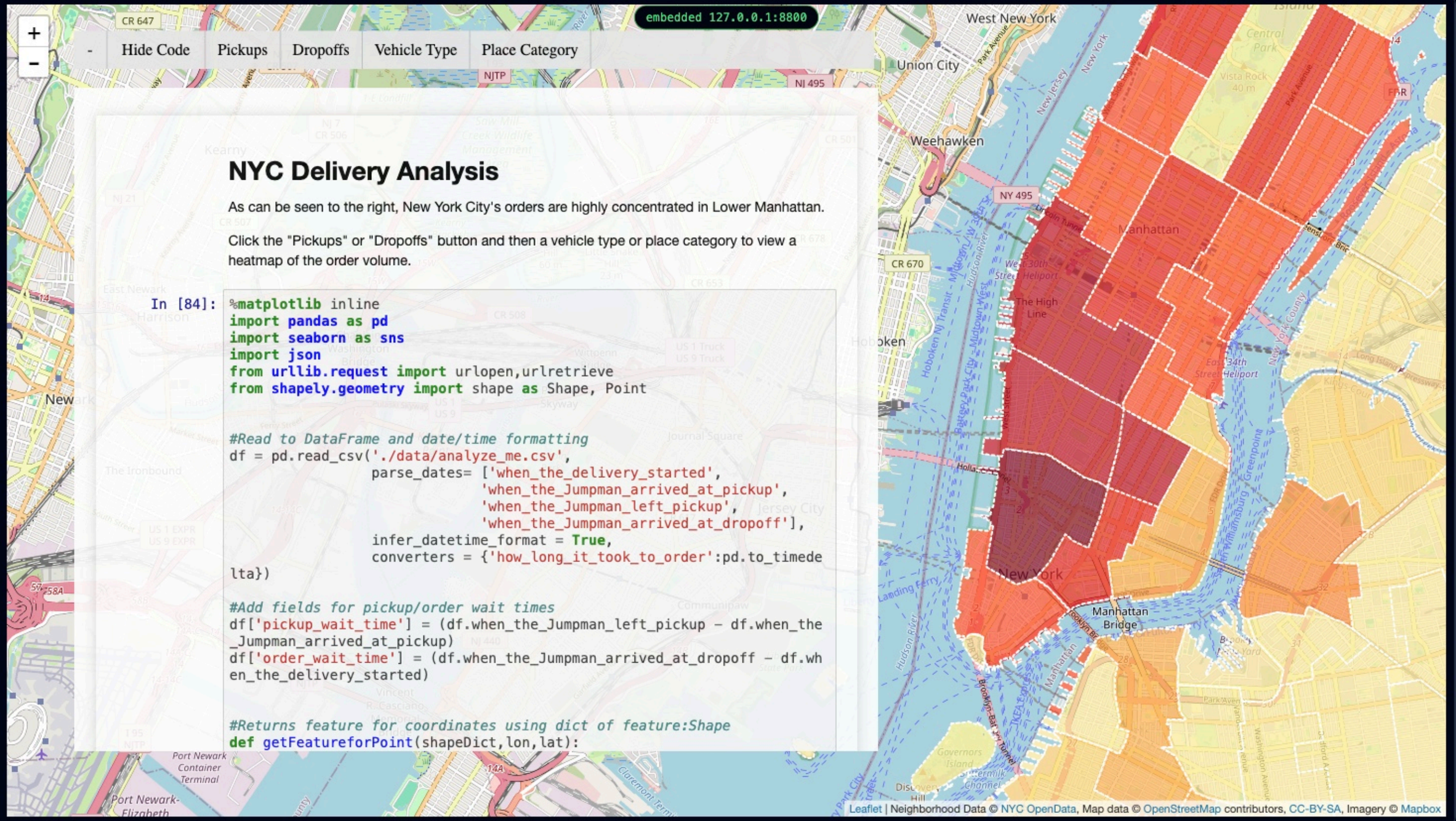
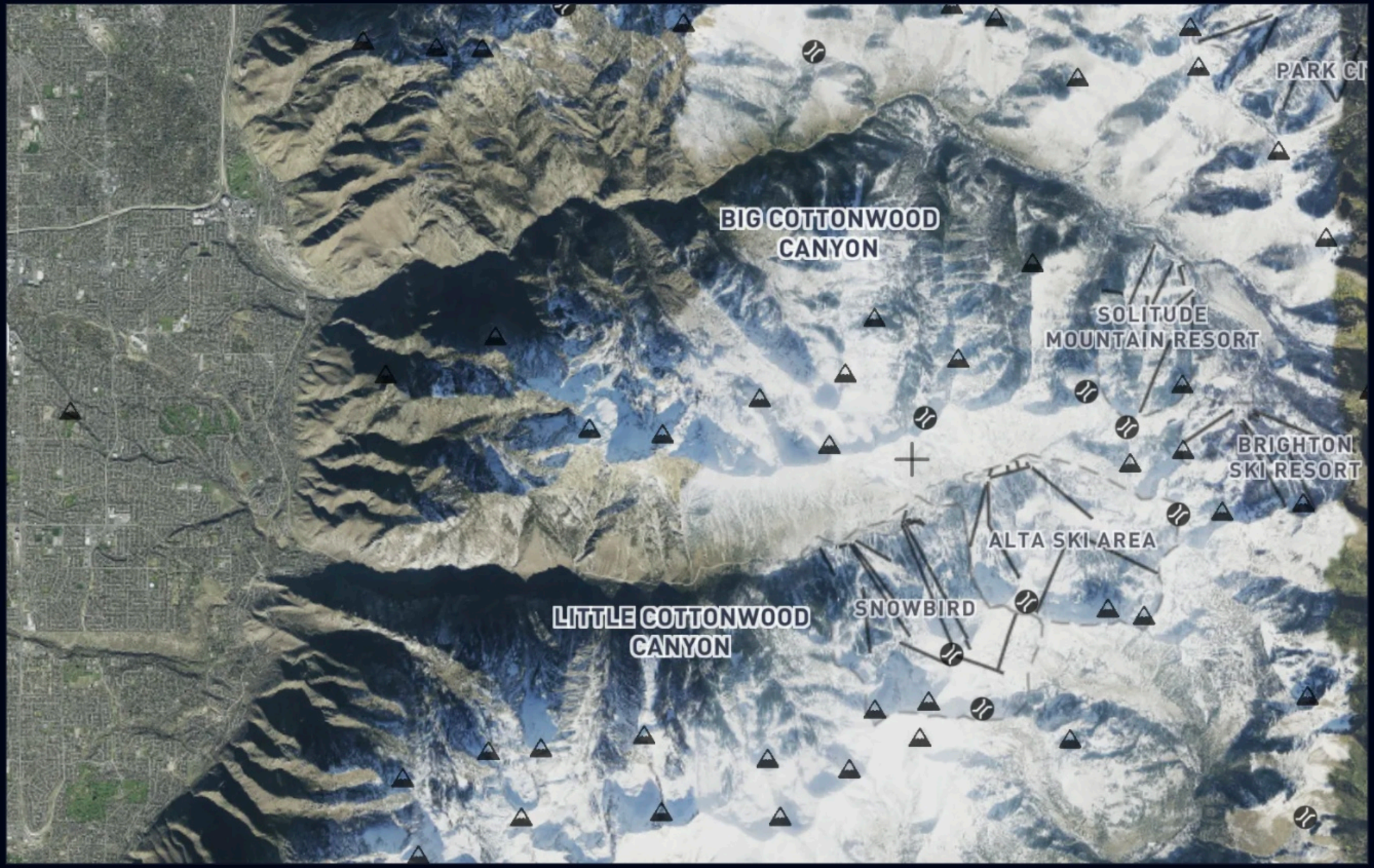
CNG NYC · COOPER UNION · SEPTEMBER 24, 2026

Adventures in Local-First Storage and Compute



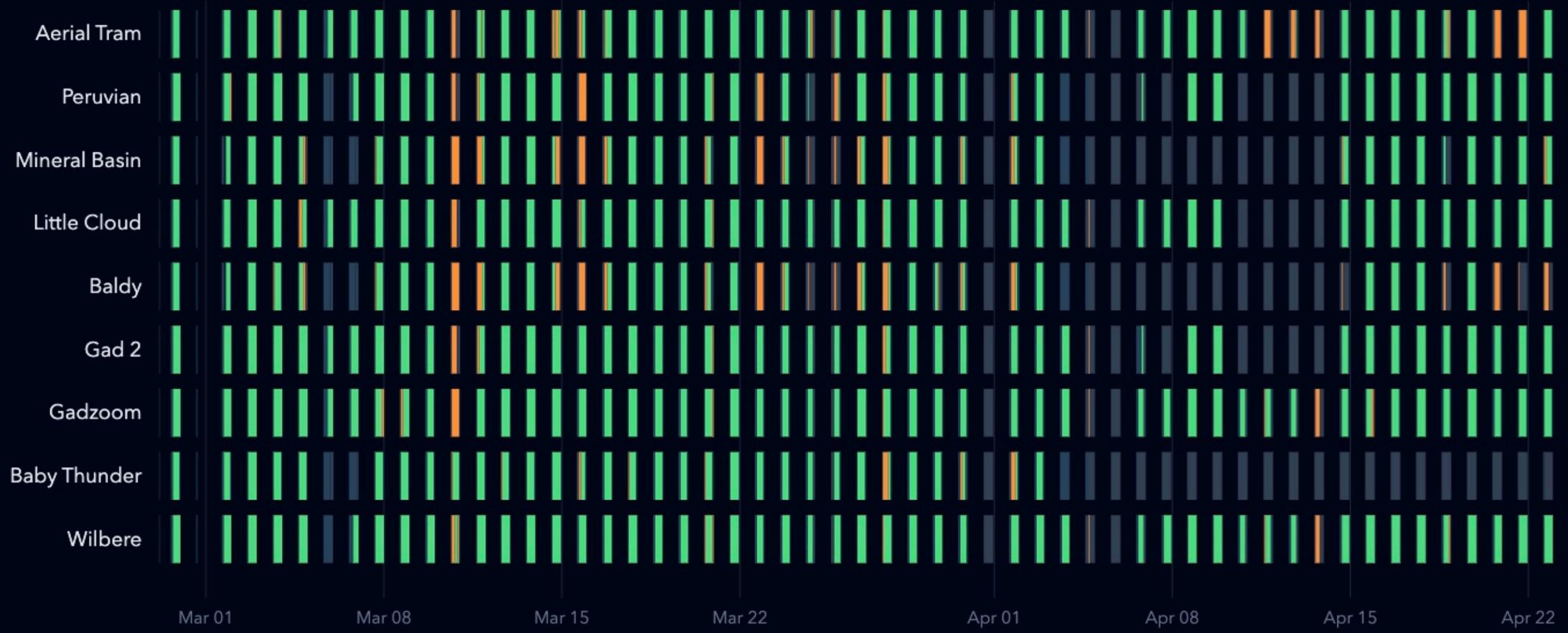

embedded 127.0.0.1:8800
-
Hide Code
Pickups
Dropoffs
Vehicle Type
Place Category
NYC Delivery Analysis
As can be seen to the right, New York City's orders are highly concentrated in Lower Manhattan.
Click the "Pickups" or "Dropoffs" button and then a vehicle type or place category to view a heatmap of the order volume.
In [84]:
%matplotlib inline
import pandas as pd
import seaborn as sns
import json
from urllib.request import urlopen,urlretrieve
from shapely.geometry import shape as Shape, Point
#Read to DataFrame and date/time formatting
df = pd.read_csv('./data/analyze_me.csv',
parse_dates= ['when_the_delivery_started',
'when_the_Jumpman_arrived_at_pickup',
'when_the_Jumpman_left_pickup',
'when_the_Jumpman_arrived_at_dropoff'],
infer_datetime_format = True,
converters = {'how_long_it_took_to_order':pd.to_timede
lta})
#Add fields for pickup/order wait times
df['pickup_wait_time'] = (df.when_the_Jumpman_left_pickup - df.when_the
_Jumpman_arrived_at_pickup)
df['order_wait_time'] = (df.when_the_Jumpman_arrived_at_dropoff - df.wh
en_the_delivery_started)
#Returns feature for coordinates using dict of feature:Shape
def getFeatureforPoint(shapeDict,lon,lat):
West New York
Union City
Weehawken
Manhattan
New York
Manhattan Bridge
Leaflet | Neighborhood Data © NYC OpenData, Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox


PARK CI
BIG COTTONWOOD
CANYON
SOLITUDE
MOUNTAIN RESORT
BRIGHTON
SKI RESORT
ALTA SKI AREA
SNOWBIRD
LITTLE COTTONWOOD
CANYON

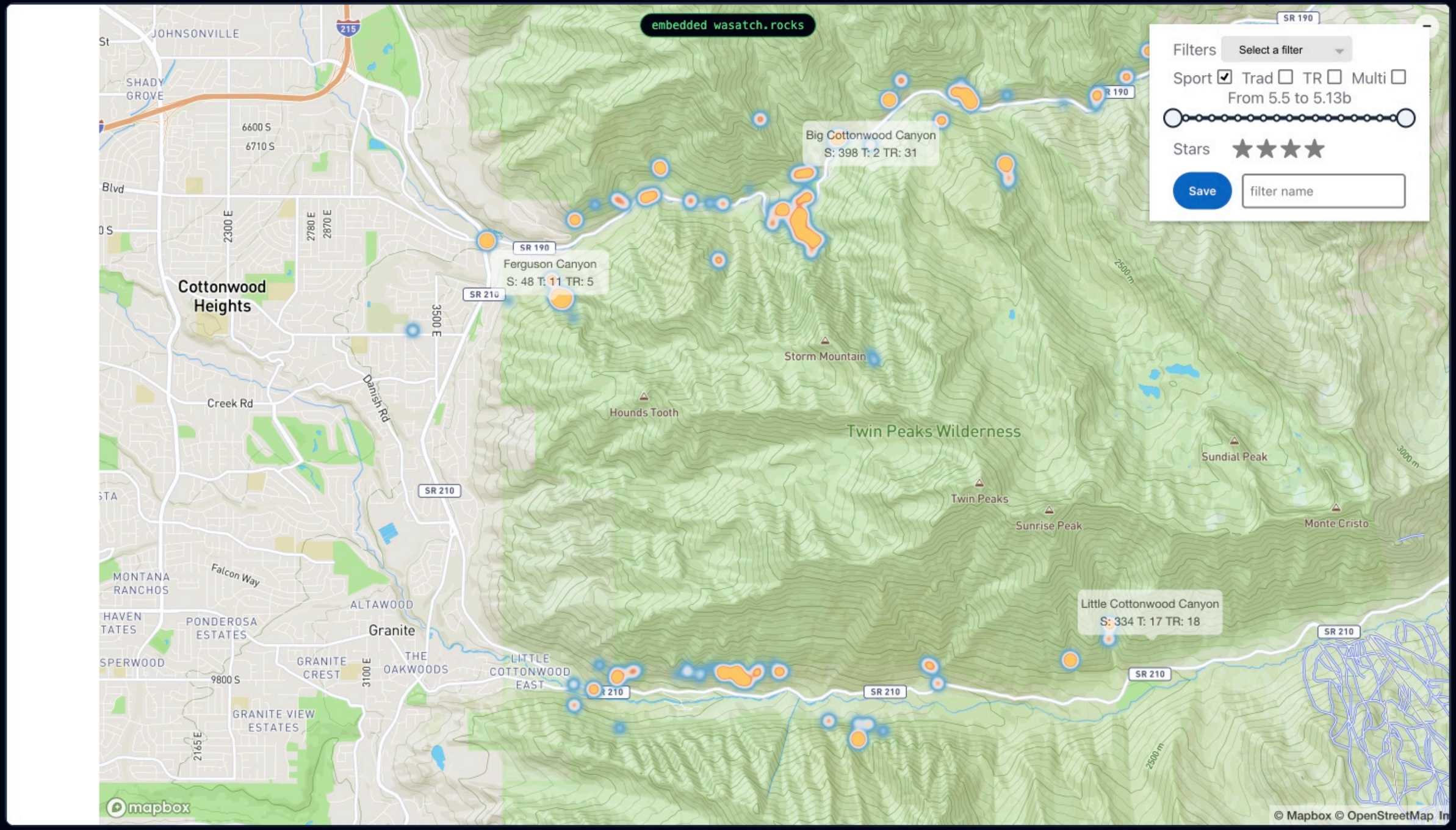
capture

Snowbird lift status, as wasatch.ski recorded it

542 snapshots, 27 Feb to 22 Apr 2023 · green open · orange on hold (control work, wind) · dim blue scheduled · slate closed · nightly closures give the daily striping



Snowbird lift status as wasatch.ski recorded it, 27 Feb to 22 Apr 2023.

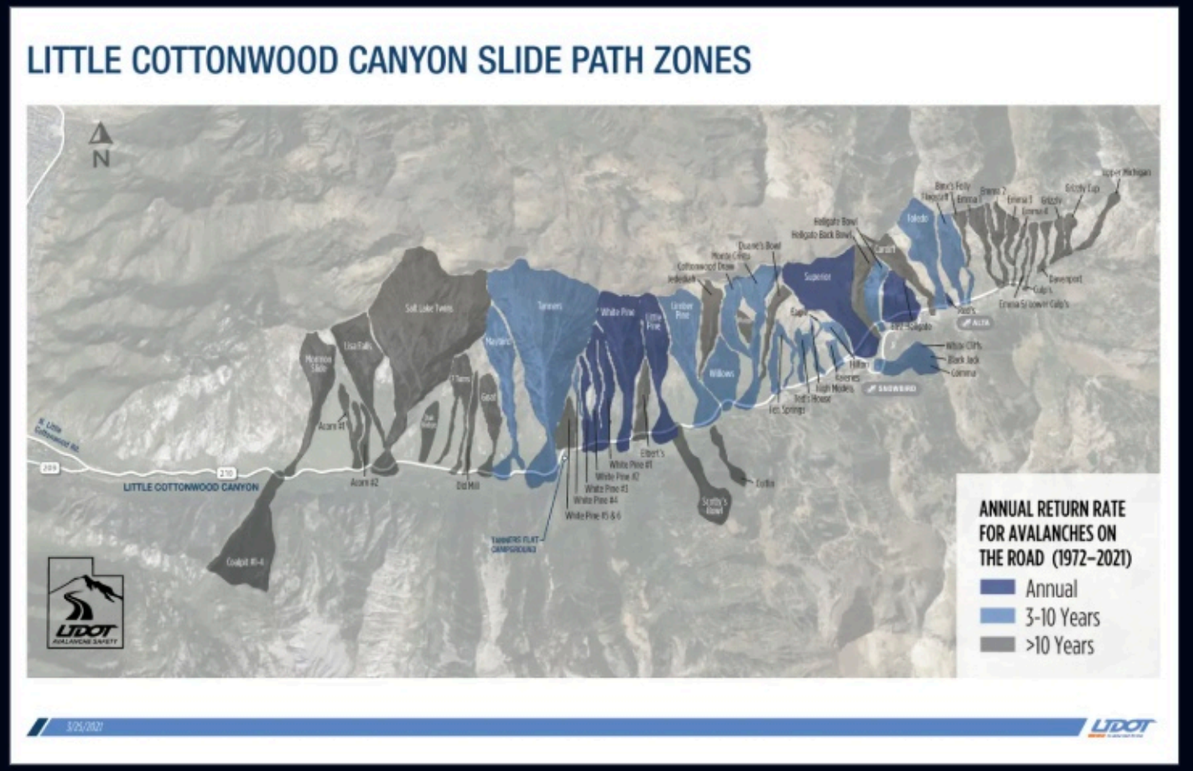

embedded wasatch.rocks
Filters
Select a filter
Sport
Trad
TR
Multi
From 5.5 to 5.13b
Stars
Save
filter name
Big Cottonwood Canyon
S: 398 T: 2 TR: 31
Ferguson Canyon
S: 48 T: 11 TR: 5
Little Cottonwood Canyon
S: 334 T: 17 TR: 18
Cottonwood Heights
Granite
Twin Peaks Wilderness
Storm Mountain
Hounds Tooth
Twin Peaks
Sunrise Peak
Sundial Peak
Monte Cristo
SR 190
SR 210
JOHNSONVILLE
SHADY GROVE
MONTANA RANCHOS
PONDEROSA ESTATES
ALTAWOOD
GRANITE CREST
THE OAKWOODS
LITTLE COTTONWOOD EAST
GRANITE VIEW ESTATES
Creek Rd
Danish Rd
Falcon Way
6600 S
6710 S
9800 S
2300 E
2780 E
2870 E
3500 E
3100 E
2165 E
2500 m
3000 m
mapbox
© Mapbox © OpenStreetMap





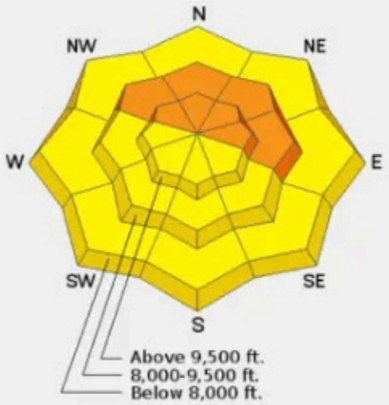
Switchback Travel, "Best Climbing Skins", switchbacktravel.com/skiing/best-climbing-skins: attaching Black Diamond Ascension skins; the tail clip.





Left: Canyon Services, "Little Cottonwood's Newest Master Gunner", canyonservices.com, March 2026. Right: UDOT Avalanche Safety, Little Cottonwood Canyon Slide Path Zones, 2021-03-25.

Tutorial: Reading the forecast



This section is a summary of our avalanche forecast including an overall danger rating and a "Danger Rose" which displays avalanche danger by aspect and elevation. This section highlights the most important avalanche information for the day.

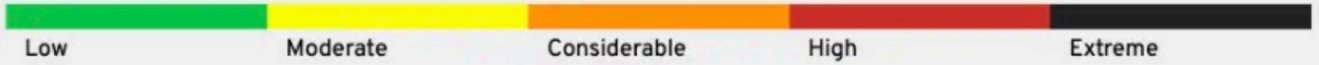
Danger Ratings include 5 levels.

LOW-MODERATE-CONSIDERABLE-HIGH-EXTREME

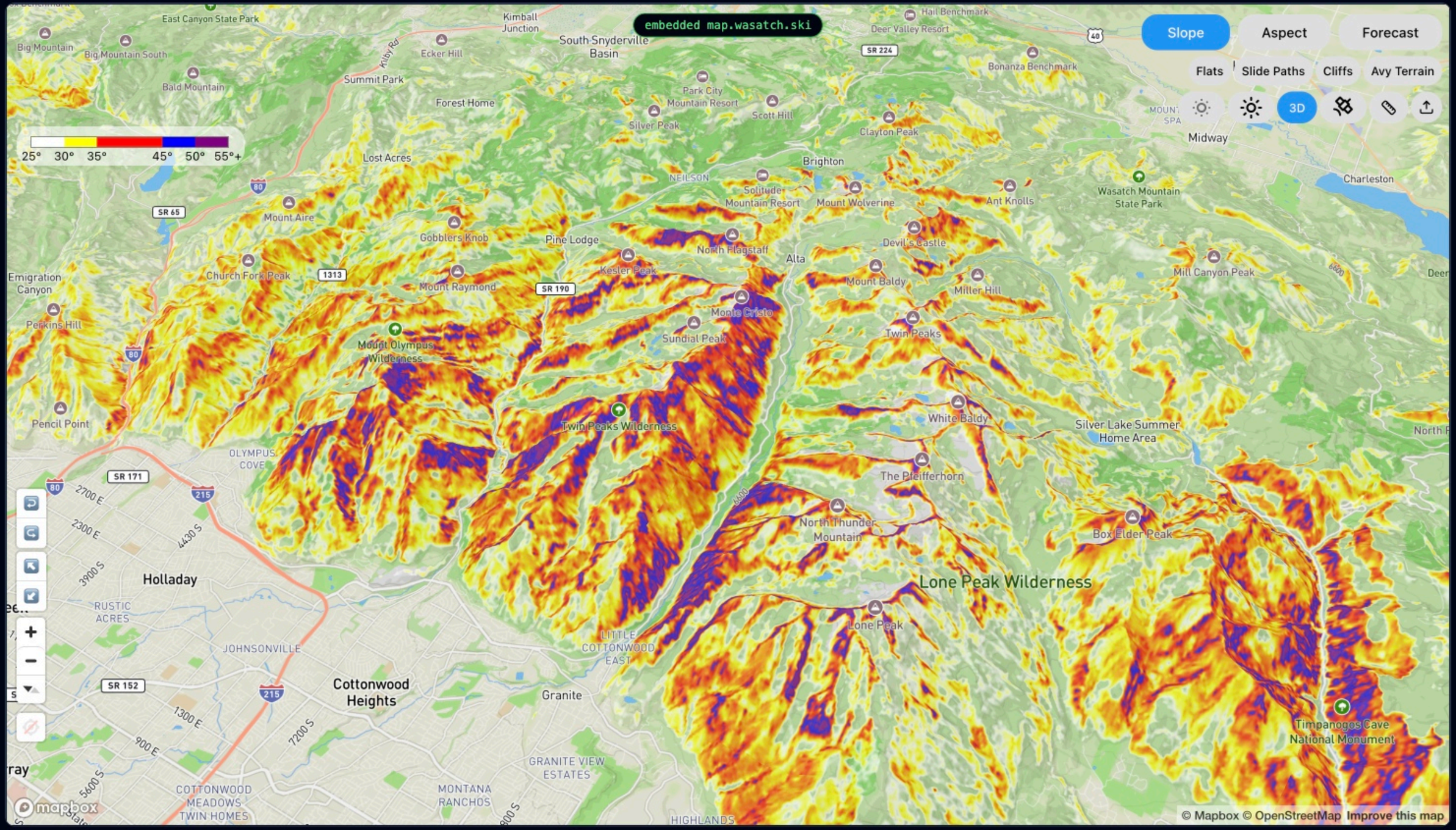
MORE INFO ON DANGER RATINGS HERE

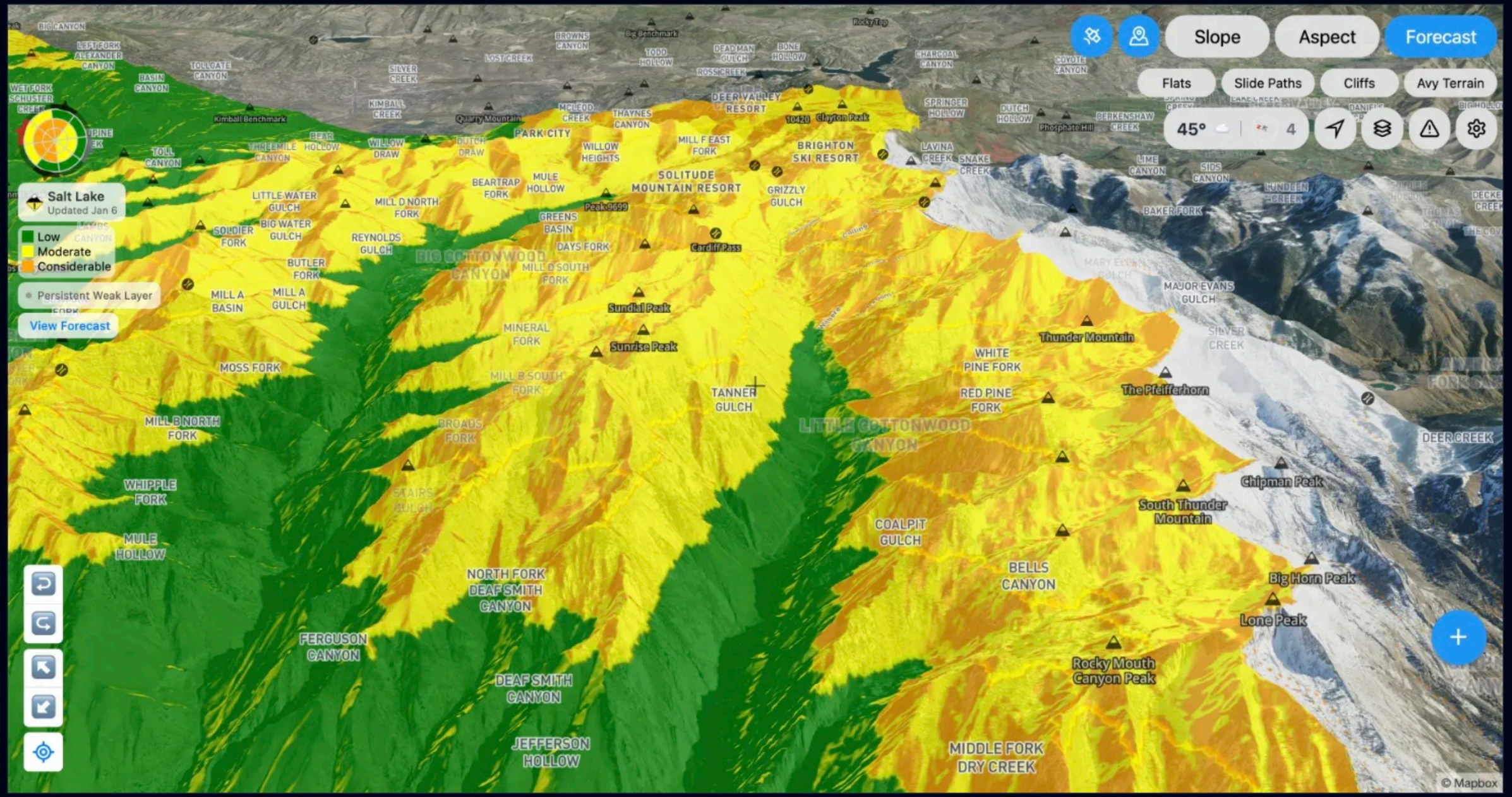
The "Danger Rose" is a general representation of how avalanche danger varies across terrain by aspect and elevation. In the example diagram, the danger is CONSIDERABLE for elevations between 8000' to 9500' and above 9500' and terrain that faces northwest, north and northeast. and east.

MORE INFO ON THE DANGER ROSE HERE

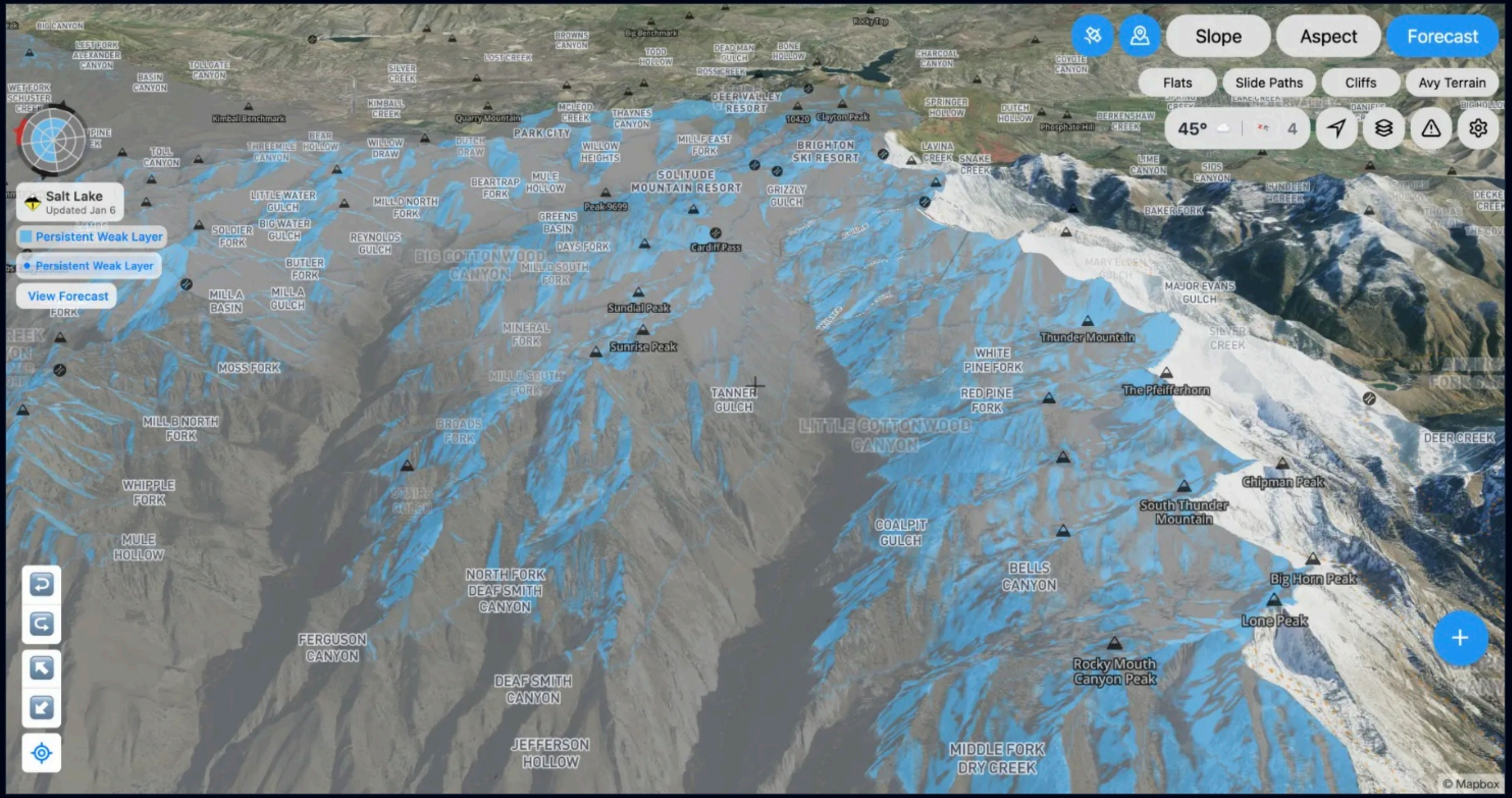


Utah Avalanche Center, "Tutorial: Reading the forecast", utahavalanchecenter.org/forecast/tutorial, captured 2026-09-22.


embedded map.wasatch.ski
Slope
Aspect
Forecast
Flats
Slide Paths
Cliffs
Avy Terrain
3D
25°
30°
35°
45°
50°
55°+
East Canyon State Park
Big Mountain
Big Mountain South
Bald Mountain
Kimball Junction
Ecker Hill
Summit Park
Forest Home
South Snyderville Basin
Park City Mountain Resort
Silver Peak
Scott Hill
Hail Benchmark
Deer Valley Resort
Bonanza Benchmark
Clayton Peak
Midway
Charleston
Wasatch Mountain State Park
Lost Acres
Brighton
Solitude Mountain Resort
Mount Wolverine
Ant Knolls
Mount Aire
Gobblers Knob
Pine Lodge
North Flagstaff
Devil's Castle
Alta
Kesler Peak
Mount Baldy
Miller Hill
Mill Canyon Peak
Emigration Canyon
Church Fork Peak
Mount Raymond
Monte Cristo
Sundial Peak
Twin Peaks
Perkins Hill
Mount Olympus Wilderness
Pencil Point
Twin Peaks Wilderness
White Baldy
Silver Lake Summer Home Area
OLYMPUS COVE
The Pfeifferhorn
North Thunder Mountain
Box Elder Peak
Holladay
RUSTIC ACRES
Lone Peak Wilderness
Lone Peak
LITTLE COTTONWOOD EAST
JOHNSONVILLE
Cottonwood Heights
Granite
Timpanogos Cave National Monument
GRANITE VIEW ESTATES
COTTONWOOD MEADOWS TWIN HOMES
MONTANA RANCHOS
HIGHLANDS
SR 65
SR 190
SR 224
SR 171
SR 152
1313
2700 E
2300 E
4430 S
3900 S
1300 E
900 E
7200 S
5600 S
mapbox
© Mapbox © OpenStreetMap Improve this map



mtnmap.app as deployed, forecast layer, Little Cottonwood Canyon looking east: the overall danger in the Salt Lake forecast for January 6, 2025, served to the app on 2026-09-22. Not a current forecast.



mtnmap.app as deployed, forecast layer, Little Cottonwood Canyon looking east: the persistent weak layer problem in the Salt Lake forecast for January 6, 2025, served to the app on 2026-09-22. Not a current forecast.

WHAT I WANTED ONE APP TO ANSWER



HIKING

Which hikes have shade?

When should I start to stay in it?

Which hikes see the city?



SKIING

What is the snow cover here?

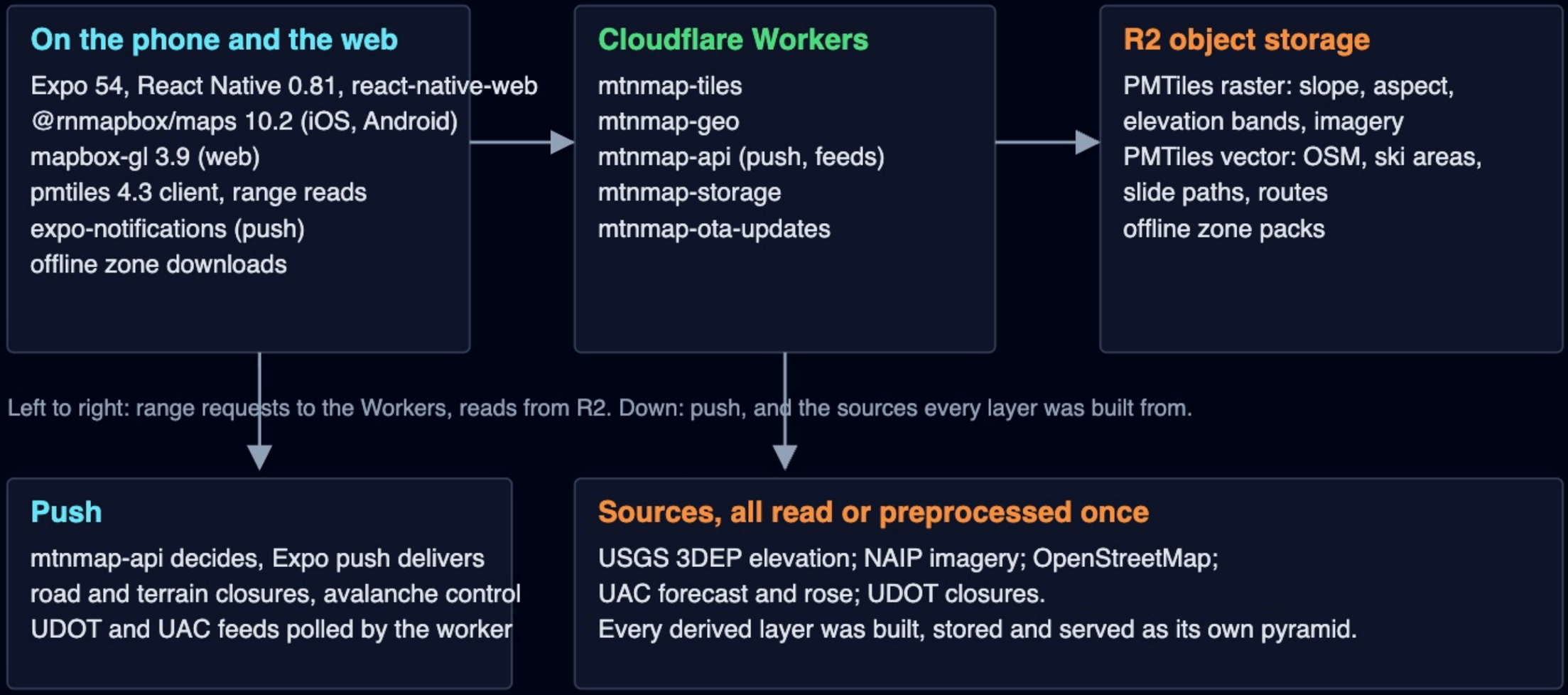


CLIMBING

Which routes are in the sun?

MtnMap v1

Web, iOS, Android





THE CONSTRAINTS

1. One codebase for web and native.
2. Works offline, computation included.
3. Free or low cost, for me and for users.
4. Search, draw and analyze vector data offline.
5. Use open data where it lives; host as little as possible.
6. Layers share inputs: one DEM for elevation, slope and aspect.

What to read, what to host

Utah, NAIP 2021: 6,032 images. Pre-generate tiles and host them, or host an index and read the open source?

At the source: NAIP on Planetary Computer
4-band COGs, public domain, read by range request

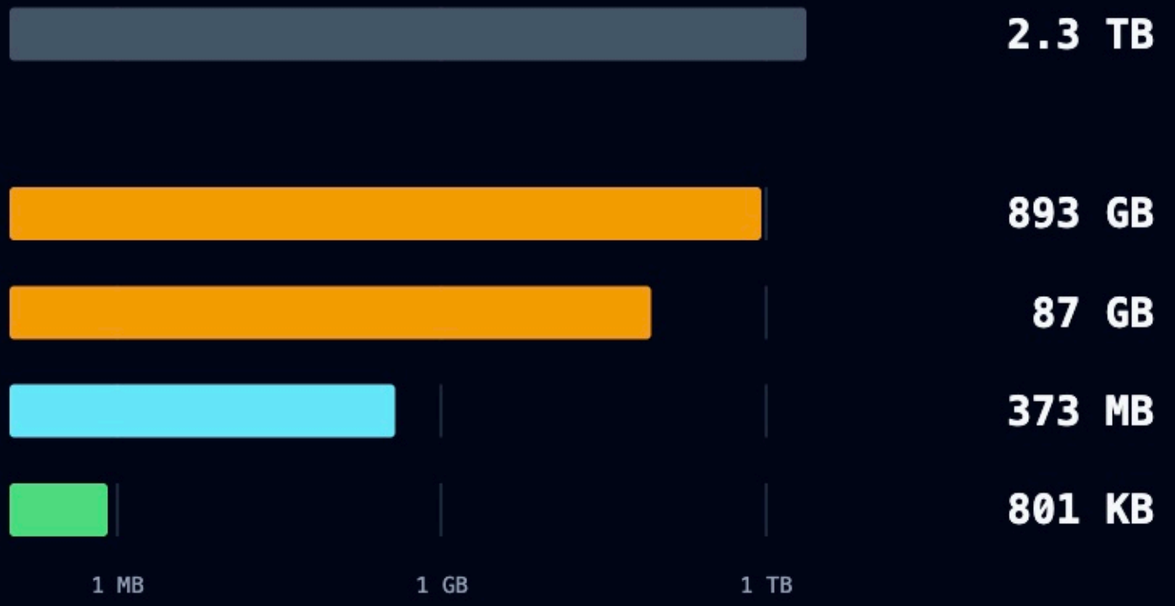
WHAT I WOULD HOST

Pre-generated tiles, exact
WebP lossless, RGB

Pre-generated tiles, for viewing
WebP lossy, RGB

An overview to zoom 12, the rest read from the source
one lossy WebP COG for the zoomed-out views

Only a stac-geoparquet index, every pixel read from the source
one row per image: footprint, date, COG URL



Log scale: each gridline is a thousand times the bytes. Still deciding.

Three jobs for vector data

	Draw it "Show me the trails."	Analyze it "Which hikes are short but steep?"	Search it "What is the tallest peak near me?"
PMTiles one file, read by range	● made for it: a zoom pyramid	○ trails cut at tile edges and simplified	○ no way to look up a name
SQLite / GeoPackage one file, downloaded whole	○ has to be cut into tiles first	● SQL and a spatial index, on the phone	● search names as you type
GeoParquet (+ overviews?) columnar, read by range	◐ overviews for the zoomed-out views	● whole trails; reads only the columns a query needs	◐ filter by elevation or type; no name search

● made for it ◐ partly ○ no

TODAY · THREE DOWNLOADS FOR ONE TERRAIN · 191,500 B/TILE

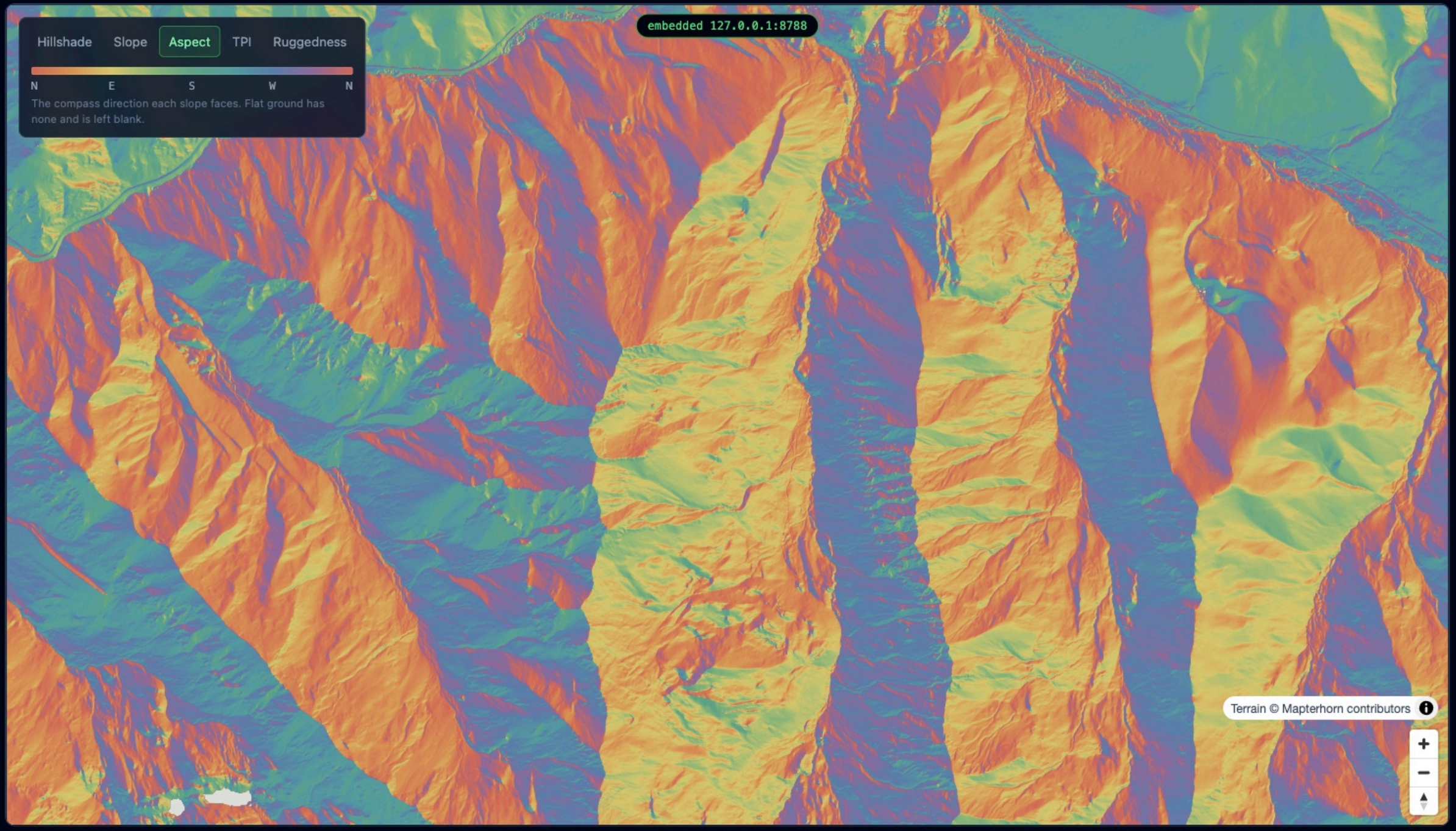
135,000 B/tile	Terrain DEM
22,500 B/tile	Slope angle hosted pyramid
34,000 B/tile	Aspect hosted pyramid

Per-tile estimates from the app's own offline size table.
Inputs shown, not measured transfer.

ONE DEM · 135,000 B/TILE · DERIVE WHERE IT IS USED



Except where a higher-resolution slope is worth hosting.


Hillshade
Slope
Aspect
TPI
Ruggedness
N
E
S
W
N
The compass direction each slope faces. Flat ground has none and is left blank.
embedded 127.0.0.1:8788
Terrain © Mapterhorn contributors

Search indices...

BANDS

CA Coastal Aerosol | B Blue | G Green | R Red | RE1 Red Edge 1 | RE2 Red Edge 2 | RE3 Red Edge 3 | N NIR | N2 NIR Narrow | S1 SWIR 1 | S2 SWIR 2 | AOT AOT | WV WV | SCL SCL | WVP WVP

MASK

Water | Snow / ice | Cloud | Shadow | Dark area

COMPOSITE (RGB)

True color | False color (IR) | Agriculture | SWIR | Geology | Color IR (veg)

CUSTOM band-math

INDICES

NDVI Normalized Difference Vegetation Index — N R

NDWI Normalized Difference Water Index — G N

NDSI Normalized Difference Snow Index — G S1

NBR Normalized Burn Ratio — N S2

NDBI Normalized Difference Built-Up Index — S1 N

NDMI Normalized Difference Moisture Index — N S1

MNDWI Modified Normalized Difference Water



single scene · no time stepping

tile 12TVK 2017-01-01 to 2026-11-13 600 scenes showing newest 600, more available

2023 41 clr | 2024 36 clr | 2025 48 clr | 2026 41 clr

INDEX | INSIGHTS × | TERRAIN | CACHE

NDWI

Normalized Difference Water Index

HYDROLOGY

FORMULA

$$\frac{G - N}{G + N}$$

G Green 520–600 nm | N NIR 760–900 nm

WHAT IT MEASURES

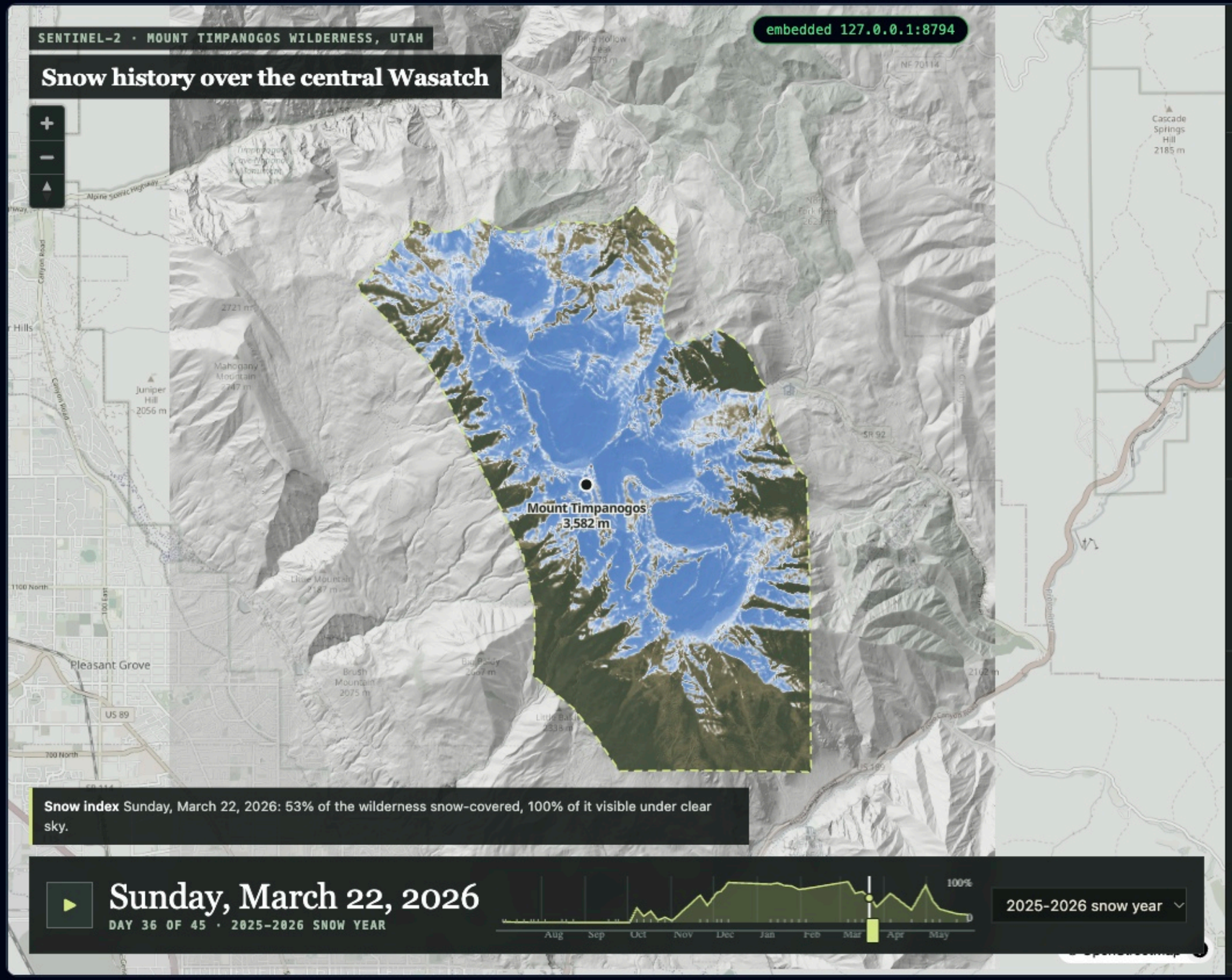
Normalized Difference Water Index (McFeeters 1996). Uses green and near-infrared to enhance open-water features while suppressing vegetation and soil. The original surface-water-extraction index; MNDWI is its shadow-robust successor.

WHY IT'S USEFUL

- Open-water body delineation and area change over multi-decadal time series
- Flood-extent mapping when SWIR bands are unavailable
- Pre-classification water masking for downstream vegetation indices

LIMITATIONS

- Misclassifies built-up areas and shadow as water — prefer MNDWI (green vs SWIR1) for urban scenes
- Confused by turbid or shallow water where bottom reflectance bleeds in
- Note that Gao 1996's vegetation-water-content



SENTINEL-2 L2A · 203 CLEAR DAYS · 2021–2026

One picture per clear day

Scrub through a snow year: how much of the wilderness was white on each day Sentinel-2 could see it.

VIEWS one at a time

01	Snow index (NDSI)	20 m
02	Snow or not	20 m
03	Terrain	10 m

OVERLAYS Independent

- [x] streets and names
- [x] shaded relief
- [x] wilderness outline
- [x] summit

Snow index (NDSI)

SENTINEL-2 L2A · BANDS 3, 11

Each pixel's snow index for this day: earth tones below zero, greys up to the snow line at 0.42, white to blue for snow. Dark grey is cloud or shadow that day; outside the wilderness nothing is drawn.

−0.6 rock, forest · 0.42 snow line · 1.0 snow

THIS DAY 2026-03-22

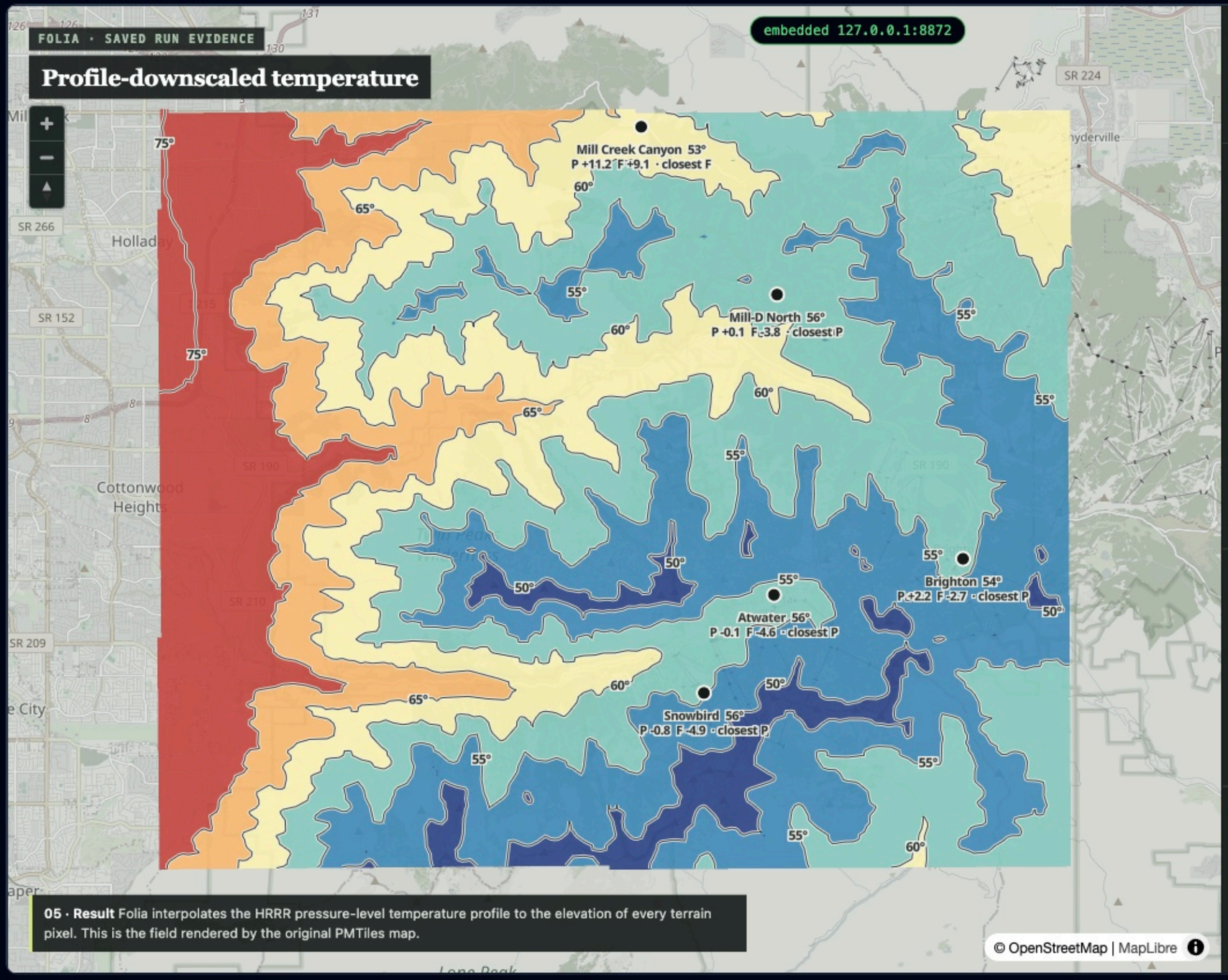
of the wilderness snow-covered

in the picture, without the shadow check: 53%

53%

clear sky over the area	100%
middle snow index (NDSI)	0.49
Sentinel-2 scene	S2C_MSIL2A_20260322T181031_R084_T12TVK_20260323T005713

Snow-covered counts pixels with snow index at or above 0.42 that are also bright in red, so shaded slopes are not mistaken for snow. Both fractions are of the clear-sky part of the wilderness.



HRRR · 2026-09-02T05:00:00Z

Downscale lineage

Inspect what Folia read, aligned, computed, and published.

Open the Folia-native replay →

SCIENTIFIC VIEW — one at a time

01	Profile-downscaled temperature	240×200
02	Profile minus fixed lapse	240×200
03	Fixed-lapse baseline	240×200
04	HRRR 2 m temperature · native grid	15×16
05	HRRR 2 m temperature · terrain grid	240×200
06	HRRR pressure-level temperature	15×16
07	Terrain elevation	240×200
08	HRRR model terrain · native grid	15×16

OVERLAYS — independent

- [x] streets
- [x] isotherms
- [x] SNOTEL stations

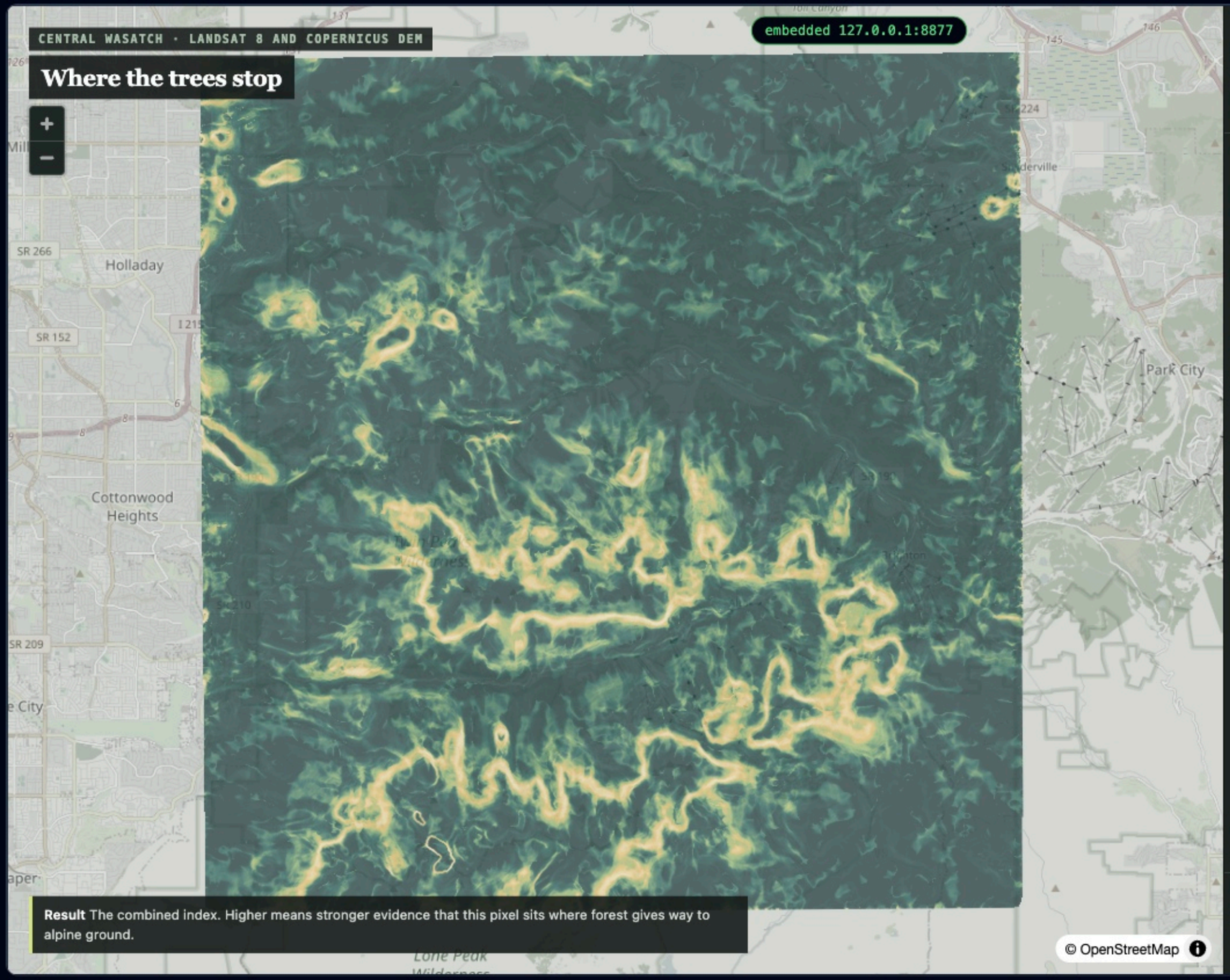
This saved run predates raster_contour. Its isotherm overlay is a labeled historical viewer fallback; the raster views remain locked run artifacts.

Profile-downscaled temperature

GOVERNED FOLIA OUTPUT

Folia interpolates the HRRR pressure-level temperature profile to the elevation of every terrain pixel. This is the field rendered by the original PMTiles map.

45.0 °F — 75.0 °F



LANDSAT 8 · 2013–2017 SUMMERS · 30 M CELLS

Alpine treeline

Summer greenness and elevation, combined the way Wei, Karger and Wilson (2020) did, over the Cottonwood canyons.

LAYERS one at a time

RESULT

01	ATEI probability	index
02	Thresholded ecotone	index

INPUTS

03	Annual greenest NDVI	5 summers
04	Multi-year greenest NDVI	NDVI
05	Copernicus GLO-30 elevation	metres

PREPARED

06	Smoothed NDVI	NDVI
07	Smoothed elevation	metres

THE THREE SIGNALS

08	C1 · NDVI gradient	signal
09	C2 · intermediate NDVI	signal
10	C3 · opposing gradients	signal
11	C1 · regional z-score	z-score
12	C2 · regional z-score	z-score
13	C3 · regional z-score	z-score

MAP

☑ streets and terrain opacity

Recipe

Roads · clipped lengths

Run context

−122.440, 37.741 → −122.372, 37.785 · static collection · this browser

Run in browser ⌘ / Ctrl Enter

Python graph compiled, executed, and displayed.

01 / METHOD — Python · Monaco

Analysis

Python is active. Run and Workflow use this format.

Setup | Code | Workflow

▾ **Study area & time** — captured at Run

West	South
−122.4401410	37.7406097
East	**North**
−122.3720065	37.7848029

Use map bounds | Reset area & dates

Road class

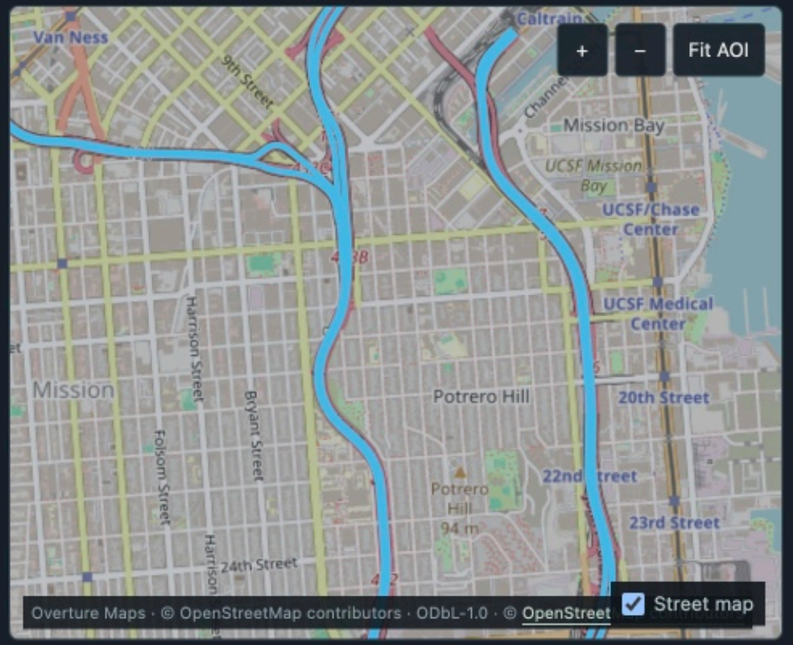
Motorway

Pan the map, use its bounds, then run. Road class and the rectangular clip are captured in the Python graph.

Browser limits: 8 km per side · 10,000 returned rows · 32 MiB FTB output. Source parts are selected from the live static catalog. Source transfer has no preventive wire-byte cap.

02 / RESULT & EVIDENCE — Computed in this browser

Study area



Timings | Layers

IN THIS PAGE

Step	Time
Python → openEO graph	4 ms
Browser limits check	0 ms
Compile graph → Folia recipe	2 ms
Catalog preflight	0 ms
▸ Engine: resolve, read, compute	612 ms
Draw result	2 ms
Total	**620 ms**

INSIDE THE ENGINE

604 ms across 7 layers · 23.99 MB fetched in 326 requests. Per layer: Layers tab.

Byte cache: 697 hits (23.99 MB), 0 misses, 0 B from the network.

Selected feature

Select a road on the map or in the table.

Returned values

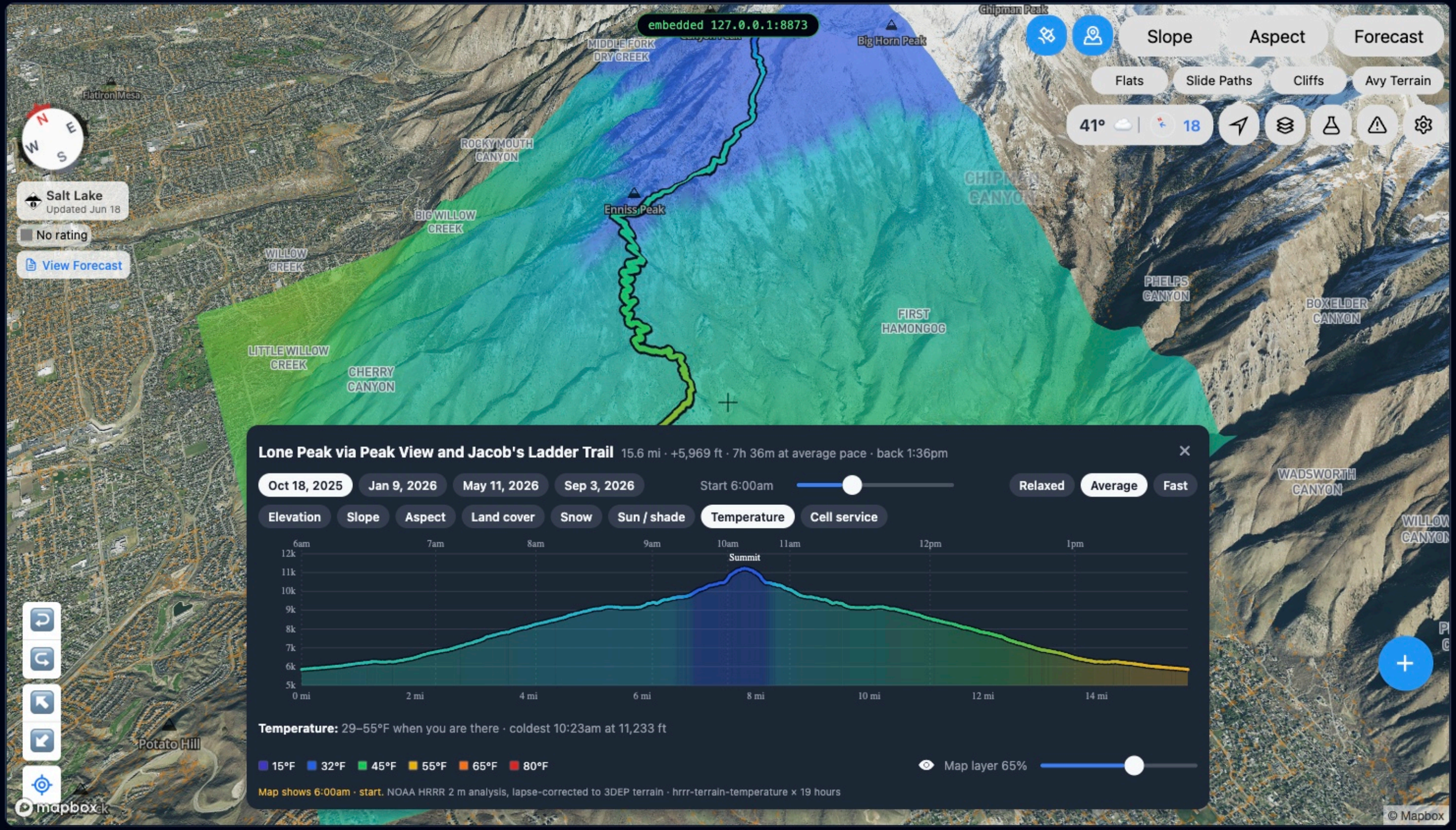
40 returned features
Per-feature lengths are computed in Rust.
Use the total-length example for an explicit sum.

▸ Display — styling only

result · Table · 40 rows · 6 columns
OGC:CRS84 · LineString, MultiLineString
Columns: id: Utf8 · subtype: Utf8 · class: Utf8 · subclass: Utf8 · geometry: Binary · length_m: Float64

WHAT EACH ANSWER NEEDS

SOURCE	WHAT IT ADDS	WHERE IT LIVES	FOR	SHOWN
Terrain Copernicus GLO-30 · Mapterhorn	Elevation, slope and aspect; shade and views are computed from it	COGs on AWS open data; Mapterhorn's terrain tiles		16, 17
Sun position	Where the shadow falls at a date and time	Computed on the device; nothing to download		not built
Routes your GPX · OpenBeta	The line you will walk or climb	A file you bring; OpenBeta and local route data		4, 8
Sentinel-2 L2A	Snow, one picture per clear day	COGs with a STAC index on Planetary Computer		18, 19
HRRR	Temperature, hourly, at the terrain	Hourly Zarr on AWS, NOAA open data		20
Landsat 8	Summer greenness: where the trees stop	COGs on Planetary Computer		21


embedded 127.0.0.1:8873
Slope
Aspect
Forecast
Flats
Slide Paths
Cliffs
Avy Terrain
41°
18
Salt Lake
Updated Jun 18
No rating
View Forecast
Lone Peak via Peak View and Jacob's Ladder Trail 15.6 mi · +5,969 ft · 7h 36m at average pace · back 1:36pm
Oct 18, 2025
Jan 9, 2026
May 11, 2026
Sep 3, 2026
Start 6:00am
Relaxed
Average
Fast
Elevation
Slope
Aspect
Land cover
Snow
Sun / shade
Temperature
Cell service
6am
7am
8am
9am
10am
11am
12pm
1pm
12k
11k
10k
9k
8k
7k
6k
5k
Summit
0 mi
2 mi
4 mi
6 mi
8 mi
10 mi
12 mi
14 mi
Temperature: 29–55°F when you are there · coldest 10:23am at 11,233 ft
15°F
32°F
45°F
55°F
65°F
80°F
Map layer 65%
Map shows 6:00am · start. NOAA HRRR 2 m analysis, lapse-corrected to 3DEP terrain · hrrr-terrain-temperature × 19 hours
Chipman Peak
Big Horn Peak
Flatiron Mesa
MIDDLE FORK DRY CREEK
ROCKY MOUTH CANYON
Enniss Peak
BIG WILLOW CREEK
WILLOW CREEK
LITTLE WILLOW CREEK
CHERRY CANYON
FIRST HAMONGOG
PHELPS CANYON
BOXELDER CANYON
WADSWORTH CANYON
Potato Hill
mapbox
© Mapbox