

EES 3506 / 5506

Observing and Modeling Climate Change

Fall 2023

Lecture:

TR 9:30 – 10:50 AM, BEURY 304

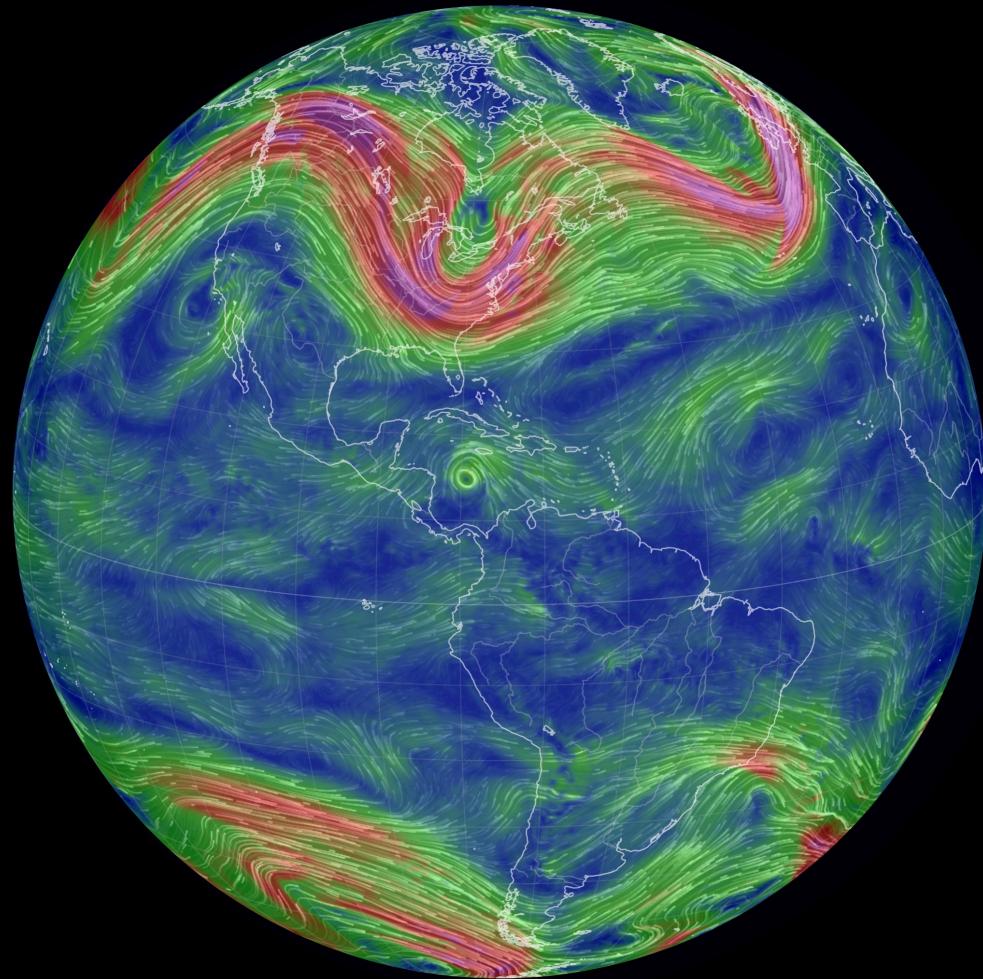
Instructor:

Dr. Becki Beadling (she/hers)

rebecca.beadling@temple.edu

315A BEURY Hall

Office hours: Wednesday 1 – 3 pm



**Do you have any questions regarding
course content / structure or anything
from the assigned readings?**

Git & GitHub for Collaboration and Version Control



Open-source version control system (VCS) on your local computer (your VM in this case) that is recording (tracking) all changes you make to a particular file

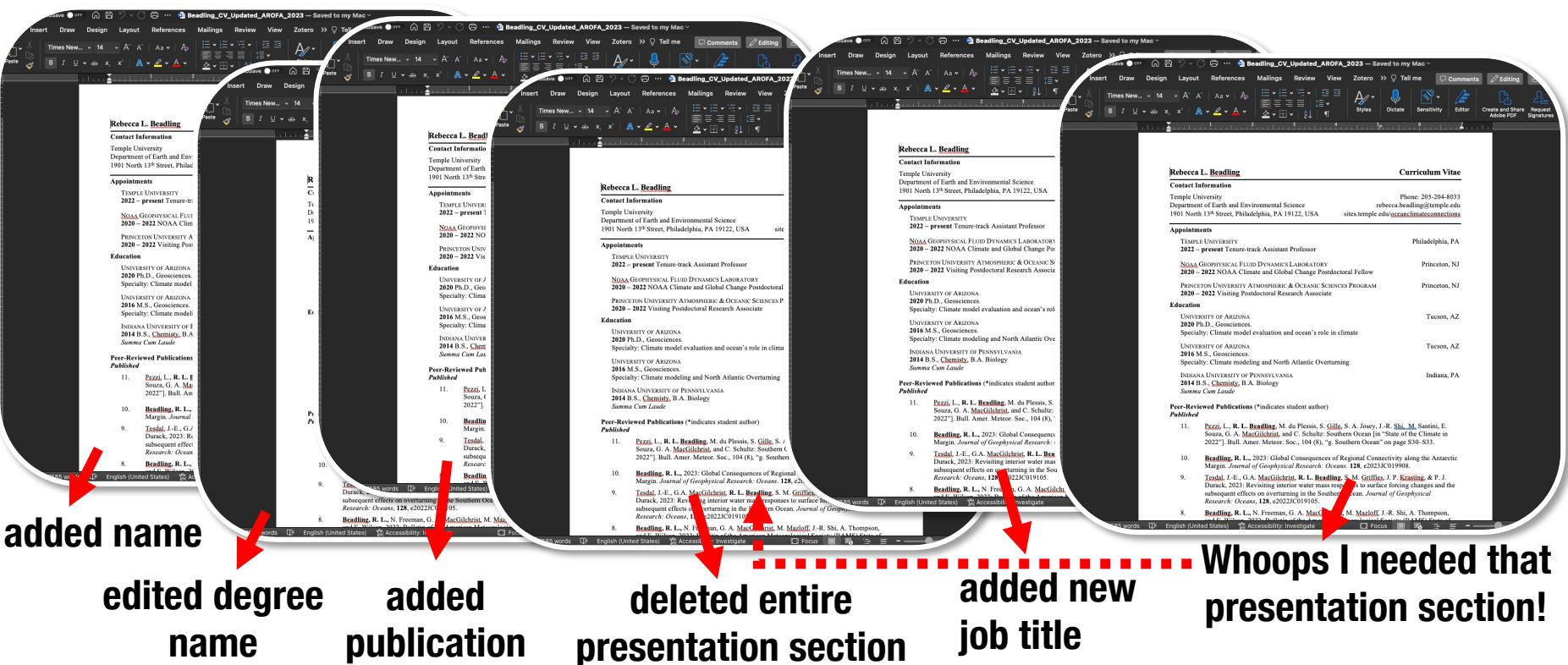


Remote repository online (a website) where all your code (and its tracked changes) is stored on the cloud. You can push your files and all changes to this web interface for secure remote back up.

Version Control: tool you use to track, make, and manage changes to your code. Stores every change you make to a file at different stages so you and your collaborators can retrieve those changes later if needed.

If you accidentally mess up some code while making changes, you can easily go back to the previous stage (*previous version*) where the mess has not occurred yet.

For simplicity let's think through this concept using a word document





Why use GitHub?

Secure version backup

Secure back up! Never lose your code and all the changes you made to it.

Easy Collaboration & Project Management

Individuals can create and **share code** and relevant datasets with one another easily across the web. Instead of requiring you to download all my code & (small) datasets, I can share these with you via a link which you can clone to whatever computer you are working on. I can also easily share example code with you that you can just read through the notebooks to learn.

Reproducible Science

It is becoming a **requirement** in academic publishing that all data and / or software used must be available at the time of publication.

Open Source

Free for use and development.



Why use GitHub?

Reproducible Science

It is becoming a **requirement** in academic publishing that all data and / or software used must be publicly available at the time of publication.

Data Availability Statement

The forcing fields that were used in these experiments as well as the code to produce the figures can be found at (https://github.com/becki-beadling/Beadling_et_al_2022_JGROceans). All model output is available on request and is in the process of being made publicly available on the Earth System Grid (https://github.com/becki-beadling/Beadling_et_al_2022_JGROceans) as part of FAFMIP. The GFDL Model 6 (MOM6) is available at (<https://www.gfdl.noaa.gov/cmip6/>) and the GFDL Model 1 (MOM1) is available at (<https://www.gfdl.noaa.gov/MOM1/>).



mom-ocean / MOM6

Type to search

Code Issues 48 Pull requests Discussions Actions Projects 1

MOM6 Public

Watch

main 1 branch 0 tags Go to file Add file Code

File	Description	Time
marshallward Merge pull request #1605 from GEOS-ESM/marshallward	Merge pull request #1605 from GEOS-ESM/marshallward ... 2dd99f8 3 weeks ago	10,901 commits
.github	github workflows: update to use actions/checkout@v3	2 months ago
.gitlab	Update icebergs source path in nolibs build	2 months ago
.testing	Merge branch 'mle-bodner-submit' into pr/352-merge	3 months ago
ac	Autoconf: Fix Python test and allow configuration	2 months ago
config_src	Fms2 io read3d slice (#399)	last month
docs	edits for resolving rtd compile errors	10 months ago
pkg	Update CVMix to v0.98-beta	2 years ago
src	Update MOM_variables.F90	last month
.codecov.yml	Refactoring of the .testing Makefile	last year
.gitignore	Testing: Update FMS to 2020.04 ; .gitignore update	3 years ago
.gitlab-ci.yml	Update the Gitlab .testing modules for c5	3 months ago

Modular Ocean Model

fortran numerical-modelling
ocean-circulation-models
numerical-modeling ocean-circulation
climate-modeling

Readme View license Activity 167 stars 53 watching 194 forks Report repository

Releases No releases published

Companies That Use Github	Who Uses Github at This Company?	What Does This Company Use Github For?	Estimated Number of Employees
3M Corporation	Information analyst, software engineer	Centralize code and teams to speed up research and development of new digital technologies	<u>95,000</u>
Adobe Systems Inc.	Software engineer, computer scientist, software development engineer	To make legal and technical processes more efficient	<u>22,516</u>
BuzzFeed	IT engineer, IT manager, principal engineer	For software engineers and news team to collaborate in one platform	<u>1,840</u>
Coinbase Global, Inc.	Software engineer, risk manager	For organization-wide transparency	<u>1,249</u>
Dell Technologies	Technical support engineer, Java developer, principal software engineer	To work on bigger projects and finish them faster	<u>158,000</u>
Facebook	Research scientist, software engineer, computer vision engineer	To give back to the developer community. Their Github projects React and PyTorch are some of the most-followed projects in the Github platform.	<u>58,600</u>
Ford Motor Company	Software engineer, product manager, data scientist	Collaboration work on complex car features	<u>186,000</u>
LinkedIn	Instructional designer, senior software engineer, front end software engineer	To manage end-to-end workflow	<u>18,000</u>
Procter & Gamble	IT manager, senior software engineer	To update DevOps and CI/CD tooling and processes	<u>101,000</u>
Seagate	Senior staff engineer, staff engineer	For its open-source software, CORTX	<u>40,000</u>

Outside of scientific research use it's a sought-after skill in the tech world.

22,516

1,840

1,249

Average Salaries for 3M Corporation Employees Who Use Github

- Information Analyst | \$98,335
- Software Engineer | \$77,429

Average Salaries for Adobe Employees Who Use Github

- Software Engineer | \$119,623
- Computer Scientist | \$143,949
- Software Development Engineer | \$110,699

Average Salaries for BuzzFeed Employees Who Use Github

- IT Engineer | \$83,721
- IT Manager | \$126,896
- Principal Engineer | \$154,914

Tour of the EES-3506-5506 GitHub Organization

The screenshot shows the GitHub organization page for EES-3506-5506. At the top, there's a navigation bar with links to YouTube, Maps, and CMIP6 Cookbook... The main header has a lock icon and the URL github.com/EES-3506-5506. To the right are standard browser controls like back, forward, search, and refresh, along with a GitHub-specific icon bar.

The organization's logo is a blue and white pixelated cube. The name "EES-3506-5506" is displayed next to it. Below the logo, there are tabs for Overview (selected), Repositories (9), Projects, Packages, Teams, People (6), and Settings.

The "Overview" section contains the following content:

- README.md**: A link to the organization's README file.
- Welcome to EES 3506 / 5506: Observing and Modeling Climate Change Fall 2023!**: The main welcome message.
- Course Online Textbook**: A link to the course textbook.
- All course materials can be downloaded from Repositories > Select Repository > Code > Download ZIP or can be cloned into an your Azure Virtual Machine.**: Instructions for getting course materials.
- For the purpose of this course, we will be using Azure Virtual Machines which I have already configured with the correct conda environment for our purposes. To run the course outside of an Azure VM, the ees3506_5506 conda environment used can be set up with the .yml located [here](#). This assumes one has miniconda & mamba already installed on their system, if not, follow the instructions [here](#) for your specific configuration.**: Configuration instructions for Azure VMs.

To the right of the main content area, there are several sidebar sections:

- View as: Member ▾**: A dropdown menu showing the current view as a member.
- You are viewing the README and pinned repositories as a member of the EES-3506-5506 organization.**: Information about the current viewing context.
- You can pin repositories visible only to members of the organization.**: A tip about pinning repositories.
- You can hide the tasks we've suggested on this page and bring them back later.**: A tip about hiding suggested tasks.
- Discussions**: A section for discussions.
- Set up discussions to engage with your community!**: A call to action for setting up discussions.
- Turn on discussions**: A link to turn on discussions.



beckibeadling-oceans

X

Set status

Your profile

Your repositories

Your projects

Your codespaces

Your organizations

Your enterprises

Your stars

Your sponsors

Your gists

Upgrade

Try Enterprise

Try Copilot

Feature preview

Settings

GitHub Docs

GitHub Support

Clicking on your profile widget in the upper right corner and clicking on “Your organizations” will bring you to a page with a link to our course org.



beckibeadling-oceans (beckibeadling-oceans)

Your personal account

Go to your personal profile

Public profile

Account

Appearance

Accessibility

Notifications

Organizations

EES-3506-5506 Member and collaborator on 2 repositories

New organization

Leave



As the semester goes on, you will see a lot of repositories (“repos”)

Search bar: Beadling

Type: Type ▾

2 results for all repositories match "Beadling"

EES3506_5506_Fall20
Unit 1 Repository
Jupyter Notebook 0 0

EES3506_5506_Fall20
Unit 1 Repository
Jupyter Notebook 0 0

Select type

- All
- Public
- Private
- Sources
- Forks
- Archived
- Mirrors
- Templates

Filter by “Type” to search for Template repos we will have one of these for each unit of the course. You will be instructed on when to clone these.

As the semester goes on, you will see a lot of repositories (“repos”)

Use the search bar at the top and search by your last name to find your repos

The screenshot shows a dark-themed user interface for managing repositories. At the top, there is a navigation bar with links for 'Repositories 10', 'Projects', 'Packages', 'Teams', 'People 6', and 'Settings'. Below the navigation bar is a search bar containing the text 'Beadling', which is highlighted with a red arrow pointing from the top of the image. To the right of the search bar are three dropdown menus labeled 'Type', 'Language', and 'Sort', followed by a green button labeled 'New repository'. A 'Clear filter' link is also visible. The main content area displays two repository results, each with a title, a 'Private' status indicator, and a list of metrics: Jupyter Notebook, forks (0), stars (0), issues (0), and last updated time. The first repository is titled 'EES3506_5506_Fall2023_Unit2_Beadling' and was updated 8 minutes ago. The second repository is titled 'EES3506_5506_Fall2023_Unit1_Beadling' and was updated 3 weeks ago. Both are described as 'Unit 1 Repository'.

Repositories 10 Projects Packages Teams People 6 Settings

Beadling Type Language Sort New repository Clear filter

2 results for all repositories matching Beadling sorted by last updated

EES3506_5506_Fall2023_Unit2_Beadling Private

Jupyter Notebook 0 forks 0 stars 0 issues 0 Updated 8 minutes ago

EES3506_5506_Fall2023_Unit1_Beadling Private

Unit 1 Repository

Jupyter Notebook 0 forks 0 stars 0 issues 0 Updated 3 weeks ago

folders / files in the repo

**Click here to use this template to
create an identical one owned by you.**

EES3506_5506_Fall2023_U1 Public template

Edit Pins Unwatch 1

main 1 branch Go to file Add file Code Use this template

Beadling removed notes/notebooks and moved them to Unit 2 0a77aea 2 weeks ago 12 commits

data added shell lesson data last month

README.md Update README.md 3 weeks ago

README.md

This repository contains datasets and Jupyter Notebooks for use in EES 3506 / 5506 Observing and Modeling Climate Change, taught by Dr. Becki Beadling in the Earth and Environmental Science (EES) Department at Temple University in Fall 2023.

Specifically, the files within this repository contain what is needed for Unit 1 which covers:

- Unix Command Line
- Gittin' started with Git & GitHub

README file with description of what is inside of the repo & the purpose

You should have already used the template to generate a copy of the Unit_1 repo in our organization and should see something similar to this if you search for your last name in our repositories.



Our next step is to “*clone*” this onto your VM which requires some one-time configuration set up (sorry!)

Detailed instructions that we will be following can be found in Chapter 2 of our Course Guide : **Gettin’ Set Up with Git and GitHub (steps 3 & 4). (pull this up so you can follow along and copy and paste the commands!!!).**

Log into your Azure VM (no need for the jupyter steps today)

Logging into your Azure VM in our Course Guide:

<https://hackmd.io/3QEs24V3QbqUmfabs7ezvg?view#Cloud-Computing-with-Microsoft-Azure>

1. Navigate to your unique VM, click the toggle on the left side if your VM is not running, and click the computer widget to get the log in information.
2. Open a terminal window on your computer:
 - Windows: search for “command prompt” in your programs
 - Mac: search for “terminal window”
3. Copy and paste the entire ssh command into your terminal window and click enter ...
4. When prompted for a password enter **Climate2023**.

3. Setting up your Git Configuration Settings

First lets customize your git environment on your VM so that git knows its supposed to communicate with *your* remote GitHub account that you've set up – we only have to do this one time. Issue the follow on in your terminal window, replacing "John Doe" in line 1 with your name, and insert the email address you used to sign up for your GitHub account in line 2.

```
git config --global user.name "John Doe"  
git config --global user.email johndoe@example.com
```

Check to confirm these changes were made by issuing the following:

```
git config user.name  
git config user.email
```

4. Setting up SSH Authentication

You do not need to understand the details here, just make sure you follow the instructions:

1. `ssh-keygen -t ed25519 -C rebecca.beadling@gmail.com`
2. Hit enter when asked where to save the key and then enter `1234` as the passphrase.

```
Generating public/private ed25519 key pair.  
Enter file in which to save the key (/home/ees-3506-5506/.ssh/id_ed25519):  
Enter passphrase (empty for no passphrase):
```

```
Your identification has been saved in /home/ees-3506-5506/.ssh/id_ed25519  
Your public key has been saved in /home/ees-3506-5506/.ssh/id_ed25519.pub  
The key fingerprint is:  
SHA256:XrZZZAwnxz123489655pk7r0TackZyZZxx77o4 email@example.com  
The key's randomart image is:  
+--[ED25519 256]--  
|*0o+.*ooo  
|+= o Oo..o  
| . . . B .o=  
| + .E=. +  
| + ...o.S+ . o  
| . oo.o o o +  
| .. o . . =  
| . . +  
| . .  
+---[SHA256]---
```

3. `eval "$(ssh-agent -s)"`
4. `ssh-add ~/.ssh/id_ed25519` and enter the passphrase you just created `1234`
5. `cat ~/.ssh/id_ed25519.pub`. What is printed out after issuing your command is your

Mini-Lecture

Climate Primer: the Climate System & Climate Change

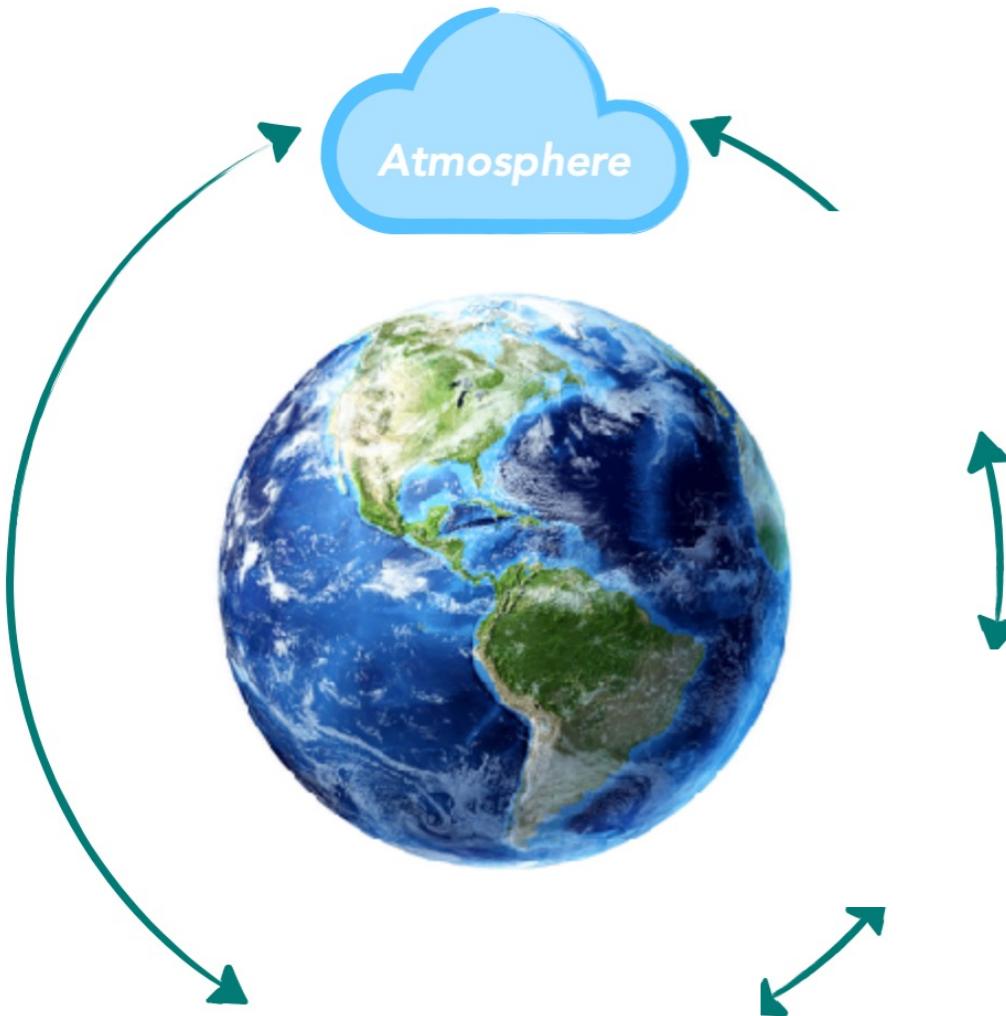
What determines climate?

The climate is determined by the interactions and exchanges (of matter and energy) between different components of the Earth System.



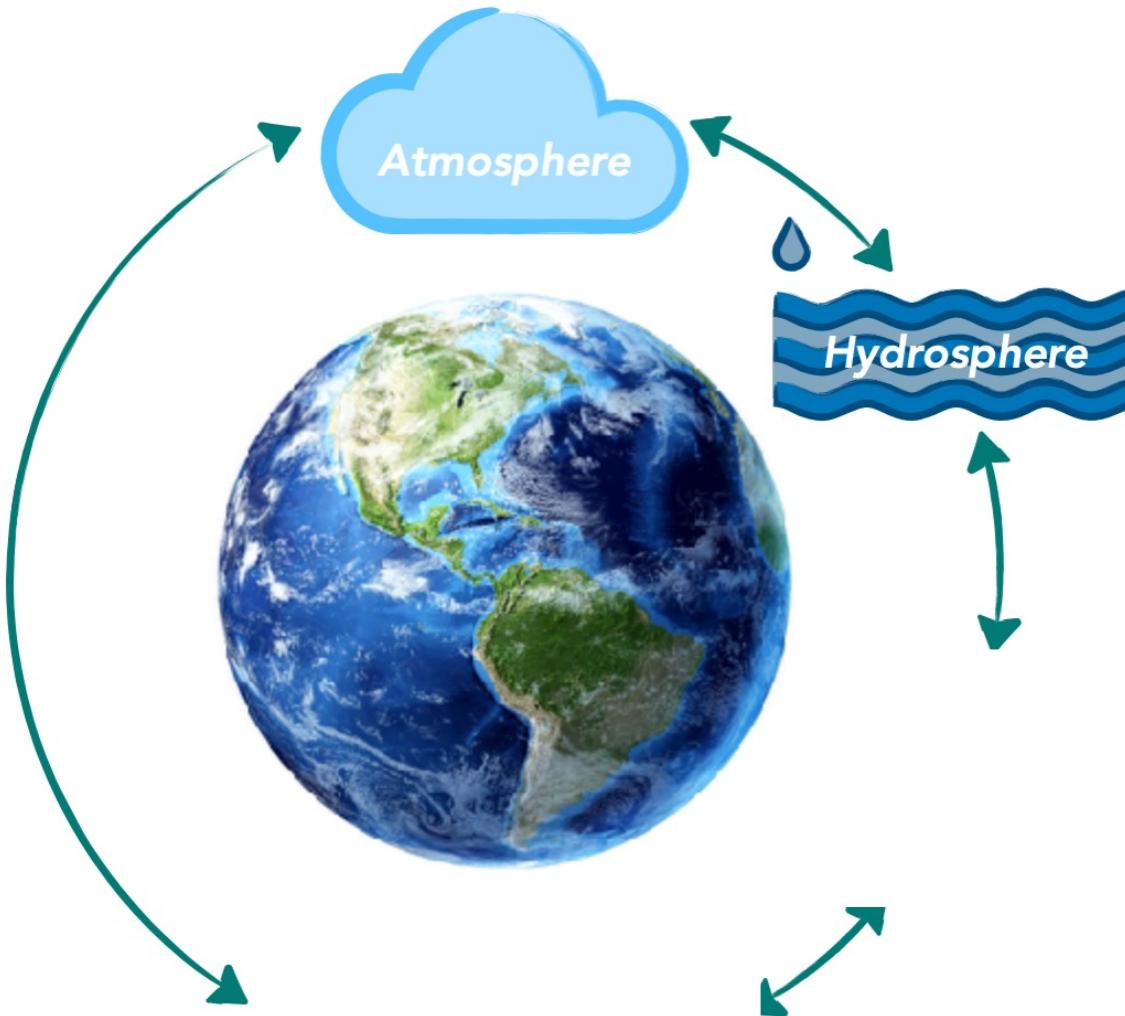
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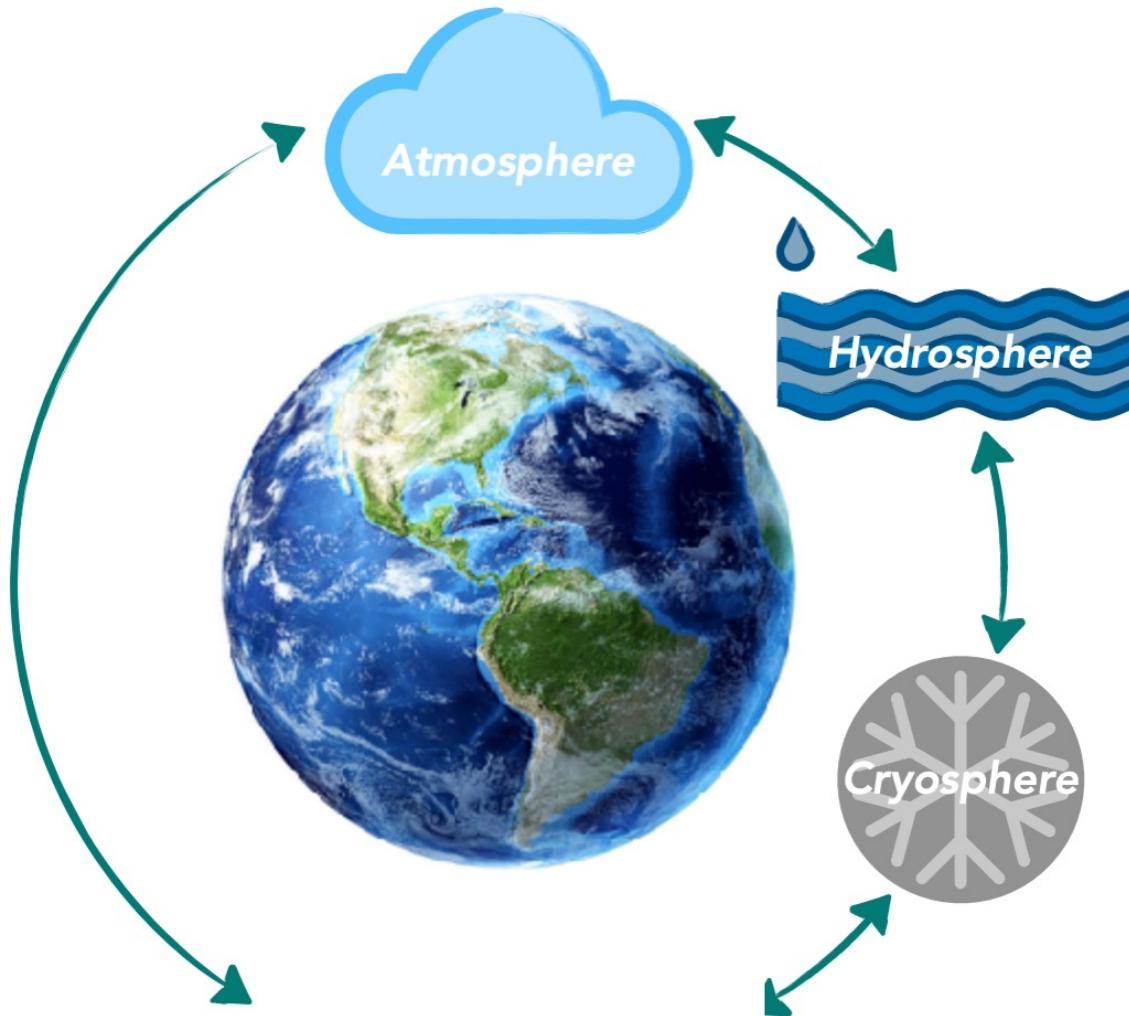
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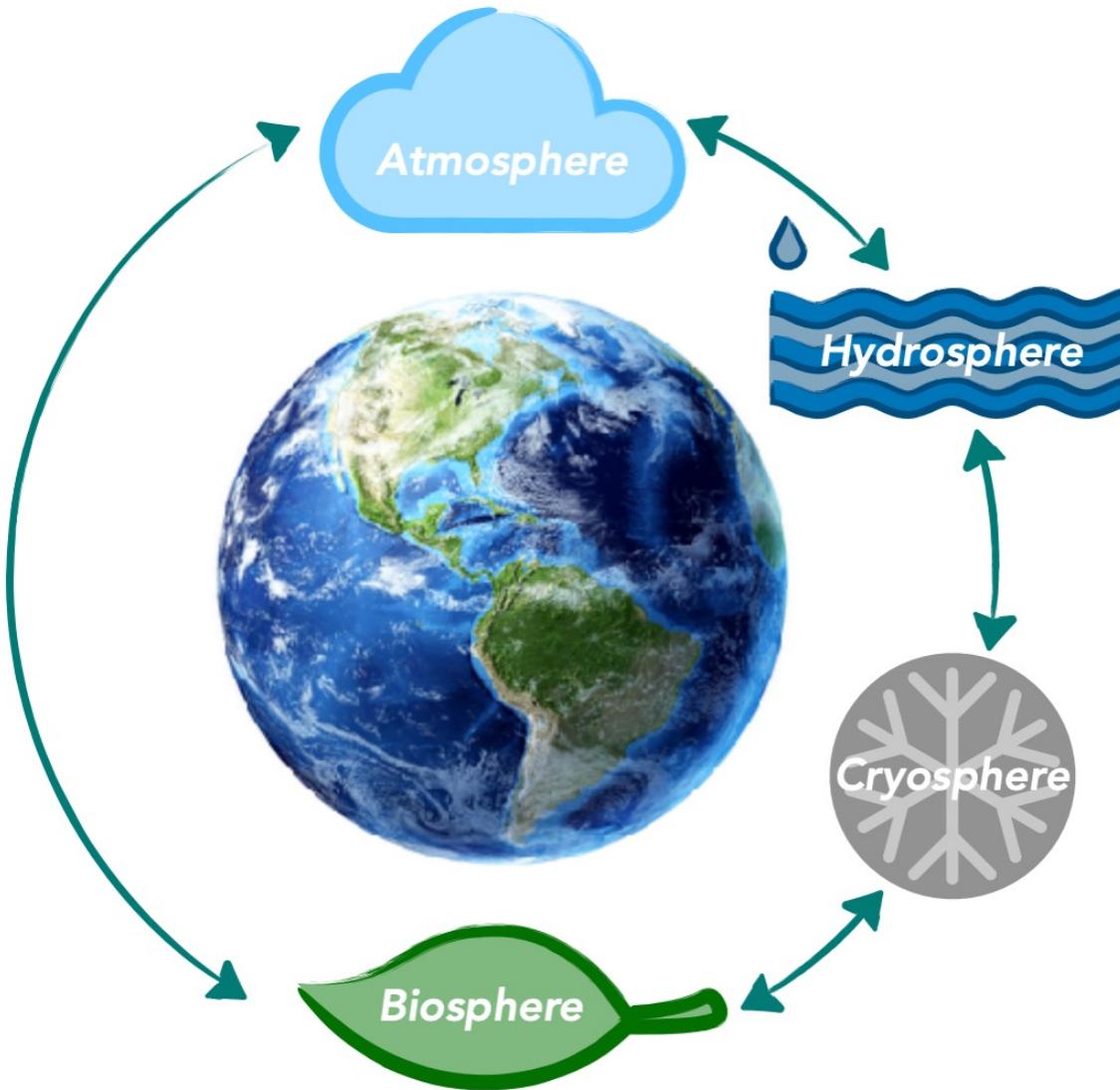
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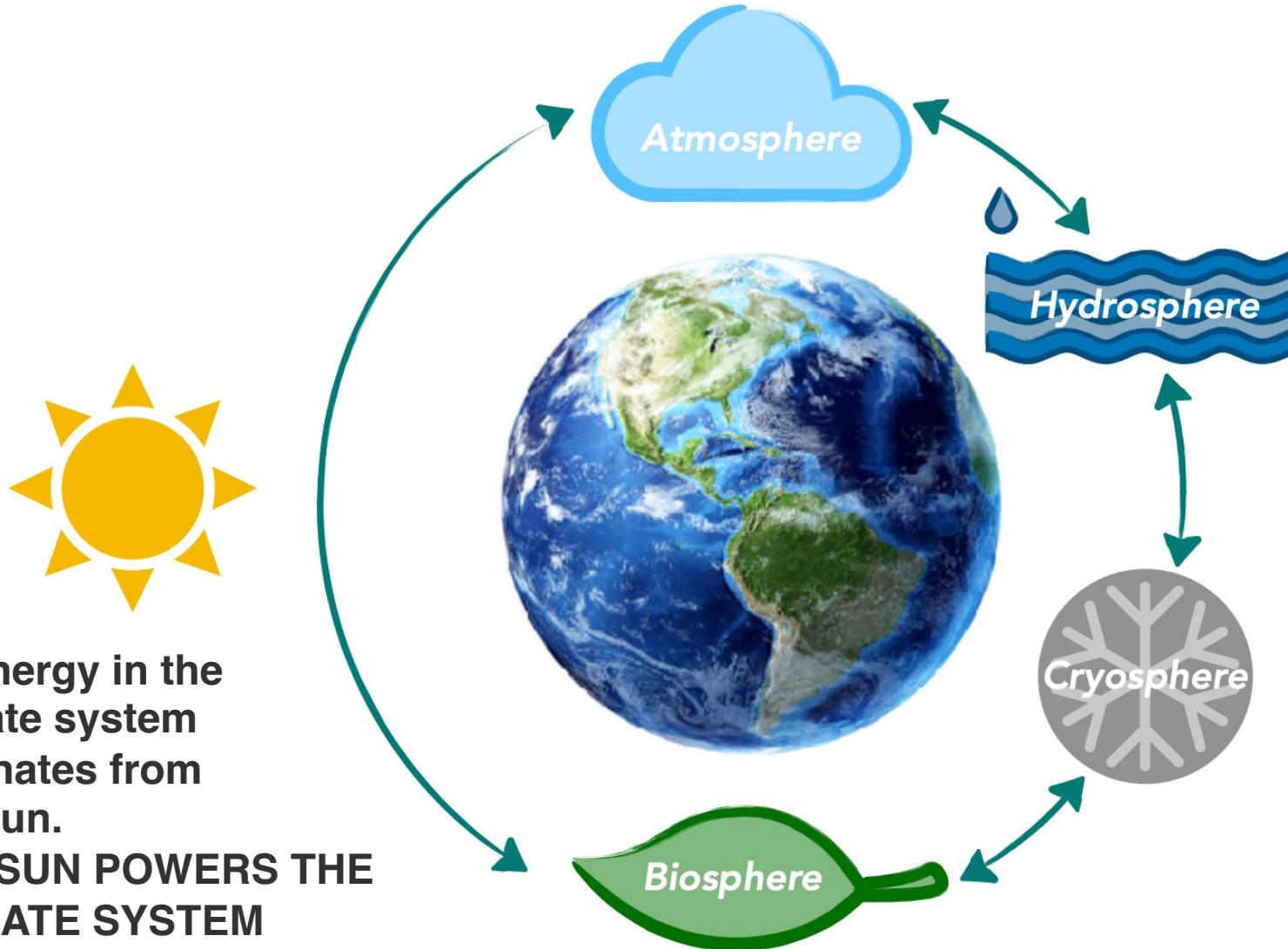
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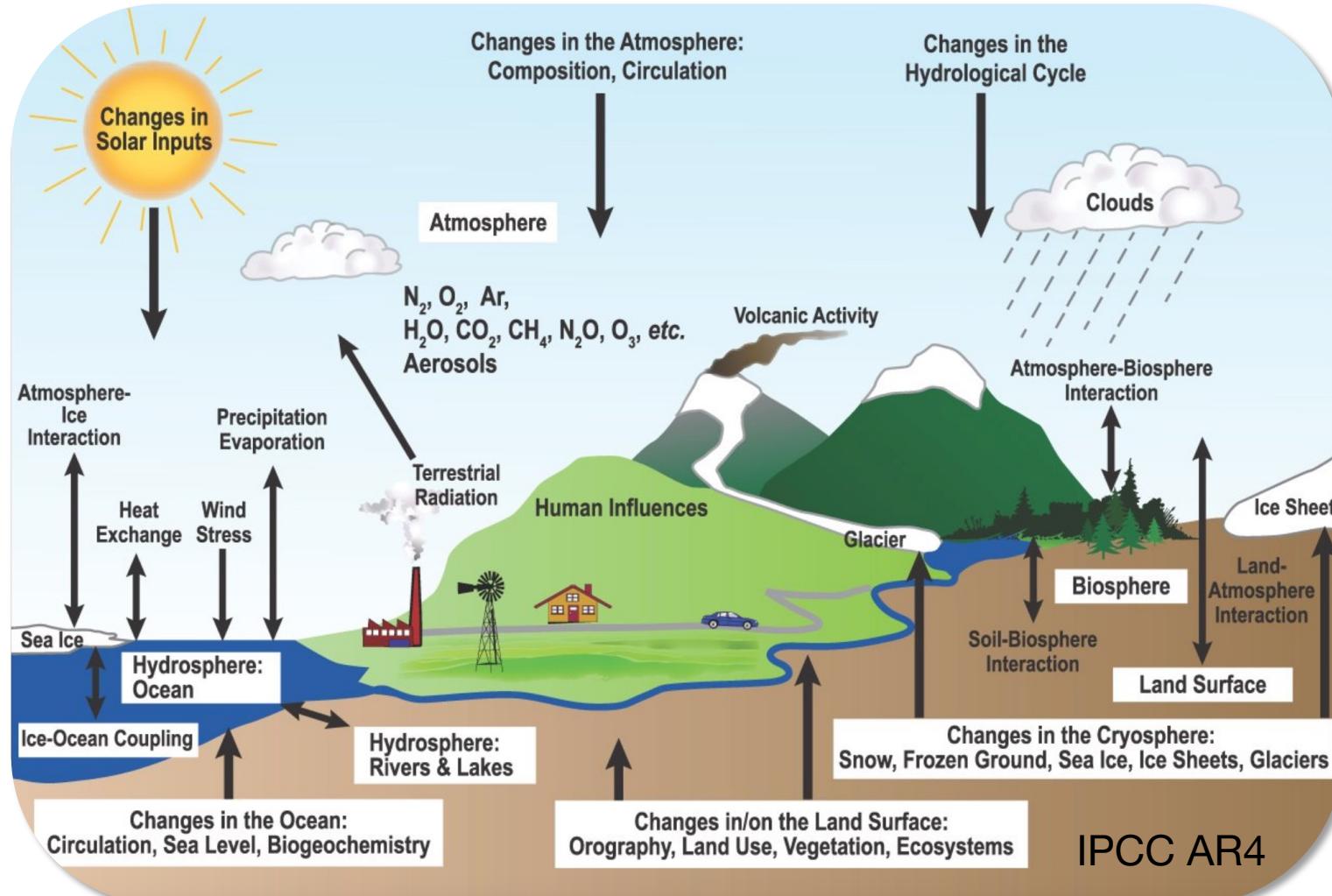
What determines climate?

The climate is determined by the interactions and exchanges (of matter and energy) between different components of the Earth System.



Interactions and processes within the climate system

No part of the Earth system can be considered in isolation from any other part. The components of the climate system overlap and are interconnected – **what affects one can affect another.**



What is weather?

Weather describes the *temporary state* of the atmosphere and changes on timescales of minutes, hours, days, and weeks. Weather is the **short-term variations** in the state of the atmosphere! Predictability is limited it days.

“it rained yesterday but today it’s sunny”

“It was foggy early this morning”

“we are expecting thunderstorms later this week”

10 PM	1 AM	4 AM	7 AM	10 AM	1 PM	4 PM	7 PM
Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
							
42° 32°	40° 26°	37° 27°	39° 26°	41° 23°	40° 27°	45° 39°	43° 18°

What is climate ?

Climate describes the “*average weather*” in a particular location on timescales longer than weeks, from seasons to multi-millennia (thousands of years).

We often describe the climate of an area in terms of its **average** precipitation, temperature, humidity, sunshine, wind, etc

“Summers in Philadelphia are humid”

“Arizona is hot and dry”

“Spring in Seattle is wet and stormy”

Climate patterns are identified by averaging the meteorological conditions over a long span of time (**generally 30 years or more**)

“**Climate is what we expect,**
weather is what we get”

Climate vs. Weather

Fred is trying to plan what he needs to bring for a hiking trip to Utah in August

.....

Based on averaged temperature records for August in Utah, he expects he might hit temperatures around 90°F, so he prepares accordingly



**It'll probably hit 90.
I'd better take lots of water.**

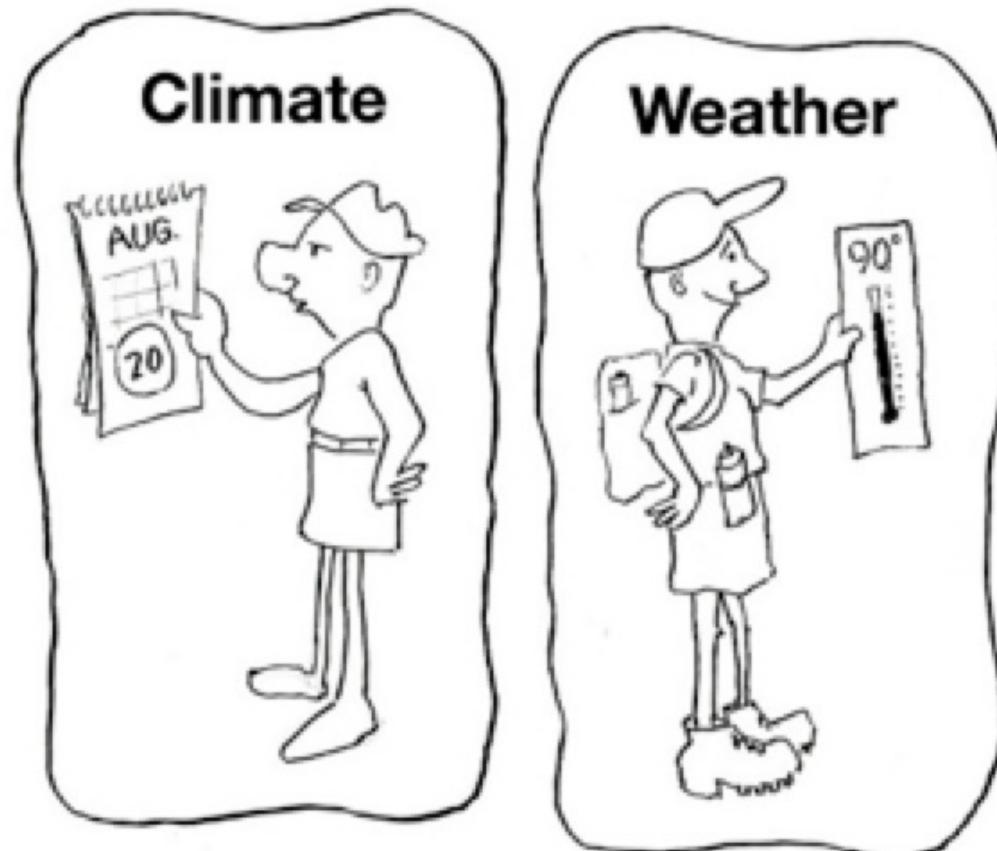
"Climate is what we *expect*,

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It'll probably hit 90.
I'd better take lots of water.

It's 90 !!! I'm glad I
brought lots of water

**“Climate is what we expect,
weather is what we get”**

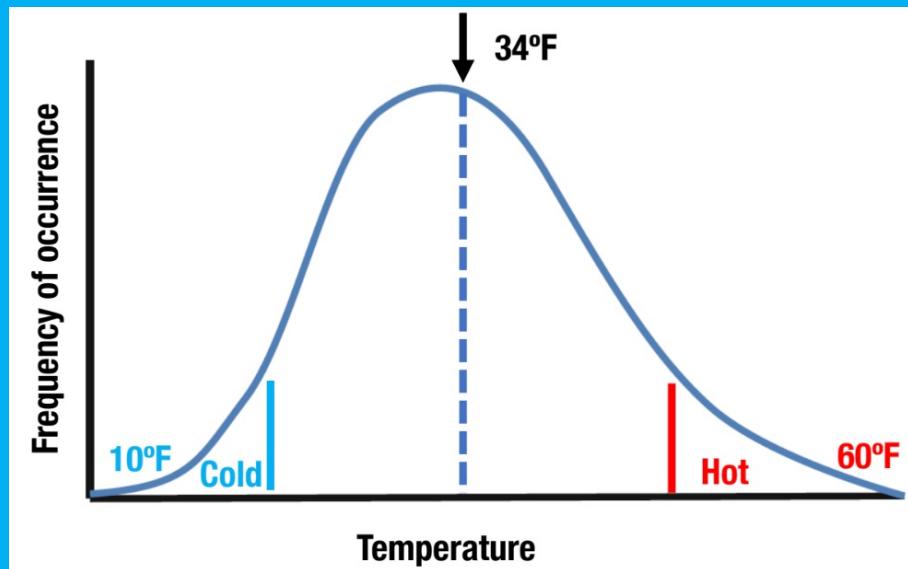
**“Climate is what we expect,
weather is what we get”**

**Weather tells you what to wear each day;
climate tells you what to have in your closet.**

What is climate change ?

Climate Change is a change in the long-term average conditions or distribution of events (i.e., rare events become more frequent) in a particular region from local to global. You can think of it as a SHIFT toward another state.

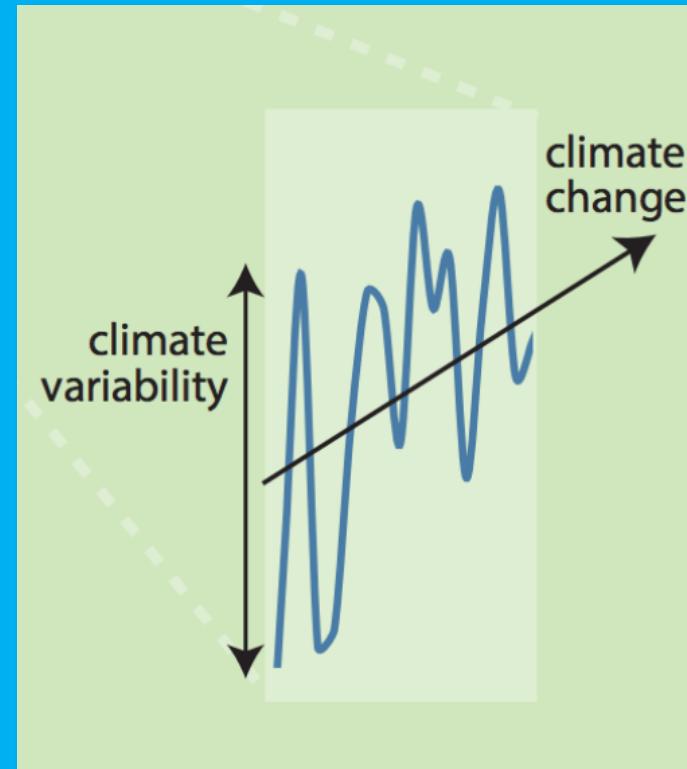
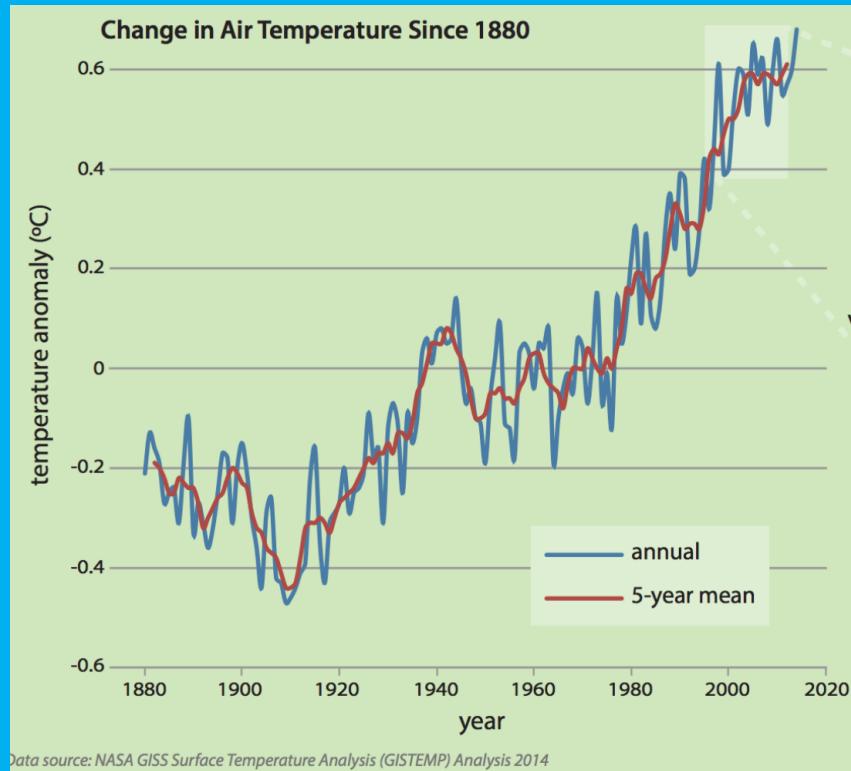
**Mean daily temperature in December in Philadelphia
from 30 years of observations**



Based on **long-term observations** we “expect” the daily temperatures in December to be around $\sim 34^{\circ}\text{F}$, and we may experience an exceptionally warm ($\sim 60^{\circ}\text{F}$), or cold (10°F) day but we expect these to occur less, i.e, they are less likely to occur or are considered “**rare**”.

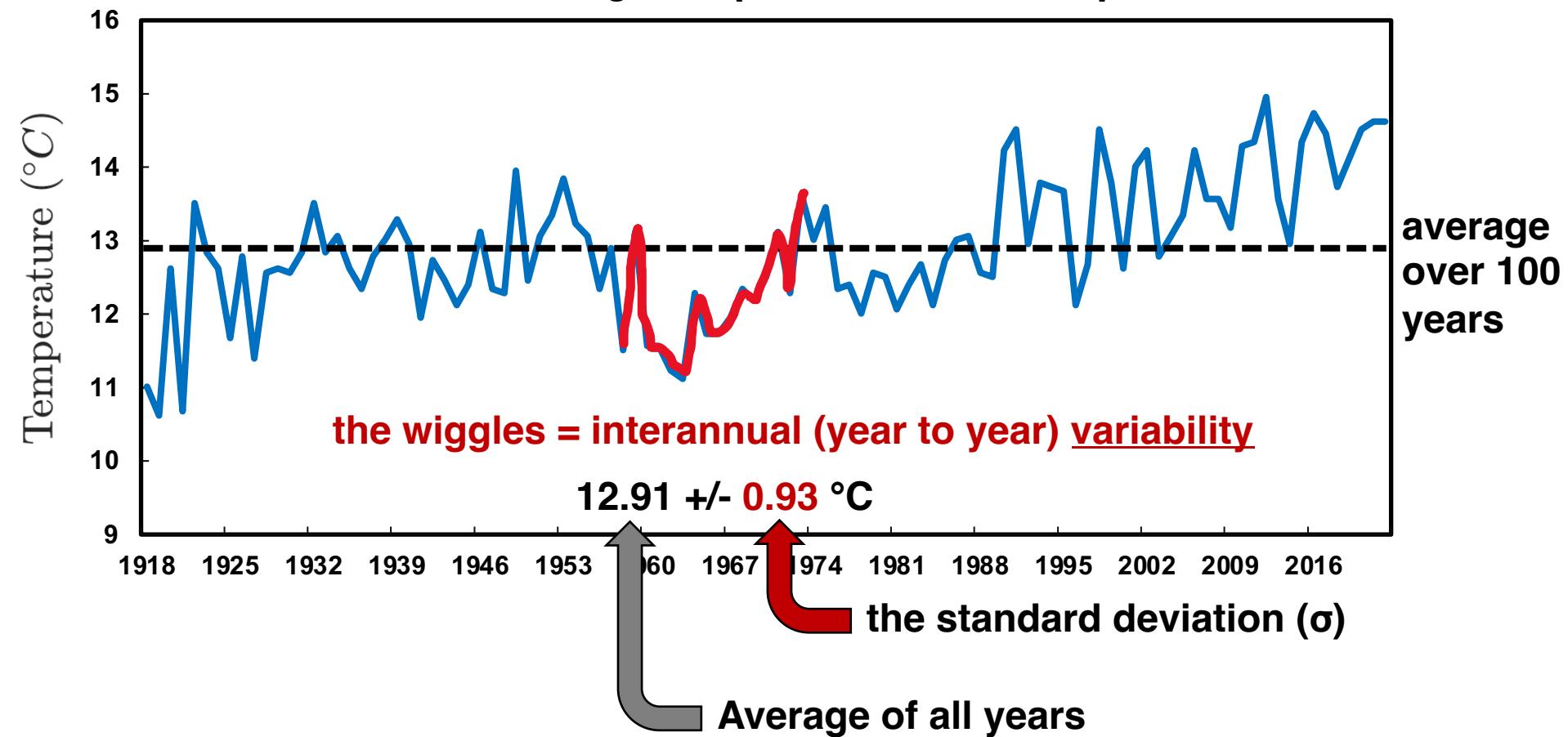
Climate Change vs. Climate Variability

Variability is defined as the short-term (relative to our time scale of interest), variations in the climate system. We often define this using the **standard deviation** of values over a particular time period.

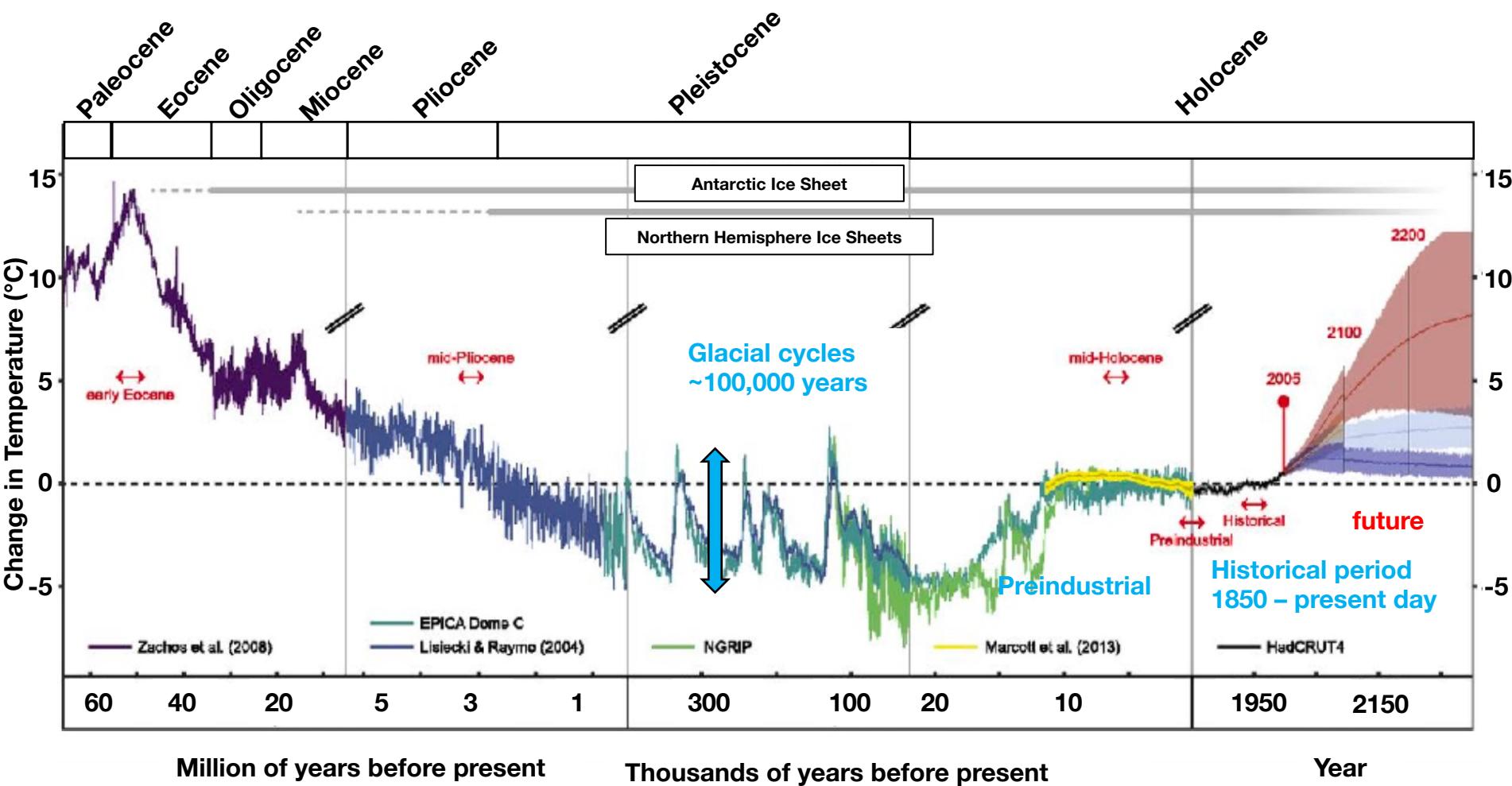


To assess whether there has been a change, we need to know both the mean and the variability of the variable of interest to know whether or not the current state is outside of the “natural variability” or natural fluctuations of the system.

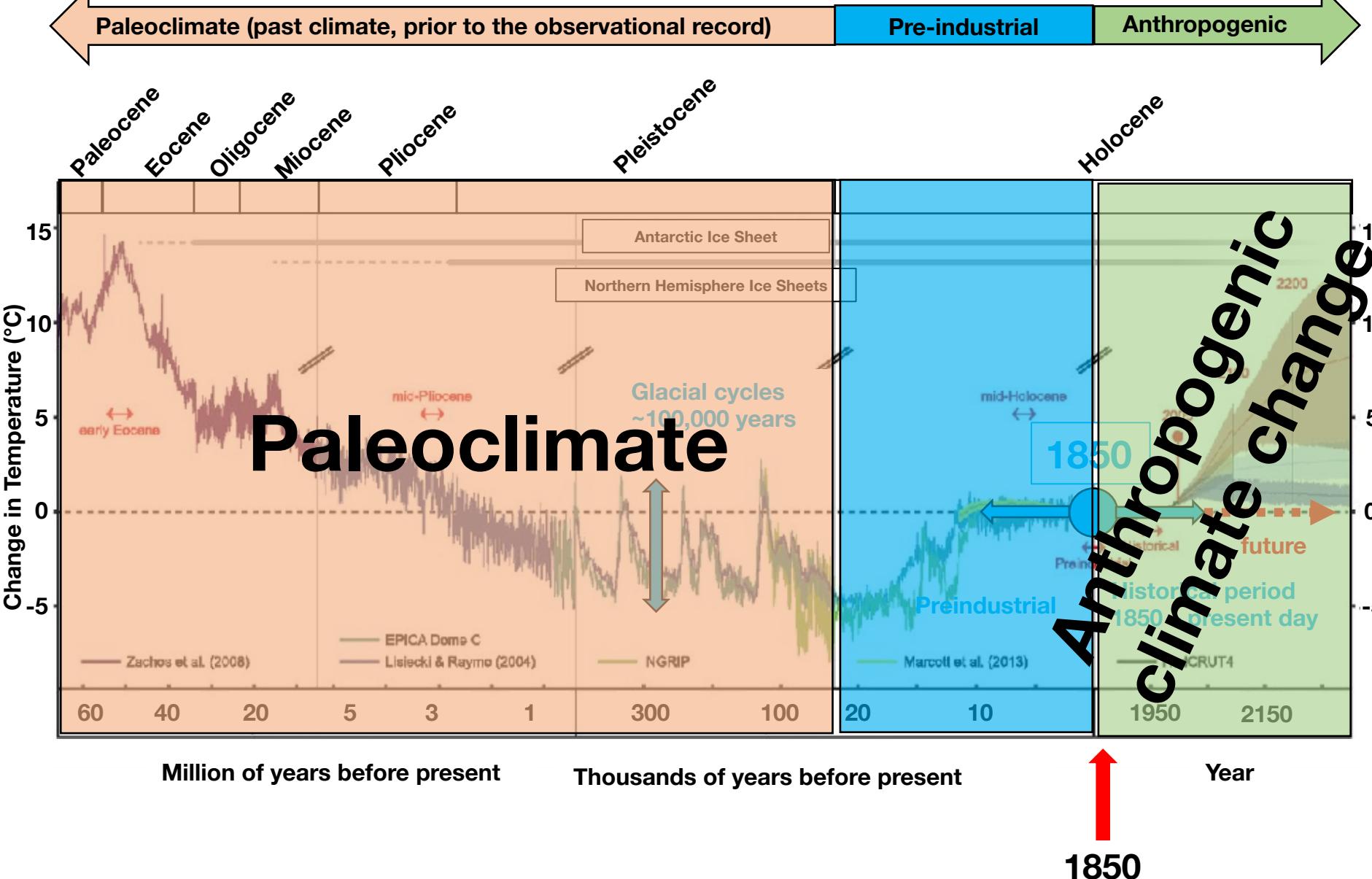
Annual average temperature in Philadelphia



We can consider climate change over various timescales

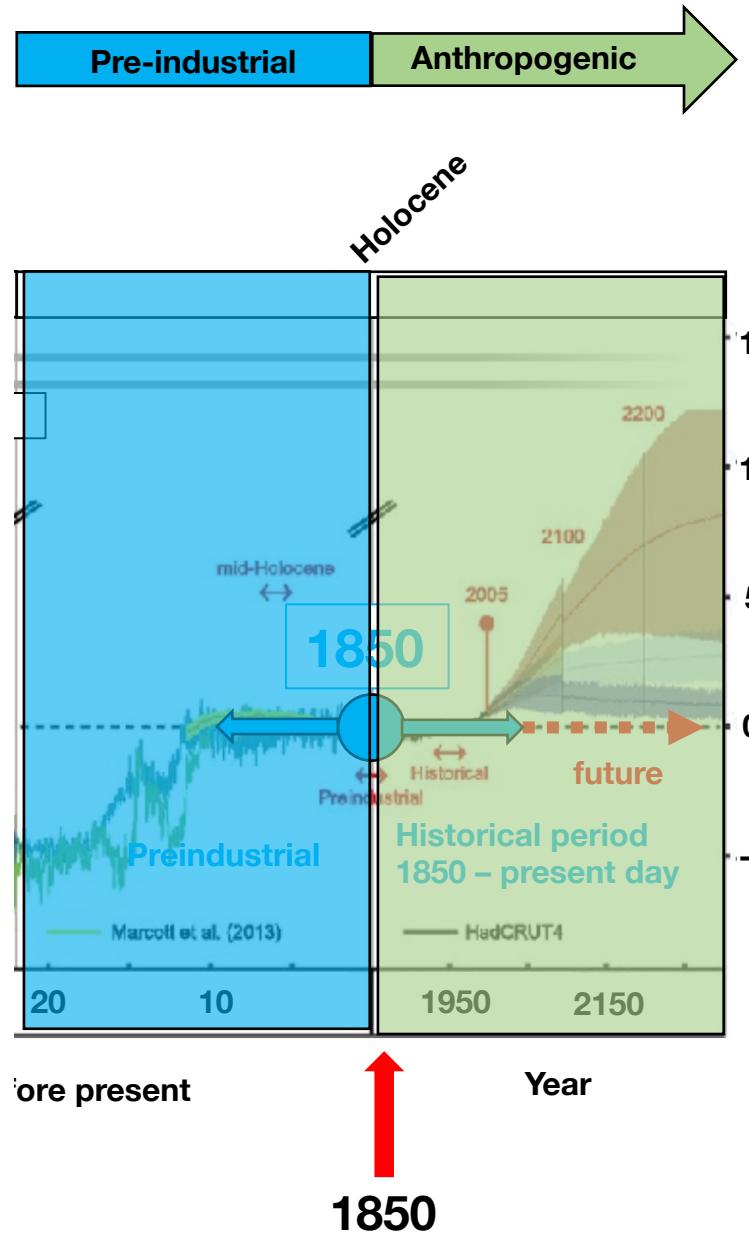


How and why has Earth's climate varied on long time scales in the absence of human activity? How is human activity impacting the climate and its trajectory?



Pre-industrial (prior to 1850), stable climate, [CO₂] ~ 285 ppm

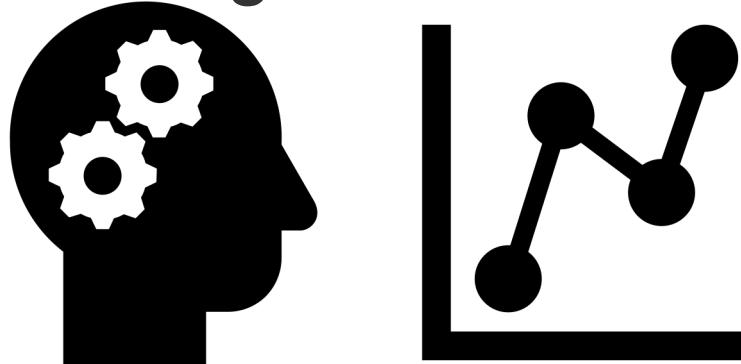
In this class we will focus on understanding the evidence of anthropogenic (human-caused) climate change & projected changes throughout the 21st century.



Pre-industrial (prior to 1850), stable climate, $[CO_2] \sim 285 \text{ ppm}$

Break Out Group Discussion

What makes a great data visualization ??



In a group of 4, explore the different graphics showing the change in global average surface temperatures over time.

For each graphic, critically about the following questions:

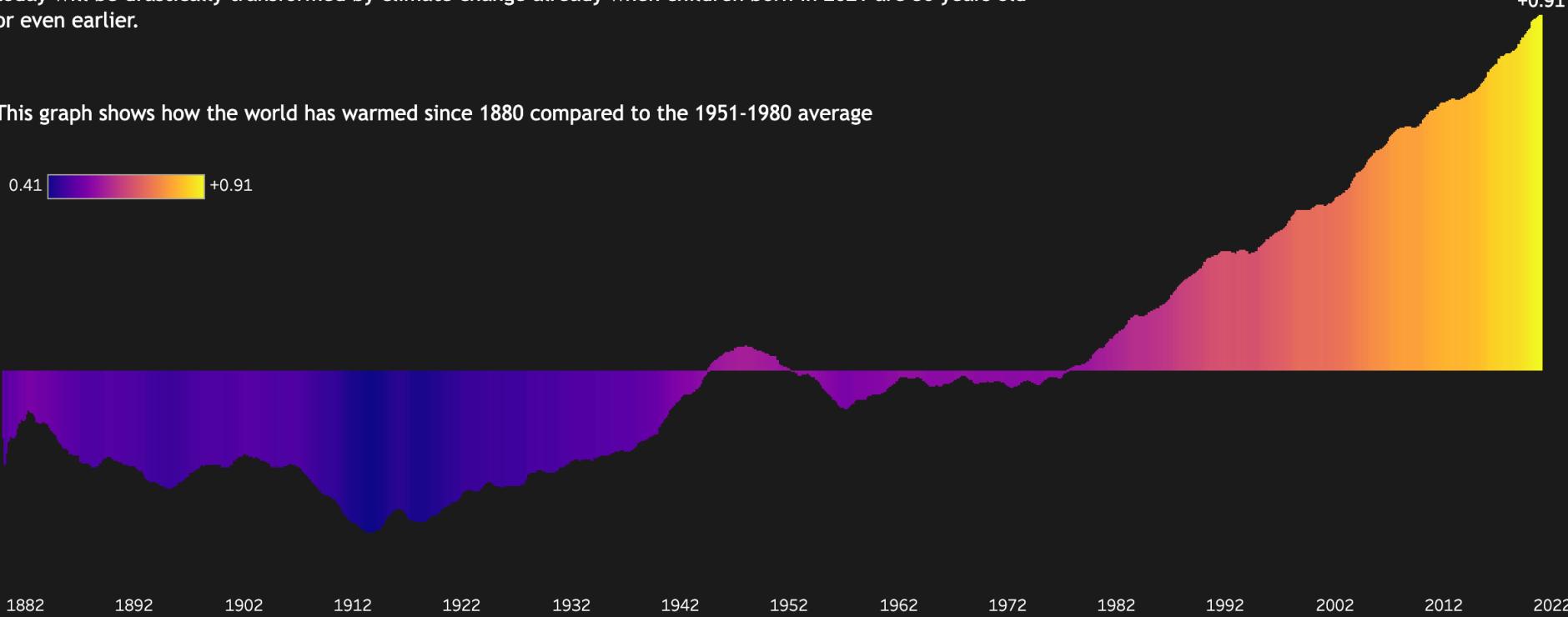
- What elements make it a good / poor visualization of data?
- What would you change?
- What audience does this work for? What audience would this not work for?
- After looking through all the plots, what are your take aways about what makes a good visualization ? Which one is your favorite and why?

GLOBAL WARMING PUTS HUMANITY AT RISK.

Water shortages, most common diseases, unbearable heat, poor and very low quality harvests, hunger and malnutrition, exodus from flooded cities and arid fields, extinction of species: life on Earth as we know it today will be drastically transformed by climate change already when children born in 2021 are 30 years old or even earlier.

This graph shows how the world has warmed since 1880 compared to the 1951-1980 average

0.41 +0.91



1882

1892

1902

1912

1922

1932

1942

1952

1962

1972

1982

1992

2002

2012

2022

<https://theglobalobservatory.org/2021/12/new-climate-data-visualizations-2021/>

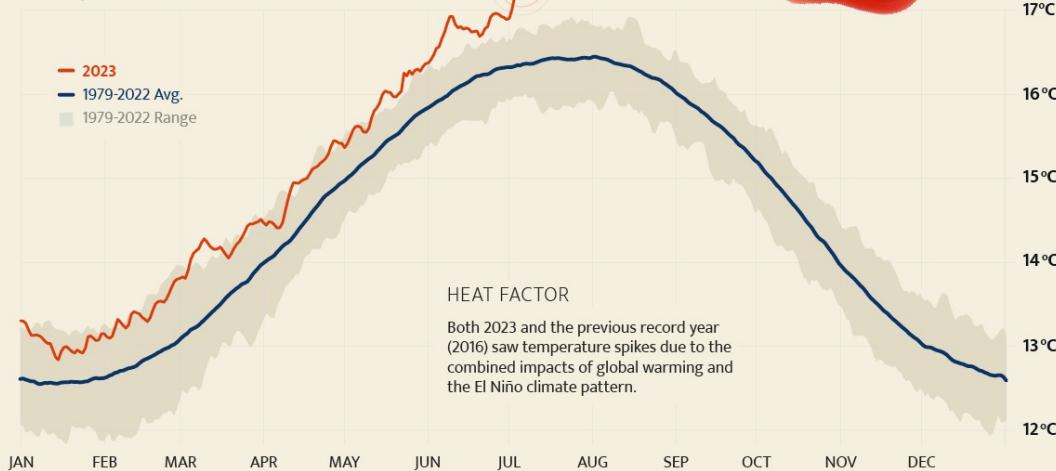
Here Comes The Heat

As daily temperatures rise across the planet, 2023 saw the global average temperature soar to record highs from July 4–7.

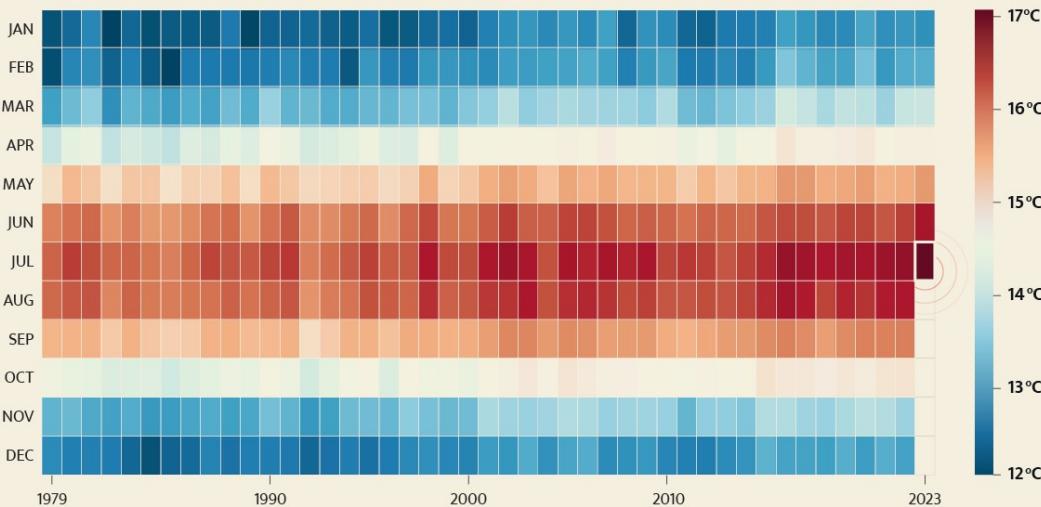
The hottest day on record reached **17.2°C** on July 6, 2023.

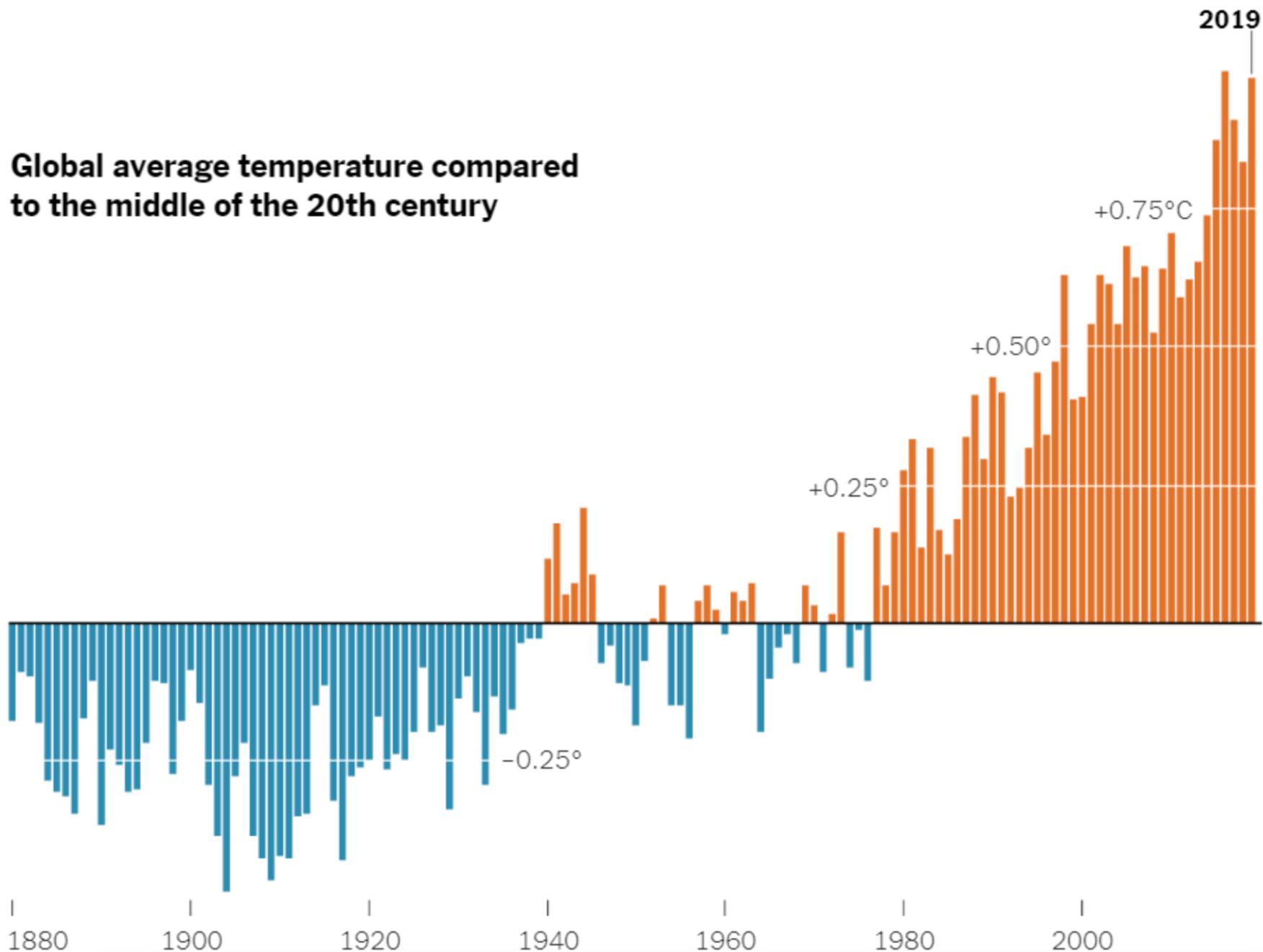


Daily GLOBAL AVG. TEMPERATURES

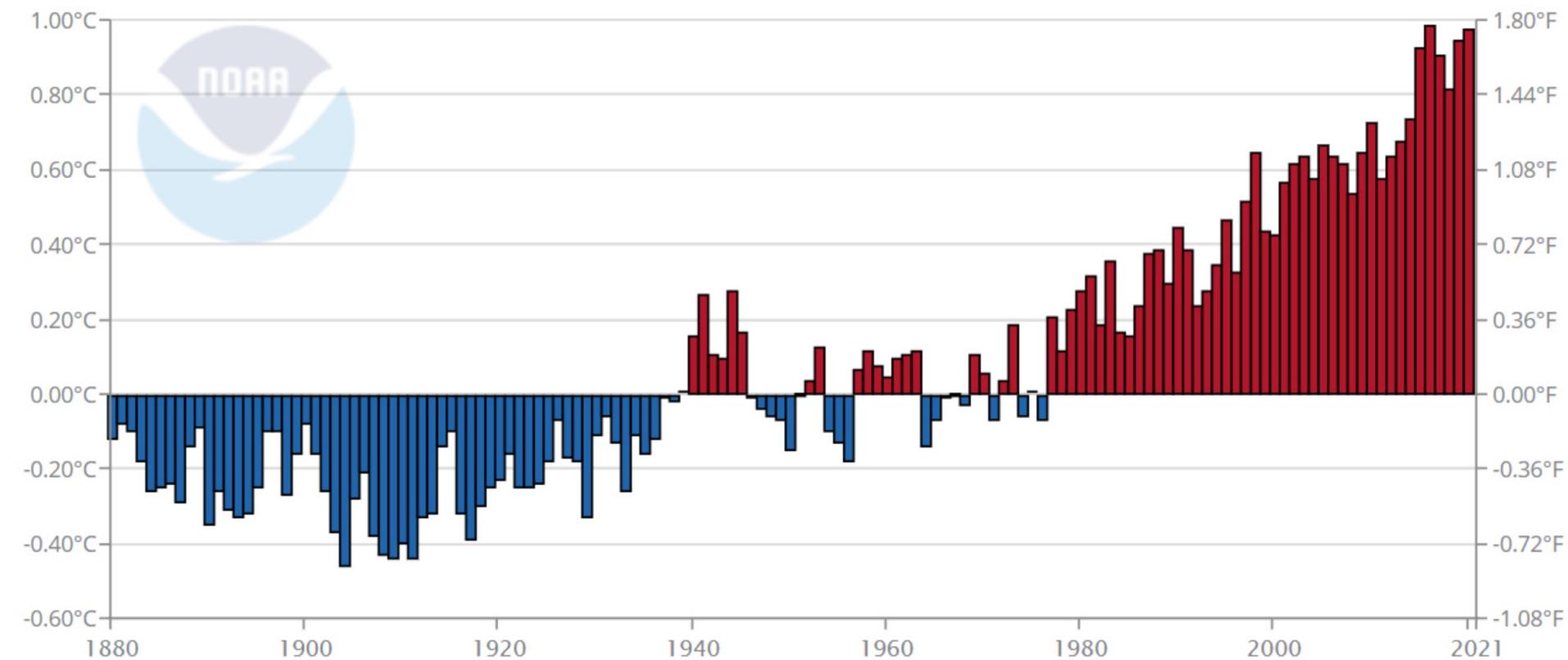


Monthly GLOBAL AVG. TEMPERATURES



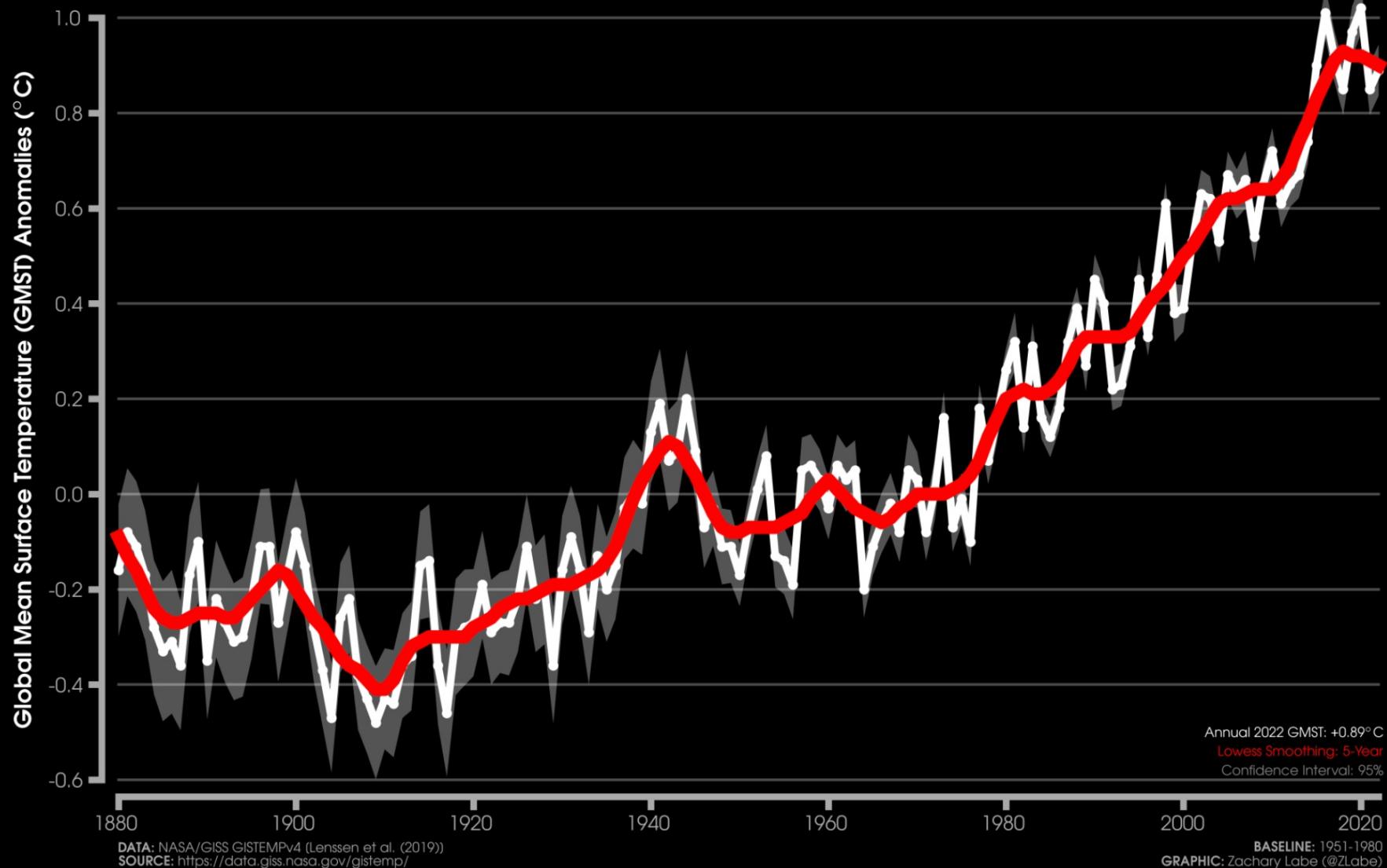


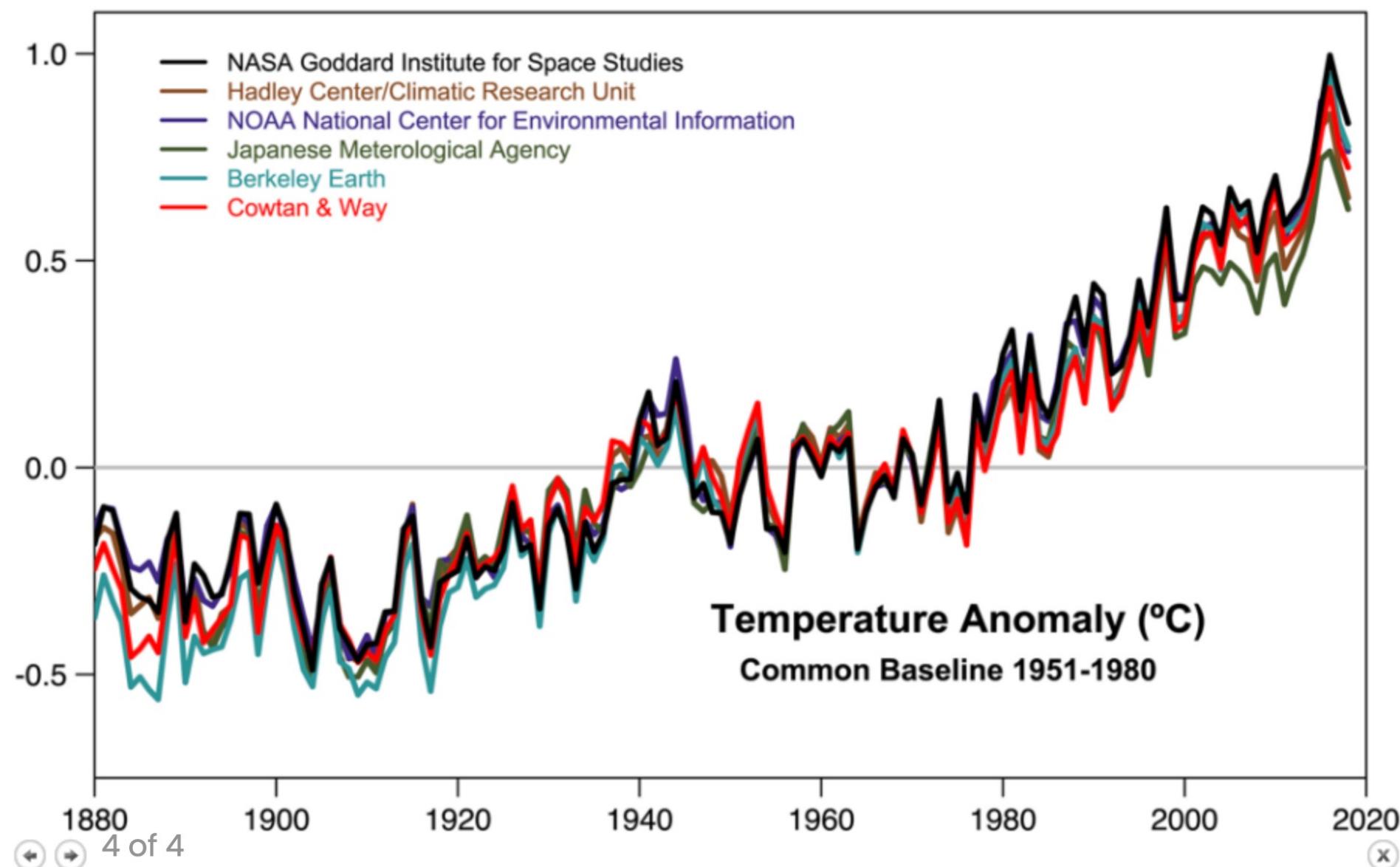
Global Land and Ocean
January–December Temperature Anomalies



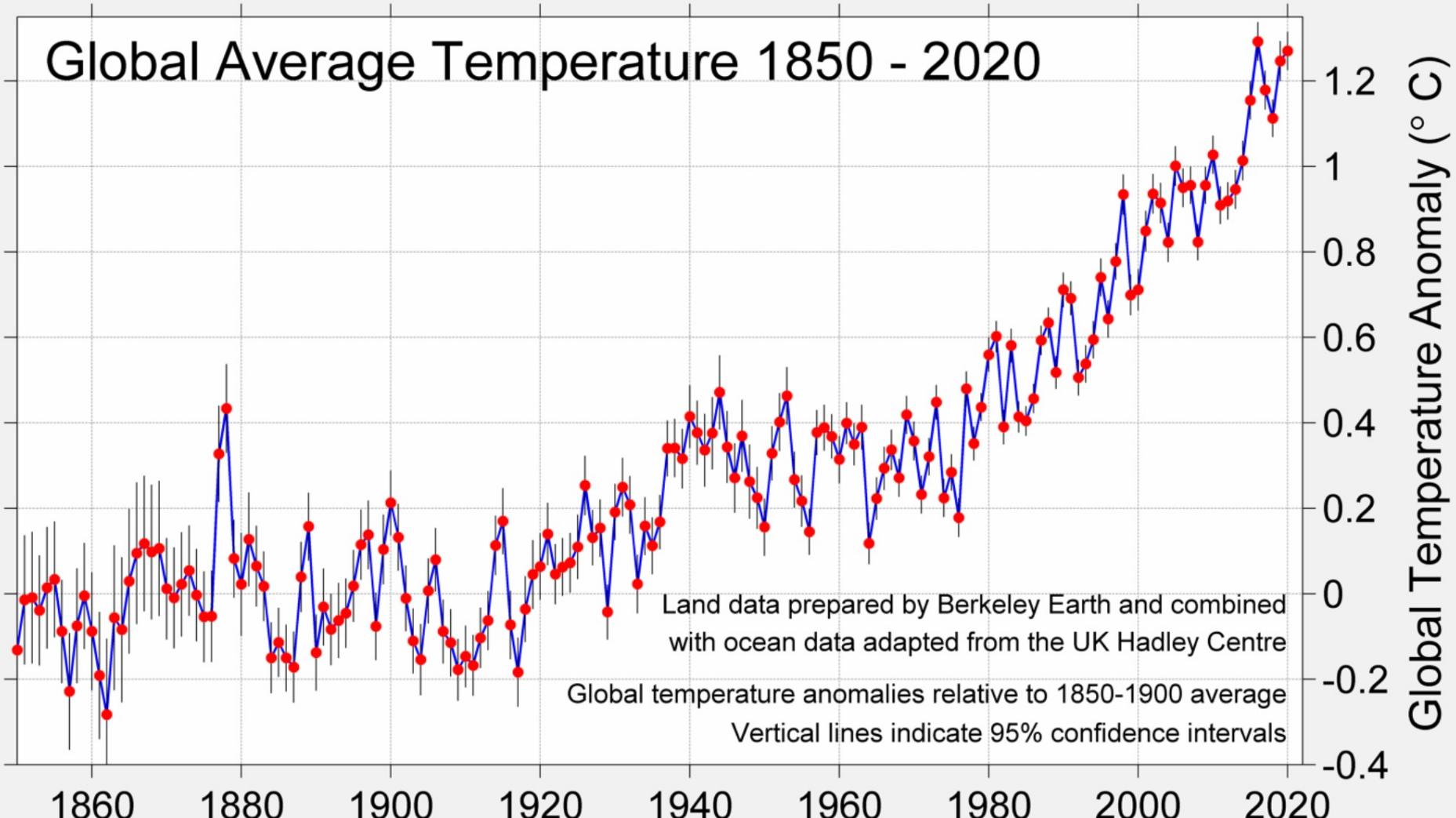
<https://www.climate.gov/maps-data/dataset/global-temperature-anomalies-graphing-tool>

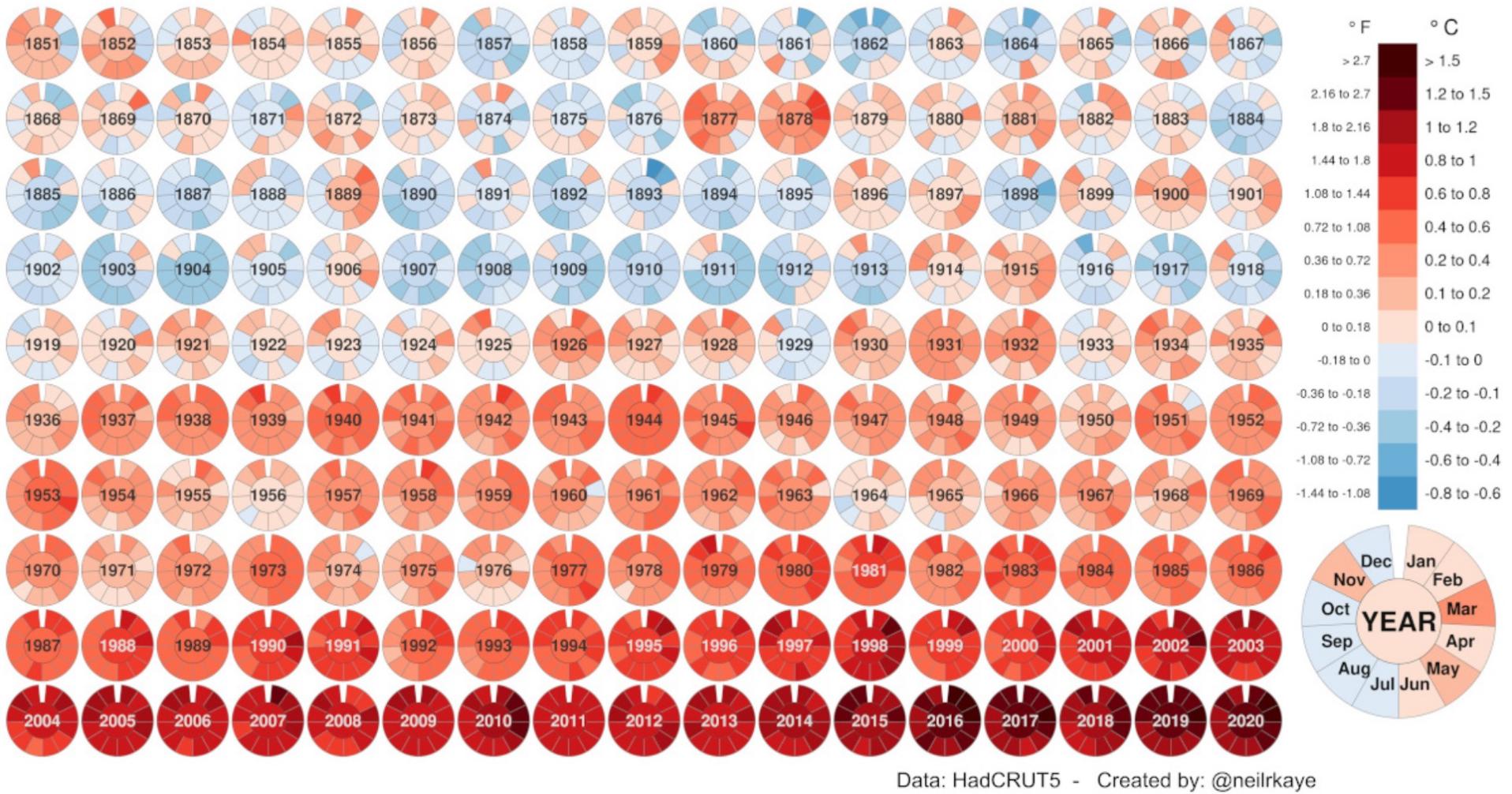
GLOBAL TEMPERATURE BY YEAR





Global Average Temperature 1850 - 2020





<https://www.visualcapitalist.com/global-temperature-graph-1851-2020/>

Additional links worth exploring for more advanced examples of climate data visualization

<https://climate.nasa.gov/>

<https://shameplane.com/>

<https://visme.co/blog/climate-change-facts/>

<https://www.makeuseof.com/tag/visualize-climate-change/>

<https://showyourstripes.info/s>

To do:



Practice logging into your Azure VM and get familiar with navigating the GitHub web interface.



Complete Reading 2.

	Content	Reading Assignment	Assignment due
08/29 (Tues)	Course Introduction		
08/31 (Thurs)	Getting Set Up	Reading 1 ↓ Course Survey	Assign. 1 [9:00 AM] ↓
09/05 (Tues)	Unix Tutorial & GitHub	Reading 2 ↓	
09/07 (Thurs)	Check-in & de-brief: <i>issues, challenges, curiosities, and excitement!</i> Python Fundamentals A & B	Reading 3 ↓	Assign. 2 [11:59 PM] ↓
	Python Fundamentals A & B continued Working with 1 - D datasets: Intro to Pandas & Matplotlib	Reading 4 ↓ Reading 5	

Reading 2: Getting Familiar with the CLI & Git / GitHub

Reading / lecture viewing assignments are expected to be completed by the due date listed on the course schedule.

This week in class we will begin using the Command Line Interface (CLI) to work with our Unit 1 Git repository, and to navigate directories and files on your Azure VM. We will work through a tutorial together in-class on Tuesday but you are expected to come to class having read through the following material (no need to "do" anything just read through it to gain a general familiarity).

- [Introducing the Shell](#)
- [Navigating Files and Directories](#)
- [Working With Files and Directories](#)

We will also dive into the basics of Git and GitHub and how to use it for version control and backing up your local work to your remote GitHub repo. This is how you will turn in assignments in this course and how you will also back up projects you are working on. Read through the following sections, the linked video, but we will go over the hands-on pieces in class.

- [Incorporating Git & GitHub into your Workflow](#)

Up Next:
Unix Tutorial &
Working with Git from the Command Line
(In class activities! Don't miss it!)

Have a great holiday weekend