

Seismicity induced by seasonal variation of reservoir level: the case of Pertusillo lake, Val D'Agri (Italy)

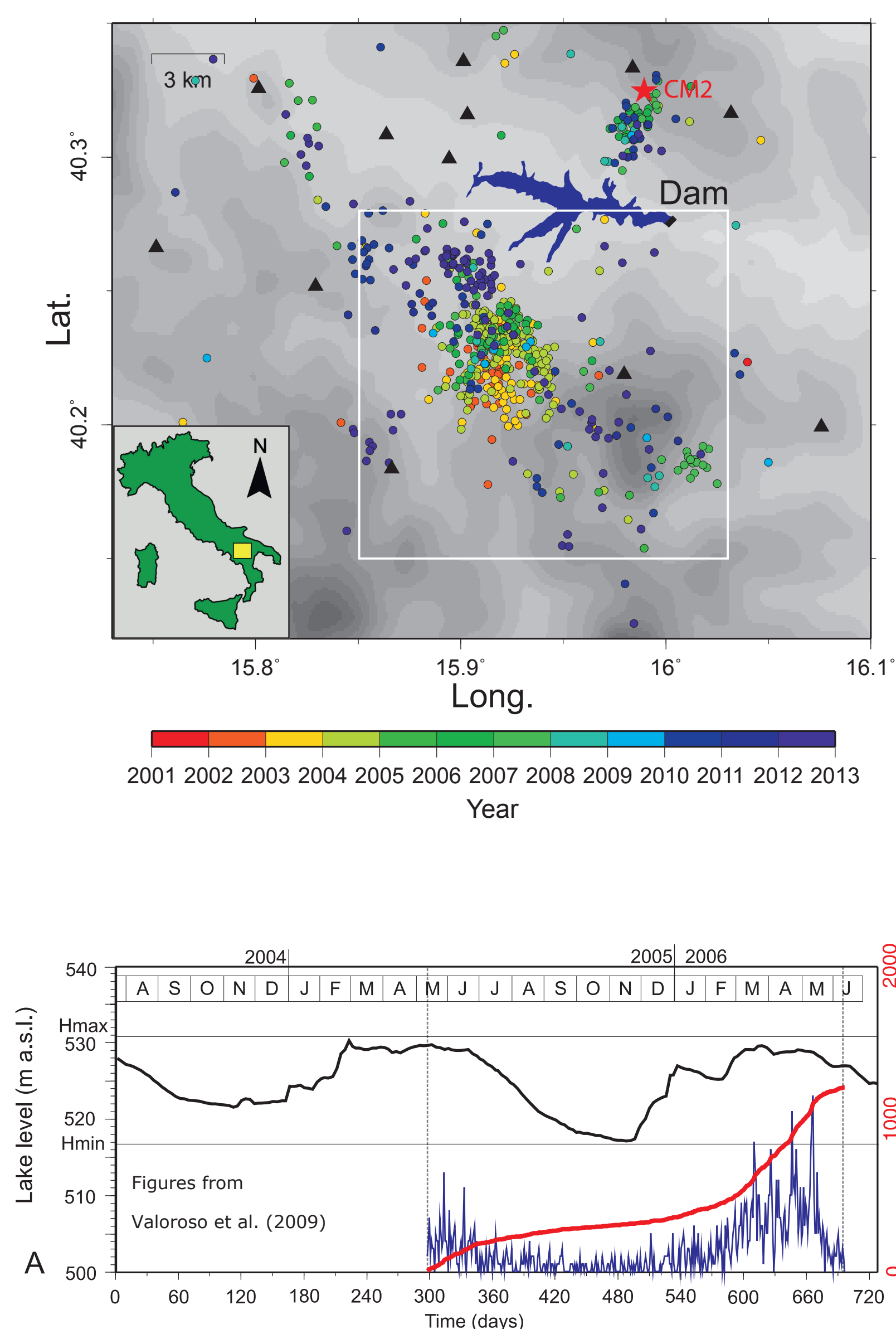
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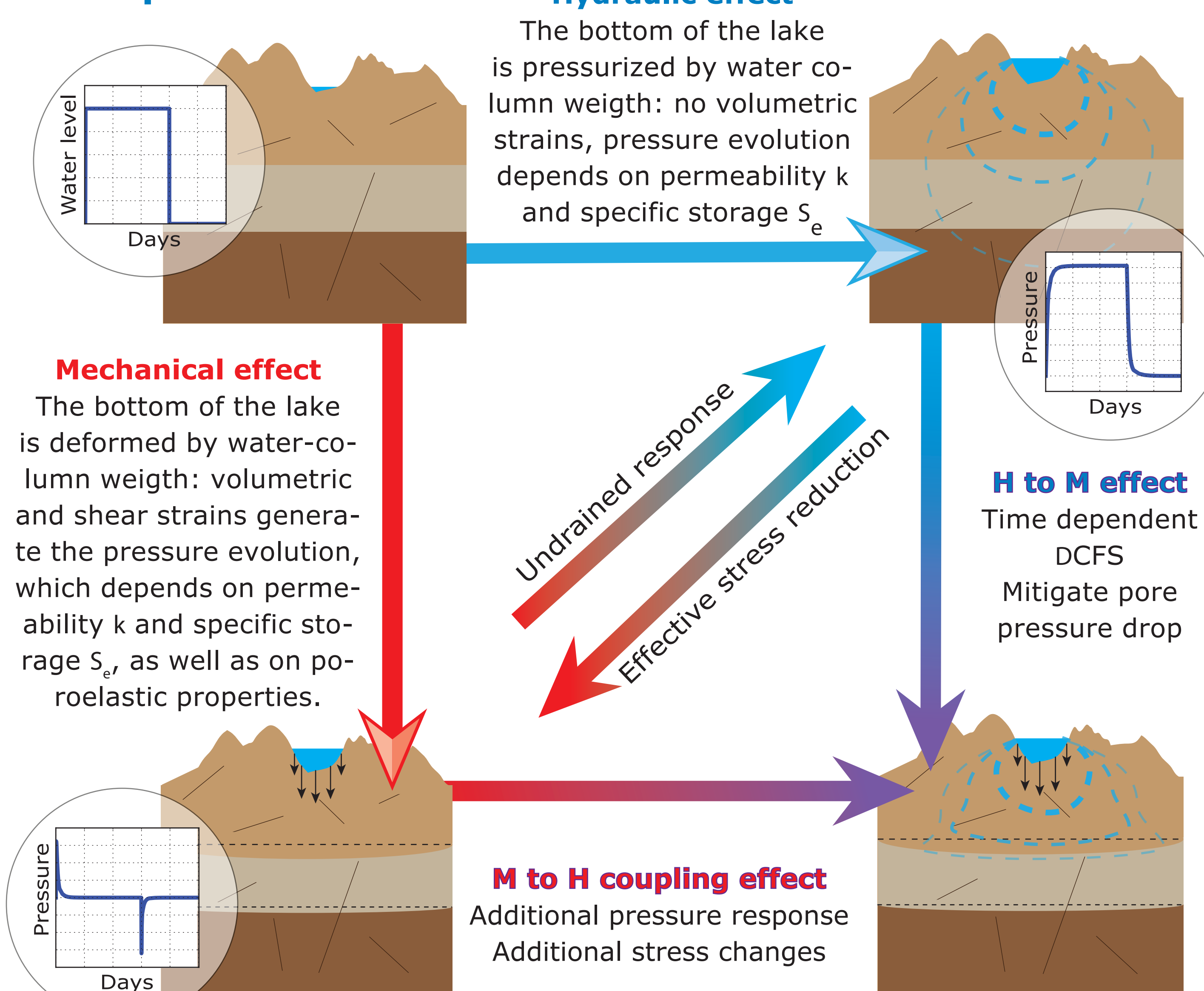
Introduction

A water reservoir affects the underlying crust stress state through the poroelastic response to the weight of the water volume stored and by the consequent fluid movement.

The artificial lake of Pertusillo in Val d'Agri (Italy) is one of the known water reservoirs showing protracted seismic activity for several years after the initial filling in 1963. More than 800 small magnitude events ($M_L < 3$; $M_c = 1.1$) were located between 2001 and 2013 by a monitoring network of a local industry operator supplemented by permanent and temporary stations of the Istituto Nazionale di Geofisica e Vulcanologia. Hypocenters concentrate at a shallow depth (< 5 km) to the south of the lake. During the same period the reservoir water level fluctuated in average of tens of meters between summer and winter periods. The observed seismicity rate positively correlates with these seasonal oscillations.



Conceptual model

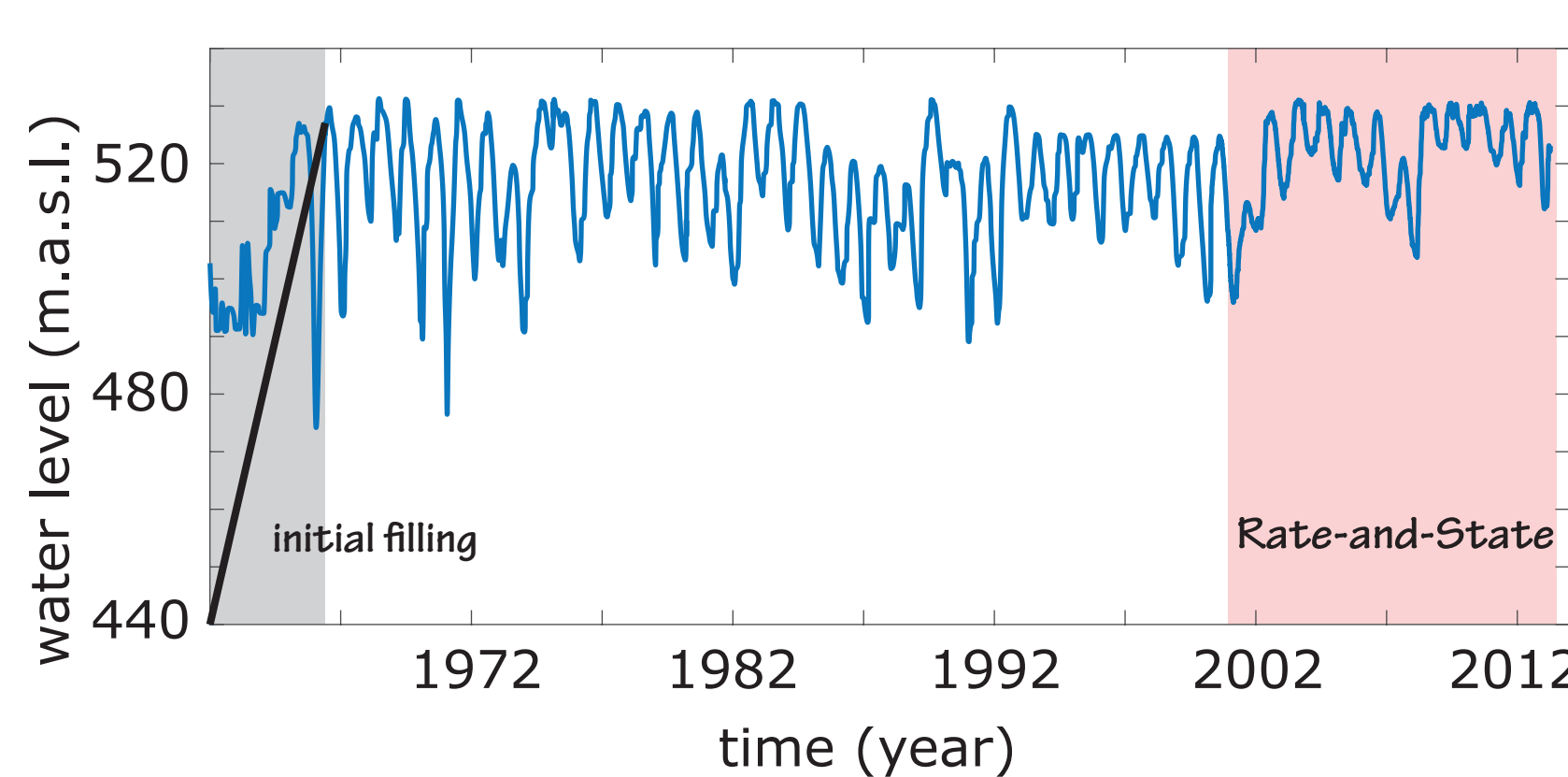


Coulomb and Rate-and-State: homogeneous model

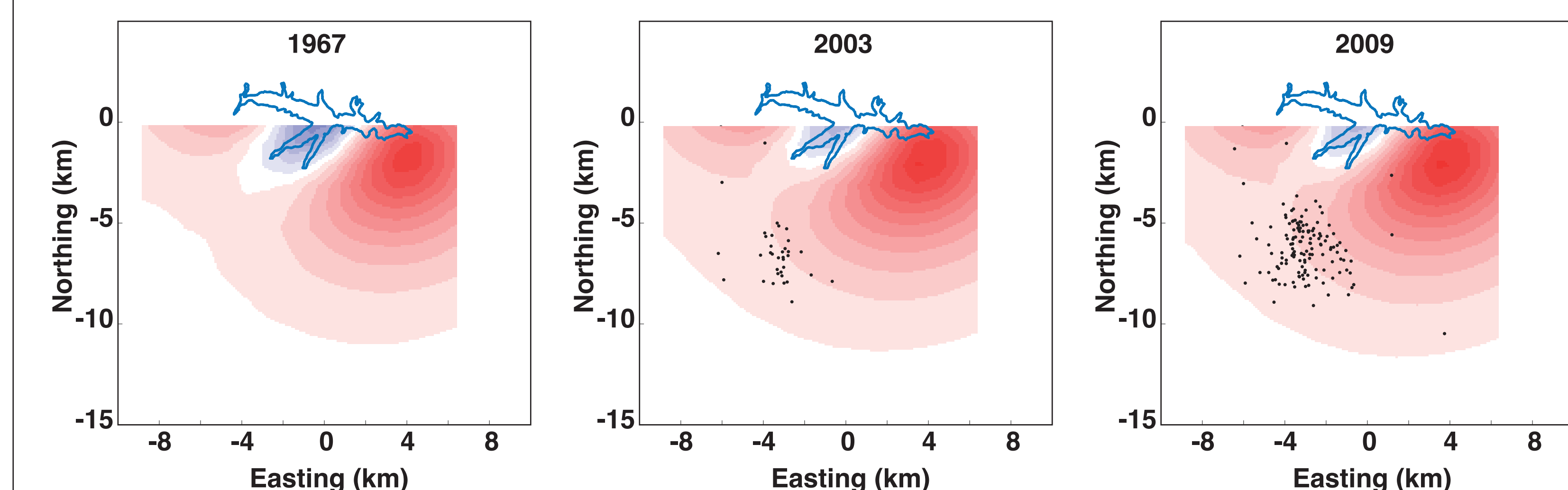
SEMI-ANALYTICAL MODEL

- Poroelastic model to compute changes in loading and pressure diffusion due to water level changes
- Resulting CFS changes are input to a Rate-and-State model to compute seismicity rate (for fault oriented similar to observation - Valoroso et al., 2009)

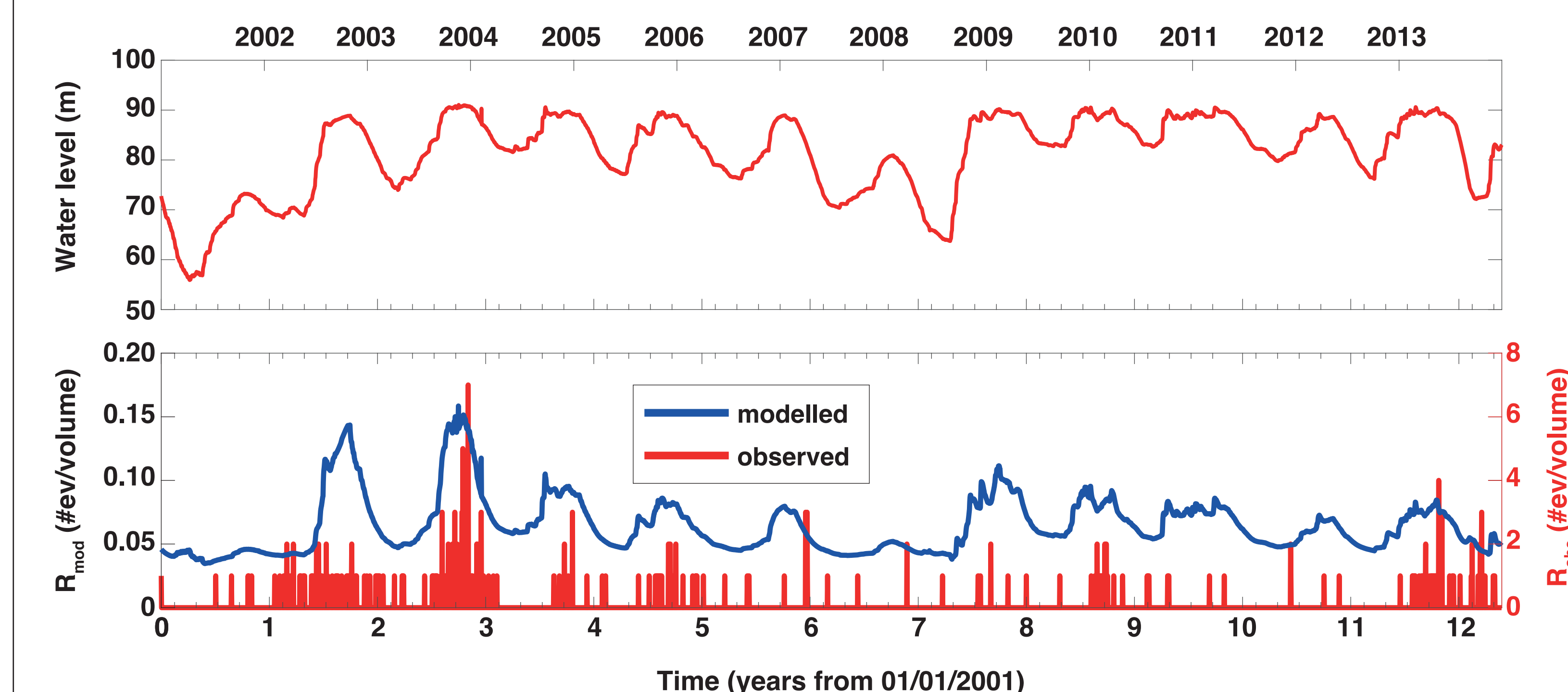
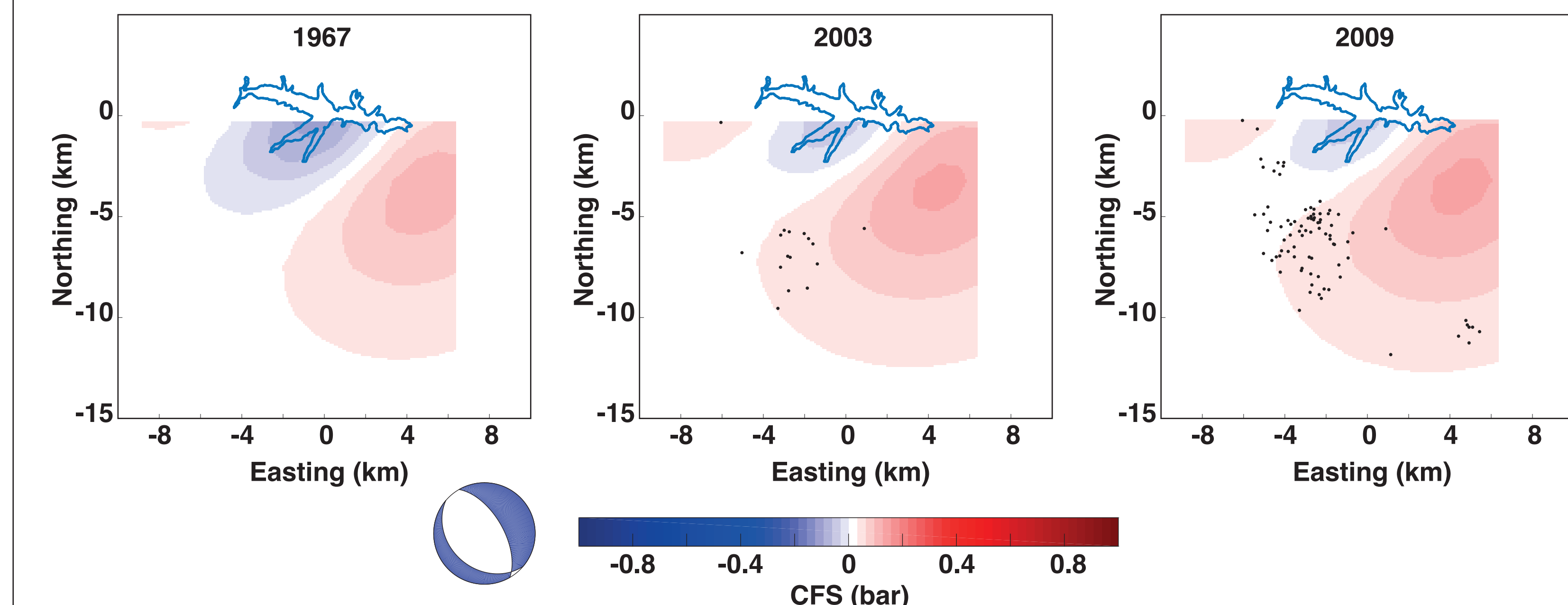
Diffusivity (m^2/s)	0.05	Rate-and-State	
B Skempton	0.5	$A\sigma$ (MPa)	0.0009
Poisson's ratio	0.25	t_s (days)	1280.7
Friction	0.6	r (#/day)	0.058



4 km depth (seismicity between 2 km and 4 km)



6 km depth (seismicity between 4 km and 6 km)

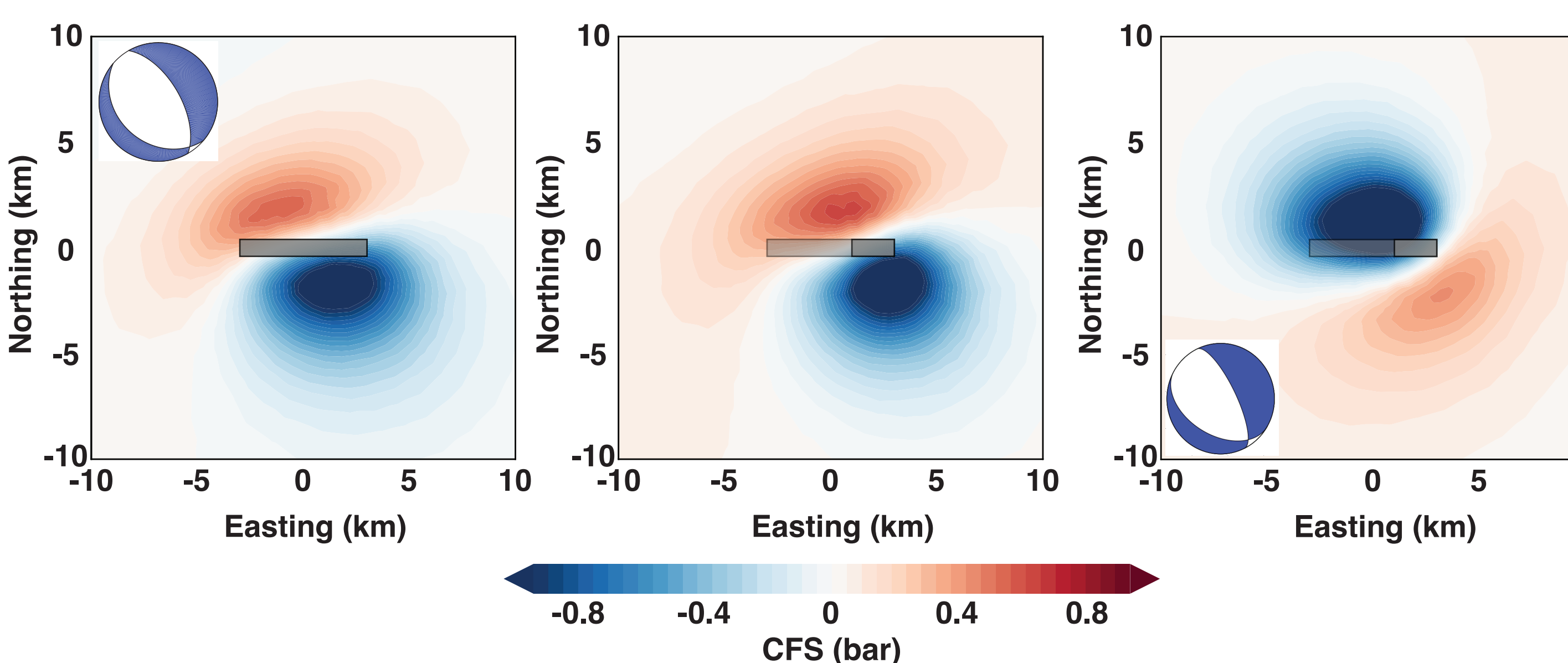
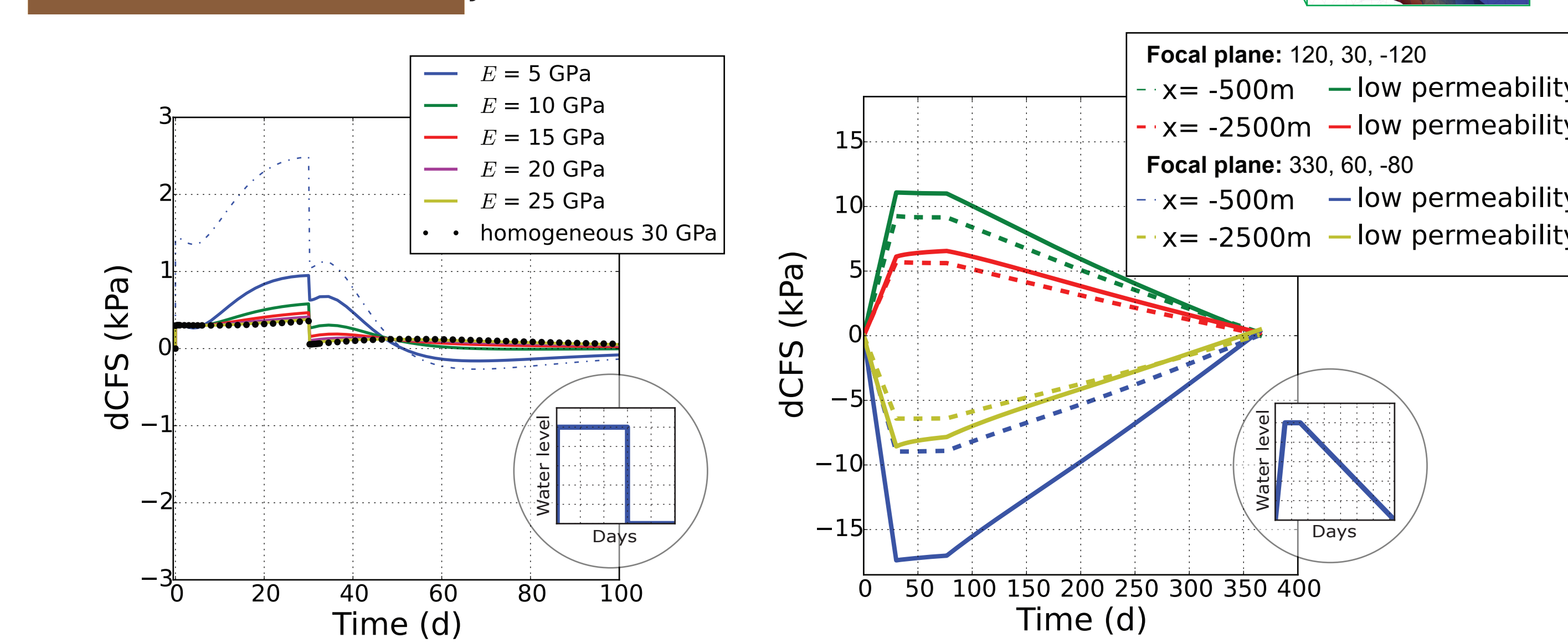
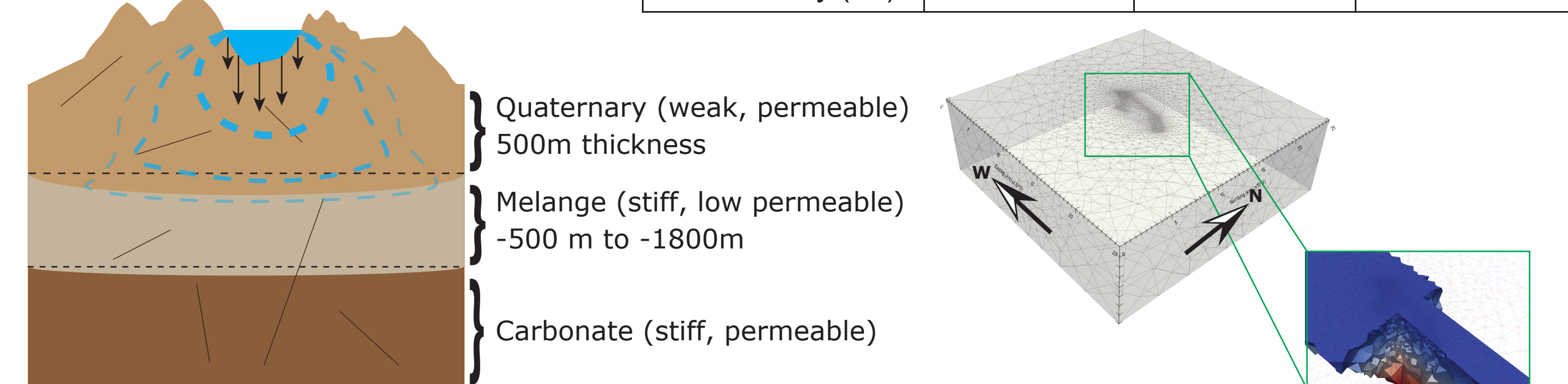


Effect of heterogeneities

OPENGEOSYS simulator

- Lake: time-dependent boundary condition. Vertical load and pore pressure
- Open pressure boundary
- Fixed displacement boundary
- 30 days loading/ protracted response

	Quaternary	Mélange	Carbonate
Density (kg/m^3)	2300	2300	2300
Young's modulus (GPa)	1-30.0	30.0	30.0
Poisson's ratio	0.25	0.25	0.25
α Biot	0.9	0.9	0.9
B Skempton	1.00	1.00	1.00
Permeability (m^2)	$5 \cdot 10^{-15}$	$5 \cdot 10^{-17}$	$5 \cdot 10^{-15}$



Conclusion

- The semi-analytical model shows that poroelastic interaction may have indeed caused changes in CFS. Observed seismicity in positive CFS changes, although the values are smaller than few decimal of bar. A rate-and-state model is able to predict peaks of seismicity, while overestimating the rate at later time of observation. Earthquakes interaction may have played a role in reducing the Coulomb stress.
- The use of a numerical model highlights the importance of accounting for heterogeneities, which could enhanced and focus the stress variation at observed seismogenetic region.

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