Texas and Global Climate Change

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Austin, Texas

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Earth’s Energy Balance
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- Solar absorbed = Infrared to Space
Earth’s Energy Balance

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- Now, Increase GH Gases....
Earth’s Energy Balance

- Solar absorbed = Infrared to Space
- Now, Increase GH Gases....
- This reduces Infrared Out, but solar absorbed stays fixed....
Earth’s Energy Balance

- Solar absorbed = Infrared to Space
- Now, Increase GH Gases....
- This reduces Infrared Out, but solar absorbed stays fixed....
- Temp Must Go Up to restore balance (but how much?)
Solar (visible)

Infrared to Emitted to Space
Both the Sun and the Earth radiate to space.
Both the Sun and the Earth radiate to space. Warmer bodies emit more to space.
Both the Sun and the Earth radiate to space. Warmer bodies emit more to space. Earth comes to equilibrium when absorbed rate = emitted.
Both the Sun and the Earth radiate to space. Warmer bodies emit more to space. Earth comes to equilibrium when absorbed rate = emitted.

Now add more CO$_2$. IR to space decreases, but Solar absorbed does not change.
Both the Sun and the Earth radiate to space.

Warmer bodies emit more to space.

Earth comes to equilibrium when absorbed rate = emitted

Now add more CO$_2$. IR to space decreases, but Solar absorbed does not change.

Heating will now exceed cooling to space and the planet will heat up.
Both the Sun and the Earth radiate to space. Warmer bodies emit more to space. Earth comes to equilibrium when absorbed rate = emitted.

Now add more CO\(_2\). IR to space decreases, but Solar absorbed does not change.

Infrared Emitted to Space decreases because the emission is from a higher and colder surface.

Heating will now exceed cooling to space and the planet will heat up.

Bottom Line:
Solar (visible) to Emitted to Space

Now add more CO$_2$. IR to space decreases, but Solar absorbed does not change.

Bottom Line: Earth’s surface temperature must go up until balance is restored.
The Last Century

- a) Global Average Temperature (Celsius)
- b) Global Average Sea Level Rise (mm)
Global Consequences
Global Consequences

- Temperature Increases
Global Consequences

- Temperature Increases
- Sea Level Rise
Global Consequences

- Temperature Increases
- Sea Level Rise
- Precipitation Changes
Global Consequences

- Temperature Increases
- Sea Level Rise
- Precipitation Changes
- Tropical Expansion
Global Consequences

- Temperature Increases
- Sea Level Rise
- Precipitation Changes
- Tropical Expansion
- Extremes
Projections for the Present Century

Global Average Temperatures under three Scenarios (degrees C)

A2
A1B
B1

Data

1900 2000 2100
Projections for the Present Century

Global Average Temperatures under three Scenarios (degrees C)

Data

about 2.7°F
Simulations for the US Southwest

Simulations for the US Southwest

Projected Trend in Precipitation

“Where it is wet, expect wetter, where dry, expect dryer”
Focus on Texas
Focus on Texas

- Temperature Trend Follows Global
Focus on Texas

- Temperature Trend Follows Global
- Likely Changes in Precipitation Patterns
Focus on Texas

- Temperature Trend Follows Global
- Likely Changes in Precipitation Patterns
- Consequences for Water Resources
Focus on Texas

- Temperature Trend Follows Global
- Likely Changes in Precipitation Patterns
- Consequences for Water Resources
- Coastal Issues
Focus on Texas

- Temperature Trend Follows Global
- Likely Changes in Precipitation Patterns
- Consequences for Water Resources
- Coastal Issues
- Agriculture & Economy
AR4 Precipitation Estimates for the next Century

Winter

Summer

Legend:
- 0 to +5
- -5 to 0
- -10 to -5
- -15 to -10
- -20 to -15
- -25 to -20
State of the Art
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• Numerical Grid getting finer
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- Precipitation is still difficult,
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  • Clouds,
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- Tropical Convection,
- Feedback Mechanisms
  - Clouds,
  - Water vapor distribution
Evolution of Grid Coarseness

- FAR 1990 Grid 500km
- TAR 2001 Grid 180km
- SAR 1996 Grid 250km
- AR4 2007 Grid 110km
Impact of GW on Texas
2nd Ed., Schmandt, Clarkson, North, Eds; UT Press, 2009
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pdfs available at: www.texasclimate.org