IMPLEMENTING THE QTM DISCRETE GLOBAL GRID SYSTEM (DGGS)

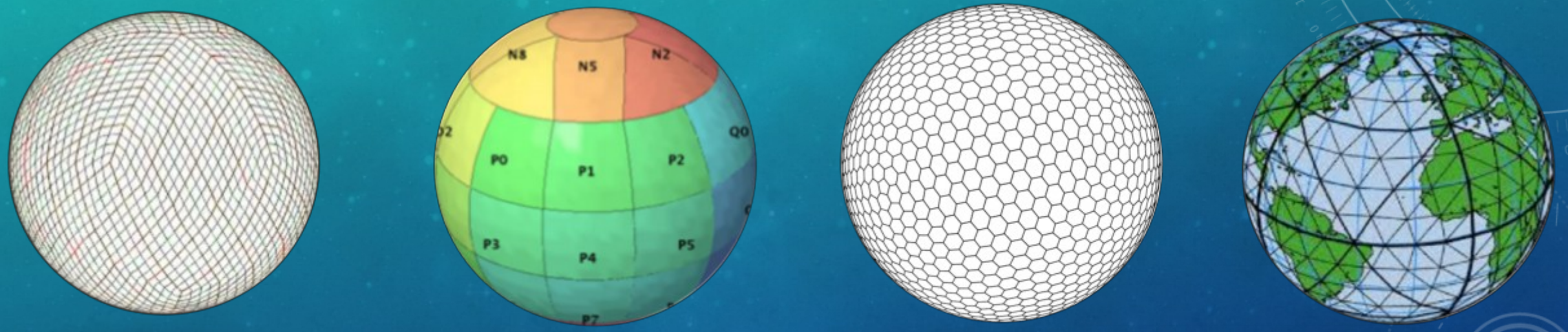
ITC Mini Symposium On Sustainable Research Software Development
For Geo-Information Science And Earth Observation

2022-11-17

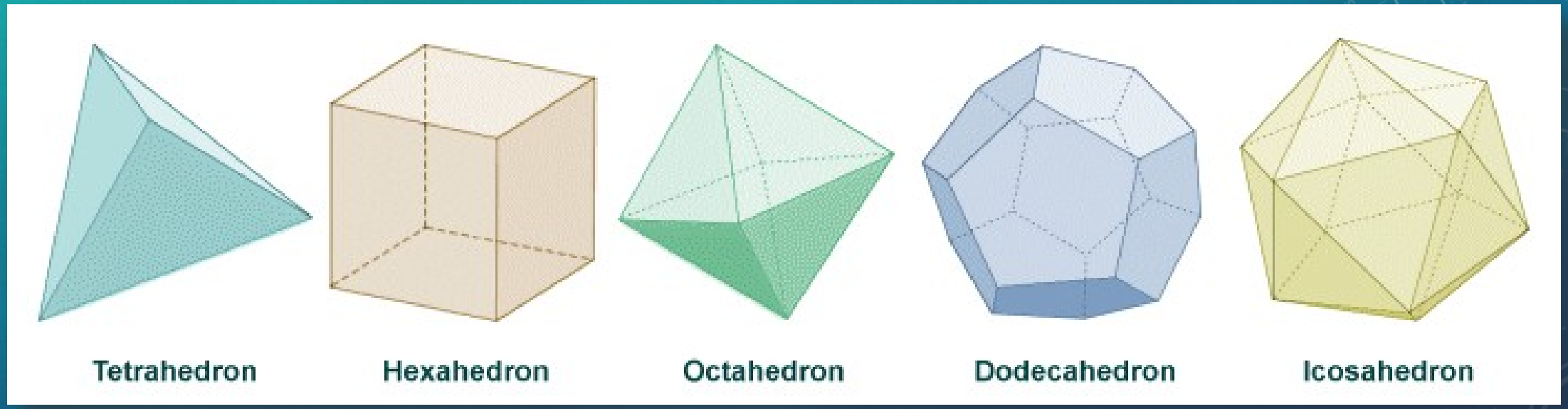
PAULO RAPOSO

GIP Department, Faculty ITC, University of Twente

DGGS



1) ISEA Triangular Grid 2) SCENZ-Grid 3) ISEA Hexagonal Grid 4) Illustration of Quaternary Triangular Mesh global grid used by permission of Geoffrey Dutton


Tetrahedron
Hexahedron
Octahedron
Dodecahedron
Icosahedron

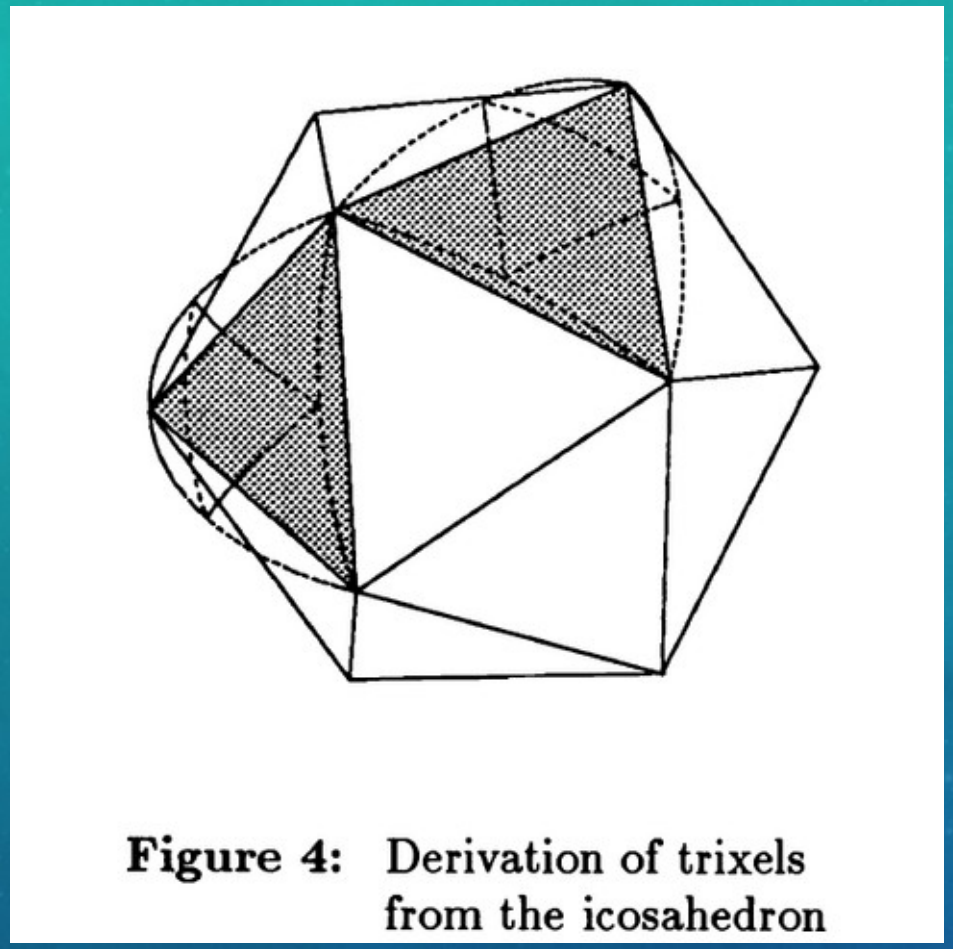


Figure 4: Derivation of trixels from the icosahedron

Fekete, G., & Treinish, L. A. (1990). Sphere quadtrees: a new data structure to support the visualization of spherically distributed data. In *Extracting Meaning from Complex Data: Processing, Display, Interaction* (Vol. 1259, pp. 242–254). International Society for Optics and Photonics.

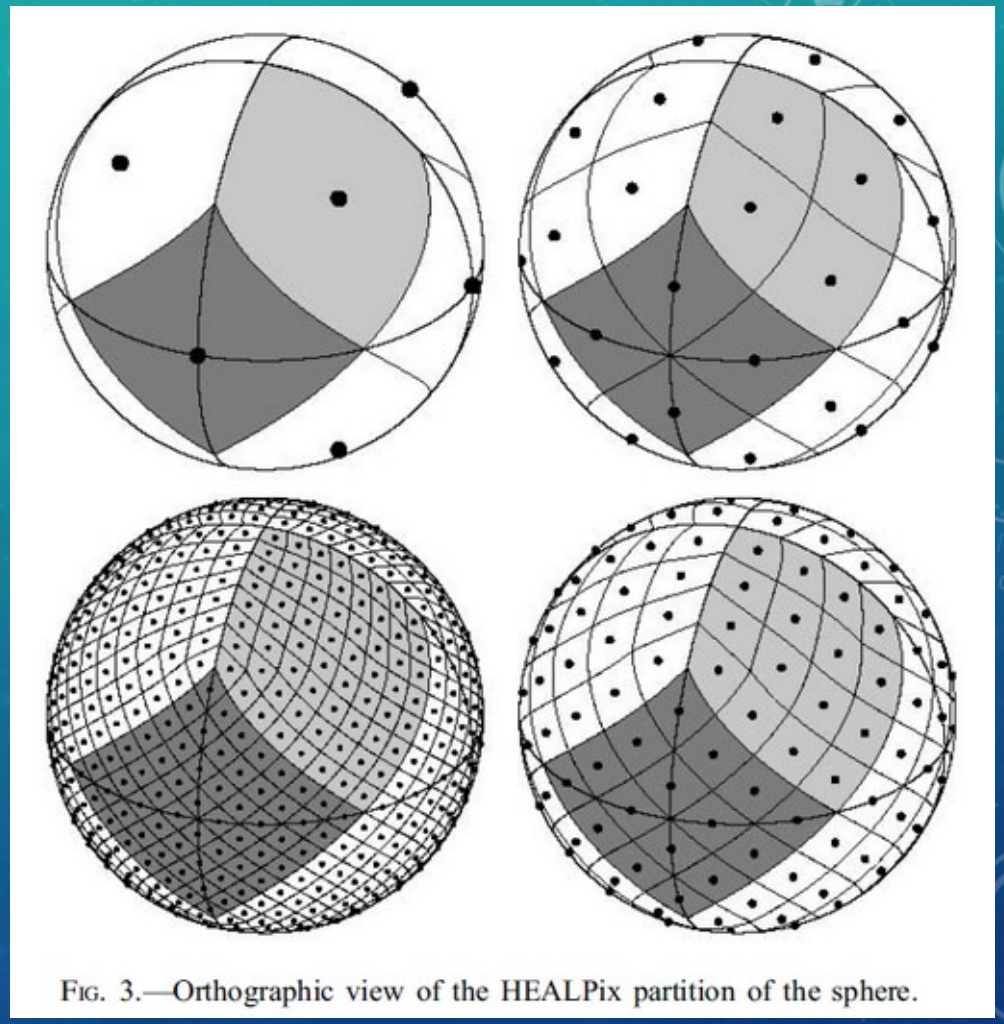
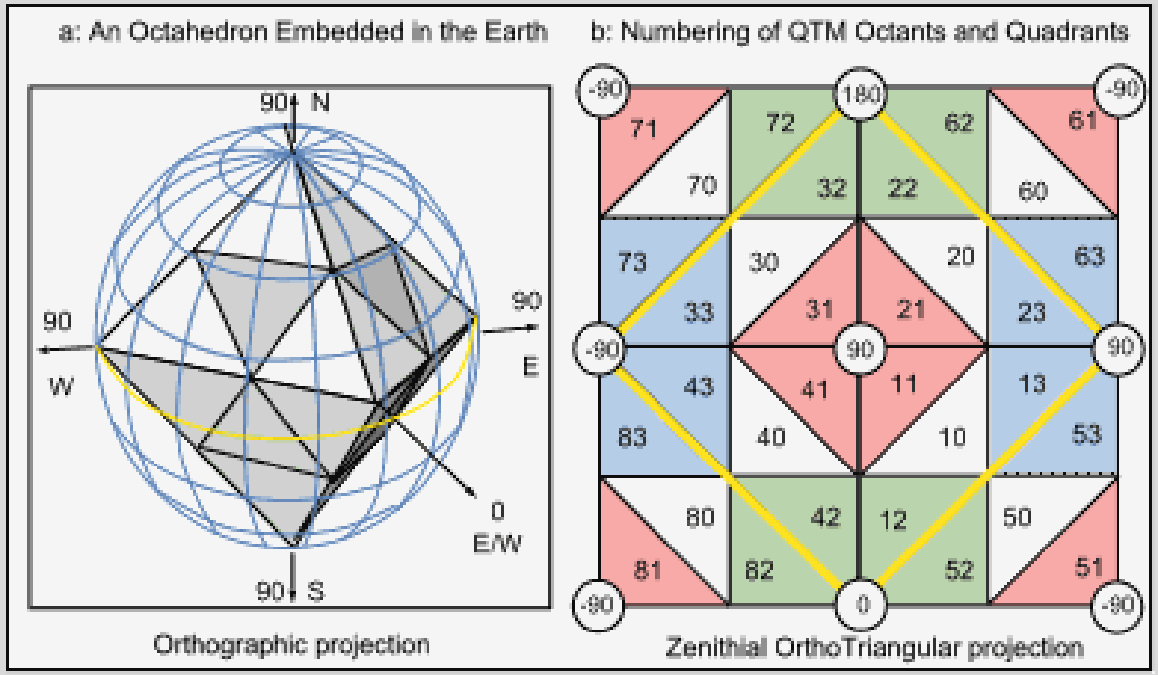
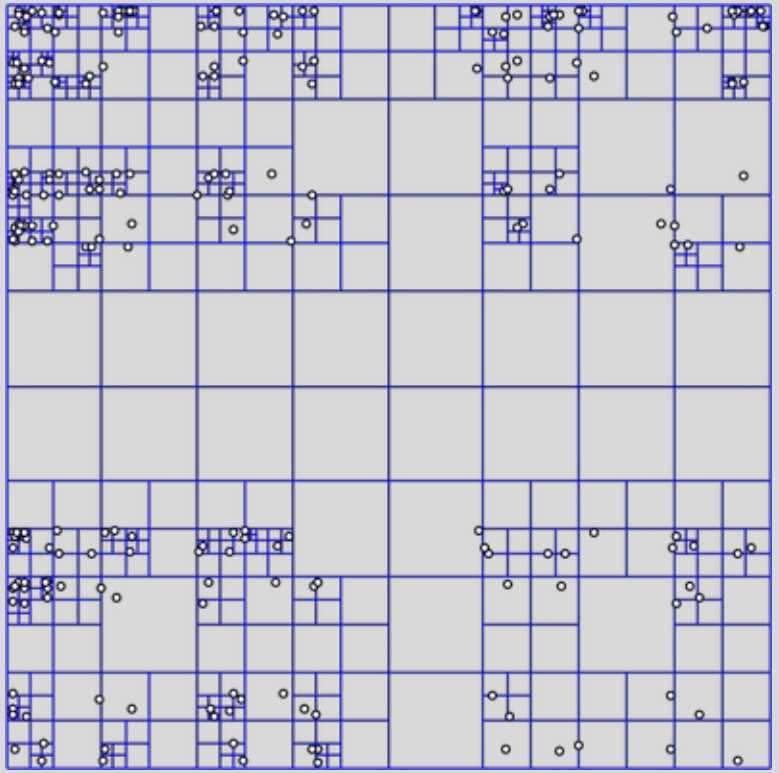


FIG. 3.—Orthographic view of the HEALPix partition of the sphere.

Górski, K. M., Hivon, E., Banday, A. J., Wandelt, B. D., Hansen, F. K., Reinecke, M., & Bartelmann, M. (2005). HEALPix: A Framework for High-Resolution Discretization and Fast Analysis of Data Distributed on the Sphere. *The Astrophysical Journal*, *622*(2), 759.





http://www.spatial-effects.com/urisa/

Subscribe to our Press Release

Subscribe here to receive future Press Releases by email: Subscribe

OGC® seeks public comment on a candidate standard that may replace legacy coordinate systems

Contact:
info@opengeospatial.org

Release Date:
Tuesday, 5 January 2016 UTC

05 January, 2016. The Open Geospatial Consortium (OGC) requests public comment on the OGC candidate Discrete Global Grid Systems (DGGS) Core Standard.

The OGC DGGS candidate standard defines a set of rules for defining highly efficient architectures for spatial data storage and analytics. The goal of DGGS is to enable rapid integration of spatial data without the difficulties of working with legacy coordinate systems. DGGSs represent the Earth as sequences of cell tessellations each with global coverage and with progressively finer spatial resolution. Individual observations can be assigned to a cell corresponding to both the position and size of the phenomenon being observed. DGGS come with a standard set of functional algorithms that enable rapid data analysis of very large numbers of cells.

OGC SPEC

- Open Geospatial Consortium
- Abstract Specification
- 2017

Open Geospatial Consortium

Submission Date: 2015-09-30

Approval Date: 2017-06-13

Publication Date: 2017-08-01

External identifier of this OGC® document: http://www.opengis.net/doc/AS/dggs/1.0

Internal reference number of this OGC® document: 15-104r5

Version: 1.0

Category: OGC® Abstract Specification

Editor: Matthew Purss

Topic 21: Discrete Global Grid Systems Abstract Specification

Copyright notice

Warning

This document is an OGC Member approved international standard. This document is available on a royalty free, non-discriminatory basis. Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

QUATERNARY TRIANGULAR MESH (QTM)

- Geoffrey Dutton 1989
- Recursively subdivide a circumscribed octahedron with small circle arcs

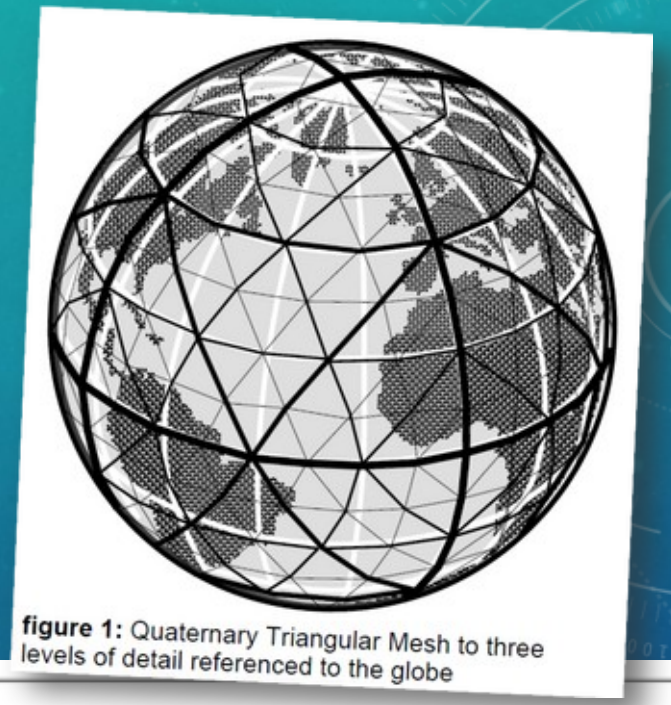


figure 1: Quaternary Triangular Mesh to three levels of detail referenced to the globe

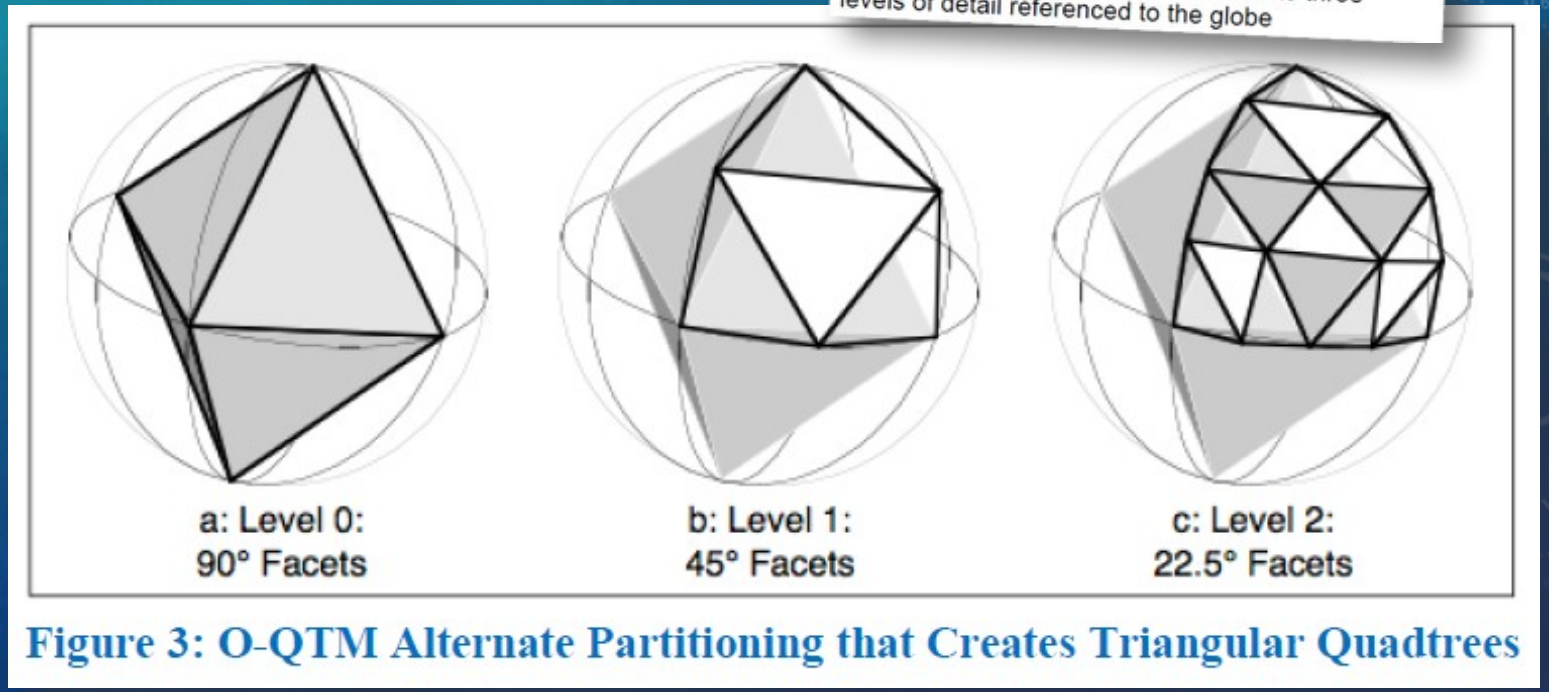
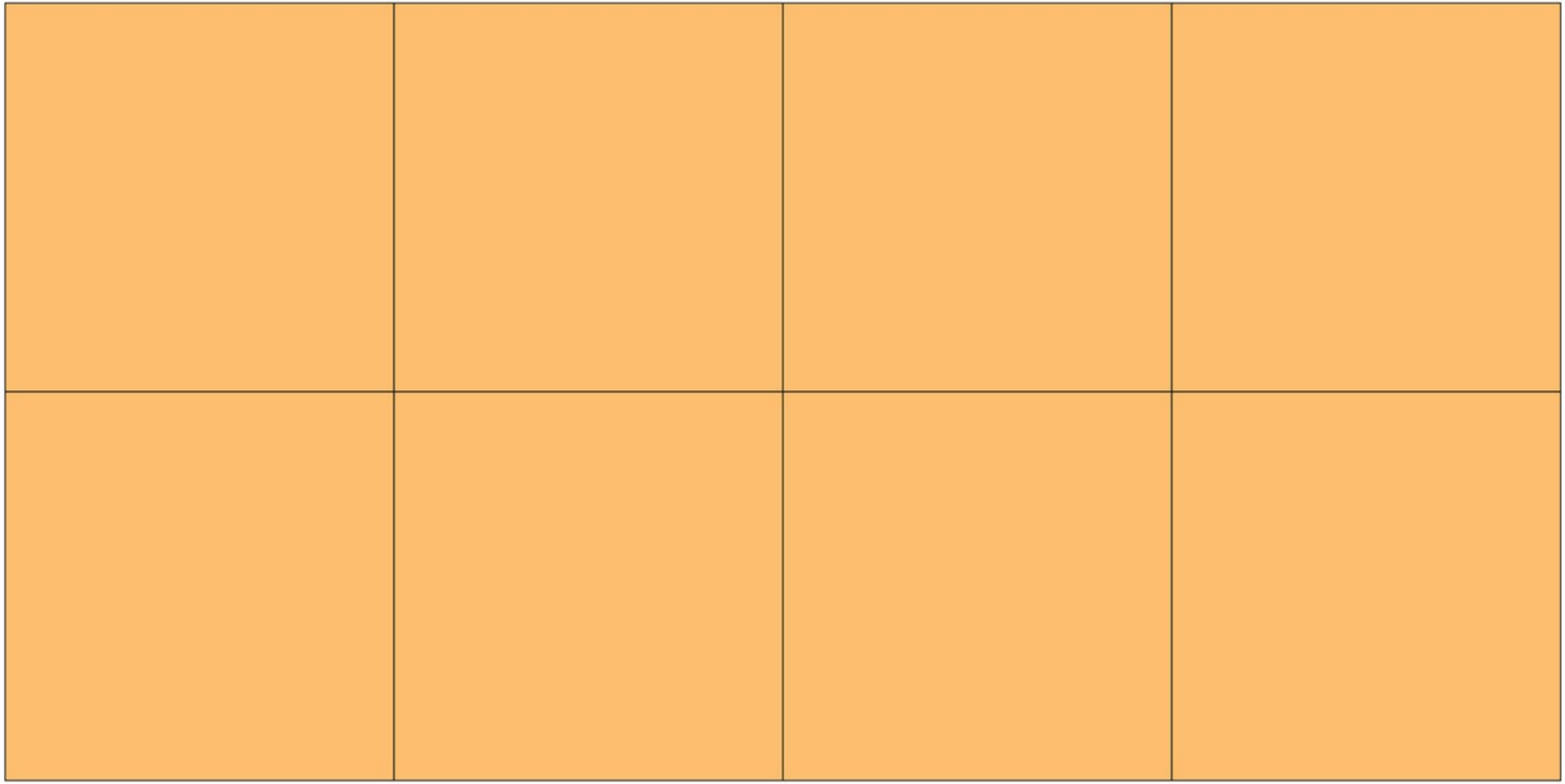
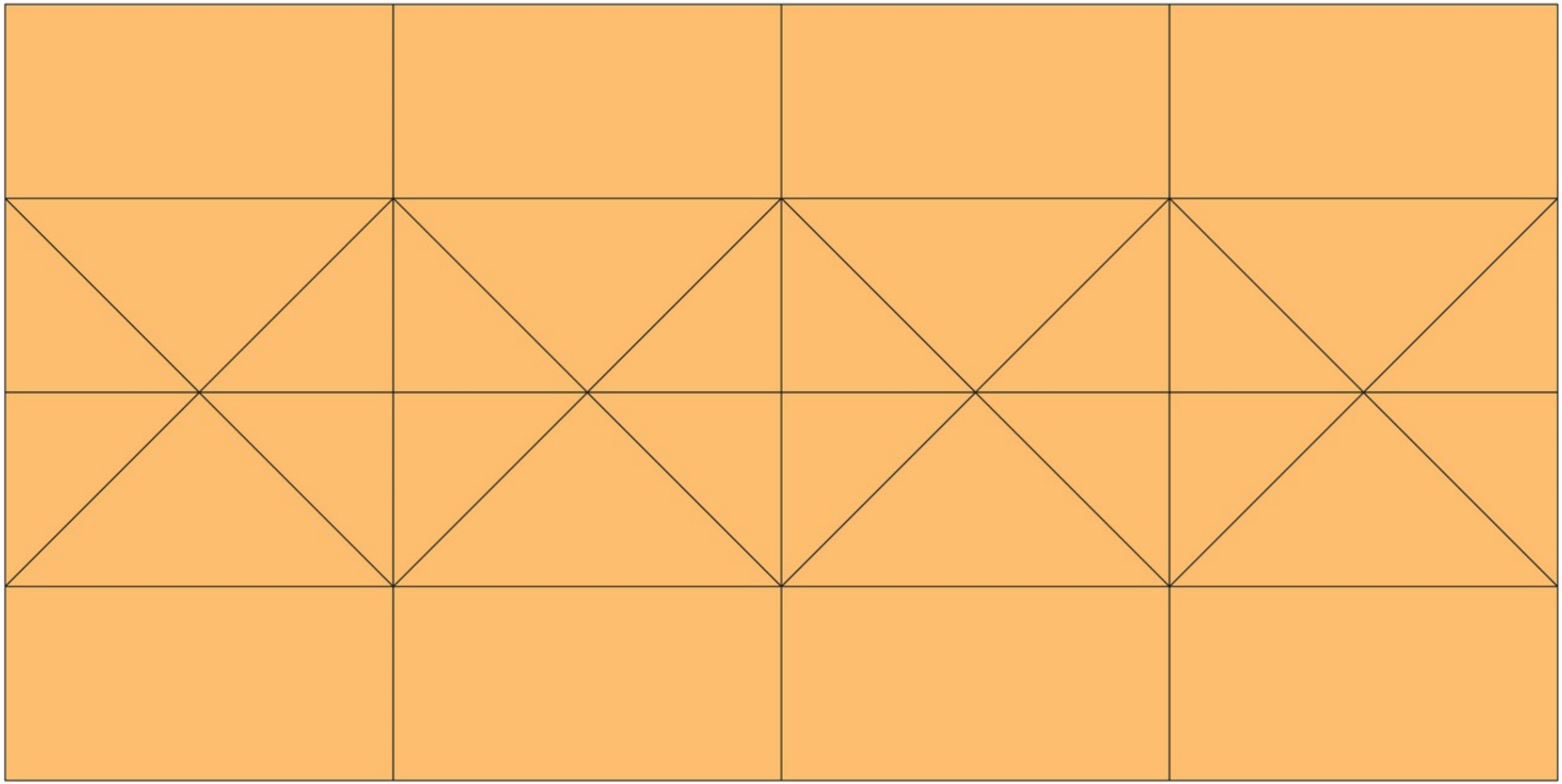
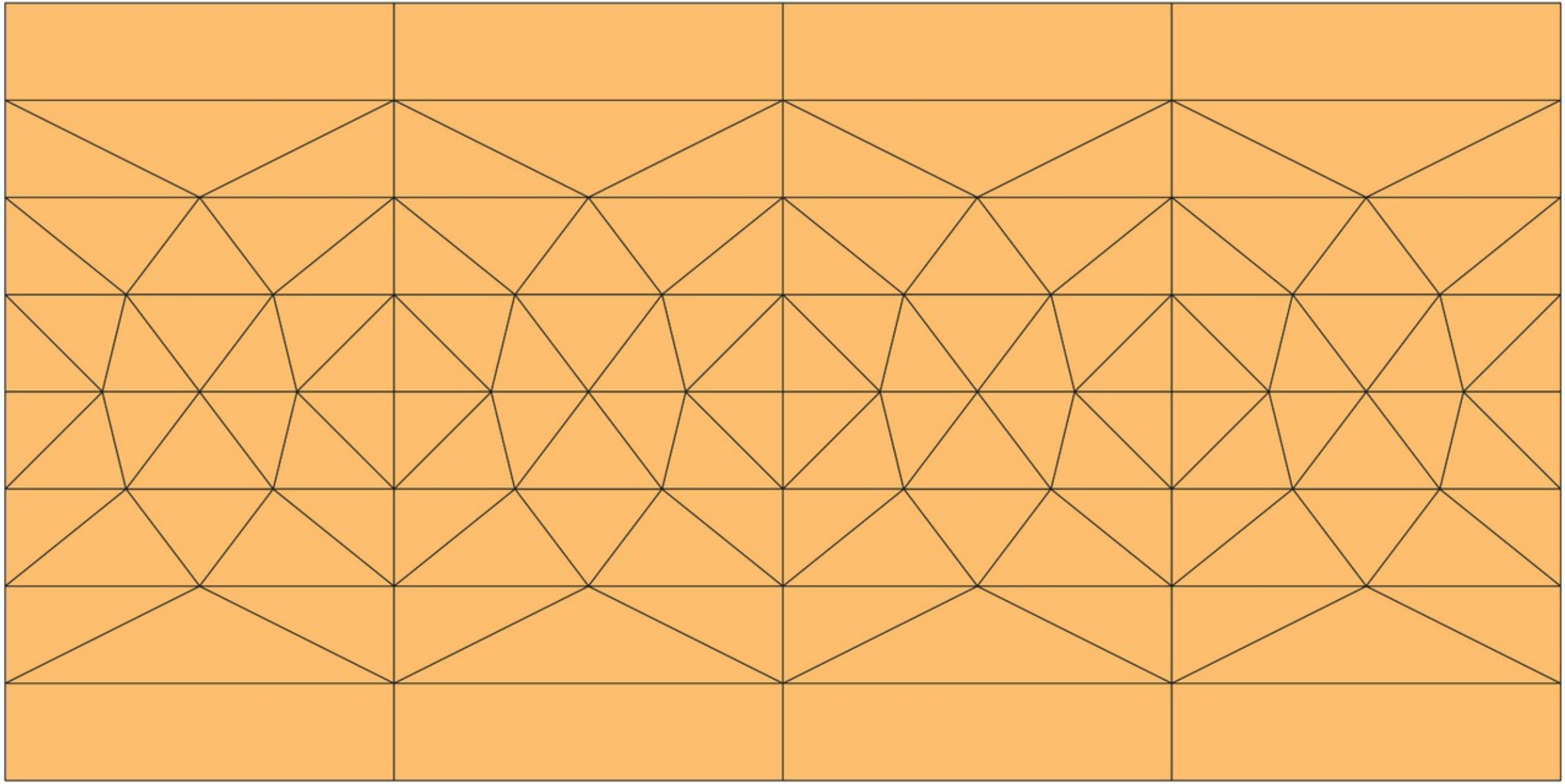


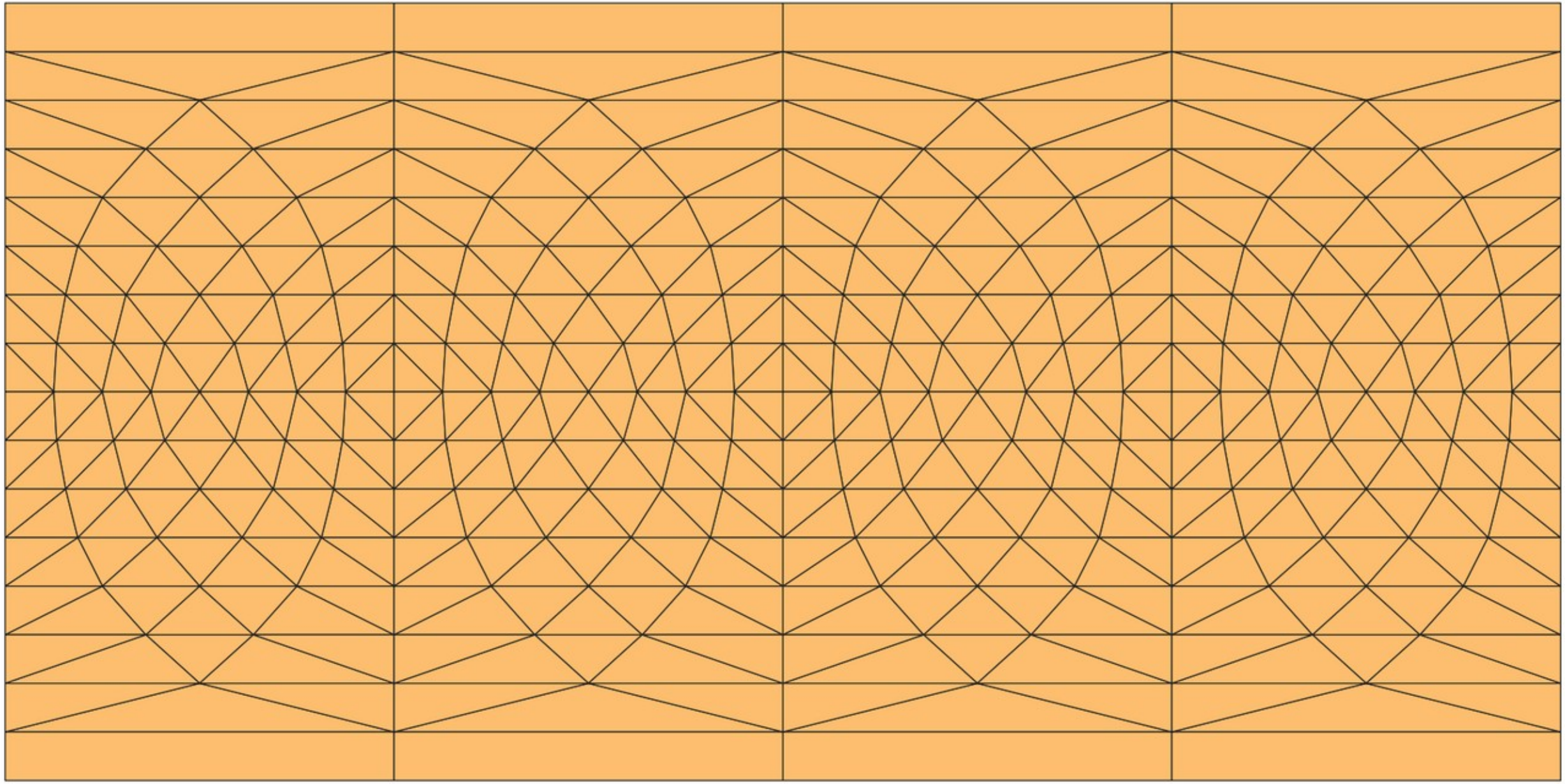
Figure 3: O-QTM Alternate Partitioning that Creates Triangular Quadtrees

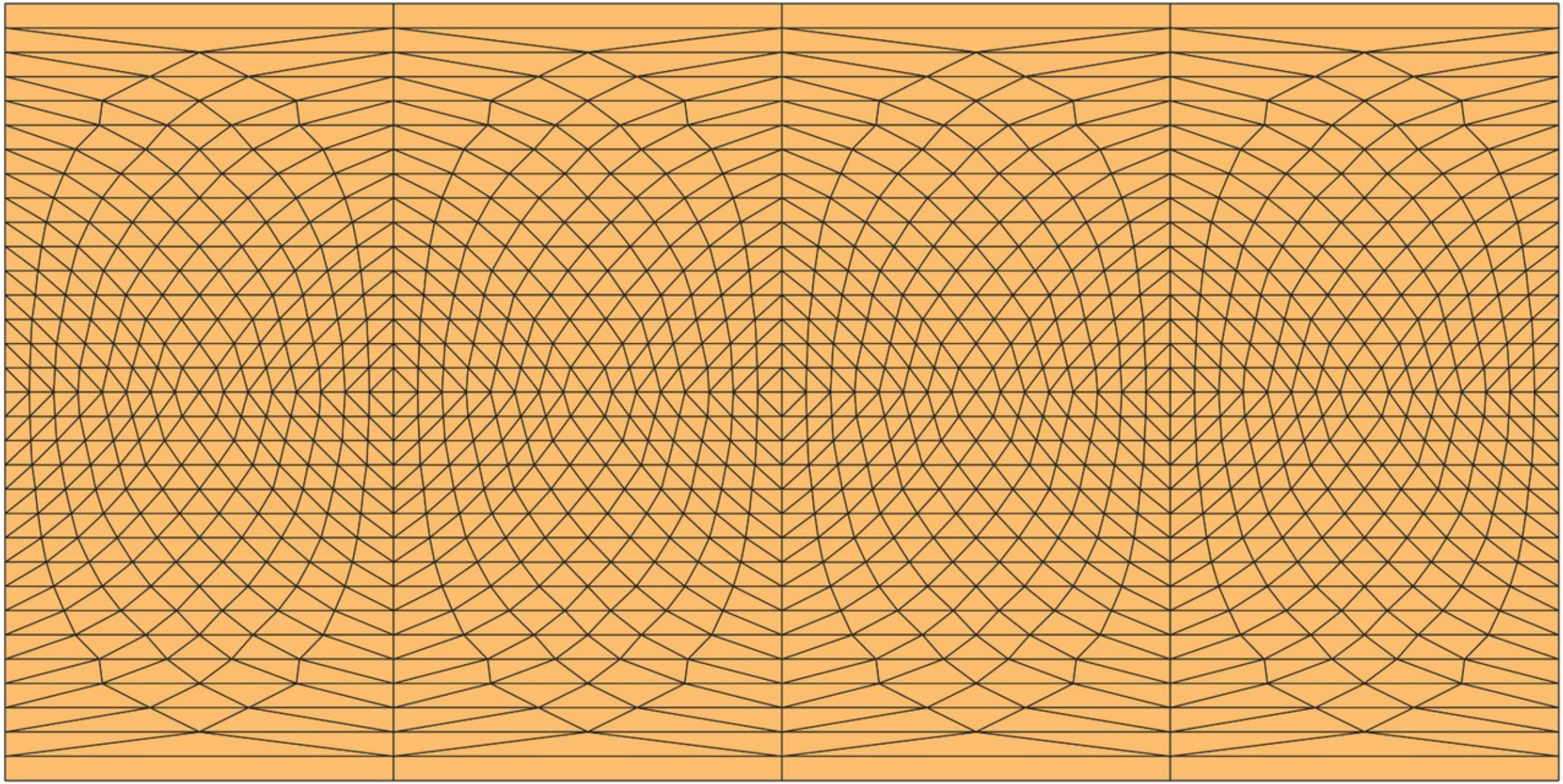
Dutton, G. (1989). Planetary modelling via hierarchical tessellation. In *Procedings of the AutoCarto 9 Conference* (pp. 462–471). Baltimore, MD.

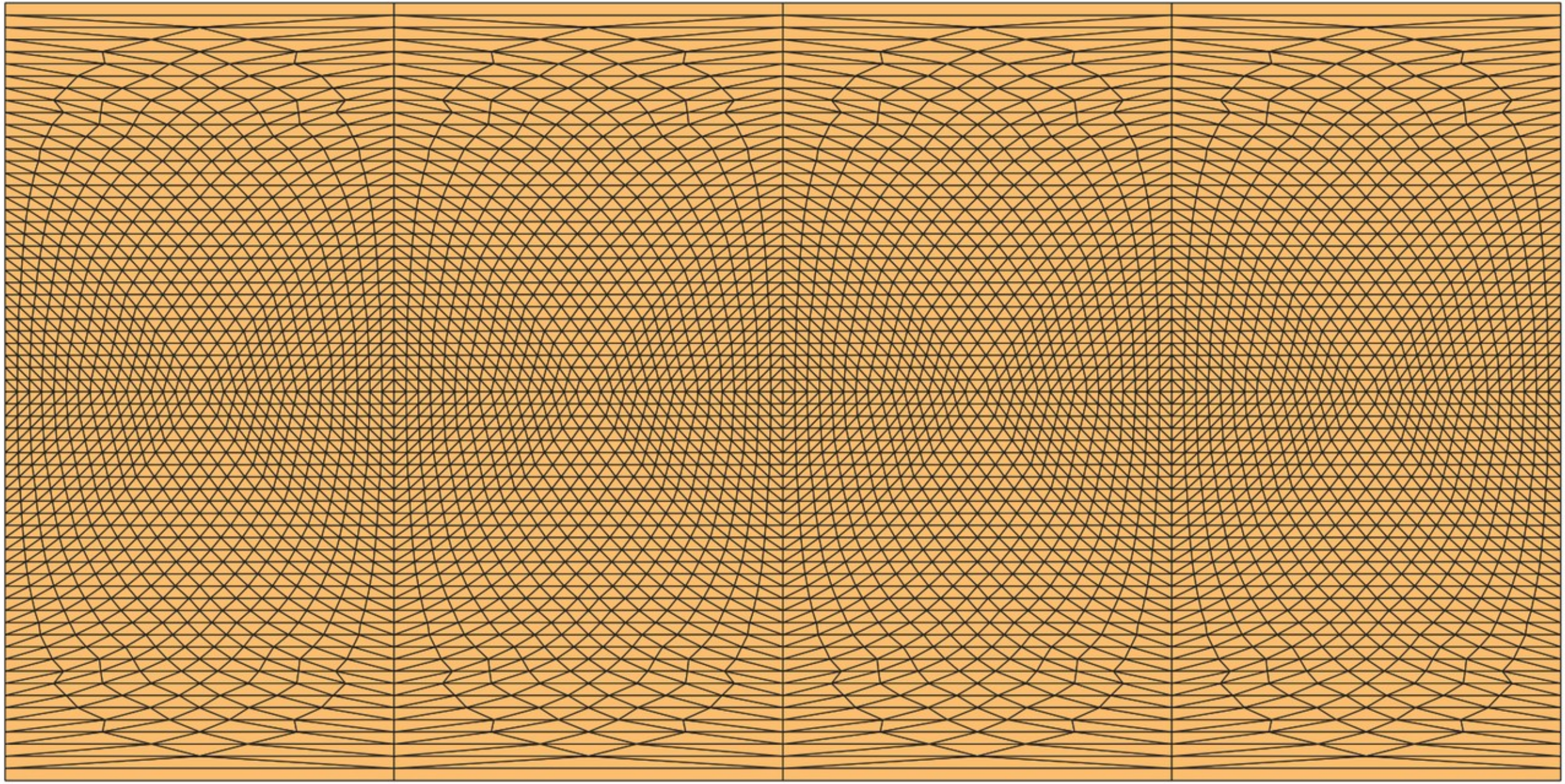








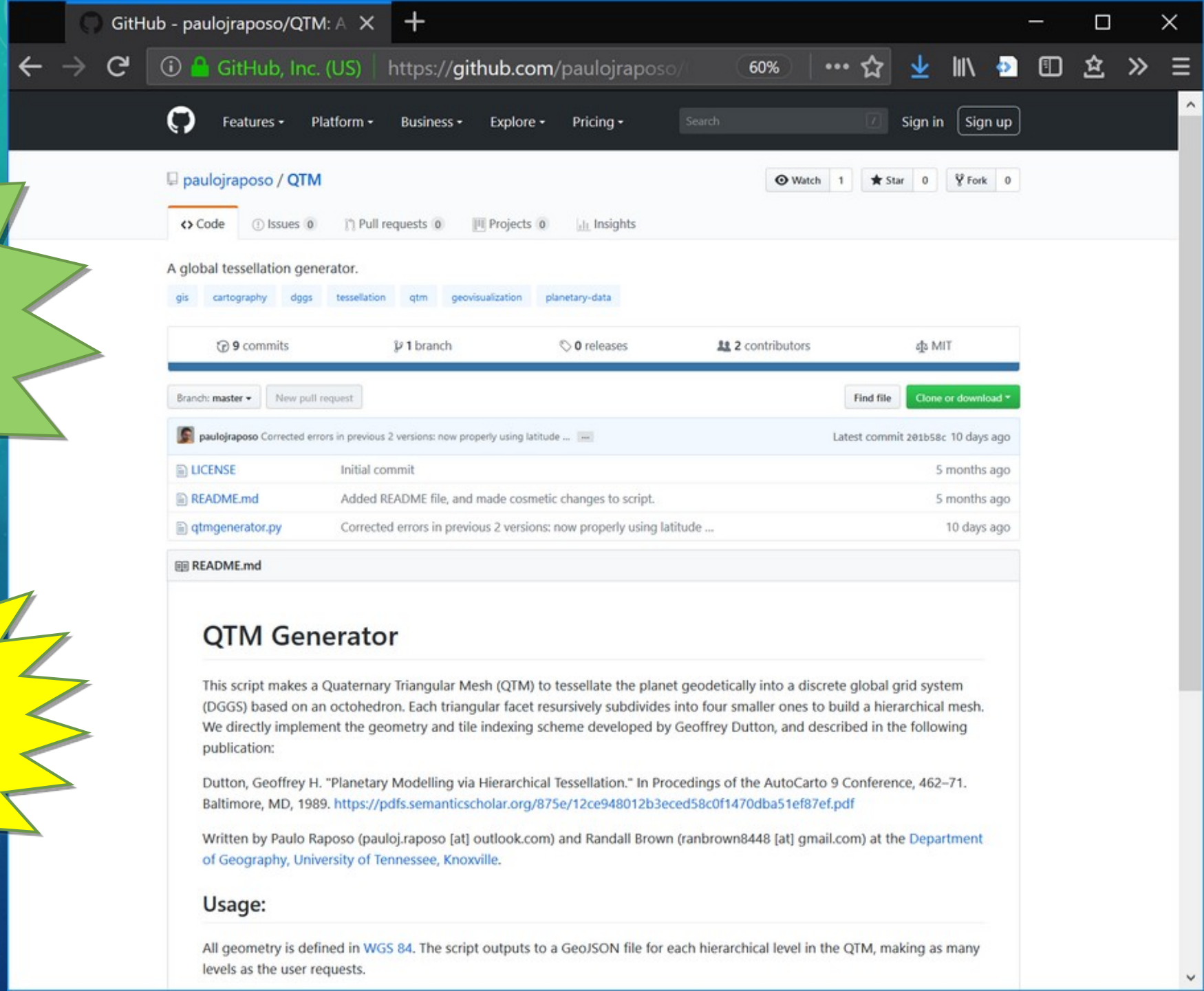


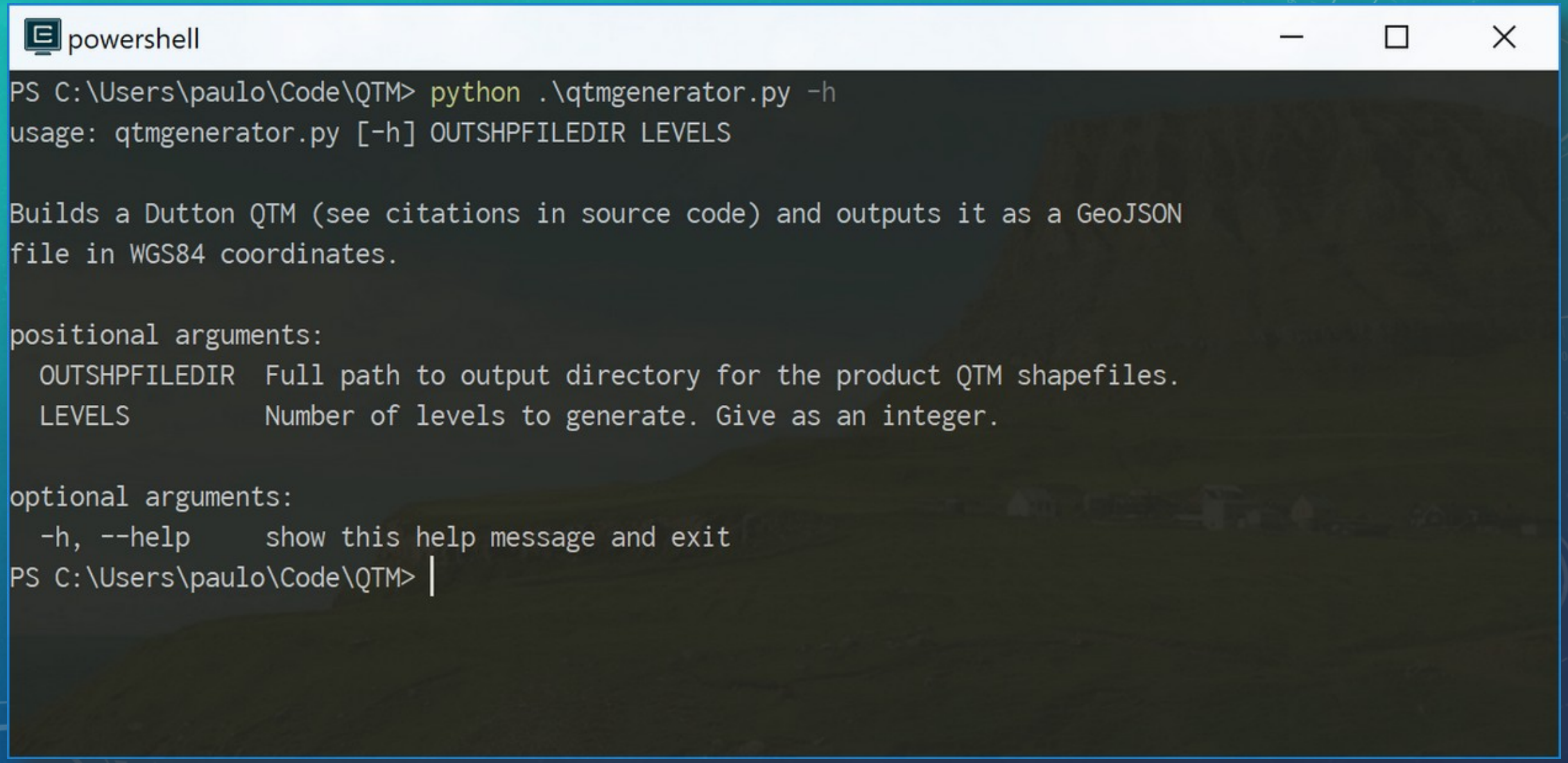


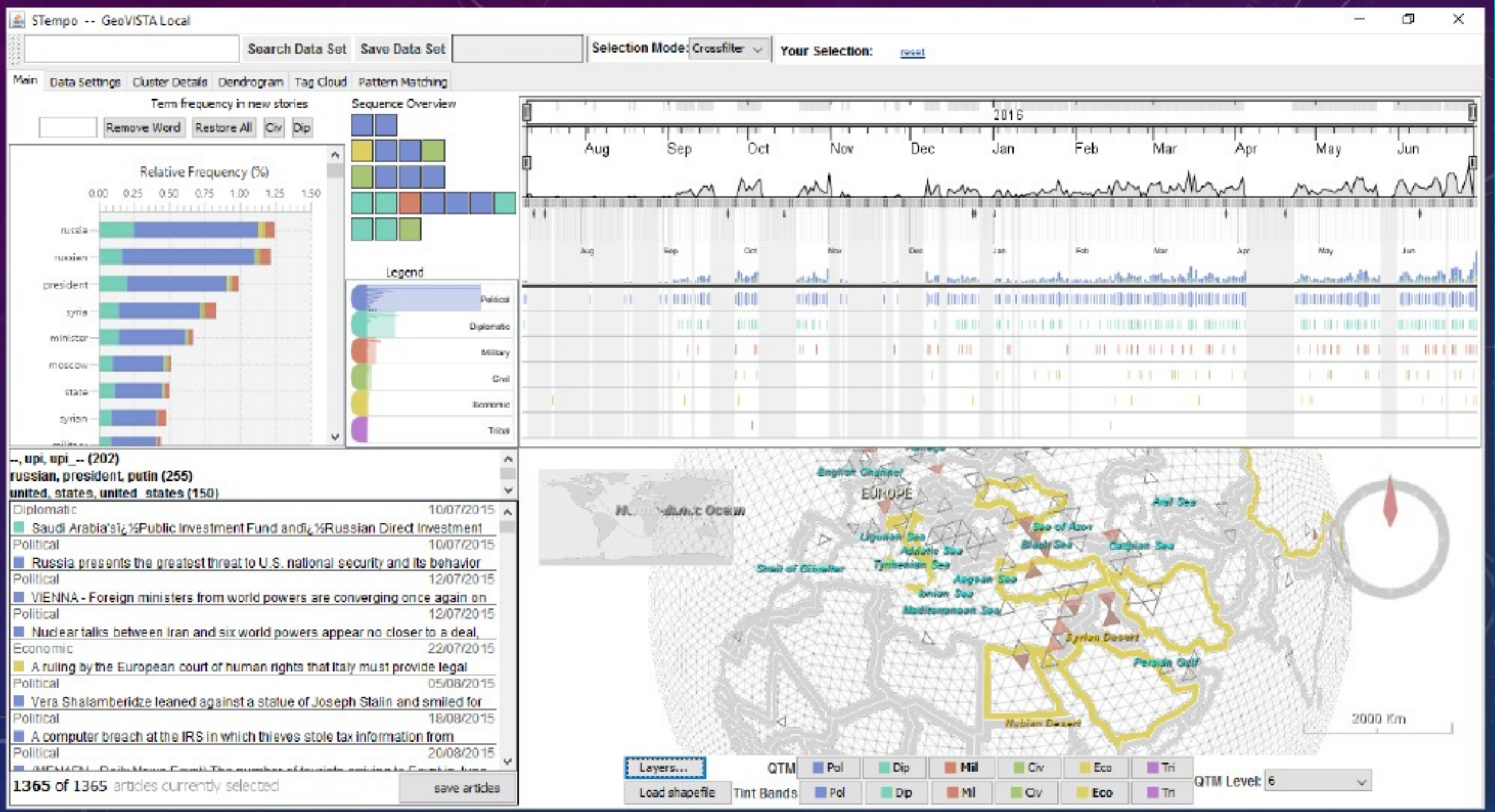
https://paulojraposo.github.io/pages/WorldWindQTMDemo/

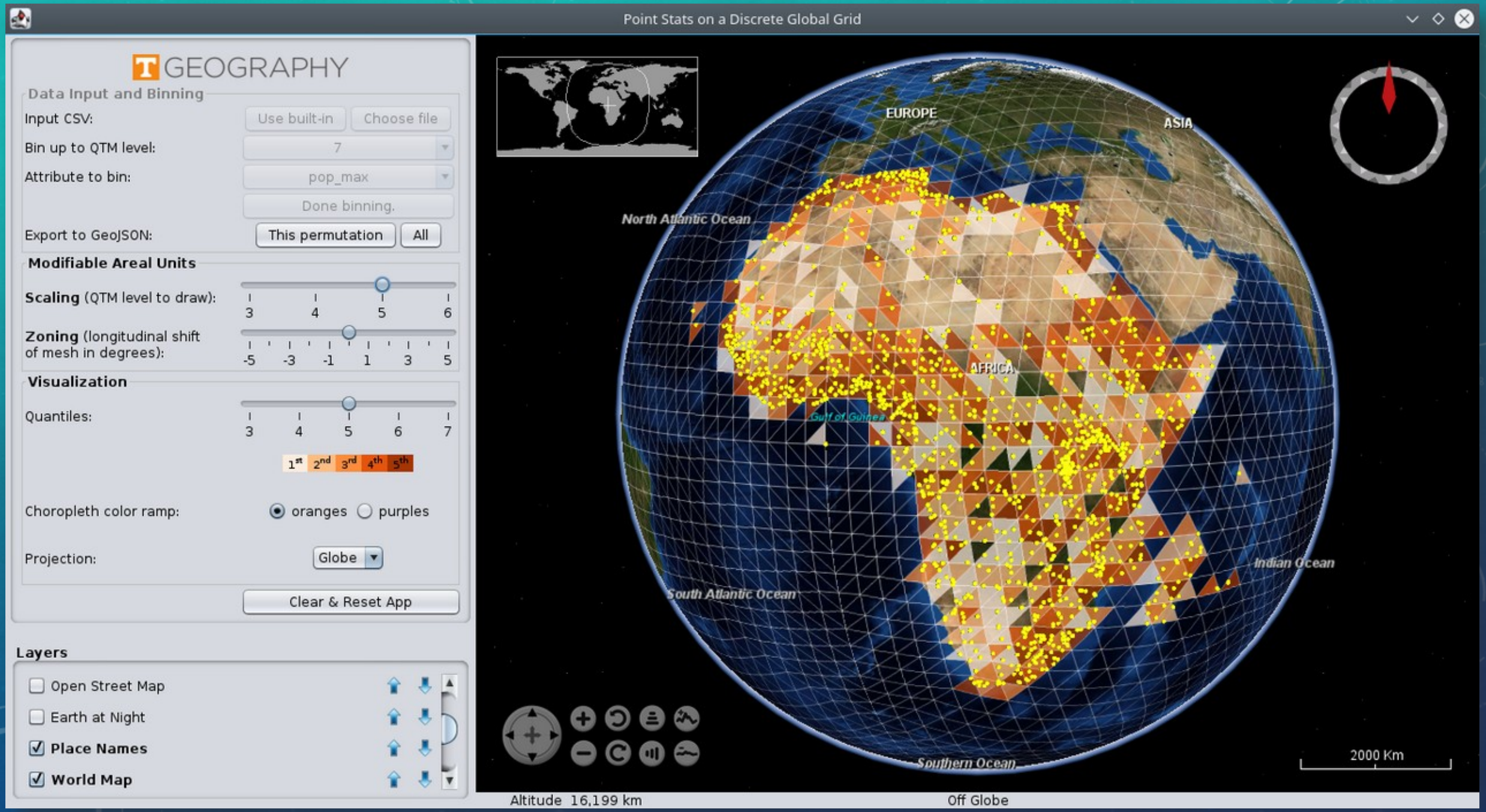
https://github.com/paulojraposo/QTM

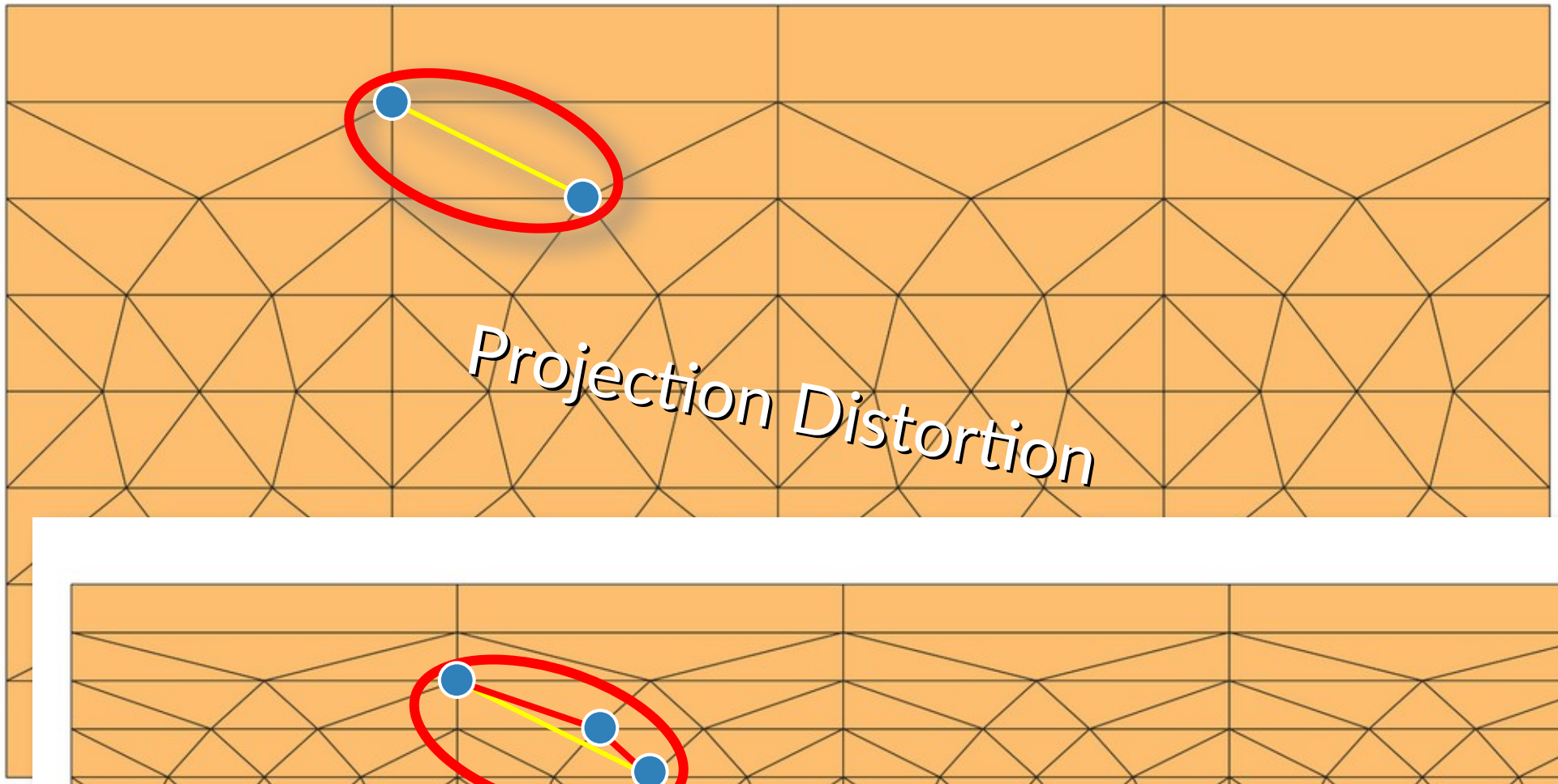
NEW!
Open-source!
Wow!

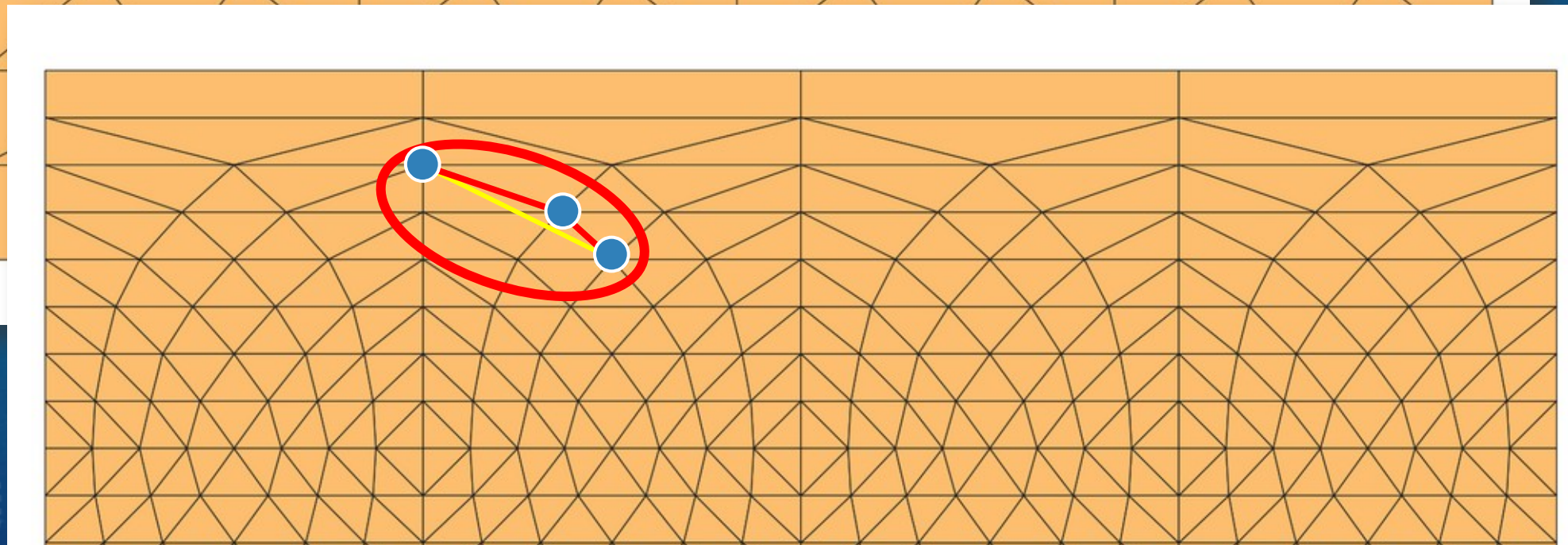



powershell
PS C:\Users\paulo\Code\QTM> python .\qtmgenerator.py -h
usage: qtmgenerator.py [-h] OUTSHPFILEDIR LEVELS
Builds a Dutton QTM (see citations in source code) and outputs it as a GeoJSON
file in WGS84 coordinates.
positional arguments:
OUTSHPFILEDIR Full path to output directory for the product QTM shapefiles.
LEVELS Number of levels to generate. Give as an integer.
optional arguments:
-h, --help show this help message and exit
PS C:\Users\paulo\Code\QTM>

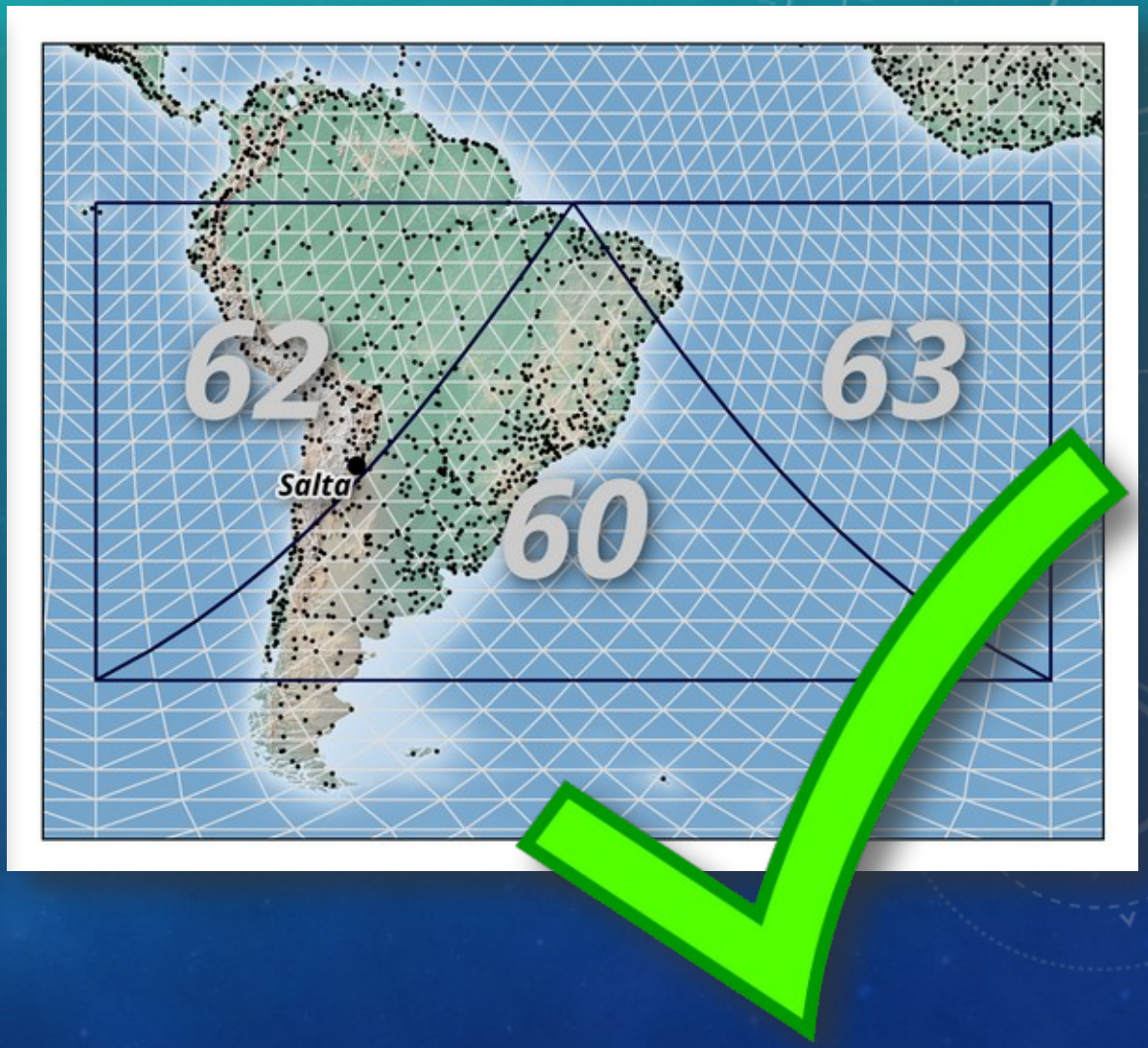

STempo -- GeoVISTA Local
Search Data Set
Save Data Set
Selection Mode: Crossfilter
Your Selection:
reset
Main
Data Settings
Cluster Details
Dendrogram
Tag Cloud
Pattern Matching
Term frequency in new stories
Remove Word
Restore All
Civ
Dip
Relative Frequency (%)
0.00 0.25 0.50 0.75 1.00 1.25 1.50
russia
russian
president
syria
minister
moscow
state
syrian
Sequence Overview
Legend
Political
Diplomatic
Military
Civil
Economic
Tribal
2016
Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
--, upi, upi_-- (202)
russian, president, putin (255)
united, states, united states (150)
Diplomatic 10/07/2015
Saudi Arabia's sï¿½Public Investment Fund andï¿½Russian Direct Investment
Political 10/07/2015
Russia presents the greatest threat to U.S. national security and its behavior
Political 12/07/2015
VIENNA - Foreign ministers from world powers are converging once again on
Political 12/07/2015
Nuclear talks between Iran and six world powers appear no closer to a deal,
Economic 22/07/2015
A ruling by the European court of human rights that Italy must provide legal
Political 05/08/2015
Vera Shalamberidze leaned against a statue of Joseph Stalin and smiled for
Political 18/08/2015
A computer breach at the IRS in which thieves stole tax information from
Political 20/08/2015
1365 of 1365 articles currently selected
save articles
English Channel
EUROPE
Aral Sea
Sea of Azov
Black Sea
Caspian Sea
Ligurian Sea
Adriatic Sea
Tyrrhenian Sea
Strait of Gibraltar
Aegean Sea
Ionian Sea
Mediterranean Sea
Syrian Desert
Persian Gulf
Nubian Desert
2000 Km
Layers...
Load shapefile
QTM
Pol
Dip
Mil
Civ
Eco
Tri
Tint Bands
QTM Level: 6


Point Stats on a Discrete Global Grid
GEOGRAPHY
Data Input and Binning
Input CSV:
Use built-in
Choose file
Bin up to QTM level:
7
Attribute to bin:
pop_max
Done binning.
Export to GeoJSON:
This permutation
All
Modifiable Areal Units
Scaling (QTM level to draw):
3 4 5 6
Zoning (longitudinal shift of mesh in degrees):
-5 -3 -1 1 3 5
Visualization
Quantiles:
3 4 5 6 7
1st 2nd 3rd 4th 5th
Choropleth color ramp:
oranges
purples
Projection:
Globe
Clear & Reset App
Layers
Open Street Map
Earth at Night
Place Names
World Map
EUROPE
ASIA
North Atlantic Ocean
AFRICA
Gulf of Guinea
South Atlantic Ocean
Indian Ocean
Southern Ocean
2000 Km
Altitude 16,199 km
Off Globe

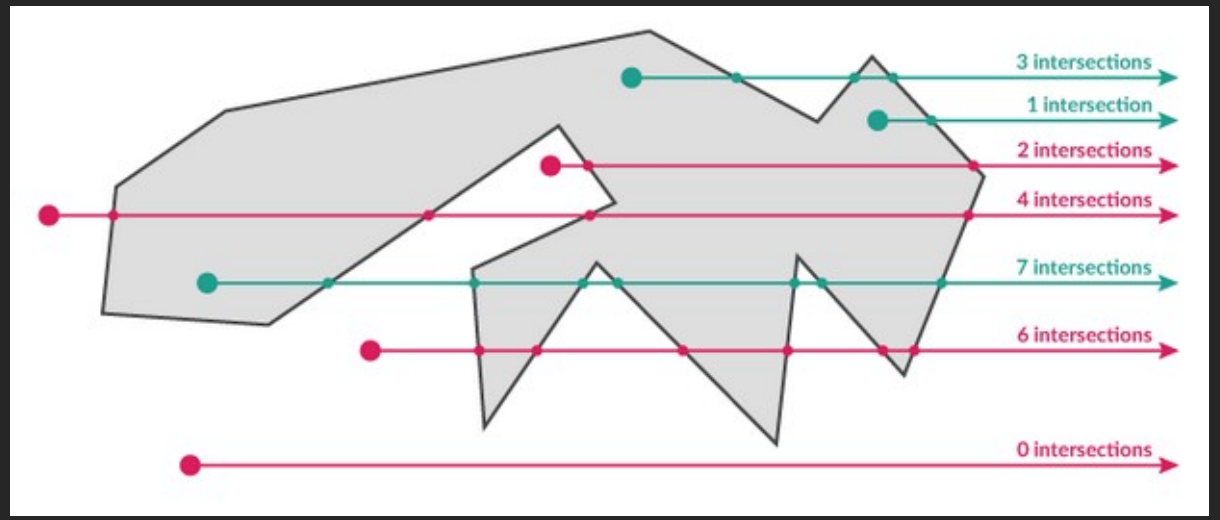

Projection Distortion

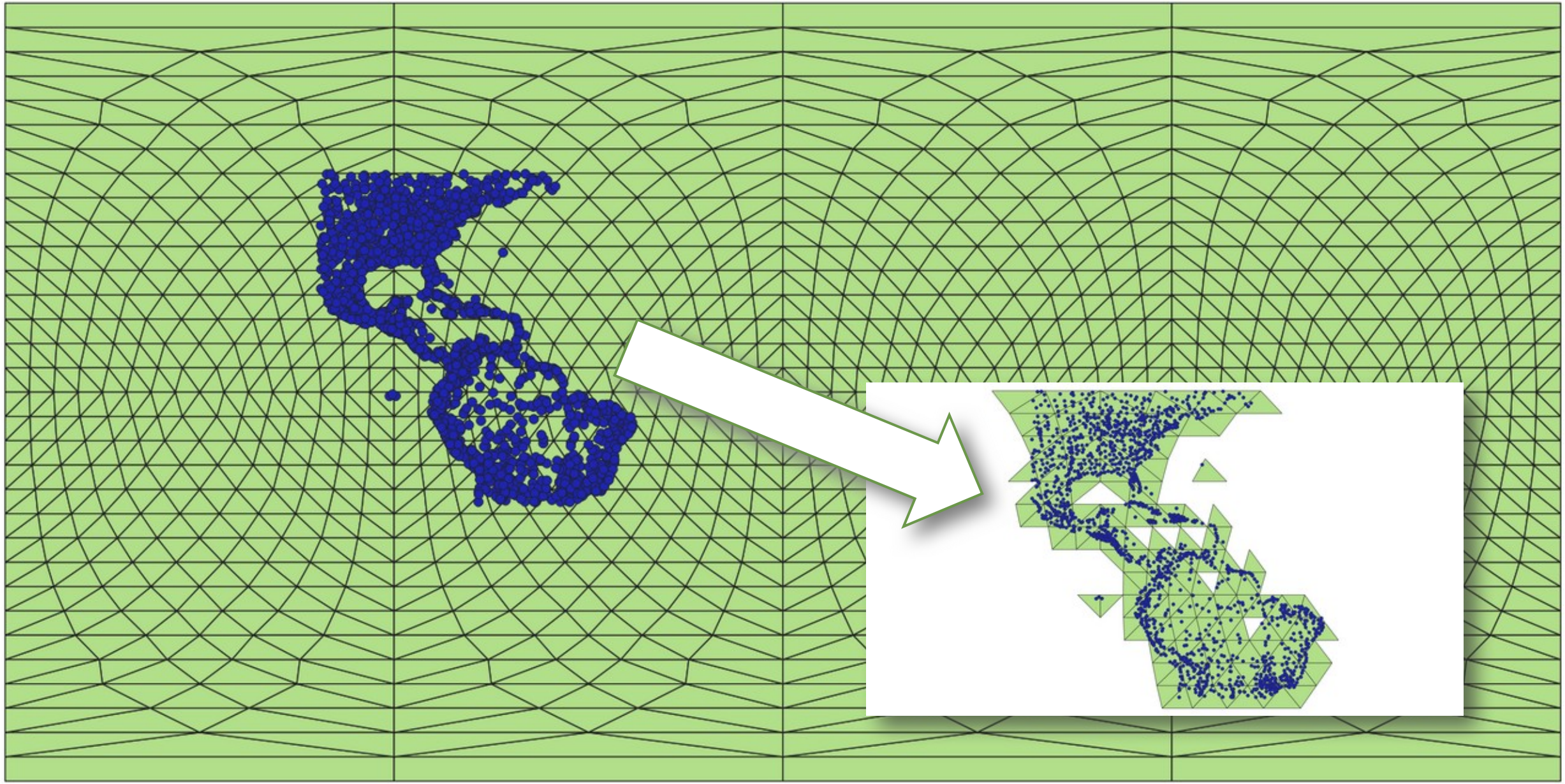


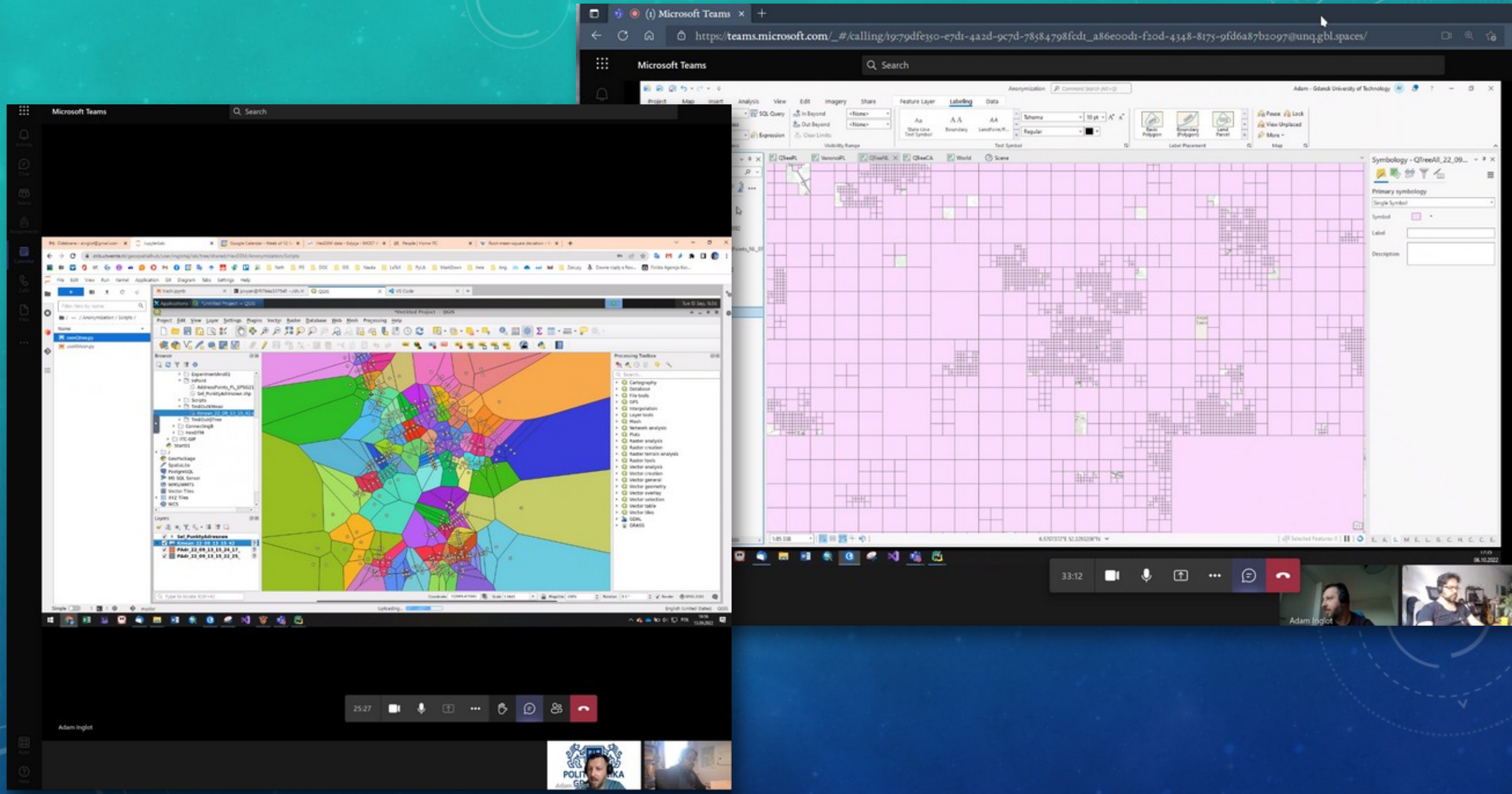

62
63
Salta
60


62
63
Salta
60

- Ray-casting point-in-polygon test
- but *geodetic!* with great and small circle arcs






(1) Microsoft Teams
https://teams.microsoft.com/_#/calling/19:79dfe350-e7d1-4a2d-9c7d-78584798fcd1_a86e00d1-f20d-4348-8175-9fd6a87b2097@unq.gbl.spaces/
Microsoft Teams
Search
33:12
Adam Inglot
Microsoft Teams
Search
25:27
Adam Inglot

Thanks!