

Climate Change: Our BIG PICTURE understanding

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C2ES

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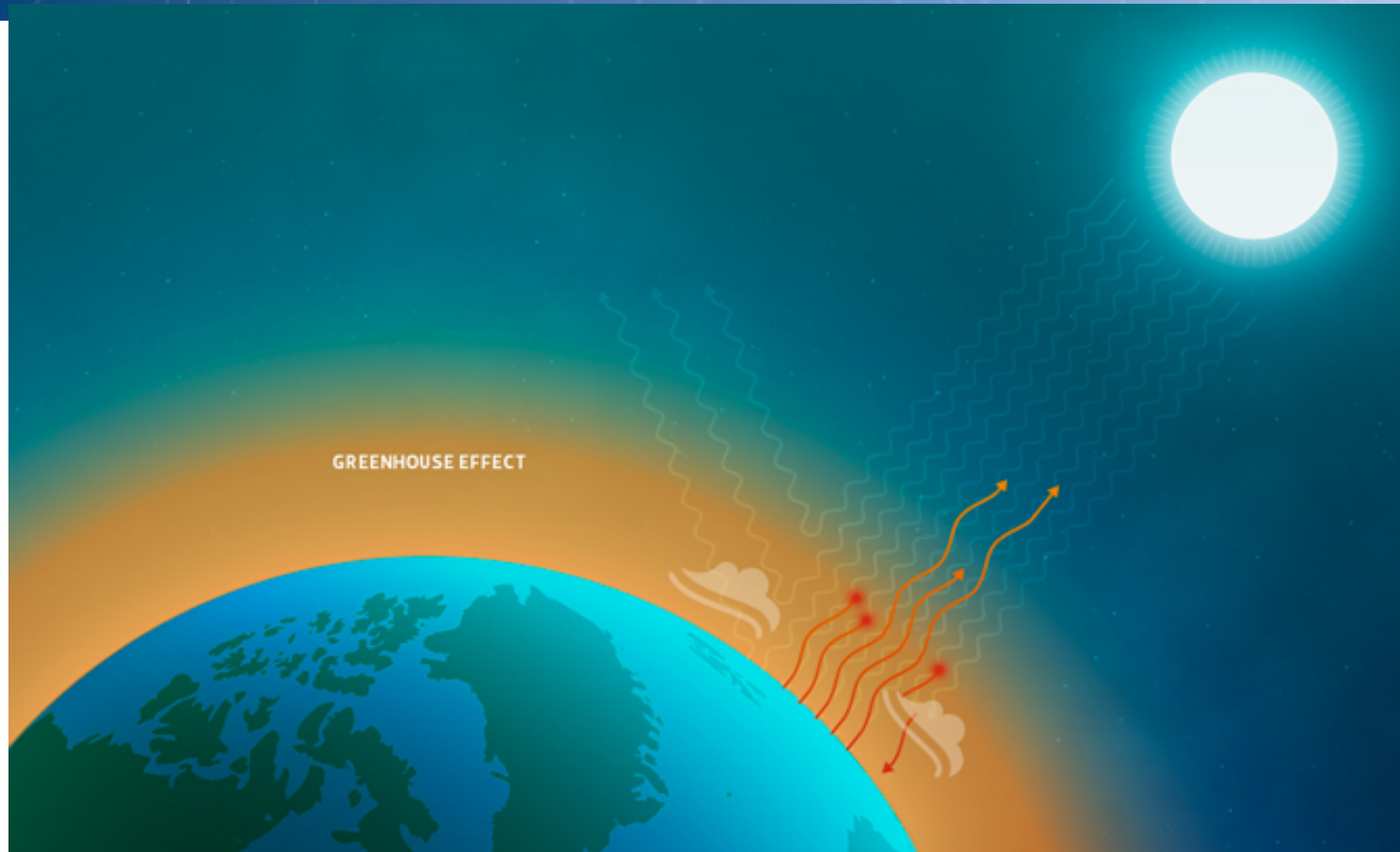


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AND ENERGY SOLUTIONS

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- 1) Carbon dioxide (CO₂) and other greenhouse gases make the planet warmer**
- 2) CO₂ is accumulating in the atmosphere**
- 3) The planet is warming**
- 4) Warming is best explained by humans' emissions of CO₂ and other greenhouse gases**
- 5) Future warming should be expected**

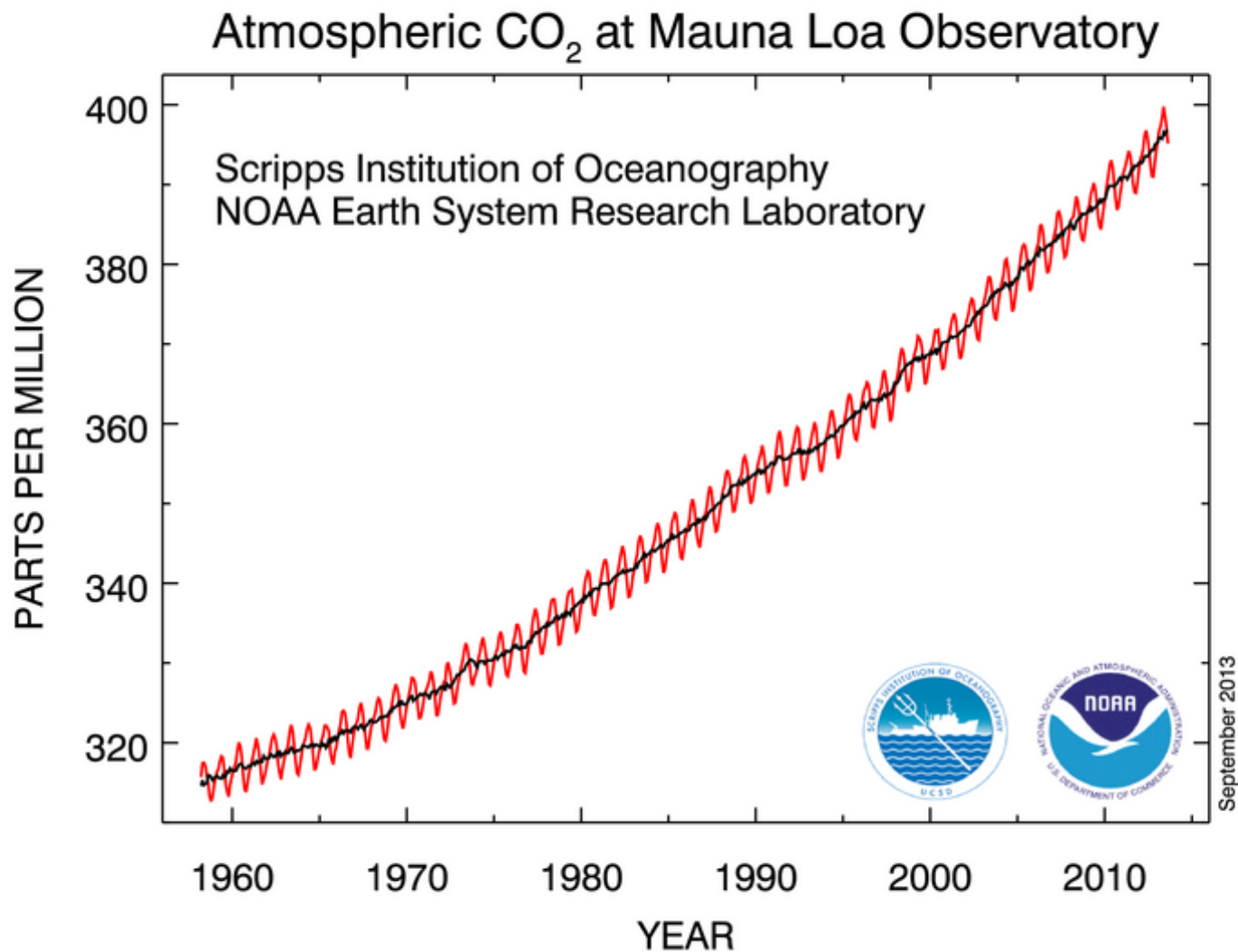
1) Greenhouse gases (GHGs) warm the planet



<http://www.epa.gov/climatechange/science/causes.html>

- GHGs absorb and re-emit infrared radiation back to the surface
- GHGs “naturally” keep the Earth about 60°F warmer than it would be without them

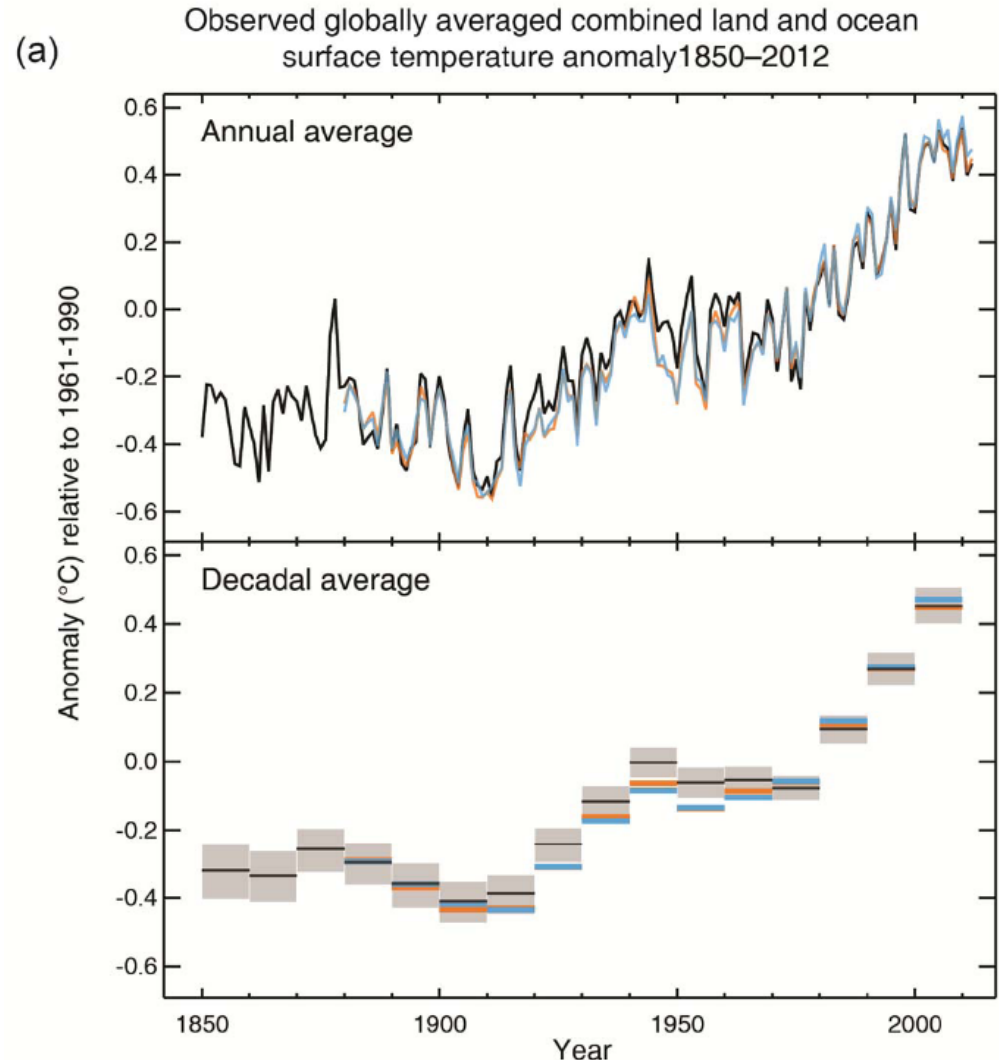
2) CO₂ is accumulating in the atmosphere



3) The Earth is warming



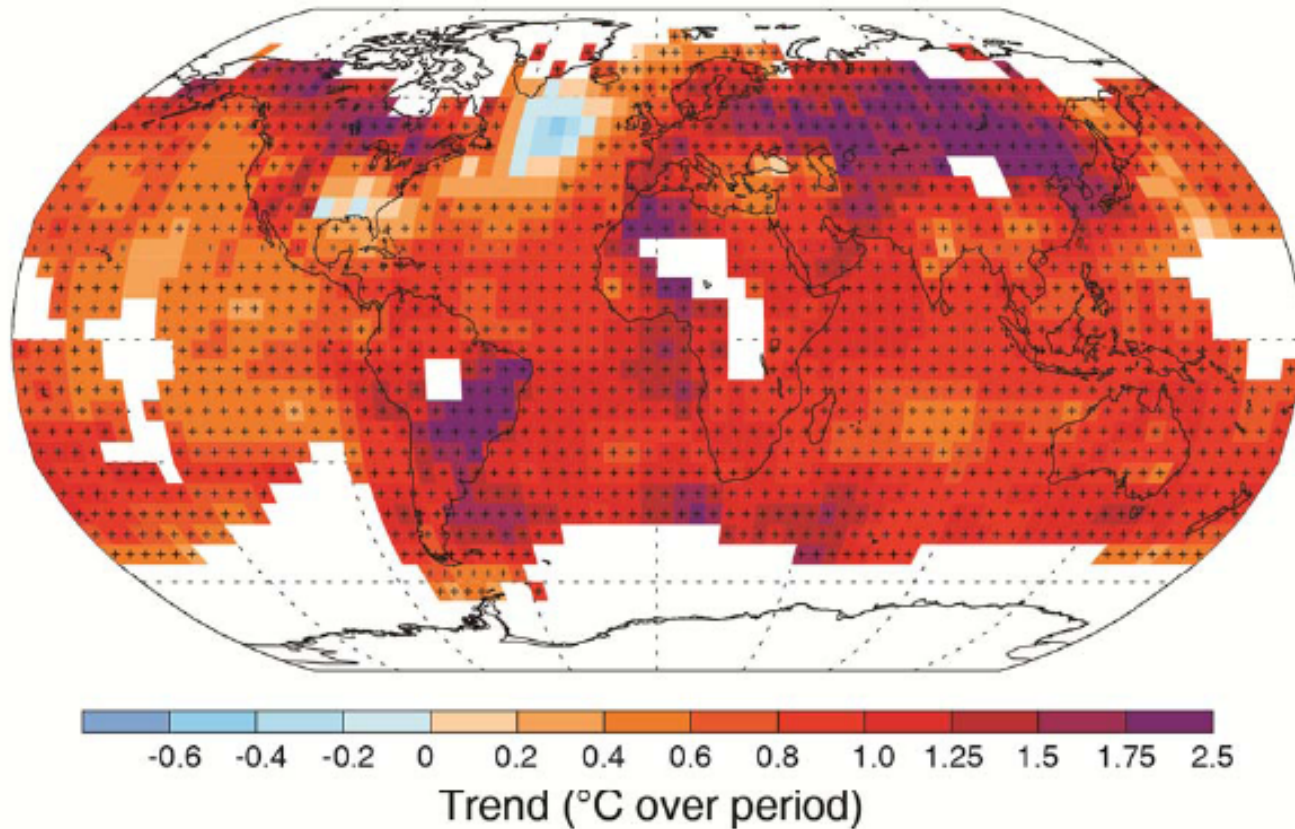
- **2000's were the warmest decade in the data record**
- **Every decade has been warmer than the previous one since the 1970s**



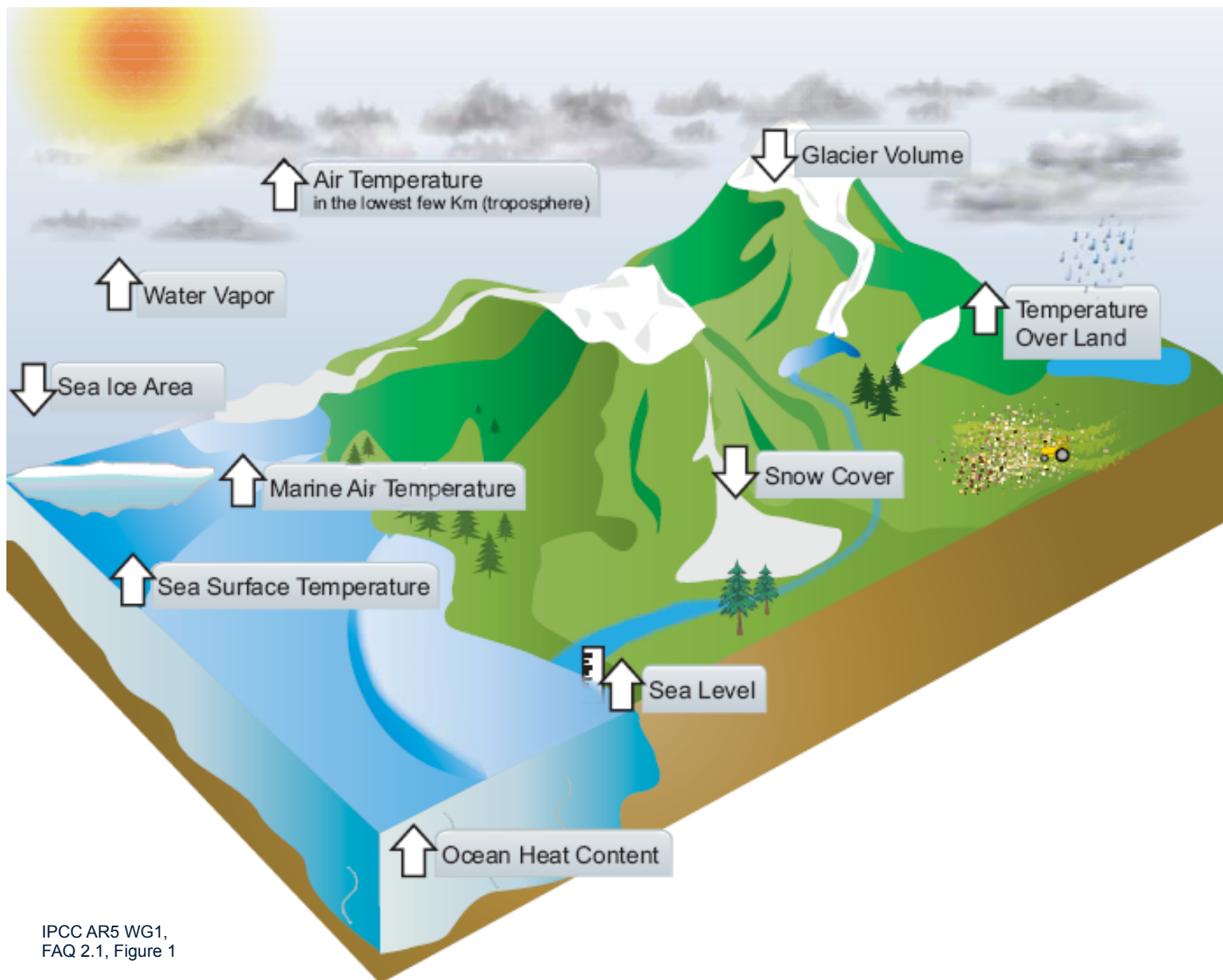
Warming nearly everywhere throughout 20th century



(b) Observed change in average surface temperature 1901–2012



Warming is consistent with other global changes



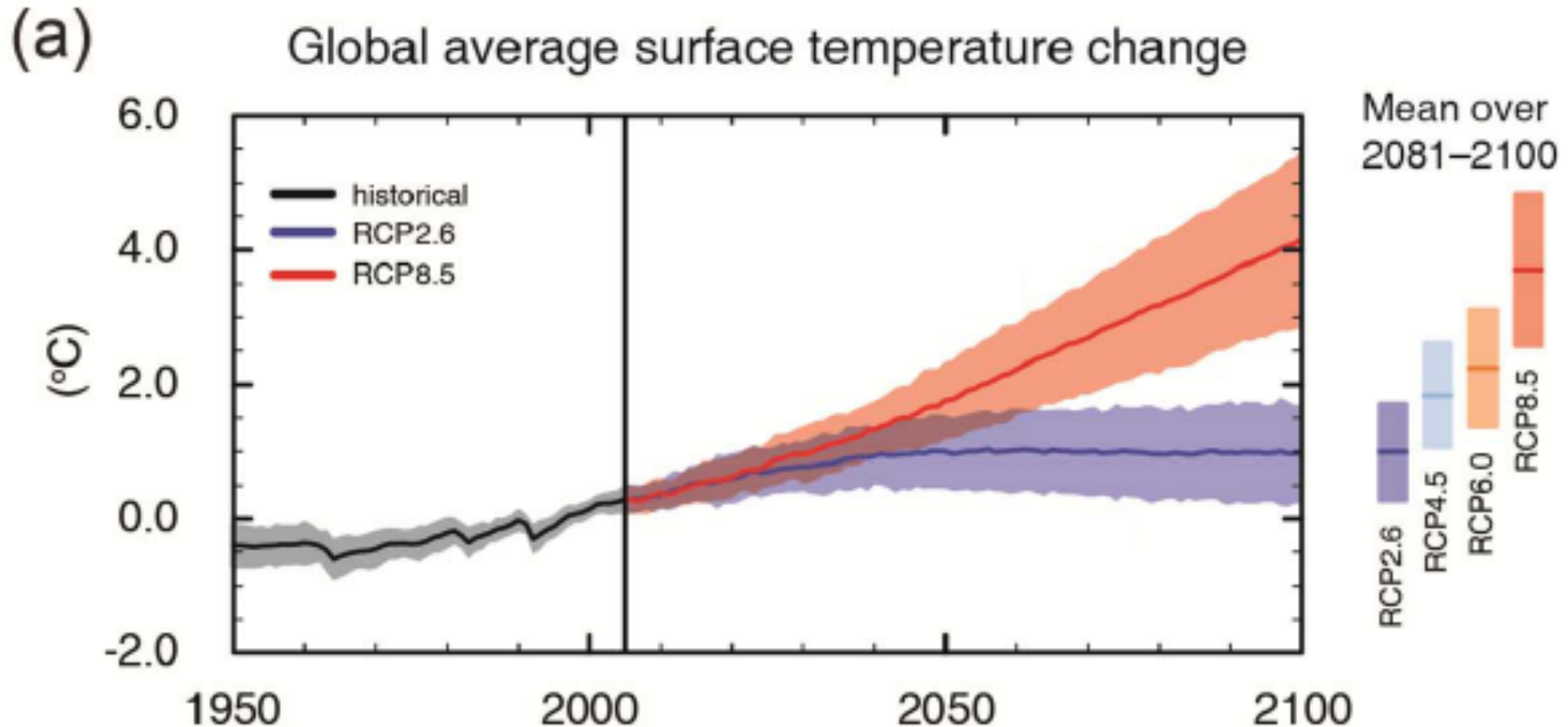
4) Warming is unusual; best explained by our emissions



- Magnitude and rate of warming is large (warmer than in last 400 years, at least; ice ages only +/- 5°C)
- Spatial and vertical pattern of warming matches what greenhouse gases “should” do
- Changes in other factors that drive climate (like the Sun) don’t explain warming
- Models can only replicate 20th century warming when greenhouse gases are included

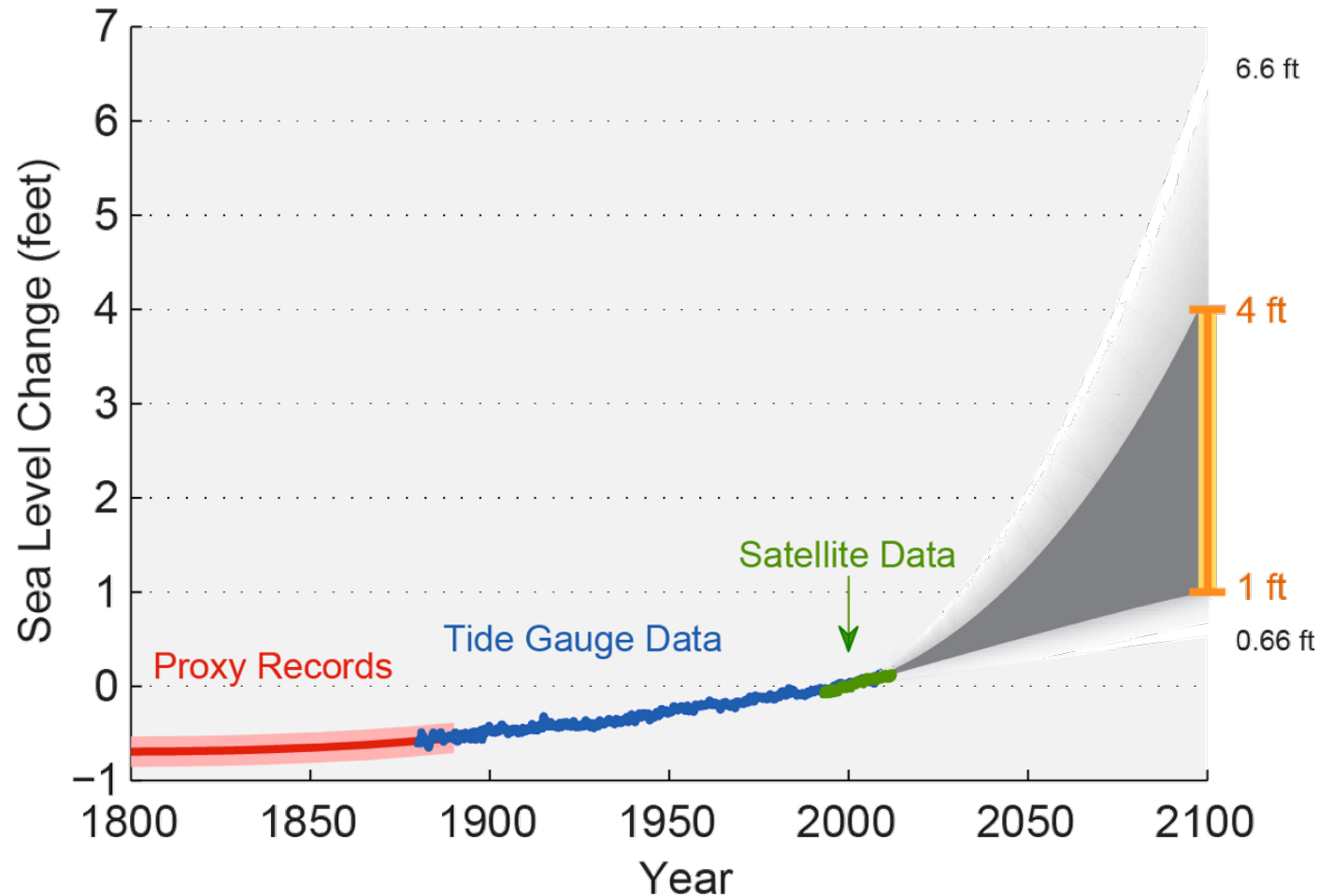


5) Future climate likely to be much warmer



“RCP” - Representative Concentration Pathways [in W/m^2]

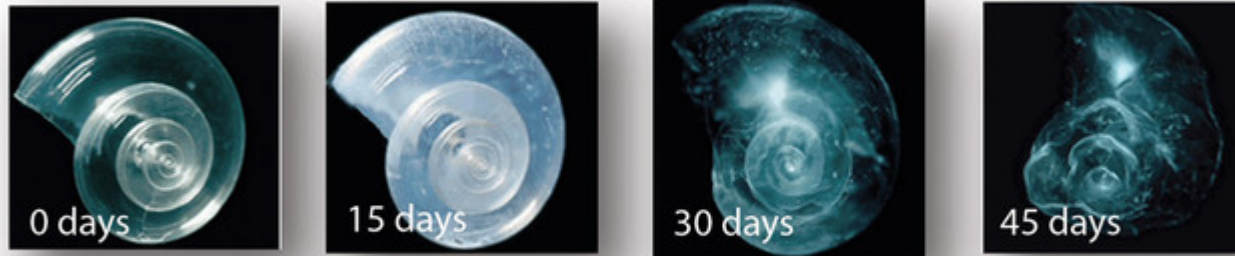
Past and Projected Changes in Global Sea Level



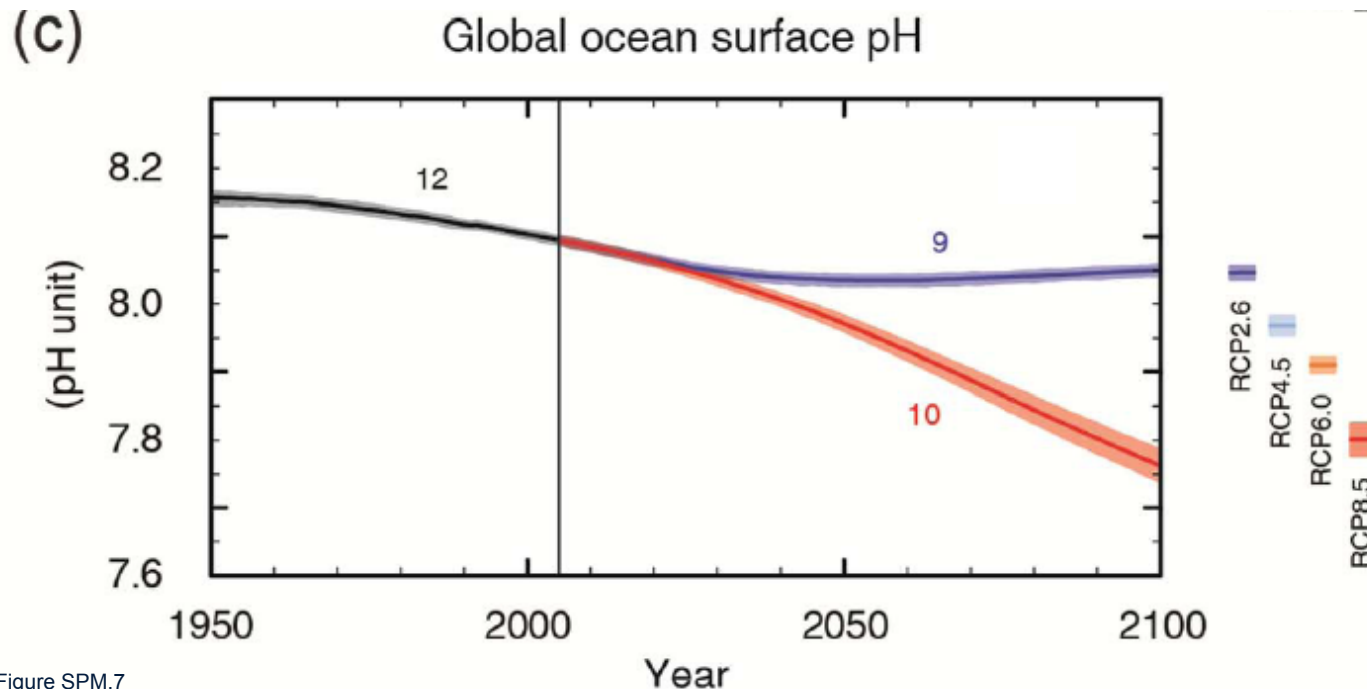
Increasing CO₂ → More acidic oceans



Pteropod exposed to “2100 seawater” (water that is 50% more acidic than present day)



National Geographic and NOAA Pacific Marine Environmental Lab
<http://ngm.nationalgeographic.com/2007/11/marine-miniatures/acid-threat-text>
<http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F>

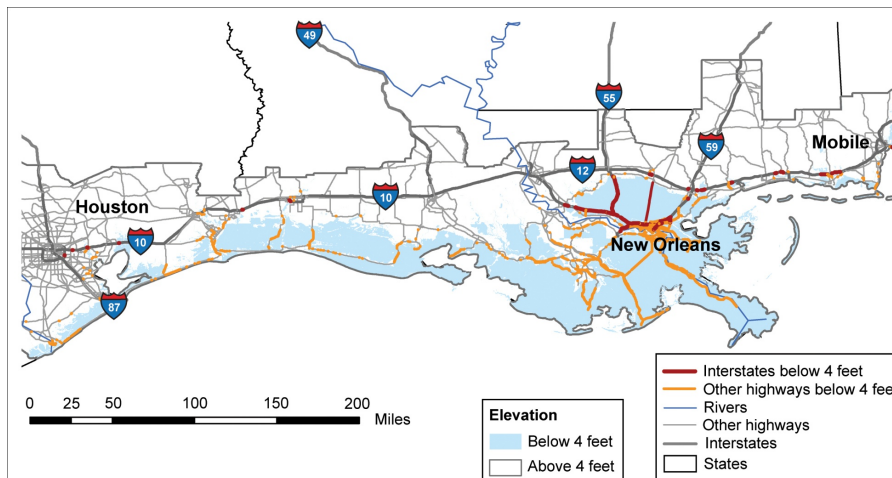
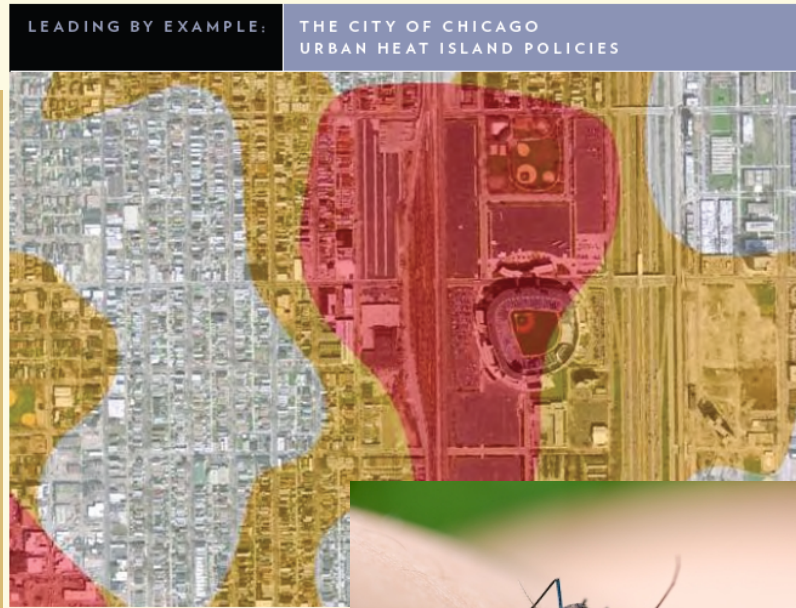


- **Evidence for *some types* of extreme events grows stronger**
 - ↑ Heat Waves (frequency and severity)
 - ↓ Cold Waves (frequency and severity)
 - ↑ Amount of Rainfall during Heaviest Rains
 - ↑ Area burned by wildfires
- **We have some physical or statistical information for changes in other types of extremes, but the evidence is weaker**
 - Changes in seasonal rainfall → regionally variable
 - Hurricanes potentially more intense, but frequency changes could be small or negative
 - Tornadoes??

Communities and businesses are sensitive to climate variations



- Transportation
- Energy
- Public Health
- Agriculture
- Water Resources
- Ecosystems



What does this mean for regulators and the electricity sector?



- The BIG PICTURE is not a subject of debate within the scientific community
- There ARE many aspects of climate that are not completely understood, but do not undermine the BIG PICTURE understanding
- Best translation into a policy context = **RISK MANAGEMENT** approach
- Compared to other business and environmental risks, we actually have lots of information about climate change!