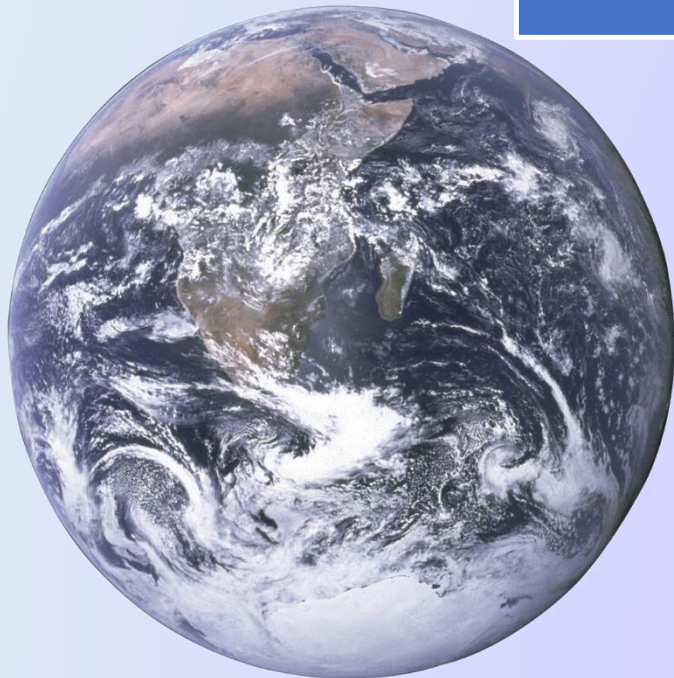


Introduction to Human-Induced Climate Change

Presentation to:
Carilion Climate Change Workshop
5 October 2019.
Roanoke, Virginia USA



Carl E. Zipper

Virginia Tech
(retired).



Presentation Goal:

Describe scientific basis for human-induced climate change theory.

Outline

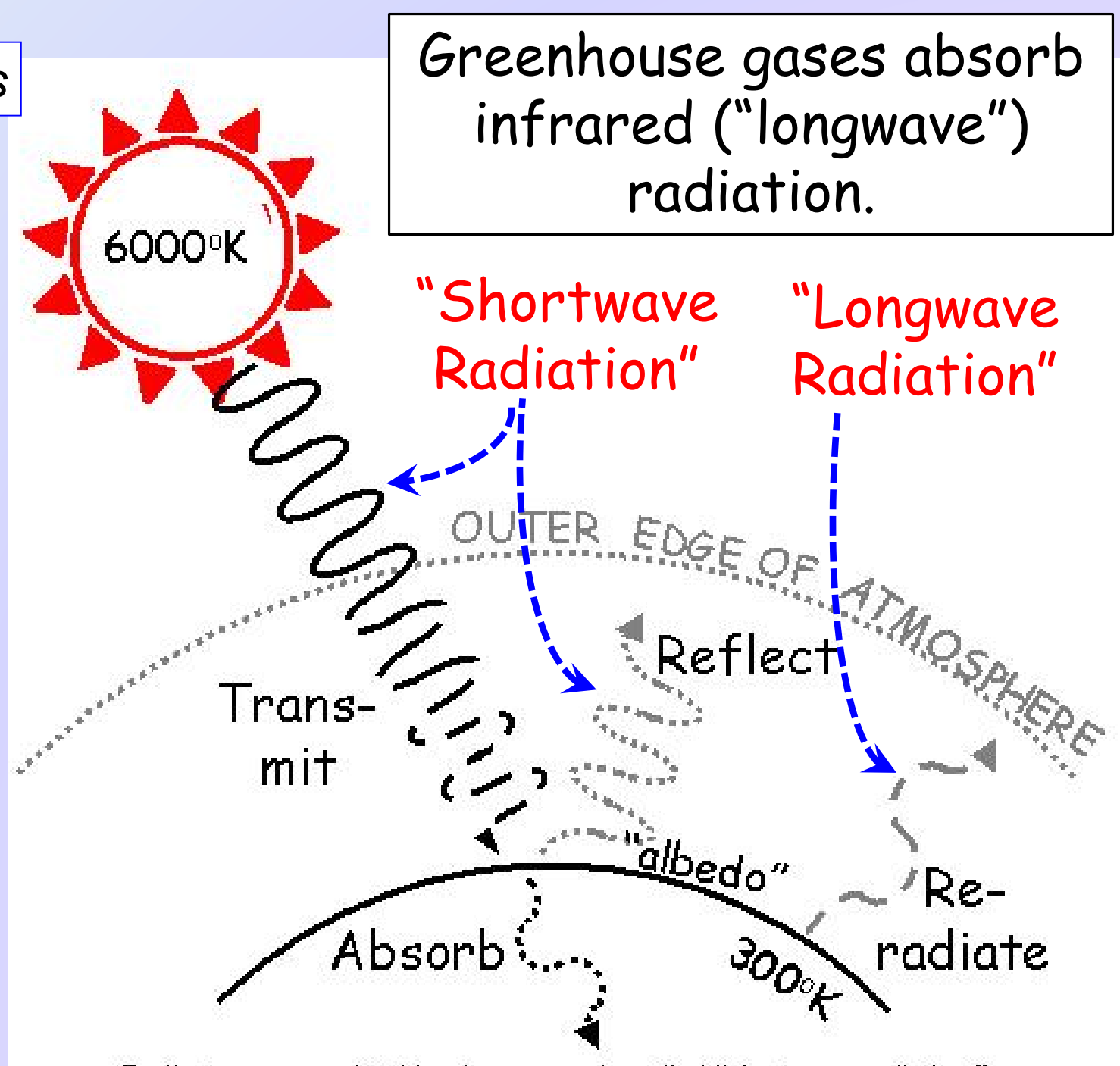
1. Well-documented scientific facts
2. The human-induced climate change theory
3. Is the theory is correct? What is the scientific evidence?
4. Climate feedbacks



Well-Documented Scientific Facts

Fact 1: Infrared (ir) absorbing “greenhouse gases” keep the earth warmer than it would otherwise be.

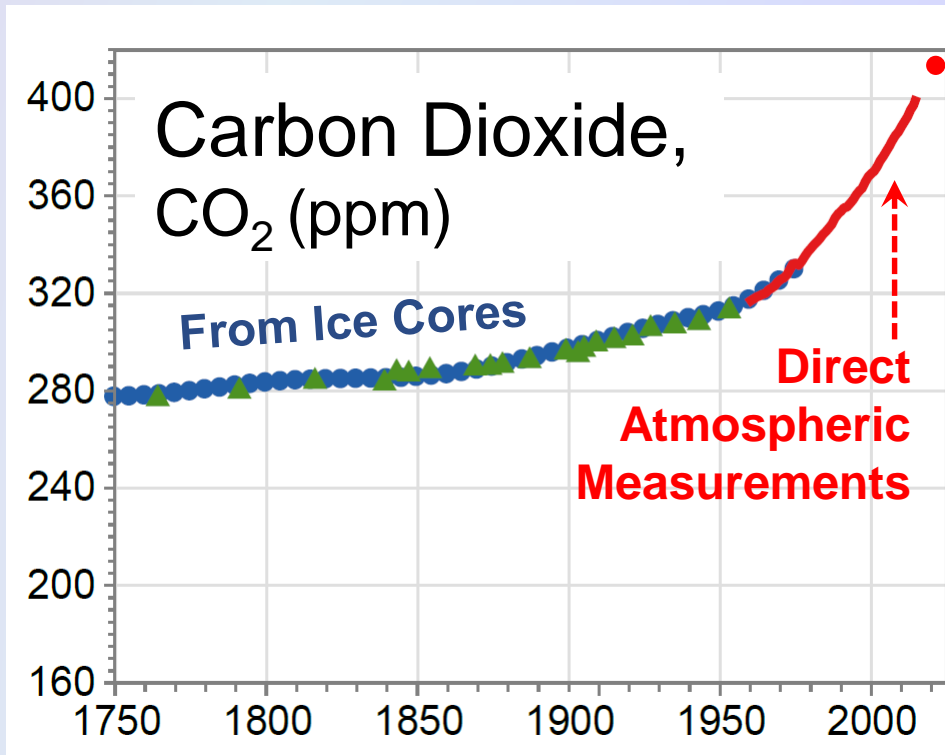
GHGs: Greenhouse gases are CO_2 , CH_4 , N_2O , O_3 , Halocarbons, and H_2O .



Well-Documented Scientific Facts

Fact 1: Infrared (ir) absorbing gases are responsible for keeping the earth warmer than it would otherwise be.

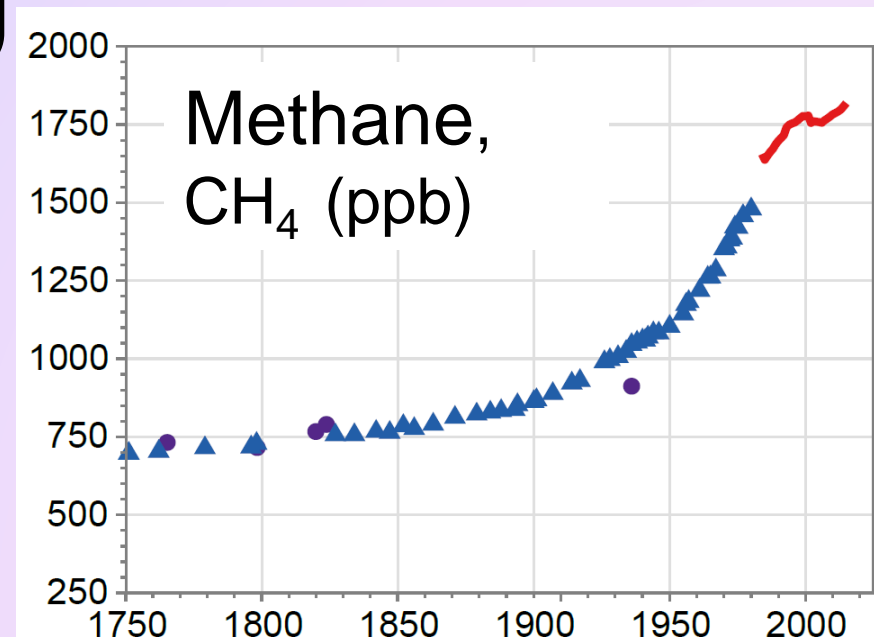
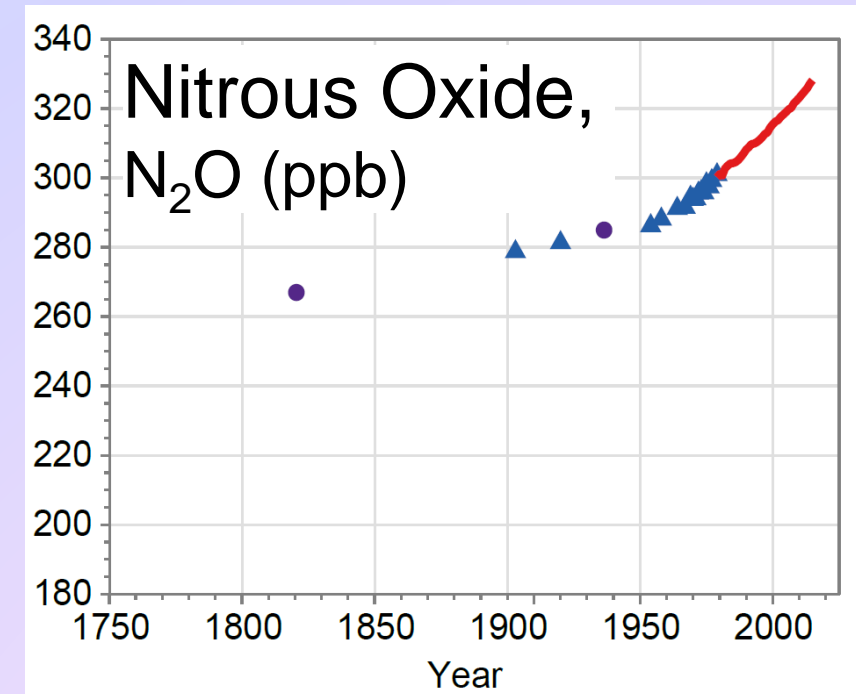
Fact 2: Atmospheric concentrations of ir-absorbing GHGs, have changed historically, are increasing rapidly today.



>415 ppm in May 2019. Highest since before human species.

Also:
Halocarbons
(classic refrigerants, CFCs, etc.)
and
Ozone (O₃)

Charts from: US Global Change Research Program, 4th National Climate Assessment 2017

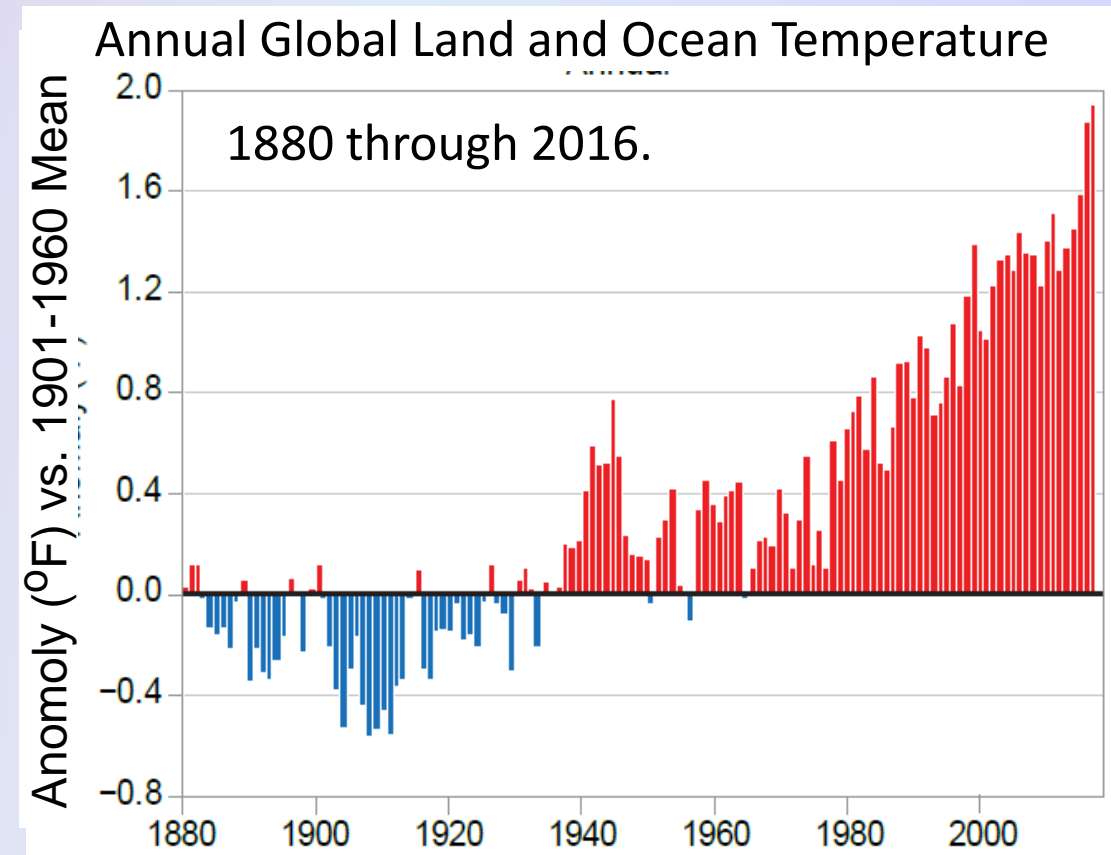


Well-Documented Scientific Facts

Fact 1: ir-absorbing gases keep the earth warmer ...

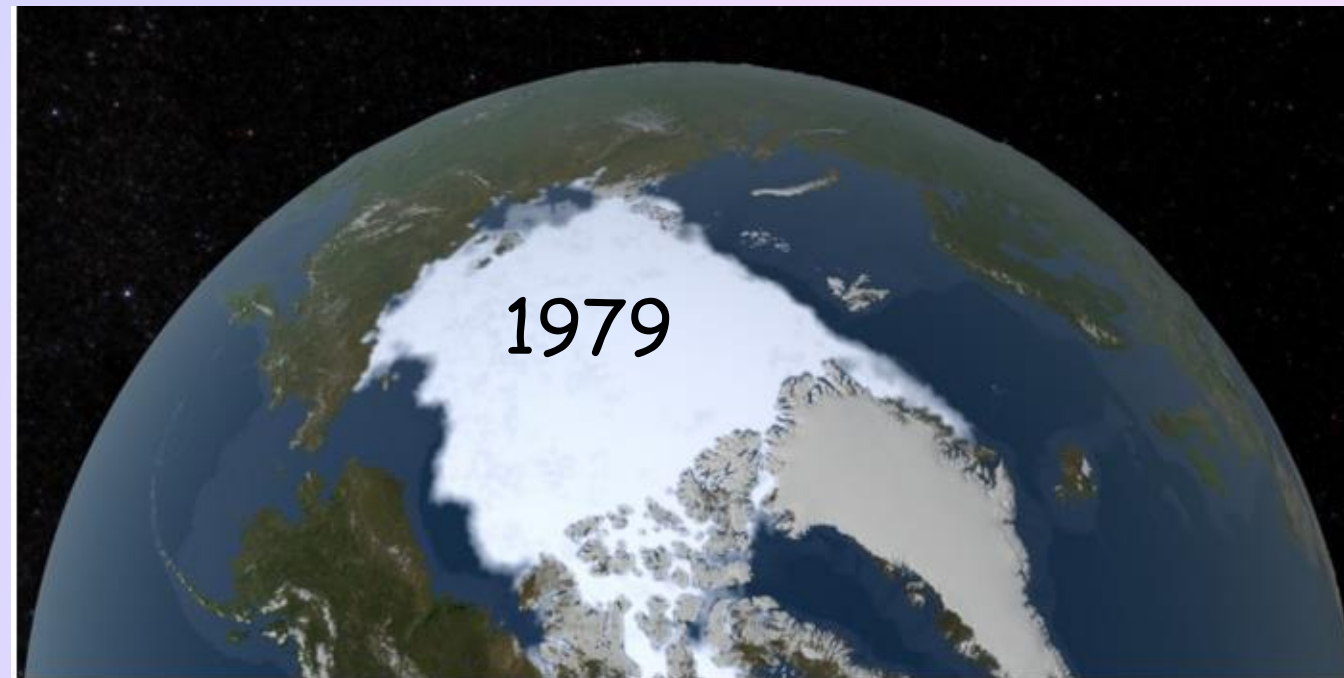
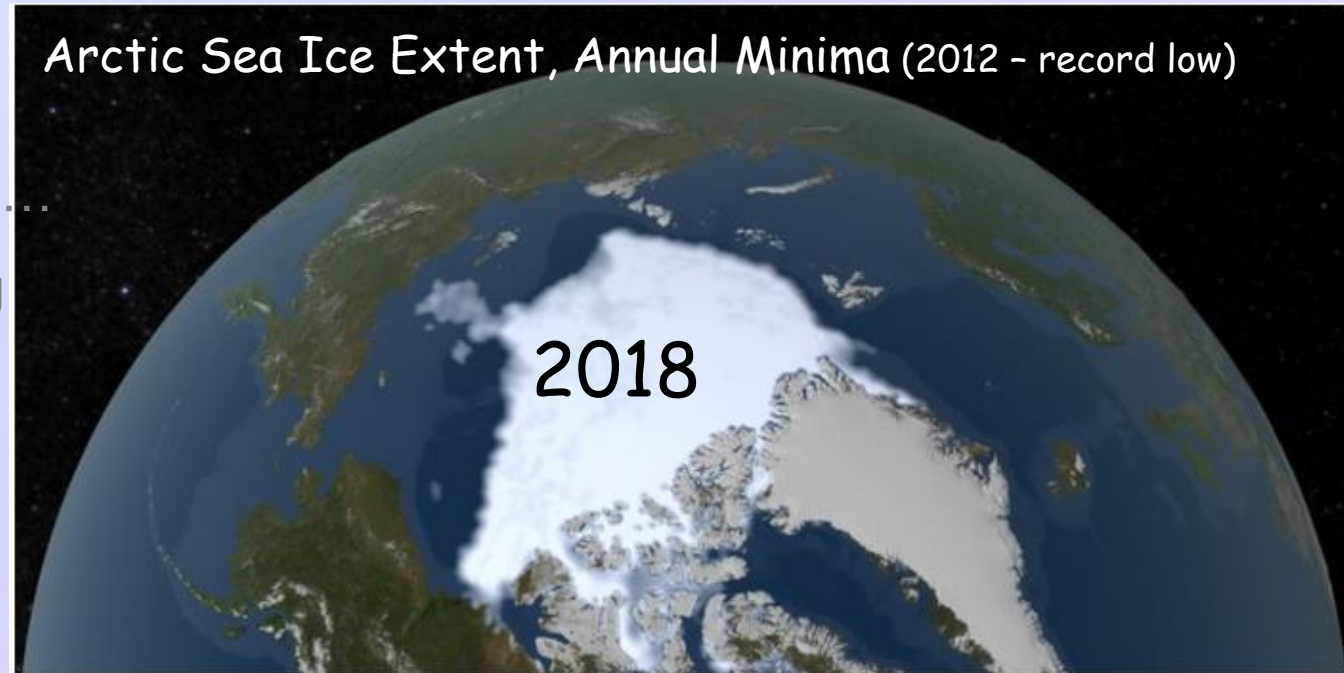
Fact 2: Atmospheric concentrations are increasing

Fact 3: Earth climate is changing ...



US Global Change Research Program, 4th National Climate Assessment 2017

Arctic Sea Ice Extent, Annual Minima (2012 - record low)

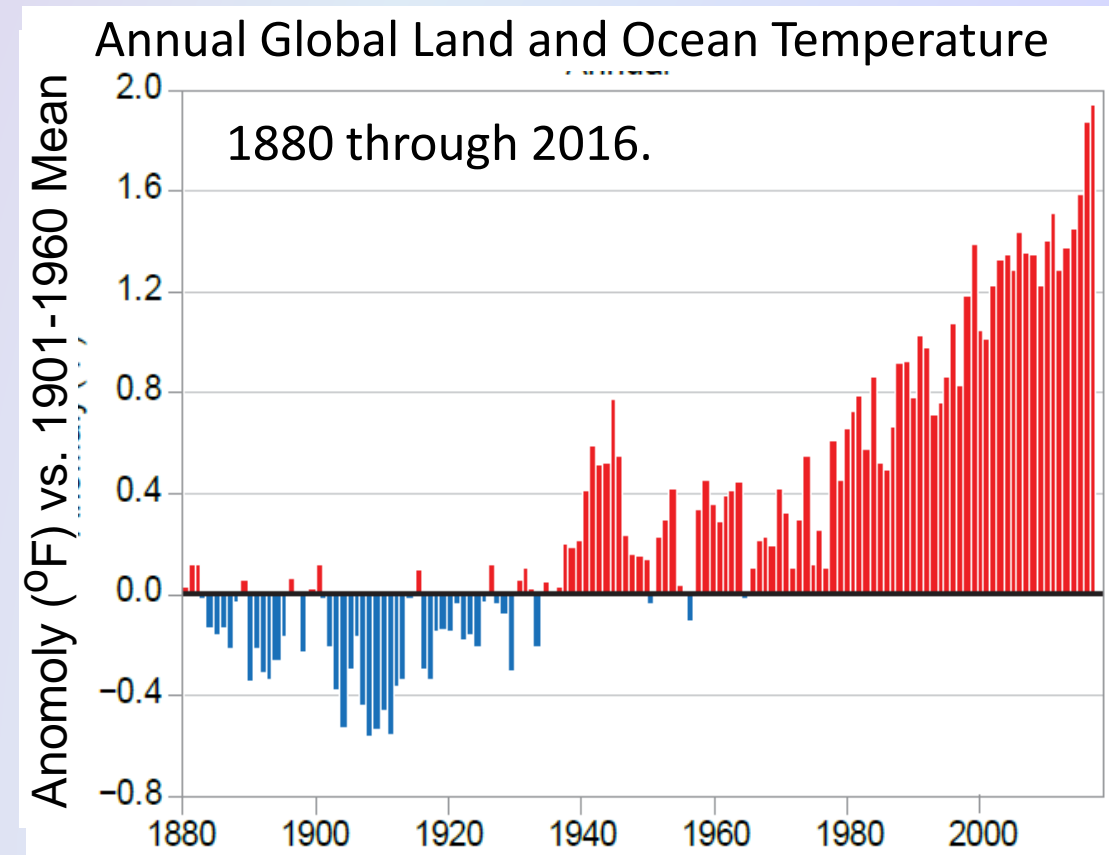


Well-Documented Scientific Facts

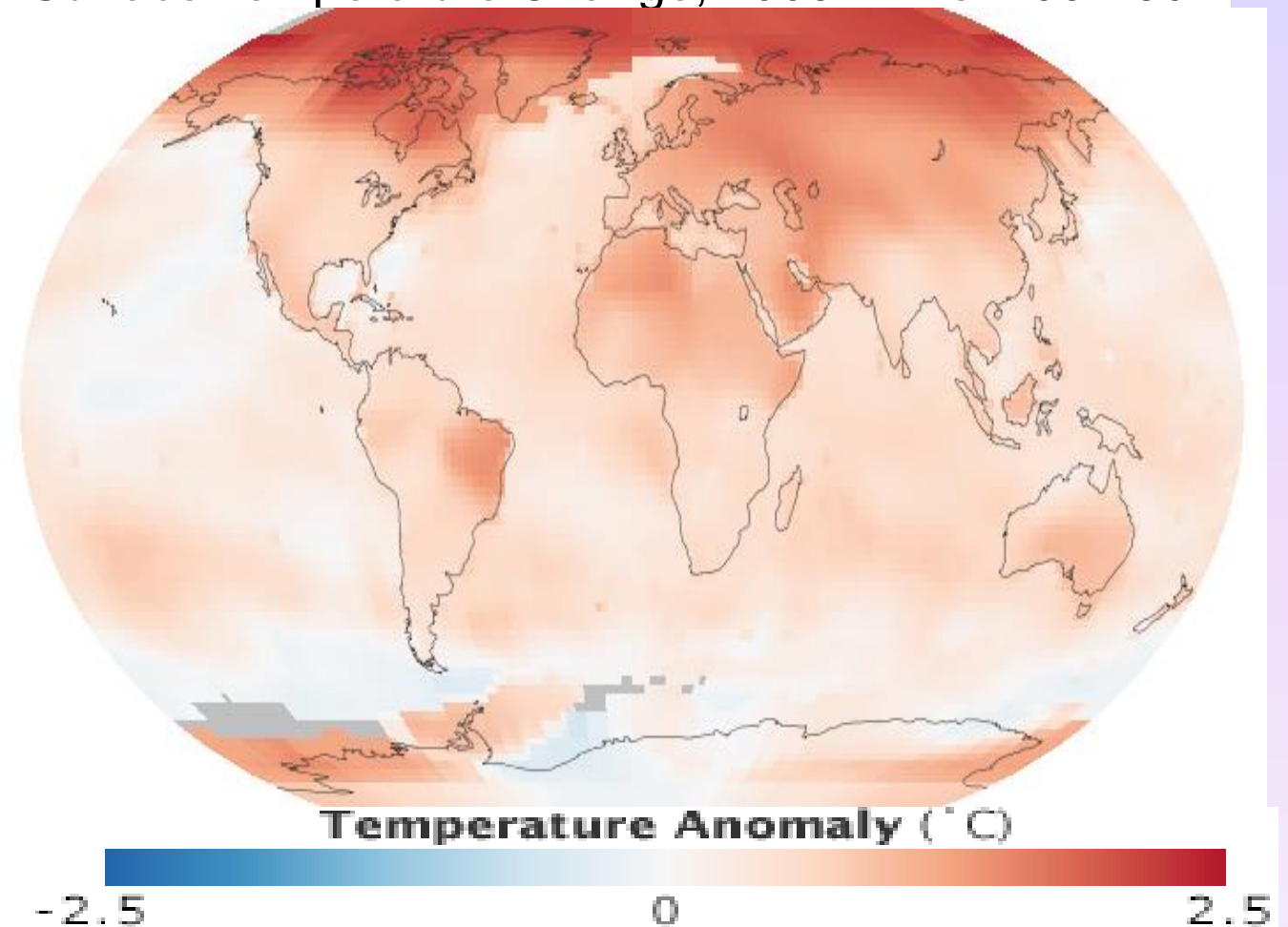
Fact 1: ir-absorbing gases keep the earth warmer

Fact 2: Atmospheric concentrations are increasing

Fact 3: Earth climate is changing ..



Surface Temperature Change, 2005-14 vs. 1951-80.



<https://earthobservatory.nasa.gov/world-of-change/DecadalTemp>

Also: Glacial retreat, sea ice extent, sea level change, rainfall distributions, ocean heat, timing of spring onset, extreme weather event frequencies, etc.

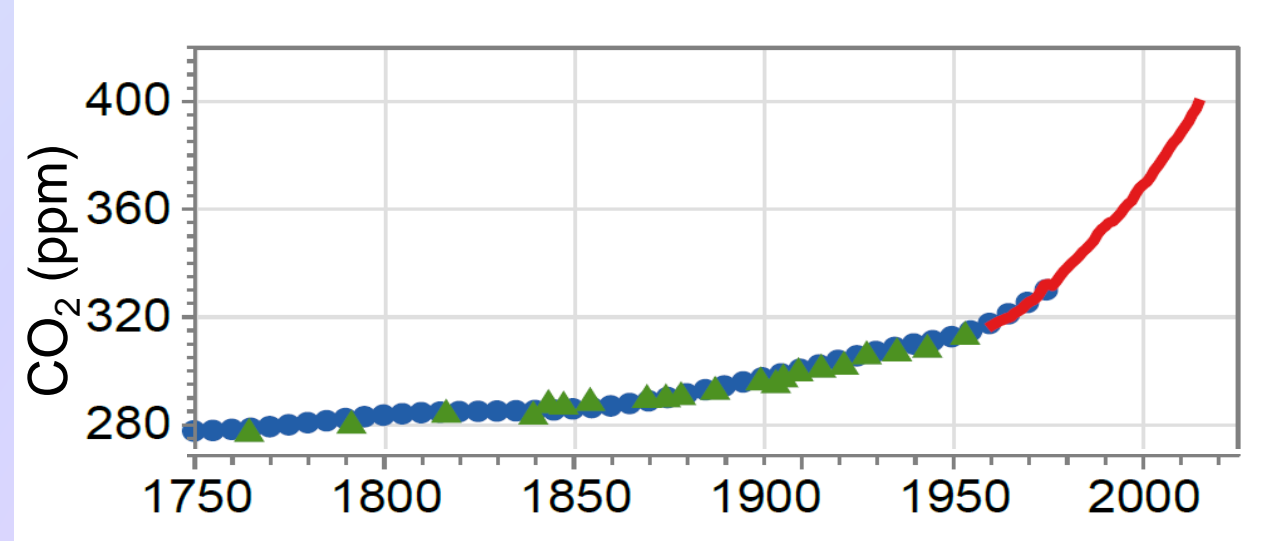
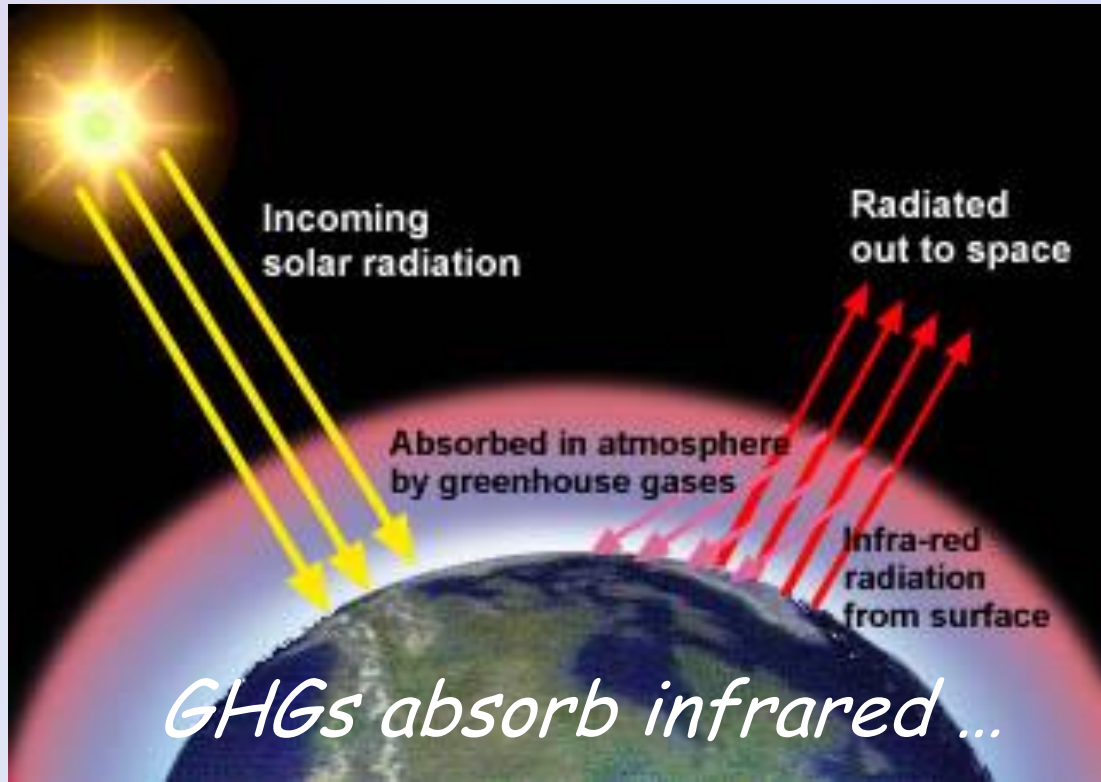
Causes of Change: Why is global climate changing?

"Anthropogenic Climate Change Theory"
(also known as "Greenhouse Theory")

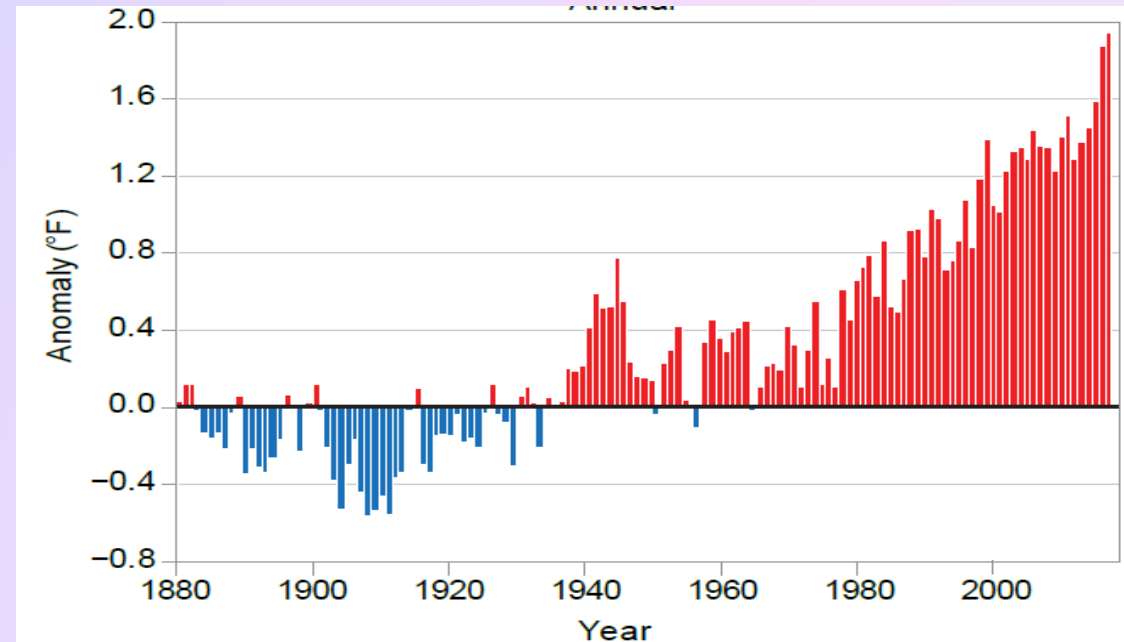
Theory: Anthropogenic
greenhouse gas emissions are
a major cause for the climate
changes that have been
observed over recent decades.

Is the theory correct? What is the scientific evidence?

1. Existence of a credible mechanism, grounded in scientific logic



combined with correspondence
in time of changing climate with
GHG concentration increases

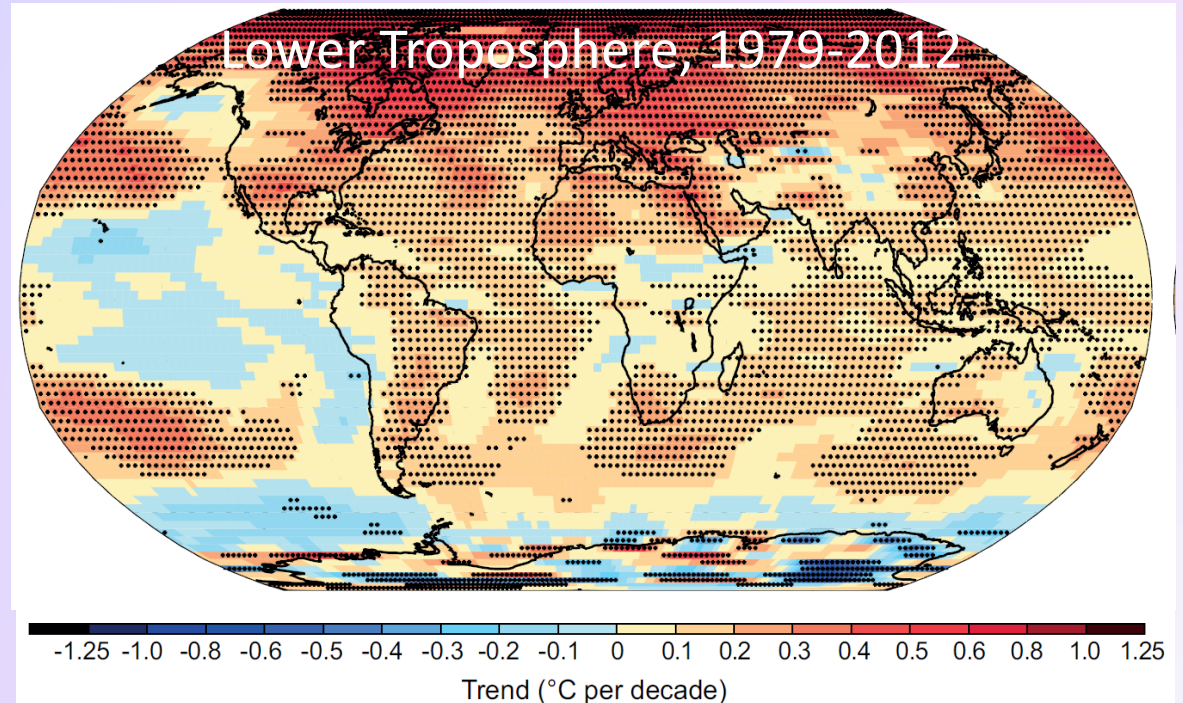
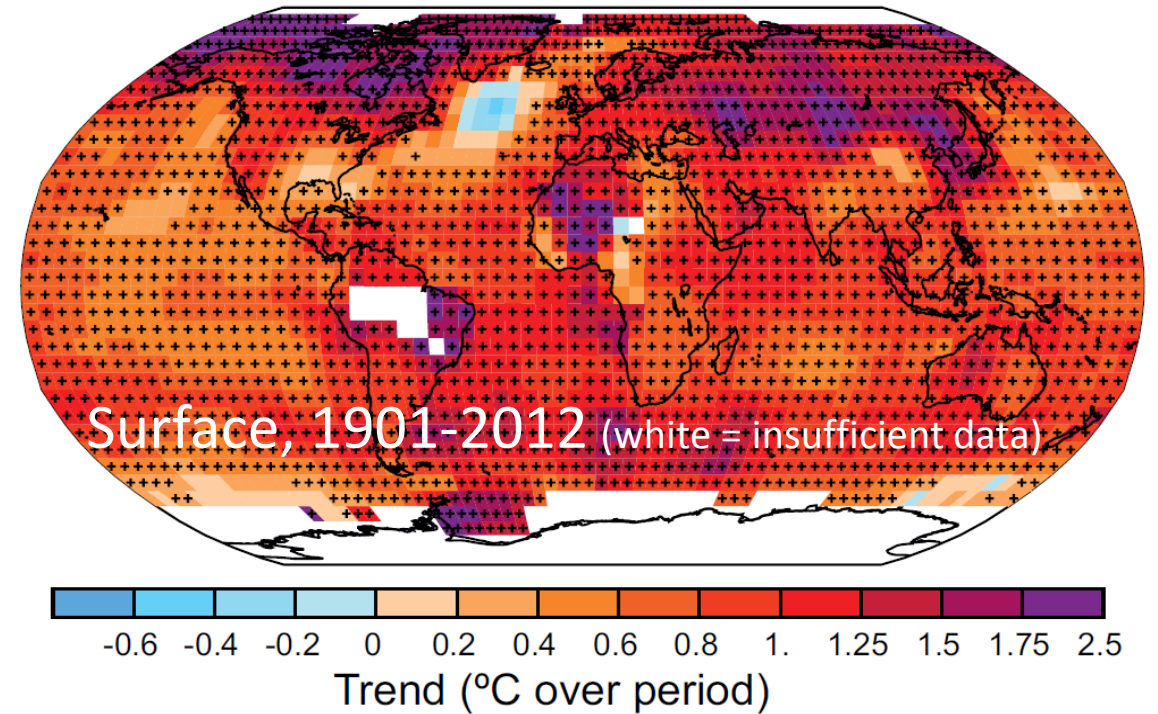


Is Anthropogenic Climate Change Theory Correct?

2. Warming is widespread ...

All continents, land surface, atmosphere, and ocean are warming. Such warming could not have occurred without "external forcing". IPCC scientists find no evidence that the sum of solar and volcanic forcings have produced such warming.

Graphics: IPCC WG1 AR5 Ch. 2, pp. 193 & 200



3. Pattern of warming is consistent with the greenhouse-theory mechanism, is inconsistent with explanations by skeptics:

Nights have warmed more than days: Infrared emission & absorption occurs both night and day. If increased solar output was cause, days would warm more than nights.

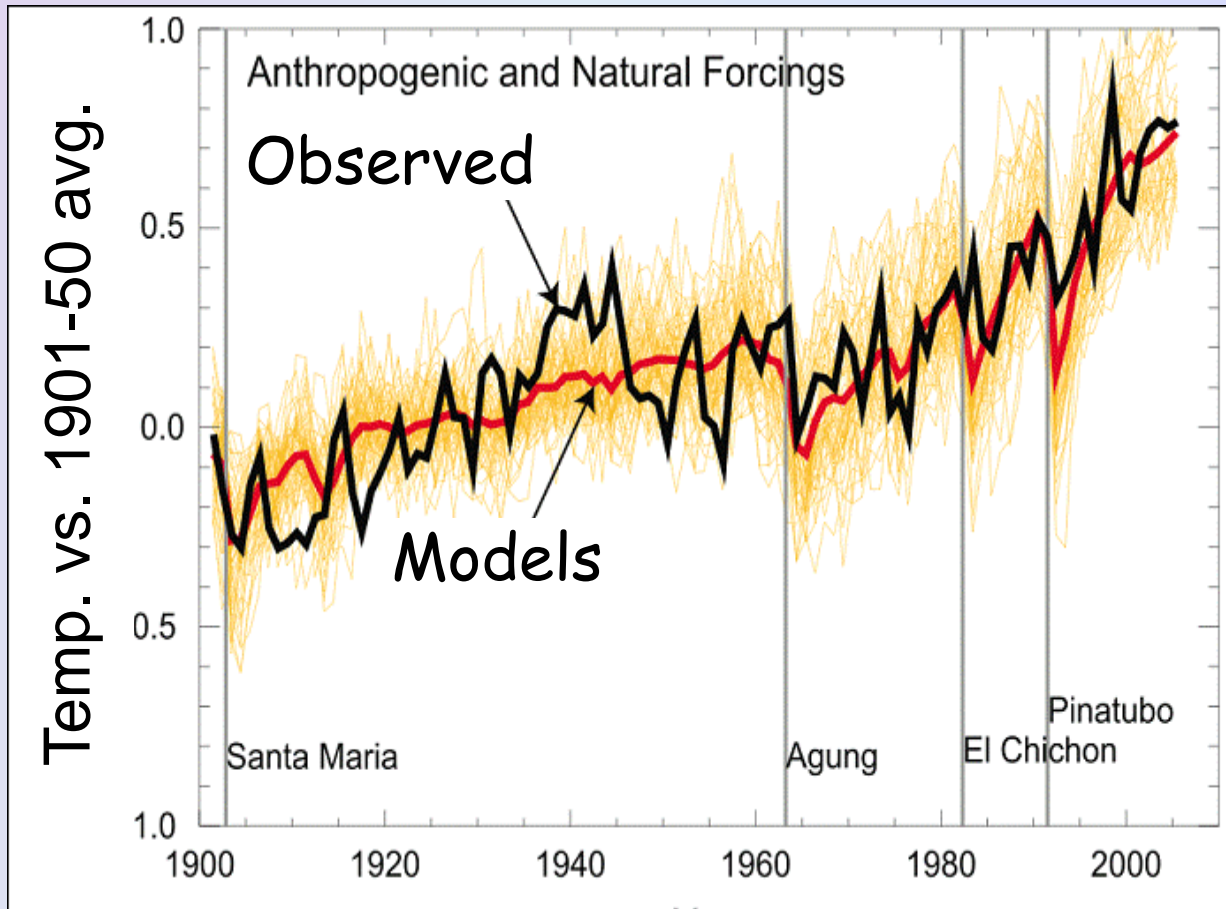
The stratosphere has cooled: If increasing solar output was cause, this would not occur.

Warming has occurred over both land and oceans: If human-induced heat, “urban heat effect”, etc. were responsible, this would not occur.

The arctic has warmed more than other regions: Evidence for “ice-albedo feedback.” Ice melting decreases albedo, increases solar absorption and infrared emissions.

Is Anthropogenic Climate Change Theory Correct?

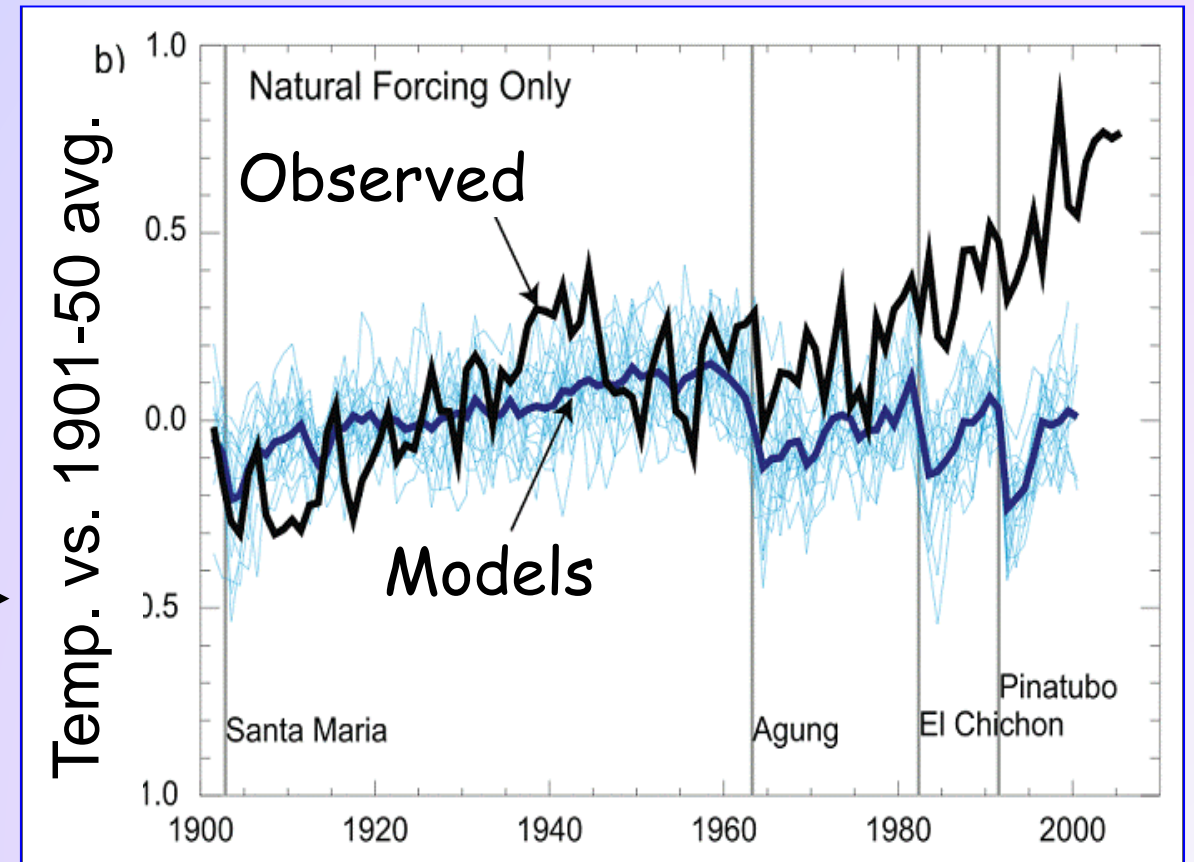
4. Global climate models reproduce recent warming only by incorporating anthropogenic GHGs.



Anthropogenic +
Natural Forcings

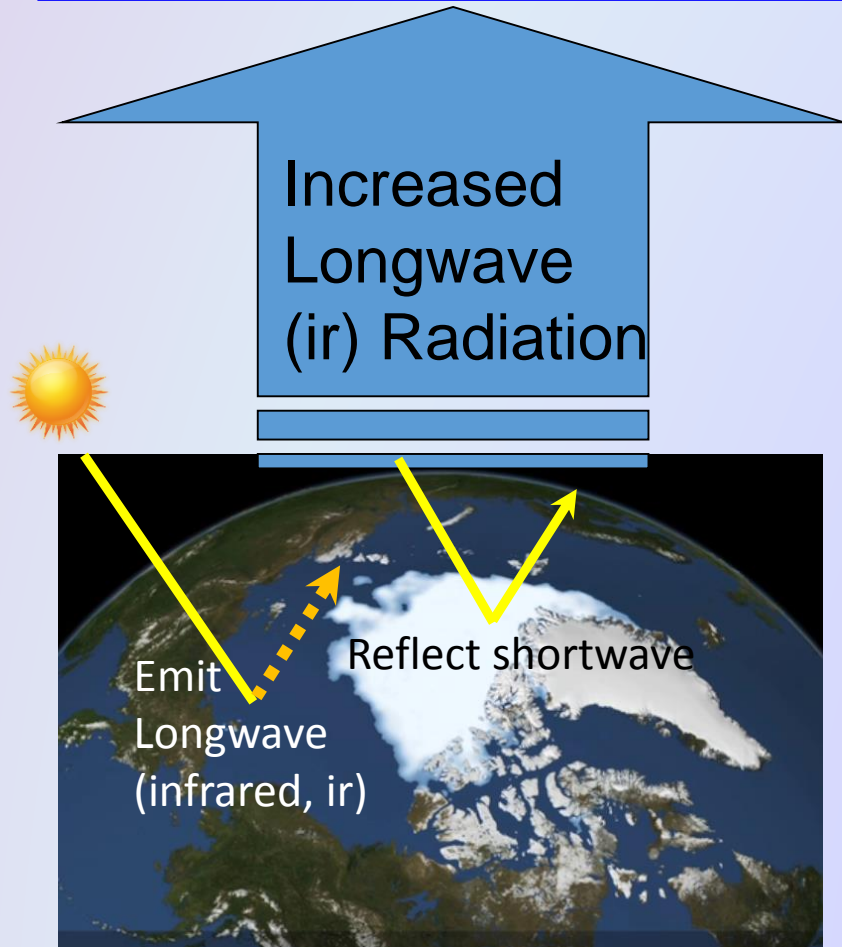
Source: IPCC, AR4 (2007), WG1
Fig. 9.5; WG1 TS Fig. 23

Natural
Forcings
Only



“Feedbacks”

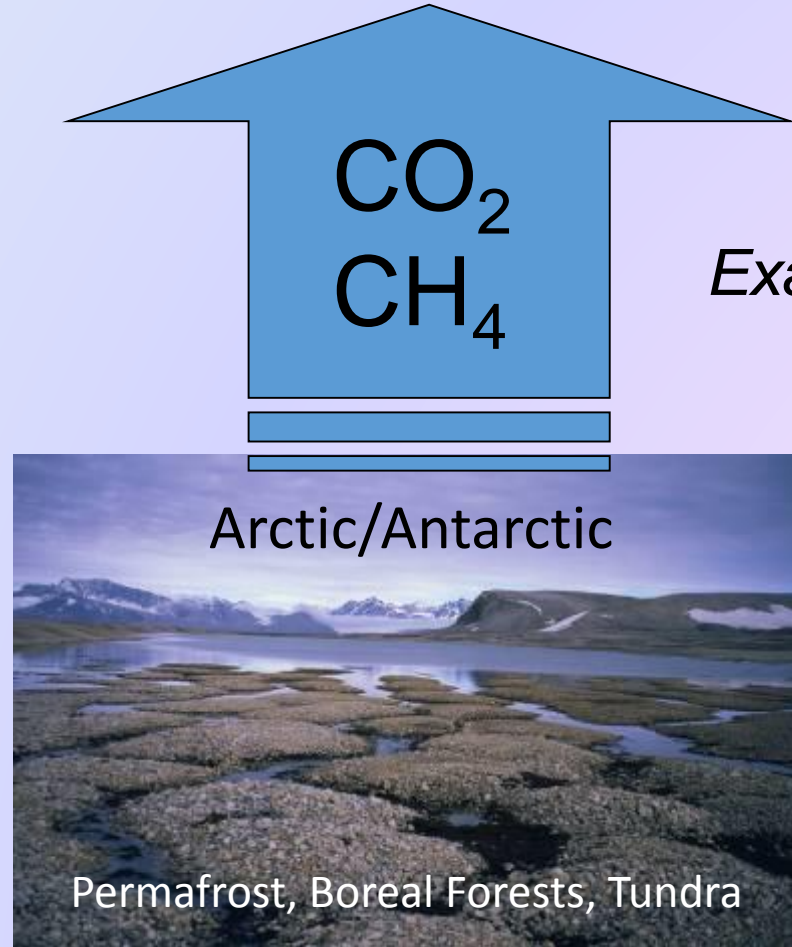
“Ice-Albedo Feedback”



Ice & snow loss increases ir for absorption.

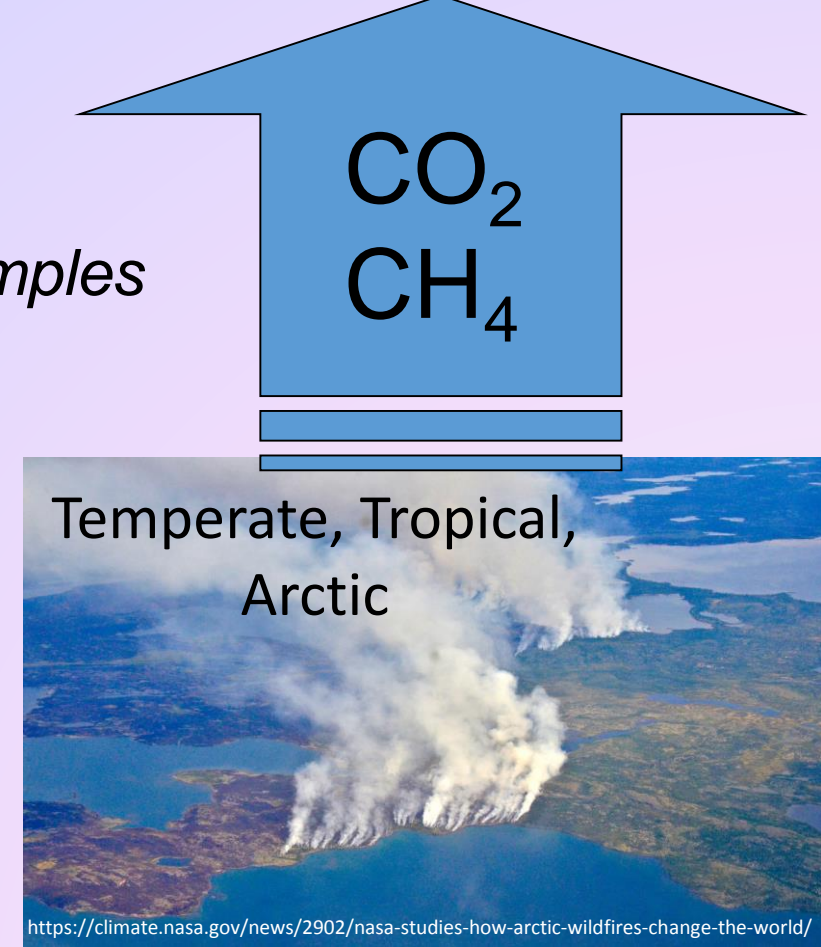
As earth-system carbon & radiation dynamics change, greater risk of climate change beyond human control.

“Biosphere Feedback”



Frozen biomass does not biodegrade.

Examples



Climate-induced ecosystem change

Introduction to Human-Induced Climate Change

Summary

1. Well-documented scientific facts
2. The human-induced climate change theory
3. Is the theory is correct? What is the scientific evidence?
4. Climate feedbacks

Thank You!