3D Modeling for Visual Analyses of Recent and Historical Weather and Ground Water Patterns

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Mesonet
Oklahoma's Weather Network

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CLIMATOLOGICAL SURVEY

Examples

- Radar rainfall estimates in Oklahoma from 2014 and 2015
    - 3D printed models
    - VRML for VR

- Visual representation of ground water levels in Oklahoma & Texas
    - Data sets in KML
    - Uses in Virtual Globes or GIS
    - Online interactive web using CesiumJS

- Tornado totals by county in Oklahoma from 1950 to 2017
   - 3D printed models
    - KML and CesiumJS

Radar rainfall estimates in Oklahoma

- NWS Arkansas-Red Basin River Forecast Center or ABRFC
  - Data as netCDF at one hour intervals
  - Each 1 hour data set was added into a new netCDF for year totals
- 3D surface using Z as rainfall totals
  - netCDF was converted to a surface (Lat, Long, and Z as rainfall totals)
  - Masked only state of Oklahoma and added sides and bottom
- Check for errors on STL
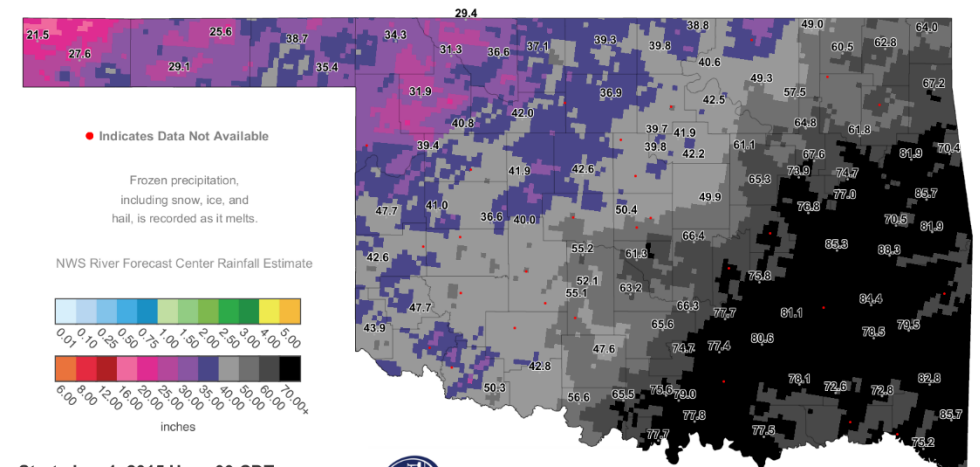 - Used ADMesh for error checking for holes or inverted facets

Rainfall totals in 2D
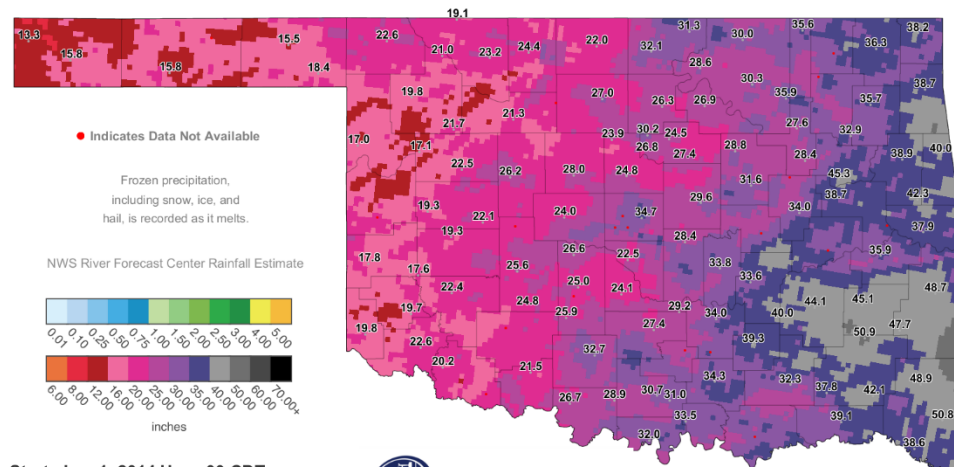
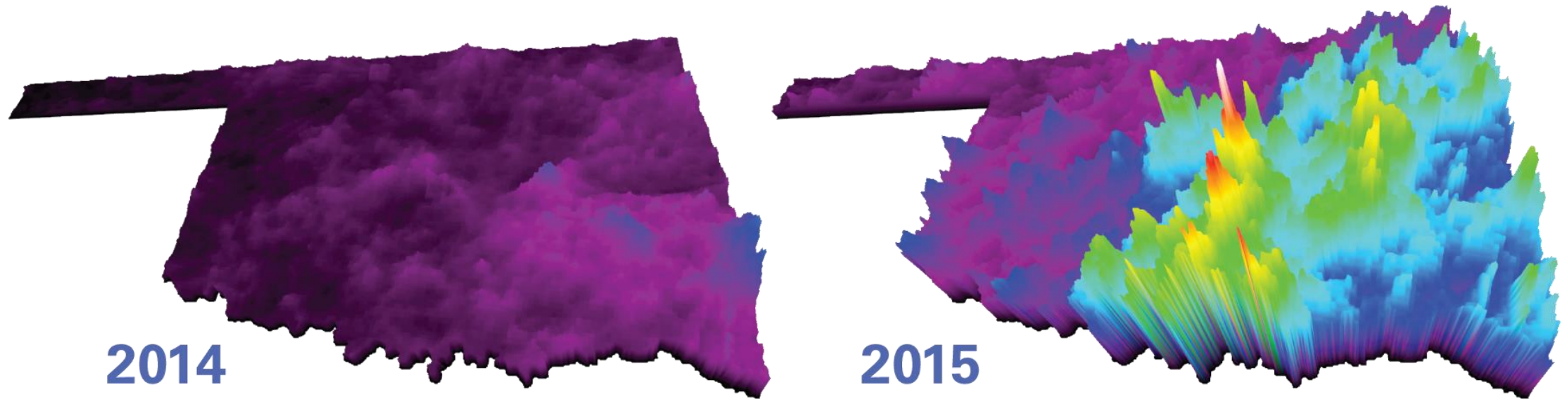# Digital STL display
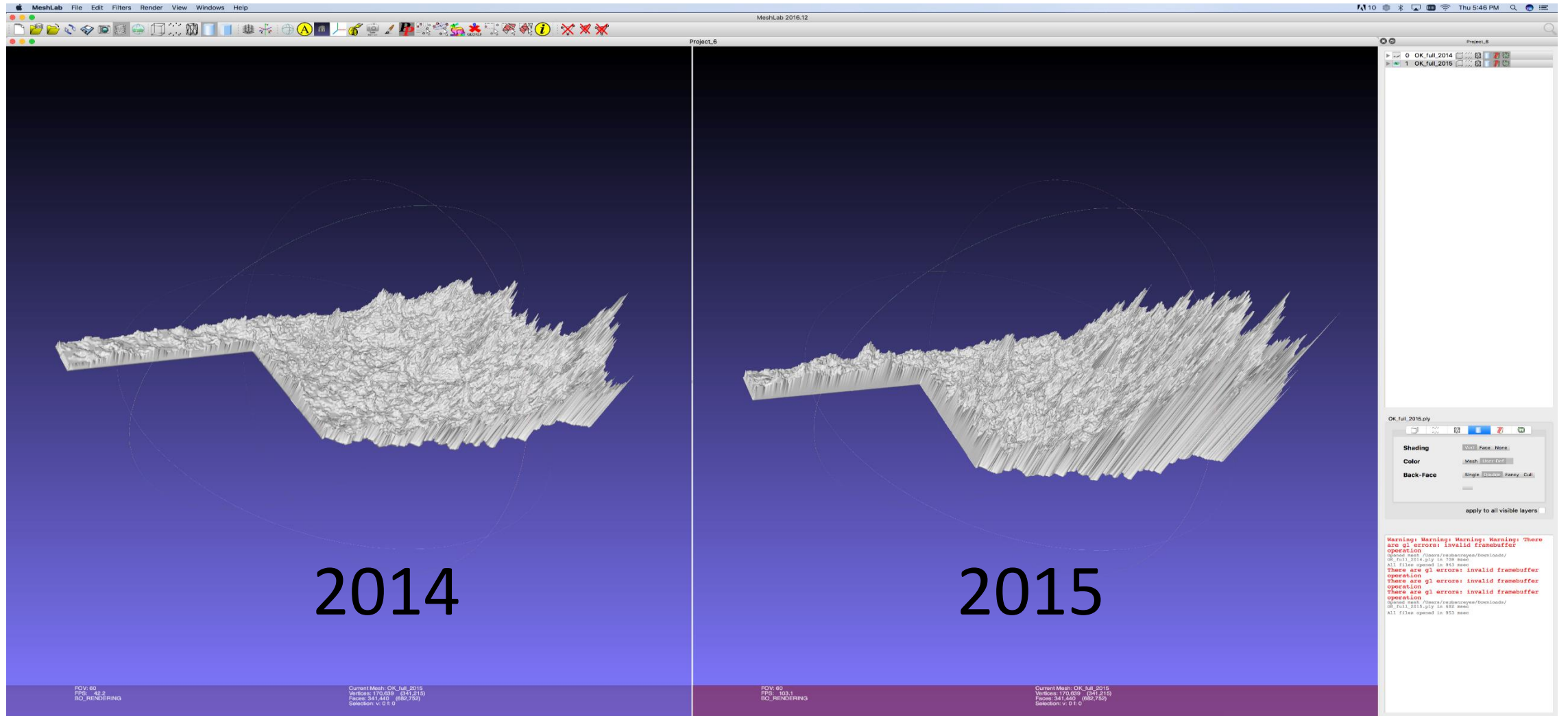
Printed 3D models

VRML format for Virtual Reality
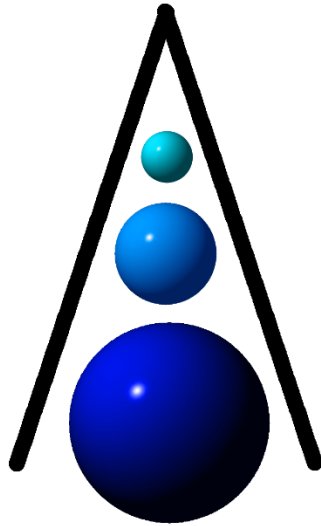

2014
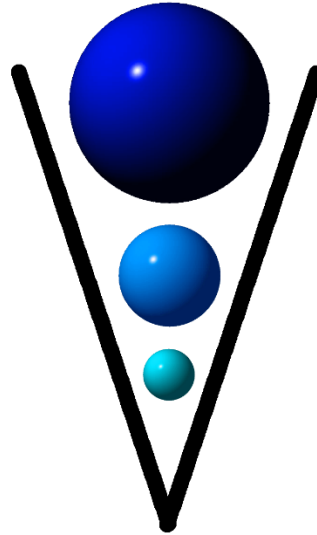
2015

Ground water levels in Oklahoma & Texas

- Subset of 4 year interval sections
  - 2003-2006, 2007-2010, 2011-2014
- Values for each well are normalized statistically
- Visualization in KML/KMZ for use in virtual globes
  - Google Earth and Google Earth Pro
  - NASA World Wind, ArcGIS Explorer, ArcGIS Earth, and
- Used VSL in both Oklahoma and Texas data sets
- Interactive web using Cesium JS
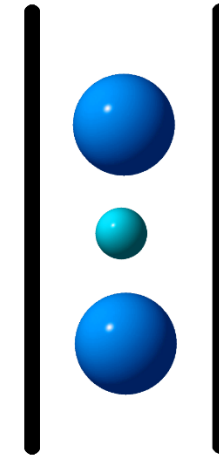 - Viewable in any modern browser

Visual Shape Logic

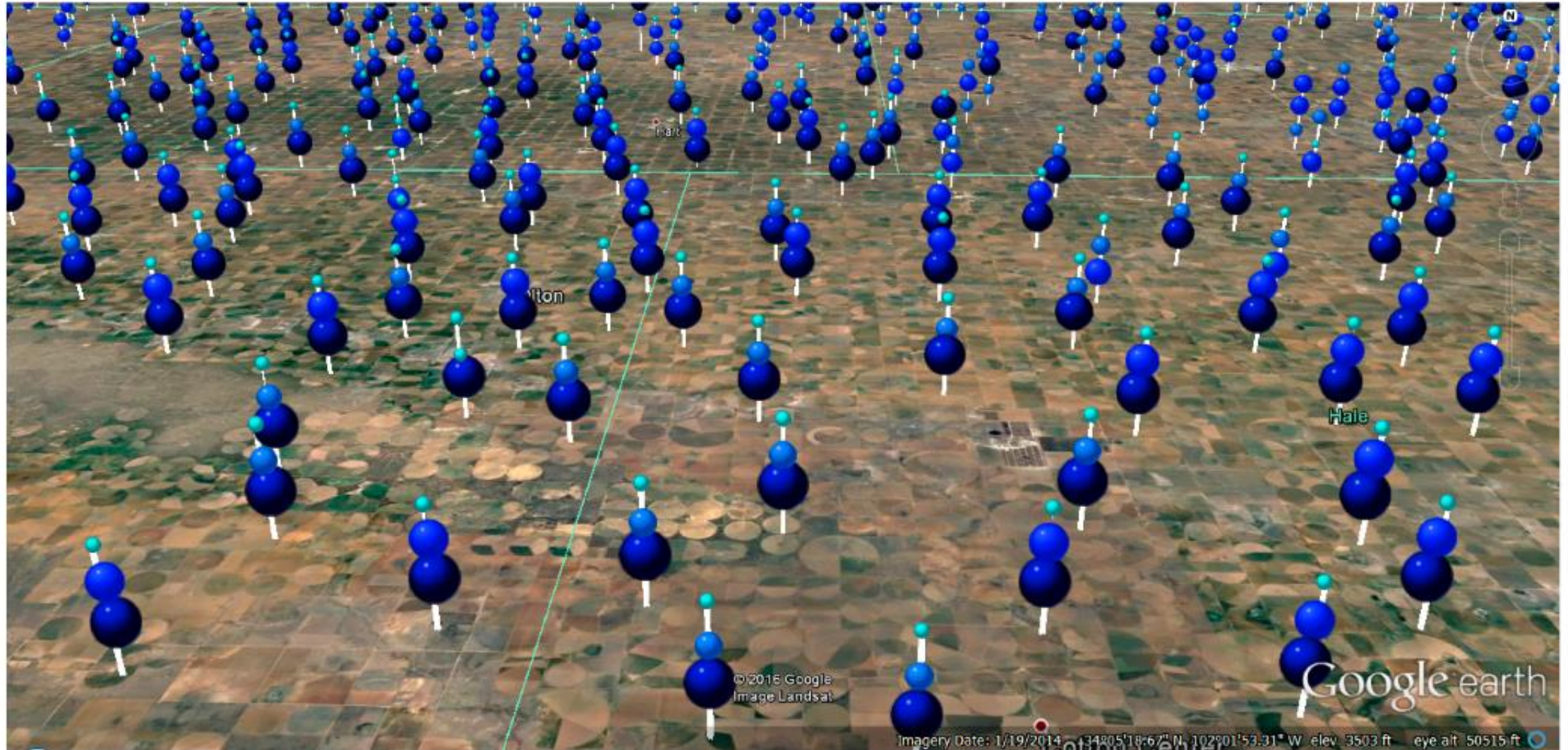
discernible decrease   **discernible increase**   **no discernible change**
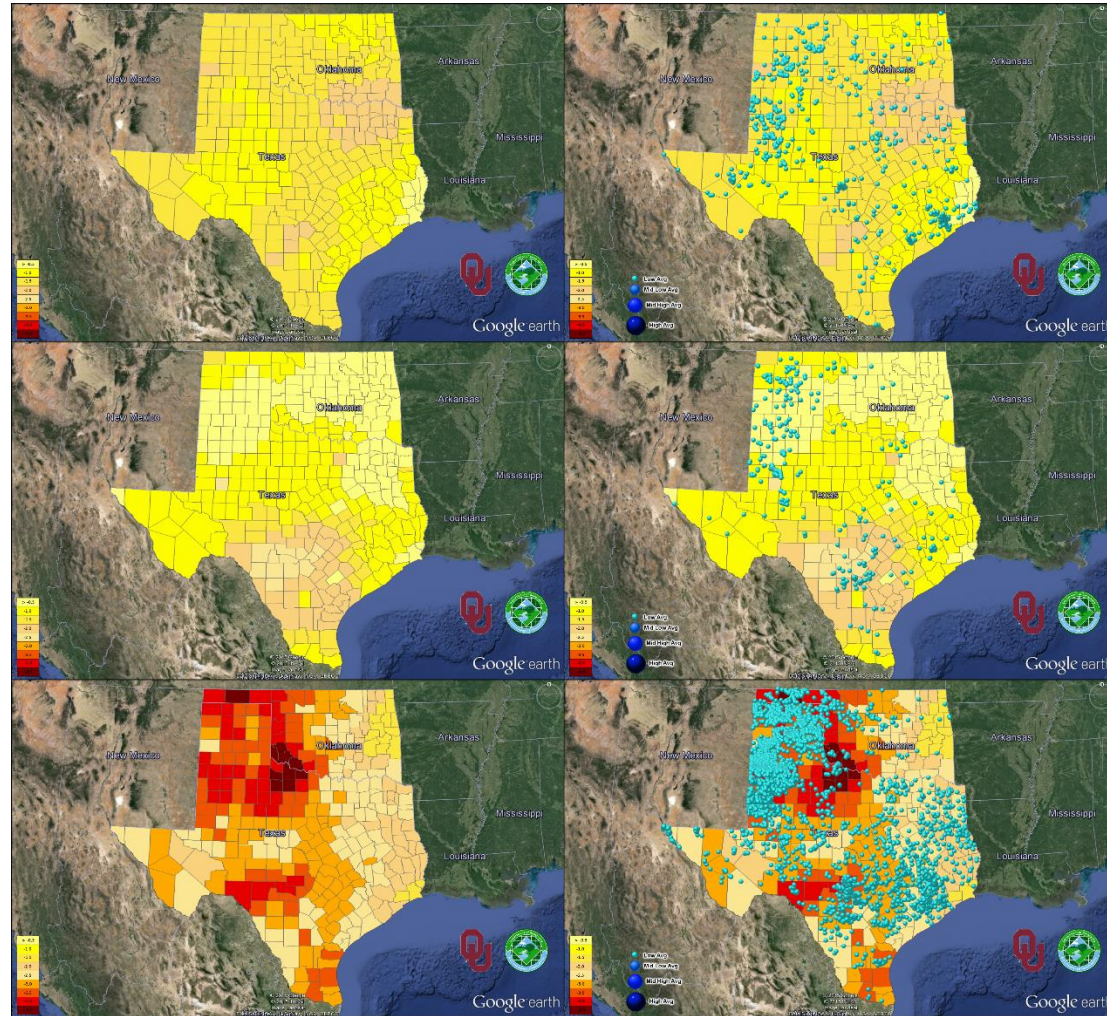
2011-2014
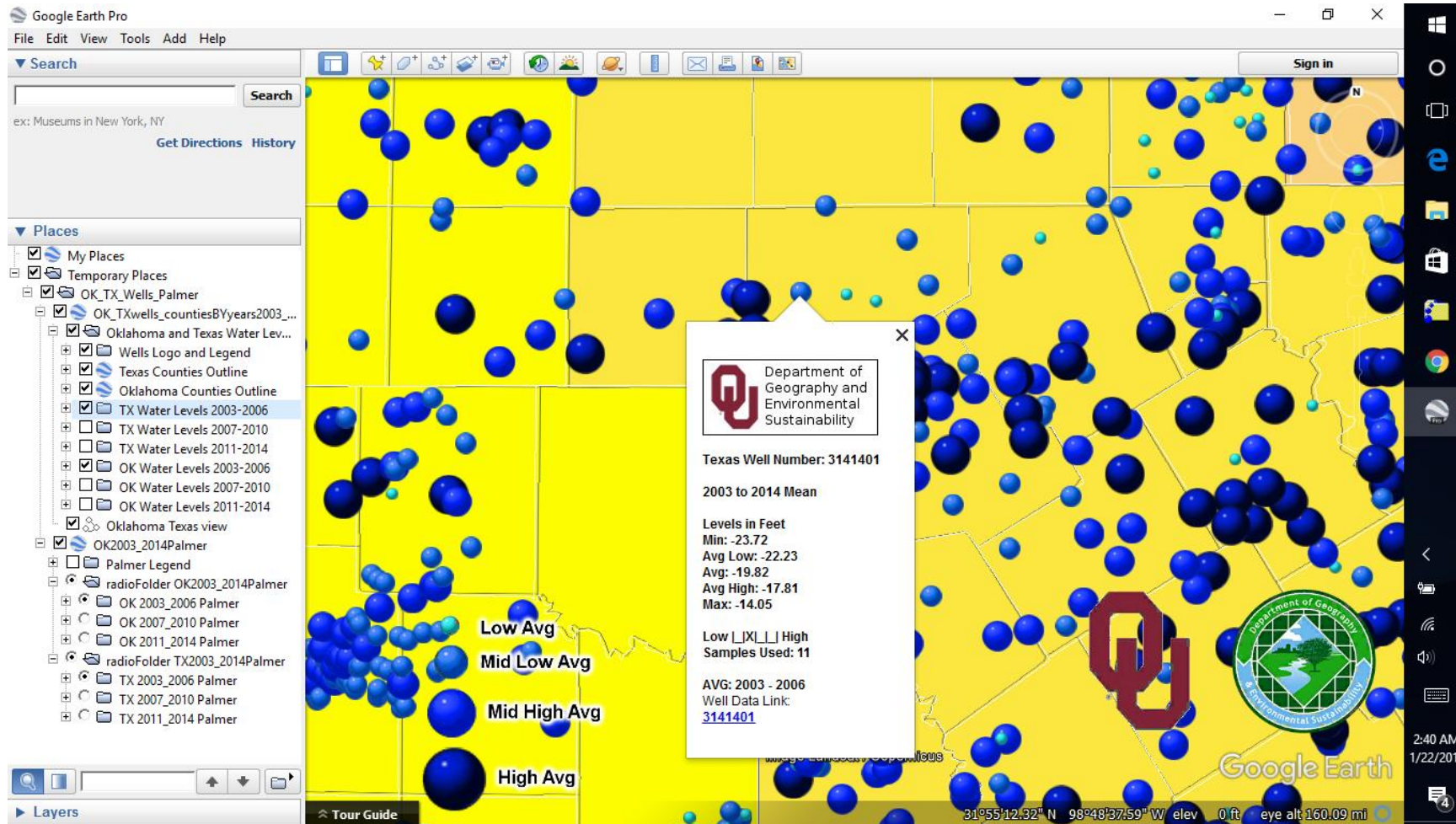
2007-2010

2003-2006

Examples in West Texas

Example views in Oklahoma and Texas

Interactive query of each data point

Tornado totals by county in Oklahoma

- County shape files were converted to KML
- Data from NWS Tornado totals for Oklahoma from 1950 to 2017
- Displayed in 2D
- Extruded county height to match Tornado totals
- Converted to STL for 3D printing
- Added 2 other data sets Area Index and Wind Area Index
- Merged all 3 data sets into KML
- Web access using CesiumJS
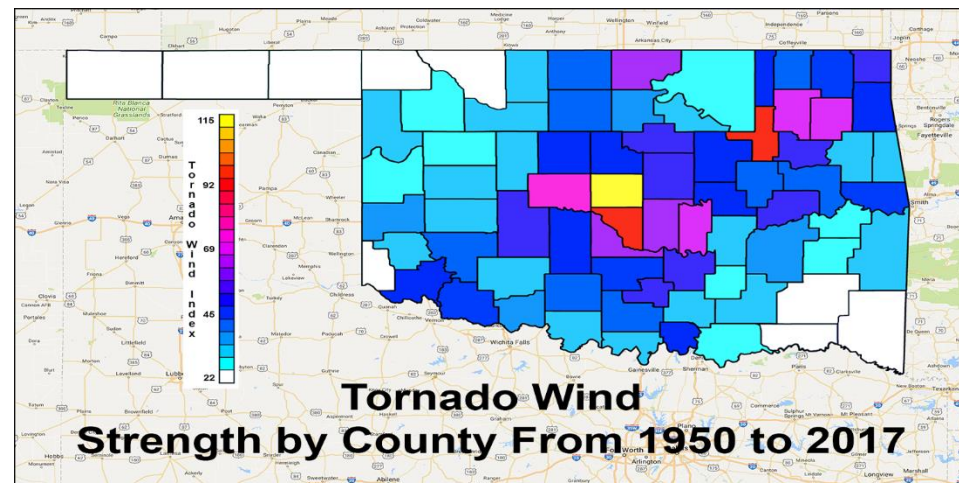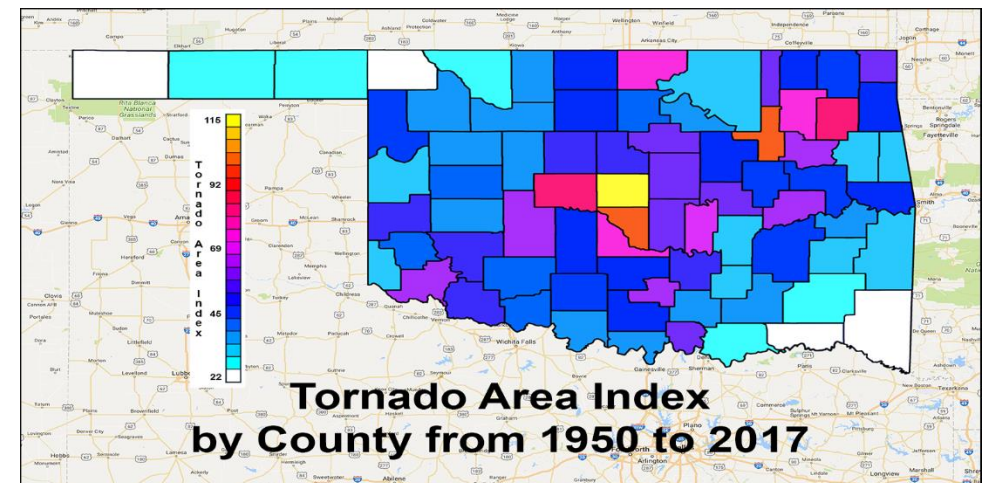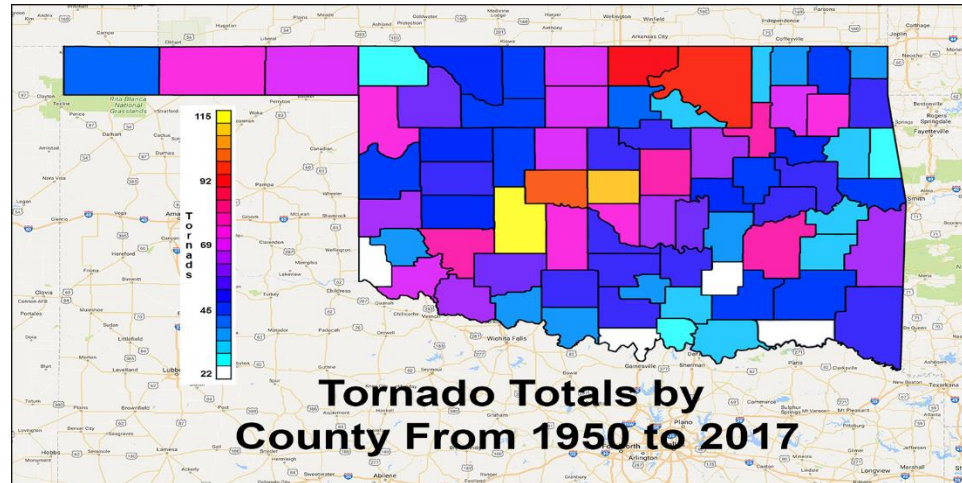
Formulas for Oklahoma Counties

$$N = \{n_1, n_2, \ldots n_i, \ldots n_{77}\};$$

$$n_i = \text{\# of tornadoes in } i^{th} \text{ county from 1950 to 2017}$$

$$N_{\text{per area}} \cdot \text{scaller1}$$

$$N_{\text{per area}} = \{\frac{n_1}{S_1}, \frac{n_2}{S_2}, \ldots \frac{n_i}{S_i}, \ldots \frac{n_{77}}{S_{77}}\};$$

$$S_i = \text{area of } i^{th} \text{ county}$$
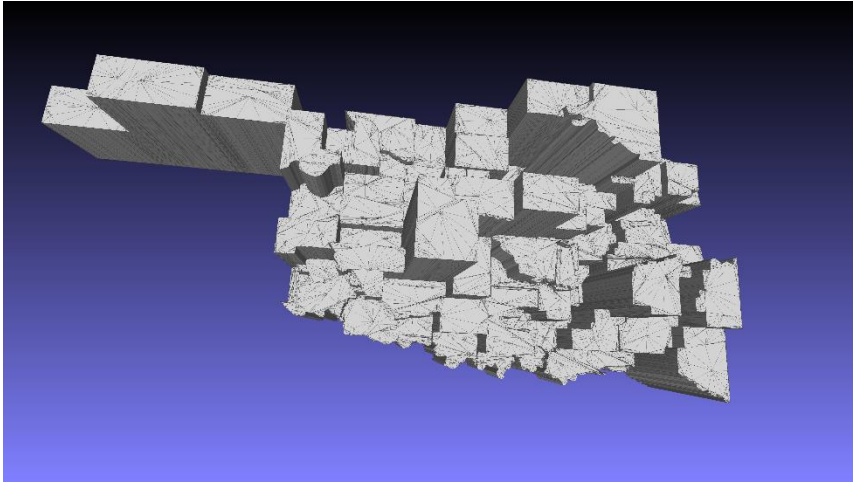
$$\text{scaller1} = \max(N_{\text{per area}})$$

$$P \cdot \text{scaller2}$$

$$P = \{\frac{\sum_{k=1}^{n_1} v_{1k}}{S_1}, \frac{\sum_{k=1}^{n_2} v_{2k}}{S_2}, \ldots \frac{\sum_{k=1}^{n_i} v_{ik}}{S_i}, \ldots \frac{\sum_{k=1}^{n_{77}} v_{77k}}{S_{77}}\};$$

$$v_{ik} = \text{wind speed of } k^{th} \text{ tornado in } i^{th} \text{ county}$$

$$\text{scaller2} = \max(P)$$

2D examples of Oklahoma Tornadoes

Tornado Totals by County From 1950 to 2017

Tornado Area Index by County from 1950 to 2017

Tornado Wind Strength by County From 1950 to 2017
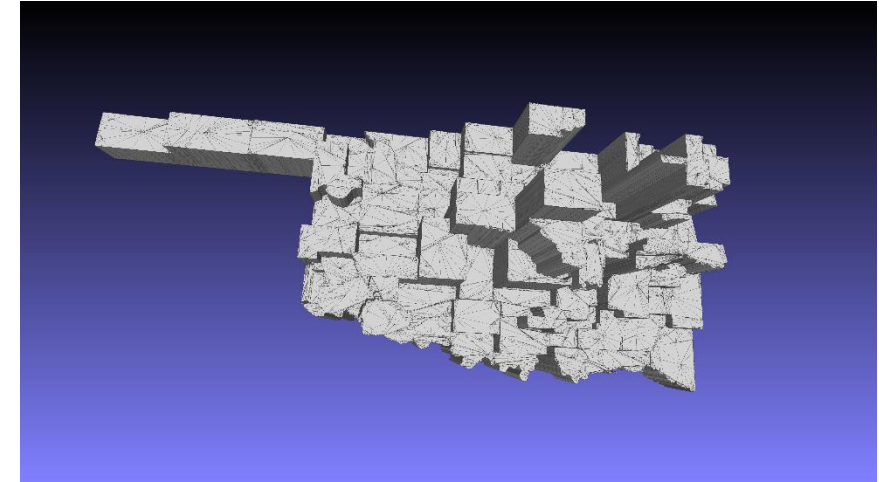
Extruded counties into 3D
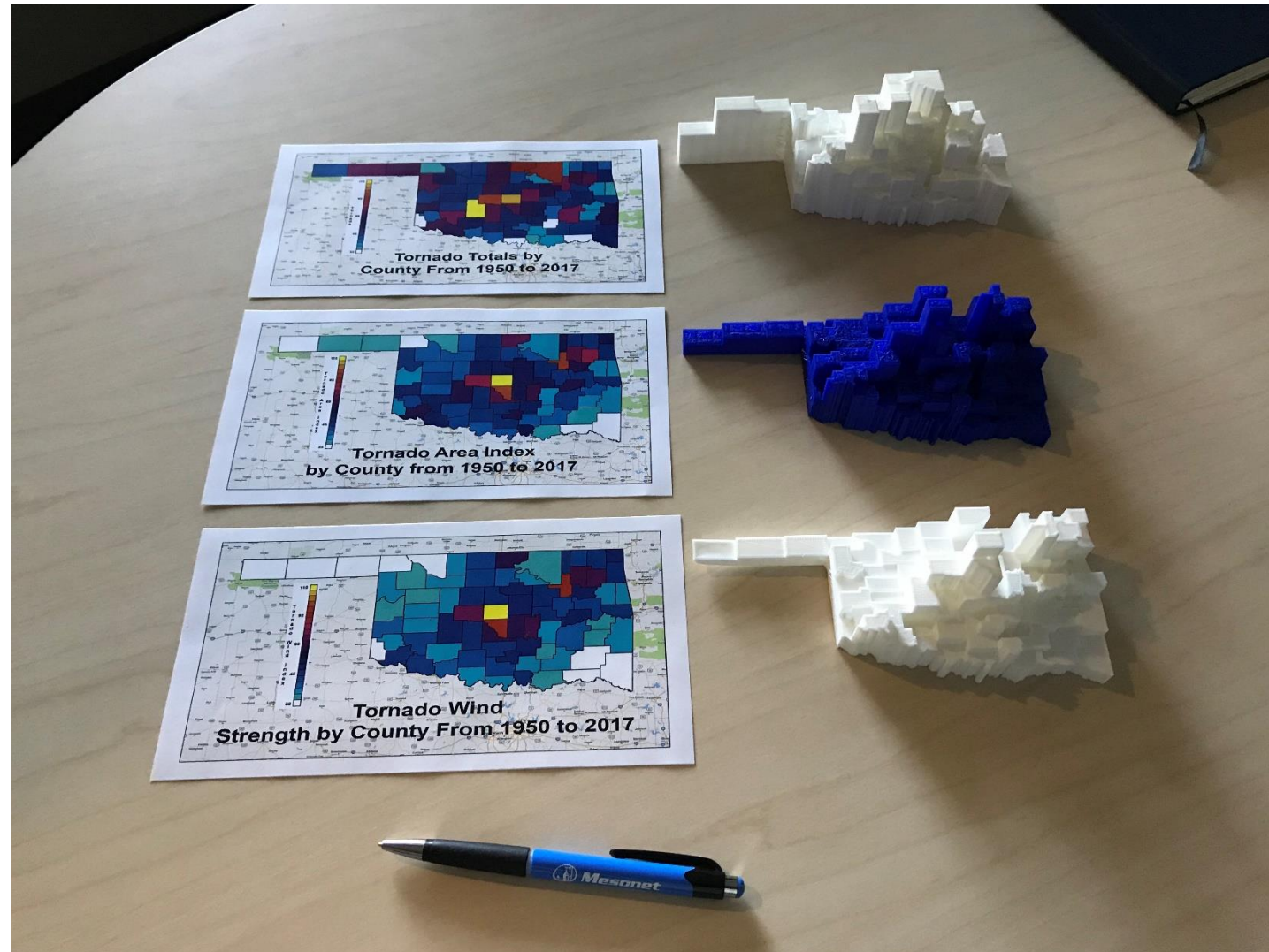

Tornado Totals by
County 1950 - 2017

Tornado Area Index
By County 1950 - 2017

Tornado Wind Index 1950 - 2017

# Converted to STL for 3D printing

Links

- Oklahoma and Texas Ground water data sets

  http://hitechmex.org/OK_TX/

- Oklahoma Tornado Totals and Area Index and Wind Index

  http://hitechmex.org/OK_Tornado_County/

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- Patrick Madden from 3D-magine
    3D prints of Oklahoma rainfall yearly totals 2014 and 2015

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    Formulas and insight on presentation

- Minori Matsuzawa from OU Innovation Hub Fablab
    3D prints of Oklahoma Tornado totals by County

Thank you for your attention
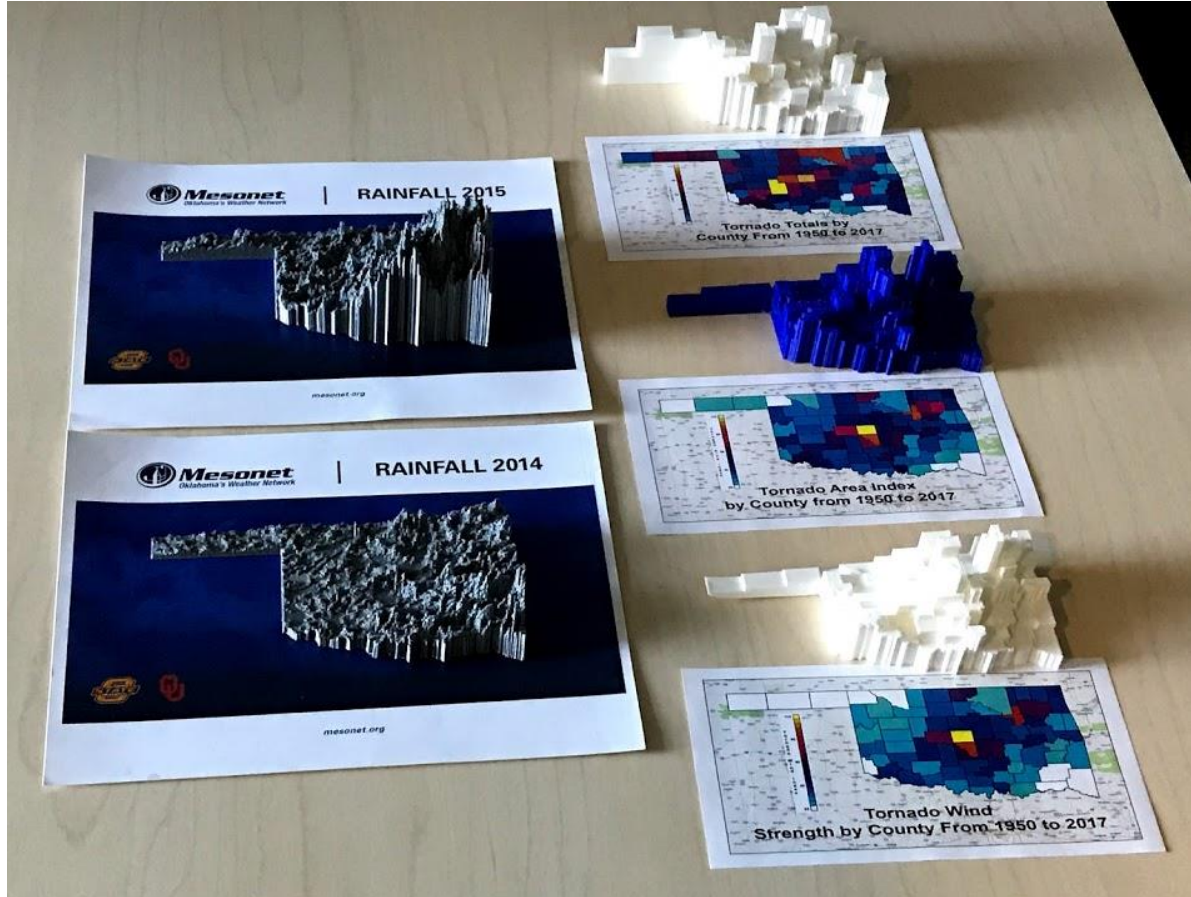
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Citations / references : AMS Paper June 2007

Population Influences on Tornado Reports in the United States

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