



FEMA

# OMG Earthquake!!!!

Twitter Based Earthquake Detection and Characterization:  
System Assessment and Future Directions

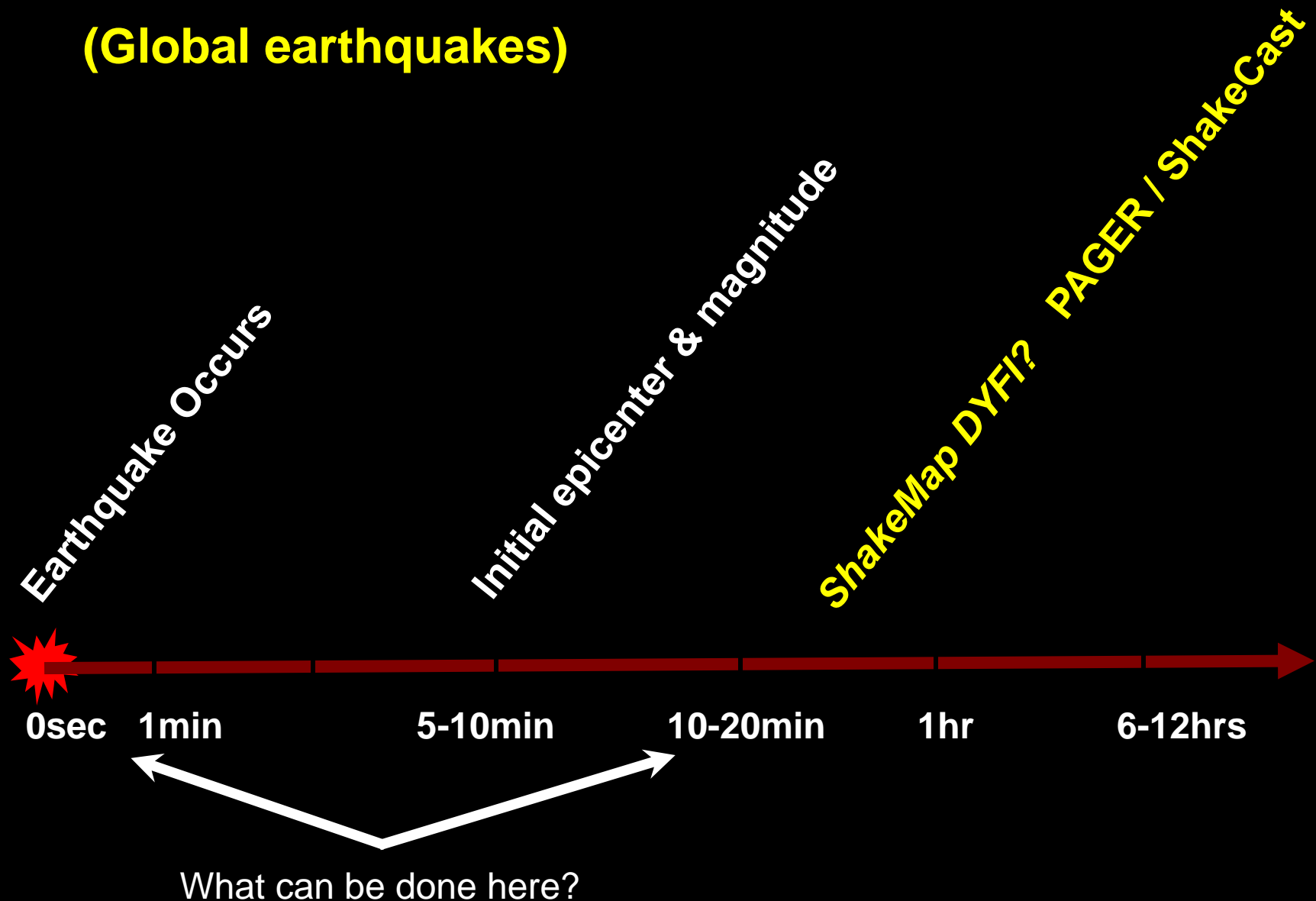
twitter



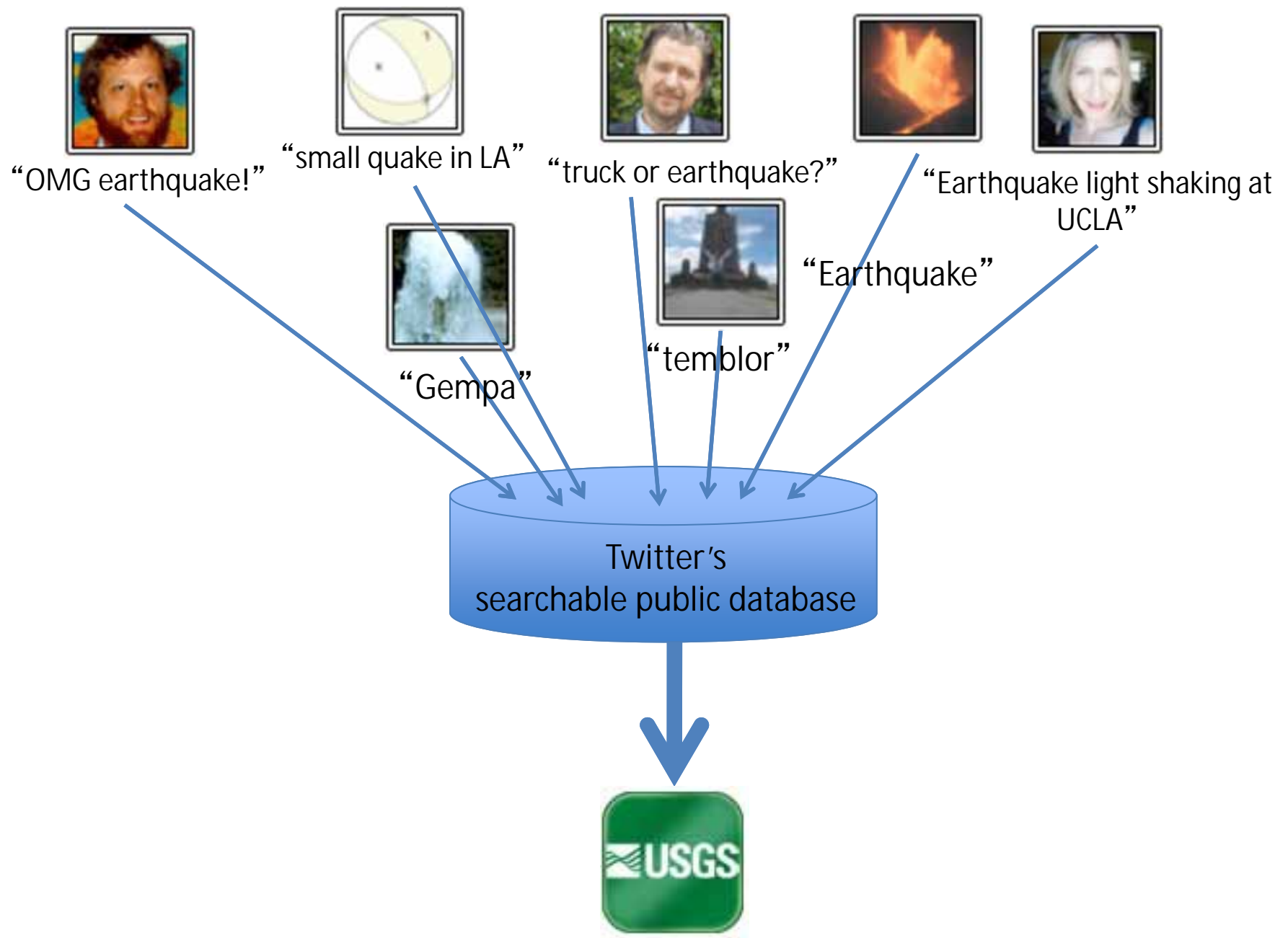
Paul Earle  
Michelle Guy  
Scott Horvath  
Jessica Turner  
Doug Bausch

# An Earthquake Information Timeline

(Global earthquakes)

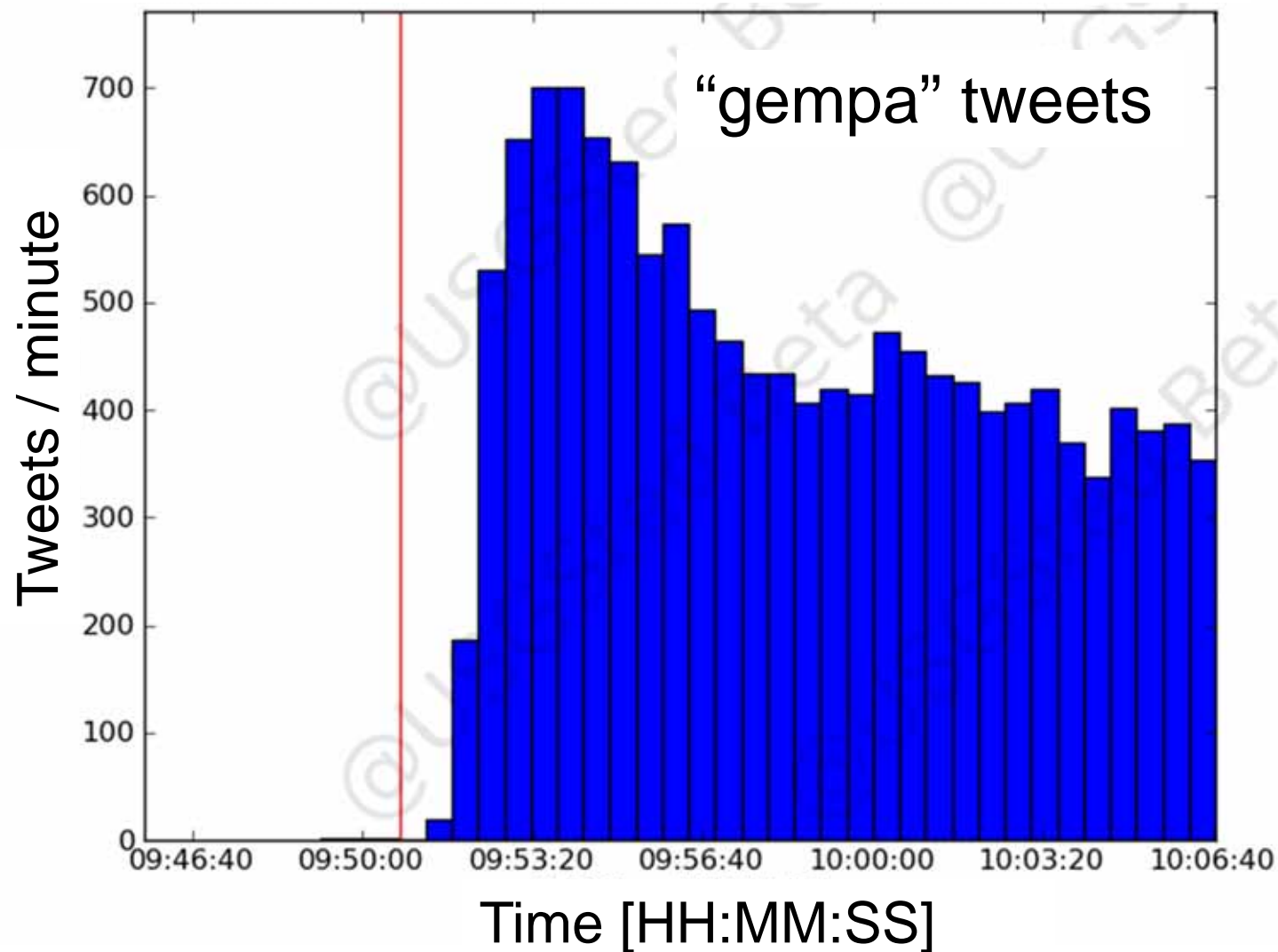


How does Twitter work?



How can you detect earthquakes  
with tweets?

# M5.8 offshore Java, Indonesia



# Each tweet has metadata

```
"profile_image_url":"http://profile_images/xxxxxxxxx.jpg",  
"created_at":"Mon, 06 Sep 2010 06:20:06 +0000",  
"from_user":"xxxxxxxxxxx","metadata":  
"to_user_id":xxxxxxxxx,  
"text":"felt another small earthquake",  
"id":xxxxxxxxxxxxx,  
"from_user_id":xxxxxxxxx,  
"to_user":"xxxxxxxxx",  
"geo":{"type":"Point","coordinates":[-43.5766,172.589]},  
"iso_language_code":"en",  
"source":"&lt;a href=&quot;http://twitter.com/&quot;  
rel=&quot;nofollow&quot;&gt;Twitter for iPhone&lt;/a&gt;"}"
```

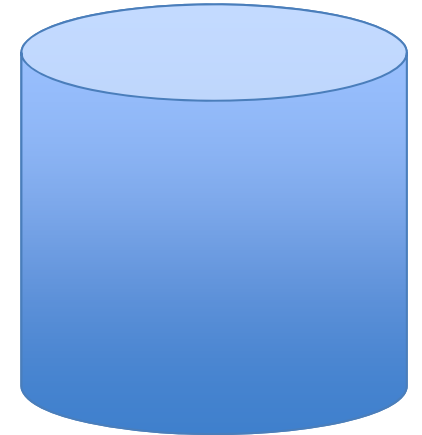
collect



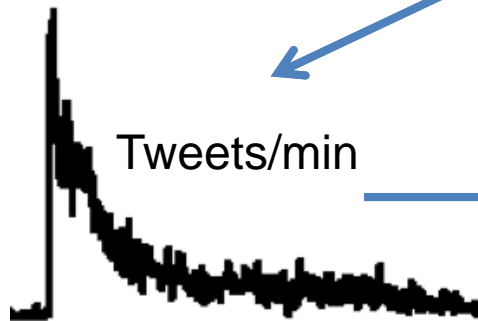
geocode



database



Select preferred tweets



timeseries



detect, locate

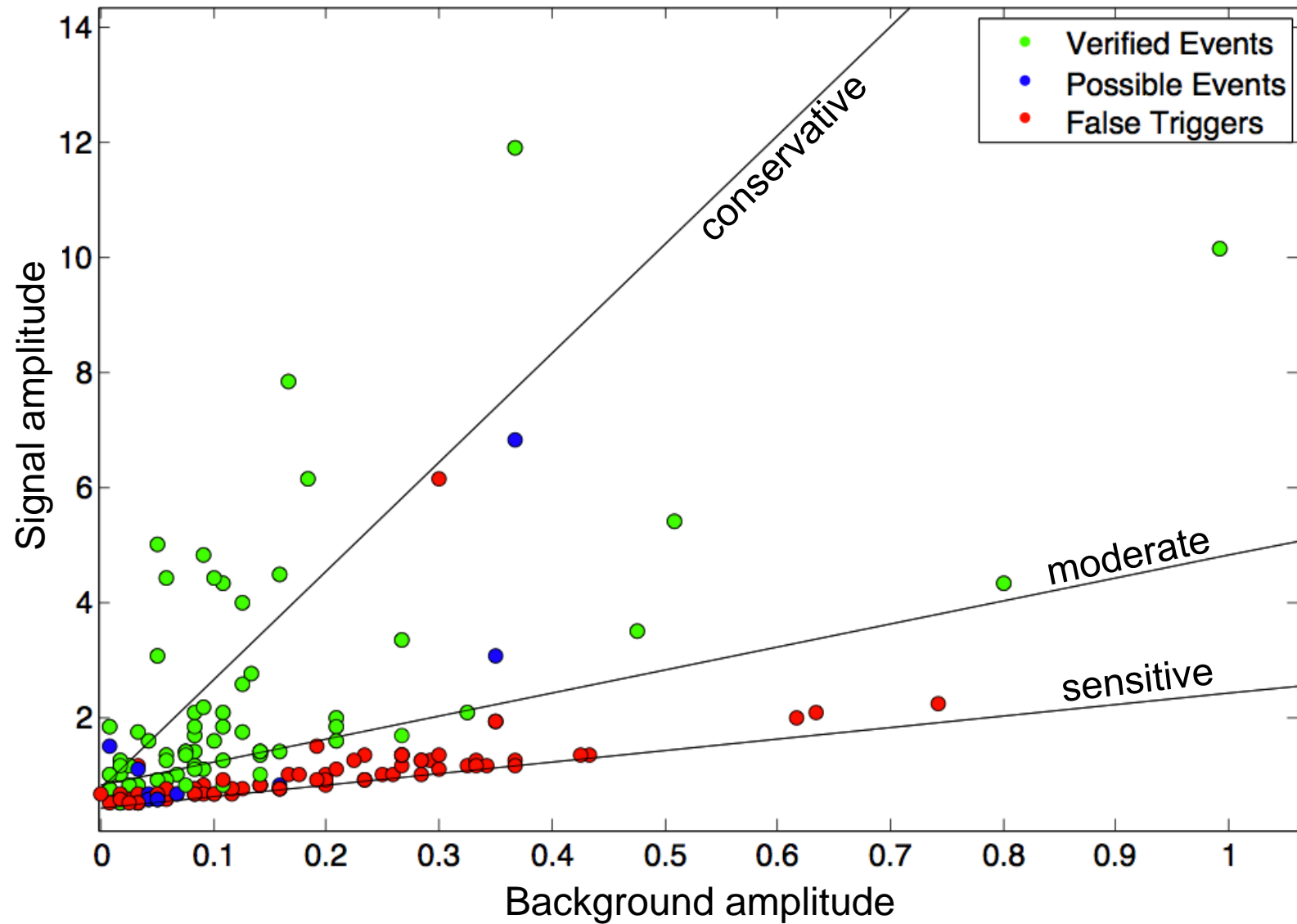
Text messages  
e-mails  
Interactive maps

outputs



Detector performance

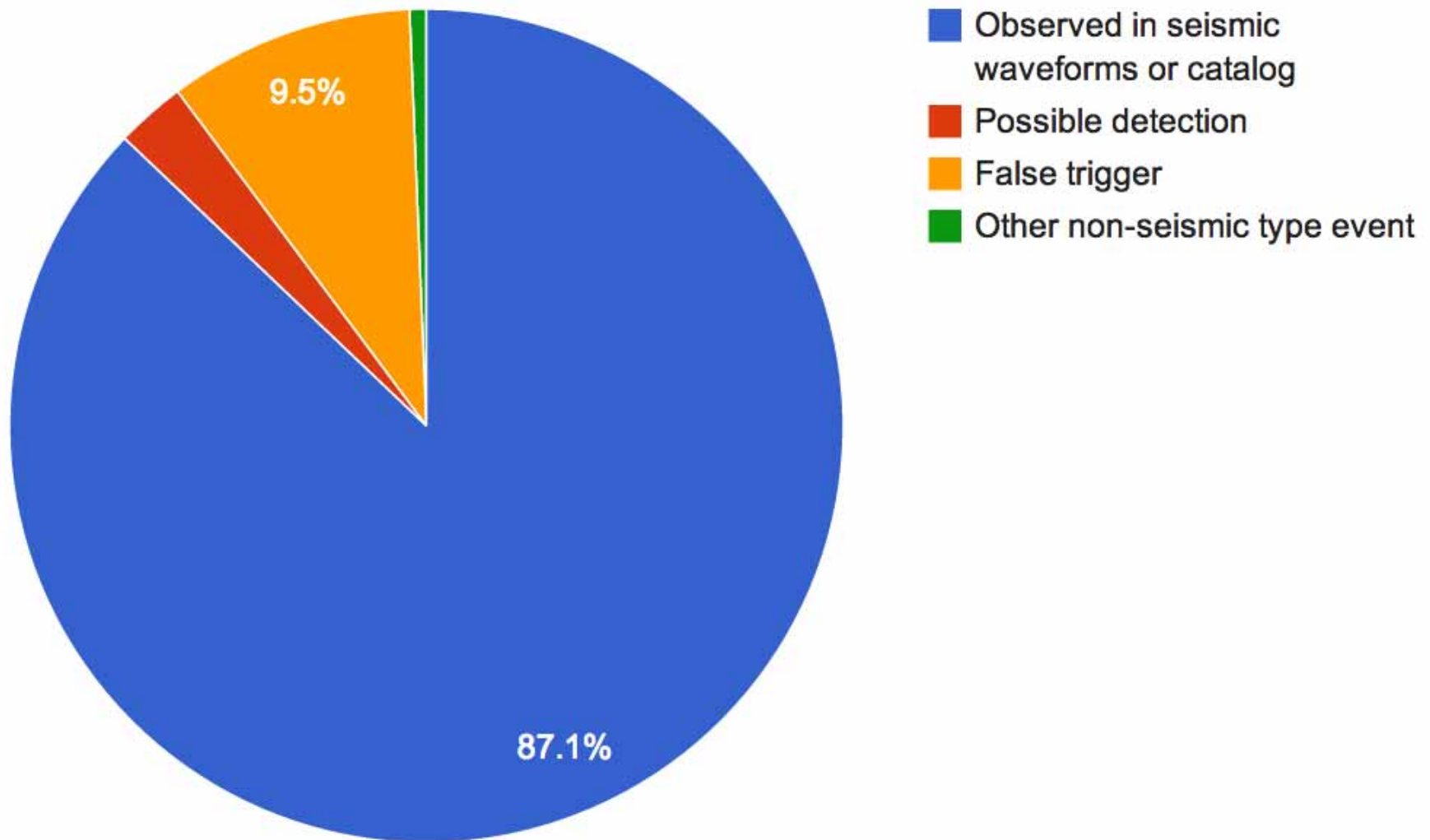
# Tuning the detector



Four months of tweets

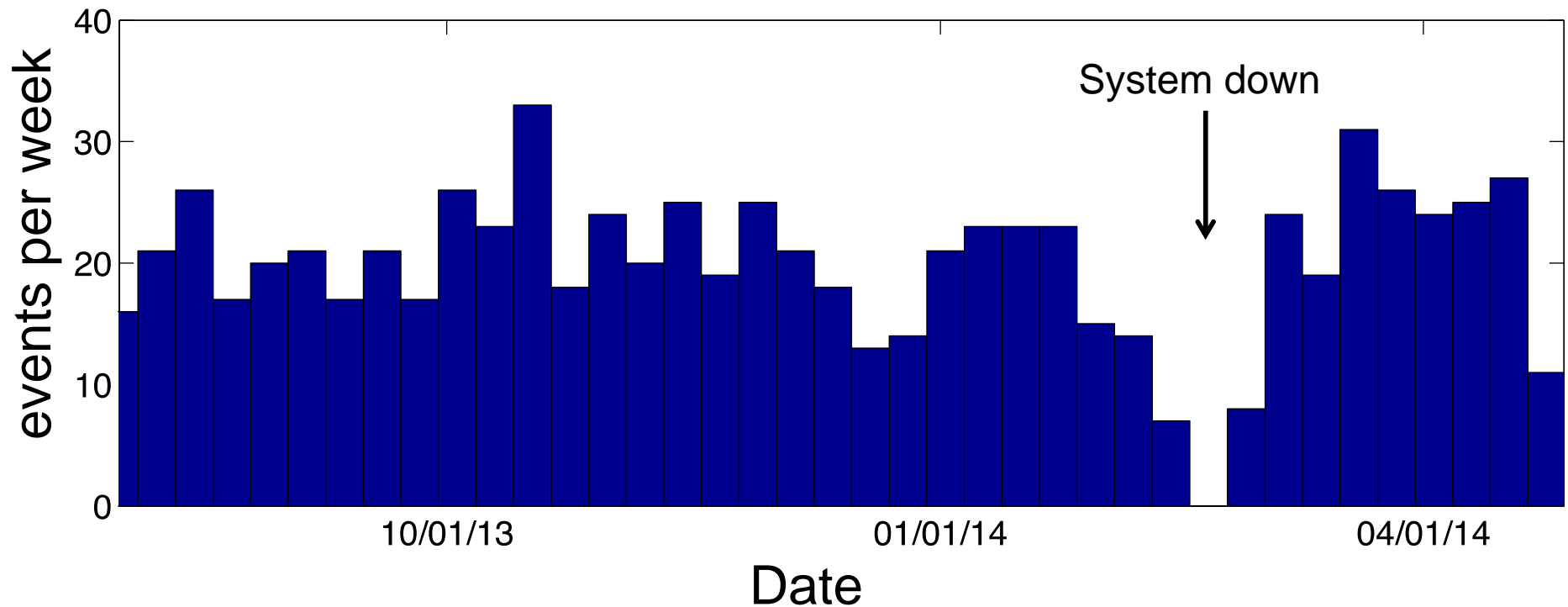
# False Trigger Rate

(since July, 2013)



# Detection Frequency

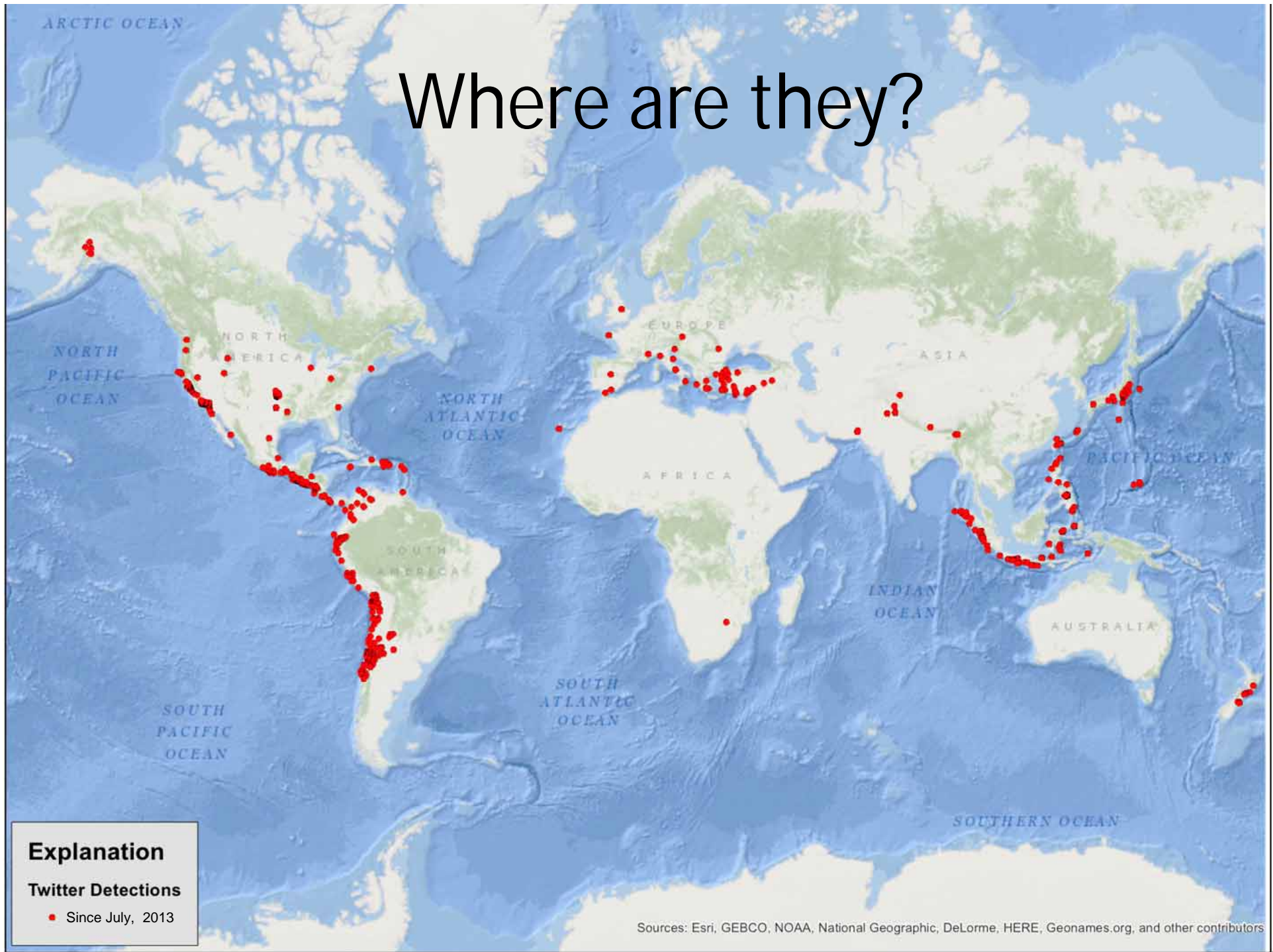
(since July, 2013)



~19 Twitter detections per week.

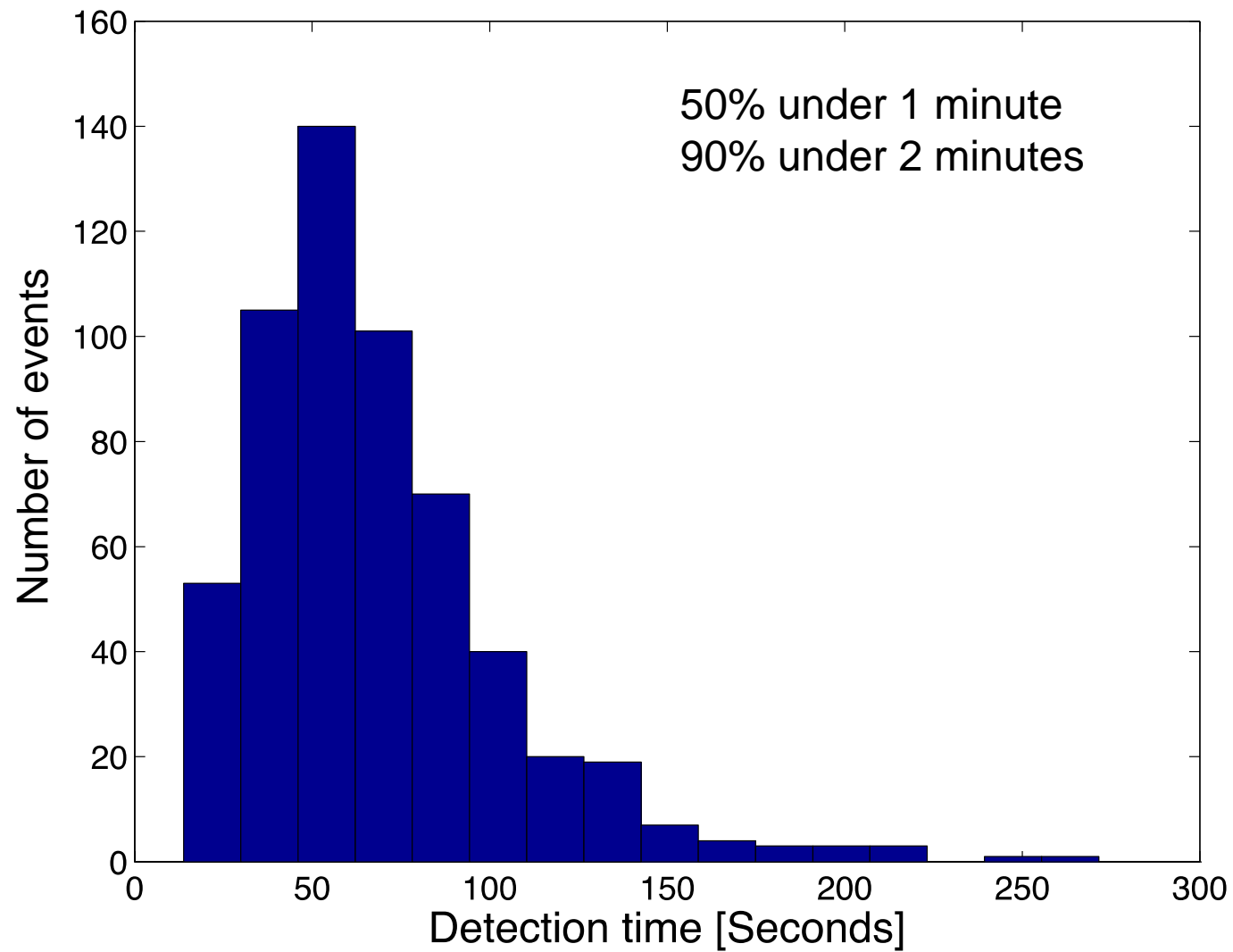
~350 NEIC earthquakes processed per week.

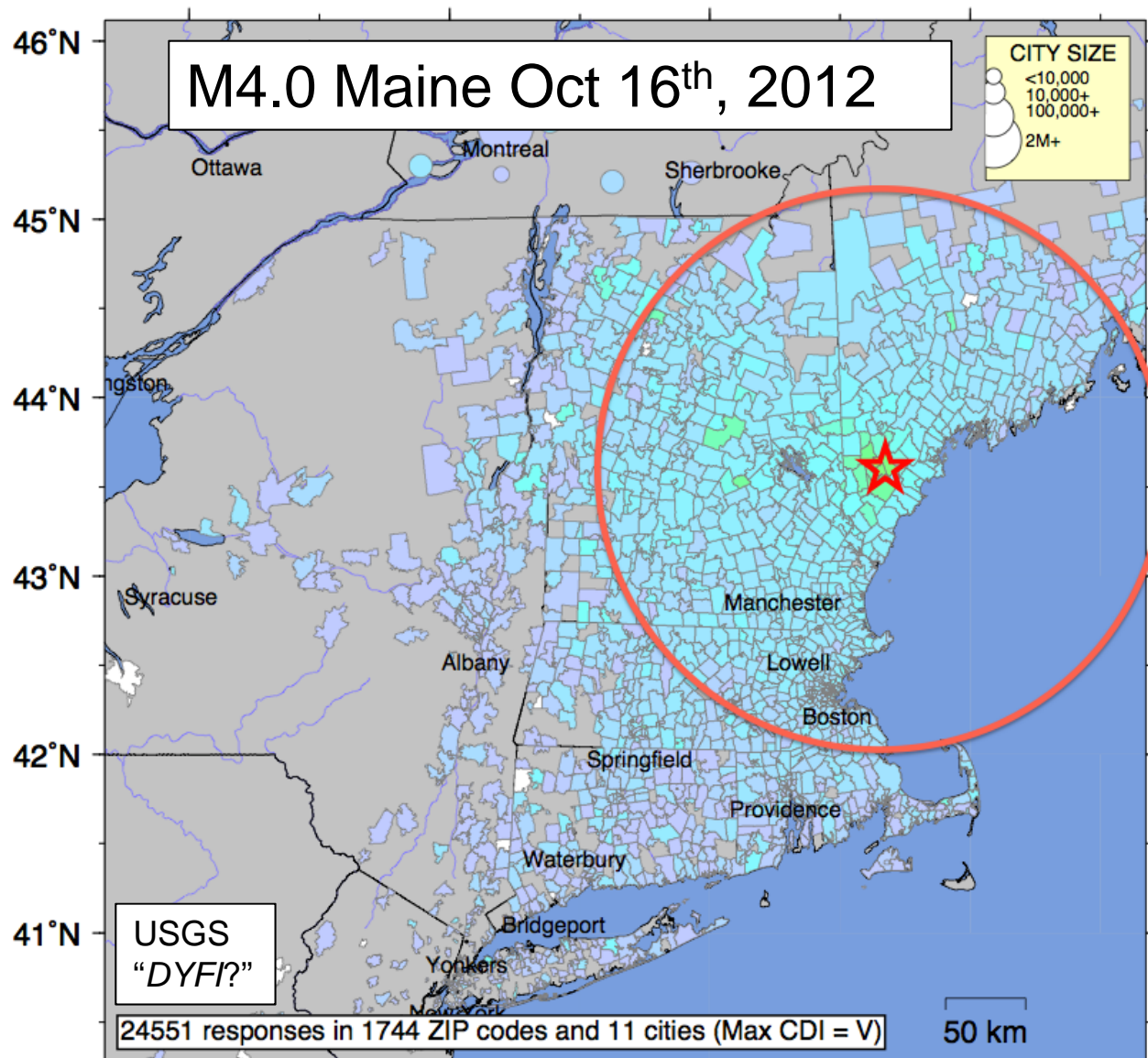
# Where are they?



# Detection delay

(since July, 2013)





Location of  
*P*-wave when  
 Twitter alert was  
 received in  
 Golden, CO.

Detection time  
 ~20 seconds

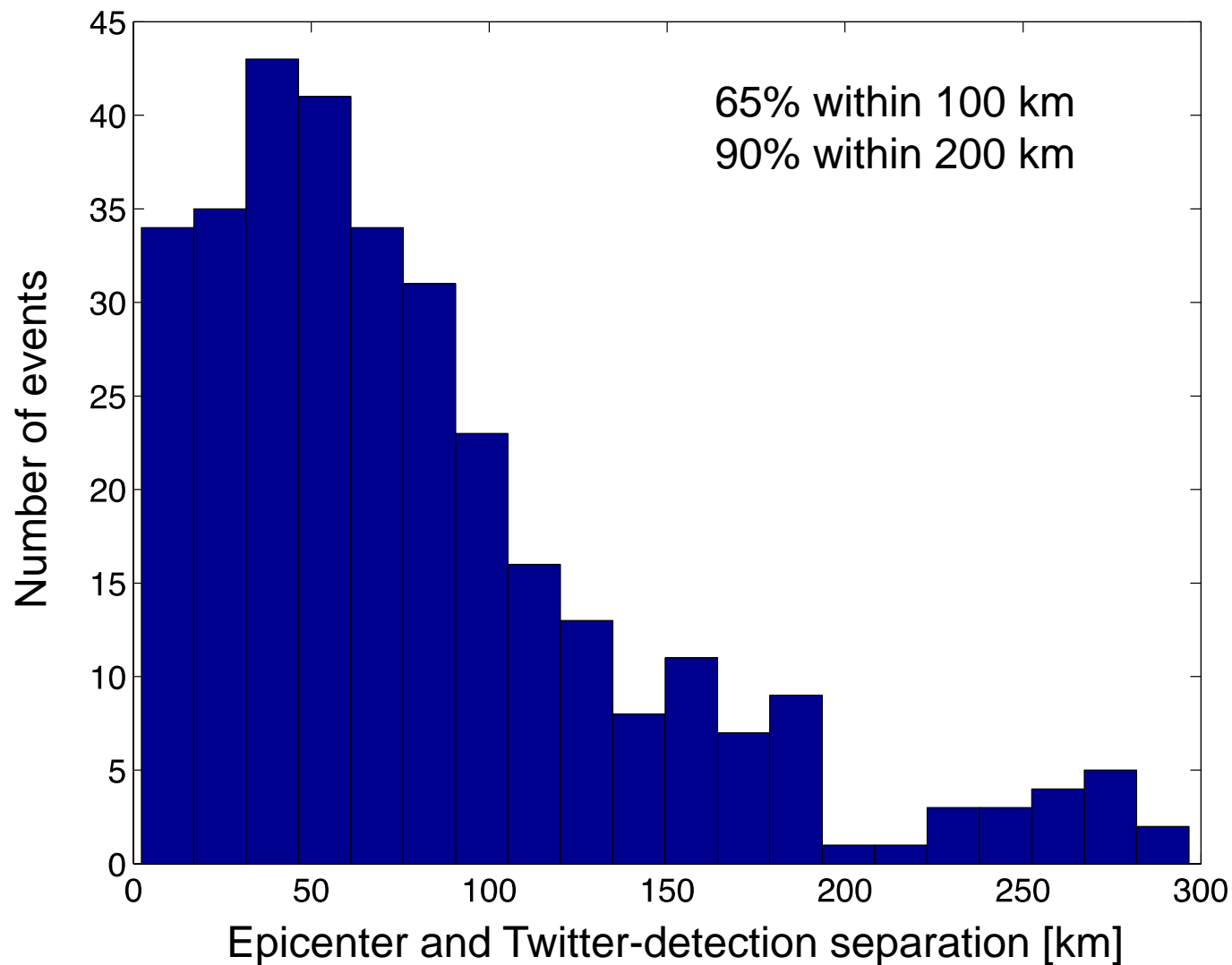
76°W		74°W			72°W		70°W		
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy

Processed: Wed Jun 5 19:22:27 2013



# “location” accuracy

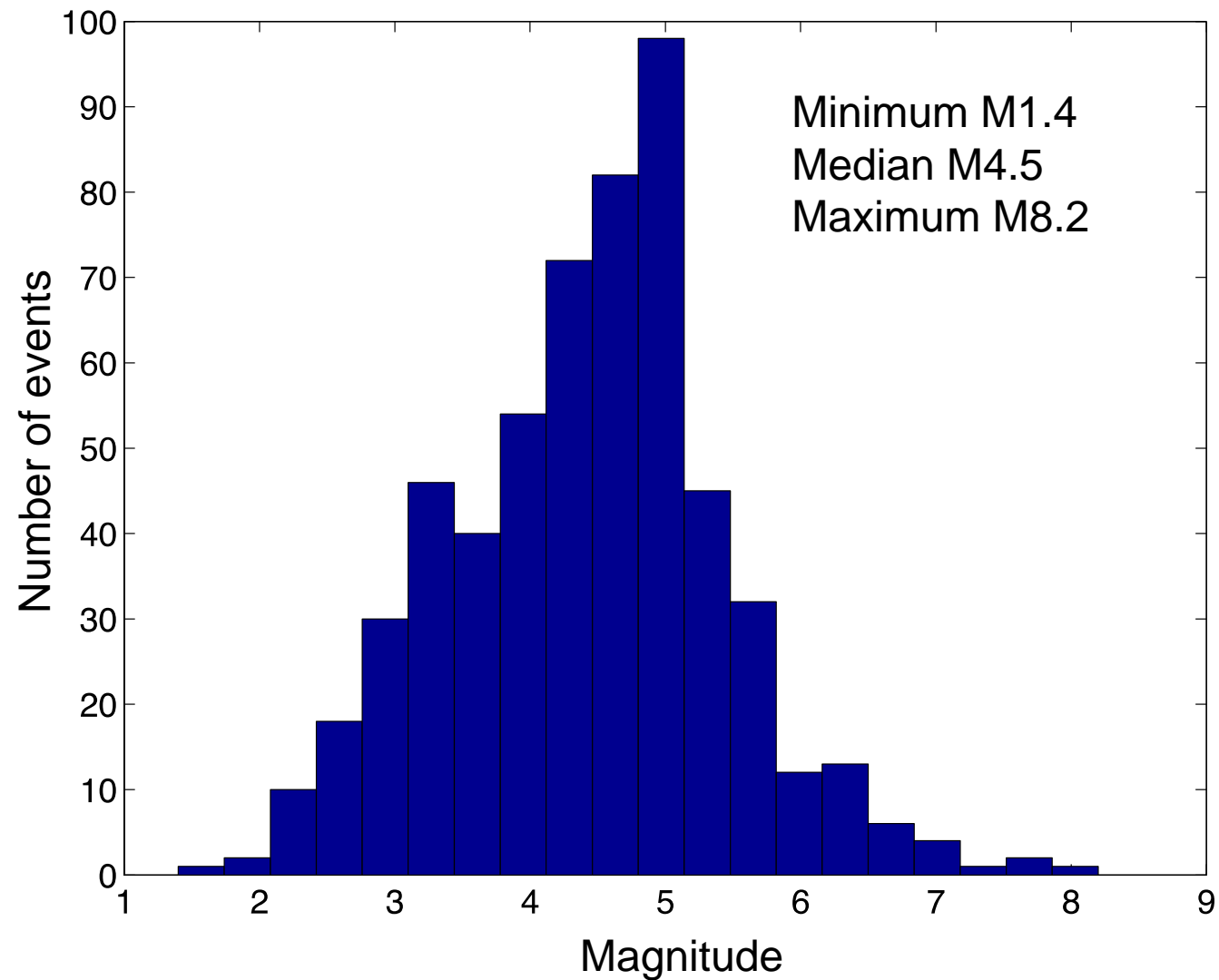
(since July, 2013)





# Magnitude Distribution

(since July, 2013)



# How are the detections used?

- Frequently NEIC's first indication of a widely felt event
- Detection of small felt events in sparsely instrumented places in the world
- Provides earthquake detections from an independent source

Can tweets be used to rapidly  
characterize shaking?

# Example alert

M5.1 76 km deep

~150 km N of Anchorage, AK

MMI IV

Twitter event detection

NOT AN OFFICIAL USGS ALERT

NOT SEISMICALLY VERIFIED

Detection Time:

2014/04/16 20:25:48

Possibly felt in:

Anchorage, Alaska, United States (3/7)

61.218, -149.858

City: Anchorage

Level2: Anchorage Borough

Level1: Alaska

Country: United States

2014/04/16 20:25:48

UL: No location string

TXT: EARTHQUAKE

2014/04/16 20:25:47

UL: No location string

TXT: Holy f\*ing s\*\*t that was an earthquake

2014/04/16 20:25:44

UL: Alaska.

TXT: Oh hi, minor earthquake.

2014/04/16 20:25:42

UL: Anchorage

TXT: Earthquake?

2014/04/16 20:25:42

UL: None

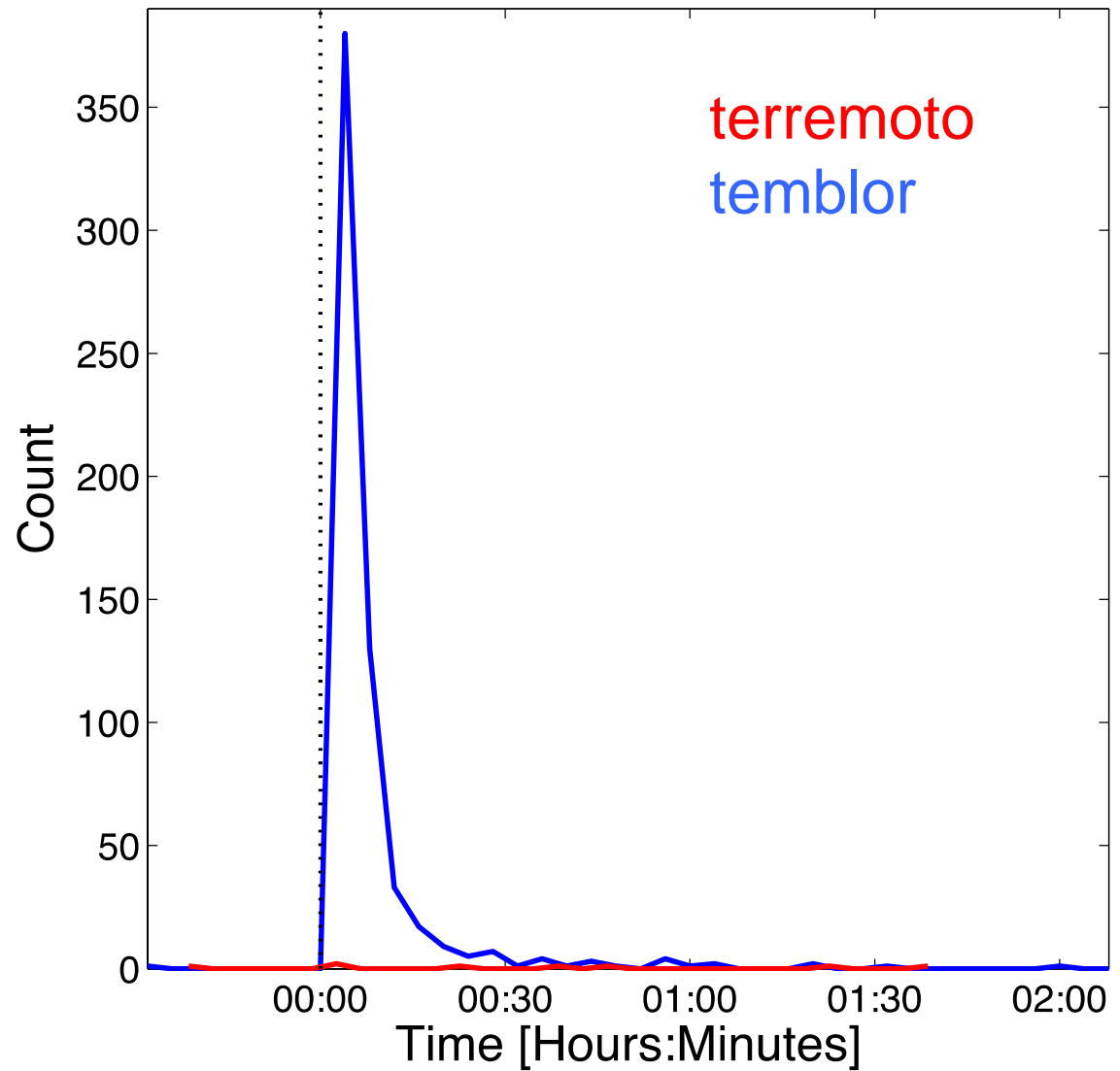
TXT: Earth quake ?

2014/04/16 20:25:41

UL: Anchorage, Alaska

TXT: Earthquake!

M5.2, Depth 95 km 2014-04-04 9:52:07

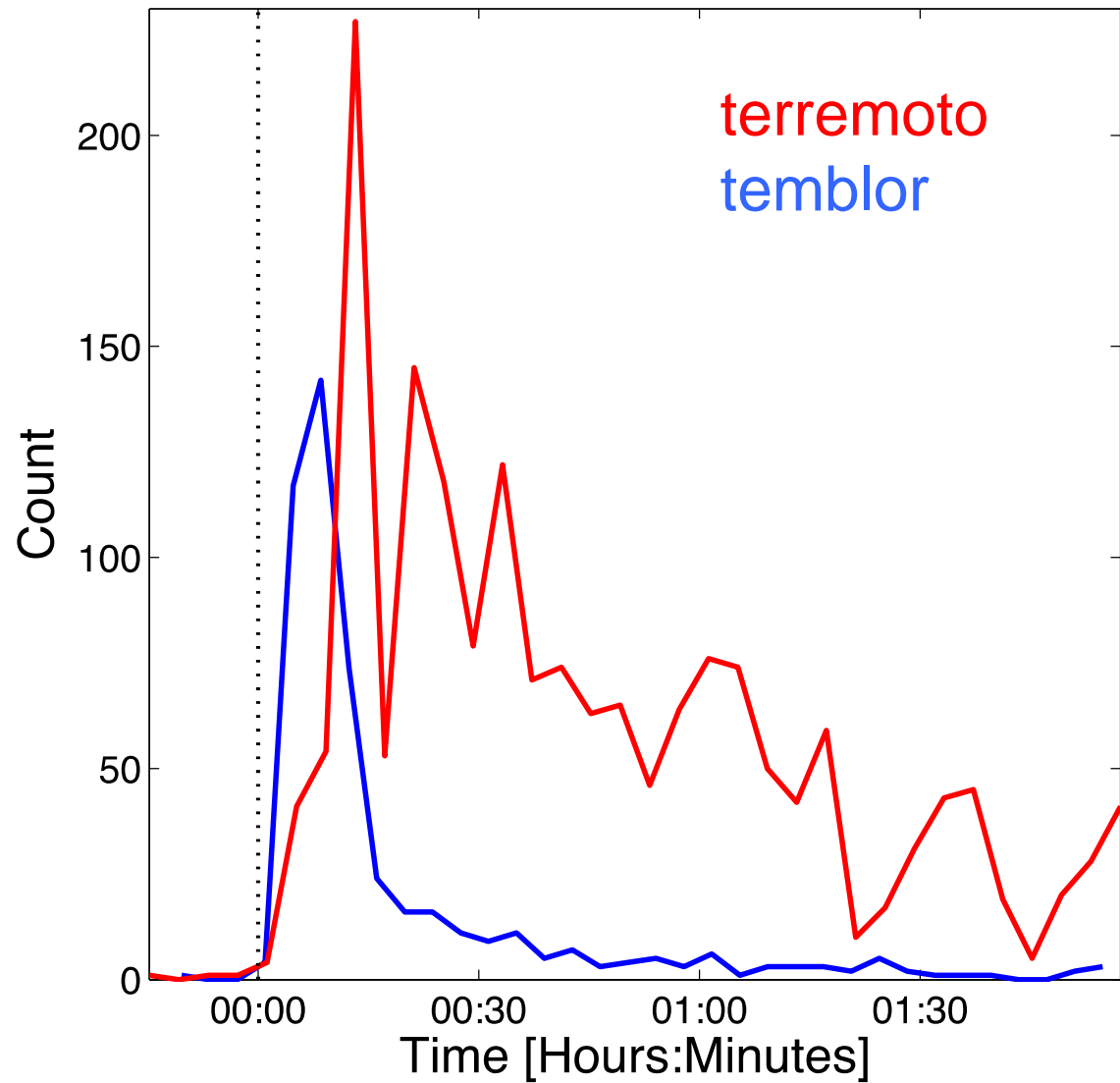


Map from Centro Sismologico  
Nacional, Chile

M8.2, Depth 20km 2014-04-01 23:46:46



Map from Centro Sismologico Nacional, Chile



# Take home

1. The USGS is running an realtime detector using solely Twitter updates for *internal* use
  - Detection of small felt earthquakes in regions with sparse seismic station coverage
  - Often provides event detections prior to seismological discovery
2. Future work includes event characterization, Instagram, etc., mapping, notification service.