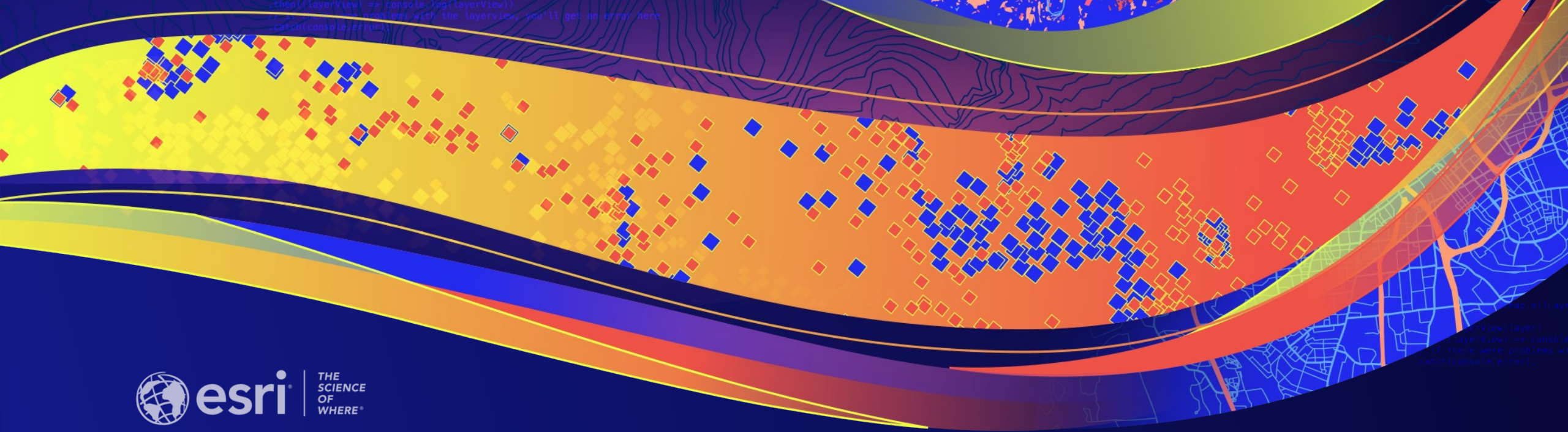

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ESRI DEVELOPER SUMMIT 2023

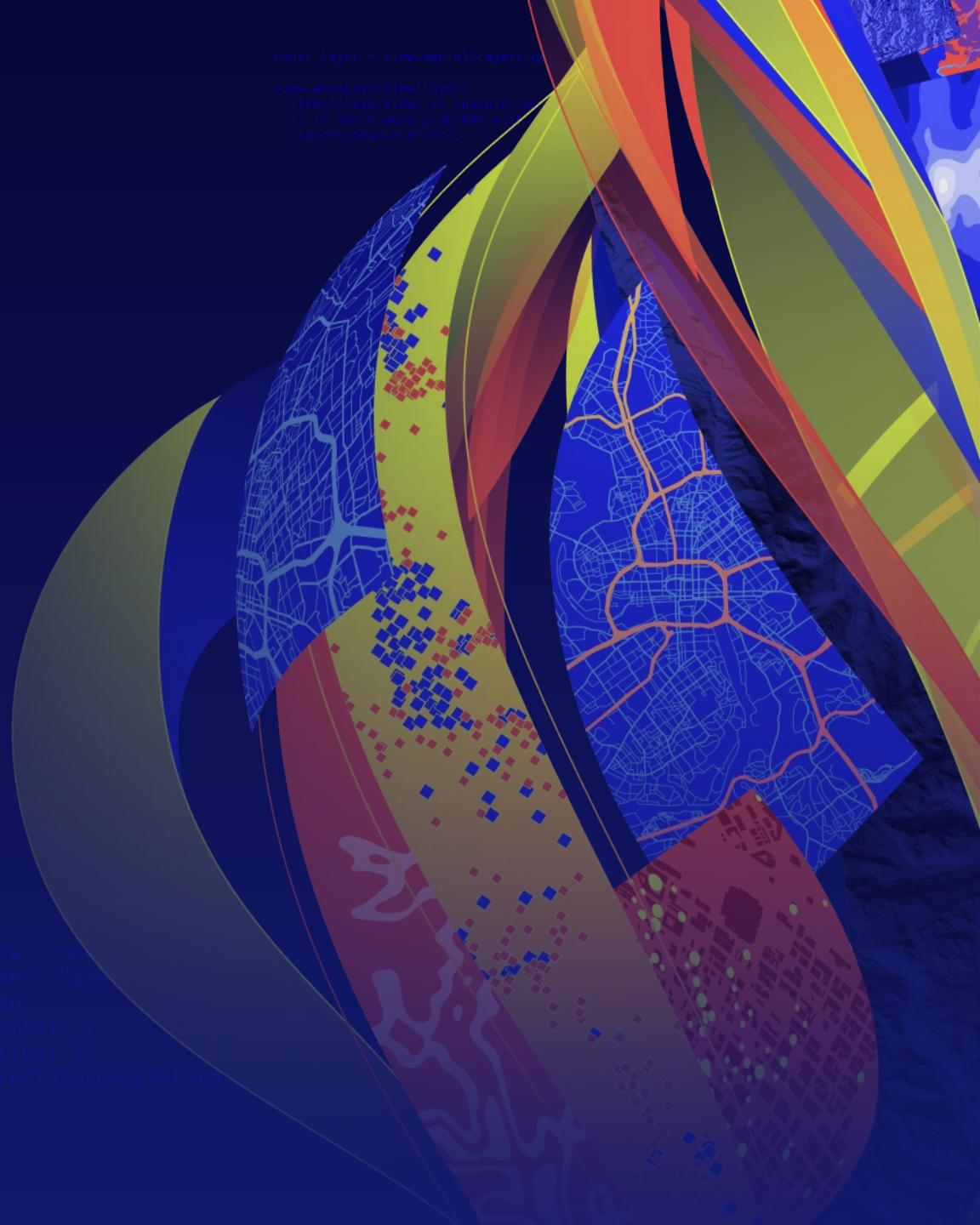
ArcGIS Maps SDK for JavaScript: Visualizing Change Over Time

Anne Fitz & Kristian Ekenes

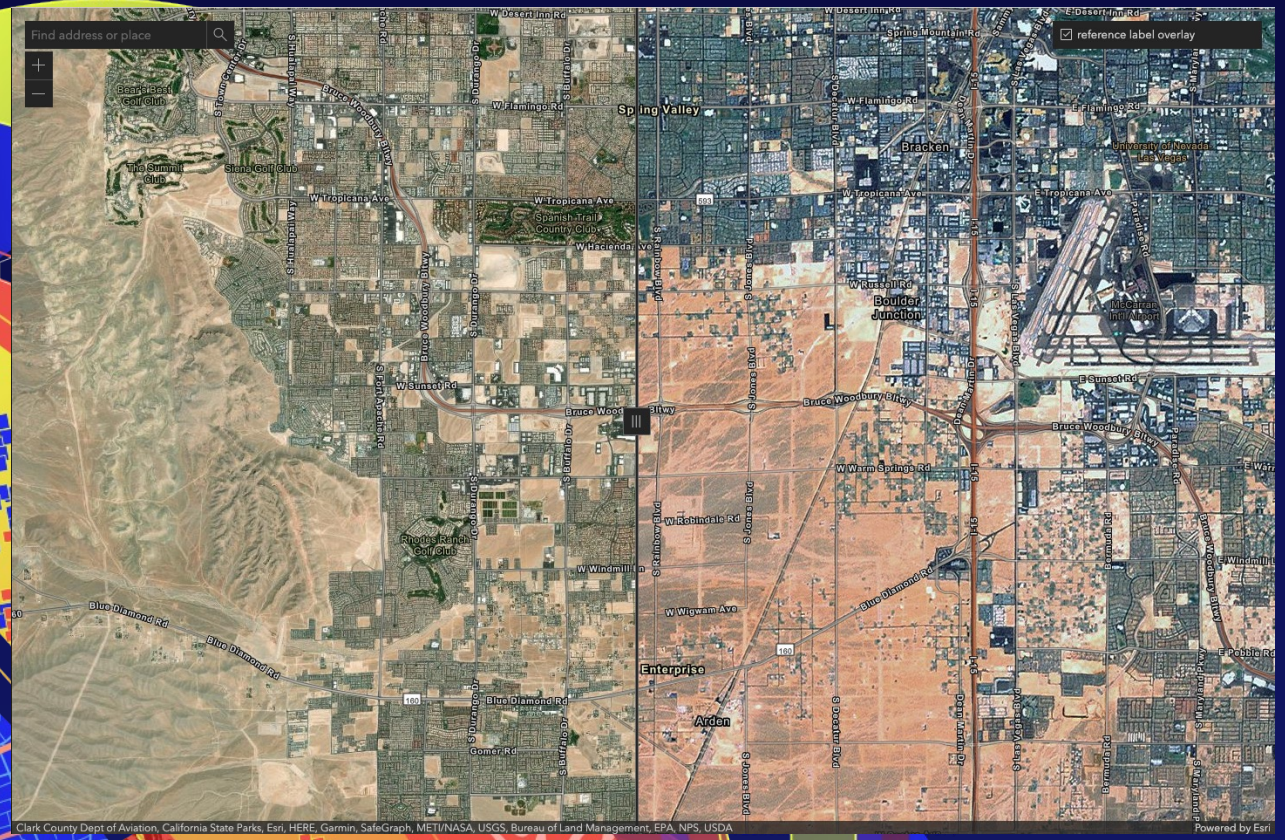
Session Overview

- Techniques for visualizing change over time
  - Swipe widget
  - Side by side comparison
  - Above and below style
- Animations!
  - Geometry animations
  - Distribution animations
  - Attribute animations

Techniques



```
nst view = new SceneView({
container: "viewDiv",
map: map,
environment: {
  lighting: {
    directShadowsEnabled: true
  }
```



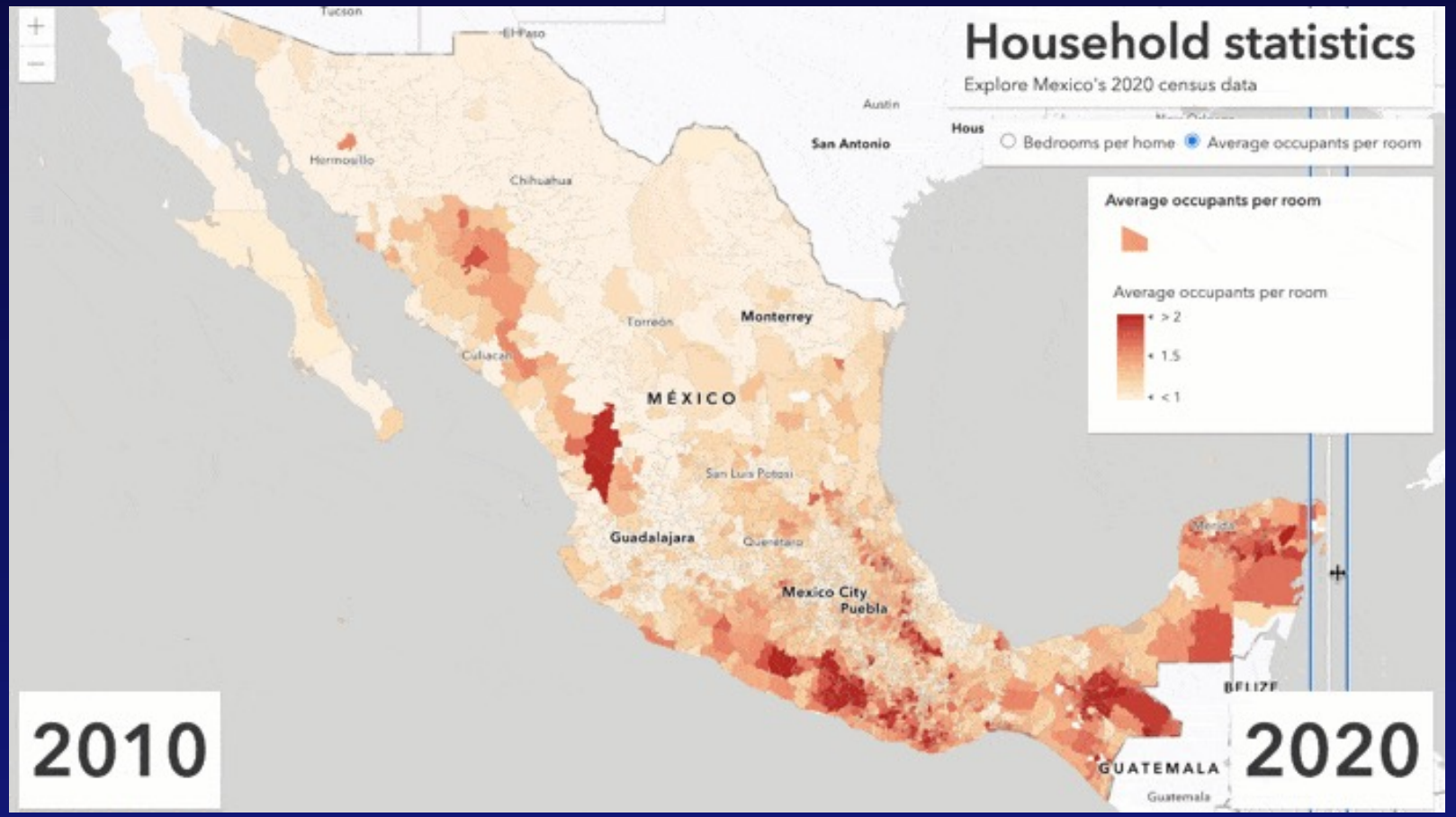
Swipe widget

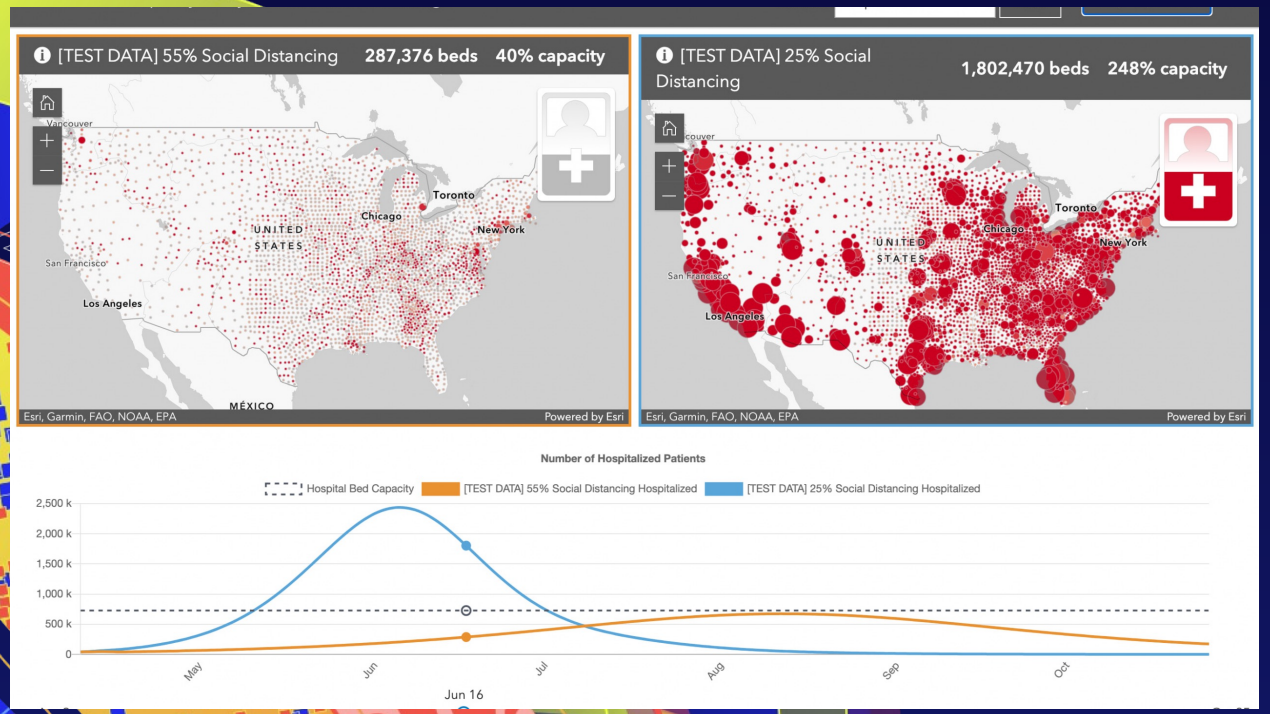
Anne Fitz

Swipe widget

- Drag the swipe handle to compare
- Use the same renderer on each layer for easy comparison

```
// create a new Swipe widget
const swipe = new Swipe({
  leadingLayers: [beds2010, ppl2010],
  trailingLayers: [beds2020, ppl2020],
  position: 85,
  view
});
// add the widget to the view
view.ui.add(swipe);
```



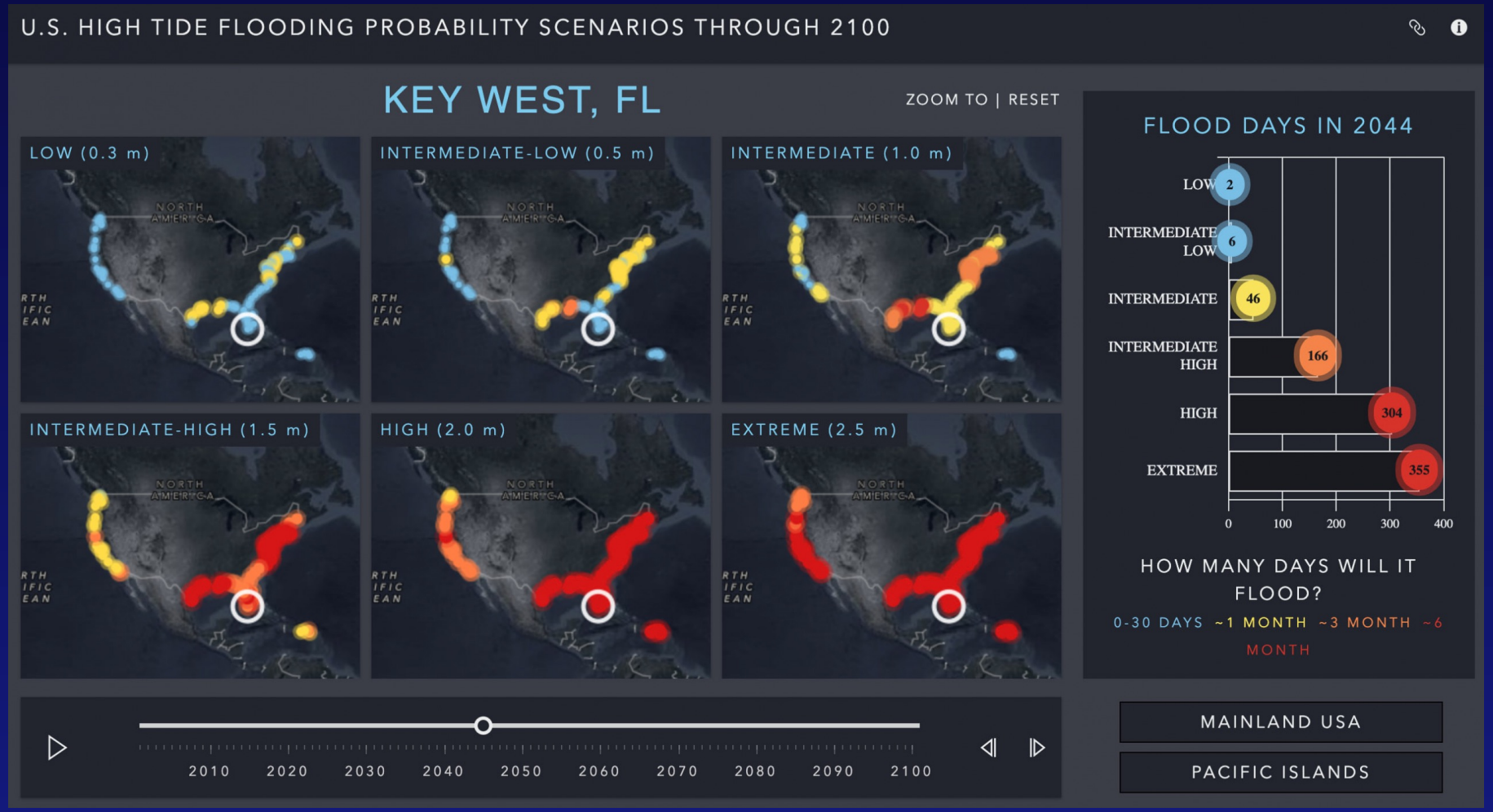


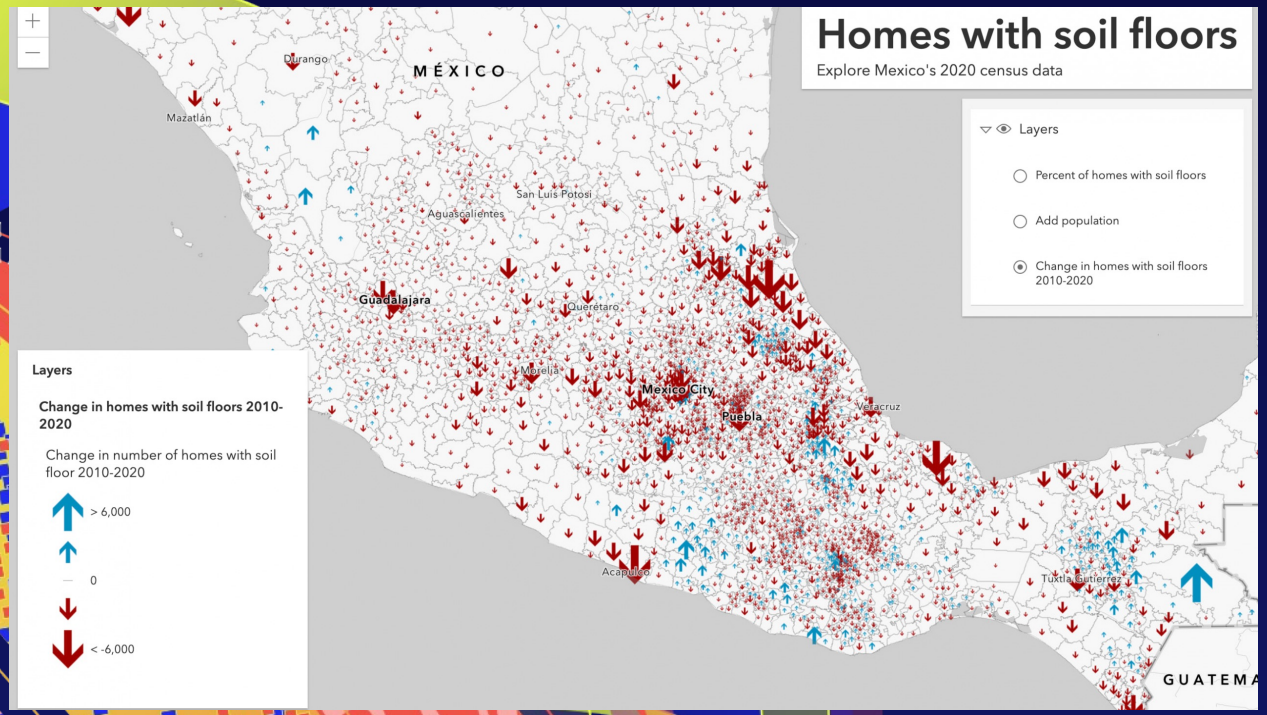
Side by side views

Anne Fitz

Side by side views

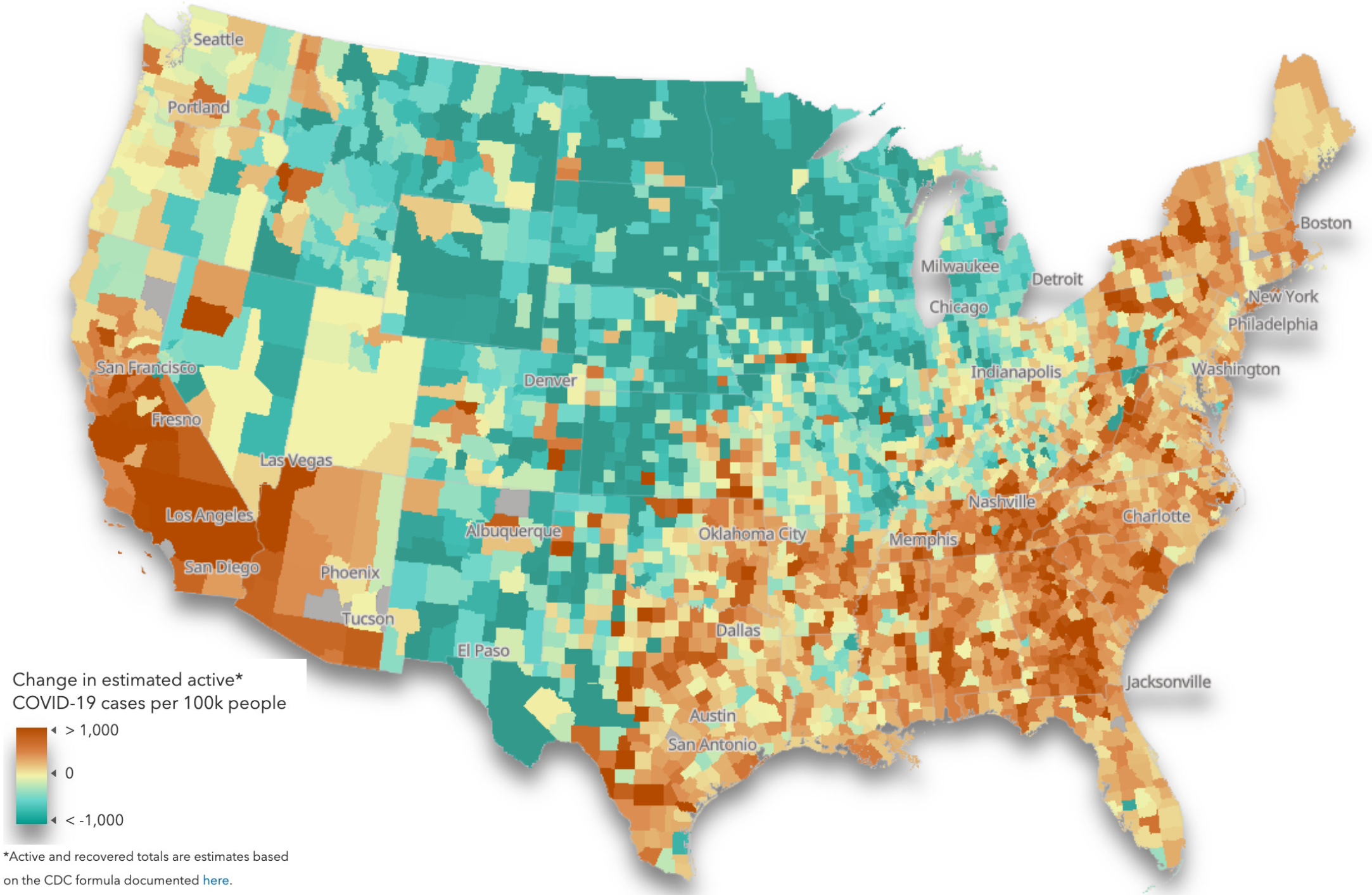
- See difference in change over time at one glance
- No user interaction required
- Works best with small-scale phenomena that show significant change over time

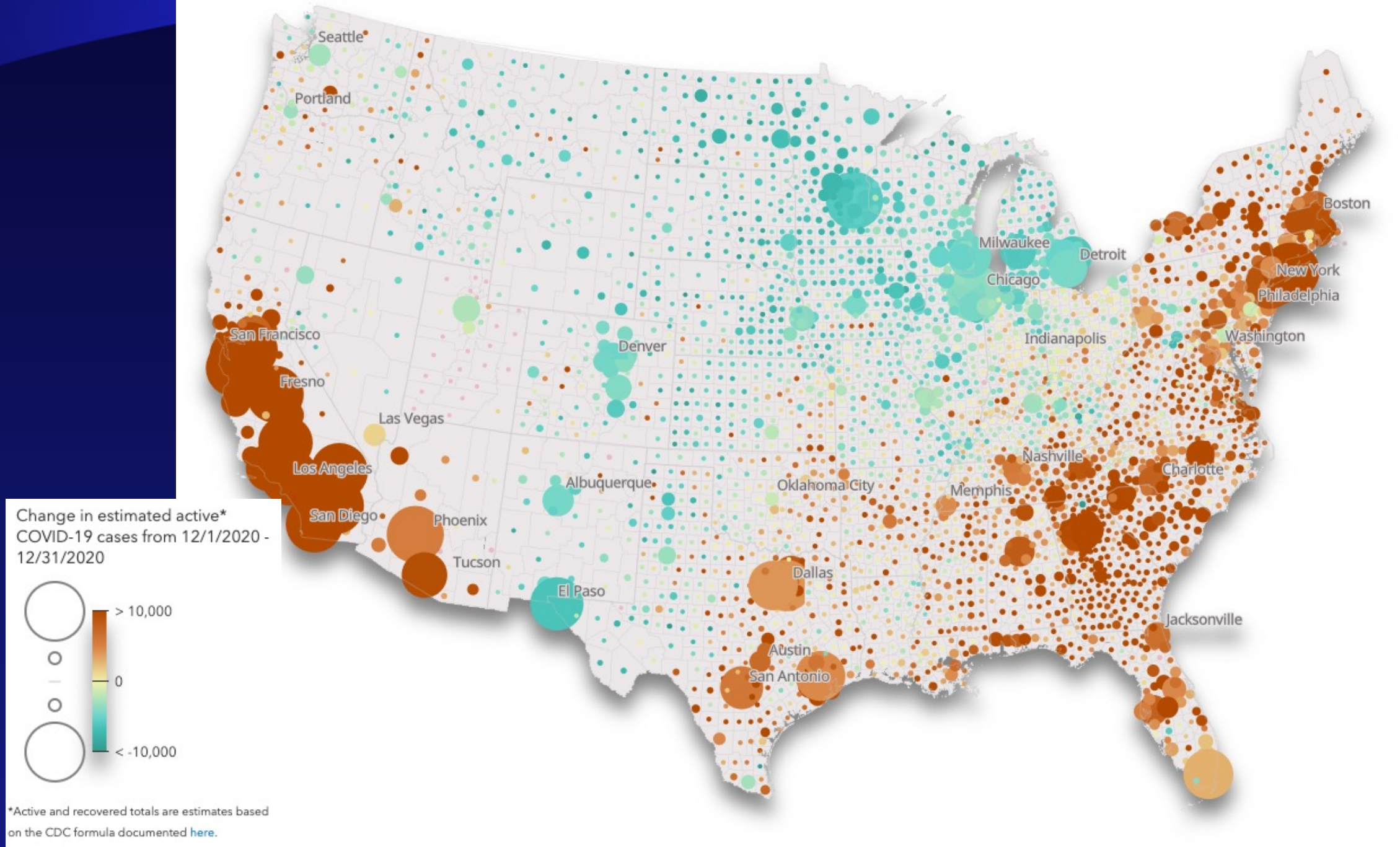




Above and Below theme

Kristian Ekenes


Seattle
Portland
San Francisco
Fresno
Las Vegas
Los Angeles
San Diego
Phoenix
Tucson
El Paso
Albuquerque
Denver
Oklahoma City
Dallas
Austin
San Antonio
Memphis
Nashville
Charlotte
Jacksonville
Indianapolis
Chicago
Milwaukee
Detroit
Washington
Philadelphia
New York
Boston
Change in estimated active* COVID-19 cases per 100k people
> 1,000
0
< -1,000
*Active and recovered totals are estimates based on the CDC formula documented here.


Seattle
Portland
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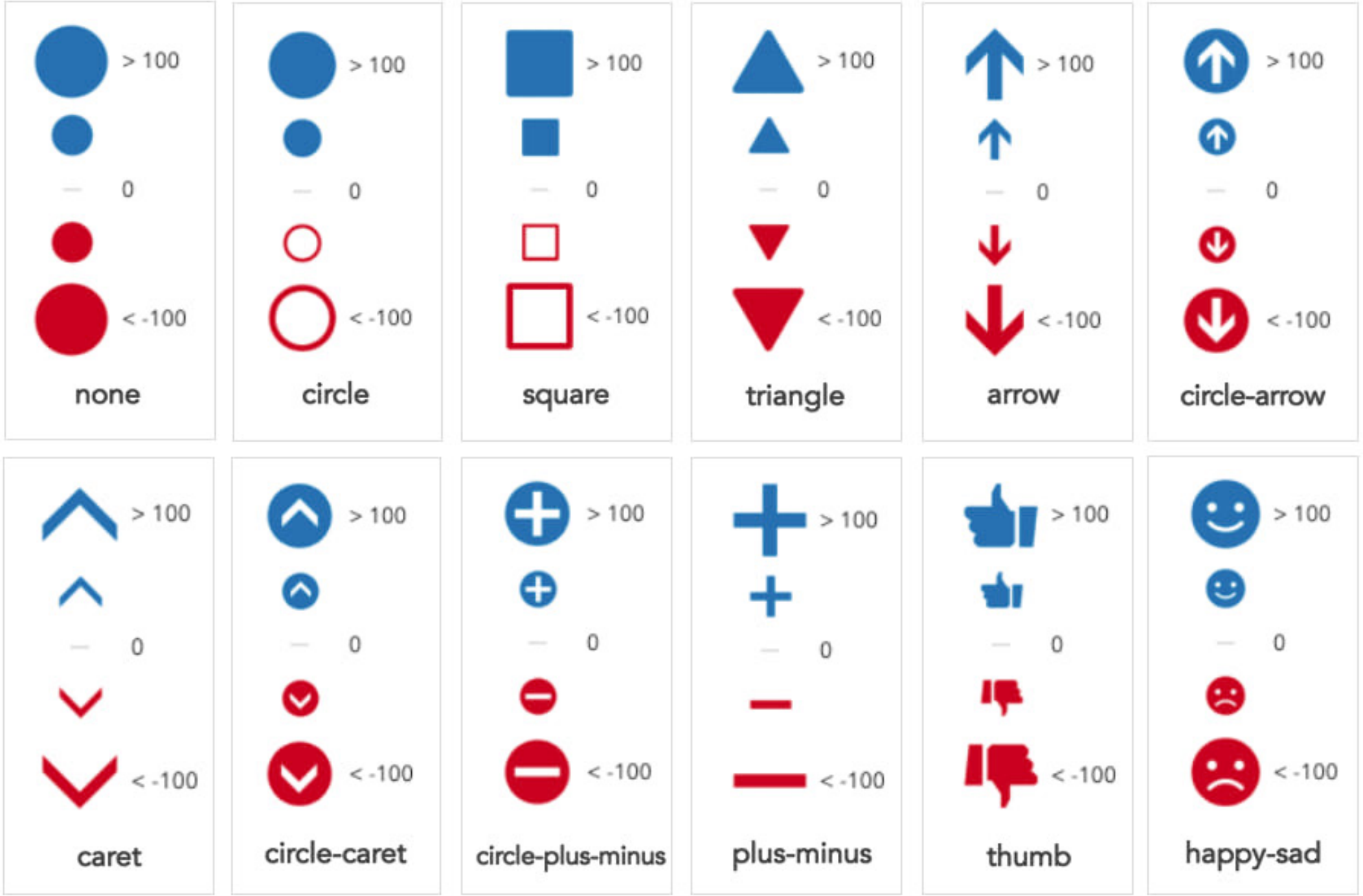
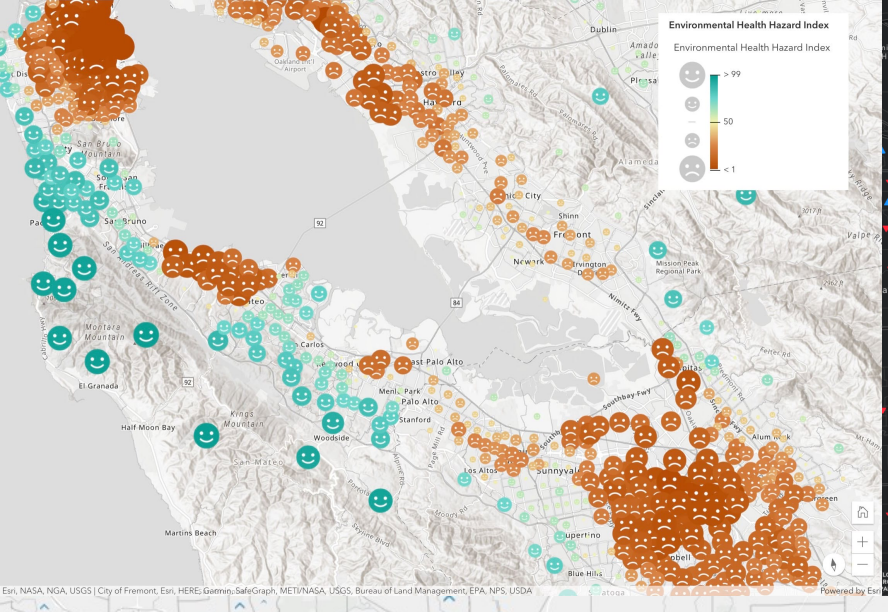
Las Vegas
Los Angeles
San Diego
Phoenix
Tucson
El Paso
Albuquerque
Denver
Oklahoma City
Dallas
Austin
San Antonio
Memphis
Nashville
Charlotte
Jacksonville
Indianapolis
Chicago
Milwaukee
Detroit
Boston
New York
Philadelphia
Washington
Change in estimated active* COVID-19 cases from 12/1/2020 - 12/31/2020
> 10,000
0
< -10,000
*Active and recovered totals are estimates based on the CDC formula documented here.


> 100
0
< -100
none
> 100
0
< -100
circle
> 100
0
< -100
square
> 100
0
< -100
triangle
> 100
0
< -100
arrow
> 100
0
< -100
circle-arrow
> 100
0
< -100
caret
> 100
0
< -100
circle-caret
> 100
0
< -100
circle-plus-minus
> 100
0
< -100
plus-minus
> 100
0
< -100
thumb
> 100
0
< -100
happy-sad


Environmental Health Hazard Index
Environmental Health Hazard Index
> 99
50
< 1
Esri, NASA, NGA, USGS | City of Fremont, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA
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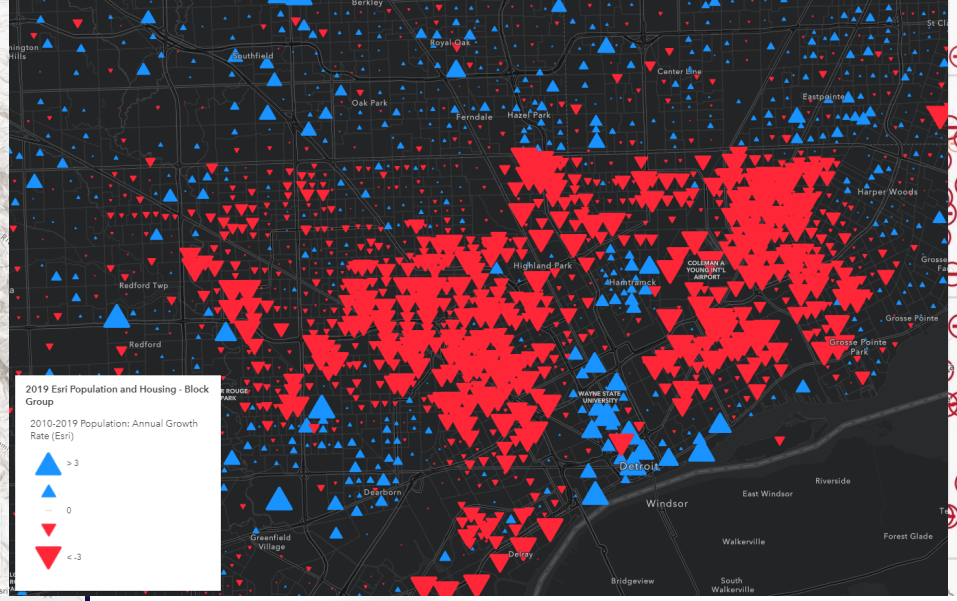
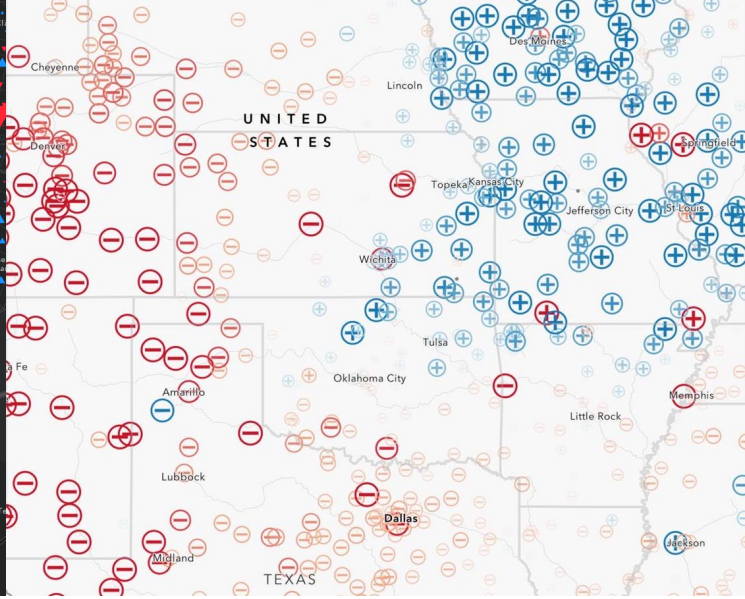
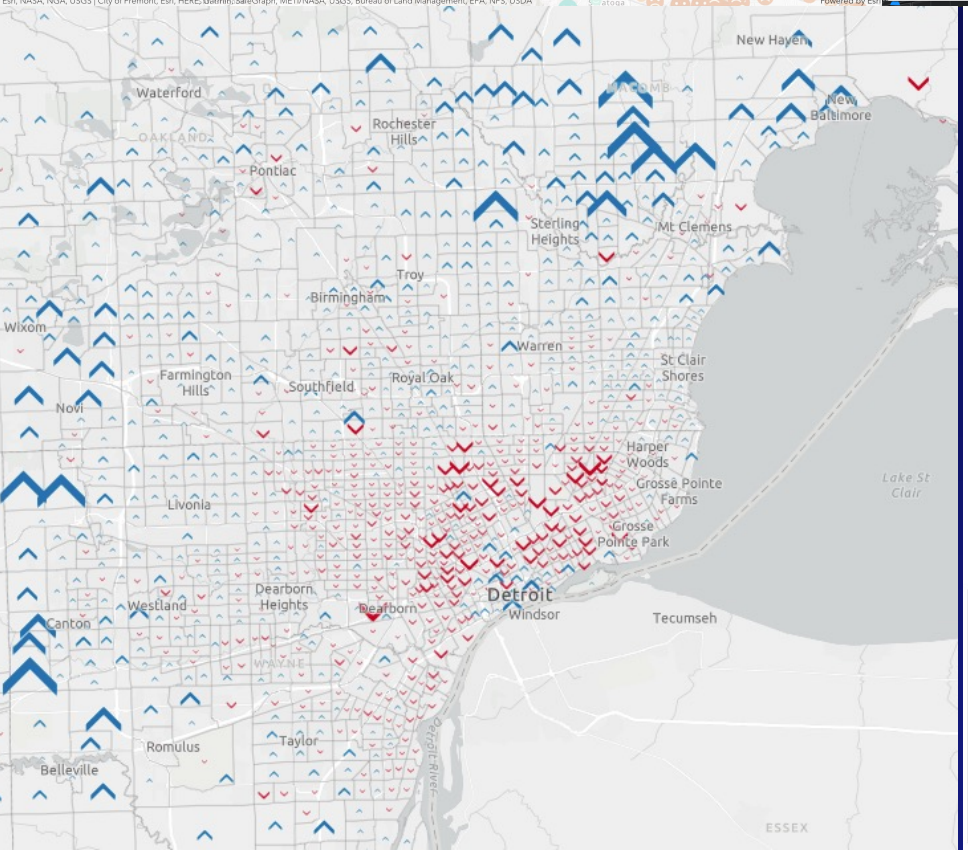

2019 Esri Population and Housing - Block Group
2010-2019 Population: Annual Growth Rate (Esri)
> 3
0
< -3
Detroit
Windsor
Dearborn
Hamtramck
Highland Park
Redford Twp
Redford
Grosse Pointe
Grosse Pointe Park
Harper Woods
East Windsor
Riverside
Walkerville
Forest Glade
Greenfield Village
Delray
Bridgeview
South Walkerville


UNITED STATES
TEXAS
Cheyenne
Denver
Lincoln
Des Moines
Topeka
Kansas City
Jefferson City
St Louis
Springfield
Wichita
Tulsa
Oklahoma City
Amarillo
Memphis
Little Rock
Lubbock
Dallas
Midland
Jackson


New Haven
Waterford
New Baltimore
Rochester Hills
Pontiac
Sterling Heights
Mt Clemens
Troy
Birmingham
Wixom
Warren
St Clair Shores
Farmington Hills
Southfield
Royal Oak
Novi
Harper Woods
Grosse Pointe Farms
Livonia
Grosse Pointe Park
Lake St Clair
Dearborn Heights
Dearborn
Detroit
Windsor
Tecumseh
Westland
Canton
Romulus
Taylor
Belleville
ESSEX


North Cascades
Glacier
Mount Rainier
Voyageurs
Isle Royale
Theodore Roosevelt
Acadia
Crater Lake
Redwood
Grand Teton
Badlands
Lassen Volcanic
Indiana Dunes
Cuyahoga Valley
Rocky Mountain
Yosemite
Great Basin
Shenandoah
Pinnacles
Arches
Gateway Arch
Death Valley
Great Sand Dunes
Mammoth Cave
Grand Canyon
Channel Islands
Great Smoky Mountains
Petrified Forest
Hot Springs
Congaree
Saguaro
Carlsbad Caverns
Big Bend
Gates of the Arctic
Denali
Wrangell-St. Elias
Glacier Bay
Katmai
Haleakala
Hawaii Volcanoes
Virgin Islands
Biscayne
Dry Tortugas
U.S. National Parks
% Change in park visitation (2017 - 2018)
> 100
0
< -100

Above and below theme

- View growth or decline over time at one glance
- Requires calculating the change between two variables

```
const renderer = new ClassBreaksRenderer({
  valueExpression: "$feature.SoilHomes2020 - $feature.SoilHomes2010",
  valueExpressionTitle: "Change in homes with soil floors 2010-2020",
  classBreakInfos: [{
    minValue: -6000,
    maxValue: 0,
    symbol: belowArrowSymbol
  }, {
    minValue: 0,
    maxValue: 6000,
    symbol: aboveArrowSymbol
  }]
});
```

2016 Presidential Election Results

AUG. 9, 2017, 9:00 AM ET

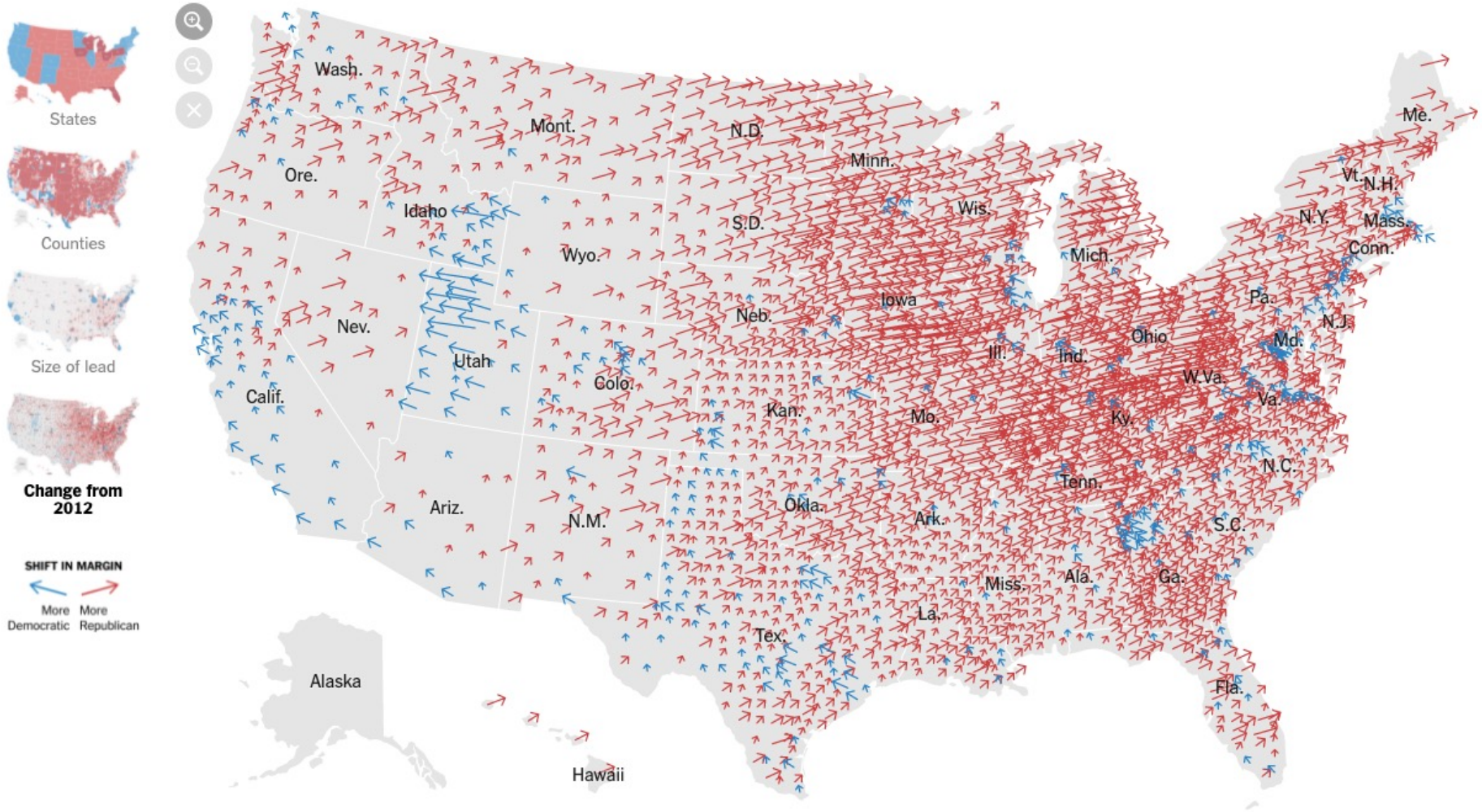
In 2016, Donald J. Trump won the Electoral College with 304
votes for Hillary Clinton. Seven electors voted for someone otl
candidate. Visit our 2020 election results pages for the latest updates.

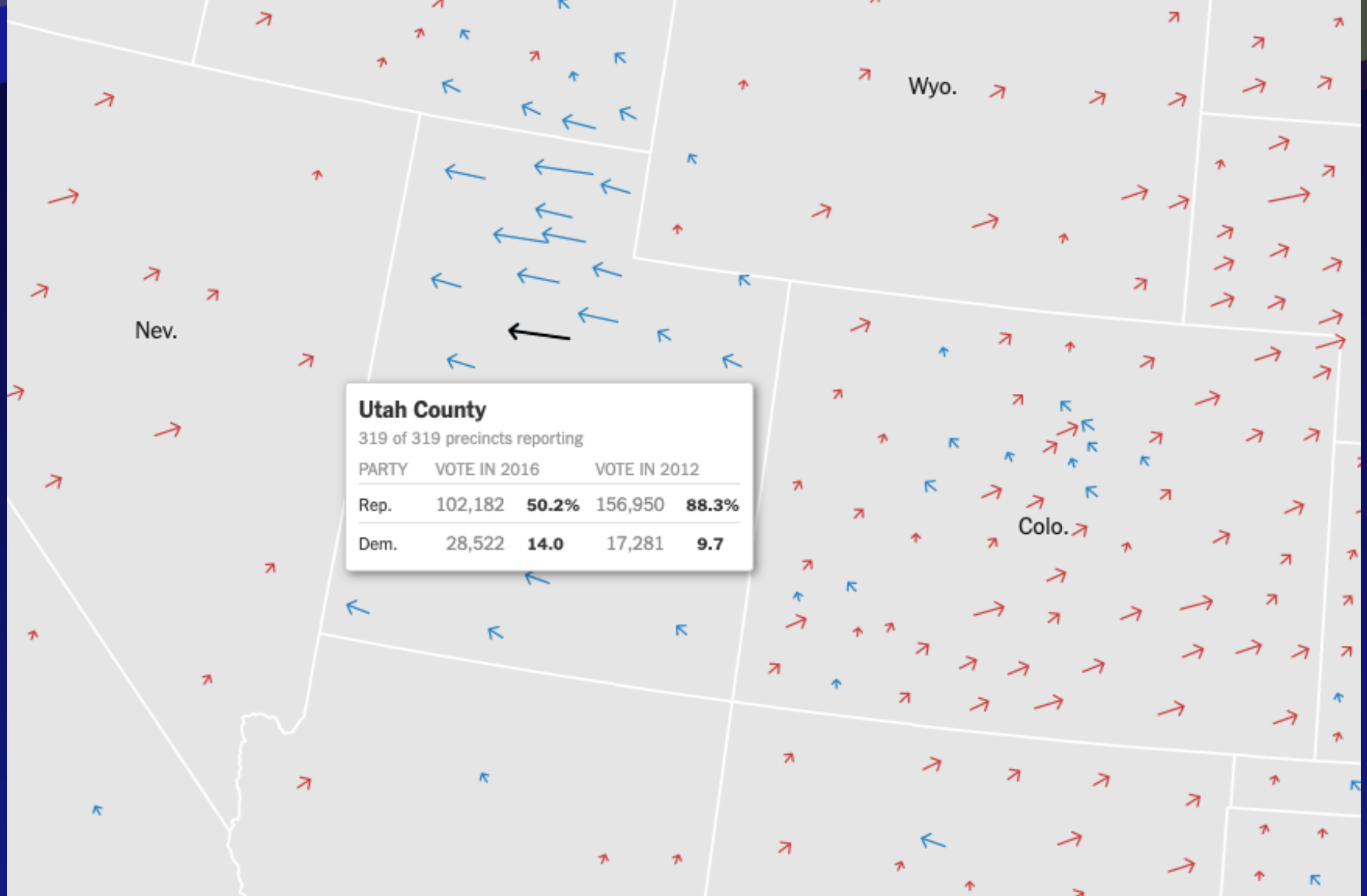
Not all changes over time are binary above and below changes!

232 Hillary Clinton

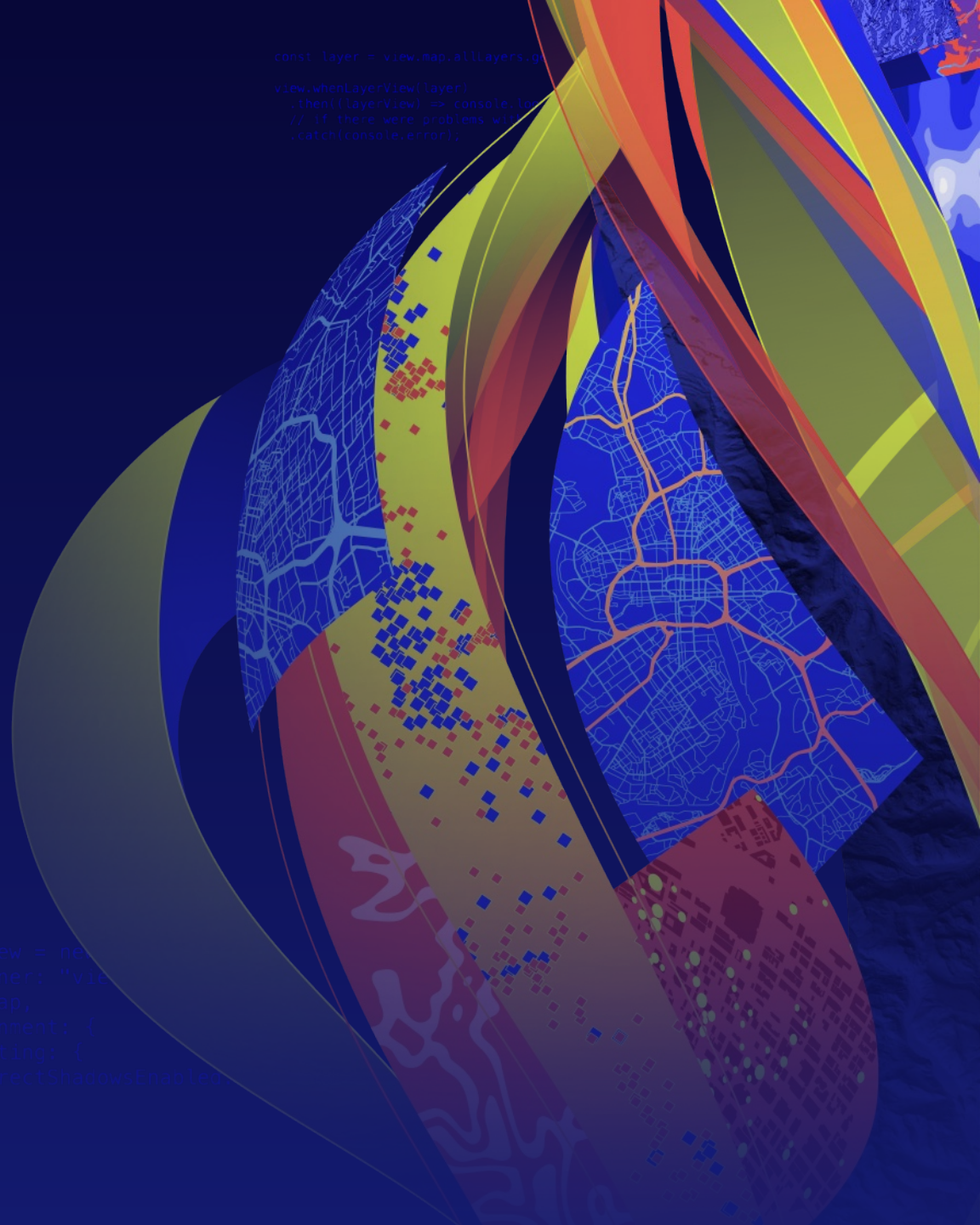
Donald J. Trump **306**

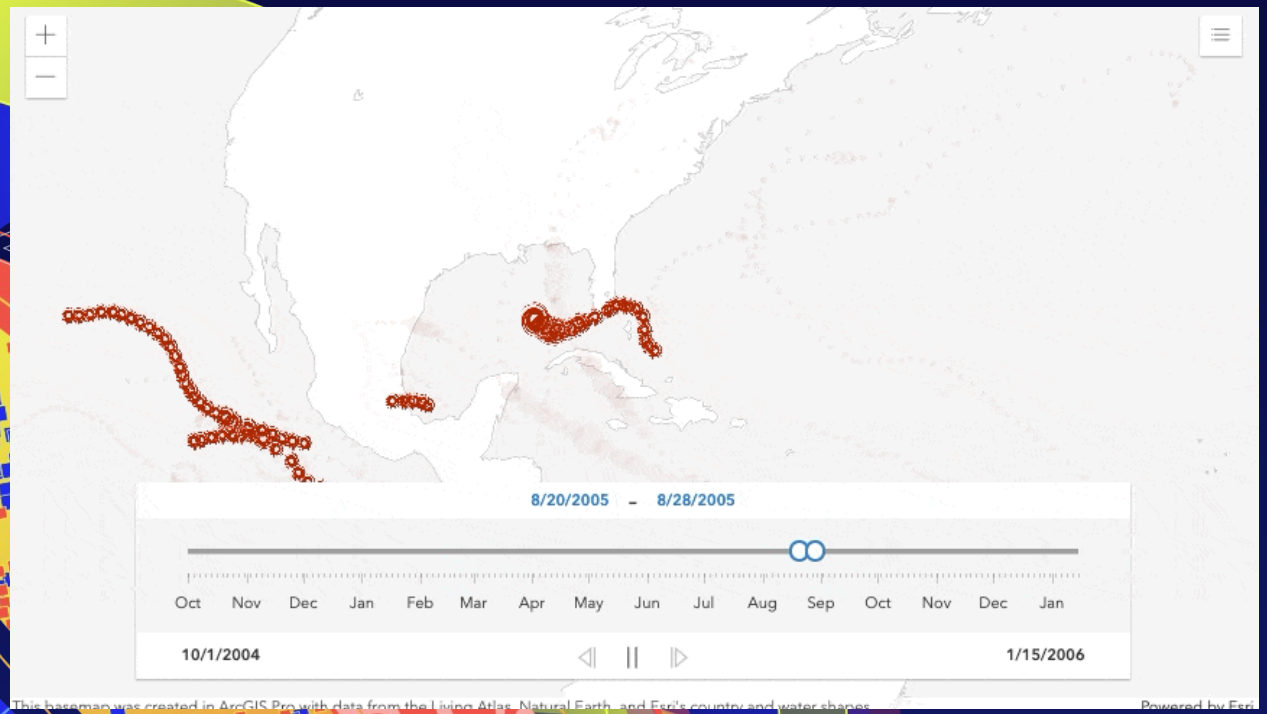
65,853,625 votes (48.0%) — 270 to win — 62,985,106 votes (45.9%)




Wyo.
Nev.
Colo.
Utah County
319 of 319 precincts reporting
PARTY VOTE IN 2016 VOTE IN 2012
Rep. 102,182 50.2% 156,950 88.3%
Dem. 28,522 14.0 17,281 9.7

Animations





Geometry animations

Anne Fitz

Geometry animations

- Visualizes features that change position or geometry over time
- Filtering feature visibility based on time extent

Data Structure
Each row in the data table should contain a unique geometry & time stamp

Category	Longitude	Latitude	Serial_Num	Season	Name	ISO_time	Nature
0	80.5	-9.800000191	1991158S10080	1,991	GRITELLE	6/6/1991, 11:00 AM	TS
0	79.80000305	-10	1991158S10080	1,991	GRITELLE	6/6/1991, 5:00 PM	TS
0	79.09999847	-10	1991158S10080	1,991	GRITELLE	6/6/1991, 11:00 PM	TS
0	78.30000305	-10	1991158S10080	1,991	GRITELLE	6/7/1991, 5:00 AM	TS
0	77.5	-10	1991158S10080	1,991	GRITELLE	6/7/1991, 11:00 AM	TS
0	76.59999847	-10	1991158S10080	1,991	GRITELLE	6/7/1991, 5:00 PM	TS
1	147.0800018	-11.52999973	2007317S11150	2,008	GUBA	11/16/2007, 4:00 AM	NR
1	147.1399994	-11.52000046	2007317S11150	2,008	GUBA	11/16/2007, 10:00 AM	NR
1	147.3200073	-11.25	2007317S11150	2,008	GUBA	11/16/2007, 4:00 PM	NR

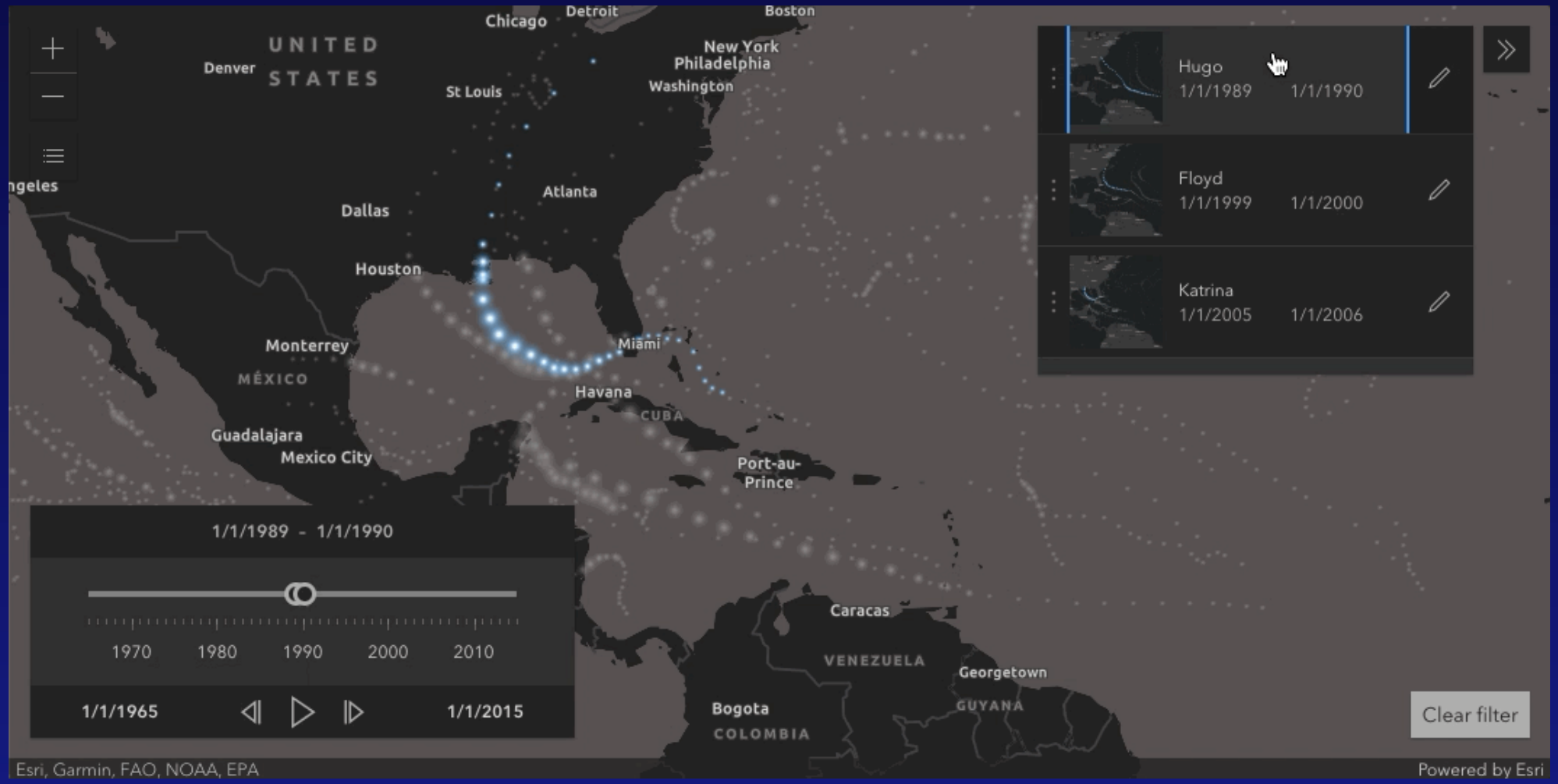
TimeSlider widget

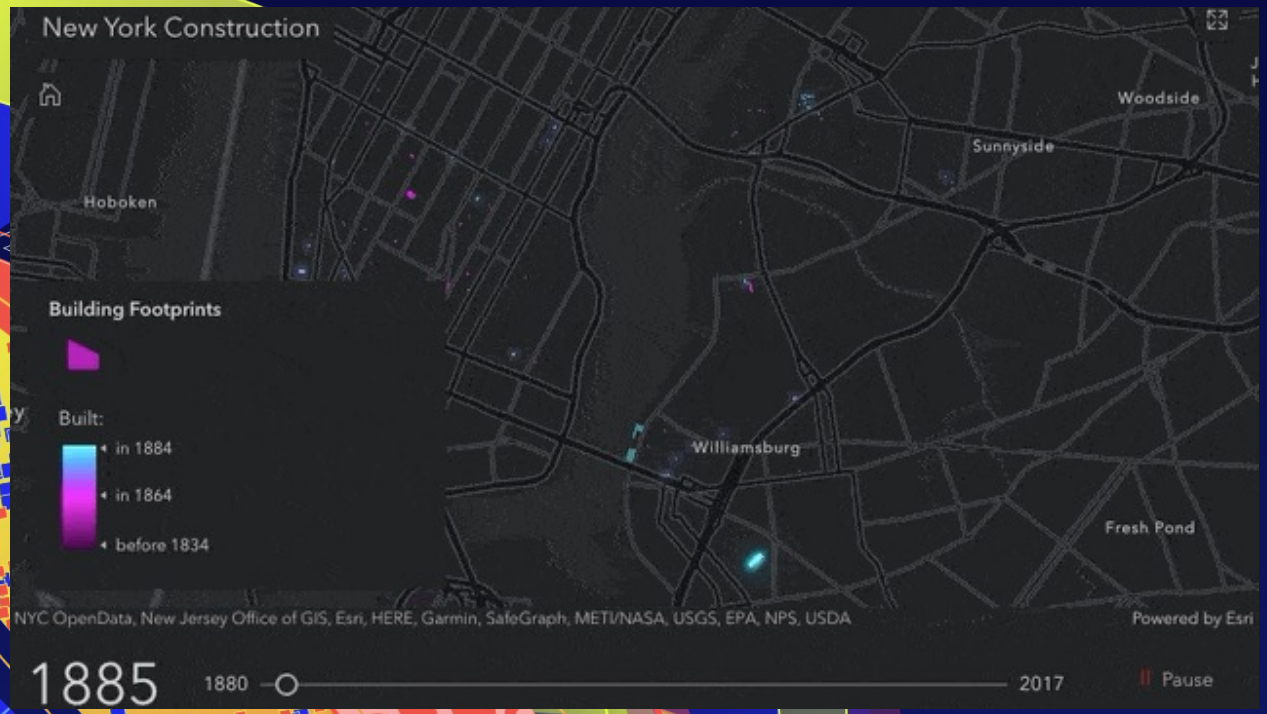
- Simplifies visualization of temporal data
- **Configuring the timeslider**
  - Update the view's time extent (minimal configuration)
  - Watch the TimeSlider's time extent (provides more control)

```
const timeSlider = new TimeSlider({
  container: "timeSlider",
  playRate: 30,
  mode: "time-window",
  fullTimeExtent: {
    start,
    end
  },
  values: [ start, next ],
  stops: {
    interval: {
      value: 6,
      unit: "hours"
    }
  },
  view: view
});
view.ui.add(timeSlider, "manual");
```

```
timeSlider.watch("values", function(values){
  trackLayerView.filter = {
    timeExtent: {
      start,
      end: values[1]
    }
  }
});
```

Time enabled Bookmarks





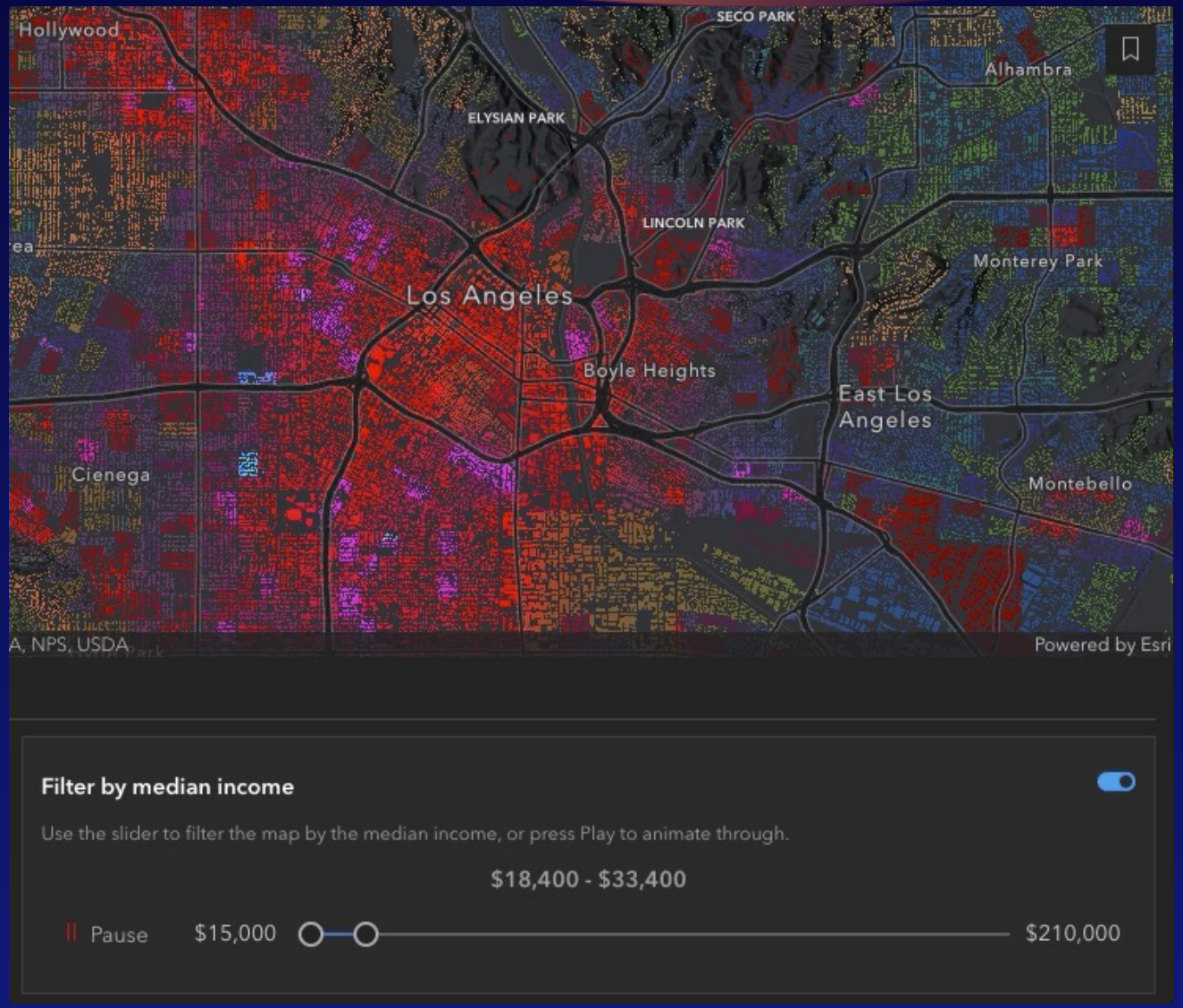
Distribution animations

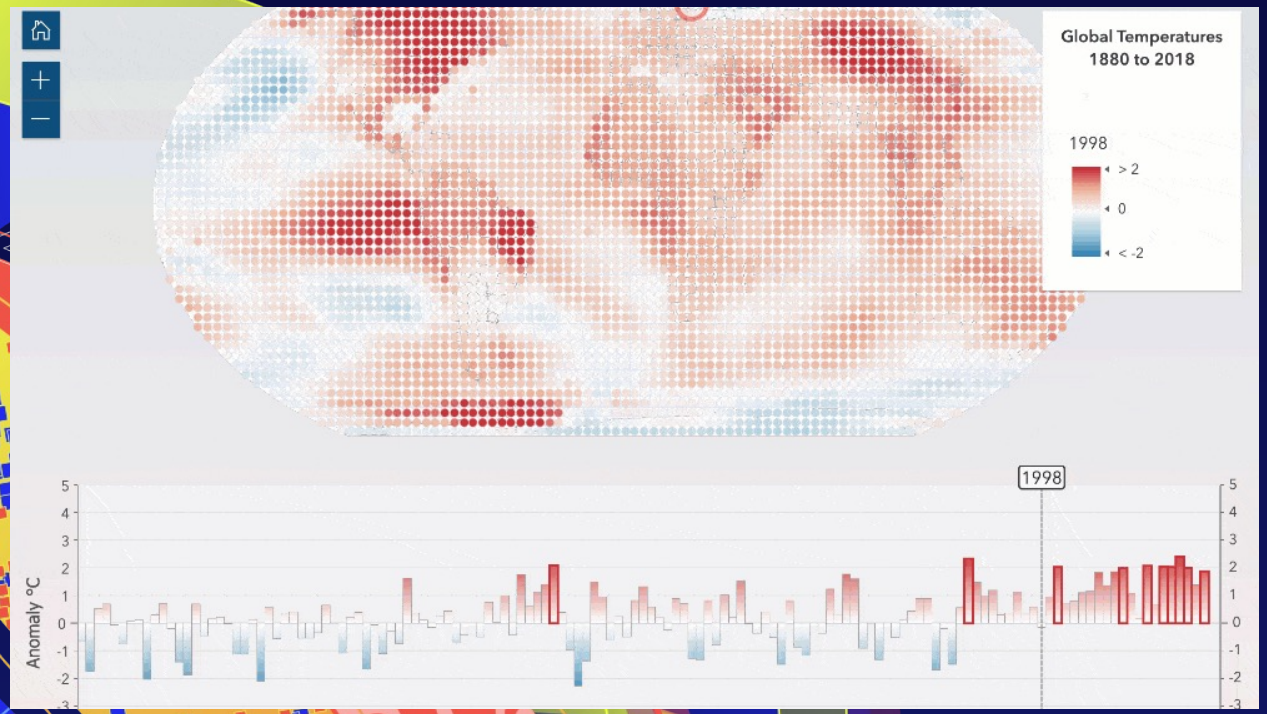
Kristian Ekenes

Distribution animation

- Visualizes the distribution of features over time or another variable
- Good technique for visualizing increases and decreases
- *Does not involve moving features*

Data Structure
Each row in the data table should represent a static object in the map, such as a building or block group, with a time field, sequence number or variable to animate





Attribute animations

Kristian Ekenes

Attribute animations

- Change a renderer's data or attribute value
- Features have fixed location

Data Structure
Each feature is represented by a single row in the table with multiple columns containing the value of an attribute at different time periods or intervals.

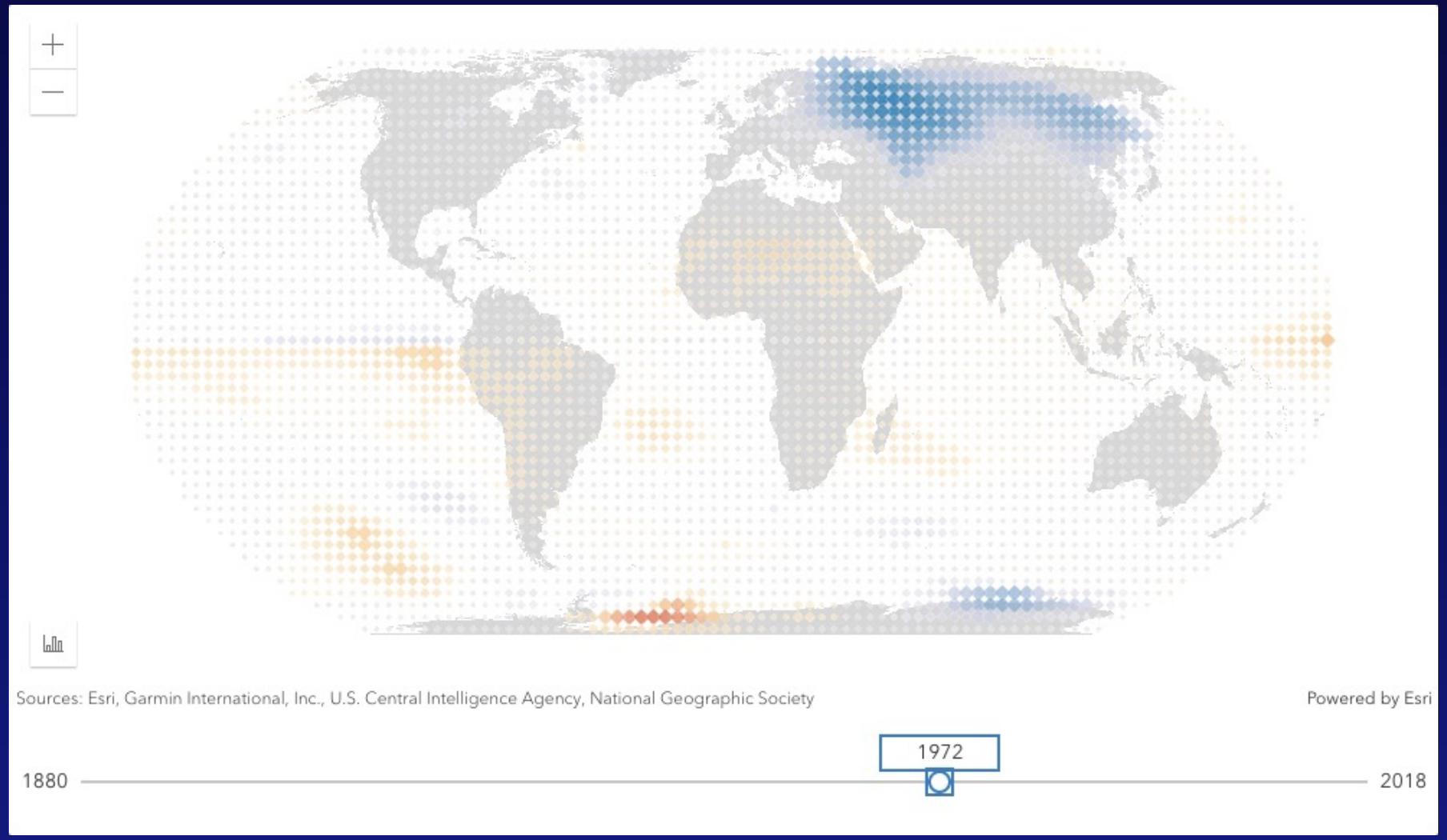
Yearly Temperature Anomaly by Time (Features: 2592, Selected: 1)

Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019
0.58	0.13	0.25	0.30	0.43	1.04	0.64	0.48	0.80
0.42	0.33	0.35	0.34	0.40	1.15	0.78	0.46	1.07
0.06	0.27	0.24	0.32	0.20	0.92	0.61	0.61	1.11
0.04	0.39						0.64	1.10
0.56	0.52						0.76	0.98
0.71	0.49						0.42	0.84
0.64	0.55						0.84	0.84
0.81	0.52						1.18	0.61
	0.52						1.53	0.71
	1.18						1.20	1.09
	0.98						1.00	0.89
	0.76						1.15	0.97
	0.85	0.33	1.85	1.61	1.03	1.28	2.14	1.69
	0.45	0.06	1.75	1.04	1.06	0.97	1.51	1.42
	0.22	0.17	1.57	0.89	1.01	0.88	1.13	1.00

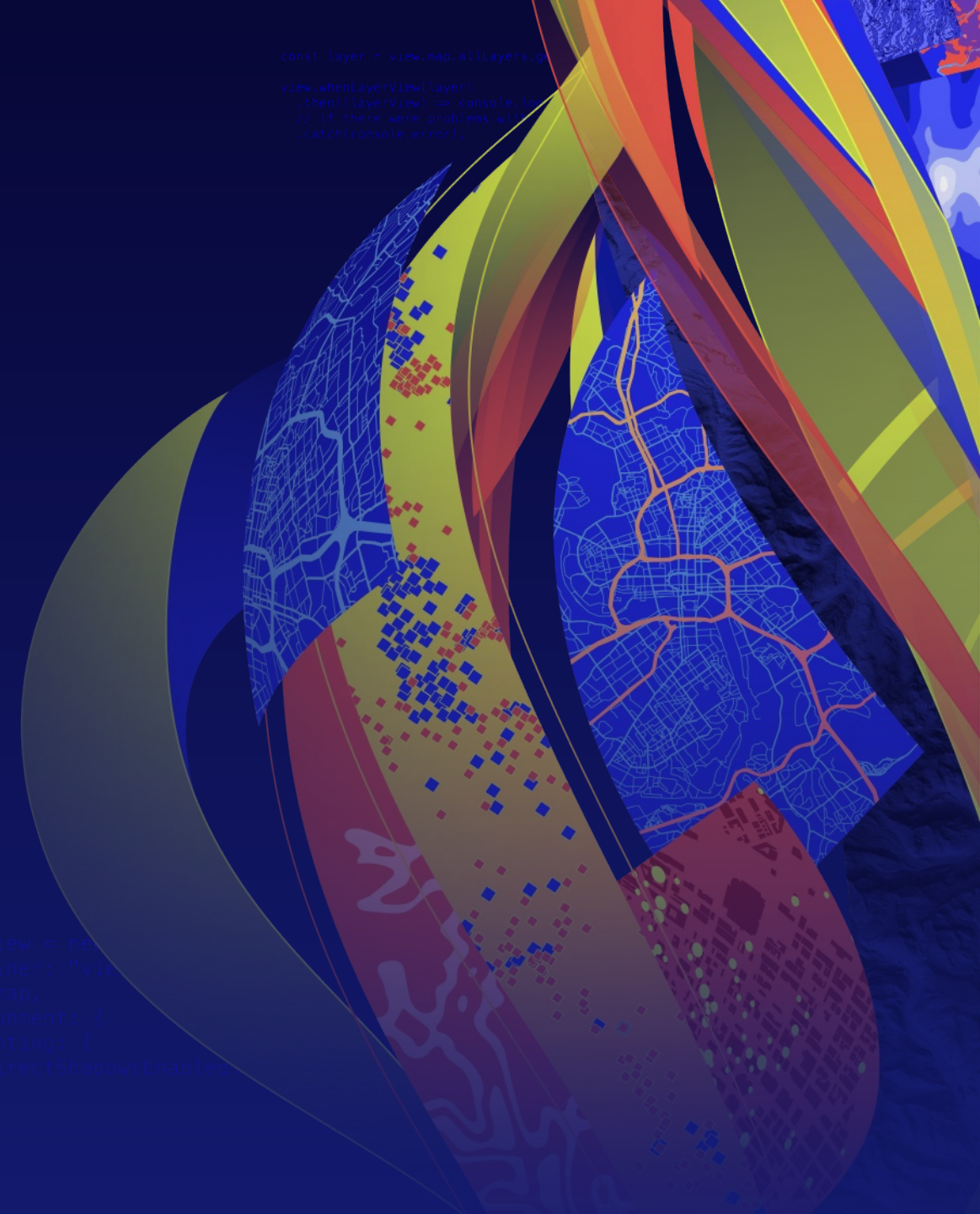
```
function updateRenderer(value) {
  renderer = layer.renderer.clone();
  const sizeVariable = renderer.visualVariables[0];
  const colorVariable = renderer.visualVariables[1];

  sizeVariable.valueExpression = getSizeValueExpression(value);
  colorVariable.field = `F${value}`;

  renderer.visualVariables = [sizeVariable, colorVariable];
  layer.renderer = renderer;
}
```


Sources: Esri, Garmin International, Inc., U.S. Central Intelligence Agency, National Geographic Society
Powered by Esri
1880
1972
2018

Conclusion



When to use which technique

Technique	Number of frames to compare	Data format	Suggested use
Swipe widget	2	Two layers in one view. Same renderer config pointing to different fields representing different values for the same variable.	Good for showing absolute numbers for both frames.
Above and below theme	2	One layer with above and below color scheme with Arcade expression subtracting difference between fields.	Good for showing change in numbers between frames.
Side by side views	2-8	One view per frame. Can point to same layer with same renderer config but pointing to different fields for each frame.	Good for showing absolute numbers in each frame and change over time for a few key frames.
Animations	100+	Multiple formats. Typically, one layer in one view with a TimeSlider. See next slide.	Good for showing many changes over long periods of time. Compelling and engaging.

When to use which animation technique

Data structure	Geometry Animation	Distribution Animation	Data Animation
Moving positions or changing geometry	●		
A fleeting event in time and location	●		
One feature with its time of creation	●	●	
Changing data values in the same location			●

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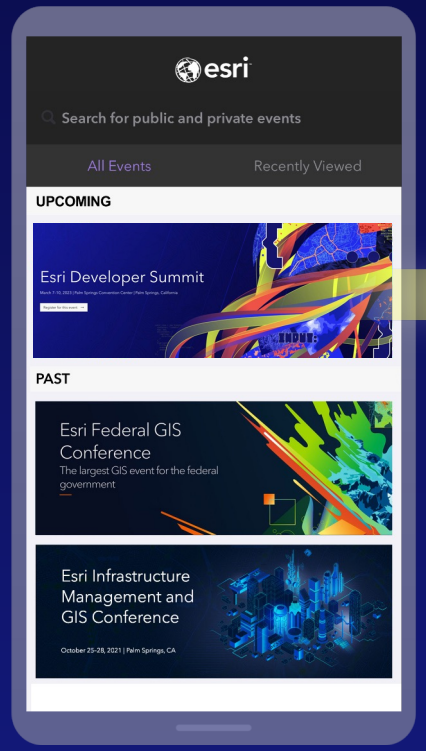
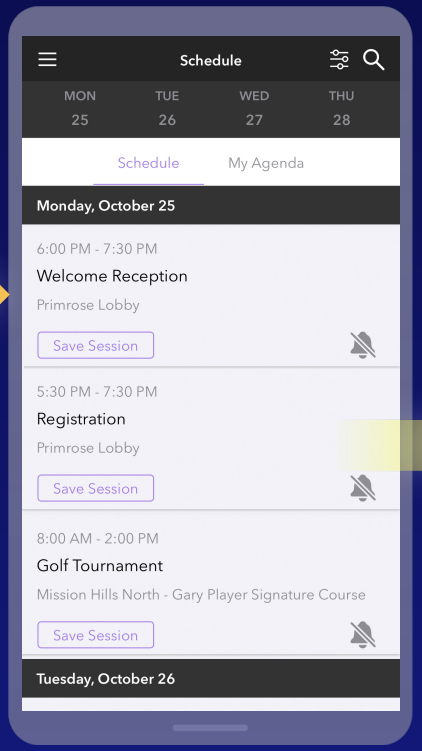
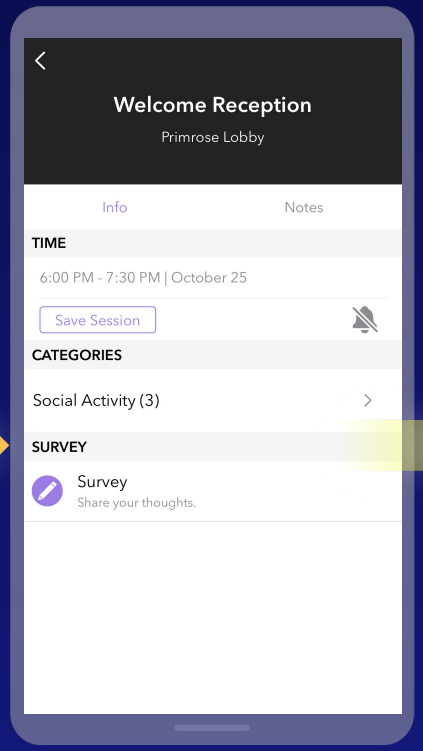
Download the Esri Events app and find your event



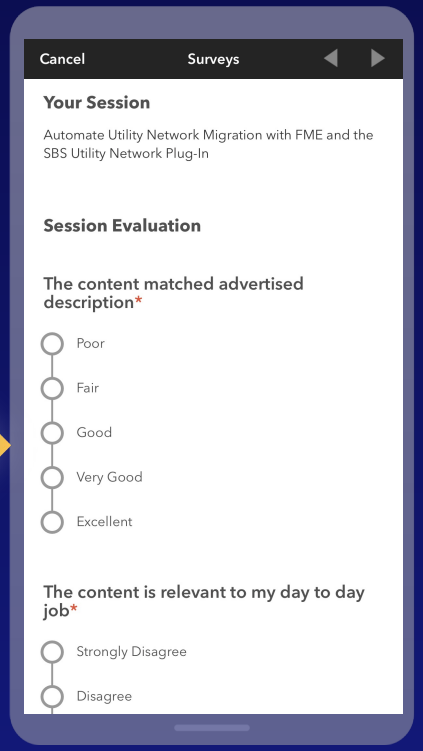
Select the session you attended



Scroll down to “Survey”



Log in to access the survey



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