

Potential Direct and Indirect Effects of Global Cellulosic Biofuel Production and Greenhouse Gas Fluxes From Future Land-use Change

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John M. Reilly³ and Sergey Paltsev³

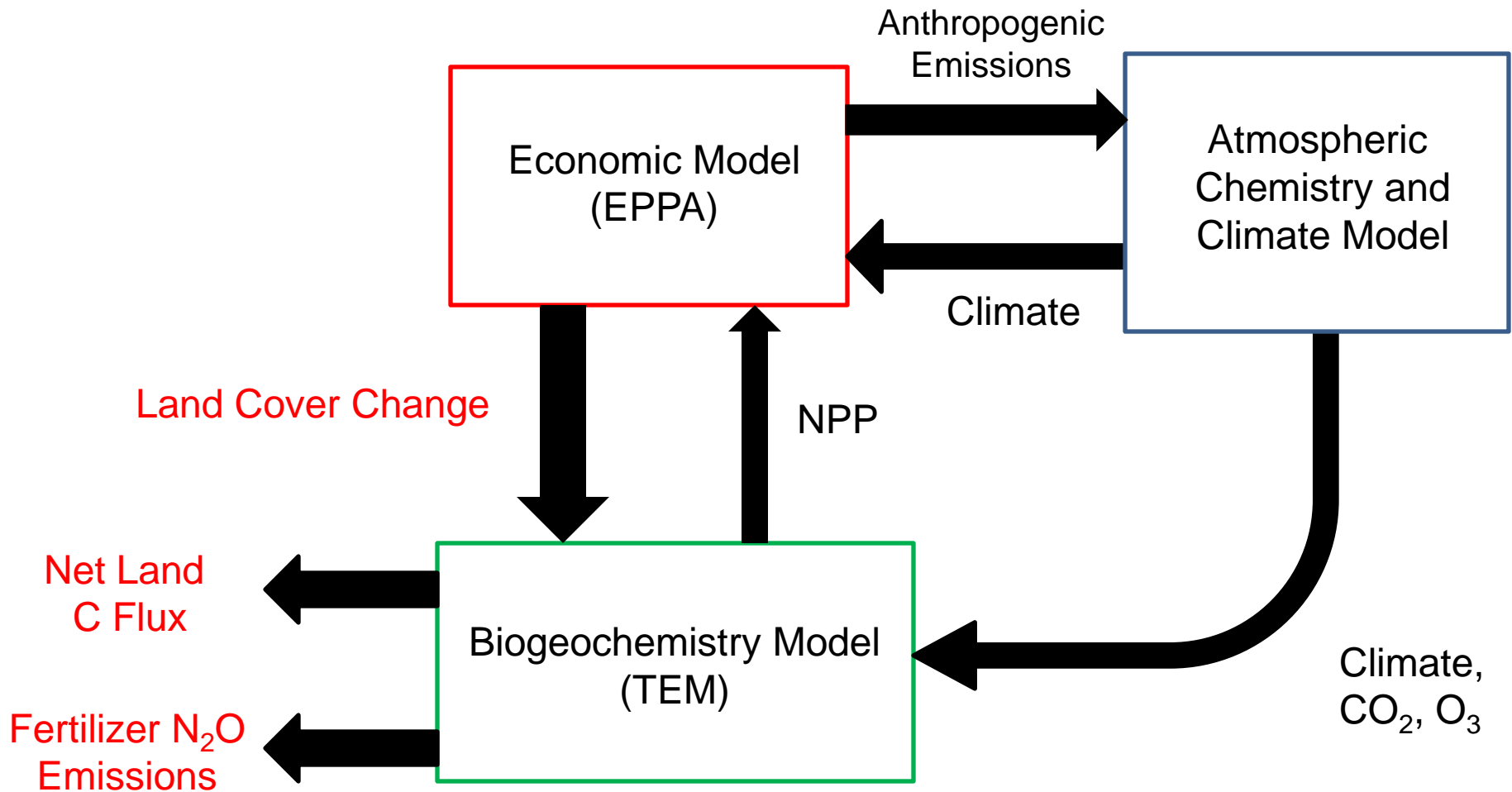
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Washington, DC

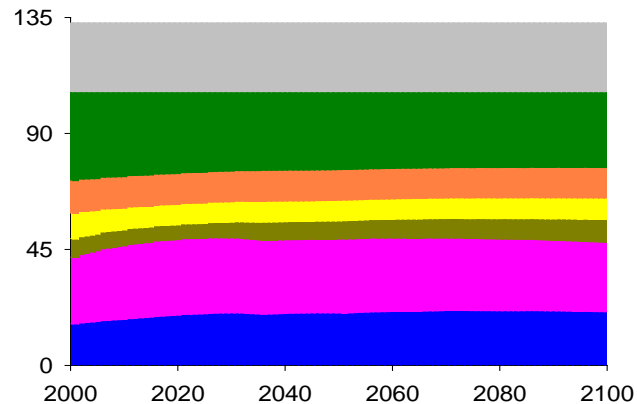
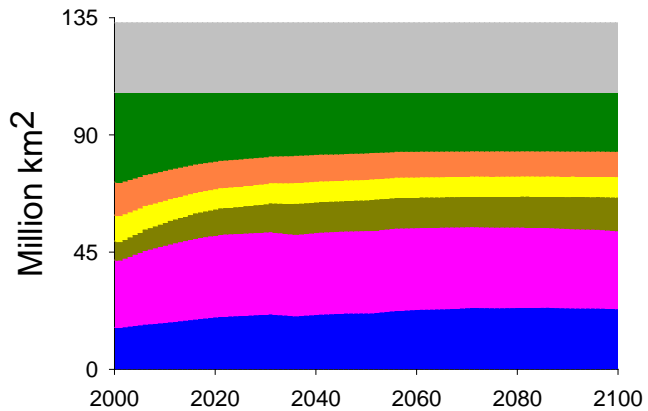
General Approach



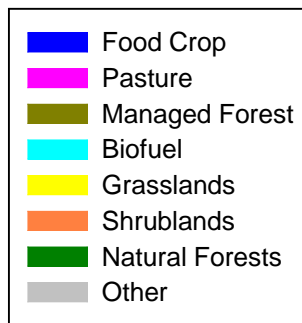
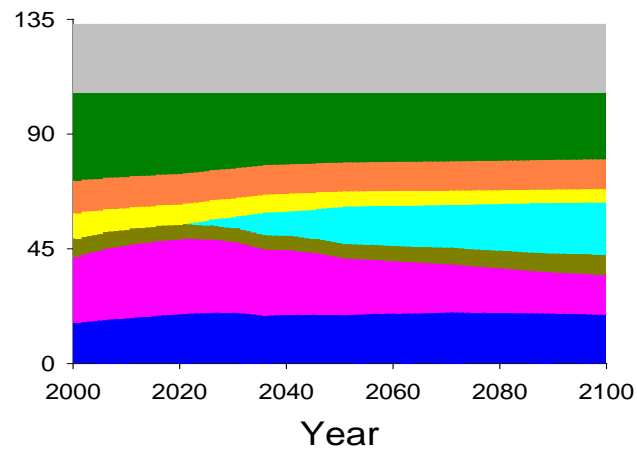
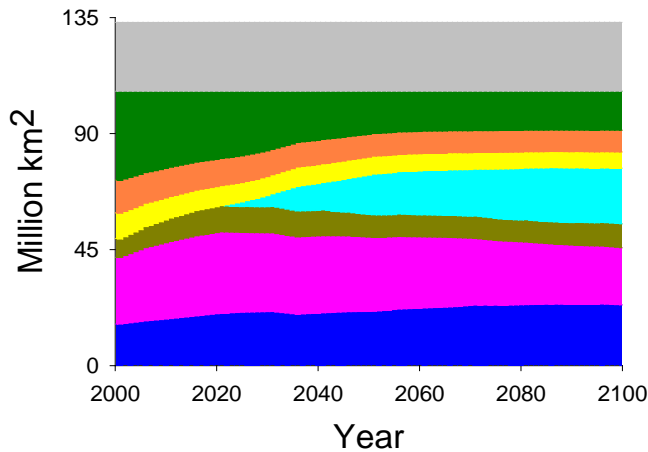
Case 1 - Deforestation

Case 2 - Intensification

Without
Biofuels

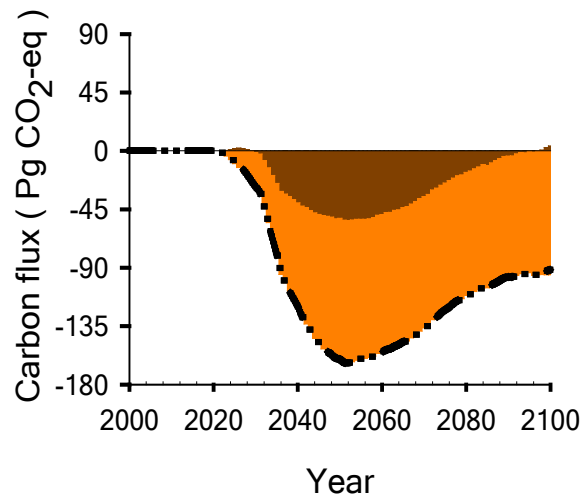


With
Biofuels

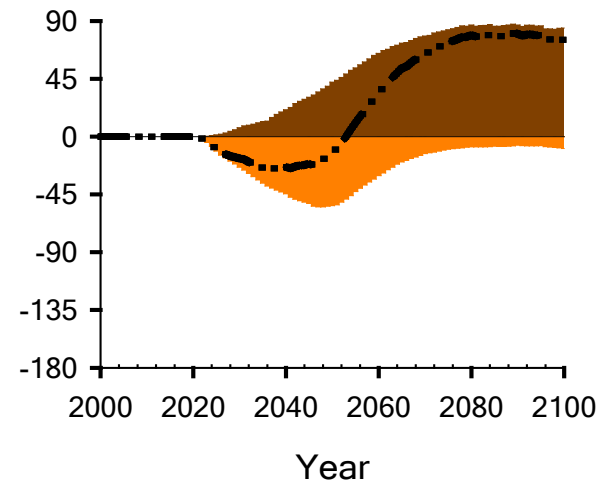


Effect of Biofuels on Cumulative Terrestrial Carbon Storage

Case 1 - Deforestation



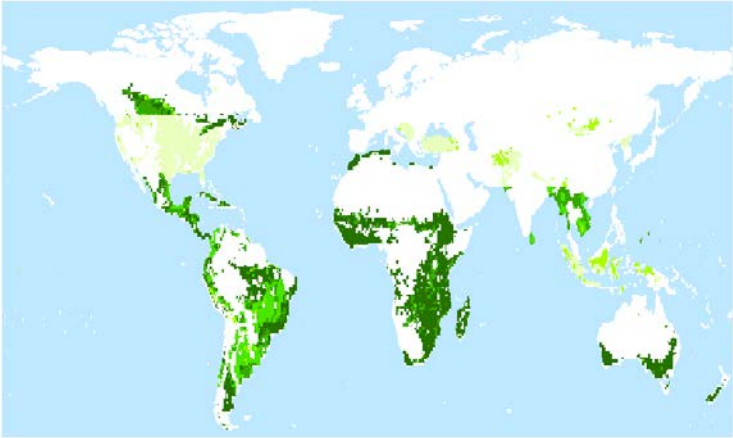
Case 2 - Intensification



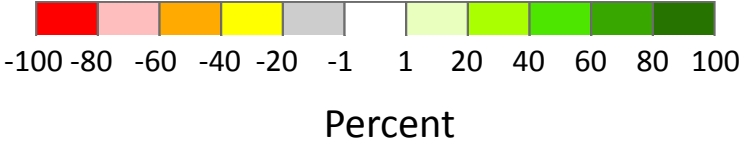
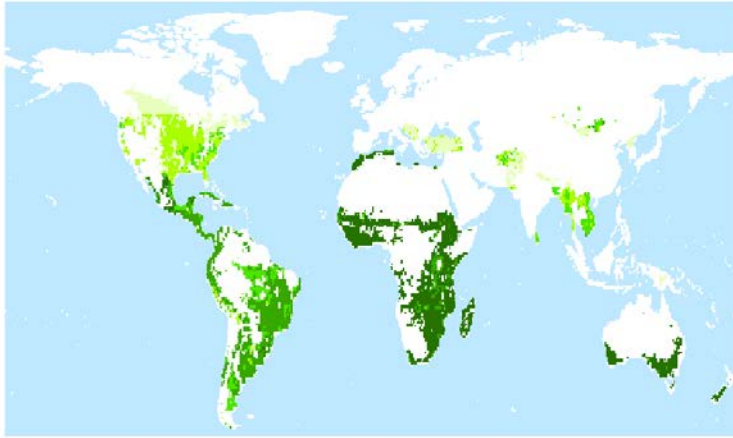
Melillo et al., 2009, *Science* **326**, 1397-1399

Distribution of Cellulosic Biofuels Production in 2100

Case 1 - Deforestation



Case 2 - Intensification



Kicklighter et al. (in prep.)

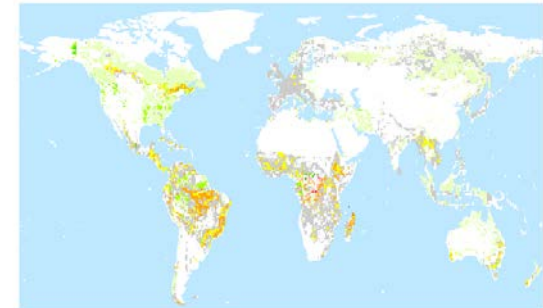
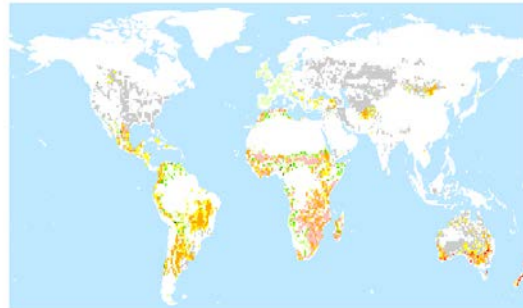
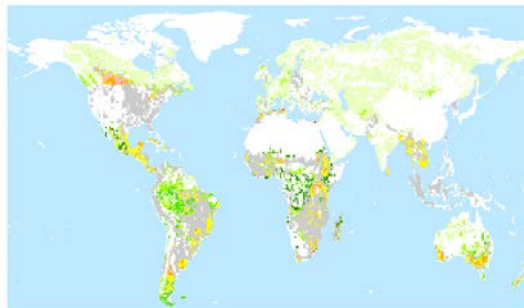
Effect of Cellulosic Biofuels Production on Distribution of Other Managed Lands in 2100

Food Crops

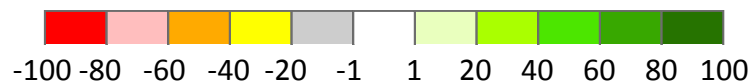
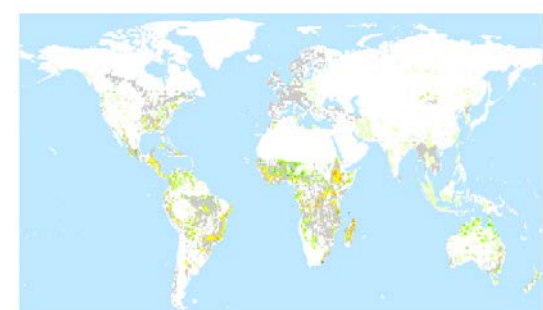
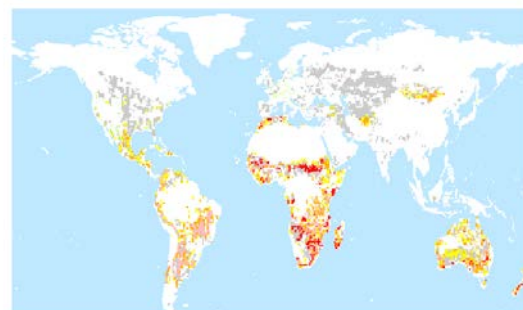
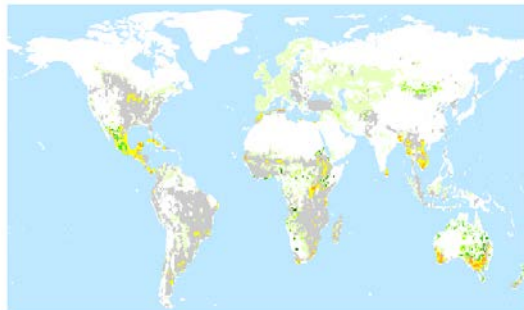
Pasture

Managed Forests

Case 1



Case 2



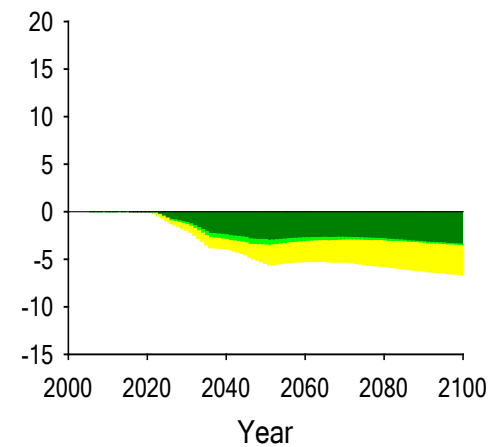
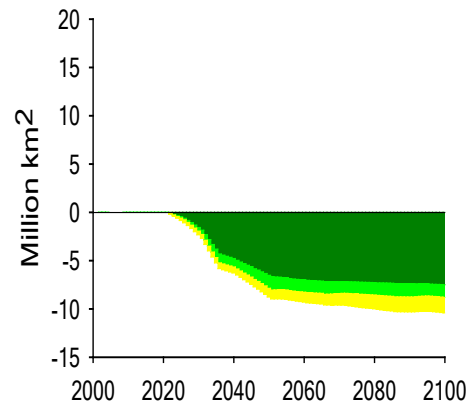
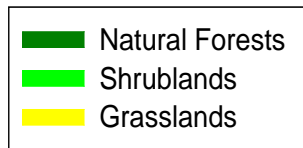
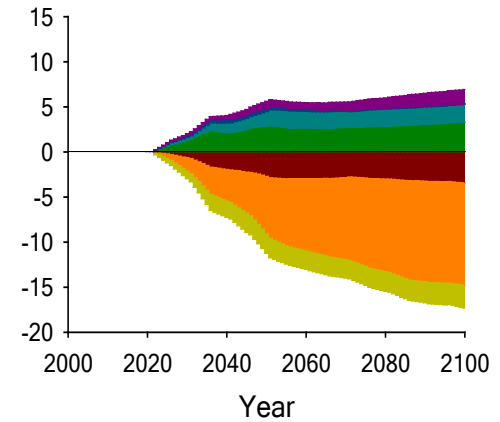
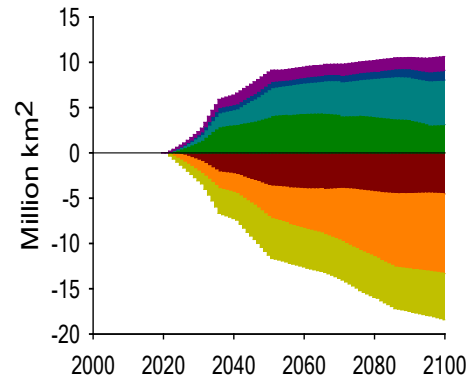
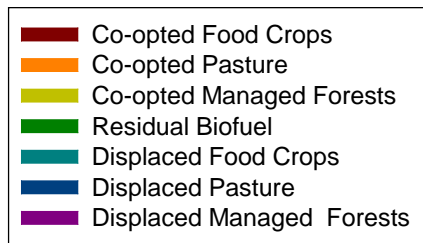
Percent

Kicklighter et al. (in prep.)

Biofuel-induced Changes in Area of **Other Managed Lands** and **Natural Lands**

Case 1 - Deforestation

Case 2 - Intensification



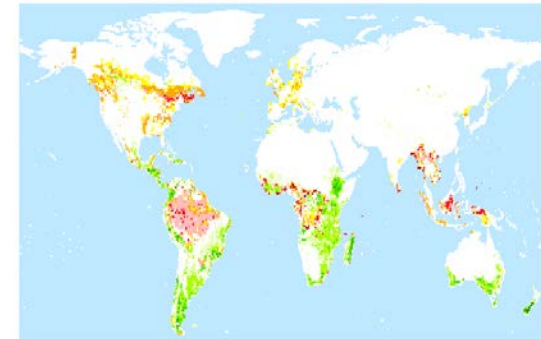
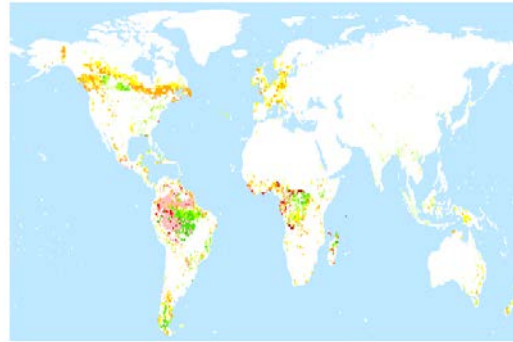
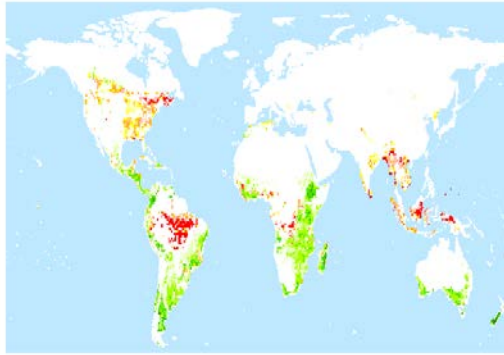
Effects of Cellulosic Biofuels Production on Carbon Storage (2001-2100)

Direct Effects

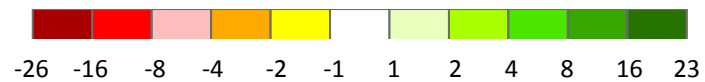
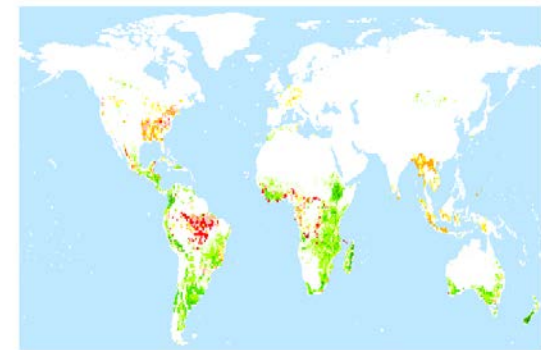
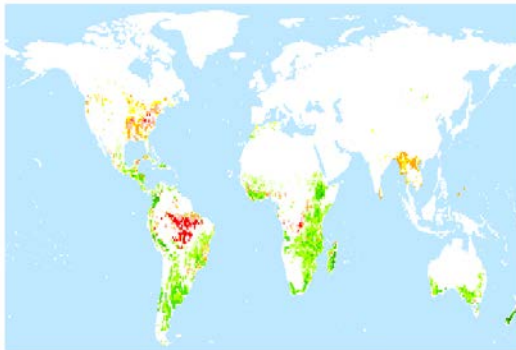
Indirect Effects

Total Effects

Case 1



Case 2

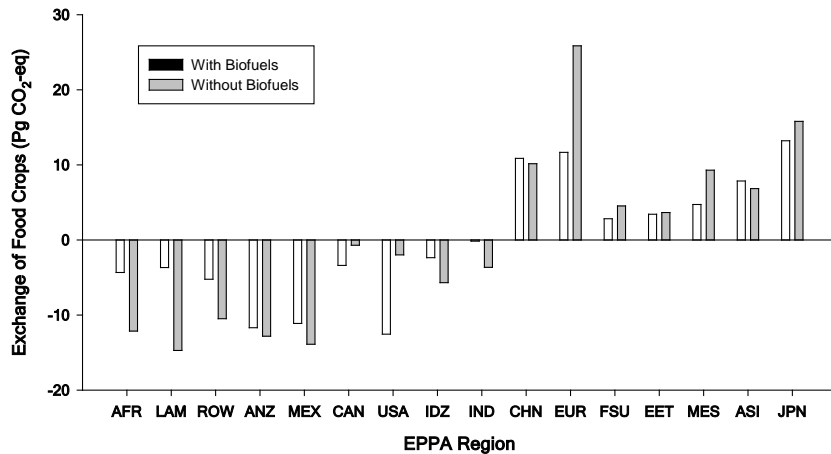


-26 -16 -8 -4 -2 -1 1 2 4 8 16 23

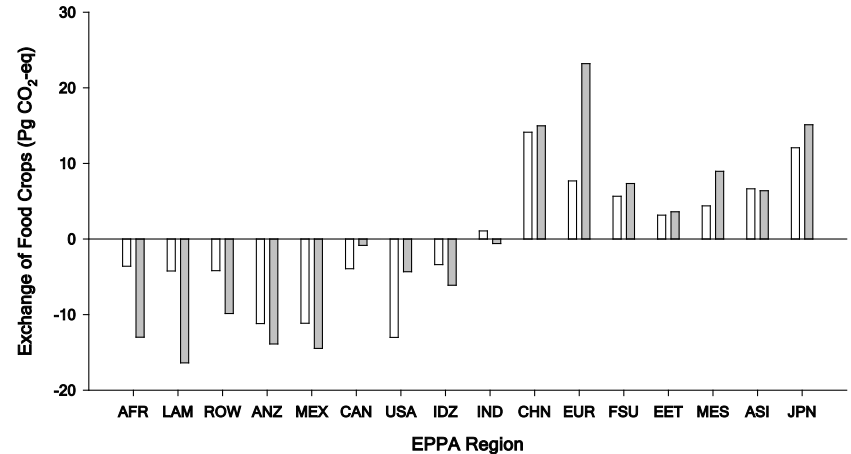
kg C m⁻²

Cumulative Imports (positive) and Exports (negative) of Food Crops with Cellulosic Biofuels Production among EPPA Regions over the 21st Century

Case 1 - Deforestation



Case 2 - Intensification



Nitrous Oxide (N₂O) Fluxes from Natural Ecosystems

$$\text{N}_2\text{O flux} = a (\text{Soil Respiration}) + b$$

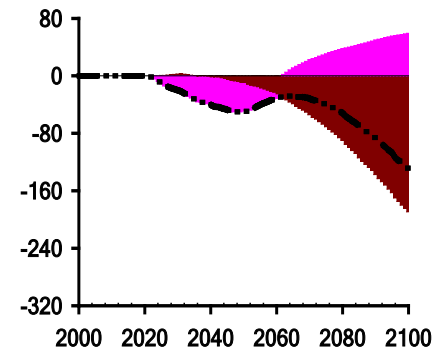
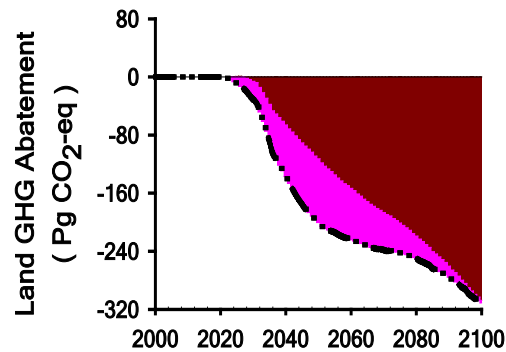
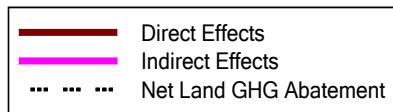
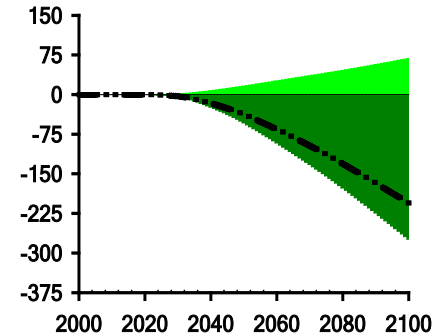
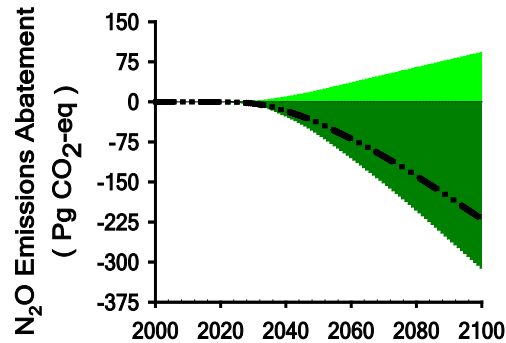
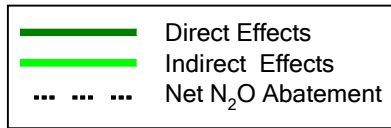
$$\text{Soil Respiration} = \alpha (\text{Plant Respiration}) + \text{Decomposition}$$

Xu et al., 2008, *Global Change Biology* **14**, 1651-1660.

Garcia-Montiel et al., 2004, *Ecological Applications* **14**(4) Supplement, S214-S220.

Effect of Cellulosic Biofuels Production on N₂O Fluxes and Net Greenhouse Gas Fluxes

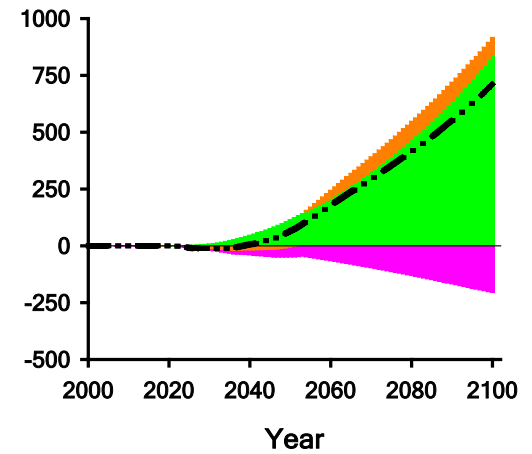
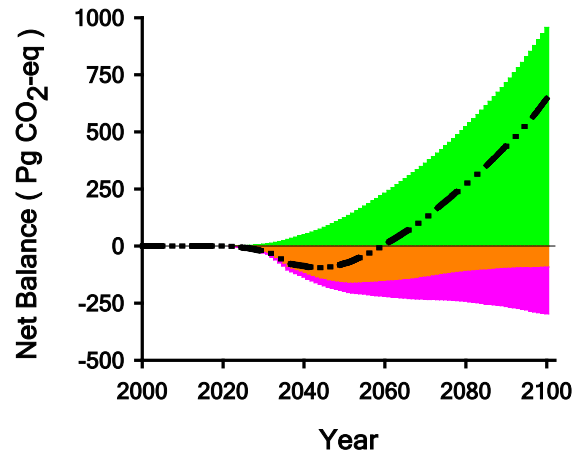
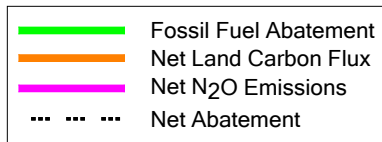
Case 1 - Deforestation Case 2 - Intensification



Effect of Cellulosic Biofuels Production on Net Greenhouse Gas Balance

Case 1 - Deforestation

Case 2 - Intensification



Conclusions

- Most cellulosic biofuels production will occur on lands that would otherwise be used for other human activities
- Displacement and redistribution of global food production leads to a reduction in the trade of food products; **exception Canada and USA**
- Reductions of natural carbon sequestration capacity by land conversion may be compensated by concurrent reductions in natural N₂O emissions
- Avoidance of deforestation and fertilizer applications will have largest impact on minimizing land GHG emissions from cellulosic biofuels production