Earthquake activity and Seismic hazard in Latin America
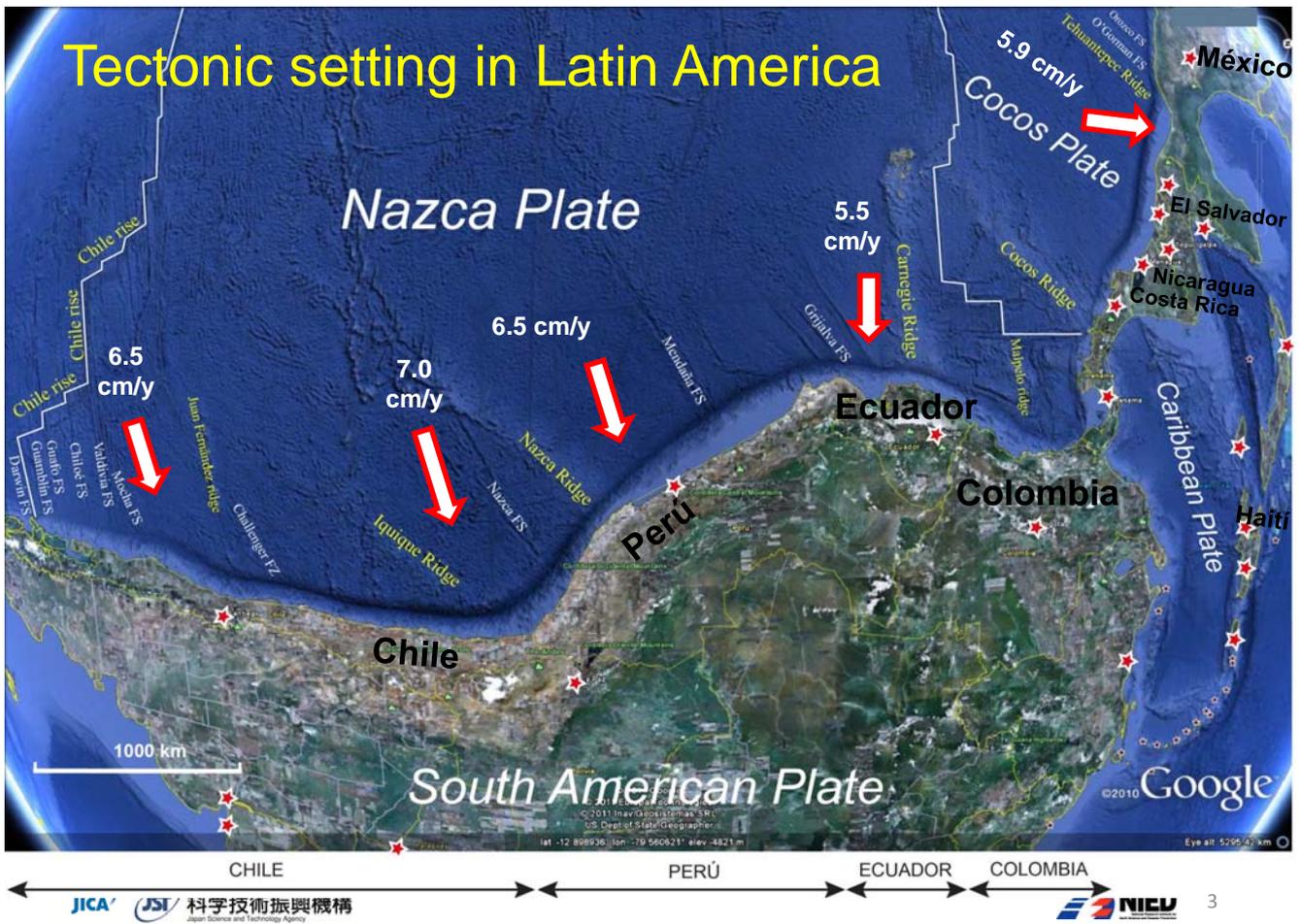
Nelson Pulido

National Research Institute for Earth Science and Disaster Prevention

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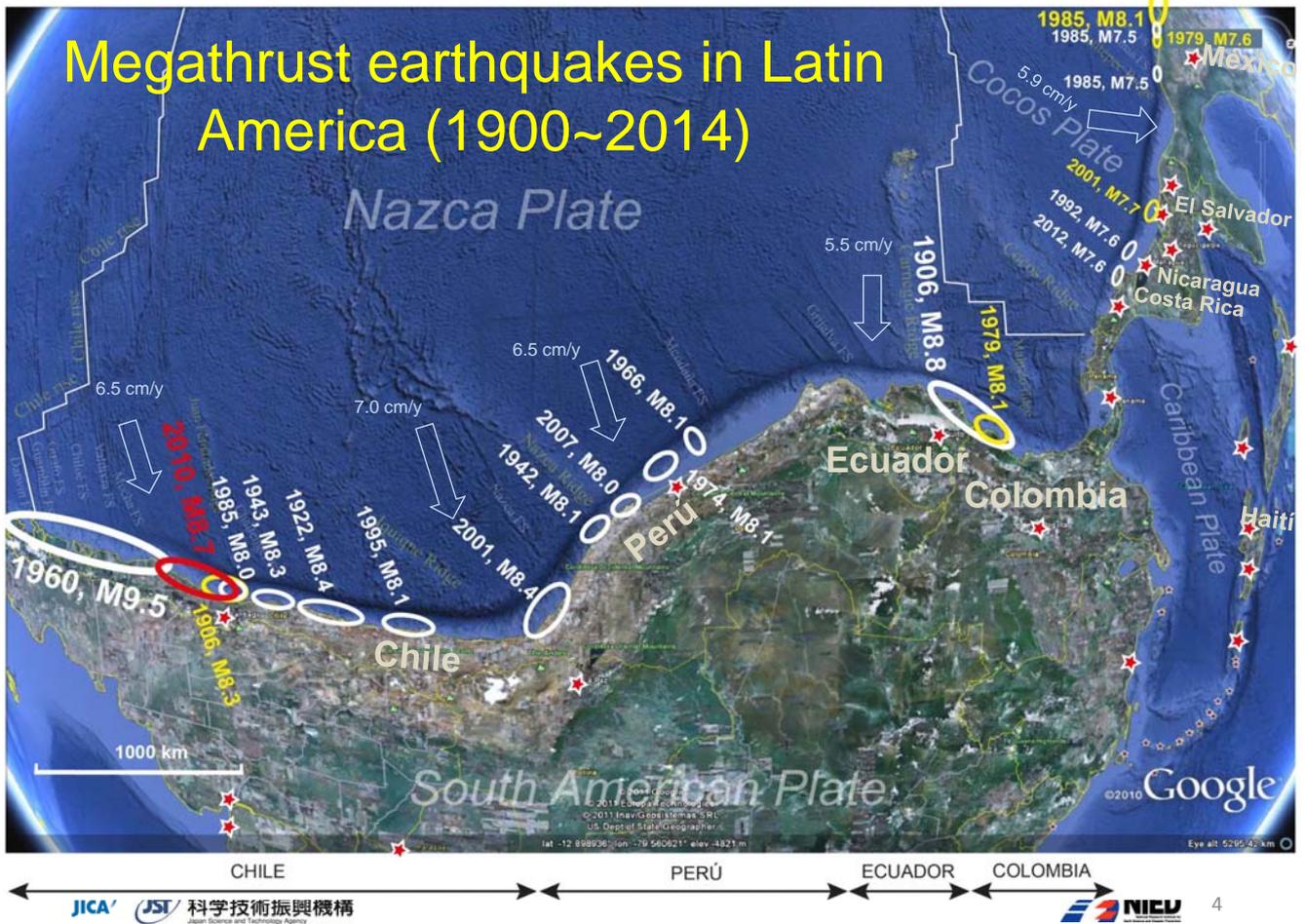
Contents

- Tectonic setting and great historical earthquakes in Latin America
- Active faults and recent seismic activity
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- Recent damaging earthquakes
- Estimation of the fault model and strong ground motion for a great subduction earthquake to strike Central Andes, Lima Perú.
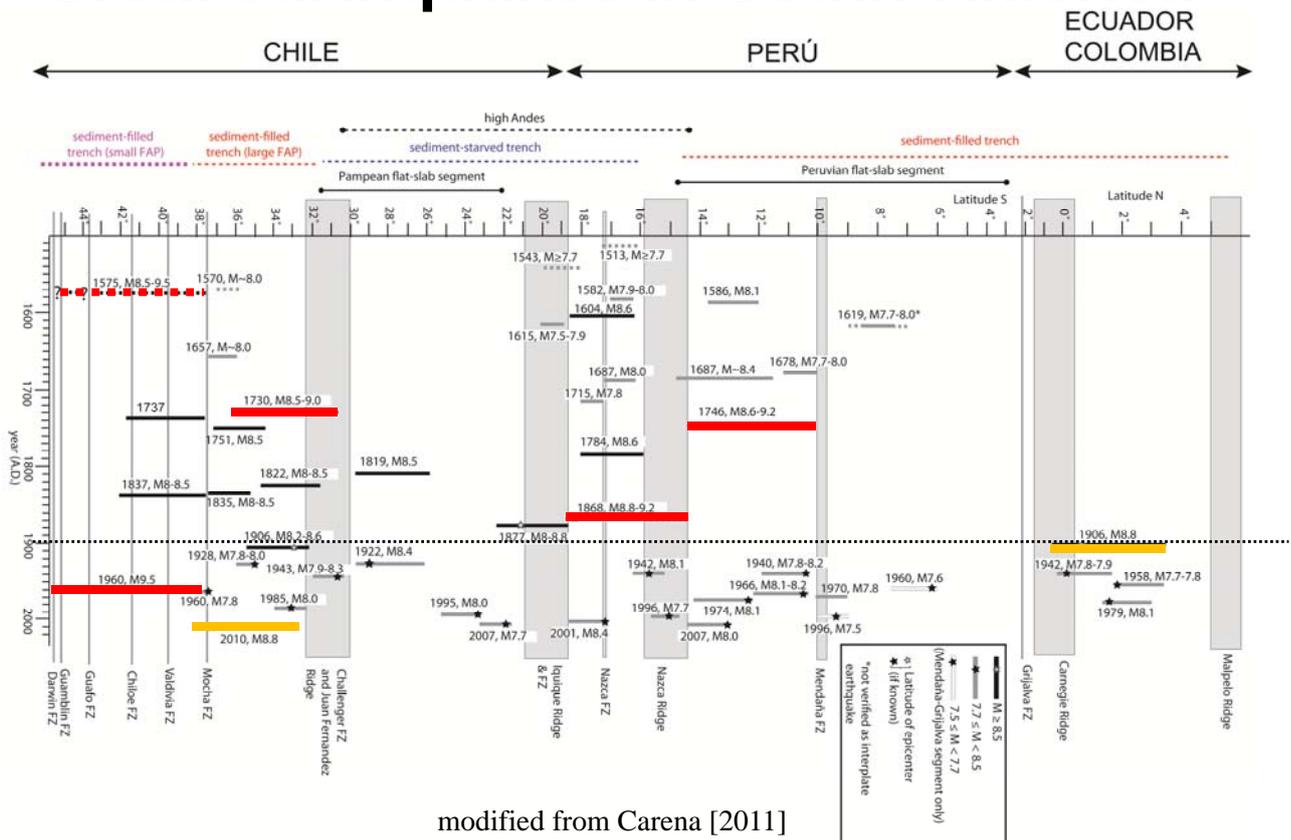- Tsunami simulation at Lima

Tectonic setting in Latin America

Megathrust earthquakes in Latin America (1900~2014)

Great earthquakes in South-America

modified from Carena [2011]

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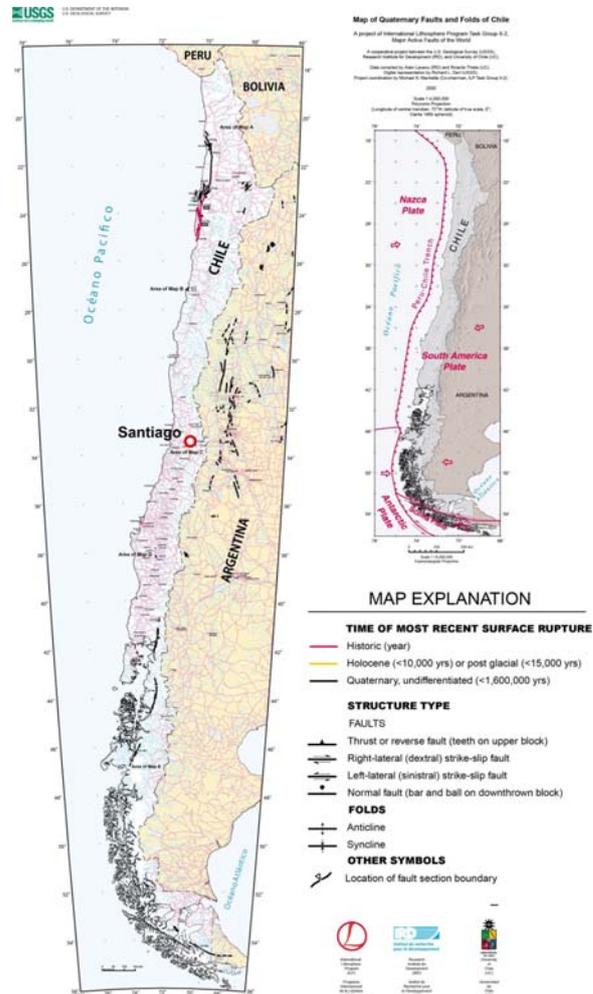# Active faults of Northern and Central Andes

Veloza (2012)
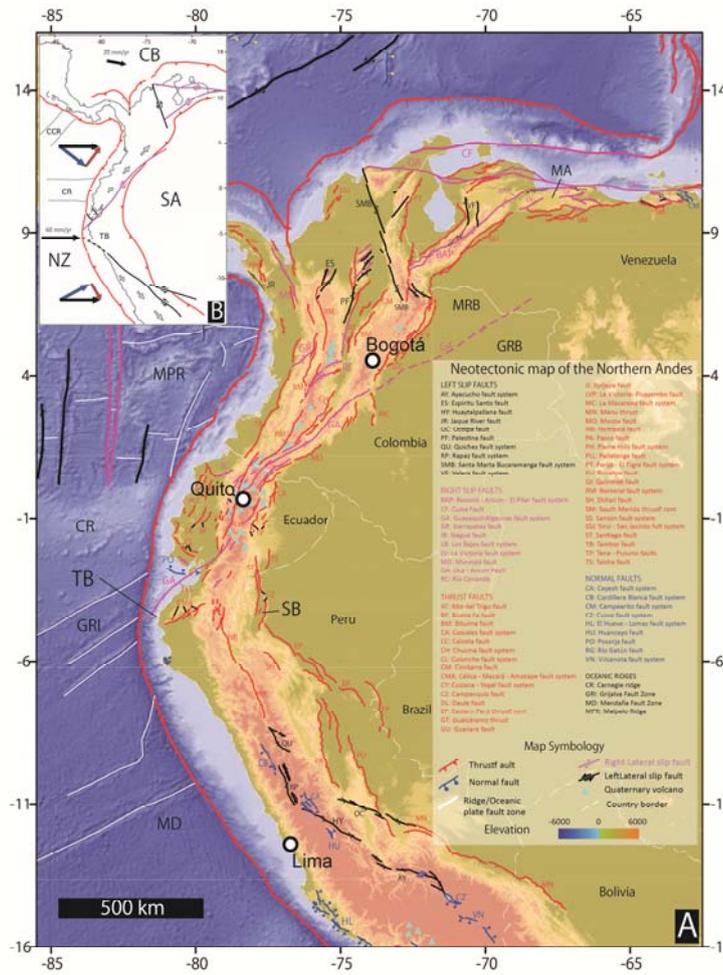
Quaternary faults of Central and South Andes

USGS, Macharé and Machette (2003) [Peru]
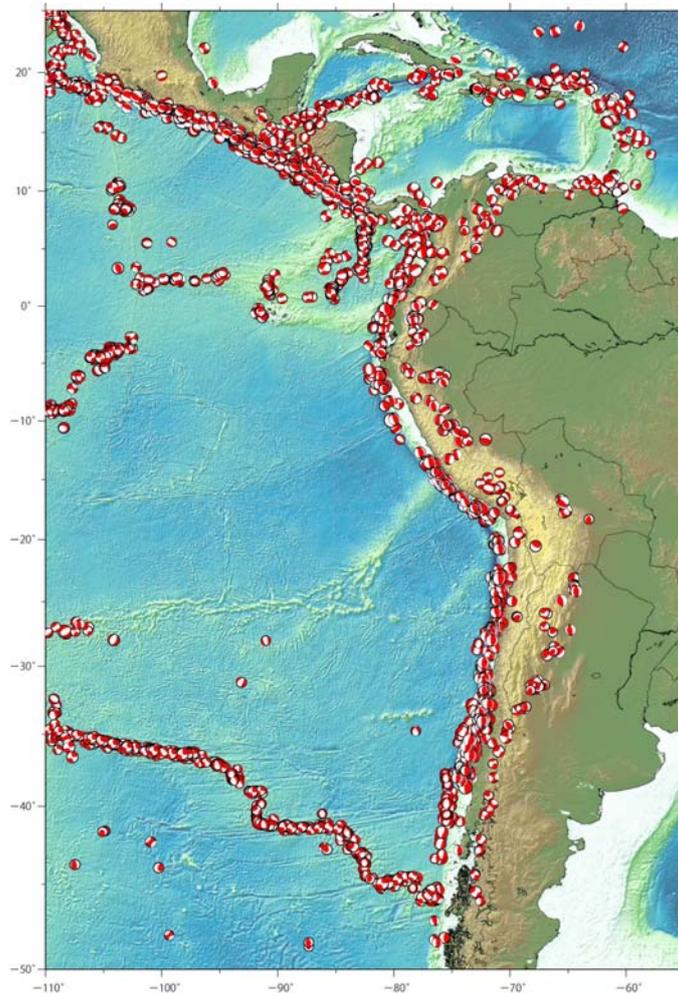
USGS, IRD, U. Chile (2000) [Chile]

# Shallow seismicity in Latin America (1976~2014)

- Earthquakes with **Mw>5.0** (Global CMT catalogue)

- Depth < 30 km

- 2765 events
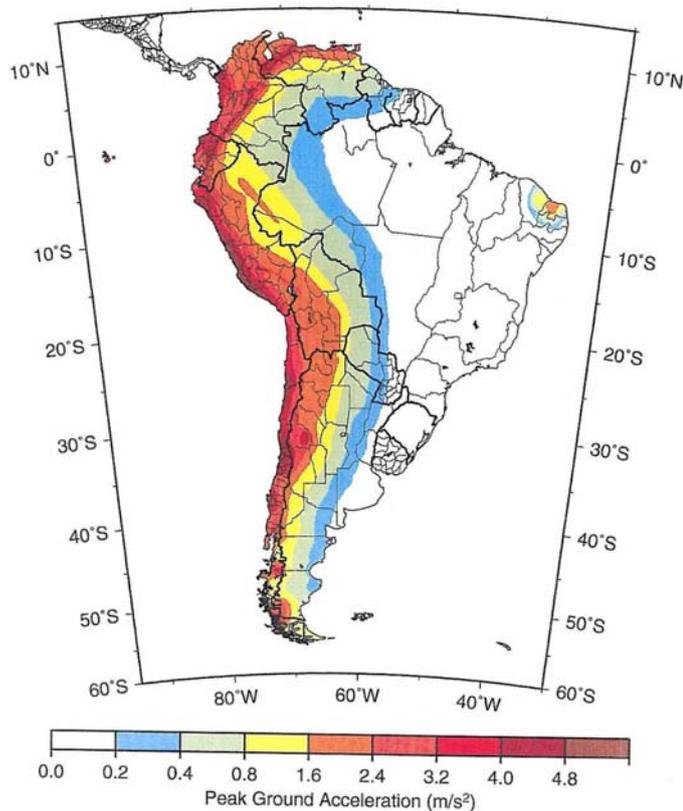(from a total of 5023 events)

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Seismic Hazard in North and Central America
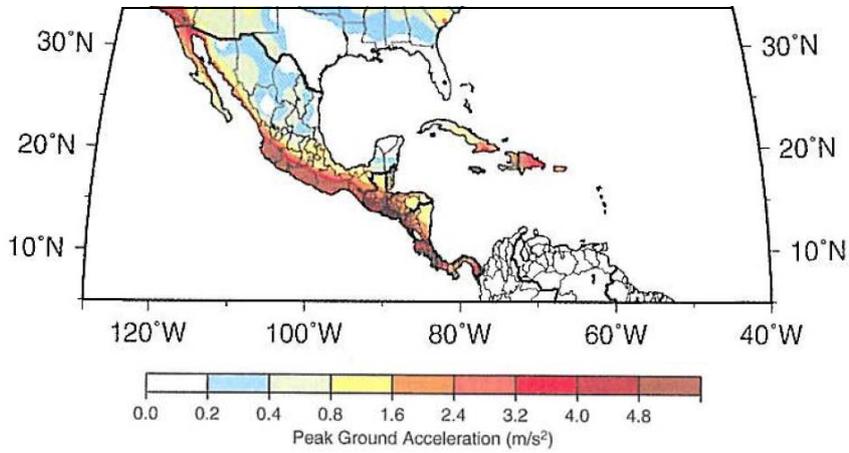
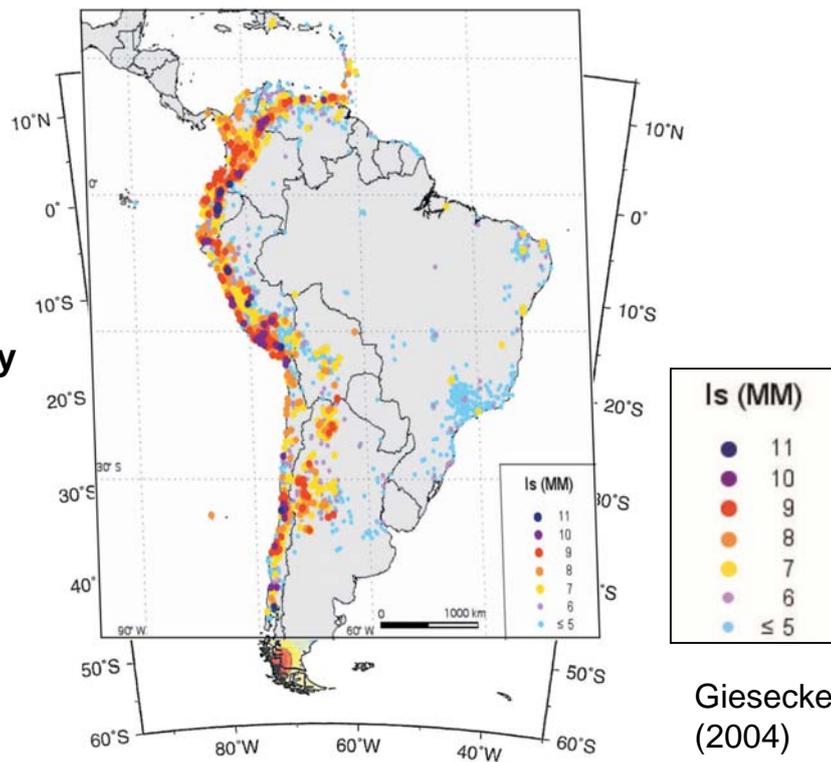Schedlock (1999)

Seismic Hazard in South America

Dimaté et al (1999)
Schedlock et al. (1999)

Historical intensities in South America

Period:
1530 ~ 1981
(450 years)

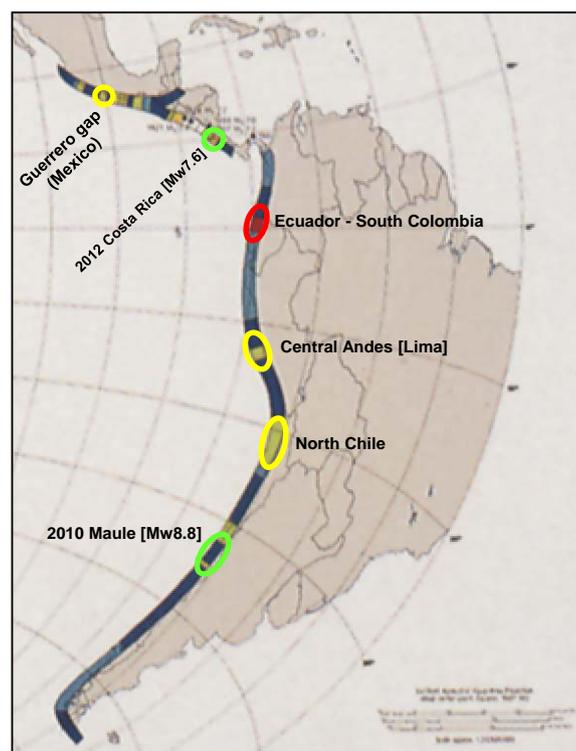**Number of intensity data points (IDP)**:
16318

Number of earthquakes:
3183

Giesecke et al. (2004)

Probability of large earthquakes in Latin America
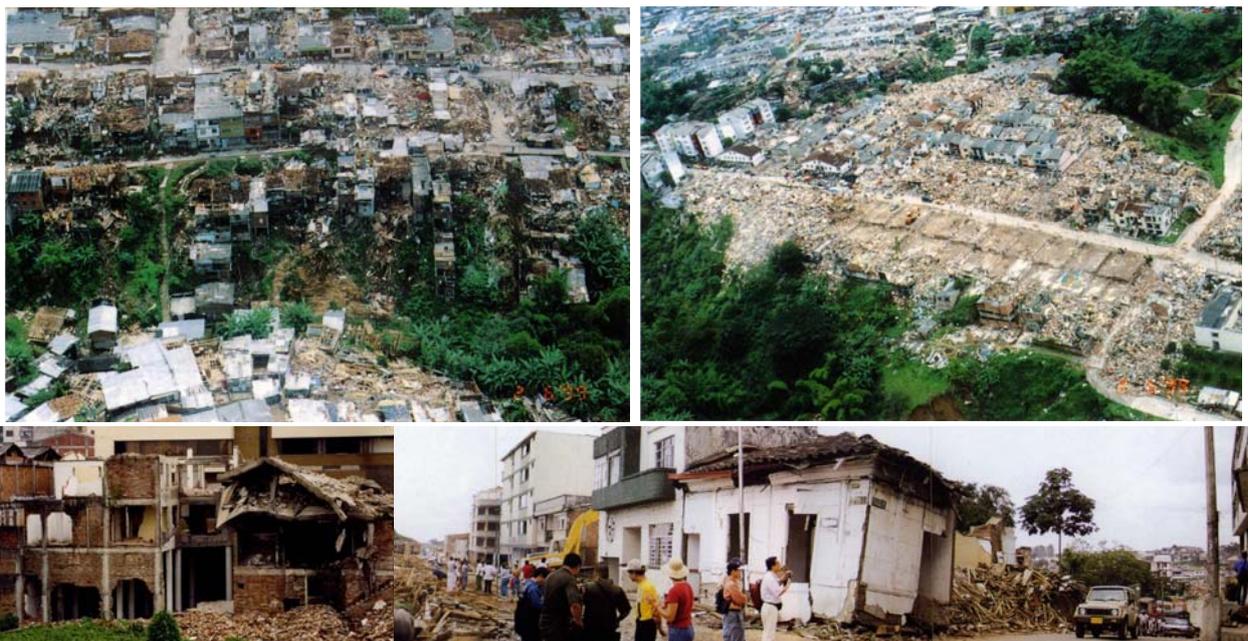
Conditional Probability (1989 -1999)

Nishenko (1991)

Contents

1999 Quindio earthquake, Colombia (Mw6.1)
Damage in Armenia city, Colombia

Reconnaissance team, Japanese Ministry of Education, Science Sport and Culture

2001 El Salvador earthquake (Mw 7.7)
Large scale landslide in Santa Tecla city, El Salvador

- 193 people buried by the earthquake triggered landslide

Reconnaissance team by the Japanese Society of Civil Engineers (JSCE)

2007 Pisco earthquake, Perú (Mw 8.0)

Large damage to adobe houses in Pisco city

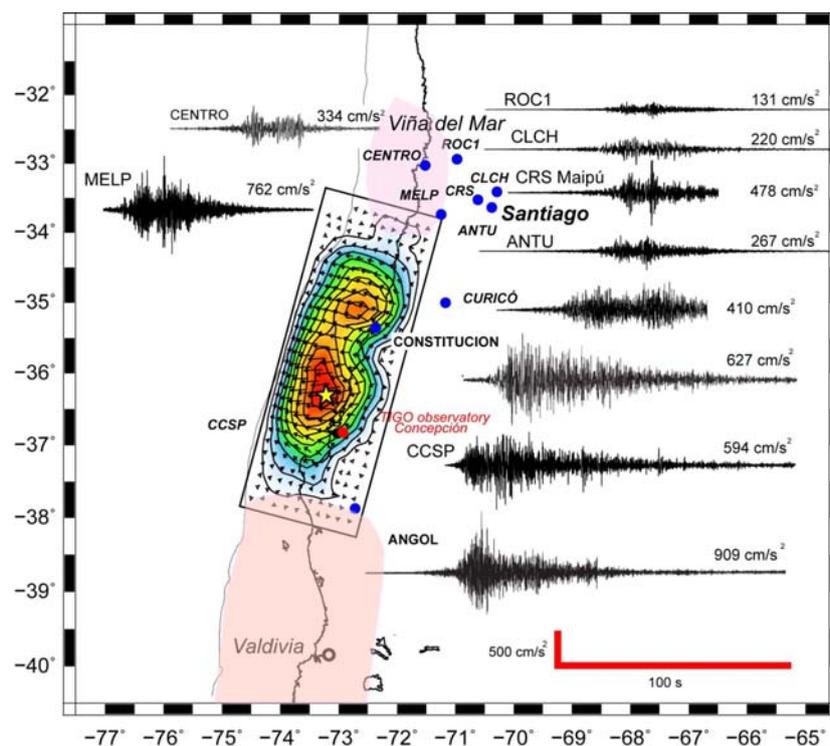Damage to reinforced concrete building with insufficient seismic resistance in Pisco city

Reconnaissance team by the Japanese Society of Civil Engineers (JSCE)

Field survey 2010 Maule Earthquake, Chile

Three reconnaissance teams dispached by SATREPS

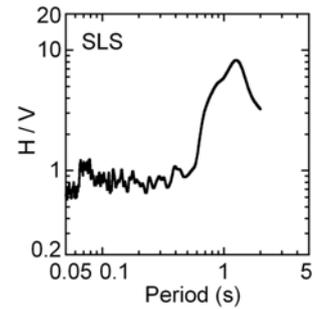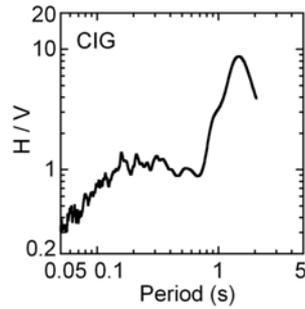# Strong ground motions of the 2010 Maule earthquake

Pulido et al. (2011)
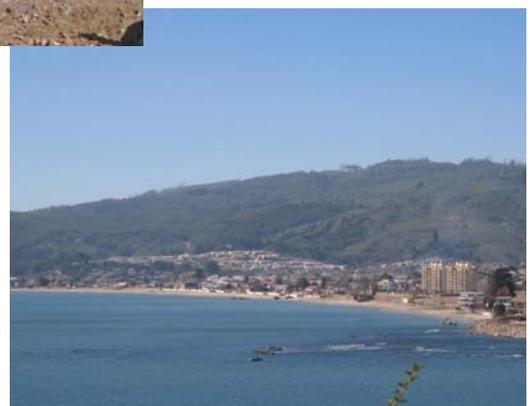
Damage to 15~20 storied buildings in Concepción

Sekiguchi et al. (2010)

Salas 1343
Concepción

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# Tsunami damage at Dichato, Concepción

- Measured runup height ~10m (Koshimura et al 2010)

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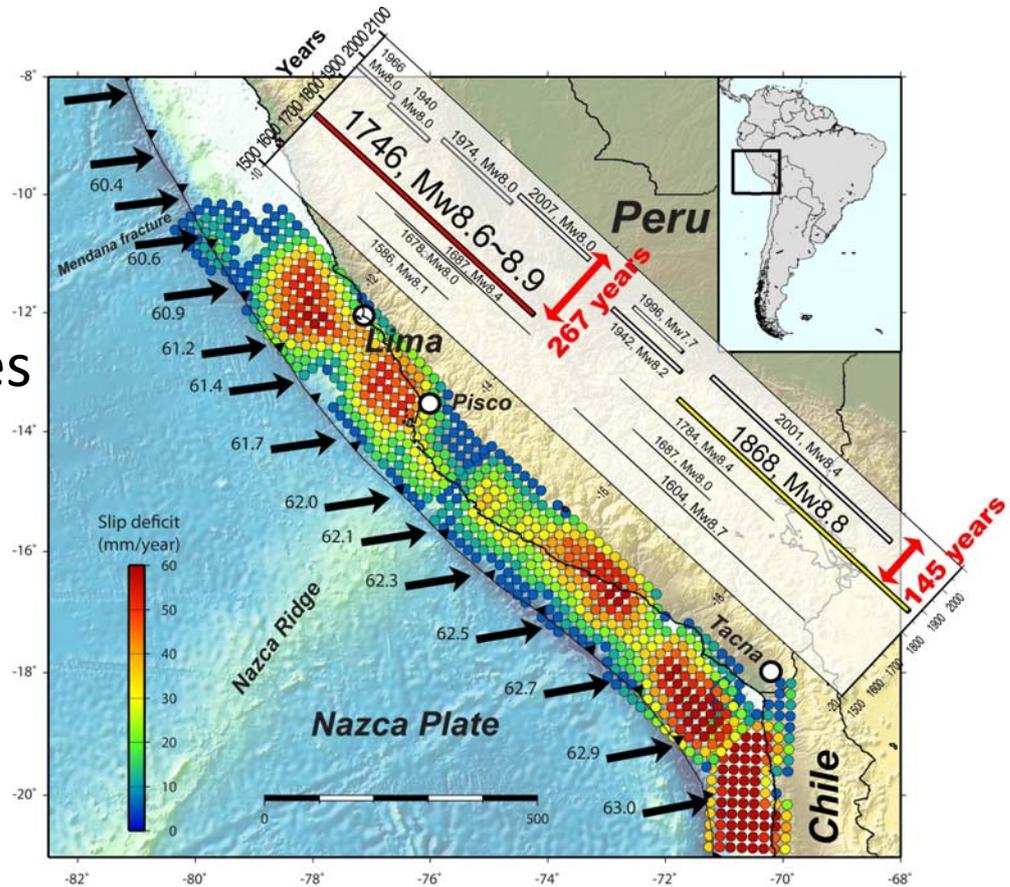

Seismic coupling and mega-earthquakes
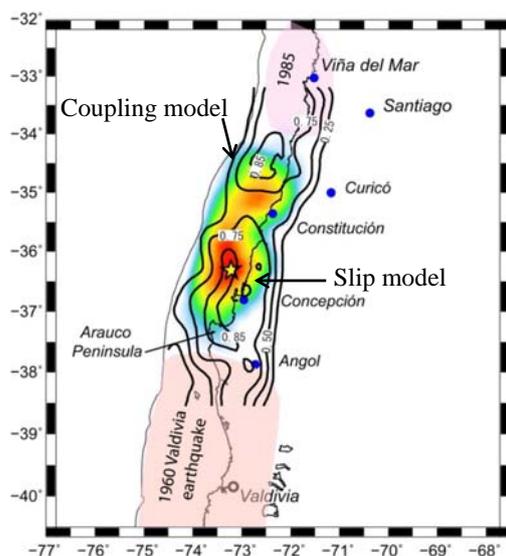
Source model of the 2010 (M8.8) Maule earthquake, Chile (Pulido et al. 2011), and seismic coupling (Moreno et al. 2010)
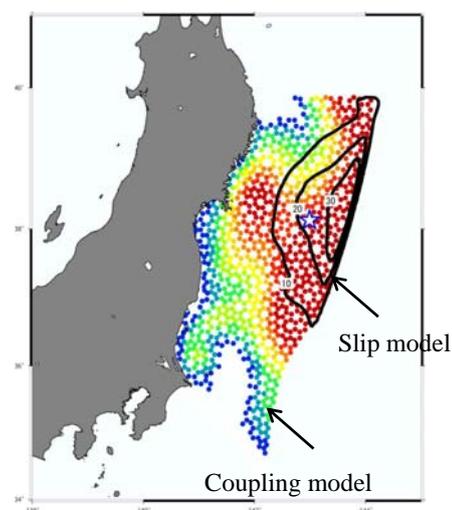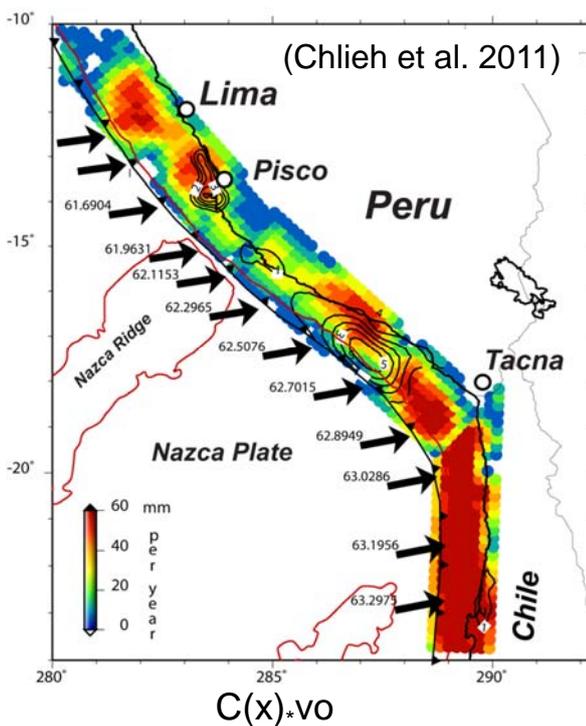
Source model of the 2011 (M9.0) Tohoku-oki earthquake, Japan (Suzuki et al. 2011), and seismic coupling (Loveless and Meade, 2012)
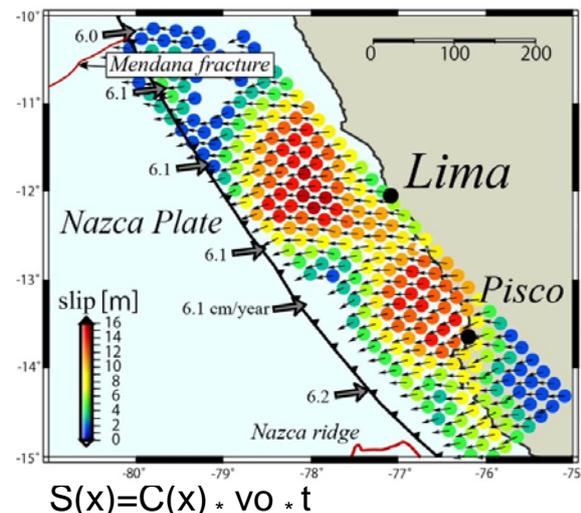
Historical earthquakes in Peru

Slip deficit rate for Peru and Northern Chile and scenario earthquake for Central Peru

(Chlieh et al. 2011)

- Slip deficit since 1746 (265 years)
- Maximum slip is 20 m
- Magnitude Mw~8.9, neglecting the 20 century earthquake sequence
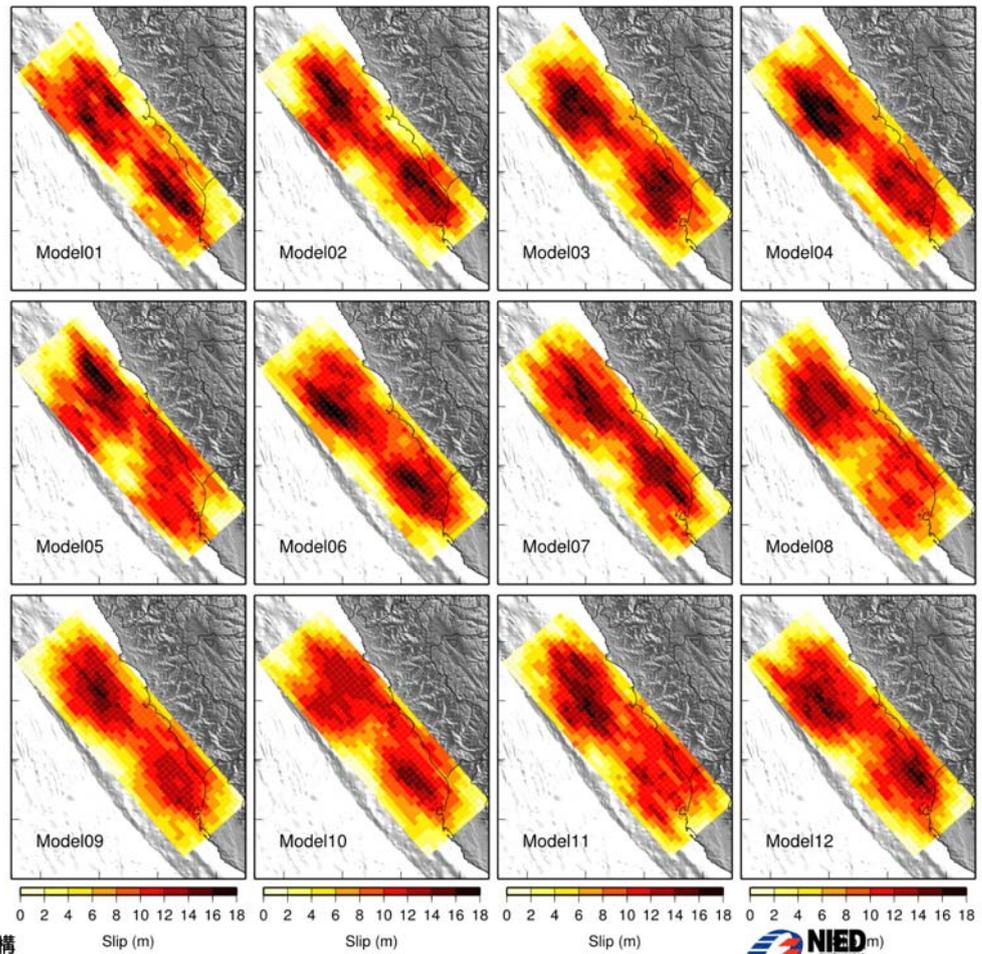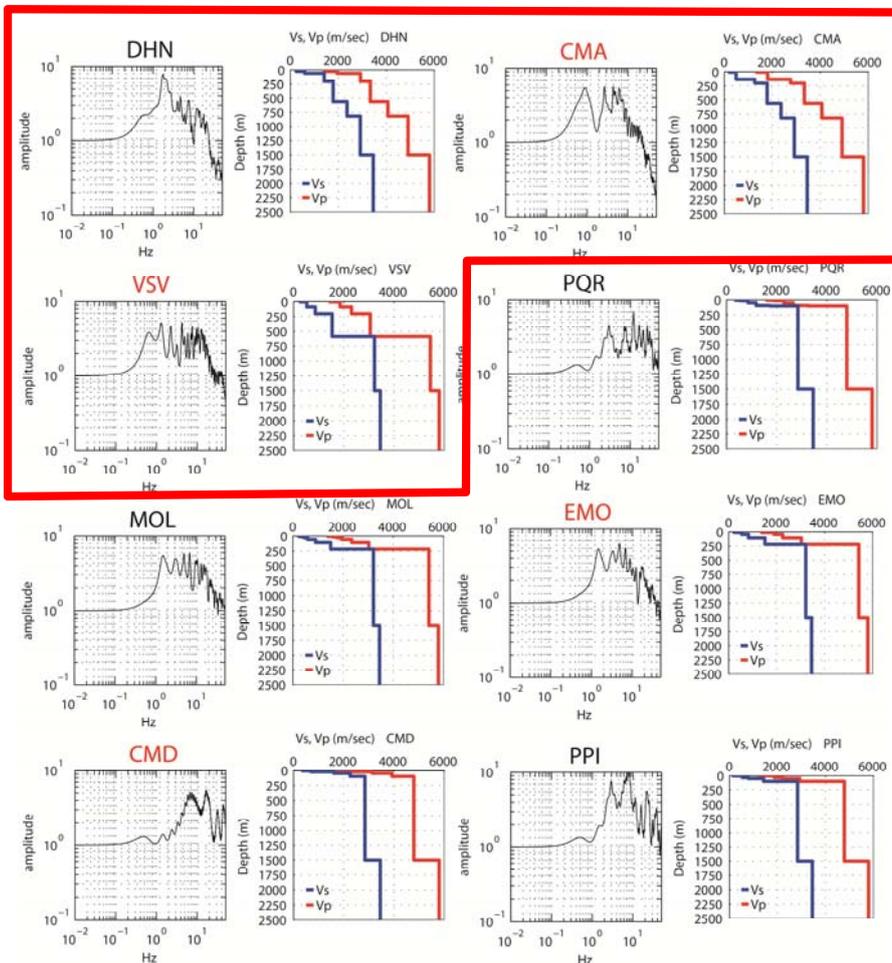
$$S(x) = C(x) * v_o * t$$

C(x)∗vo

(Pulido et al. 2011)

S(x): slip, t : elapsed time

EARTHQUAKE SLIPS SCENARIOS FOR CENTRAL PERU

obtained from geodetic data, as well as information of recurrence of historical earthquakes (Pulido 2013)
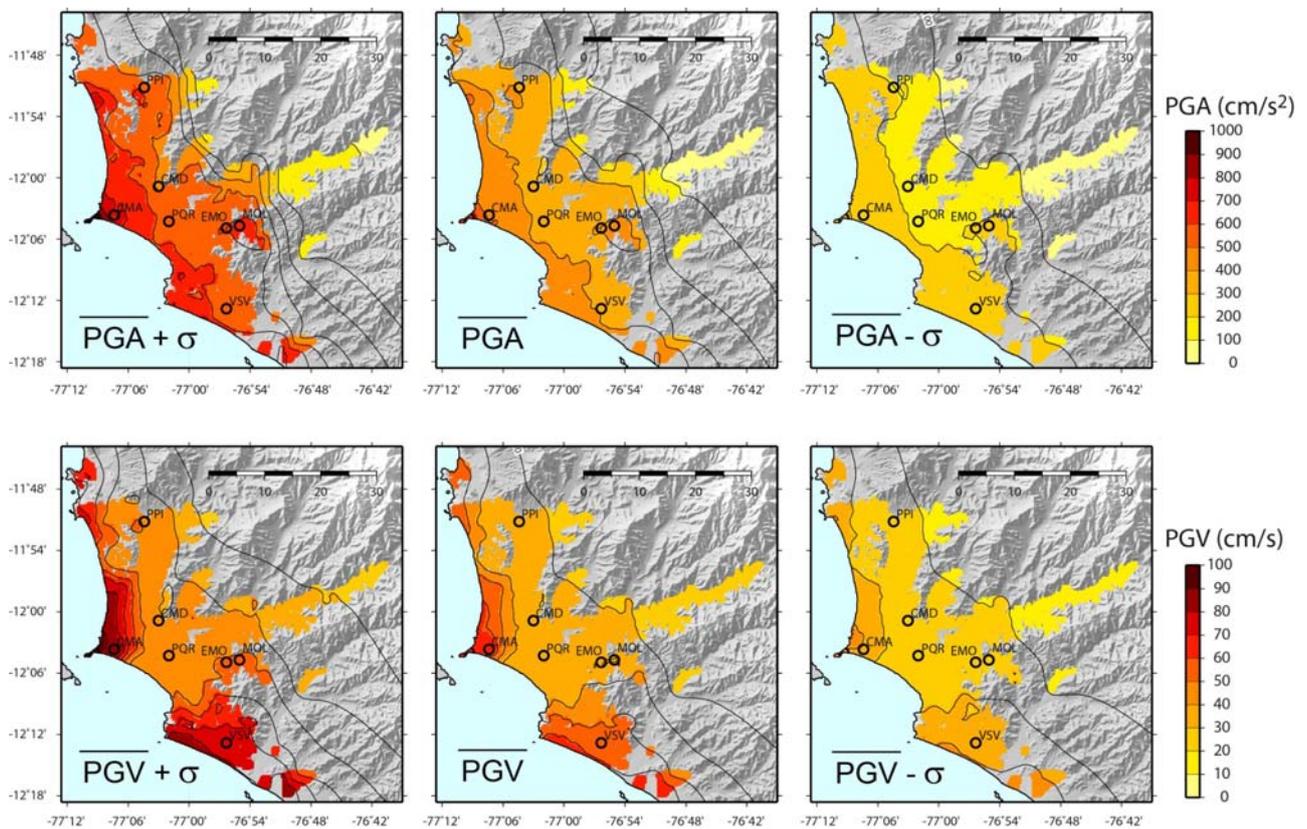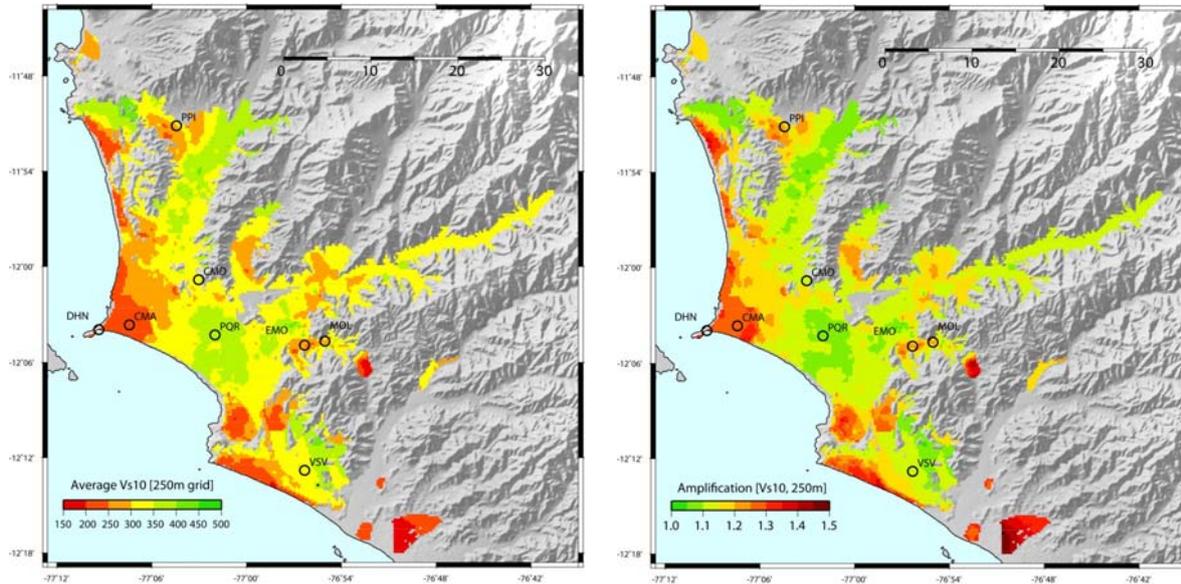
*http://www.j-shis.bosai.go.jp/staff/nelson/smsimu_Central_Peru_v1p0/Lima_SMsimu_v1p0.htm*

Velocity models obtained from microtremors arrays in Lima and their 1D transfer functions (Calderón et al. 2012)
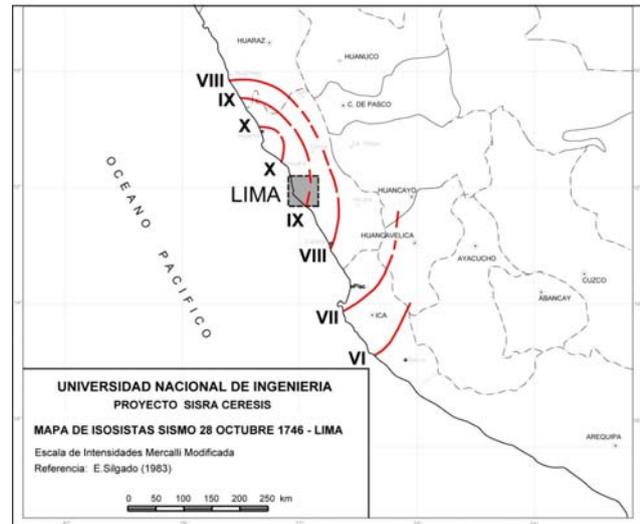
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Average S-wave velocity for the upper 10m and soil amplifications to engineering bedrock (Vs ~ 400m)

Most critical scenario & Observed intensities during the 1746 earthquake (M ~ 9)
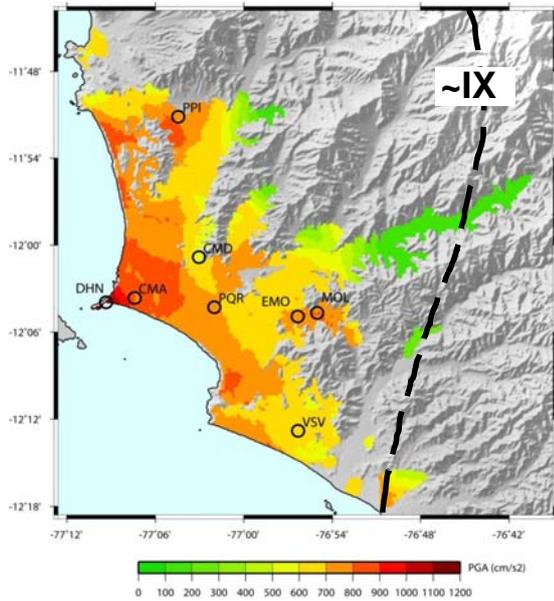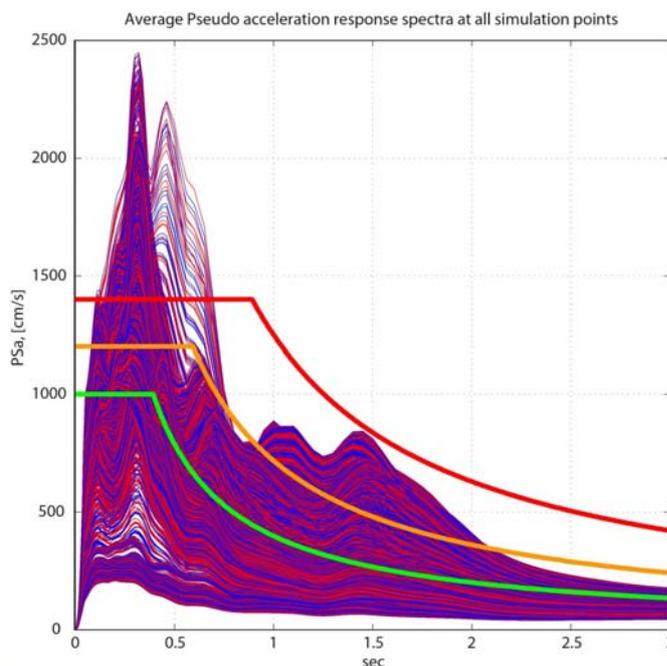

PGA for most critical slip, includes soil amplification

Maximum MMI intensity in Lima IX~X
(Alva et al. 1984)
PGA ~1g,   PGV ~90 cm/s

Simulated Pseudo acceleration response spectra (average for all scenarios) at all grid points and the Peruvian seismic building code design spectra (2003)
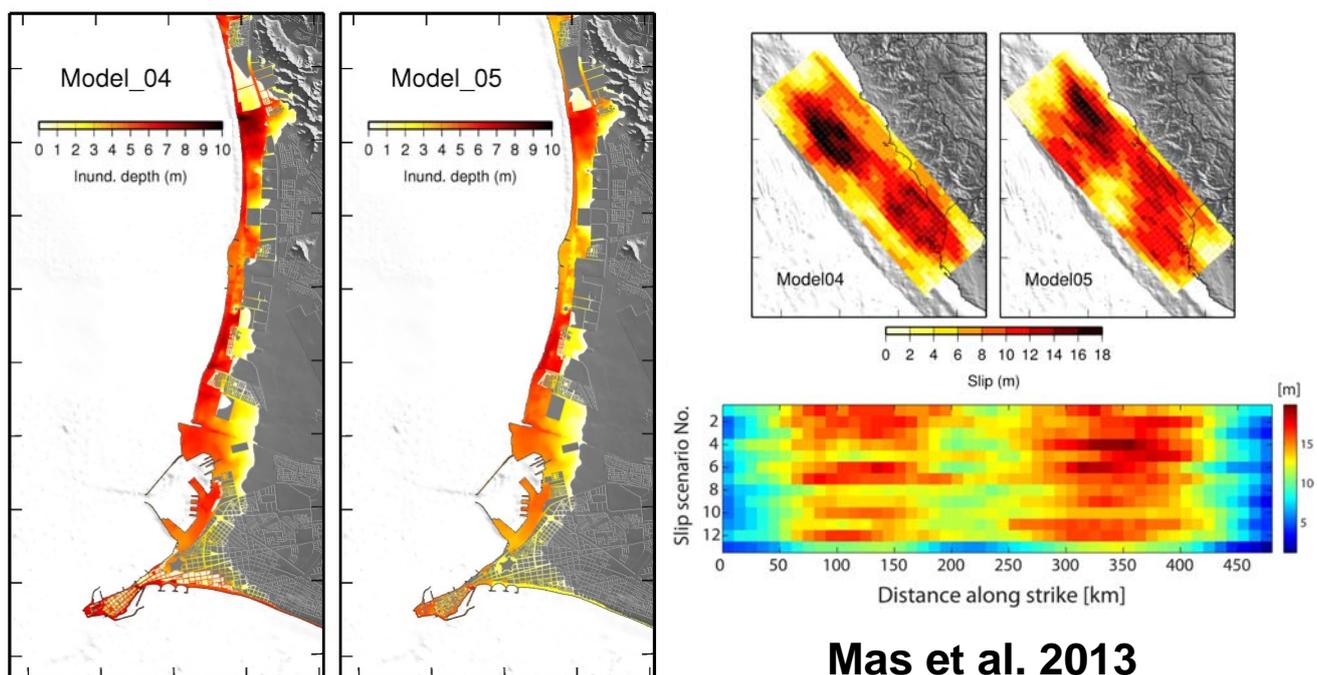

Peruvian building code for the highest seismic zone (Z=0.4g),
in rock (green),
hard soil (orange)
and soft soils (red)

Contents

- Tsunami simulation at Lima

Tsunami inundation at Lima from scenario earthquakes

Mas et al. 2013

Modeling Social Response

Erick Mas@Tohoku Univ.

Multi-Agent Horizontal Evacuation Simulation at La Punta

Multi-Agent Vertical Evacuation Simulation at La Punta

Thank you very much!
Muchas Gracias!
ご清聴ありがとうございます.