

An aerial photograph of a coastal wetland or estuary. The landscape is a mix of dark, muddy water channels and lighter, sandy or silty areas. The water channels are irregular and interconnected, creating a complex network. The overall color palette is muted, with various shades of grey, brown, and beige. A semi-transparent grey rectangular box is centered over the image, containing the word "Convergence" in a bold, red, sans-serif font.

Convergence

CONVERGENCE

CONSISTENCY REQUIREMENTS

- As the size of the elements (i. e. the *discretization*) tends to zero, the approximated equations will represent the exact differential equations to be solved and the boundary conditions

STABILITY CONDITIONS

- The solution of the discrete equation system is unique
- Avoid spurious mechanisms which may pollute the solutions for all sizes of elements



CONVERGENCE

- **How good** the approximation is;
- How can it **systematically improved** to approach the *exact* solution of the problem.



Convergence conditions for BLE with SW constitutive law

Uniqueness of the solution in the integration of linear system (Andrews, 1985; B2001)

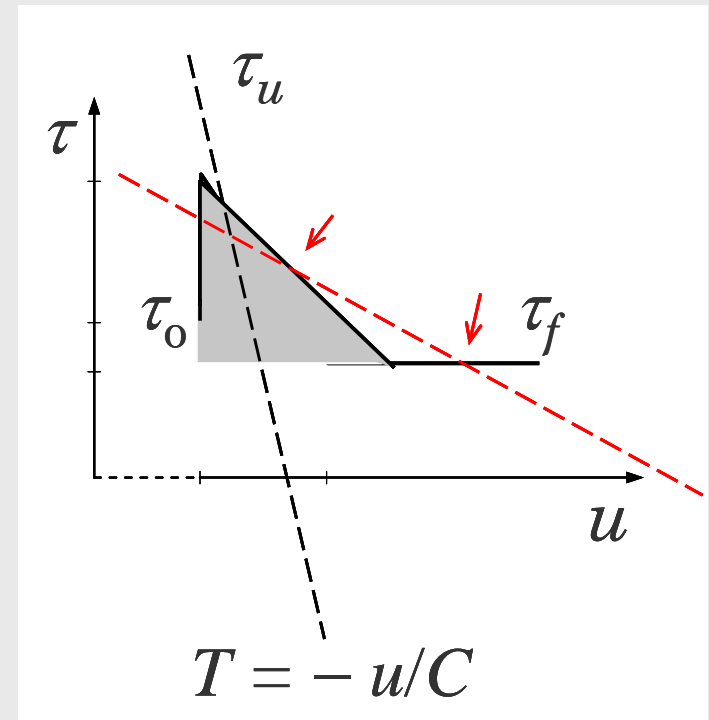
$$\Delta x < -\frac{v_P \mu}{\beta \frac{dS}{du}} \Leftrightarrow \frac{L_c^{(II)}}{\Delta x} > \frac{2}{\pi} \frac{a-1}{\sqrt{a}} (1+S)^2; a^2 = \alpha/\beta$$

Resolution of the cohesive zone

$$\Delta t \ll T_b \quad \text{or} \quad \Delta x \ll X_b$$

First neighbours decoupling

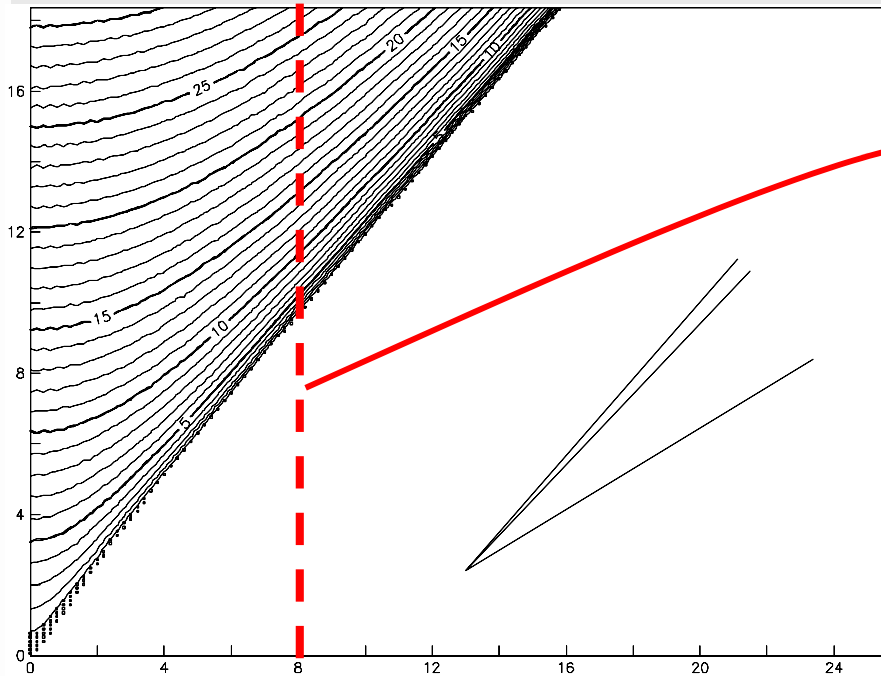
$$\Delta t \ll \Delta x / v_P$$





Convergence – Example #1: No resolution of the cohesive zone

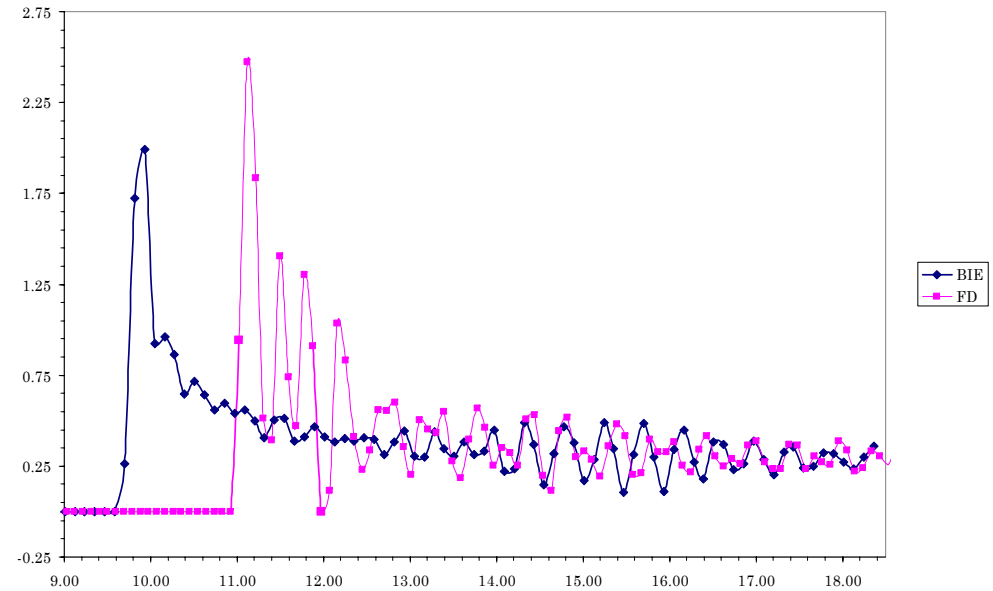
Slip



Space

BIE and FD 2 – D simulations with the classical slip – weakening law.

Slip velocity



Time



Convergence conditions for FD with RS constitutive law

Continuum approximation (Rice, 1993)

$$k_{diag} \gg k_{cr} \quad \Delta t \ll \Delta t^* \quad \text{or} \quad \Delta x \ll \Delta x^*$$

$$\Delta t^* = \frac{v_S \rho L}{(b-a) \sigma_n^{eff}} \quad \text{or, alternatively,} \quad \Delta x^* = \frac{v_S^2 \rho L}{w_{CFL} (b-a) \sigma_n^{eff}}$$

Resolution of the cohesive zone

$$\Delta t \ll T_b^{eq} \quad \text{or} \quad \Delta x \ll X_b^{eq}$$

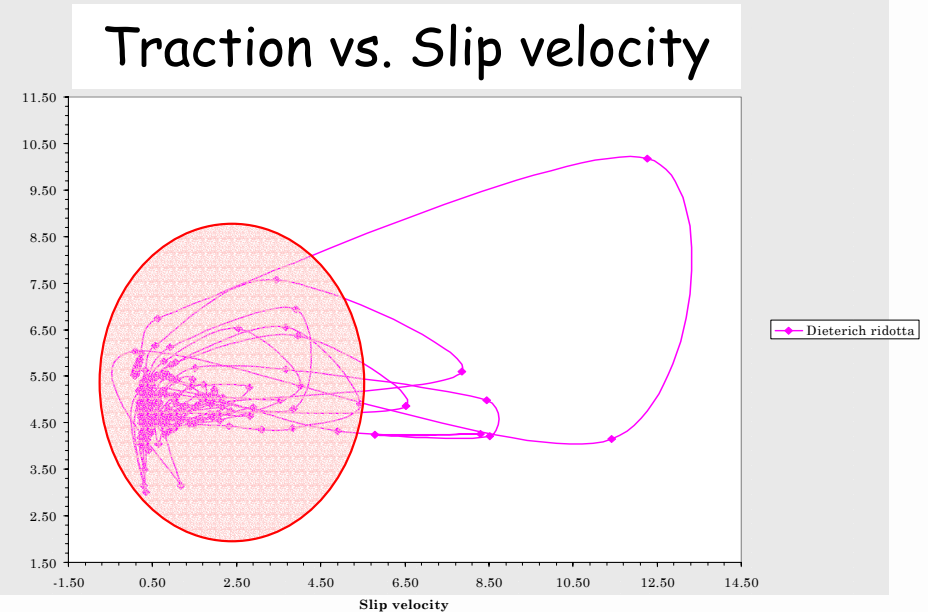
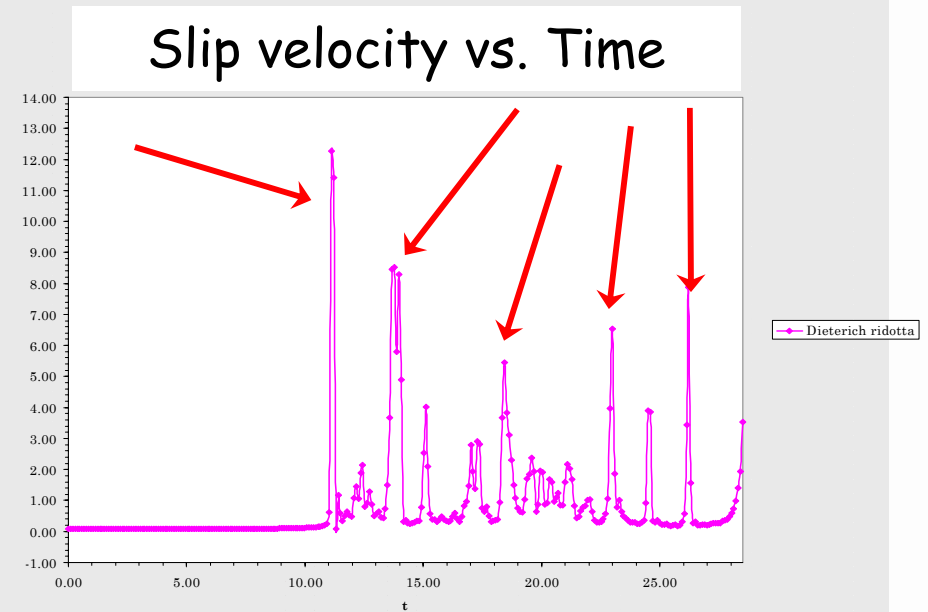
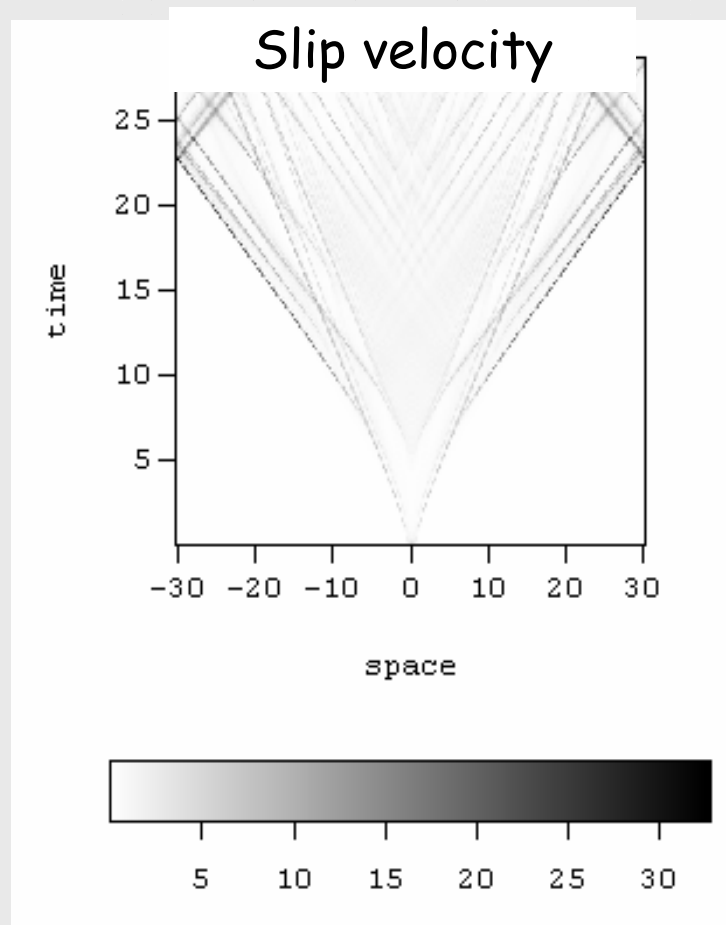
First neighbours decoupling

$$\Delta t \ll \Delta x / v_P$$



Convergence – Example #2: Continuum approximation violation

FD 2 – D simulations with Dieterich in reduced form friction law.



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