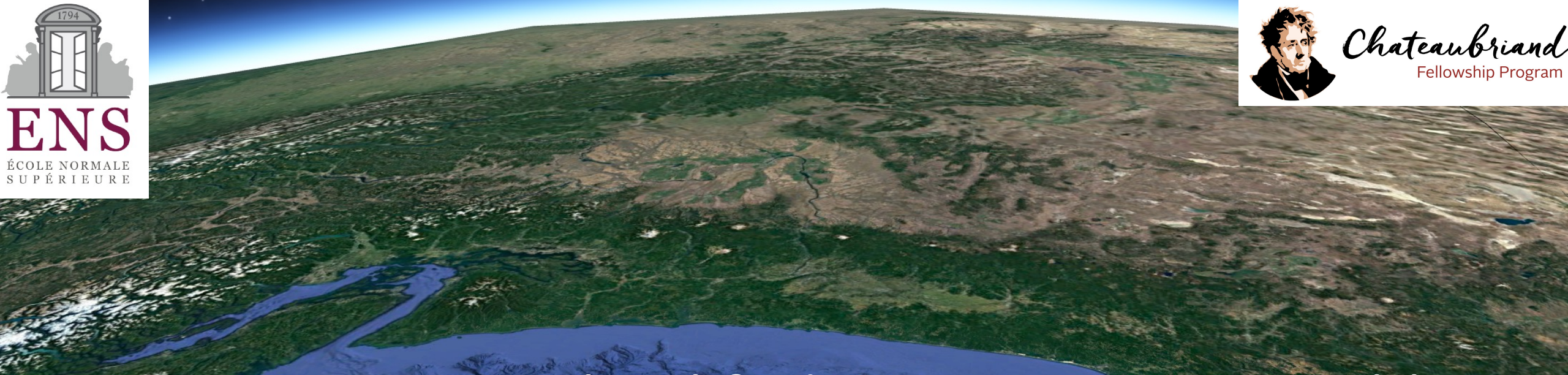

Long-term coastal uplift due to non-recoverable forearc deformation during the interseismic phase of the subduction earthquake cycle

Bar Oryan[1], Jean-Arthur Olive[1], Romain Jolivet[1], Luca Malatesta[2], and Lucile Bruhat[1].

EGU 2022

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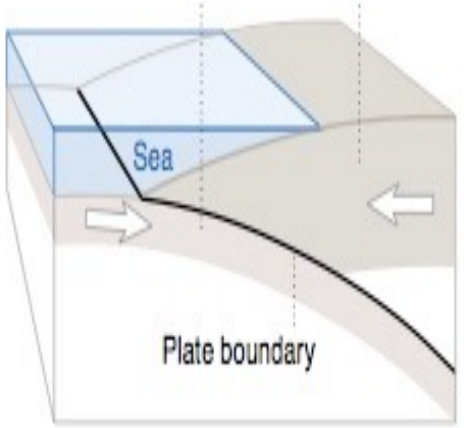
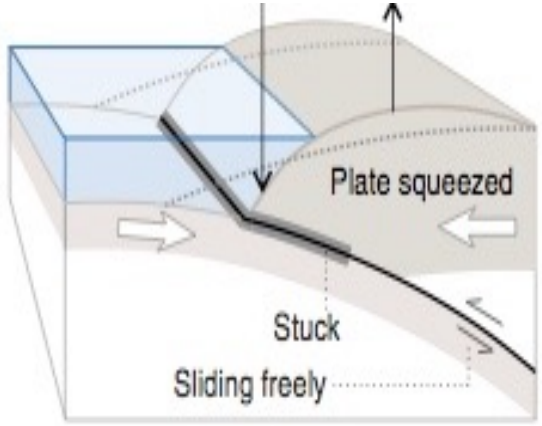
THE STANDARD ELASTIC EARTHQUAKE CYCLE MODEL

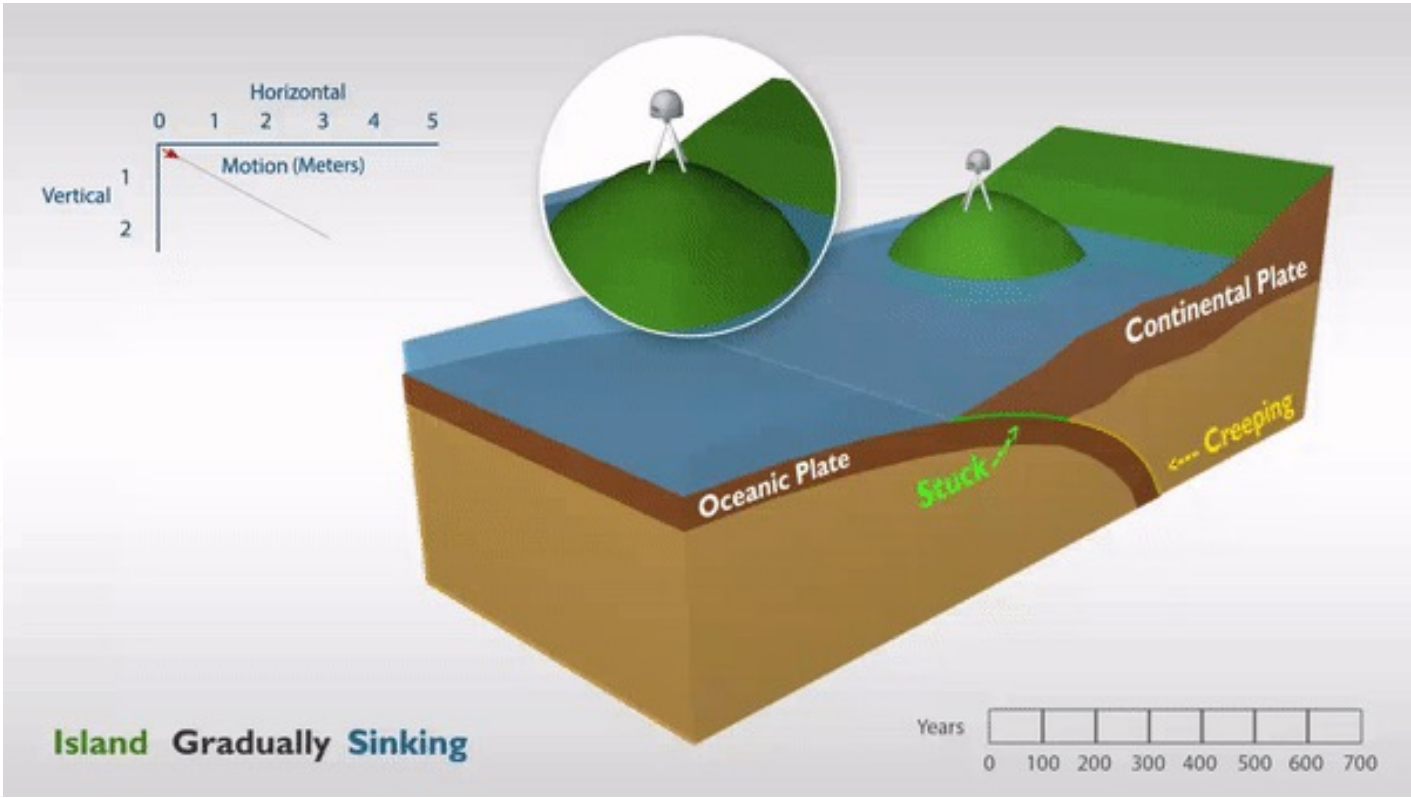


Long-term: downgoing plate descends beneath the upper plate in stick-slip fashion.

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



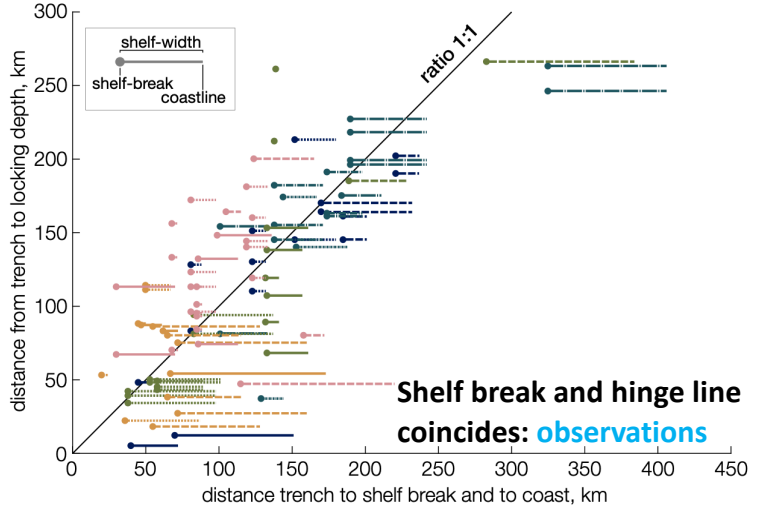
Coseismic: locked section moves abruptly. Upper plate deform elastically in an opposite sense.



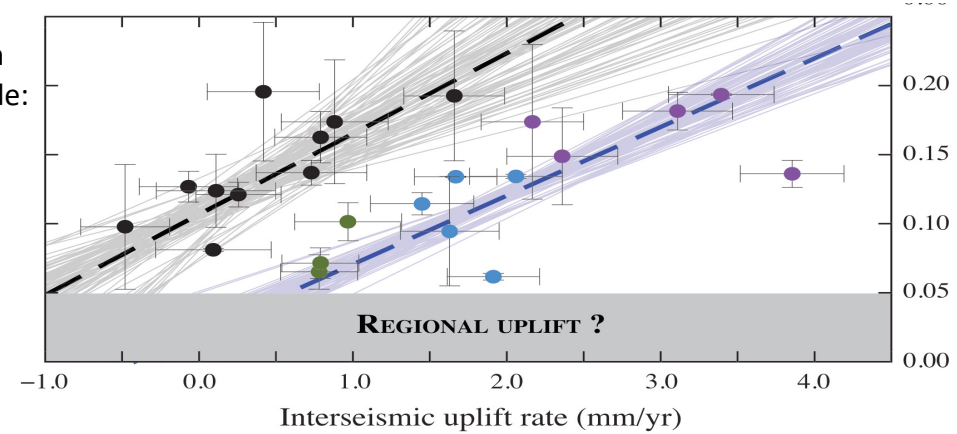
SIMILARITIES BETWEEN LONG-TERM AND SHORT-TERM DEFORMATION

Recent Observations suggest that the elastic description of seismic cycles is incomplete:

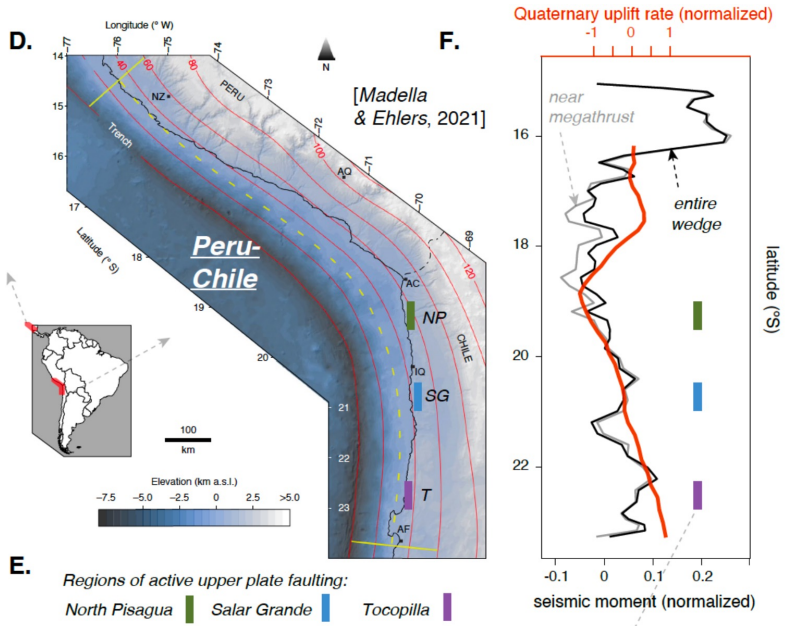
1. The position of the shelf break (🐢) and locking point coincides (🐇).
2. Long-term coastal uplift rates (🐢) coincide with interseismic uplift rates (🐇).
3. Coastal uplift rates (🐢) coincide with the release of interseismic forearc seismicity (🐇).



Long-term and short-term coastal uplift rates coincide: **observations**



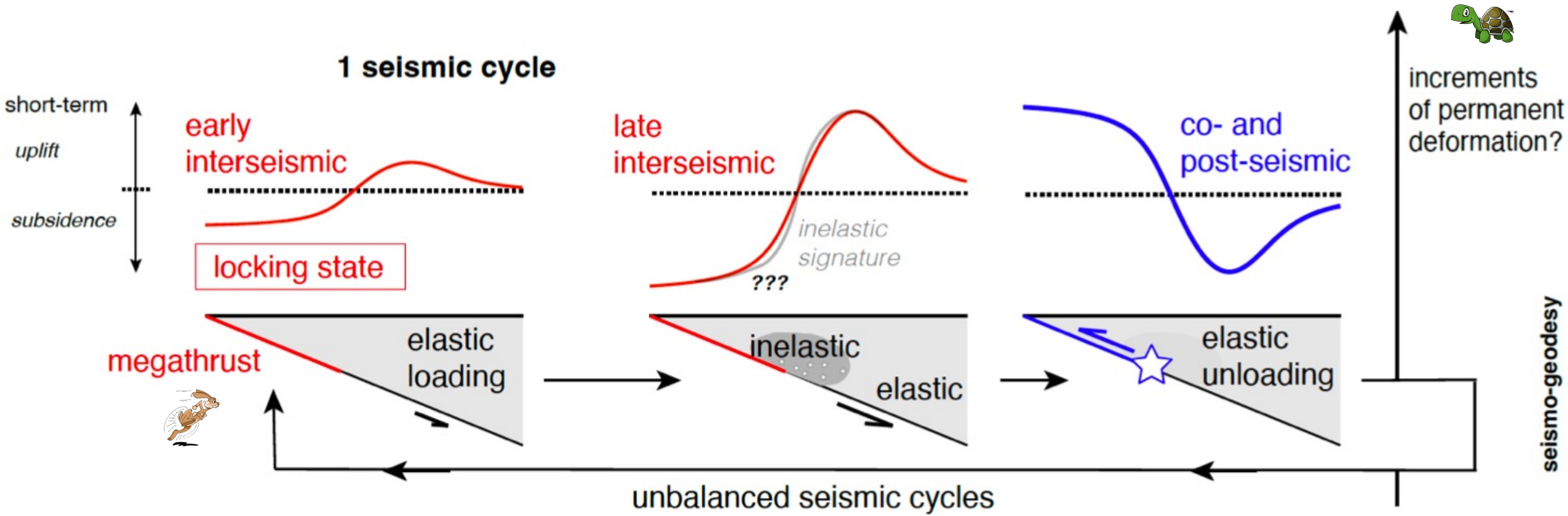
Coastal uplift rates and interseismic seismicity coincide : **observations**



Madella and Ehlers [2021]; Malatesta et al [2021]; Jolivet et al. [2020]

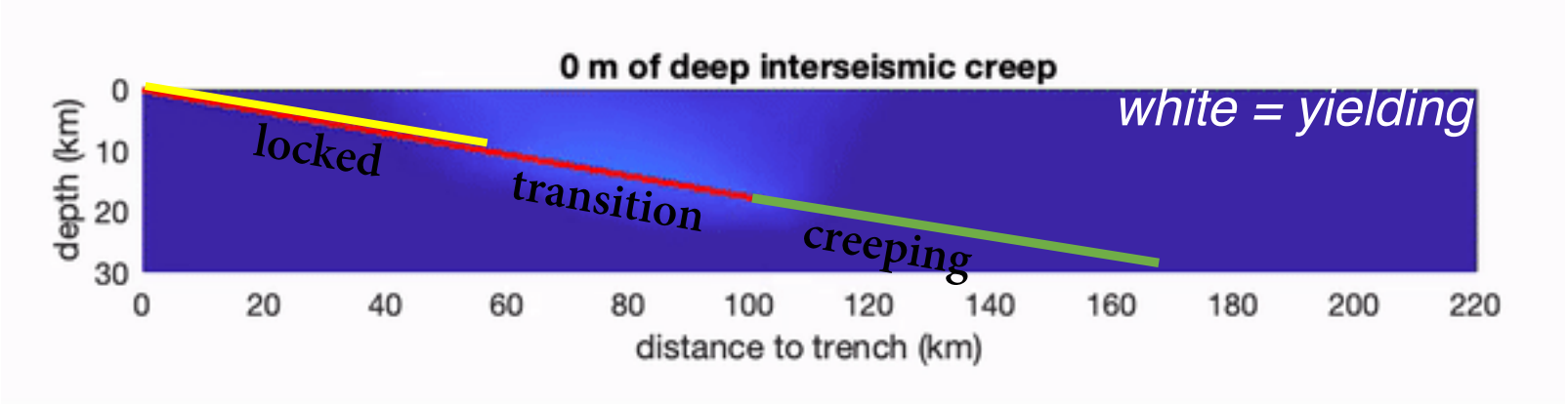
HYPOTHESIS

We suggest that the addition of **shallow horizontal compression** imparted by creep at depth is capable of pushing parts of the upper plate to failure during the interseismic period so repeated failure over many earthquake cycles can explain the overlap observed between permanent deformation, interseismic uplift and background seismicity.



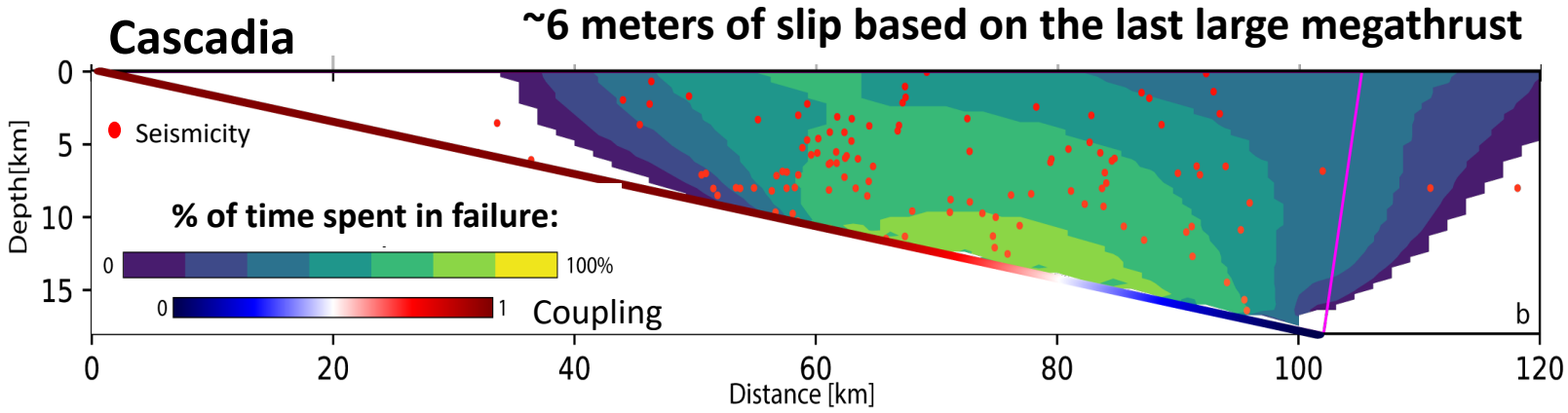
OUR MECHINAL MODELS

- We model frictional yielding within the forearc as a function of interseismic coupling and upper plate strength.



- The onset of yielding in the late interseismic phase coincides with observed areas of micro-seismicity.

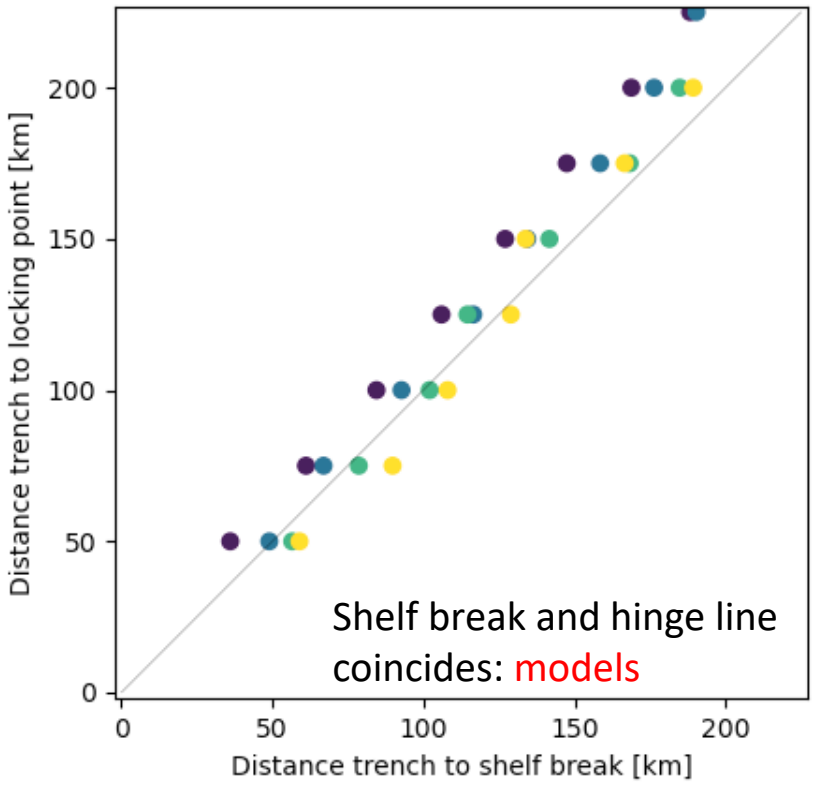
- We estimate the permanent surface uplift imparted by this failure by combing our numerical models and a statistical approach.

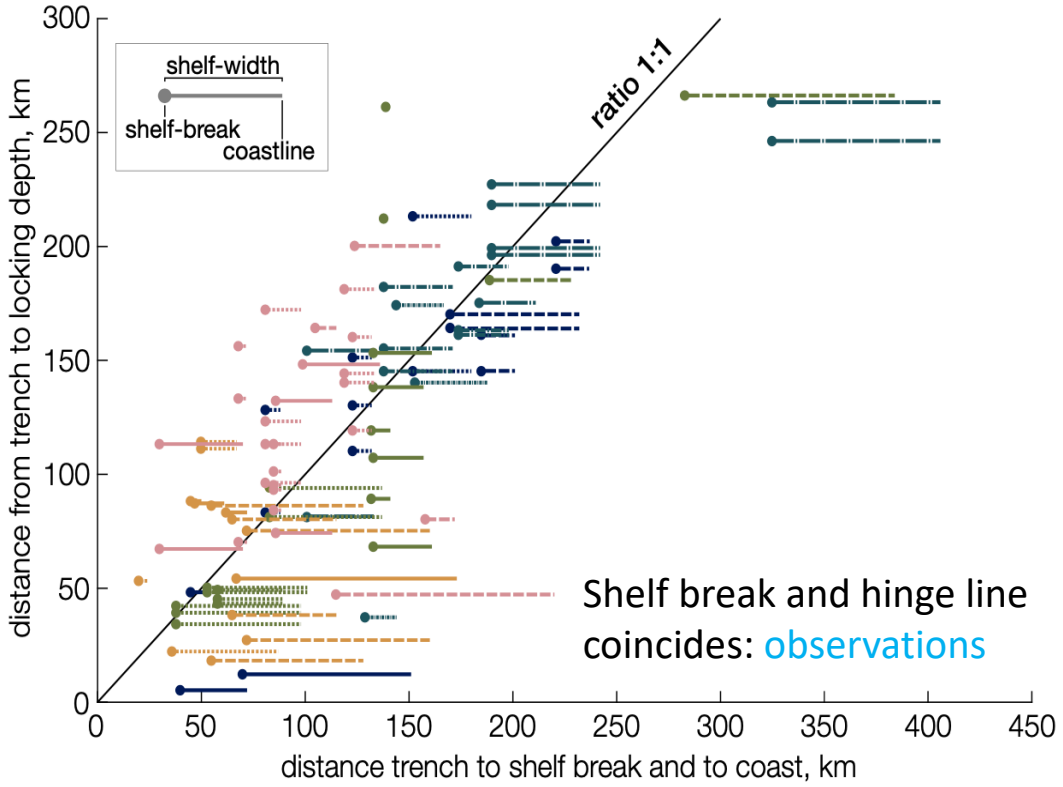


SIMILARITIES BETWEEN LONG-TERM AND SHORT-TERM DEFORMATION

Our model can account for long-term permeant surface deformation and its similarities with seismic cycles:

1. The position of the shelf break (🐢) and locking point coincide ( ).





SIMILARITIES BETWEEN LONG-TERM AND SHORT-TERM DEFORMATION

Our model can account for long-term permeant surface deformation and its similarities with seismic cycles:

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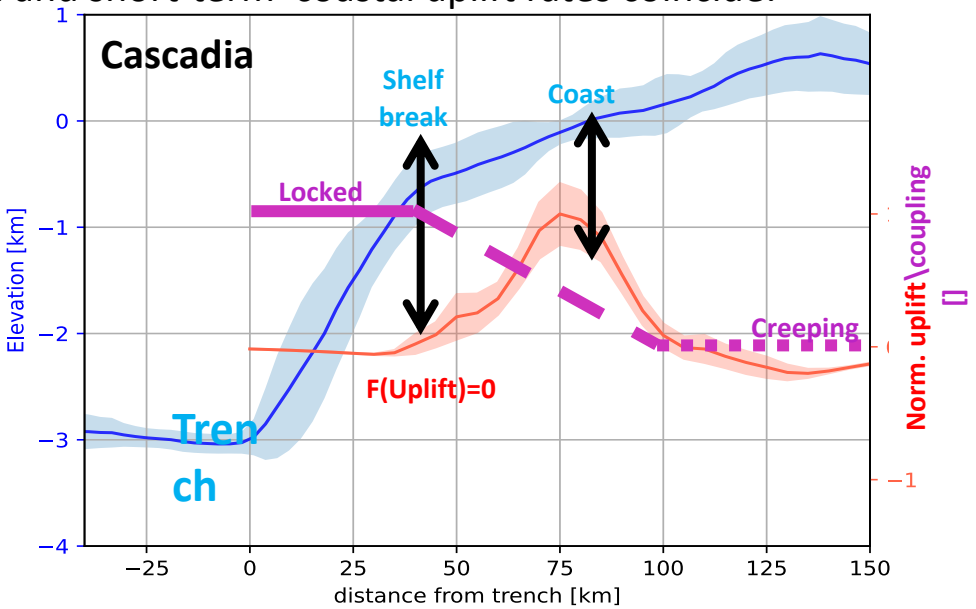
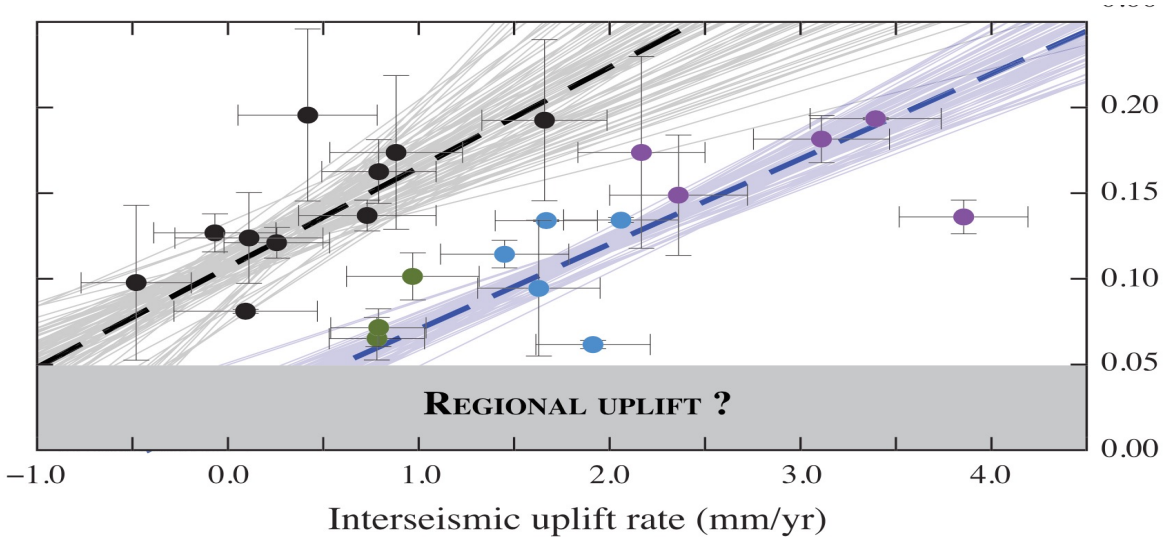
2. Long-term coastal uplift rates (🐢) coincide with interseismic uplift rates (🐇).

Long-term and short-term coastal uplift rates coincide: **models**



Long-term and short-term coastal uplift rates coincide: **observations**

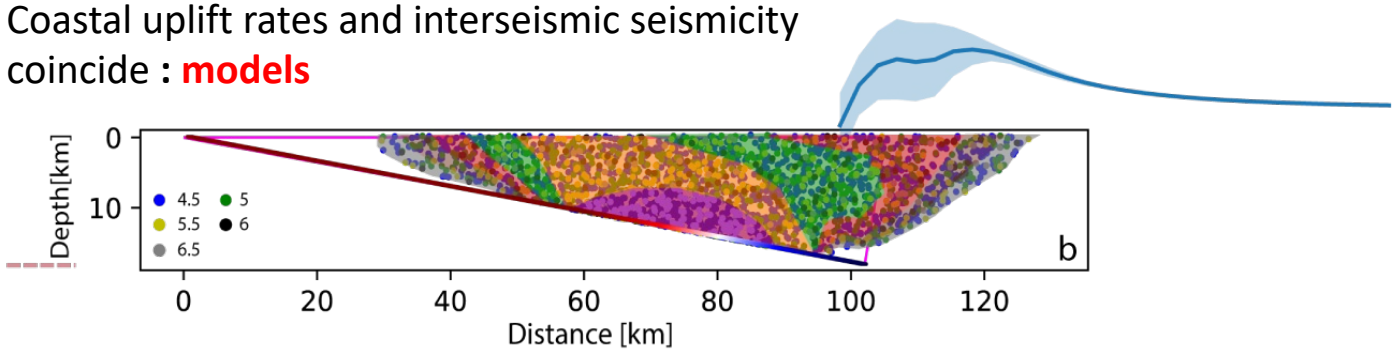


SIMILARITIES BETWEEN LONG-TERM AND SHORT-TERM DEFORMATION

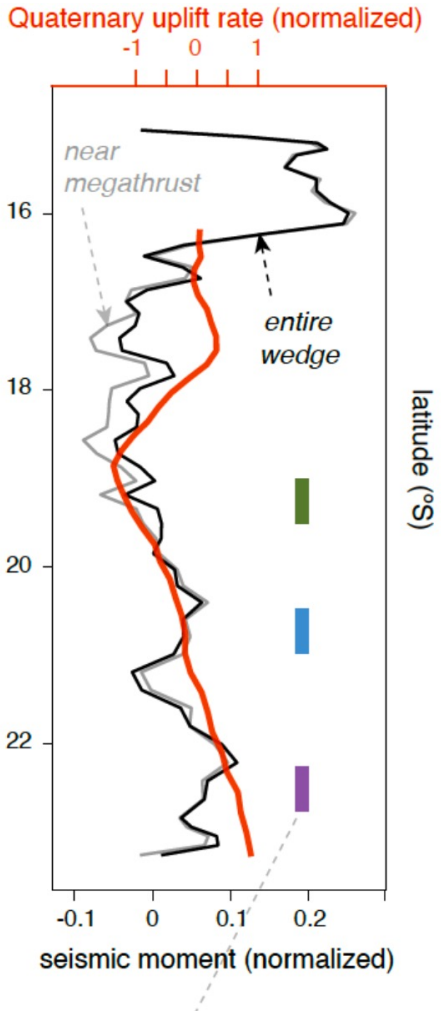
Our model can account for long-term permeant surface deformation and its similarities with seismic cycles:

1. The position of the shelf break (🐢) and hinge line coincide (🐇).
2. Long-term coastal uplift rates (🐢) coincide with interseismic uplift rates (🐇).
3. Coastal uplift rates (🐢) coincide with the release of interseismic forearc seismicity (🐇).

Coastal uplift rates and interseismic seismicity coincide : **models**

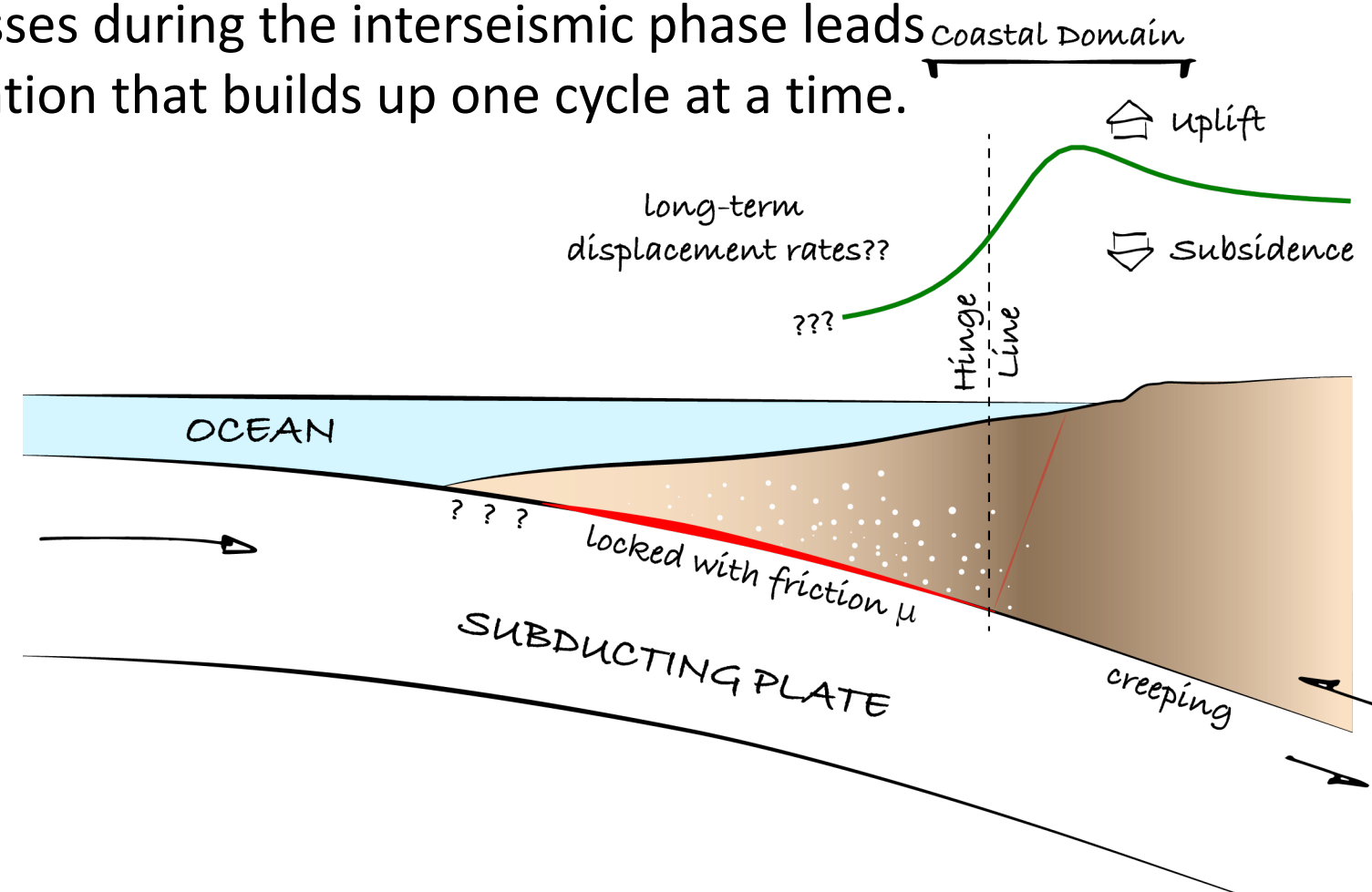


Coastal uplift rates and interseismic seismicity coincide : **observations**



Take away

- Fingerprints of interseismic deformation are found in the long-term coastal morphology.
- Interseismic deformation can trigger brittle yielding in the forearc.
- The accumulation of elastic stresses during the interseismic phase leads to net, non-recoverable deformation that builds up one cycle at a time.
- The summation of this permanent deformation over many seismic cycles may play an important role in shaping the long-term morpho-structure of subduction margins.



Jolivet et al. [2020]