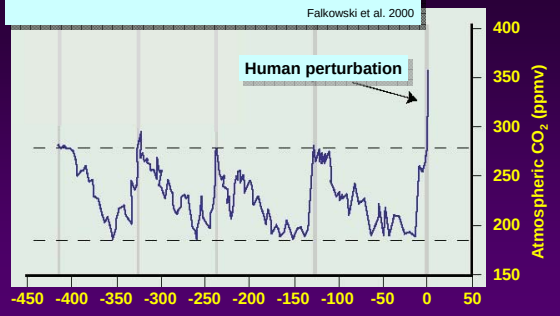
The Global Climate Challenge: How will Kansas Respond?

Charles W. Rice
Department of Agronomy

K-State Research and Extension

We have left the domain that defined the Earth system for the 420,000 years before the Industrial Revolution

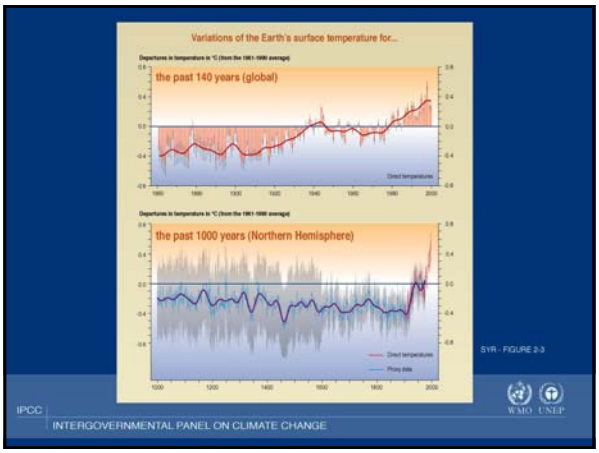
Falkowski et al. 2000



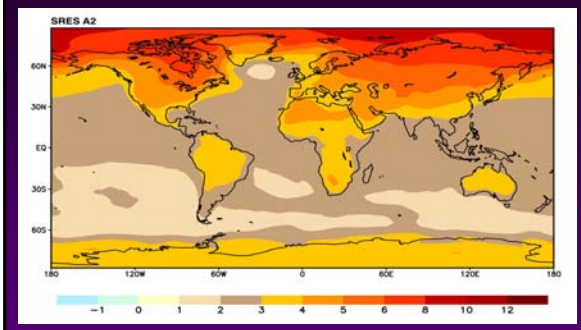
Source: Petit et al. 1999

Consequences

Temperature

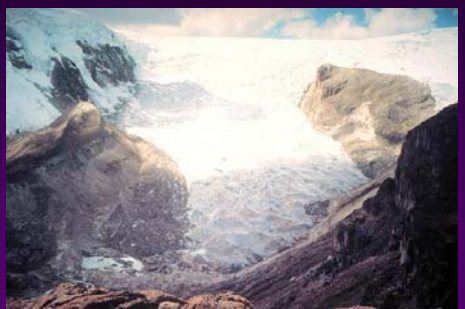


Land areas are projected to warm more than the oceans with the greatest warming at high latitudes



Annual mean temperature change, 2071 to 2100 relative to 1990: Global Average in 2085 = 3.1°C

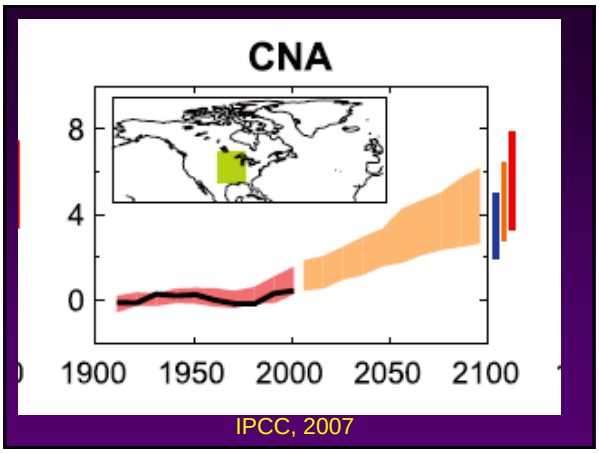
Qori Kalis, Peruvian Andes 1978…



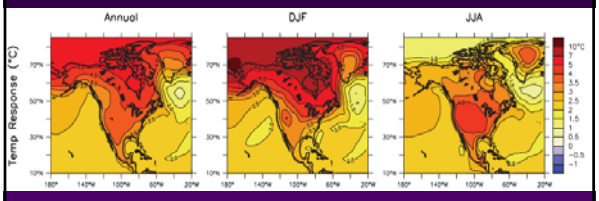
- In 1978, the Qori Kalis Glacier looked like this, flowing out from the Quelccaya Ice Cap in the Peruvian Andes Mountains.

Glaciers are shrinking nearly worldwide

Source: L. Thompson



IPCC, 2007



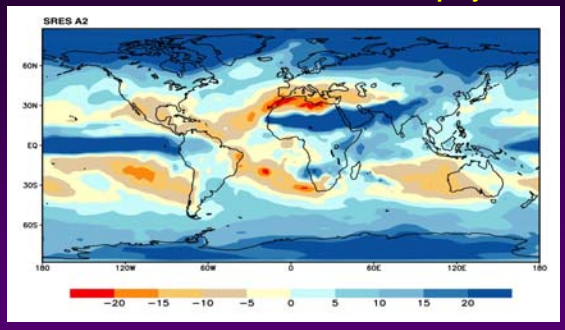
Annual DJF JJA

IPCC, 2007

Consequences

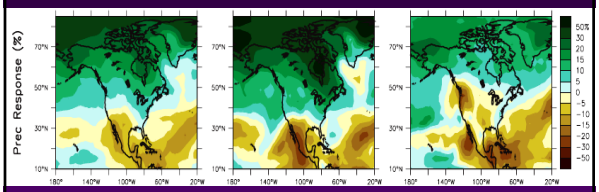
Precipitation

Some areas are projected to become wetter, others drier with an overall increase projected



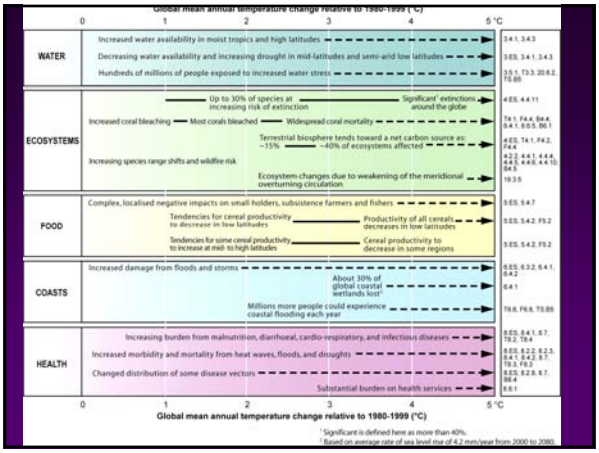
Annual mean precipitation change: 2071 to 2100 Relative to 1990

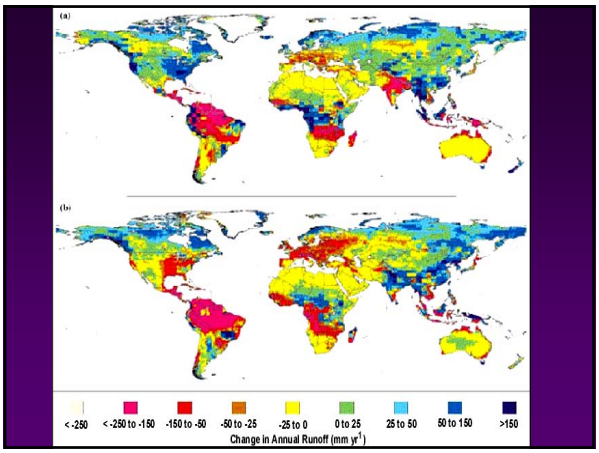
Precipitation Response



Annual DJF JJA

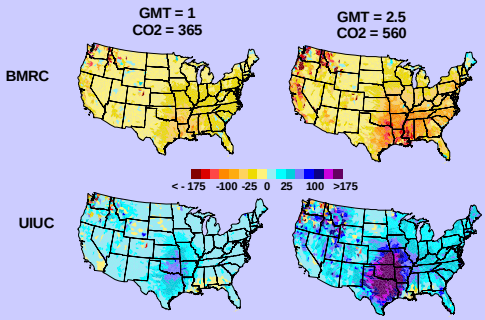
IPCC, 2007



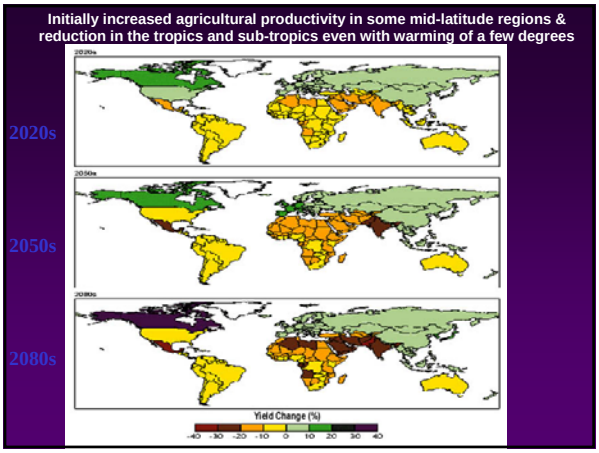


Projections of water yield (mm) changes under climate change

Thomson et al. 2005. CC 69:67-88.



Initially increased agricultural productivity in some mid-latitude regions & reduction in the tropics and sub-tropics even with warming of a few degrees



Climate Response

Adaptation

Consequences of Increased Atmospheric CO_2

- Plants positively respond to CO_2
  - N availability
  - Change in C:N ratio of plant material
  - Impacts forage quality
  - Grain quality?
  - Hasten maturity
  - Shorten growing season

Consequences of Increased Atmospheric CO_2

Potential impacts: Temperature

However

- Water is tied to temperature
- Increased temperature increases evaporation regardless of a change in precipitation
  - For those areas that receive increase temperature and increase precipitation positive effect
  - For those that receive similar or less precipitation net negative effect

Consequences of Increased Atmospheric CO_2

Potential impacts: Generally positive with adaptation

- Mid to high latitudes generally expect increased productivity
- But is increased productivity desirable
  - requires other things?
  - Comes with a cost
- ***HOWEVER!!***

Climate Variability

If precipitation is the same but more variable

- i.e. less frequent but more intense thunderstorms

Then:

- More droughts
  - Shift crops (corn to sorghum)
- Greater erosion

If temperature less variable

Then:

- Crops on margins of growing range will benefit
  - Winter wheat extended range or shifts northward

Consequences of Increased Temperature: Effect on Water Resources

- Depends on water availability
- Crop water requirements will increase
- Warmer winters
  - Reduced winter storage thus low stream flows in late summer and early fall
- Increased competition for water resources
  - Ag, urban, industrial, domestic

Consequences of Climate Change Grazing lands

- Based on models 10% decrease or 5-10% increase in productivity

Potential impacts:
- Species shift?
- Diversity?
- Grasslands exists because of climate variability

However management will override most impacts
- Grazing patterns
- Fire

Consequences of Climate Change Agricultural Pests

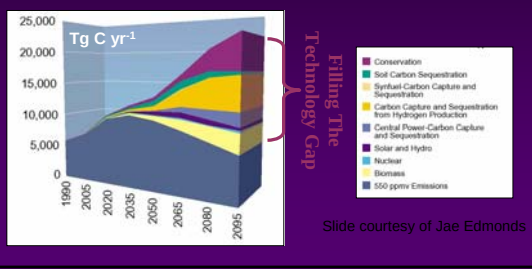
- Distribution regulated by temperature, moisture and light

If warmer nights result in greater persistence

Potential impacts:
- Expanded range and populations
- Increased chemical use

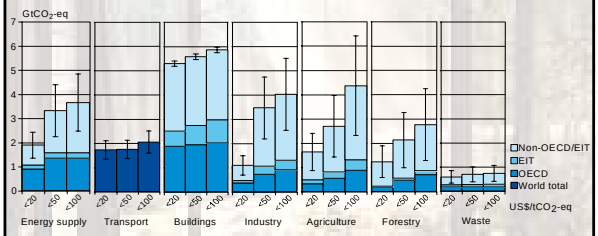
Stabilizing CO_2 concentrations means…

- Changing the global energy system
- Developing a least-cost technology portfolio

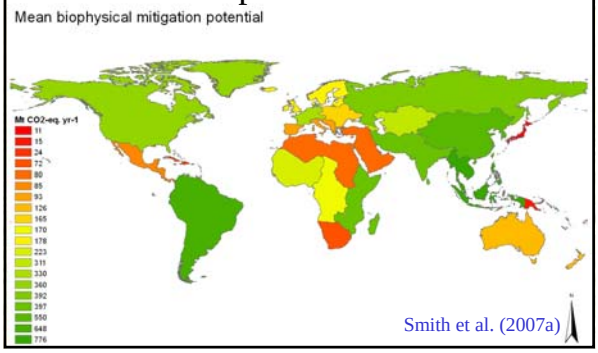


Slide courtesy of Jae Edmonds

Global economic mitigation potential for different sectors at different carbon prices



Regional breakdown of mitigation potential



Smith et al. (2007a)

Additional mitigation from agriculture

- **Feed-stocks for bio-energy**.
- The economic mitigation potential for agricultural bio-energy in 2030 is estimated to be 70-1260, 560-2320 and 2720 Mt CO_2-eq. yr^{-1} at prices up to 20, 50 and above 100 USD t CO_2-eq.$^{-1}$, respectively (5-90% of all other measures together).
- Additional mitigation of 770 Mt CO_2-eq. yr^{-1} could be achieved by 2030 by **improved energy efficiency** in agriculture

Smith et al. (2007a)

North America: Key messages

- A wide range of impacts of climate change are now clearly documented
- Risks from future impacts concentrated on extreme events
- Vulnerable people and activities in almost every region
- Opportunities for improving adaptation
- Opportunities for mitigation

Future risks-Kansas

- Decreasing water availability (& quality)
- More frequent and more severe heat waves
- Heat stress for some plants and animals
- International trade and security
- Human health

Conclusions Adaptation

- Competition for water resources
- Stress on human, animal and plant systems from infectious diseases
- Stress on natural resources
  - Soil
  - Water
  - Natural ecosystems
- Agriculture may adapt but at some costs

Conclusions Mitigation

- Agriculture has a significant role to play in climate mitigation
- Agriculture is cost competitive with mitigation options in other sectors
- Bio-energy crops and improved energy efficiency in agriculture can contribute to further climate mitigation
- Agricultural mitigation should be part of a portfolio of mitigation measures to reduce emissions / increase sinks whilst new, low carbon energy technologies are developed.

Solving the climate challenge: Risk versus Opportunity

- Focus action where it can make the biggest difference
- Avoid severe climate change
- Adapt to a warmer world
- Portfolio approach
- Develop leadership role

Chuck Rice
Phone: 785-532-7217
Cell: 785-587-7215
cwrice@ksu.edu

- Websites

www.oznet.ksu.edu/kccm
www.soilcarboncenter.k-state.edu/
www.oznet.ksu.edu/ctec
www.casmgs.colostate.edu/

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