Department of
Civil & Environmental Engineering
Massachusetts Institute of Technology

Effect of CO_2 Inhibition of Isoprene Emission

Air quality under 2000-2050 changes in climate, vegetation and land use

Amos P. K. Tai

(With Loretta Mickley, Colette Heald, Shiliang Wu)

6th International GEOS-Chem Users' Meeting

May 7, 2013

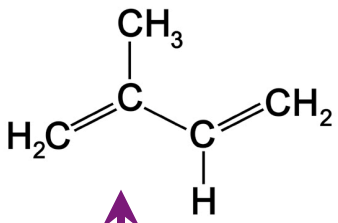
MIT ATMOSPHERIC CHEMISTRY

Croucher Foundation
裘槎基金會

Climate Change Will Worsen Ozone Air Quality

- Ozone air quality will worsen by +1-10 ppbv in polluted (high-NO_x) regions by 2050, driven mainly by higher temperature

Isoprene → high NO_x → ozone



- At least half of such sensitivity is driven by increased isoprene emission in warmer climate

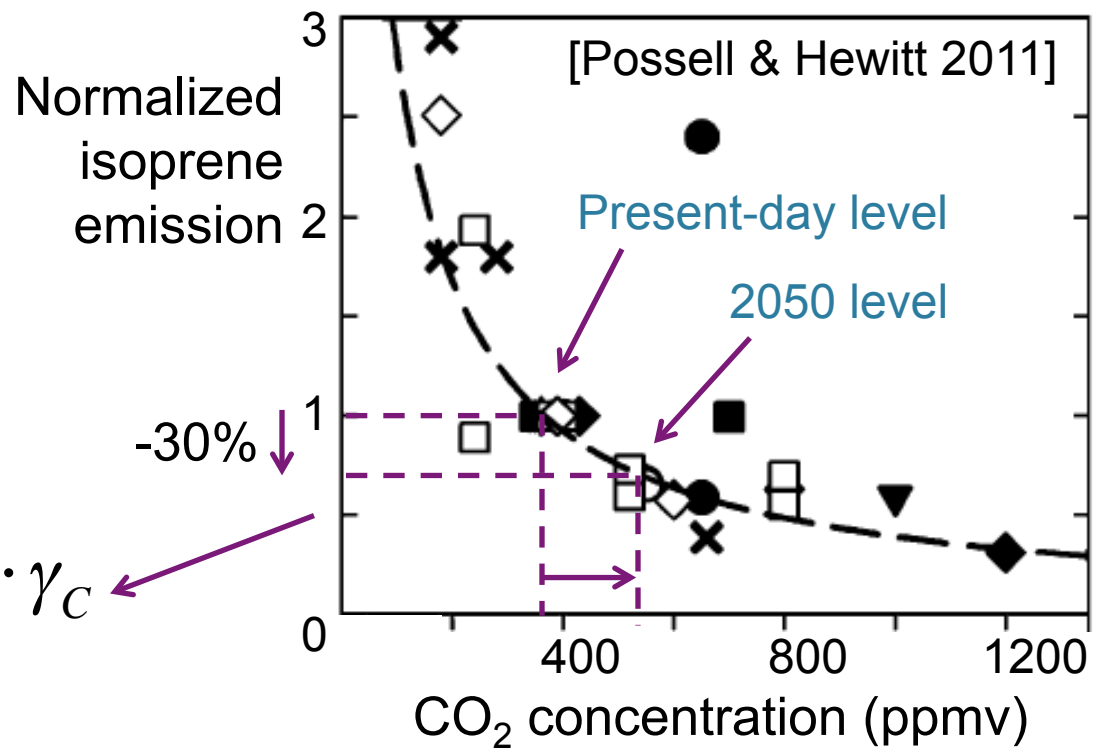
- But recent studies suggest higher CO_2 levels may inhibit isoprene production in plants, at least partially offsetting increases due to warming

Elevated CO_2 Inhibits Isoprene Emission

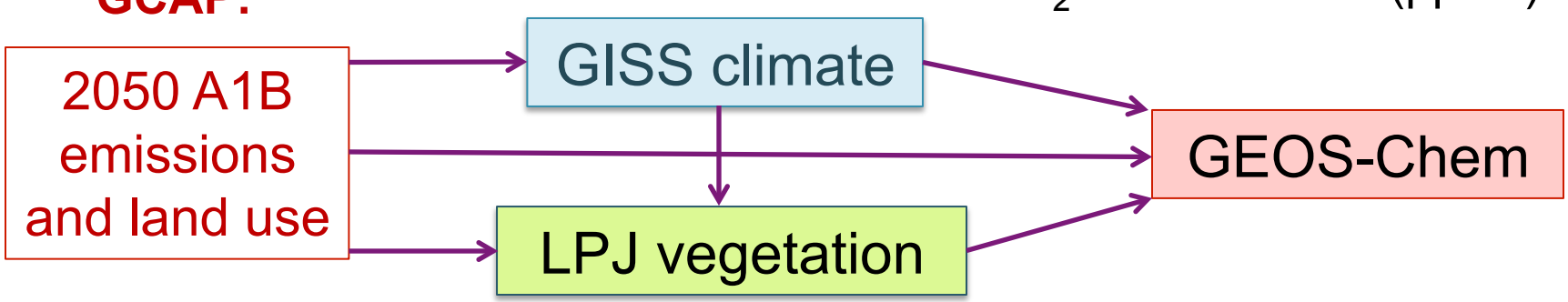
- Isoprene emission is suppressed at elevated CO_2 levels
- Revise 2000-to-2050 ozone projections by incorporating this effect in MEGAN in GEOS-Chem:

$$E_{\text{isop}} = E_0 \cdot \gamma_{\text{other factors}} \cdot \gamma_C$$

Observations of leaf isoprene emission at different ambient CO_2 levels



GCAP:



CO_2 Effect Reduces Ozone Sensitivity to Climate Change

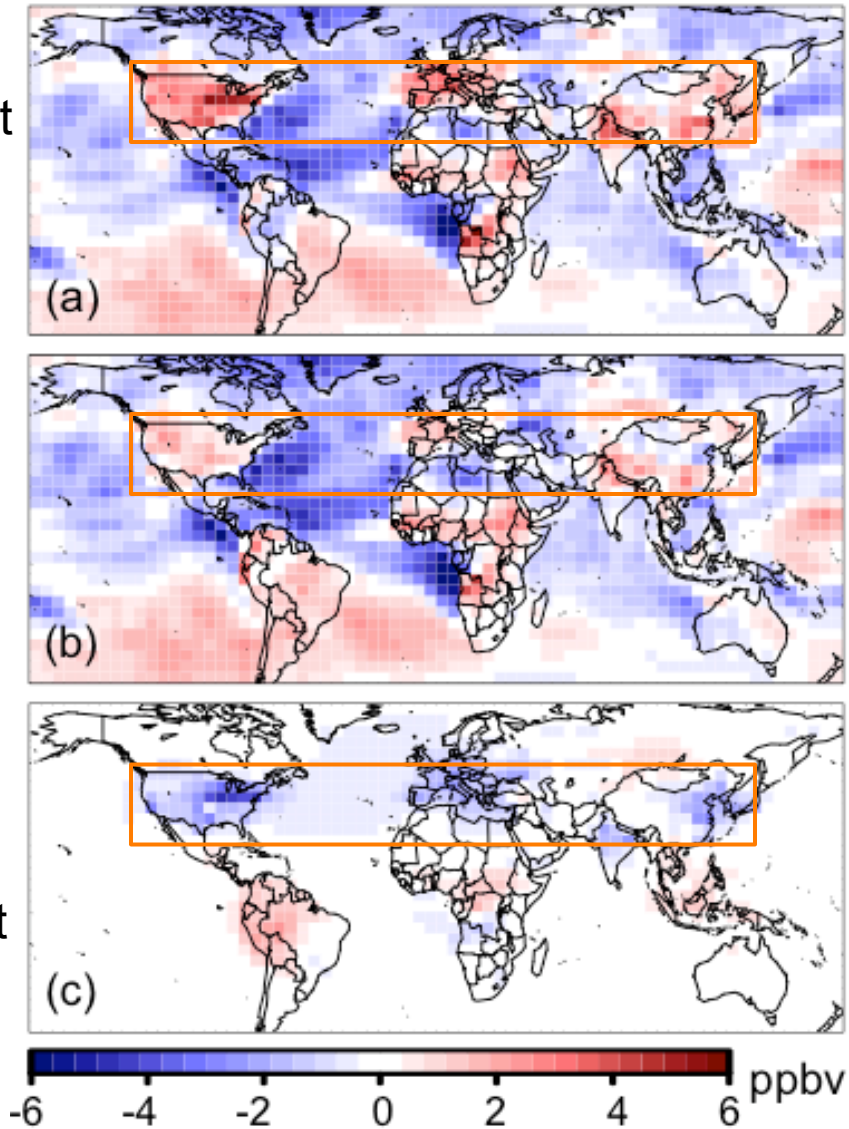
2000-to-2050 change in surface ozone (MDA8) due to climate change alone

[Tai et al. submitted]

Without CO_2 effect

With CO_2 effect

With minus without

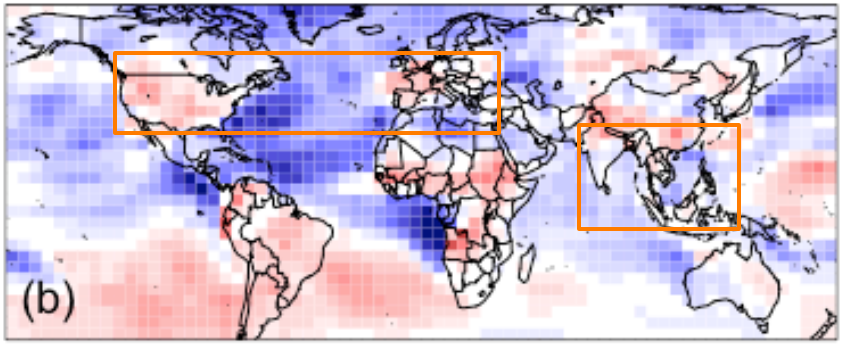


- Original projected ozone increase due to climate change: +6 ppbv max.
- With CO_2 inhibition of isoprene emission: +3 ppbv max.
- Ozone sensitivity to changes in climate (and natural vegetation) is reduced by >50%

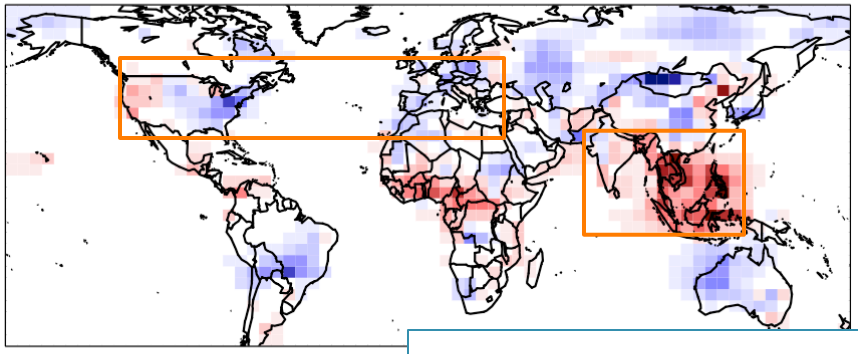
Land Use Change Can Become Key Ozone Driver

2000-to-2050 (A1B) changes in surface ozone

Climate change effect



Land use change effect



			Anthropogenic emissions change:
East US:	+2 ppbv	-3 ppbv	-5 ppbv
West Europe:	+2 ppbv	-1 ppbv	-2 ppbv
India:	no change	+2 ppbv	+30 ppbv
Southeast Asia:	no change	+5 ppbv	+30 ppbv

- Land use change can offset or reverse in sign the effect of climate change on ozone air quality
- Land use change can become key driver of ozone that can offset or enhance anthropogenic emissions control efforts