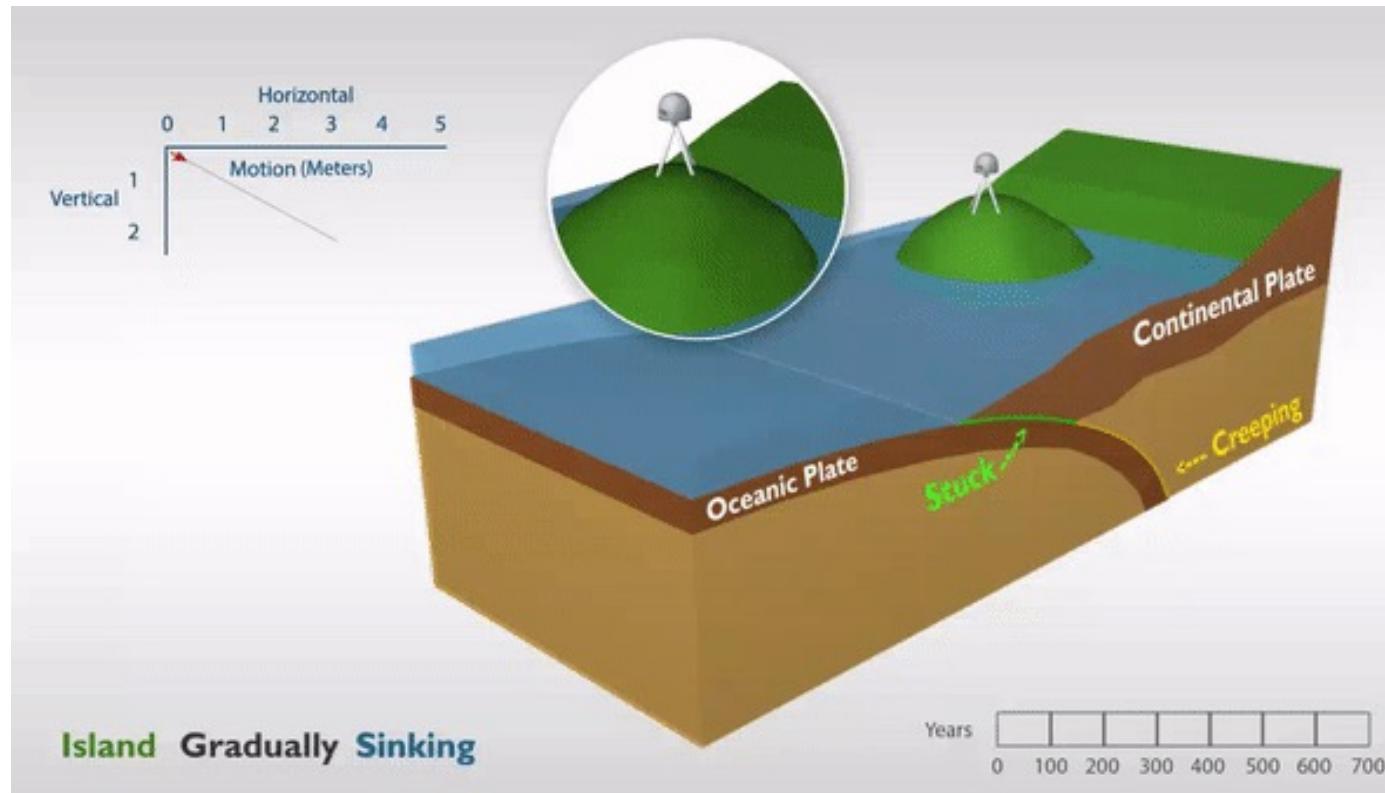


THE STANDARD ELASTIC EARTHQUAKE CYCLE MODEL



Long-term: downgoing plate descends beneath the upper plate in stick-slip fashion.

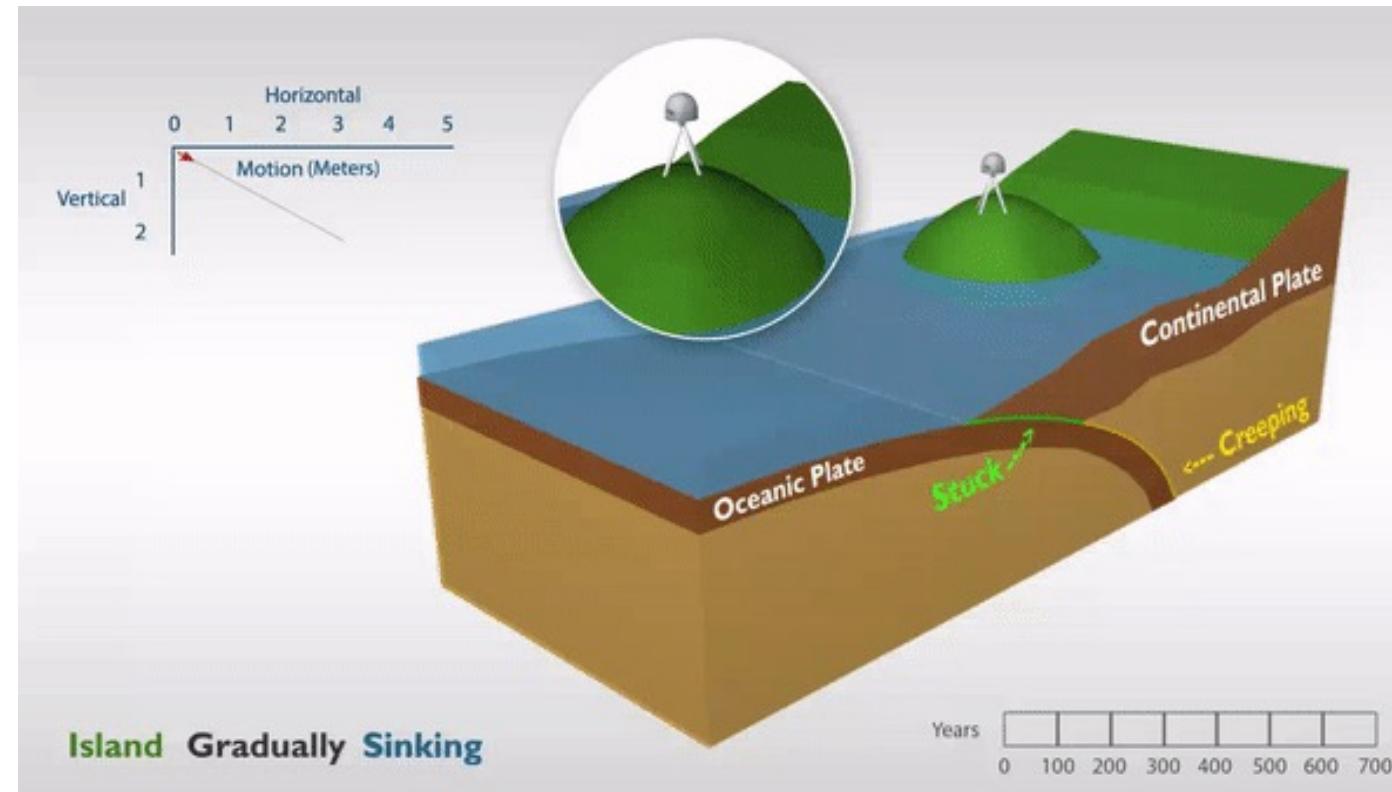
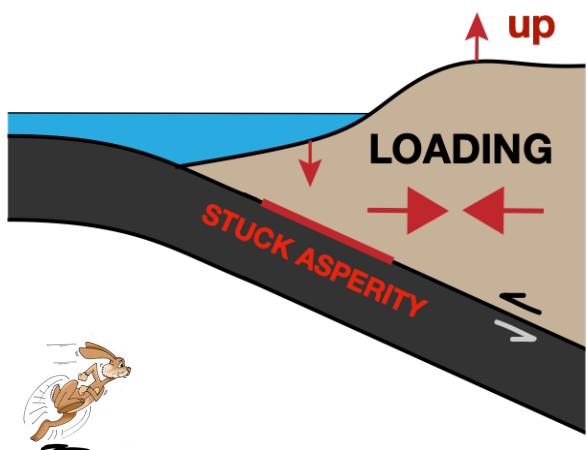


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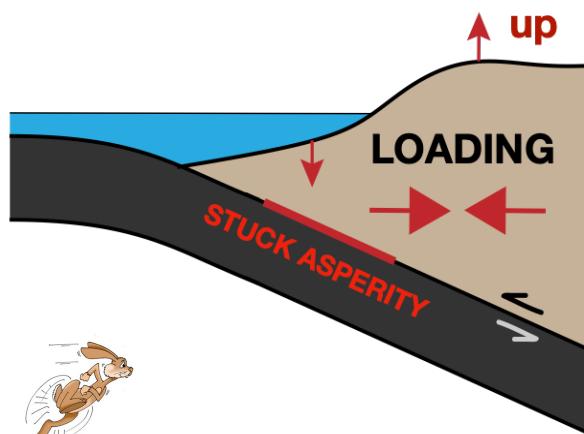
Interseismic: locked section is “stuck”. Creeping section moves slowly. Upper plate deform elastically.



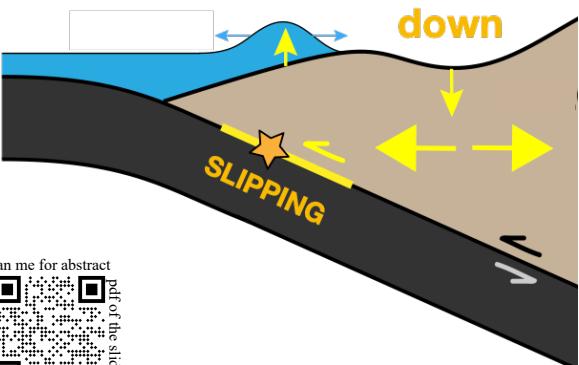
THE STANDARD ELASTIC EARTHQUAKE CYCLE MODEL



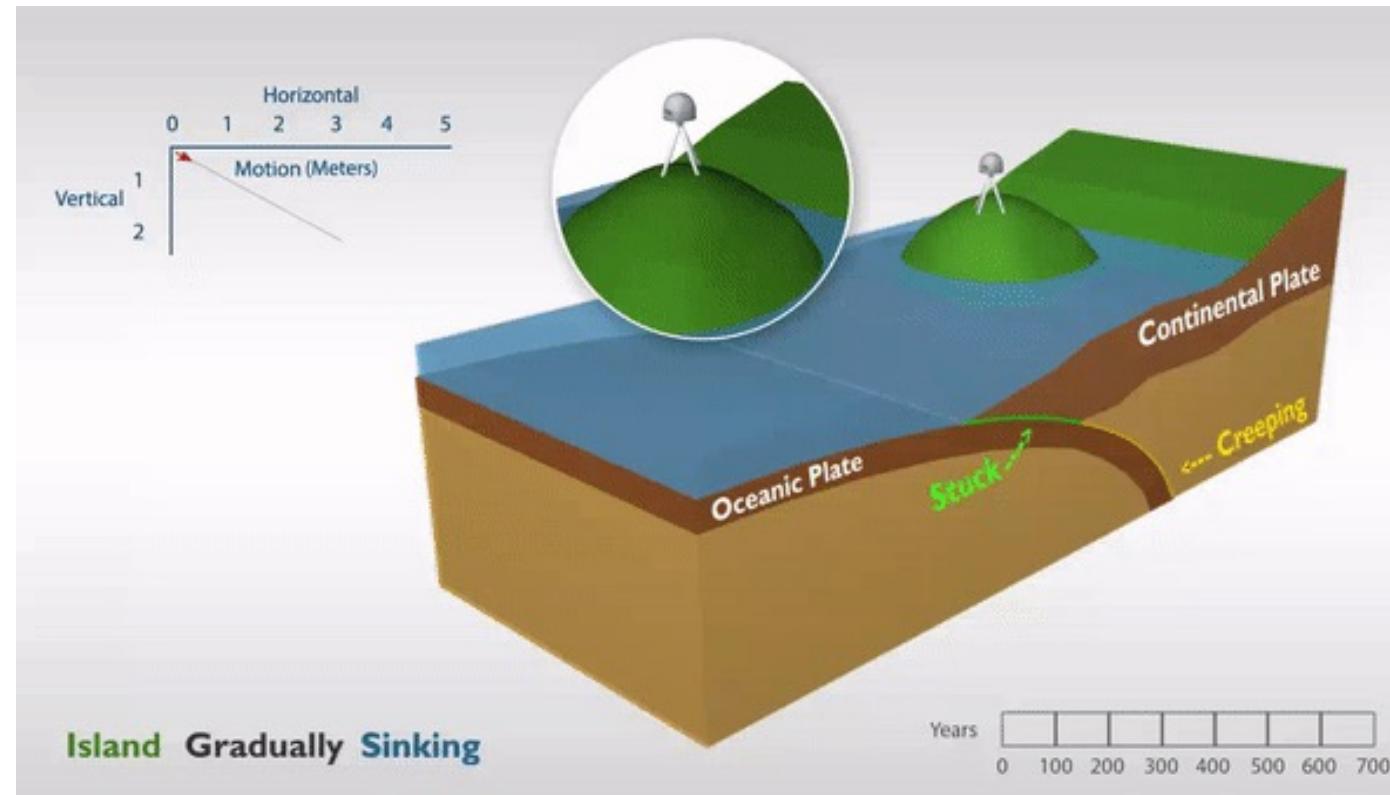
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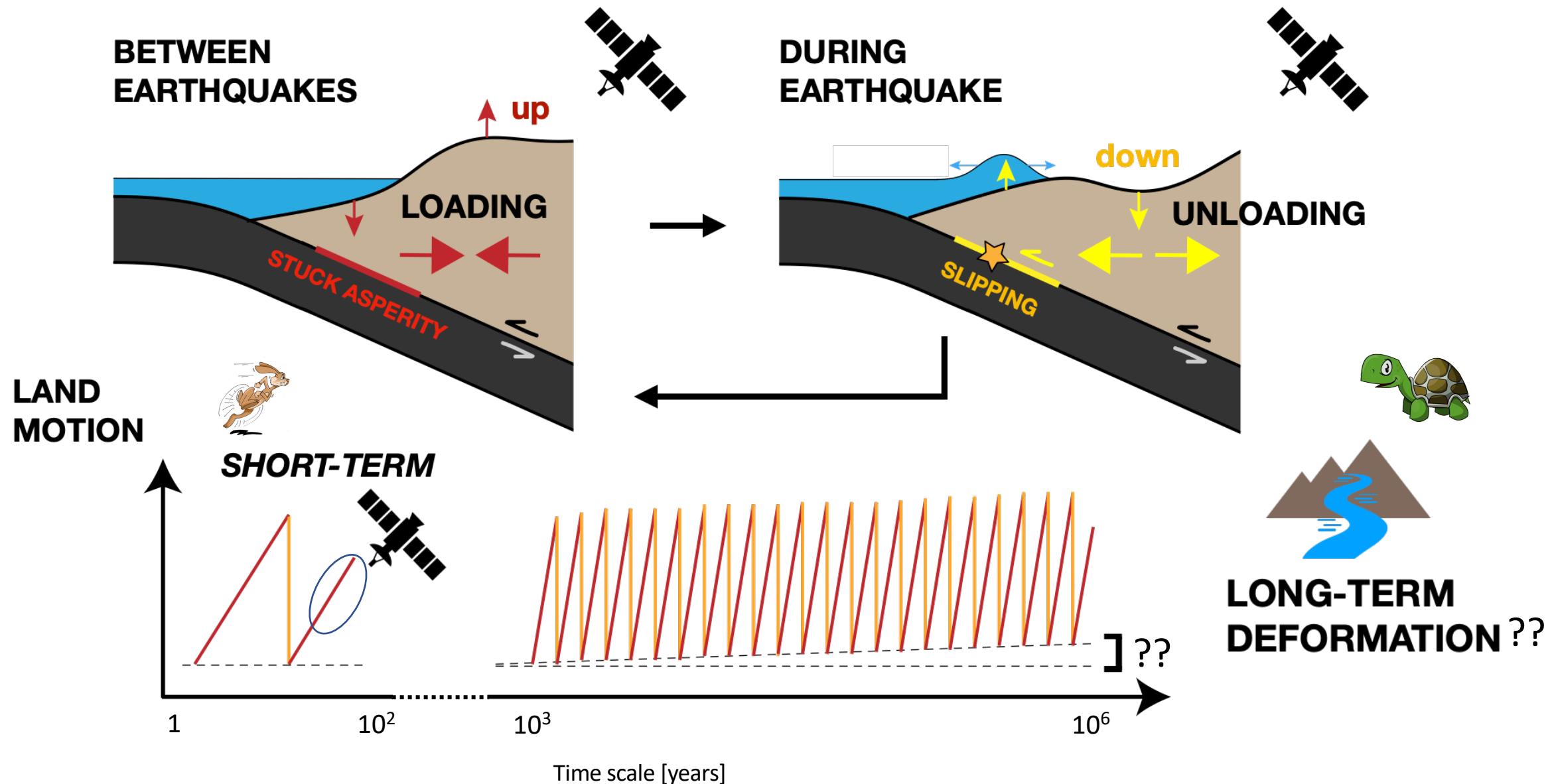


Coseismic: locked section moves abruptly. Upper plate deform elastically in an opposite sense.

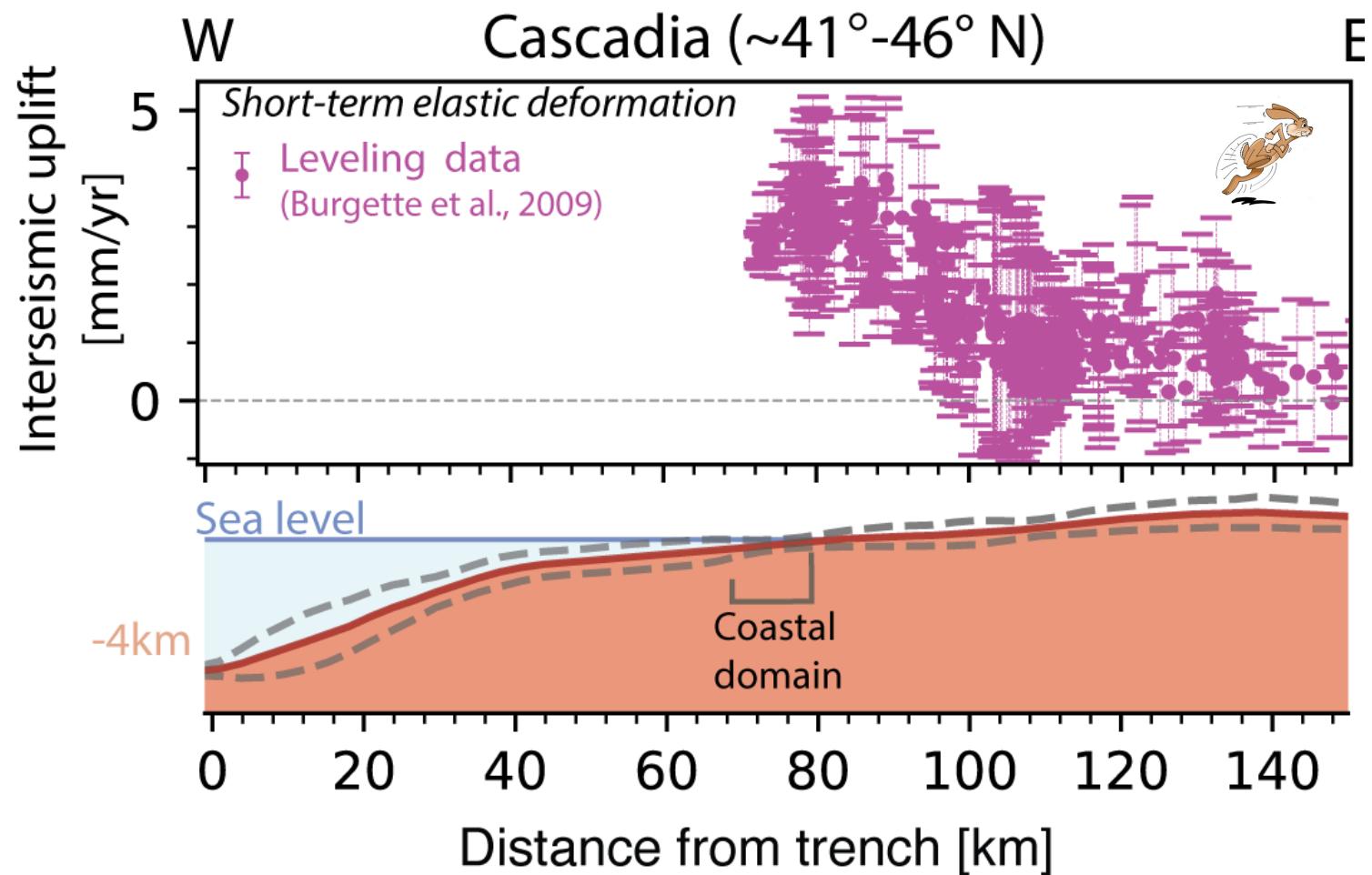


No off-fault permanent deformation!

SHORT- AND LONG-TERM DEFORMATION DURING EARTHQUAKE CYCLES

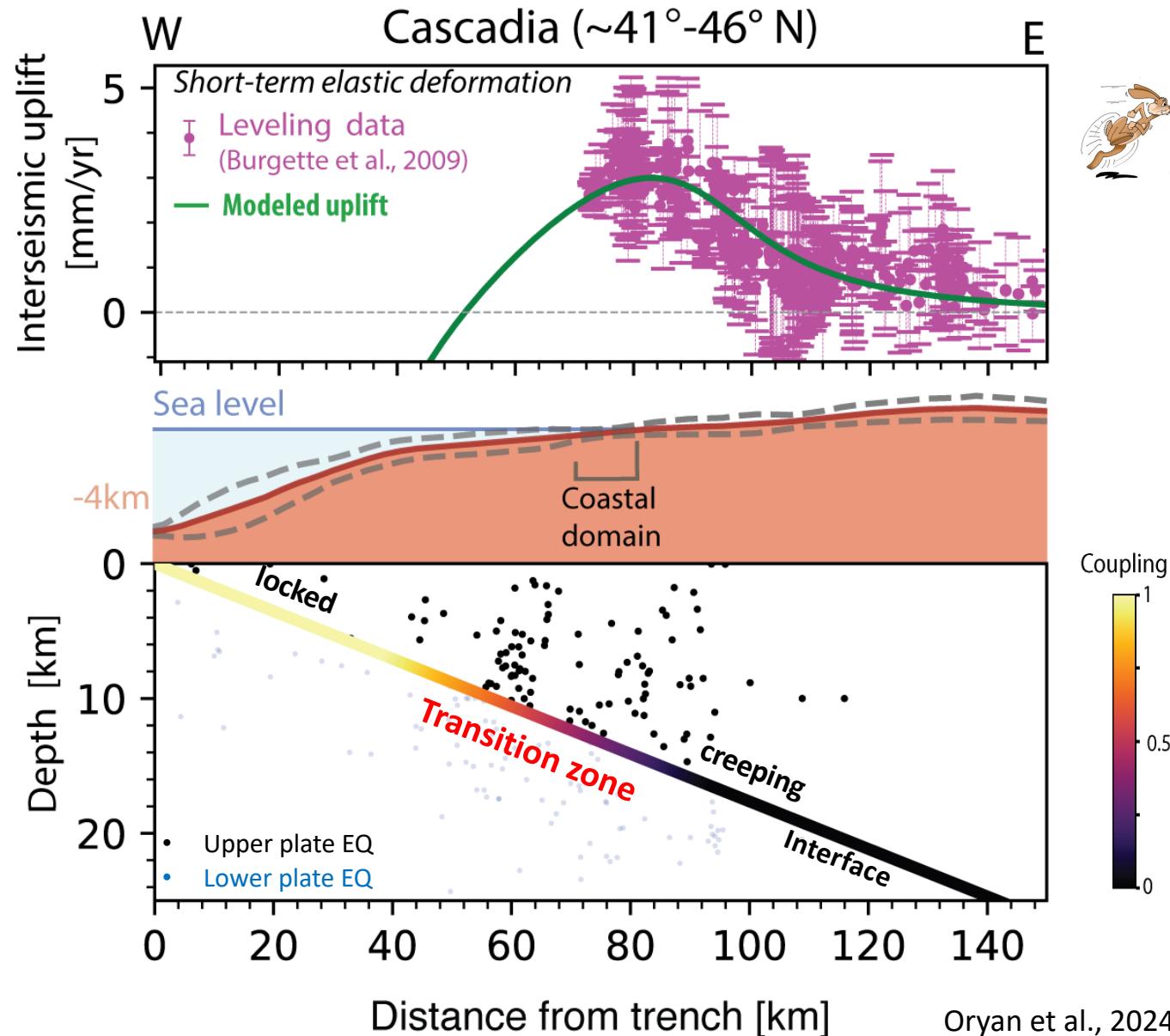


SHORT-TERM DEFORMATION IN CASCADIA



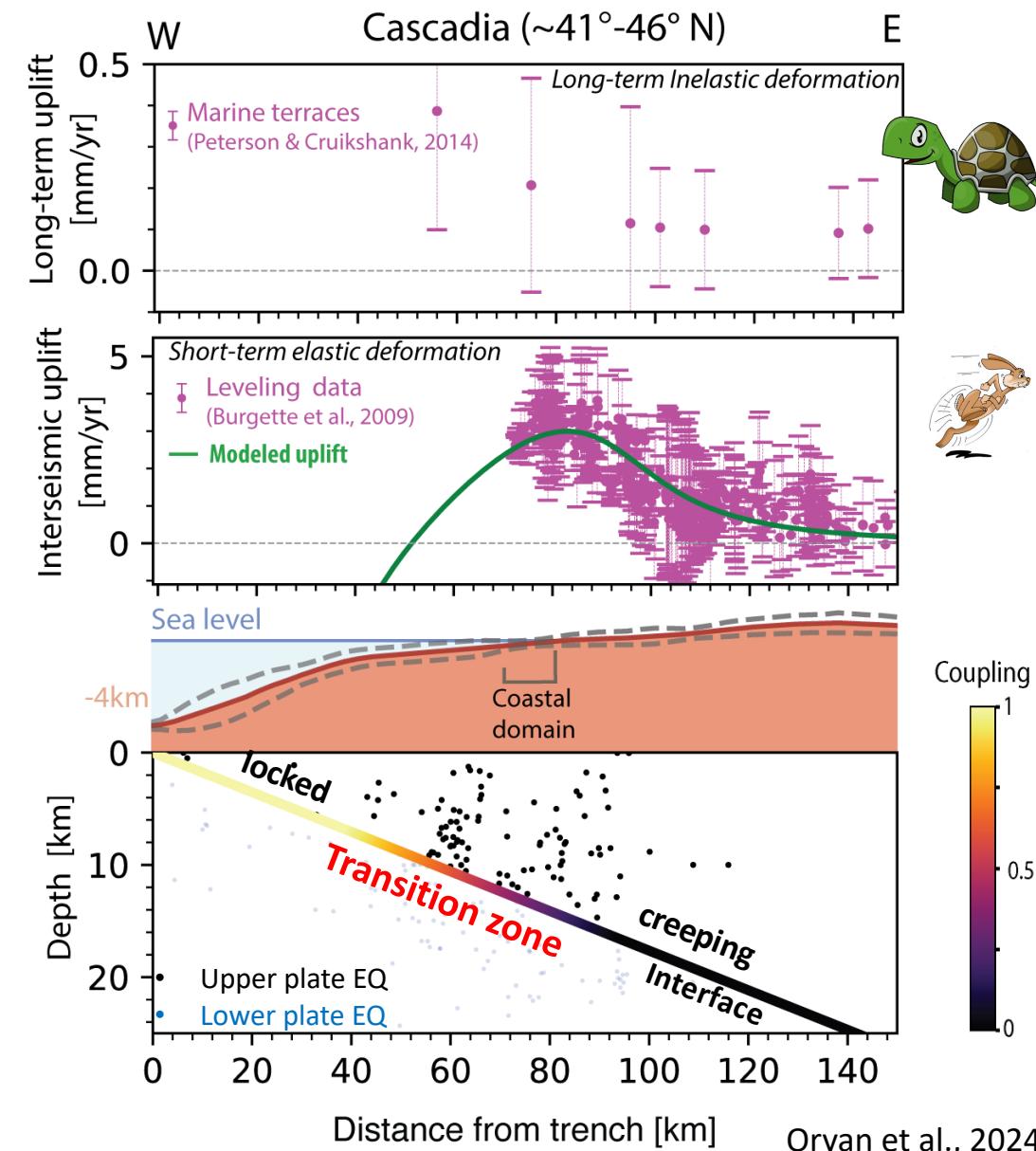
SHORT-TERM DEFORMATION IN CASCADIA

- **Short-term (elastic) uplift** shows a peak above the transition zone.



SHORT- AND LONG-TERM DEFORMATION IN CASCADIA

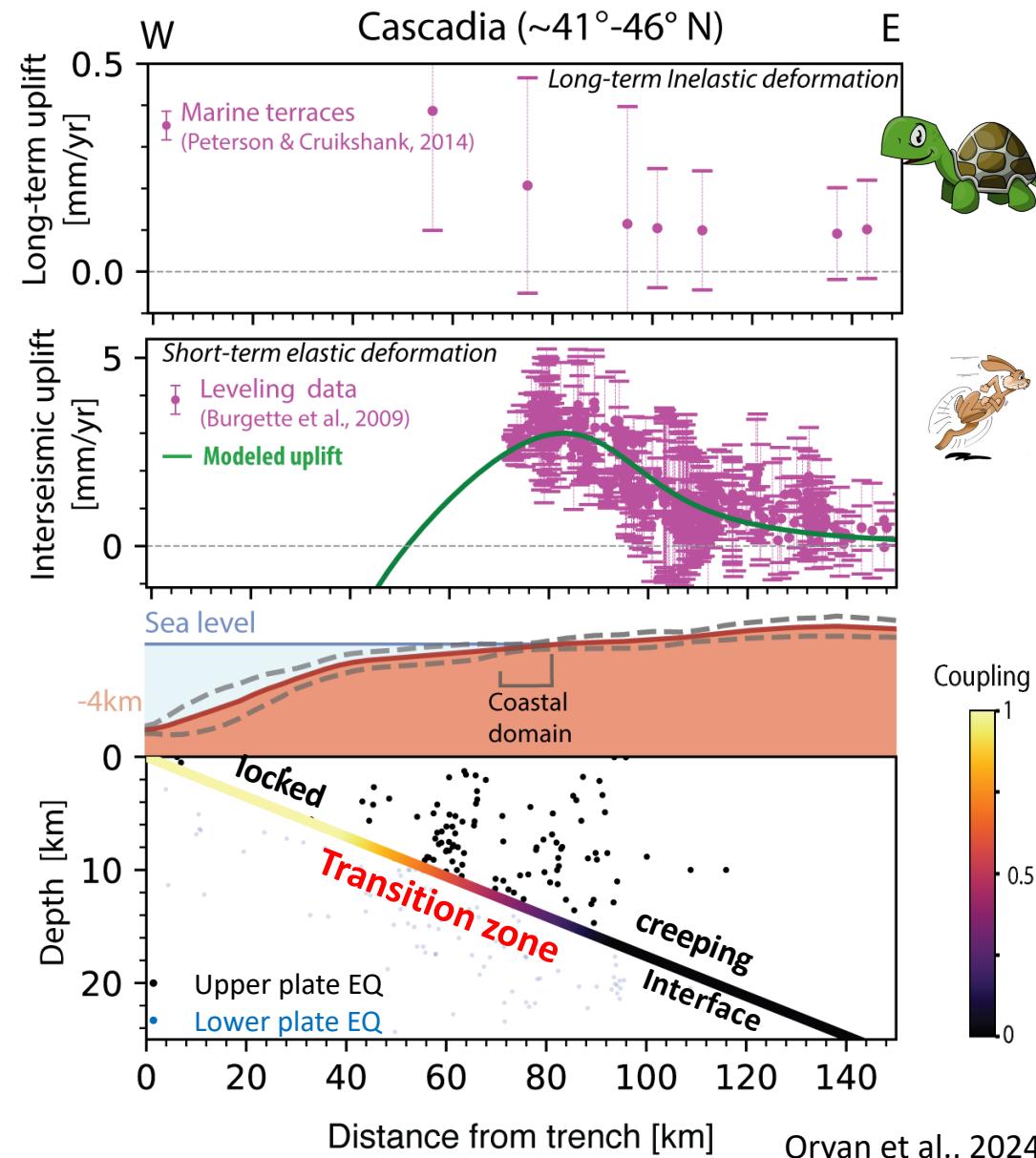
- **Short-term (elastic)** uplift shows a peak above the transition zone.
- **Long-term (inelastic)** uplift aligns with the short-term deformation, peaking above the transition zone.



SHORT- AND LONG-TERM DEFORMATION IN CASCADIA

- **Short-term (elastic)** uplift shows a peak above the transition zone.
- **Long-term (inelastic)** uplift aligns with the short-term deformation, peaking above the transition zone.
- **Upper plate seismicity (inelastic)** is concentrated above the transition zone.

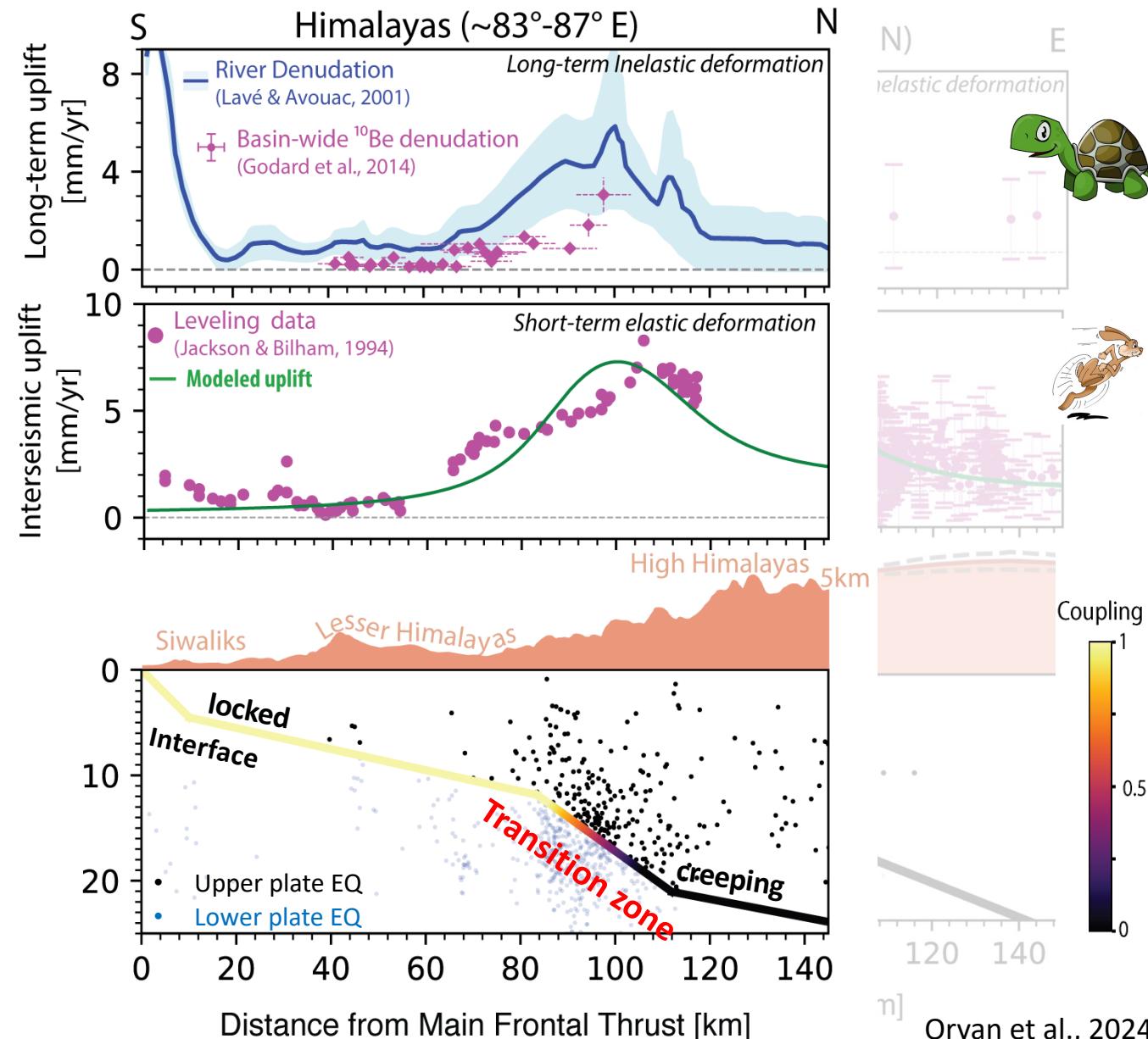
Short- (elastic) and Long-term (inelastic) deformation coincide.



SHORT- AND LONG-TERM DEFORMATION IN HIMALYAS

- **Short-term (elastic) uplift** shows a peak above the transition zone.
- **Long-term (inelastic) uplift** aligns with the short-term deformation, peaking above the transition zone.
- **Upper plate seismicity (inelastic)** is concentrated above the transition zone.

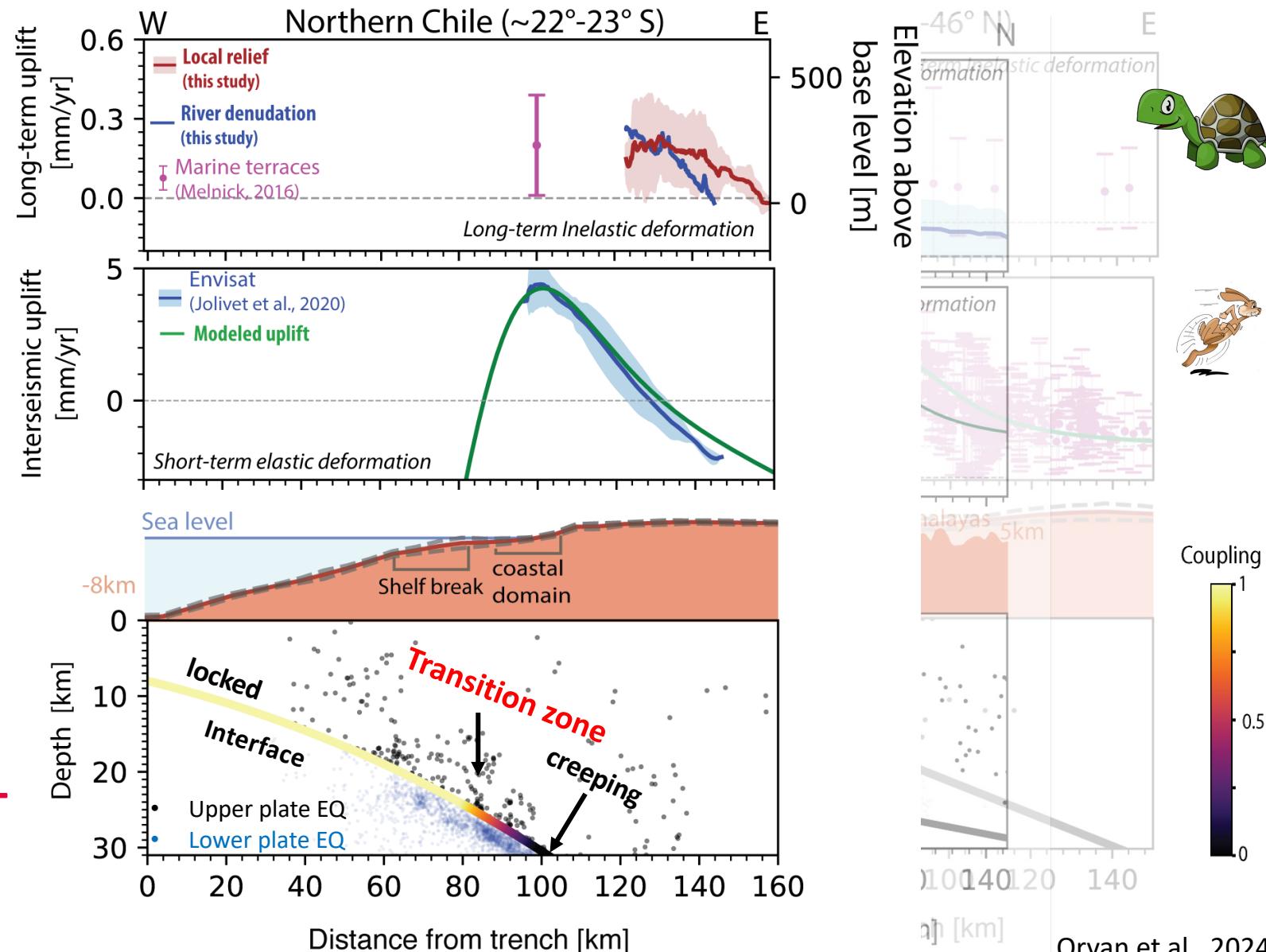
Short- (elastic) and Long-term (inelastic) deformation coincide.



SHORT- AND LONG-TERM DEFORMATION IN CHILE

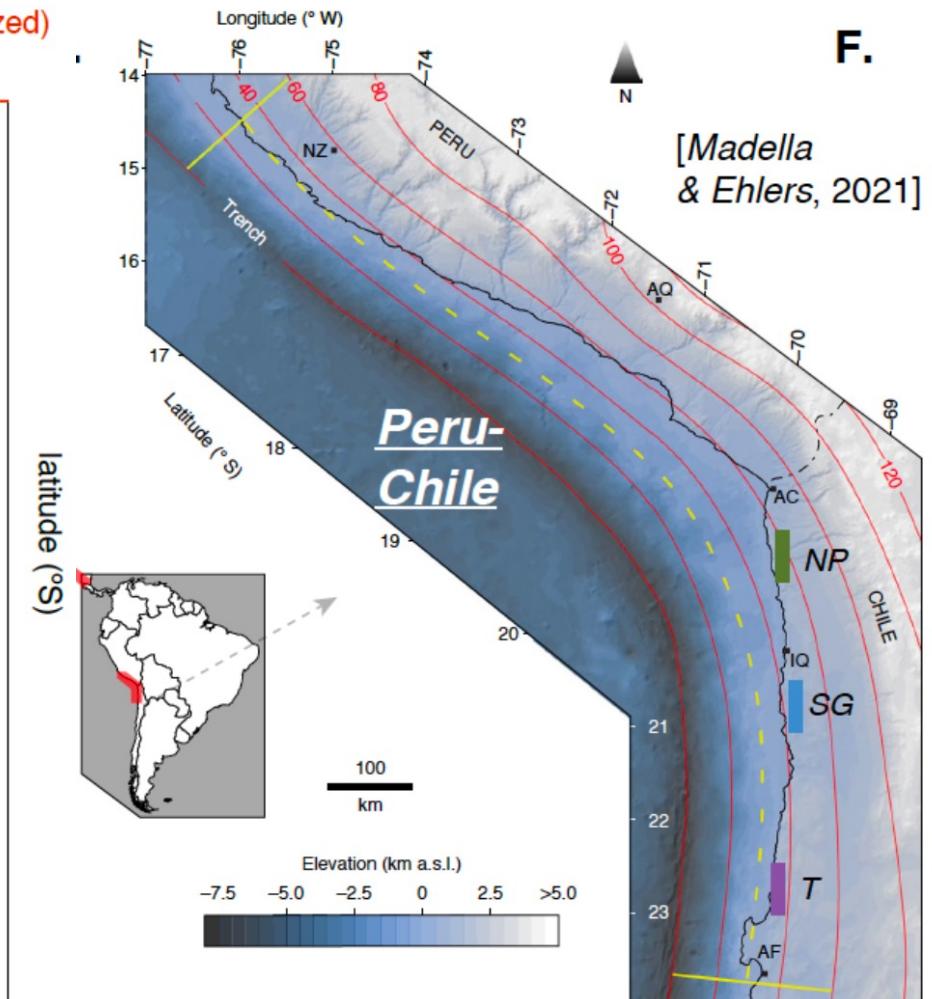
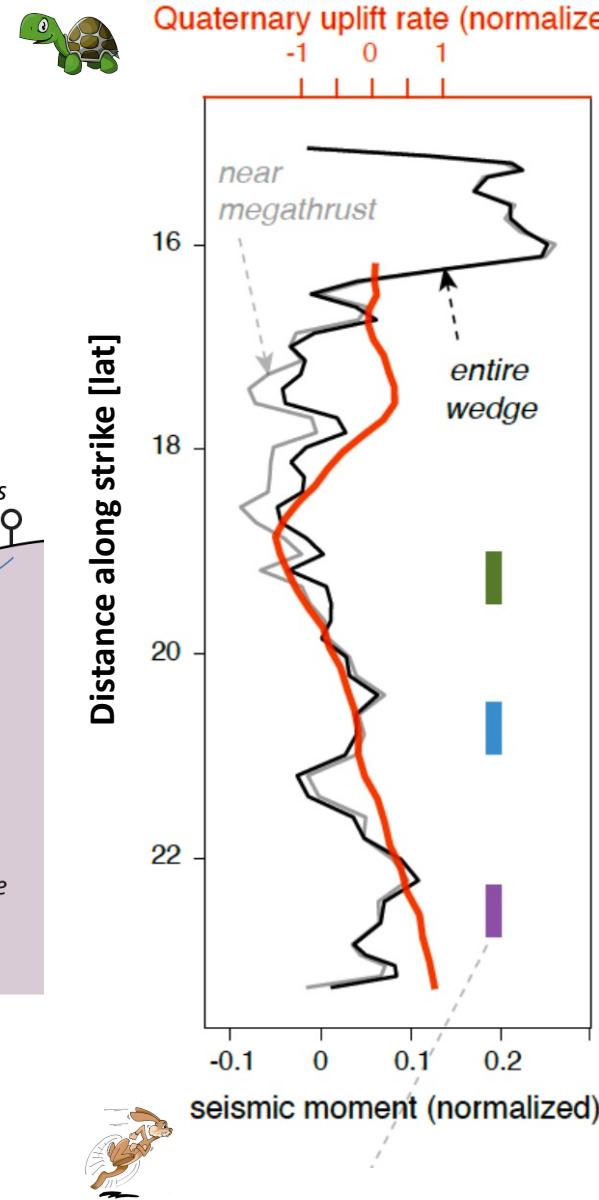
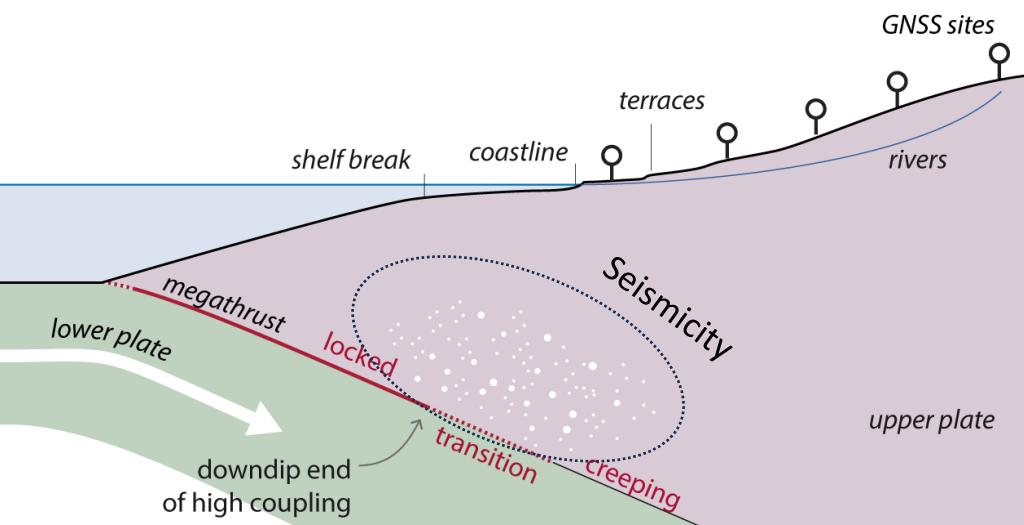
- Short-term (**elastic**) uplift shows a peak above the Transition zone.
- Long-term (**inelastic**) uplift aligns with the short-term deformation, peaking above the transition zone.
- Upper plate seismicity (**inelastic**) is concentrated above the transition zone.

Short- (elastic) and Long-term (inelastic) deformation coincide.



UPPER PLATE SEISMISTY AND LONG-TERM UPLIFT IN CHILE

Moment release of earthquakes within a distance of 15km of the interface correlates with long-term coastal uplift rates along the coast of Chile.

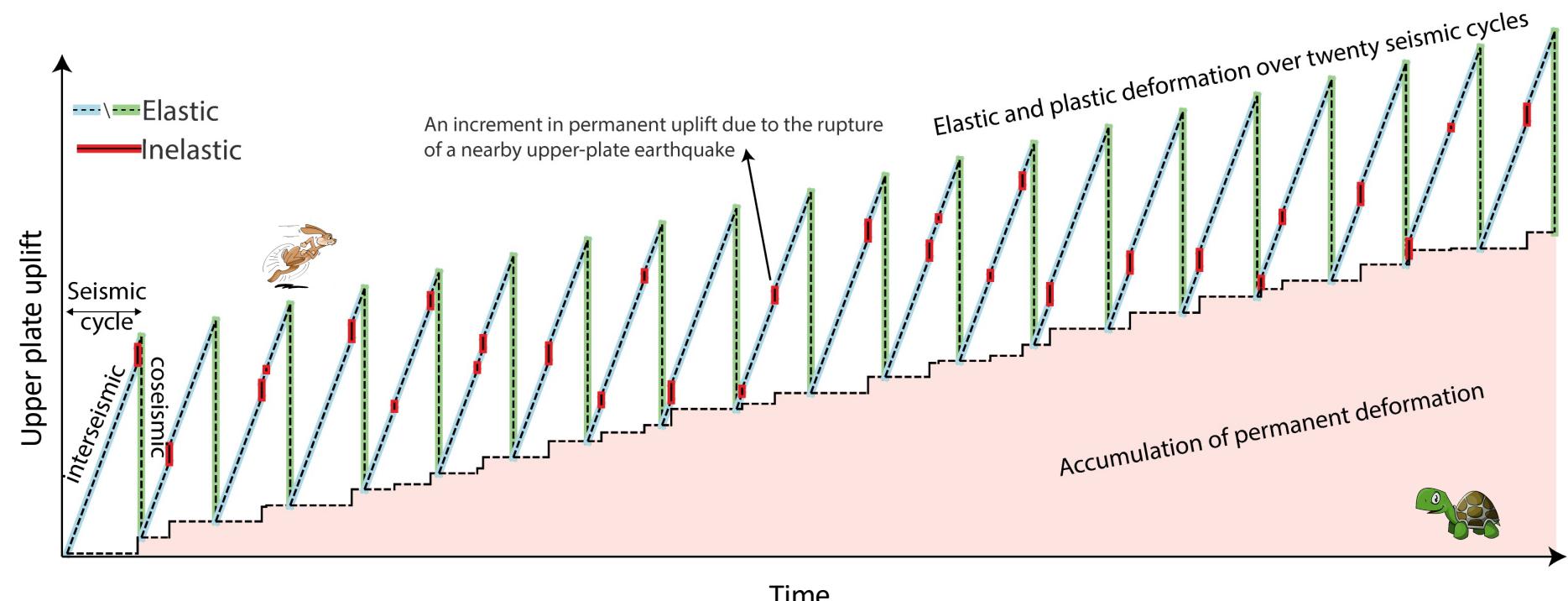


Regions of active upper plate faulting:

North Pisagua Salar Grande Tocopilla

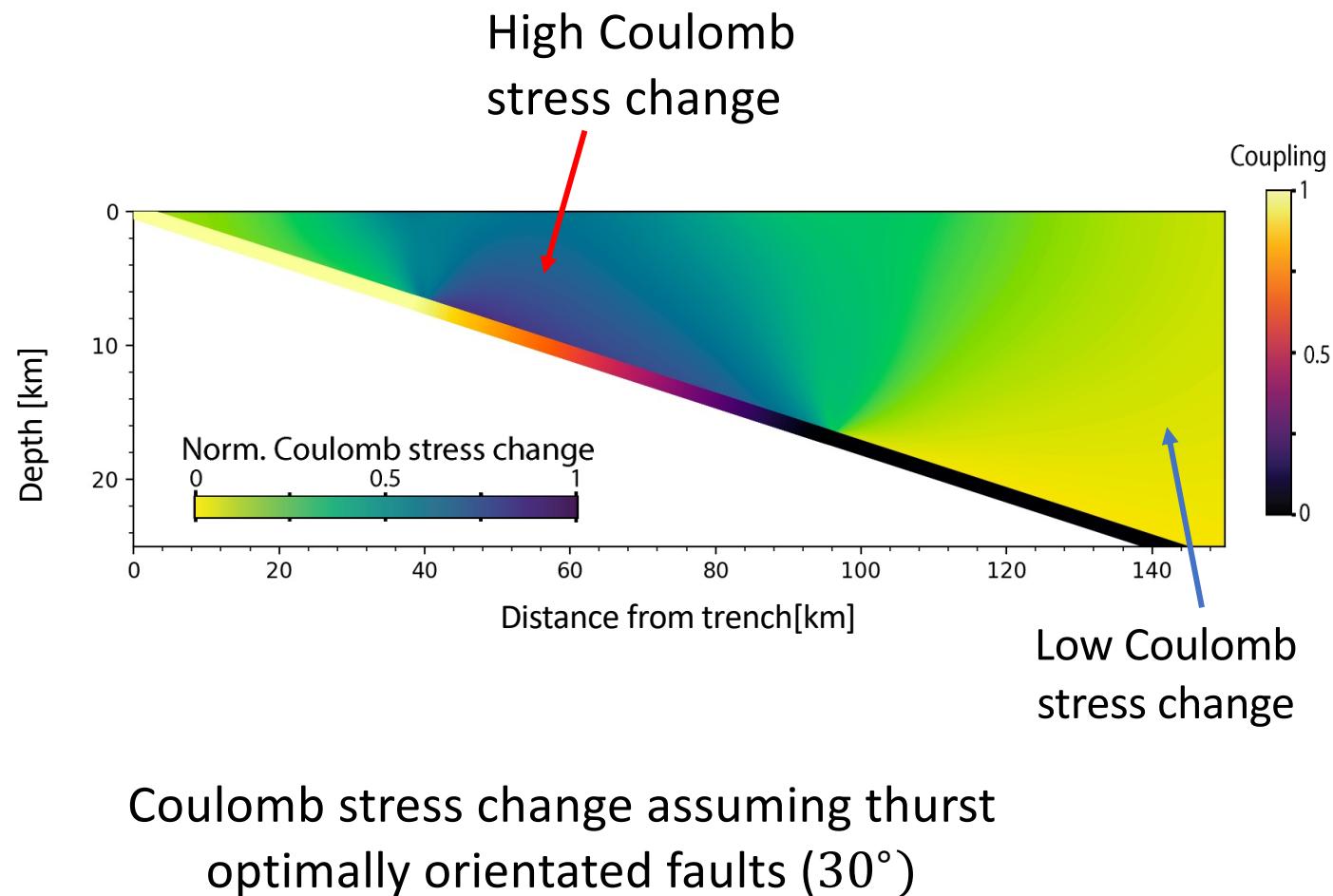
HOW INTERSEISMIC FAULT LOCKING IMPRINTS FOREARCS ?

- **Upper plate stresses** induced by locking gradients push parts of the upper plate to **failure** during the interseismic period.
- Repeated **failure** over multiple earthquake cycles may explain the overlap between short- and long-term deformation.



MODELING INTERSEISMIC INELASTIC DEFORMATION ACROSS UPPER PLATES

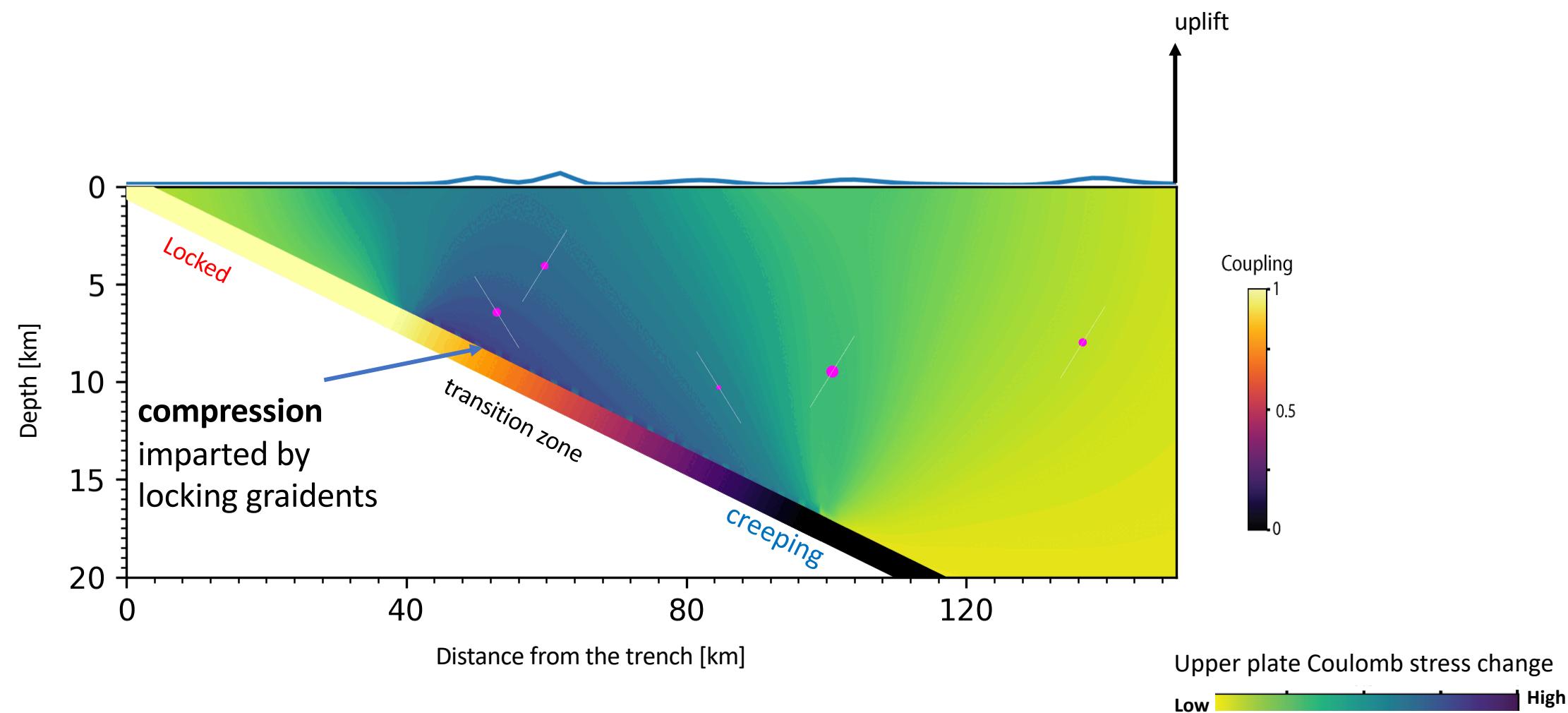
- We compute upper plate Coulomb stress change imparted by locking gradients.
- We link stresses and seismicity [Dieterich, 1994] and populate millions of synthetic earthquakes spanning thousands of years and dozens of seismic cycles according to the Coulomb stress change.
- We use the Okada solution to sum events surface displacement.



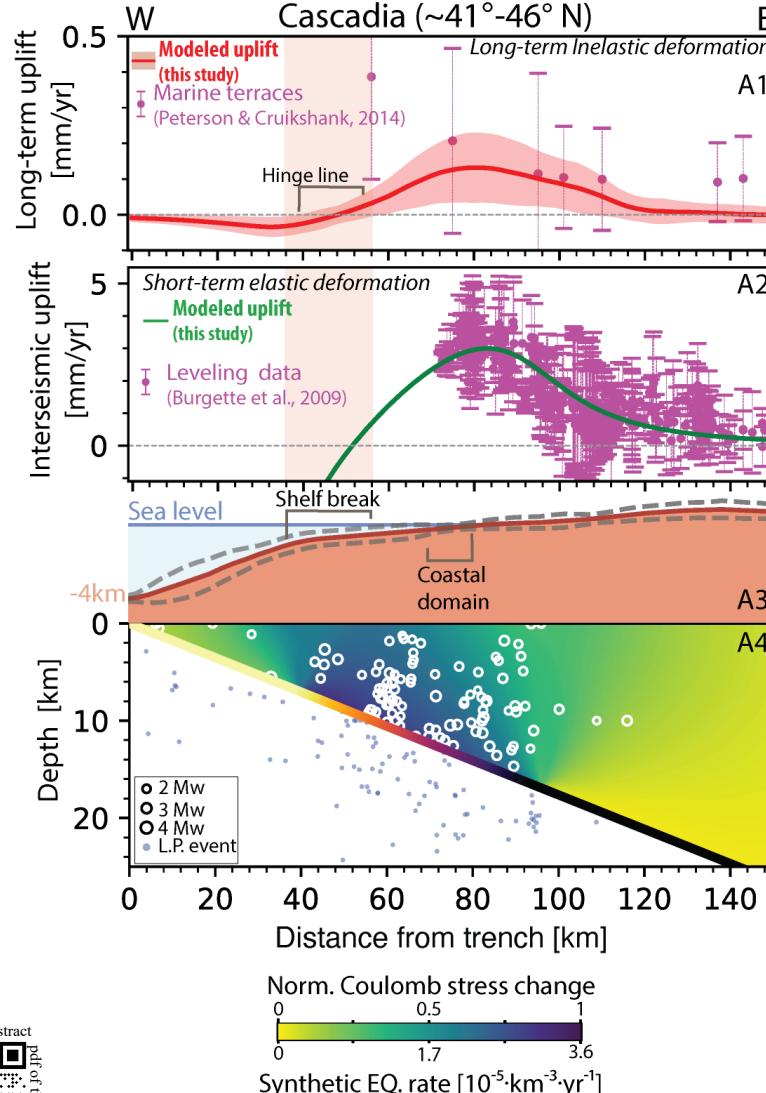
MODELING INTERSEISMIC INELASTIC DEFORMATION ACROSS UPPER PLATES

10 degree dip, fully locked to 40km

Uplift during three seismic cycles producing average long-term rate of 0.1 mm/yr

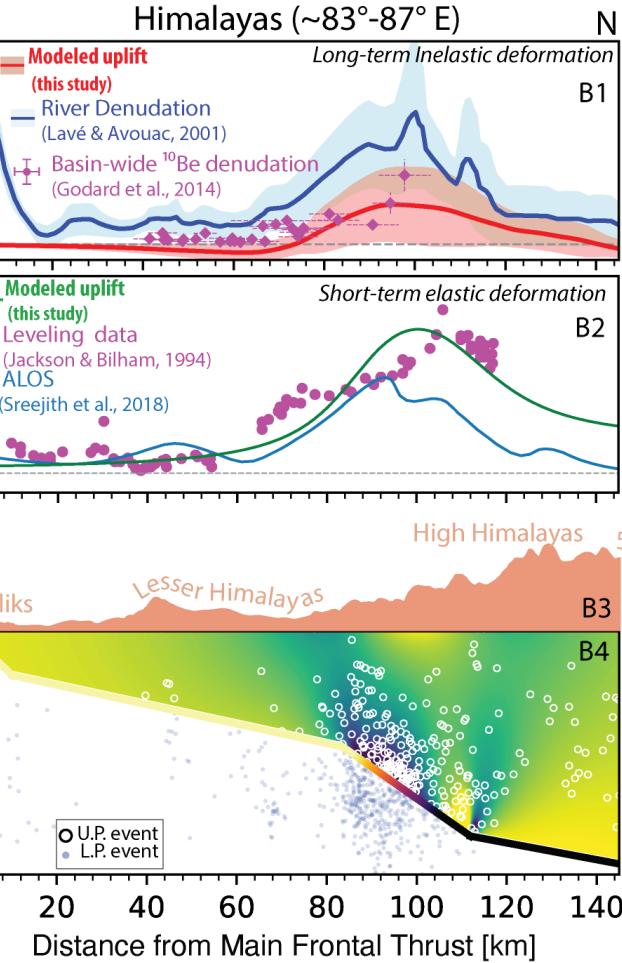
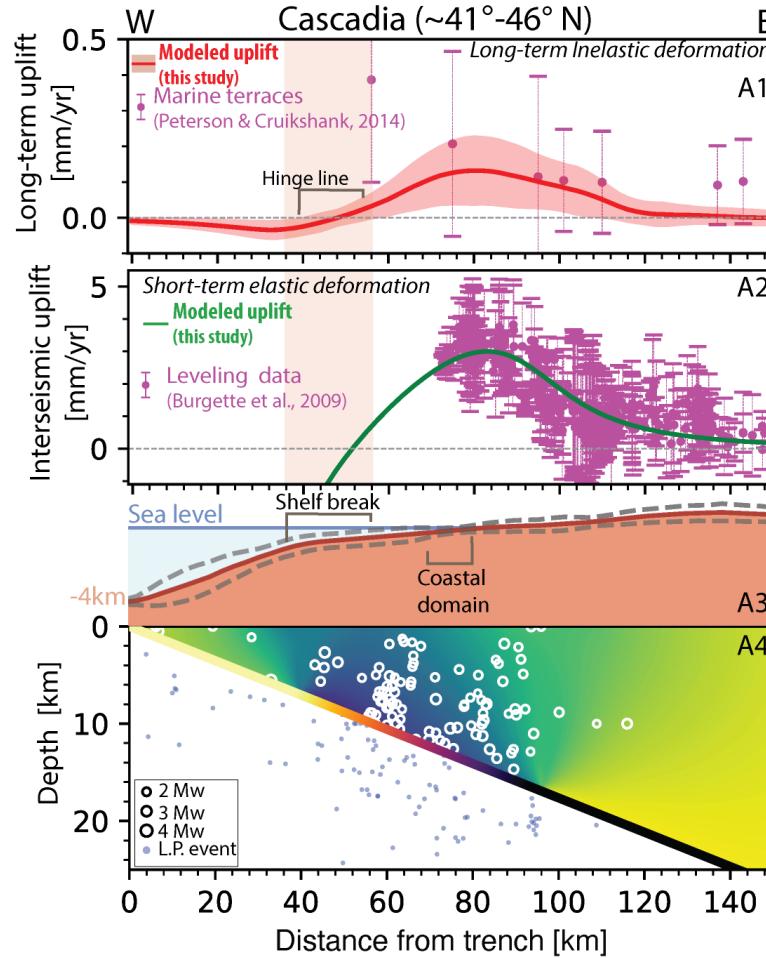


DEFORMATION IN CASCADIA, HIMALYAS AND CHILE

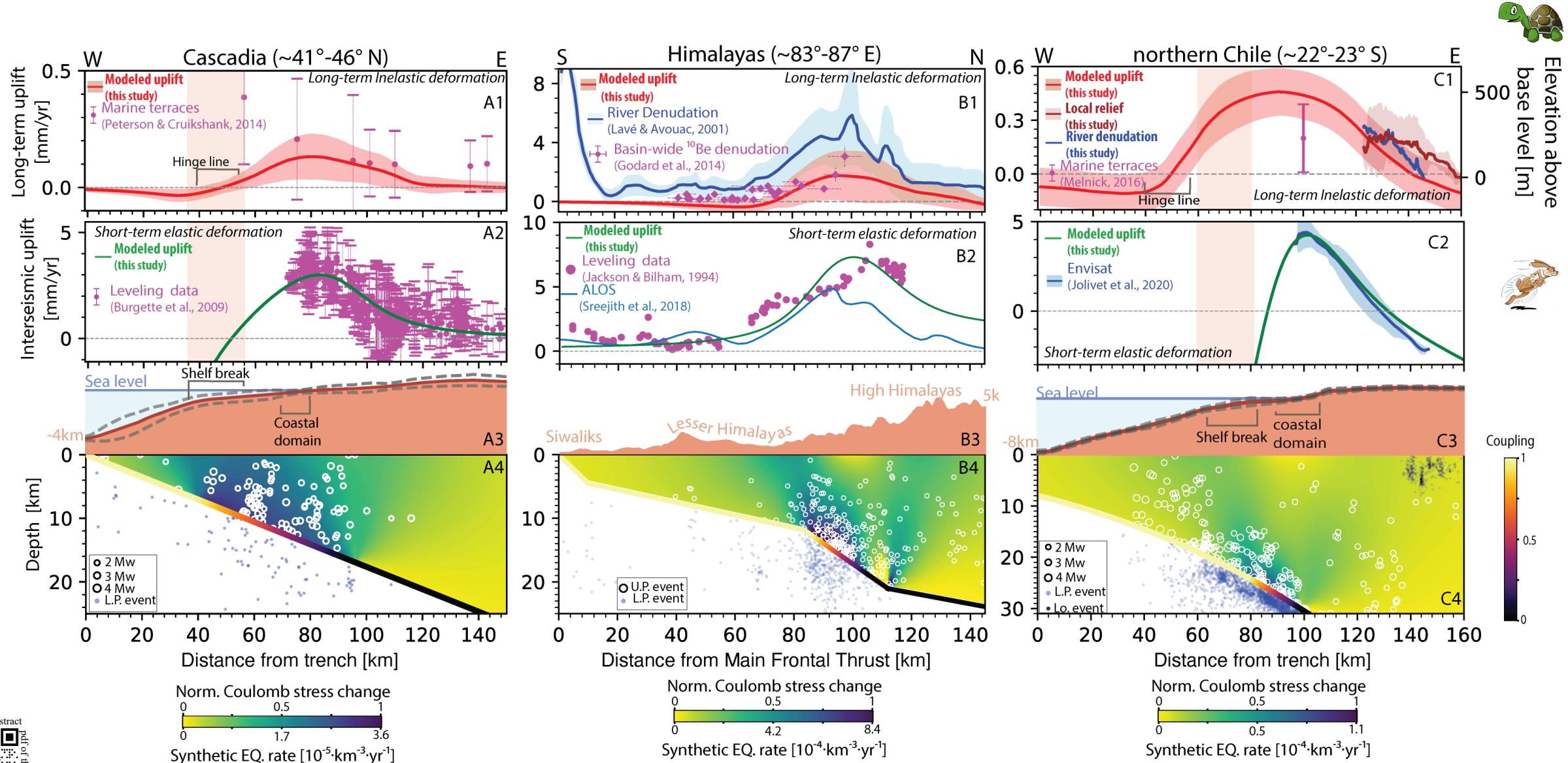


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DEFORMATION IN CASCADIA, HIMALYAS AND CHILE



DEFORMATION IN CASCADIA, HIMALYAS AND CHILE



Coupling
0 0.5 1

TAKE AWAY MESSAGE

- Variations in the degree of **megathrust locking** generate increments of **non-recoverable brittle deformation** within the overriding plate.
 - This is expressed primarily as interseismic **upper plate seismicity**.
 - Over time, this process **imprints** subduction landscapes one seismic cycle at a time hinting that megathrust locking remains stable over multiple earthquake cycles.
 - Geomorphology can play an important role in constraining Earth's greatest source of seismic hazard.

Curious about how geomorphology can help advance our understanding of seismic hazards?

- Visit EP21C-09 ! Tuesday 09:50AM - 152A

Interested in understanding how upper plate inelastic deformation influences both coseismic and aseismic megathrust behavior?

- Visit T41C-3253 ! Thursday AM Poster Hall

