

Mobile, Offline Maps With Open Tools & Data

Justin Miller • MapBox • FOSS4G NA 2013



Intro

- iOS engineer at MapBox
- Background in sysadmin, web app dev, and Mac dev
- Startups + open source since the 90s
- Based in Portland, OR

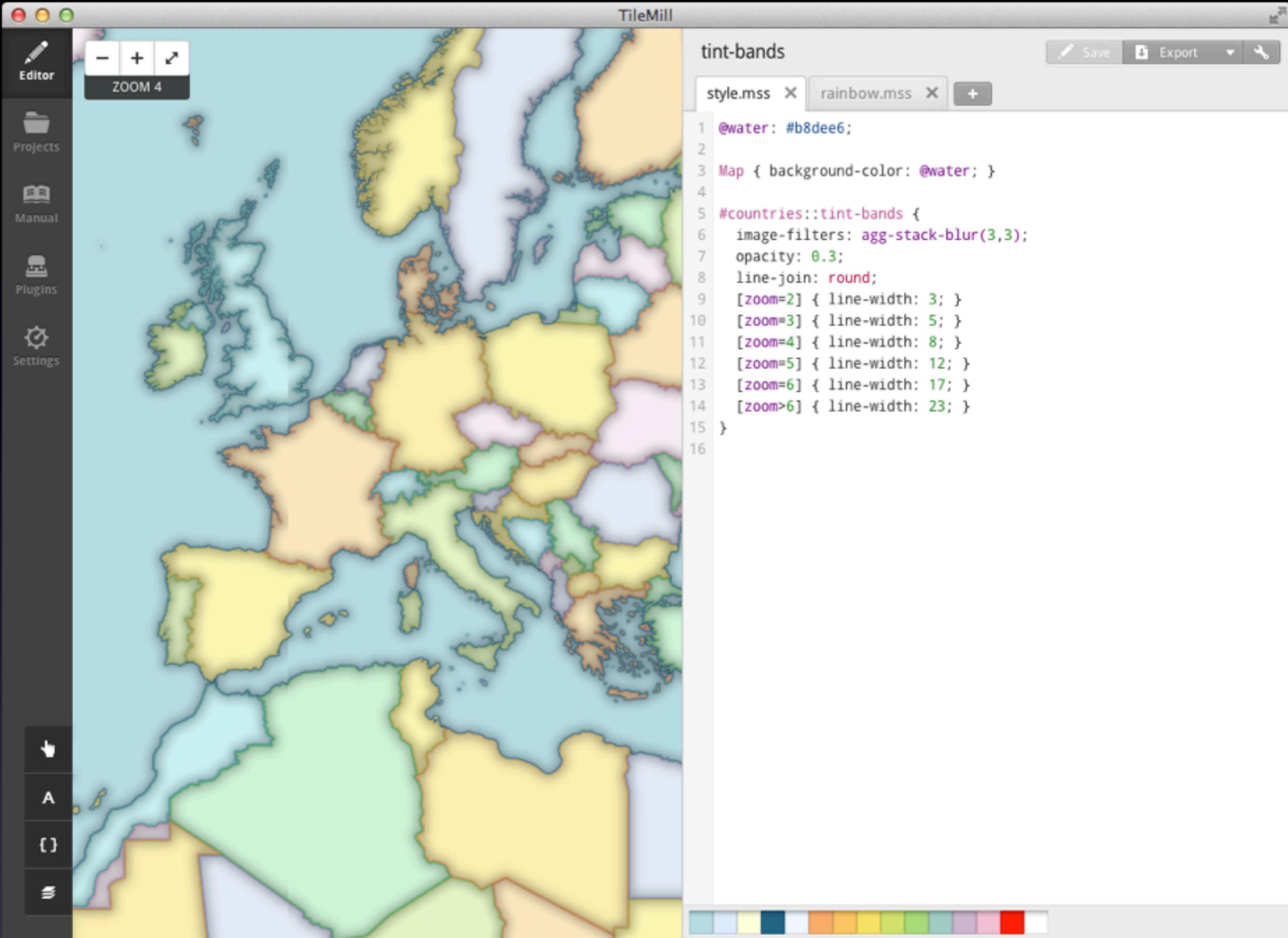
MapBox

- “Beautiful custom maps with open source tools”
- High-availability cloud hosting of maps
- Easily make maps with OSM & other data
- The software is open source & free (as in beer)
 - 115 (and counting) public repos on GitHub
 - *Our core technology is all open source*



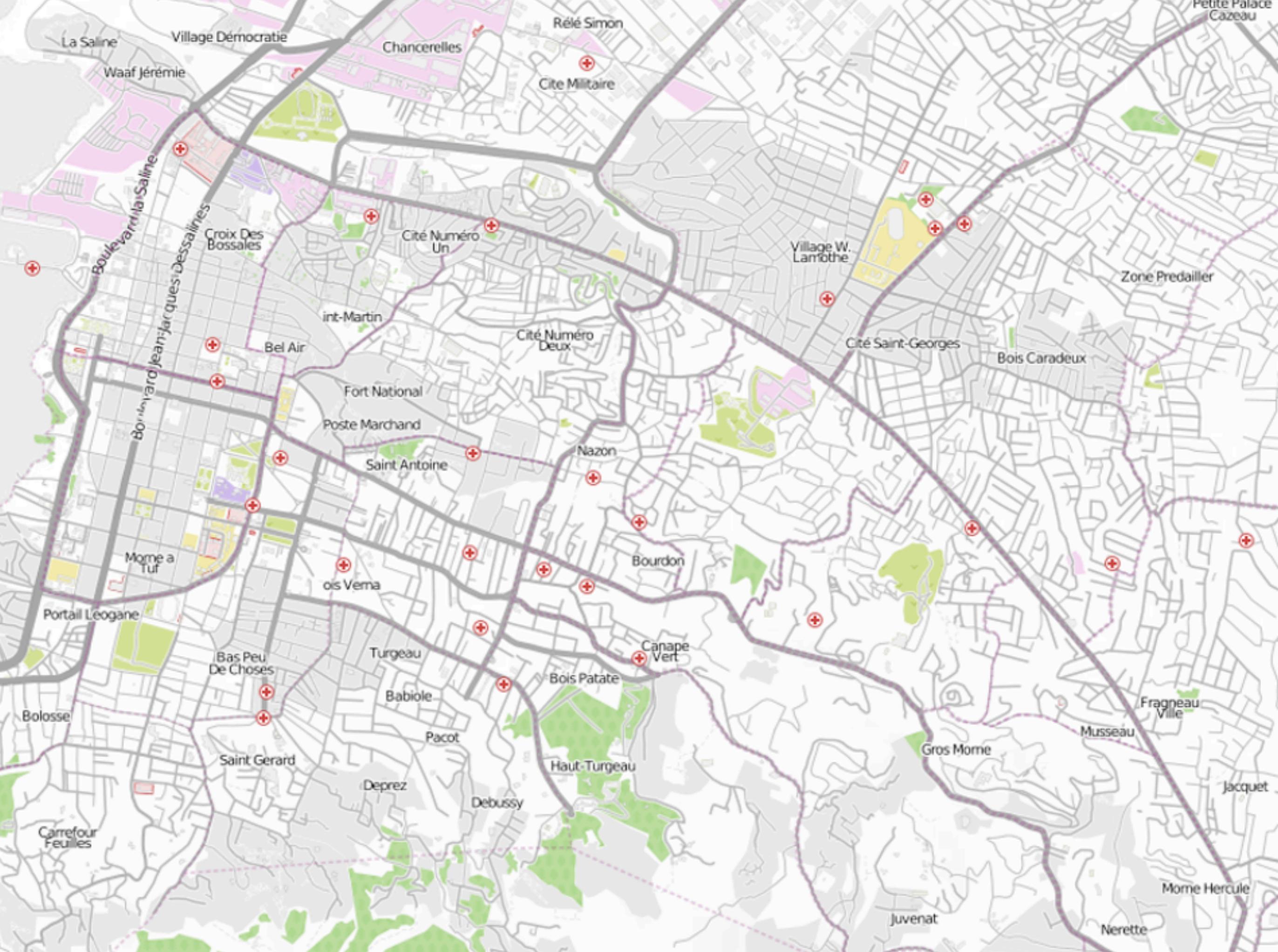
TileMill

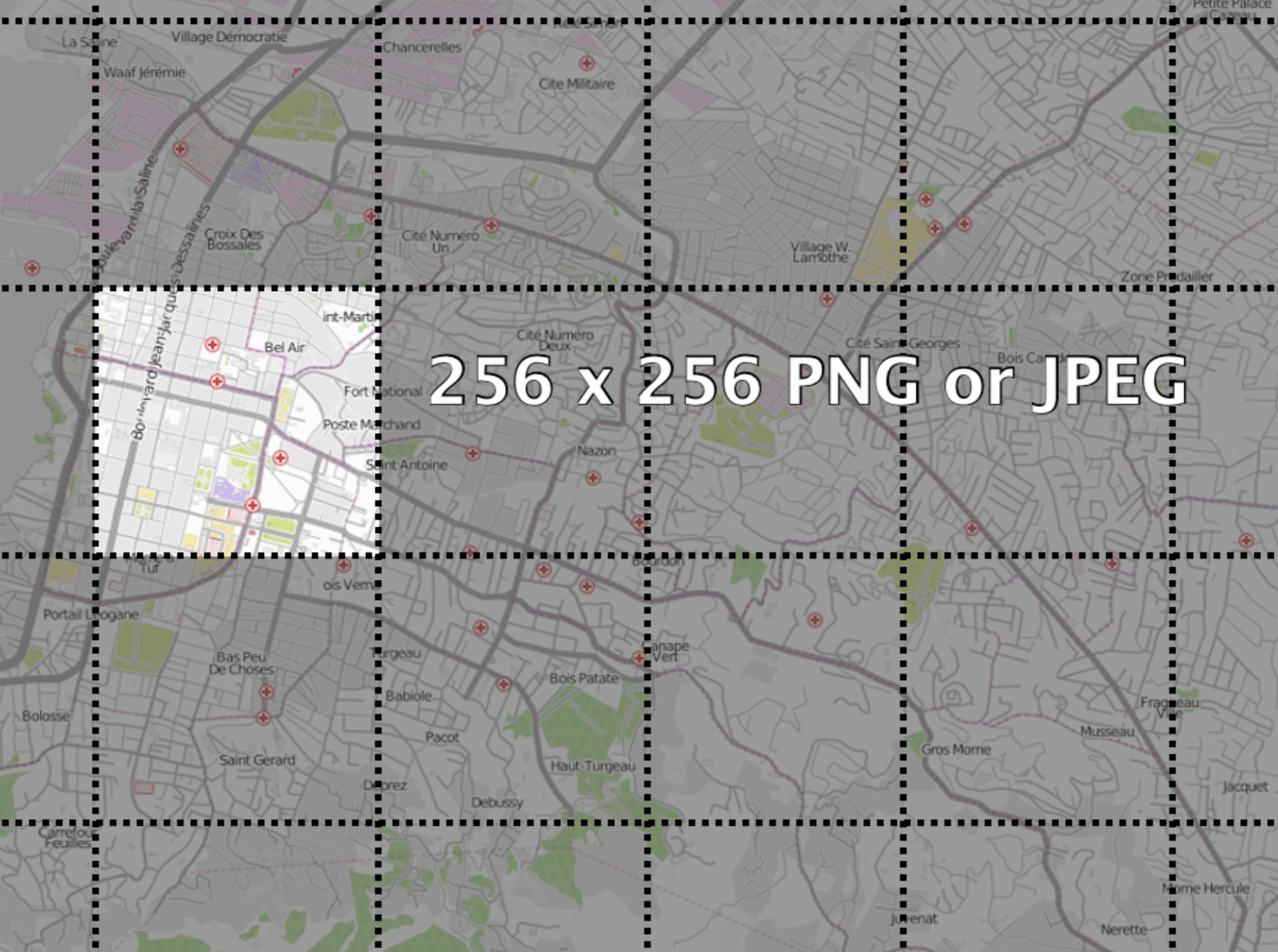
- Desktop app for making maps
- Desktop app for making *mappers*
- Put data in
 - Shapefile, GeoJSON, OSM PostGIS, etc.
(pretty much anything GDAL can do)
- Get map tiles out



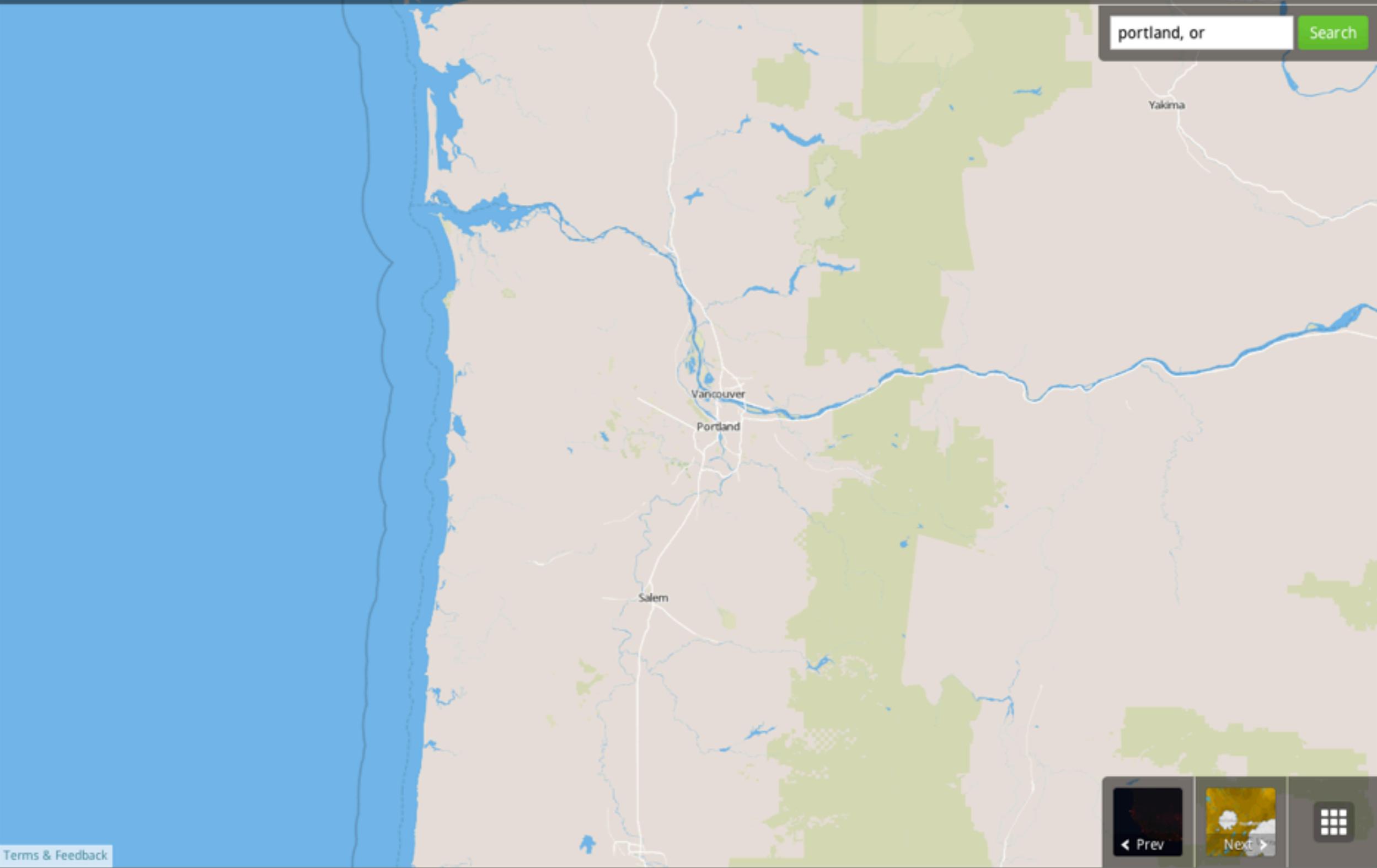
MapBox iOS SDK

- Open source rebuild of Apple's MapKit
- Works with MapBox, OSM, whatever tiles
- Add map tiles, point/polyline overlays
- ~15,000 lines of code

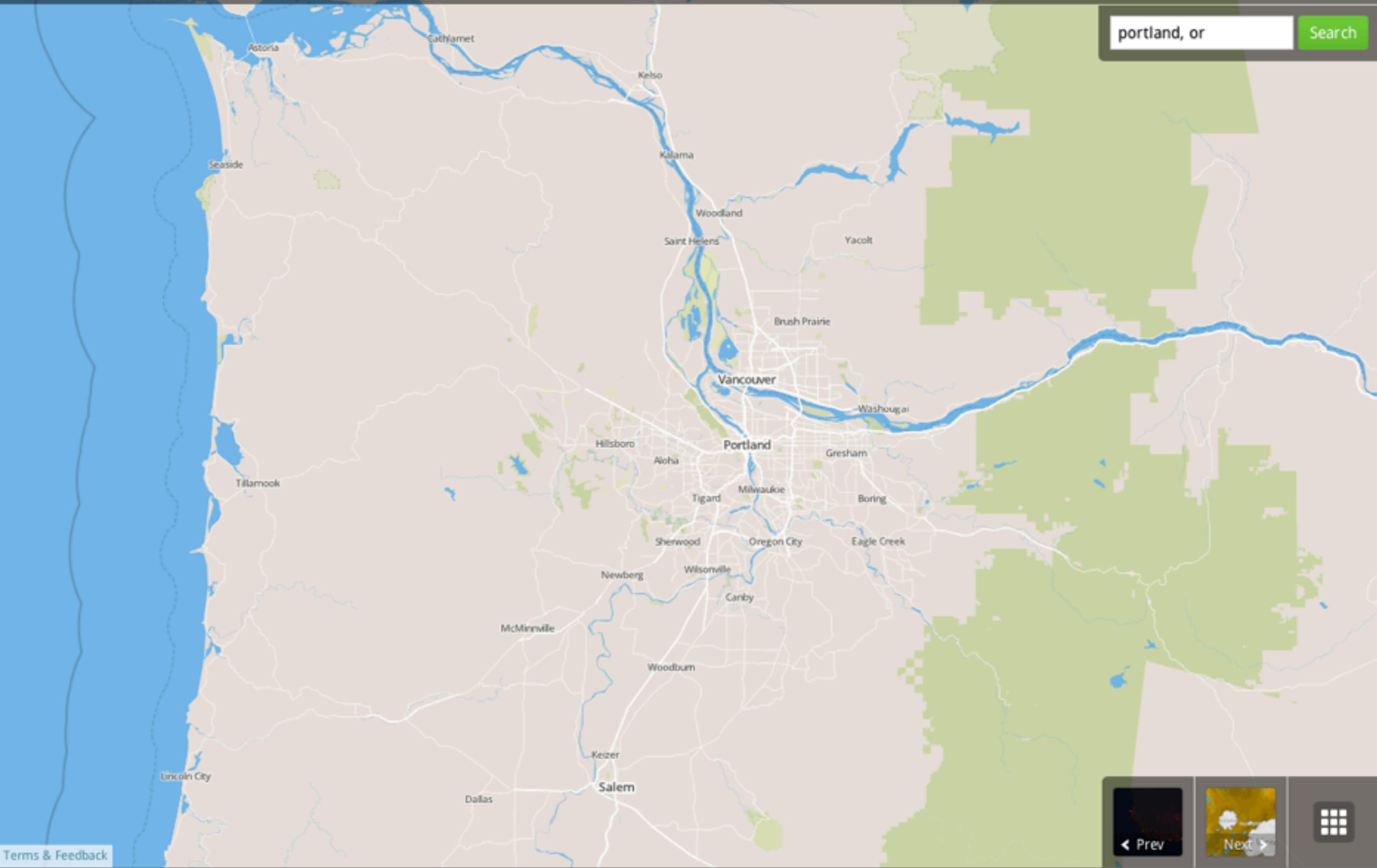




256 x 256 PNG or JPEG



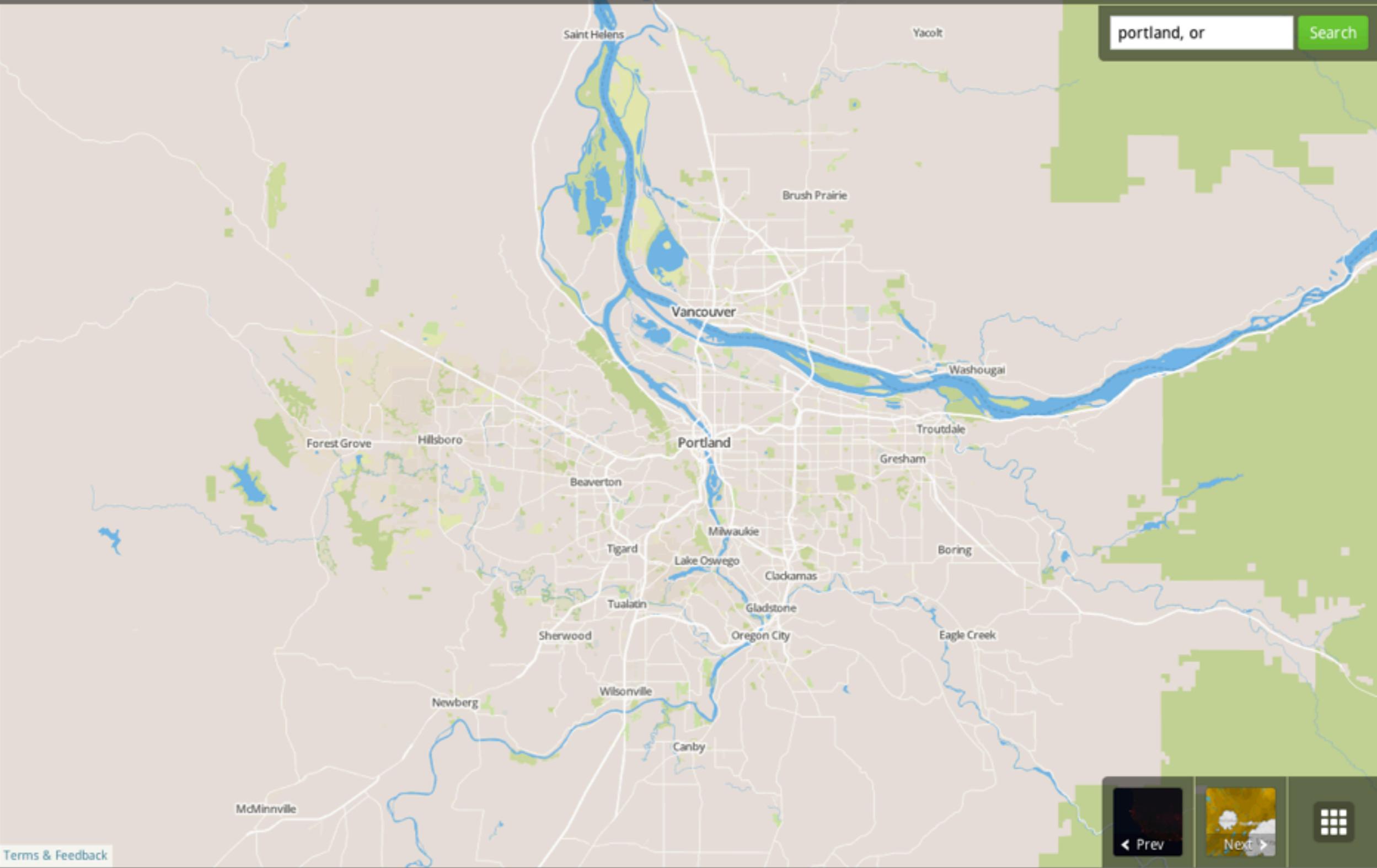
portland, or



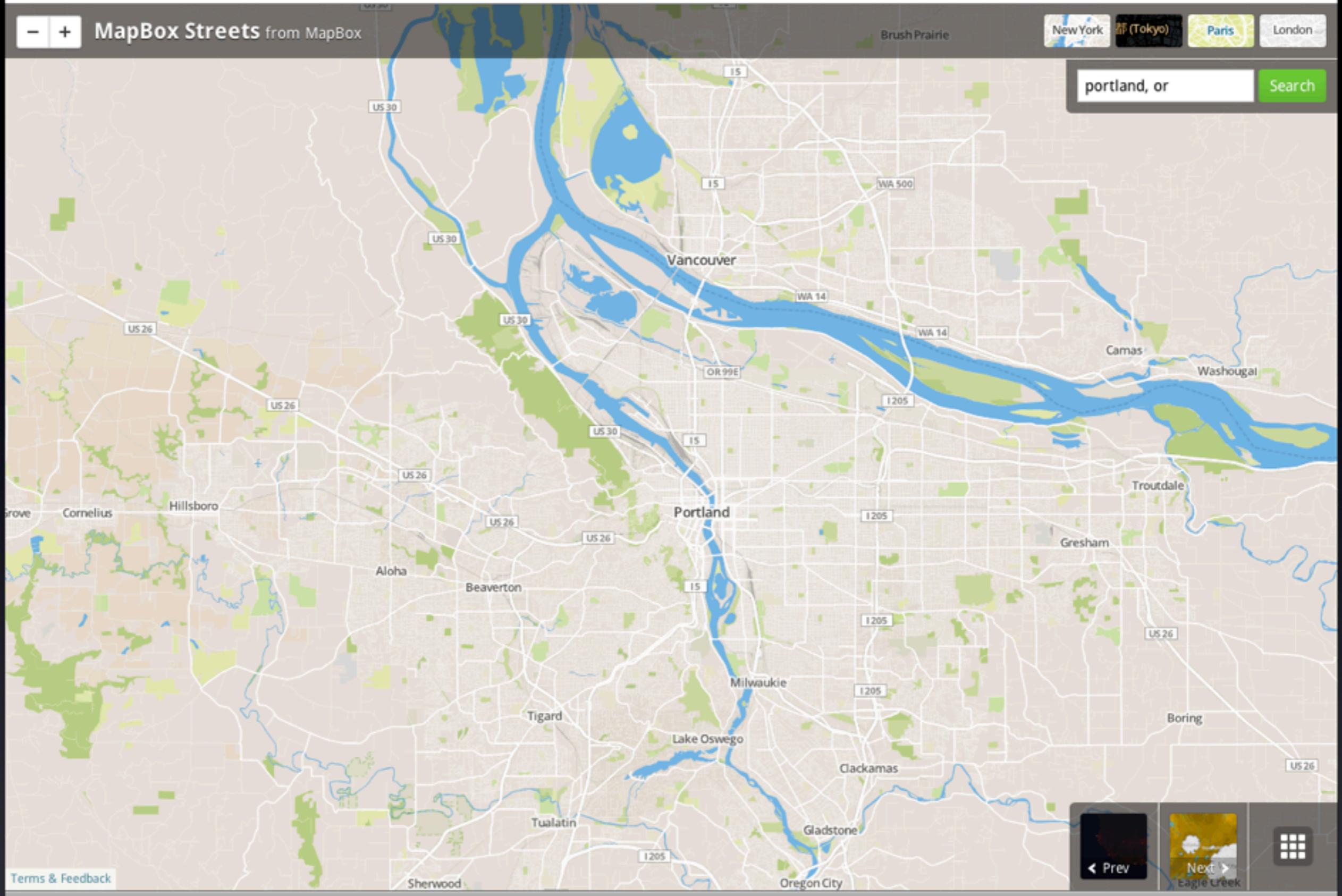
MapBox Streets from MapBox

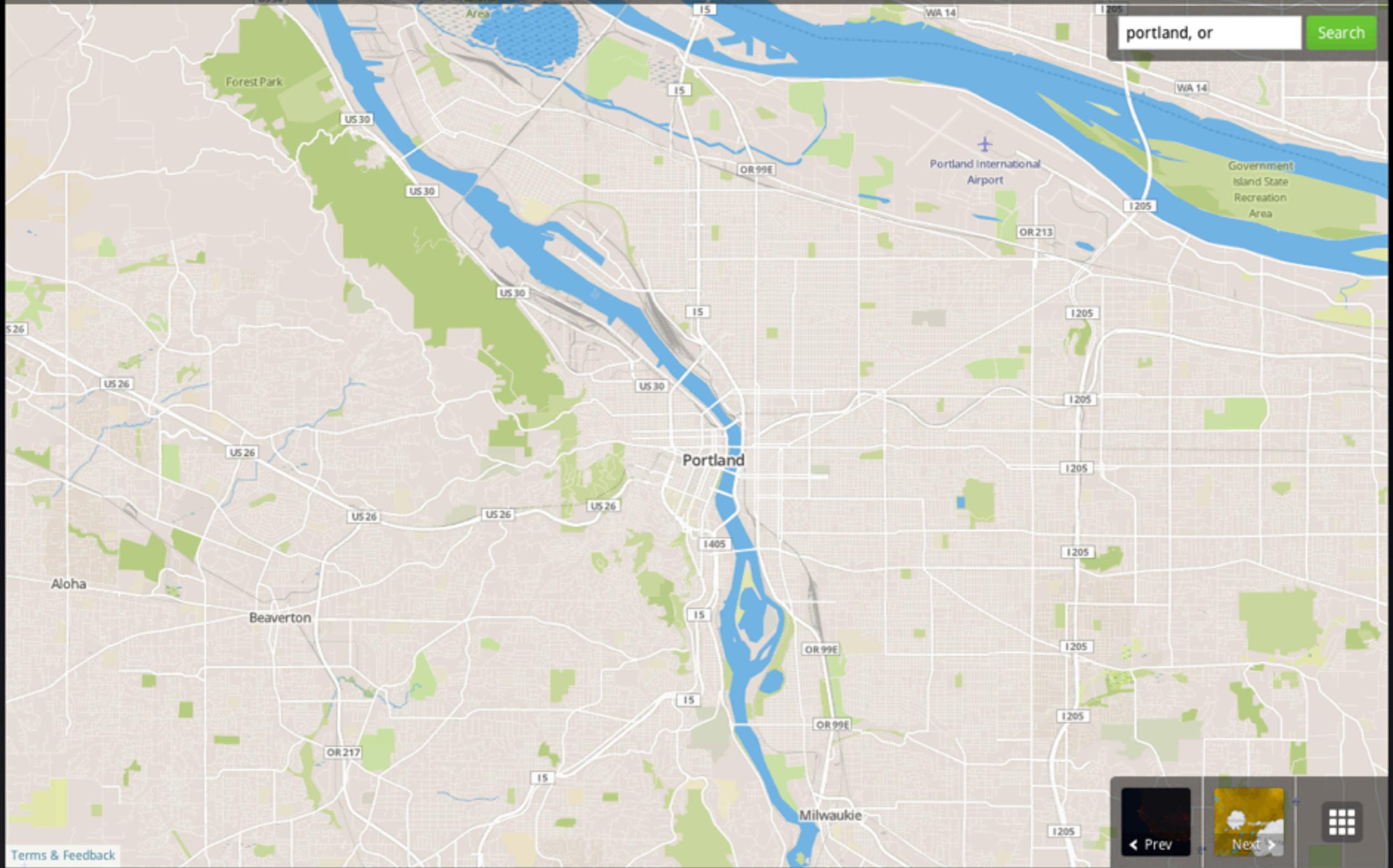
New York Tokyo Paris London

portland, or Search



Navigation controls: Prev, Next, and a grid icon.

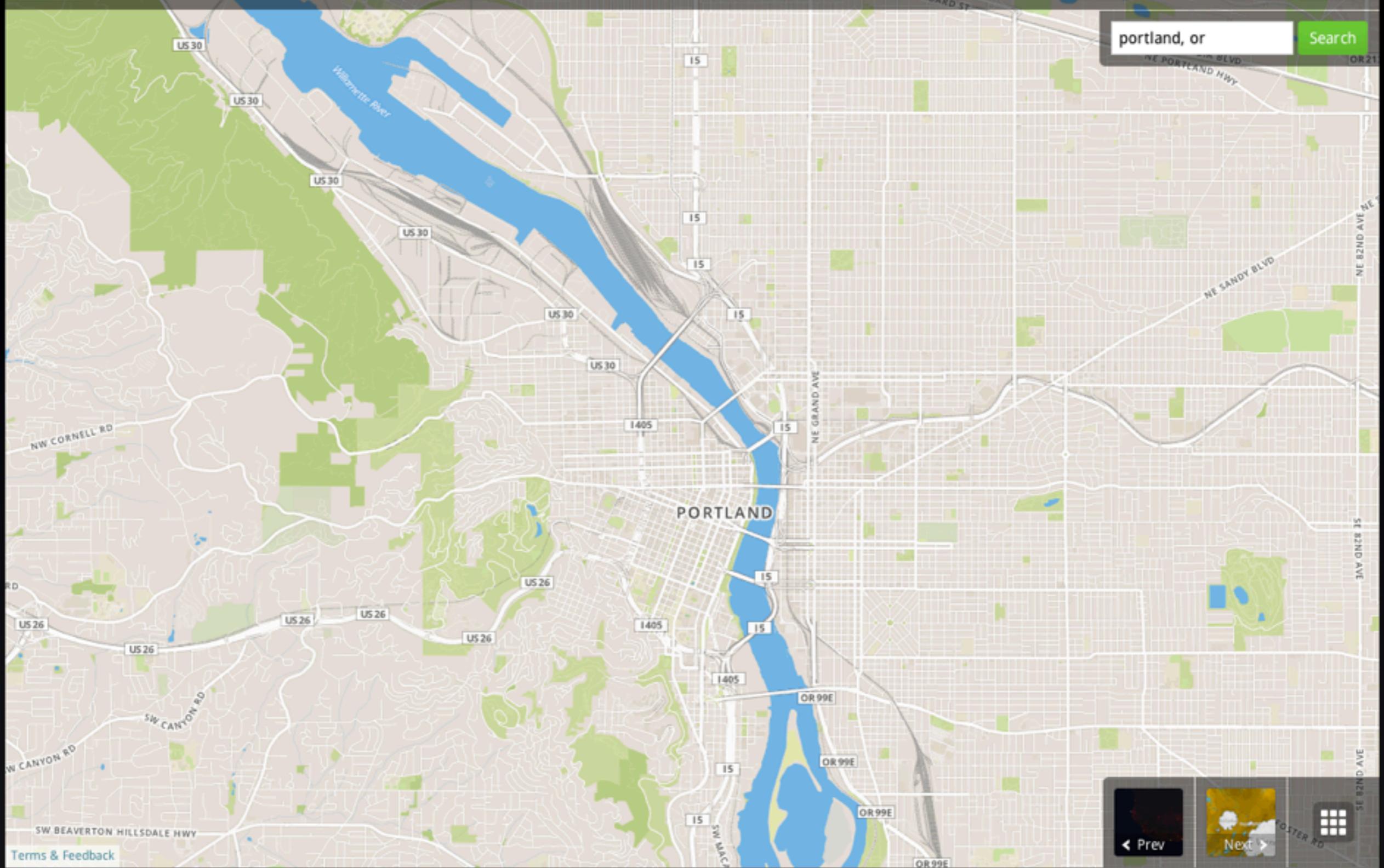




MapBox Streets from MapBox

New York Tokyo Paris London

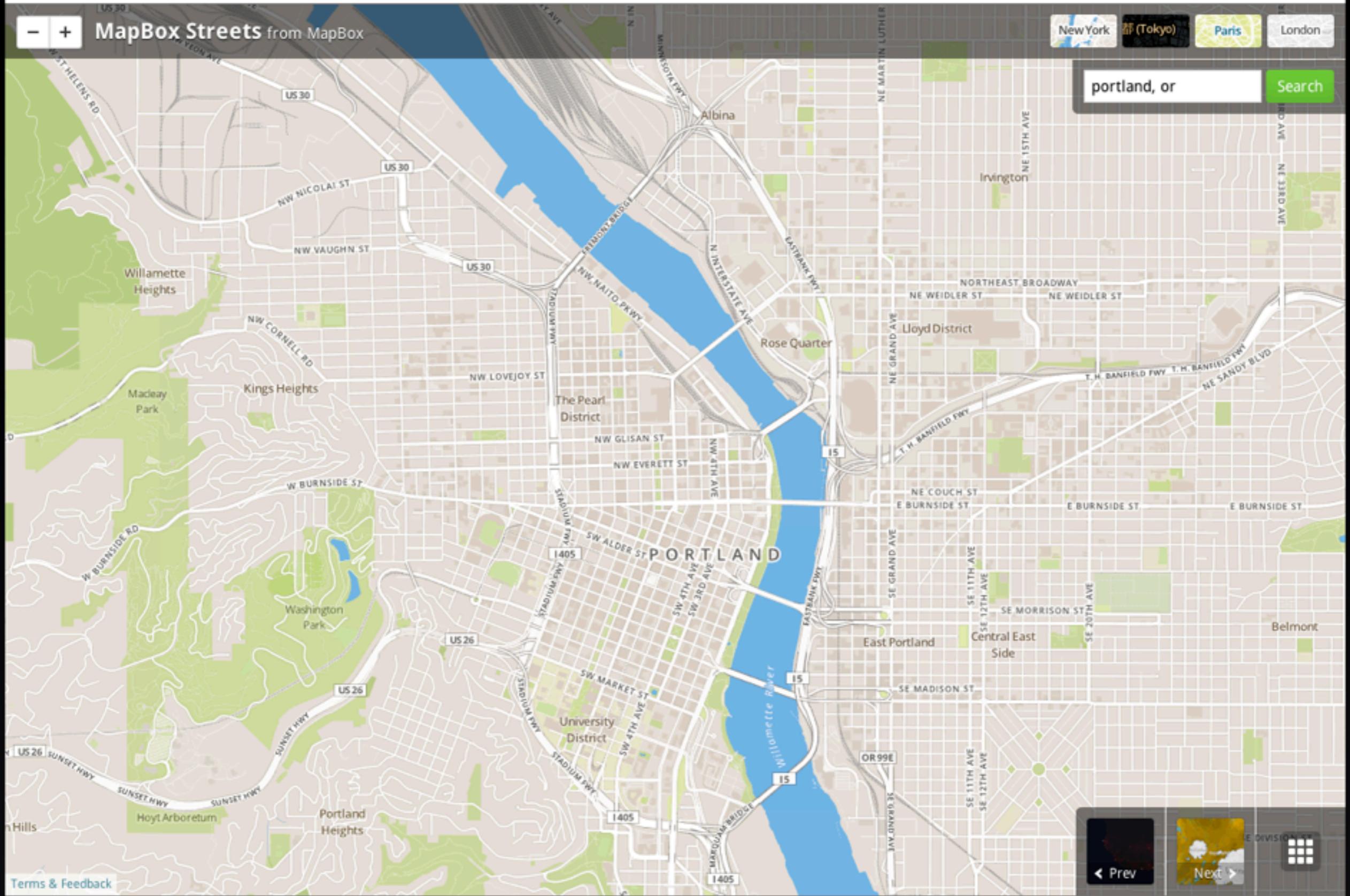
portland, or Search



MapBox Streets from MapBox

New York Tokyo Paris London

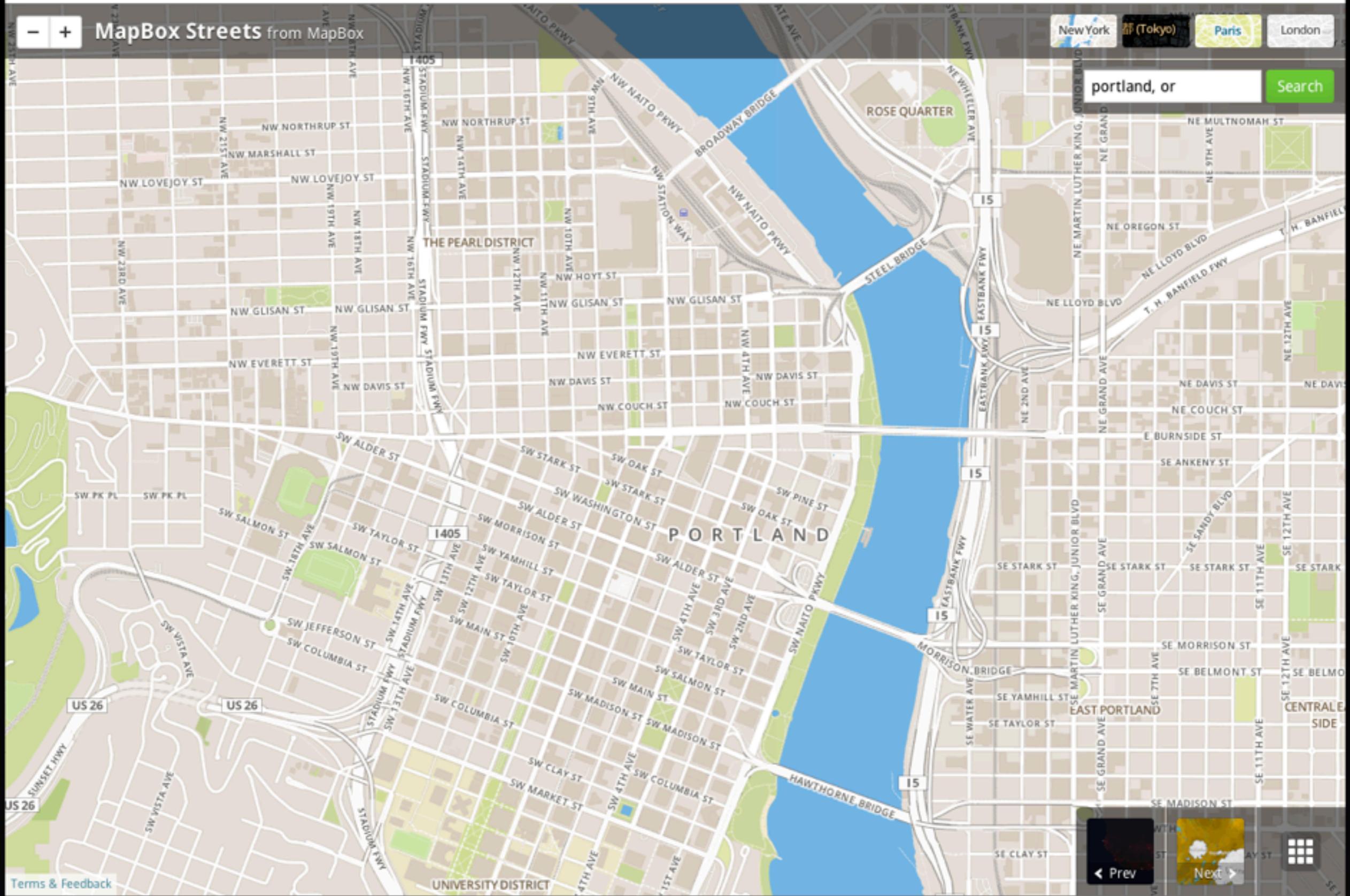
portland, or Search



MapBox Streets from MapBox

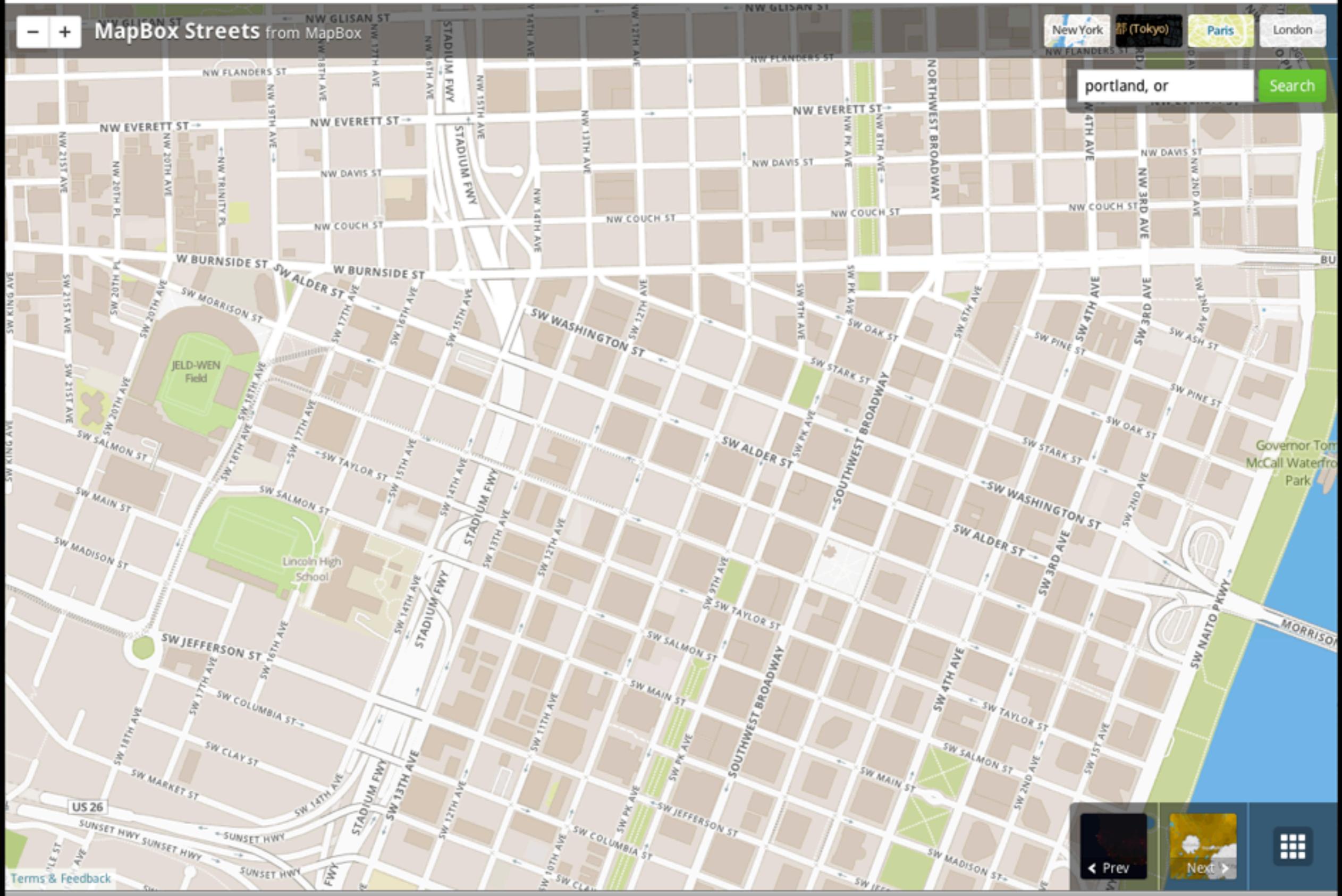
Map style selector: New York, Tokyo, Paris, London

Search bar: portland, or Search





MapBox Streets from MapBox



Governor Tom McCall Waterfront Park

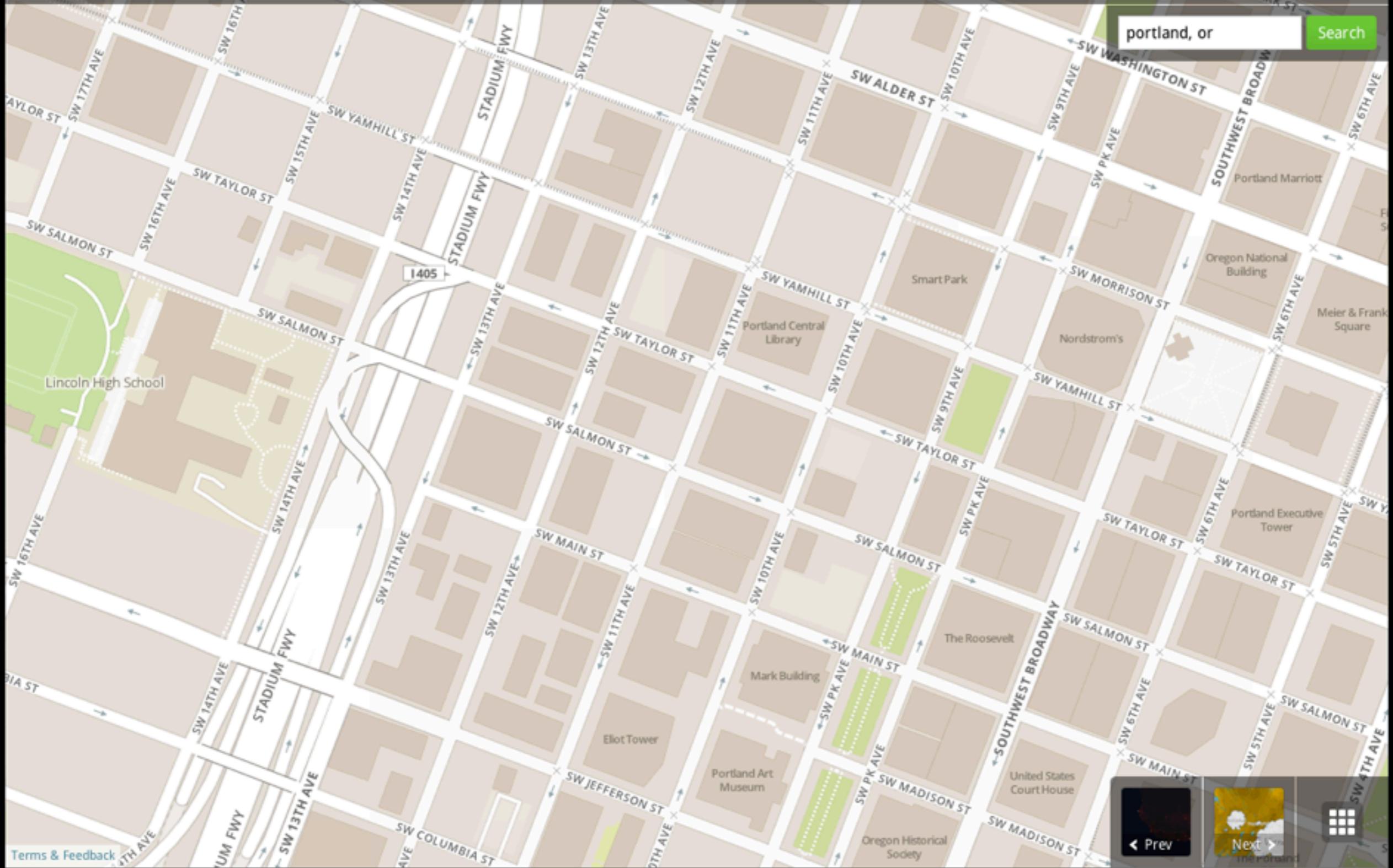
US 26

MapBox Streets from MapBox

Pittcock Blvd New York Tokyo Paris London

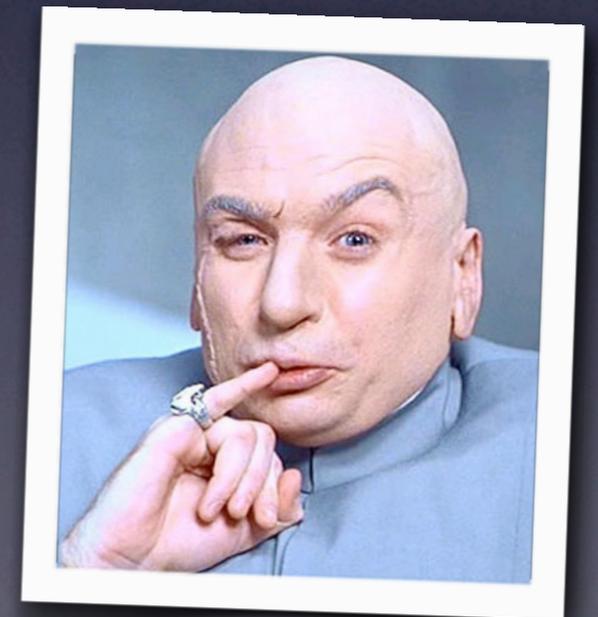
portland, or

Search



Many, Many Tiles

- Can easily number in the millions
 - Zoom level 0
 - One 256x256 tile (4^0)
 - Zoom level 17
 - **17,179,869,184** tiles (4^{17})



The Offline Problem

- Main factor is these tile quantities
- Transfer over USB & network is painful
- Maintaining data integrity is error-prone

Initial Approach

- Filesystem storage (files & folders)
 - This is how tiles had been done before
- Cloud storage like Amazon S3
 - Costs \$\$ just to read/check, though
 - Still time-consuming & error-prone

There has to be a better way...

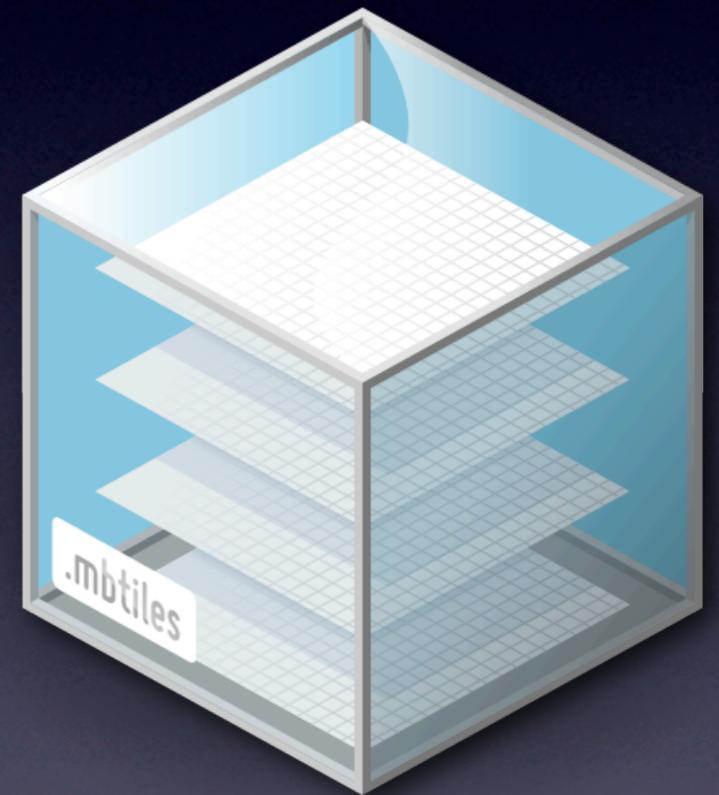
Enter



- Self-contained server-less database
 - *“Small. Fast. Reliable. Choose any three.”*
- Cross-platform (desktop/mobile)
 - Windows/Mac/Linux/iOS/Android/etc.
- Fast and lightweight
- Simple & easy to grok

MBTiles

- Open standard for tile storage
- One SQLite-backed file for whole layer
- Tile $z/x/y$.png becomes a data row



.../JustinMap/9/4/2.png



JustinMap.mbtiles			
z	x	y	tile_data
9	4	2	



Geography Class

Iceland

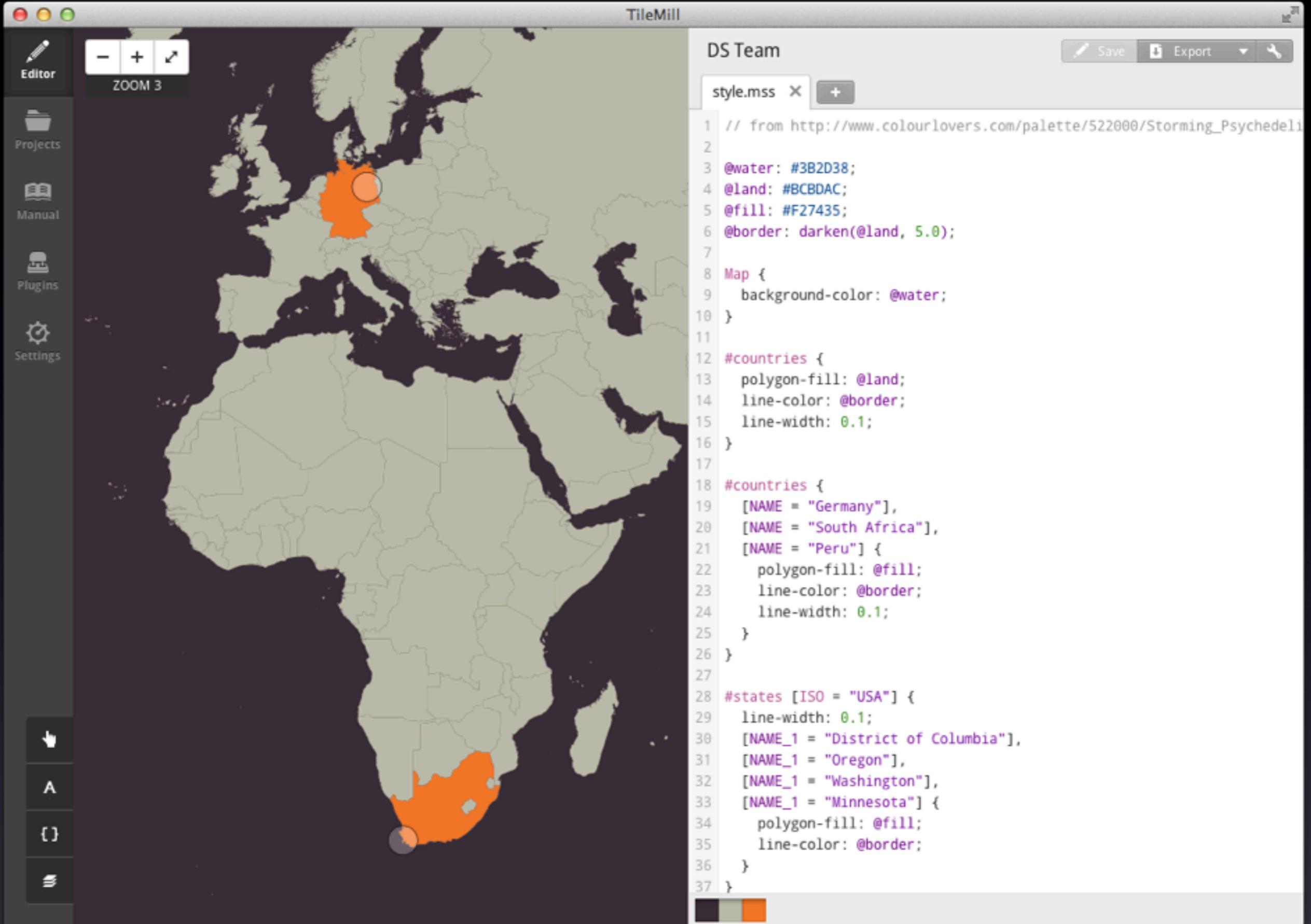
Washington, DC

Nigeria

OpenStreetMap

Building The Stack

- TileMill exports
- MapBox hosting backend
- iOS offline
- WhirlyGlobe/Maply
- *Whatever else*



Editor

Projects

Manual

Plugins

Settings

ZOOM 3

DS Team

style.mss X +

```
1 // from http://www.colourlovers.com/palette/522000/Storming_Psychedeli
2
3 @water: #3B2D38;
4 @land: #BCBDAC;
5 @fill: #F27435;
6 @border: darken(@land, 5.0);
7
8 Map {
9   background-color: @water;
10 }
11
12 #countries {
13   polygon-fill: @land;
14   line-color: @border;
15   line-width: 0.1;
16 }
17
18 #countries {
19   [NAME = "Germany"],
20   [NAME = "South Africa"],
21   [NAME = "Peru"] {
22     polygon-fill: @fill;
23     line-color: @border;
24     line-width: 0.1;
25   }
26 }
27
28 #states [ISO = "USA"] {
29   line-width: 0.1;
30   [NAME_1 = "District of Columbia"],
31   [NAME_1 = "Oregon"],
32   [NAME_1 = "Washington"],
33   [NAME_1 = "Minnesota"] {
34     polygon-fill: @fill;
35     line-color: @border;
36   }
37 }
```

Editor

— + ↗

ZOOM 3

- Projects
- Manual
- Plugins
- Settings



DS Team

Save Export

style.mss X +

```

1 // from http://www.colourlovers.com/palette/522006
2
3 @water: #3B2D38;
4 @land: #BCBDAC;
5 @fill: #F27435;
6 @border: darken(@land, 5.0);
7
8 Map {
9   background-color: @water;
10 }
11
12 #countries {
13   polygon-fill: @land;
14   line-color: @border;
15   line-width: 0.1;
16 }
17
18 #countries {
19   [NAME = "Germany"],
20   [NAME = "South Africa"],
21   [NAME = "Peru"] {
22     polygon-fill: @fill;
23     line-color: @border;
24     line-width: 0.1;
25   }
26 }
27
28 #states [ISO = "USA"] {
29   line-width: 0.1;
30   [NAME_1 = "District of Columbia"],
31   [NAME_1 = "Oregon"],
32   [NAME_1 = "Washington"],
33   [NAME_1 = "Minnesota"] {
34     polygon-fill: @fill;
35     line-color: @border;
36   }
37 }

```

- Upload
- PNG
- PDF
- SVG
- MBTiles
- Mapnik XML
- View exports



Hand cursor icon

A

{ }

≡

Editor

Projects

Manual

Plugins

Settings

View exports

	ds_team.mbtiles	<div style="width: 100%;"><div style="width: 10%;"></div></div>	00:04:36s remaining	
	chocolate_map.mbtiles		 Save	
	ctoutage.png		 Save	
	demo.mbtiles		 Save	

DS Team

 Save Export

style.mss X

```
1 // from http://www.colourlovers.com/palette/522000/Storming_Psychedeli
2
3 @water: #3B2D38;
4 @land: #BCBDAC;
5 @fill: #F27435;
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36   }
37 }
```



Justin Miller

iOS/Mac developer at @MapBox & photographer at @MallornImagery. Code, photography, travel, trying, learning, discovering.

Staff

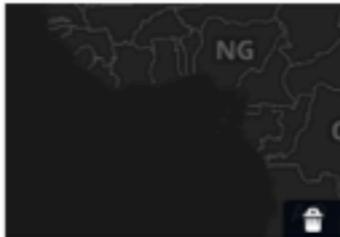
[Change plans](#)

Map views 1.6k of 300.0k views

Storage 988.0 MB of 25.0 GB

+ NEW MAP

Untitled map
May 18 2013



Untitled map
May 17 2013



Untitled map
May 17 2013



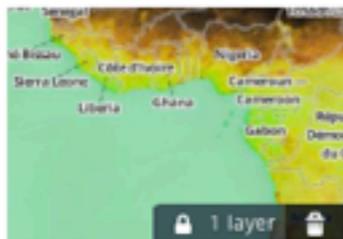
Thursday
May 2 2013



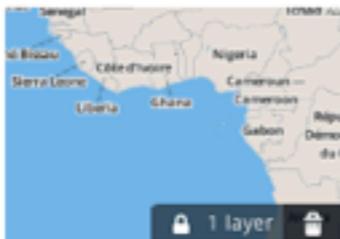
Untitled map
Apr 29 2013



Untitled map
Apr 29 2013



Untitled map
Apr 29 2013



Flag Overlay
Apr 29 2013



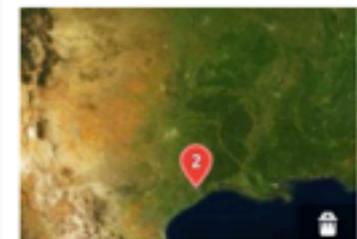
Untitled map
Apr 23 2013



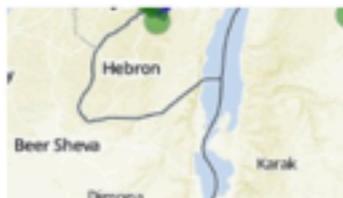
Untitled map
Apr 21 2013



Justin's April Travels
Apr 20 2013



President Obama's Mi...
Apr 20 2013



Portland-Ottawa Latit...
Apr 20 2013



ExploreNet Dark Retina
Mar 29 2013



ExploreNet Dark
Mar 29 2013



President Obama
Mar 29 2013



ExploreNet Retina
Mar 28 2013





- New map
- Upload layer
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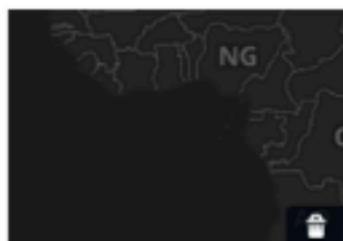
Staff
[Change plans](#)

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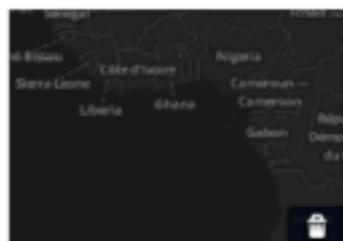
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+ NEW MAP

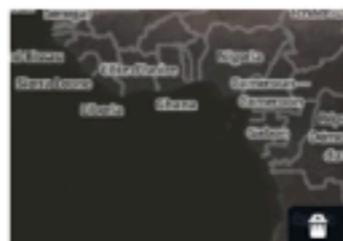
Untitled map
May 18 2013



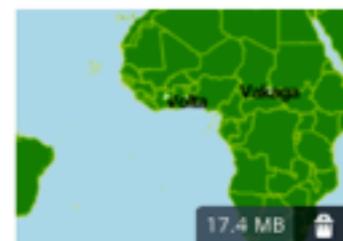
Untitled map
May 17 2013



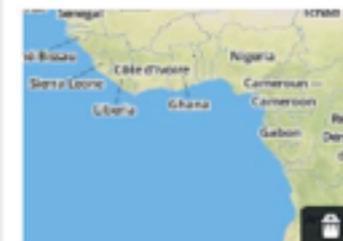
Untitled map
May 17 2013



Thursday
May 2 2013



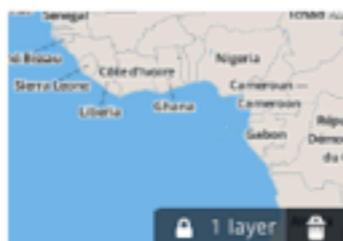
Untitled map
Apr 29 2013



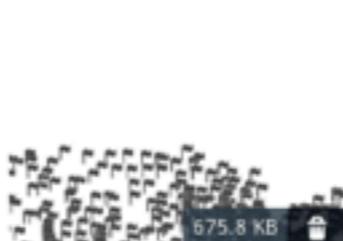
Untitled map
Apr 29 2013



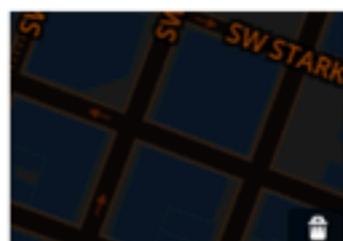
Untitled map
Apr 29 2013



Flag Overlay
Apr 29 2013



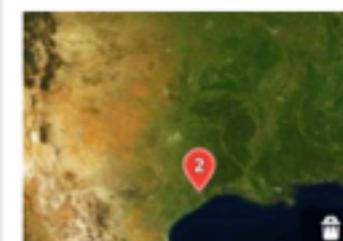
Untitled map
Apr 23 2013



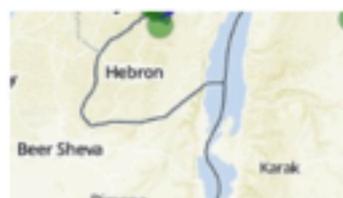
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President Obama's Mi...
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Portland-Ottawa Latit...
Apr 20 2013



ExploreNet Dark Retina
Mar 29 2013



ExploreNet Dark
Mar 29 2013



President Obama
Mar 29 2013



ExploreNet Retina
Mar 28 2013





Upload map

Upload your MBTiles file to publish your map.

Before you upload make sure...

- Your map is less than 5 GB
- You have all necessary permissions to upload this map
- Your map does not contain hateful, defamatory, or discriminatory content
- You agree to the full [Terms of Service](#)

MBTiles file 24.0 GB remaining

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- 1 Upload MBTiles file
- 2 Create or update map
- 3 Process MBTiles file

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MapBox, LLC tiles.mapbox.com/justin/create

Justin Miller

MapBox

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Brian.jpg
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geography-class.mbtiles



Name geography-class.mbtiles
Kind MBTiles Map Tiles
Size 134.7 MB
Created 1/24/12 2:13 PM
Modified 1/24/12 2:13 PM
Last opened 1/24/12 2:13 PM

Cancel Choose

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geography-class-mini.mbtiles Info

geography-class-mini.mbtiles 30.7 MB
Modified: Friday, April 6, 2012 2:51 PM

▶ **Spotlight Comments:**

▶ **General:**

▼ **More Info:**

Display name: Geography Class
Description: One of the example maps that comes with TileMill – a bright & colorful world map that blends retro and high-tech with its folded paper texture and interactive flag tooltips.
Kind: MBTiles

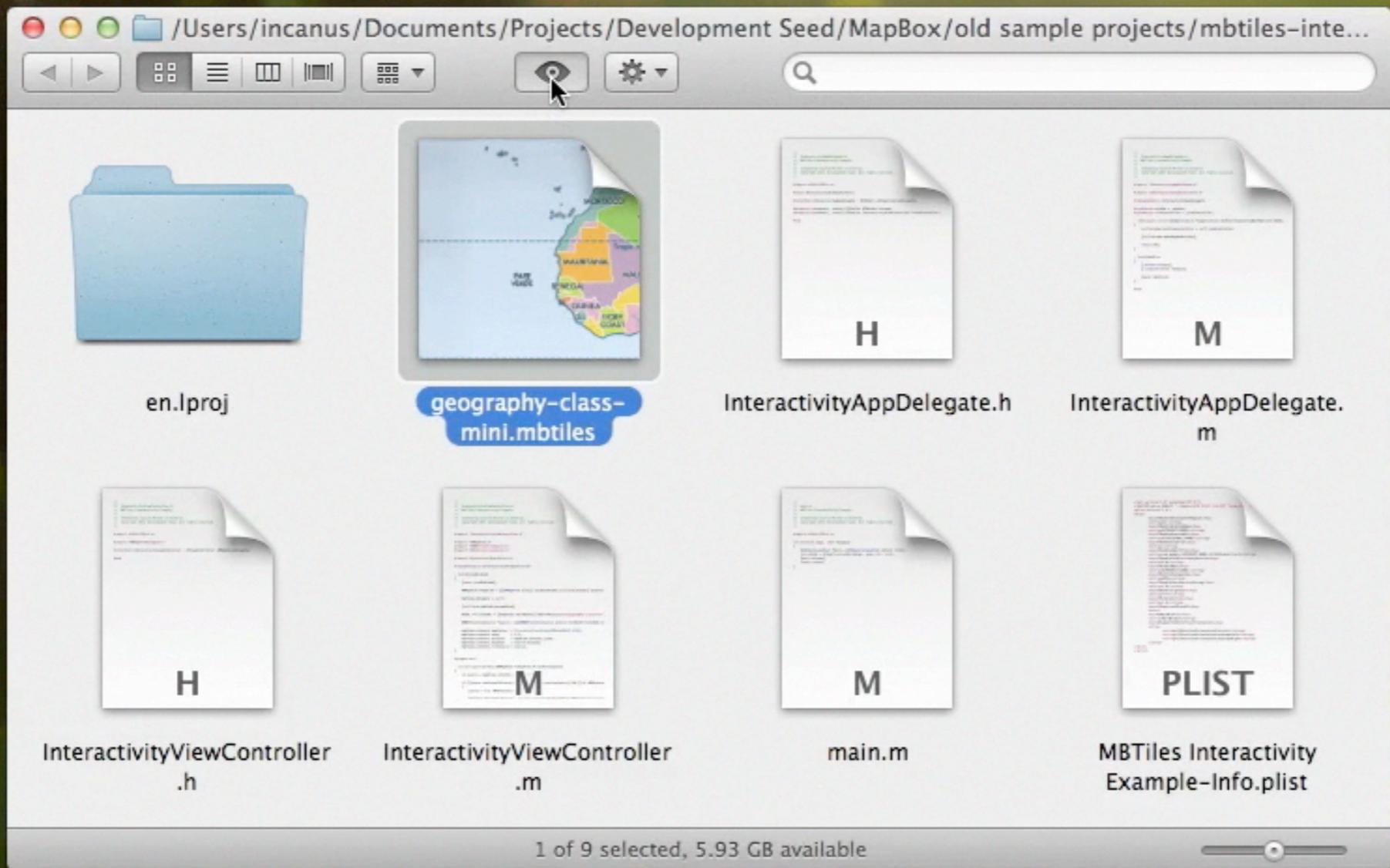
▶ **Name & Extension:**

▶ **Open with:**

▼ **Preview:**



▶ **Sharing & Permissions:**





GDAL - Geospatial Data Abstraction Library

Select language: [English][Russian][Portuguese][French/Francais]



GDAL is a translator library for raster geospatial data formats that is released under an X/MIT style Open Source license by the Open Source Geospatial Foundation. As a library, it presents a single abstract data model to the calling application for all supported formats. It also comes with a variety of useful commandline utilities for data translation and processing. The NEWS page describes the May 2012 GDAL/OGR 1.9.1 release.

The related OGR library (which lives within the GDAL source tree) provides a similar capability for simple features vector data.

Master: <http://www.gdal.org>

Download: ftp at remotesensing.org, http at download.osgeo.org

User Oriented Documentation

- [Wiki](#) - Various user and developer contributed documentation and hints
- [Downloads](#) - Ready to use binaries (executables)
- [Supported Formats](#) : GeoTIFF, Erdas Imagine, SDTS, ECW, MrSID, JPEG2000, DTED, NITF, ...
- [GDAL Utility Programs](#) : gdalinfo, gdal_translate, gdaladdo, gdalwarp, ...
- [GDAL FAQ](#)
- [GDAL Data Model](#)
- [GDAL/OGR Governance and Community Participation](#)
- [GDAL Service Provider Listings \(not vetted\)](#)
- [Sponsors, Acknowledgements and Credits](#)
- [Software Using GDAL](#)

Developer Oriented Documentation

- [Building GDAL From Source](#)
- [Downloads - source code](#)
- [API Reference Documentation](#)
- [GDAL API Tutorial](#)
- [GDAL Driver Implementation Tutorial](#)
- [GDAL Warp API Tutorial](#)
- [OGRSpatialReference Tutorial](#)
- [GDAL C API](#)
- [GDAL Algorithms C API](#)
- [GDALDataset C++ API](#)
- [GDALRasterBand C++ API](#)
- [GDAL for Windows CE](#)

Mailing List

A [gdal-announce mailing list subscription](#) is a low volume way of keeping track of major developments with the GDAL/OGR project.

The gdal-dev@lists.osgeo.org mailing list can be used for discussion of development and user issues related to GDAL and related technologies. Subscriptions can be done, and archives reviewed [on the web](#). The mailing list is also available in read-only format by NNTP at <news://news.gmane.org/gmane.comp.gis.gdal.devel> and by HTTP at <http://news.gmane.org/gmane.comp.gis.gdal.devel>. Archives since 2005 are searchable on [Nabble](#).

Some GDAL/OGR users and developers can also often be found in the [gdal](#) IRC channel on irc.freenode.net.

Bug Reporting

GDAL bugs can be reported, and can be listed using [Trac](#).

GDAL In Other Languages

MBTiles

Starting with GDAL 2.0, the MBTiles driver allows to read rasters in the MBTiles format, which is a specification for storing tiled map data in SQLite databases.

GDAL/OGR must be compiled with OGR SQLite driver support, and JPEG and PNG drivers.

The SRS is always the Pseudo-Mercator (a.k.a Google Mercator) projection.

The driver can retrieve pixel attributes encoded according to the UTFGrid specification available in some MBTiles files. They can be obtained with the `gdallocationinfo` utility, or with a `GetMetadataItem("Pixel_iCol_iLine", "LocationInfo")` call on a band object.

Examples:

- Accessing a remote MBTiles raster :

```
$ gdalinfo /vsicurl/http://a.tiles.mapbox.com/v3/kkaefer.iceland.mbtiles
```

Output:

```
Driver: MBTiles/MBTiles
Files: /vsicurl/http://a.tiles.mapbox.com/v3/kkaefer.iceland.mbtiles
Size is 16384, 16384
Coordinate System is:
PROJCS["WGS 84 / Pseudo-Mercator",
  GEOGCS["WGS 84",
    DATUM["WGS_1984",
      SPHEROID["WGS 84",6378137,298.257223563,
        AUTHORITY["EPSG","7030"]],
      AUTHORITY["EPSG","6326"]],
    PRIMEM["Greenwich",0,
      AUTHORITY["EPSG","8901"]],
    UNIT["degree",0.0174532925199433,
      AUTHORITY["EPSG","9122"]],
    AUTHORITY["EPSG","4326"]],
  PROJECTION["Mercator_1SP"],
  PARAMETER["central_meridian",0],
  PARAMETER["scale_factor",1],
  PARAMETER["false_easting",0],
  PARAMETER["false_northing",0],
  UNIT["metre",1,
    AUTHORITY["EPSG","9001"]],
  AXIS["X",EAST],
  AXIS["Y",NORTH],
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  AUTHORITY["EPSG","3857"]]]
Origin = (-3757031.2500000000000000,11271093.7500000000000000)
Pixel Size = (152.873992919921875,-152.873992919921875)
Image Structure Metadata:
  INTERLEAVE=PIXEL
Corner Coordinates:
Upper Left  (-3757031.250,11271093.750) ( 33d44'59.95"W, 70d36'45.36"N)
Lower Left  (-3757031.250, 8766406.250) ( 33d44'59.95"W, 61d36'22.97"N)
Upper Right (-1252343.750,11271093.750) ( 11d14'59.98"W, 70d36'45.36"N)
Lower Right (-1252343.750, 8766406.250) ( 11d14'59.98"W, 61d36'22.97"N)
```

TileStache is a Python-based server application that can serve up map tiles based on rendered geographic data.

You might be familiar with [TileCache](#), the venerable open source WMS server from MetaCarta. TileStache is similar, but we hope simpler and better-suited to the needs of designers and cartographers.

Read more about the motivations behind TileStache in an [introductory blog post](#).

Get TileStache: [on GitHub](#), [from PyPI via easy_install](#), and as a [direct download here](#). Modest Maps ([Github](#), [PyPI](#), [download](#)) is required to use TileStache.

See also [documentation](#), and ask for help in [the Tilestache group](#).



Mustaches: [IMG_7531](#) by [locaburg](#), on Flickr.

Features

Things TileStache does now:

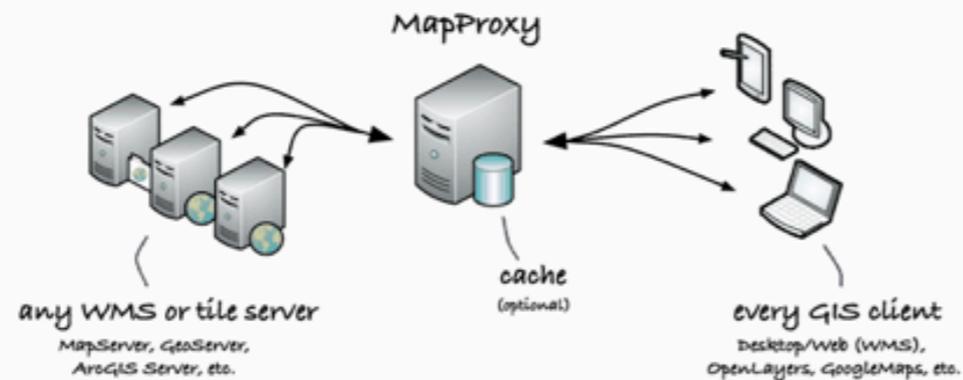
- Renders [Mapnik](#) maps.
- Serves pre-rendered tiles out of [MBTiles](#) tilesets.
- Generates vector tiles from [OGR](#) datasources in [GeoJSON](#) usable in [Polymaps](#).
- Caches to disk, [Memcache](#), [Amazon S3](#), [MBTiles](#), and elsewhere.
- Serves tiles in Google-style spherical mercator projection and WGS84 lat/lon projection.

MapProxy

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About

MapProxy is an open source proxy for geospatial data. It caches, accelerates and transforms data from existing map services and serves any desktop or web GIS client.



MapProxy is a tile cache solution, but also offers many new and innovative features like full support for WMS clients.

MapProxy is actively developed and supported by [Omniscale](#), it is released under the [Apache Software License 2.0](#), runs on Unix/Linux and Windows and is [easy to install and to configure](#).

News

- 2012-05-15: [New MapProxy 1.4.0 release](#)
- 2012-01-13: [New MapProxy 1.3.0 release](#)
- 2011-08-31: [New MapProxy 1.2.0 release](#)
- 2011-06-26: [New MapProxy 1.1.1 release](#)
- 2011-05-31: [New MapProxy 1.1.0 release](#)

Features of MapProxy

Tile cache

MapProxy is a tile server (WMS-C, TMS, WMTS, KML SuperOverlays)

It reads data from:

- WMS sources (1.0.0–1.3.0)
- TMS/WMTS sources
- Mapserver and Mapnik configurations
- any TileCache, Google Maps or Bing compatible source

Other features:

- cache data on filesystem, as MBTiles or inside CouchDB
- reproject WMS sources to other SRS
- stores identical images just once (e.g. ocean tiles)



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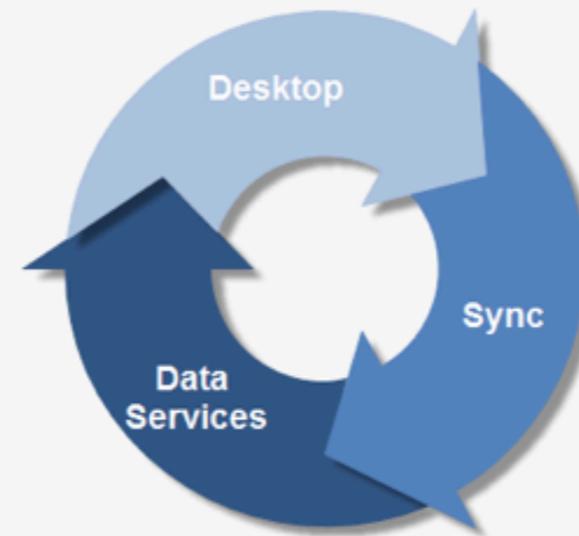
Tools and Services for ArcGIS

Desktop KML and Tile Cache Creation

View Google Maps directly in ArcGIS

Synchronize your ArcGIS data with multiple Cloud providers

[Learn More](#)

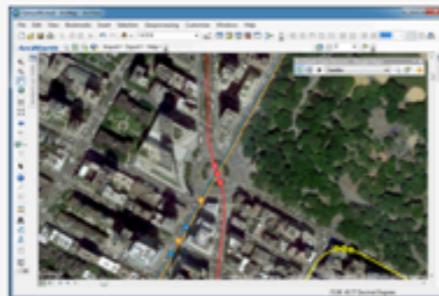


[Overview](#)

[Arc2Earth Desktop](#)

[Arc2Earth Data Services](#)

[Arc2Earth Sync](#)



New Version of Data Services

You asked for it and we listened. Printing, exporting, layout view, multiple projections and more! New monthly subscriptions also let you get started for just \$49/month! Check out the all new [Data Services](#)

NEWS FROM THE BLOG



- [Arc2Earth Sync – Live Mobile Data Collection in 5 Minutes](#)
- [Table Sharing in Arc2Earth Sync](#)
- [New Provider Model and CartoDB Provider for Sync](#)



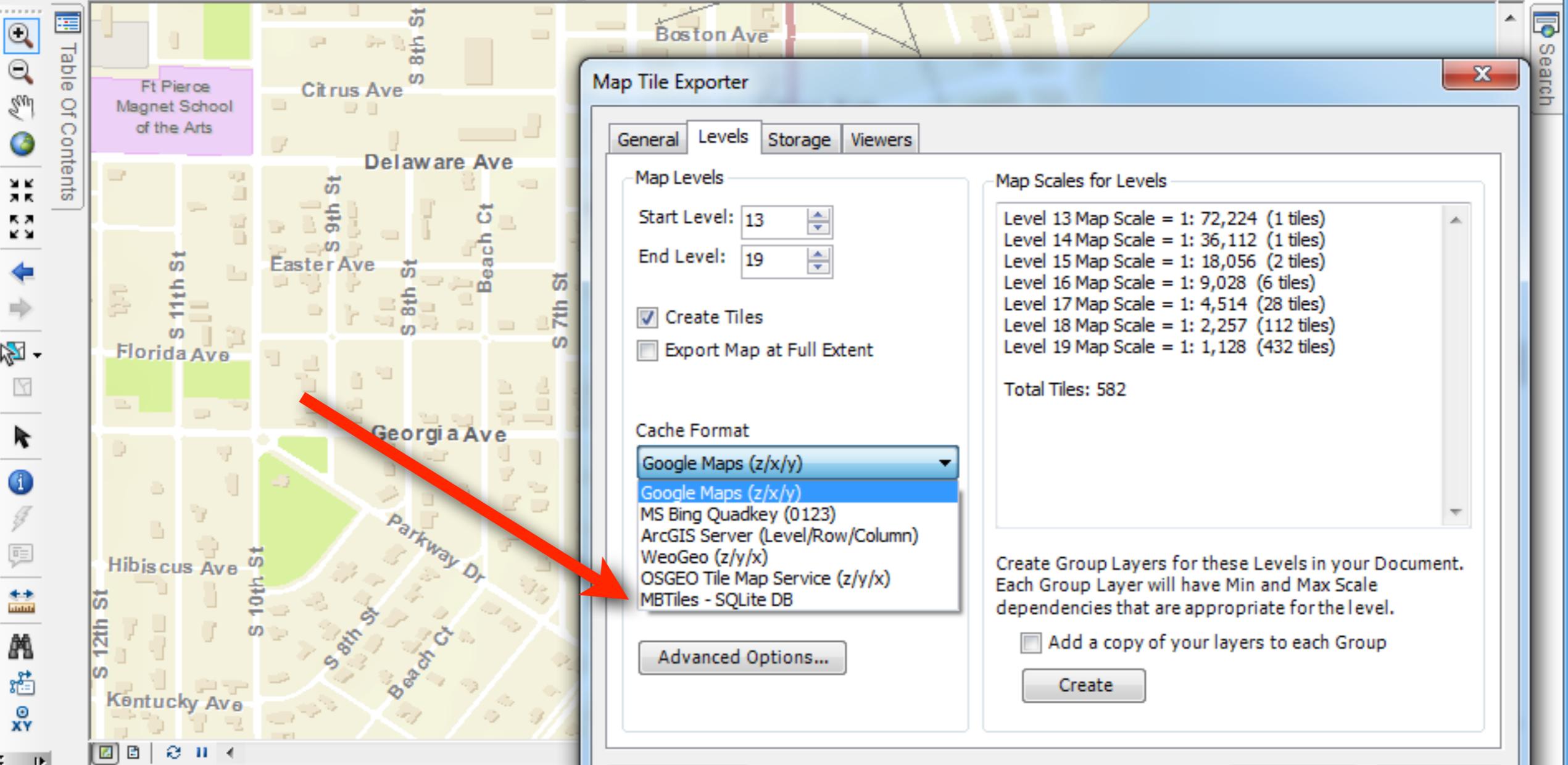
Arc2Earth Sync Public Beta

Try out [Sync](#) for your ArcGIS data. Update Fusion Tables, Earth Builder or CartoDB from ArcMap. ArcGIS.com support tool.

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RT @NLTMarketing: New Blog Post - Arc2Earth Has a New Product Called Sync by William



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9

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------	---------	-----------------	-----------	------	--------

specification documents for the MBTiles tileset format — [Read more](#)
<http://mbtiles.org/>

Clone in Mac ZIP HTTP SSH Git Read-Only git@github.com:mapbox/mbtiles-spec.git Read+Write access

branch: master

Files

Commits

Branches 2

Tags

Downloads

Latest commit to the master branch

Reformat Implementations link

tmcw authored a month ago

commit 5afa38ead7

mbtiles-spec /

name	age	message	history
1.0	a year ago	Updating 1.0 [Tom MacWright]	
1.1	10 months ago	Line-breaking 1.1 spec, expanding README [tmcw]	
1.2	7 months ago	Add link to utfgrid-spec. [willwhite]	
README.md	a month ago	Reformat Implementations link [tmcw]	

README.md

MBTiles Specification

MBTiles is a specification for storing tiled map data in [SQLite](#) databases for immediate usage and for transfer. MBTiles files, known as **tilesets**, must implement the specification below to ensure compatibility with devices.



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branch: master **Files** Commits Branches 2 Tags Downloads

mbtiles-spec / 1.1

name	age	message	history
..			
demo.json	a year ago	add demo file to test implementations [kkaefer]	
interaction.md	a year ago	Add interaction.md, remove formatter.md [yhahn]	
spec.md	10 months ago	Line-breaking 1.1 spec, expanding README [tmcw]	
utfgrid.md	a year ago	clarify codepoint ranges [kkaefer]	



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branch: master Files Commits Branches 2 Tags Downloads

mbtiles-spec / 1.1 / spec.md

tmcw 10 months ago Line-breaking 1.1 spec, expanding README

3 contributors

100644 | 85 lines (54 sloc) | 2.923 kb Edit this file Raw Blame History

MBTiles 1.1

Sub-sections:

- Interaction: HTTP endpoints needed for implementing interactivity
- UTFGrid: storage of data used for interactivity

Abstract

MBTiles is a specification for storing tiled map data in [SQLite](#) databases for immediate usage and for transfer. MBTiles files, known as **tilesets**, must implement the specification below to ensure compatibility with devices.

Database Specifications

Tilesets are expected to be valid SQLite databases of [version 3.0.0](#) or higher. Only core SQLite features are permitted; tilesets **cannot** require extensions.

Database

Implementations

1.1 Compliant

- [MapBox Hosting](#)
- [TileStream](#)
- [MapBox iOS SDK \(example\)](#)
- [GDAL](#)
- python: [raster2mb](#) (write)
- python: [mbutil](#) (read/write)
- python: [landez](#) (read/write) (uses mbutil)
- python: [TileStache \(code\)](#) (read/write) - a full, high-quality tile server
- python: [TileCloud](#)
- [Arc2Earth](#) (write)
- python: [mapproxy \(announcement\)](#) (read/write)

Others

- python/Django: [django-mbtiles](#)
- objc: [MapDBImporter](#) (write)
- java/android: [MBTilesDroidSpitter \(example\)](#) (read)
- objc/iPhone: [Maptual](#) (read)
- java/Android: [Locus](#) (read)
- Windows compatible viewer: [MBTilesViewer](#) (read)
- java/Android: [Nutiteq SDK](#)
- Python: [MBTiles-Extractor](#)
- Java/Processing: [Unfolding](#) (read) (example)

Applications

- [MapBox for iPad](#) (read)
- js: [TileMill](#) (write)
- [TileMill OS X QuickLook & Spotlight plugins](#) (read)

Last edited by [tillnagel](#), 5 days ago

[Delete this Page](#)

Unrelated SQLite Stuff

- R*Tree
- SpatiaLite
- Don't needlessly complicate

Further Benefits

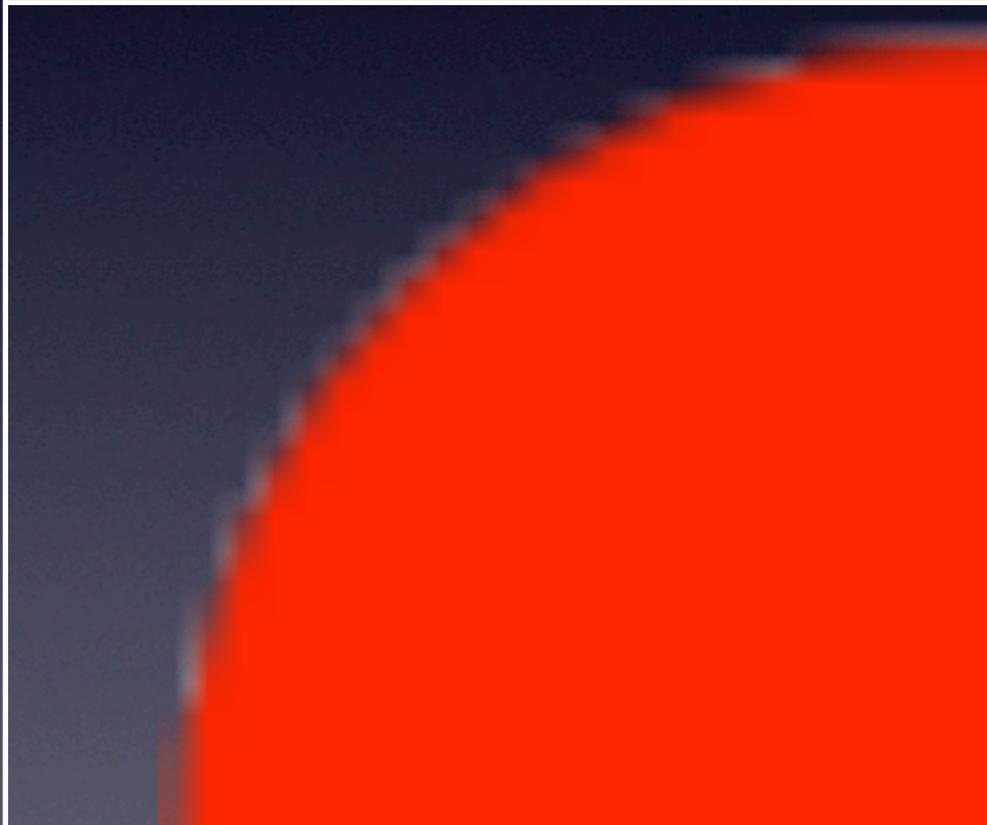
- Reduced filesystem overhead
 - 3GB → 1GB → 300MB
- De-duplication
 - Blue ocean tiles, light sand tiles, etc.
- Vector tiles
 - Binary blob per row (again)
 - We're already doing this with UTFGrid

Future Plans

- Vector tiles
 - Efficiently store *source data* client-side
- Client-side rendering
 - Style on-the-fly
- Overzooming

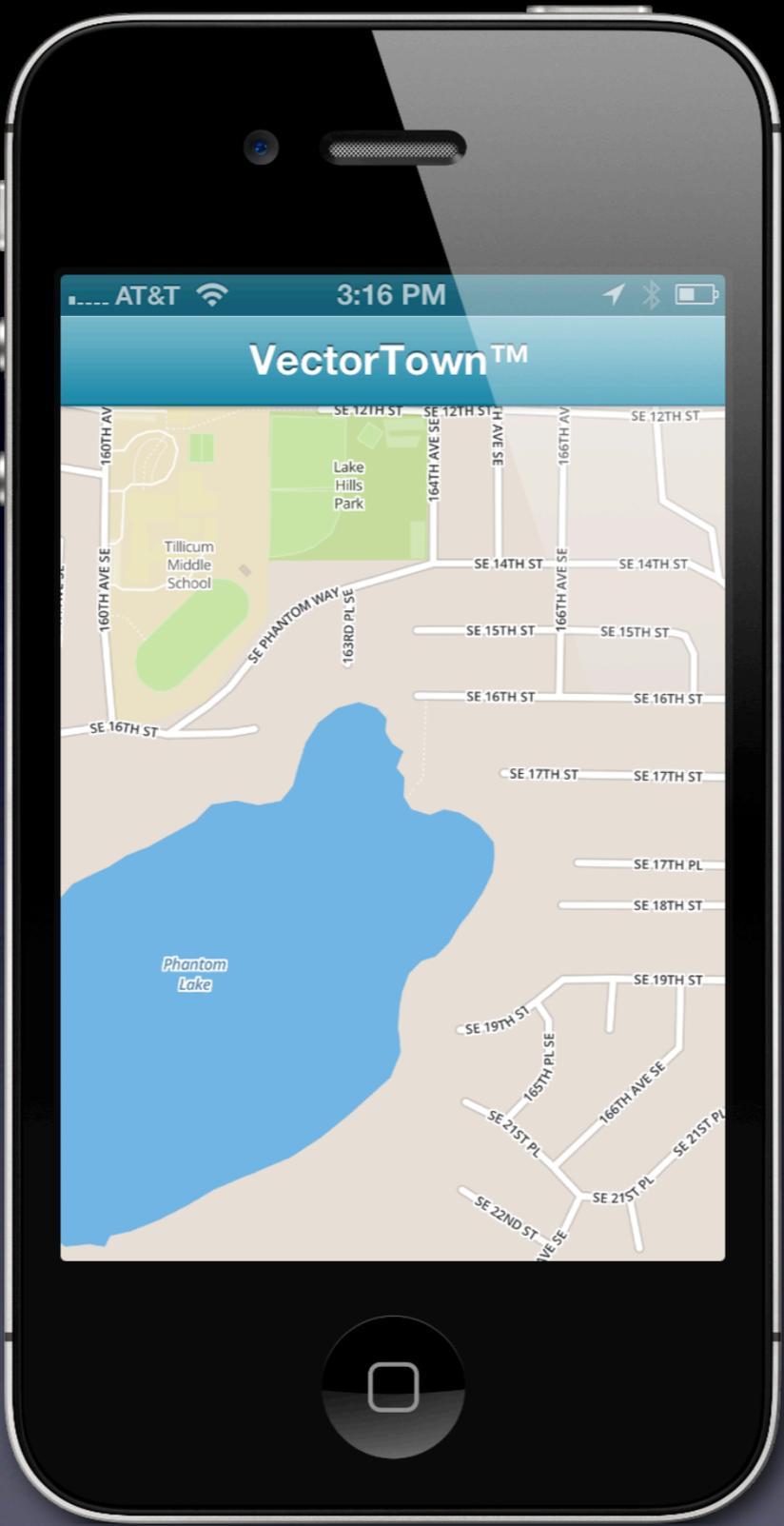
Overzooming

Raster



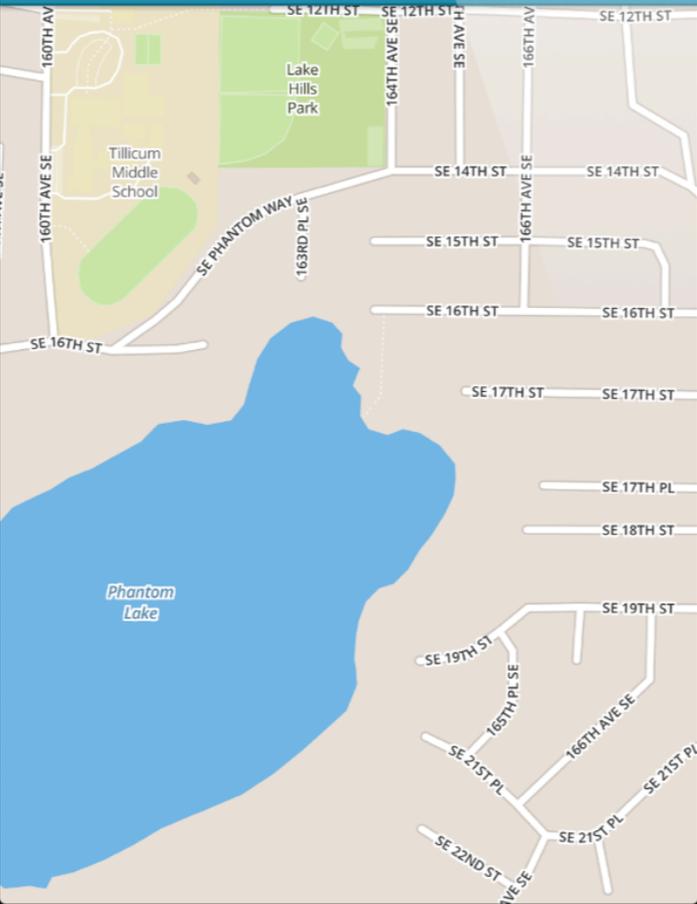
Vector

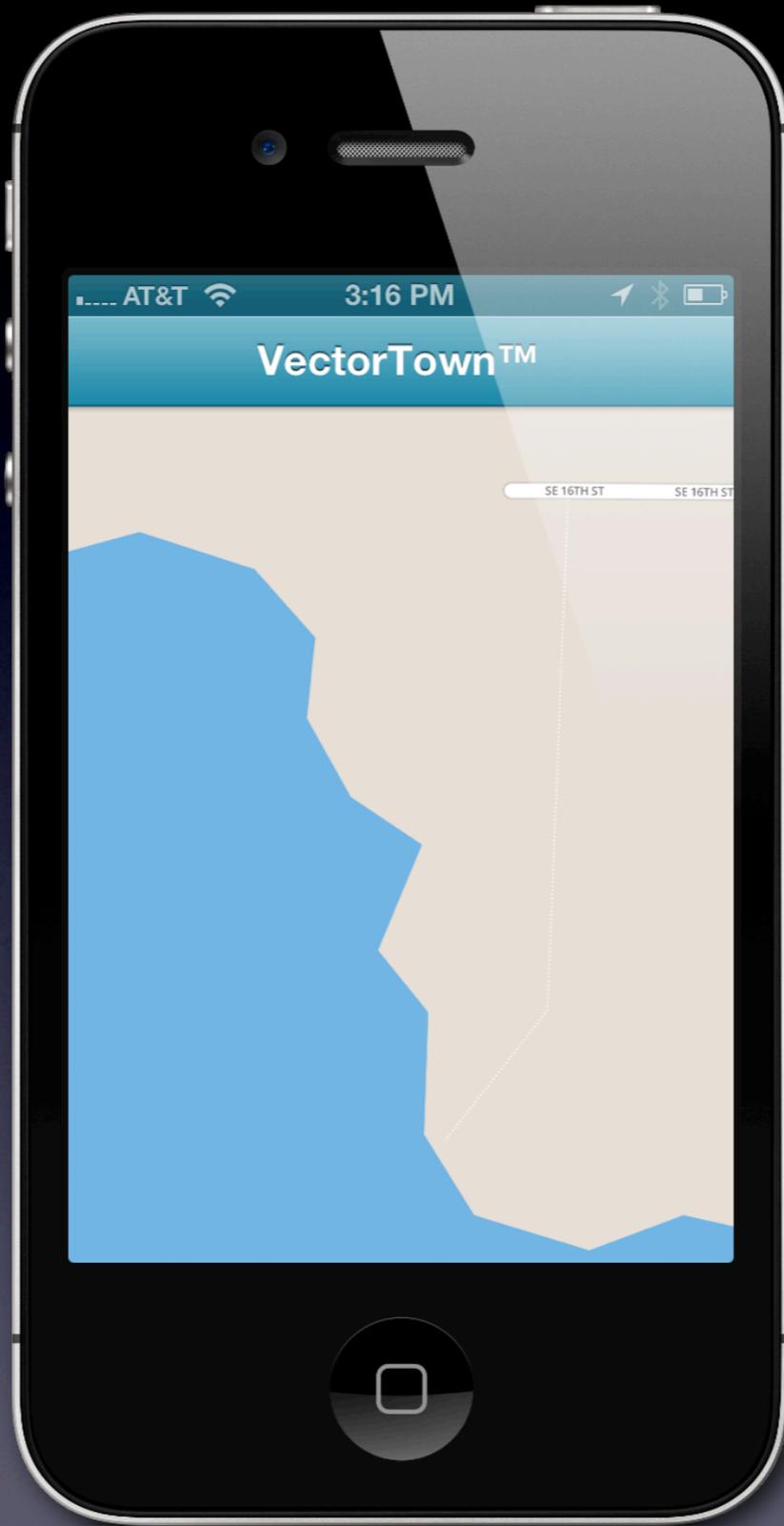
1. Start at the top right
2. Draw a curve to the bottom left
3. Fill with red

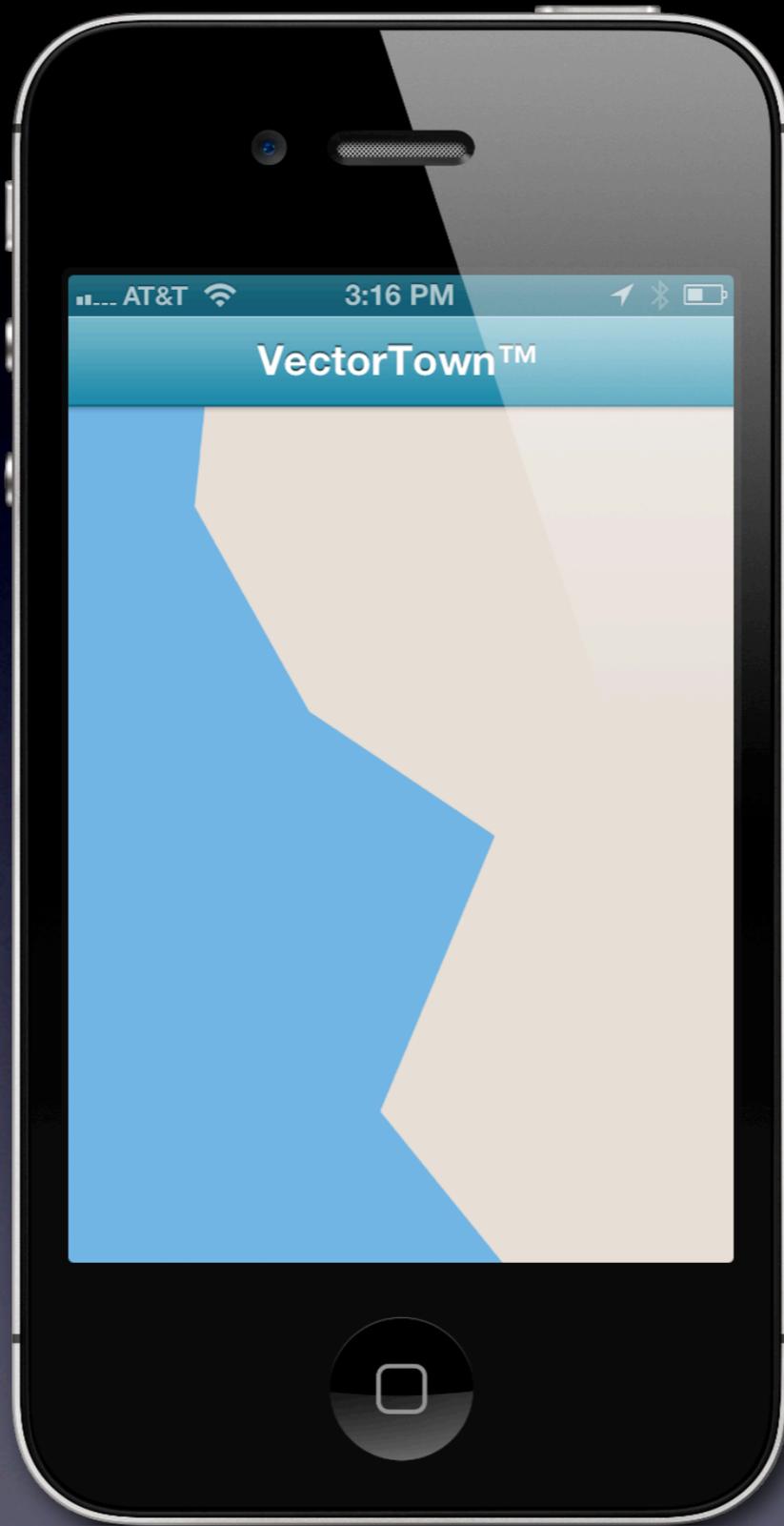


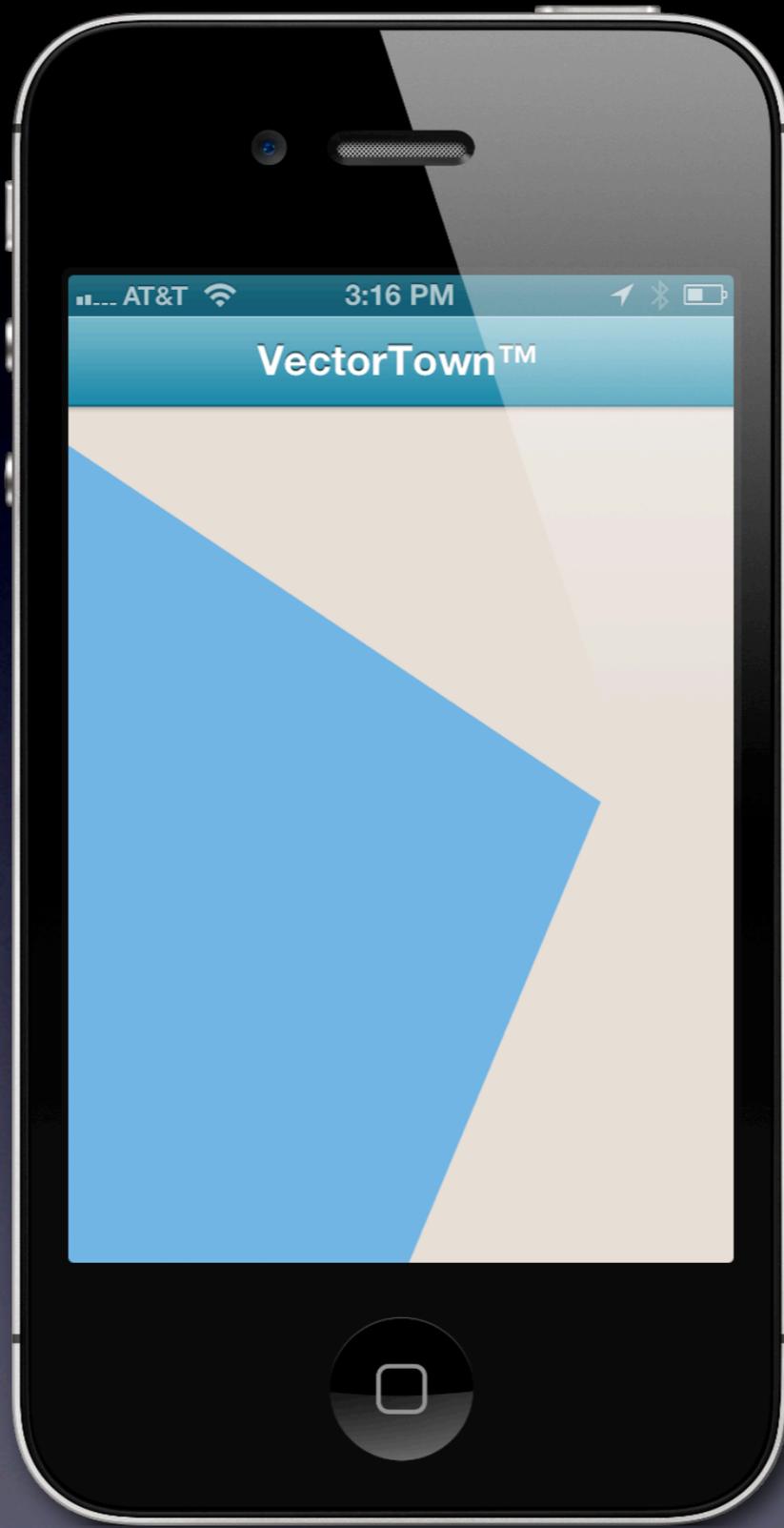
AT&T 3:16 PM

VectorTown™









Recap

- Open data - OSM, file formats
- Open source - TileMill, iOS SDK
- Open formats - MBTiles

Thank You!

- <http://mapbox.com/developers>
- <http://github.com/mapbox>
- justin@mapbox.com
- [@incanus77](#) (Twitter & App.net)
- Find me later!

