

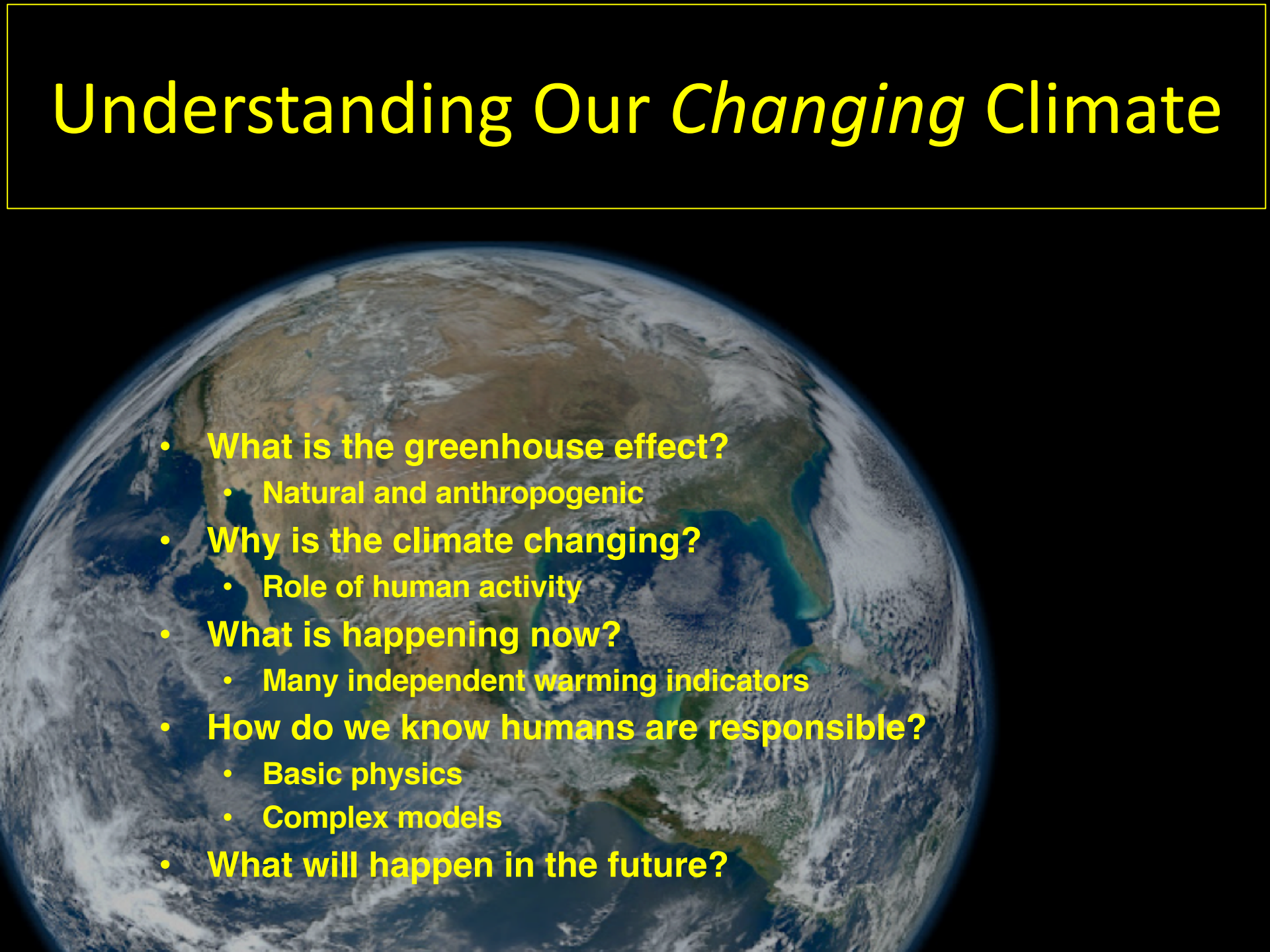
Understanding Our *Changing* Climate



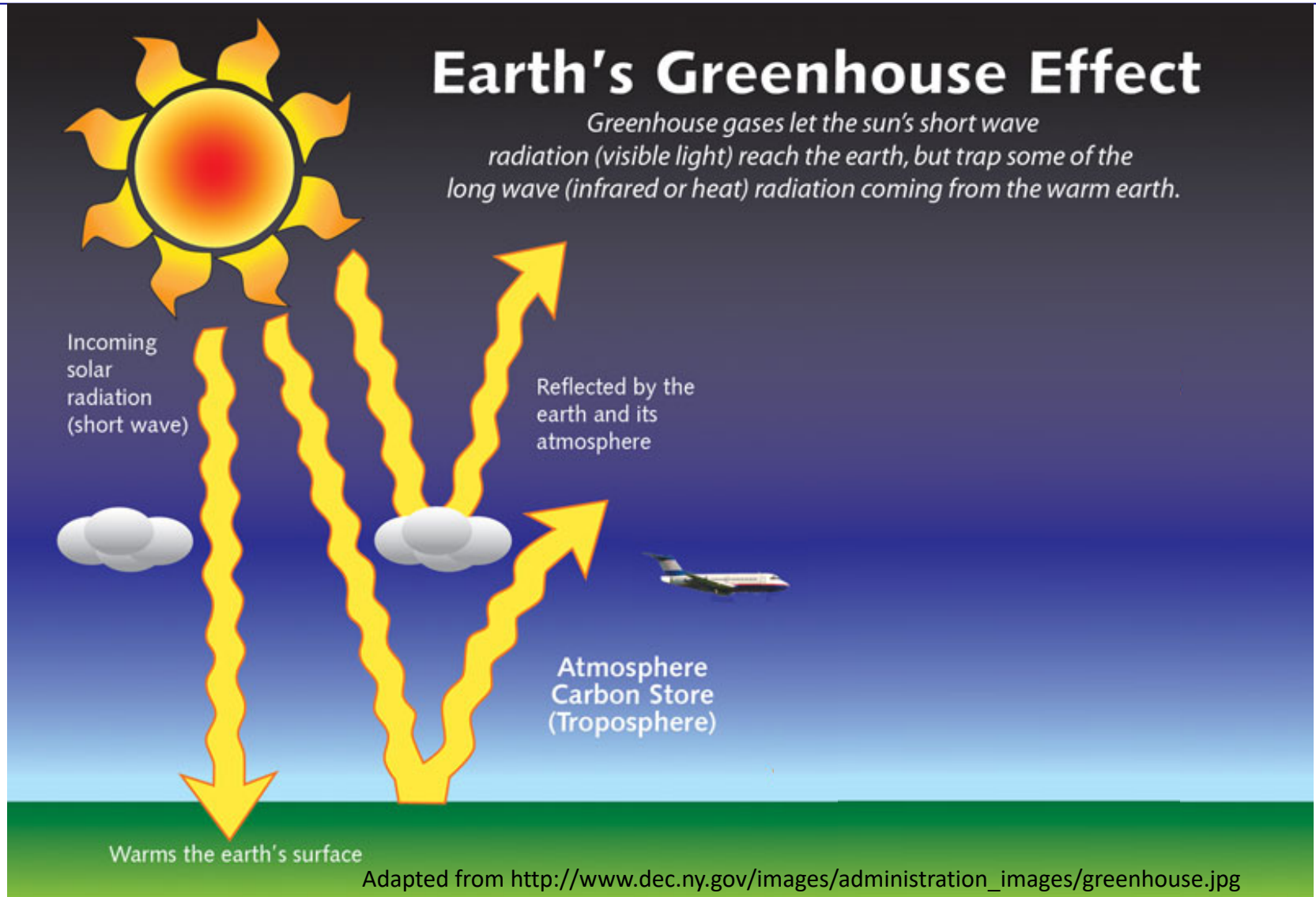
Benjamin A. Cash
Center for Ocean-Land-Atmosphere Studies
George Mason University

Virginia Clinicians for Climate Action
Health in a Changing Climate
10 February 2018

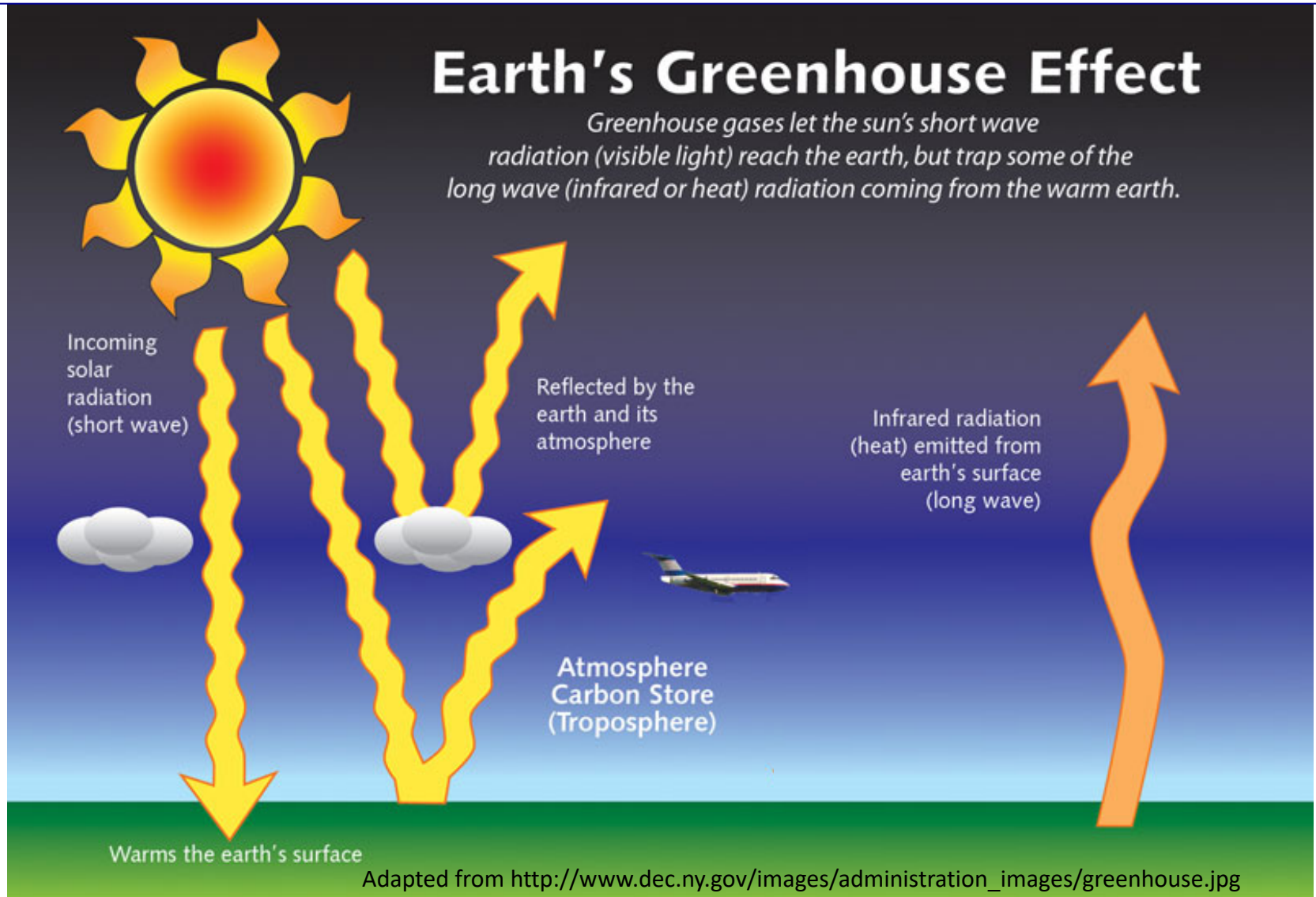
Understanding Our *Changing* Climate

- 
- A satellite view of Earth showing the Americas and surrounding oceans. The image is used as a background for the text.
- **What is the greenhouse effect?**
 - Natural and anthropogenic
 - **Why is the climate changing?**
 - Role of human activity
 - **What is happening now?**
 - Many independent warming indicators
 - **How do we know humans are responsible?**
 - Basic physics
 - Complex models
 - **What will happen in the future?**

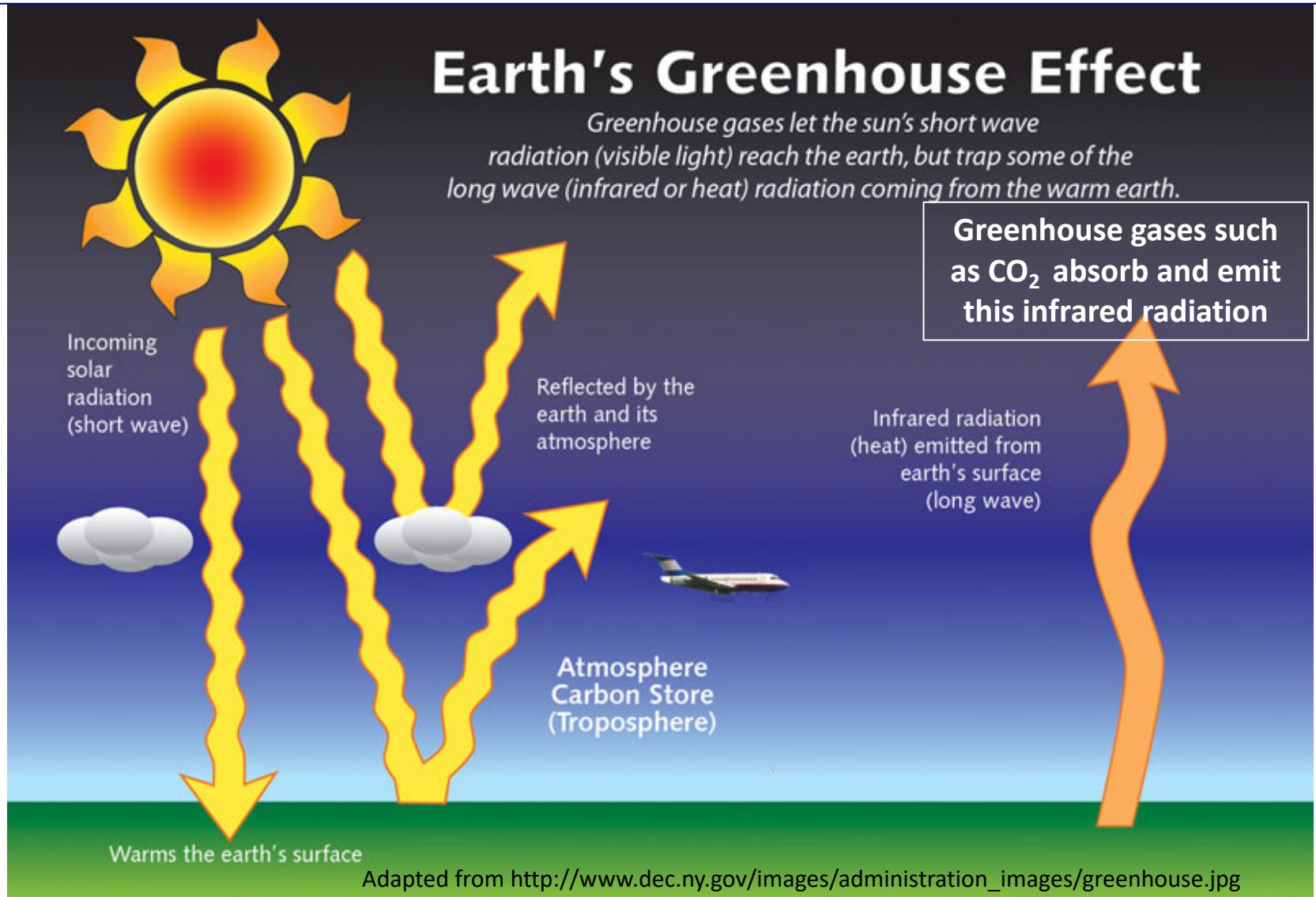
What is the Greenhouse Effect?



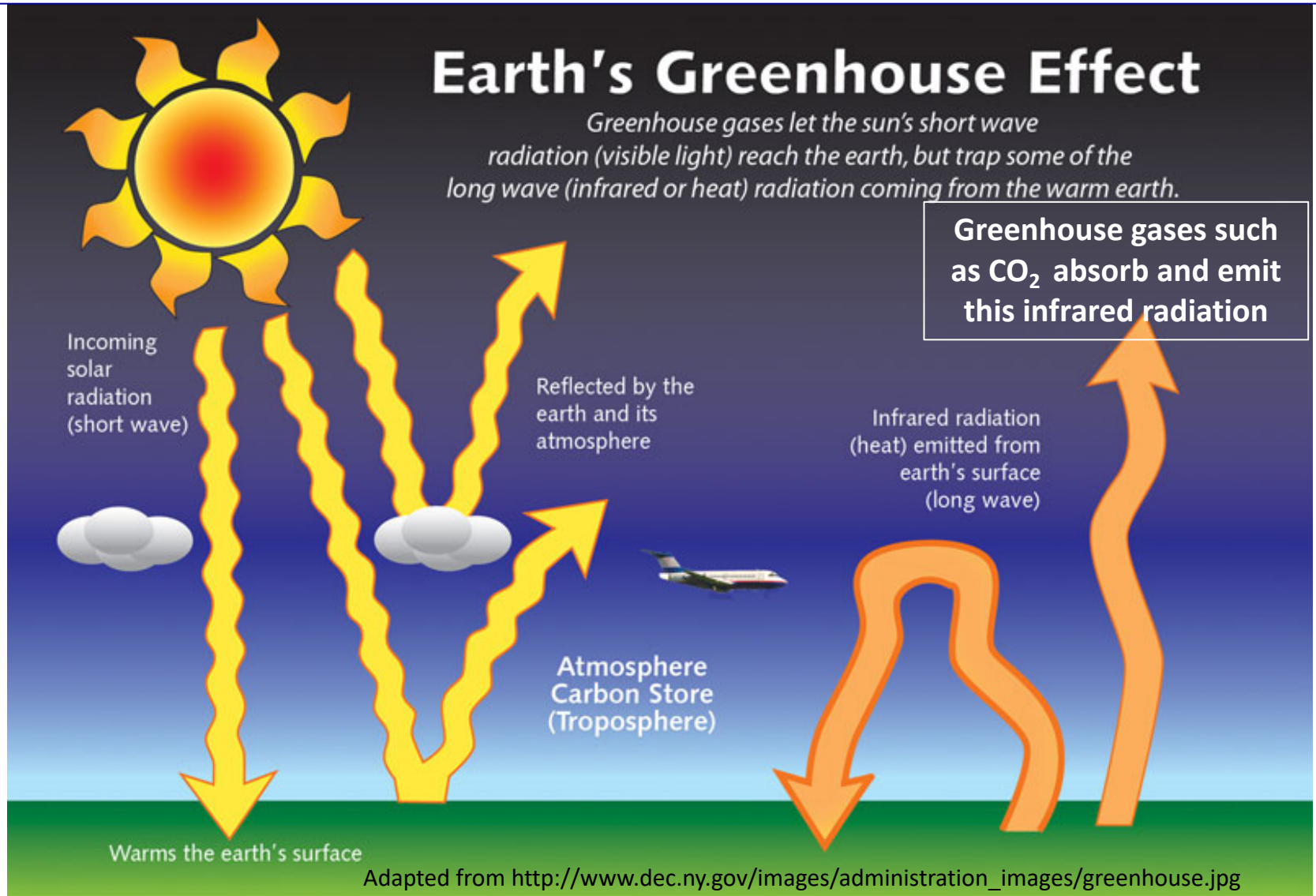
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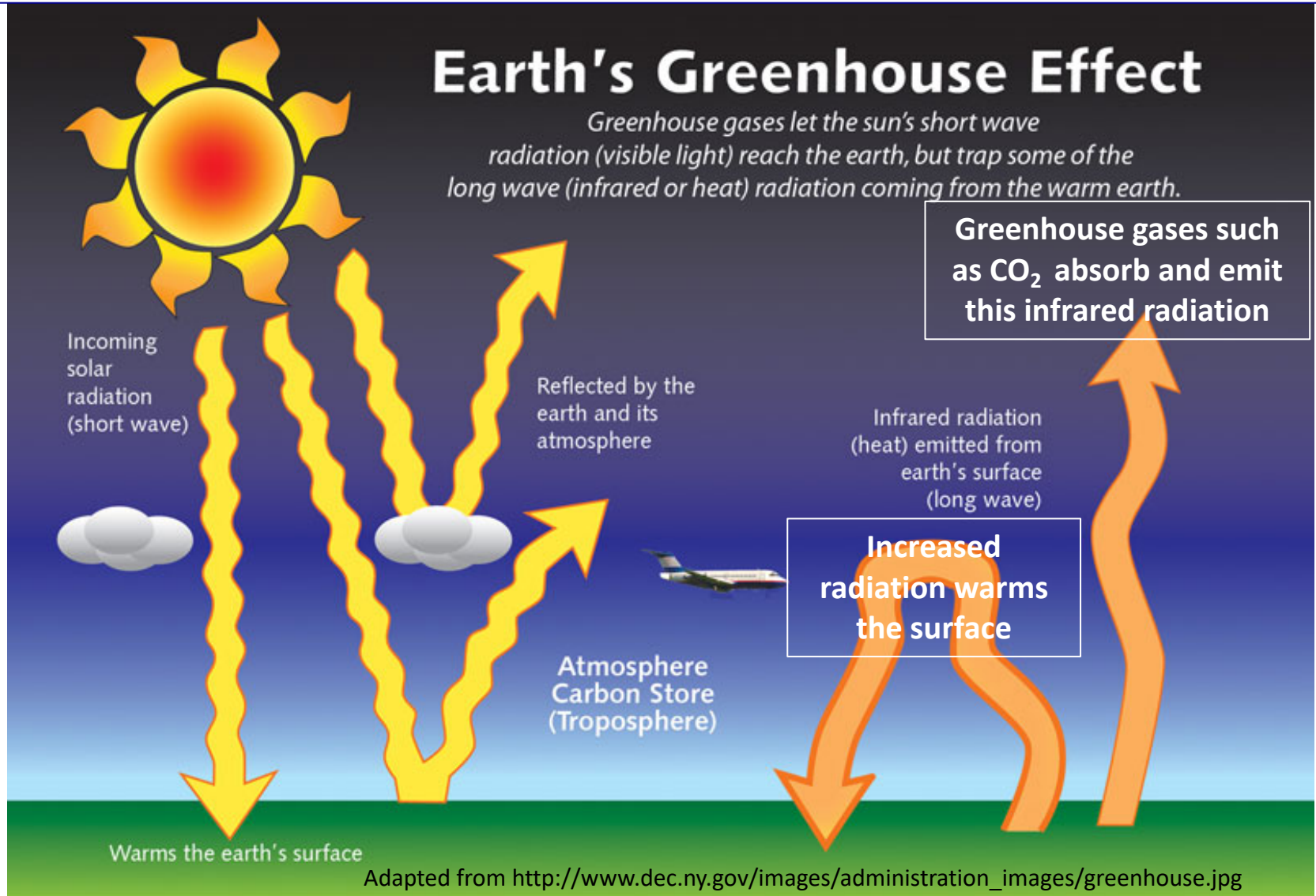


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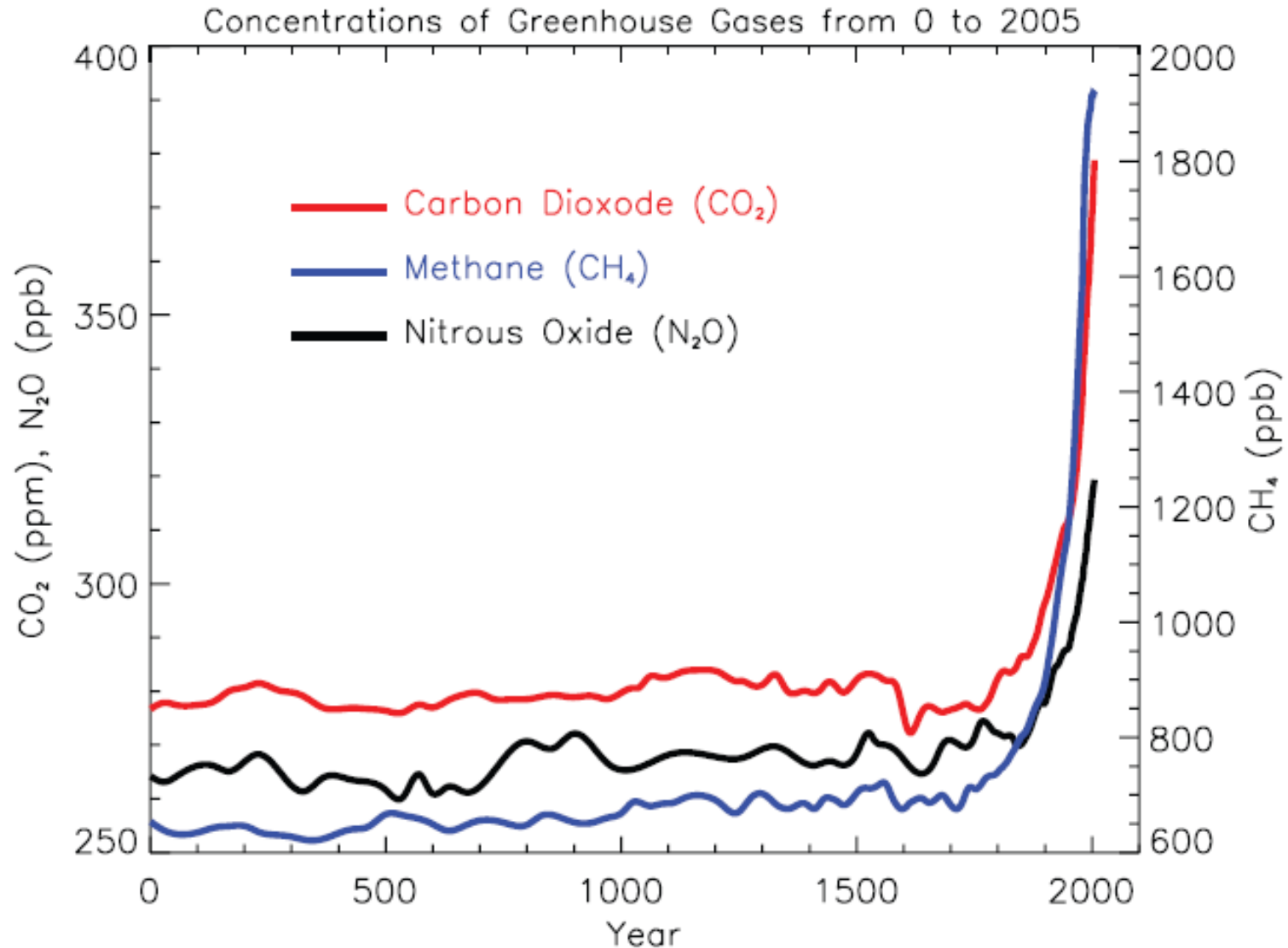


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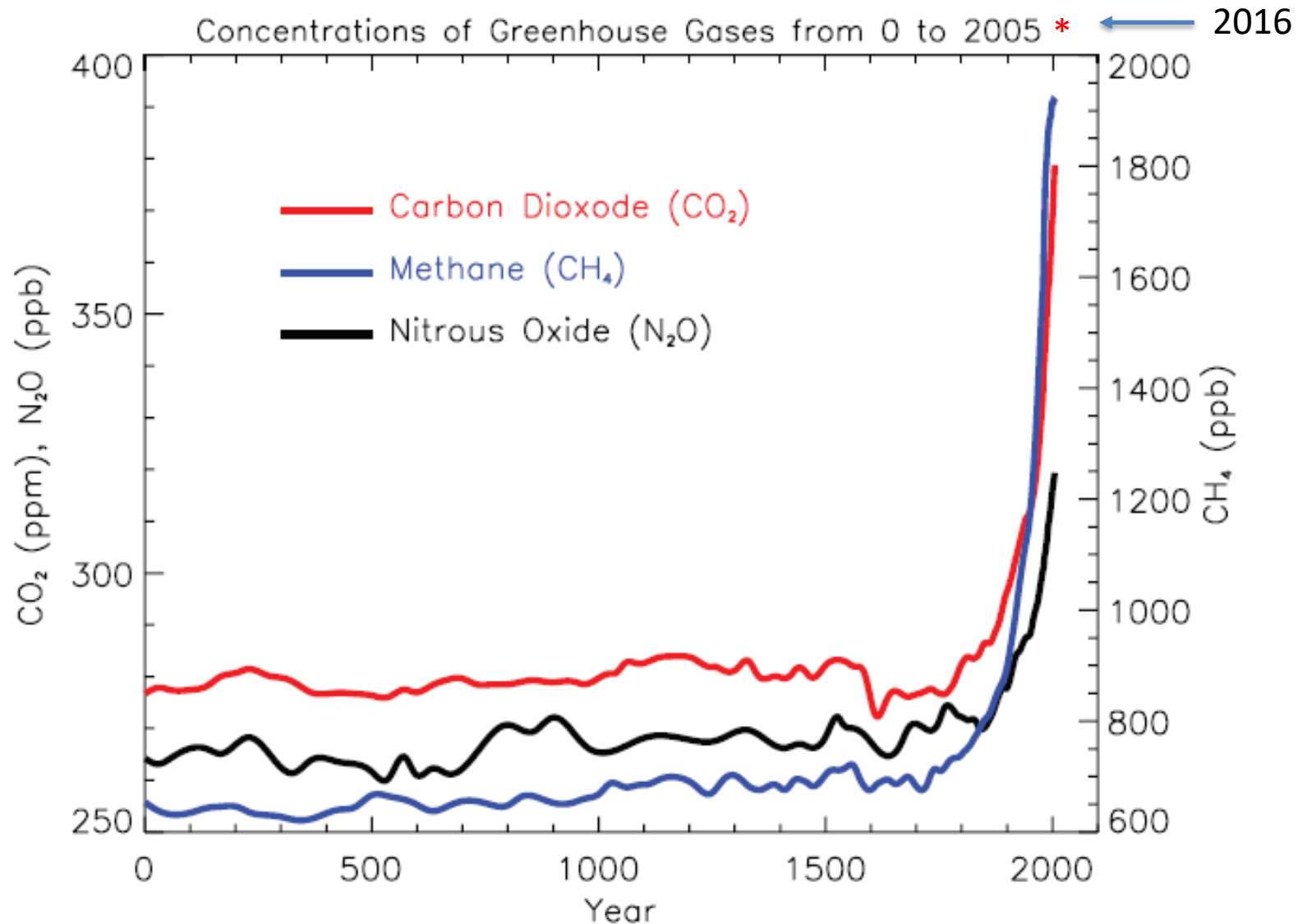
Natural and essential aspect of the climate



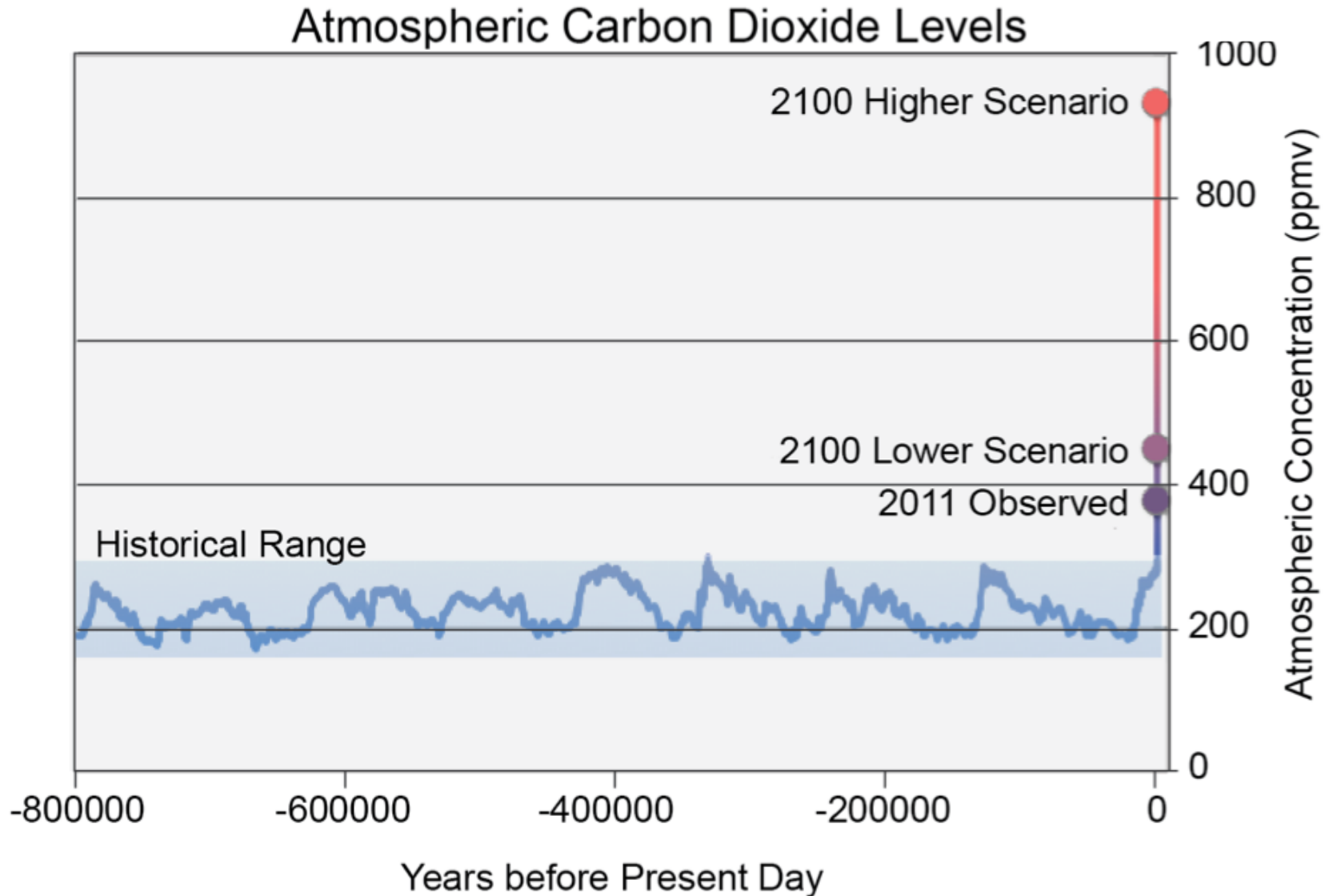
Why is the Climate Changing?



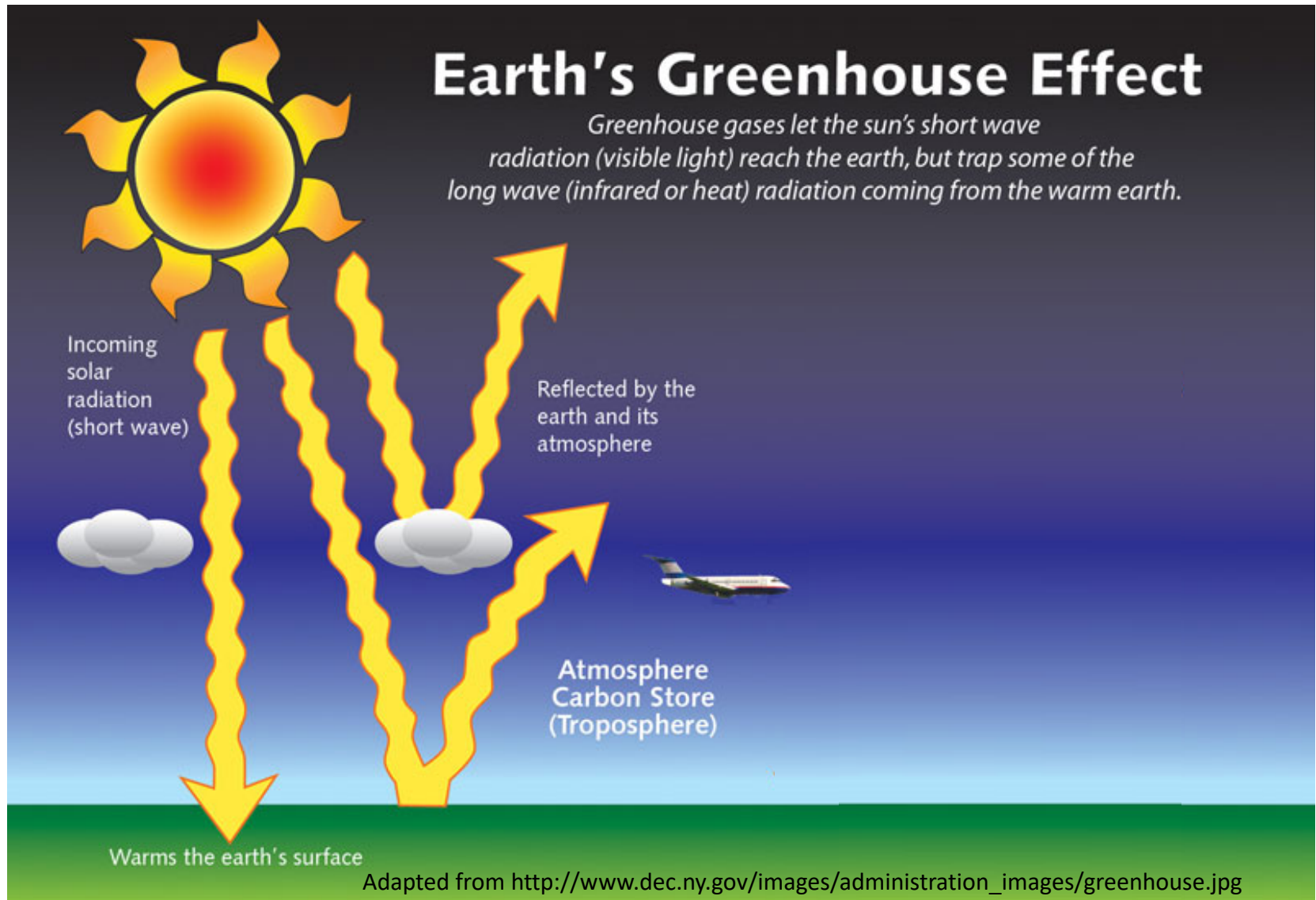
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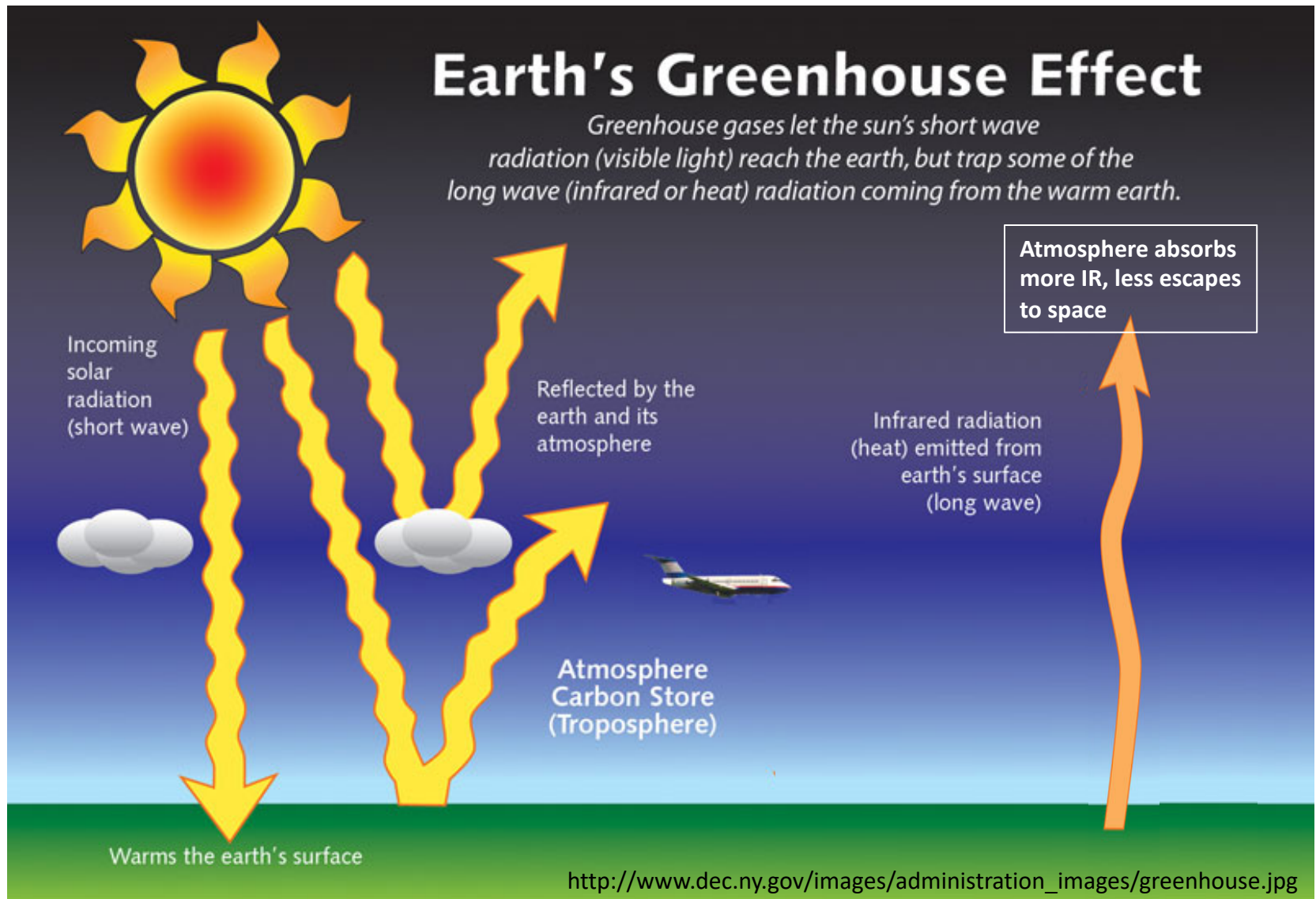
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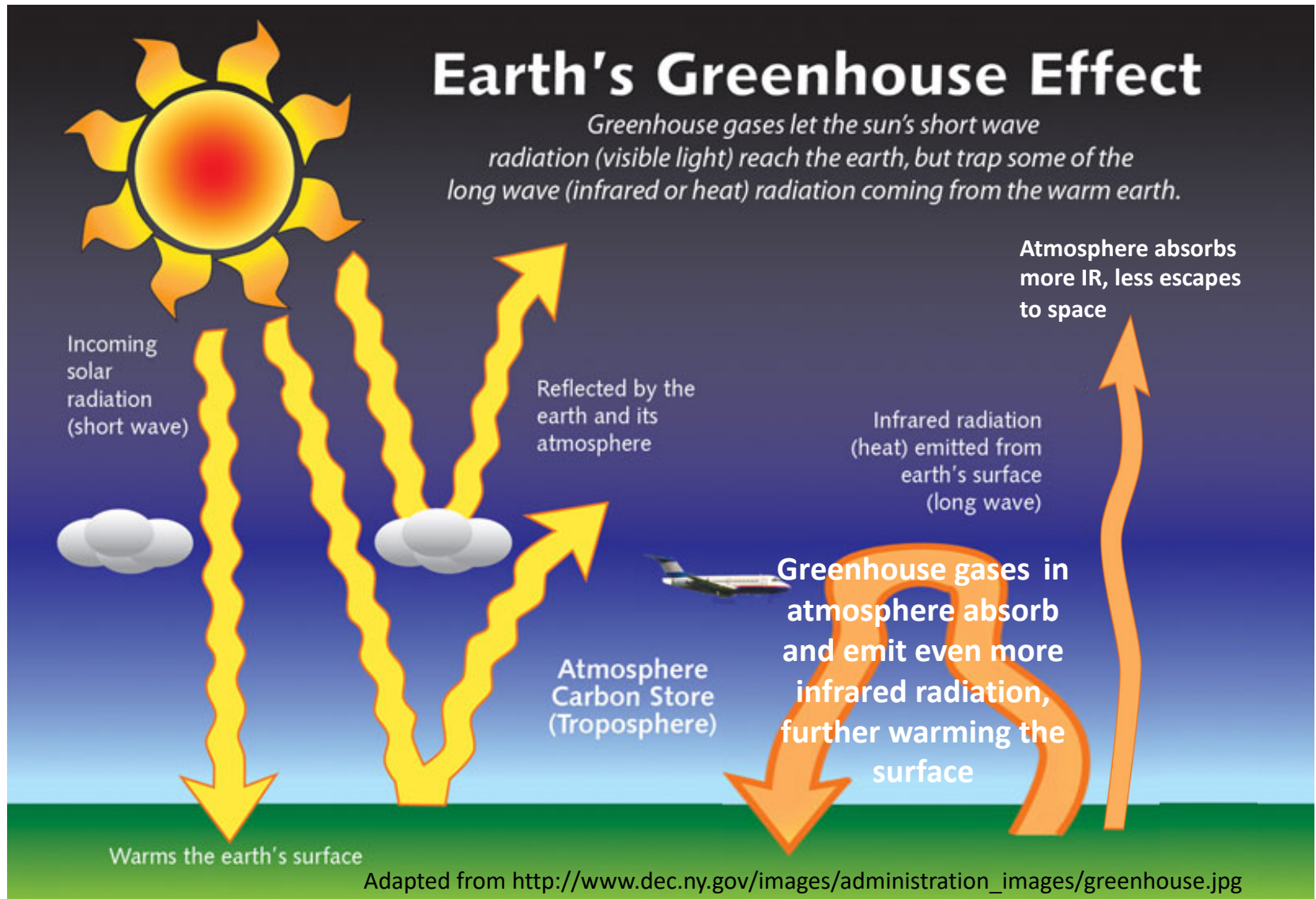
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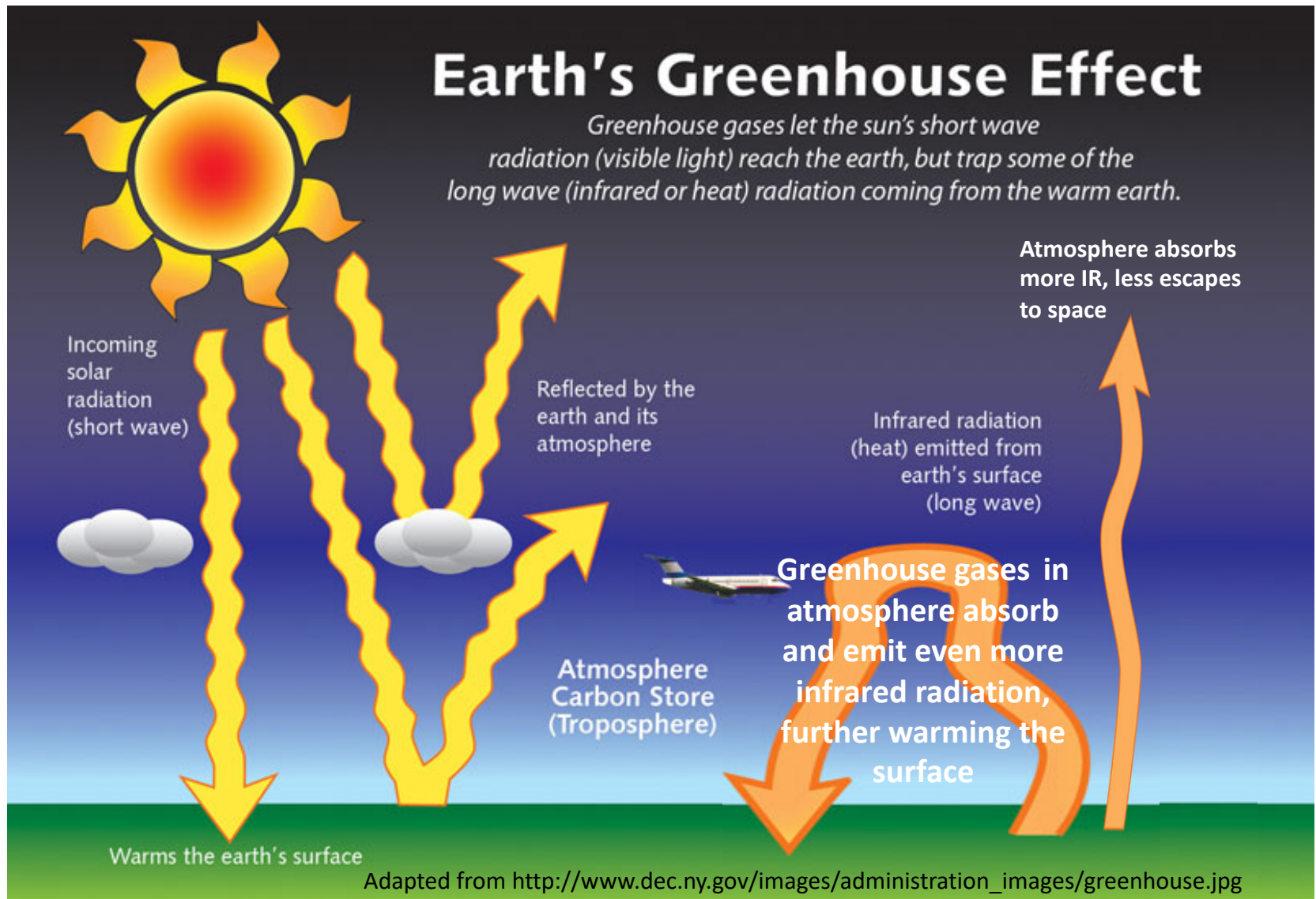


Why is the Climate Changing?



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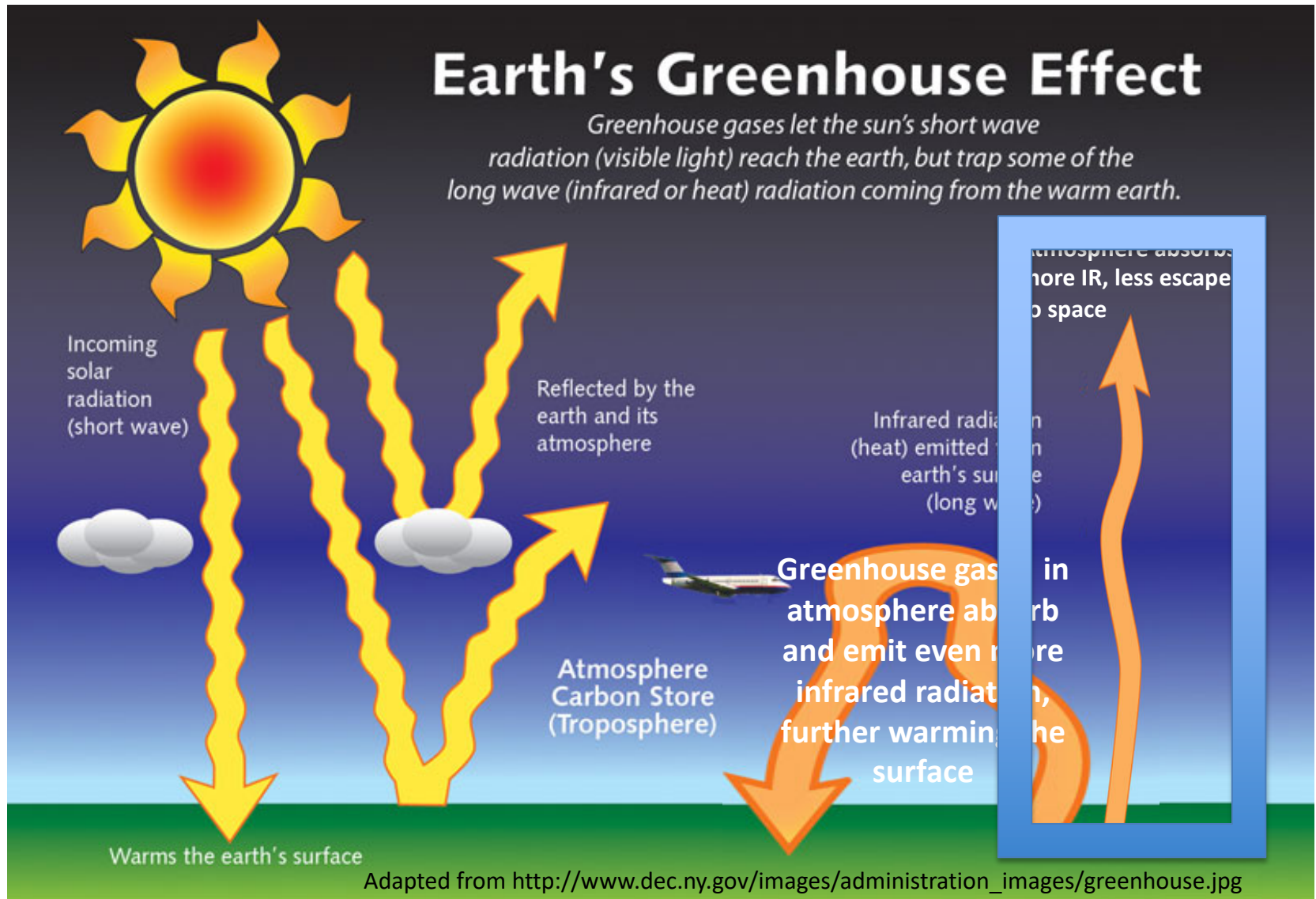
... but what about uncertainty?



Adapted from http://www.dec.ny.gov/images/administration_images/greenhouse.jpg

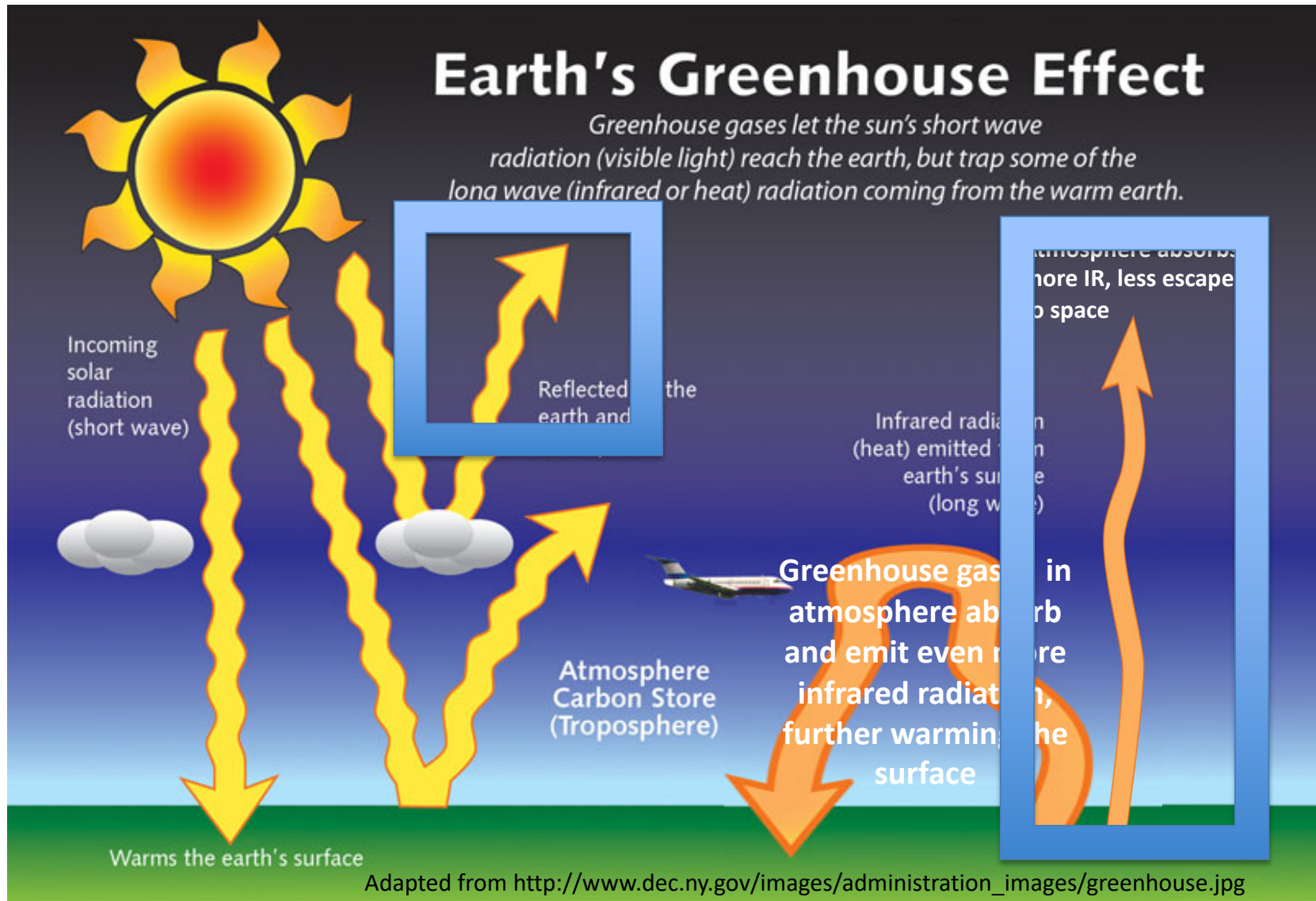
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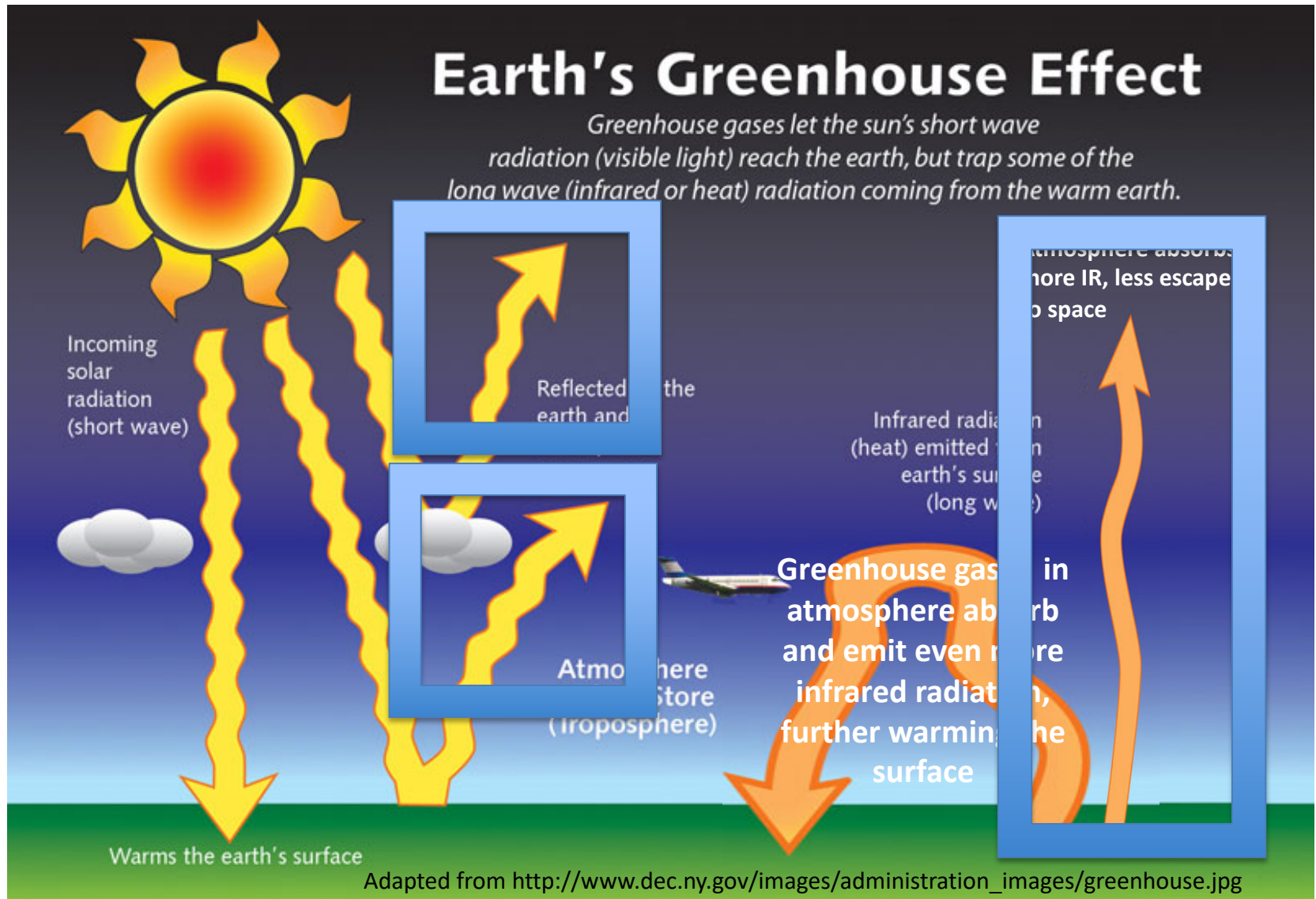
Why is the Climate Changing?

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Why is the Climate Changing?

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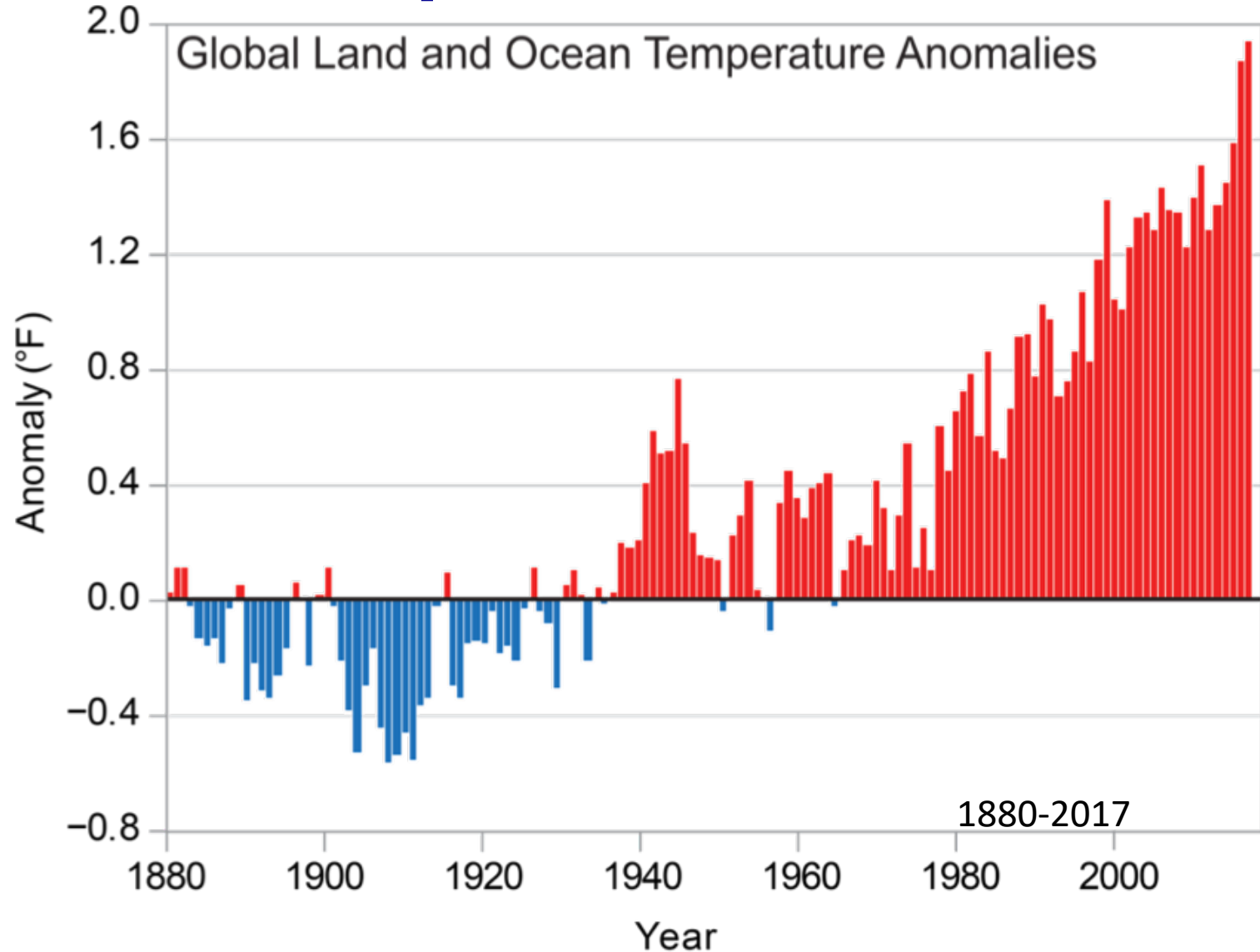


Greenhouse Effect Summary

- Potential for emitted CO₂ to alter climate has been recognized for a long time
 - 1824: Joseph Fourier establishes existence of natural greenhouse effect
 - 1859: John Tyndall confirms heat-trapping properties of greenhouse gases
 - 1890: Svante Arrhenius computes first estimate of expected global temperature increase from fossil fuel use
- Simple physics tells us increasing CO₂ should increase temperature
 - NOT having the temperature go up would be the odder result
 - Climate system is extremely complex, so odd results are possible
 - Does not appear to be the case

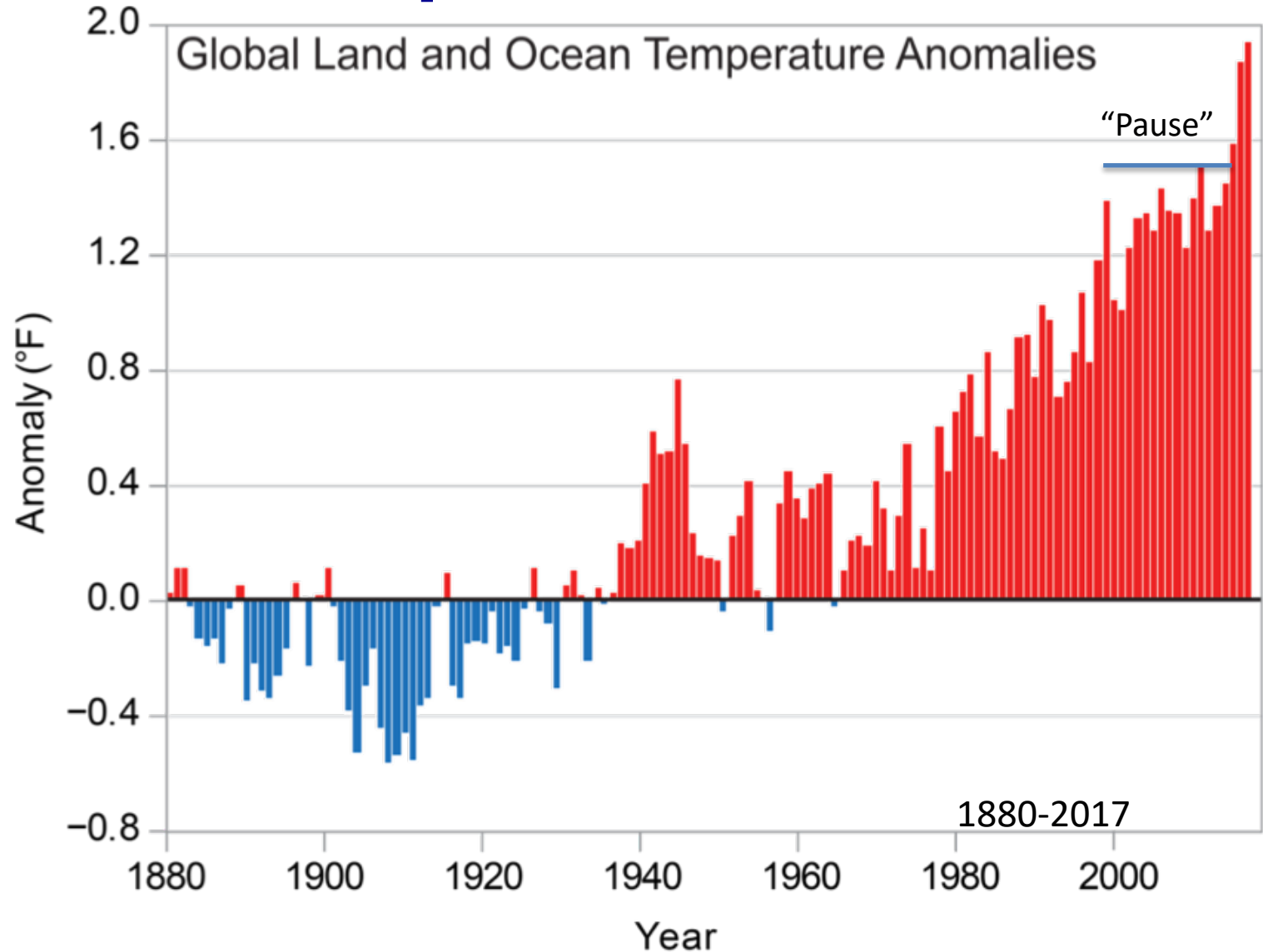
What is happening now?

Global Temperature is Increasing



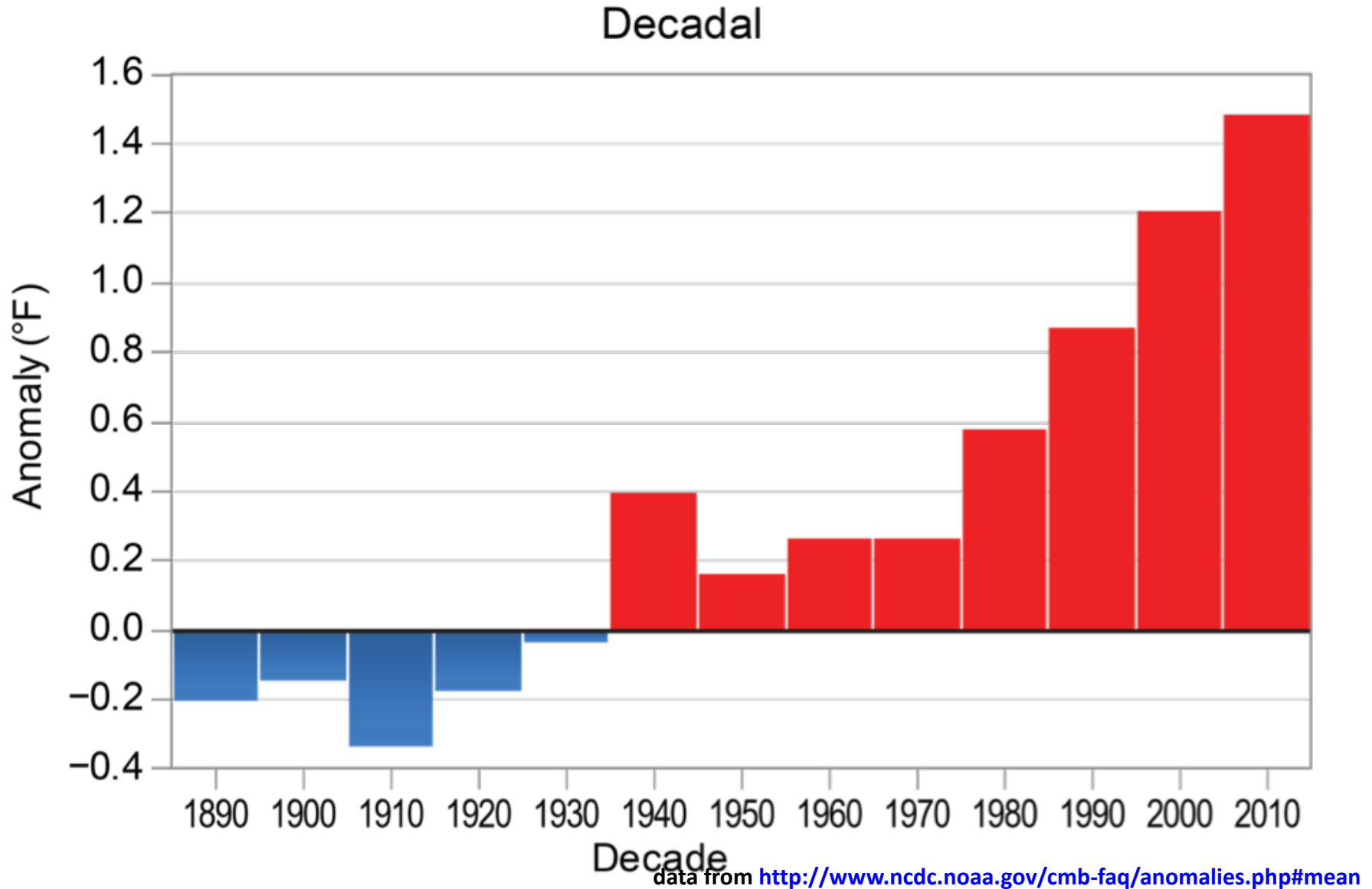
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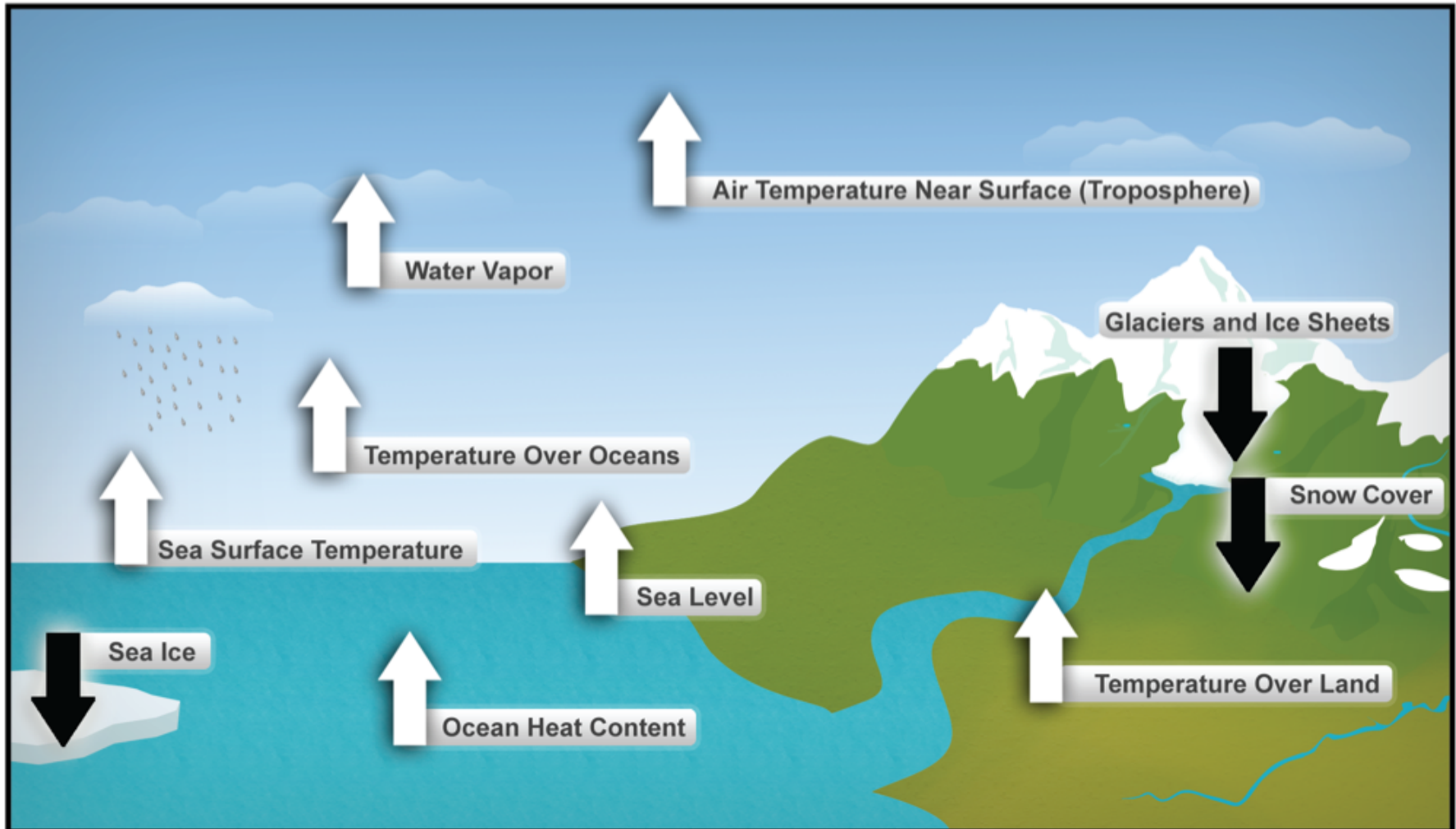
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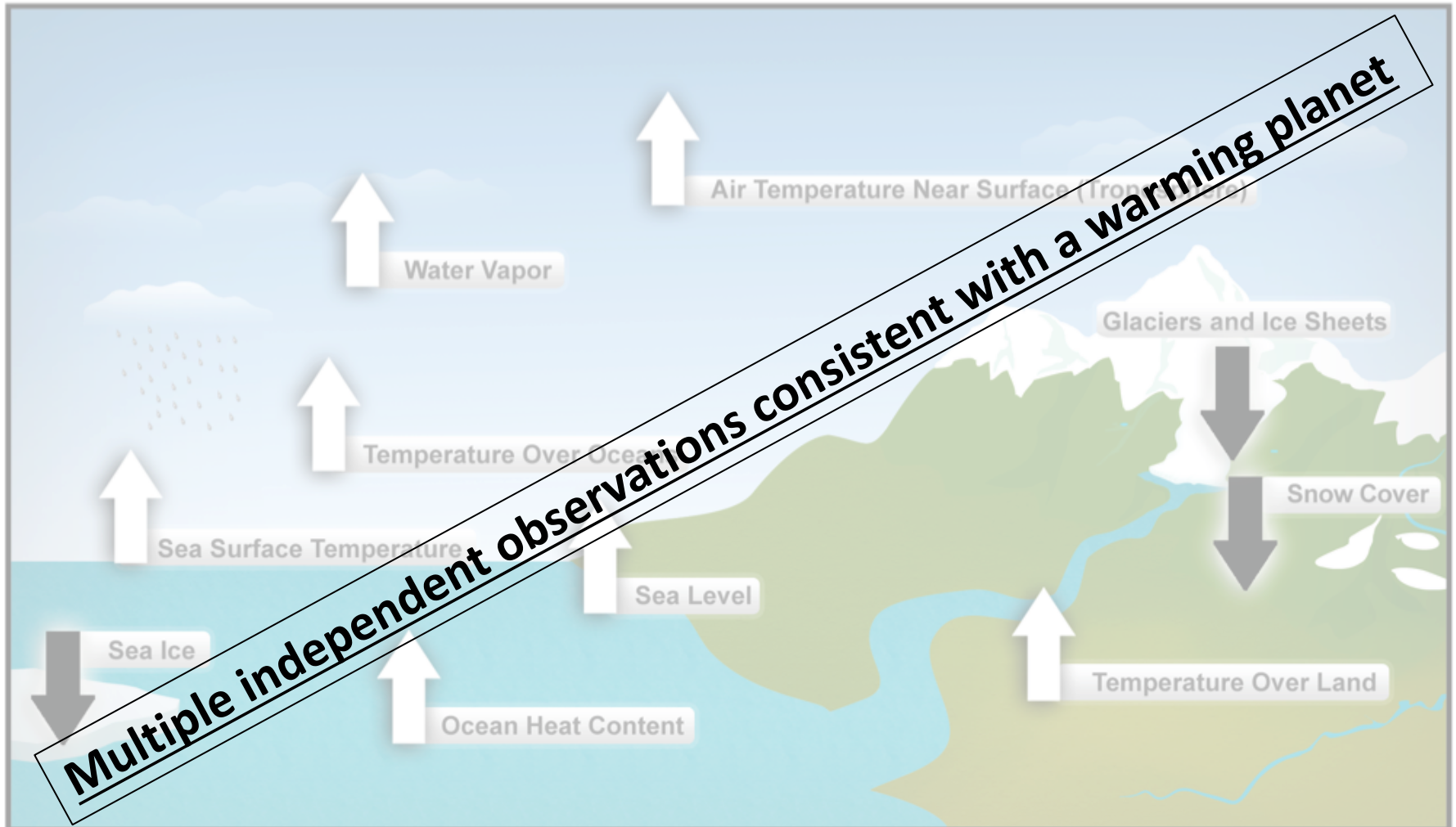
Is the temperature really increasing? How do we know?

Ten Indicators of a Warming World



Is the temperature really increasing? How do we know?

Ten Indicators of a Warming World

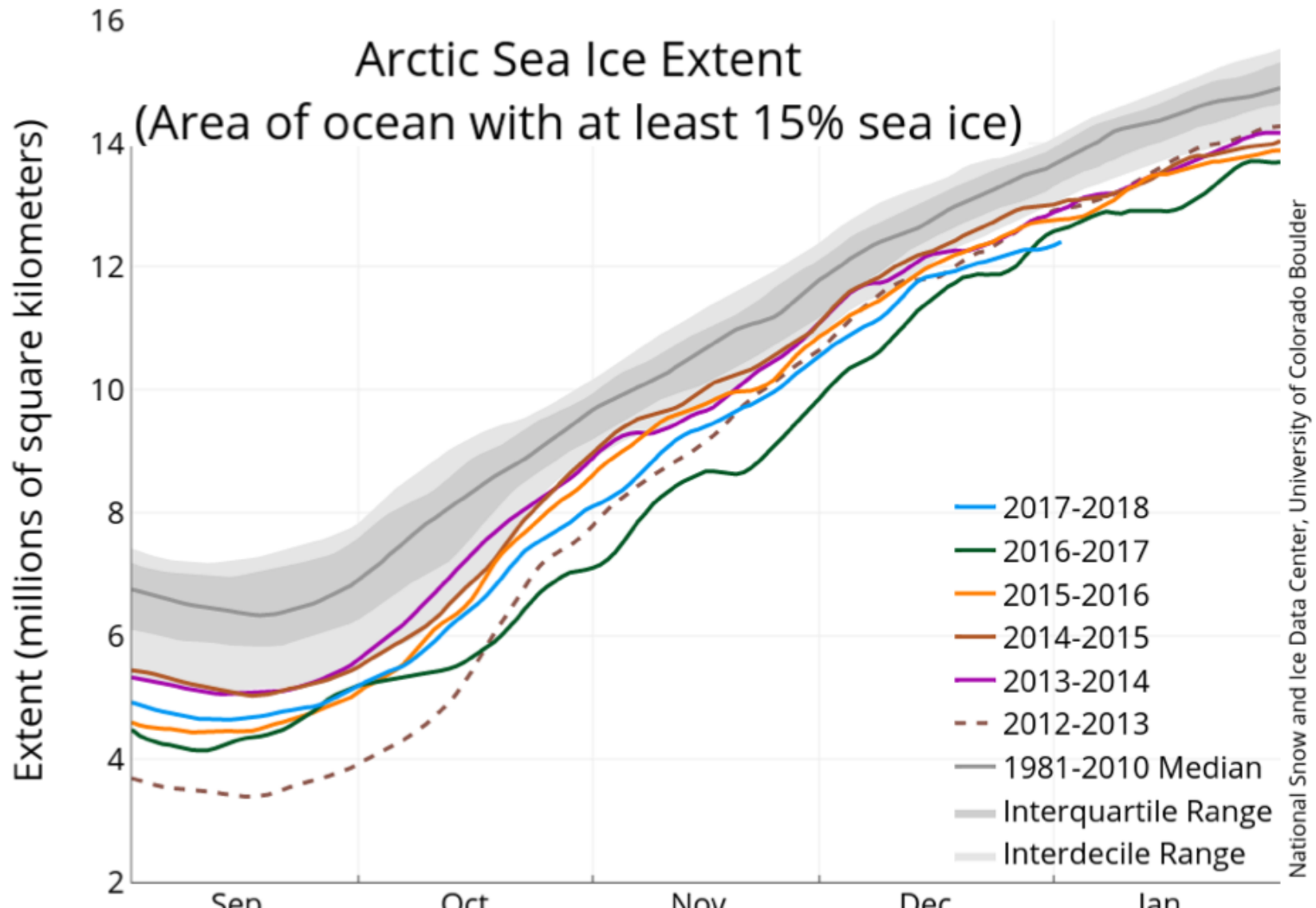


What is happening now? Sea Level is Rising

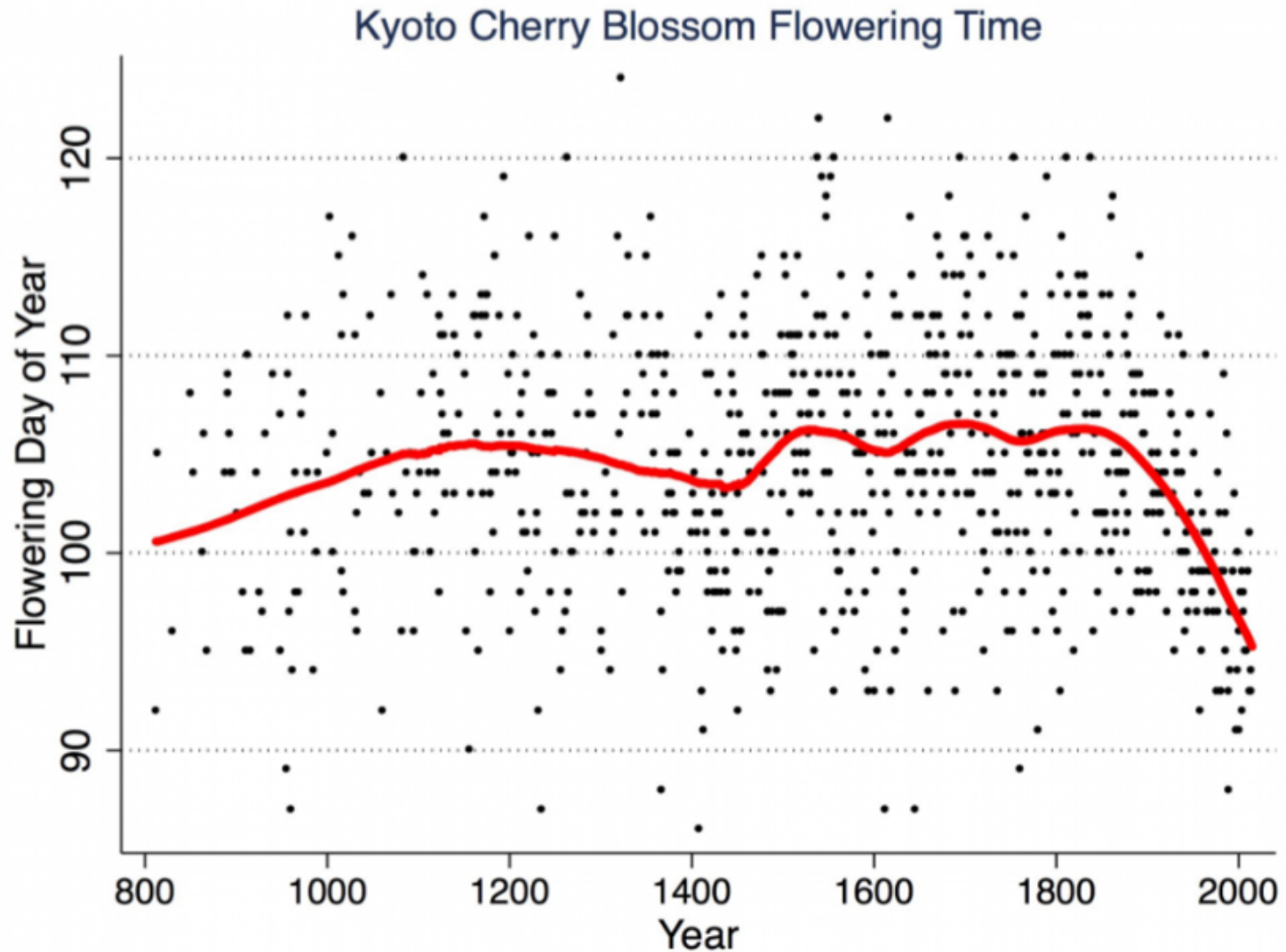


Crisfield, Maryland, at high tide
© 2013 Greg Kahn

What is happening now? Sea Ice is Disappearing

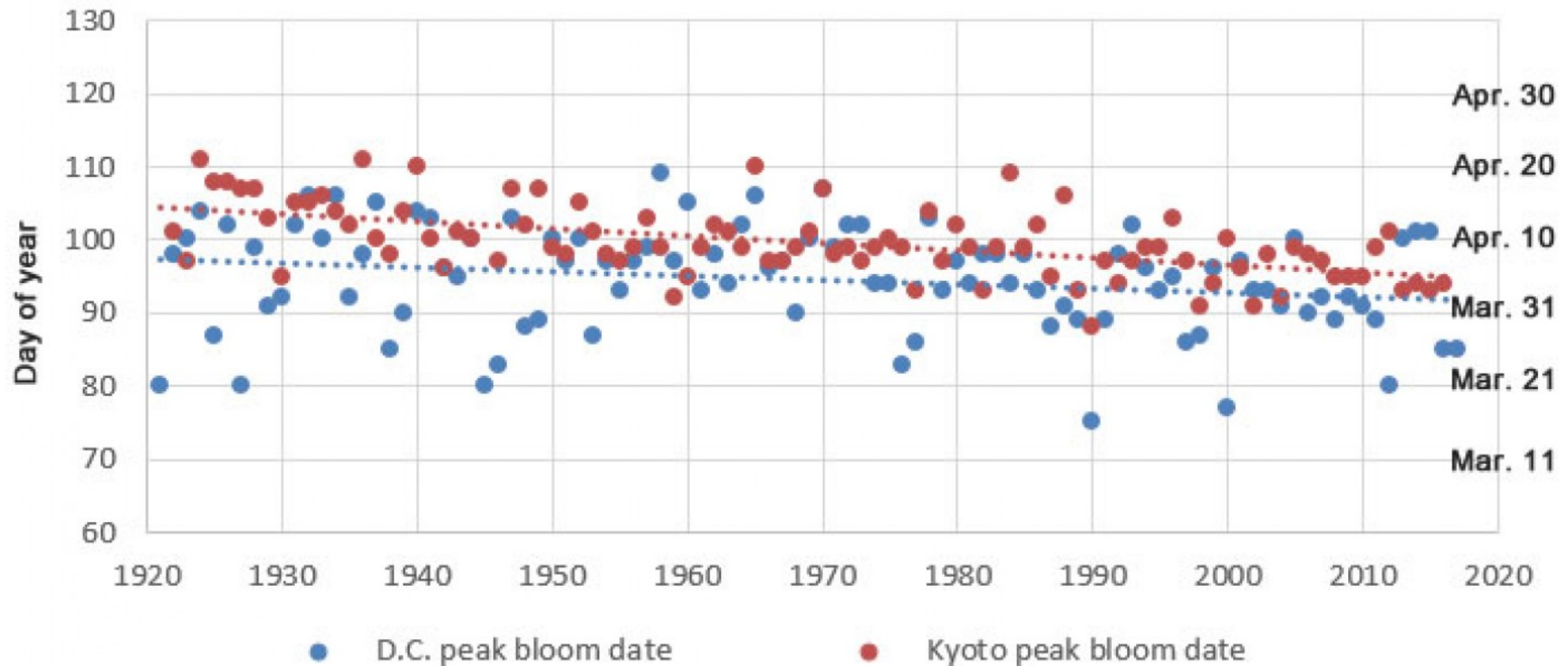


What is happening now? Trees Are Blooming Earlier



What is happening now? Trees Are Blooming Earlier

Cherry blossom peak bloom dates in
Washington, D.C. and Kyoto (1921-2017)



How do we know humans are responsible for these changes?

Climate models represent multiple physical processes and their interactions numerically

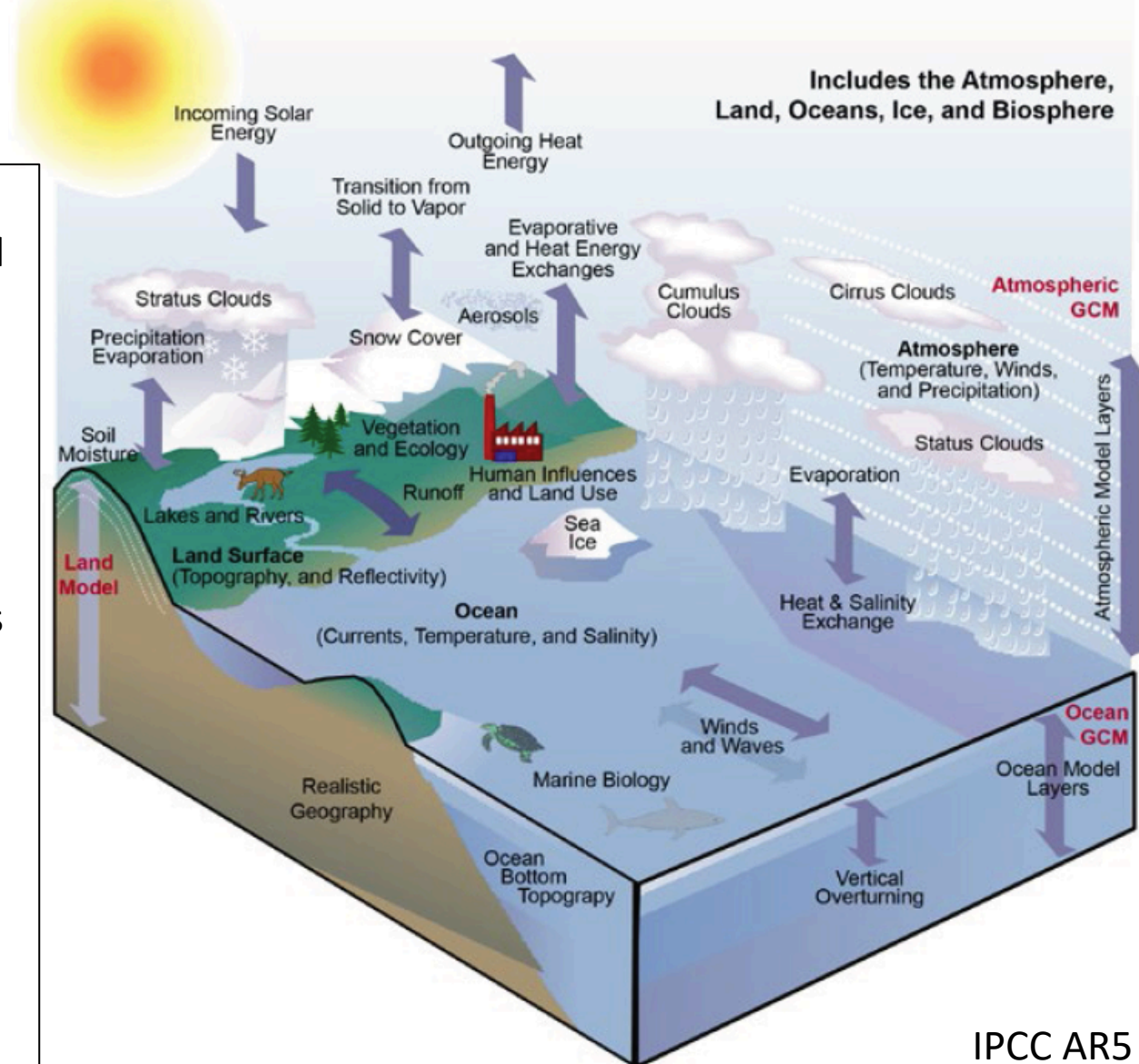
Supercomputers are used to solve resulting equations

Require hundreds of hours on 10's of thousands of processors

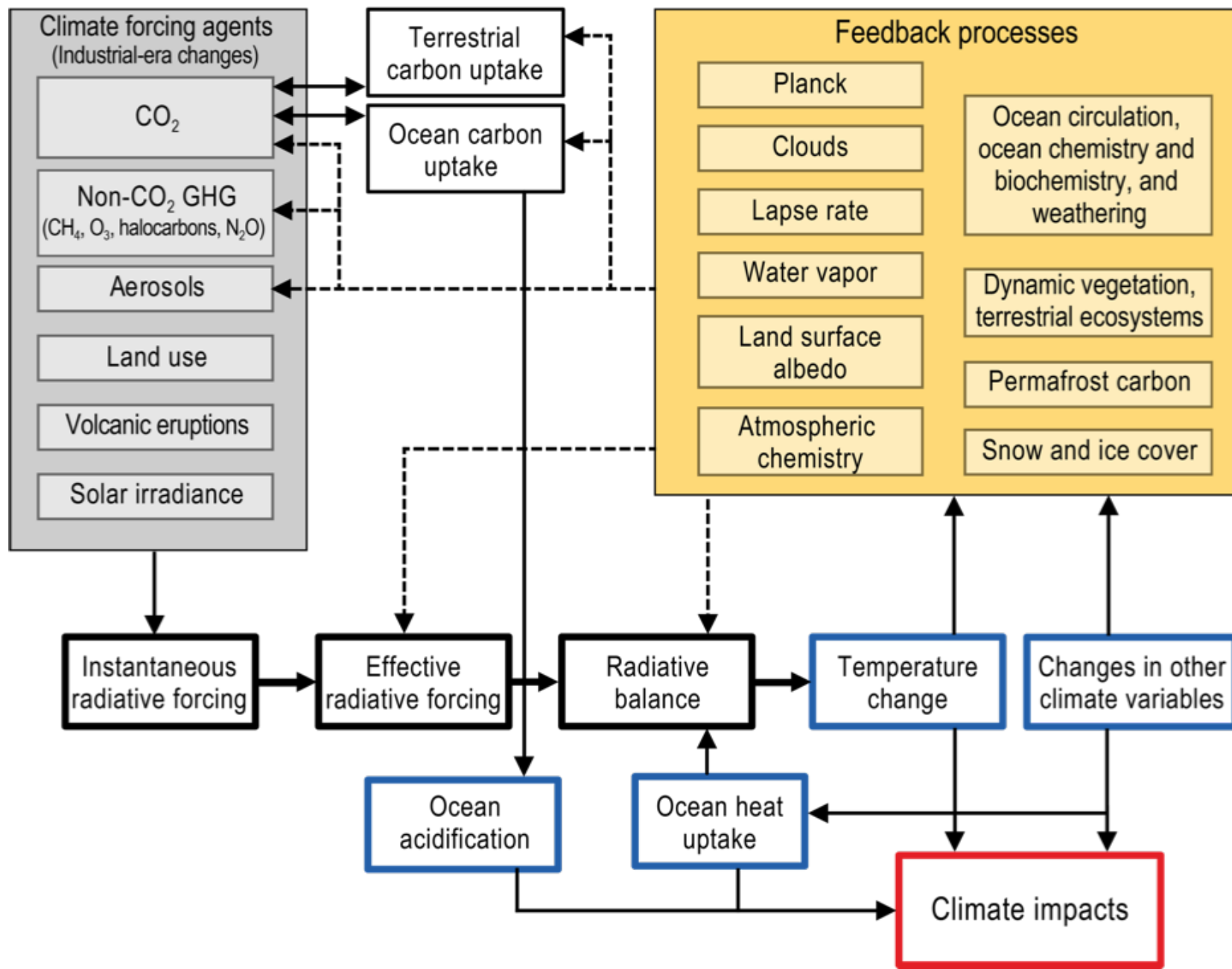
Not without flaws!

Allow for "What if?" questions

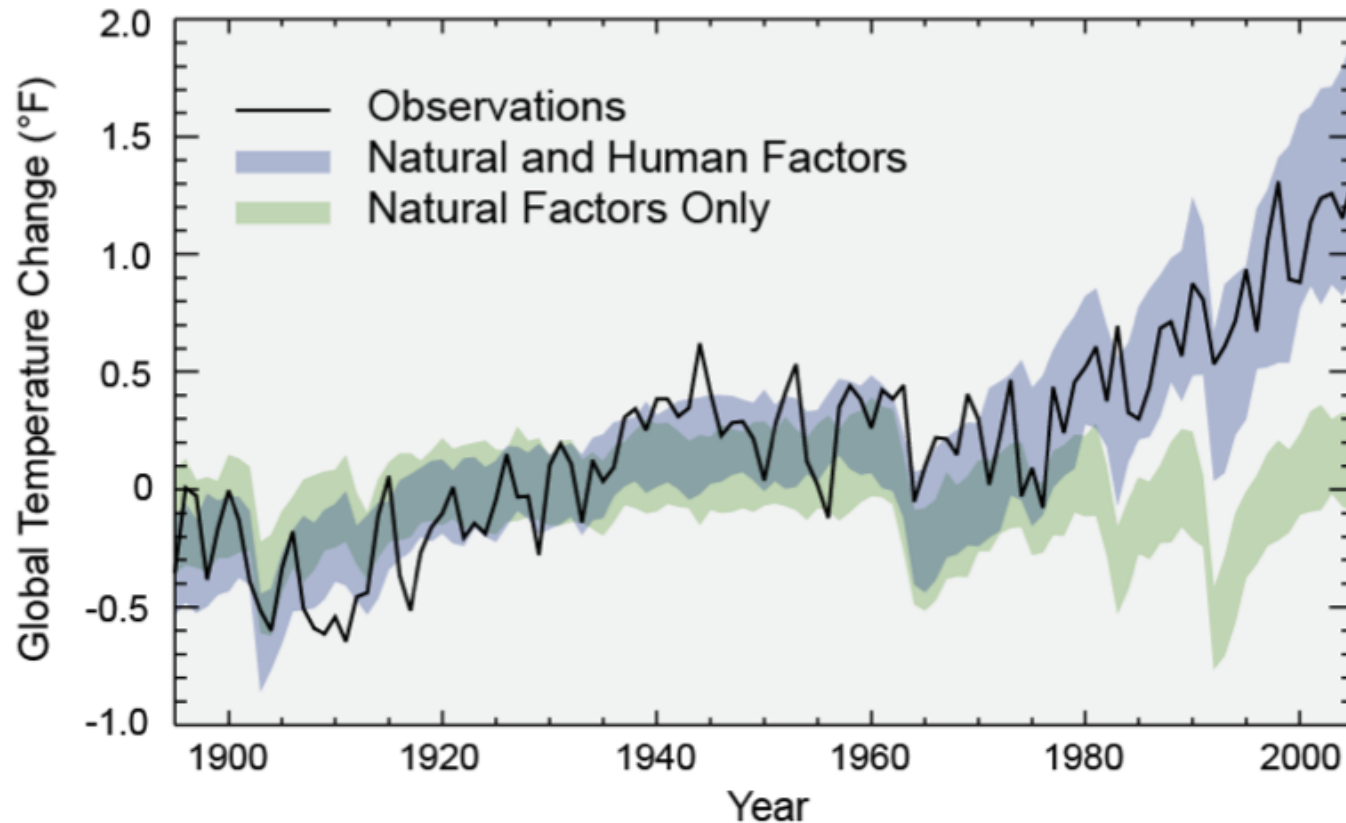
- What if greenhouse gases had not increased?
- What if they continue to increase?



Simplified Conceptual Framework of the Climate System



Separating Human and Natural Influences



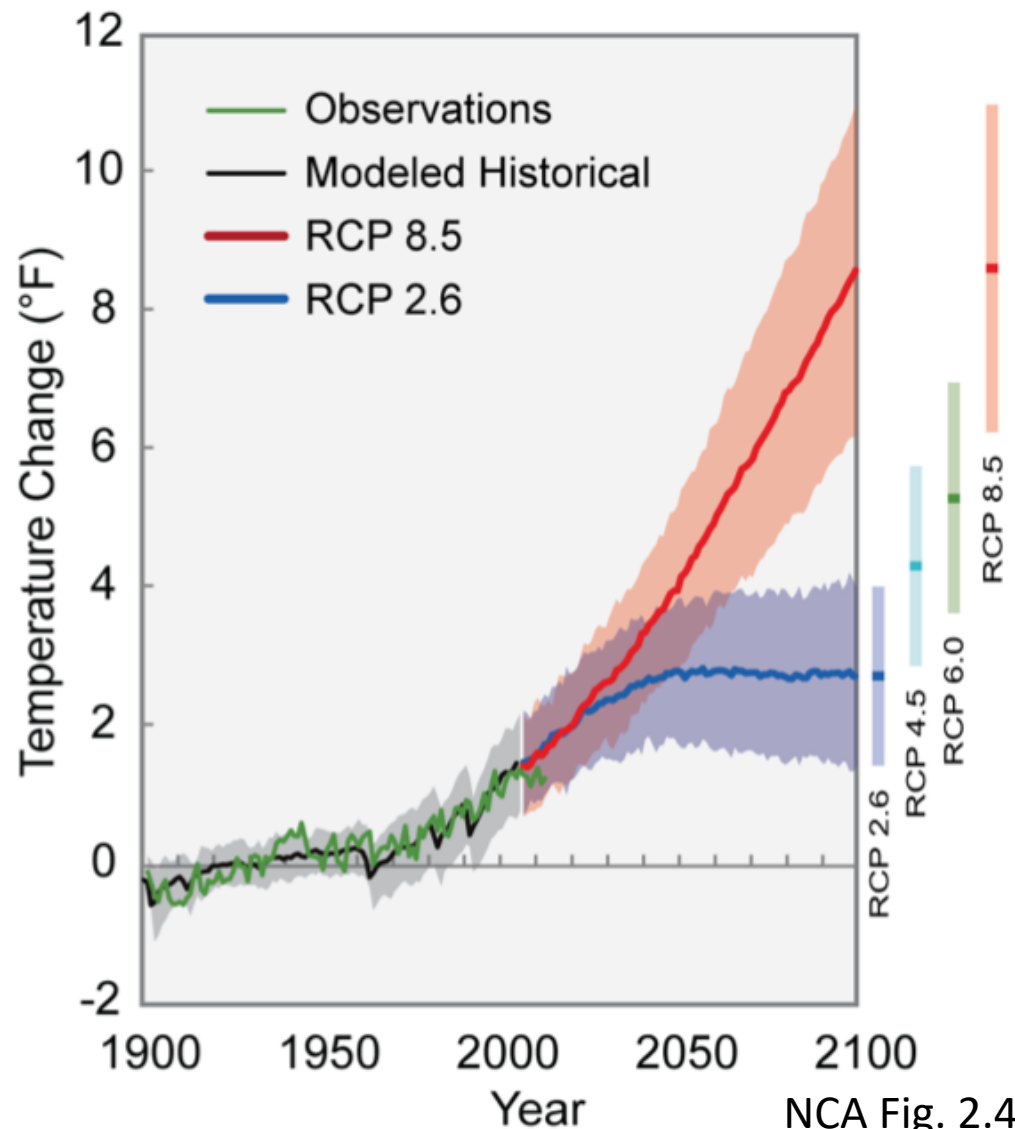
Based on our best understanding of the climate system at this time, recent warming trends cannot be explained by natural forcing alone

What Happens Next?

Mostly, it depends on us.

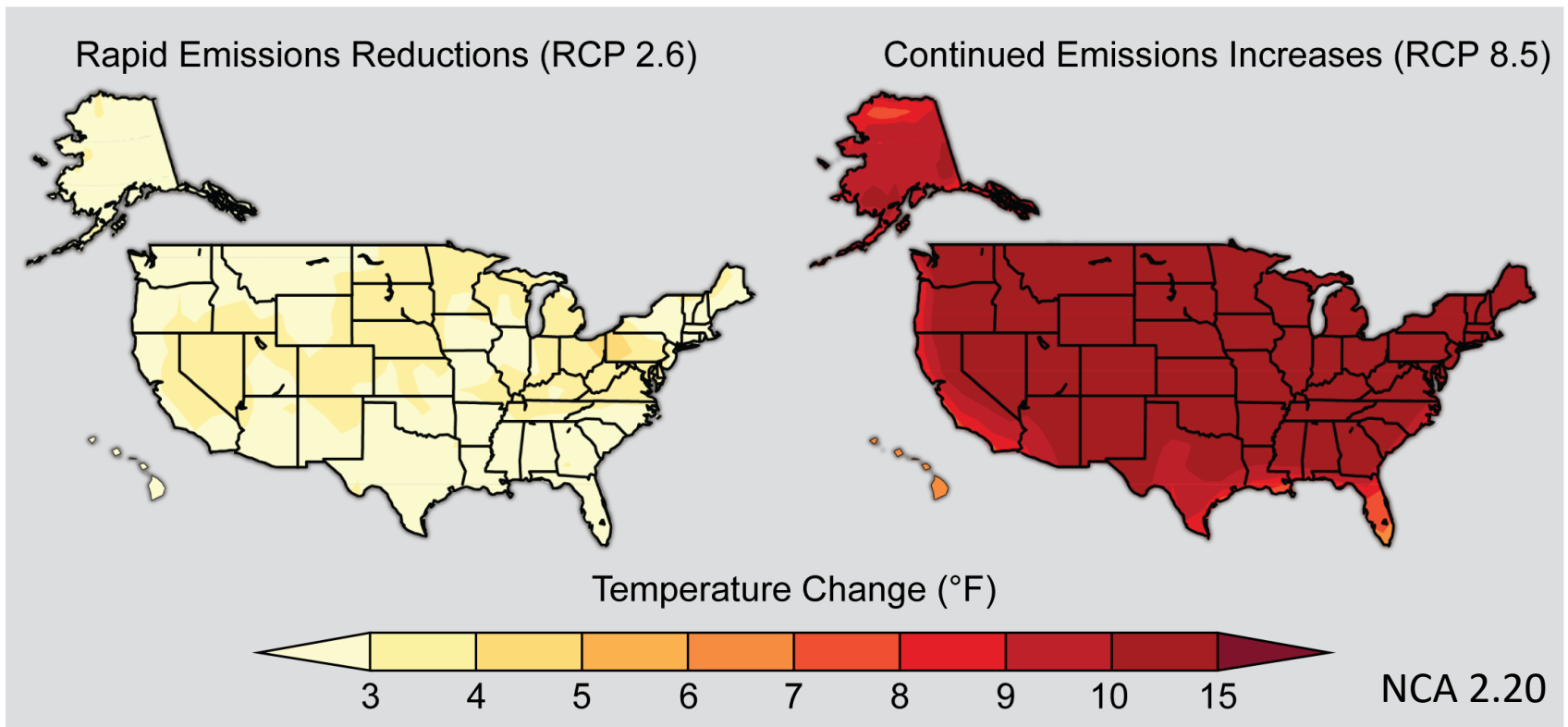
Aggressive emission reductions still lead to additional warming, but only about another 1 °F.

Worst case scenario does not really bear thinking about...



What Happens Next? Severity of Hottest Days Will Increase

Projected Temperature Change of Hottest Days



10+ (!) degree increase for Virginia under worst-case scenario

Summary

- Climate change is happening now, and will continue into the future
 - Human activity is amplifying planet's natural greenhouse effect
 - Multiple indicators pointing to a warming planet
 - We (hopefully) still have time to avoid the worst effects
- What do we do now?
 - Reduce, reduce, reduce
 - Mitigation needs to be part of any strategy. The sooner we start, the less painful it will be
 - Benefits beyond carbon reduction
 - Improved air-quality
 - Energy independence
 - We do not want to adapt to a worst-case scenario world



CLIMATE SUMMIT

WHAT IF IT'S
A BIG HOAX AND
WE CREATE A BETTER
WORLD FOR NOTHING?

- ENERGY INDEPENDENCE
- PRESERVE RAINFORESTS
- SUSTAINABILITY
- GREEN JOBS
- LIVABLE CITIES
- RENEWABLES
- CLEAN WATER, AIR
- HEALTHY CHILDREN
- ETC. ETC.



12/19 USA TODAY
JOEL PITT