Role of the lower crust in the postseismic deformation of the 2010 Maule earthquake: Insights from a model with non-linear rheology

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Postseismic GPS of the Maule 2010 earthquake
Primary postseismic processes

1. Locking
2. Relaxation
3. Afterslip

Elastic

Linear viscoelastic
  - Bedford et al. (2016)
  - Klein et al. (2016)
  - Li et al. (2017)

Wang et al. (2012)

What is the impact of using non-linear rheology?
Model setup

Dislocation creep

\[ \dot{\varepsilon} = A\sigma^n \exp \left( \frac{-Q}{RT} \right) \]

- \(\dot{\varepsilon}\) strain rate
- A material constant
- \(\sigma\) differential stress
- Q activation enthalpy
- R gas constant
- T absolute temperature

Boundary conditions on the fault plane

- Dislocation creep equation
- Coseismic slip graph
- After slip graph
- Re-locking graph

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Sensitivity regarding afterslip magnitude

Cumulative vertical displacement after 6 yr

Distance from the trench (km)

Vertical (cm)

Afterslip distribution

GPS ± 1 cm
Non-linear
Linear

Dip-slip (m)

Distance along the fault plane (km)

Relocking distribution

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Cumulative horizontal displacement after 6 yr
Sensitivity regarding afterslip location

Cumulative horizontal displacement after 6 yr

Graph showing cumulative horizontal displacement over distance from the trench.
Summary

- Cumulative horizontal surface displacement is similar, but vertical shows large differences.

- Afterslip in models with non-linear rheology is shifted to shallower region to reproduce vertical displacement pattern.

- Tensional stresses are mainly relaxed in the lower crust in a non-linear model.