VolGIS:
a new volcano-oriented GIS for multidisciplinary volcano analysis.

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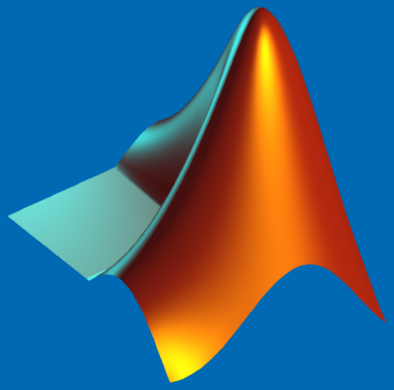
*An **open-source** volcano oriented-GIS*
that offers the possibility
*to **analyze, model** and **visualise***
*different **volcano-related***
*available **data** in a **user-friendly***
***high-resolution** visualisation environment.*

Why are you developing another Geographic Information System when others softwares are available?



gVSIG
Whitebox GAT
SAGA GIS
GRASS GIS
MapWindow
ILWIS

Which is the novelty?

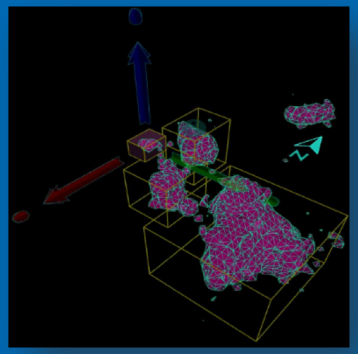
OpenJump
Diva GIS
FalconView
OrbisGIS

1. Open source;

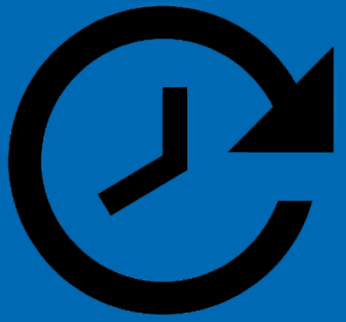
The core

The tools

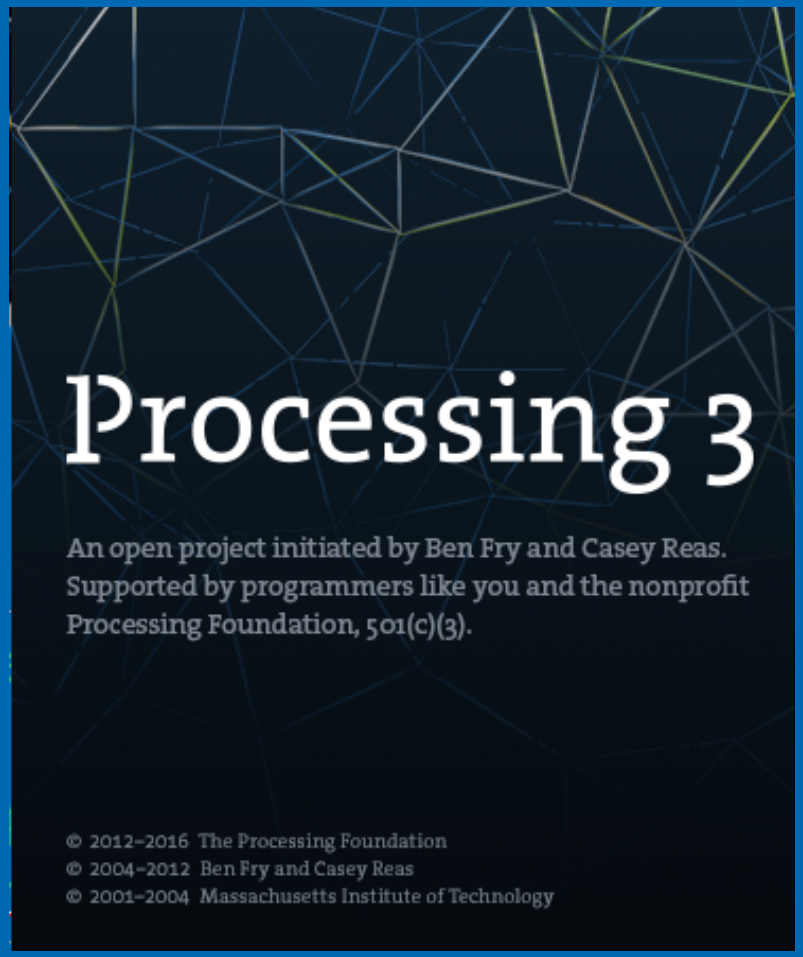
First results



Future implementation



Open source.

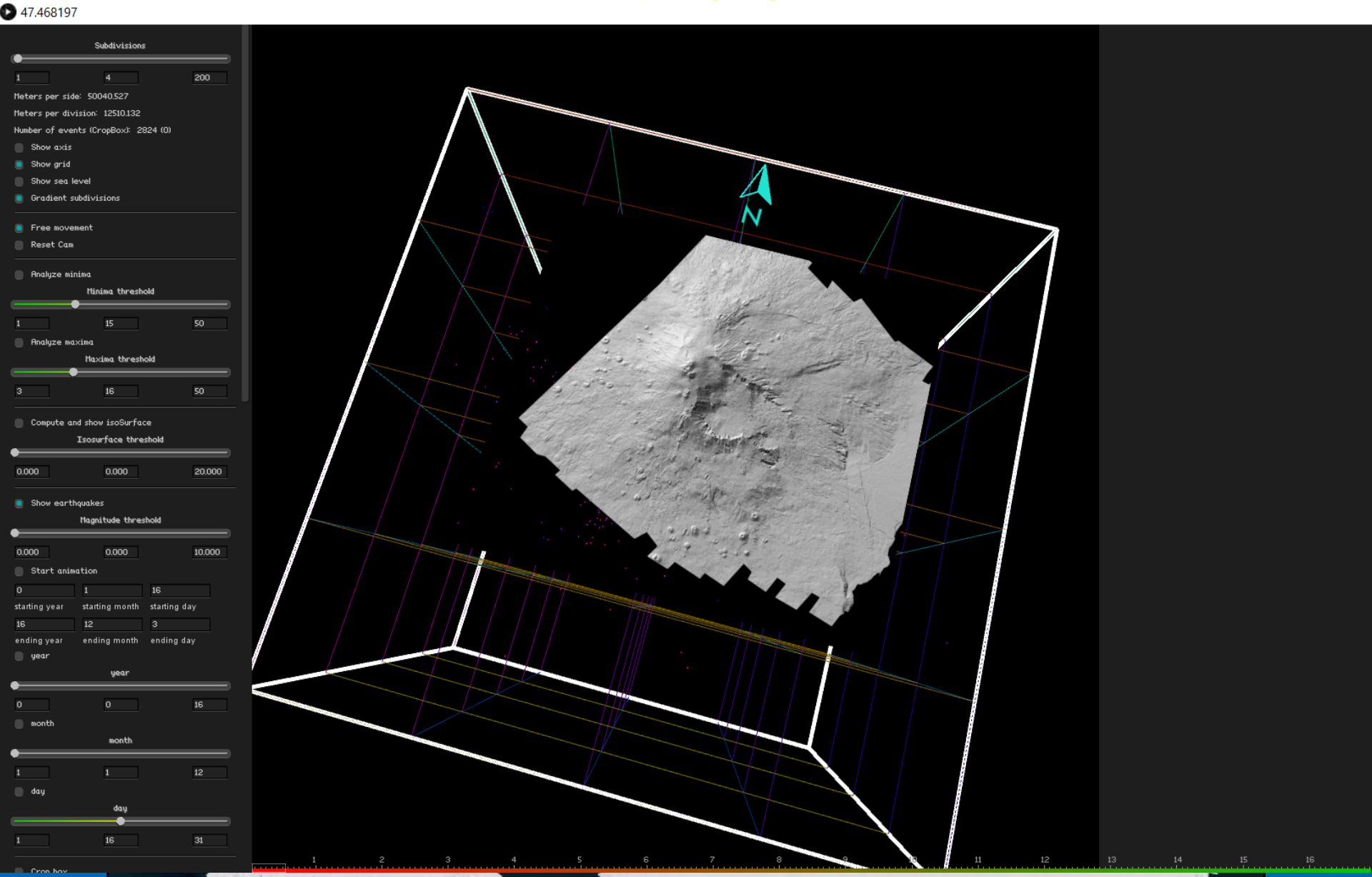


An open source language and it uses a simplified syntax and a graphics user interface.

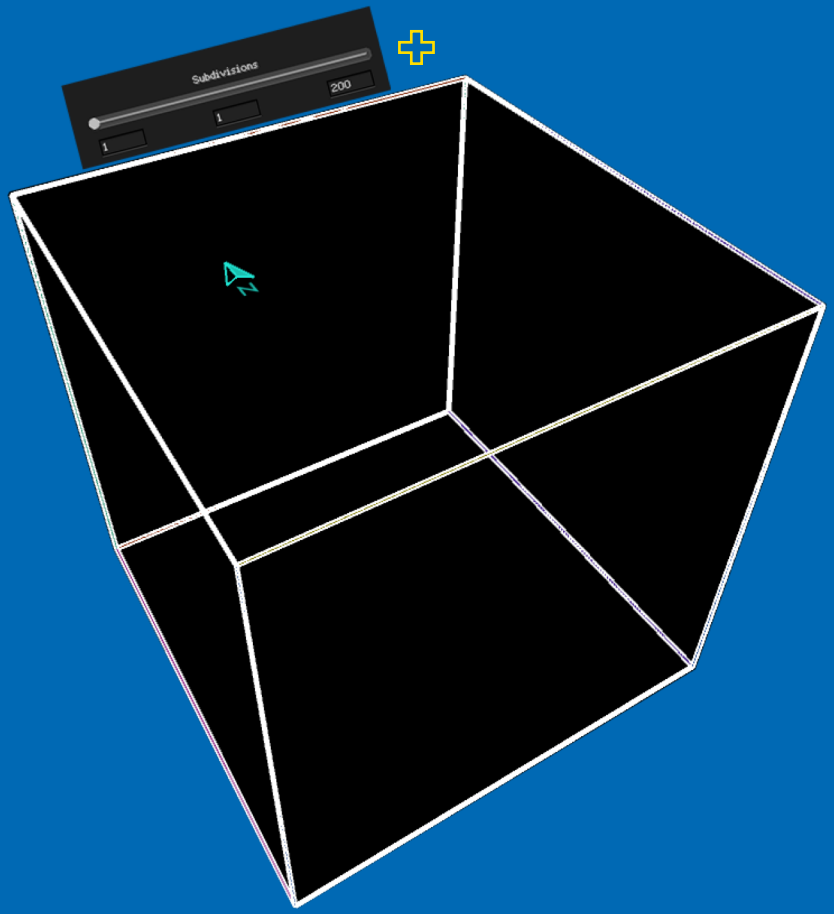
Language Mode:
- Processing.R
- Processing.J

Libraries:
- Computation Geometry
- GicentreUtils

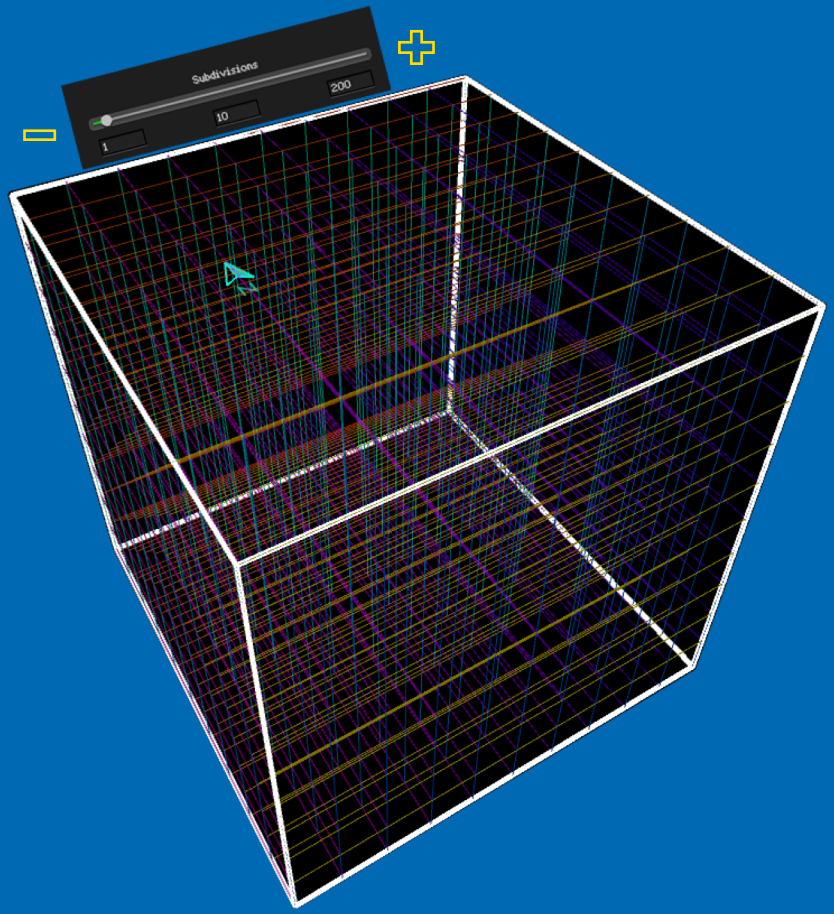
VolGIS

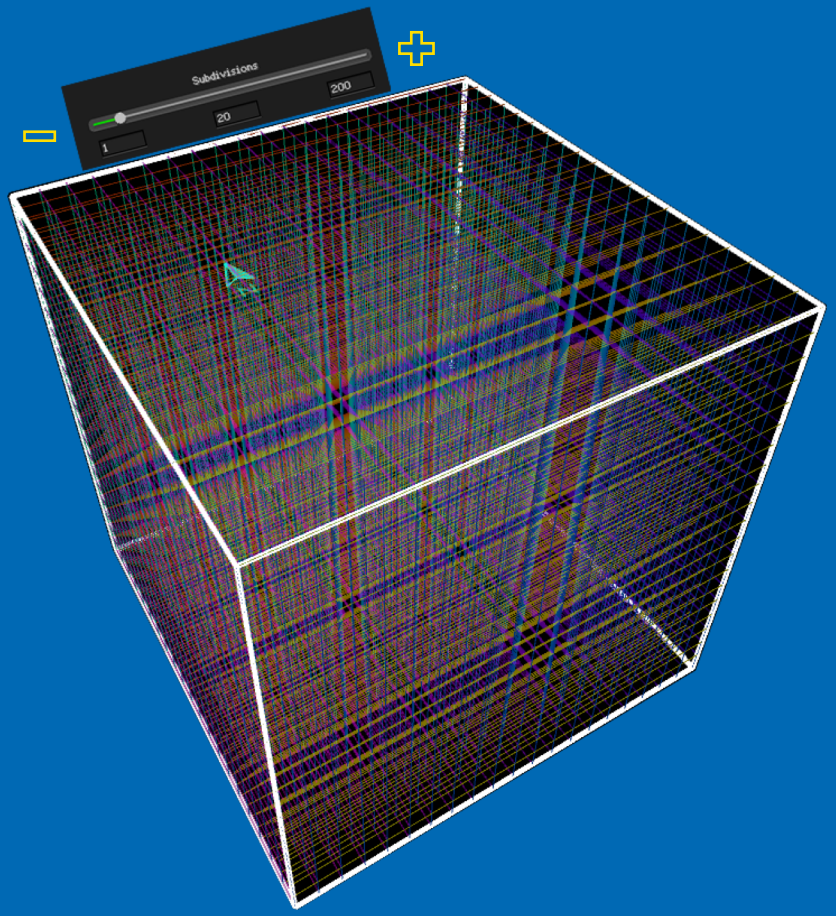

47.468197
Subdivisions
1
4
200
Meters per side: 50040.527
Meters per division: 12510.132
Number of events (CropBox): 2824 (0)
Show axis
Show grid
Show sea level
Gradient subdivisions
Free movement
Reset Cam
Analyze minima
Minima threshold
1
15
50
Analyze maxima
Maxima threshold
3
16
50
Compute and show isoSurface
Isosurface threshold
0.000
0.000
20.000
Show earthquakes
Magnitude threshold
0.000
0.000
10.000
Start animation
0
starting year
1
starting month
16
starting day
16
ending year
12
ending month
3
ending day
year
year
0
0
16
month
month
1
1
12
day
day
1
16
31
Crop box
N
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Analyse / Model / Visualise



Grid Subdivision

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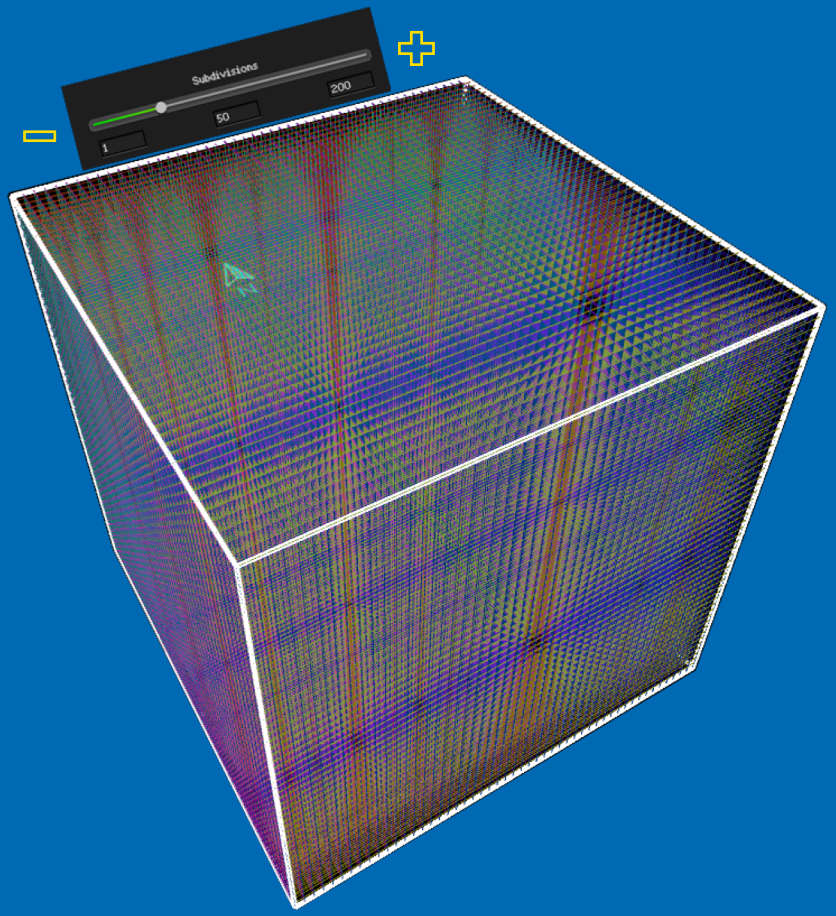

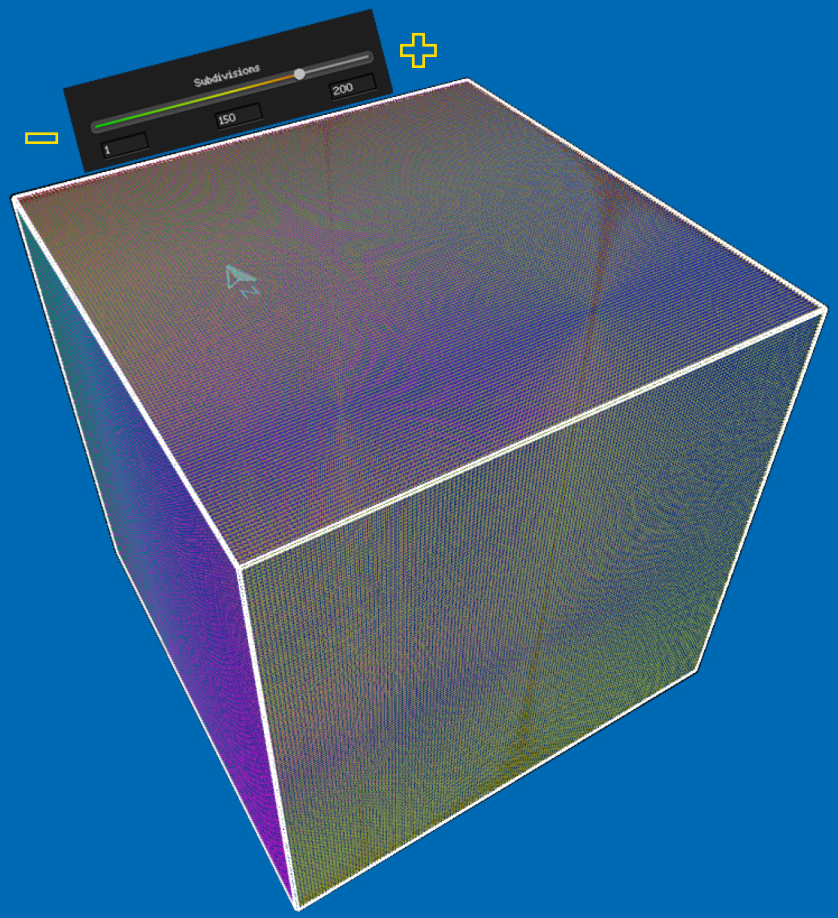
Subdivisions
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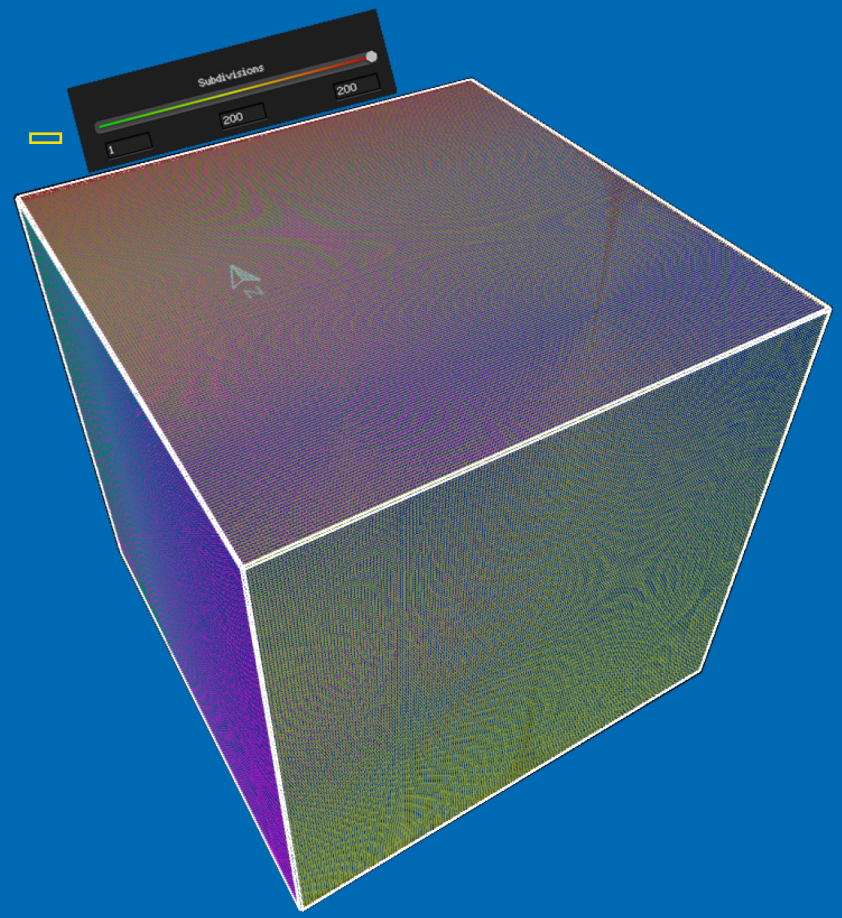
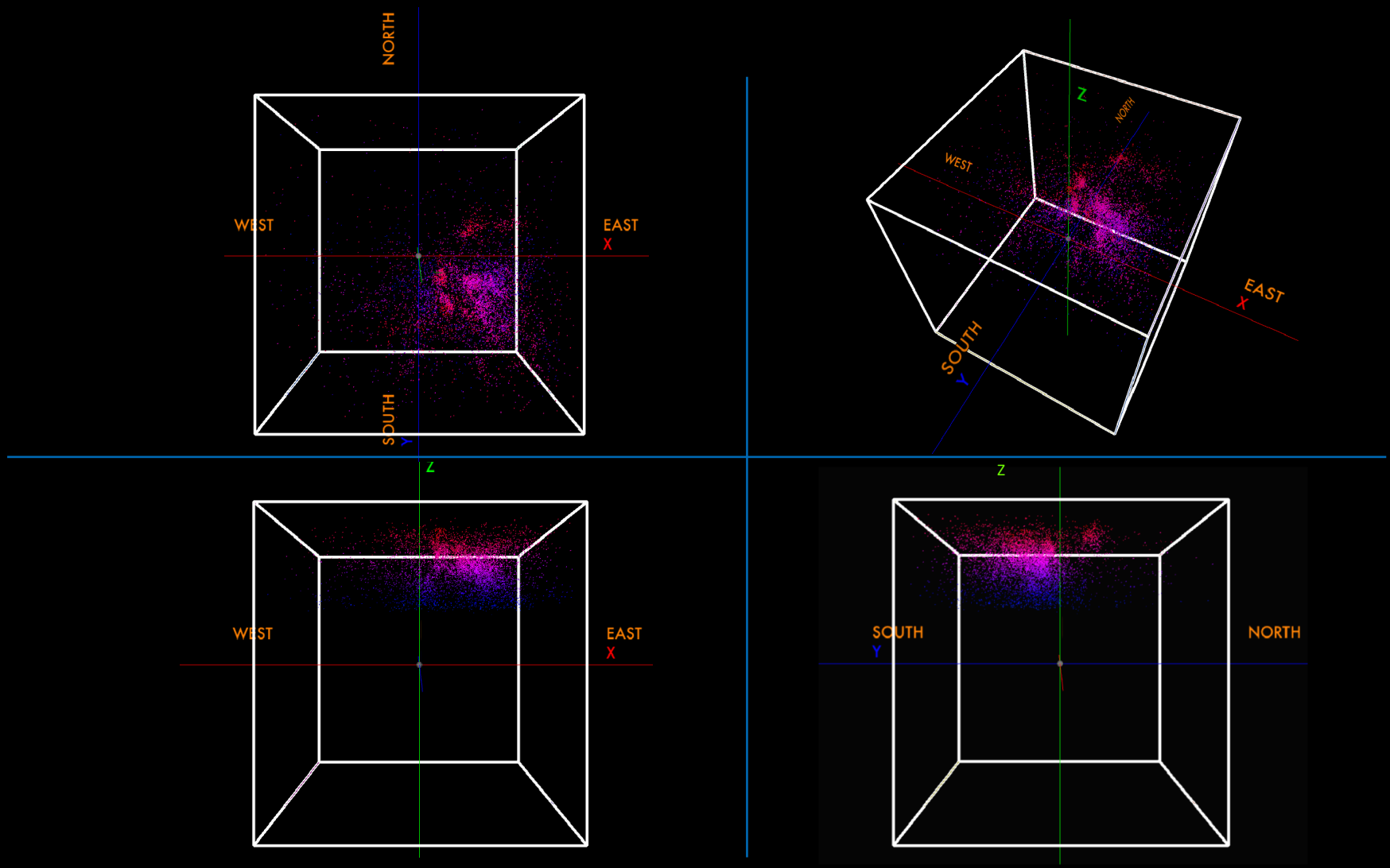
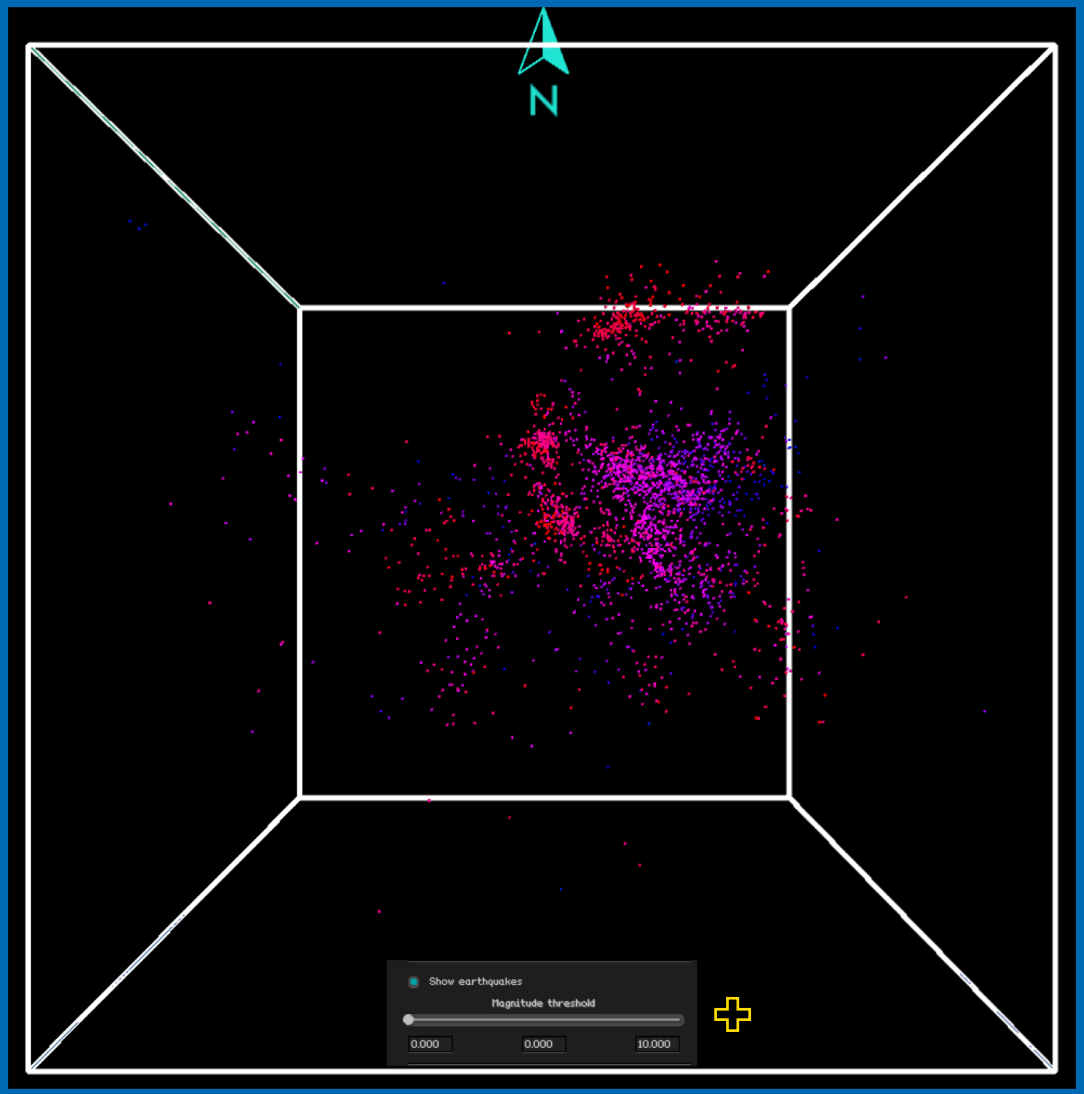
150
200


Subdivisions
200
1
200

Earthquakes Visualization

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Show earthquakes
Magnitude threshold
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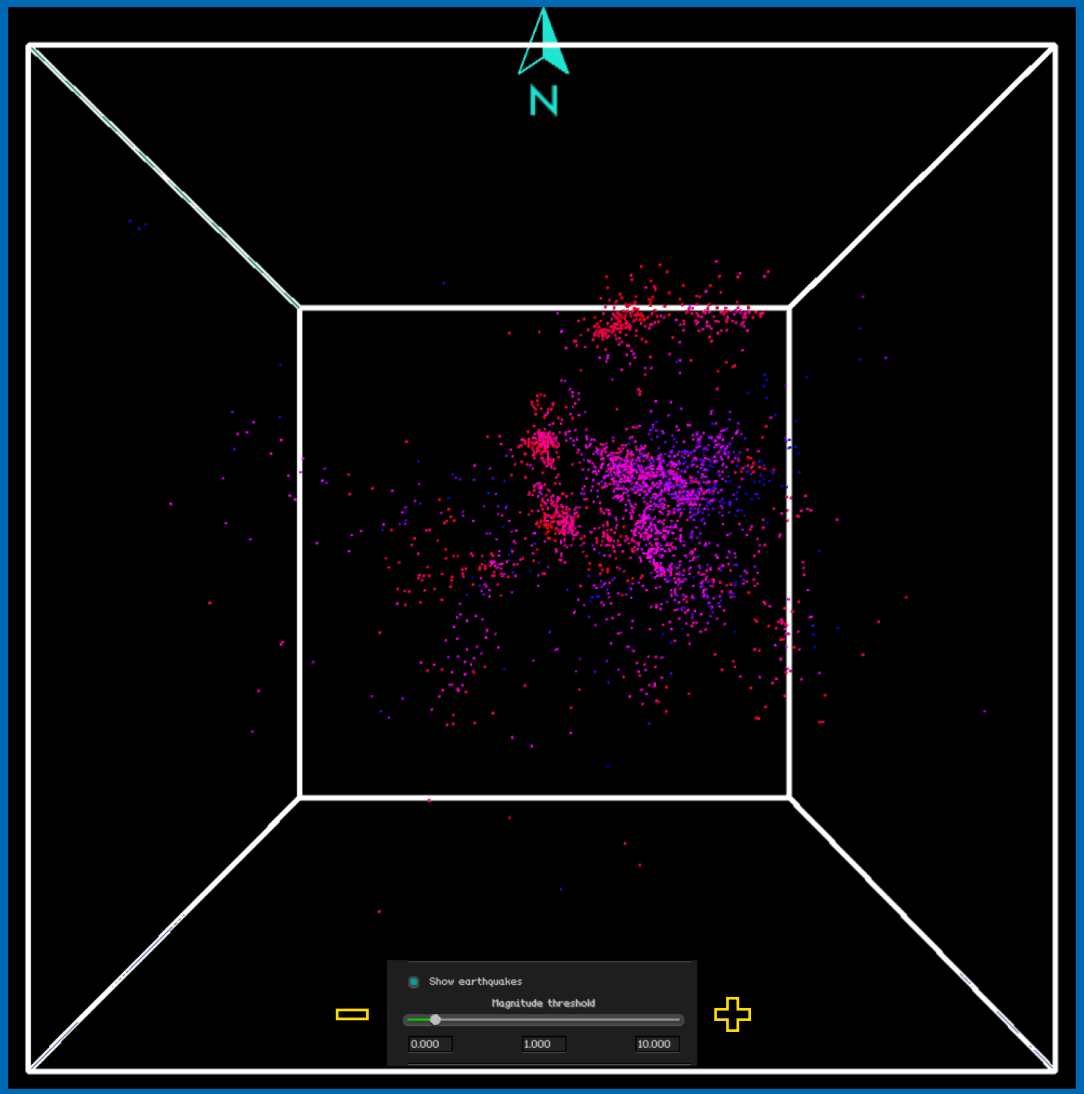
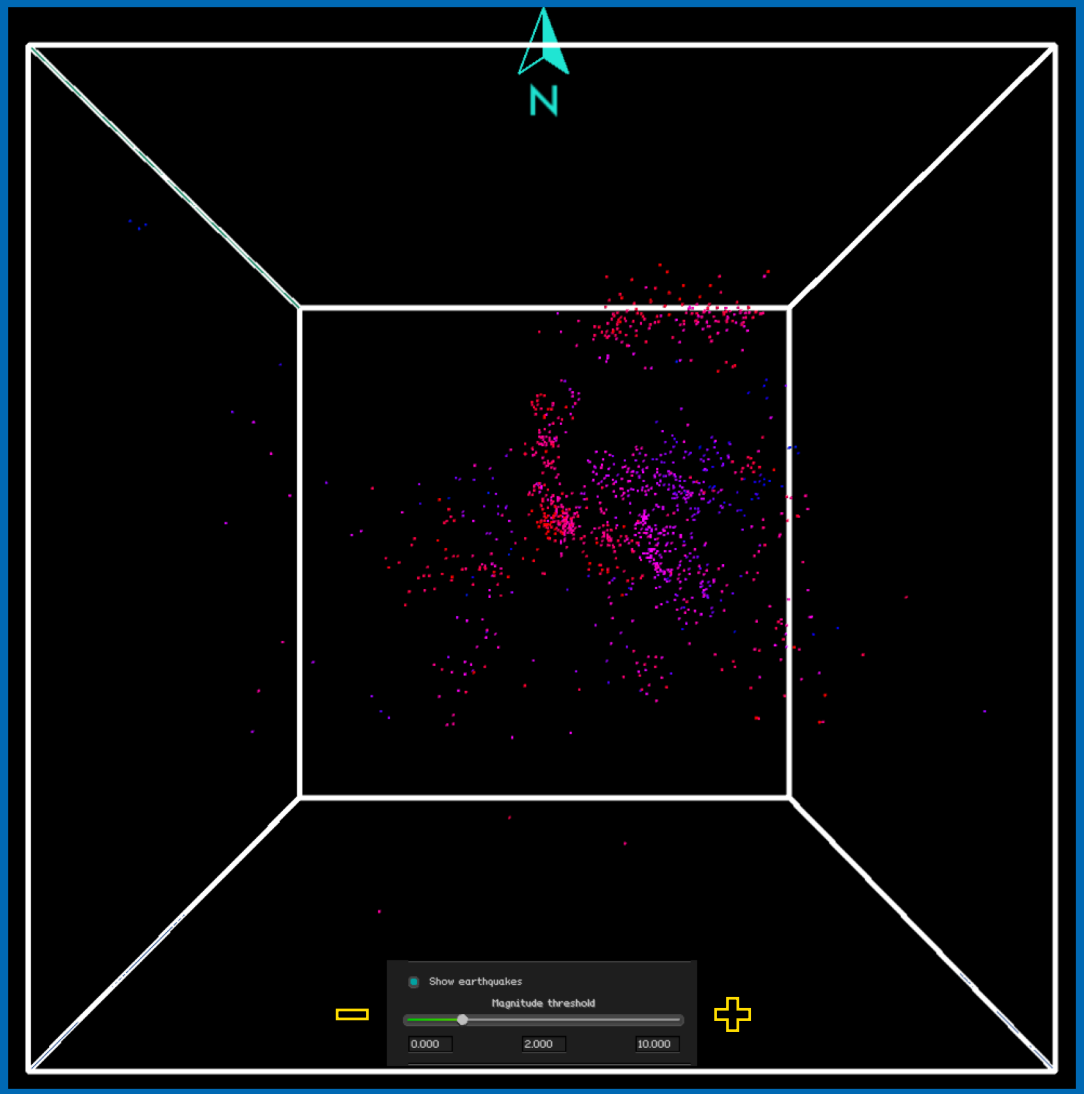
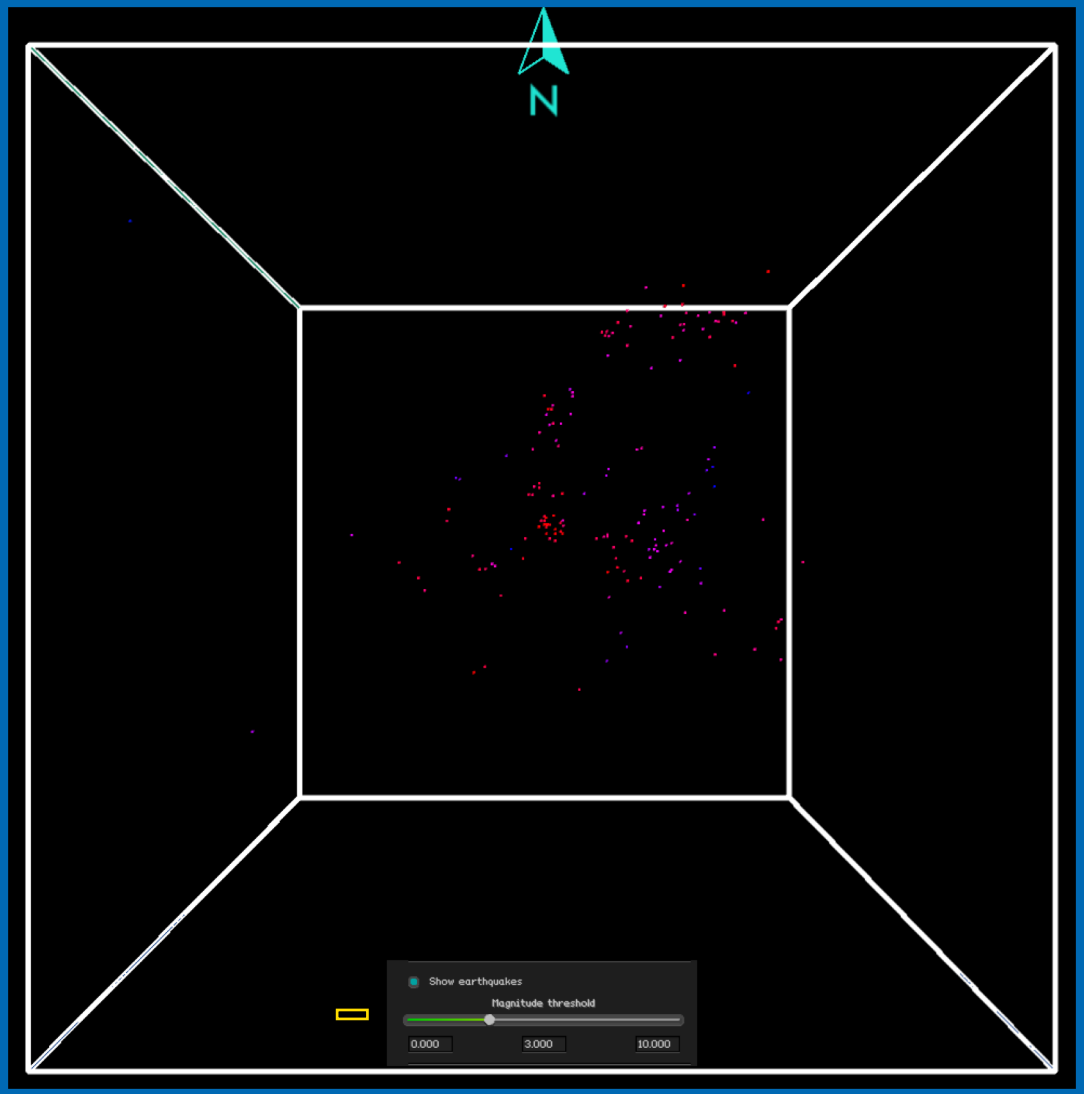
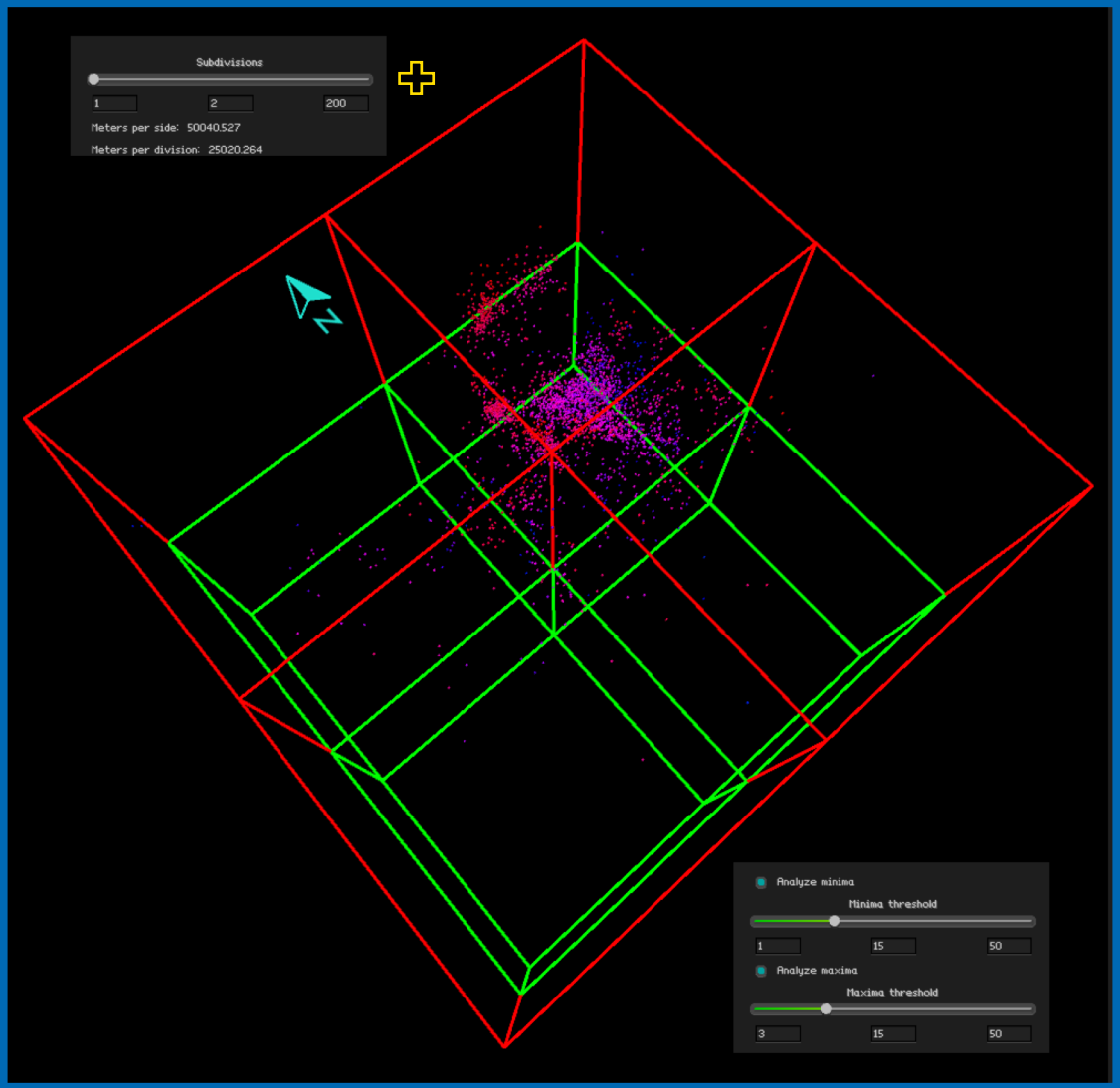
0.000
10.000

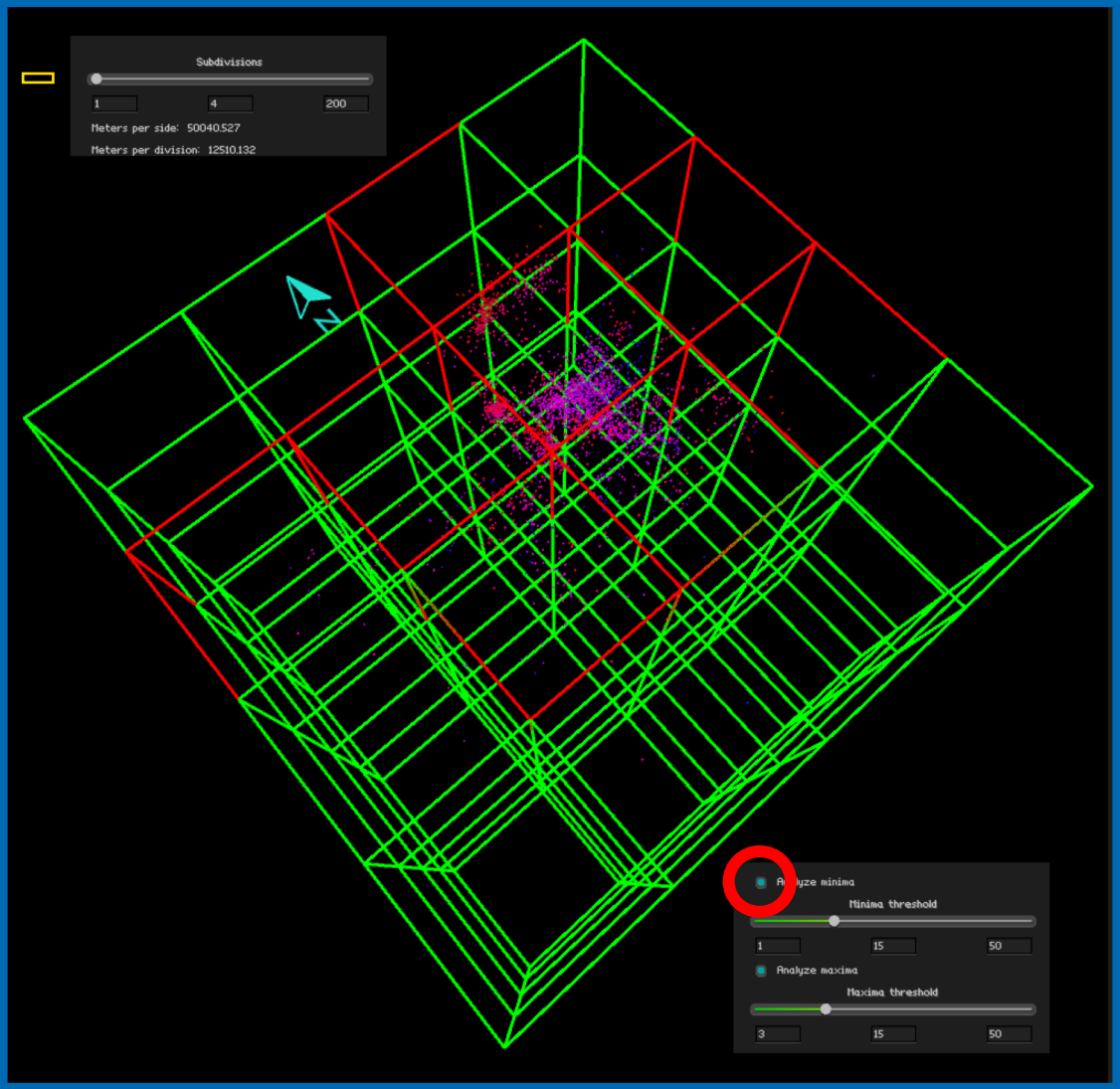

N
Show earthquakes
Magnitude threshold
0.000
1.000
10.000


N
Show earthquakes
Magnitude threshold
0.000
2.000
10.000


N
Show earthquakes
Magnitude threshold
0.000
3.000
10.000

Earthquakes Density Analysis




Subdivisions
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4
200
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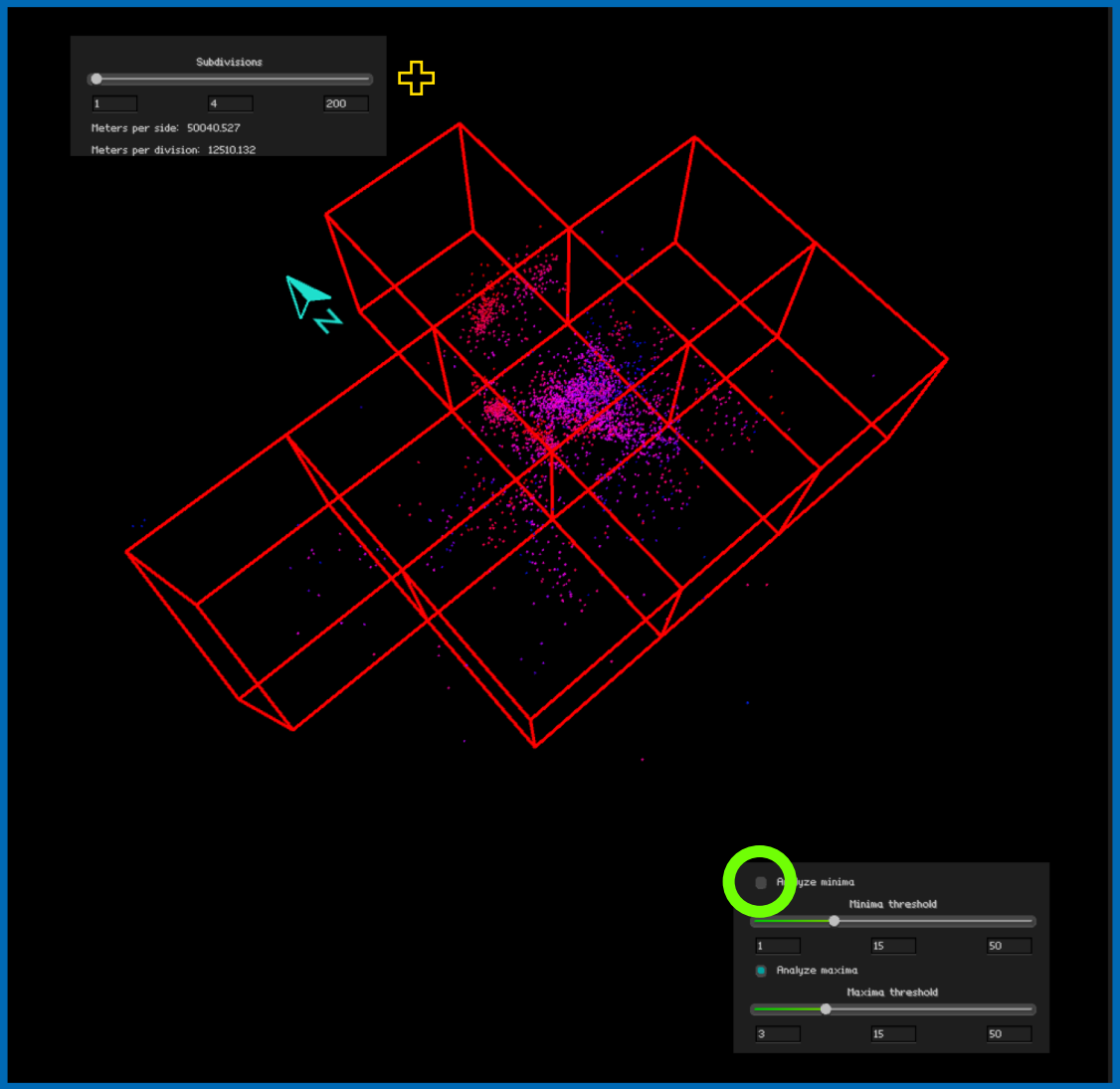
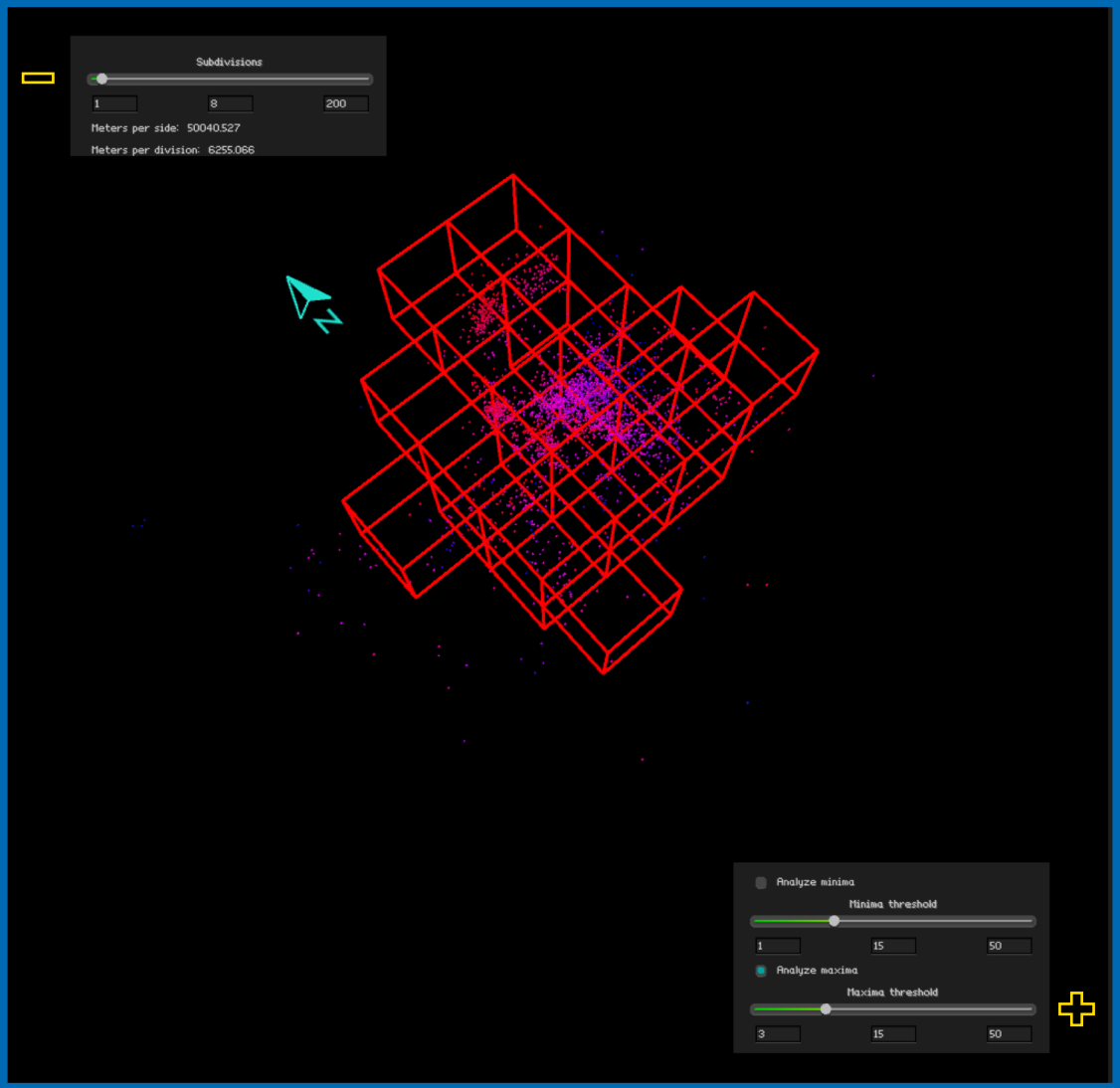
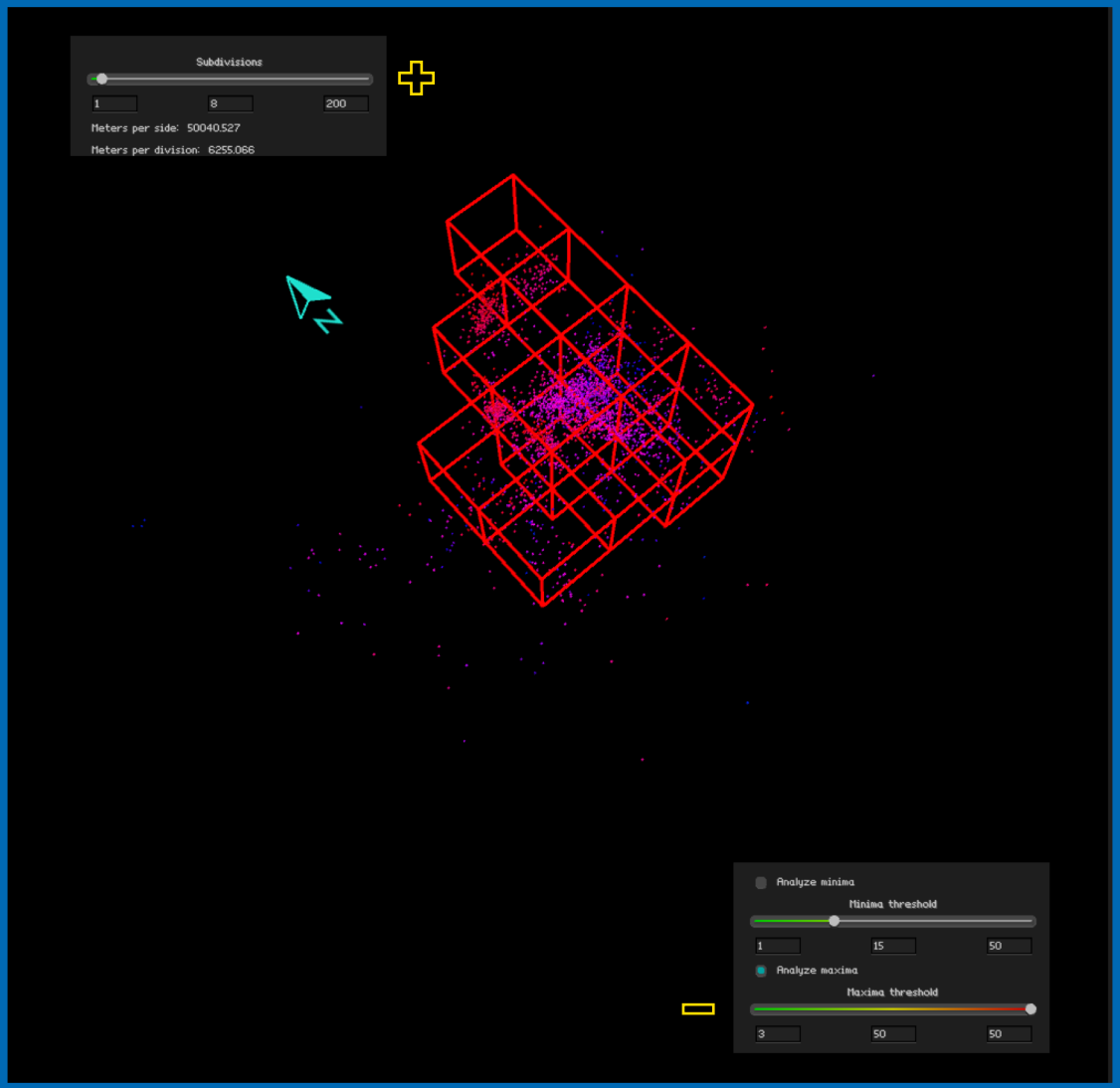
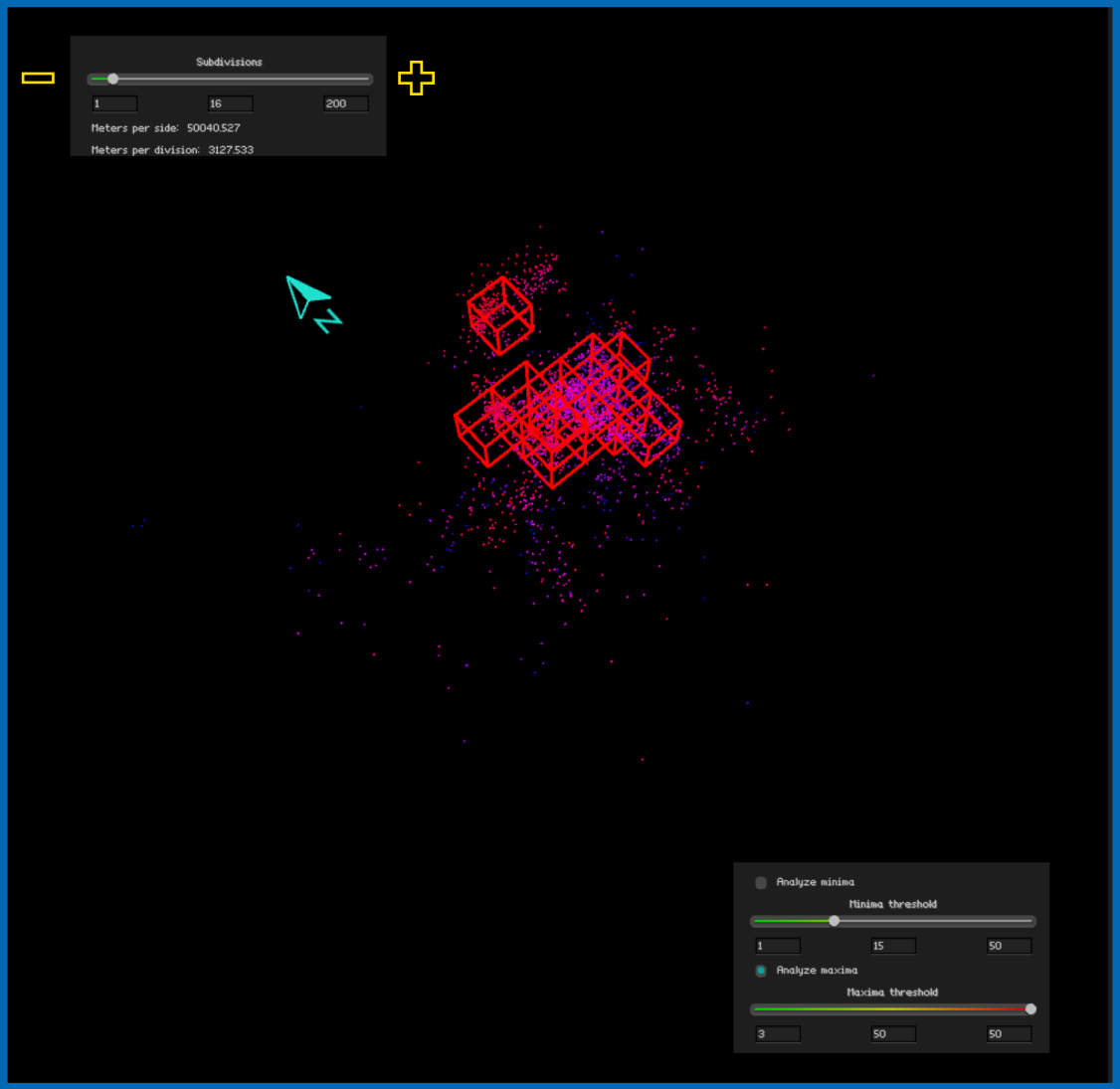
Meters per division: 12510.132
N
Analyze minima
Minima threshold
1
15
50
Analyze maxima
Maxima threshold
3
15
50


Subdivisions
1
4
200
Meters per side: 50040.527
Meters per division: 12510.132
N
Minima threshold
1
15
50
Analyze maxima
Maxima threshold
3
15
50


Subdivisions
1
8
200
Meters per side: 50040.527
Meters per division: 6255.066
N
Analyze minima
Minima threshold
1
15
50
Analyze maxima
Maxima threshold
3
15
50


Subdivisions
1
8
200
Meters per side: 50040.527
Meters per division: 6255.066
N
Analyze minima
Minima threshold
1
15
50
Analyze maxima
Maxima threshold
3
50
50


Subdivisions
1
16
200
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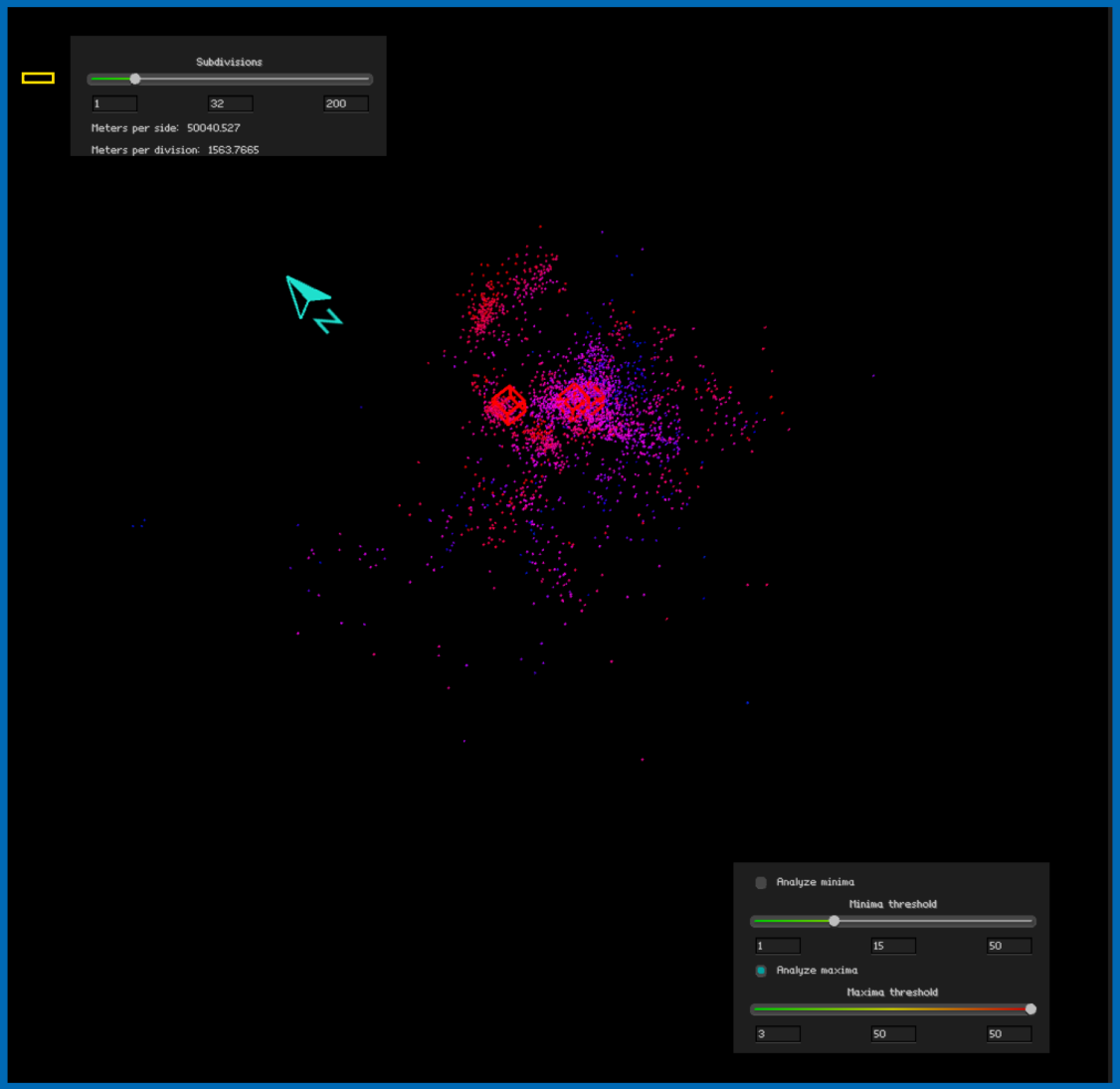
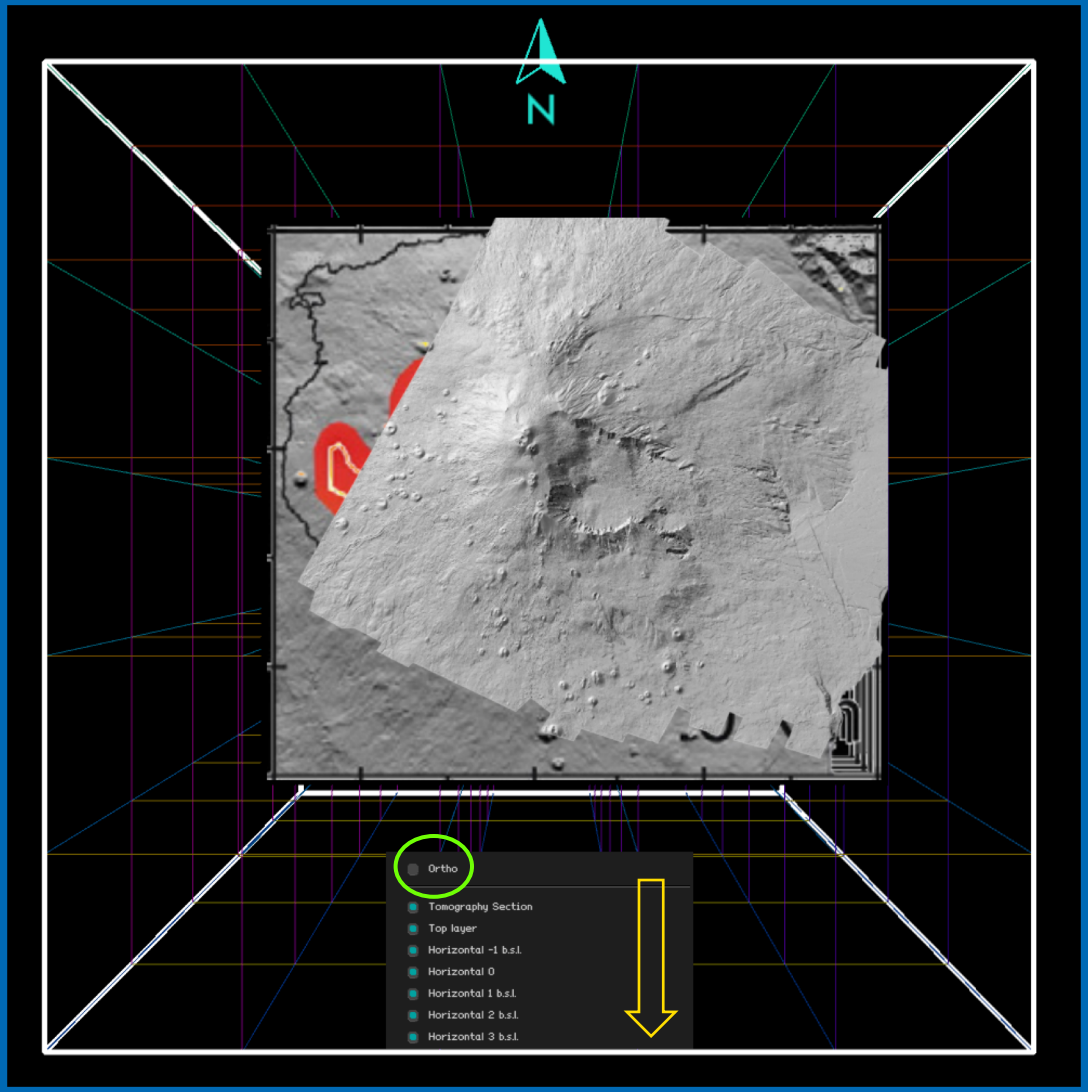
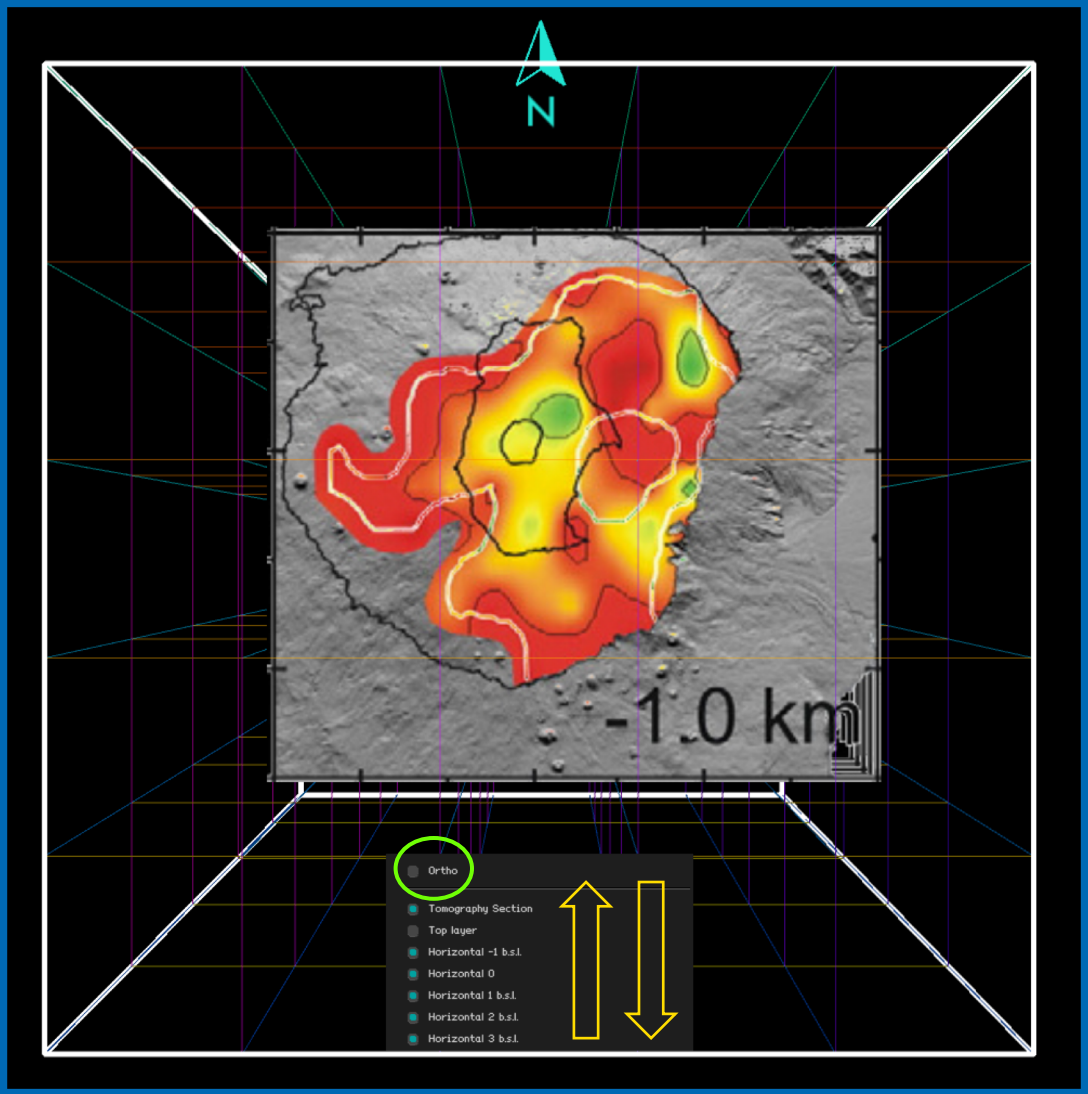
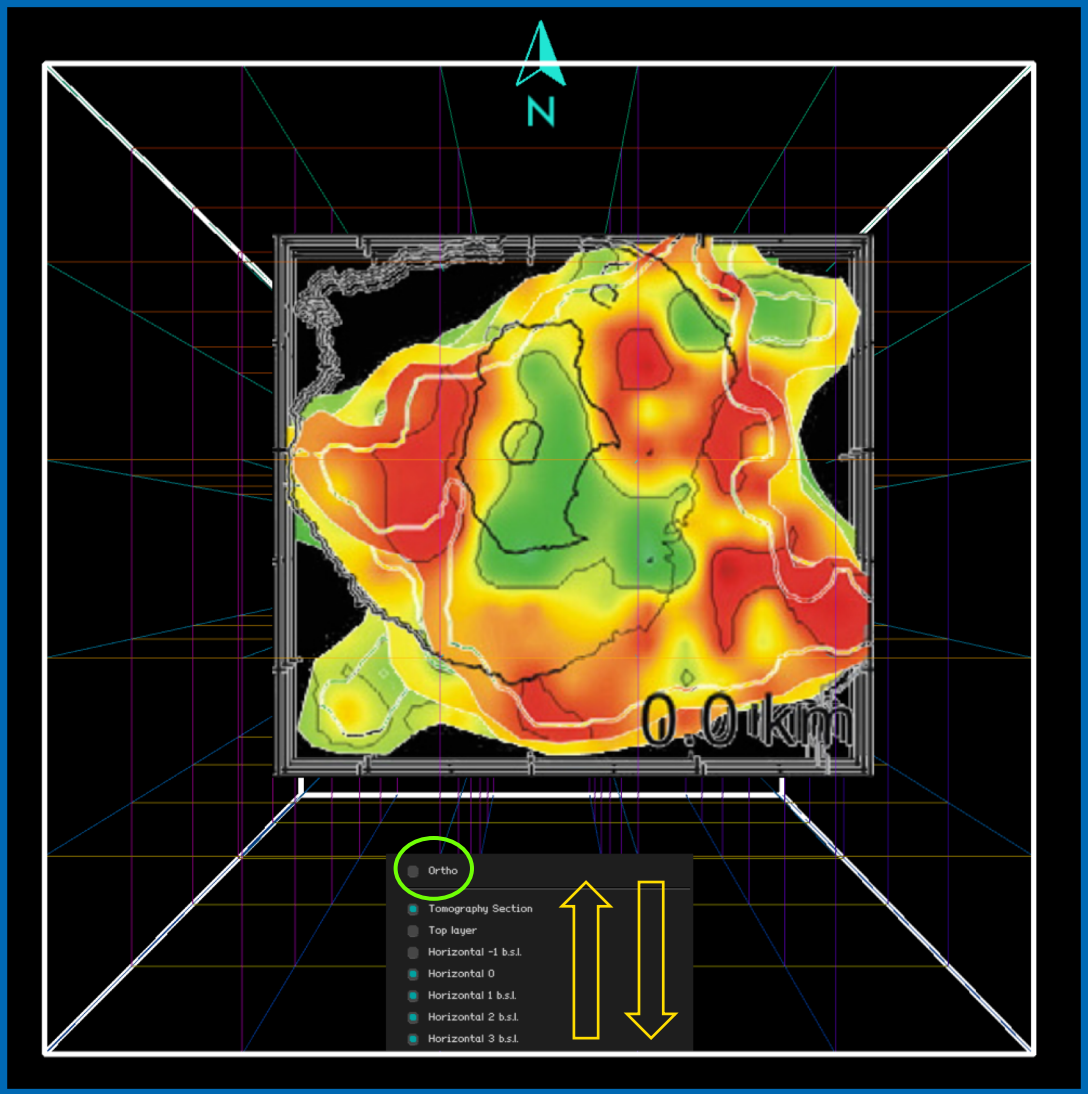
Meters per division: 3127.533
Analyze minima
Minima threshold
1
15
50
Analyze maxima
Maxima threshold
3
50
50

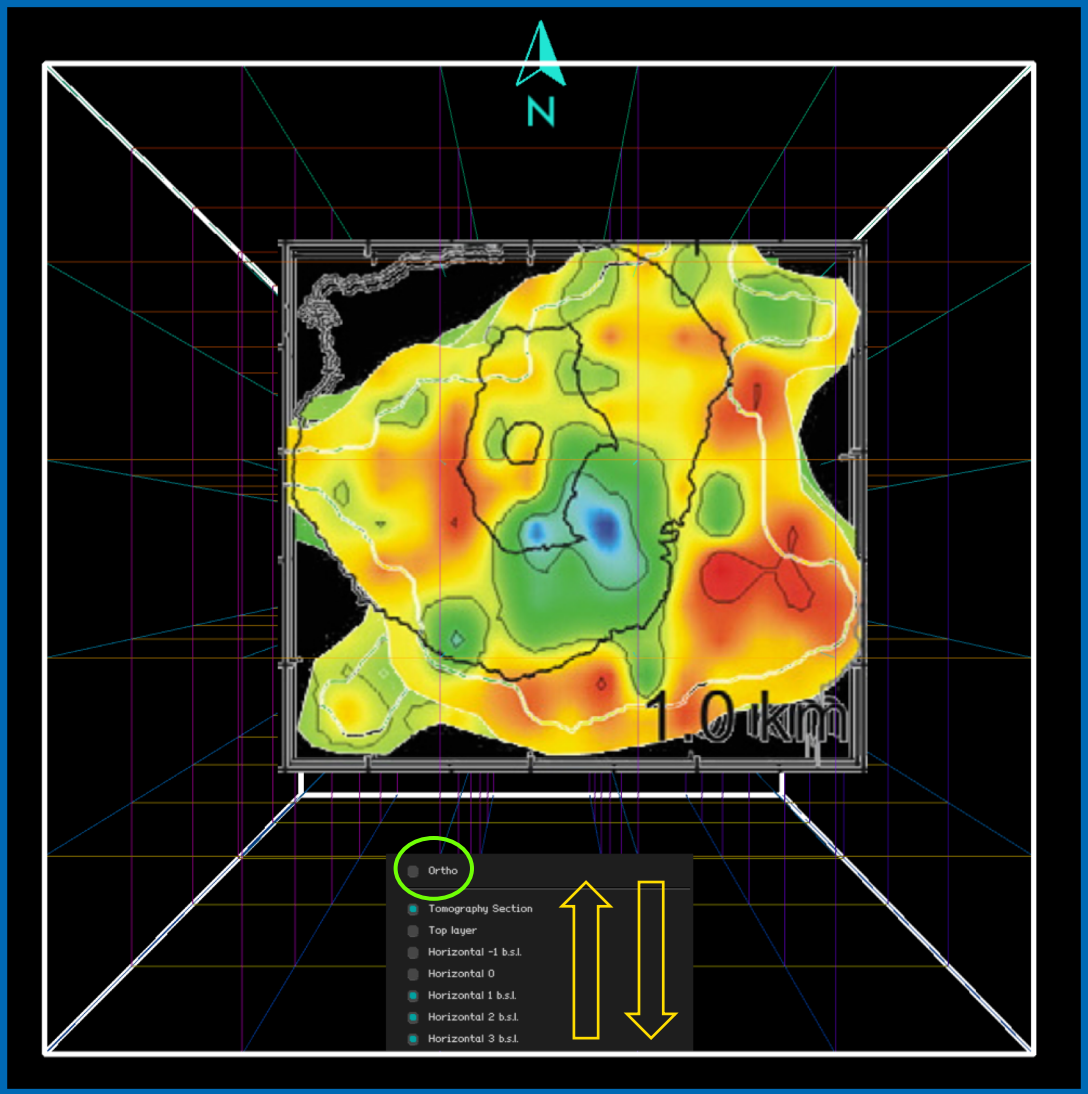

Subdivisions
1
32
200
Meters per side: 50040.527
Meters per division: 1563.7665
Analyze minima
Minima threshold
1
15
50
Analyze maxima
Maxima threshold
3
50
50

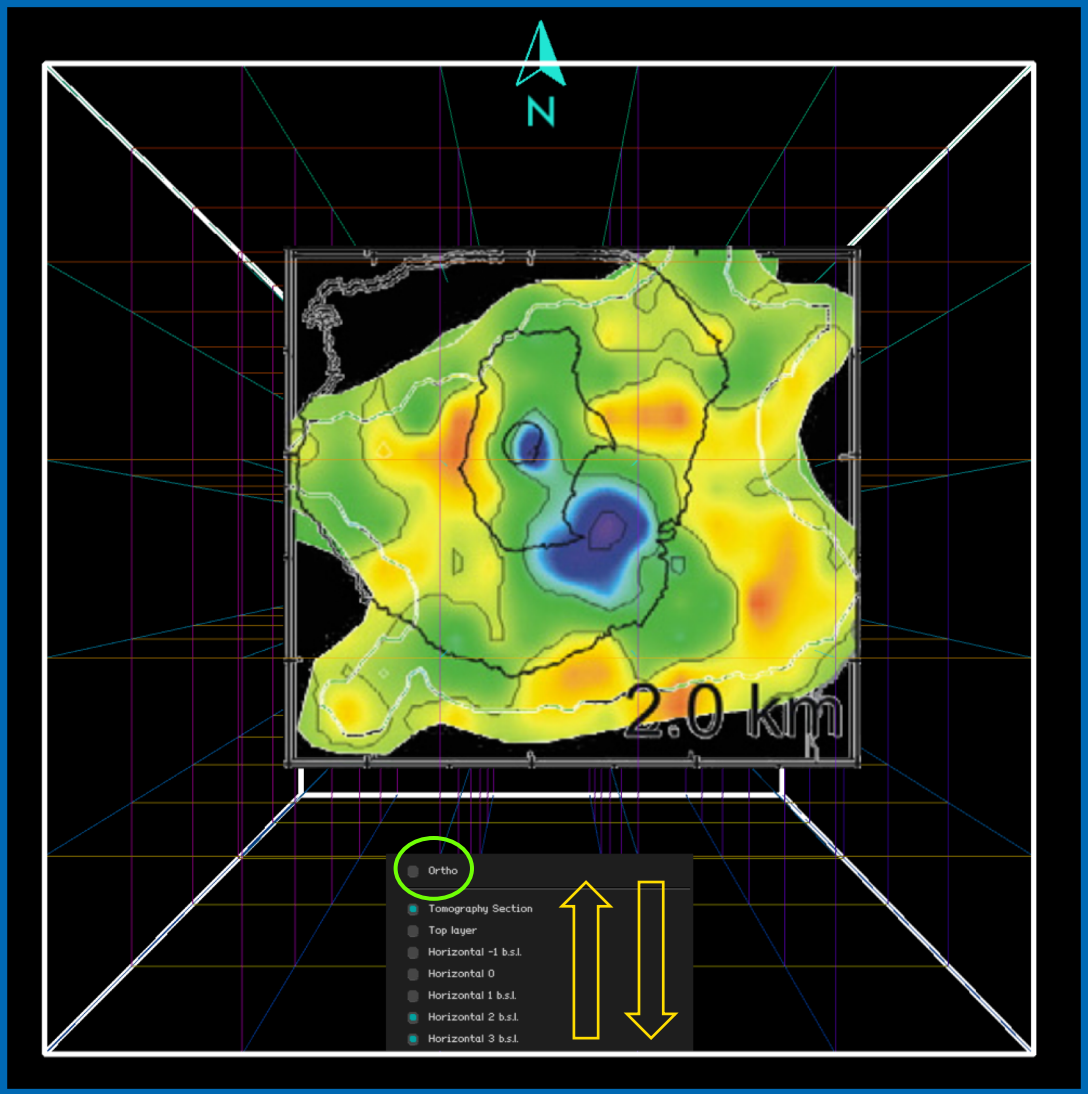
Import Maps (Stereo vs Ortho)

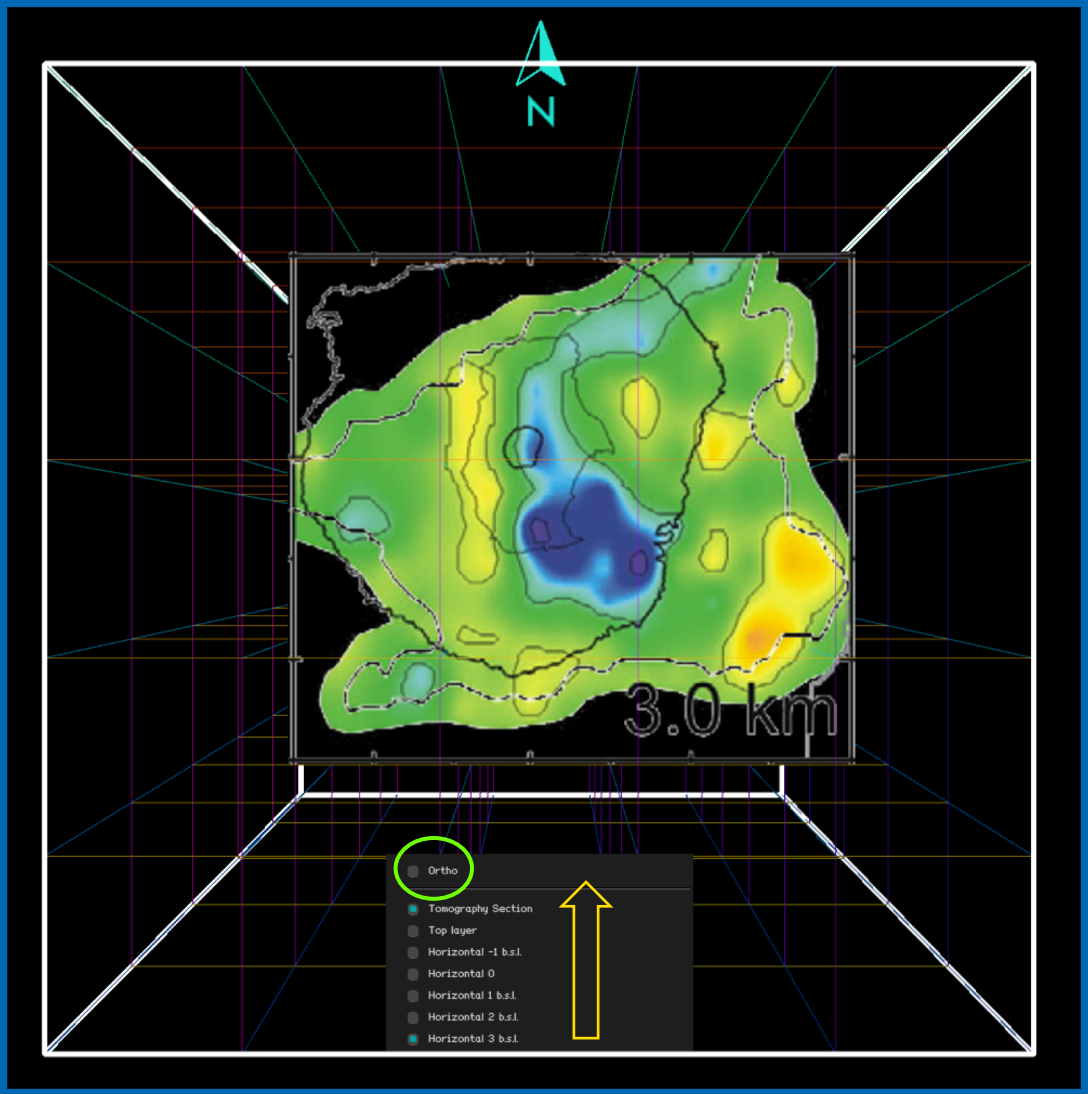


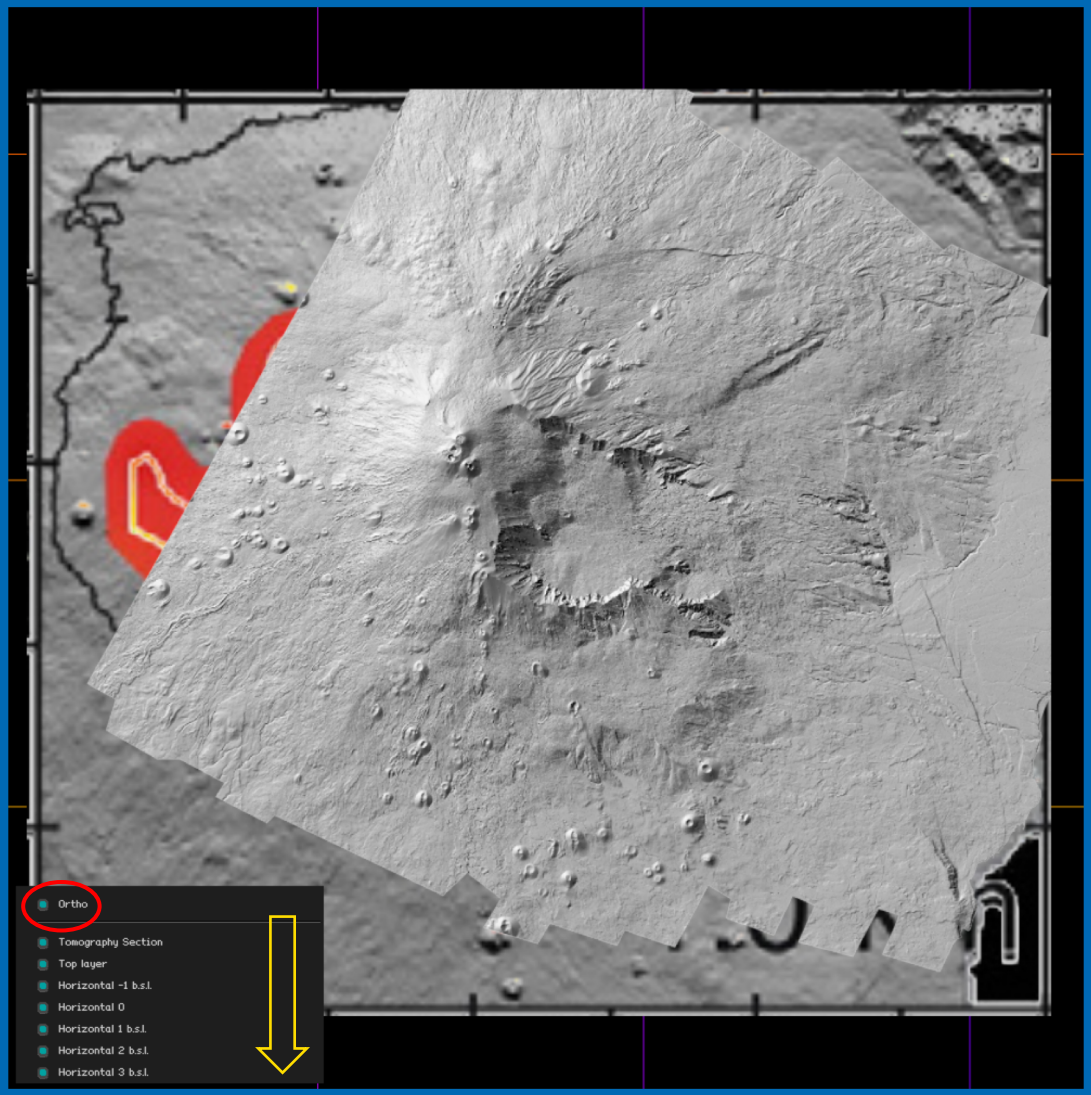

N
-1.0 km
Ortho
Tomography Section
Top layer
Horizontal -1 b.s.l.
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.


N
0.0 km
Ortho
Tomography Section
Top layer
Horizontal -1 b.s.l.
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.


N
1.0 km
Ortho
Tomography Section
Top layer
Horizontal -1 b.s.l.
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.


N
2.0 km
Ortho
Tomography Section
Top layer
Horizontal -1 b.s.l.
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.


N
3.0 km
Ortho
Tomography Section
Top layer
Horizontal -1 b.s.l.
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.


Ortho
Tomography Section
Top layer
Horizontal -1 b.s.l.
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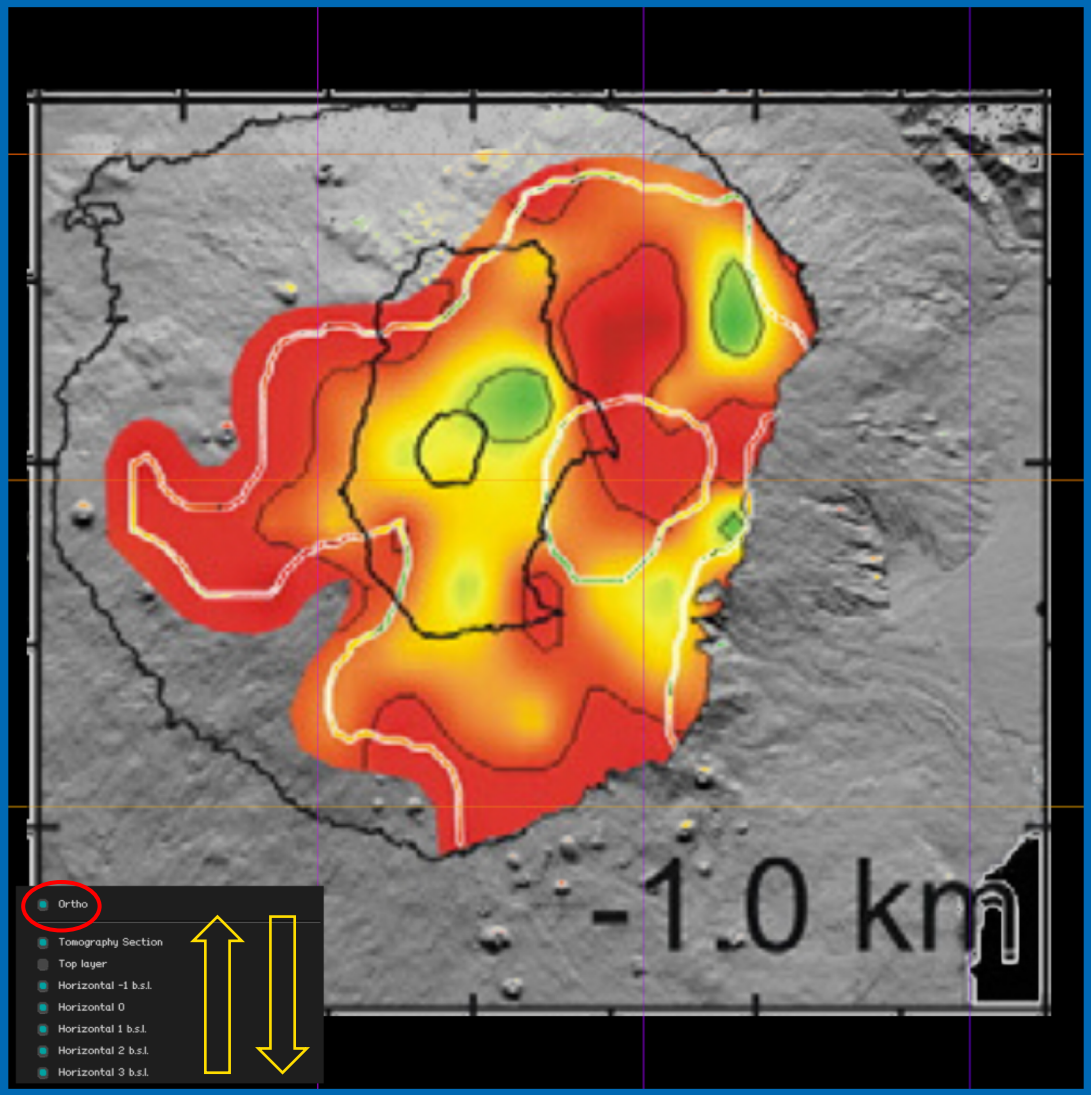
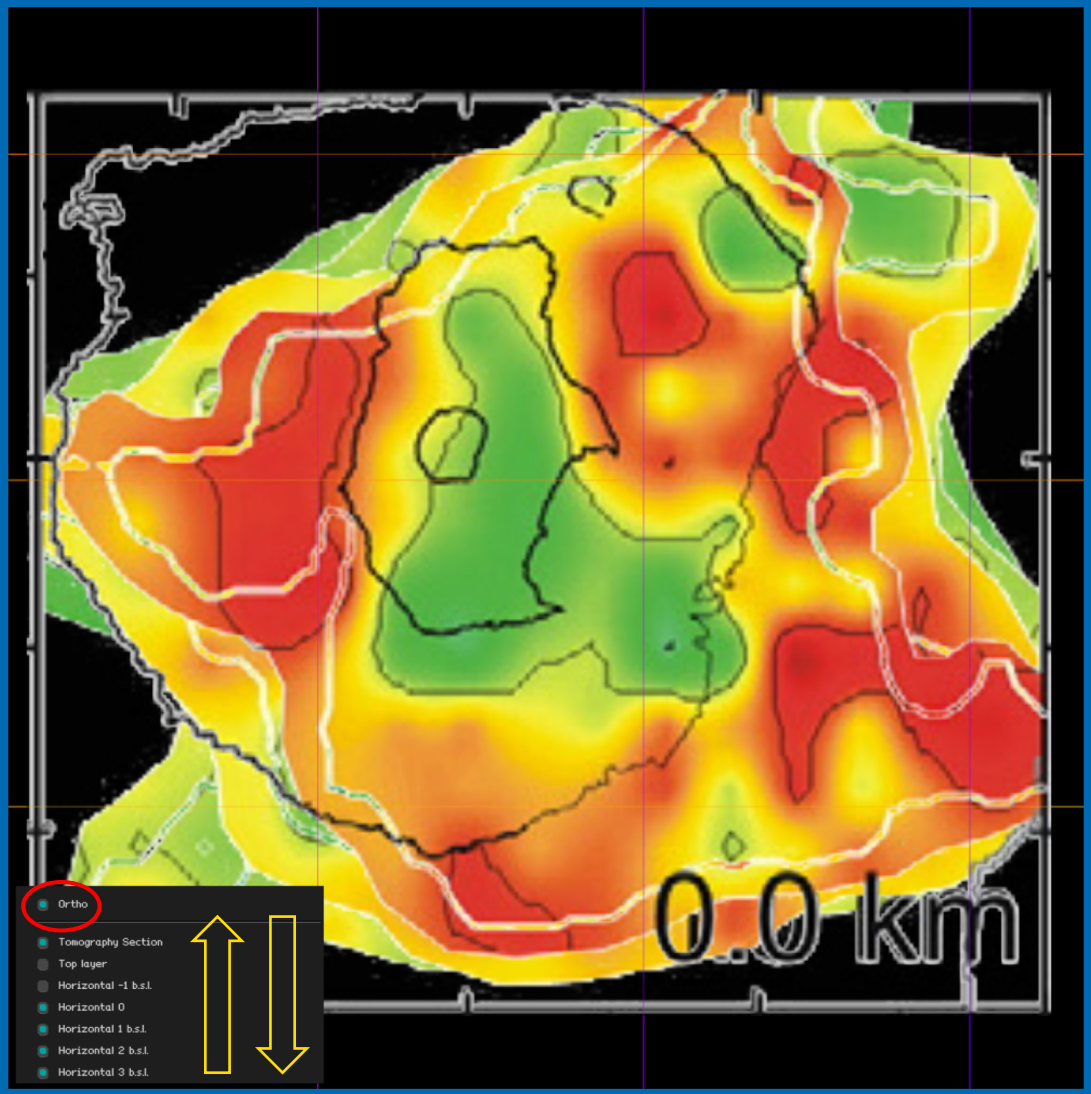
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.


Ortho
Tomography Section
Top layer
Horizontal -1 b.s.l.
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.
-1.0 km


Ortho
Tomography Section
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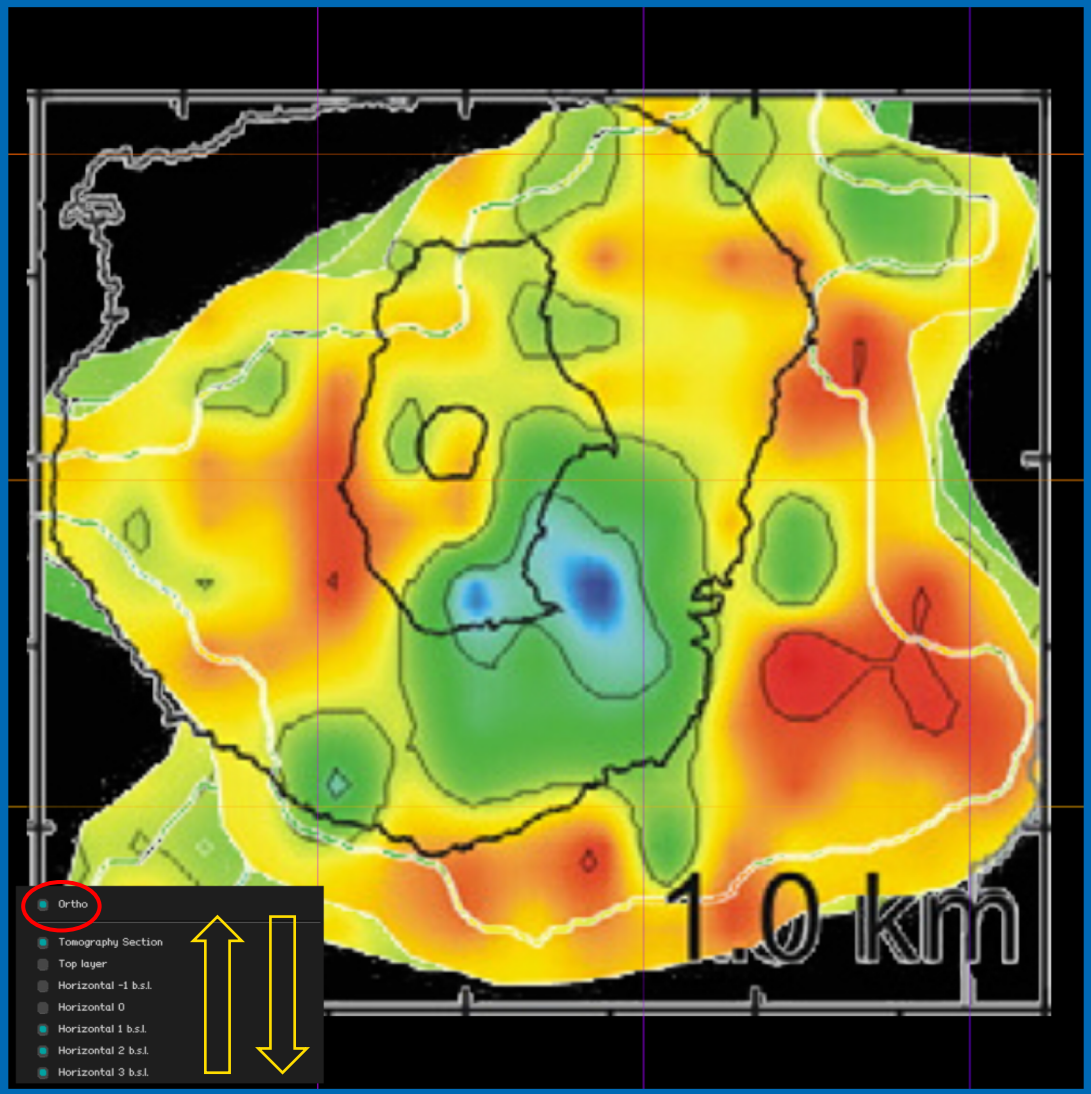
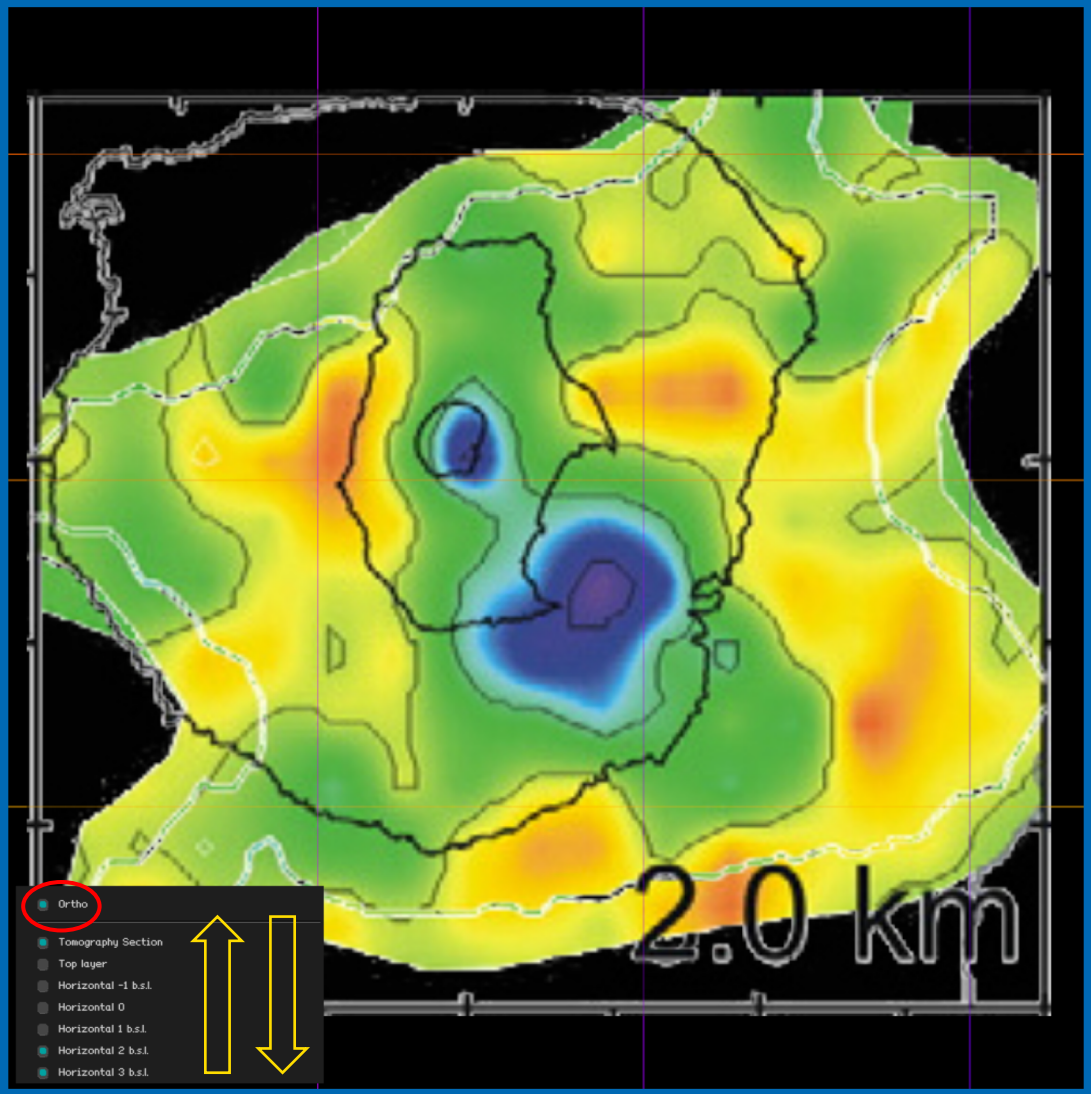
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.
0.0 km


Ortho
Tomography Section
Top layer
Horizontal -1 b.s.l.
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.
1.0 km


Ortho
Tomography Section
Top layer
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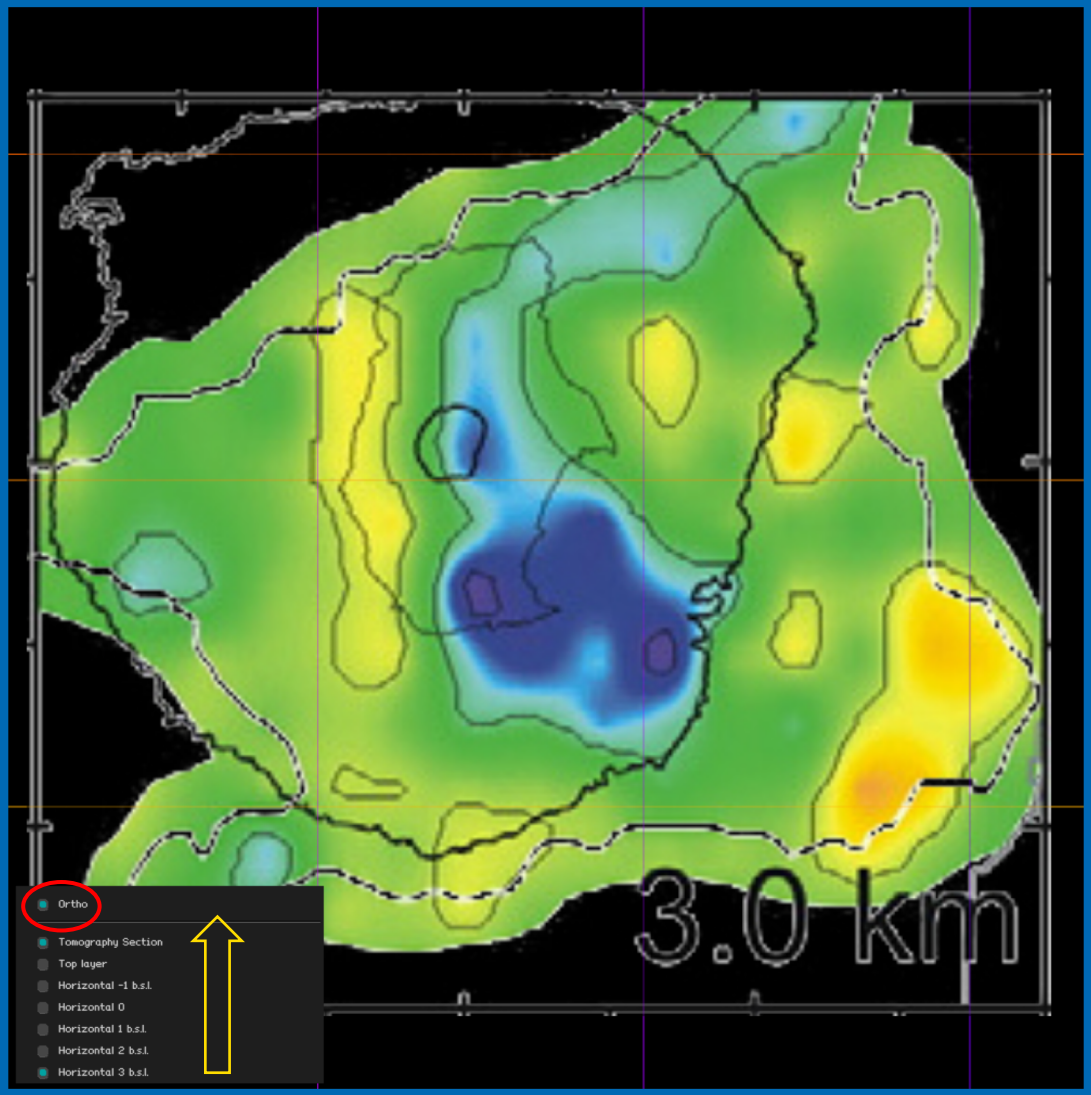
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.
2.0 km


Ortho
Tomography Section
Top layer
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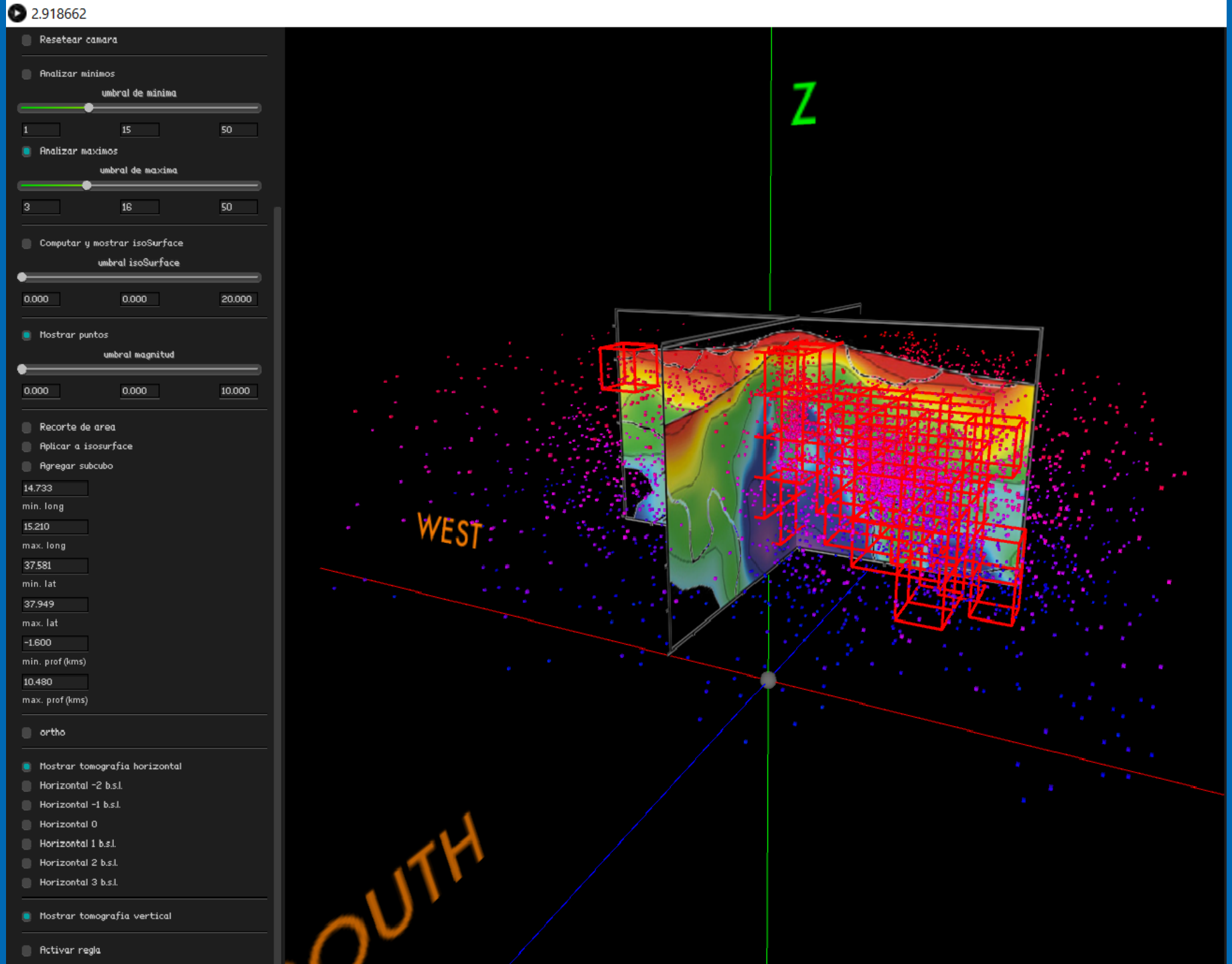
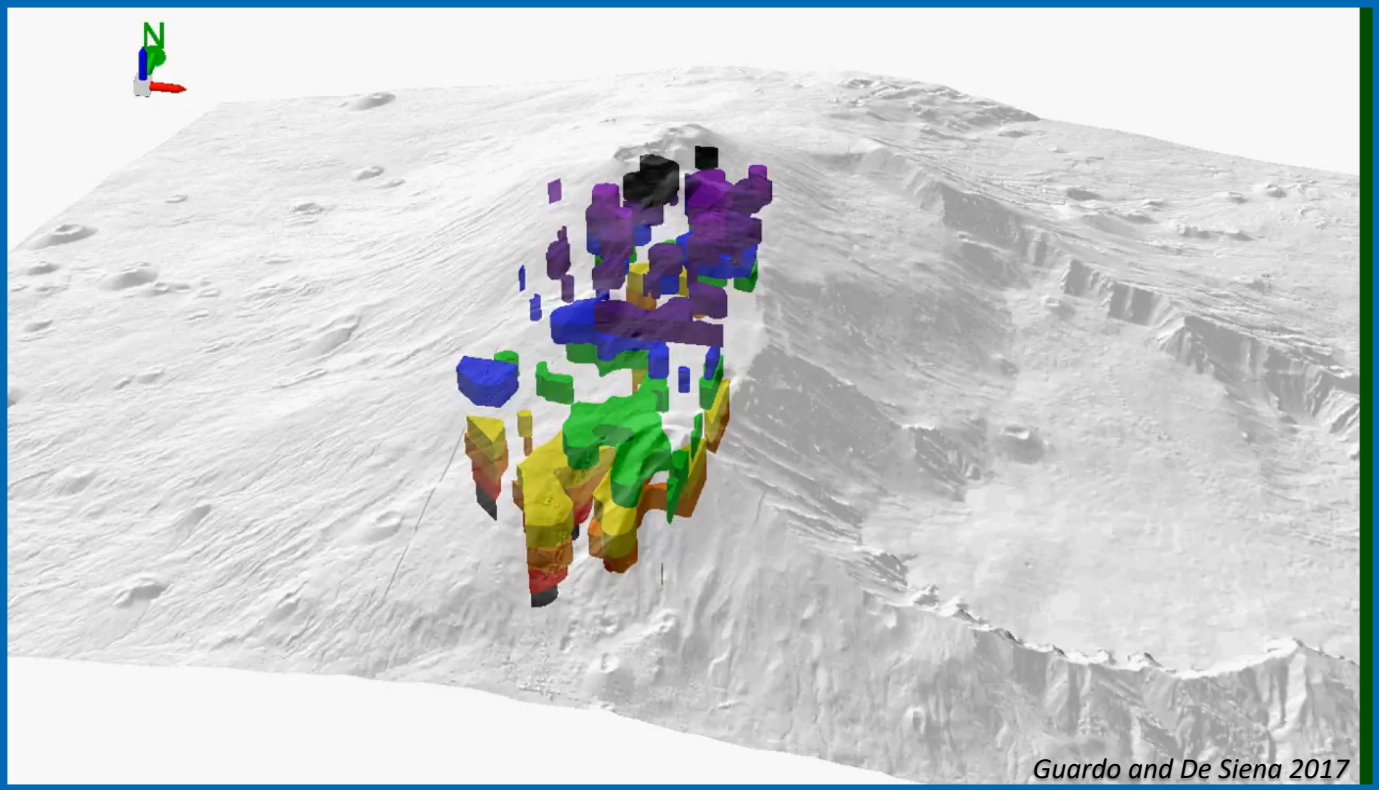
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.
3.0 km


2.918662
Resetear camara
Analizar minimos
umbral de minima
1
15
50
Analizar maximos
umbral de maxima
3
16
50
Computar y mostrar isoSurface
umbral isoSurface
0.000
0.000
20.000
Mostrar puntos
umbral magnitud
0.000
0.000
10.000
Recorte de area
Aplicar a isosurface
Agregar subcubo
14.733
min. long
15.210
max. long
37.581
min. lat
37.949
max. lat
-1.600
min. prof (kms)
10.480
max. prof (kms)
ortho
Mostrar tomografia horizontal
Horizontal -2 b.s.l.
Horizontal -1 b.s.l.
Horizontal 0
Horizontal 1 b.s.l.
Horizontal 2 b.s.l.
Horizontal 3 b.s.l.
Mostrar tomografia vertical
Activar regla
Z
WEST
OUTH

Real 3D environment



"In the case of bedding planes, contours, triangulated irregular network (TIN) the surface elevation isn't an independent variable, so these system are best defined as quasi-3D or 2.5D systems, which can accept **only single elevation value for any surface at any given location**."

- A.K. Turner

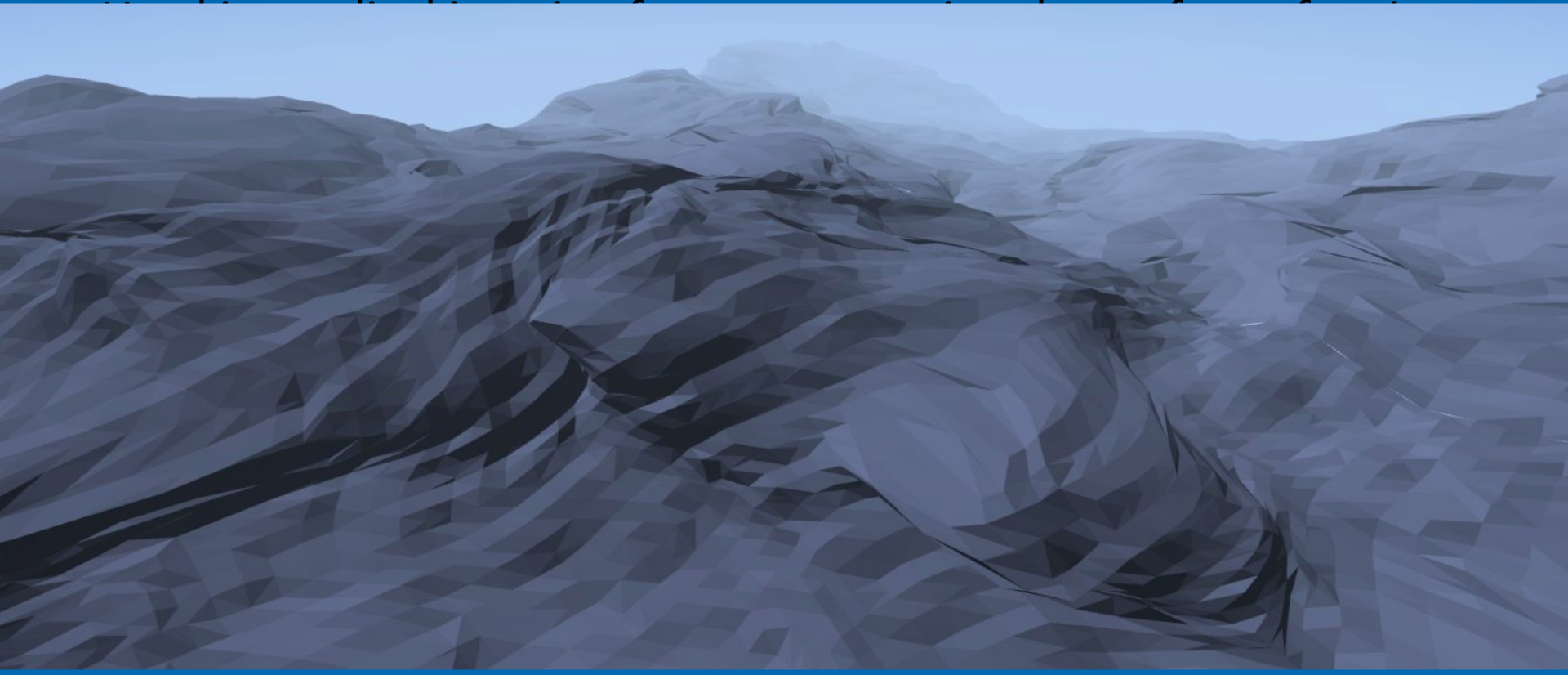
Marching Cubes (MC) Algorithm

Others applications:

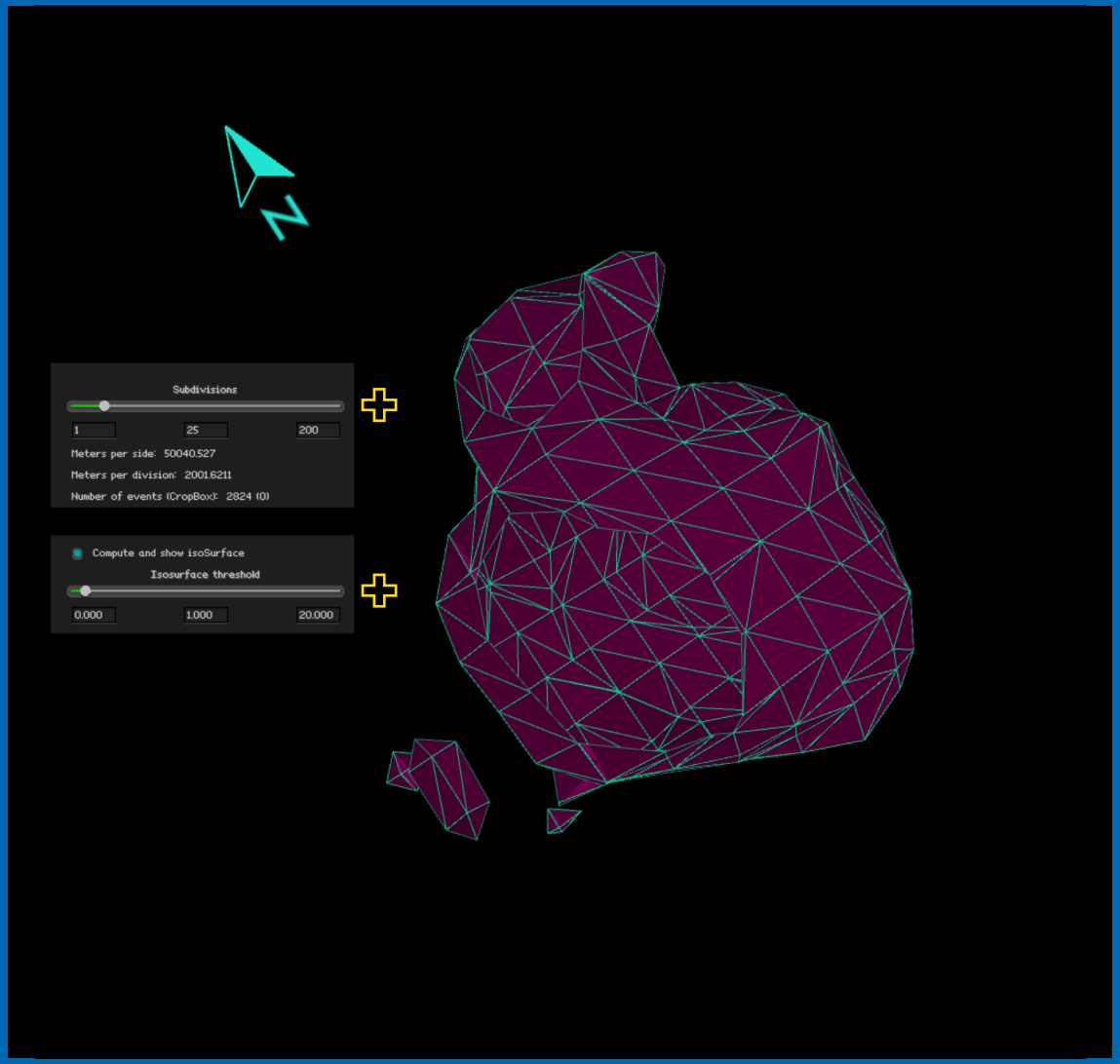
- MC is an algorithm of surface reconstruction and generation of 3D meshes defining a spatial volume (Lorensen and Cline, 1987).

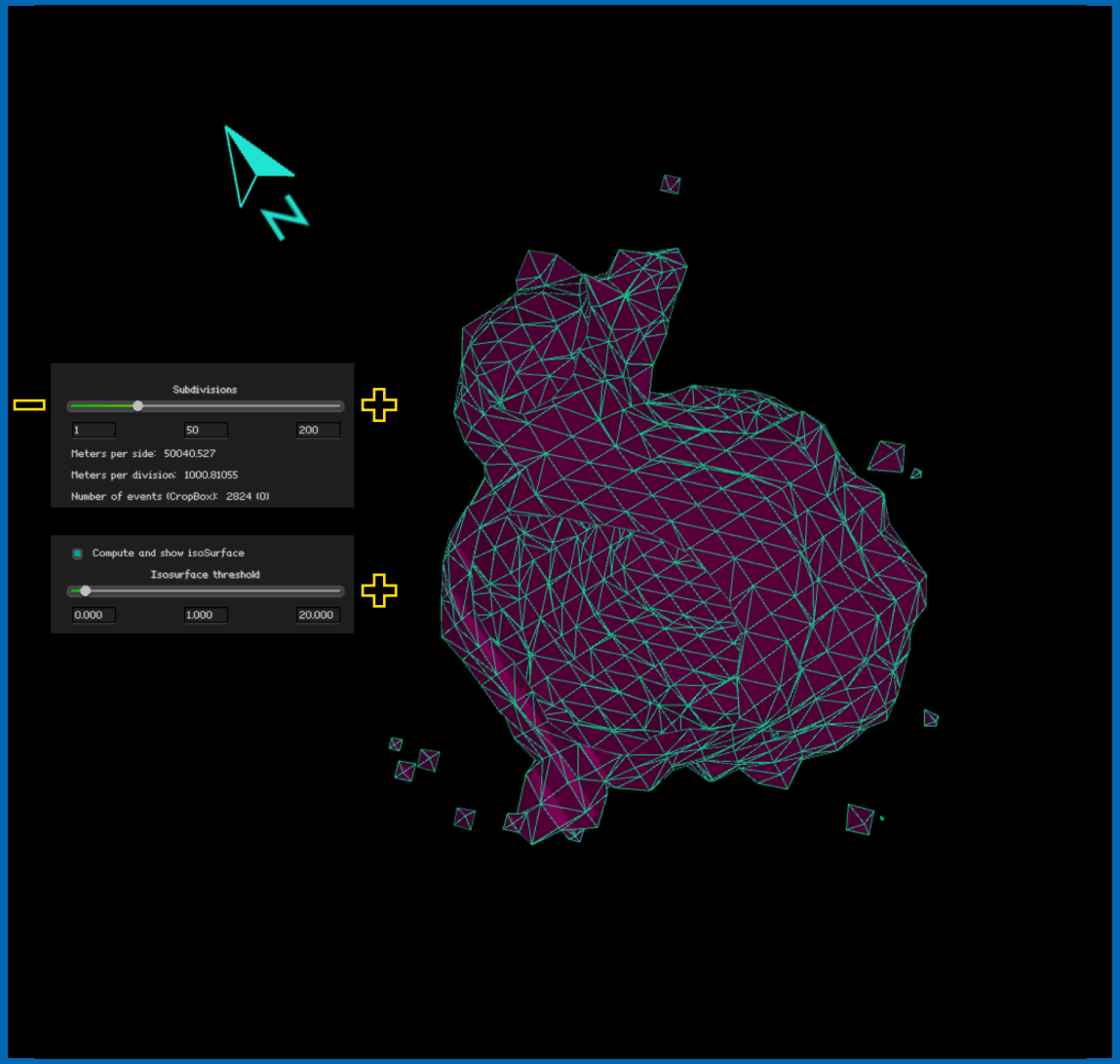
pharmacology, chemistry, geophysics, and meteorology.

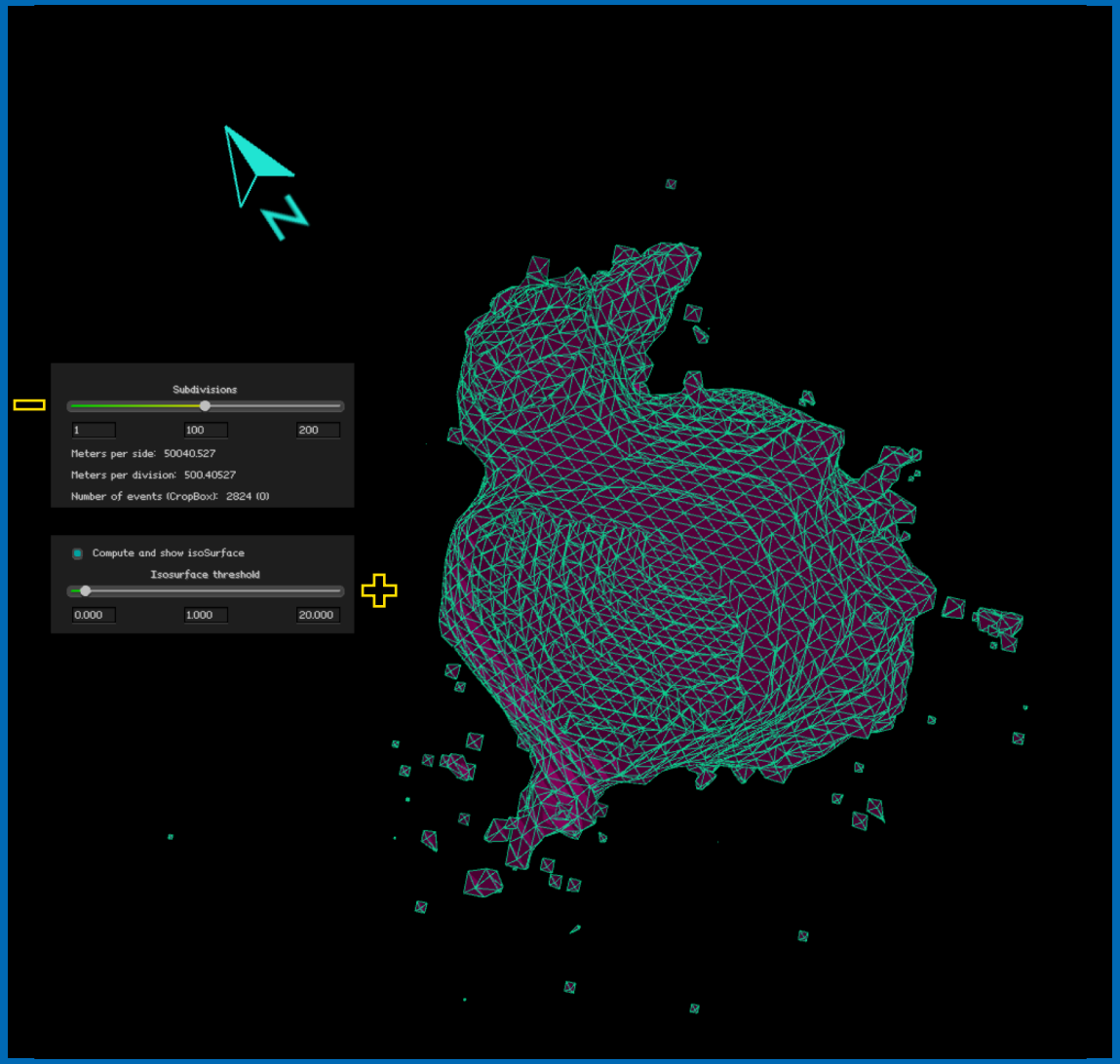
New algorithms allow to generate MC surfaces interactively.



Isosurface Generation MC Algorithm




N
Subdivisions
1
50
200
Meters per side: 50040.527
Meters per division: 1000.81055
Number of events (CropBox): 2824 (0)
Compute and show isoSurface
Isosurface threshold
0.000
1.000
20.000


N
Subdivisions
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100
200
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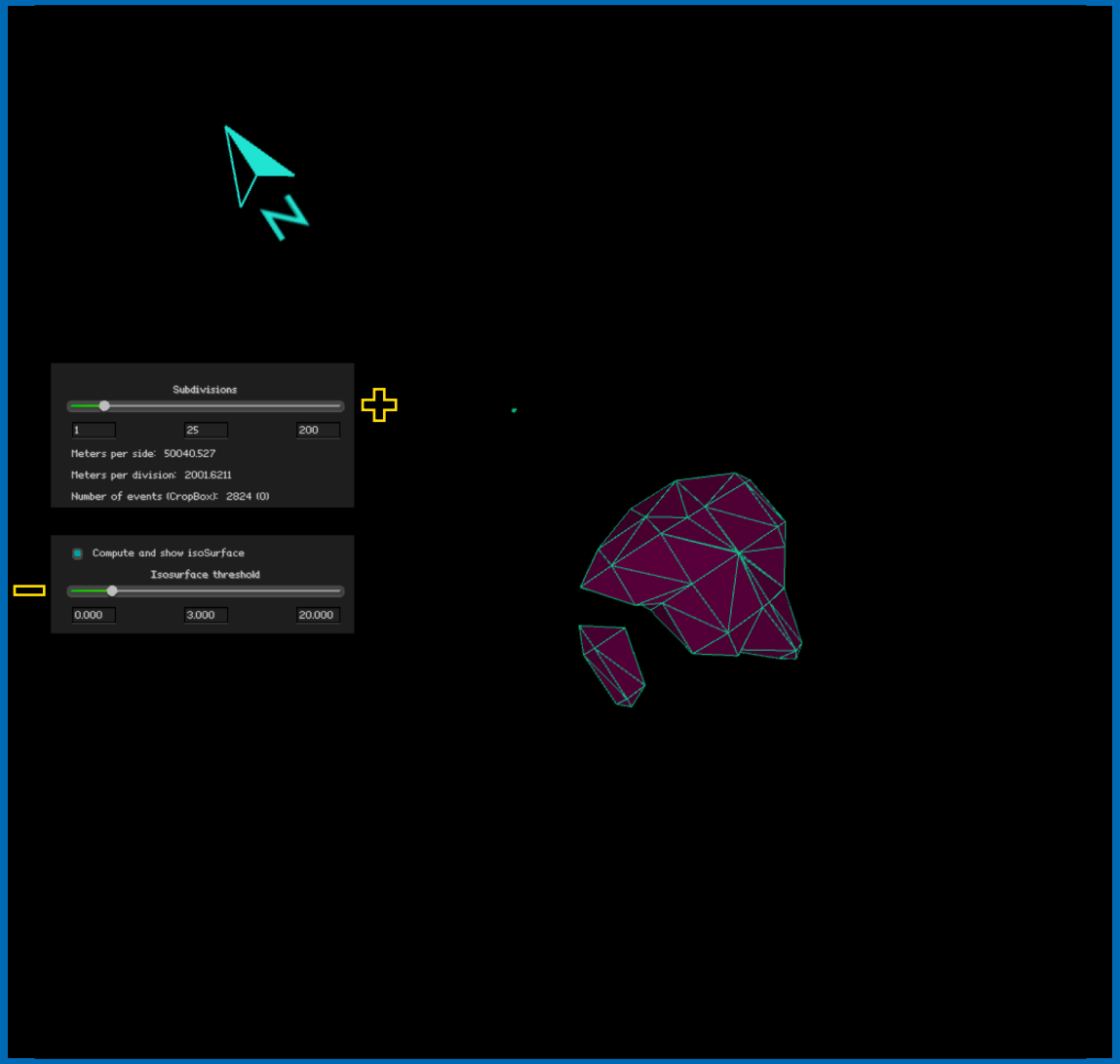
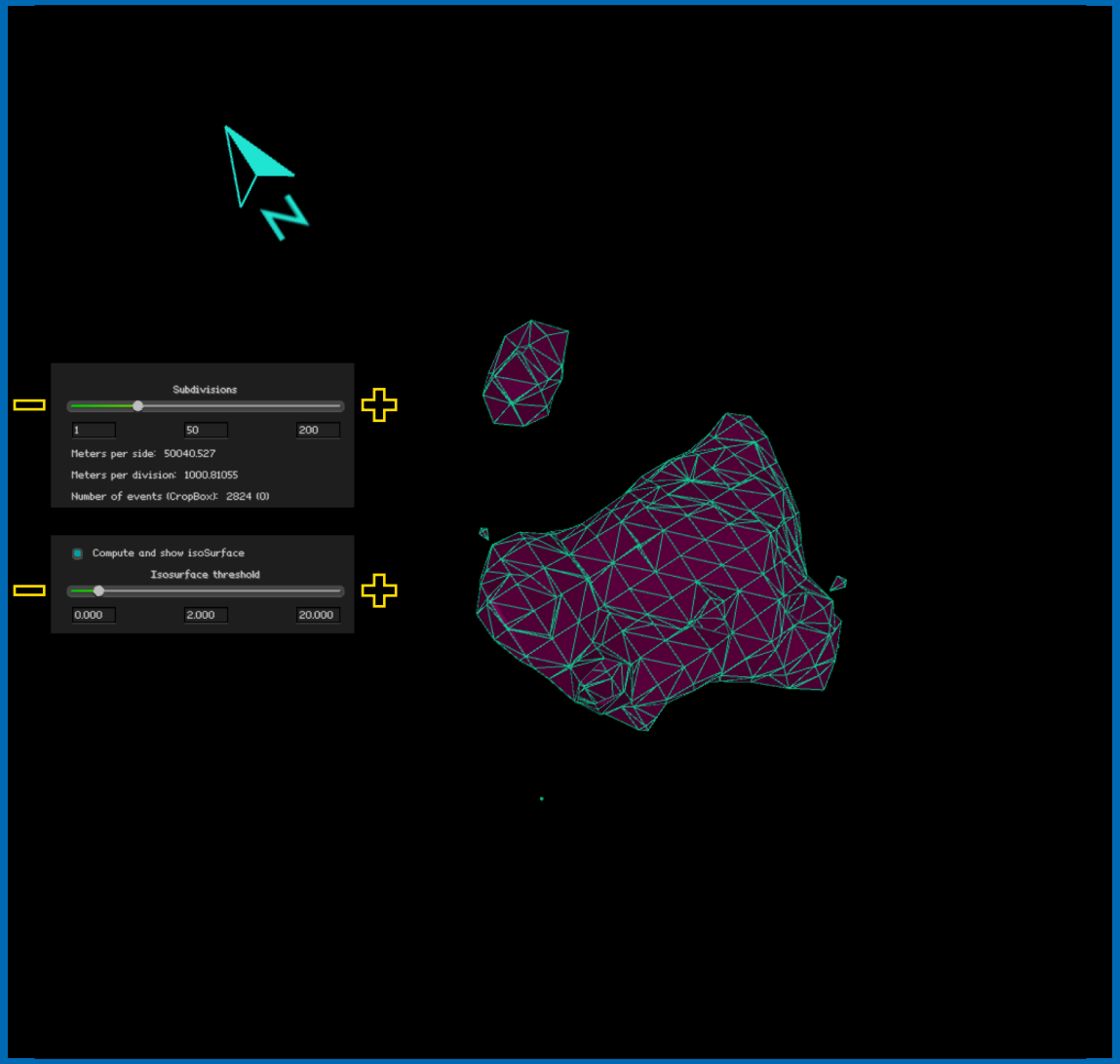
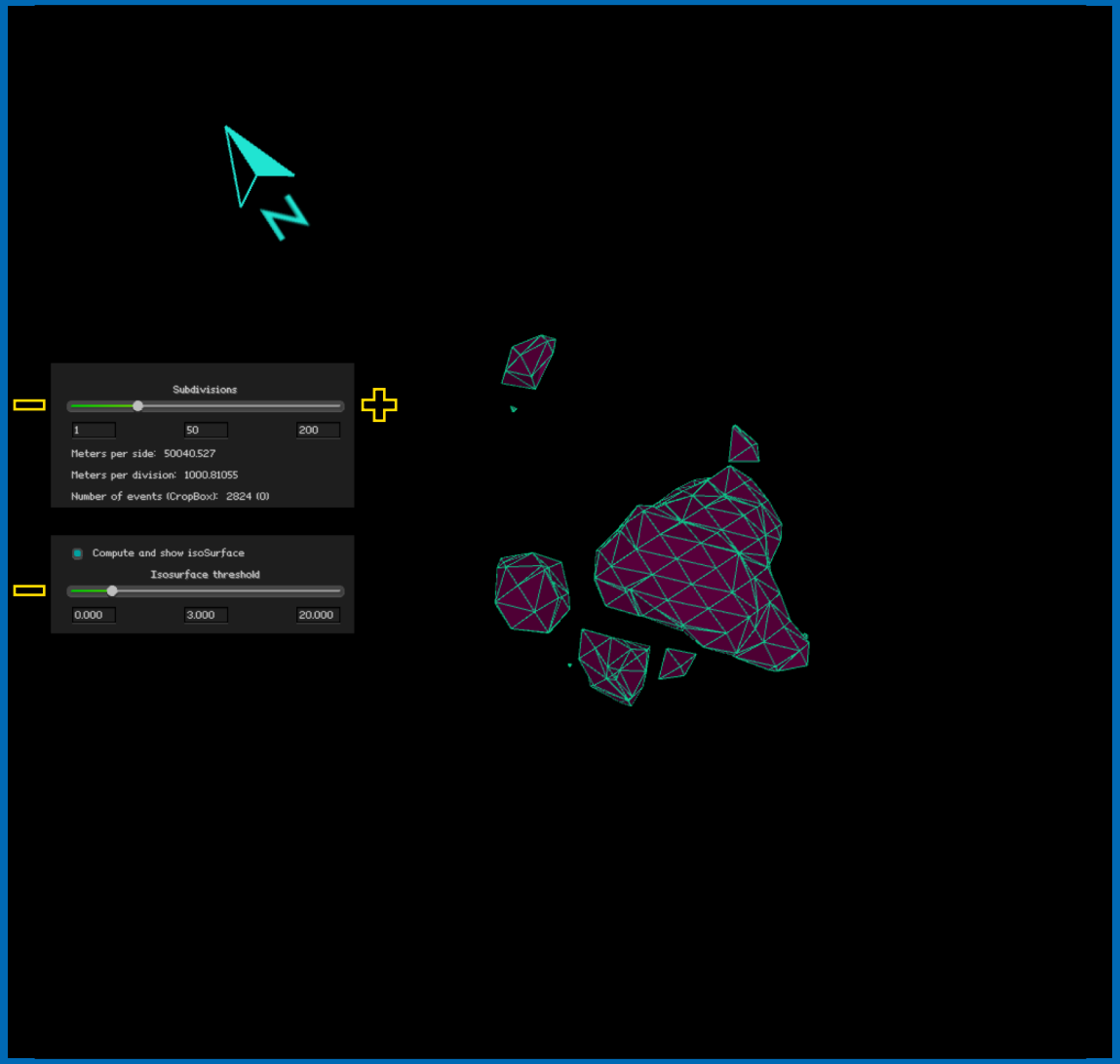
Meters per division: 500.40527
Number of events (CropBox): 2824 (0)
Compute and show isoSurface
Isosurface threshold
0.000
1.000
20.000


N
Subdivisions
1
25
200
Meters per side: 50040.527
Meters per division: 2001.6211
Number of events (CropBox): 2824 (0)
Compute and show isoSurface
Isosurface threshold
0.000
2.000
20.000


N
Subdivisions
1
25
200
Meters per side: 50040.527
Meters per division: 2001.6211
Number of events (CropBox): 2824 (0)
Compute and show isoSurface
Isosurface threshold
0.000
3.000
20.000


N
Subdivisions
1
50
200
Meters per side: 50040.527
Meters per division: 1000.81055
Number of events (CropBox): 2824 (0)
Compute and show isoSurface
Isosurface threshold
0.000
2.000
20.000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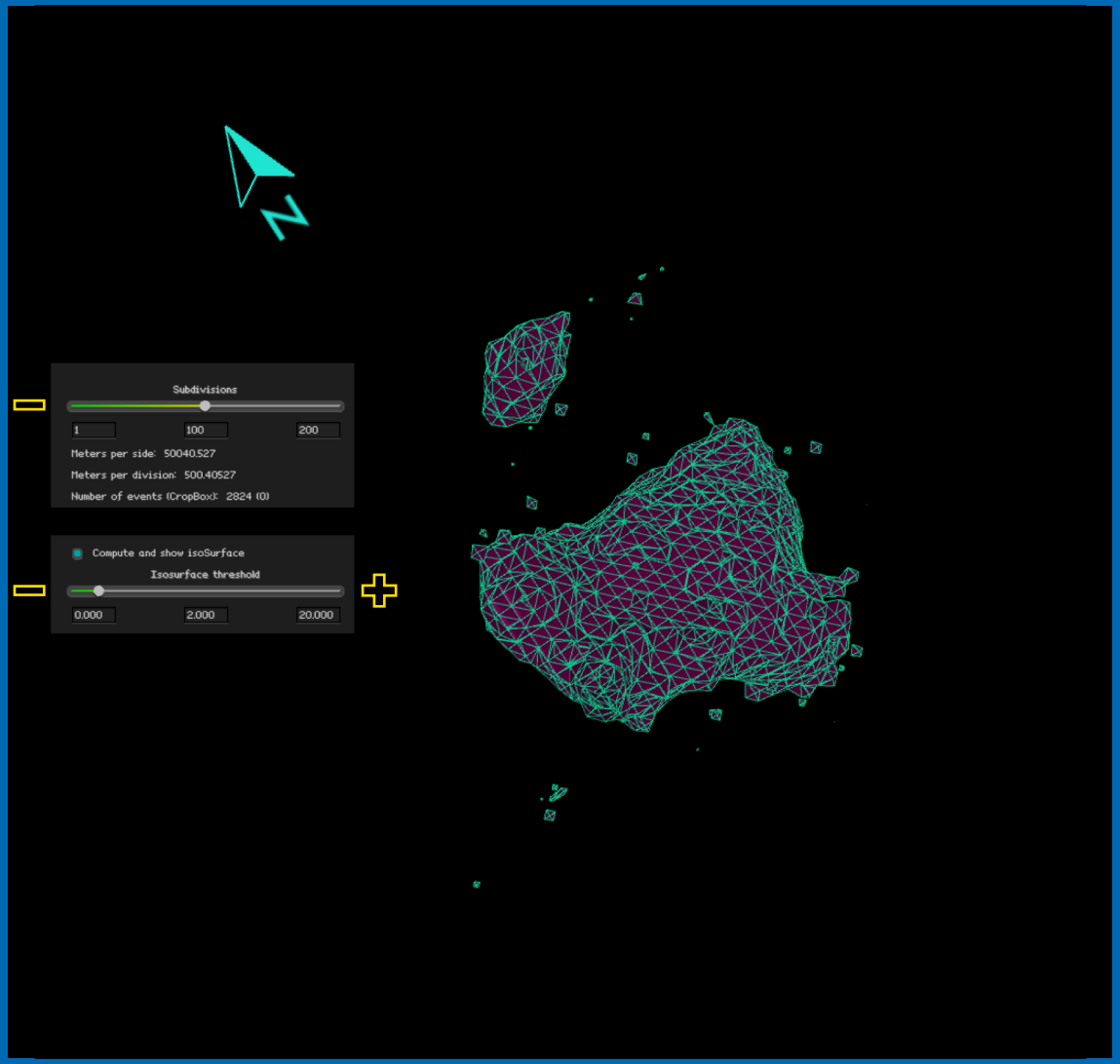
Subdivisions
1
50
200
Meters per side: 50040.527
Meters per division: 1000.81055
Number of events (CropBox): 2824 (0)
Compute and show isoSurface
Isosurface threshold
0.000
3.000
20.000


N
Subdivisions
1
100
200
Meters per side: 50040.527
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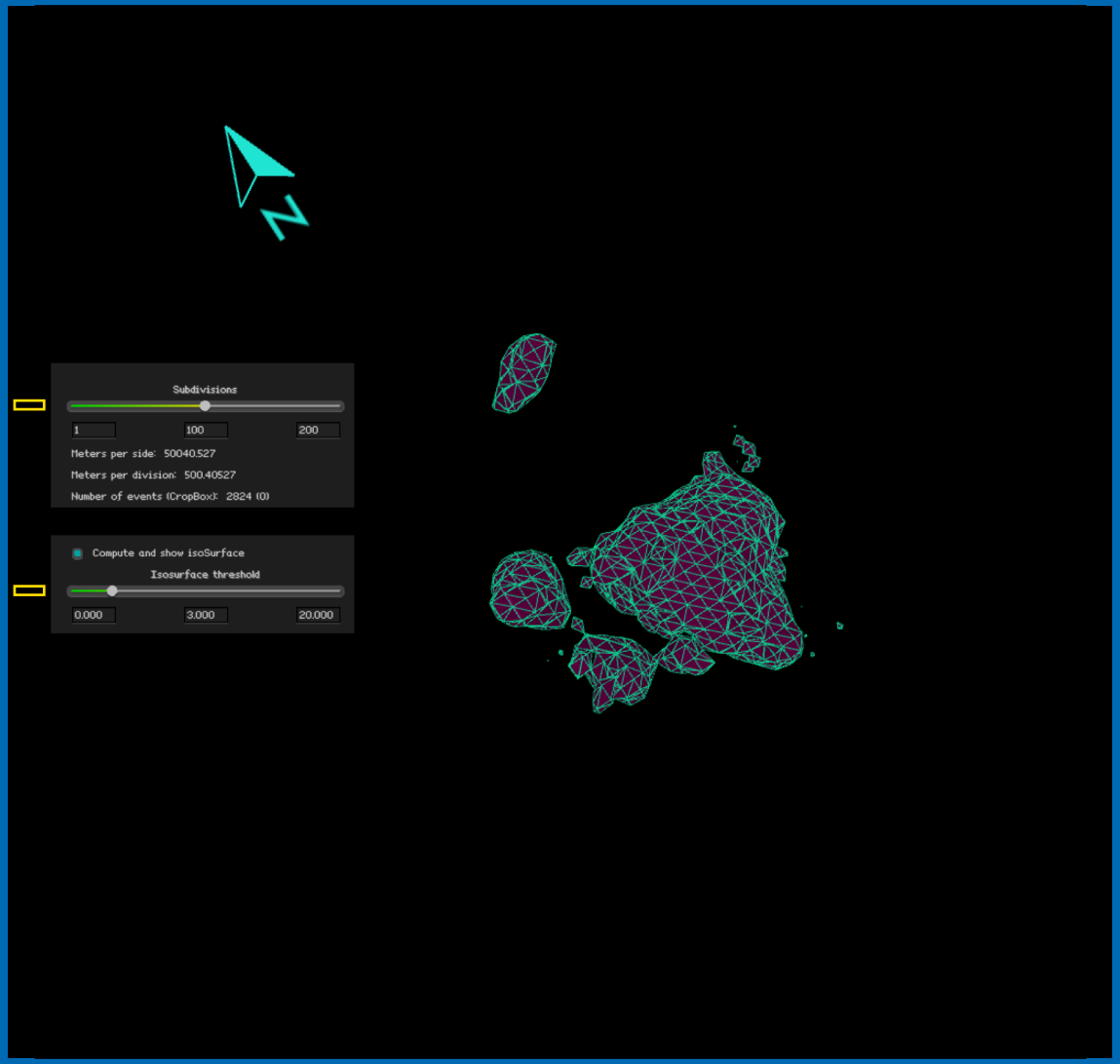
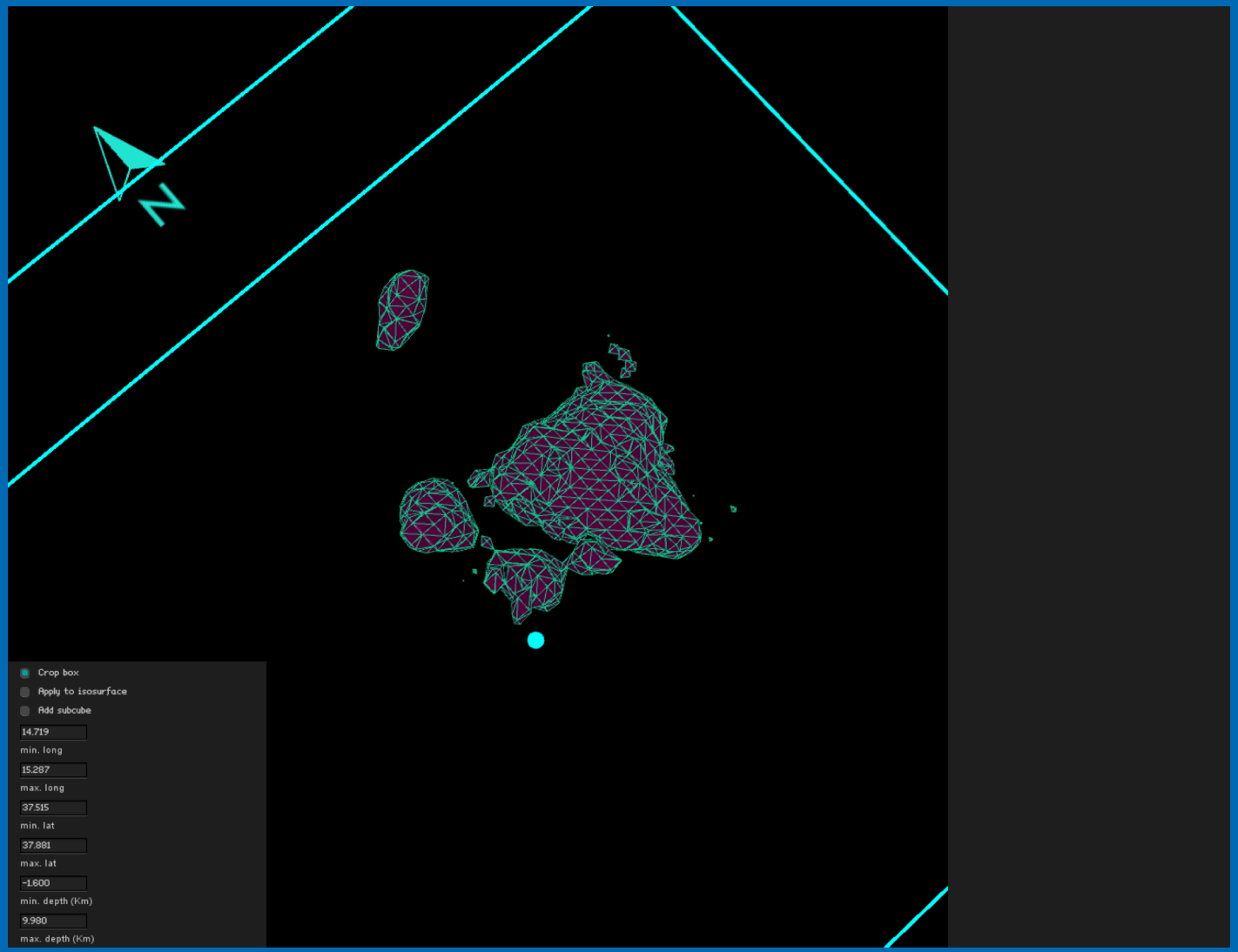
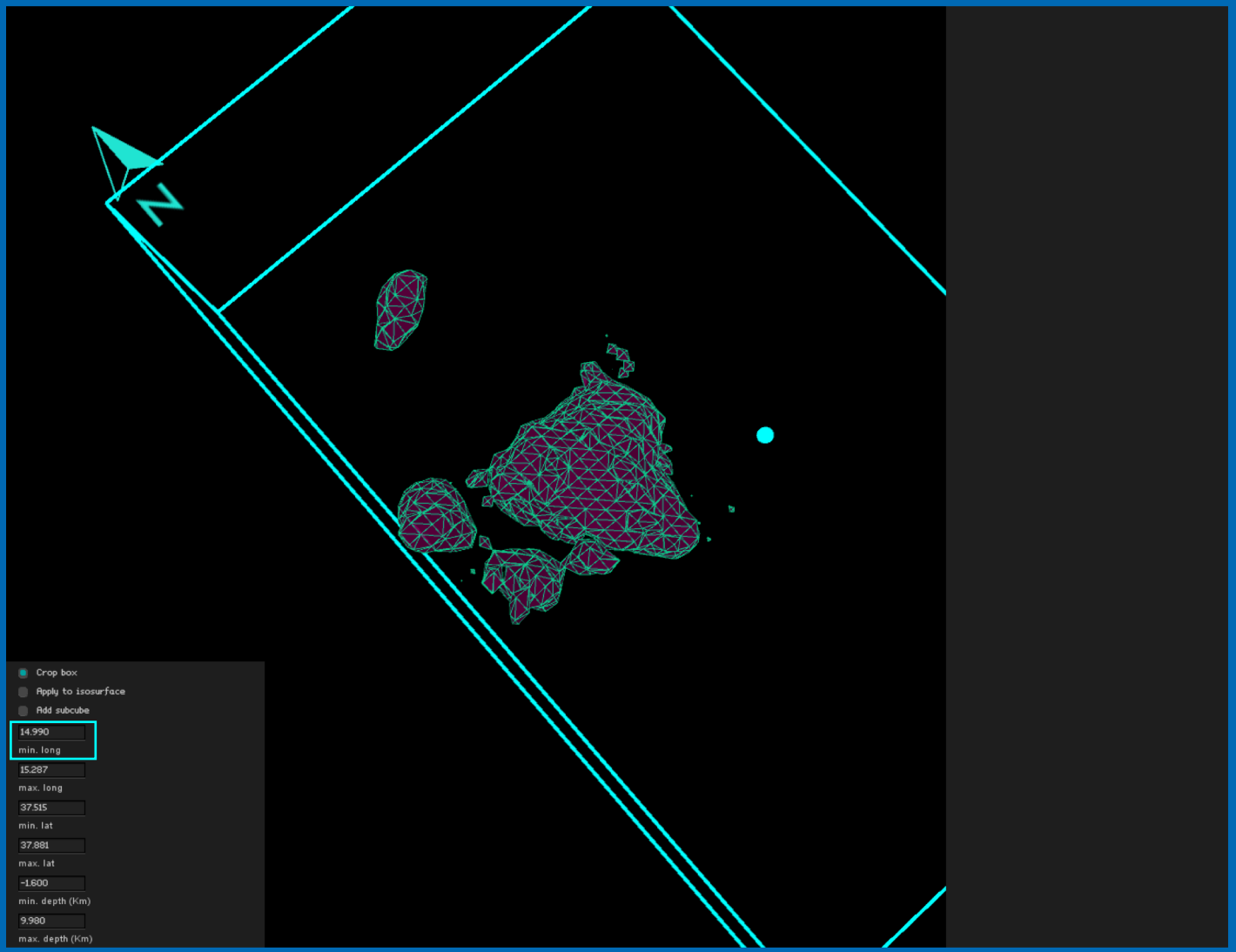
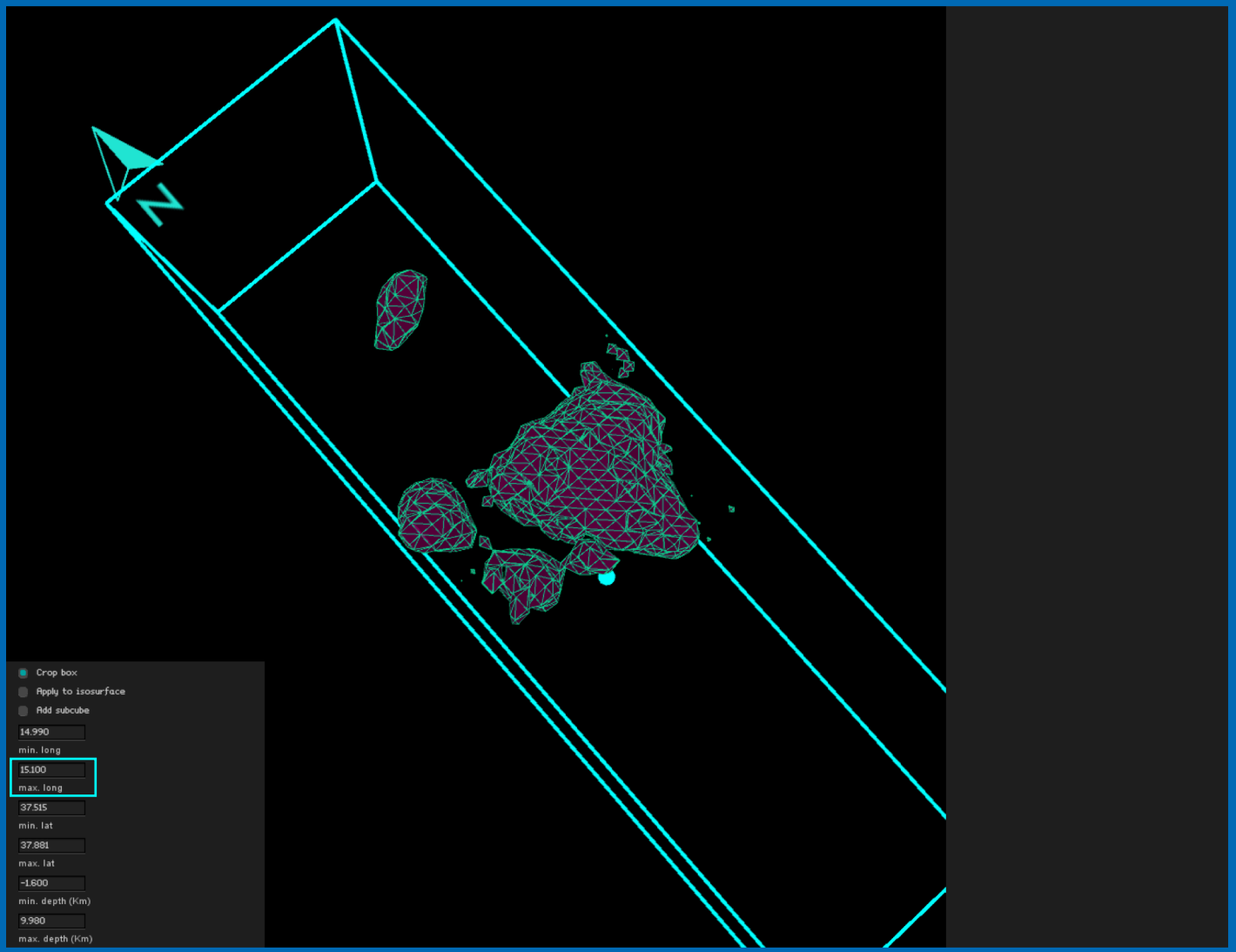
Number of events (CropBox): 2824 (0)
Compute and show isoSurface
Isosurface threshold
0.000
2.000
20.000


N
Subdivisions
1
100
200
Meters per side: 50040.527
Meters per division: 500.40527
Number of events (CropBox): 2824 (0)
Compute and show isoSurface
Isosurface threshold
0.000
3.000
20.000

Crop Box – Detail Analysis




N
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.287
max. long
37.515
min. lat
37.881
max. lat
-1.600
min. depth (Km)
9.980
max. depth (Km)


N
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.515
min. lat
37.881
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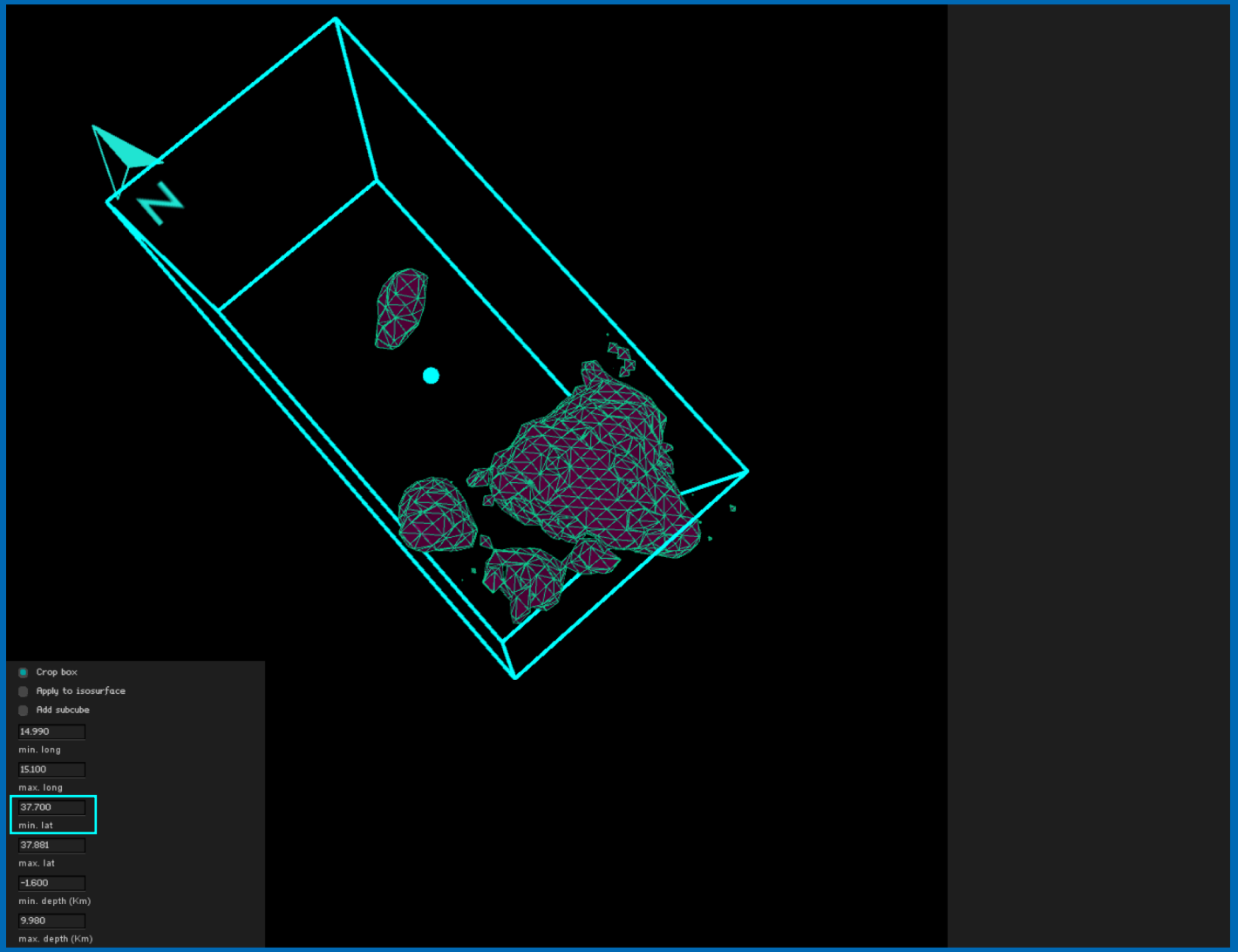
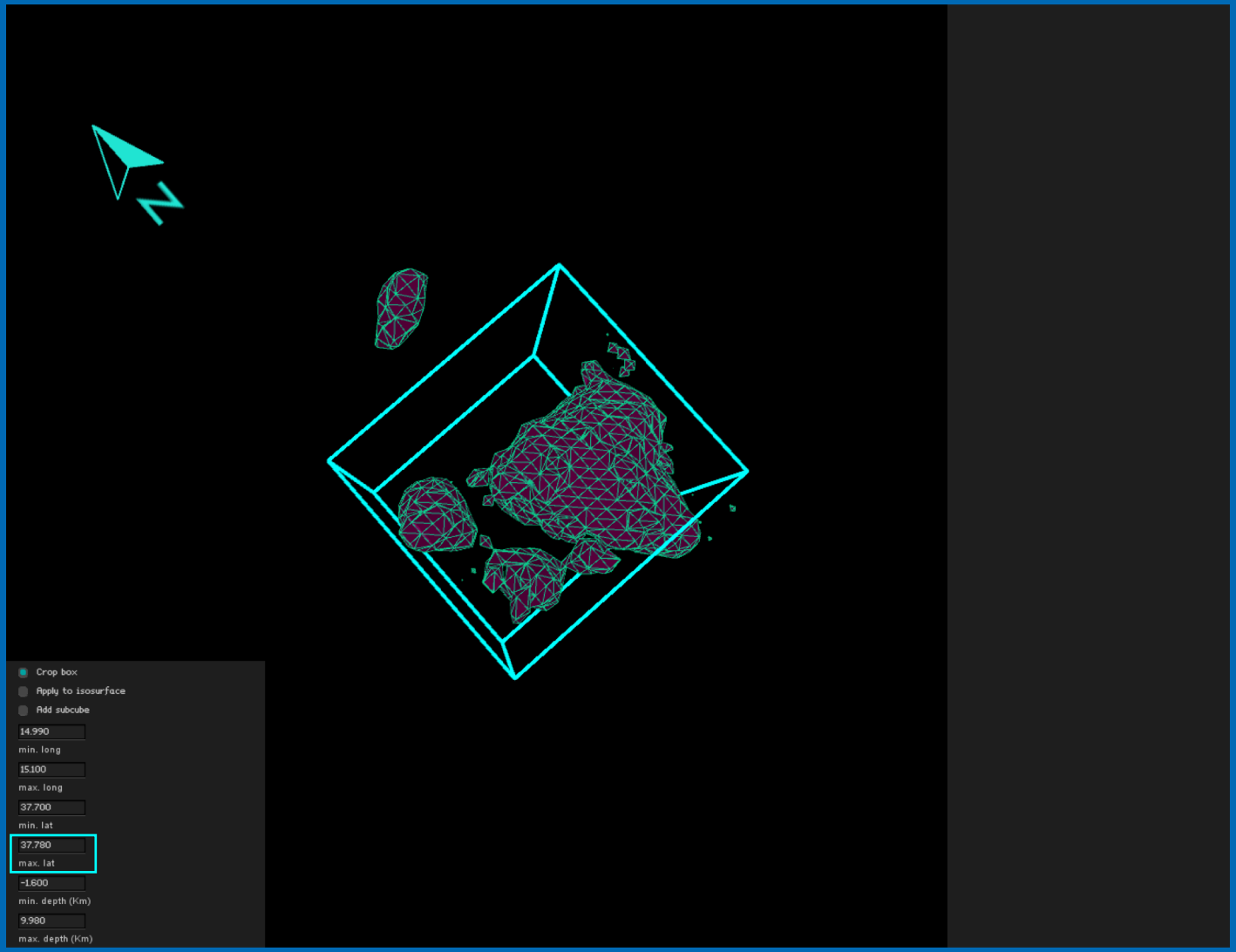
-1.600
min. depth (Km)
9.980
max. depth (Km)


N
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.881
max. lat
-1.600
min. depth (Km)
9.980
max. depth (Km)


N
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.780
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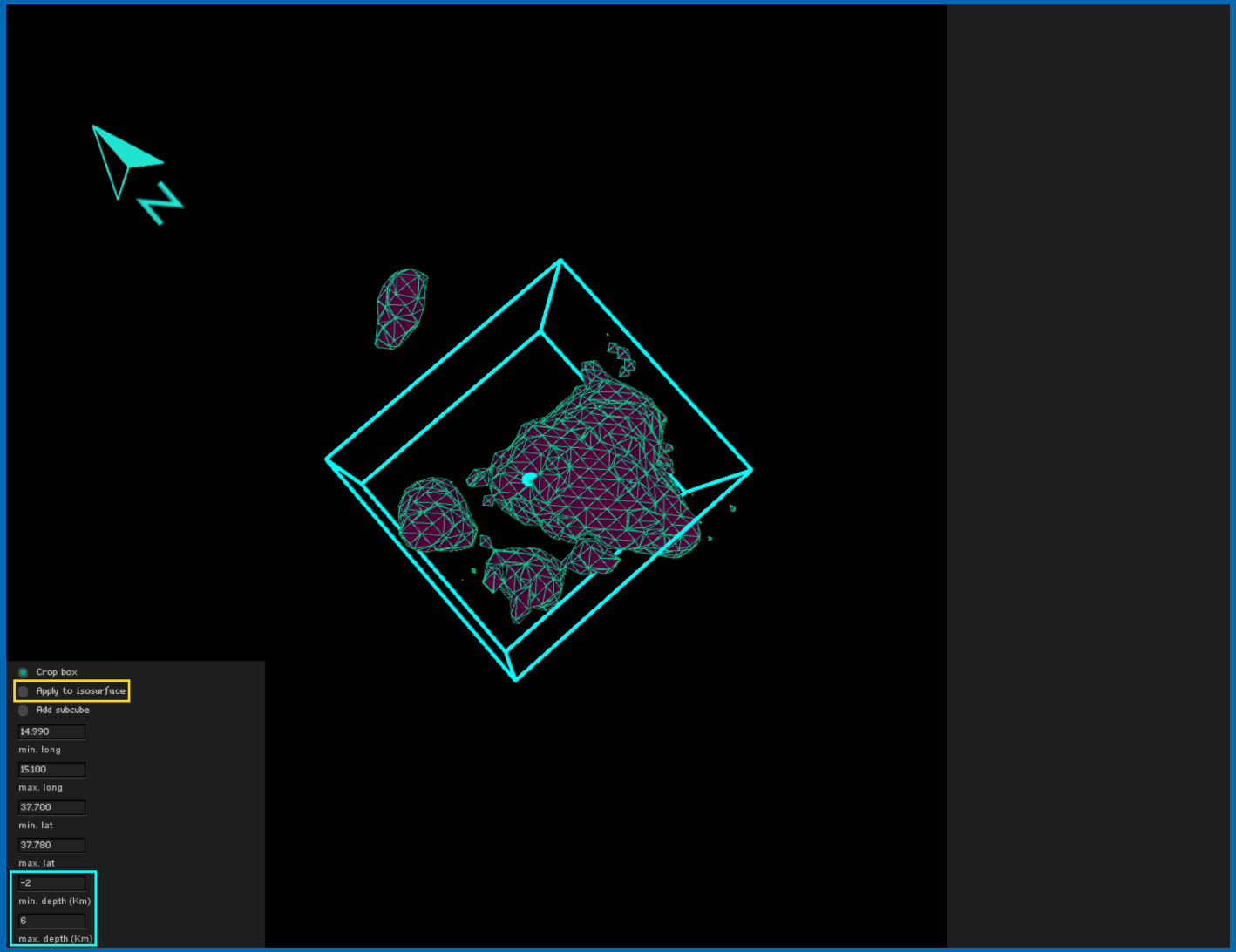
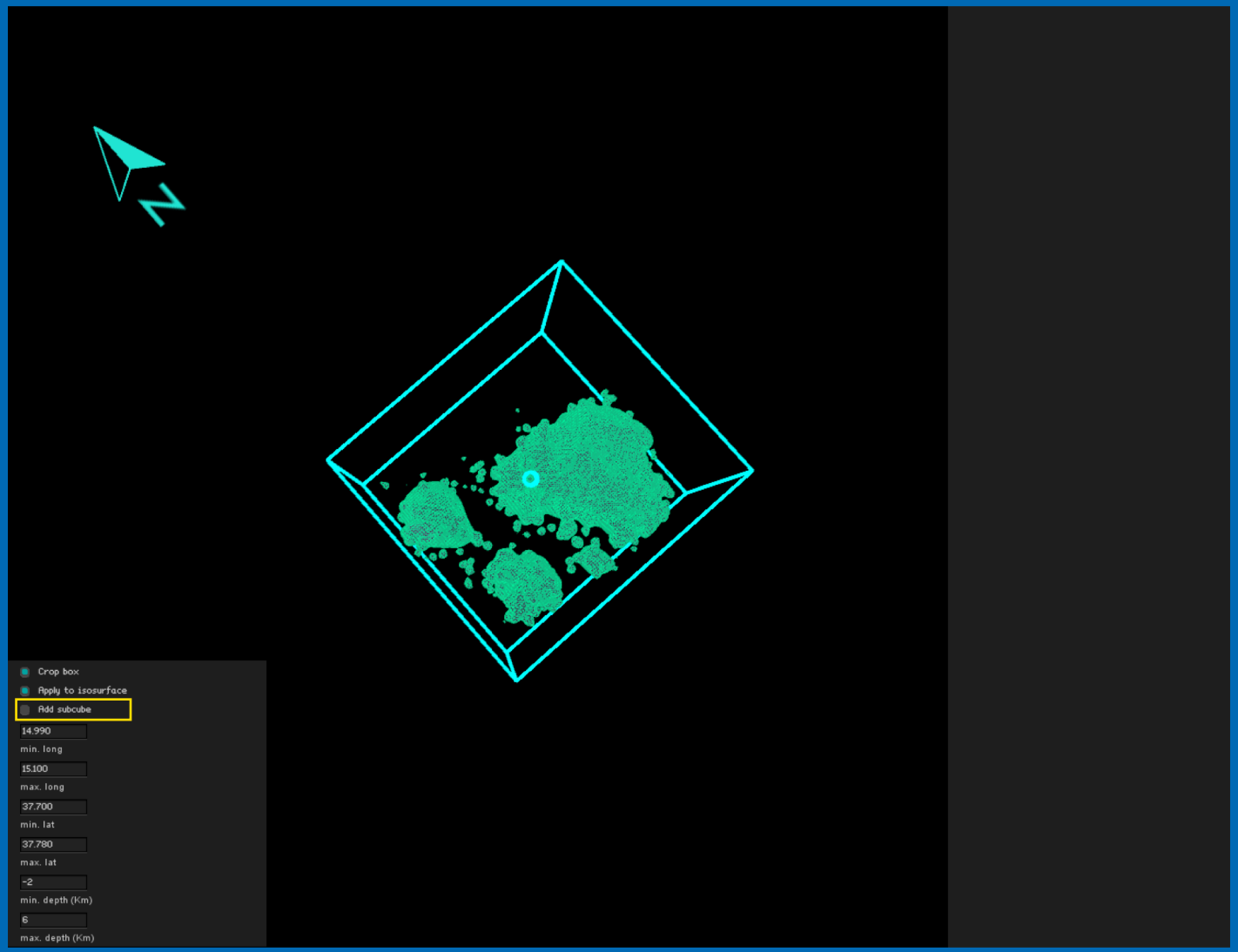
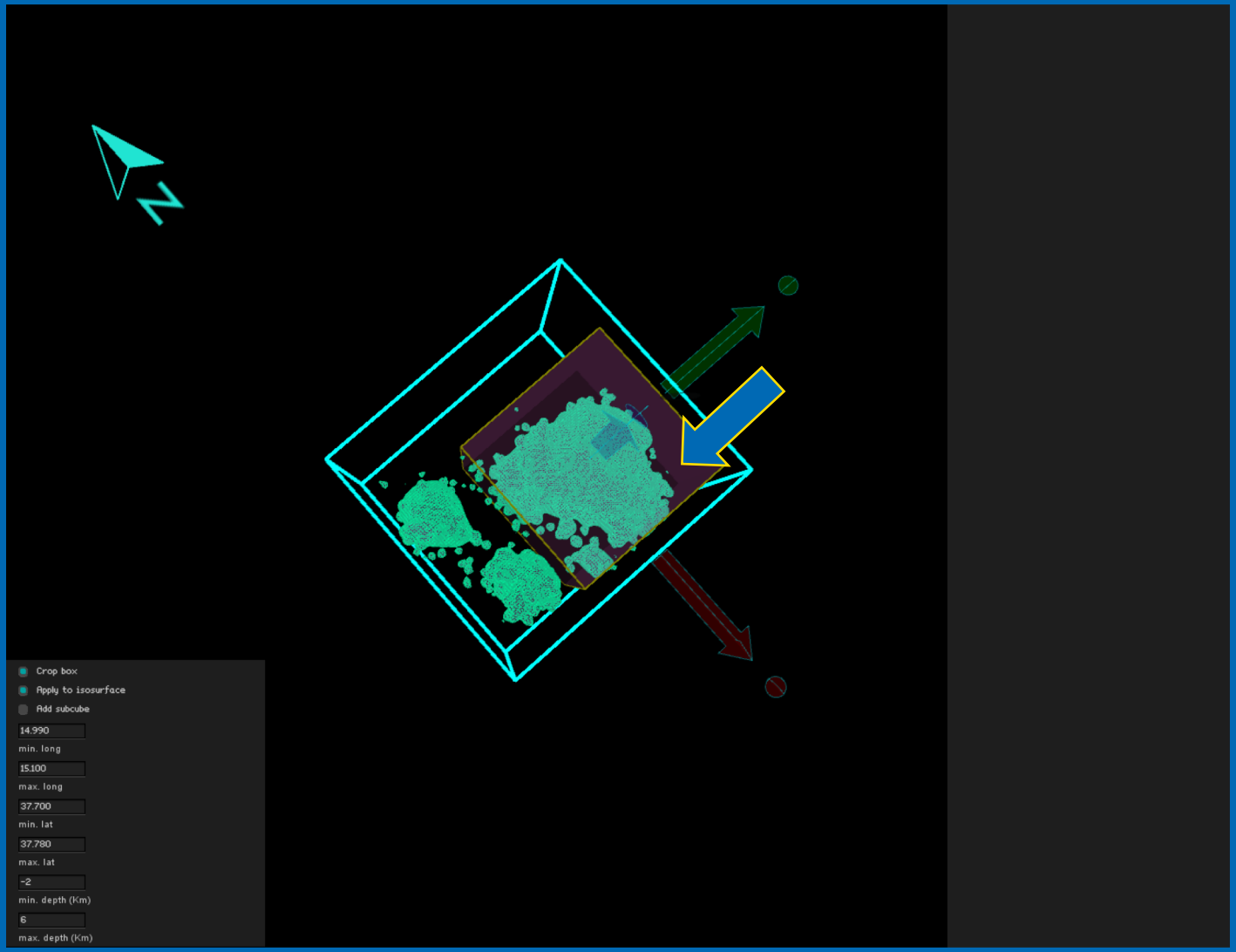
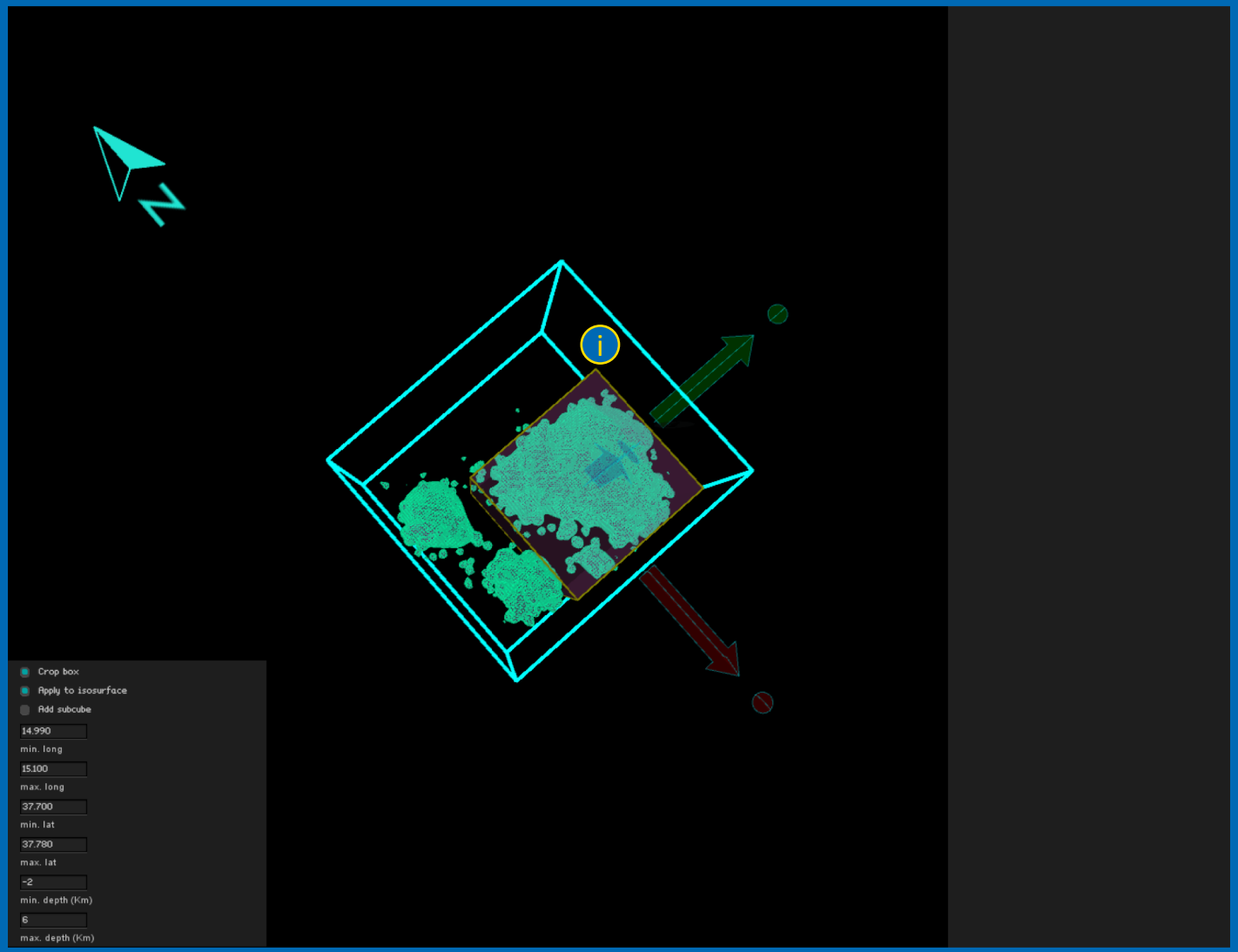
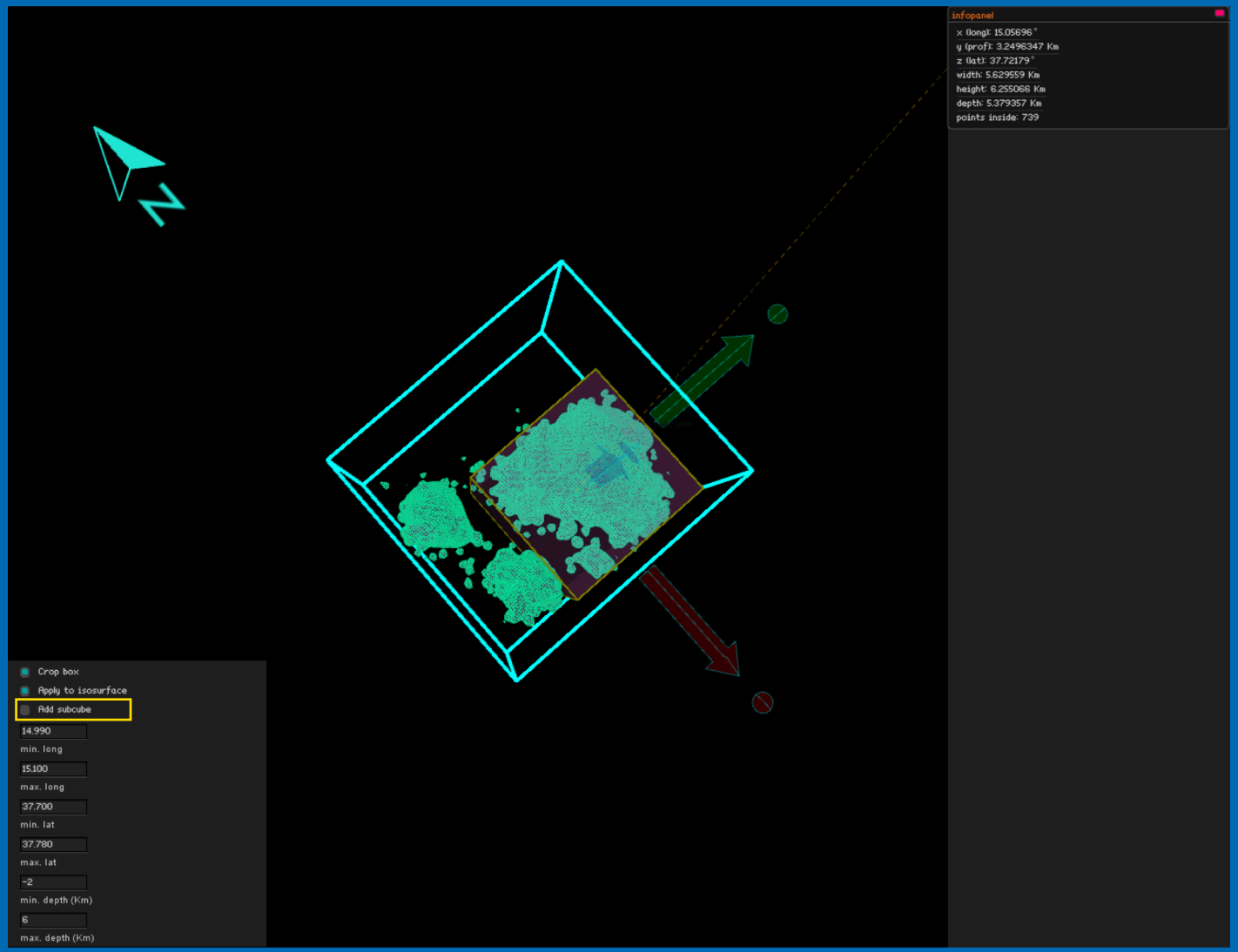
-1.600
min. depth (Km)
9.980
max. depth (Km)

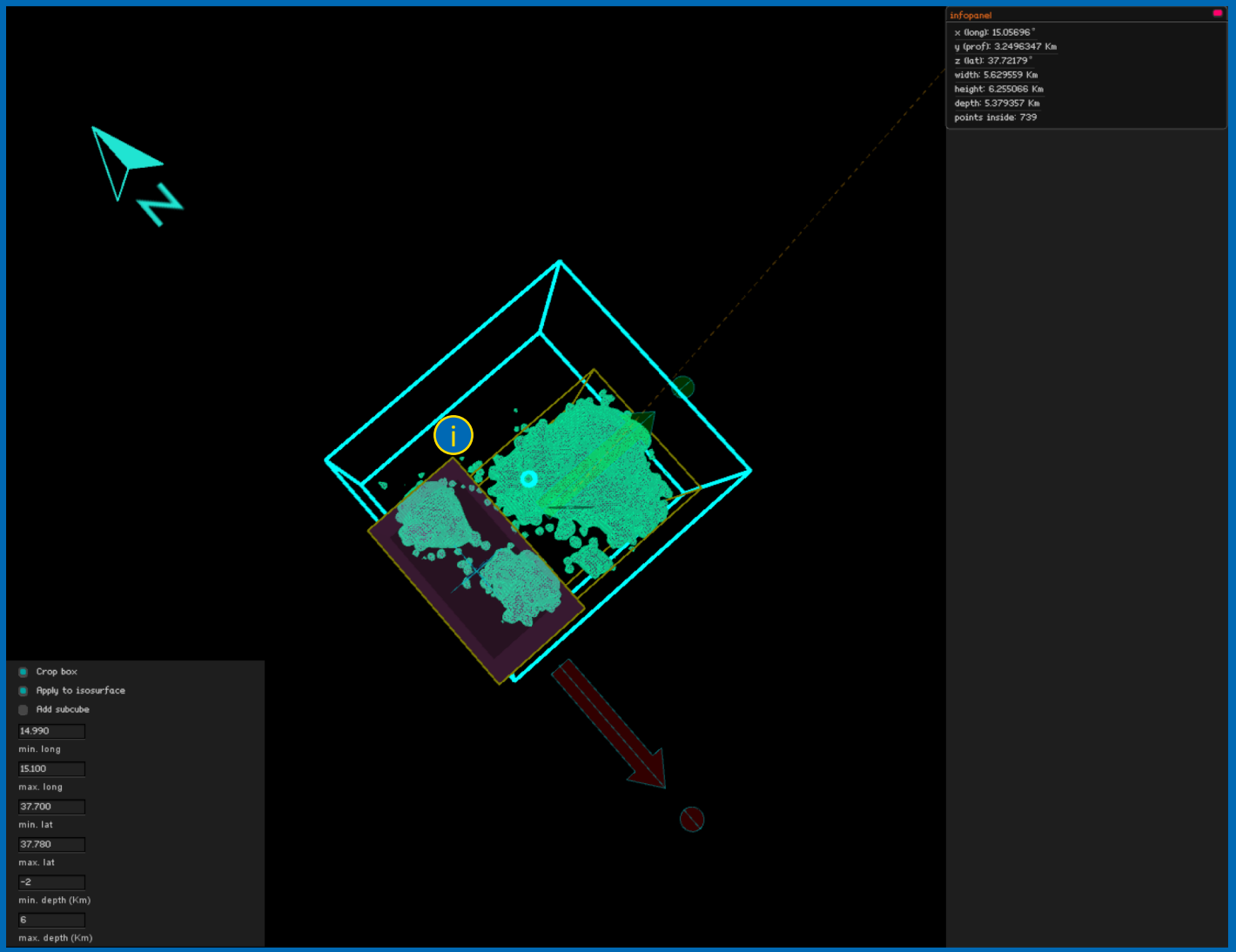

N
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.780
max. lat
-2
min. depth (Km)
6
max. depth (Km)

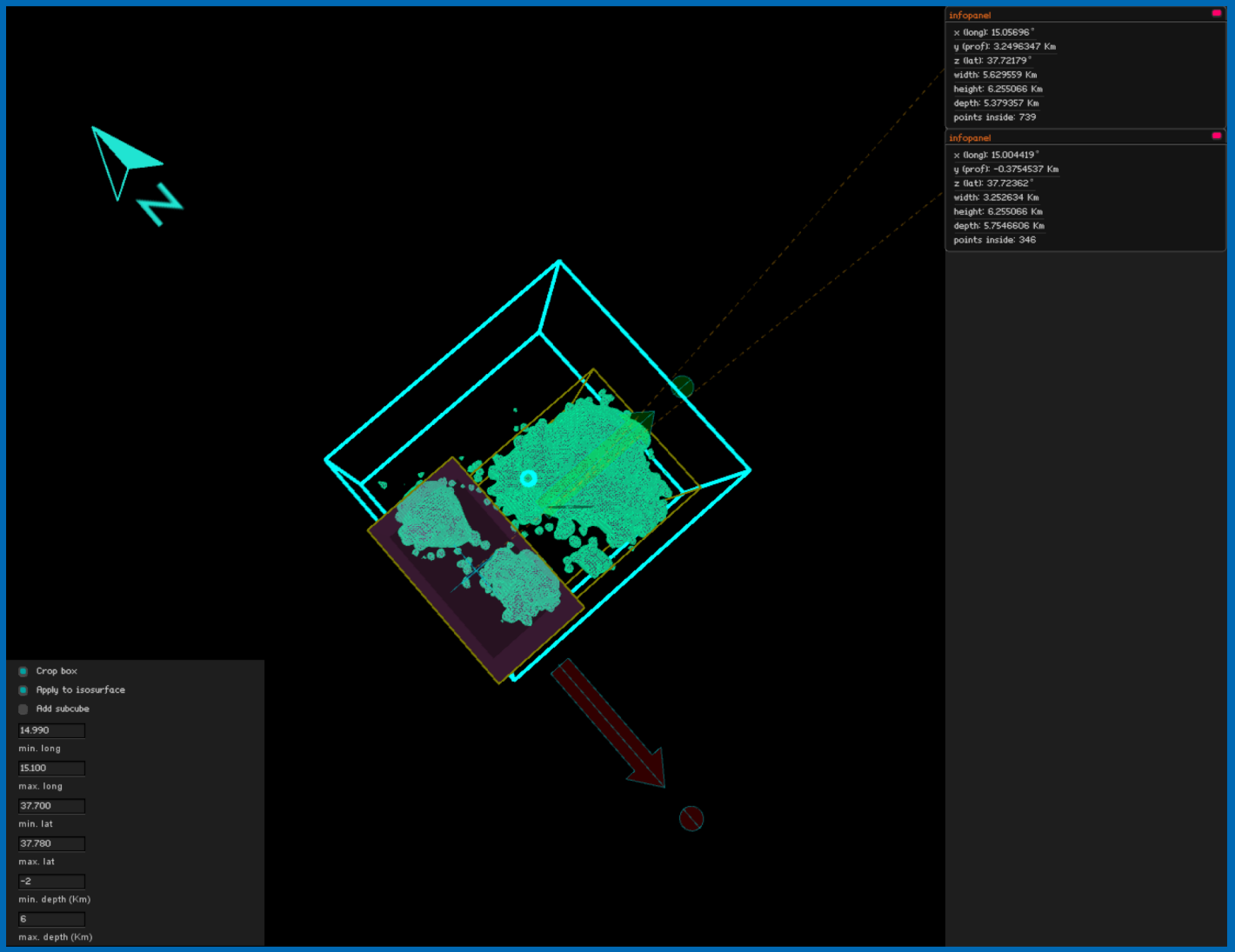

N
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.780
max. lat
-2
min. depth (Km)
6
max. depth (Km)


N
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.780
max. lat
-2
min. depth (Km)
6
max. depth (Km)

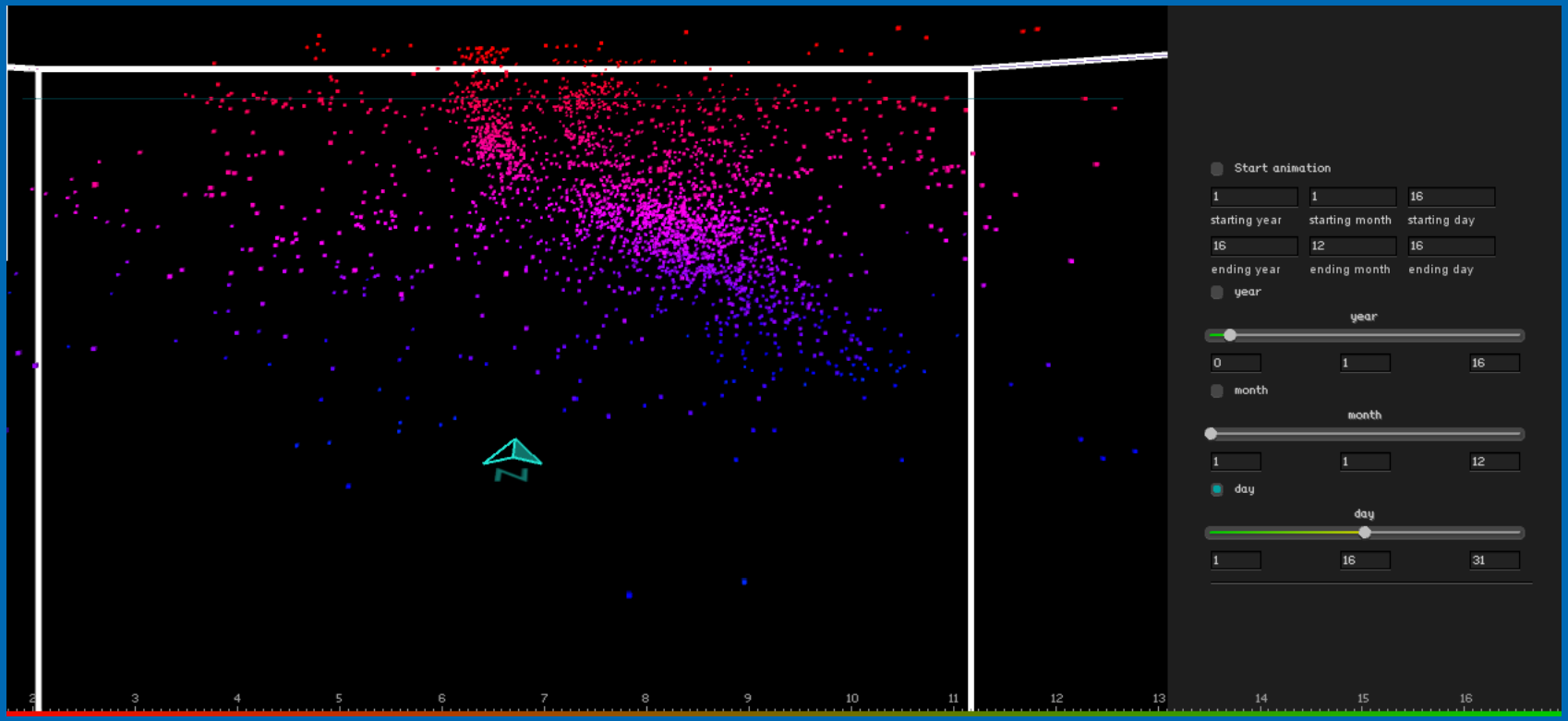

N
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.780
max. lat
-2
min. depth (Km)
6
max. depth (Km)


N
infopanel
x (long): 15.05696°
y (prof): 3.2496347 Km
z (lat): 37.72179°
width: 5.629559 Km
height: 6.255066 Km
depth: 5.379357 Km
points inside: 739
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.780
max. lat
-2
min. depth (Km)
6
max. depth (Km)


N
infopanel
x (long): 15.05696°
y (prof): 3.2496347 Km
z (lat): 37.72179°
width: 5.629559 Km
height: 6.255066 Km
depth: 5.379357 Km
points inside: 739
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.780
max. lat
-2
min. depth (Km)
6
max. depth (Km)


N
infopanel
x (long): 15.05696°
y (prof): 3.2496347 Km
z (lat): 37.72179°
width: 5.629559 Km
height: 6.255066 Km
depth: 5.379357 Km
points inside: 739
infopanel
x (long): 15.004419°
y (prof): -0.3754537 Km
z (lat): 37.72362°
width: 3.252634 Km
height: 6.255066 Km
depth: 5.7546606 Km
points inside: 346
Crop box
Apply to isosurface
Add subcube
14.990
min. long
15.100
max. long
37.700
min. lat
37.780
max. lat
-2
min. depth (Km)
6
max. depth (Km)

4D Analysis


Start animation
1
1
16
starting year
starting month
starting day
16
12
16
ending year
ending month
ending day
year
year
0
1
16
month
month
1
1
12
day
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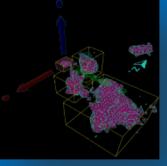
7
8
9
10
11
12
13
14
15
16



First results

Mt. Etna feeding system:
a new 3D image constrained by earthquakes distribution and 3D modelling analysis in a customizable GIS.

R. Guardo[a,d] (rguardo@unrn.edu.ar), A. Colubri[b], L. De Siena[c], C. Dreidemie[d]

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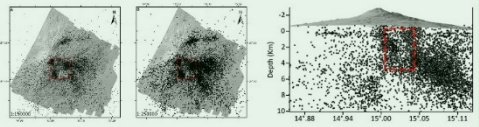
[c] School of Geoscience, University of Aberdeen, UK; [d] Laboratorio de Visualización Grafica y Codigo Creativo, Universidad Nacional de Rio Negro, Argentina.

Aim

Constrain the feeding system of Mt. Etna using the 3D earthquakes distribution integrated with an experimental GIS: "VolGIS"

Data, Method and Analysis

A low seismicity volume is visible when plotting the hypocenter distribution recorded at Mt. Etna between 2000 and 2016.



To constrain the low seismicity volume we used the marching cube (MC) algorithm, commonly used in medical imaging and computer graphics, in the framework of a novel volcano-oriented GIS (VolGIS).

How does MC works?

Given a point cloud and a grid, the contribution of each point in the cloud to the vertices of the grid is computed using an inverse of the distance dependency. This result in a scalar field defined over the grid vertices i, by adding up all the cloud points j: $W(i) = \sum_j \frac{1}{d(i,j)^2}$ A threshold value T is chosen to assign: 1 to each vertex in the grid if W(i) > T, 0 otherwise.

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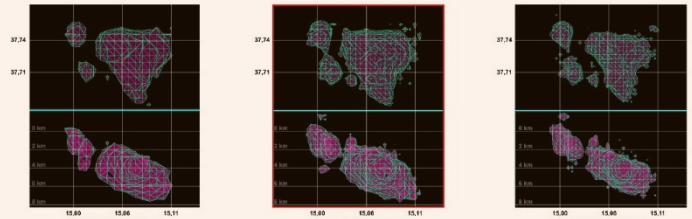
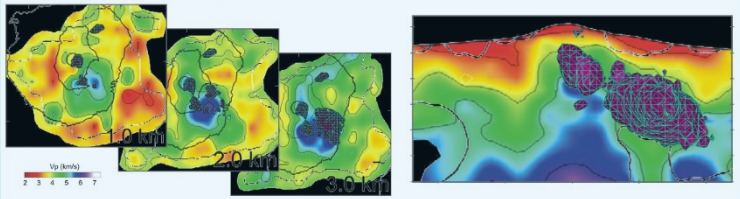
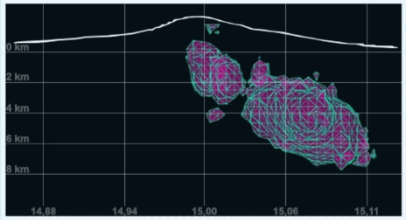


ERH-ERZ < 700 m | ERH-ERZ ≤ 500 m | ERH-ERZ ≤ 400 m

Results and Conclusions

The high-seismicity bodies correspond to a high-Vp body (P-wave velocity of about 6 km/s) detected by all the tomographic studies performed at Etna since 1998 (in the figures we use the maps of Alparone et al. 2012).





Both the bodies and the aseismic volumes located west of them are interpreted as a portion of the feeding system, where the rocks pass from a brittle fracture to a plastic deformation system. The clusters highlight a sliding plane with a dip angle of ~30° (mainly located below the Valle del Bove area).

Given their shape and position, an interpretation in terms of magmatic intrusions confirms their implications for the flank instability, proposed by previous authors (e.g. Murray et al. 2018).

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DATA

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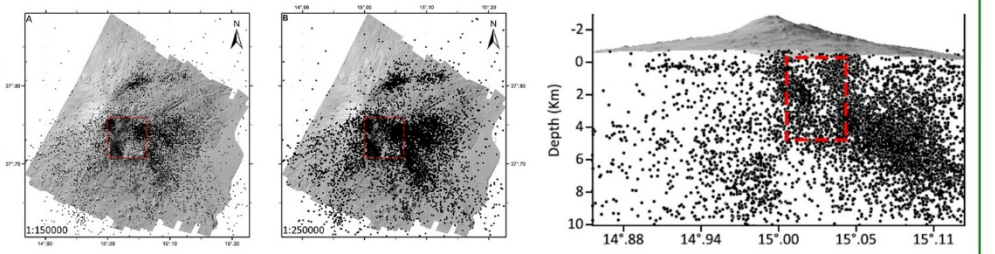

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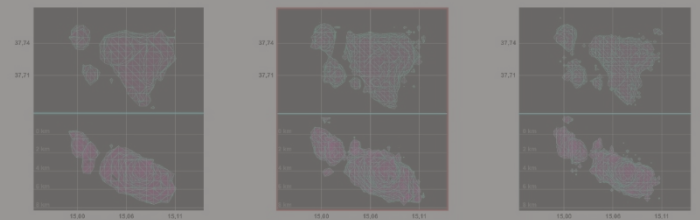

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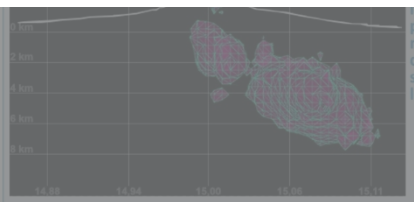

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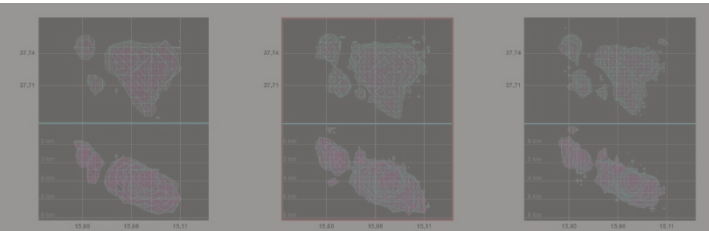
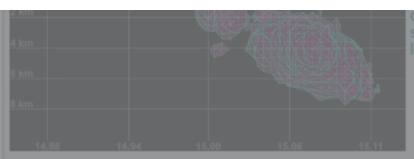


Results and Conclusions



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ANALYSIS

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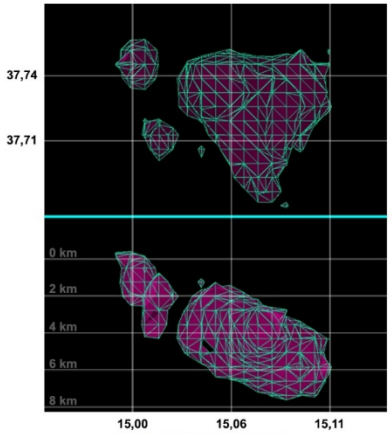
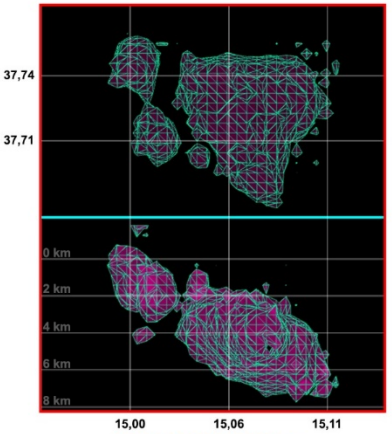
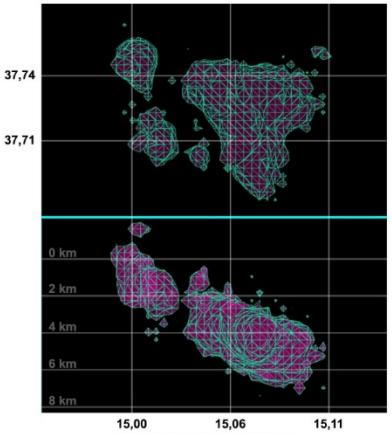


ERH-ERZ < 700 m



ERH-ERZ ≤ 500 m



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RESULTS

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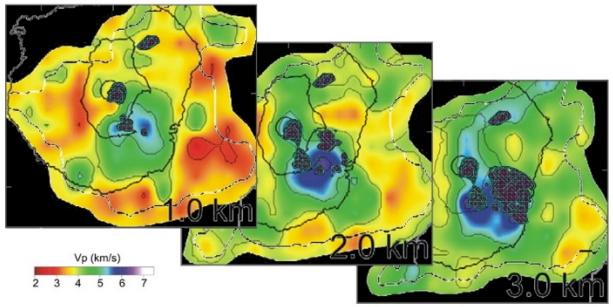

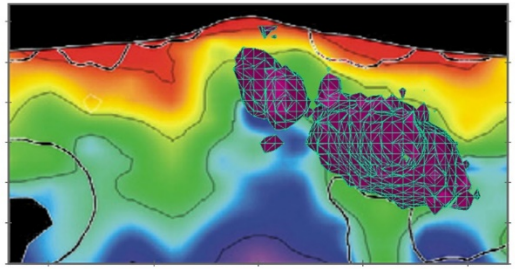

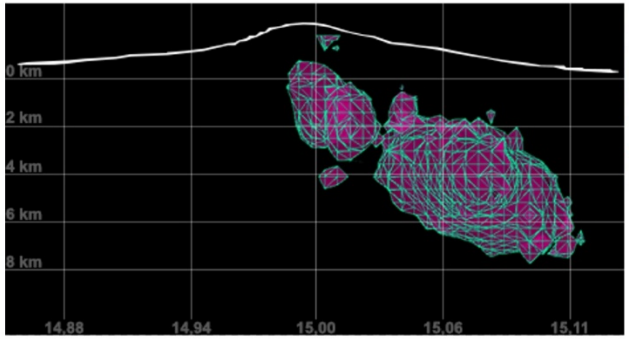

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Future Implementations

- **Create a module to import the *shapefile;***
- ***Integration tomography codes (i.e. Qc, MuRAT, LOTOS);***
- ***Ash dispersion model (ATLAS) 3D – 4D.***

We are looking for collaborators!

If you have ideas or suggestions, please send an email to volgis@robertoguardo.eu