Data analysis of recordings of slow earthquakes: Tectonic tremor, low-frequency earthquakes and slow slip events

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General Exam - October 2019?

Slow earthquakes

Slow slip

Slow slip

Tectonic tremor

- Long (several seconds to many minutes)
- Low amplitude
- Emergent onsets
- Absence of clear impulsive phases

Tectonic tremor

Low-frequency earthquakes (LFEs)

- Small magnitude earthquakes (M $\sim$ 1)
- Frequency content (1-10 Hz) lower than for ordinary earthquakes (up to 20 Hz)
- Source located on the plate boundary,
- Focal mechanism: Shear slip on a low-angle thrust fault dipping in the same direction as the plate interface

Low-frequency earthquakes (LFEs)

Episodic Tremor and Slip (ETS)

- Tectonic tremor observations spatially and temporally correlated with slow slip observations (Nankai, Cascadia)
- Only biggest tremor episode associated with slow slip
- No spatial or temporal correlation in other regions like New Zealand

Depth of the source of the tectonic tremor in the eastern Olympic Peninsula

- Lack of impulsive phases $\rightarrow$ Difficult to determine the depth of the source of the tremor
- Tectonic tremor is at least partly made of a swarm of LFEs
- LFEs are located on the plate boundary

$\rightarrow$ Research question: Is the source of the tectonic tremor located on the plate boundary? What is the depth extent of the location of the source of the tremor?

A low-frequency earthquake catalog for Northern California

- LFEs grouped into families of events
- All the earthquakes of a given family originate from the same small patch on the plate interface
- LFEs recur more or less episodically in a bursty manner
- Wide range of recurrence behavior between seismic regions, and within the same seismic region

LFEs in Washington State

LFEs on the San Andreas Fault

A low-frequency earthquakes catalog for southern Cascadia

- LFE families in southern Cascadia:
  - 34 LFE families on the subduction zone
  - 3 LFE families on two strike-slip faults from the San Andreas Fault system
- Wide range of recurrence behavior between Washington State and the San Andreas Fault, and within the San Andreas Fault zone

$\rightarrow$ Do low-frequency earthquakes families behave similarly or differently in southern Cascadia, compared to Washington State and the San Andreas Fault?

Detection of slow slip events in New Zealand

- Small (M $\sim$ 5) or long (several months) slow slip events are harder to detect
- In Cascadia, Mexico, tremor used as a proxy to study slow slip events
- Different pattern in northern new Zealand:
  - Tremor source located downdip of the slow slip on the plate boundary
  - Tremor activity does not seem to increase during slow slip events

$\rightarrow$ Can we detect smaller and / or longer slow slip events in the absence of spatially and temporally correlated tectonic tremor?

Questions?