Climate Change II: Projections

“The picture is pretty bleak gentlemen. The climate is changing. The mammals are taking over. And we’ve all got a brain the size of a walnut”

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4. Table SPM.3 lists approaches for managing climate change risks. Give two examples of ecosystem-related management solutions and briefly explain how they could reduce risk from climate change.
Vocab: IPCC summary for policymakers

• Adaptation – change behavior or ecosystem structure to ‘roll with’ climate change
• Mitigation – reducing GHG emissions to reduce the severity of climate change
(a) Risks from climate change...
(b) ...depend on cumulative CO₂ emissions...
(c) ...which in turn depend on annual GHG emissions over the next decades.
Projecting future atmospheric GHG concentrations: What info do we need?

GHG emissions depend on:

• Population growth

• Economic growth
  – Consumption & lifestyle changes
  – Technological change

• Policy choices
Technology can move faster than predicted

Images of the future, circa 1950
Scenarios of future CO$_2$ concentration from AR4 (IPCC 4$^{\text{th}}$ Assessment Report)
Measured CO$_2$ emissions currently match the highest IPCC scenario.

Le Quere et al., 2009

![Graph showing fossil fuel CO$_2$ emissions (Pg C yr$^{-1}$) from 1990 to 2010, with measured emissions falling within the highest IPCC scenario.](image-url)
CO$_2$ concentrations below 300 ppm for 650,000 years
Why is there uncertainty in models? Earth is a complicated place.
Projected Climate Response

Lower Certainty:
- Amount of sea level rise
- Precipitation changes
- Extreme events
- Fire regimes

Higher Certainty:
- Rising temperature
- Glacier melting
- Ocean acidification
High certainty: ocean acidification
High certainty: ocean acidification

- Oceans are 30% more acidic today than 100 years ago
- Higher acidity makes it harder for carbonate life forms to make shells
High certainty: rising temperatures

(a) Change in average surface temperature (1986–2005 to 2081–2100) for RCP 2.6 and RCP 8.5.
Scenarios of future temperature

©IPCC 2007: WG1-AR4

Global surface warming (°C)

Year

1900  2000  2100

A2  A1B  B1

Year 2000 Constant Concentrations

20th century
High certainty: Temperature extremes

Australia: heat waves cause fires
More frequent and extensive droughts are projected for the southwest U.S.

Fig. 1. Modeled changes in annual mean precipitation minus evaporation over the American Southwest (125°W to 95°W and 25°N to 40°N. land areas only). Averaged over ensemble members for each of the 19

Seager et al., 2007
High certainty: Loss of montane glaciers

Mt. Kilimanjaro is expected to lose its glaciers by 2020.

NASA images
High certainty: Loss of montane glaciers

Upsala Glacier, Argentina

Honeycomb Glacier, Washington
Antarctica - Larsen-B Ice Shelf, 2002
Increased melting of Greenland glaciers
Projected Climate Response

Lower Certainty:

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Higher Certainty:

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Sea level rise

Influenced by:
1. Thermal expansion (ocean warming)
2. Rate of glacial melting
Lower certainty: Precipitation

(b) Change in average precipitation (1986–2005 to 2081–2100)

RCP 2.6
RCP 8.5

(%)
Rule of thumb for precipitation

Models show a tendency toward “peaking” in hydrological cycle:

• Wet tends to get wetter
• Dry tends to get drier
• So, both drought and flooding may increase, in some cases at the same location
Precipitation extremes

Australian drought, 2002-2003

Iowa flooding, 2008
Increase in heavy rainfall events

Kunkel et al. 2013
More Than 1,000 Died in South Asia Floods This Summer
Hurricanes: More intense, but not more frequent

Challenge for understanding hurricanes: Early records are inconsistent, so time-series are relatively short. Trends in intensity have been identified. Trends in frequency have not been identified.
Fires due to drought + extreme heat

Western USA, Sept 1, 2017

Texas, July 2011

Western Russia, July 29, 2010
Summary of future climate

• Warmer temperatures *(up to 4°C likely by 2100 given current trajectory)*
  – Less snow pack, loss of glaciers
  – Rising sea level
  – More fires

• Peakier precipitation
  – More droughts, more floods, more extremes

• More acidic ocean
Small Groups Discussion

1. This report is presented very differently from the last reading (Smoke, Mirrors). Do you think the science is communicated effectively for policymakers? Why or why not?

2. List some of the consequences of climate change for polar regions

3. Environmental justice aims for fair treatment of all people with respect to environmental risk. Give an example of how climate change creates an environmental justice problem.