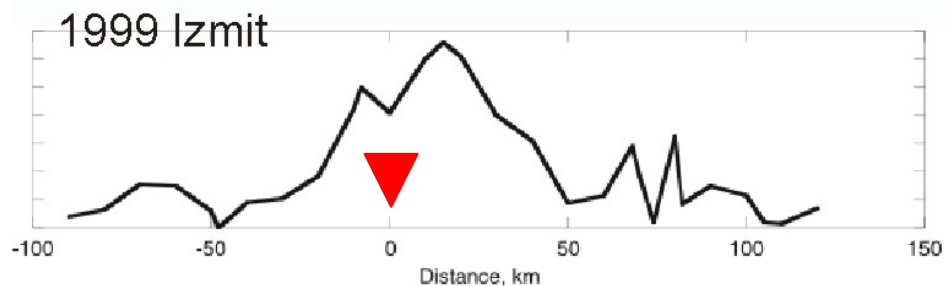
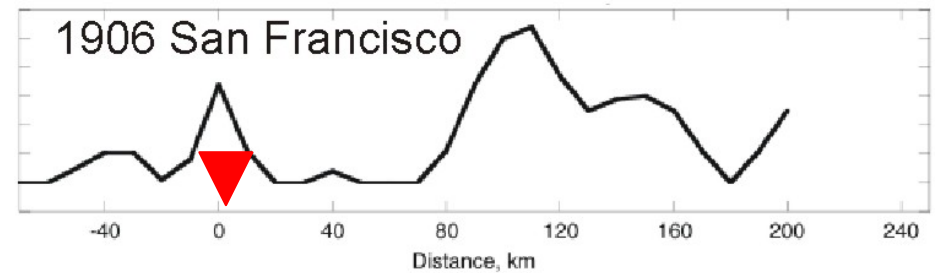
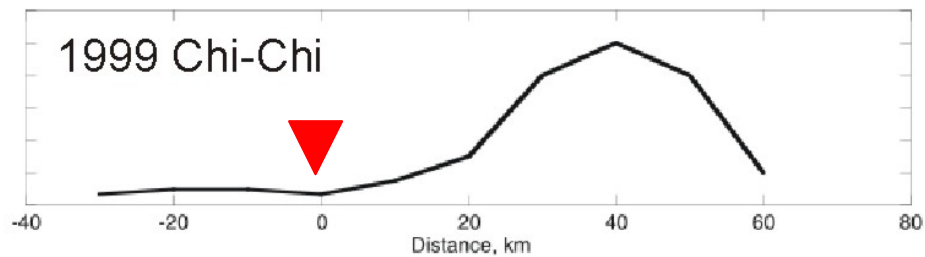
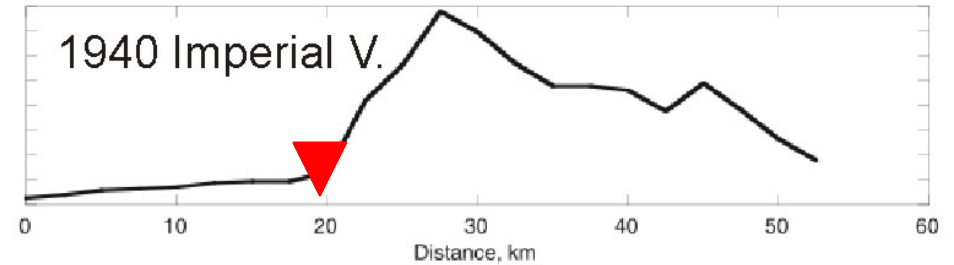
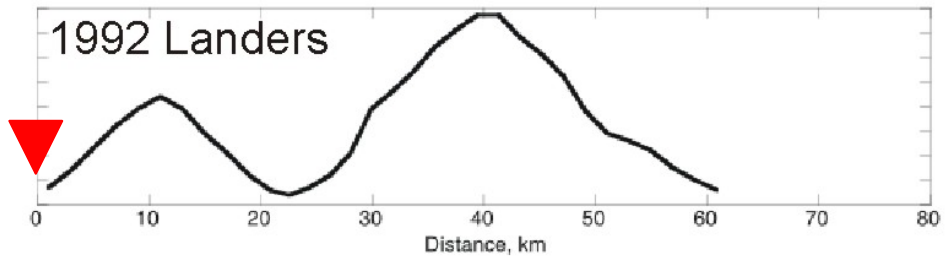
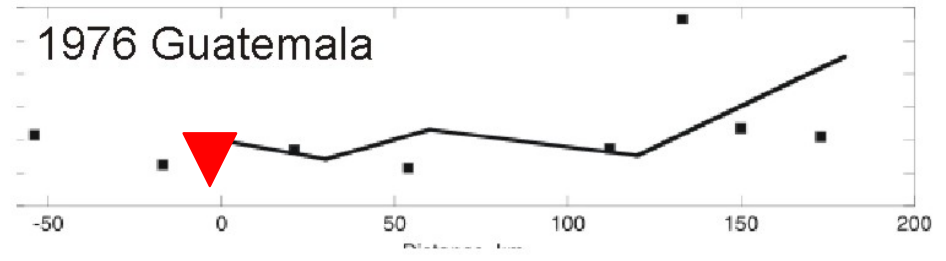
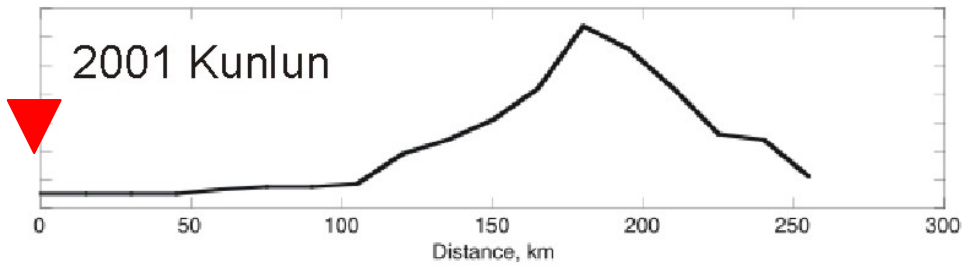
The image shows a wide, flat, light-colored surface, likely a concrete slab or a wetland, with a large, dark, irregularly shaped area in the center. This dark area has a mottled, textured appearance, suggesting it might be a large crack or a region of material degradation. The surrounding surface is lighter and shows some minor texture and small, scattered dark spots. The overall scene is captured from an elevated perspective, showing the extent of the dark area across the lighter surface.

**Rheological heterogeneities,  
crack arrest and healing  
phenomena**

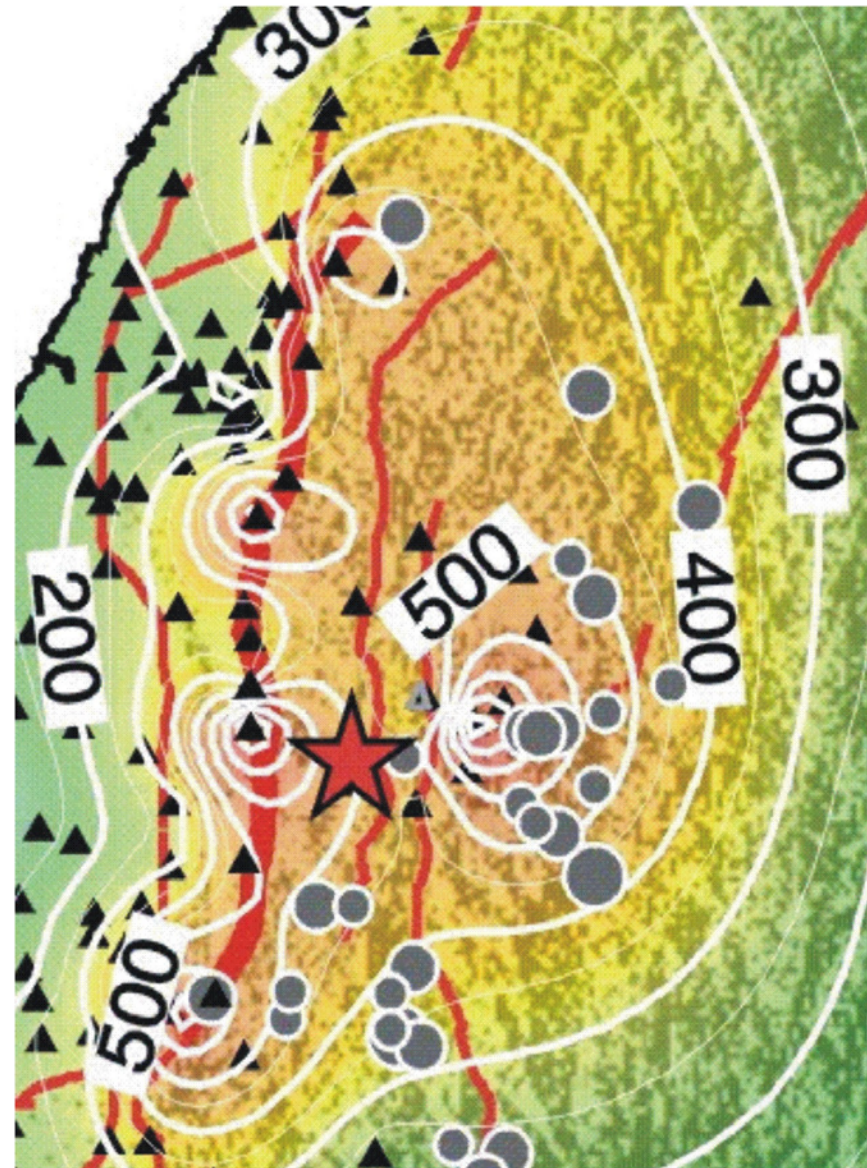
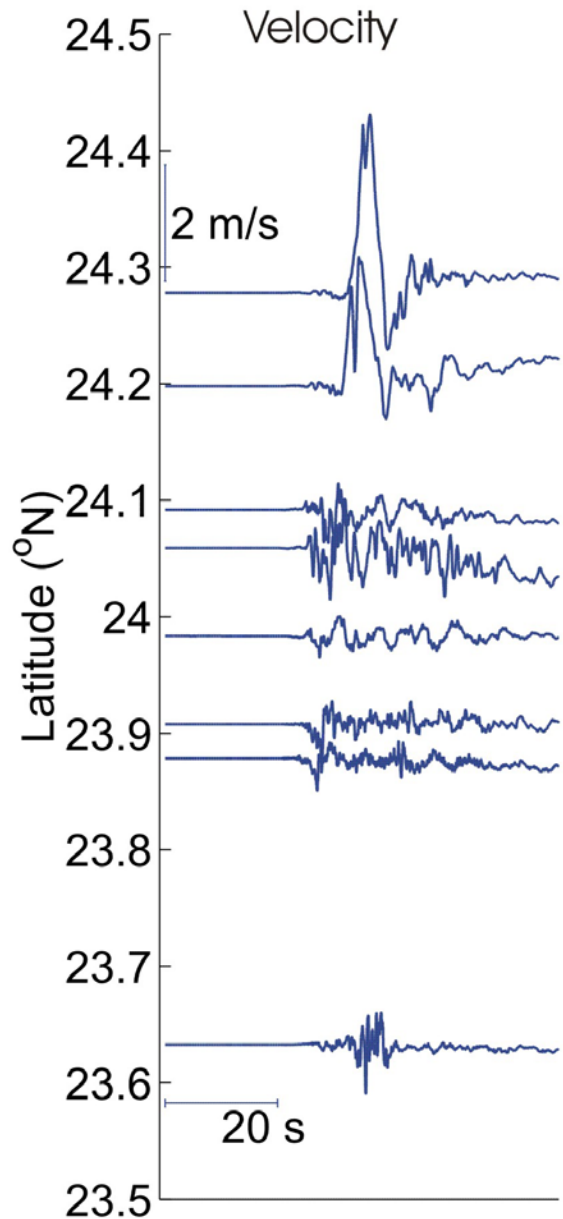
# Slip distribution of large earthquakes



# Ground motion from Chi – Chi, Taiwan, EQ

*Brodsky and Kanamori ( 2001 )*

*Ma et al. ( 1993 )*



# Healing types

## **1. CLASSICAL ENLARGING CRACK**

- The dynamic problem is solved for homogeneous configurations
- No healing occurs: the fracture propagates without limit
- Non realistic; only reference case

## **2. ARTIFICIOUS ANALYTICAL MODIFICATION TO FRICTION LAW TO INCORPORATE HEALING**

- *Perrin et al. ( 1995 ); Zheng and Rice ( 1998 ), ...*
- *Self – healing or short slip duration*

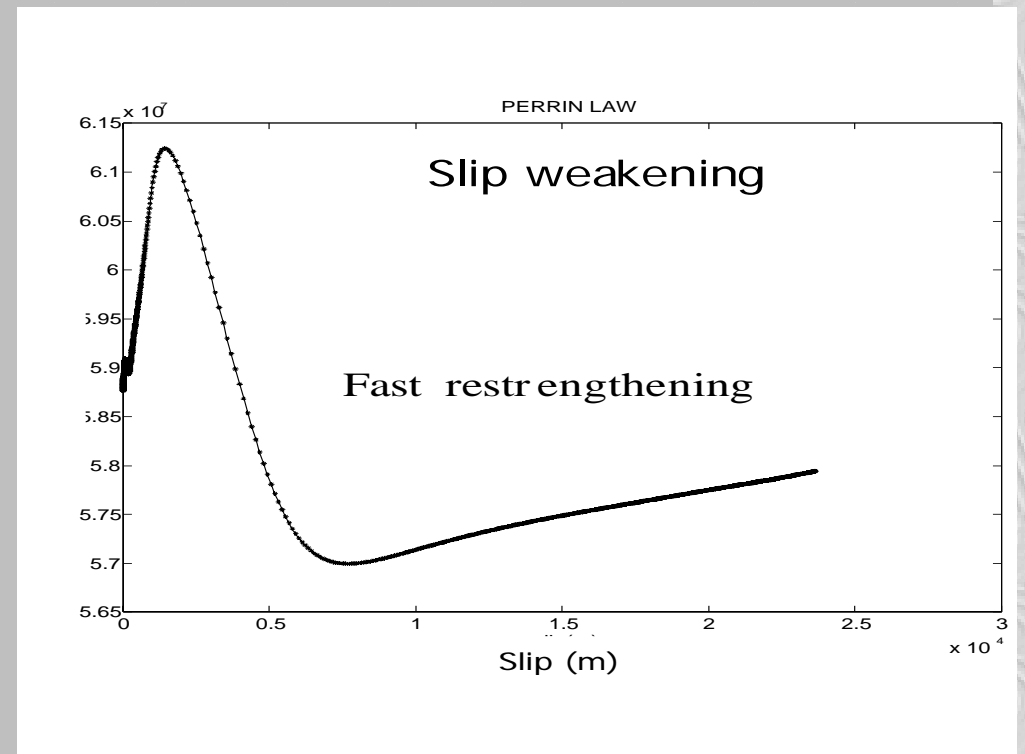
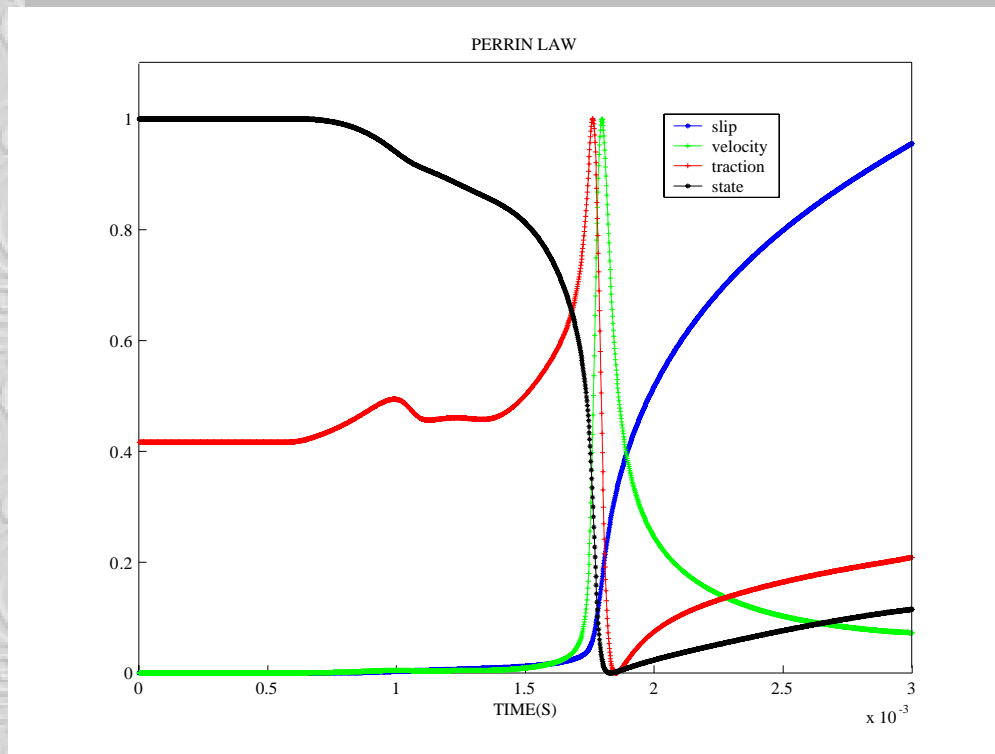
## **3. HETEROGENEOUS CONFIGURATIONS**

- *Heterogeneities in the spatial distributon of frictional parameters*
- *Realistic configurations*
- *Barrier – healing vs. self – healing*



# Self – healing with Perrin law

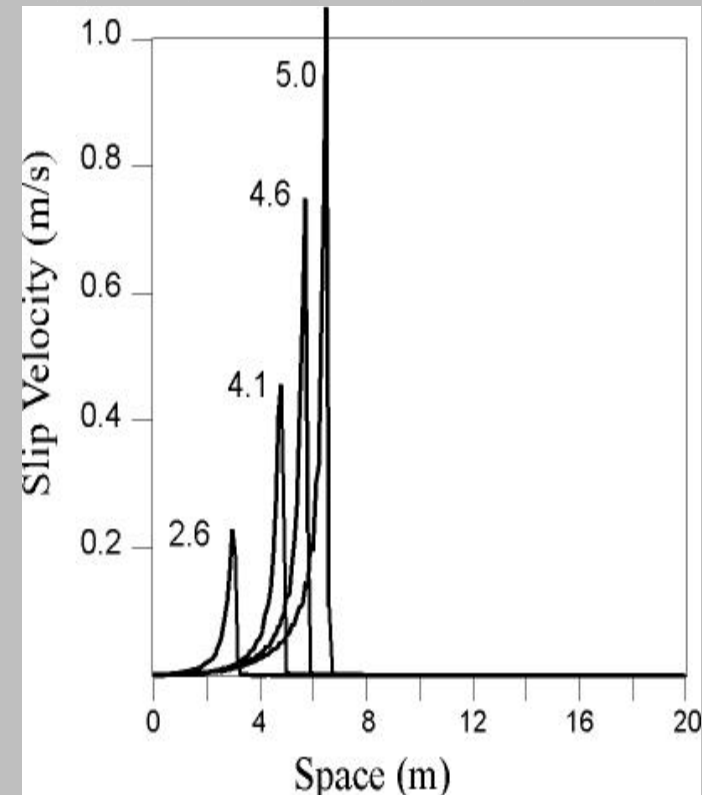
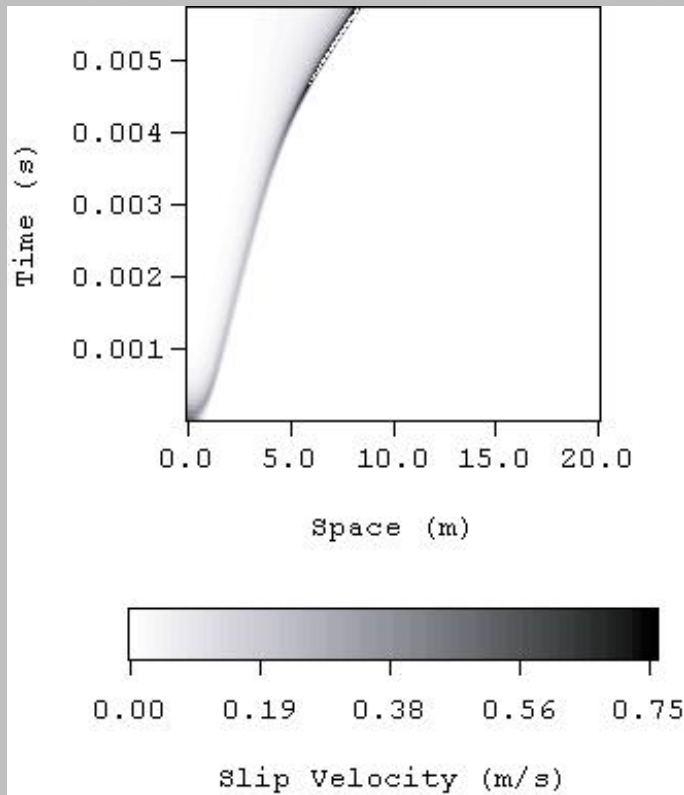
$$\left\{ \begin{array}{l} \tau = \left[ \mu_* - a \ln \left( \frac{v + v_*}{v + v_p} \right) + b \ln \left( \frac{\Psi (v - v_p)}{L} + 1 \right) \right] \sigma_n^{eff} \\ \frac{d}{dt} \Psi = 1 - \frac{\Psi (v + v_p)}{L} \end{array} \right.$$





# Self – healing with Carlson law

$$\left\{ \begin{array}{l} \tau = \left[ \mu_* - a \ln \left( \frac{v_*}{v} + 1 \right) + b \ln \left( \frac{\Psi v_*}{L} + 1 \right) \right] \sigma_n^{eff} \\ \frac{d}{dt} \Psi = \frac{\gamma - \Psi}{t_{fh}} - \frac{\Psi v}{L} \end{array} \right.$$

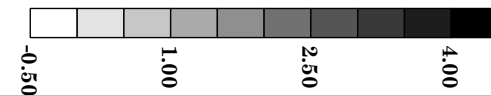
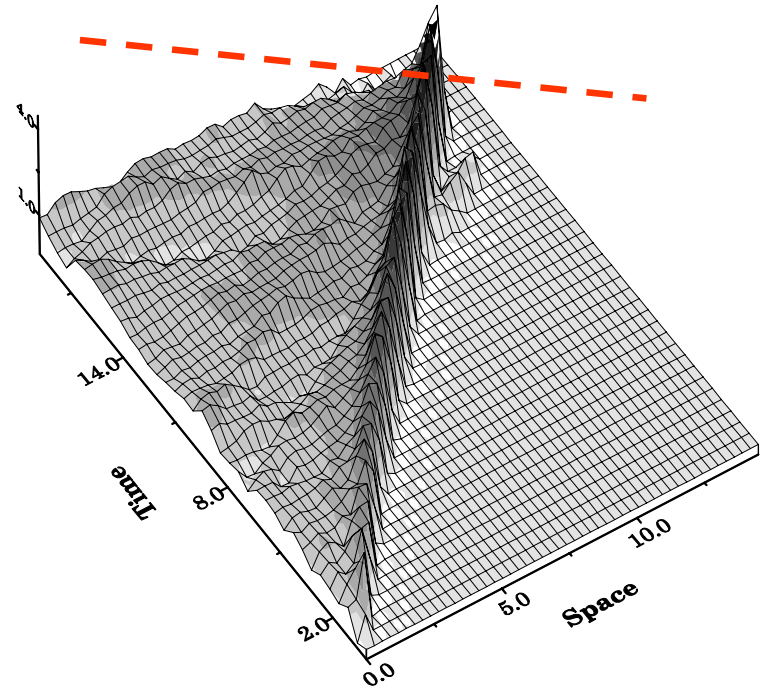
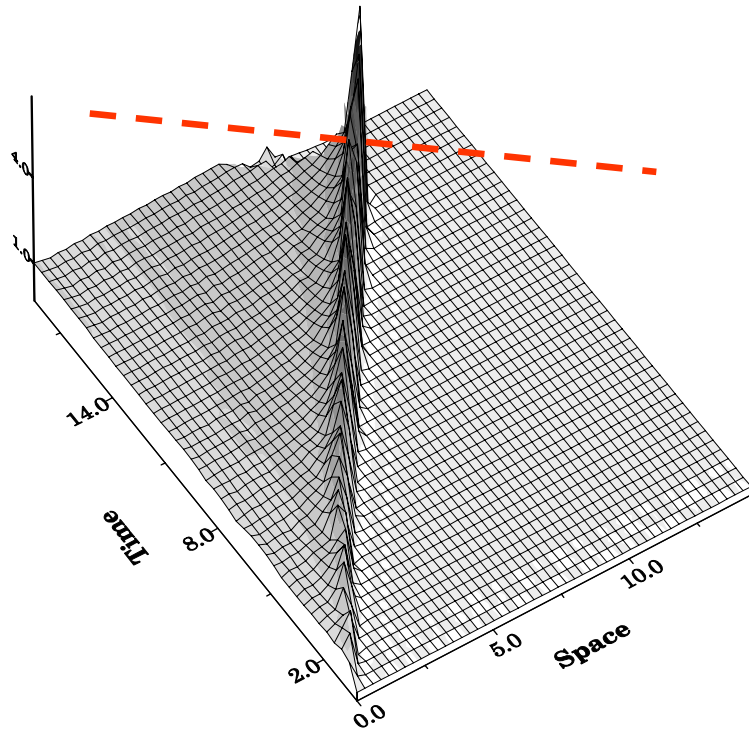
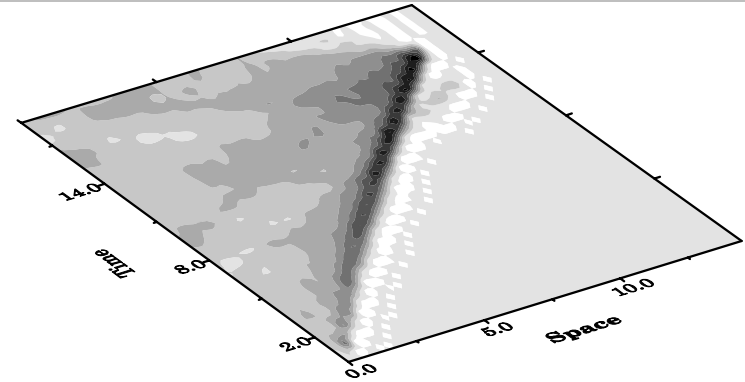
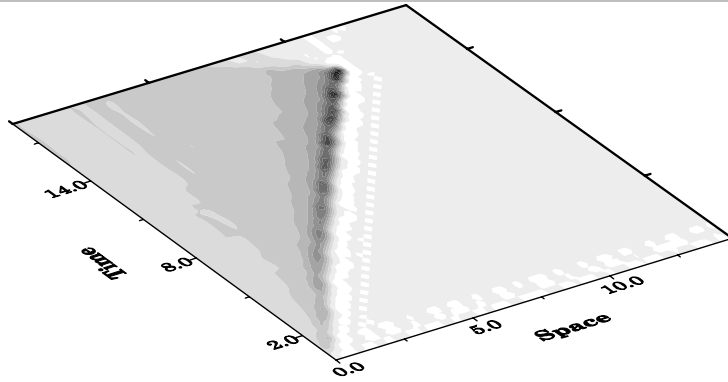




# Barrier – healing with SW

BIE

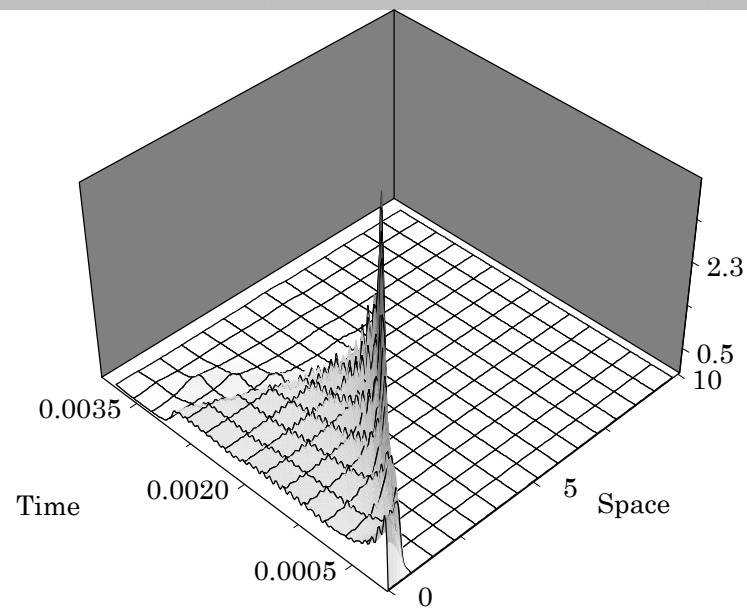
FD





# Healing with RS #1

**Barrier – healing:  
heterogeneity of  $L$  parameter**

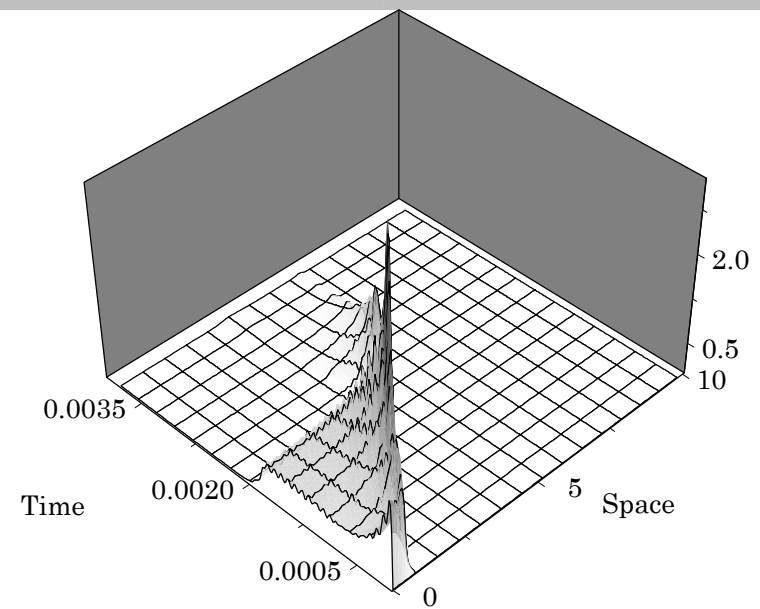


0.5

1.7

2.8

**Self – healing: heterogeneity  
of  $a$  and  $b$  parameters**



0.5

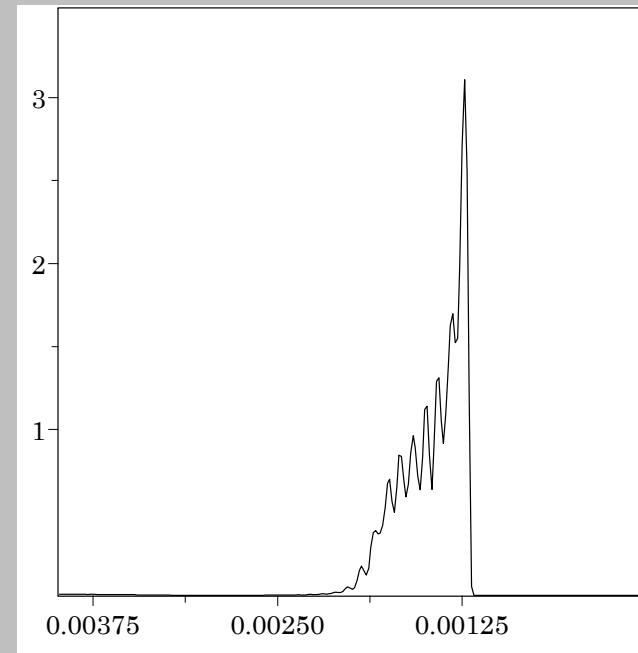
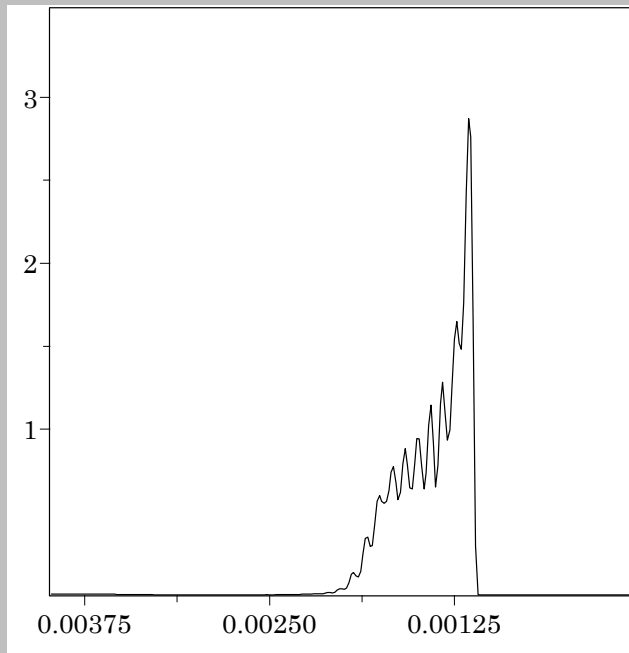
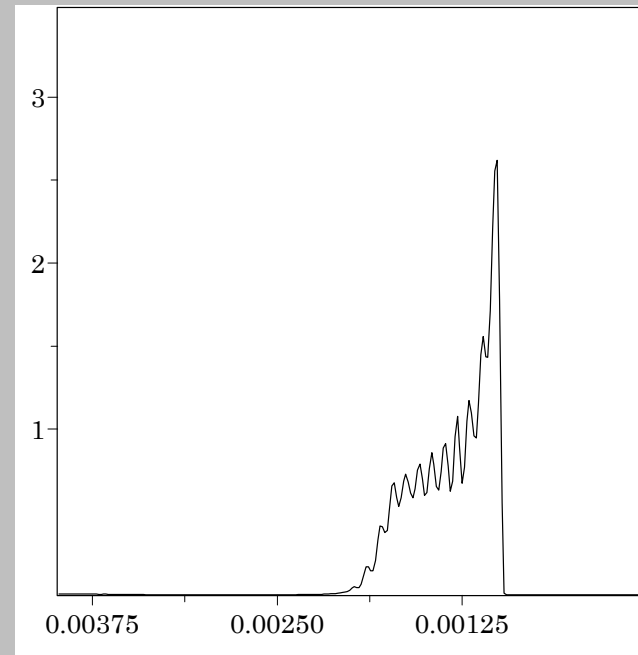
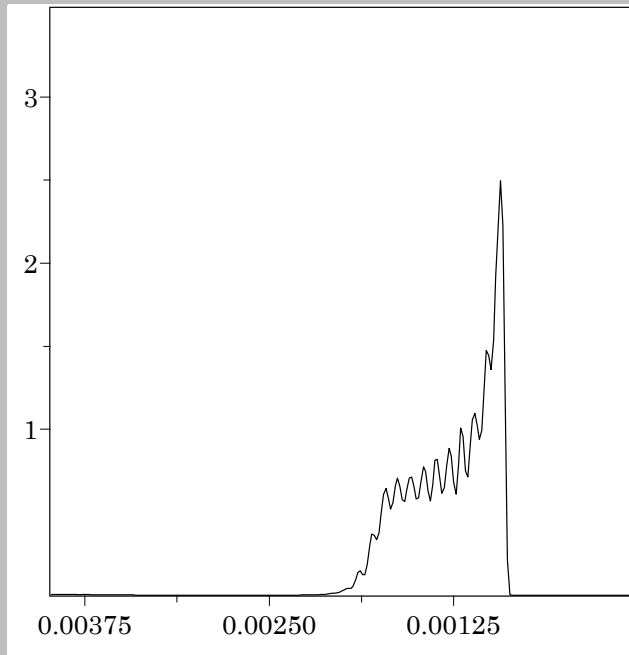
1.5

2.5





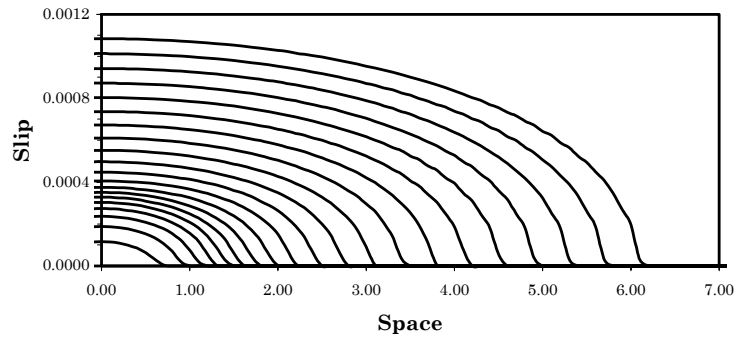
# Healing with RS #2



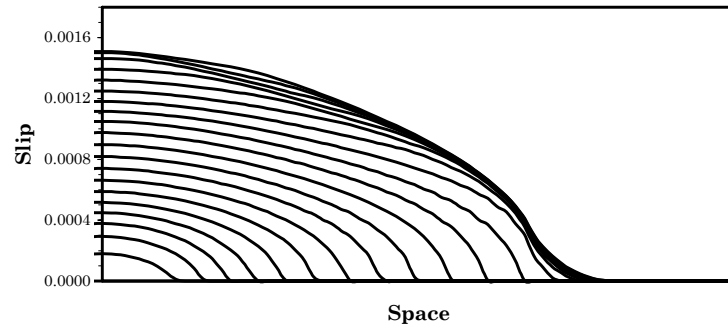


# Healing with RS #3: DRF

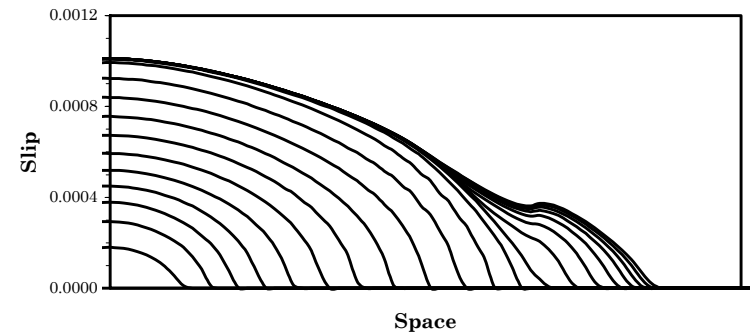
**Classical enlarging crack**



**Barrier - healing**

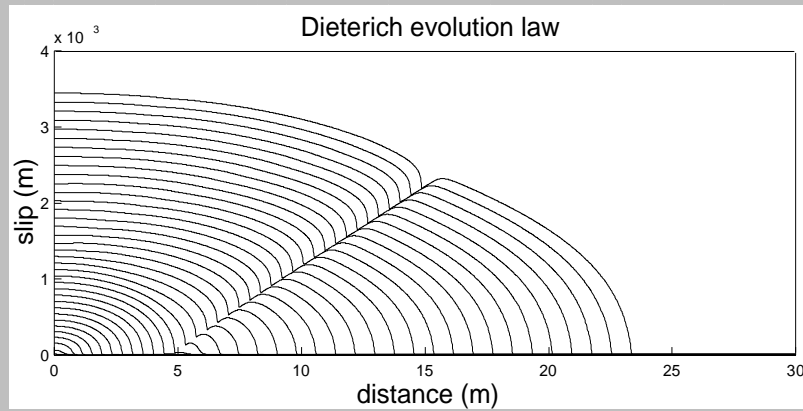


**Self - healing**



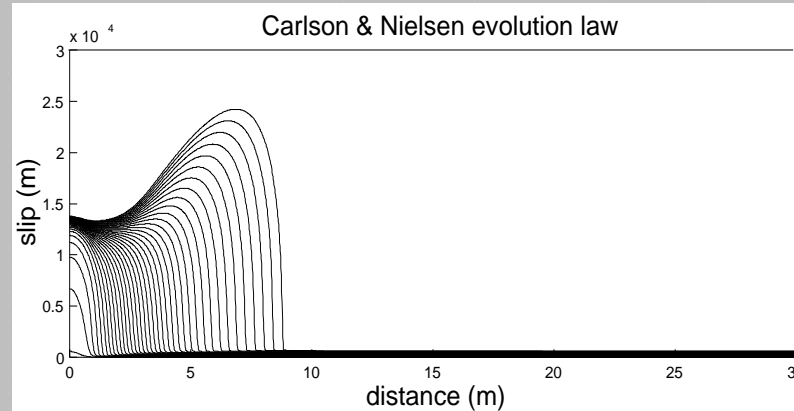


# Healing with RS #4

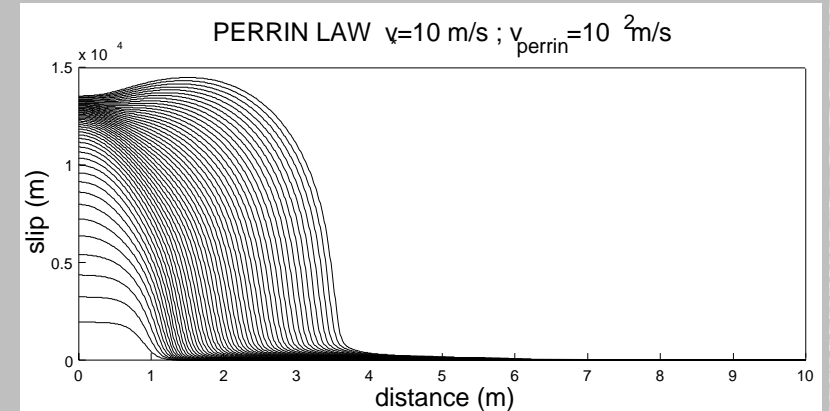


**Classical enlarging crack**

**Self – healing with Carlson’s law**



**Self – healing with Perrin’s law**



**This slide is empty intentionally.**

