



CLIMATE AS A SYSTEM

Thinking and teaching climate systems

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CONTENTS

1. Properties of systems & concepts for systemic thinking
2. "Simple" climate model
3. Education
4. Summary



WHAT WE TEACH VS WHAT IS

We like to teach

- facts
- terminology
- simple, clear cases
- rules

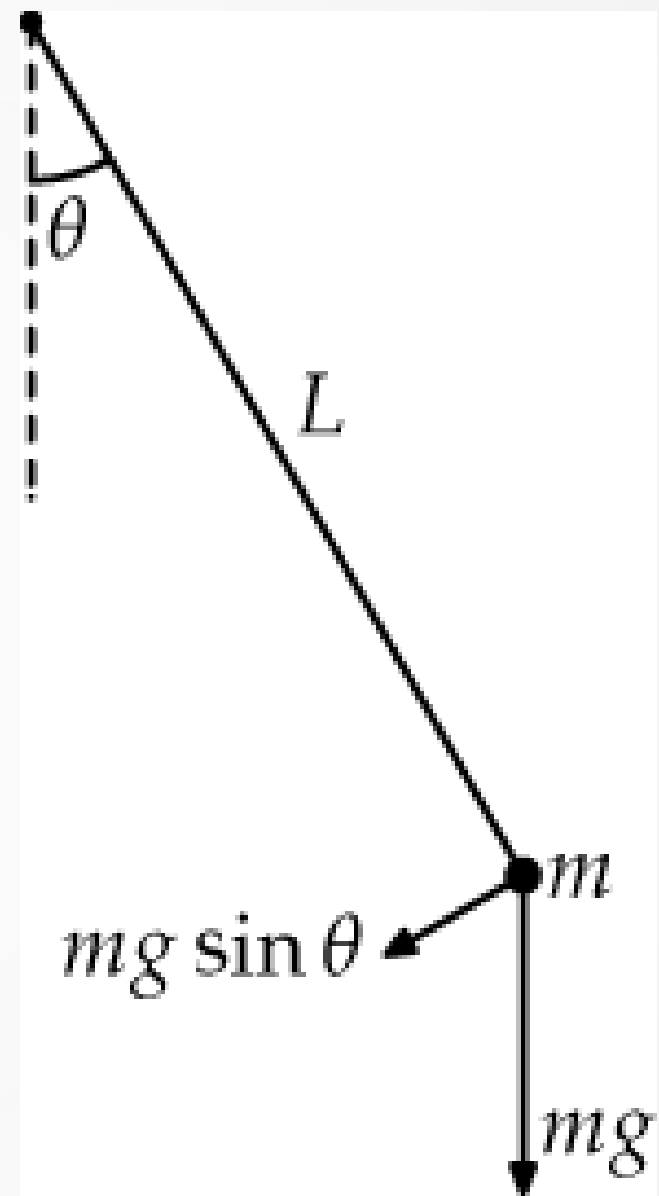
What exists in the world

- ways of understanding
- ways of talking about ideas
- complicated cases
- patterns, exceptions



PENDULUM

$$T = 2\pi \sqrt{\frac{L}{g}}$$





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[https://commons.wikimedia.org/wiki/File:Double_pendule_\(simulation_Algodoo%C2%A9\).gif](https://commons.wikimedia.org/wiki/File:Double_pendule_(simulation_Algodoo%C2%A9).gif)



PROPERTIES OF SYSTEMS

- Internal interactions -> Complexity
- Chaos (unpredictability)
- Can me modeled, but never perfectly

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PROPERTIES OF SYSTEMS

- Internal interactions -> Complexity
- Chaos (unpredictability)
- Can be modeled, but never perfectly

- **Example: health – hard to predict, but not useless to predict!**
 - "Smoking is bad for you"

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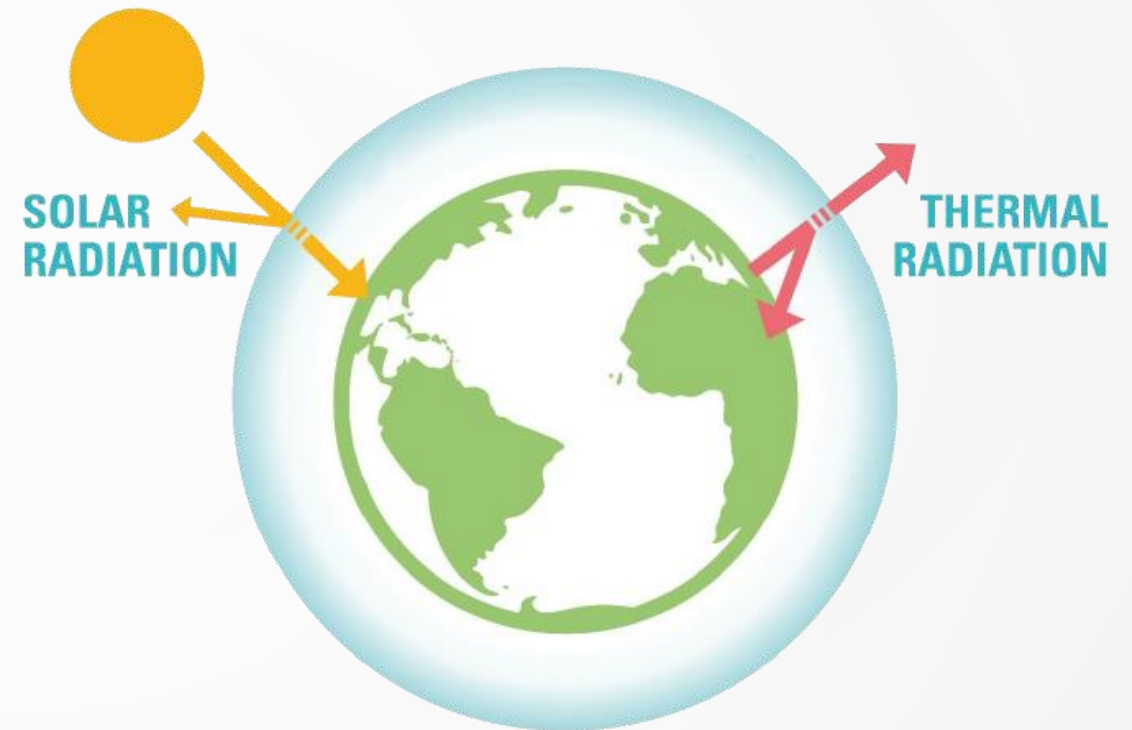


QUESTIONS

- How can teachers promote understanding of complicated ideas?
- How does students' age affect what they can learn?
- Is it a bad idea to teach our students that to some questions there are no answers?
- **Example: "what will the world look like in 2050?"**

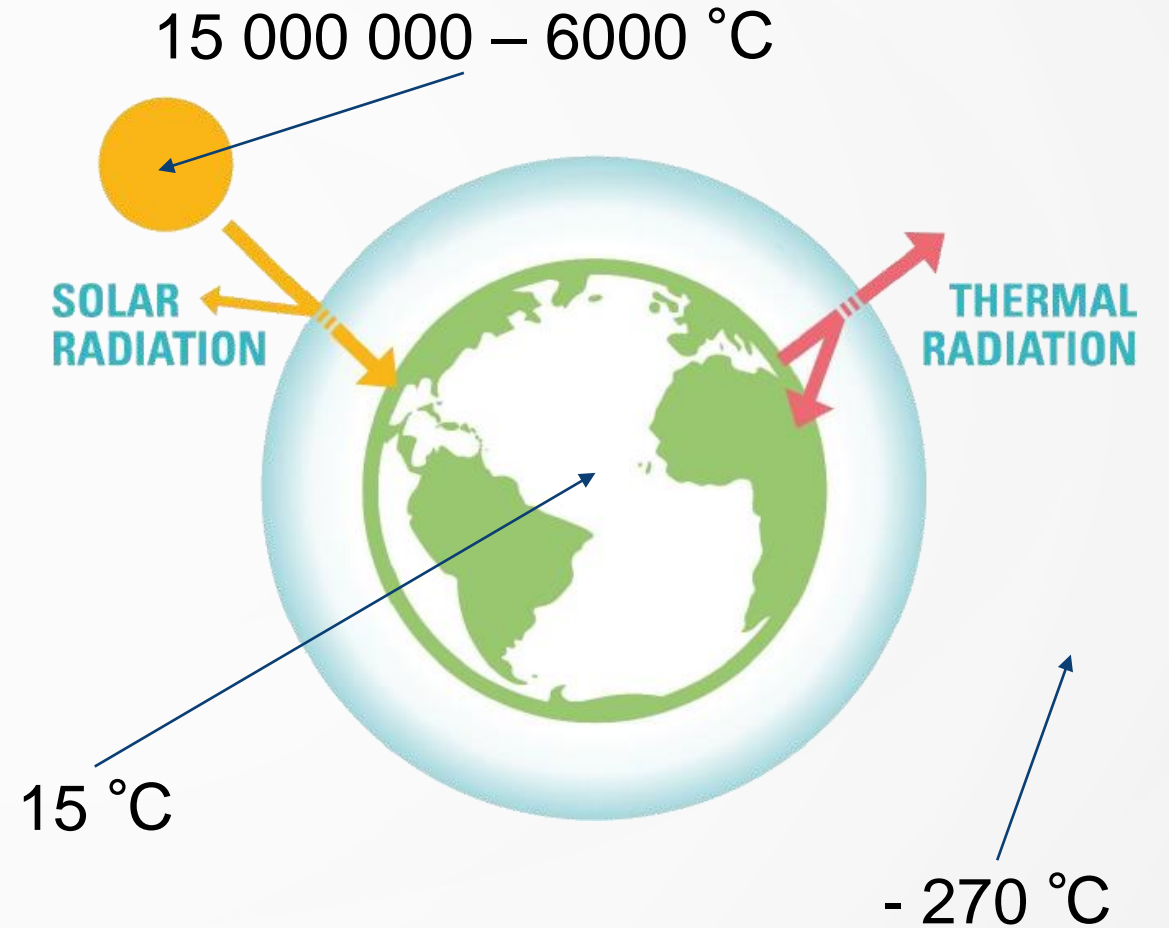


EARTH'S CLIMATE IS A SYSTEM



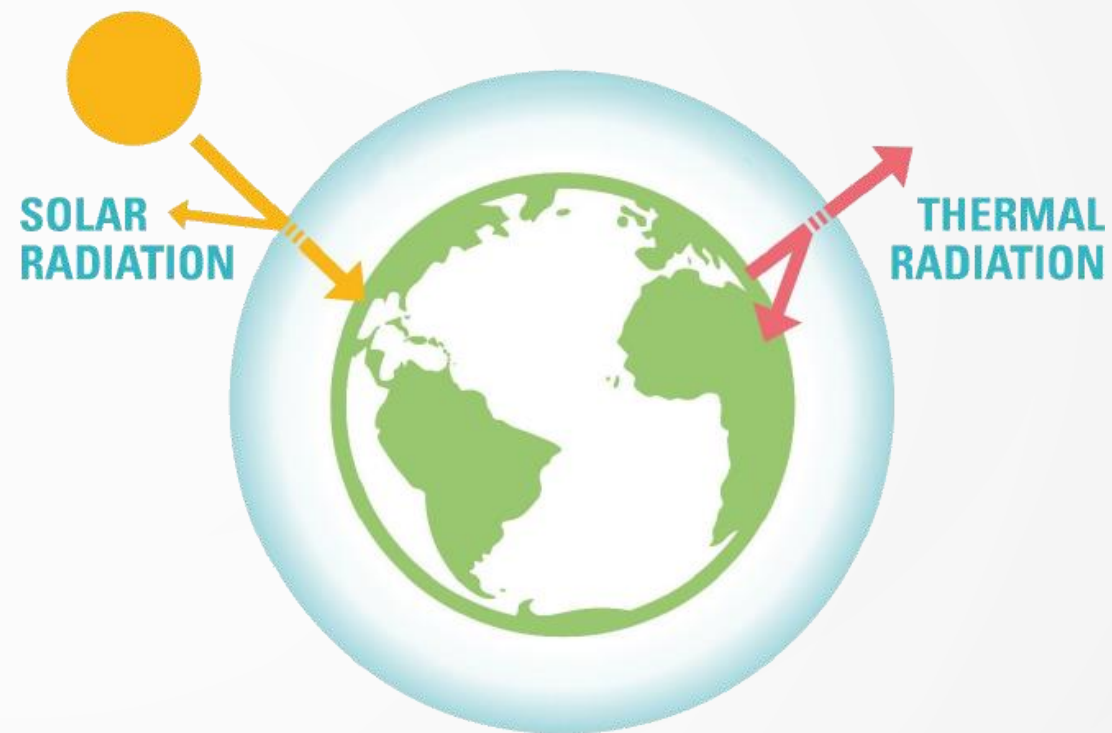


EARTH'S CLIMATE IS A SYSTEM





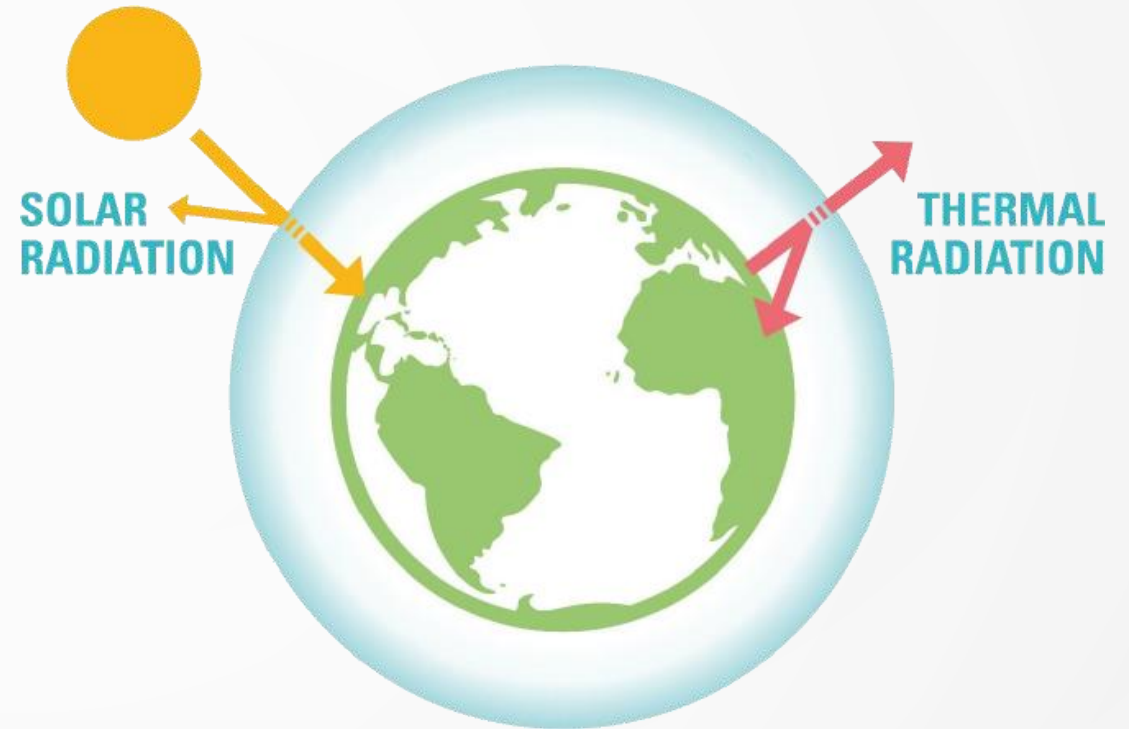
EARTH'S CLIMATE IS A SYSTEM





"SIMPLE" CLIMATE MODEL

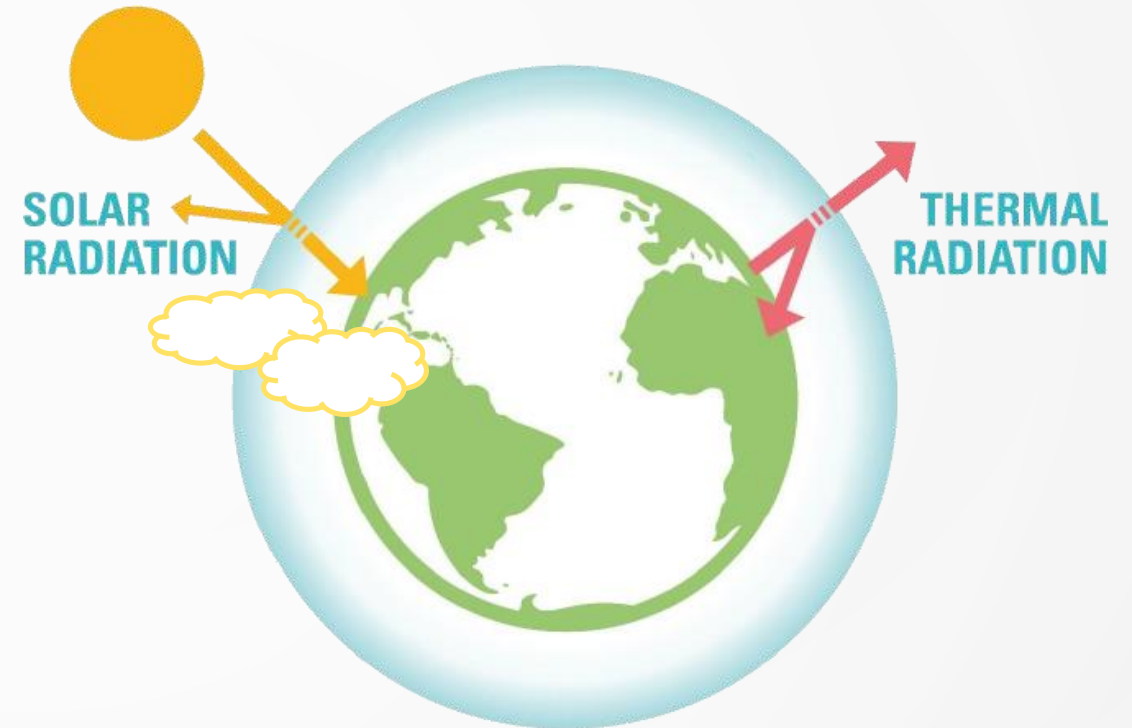
Energy flowing in
Energy flowing out





"SIMPLE" CLIMATE MODEL

Energy flowing in
Energy flowing out

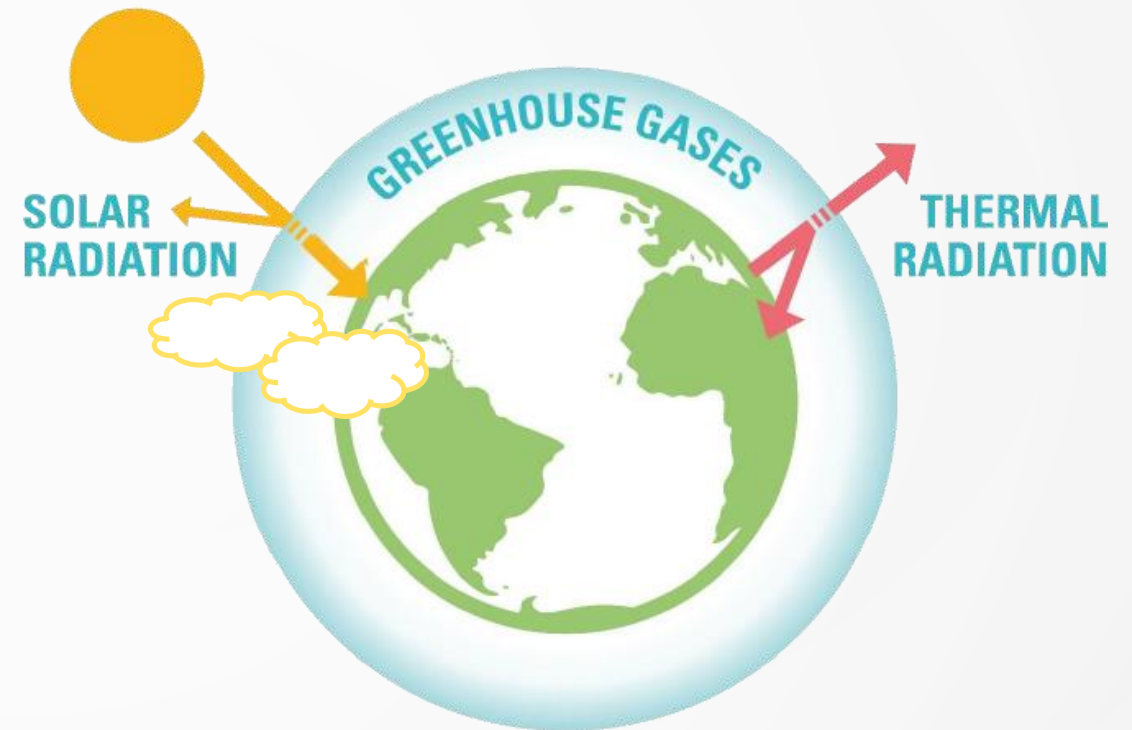




"SIMPLE" CLIMATE MODEL

Energy flowing in

Energy flowing out

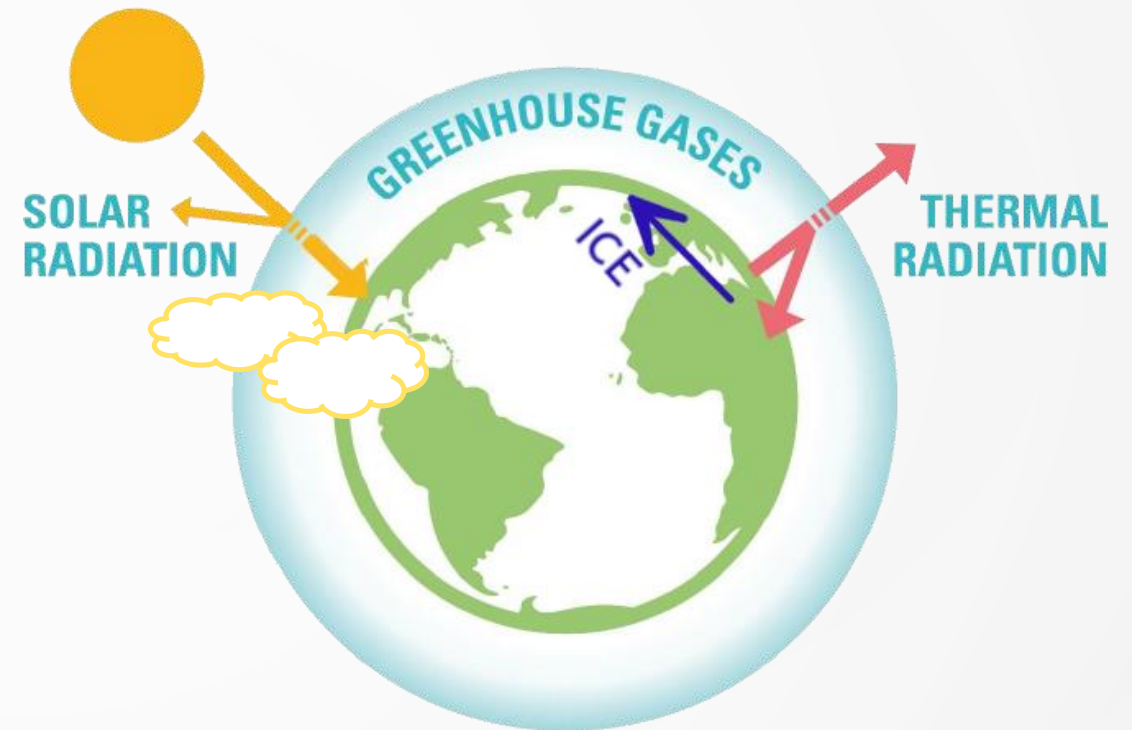




"SIMPLE" CLIMATE MODEL

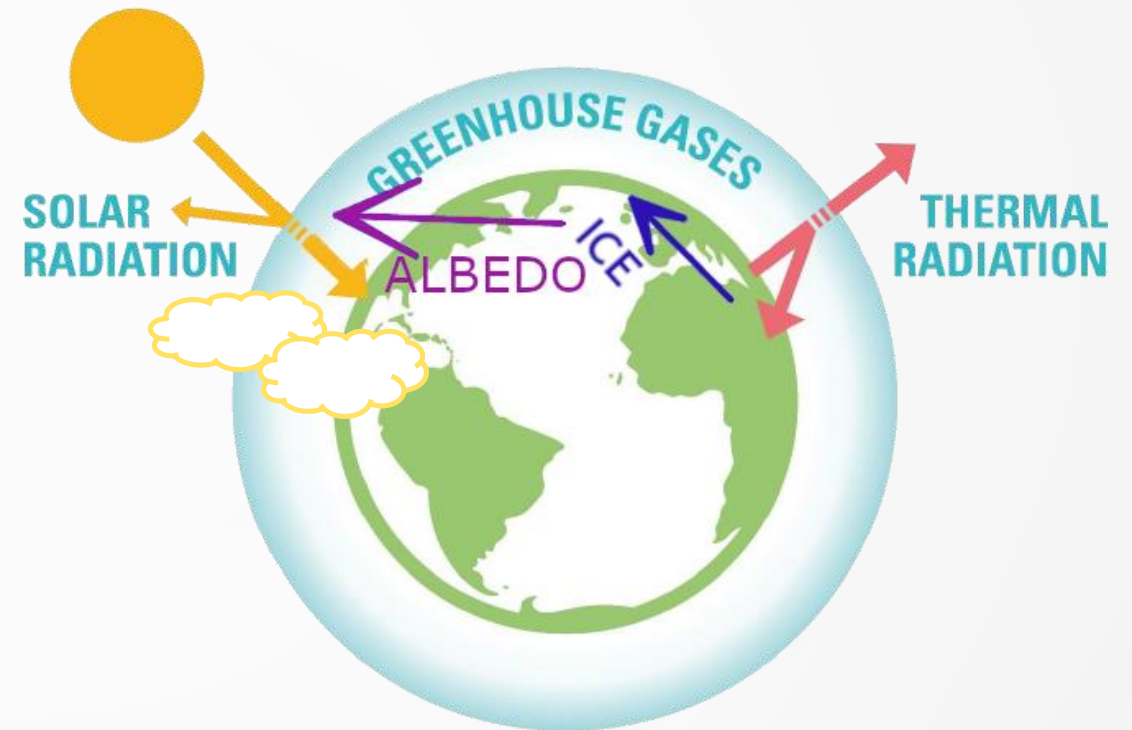
Energy flowing in

Energy flowing out





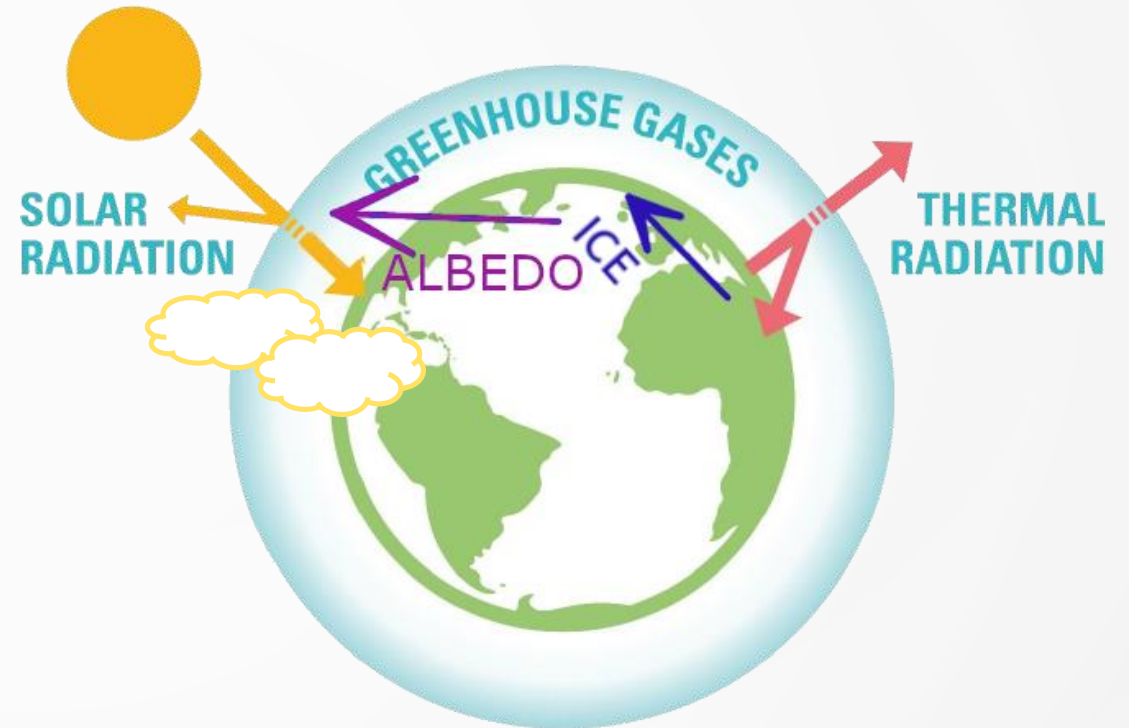
"SIMPLE" CLIMATE MODEL

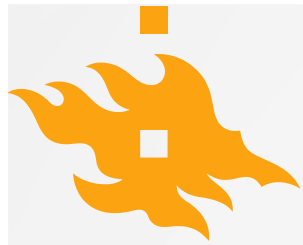




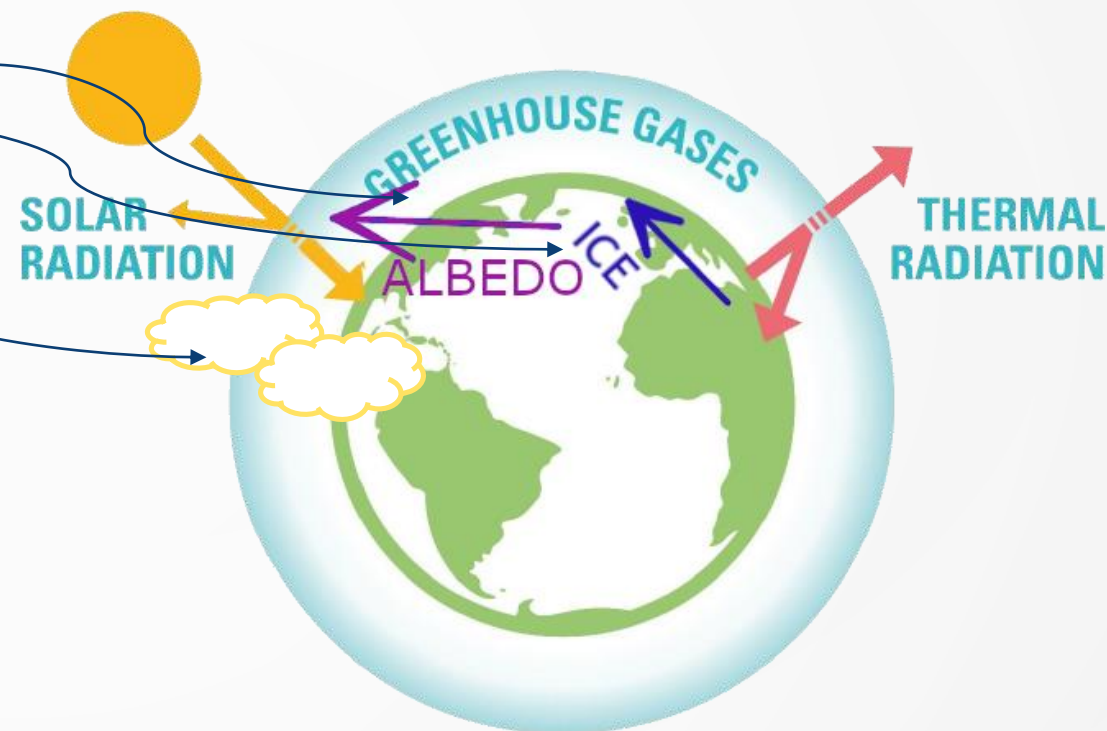
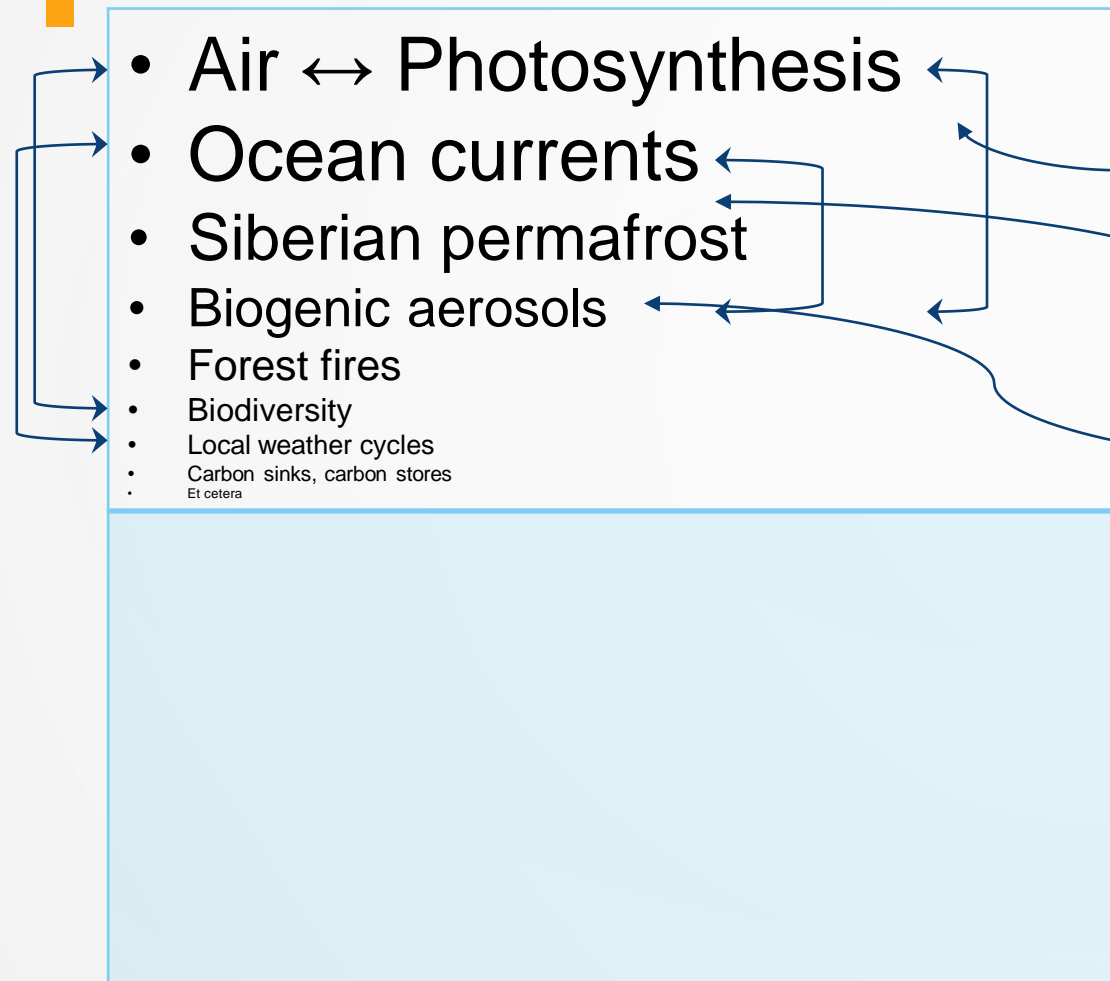
"SIMPLE" CLIMATE MODEL

- Air ↔ Photosynthesis
- Ocean currents
- Siberian permafrost
- Biogenic aerosols
- Forest fires
- Biodiversity
- Local weather cycles
- Carbon sinks, carbon stores
- Et cetera





"SIMPLE" CLIMATE MODEL



A. Understanding Global Warming of 1.5°C⁴

A.1 Human activities are estimated to have caused approximately 1.0°C of global warming⁵ above pre-industrial levels, with a *likely* range of 0.8°C to 1.2°C. Global warming is *likely* to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. (*high confidence*) (Figure SPM.1) {1.2}

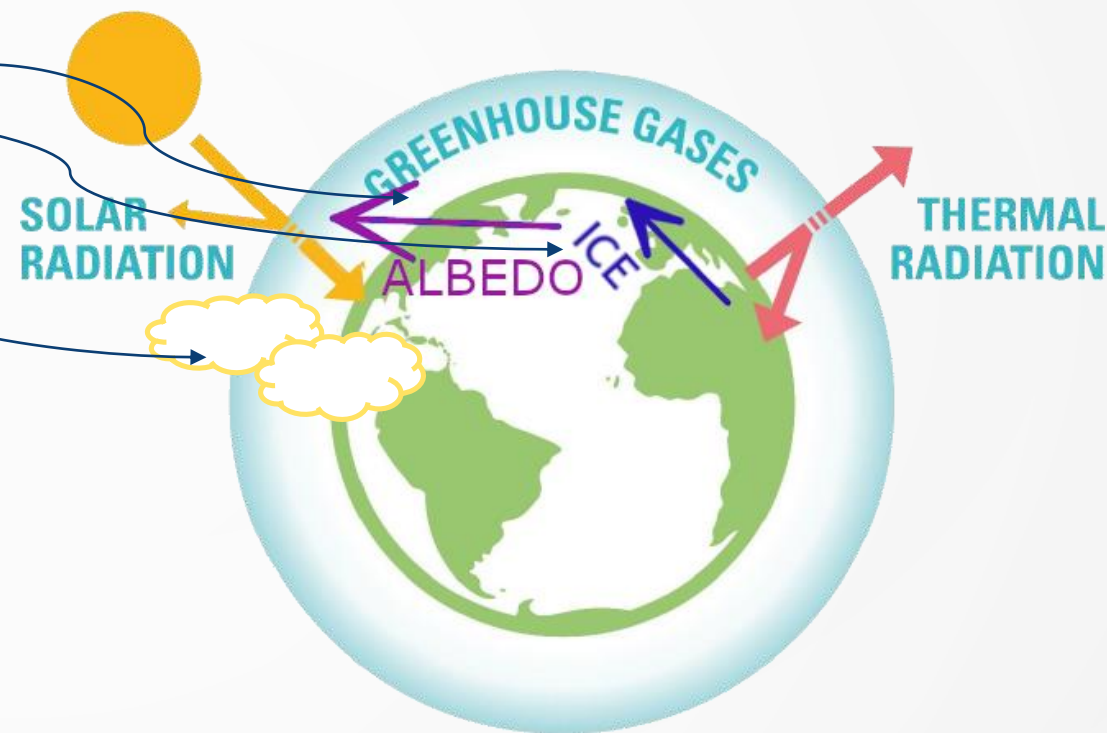
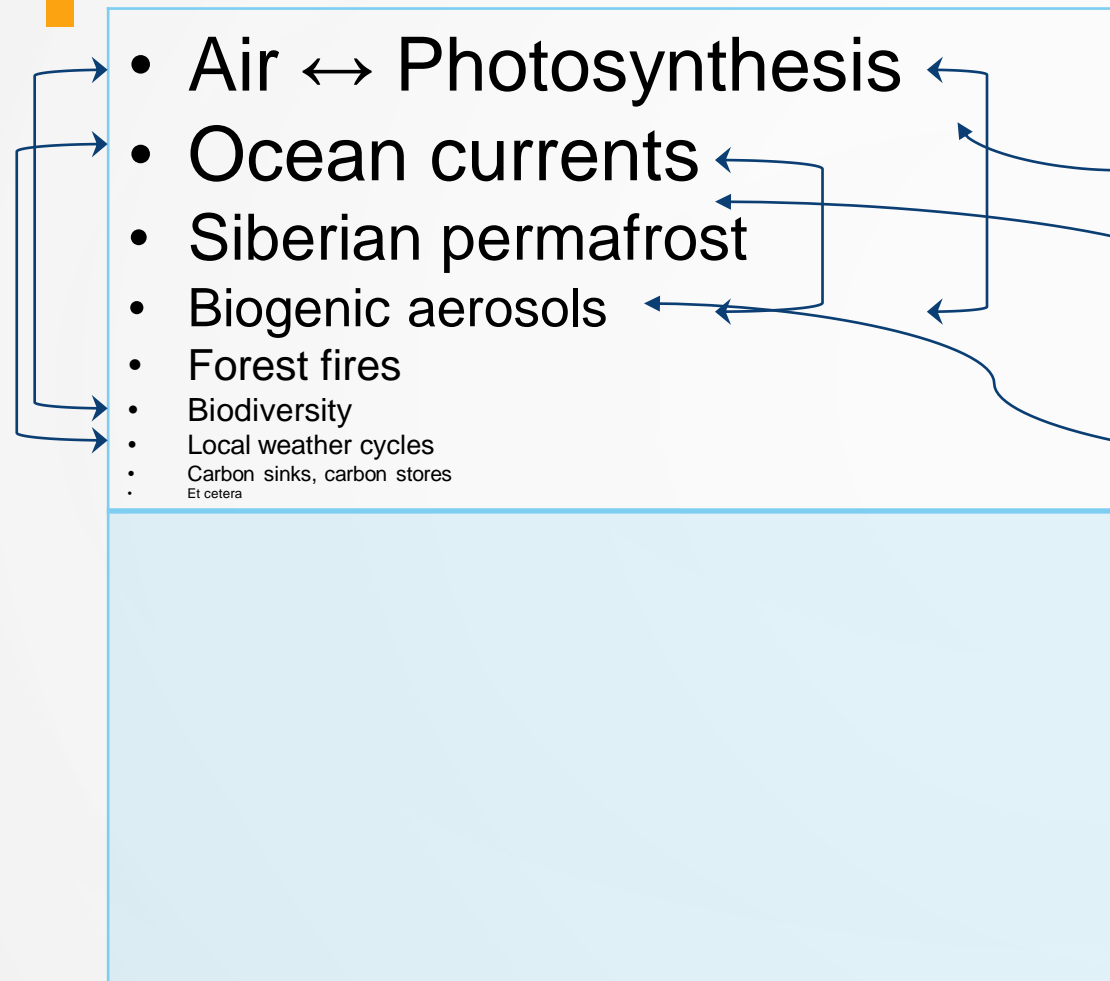
A.1.1 Reflecting the long-term warming trend since pre-industrial times, observed global mean surface temperature (GMST) for the decade 2006–2015 was 0.87°C (*likely* between 0.75°C and 0.99°C)⁶ higher than the average over the 1850–1900 period (*very high confidence*). Estimated anthropogenic global warming matches the level of observed warming to within ±20% (*likely range*). Estimated anthropogenic global warming is currently increasing at 0.2°C (*likely* between 0.1°C and 0.3°C) per decade due to past and ongoing emissions (*high confidence*). {1.2.1, Table 1.1, 1.2.4}

A.1.2 Warming greater than the global annual average is being experienced in many land regions and seasons, including two to three times higher in the Arctic. Warming is generally higher over land than over the ocean. (*high confidence*) {1.2.1, 1.2.2, Figure 1.1, Figure 1.3, 3.3.1, 3.3.2}

A.1.3 Trends in intensity and frequency of some climate and weather extremes have been detected over time spans during which about 0.5°C of global warming occurred (*medium confidence*). This assessment is based on several lines of evidence, including attribution studies for changes in extremes since 1950. {3.3.1, 3.3.2, 3.3.3}



"SIMPLE" CLIMATE MODEL

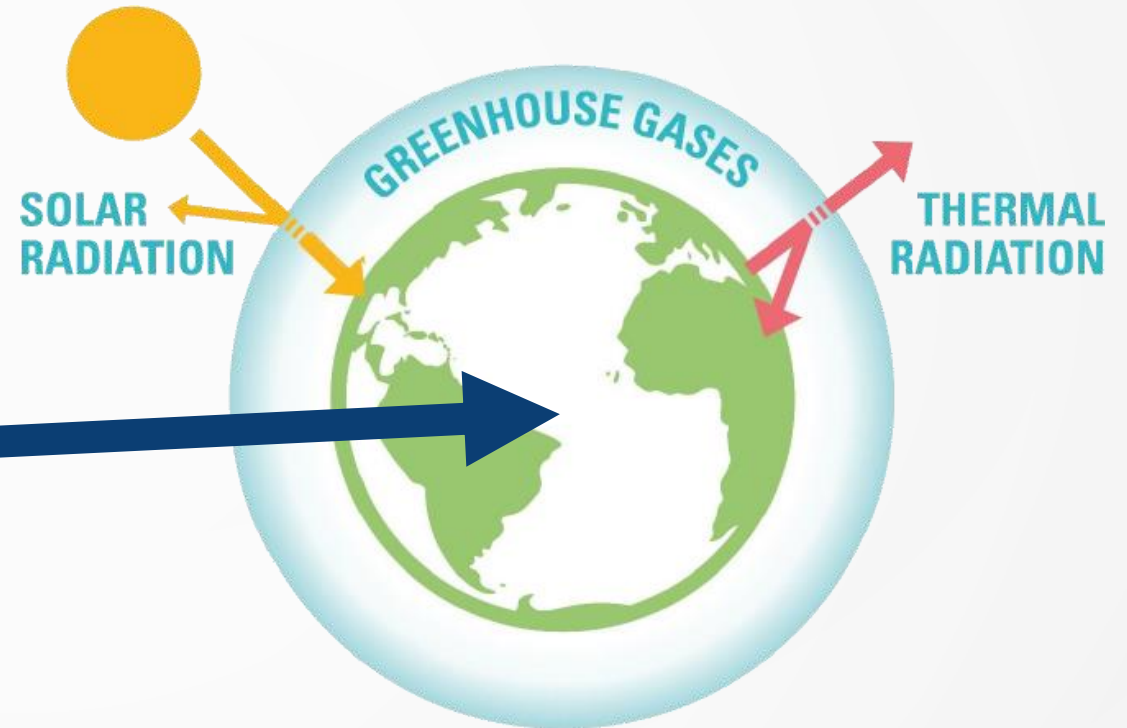




"SIMPLE" CLIMATE MODEL

- Air ↔ Photosynthesis
- Ocean currents
- Siberian permafrost
- Biogenic aerosols
- Forest fires
- Biodiversity
- Local weather cycles
- Carbon sinks, carbon stores
- Et cetera

- Human behaviour:
 - CO₂ emissions
 - Land use / ecosystem effects

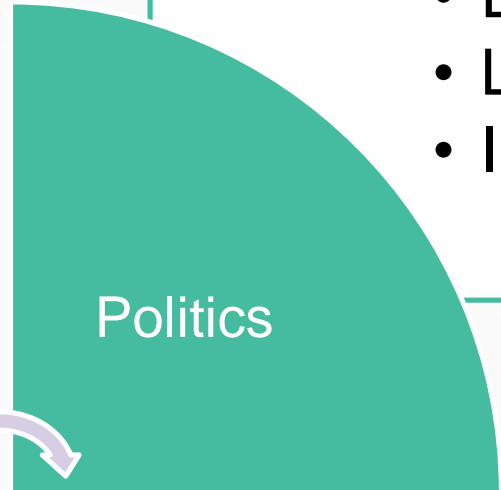




- Opinions
- Buying
- Voting

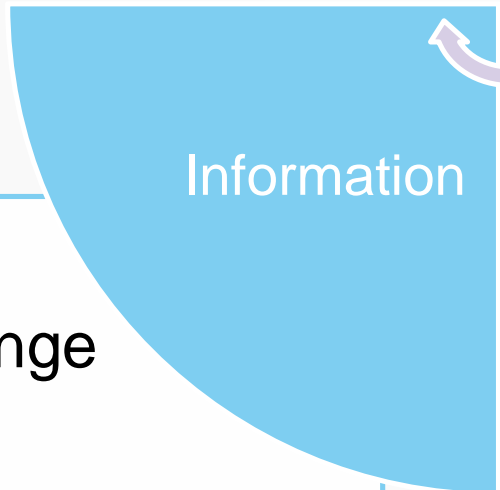


Human behaviour



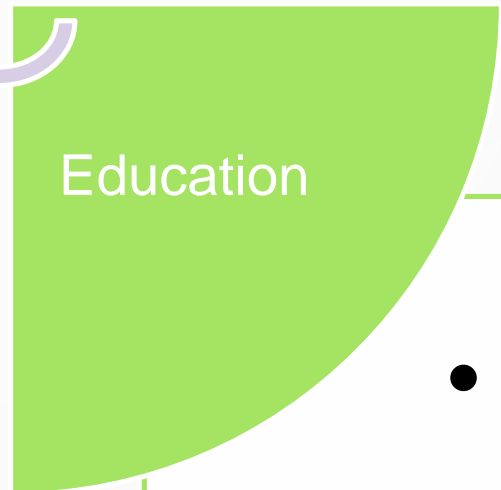
Politics

- Energy
- Land use
- Infrastructure



Information

- Climate change
- Risks
- Solutions

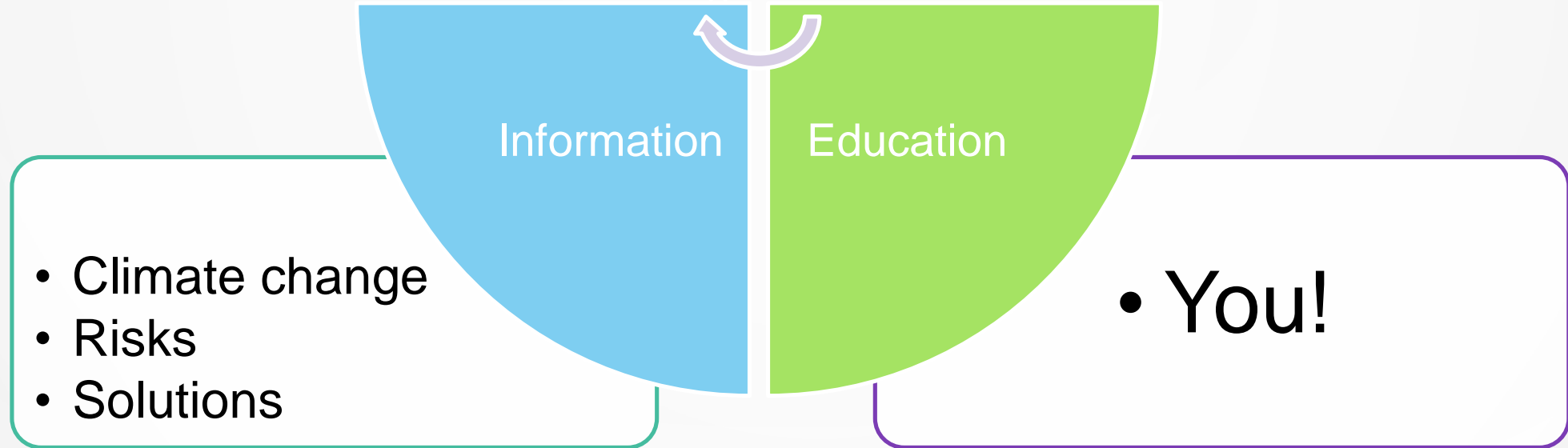


Education

- You!

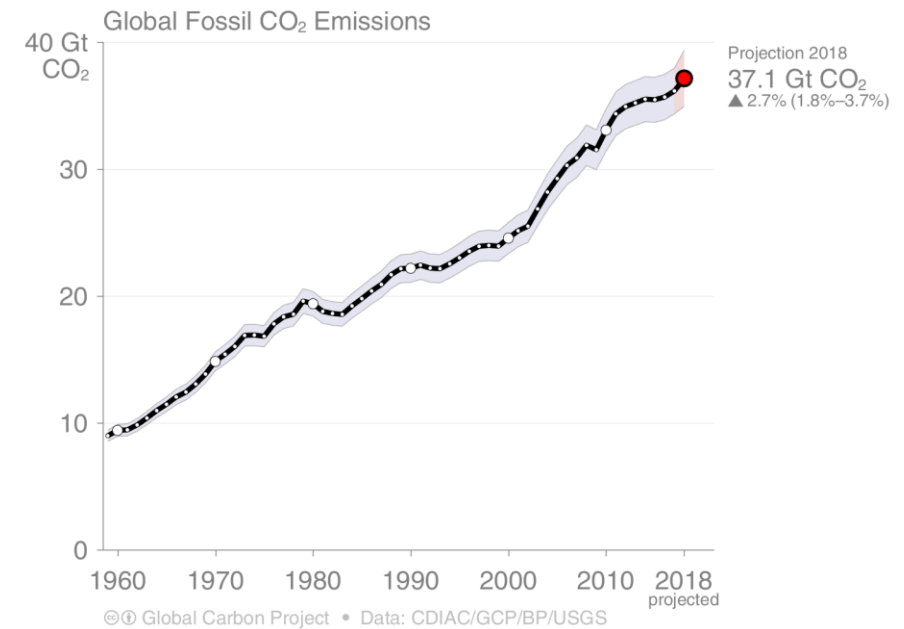
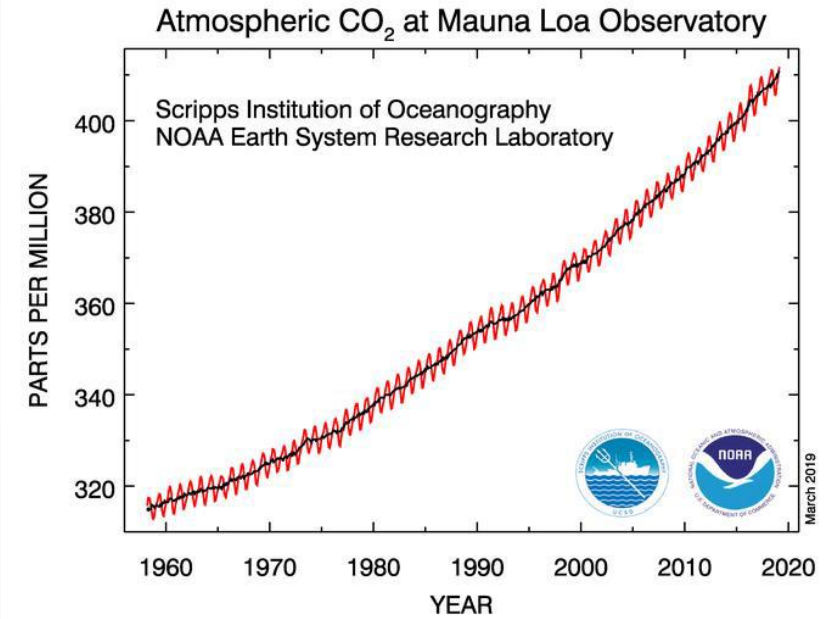
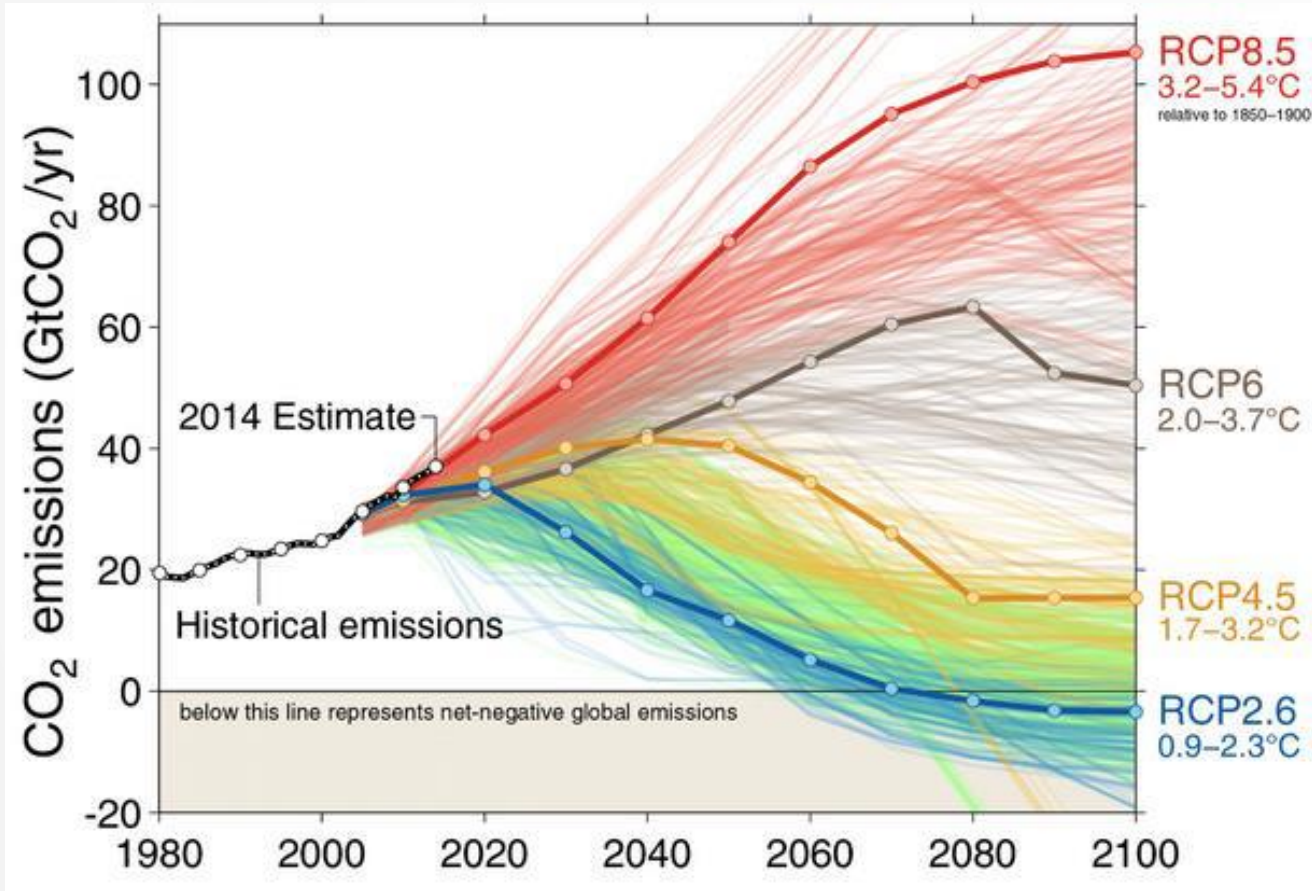


What can I do? What should I do?



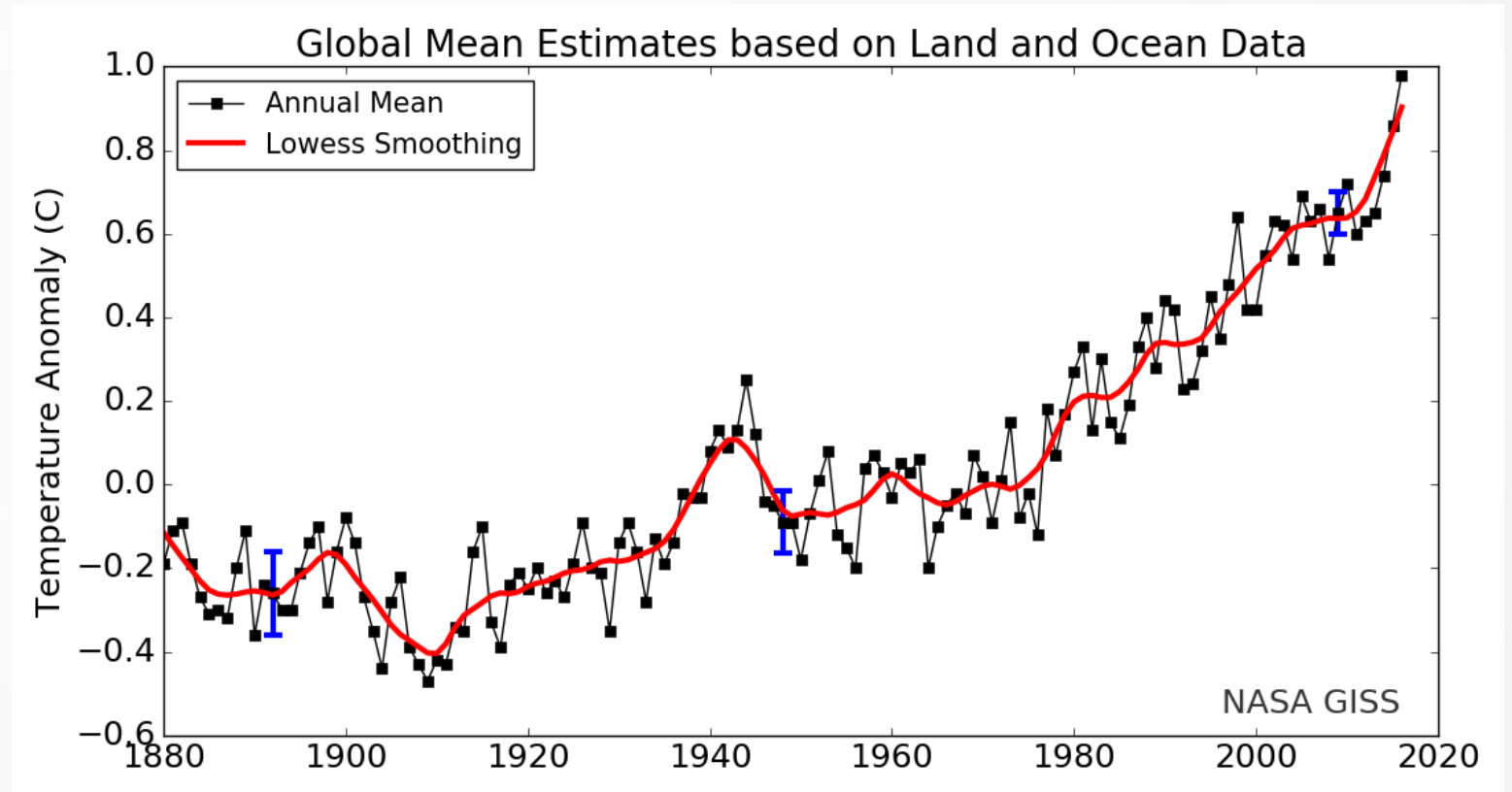


EDUCATION EXISTS FOR THE FUTURE





THE CLIMATE IS ALREADY CHANGING AND THE CHANGE WON'T STOP QUICKLY





QUESTIONS FOR TEACHERS

What challenges can my students face?

- Ecosystem problems (Dry years → Food production problems?)
- Changes to ways of life
- Social and global problems (Less drinking water → conflicts? Less consumption → less jobs?)

Humans ↔ natural environment



QUESTIONS FOR TEACHERS

What can I do? What should I teach?

- We can affect the climate for better or worse
- Changes may be slow (10-50 years)
- We need to be able to discuss difficult problems



LINKS FOR TEACHERS AND STUDENTS

Free online courses and other materials by Uni. Helsinki

<https://blogs.helsinki.fi/climateuniversity/online-resources/>

Or simply: bit.ly/climatehelsinki



Thank you!

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