

# Earthquake ground motions, Hawaii 2018

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Hawaii Seismic Hazard Model Workshop

Honolulu, HI

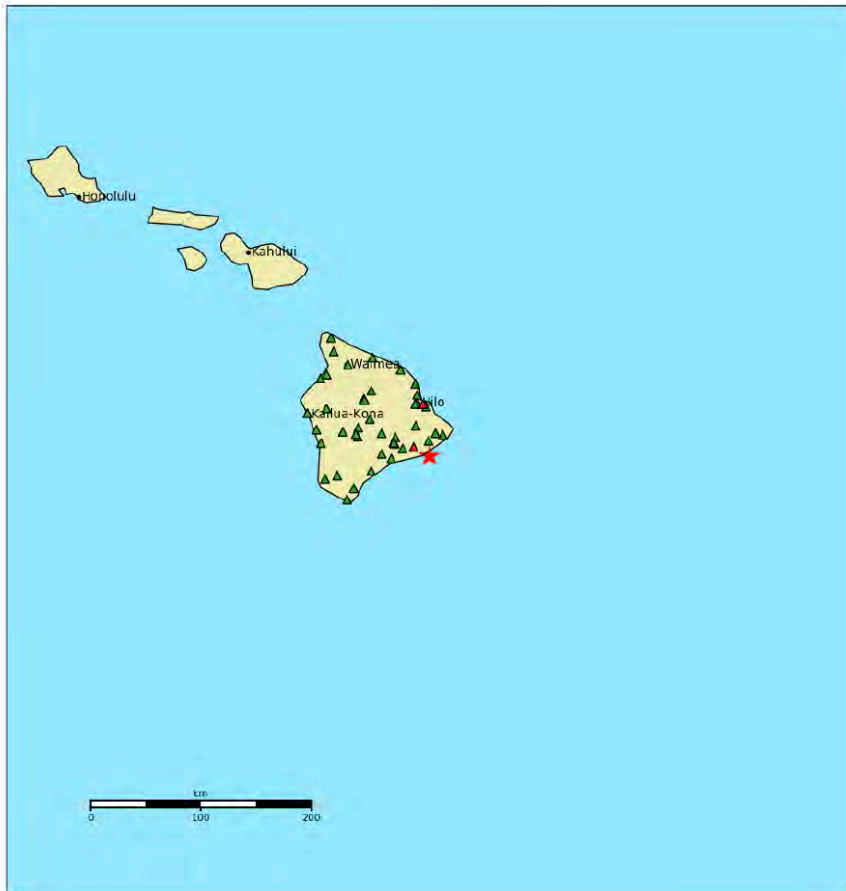
September 18, 2019

Summary Report

gmprocess

Code version: 0.2.0+173.gae28ad7

September 5, 2019



# Ground motion processing, USGS

- Takes advantage of recent efforts in USGS to compute ground motions
- Applications for near-real-time and ground-motion-model evaluations (induced earthquakes, Oklahoma/Kansas; Hawaii; Anchorage EQ; Ridgecrest, CA earthquake)
- Summarize ground motion processing steps and the Hawaii ground motion data set

<https://github.com/usgs/groundmotion-processing>

**usgs / groundmotion-processing** Unwatch 17 Star 5 Fork 10

Code Issues 44 Pull requests 1 Projects 1 Wiki Security Insights Settings

Parsing and processing ground motion data <https://usgs.github.io/groundmotion-p...> Edit

Manage topics

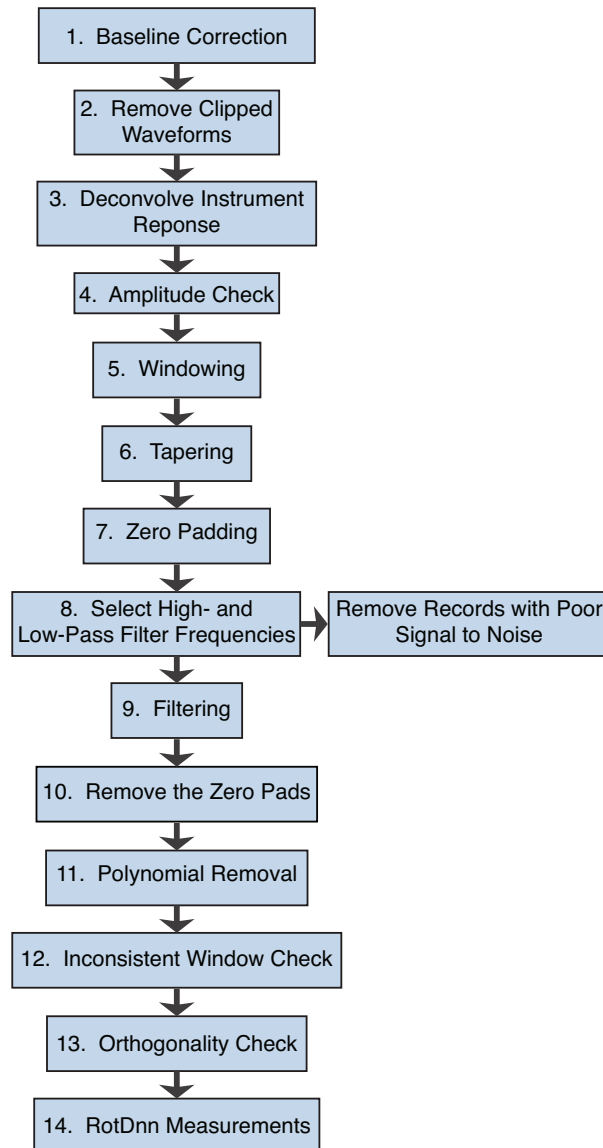
409 commits 1 branch 8 releases 1 environment 6 contributors View license

Branch: master New pull request Create new file Upload files Find File Clone or download

mhearne-usgs Merge pull request #267 from emthompson-usgs/colocated Latest commit 79404bf 2 days ago

|                           |  |              |
|---------------------------|--|--------------|
| <a href="#">.atom</a>     | Add Atom project configuration (preferred line length).        | 17 days ago  |
| <a href="#">bin</a>       | Added stations map to list of products generated by gmprocess2 | 3 days ago   |
| <a href="#">docs</a>      | Use baseurl in navbar links.                                   | 2 days ago   |
| <a href="#">gmprocess</a> | Add colocated instrument data                                  | 2 days ago   |
| <a href="#">notebooks</a> | Added reader for Iran strong motion format.                    | 2 months ago |

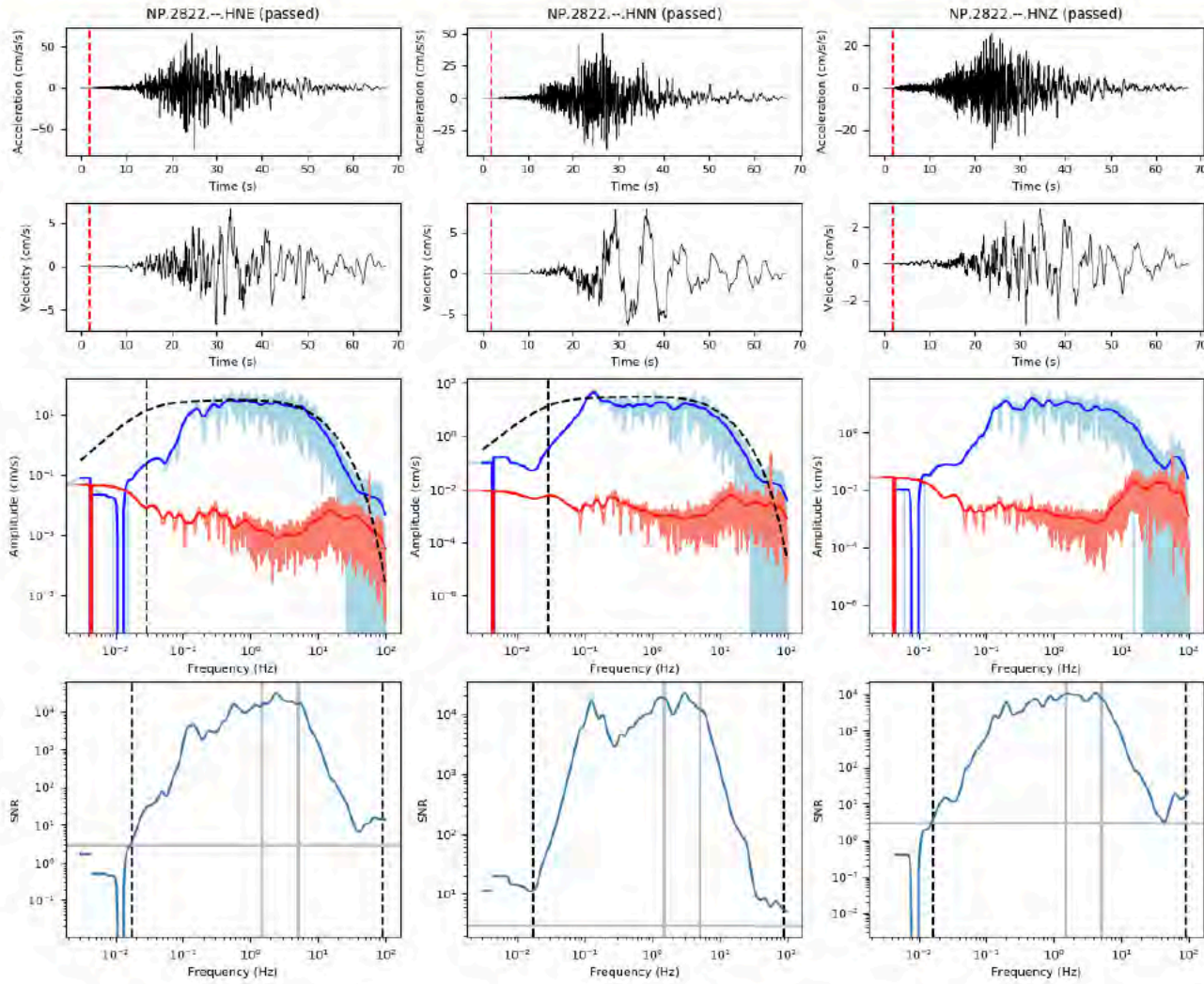
# Strong-motion processing workflow



- Follows processing methods of NGA-West-2 (Ancheta et al., 2013) and NGA-East (Goulet et al., 2014) (standard strong-motion methods)
- Automated workflow
- Significant efforts to:
  - Enable reading of multiple seismic data formats (FDSN and strong-motion—e.g., CESMD--data centers and internationally)
  - Picking signal/noise windows
    - P-wave picking
    - Waveform durations
  - Ensuring useable signal:
    - Clipping (broadband and short-period instruments)
    - Machine learning algorithms for signal character

M 6.9 - hv70116556 - 05/04/2018 22:32:54

NP.2822.HN

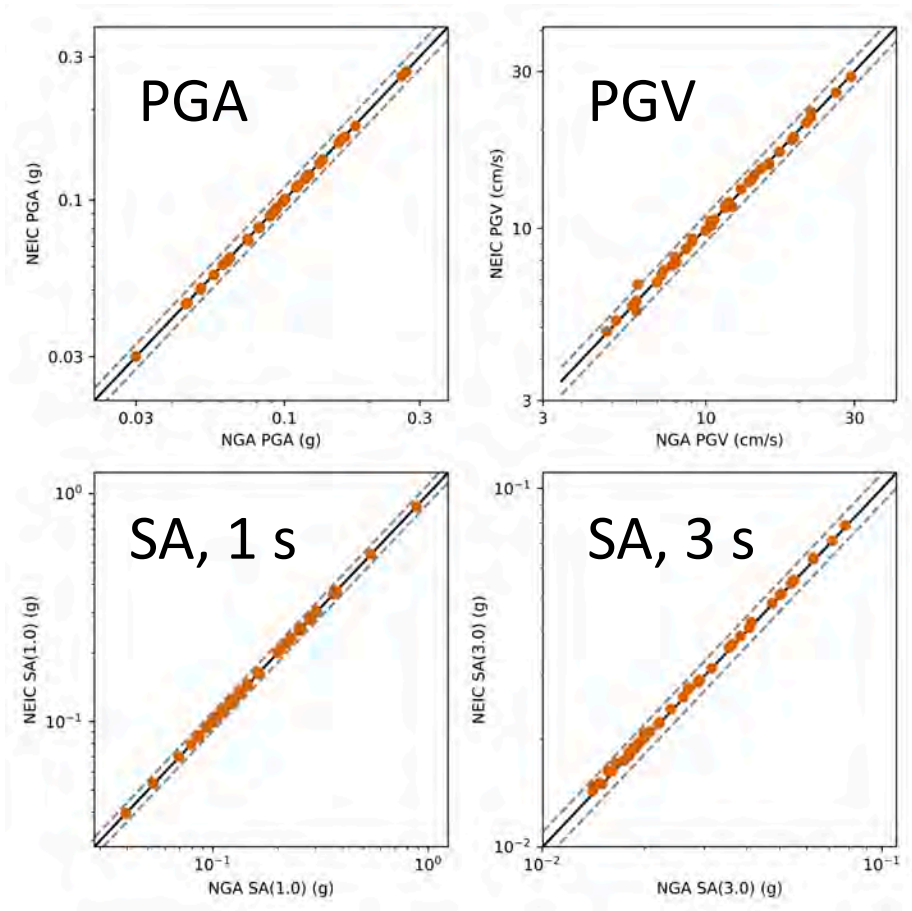


| Process Step    | Process Attribute | HNE Value            | HNN Value            | HNZ Value            |
|-----------------|-------------------|----------------------|----------------------|----------------------|
| Detrend         | detrending_method | demean               | demean               | demean               |
| Remove Response | method            | remove_sensitivity   | remove_sensitivity   | remove_sensitivity   |
|                 | input_units       | counts               | counts               | counts               |
|                 | output_units      | cm/s <sup>2</sup>    | cm/s <sup>2</sup>    | cm/s <sup>2</sup>    |
| Cut             | new_start_time    | 2018-05-04 22:33:04  | 2018-05-04 22:33:04  | 2018-05-04 22:33:04  |
|                 | new_end_time      | 2018-05-04 22:34:11  | 2018-05-04 22:34:11  | 2018-05-04 22:34:11  |
| Taper           | window_type       | Hann                 | Hann                 | Hann                 |
|                 | taper_width       | 0.05                 | 0.05                 | 0.05                 |
|                 | side              | both                 | both                 | both                 |
| Highpass Filter | filter_type       | Butterworth          | Butterworth          | Butterworth          |
|                 | filter_order      | 5                    | 5                    | 5                    |
|                 | number_of_passes  | 2                    | 2                    | 2                    |
|                 | corner_frequency  | 0.0172633491501      | 0.0172633491501      | 0.0161072743014      |
| Lowpass Filter  | filter_type       | Butterworth          | Butterworth          | Butterworth          |
|                 | filter_order      | 5                    | 5                    | 5                    |
|                 | number_of_passes  | 2                    | 2                    | 2                    |
|                 | corner_frequency  | 90.0                 | 90.0                 | 90.0                 |
| Detrend         | detrending_method | baseline_sixth_order | baseline_sixth_order | baseline_sixth_order |

Pick Method: travelTime

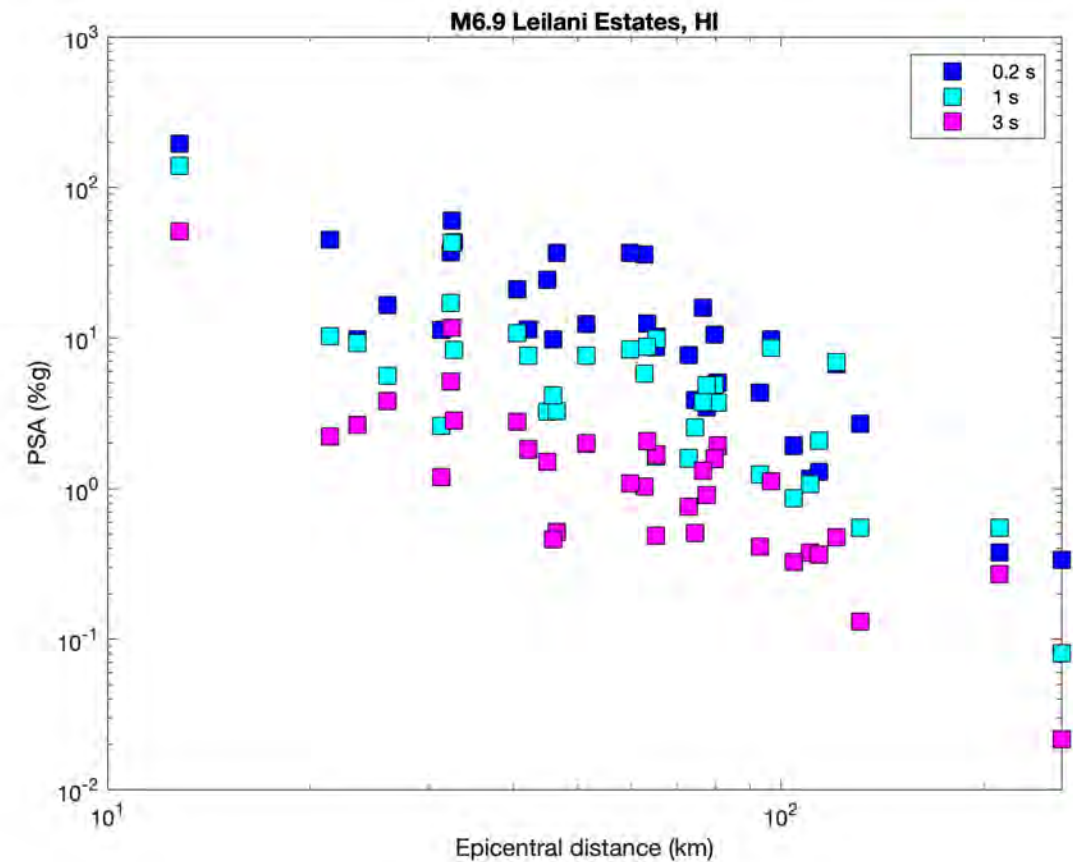
# Comparison with NGA-West-2 Project

1983 M6.7 Coalinga Earthquake

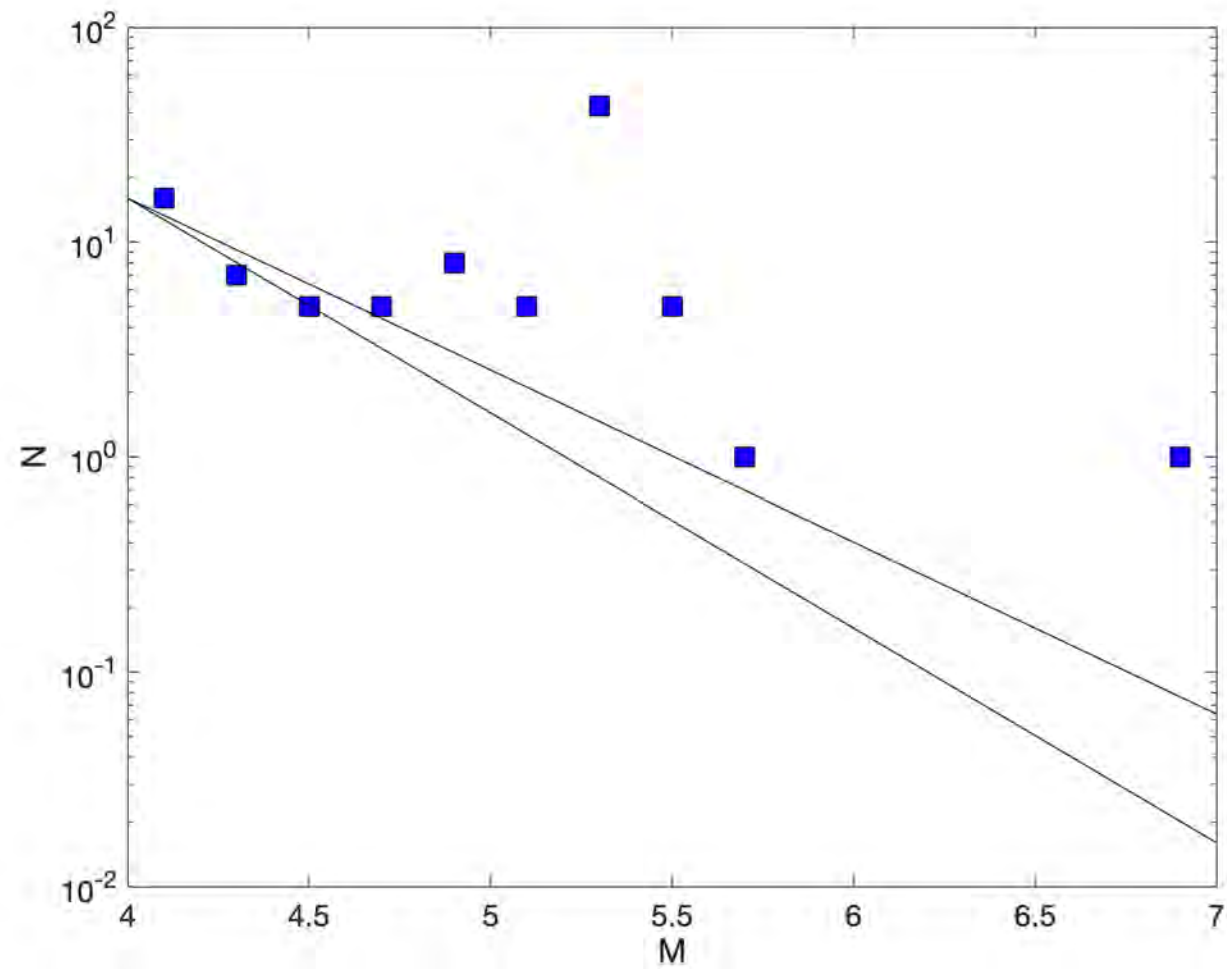
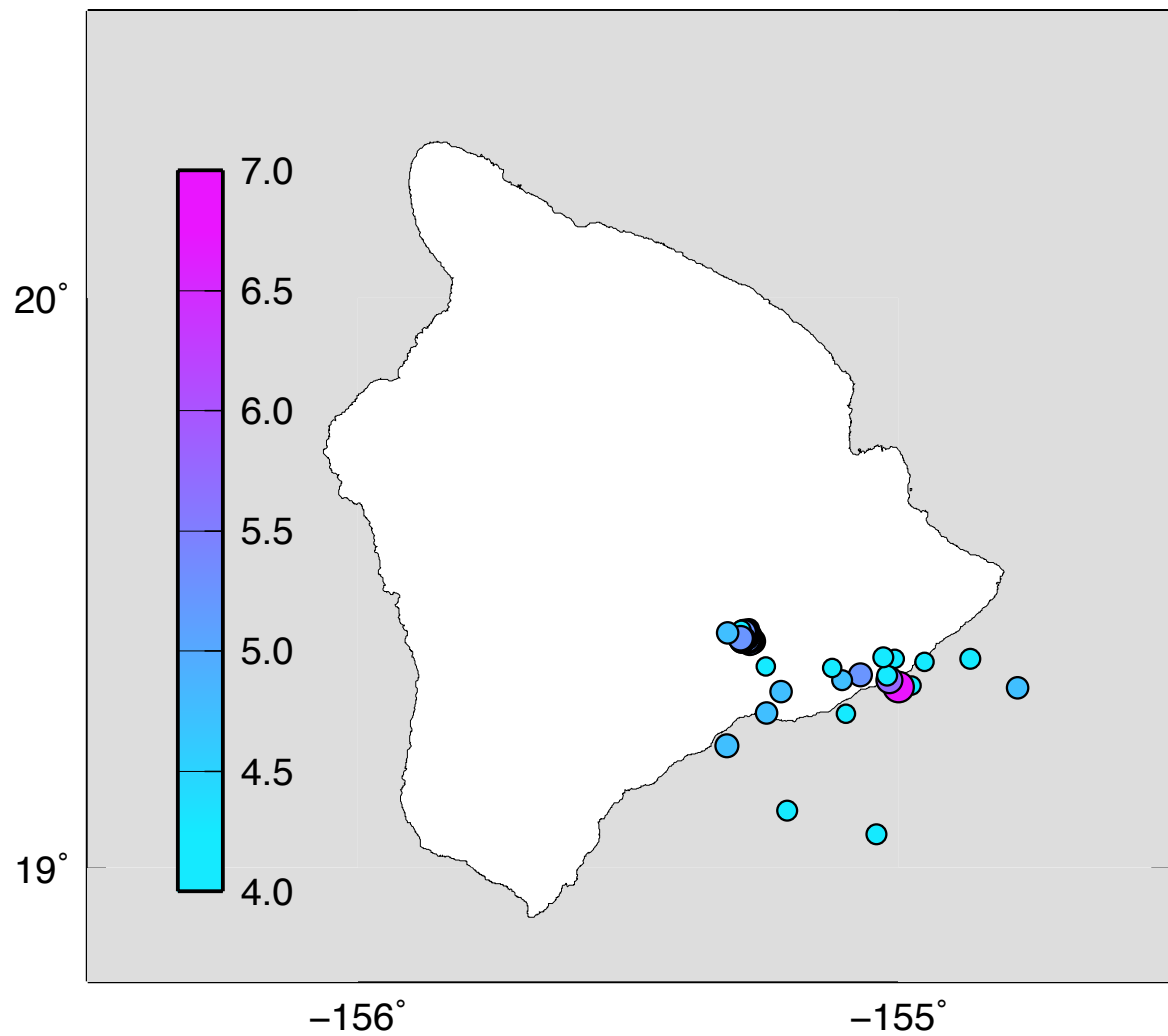


# Hawaii ground motion processing

- May–August 2018—Leilani Estates M6.9 (and aftershocks) and active volcanic sequence
- $M \geq 4$
- Recordings within 250 km
- Strong-motion instruments (HN-channels)
- HV, NP, IU networks—IRIS-DMC
- Processed waveforms for PGA, PGV, SA (0.01–10 s) (set ~21 periods, NSHM)
- RotD50
- >1700 records

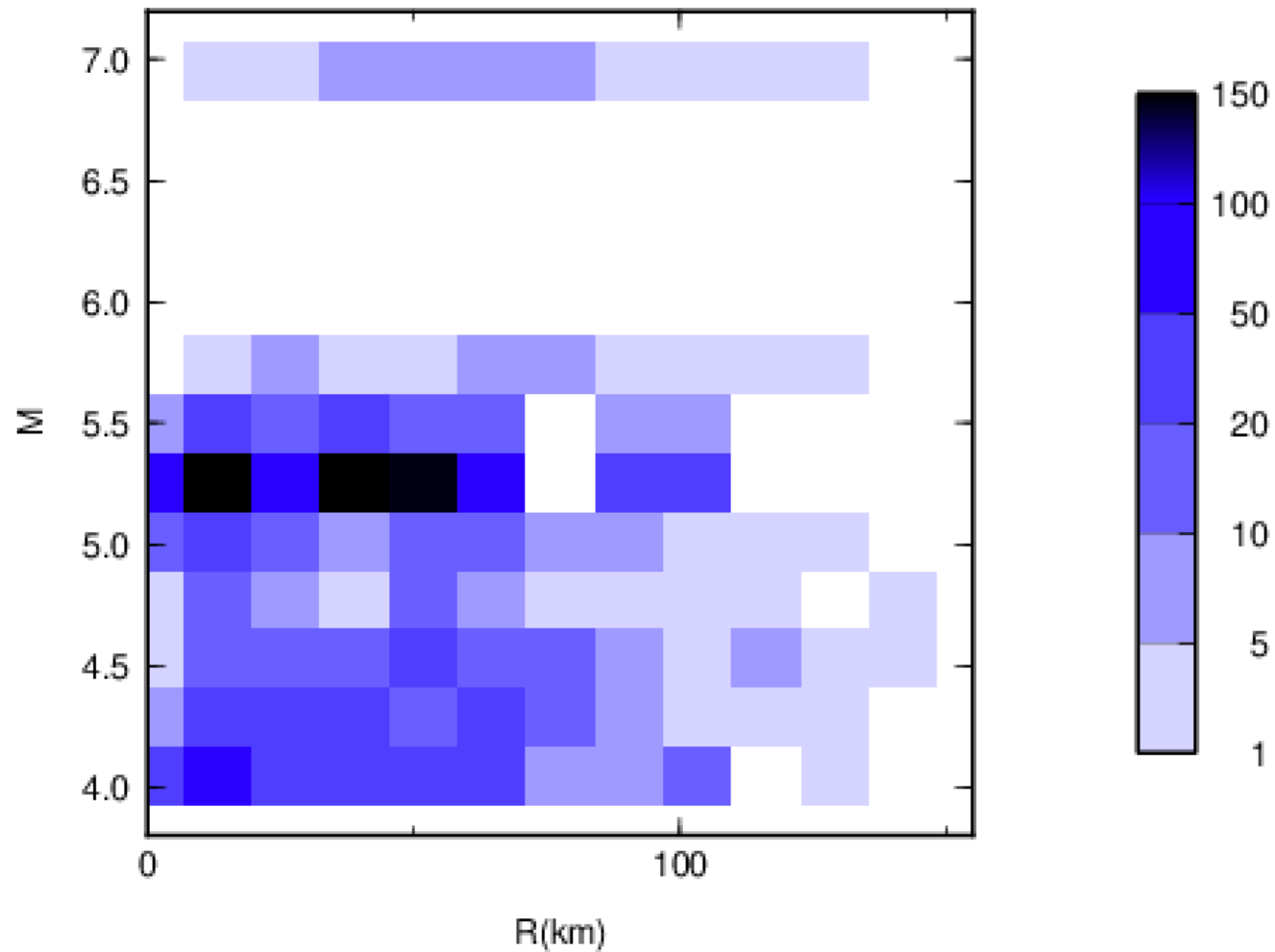
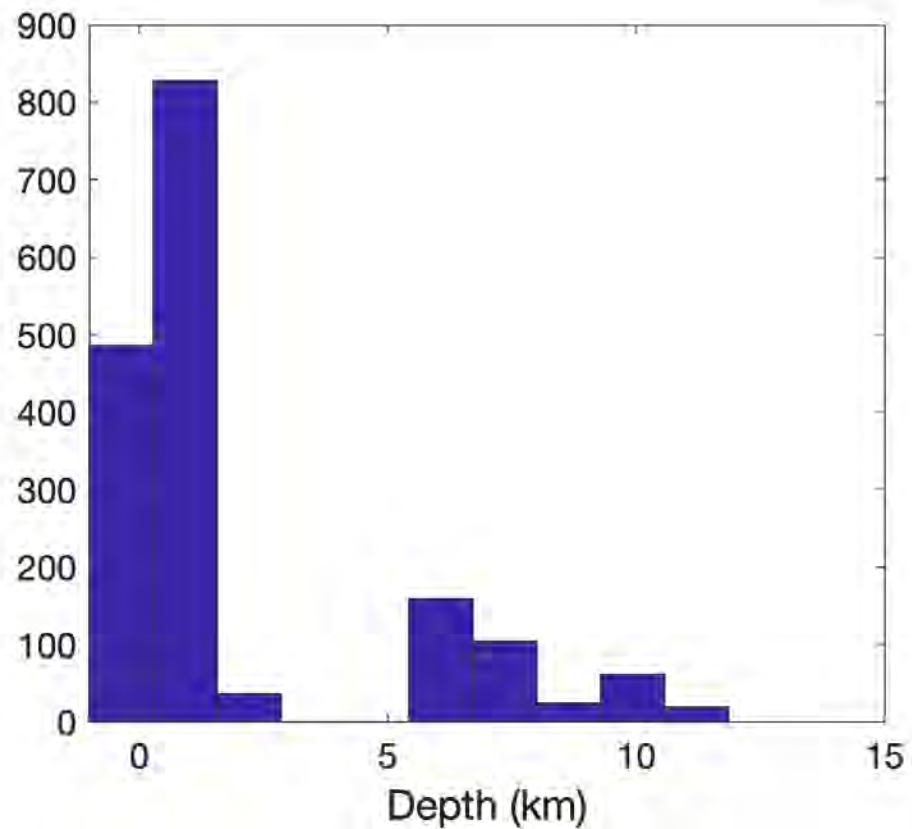


# Earthquake Catalog (97 events)





# Ground motion database



# Questions and comments

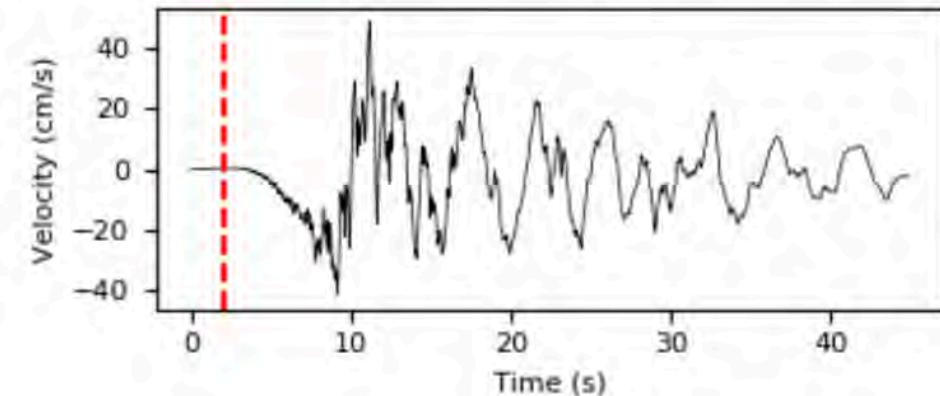
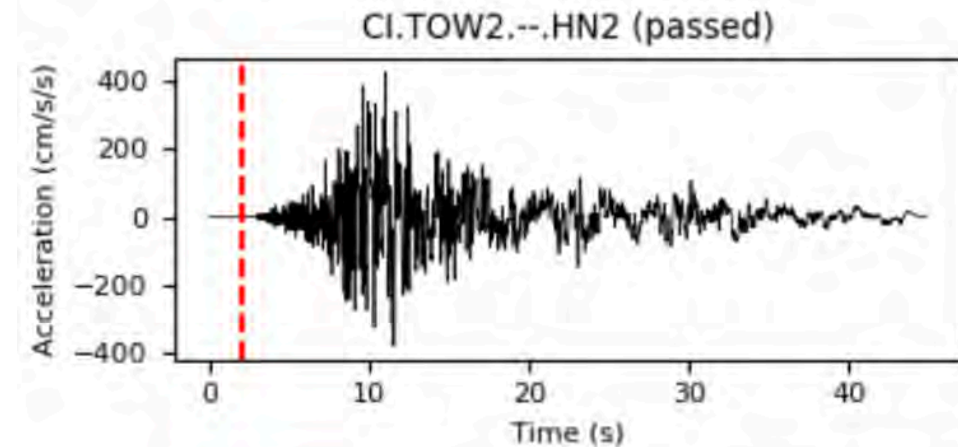
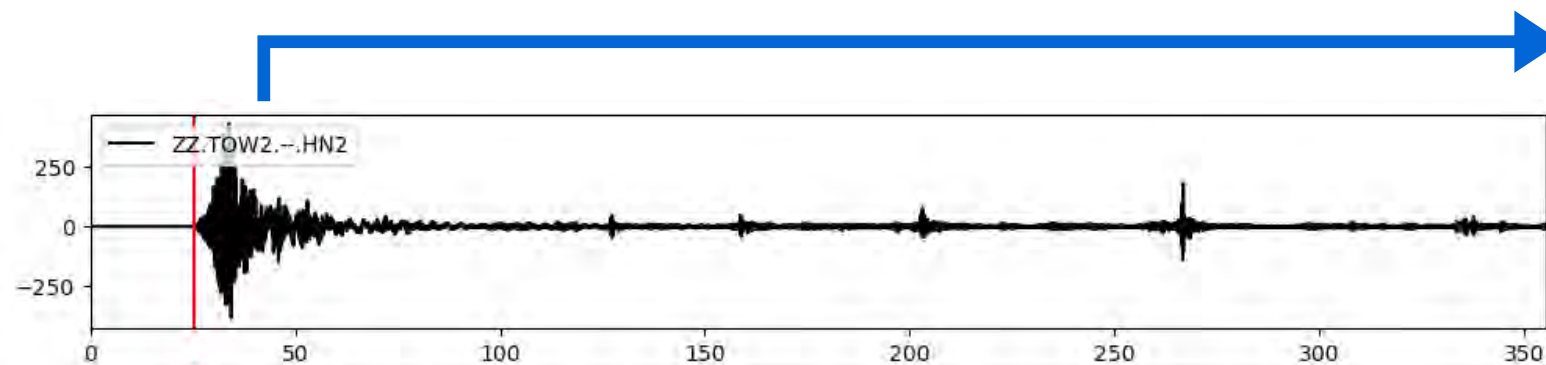
- ???

# Currently supported metrics

| IMC               | FAS | AI | Duration | PGA | PGV | SA |
|-------------------|-----|----|----------|-----|-----|----|
| Channels          |     |    | ✓        | ✓   | ✓   | ✓  |
| "Greater"         |     |    | ✓        | ✓   | ✓   | ✓  |
| Radial/transverse |     |    | ✓        | ✓   | ✓   | ✓  |
| Arithmetic mean   | ✓   | ✓  | ✓        | ✓   | ✓   | ✓  |
| Geometric mean    | ✓   |    | ✓        | ✓   | ✓   | ✓  |
| Quadratic mean    | ✓   |    | ✓        | ✓   | ✓   | ✓  |
| GMRotD            |     |    | ✓        | ✓   | ✓   | ✓  |
| RotD              |     |    | ✓        | ✓   | ✓   | ✓  |

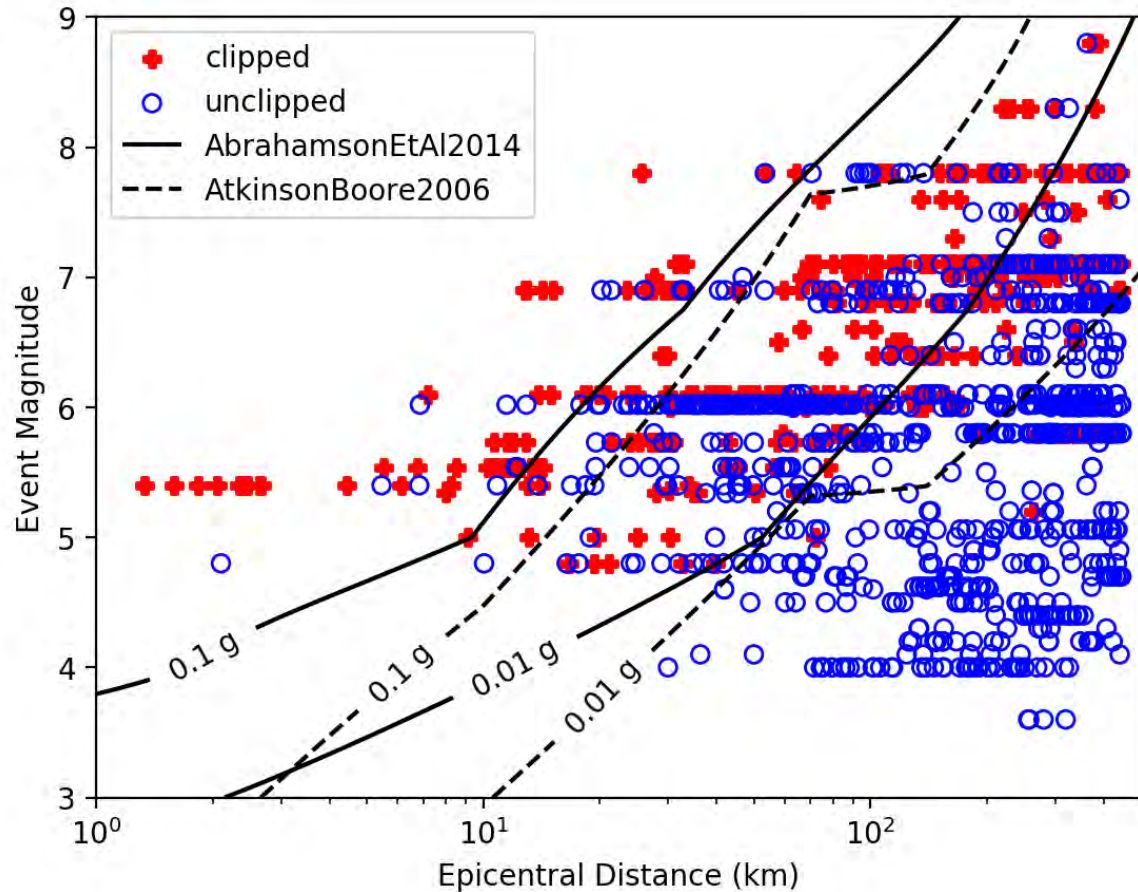
# Noise and Signal Windows

- Selecting the duration of the signal window
- Use Afshari and Stewart (2016) duration model



# Clipping Detection

Kael Kleckner and others



| Method                     | Accuracy | TPR    | TNR    |
|----------------------------|----------|--------|--------|
| Ping                       | 0.7726   | 0.2972 | 0.9725 |
| Ping(~optimized)           | 0.7748   | 0.3174 | 0.9672 |
| Std Dev Check              | 0.8039   | 0.9270 | 0.7521 |
| Std Dev Check (~optimized) | 0.8877   | 0.7761 | 0.9430 |
| Histogram                  | 0.7696   | 0.2242 | 0.9989 |
| Histogram (~optimized)     | 0.9484   | 0.8763 | 0.9842 |
| Jerk Check                 | 0.6589   | 0.8507 | 0.5639 |
| Abs Max Amp (2 mil)        | 0.8199   | 0.8316 | 0.8141 |
| Abs Max Amp (4 mil)        | 0.8559   | 0.7740 | 0.8965 |
| Abs Max Amp (6 mil)        | 0.8630   | 0.7271 | 0.9303 |
| Abs Max Amp (8 mil)        | 0.8121   | 0.5288 | 0.9525 |