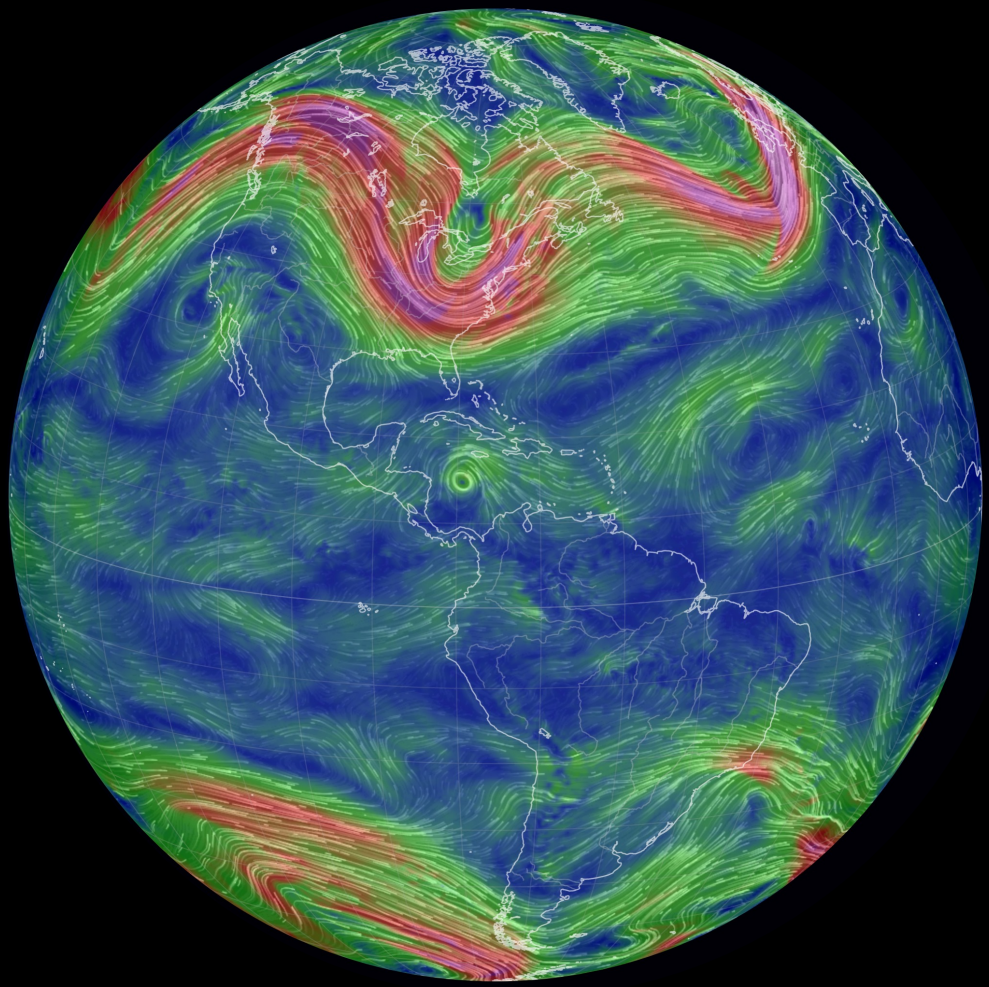
EES 3506 / 5506
Observing and Modeling Climate Change
Fall 2023

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

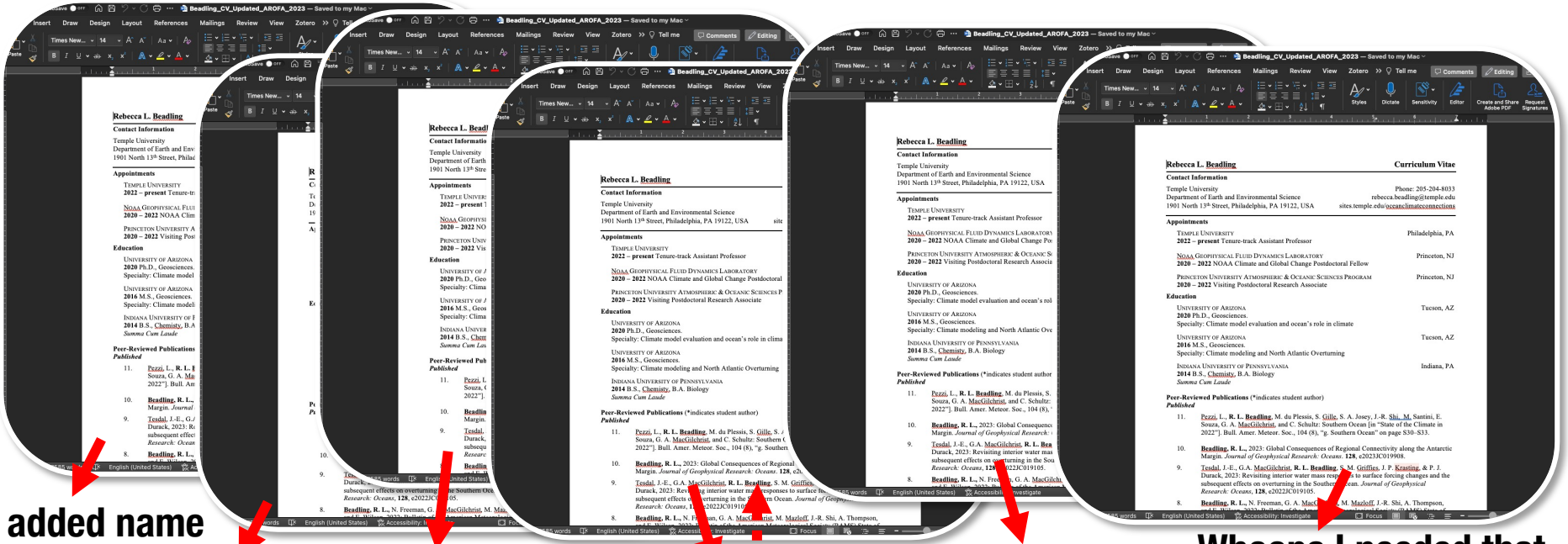
Open-source version control system (VCS) on **your local computer (your VM in this case)** that is **recording (tracking) all changes you make to a particular file**

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.

Versatility

Can be used by designers, writers, and anyone who wants to keep track of the history of their projects.

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

https://github.com/becki-beadling/
Beadling_et_al_2022_JGROceans

sgf-node.llnl.gov/projects/cmip6/) as part of FAFMIP. The GFDL MC

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Code | Issues 48 | Pull requests | Discussions | Actions | Projects 1

MOM6

Public

Wat

main | 1 branch | 0 tags | Go to file | Add file | Code

marshallward Merge pull request #1605 from GEOS-ESM/ma... ... 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

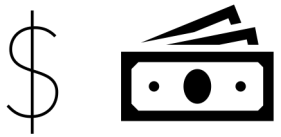
Report repository

Releases

No releases published

Companies That Use Github	Who Uses Github at This Company?	What Does This Company Use Github For?	Estim Numb Emplo
3M Corporation	Information analyst, software engineer	Centralize code and teams to speed up research and development of new digital technologies	95,00
Adobe Systems Inc.	Software engineer, computer scientist, software development engineer	To make legal and technical processes more efficient	22,516
BuzzFeed	IT engineer, IT manager, principal engineer	For software engineers and news team to collaborate in one platform	1,840
Coinbase Global, Inc.	Software engineer, risk manager	For organization-wide transparency	1,249
Dell Technologies	Technical support engineer, Java developer, principal software engineer	To work on bigger projects and finish them faster	158,(
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.	58,6(
Ford Motor Company	Software engineer, product manager, data scientist	Collaboration work on complex car features	186,000
LinkedIn	Instructional designer, senior software engineer, front end software engineer	To manage end-to-end workflow	18,0(
Procter & Gamble	IT manager, senior software engineer	To update DevOps and CI/CD tooling and processes	101,000
Seagate	Senior staff engineer, staff engineer	For its open-source software, CORTX	40,000

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



Average Salaries for 3M Corporation Employees Who Use Github

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

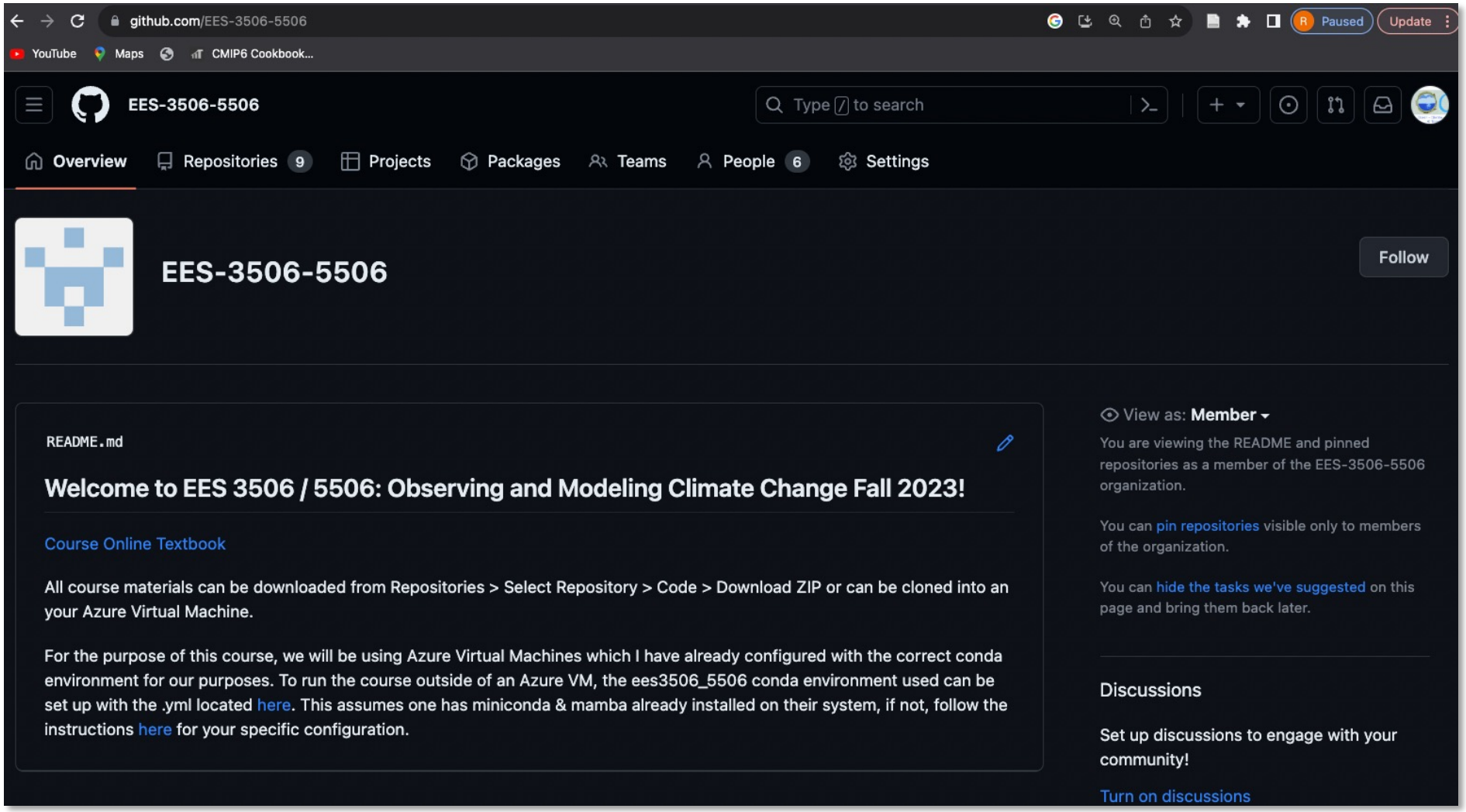
Average Salaries for Adobe Employees Who Use Github

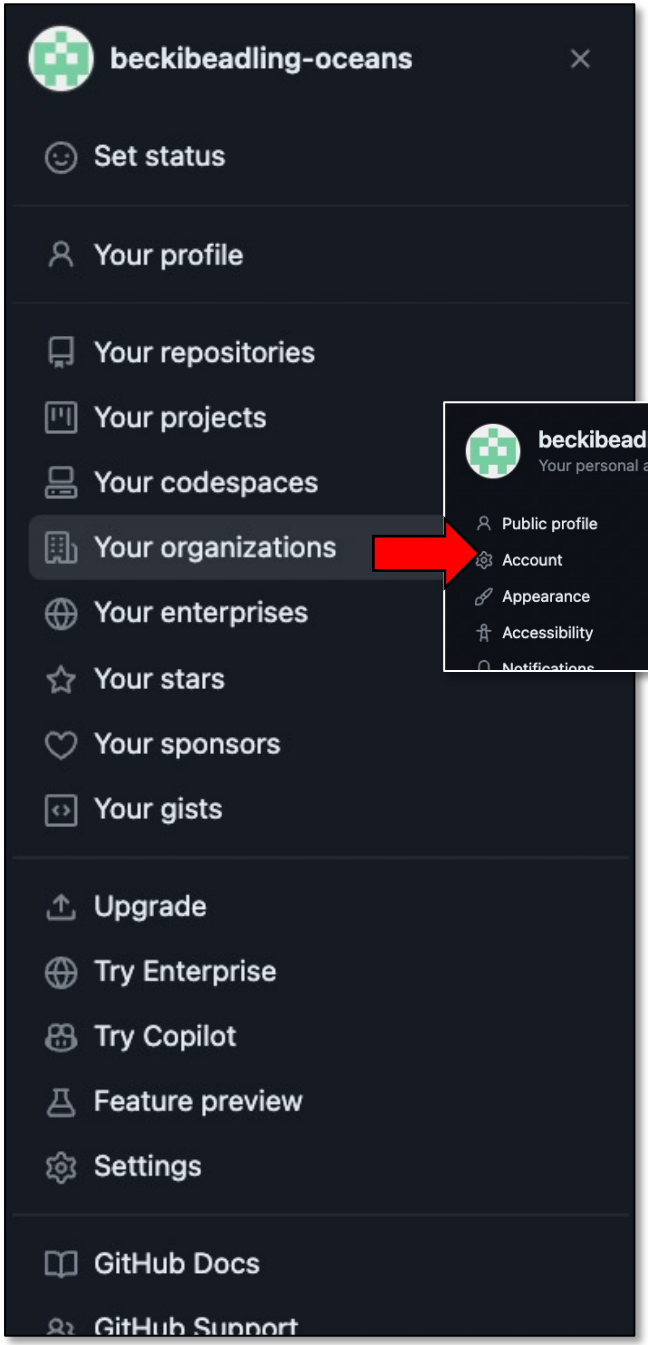
- Software Engineer | **$119,623**
- Computer Scientist | **$143,949**
- Software Development Engineer | **$110,699**

Average Salaries for BuzzFeed Employees Who Use Github

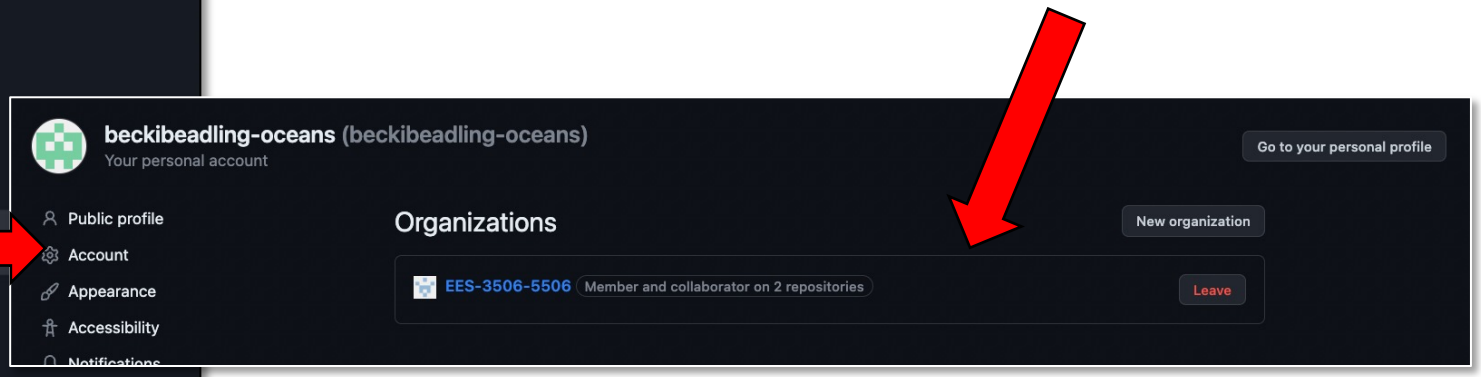
- IT Engineer | **$83,721**
- IT Manager | **$126,896**
- Principal Engineer | **$154,914**

Tour of the EES-3506-5506 GitHub Organization

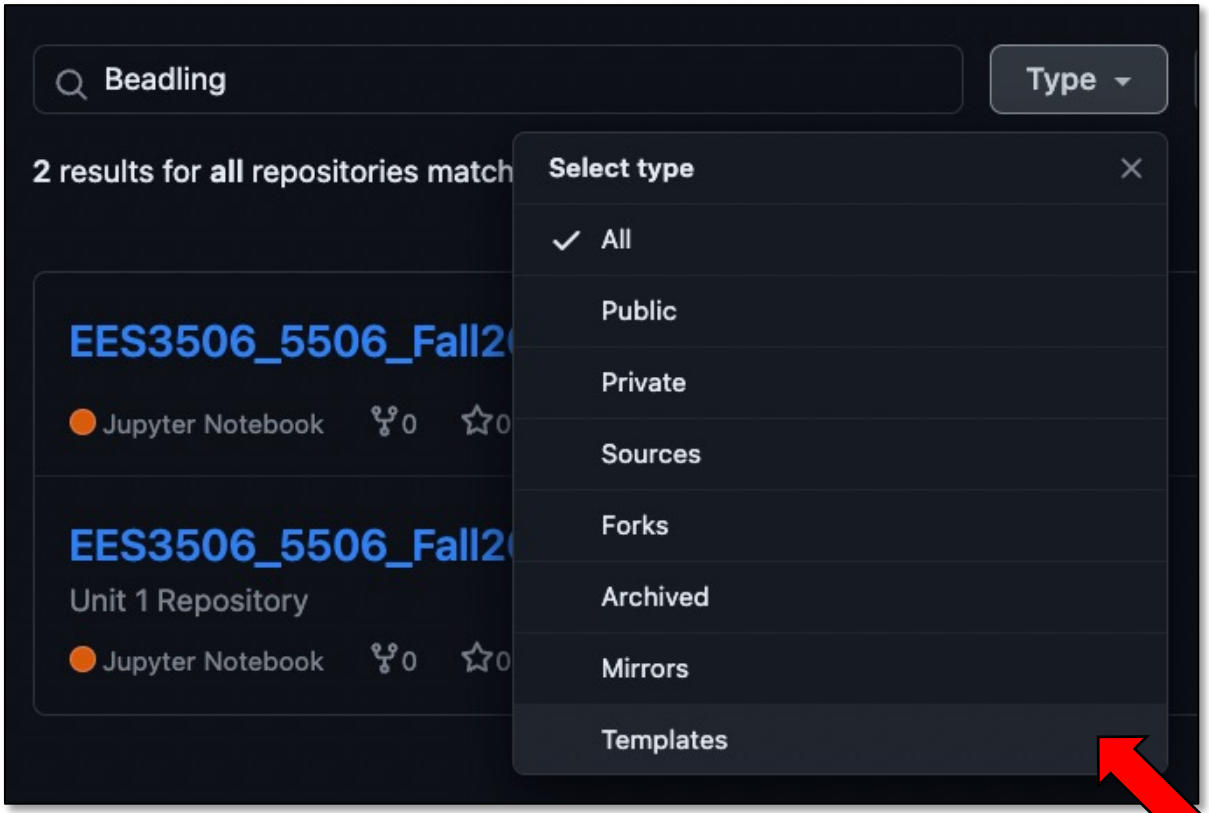




Clicking on your profile widget in the upper right corner and clicking on "Your organizations" will bring you to a page with a link to our course org.



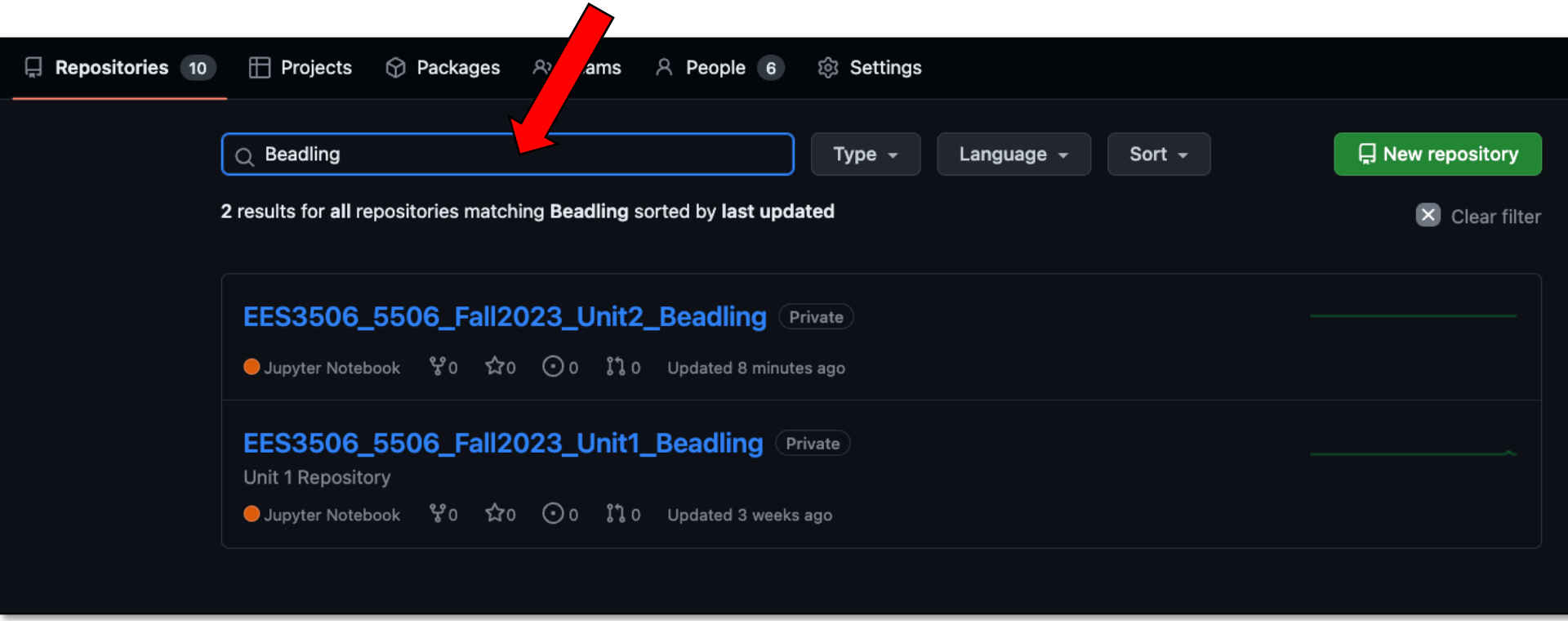
As the semester goes on, you will see a lot of repositories (“repos”) …..



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.

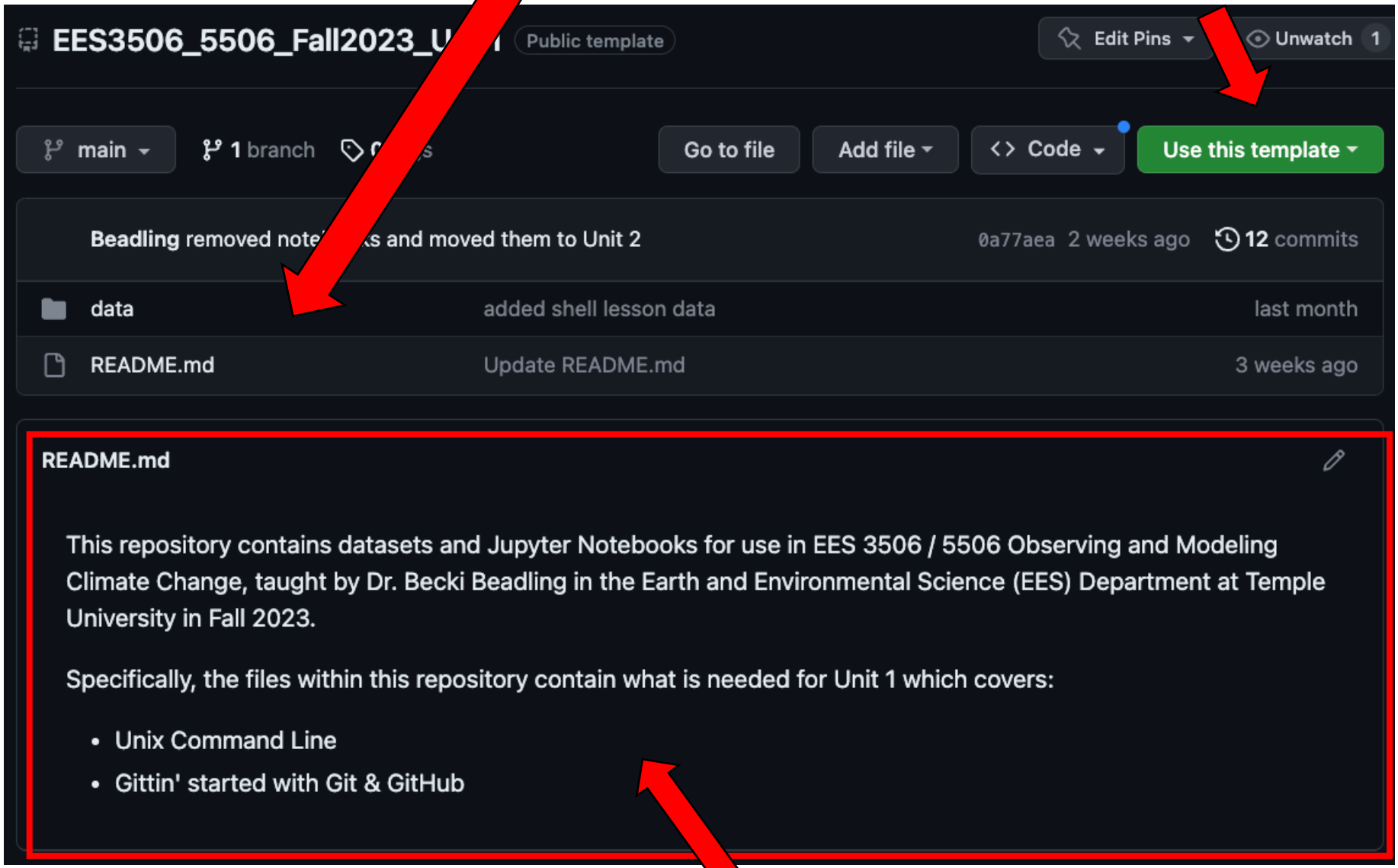
As the semester goes on, you will see a lot of repositories ("repos") .....

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



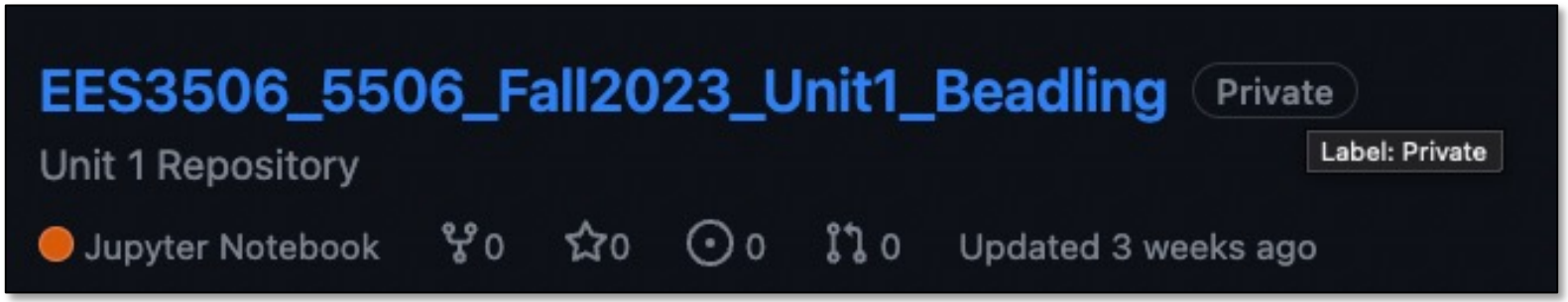
folders / files in the repo

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



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 Authentification

> 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:XrZZZAwnxx123489655pk7r0TackZyZZxx77o4 email@example.com
The key's randomart image is:
+--[ED25519 256]--+
|*Oo+.*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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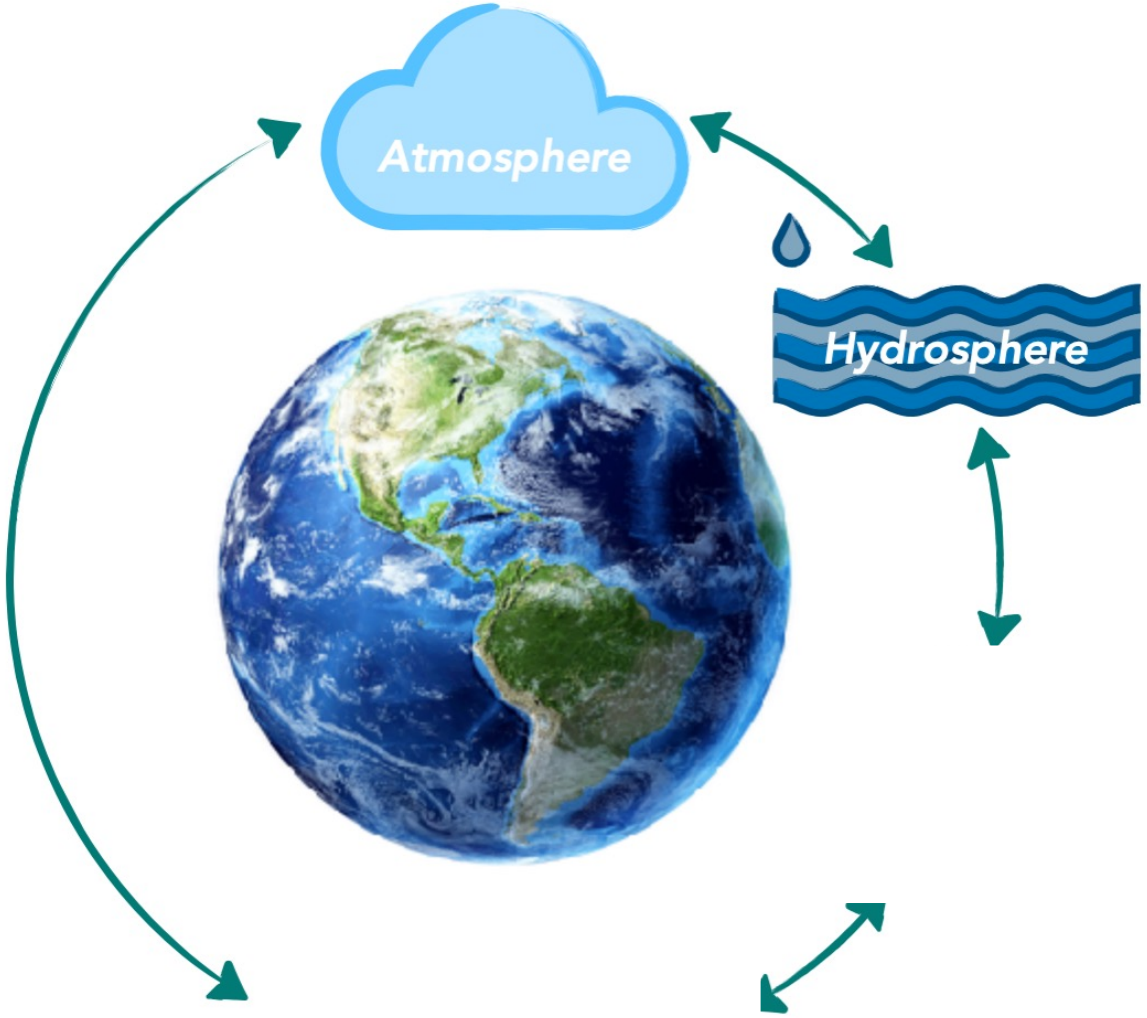

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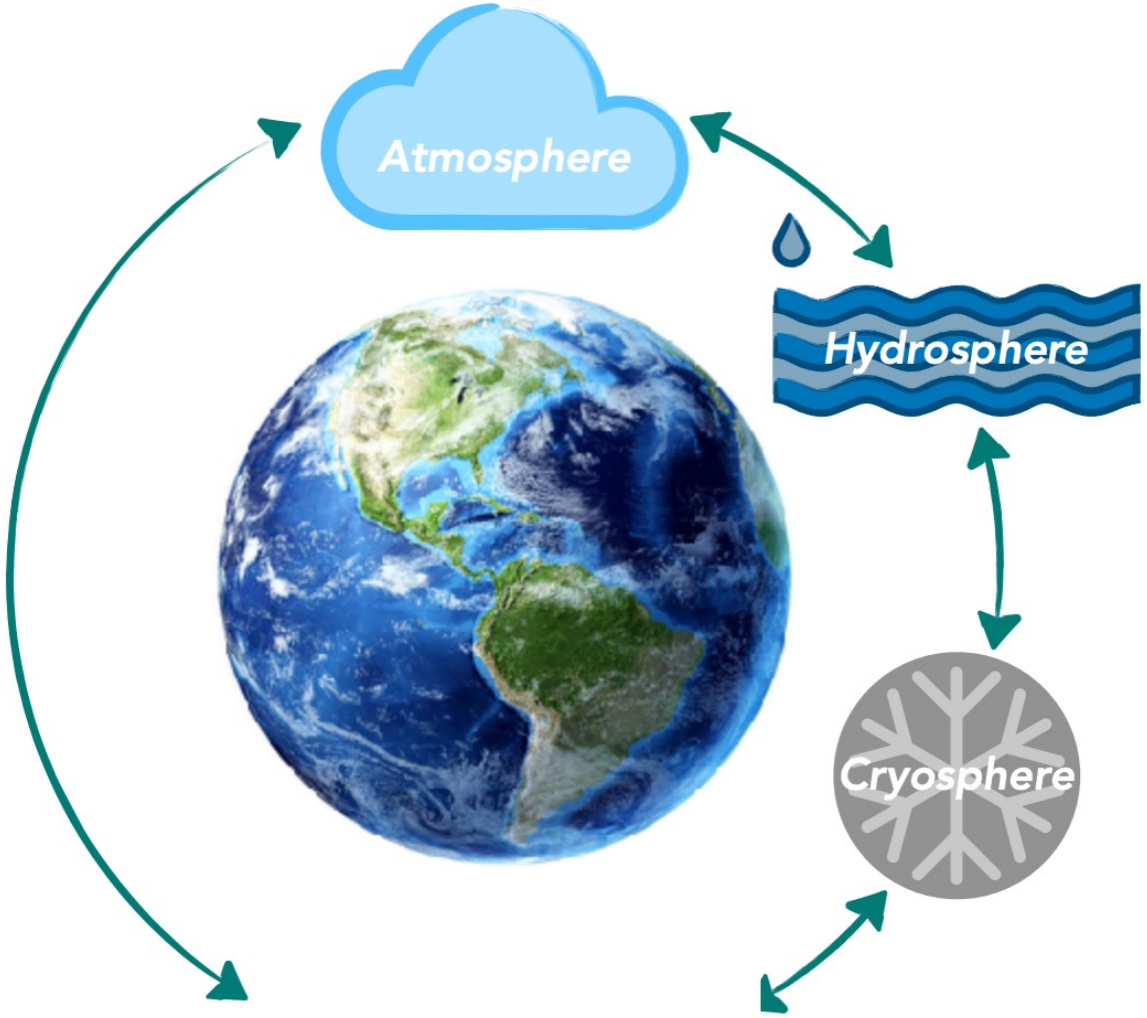

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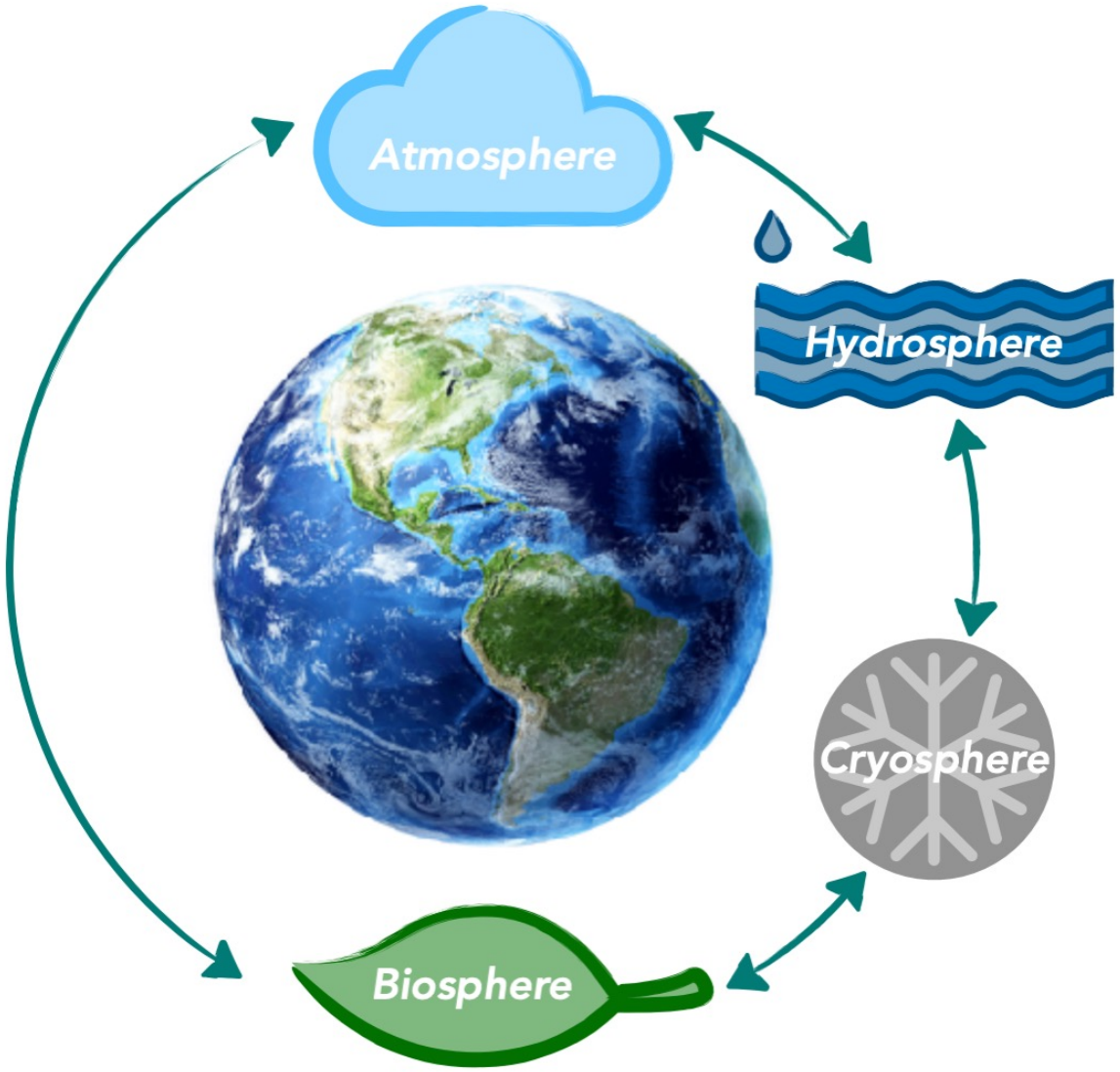

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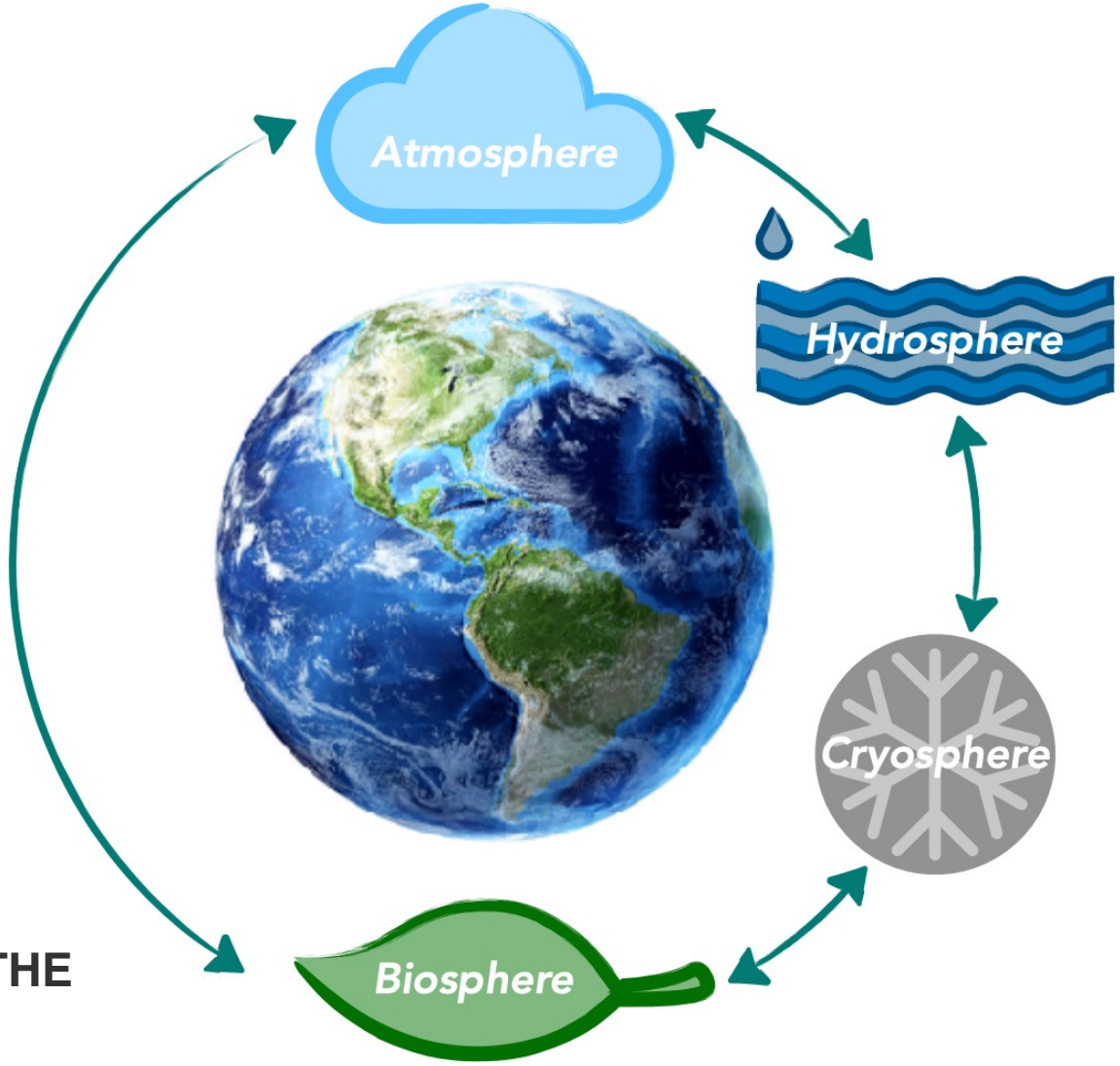
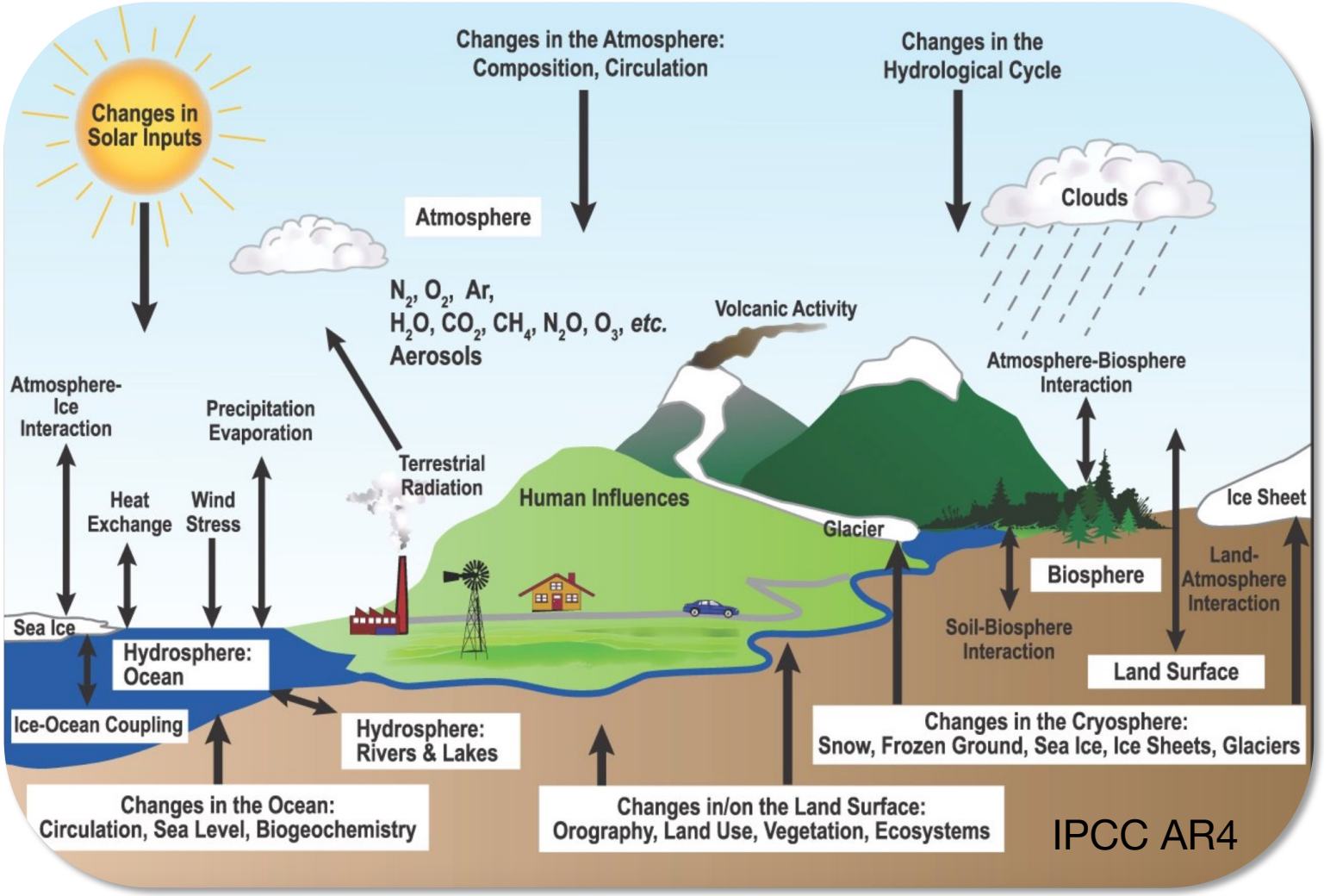


All energy in the climate system originates from the Sun.
THE SUN POWERS THE CLIMATE SYSTEM

Interactions and processes within the climate system

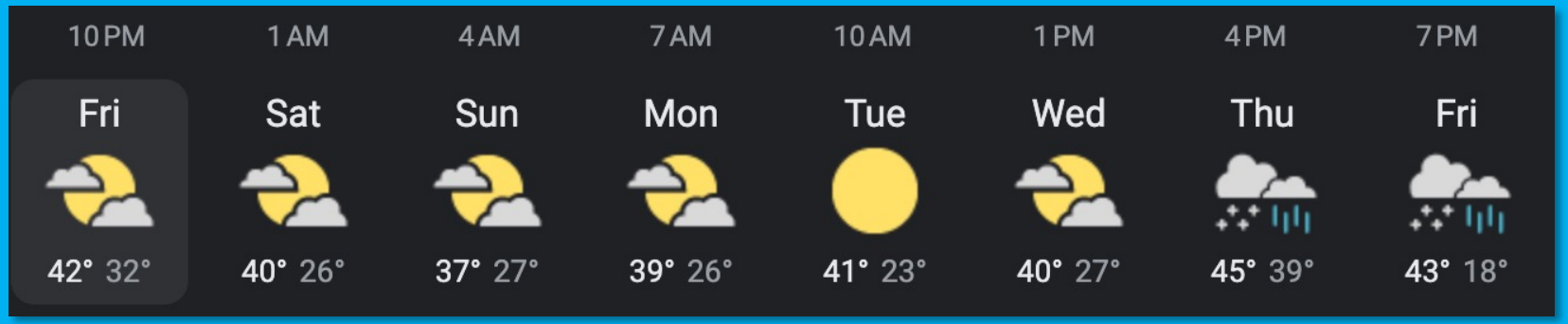
No part of the Earth system can be considered in isolation from any other part. The components of the climate system overlap and are interconnected – **what affects one can affect another.**



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"



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

"*Climate* is what we *expect*,

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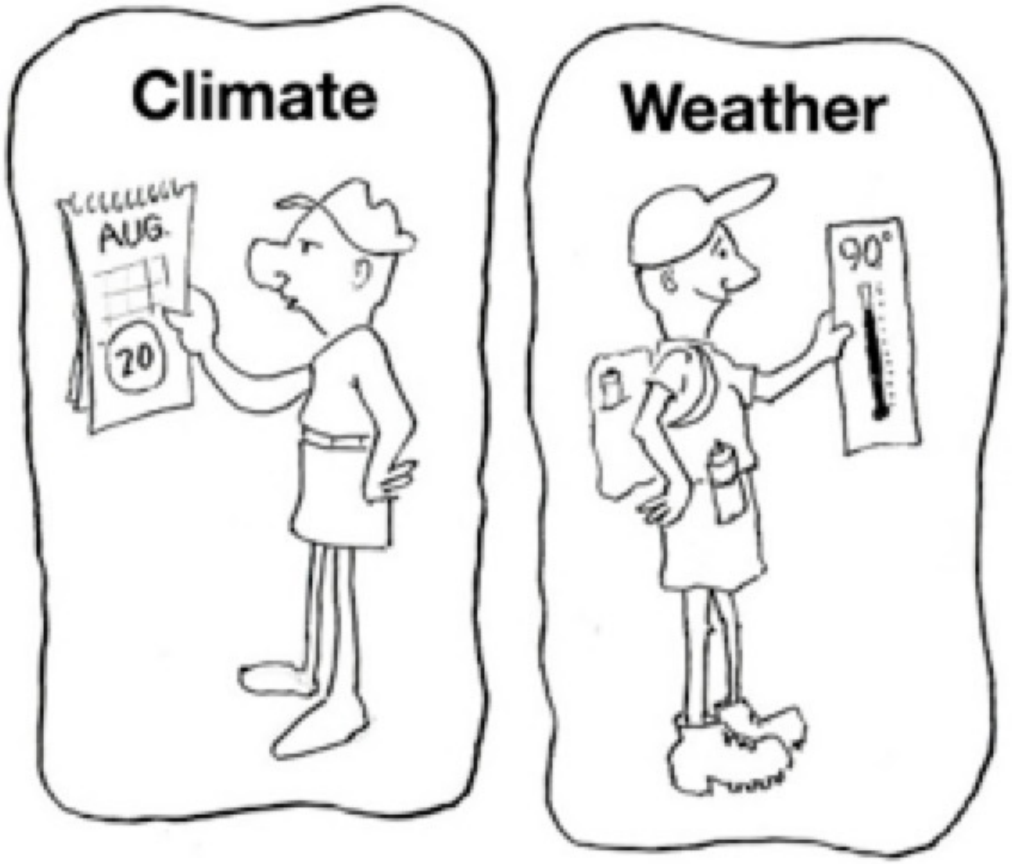


**"*Climate* is what we *expect*,
weather is what we *get*"**

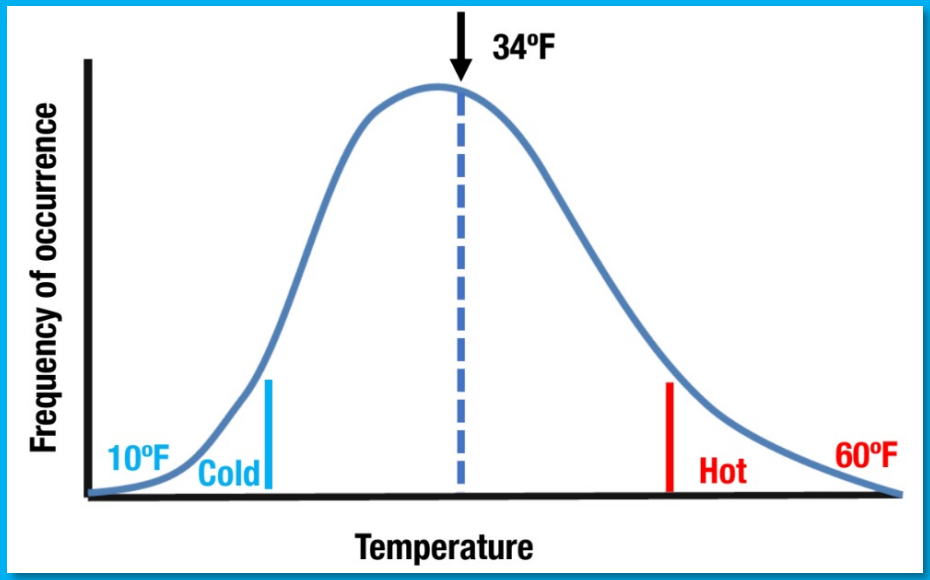
“*Climate* is what we *expect*,
weather is what we *get*”

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.**

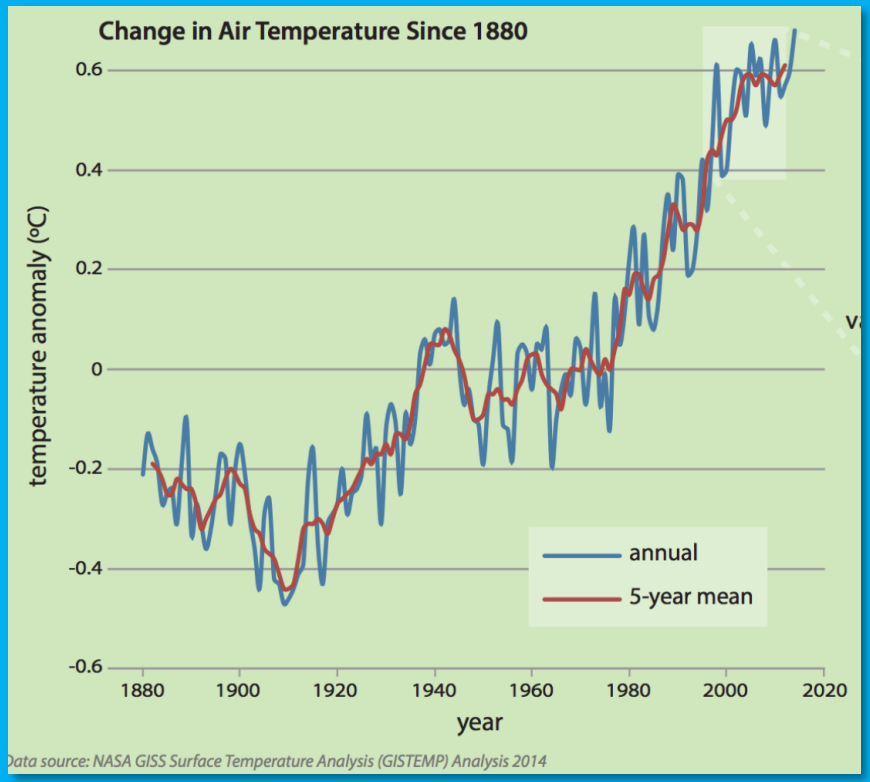
Mean daily temperature in December in Philadelphia from 30 years of observations

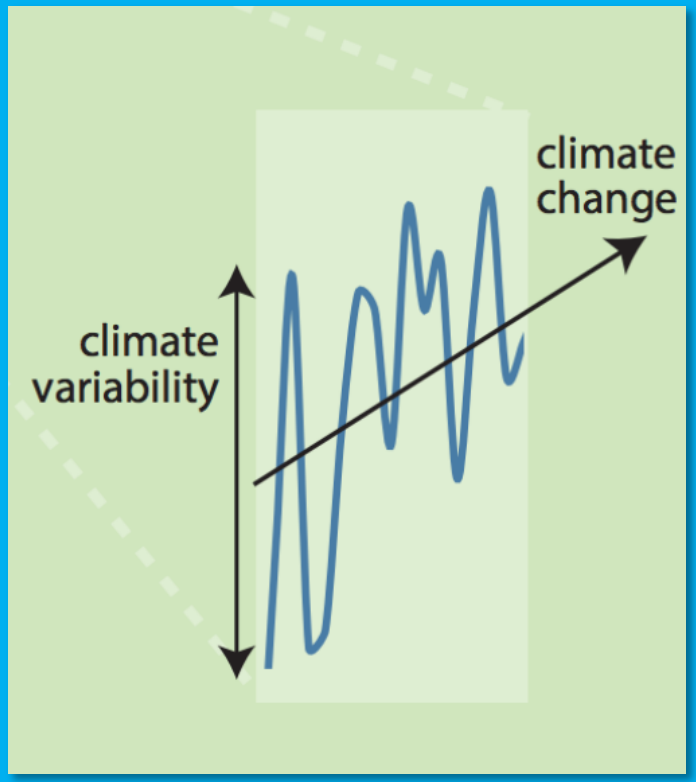


Based on **long-term observations** we "expect" the daily temperatures in December to be around ~ 34°F, and we may experience an exceptionally warm (~60 °F), or cold (10 °F) day …. but we expect these to occur less, i.e, they are less likely to occur or are considered **"rare".**

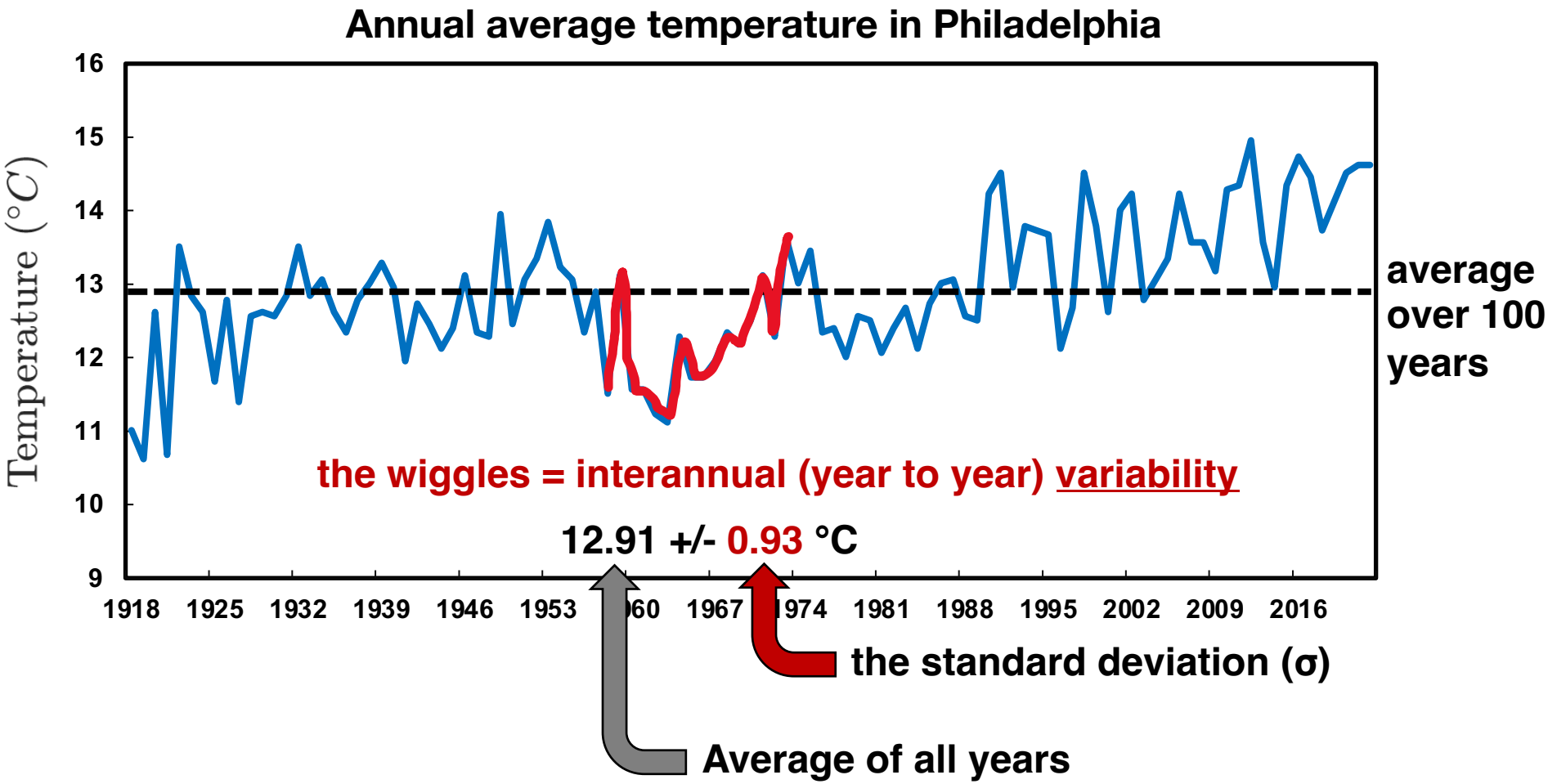
Climate Change vs. Climate Variability

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.

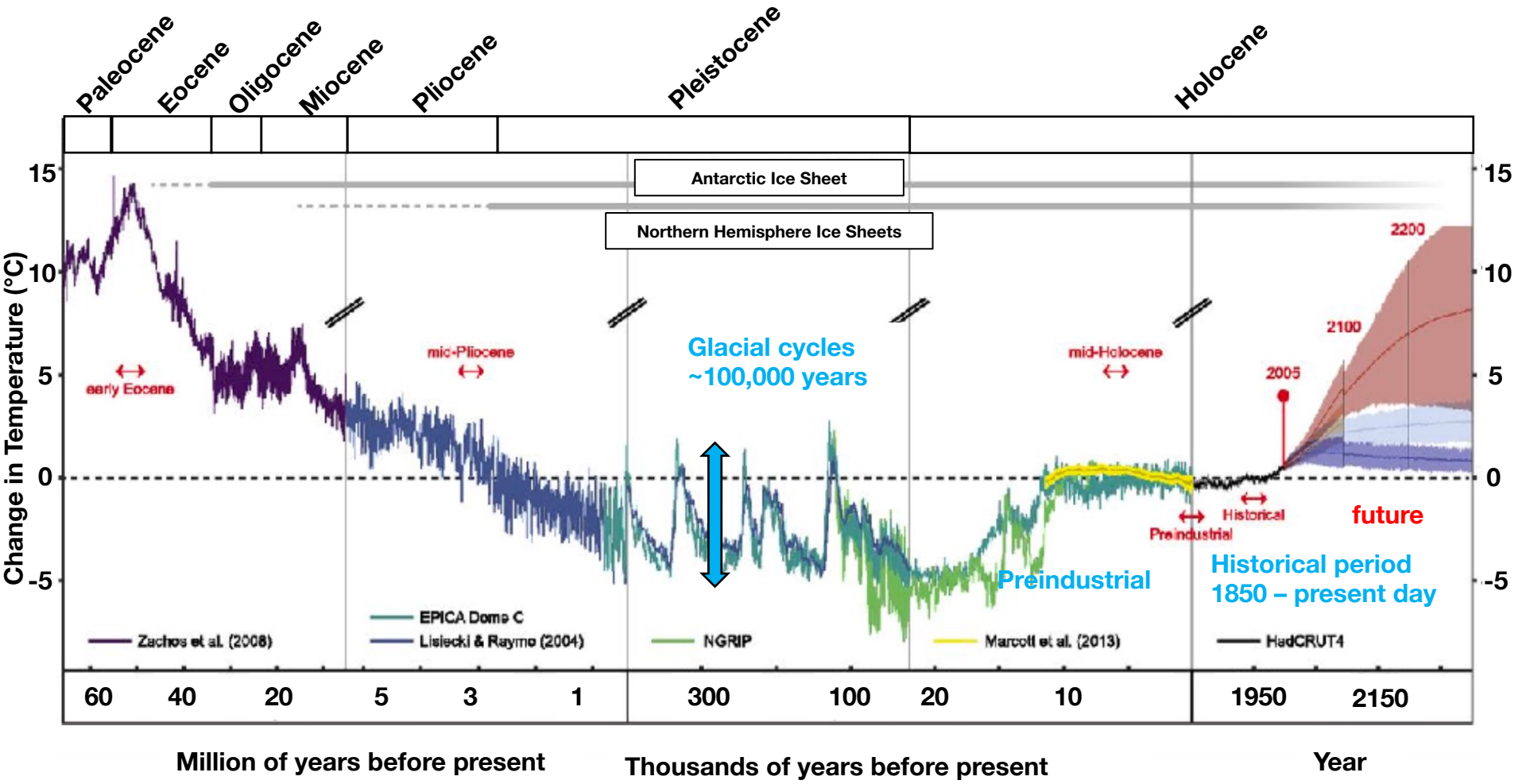




To assess whether there has been a change, we need to know both the mean and the variability of the variable of interest to know whether or not the current state is outside of the "natural variability" or natural fluctuations of the system.


Annual average temperature in Philadelphia
Temperature (°C)
16
15
14
13
12
11
10
9
1918
1925
1932
1939
1946
1953
1967
1974
1981
1988
1995
2002
2009
2016
average over 100 years
the wiggles = interannual (year to year) variability
12.91 +/- 0.93 °C
the standard deviation (σ)
Average of all years

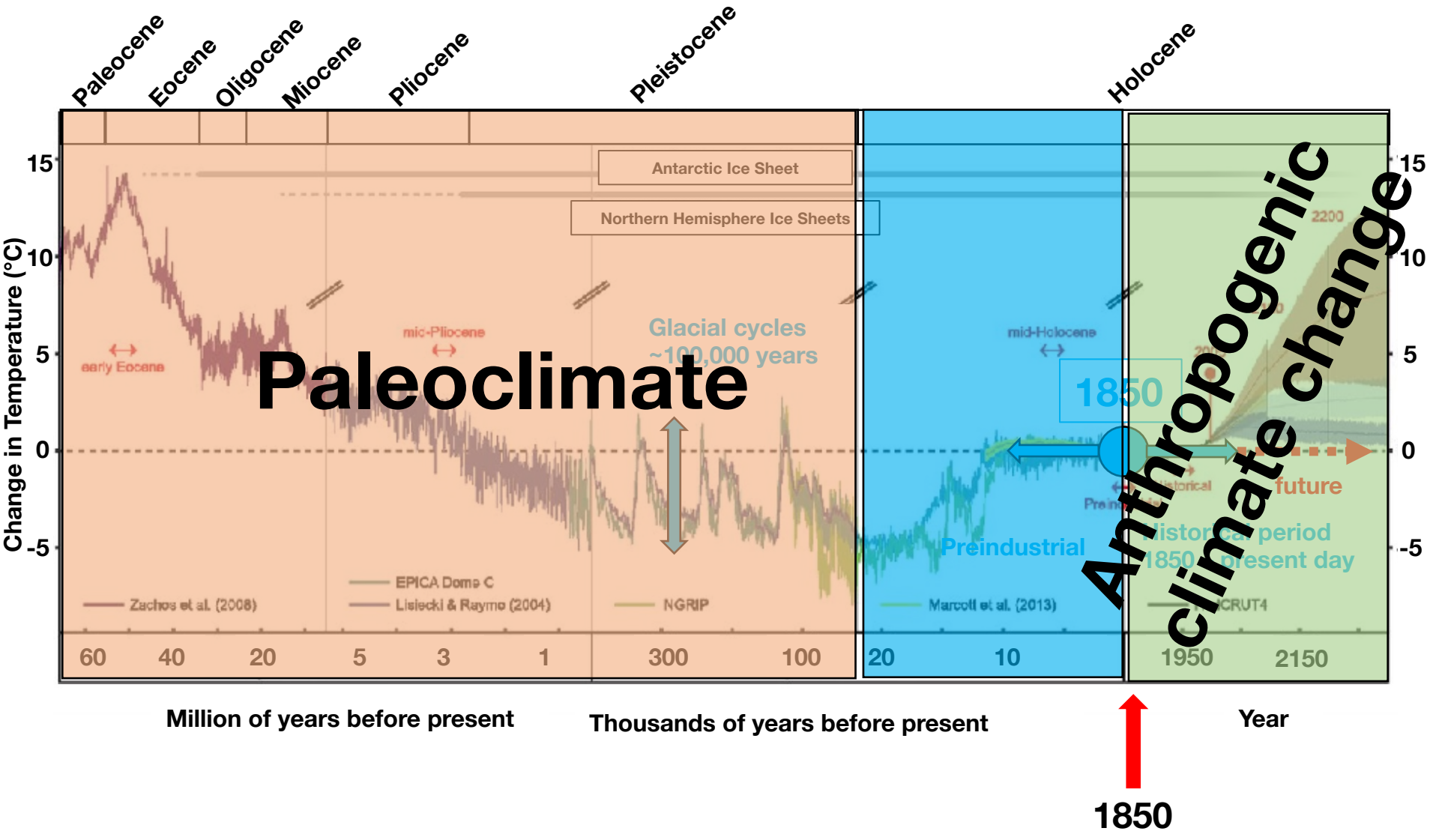
We can consider climate change over various timescales



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?

Paleoclimate (past climate, prior to the observational record) | Pre-industrial | Anthropogenic

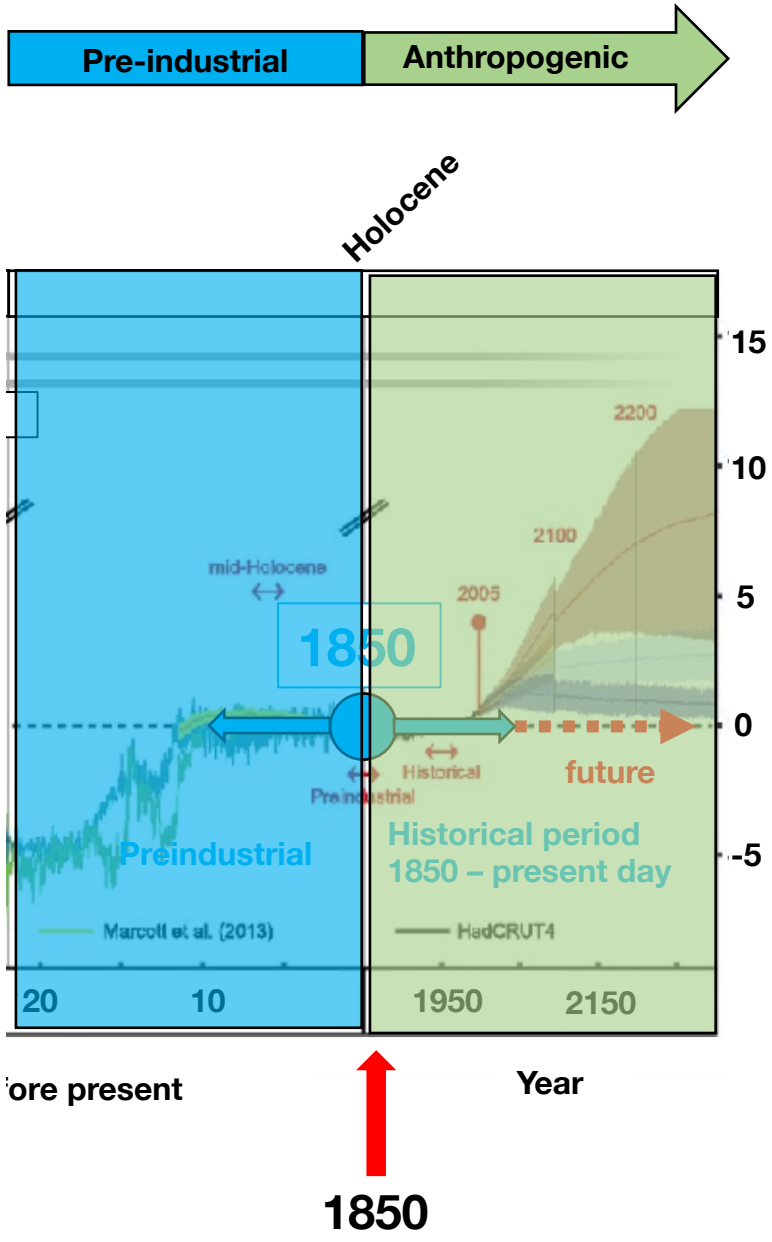


Million of years before present | Thousands of years before present | Year

1850

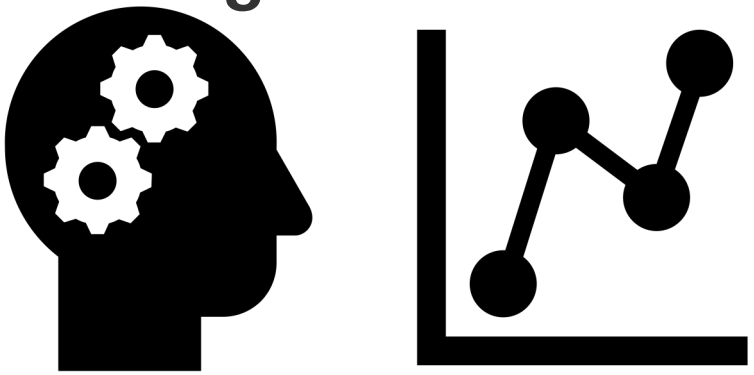
Pre-industrial (prior to 1850), stable climate, [CO2] ~ 285 ppm

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, [CO2] ~ 285 ppm

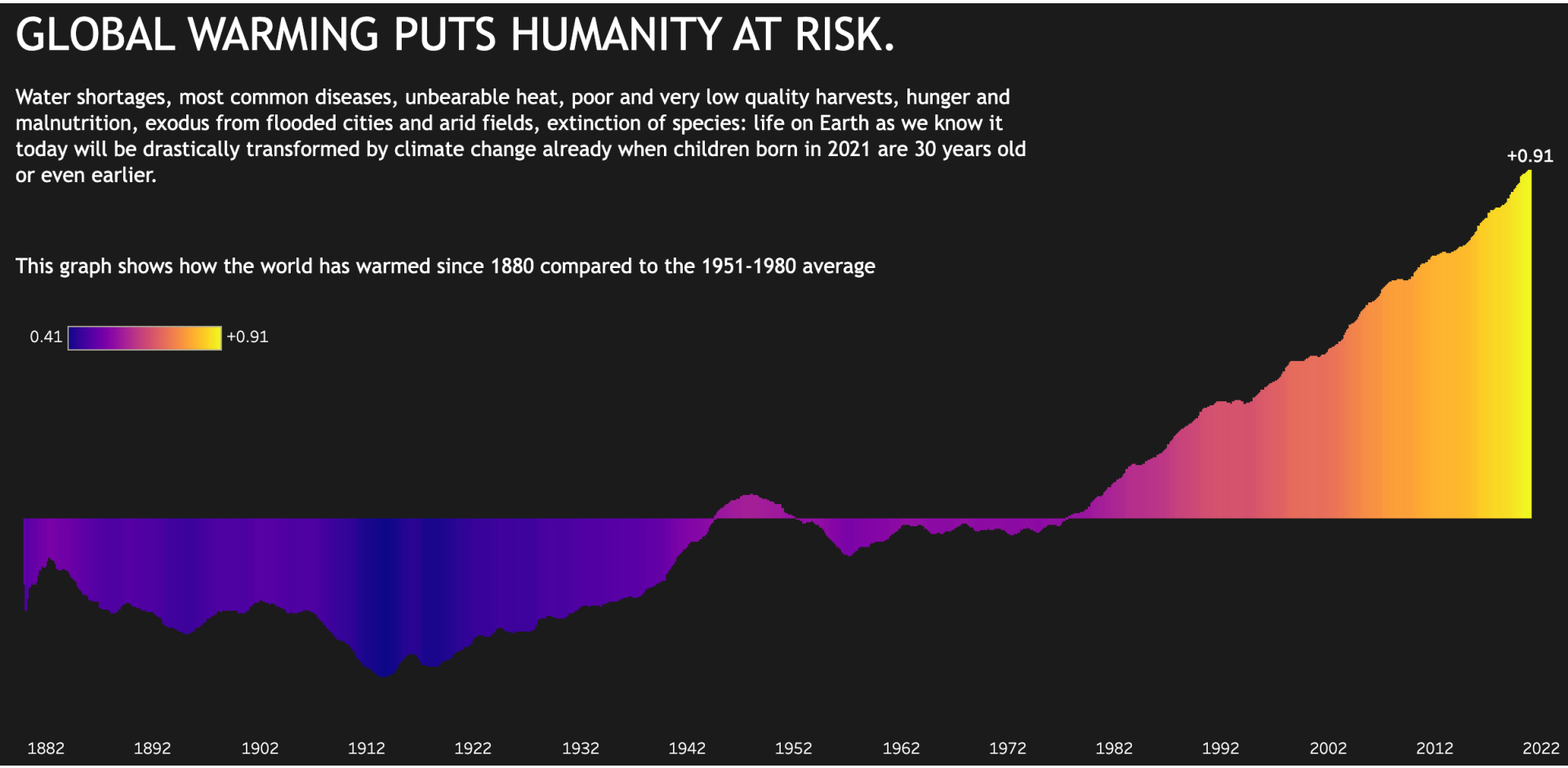
Break Out Group Discussion
What makes a great data visualization ??



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?



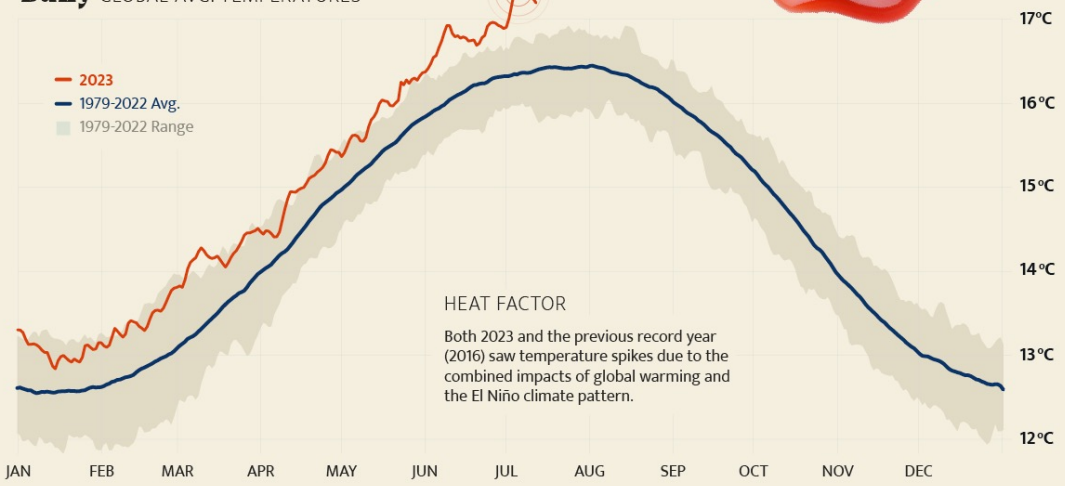
https://theglobalobservatory.org/2021/12/new-climate-data-visualizations-2021/

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.

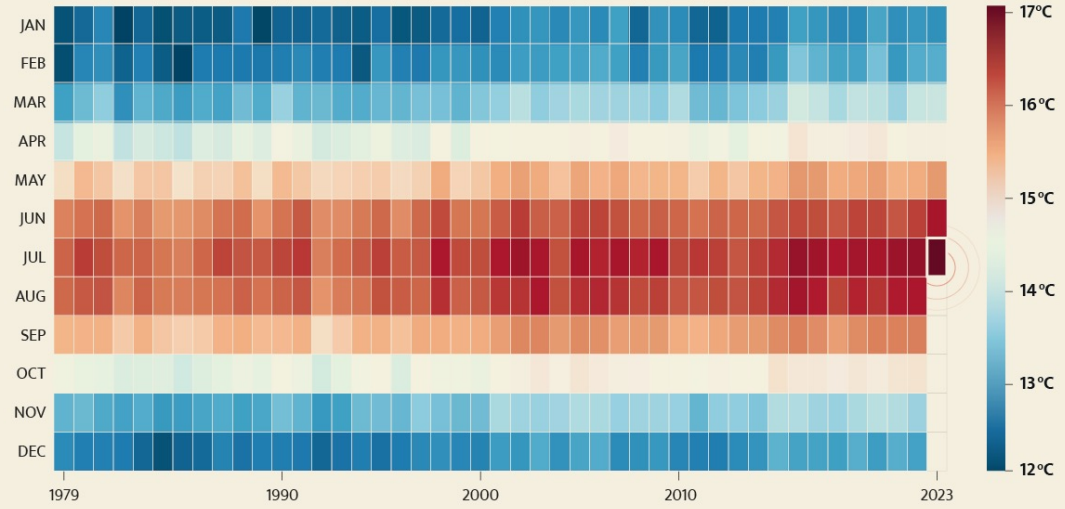
Daily GLOBAL AVG. TEMPERATURES



HEAT FACTOR

Both 2023 and the previous record year (2016) saw temperature spikes due to the combined impacts of global warming and the El Niño climate pattern.

Monthly GLOBAL AVG. TEMPERATURES

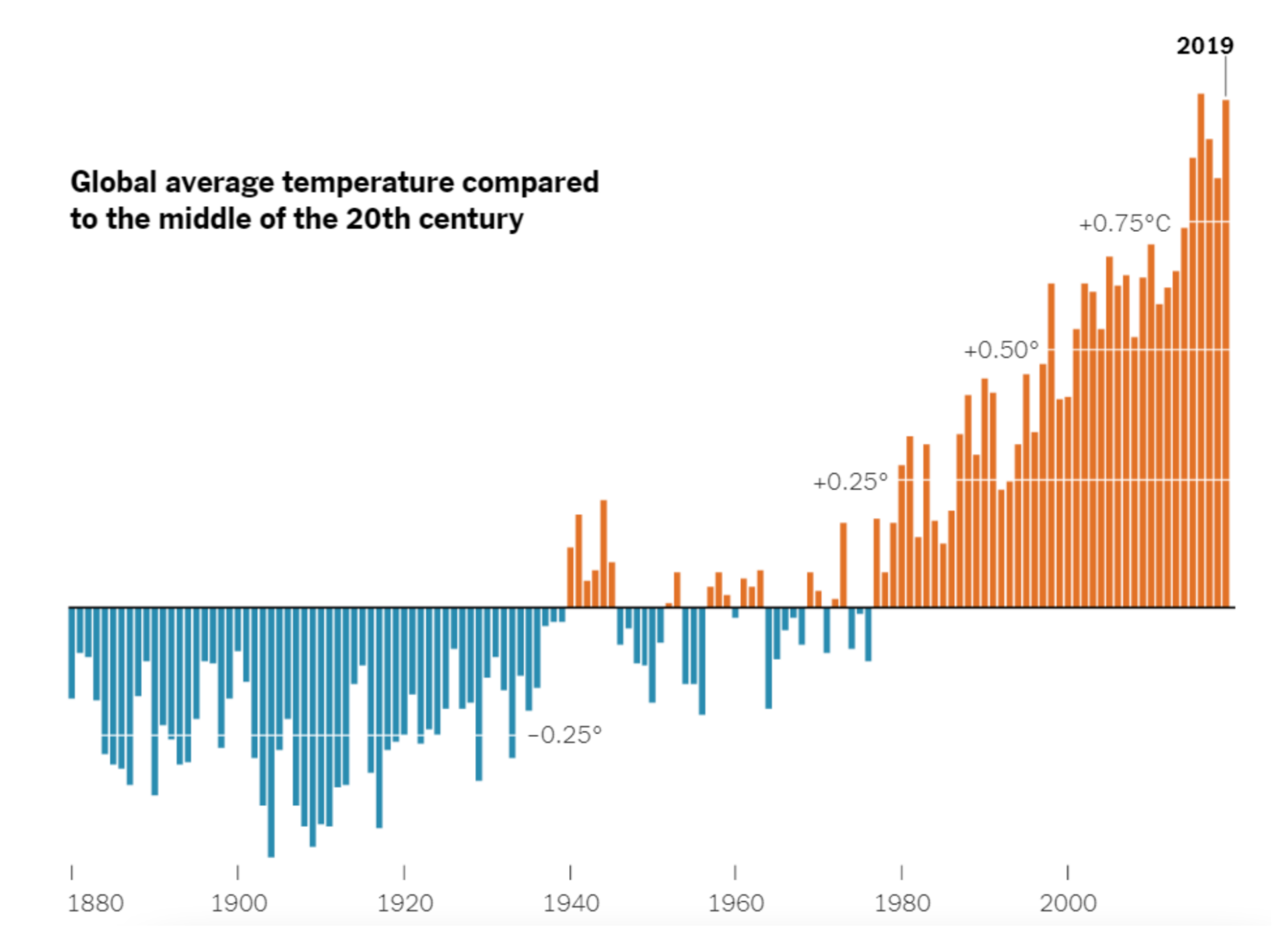


VISUAL CAPITALIST

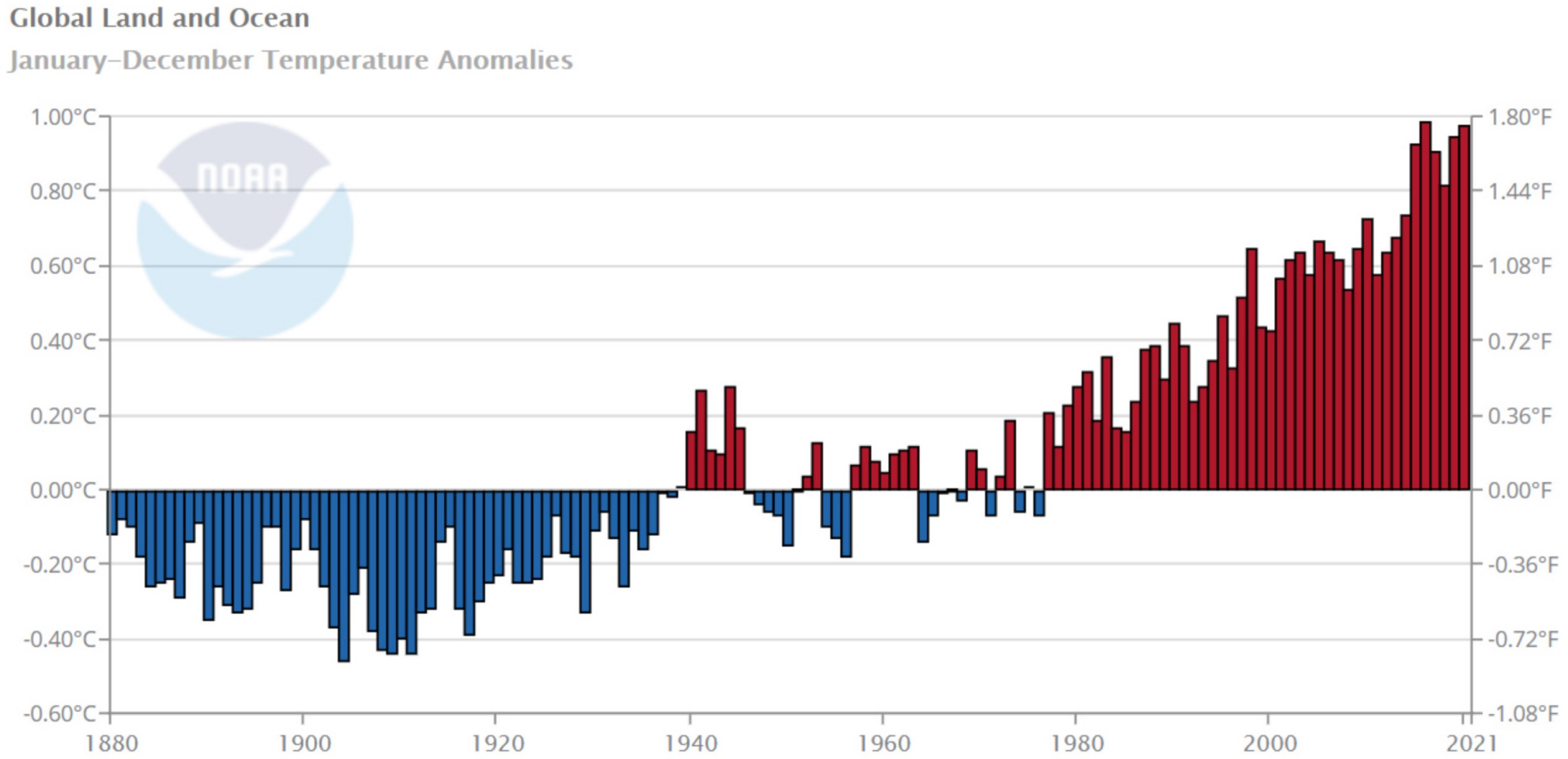
Note: Air temperatures measured at 2 meters above surface.
Source: Climate Reanalyzer; World of Change: Global Temperatures

/visualcapitalist @visualcap visualcapitalist.com

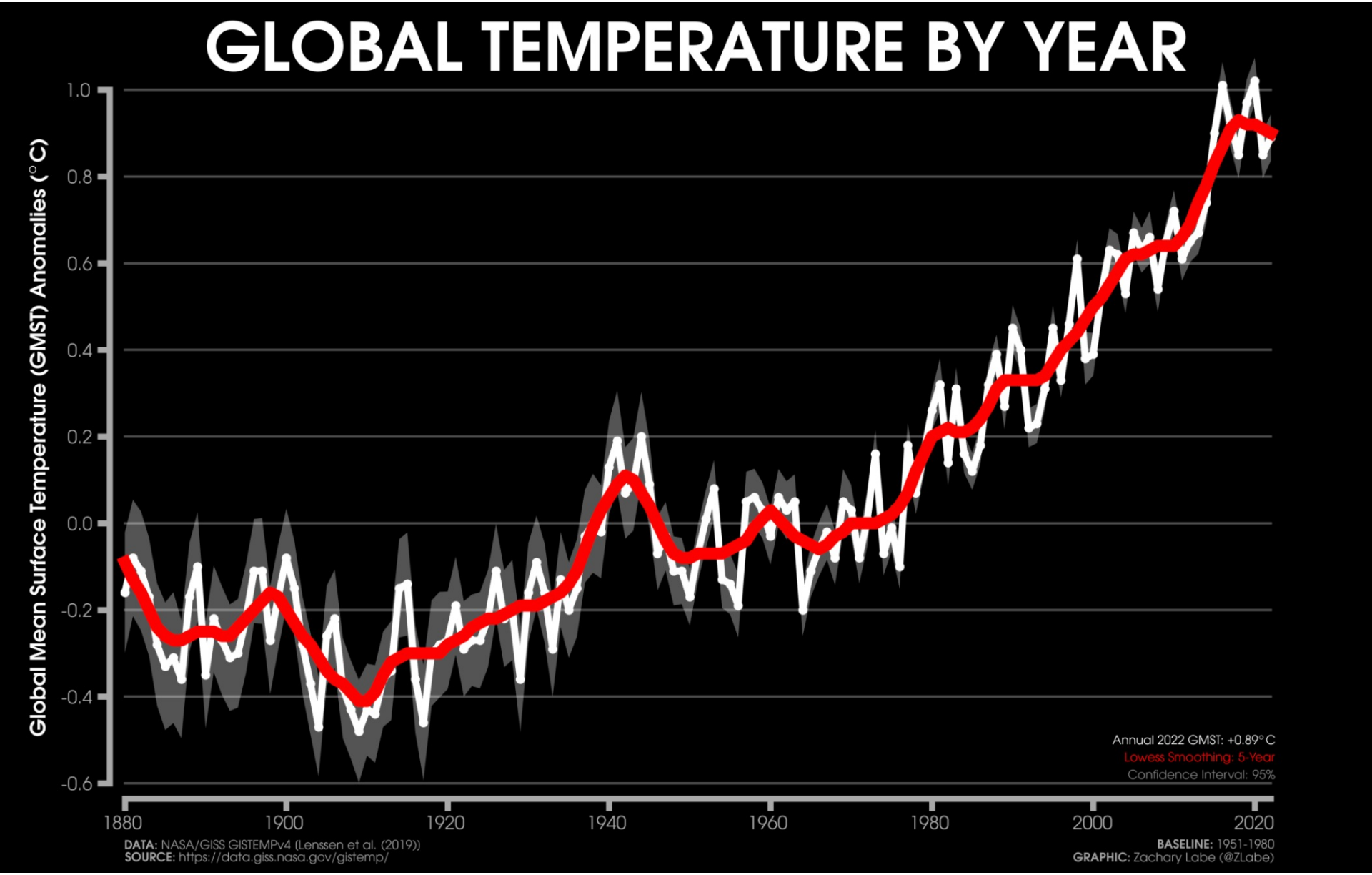
https://www.visualcapitalist.com/charting-global-temperature-records/



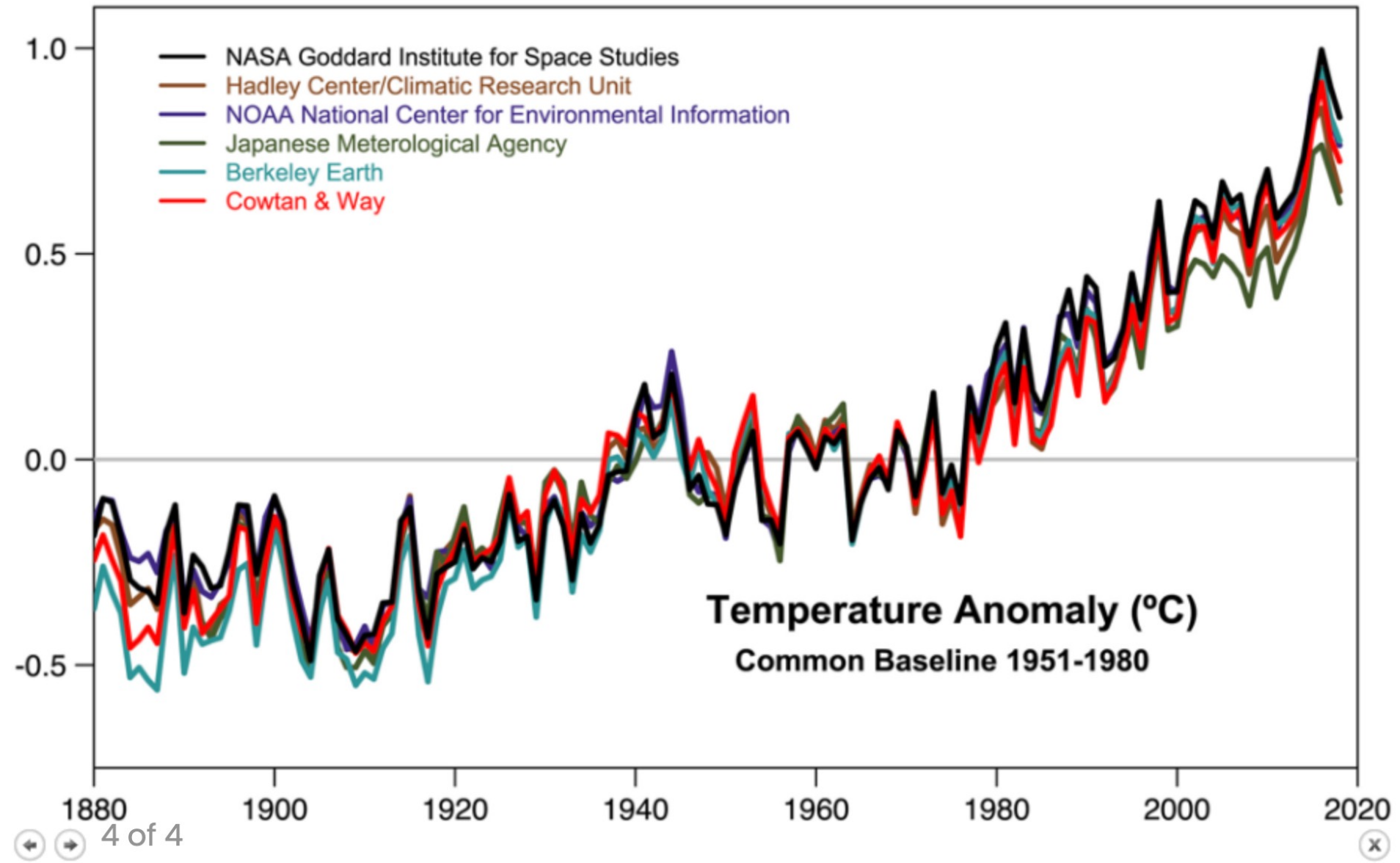
https://www.nytimes.com/2020/04/23/learning/whats-going-on-in-this-graph-global-temperature-change.html



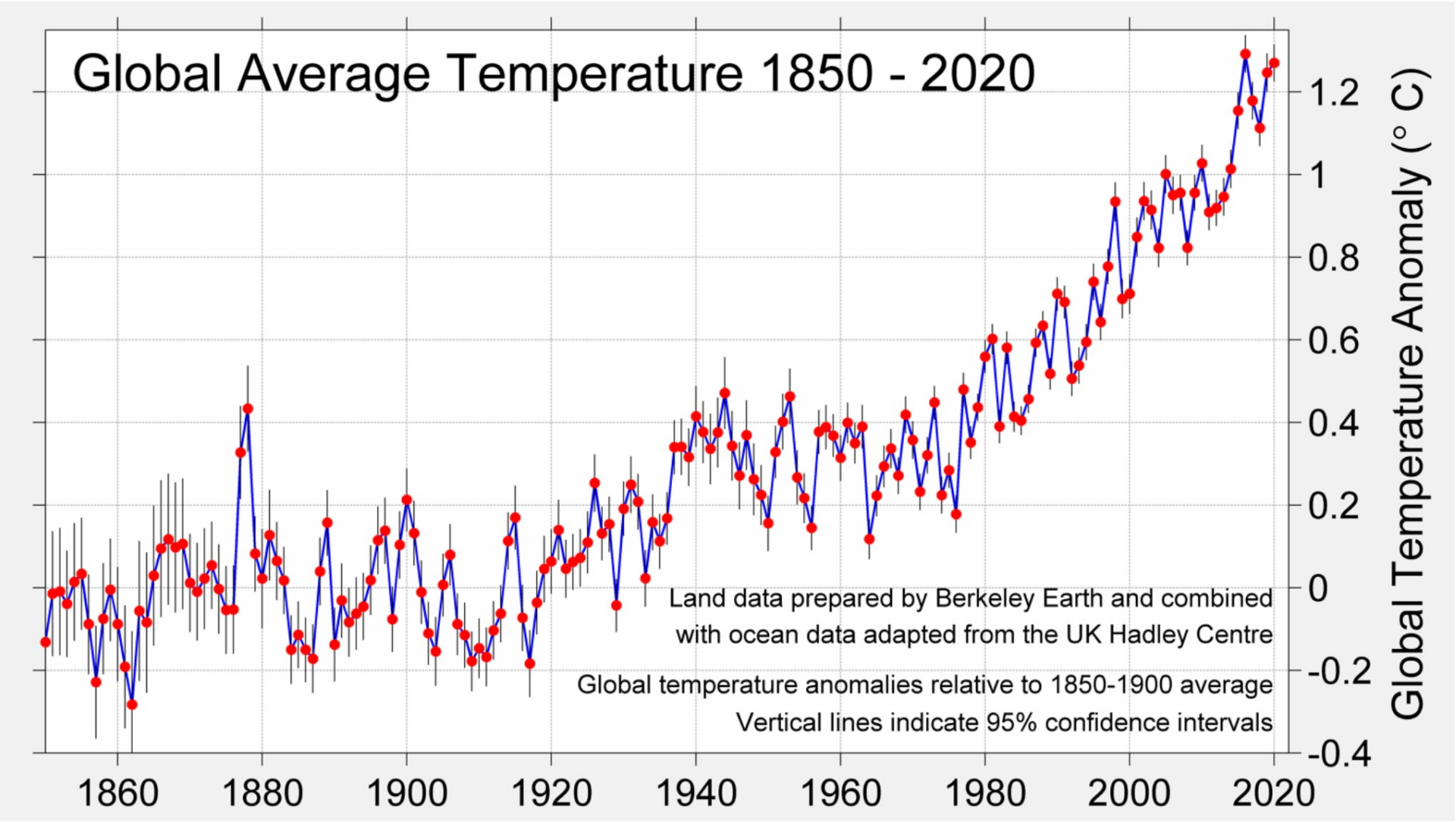
https://www.climate.gov/maps-data/dataset/global-temperature-anomalies-graphing-tool



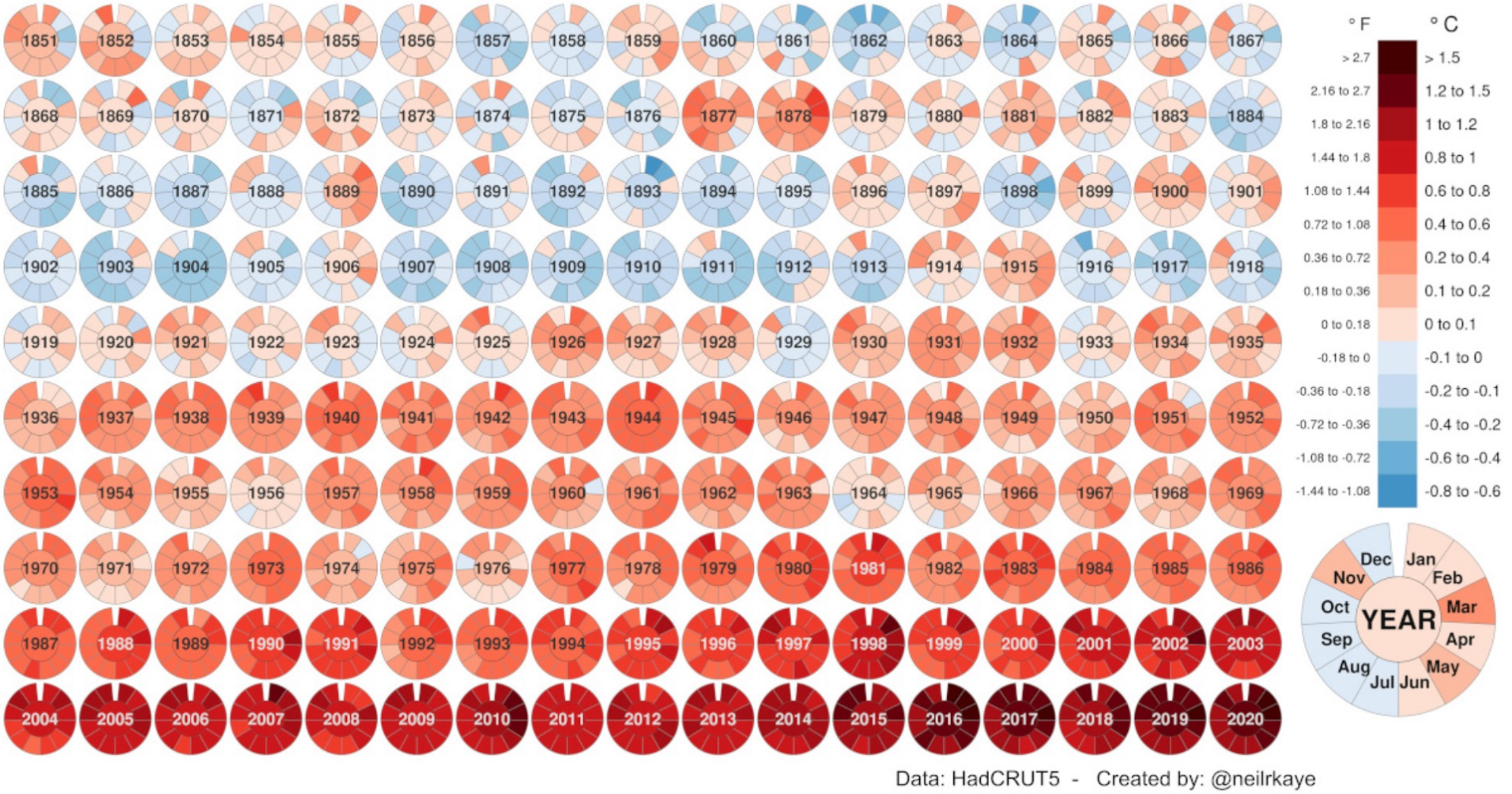
https://zacklabe.com/arctic-temperatures/



https://climatedataguide.ucar.edu/climate-data/global-surface-temperature-data-gistemp-nasa-goddard-institute-space-studies-giss



https://berkeleyearth.org/global-temperature-report-for-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:

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

- [x] Complete Reading 2.

	Content	Reading Assignment	Assignment due
08/29 (Tues)	Course Introduction		
08/31 (Thurs)	Getting Set Up	Reading 1	Assign. 1 [9:00 AM] Course Survey
09/05 (Tues)	Unix Tutorial & GitHub	Reading 2	
09/07 (Thurs)	Check-in & de-brief: ***issues, challenges, curiosities, and excitement!*** 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