Twelfth meeting of the ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region (ICG/PTWS WG-SCS), Jakarta, 7 - 8 November 2024

Tsunami Warning Operation and Services in China during 2023 ~ 2024

(National Progress Report)

WANG, ZONGCHEN
National Marine Environmental Forecasting Center(NTWC)
***Ministry of Natural Resources*, P. R. China**

Outlines

1. Earthquake Detection and Tsunami Monitoring

2. Numerical Tsunami Forecast and Decision Supporing System

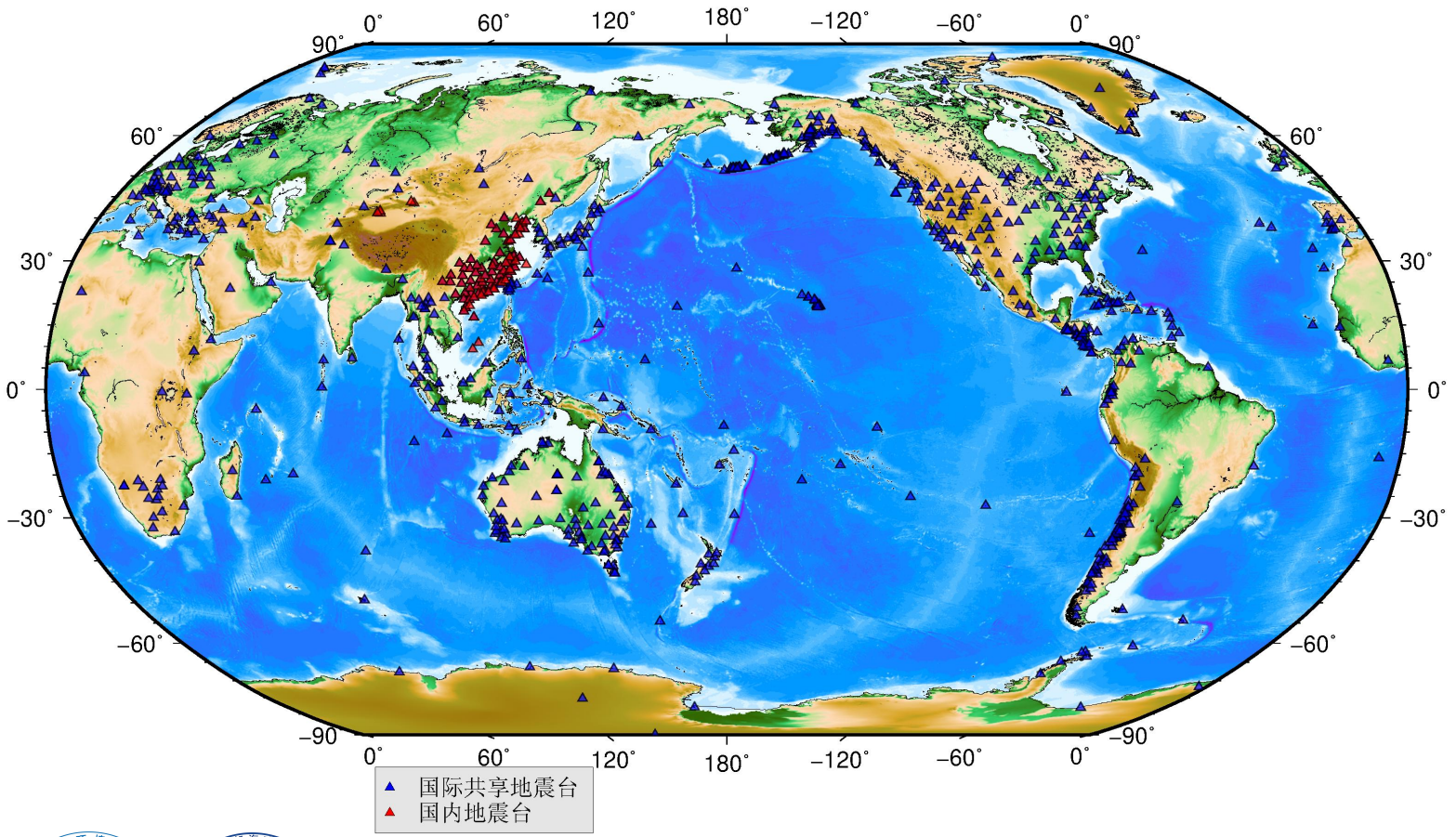
3. Tsunami Warning Operation and Dissemination

4. Coordination, Training, Workshop and Visiting activities

1. Earthquake Detection and Tsunami Monitoring

Global Seismic Dataset

National and International Seismic Station



Real-time, broadband seismic waveform data from:

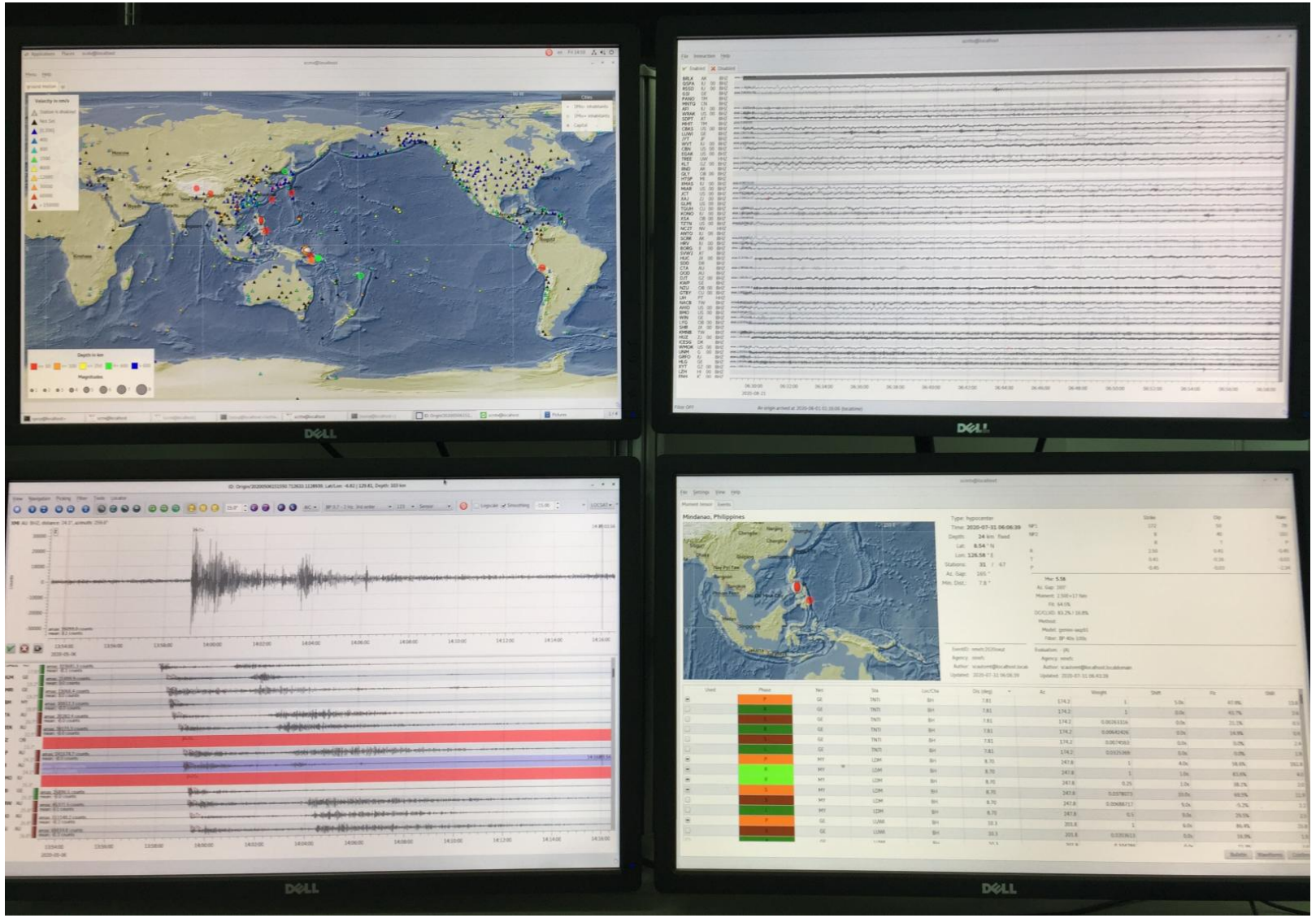
- MNR(27)
- CEA(54)
- IRIS
- GEOFON
- GEOSCOPE

- （700+）

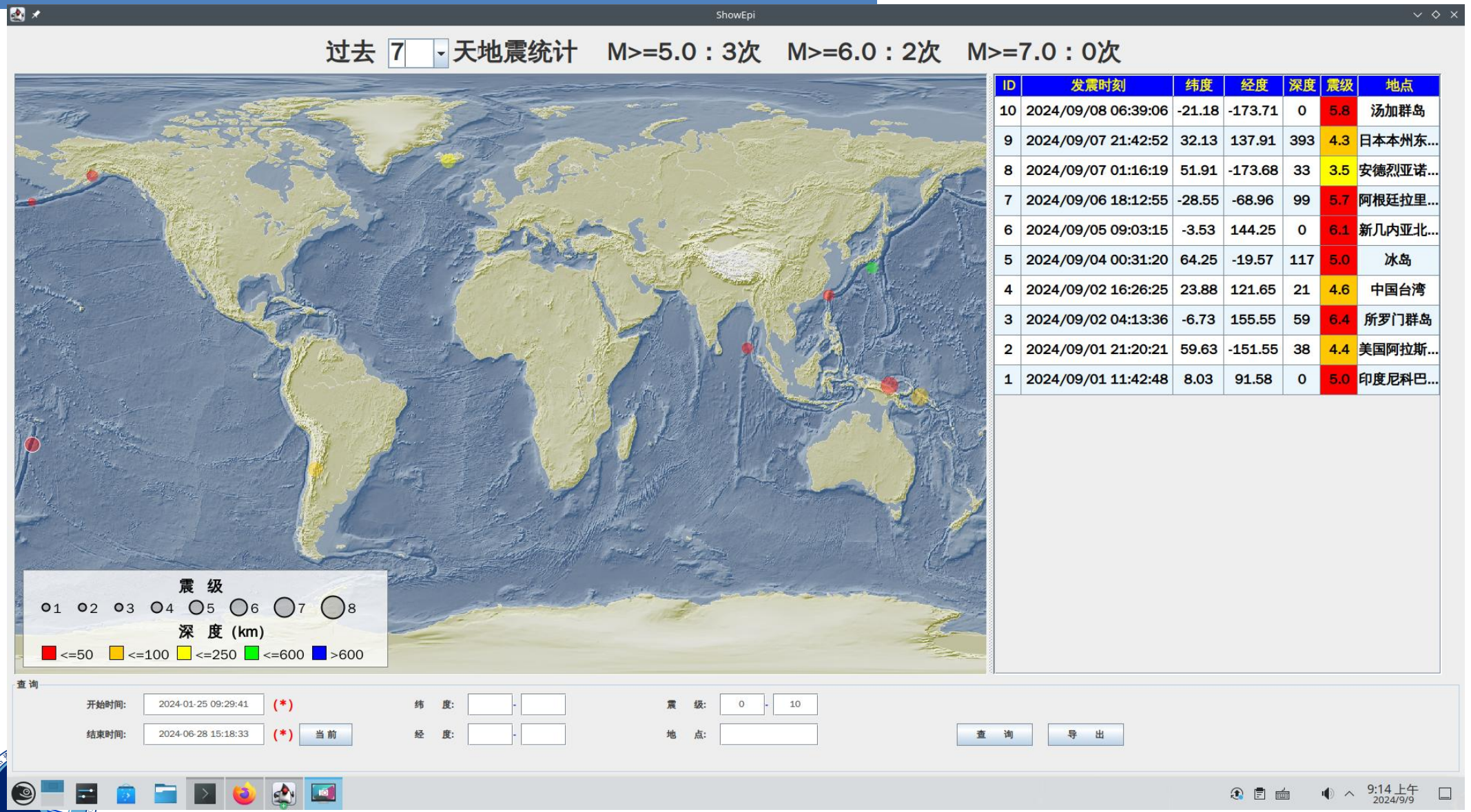
Seismic Analysis and Earthquake Detecting

Earthquake Preliminary Report

- **SeisComp**
- **GEDLS**
- **CEA EQIM**
- **Antelope**
- **USGS**
- **PTWC**



Seismic Analysis and Earthquake Detecting

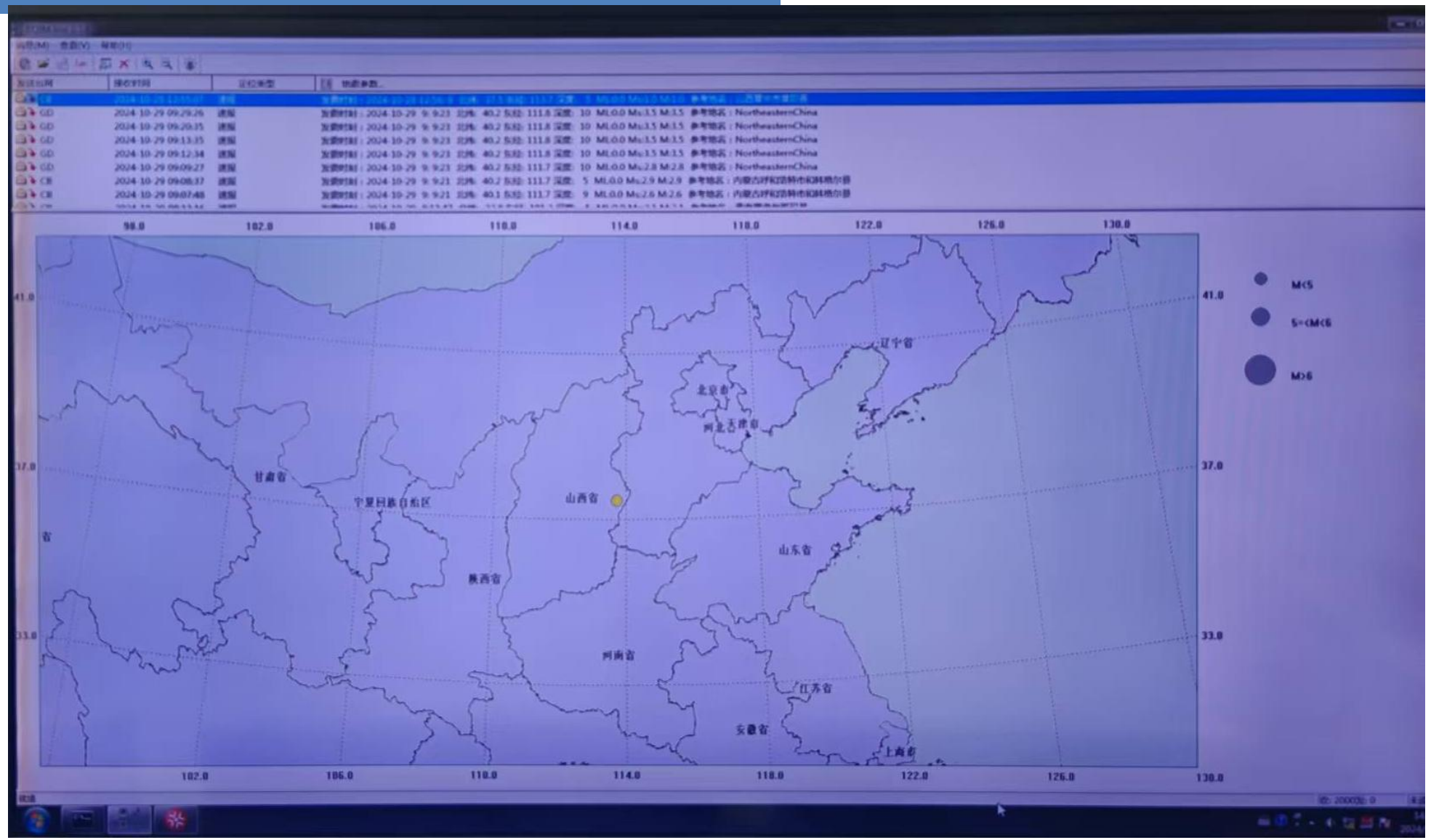


ID	发震时刻	纬度	经度	深度	震级	地点
10	2024/09/08 06:39:06	-21.18	-173.71	0	5.8	汤加群岛
9	2024/09/07 21:42:52	32.13	137.91	393	4.3	日本本州东...
8	2024/09/07 01:16:19	51.91	-173.68	33	3.5	安德烈亚诺...
7	2024/09/06 18:12:55	-28.55	-68.96	99	5.7	阿根廷拉里...
6	2024/09/05 09:03:15	-3.53	144.25	0	6.1	新几内亚北...
5	2024/09/04 00:31:20	64.25	-19.57	117	5.0	冰岛
4	2024/09/02 16:26:25	23.88	121.65	21	4.6	中国台湾
3	2024/09/02 04:13:36	-6.73	155.55	59	6.4	所罗门群岛
2	2024/09/01 21:20:21	59.63	-151.55	38	4.4	美国阿拉斯...
1	2024/09/01 11:42:48	8.03	91.58	0	5.0	印度尼科巴...

Self-designed Global Earthquake Detection and Location System (GEDLS)

Seismic Analysis and Earthquake Detecting

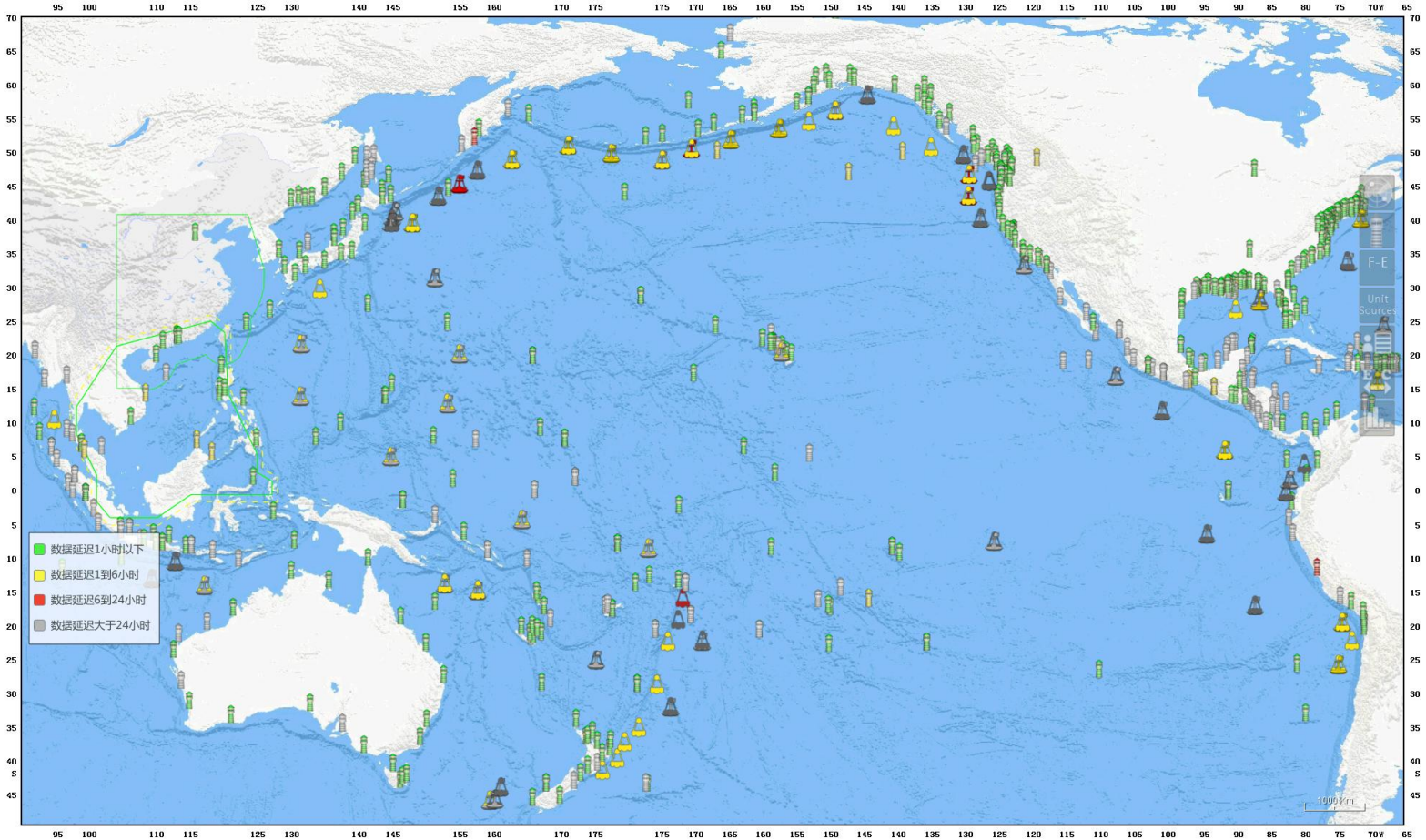
Cooperation with CEA



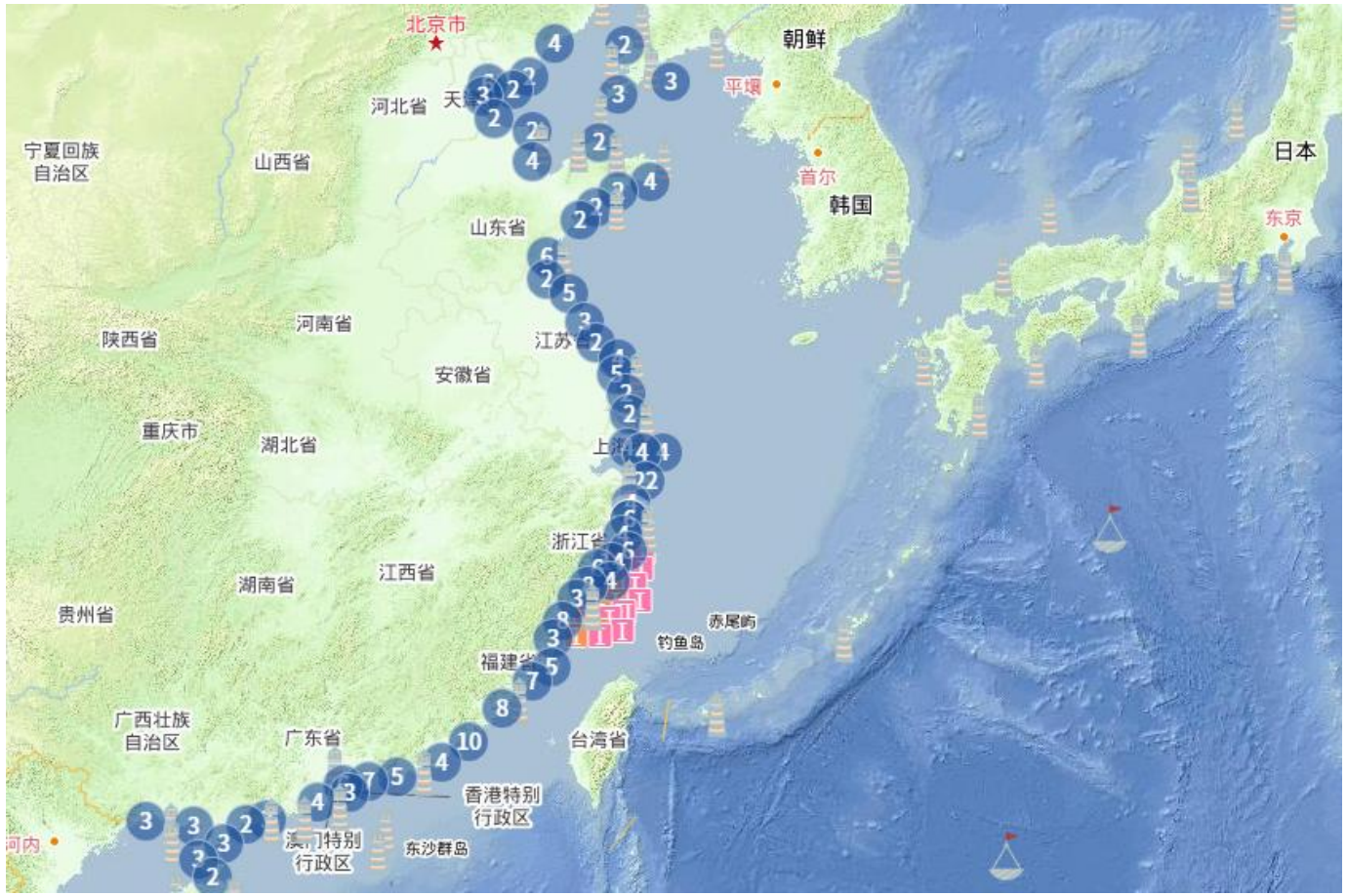
EarthQuakes Instant Messenger (EQIM) developed by China Earthquake Administration

Global Sea Level Dataset

- Real-time sea level data from nearly **600** functional tidal gauges and Dart bouys via GTS and from sea-level monitoring facility website
- Metadata file will be updated following PTWC's Emails



Chinese Sea Level Station



- ~150 tidal gauges along the Chinese coasts are accessible via operational LAN
- 5 gauges are involved in data sharing via GTS for tsunami warning and mitigation system in the SCS region:

✓ Shenzhen (Chinese Mainland)

✓ Zhapo (Chinese Mainland)

✓ Qinglan (Chinese Mainland)

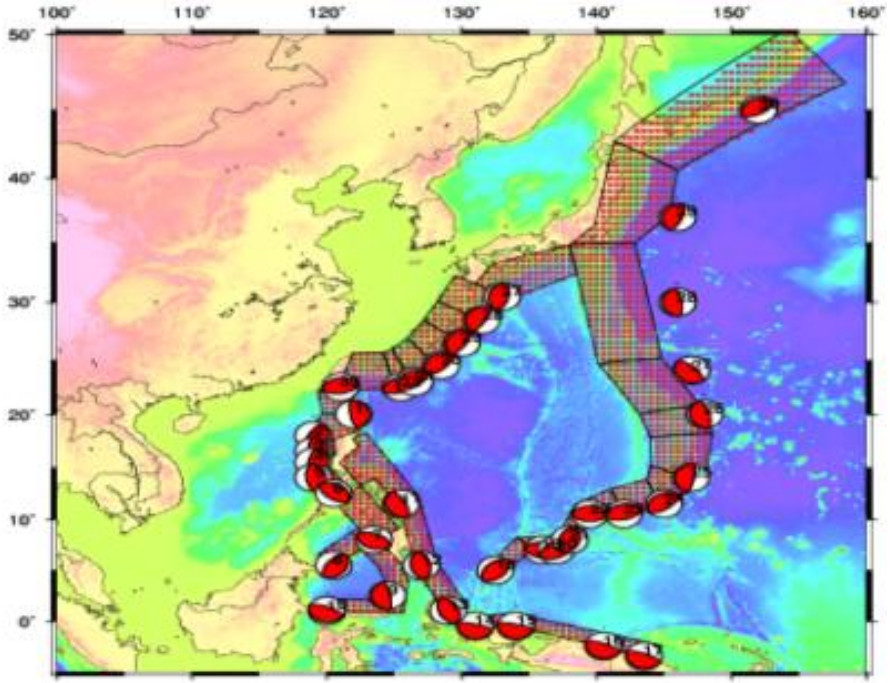
✓ Quarry Bay (Hongkong)

✓ Shek (Hongkong)

2. Numerical Tsunami Forecast .&. Decision Supporing System

Two Sets of Tsunami Database

NW Pacific Scenario Database



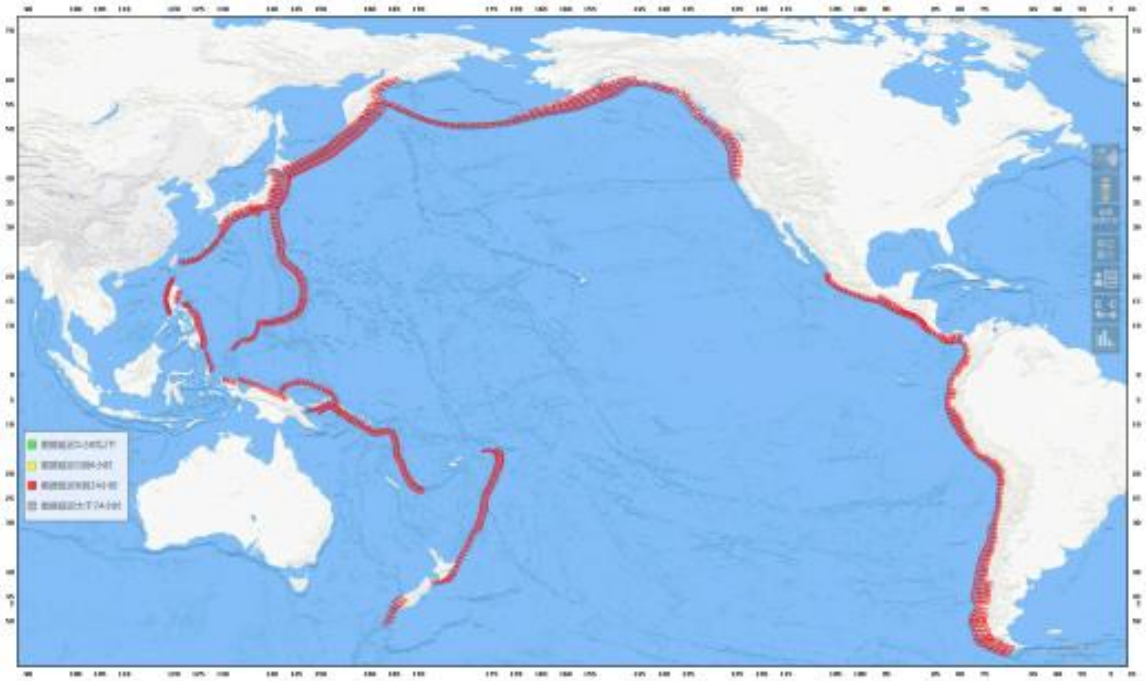
Source Coverage:

37 partitions, 1671 sources

Resolution: 0.5° ×0.5°

Totally: 60,156 tsunami scenarios

The Pacific Unit Source Database



Source Coverage:

Length: 100 km

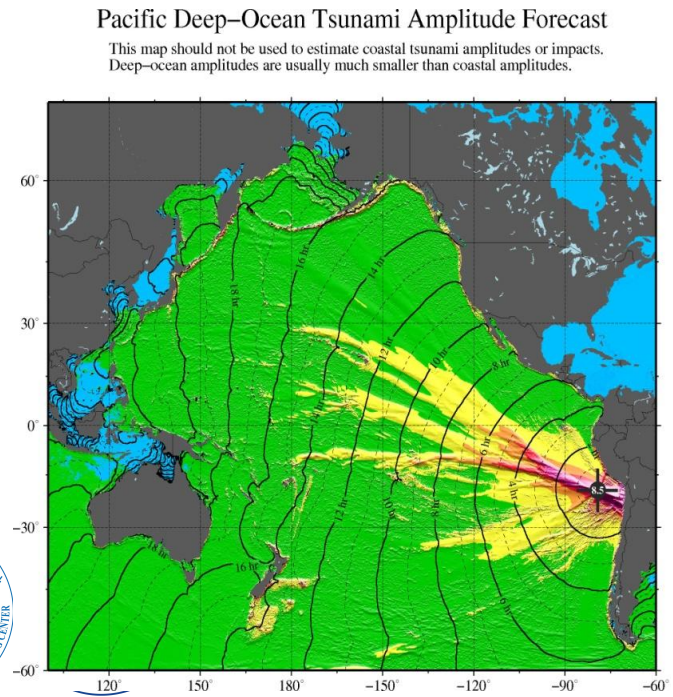
Width: 50 km

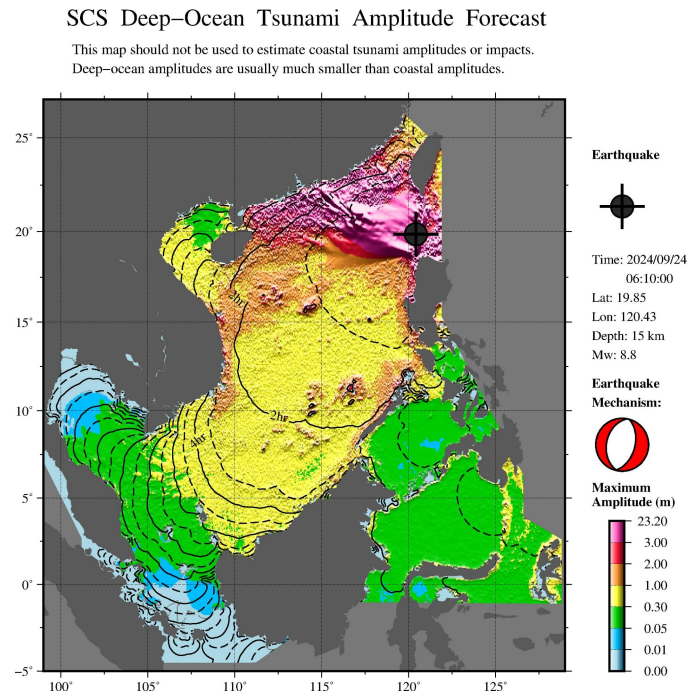
Totally: 1391 unit sources

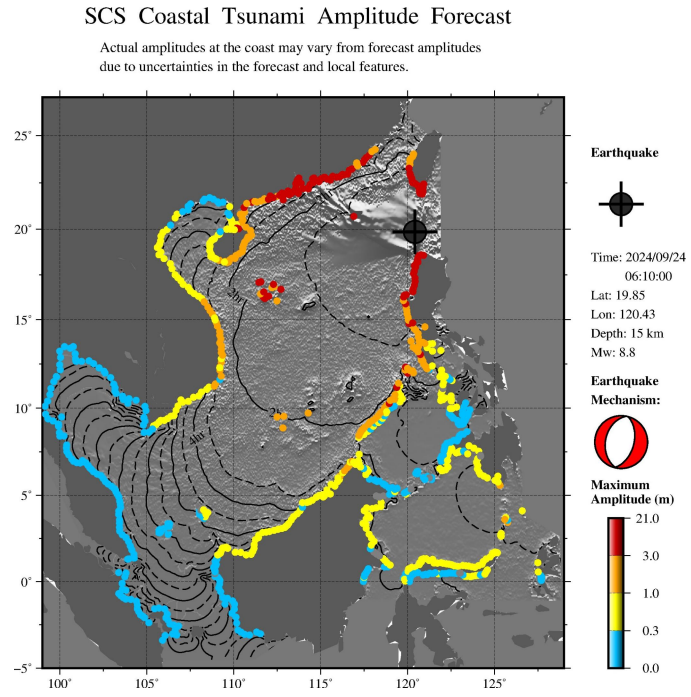
On-the-Fly Tsunami Forecast Model

Numerical model performance on NVIDIA Tesla V100(GPU)

Forecast region	Space resolution	Forecast period (hours)	Consuming time (seconds)			Efficiency promotion	
			Series	OpenMP	**GPU**	OpenMP	**GPU**
Pacific Ocean	5 arc-min	32	6070	410	**45**	15	**135**
NW Pacific Ocean	4 arc-min	15	450	32	**4**	14	**113**
South China Sea	2 arc-min	15	467	31	**4**	15	**117**



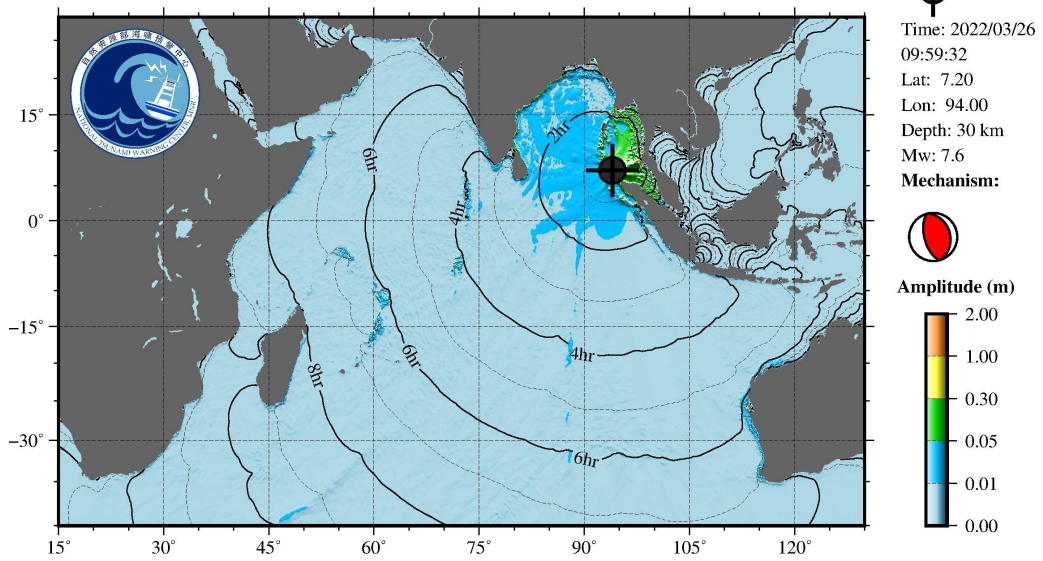




Glabal Numerical Tsunami Forecast

North Indian Deep–Ocean Tsunami Amplitude Forecast

This map should not be used to estimate coastal tsunami amplitudes or impacts.
Deep–ocean amplitudes are usually much smaller than coastal amplitudes.

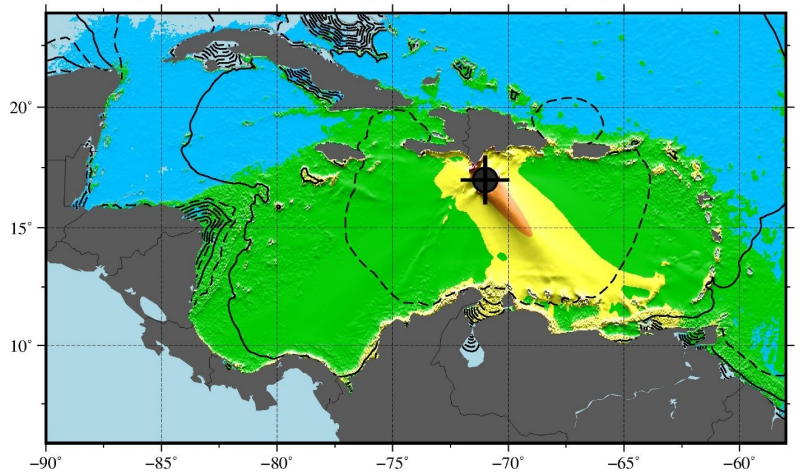


Earthquake
Time: 2022/03/26 09:59:32
Lat: 7.20
Lon: 94.00
Depth: 30 km
Mw: 7.6
Mechanism:

Amplitude (m)
2.00
1.00
0.30
0.05
0.01
0.00

Caribbean Sea Tsunami Amplitude Forecast

This map should not be used to estimate coastal tsunami amplitudes or impacts.
Deep–ocean amplitudes are usually much smaller than coastal amplitudes.

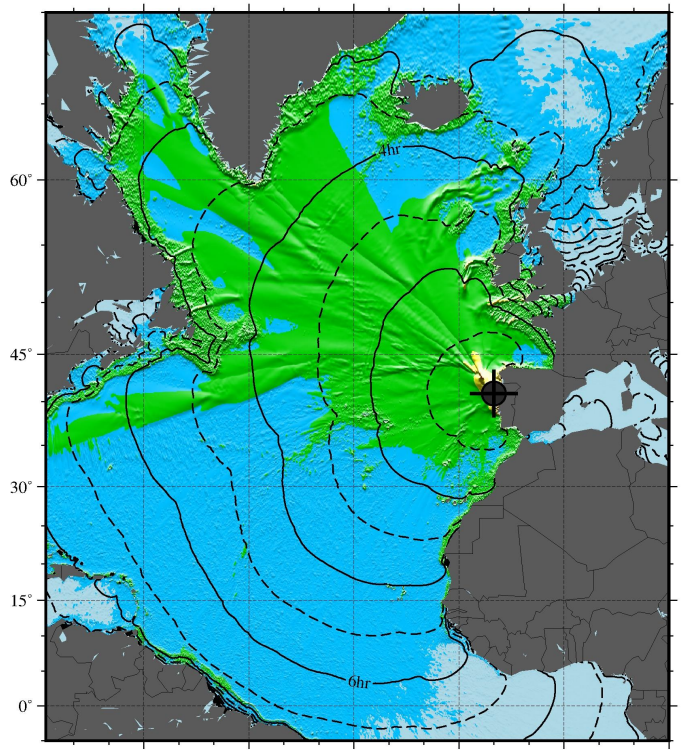


Earthquake
Time: 2022/01/03 08:29:34
Lat: 17.00
Lon: −71.00
Depth: 15 km
Mw: 8.0

Maximum Amplitude (m)
6.40
3.00
2.00
1.00
0.30
0.05
0.01
0.00

North Atlantic Ocean Tsunami Forecast

This map should not be used to estimate coastal tsunami amplitudes or impacts.
Deep–ocean amplitudes are usually much smaller than coastal amplitudes.

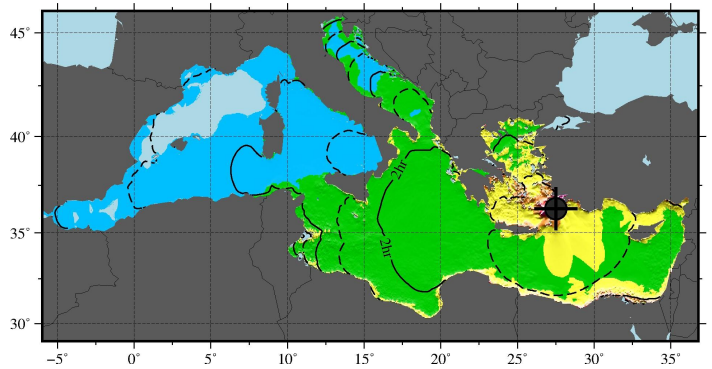


Earthquake
Time: 2021/01/02 07:48:34
Lat: 40.87
Lon: −10.00
Depth: 15 km
Mw: 8.0

Earthquake Mechanism:

Maximum Amplitude (m)
3.30
3.00
2.00
1.00
0.30
0.05
0.01
0.00

Deep–ocean amplitudes are usually much smaller than coastal amplitudes.



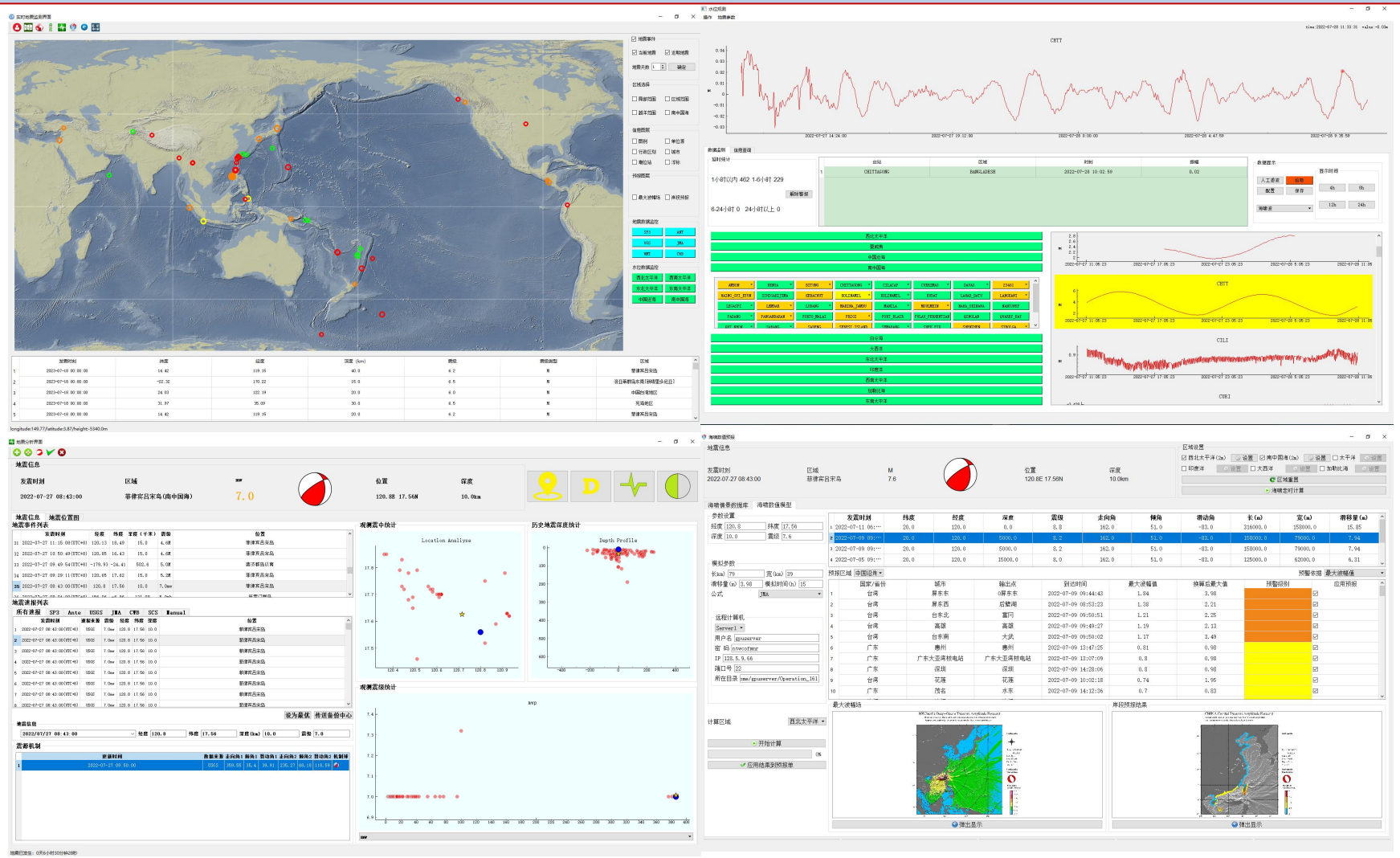
Earthquake
Time: 2022/01/01 05:32:26
Lat: 36.29
Lon: 27.50
Depth: 15 km
Mw: 8.5

Maximum Amplitude (m)
10.80
3.00
2.00
1.00
0.30
0.05
0.01
0.00

Decision Supporting System

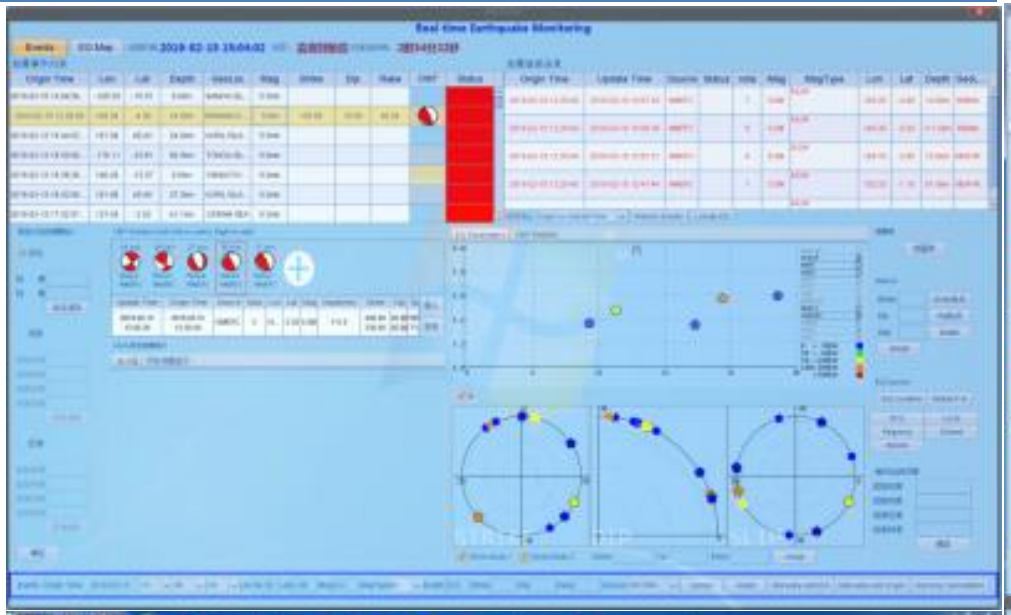
Smart Tsunami Information Processing System(STIPS): A fully self-desighed tsunami warning and decision support system based on Python language is in operation for domestic tsunami service, and SCSTWS.

- Self designed by Python
- User-friendly and well-maintained
- GIS Interface
- Earthquake information
- Tsunami monitoring
- Pre-computing tsunami database
- On-the-fly tsunami model integration;
- Automatic making and release of tsunami products;



Former Decision Supporting System

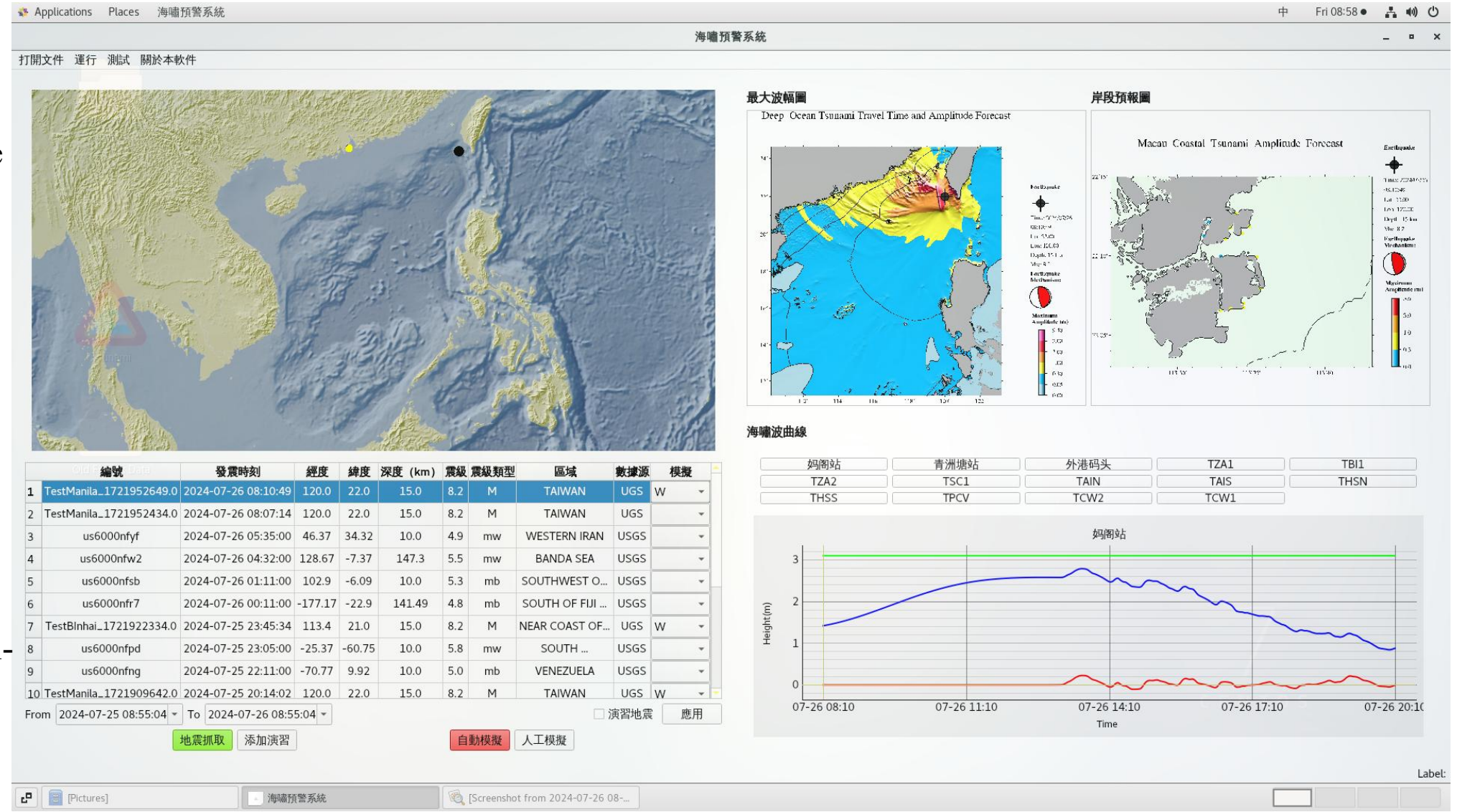
- Stand-by
- In maintenance with low cost



Lightweight DSS Application in Macau

Feature:

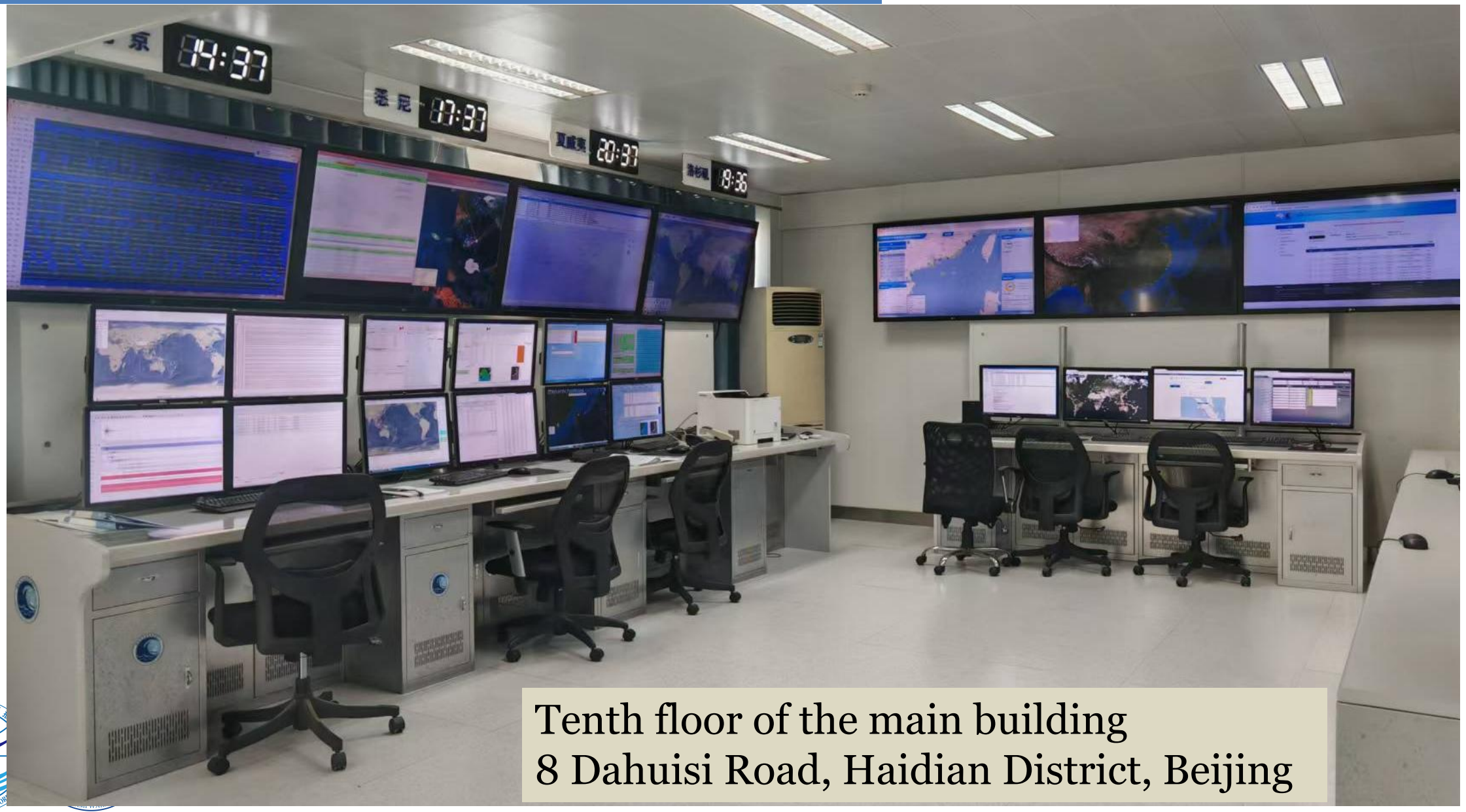
- Automatically modelling for earthquake with *M*w 7.0+ in SCS
- Refined-scale numerical model
- 120s time consuming for 12-hour simulation (Bsed on NVIDIA RTX 2080Ti)
- Cost-effictive and well-maintained



	編號	發震時刻	經度	緯度	深度（km）	震級	震級類型	區域	數據源	模擬
1	TestManila_1721952649.0	2024-07-26 08:10:49	120.0	22.0	15.0	8.2	M	TAIWAN	UGS	W
2	TestManila_1721952434.0	2024-07-26 08:07:14	120.0	22.0	15.0	8.2	M	TAIWAN	UGS	
3	us6000nfyf	2024-07-26 05:35:00	46.37	34.32	10.0	4.9	mw	WESTERN IRAN	USGS	
4	us6000nfw2	2024-07-26 04:32:00	128.67	-7.37	147.3	5.5	mw	BANDA SEA	USGS	
5	us6000nfsb	2024-07-26 01:11:00	102.9	-6.09	10.0	5.3	mb	SOUTHWEST O...	USGS	
6	us6000nfr7	2024-07-26 00:11:00	-177.17	-22.9	141.49	4.8	mb	SOUTH OF FIJI ...	USGS	
7	TestBInhai_1721922334.0	2024-07-25 23:45:34	113.4	21.0	15.0	8.2	M	NEAR COAST OF...	UGS	W
8	us6000nfpd	2024-07-25 23:05:00	-25.37	-60.75	10.0	5.8	mw	SOUTH ...	USGS	
9	us6000nfng	2024-07-25 22:11:00	-70.77	9.92	10.0	5.0	mb	VENEZUELA	USGS	
10	TestManila_1721909642.0	2024-07-25 20:14:02	120.0	22.0	15.0	8.2	M	TAIWAN	UGS	W

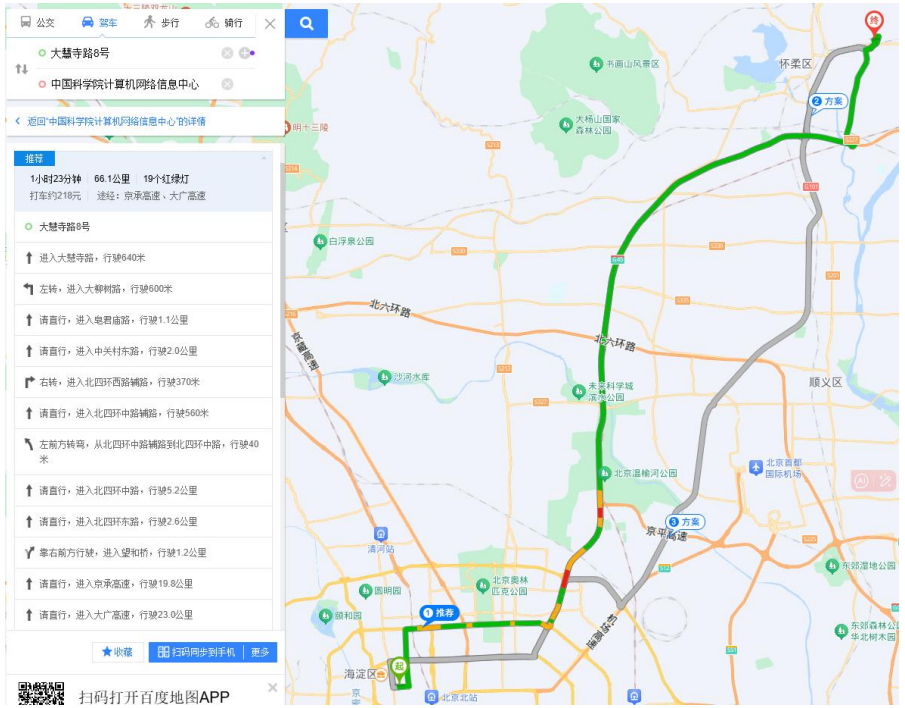
3. Tsunami Warning Operation and Dissemination

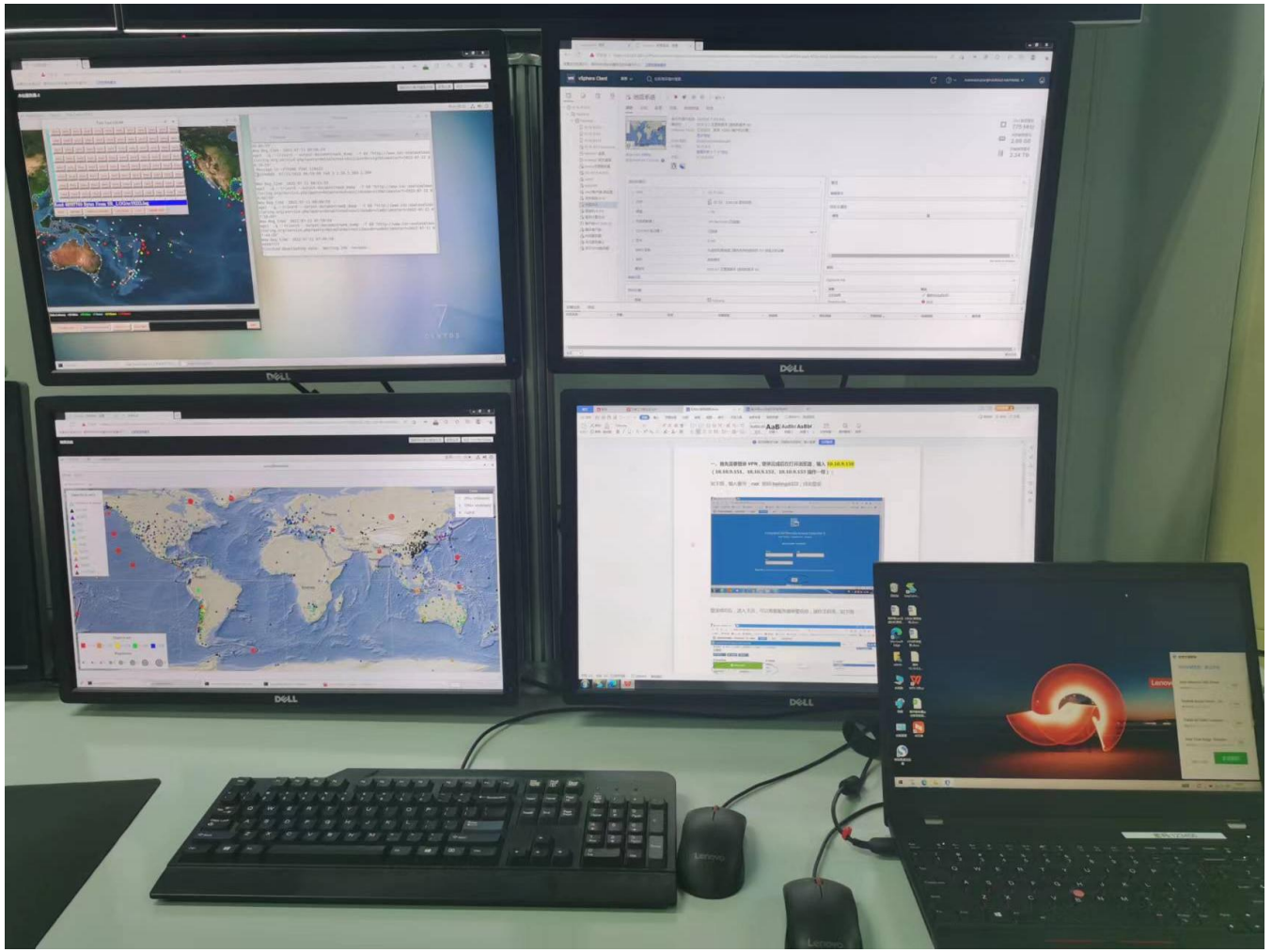
Main Operation Platform



Remote Backup Platform

- Located in Jingmi North 1st Street, Yanqi Economic Development Zone, Huairou District, Beijing
- Connected with VPN based on independent network card and standby battery power

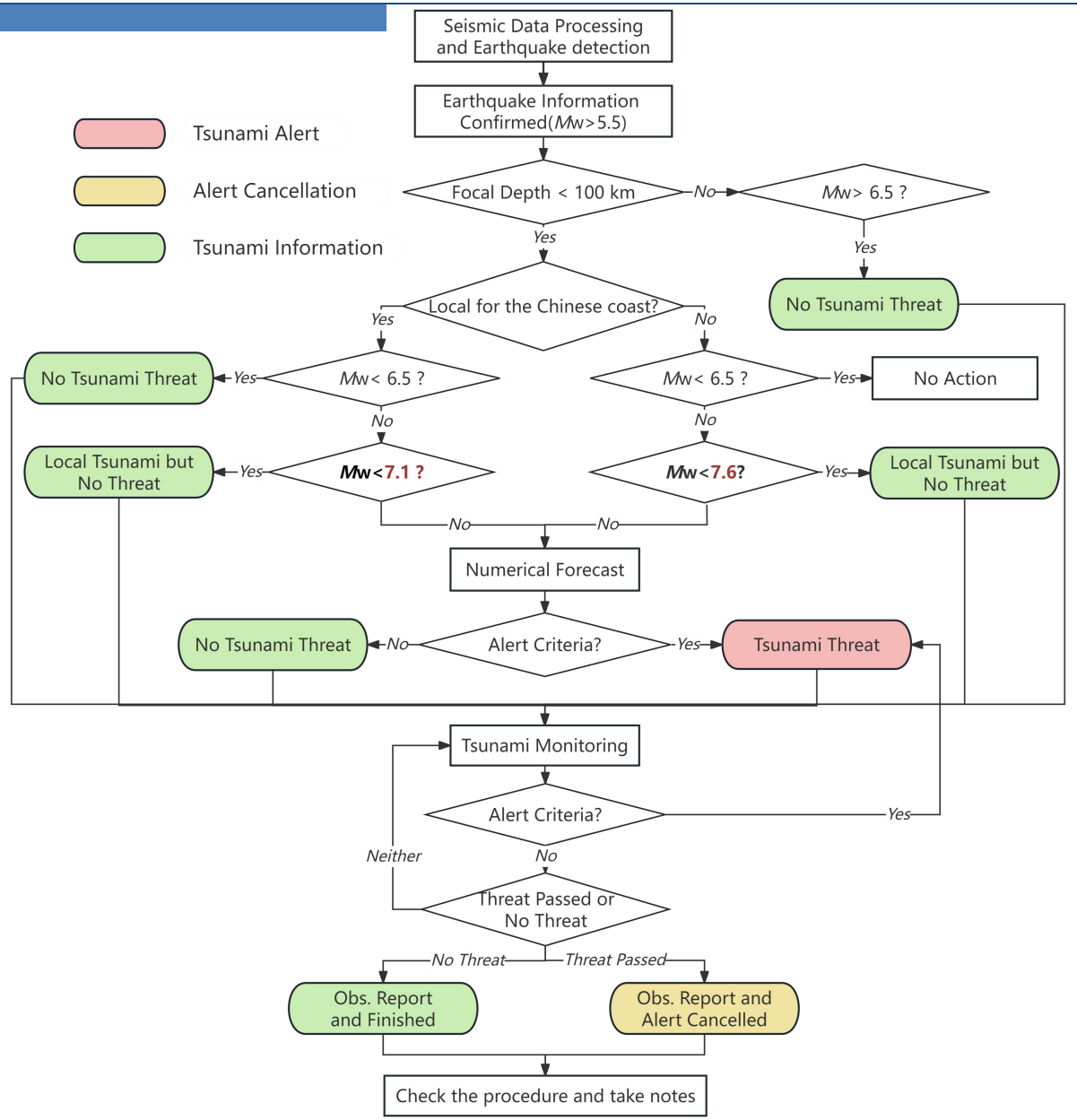




Operation Procedure and Warning Criteria

Tsunami alerts/Threat levels are classified as three levels:

- Red (Max. tsunami wave amplitude >= 300cm), corresponding to 'especially severe disaster possibly causing a number of casualties and huge economical losses'
- **Orange (Amp. max>= 100cm), 'possibility of severe damage'**
- Yellow (Amp. max>= 30cm) , 'watch out for potential danger near the coastline'



Product and Dissemination

- Tsunami Alerts . &. Cancellation
- Tsunami Information Statement
- Major Tsunami Summary

自然资源部海啸预警中心

橙色

海啸警报

时间：2024 年 4 月 3 日 8 时 52 分

编号：海啸 2024-0403-0758-2　　签发：

自然资源部海啸预警中心根据《海洋灾害应急预案》，发布海啸Ⅱ级警报（橙色）。

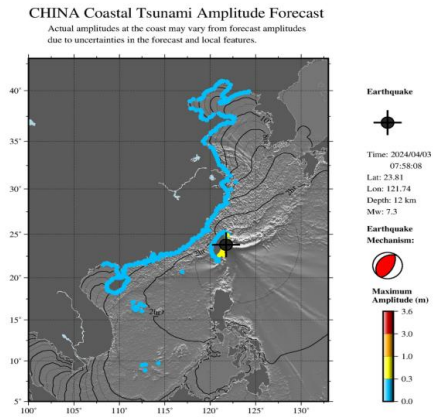
2024 年 4 月 3 日 7 时 58 分（北京时间），中国台湾海域（23.81° N, 121.74° E）发生 7.3 级地震，震源深度为 12.0 千米（震源参数修订）。自然资源部海啸预警中心综合分析判断，地震可能会在震源周围引发局地海啸，预计对我国沿岸局部区域造成灾害性影响。

预报信息如下（修订）：

省份	预报区域	预报点	预计抵达时间（BJT）	最大波幅（厘米）	预警级别
台湾	花莲	花莲	08:01	100-300	橙色
台湾	宜兰	宜兰县	08:17	30-100	黄色
台湾	台东北	富冈	08:20	30-100	黄色

* 预计抵达时间 - 海啸初波抵达某一预报点的时刻。
* 最大波幅 - 相对于观测站平均海平面起算的高度。

岸段预报图如下：



中国台湾海域发生7.3级地震海啸 自然资源部海啸预警中心立即启动海啸预警流程

澎湃 政务：国家海洋预报台 2024-04-03 19:46

国家海洋预报台01

地震海啸概况

据全球海底地震监测台网数据，自然资源部海啸预警中心测定，2024年4月3日7时58分（北京时间），中国台湾海域（23.81°N,121.74°E）发生7.3级地震，震源深度为12千米。

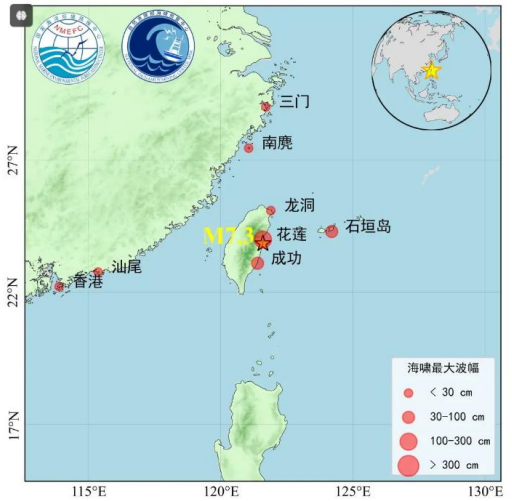
自然资源部海啸预警中心根据全球海啸监测网分析，地震在震源附近引发海啸，并对台湾沿岸造成灾害性影响。

02

历史地震海啸概述

此次地震发生在菲律宾海板块和欧亚板块的边界，在该位置，菲律宾海板块以78毫米/年的速率俯冲到欧亚板块之下。台湾位于一个地质构造复杂的区域，是三个板块的交汇处—菲律宾海板块、欧亚板块以及巽他板块。由于其特殊的板块边界位置，台湾通常发生中型到大型地震。

根据全球海啸监测数据显示，此次地震在震源附近引发了海啸。截至2024年4月3日16点30分（北京时间），中国台湾花莲站（震中附近）于8时08分监测到105厘米的海啸波，龙洞站于8时29分监测到21厘米的海啸波，日本石垣岛于8时30分监测到30厘米的海啸波，中国台湾成功站于8时41分监测到45厘米的海啸波，浙江南麂站于11时52分监测到19厘米的海啸波，广东汕尾站于13时35分监测到9厘米的海啸波，浙江三门站于13时39分监测到15厘米的海啸波，香港天文台石壁站于13时左右监测到7厘米的海啸波。



SMS/Website/APP

Broad and TV

TicTok

Toutiao(NEWS APP)

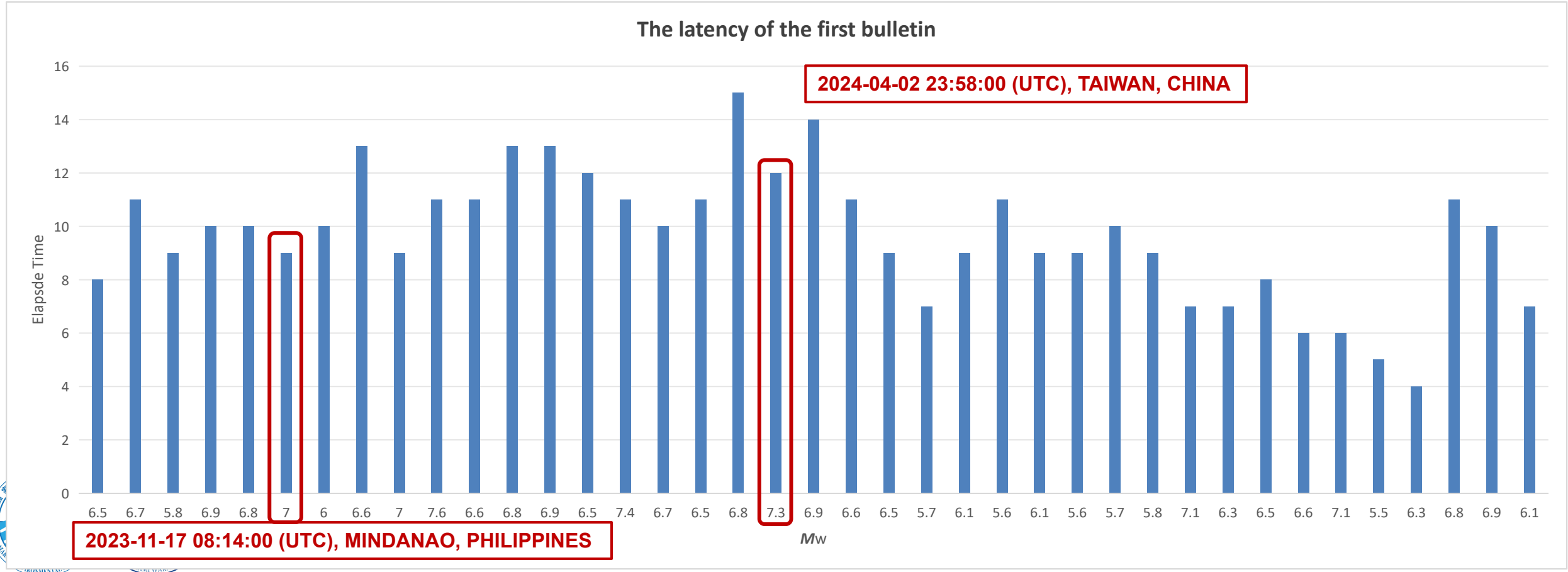
Weibo

EMAIL

FAX

Operation Performance (Oct. 2023 ~ Oct. 2024)

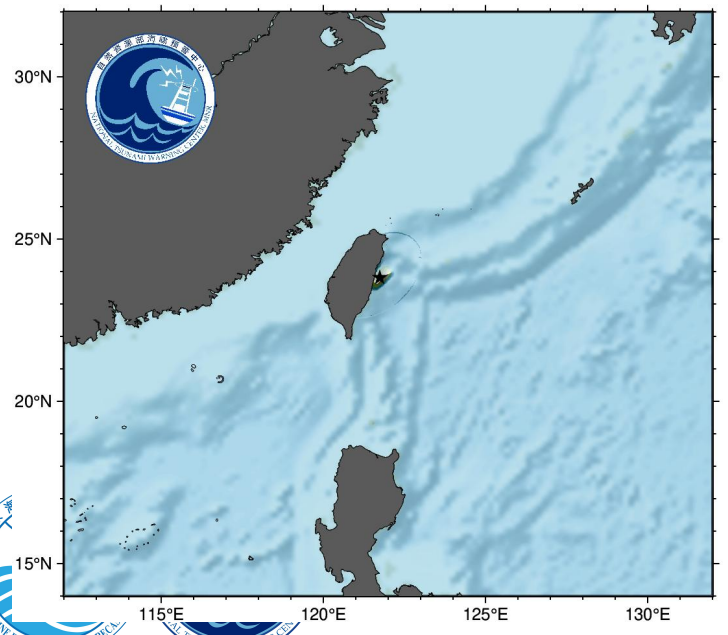
- Responded to 39 major Earthquakes
- Issued 66 tsunami information bulletins, 8 tsunami threat bulletins
- Average latency is 9.7 **minute** for the first message



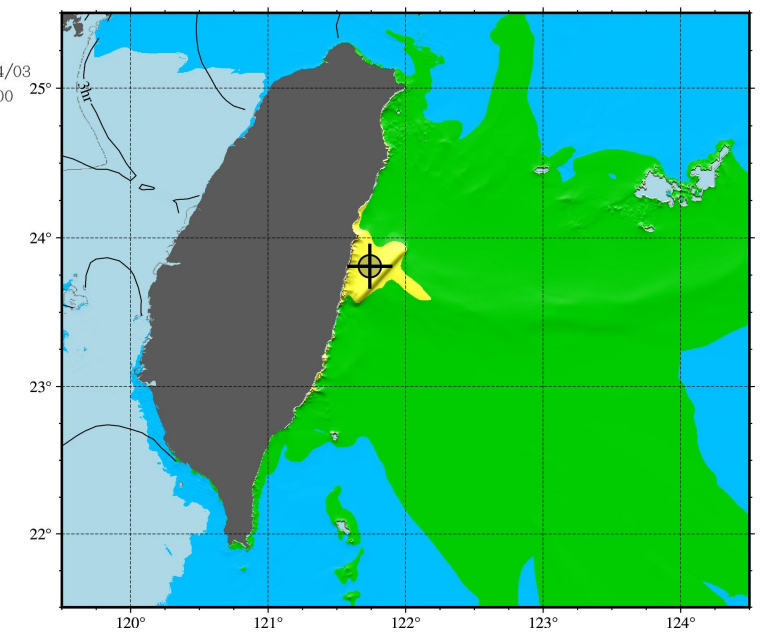
Response to Hualien Tsunami in 2024

- **At 7:58 (BJT) on April 3, 2024, a 7.3-magnitude earthquake** occurred off the west coast of Taiwan, China, with a focal depth of **12.0 kilometers**
- The Tsunami Warning Center issued **a Orange alert** for potential tsunami hazards in accordance with the "Marine Disaster Emergency Response Plan of China". This earthquake is expected to triggered a local tsunami near Hualien and may lead **a disastrous impact on some coastal areas of East Taiwan**
- The first bulletin issued with the elapse time of **12 mins**
- Hualien station reported a **105-centimeter** tsunami amplitude

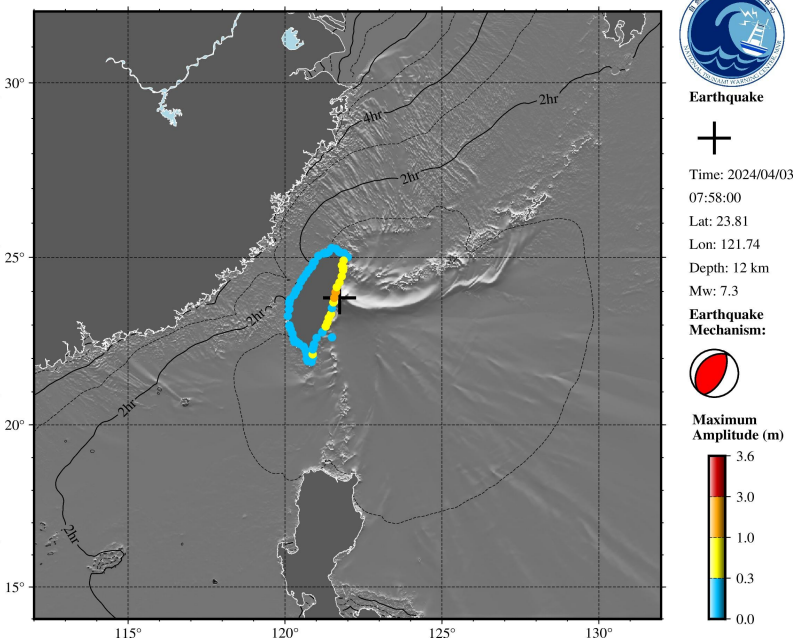
Tsunami forecast movie



Tsunami Travel Time and Refined Amplitude Forecast



Coastal Tsunami Amplitude Forecast



PacWave-2024 on Tsunami Awareness Day (5th NOV.)

- **The tsunami drill was conducted on November 5, 2024**
  - At 8:00 (Beijing Time), communication tests in the SCS Region
  - At 14:00 (Beijing Time), with the assumption of a magnitude 9.0 earthquake occurring in the Nankai Trough, a tsunami would be triggerred, and severely impact Jiangsu, Shanghai, Zhejiang, Fujian, Taiwan, Guangdong, Hong Kong, and Macao in China.

自然资源部海啸预警中心

演习专用

橙色

海啸警报

时间：2024 年 11 月 05 日 14 时 08 分

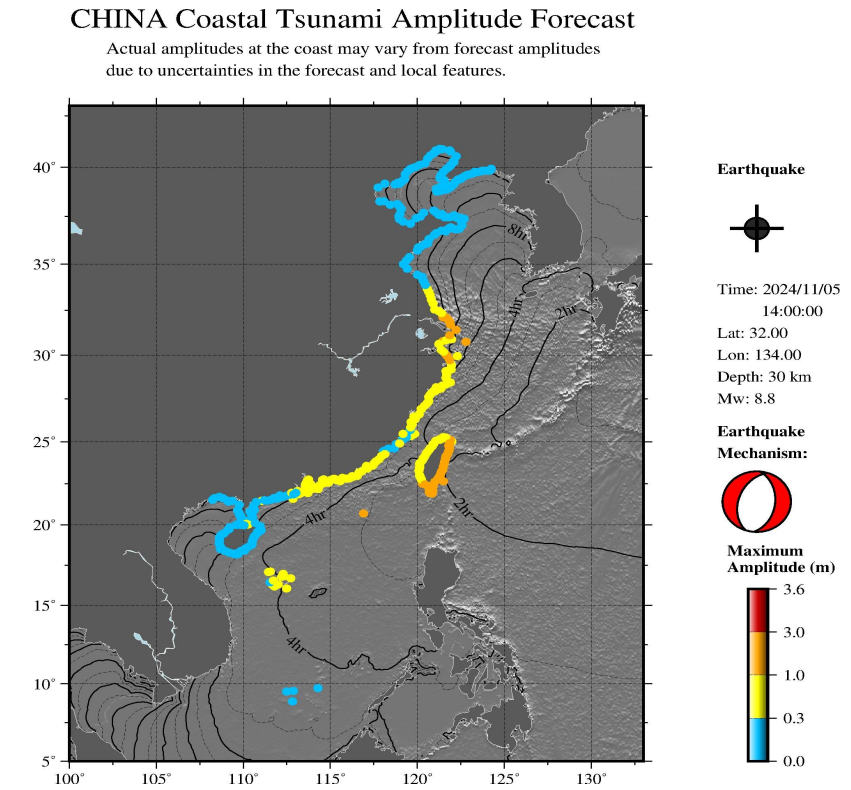
编号：海啸 2024-1105-1400-1　　签发：

自然资源部海啸预警中心根据《海洋灾害应急预案》，发布海啸橙色警报。

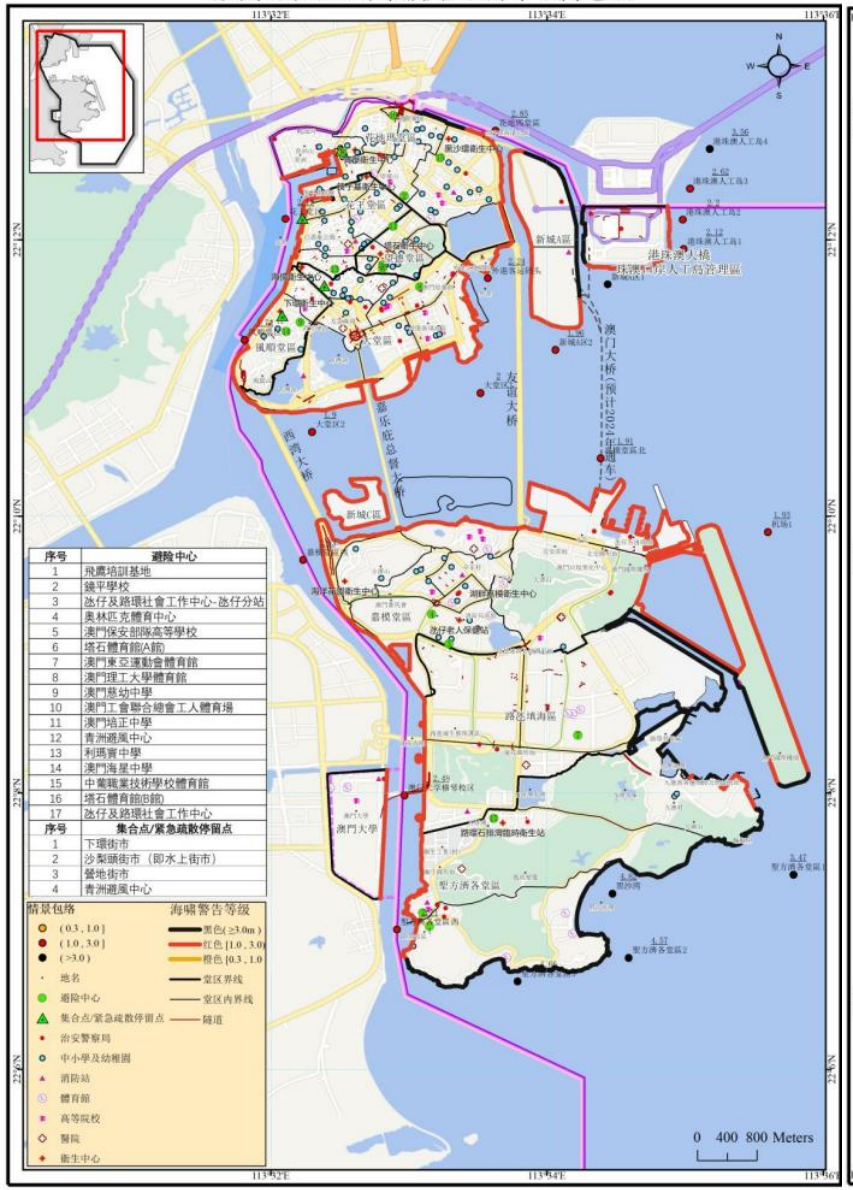
2024 年 11 月 05 日 14 时 00 分（北京时间），日本四国岛海域（32.0° N, 134.0° E）发生 8.8 级地震，震源深度为 30 千米。自然资源部海啸预警中心根据初步地震参数判断，地震可能引发太平洋越洋海啸，预计会对我国部分沿岸造成灾害性影响。

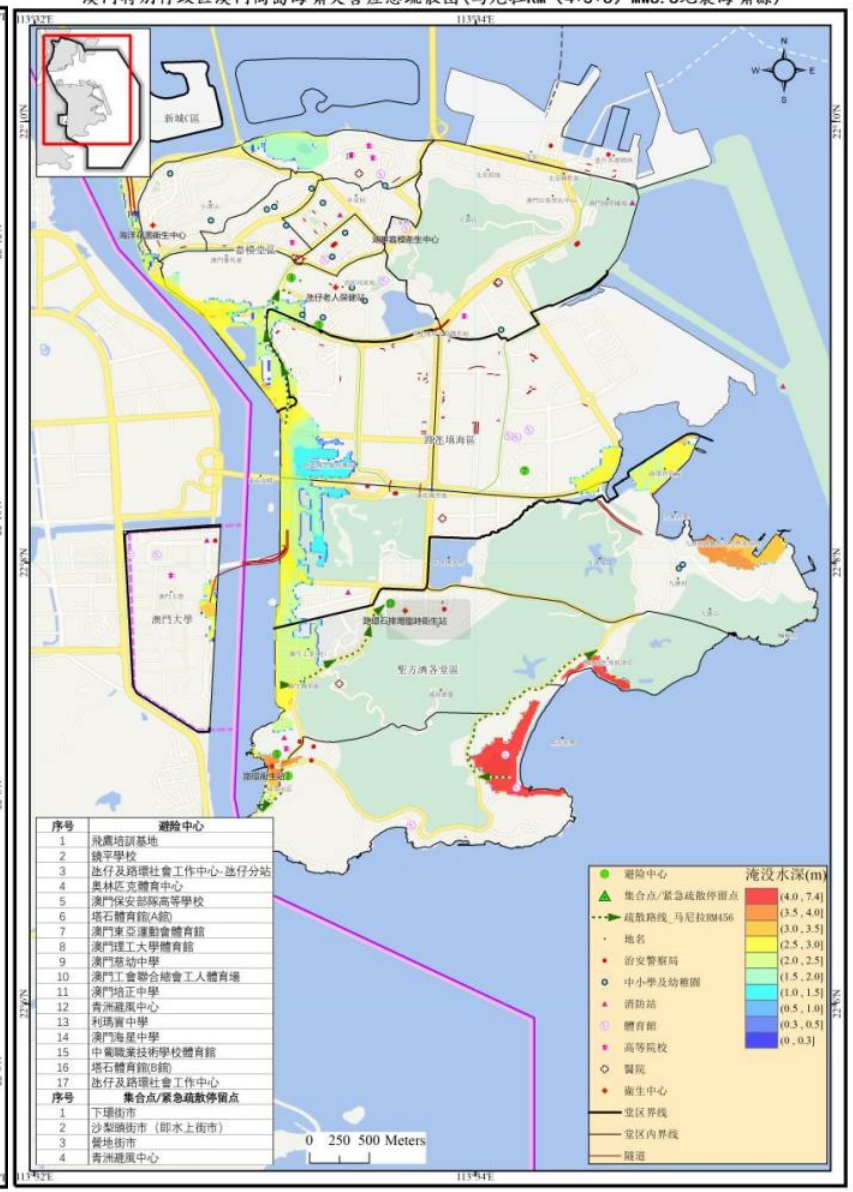
预报信息如下：

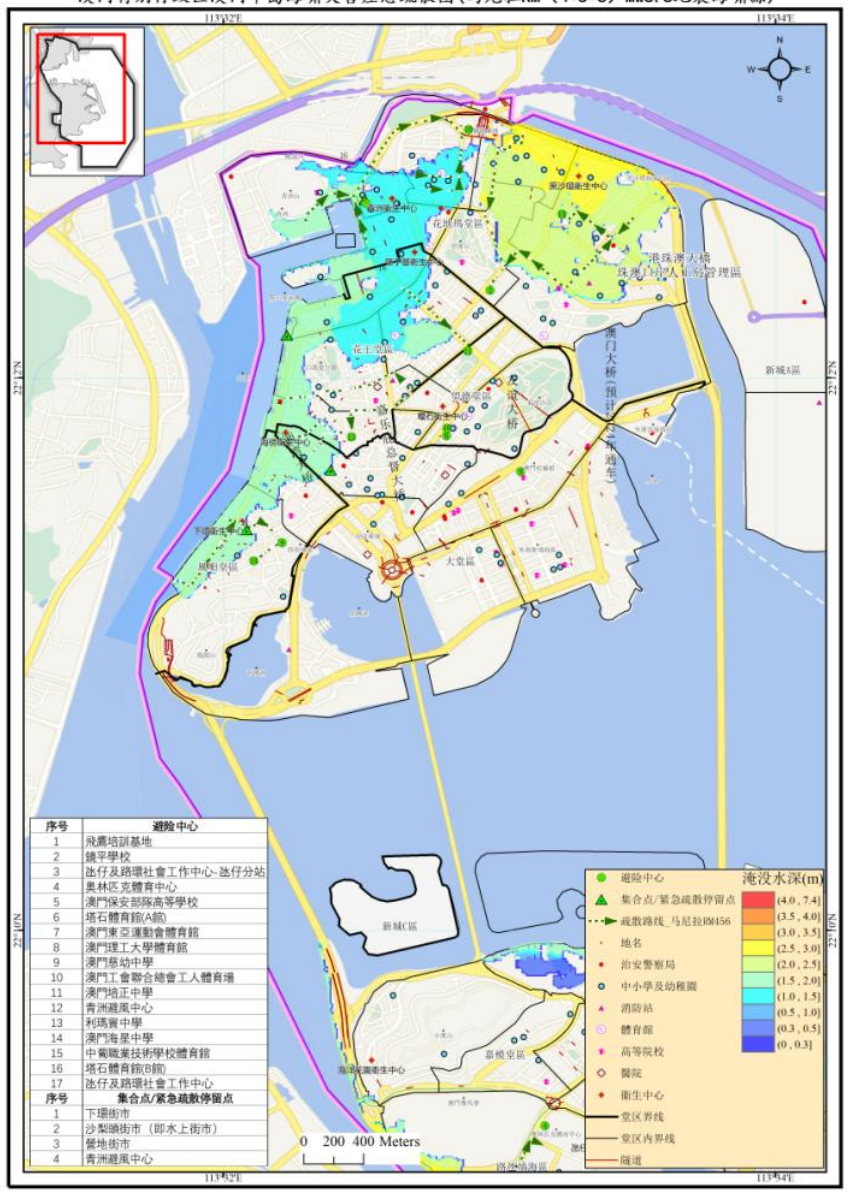
省份	预报区域	预报点	预计抵达时间（BJT）	最大波幅（厘米）	预警级别
江苏	南通	吕泗	00:04	100-300	橙色
江苏	盐城	滨海	01:24	30-100	黄色
上海	上海	佘山	21:51	100-300	橙色
浙江	秦山核电站	嘉兴海盐	01:01	30-100	黄色
浙江	舟山南	朱家尖	21:04	30-100	黄色
浙江	三门核电站	三门健跳	21:41	30-100	黄色
浙江	宁波北	镇海	22:36	100-300	橙色
浙江	嘉兴	嘉兴	23:48	30-100	黄色
台湾	花莲	花莲	16:03	30-100	黄色
台湾	台东北	富冈	16:06	30-100	黄色
台湾	台东南	大武	16:12	30-100	黄色
台湾	屏东东	屏东东	16:13	30-100	黄色
台湾	宜兰	宜兰县	16:16	30-100	黄色
台湾	台北东	台北东	16:21	30-100	黄色
台湾	屏东西	后壁湖	16:23	30-100	黄色
台湾	高雄	高雄	16:44	30-100	黄色
台湾	基隆	基隆	16:45	30-100	黄色



Tsunami Risk Assessment For Macau







4. Coordination, Training, Workshop and Visiting activities

Coordination

11th Meeting of the ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region in Guangzhou;

Training and workshop

Training course on numerical tsunami models in the South China Sea Region, Zhenjiang city of Jiangsu Province, 22 May, 2024

Domestic operation and management workshop on seismic station for tsunami warning services, 28-29 August, 2024

Visiting Reception and Communication

The Director of the Tsunami Resilience Department of the IOC/UNESCO visited NMEFC in 2024

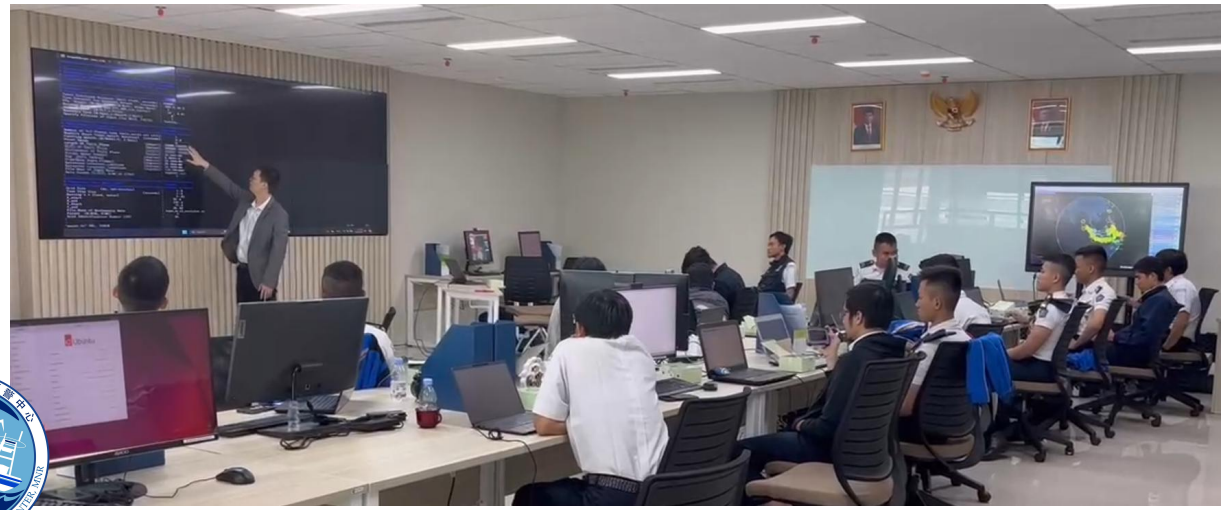
The Director of the Solomon Islands Meteorological Service visited NMEFC to seek cooperation in 2024

Visiting Activities

- Technical exchanges on marine disaster prevention and reduction with South Pacific island countries

Joint workshop with Indonesia

- An agreement was struck between STMKG-BMKG and NMEFC in 2024
- Joint workshop on tsunami, storm surge, and other ocean hazards forecasting with STMKG



Joint workshop with Bangaladesh

- Joint workshop on storm surge, ocean wave and tsunami forecasting with BMD
- Visit Dhaka University for international research corporation

Thank You!

National Marine Environmental Forecasting Center
National Tsunami Warning Center
Ministry of Natural Resources, P. R. China