

Weather Change vs. Climate Change



In the eye of Hurricane Katrina
Photo courtesy of Prof Bob Houze's group

- A single hurricane is an example of weather.
- An increase in the average number per year, or average strength is a climate question.

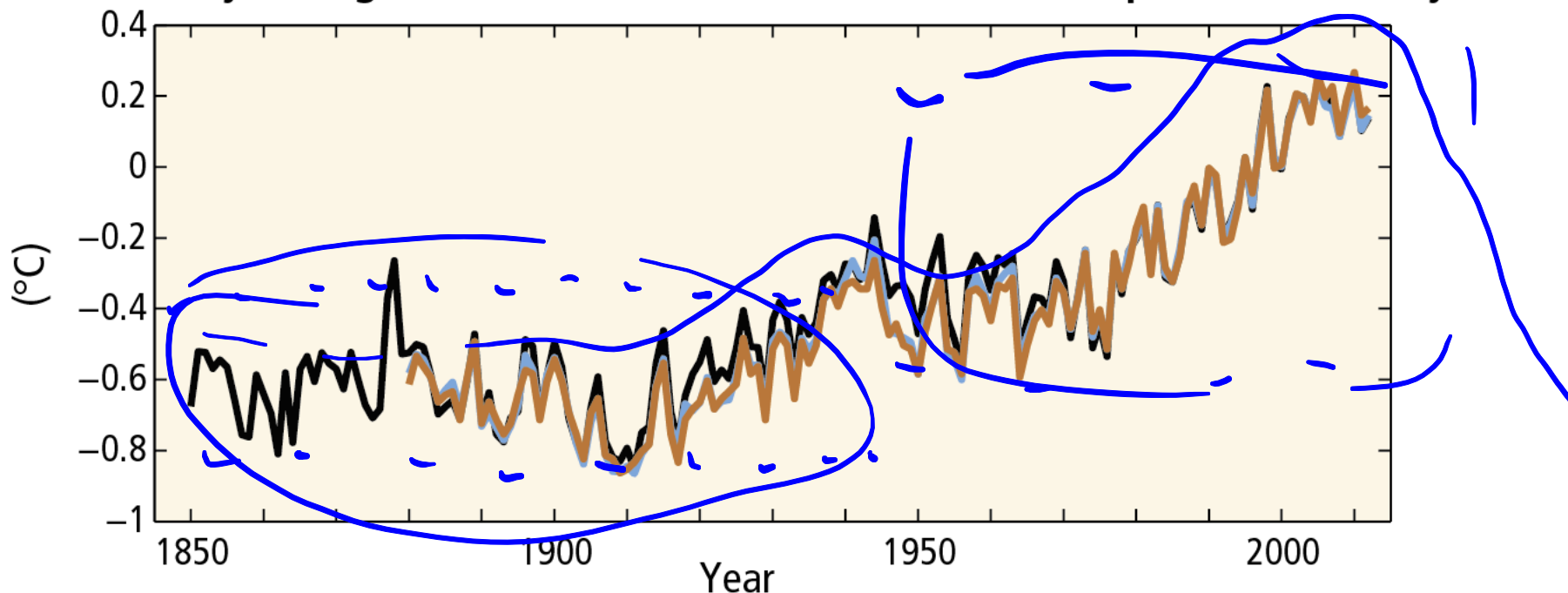
What do we mean by climate change?

multi-decadal

Long-term variation in an average property related to weather, that is significant compared to natural variability, or is an alteration in the patterns of variability.

Statistical meaning

(a) Globally averaged combined land and ocean surface temperature anomaly

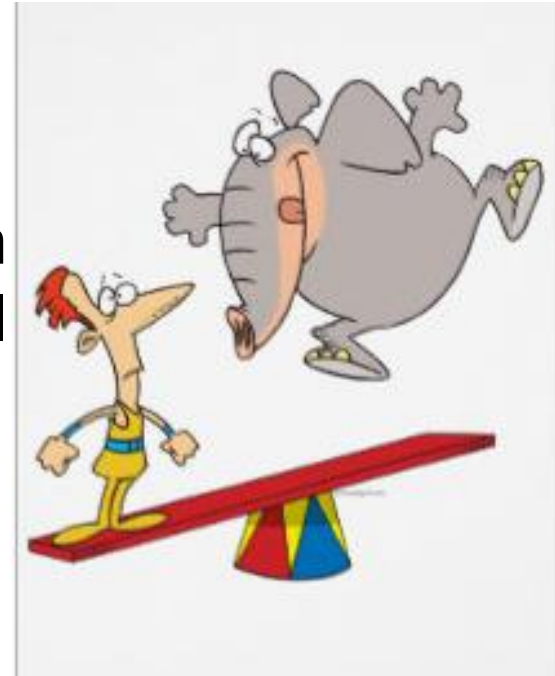


Basic Change Concepts

Why is there change?

an ***imbalance*** between mass or energy flowing into and out of some ***place*** over some interval ***time***.

Laws of Mass and Energy Conservation



Goal for this course: figure out what causes these imbalances in Earth's climate system, so we can understand/predict change

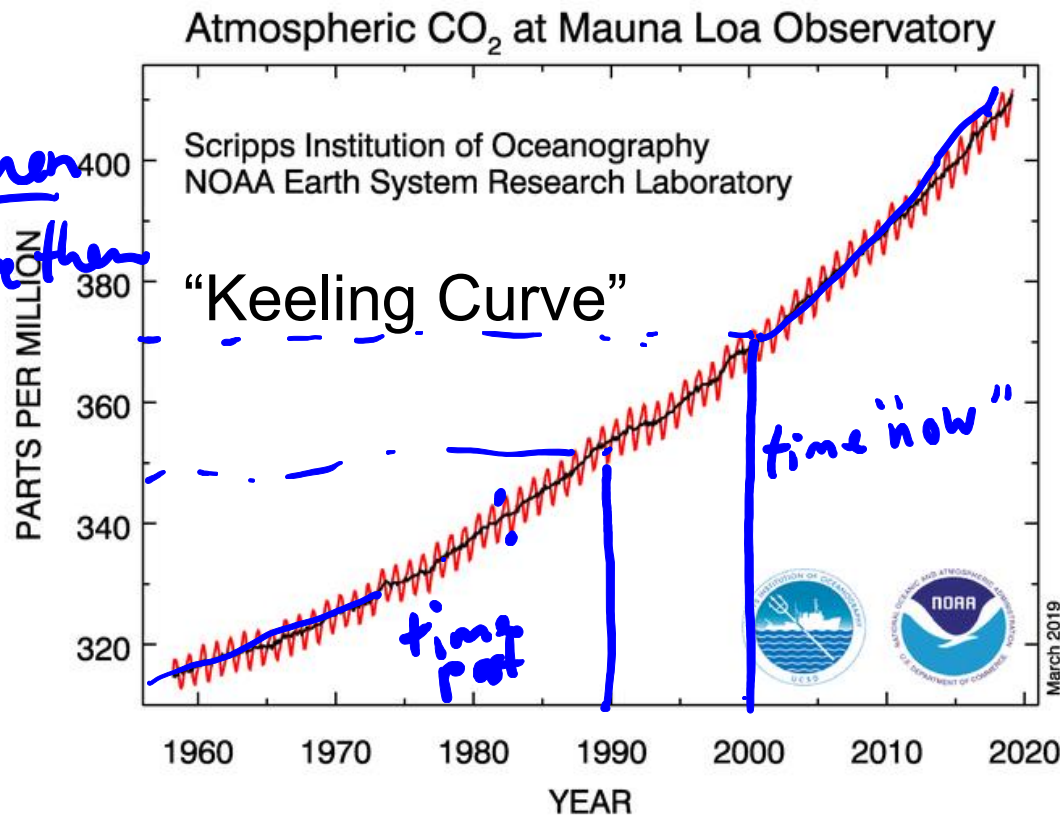
Basic Change Concepts

How is Change Quantified?

The “**rate of change**”: amount by which mass or energy changes in a specified time interval. Helps **predict** what will happen next and compare possible causes of change.

$$\frac{370 - 350 \text{ ppm}}{10} \sim 2 \text{ ppm/year}$$

$$\frac{CO_2 \text{ now} - CO_2 \text{ then}}{\text{time now} - \text{time then}}$$

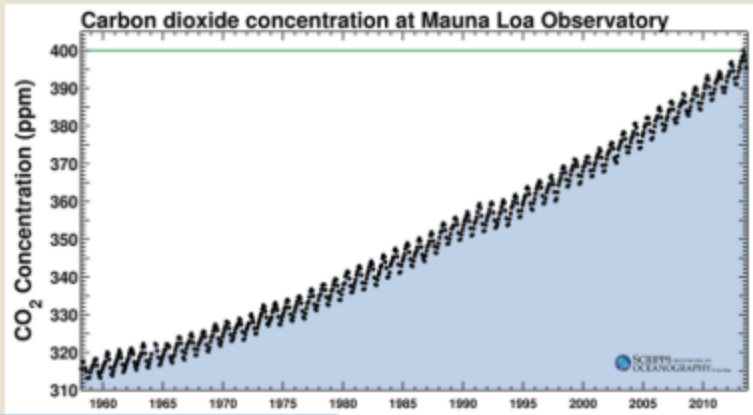


Poll Question – Rate of Change

W

Has the rate of increase of carbon dioxide in the atmosphere ever been negative since measurements began?

 **Poll locked.** Responses not accepted.



Yes

No

Visual settings 

Activate 

Show results 

Show correct 

Lock 

Clear results 

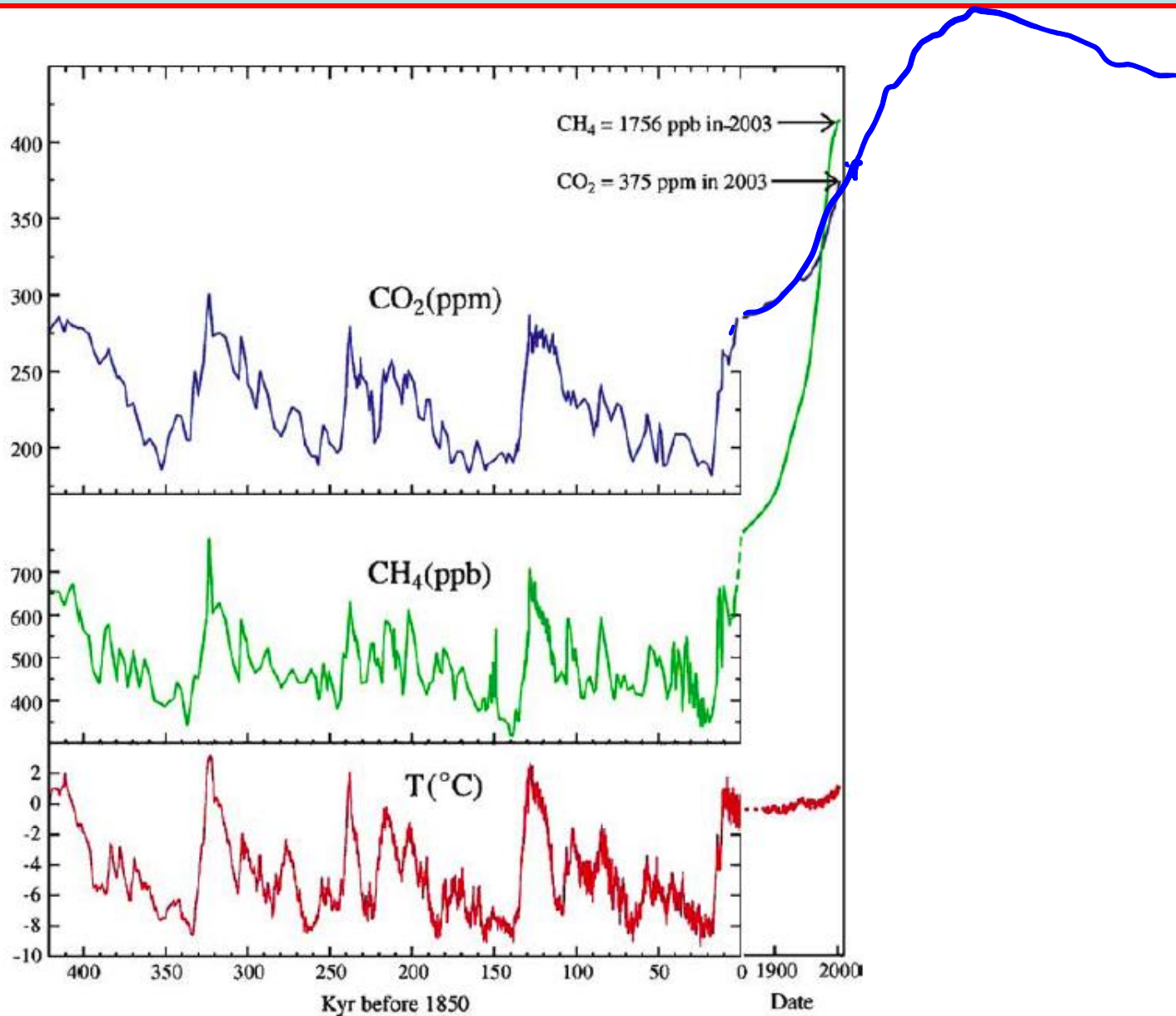
Fullscreen 

Next 

Previous 

Total Results: 0

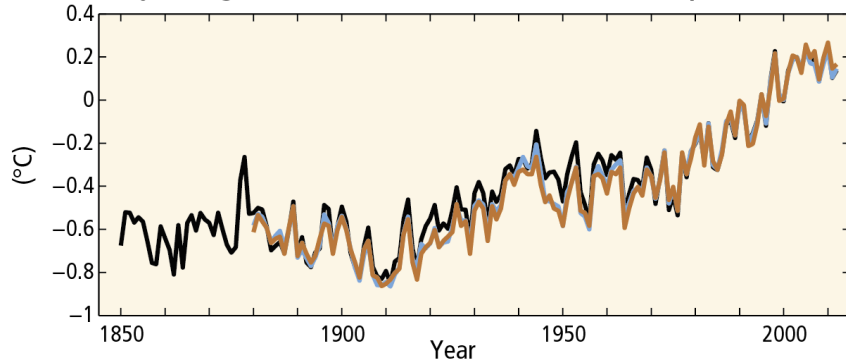
Rates of Change Can Also Change



When and Why's of Climate Change

Detection

(a) Globally averaged combined land and ocean surface temperature anomaly



Has there been a change in average property?

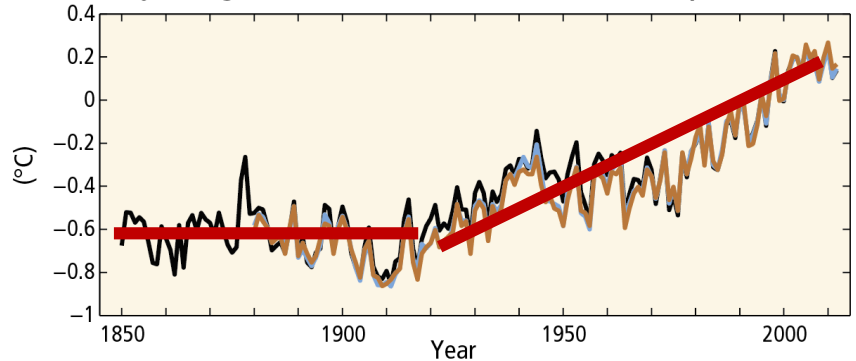
no

Do something else

yes

Attribution

(a) Globally averaged combined land and ocean surface temperature anomaly



Determine the cause:
Natural? Non-natural (i.e. by humans)?

anthropogenic

Defining Attribution

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Assigning a **cause** to the observed change

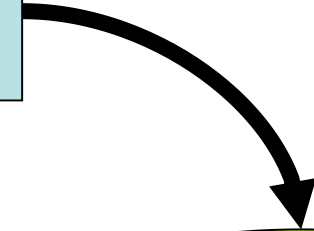
- not so easy!
- must use scientific method

Scientific Method

**Make Observation
or Computation**

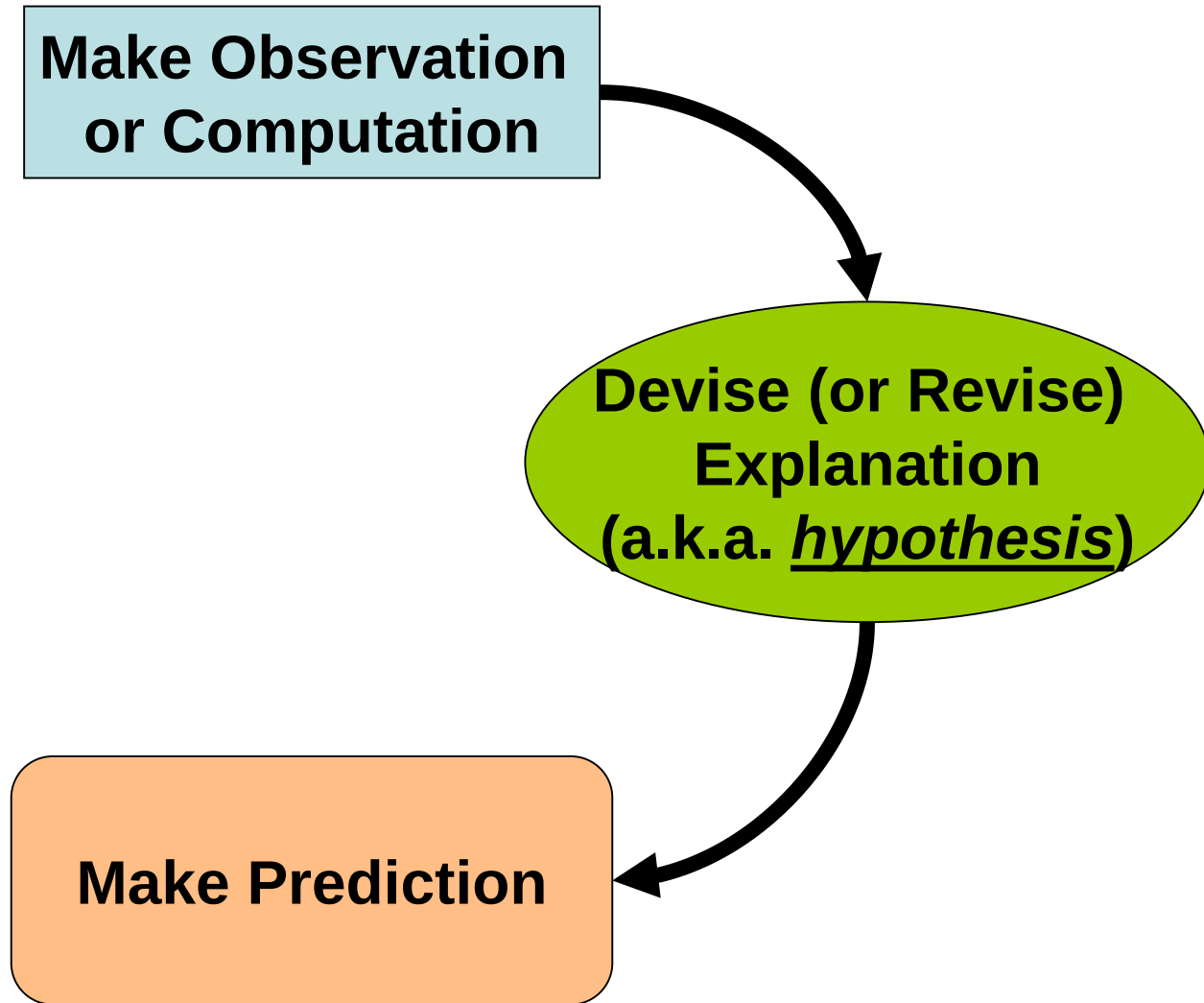
Scientific Method

**Make Observation
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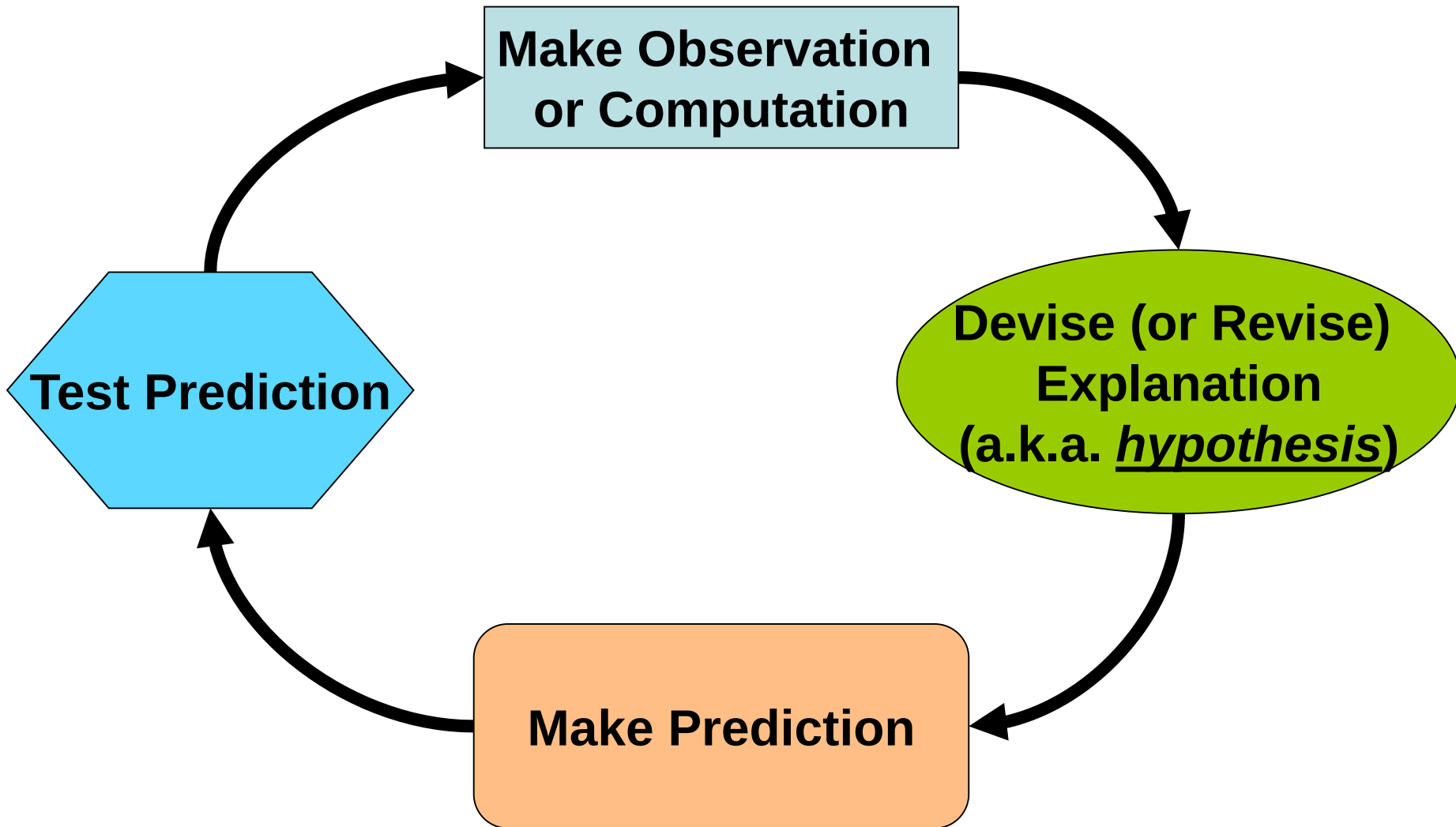


**Devise (or Revise)
Explanation
(a.k.a. hypothesis)**

Scientific Method

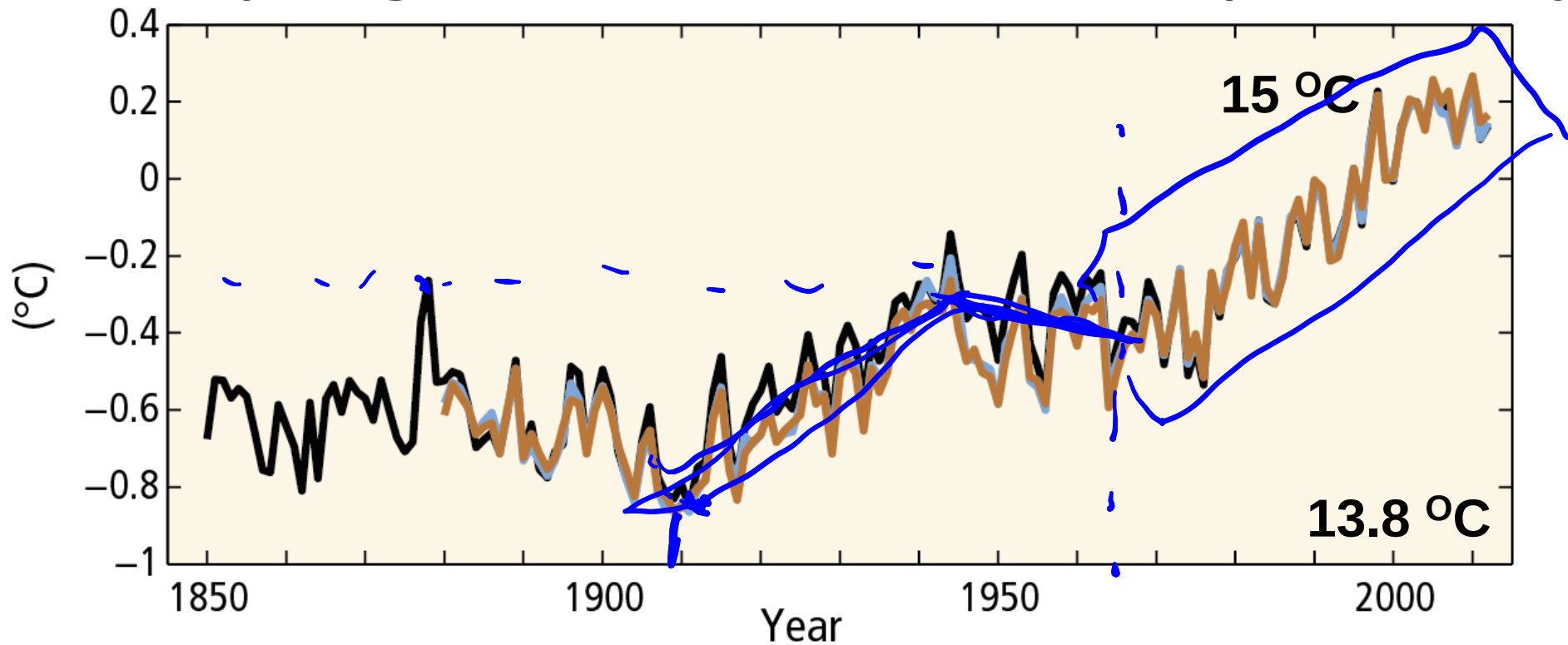


Scientific Method



Recent climate change?

(a) Globally averaged combined land and ocean surface temperature anomaly



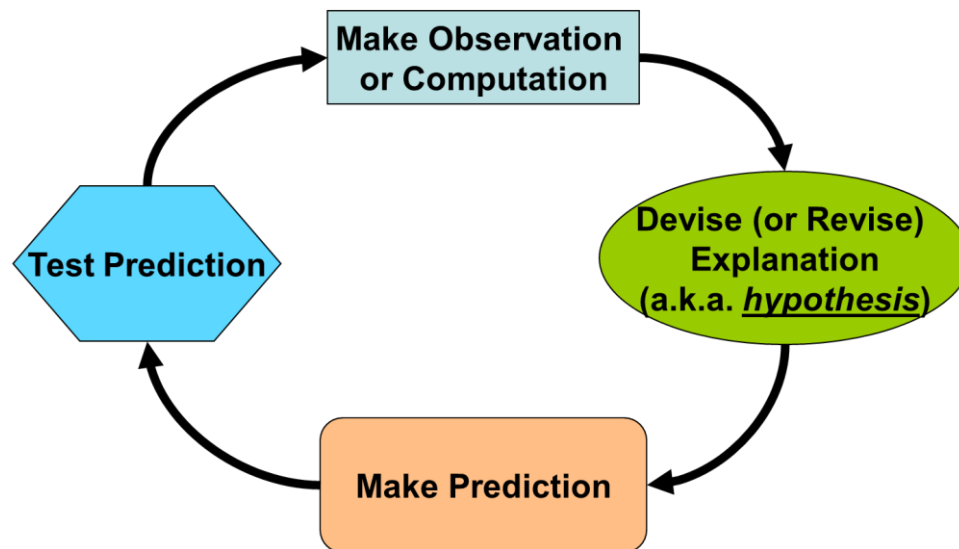
From Intergovernmental Panel on Climate Change AR5 2014.

Quick Summary

Detection of Climate Change: requires “statistical” proof

Attribution: assigning a cause to the change using Scientific Method

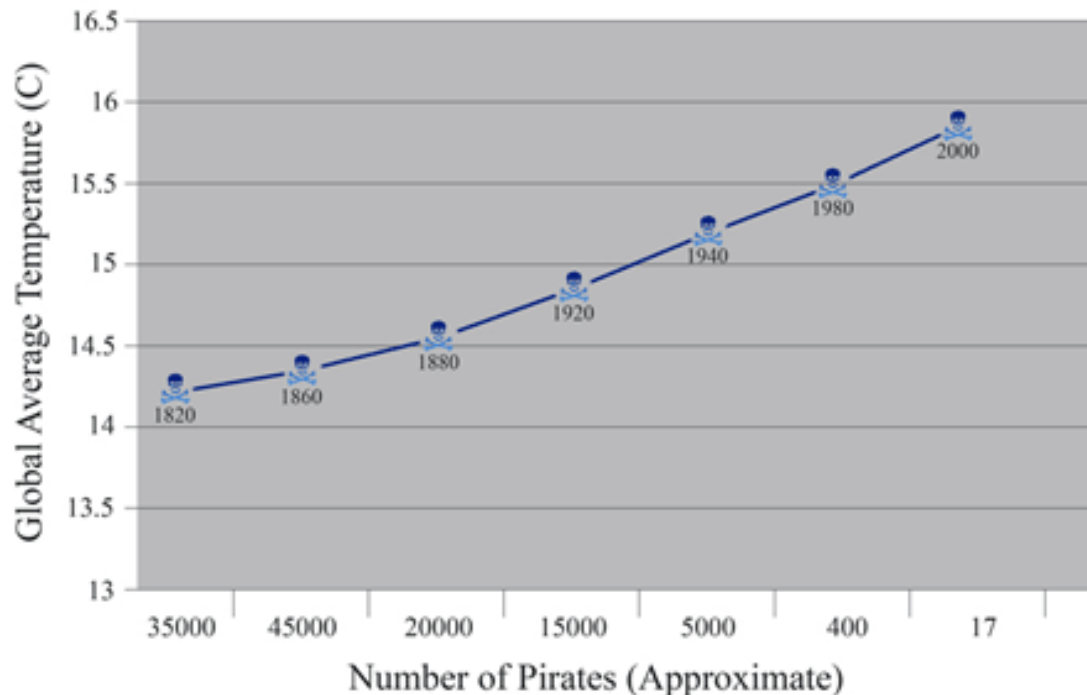
Scientific Method: A loop of observation → hypothesis → prediction → testing → observation



Valid Explanation?

“The decrease in pirates anti-correlates with global temperature. Thus, global warming is caused by fewer pirates.”

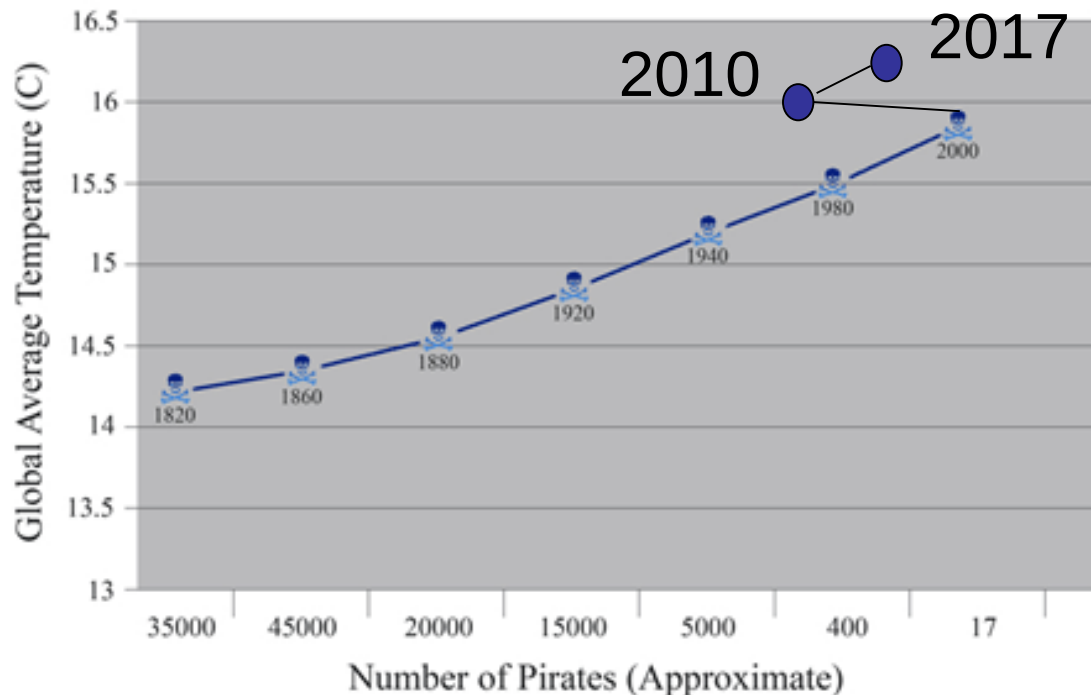
Global Average Temperature Vs. Number of Pirates



Valid Explanation?

“The decrease in pirates anti-correlates with global temperature. Thus, global warming is caused by fewer pirates.”

Global Average Temperature Vs. Number of Pirates



Need to have a physical explanation for correlations to be meaningful