Managing the Carbon Cycle: Interactions between the Economy and Biosphere

Source or Sink; Promise or Peril

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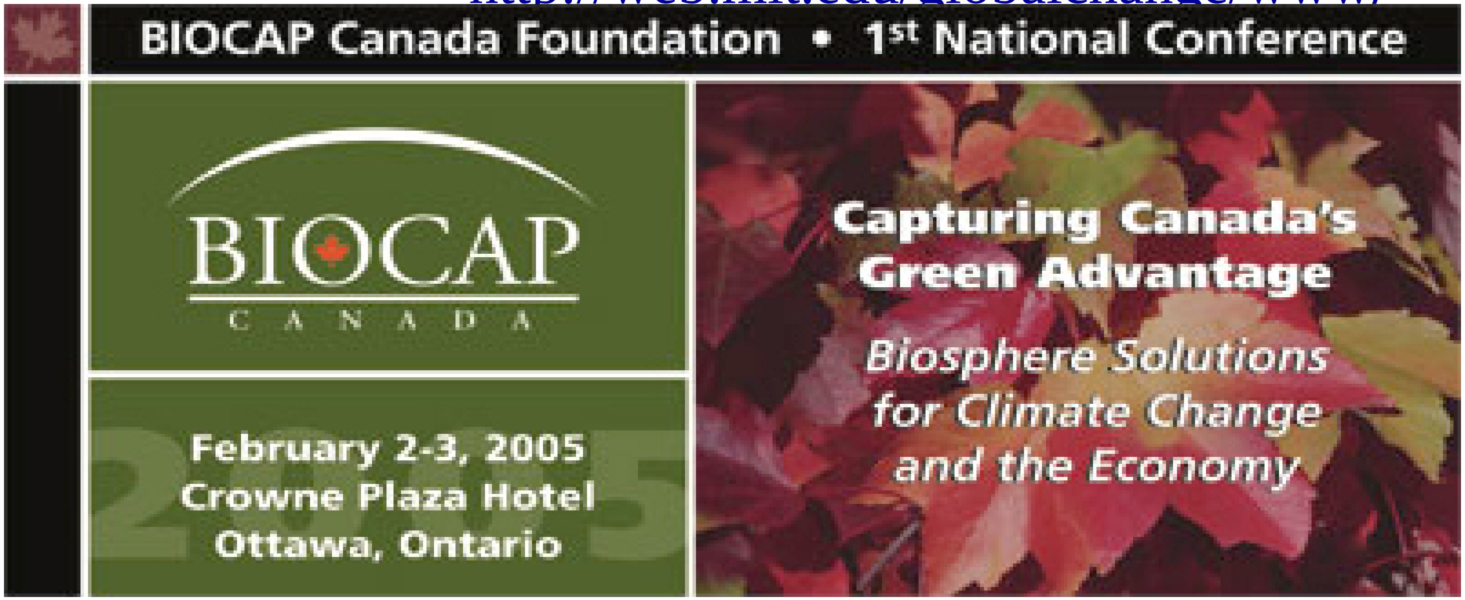
http://web.mit.edu/globalchange/www/



Key Issues

- Canada and Kyoto
- Biological Interactions & Climate Feedbacks
- Sinks Economic & Policy Considerations

Funding Support

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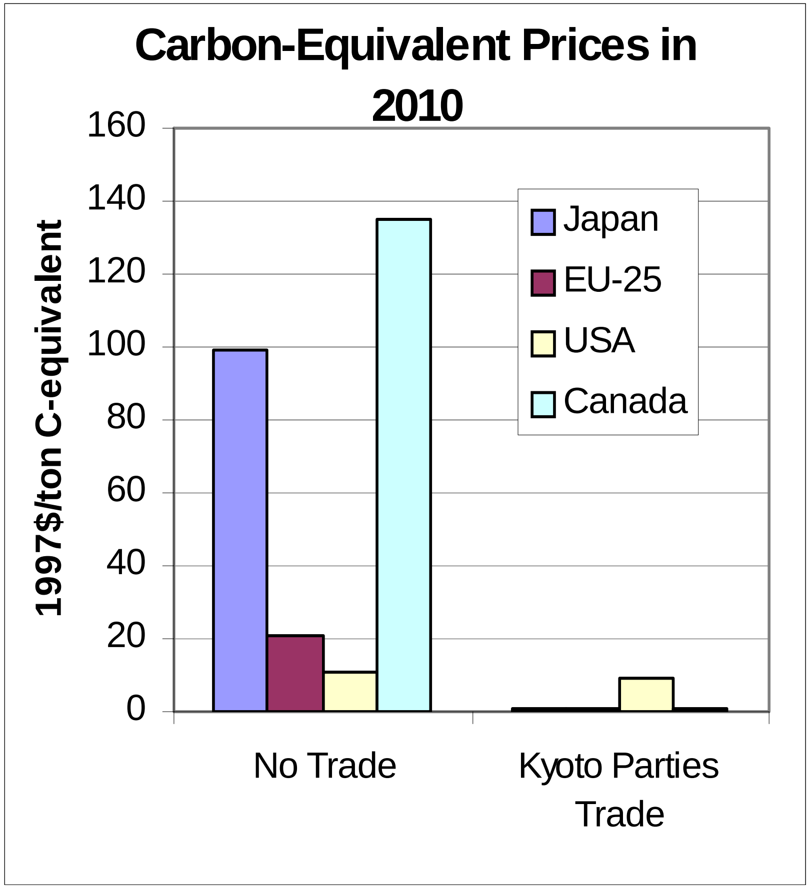
Kyoto with Article 4 Sinks, All GHGs

(US Achieving Bush Intensity Target)

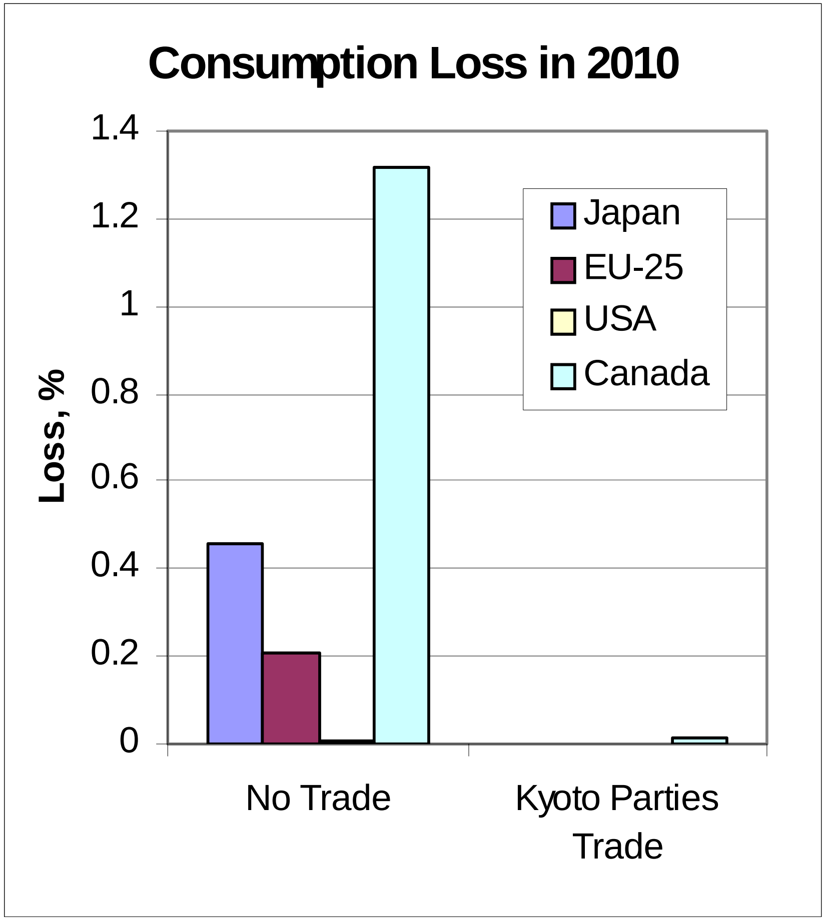
- No Trade, high costs among Kyoto Parties, highest C-equiv. price in Canada
- Meeting US intensity target (18% reduction in GHG intensity of GDP over 10 years) would require equivalent of about $10/t c-equiv.
- With trade, Kyoto Parties c-equiv. price << $1/t. (Russian hot air enough to cover emissions of other Parties.)



Source: Paltsev, et al. The Cost of Kyoto Protocol Targets: The Case of Japan, Joint Program Report No. 112

Consumption Losses

- C-equiv. price, a popular measure of costs, often is not a good measure of the full cost.
- Consumption loss relatively worse for Canada
- One reason: Canada, an energy exporter, is hurt by falling world fuel prices (Japan and EU—fuel importers—an offsetting gain from lower world fuel prices)



Among Parties, Canada most in need of trade or expanded sinks opportunities

Biophysical and Economic Interactions
Some Examples

1. Geographical and management dependence of carbon uptake
2. Weather/climate effects on carbon uptake
3. Pollution policy interactions and effects on carbon uptake.
4. Permafrost, methane, carbon, and warming

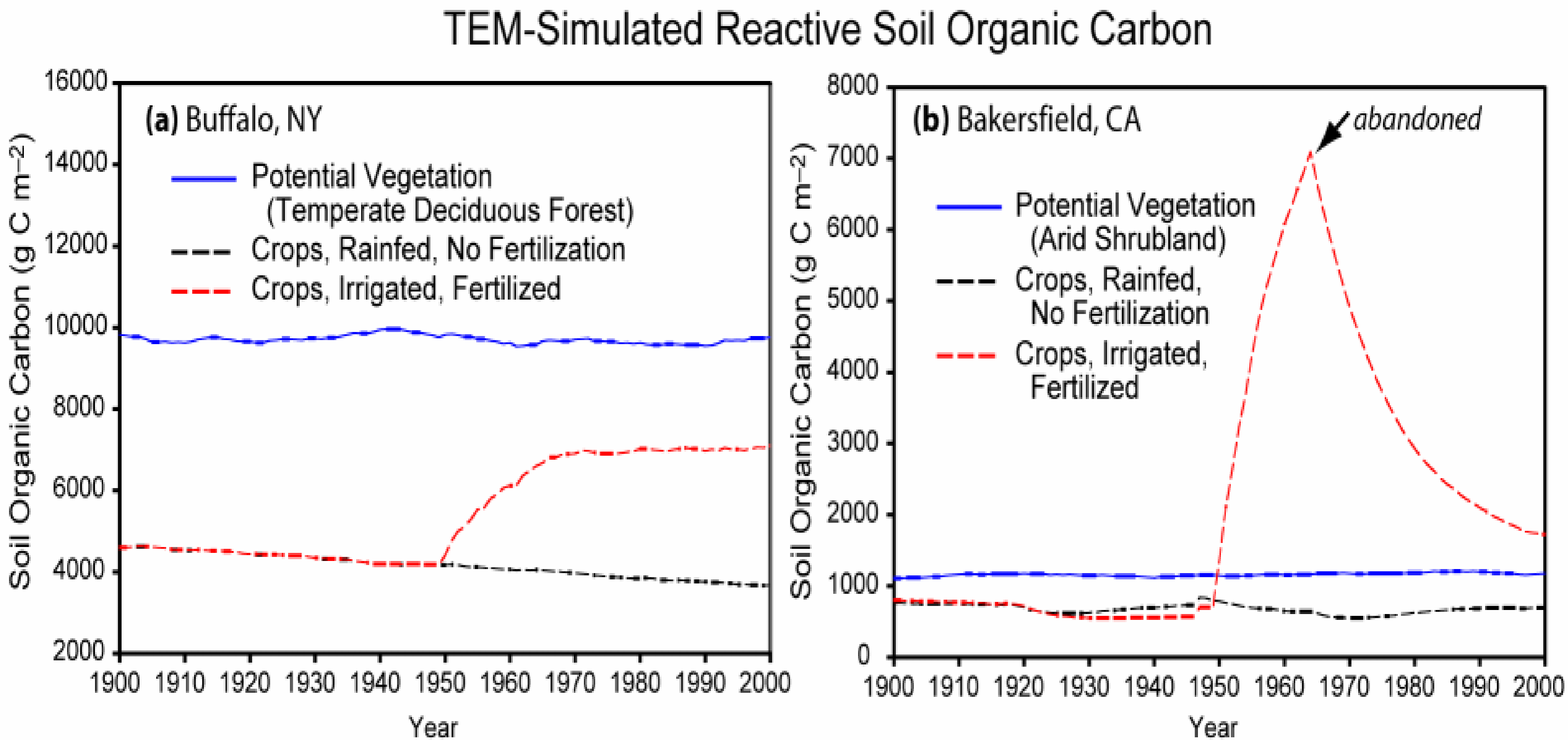
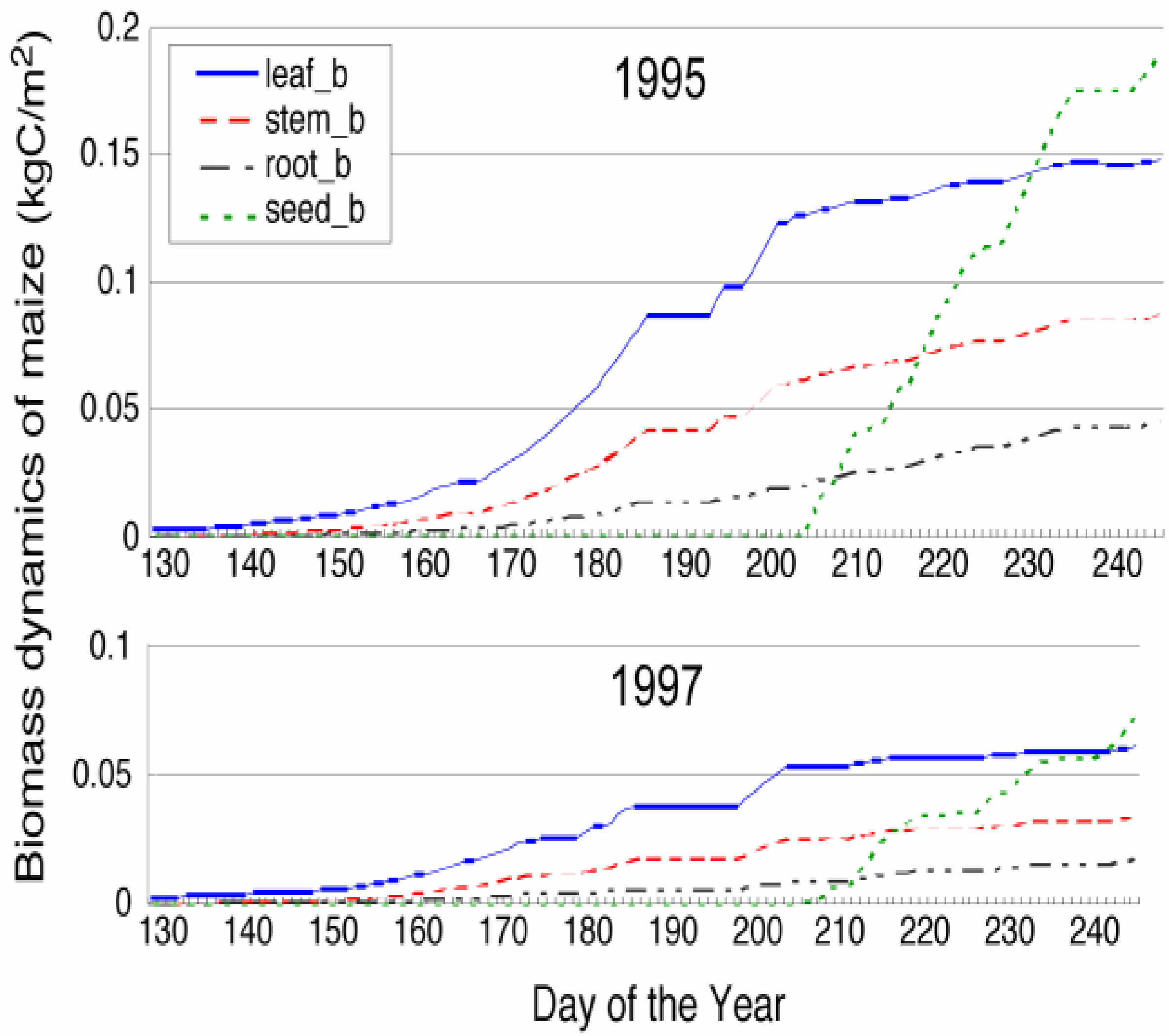


Figure 1. Historical changes in reactive soil organic carbon at agricultural sites in **(a)** Buffalo, New York, and **(b)** Bakerfield, California, under three management scenarios. Please note that fertilizer application did not occur until 1950 in the fertilized scenario and that cropland at the Bakersfield site was abandoned in 1965.

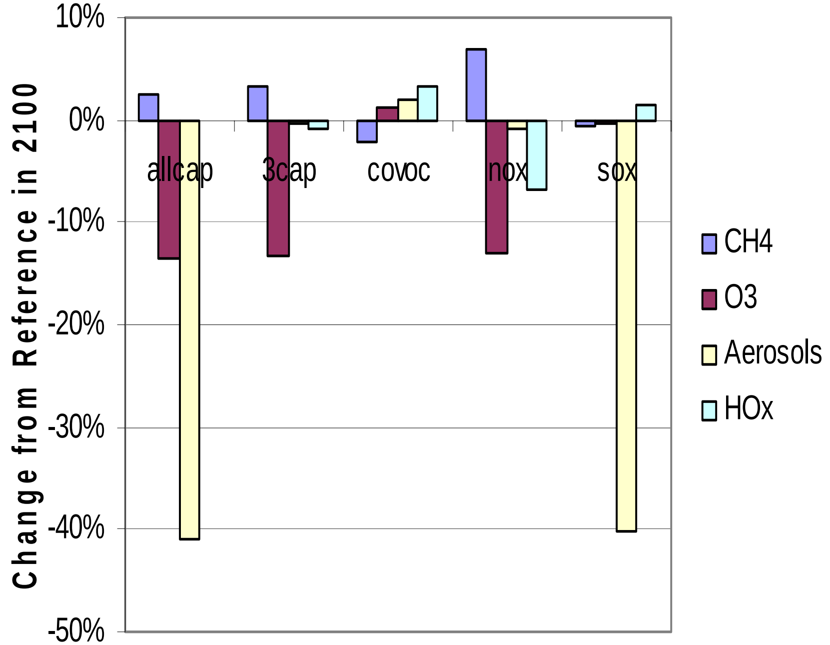
Preliminary Results: Jerry Melillo, David Kicklighter, Benjamin Felzer, MBL: Acknowledging Francesco Tubiello and Cynthia Rosenzweig (GISS) and NOAA (NA16gp2290) funding of joint GISS, MBL, MIT, IIASA project.

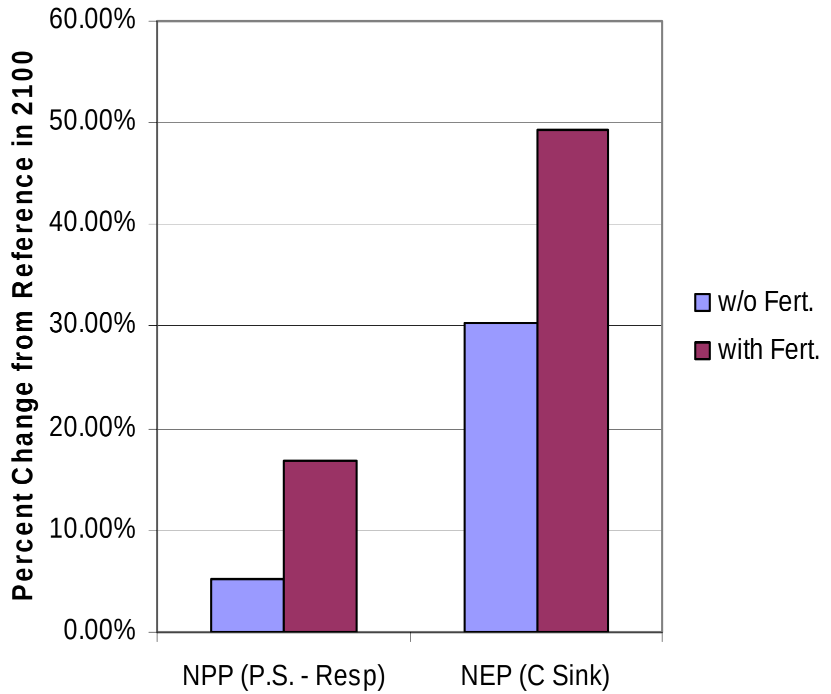
Figure 3. Simulated carbon allocation among major plant parts from TEM's new agricultural ecosystem module for maize grown at a site in Northeastern China (117˚12' W 39˚06' N). Actual daily climate data for 1995 (wet) and 1997 (dry) years were used in the simulations.



Preliminary Results: Hanqin Tian (Auburn University) Jerry Melillo, David Kicklighter, Benjamin Felzer (Marine Biological Laboratory). NSF (BCS-0410344) and other funding.

Effects on NPP of holding pollution emissions to 2005 levels compared with growth of 1.5(SO_2), 2.5(CO, VOC), 5 (NOx) times current emissions by 2100.

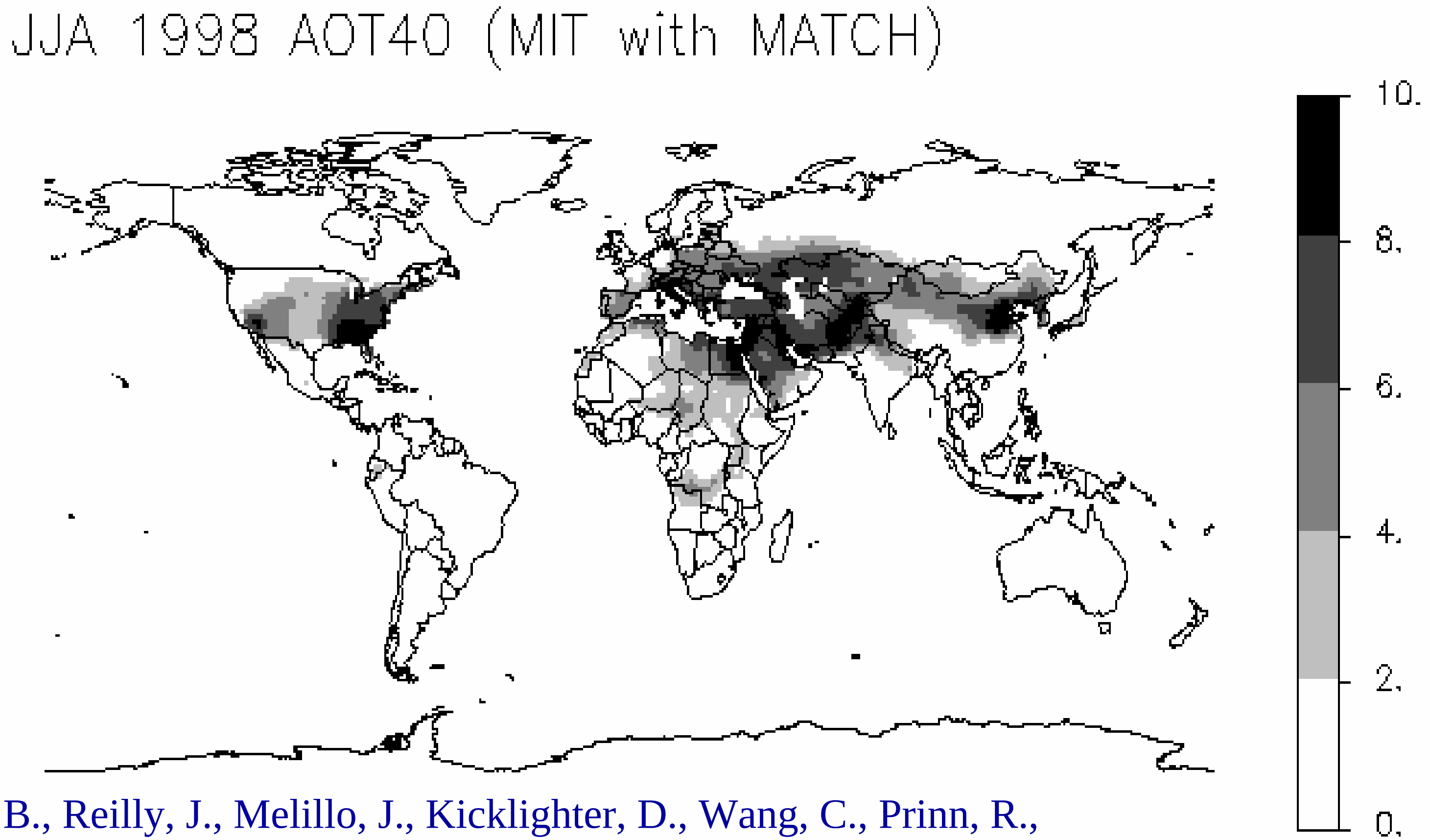




From: R. Prinn, J. Reilly, M. Sarofim, C. Wang, B. Felzer Effects of Air Pollution Control on Climate, (Schlesinger et al. eds.) **Human-Induced Climate Change:** An Interdisciplinary Assessment, *Cambridge University Press, (Chapter submitted).*

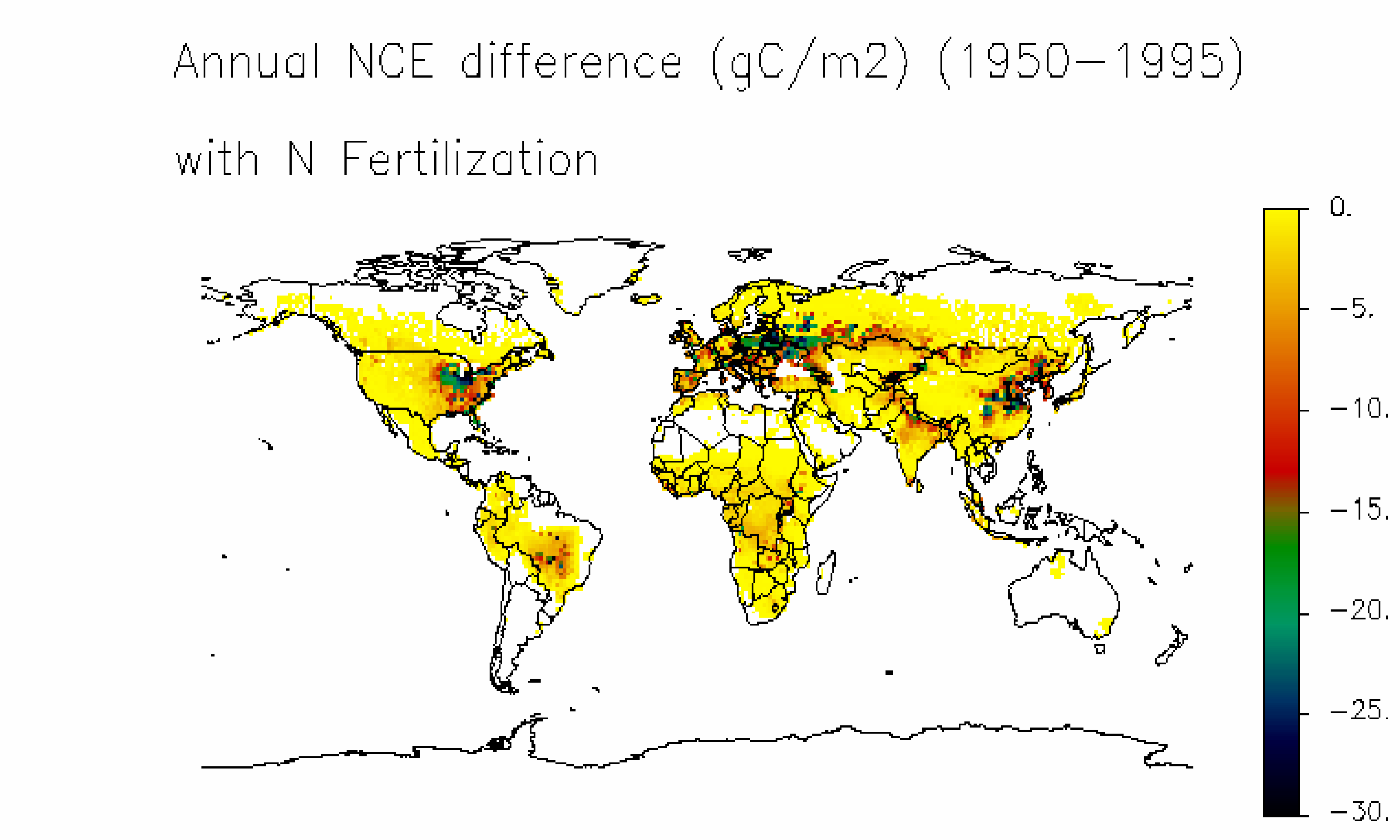
GLOBAL SCIENCE POLICY CHANGE MIT

Current Ozone Levels (AOT40)



Felzer, B., Reilly, J., Melillo, J., Kicklighter, D., Wang, C., Prinn, R., Sarofim, M. & Zhuang, Q., 2004. Past and future effects of ozone on net primary production and carbon sequestration using a global biogeochemical model, Climatic Change, forthcoming.

Effects of Ozone on Carbon Uptake by Vegetation



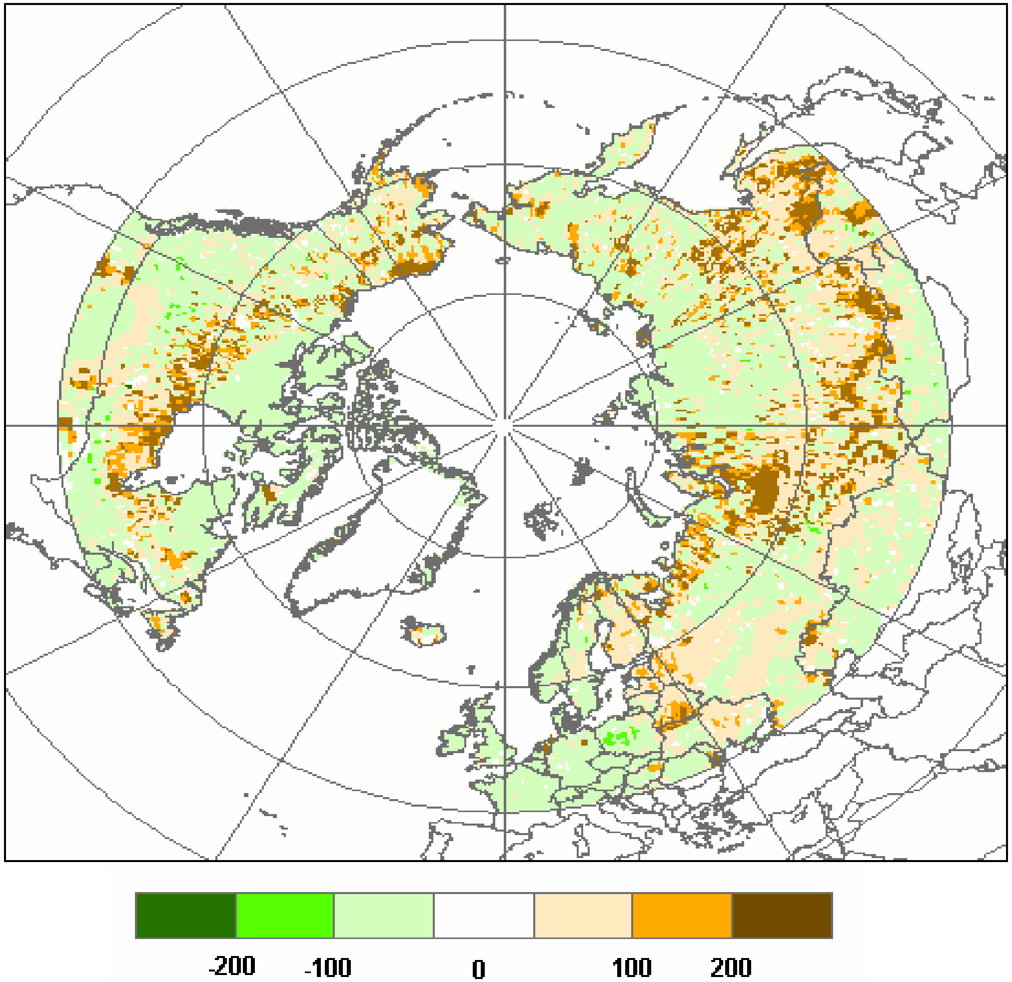
Felzer, B., et al., 2004. op cit.

Table 5. Net present value consumption loss, (Billions of 1997 dollars, 5% discount rate). (due to ozone damages)

	United States	European Union	China	Global
Cost of GHG Stabilization	2,888	4,238	6,396	20,781
Additional Costs from Ozone Damage				
Climate Policy	622	1769	1181	4461
Climate Policy & Pollution Policy	335	921	171	1819

Felzer, B., et al., 2004. op cit.

Pan-Arctic Greenhouse Gas Budget for the 1990s

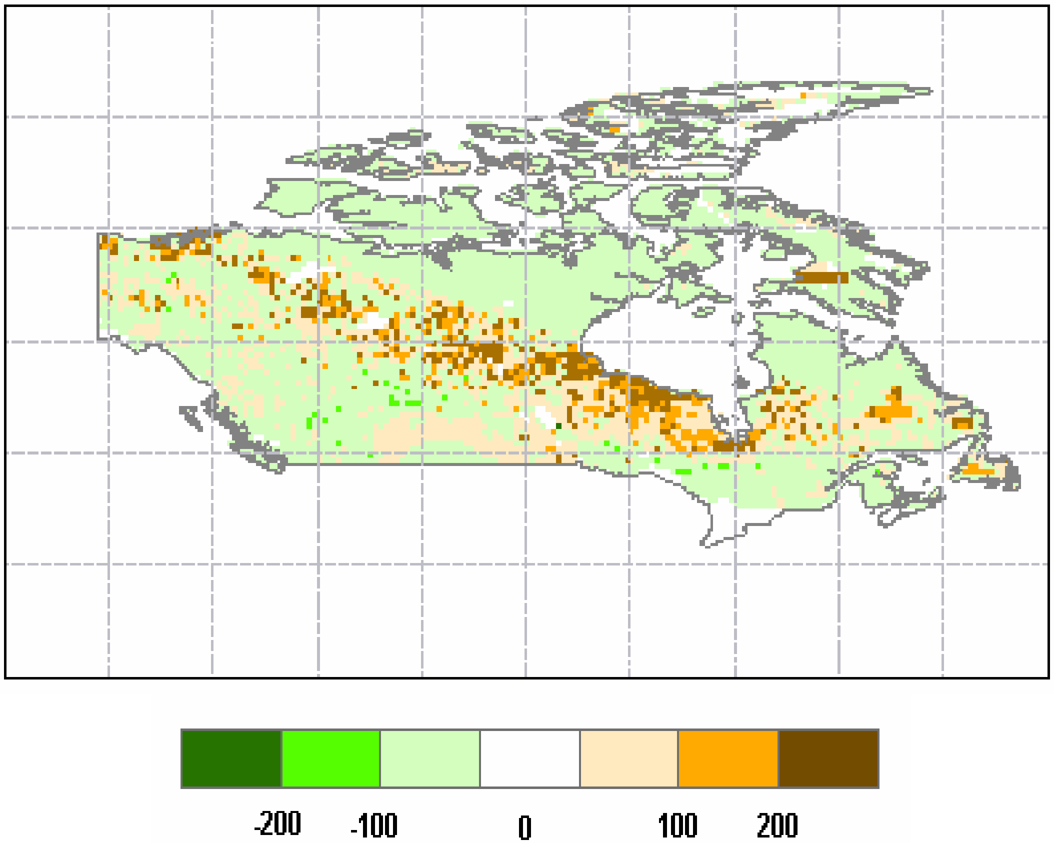


Sink **(g CO_2-eq. m^{-2} yr^{-1})** **Source**

GHG Sources
2.1 Pg CO_2-eq. yr^{-1}

Source: Q. Zhuang.et al., 2004, Methane Fluxes Between Terrestrial Ecosystems and the Atmosphere at Northern High Latitudes During the Past Century: A Retrospective Analysis with a Process-Based Biogeochemistry Model,Global Biogeochemical Cycles 18: GB3010

Canadian Greenhouse Gas Budget for the 1990s



Sink **(g CO_2-eq. m^{-2} yr^{-1})** **Source**

GHG Sources
200 Tg CO_2-eq. yr^{-1}

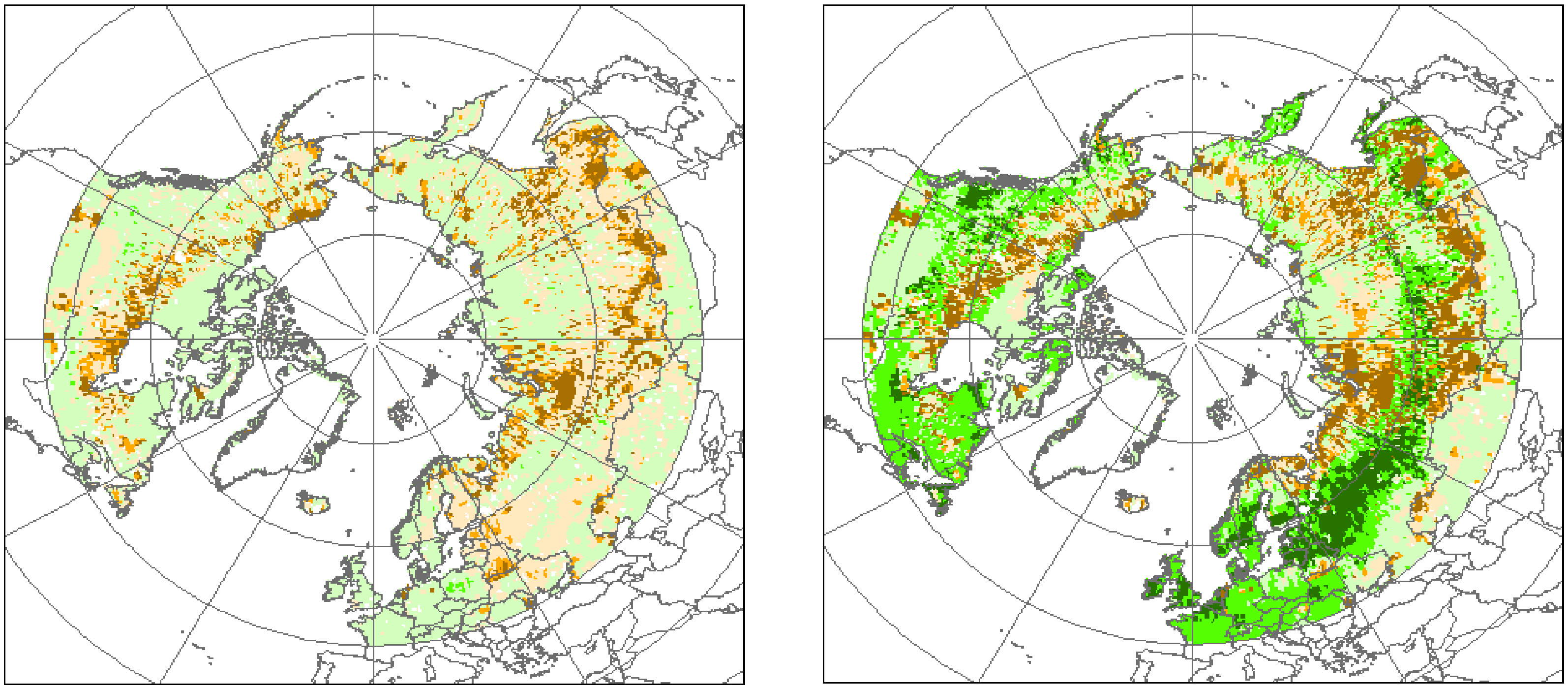
Source: Q. Zhuang, et al., 2004, op cit.

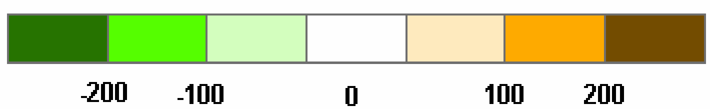
1990s:

Source 2.1 Pg CO2-eq.yr-1

2090s:

Source 0.4 Pg CO2-eq.yr-1





Sink **(g CO_2-eq. m^{-2} yr^{-1})** **Source**

Source: Q. Zhuang, et al., preliminary

Economics

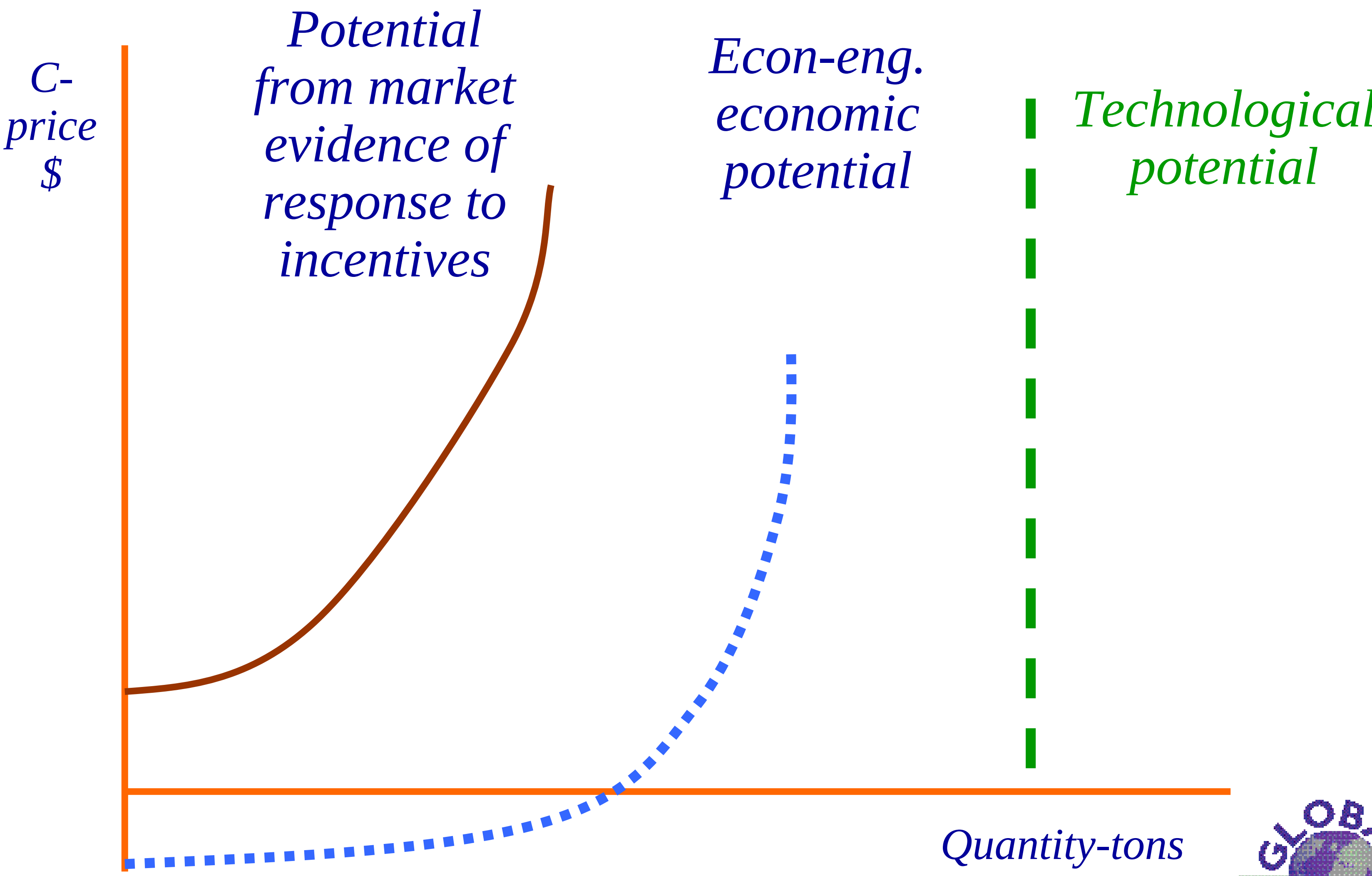
$$NPV = p(0)a(0) + \sum_{1}^{\infty} p(t)a(t)(1+r)^{-t}$$

Valuing a stream of carbon emissions or uptake where p(t) price of carbon at time t, a(t) quantity of carbon (uptake (+) or emission (-), discount rate r

- But this simple problem is often confused.
- Leakage not priced.
- C-price implicitly assumed constant
- Use of equivalency discount factors.
  - Discount factor can be computed for a project over time to compare to a current (time 0) project.
  - Factors not independent of r, time profiles of p(t), a(t) that vary by project.
  - Time profile of a(t) is under the control of agents (i.e. landowners) who have no incentive to prevent emissions unless contractually obligated.

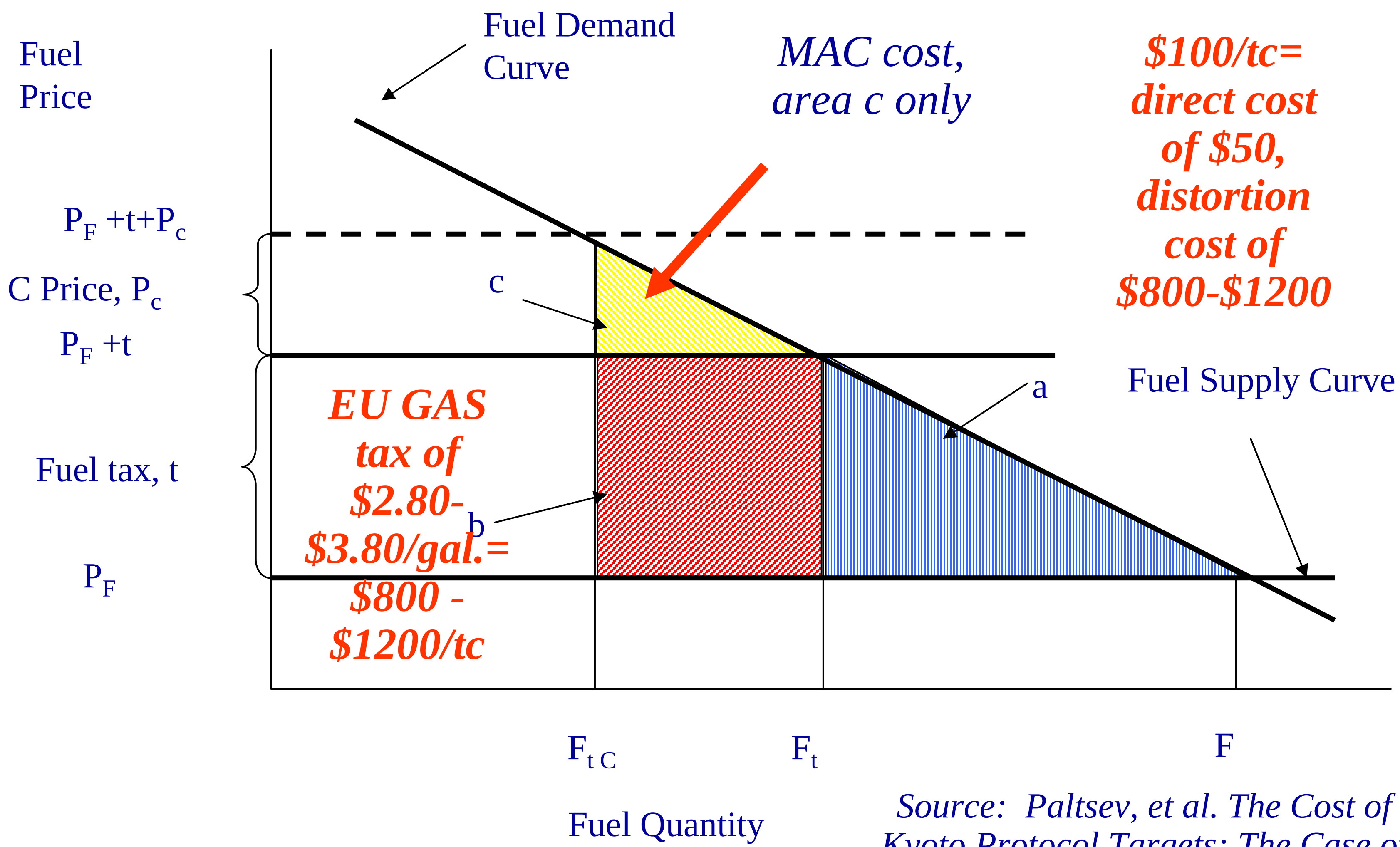
See: Herzog, H., K. Caldeira, J. Reilly, "An Issue of Permanence: Assessing the Effectiveness of Ocean Carbon Sequestration", Climatic Change, 59: 293-310, 2003.

Realistic Potential



Acknowledging and after Bruce McCarl

Distortions in Fuel Markets: Similar Distortions in Ag.?



Source: Paltsev, et al. The Cost of Kyoto Protocol Targets: The Case of Japan, Joint Program Report No. 112

Larger Role of Ag./Forest Carbon

- Carbon as bridge to the future?

- Option value of potential forest and land sink.

Policy Issues and Concerns

- Cap NOT Credit (or mandatory baseline if C tax or other instrument)
  - Opt in choice for small land-owners
- Sell as you sequester, pay as you emit—NO payment for 'discounted' tons.
  - By public agency—contractual deals among private market participants can take any form as long as..
- Measured quantities NOT payments based on practices.
- Permanent liability—once capped, always under cap.
  - But preserve flexibility to emit stored carbon by paying carbon price at the time.
- Transactions costs (I.e. measurement, verification) borne by the market NOT a public Agency—symmetric treatment with fossil fuel emitters.
- Enforcement
- Allow market participants to bank credits for disasters, less than expected results from sequestration NO bailouts or limited liability provisions.

Challenges for Research and Modeling

- Hold to principles to ensure integrity of carbon in ag. and forestry.
- Develop measuring and monitoring technologies.
- Develop realistic estimates of storage potential.
- Model and contrast less than ideal policy mechanisms with ideal mechanisms.
- Develop ability to estimate and show leakage from credit-based systems.