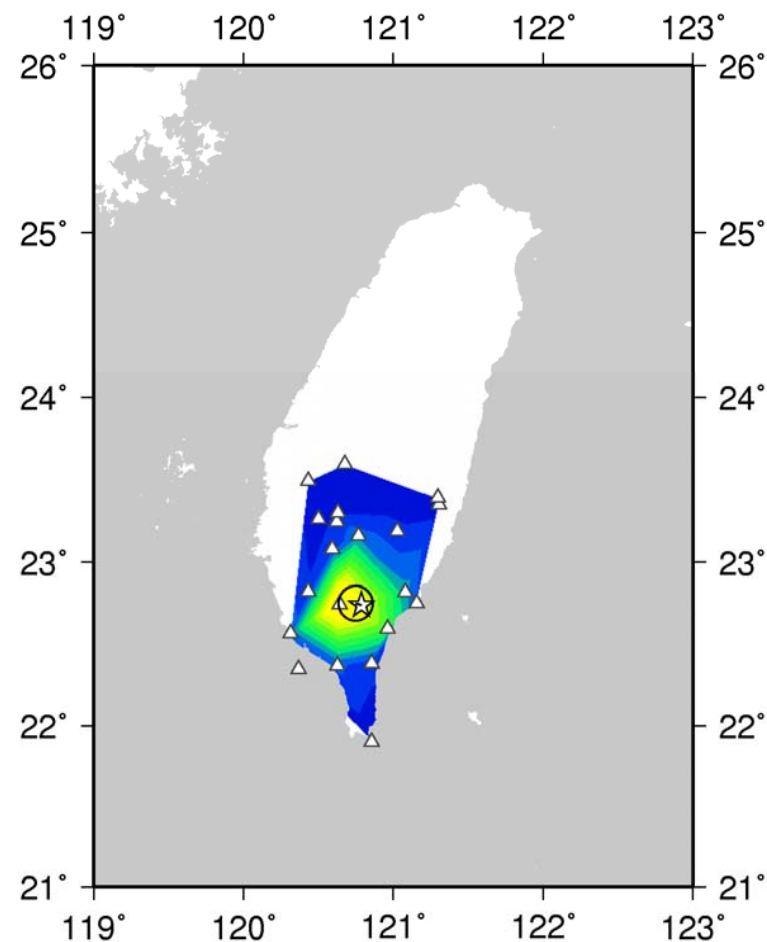
Example

Origin time (Taiwan Standard Time: GMT+08:00):
2/26/2012 10:35:04
Location: 22.75N, 120.75E
i.e. 28.4 km ENE of Pingtung County
Depth: 26.3 km
Magnitude(ML): 6.4



圖說：★表震央位置，阿拉伯數字表示該測站震度

20120226023527_n26.rep Mpd=6.23, Mtc=6.32, Time=27.05



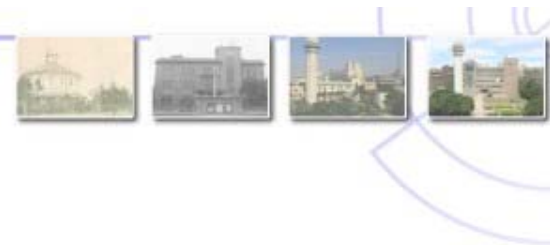
Pa (gal)

(陳達毅)



The End

Thank you for your attention!



Intensity estimate

161個地震中3539筆震度預估，與實際觀測值比較，震度完全吻合者53%，震度相差1級者44%，相差2級者3%。

$I_p \backslash I_o$	1	2	3	4	5	6	7
2	297	1164	534	20	0	0	0
3	24	321	512	135	8	0	0
4	0	36	168	163	24	0	0
5	0	0	26	58	37	2	0
6	0	0	0	4	5	0	0
7	0	0	0	0	1	0	0