

Learning from evidence in the context of global climate change

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Science literacy involves *learning from evidence*

- Analyzing and interpreting data
- Constructing explanations
- Engaging in argument from evidence

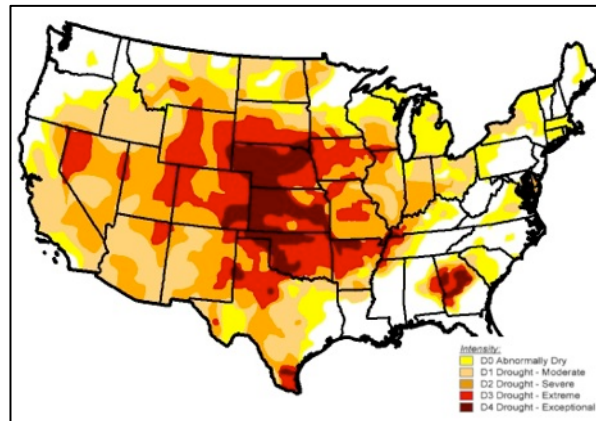
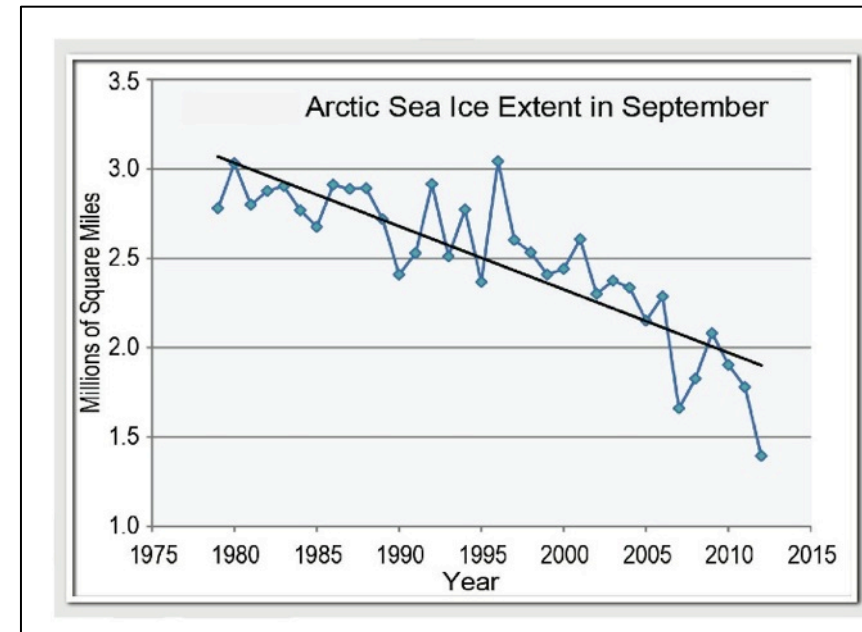
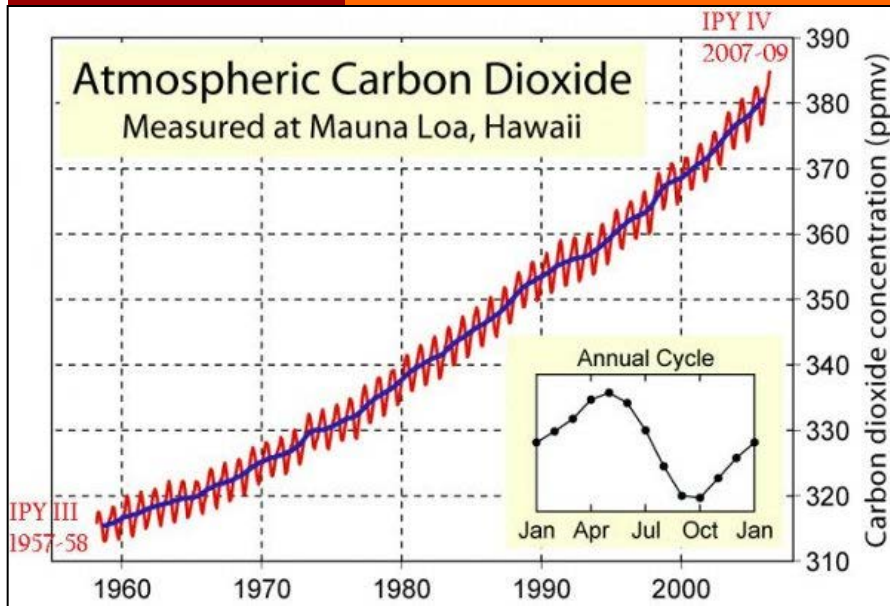


In context of global climate change (GCC)?

Evidence is situated in complex interdisciplinary models of earth systems



What does it mean to understand evidence about global climate change (GCC)?

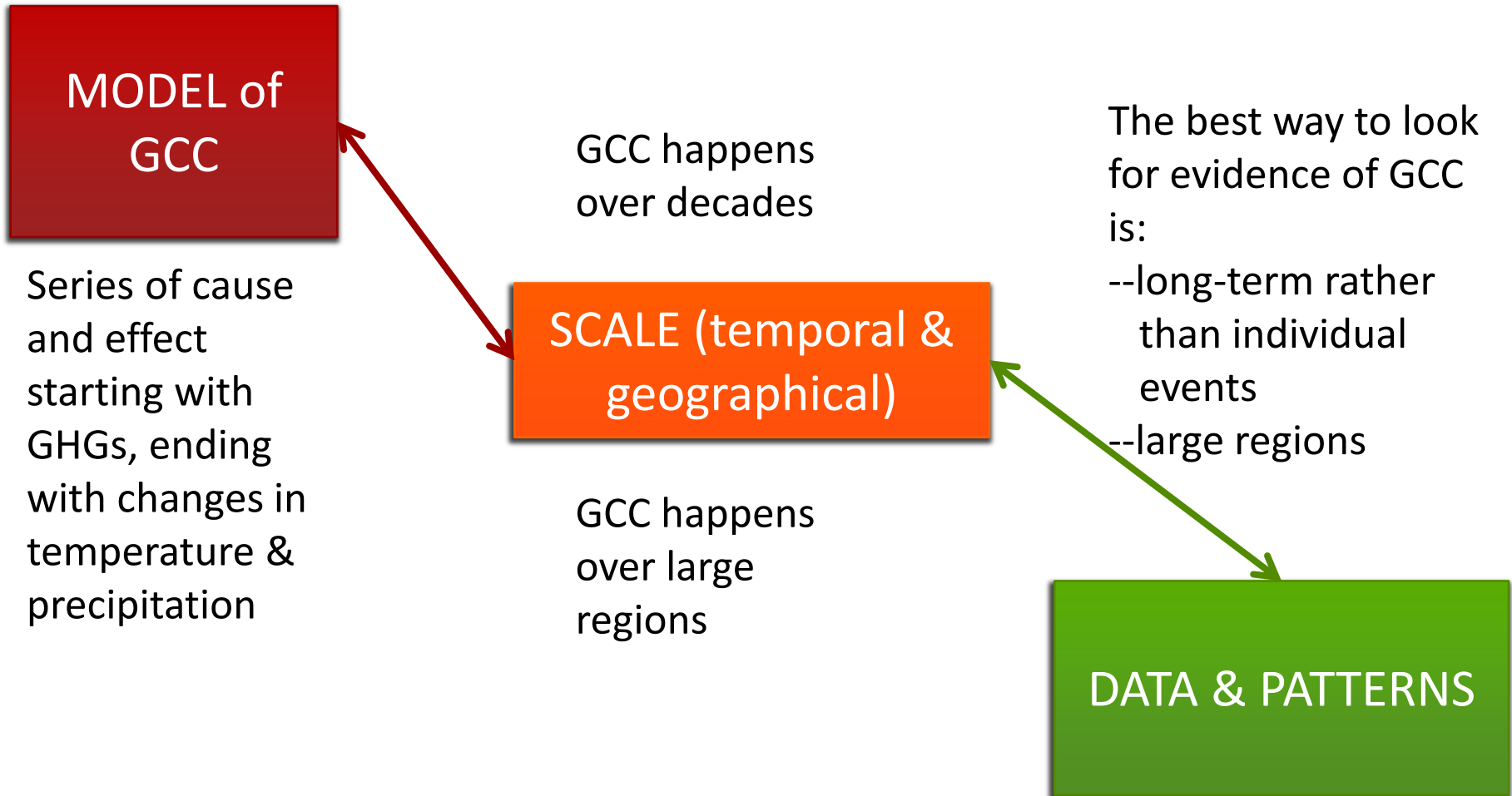


Qualitative research methods

Preliminary interviews and analysis

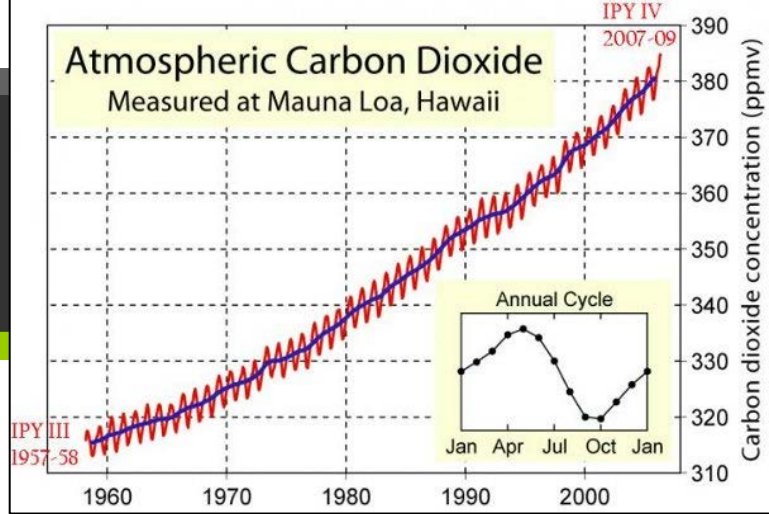
- 30 middle and high school students in science classes in rural Michigan, no common instruction
- Coding using grounded theory with a team at MSU

How do students think about GCC compared to scientists?



What do you think is the cause of the increasing CO₂?

Problems with GCC MODEL



SARAH: Industries are responsible for pollution

PETER: Maybe if the CO₂ is from a volcano that maybe the volcano will keep doing that until maybe it erupts.

SHAYLEE: The atmosphere is kind of like breaking down and so the carbon dioxide can get in more.



Global Circulation of Gases

Do you think we could use these data to estimate CO₂ concentrations in Michigan during this period?

Across 28 interviews:

No (39%) because:

“atmospheres of HI and MI are **not** connected”

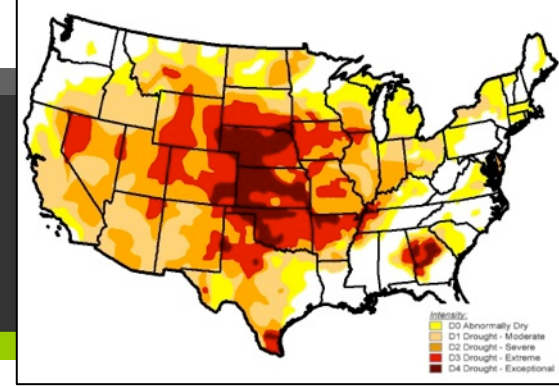
“HI and MI are different”

Yes (32%) because:

“atmospheres of HI and MI are connected”

“HI and MI are alike”

Do you think that drought in the Great Plains in 2012 is related to the theory of global climate change?



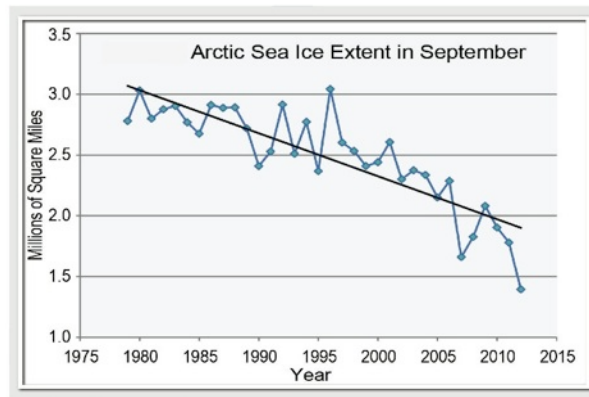
Problems with GCC MODEL and SCALE

TESSA: Because it experienced an abnormal drought that year and it hadn't done that before. So climate change could have something to do with that.

HARRISON: Like all the farming and stuff that goes on in this region... the soil isn't as good and it can't retain the moisture and it hasn't been as much rain I'm guessing.

PAT: since it was so big and huge event, global warming had something to do with it. I'm just not sure how.

What do you think could be the cause of this pattern?



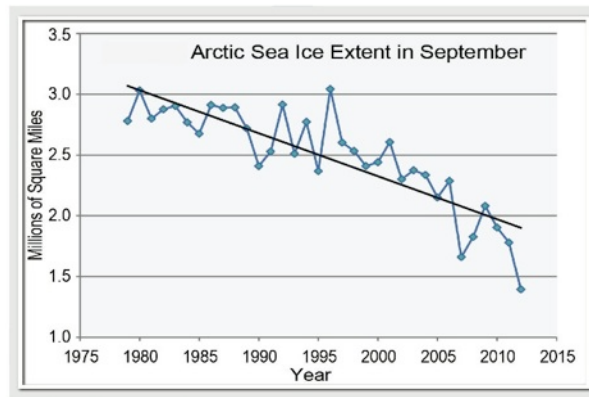
Problems with SCALE

AMBER: Probably the weather, so then the weather changed every year. So then it would either be a warmer winter or a colder winter to cause the ice to melt or grow.

So why do you think the satellites got such different readings in back to back years?

DAVID: How much pollution was in the air that year.

Do you see a pattern in these data?



Problems with DATA and PATTERNS

SHAYLEE: Yep. It starts out low then it goes up a lot then it goes down and then it goes up a little then goes down and then goes up, kind of evens out then dramatically goes down and goes up a lot – or it goes up a little and then it goes up a lot and then kind of goes back down, then up and then down, then up and then down.

PAT: Not really. They all clump together.

Draft Learning Progression Framework

	MODEL
Level 4	<p>Student can link:</p> <ul style="list-style-type: none">- increasing CO₂ to combustion of fossil fuels.- Increasing CO₂ to buildup of thermal energy and increasing temperature.- the cause of melting Arctic Sea Ice to increasing greenhouse gases.
Level 3	<p>Confused or conflated mechanisms. Can state an unseen mechanism, a series of cause/effect, but with mistakes Confused directionality of overall changes.</p>
Level 2	<p>GCC is a vague phenomenon with a single cause and effect</p>



Draft Learning Progression Framework

	SCALE (temporal and geographical)
Level 4	<p>Student sees GCC as:</p> <ul style="list-style-type: none">- primarily long-term and large-region changes- unusual phenomena (but longer-term than a single extreme event). <p>Sees atmosphere as having:</p> <ul style="list-style-type: none">- Well mixed global signals (as well as local signals)
Level 3	<p>Inconsistencies or mismatches in temporal and geographical scale.</p> <p>Doesn't see how Keeling Curve or Arctic Ice could represent global phenomena.</p>
Level 2	<p>Sees GCC as only extreme events (single time point, single geographical point).</p>



Draft Learning Progression Framework

	DATA & PATTERNS
Level 4	<p>The best indicators of GCC are:</p> <ul style="list-style-type: none">- trends over decades (of CO₂, of temp, of precipitation and of ice) rather than inter-annual variability.- global signals of CO₂ (rather than local signals) and large bodies that hold thermal energy and change more slowly.
Level 3	<p>Focuses on up-down pattern (variability) or “outliers” rather than overall trend over decades.</p>
Level 2	<p>Has difficulty interpreting the graph.</p>

In conclusion

- In addition to the challenges of interpreting data with models (previous paper), the geographical and temporal scale of GCC poses additional challenges
 - Interpreting representations of large-scale, long-term data
 - Separating data from noise
 - Connecting causal models of climate change with patterns in data

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