Global Climate Change:
Implications for South Florida

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IPCC 2007

Climate Change 2007: The Physical Science Basis

Summary for Policymakers

Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

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Note:
Text, tables and figures given here are final but subject to checking and copy-editing and editorial adjustments to figures.

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The physical science basis

• Detection
• Attribution
• Projections
Detection: Global warming in 3 parameters

Changes in Temperature, Sea Level and Northern Hemisphere Snow Cover

(a) Global mean temperature
(b) Global average sea level
(c) Northern hemisphere snow cover

Blue shading represents error in estimates
Attribution: Global Climate Models

• 23 coupled ocean-atmosphere models
  – General circulation described by equations of motion
  – Radiation, thermodynamics, convection… parameterizations

• 20\textsuperscript{th} century forcing (CO2 + aerosols + volcanoes + solar variability)

• 21\textsuperscript{st} century CO2 forcing (Projections)

• Multi-model average + statistics
Attribution: 20th century simulations

- Black line: observations
- Pink: Natural + anthropogenic forcing
- Blue: Natural forcing only

- North America
  - Temperature anomaly (°C)
  - Year: 1900 to 2000

- Europe
  - Temperature anomaly (°C)
  - Year: 1900 to 2000

- Africa
  - Temperature anomaly (°C)
  - Year: 1900 to 2000

- South America
  - Temperature anomaly (°C)
  - Year: 1900 to 2000

- Asia
  - Temperature anomaly (°C)
  - Year: 1900 to 2000

- Australia
  - Temperature anomaly (°C)
  - Year: 1900 to 2000

- Global
  - Temperature anomaly (°C)
  - Year: 1900 to 2000

- Global Land
  - Temperature anomaly (°C)
  - Year: 1900 to 2000

- Global Ocean
  - Temperature anomaly (°C)
  - Year: 1900 to 2000
Temperature Projection

Multi-model averages and assessed ranges for surface warming

Solid lines are multi-model average and shading is +/- 1 σ

Range is primarily due to clouds

Best estimate and likely range for different scenarios
Continuation of 1993-2006 trend (green line)

0.2-0.5 m by 2100

1900-2000: ~1.7 mm/yr
1993-2006: 3.1 mm/yr = 30cm/100yr

"Models used to date do not include the full effects of changes in ice sheet flow, because a basis in published literature is lacking. The projections include a contribution due to increased ice flow from Greenland and Antarctica at the rates observed for 1993 to 2003, but these flow rates could increase or decrease in the future."
Precipitation Projection

White areas are where less than 60% of models agree in sign of the change. Stippled areas are where more than 90% of models agree in sign.
<table>
<thead>
<tr>
<th>Phenomenon and direction of trend</th>
<th>Likelihood that trend occurred in late 20th century (typically post 1960)</th>
<th>Likelihood of a human contribution to observed trend</th>
<th>Likelihood of future trends based on projections for 21st century using SRES scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmer and fewer cold days and nights over most land areas</td>
<td>Very likely</td>
<td>Likely</td>
<td>Virtually certain</td>
</tr>
<tr>
<td>Warmer and more frequent hot days and nights over most land areas</td>
<td>Very likely</td>
<td>Likely (nights)</td>
<td>Virtually certain</td>
</tr>
<tr>
<td>Warm spells/heat waves. Frequency increases over most land areas</td>
<td>Likely</td>
<td>More likely than not</td>
<td>Very likely</td>
</tr>
<tr>
<td>Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most land areas</td>
<td>Likely</td>
<td>More likely than not</td>
<td>Very likely</td>
</tr>
<tr>
<td>Area affected by droughts increases</td>
<td>Likely in many regions since 1970</td>
<td>More likely than not</td>
<td>Likely</td>
</tr>
<tr>
<td>Intense tropical cyclone activity increases</td>
<td>Likely in some regions since 1970</td>
<td>More likely than not</td>
<td>Likely</td>
</tr>
<tr>
<td>Increased incidence of extreme high sea level (excludes tsunamis)</td>
<td>Likely</td>
<td>More likely than not</td>
<td>Likely</td>
</tr>
</tbody>
</table>
More recent findings

1. Sea level rise may be faster than reported in IPCC 2007

2. Precipitation projected to decrease & evaporation increase in the subtropics

3. The jury is out on Atlantic storm activity
Observed sea level rise has been following the upper end of the 2001 IPCC sea level projection.

Rhamstorf et al. 2007
"Statement on Sea Level Rise in the Coming Century"
Miami-Dade Climate Change Task Force
Science and Technology Committee
January 2008

<table>
<thead>
<tr>
<th>Co-Chairs</th>
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<tbody>
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</tbody>
</table>
Key points from report

“With what is happening in the Arctic and Greenland, [there will be] a likely sea level rise of at least 1.5 feet in the coming 50 years and a total of at least 3-5 feet by the end of the century, possibly significantly more. “

• Relative sea level in S. Florida has been rising at a rate of 1.5 inch/century for the last 2500 years.
• Since 1932, sea level has risen by 9 inches.
• IPCC 2007 projects 1-3 feet by 2100, but this does not include contribution from recent rates of melt
• Key uncertainties: high latitude ice cover (Greenland, Antarctic & Arctic sea ice)
• Committee recommends detailed documentation of elevation of infrastructure and natural resources at 1, 2, 3… feet of sea level rise.
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Robust signals:

- Hadley cell expands
- Subtropics dry

Held and Soden (2006); Seager et al. (2007, 2008)
Tree ring records show that much longer droughts of equal severity in any one year have occurred in the southeast and that the twentieth century appears to have been unusually wet by the standard of the last one thousand years.

Seager et al. (2008)
More recent findings

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Current computing power limits ability of global climate models to represent hurricanes

Hurricane Rita (2005): orange grid is representative of current *global* climate model resolution.

Size of grid limited by power of computers.
Nonetheless, tropical storms are affected by \textit{large-scale} conditions that today’s climate models \textit{can} represent.

Factors that influence storm development and intensification:

- Warm ocean surface

Nonetheless, tropical storms are affected by *large-scale* conditions that today’s climate models *can* represent.

**Factors that influence storm development and intensification:**
- Warm ocean surface
- Cool upper atmosphere
- Vertical wind shear

**Climate model projections for Atlantic development:**
- Favor
- Inhibit (Vecchi and Soden 2007)
- Inhibit (Vecchi and Soden 2007)

**Net effect? Unknown**

**Next step:** embedding regional models within global models (Knutson et al. 1998; Knutson and Tuleya 2004; Knutson 2007; Emanuel et al. 2008)
Florida: Public Opinion on Climate Change

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Florida Statewide Survey

- May 2008
- \( n = 1,077 \)
- \( \pm 2.9\% \)

**Does a problem exist?**

**FIGURE 1: PERSONALLY CONVINCED**

“How convinced are you that global warming is happening?”

- Completely Convinced: 29%
- Mostly Convinced: 42%
- Not So Convinced: 18%
- Not at All Convinced: 11%
FIGURE 2: CAUSE OF GLOBAL WARMING

“If global warming is happening, do you think it is due more to normal cycles in the Earth’s environment, more to human activity such as burning fossil fuels, or by both equally?”

- Human activities: 55%
- Normal cycles: 32%
- Both: 13%
Impacts

A majority of Floridians support climate change policies at both state and federal levels.
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Bibliography