Global Agriculture and Forestry in the 21st Century: A View from the IPCC-TAR

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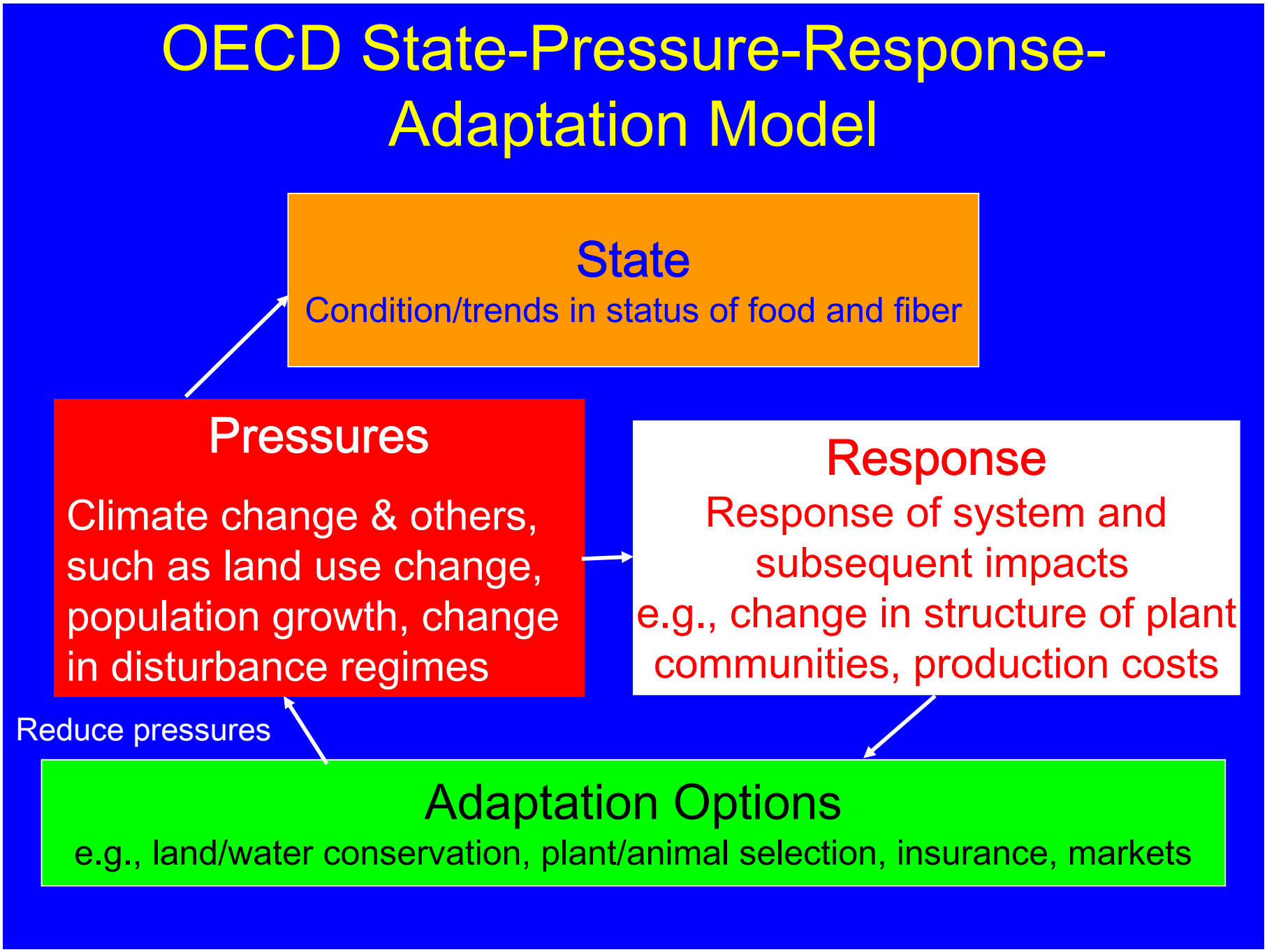
Points to cover

- The OECD State-Pressure-Response-Adaptation model
  - consistent portrayal of uncertainty
  - Current & future state of agriculture and forestry
  - Pressures: climate, other environmental, human
  - Response
    - sources of uncertainty
    - précis of major conclusions
  - Adaptation and Vulnerability (major focus of TAR)
    - biophysical and socioeconomic

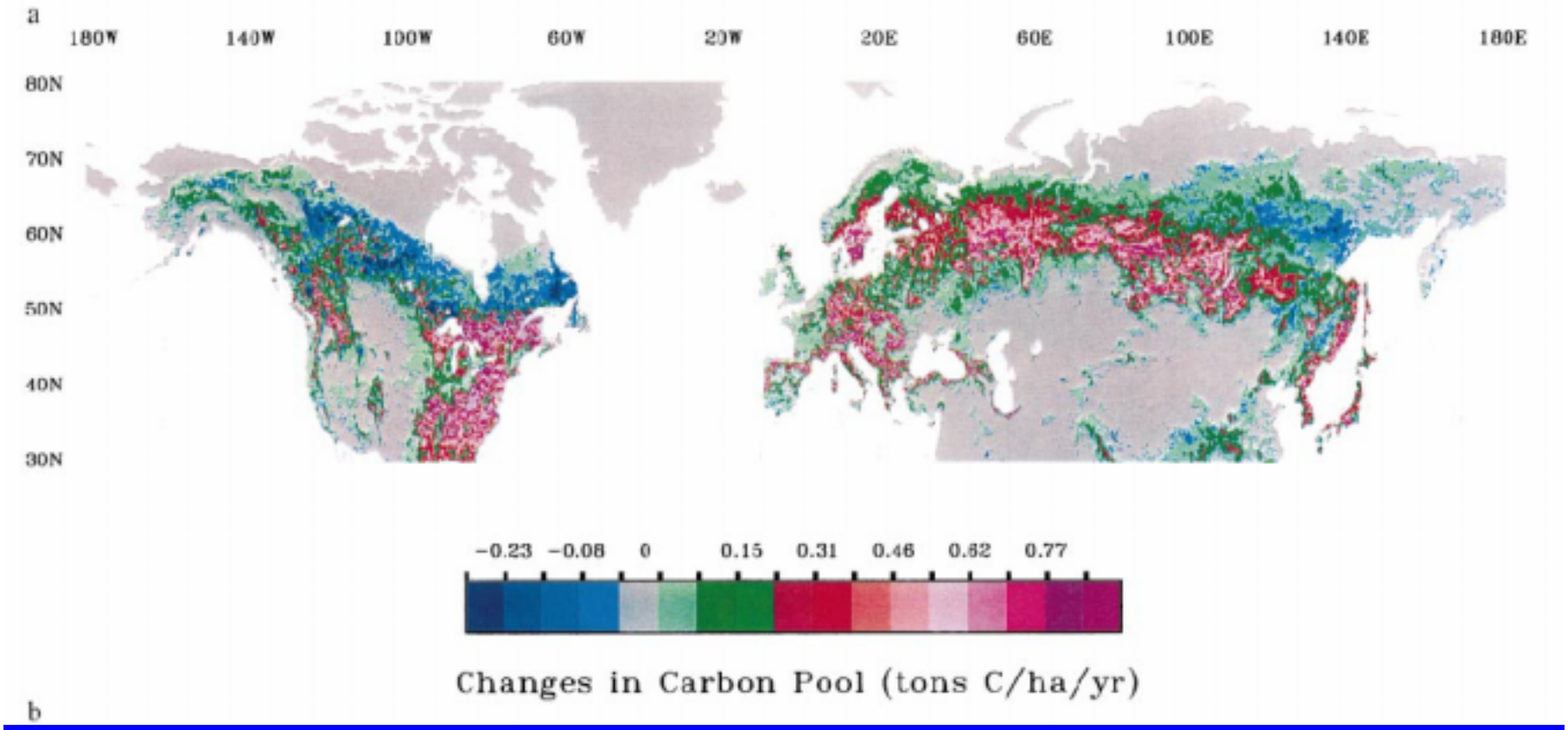
OECD State-Pressure-Response-Adaptation Model



State of Agriculture & Forests

- >40% of Earth's land covers in agriculture and forests
- Constant or declining food prices over next 25 years
  - --debate over adequacy of new agricultural land increases uncertainty
  - --food security remains problem in developing countries
- Deforestation rates slowed since early 1990s
  - --global forest productivity increasing,

Global estimates of changes in woody biomass carbon since 1981 (Myneni et al 2001)



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  - --global forest productivity increasing, but net global biomass decreasing

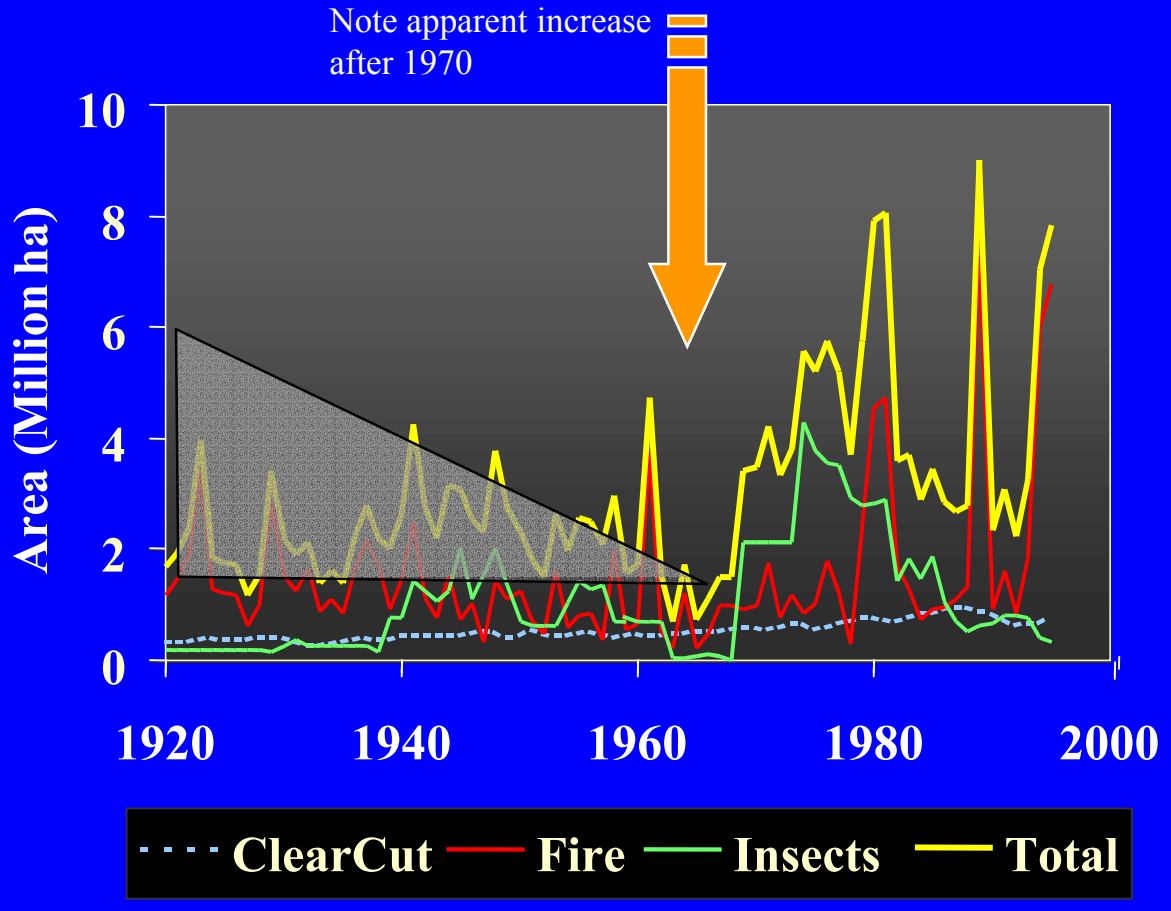
Pressures

- Observational evidence of climate change effects on agriculture and forestry thin

  --especially in agriculture because of human domination

  --weak signals emerging in forest ecosystems

Disturbances in Canada's forests (1920 - 1995)

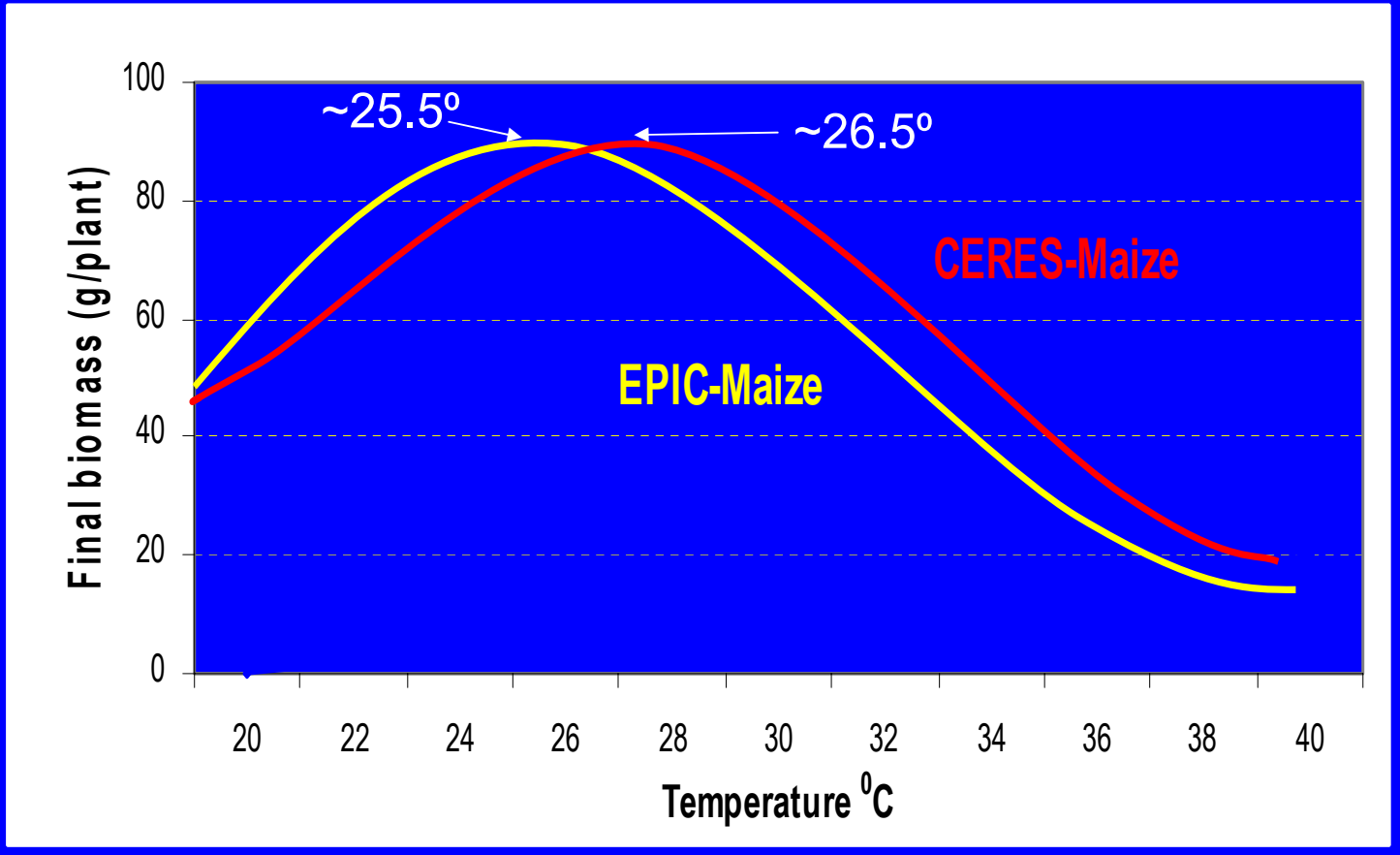


Response to Climate Change

- Agriculture and forestry: large advances in understanding but uncertainty remains

  --e.g., variation in parameterizations and algorithms in physiological models: “the devil is in the details”

Optimum temperature curve for plant growth in EPIC and CERES maize



Response: Major Conclusions

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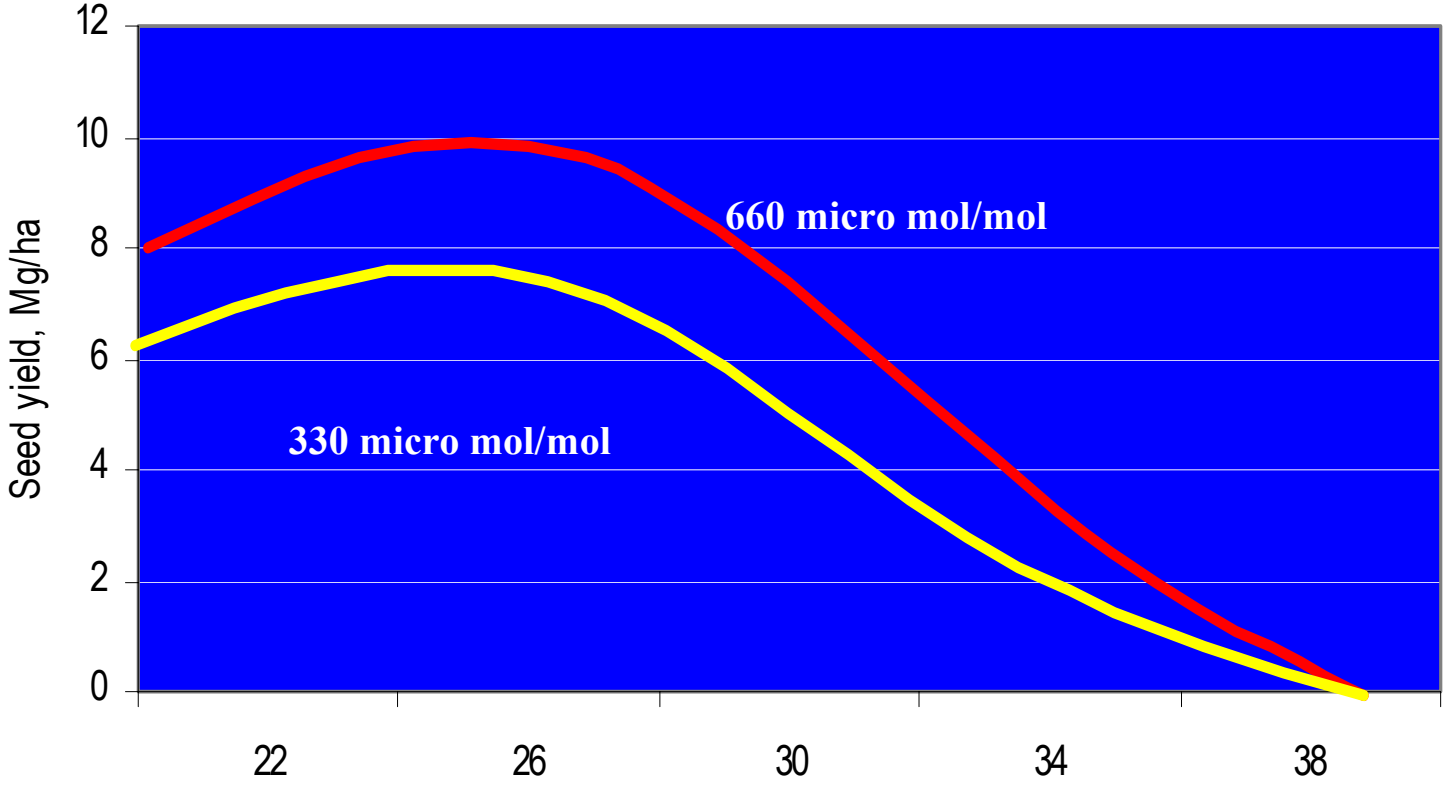
- CO_2 sensitivity of some crops (mainly C_4 species, e.g., maize) may be greater under mild-moderate drought than well-watered conditions [established, but incomplete]

- CO_2 sensitivity of many crops rises with temperature, up to a point—but…

Rice seed yield vs. weighted mean day/night air temperature for plant growth to maturity in CO_2 concentration of 330 & 660 μmol/mol in five experiments



Yields decrease 10% for each +1º above 26ºC

Response: Major Conclusions

- CO_2 sensitivity of some crops (mainly C_3 species, e.g., wheat, soybeans) may be greater under mild-moderate drought than well-watered conditions **[established, but incomplete]**

- CO_2 sensitivity of many crops rises with temperature, up to a point—but may decline rapidly as temperature rises above photosynthetic optimum

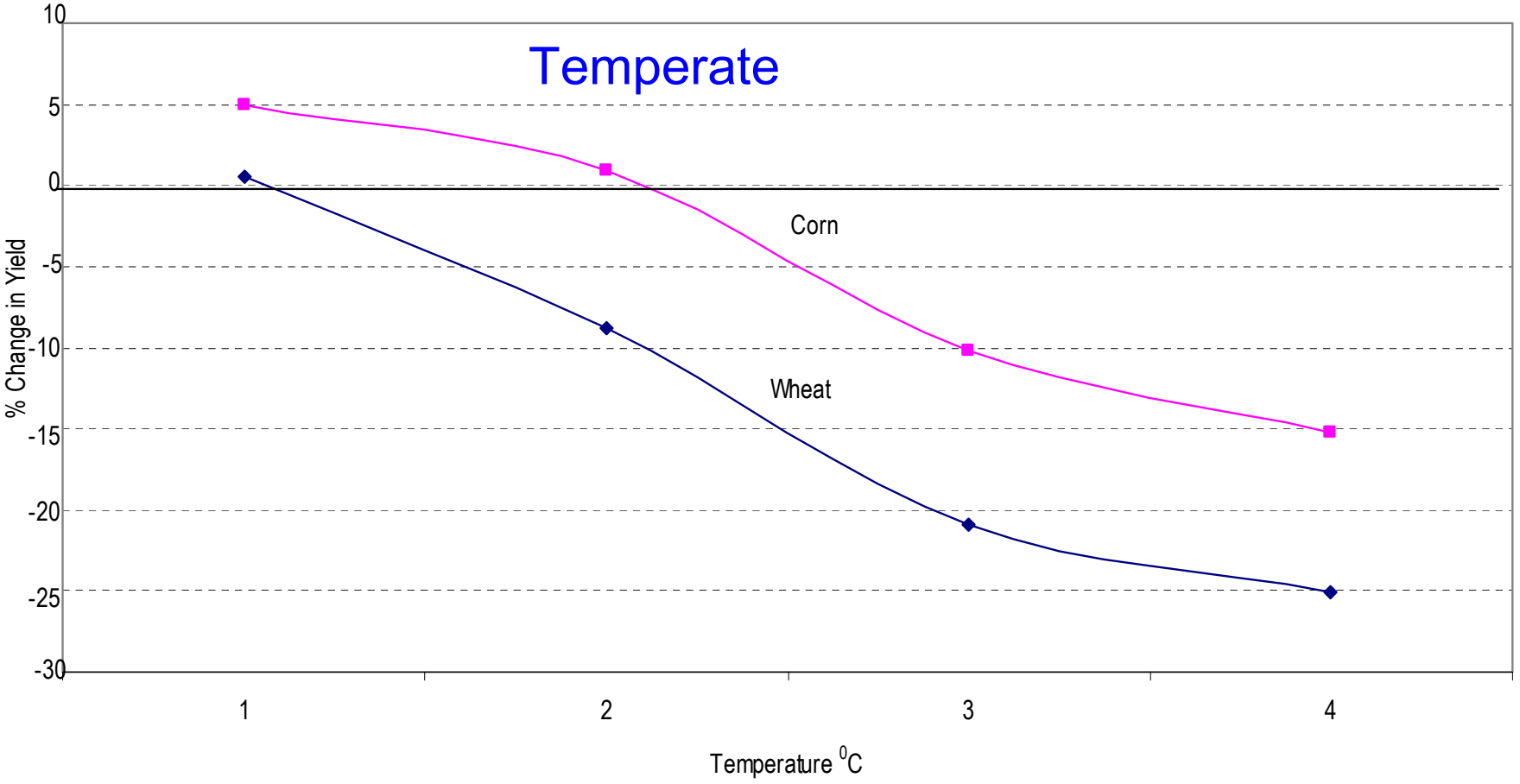
- CO_2 sensitivity of forests highly uncertain, but generally believed to be temporary

Response: Major Conclusions, cont.

- Absent adaptation, temperate crop yields tolerate 2-3º C warming before declining, tropical yields decline immediately [medium confidence]

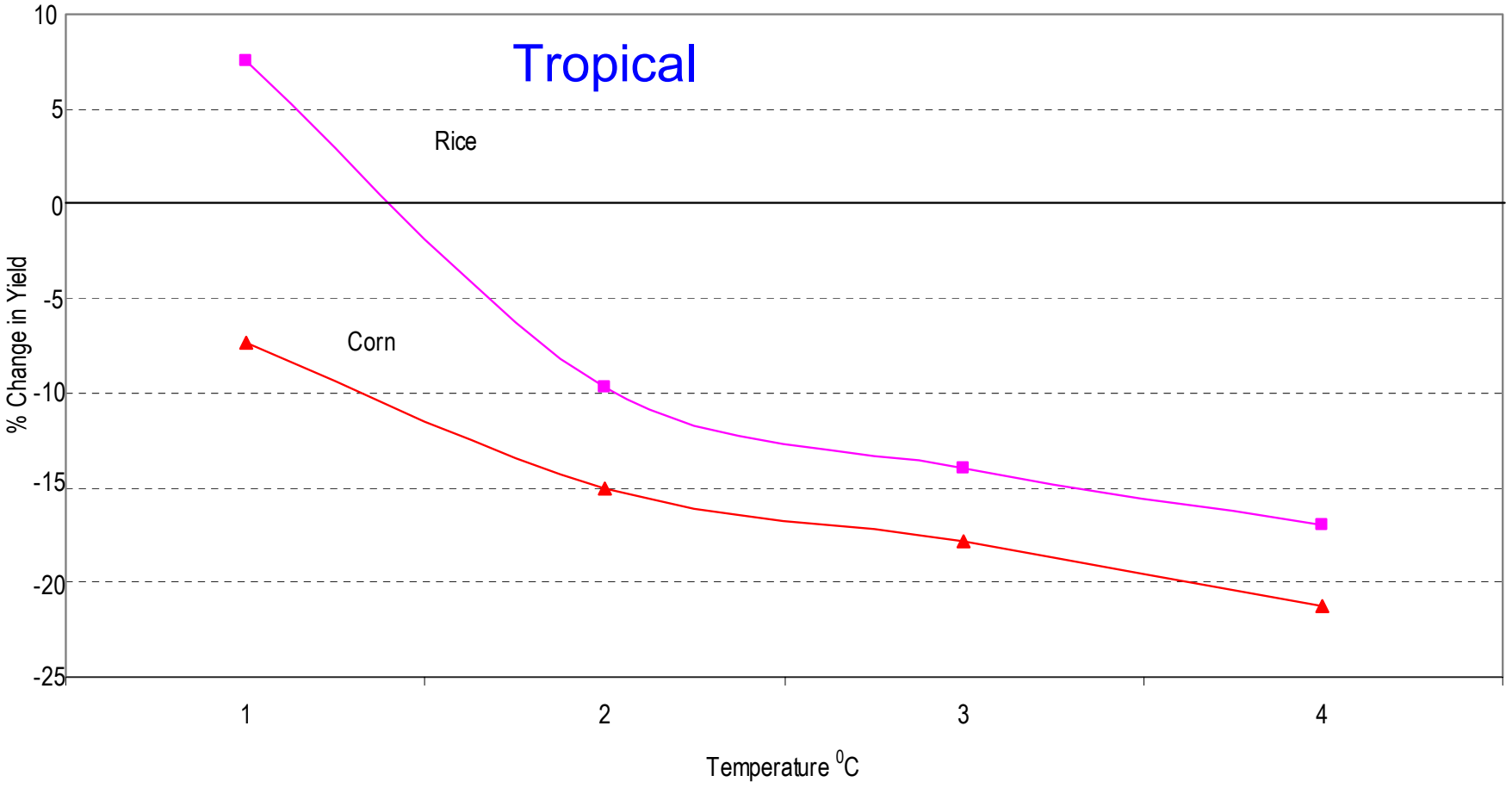
Trends in Log Distribution of Simulated Temperate Crop Yield with Increase in Temperature, from Studies Reviewed in WG II TAR

5.3: All Studies Included Direct Effects of CO_2, Positive Change in Precipitation, and No Adaptation



Trends in the Log Distribution of Simulated Tropical Crop Yield with Increase in Temperature, from Studies Reviewed in WG II

TAR 5.3: All Studies Included Direct Effects of CO_2, Positive Change in Precipitation, and No Adaptation

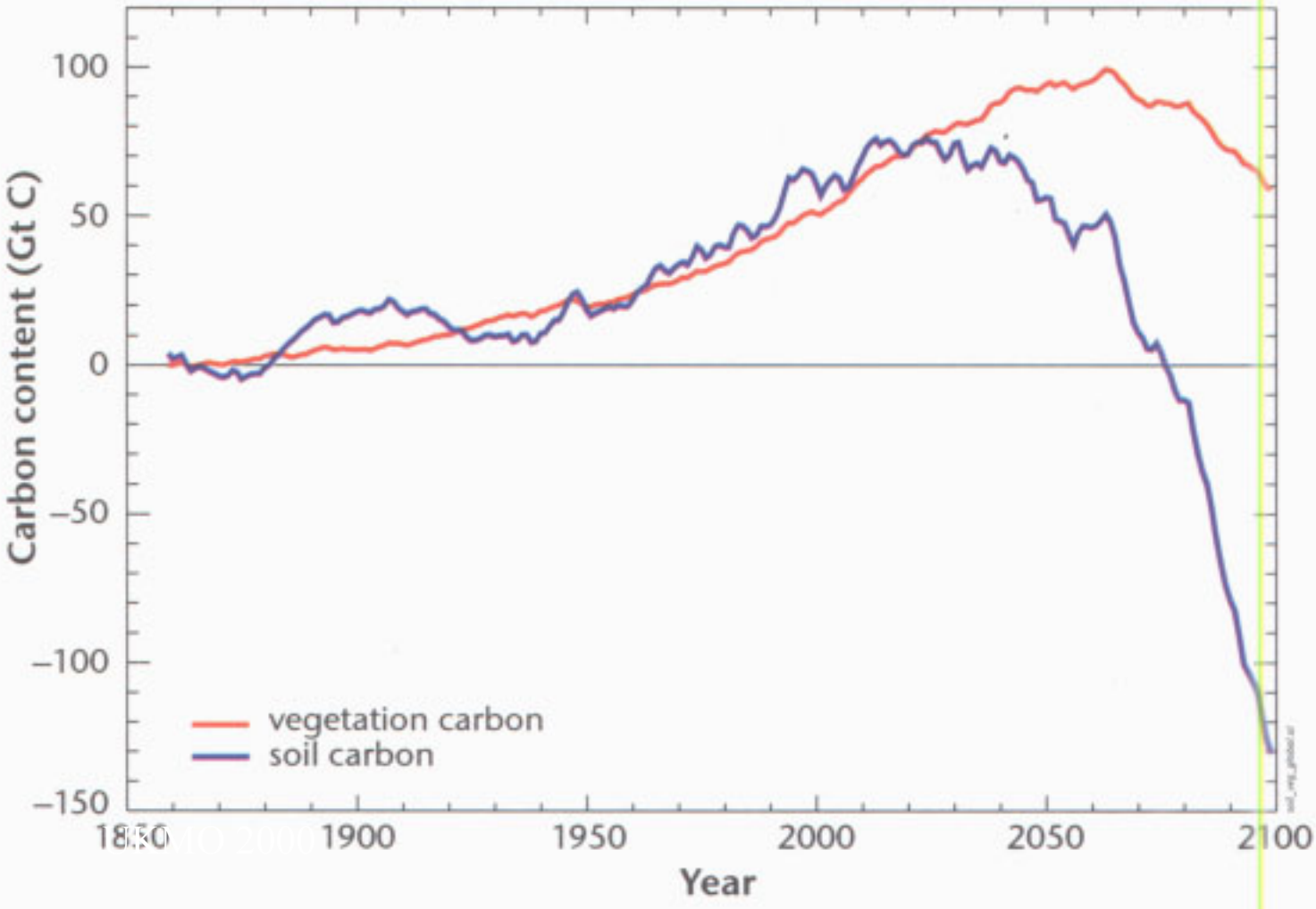


Response: Major Conclusions, cont.

- Absent adaptation, temperate crop yields tolerate 2-3º C warming before declining, tropical yields decline immediately [medium confidence]

- Transient effects of climate change on forests become more dominant farther out into 21st century

UK climate model feedbacks also suggest changes in global terrestrial C



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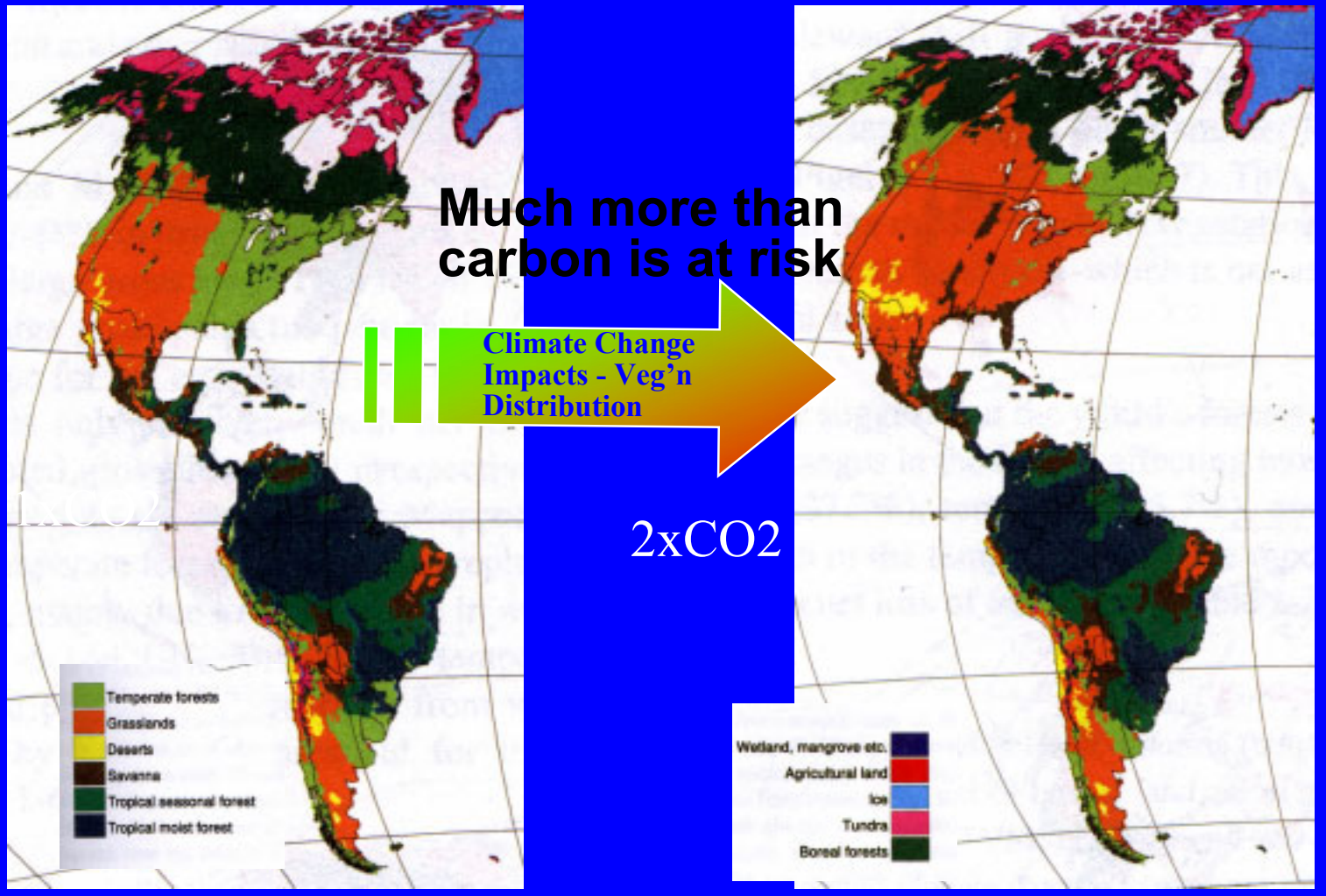
- Forest distributions sensitive to climate change

How will forests be affected?

GFDL + MAPPS models

Current

Future



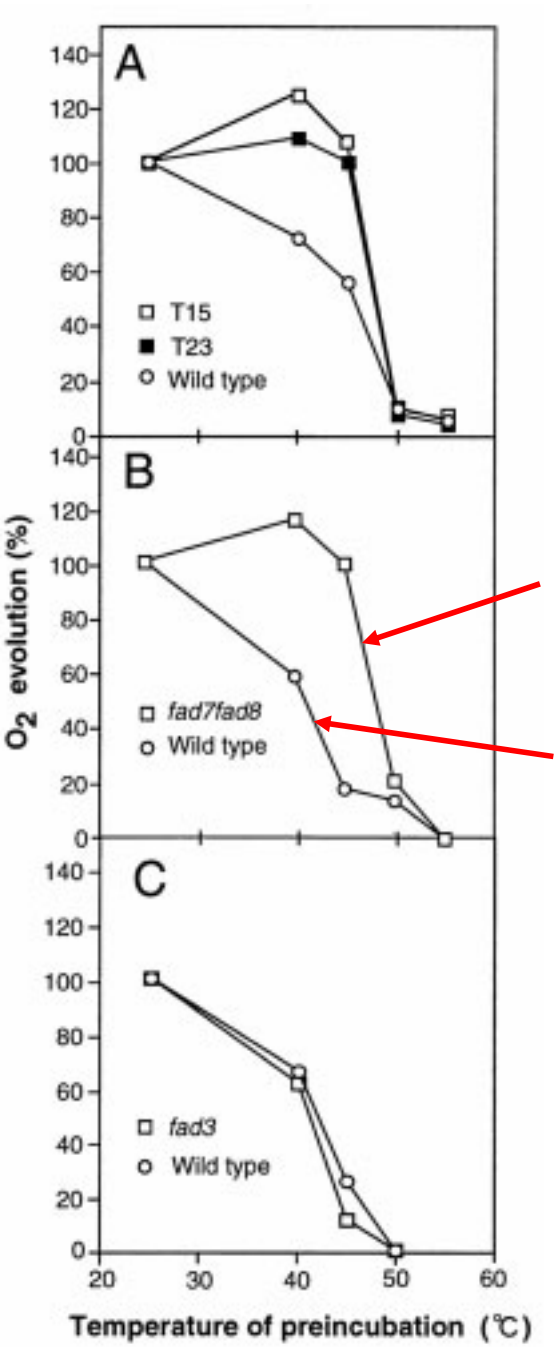
Adaptation

- adaptation to ameliorate economic impacts across regions depends critically on regional resource endowments [low-medium confidence]

  --developed countries fare better, developing countries and countries in transition, especially in the tropics and subtropics, fare worse.

- how responsive will the agricultural research establishment be in delivering adaptive knowledge and technologies?

Biotechnology: Splicing in a gene to raise the maximum temperature of photosynthesis (tobacco with gene from *Arabidosis thaliana*)



Three trials:

Genetically modified

Wild strain

Vulnerability: Impacts Net of Adaptation

- Vulnerability: prices rise at global +2-3º C [low confidence]

Implied percentage Δ world food prices with Δ temperature by studies