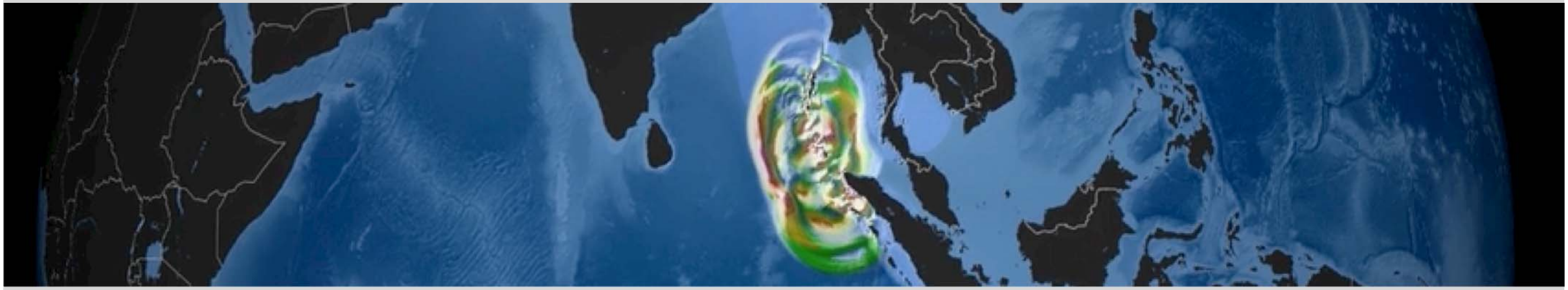


Incorporating Progressive Rupture into Tsunami Models for Tsunami Warning

Gerard J. Fryer, Nathan C. Becker, and Dailin Wang

Pacific Tsunami Warning Center, Ewa Beach, HI

Chile, 1960

M_W 9.5

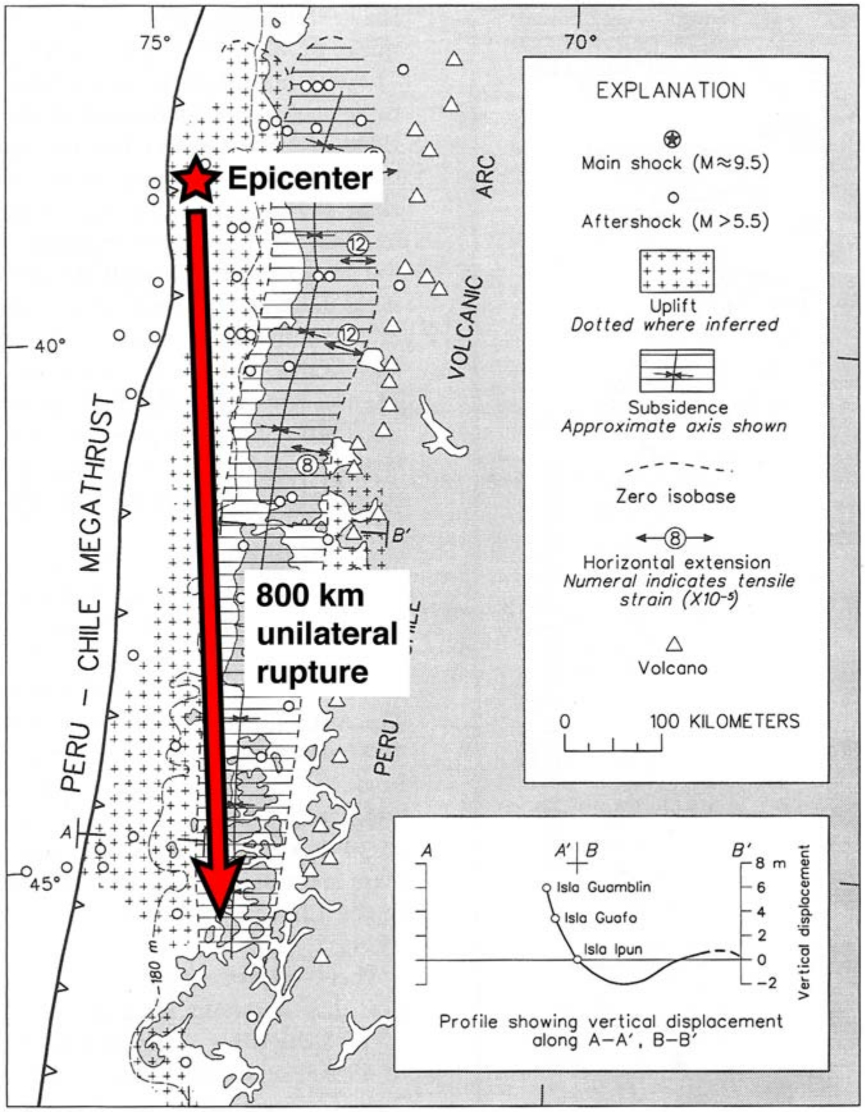


Figure 11–44. Tectonic displacements and seismicity associated with the 1960 Chilean earthquake. Compare with Figure 11–30. After Plafker (1972).

Alaska, 1964 M_W 9.2

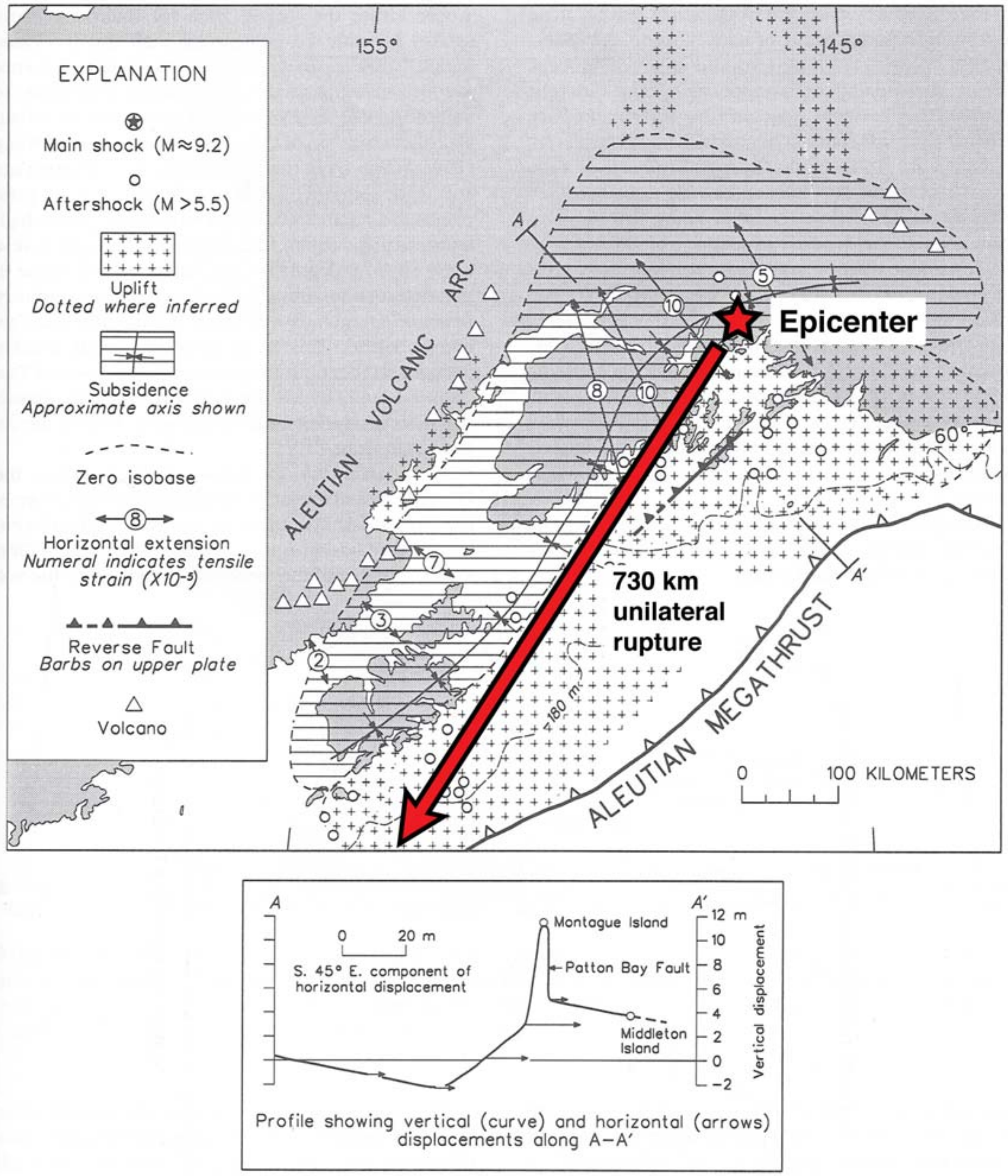
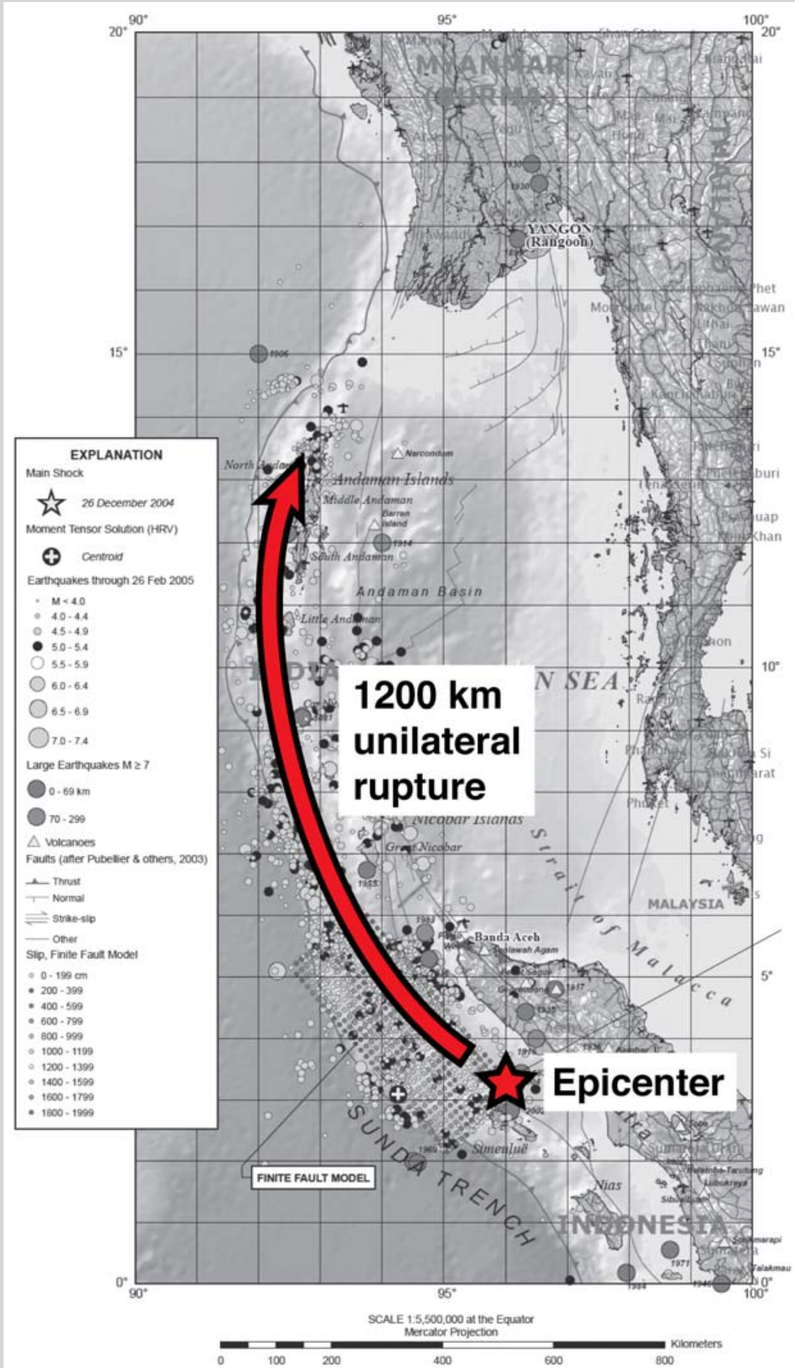


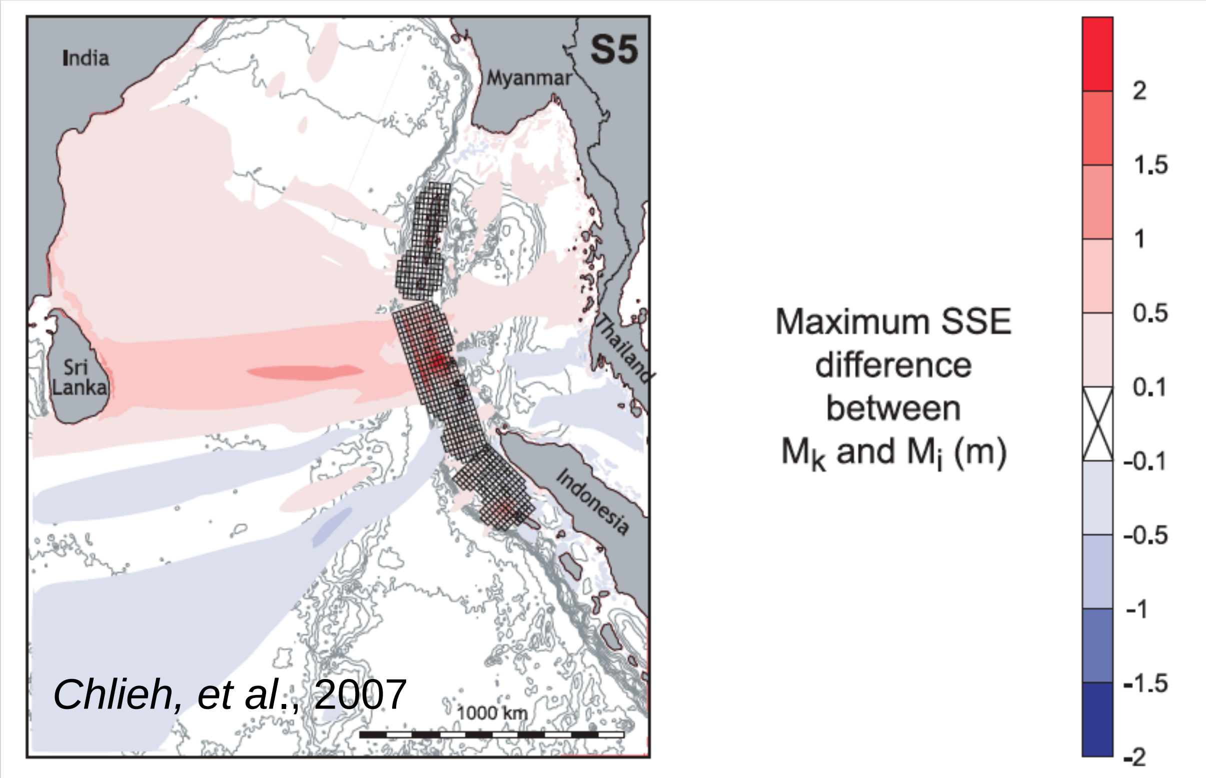
Figure 11–30. Tectonic displacements and seismicity accompanying the 1964 Alaskan earthquake relative to the Aleutian trench and the volcanic arc. From Plafker (1972).



Sumatra-Andaman, 2004 M_W 9.1

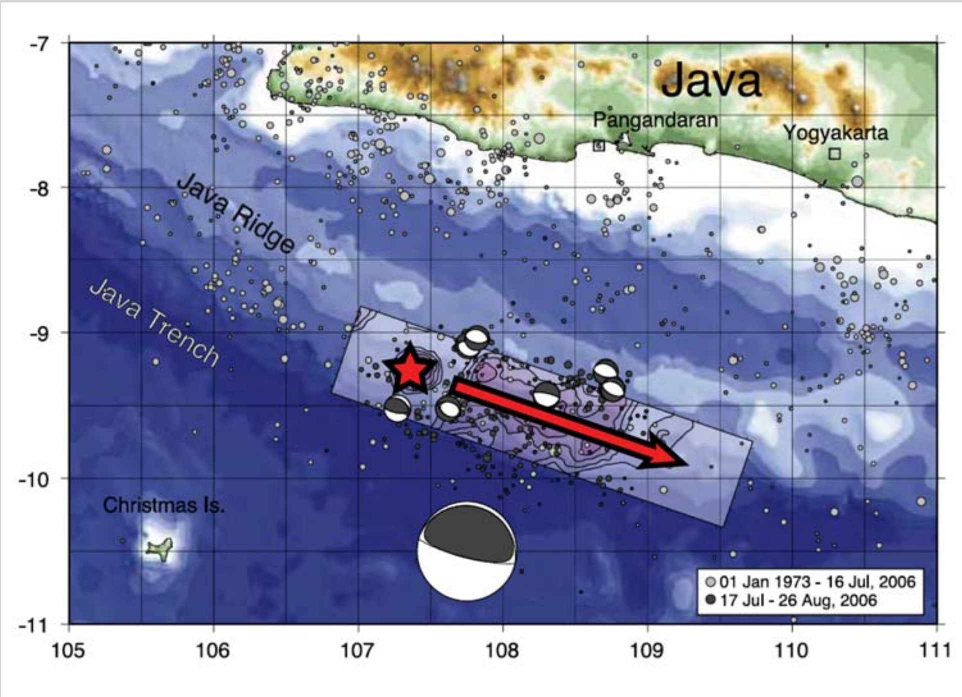
2004 Indian Ocean tsunami
finite fault solution of *Chlieh, et al.,* 2007

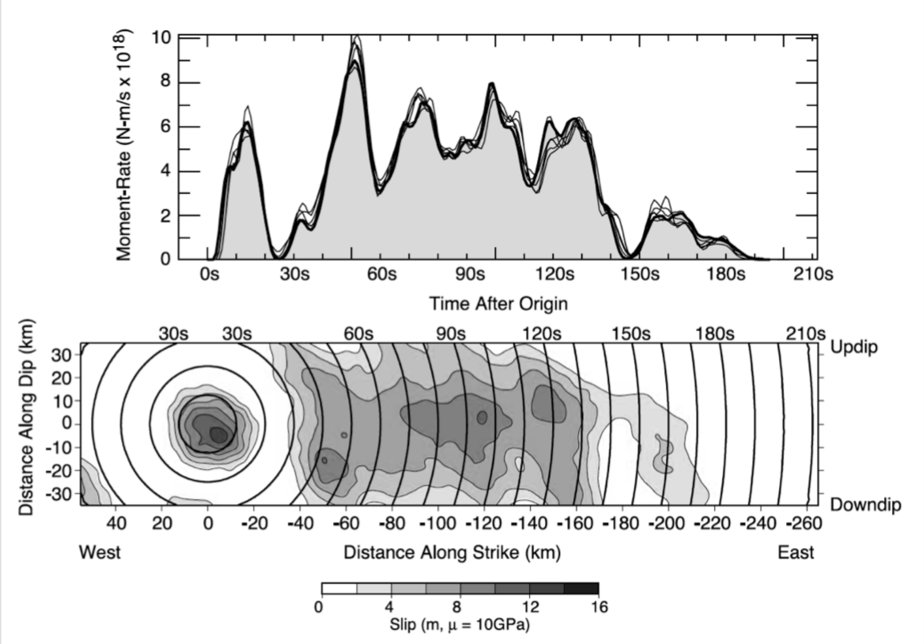
Instantaneous vs. kinematic rupture
Poisson, et al., 2011



- Kinematic rupture is necessary to explain runup on the coasts of Sri Lanka and India.
- If rupture direction is necessary in hindcasting, it is also necessary in forecasting.

West Java, 2006; M_W 7.8

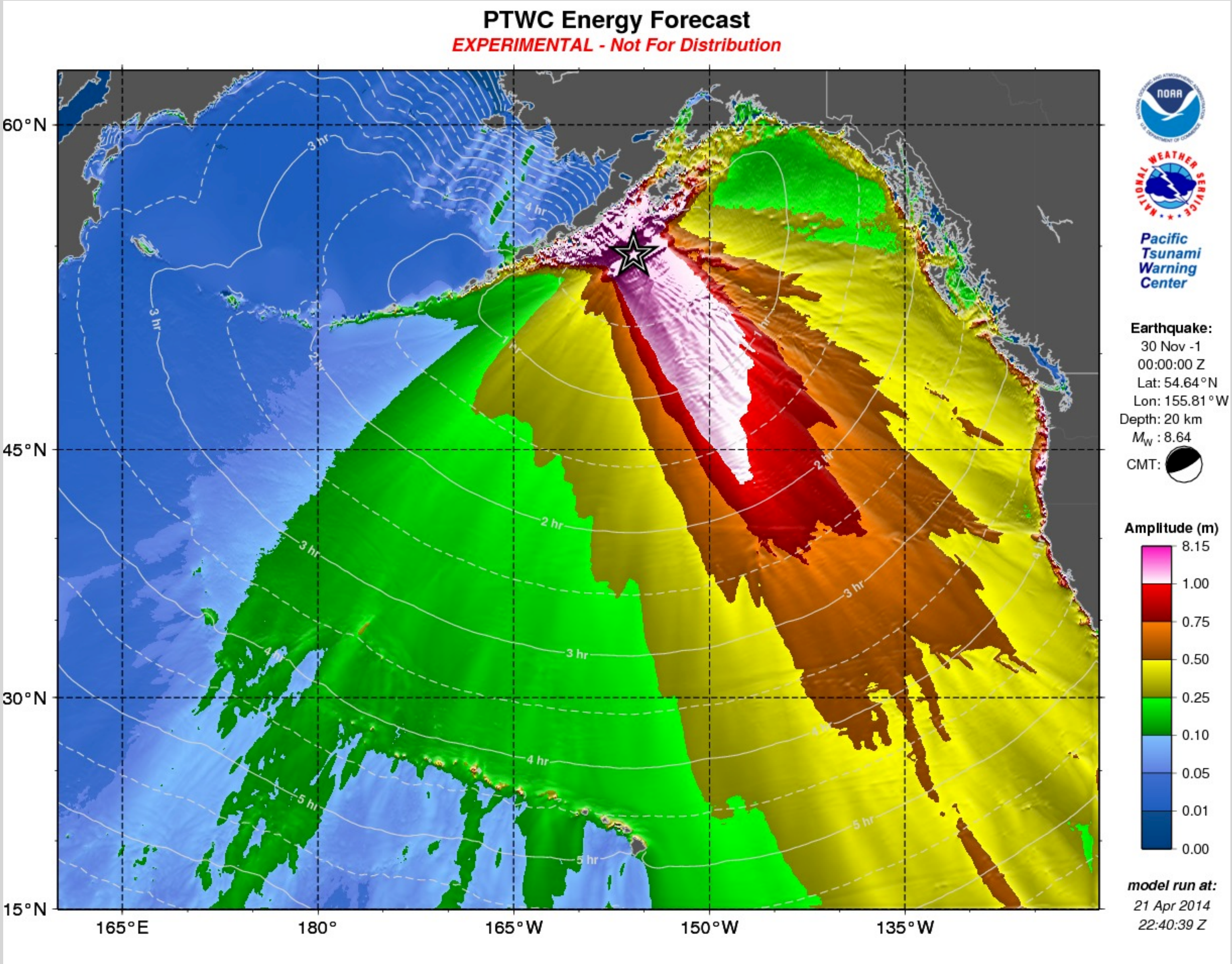




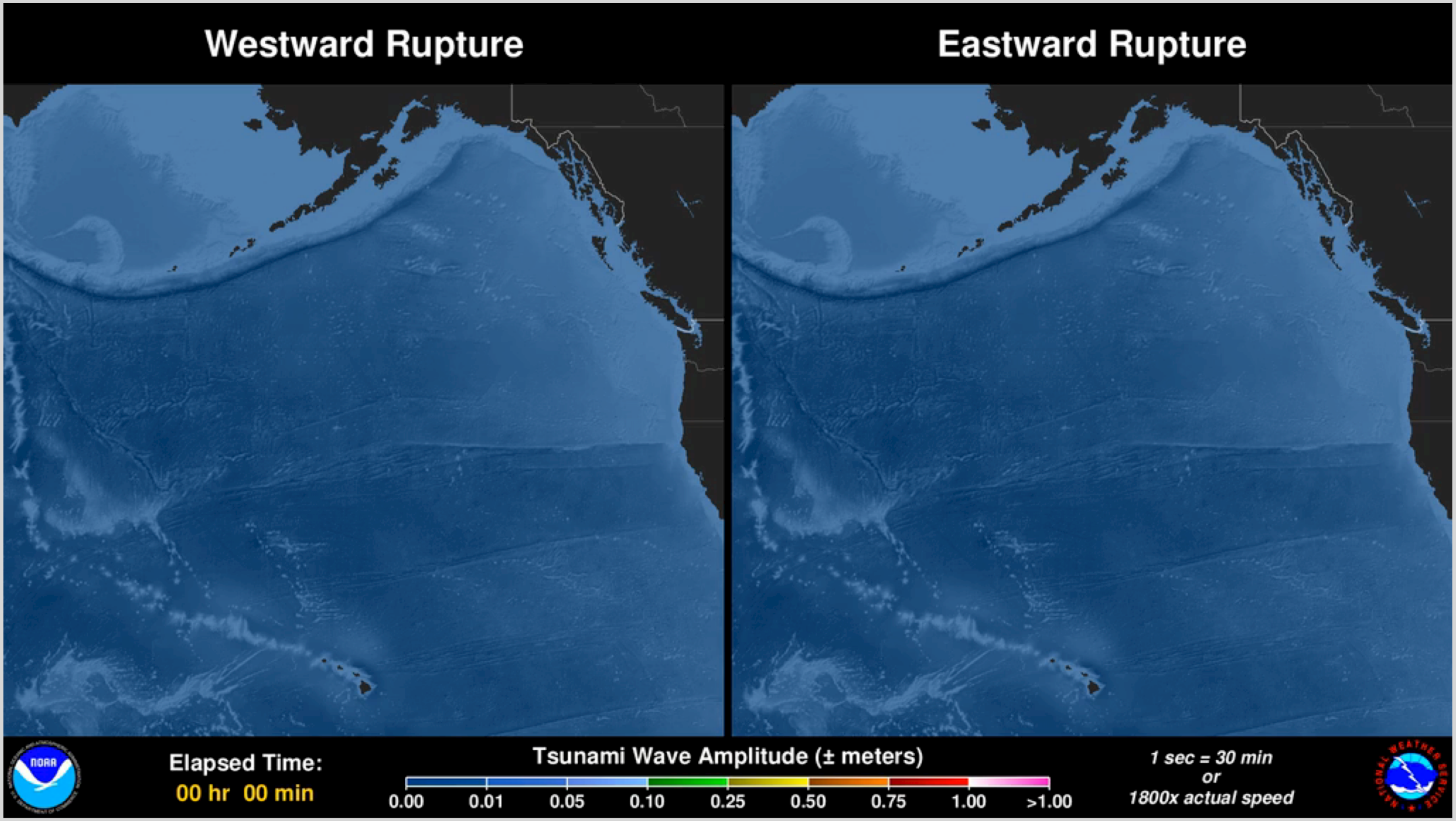
Ammon, *et al.*, 2006

- Unilateral rupture
- Tsunami earthquake
- Rupture speed 1.0–1.25 km/s

Consider an M8.6 earthquake off the Alaska Peninsula

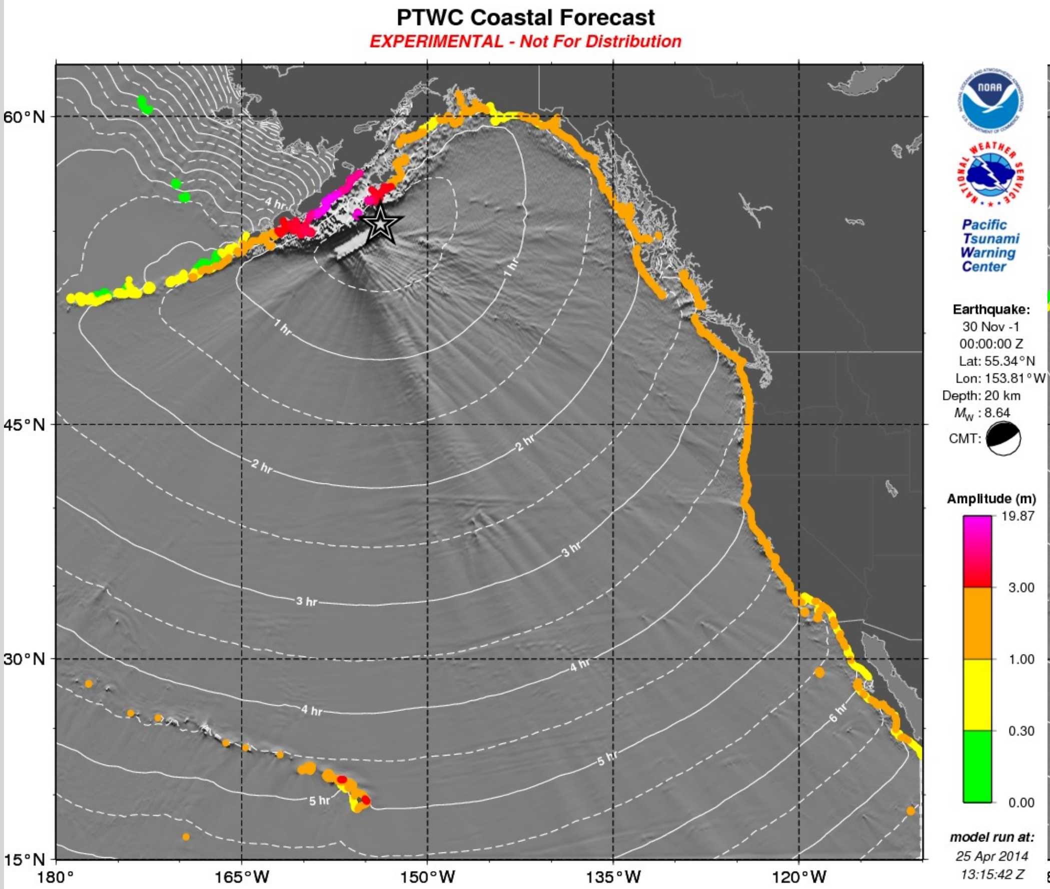


But what if the rupture were unilateral?

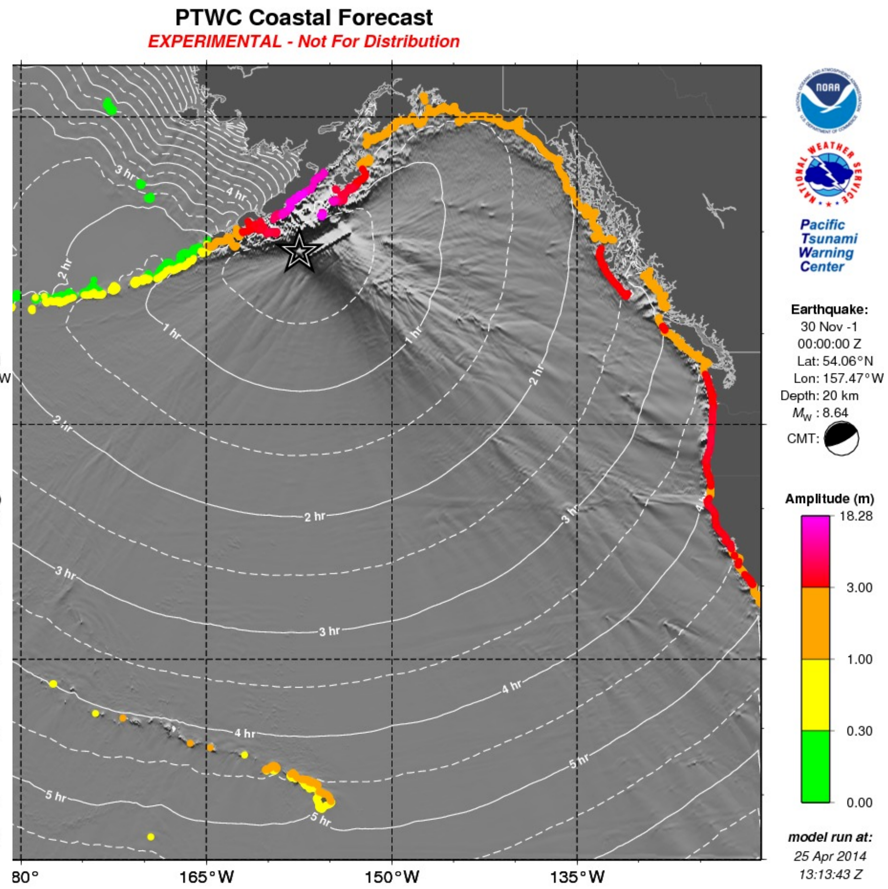


Rupture speed 1.12 km/s

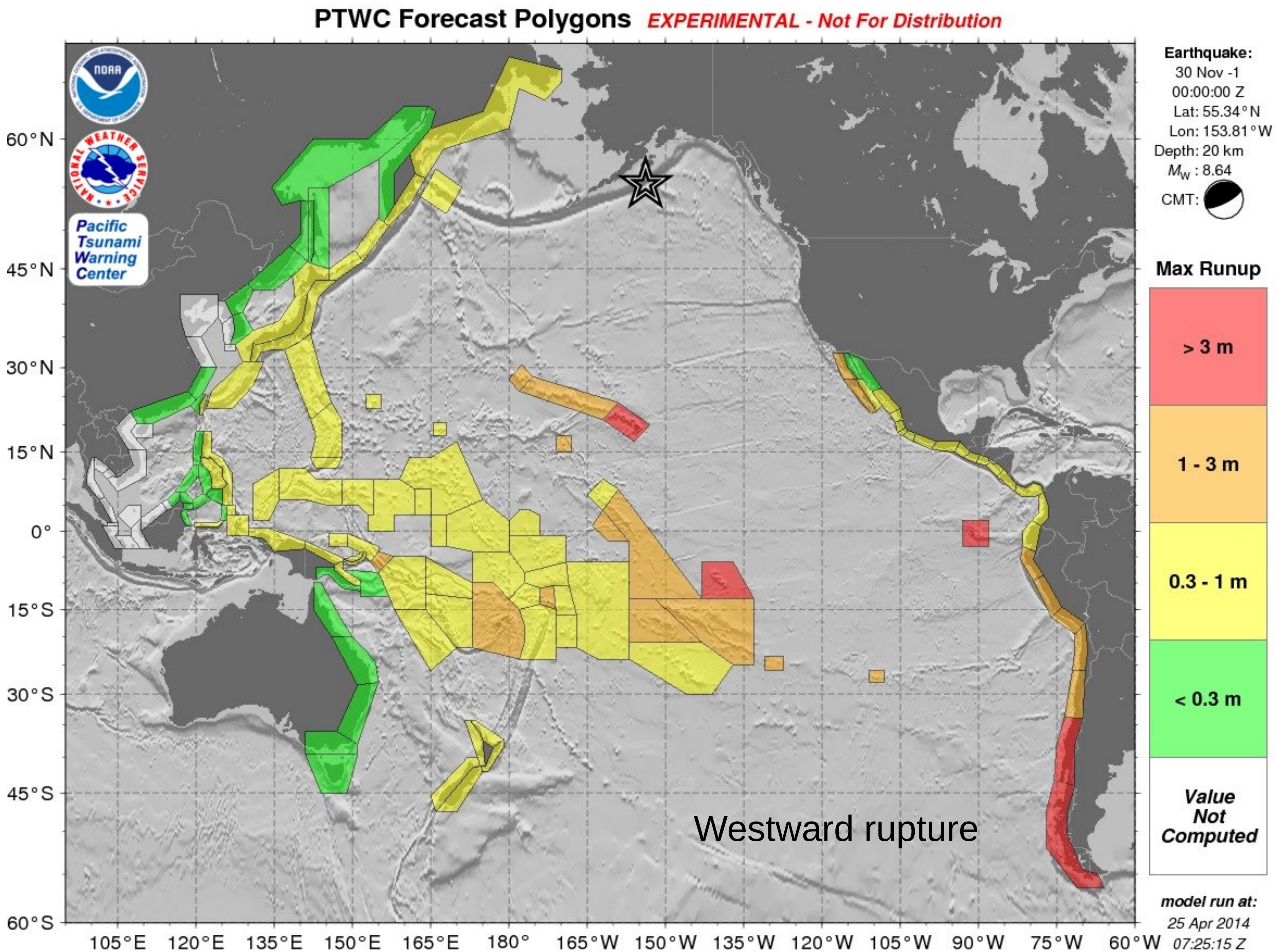
Coastal Runup via Green's Law

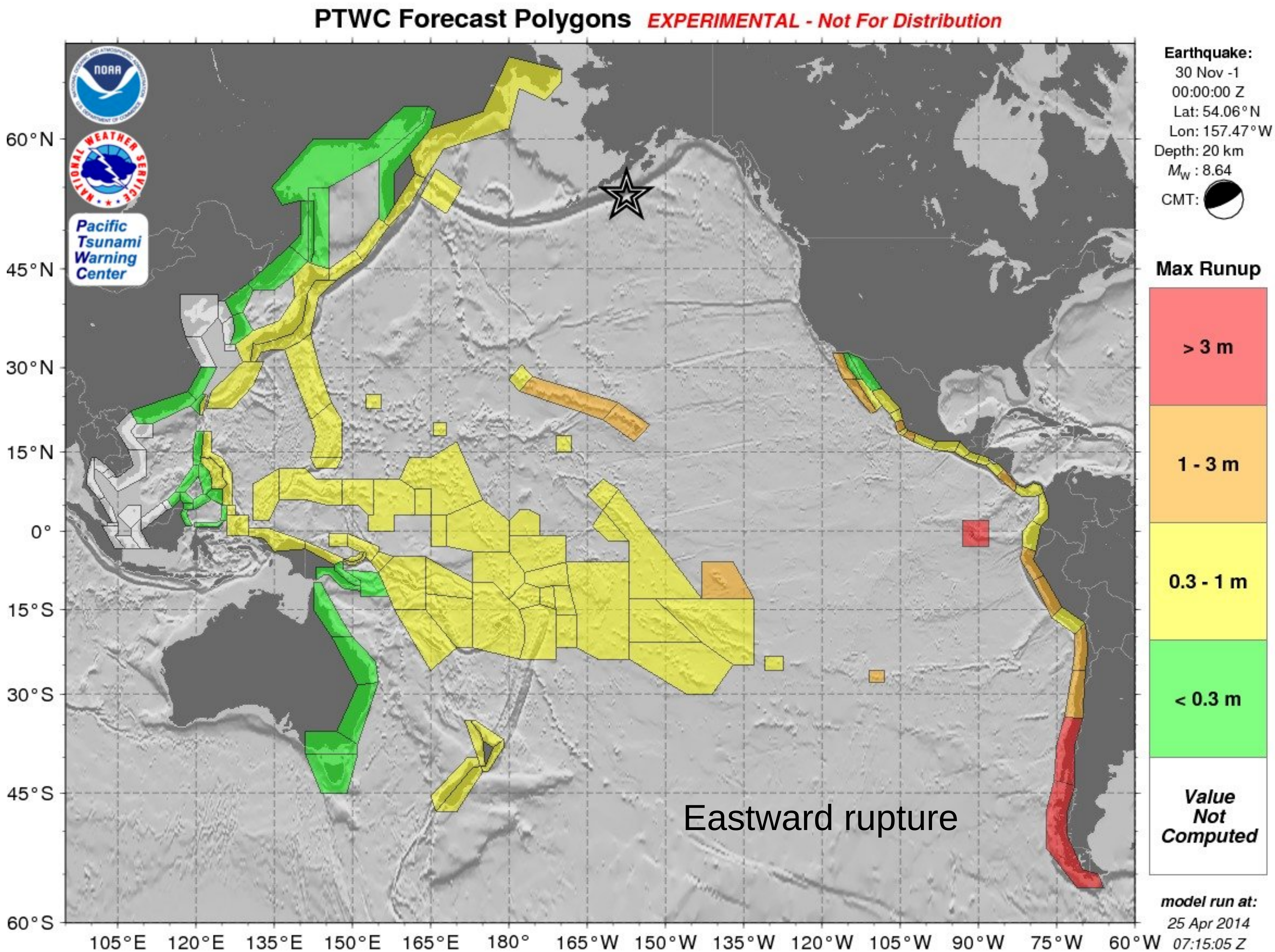


Westward rupture

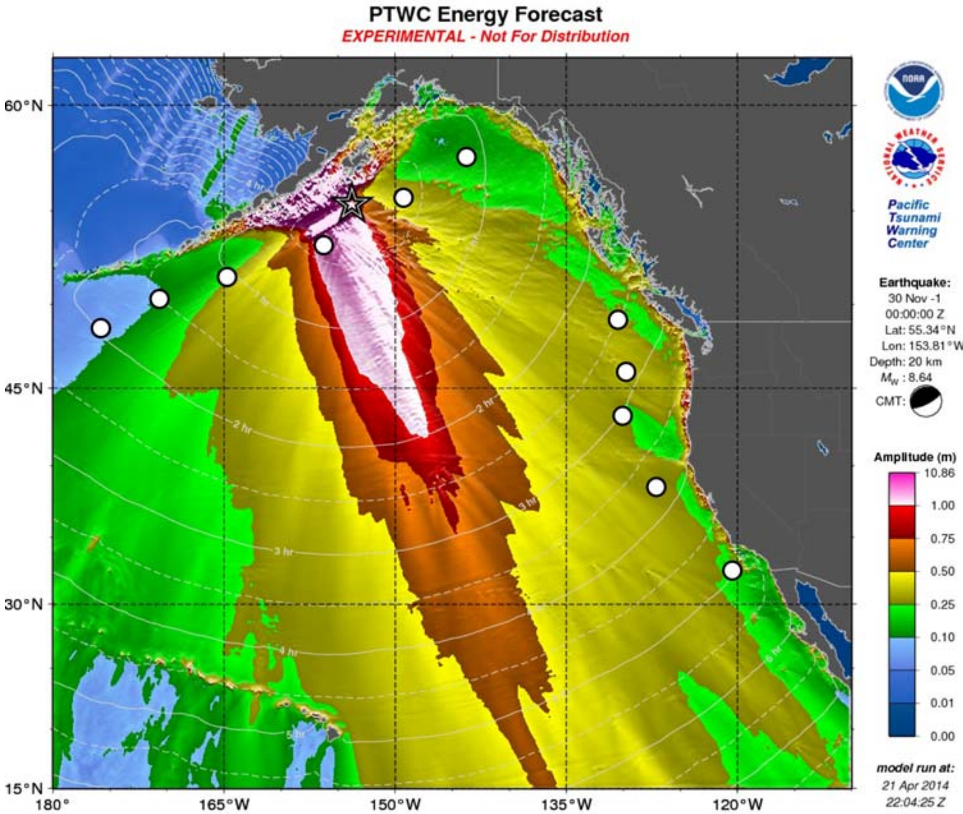


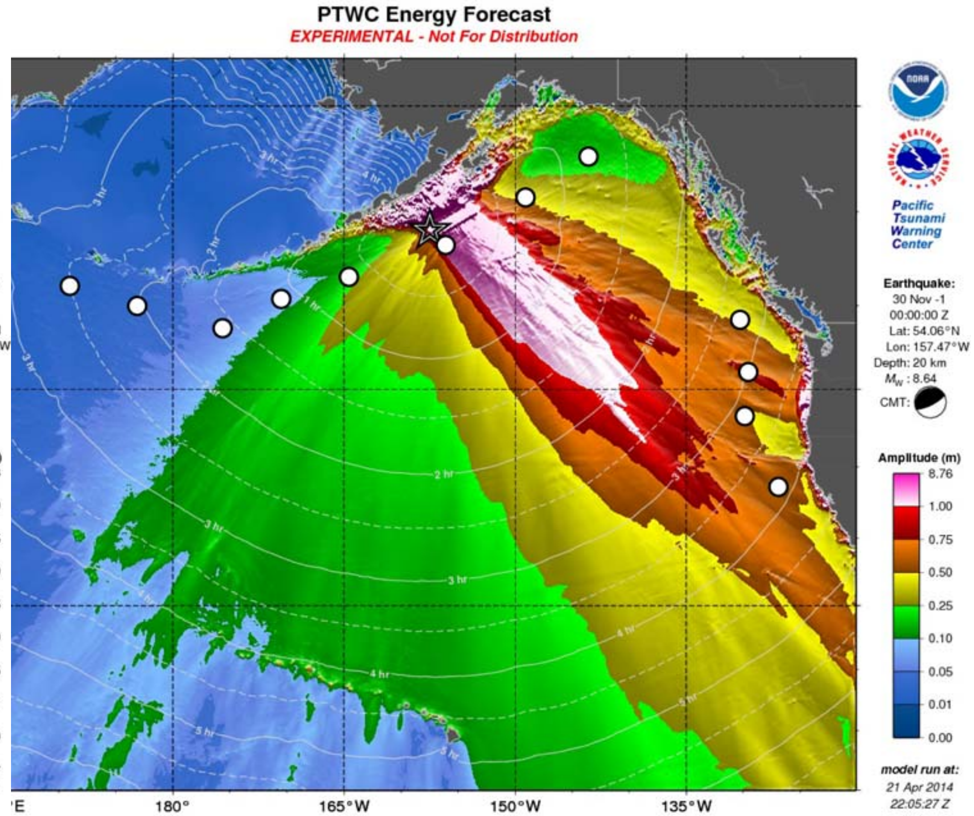
Eastward rupture


PTWC Forecast Polygons EXPERIMENTAL - Not For Distribution
Pacific Tsunami Warning Center
Earthquake:
30 Nov -1
00:00:00 Z
Lat: 55.34°N
Lon: 153.81°W
Depth: 20 km
M_W : 8.64
CMT:
Max Runup
> 3 m
1 - 3 m
0.3 - 1 m
< 0.3 m
Value Not Computed
model run at:
25 Apr 2014
07:25:15 Z
60°N
45°N
30°N
15°N
0°
15°S
30°S
45°S
60°S
105°E 120°E 135°E 150°E 165°E 180° 165°W 150°W 135°W 120°W 105°W 90°W 75°W 60°W
Westward rupture


PTWC Forecast Polygons
EXPERIMENTAL - Not For Distribution
Pacific Tsunami Warning Center
Earthquake:
30 Nov -1
00:00:00 Z
Lat: 54.06°N
Lon: 157.47°W
Depth: 20 km
M_W : 8.64
CMT:
Max Runup
> 3 m
1 - 3 m
0.3 - 1 m
< 0.3 m
Value Not Computed
model run at:
25 Apr 2014
07:15:05 Z
60°N
45°N
30°N
15°N
0°
15°S
30°S
45°S
60°S
105°E
120°E
135°E
150°E
165°E
180°
165°W
150°W
135°W
120°W
105°W
90°W
75°W
60°W
Eastward rupture

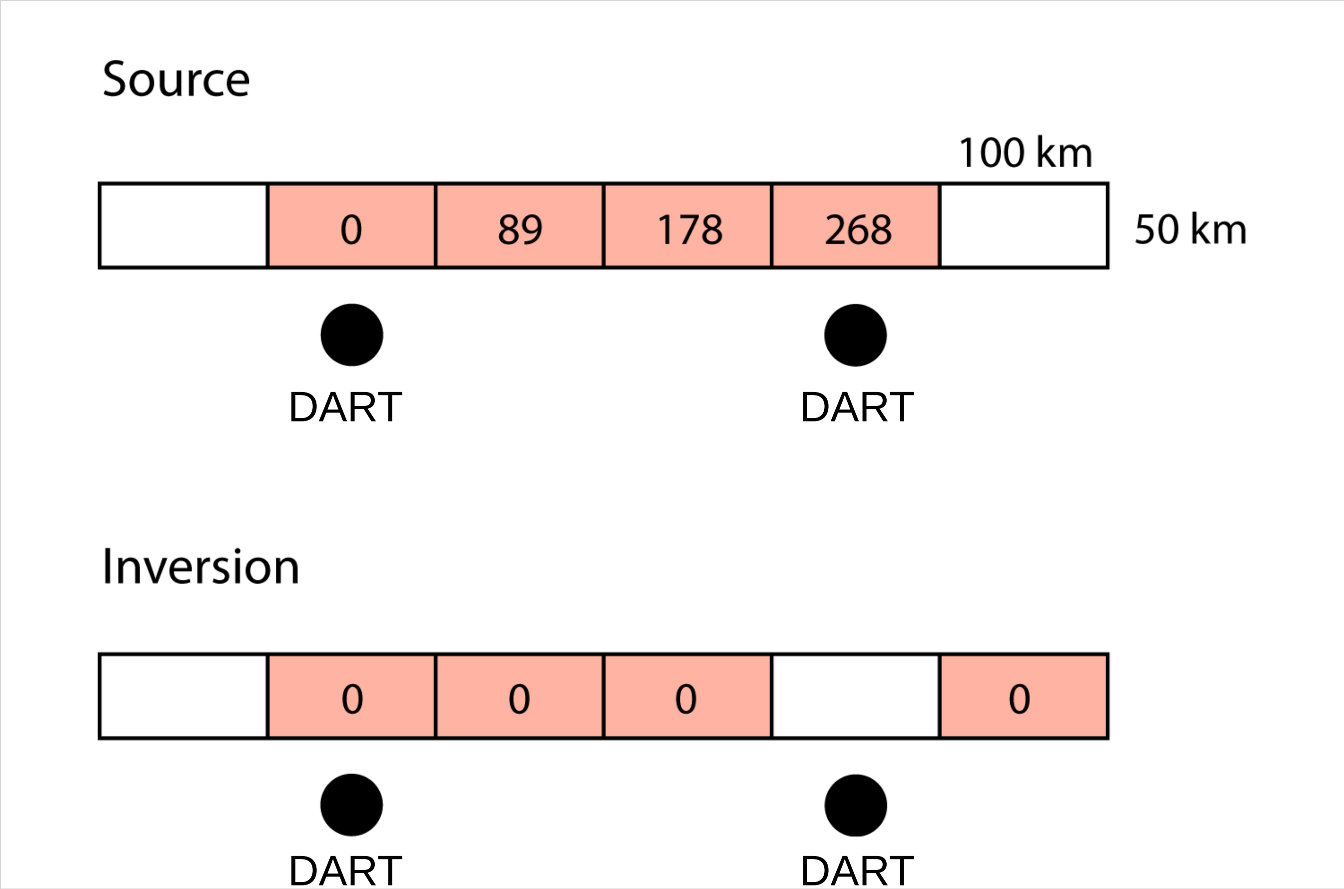
Do the DARTs help?





Gedanken: 2-DART inversion

- The source: sequential rupture at a speed of 1.12 km/s
- The model: Instantaneous rupture; tsunami travels at 0.2 km/s



Comments

- We must compute finite fault slip models (~25 minutes from seismic data, <10 minutes if high-rate GPS available).
- Measurements are too sparse to allow us to choose between models from water level alone.
- The tsunami warning centers are going to have to do a lot more seismology.
- Should we do away with the DARTs? No. They are essential for calibrating forecasts. If rupture is slow enough to suggest a tsunami earthquake, we drop our assumed shear modulus from 45 *to* 25 GPa. But what if it is only 10 GPa?