AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

PRECISE IRRADIANCE MODELING AS SOURCE OF PARTIAL SHADING ANALYSIS

Bernhard Kubicek

AIRBORNE LASERSCANS

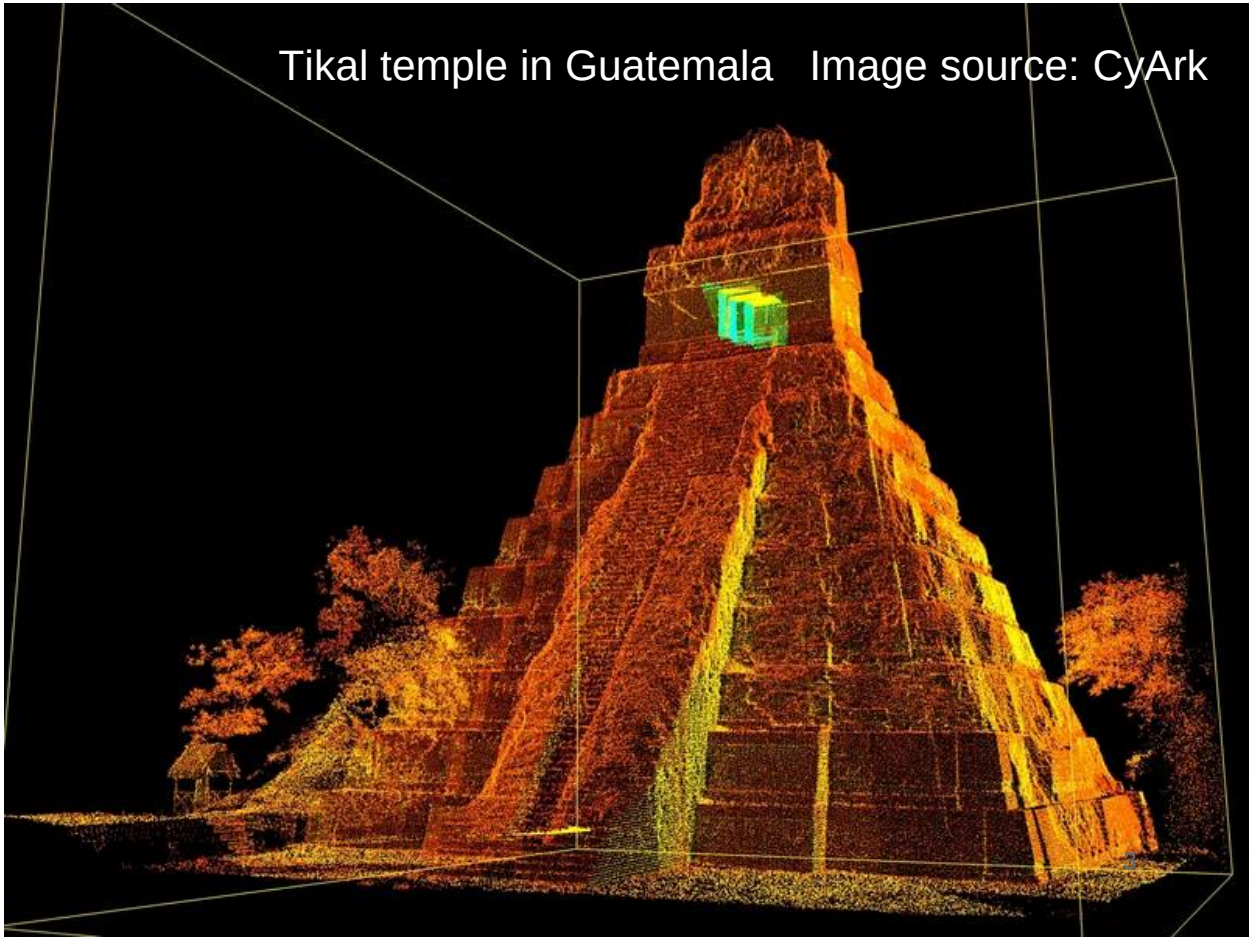
- Laser-Runtime measurement with fast mirrors for 2d-deflection
- Helicopter/plane mounted devices
- Heavy duty drones
- Additional visible light camera

- Result:
  - List of colored points in 3d
  - „Pointcloud“

Source: riegl.com

POINTS?!

- Can be visualized fast!
  - Realtime viewing of 10^6 points no problem on laptop
- Contain the full measured data
- Geolocated



CREATION OF DSM /DTM

- GeoTIFFs:
  - 2D images that are geolocated
    - A defined transformation for each pixel to a position on the globus
  - Instead of color triplets (RGB):
    - One or more floating point values (e.g. height above see level)
- One defines a resolution (e.g. 1m in NS and EW)
  - There are multiple laserscan-Points in such a pixel
  - Relatively high height:
    - Value for the digital SURFACE model
  - Relativiely low height:
    - Digital terrain model

LIDAR DATA

„Moosbrunn“ south of Vienna/Austria

Floating point height scaled min to max: ~16m

DSM aka „highest points“

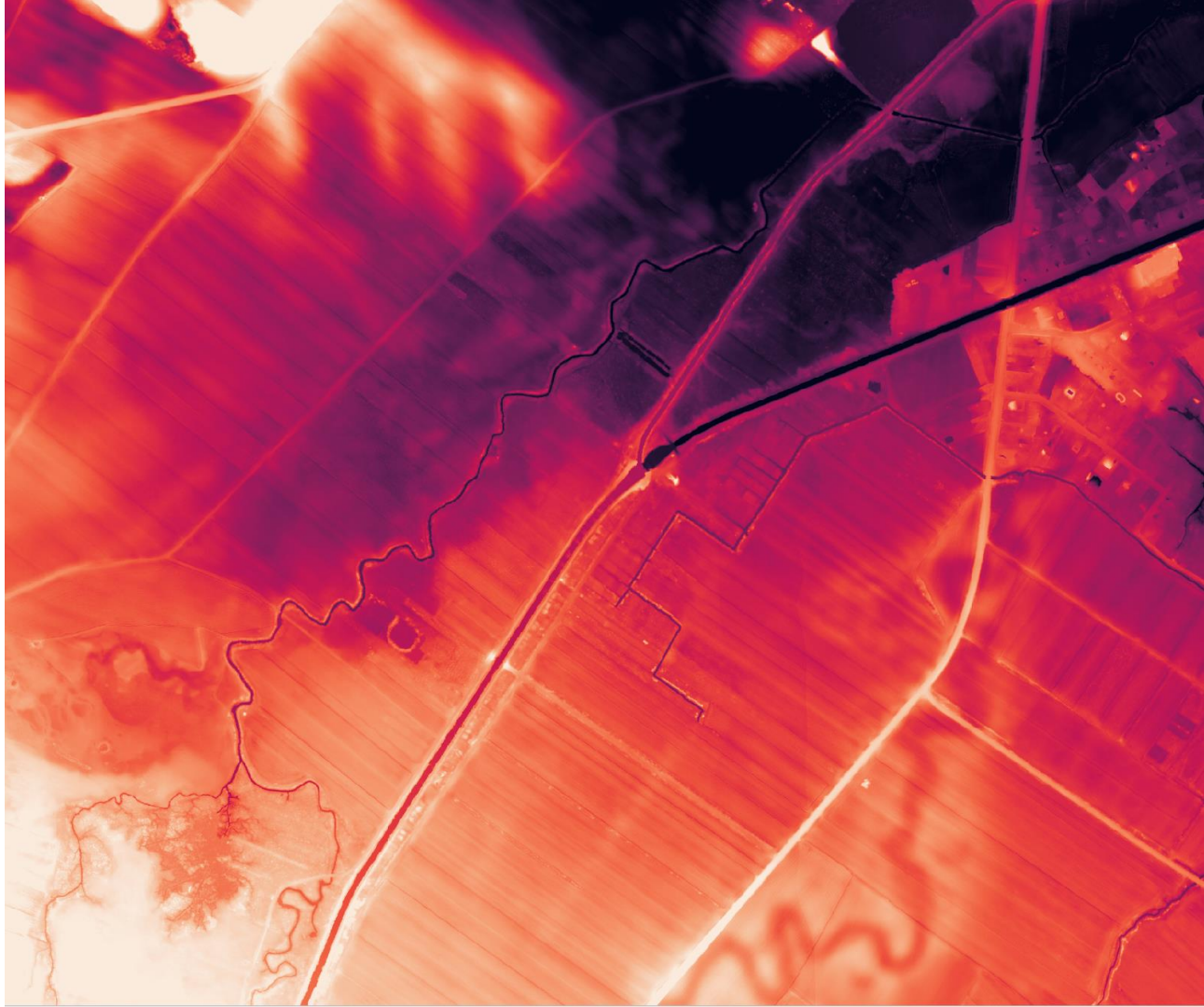
LIDAR DATA

DEM: lowest points

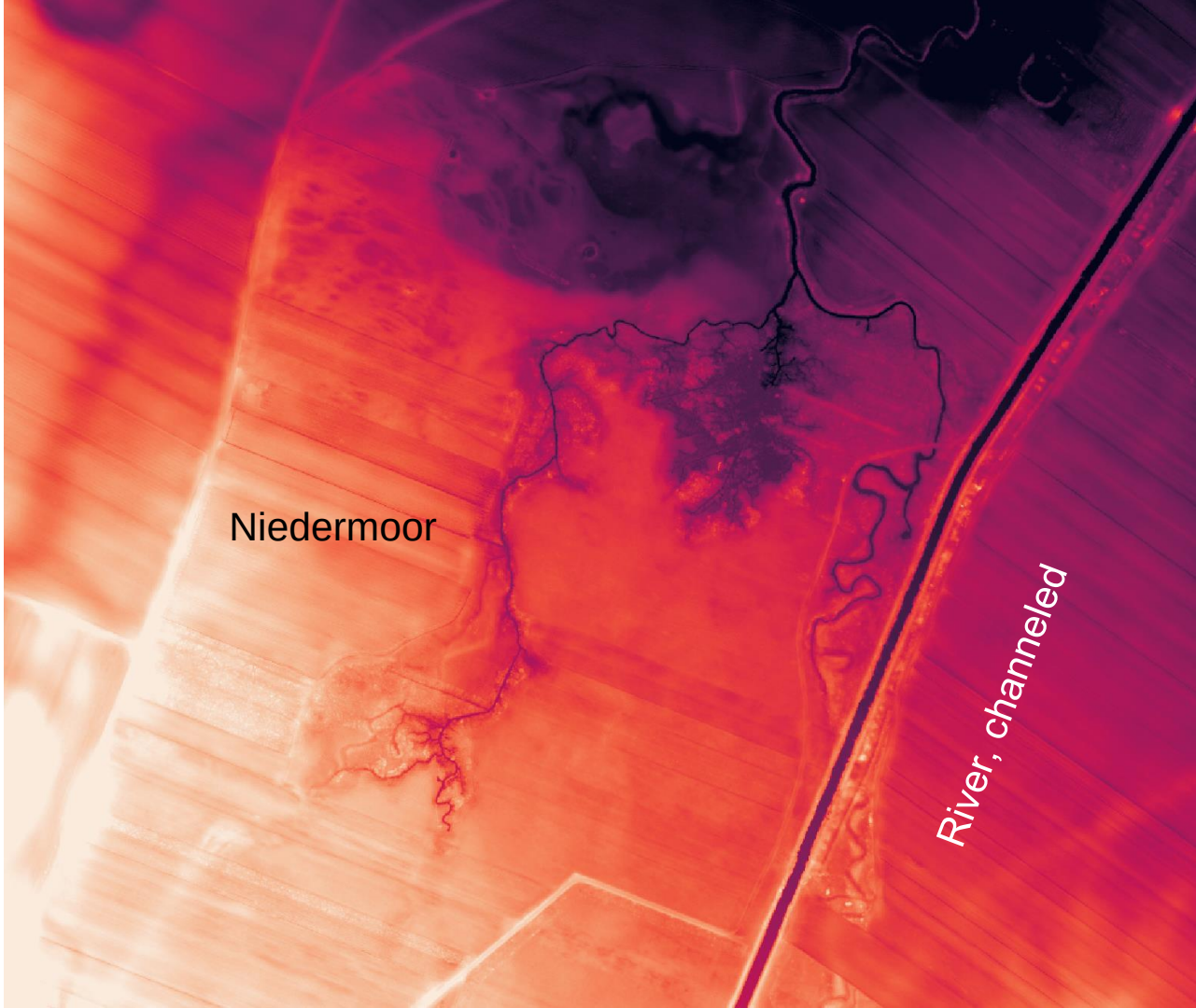
NO Trees+Buildings

Good for Water flow

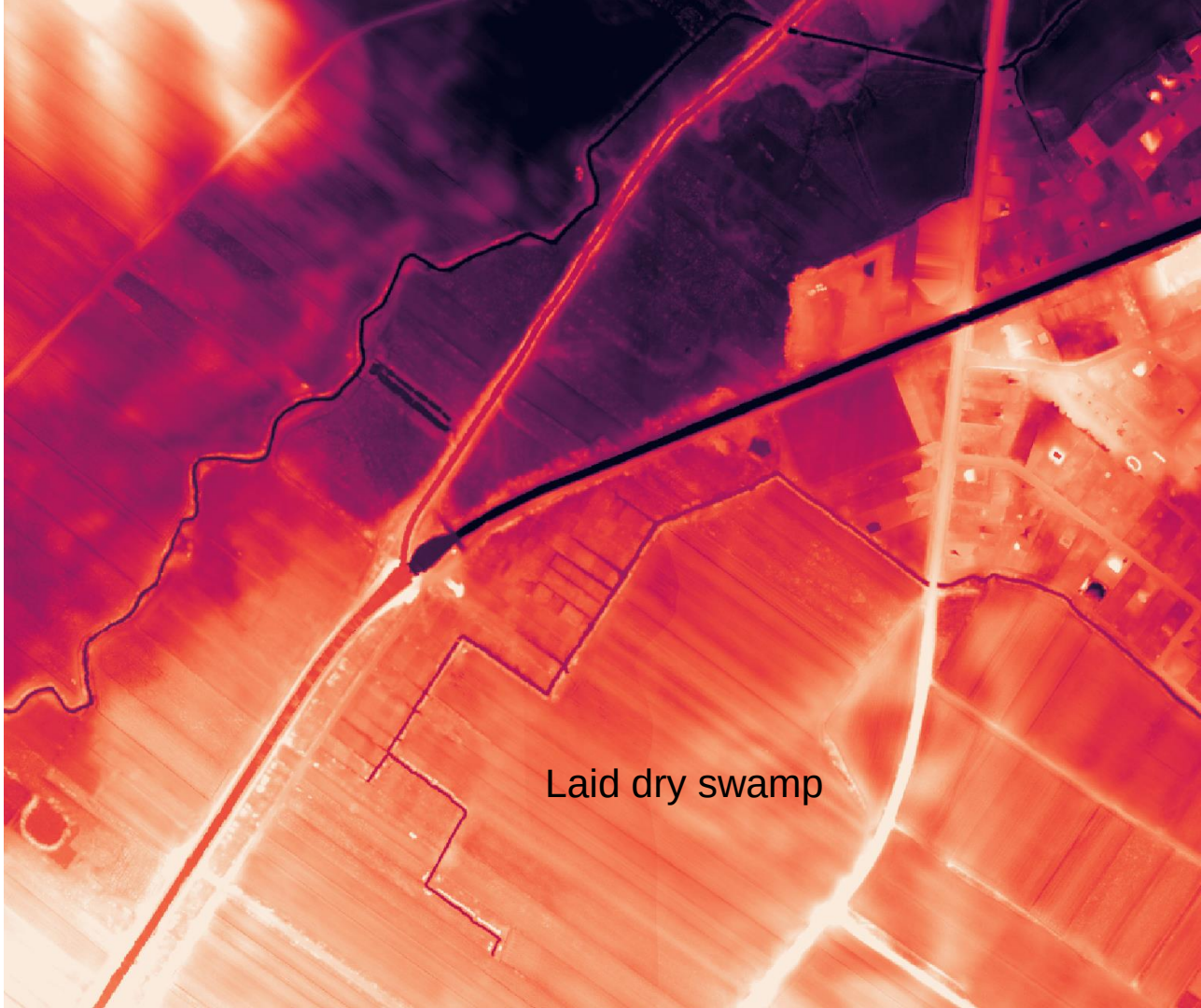
Less height variation



Height variation: 3m



Height variation: ~3m



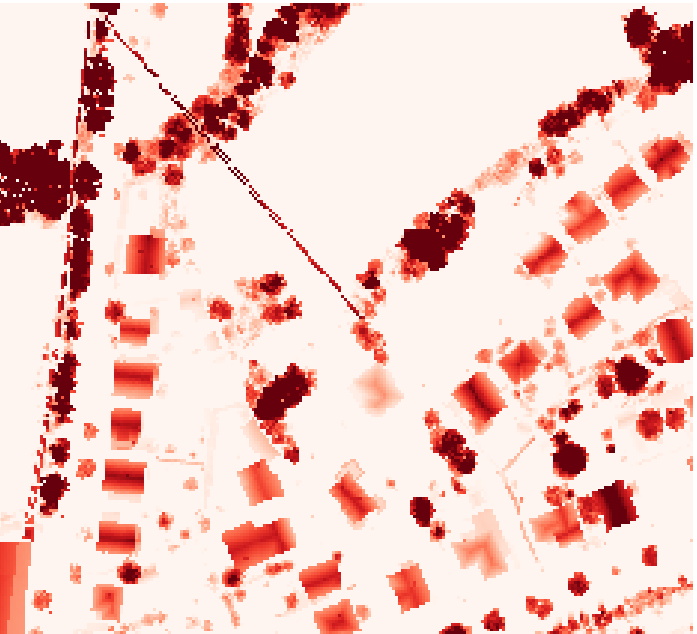
SUBTRACTION

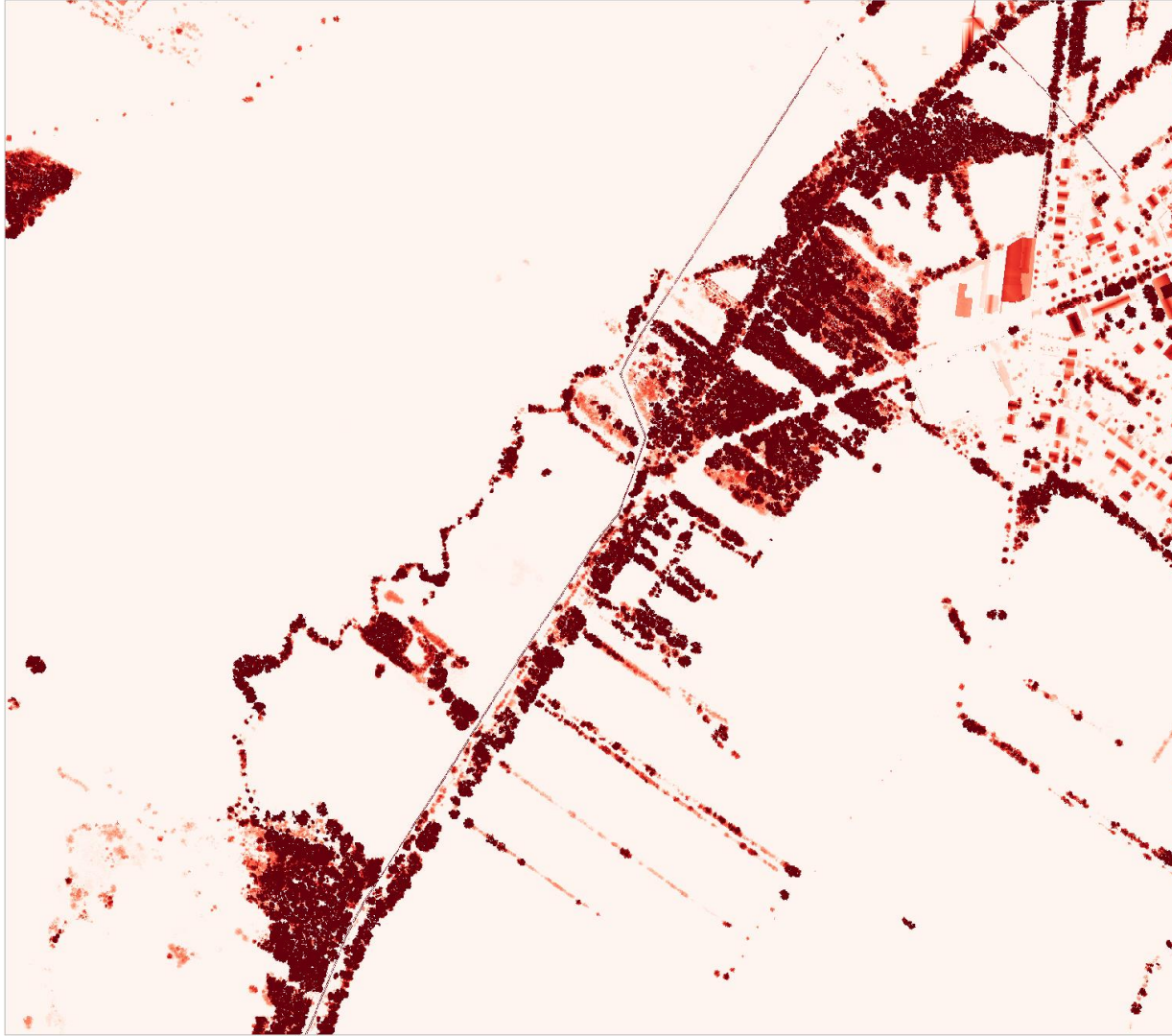
(DSM-DEM)

Elevation of trees+buildings

above ground level

Why? Separate trees and buildings





YOU TALK ABOUT SWAMPS?

What has that to do with PV ?!

LIDAR DSM/DEM

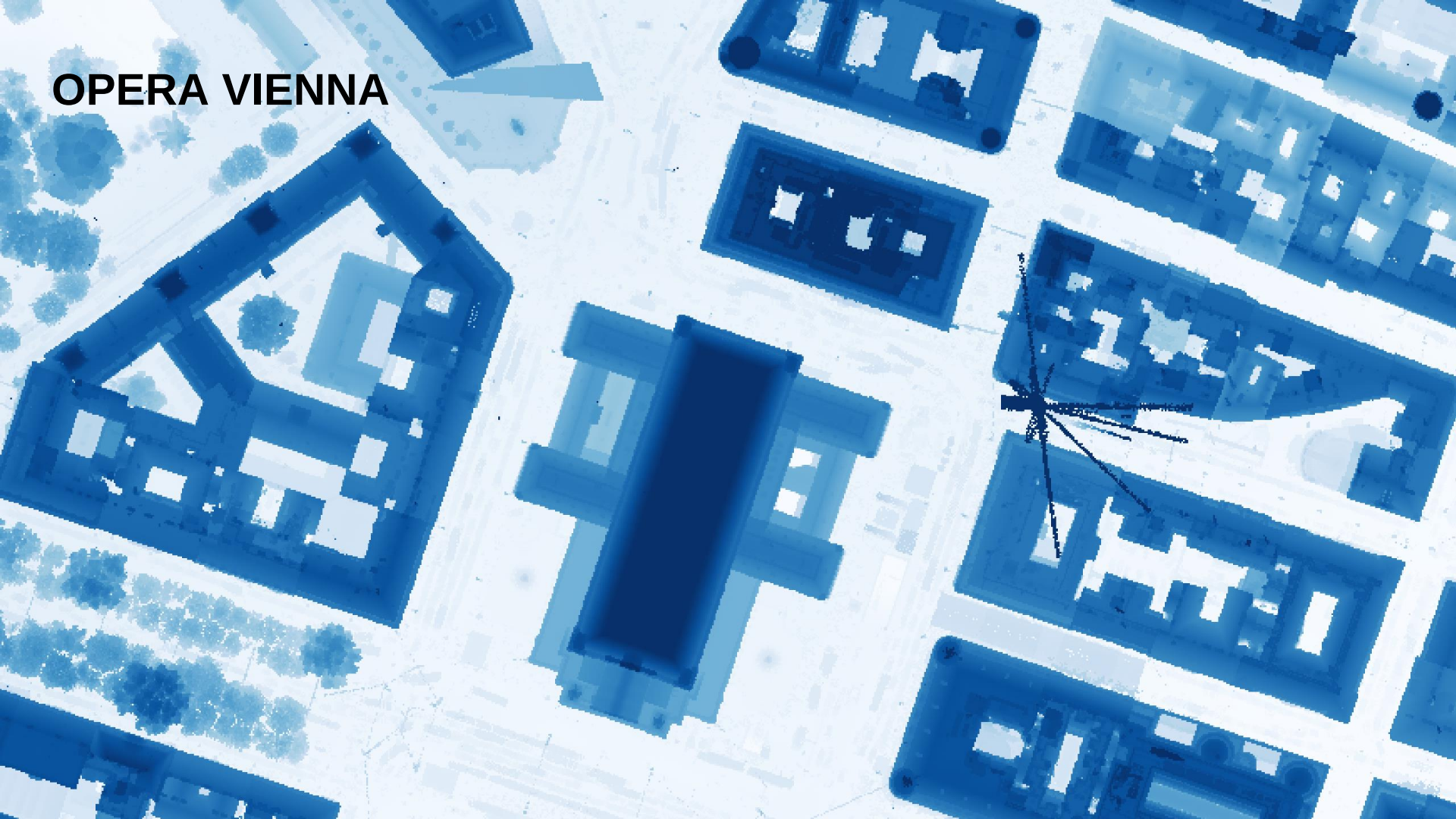
- Availability:
  - Austria: 1m resolution, Vienna: 0.5m
  - Swiss: 0.5m
  - France: 0.25m
  - Typically FREE
- Exist especially in large cities

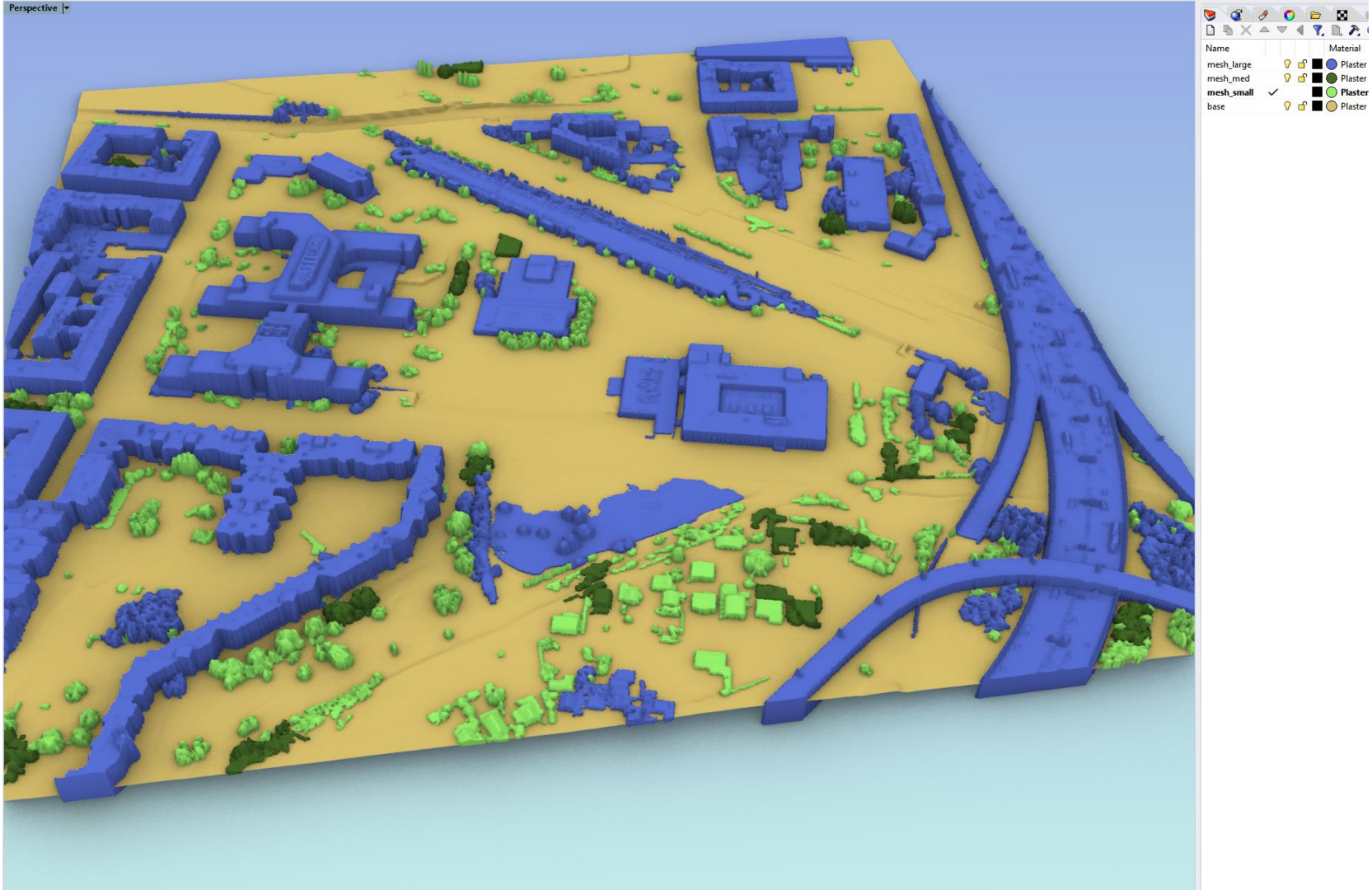
- Very often:
  - Free!!

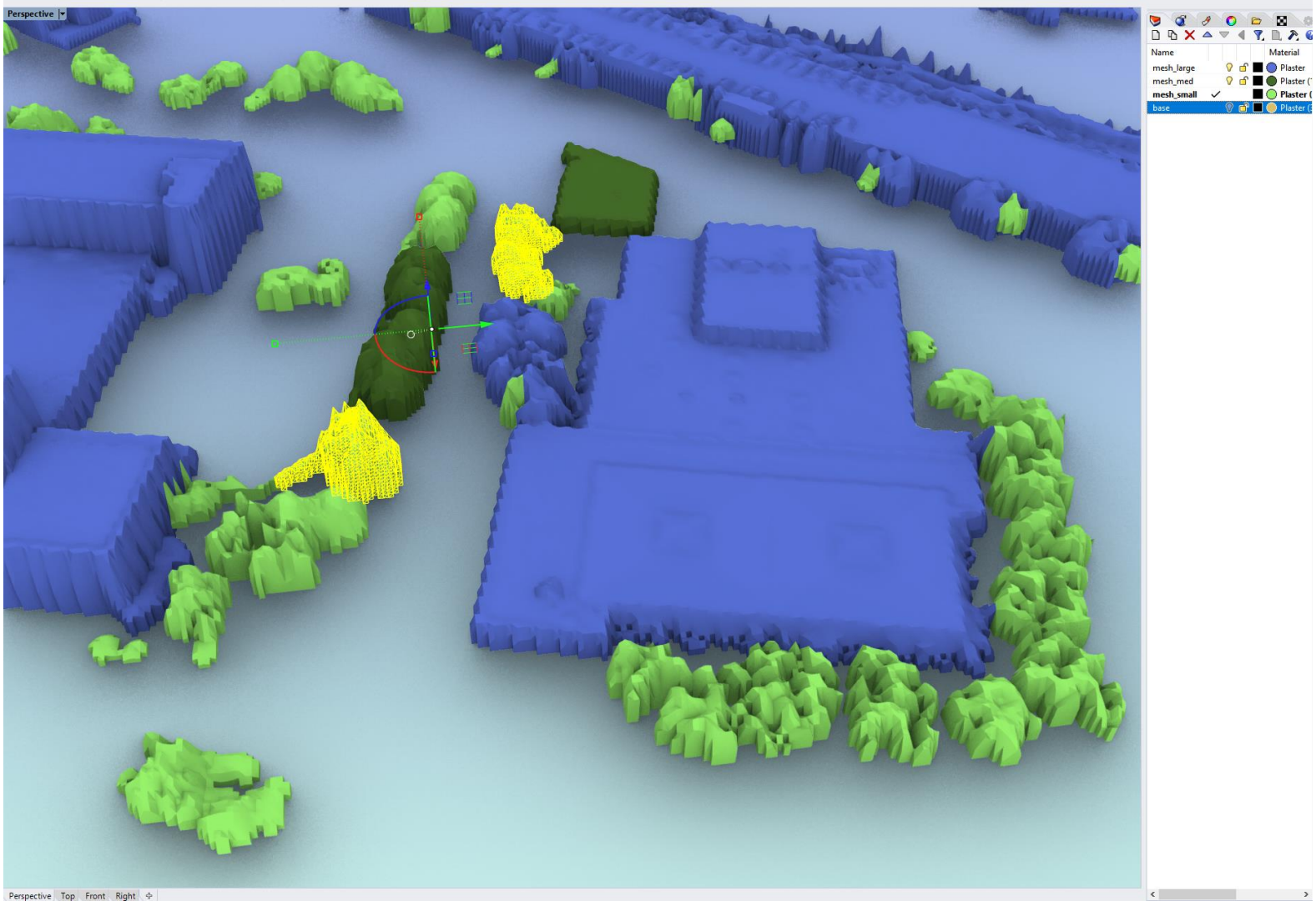
20/09/2023

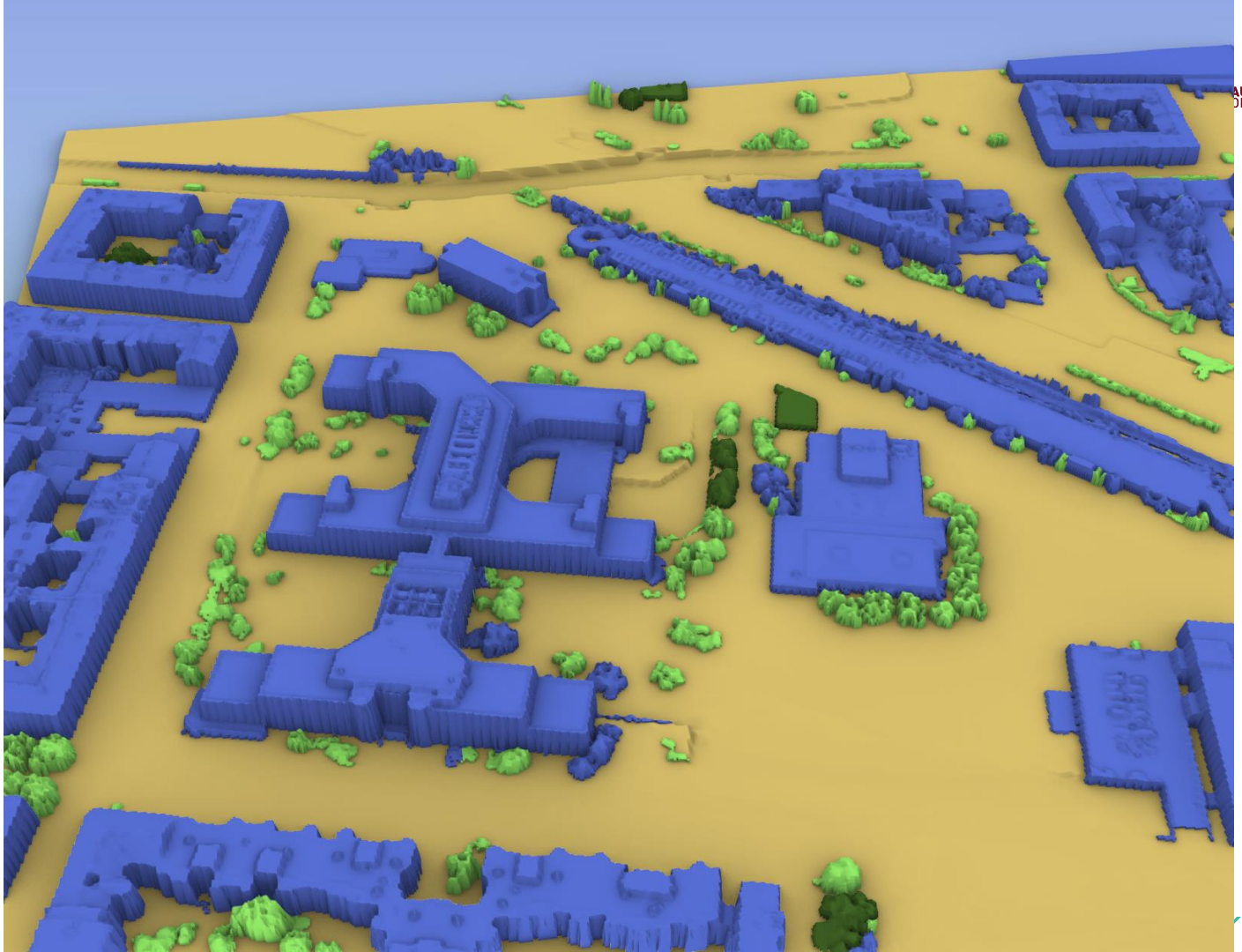
Country / Province	Free	EPSG	Projection	Resolution	Format *
Australia	Yes	28348-28358	GDA94 / MGA Zone 48-58	5 m	ASC, GeoTIFF
Australia	Yes	28348-28358	GDA94 / MGA Zone 48-58	1 m	ASC
Austria	Yes	3035	ETRS89-extended / LAEA Europe	1 m	GeoTIFF
Austria / Burgenland	Yes	31256	MGI / Austria GK East	0.5 m	GeoTIFF
Austria / Kärnten	Yes	31258	MGI / Austria GK M31	1 m	ASC
Austria / Niederösterreich	Yes	31259	MGI / Austria GK M34	1 m	ASC
Austria / Oberösterreich	Yes	31255	MGI / Austria GK Central	0.5 m	XYZ, GeoTIFF
Austria / Salzburg	Yes	31258	MGI / Austria GK M31	1 m	ASC
Austria / Steiermark	Yes		UTM 33 North	1 m	GeoTIFF
Austria / Tirol	Yes	31254, 31255	MGI / Austria GK West, Central	1 m	GeoTIFF
Austria / Vorarlberg	Yes	31254	MGI / Austria GK West	5 m	IMG
Austria / Wien	Yes	31256	MGI / Austria GK East	1 m	ASC, GeoTIFF
Belgium / Vlaanderen	Yes	31370	Belgian Lambert 72	1 m	GeoTIFF
Belgium / Wallonie	Yes	3812	Belgian Lambert 2008	0.5 m	GeoTIFF
Brazil / São Paulo	Yes		UTM 23 South	1 m	LAZ
Canada	Yes		NAD83	0.75 arcs	GeoTIFF
Canada / New Brunswick	Yes	2953	NAD83 / New Brunswick Stereo	1 m	LAS
Canada / British Columbia	Yes		UTM xx North	1 m	LAZ, GeoTIFF
Canada / Nova Scotia	Yes		UTM 20 North	1 m	LAZ
Denmark	Yes		UTM 32 North	0.4 m	ASC, GeoTIFF
Estonia	Yes	3301	Estonian Coordinate System of 1997	1 m	XYZ, GeoTIFF
Finland	Yes		UTM 33-35 North	2 m	ASC, GeoTIFF
France	Yes	2154	RGF93 / Lambert-93	0.25 m	LAZ
Germany / Baden-Württemberg		31467	Gauss Krueger Potsdam Zone 3	1 m	XYZ
Germany / Bayern	Yes		UTM 32 North	1 m	GeoTIFF
Germany / Berlin	Yes		UTM 33 North	1 m	XYZ
Germany / Brandenburg	Yes		UTM 33 North	1 m	XYZ
Germany / Bremen			UTM 32 North	1 m	XYZ
Germany / Hamburg	Yes		UTM 32 North	1 m	XYZ
Germany / Hessen	Yes		UTM 32 North	1 m	XYZ
Germany / Mecklenburg-Vorpommern			UTM 33 North	1 m	ASC
Germany / Niedersachsen			UTM 32 North	1 m	XYZ
Germany / Nordrhein-Westfalen	Yes		UTM 32 North	1 m	XYZ, LAZ
Germany / Rheinland-Pfalz			UTM 32 North	1 m	XYZ
Germany / Saarland		31466	Gauss Krueger Potsdam Zone 2	1 m	XYZ
Germany / Sachsen	Yes		UTM 33 North	1 m	XYZ, LAZ
Germany / Sachsen-Anhalt	Yes		UTM 32 North	2 m	XYZ
Germany / Schleswig-Holstein		31468	Gauss Krueger Potsdam Zone 4	1 m	XYZ
Germany / Thüringen	Yes		UTM 32 North	1 m	XYZ, LAZ

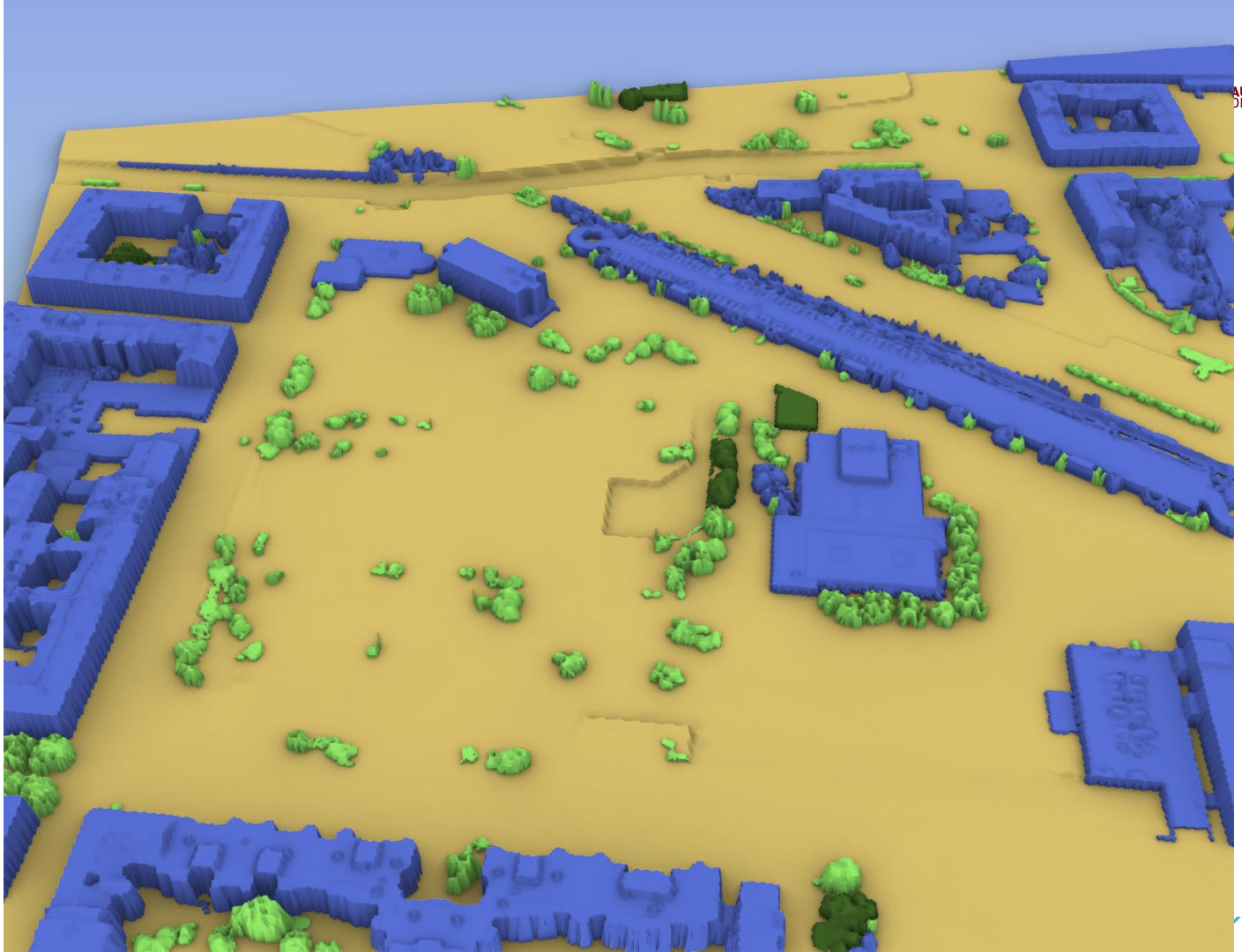
OPERA VIENNA




Perspective
Name
Material
mesh_large
Plaster
mesh_med
Plaster
mesh_small
Plaster
base
Plaster


Perspective
Name
Material
mesh_large
Plaster
mesh_med
Plaster
mesh_small
Plaster
base
Plaster
Perspective
Top
Front
Right






TEXTURED BY ORTHOPHOTOS

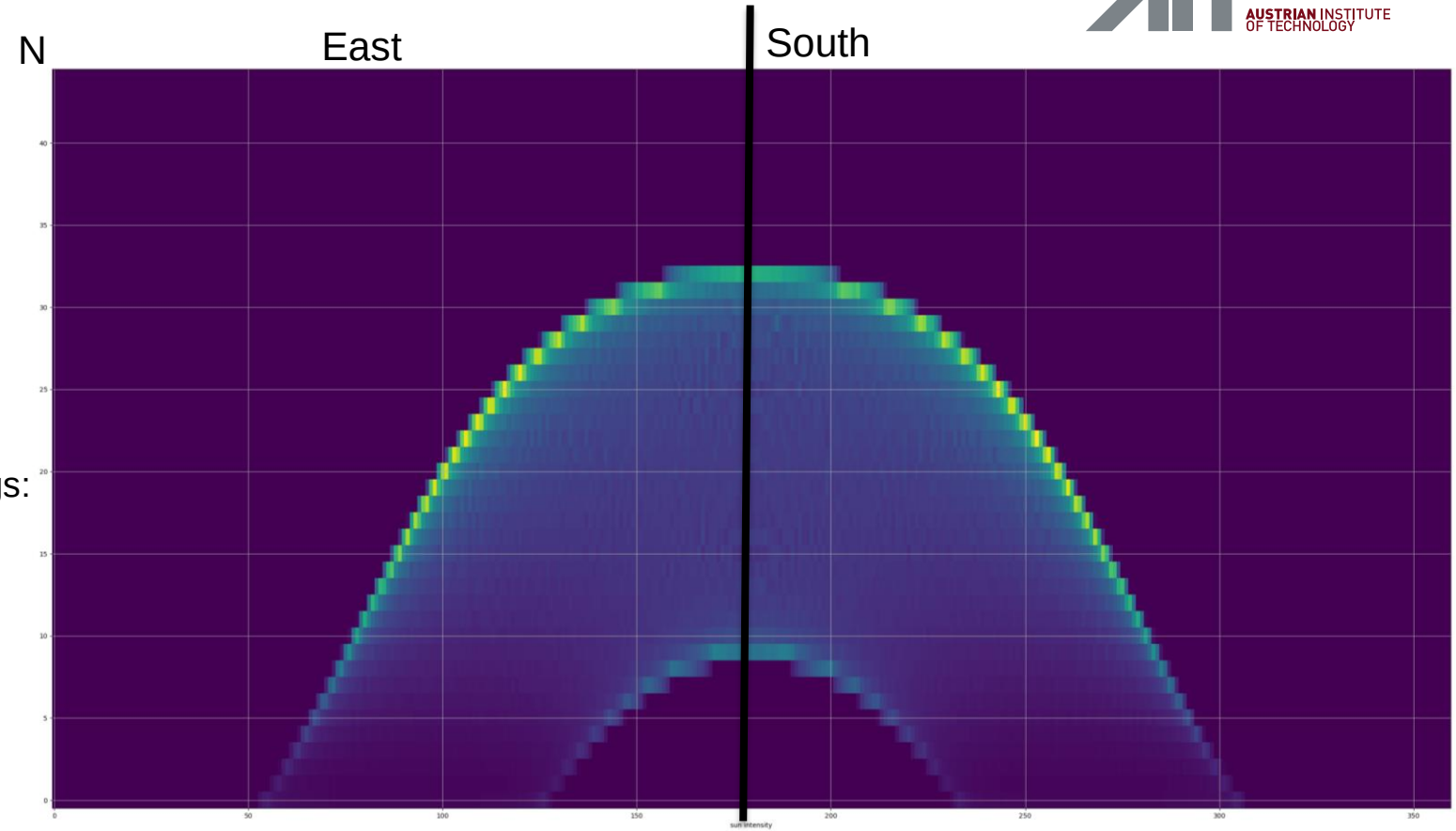
CLEARSKY SUN OVER THE YEAR

Accumulated
To hemispheric
Density

Diffuse irradiation:
From sky
Can be included

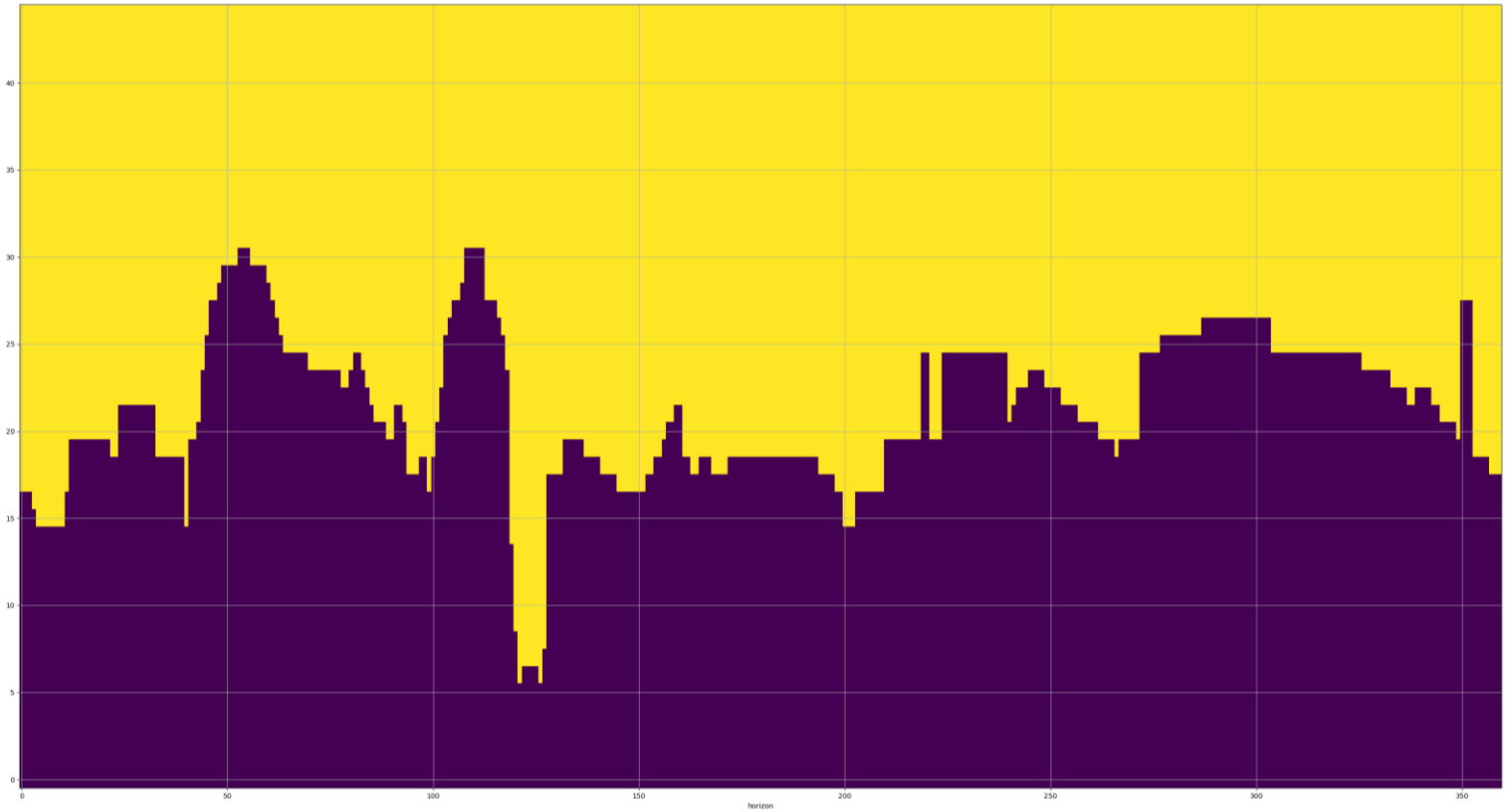
From close buildings:
Not directly

Known historic
Weather: possible

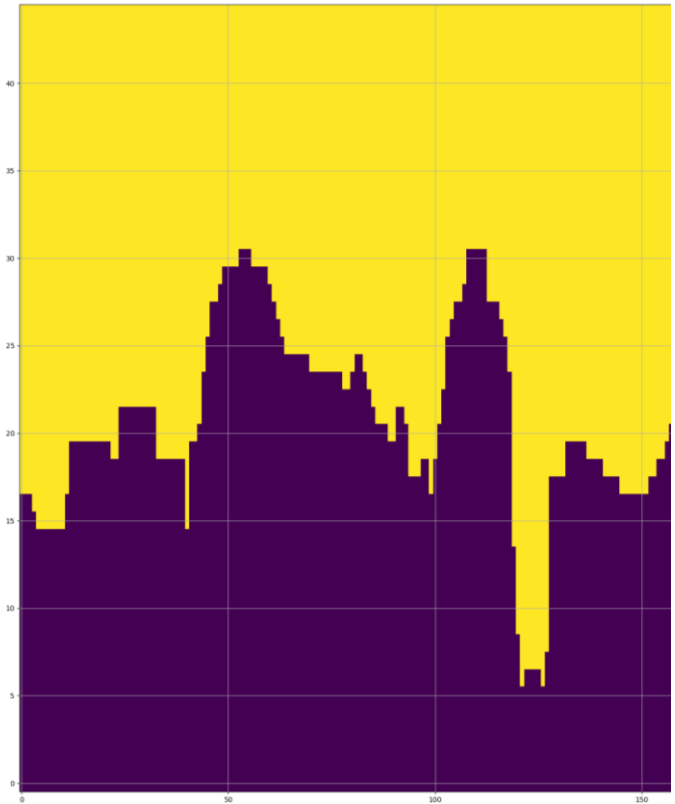


FOR EACH TARGET POSITION

Horizon in Hemispheric map

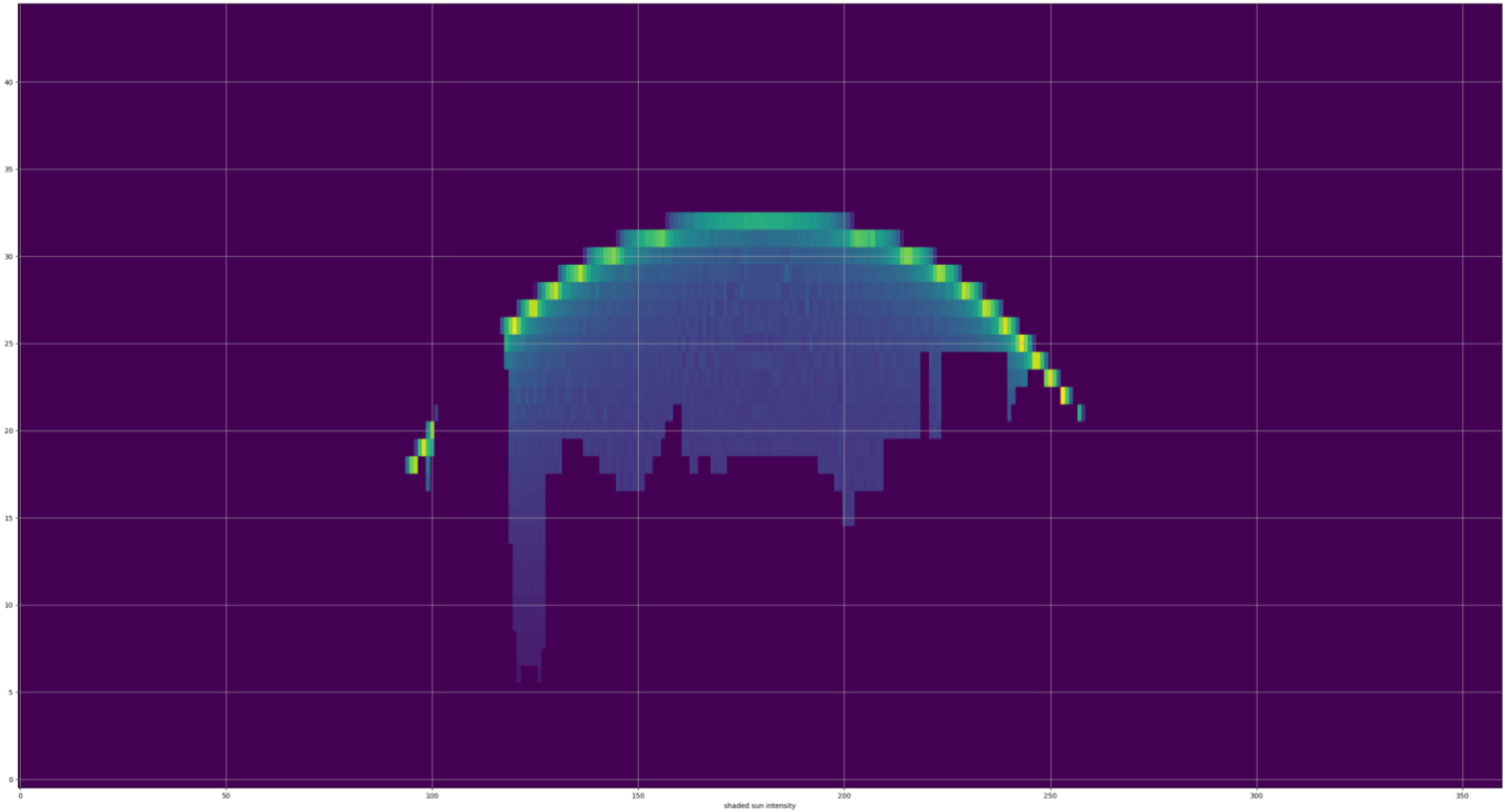


FOR EACH TARGET POSITION



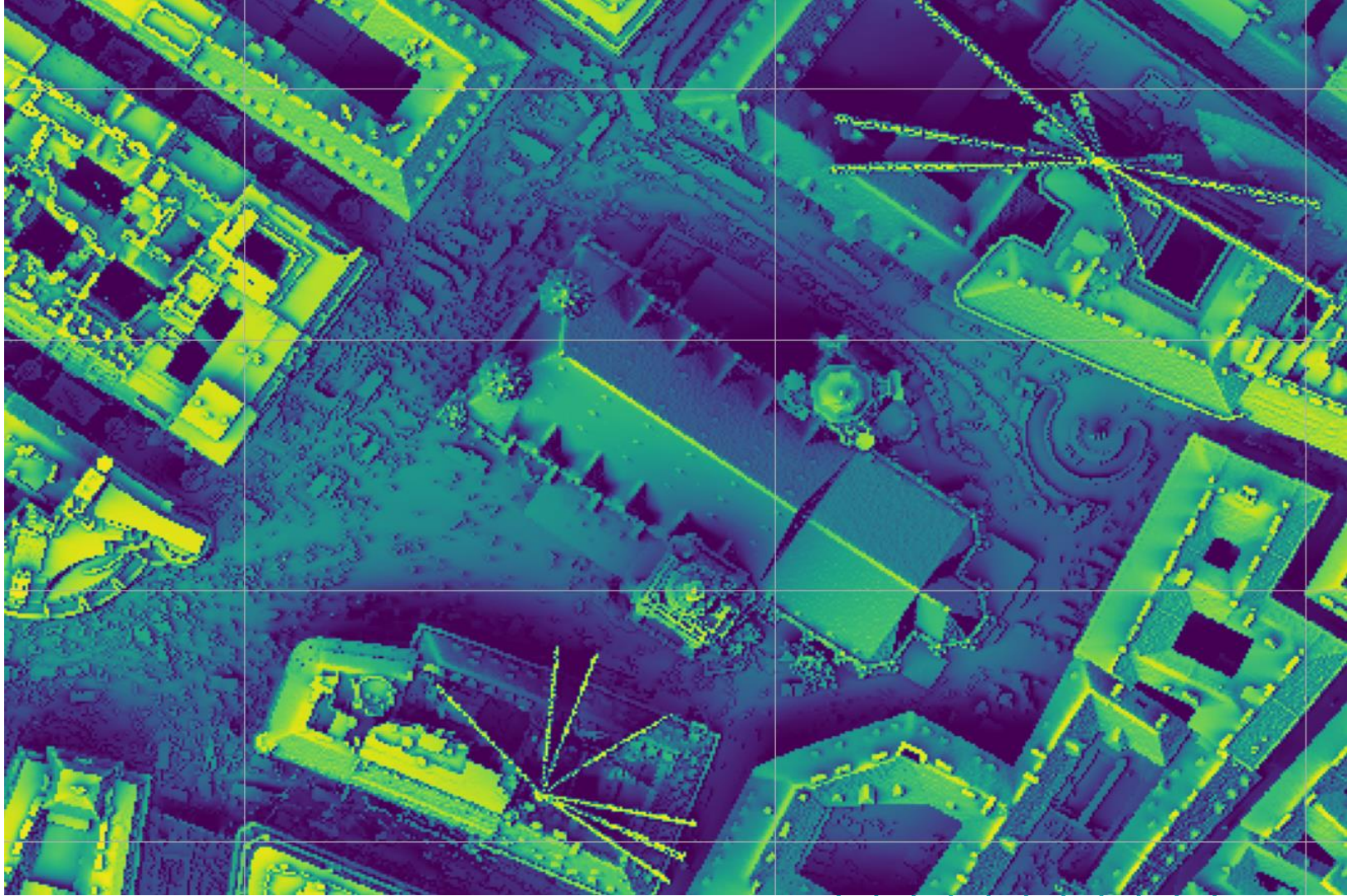
OVERLAY OF HORIZON AND SUN

Integration
Including
Distortion
Correction
=
Clearsky
PV potential



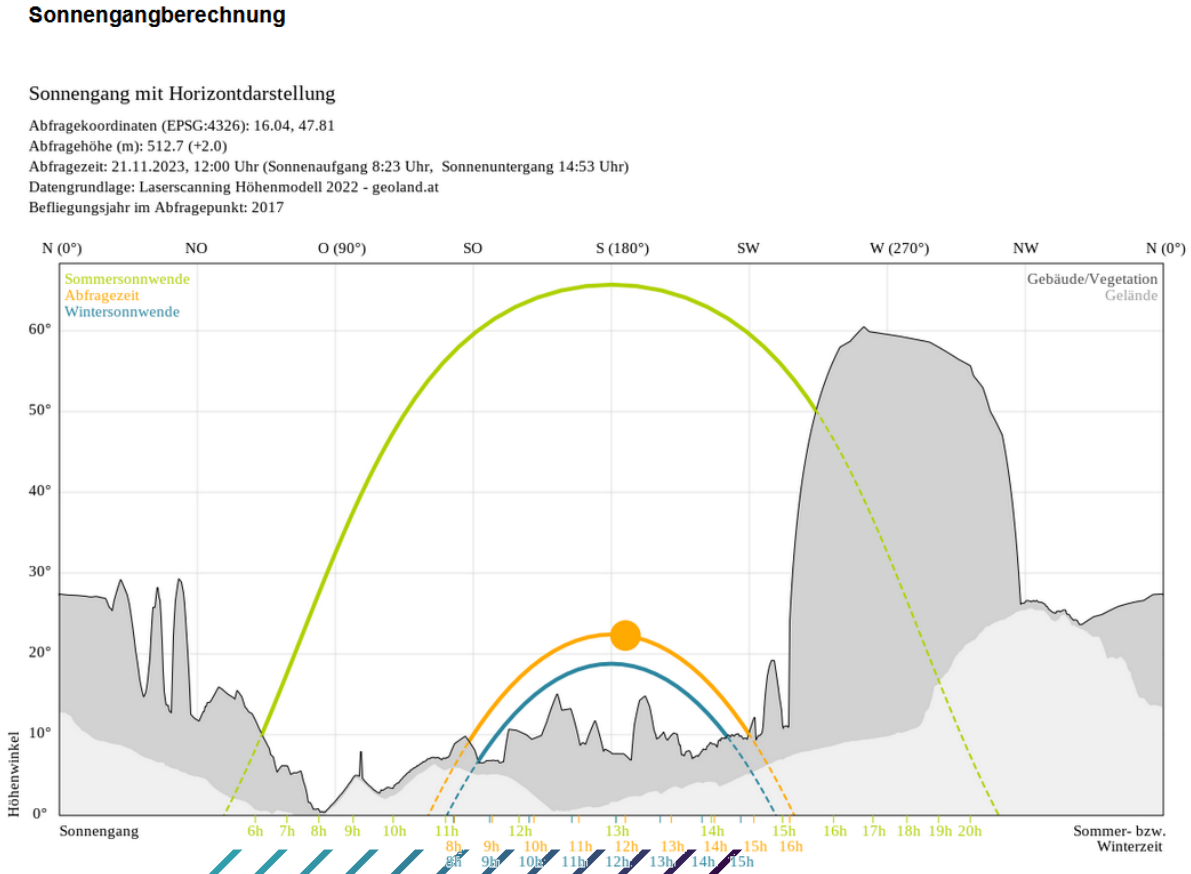
METHOD

- Full resolution grid
- Decrease to hypergrid 5x5 pixel, value=max(domain)
- do one more, 25x25px
- Do one more 125x125px
- For a point:
  - Start in the vicinity in the finest grid, create shadow map
- Go slightly further away, check the most corse grid
  - If shadow already larger in this direction than the corse grid value
    - Ignore
  - Otherwise refine
- SUPER efficient, very fast
- ONLY DNI



20/09/2023

Austria: Public interface, allows Horizo creation for PVGIS



https://voibos.rechenraum.com/voibos/voibos?name=sonnengang&Koordinate=16.03501,47.80624&CRS=4326&Datum=11-21:12:34&H=2

PROBLEMS OF LIDAR

- Commonly outdated!
  - In Vienna ~6 years old.
- Façades:
  - Jagged.

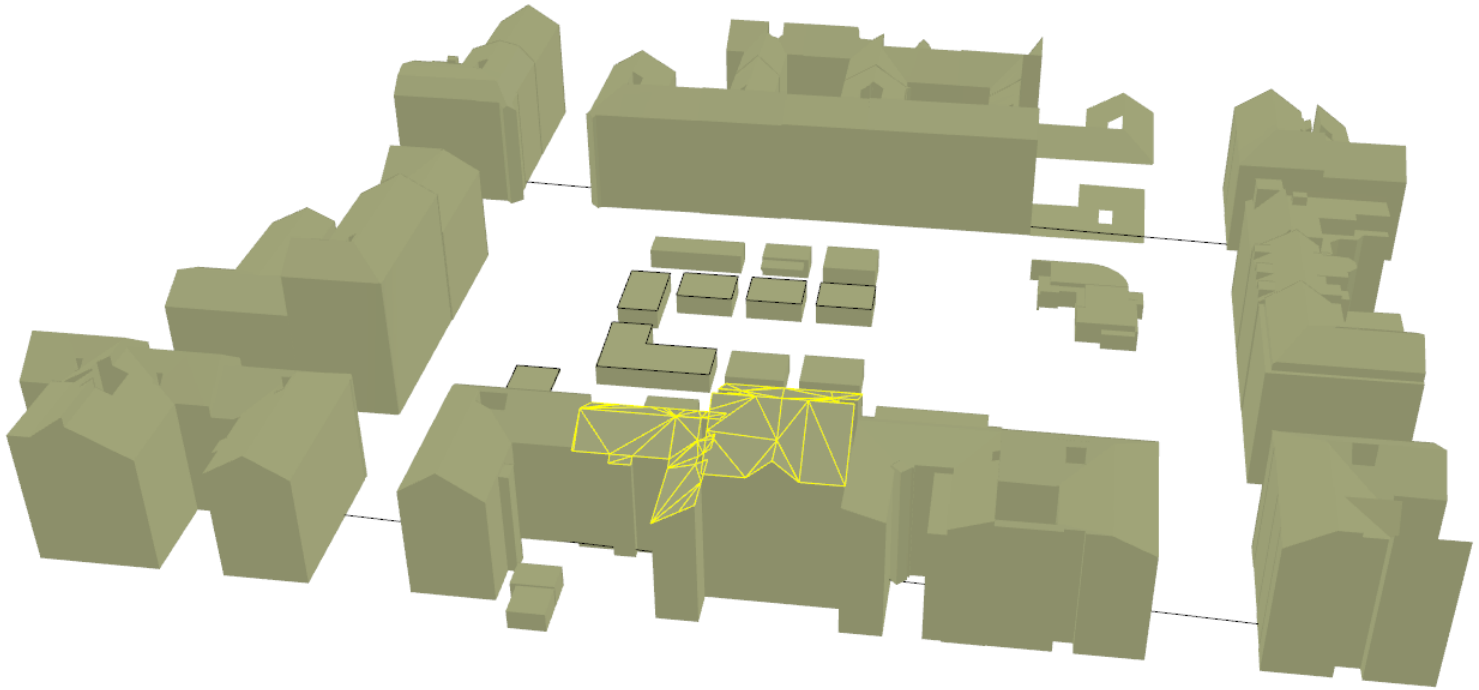
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

LOD 2.1

Manual building shapes based on development plans

Only exist in large cities

Often outdated



3D RECONSTRUCTION

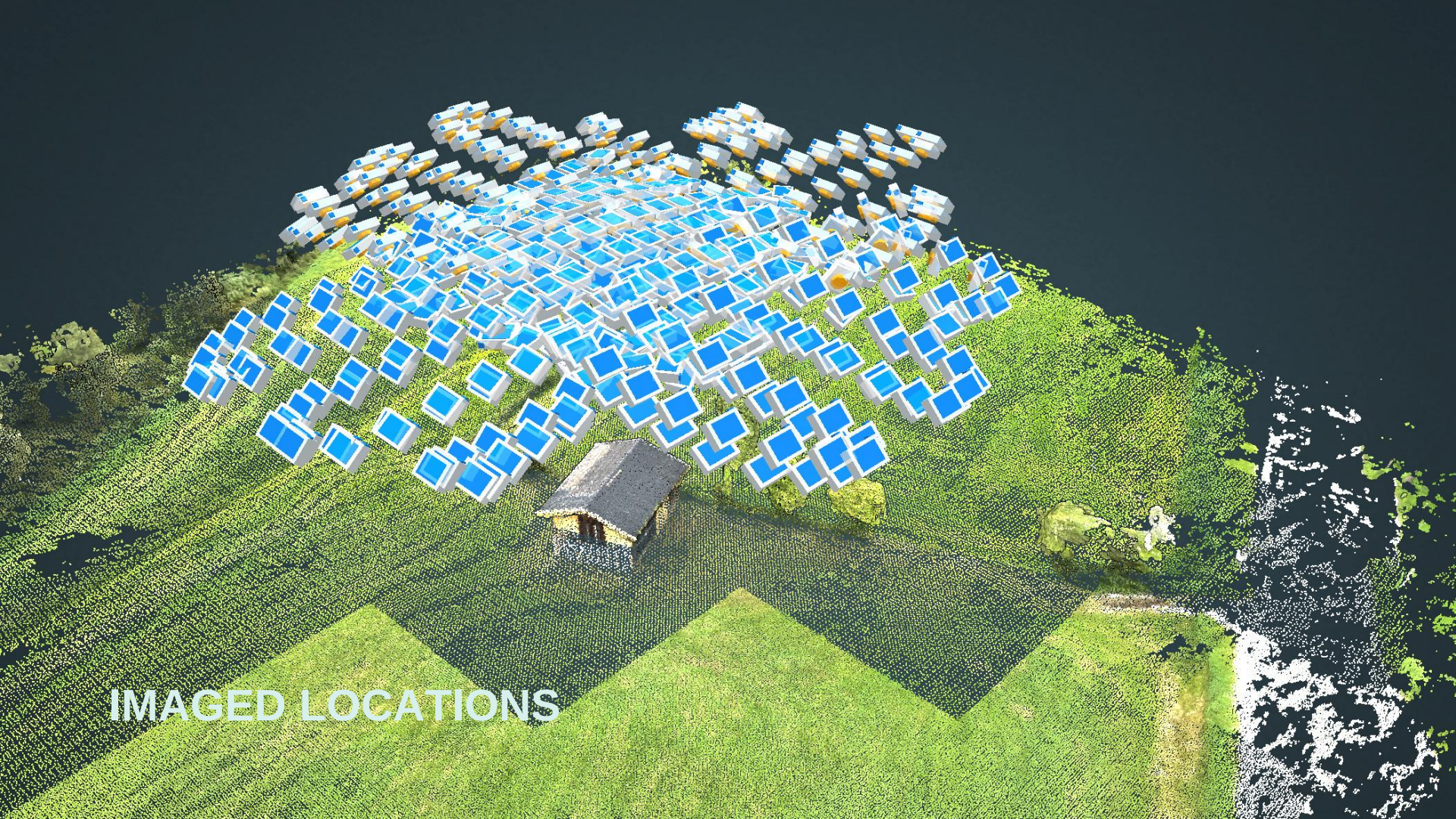
Photogrammetry

RECIPE

- Take a 700€ DJI drone
- Programm a flight path
- Takes images of a house from multiple directions (50-500)
  - Images contains GPS positions in EXIF Metadata
    - Only accurate to 5m
- Put images into Photogrammetry software
  - Wait (0.5-3h)
- Get textured 3d model

- This can be done 100% with open source software
  - WebODM
- Or commercially: Pix4D


POINT CLOUD


IMAGED LOCATIONS

PV*SOL

Textured Objects can be used in PV planning software, i.E.

PV*Sol

Source: Valentin Software

CONCLUSION

- It is nowadays:
  - Free/very cheap to obtain detailed 3d models
- In the digital 3d model:
  - One can easily remove old buildings/trees
  - Plant custom geometry
- If one only performs direct irradiation:
  - Very fast algorithms exist
  - Suitable to find joint patches for strings of modules

- Public available data from goverments:
  - VERY NICE TO HAVE
  - Any € into that pays back!