Tsunami Research and Its Practical Use for Hazard Mitigation

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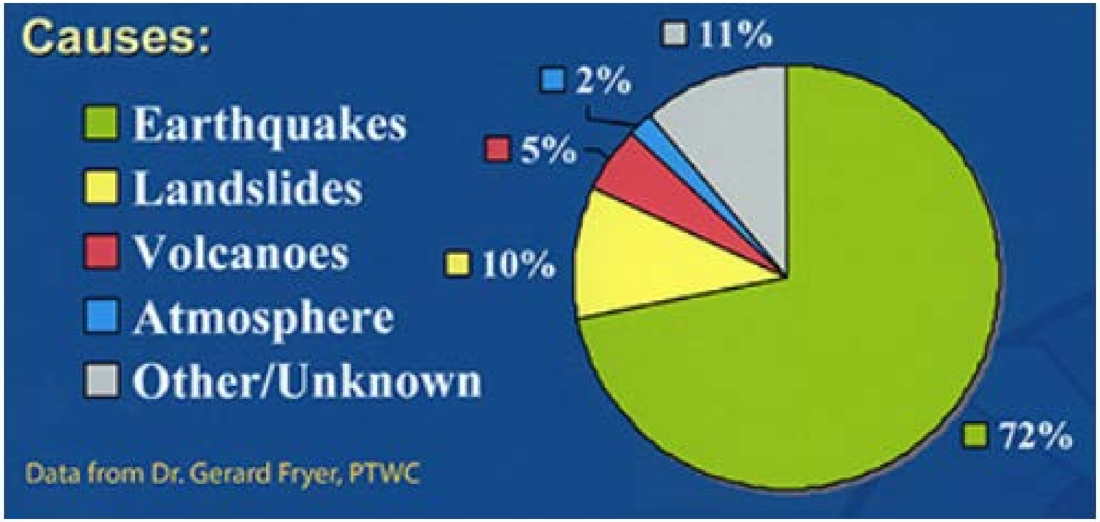
Cause of Tsunami

Earthquakes
Landslides
Volcanic origin
Impact



(Dr. Gerald Fryer, PTWC)

Earthquakes are the most common origin.

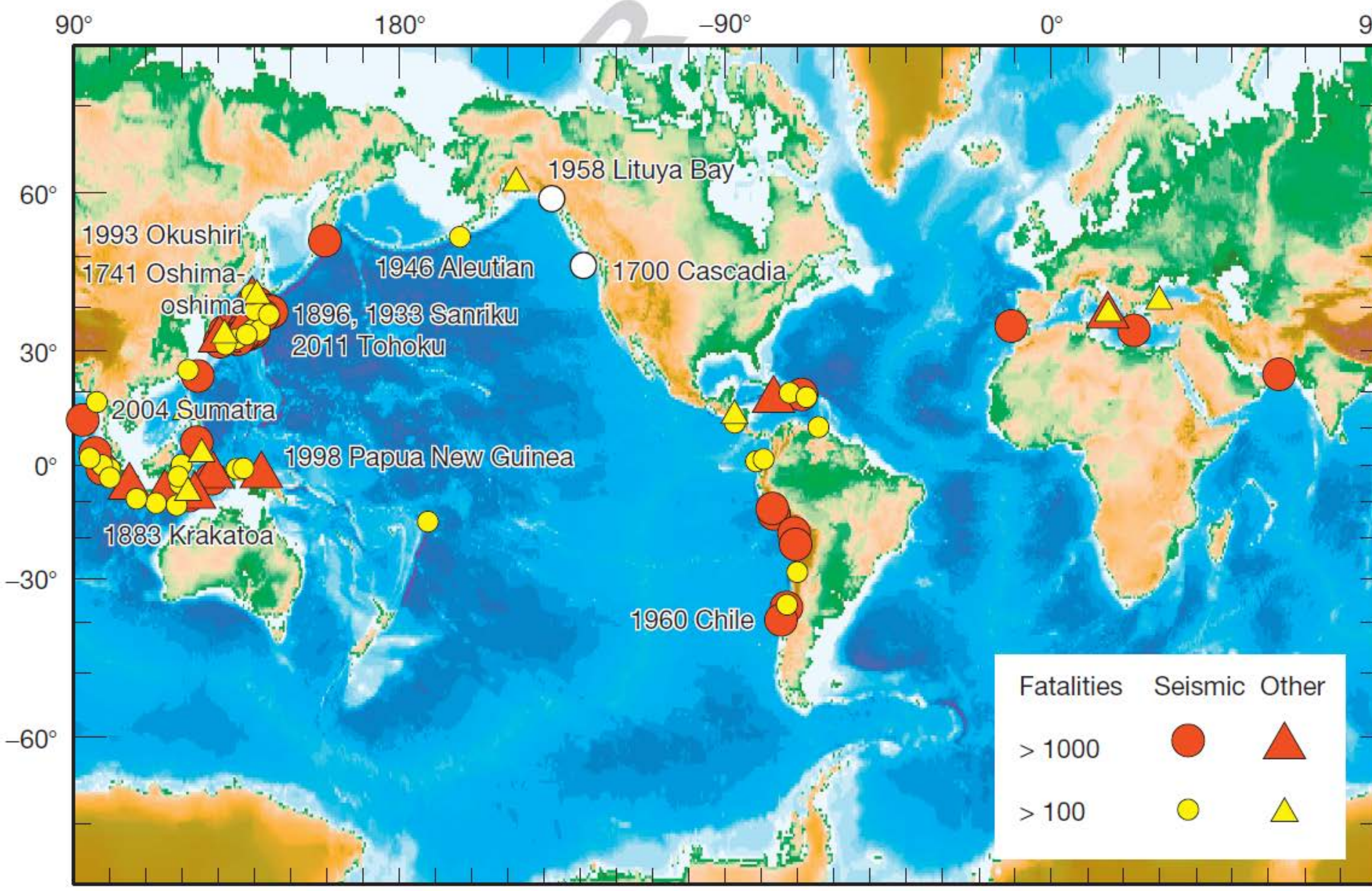


Figure 6 Distribution of tsunami occurrences throughout the world. Symbols represent the historical events with intensity ≥2 and validity ≥3 from the NOAA NGDC Tsunami Database.

(K. Satake, 2015)

First

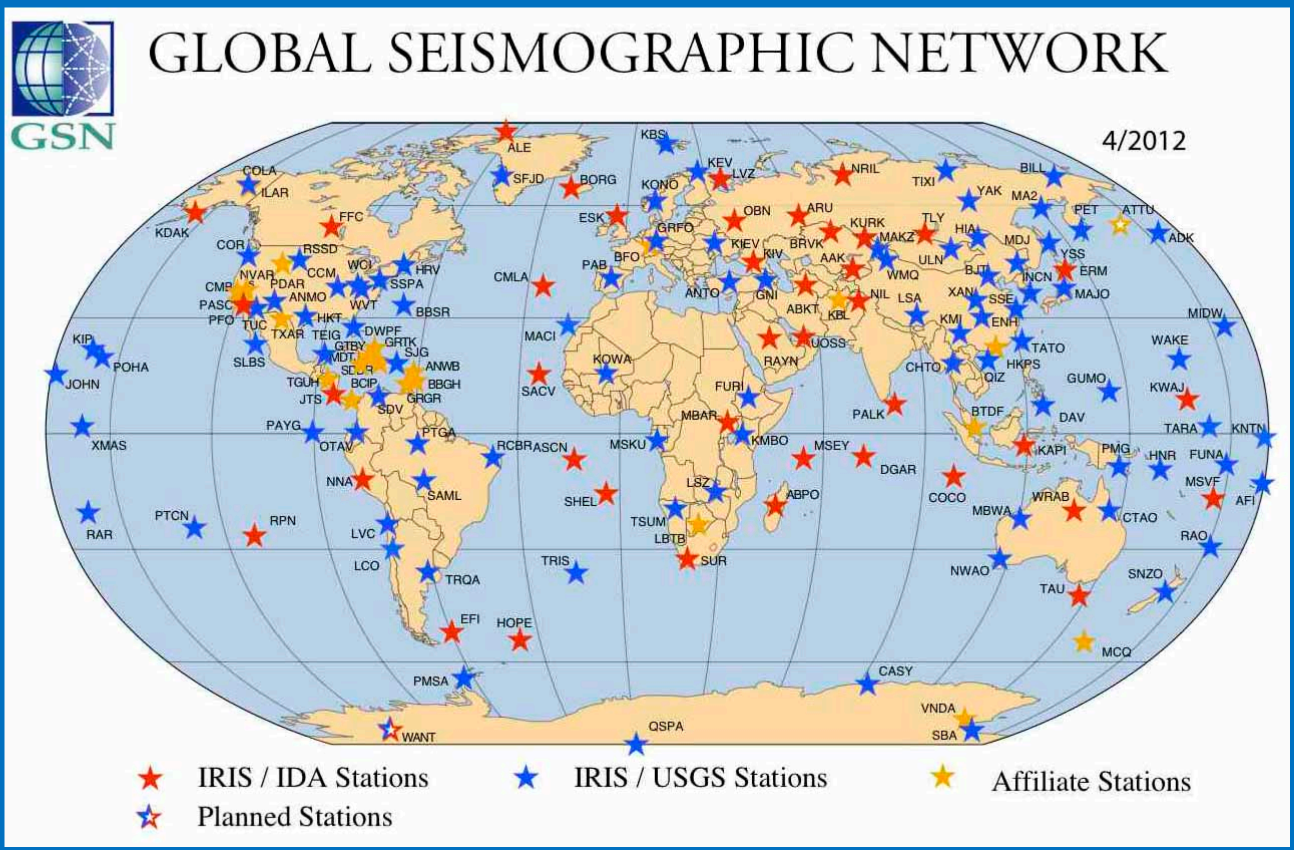
Science and technical matters

Earthquakes and Seismology

Most common and Traditional

→ Science and Technology, Extensively used.

Global monitoring, also promotes science



For monitoring, "Real-time availability is important"

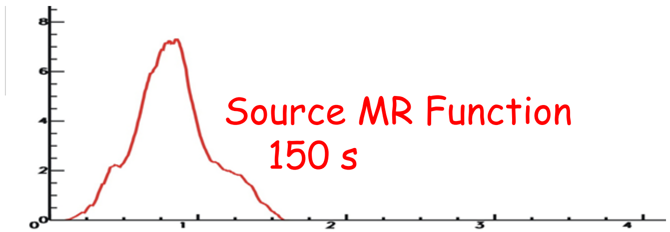
Other networks

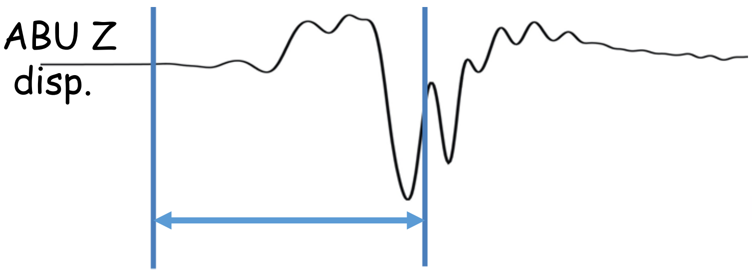
e.g., Japan
China
etc

More than 1000.

Use of close-in stations for rapid retrieval of source parameters

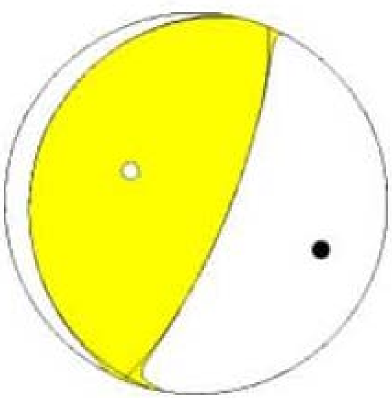
Rivera, Duputel, and others ………….

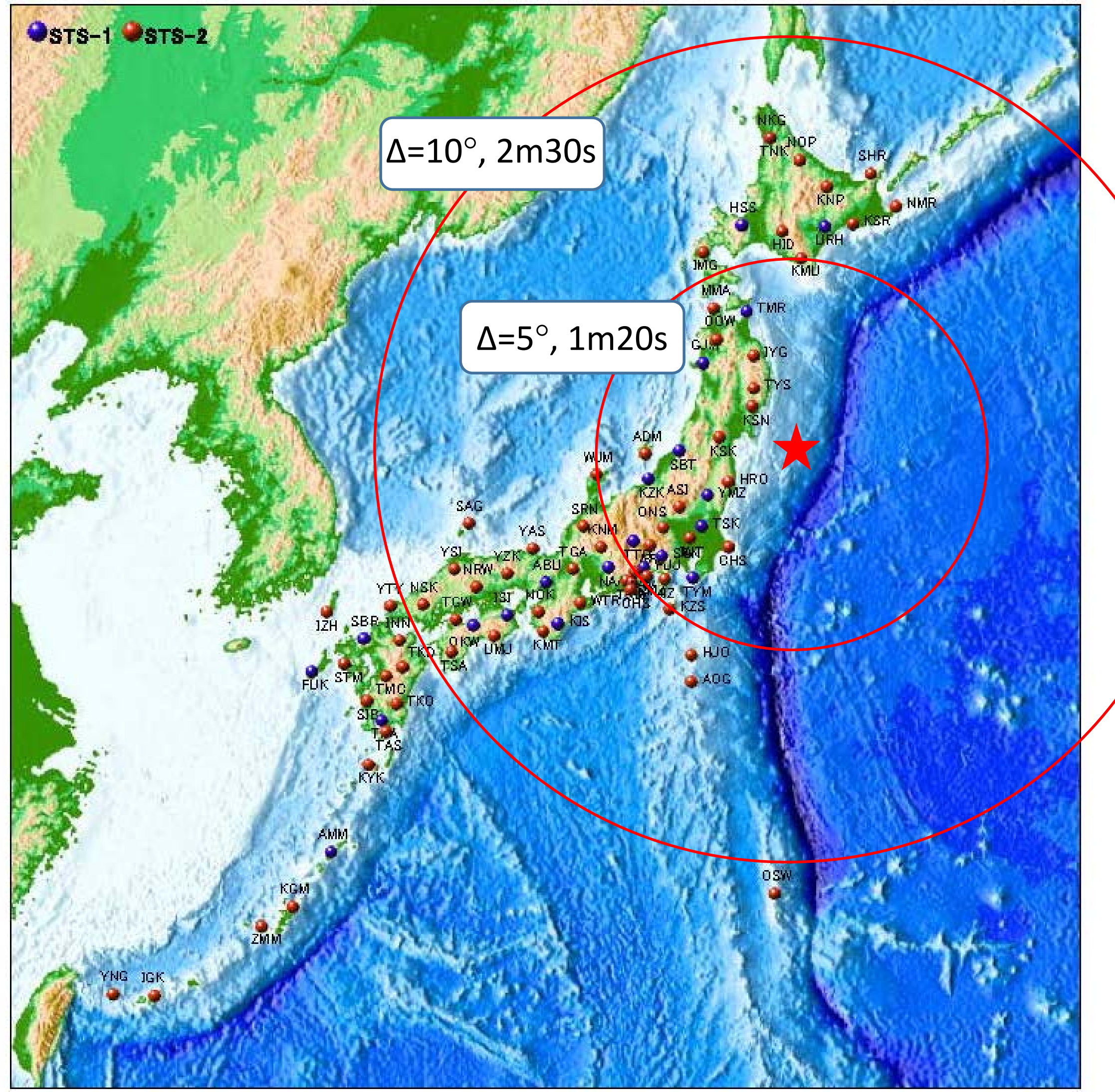




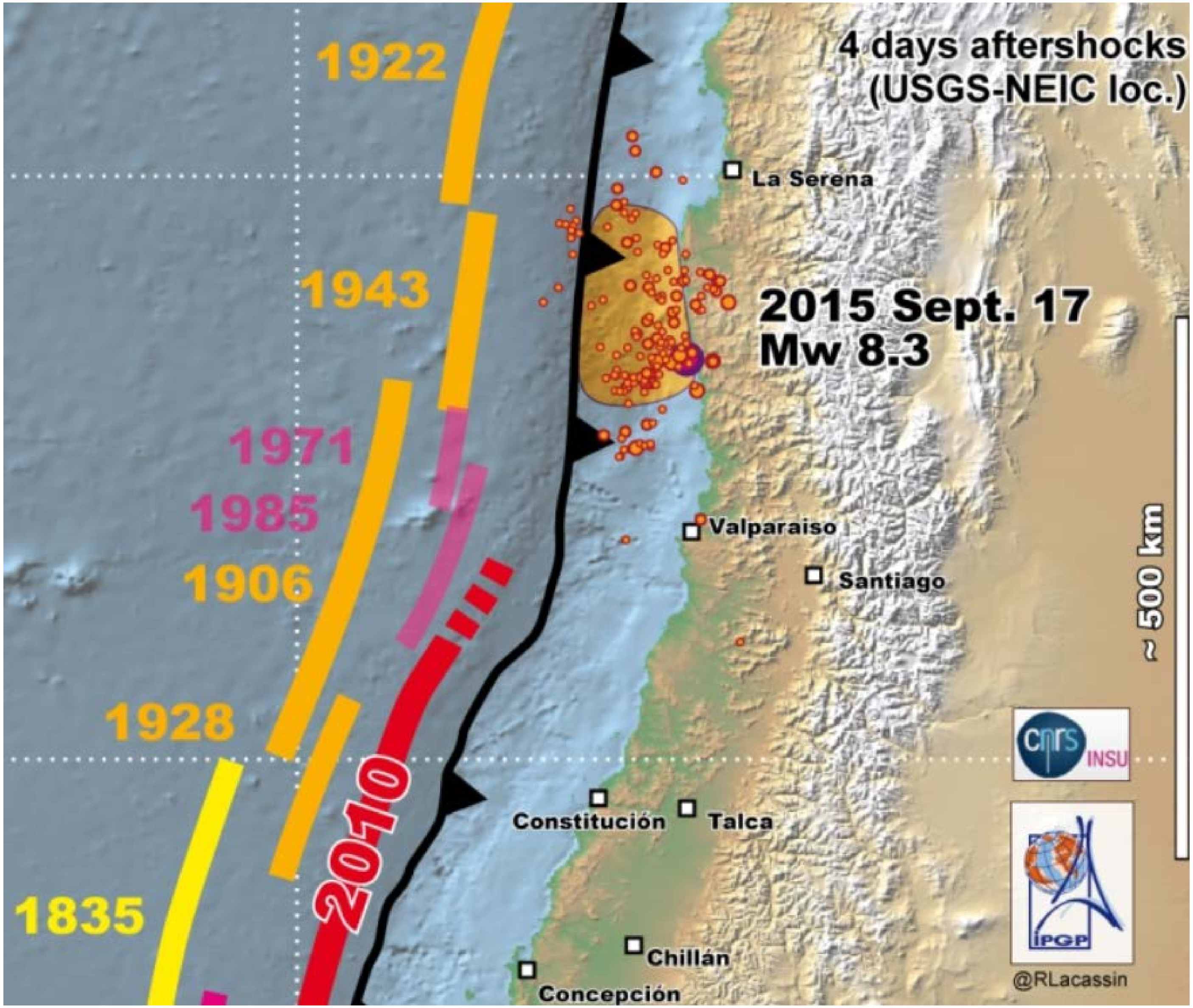
W phase window, 180 s

M_w=9.1



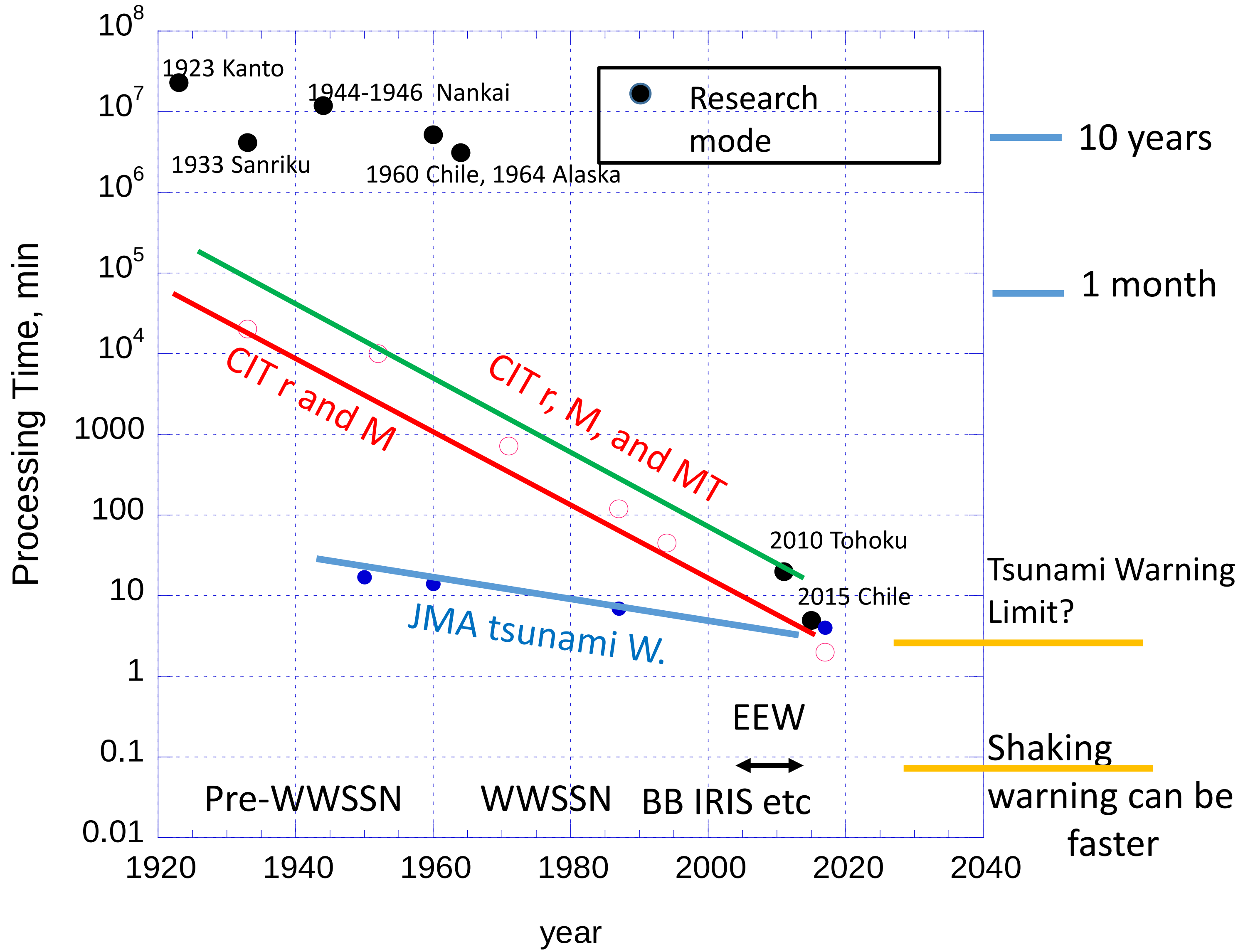


Chilean Rapid Warning: The 2015 Illapel earthquake (Mw=8.3)



http://www.ipgp.fr/en/earthquake-offshore-illapel-chile

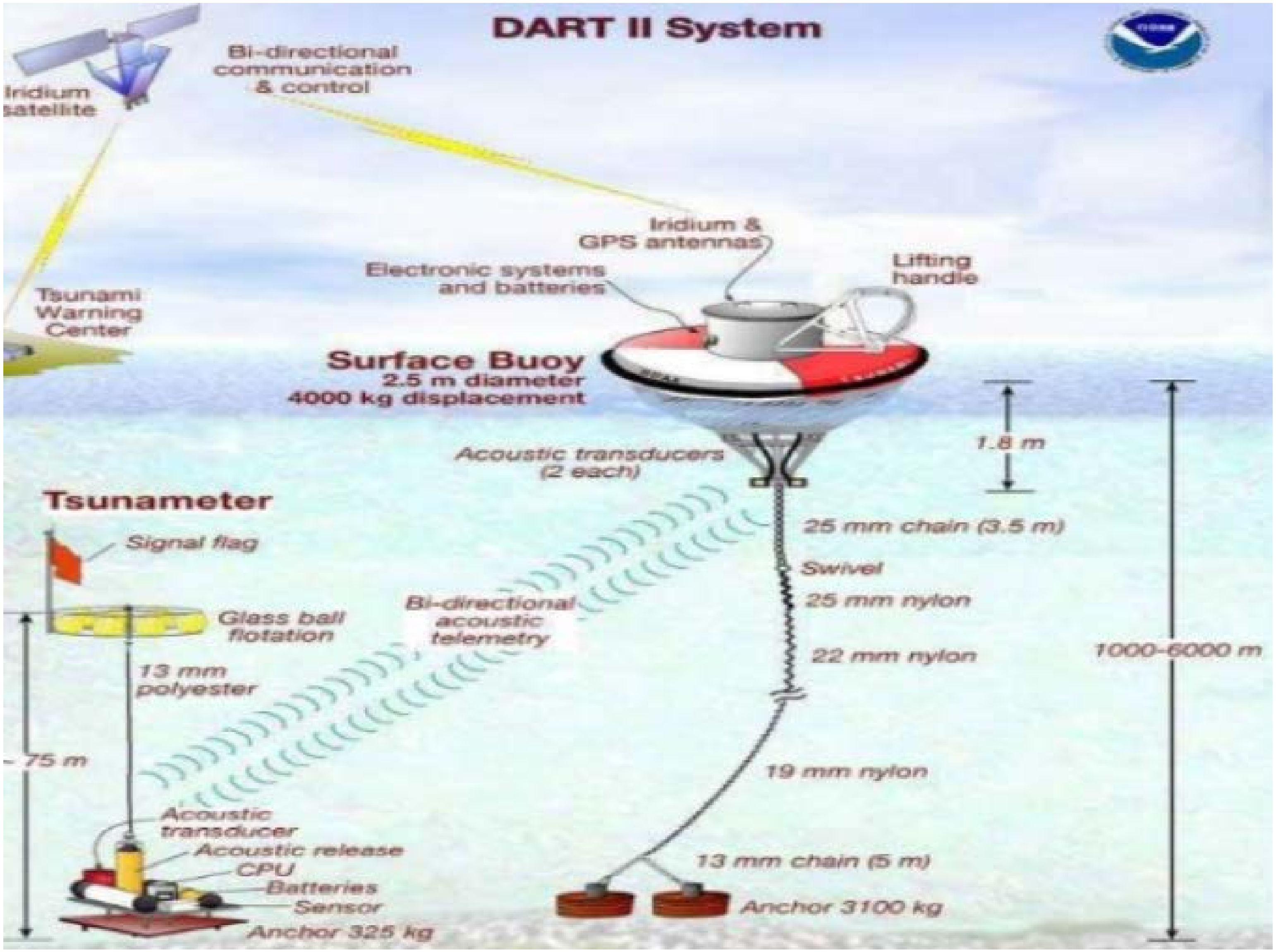
Evolution of reporting speed



Data provided by E. Hauksson and M. Hoshiba

Ocean-bottom pressure gauge

Measures tsunami more directly, but it must be “there”.



GPS, Pressure gauge, Cable system

More accurate, detailed

but time-wise, limit=a few minutes?

Tsunamis of landslides, volcanic, impact origin

Science has advanced but

Technology for warning must be developed.

Difficulty

Most natural processes, especially earthquakes

Stochastic or Chaotic, because of “many” factors involved.

Prediction on a time scale of our daily life is difficult.

Rare, but with grave consequences.

Near-field tsunamis (e.g., 2018 Sulawesi) require very rapid (< a few minutes) response and evacuation

We need to prepare for the unexpected.

A comprehensive program including science, technology, vulnerability, infrastructure, land-use planning, education, evacuation drills, etc is necessary.

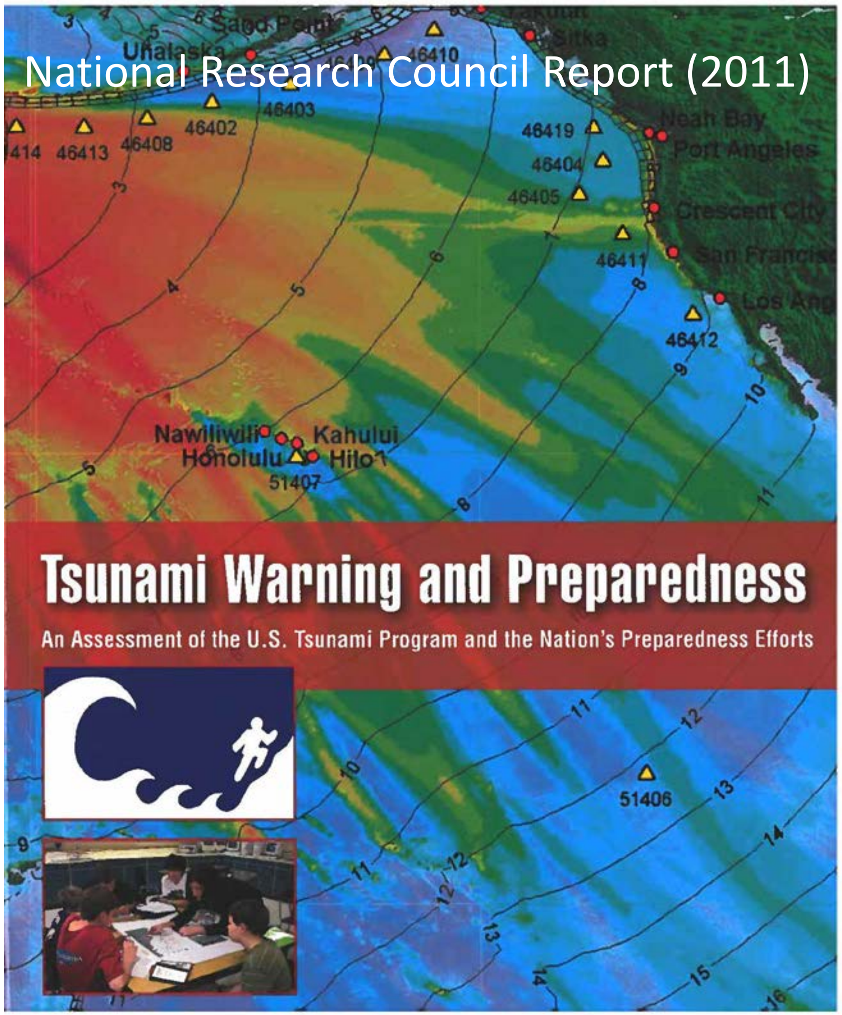
Long-term preparedness with long-term stable funding (sustainability) is important.

Tsunami Hazard Mitigation Program

Not just a matter of science and technology

Input: Science → Government

Example, US. Congress: request → NAS→ Report



On

Assessment of Tsunami Risk

Preparedness, Education

Detection and Forecast

Improve TWC's Reliability and Sustainability of Operations

Issues:

1. For large "regular" earthquakes (2004 Sumatra, 2011 Tohoku)
   a few minutes
   Improve the traditional method for warning.
   (seismic, GPS, Ocean cable system)

2. For tsunamis of landslides, volcanic origin,
   Further development is required.

3. For "near-field" earthquake (1993 Okushiri, 2018 Sulawesi))
   less than a few minutes,
   Self-evacuation (seismic shaking) may be the only way.
   Deal with frequent false alarms

4. For slow (tsunami) earthquakes (1896 Sanriku, 1992 Nicaragua)
   Self evacuation may not work (no shaking)

5. How to handle property loss? Insurance?

Some examples

Land-use planning
Infrastructure
Vulnerability
Education (signs etc)
Special studies
Vertical evacuation structure

Land-use management

Yoshihama, Iwate Pref. (Photo. Oct. 2010 Luis Rivera)

1896 tsunami Almost the entire village was wiped out.
Advised to live on higher grounds.
2011 Tohoku-Oki tsunami No casualty

Tsunami Wall (15.5 m) protected the village of Otanabe behind it

Otanabe photo taken by Y. Nakamura (4/11/2011)


TSUNAMI
EVACUATION ROUTE
TSUNAMI
EVACUATION ROUTE
U.S. DIVERS
AQUA LUNG
U.S. DIVERS

Vertical Evacuation

日本の協力により建てられた避難タワー。普段はコミュニティ活動に利用されている。（バンダ・アチェ市）

(From JICA publication)

(From Cedillos et al., 2010)

Conclusion

1. Science and Technology
 Seismology, GPS, Ocean-bottom instrumentation, and Telemetry steadily advancing, and being effectively used for warning.

2. Difficulty (unique)
 Rare and unexpected events with grave consequences
 Especially serious for near-field tsunamis

3. Sustainability: Long-term funding. Use of monitoring network for science. e.g., Global network for seismology, DART for tsunami research

4. Vulnerability study, Land-use planning, Evacuation strategy, Education and Drills

5. Close collaboration between scientists, engineers, practitioners, and government officials Review and recommendation