

Inferring a shallow degassing model for Villarrica Volcano from seismic explosion signals and SO₂ flux

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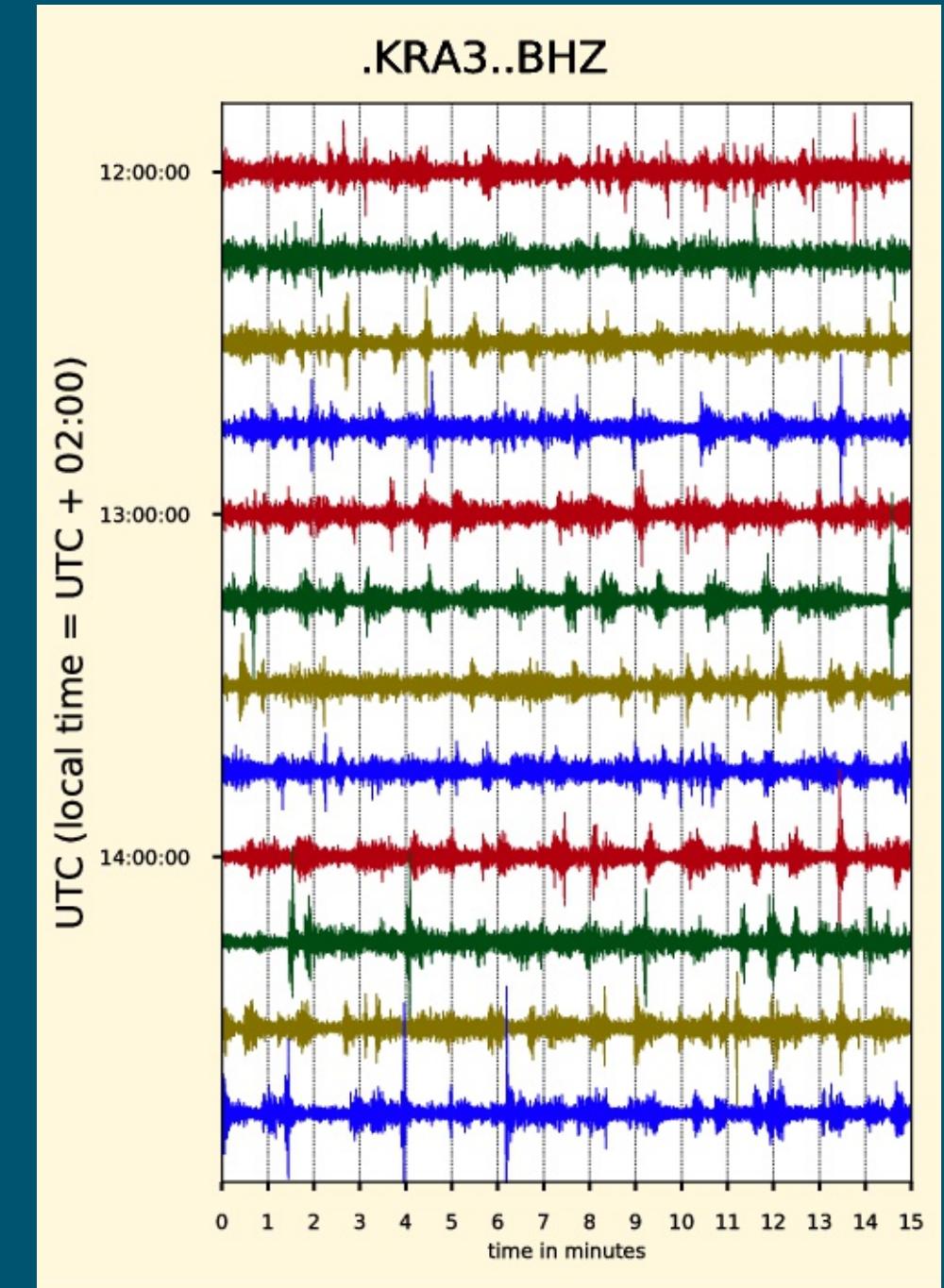
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vEGU21

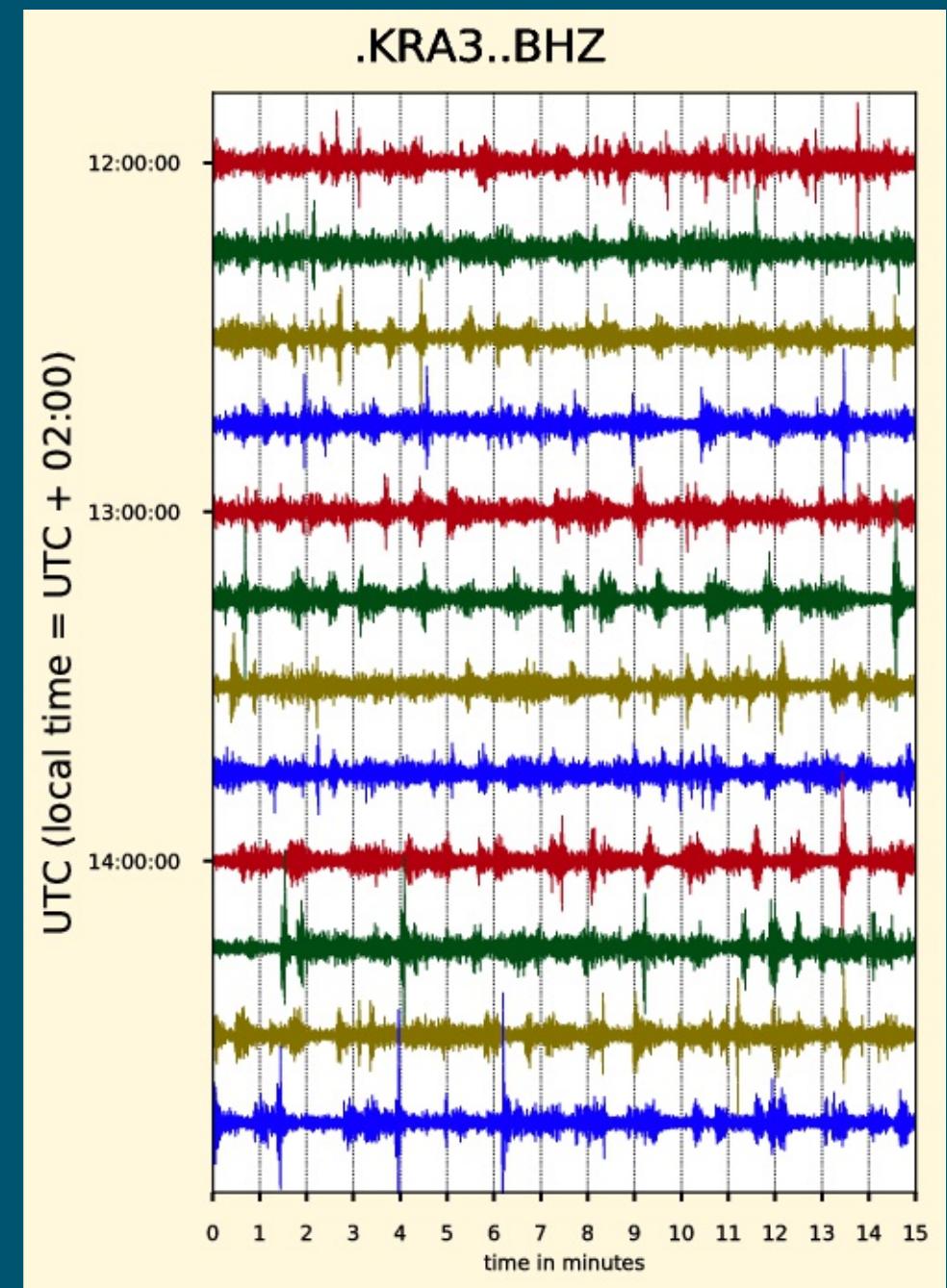
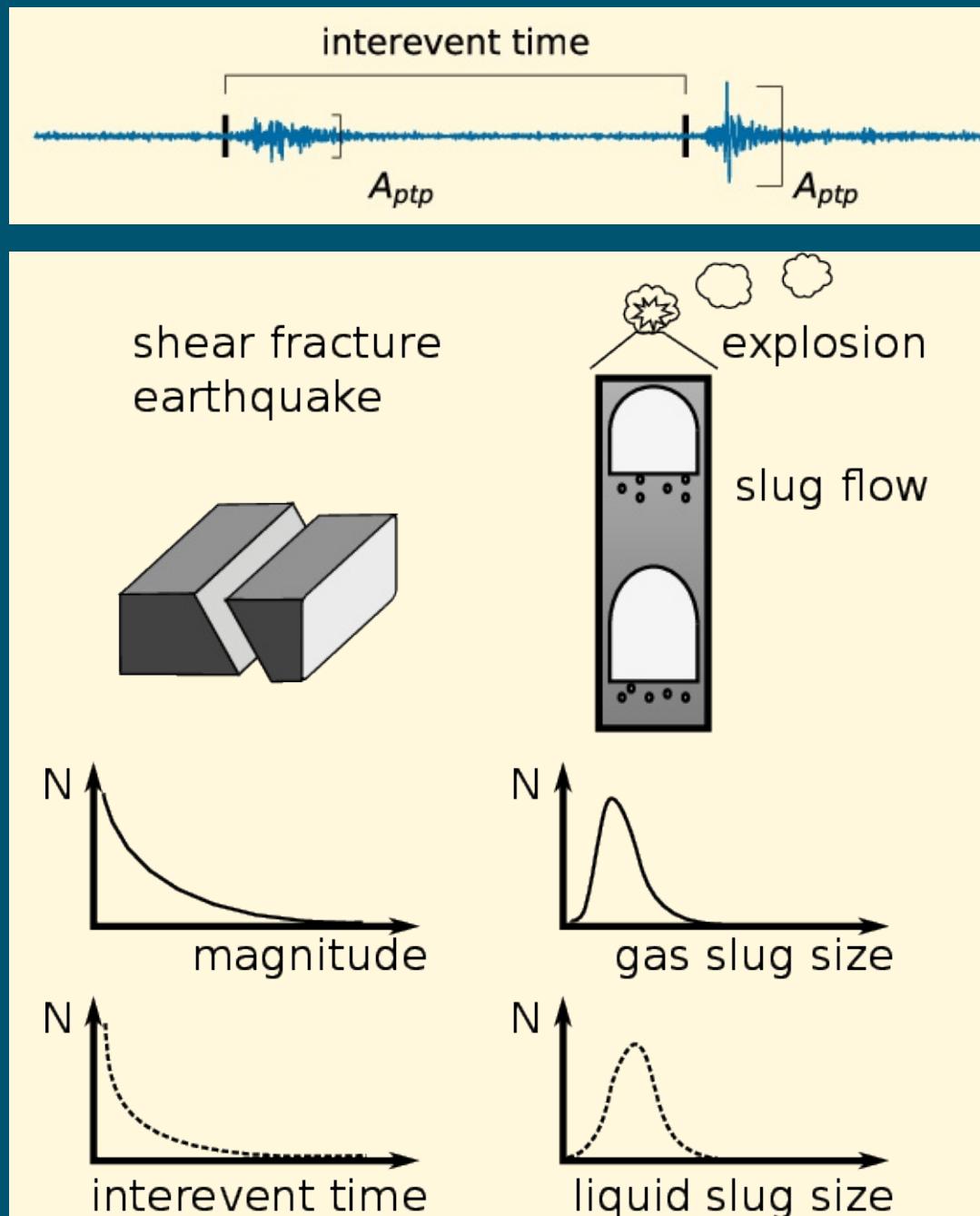


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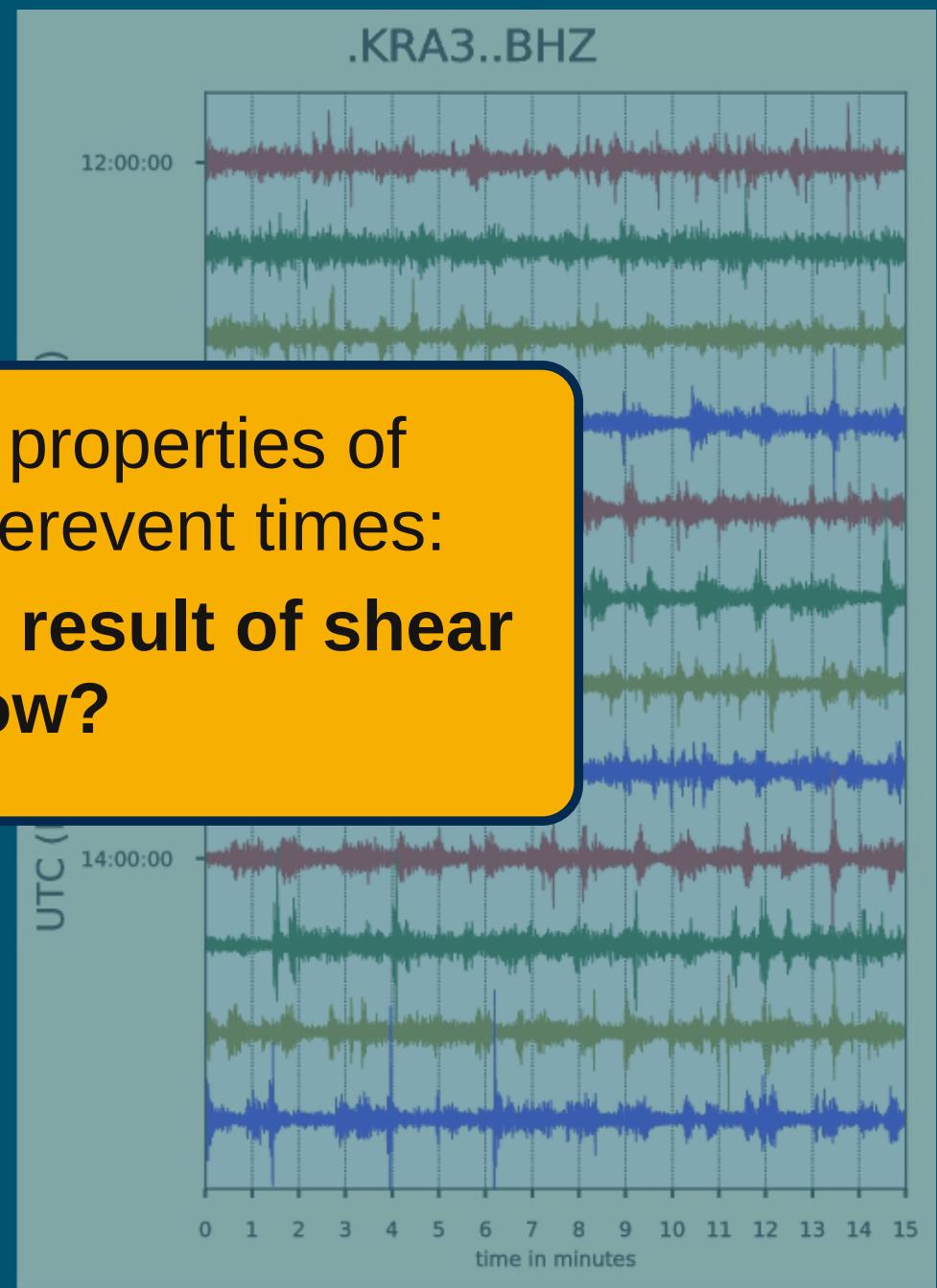
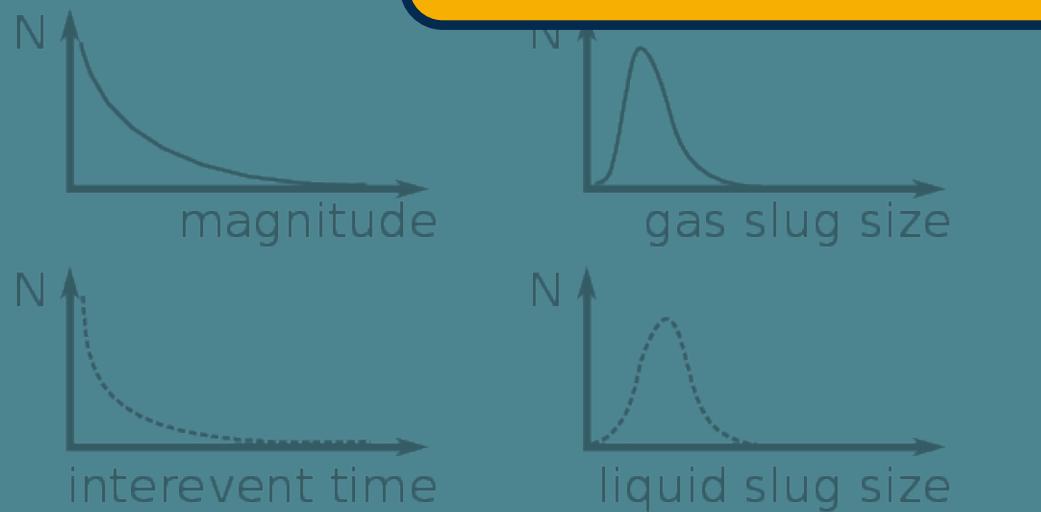
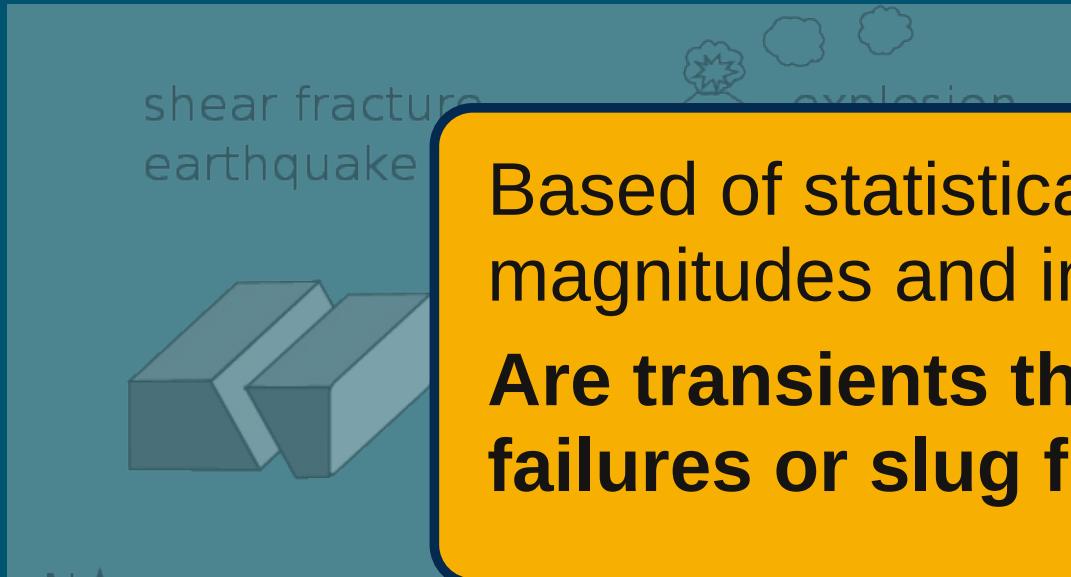
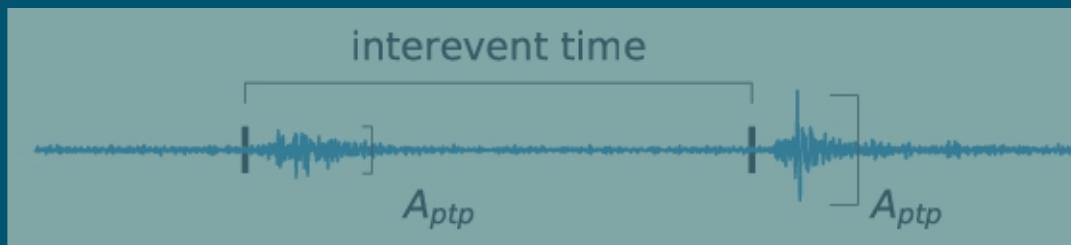
Seismic transients - brittle failure or explosions?



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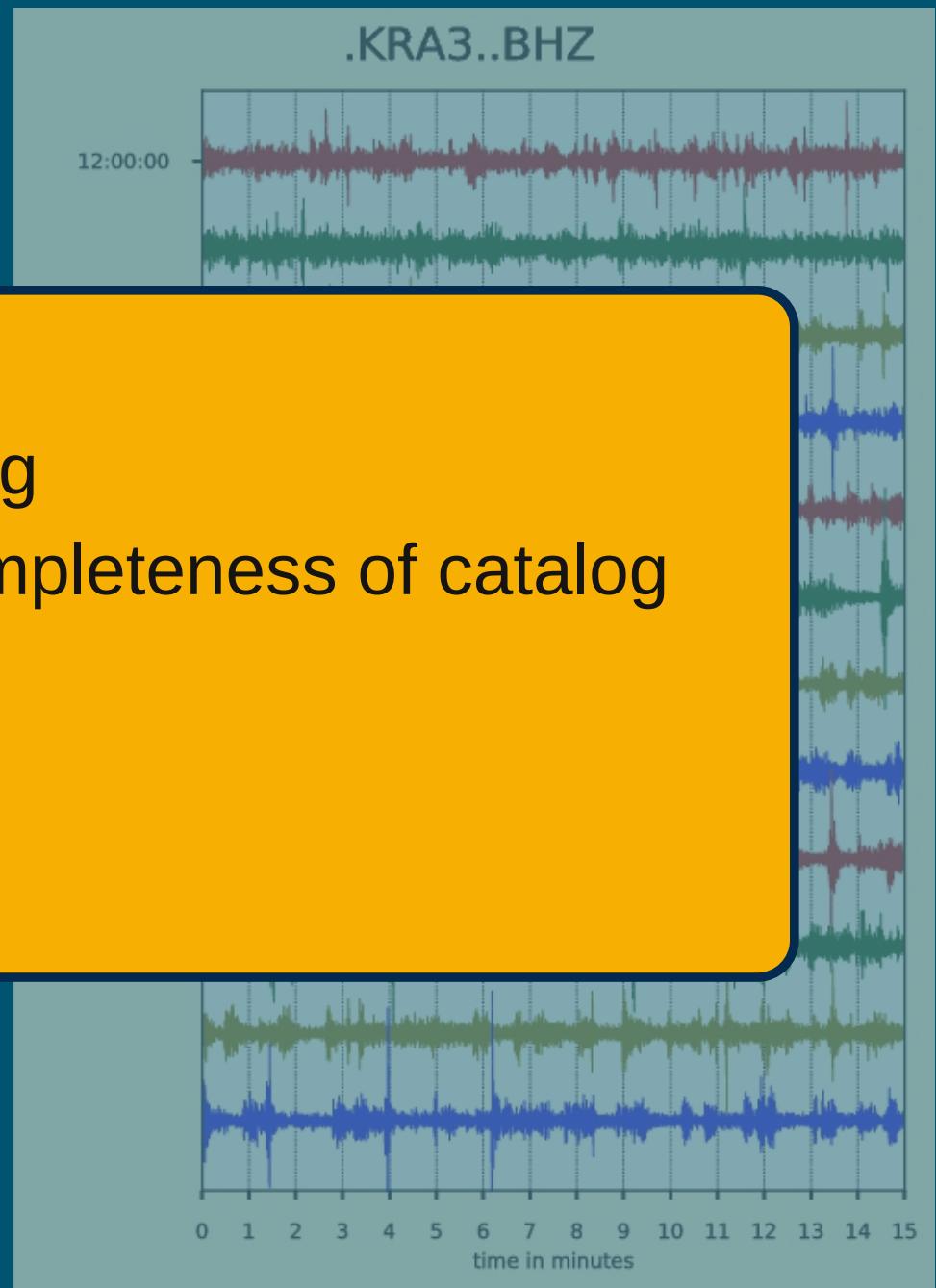
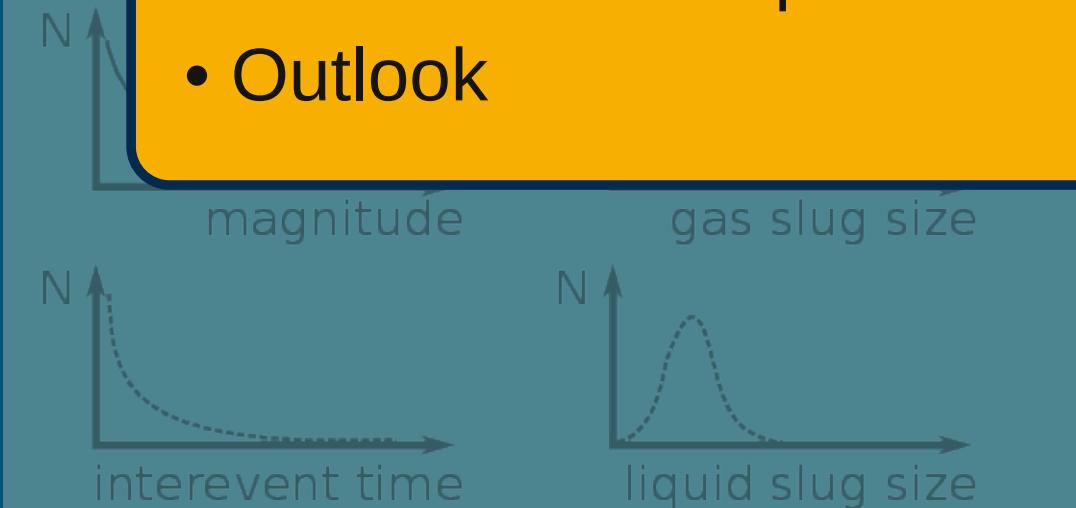
Seismic transients - brittle failure or explosions?



Based on statistical properties of magnitudes and interevent times:
Are transients the result of shear failures or slug flow?

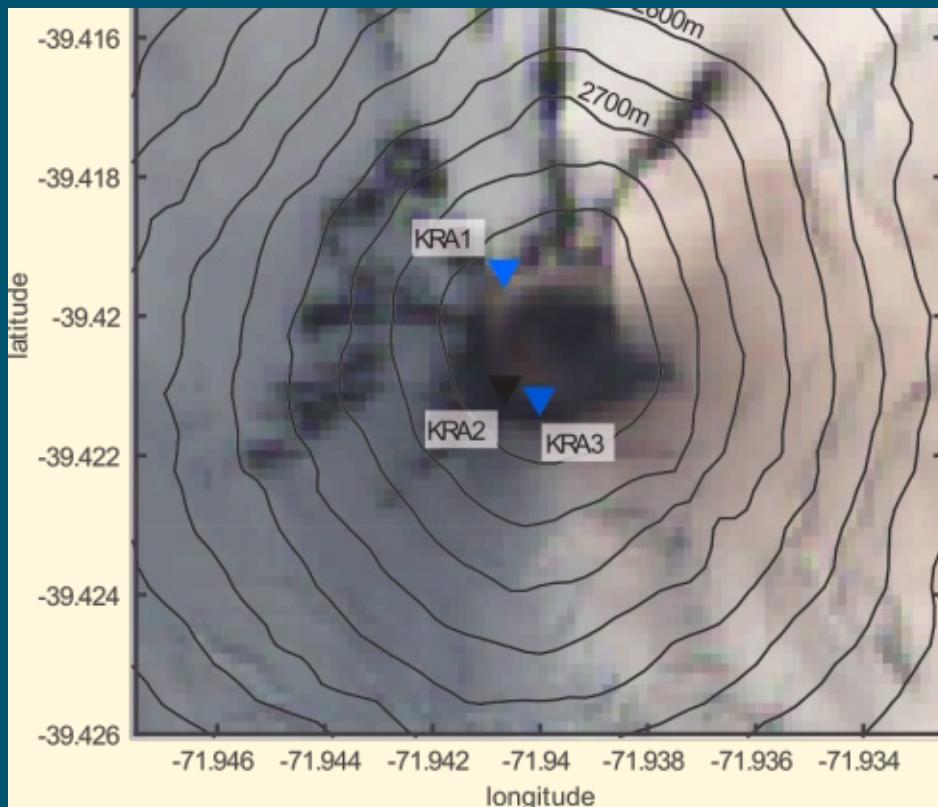
Seismic transients - brittle failure or explosions?

- Methods
 - Event detection & catalog
 - Trigger simulation & Completeness of catalog
- Results
- Discussion of implications
- Outlook

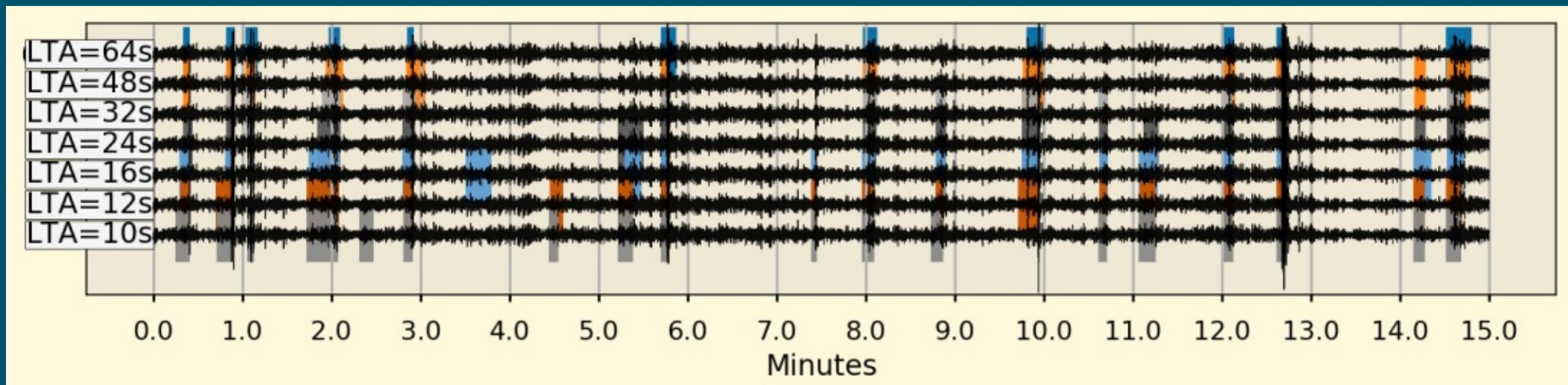


Methods

Event detection & catalog



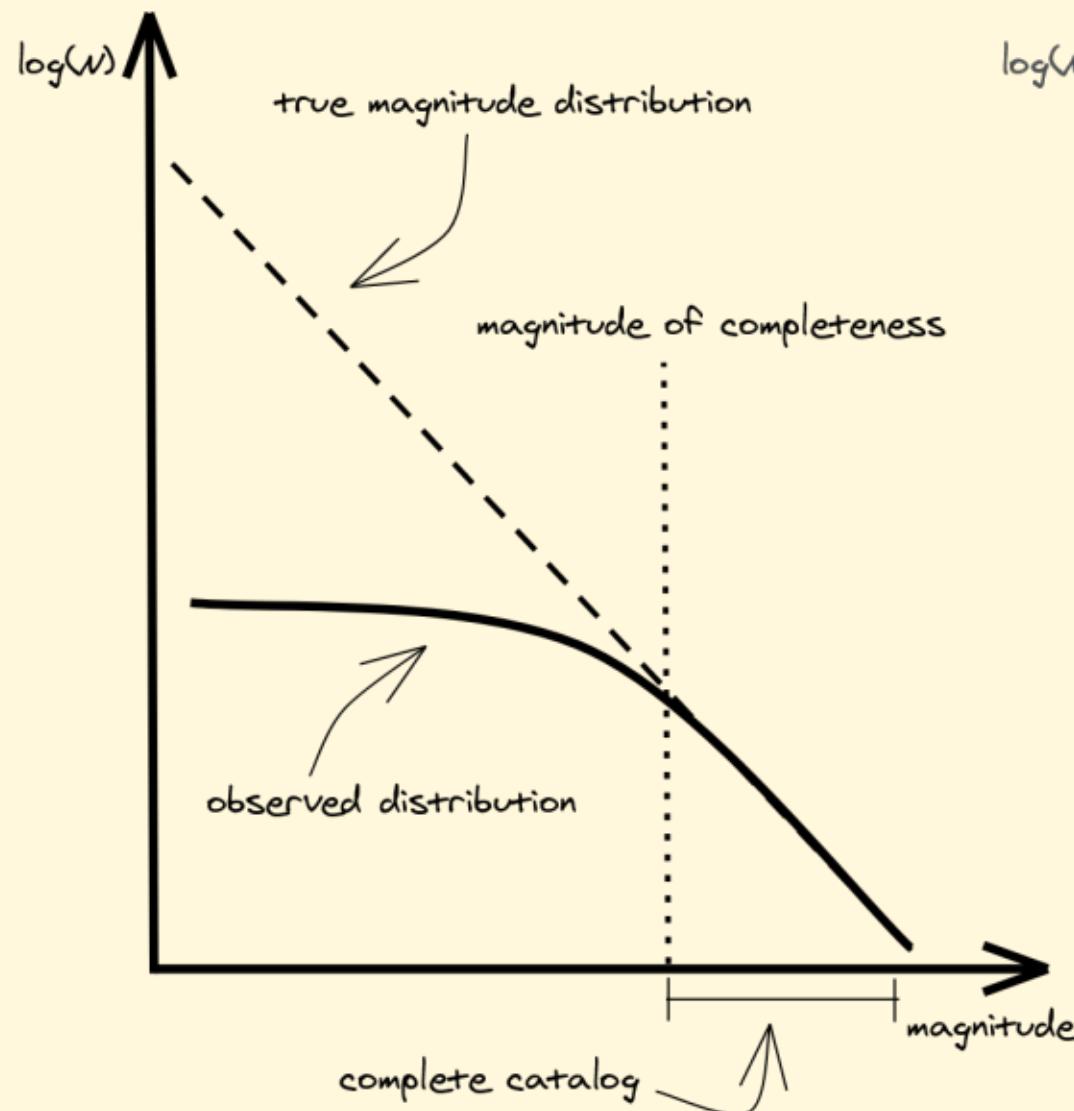
- 10 days of data
- 2 stations at the crater rim
- STALTA trigger
→ 23,505 events
- Local magnitude scale:
 $M \sim \log(A_{\text{ptp}} / 2)$



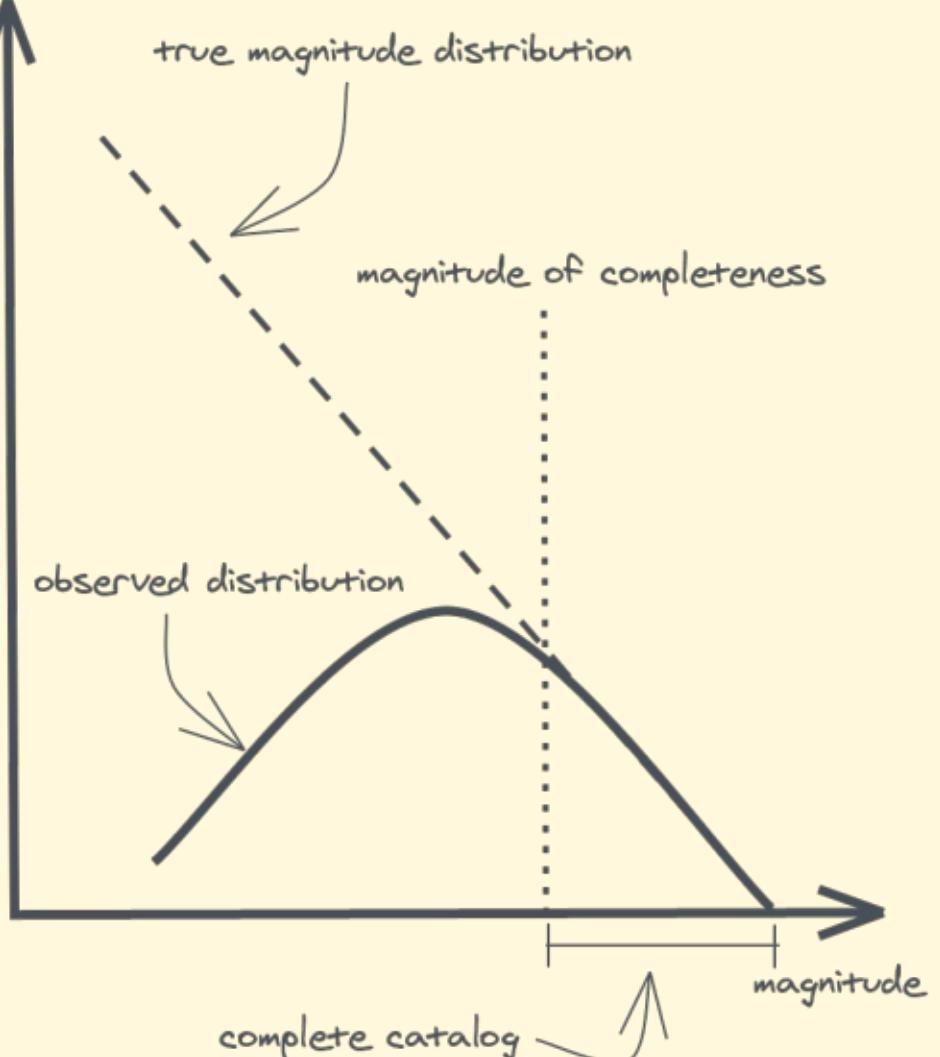
Methods

Completeness problem

Empirical survival function



Histogram



Methods

Trigger simulation

per event

Noise model

- lognormal pdfs of LTA values from 5-min long samples of every hour
- correlation matrix of LTA between channels

— generate random LTA samples for each channel

STA / LTA per channel

STA samples for each channel

M - STA relation
empirical linear relation between magnitude and STA values

Magnitude model
pdf describing frequencies of magnitudes

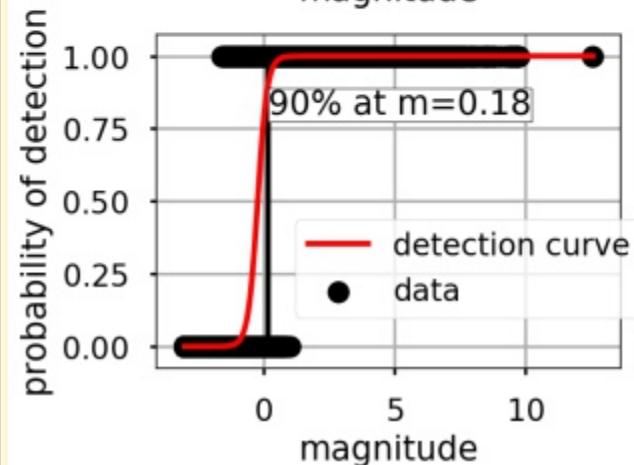
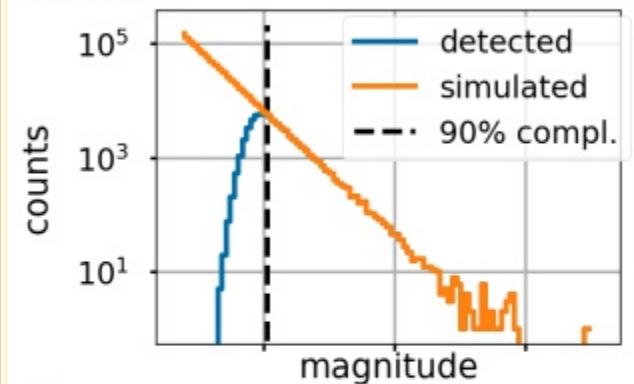
detected
not detected

trigger logic kernel
combine different stations, LTA window lengths

Monte-Carlo approach

detection curve

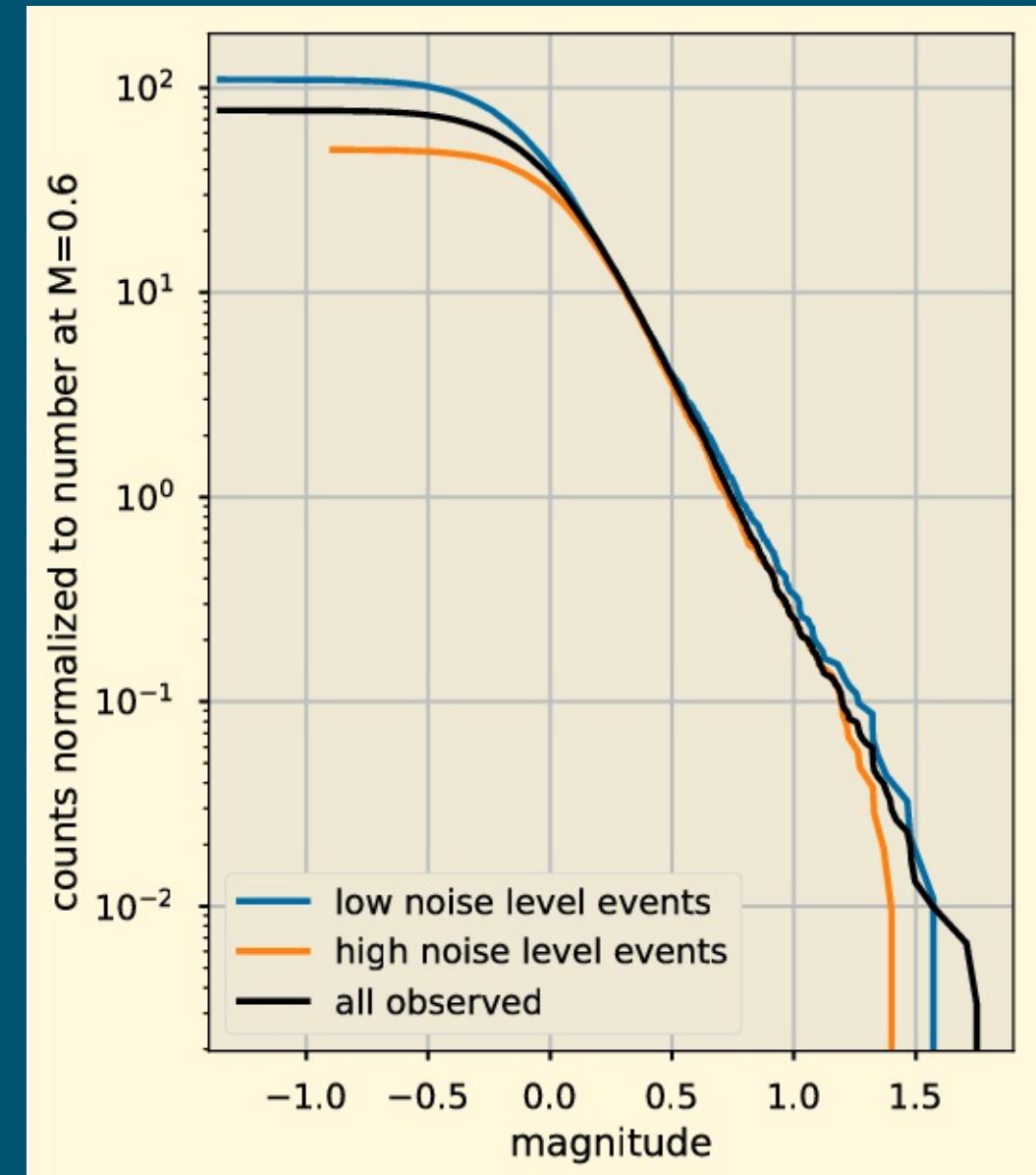
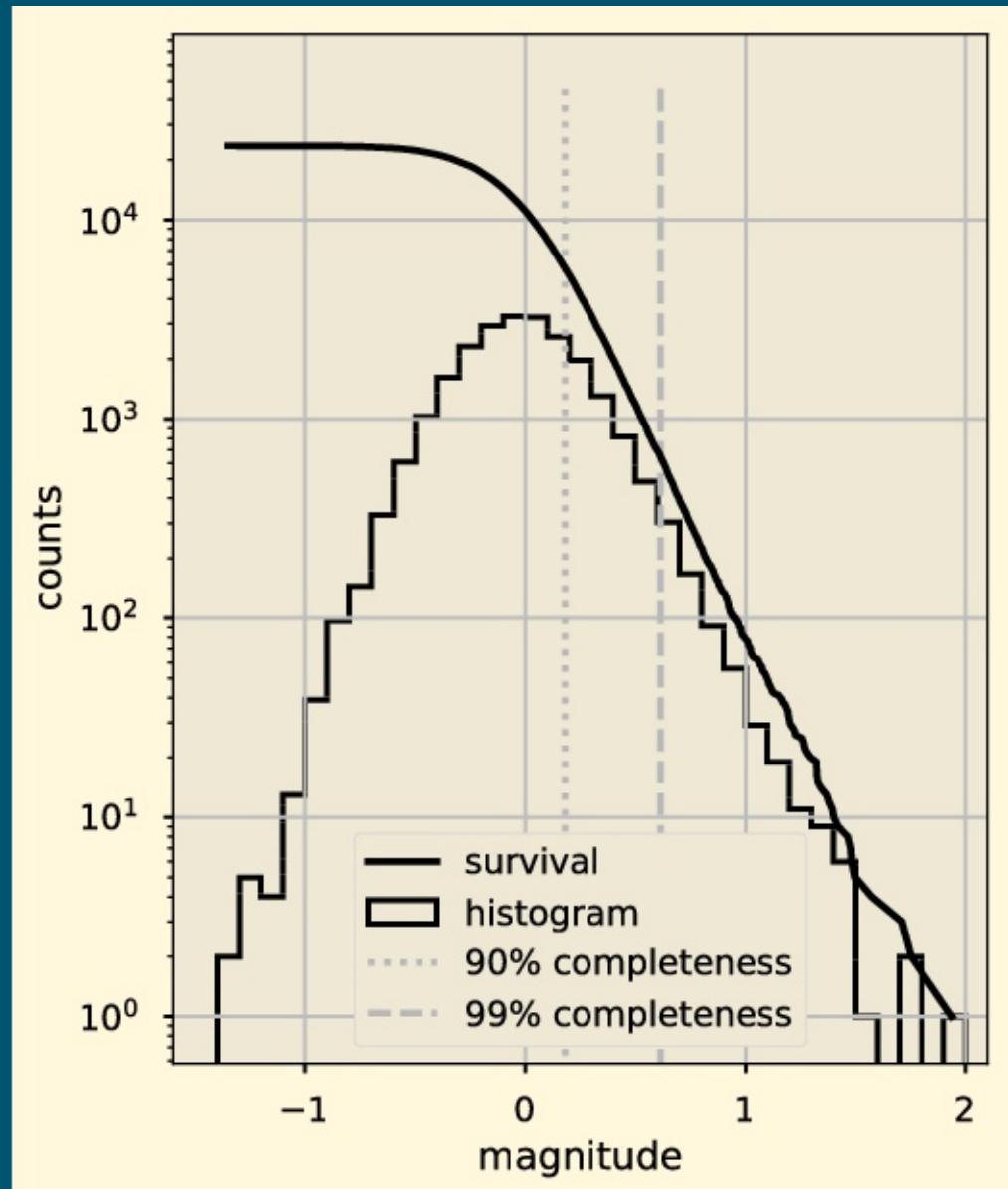
logistic regression between detected and undetected events



based on Ringdal (1975), v. Seggern et al. (1976), v. Seggern (2004)

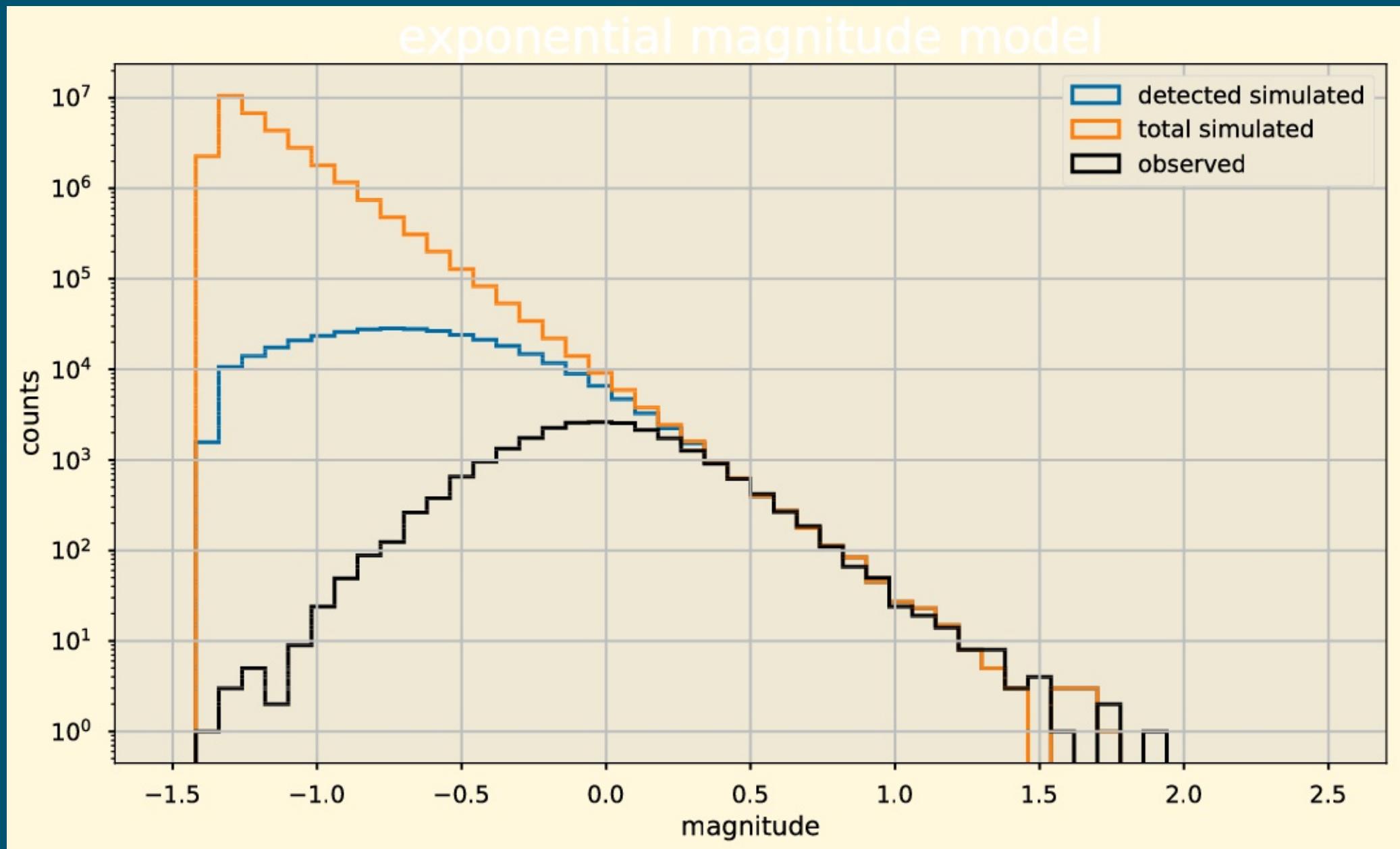
Results

Magnitudes



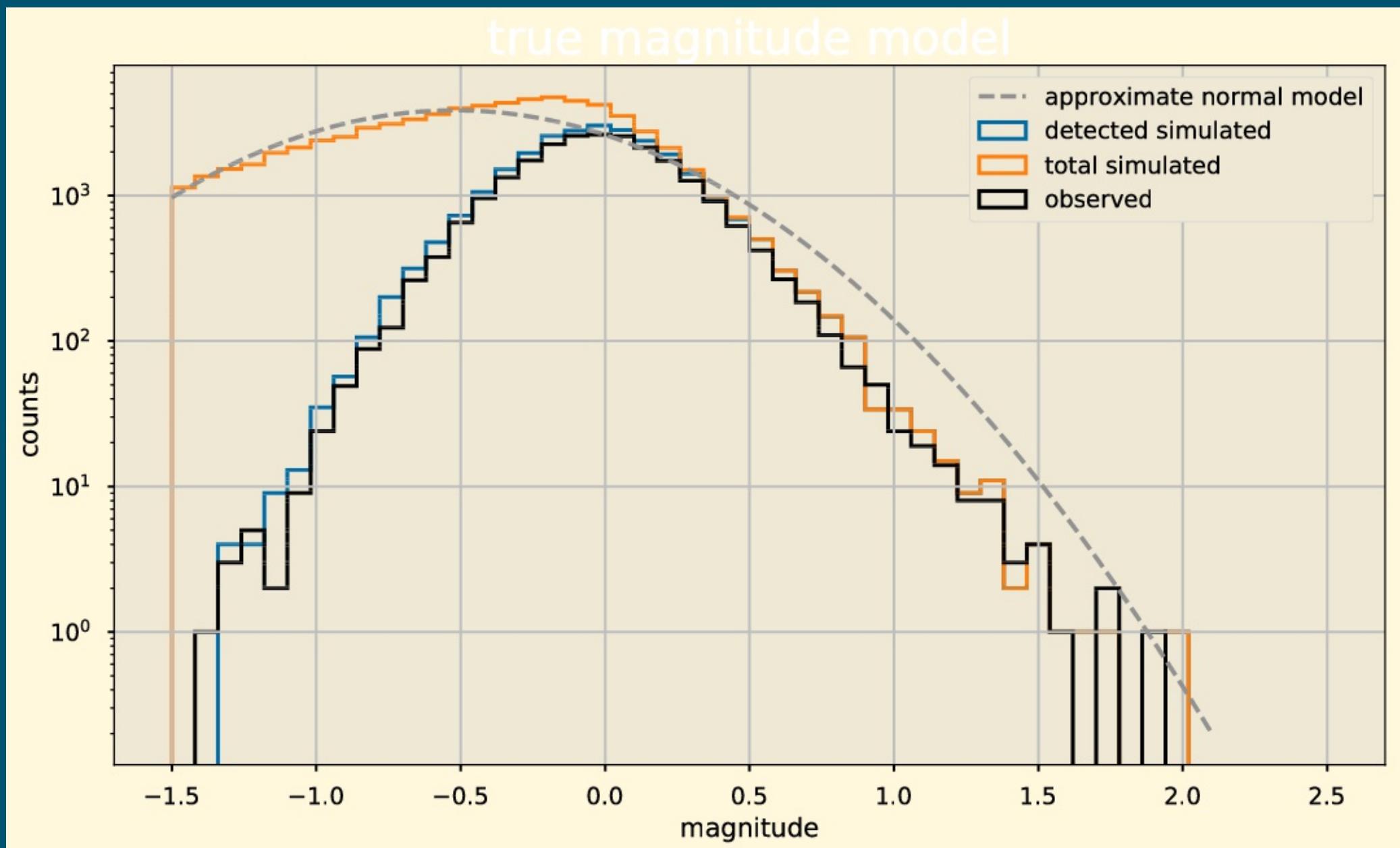
Results

Discard exponential magnitude model



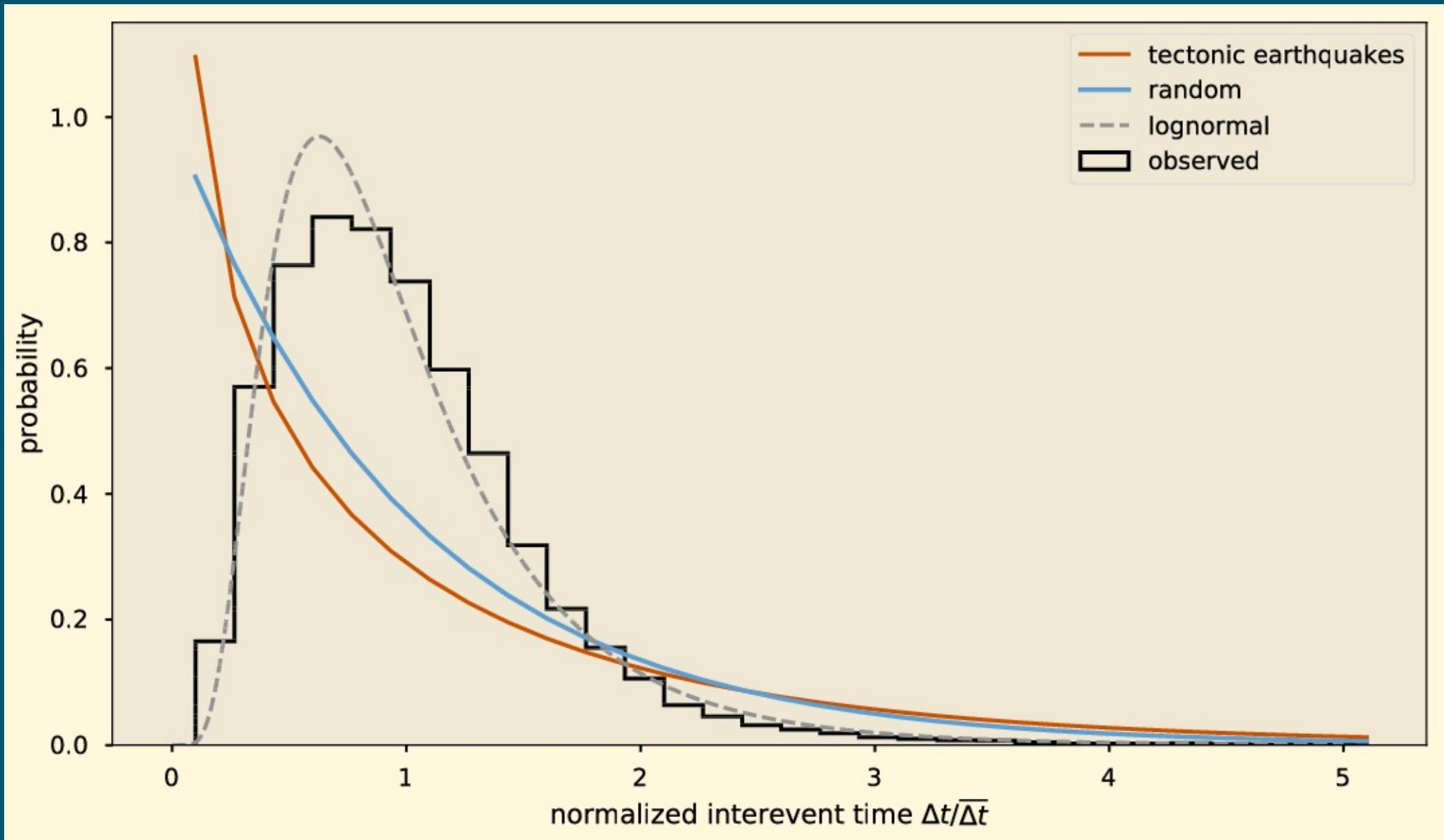
Results

Infer magnitude model



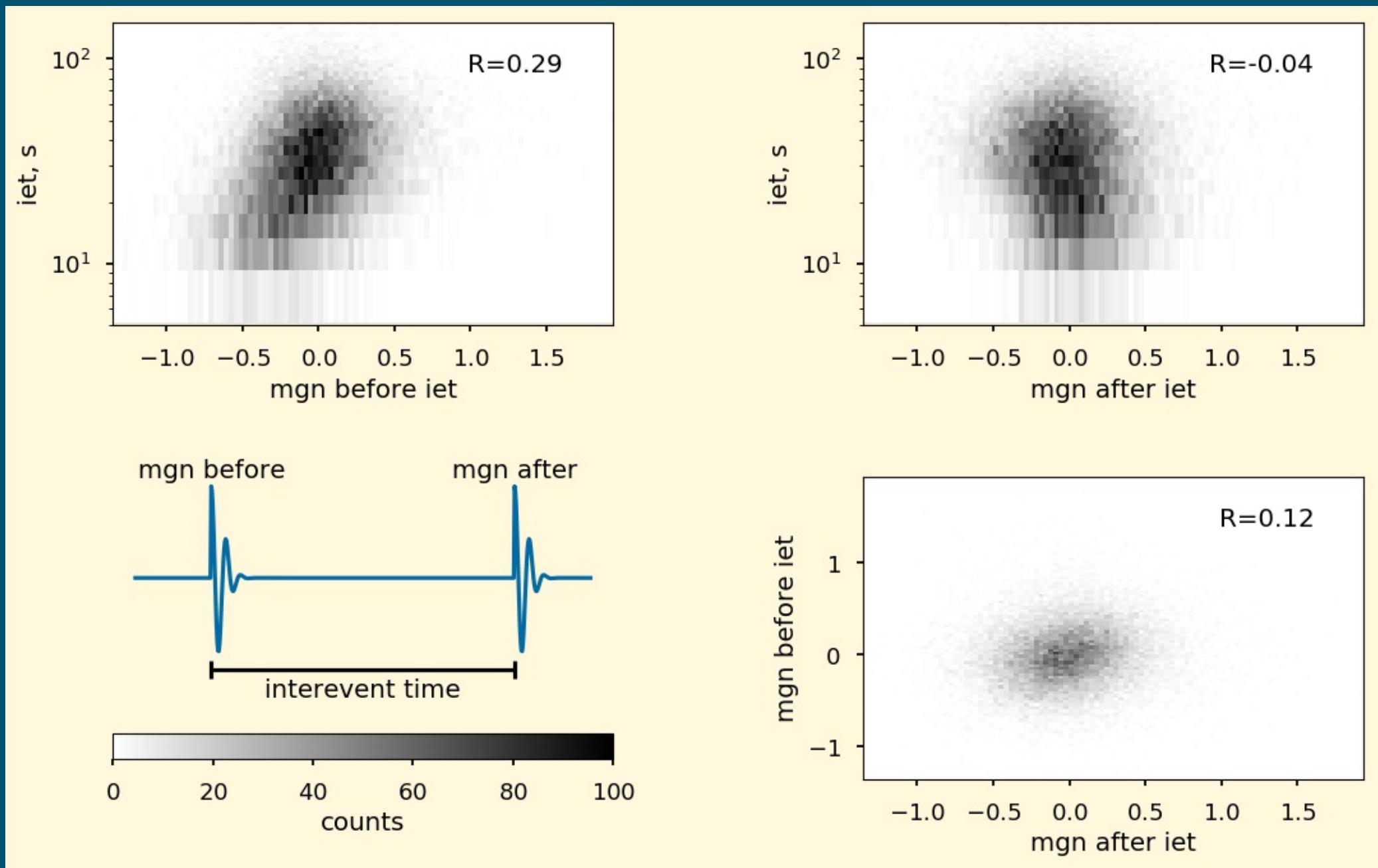
Results

Interevent times

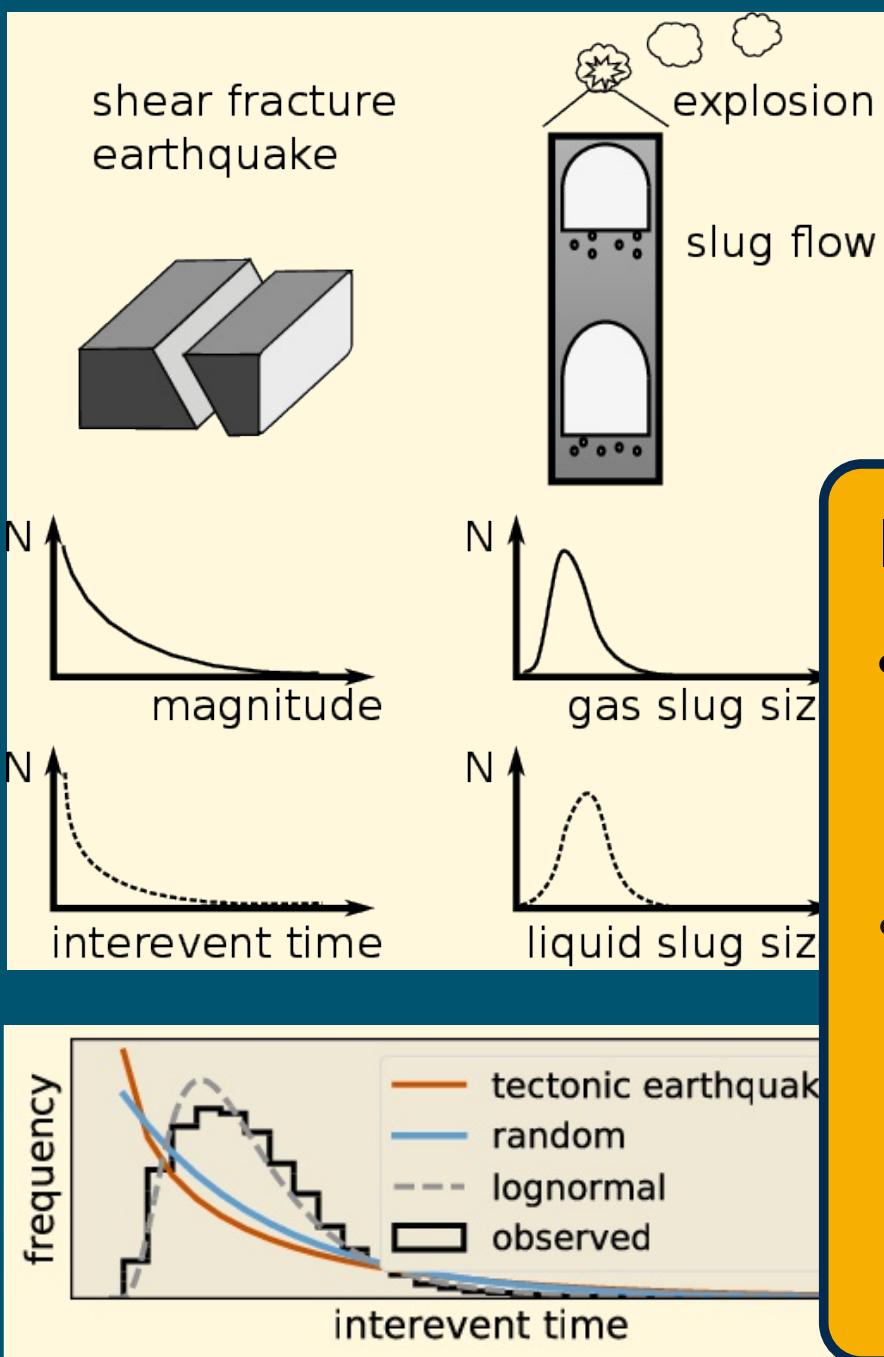


Results

Interdependences



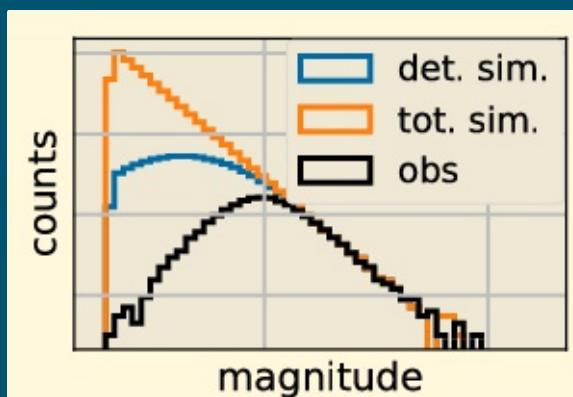
Seismic transients - brittle failure or explosions?



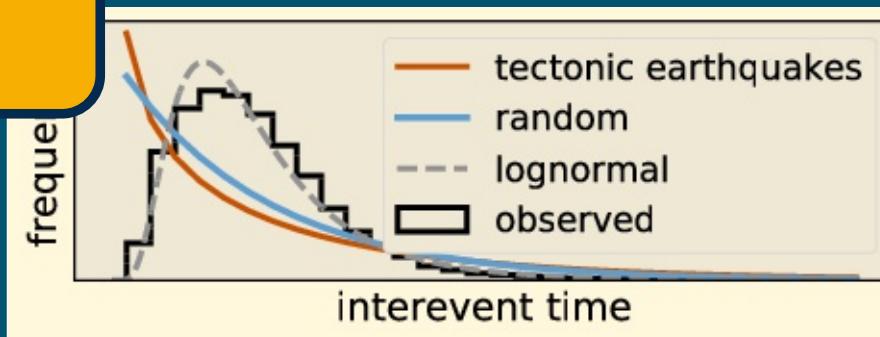
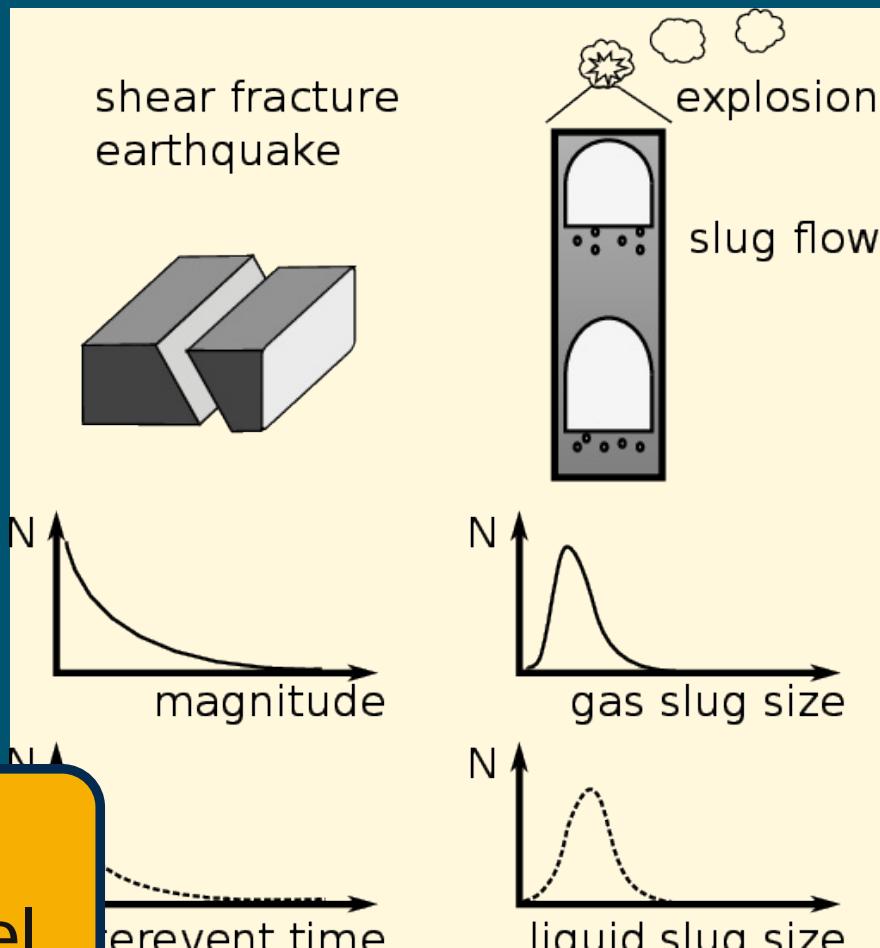
Interevent times

- obtained from total catalog (thus incomplete!)
- lognormal-like distribution
 - periodicity
 - slug flow

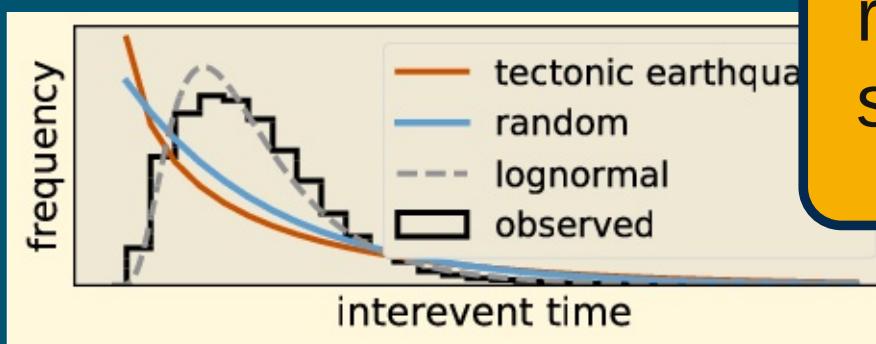
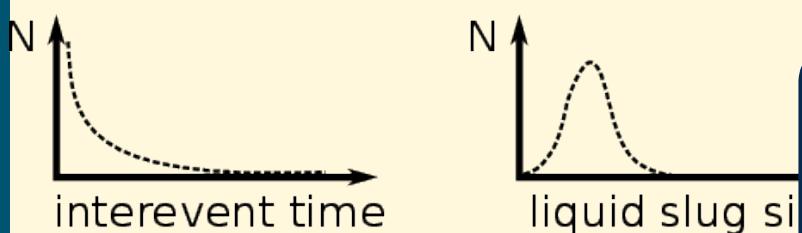
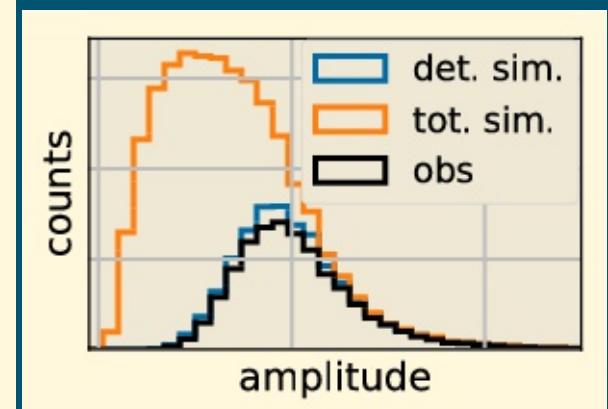
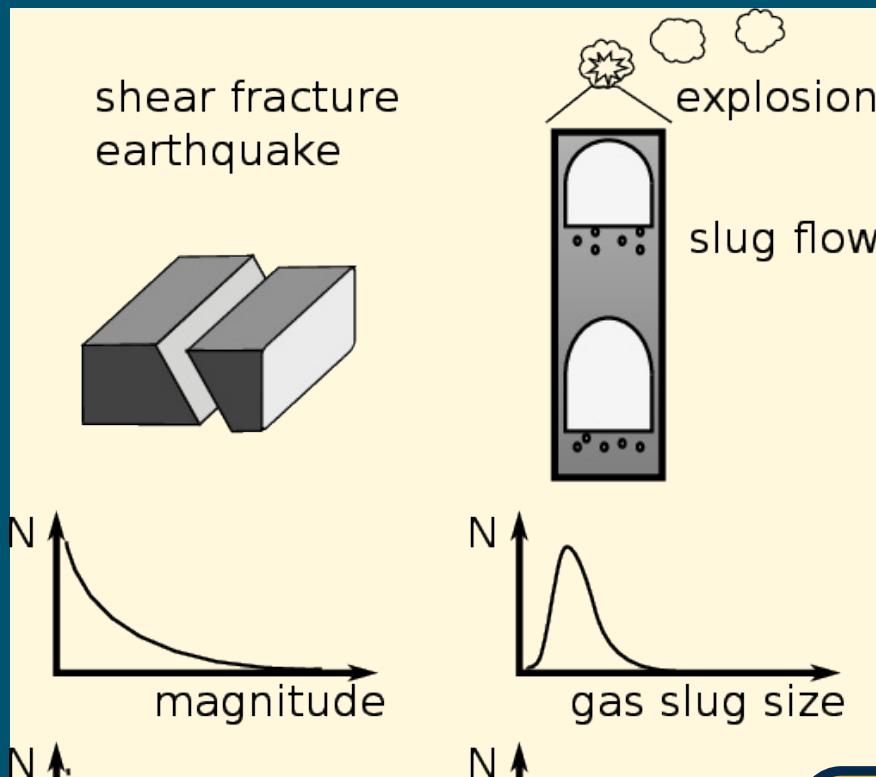
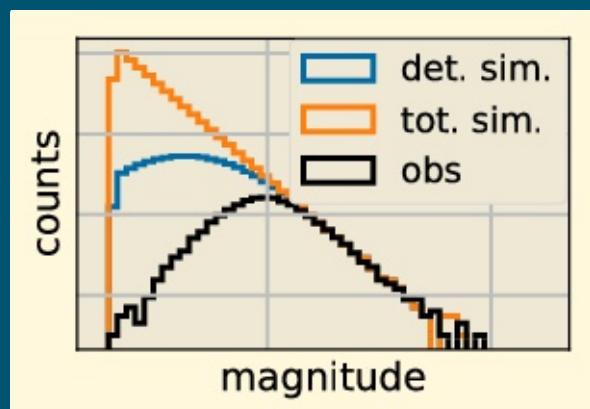
Seismic transients - brittle failure or explosions?



Exponential
magnitude model
discarded



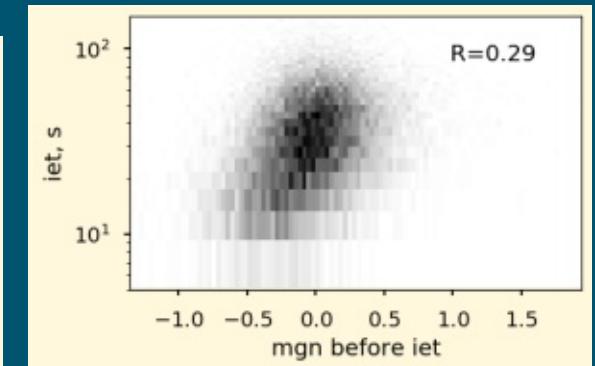
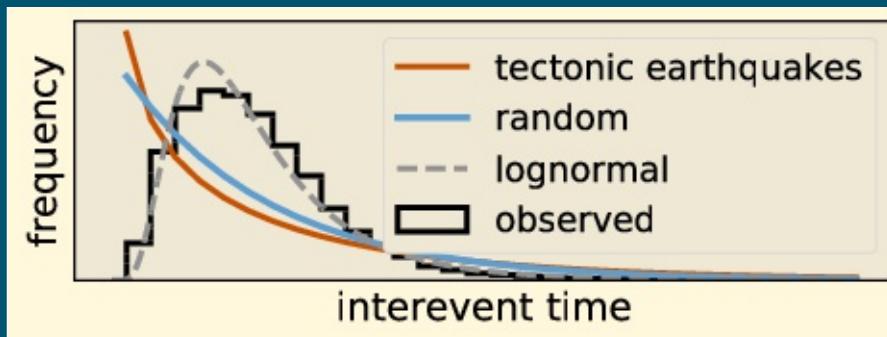
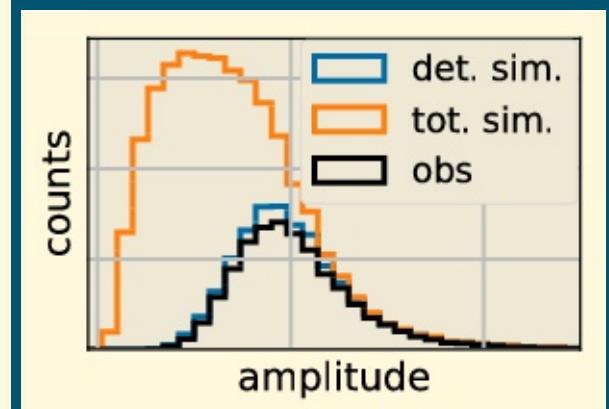
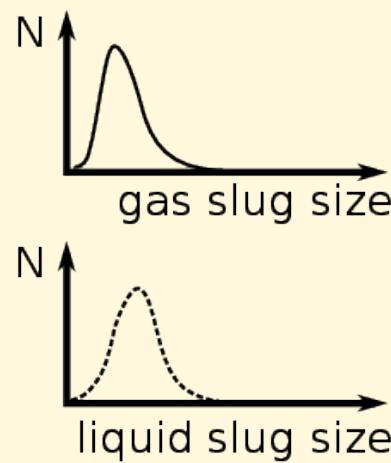
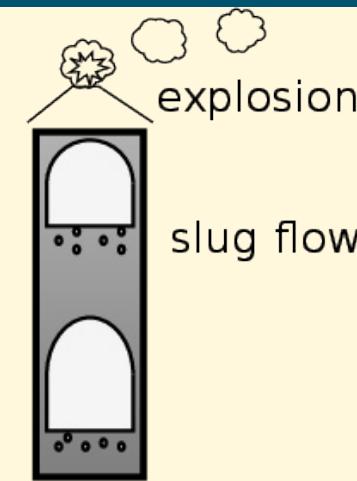
Seismic transients - brittle failure or explosions?



Inferred
magnitude model
resembles slug
size distribution

Seismic transients - brittle failure or explosions?

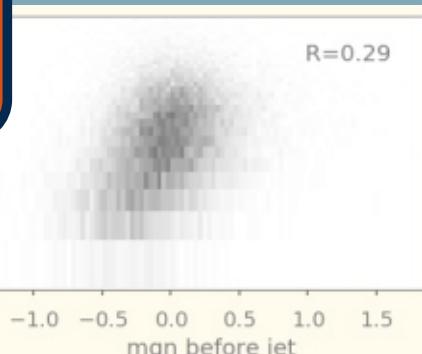
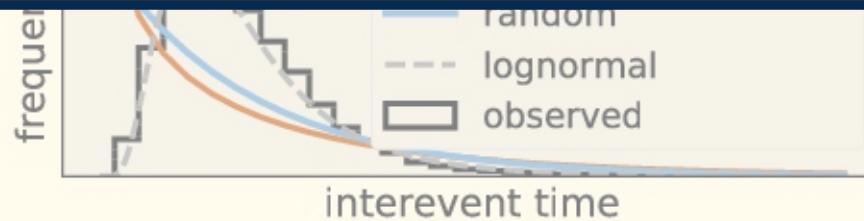
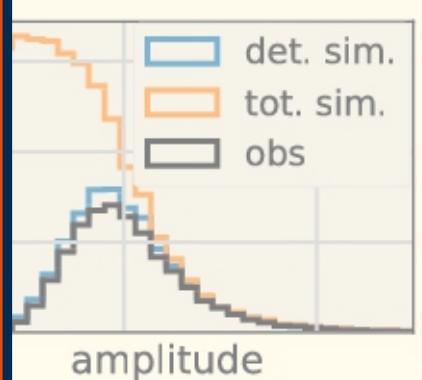
- Weak correlation between $\log(iet)$ and preceding magnitude
- Pering et al. (2015, 2017) showed similar relation for interevent times and slug lengths due to coalescence in slug trains.



Seismic transients - brittle failure or explosions?

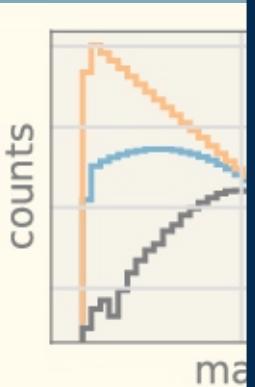
Conclusions

- No evidence for tectonic seismicity (brittle failure) in the statistics
- Found distributions of interevent times and magnitudes are consistent with bubble size distributions in slug flow
- Simulation of noise conditions allows inference of magnitude models



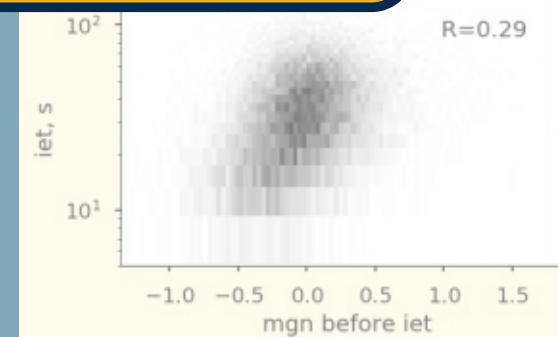
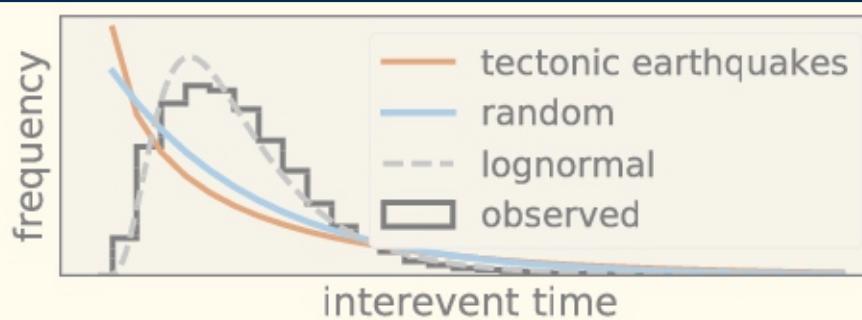
Seismic transients - brittle failure or explosions?

shear fracture
earthquake



Outlook

- Inference of interevent time model
- Conversion of seismic magnitudes to slug sizes
- Comparison with degassing rates
- Comparison with fluiddynamic parameters



References

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Jonathan Lewis from London i´s pose....., Blighty, CC BY-SA 2.0,

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