

IT'S HOT IN HERE: EXAMINING 100M TEMPERATURE READINGS TO UNDERSTAND GLOBAL WARMING

alteryx | The Thrill
of Solving

PRESENTED BY

Ken Black

datablends@gmail.com

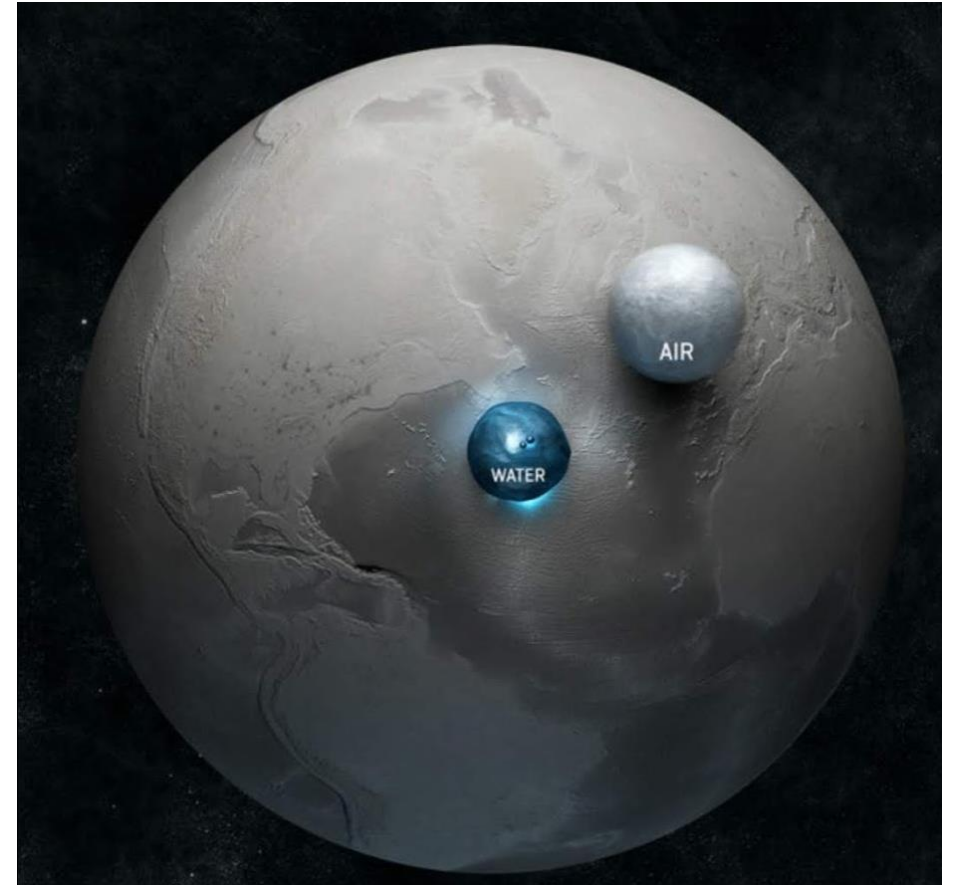
TODAY'S AGENDA

- 1. Introductions**
Who is Ken?
- 2. Global Warming Definition**
What do people think they know about this topic?
- 3. Temperature Data Basics**
The data used for this study.
- 4. The Role of Alteryx**
Transforming >100M temperature readings.
- 5. Understanding Daily Weather Variation**
What do we understand about daily temperatures?
- 6. Comprehending Six Decades of Temperature Change**
Using visualizations to understand the spatial and temporal changes in daily temperatures over 57 years

WHO IS KEN?

Background

- Geologist/Hydrogeologist
- Computer Programmer
- Applied Mathematician/Numerical Computations
- Process Improvement
- Alteryx ACE
- Tableau Zen Master
- Data Scientist/Advanced Analytics at General Motors
- Independent Global Warming Researcher



GLOBAL WARMING DEFINITION

Q: What is global warming?

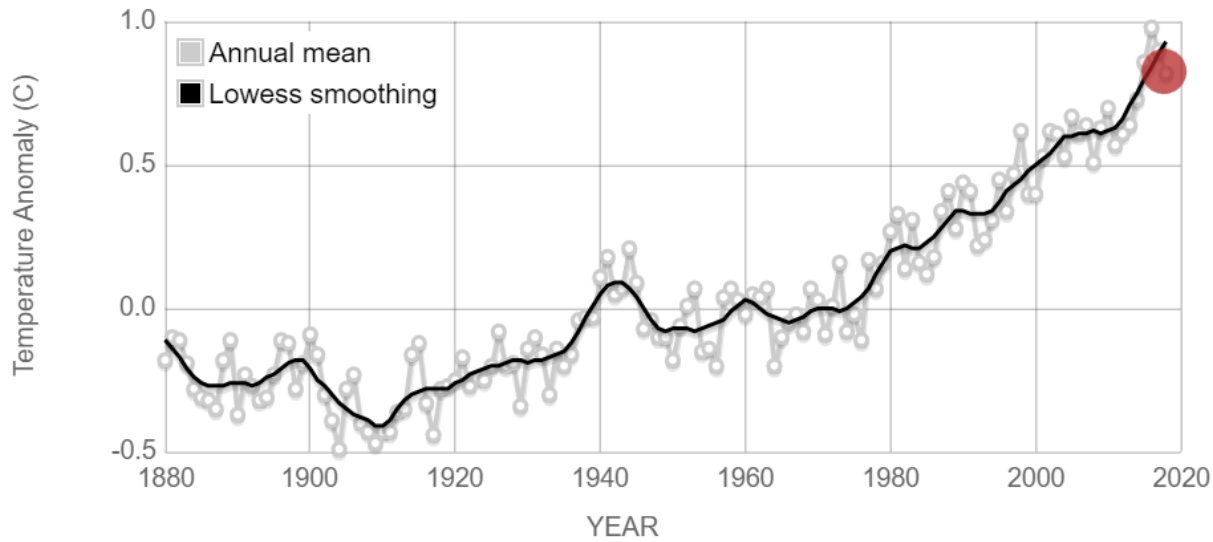
A: Here's a simple definition of global warming. (And yes, it's really happening.) Over the past 50 years, the average global temperature has increased at the fastest rate in recorded history. And experts see the trend is accelerating: All but one of the 16 hottest years in NASA's 134-year record have occurred since 2000.

[National Defense Research Council](#)

GLOBAL WARMING TRENDS

GLOBAL LAND-OCEAN TEMPERATURE INDEX

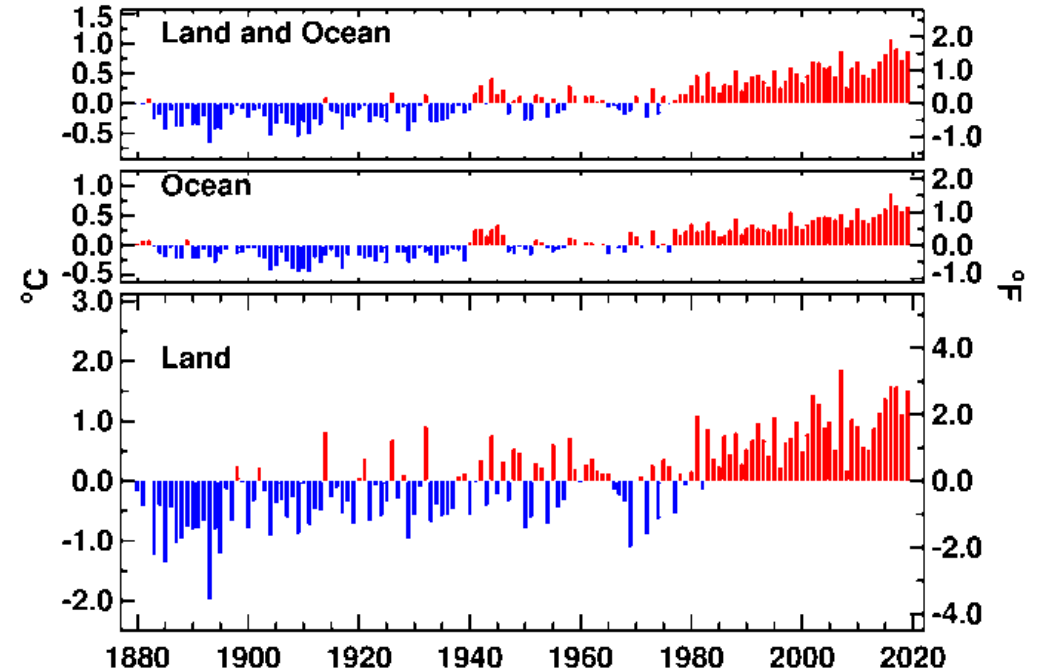
Data source: NASA's Goddard Institute for Space Studies (GISS).
Credit: NASA/GISS



January Global Surface Mean Temp Anomalies

NCEI/NESDIS/NOAA

Analysis is based upon Smith et al. (2008) methodology.



[Source NASA](#)

[Source NOAA](#)

GLOBAL WARMING IMPACTS

[The Most Comprehensive Analysis of Global Warming Impacts](#)



BBC

CLIMATE CHANGE – THE FACTS

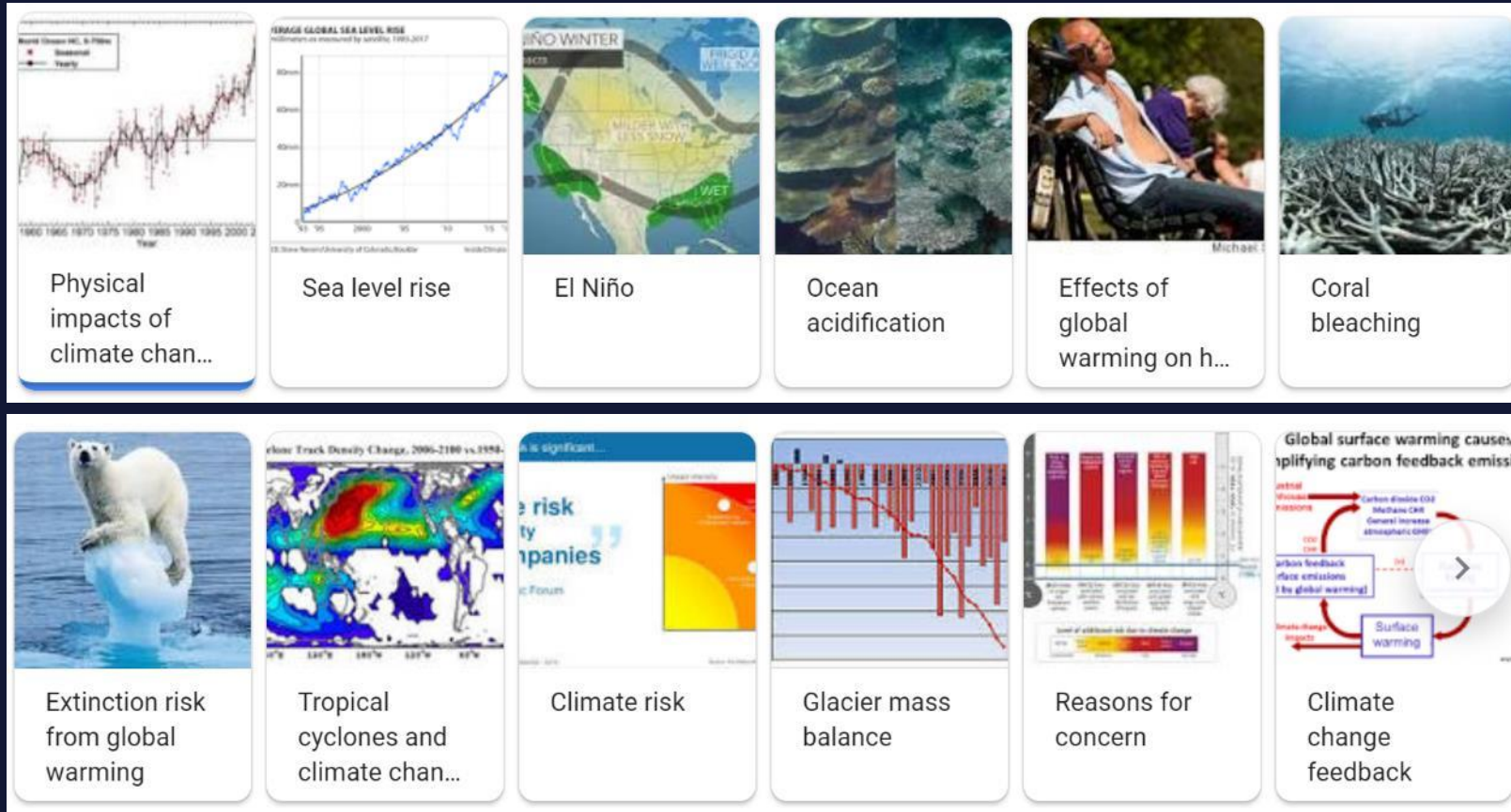
presented by
DAVID ATTENBOROUGH

Play (k)

2:32 / 57:31

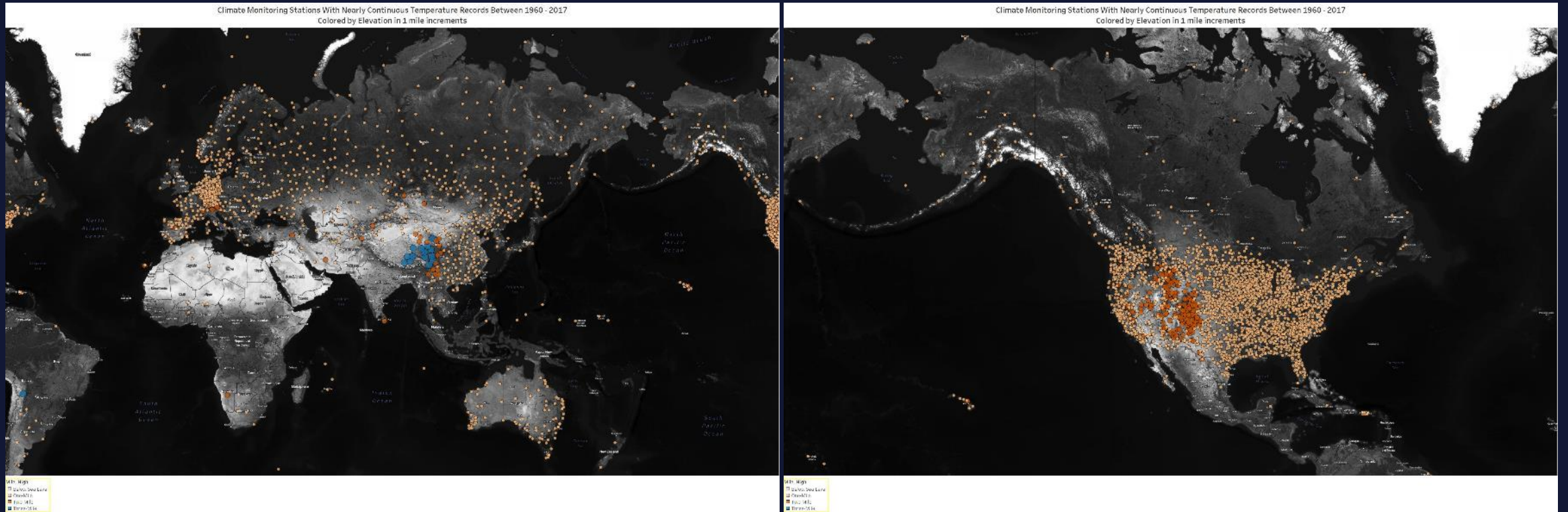
 **Global warming**
Global warming is a long-term rise in the average temperature of the Earth's climate system, an aspect of climate change shown by temperature measurements and by multiple effects of the warming.
[Wikipedia](#)

SPECIFIC GLOBAL WARMING IMPACTS



TEMPERATURE DATA BASICS

Daily Maximum and Minimum Temperatures are measured from monitoring stations all around the world. Data from >5,000 stations (1960-2018) is used to uncover the insights in this study. Monitoring station elevations exceed 3 miles high (big blue dots).



THE ROLE OF ALTERYX

Alteryx has been the data engine on this study for five years. Without Alteryx, I would not have been able to gain these insights. Alteryx has literally completed trillions of calculations to answer the questions I have created. About 70 workflows have been built over time.

Phase I (2014) – My Alteryx Manifesto

When I first started learning Alteryx, I wanted to give myself a grand challenge. I wanted to give a gift to college professors that are teaching analytics. I wanted to create a project that could be emulated within a semester, using great software like Alteryx and Tableau. I wanted to design and complete a full-spectrum analytics project that could serve as a teaching tool and one in which would educate our students. I believe I have accomplished this by developing my “Alteryx Manifesto”.

I started the work in late 2014 and I first documented the preliminary work in a series of five articles in early 2015. These articles explain in detail how components of daily weather data can be accessed, processed in Alteryx, and visualized in Tableau. With easily over 100 hours of work invested in this series of articles, it was a great reference for me to be able to continue the work a couple of years later. You can access the articles by clicking the blue text.

1. [Part 1 – Project Introduction](#)
2. [Part 2 – The Source of Climate Data](#)
3. [Part 3 – Reading Weather Station Data](#)
4. [Part 4 – Alteryx Workflow Details For Reading Data](#)
5. [Part 5 – Using Tableau To Examine Texas Temperature and Precipitation Data](#)

Phase II (2016-2017)

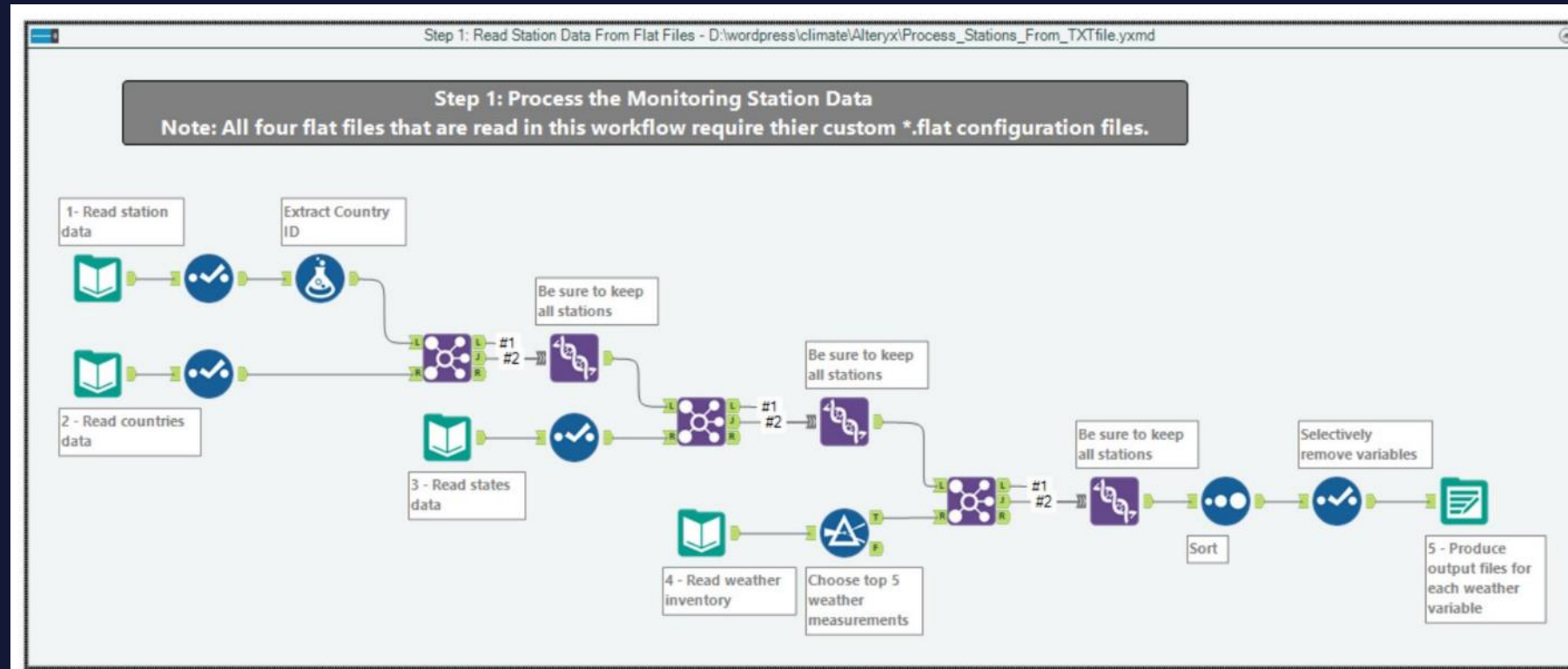
After moving to Texas and then back to Tennessee and Georgia, I finally found some time to revisit this work. After a couple of years of record high temperatures, I decided to attack this work with renewed enthusiasm. The following articles are the result of this work.

1. [Investigating Global Climate Change](#)
2. [Uncovering Surprising Temperature Changes](#)
3. [Visualizing Worldwide Air Temperature Changes](#)
4. [Visualizing Warming and Cooling Patterns in North America](#)
5. [Descriptive and Predictive Study of North American Air Temperature Changes](#)
6. [Do You Live In An Area Impacted By Global Warming?](#)
7. [How I Use Alteryx and Tableau to Comprehend Climate Change](#)
8. [How To Achieve Better Data Comprehension \(Climate Case Study\)](#)
9. [My 2017 Alteryx Inspire Climate Change Presentation](#)
10. [Global Climate Data Set 1 – Daily Temperatures](#)
11. [Global Climate Data Set 2 – Monthly and Decade Average Temperatures](#)
12. [Temperature Changes Over the Past 50 Years: A Visual Tour Country by Country](#)
13. [Buckled Roads and Melting Permafrost in Bethel, Alaska](#)
14. [Using Temperature Anomalies to Visualize Global Warming Via #Alteryx, #Tableau, and #Mapbox](#)

<https://datablends.us/climate-change-quantified/>

THE ROLE OF ALTERYX

An Example Workflow



<https://datablends.us/climate-change-quantified/>

UNDERSTANDING DAILY WEATHER VARIATION

We all realize that weather can change dramatically from day to day.

In the following 4 slides, 4 consecutive days of worldwide weather are shown

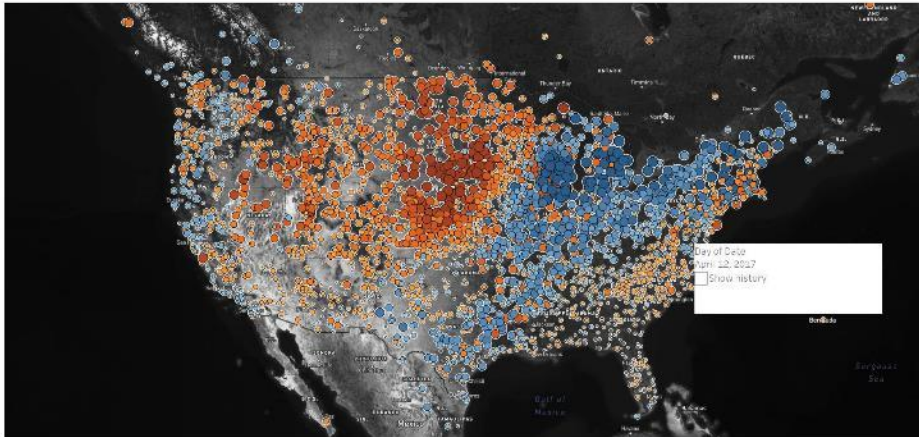
Notice how hot zones and cold zones move across space and time

APRIL 12, 2019 WEATHER

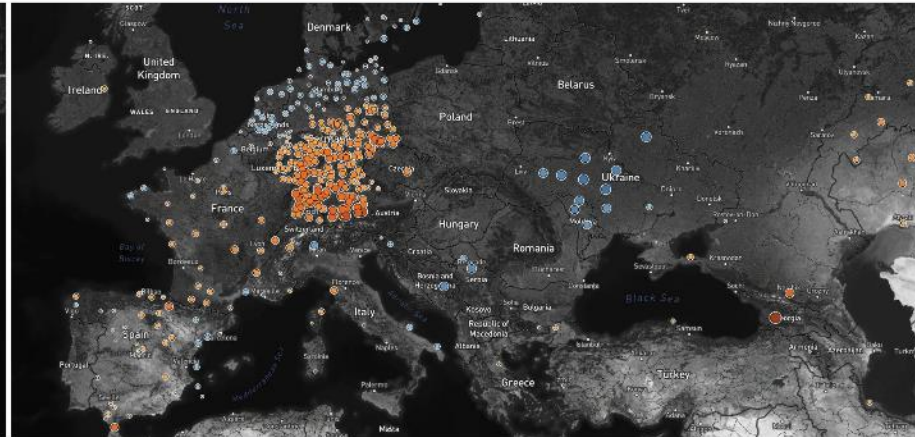
We all realize that weather can change dramatically from day to day.

2017 Changes in Maximum Temperature From the Previous Day
The temperature change data range has been limited to +/- 20 deg F for visual clarity.

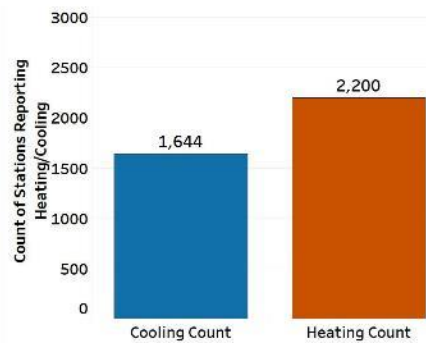
Change in Maximum Daily Temperature From Previous Day in 2017 on April 12, 2017



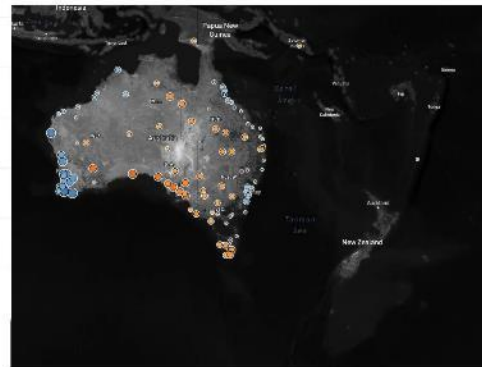
Change in Maximum Daily Temperature From Previous Day in 2017 on April 12, 2017



Change in Maximum Daily Temperature From Previous Day in 2017 on April 12, 2017



Change in Maximum Daily Temperature From Previous Day in 2017 on April 12, 2017

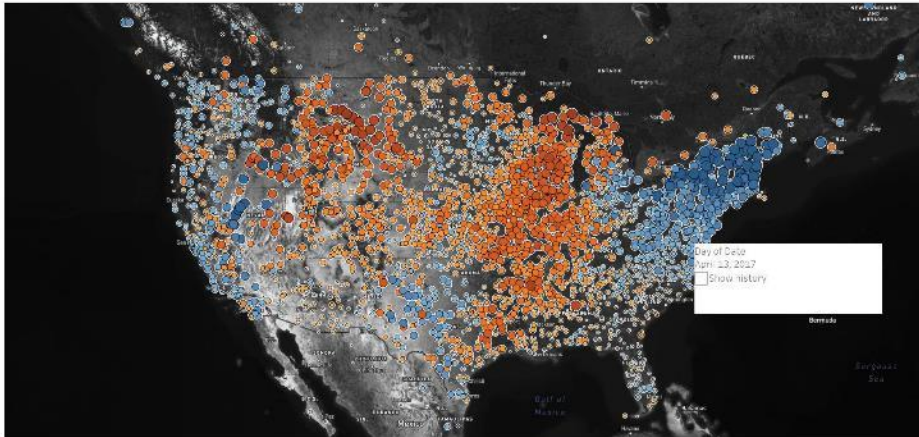


APRIL 13, 2019 WEATHER

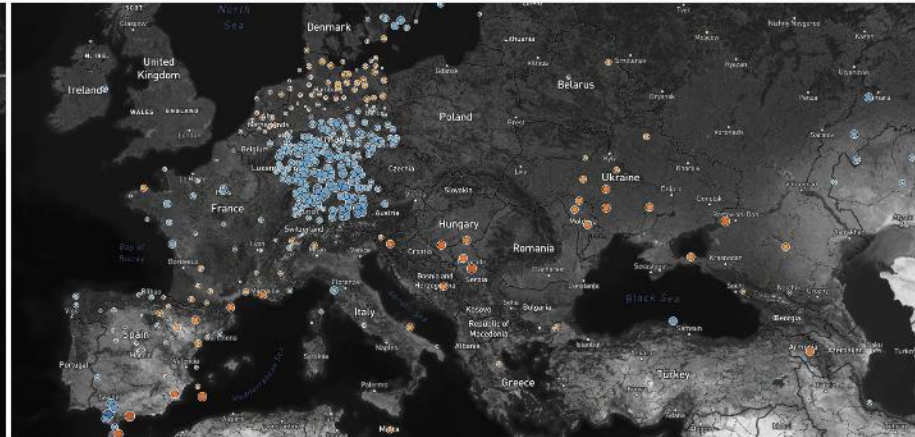
The next day...

2017 Changes in Maximum Temperature From the Previous Day
The temperature change data range has been limited to +/- 20 deg F for visual clarity.

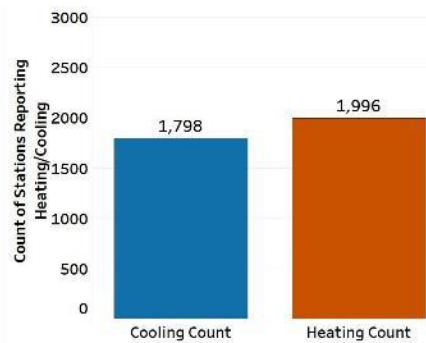
Change in Maximum Daily Temperature From Previous Day in 2017 on April 13, 2017



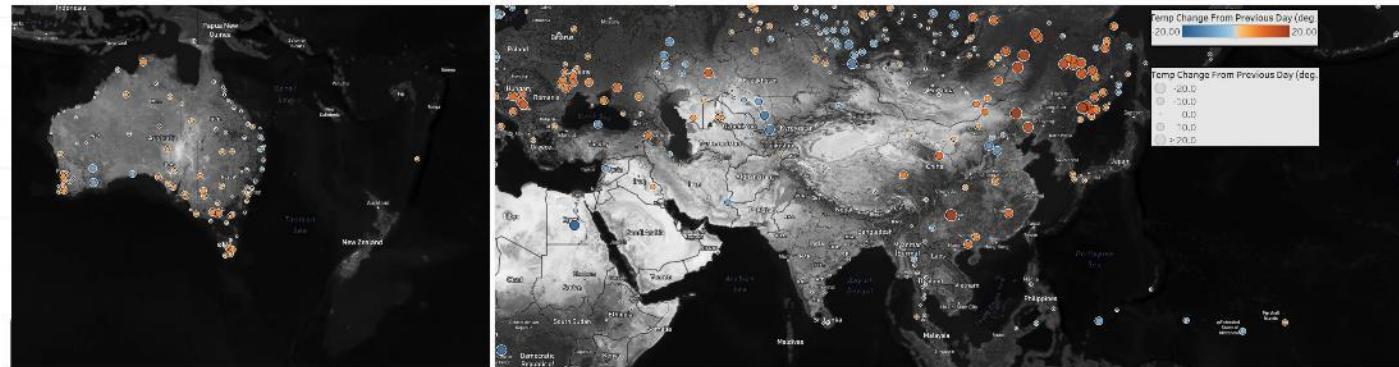
Change in Maximum Daily Temperature From Previous Day in 2017 on April 13, 2017



Change in Maximum Daily Temperature From Previous Day in 2017 on April 13, 2017



Change in Maximum Daily Temperature From Previous Day in 2017 on April 13, 2017

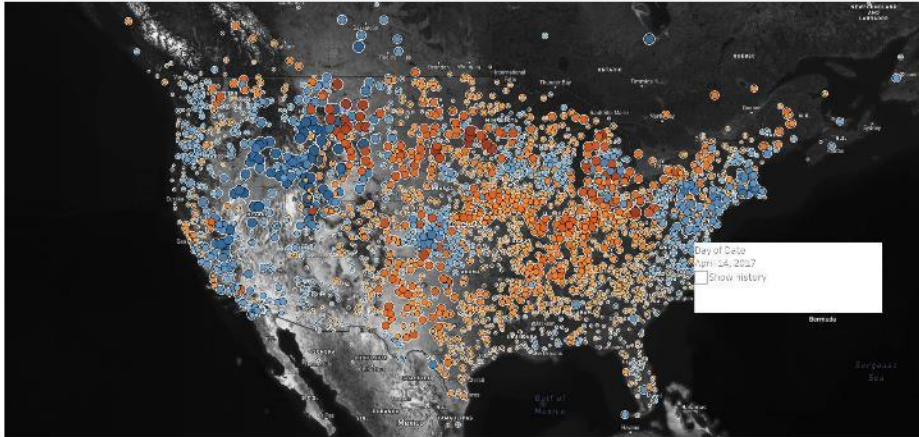


APRIL 14, 2019 WEATHER

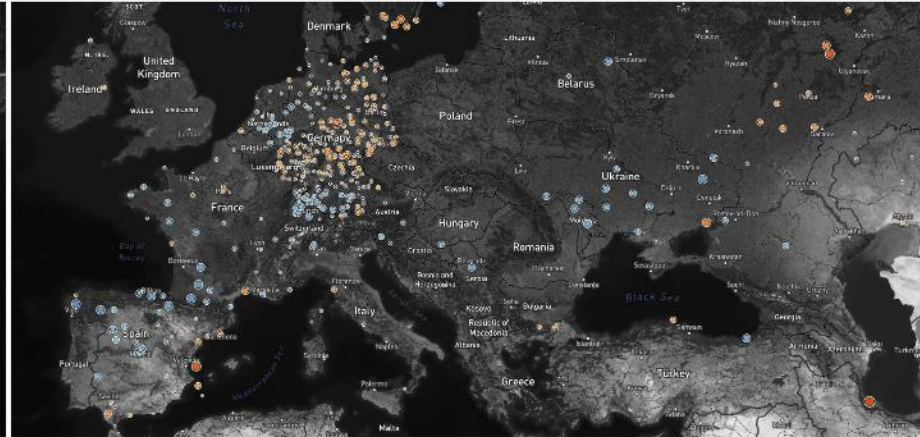
The next day...

2017 Changes in Maximum Temperature From the Previous Day
The temperature change data range has been limited to +/- 20 deg F for visual clarity.

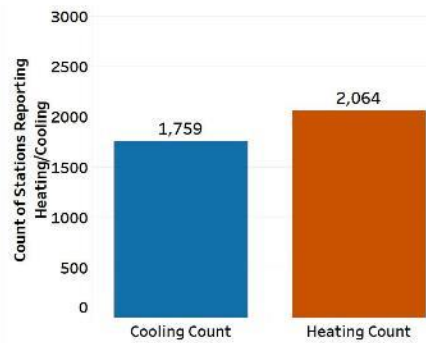
Change in Maximum Daily Temperature From Previous Day in 2017 on April 14, 2017



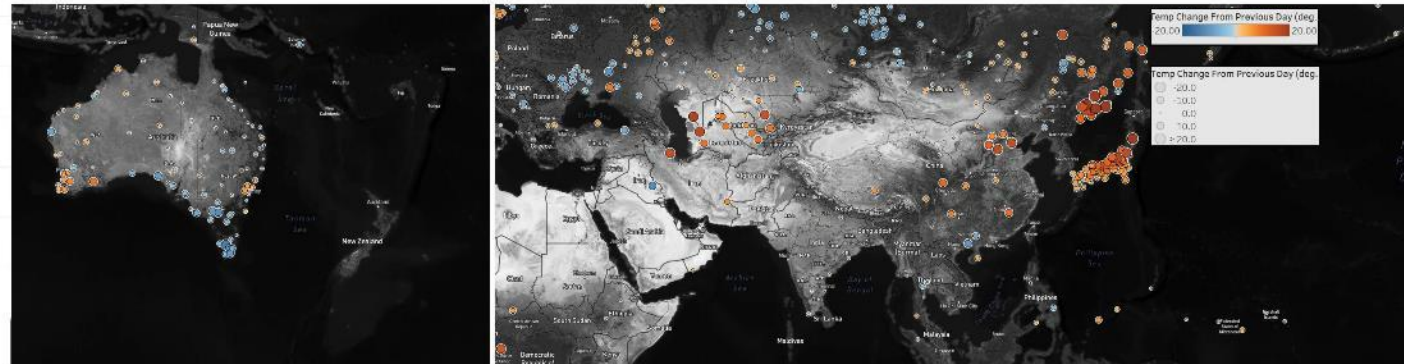
Change in Maximum Daily Temperature From Previous Day in 2017 on April 14, 2017



Change in Maximum Daily Temperature From Previous Day in 2017 on April 14, 2017



Change in Maximum Daily Temperature From Previous Day in 2017 on April 14, 2017

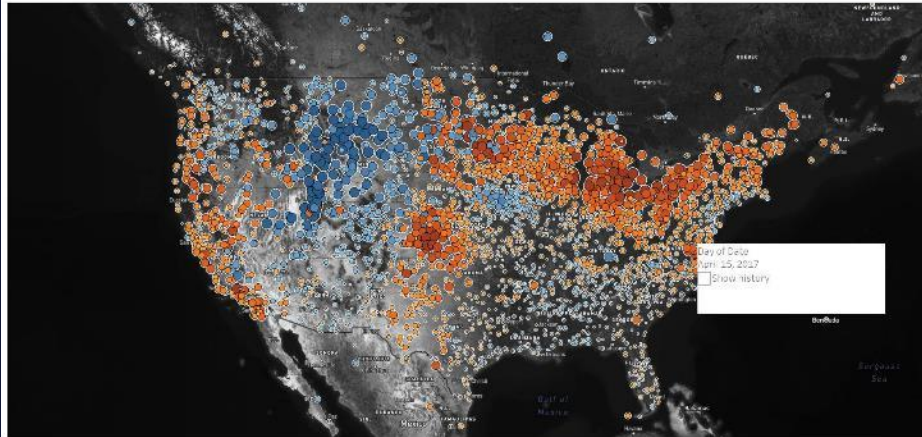


APRIL 15, 2019 WEATHER

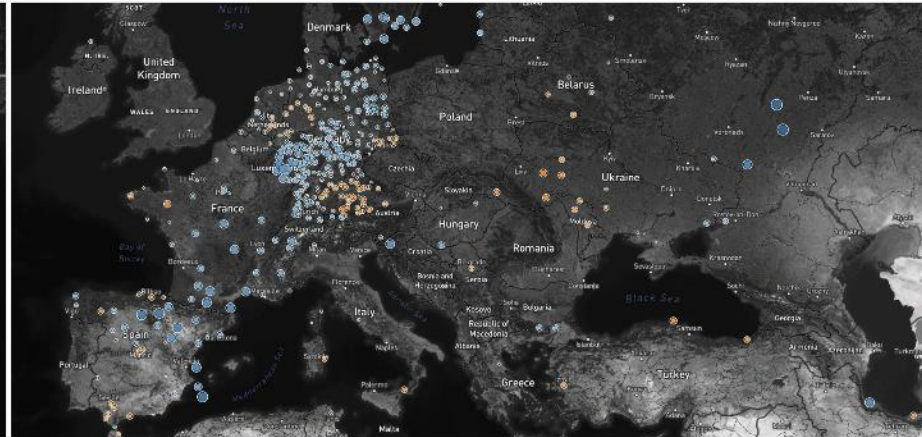
And the next day...

2017 Changes in Maximum Temperature From the Previous Day
The temperature change data range has been limited to +/- 20 deg F for visual clarity.

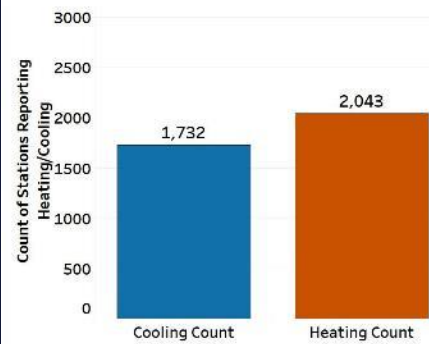
Change in Maximum Daily Temperature From Previous Day in 2017 on April 15, 2017



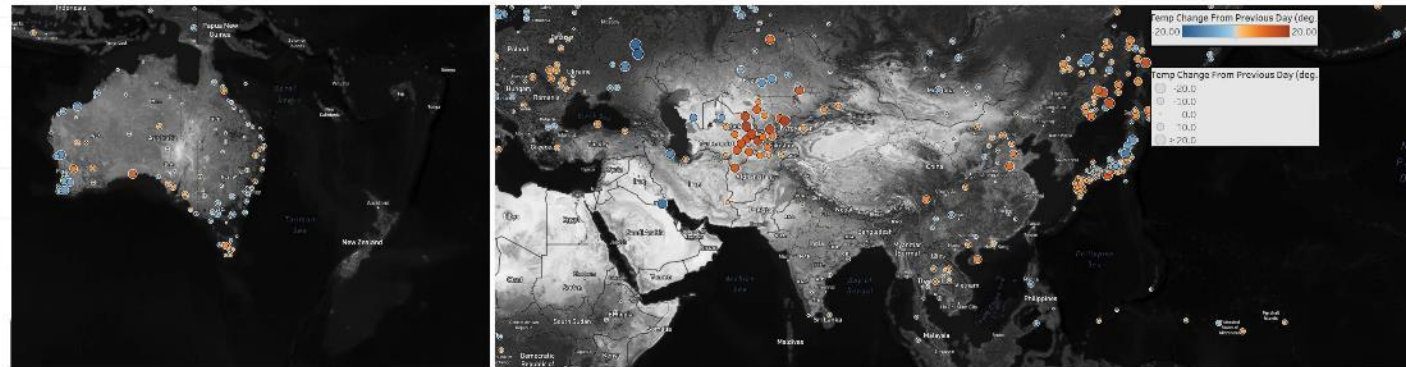
Change in Maximum Daily Temperature From Previous Day in 2017 on April 15, 2017



Change in Maximum Daily Temperature From Previous Day in 2017 on April 15, 2017

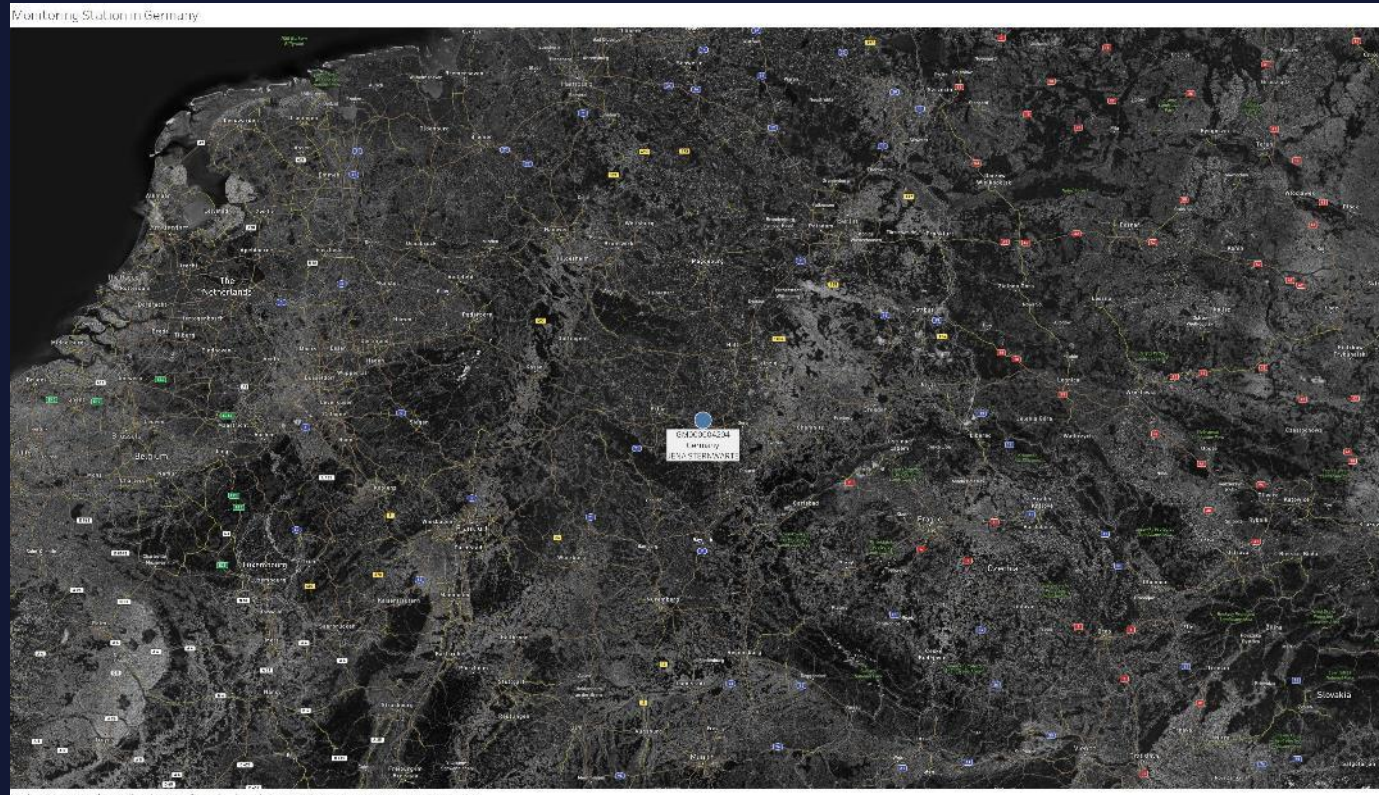


Change in Maximum Daily Temperature From Previous Day in 2017 on April 15, 2017



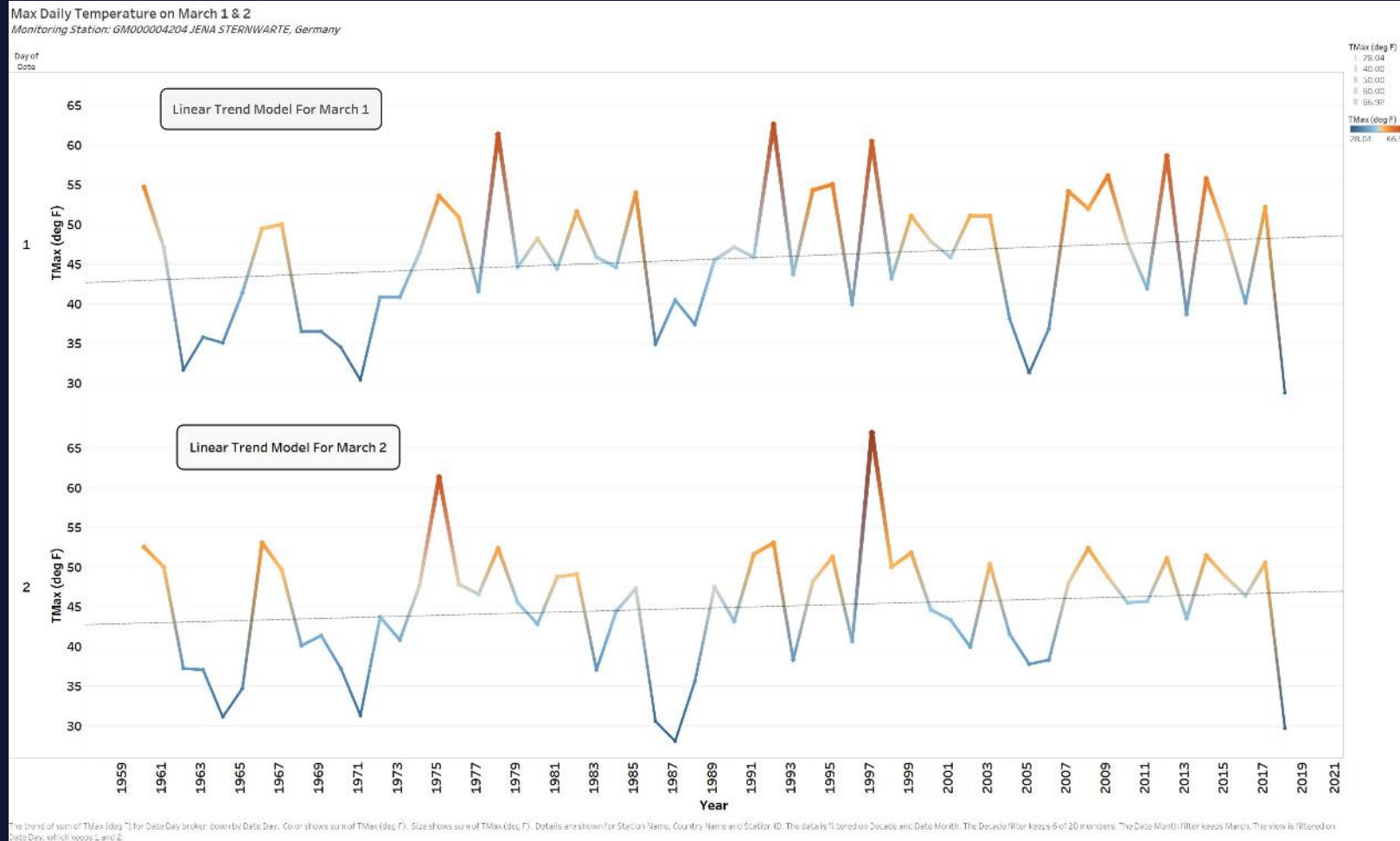
UNDERSTANDING DAILY WEATHER ACROSS TIME

Now imagine you could stop on any day of the year and look at what happens the following year, and another year...



LOCAL WEATHER VARIATION

Here are two days in March as an example from that monitoring station ...

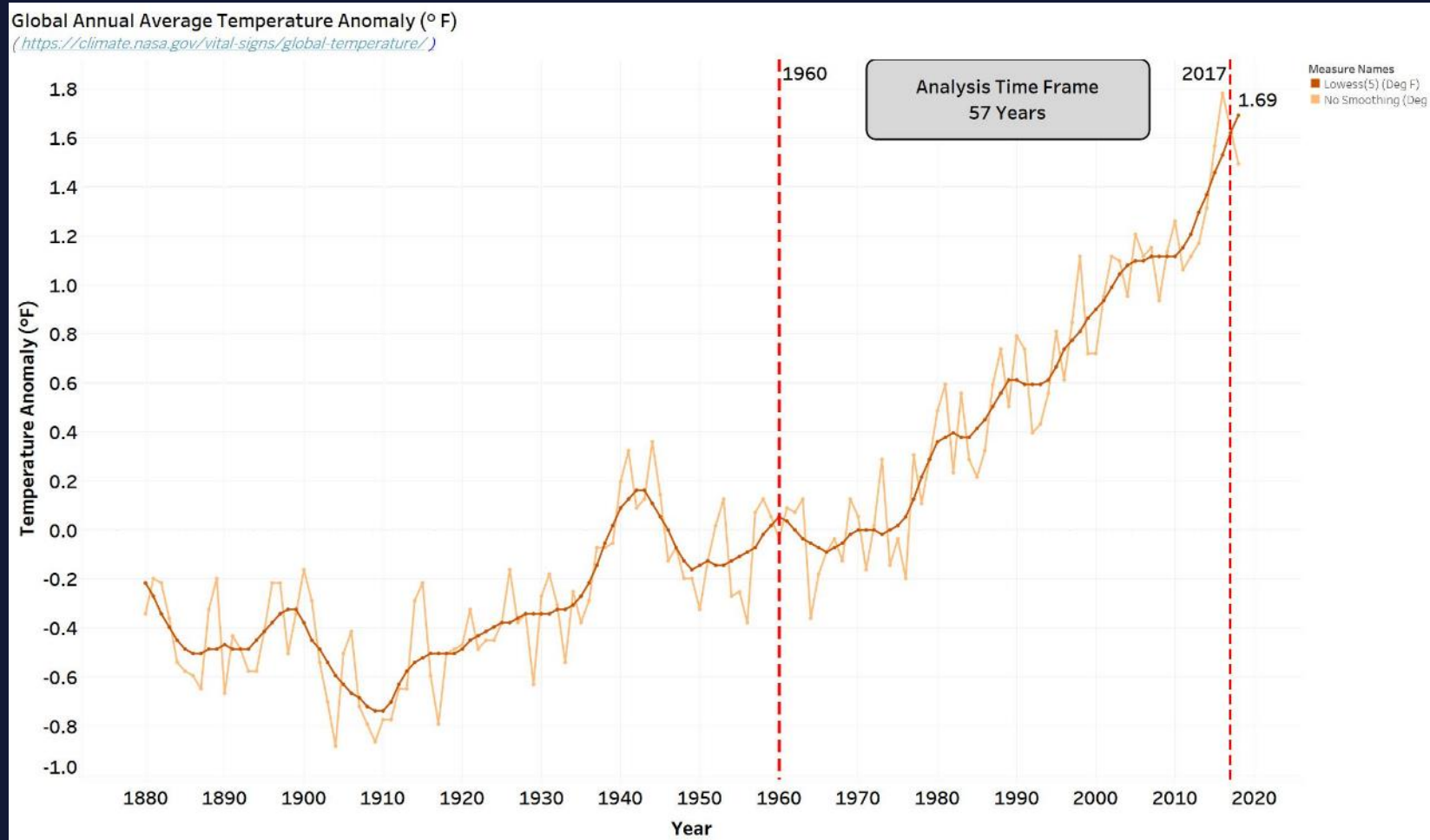


The linear trend lines show that both March 1 and 2 have experienced about 3-4 deg F of warming in 57 years.

Some stations are warmer, some are cooler across this timeframe.

GLOBAL VARIATION

Now imagine we compute a couple of million linear models across 57 years...



These linear models can be visualized in map form. We can now begin to understand how the spatial and temporal changes across the world have led to this global average temperature anomaly.

COMPREHENDING SIX DECADES OF TEMPERATURE CHANGE

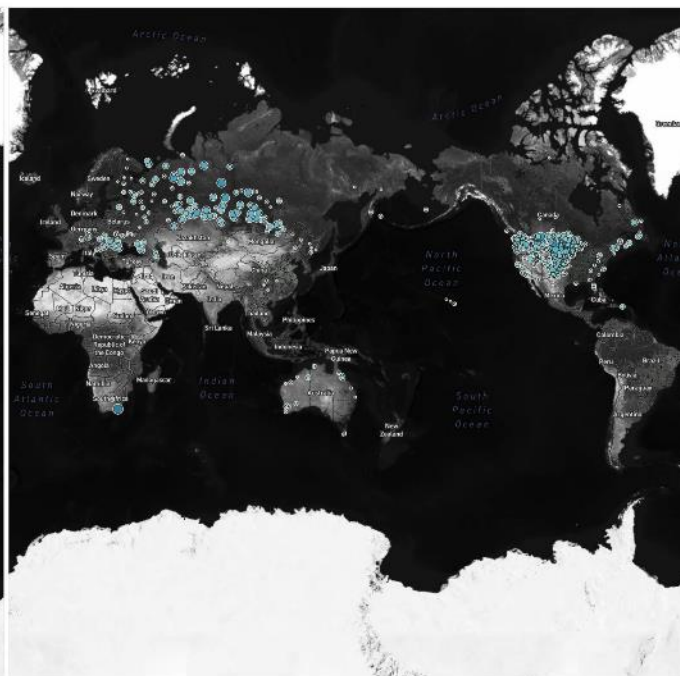
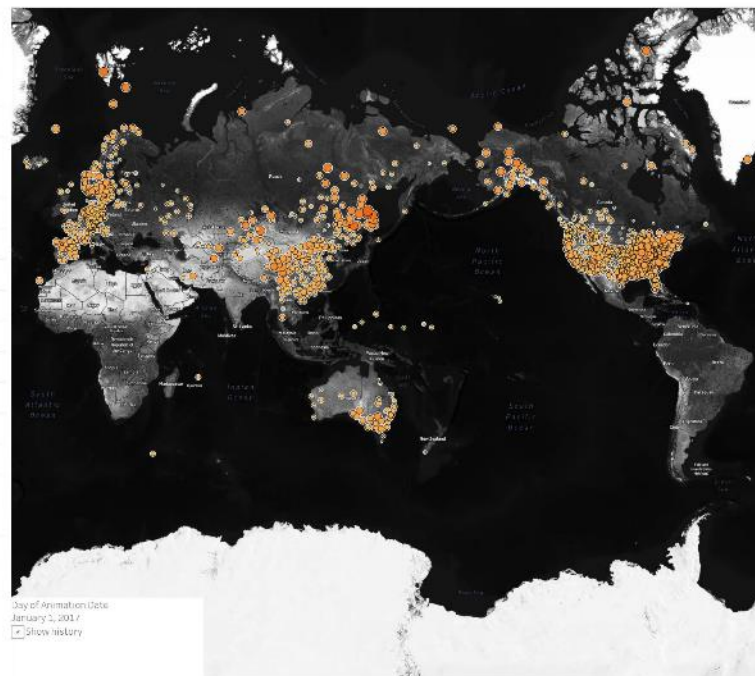
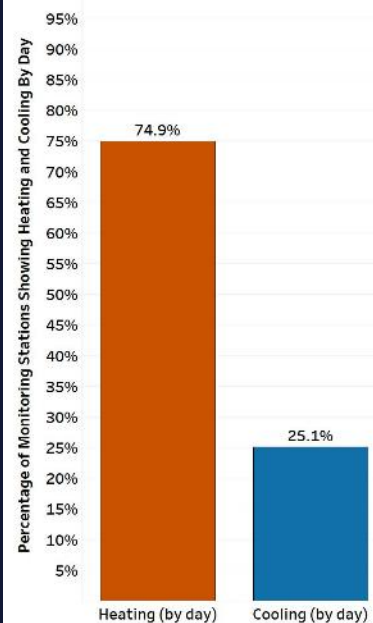
The Global Warming Imagination Dashboard Showing The Percentage of Worldwide Monitoring Stations That Have Heated and Cooled

Imagine that you stood somewhere on planet earth in 1960. You then closed your eyes for a moment, and 57 years suddenly elapsed. How would the change in temperature feel to you? Would you suddenly be hotter or colder when you opened your eyes?

January 1, 2017

Warming Stations From 1960 to 2017 on January 1, 2017

Cooling Stations From 1960 to 2017 on January 1, 2017



January 1, 2017



January 1

COMPREHENDING SIX DECADES OF TEMPERATURE CHANGE

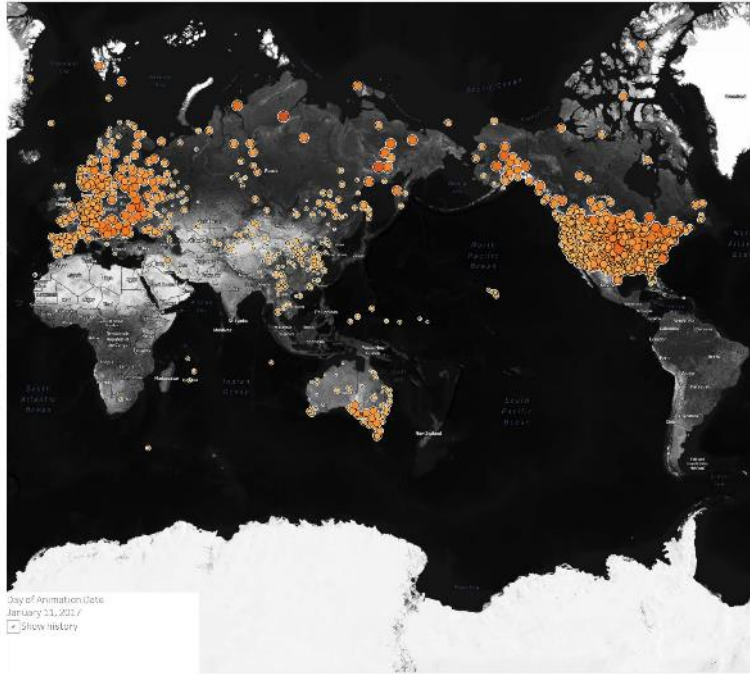
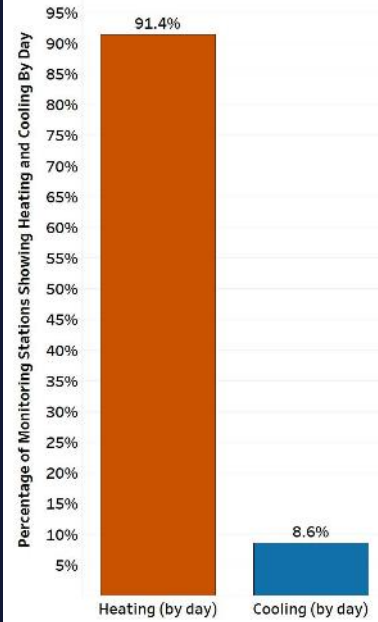
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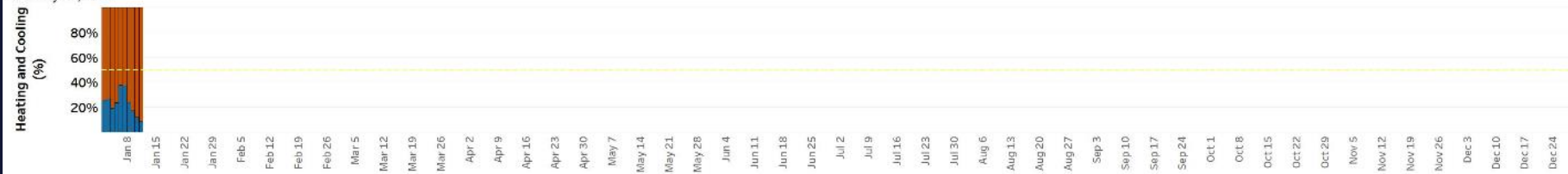
January 11, 2017

Warming Stations From 1960 to 2017 on January 11, 2017

Cooling Stations From 1960 to 2017 on January 11, 2017



January 11, 2017



January 11

COMPREHENDING SIX DECADES OF TEMPERATURE CHANGE

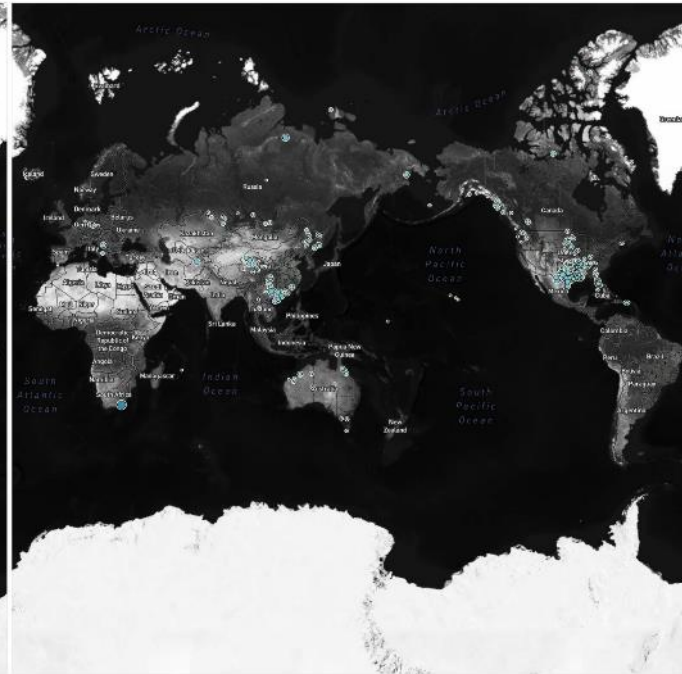
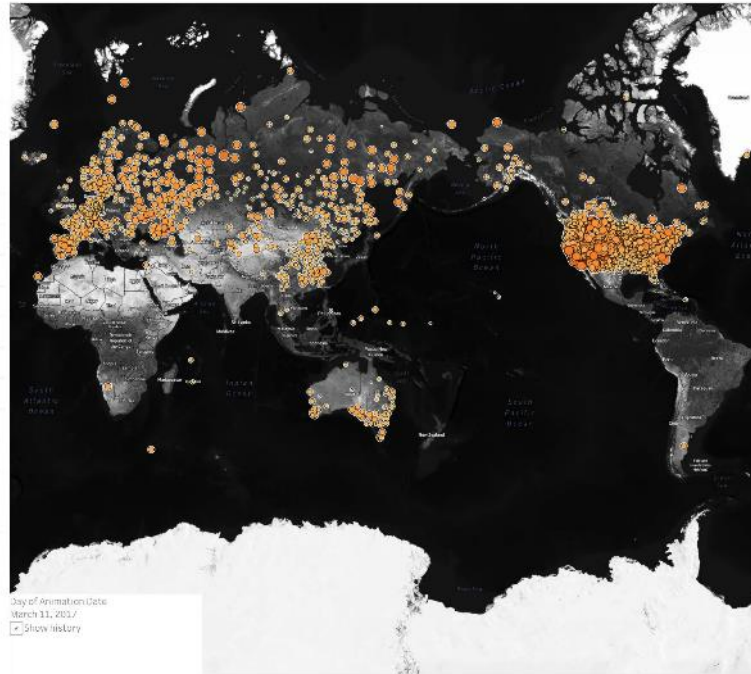
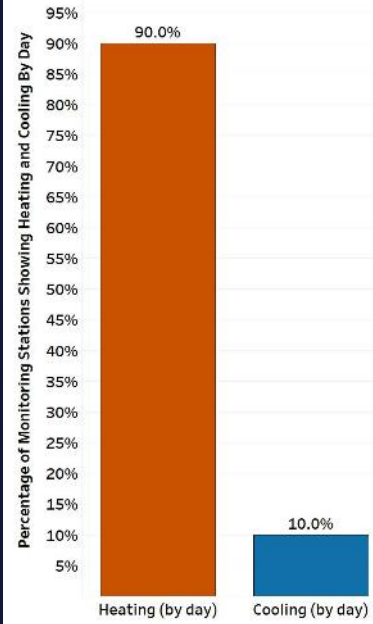
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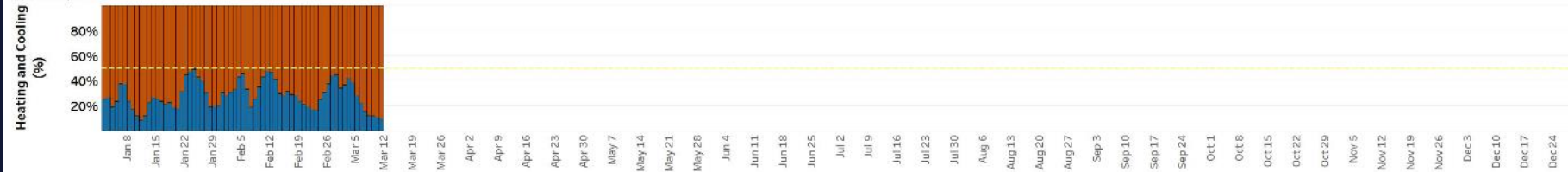
March 11, 2017

Warming Stations From 1960 to 2017 on *March 11, 2017*

Cooling Stations From 1960 to 2017 on *March 11, 2017*



March 11, 2017



March 11

COMPREHENDING SIX DECADES OF TEMPERATURE CHANGE

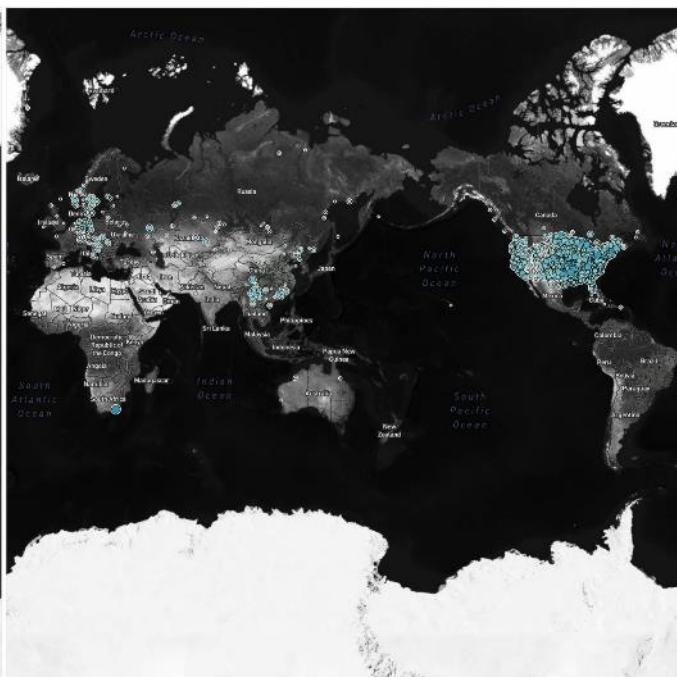
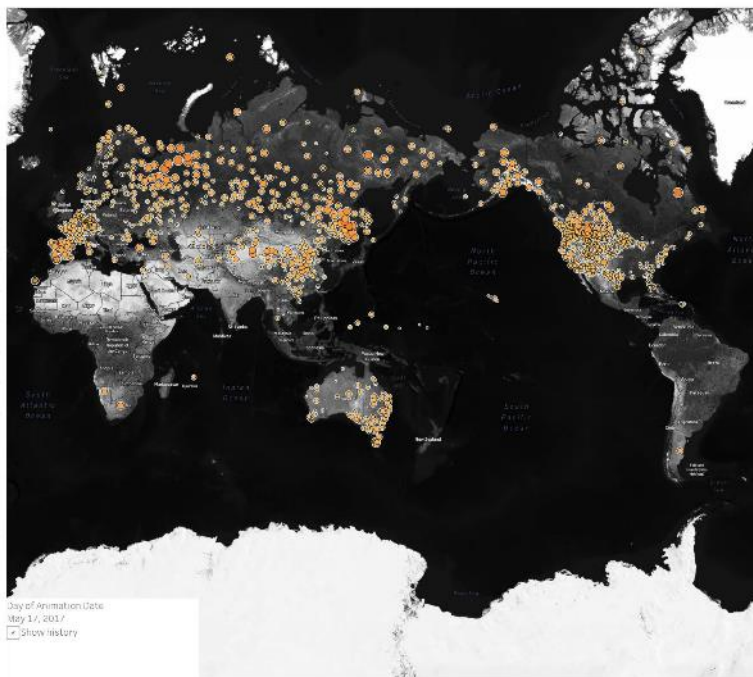
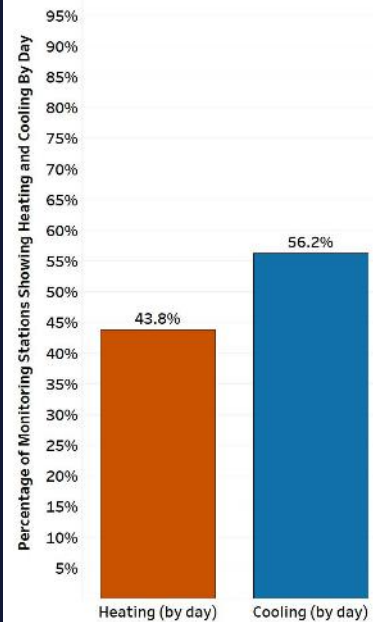
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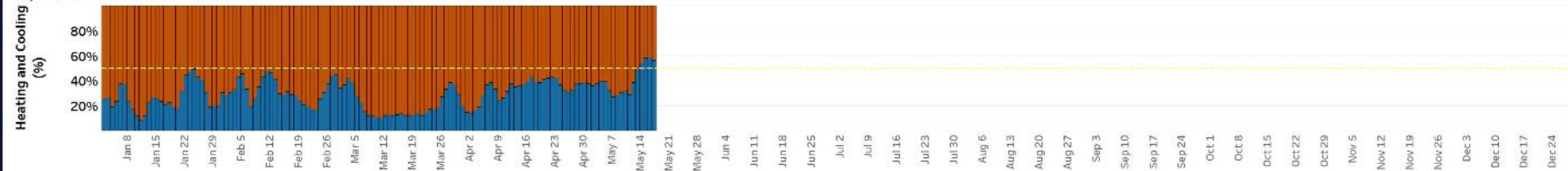
May 17, 2017

Warming Stations From 1960 to 2017 on May 17, 2017

Cooling Stations From 1960 to 2017 on May 17, 2017



May 17, 2017



May 17

COMPREHENDING SIX DECADES OF TEMPERATURE CHANGE

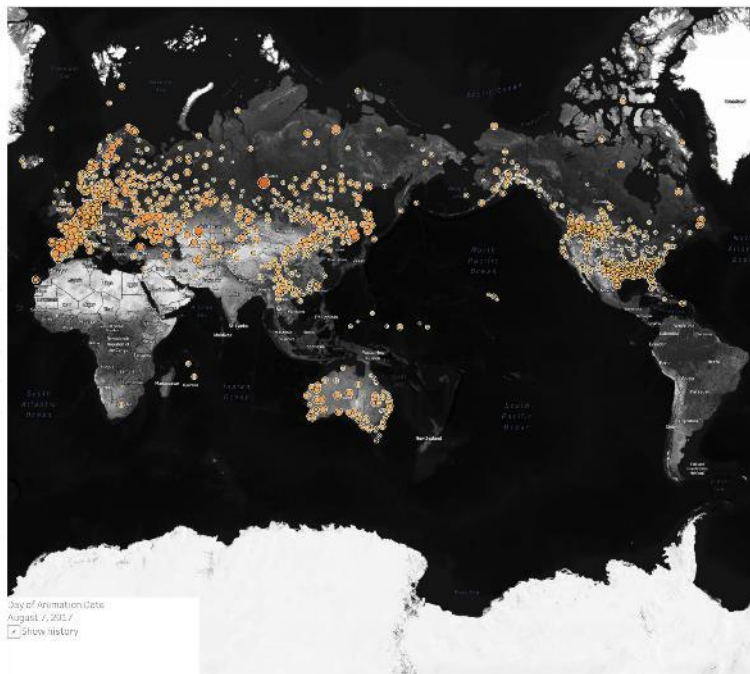
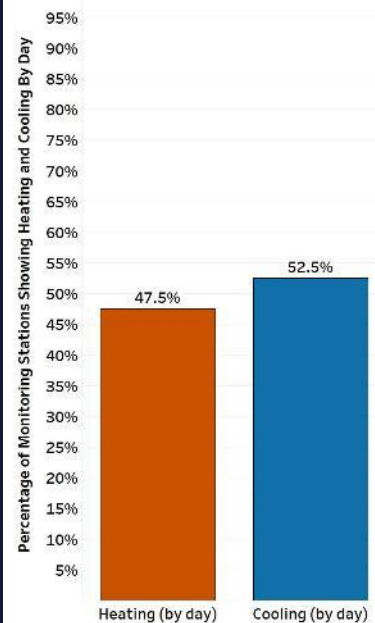
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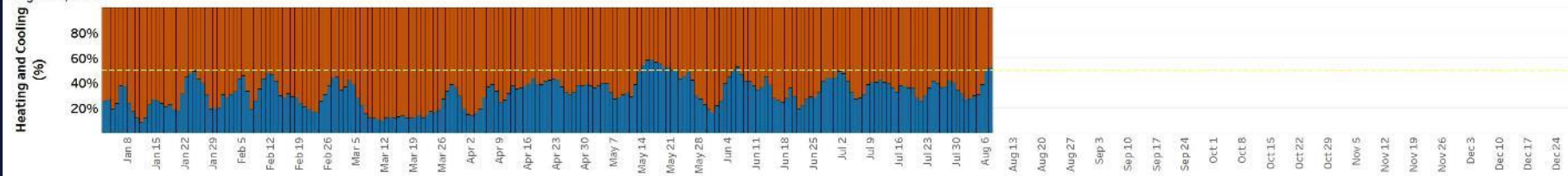
August 7, 2017

Warming Stations From 1960 to 2017 on August 7, 2017

Cooling Stations From 1960 to 2017 on August 7, 2017



August 7, 2017



August 7

COMPREHENDING SIX DECADES OF TEMPERATURE CHANGE

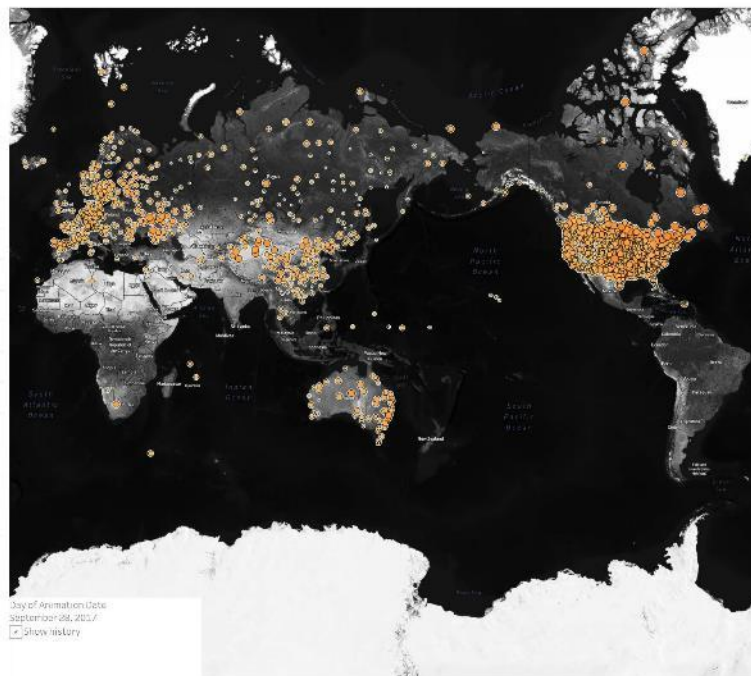
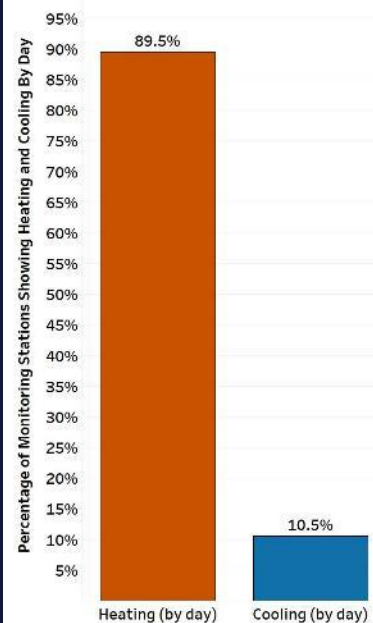
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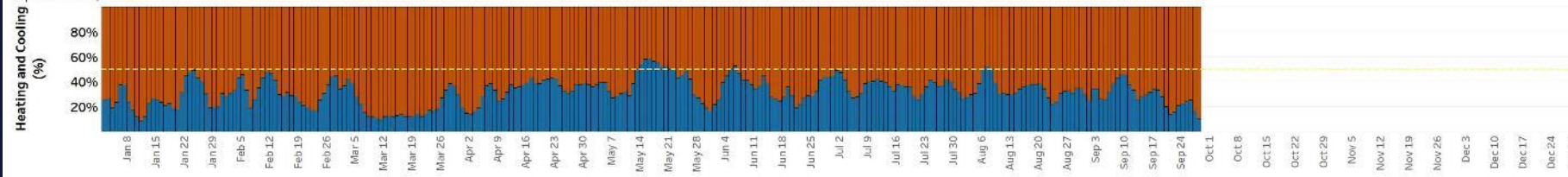
September 28, 2017

Warming Stations From 1960 to 2017 on September 28, 2017

Cooling Stations From 1960 to 2017 on September 28, 2017



September 28, 2017



September 28

COMPREHENDING SIX DECADES OF TEMPERATURE CHANGE

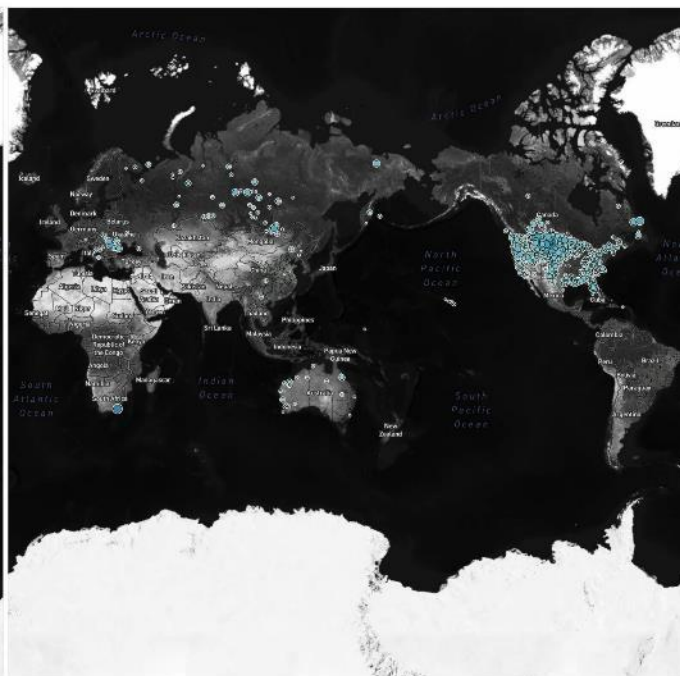
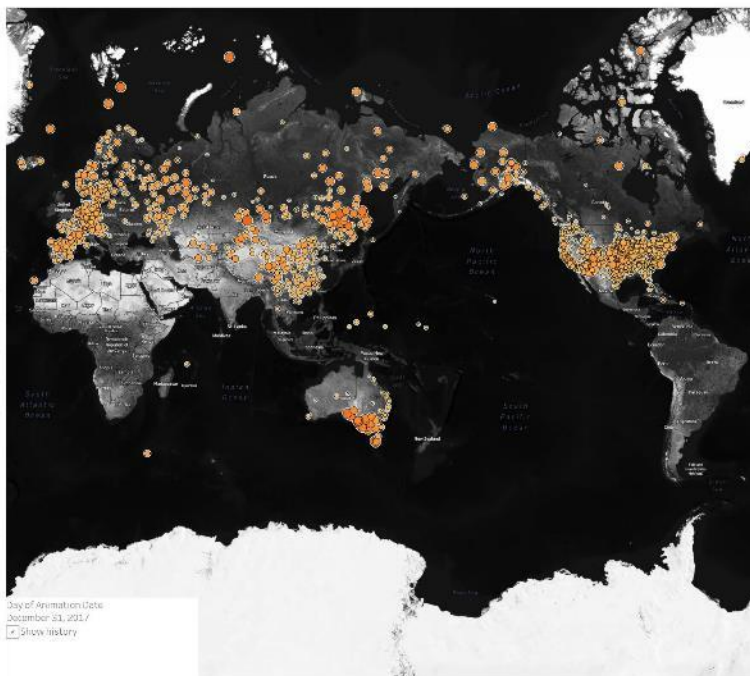
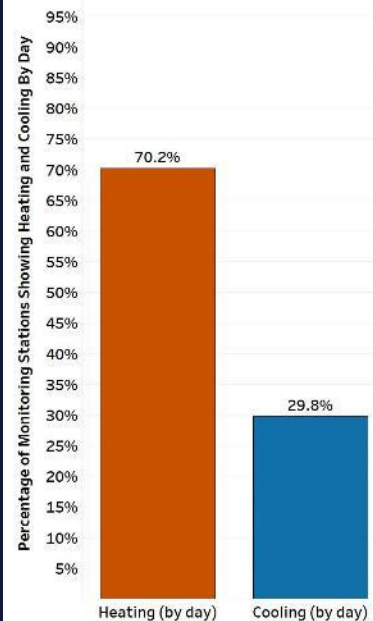
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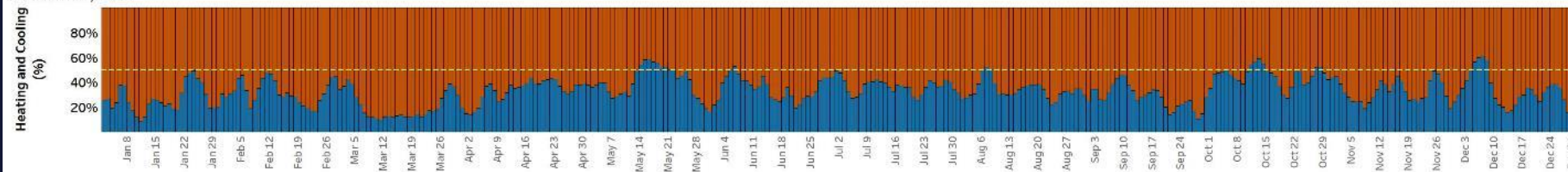
December 31, 2017

Warming Stations From 1960 to 2017 on December 31, 2017

Cooling Stations From 1960 to 2017 on December 31, 2017



December 31, 2017



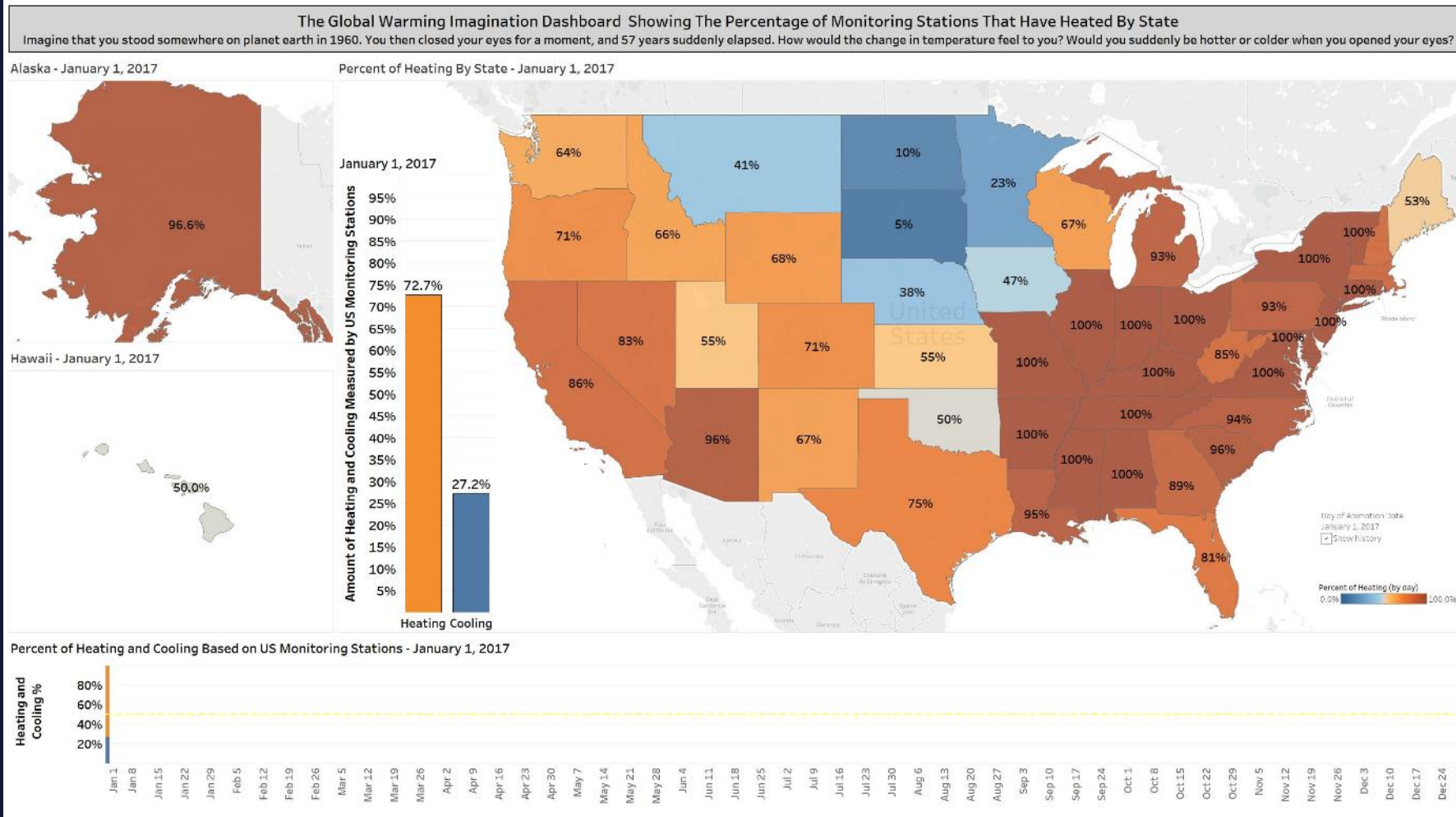
December 31

SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES

Now the focus will shift to North America

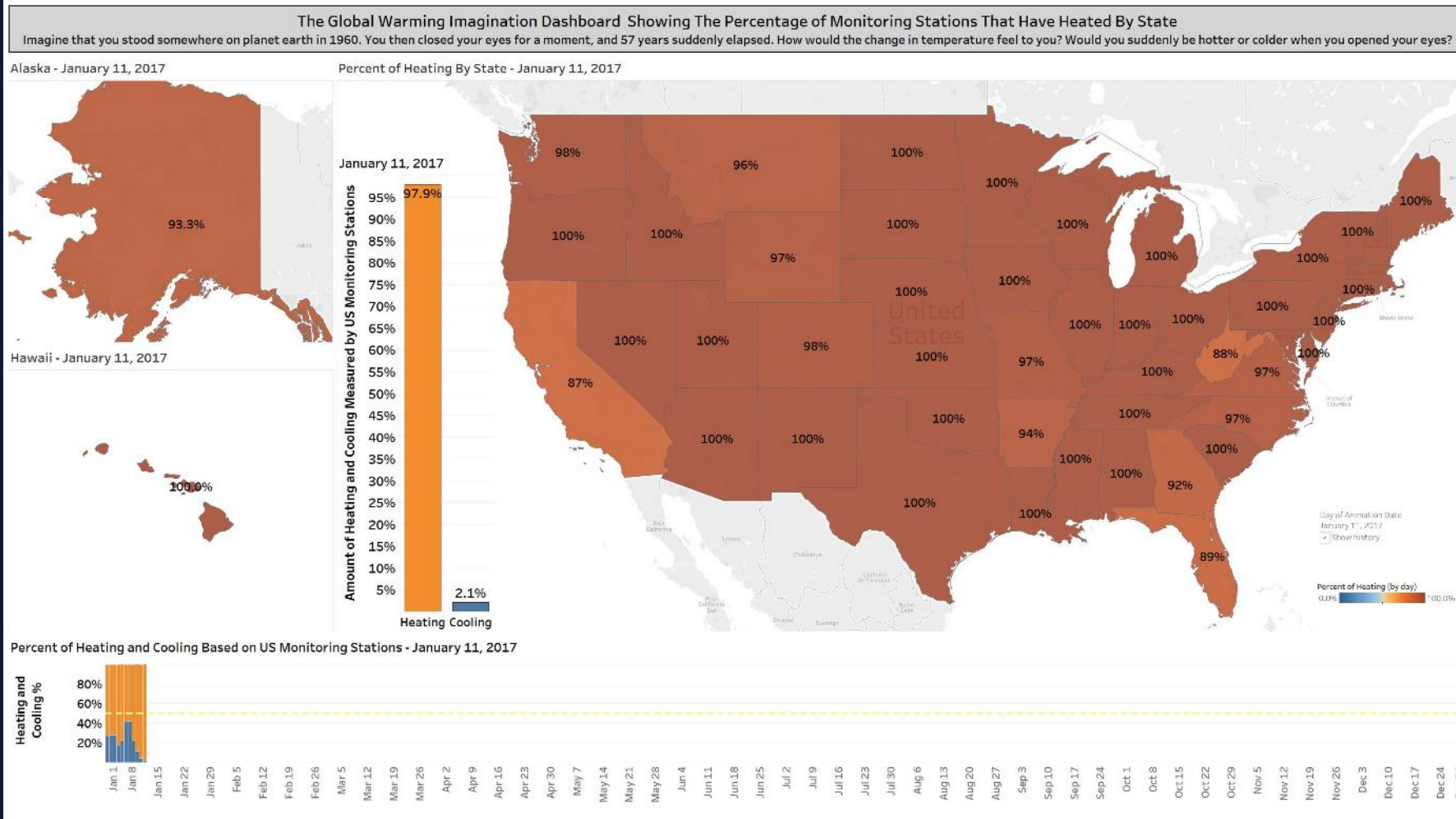
Temperature changes are still shown as percentages

SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES



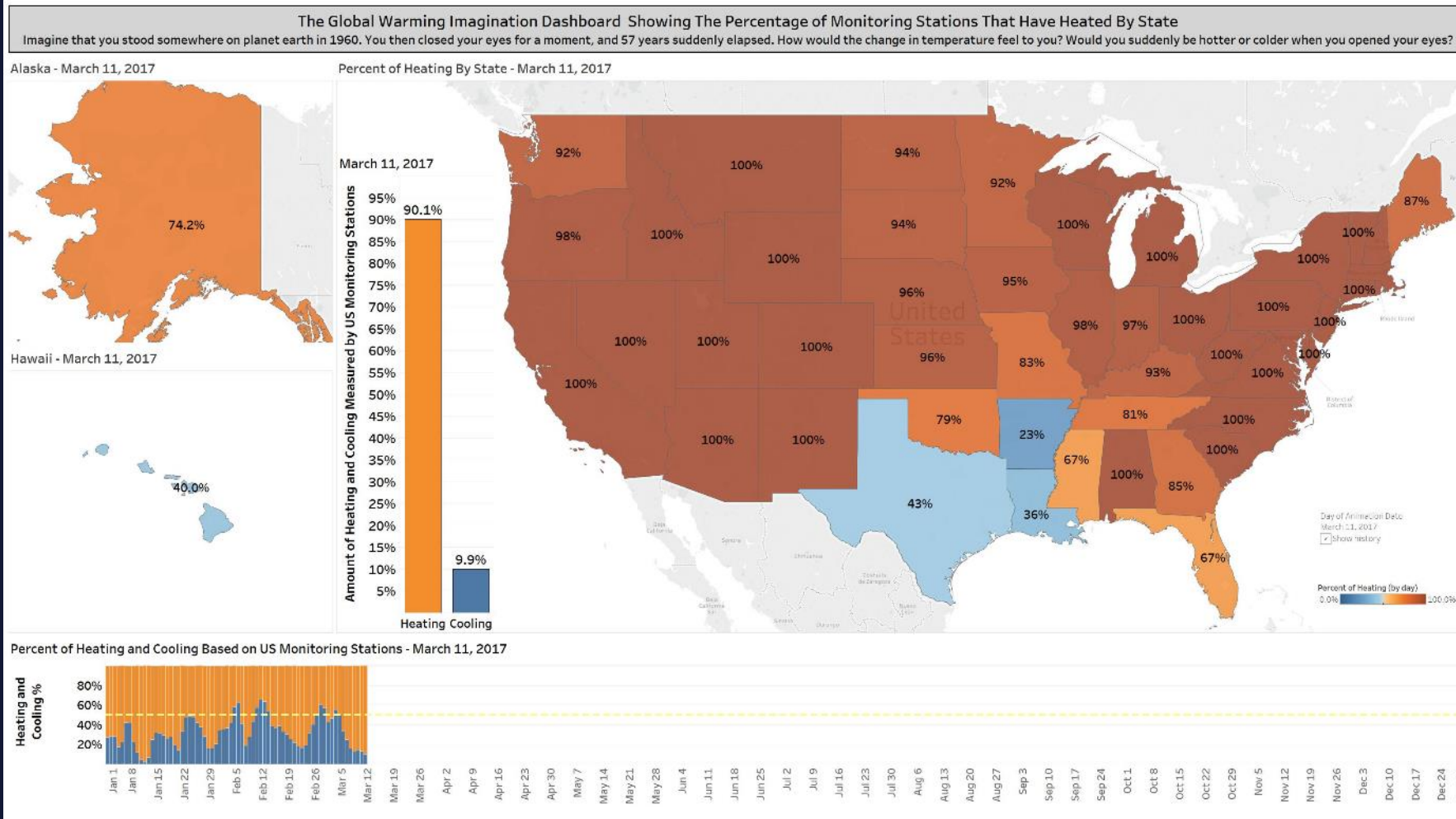
January 1

SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES



January 11

SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES

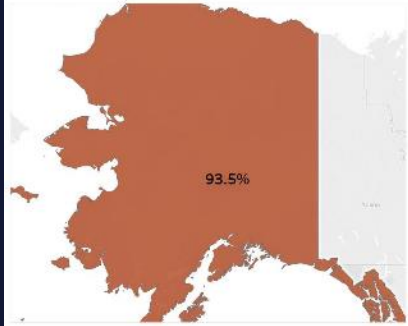


March 11

SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES

The Global Warming Imagination Dashboard Showing The Percentage of Monitoring Stations That Have Heated By State
 Imagine that you stood somewhere on planet earth in 1960. You then closed your eyes for a moment, and 57 years suddenly elapsed. How would the change in temperature feel to you? Would you suddenly be hotter or colder when you opened your eyes?

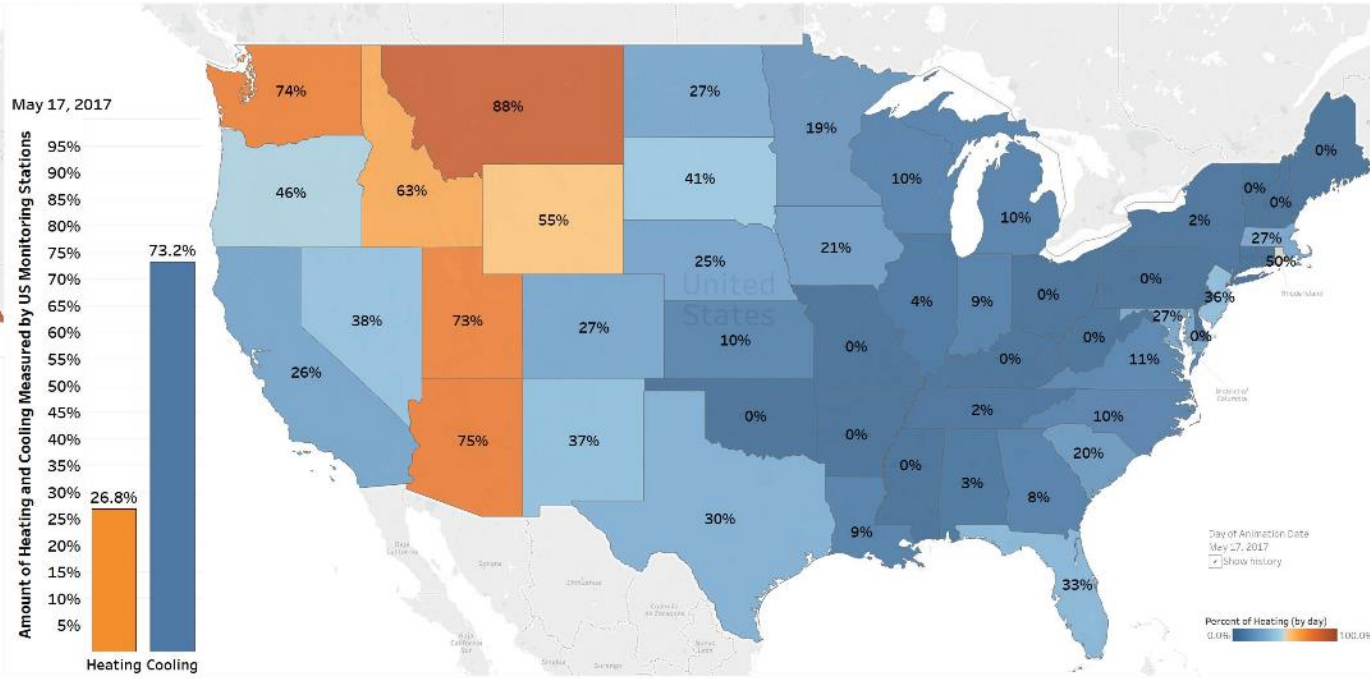
Alaska - May 17, 2017



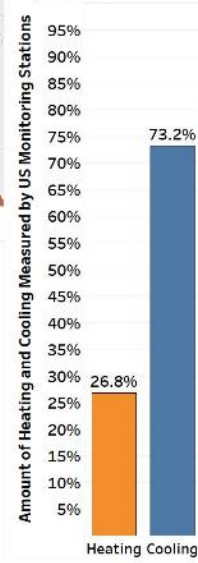
Hawaii - May 17, 2017



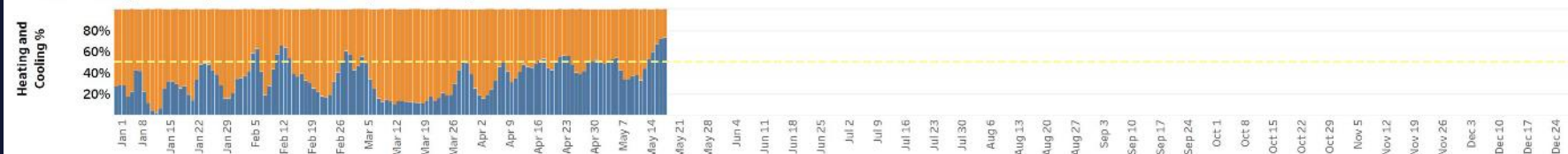
Percent of Heating By State - May 17, 2017



May 17, 2017



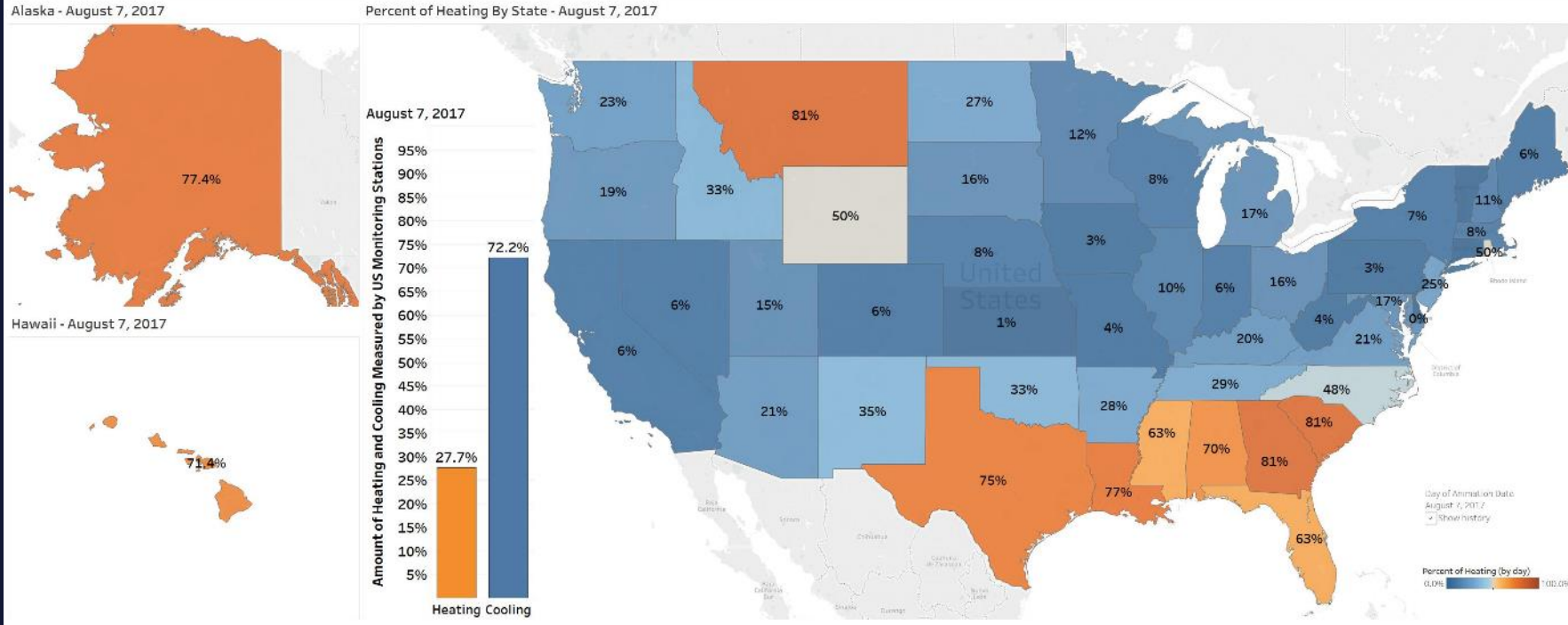
Percent of Heating and Cooling Based on US Monitoring Stations - May 17, 2017



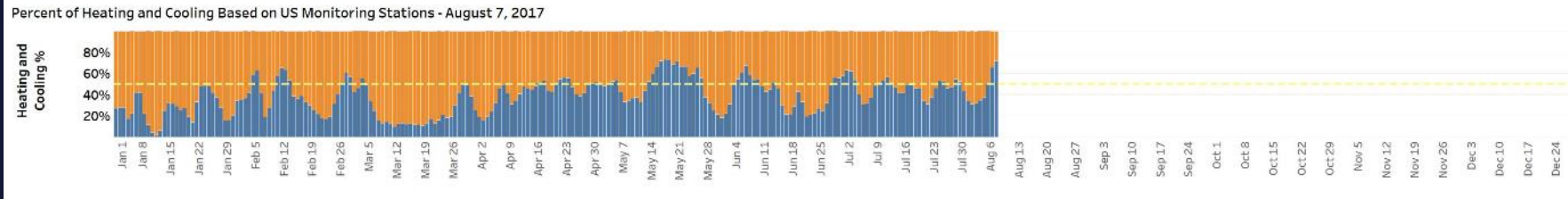
May 17

SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES

The Global Warming Imagination Dashboard Showing The Percentage of Monitoring Stations That Have Heated By State
 Imagine that you stood somewhere on planet earth in 1960. You then closed your eyes for a moment, and 57 years suddenly elapsed. How would the change in temperature feel to you? Would you suddenly be hotter or colder when you opened your eyes?



August 7



SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES

The Global Warming Imagination Dashboard Showing The Percentage of Monitoring Stations That Have Heated By State
 Imagine that you stood somewhere on planet earth in 1960. You then closed your eyes for a moment, and 57 years suddenly elapsed. How would the change in temperature feel to you? Would you suddenly be hotter or colder when you opened your eyes?

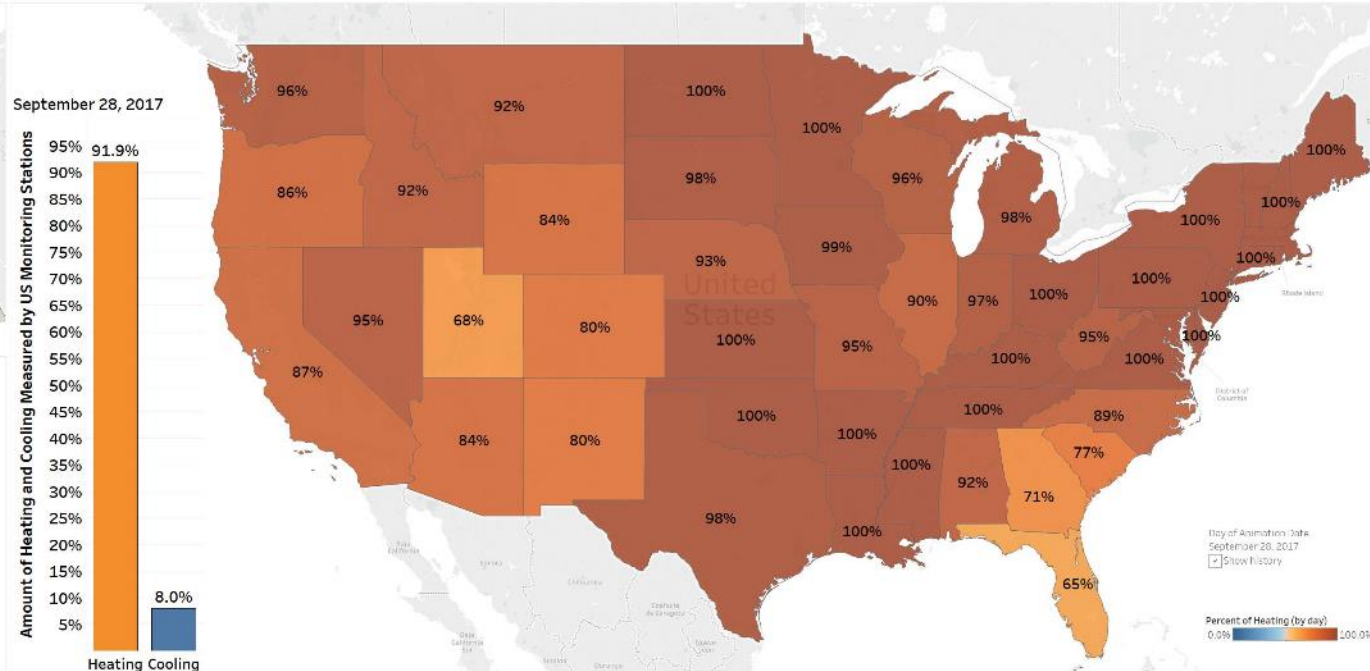
Alaska - September 28, 2017



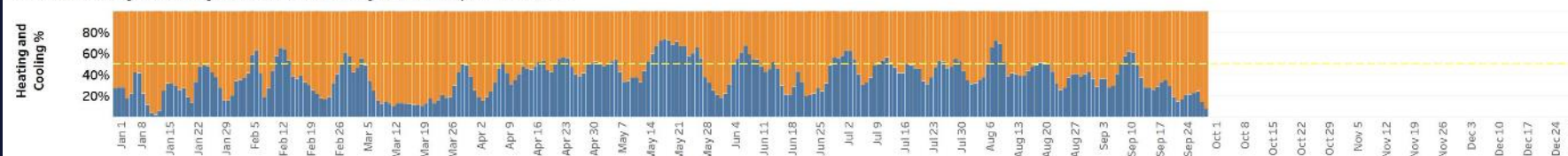
Hawaii - September 28, 2017



Percent of Heating By State - September 28, 2017

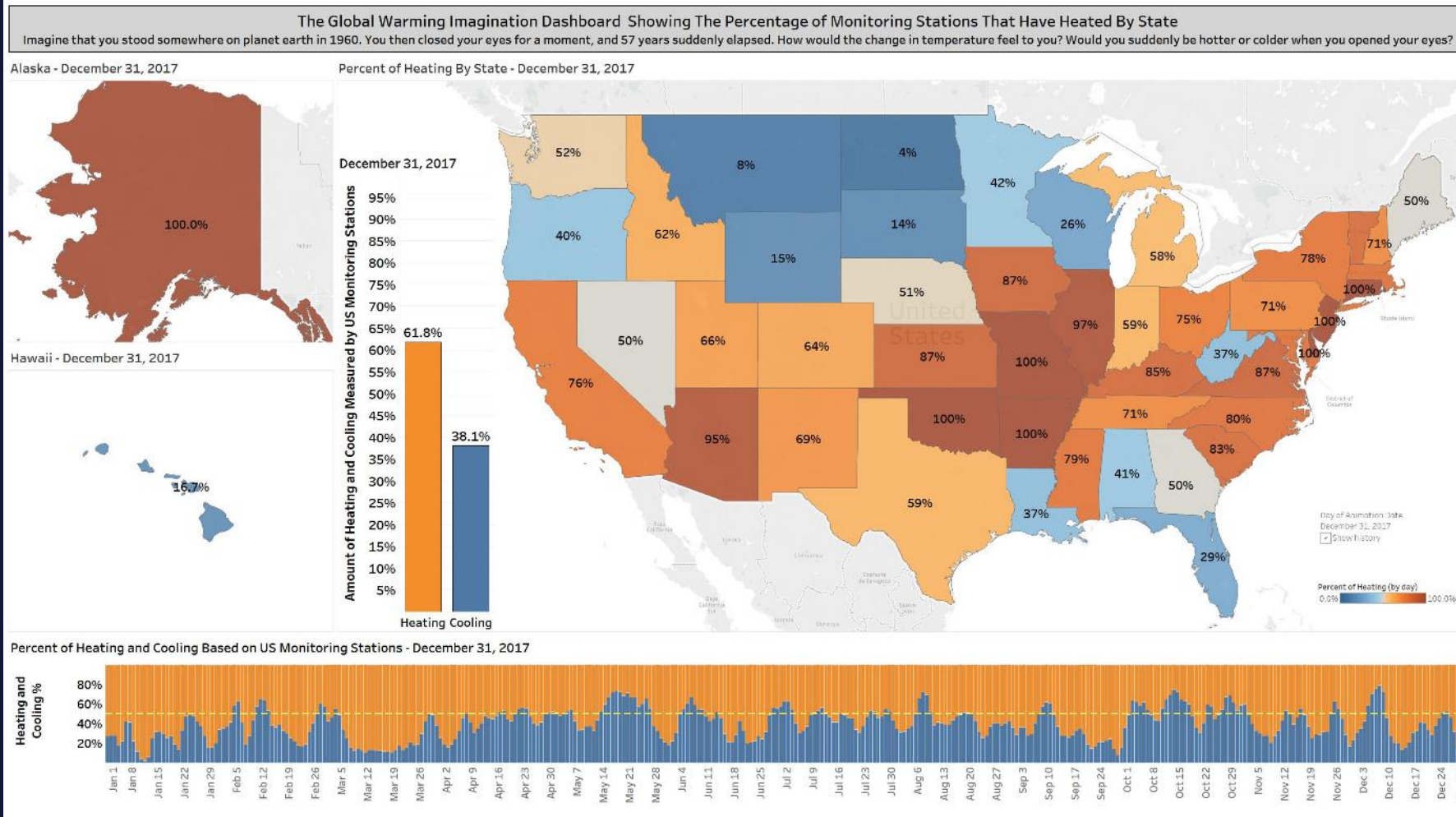


Percent of Heating and Cooling Based on US Monitoring Stations - September 28, 2017



September 28

SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES



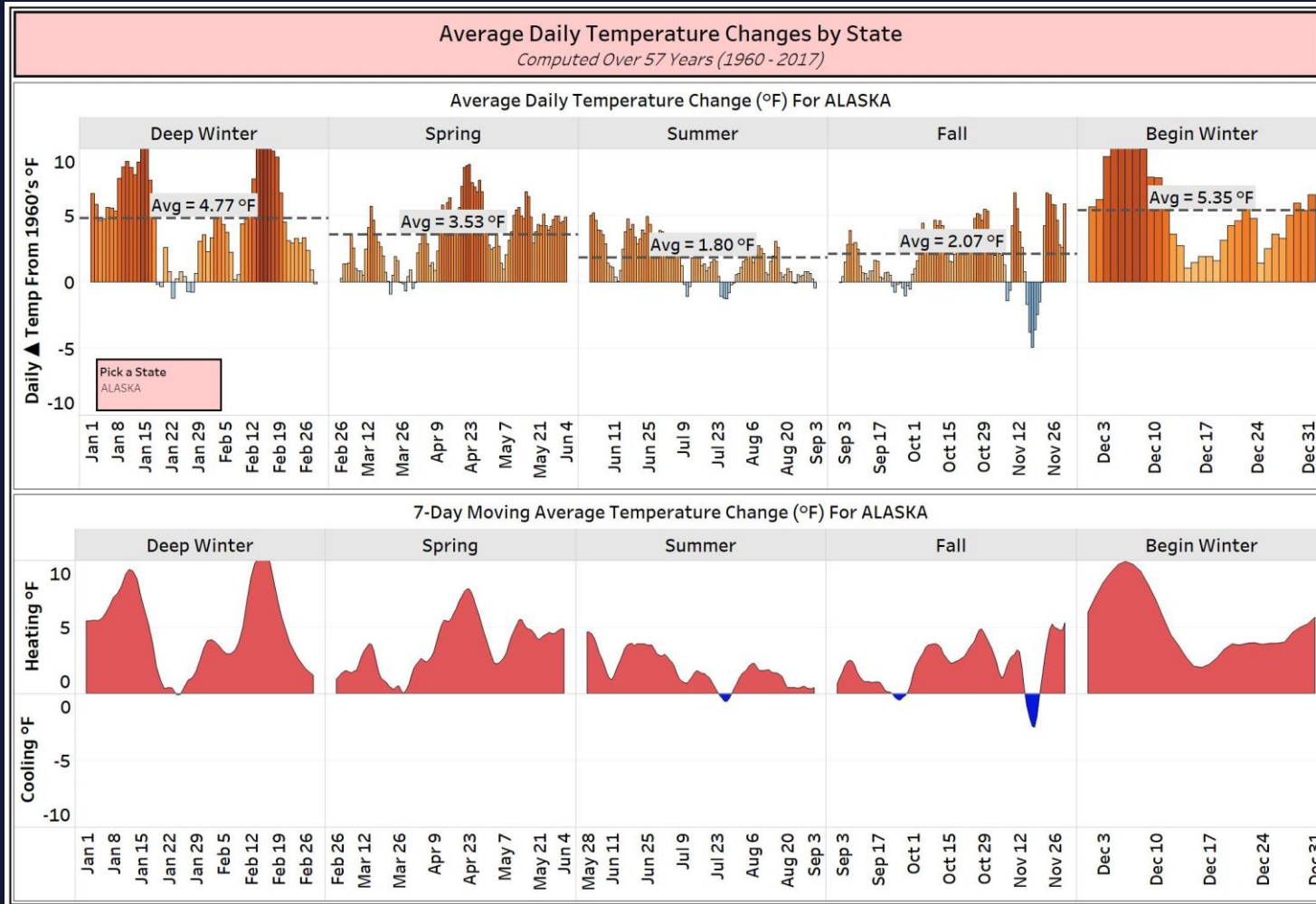
December 31

SIX DECADES OF NORTH AMERICAN TEMPERATURE CHANGES

Now the focus will stay in North America

Temperature changes are now shown as actual values and as 7-day moving averages

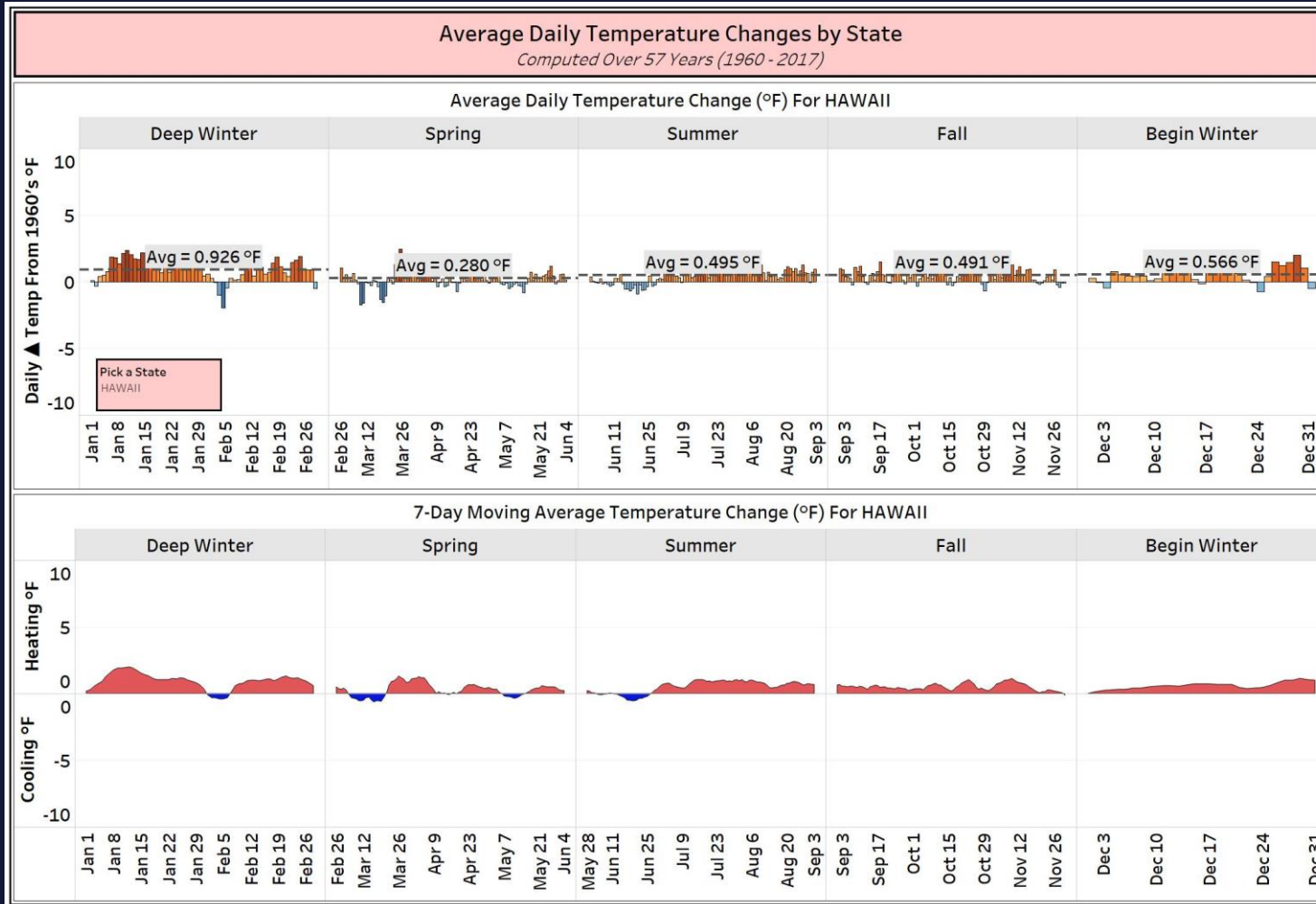
SEASONAL NORTH AMERICAN TEMPERATURE CHANGES



Most Heating

Alaska

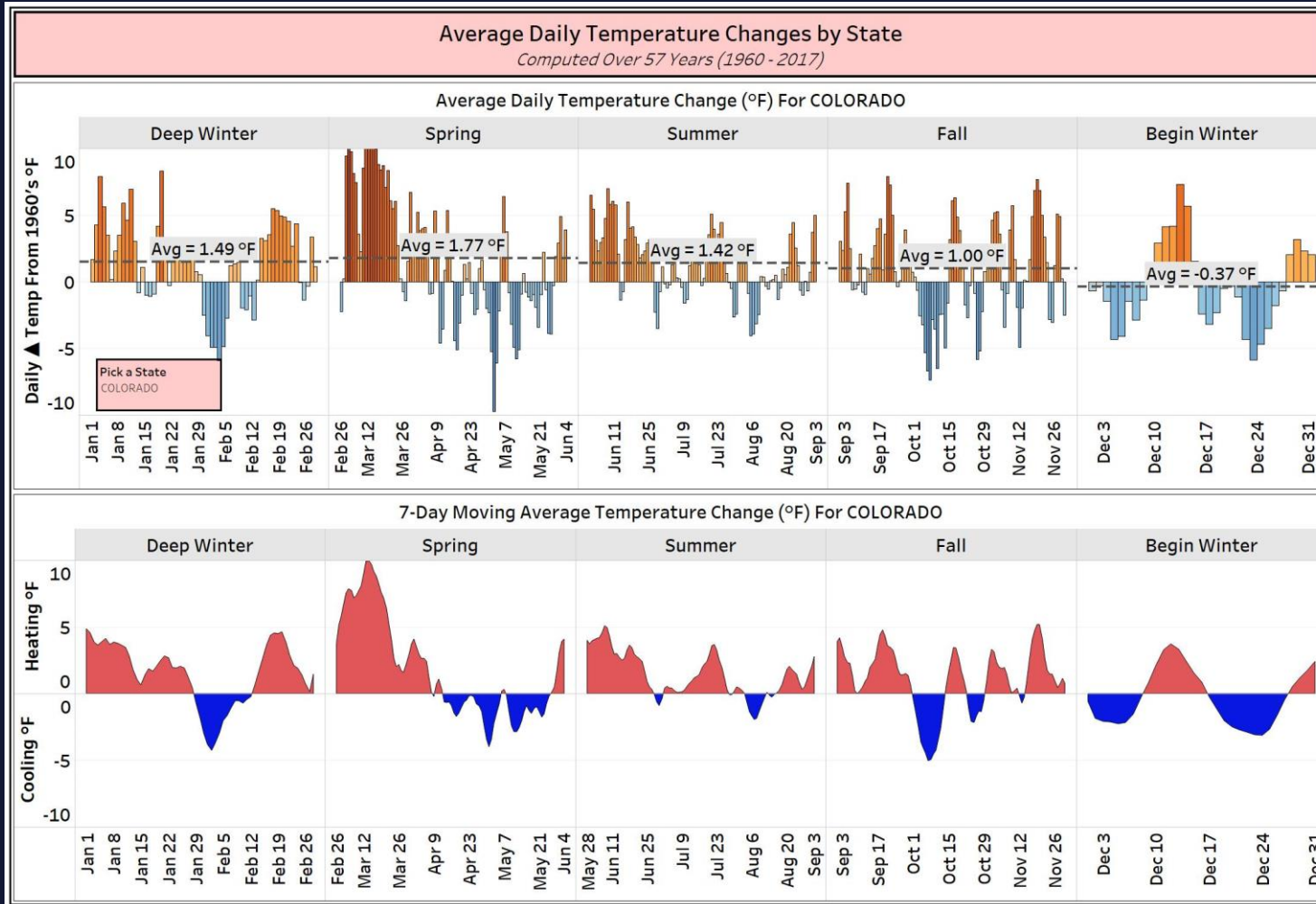
SEASONAL NORTH AMERICAN TEMPERATURE CHANGES



Least Heating

Hawaii

SEASONAL NORTH AMERICAN TEMPERATURE CHANGES



Interesting Effect:
Late Season Snowfall

Colorado

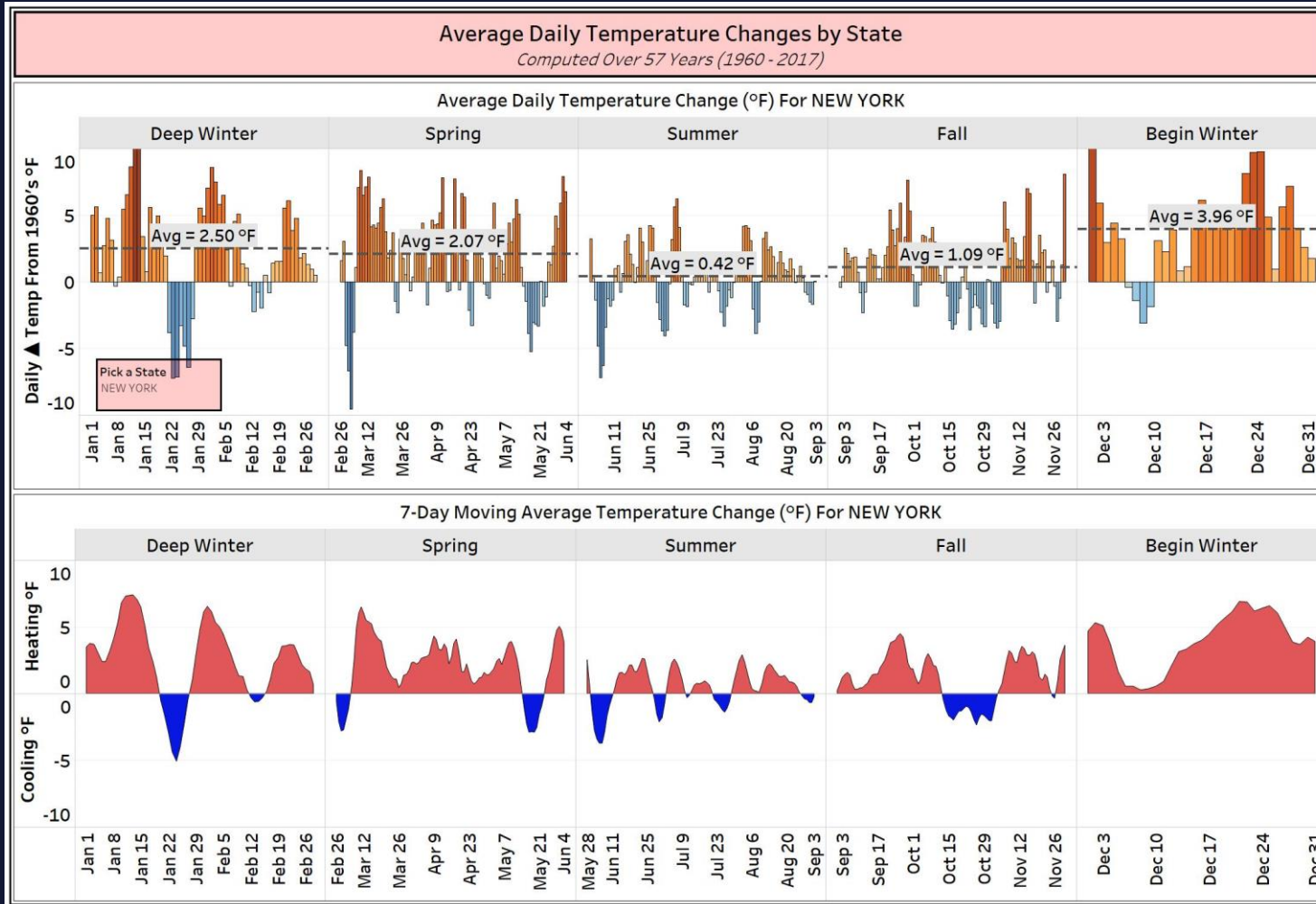
SEASONAL NORTH AMERICAN TEMPERATURE CHANGES



Interesting Effect:
Late Season Snowfall
On May 23rd Rocky
Mountain NP

Colorado

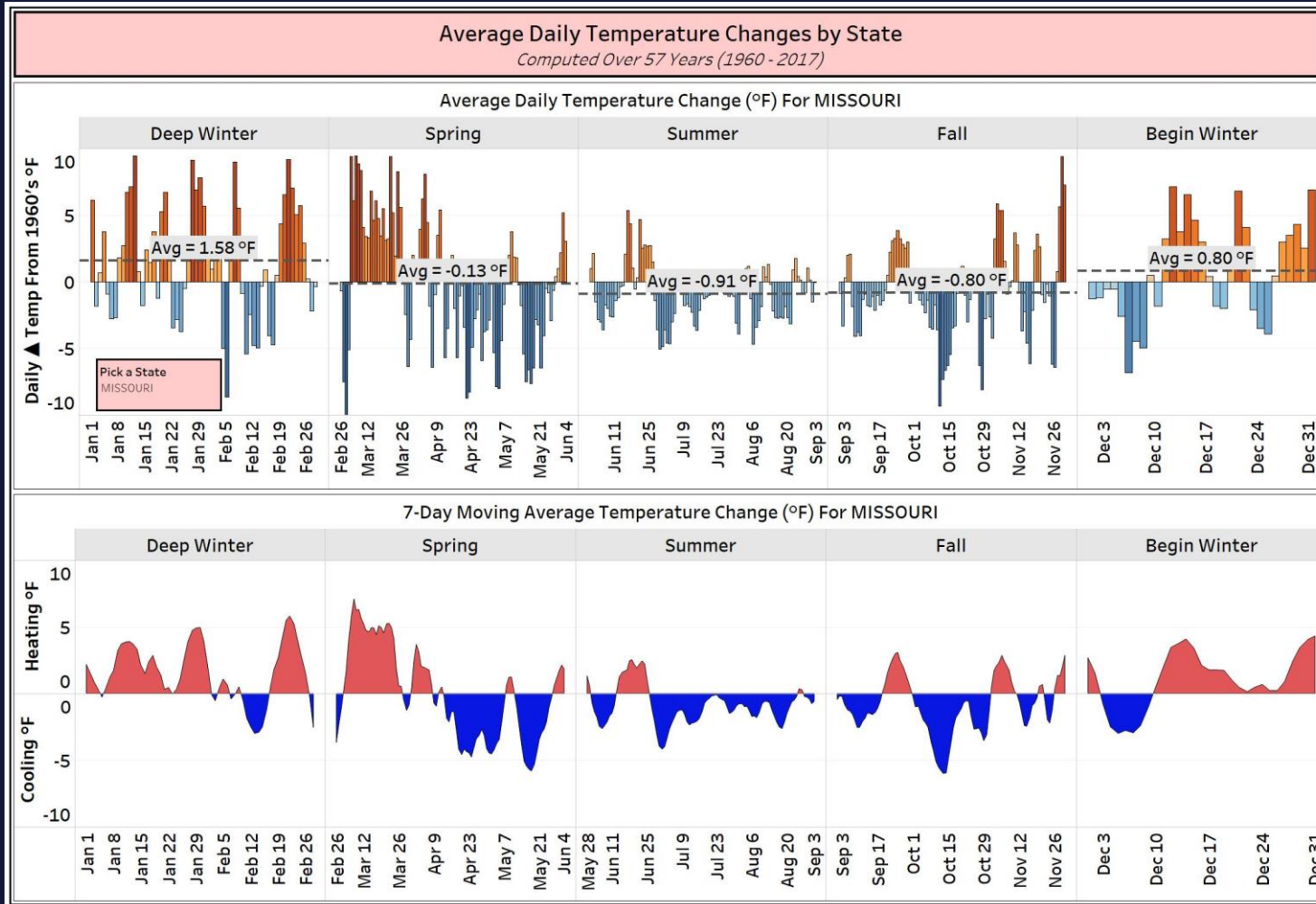
SEASONAL NORTH AMERICAN TEMPERATURE CHANGES



Interesting Effect:
Significant Winter
Heating

New York

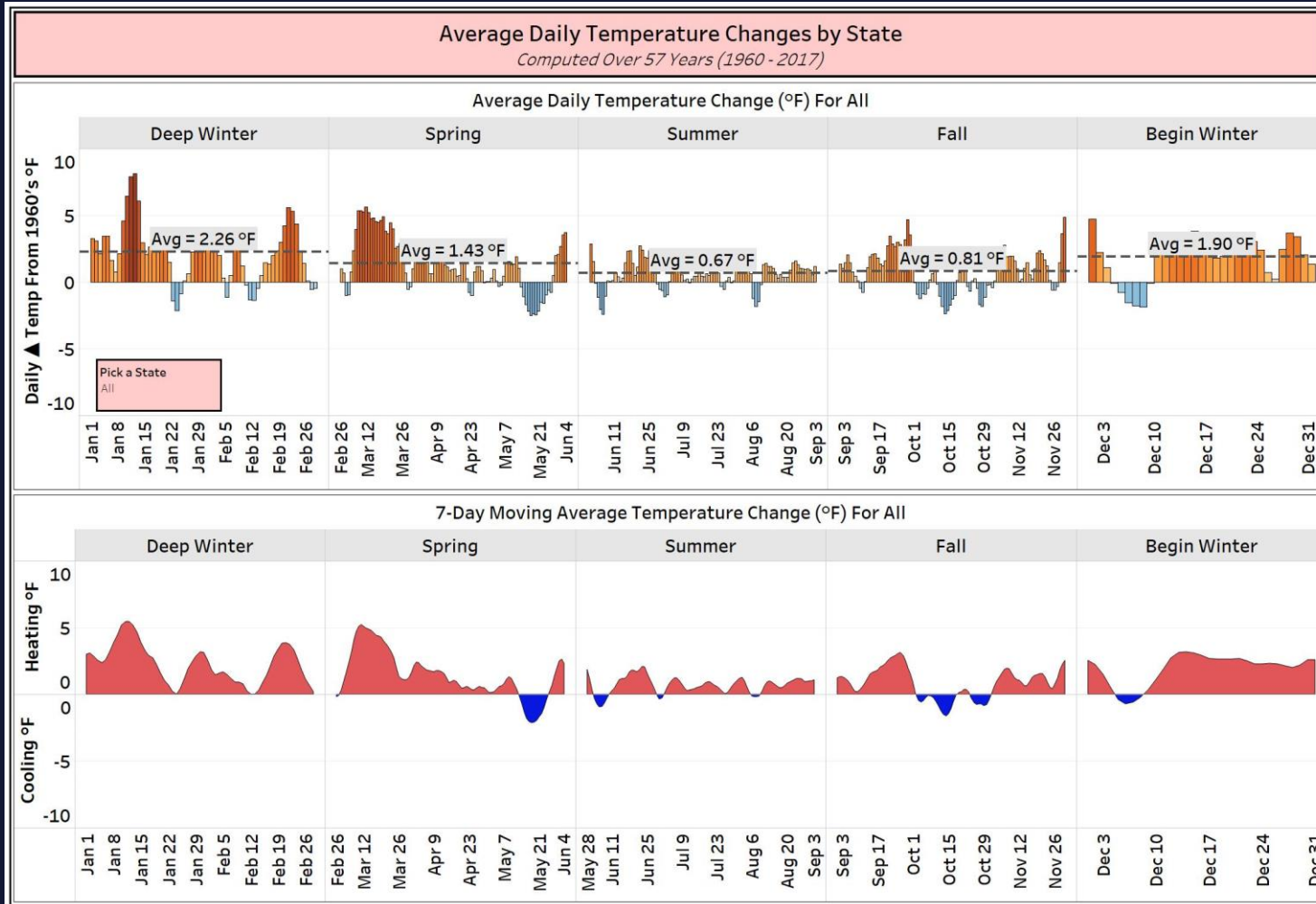
SEASONAL NORTH AMERICAN TEMPERATURE CHANGES



Interesting Effect:
Cooling Summers

Missouri

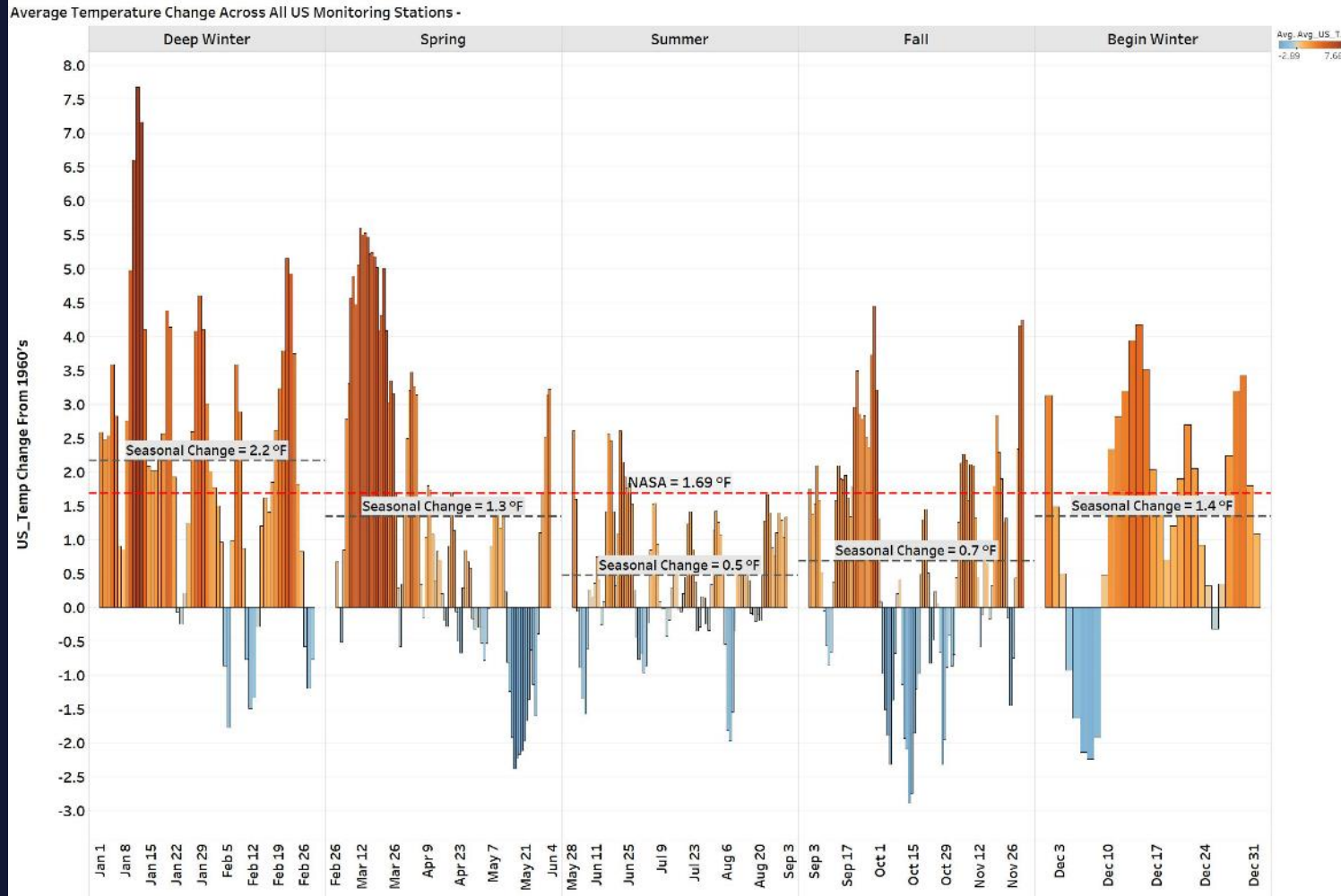
SEASONAL NORTH AMERICAN TEMPERATURE CHANGES



The US temperature changes are shown across the seasons

All States

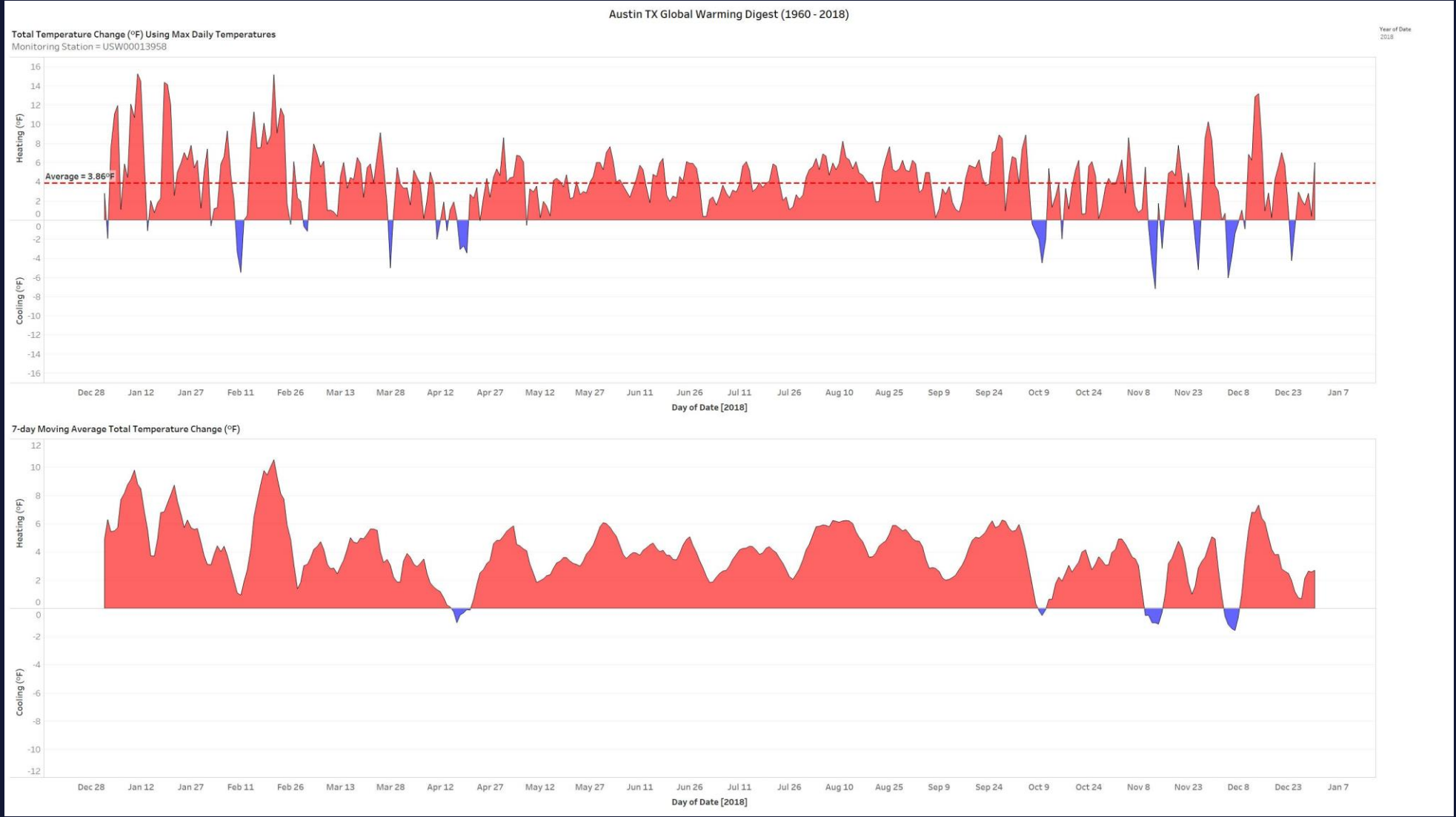
SEASONAL NORTH AMERICAN TEMPERATURE CHANGES



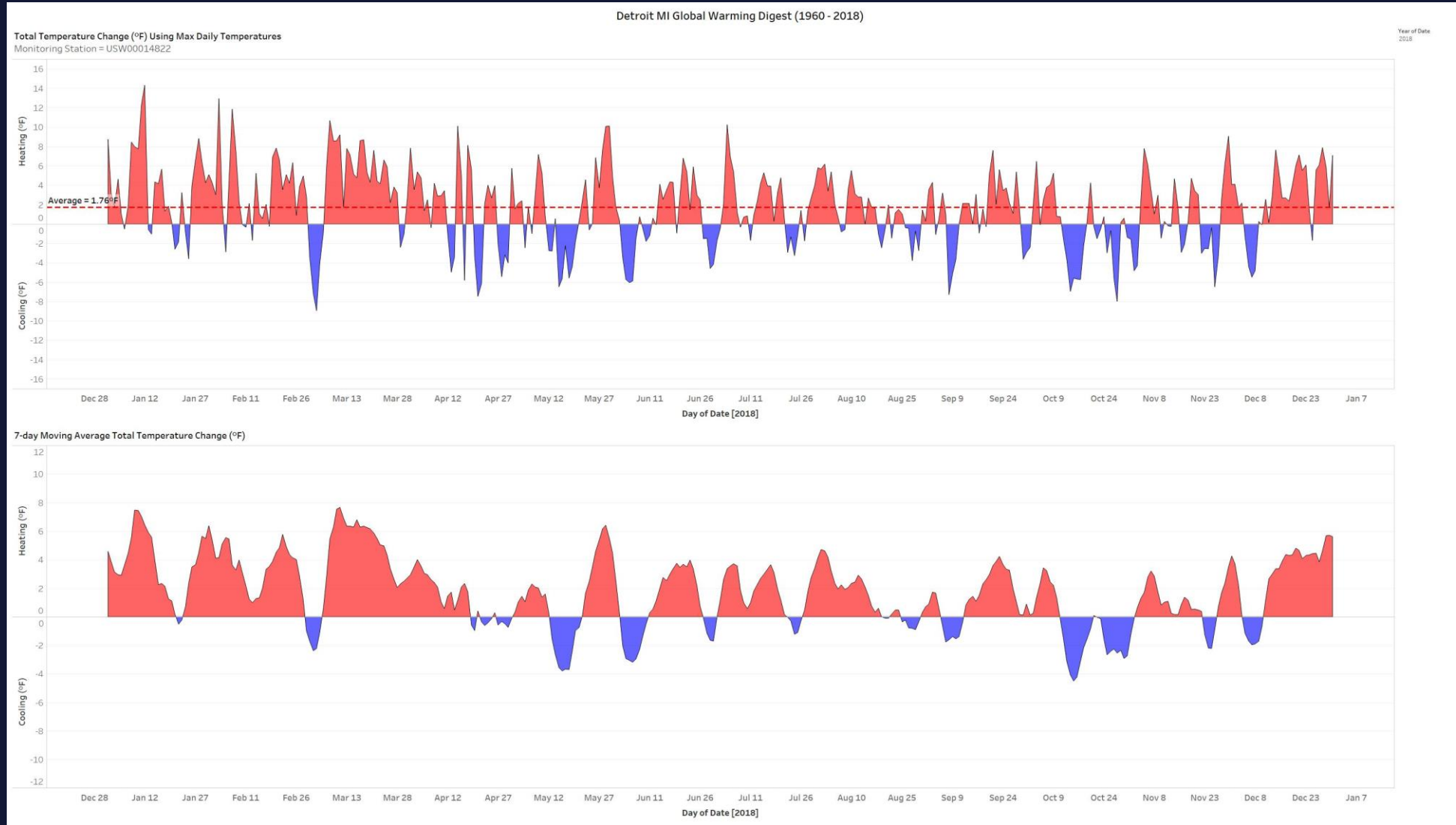
The US temperature changes are shown across the seasons

We can now understand how the daily variations relate to the NASA 1.69 degree F of global change

AUSTIN TEMPERATURE CHANGES



DETROIT TEMPERATURE CHANGES

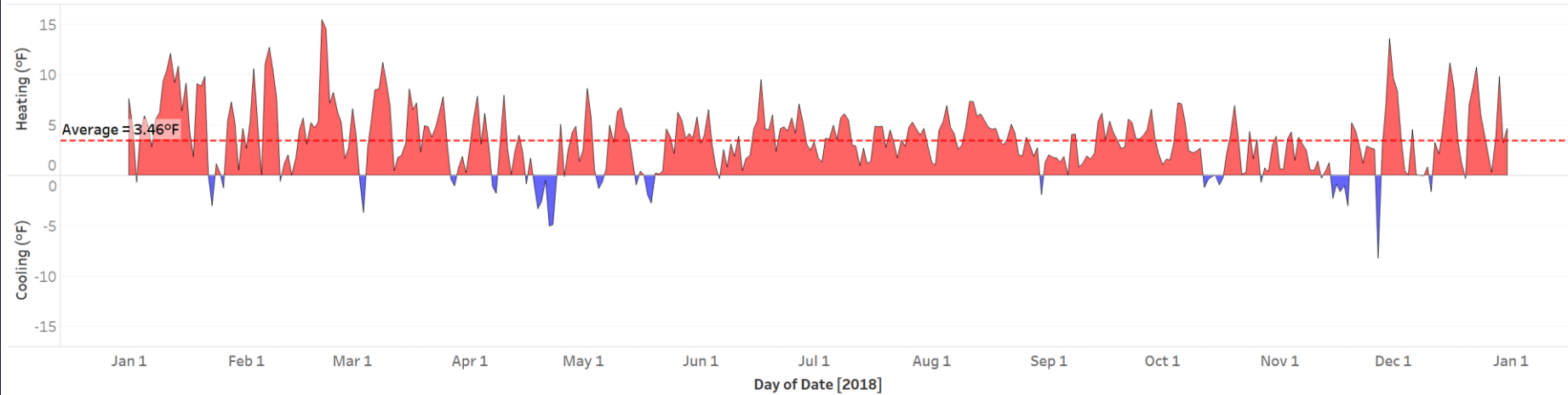


ATLANTA TEMPERATURE CHANGES

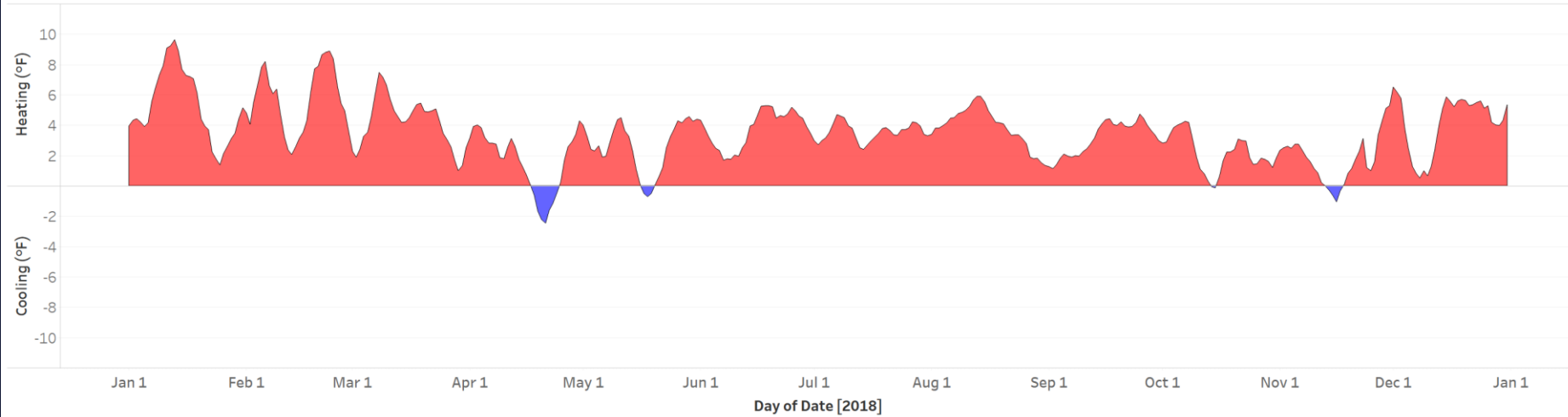
Atlanta, GA Global Warming Digest (1960 - 2018)

Total Temperature Change (°F) Using Max Daily Temperatures
Monitoring Station = USW00013874

Year of Date
2018



7-day Moving Average Total Temperature Change (°F)

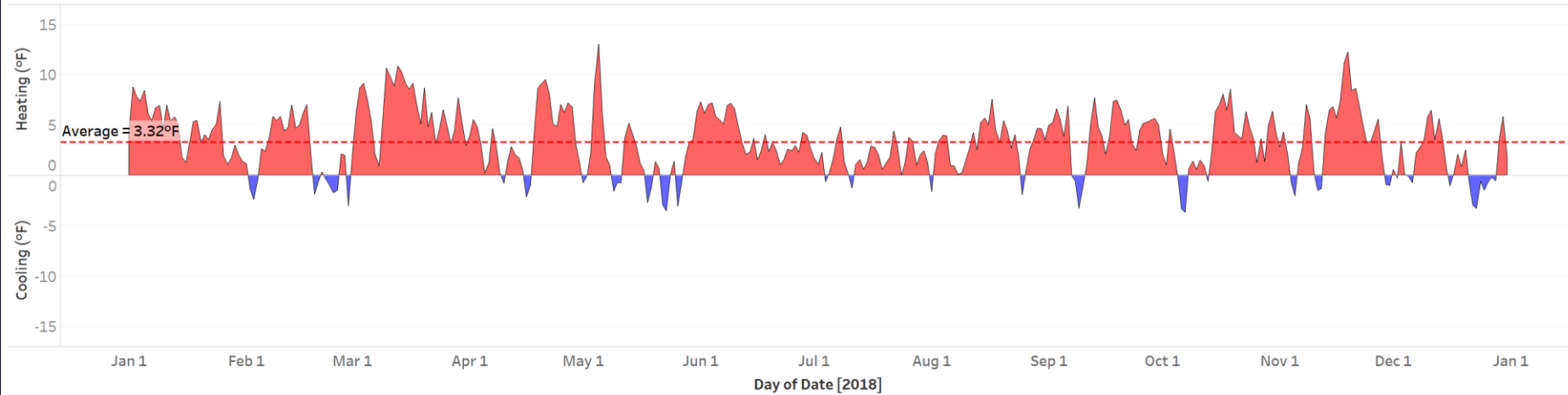


PHOENIX TEMPERATURE CHANGES

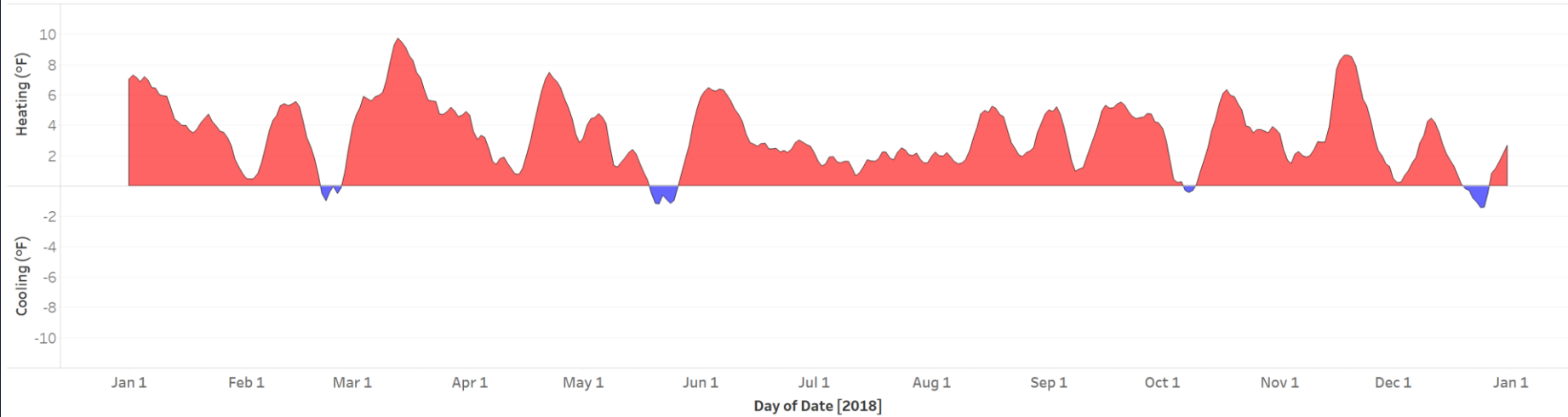
Phoenix AZ Global Warming Digest (1960 - 2018)

Total Temperature Change (°F) Using Max Daily Temperatures
Monitoring Station = USW00023183

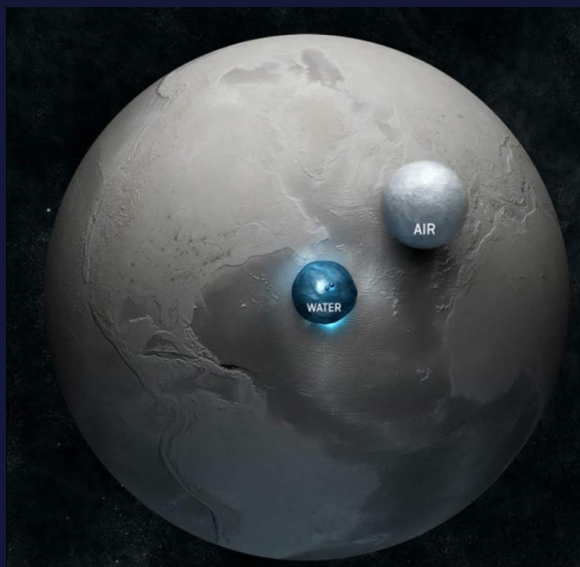
Year of Date
2018



7-day Moving Average Total Temperature Change (°F)



FIVE KEY POINTS



GLOBAL WARMING IS REAL

- A lot of data was used to comprehend spatial and temporal changes in daily temperatures across the world
- Over 100M data points and 2M linear models tell the story
- There is a lot of consistency in what is happening over time
- What causes those changes is up for debate

1

Global Warming Is Real

2

Warming and Cooling Are Spatially and Temporally Variable

3

Long-term Changes Can Be Understood at the Daily Level

4

Alteryx Crushes Massive Amounts of Data

5

Tableau is Superb At Helping Us Understand Our Data

THANK YOU

alteryx | The Thrill
of Solving

KEN BLACK

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