unesco
Intergovernmental
Oceanographic
Commission

Thirteenth Meeting of the ICG/PTWS Regional Working Group
on Tsunami Warning and Mitigation System in the South China Sea Region,
18-19 November 2025, online

Report from SCS WG Task Team on Capacity Development and Services

Peitao Wang
South China Sea Tsunami Advisory Center, UNESCO/IOC

Outline

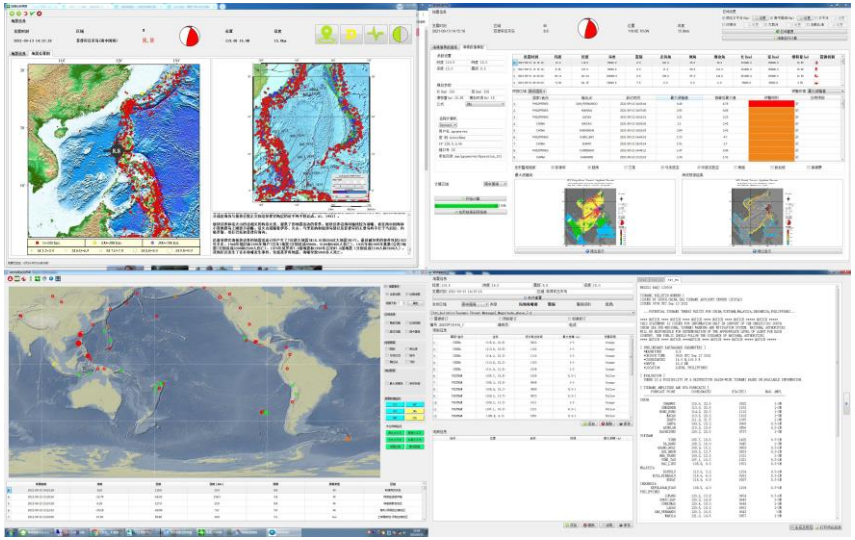
1. SCS WG TT on Capacity Development
2. Tsunami Warning Capacity Enhancement
3. Tsunami Preparedness and Trainning
4. Further Plans

1. SCS WG TT on Capacity Development

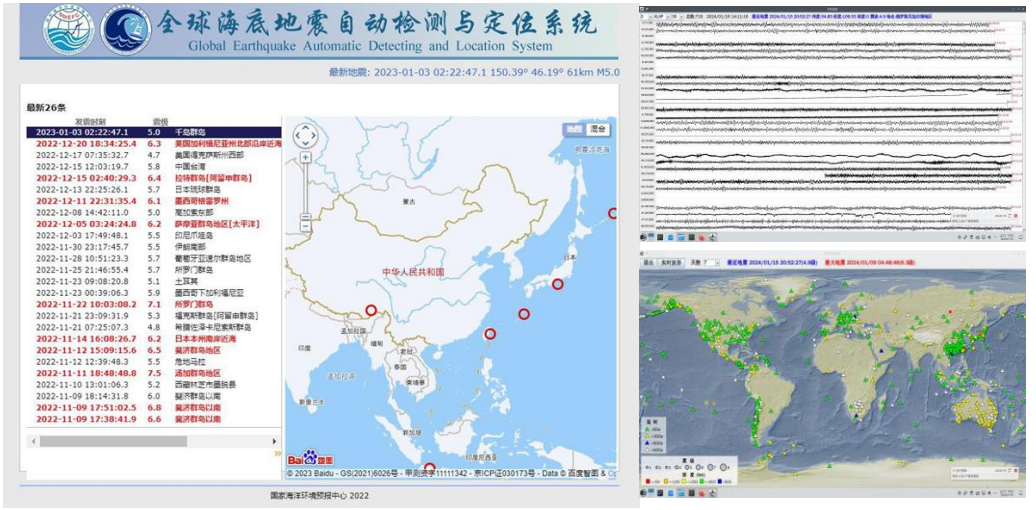
- Recommended the dissolution of the Task Team on Establishment of a South China Sea Tsunami Advisory Center of the Regional Working Group on Tsunami Warning and Mitigation in the South China Sea, and the establishment of a Task Team on Capacity Development and Services at the Tenth Meeting of ICG/PTWS WG-SCS (online) on 28 and 30 September 2021
- WG-SCS Task Team on Capacity Development and Services
  - Chair: Mr. Zhiguo Xu (China), 2021–2024
- ICG/PTWS-WG-SCS-XII
  - Mr. **Peitao Wang** (China) to continue serving as Chair of TT-CDS in the next intersessional period of ICG/PTWS
  - Mr. **Indra Gunawan** (Indonesia) as Vice Chair of TT-CDS in the next intersessional period of ICG/PTWS
  - Term: 2025

1. SCS WG TT on Capacity Development

- **Smart Tsunami Information process System in full operation**

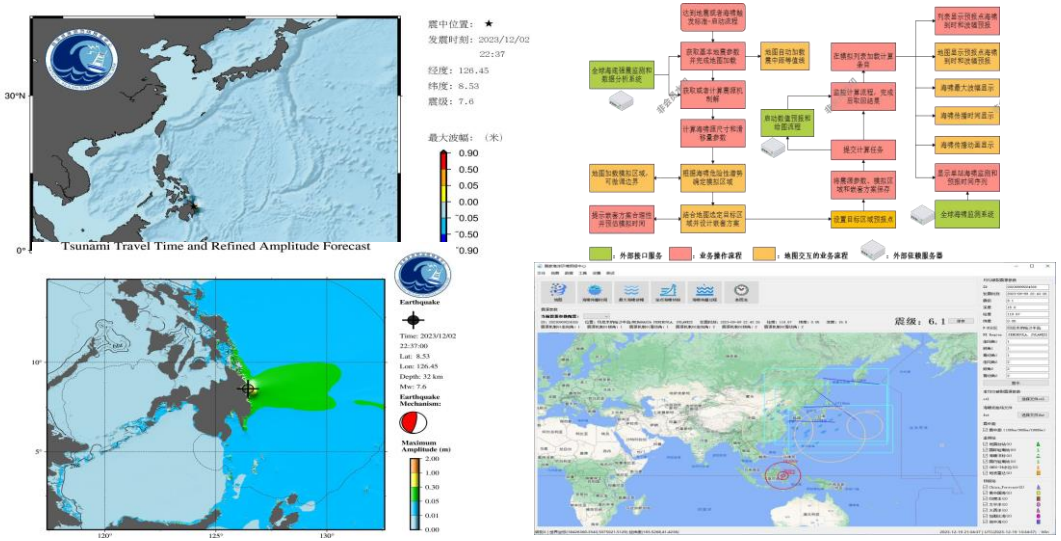


- **Global EarthquakeAutomatic Detecting and Location System**



- **GTS sea level data decoding and processing module**

- **Global tsunami warning product production and release**

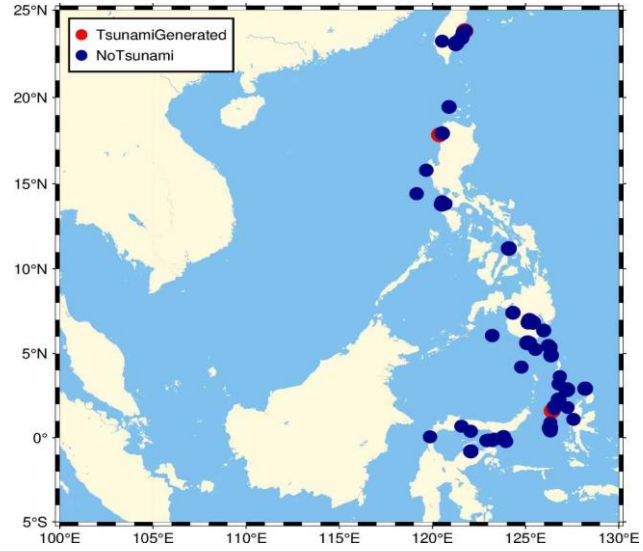


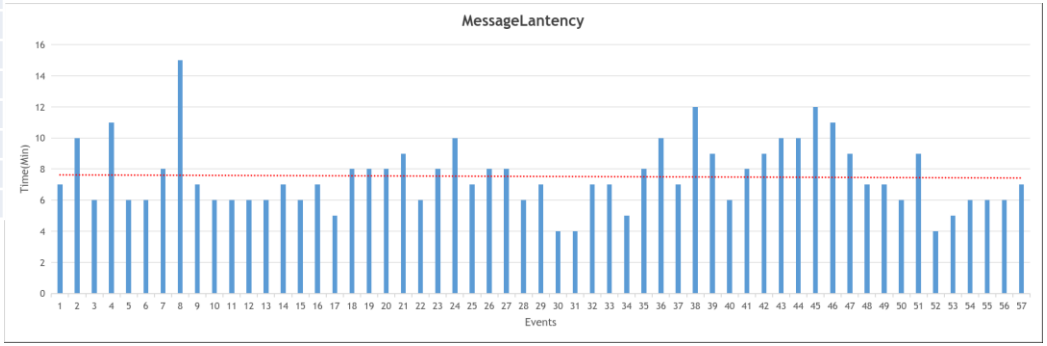
1. SCS WG TT on Capacity Development

Issued Tsunami Bulletins (Jan. 2019- Nov. 2025)

- ✓ **SCSTAC issued 63 bulletins for 57 earthquake events occurred around the SCS region since Jan. 2019.**
- ✓ **Most of the first Bulletins were issued in less than 8 minutes from EQ. origin time**
- ✓ **The tsunami with 105cm amplitude generated by the Mw7.3 occurred in Taiwan on 3 April 2024.**

Time	Magnitude	Depth	Area	Latitude	Longitude
2025-1104-2332	6.1	15	MINAHASSA PENINSULA, SULAWESI	-0.17	123.21
2025-0930-2159	6.9	10	LEYTE, PHILIPPINES	11.2	124.1
2025-0725-2129	6	15	NORTHERN MOLUCCA SEA	2.01	126.79
2025-0723-2050	6.2	125	MINAHASSA PENINSULA, SULAWESI	0.38	122.05
2025-0627-2307	6.2	100	MINDANAO, PHILIPPINES	5.37	126.33
2025-0611-1900	6.2	19	TAIWAN, PROVINCE OF CHINA	23.46	121.59
2025-0503-1251	6.1	15	MINAHASSA PENINSULA, SULAWESI	0.68	121.56
2025-0121-0017	6.1	15	TAIWAN, PROVINCE OF CHINA	23.23	120.52
2024-0923-1951	6.1	140	MINAHASSA PENINSULA, SULAWESI	-0.17	122.9
2024-0711-0213	6.3	613	MINDANAO, PHILIPPINES	6.06	123.21
2024-0423-0226	6.1	15	TAIWAN, PROVINCE OF CHINA	23.72	121.63
2024-0409-1748	6.6	70	NORTHERN MOLUCCA SEA	2.82	127.2
2024-0403-0758	7.3	12	TAIWAN, PROVINCE OF CHINA	23.81	121.74
2024-0109-0448	6.7	102	TALAUD ISLANDS, INDONESIA	4.89	126.37
2023-1122-0248	6	112	HALMAHERA, INDONESIA	1.79	127.25
2023-1117-1614	7	79	MINDANAO, PHILIPPINES	5.63	125.1
2023-1004-1921	6.5	130	MINDANAO, PHILIPPINES	5.45	126.23
2023-0912-1903	6.4	10	PHILIPPINE ISLANDS REGION	19.46	120.89
2023-0911-1251	6.1	157	HALMAHERA, INDONESIA	1.09	127.57





2. Tsunami Warning Capacity Enhancement

The tsunami warning system for the SCS region is supported by the National Marine Environmental Forecasting Center/National Tsunami Warning Center of China, located in Beijing, with a backup center(BSCSTAC) being run by the Hong Kong Observatory.

2. Tsunami Warning Capacity Enhancement

2.1 The revision of the User's Guide for SCSTAC products

☐ From "Product Description" to "Operational Manual"

The structure has been reorganized, with a new "Operations" chapter added to detail the facilities, tools, and procedures of SCSTAC.

☐ Comprehensive update

The content has been comprehensively updated to reflect institutional developments up to 2025, including the backup center and new decision support systems.

☐ Enhanced Professionalism & Consistency

Terminology has been standardized, product templates have been refined, and the quality of graphics has been significantly improved.

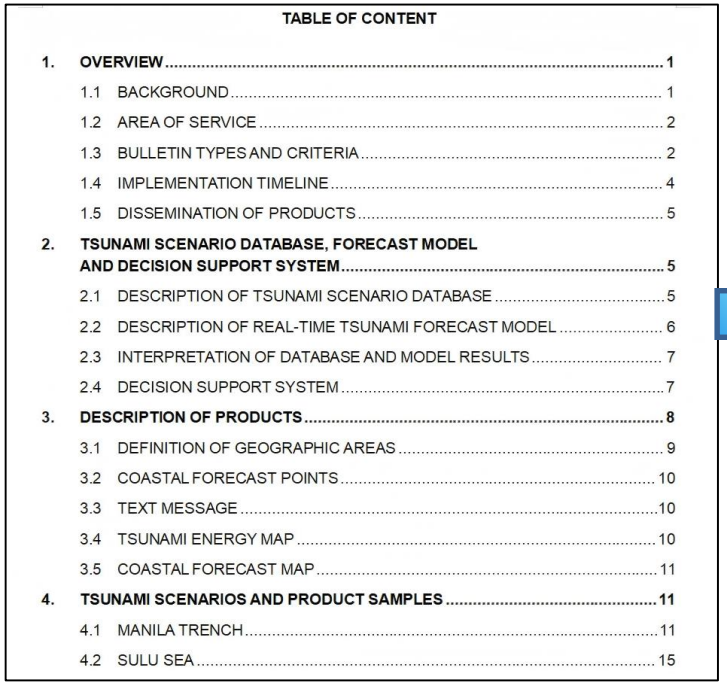


TABLE OF CONTENT

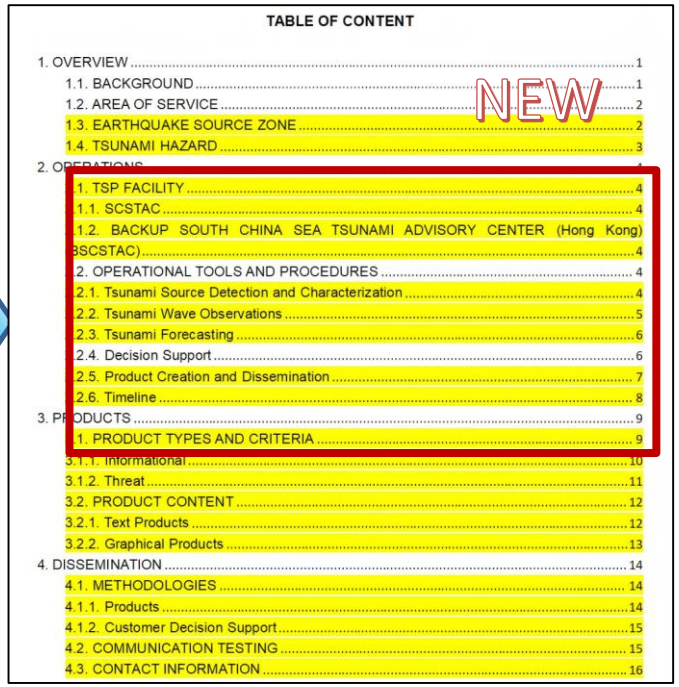


TABLE OF CONTENT

NEW

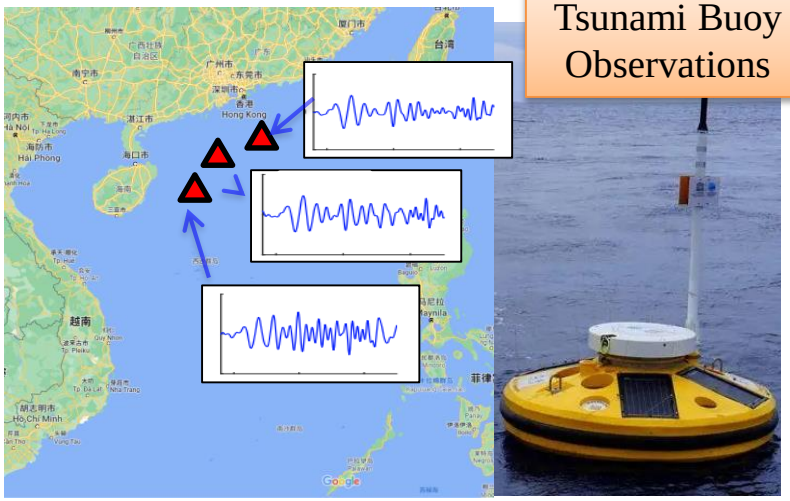
The 2019 version

The 2025 version

2. Tsunami Warning Capacity Enhancement

2.2 Tsunami Data Assimilation System

- **Tsunami Assimilation Model and Methods**



Assimilation Methods

Nearshore and deep-ocean tsunami observation data

Numerical model produces accurate early warning

Optimal interpolation method reconstructs the analysis field of model state using a linear combination of background field and observational data:

$$X_a = X_b + K(d - HX_b)$$

$$K = BH^T[HBH^T + R]^{-1}$$

Tsunami Wave Field

$$x_n = (h(n\Delta t, x, y), M(n\Delta t, x, y), N(n\Delta t, x, y))^T$$

Height X-Velocity Y-Velocity

$$x_n^f = Fx_{n-1}^a \qquad x_n^a = x_n^f + W(y_n - Hx_n^f)$$

I. Forecast Step II. Assimilation Correction Step

Assimilation process is iteratively executed by linear shallow water equations

$$\frac{\partial \eta(x,y,t)}{\partial t} = -\frac{\partial M(x,y,t)}{\partial x} - \frac{\partial N(x,y,t)}{\partial y}$$

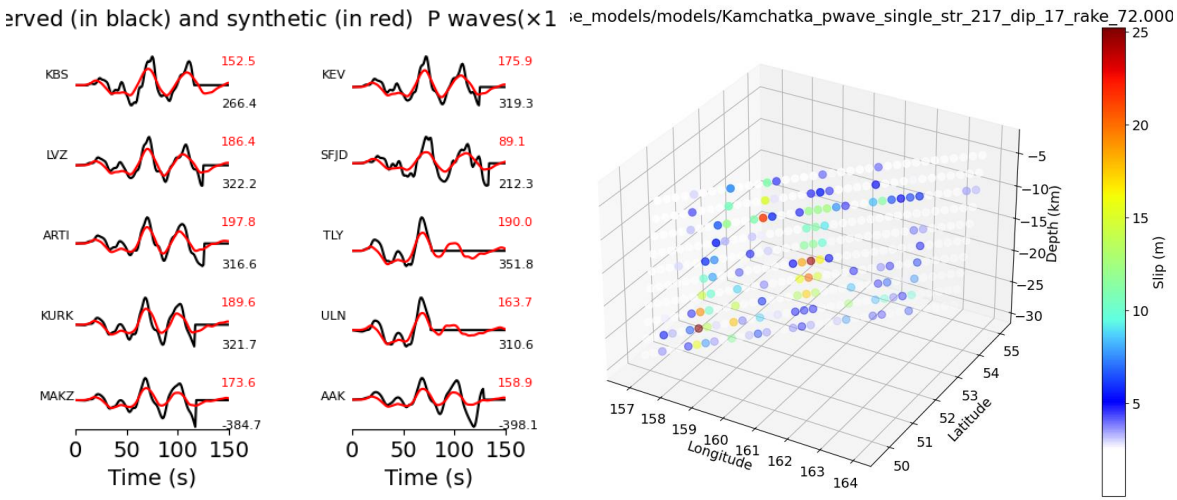
$$\frac{\partial M(x,y,t)}{\partial t} = -gD(x,y)\frac{\partial \eta(x,y,t)}{\partial x}$$

$$\frac{\partial N(x,y,t)}{\partial t} = -gD(x,y)\frac{\partial \eta(x,y,t)}{\partial y}$$

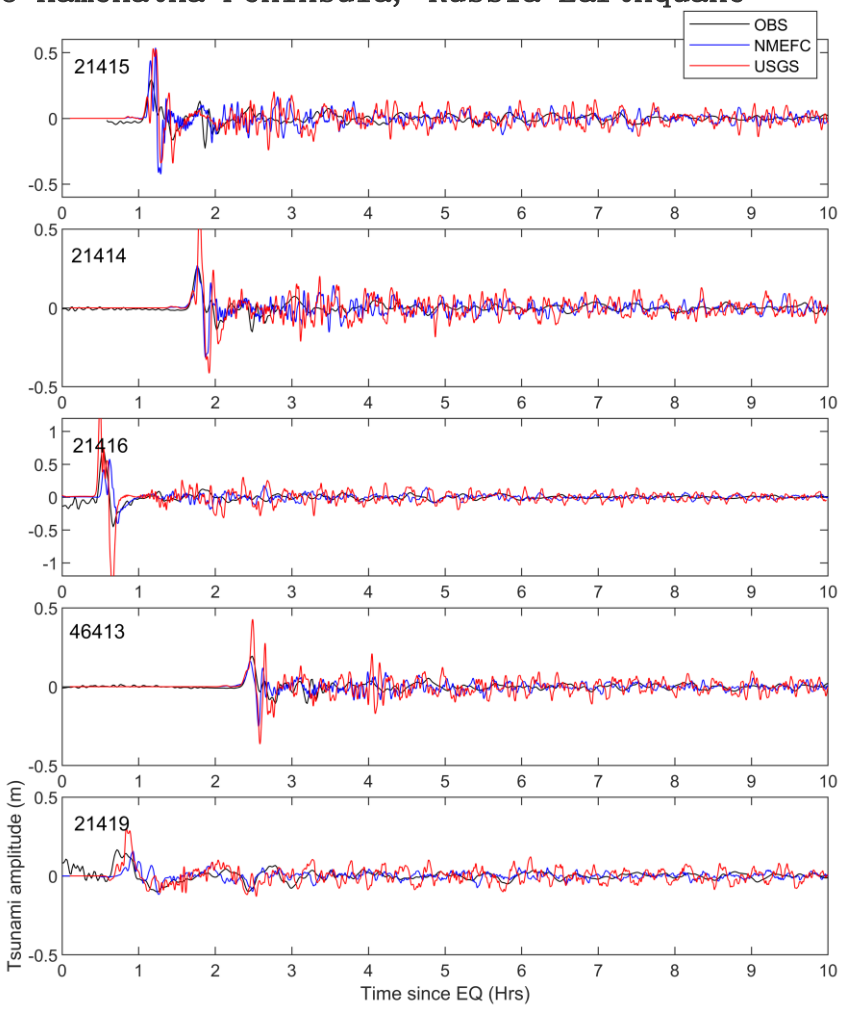
Without considering the source process, spatiotemporal constraints and reconstruction of the propagation process are performed through observational data

2. Tsunami Warning Capacity Enhancement

2.3 Tsunami Data Inversion



- Overall, the observed ground motion is consistent with the simulated ground motion.
- Slip on the fault plane is mainly distributed within 0km~240km along strike and -10km~80km along dip from the epicenter. The maximum slip of 26m occurs at 157.6° E, 51° N, at a depth of 25km.
- The overall rupture pattern of the fault is dominated by westward and southward slip, which is consistent with USGS aftershock data.
- Using the inversion results for tsunami simulation and comparing tsunami waves at four stations with observational data shows good consistency.

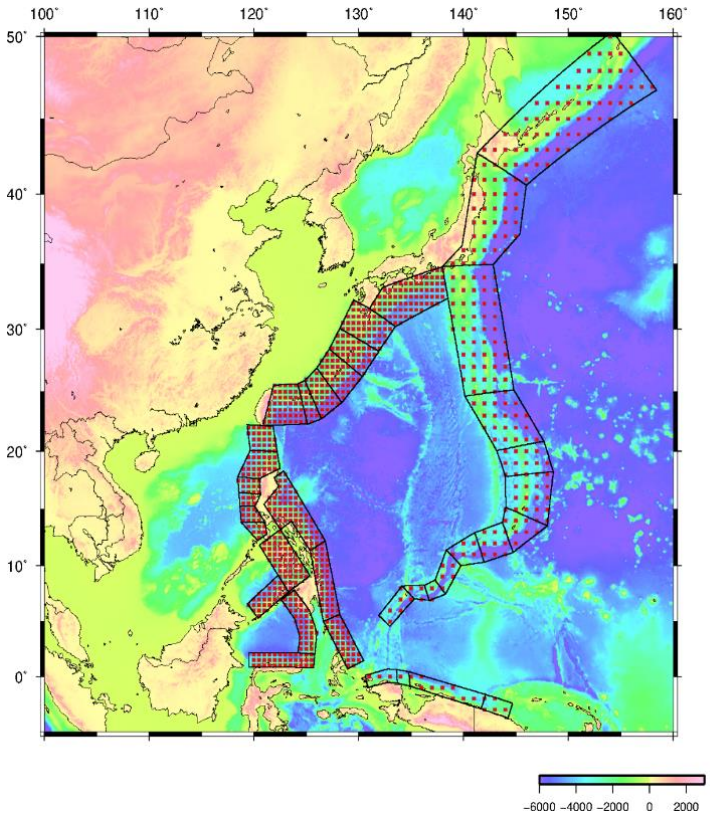


Comparative Analysis of Tsunami Simulation Results

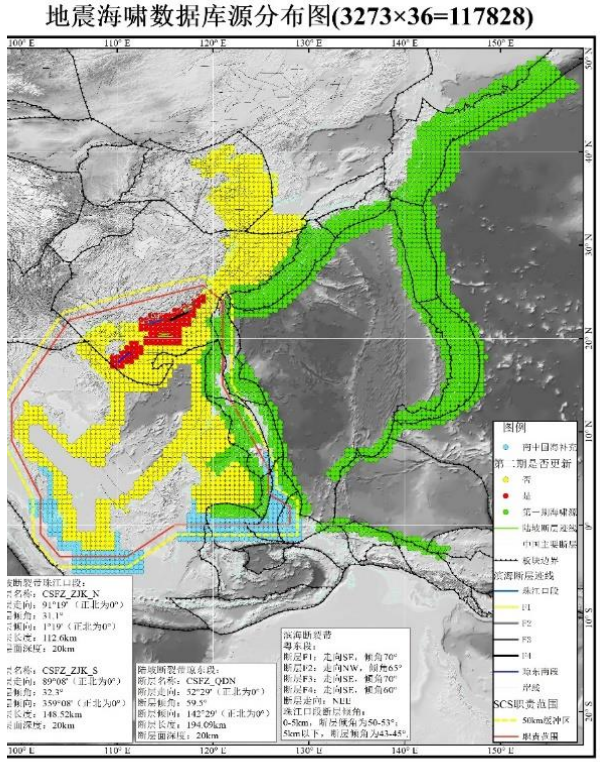
2. Tsunami Warning Capacity Enhancement

2.4 Tsunami Scenario Database Expansion

- **Expanded the tsunami scenario database for the South China Sea region from 60,000 to nearly 120,000 scenarios, significantly improving the efficiency of quantitative emergency response in the South China Sea region.**
- **The new tsunami scenario database achieved full coverage of potential intraplate seismic sources in the continental slope and continental shelf areas of China's coastal waters and the South China Sea region.**
- **Given the limited data on intraplate seismic source mechanisms, historical data was compiled and multiple research teams from both domestic and international sources were consulted to determine the source mechanism parameters for the newly added scenarios.**



Tsunami scenarios before expansion: 60,156

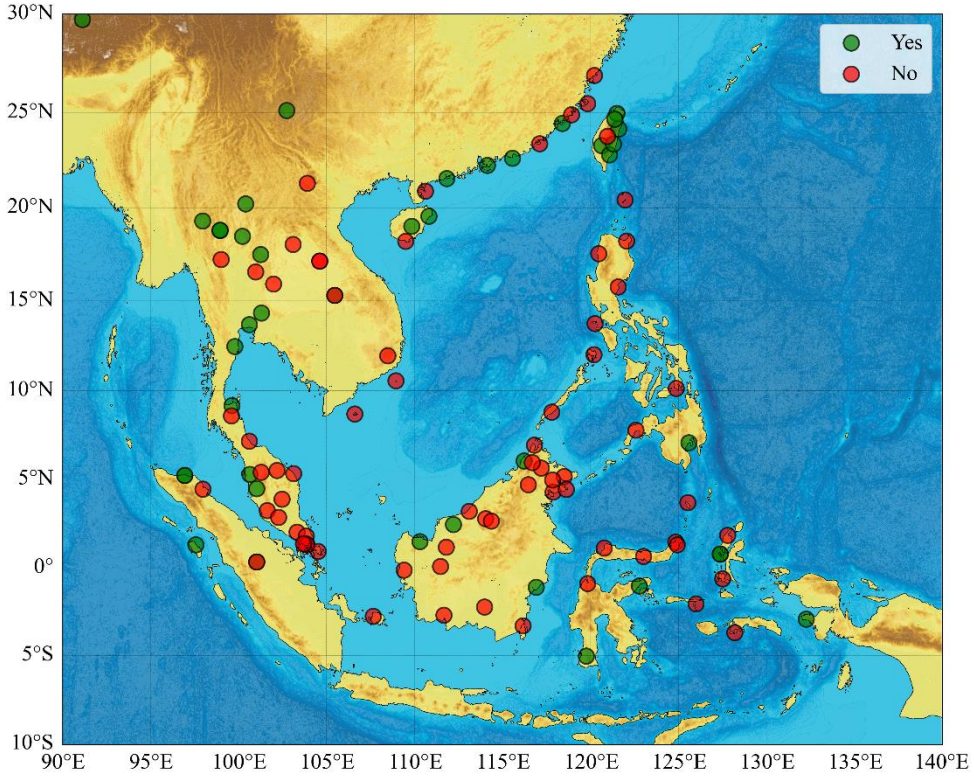


Tsunami scenarios after expansion: 117,828

2. Tsunami Warning Capacity Enhancement

2.5 Seismic stations in the core network in SCS

- Accessibility of Seismic Core Stations(116) in the SCS region in 2025



China: 22[14Yes/8No]
Indonesia : 30[10Yes/20No]
Malaysia : 25[5Yes/20No]
Philippines :10[1Yes/9No]
Singapore: 4[1Yes/3No]
Thailand : 20[10Yes/10No]
Viet Nam: 4[0 Yes/4No]
Brunei: 1[0 Yes/1 No]

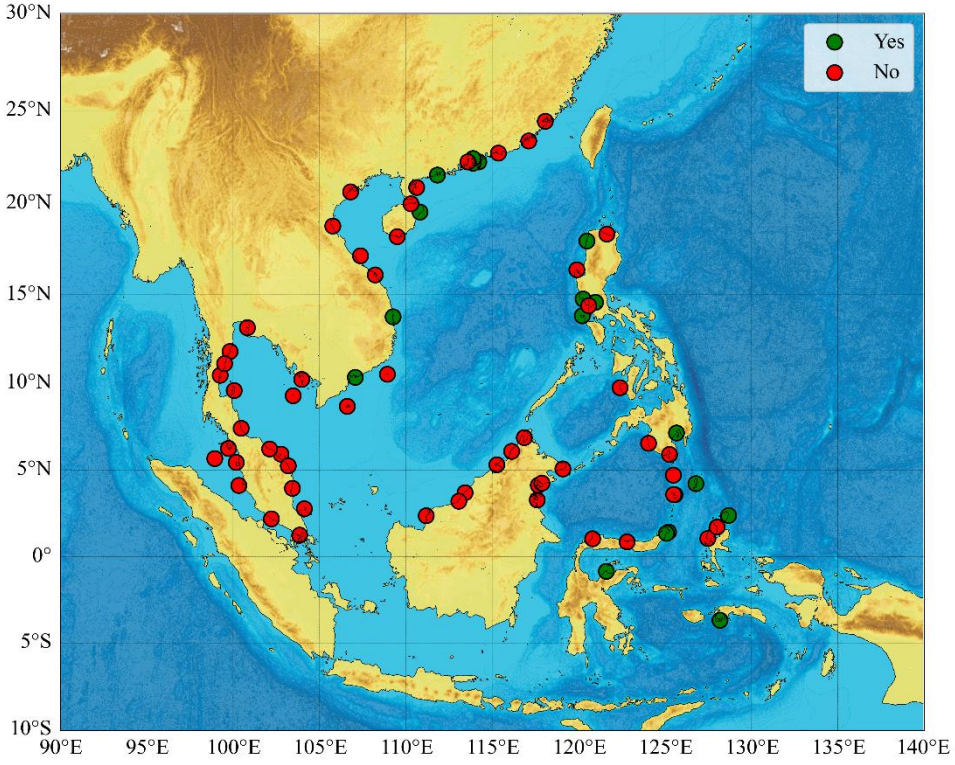
---

116 [41 Yes/75 No]

2. Tsunami Warning Capacity Enhancement

2.6 Sea Level Stations in the core network in SCS

- **Availability of** Sea Level Stations in the SCS region **in 2025**
- **19(accessibility)** /71(total) up to 31 Oct. 2025



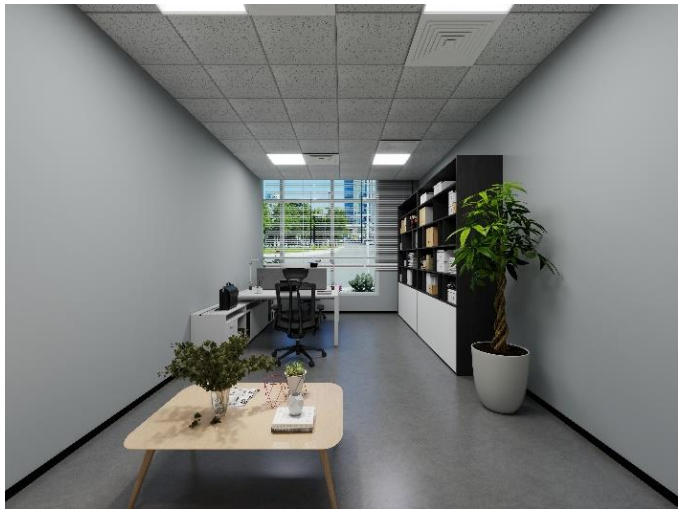
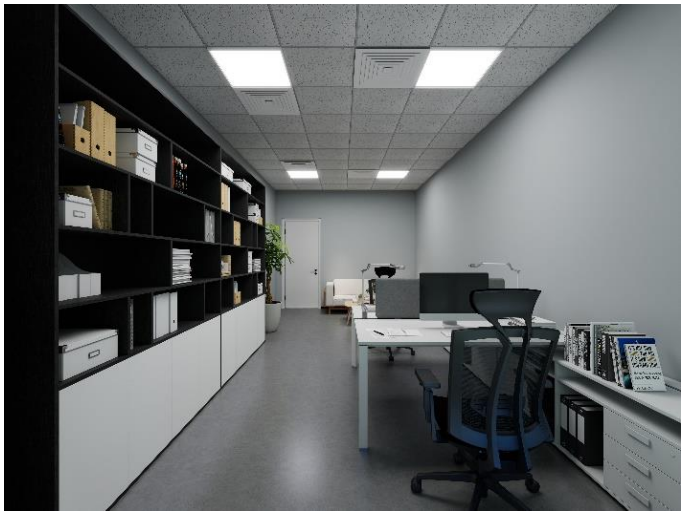
China:	**12 [5 Yes/7 No]**
Indonesia:	**10 [7 Yes/3 No]**
Malaysia:	**20 [0 Yes/20 No]**
Philippines:	**11 [5 Yes/6 No]**
Singapore:	**1 [0 Yes/1 No]**
Thailand:	**7 [0 Yes/7 No]**
Viet Nam:	**10 [2 Yes/8 No]**
	71 [19 Yes/52 No]

Green - accessible .vs. red - unaccessible

2. Tsunami Warning Capacity Enhancement

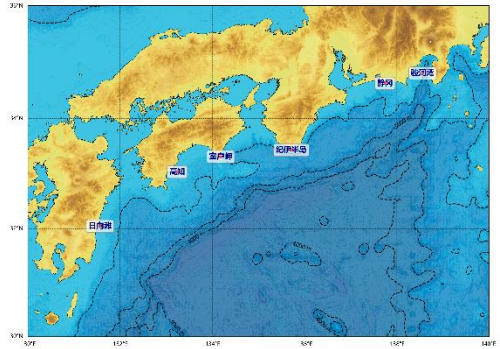
2.8 Backup tsunami warning system in Hainan, China



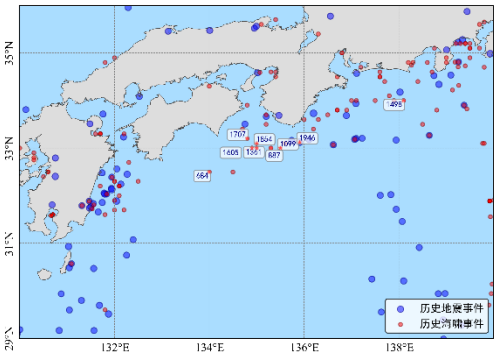




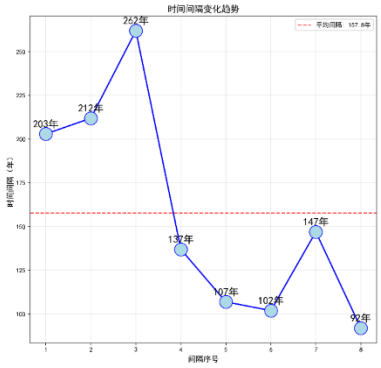

3. Tsunami Preparedness and Trainning

3.1 Tsunami Risk Assessment (Nankai Trough)

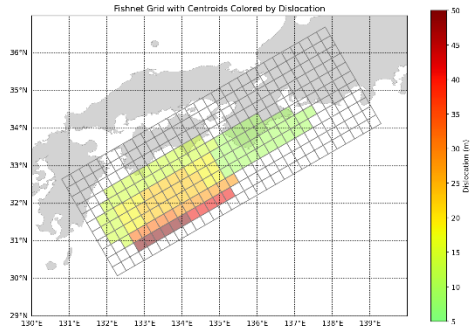


- **Analyze the geological structure around the fault**
- **Historical earthquake and tsunami events**

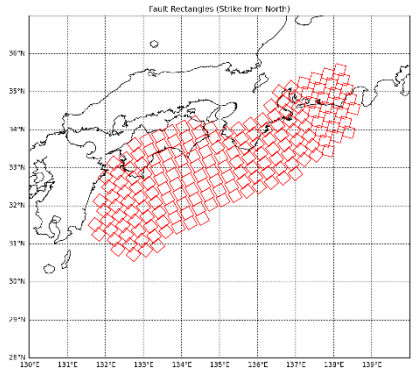




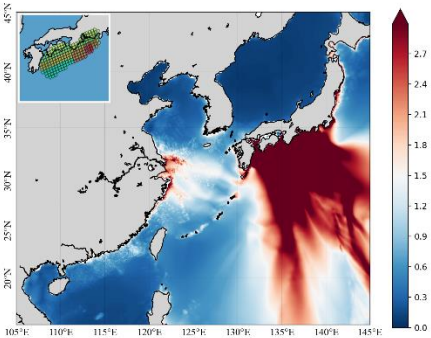
- **Geometric Parameters**
  - Subfault length and width: 30 kilometers
  - Number of subfaults: 187
- **Slip Distribution (EXSIM12 Model)**
  - Stochastic finite-fault method

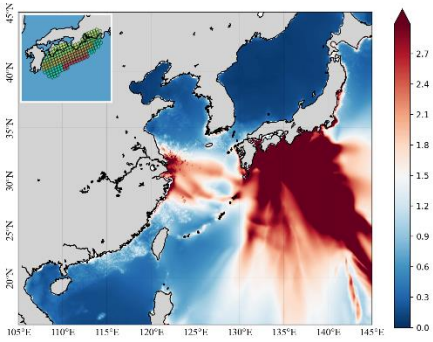


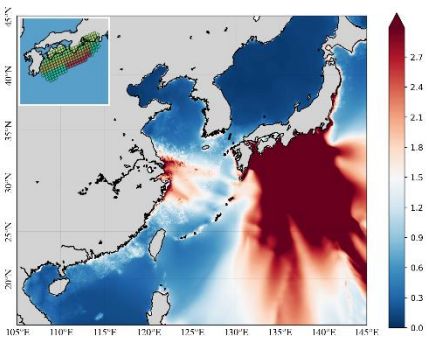
- **Source Mechanism Parameters (Slab 2.0)**
  - Strike
  - Dip
  - Rake
  - Focal depth

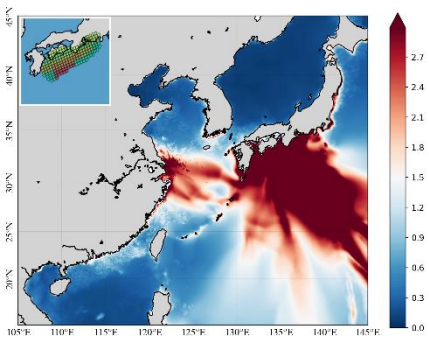


- **Numerical calculation and result analysis**





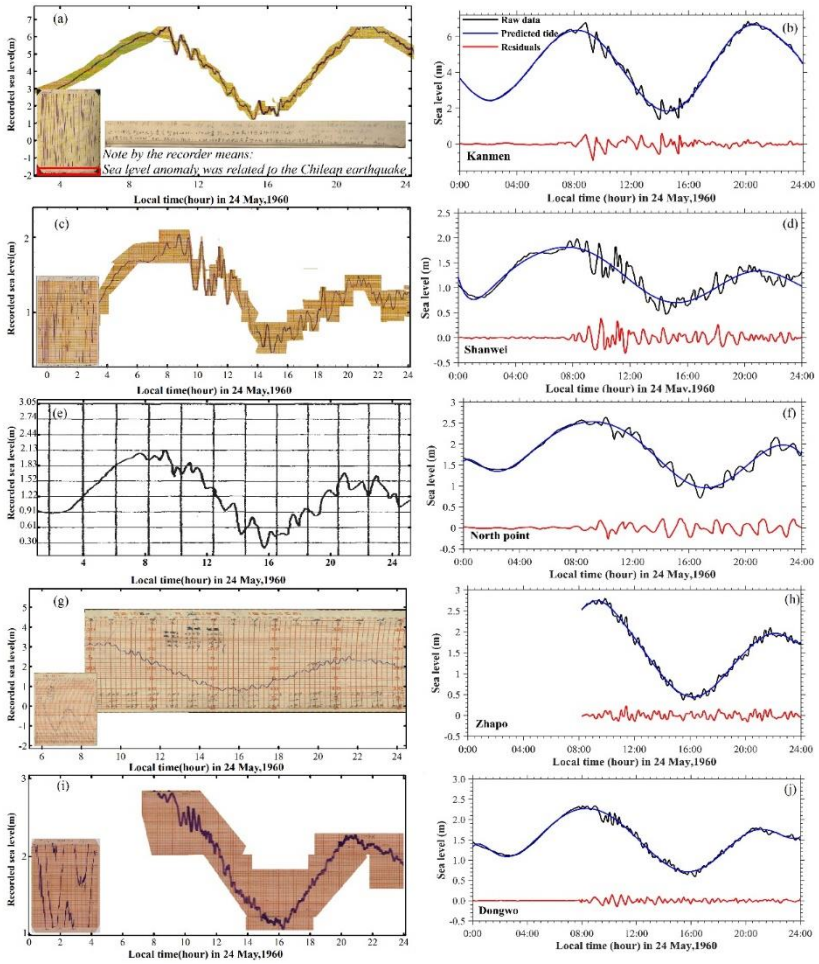




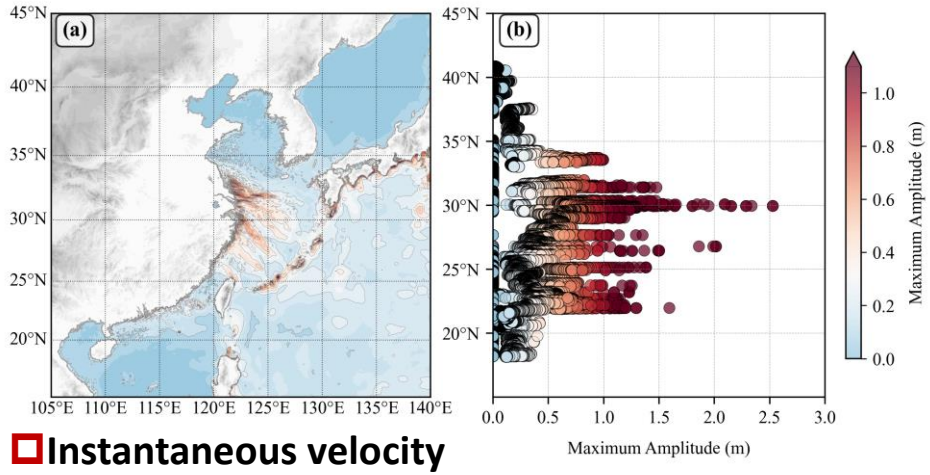
3. Tsunami Preparedness and Trainning

3.3 Reconstruction of historical 1960 Chilean tsunami

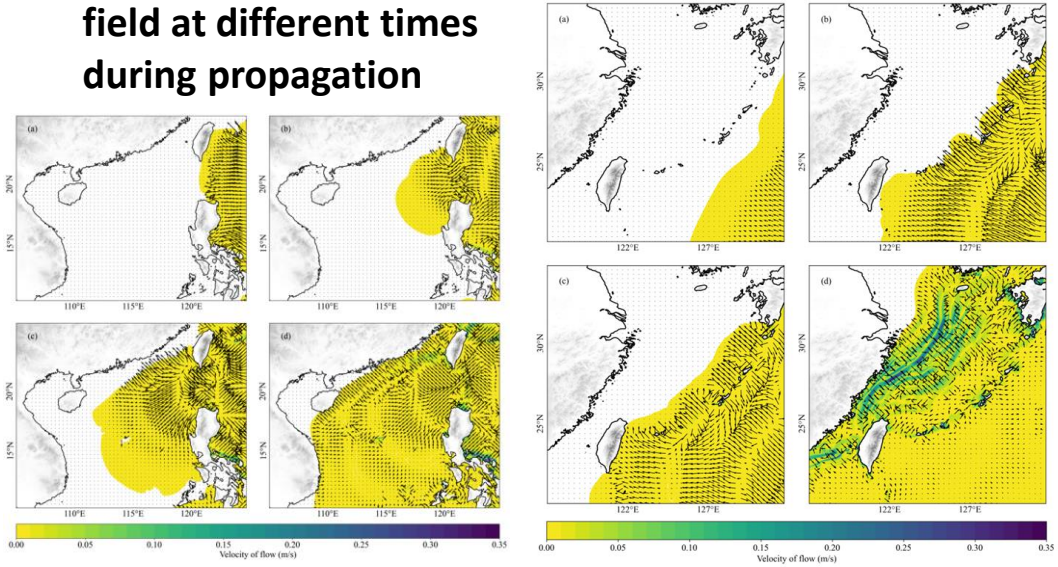
- **Tsunami observation extracted from historical paper water level records**



- **Maximum amplitude of Chile tsunami in 1960**



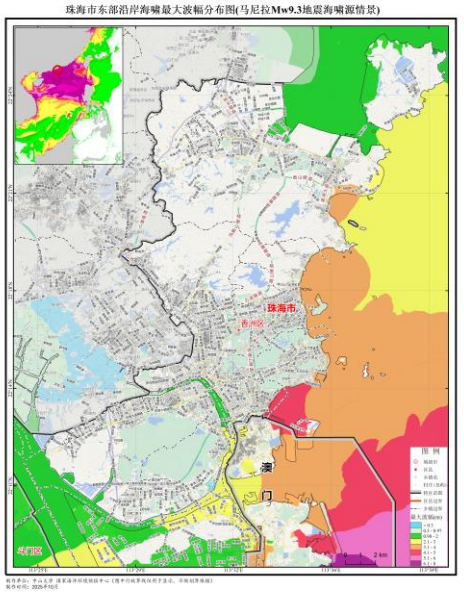
- **Instantaneous velocity field at different times during propagation**

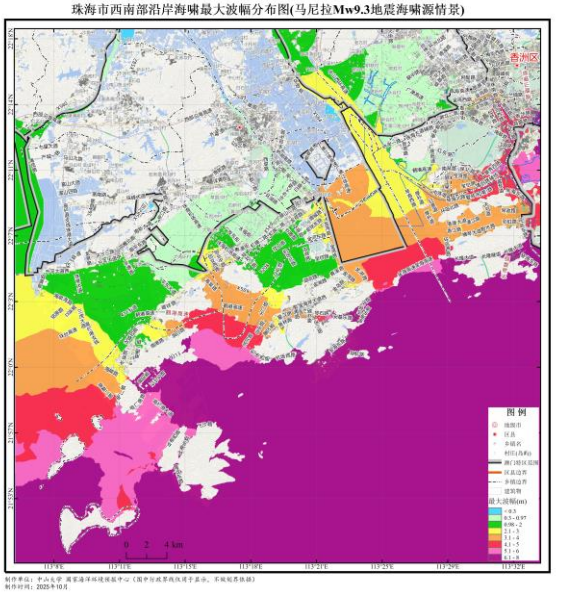


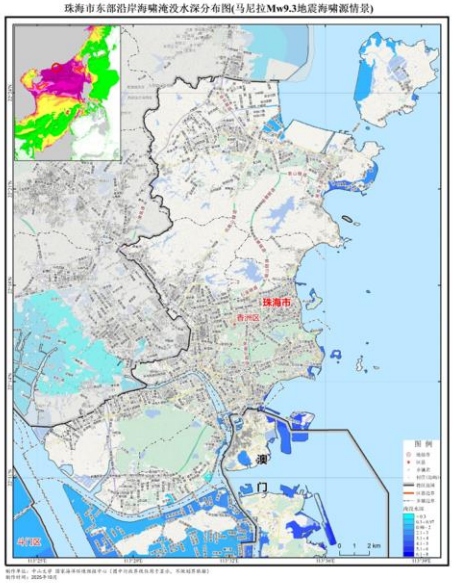
3. Tsunami Preparedness and Trainning

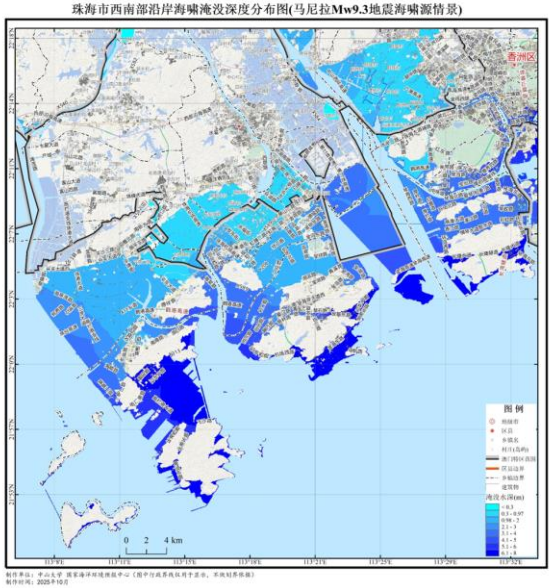
3.2 Tsunami Inundation

- **Based on the global earthquake-landslide-tsunami dataset since 1900, a systematic analysis of 147 earthquake, landslide, tsunami, submarine cable rupture disaster chain events was conducted to identify hazardous seismic tsunami sources. Comprehensive numerical simulation and analysis of historical tsunami events and potential scenario earthquakes along the South China coast were completed, and two key research areas were identified: the Pearl River Estuary and Shantou with their adjacent offshore regions.**









3. Tsunami Preparedness and Trainning

3.4 "Mazu" Ocean Models Training in STMKG

- Localized deployment and application of the "Mazu" models in Indonesia
- 15 professional technical staff from STMKG participated in the training
- Nearly 4 days of hands-on computer practice
- Participants are now capable of independently conducting operational modeling for specific requirements

MEMORANDUM OF UNDERSTANDING

BETWEEN

STATE COLLEGE OF METEOROLOGY, CLIMATOLOGY, AND GEOPHYSICS
AGENCY FOR METEOROLOGY, CLIMATOLOGY, AND GEOPHYSICS
OF THE REPUBLIC OF INDONESIA

AND

NATIONAL MARINE ENVIRONMENTAL FORECASTING CENTER
MINISTRY OF NATURAL RESOURCES
PEOPLE'S REPUBLIC OF CHINA

CONCERNING
TSUNAMI HAZARD, CLIMATE CHANGE AND COMPOUND DISASTER

ARTICLE 12
ENTRY INTO FORCE, DURATION, AND TERMINATION

1. This MOU shall be effective on the date of its signing and remain valid for a period of 5 (five) years and may be extended for another 5 (five) years by mutual written consent among the Parties.
2. This MOU may be terminated by either Party by giving written notice to the other Party of its intention to terminate this MOU at least 6 (six) months prior to the intended date of termination.
3. The expiration or termination of this MOU shall not prejudice the completion of any ongoing programs or projects that was mutually agreed upon by the Parties prior to the expiration or termination of the MOU, unless decided otherwise by the Parties.

IN WITNESS THEREOF, the undersigned have signed this MOU.

DONE in four copies in English languages on 28 June, 2024.

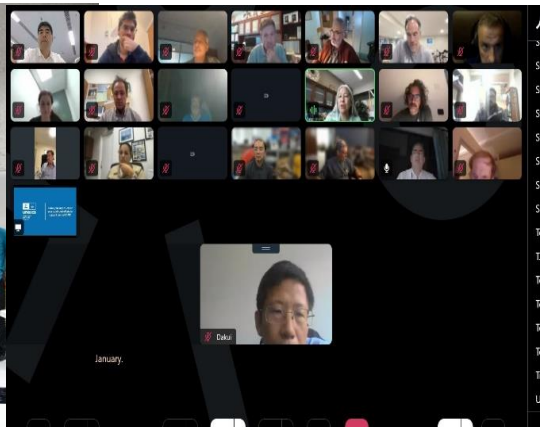
For STMKG
Dr. Suko Prayitno Adi, M.Si, M.I.Kom, IPU
Acting, Director

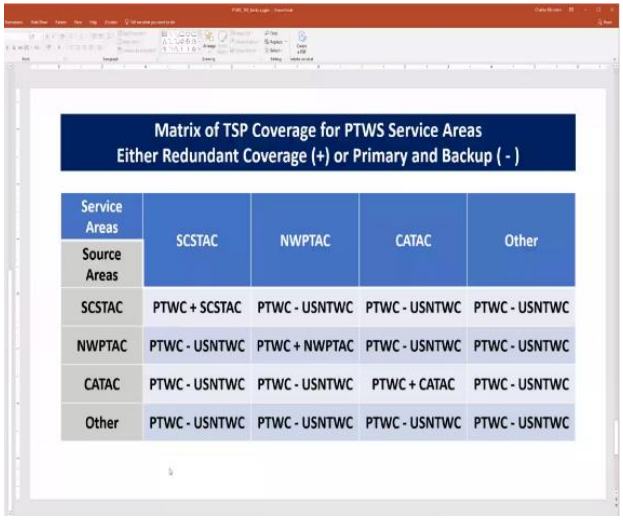
For NMEFC
Mr. Fuqiang Yu
Director-General

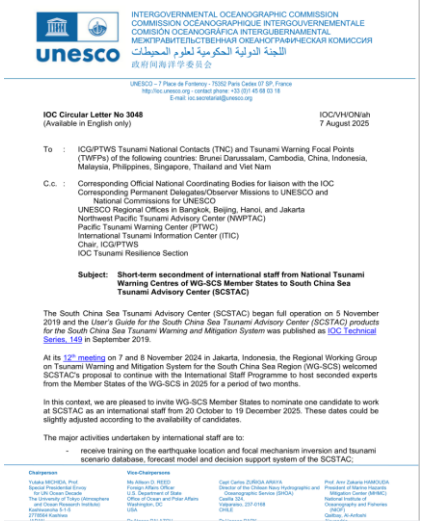
3. Tsunami Preparedness and Trainning

3.5 International cooperation and capacity building

- **April 7-12: Assisted the Operations Department in successfully hosting the 31st ICG/PTWS Session and the 9th PTWS/IUGG Tsunami Symposium**
- **May 13-17: Attended the first PTWS Tsunami Preparedness Assessment Workshop in the Philippines**
- **June 24-27: IOC 33rd Session**
- **August 12: Participated in the PTWS Kamchatka Tsunami Warning Response Capacity Assessment briefing**
- **August 18: Participated in PTWS WG2 meeting on backup mechanisms for warning centers**
- **August 20: Recruitment and selection of short-term international staff applications for 2025**







3. Tsunami Preparedness and Trainning

3.6 Questionnaire on tsunami Warning products

Tsunami Warning Information Public Feedback Survey

- **Survey Overview**

•**Purpose**: Collect public feedback to improve tsunami warning services

•**Anonymity**: Fully anonymous survey

•**Time Cost**: Only 3-5 minutes to complete

•**Issuer**: South China Sea Tsunami Advisory Center, UNESCO/IOC

- **Survey Structure & Core Content**

1. Basic Information

•Country/region (covers China, Indonesia, Philippines, etc.)

•Age group

•Whether you have received tsunami warning information

•2. Warning Information Reception

•Reception channels (mobile text, TV/radio, official apps, social media, etc.)

•Satisfaction with timeliness of information dissemination

3. Warning Information Content Evaluation

•Completeness of current content (earthquake info, tsunami occurrence, arrival time, etc.)

•Clarity of information presentation

•Most important content (select up to 3: wave height, affected areas, evacuation guidance, etc.)

4. Improvement Suggestions

•Desired additional content (evacuation routes, impact classification, multi-language, etc.)

•Suggestions for information dissemination

•Willingness to participate in warning education/drills

Part 1: Basic Information

1. Your country/region:
   - ☐ China
   - ☐ Indonesia
   - ☐ The Philippines
   - ☐ Malaysia
   - ☐ Viet Nam
   - ☐ Thailand
   - ☐ Cambodia
   - ☐ Brunei
   - ☐ Singapore
   - ☐ Other: _____
2. Your age group:
   - ☐ Under 18
   - ☐ 18-30
   - ☐ 31-45
   - ☐ 46-60
   - ☐ Over 60
3. Have you ever received tsunami warning information?
   - ☐ Yes
   - ☐ No (If "No", please skip to Question 10)

Part 2: Warning Information Reception

4. Through which channels do you usually receive tsunami warning information? (Multiple selections allowed)
   - ☐ Mobile phone text messages
   - ☐ Television and radio
   - ☐ Official government websites/apps
   - ☐ Social media (Weibo, WeChat, etc.)
   - ☐ Community/village committee notifications
   - ☐ Other: _____
5. How satisfied are you with the timeliness of warning information dissemination?
   - ☐ Very satisfied
   - ☐ Somewhat satisfied
   - ☐ Neutral
   - ☐ Somewhat dissatisfied
   - ☐ Very dissatisfied

Part 3: Warning Information Content Evaluation

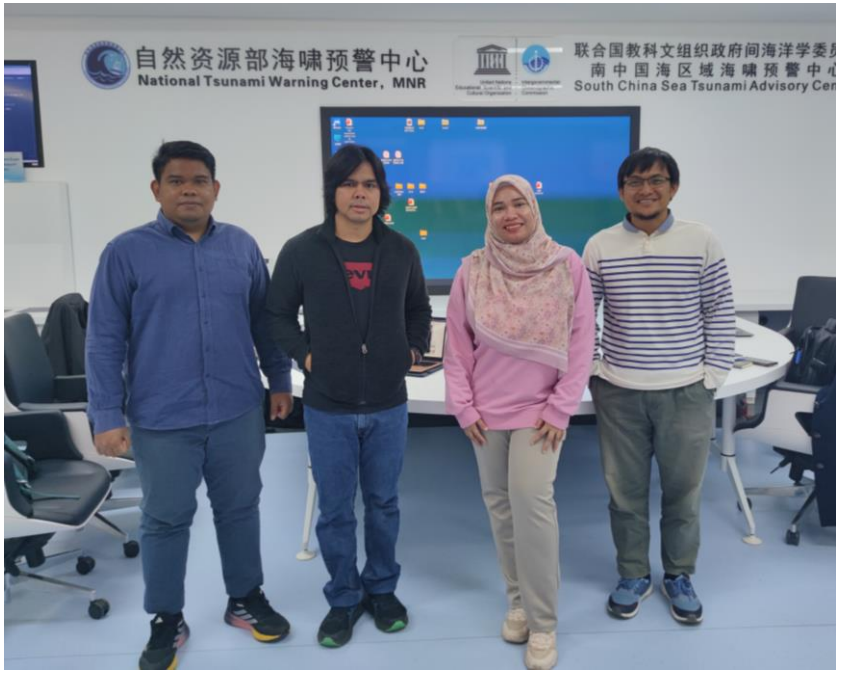
Current tsunami warning information includes: earthquake occurrence time, location, magnitude, focal depth, whether a tsunami will occur, and the arrival time and amplitude of tsunami waves at coastal areas.

6. How do you rate the completeness of the current warning information content?
   - ☐ Very complete, sufficient information
   - ☐ Relatively complete
   - ☐ Neutral, somewhat inadequate
   - ☐ Not complete enough, missing important information
   - ☐ Too little content, unable to assess danger
7. How do you rate the clarity of the warning information presentation?
   - ☐ Very clear, easy to understand
   - ☐ Relatively clear
   - ☐ Neutral
   - ☐ Not clear enough, somewhat confusing
   - ☐ Very difficult to understand
8. Which content in the warning information do you consider most important? (Select up to 3)
   - ☐ Earthquake occurrence time
   - ☐ Earthquake location
   - ☐ Magnitude and focal depth
   - ☐ Determination of whether a tsunami will occur
   - ☐ Tsunami wave arrival time
   - ☐ Expected tsunami wave height
   - ☐ Affected areas
   - ☐ Emergency evacuation guidance
   - ☐ Other: _____

3. Tsunami Preparedness and Trainning

3.7 Short-Term visits of International Staff in 2025

SCSTAC continues International Secondment Programme with full funding by hosting 4 experts from SCS-WG Member States from October to December 2025 for a two-month period.



- Mr. Arif NurRokhim from BMKG of Indonesia
- Mr. Abdul Rosid from BMKG of Indonesia
- Mr. Jun Daligdig Bonita from PHIVOLCS of the Philippines
- Ms. Faizah Binti Mohamad from MMD of Malaysia.

the major activities will be involved in are:

✓ Receive training on the earthquake location and focal mechanism inversion and tsunamiscenario database, forecast model and decision support system of the SCSTAC;

✓ Serve as a watch-stander once every week with shift time of 12 hours;

✓ Conduct communication and coordination among WG-SCS Member States regarding theactivities related to the full operation of SCSTAC.

4. Further Plans

- A workshop on tsunami ready in the South China Sea region will be held online on December 15, 2025
- Expand the sharing of tsunami early warning products, including focal mechanism solutions and tsunami amplitude predictions;
- Share tsunami monitoring data during major tsunami events;
- Determine new tasks for the Task Team based on the latest developments;
- Deepen domestic and international cooperation and communication on tsunami warning, promote tsunami warning technology and platforms;
- Provide opportunities for in-person education, outreach and training activities in the region;
- Develop methods and tools for tsunami warning and mitigation to enhance the capability of tsunami services.

unesco
Intergovernmental
Oceanographic
Commission

Thirteenth Meeting of the ICG/PTWS Regional Working Group
on Tsunami Warning and Mitigation System in the South China Sea Region,
18-19 November 2025, online

Thank You

Peitao Wang
South China Sea Tsunami Advisory Center, UNESCO/IOC