Testing spatial aftershock forecasts accounting for large secondary events during on going earthquake sequences: A case study of the 2017-2019 Kermanshah sequence

Behnam Maleki Asayesh

Hamid Zafarani, Sebastian Hainzl, Shubham Sharma

International Institute of Earthquake Engineering and seismology (IIEES)

GFZ German Research Centre for Geosciences

Corresponding paper: GJI, under review

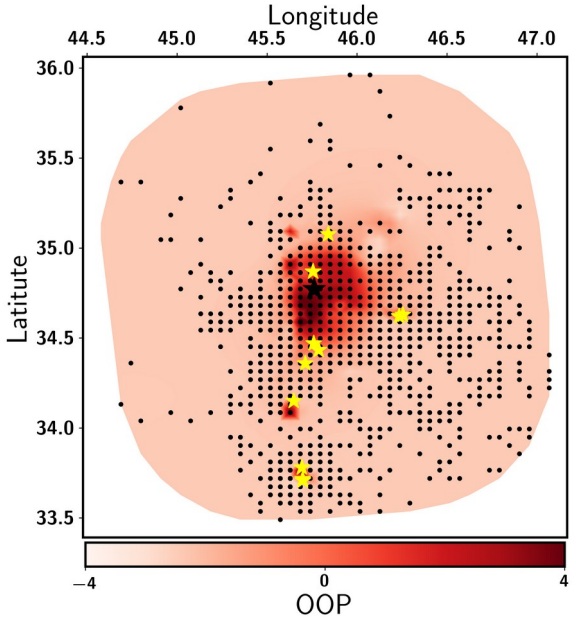
Motivation

- Aftershocks can be destructive or deadly as the mainshock or even worse.
- Accurate forecast of the aftershock is of utmost importance.
- Imparted stress from mainshock is accepted to explain aftershocks triggering.

Forecasting Methods

1. ΔCFS on master fault orientation (**MAS**)
2. ΔCFS on optimally oriented planes (**OOP**)
3. ΔCFS assuming fault variability (**VM**)
4. Maximum Shear (**MS**)
5. von-Mises stress (**VMS**)
6. Distance-slip model (**R**)

DeVries et al. (2018), Mignan and Broccardo (2019), Sharma et al. (2020)

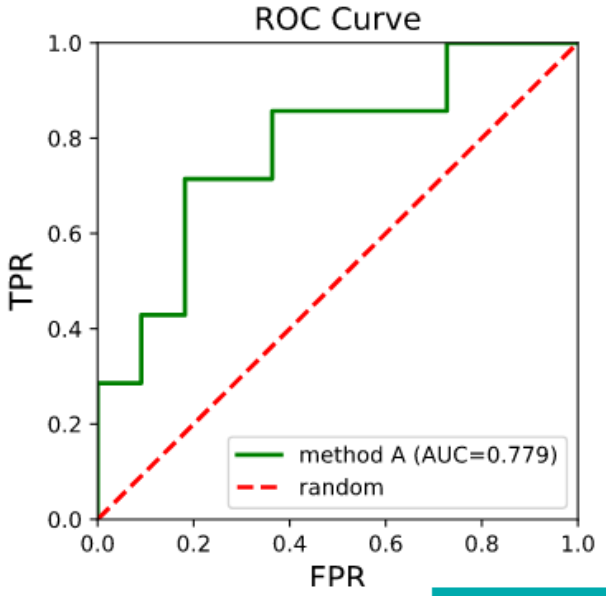


By considering secondary stress from large aftershocks

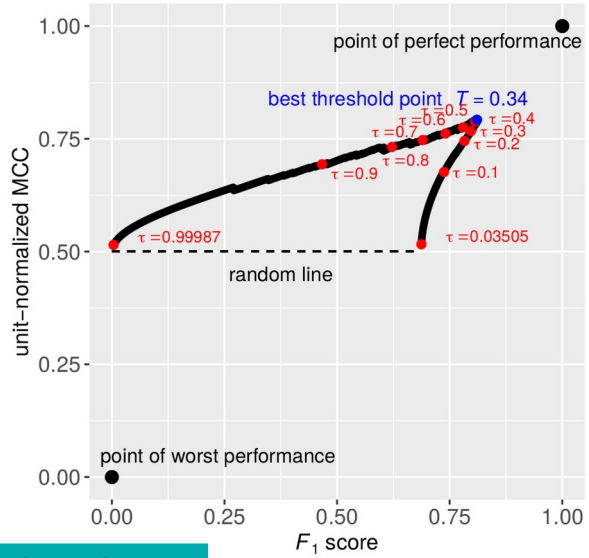
Asayesh et al. GJI, under review.

Test Methods

1. AUC from ROC curves

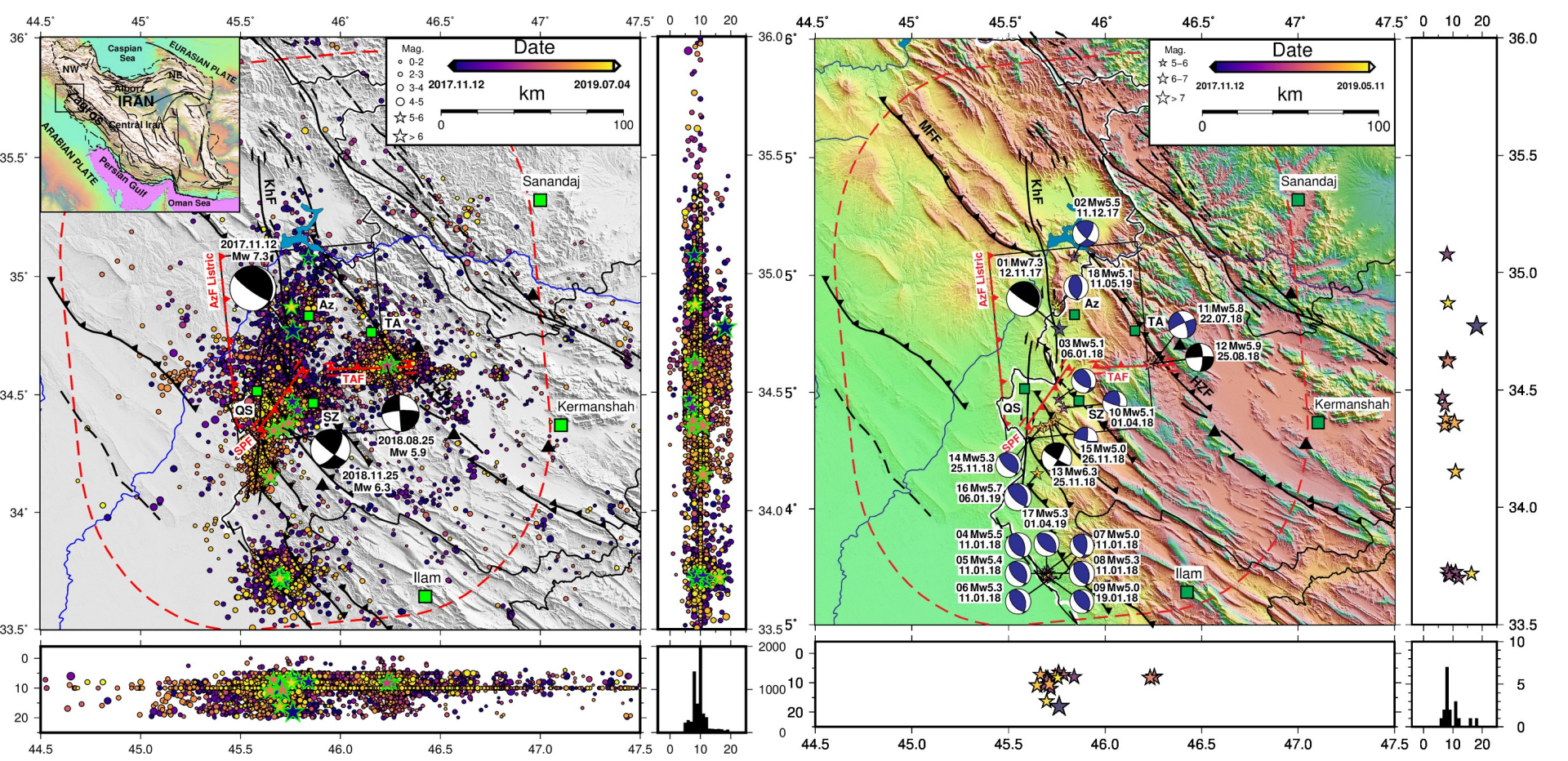


2. MCC-F1 metric



	actual positive	actual negative
predicted positive predicted negative	true positives (TP) false negatives (FN)	false positives (FP) true negatives (TN)

Cao et al. (2020). The MCC-F1 curve: a performance evaluation technique for binary classification. arXiv preprint arXiv.



Asayesh et al. GJI, under review.

5 × 5 × 5 and 2 × 2 × 2 km gridded target volume

$$S_k(\vec{x}) = \sum_{i=0}^{k} w_i S_i(\vec{x})$$

PSGRN + PSCMP tool of Wang et al. (2006)

solid = mainshock

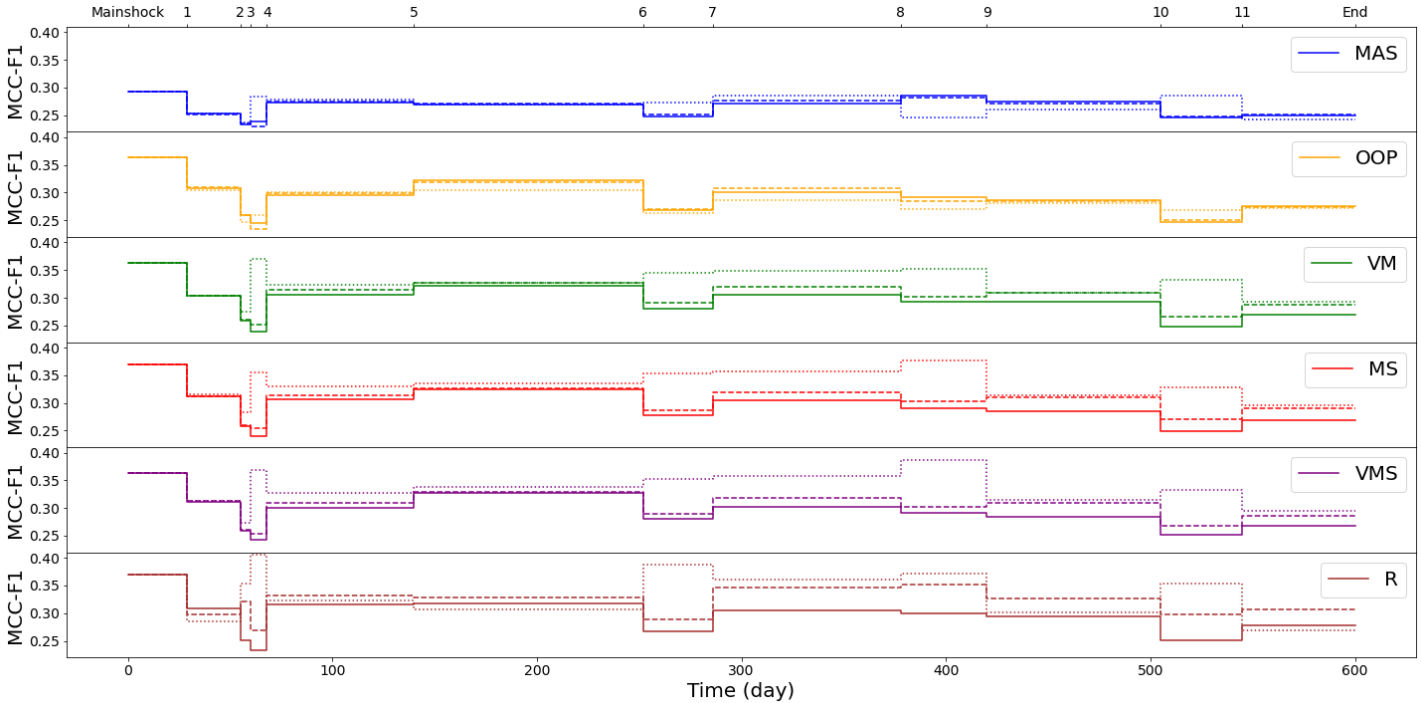
$$w_0 = 1, w_i = 0 \; for \; i \geq 1$$

dashed = uniform weights

$$w_i = 1 \; for \; i \leq k$$

dotted = Omori-type weights

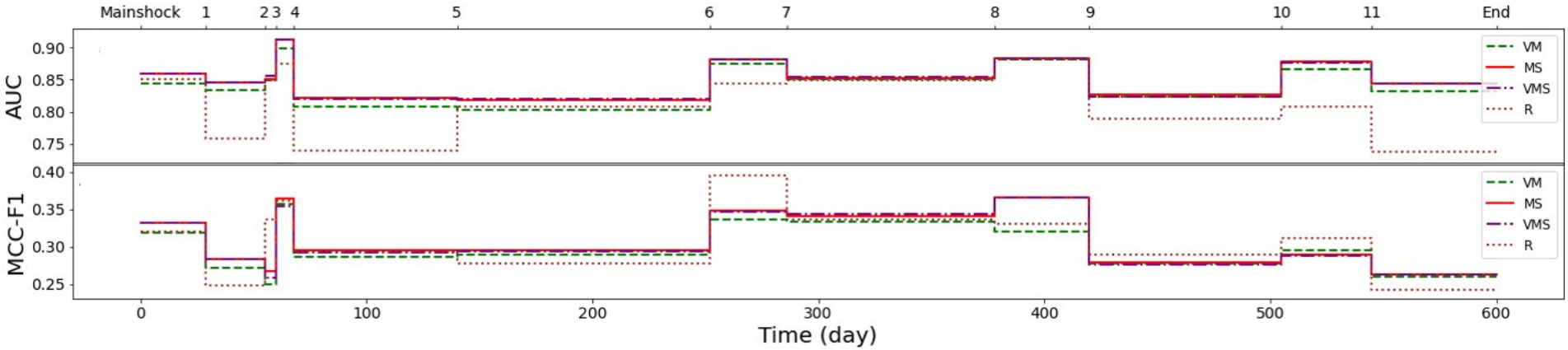
$$w_i = (t_k - t_i + c)^{-p}$$



MCC-F_1 results for the different stress metrics and R model for 5 km grid-spacing.

Asayesh et al. GJI, under review

Comparison for Omori-weighted multiple sources for the best stress metrics and the R model



Conclusion:

Importance of secondary stress triggering in aftershocks redistribution.

The best metrics for aftershocks spatial forecasting are simple stress scalars.

The best approach for considering secondary triggering is Omori-type weighted approach.

Epidemic Type Aftershock Sequence (ETAS).

Thank you for your attention!

This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

maleki@gfz-potsdam.de