Modelling the post-seismic deformations measured by GNSS and InSAR, following the 2014 Iquique earthquake, Chile

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ISTerre UGA Université Grenoble Alpes UNIVERSITÉ SAVOIE MONT BLANC cnrs DEEPtrigger erc European Research Council Established by the European Commission

Scientific questions

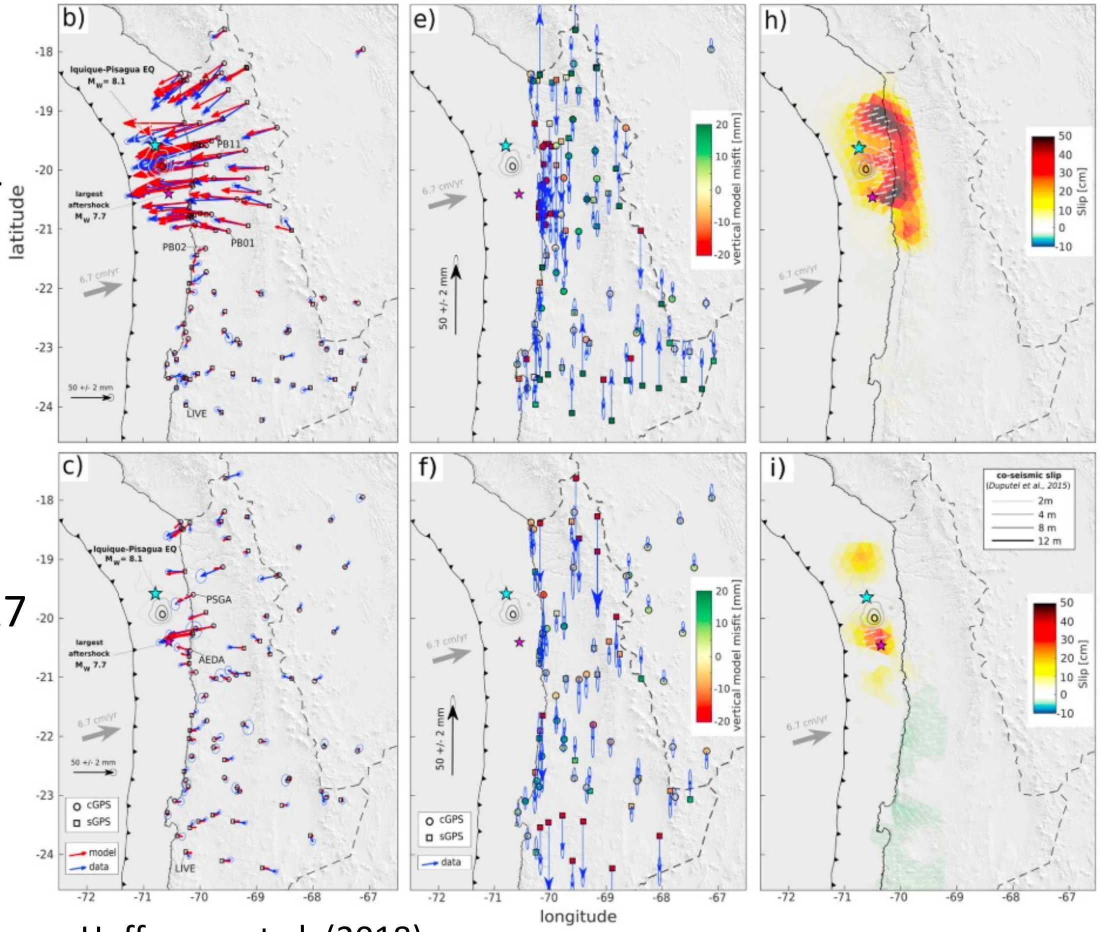
Displacements due to the afterslip

Vertical GPS data

Predicted afterslip

17–334 days

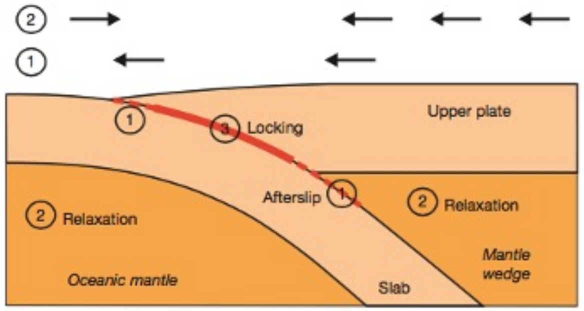
335–717 days

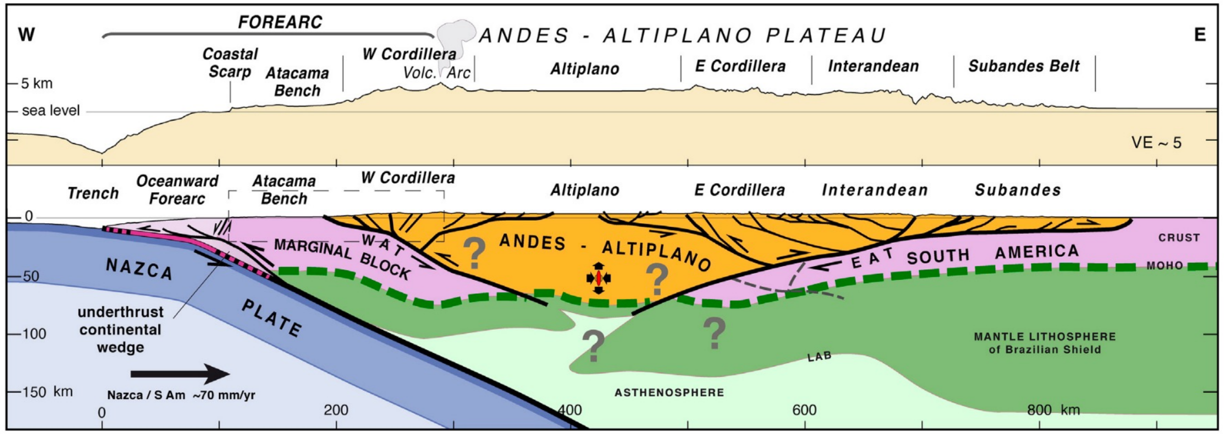


Hoffmann et al. (2018)

Post-seismic processes:

1. afterslip
2. visco-elastic relaxation





Structure: Where is the lithosphere-asthenosphere boundary? Presence of a cold nose? Craton? Mantle wedge?

Rheology: Viscosities in the mantles, does it evolves with the time?

Data

interseismic | seasonal | antenna change

$$x(t) = xR + v(t - t_R) + \sum_{k=1}^{2}\left[s_k \sin\left(2k\pi(t - tR)\right) + ck \cos\left(2k\pi(t - tR)\right)\right] + \sum_{a=1}^{n_A} b_a H(t - ta)$$

$$+ \sum_{j=1}^{n_J} c_j H(t - tj) + \sum_{i=1}^{n_I} m_i H(t - ti) \times \log\left(1 + \frac{t - ti}{T_R}\right)$$

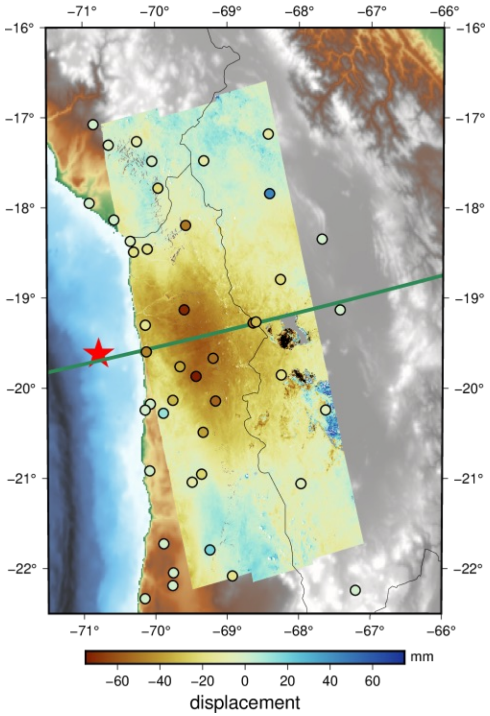
co-seismic jumps | post-seismic

45 days

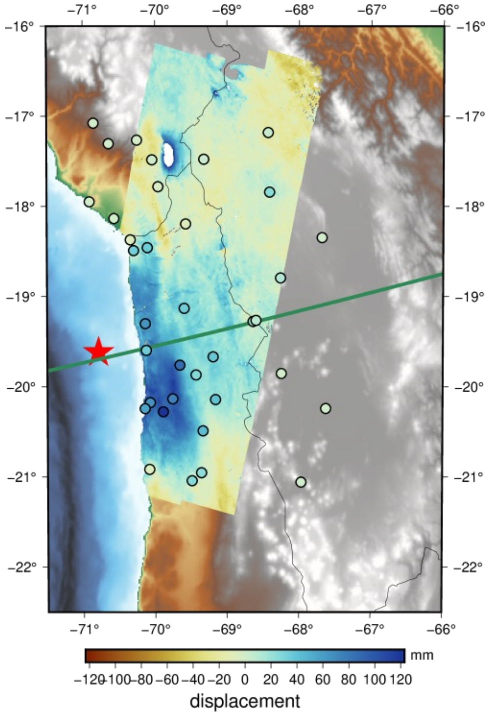
Marill et al. (2021)

InSAR

InSAR A149 and GPS in LOS

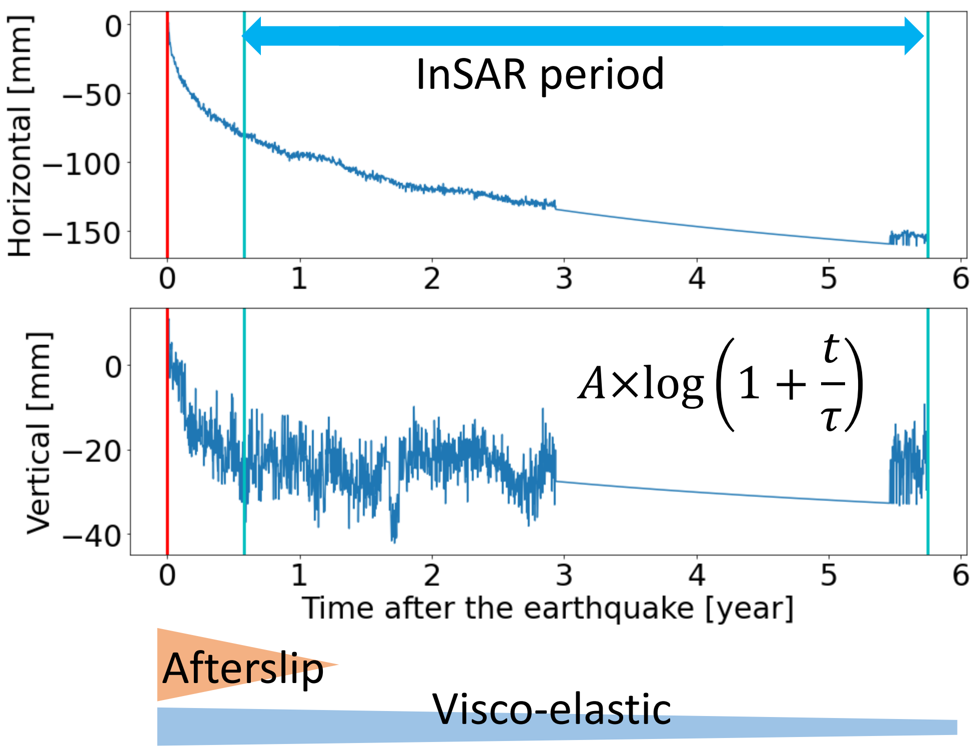


InSAR D054 and GPS in LOS



GPS

Time serie for the station PSGA



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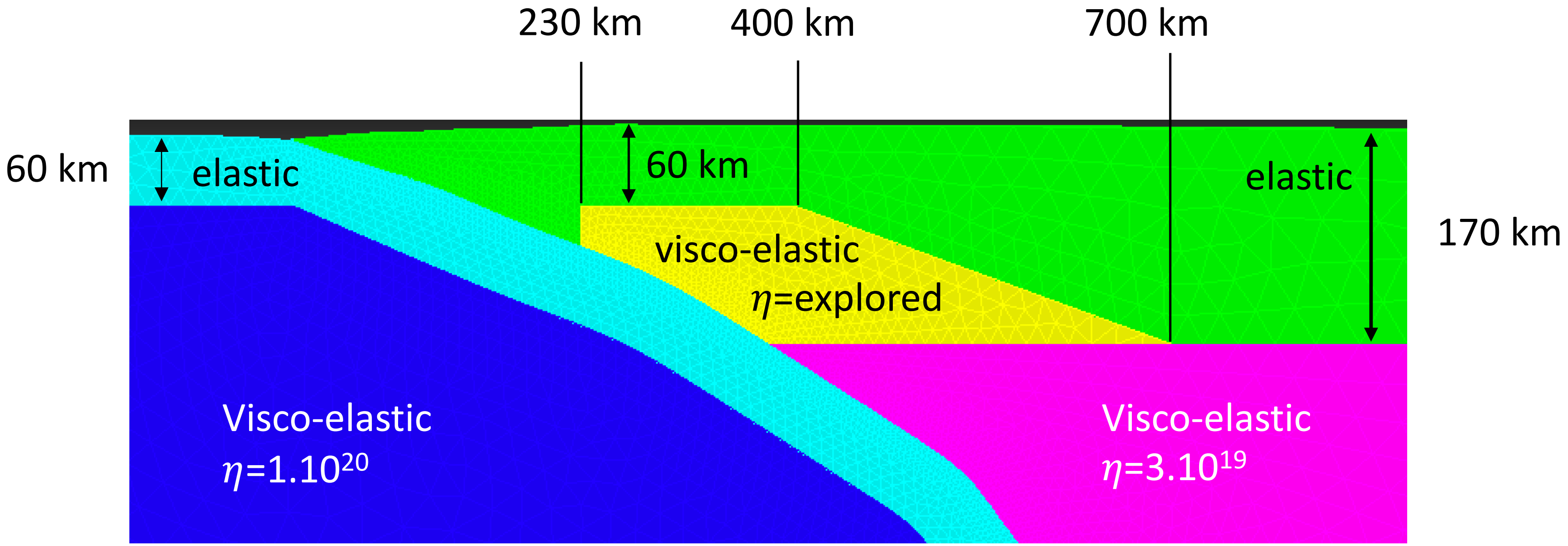
Structure and rheology of the model

- 2D Finite Element Model
- Low viscosity area (mantle wedge) to explore

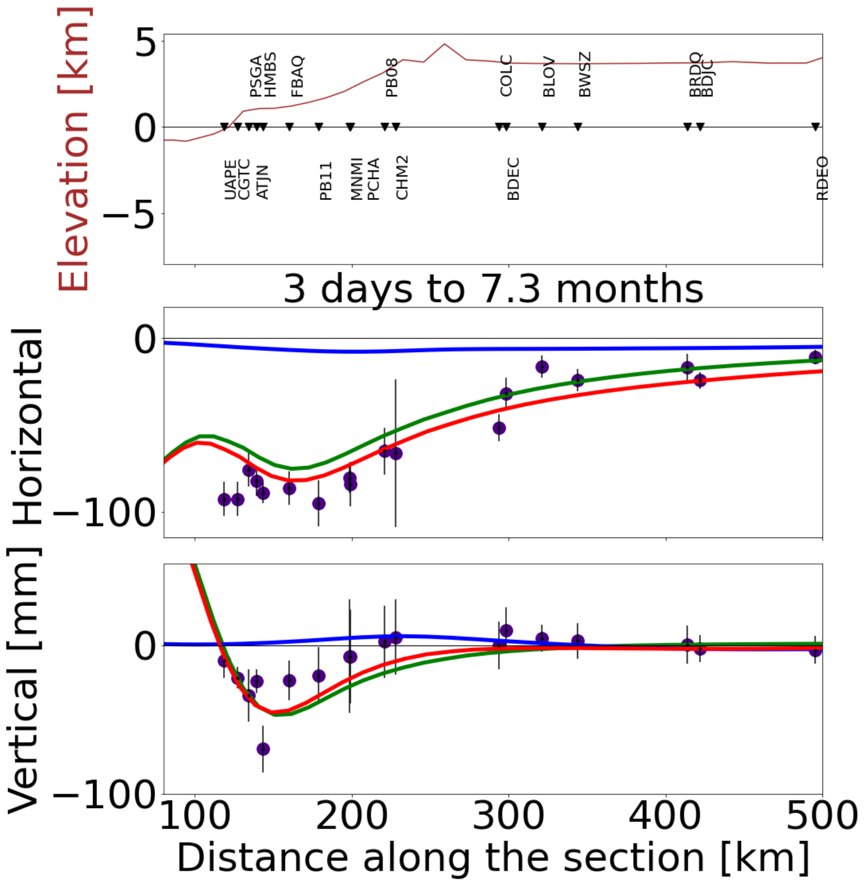


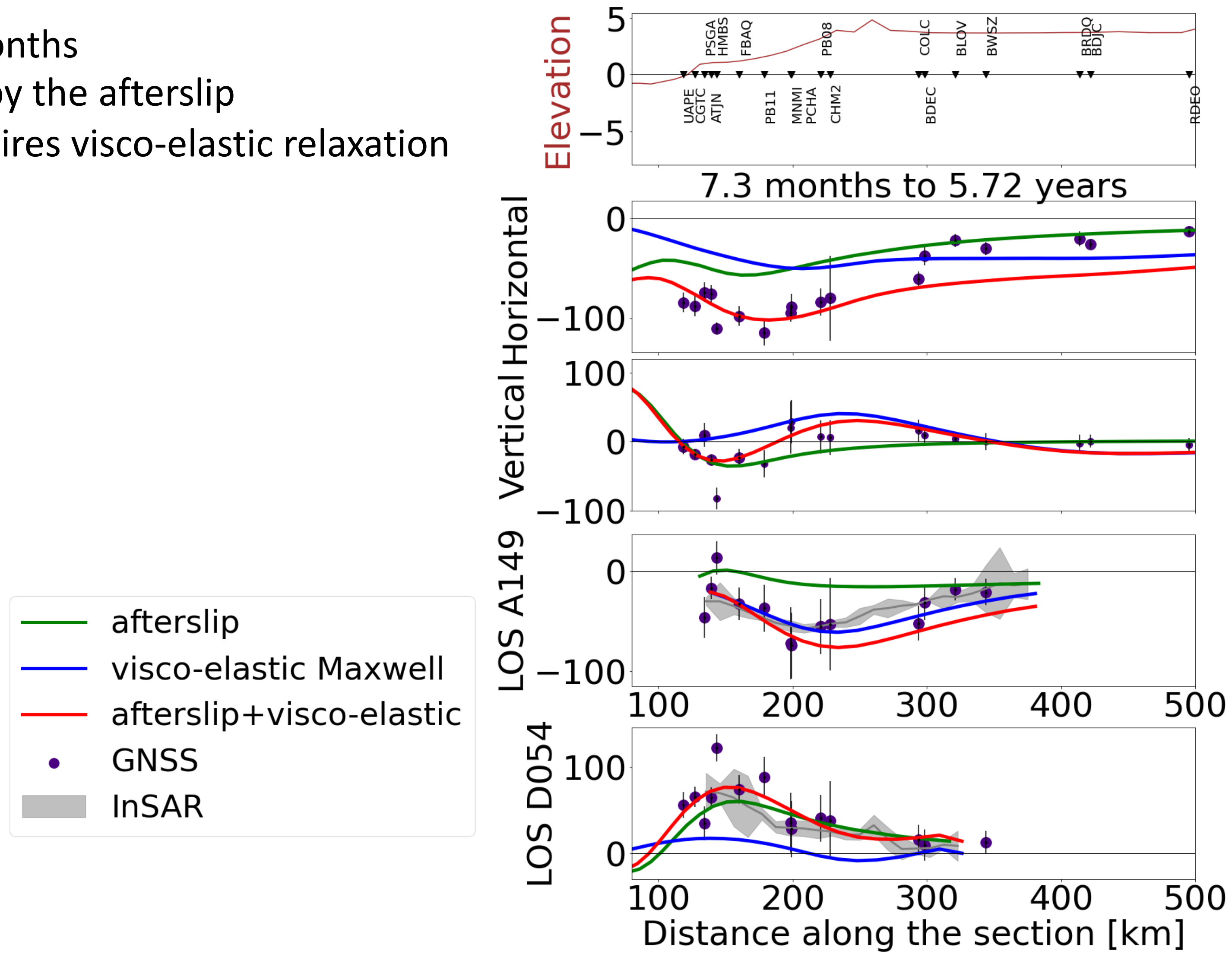
Visco-elastic relaxation model
Different viscosity in the oceanic and continental mantle and in the mantle wedge
Test the required shape of the mantle wedge area

Afterslip model
Imposed gaussian slip
with a temporal evolution in $A \times \log\left(1 + \frac{t}{\tau}\right)$
τ = 11 days

Contributions of the afterslip and visco-elastic modelling

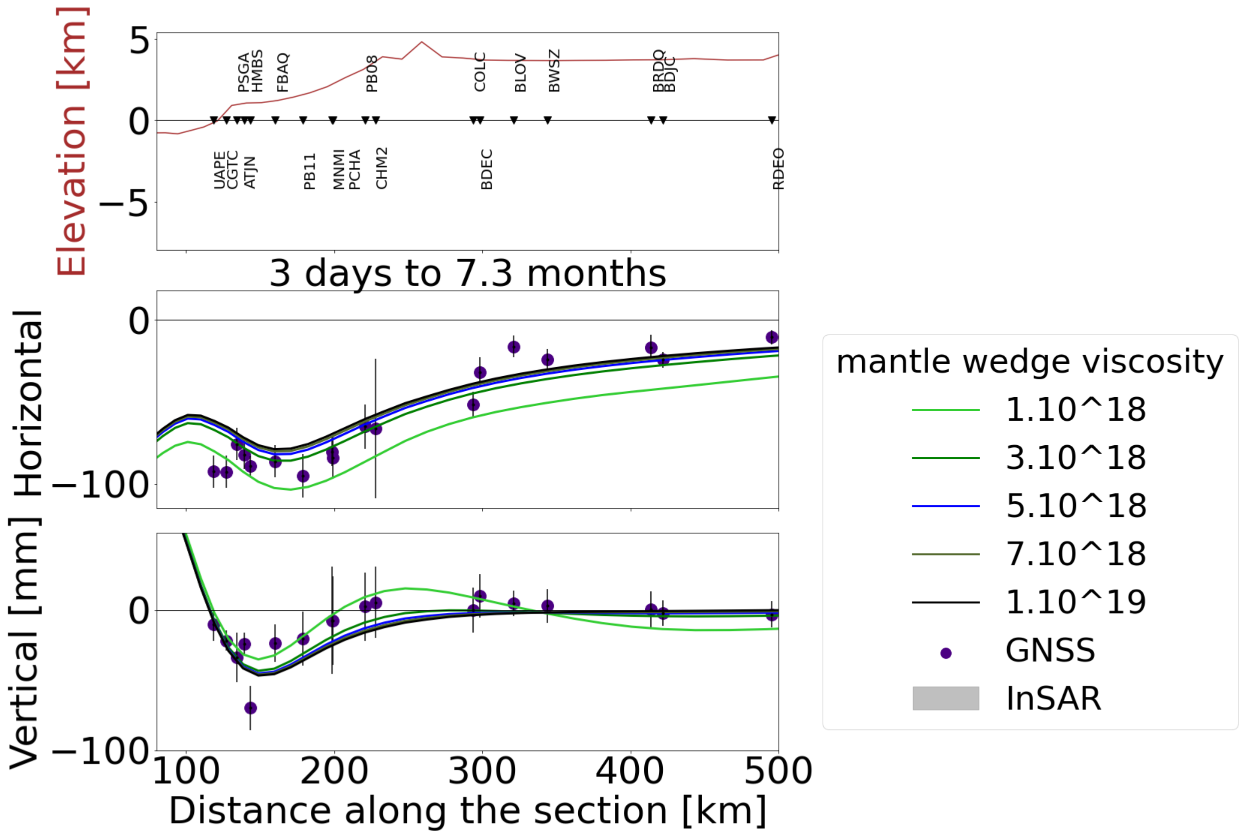
- Afterslip is dominant on the 7 first months
- Near trench subsidence is explained by the afterslip
- Uplift at 230 km from the trench requires visco-elastic relaxation

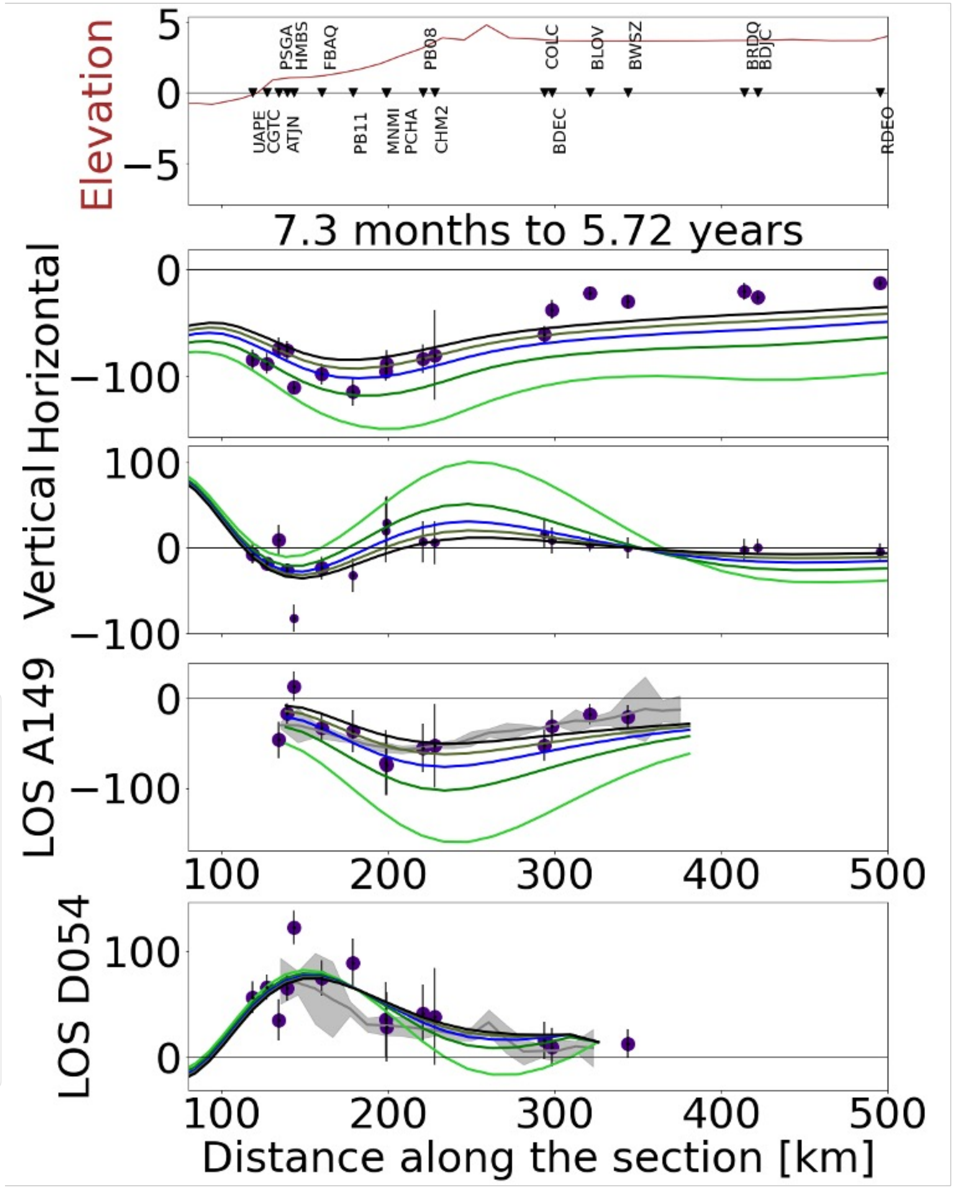




Variation of the mantle wedge viscosity

- We need a lower viscosity at short-term and longer at long-term.





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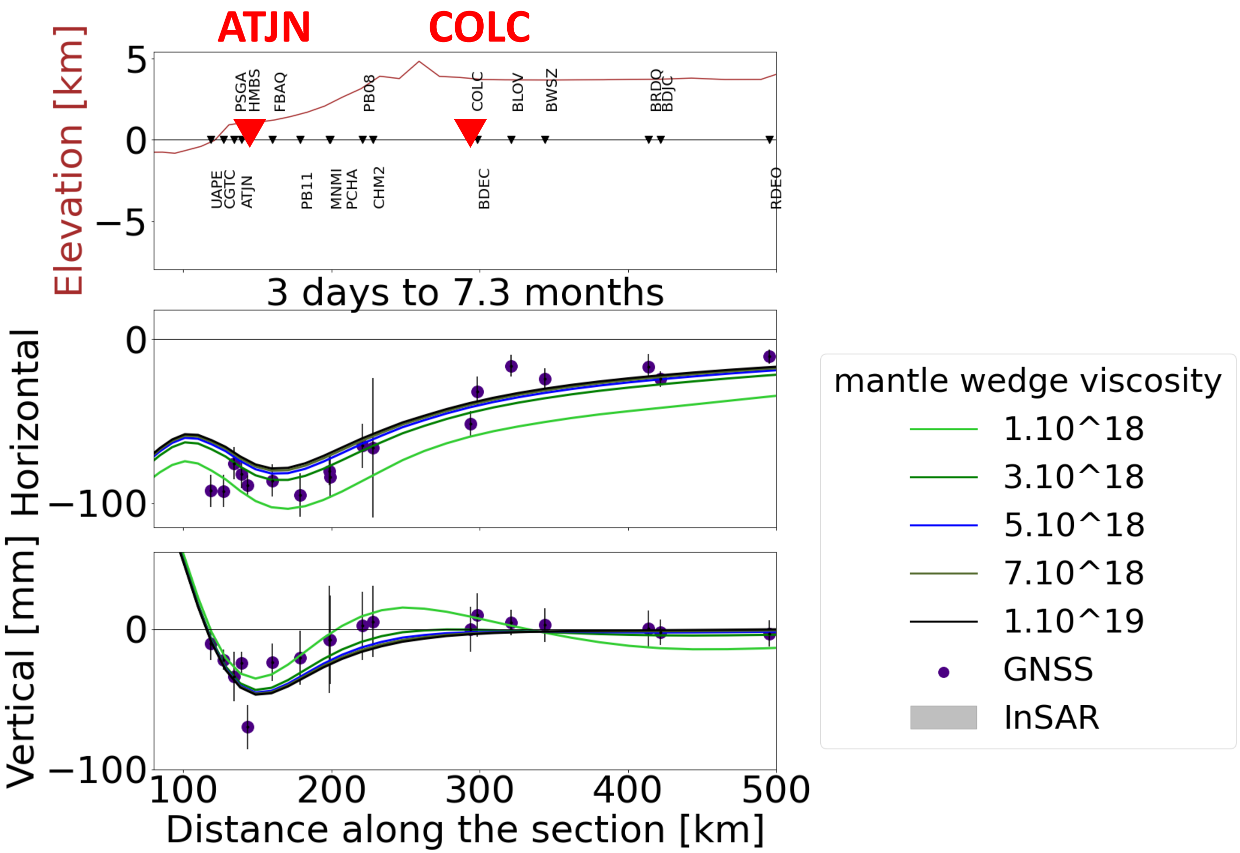
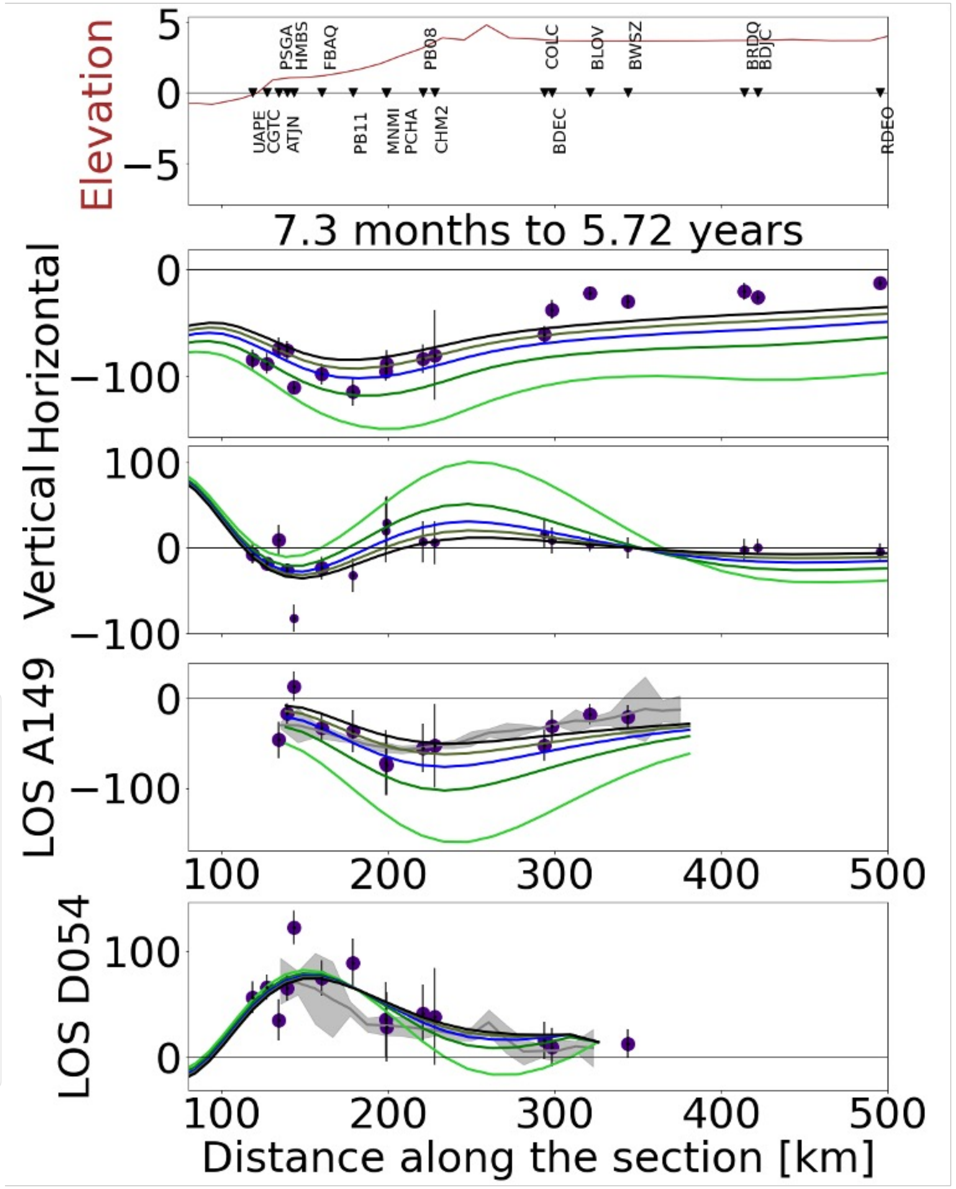
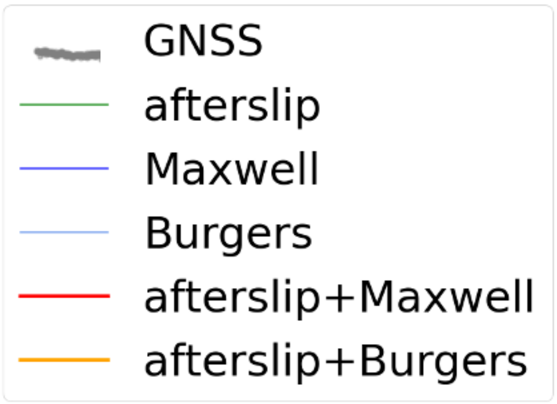


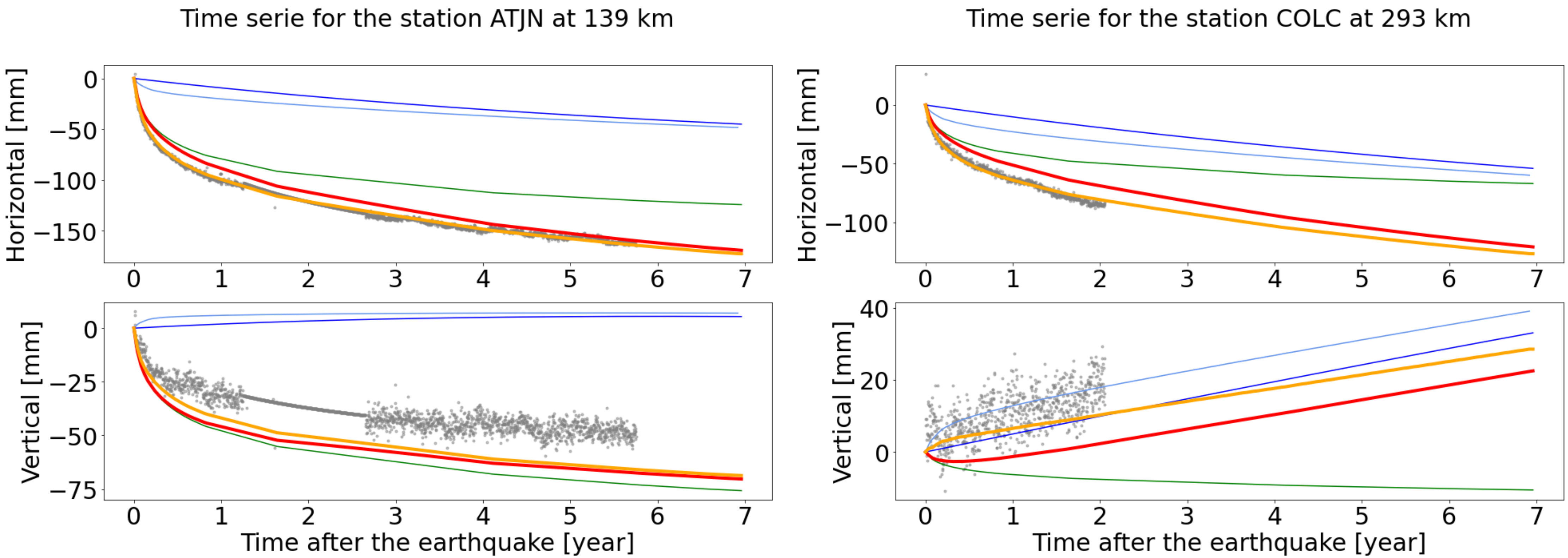


Temporal evolution - From Maxwell to Burgers rheology



The Maxwell viscosity leads to a lack of amplitude around 2 years.
We need a Burgers rheology to better fit the temporal evolution

$\eta_{Moc}=1.10^{21}$	$\eta_{Mcont}=3.10^{19}$	$\eta_{Mmw}=5.10^{18}$
$\eta_{Koc}=1.10^{20}$	$\eta_{Kcont}=3.10^{18}$	$\eta_{Kmw}=5.10^{17}$



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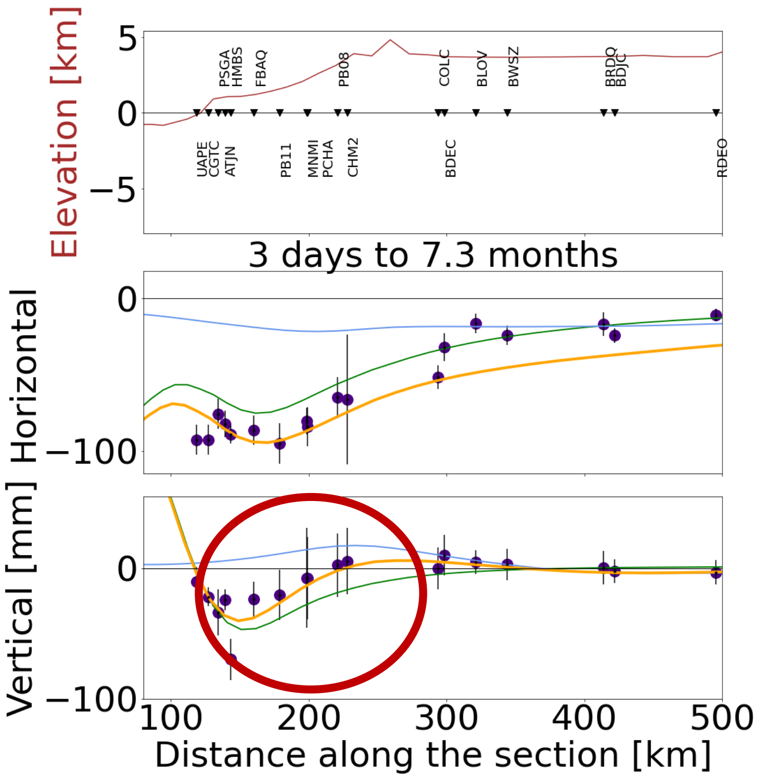
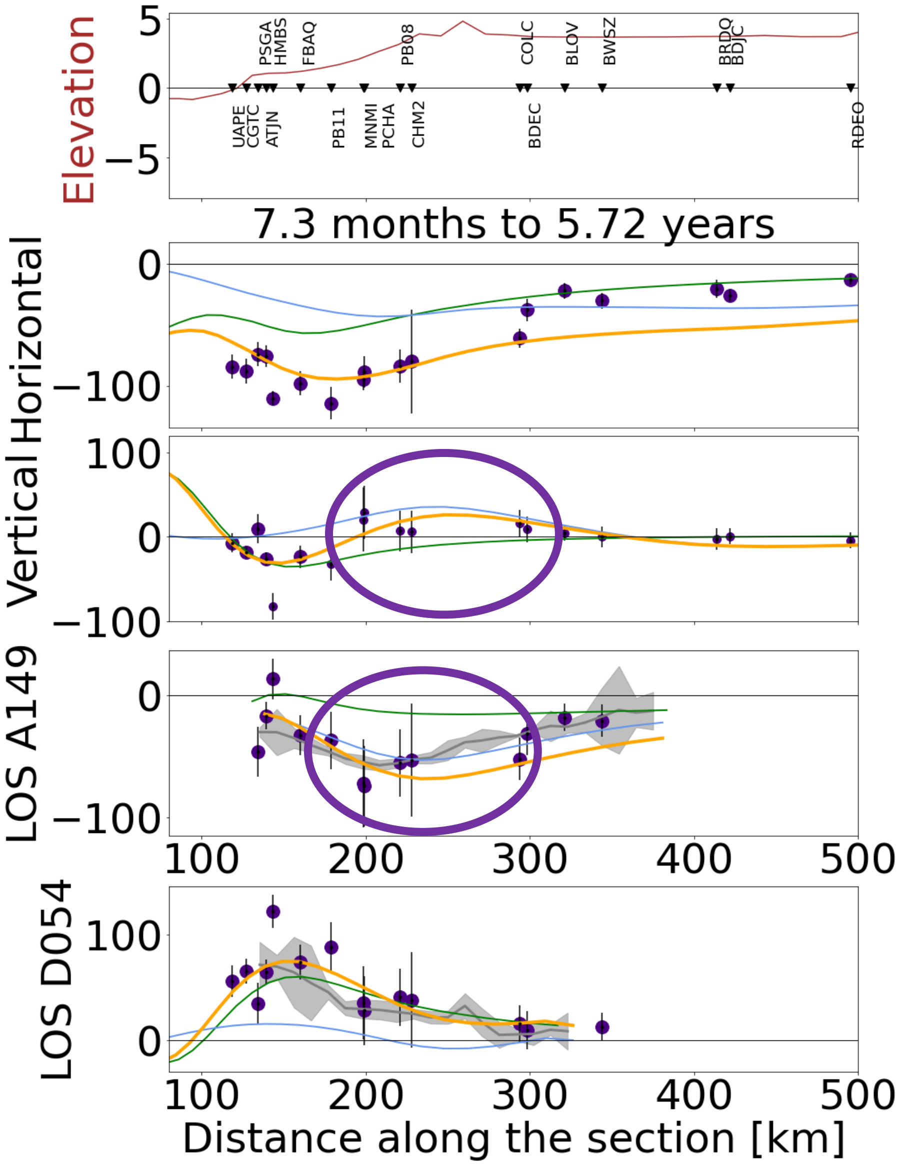
Main results

- **1.** Need a low viscosity area (mantle wedge) to fit the uplift at long term.
- **2.** At short term, the visco-elastic relaxation is needed to explain vertical amplitude.





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