



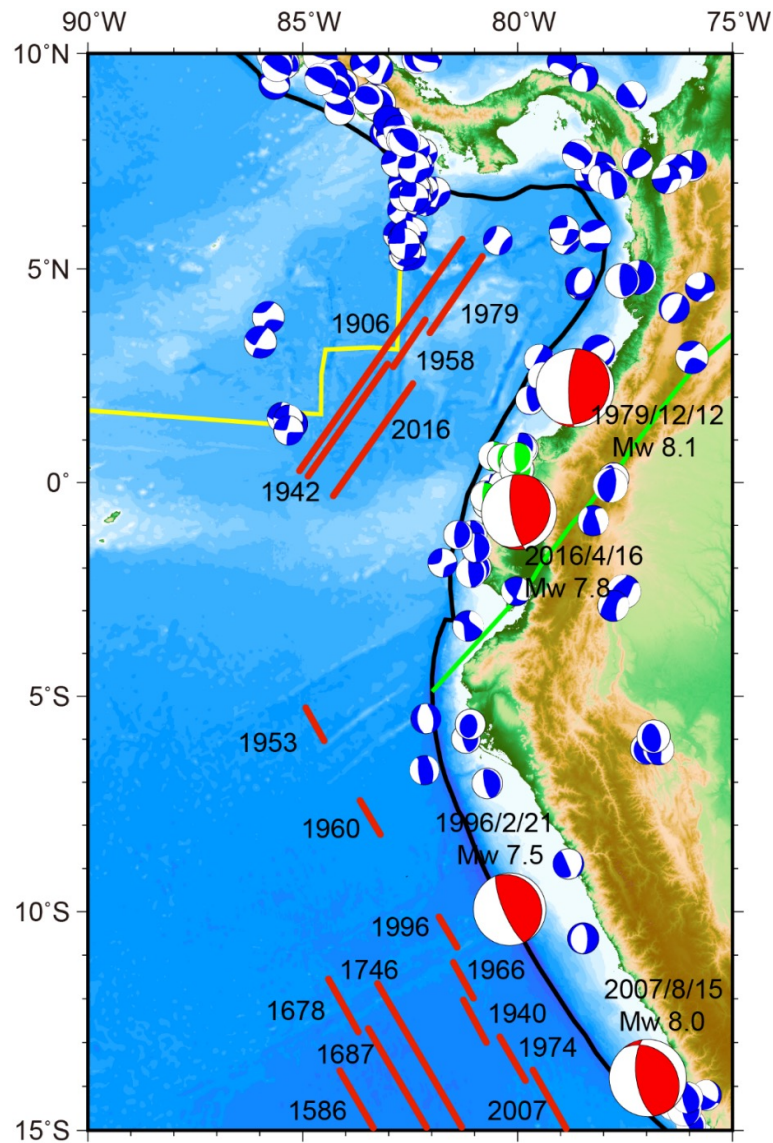
UNESCO/IOC – NOAA ITIC Training Program in Hawaii (ITP-TEWS Chile)
TSUNAMI EARLY WARNING SYSTEMS
AND THE PACIFIC TSUNAMI WARNING CENTER (PTWC) ENHANCED PRODUCTS
TSUNAMI EVACUATION PLANNING AND UNESCO IOC TSUNAMI READY PROGRAMME
19-30 August 2024, Valparaiso, Chile

South American Earthquake and Tsunamis

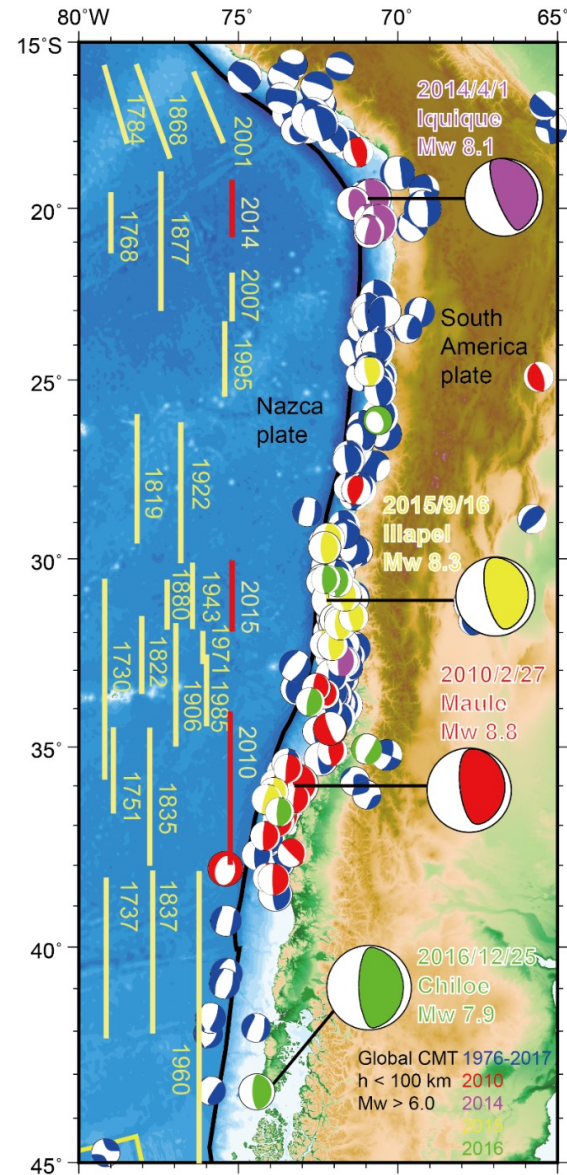
Kenji Satake
University of Tokyo



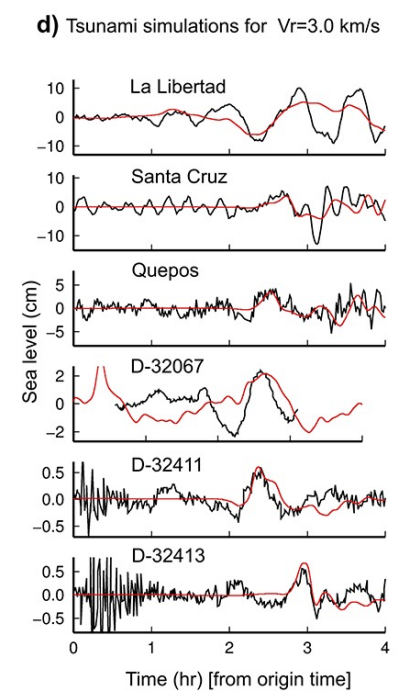
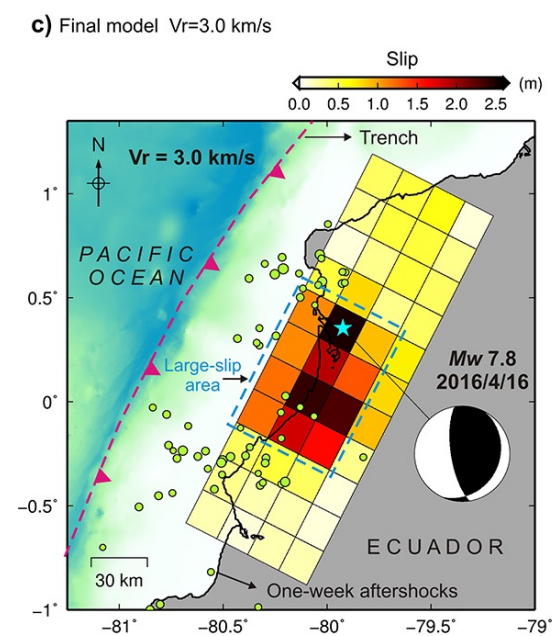
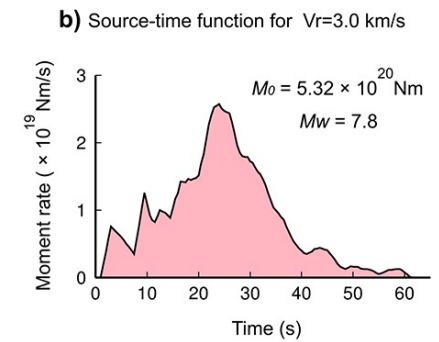
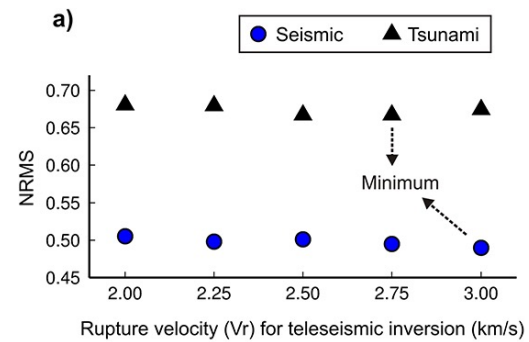
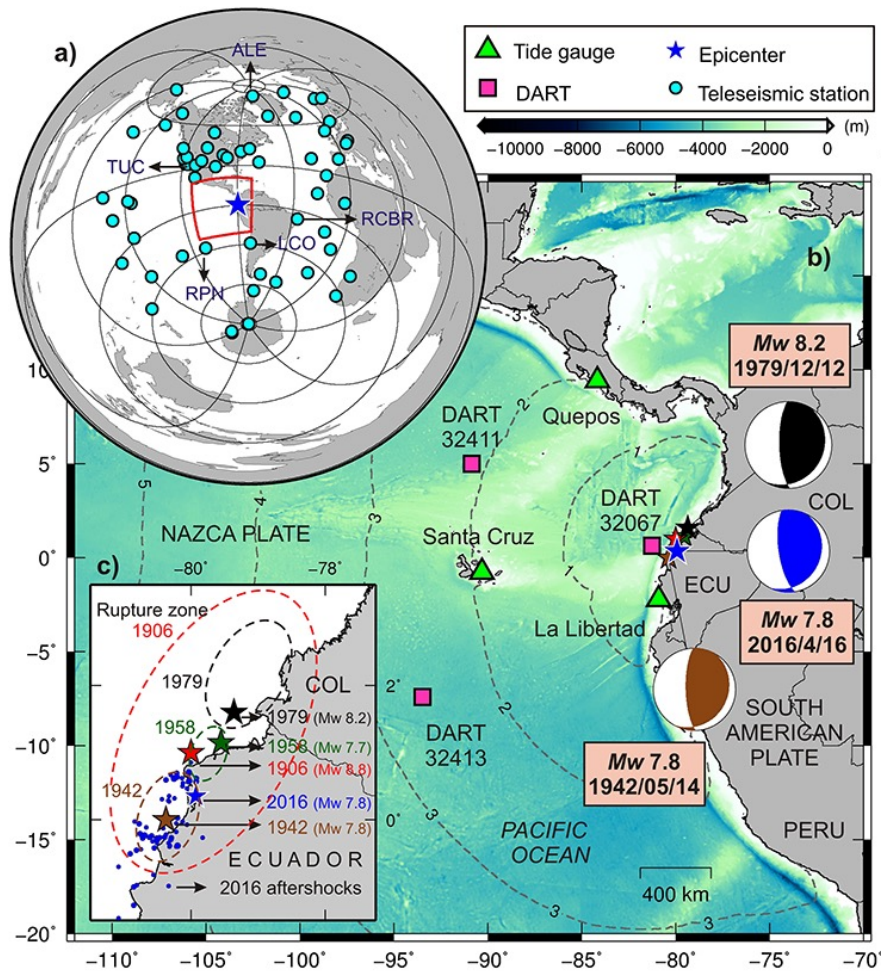
Recent Earthquakes in South America



International Tsunami Information Center

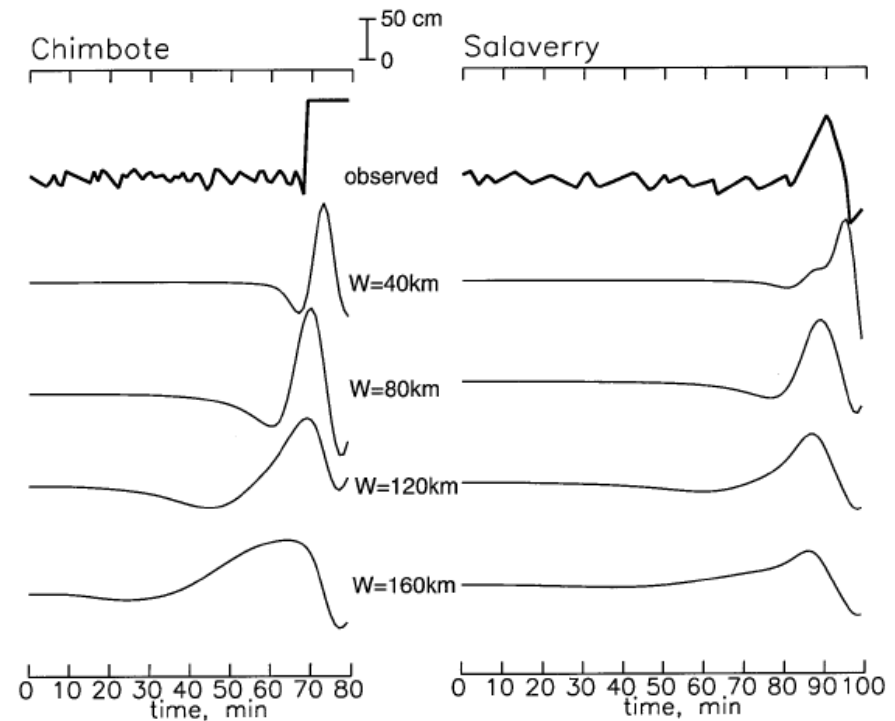
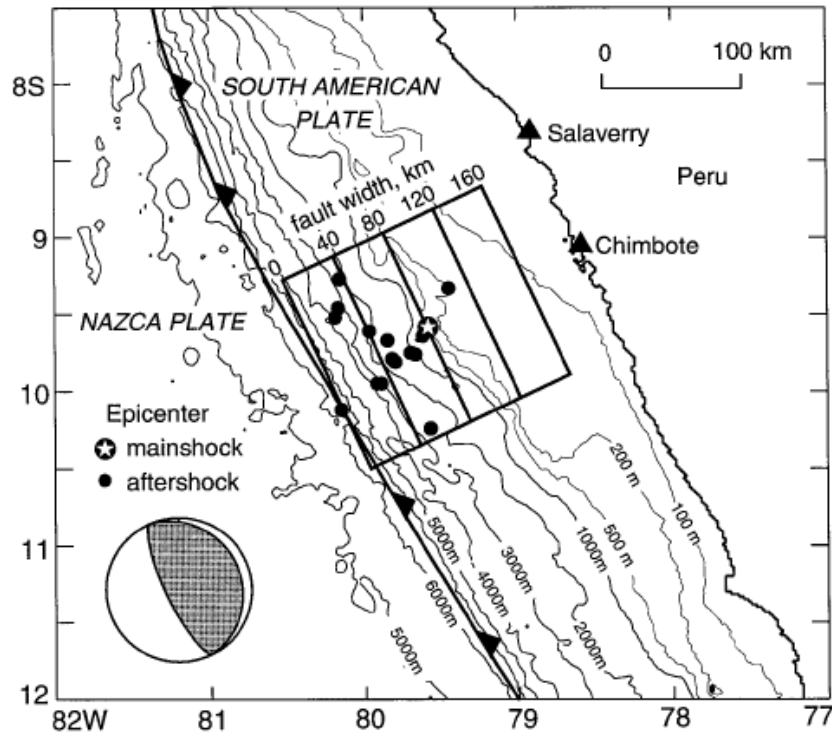


2016 Ecuador earthquake

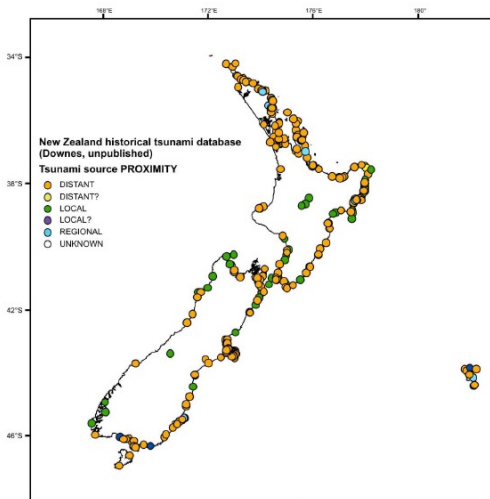
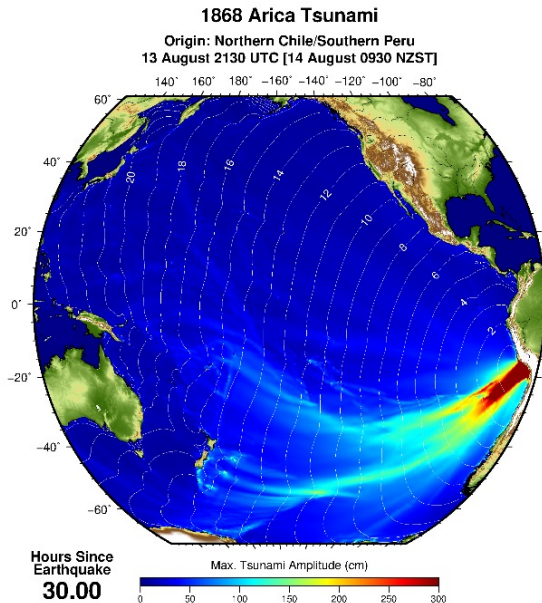


1996 Peru earthquake

Typical “tsunami earthquake”



Historical tsunamis from Peruvian earthquakes



(Power, 2013)

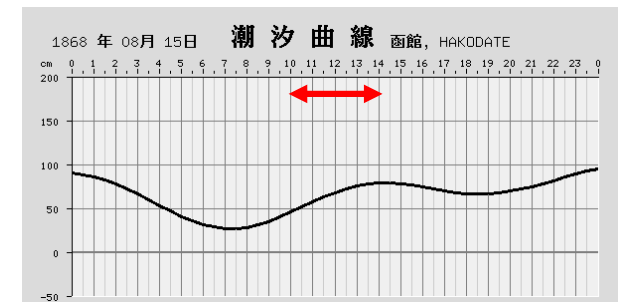
1868 (August 13) Arica earthquake

Hakodate (Capt. T. Blakiston) August 15

A series of bore or tidal waves from 10:30 to 15:00

Sea level difference 10 ft in 10 min

(ordinary tide: 2.5 to 3 ft)



Chatham Island

Up to 10 m tsunami and a few casualties
(the only tsunami casualty in New Zealand)

New Zealand

1-4 m tsunami in main island

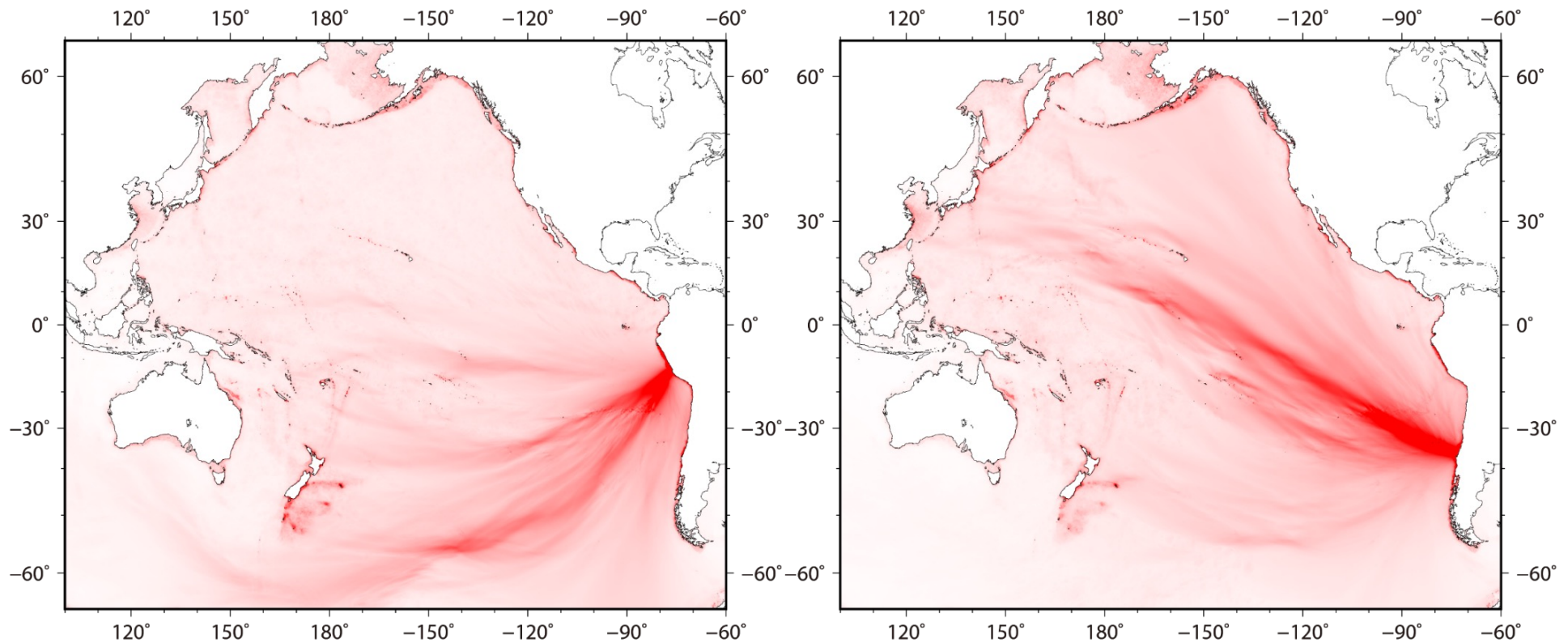
Sandwich Island

oscillation continued for 3 days

Directivity effect: Peru and Chile sources

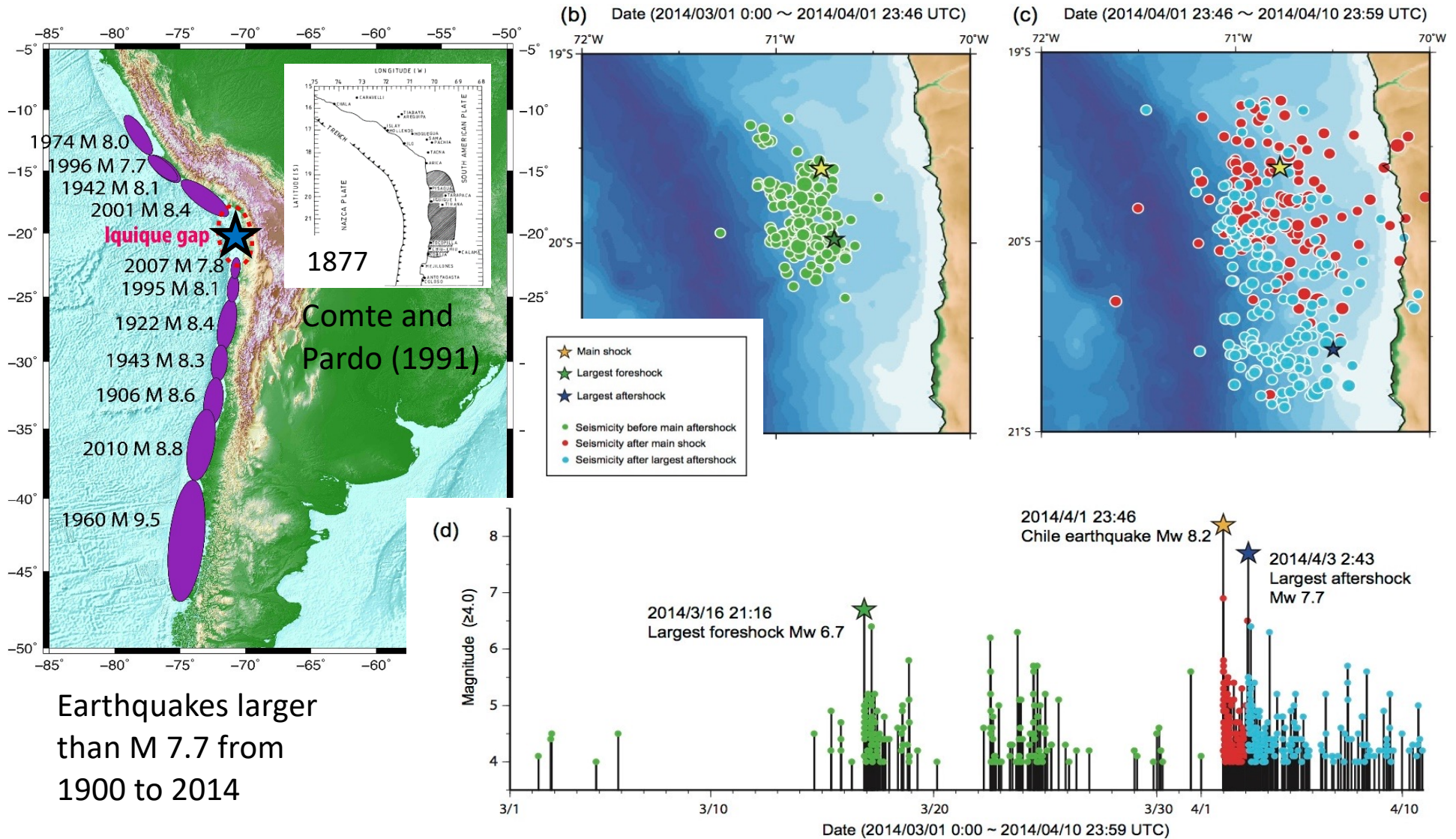
Peru
1687 earthquake

Chile
2010 Maule earthquake

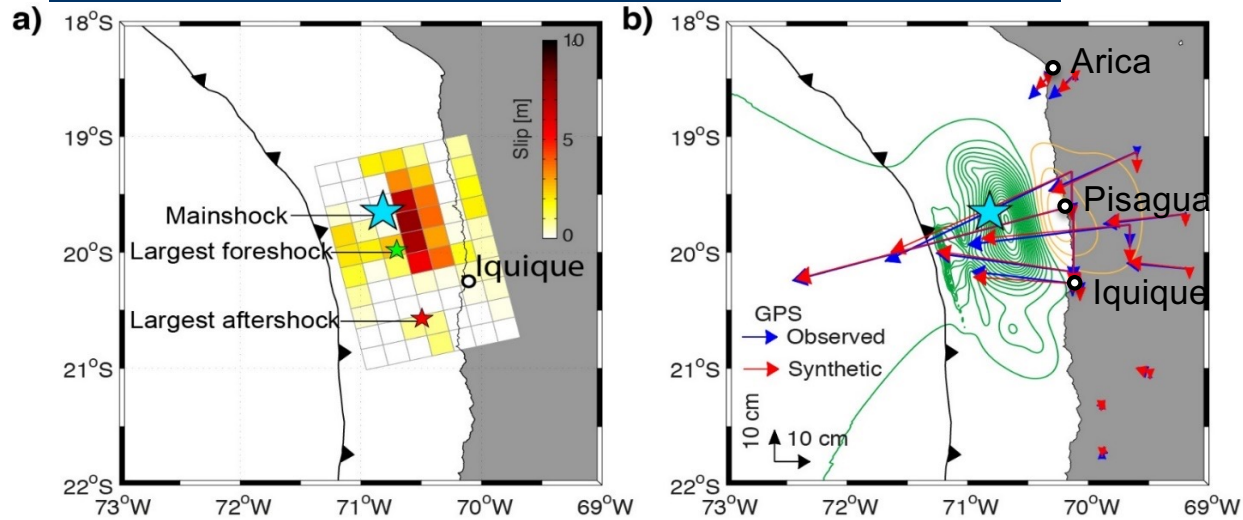


Length	Width	Slip	Mw
300 km	150 km	10 m	8.8

Seismicity from March 1 to April 11, 2014



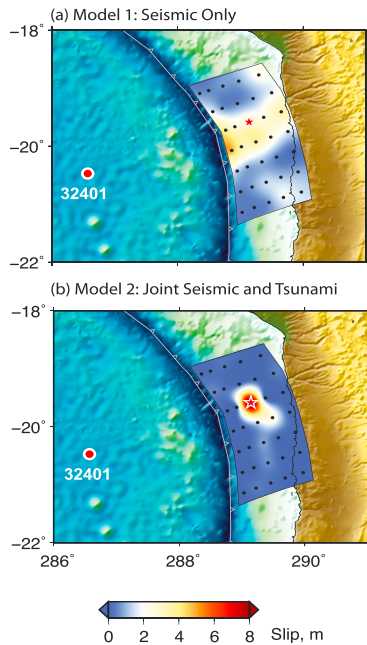
2014 Iquique earthquake



Tsunami + GPS

1.24×10^{21} Nm, M_w 8.0

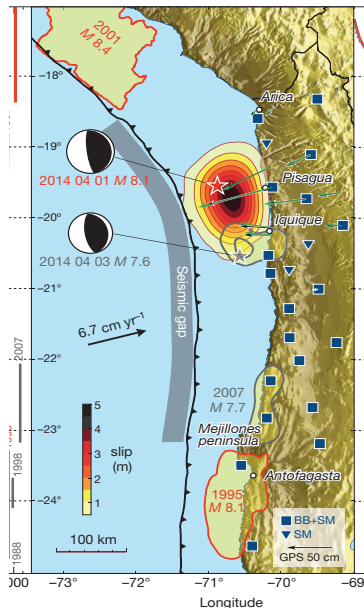
Gusman et al. (2015, GRL)



Teleseismic

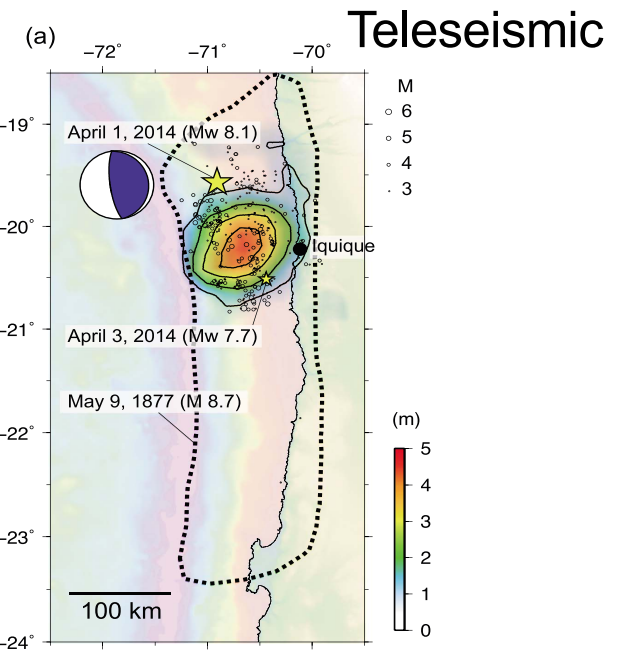
Teleseismic + tsunami

Lay et al. (2014, GRL)



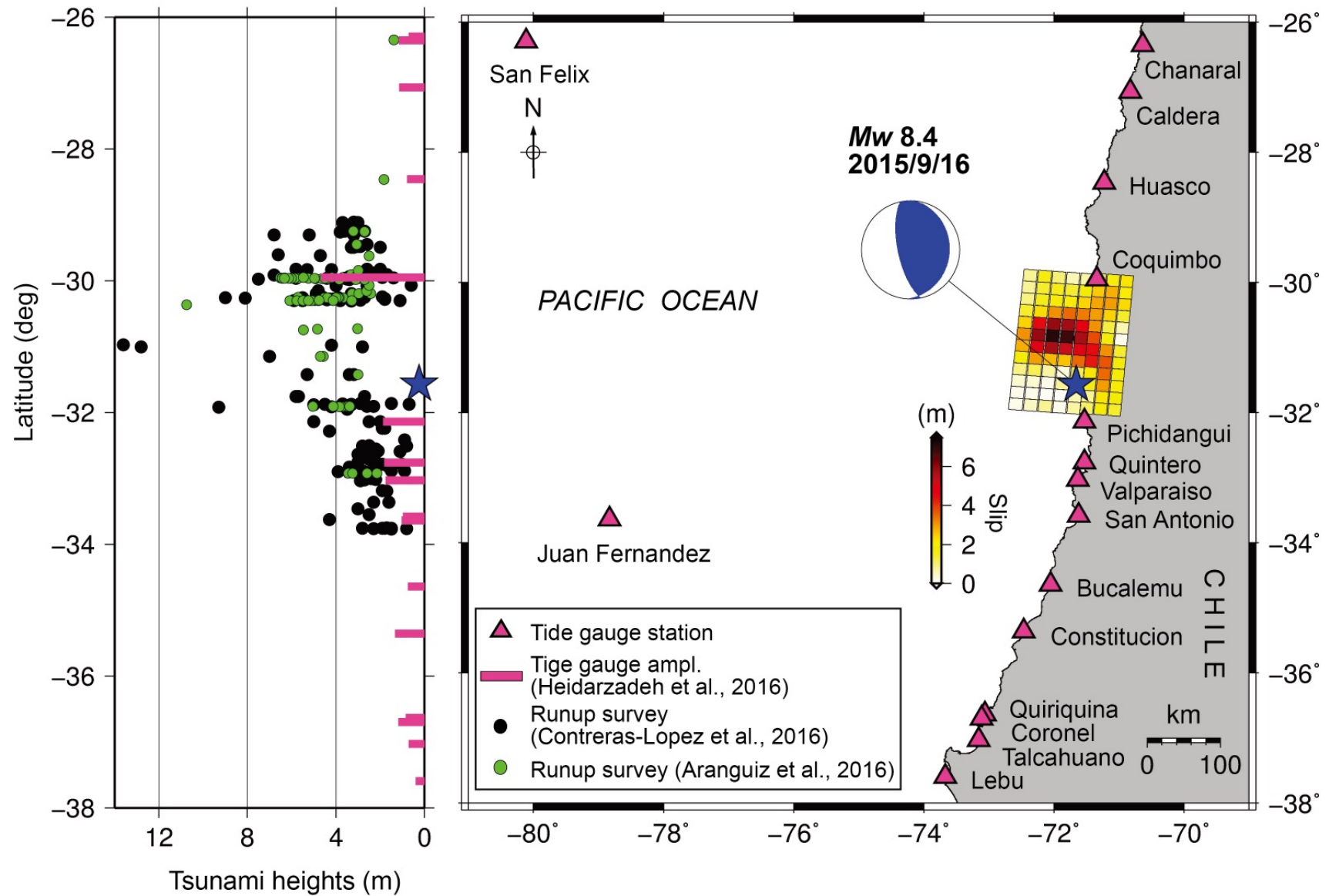
Teleseismic + strong motion + GPS

Schurr et al. (2014, Nature)

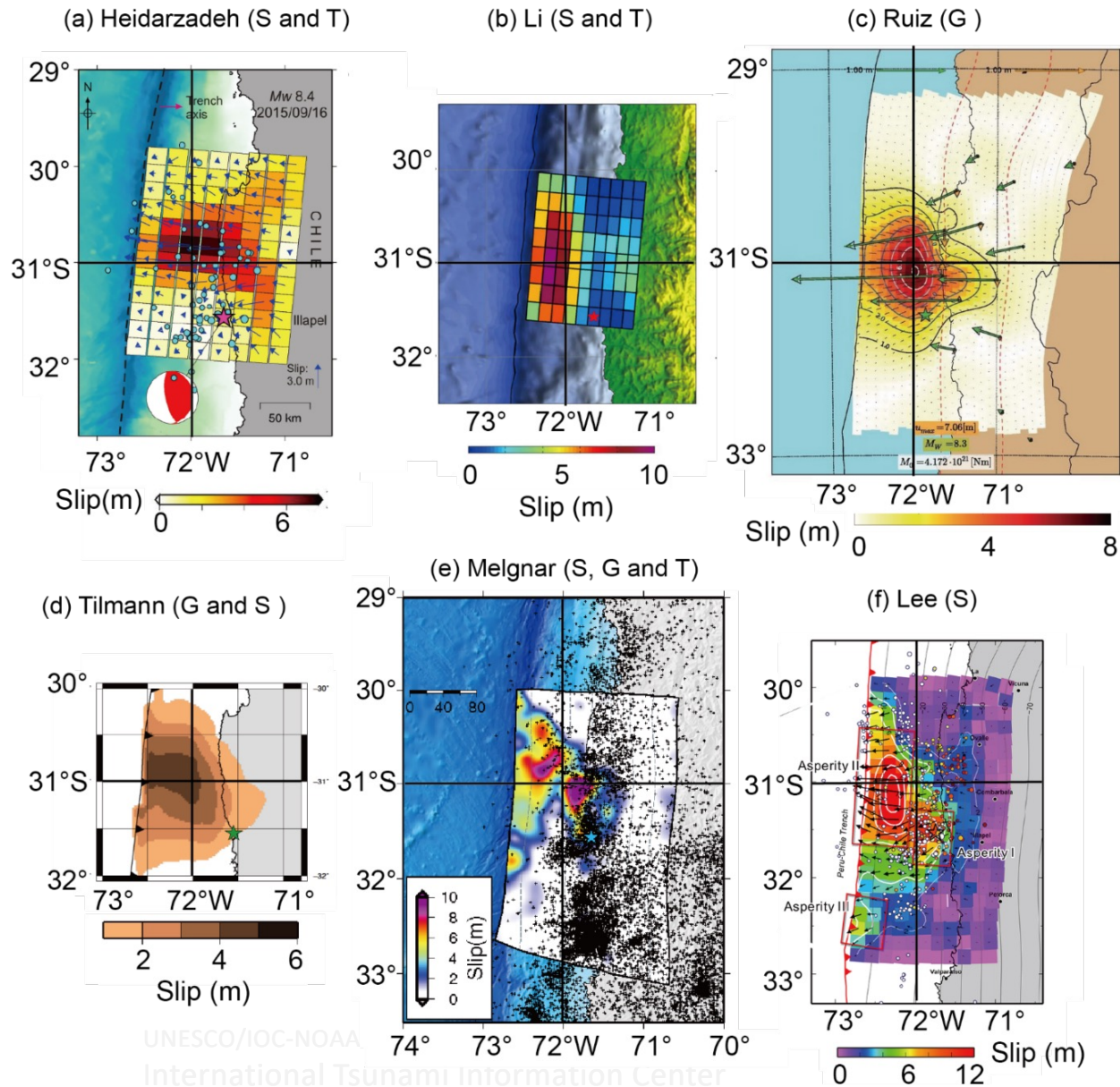


Yagi et al. (2014, GRL)

The 2015 Illapel earthquake



The 2015 Illapel earthquake



Satake and Heidarzadeh (2017)

2010 Chile (Maule or Bio-Bio) Earthquake

San Antonio, Chile



Santiago Airport (AP)



The 6th largest earthquake in the last 100 years, the casualties were 577



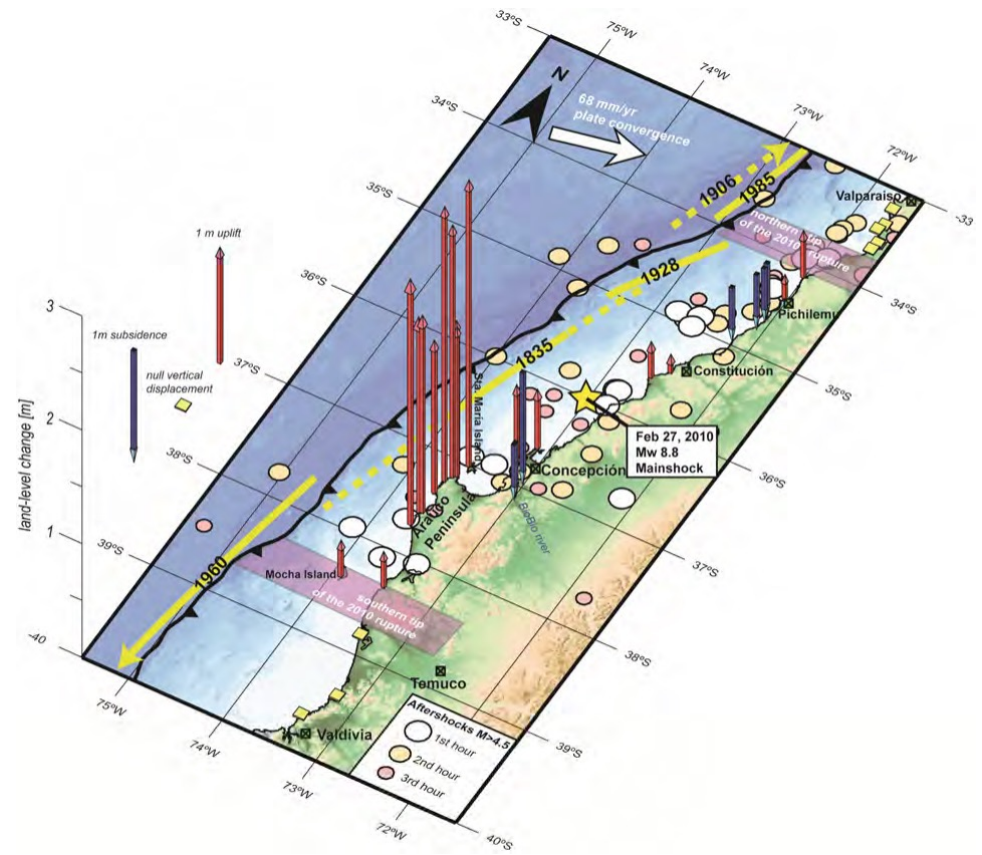
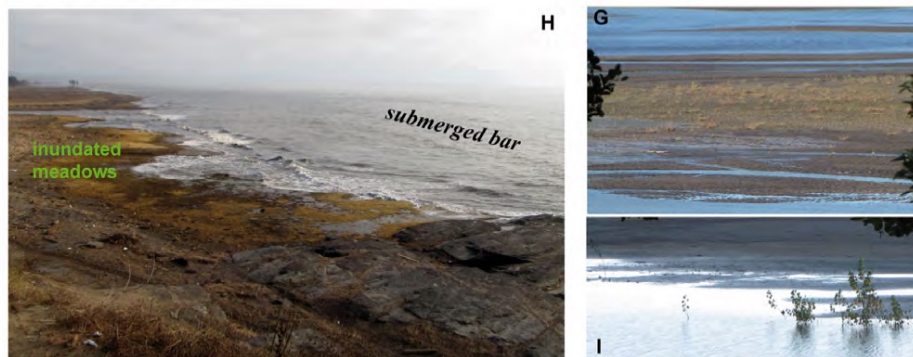
Date	Location	M
1960 May 22	Chile	9.5
1964 March 28	Alaska	9.2
2004 December 26	Sumatra-Andaman	9.1
1952 November 4	Kamchatka	9.0
2011 March 11	Japan	9.0
2010 February 27	Chile	8.8

Coastal Uplift/Subsidence

UPLIFT

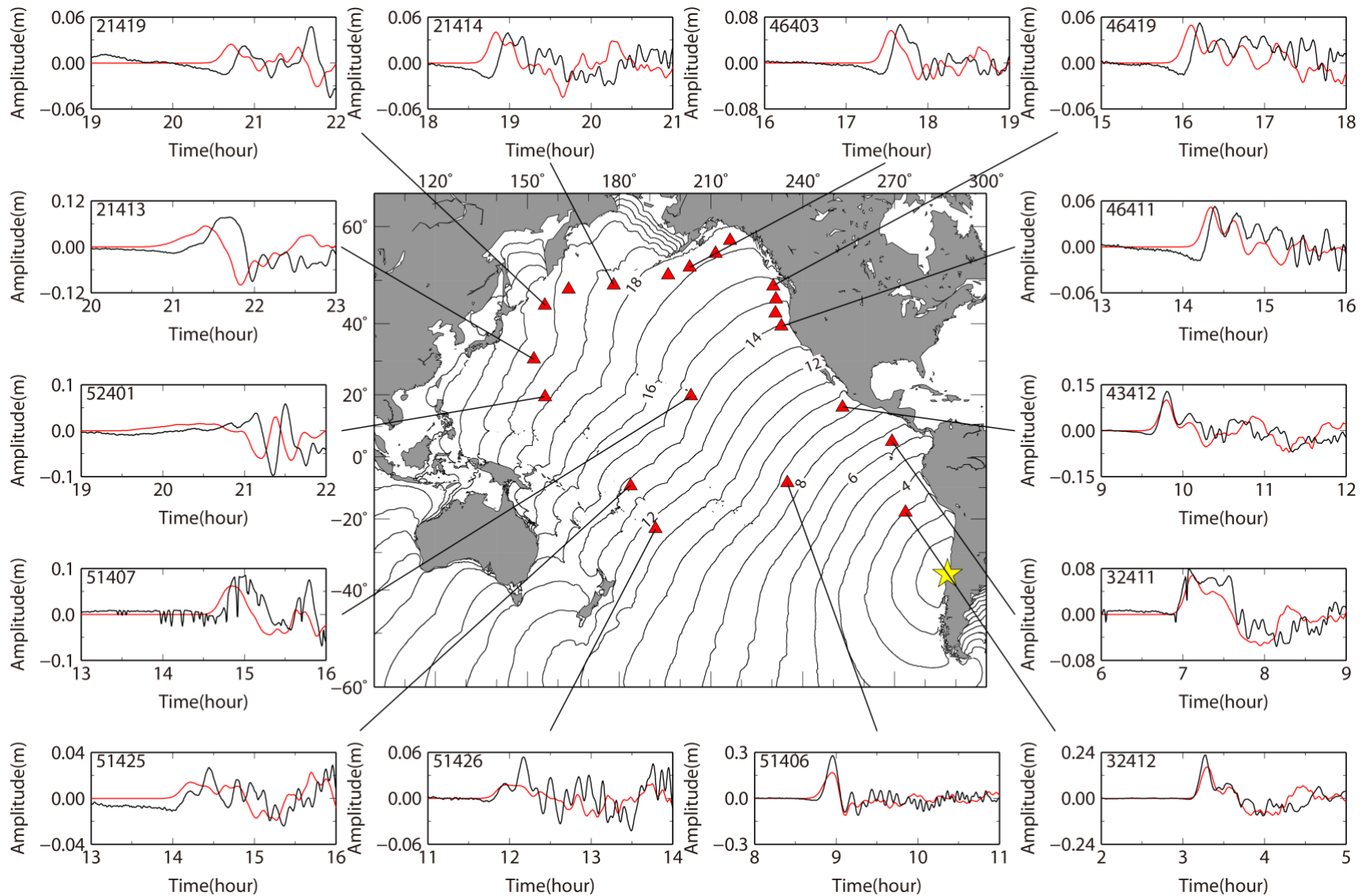


SUBSIDENCE

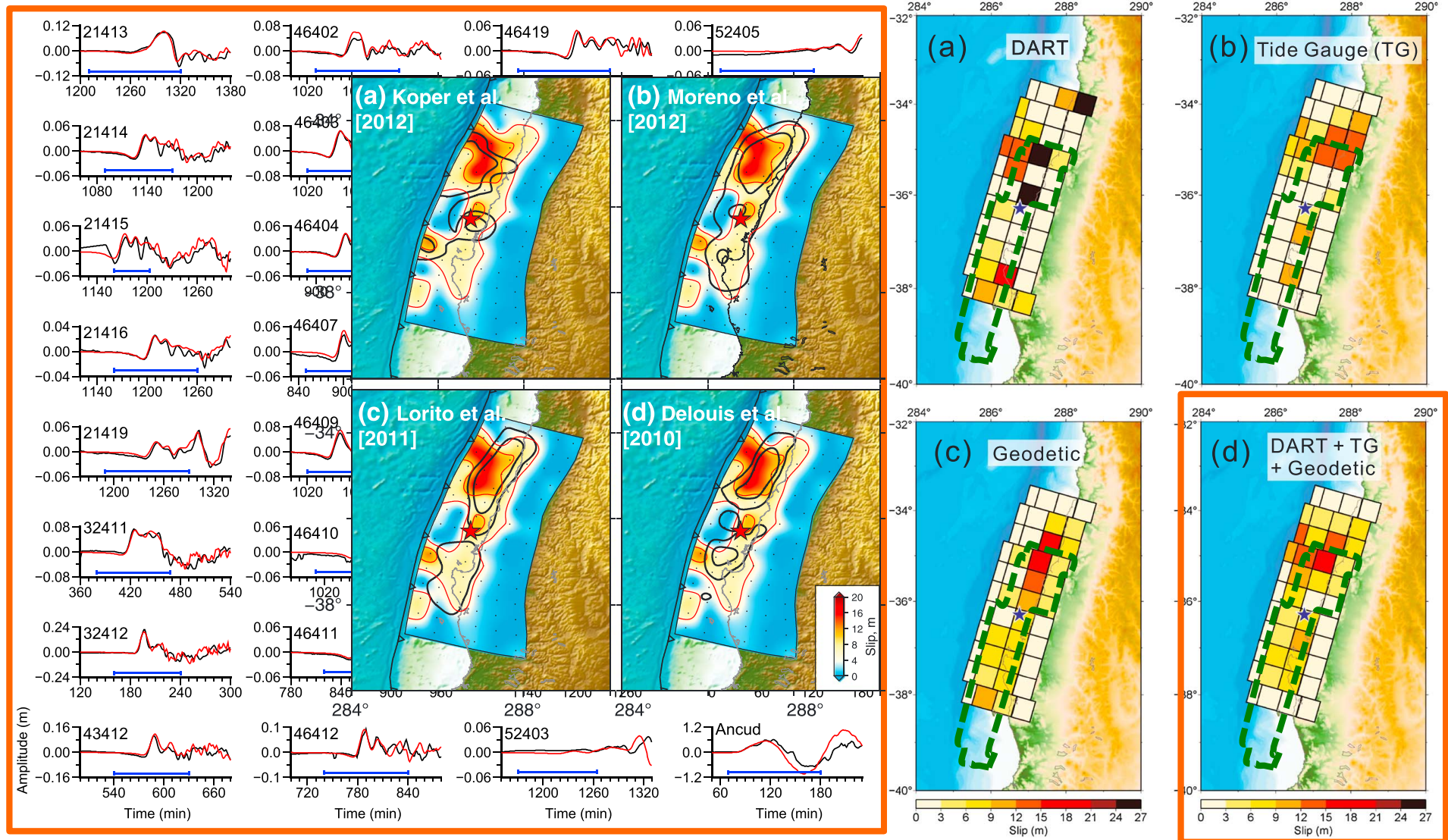


Farias et al. 2010
(August 20 issue of Science)

The 2010 Chile earthquake tsunami



Slip inversions



The 1960 Chilean tsunami

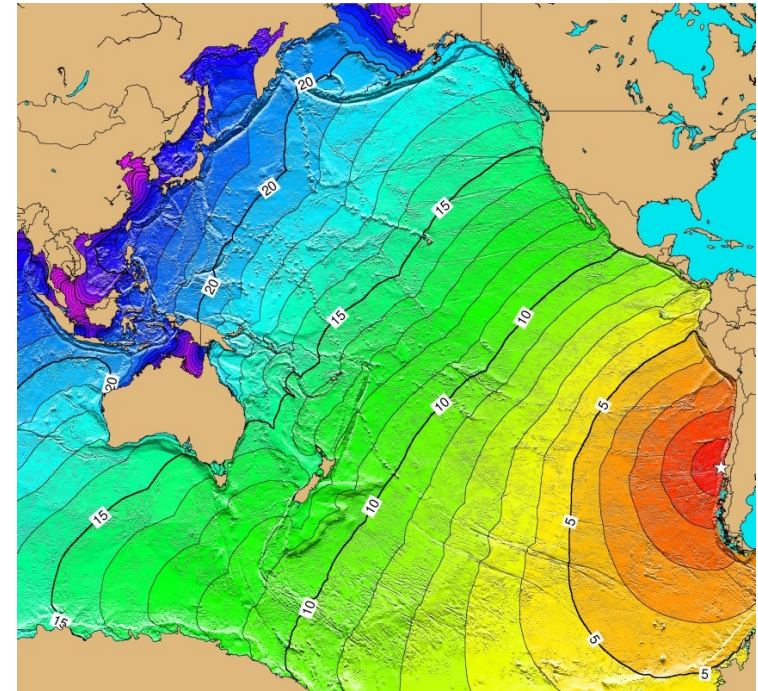
Largest eq. in 20th century

The tsunami arrived

Hawaii 15 hrs; 61 casualties

Japan 23 hrs; 139 casualties

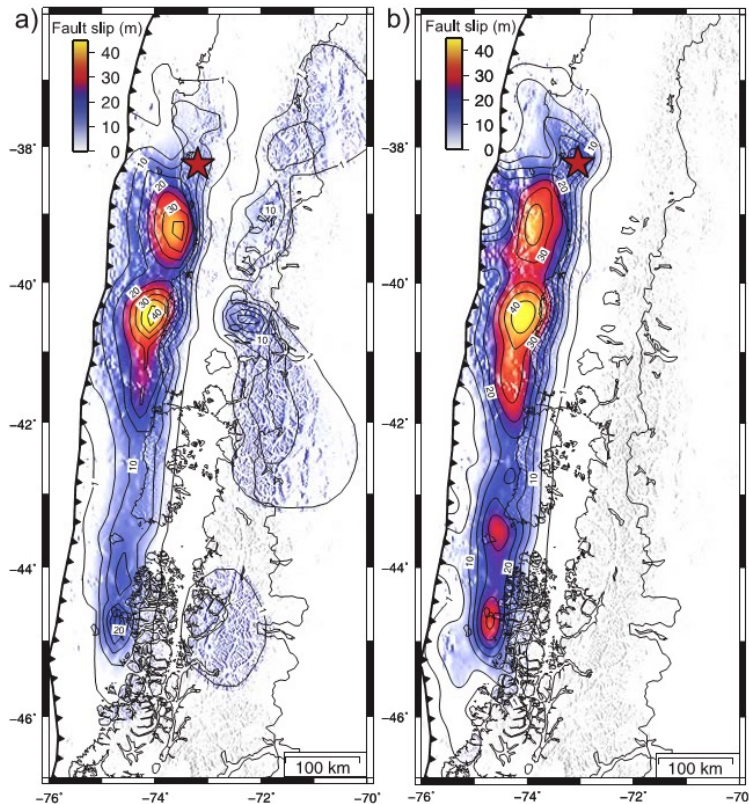
International Tsunami Warning System



Hilo, Hawaii

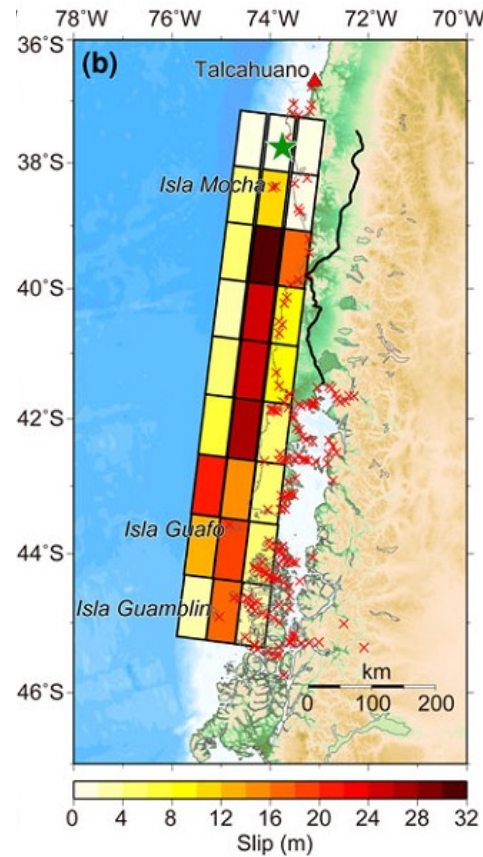
1960 Chile earthquake

Barrientos and Ward (1990, GJI)
Moreno et al. (2009, GRL)



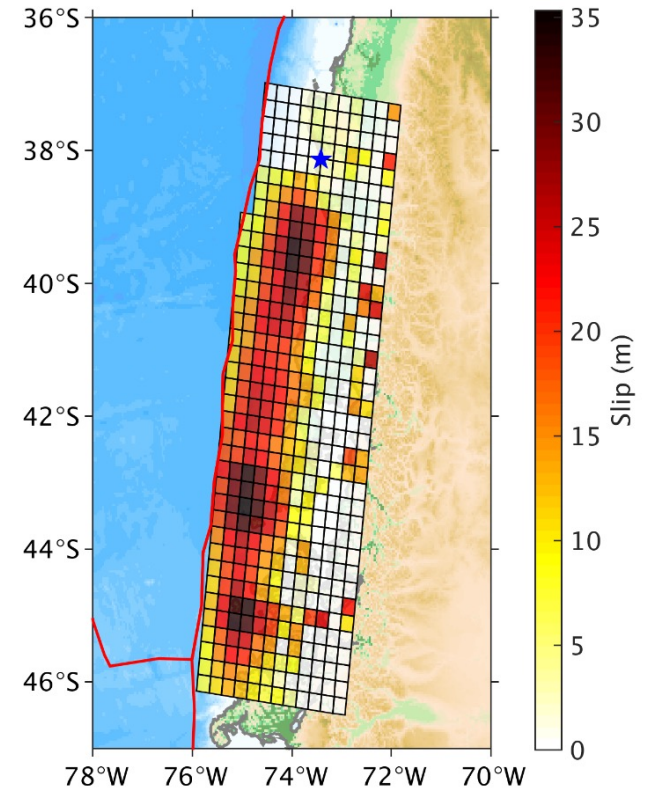
9.5×10^{22} Nm 9.6×10^{22} Nm
 $M_w \approx 9.3$ $M_w \approx 9.3$

Fujii and Satake
(2013, Pageoph)



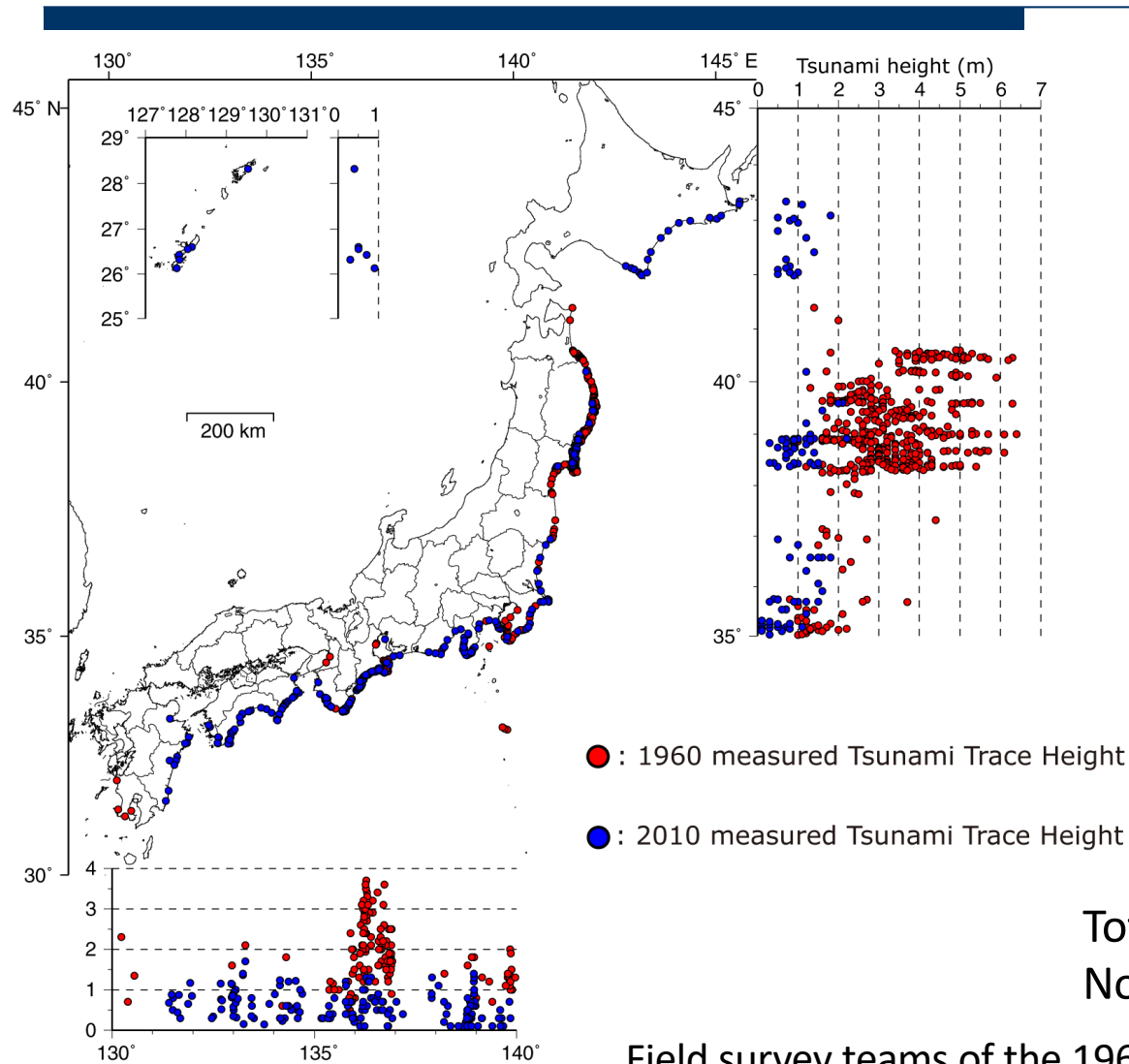
7.2×10^{22} Nm
 $M_w \approx 9.2$

Ho et al.
(2019, JGR)



1.27×10^{23} Nm
 $M_w \approx 9.3$

The 2010 and 1960 Chilean Tsunamis in Japan



Kesen-numa Port 2.3 m



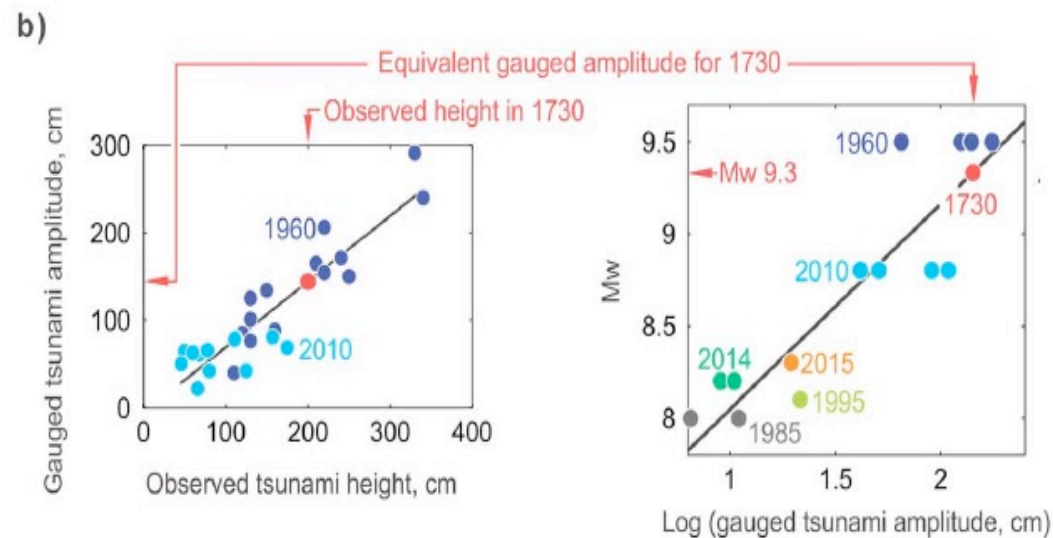
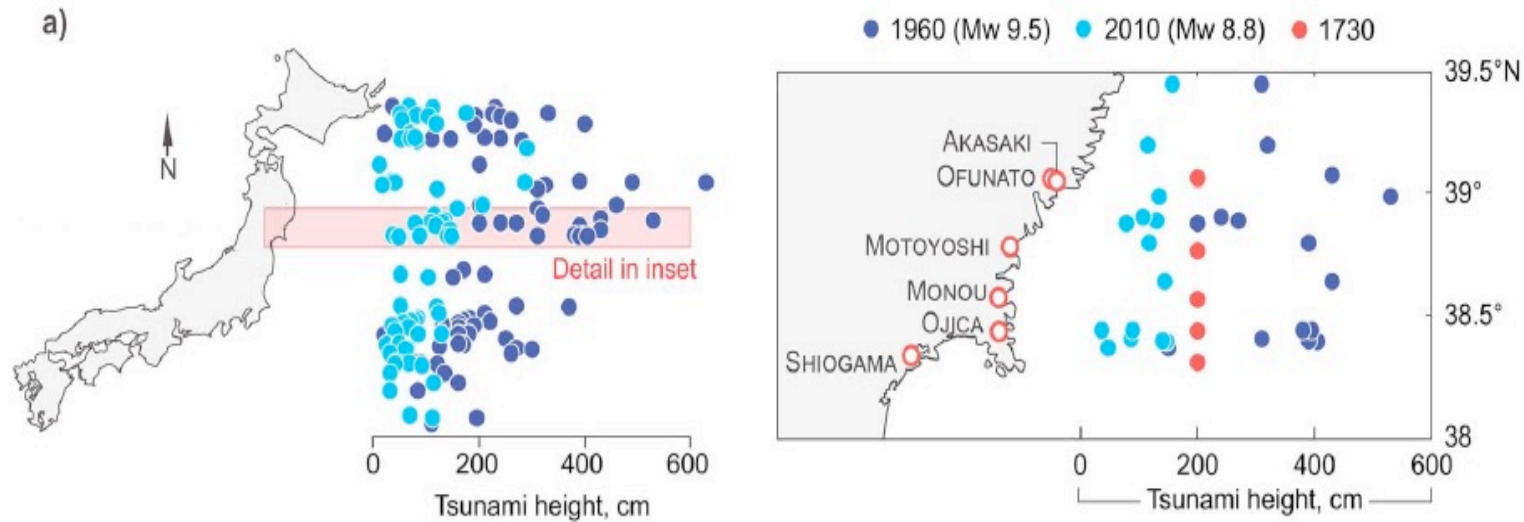
Miyako Bay Aquaculture



Total damage about US \$ 60 million
No human damage in Japan

Field survey teams of the 1960 and 2010
Chilean earthquake tsunamis in Japan;
Compiled by Kentaro Imai

Tsunami heights in Japan from Chilean earthquakes



The 1730 earthquake

Mw 9.3

Slip distributions of Chilean earthquakes

2014 Iquique

2015 Illapel

2010 Maule

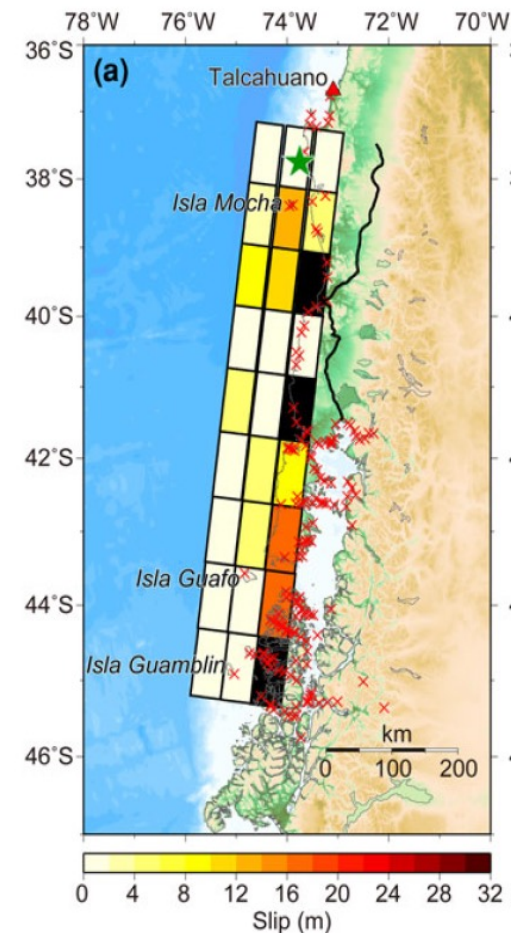
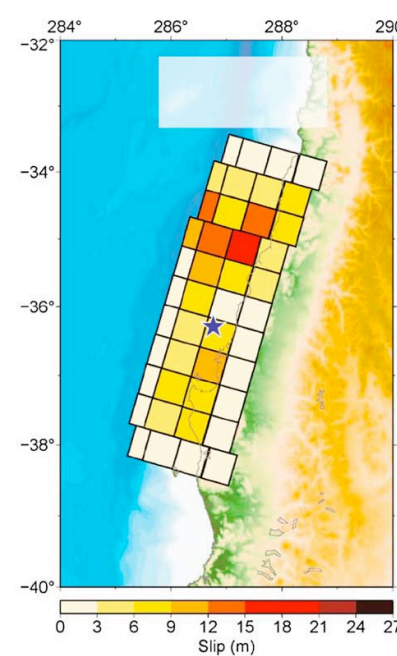
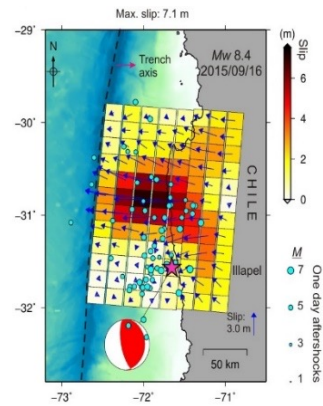
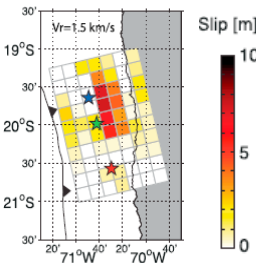
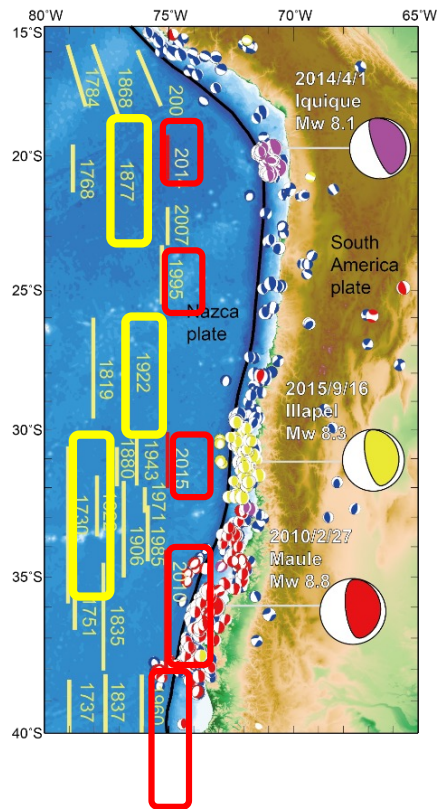
1960 Valdivia

Mw 8.0

Mw 8.3

Mw 8.8

Mw 9.2





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Intergovernmental
Oceanographic
Commission



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Thank You

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