

Modeling of earthquake interactions for induced seismicity

Rinaldi A. P.⁽¹⁾, Catalli F.⁽²⁾, Nespoli M.⁽³⁾, Gischig V.⁽⁴⁾, Wiemer S.⁽¹⁾

(1) Swiss Seismological Service, ETH Zürich, Switzerland; (2) Deutsches GeoForschung- Zentrum, GFZ – Potsdam, Germany; (3) Dip. di Fisica e Astronomia, Università di Bologna, Italy; (4) Swiss Competence Center for Energy Research, ETH Zürich, Switzerland

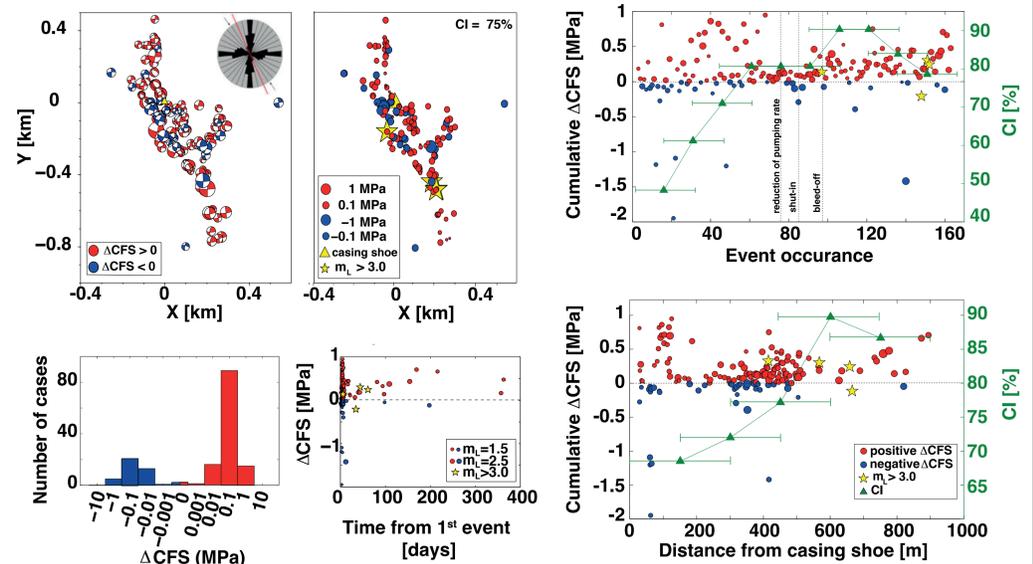
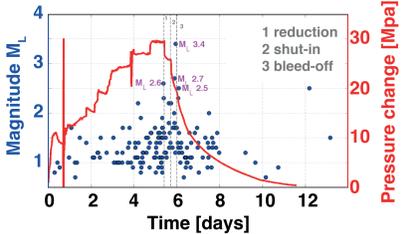


Introduction

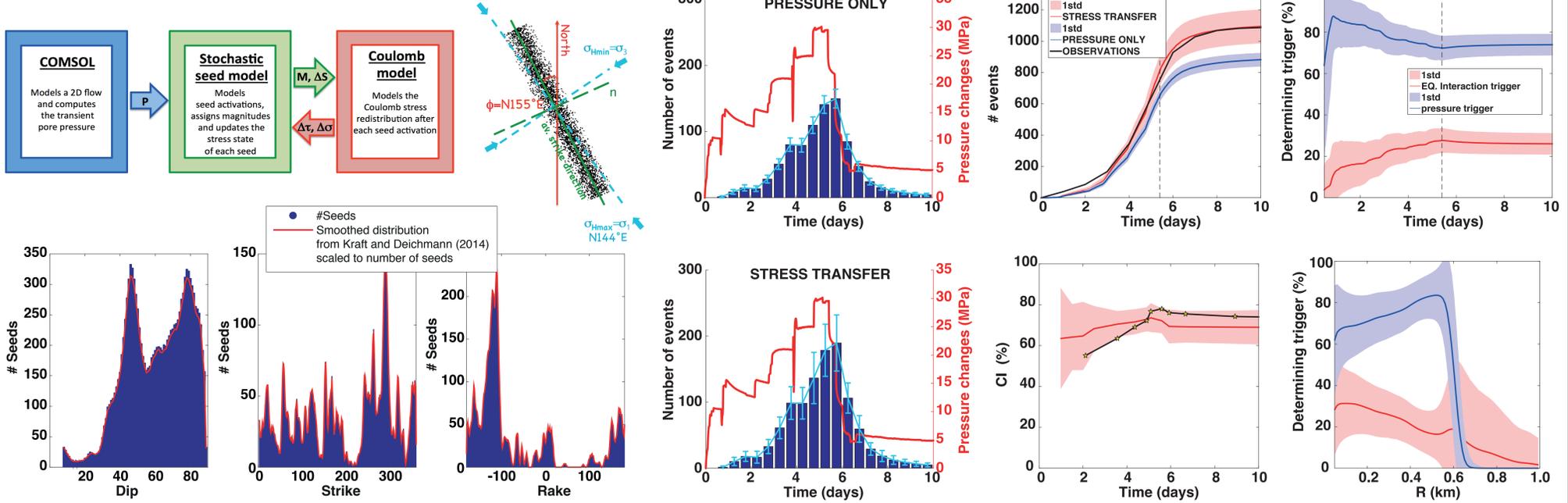
We explore the role of earthquake interactions during an injection induced seismic sequence. We first propose a 2D model based on data from Basel and that considers both a transient pressure and the static Coulomb stress redistribution due to event interactions as triggering mechanisms for induced seismicity. Then, we generalized the model for injection induced seismicity to a full 3D fluid flow and geomechanical-stochastic configuration, including stress transfer and permeability changes. We applied the 3D model to synthetic cases and compare two different model of static stress transfer. For each approach, we produce a number of stochastic seismic catalogues that allow a probabilistic analysis of the problem.

The case of Basel EGS (Catalli et al., 2013)

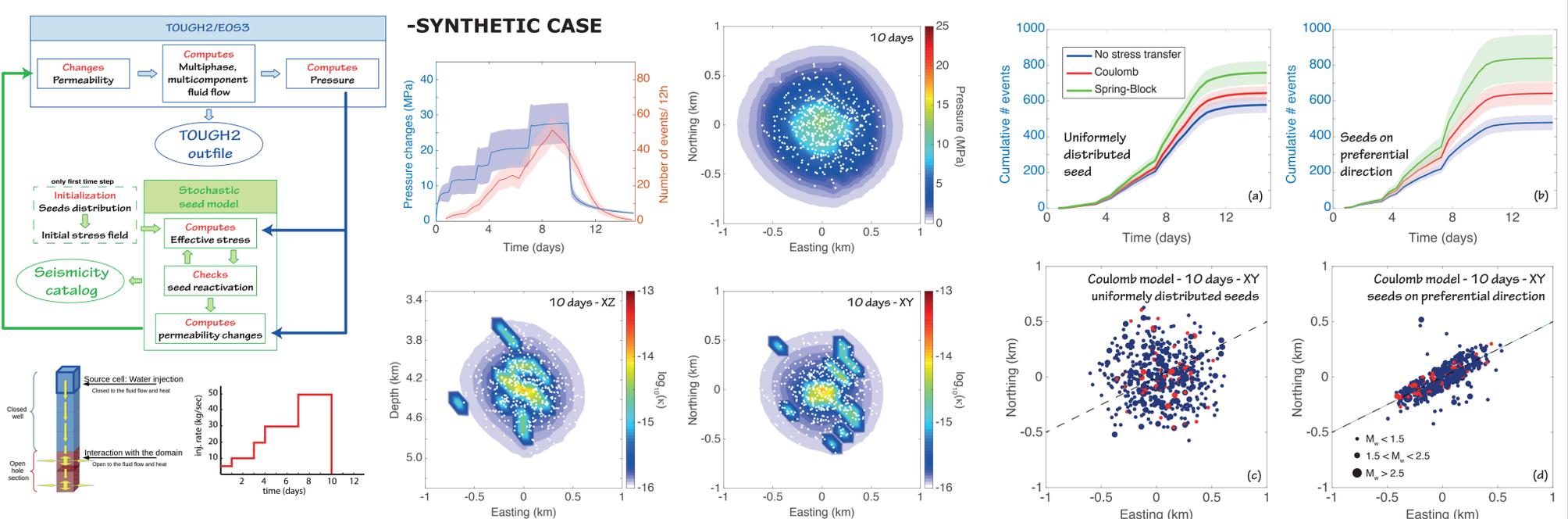
Data from Basel show that the earthquake interactions may have played a role in the distribution of the seismic cloud. The amount of events with positive Coulomb Stress increases with time and far from casing shoe. The percentage of events with positive CFS changes reaches about 90%.



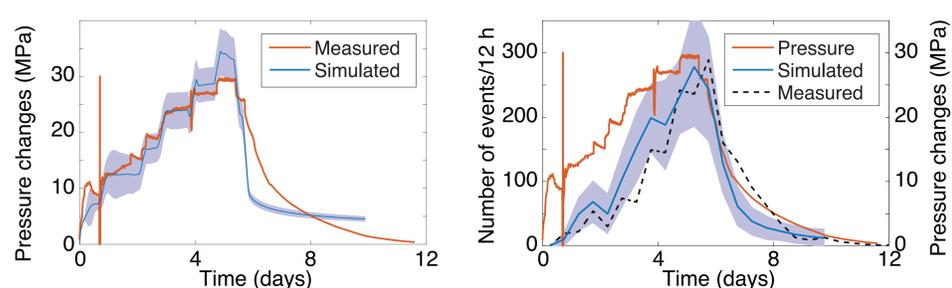
2D modeling approach (Catalli et al., 2016)



TOUGH2-seed: a 3D modeling approach (Rinaldi & Nespoli, 2016)



-APPLICATION TO BASEL



Conclusion

- With a 2D modeling approach calibrated for the Basel EGS, we observe that considering earthquake interactions in the modelling can lead to a larger number of expected seismic events (24% more) if compared to a pressure-induced seismicity only. The increase of the rate is true particularly after the end of the injection activity, in accordance with the simultaneous increase of the Coulomb Index.
- The use of a more sophisticated 3D modeling approach allows to generalize the effect of earthquake interactions during an injection-induced seismicity. The model confirms that for a case with distributed seismicity (e.g. Basel), the static stress transfer has a large effect on the number of events
- We conclude that implementing a model for estimating the static stress changes due to mutual event interactions increases significantly the understanding of the process.

REFERENCES

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