Exploring complex normal faulting systems through physics-based dynamic rupture modeling.

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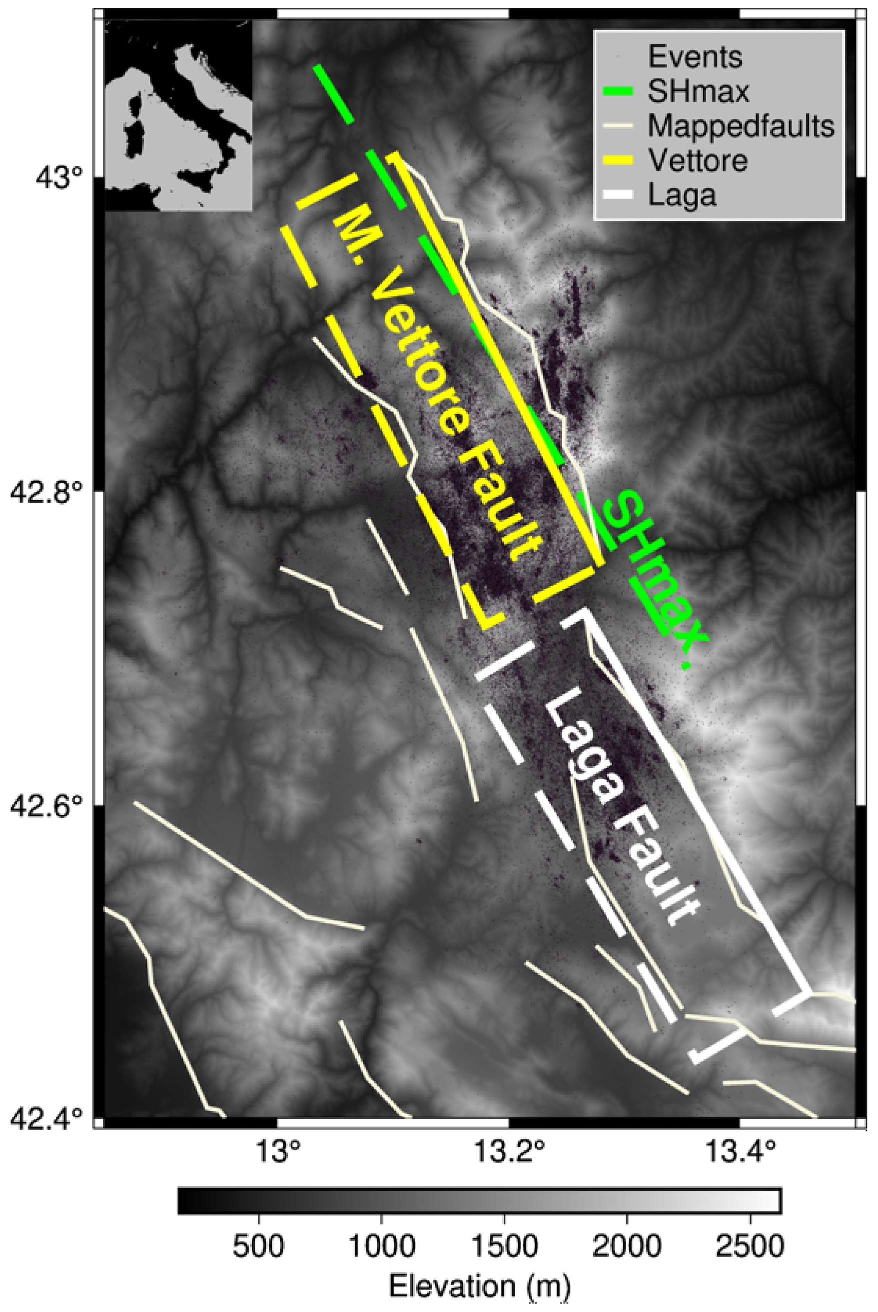
1. Introduction

Norcia-Amatrice-Visso



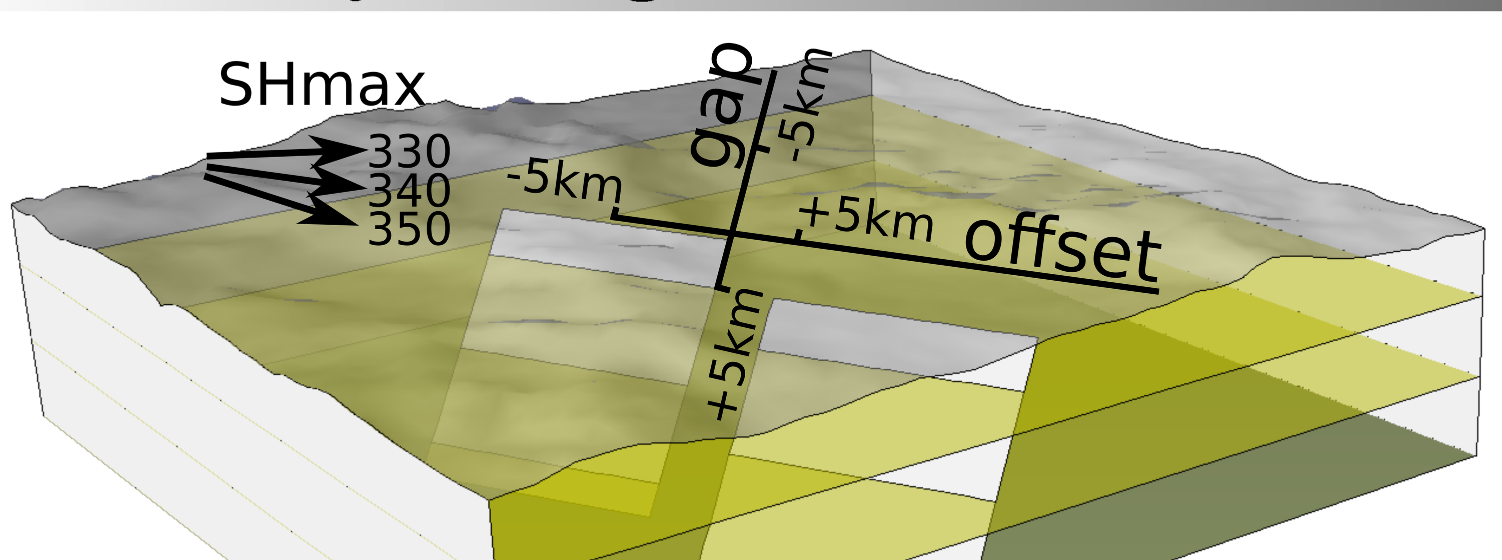
Geological context:

The Apennine seismic belt in Italy is an extensional province characterized by multi-fault normal-faulting seismic activity. Earthquakes and/or seismic sequences ocurring across multi-fault segments during a single event (e.g. 1980 Ms 6.9 Irpinia Bernanrd & Zollo (1989)) or sequences spanning a period of days (e.g. 2009 Mw 6.1 L'Aquila Valoroso et al (2013)) to months (e.g. 2016 Amatrice-Visso-Norcia Improta et al. (2019)), are controlled by the physical complexities of the active normal fault system.

Understanding rupture propagation across step overs, breaking multiple fault segments during a single earthquake, is crucial to enhance the current seismic hazard assessment Bai and Ampuero (2017).

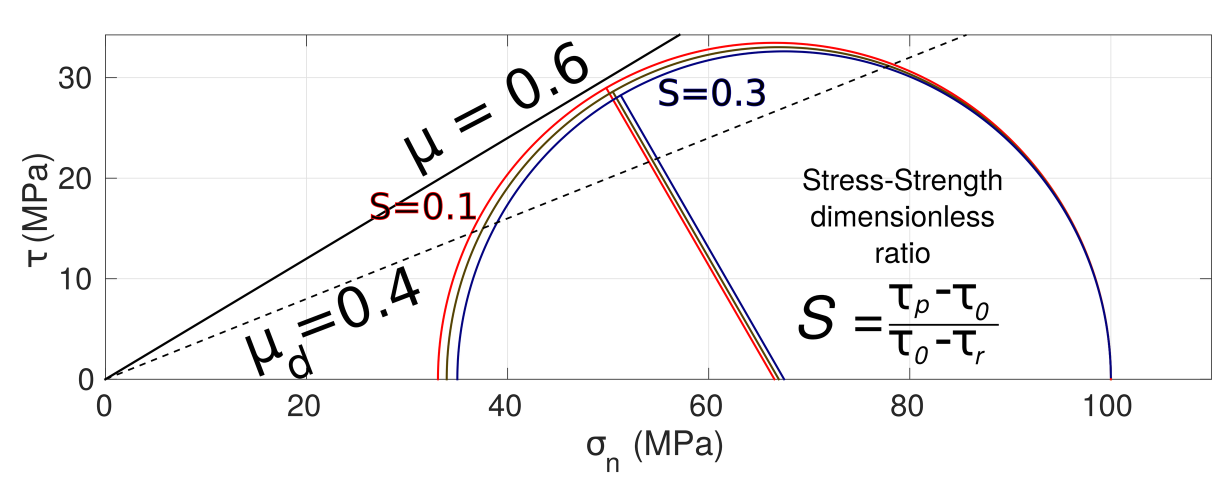
Goal: Explore dynamic rupture parameters to better understand the physical condition promoting rupture jumps in normal faulting systems

2. Geometry-Settings



Parameters	Range
Offset distance	-5:+2.5:+5 km
Gap distance	-5:+1:+5 km
SHmax	335º:5º:355º
S parameter	0.1, 0.2, 0.3

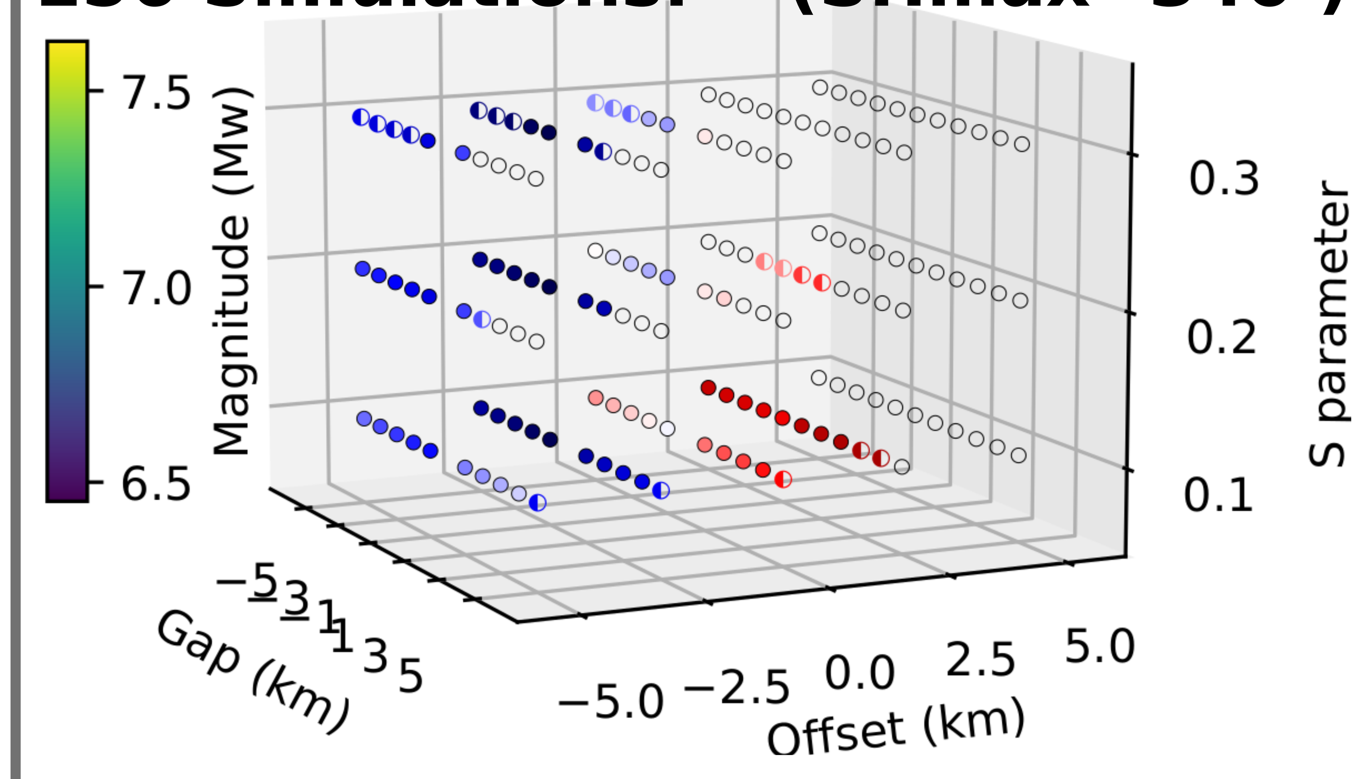
2 Faults:
size: 10X10 km
$\mu_s = 0.6$
$\mu_d = 0.4$



$$S = \frac{\tau_p - \tau_0}{\tau_0 - \tau_r}$$

3. Simulation-Results

156 Simulations: (SHmax=340º)



156 Simulations were performed using this configuration, where S depends only on the stress level and not on μ_s or μ_d. In some cases, the rupture did not fully break both faults, mainly due to the pre-stress level of the faults.

Hanging/foot wall asymmetry:

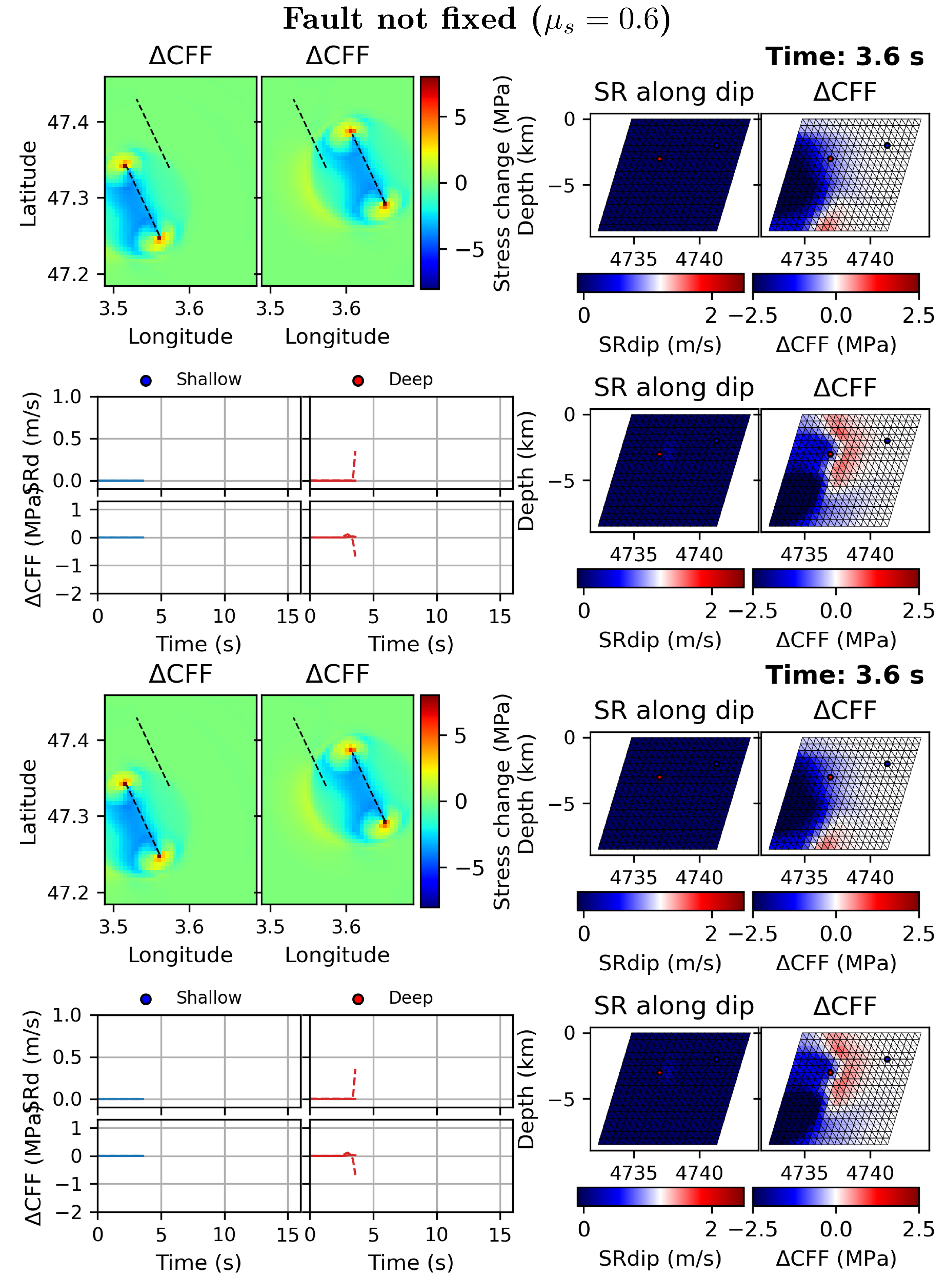
A small asymmetry regarding the triggering potential of the secondary fault related to its location with respect to the main fault (hanging or foot wall) is observed. When the secondary fault is on the hanging wall, the dynamically triggered rupture is more likely to be self-sustainable.

Stress shadow:

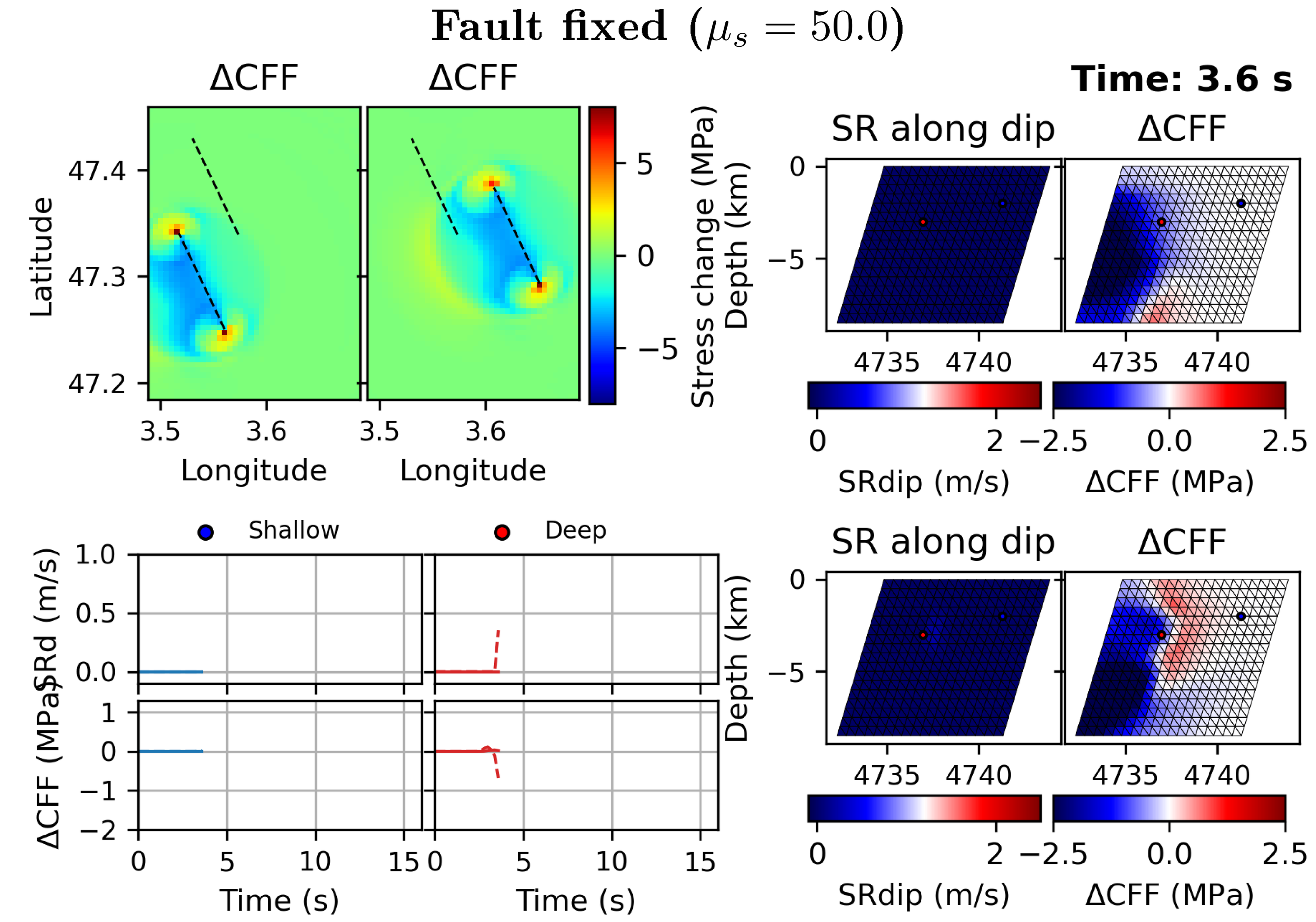
The final energy released (estimated magnitude) increases/decreases according to the distance between faults (i.e. offset and gap). Although the overlap increases the triggering effect, the stress shadow, due to the fault proximity, inhibits a large stress drop on the secondary fault.

4. Jump ? How ? When ? Why ?

Fault not fixed ($\mu_s = 0.6$)



Fault fixed ($\mu_s = 50.0$)



References

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