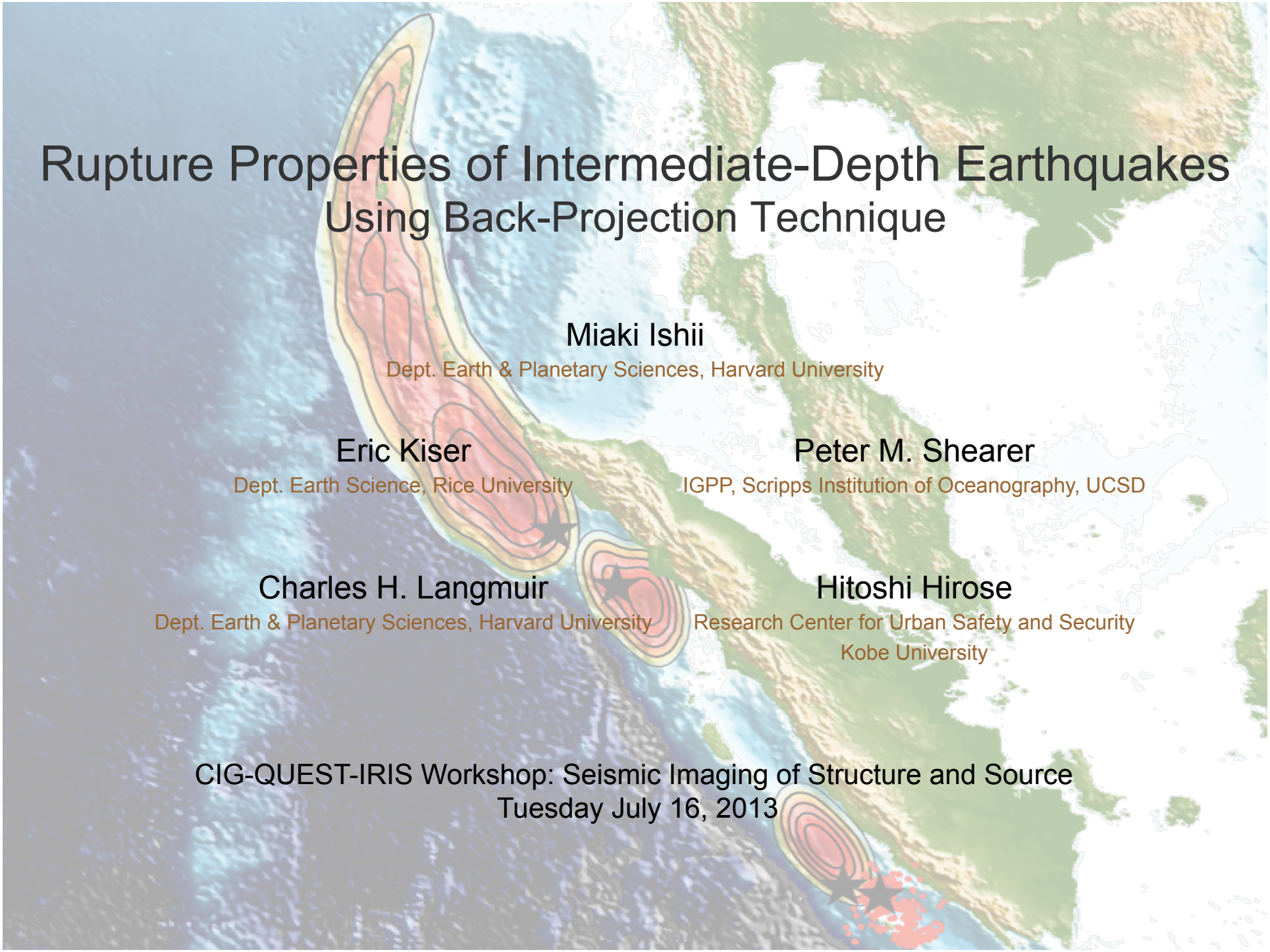

Rupture Properties of Intermediate-Depth Earthquakes Using Back-Projection Technique

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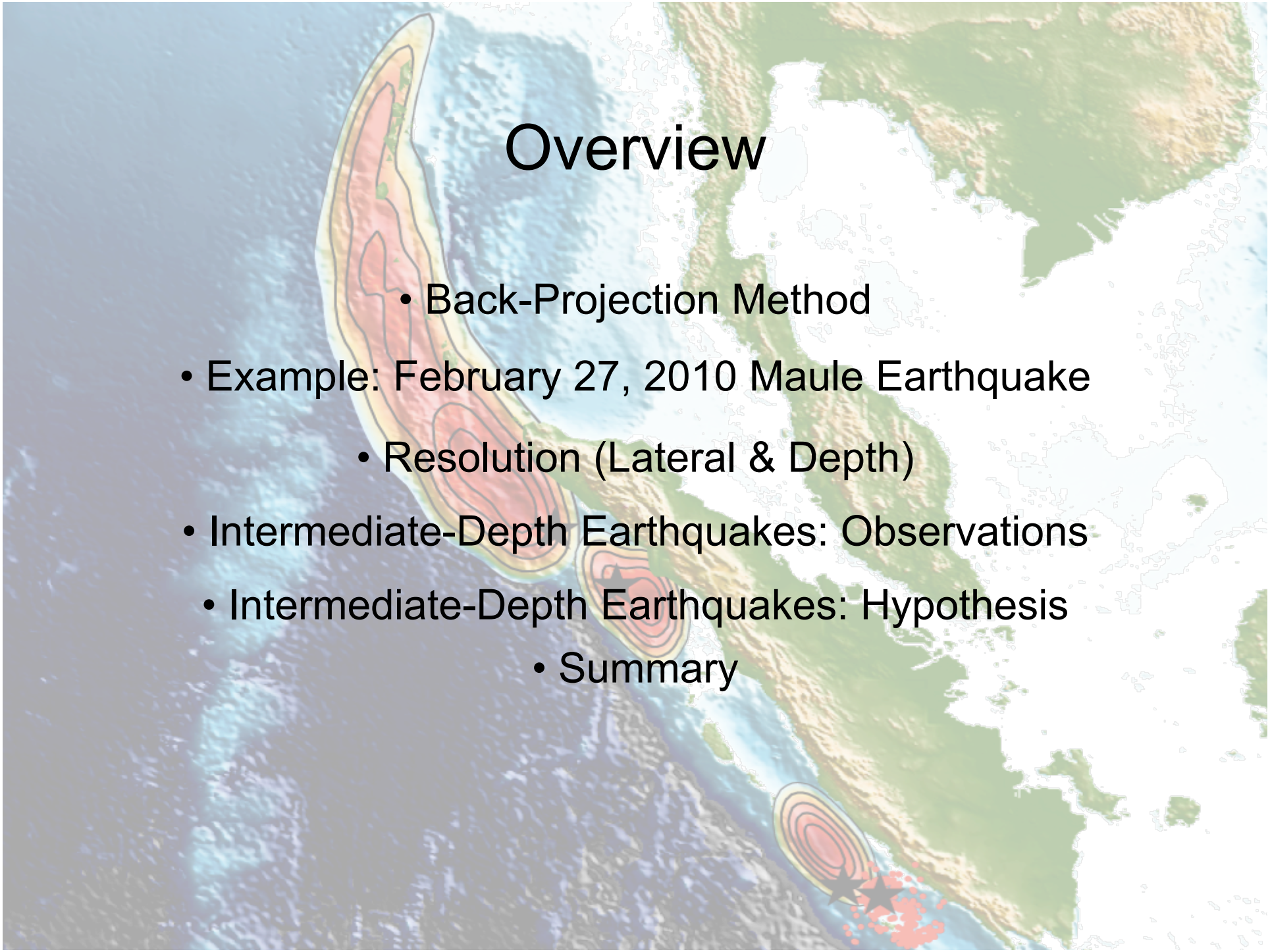
CIG-QUEST-IRIS Workshop: Seismic Imaging of Structure and Source
Tuesday July 16, 2013



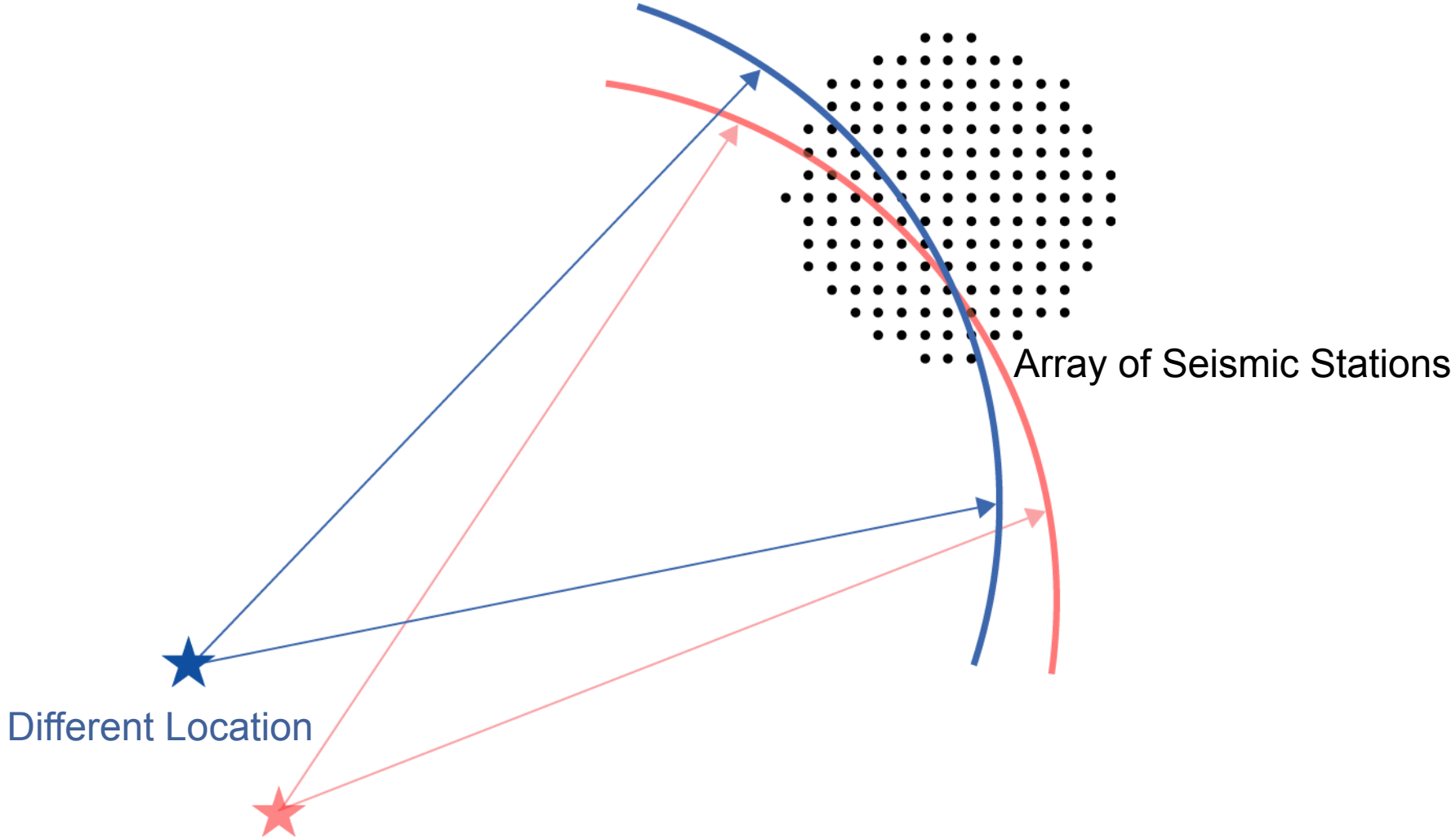
Overview

- Back-Projection Method
- Example: February 27, 2010 Maule Earthquake
- Resolution (Lateral & Depth)
- Intermediate-Depth Earthquakes: Observations
- Intermediate-Depth Earthquakes: Hypothesis
- Summary

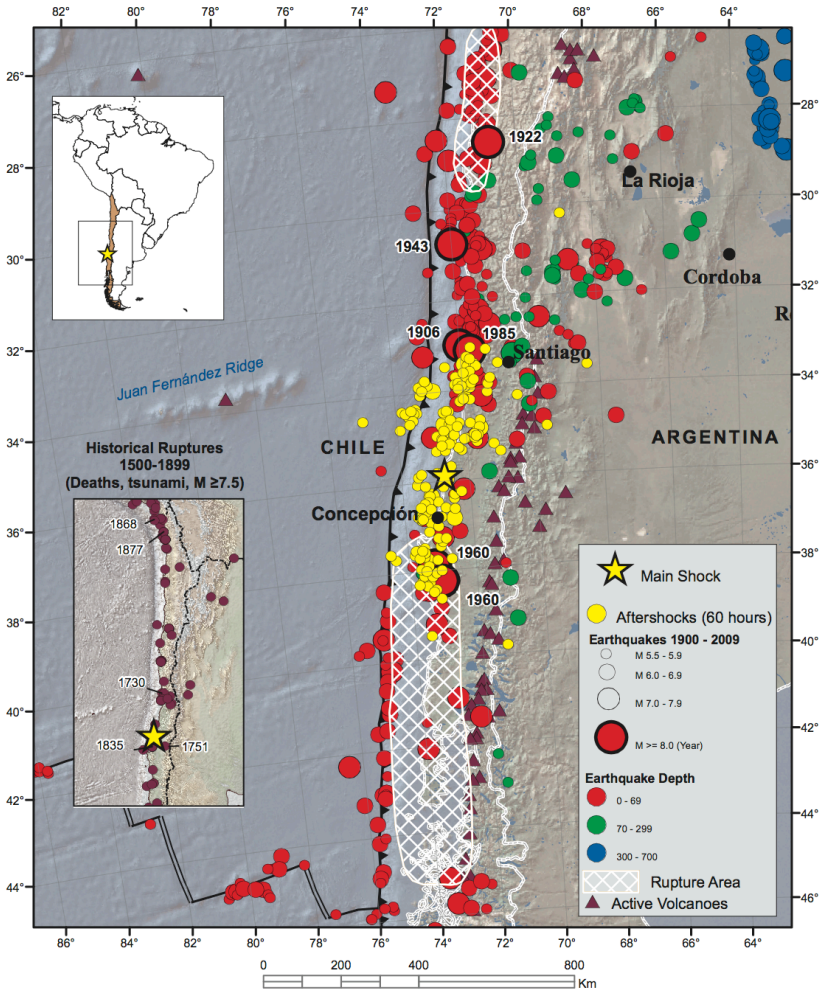
Back-Projection Method

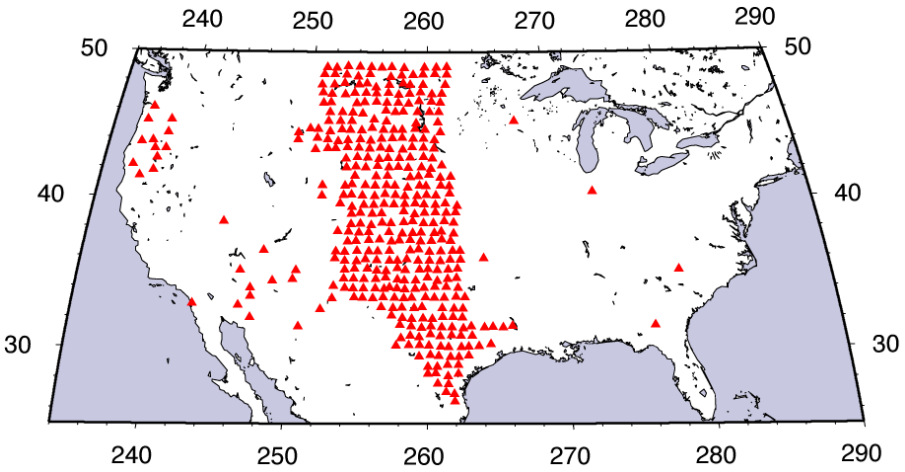
➔ Location & Timing of Relative Energy Release

Seismic Wavefront and Seismic Array



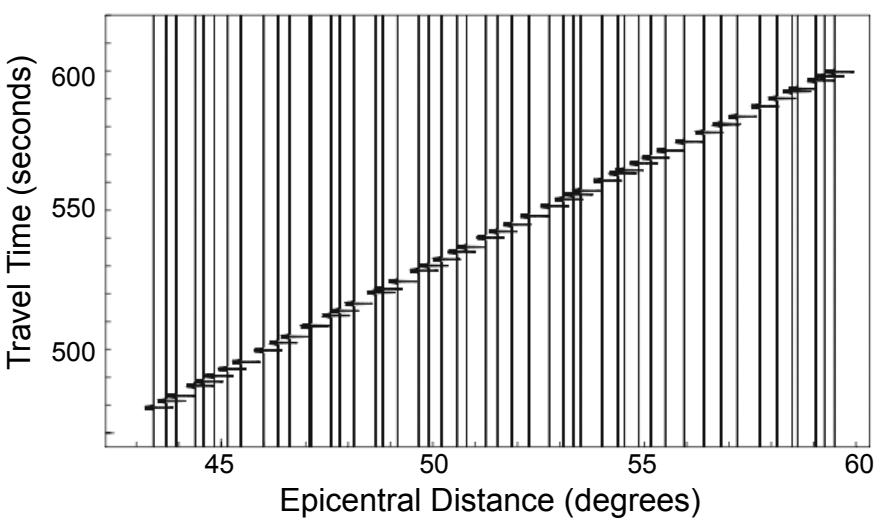
February 27, 2010 Maule Earthquake

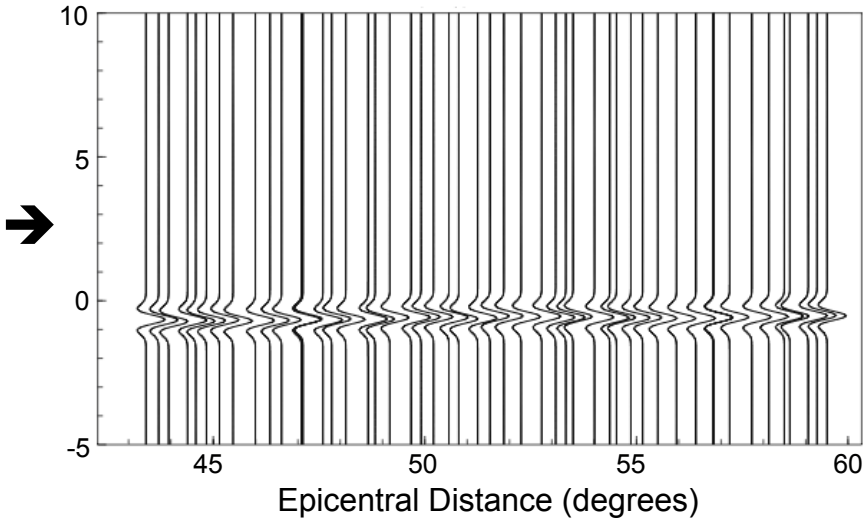


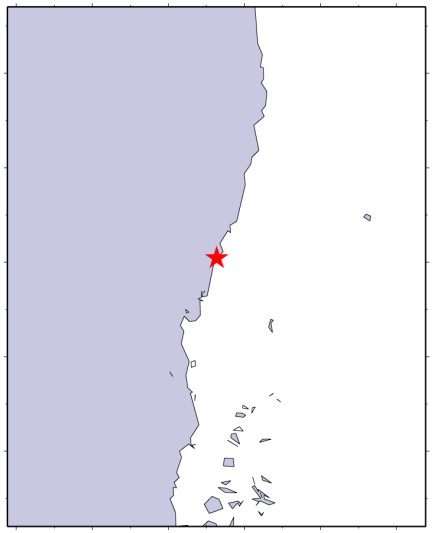


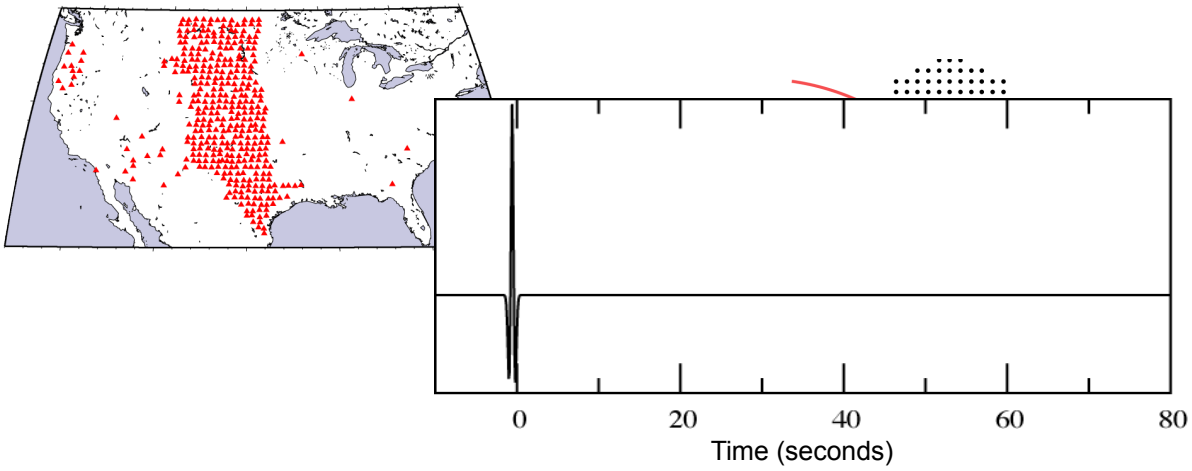
http://earthquake.usgs.gov/earthquakes/eqinthenews/2010/us2010tfan/20100227_Main.pdf

Synthetic Data

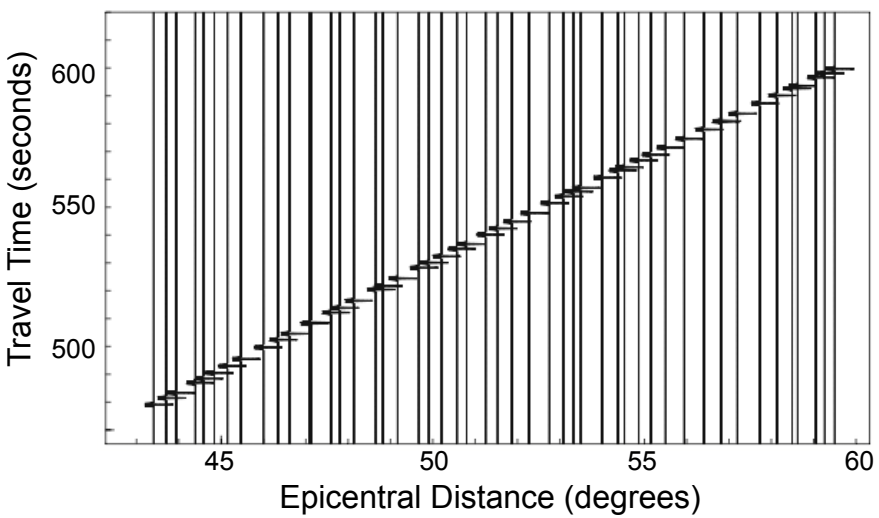


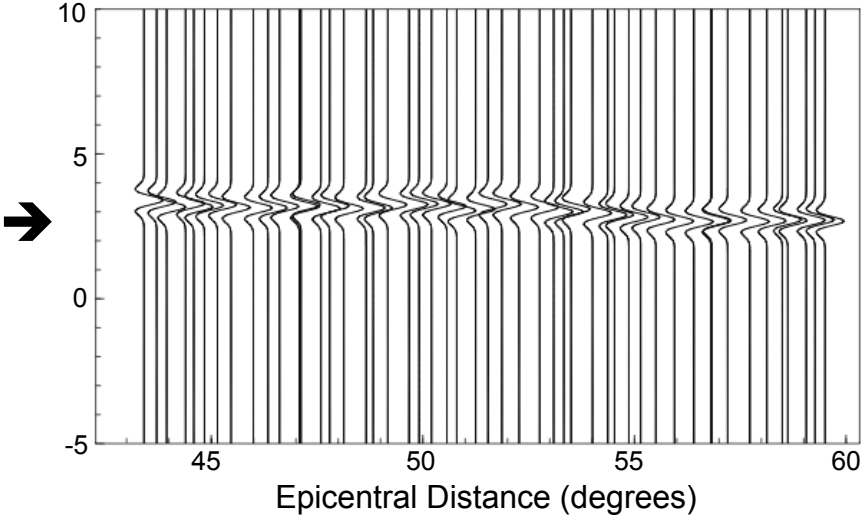


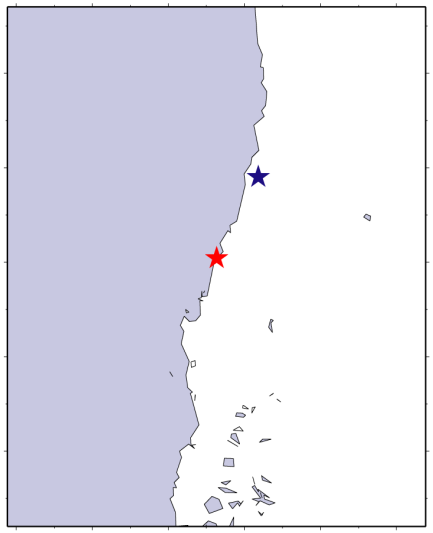


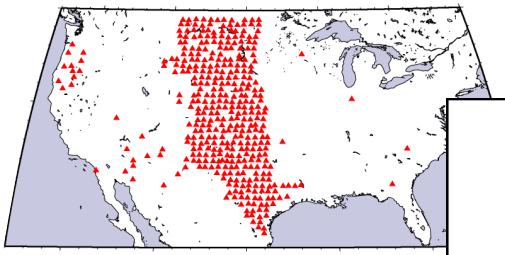


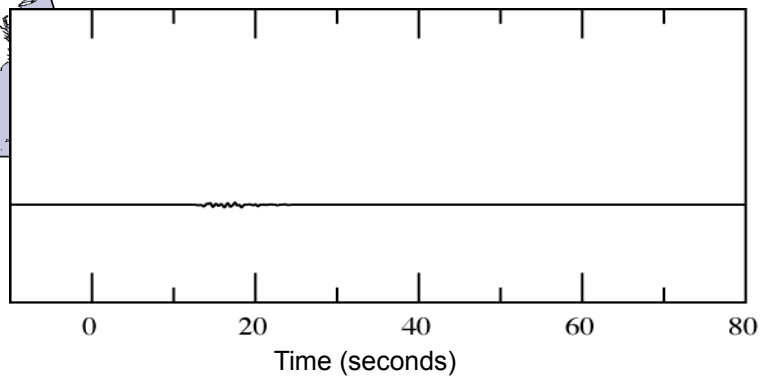
Synthetic Data (Incorrect Location)



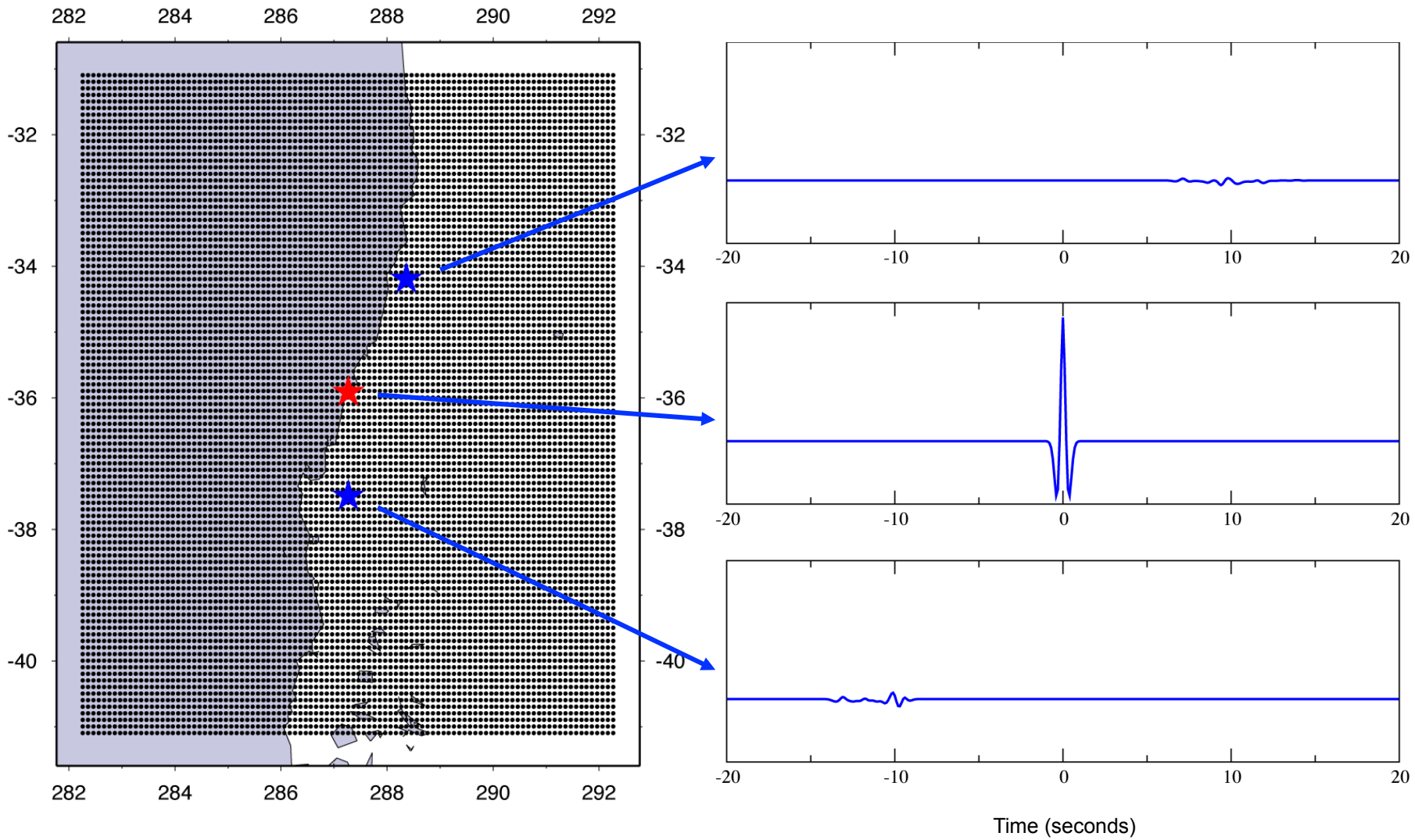




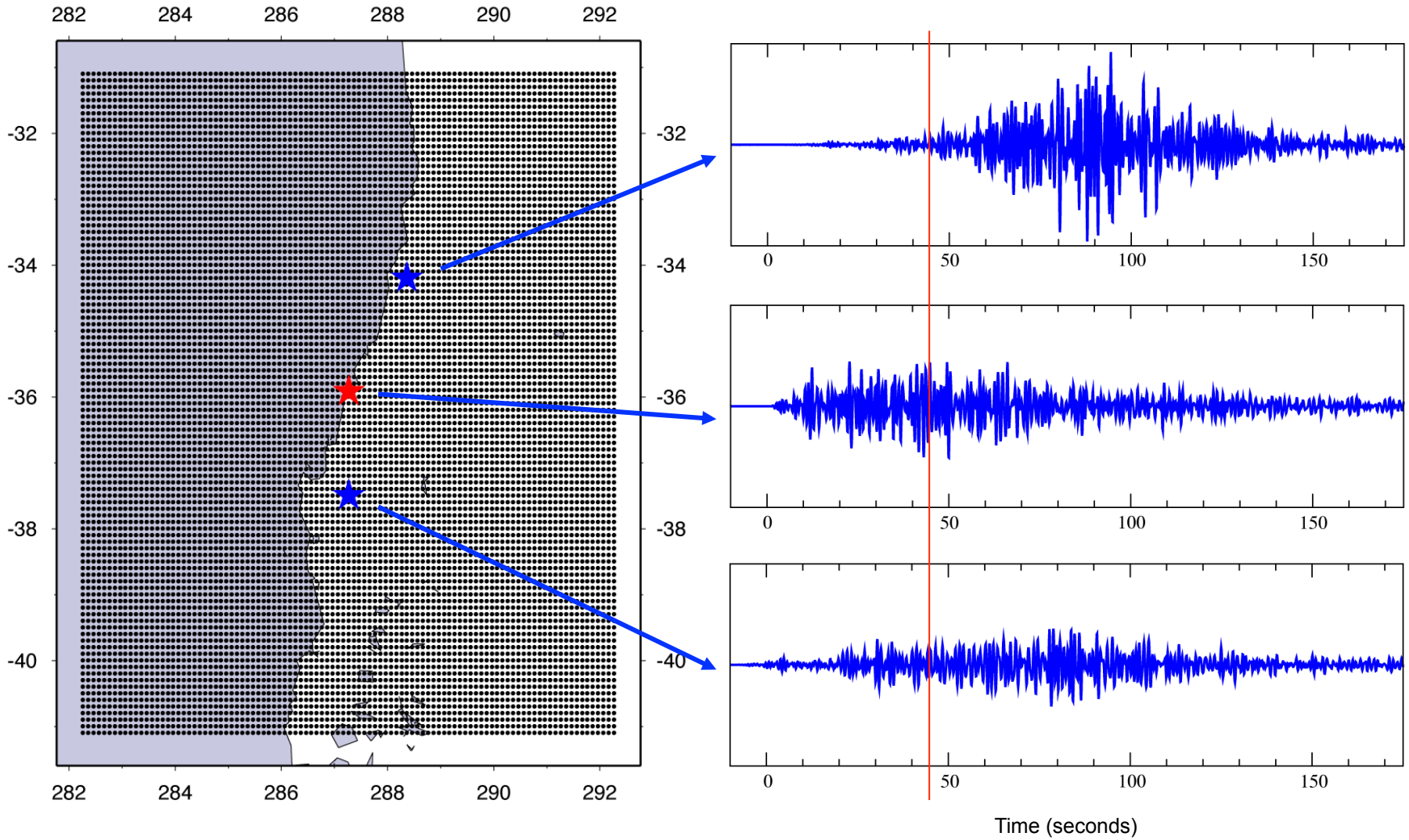




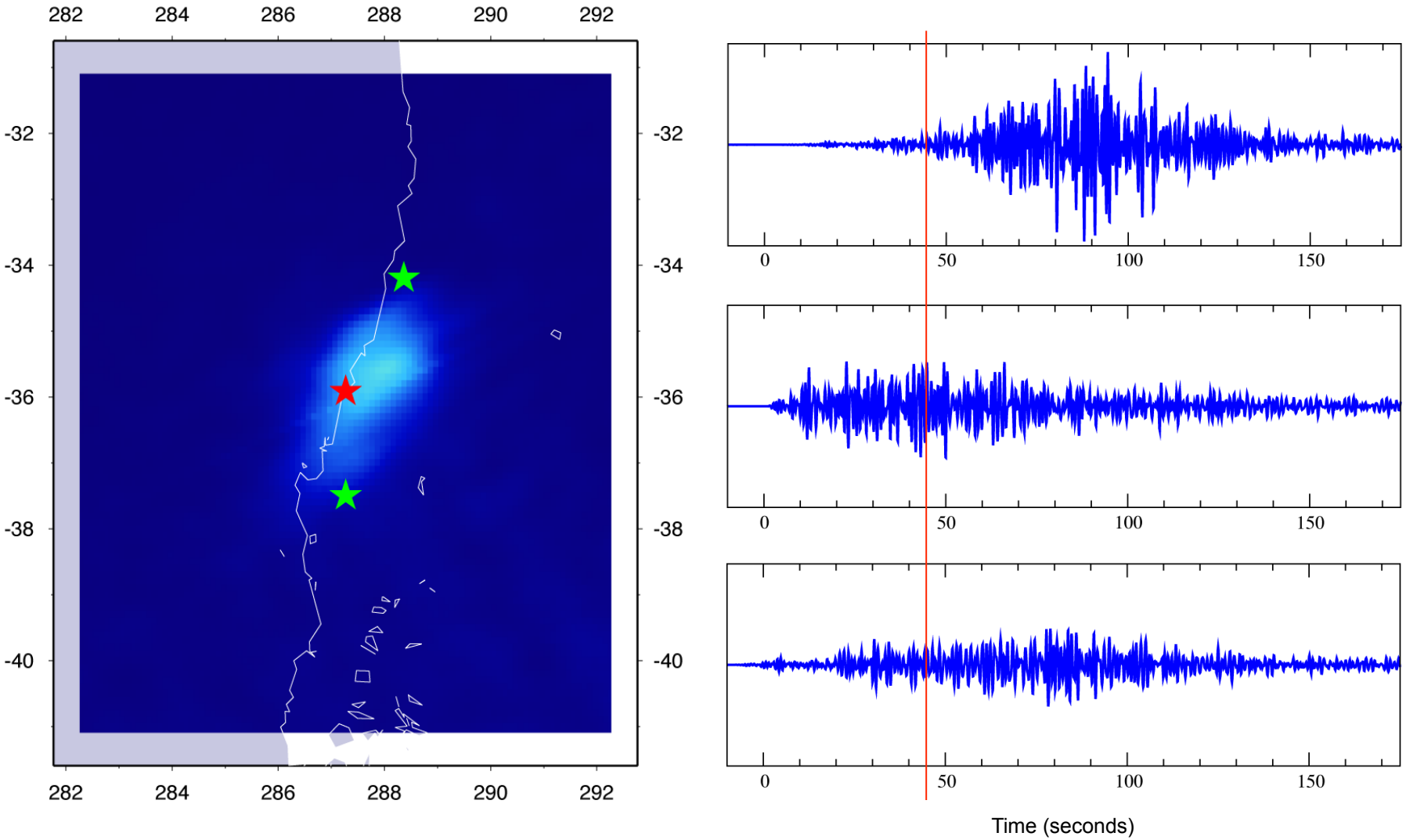
Synthetic Stacks



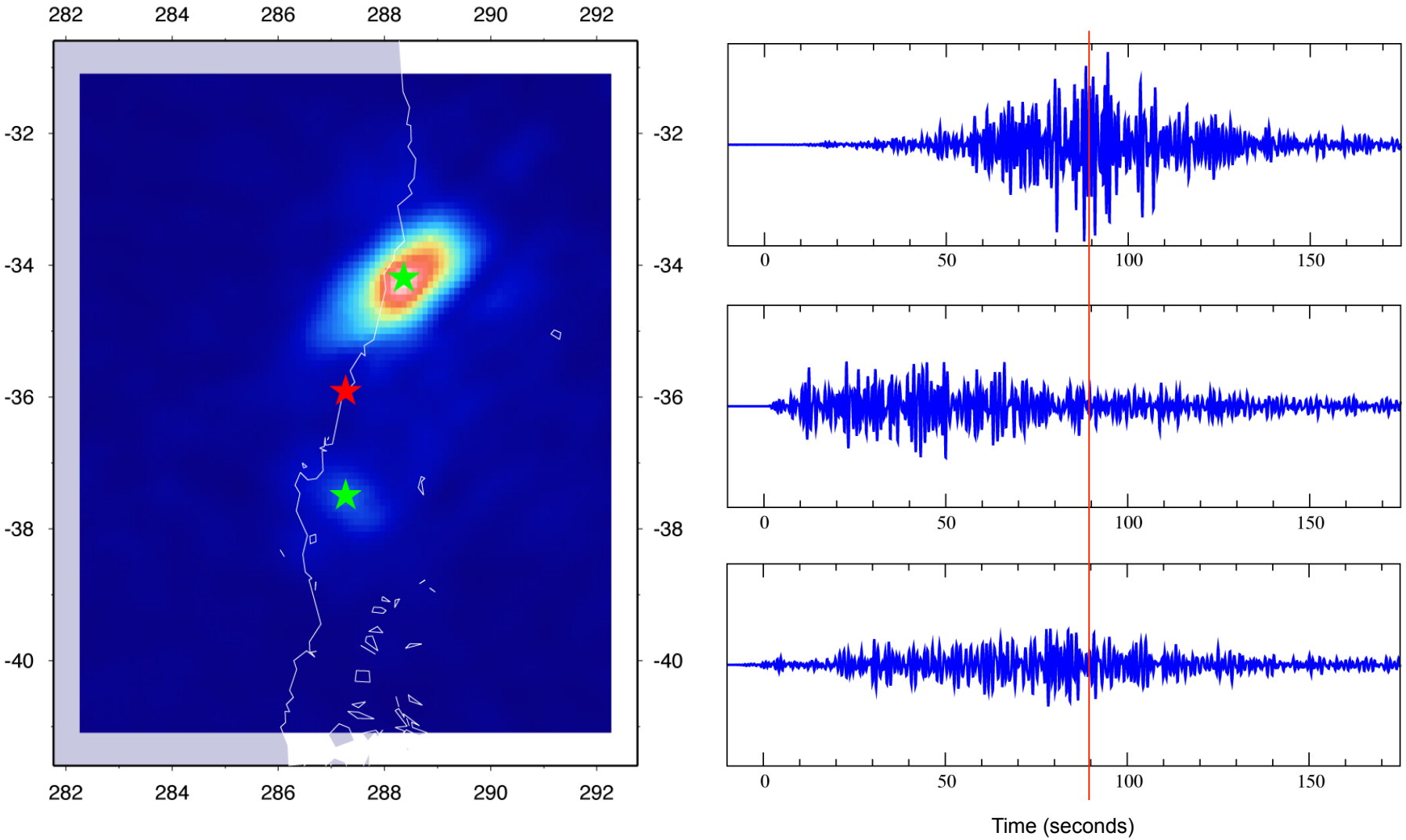
USArray Stacks



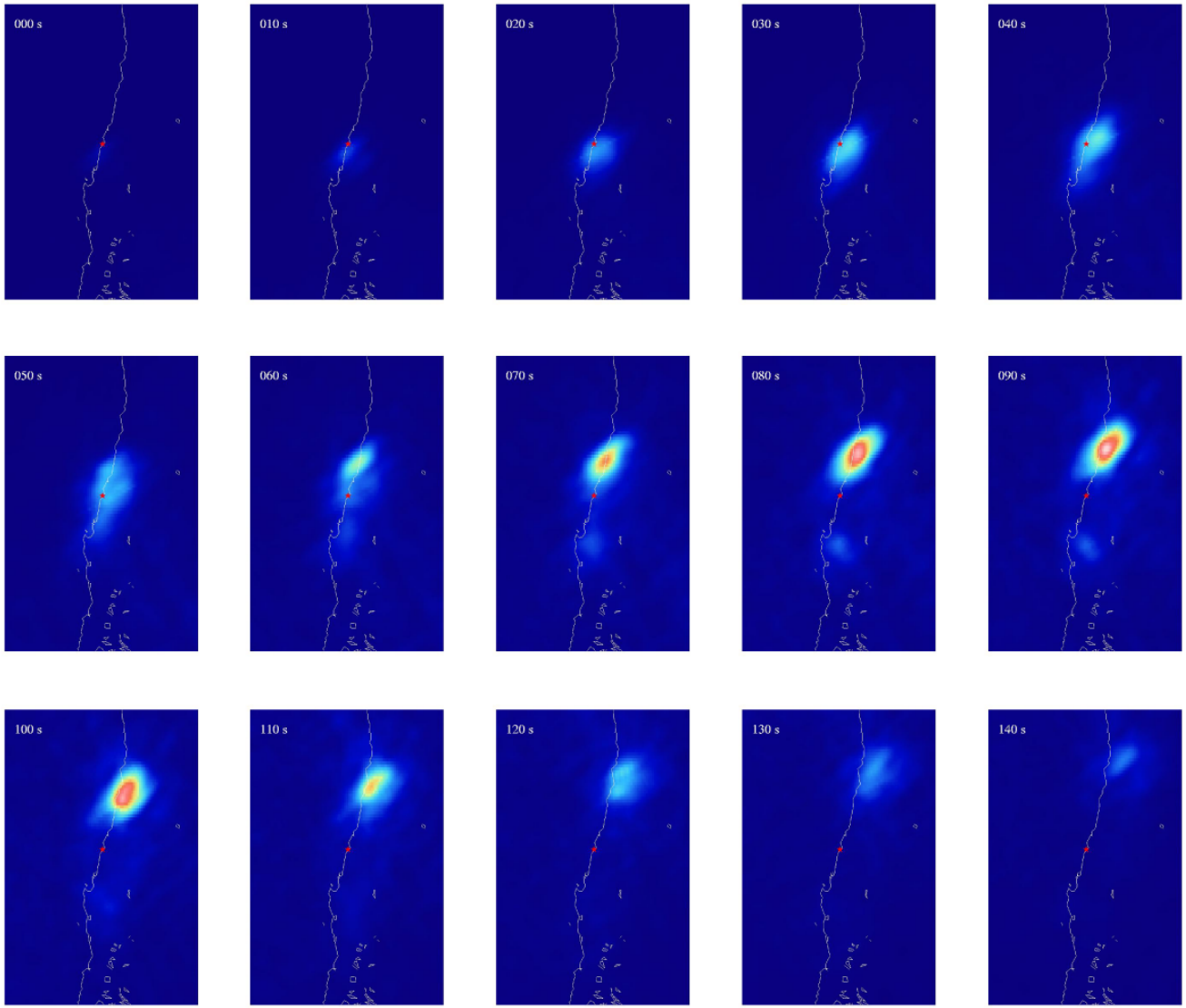
Time Slice (45 seconds)



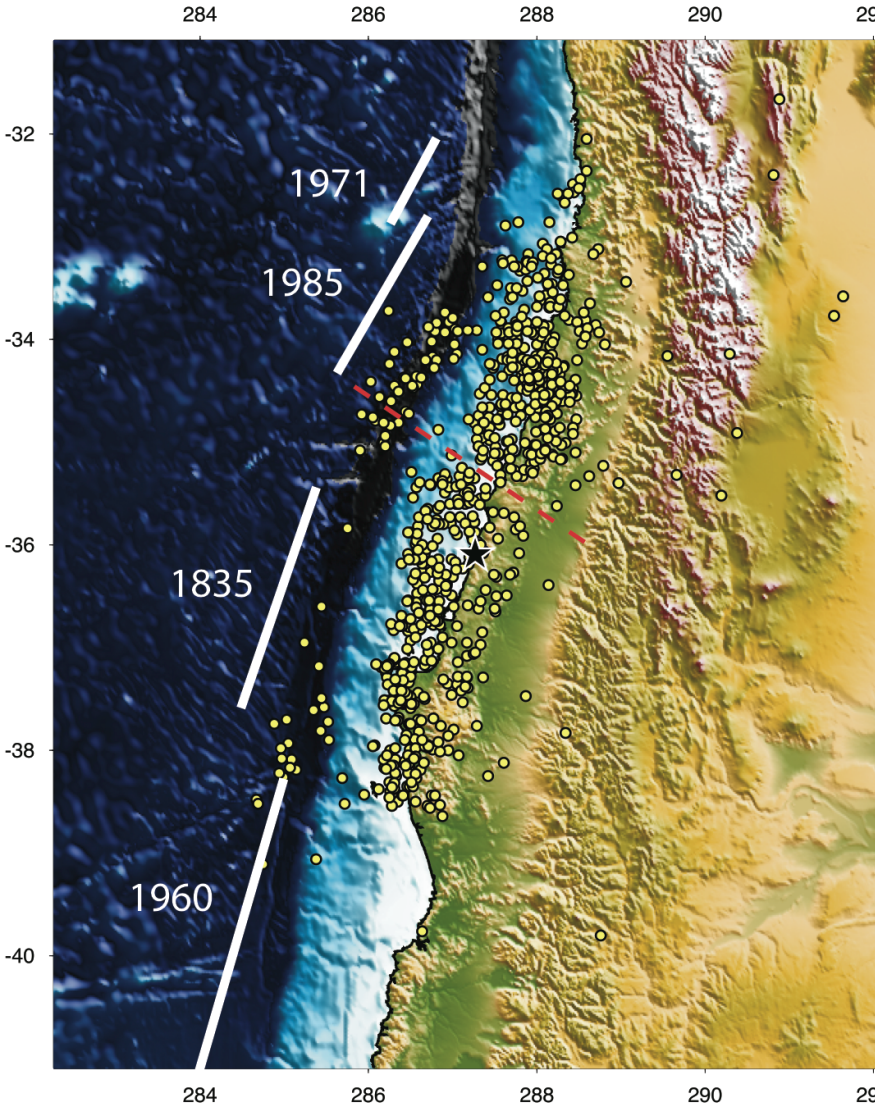
Time Slice (90 seconds)

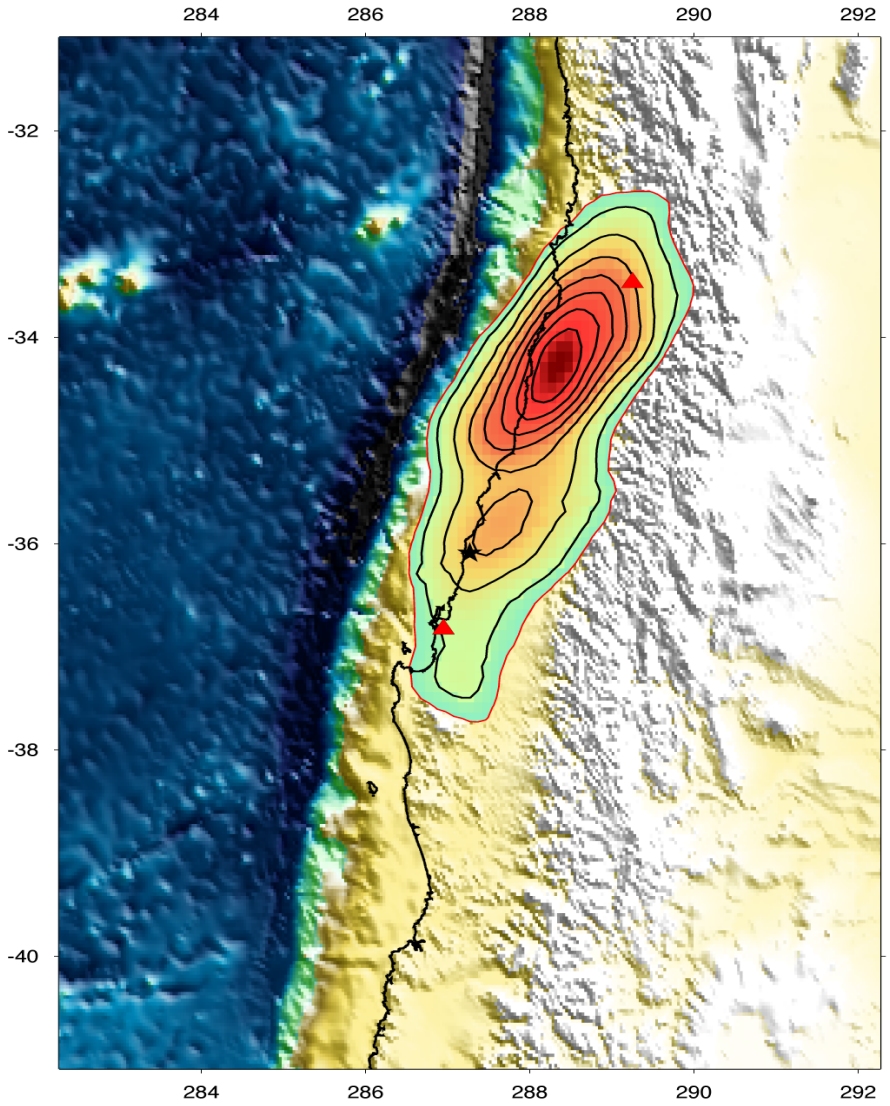


Time Slices


000 s
010 s
020 s
030 s
040 s
050 s
060 s
070 s
080 s
090 s
100 s
110 s
120 s
130 s
140 s

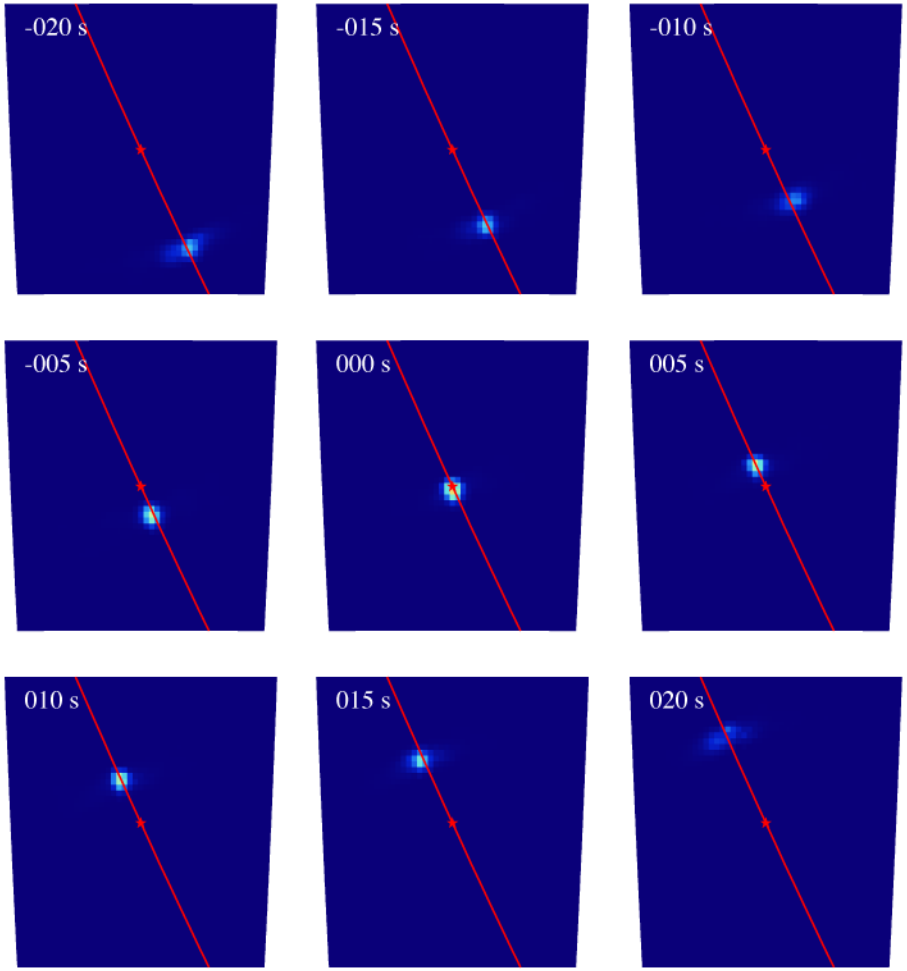
February 27, 2010 Maule Earthquake

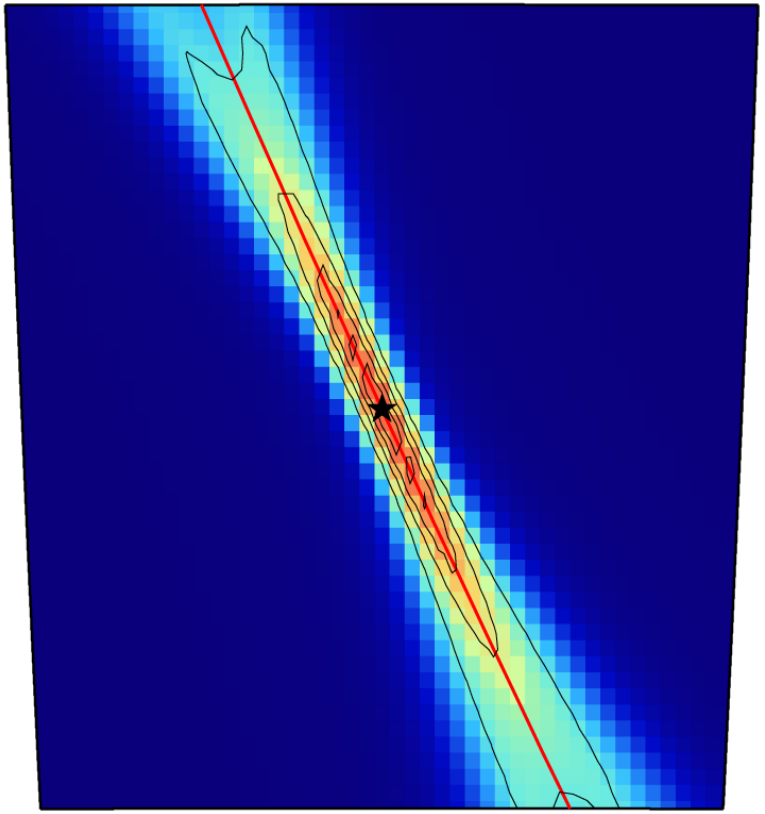




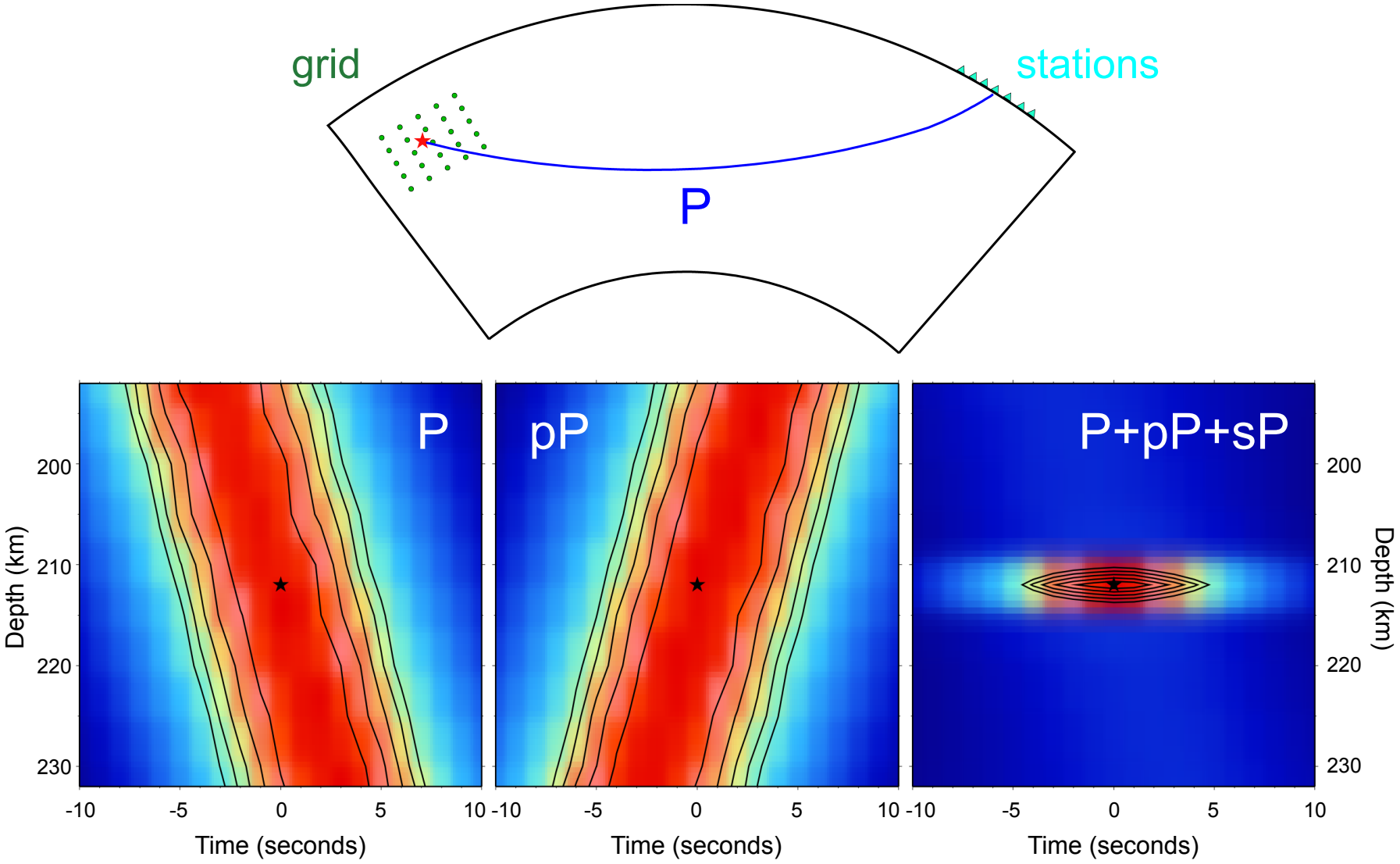
animation available at
http://seismology.harvard.edu/resources.html

Along-Path Smearing (Synthetic)

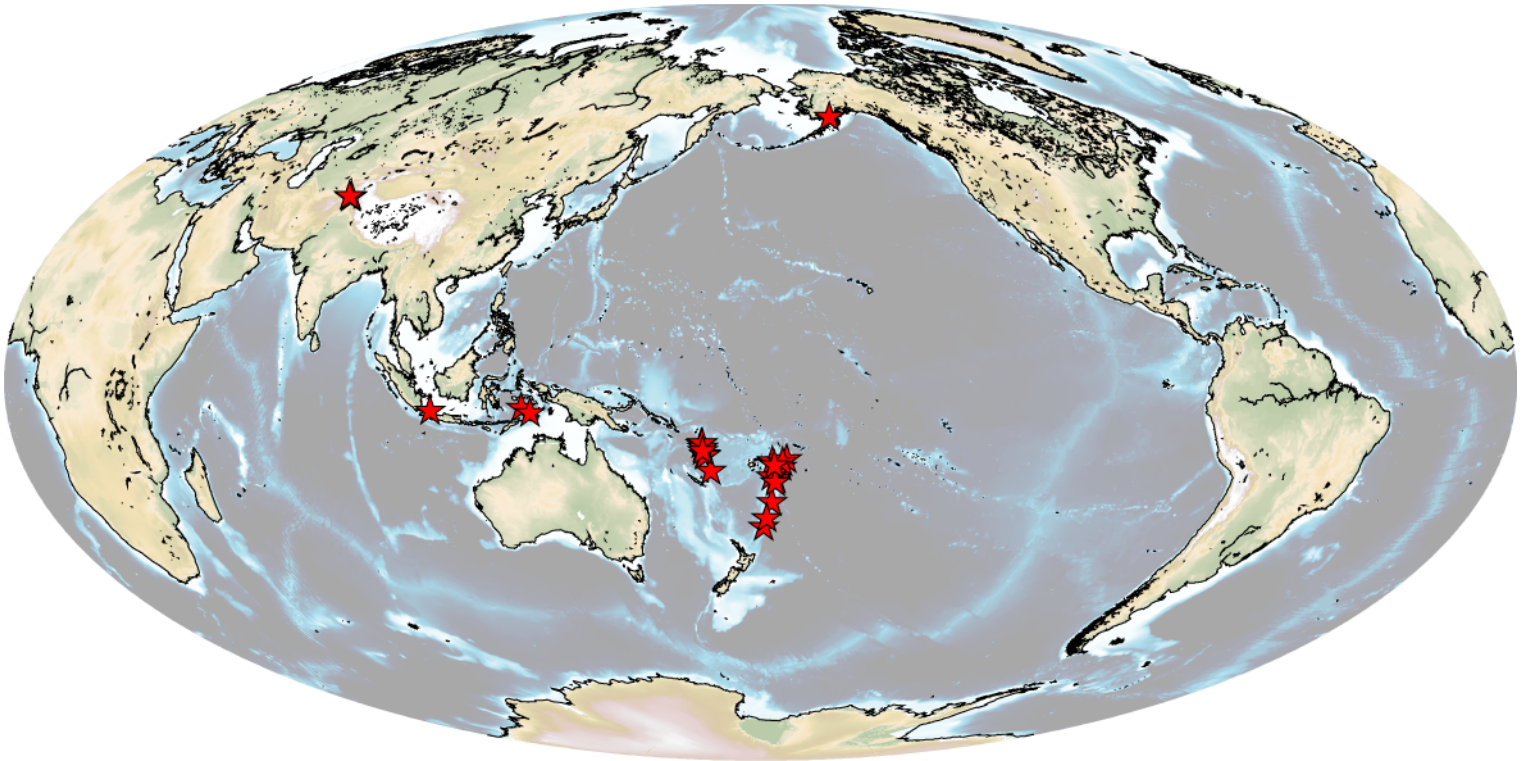




Seismic Phases and Depth Resolution



Earthquakes

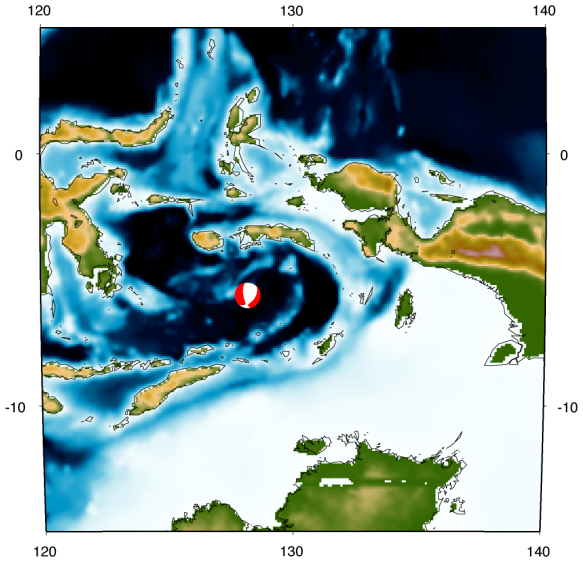


- Mw ≥ 6.5
- depth: 100 km ~ 400 km
- distance: teleseismic

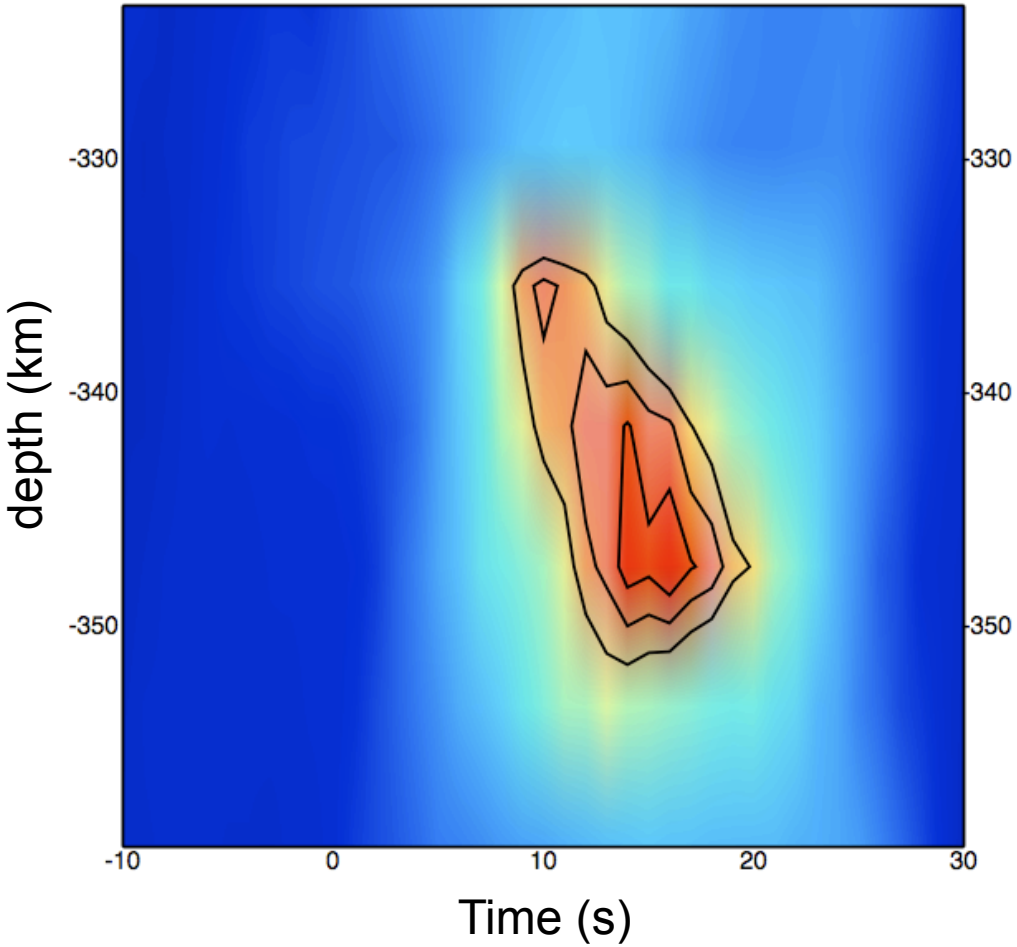
➔ 22 earthquakes

Vertical Rupture: Java

- Mw 7.6

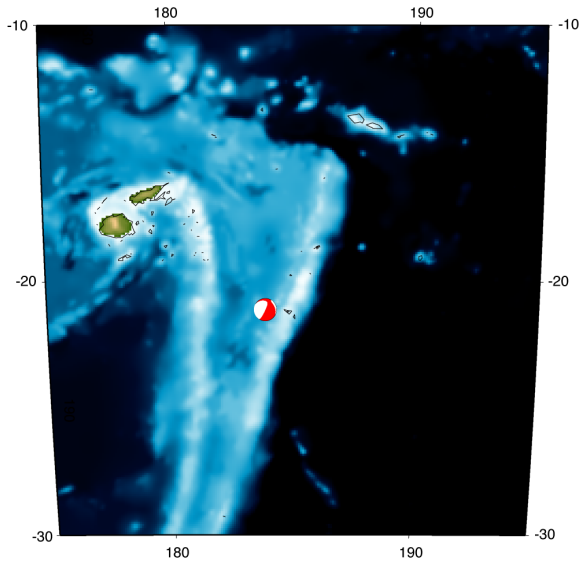


2 out of 22 events

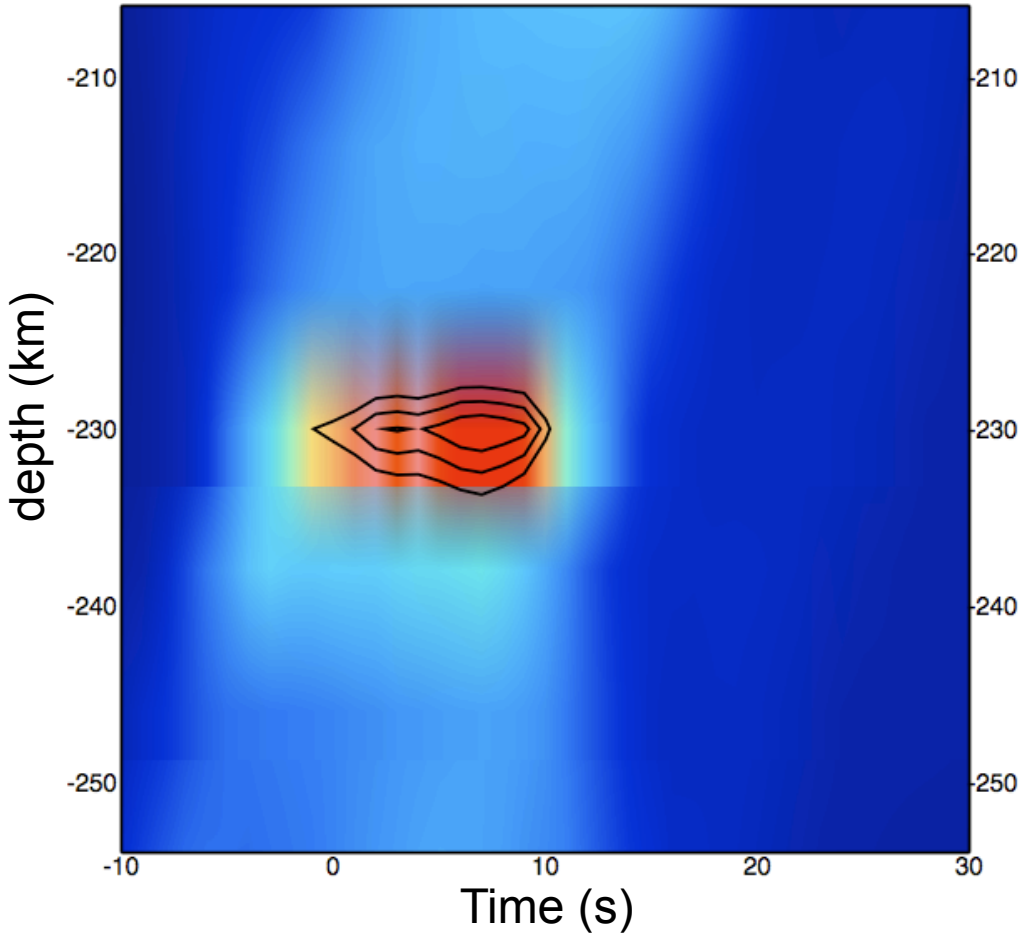


Sub-Horizontal Rupture: Fiji

- Mw 6.6

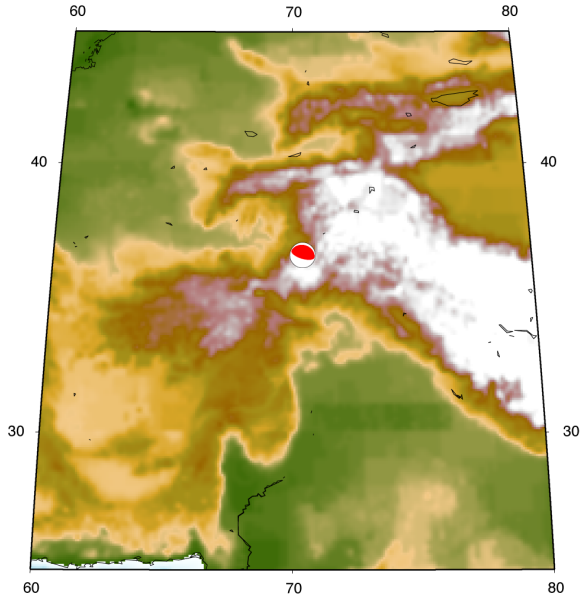


20 out of 22 events

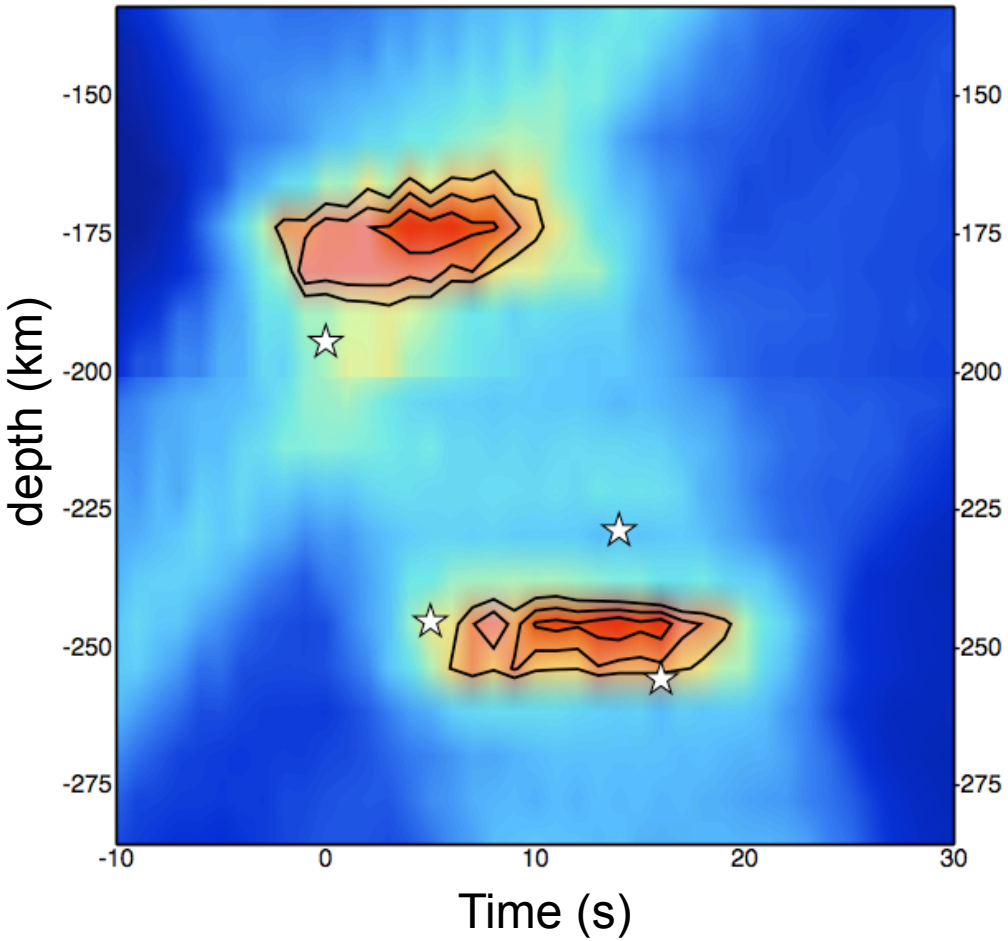


Composite Rupture: Hindu Kush

- Mw 7.4



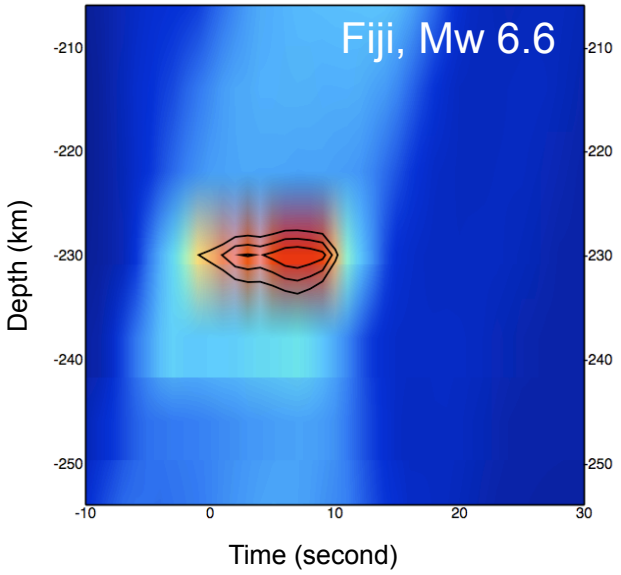
11 out of 20 events

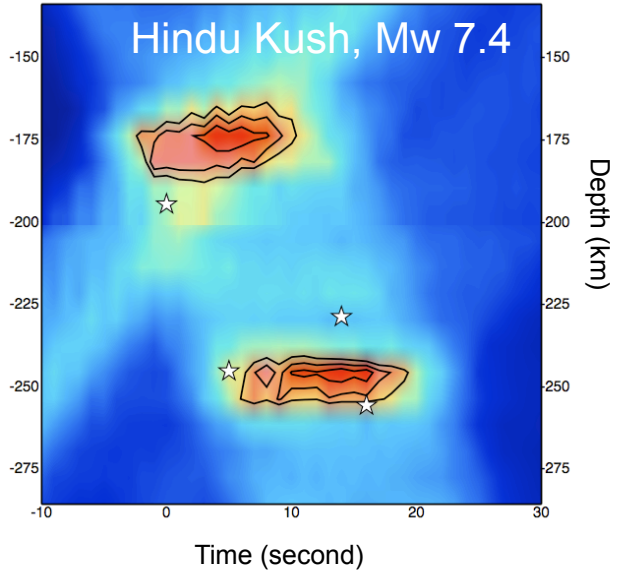


- Depth separation ~ 70 km
- Time separation ~ 10 seconds

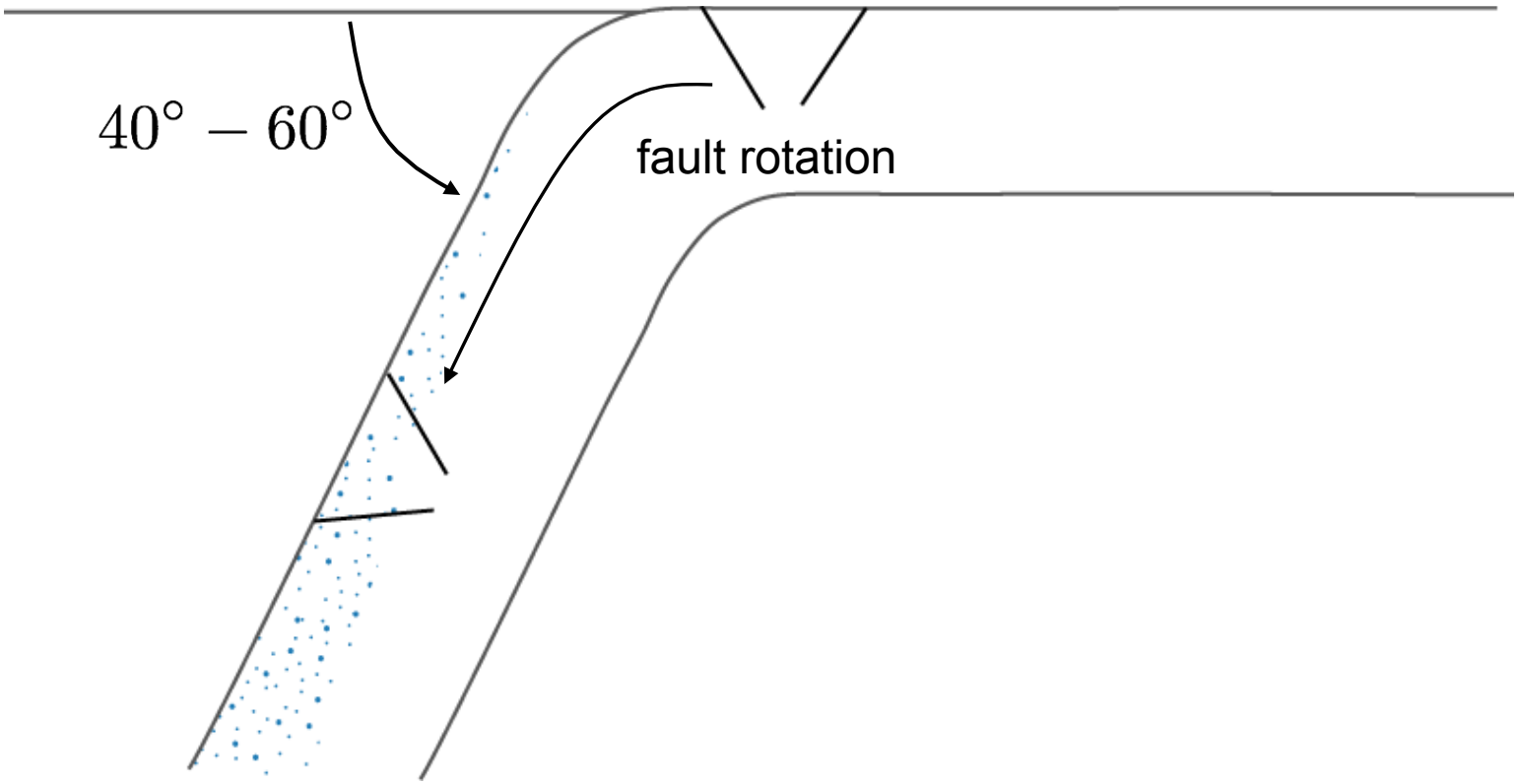
Earthquakes Summary

1. sub-horizontal fault planes
2. multiple faults

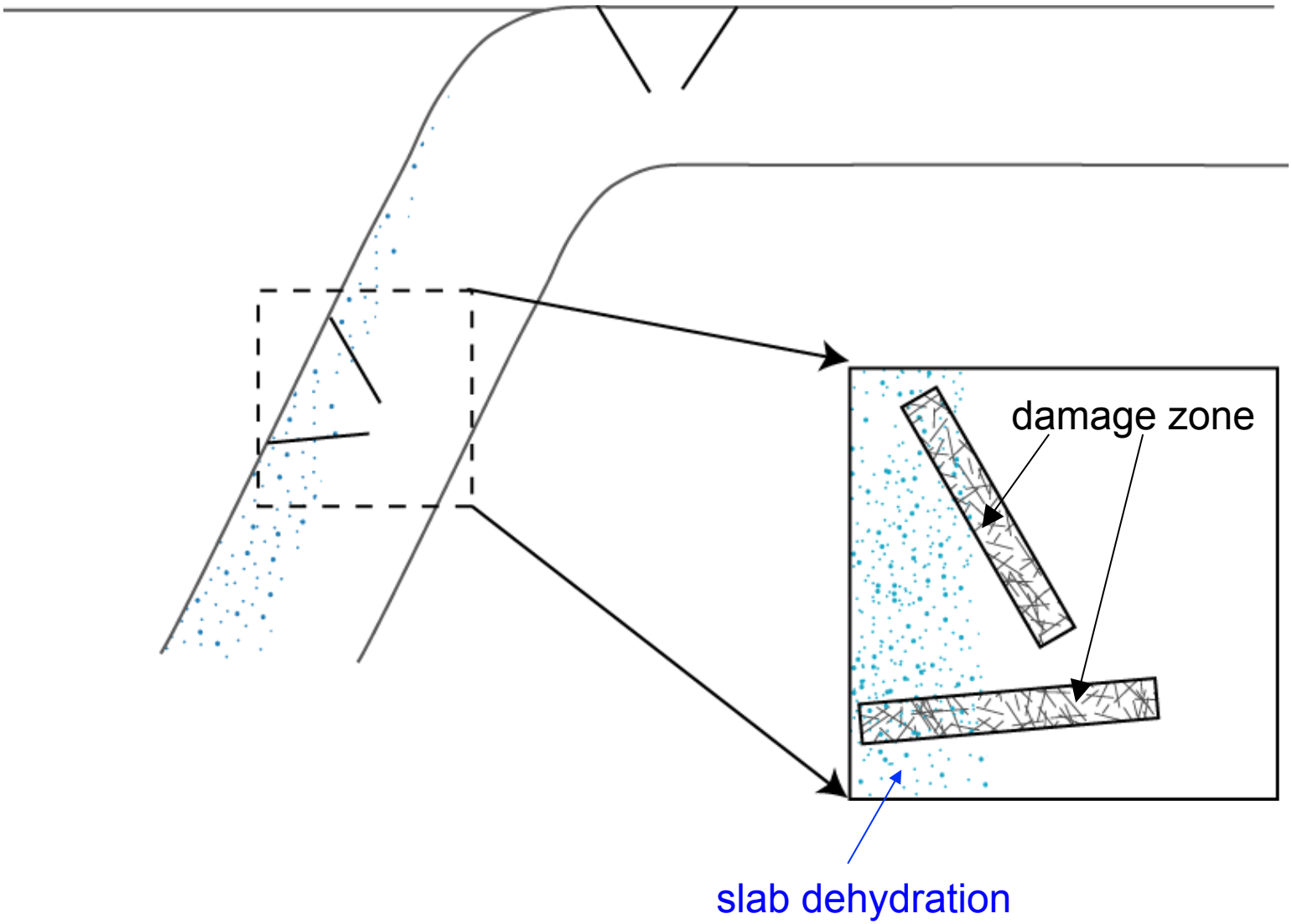




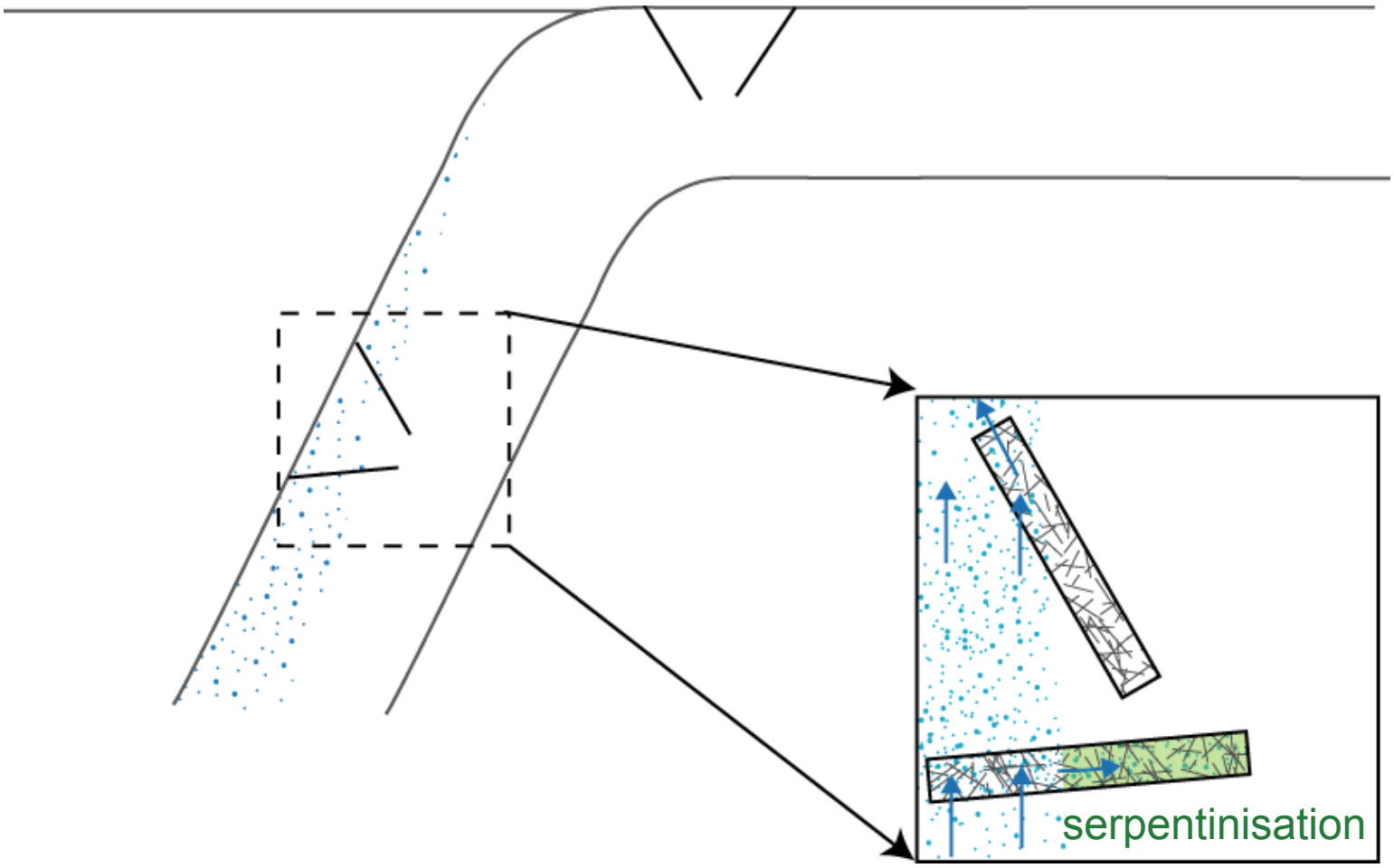
Mechanism for Intermediate-Depth Earthquakes



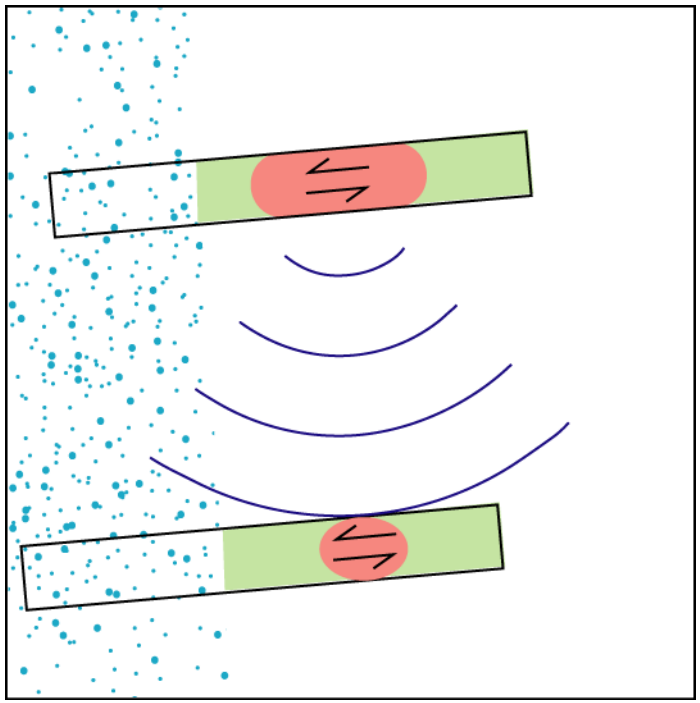
Mechanism for Intermediate-Depth Earthquakes



Mechanism for Intermediate-Depth Earthquakes



Mechanism for Intermediate-Depth Earthquakes



Shear Instability

↓

Slip & Frictional Heating

↓

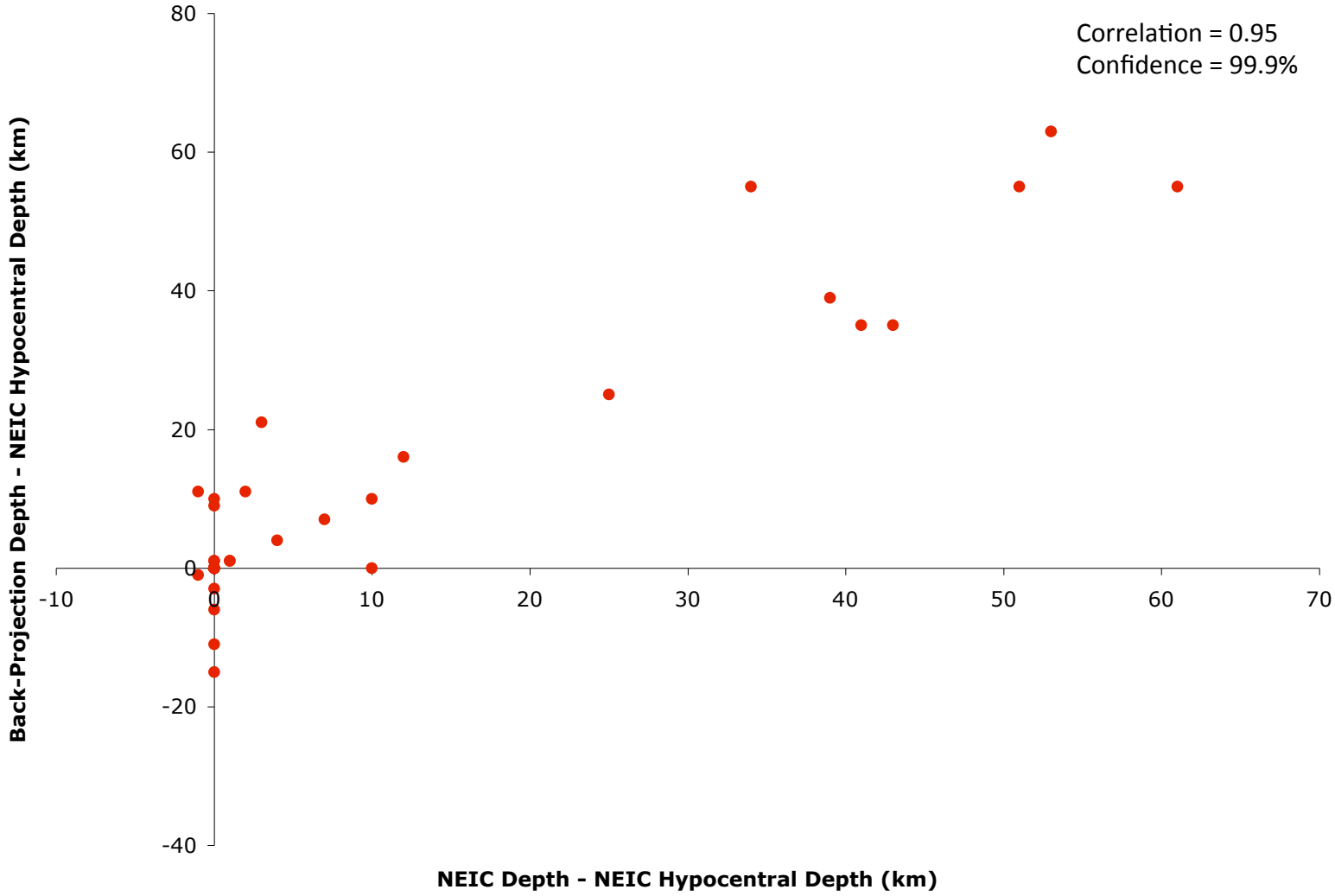
Dehydration

↓

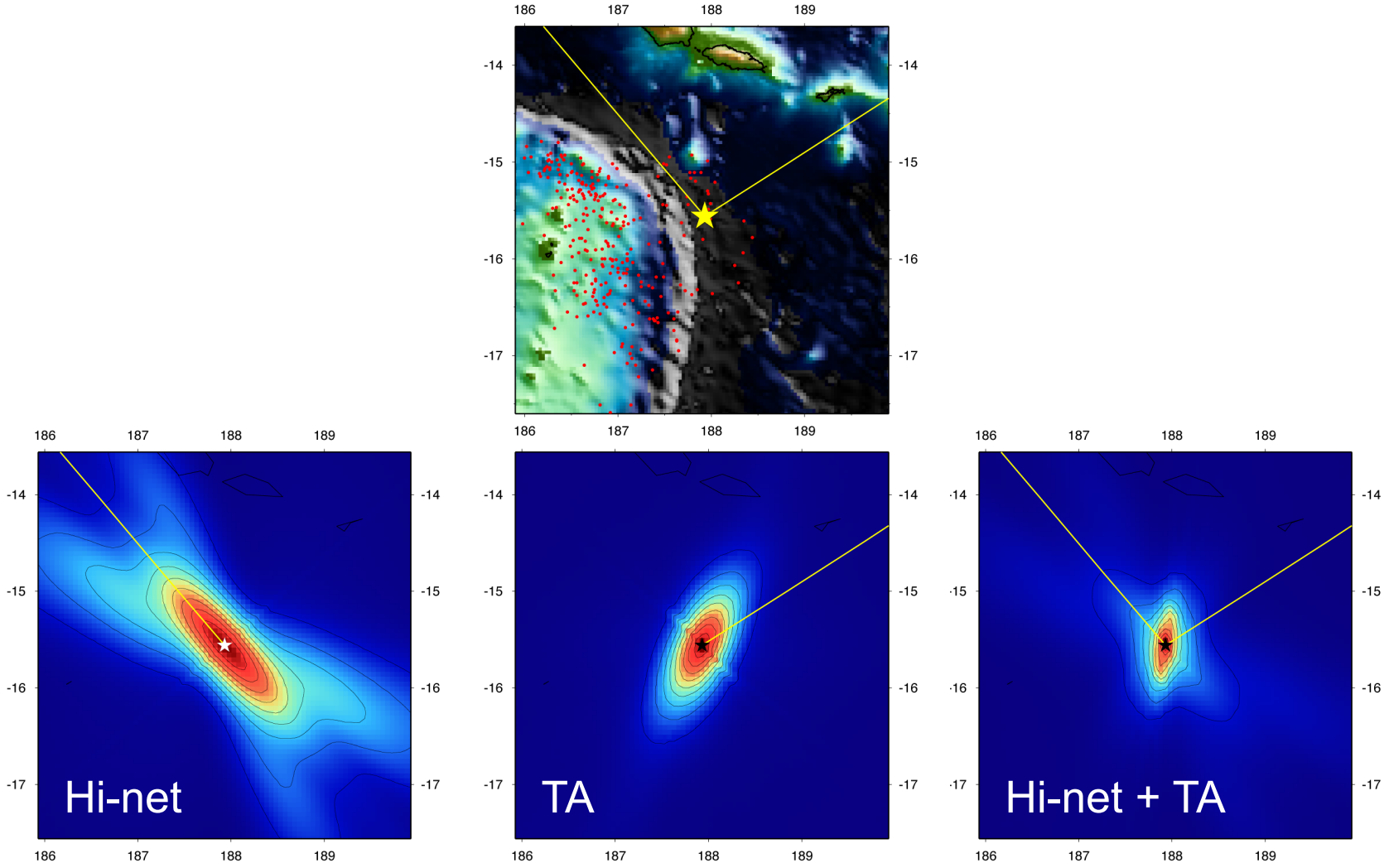
Embrittlement

positive feedback

Correlation (Near Real-Time)



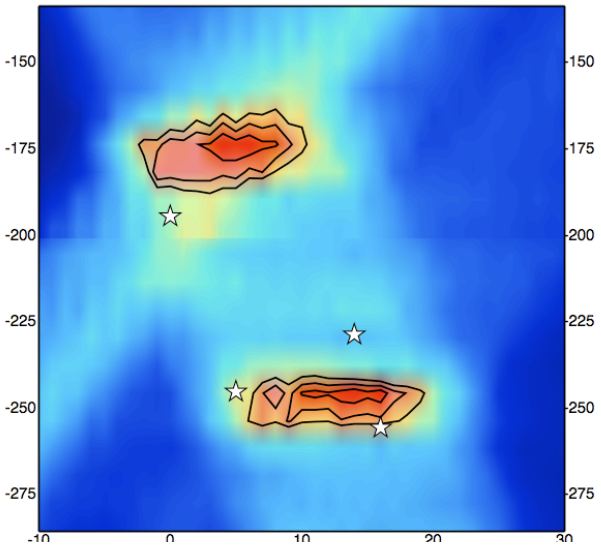
September 29, 2009 Samoa Earthquake

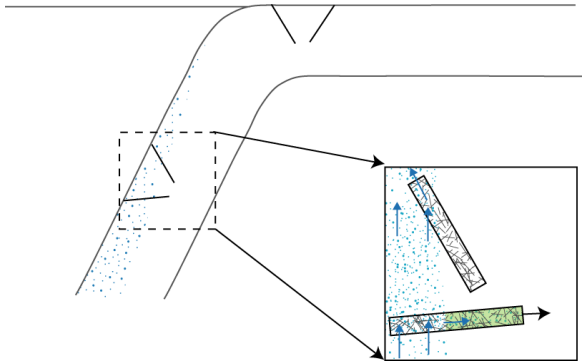


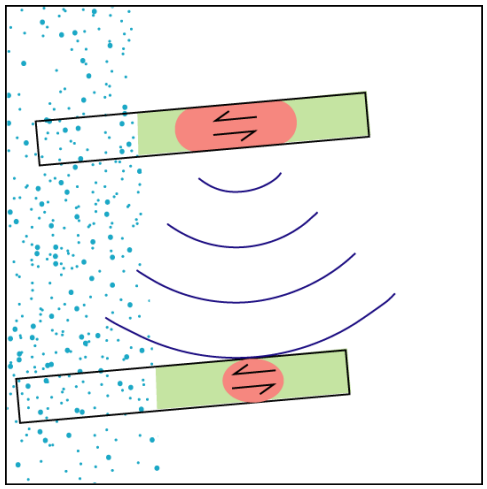
Summary

Observations

- dominance of sub-horizontal ruptures
- frequency of composite events







Model of Intermediate-Depth Earthquake

- pre-existing faults (horizontal & vertical)
- water from slab dehydration
- water and fault interaction
- runaway dehydration of serpentine
- dynamic triggering