UNESCO/IOC – NOAA ITIC Training Program in Hawaii (ITP-TEWS Chile)
TSUNAMI EARLY WARNING SYSTEMS
AND THE PACIFIC TSUNAMI WARNING CENTER (PTWC) ENHANCED PRODUCTS
TSUNAMI EVACUATION PLANNING AND UNESCO IOC TSUNAMI READY PROGRAMME
19-30 August 2024, Valparaiso, Chile

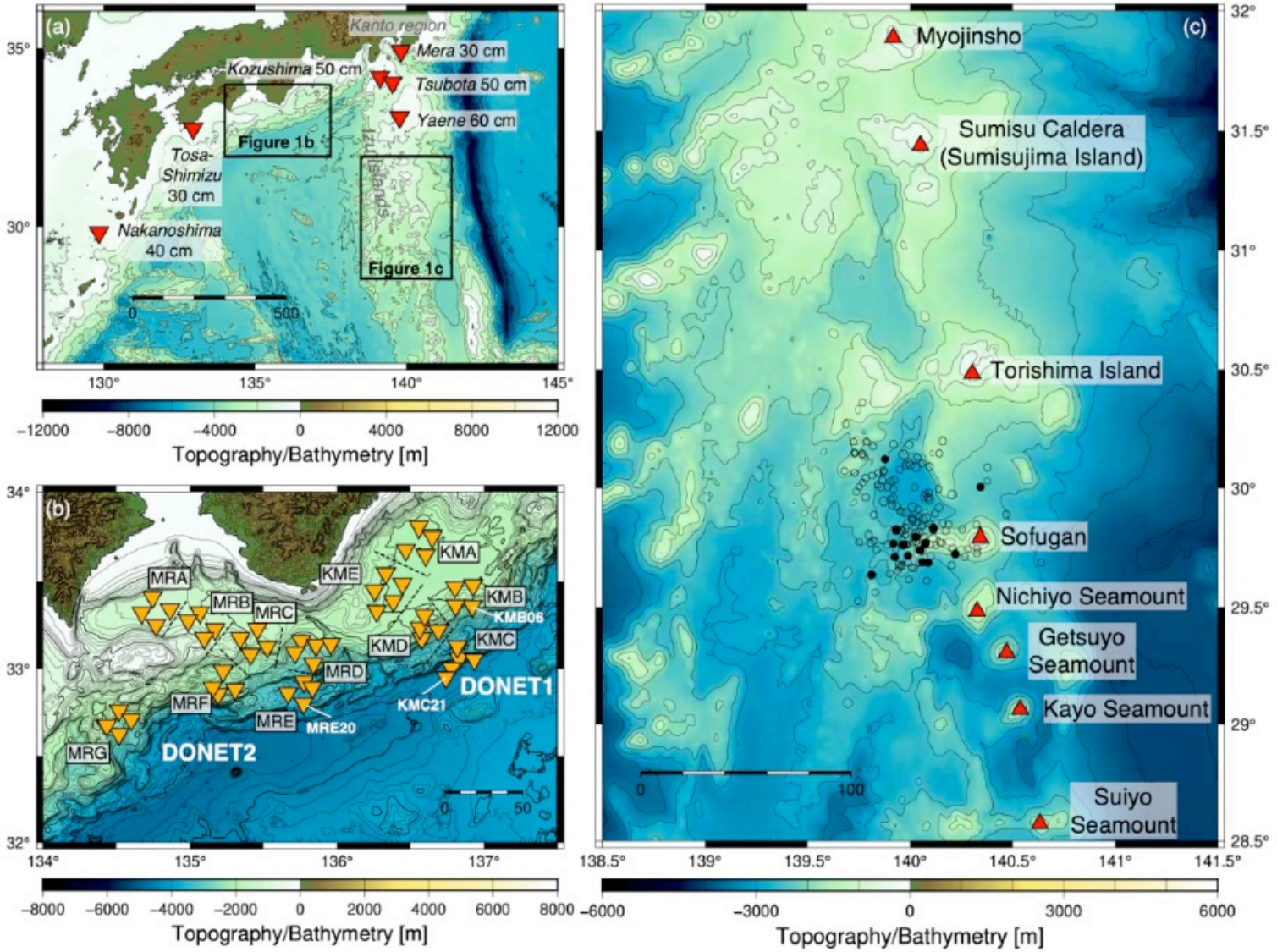
Local-source tsunami response

Kenji Satake
University of Tokyo

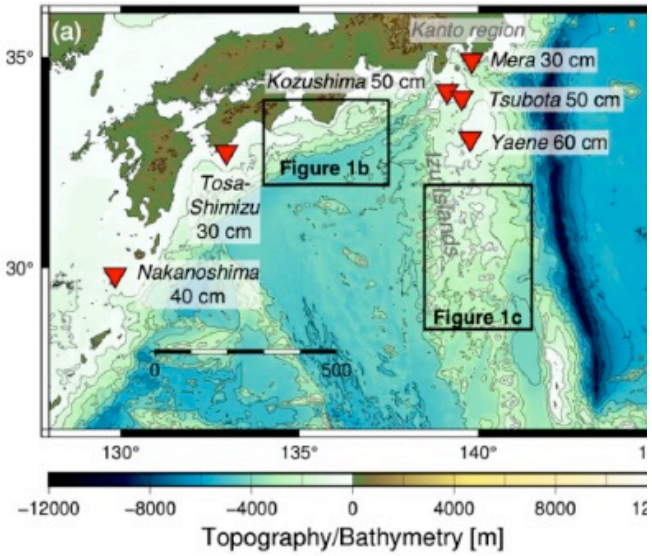
Recent tsunamis in Japan

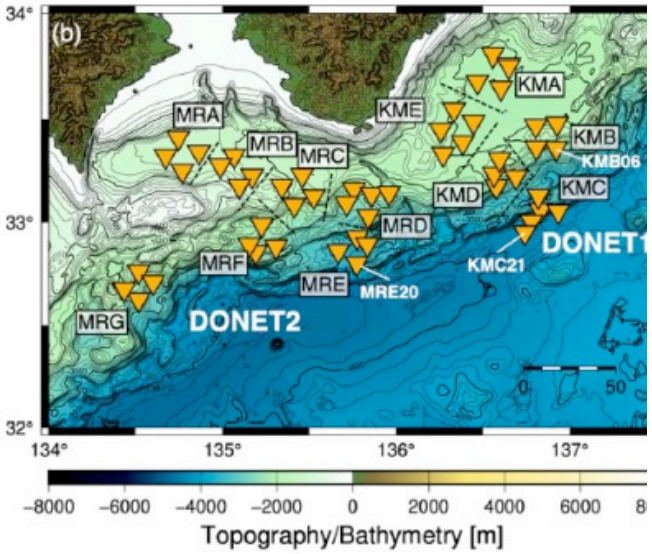
- 2023 Sofugan tsunami
- 2024 Noto earthquake
- Nankai megathrust earthquake attention

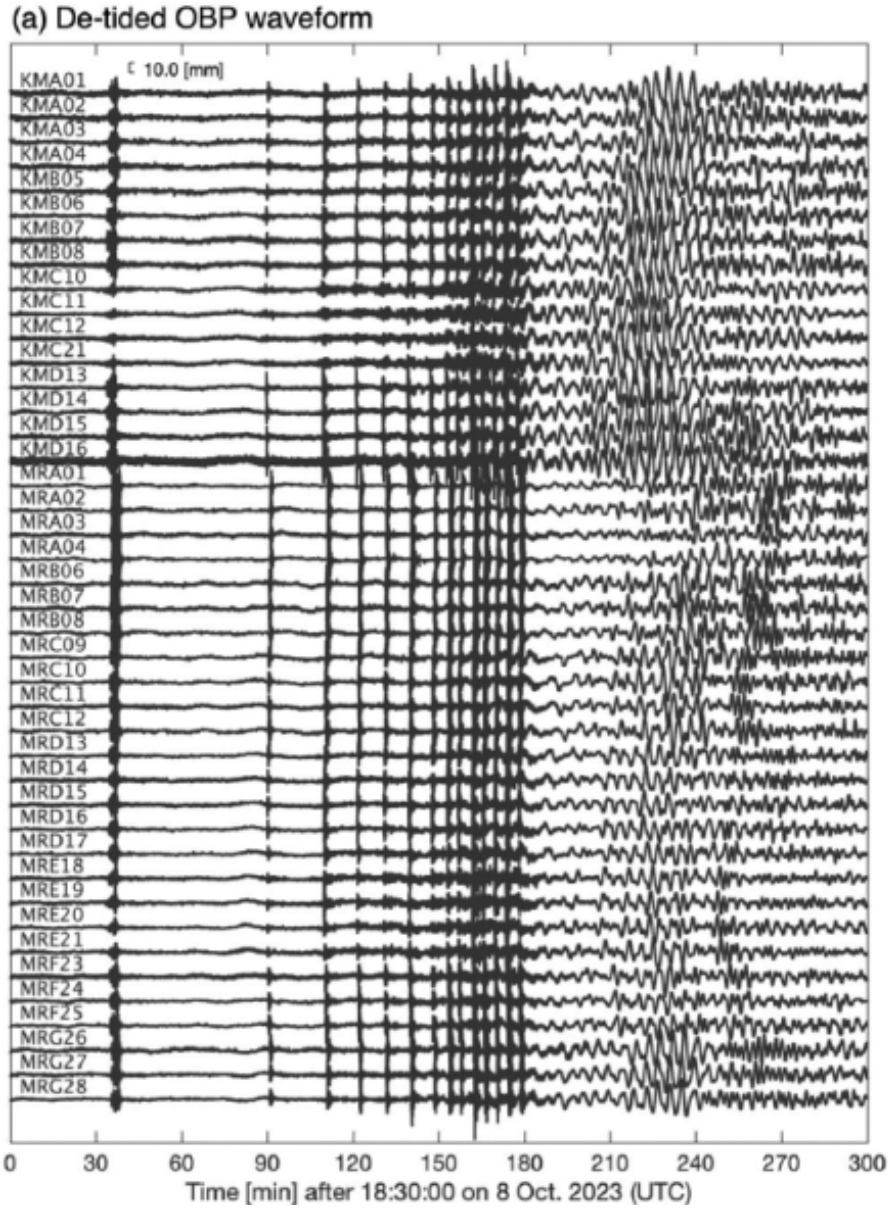
Sofugan tsunami (October 8, 2023)



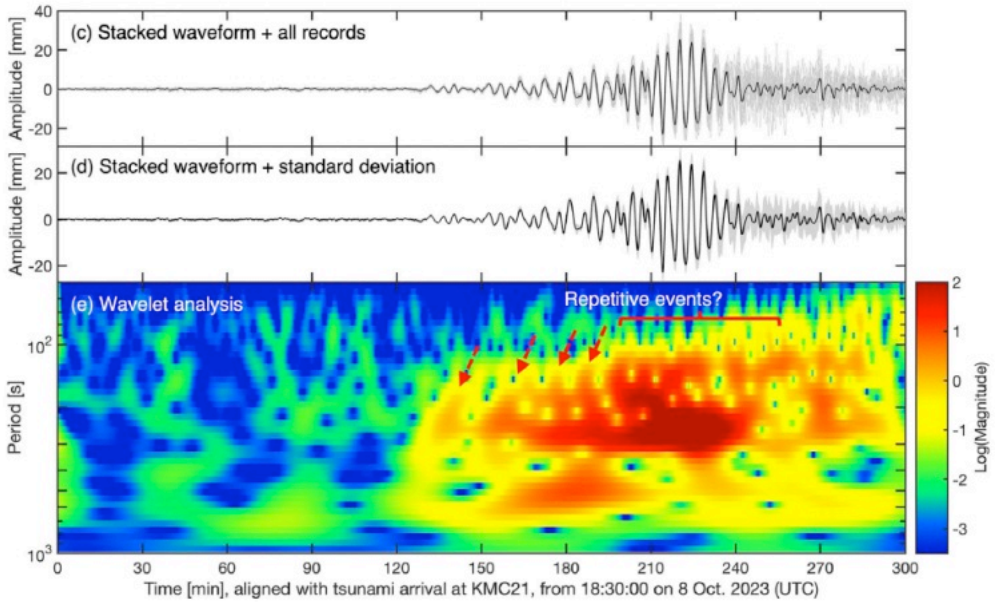
Sofugan tsunami (October 8, 2023)

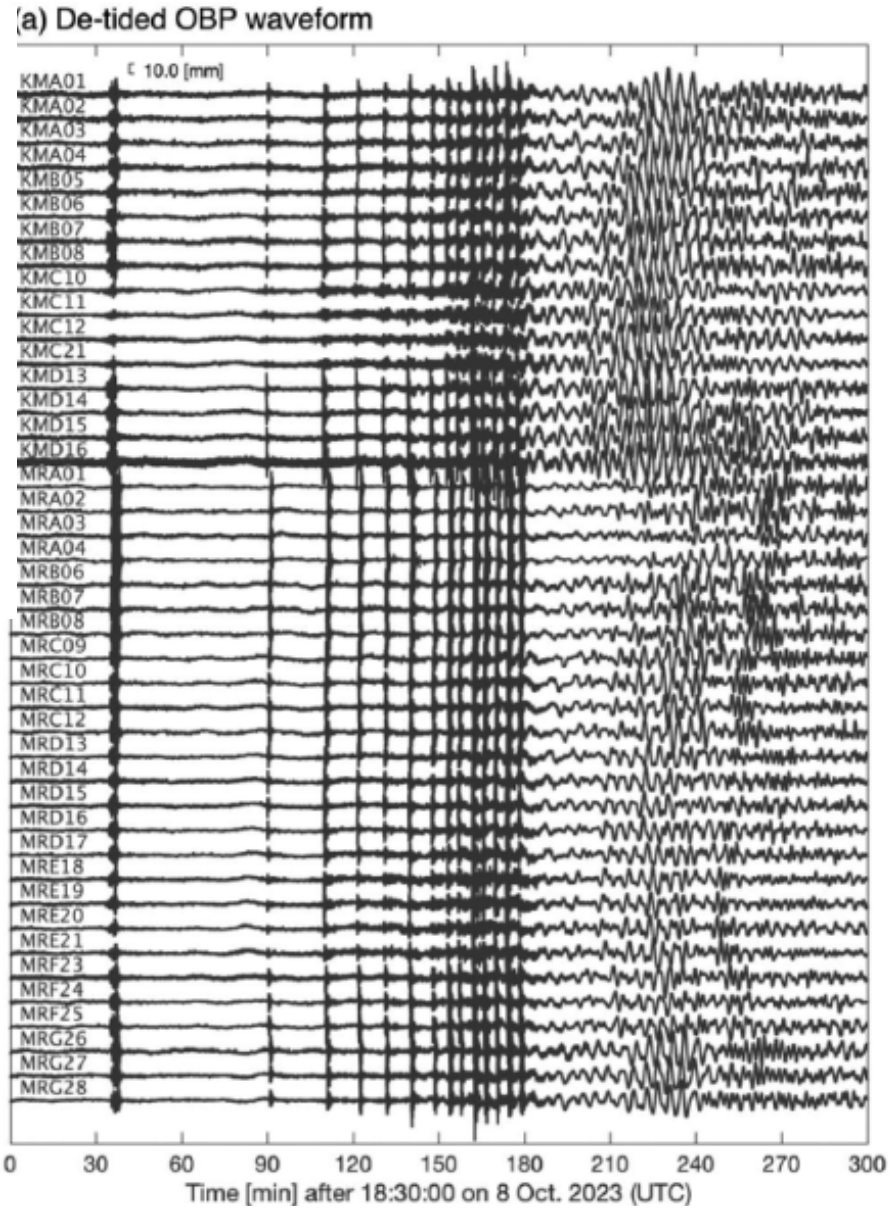






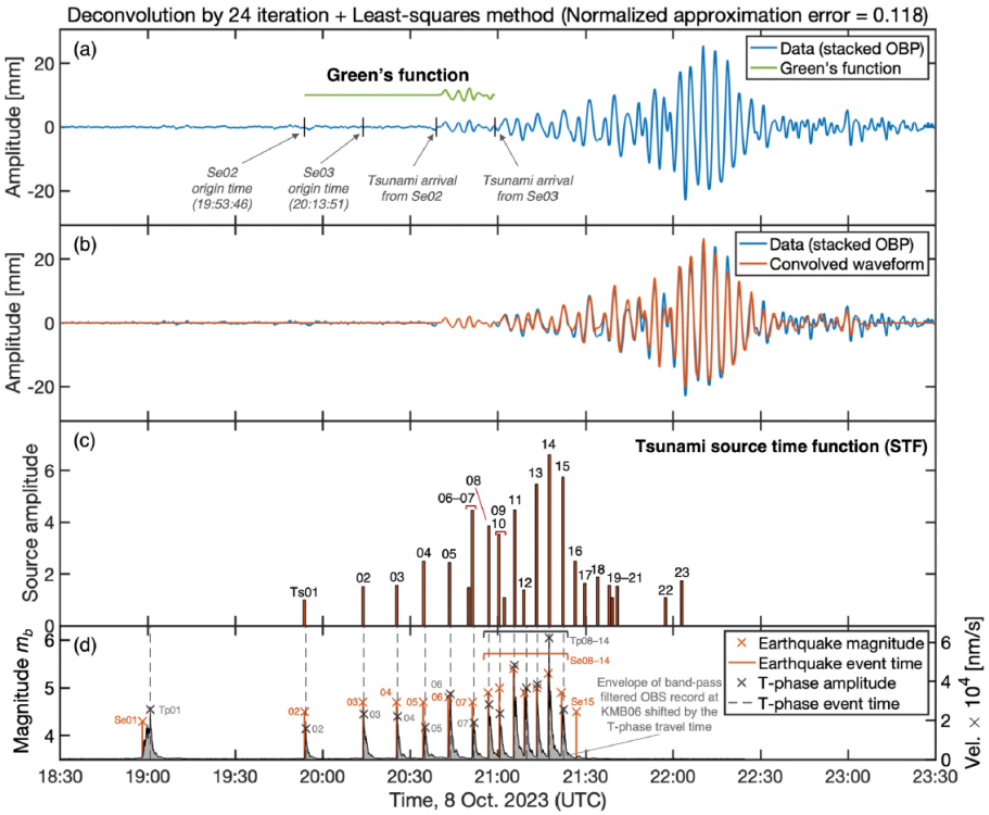
Sofugan tsunami (October 8, 2023)

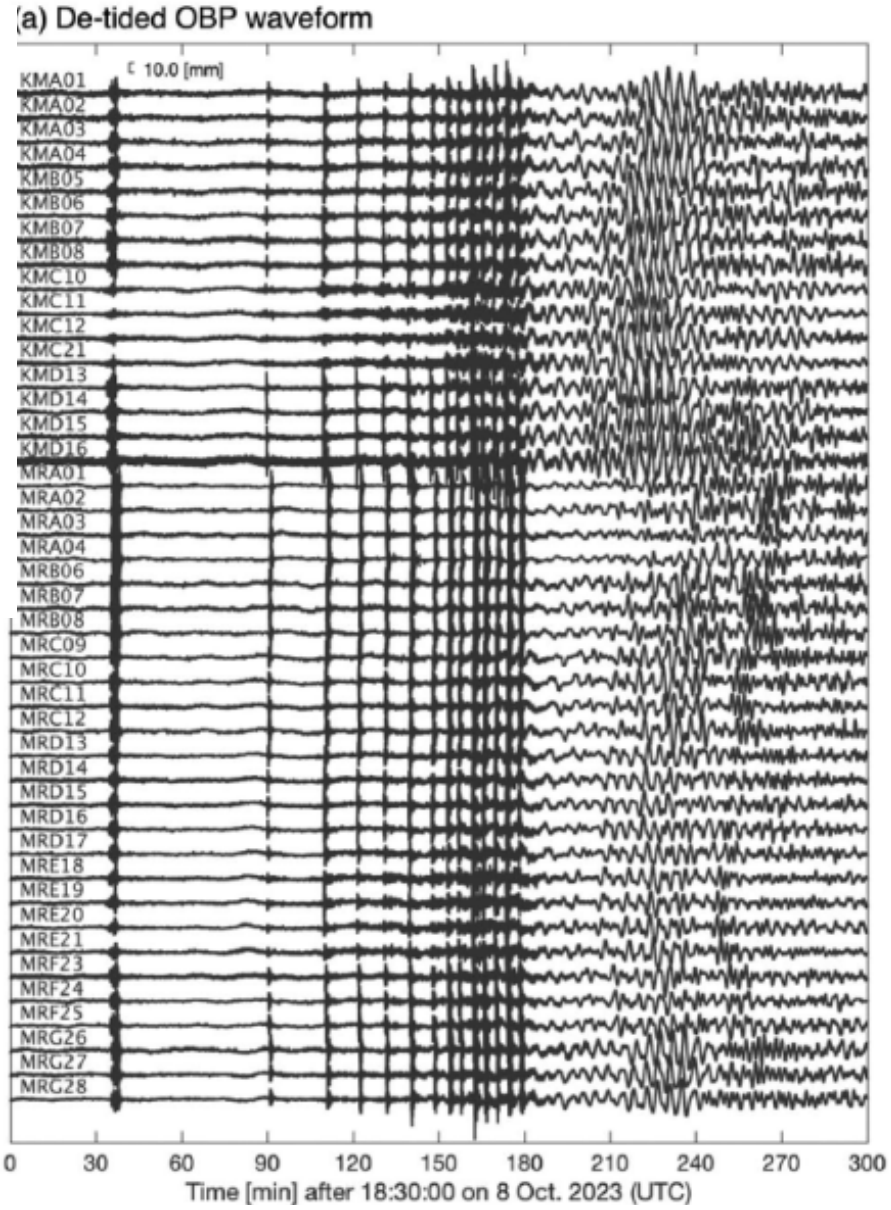




Sandanbata et al. (2024)
https://doi.org/10.1029/2023GL106949

Sofugan tsunami (October 8, 2023)



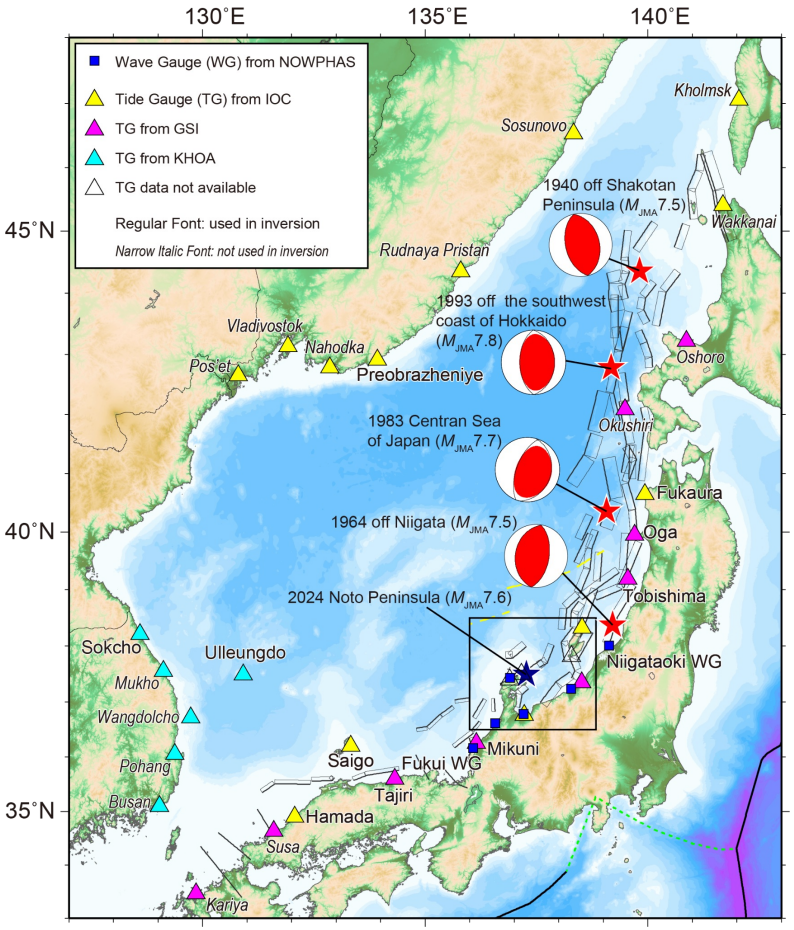


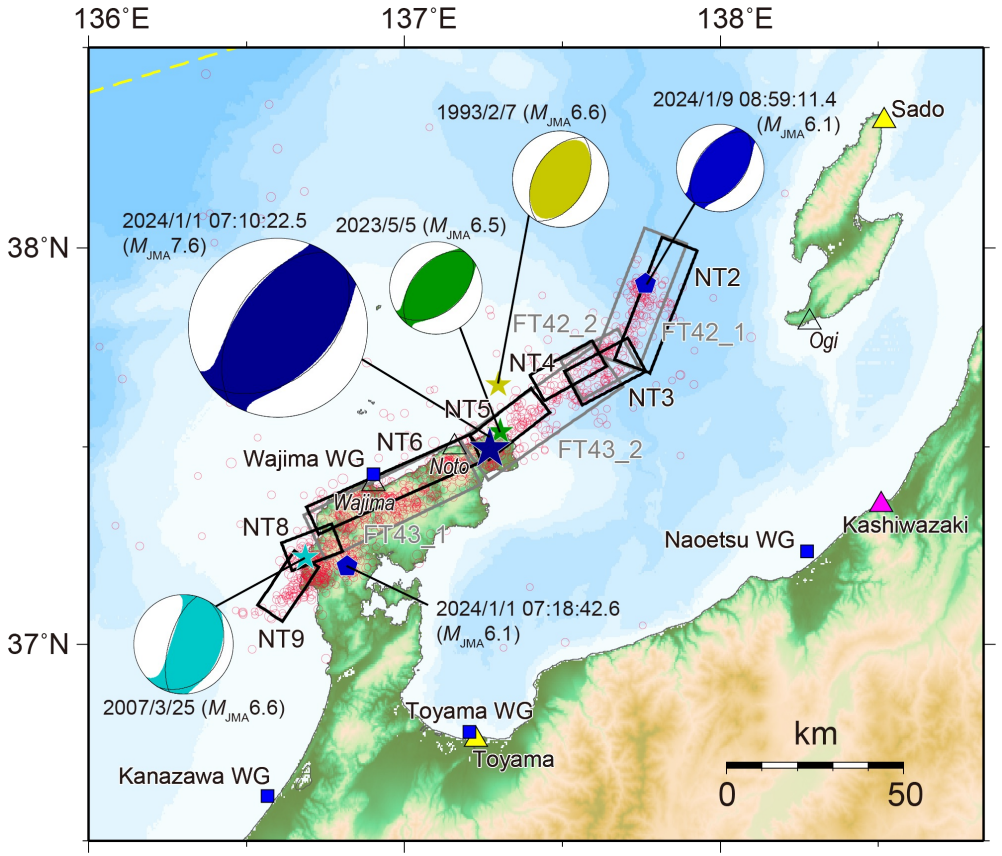
Sandanbata et al. (2024)
https://doi.org/10.1029/2023GL106949

The Noto Peninsula earthquake and tsunami on January 1, 2024

- The earthquake caused 245 casualties, mostly due to collapse of houses
- It also generated tsunami as high as 5 m, but human casualties were minimal
- The inundation area was smaller than tsunami hazard map based on simulation
- Tsunami early warning and its dissemination urged residents to evacuate
- Instrumental tsunami observation failed due to coastal uplift

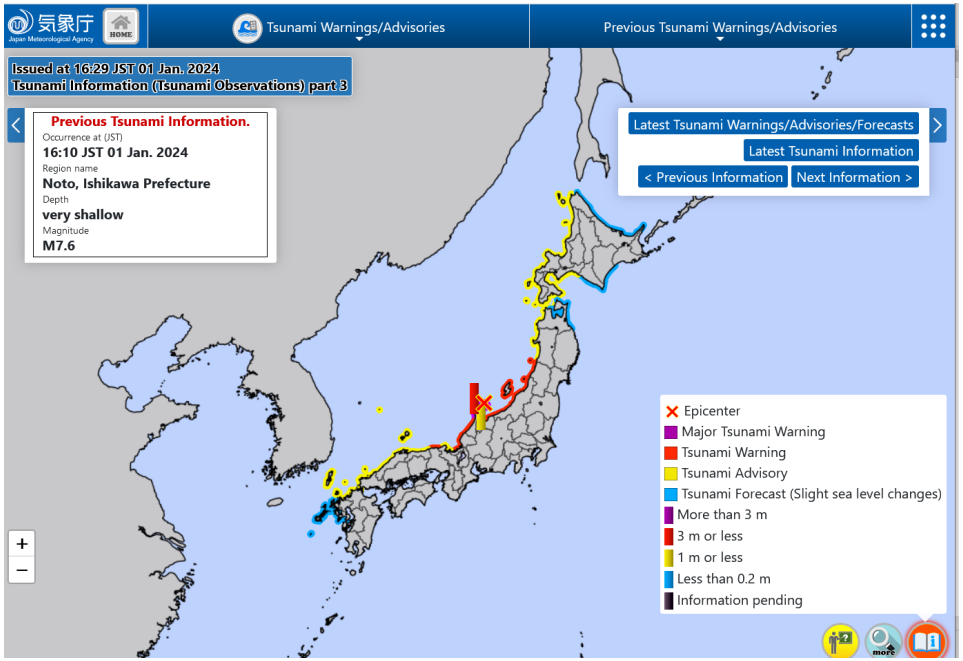
Tsunamigenic earthquakes along eastern margin of Japan Sea





Fujii and Satake (2024, Earth Planets, Space)
https://doi.org/10.1186/s40623-024-01991-z

Tsunami warning issued by Japan Meteorological Agency



All times are Japan Standard Time

16:06 Earthquake (M 5.5)
Earthquake Early Warning
16:10 Earthquake (M 7.6)
Earthquake Early Warning
16:12 Tsunami warning
16:22 Major tsunami warning

https://www.jma.go.jp/bosai/map.html#5/40.662/136.691/&elem=hist&contents=tsunami&lang=en

Tsunami warning issued by Japan Meteorological Agency

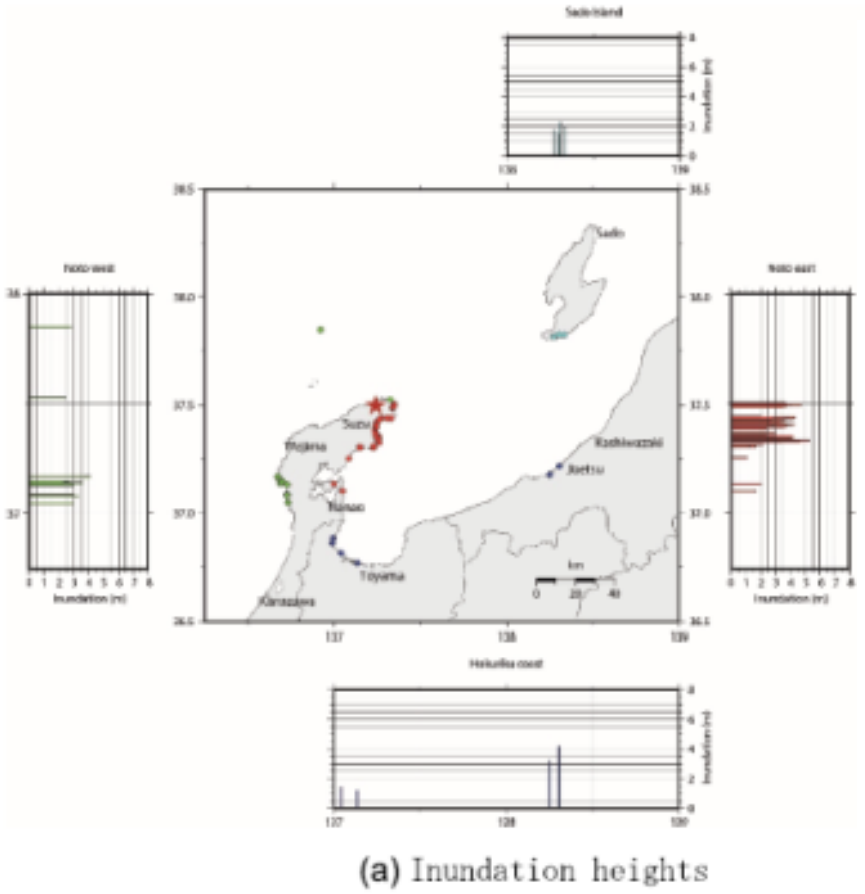
Tsunami up to 5 m inundated soon after the earthquake

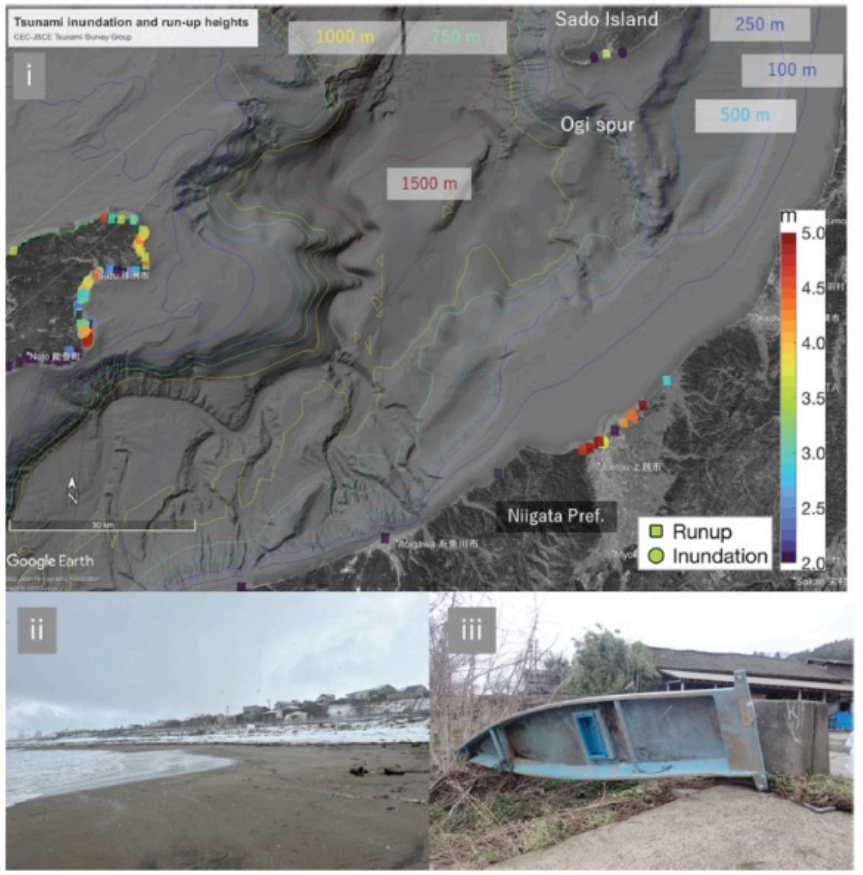
Tsunami up to 5 m inundated soon after the earthquake

Asahi Shimbum Digital https://www.youtube.com/watch?v=h_4BIsoWg1U

Tsunami survey by JSCE group

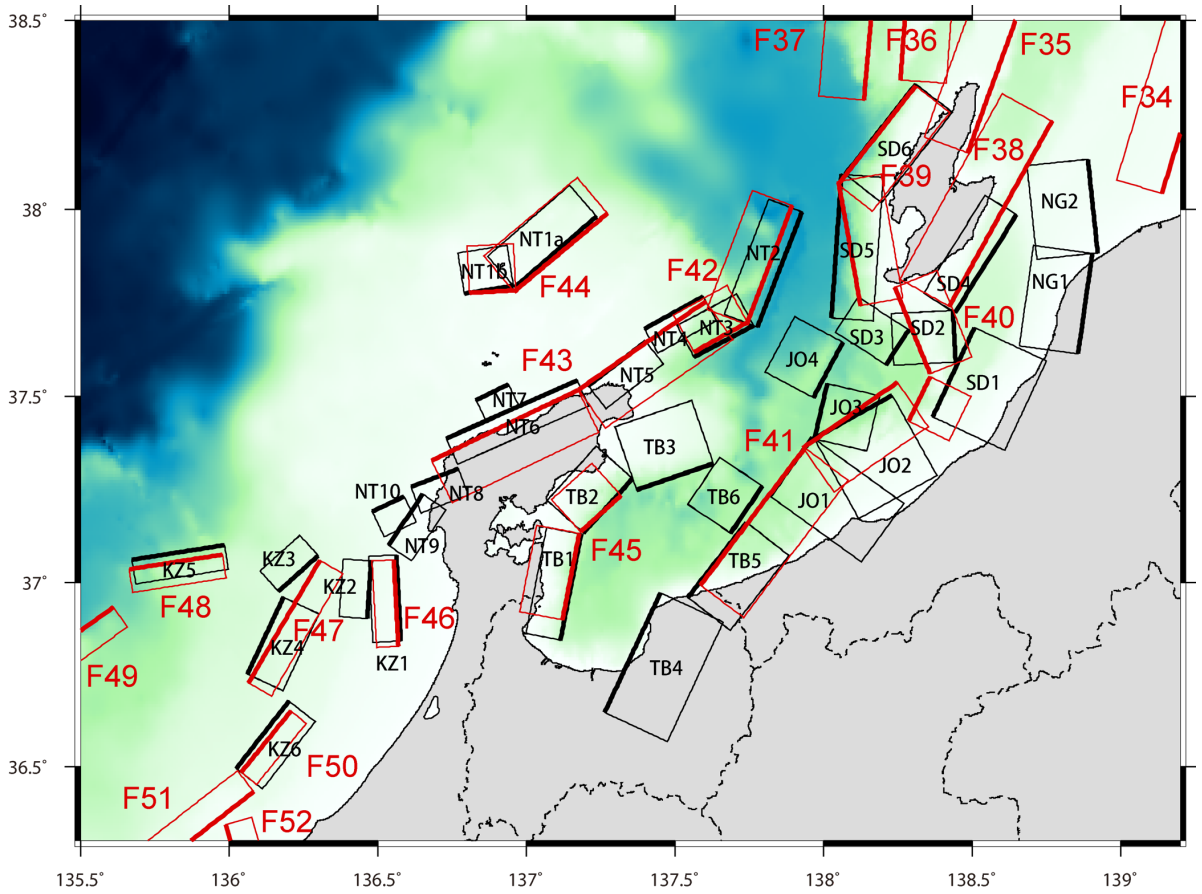
- Maximum runup height ~ 6 m
- Large tsunami on the east coast of Noto Peninsula and Niigata coast





https://doi.org/10.1080/21664250.2024.2368955

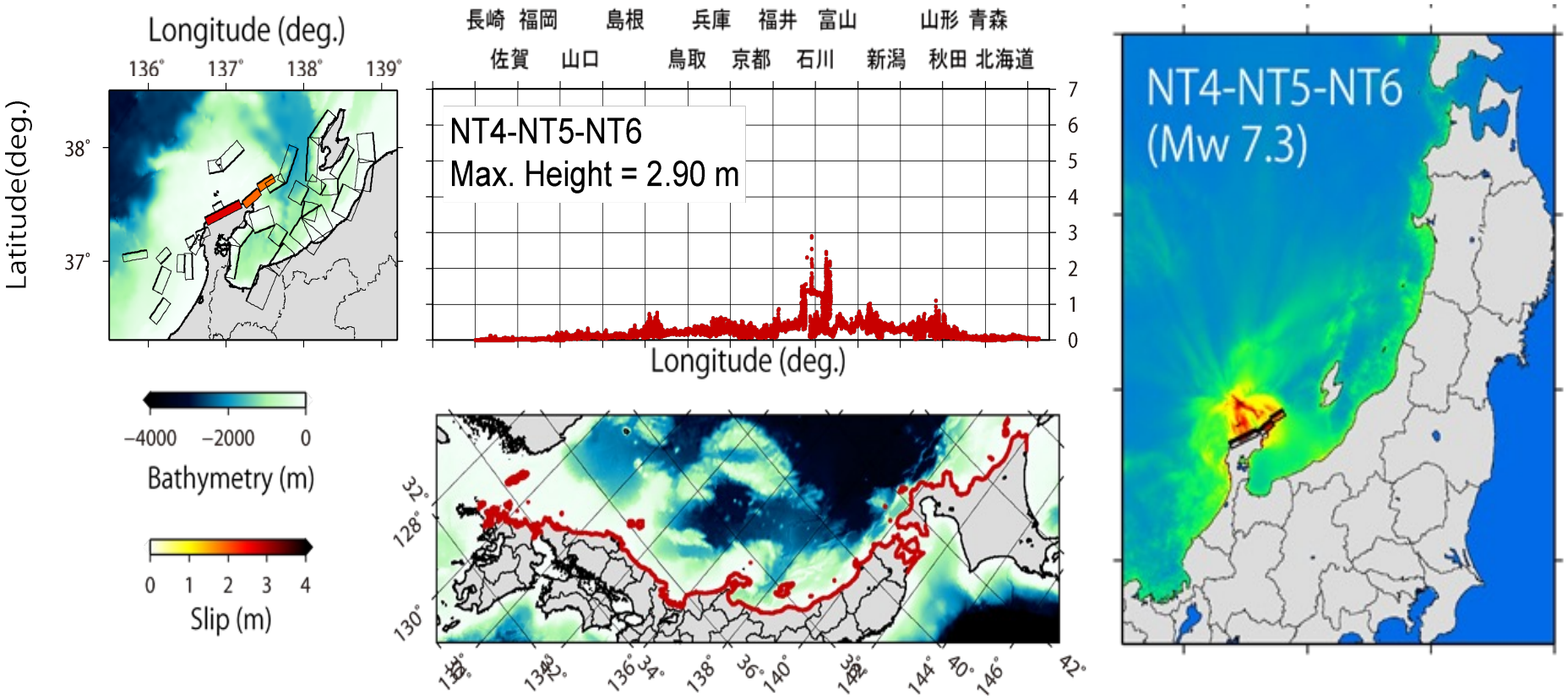
Submarine active faults previously mapped



MILT models (2014)

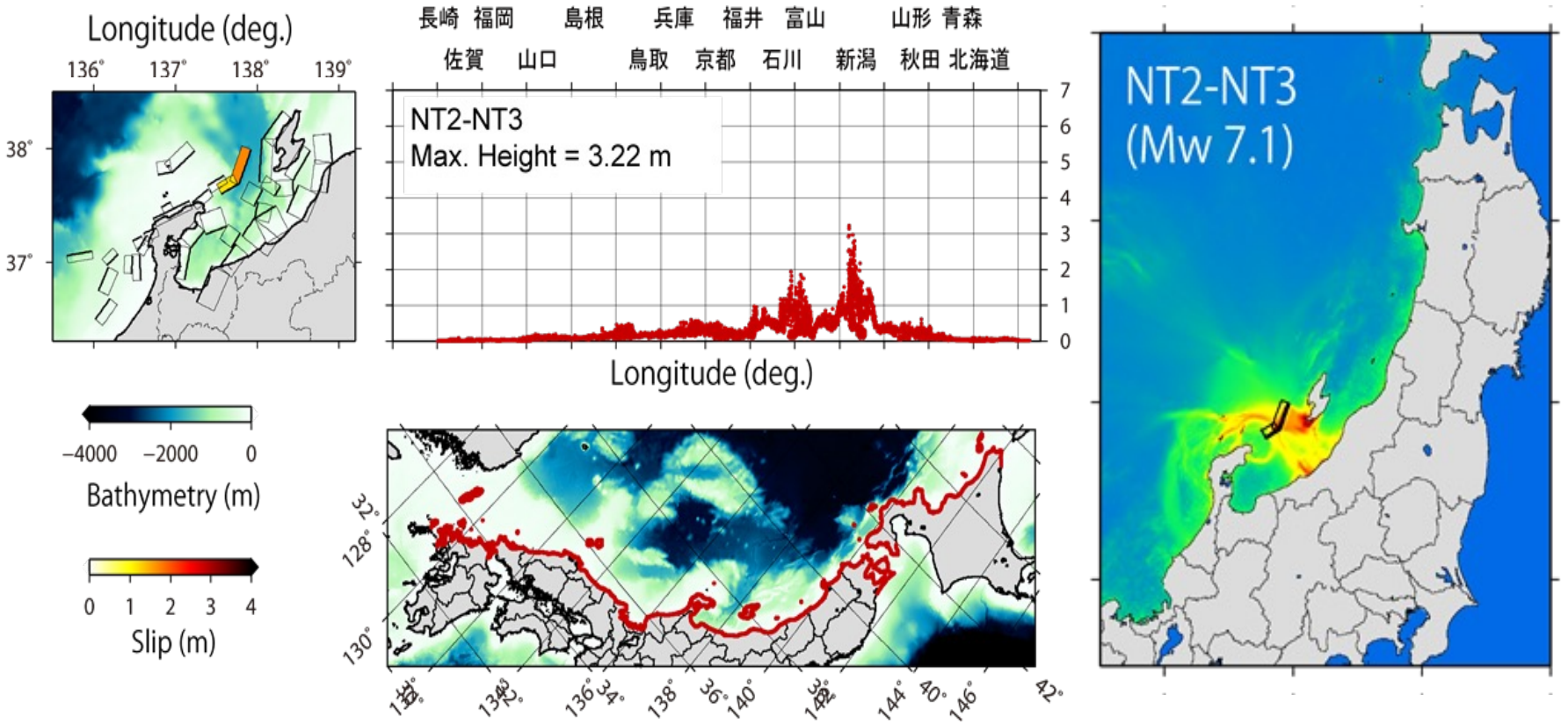
Japan Sea project models (2014-2020)

Predicted tsunami from NT4-NT5-NT6（Mw 7.3)



https://www.eri.u-tokyo.ac.jp/project/Japan_Sea/JSH27Report/PDF/20_H27JSPJ-C3.3.1.pdf

Predicted tsunami from NT2-NT3（Mw 7.1)



https://www.eri.u-tokyo.ac.jp/project/Japan_Sea/JSH27Report/PDF/20_H27JSPJ-C3.3.1.pdf

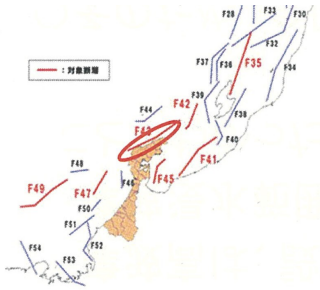
The tsunami inundation area was smaller than hazard map

津波浸水想定と今回の津波の浸水範囲の比較

MLIT
Ministry of Land, Infrastructure, Transport and Tourism

○今回の地震・津波を引き起こした主な断層と思われる、F43断層による津波の浸水想定と今回の浸水実績を比較した（県が公表している浸水想定は7つの断層による津波の最大包絡）。
○地震の規模や海岸保全施設の破壊の有無、設定潮位の影響もあり、今回の津波浸水範囲は、F43断層単独の津波浸水範囲より狭い。

Assumed fault: F43 (Mw 7.6)

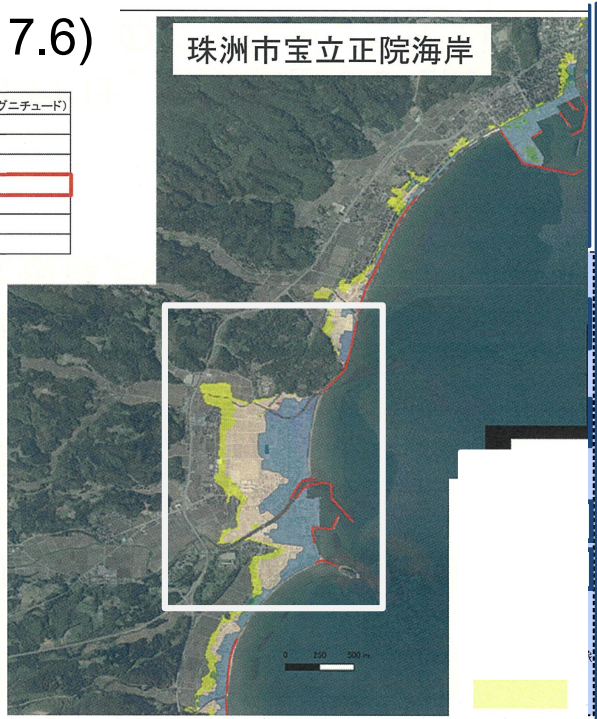


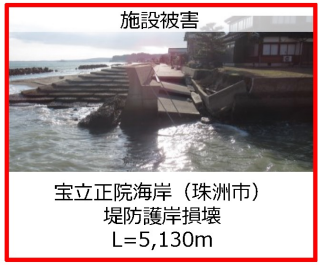
断層モデル	Mw（モーメントマグニチュード）
F35	7.6
F41	7.6
F42	7.3
F43	7.6
F45	7.2
F47	7.1
F49	7.4

今回の地震の位置・規模

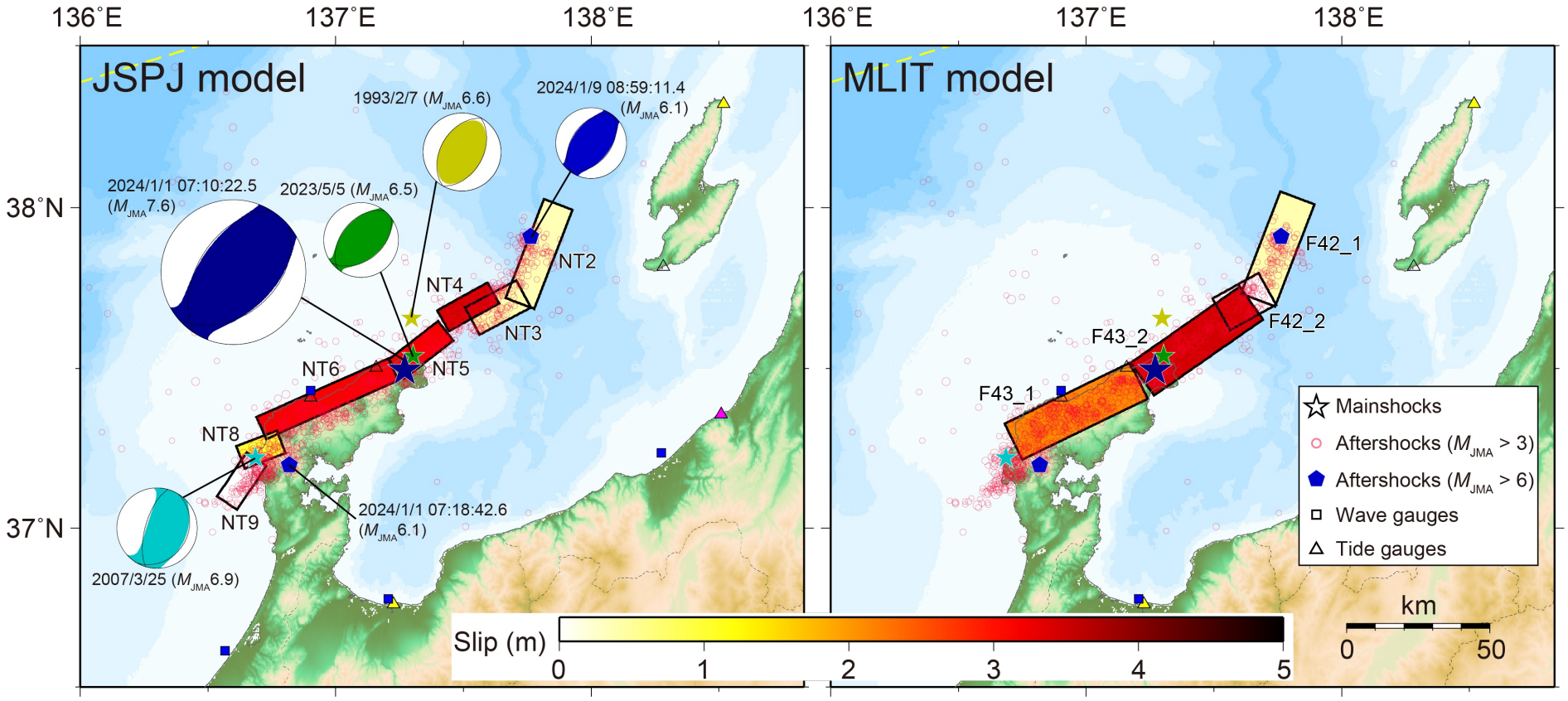
断層の位置	F43
モーメントマグニチュード ※1/2時点　気象庁速報値	7.5

今回の浸水実績※
構造物（護岸など）
※石川県・北陸地整の防災ヘリ等による画像や国土地理院による津波到達範囲の判読結果等を基に設定。



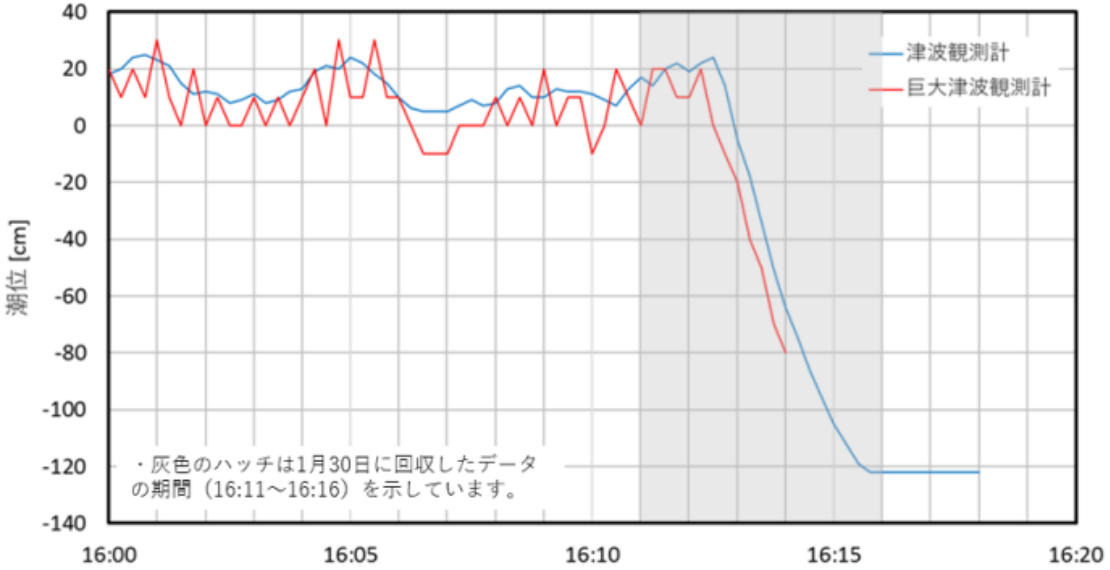


Estimated slips on active faults



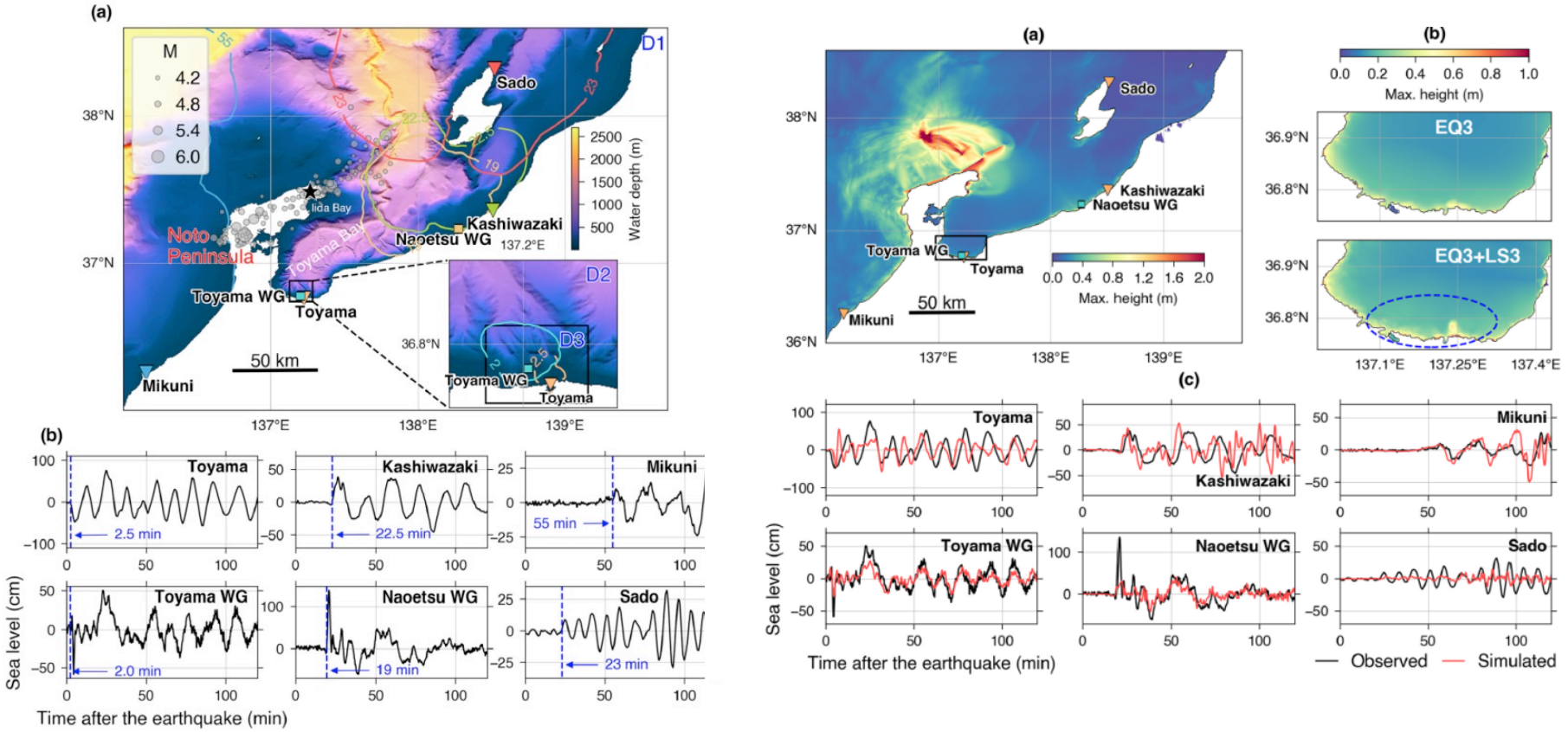
Fujii and Satake (2024, Earth Planets, Space)
https://doi.org/10.1186/s40623-024-01991-z

Tsunami observation failed due to coastal uplift



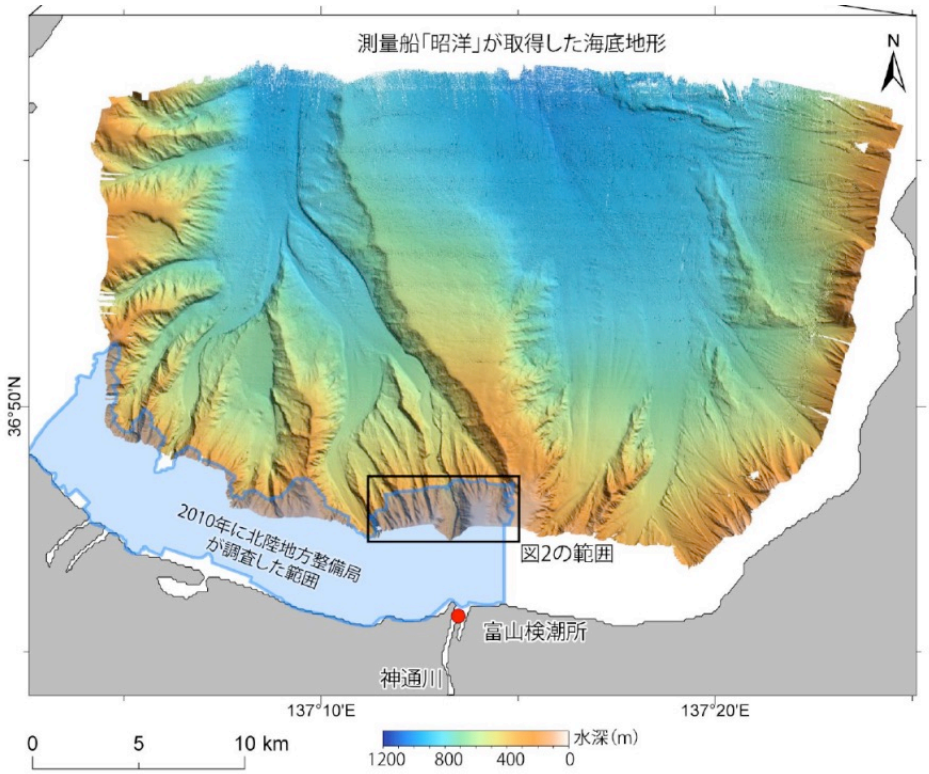
https://www.jma.go.jp/jma/press/2402/01a/nagahashi_press.pdf

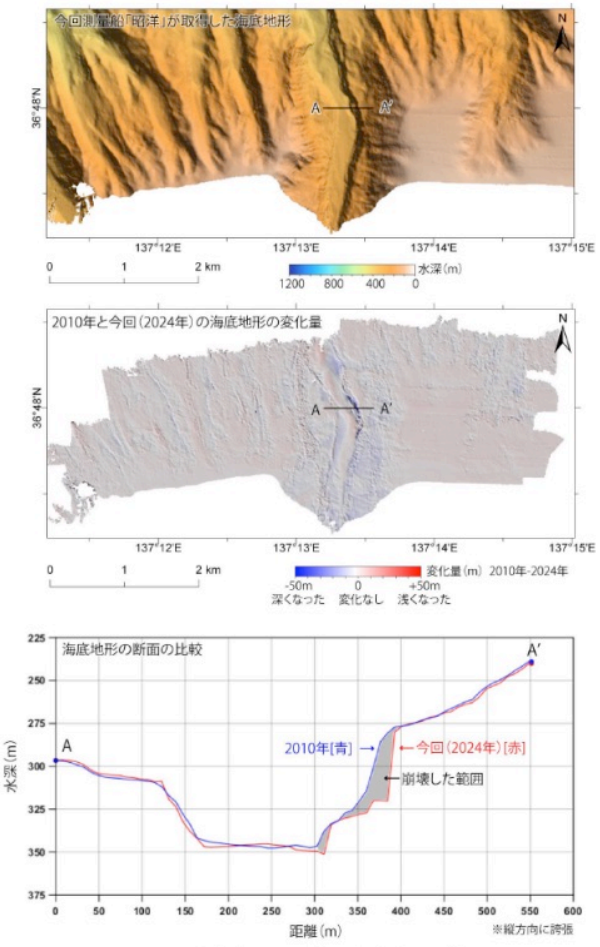
Early arrival of tsunami at Toyama



Mulia et al. (2024)
https://doi.org/10.1016/j.oceaneng.2024.118698

Bathymetry survey by Japan Coast Guard





https://www.kaiho.mlit.go.jp/info/kouhou/r6/k240124/k240124.pdf

Nankai trough earthquake attention

BBC

Japan warns of heightened risk of megaquake

9 August 2024

Shaimaa Khalil
BBC News
Reporting from Japan

Flora Drury
BBC News
Reporting from London

Japan lifts 'megaquake' warning after one week

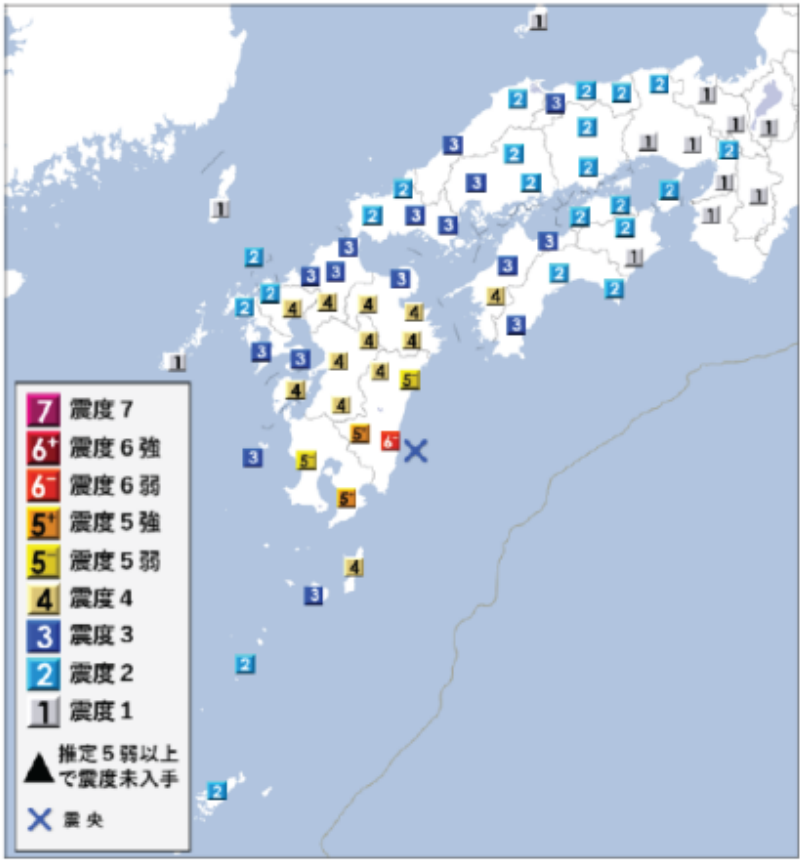
6 days ago

Share

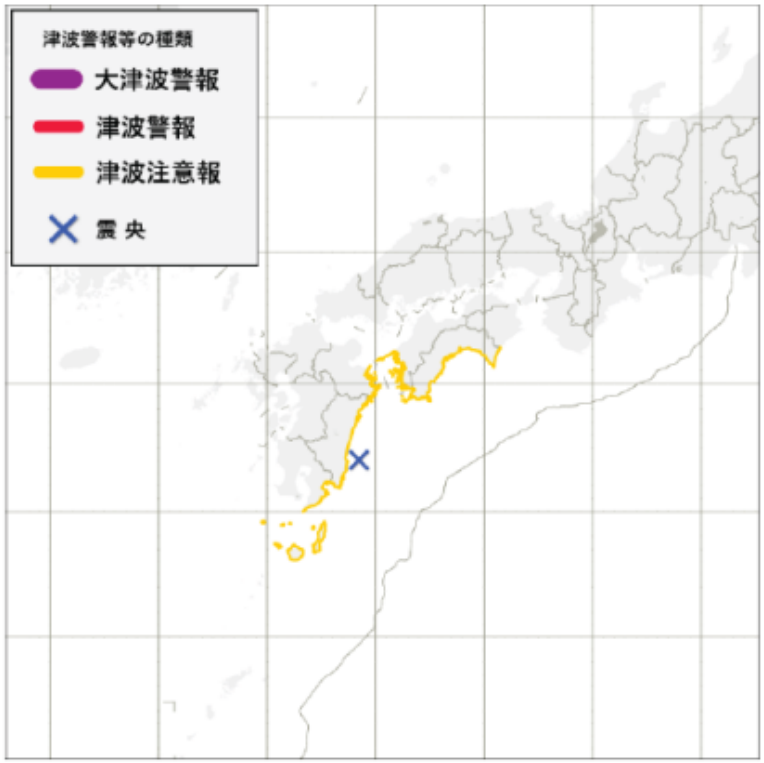
Jemma Crew
BBC News

An M 7.1 earthquake on August 8, 2024

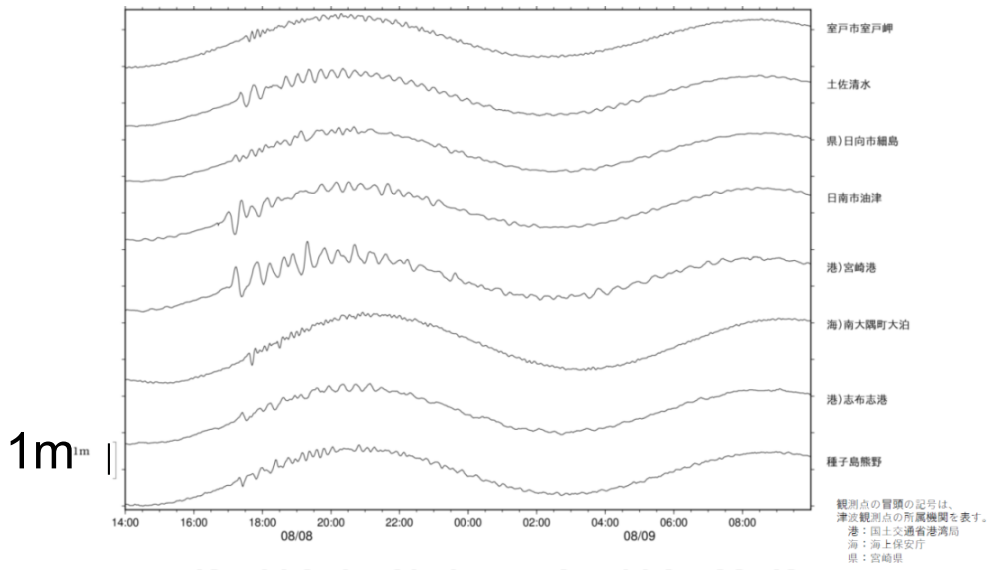
8月8日16時55分発表

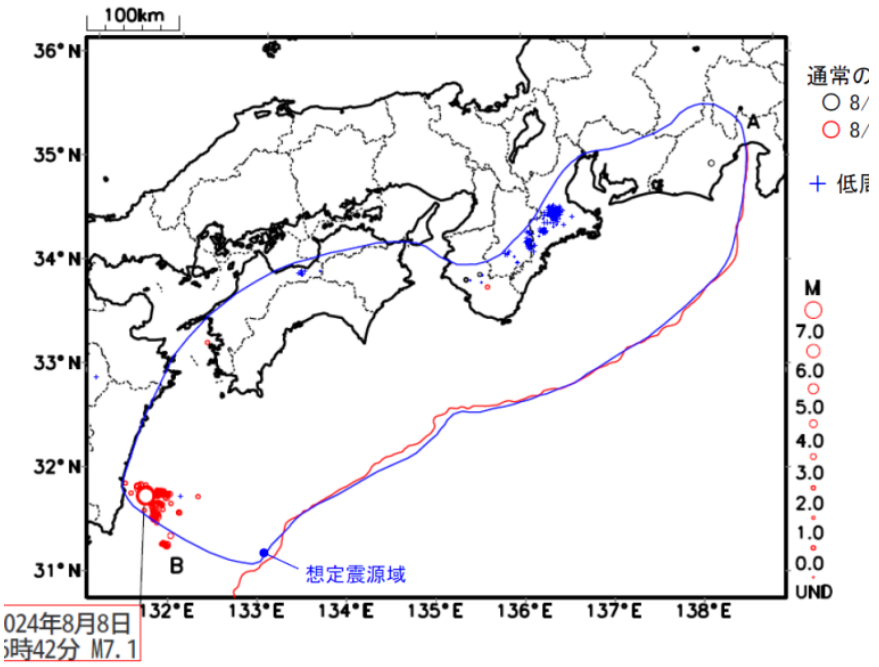


8月8日16時52分発表

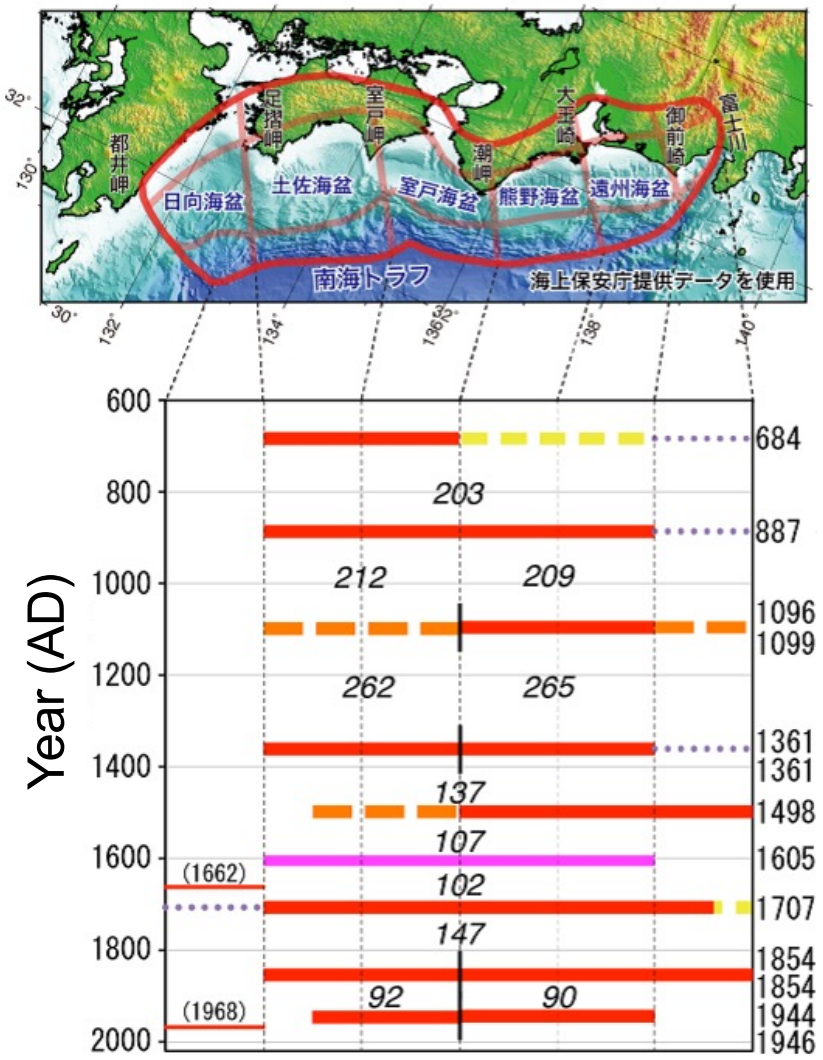


An M 7.1 earthquake on August 8, 2024

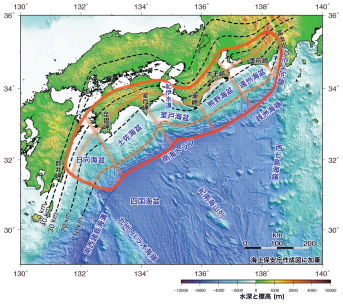




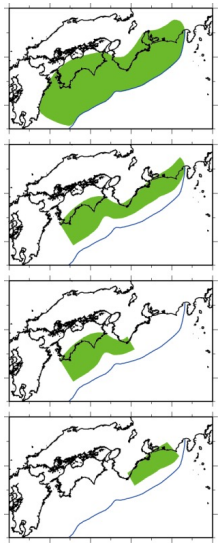
Nankai trough earthquake attention



Long-term forecast（2013）



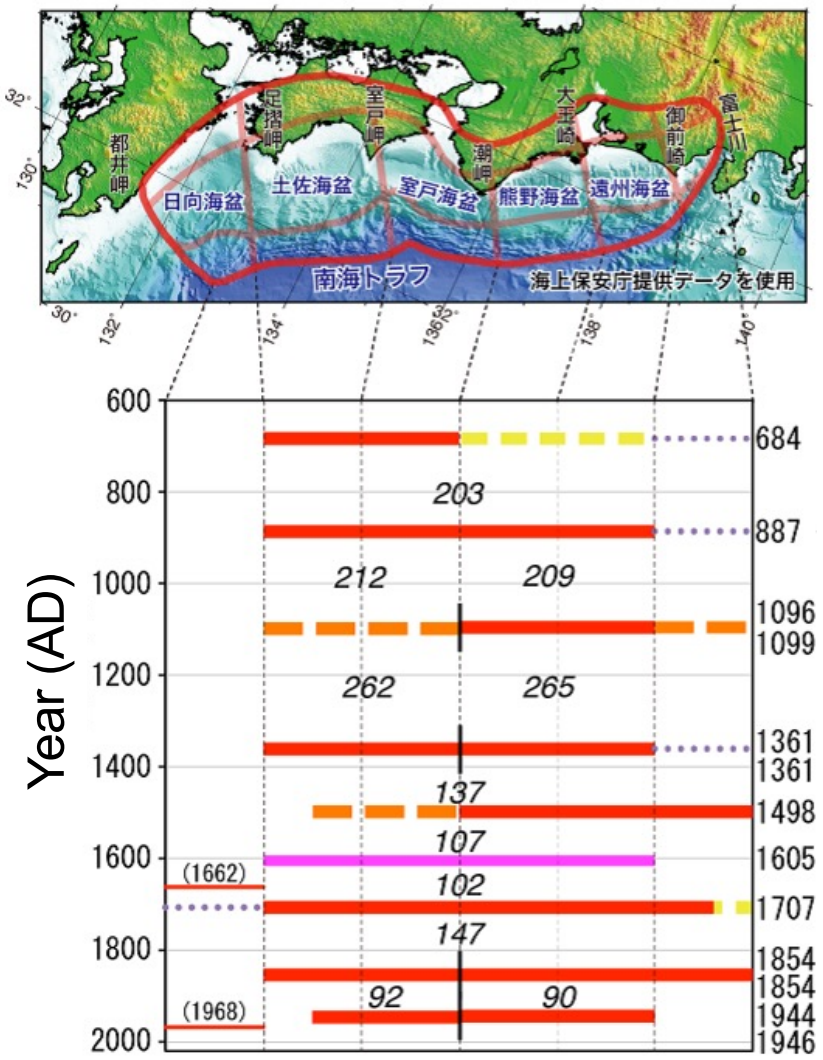
Maximum source based on geo-morphology, historical data, seismicity

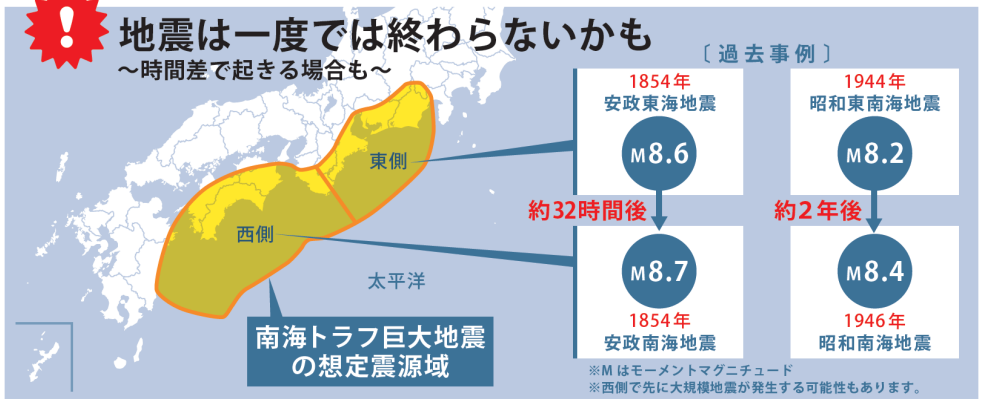


Variability

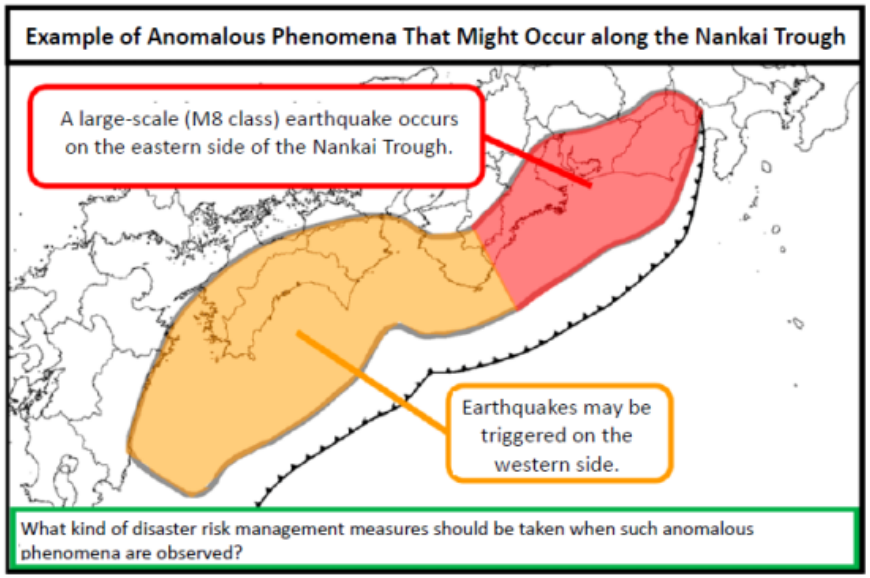
	Size	30 yr prob
Nankai Trough	M8～M9	70 - 80%

Nankai Trough Earthquake Information





When an earthquake of Mw ≥ 8.0 occurs



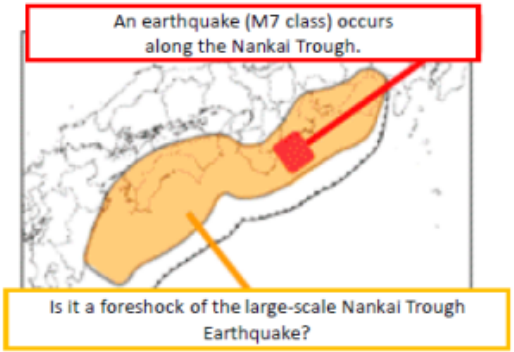
https://www.bousai.go.jp/jishin/nankai/pdf/leaflet.pdf

Nankai Trough Earthquake Information

When an earthquake of Mw ≥ 7.0 occurs

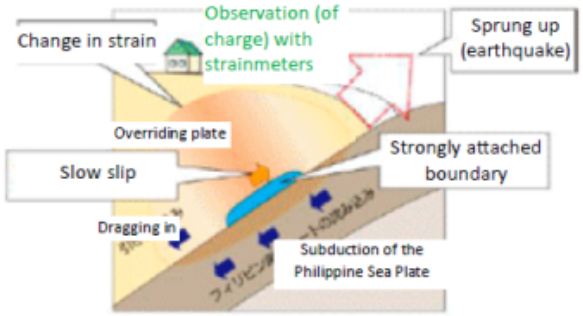
When a slow slip is observed

The case of a limited area rupture causing limited damage (possible foreshock with a magnitude between 7.0 and 8.0)



- ✓ Some residents start evacuation.
- ✓ No major damage has yet occurred in most regions.

The case of a slow slip causing no damage



- ✓ No shock or tsunami. Transportation infrastructure operates as normal
- ✓ Attracting higher interest from the public as an unprecedented case

Review earthquake preparedness, raising the alert level, etc.

(Limited area rupture case) Disaster management measures are implemented over a week of maximum alert period in principle
(Slow slip case) Disaster management measures will be continued until it is confirmed that no new change has occurred after the same amount of time as the period in which the change in the slip was observed.

Example of items to review for earthquake preparedness

[Residents]
- Check if the furniture is securely fixed
- Check means for confirming family members' safety
- Evacuation centers
- Evacuation routes
- Check the inventory of household emergency supplies

[Companies]
- Check means for confirming employees' safety
- Check evacuation instructions for facility users and evacuation routes for employees
- Inspection of facilities and equipment
- Check if the furniture and equipment are securely fixed.

Example of disaster management measures taken according to the situation

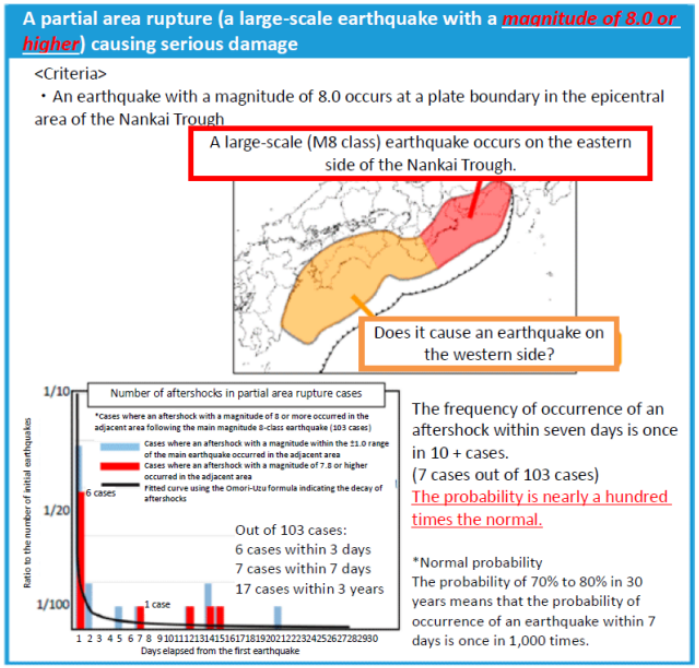
[Residents]
- Be ready for evacuation (prepare emergency bags, etc.)
- Voluntary evacuation to houses of relatives or acquaintances
- Stay in a safe room with no objects with a risk of collapse or fall

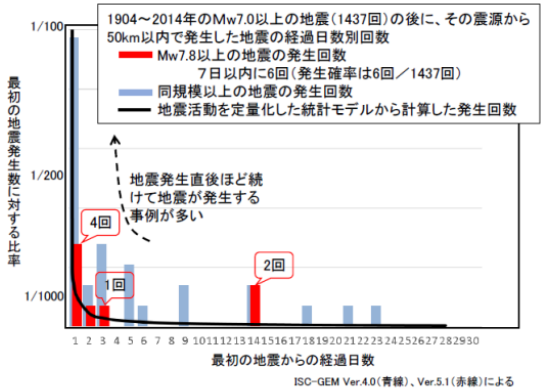
[Companies]
- Traffic control along the coasts
- Increase parts inventory
- Restrict the use of rooms whose ceilings have objects that may fall
- Backup and storage of electronic data and important documents

https://www.bousai.go.jp/en/documentation/white_paper/pdf/SF3.pdf

Nankai Trough Earthquake Information

Probability increase





Probability of Nankai eq. is
70 – 80 % for 30 years
= 0.1 % for one week

Global earthquake catalog (1904-2014) shows
103 eqs. with Mw ≥ 8.0. Among them,
7 eqs. with Mw ≥ 8.0 within 7days and 50 km

7/103 = 6.7 % → 67 times increase

1437 eqs. with Mw ≥ 7.0. Among them,
6 eqs. with Mw ≥ 7.8 within 7days and 50 km

6/1437 = 0.4 % → 4 times increase

https://www.bousai.go.jp/jishin/nankai/taio_wg/pdf/h301225gaiyoban.pdf

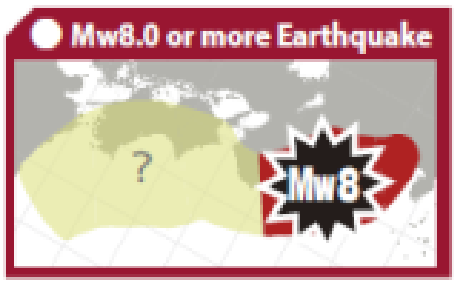
Nankai Trough Earthquake Information

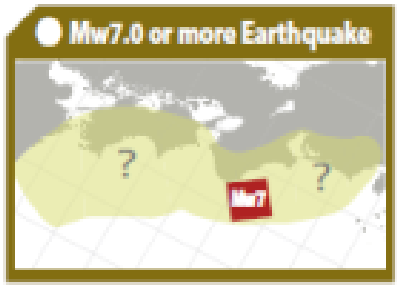
Keywords of Nankai Trough Earthquake Extra Information

Nanaki Trough Earthquake Extra Information is issued with the title Nankai Trough Earthquake Extra Information (Megathrust Earthquake Alert) with appended keywords. Examples of keywords and disaster prevention measures are shown below.

Keywords	Conditions
Under Analysis	When analysis is underway to determine whether anomalies relate to the Nankai Trough Earthquake
Megathrust Earthquake Alert	For an earthquake of Mw*8.0 or more considered to have occurred at a plate boundary with an anticipated focal region along the Nankai Trough
Megathrust Earthquake Attention	For an earthquake of Mw7.0 or more considered to have occurred with an anticipated focal region and surroundings along the Nankai Trough (except in Megathrust Earthquake Alerts) For an unusual slow slip considered to have occurred at a plate boundary with an anticipated focal region along the Nankai Trough
Analysis Complete	When the results of analysis indicate that the anomalies are not classified into either Megathrust Earthquake Alert or Megathrust Earthquake Attention output

*Mw: Moment magnitude. It is a type of magnitude calculated based on the scale of rupture area along source fault, average slip, and rigidity of rocks.





https://www.jma.go.jp/jma/kishou/books/jishintsunami/en/jishintsunami_en.pdf

Nankai Trough Earthquake Information

	Alert	Attention	Complete
2 hours to 1 week	- Be prepared - Evacuation if needed	Be prepared	Normal life, but remember eq. potential
1 week to 2 weeks	- Be prepared	Normal life, but remember eq. potential	
After 2 weeks	- Normal life		

https://www.jma.go.jp/jma/kishou/books/jishintsunami/en/jishintsunami_en.pdf

Thank You

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