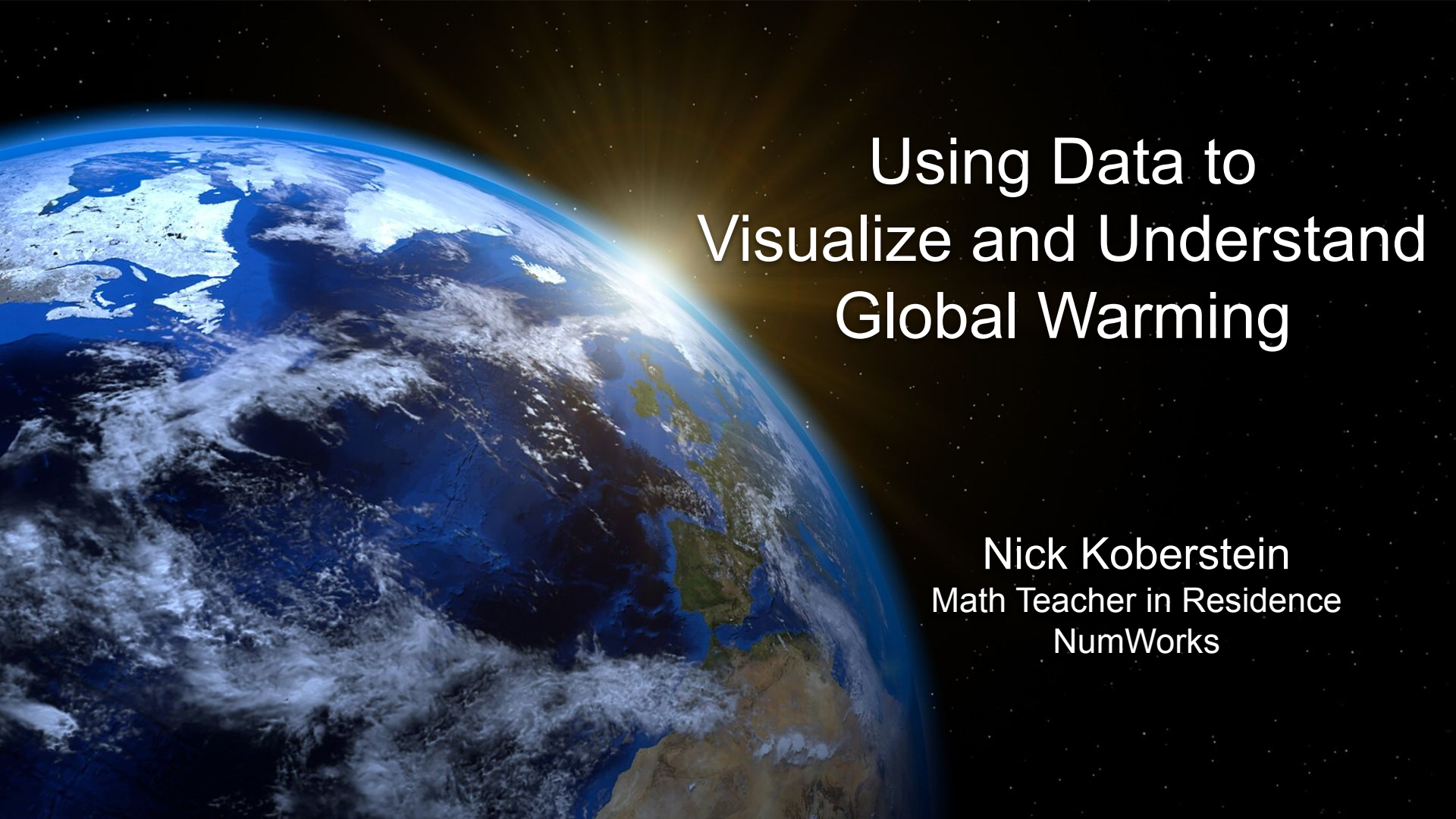

Using Data to Visualize and Understand Global Warming

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NumWorks

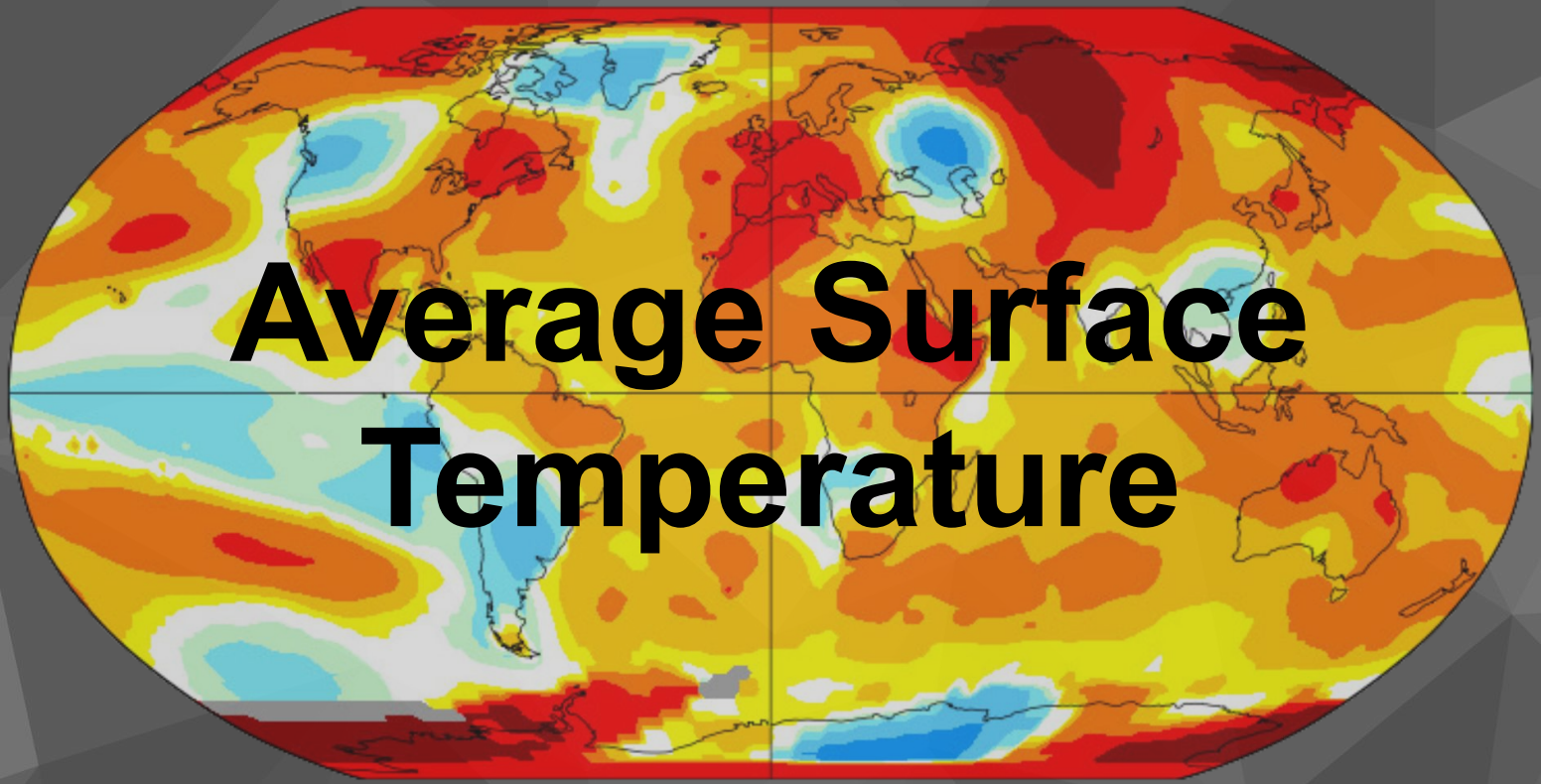
My Story

NCSSM

A LOOK BACK: 2022'S TEMPERATURE RECORD


120
100
80
60
40
PHOTOGRAPH BY GEORGE STEINMETZ /
NATIONAL GEOGRAPHIC

Average Surface Temperature



GISTEMP Team, 2023: GISS Surface Temperature Analysis (GISTEMP), version 4. NASA Goddard Institute for Space Studies. Dataset accessed 2023-06-06 at data.giss.nasa.gov/gistemp/.

Vocabulary

- **Global Warming**: the long-term heating of Earth’s surface observed since the pre-industrial period due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth’s atmosphere. This term is not interchangeable with the term "climate change."

- **Climate change**: a long-term change in the average weather patterns that have come to define Earth’s local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term.

https://climate.nasa.gov/global-warming-vs-climate-change

Vocabulary

- **Surface Area Temperature**[1]: the temperature of the air near the surface of the earth; almost invariably determined by a thermometer in an instrument shelter.

- **Anomaly**[2]: A departure from a reference value or long-term average. A positive anomaly indicates that the observed temperature was warmer than the reference value, while a negative anomaly indicates that the observed temperature was cooler than the reference value.

- **Base period**[3]: Time interval to which anomalies are relative. For our data, the base period is 1951-1980.

1: https://glossary.ametsoc.org/wiki/Surface_temperature
2: https://www.ncei.noaa.gov/access/monitoring/global-temperature-anomalies
3: https://earthobservatory.nasa.gov/world-of-change/global-temperatures

Task 1: Analyzing global annual mean temperatures

The global mean surface area temperature from 1951 - 1980 was 14ºC (57ºF).

- The anomaly for 2000 was 0.39ºC. What was the mean temperature in ºC and ºF?

- The anomaly for 2020 was 1.02ºC. What was the mean temperature in 2020?

$$^{o}\mathrm{F} = \frac{9}{5} \cdot ^{o}\mathrm{C} + 32$$

1980's

Year	Anomaly
1980	0.26
1981	0.32
1982	0.14
1983	0.31
1984	0.16
1985	0.12
1986	0.18
1987	0.32
1988	0.39
1989	0.27

1990's

Year	Anomaly
1990	0.45
1991	0.40
1992	0.22
1993	0.23
1994	0.32
1995	0.45
1996	0.33
1997	0.46
1998	0.61
1999	0.38

2000's

Year	Anomaly
2000	0.39
2001	0.54
2002	0.63
2003	0.62
2004	0.53
2005	0.68
2006	0.64
2007	0.66
2008	0.54
2009	0.66

2010's

Year	Anomaly
2010	0.72
2011	0.61
2012	0.65
2013	0.68
2014	0.75
2015	0.90
2016	1.02
2017	0.92
2018	0.85
2019	0.98

2020's

Year	Anomaly
2020	1.02
2021	0.85
2022	0.89

1980's

Year	Anomaly
1980	0.26
1981	0.32
1982	0.14
1983	0.31
1984	0.16
1985	0.12
1986	0.18
1987	0.32
1988	0.39
1989	0.27
Average	**0.247**

1990's

Year	Anomaly
1990	0.45
1991	0.40
1992	0.22
1993	0.23
1994	0.32
1995	0.45
1996	0.33
1997	0.46
1998	0.61
1999	0.38
Average	**0.385**

2000's

Year	Anomaly
2000	0.39
2001	0.54
2002	0.63
2003	0.62
2004	0.53
2005	0.68
2006	0.64
2007	0.66
2008	0.54
2009	0.66
Average	**0.589**

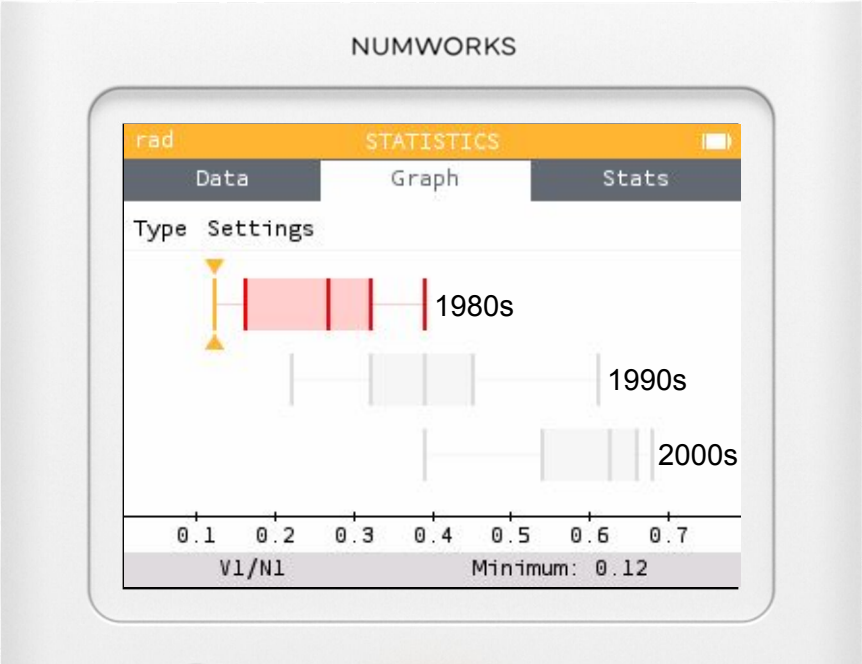
2010's

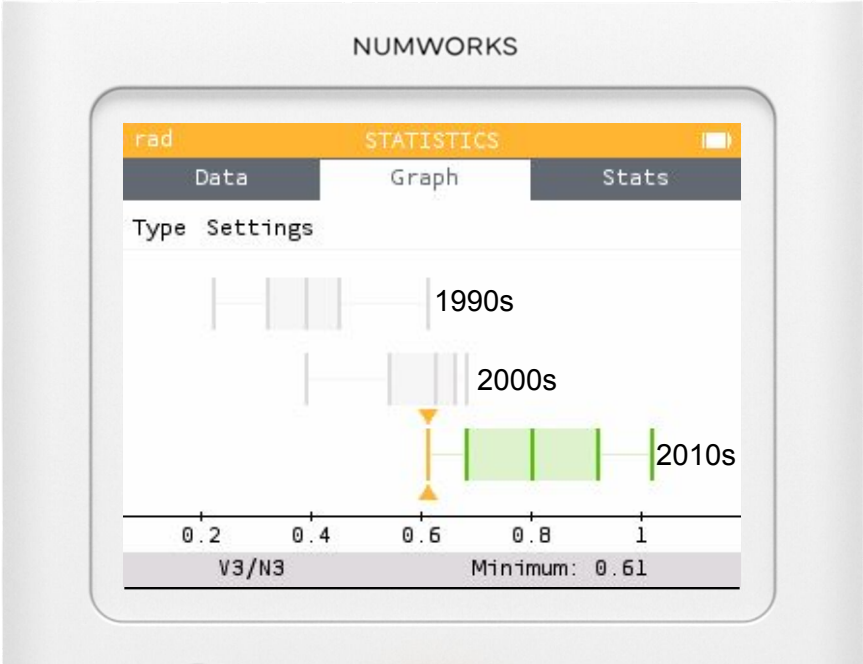
Year	Anomaly
2010	0.72
2011	0.61
2012	0.65
2013	0.68
2014	0.75
2015	0.90
2016	1.02
2017	0.92
2018	0.85
2019	0.98
Average	**0.808**

Construct boxplots for each decade

- How do the centers compare?
- How do the spreads compare?

my.numworks.com/simulators/41te9s


NUMWORKS
rad
STATISTICS
Data
Graph
Stats
Type Settings
1980s
1990s
2000s
0.1 0.2 0.3 0.4 0.5 0.6 0.7
V1/N1
Minimum: 0.12

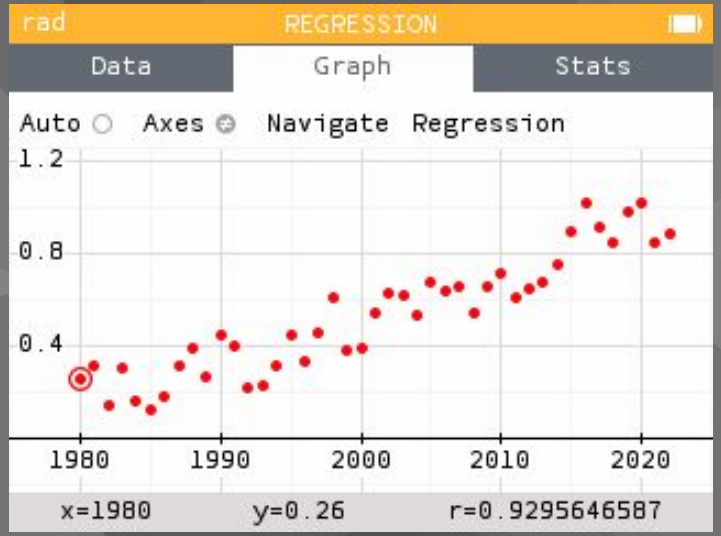

NUMWORKS
rad
STATISTICS
Data
Graph
Stats
Type Settings
1990s
2000s
2010s
0.2 0.4 0.6 0.8 1
V3/N3
Minimum: 0.61

What is the overall trend?

1. Create a scatterplot of year vs anomaly
2. Describe the association between year and anomaly
3. What is the correlation coefficient and what does that tell you about the association

my.numworks.com/simulators/dqvrwb

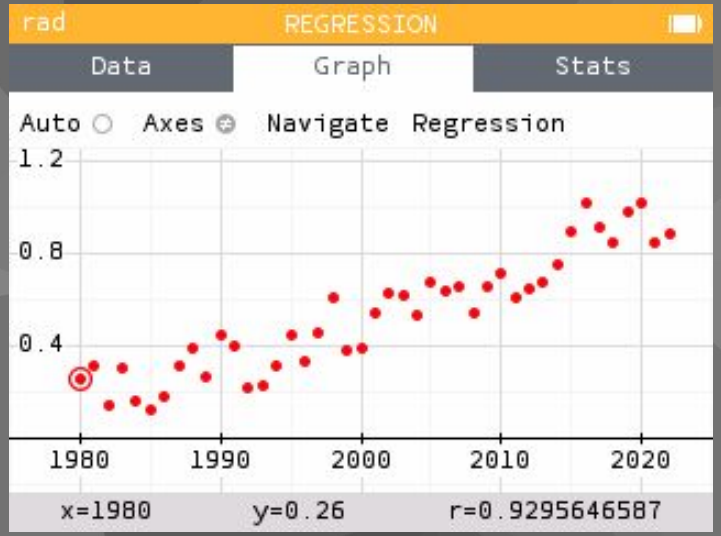
What is the overall trend?



Here is a scatterplot of anomaly vs year.

Describe the association between year and anomaly

What is the overall trend?



The correlation coefficient is r = 0.9296.

What does that tell you about the association between the anomaly and the year?

Pick up where we left off!

See if you can add a linear regression model to the dataset.

- Interpret the y-intercept and slope of the model.
- If this trend were to continue, predict the global mean temperatures for 2030, 2050 and 2100.

my.numworks.com/simulators/dqvrwb


Lake Ontario
Lake Erie
Detroit
Fort Wayne
South Bend
Ann Arbor
Pontiac
Warren
Port Huron
Niagara Falls
Rochester
Indianapolis
Columbus
OHIO
INDIANA
ILLINOIS
KENTUCKY
Harrisburg
Allentown
State College
Altoona
Johnstown
Reading
York
Lancaster
Wilmington
Philadelphia
Trenton
Cumberland
Hagerstown
Frederick
Morgantown
Winchester
Baltimore
MARYLAND
Dulles
Arlington
DISTRICT OF COLUMBIA
WASHINGTON DC
Annapolis
Dover
Vineland
Atlantic City
Harrisonburg
Fredericksburg
Charlottesville
Lynchburg
James River
Potomac River
Salisbury
Spruce Knob
1482m
VIRGINIA

Task 2: Analyzing local annual mean temperatures

Navigate to **tinyurl.com/nctm-temps** and scroll down to the globe.

Find the station nearest you. You can also search your city.

Once your station is selected, scroll down to “Download monthly data as text or **CSV**”.

tinyurl.com/nctm-temps

https://data.giss.nasa.gov/gistemp/station_data_v4_globe/

This provides **mean temperatures** (in ºC) for your area.

Task 2: Analyzing local annual mean temperatures

Examine the **metANN** column (annual mean temperature) for the years 1980 - 2023.

What do you notice? What do you wonder?

Task 2: Analyzing local annual mean temperatures

- Construct boxplots for each decade
  - How do the centers compare?
  - How do the spreads compare?

- What is the overall trend?
  - Construct a scatterplot and add a linear regression.
  - Interpret the slope.
  - Predict the temperature in your area in 2030, 2050 and 2100.

Need a calculator?

numworks.com/simulator

Task 3: Repeat Task 2 for one of the following cities

- Moscow, Russia
- Paris, France
- Östersund, Sweden
- La Serena, Chile
- Washington DC, USA

Discussion:

How do the changes in mean temperatures in these local areas compare to the global change?

List of Deliverables

- Google slides
- Activity Handout (in folder)
- NumWorks free online simulator
- Request a free sample NumWorks calculator!

https://tinyurl.com/koberstein2-camt