

Incorporating Distributed Acoustic Sensing Observations into the FinDer Earthquake Early Warning Algorithm

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Summary

We highlight our ongoing efforts to augment the existing seismic data streams into the FinDer earthquake early warning (EEW) algorithm with data from distributed acoustic sensing (DAS) arrays.

FinDer requires peak ground acceleration (PGA) observations as input. DAS PGA values are calculated using an empirical scaling relationship calibrated using ShakeMaps.

We are evaluating this approach by testing FinDer using simulated DAS data for large earthquakes as well as by developing a test suite of previously recorded earthquakes for simulated real-time playbacks.

Starting in April 2026, we set up an internal real-time testing environment of FinDer using DAS data from the Ridgecrest South Array.

This system detected the 13 July 2026 M4.3 Johannesburg earthquake. Two of the DAS channels participated as triggers, enabling FinDer to detect the earthquake 2 s faster compared to the seismic-station only version of FinDer.

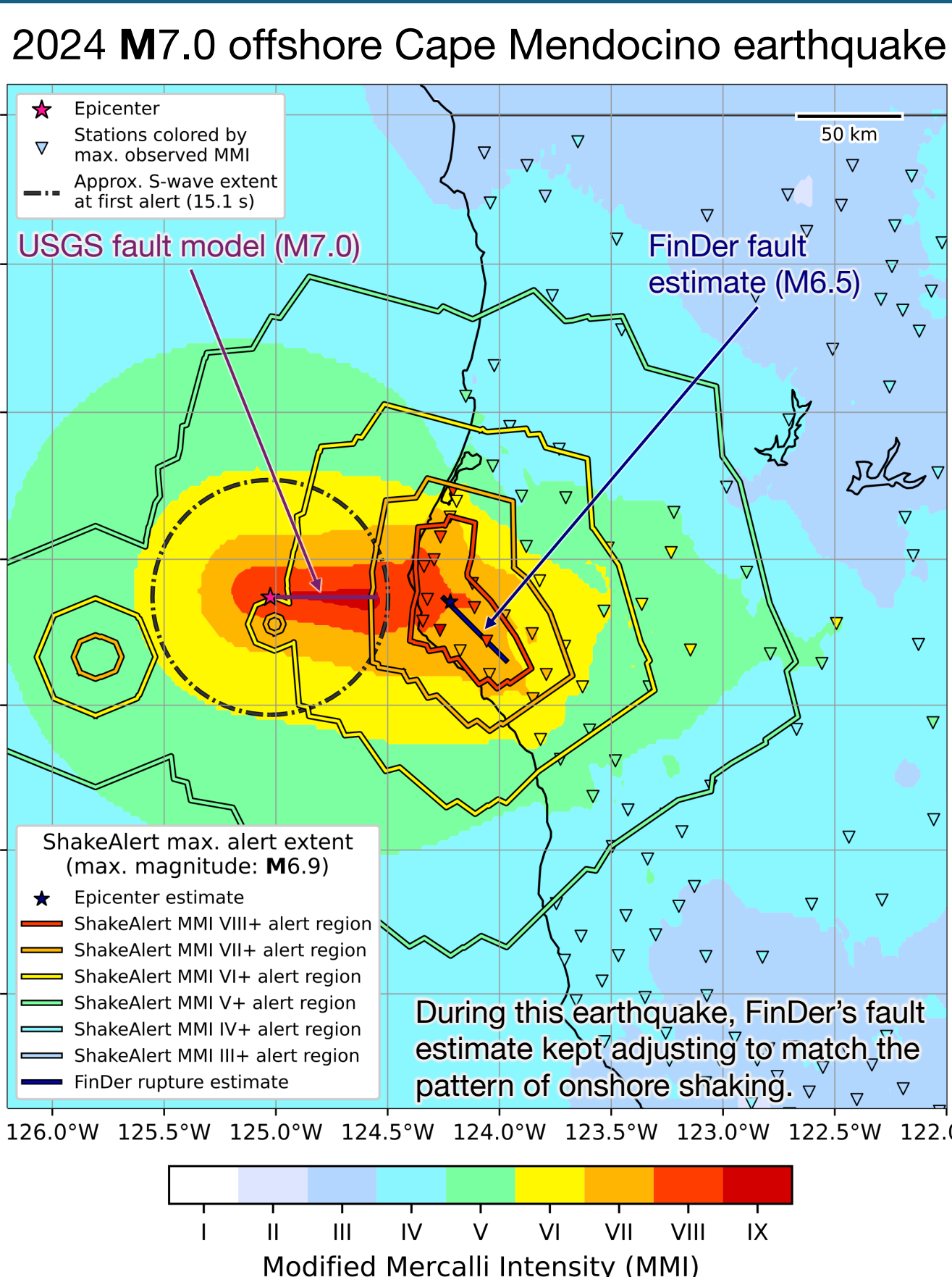
The FinDer EEW Algorithm

The Finite-Fault Rupture Detector (FinDer) algorithm estimates earthquake source parameters using PGA observations.

It does this by comparing the observed PGA distribution at seismic stations with pre-computed ground-motion distribution templates using image correlation methods.

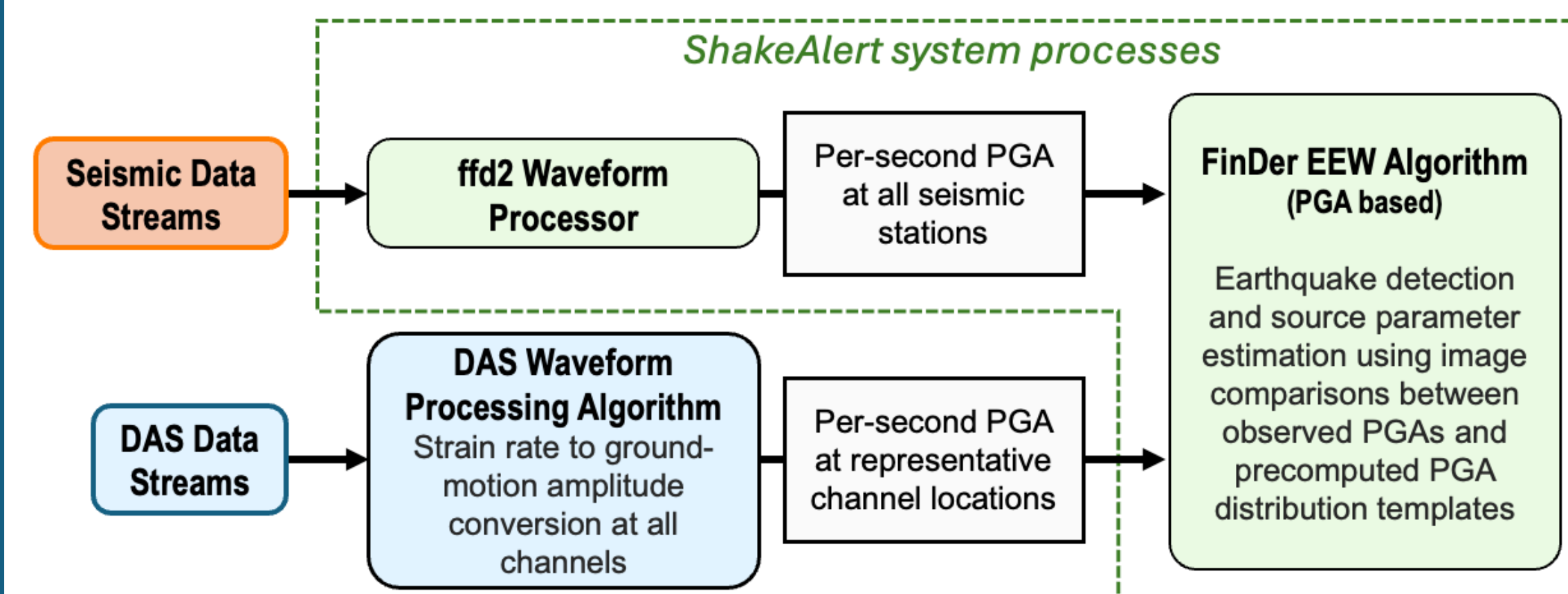
FinDer performs best in places with good station coverage. For out-of-network or offshore earthquakes, FinDer's source estimates tend to pull solutions within the network, which results in lower magnitude estimates.

Adding offshore data, such as from DAS, will improve FinDer's estimates and earthquake detection times.



DAS Data Ingestion Into FinDer

We developed a waveform processor that converts per-second packets of DAS strain rate values into PGA in the same format that FinDer expects from the seismic data streams.



In April 2026, we set up an internal instance of FinDer that is receiving DAS data from the Ridgecrest South DAS array, which is streaming real-time data to the Southern California Seismic Network (SCSN).

We are currently developing a test suite of past events with DAS recordings to run through FinDer in the same simulated real-time environment that ShakeAlert uses for their testing.

References and Acknowledgments

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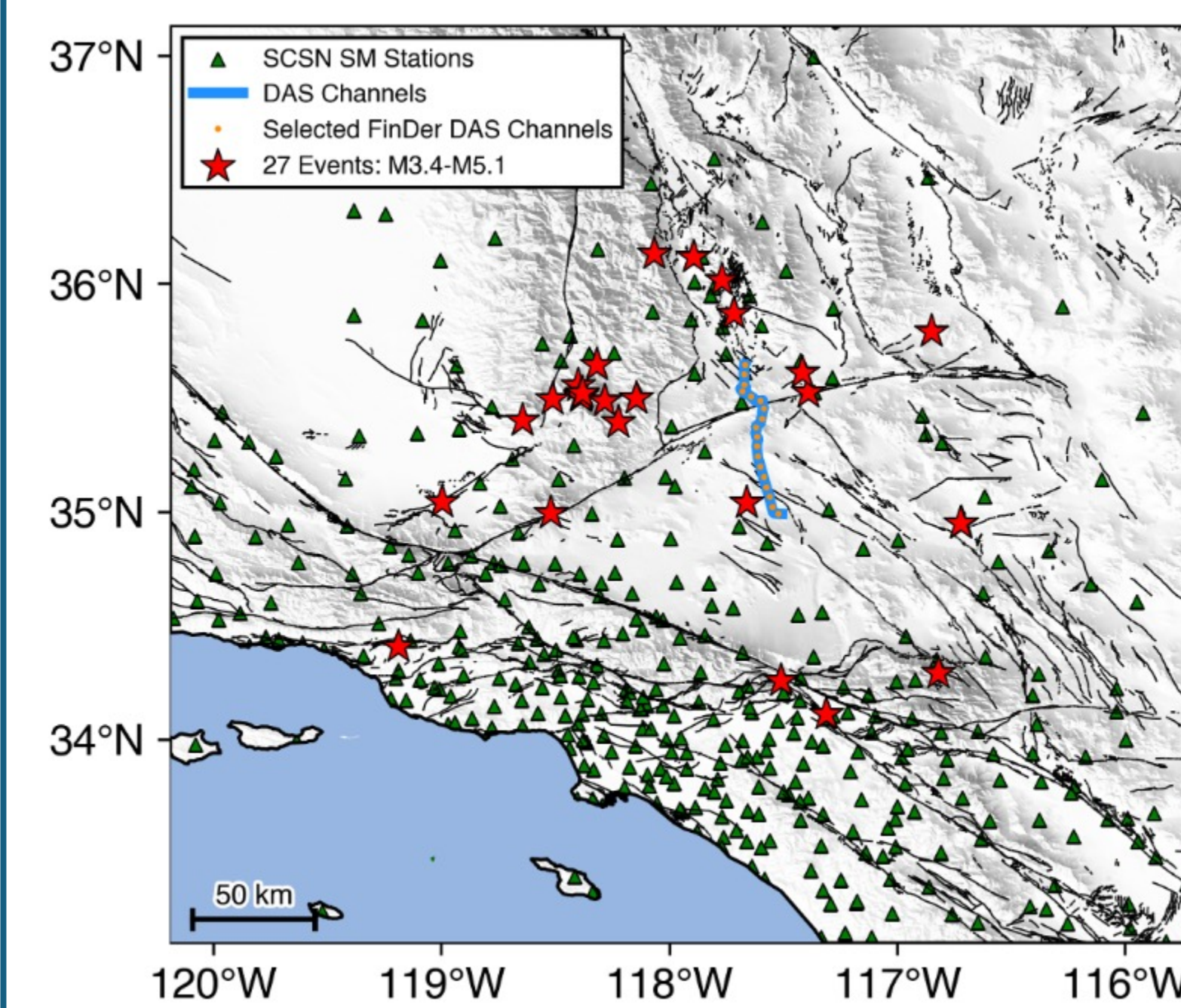
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Earthquake source information, ShakeMaps, station observations, and ShakeAlert performance summaries can be accessed via the USGS Comprehensive Catalog at earthquake.usgs.gov. DAS data for the Ridgecrest South Array can be accessed via the Caltech DAS Hub at dashub.caltech.edu.

Converting DAS Strain Rate to Acceleration

We use an empirical scaling relationship to convert DAS peak strain rate to PGA along the cable every second.

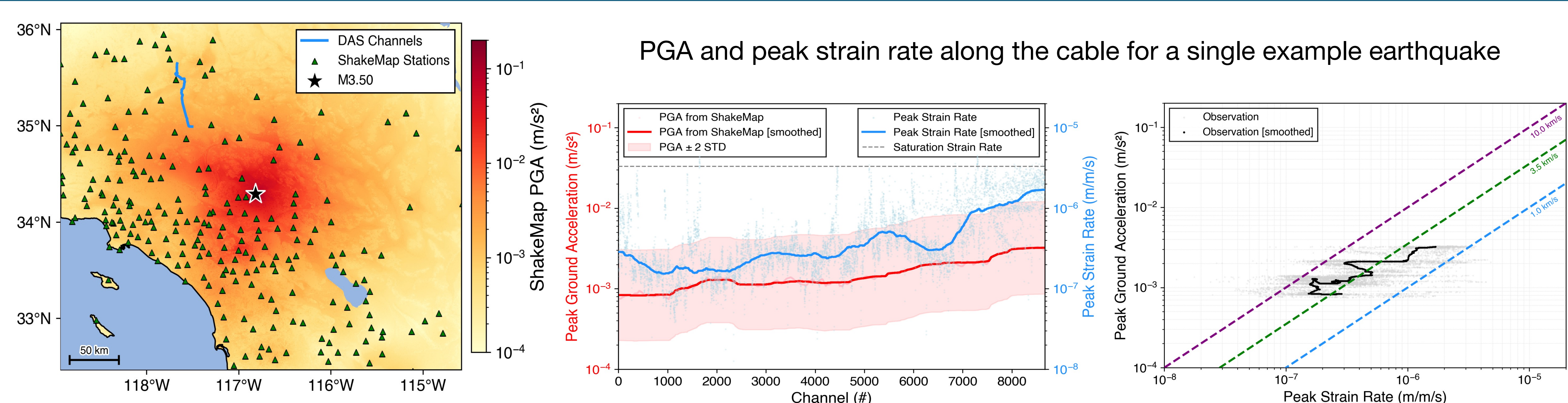
As there are few co-located seismic sensors along the DAS cable, we use ShakeMap PGA distributions for this calibration.



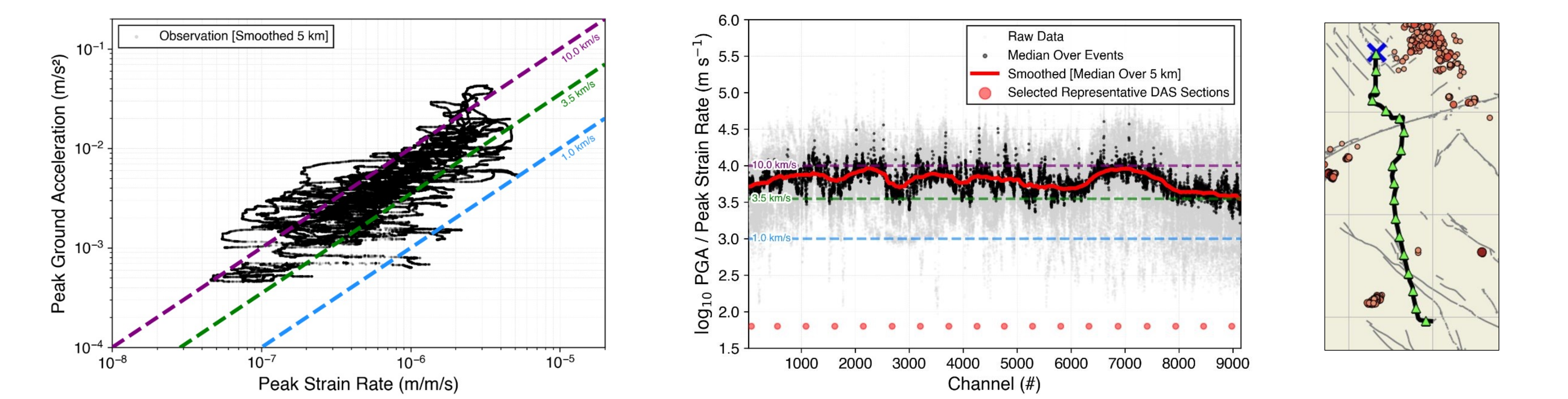
For a given one-second DAS data packet, peak strain rate is converted to PGA at every channel using the median empirical scaling value derived for each channel.

Then, the median PGA value around representative DAS sections is selected, which smooths the data and reduces spurious signals. These values are then sent to FinDer.

We use the same channel locations (~5 km spacing) as the Ridgecrest DAS channels that are currently being ingested by SCSN's earthquake monitoring operations.

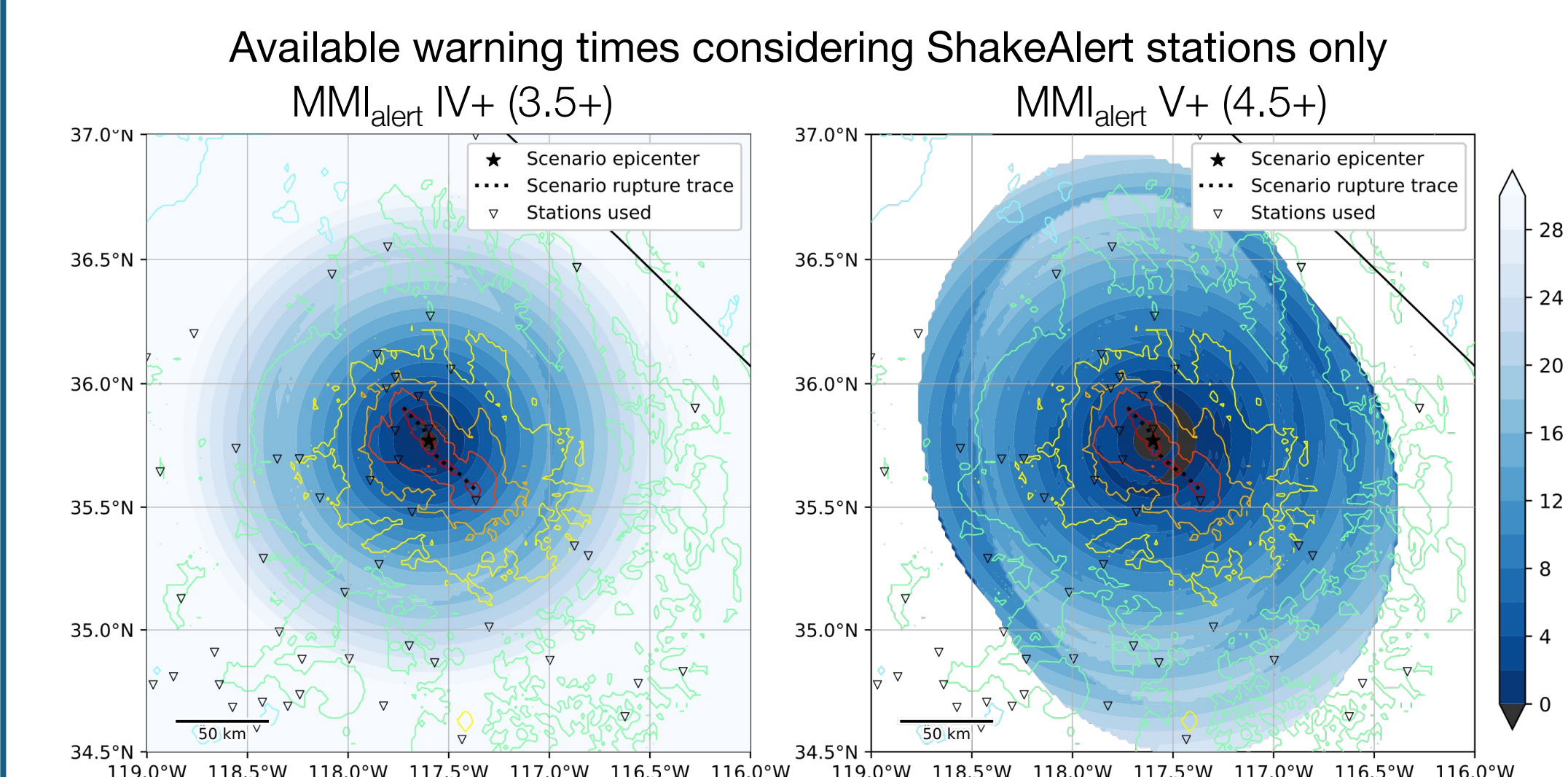
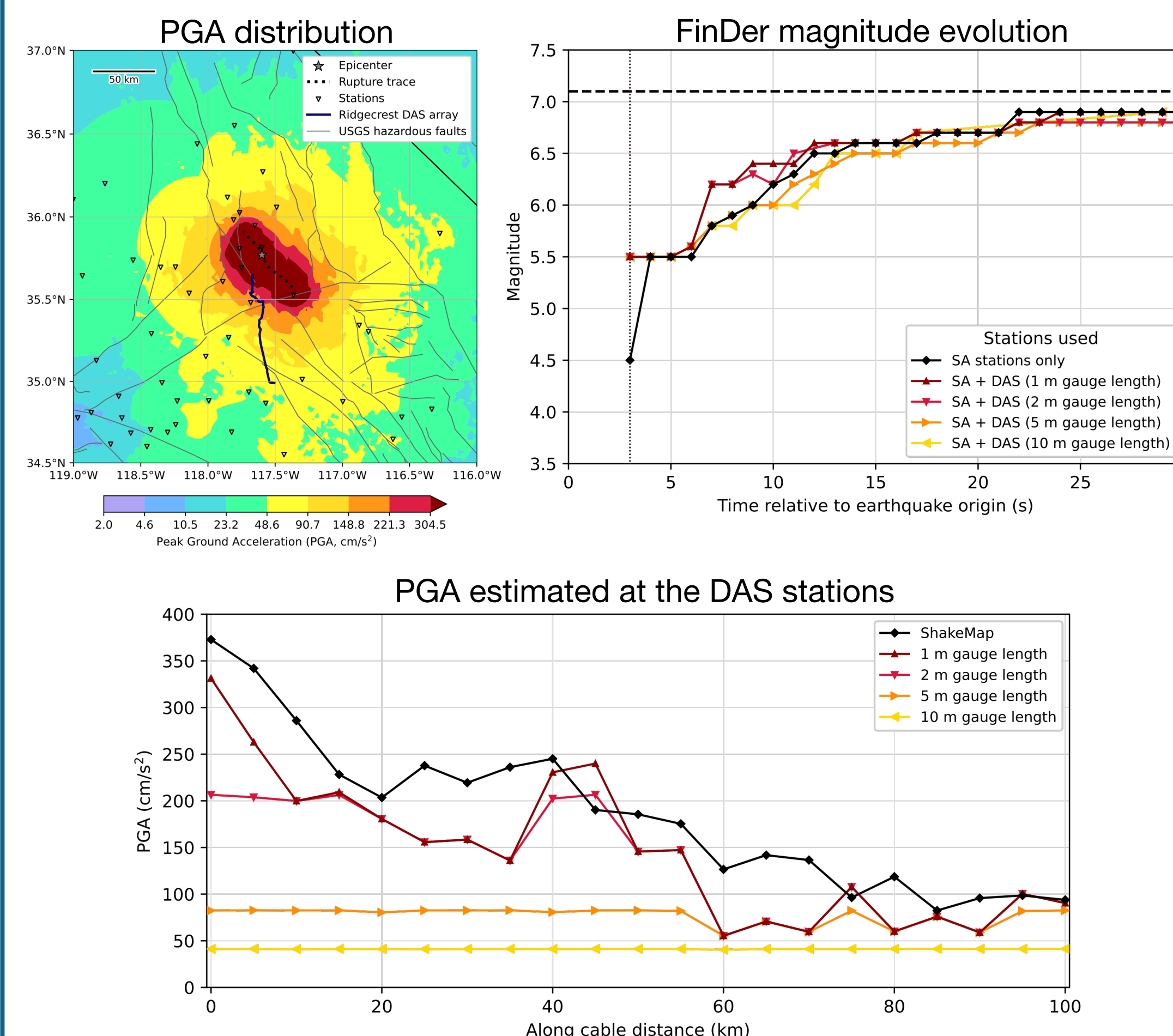


PGA and peak strain rate along the cable for all earthquakes in the calibration



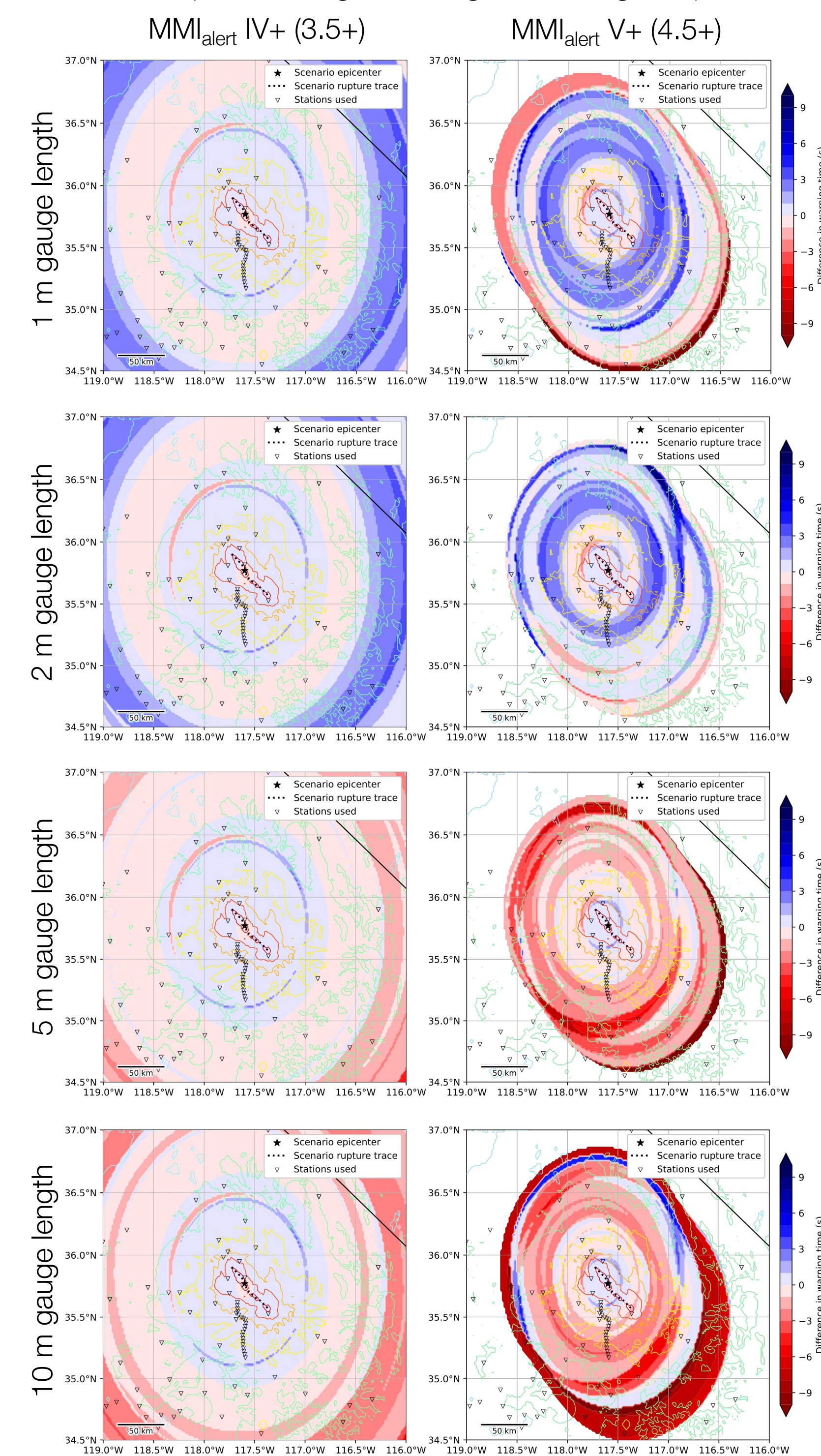
Investigating the Effects of DAS Amplitude Saturation on FinDer Source Estimates

We evaluate FinDer's performance for the 2019 M7.1 Ridgecrest earthquake considering observed seismic data augmented with simulated DAS data using different gauge lengths.



Differences in warning time considering different DAS gauge lengths

(Blues = longer warning times using DAS)



13 July 2026 M4.3 Johannesburg Earthquake

FinDer on ShakeAlert production:

- Initial alert: M4.5 at 15.3 s after OT
- Peak alert: M4.9 at 31 s after OT

DAS stations CI.DRS04 and CI.DRS13 were included as triggers in FinDer's initial event detection.

Internal FinDer instance with DAS data:

- Initial alert: M4.3 at 13.0 s after OT
- Peak alert: M4.6 at 16.0 s after OT

Including DAS helped FinDer detect the earthquake 2 s faster than with seismic stations only.

