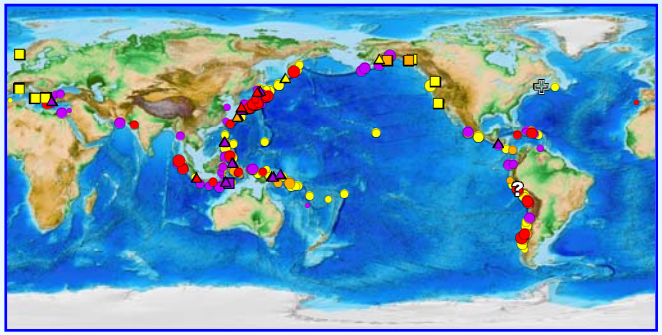
NOAA/NGDC/WDC
Historical Tsunami Database



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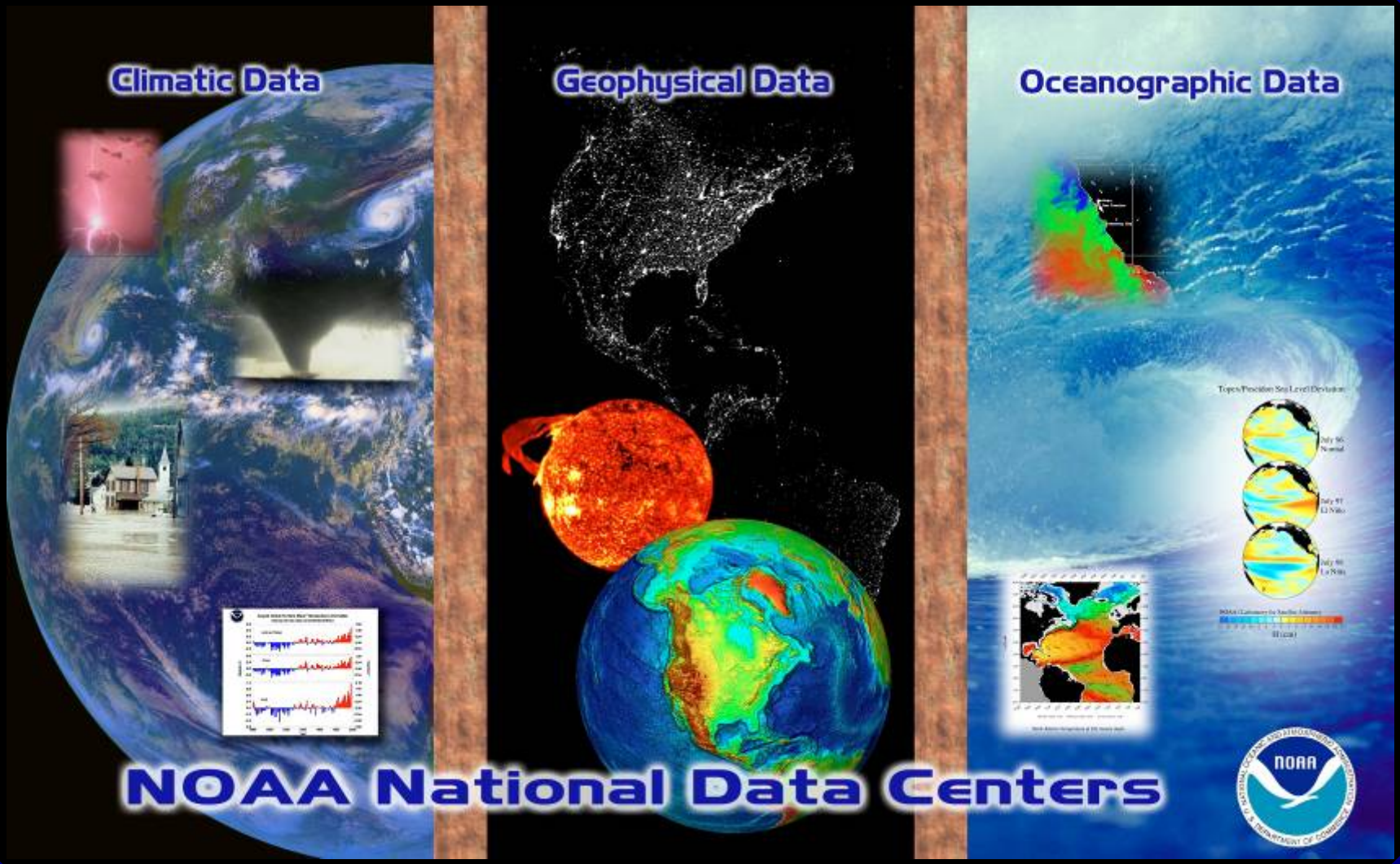
Outline

- Brief Introduction to NGDC/WDC
- Update on NGDC/WDC Tsunami Data Archive
- Content of the Historical Tsunami Event and Runup Databases
  - Summary of geographic distribution, causes, effects
- Can the Historical Tsunami database answer questions such as:
  - What are the sources of the most damaging and fatal tsunamis?
  - How far from the source do most tsunamis cause damage and fatalities?
  - What is the total number of deaths from all tsunamis?
  - What is the total $ dollar damage from all tsunamis?

NOAA's Three National Data Centers



NGDC/World Data Center for Geophysics and Marine Geology, Boulder, Colorado

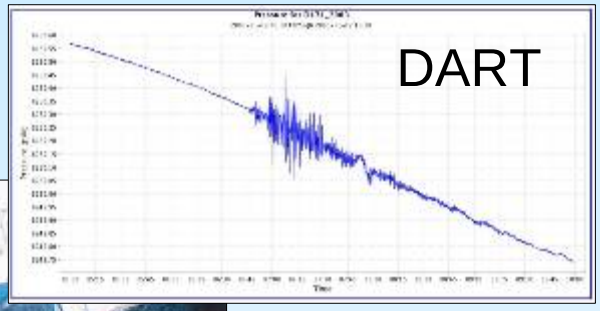
- World Data Center (WDC) established in 1957
- Moved to Boulder in the 1970s

- Scientific data management of global and regional geophysics and marine geology data including natural hazards (earthquake, tsunami, volcanic eruptions)
  - Data and Metadata in standard formats (ISO, National, Community)
- Hosted by the National Oceanic and Atmospheric Administration (NOAA) / National Geophysical Data Center (NGDC), Boulder, CO, USA

Tsunami Data Archive

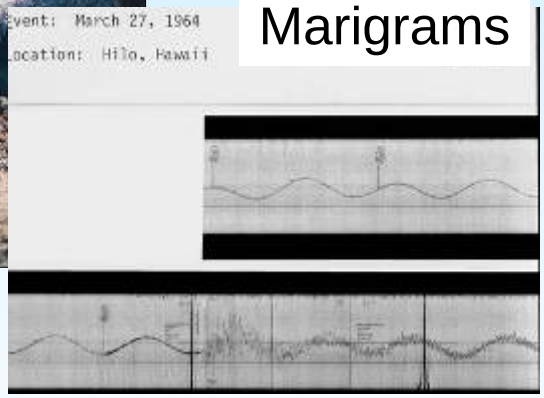
Data Types:

- Global destructive or tsunamigenic historical events
  - Tsunami Events and Runups
  - Significant Earthquakes
  - Significant Volcanic Eruptions
- Tsunami Deposits bibliographic database – 572 citations online
- Tsunami References
  - 968 source documents
- DART® buoy database
  - 18 Gb, 1988-2009
- High resolution tide-gauge data
  - 7 GB NOS Jan 2008 to present
  - 102 GB marigrams 1854-1980
- Damage Photos
- Bathymetry/topography data for tsunami inundation modeling

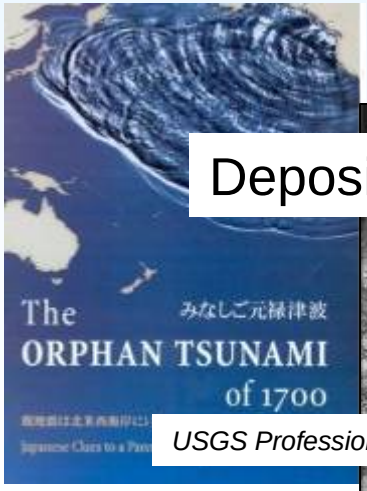


Photos

Marigrams



Deposits



USGS Professional Paper

Historical Tsunami Database

- Source event (time, location, magnitude)
- Runup locations where tsunami waves were observed
  - water heights, arrival times, wave periods
  - range from barely perceptible recordings on coastal sea level gauges to descriptions of powerful tsunami waves that caused massive death and destruction.
- Damage, deaths, injuries, houses destroyed, houses damaged from the source and the tsunami
- List of references associated with each event and runup
- Validities
  - determined from the number of reports, reliability of the source, and instrumental recordings vs. eyewitness accounts
- Additional comments

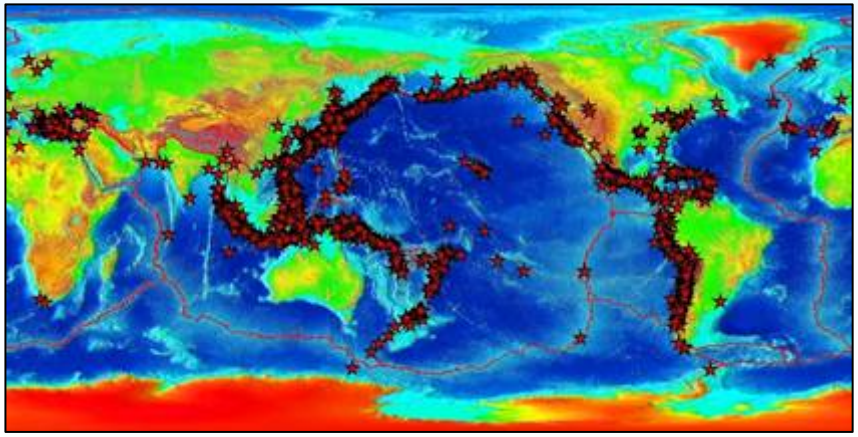
Spatial Distribution

Historical Tsunami Event Database (validity ≥1)

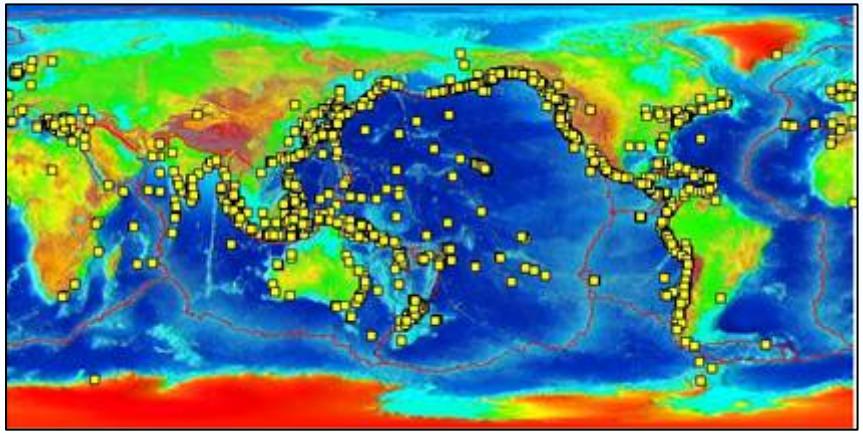
- 2,041 Source Events
  - 60% Pacific, 23% Mediterranean (+ Black Sea), 11% Atlantic (+Caribbean Sea), 6% Indian Ocean (+Red Sea)

Historical Tsunami Runup Database (source event validity ≥1)

- 13,069 Runup Observations
  - 83% Pacific, 4% Mediterranean (+ Black Sea), 4% Atlantic (+Caribbean Sea), 9% Indian Ocean (+Red Sea)
    - 7.6 % from 2004 Indian Ocean event



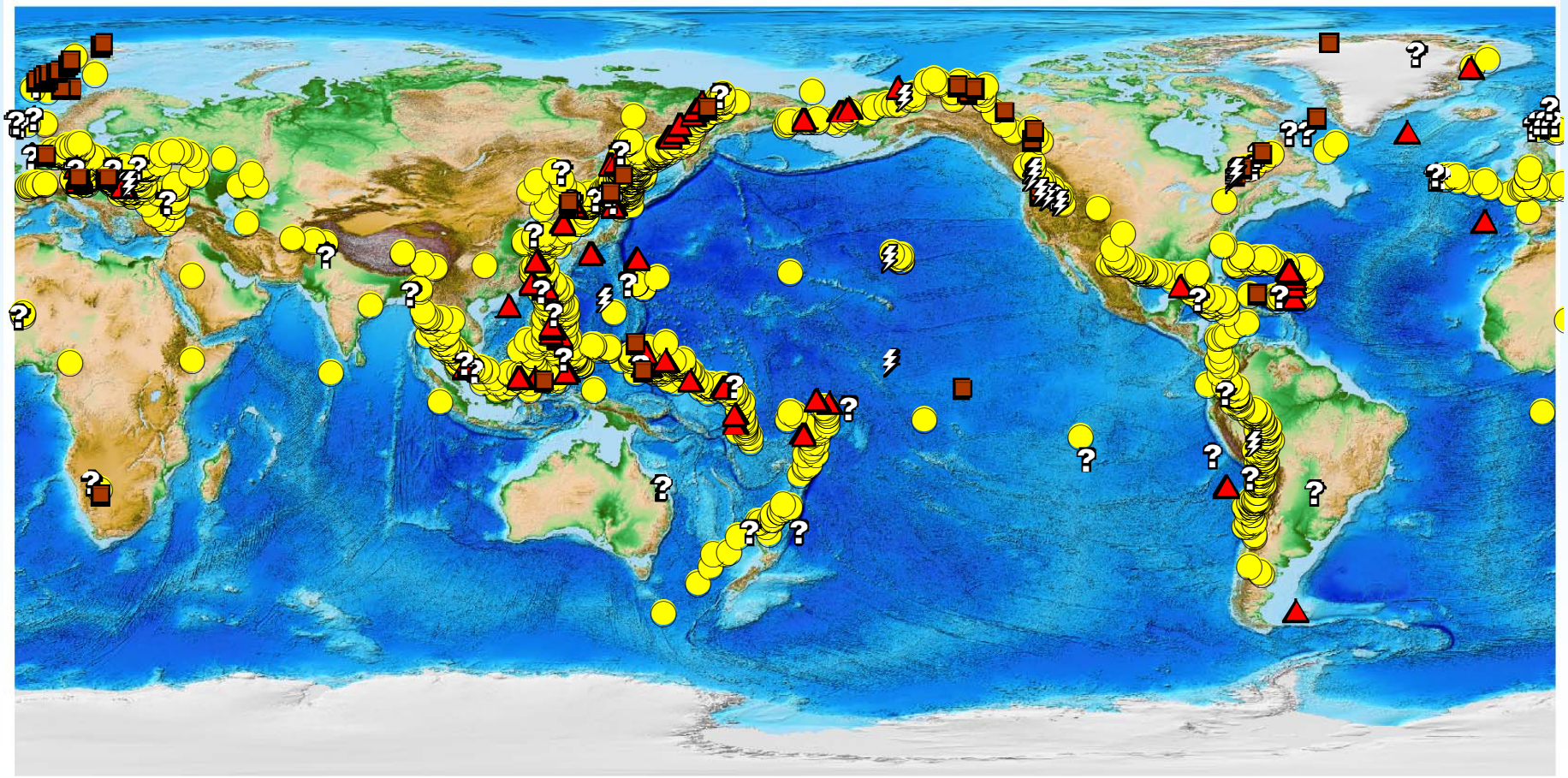
Tsunami Source Events (WDC)



Tsunami Runup Locations (WDC)

Tsunami Causes

1% Meteorologic 3% Landslide 6% Volcano 9% Unknown 81% Earthquake



Socio-economic data

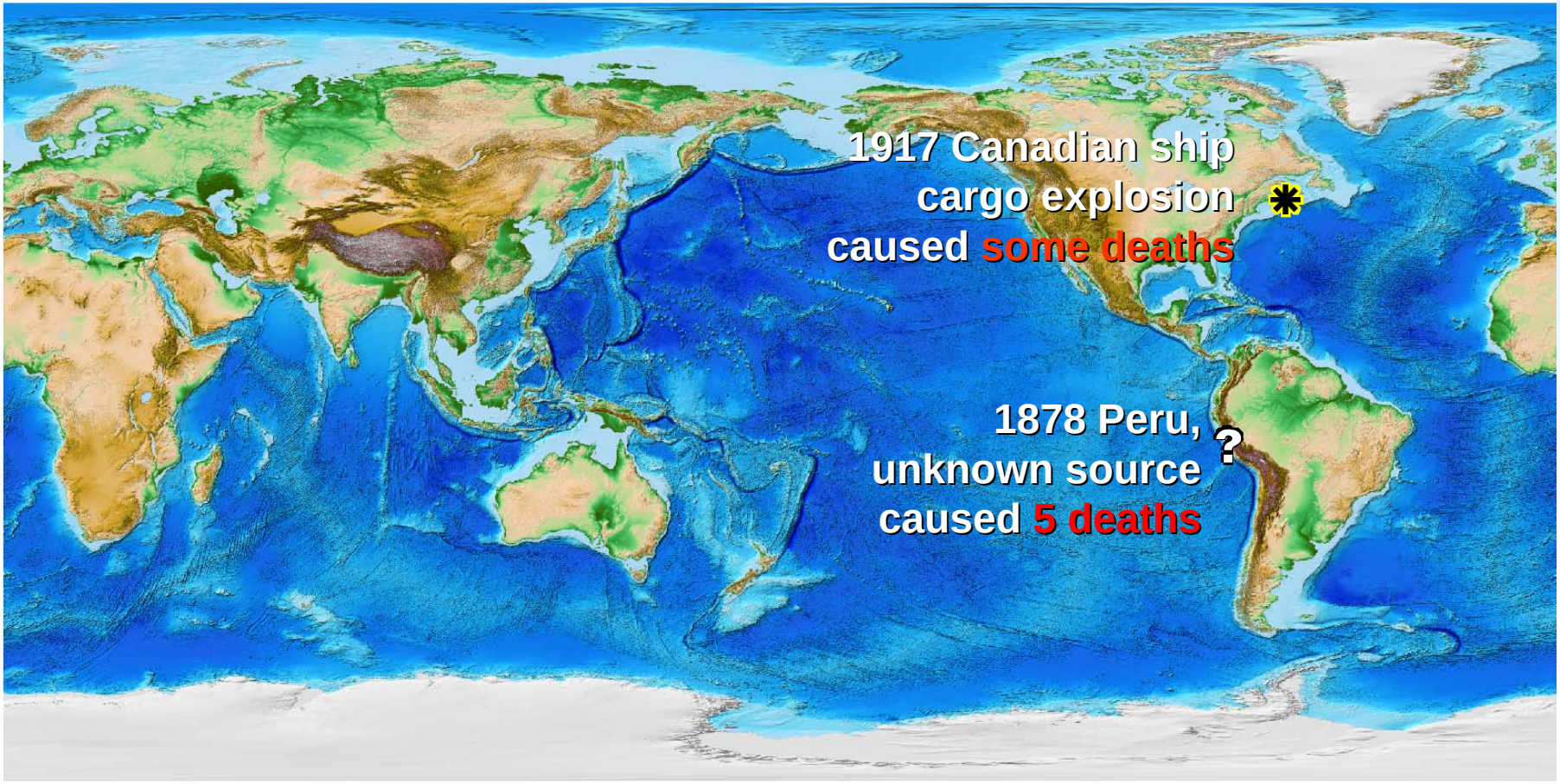
- The actual $ dollar damage or number of deaths is often not known:
  - January 1965: There was a large destructive earthquake on Sulawesi Island. … The **tsunami destroyed 90% of the houses of Sanana City** ….
  - November 1952: Severo runup height 15 m, second wave highest, **destroyed most of town, and caused considerable loss of life.**

Defined Categories

- Deaths, Injuries, or Missing
  - Few = 1 to 50
  - Some = 51 to 100
  - Many = 101 to 1000
  - Very Many = > 1000
- $ Dollar Damage
  - None
  - Limited (roughly corresponding to less than $1 million)
  - Moderate ($1 to $5 million)
  - Severe (>$5 to $24 million)
  - Extreme (≥$25 million)
- Houses Destroyed or Houses Damaged
  - Few = 1 to 149
  - Some = 150 to 500
  - Many = 500 to 1000
  - Very Many > 1000

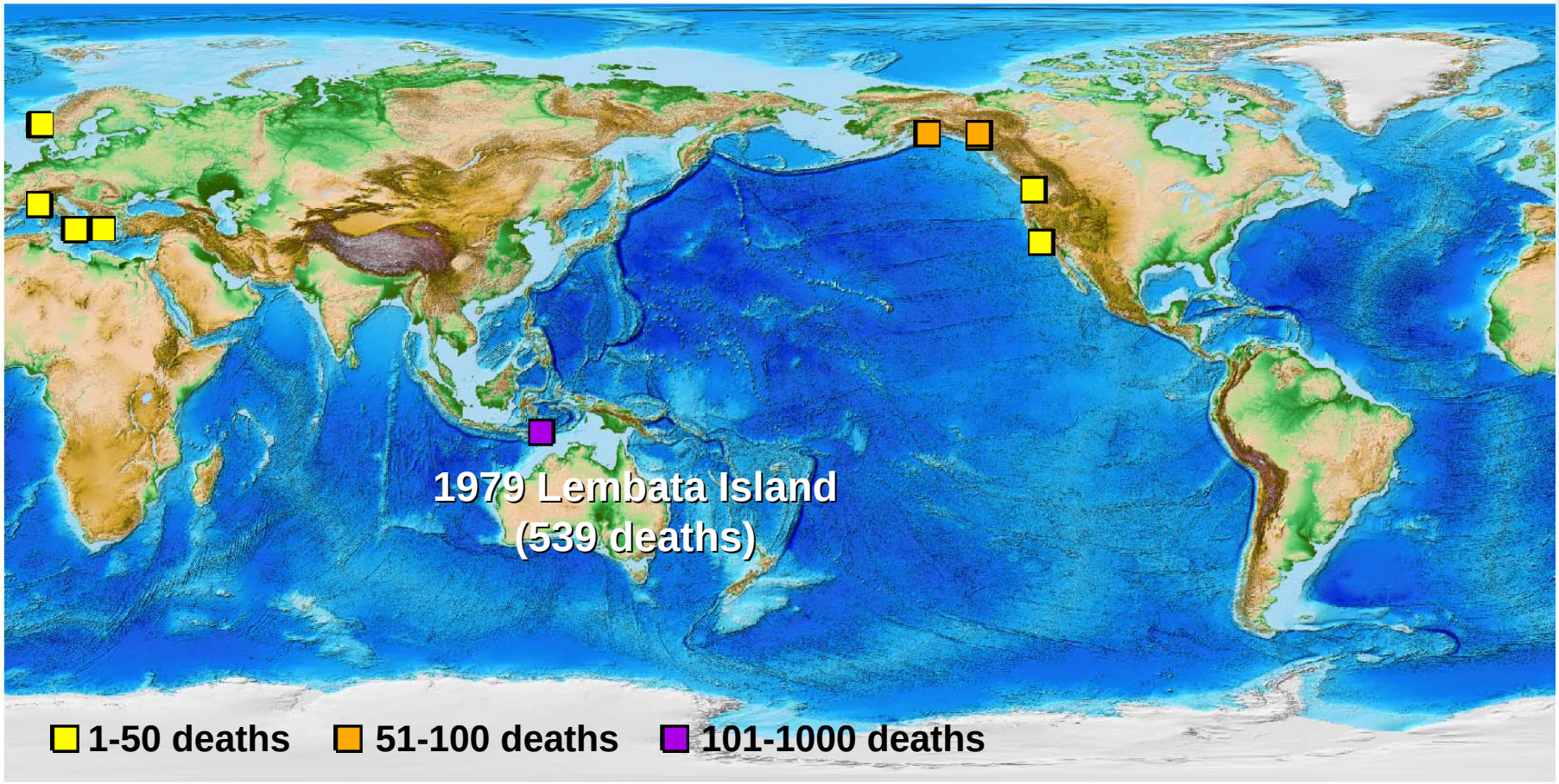
Sources of Fatal Tsunamis

- 1 Unknown source generated a Fatal Tsunami
- 1 Explosion generated a Fatal Tsunami



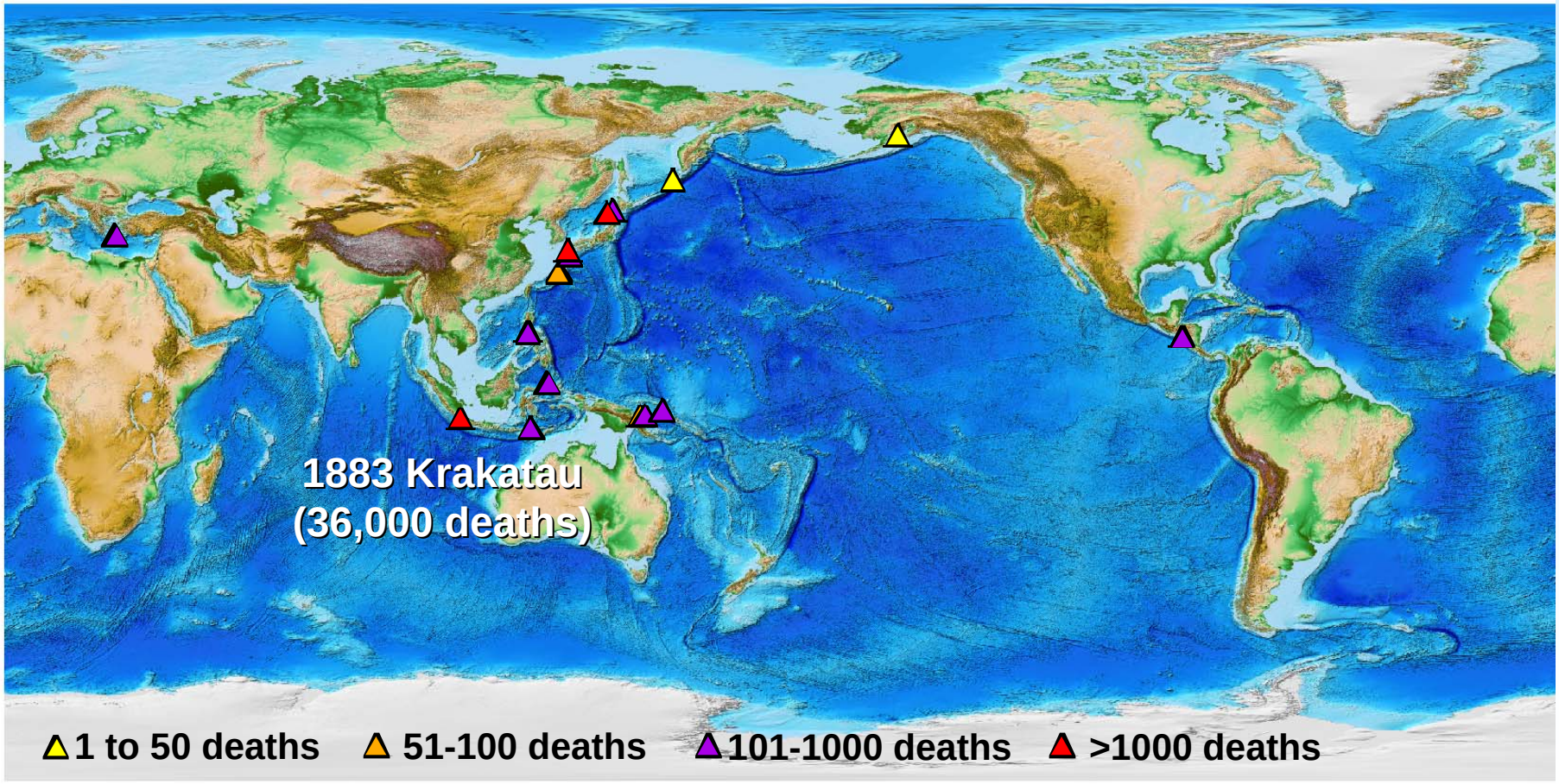
Sources of Fatal Tsunamis
(Landslides)

- 10 Landslides generated Fatal Tsunamis
  - ~700 Deaths total
  - $25 million damage



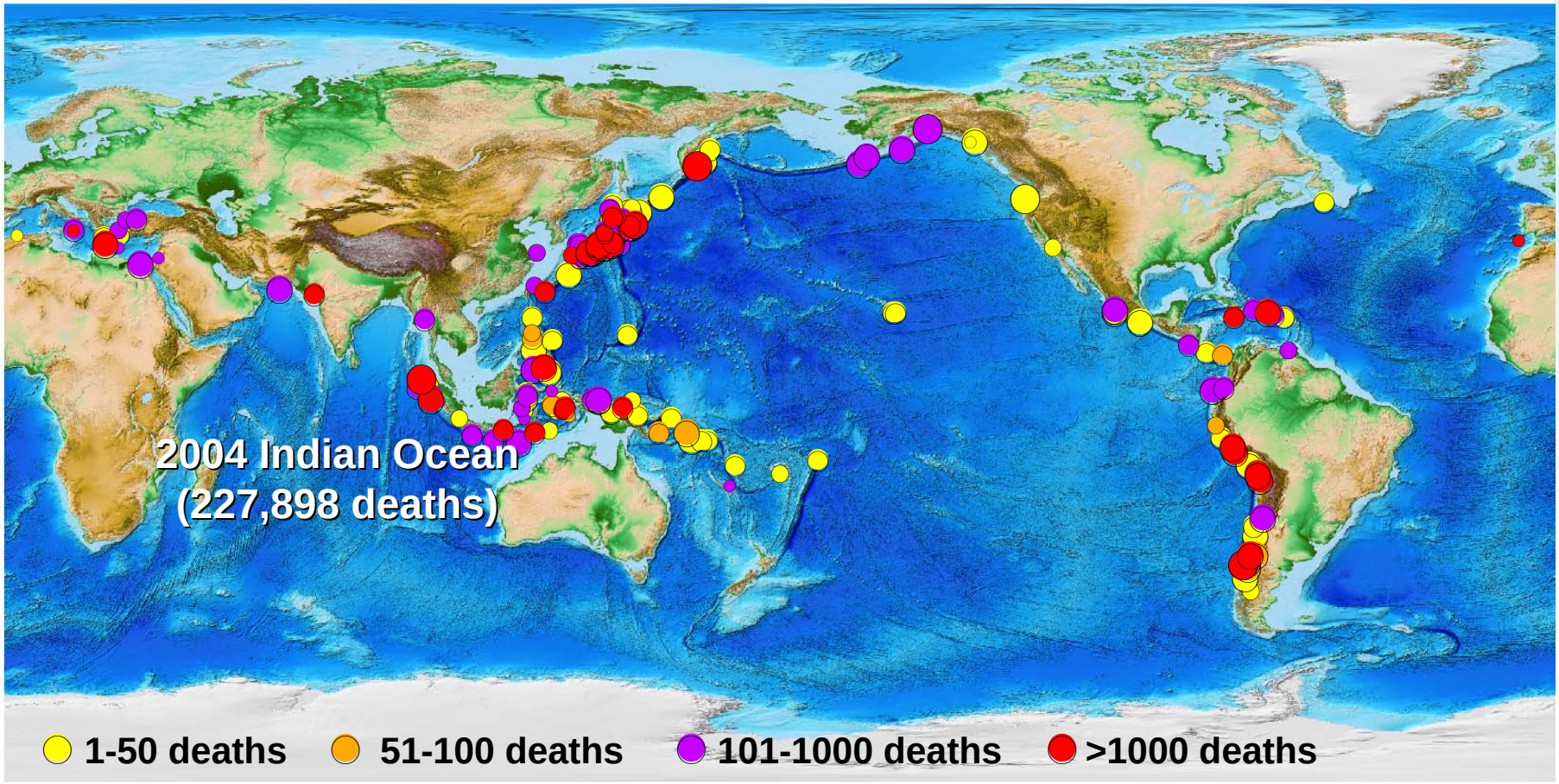
Sources of Fatal Tsunamis
(Volcanic Eruptions)

- 18 Volcanic Eruptions generated Fatal Tsunamis
  - 44,000 deaths total
  - $4 million damage



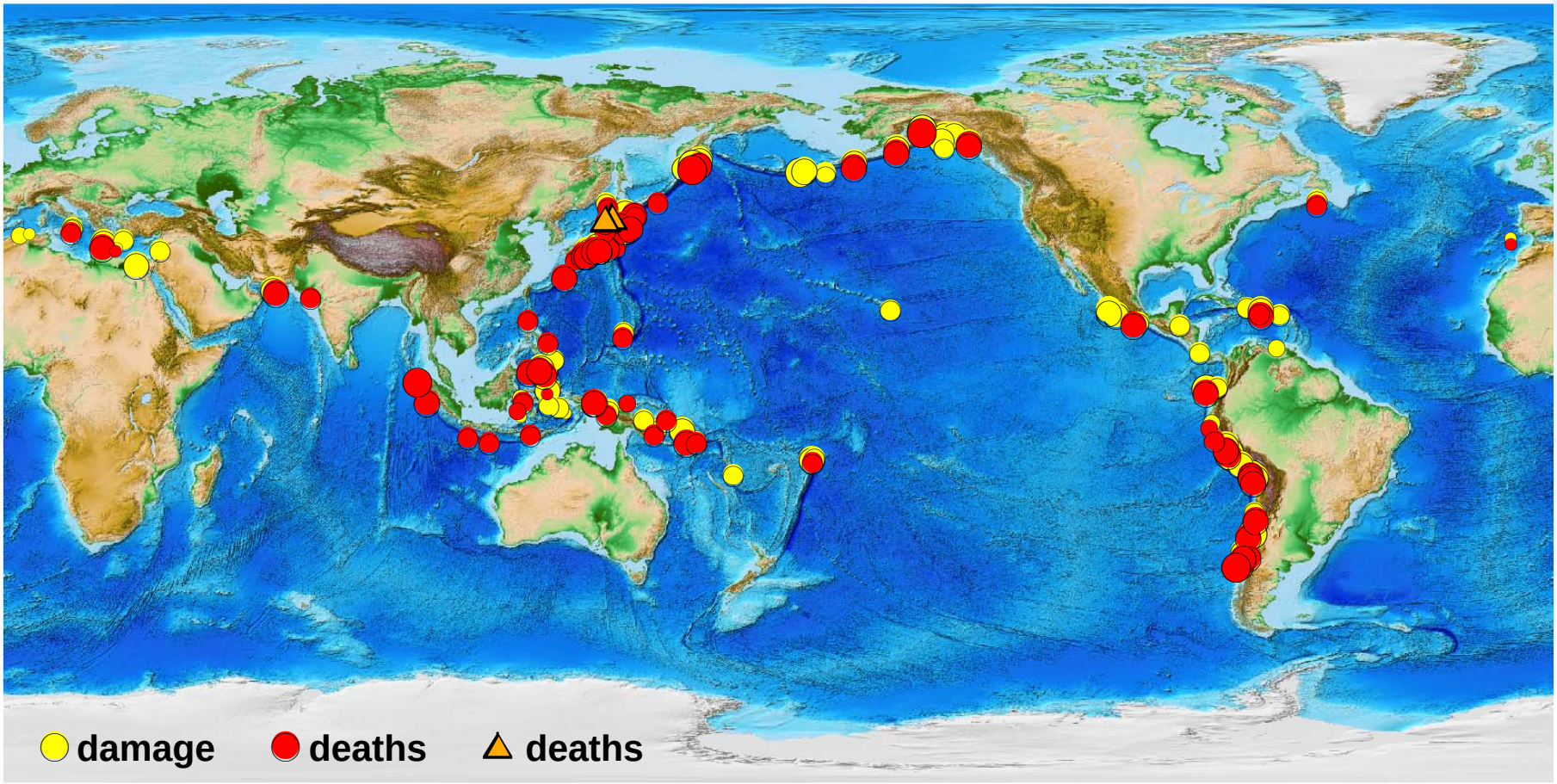
Sources of Fatal Tsunamis
(Earthquakes)

- 200 Earthquakes generated Fatal tsunamis
  - 520,000 deaths total
  - $12.6 billion damage



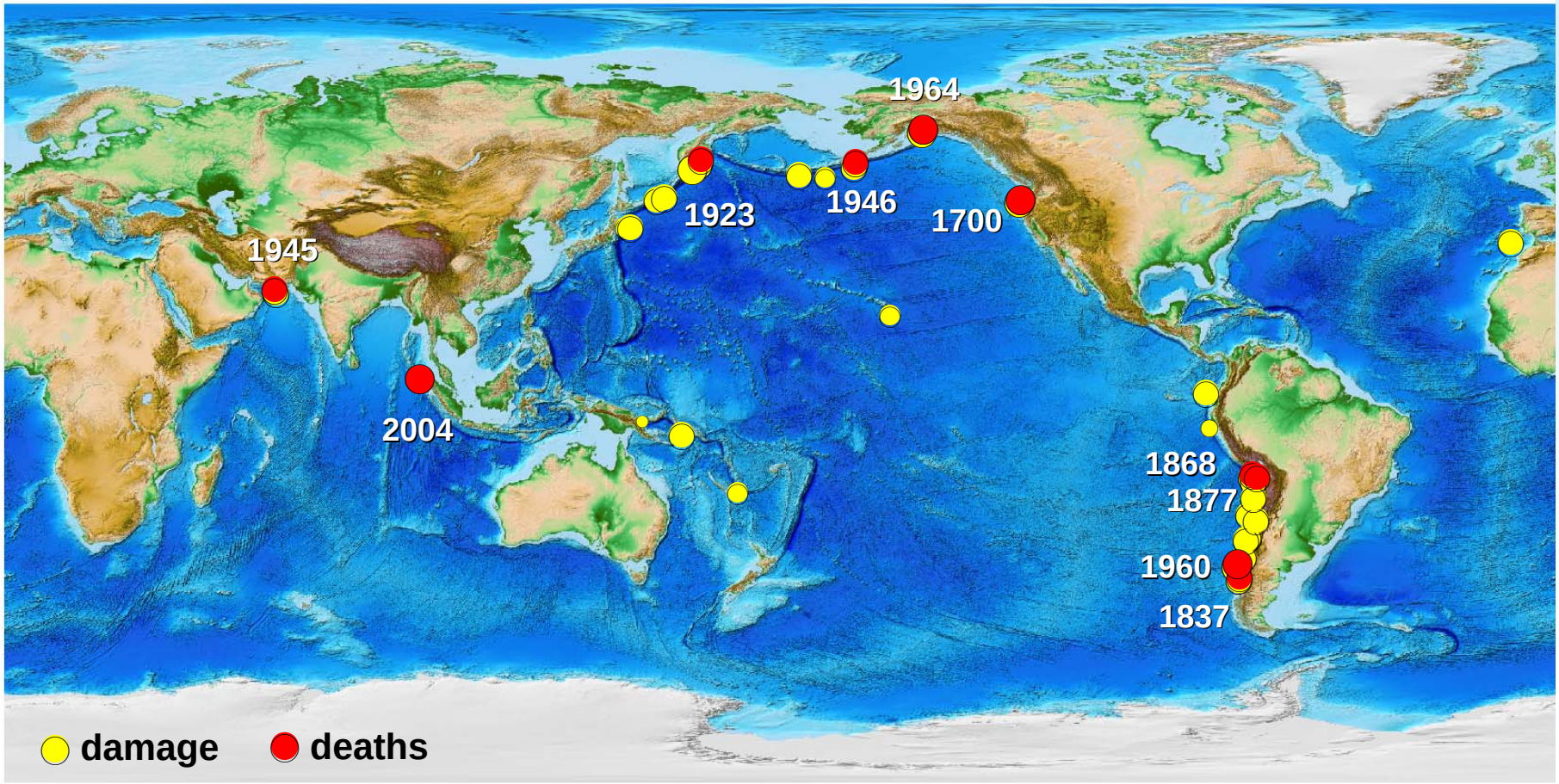
Sources of Damaging and Fatal Tsunamis
(observed 100-1000 km from source)

- 78 Earthquakes generated Fatal Tsunamis
- 2 Volcanic Eruptions generated Fatal Tsunamis
- 95,877 Deaths total

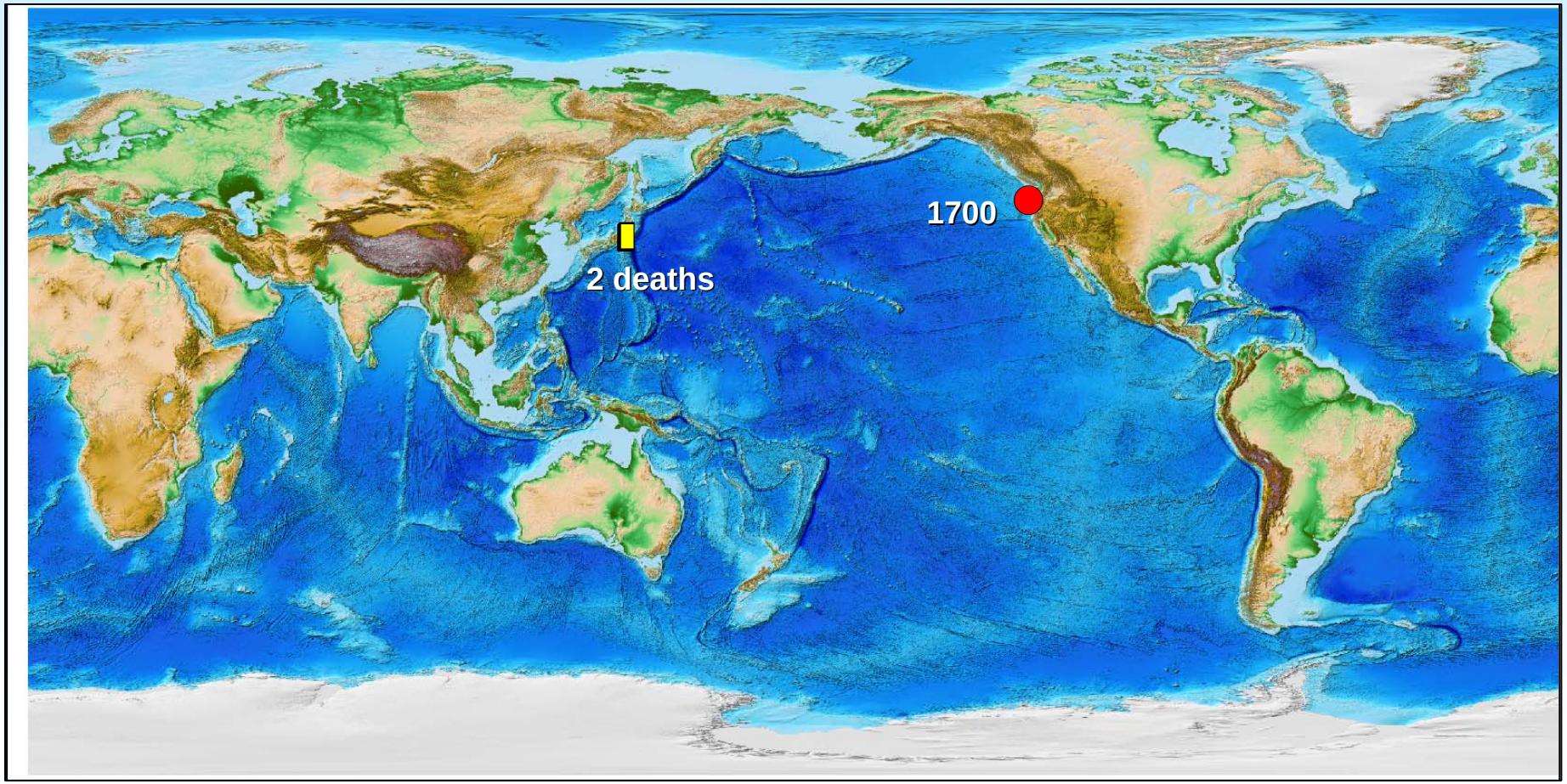


Sources of Damaging and Fatal Tsunamis
(observed >1000 km from source)

- 10 Earthquakes generated Fatal Tsunamis
- 54,658 Deaths total



Fatal Runups
(observed >1000 km from source)



Fatal Runups
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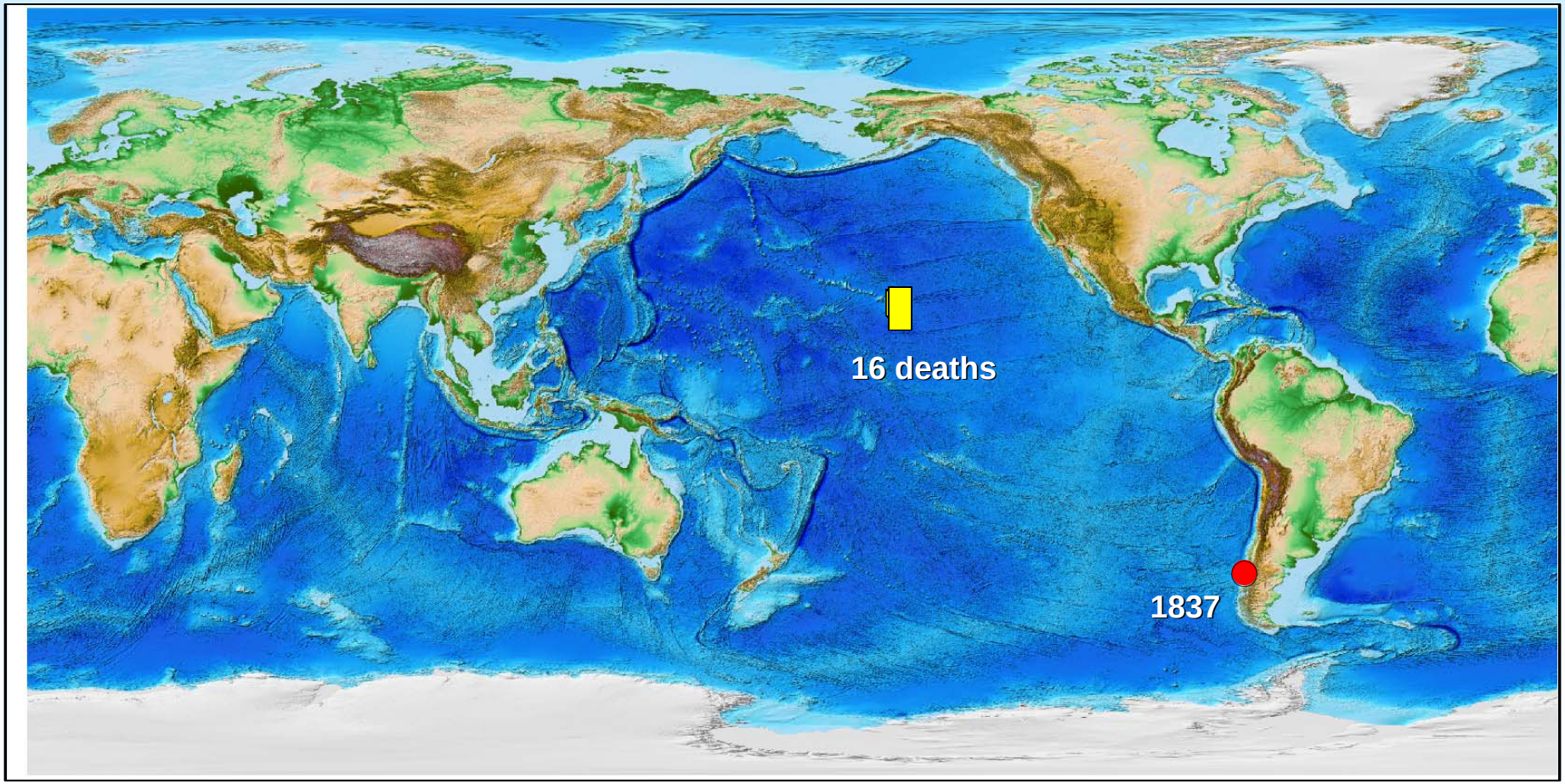

Fatal Runups
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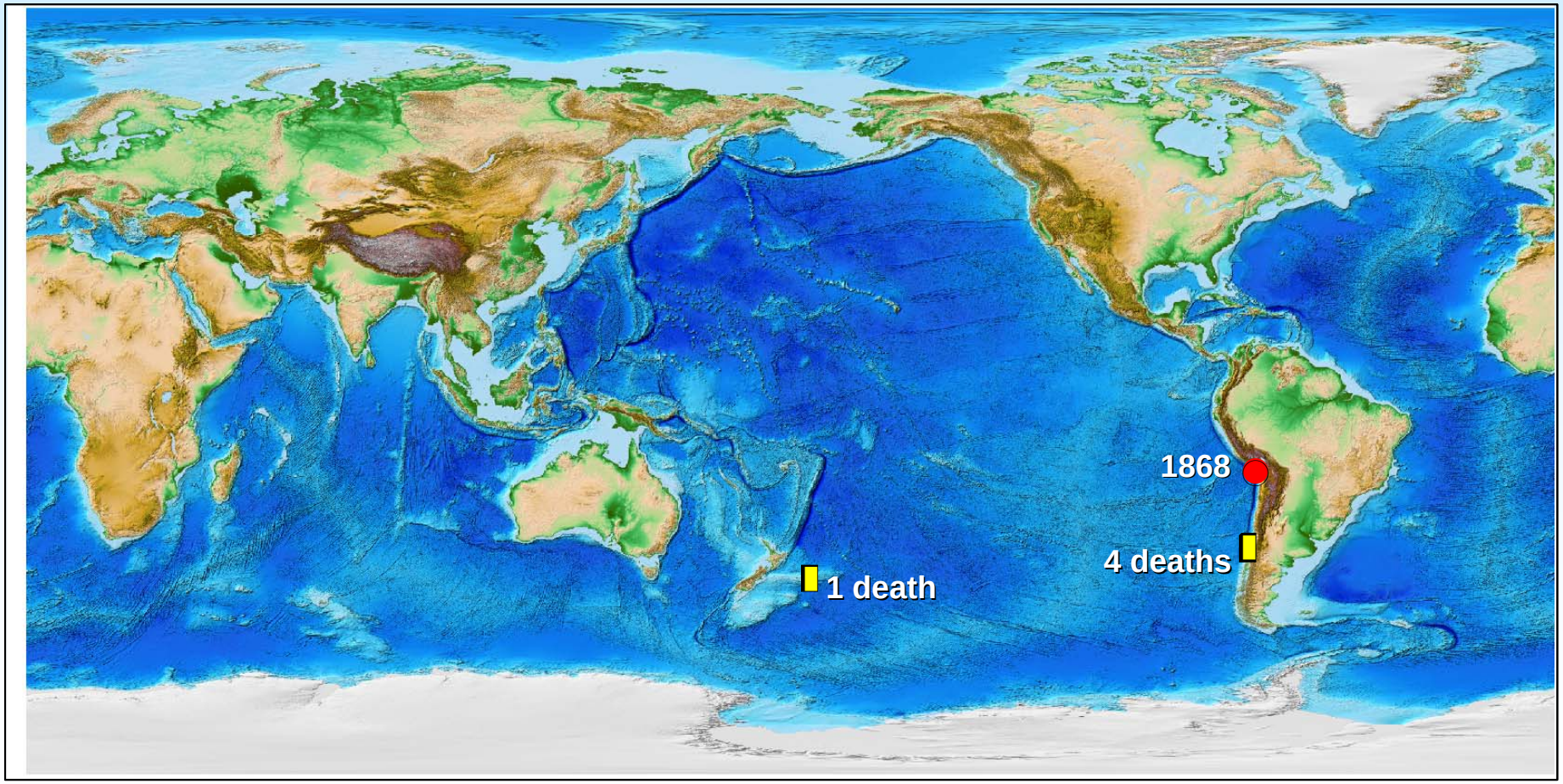

Fatal Runups
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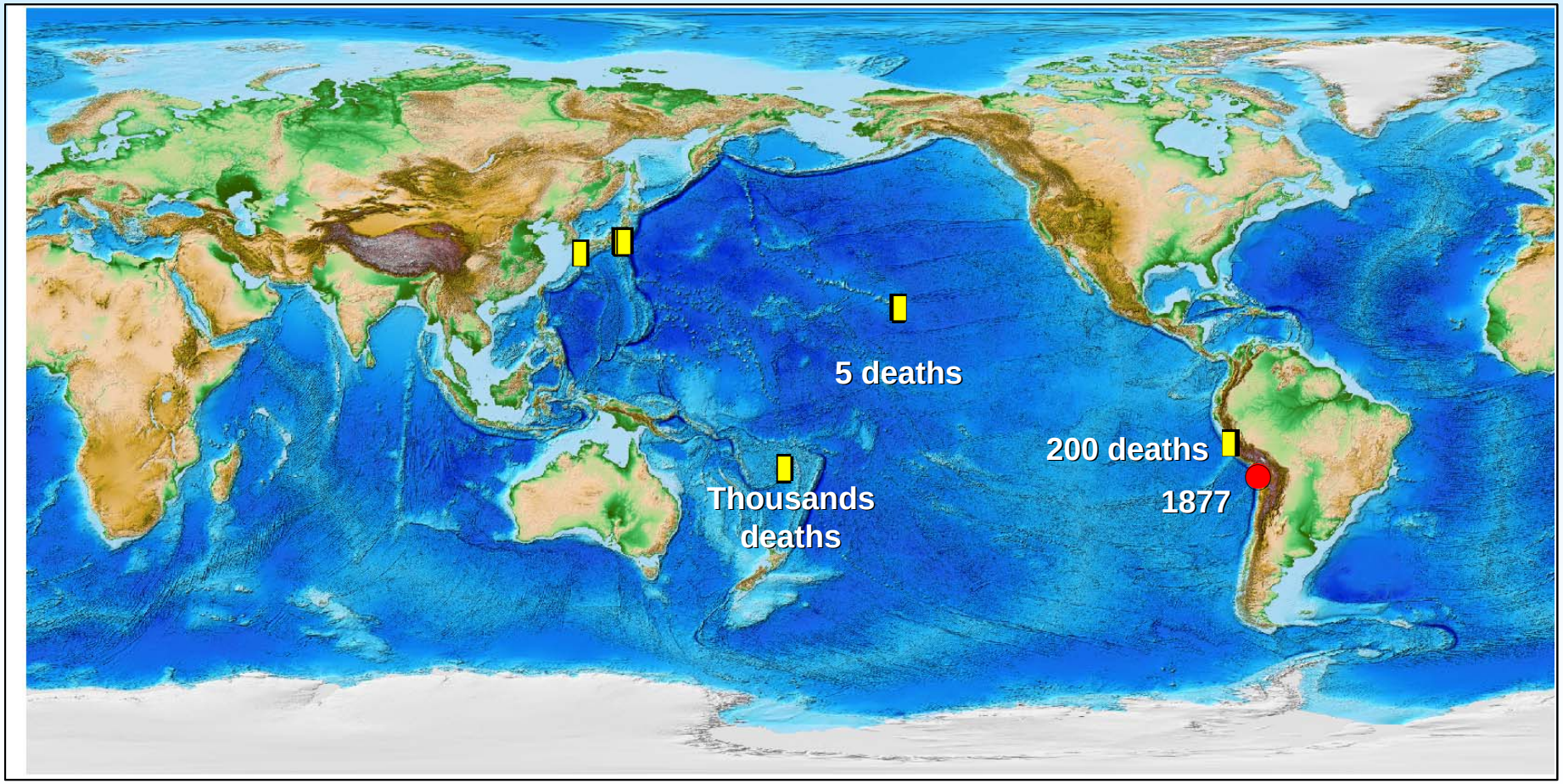

Fatal Runups
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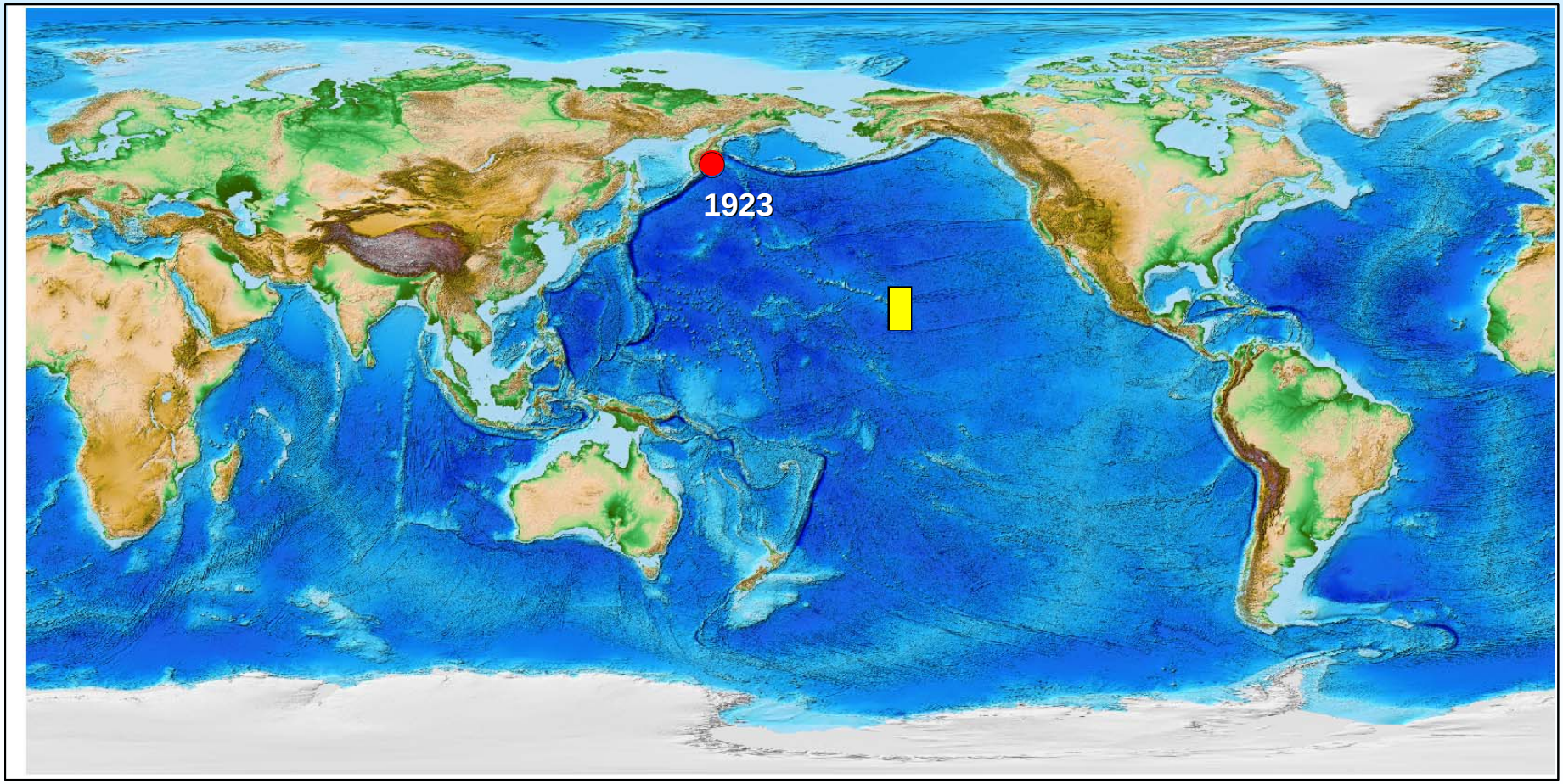
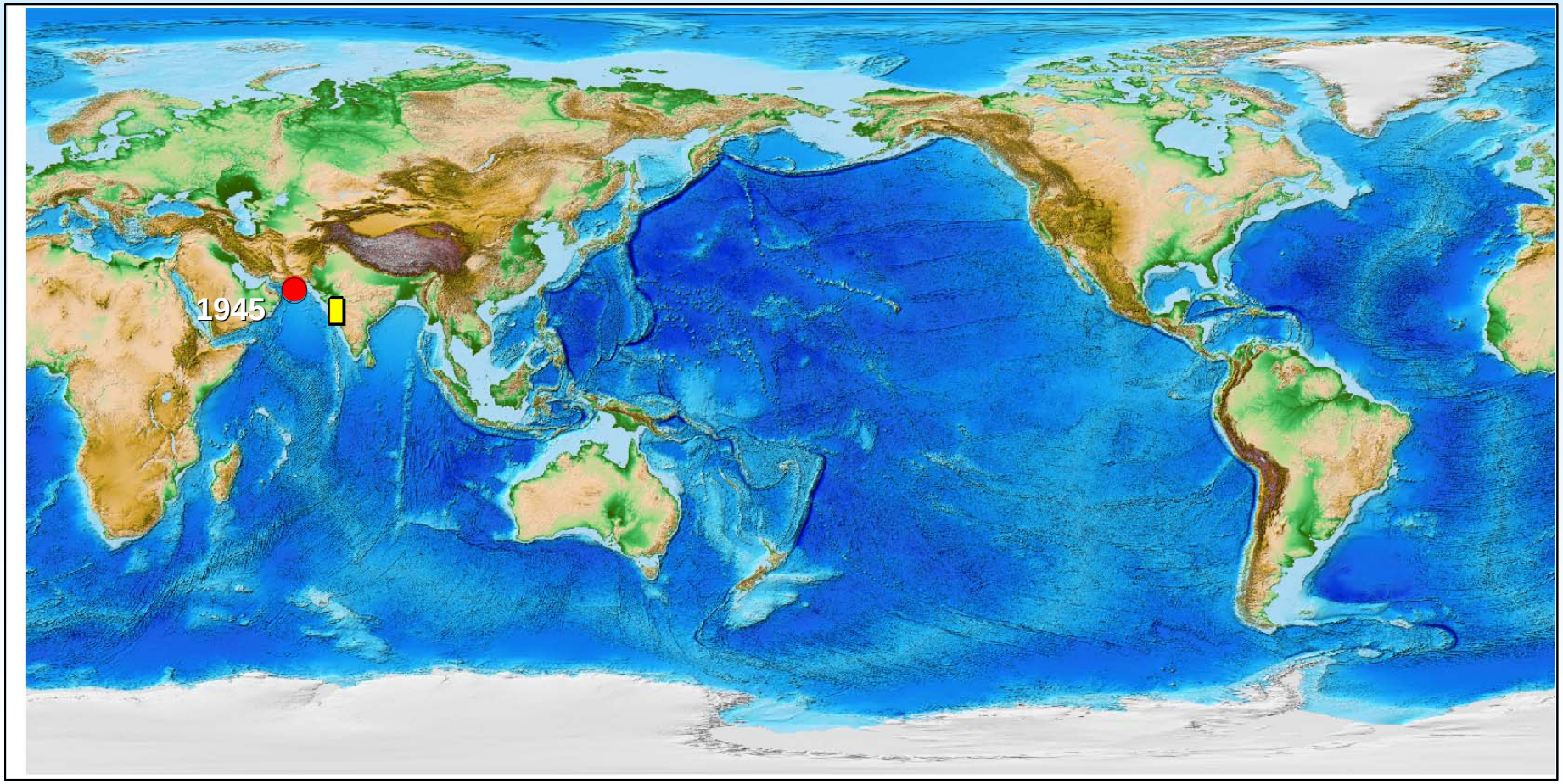
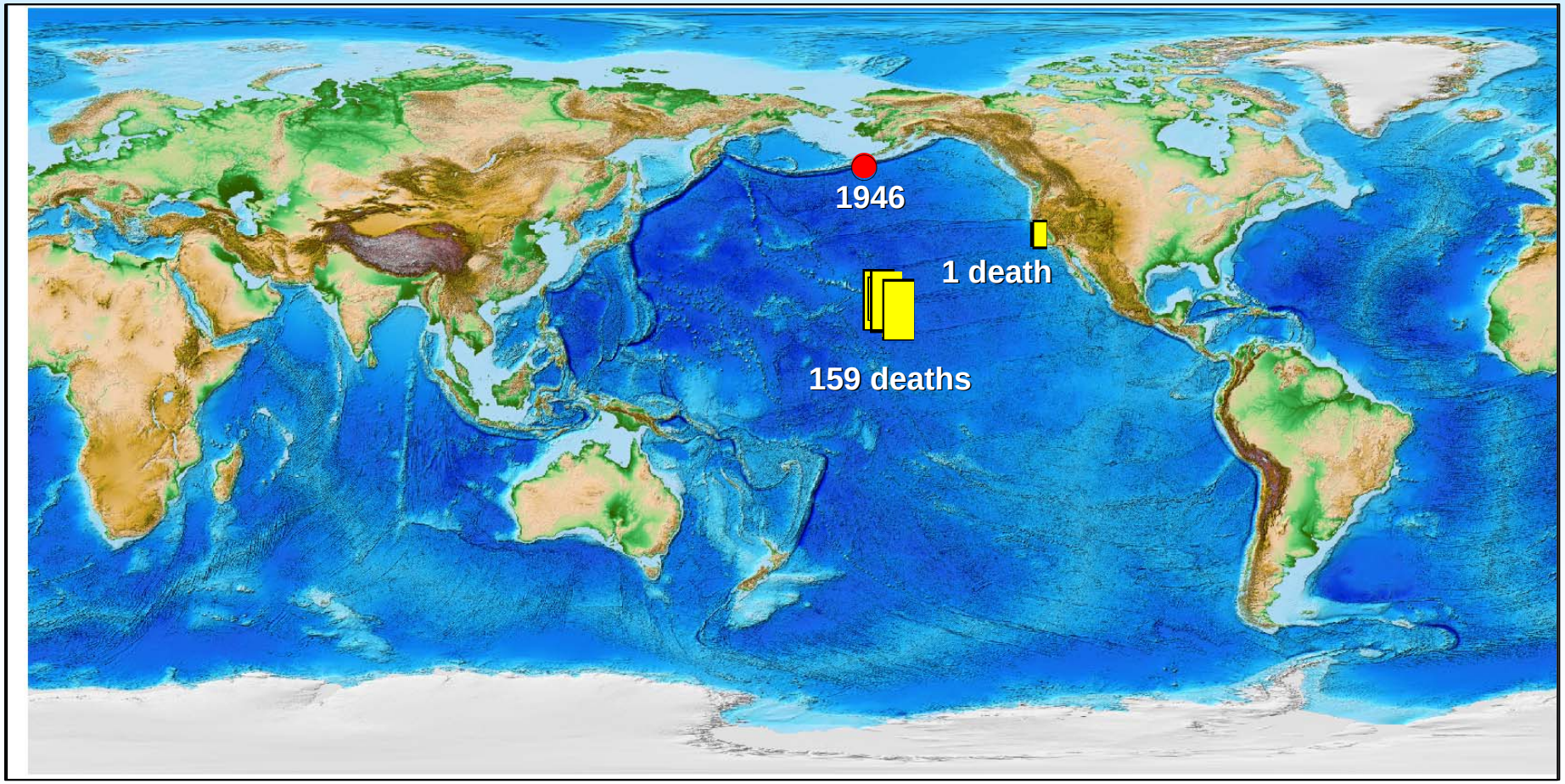


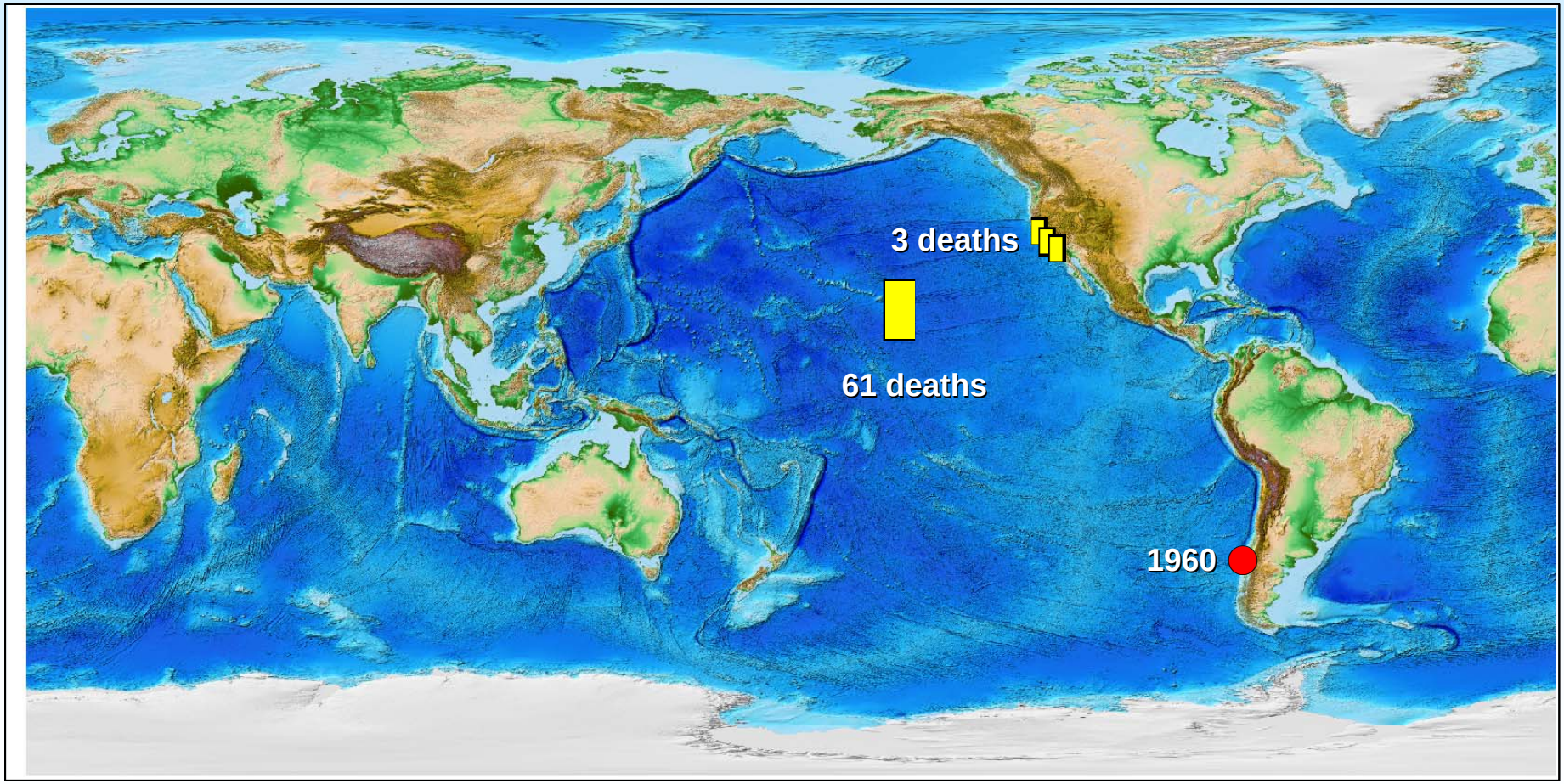
Fatal Runups
(observed >1000 km from source)



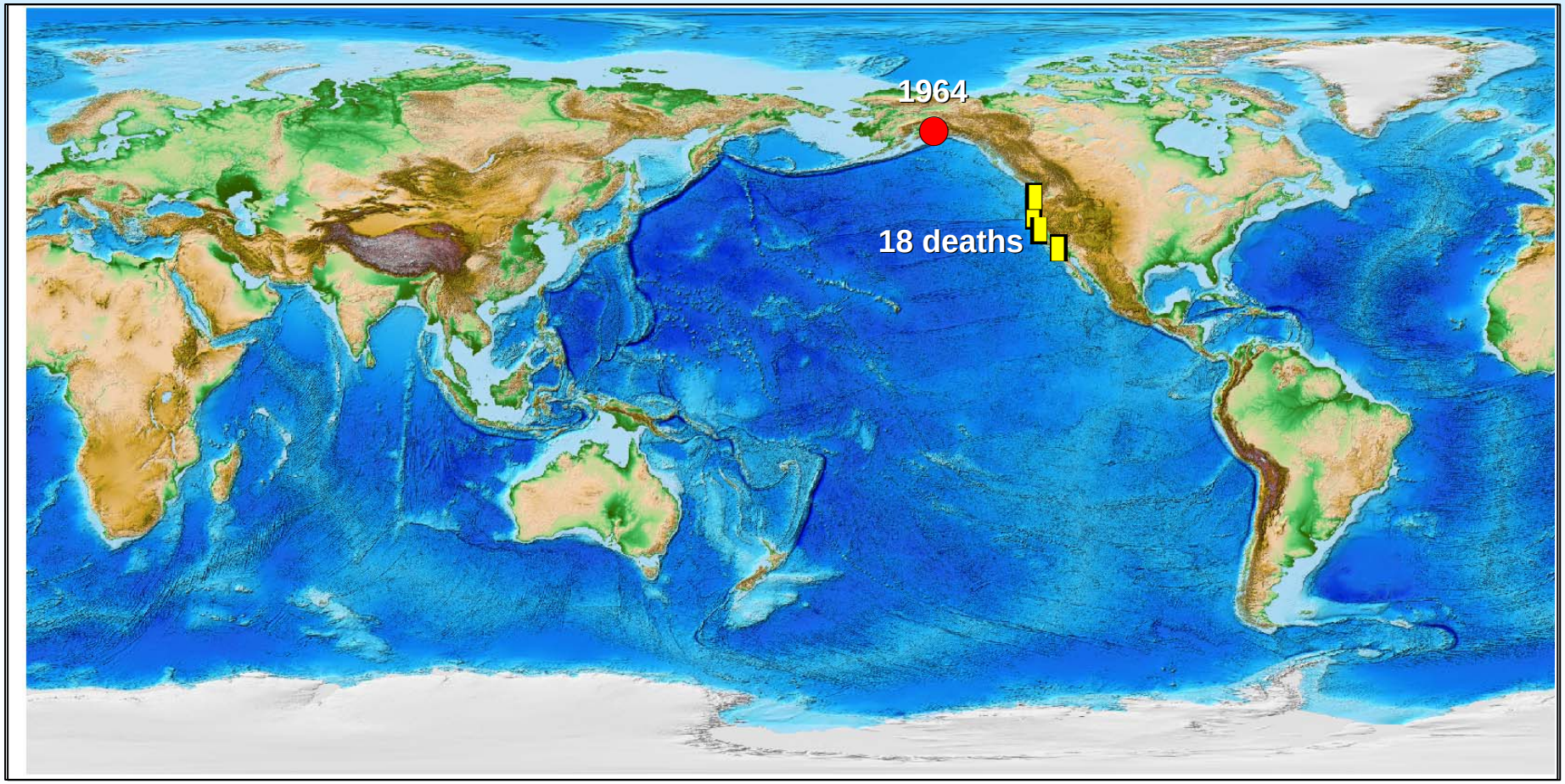
Fatal Runups
(observed >1000 km from source)



Fatal Runups
(observed >1000 km from source)



Fatal Runups
(observed >1000 km from source)



Fatal Runups
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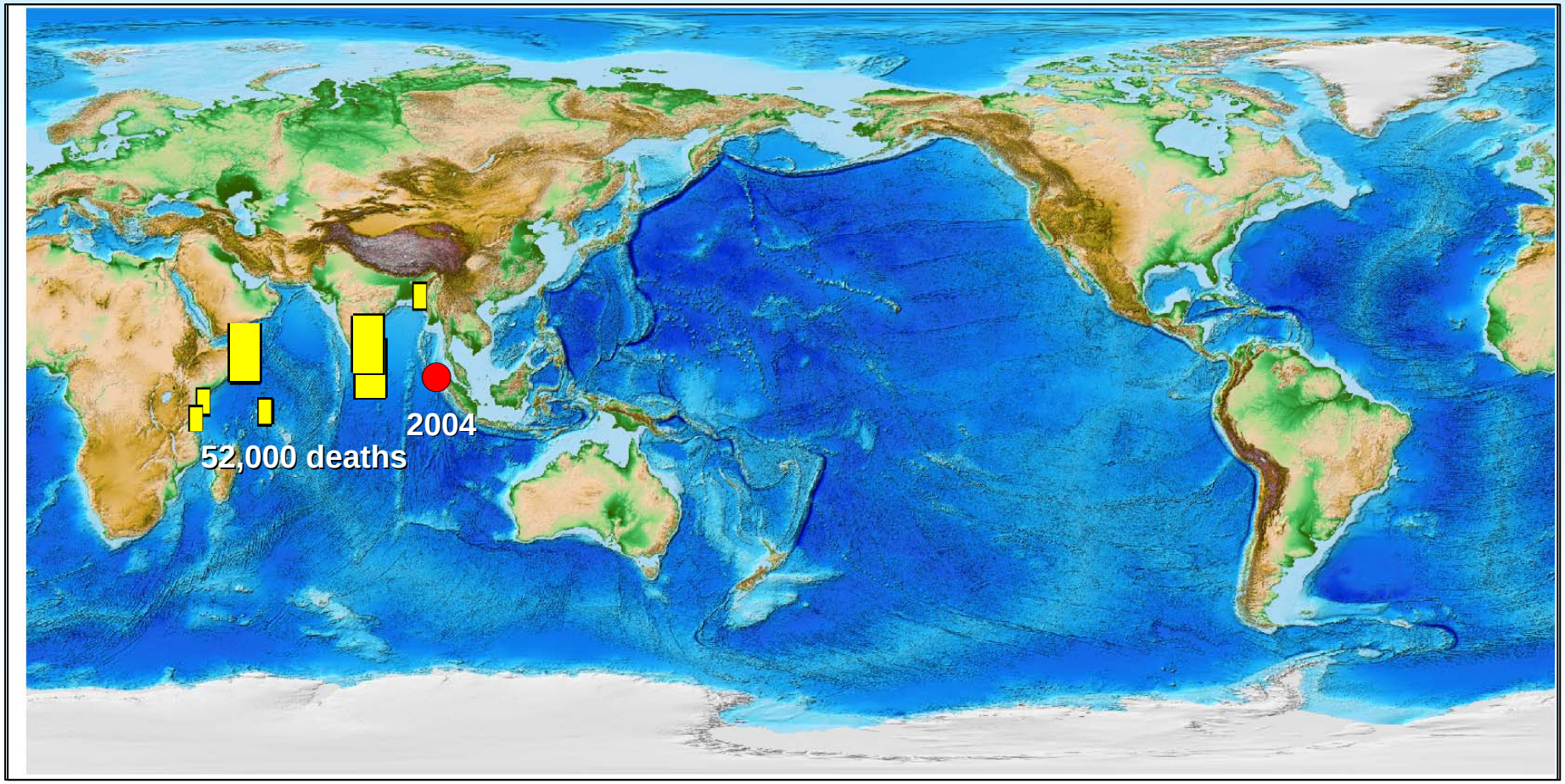


Deaths and Damage from Tsunamis

- **566,563 total deaths**
  - 227,898 from 2004 Indian Ocean (40% of total)
  - 416,118 deaths <100 km
    - 175,827 IO
  - 95,877 deaths 100-1000 km
    - 11,029 IO
  - 54,568 deaths >1000 km
    - 52,071 IO

- **$12.6 billion total damage**
  - $10 billion from 2004 Indian Ocean (80% of total)
  - $6,259.3 million <100 km
    - $4,014 million IO
  - $1,672.3 million 100-1000 km
    - $1,600 million IO
  - $4613.5 million >1000 km
    - $4,386 million IO

Statistical Assessment of Content

Tsunami Events

- 13% of events have Death descriptions
  - 75% of these have Number of Deaths
- 17% of events have Damage descriptions
  - 8% have $ Dollar Damage
- 8% of events have Houses Destroyed descriptions
  - 43% have Number of Houses Destroyed

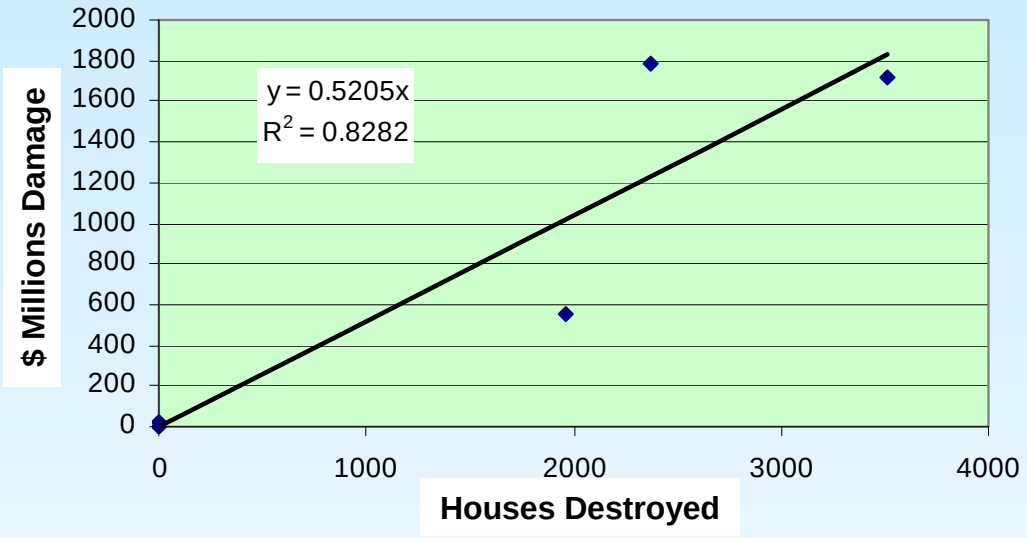
Tsunami Runups

- 3.6% of runups have Death descriptions
  - 84% of these have Number of Deaths
- 6.7% of runups have Damage descriptions
  - 10% have $ Dollar Damage
- 2.6% of runups have Houses Destroyed descriptions
  - 44% have Number of Houses Destroyed

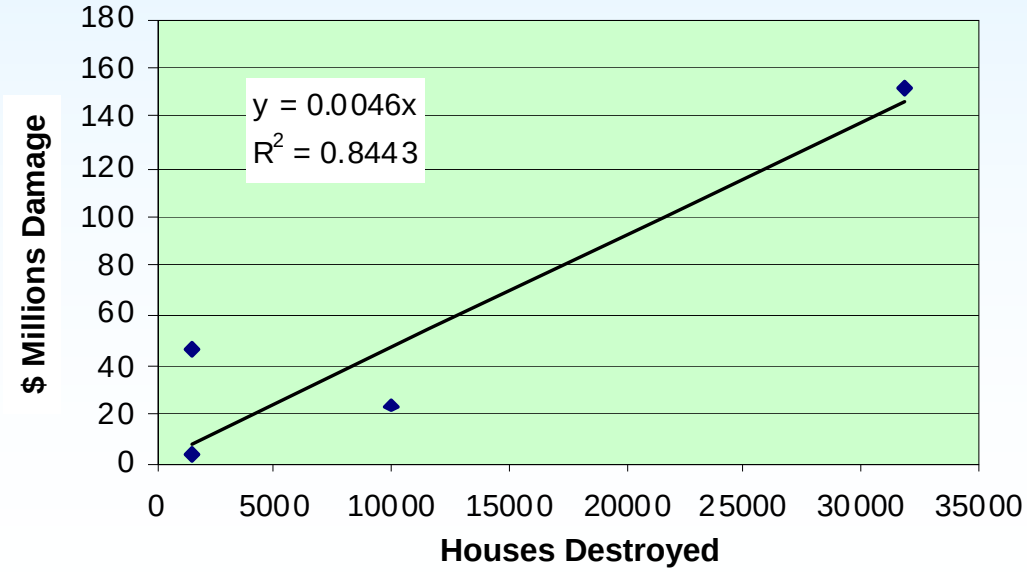
Number of Houses vs $ Damage
(Tsunami Event Totals)

Year	Location	$ Millions*	Houses Destroyed
1934	S. California	1.2	1
1964	Honshu	551.89	1960
1973	Hokkaido	24.08	2
1983	Noshiro	1717.82	3513
1993	Sea of Japan	1786.33	2374

*adjusted for inflation



Year	Location	$ Millions*	Houses Destroyed
1979	Columbia	23.57	10,000
1992	Nicaragua	45.73	1,500
1992	Flores Sea	152.43	31,785
1994	Java	3.17	1,500



Summary

- During the past 5 years significant work has gone into improving the content and quality of the global historical event and runup databases
- We are now using these databases to answer a variety of scientific and management questions
- Additional work remains to be done
  - Proxies for assessing economic impact
  - Additional building damage data
  - Challenges in separating runup effects
- We now have high quality global databases supporting intuitive scientific assumptions

Thank you