Slow Slip Events & Related Phenomena:

A Discussion of their Mechanisms

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Text

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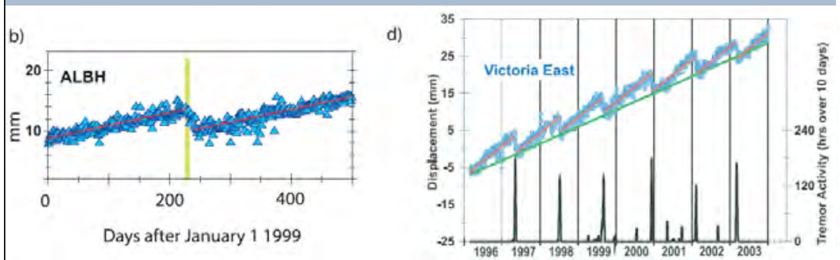
Basic Observations

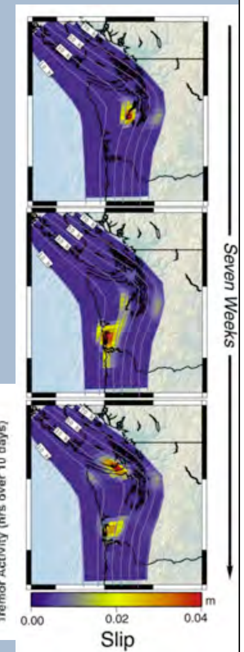
Cascadia GPS observations & inversion

Recurence time ~ 14 mo. And V_{prop}~10km/day

Slip per event 2-3cm. Slip rate from SSEs ~2cm/yr, ~ 60% of plate rate

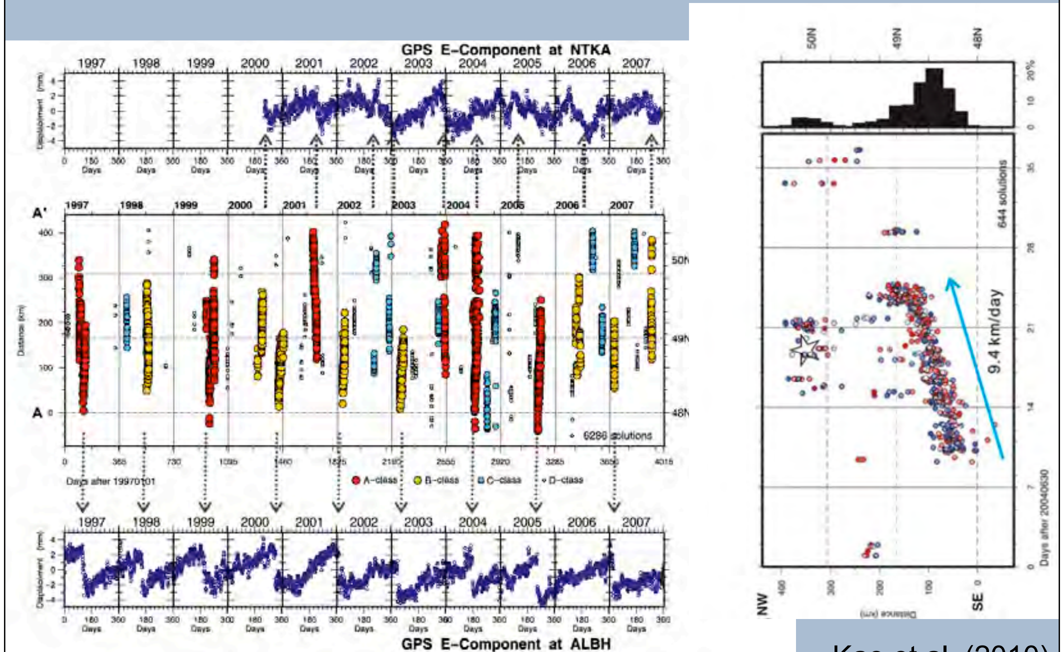


Dragert et al. (2004)



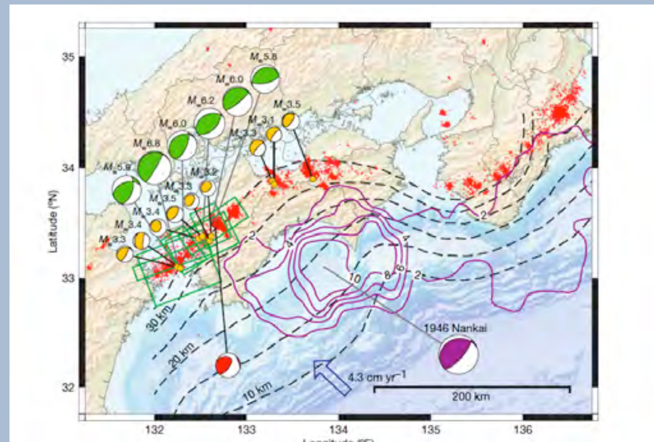
Melbourne et al (2005)

Cascadia, Tremor

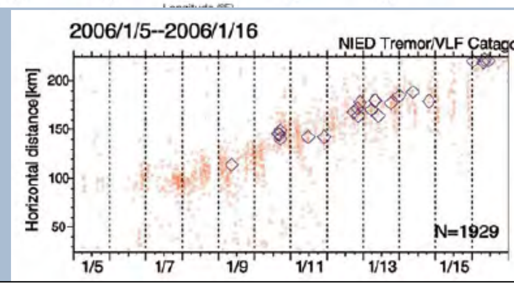


Kao et al. (2010)

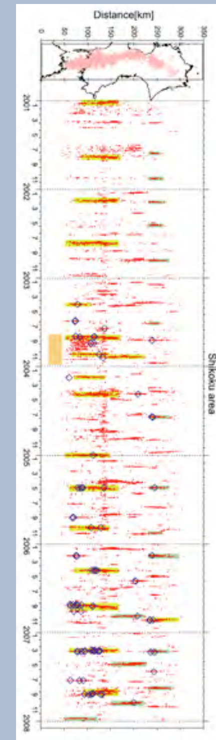
Nankai SSEs and Tremor



Ide et al (2007)



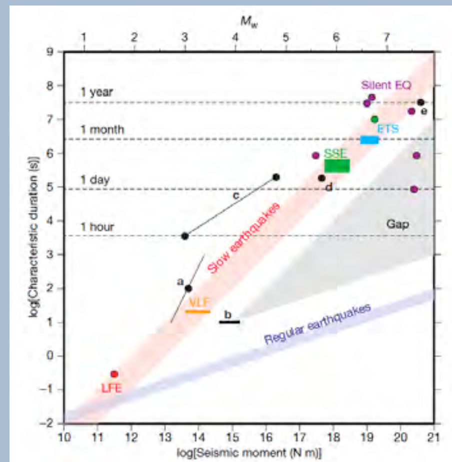
Obara (2009)



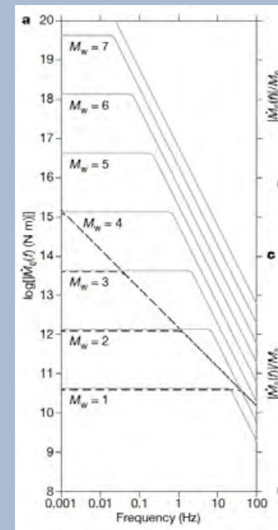
Obara (2010)

SSEs and tremor in a band centered at 35 km depth, SSE amplitude smaller than cascadia (usually not detected by GPS but only be tiltmeters) but large events more frequent, with return period ~ 6 mos. Events propagate at 5-15 km/day as a pulse in a narrow width band.

Scaling Law



Ide et al (2007)



Scaling Model

Ide et al. (2007) proposed 2 models to explain the scaling law:

1. A constant stress drop model in which
   $V_{prop} \propto 1/L^2$
2. A model in which D is constant, and
   $V_{prop} \propto 1/L$

They justified the scale dependence of V_{prop} by citing the much higher dip velocity than strike velocity. However, we argue that duration t must be determined by the strike velocity and length. V_{prop} in the strike direction is constant.

We propose a strip-pulse model:

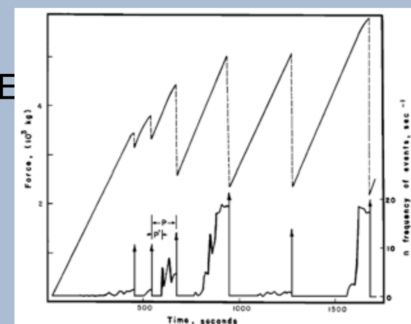
The SSE is a slip pulse confined to a strip of constant width W*

If we assume $\Delta\sigma = \mu D/W^*$ is constant then D is constant,
And, $M_o \propto L \propto t$ $\therefore$ V_{prop} and $\dot{M}_o$ are constant

LFEs, VLFs, Tremor and SSE Scaling

It has been argued that tremor is a swarm of LFEs (and VLFEs (Shelly et al 2007), and that the moment of tremor is proportional to (but much smaller) than the moment of SSEs (Obara, 2010).

We propose that tremor is the incidental rubbing noise of SSEs. Because $\dot{M}_o$ is constant for SSEs, is must also be so for tremor and the spectra of tremor should decay as 1/*f.*



Acoustic emission during stable Sliding in the lab (Scholz, 1968)

Scaling of tremors etc fills in the blank left by Ide et al who just assumed they scaled similaly to SSEs