Report from SCS WG Task Team on Capacity Development and Services

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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

Tenth meeting of ICG/PTWS WG-SCS (online) on 28 and 30 September 2021;

- Recommendedto dissolve 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 further establish a Task Team on Capacity Development and Services;
- WG-SCS Task Team on Capacity Development and Services - Chair Dr. Zhiguo Xu (China).

1. SCS WG TT on Capacity Development

The general objectives of this task team are not limited to:

- Develop methods and tools for tsunami warning and mitigation;
- Enhance the Standard Operating Procedure for issuing warnings and response to tsunamis;
- Review of experiences and lessons learned from major tsunami events;
- Provide guidance and assistance to the training and capacity building on tsunami services;
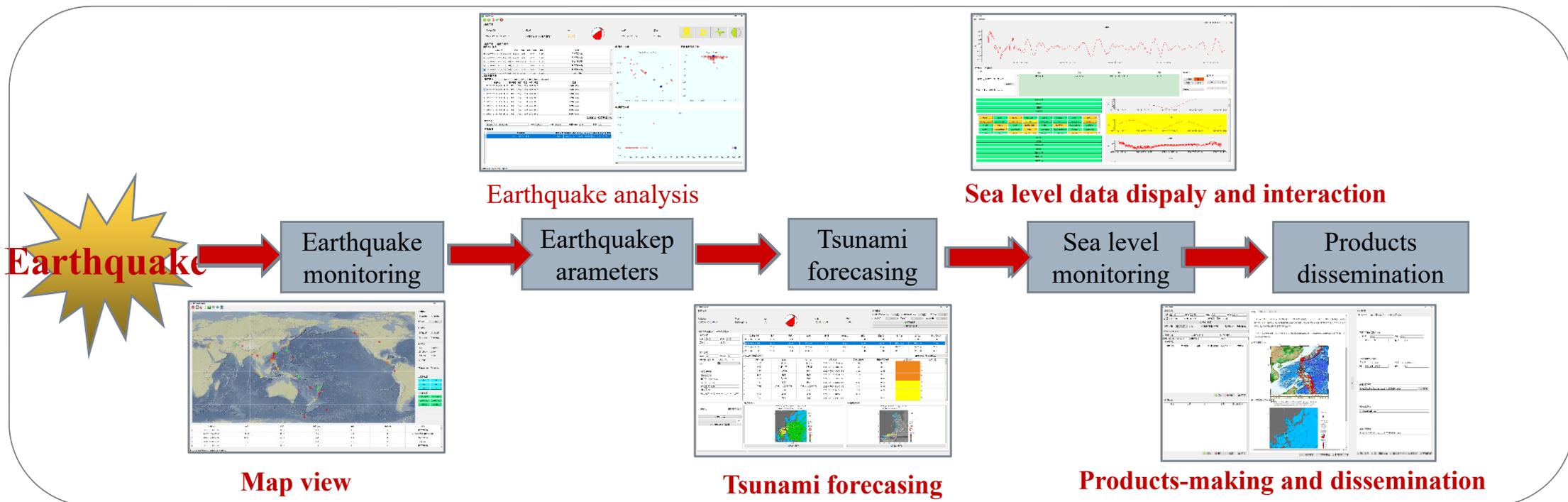- Identify potential requirements for the full operation of the SCSTAC;

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2. Tsunami Warning Capacity Enhancement

## 2.1 Smart Tsunami Information process System in full operation

The Smart Tsunami Information Processing System (STIPS) is a tsunami early warning and decision-making products release system, which developed by SCSTAC's staff using Python language, and it has been put into full operation at the end of 2022.

Earthquake analysis

Sea level data dispaly and interaction

Earthquake → Earthquake monitoring → Earthquakep arameters → Tsunami forecasing → Sea level monitoring → Products dissemination

Map view

Tsunami forecasing

Products-making and dissemination
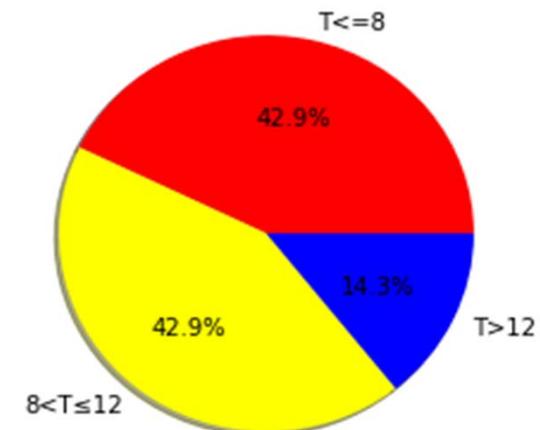
2. Tsunami Warning Capacity Enhancement

2.1 Smart Tsunami Information process System in full operation

- Real-time monitoring, receiving and processing of seismic and sea level data;
- Tsunami scenario database;
- GPU parallel tsunami numerical simulation;
- Automatic generation and release of tsunami warning products;
- An integrated decision support system for tsunami warning;
- User-friendly, comprehensive, well-maintained and open source software.
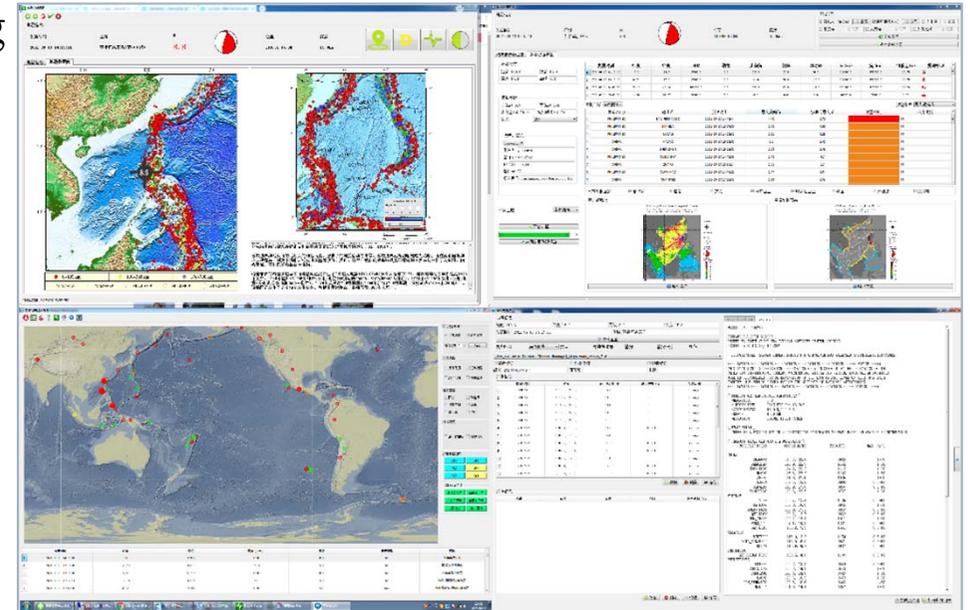

Routine operation assessment:

- The average release delay is less than 10 minutes after the earthquake;
- The average delay of earthquake alarm is 4.6 minutes;
- The average response time of tsunami watch duty is 5.4 minutes.

2.2 Global Earthquake Automatic Detecting and Location System

✓ **The near real-time waveform reading and format conversion module;**

✓ **Earthquake phase picking module;**

✓ **Automatic location and Magnitude calculationmodule;**

✓ **Parameters storage and release module;**

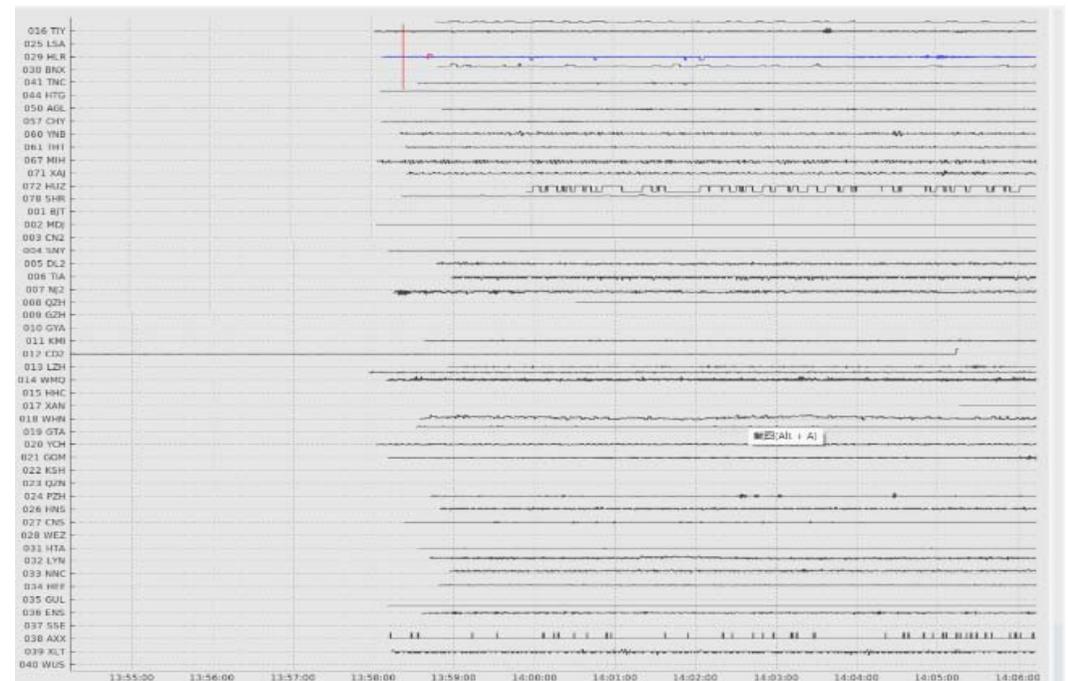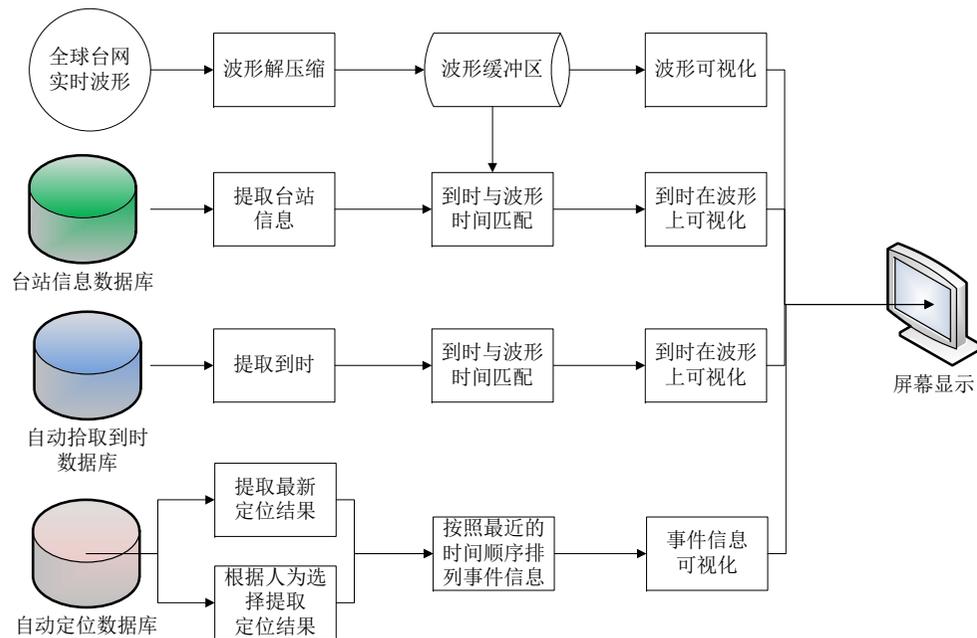✓ **Realizes the near real-time automatic location to the global moderate-strong earthquake.**
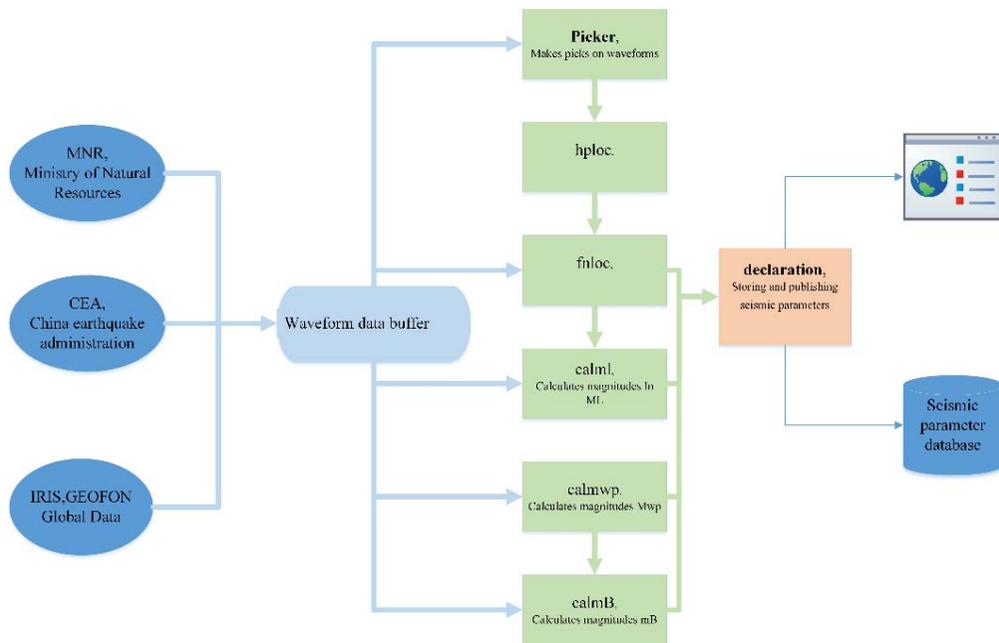
System function module architecture diagram

2.2 Global Earthquake Automatic Detecting and Location System

real-time data decode, preprocessing, and analysis, and achieve visual display of real-time seismic waveforms.
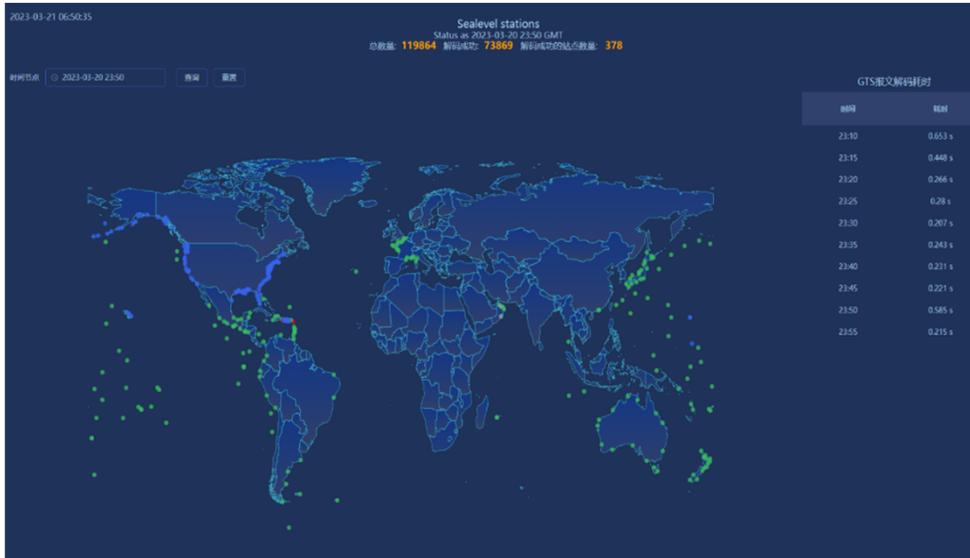
2. Tsunami Warning Capacity Enhancement

2.3 GTS sea level data decoding and processing module

Self-developed GTS sea level data decoding and processing module, effectively expanding the channels for acquiring sea level data and enhanc the automatic capability of tsunami monitoring; Realized controllable decoding and processing function of shared sea level observation data.
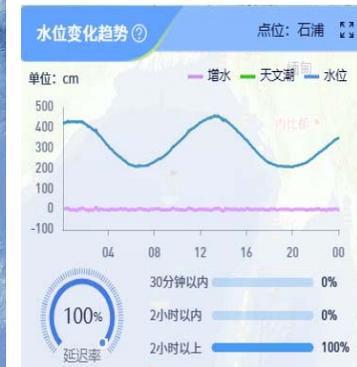

sea level monitoring

GTS transmission data decoding
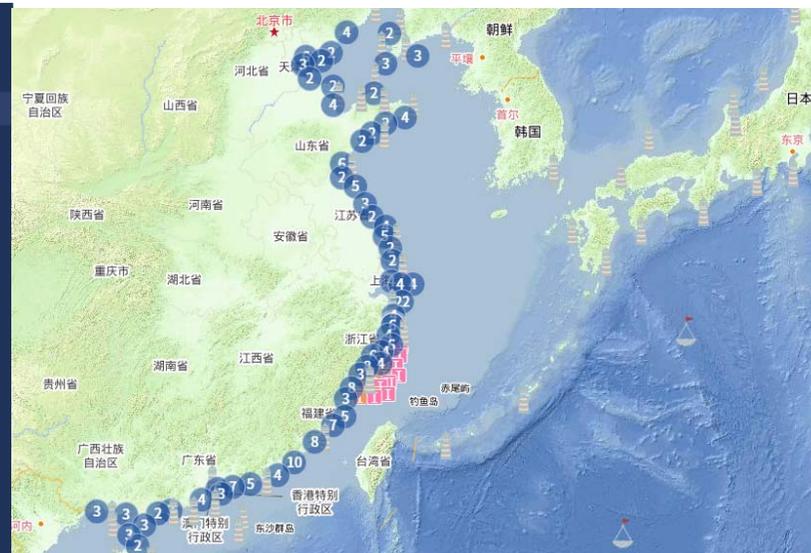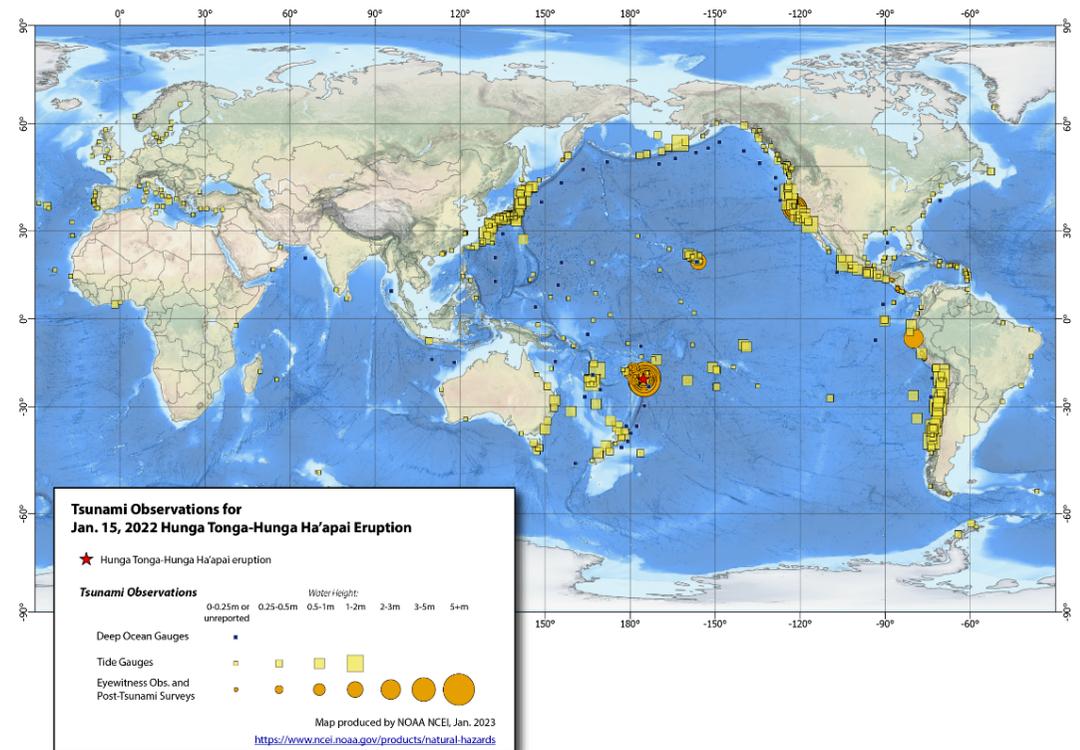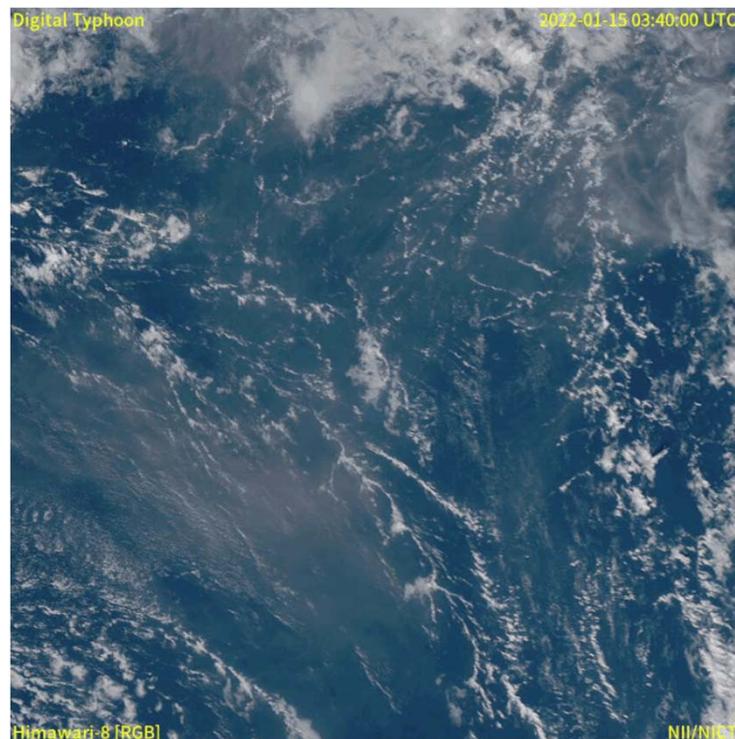

Data mergng and Monitoring Analysis System

data interactive

2. Tsunami Warning Capacity Enhancement

2.3 Developed Volcanic Eruption Display and Sea Level Alarm System

2022 Tonga Volcano Eruption Triggered Global Tsunami

On January 15, 2022 at 4:07 am (GMT), the Hunga Tonga Hunga Ha'apai (HTHH) volcano erupted violently.

Digital Typhoon 2022-01-15 03:40:00 UTC
Himawari-8 [RGB] NII/NICT

Tsunami Observations for
Jan. 15, 2022 Hunga Tonga-Hunga Ha'apai Eruption

★ Hunga Tonga-Hunga Ha'apai eruption

Tsunami Observations

Water Height:
0-0.25m or unreported | 0.25-0.5m | 0.5-1m | 1-2m | 2-3m | 3-5m | 5+m

Deep Ocean Gauges
Tide Gauges
Eyewitness Obs. and Post-Tsunami Surveys

Map produced by NOAA NCEI, Jan. 2023
https://www.ncei.noaa.gov/products/natural-hazards

The volcanic eruption triggered a tsunami throughout the entire Pacific Basin. At the same time, significant tsunami waves were recorded in the Atlantic, Caribbean, and Mediterranean regions.
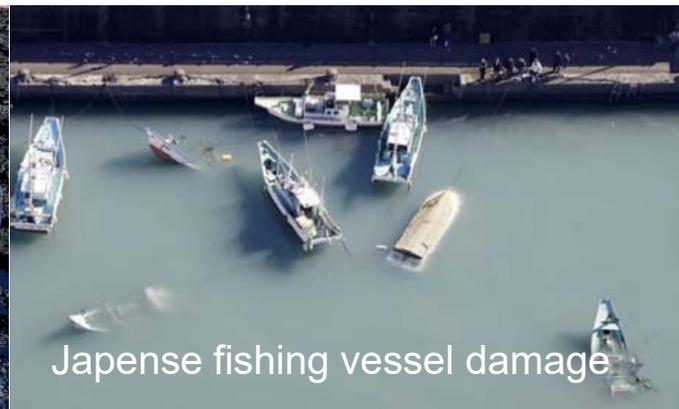
2. Tsunami Warning Capacity Enhancement

2.3 Developed Volcanic Eruption Display and Sea Level Alarm System

Tsunami strikes Tongatabu Island

2022 Tonga Tsunami

The volcanic tsunami severely hit the western coastal area of Tonga, some houses, communication networks, roads have been damaged to varying degrees on the main island of Tonga. Volcano eruption and tsunami disaster causing 4 deaths in Tonga.

Oil spill along the coast of Peru

Japense fishing vessel damage


New Zealand ship damage

In addition, the destructive tsunami also hit New Zealand, Hawaii, the west coast of the United States, as well as Peru, Chile, and Japan and China. The volcanic eruption caused a tsunami across the Pacific Ocean, resulting in two deaths in Peru, a severe oil spill along the coast, and damage to ships in Santa Cruz, California, USA and Japanese ports.

2. Tsunami Warning Capacity Enhancement

2.3 Developed Volcanic Eruption Display and Sea Level Alarm System

✓Capture volcanic ash alert sheets online to obtain near real-time volcanic eruption information;
✓Analyze volcanic eruption types and locations;
✓Monitor water level fluctuations to achieve sea level alarm;
✓Achievements: The system has been commanded for trial operation.

System framework
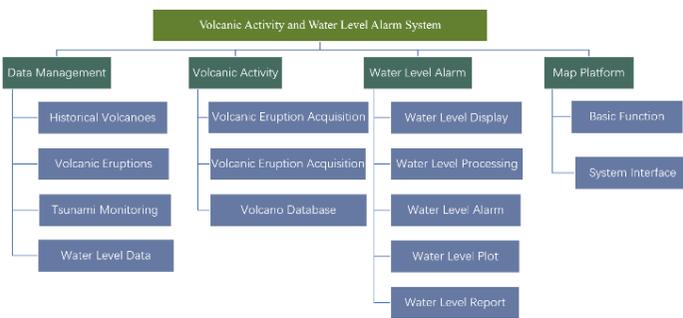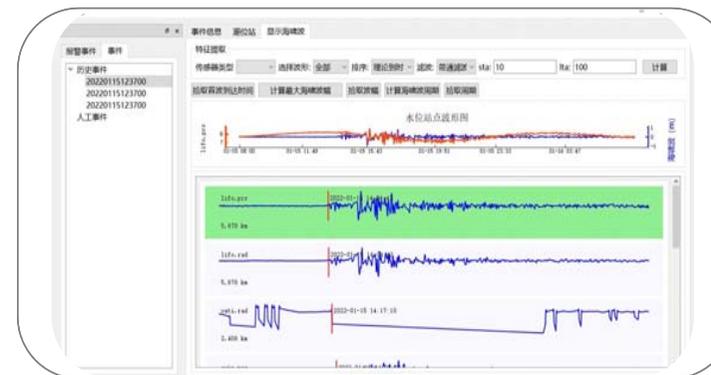
Map view
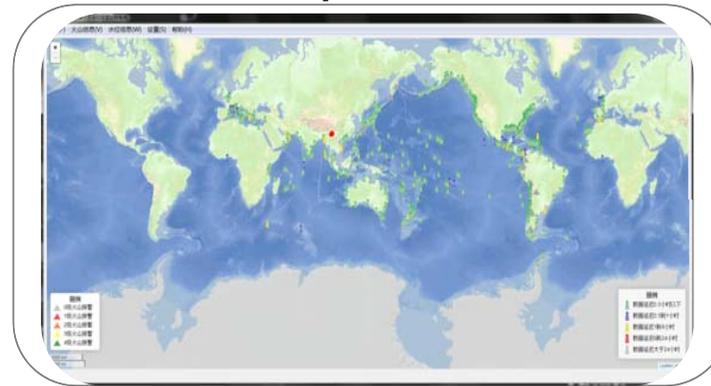
Near real-time sea level data display

It is best to conduct the early warning of atypical tsunami by directly observing the tsunami wave field, rather than observing the source itself, using the earliest arriving tsunami wave to identify the earliest indication of the most potential tsunami impact level.
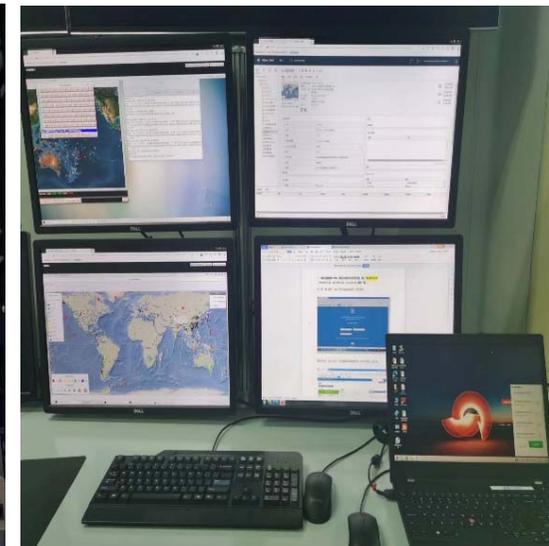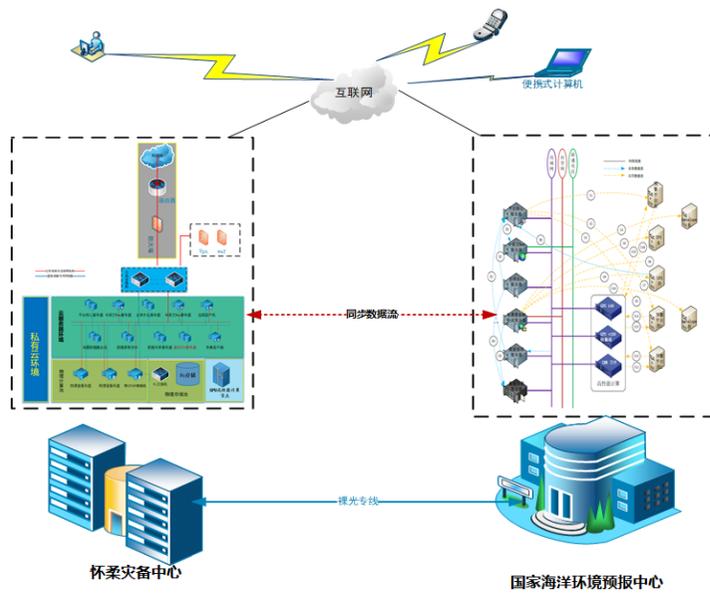
Interactive analysis

Tsunami observation report

2. Tsunami Warning Capacity Enhancement

2.4 Backup tsunami warning system in Huairou District Beijing, China

- Implement independent function backup
- The synchronization of data but not dependence

2. Tsunami Warning Capacity Enhancement

2.5 Backup SCSTAC (Hong Kong) in full operation

- MNR approved the construction of the BSCSTAC by Hong Kong Observatory on January 13, 2020 ;
- Sharing technical issues with the Hong Kong Observatory through online meeting and on-site visiting;
- Further improvements and modifications for the BSCSTAC in accordance with the local needs of the Hong Kong Observatory;
- Complete the optimization and deployment of the backup website, and achieve synchronous operation with SCSTAC;
- Conducted data and product sharing with the Hong Kong Observatory;
- The BSCSTAC officially launched its full operation on March 29, 2023.

2. Tsunami Warning Capacity Enhancement

2.6 GPU-Boost on tsunami modeling

✓ **Efficiency Improvement of Tsunami Modeling for the SCS Region;**

✓ **Tesla is for rack-mounted server; Geforce is used to workstaion, and much cheaper.**

Efficiency Improvement of Tsunami Modeling for the SCS Region

Year	GPU	Grid Resolution	Time Step	Modeling Duration	Time Consuming
2016	Nvidia Tesla K40	2 arc-min	4 s	18 hrs	~ 17 s
2019	Nvidia Tesla V100				~ 6 s
2021	Nvidia Geforce RTX 2080Ti				~ 6 s
2022	Nvidia Tesla A100				**less than 3 s**

K 40

V10 0

A10 0
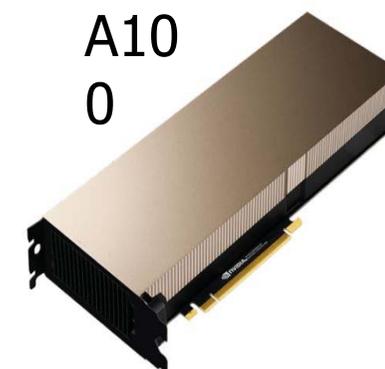
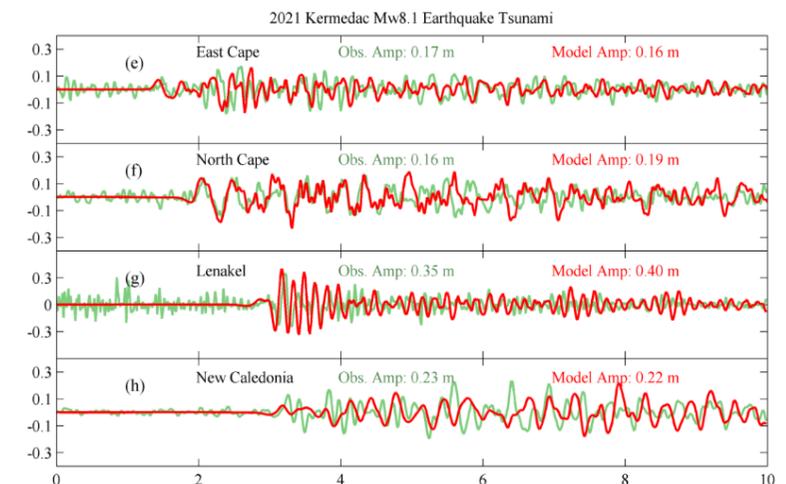# 2. Tsunami Warning Capacity Enhancement
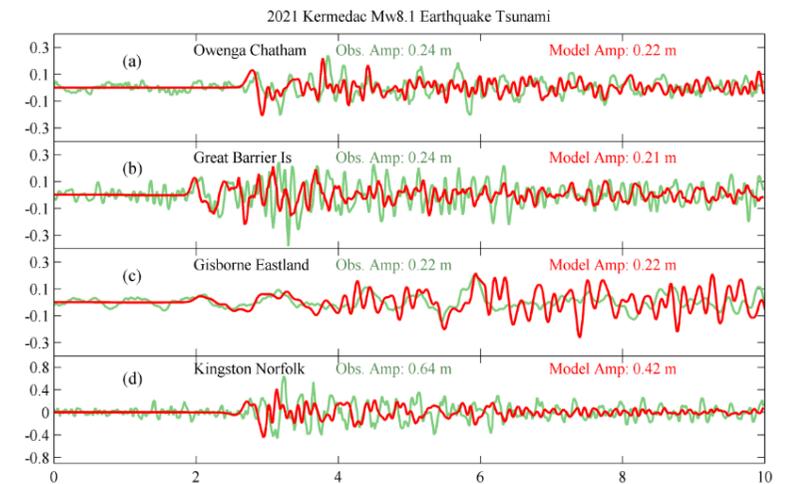
2.7 Refined modeling: Maximum Simulated Amplitude

Kermadec Islands Tsunami, March 4, 2021
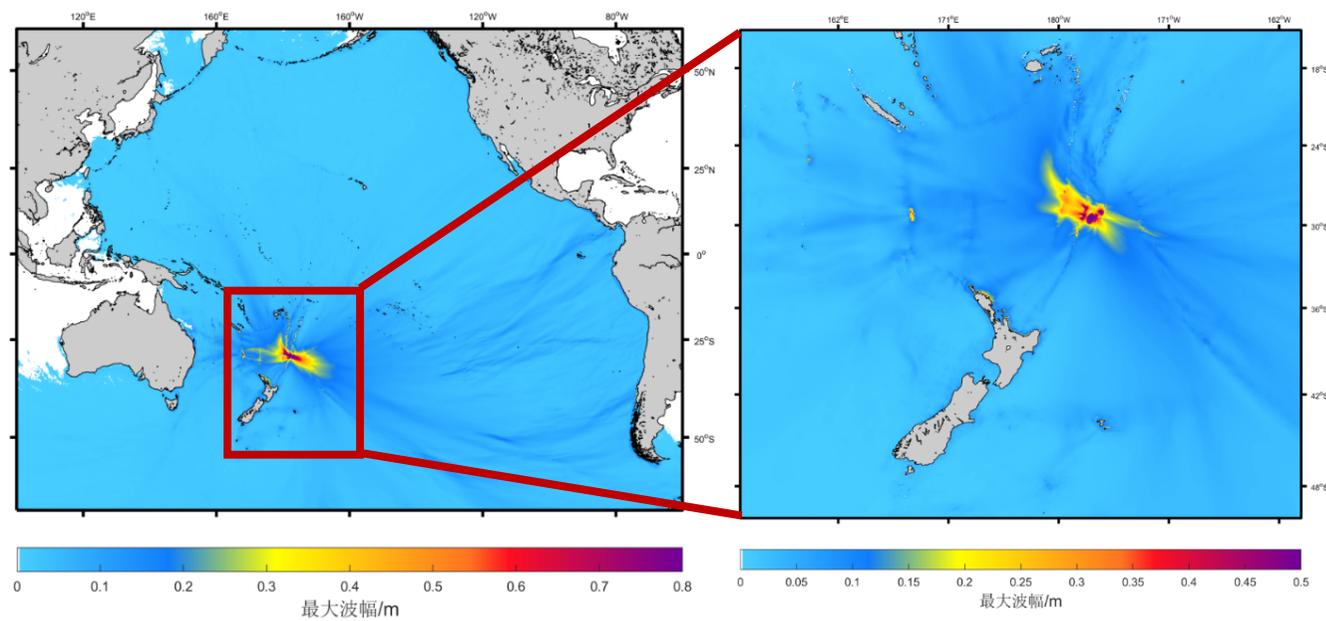
Waveforms of Observation and Simulation

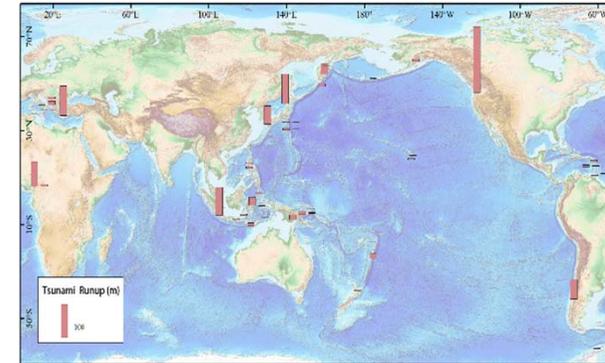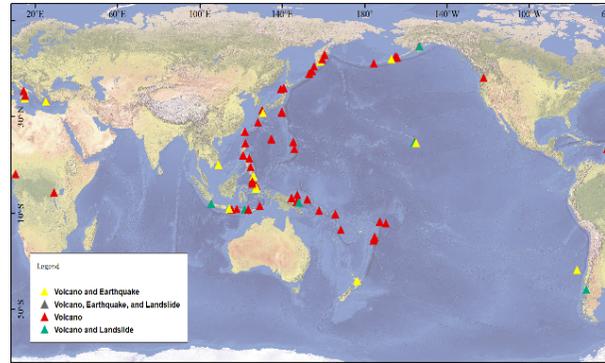Kermadec Islands Tsunami, March 4, 2021
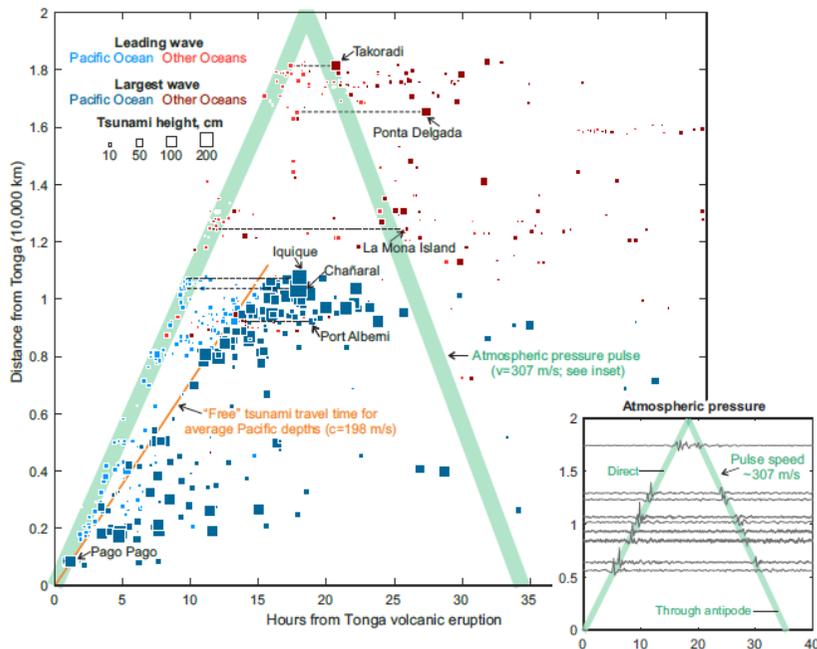
2. Tsunami Warning Capacity Enhancement

2.8 Mechanism of Landslide Tsunami and Volcanic Tsunami

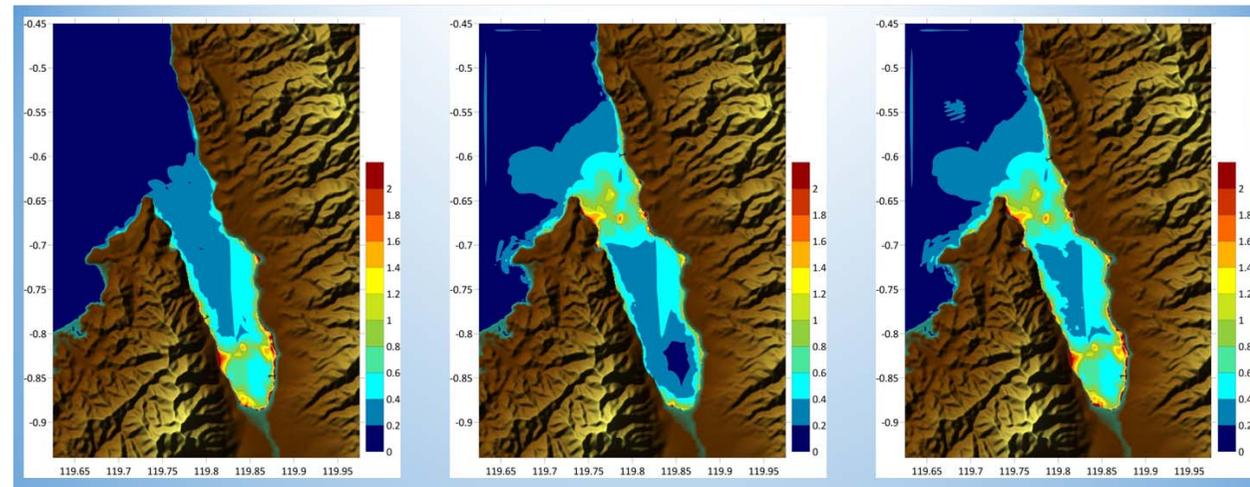In recent years, landslides and volcanic tsunamis have occurred frequently.

- 2018 Palu Tsunami,
- 2018 Anak Krakatao volcanoic tsunami
- 2022 Tonga tsunami.

Global Historical Volcanic Tsunami Events and Tsunami Height

(Carvajal, et al. 2022)

2018 Palu Tsunami simulation

3. Tsunami Preparedness and Trainning

3.1 Tsunami Disaster Mitigation and Popularization

✓Technical Guidelines for Tsunami Risk Assessment and Zoning;
✓Modern Earthquake Tsunami Warning Technology;
✓Introduction to the South China Sea Tsunami Advisory Center;
✓ Frequently Asked Questions of Tsunami.

Guidelines for Tsunami Risk Assessment

☐Unify the tsunami risk assessment method;
☐Standardize the tsunami risk assessment process.

Introduction to SCSTAC

☐Introduction to the SCSTAC;
☐Enhancement of communication among countries.

《Modern Earthquake Tsunami Warning Technology》

☐Summarize tsunami early warning research;
☐Promote tsunami warning technology.

《Frequently Asked Questions of Tsunami》

☐A question-and-answer format;
☐Popularize tsunami knowledge;
☐Raise awareness of tsunami mitigation.
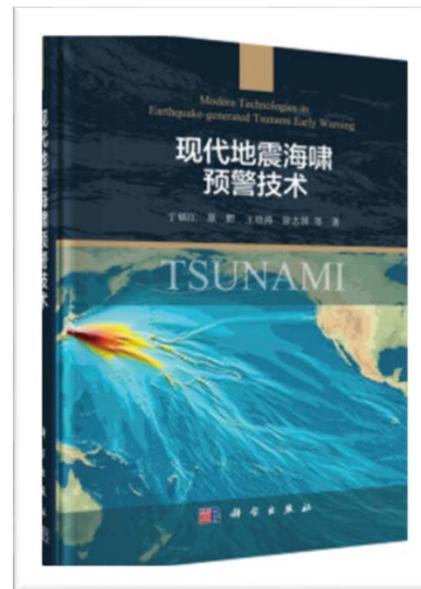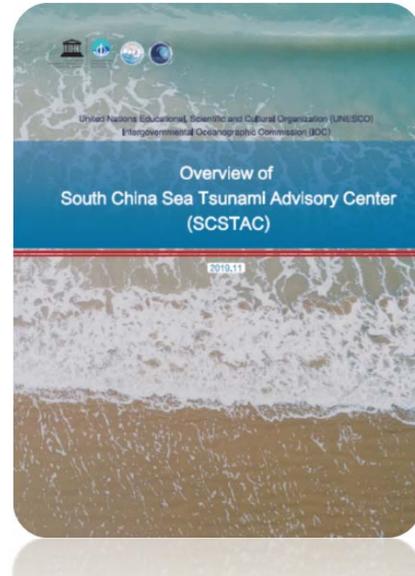
3. Tsunami Preparedness and Trainning

3.2 Regional Training and Workshop

Training for seismic and tsunami warning operators on strengthening standard operating procedures for seismic data and tsunami warning in the South China Sea region, 9-10 December 2021, Online.
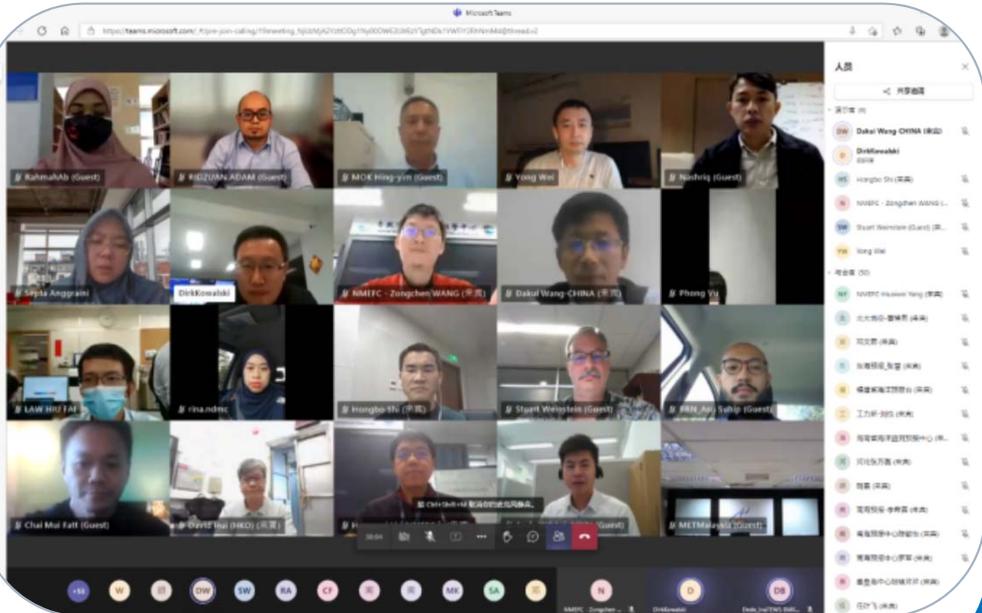
First NMEFC-BMKG Workshop on Non-seismic Tsunamis and Complex Tsunamis, 14 July 2022, [Online].

3. Tsunami Preparedness and Trainning

3.2 Regional Training and Workshop

2022 International Symposium on Applied Technologies for Earthquake and Tsunami Monitoring, Early Warning and Disaster Mitigation in the South China Sea Region, 20th December 2022, Online.

Face to face communications between SCSTAC and Hong Kong Observatory, 6-18 February 2023. Topic not limited to operation workflow, earthquake detection, tsunami modelling, product making, experience and skills.

3. Tsunami Preparedness and Trainning

3.3 Short-Term visits of International Staff in 2023

SCSTAC continues International Secondment Programme with full funding by hosting 4 experts from SCS-WG Member States from October to December 2023 for a two-month period.

- ■ Ms. Nadira Binti Janius (MMD)
- ■ Mr. Muhammad Hafizh Ghifari (BMKG)
- ■ Mr. Fakhry Dwi Sulistio (BMKG)
- ■ Mr. TomCarlo E.Simborio (PHIVOLCS)

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.
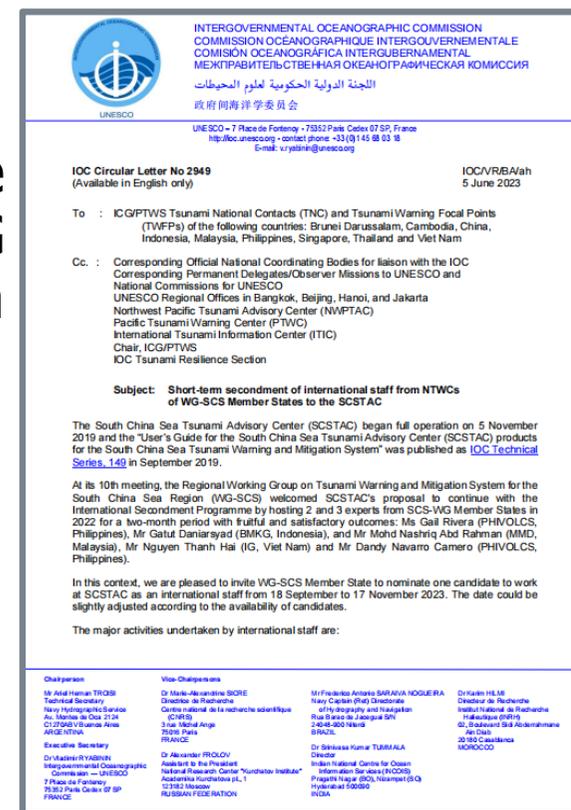
4. Further Plans

- Develop methods and tools for tsunami warning and mitigation to enhance the capability of tsunami services;
- 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;
- Conducts an online Training Workshop on Tsunami Warning Technology and Platforms in the South China Sea region hosted by China.

11th Session (online) of the ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region (ICG/PTWS WG-SCS), Guangzhou, China, 25–27 September 2023

Thank You

Zhiguo Xu
South China Sea Tsunami Advisory Center, UNESCO/IOC