# Using 3D Terrain Data of Earth, Mars, and the Moon

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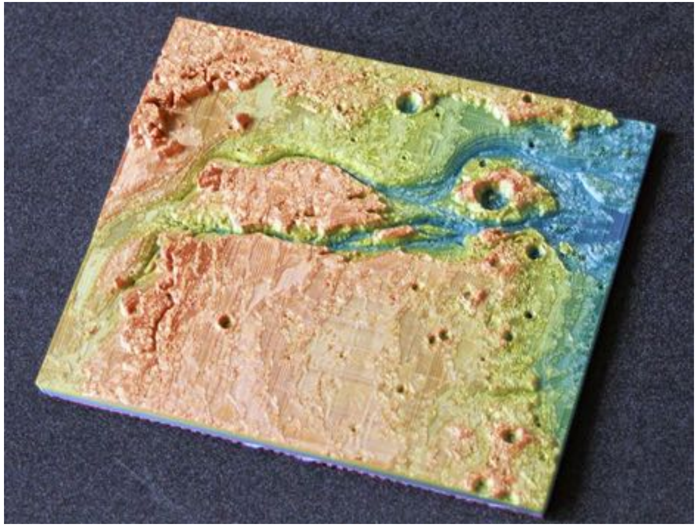
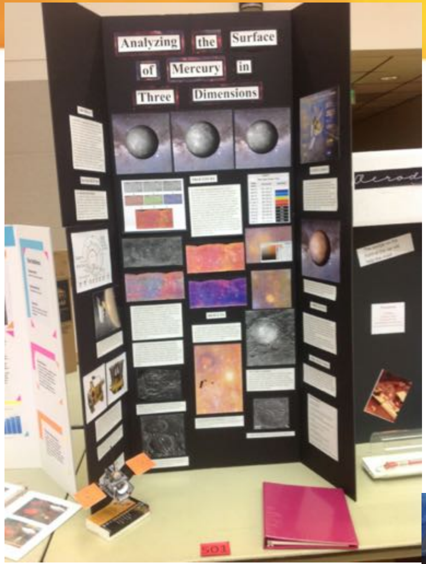
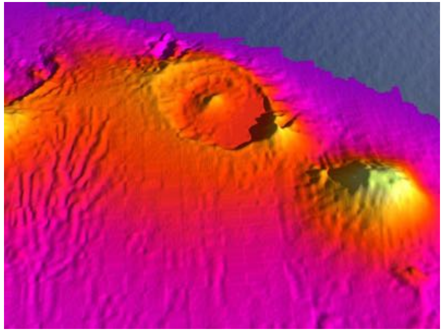
http://spacedoutclassroom.com

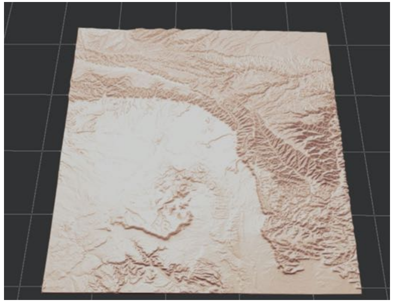


# Examples of Projects Using Big Data

- Plate tectonics: Gunung Batur on Bali, uplift and erosion patterns of the San Rafael Swell and Book Cliffs, Utah.
- Narrow-band image data of Mercury from the MESSENGER space probe to determine if surface features are from impacts or volcanoes.
- Data from the Mars Reconnaissance Orbiter CRISM instrument to look for explosive volcanoes on Mars.
- Tutorial video on using Mars MOLA data: [https://youtu.be/kzdO9PANu_8](https://youtu.be/kzdO9PANu_8)

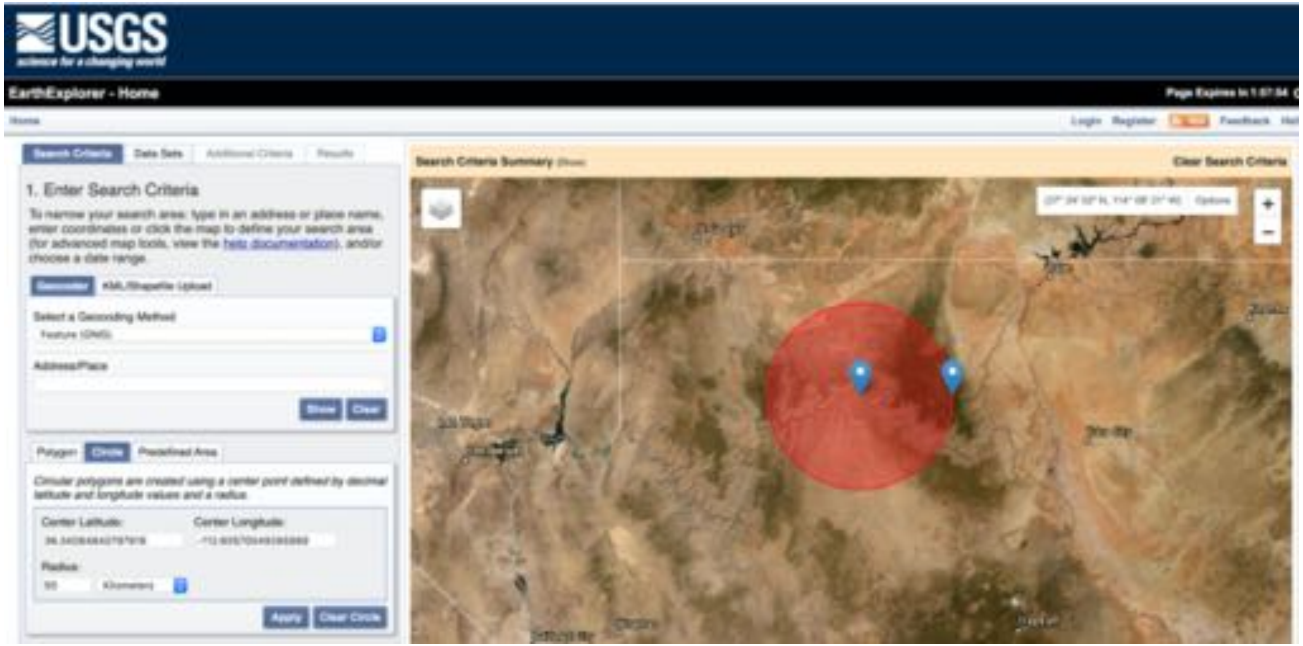




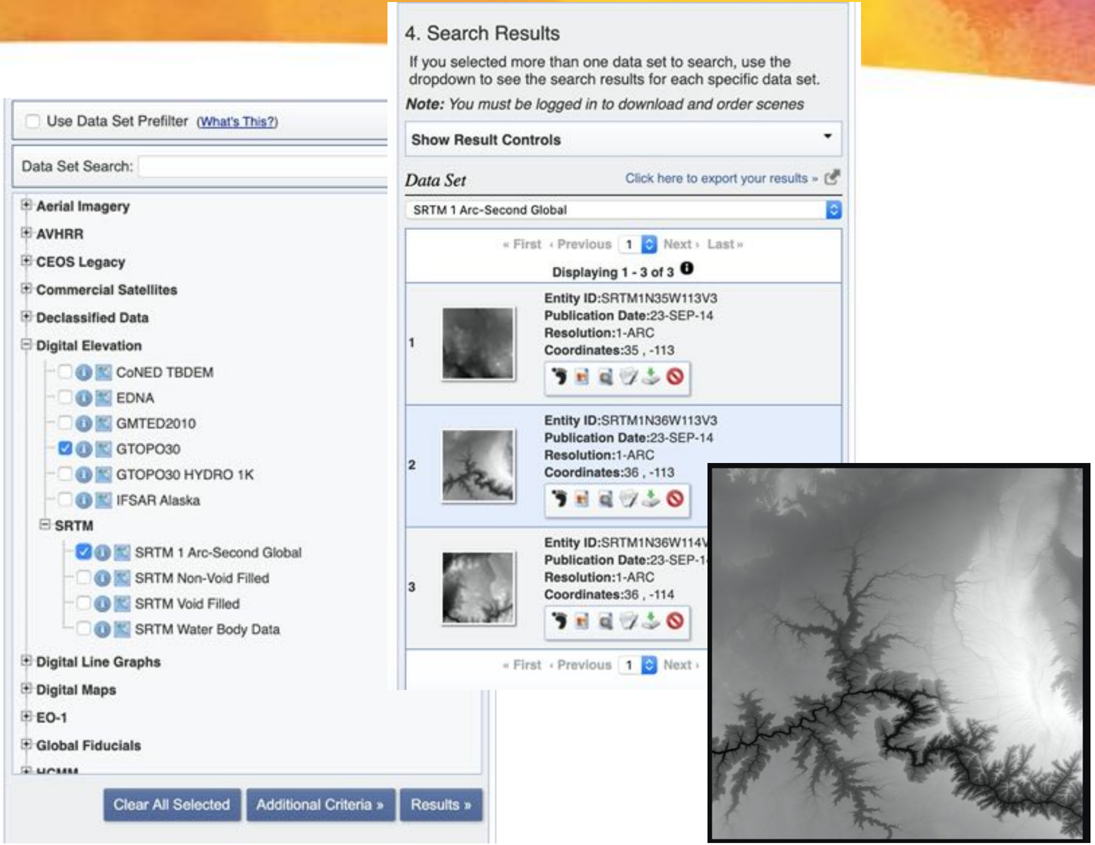
# Part 1: Finding the Data
# Earth Data: USGS EarthExplorer

- EarthExplorer is a one-stop site for geological and geographical data.
- It includes many data sets for the entire Earth.
- Use the map to define the area you want data from.



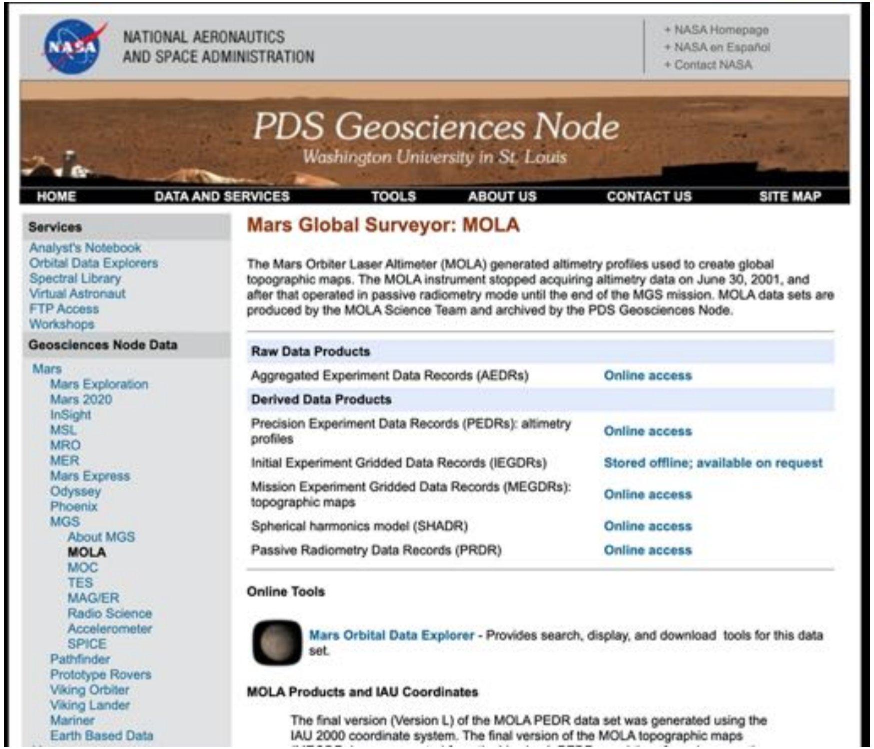
# Selecting Data Sets in EarthExplorer

- Under the **DataSets** tab at the bottom, you can select the type of data you want.
- For **Digital Elevation** models, the best resolution data is from the **Shuttle Radar Topography Mission**.
- **SRTM** covers 55 ° N to 55 ° S latitude.
- Use **GTOPO30** for other areas.
- Choose **Results** and select the best image, then download.



# Mars MOLA Data

- Part of NASA Planetary Data System (PDS) Node for Geosciences at the Washington University in St. Louis (WUSTL)
- Choose **Mars** from the list at left and the **Mars Experimental Gridded Data Record (MEDGR)** link.
- Scroll to the bottom and choose the desired  quadrant of Mars from the table according to latitude and longitude.



# Downloading MOLA Data

- Choose the Topography data, with prefix **MEGT.**
- Read the corresponding .LBL metadata file to see the numbers of rows and columns. You will need this information for ImageJ.
- The data is 16 bit signed data.
- This is the most detailed data, but a lower resolution image of all of Mars can be found at: [http://astrogeology.usgs.gov/search/details/Mars/GlobalSurveyor/MOLA/Mars_MOLA_DEM_mosaic_global_463m/cub](http://astrogeology.usgs.gov/search/details/Mars/GlobalSurveyor/MOLA/Mars_MOLA_DEM_mosaic_global_463m/cub)

**MEGDR Tiled Image Files and Labels at 128 Pixels Per Degree**

| Area Covered | 88°N to 44°N lat, 0°E to 90°E lon | 88°N to 44°N lat, 90°E to 180°E lon | 88°N to 44°N lat, 180°E to 270°E lon | 88°N to 44°N lat, 270°E to 360°E lon |
|---|---|---|---|---|
| Counts | megc88n000hb.img, megc88n000hb.lbl | megc88n090hb.img, megc88n090hb.lbl | megc88n180hb.img, megc88n180hb.lbl | megc88n270hb.img, megc88n270hb.lbl |
| Radius | megr88n000hb.img, megr88n000hb.lbl | megr88n090hb.img, megr88n090hb.lbl | megr88n180hb.img, megr88n180hb.lbl | megr88n270hb.img, megr88n270hb.lbl |
| Topography | megt88n000hb.img, megt88n000hb.lbl | megt88n090hb.img, megt88n090hb.lbl | megt88n180hb.img, megt88n180hb.lbl | megt88n270hb.img, megt88n270hb.lbl |
| Area Covered | 44°N to 0° lat, 0°E to 90°E lon | 44°N to 0° lat, 90°E to 180°E lon | 44°N to 0° lat, 180°E to 270°E lon | 44°N to 0° lat, 270°E to 360°E lon |
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| Area Covered | 0° to 44°S lat, 0°E to 90°E lon | 0° to 44°S lat, 90°E to 180°E lon | 0° to 44°S lat, 180°E to 270°E lon | 0° to 44°S lat, 270°E to 360°E lon |
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| Radius | megr00n000hb.img, megr00n000hb.lbl | megr00n090hb.img, megr00n090hb.lbl | megr00n180hb.img, megr00n180hb.lbl | megr00n270hb.img, megr00n270hb.lbl |
| Topography | megt00n000hb.img, megt00n000hb.lbl | megt00n090hb.img, megt00n090hb.lbl | megt00n180hb.img, megt00n180hb.lbl | megt00n270hb.img, megt00n270hb.lbl |
| Area Covered | 44°S to 88°S lat, 0°E to 90°E lon | 44°S to 88°S lat, 90°E to 180°E lon | 44°S to 88°S lat, 180°E to 270°E lon | 44°S to 88°S lat, 270°E to 360°E lon |
| Counts | megc44s000hb.img, megc44s000hb.lbl | megc44s090hb.img, megc44s090hb.lbl | megc44s180hb.img, megc44s180hb.lbl | megc44s270hb.img, megc44s270hb.lbl |
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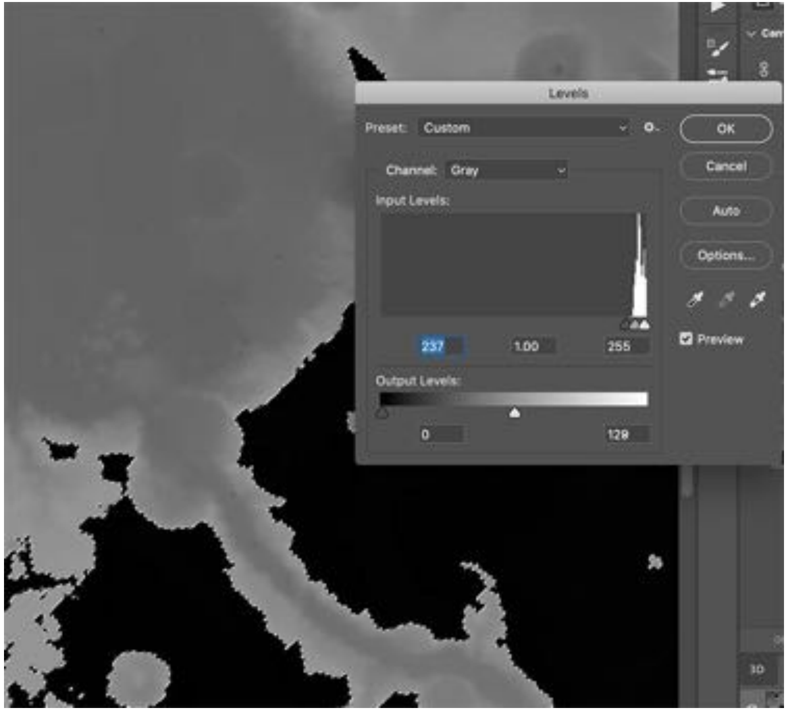
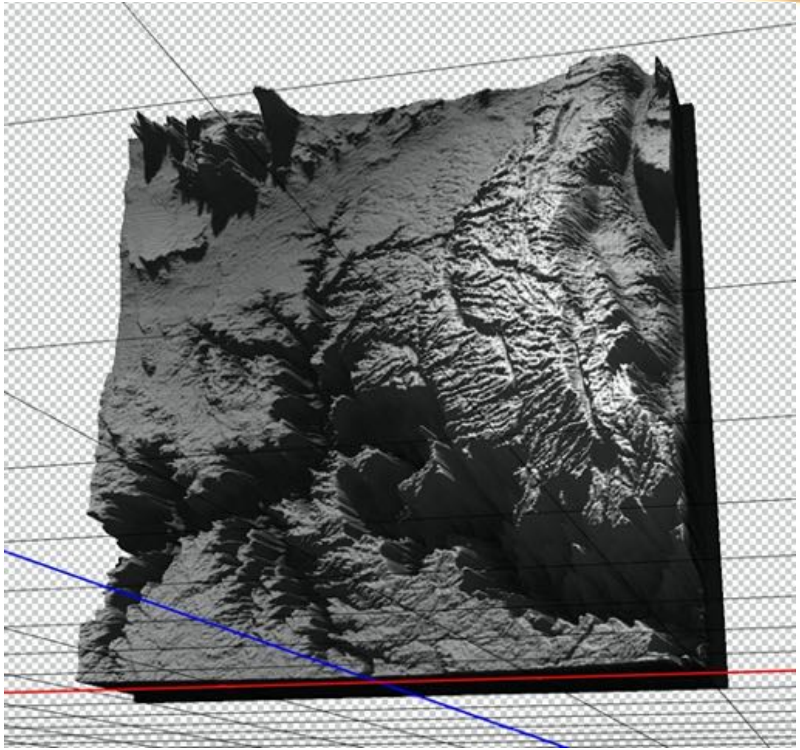
# Fixing the Bi-Gradient Problem

- Open the global TIFF file in Adobe Photoshop. It will have a light area and a dark area, which are both gradients.
- Use the magic wand tool set to a tolerance of 50 and with contiguous and anti-aliasing turned off to select the light area (low altitude).
- Choose **Image-Adjustments-Levels** and move the white output slider to **128** and the black input slider to the edge of the curve.
- Inverse the selection and choose **Image-Adjustments-Levels** again. Move the black output slider to **128** and the white input slider to the edge of the curve.



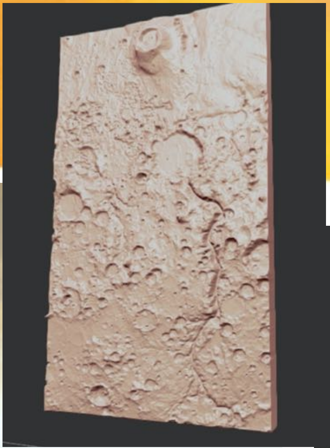
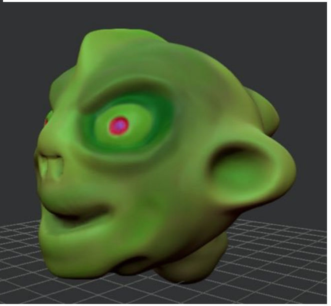
# Part 2: Turning the Heightmap into a 3D Model

- Open the saved heightmap into Adobe Photoshop (newer version).
- Select and crop the part you want.
- Choose **3D,** then **New Mesh from Layer,** then **Depth Map to**, then **Solid Extrusion**.
- A model will appear in a few moments. It will have exaggerated height.
- Choose **3D**, then **Export 3D Layer**, and save as a **WavefrontOBJ**.
- You won't want to 3D print this yet - it will crack through the lowest elevation.



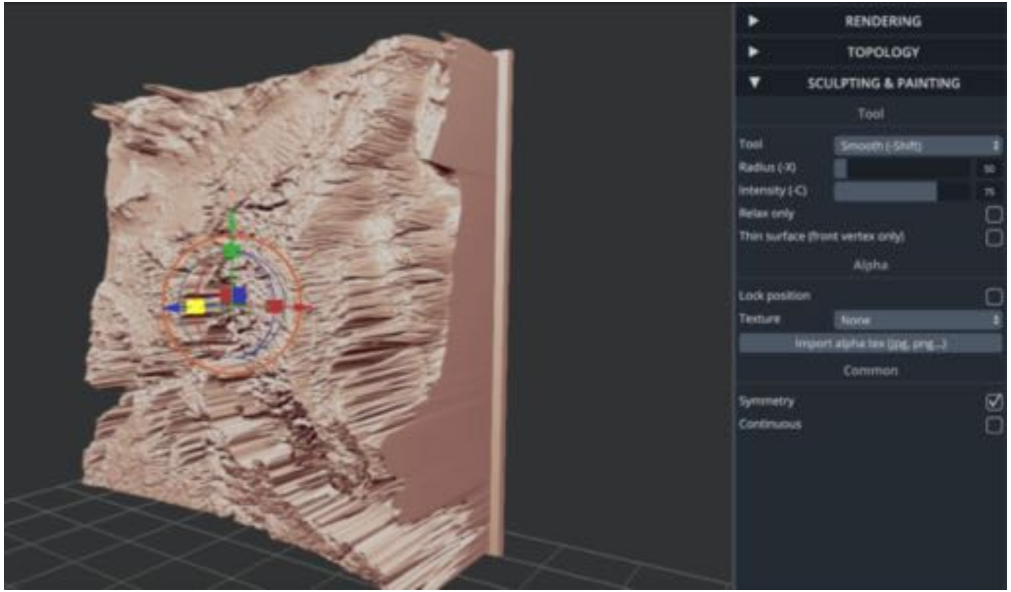
# SculptGL

- SculptGL is an online browser-based 3D modeling platform. It can be used to model and paint many organic shapes.
- Easy tool set that can take a virtual ball of clay and pull and push it, adding polygons automatically as you go.
- Examples: Creating 3D portraits of famous scientists or alien life forms.

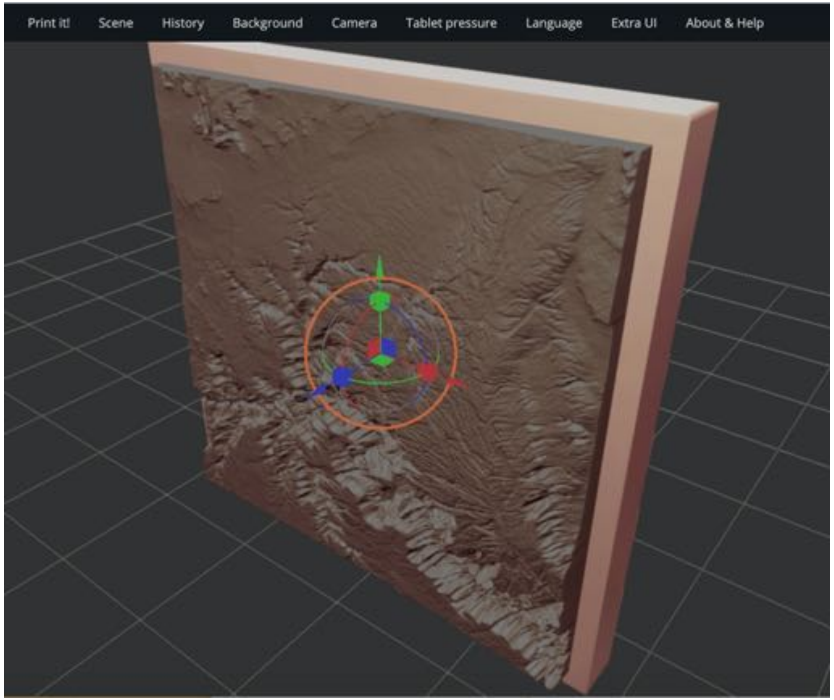
# Flattening the Model in SculptGL

- Inside **SculptGL**, choose **Scene**, then **Clear Scene** to get rid of the clay ball.
- Import your terrain model.
- To flatten the height, choose the **Transform** tool in the pull-down **Tool** menu on the right.
- Choose the blue box (not the arrow or arc). It will turn yellow. Push it in to flatten until the height of the model looks realistic.



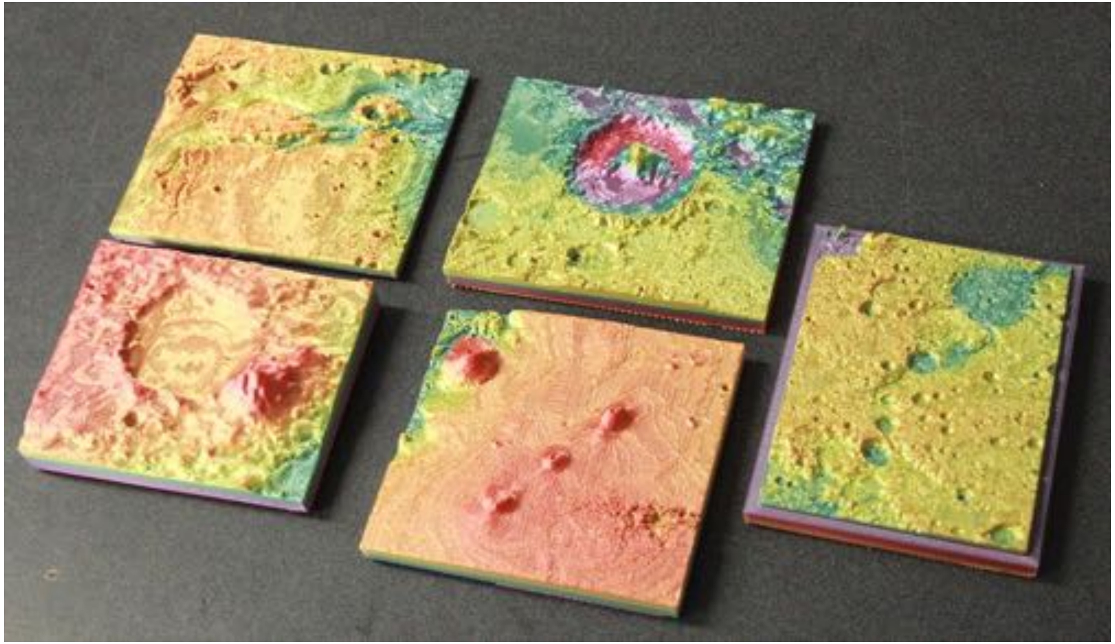
# Adding a Base in SculptGL

- Choose **Scene**, then **Add Cube**. A large cube will appear and will be selected - the terrain will go dark (unselected).
- Use the **Transform** tool to shrink the cube and move it so that it is just barely touching the bottom of the terrain.
- Select both objects by holding down **Shift** and clicking on them.
- Choose **Scene**, then **Merge Selection**.
- Export the model as an .obj or .stl file. It is now suitable for 3D printing.



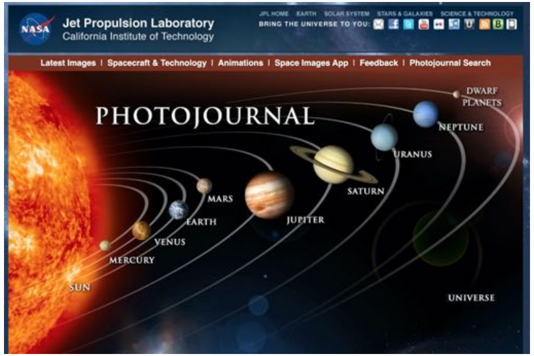
# 3D Printing

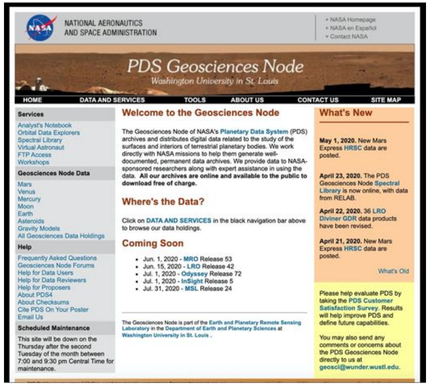
- Once the models are merged, you will need to reduce their resolution to make them printable.
- Using the Topology pull down menu, move the slider to about 250, then choose **Remesh**.
- The model can now be exported as an .STL or .OBJ and sliced and printed in your favorite slicer software.



# Other Sources of Big Data

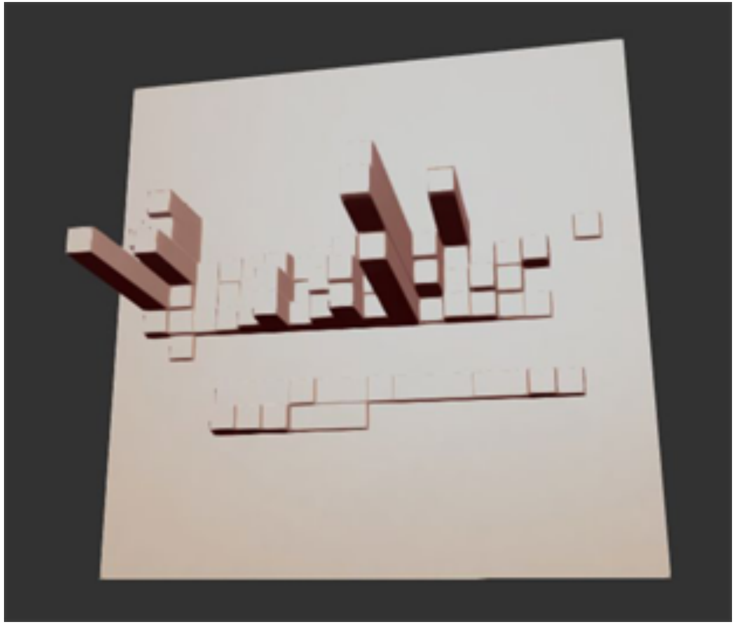
- NASA Geosciences Data: https://pds-geosciences.wustl.edu/
- NASA Image Data: https://photojournal.jpl.nasa.gov/
- NOAA data (oceans, weather, climate): https://data.noaa.gov/datasetsearch/
- CDC Disease Data: https://www.cdc.gov/datastatistics/index.html
- U.S. Census Bureau (demographics, population, voting): https://data.census.gov/cedsci/
- Infrared Astronomy Data - IPAC. https://irsa.ipac.caltech.edu/frontpage/
- The challenge is to find raw data that hasn't already been interpreted and the tools to manipulate it.



# Or Use Your Own Field Data

- Field research can gather data on environmental conditions such as water or soil quality.
- If tied to geographic or GPS data, it creates a grid of numbers.
- If all the rows are of equal length, then the data can be loaded into ImageJ from the National Institutes of Health by importing it as a **Text Image.**
- It will create a grayscale image with the highest number white and the lowest number black.
- This image can become a heightmap for 3D modeling.



Questions? Contact David Black at:
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