3D Printing Applications in Surveying and Forestry
A Beginners Guide

Oregon GNSS Users Group–
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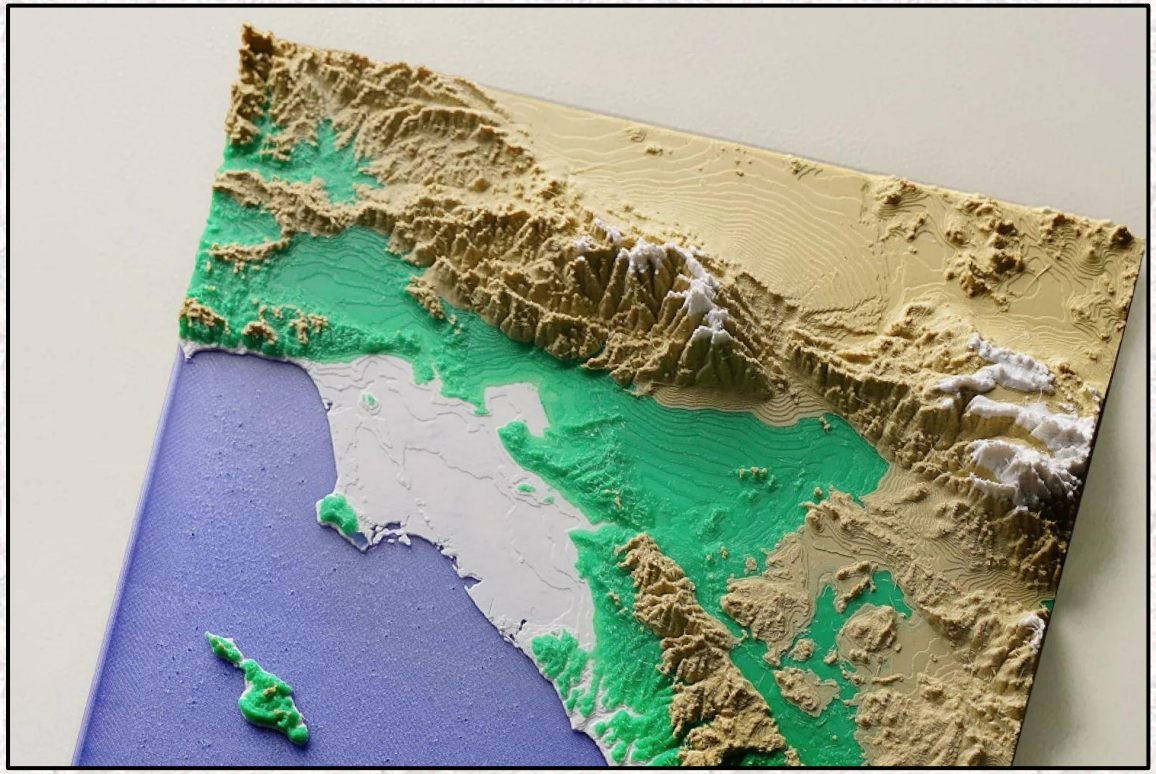


Review: What is 3D Printing?

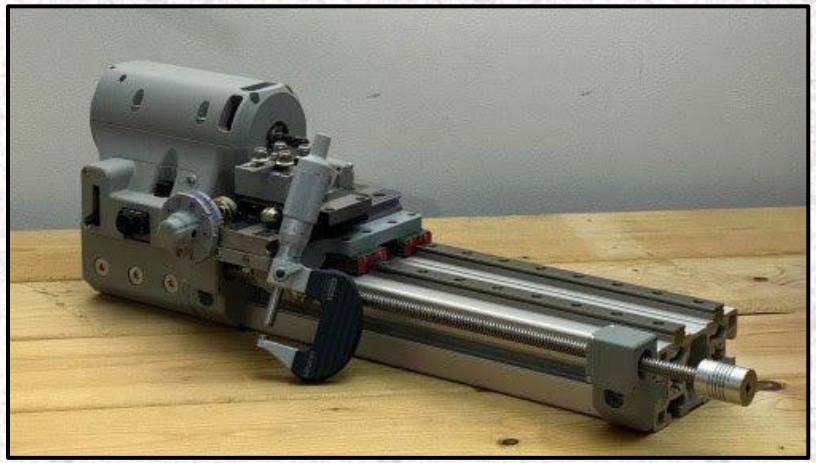
- **3D printing is a process of making three-dimensional objects from digital models by depositing layers of material on top of each other.**
  - **Also known as additive manufacturing.**
  - **Most common material is 1.75 mm plastic filament. Also:**
    - **Metal**
    - **Ceramic**
    - **Biological substances**
    - **Concrete**

History of 3D Printing

- **Stereolithography (SLA) was invented by Chuck Hull in 1984.**
  - **He founded 3D Systems**
  - **First-ever 3D printer, the SLA-1 (1987)**
- **2009 – Patents expired and 3D printing exploded**
- **Early 3D printers:**
  - **Makerbot**
  - **RepRap**

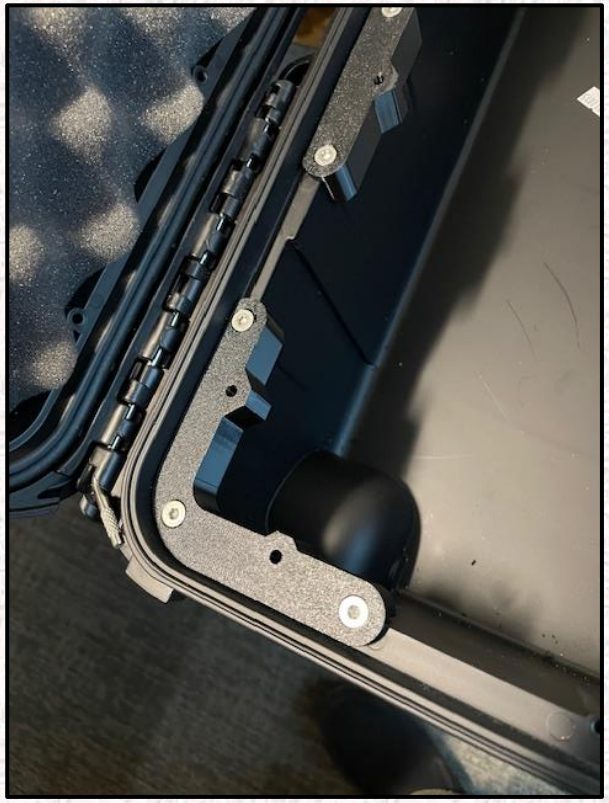
What Can Be 3D Printed?

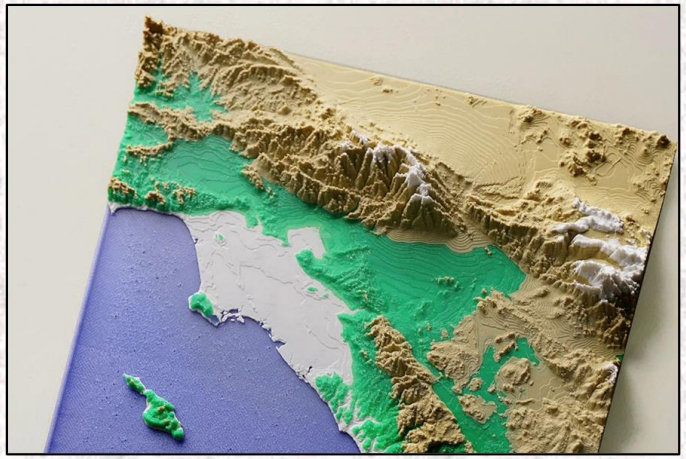
- Items made from a variety of plastic. PLA, PETG, ABS, Nylon
- Items made from metal welding
- Houses
  - Made from fiber reinforced concrete



3D Forestry/Surveying Related Print Items

- **Data collector brackets & Housings**
- **Angle Gauges For Timber Cruising**
- **Topo models**
- **Replacement parts**

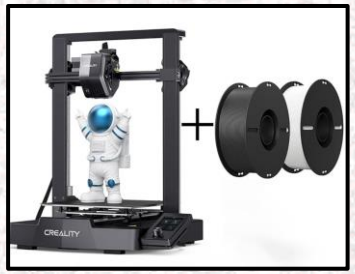


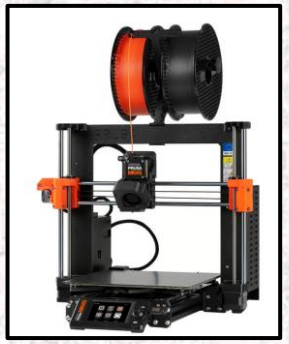


How Big Of An Object Can You Print?

- **Bambu Lab X1- Carbon: $1,099 10” x 10” x 10”**
- **Bambu Labs X1 Mini: $349 7” x 7” x 7”**
- **Creality Ender 3 V3 SE 3D: $232 8.66x8.66x9.84”**
- **Prusa MK4S 3D Printer kit: $729/$999**
  - **9.84 x 8.3 x 8.6”**

- **Buy a kit and save money?**
  - **Save $100 to $200**
  - **Expect to spend 8 plus hours for assembly**





Commercial Printing

Bambu Lab X1- Carbon

Prusa MK4's
Discovery Management

3D Print File Formats

Primary File Format: STL

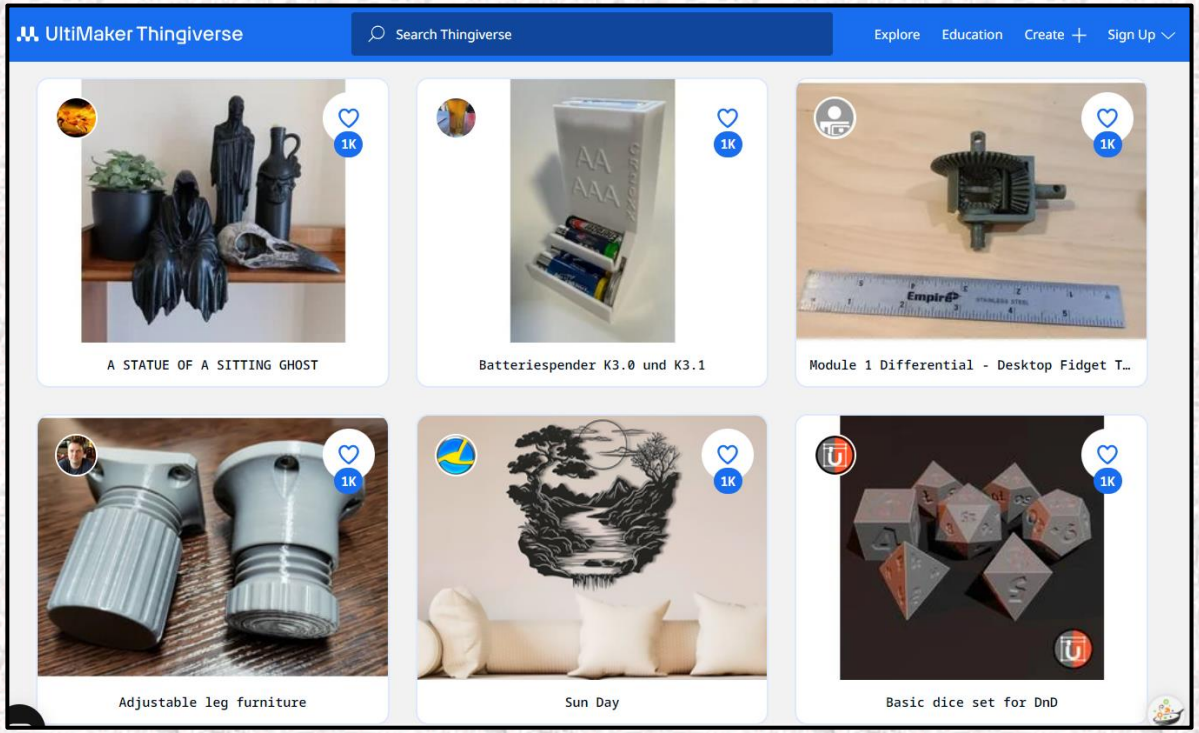
- Standard Tessellation Language or:
- Standard Triangle Language

Other Formats:

- OBJ
- X3G
- PLY
- 3MF
- AMF
- STEP

How Many STL files Are Available To Users?

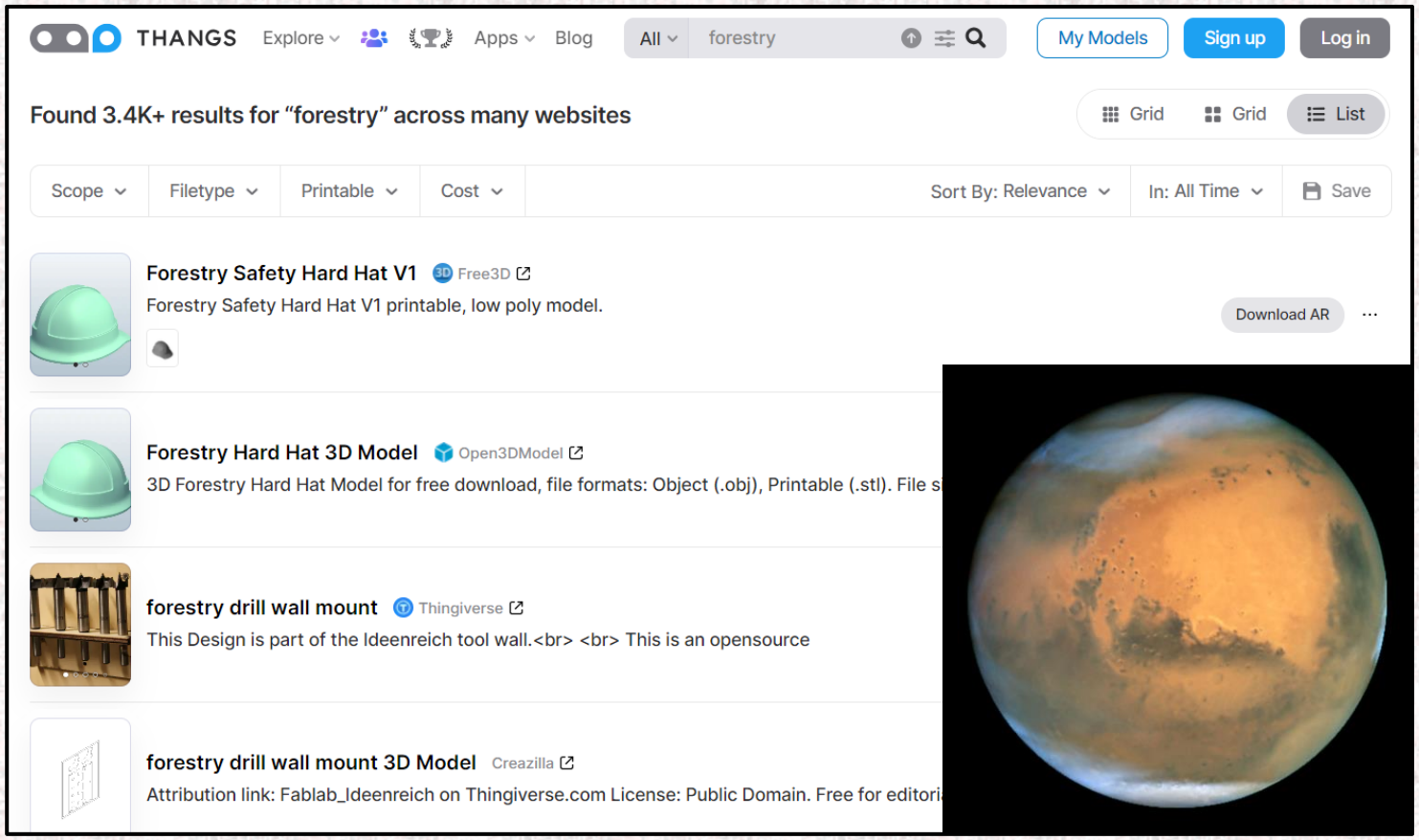
(Free or Nearly Free)



Millions!!!

3D Search Engines:

- Thangs.com
- Thingiverse.com
- Printables.com
- Cults
- Yeggi
- RankRed
- NASA
- And Dozens more



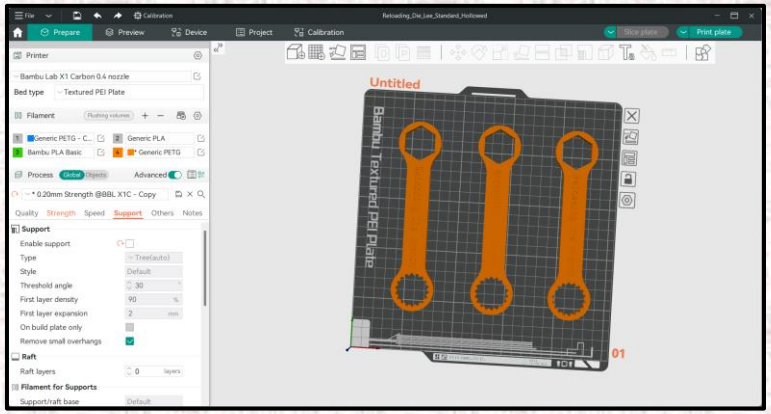
How to Use an STL File

Slicer Software Is Needed

- **Converts 3D models into printer instructions**
- **Tells the printer head where to go and what to do**
- **“slices” digital models into layers to be printed**

Slicer Programs:

- **Many are Free**
- **Often based on open-source software**



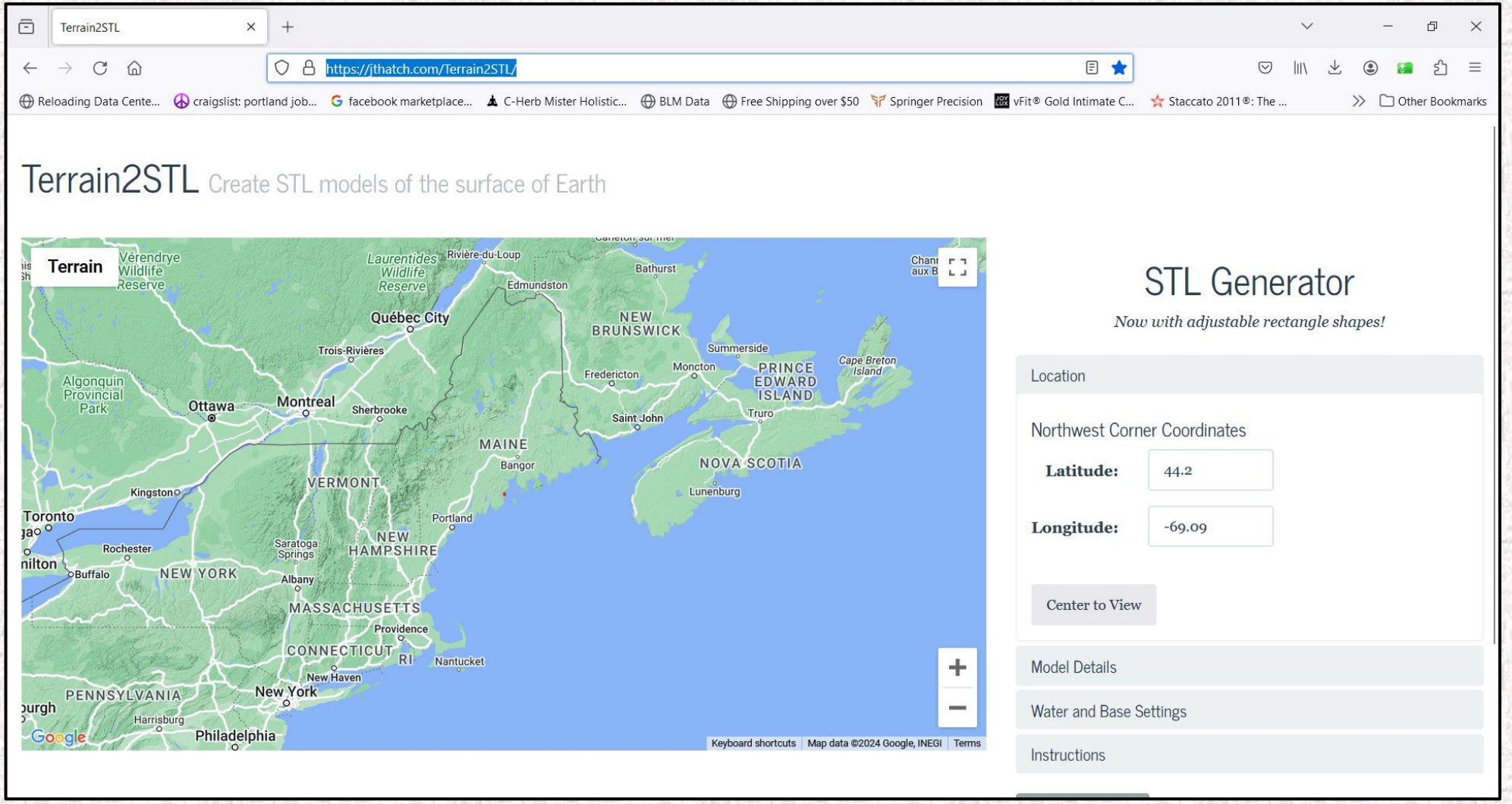
Making 3D Terrain Models

- **Terrain2STL (https://jthatch.com/Terrain2STL/)**
- **Touch Terrain (https://touchterrain.geol.iastate.edu/)**
- **QGIS DEMto3D**

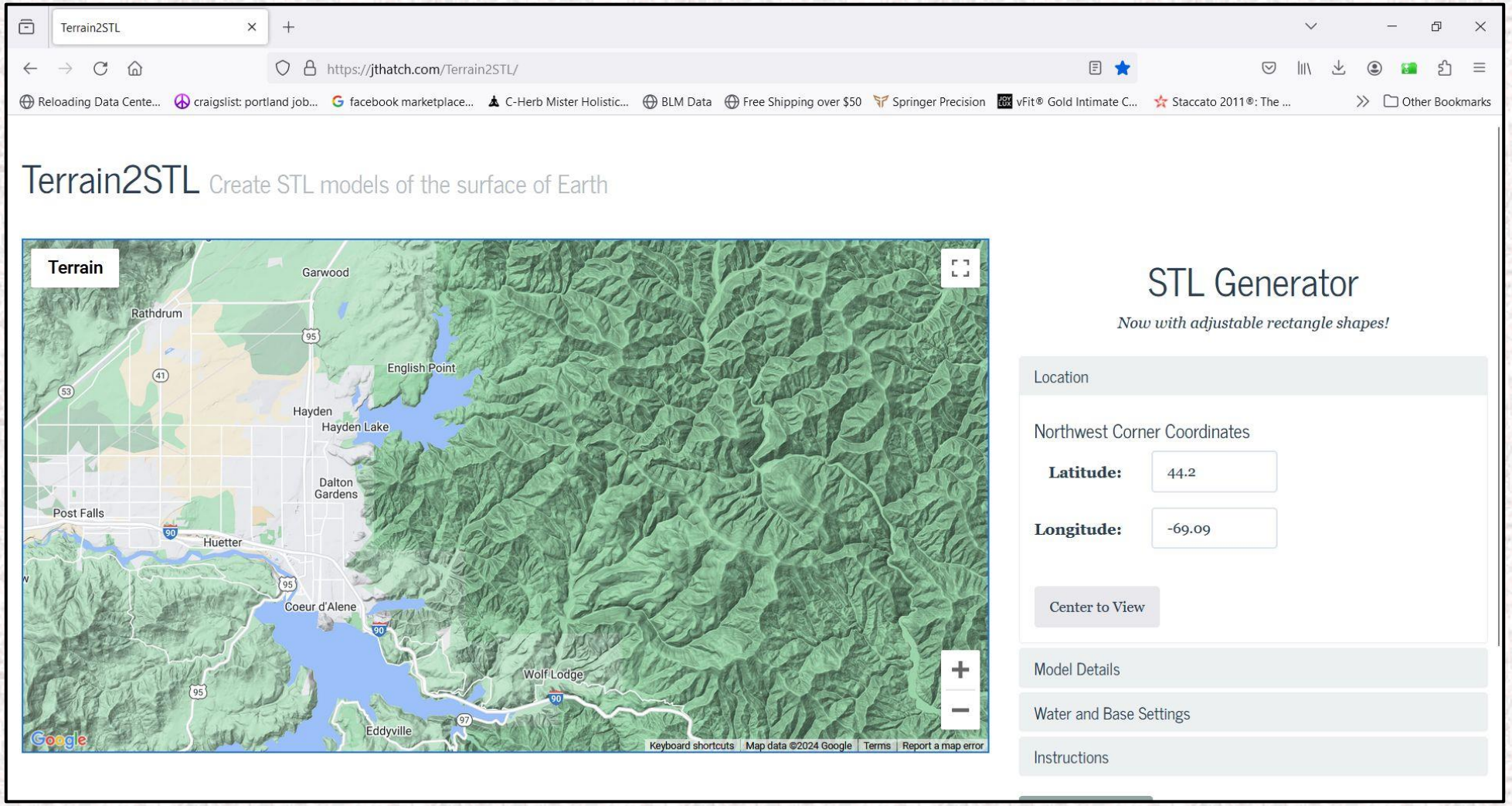
Benefits of Making a Topo Model

- **Models help people visualize topo issues better**
- **Giving someone a topo model is impressive.**
- **Topo models can help loggers position equipment when lift issues are present with cable logging.**
- **Making Topo models is very inexpensive and uses very little filament because they are hollow.**

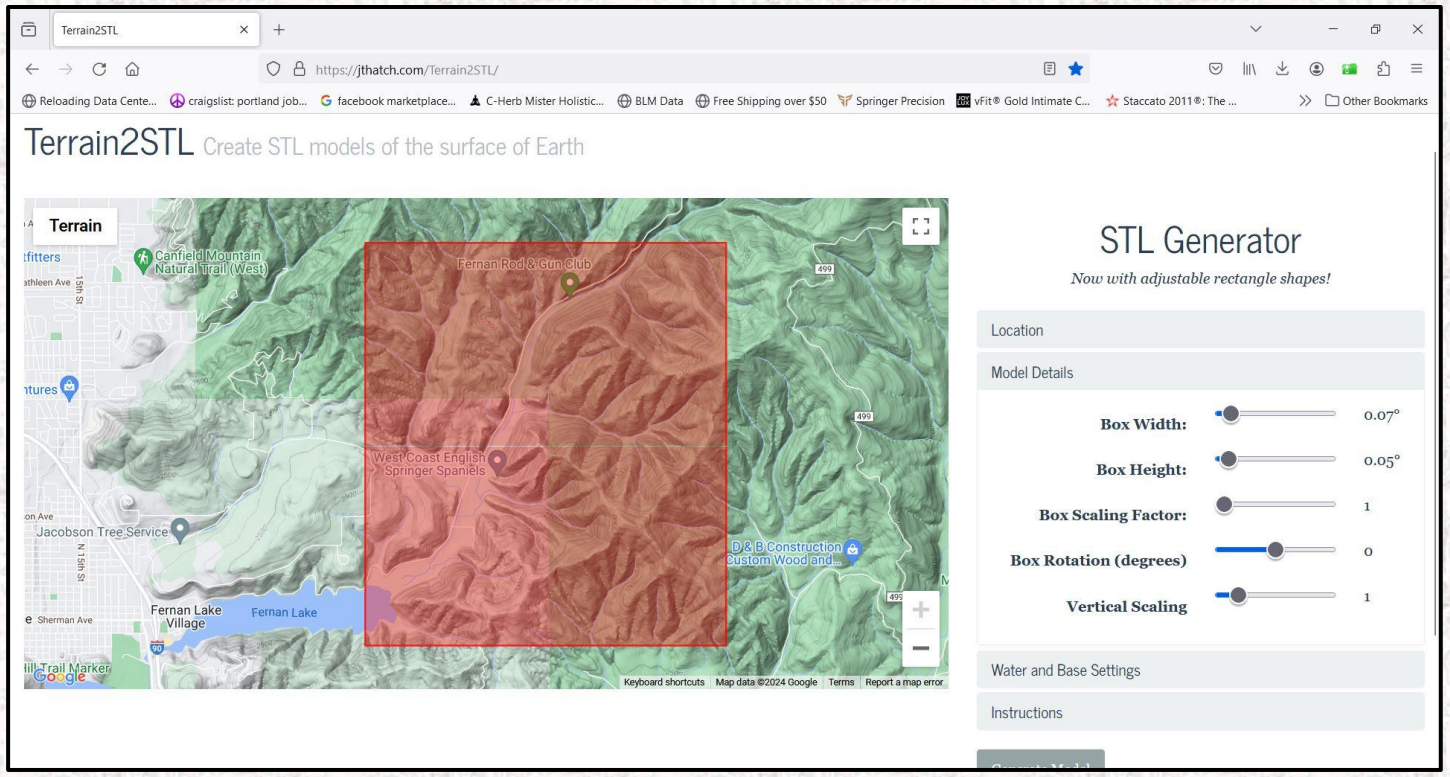
Terrain 2 STL Software

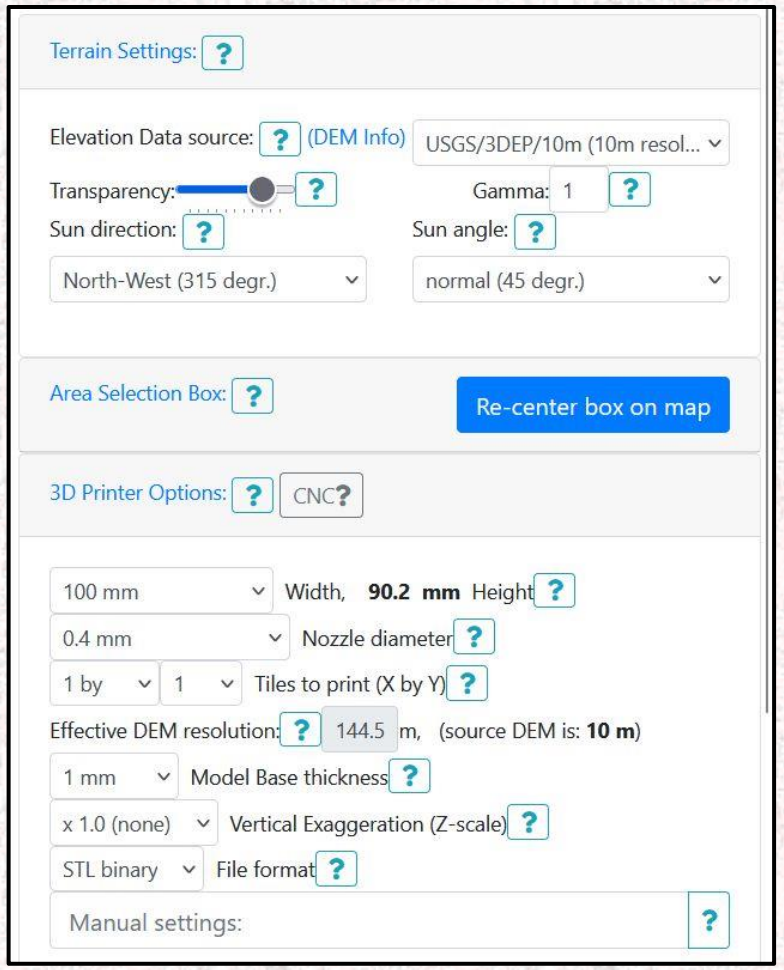


Getting Started With Terrain 2 STL

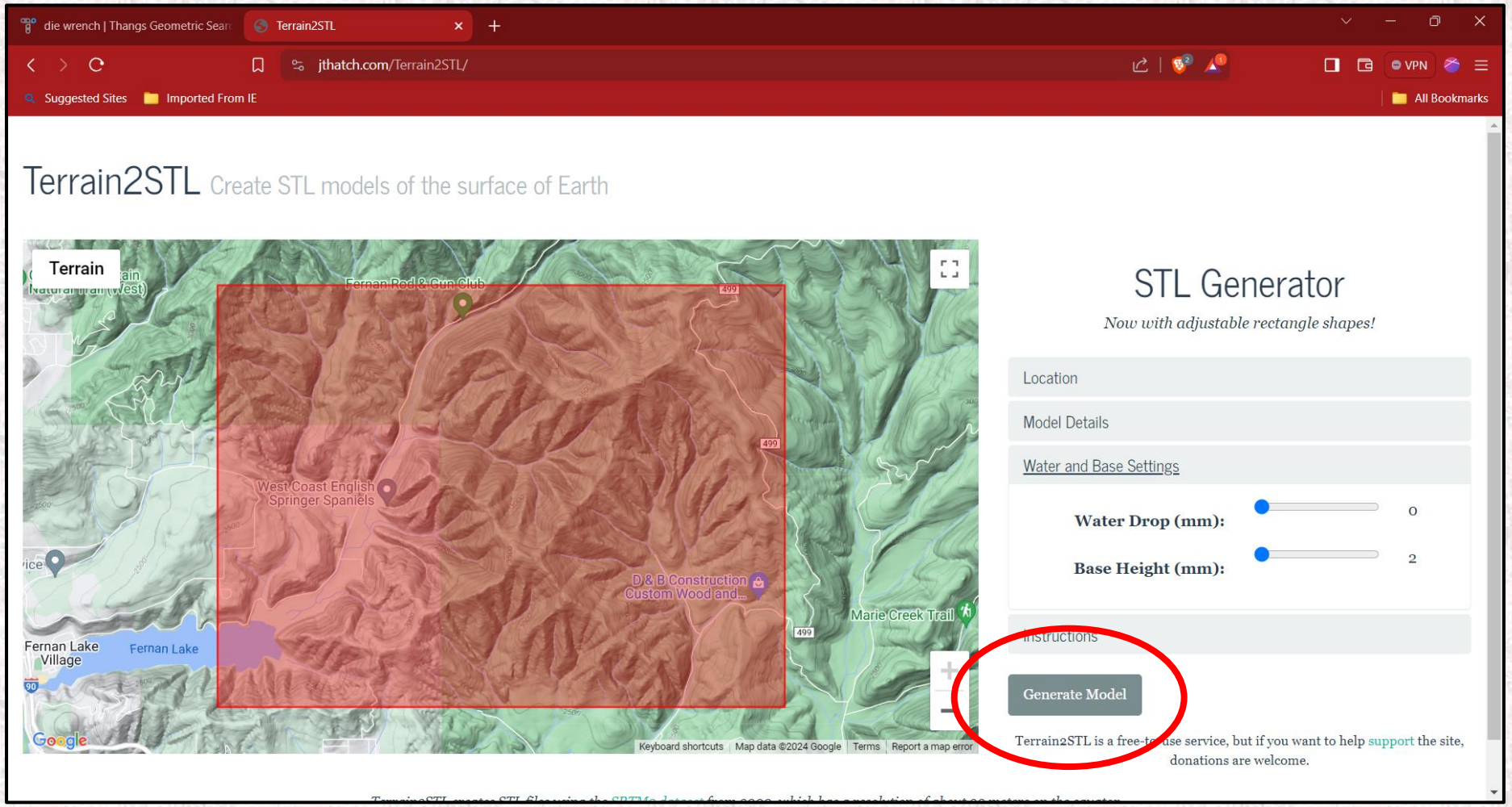


Select Your Area for Topo





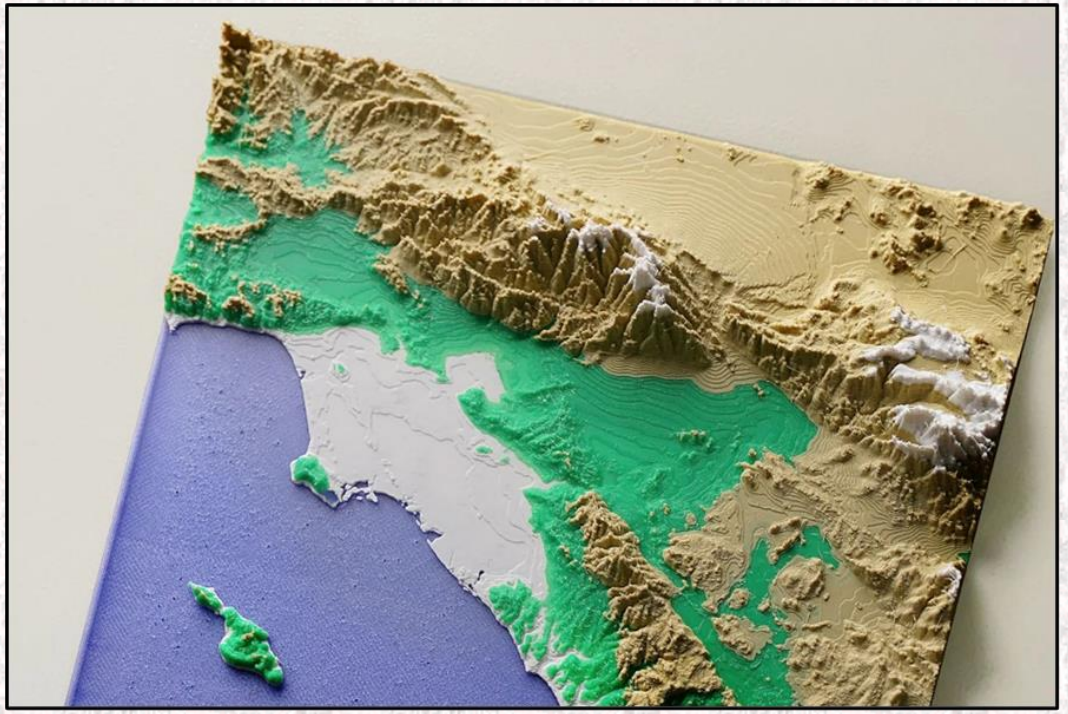
Build The STL File



Actual 3D Topo Models

Single Color

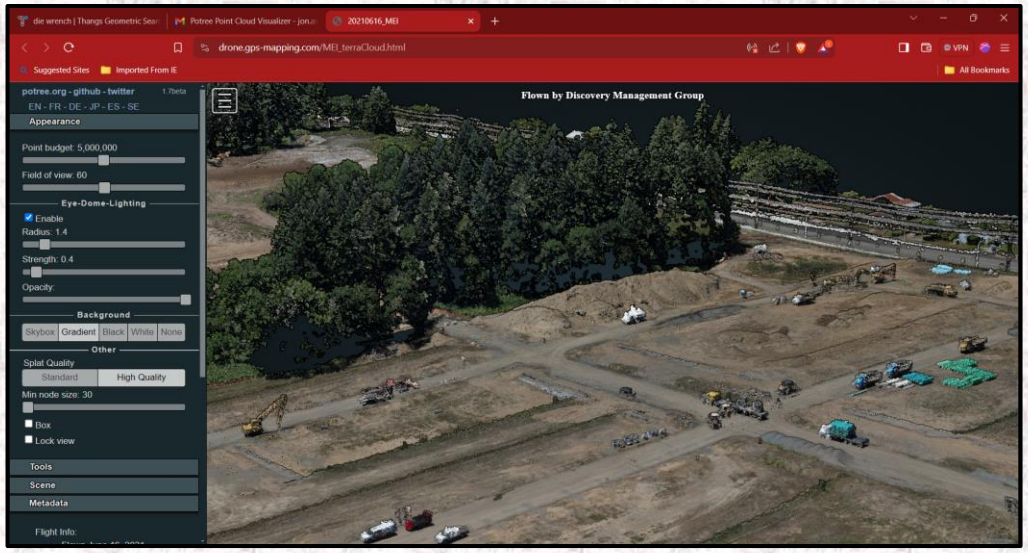
Light Color for Contours



Four Color Model

How to Improve Resolution

- **Use a Drone to Collect DEM (6” contours possible)**
- **Use survey grade GPS unit**
- **Find available high accuracy DEM files**



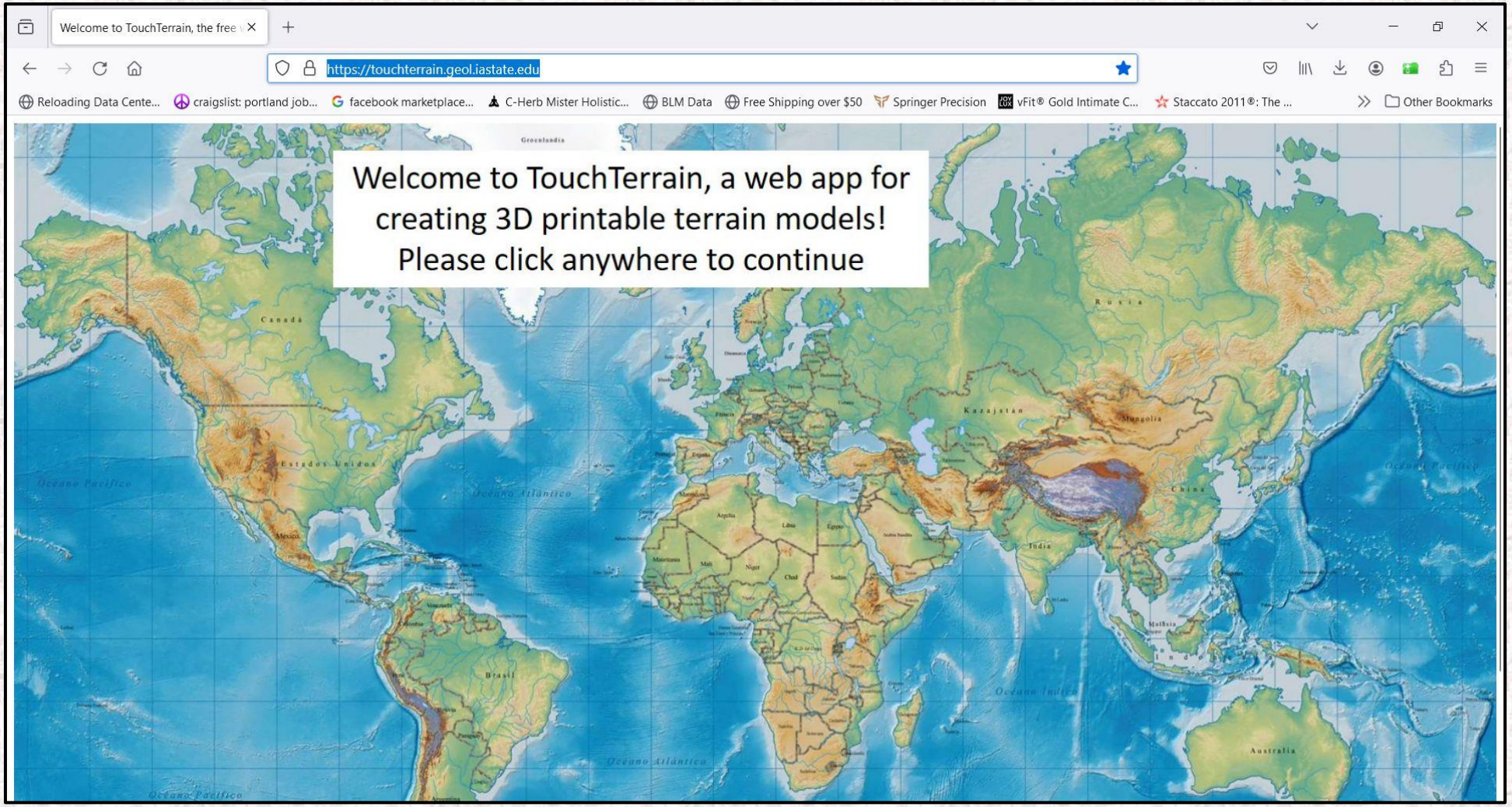
Note: These images are composed of millions of points of X,Y,Z data.

Lidar in drones offers ability to just collect ground level for better contours.

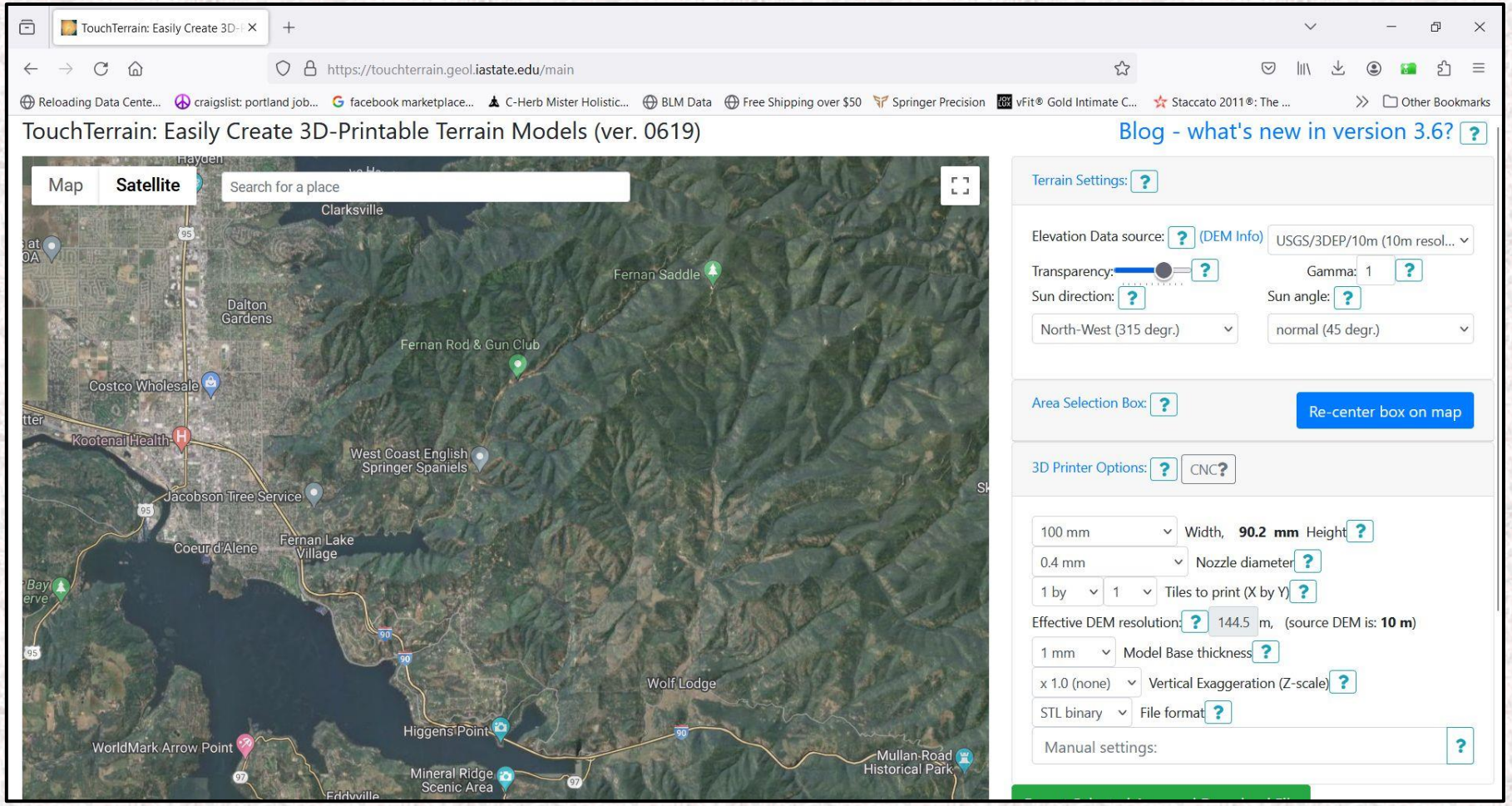
Touch Terrain Software

- **No Cost**
- **Developed by Iowa State University**
- **Terrain models available for entire world**
- **Most of US has 10 Meter DEM Data**

Getting Started with Touch Terrain

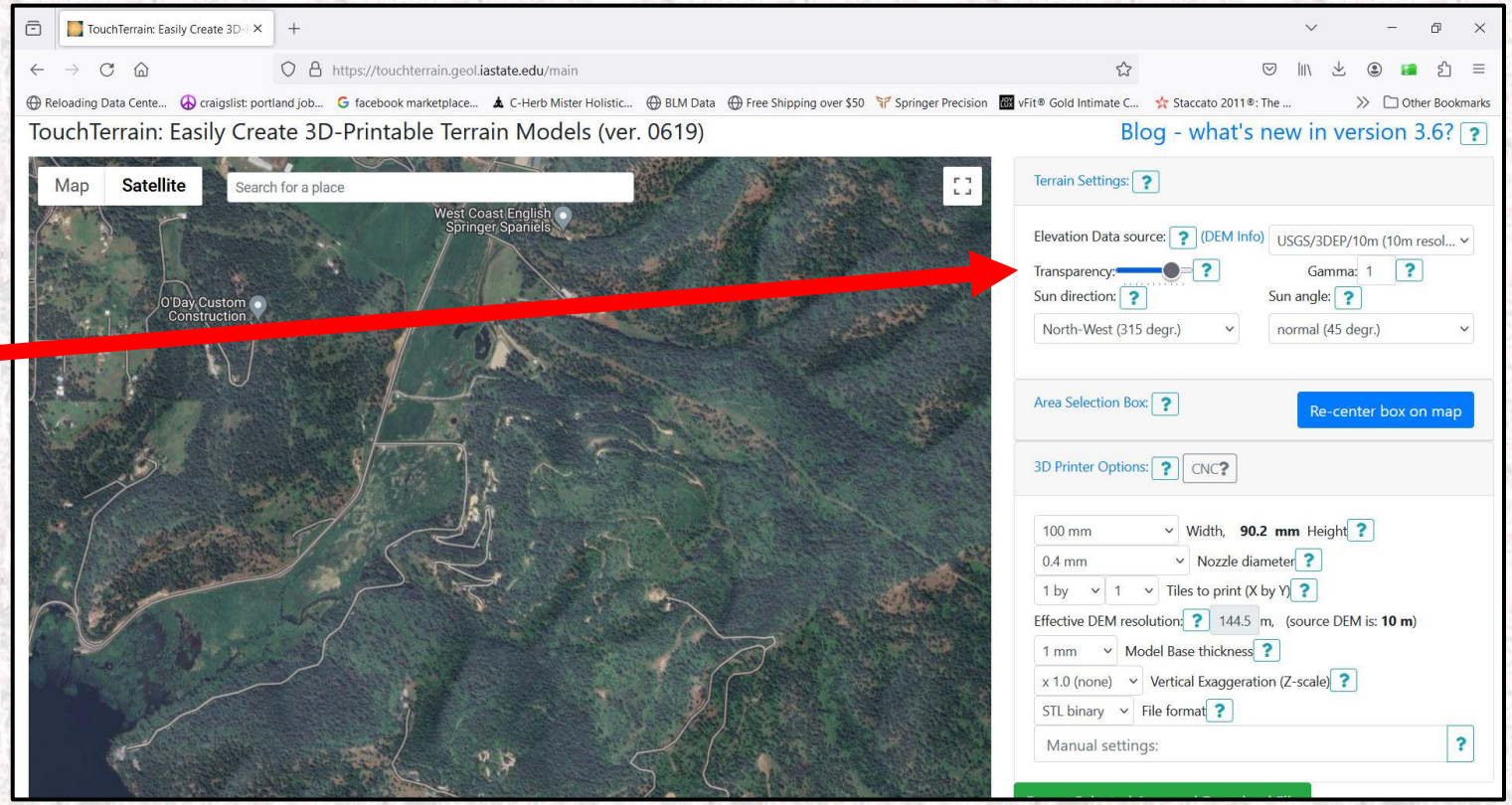


Pick Your Area

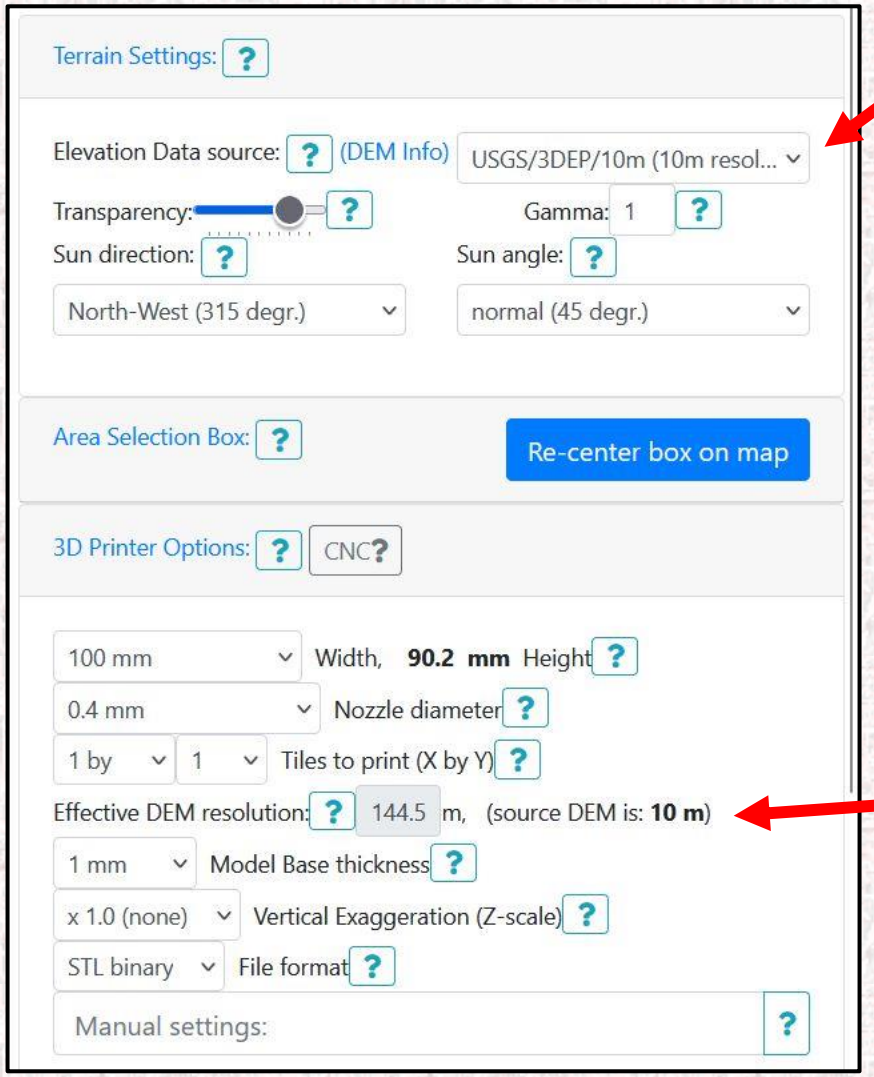


Moving & Zooming in Touch Terrain

- Use Ctrl-Scroll to zoom
- Drag mouse to pan
- Move transparency slider to go between imagery and hillshade



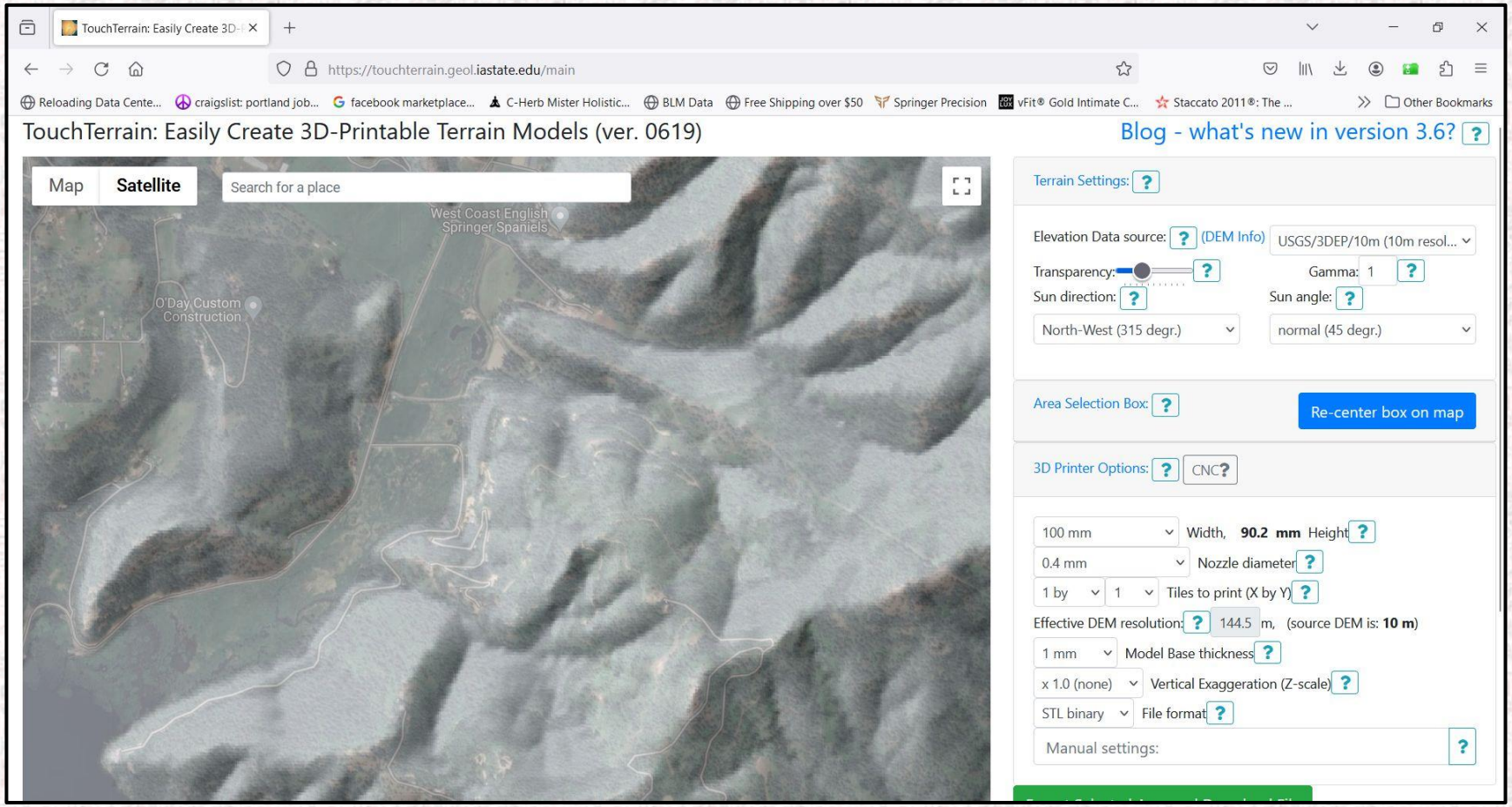
Settings



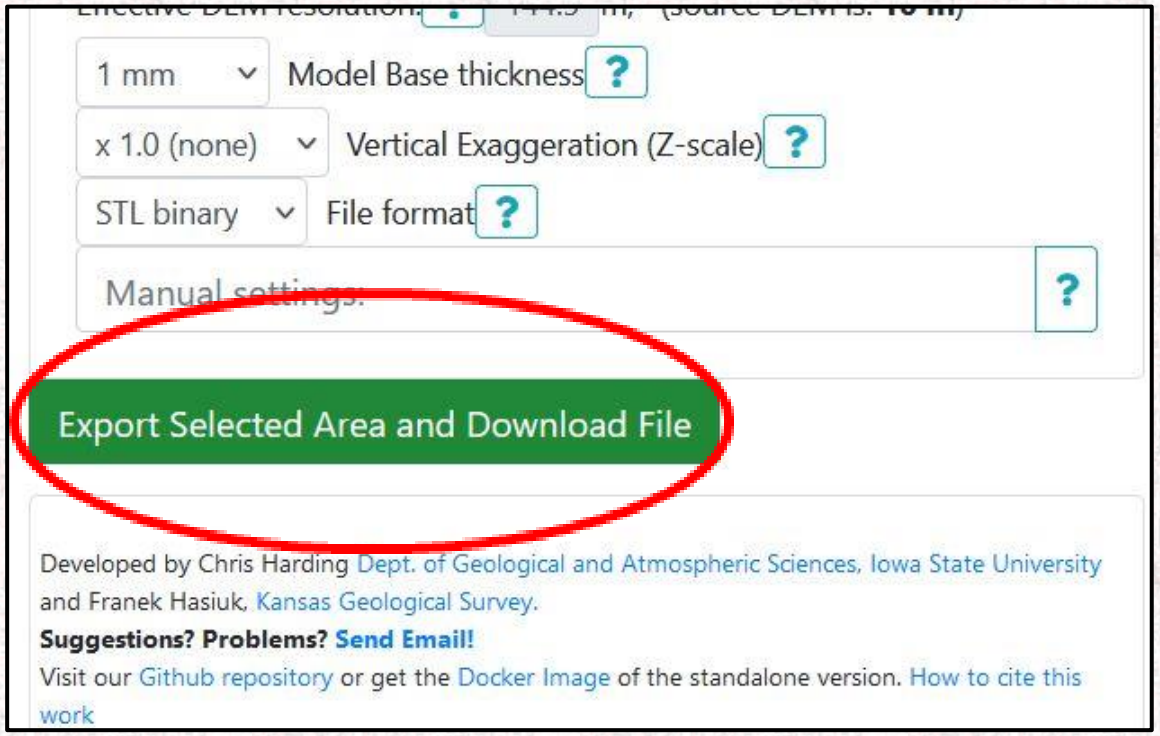
Elevation Data Source

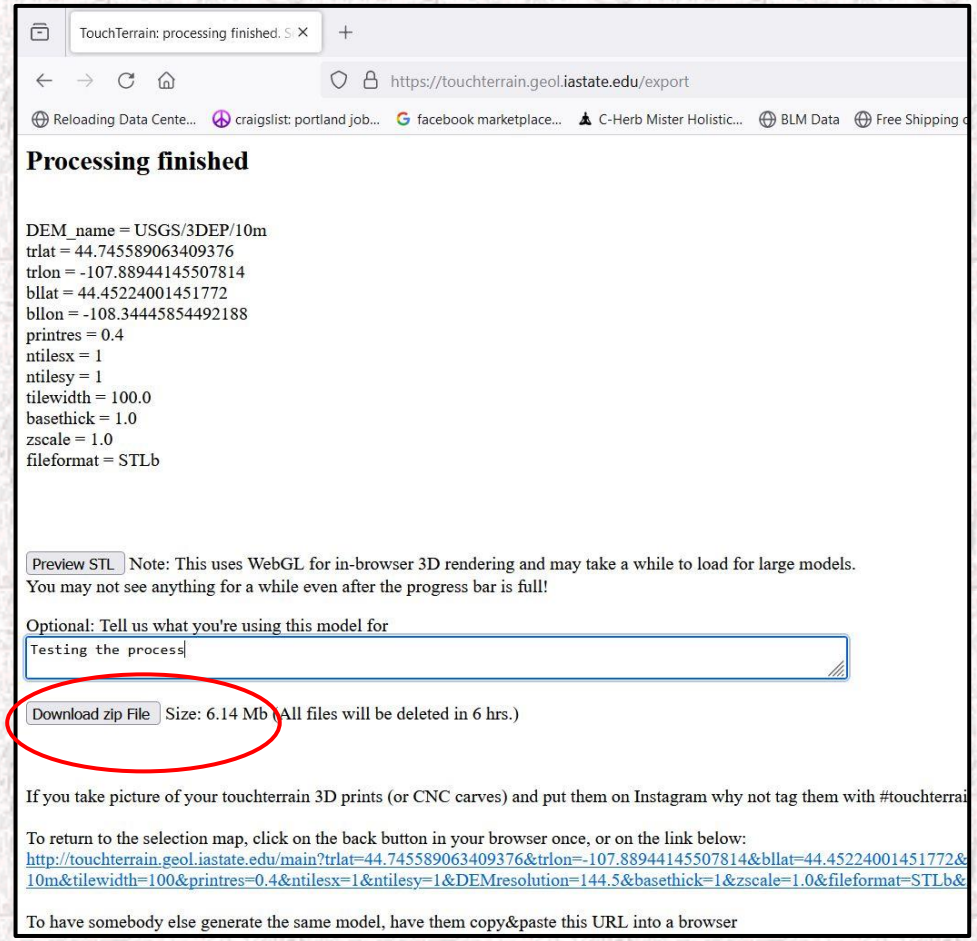
Source Digital Elevation Model 10 Meters

Hillshade Imagery

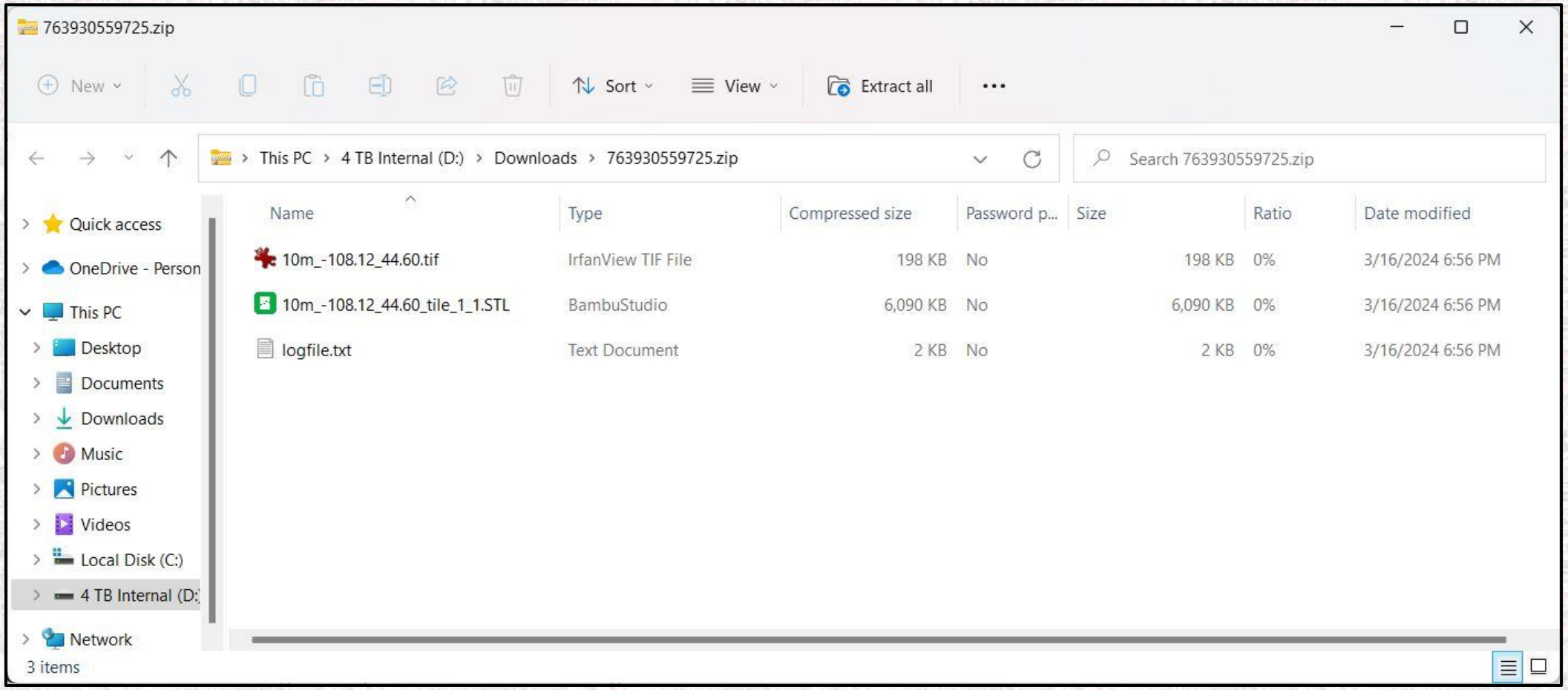


You Are Ready to Make The STL File



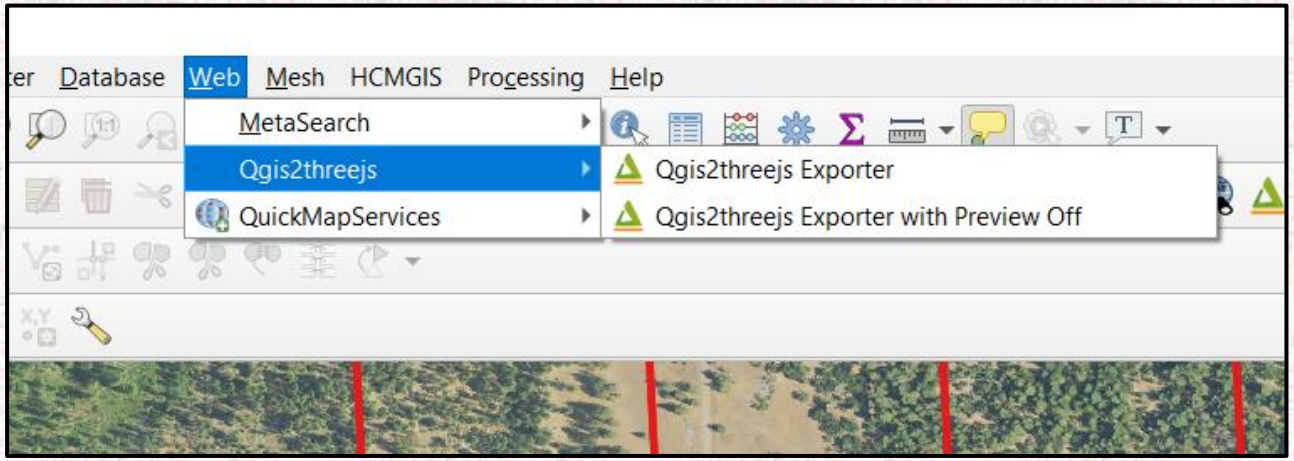


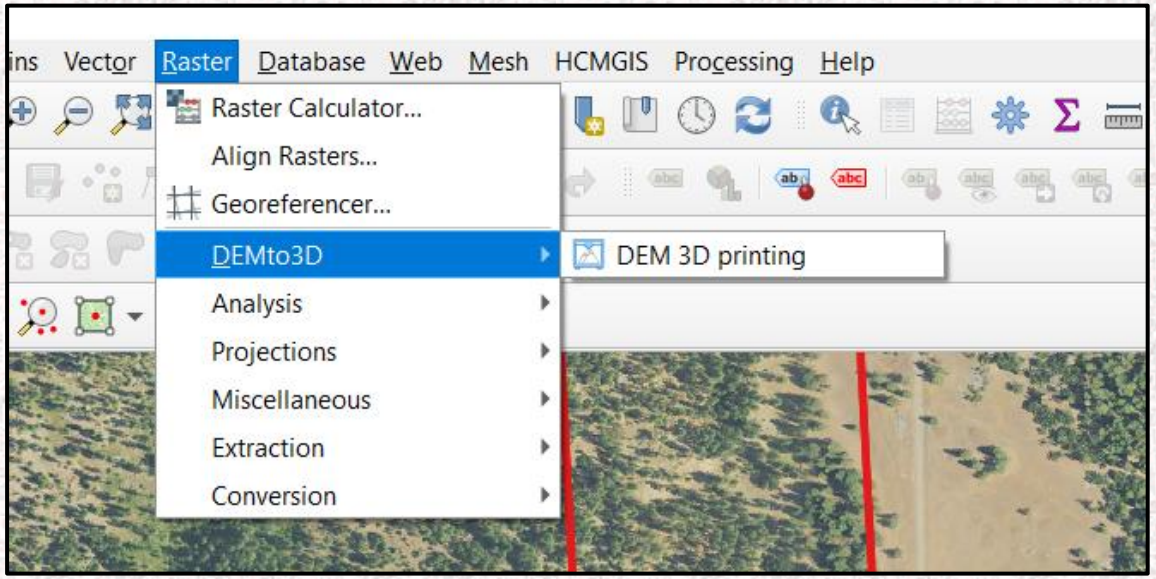
Remember Where You Downloaded the File!



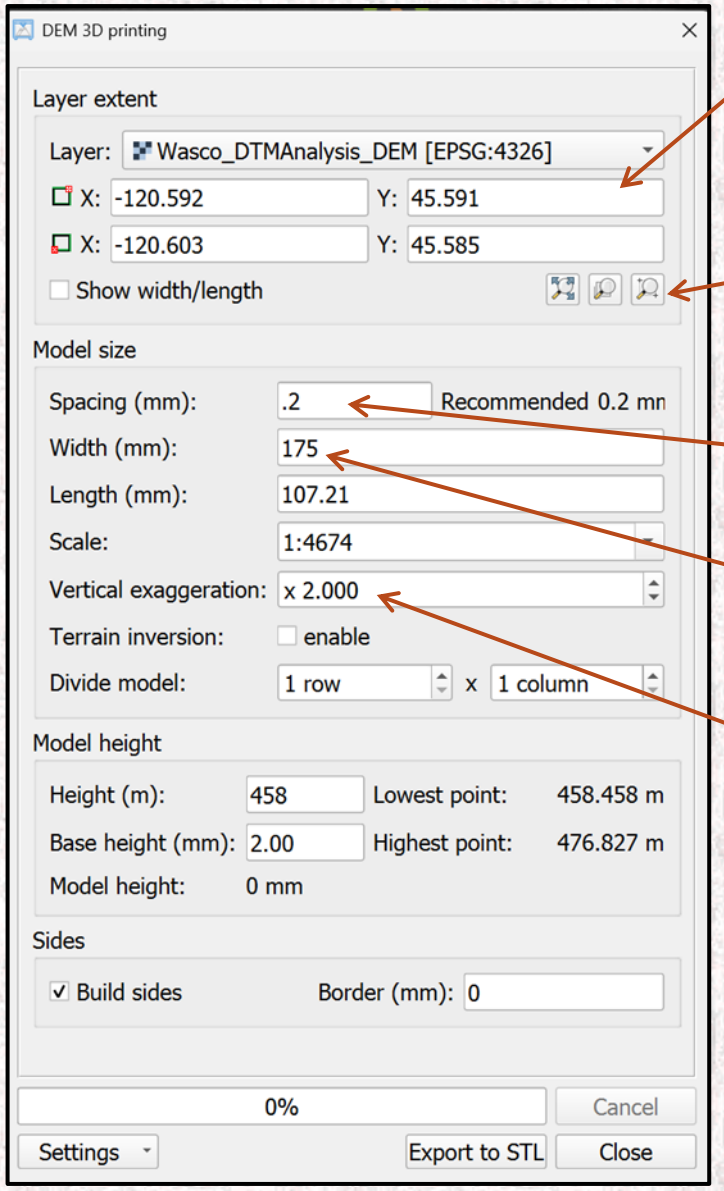
Making STL Files in QGIS

- Load the Plugin called: QGIS2threejs
- Load the Plugin called: DEMto3D (Tested by Jon)
- You have to have your own DEM





DEMto3D in QGIS



Coordinates for NE and SW corners

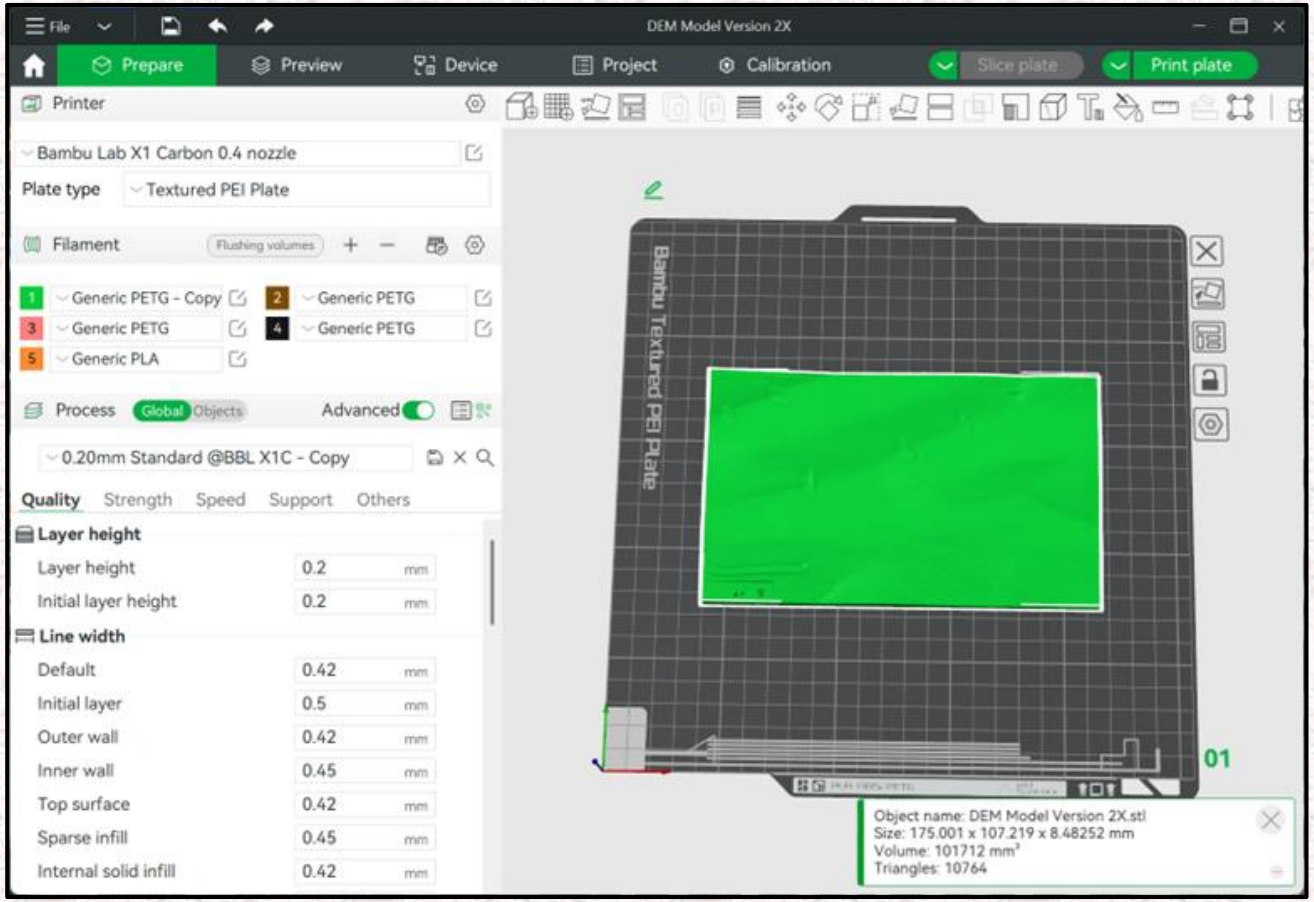
Drag area of interest.

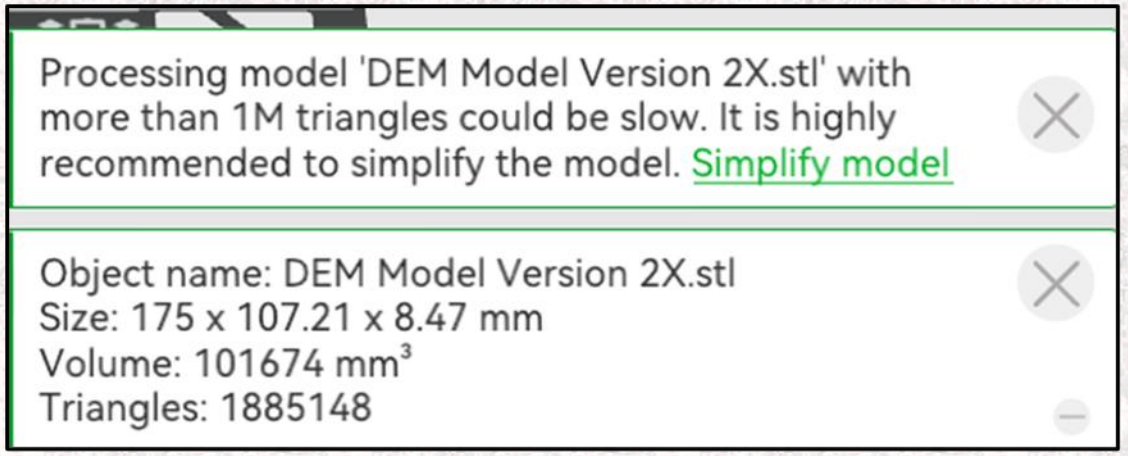
Fill in .2

Enter width of STL in mm

Exaggerate Z if needed

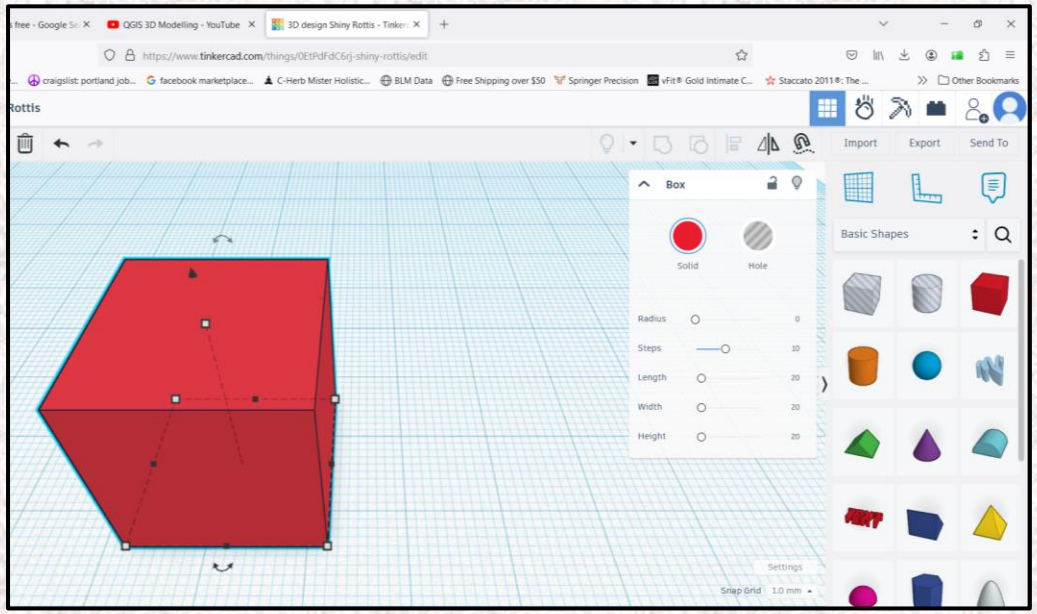
Bringing the STL Topo File Into a Slicer





How to Design Your Own 3D Print Files

- **Tinker Cad (Free, designed for kids to use)**
  - **This is what I use - because it is easy!**
- **Fusion 360 (Free, more powerful & cloud based)**
- **FreeCAD (Free)**
- **Solidworks (Not Free)**
- **Hire your 14-year-old neighbor kid**



Licensing of 3D Printed Objects

Model origin

The user re-uploaded this model. The user is not the original author of the model.

Maya Death Whistle (Easy Print, Very Loud)
Tacblades (thingiverse.com)

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Model origin

The author marked this model as their own original creation.

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The Best About 3D Printing

- **Most STL Files are FREE**
- **Most Slicer Programs use common notation**
- **3D Printers are relatively inexpensive**
- **Filament is readily available and relatively cheap**
- **Make professional Topo models in minutes**
- **Thousands of new STL files are being made every day**
- **Most 3D printer people are helpful to beginners**
- **3D printer help files are (usually) actually helpful**

The Worst About 3D Printing

- **Getting Started can be overwhelming**
- **3D filament absorbs water from the air**
- **You must be diligent to keep your filament dry**
- **Clogs, blobs, stringing, and spaghetti defects are inevitable. (but fixable)**
- **Searching for STL files can be really confusing**
- **You may become a 3D Printer addict!**

3D Printing: Conclusions

- 3D Printing is viable
- FREE STL files are definitely worth the price
- Expect to be frustrated at times!!!!
- Find a mentor.
- Be Persistent!!!

Thanks!

- **May your nozzles never clog.**
- **May your filament roll last the entire print.**
- **May your filament never absorb moisture**
- **May your 3D print frustrations be much less than your successes**

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