

Beyond Pretty Pictures: Topographic Labels in 3D Maps of High Terrain

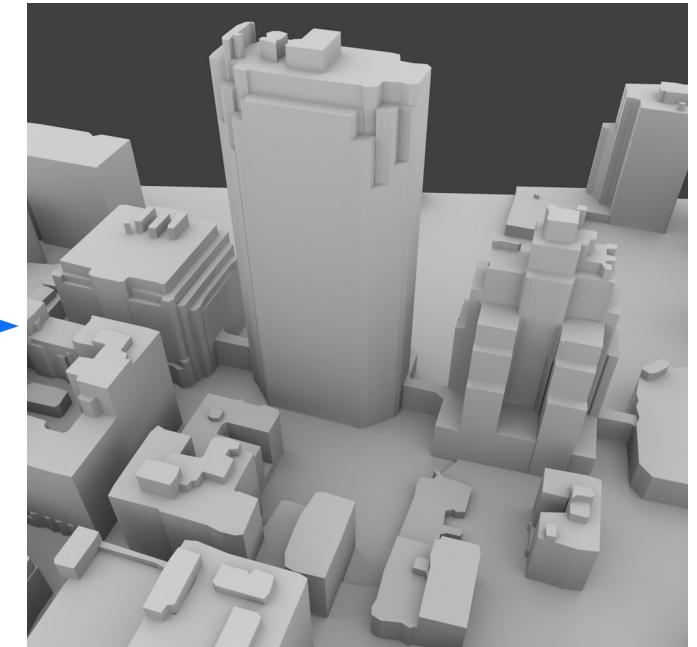
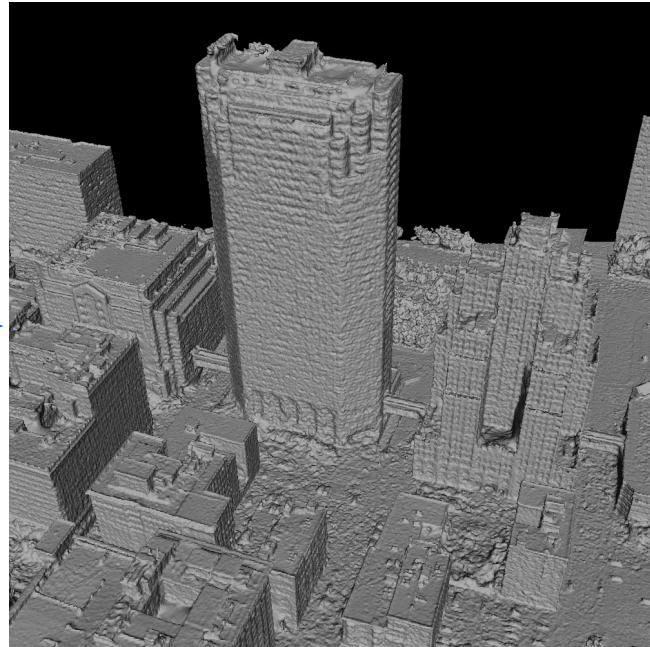
Ondřej Procházka, CEO Melown Technologies SE



**Melown Tech is a software-development company
in the 3D mapping business**

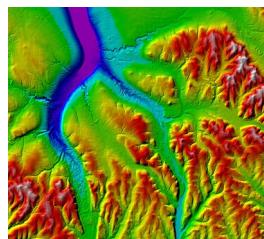
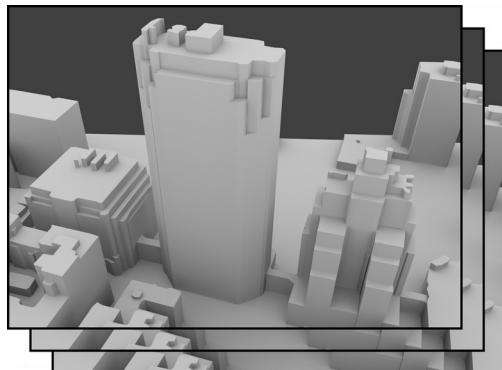
What our software does:

I) Computer-vision and deep-learning driven reality capture



What our software does:

II) 3D data fusion, virtual landscape streaming and rendering



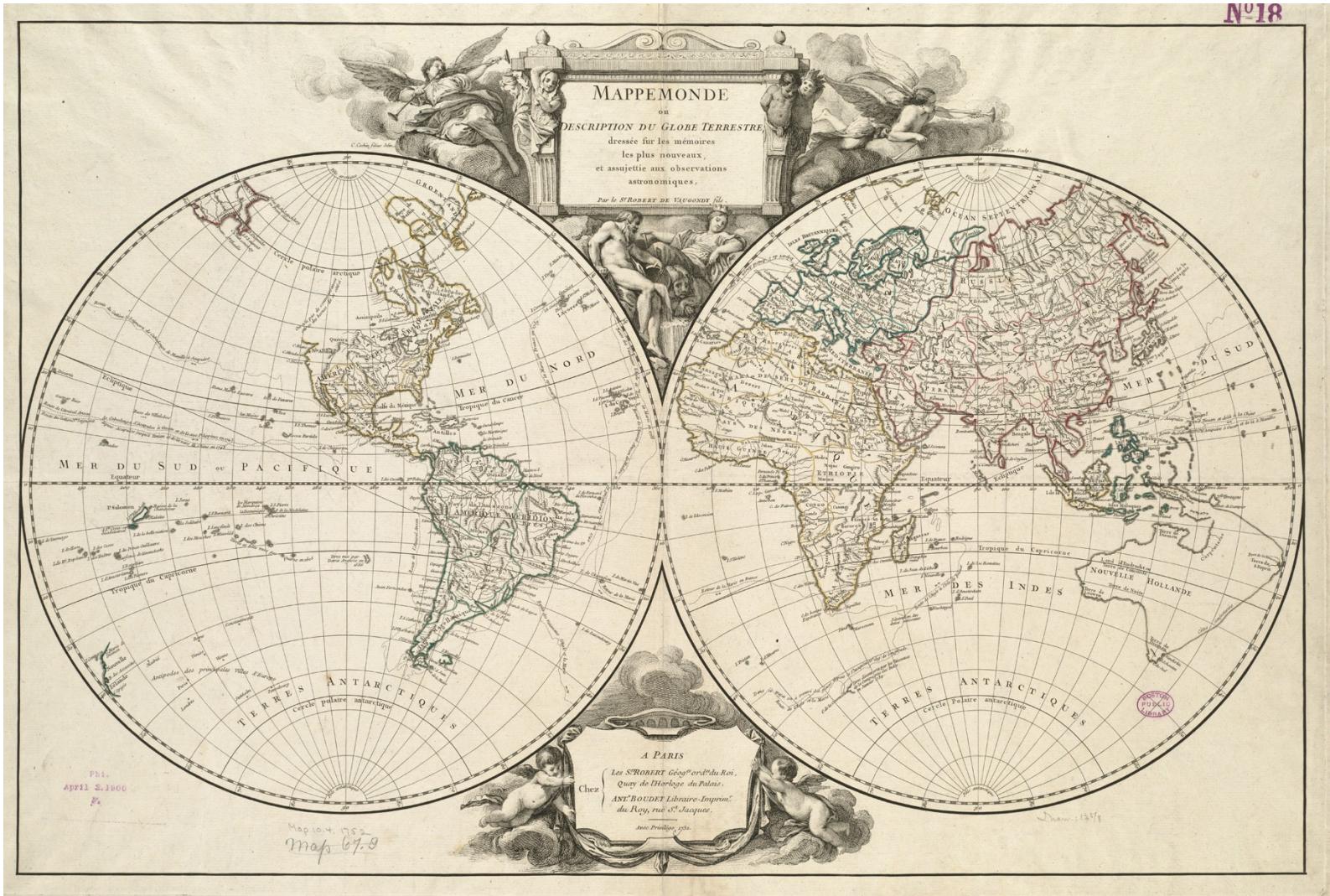
Applications

- VR and AR
- interactive simulations
- gaming
- geospatial (3D mapping)

The conceptual problem behind “3D mapping”

Cartography

N°18



Cartography



Cartography:

A map is a diagrammatic representation of an area, or a symbolic depiction emphasizing relationship between elements of space

3D mapping:

A map is mostly orthophotos draped over DEMs, viewed from arbitrary angle

Cartography:

A map works with a hierarchy of features, both intellectual and visual

3D mapping:

A map aims for data visualization, or simply for visual realism (“pretty pictures”)

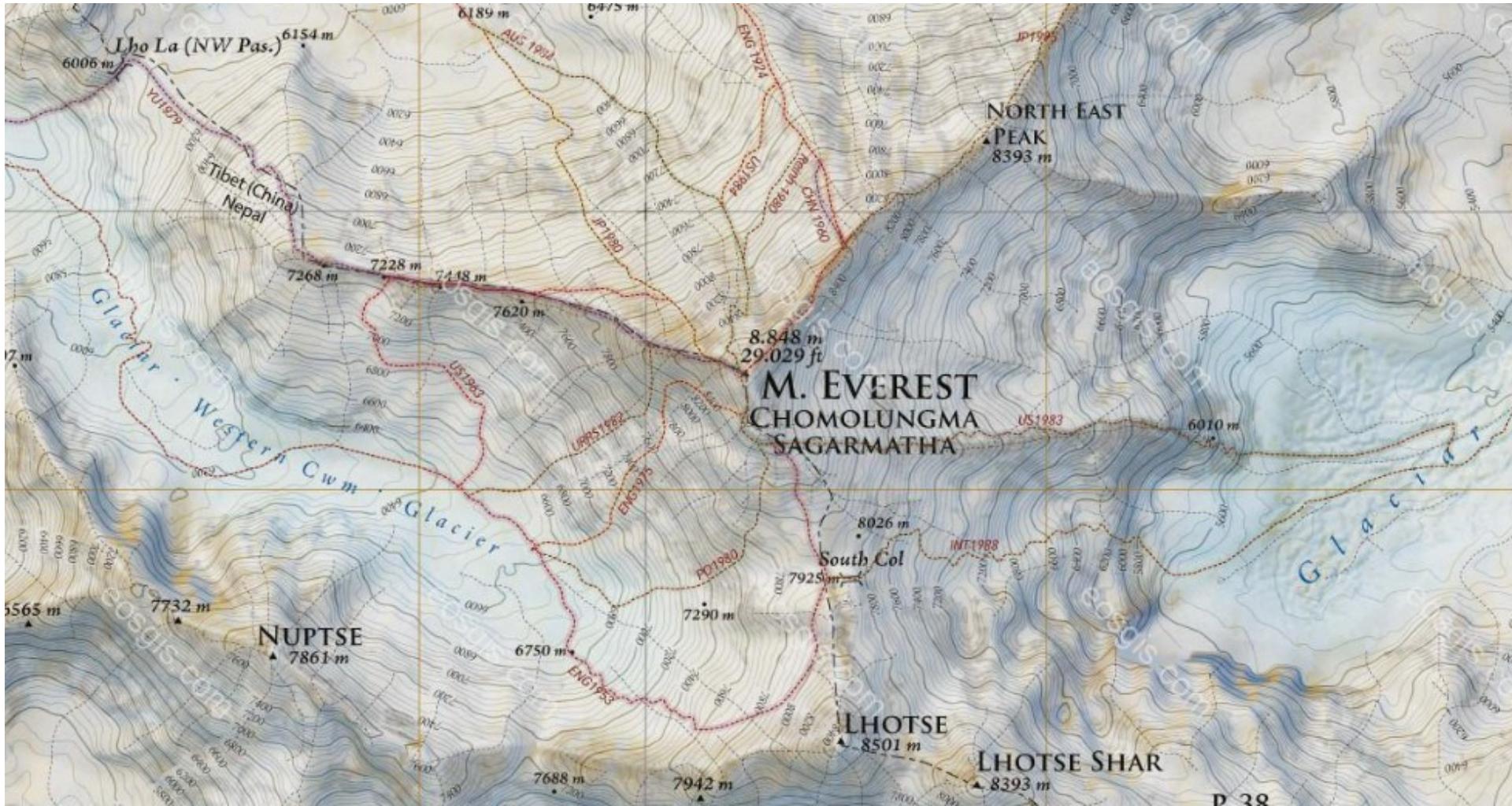
Cartography:

A map relies on cartographic principles which have evolved in 4300 years.

3D mapping:

A map relies on applied computer graphics, which has evolved in ~50 years.

Where cartography gives you this...



... 3D mapping gives you this...



... or this.



Our goal in this talk:

to create a FOSS-based map application

- leveraging on the benefits of 3D (realism, arbitrary angles), while
- staying true to cartographic principles

A global high-terrain 3D map with VTS

Inspiration



Inspiration



Ingredients (technology)

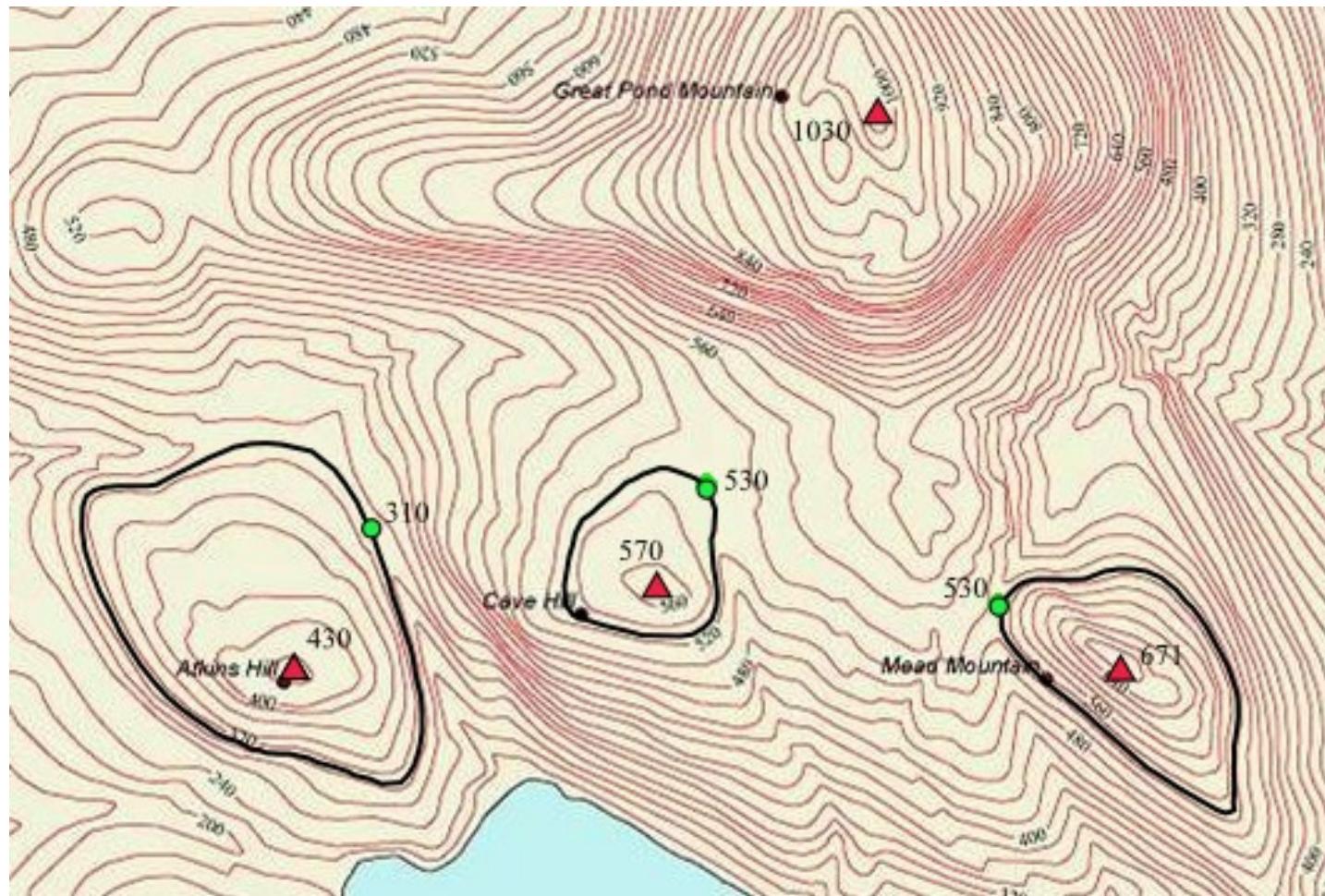
- Major distro Linux server
- VTS 3D Geospatial Software Stack
 - ➔ Backend streaming servers (mapproxy and vtsd)
 - ➔ Data-fusion command-line utility (vts)
 - ➔ JavaScript rendering library (vts-browser-js)

Ingredients (data)

- Global Sentinel2 Cloudless mosaic (by EOX IT GmbH)
- Viefinder Panoramas 3 arc second DEM (by Johnathan de Ferranti)
- OpenStreetMap (by OSM contributors, Klokan Technologies GmbH)
- “The Ultras” (by Peaklist.org)*)

*) Peaklist.org “Ultras” is not a public-domain dataset. See the authors’ site for licensing.

Intellectual hierarchy - topographic prominence



Prerequisite: VTS Backend

On Ubuntu 16.04 or 18.04:

```
$ sudo apt install vts-backend
```

Step 1: The Basemap

Add global Viewfinder Panoramas DEM to VTS storage:

```
$ vts ~/store/stage.melown2015 --add \
  //cdn.melown.com/vts/melown2015/terrain/global/viewfinder3/ --top
```

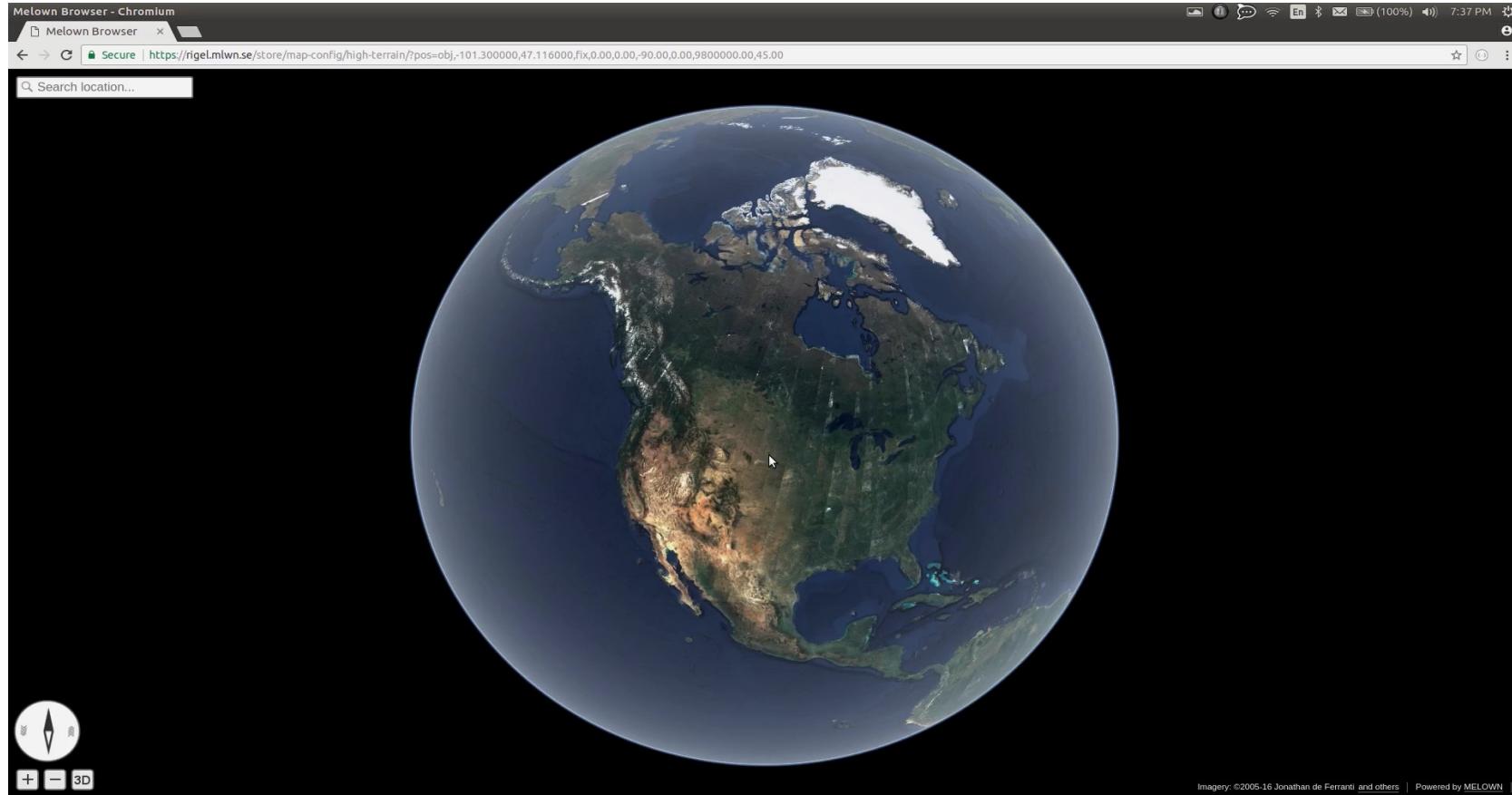
Step 1: The Basemap (cont'd)

Create a VTS storage view at [~/store/map-config/high-terrain](#):

```
{  
    "storage": "../stage.melown2015",  
    "tilesets": ["terrain-viewfinder3"],  
    "credits": {},  
    "boundLayers": {  
        "eox-it-sentinel2-cloudless"  
            : "//cdn.melown.com/vts/melown2015/imagery/global/eox-it-sentinel2-cloudless/boundlayer.json"  
    },  
    "freeLayers": {},  
    "view": {  
        "surfaces": { "terrain-viewfinder3": ["eox-it-sentinel2-cloudless"] },  
        "freeLayers": {}  
    },  
    "position": [ [ "obj", -101.3, 47.116, "float", 0, 0, -90, 0, 9333674, 45],  
    "version": 1  
}
```

Step 1: The Basemap (check)

At <http://<your-server>:8070/vts/store/map-config/high-terrain>:



Step 2: The Ultra-prominent Peaks

Download the dataset:*)

```
$ wget http://cdn.melown.com/pub/vts-tutorials/high-terrain/world1500.json  
-O ~/mapproxy/datasets/world1500.json
```

*) Peaklist.org “Ultras” is not a public-domain dataset. See the authors’ site for licensing.

Step 2: The Ultra-prominent Peaks (cont'd)

Define a geodata free layer in mapproxy (create [/etc/vts/mapproxy/examples.d/peaklist-org-ultras.json](#)):

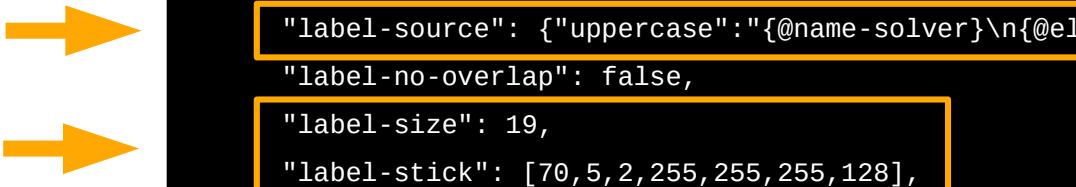
```
[{  
    "group": "high-terrain", "id": "peaklist-org-ultras",  
    "comment": "ultra-prominent peaks on earth, compiled by peaklist.org",  
    "driver": "geodata-vector",  
    "type": "geodata",  
    "definition": {  
        "dataset": "world1500.json",  
        "format": "geodataJson",  
        "formatConfig": { "resolution": 65536 },  
    },  
    "referenceFrames": { "melown2015": { "lodRange": [1,1], "tileRange": [[0,0], [1,1]] } },  
    "registry": {  
        "credits": {  
            "peaklist-org": { "id": 205, "notice": "{copy} 2004-07 [http://www.peaklist.org/ultras.html peaklist.org]" }  
        },  
        "credits": ["peaklist-org"]  
    }  
}]
```

Step 2: The Ultra-prominent Peaks (cont'd)

Create a stylesheet for the layer (edit `~/store/stylesheets/peaklist-org-ultras.style`):

```
{  
  "constants": {  
    "@name-solver": {"if": [["has", "$name"], "$name", "$Name"]]},  
    "@ele": {"if": [["has", "$elevation"], "$elevation", "$Elevation"]]},  
    "@feet": {"round": {"mul": [3.2808399, {"str2num": "@ele"}]}},  
    "@ele-solver": {"if": [{"==", "#metric", true}, {"{{'round': {'str2num': '@ele'}}} m", "{@feet} ft"]]},  
    "@id-solver": "@ele-solver {@name-solver}"  
},  
  "layers": {  
    "peak-labels": {  
      "label": true,  
      "label-source": {"uppercase": "@name-solver\n@ele-solver"},  

```



Step 2: The Ultra-prominent Peaks (cont'd)

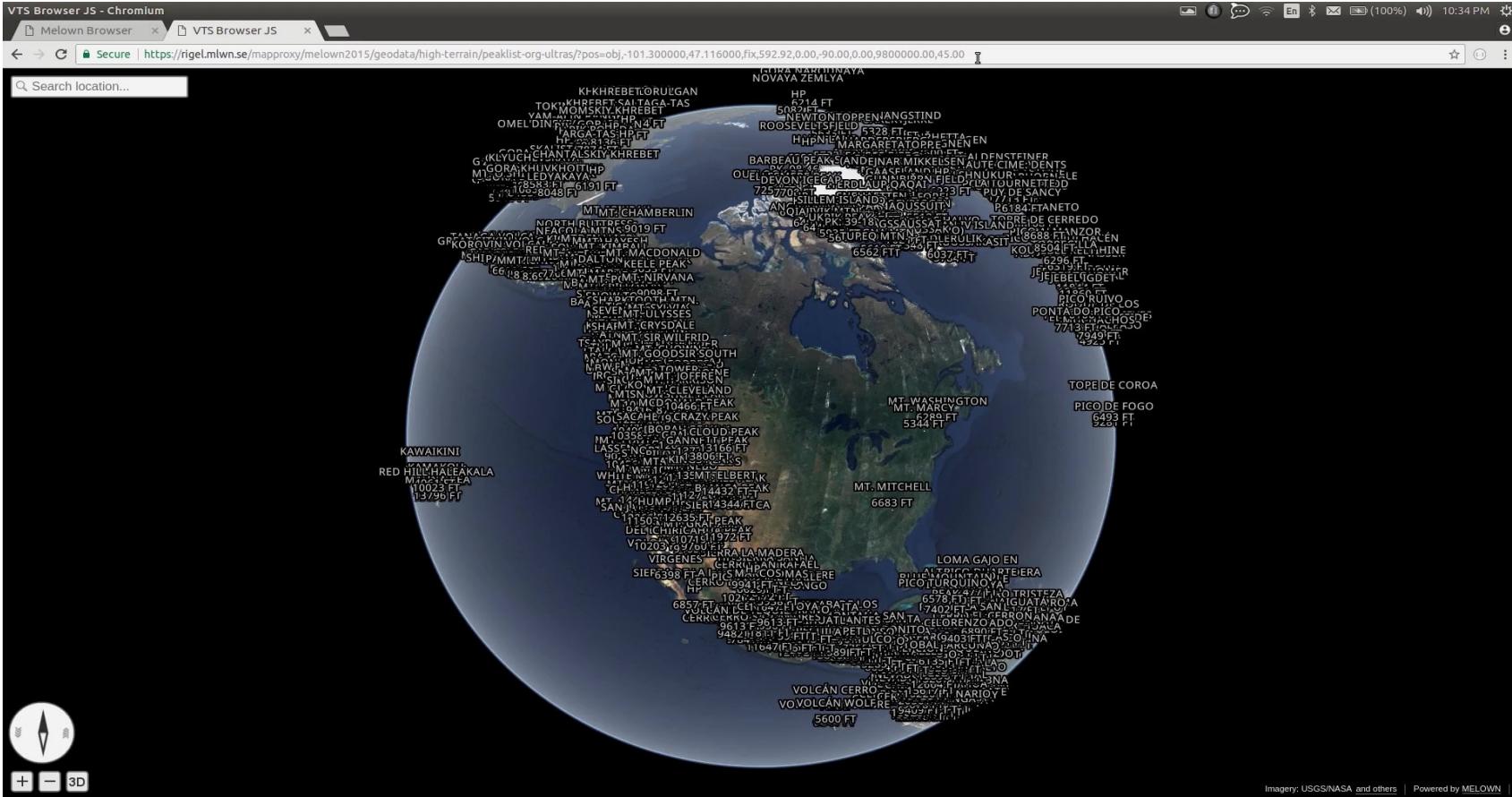
Add the layer to the storage view, at ~store/map-config/high-terrain:

```
{  
    "storage": "../ht-stage.melown2015",  
    "tilesets": ["terrain-viewfinder3"],  
    "credits": {},  
    "boundLayers": {  
        "eox-it-sentinel2-cloudless":  
            "//cdn.melown.com/vts/melown2015/imagery/global/eox-it-sentinel2-cloudless/boundlayer.json"  
    },  
    "freeLayers": {  
        "peaklist-org-ultras": "/mapproxy/melown2015/geodata/high-terrain/peaklist-org-ultras/freelayer.json"  
    },  
    "view": {  
        "surfaces": { "terrain-viewfinder3": ["eox-it-sentinel2-cloudless"] },  
        "freeLayers": {  
            "peaklist-org-ultras": { "style": "/store/stylesheet/peaklist-org-ultras.style?4" }  
        }  
    },  
    "position": ["obj", -101.3, 47.116, "float", 0, 0, -90, 0, 9800000, 45],  
    "version": 1  
}
```



Step 2: The Ultra-prominent Peaks (check)

At <http://<your-server>:8070/vts/store/map-config/high-terrain>:



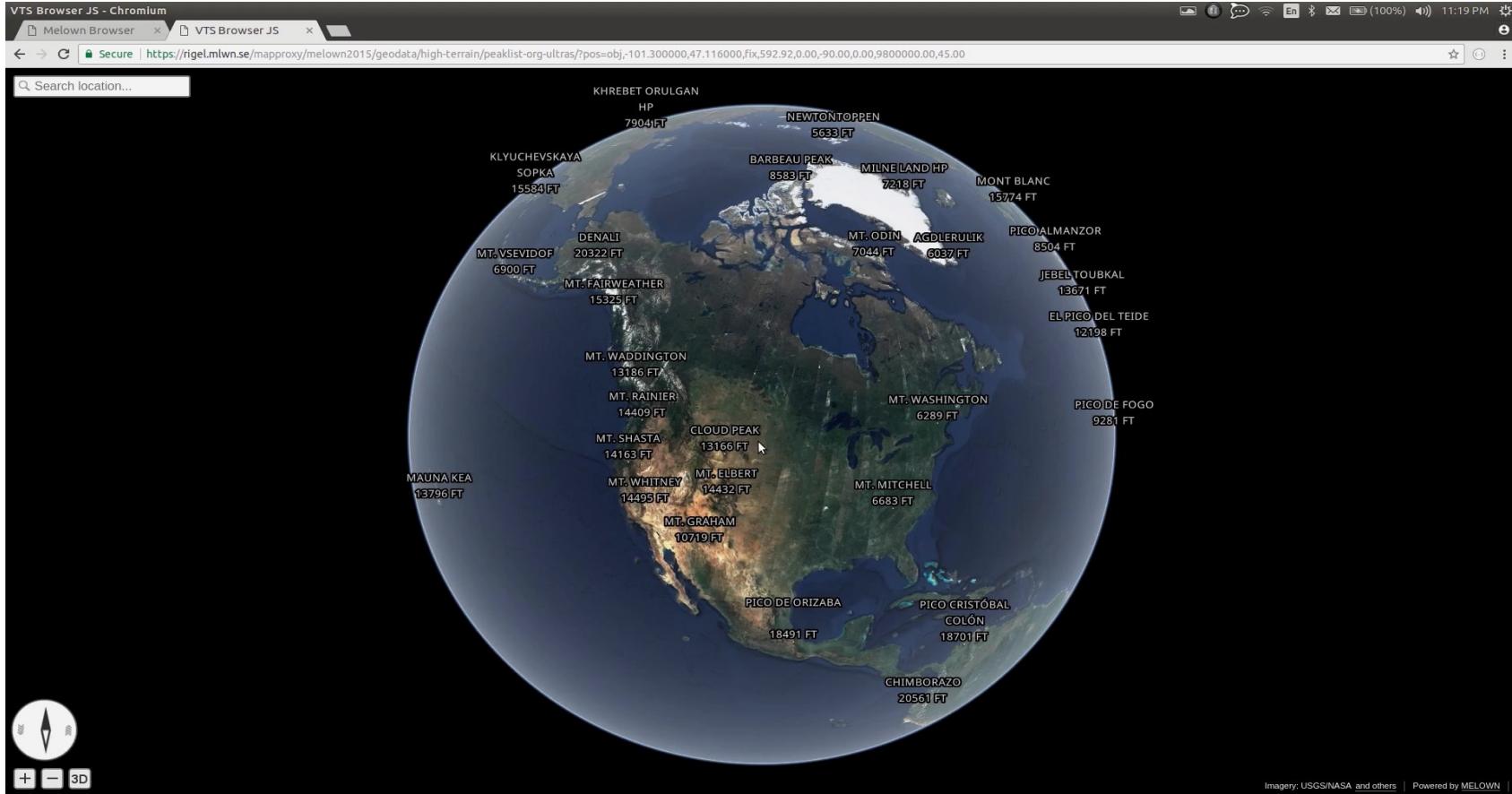
Step 2: The Ultra-prominent Peaks (cont'd)

Solve occlusions by the rule of higher prominence (edit `~/store/stylesheets/peaklist-org-ultras.style`)

```
{  
  "constants": {  
    ...  
    "@prom-solver": {"mul": [-1, {"str2num": {"if": [["has", "$prom"], "$prom", "$Prom"]]}]}]  
  },  
  "layers": {  
    "peak-labels": {  
      ...  
      "label-no-overlap": true,  
      "label-no-overlap-factor": ["div-by-dist", "@prom-solver"],  
      ...  
    }  
  }  
}
```

Step 2: The Ultra-prominent Peaks (check)

At <http://<your-server>:8070/vts/store/map-config/high-terrain>:



Step 3: Mountain peaks from OSM

Add the public OSM-based geodata layer to the storage view (edit `~/store/map-config/high-terrain`):

```
{  
    "storage": "../ht-stage.melown2015",  
    ...  
    "freeLayers": {  
        "peaklist-org-ultras":  
            "/mapproxy/melown2015/geodata/high-terrain/peaklist-org-ultras/freelayer.json",  
        "osm-maptiler": "//cdn.melown.com/vts/melown2015/features/global/osm-maptiler/freelayer.json"  
    },  
    "view": {  
        "surfaces": { "terrain-viewfinder3": ["eox-it-sentinel2-cloudless"] },  
        "freeLayers": {  
            "peaklist-org-ultras": { "style": "/store/stylesheet/peaklist-org-ultras.style" },  
            "osm-maptiler": { "style": "//<your-server>/store/stylesheet/osm-maptiler.style" }  
        }  
    },  
    ...  
}
```

Step 3: Mountain peaks from OSM (cont'd)

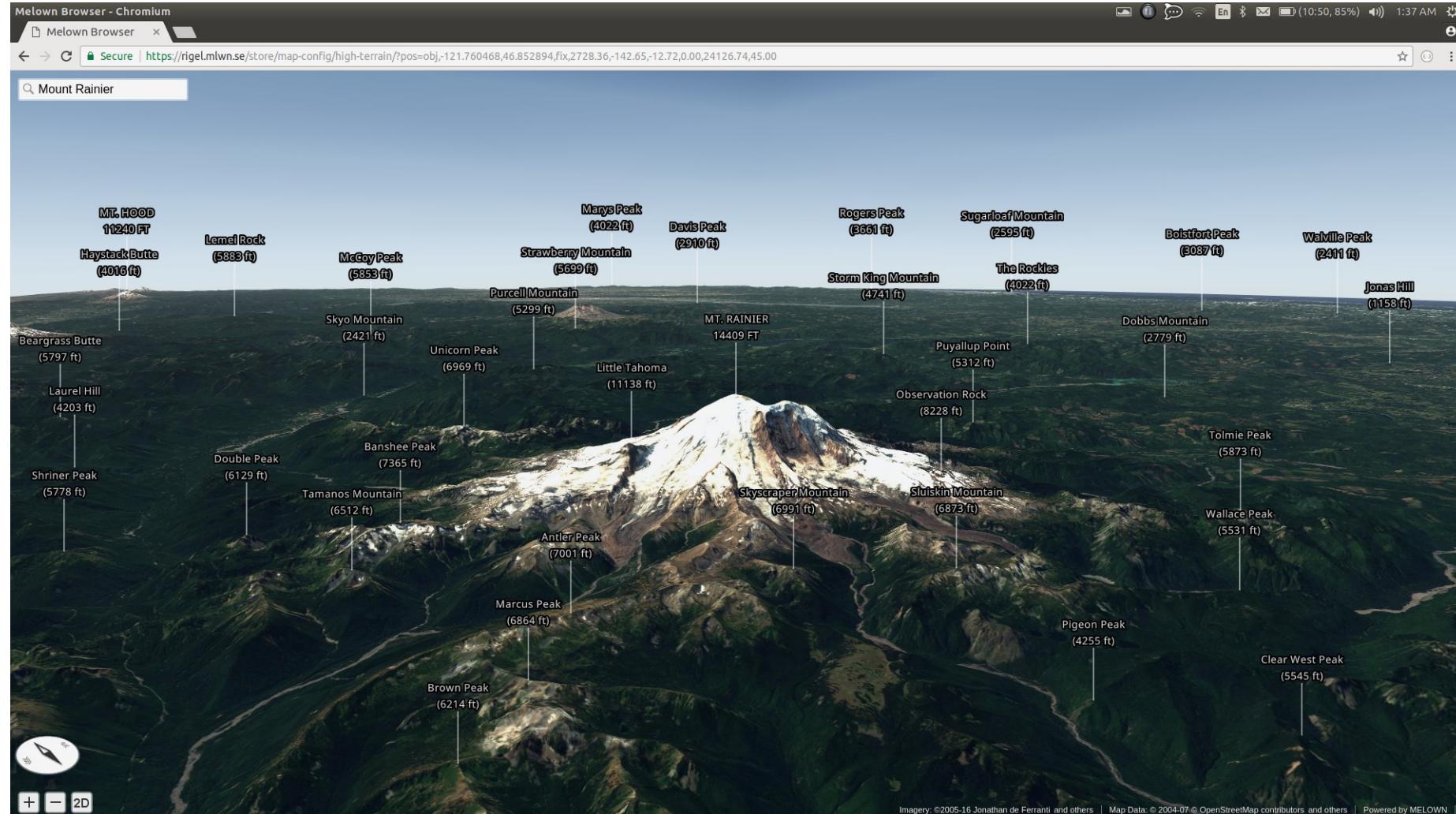
Create a stylesheet for the layer (create `~/store/stylesheets/osm-maptiler.style`):

```
{  
    "constants": {  
        "@feet": {"round": {"mul": [3.2808399, {"str2num": "$ele"}]}},  
        "@name-solver": {"if": [{"has": "$name"}, {"if": [{"has": "$name:en"}, {"!has": "$name:en"}], "eq": {"has-latin": "$name"}, true}], "{$name}", "{$name}\n{$name:en}"], ""}],  
        "@ele-solver": {"if": [{"eq": "#metric", true}], {"round": {"str2num": '$ele'}} m", "[@feet] ft"},  
        "@peak-name": {"if": [{"has": "$ele"}, {"name-solver": "\n(@name-solver)\n(@ele-solver)"}, {"name-solver": "1"}]},  
        "@prominence": {"add": [{"if": [{"has": "$ele"}, {"mul": [-0.0001, {"str2num": "$ele"}]}, 0]}, {"if": [{"has": "$prominence"}, {"mul": [-0.3048, {"str2num": "$prominence"}]}, 0]}]}},  
        "@osmid": {"if": [{"has": "$osm_id"}, {"osm_id": ""}]},  
        "@id-solver": "@osmid" {@ele-solver} {@name-solver}"  
    },  
    "layers": {  
        "peaks": {  
            "filter": ["all", ["eq", "#group", "mountain_peak"]],  
            "visible": [{"if": [{"!": "@name-solver", ""}], true, false}],  
            "dynamic-reduce": ["scr-count2", 1, 50],  
            "label": true,  
            "label-color": [255, 255, 255, 255],  
            "label-stick": [70, 5, 2, 255, 255, 255, 128],  
            "label-size": 19,  
            "label-source": "@peak-name",  
            "label-font": "@main-font",  
            "label-no-overlap": true,  
            "label-no-overlap-factor": ["div-by-dist", "@prominence"],  
            "zbuffer-offset": [-0.25, 0, 0],  
            "culling": 94,  
            "hysteresis": [1500, 1500, "@id-solver", true]  
        }  
    }  
}
```



Step 3: Mountain peaks from OSM (check)

At <http://<your-server>:8070/vts/store/map-config/high-terrain>:



Step 4: The visual hierarchy

Change style for ultra-prominent peaks (edit [~/store/stylesheets/peaklist-org-ultras.style](#)):

```
{  
  "constants": {  
    "@name-solver": {"if": [[{"has": "$name"}, {"$name": "$Name"}],  
    "@ele": {"if": [[{"has": "$elevation"}, {"$elevation": "$Elevation"}],  
    "@feet": {"round": {"mul": [3.2808399, {"str2num": "@ele"}]}},  
    "@ele-solver": {"if": [[{"==": "#metric"}, true], {"{{'round': {'str2num': '@ele'}}} m", {"@feet} ft"]]},  
    "@id-solver": "@ele-solver} {@name-solver}"  
  },  
  "layers": {  
    "peak-labels": {  
      "label": true,  
      "label-source": {"uppercase": "{@name-solver}\n({@ele-solver})"},  
      "label-stick": [70, 5, 2, 255, 233, 0, 128],  
      "label-color": [255, 233, 0, 255],  
      "label-no-overlap": false,  
      "label-size": 19,  
      "label-stick": [70, 5, 2, 255, 255, 255, 128],  
      "culling": 92,  
      "hysteresis": [1500, 1500, "@id-solver", true]  
    }  
  }  
}
```



Step 4: Visual hierarchy (cont'd)

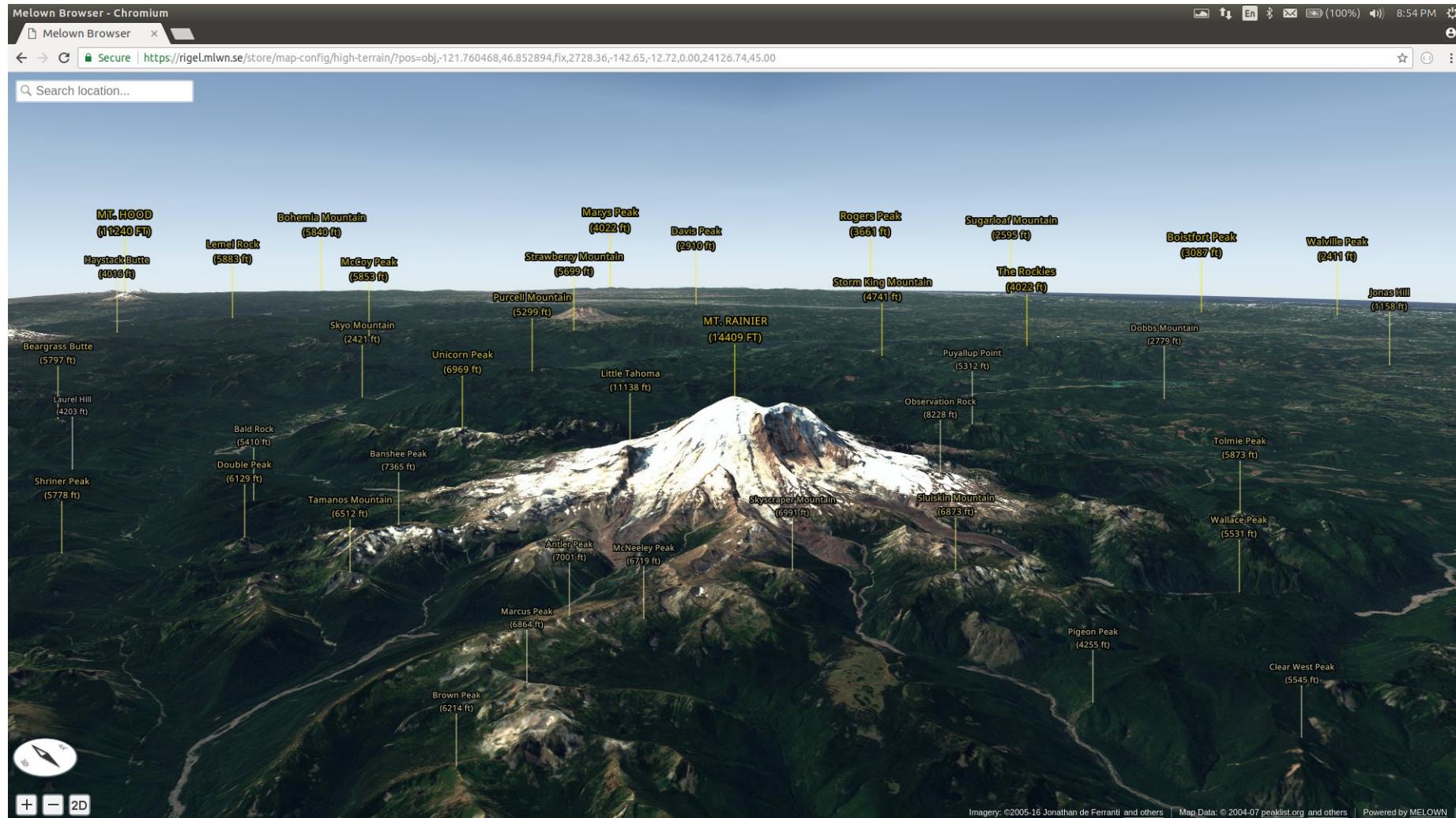
Add visual hierarchy rules to OSM data (edit [~/store/stylesheets/osm-maptiler.style](#)):

```
{  
  "constants": {  
    ...  
    "@peak-rank": {"discrete2": ["@prominence",  
      [[-1501,0],[-1499,1],[-751,1],[-749,2],[-326,2],[-324,3],[-164,3],[-162,4],[-2,4],[-1,5]]]},  
    "@peak-name2": {"if": [{"==": "@peak-rank", 0}, {"uppercase": "@peak-name"}, "@peak-name"]}  
  },  
  "layers": {  
    "peaks": {  
      "filter": ["all", ["==", "#group", "mountain_peak"]],  
      ...  
      "label-color": {"linear2": ["@peak-rank", [[1,[255,233,0,255]],[5,[230,230,230,255]]]]},  
      "label-stick": {"linear2": ["@peak-rank", [[1,[70,5,2,255,233,0,128]],[5,[70,5,2,230,230,230,128]]]]},  
      "label-size": {"discrete2": ["@peak-rank", [[0,19],[1,18],[2,17],[3,16],[4,15],[5,14]]]},  
      "label-source": "@peak-name2",  
      ...  
    }  
  }  
}
```



Step 4: Visual hierarchy (check)

At <http://<your-server>:8070/vts/store/map-config/high-terrain>:



Live demo of the map

<http://rigel.mlwn.se/high-terrain>

Sources of VTS information

vtsdocs.melown.com

github.com/Melown