

Overview:

The Visivent iOS App allows a geologist to visualize various events and points of interest on a map. E.g. a geologist travels through the US and has access to real time earthquakes, volcanic activity and volcanic features on his/her iPhone. It is possible to animate a heat map of earthquake events as sliding time window back into the past. This shows the propagation of earthquake, the pattern in accumulation (fold versus thermal earthquakes). The Satellite view also allows to find alternate sources of earthquakes like e.g. Geo-thermal power plants. Further a catalog of more than 1500 volcanic features are available through the map with a detailed description, image and an optional webcam link. So earthquakes near a volcano may hint upcoming volcanic activity. Additional the user can add other events like news and Twitter messages which contained certain keywords (e.g. earthquake, volcano). The News events and Twitter messages can e.g. serve as a clue of communication activity in a region (e.g. a spectacular eruption, earthquake or nuclear weapon test shaking a whole region).

Visivent loads the following data in a configurable schedule and lifetime:

- Earthquakes (US Geological Survey / USGS)
 - 15min real-time data
 - high resolution for North America
 - magnitude ≥ 4.5 for the rest of the world
 - Format: REST / JSON
 - URL: <http://earthquake.usgs.gov/earthquakes/feed/v1.0/summary/{period}.geojson>
- Volcanoes (Golbal Volcanism Program / GVP)
 - Volcanic activity
 - World-wide weekly volcanic activity reports
 - Format: CAP (Common Alerting Protocol) XML format
 - URL: <http://volcano.si.edu/news/WeeklyVolcanoCAP.xml>
 - Volcano locations
 - Formal: KML
 - URL: <http://www.volcano.si.edu/news/WeeklyVolcanoGE-Reports.kmz>
 - Extracted data outside of App, cleaned the text up and enriched it with Webcam links
- Reuters News
 - Various news feeds can be added (Arts, Business, Company News, Entertainment, Environment, Health News, Lifestyle, Media, Money, Most Read Articles, Oddly Enough, People, Politics, Science, Sports, Technology, Top News, US News, World)
 - News events can optionally be filtered by keyword(s)
 - News events are geo decoded and displayed on the map
 - Format: RSS
 - URL: <http://feeds.reuters.com/{subUrlForNewsTopic}>
- Twitter Messages
 - Twitter message up to a configurable number are read from the Twitter live stream
 - Twitter message can be optionally filtered by keyword(s)
 - Twitter message are geo decoded and displayed on the map

- Swifter framework (<https://github.com/mattdonnelly/Swifter>)
- A free developer account must be created and the consumer key and secret can be configured in the App
- Format: REST / JSON
- Geo decoding
 - Apple, MapQuest and Maxmind are used as geo decoder.
 - Apple is used as primary provider. If it fails (e.g. too many Geo decoding requests have been sent or the service is blocked), then MapQuest is taken as backup.
 - MapQuest is used as backup provider. A free developer API key must be requested and can be configured in the App.
 - URL: <http://www.mapquestapi.com/geocoding/v1/address?key={apiKey}&location={location}>
 - Format: REST / JSON
 - Maxmind's global city database ([World cities with population](#)) is used too minimize the geo decoding request by pre-storing 3.5 million locations (population is used to weigh locations in case of naming conflict) in the SQLite database.
 - URL: <https://www.maxmind.com/en/free-world-cities-database>
 - Format: CSV (comma separate values)
 - Further geo decoding results are stored in the database to eliminate repeated request.

Visivent has visualizes in the following ways:

- Static map
 - Standard map
 - Satellite view
 - Both combined (hybrid)
- Static content
 - Content can be configured to be displayed/hidden and considered over a time window via a sliders
 - Static map displays configurable events and points of interest
 - Earthquake events show the magnitude in the pin icon and display details when clicked on
 - Twitter messages are green round pins and display details when clicked on
 - News events are blue round pins and display details when clicked on
 - Volcanic activity events are red round pins and display details when clicked on
 - Volcanic points of interests (locations) are orange triangle pins and displays an optional webcam link, an image and a description when clicked.
 - Heat map displays configurable events by their frequency and weight (magnitude of earthquakes)
 - Used native framework DTMHeatMap
 - URL: <https://github.com/dataminr/DTMHeatmap>
- Dynamic content
 - An animation of the heat map is show with a configuration sliding time window (e.g. 4 hour time windows sliding over the last 72 hours).
 - This especially the dynamics of earthquakes and other configurable events
 - Points of interest are not considered since they are static
 - The time sliders can be change during an animation to jump fast back and forth. Further the time window length can be changed.
- The map shows the users current location. E.g. this help finding geological features when moving in the field. The user may even feel and then visualize an earthquake.
- The map is zoomable in the static and dynamic map. So e.g. detailed earthquake activity in the small region can be studied.

Build:

The App source code must be fetched in the following way:

```
# make a local directory
mkdir LocalProject
cd LocalProject
# clone git hub project
git clone https://github.com/oliverhager29/Visivent
cd Visivent/Visivent
# Download large files from external Website (there is a 100MBytes file size lim
wget https://www.webporting.com/Visivent/Visivent.sqlite
wget https://www.webporting.com/Visivent/worldcitiespop.txt
cd ..
# run Cocoa pod to retrieve and install third party libraries (DTHeatmap), see h
# You should get an output:
# Analyzing dependencies
# Downloading dependencies
# Using DTHeatmap (1.0)
# Generating Pods project
# Integrating client project
# Sending stats
# Pod installation complete! There is 1 dependency from the Podfile and 1 total
pod install
cd ..
wget https://www.webporting.com/Visivent/swifter.zip
unzip swifter.zip
cd Visivent
# Please only open Xcode 7.2.1 the following way (only the workspace not the pro
open Visivent.xcworkspace
# In XCode right click on "Visivent" project, go to "Linked Frameworks and Libra
# add file "Swifter.xcodeproj" (Add other ...) in the extracted Swifter director
# Wait for completion of processing the file
# Under Embedded Binaries add Frameworks -> SwifteriOS.frameworkiOS
# Wait for completion of processing the file
# Select menu item Product -> Clean
# Select menu item Product -> Build
# The project should be successfully built
```

After that the project is build as usual.

Currently the following 3rd party library is integrated via Cocoapods:

DTHeatmap

Implementation:

Events and points of interest:

Visivent is a Swift iOS App that uses a SQLite (using Apple's Core Data API) to store and retrieve events and points of interest. For performances reasons the SQLite database is initially pre-filled with the volcano points of interest and the Maxmind city database. But there is still the possibility to seed that database via App Settings from text files (may take up to 20min). A special challenge was that the Swift API is using a lot of memory ($O(n)$) so standard C library function are invoked which have constant memory usage ($O(1)$). Another problem is CoreData to store the location. Here committing after e.g. 1000 inserted rows keep the memory usage constant. If it is committed after each creation/insert then memory is not deallocated and this would lead to memory exhaustion after hundred thousand rows. This problem is discussed on Stackoverflow (<https://stackoverflow.com/questions/32034100/memory-leak-with-large-core-data-batch-insert-in-swift>).

Individual schedules can be configured to read events from external Web sites at different times and frequencies. The App implements different clients to access RSS feeds, CAP XML feeds, JSON REST services and download images/cache (for volcano locations). Since many events are polled the schedules should be not too frequent and distributed over non-overlapping time periods. The default configuration is following this advice.

A truncation process is started every hour that deletes events older than a configurable number of hours. The reason is that the SQLite database does not grow unlimited. But the SQLite database can handle several hundred Mbytes.

The data is visualized on a MapKit Map that displays annotations of different appearance and optionally a heat map overlay.

The heat map overlay can be animated.

Since thousands of events (Twitter and Reuters News) are geo decoded in one batch, the processing has to be serialized because thousands of threads consume too much memory (leads to the termination of the app) and also produce a CPU load of 100% effectively blocking the application. The SyncAsync framework (<https://github.com/Kametrixom/Swift-SyncAsync>) is used to wait for the result of asynchronous method invocations. For Twitter the messages are first read from Twitter via REST service (using Swifter) and after that all messages (if there is any location name) are enriched with coordinates using Apple, MapQuest or Maxmind as provider.

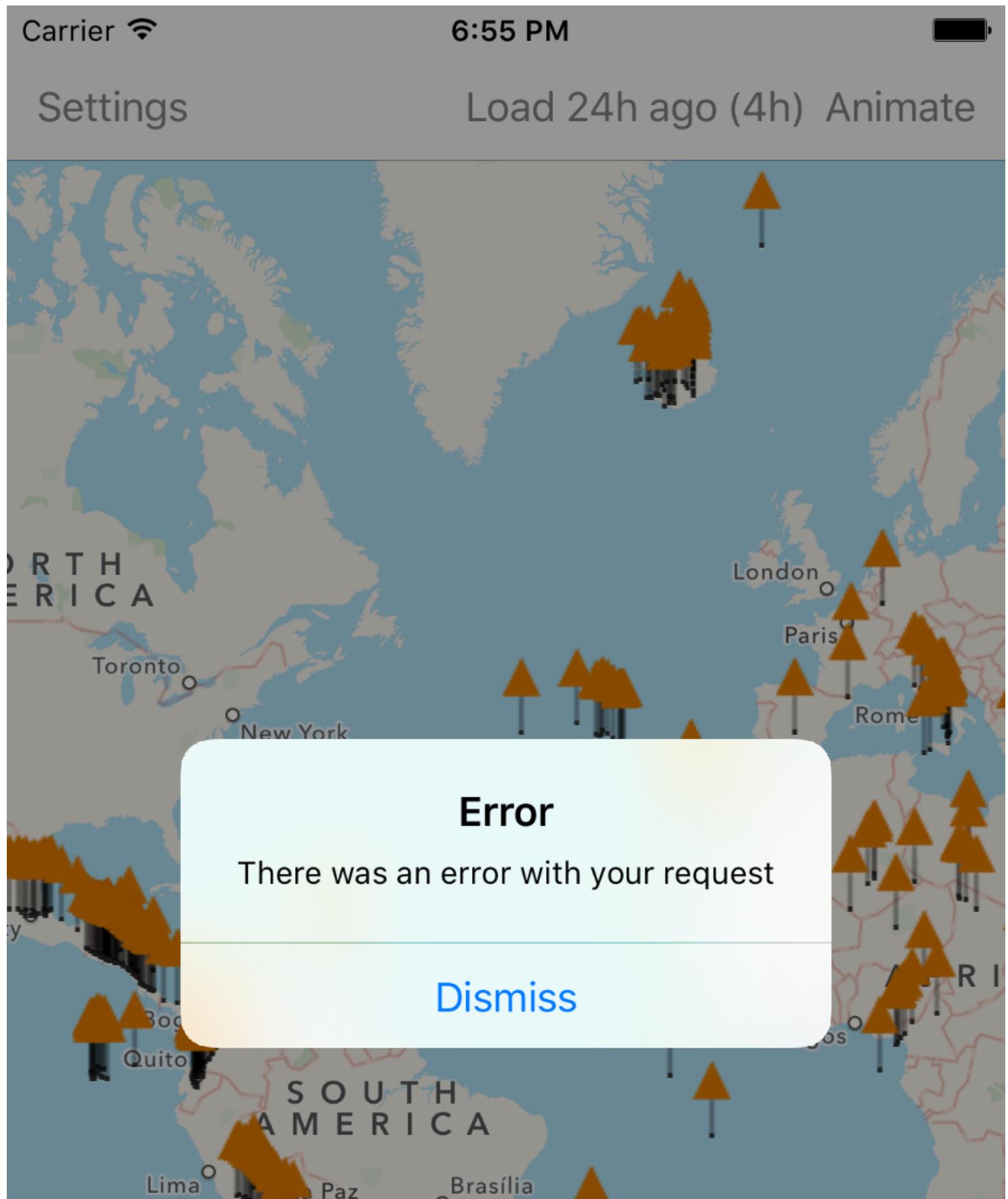
Errors / activities:

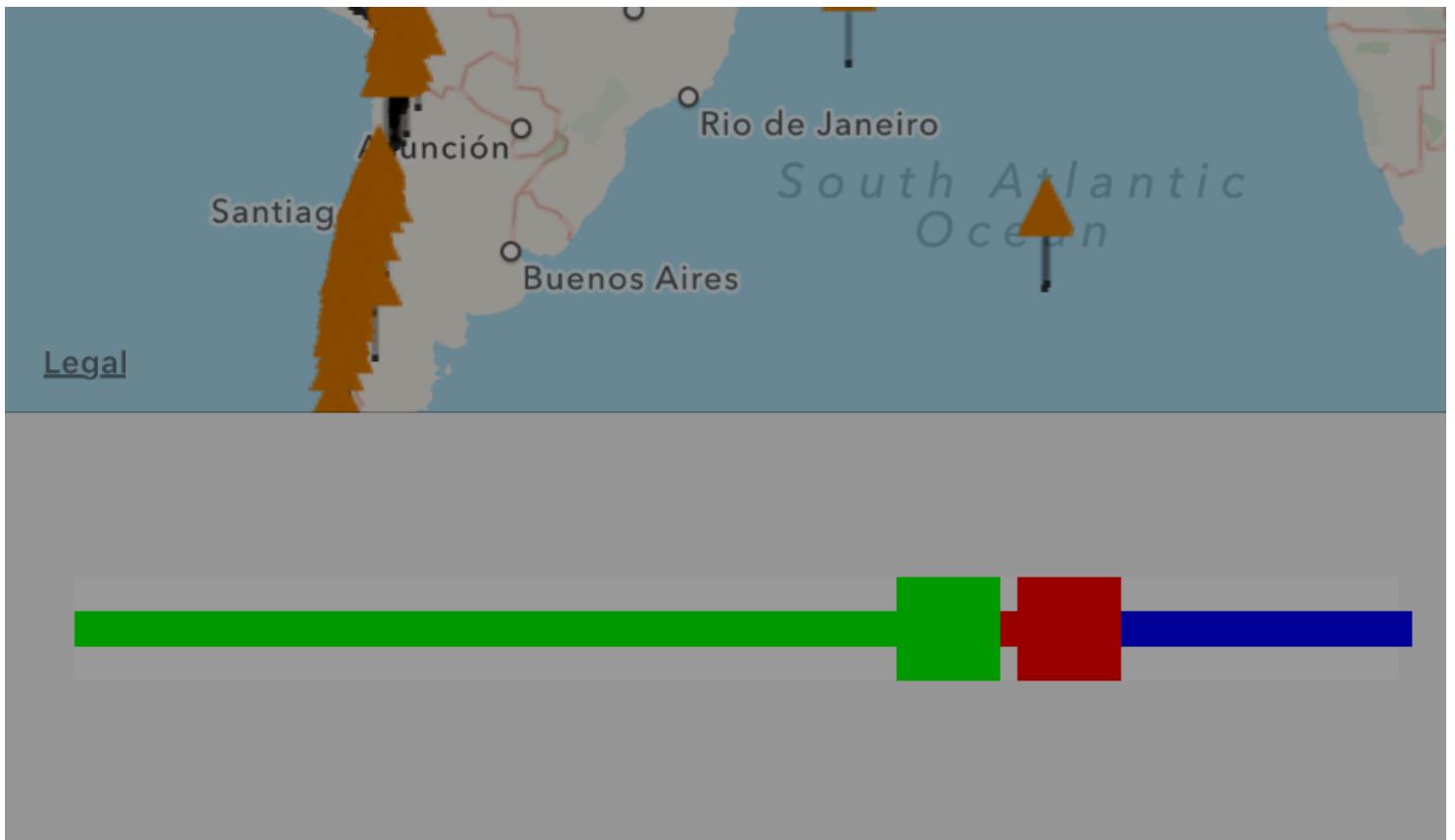
- if an network, file or database error occurs then a notification is created in the iOS notification center. The reason is that there are many concurrent processes which are not aware of the screen currently displayed. Notifications can be deleted with one click that makes it more useful than error prompts. the user may even disallow notifications and ignore them at all. Since events are polled redundant over a regular schedule, single network failures do not do any harm except events are displayed at a later time

on the map and an alert dialog is displayed that can be dismissed by the user.

- Loading the map and seeding the database shows an activity indicator until it finished.

Alert dialog for network error:





Notifications in the notification center:





GVP Volcanic Activities now

Finished loading GVP Volcanic Activity



GVP Volcanic Activities now

Started loading GVP Volcanic Activity



USGS Earthquakes now

Started loading USGS Earthquakes



Reuters News now

Started loading Reuters News



Network error 1m ago

There was an error with your request



Network error 2m ago

There was an error with your request



Network error 3m ago

There was an error with your request



Activity indicator during loading map and annotations:

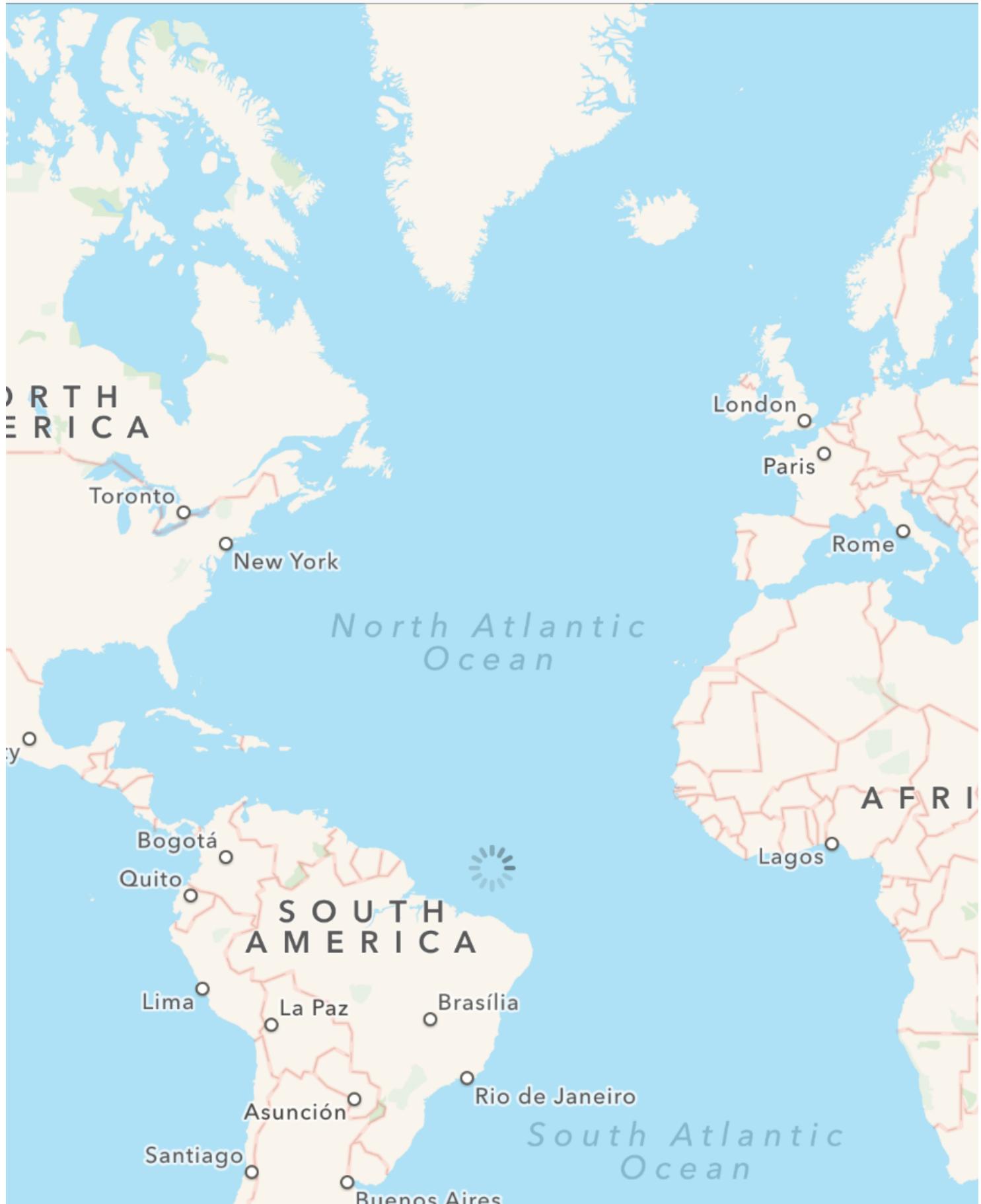
Carrier

7:00 PM



Settings

Load 24h ago (4h) Animate

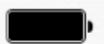




Activity indicator while seeding volcano locations

Carrier

7:11 PM



[Settings](#)

Volcanoes

Refresh interval:

10080

Refresh start time:

0

Max hours:

2880

Data collected:



Activity displayed:



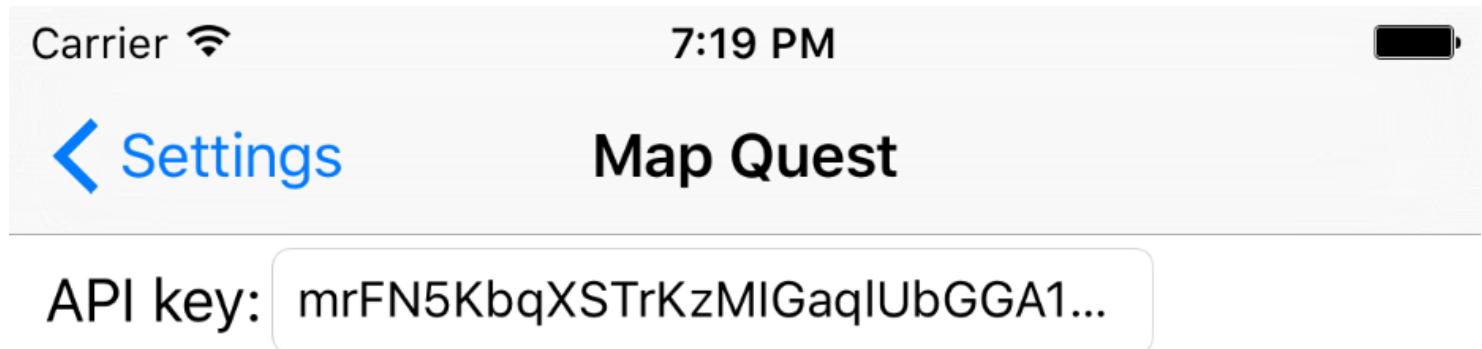
Location displayed:



[Seed volcano locations](#)



Activity indicator when seeding the word city data:

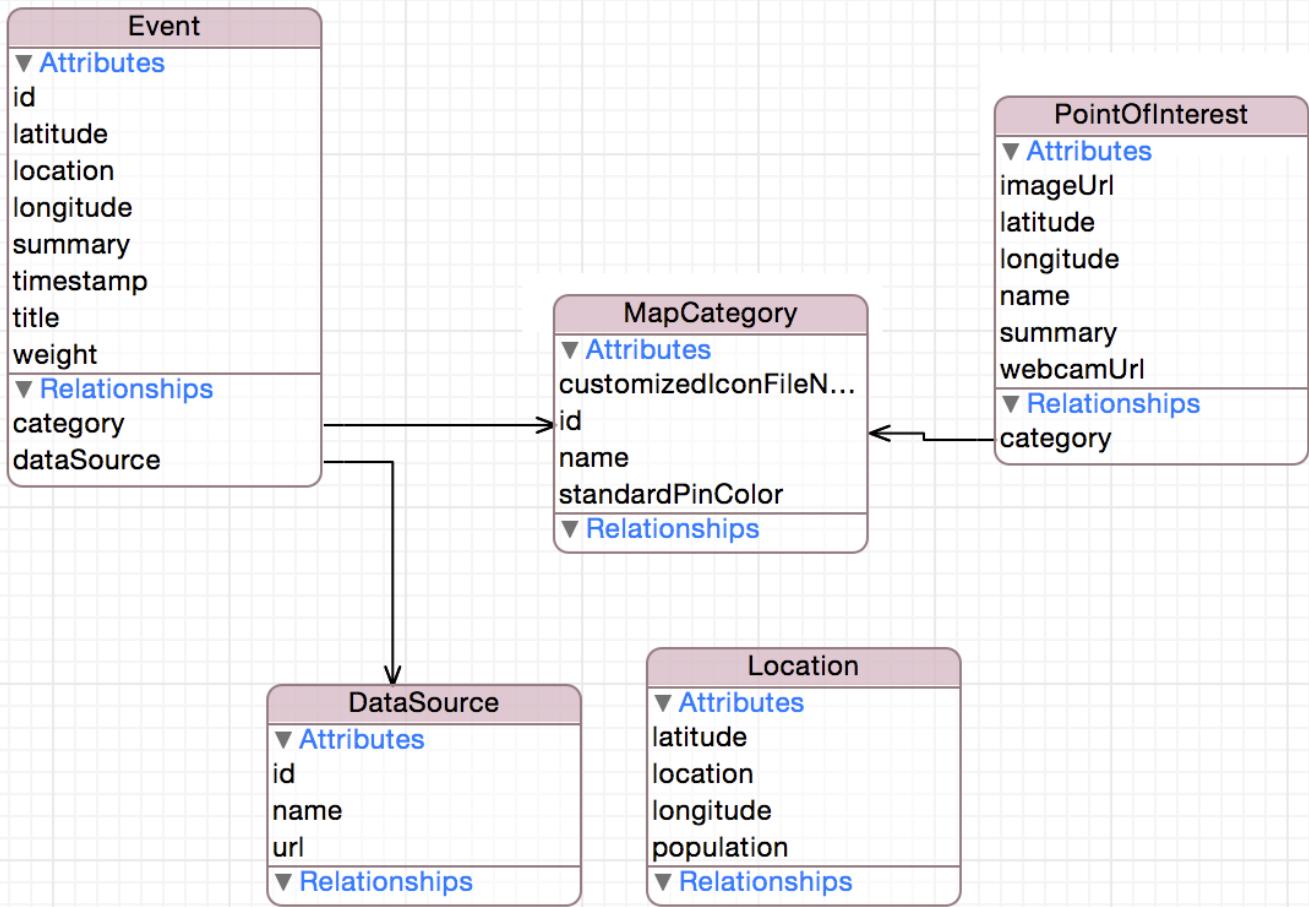


Seed City DB * This may take up to 20min



Persistent entities:

- SQLite database is stored in files <Documents directory>/Visivent.sqlite | Visivent.sqlite-shm | Visivent.sqlite-wal
- Event - represents an event like earthquake, volcanic activity, news event, Twitter message
 - name
 - description
 - coordinate
 - weight
 - category (one-to-one relationship to Map category)
 - data source (one-to-one relationship to Data source)
- Map category
 - earthquake, volcanic activity, news, Twitter message
 - id
 - name
- Data source
 - Reuter News, Twitter, USGS, GVP
 - id
 - name
- Location - used for pre-defined and cache geo locations to make geo decoding more efficient
 - location name
 - coordinate
- Point of interest
 - name
 - description
 - coordinate
 - image link
 - web cam link (optional)



Used Help:

- Stackoverflow iOS forum
 - URL: <https://stackoverflow.com/questions/tagged/ios>
- Udacity iOS Swift course material
 - <https://www.udacity.com/course/ios-developer-nanodegree--nd003>
- Customized UIControl
 - <http://www.raywenderlich.com/76433/how-to-make-a-custom-control-swift>

Used Frameworks:

- SyncAsync - a framework allowing to synchronize asynchronous method invocations (like a promise): <https://github.com/Kametrixom/Swift-SyncAsync>
- DTM Heatmap - a framework for generating a heat map (of events with weights) as an overlay for a MapView: <https://github.com/dataminr/DTMHeatmap>
- Swifter - a framework for accessing all Twitter Web services: <https://github.com/mattdonnelly/Swifter>

Used Tools:

- Xcode 7.2.1
- Gimp 2.8 - for drawing launch screen logo, annotation icons: <http://www.gimp.org/>

- Cocoapods - for managing 3rd party libraries: <https://cocoapods.org/>
- DB Visualizer PRO 9.2.14 - DB tool for reading the SQLite database: <http://www.dbvis.com>
- UNIX tools like grep and sed for scrapping volcano location data

Used Data Sources:

- Earthquakes REST API / JSON service: <http://earthquake.usgs.gov/earthquakes/feed/v1.0/summary/{period}.geojson>
- Volcanoes (Golbal Volcanism Program / GVP)
 - Volcanic actibity CAP (Common Alerting Protocol) XML format: <http://volcano.si.edu/news/WeeklyVolcanoCAP.xml>
 - Volcano locations KML: <http://www.volcano.si.edu/news/WeeklyVolcanoGE-Reports.kmz>
 - Googled Webcam links
- Reuters News RSS feed: <http://feeds.reuters.com/{subUrlForNewsTopic}>
- Twitter Messages REST API /JSON (using Swifter): <https://dev.twitter.com/overview/documentation>
- Apple Geo decoding
- MapQuest REST API / JSON: <http://www.mapquestapi.com/geocoding/v1/address?key={apiKey}&location={location}>
- Maxmind's global city database: <https://www.maxmind.com/en/free-world-cities-database>

Pages:

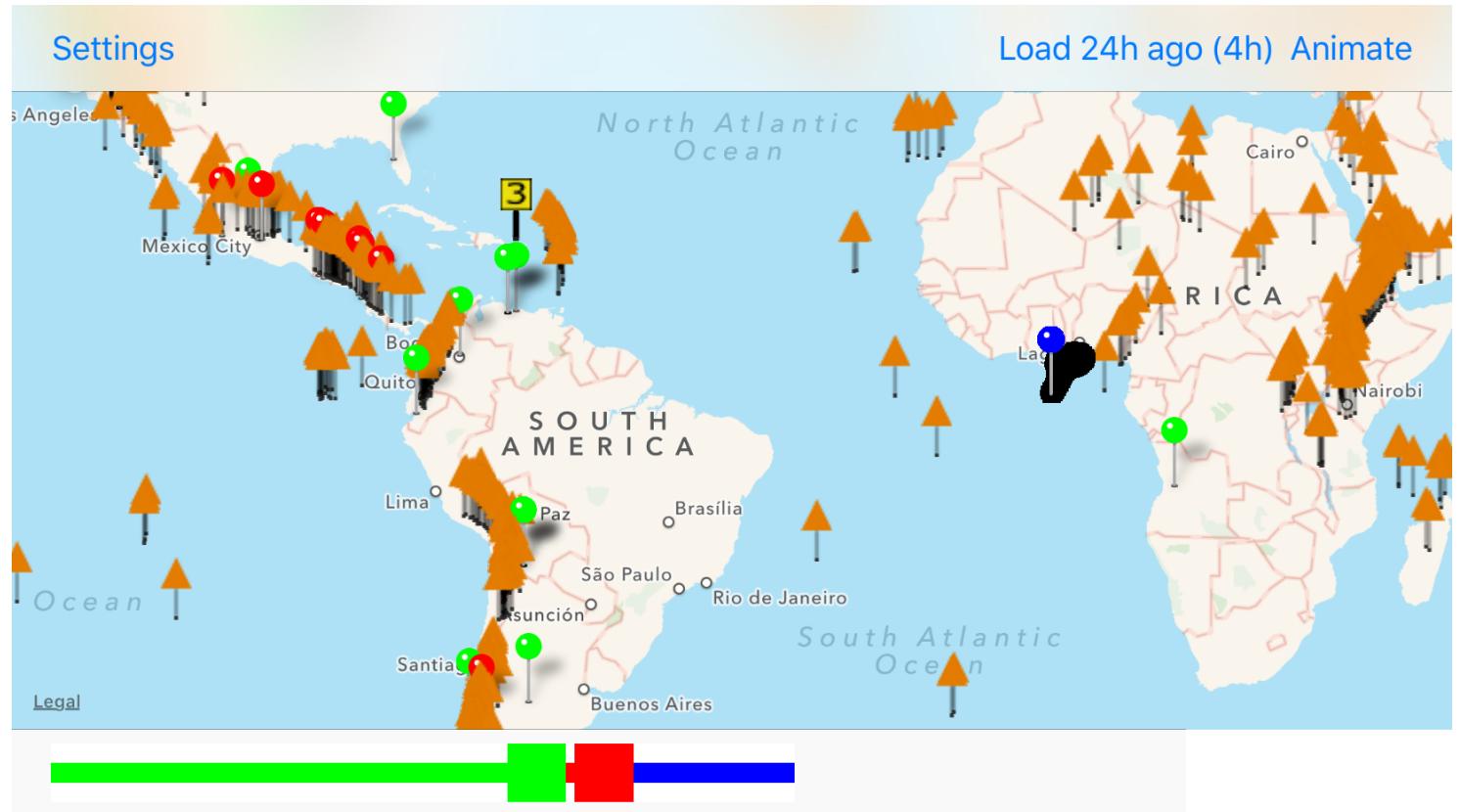
Lauch Screen:

Just shows lauch image and copyright notice.

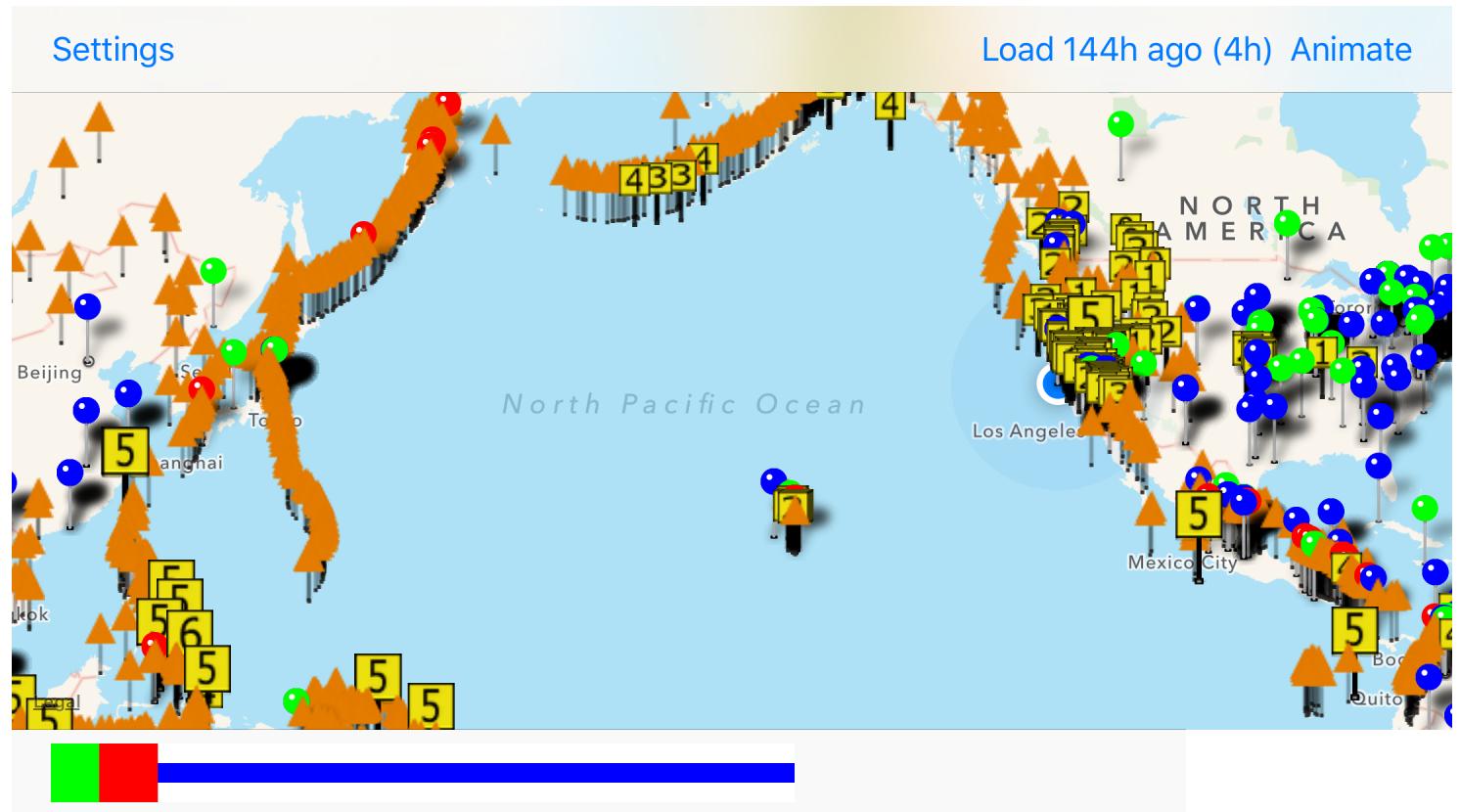


Map screens:

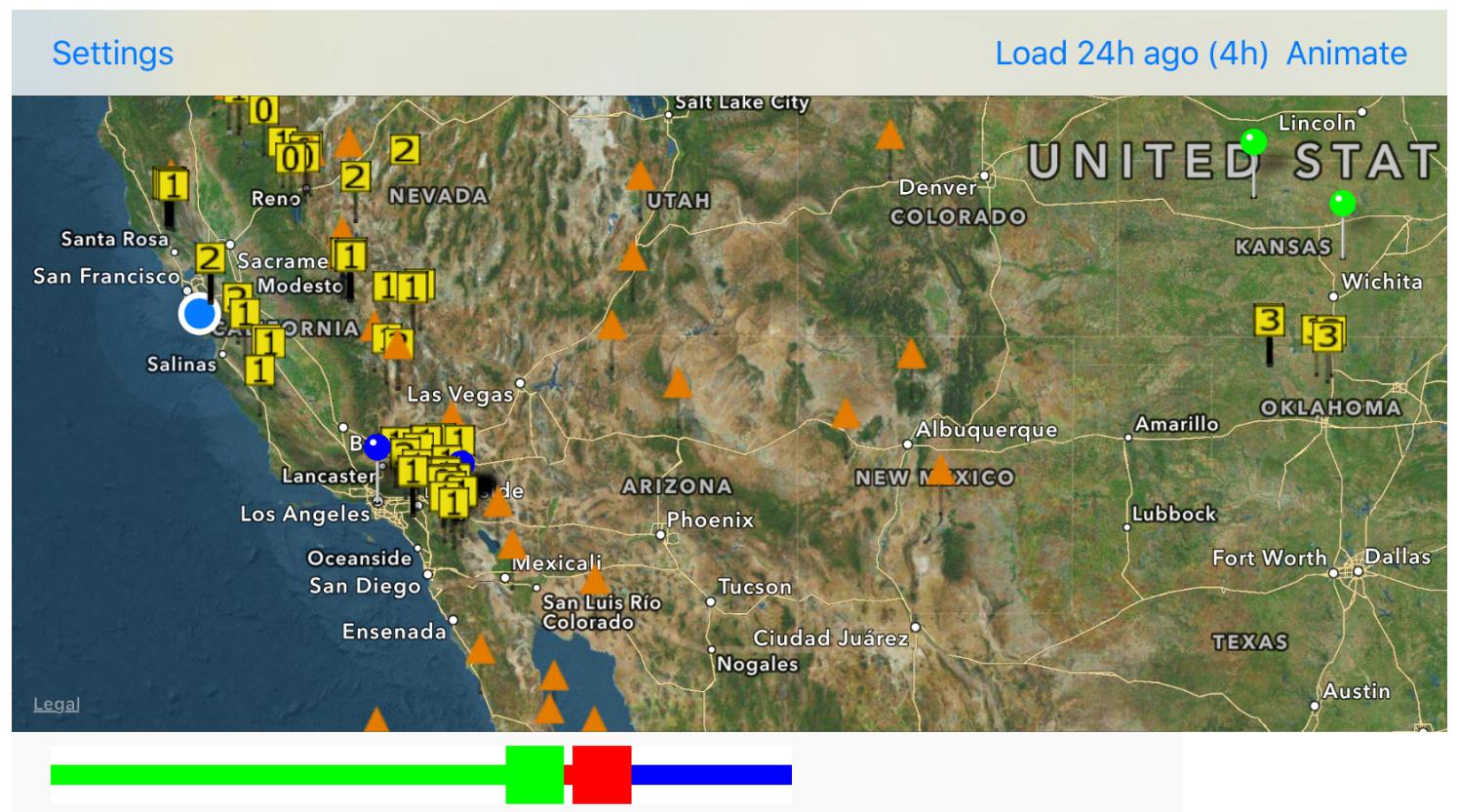
Standard map view with event pins (Twitter messages (green), News events (blue)), sign pins (earthquakes with magnitude) and location triangles:



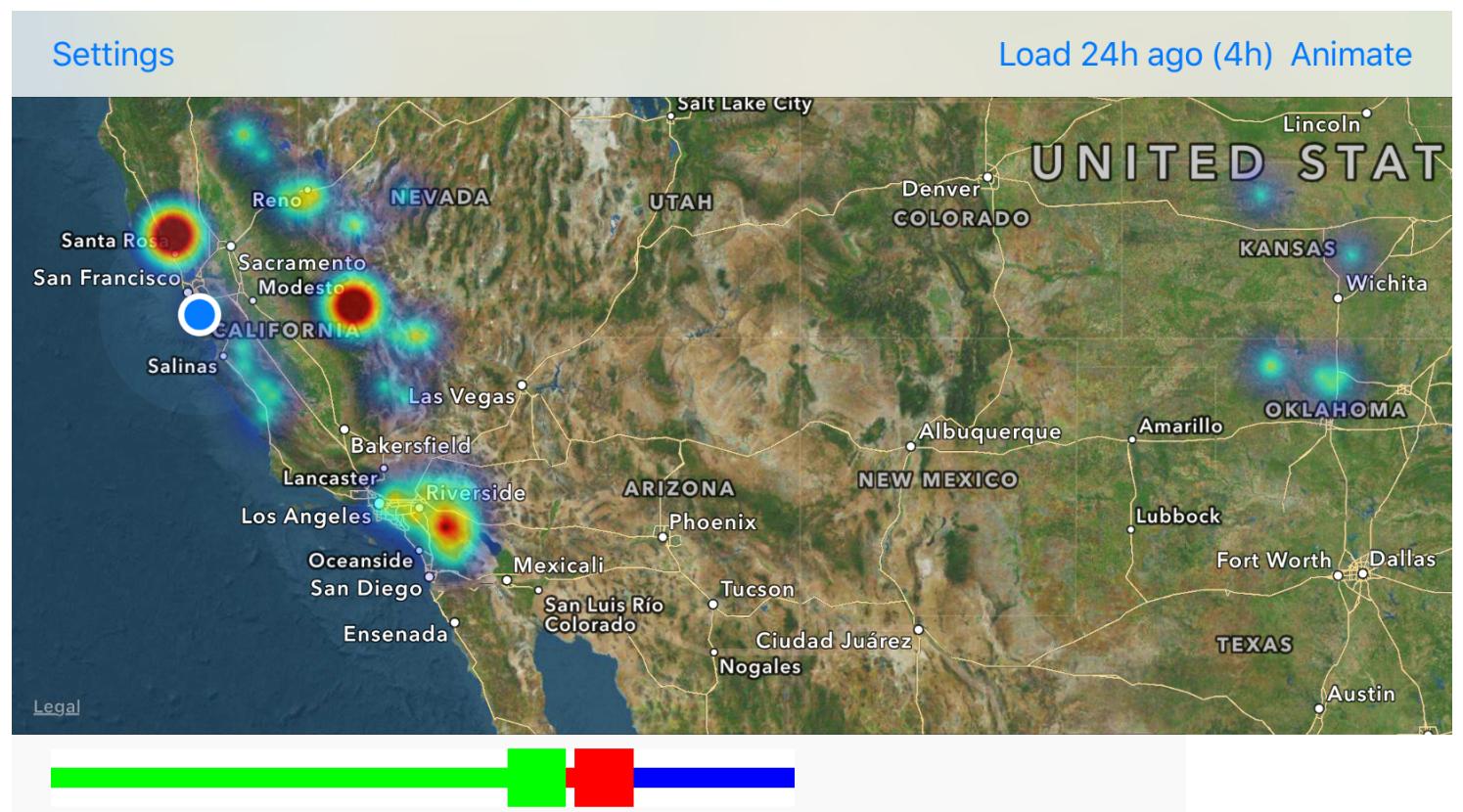
“The Ring Of Fire”:



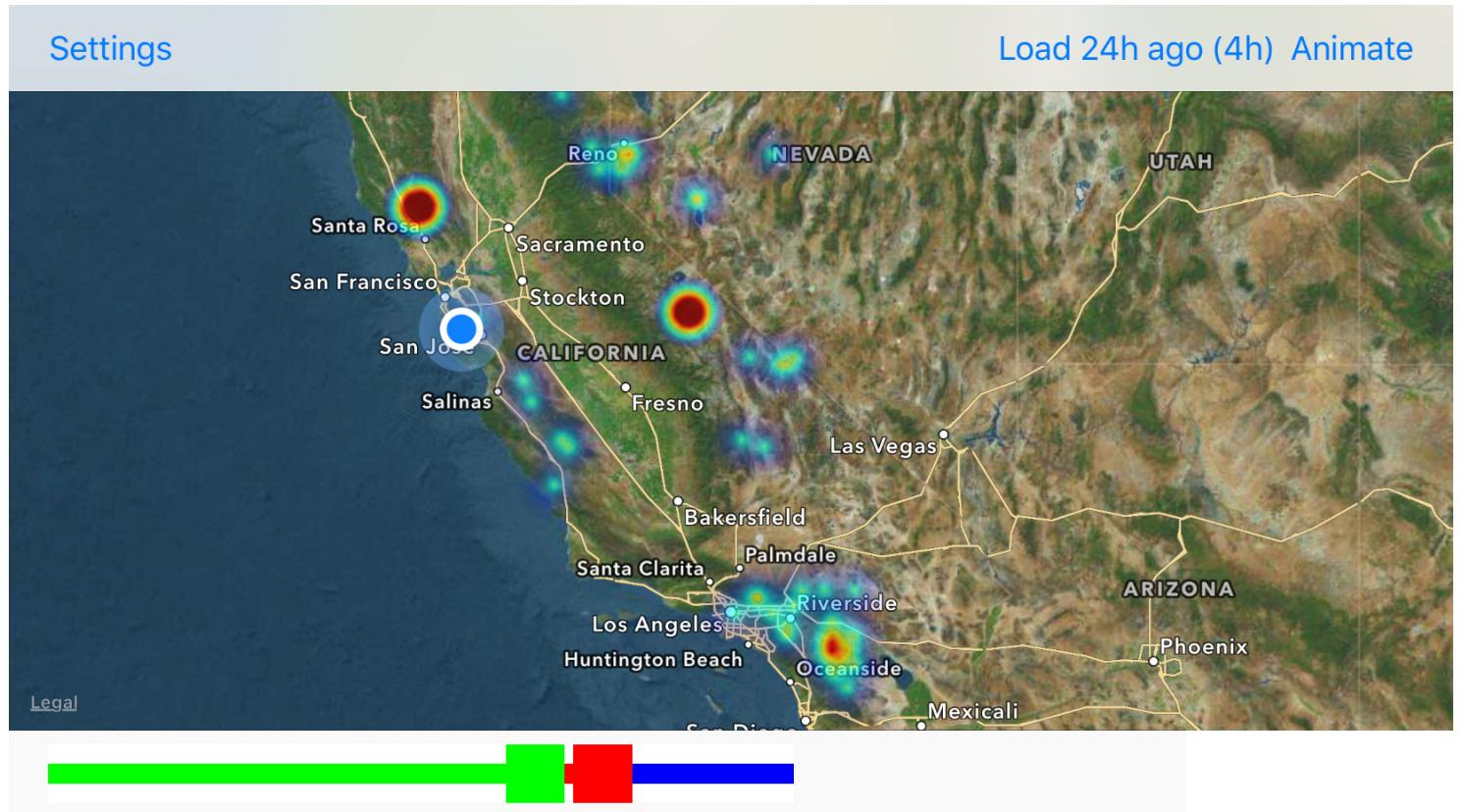
Hybrid (satellite and standard) map view with the current location (blue circular spot), earthquake (yellow signs with the magnitude), news (blue pins) and Twitter messages (green pins):



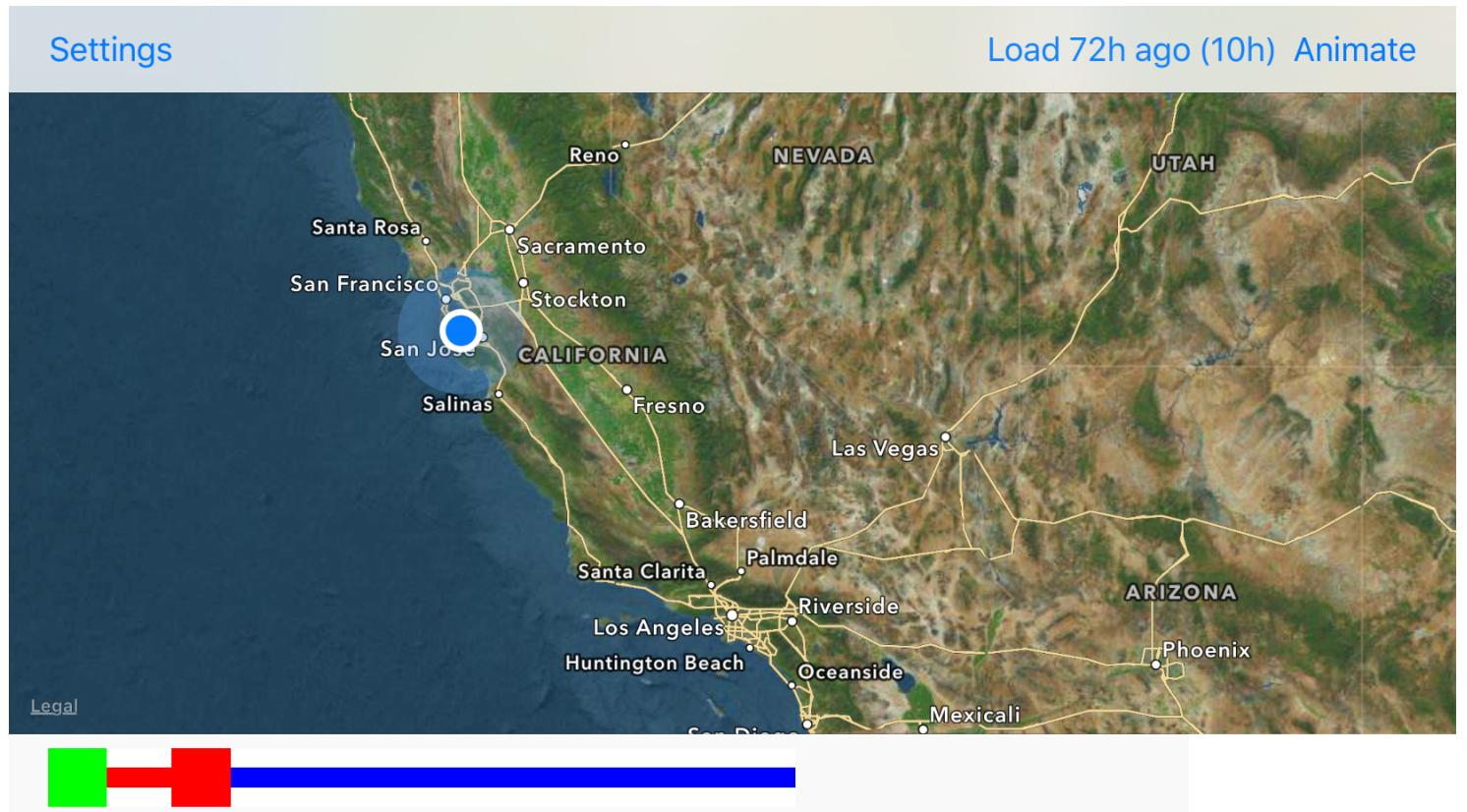
Heat map view:



Heat map zoomed in:

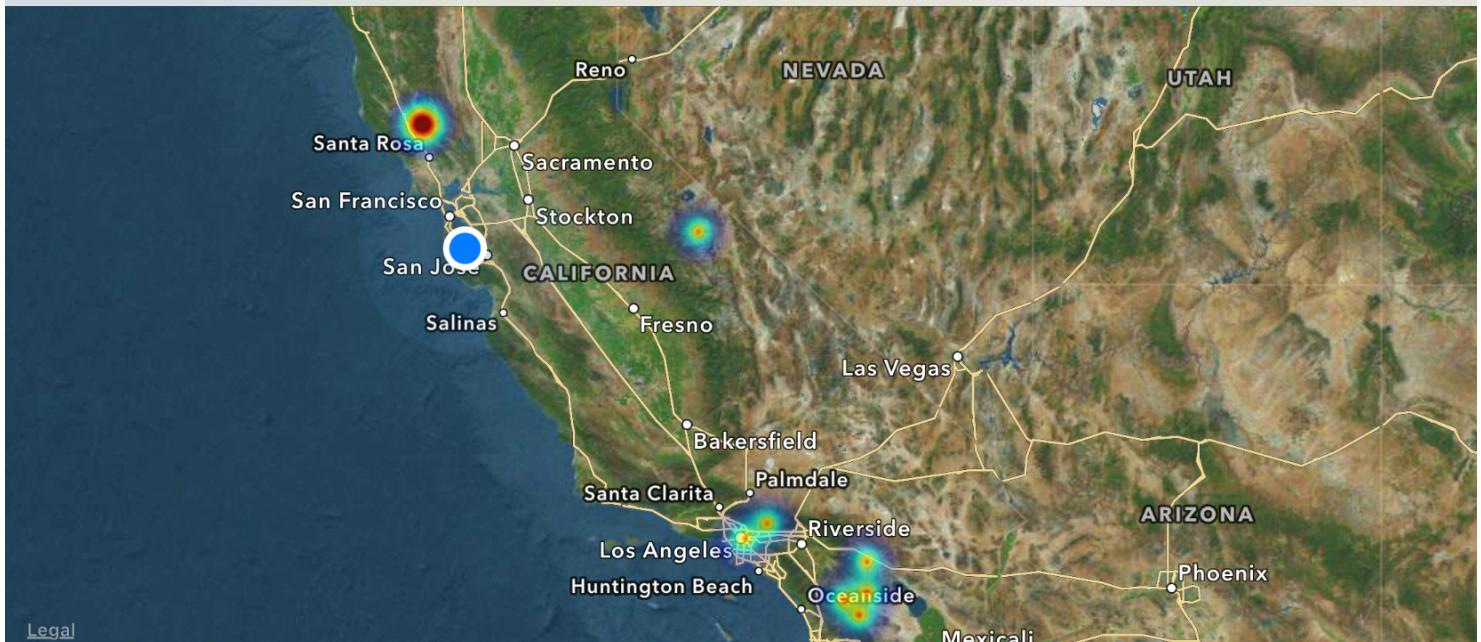


Animated Heat Map Sequence:



Settings

Load 68h ago (10h) Animate

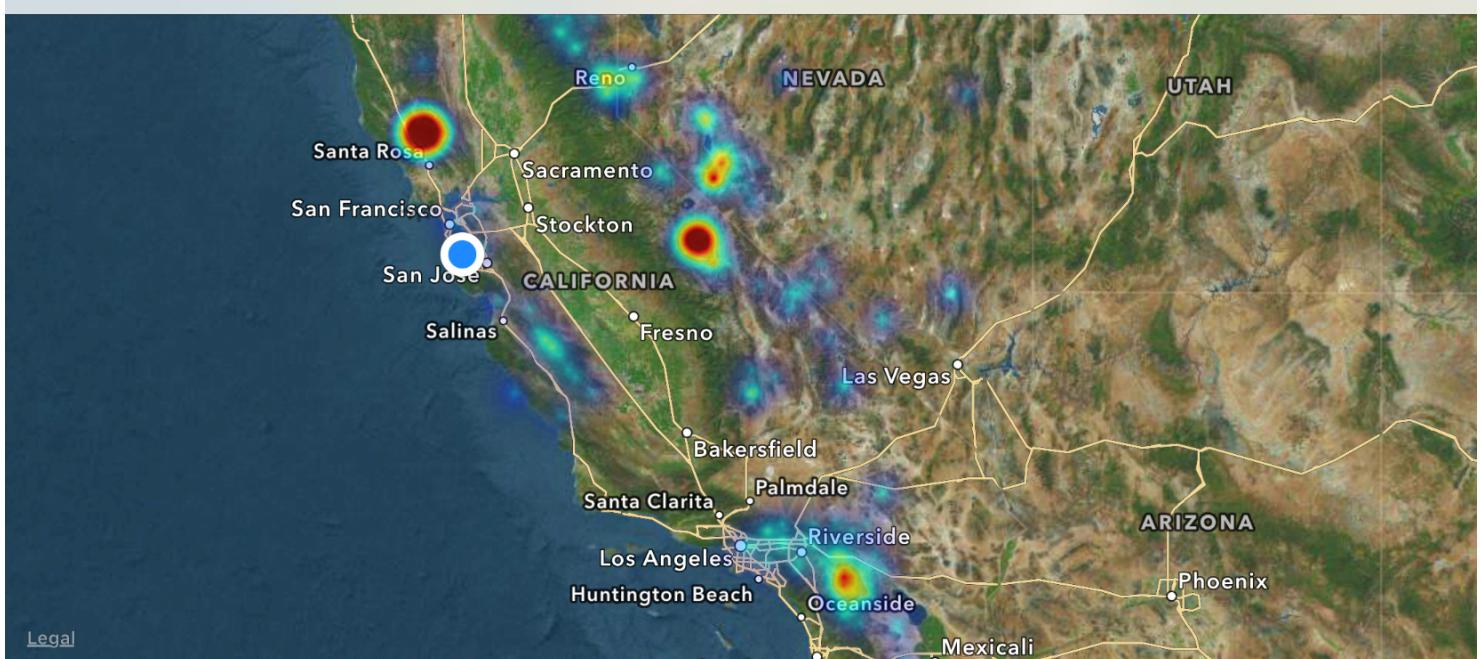


Legal



Settings

Load 62h ago (10h) Animate



Legal



- Two time slider thumbs select over how many hours ago and how many hours since then events are displayed i.e. a time window
 - [] two slider thumbs []

- |————> selected hours ago (green track)
 - <————> selected interval hours (red track)
 - Past Present
 - Maximum hours ago 0 hours ago
 - Animate button sets map into heat map animation view (animating events with their weight with a sliding time window). The start time in hours ago is displayed and the time slide is also animated. The time slider can be change during an animation to jump fast back and forth.
 - Load button stops animation and loads configured events over the specified time window and if configured loads points of interest
 - Settings navigates into various Settings screens in order to configure the map, geo decoders and the various events and their data sources
 - Various annotations are shown for the events and points of interest
 - **Earthquake events** show the magnitude yellow signs with the magintude (from 0 to 10) and display details when clicked on. the magnitude is used as weight on the heat map.
 - **Twitter messages** are green round pins and display details when clicked on
 - **News events** are blue round pins and display details when clicked on
 - **Volcanic activity** events are red round pins and display details when clicked on
 - **Volcanic points of interests (locations)** are orange triangle pins and displays an optional webcam link, an image and a description.
 - Maps can be shown as standard map, satellite map or both
 - Only annotations, only heat map overlay and both can be shown

Volcanic Location / Activity:

Settings Load 144h ago (4h) Animate

United States 2016-02-16 10:26
HVO reported that seismicity beneath Kilauea's sum... (i)

Legal

Settings

Load 144h ago (4h) Animate

United States 2016-02-16

10:26

HVO reported that seismicity beneath Kilauea's summit, upper East Rift Zone, and Southwest Rift Zone was at background levels during 3-9 February. The lava lake continued to circulate and spatter in the Overlook vent. Webcams recorded multiple incandescent outgassing vents within Pu'u 'O'o Crater and high on the NE rim. On 8 February a small lava flow erupted from the E vent. The June 27th NE-trending lava flow continued to be active within 6 km NE of Pu'u 'O'o Crater, burning some areas of forest.

[Close](#)

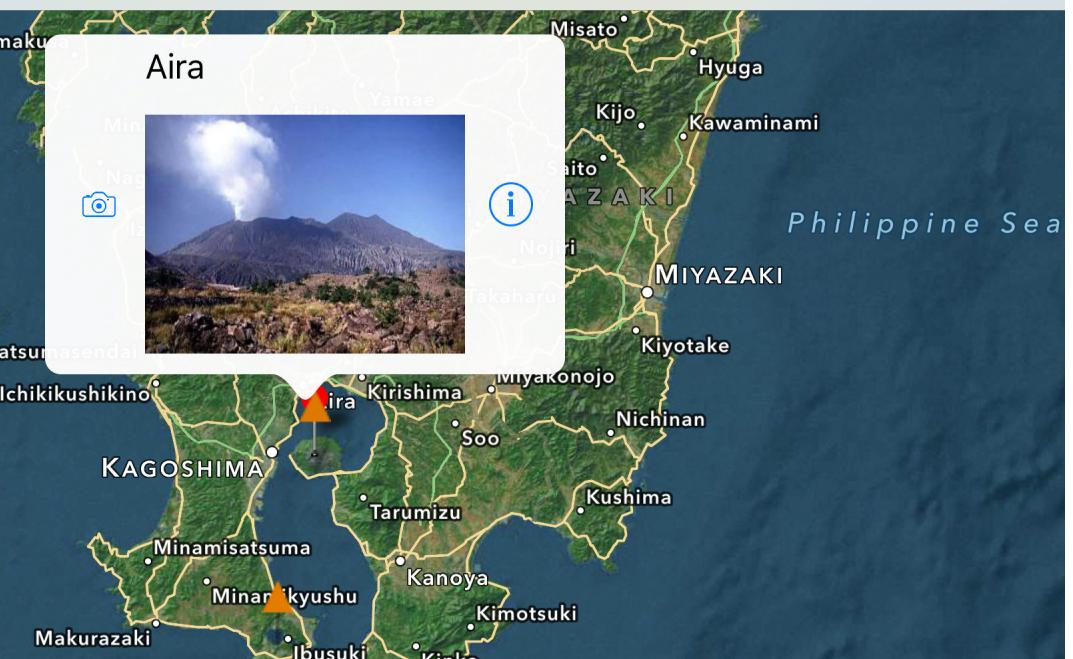
Legal



Settings

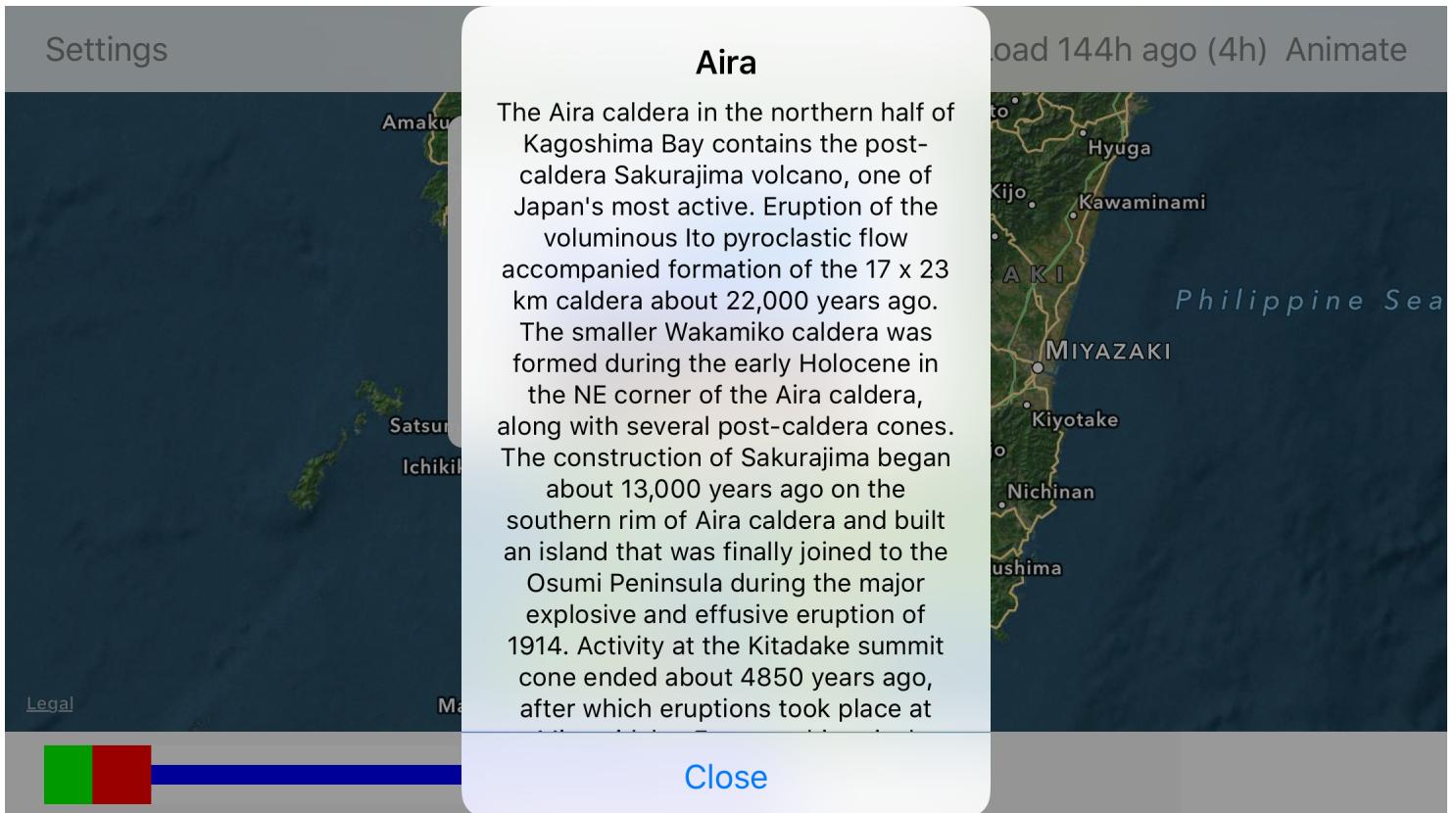
Load 144h ago (4h) Animate

Aira



Legal

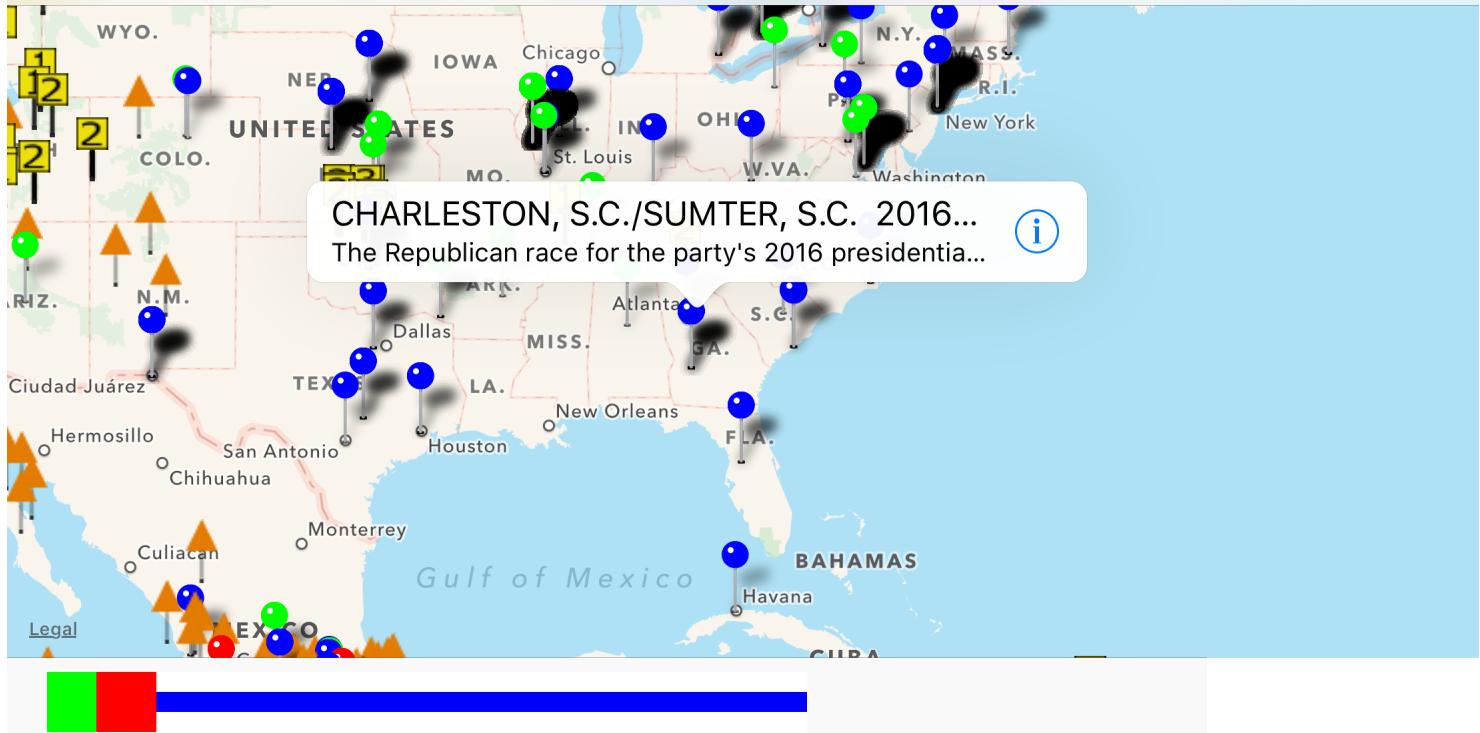




News event:

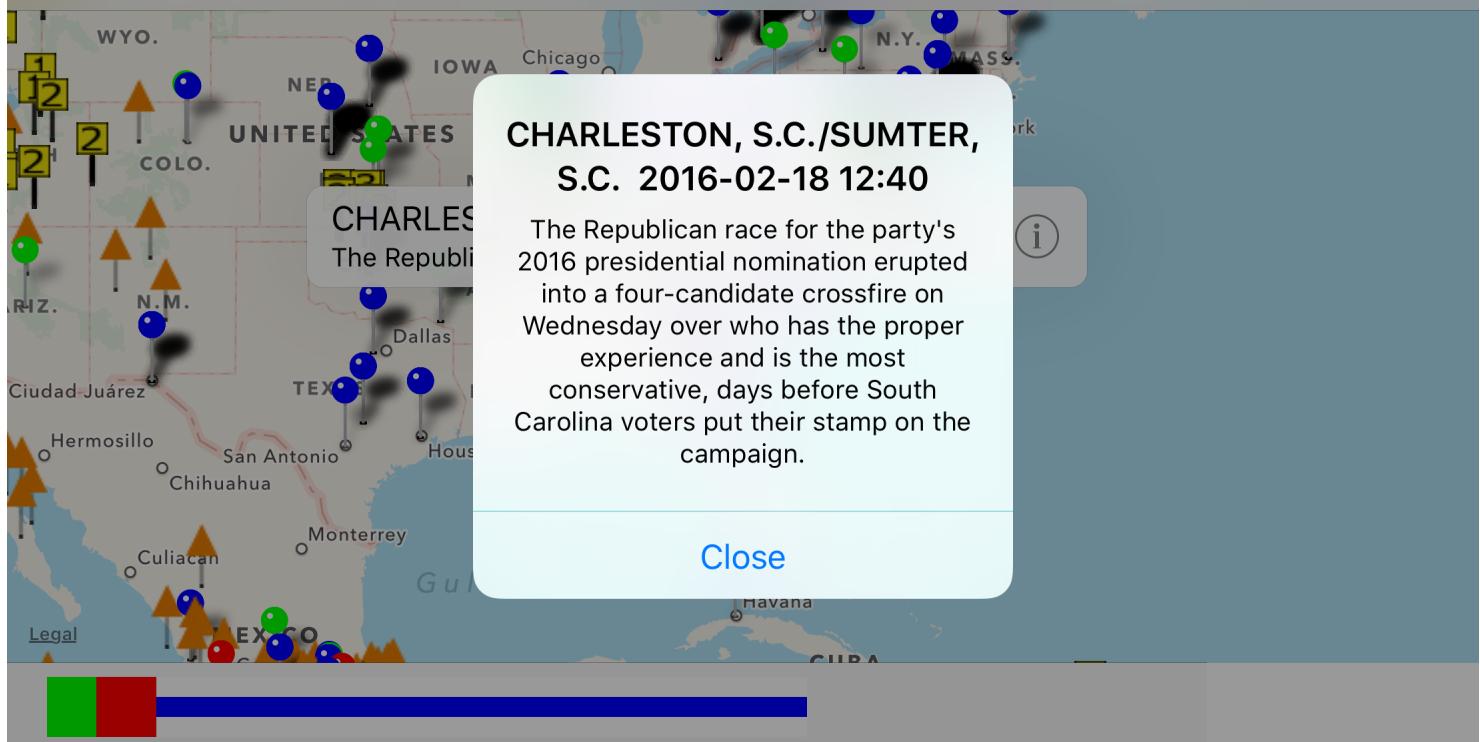
Settings

Load 144h ago (4h) Animate



Settings

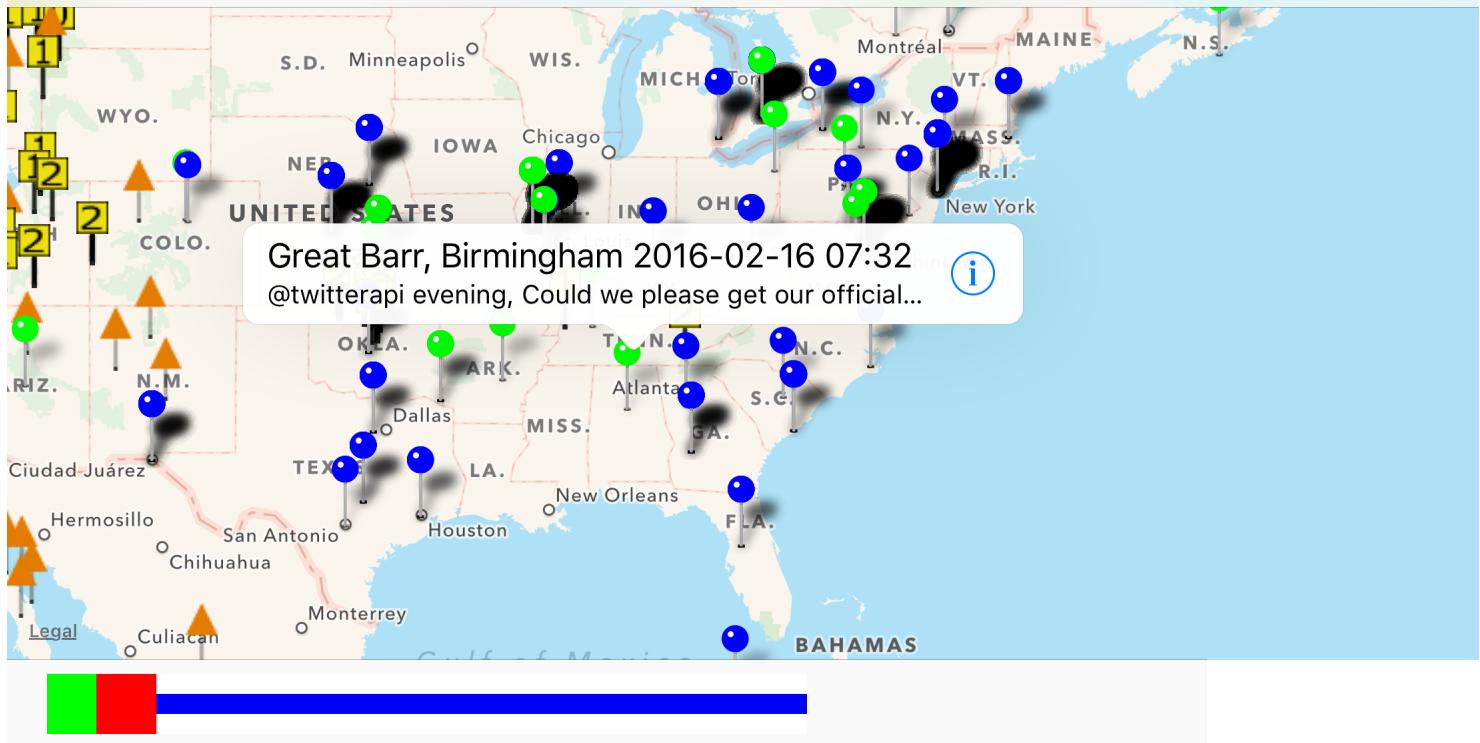
Load 144h ago (4h) Animate



Twitter message:

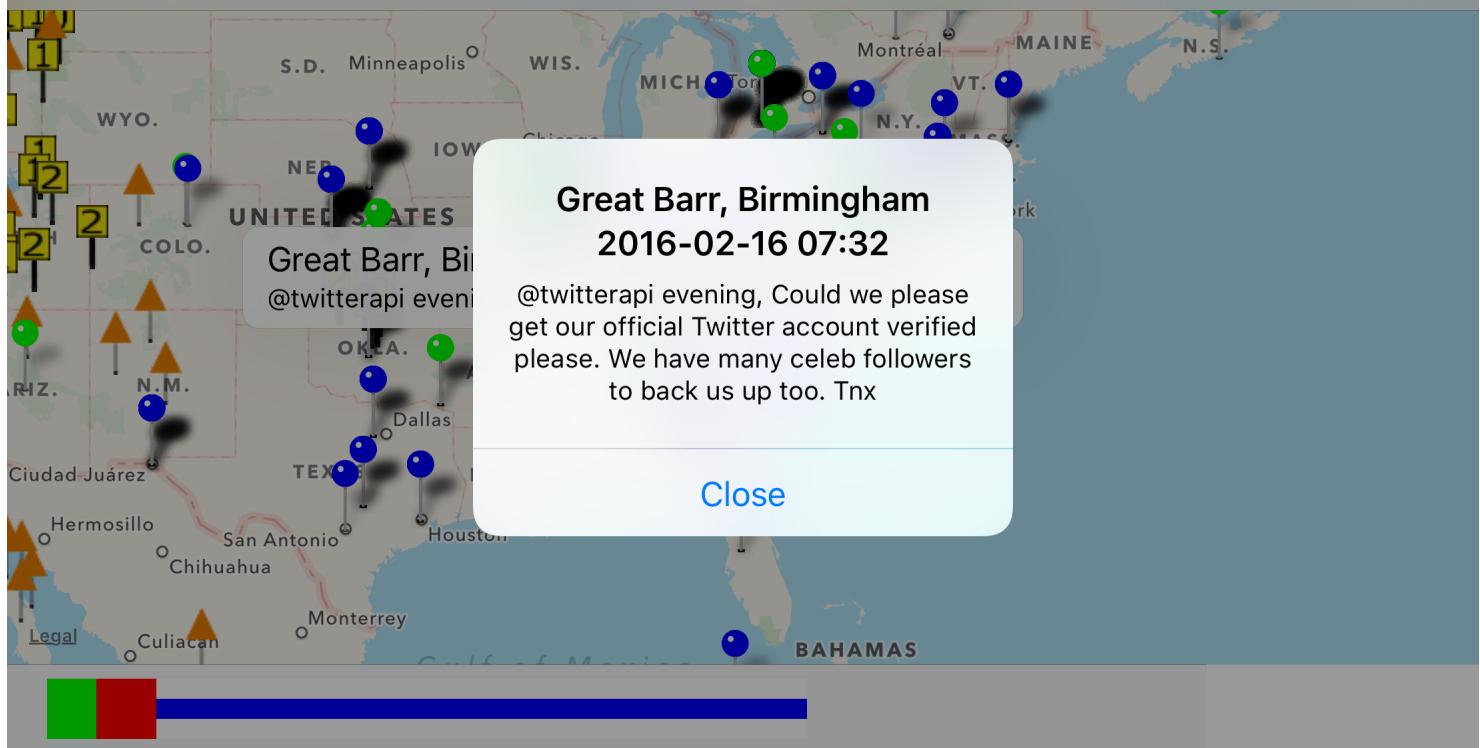
Settings

Load 144h ago (4h) Animate



Settings

Load 144h ago (4h) Animate



Settings screens:

Map Configuration

- Max hours ago for slider

- sliding time window in hours
- map view (standard, satellite or both/hybrid)
- map content (pins, heat map or both/hybrid)
- configuration is serialized into file <Documents directory>/visivent-map-Context

[Back](#) **Settings**

Map Configuration

Max hours for slider:

Sliding time window:

[Standard](#) [Satellite](#) [Hybrid](#)

[Pins](#) [Heat](#) [Hybrid](#)

Event Configuration

Data sources >

Geo coders >

Data Sources

[Settings](#) **Data sources**

Reuters News >

Earthquakes >

Volcanoes >

Twitter >

- Reuters News
 - Refresh Interval in seconds for loading news events
 - Refresh start time in seconds for first refresh (to load work over the time)
 - Max hours to keep events
 - Data collection enabled/disabled
 - Events display on map enabled/disabled
 - New topics screen to add and remove new topics to consume
 - Keywords to add and remove keywords for filtering event (looks for case insensitive keyword in event description)
 - configuration is serialized into file <Documents directory>/visivent-rss-Context

[!\[\]\(c3fc175bc90da56b0b7d34c090738a93_img.jpg\) Data sources](#) **Reuters News**

Refresh interval:	<input type="text" value="3600"/>
Refresh start time:	<input type="text" value="0"/>
Max hours:	<input type="text" value="72"/>
Data collected:	
Displayed:	
Topics:	Change
Keywords:	Change

News Topics:

Entertainment

Environment

Health News

Lifestyle

Media

Money

Most Read Articles

Oddly Enough

Keywords:

<input type="text"/>	Add
volcano	Remove
eruption	Remove
earthquake	Remove
geological	Remove
usgs	Remove

- Earthquakes
 - Refresh Interval in seconds for loading news events
 - Refresh start time in seconds for first refresh (to load work over the time)
 - Max hours to keep events
 - Minimum magnitude to store (in case there is no interest in micro quakes)
 - Data collection enabled/disabled
 - Events display on map enabled/disabled
 - configuration is serialized into file <Documents directory>/visivent-usgs-Context

[!\[\]\(755146c35f14b08061fd8fb7c17b11a9_img.jpg\) Settings](#) **Earthquakes**

Refresh interval:	<input type="text" value="3600"/>
Refresh start time:	<input type="text" value="0"/>
Max hours:	<input type="text" value="72"/>
Min magnitude:	<input type="text" value="0.0"/>
Data collected:	
Displayed:	

- Volcanoes
 - Refresh Interval in seconds for loading news events
 - Refresh start time in seconds for first refresh (to load work over the time)
 - Max hours to keep events
 - Minimum magnitude to store (in case there is no interest in micro quakes)
 - Data collection enabled/disabled
 - Activity events display on map enabled/disabled
 - Locations display on map enabled/disabled
 - Seed volcano locations from text file volcano_list.txt bundled with App (SQLite database is already seeded because of performance reasons)
 - configuration is serialized into file <Documents directory>/visivent-map-Context

Refresh interval:	10080
Refresh start time:	0
Max hours:	2880
Data collected:	<input checked="" type="checkbox"/>
Activity displayed:	<input checked="" type="checkbox"/>
Location displayed:	<input checked="" type="checkbox"/>

[Seed volcano locations](#)

- Twitter
 - Refresh Interval in seconds for loading news events
 - Refresh start time in seconds for first refresh (to load work over the time)
 - Twitter consumer key (needed for reading Twitter messages, create free developer account)
 - Twitter consumer secret (needed for reading Twitter messages, create free developer account)
 - Max hours to keep events
 - Data collection enabled/disabled
 - Twitter message display on map enabled/disabled
 - New topics screen to add and remove new topics to consume
 - Keywords to add and remove keywords for filtering event (looks for case insensitive keyword in twitter message)
 - configuration is serialized into file <Documents directory>/visivent-twitter-Context

[Data sources](#)

Twitter

Refresh interval:	3600
Refresh start time:	240
Consumer key:	WZiogG1AC9Y3zQxiAxisUJJrF
Consumer secret:	S9vJAs94BBbaiv40NsCdVED15o...
Max hours:	72
Data collected:	
Displayed:	
Keywords:	Change

Keywords: [Twitter](#) [Add](#)

volcano	Remove
lava	Remove

Future Releases:

- The Visivent app could be extended with additional datasources like e.g. airplane flight data (may be effected by clouds of volcano ash), earthquake predictions (USGS will make available data soon). Though the primary application domain is geology also other domains like a crime map are thinkable in future iterations.
- Showing dense population centers ((Maxmind world city database) to e.g. assess a risk.
- There is a limitation in the number of annotations so pre-computed overlays seem to be more promissing when displaying many events/locations.
- Having a selection of categories of events on the map itself is a future candidate.
- A geologist notebook with map annotations