

# ERIC'S EARTHQUAKE EXPLORATION

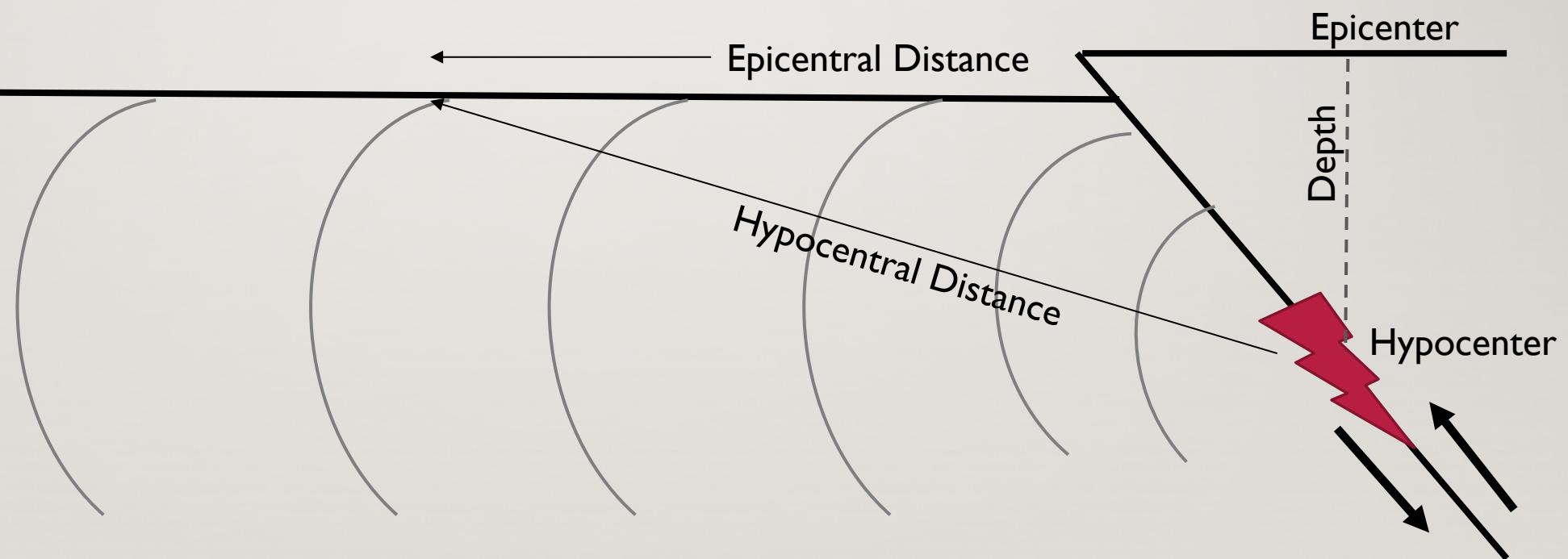
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*INCREASED UNDERSTANDING WITH DATA SCIENCE*

ERIC HEPP

# INTENSITY AND DISTANCE

SHAKING INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+	
EXPECTED DAMAGE (Building Type)	(Sturdy)	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	(Fragile)	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

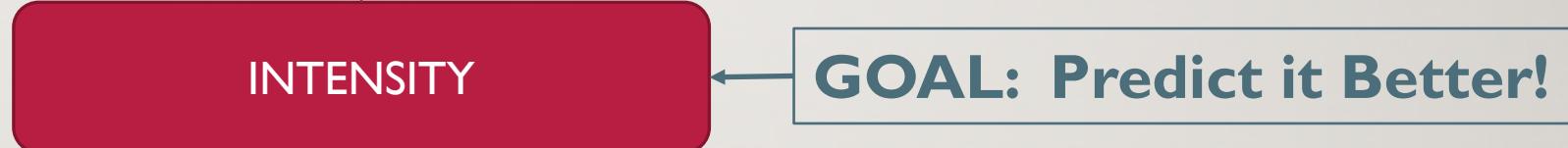


# INTENSITY FACTORS AND MEASUREMENT

Contributing Factors:

Methods to Quantify:

Magnitude      Distance      Depth      Crustal Properties

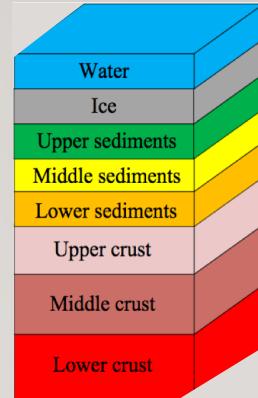


## Modified Mercalli (MMI)

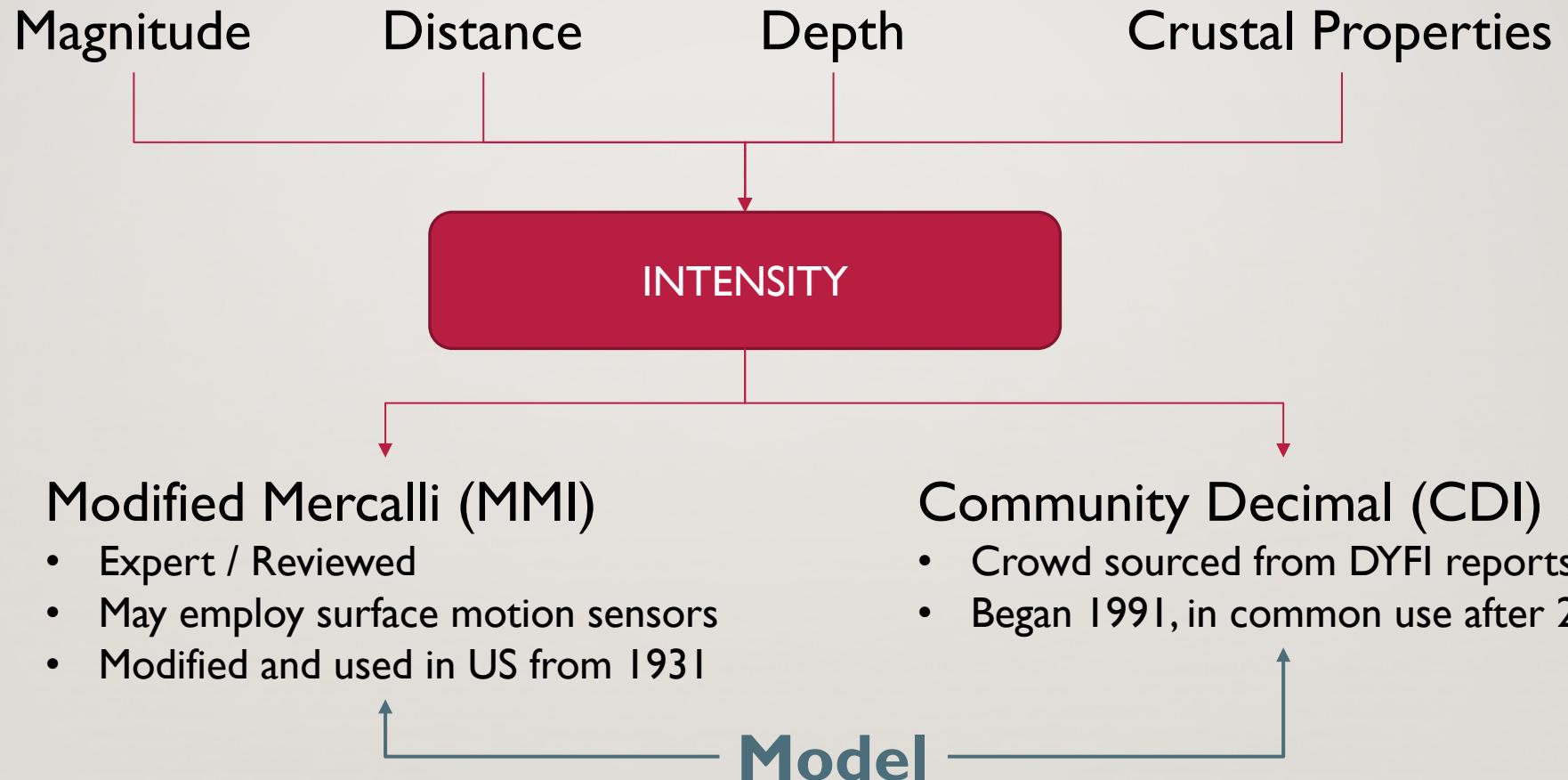
- Expert / Reviewed
- May employ surface motion sensors
- Modified and used in US from 1931

## Community Decimal (CDI)

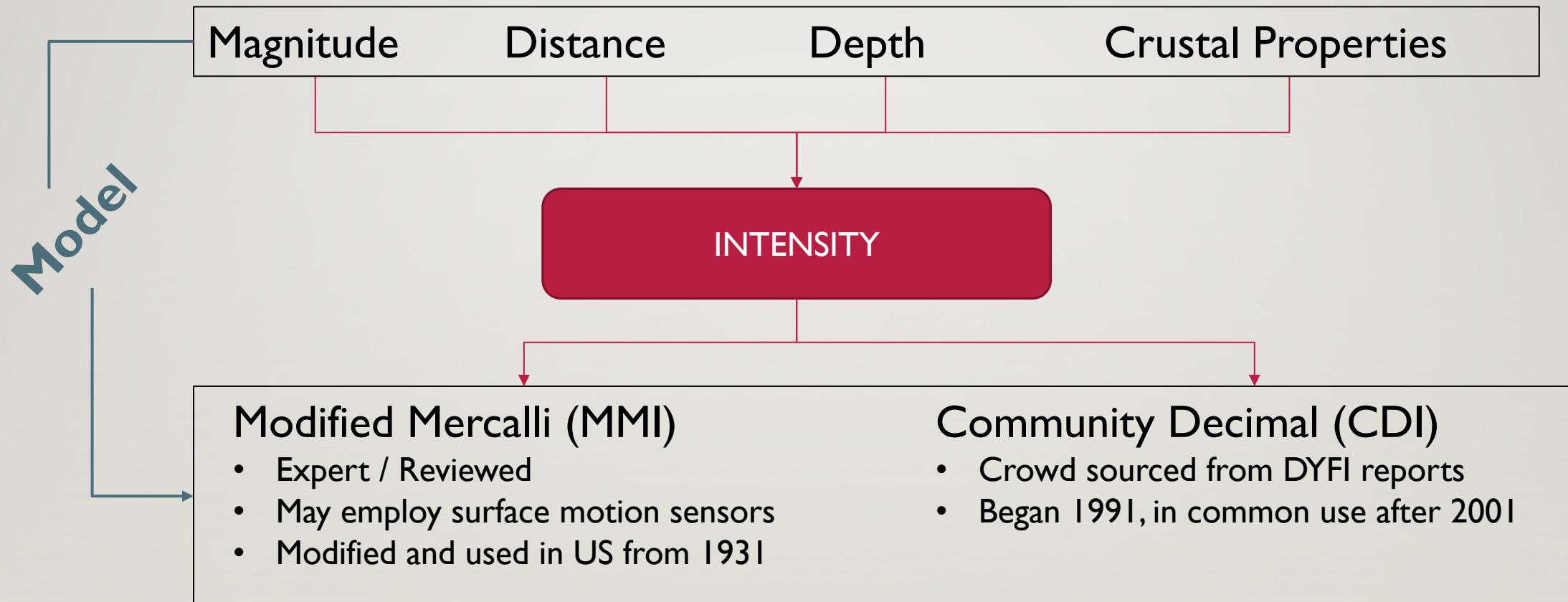
- Crowd sourced from DYFI reports
- Began 1991, in common use after 2001



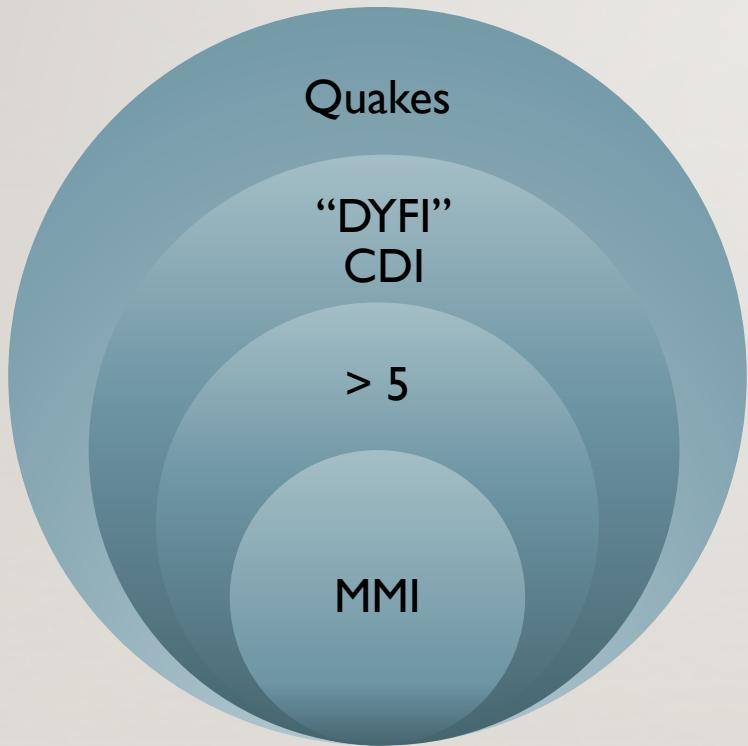
# INTENSITY MODELING: VALIDATE CDI



# INTENSITY MODELING: ADD DETAIL

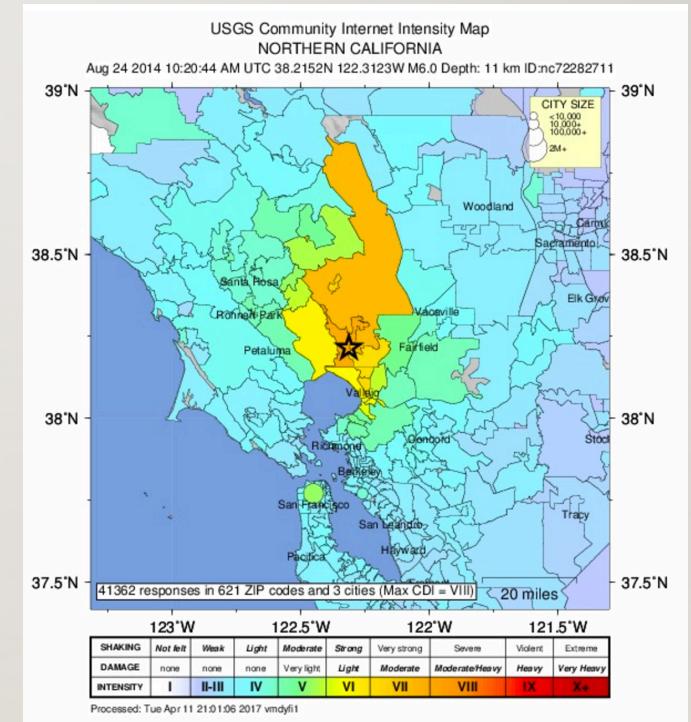


# DATA: HOW MUCH

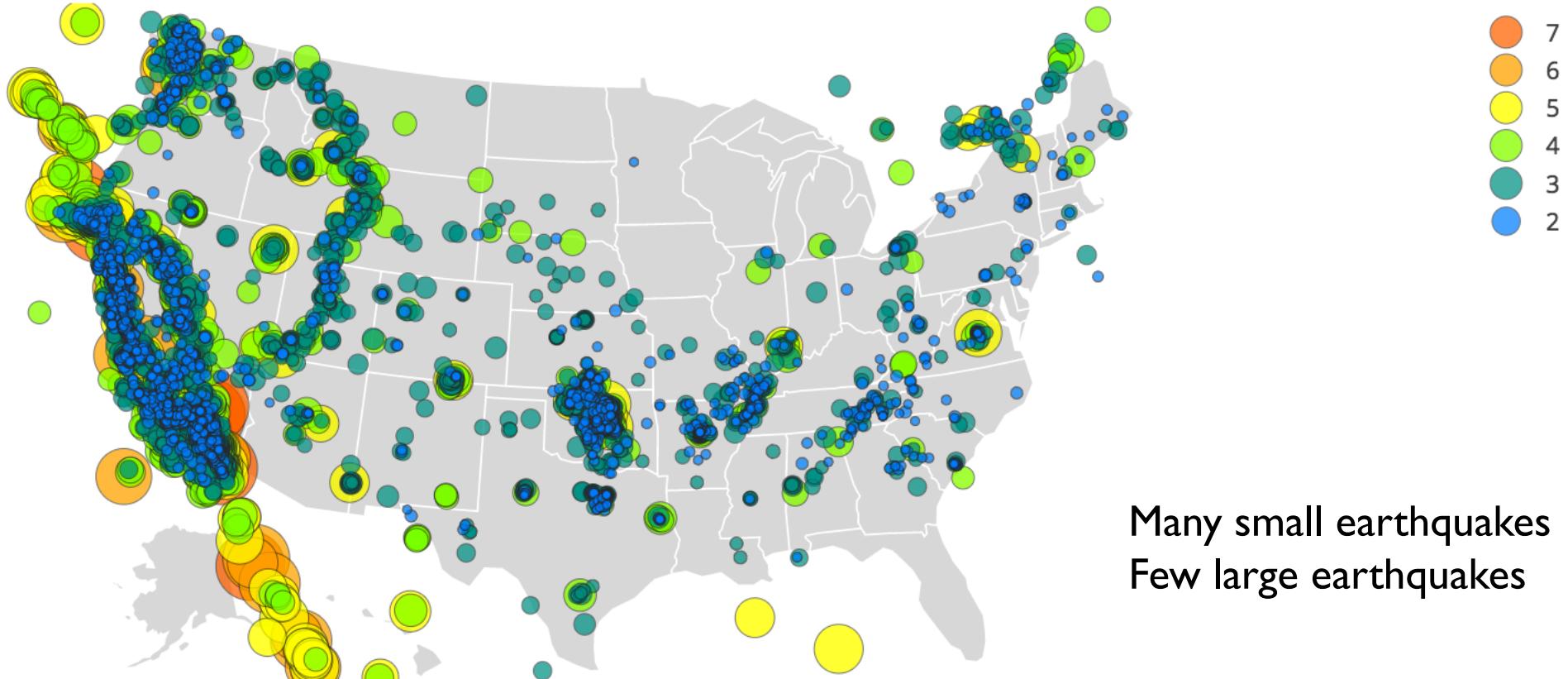


Earthquakes from 1970 to mid 2017

Earthquakes	Did You Feel It Intensity
117,459	
7287	273,499
4425	85,236
1206	55,888

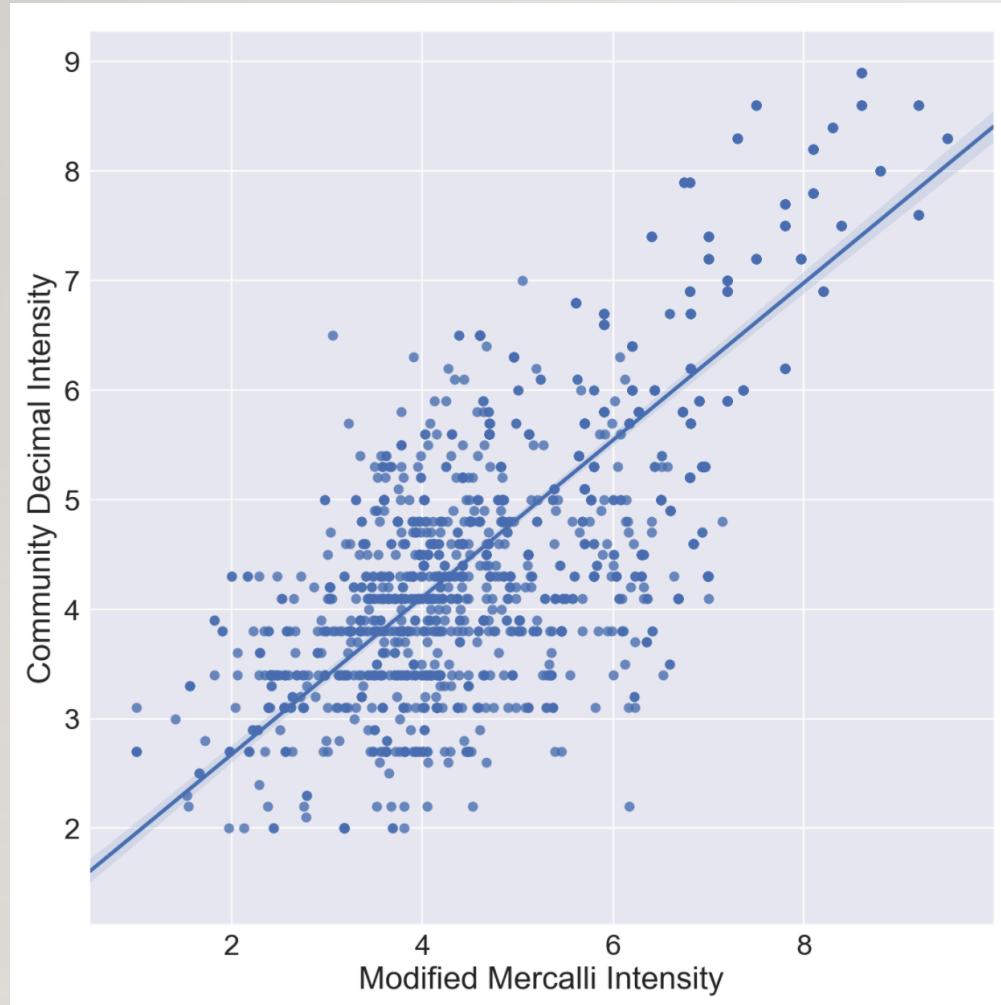


# EARTHQUAKES WITH DYFI / CDI DATA

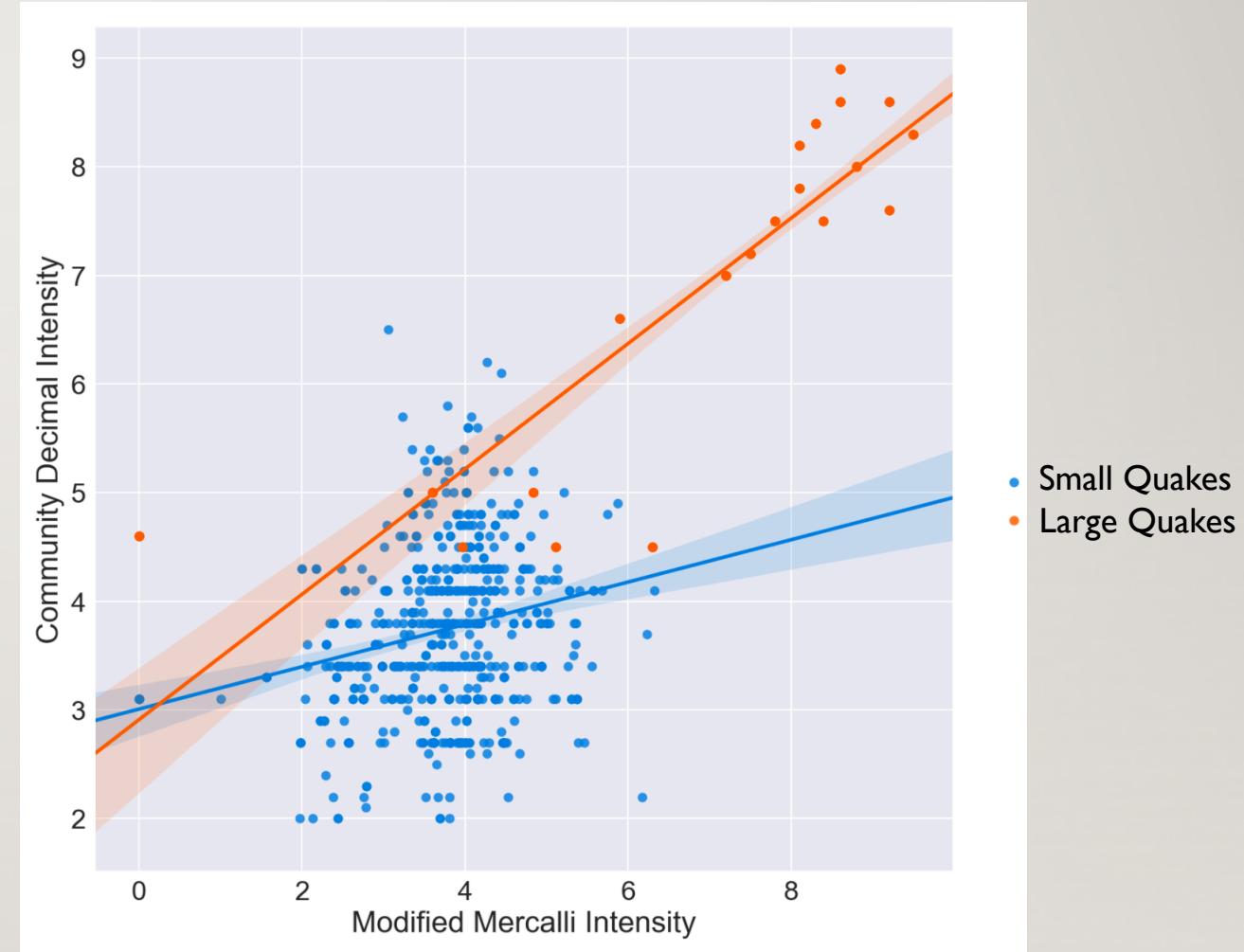


# CDI / MMI COMPARISON

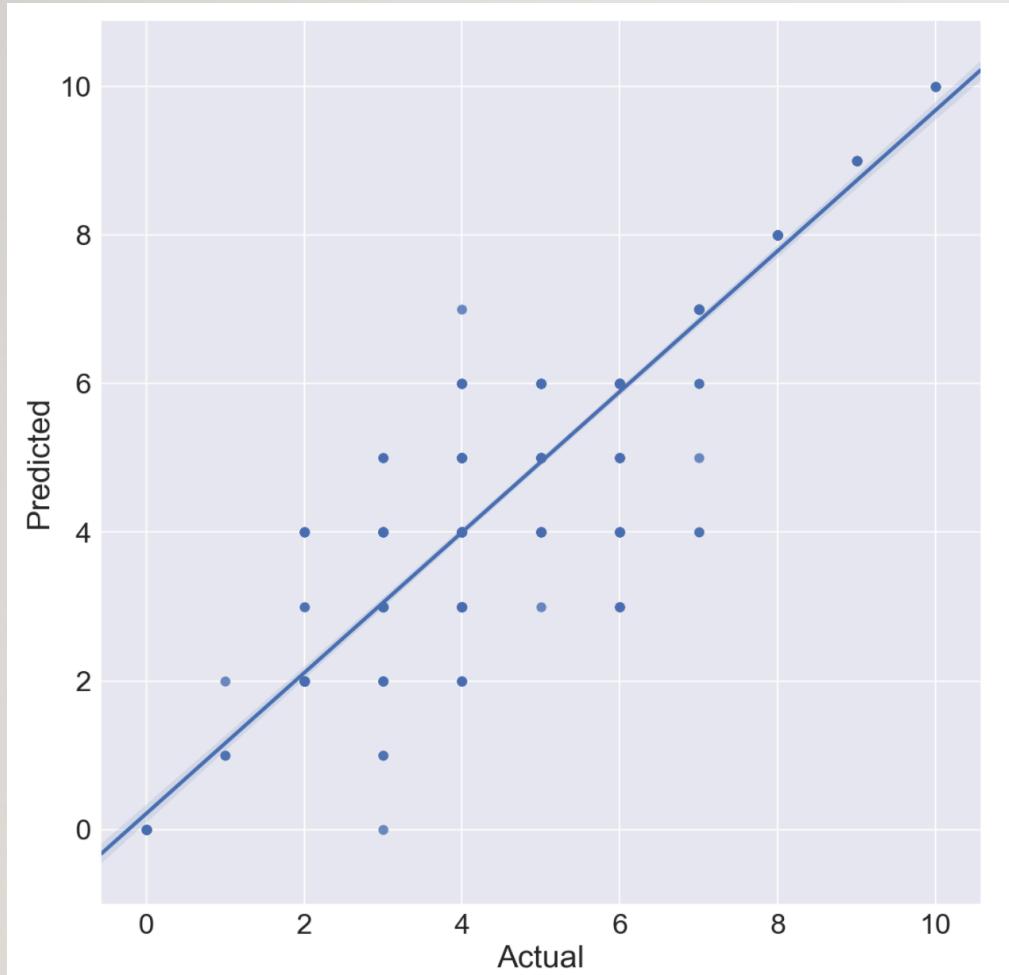
## Maximum Intensity Data



Can one predict the other?



# PREDICT "EXPERT" MMI FROM "CITIZEN" CDI



Method: Decision Tree

Convert MMI to Integer Numbers

Use additional information:

US Region: West, Central, East

Depth of earthquake

Number of DYFI reports

(many are better than one)

# PREDICT CDI AT DISTANCE

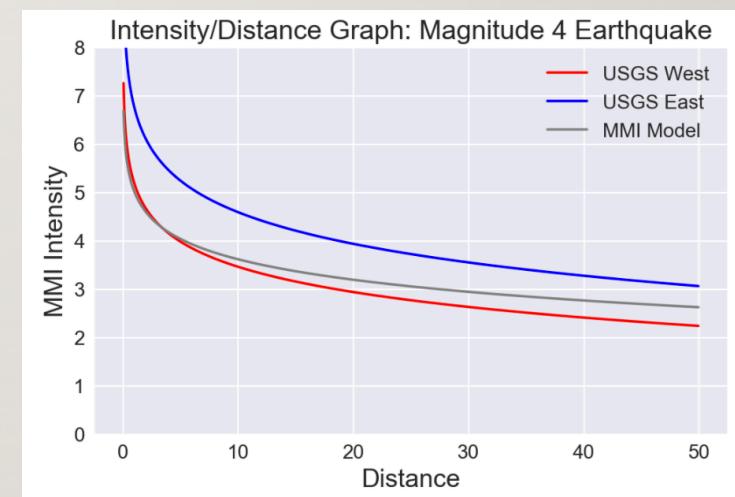
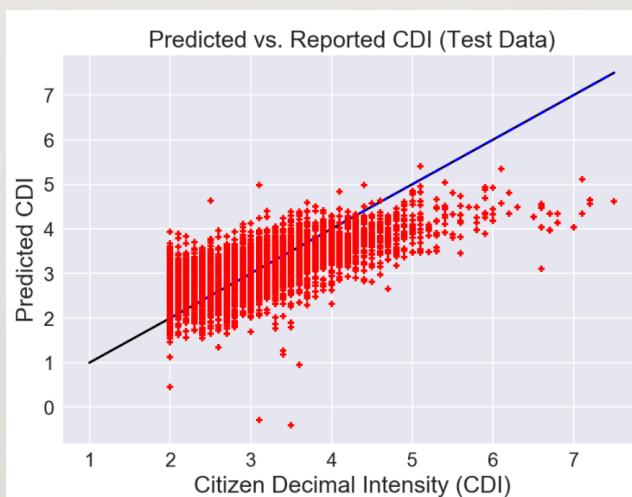
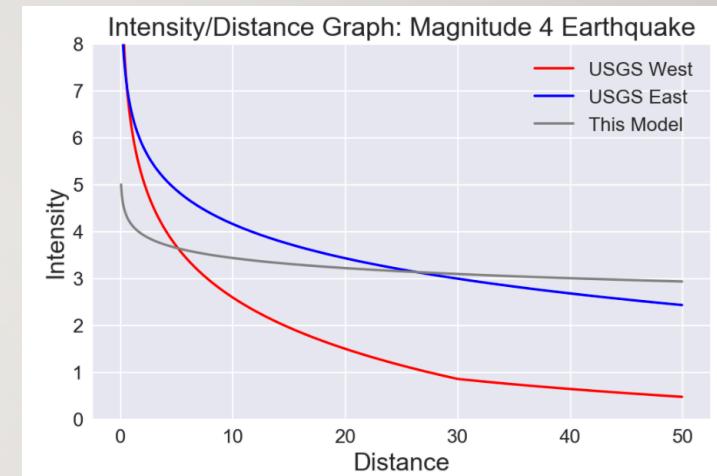
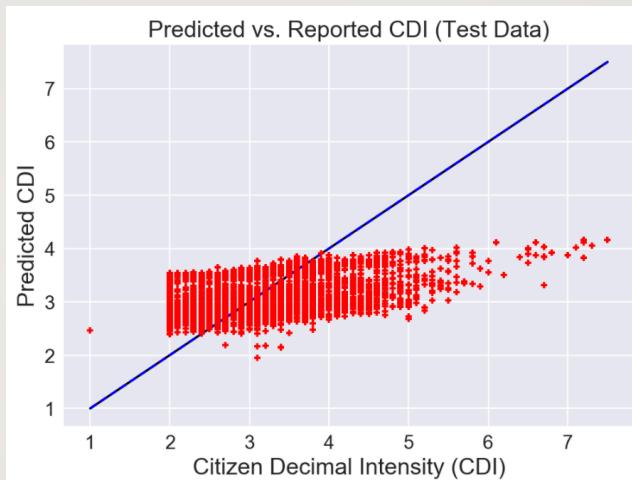
Use Magnitude & Distance only

Only 18% of the difference between the average CDI earthquake intensity for all observations can be explained by this approach

45% of difference between average CDI intensity of all earthquakes and actual intensity observed can be explained by using:

Magnitude and Distance and ...

- Depth,
- Crustal Density & Thickness
- Method of computing magnitude



# PREDICT MMI FROM MAGNITUDE AND DISTANCE

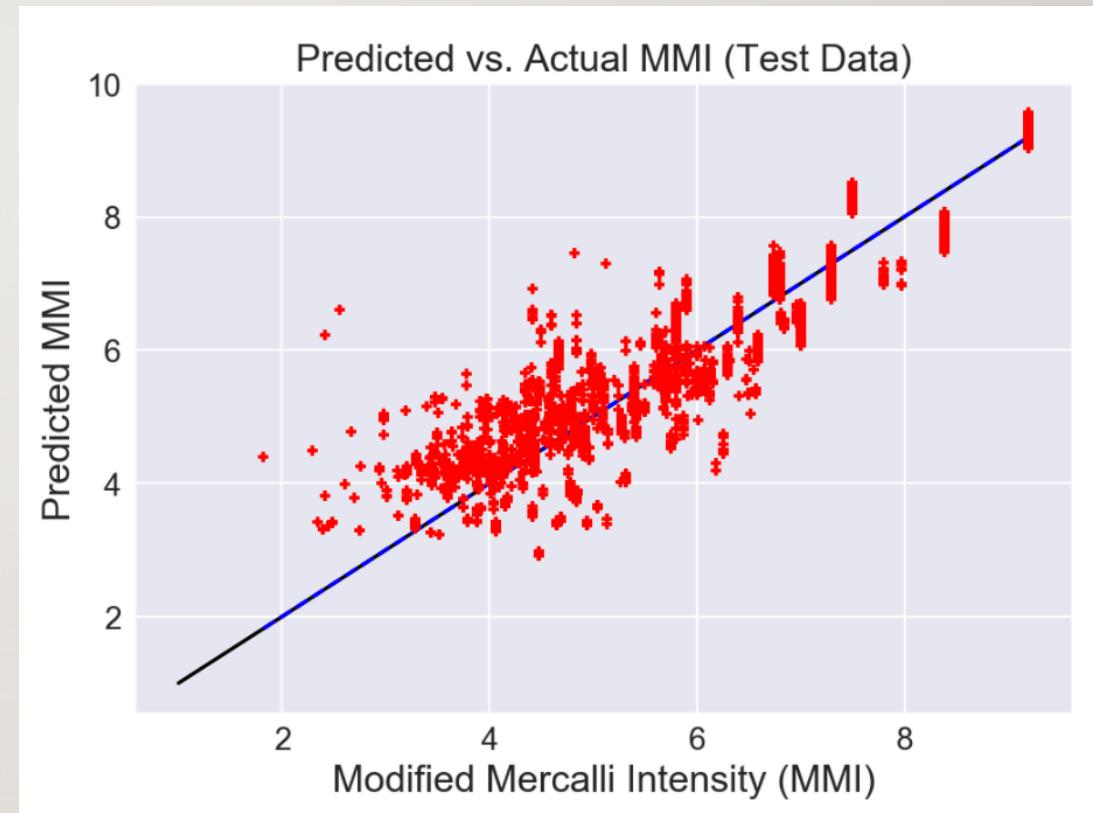
## Modified Mercalli Intensity (MMI)

This explains 91% of the difference between average MMI intensity of all earthquakes and actual intensity observed –

... and only magnitude and distance were used!

What's up with this?

- Data reported and reviewed by experts
- Reported over longer period of time
  - Includes larger proportion of high magnitude earthquakes



# COMMUNITY DECIMAL INTENSITY USEFULNESS

**Conclusion:** Based on this dataset, CDI is useful as initial evaluator; it is cheap and easy to collect data.

- It can be a reasonable predictor of MMI when considering the maximum values of each which occur near earthquake epicenter, especially when combined with additional factors of depth and region.
- CDI can be predicted from magnitude and distance when enhanced by additional non-traditional factors.

# DATA SOURCES

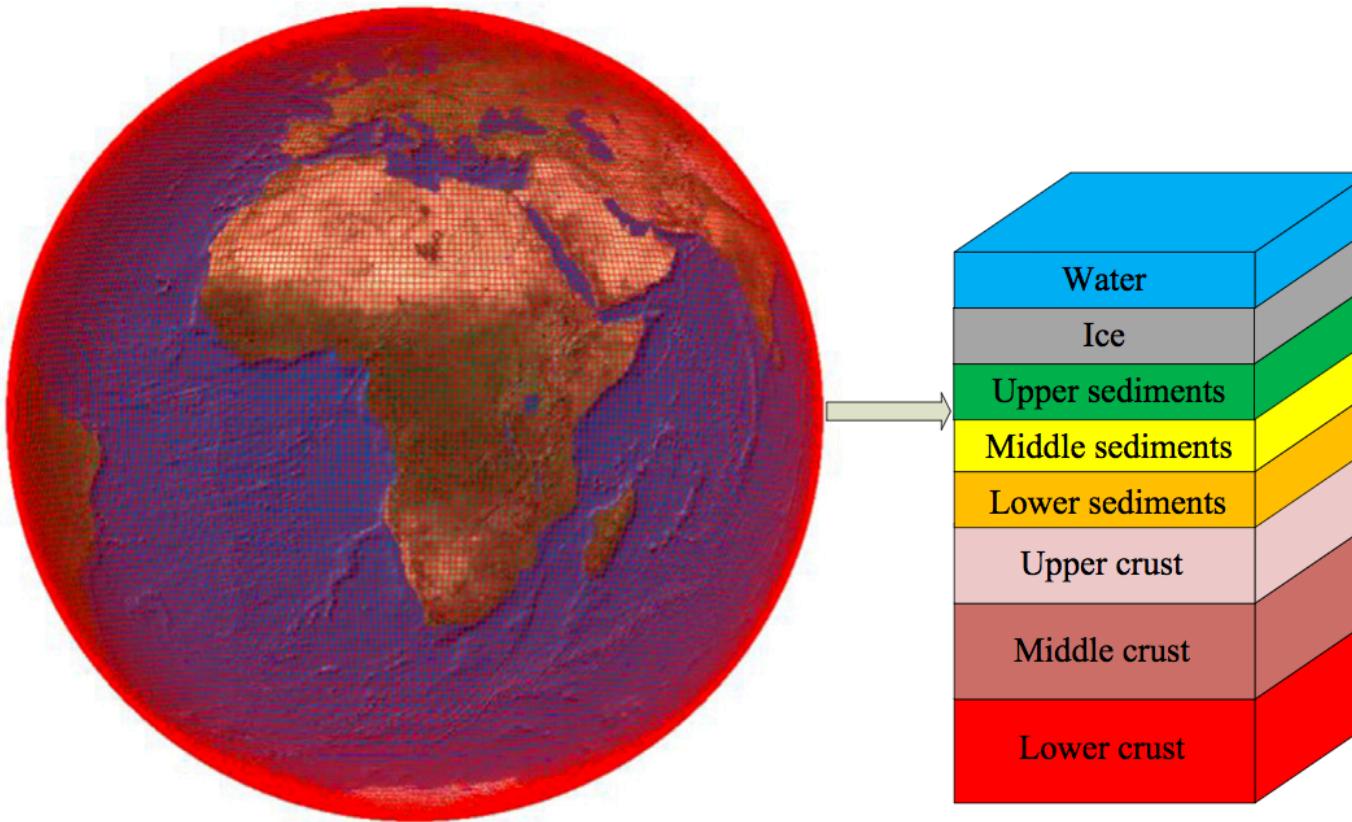
## References

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- USGS: Common Catalog
  - Aggregation of Earthquake Events from many reporting agencies
  - Includes “Did You Feel It,” CDI data, MMI and Magnitude
- LLNL: Crust 1.0 Model
  - Crustal Boundary and Density Data

- [Wald, David J. \(2011\). USGS “Did You Feel It?” Internet-based macroseismic intensity maps. ANNALS OF GEOPHYSICS, 54.6](#)
- [Oklahoma Example: Matthew Schroyer paper](#)
- [Crowdsourced Geographic Information use in Govt.](#)

# GLOBAL CRUSTAL MODEL



**Fig. 1.** Crustal structure representation implemented in CRUST 1.0. The crust is parametrized laterally by 64800  $1^\circ \times 1^\circ$  latitude-longitude grids and vertically as eight geophysically identified sublayers.

Zhu, L.F., Pan, Z., Sun, J.Z., (2016). Visualization and dissemination of global crustal models on virtual globes, Computers and Geosciences v90, Part A, 34-40. Elsevier,  
<https://doi.org/10.1016/j.cageo.2016.01.015>

<https://igppweb.ucsd.edu/~gabi/crust1.html#visualization>

Intensity	Shaking
I	Not felt
II	Weak
III	Weak
IV	Light
V	Moderate
VI	Strong
VII	Very strong
VIII	Severe
IX	Violent
X	Extreme

# DID YOU FEEL IT?

<https://earthquake.usgs.gov/earthquakes/eventpage/unknown#tellus>

A decision tree is used to calculate CDI from these reports. CDI = Community Decimal Intensity

## Felt Report - Tell Us!

OMB No. 1028-0048  
Expires 05/31/2018

### Your location when the earthquake occurred

Choose Location

Time of Earthquake Local time **1/31/2008 9:00 AM**, or Relative time **5 minutes ago**

### Did you feel it?

- Yes
- No

**i** The remainder of this form is optional.

Help make a shaking intensity map by telling us about the shaking at your location.

### What was your situation during the earthquake?

- Not specified
- Inside a building
- Outside a building
- In a stopped vehicle
- In a moving vehicle
- Other

Please describe

### Were you asleep?

- Not specified
- No
- Slept through it
- Woke up

### Did others nearby feel it?

- Not specified
- No others felt it
- Some felt it, most did not
- Most felt it
- Everyone/almost everyone felt it

### How would you describe the shaking?

- Not specified
- Not felt
- Weak
- Mild
- Moderate
- Strong
- Violent