The Case of the Mislabeled Axis

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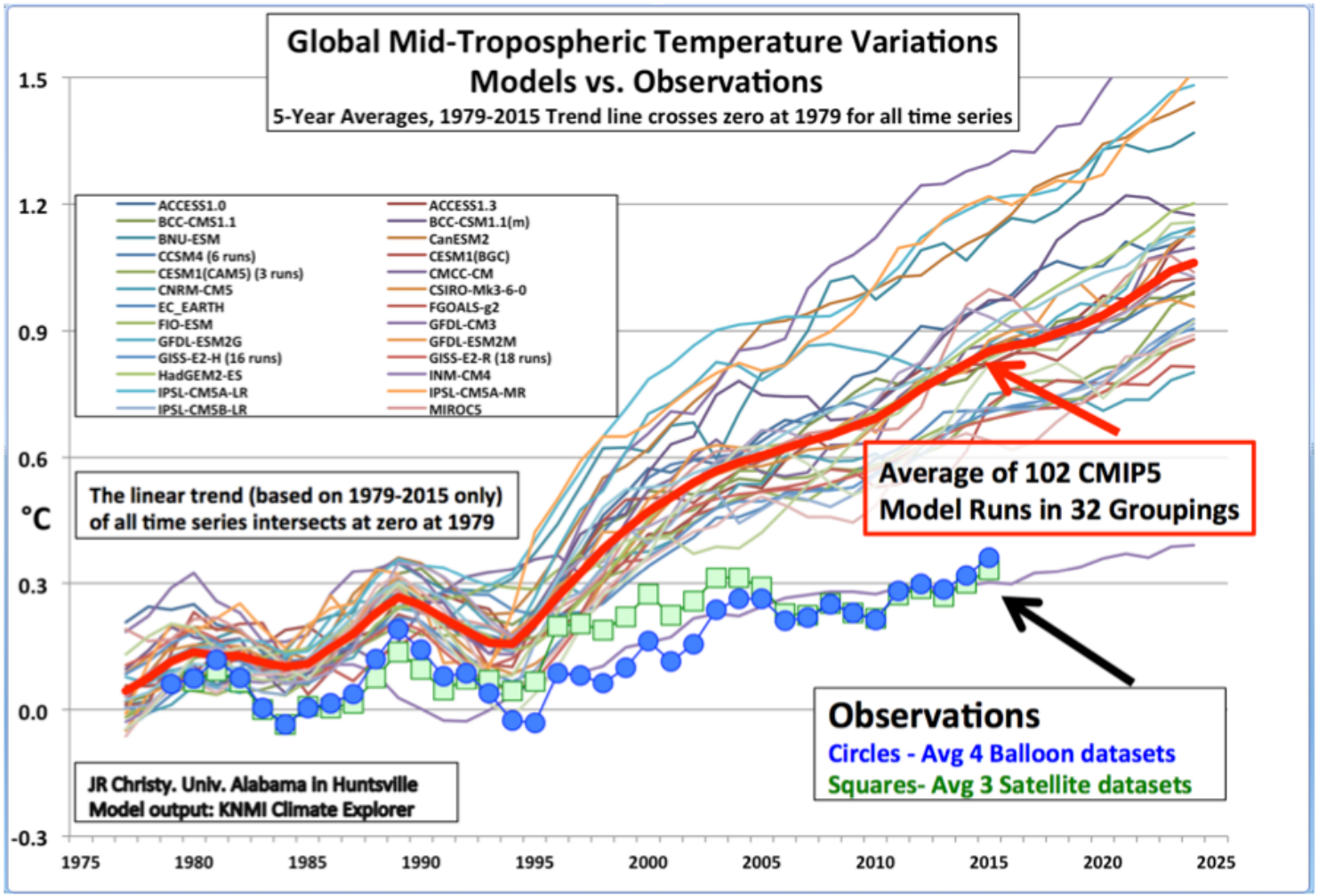
A controversial graph



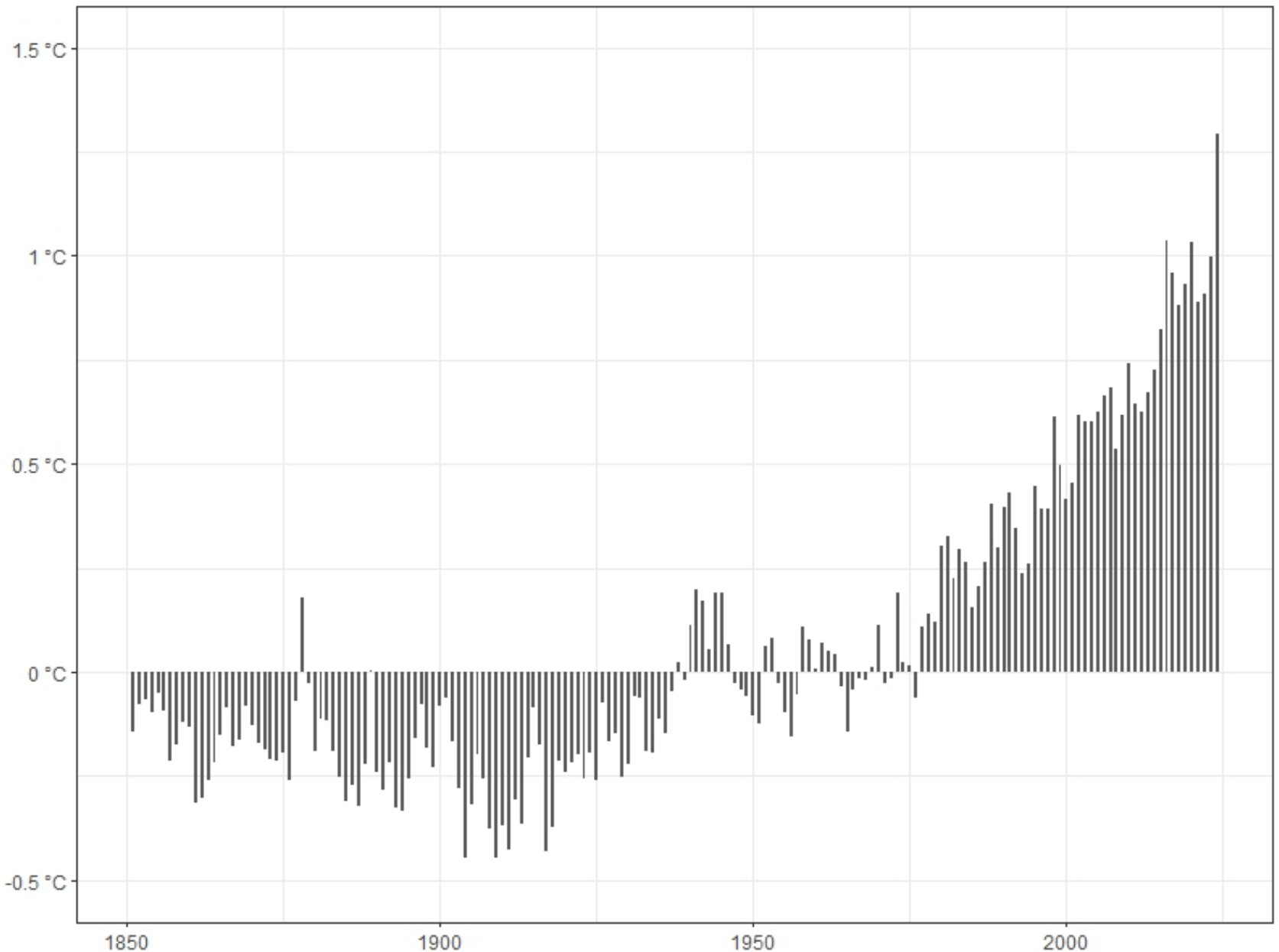
– Christy (2016)

Plan for the talk

1. What makes a graph accurate?
   (What are the *truth conditions* of graphs?)
2. What's wrong with Christy's graph?
   (What's wrong with it *qua graph*?)
3. What can this case teach us about scientific representation?
   (What's the difference between a graph and a model?)

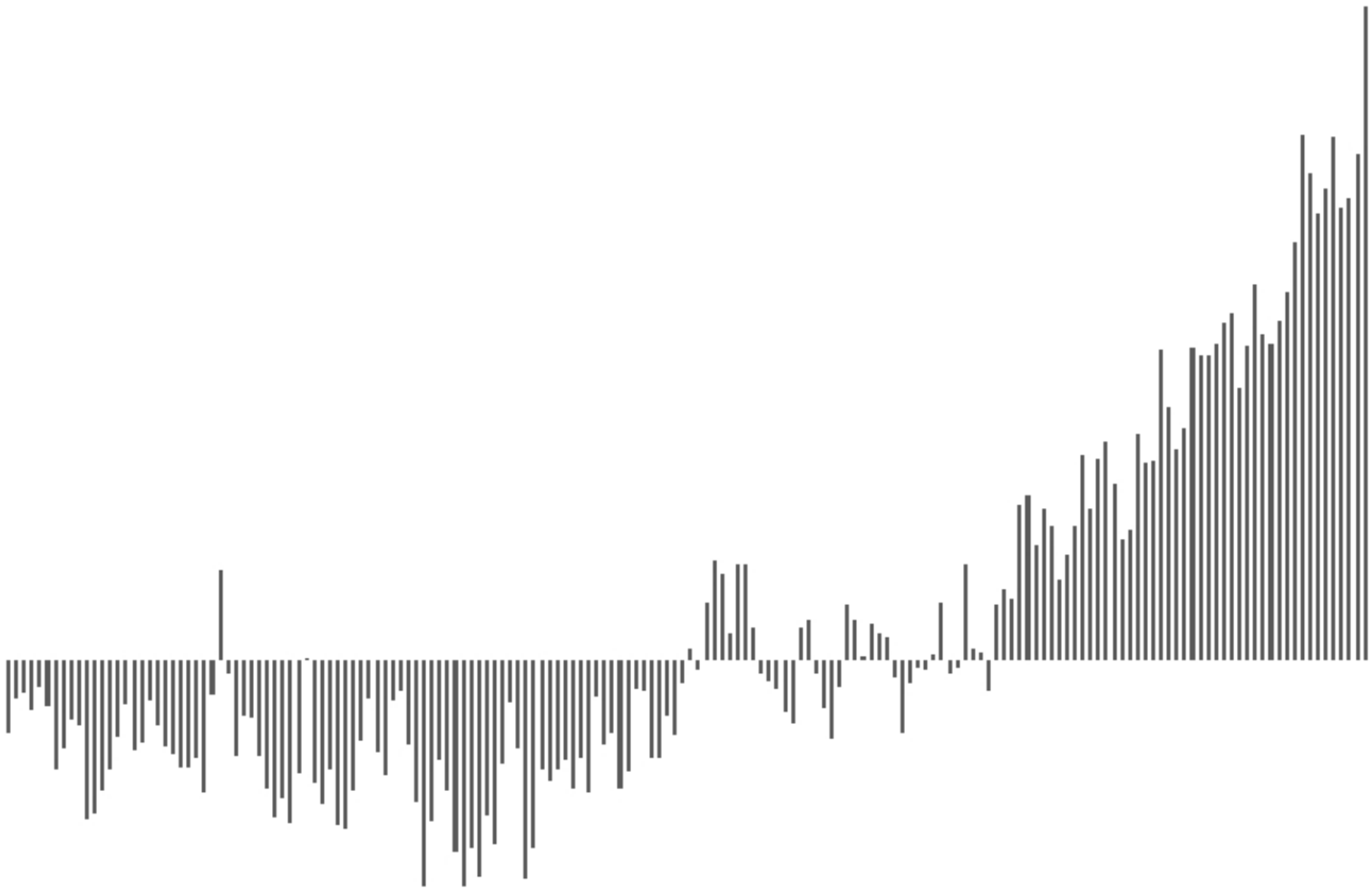
Graphical truth conditions

Mean global temperature relative to 20th century average

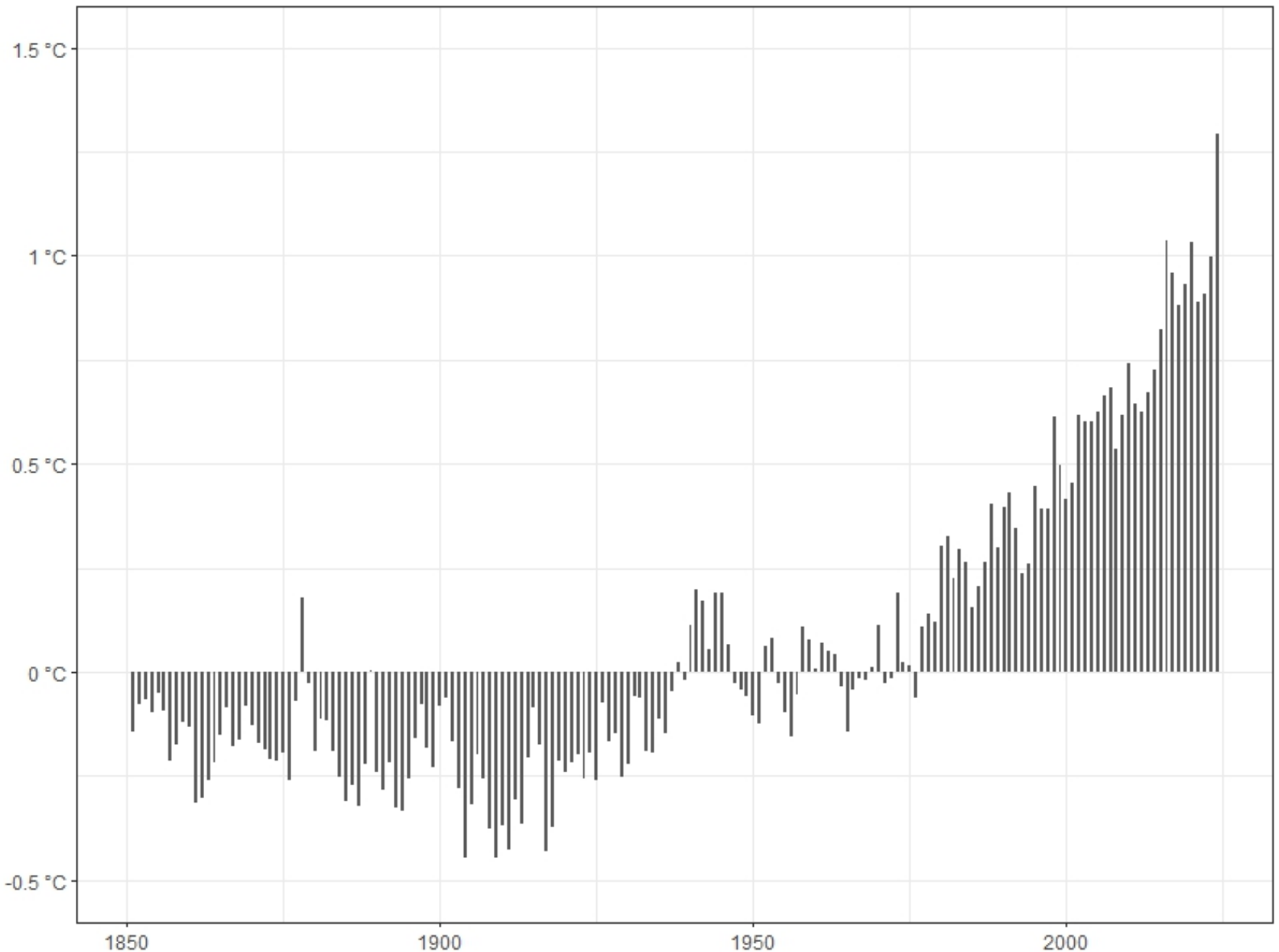


The frame

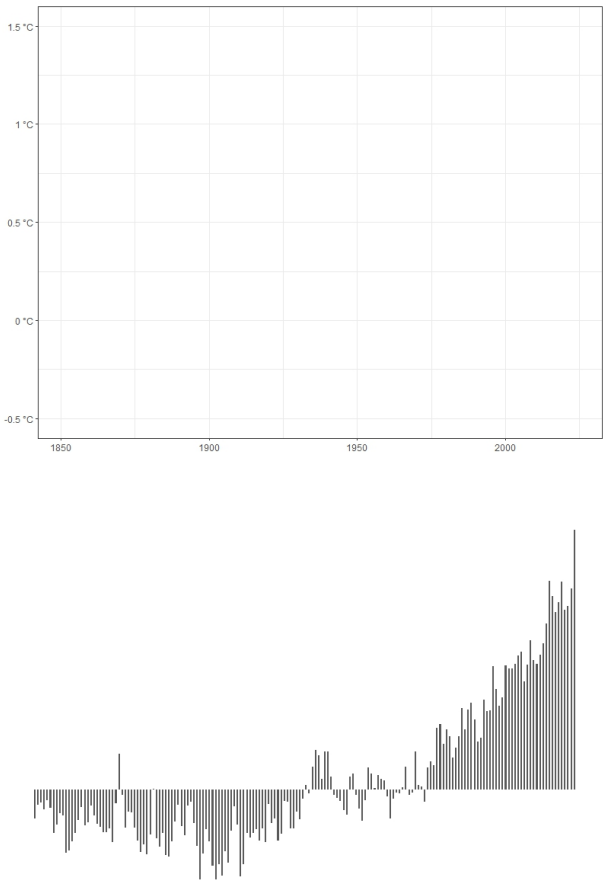
The marks



Mean global temperature relative to 20th century average



How it works



The marks: pick out two objects.

The frame: tells us how those objects are related. (Defines a function from possible marks to {T,F}.)

In short: marks are like nouns, frames are (kinda) like predicates.

Graphical truth conditions (aka graphical content)

A graph is true iff each of its marks is accurately placed.

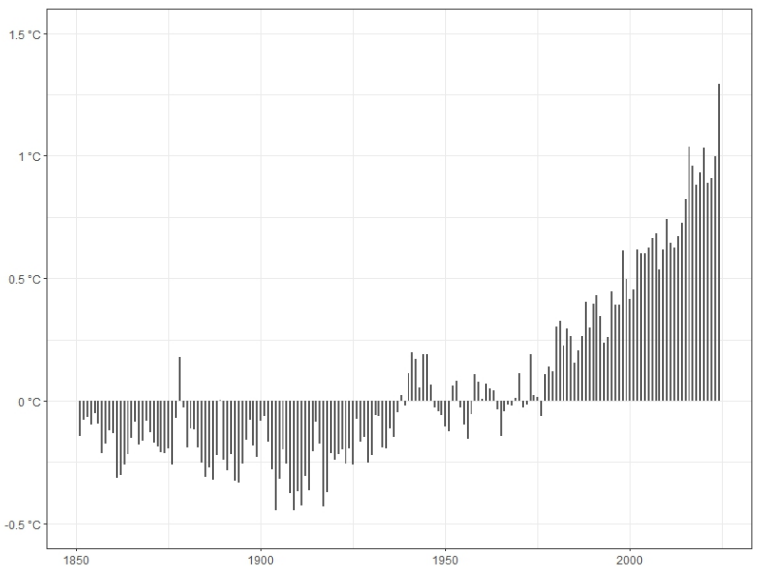
(So far in line with the view you find in Irving (2011), Kulvicki (2010), and Perini (2005); Dethier (2025) raises some worries.)

There are unanswered questions

Does our running example *say* or merely *imply* the following?

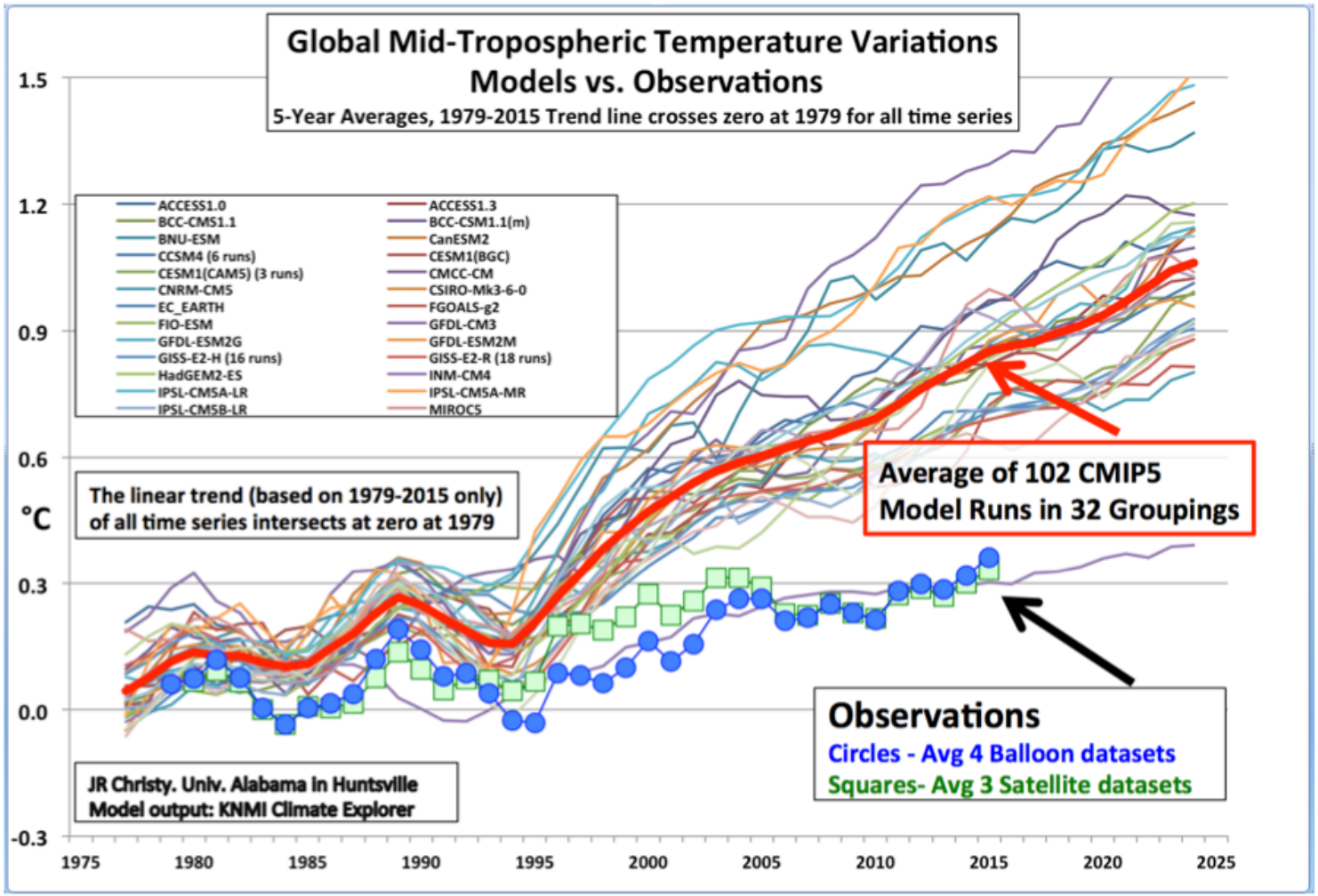
(NEG) In 1979, the mean global temperature was *not* 0.90°C above the 20th century average.

(DIF) The mean global temperature was 1.43°C higher in 2024 than it was in 1851.



What's wrong with Christy's graph

A controversial graph



– Christy (2016)

What's wrong with this graph?

1. The visual distance between the lines is supposed to tell us something about model accuracy, but it doesn't do that.
2. At least one of the axes is mislabeled.

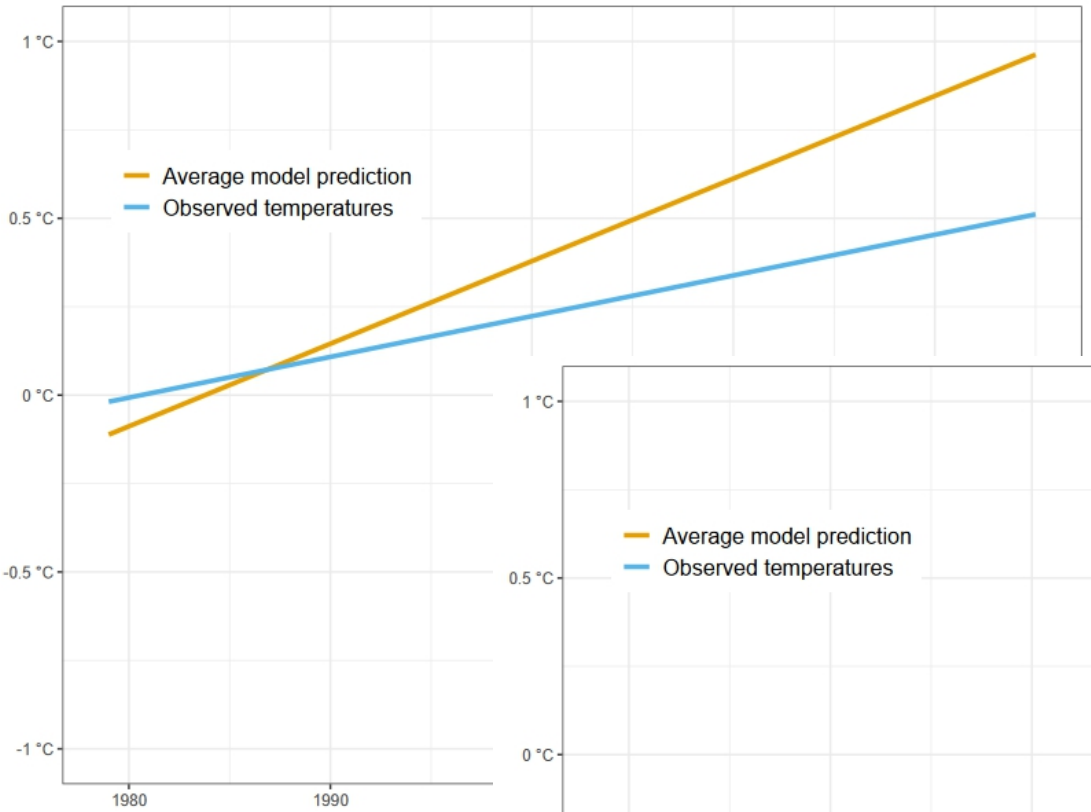
Visual distance 1: model evaluation

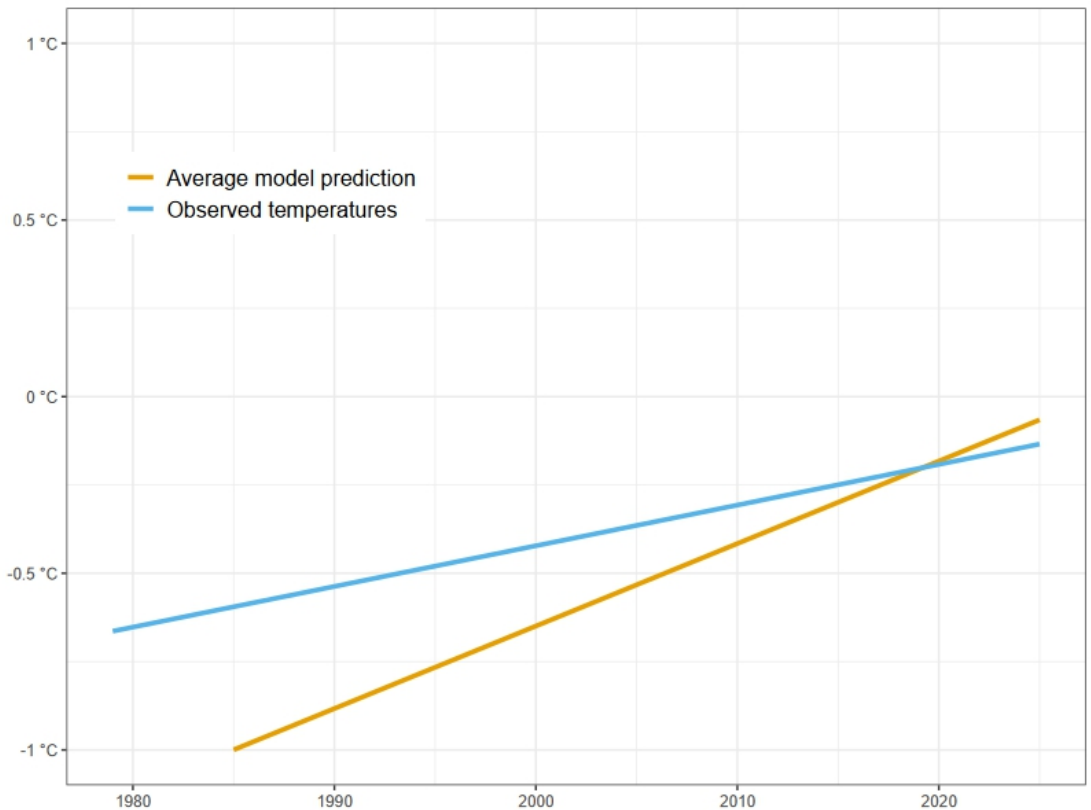
To evaluate models, we first need to set a **baseline**: the state of the model / world that we measure relative to.

A common practice in serious studies is to use the latter half of the 19th century as the baseline.

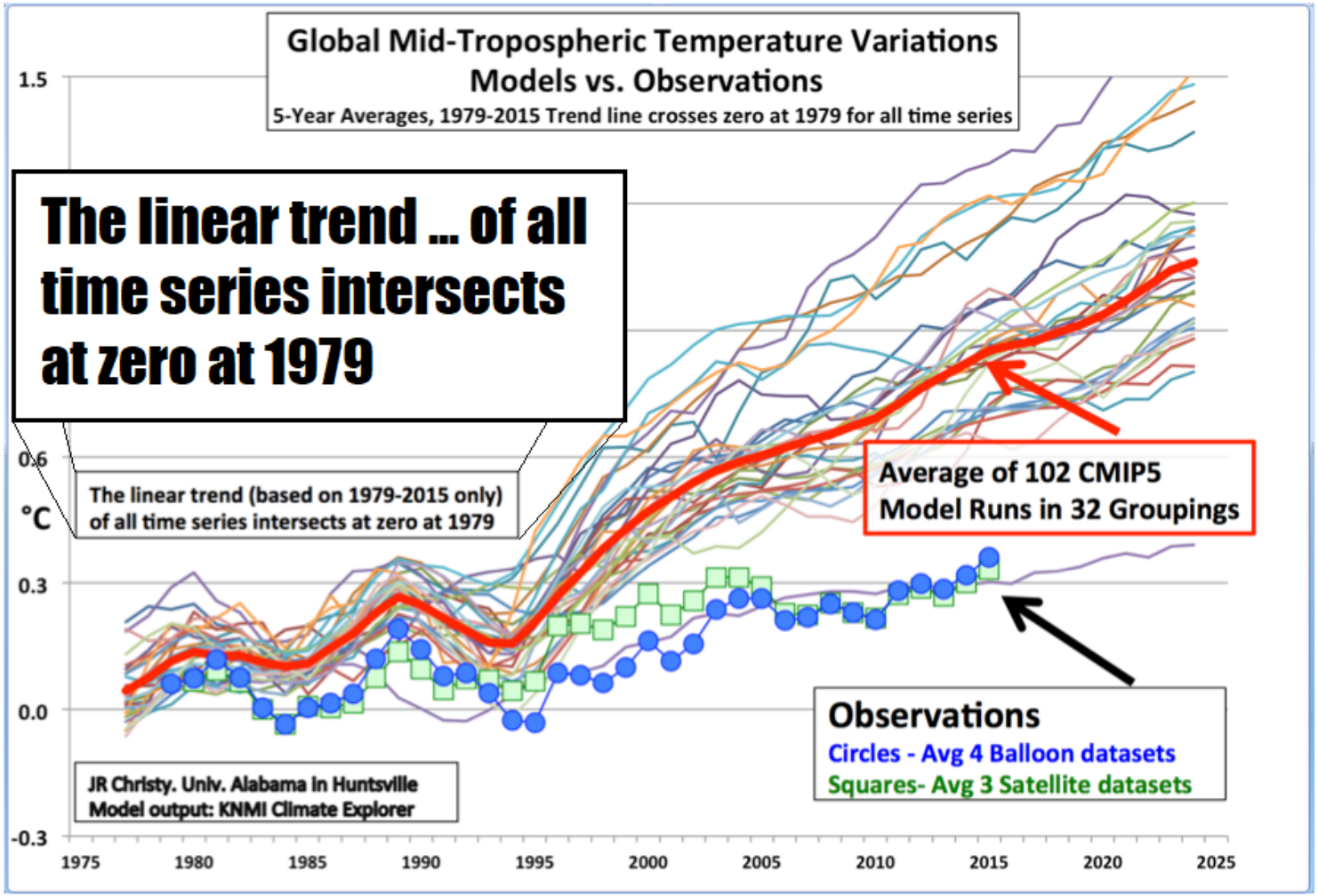
(Schmidt (2016) identifies Christy's choice of baseline as a serious problem; his discussion inspired the present talk.)

Visual distance 2: baseline sensitivity





Mislabeled Axis 1: Christy's graph



Mislabeled Axis 2: Christy's method

1. Find the slope of each line.
2. Shift each line by a (different & arbitrary) value so that it passes through $(1979, 0)$.

Schmidt (2016): "To my knowledge this is a unique technique and I'm not even clear on how one should label the y-axis."

Mislabeled Axis 3: the contrast

Standard

Models and observations are fixed in the same way.

Placing a mark at (1980, .239) means that in the year 1980, there was a .239°C departure from (e.g.) 1979.

Offers one perspective on actual temperature measurements and estimates.

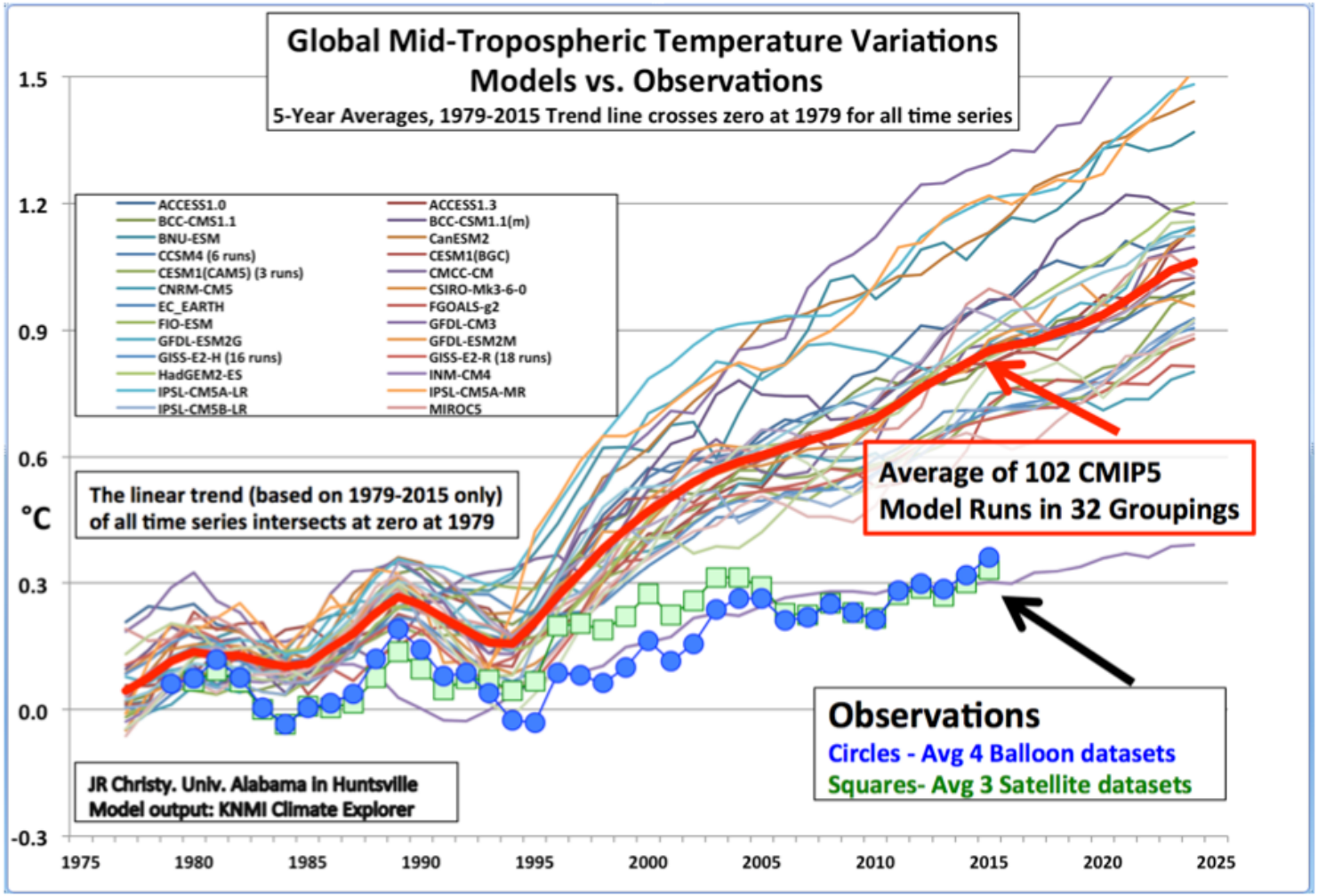
Christy

Models and observations are adjusted in different ways.

Placing a mark at (1980, .239) means that in the year 1980, there was a .239°C departure from an arbitrary constant.

Offers a view of counterfactual temperature measurements and estimates.

Mislabeled Axis 4: the mislabeled axis



Upshot

The first problem doesn't have anything to do with whether the graph is accurate.

Does the second problem? Maybe.

Natural conclusion: what makes a graph a good representation is not the same as what makes it accurate.

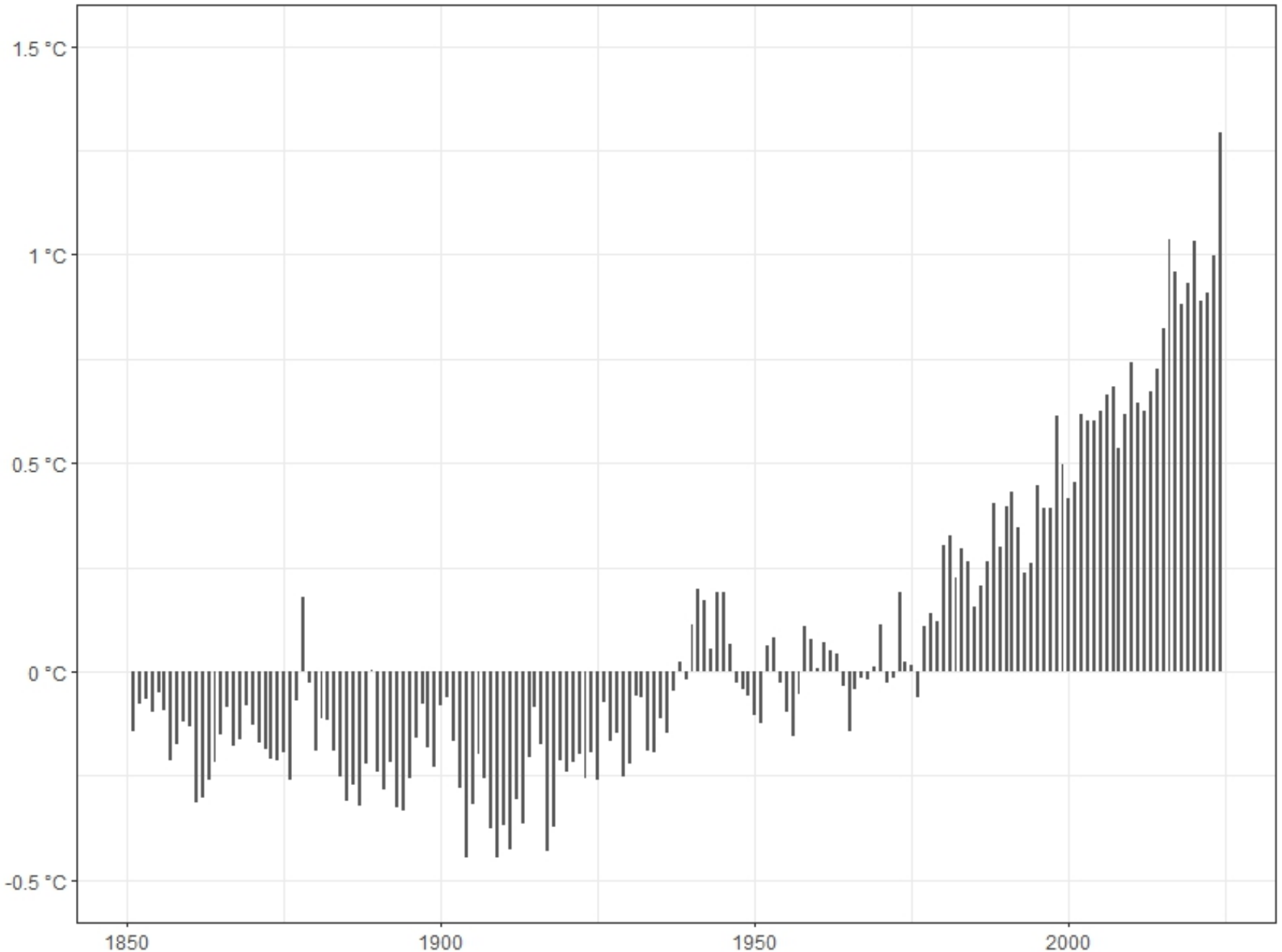
Graphs and scientific representation

Not surprising

Widely agreed that the conditions that make models useful are not the same as those that make them accurate (e.g., Parker 2020).

Reasonable to expect that the same is true for graphs.

Mean global temperature relative to 20th century average



More specifically

The information that we get out of a graph is not equivalent to, and indeed only loosely related to, its content.

Major questions relating to good graphs are empirical: what kinds of graphs are *we* good at interpreting? (cf. Irving 2011)

Graphs as models

Appropriate to think of graphs as a kind of model – one whose adequacy conditions depends on the nature of our visual processing systems.

Or, at least: graphs are more like models than they are like photos, paintings, sketches, etc.

Conclusion

What we've done

1. What makes a graph accurate?
   Accurate placement of each "mark."
2. What's wrong with Christy's graph?
   Visual distance is bad evidence and the axes are mislabeled.
3. What can this case teach us about scientific representation?
   Graphs are more like models than like pictures.

Christy, John R. (2016). Testimony of John R. Christy. *U.S. House Committee on Science, Space & Technology*: 1–23.

Dethier, Corey (2025). How do you Assert a Graph? Towards an account of depictions in scientific testimony. *Noûs* 59.3: 678–99. DOI: 10.1111/nous.12529.

Irving, Zachary C. (2011). Style, but Substance: An Epistemology of Visual versus Numerical Representation in Scientific Practice. *Philosophy of Science* 78.5: 774–87. DOI: 10.1086/662567.

Kulvicki, John (2010). Knowing with Images: Medium and Message. *Philosophy of Science* 77.2: 295–313. DOI: 10.1086/651321.

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Perini, Laura (2005). The Truth in Pictures. *Philosophy of Science* 72.1: 262–85. DOI: 10.1086/426852.

Schmidt, Gavin A. (2016). *Comparing Models to the Satellite Datasets*. URL: https://www.realclimate.org/index.php/archives/2016/05/comparing-models-to-the-satellite-datasets/ (visited on 04/02/2023).