Progress at Cornell

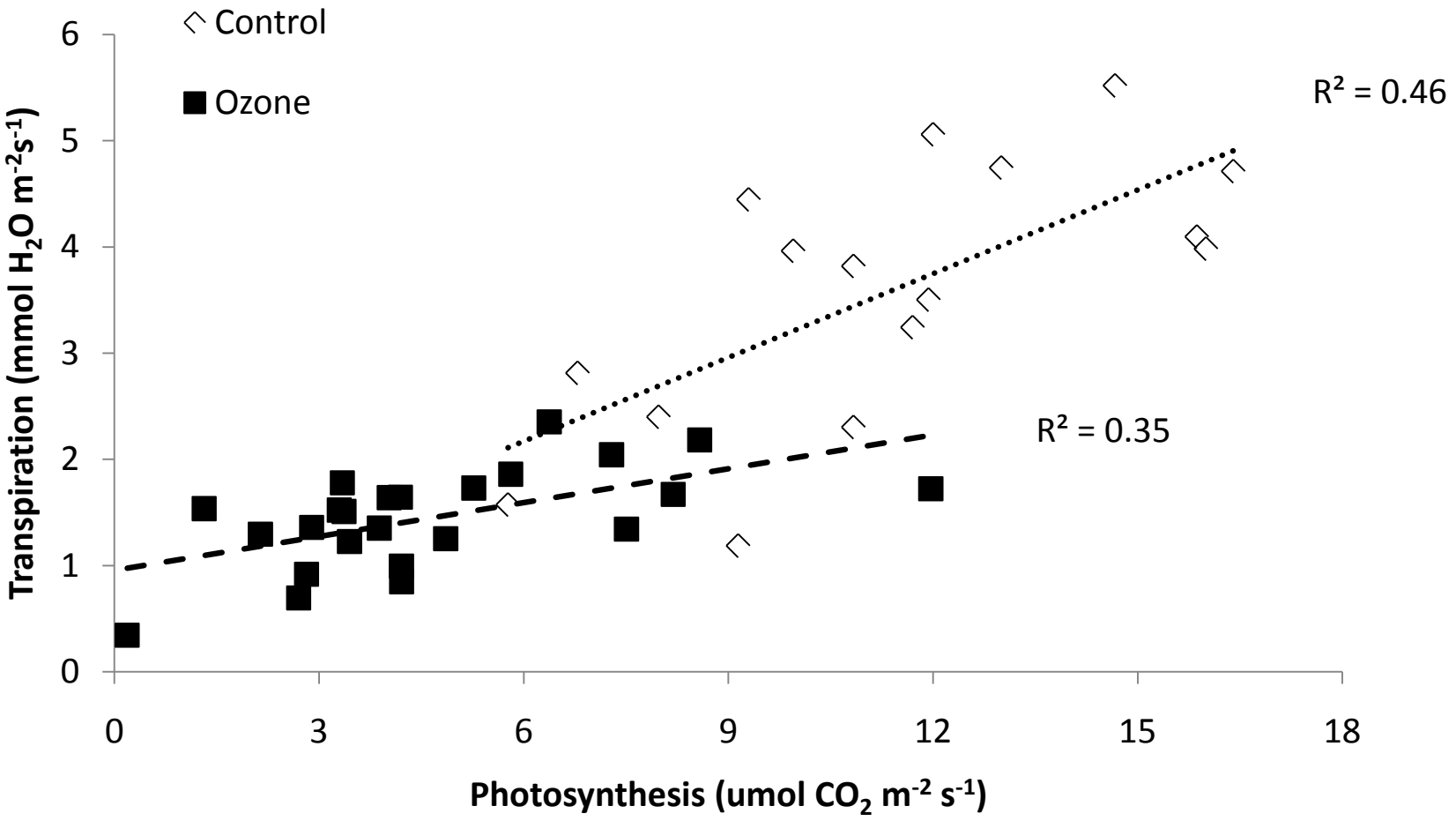
1. Development Applications
2. Other Science

O_3 Effects on Plants

Danica Lombardozzi

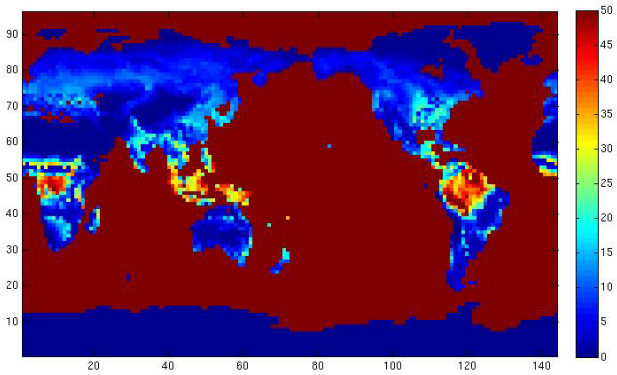
- Ozone decreases primary productivity and alters carbon cycling [Sitch et al., 2007: radiative impacts comparable to direct forcing from ozone]
- Ozone may modify transpiration of plants and alter the hydrological cycle
- Ozone part of the coupling between nitrogen cycle and climate

Field Experiments Showing Plant Response to Fumigation

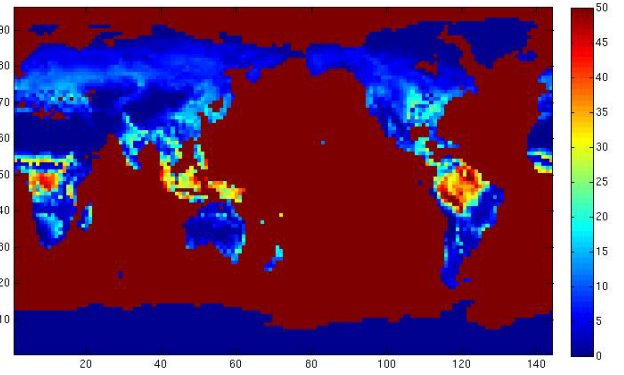


→Transpiration and Photosynthesis are Changing Independently

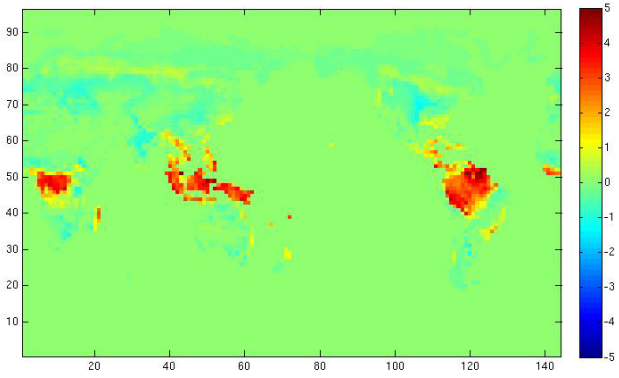
Average Monthly Transpiration (Watts m^{-2})



A: Modifications to *only photosynthesis*, similar to Sitch et al. 2007



B: Independent modifications to *photosynthesis and transpiration*



C: Net difference between *photosynthesis-only* and *photosynthesis + transpiration* modifications

Simulated 3-year average photosynthesis and transpiration rates after continuous daytime exposure to 60 ppb O_3. Results on left panel include only photosynthesis modifications (similar to Sitch et al. 2007) while the right panel includes modifications made to photosynthesis and transpiration independently.

Fire dynamics during the 20th century simulated by the Community Land Model

•Silvia Kloster1, Natalie M. Mahowald1, James T. Randerson2, Peter E. Thornton3, Forrest M. Hoffman3, Samuel Levis4, Peter J. Lawrence4, Johannes J. Feddema5, Keith W. Oleson4, and David M. Lawrence4

•Submitted to Biogeosciences (in discussion)

•Available at Biogeosciences or http://www.geo.cornell.edu/eas/PeoplePlaces/Faculty/mahowald/

•Improve prognostic fire algorithm in CLM-CN to better match observations (mostly from satellite)

•Include moisture, fuel load, human and natural ignition, wind strength, fire suppression, land use/deforestation

•Goal: capture satellite era observations of fire, so we need humans.

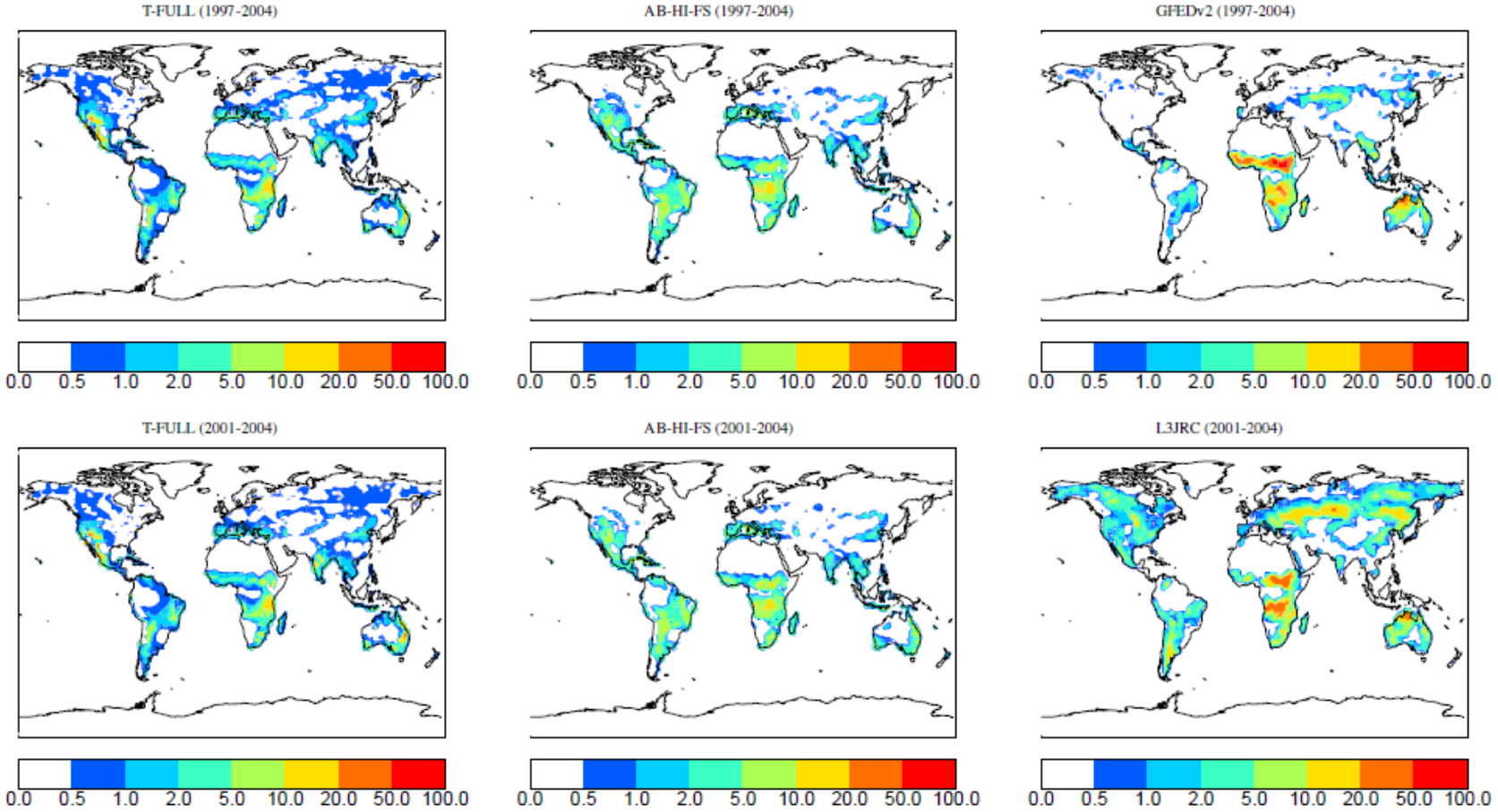
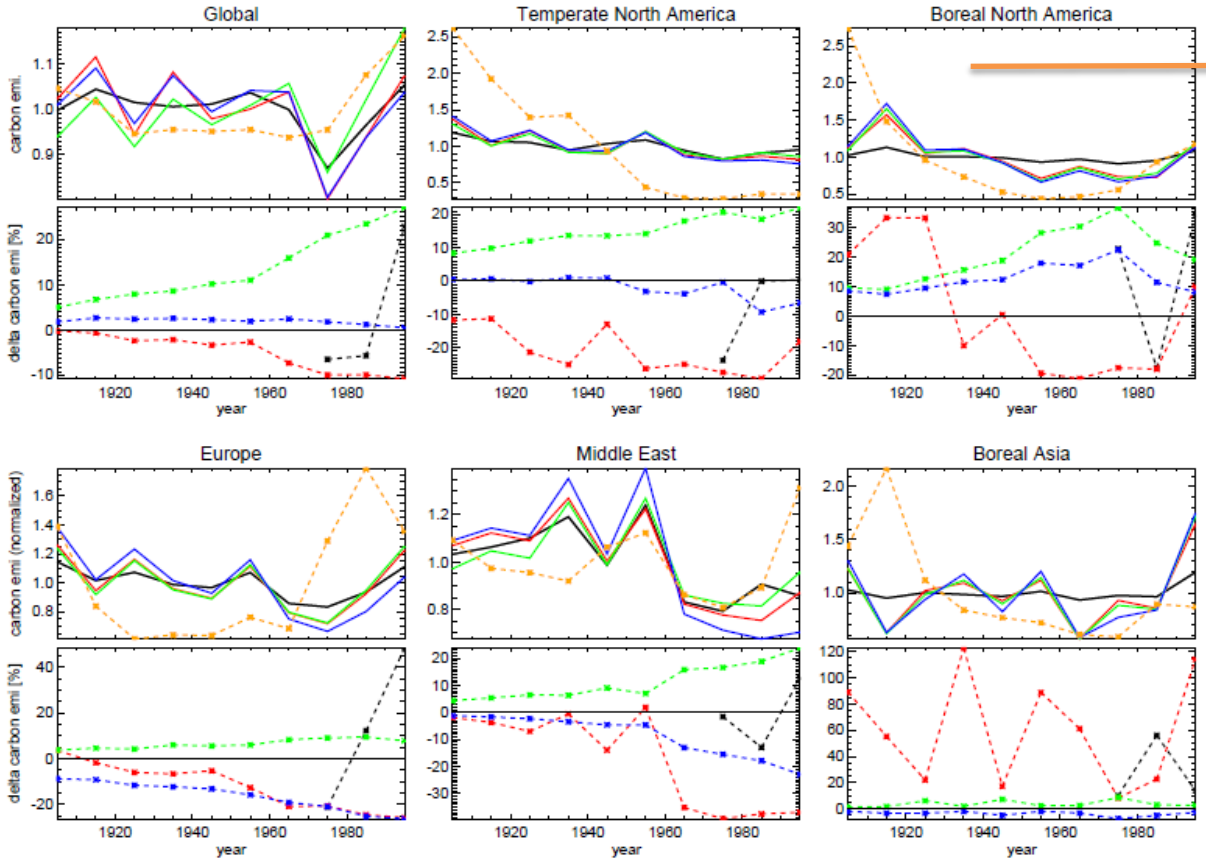


Fig. 1. Simulated annual total (wildfire plus deforestation) area burned [percentage of grid box] compared to satellite based fire products: GFEDv2 (*van der Werf et al.*, 2006) and L3JRC (*Tansey et al.*, 2008). The model simulations are averaged over the corresponding observational periods (GFEDv2: 1997-2004; L3JRC: 2001-2004). Regional values for all simulations performed are given in Fig 2.

T-Full: Thonicke, AB-HI-FS Arora and Boer w/ human ignition, fire supression
New algorithm (AB-HI-FS) better matches observational based estimates
Improves boreal region.
(also compare to other data/estimates: see paper for details)



Upper

Observations

Blue: Arora and Boer w/ Ignition and suppression

Lower:

Red: landuse and harvest

Green: human ignition

Blue: human ignition and Suppresion

Black: climate

Fig. 10. Upper panels: Trend in decadal total (wildfire and deforestation) fire carbon emissions compared to decadal mean GICChist estimates (*Mieville et al.*, 2009) for different regions from 1900 to 2000 normalized with the mean value for 1900-2000. Solid lines represent model simulations: black: T-FULL, red: AB-FULL, green: AB-HI; blue: AB-HI-FS. Dashed orange line with symbols are observations (GICChist); Lower panels: decadal mean change in total carbon loss in [%] with respect to the respective control simulation caused by red: land use change and wood harvest, green: human ignition, blue: human ignition and fire suppression, black: climate. Note here, that the fire carbon-system is highly non-linear and therefore the individual responses are not additive.

Estimated trends in fires, and sensitivity studies to see impact.

Next steps

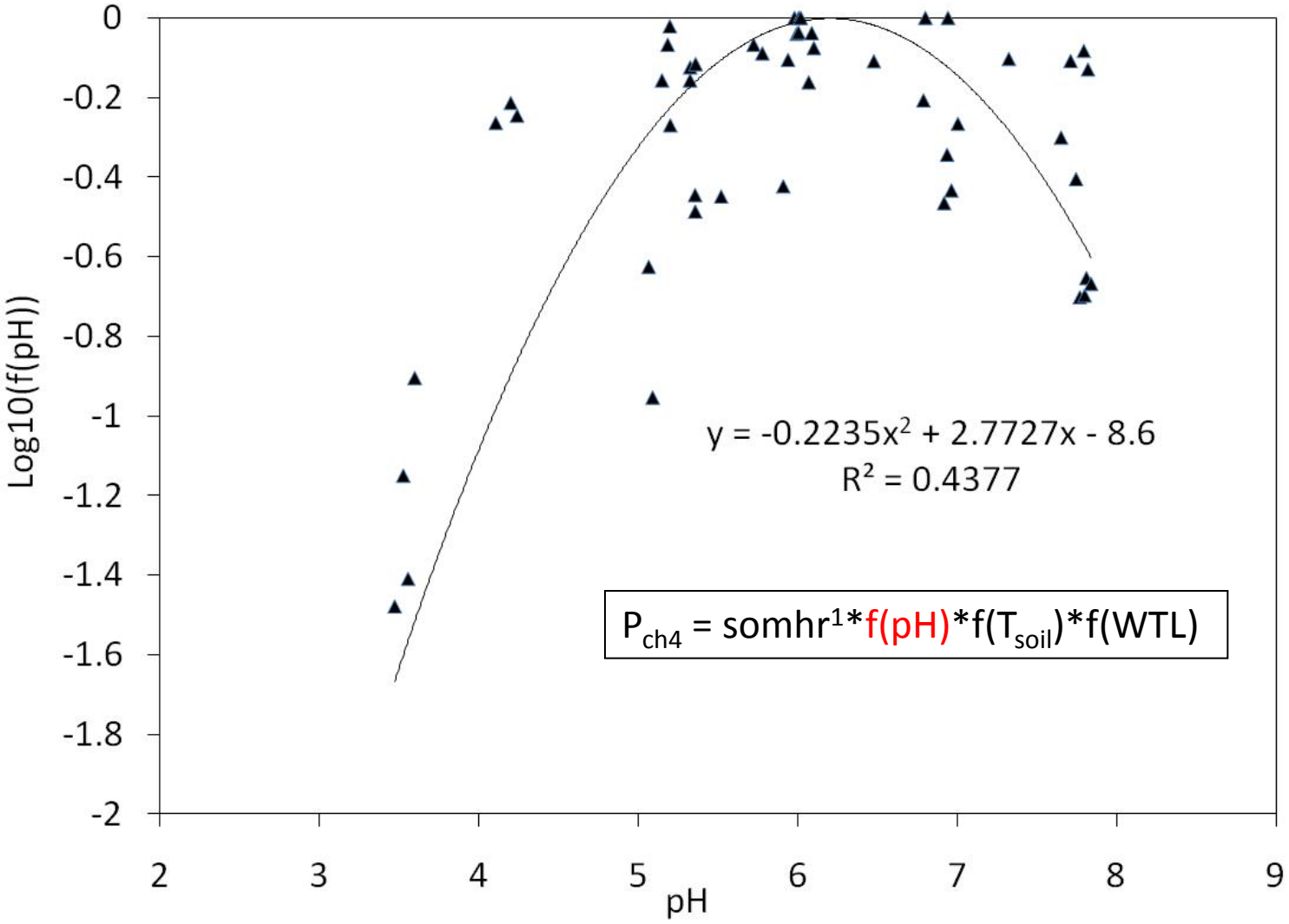
- Future fires
- Coupling with climate/carbon/chemistry system

Simulating methane emissions from wetlands in CLM3.6

Cornell: Lei Meng, Peter Hess,
Natalie Mahowald, and Joseph Yavitt

In collaboration with Zack Subin and
Bill Riley at Lawrence Berkeley National Lab

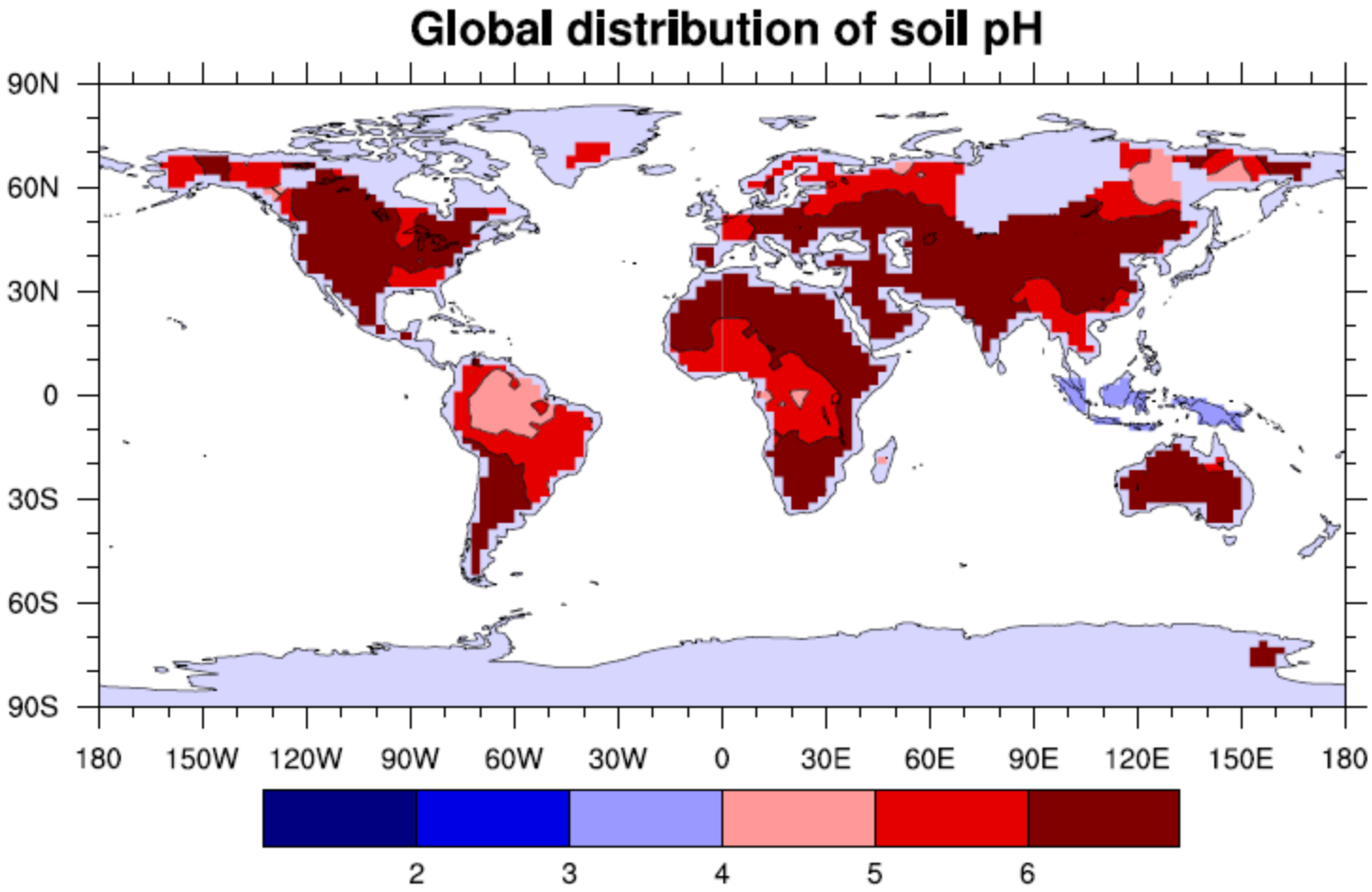
pH dependence of CH4 production



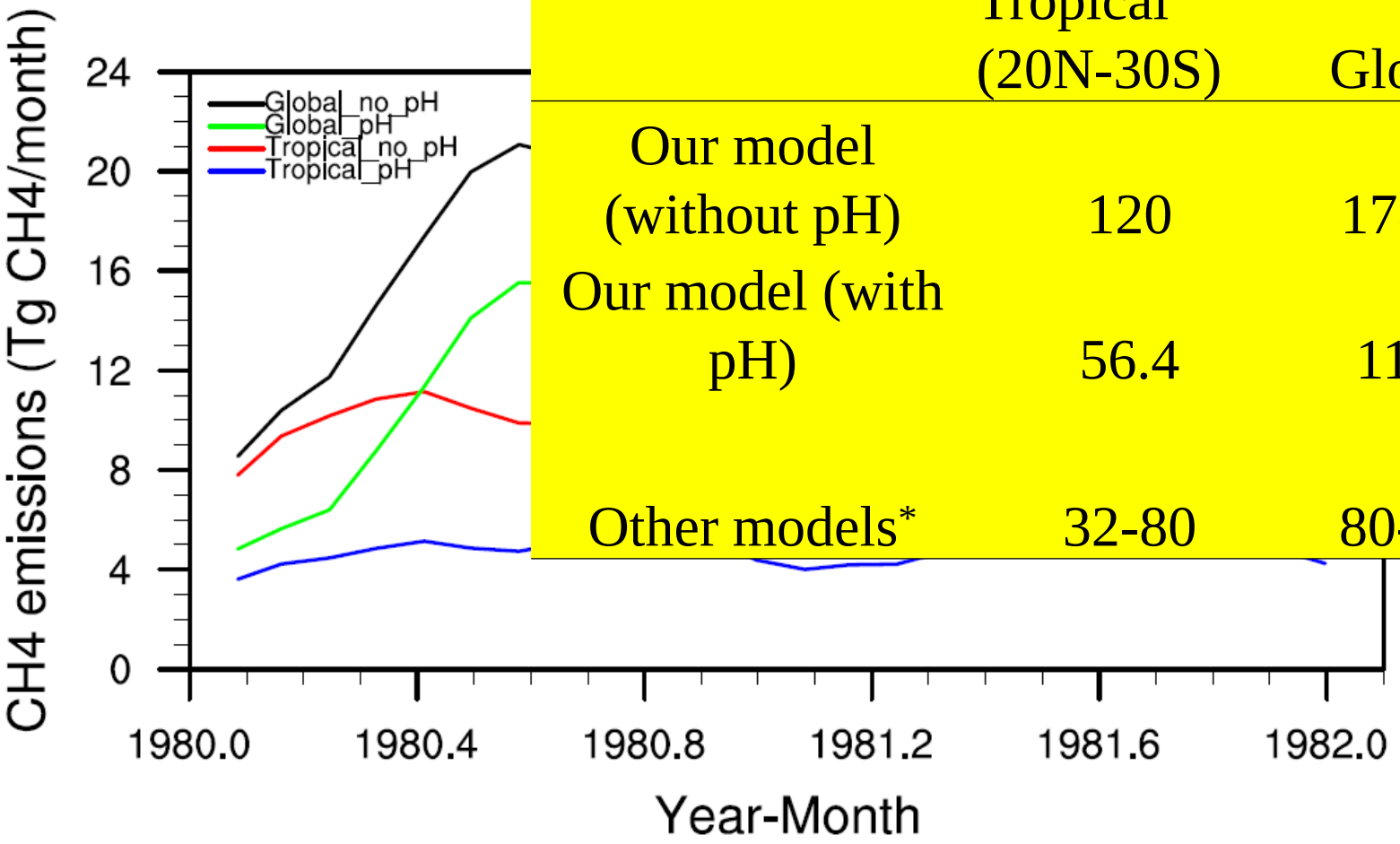
Field and laboratory datasets

[1]Soil organic matter hetereotrophic respiration

(Data from Dunfield et al. 1993,Soil Biol. Biochem)



Source: ISRIC's Soil Information System (ISIS) and the soil CD-ROM of the Natural Resources Conservation Service (USDA-NRCS)

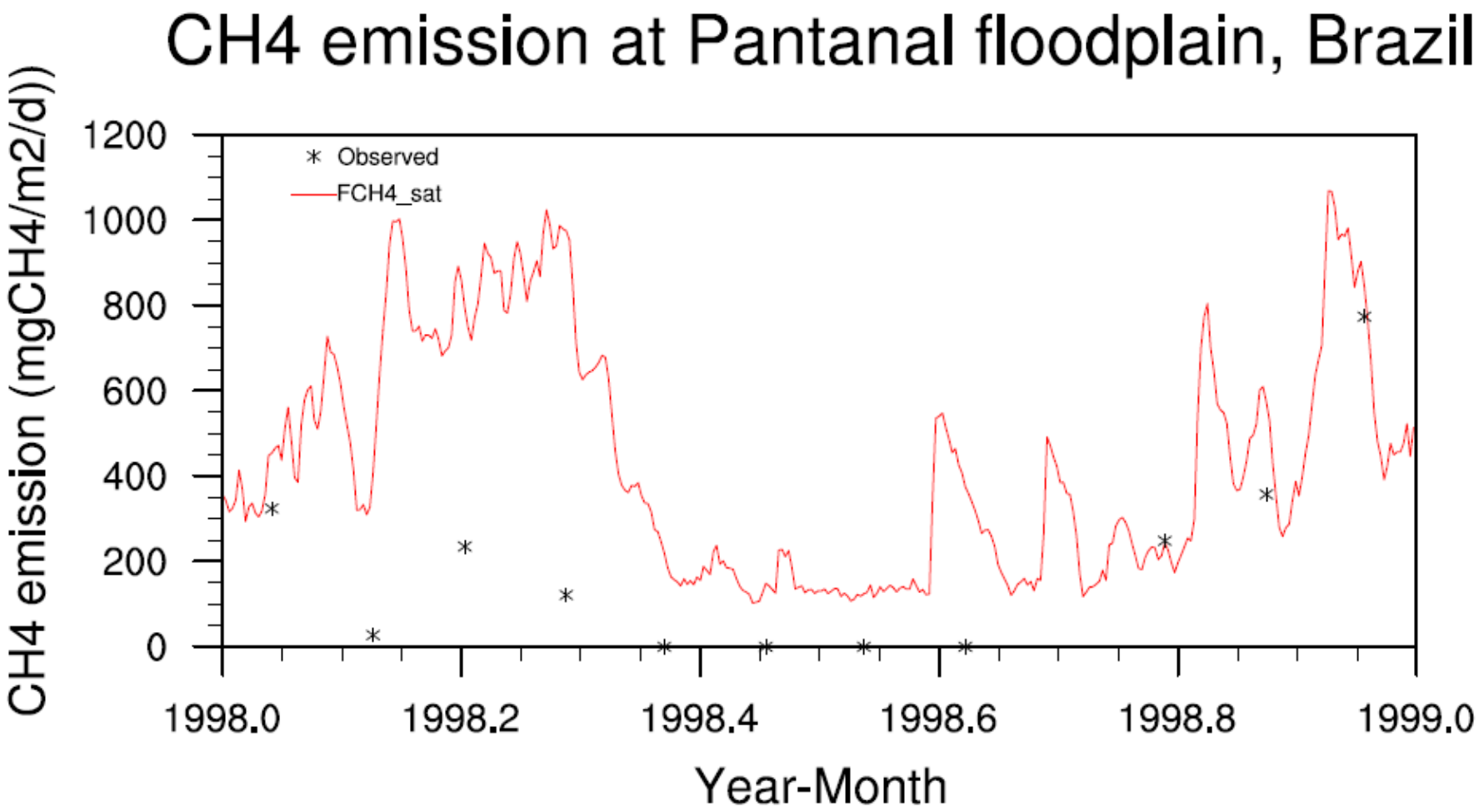


Global and Tropical methane flux estimates

	Tropical (20N-30S)	Global
Our model (without pH)	120	178.44
Our model (with pH)	56.4	116.8
Other models*	32-80	80-115

*Other Models: Matthews&Fung, 1987, Bartlett et al. 1990, Aselmann&Crutzen,1989, Bartlett&Harriss, 1993

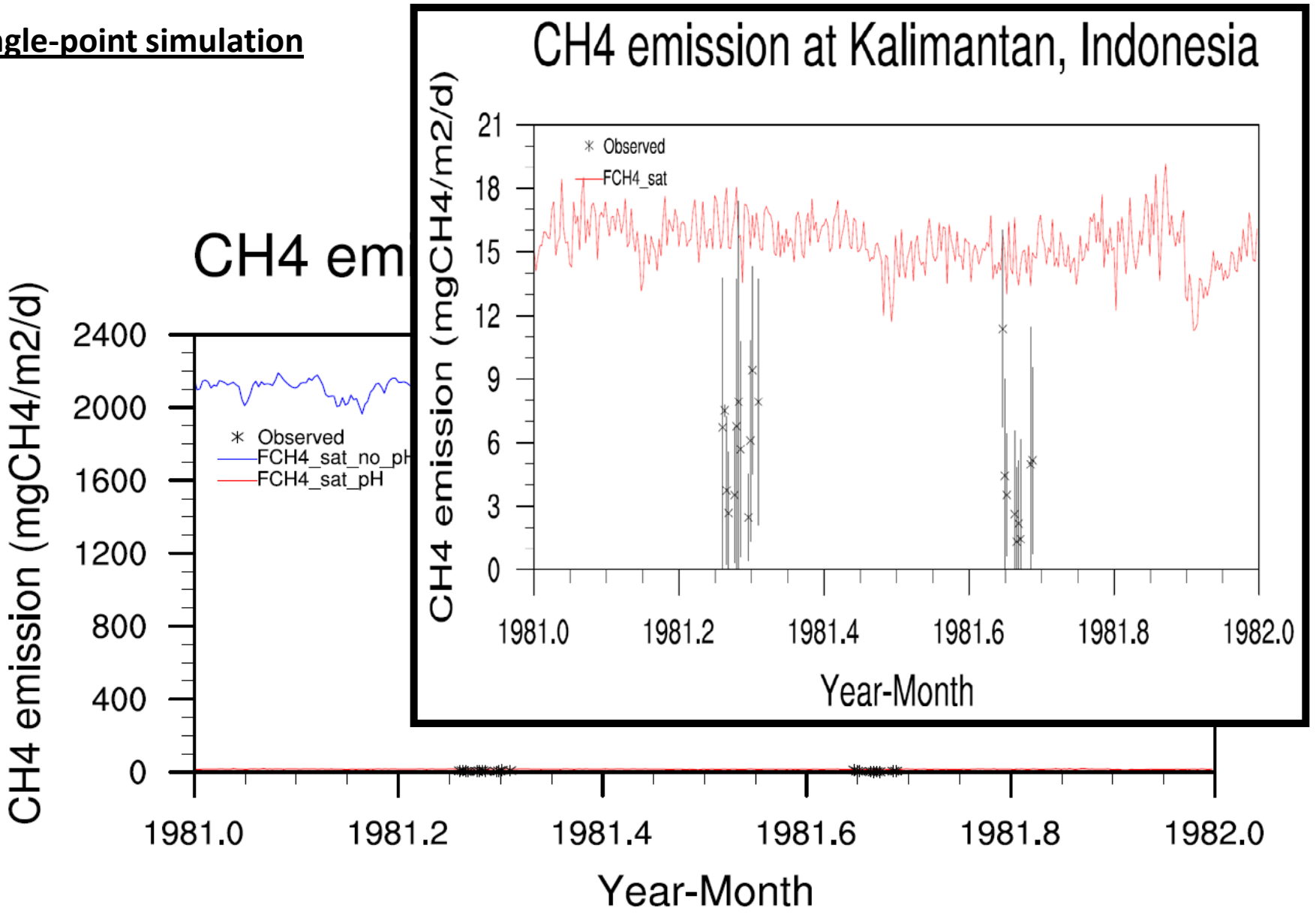
Single-point simulation



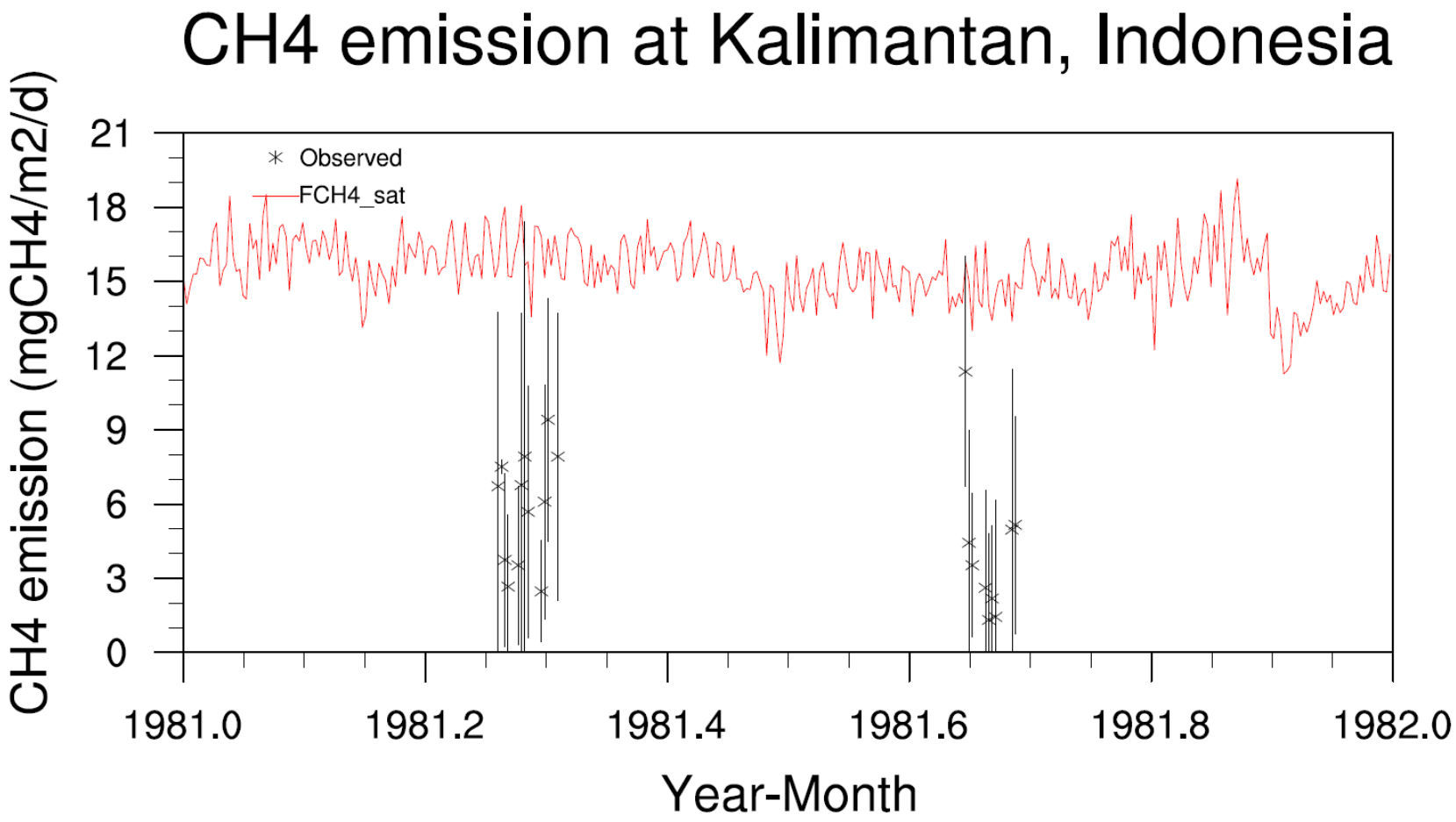
pH = 6.01

At this site, pH does not have significant impacts on methane production since pH value is close to the optimal pH for methanogenesis.

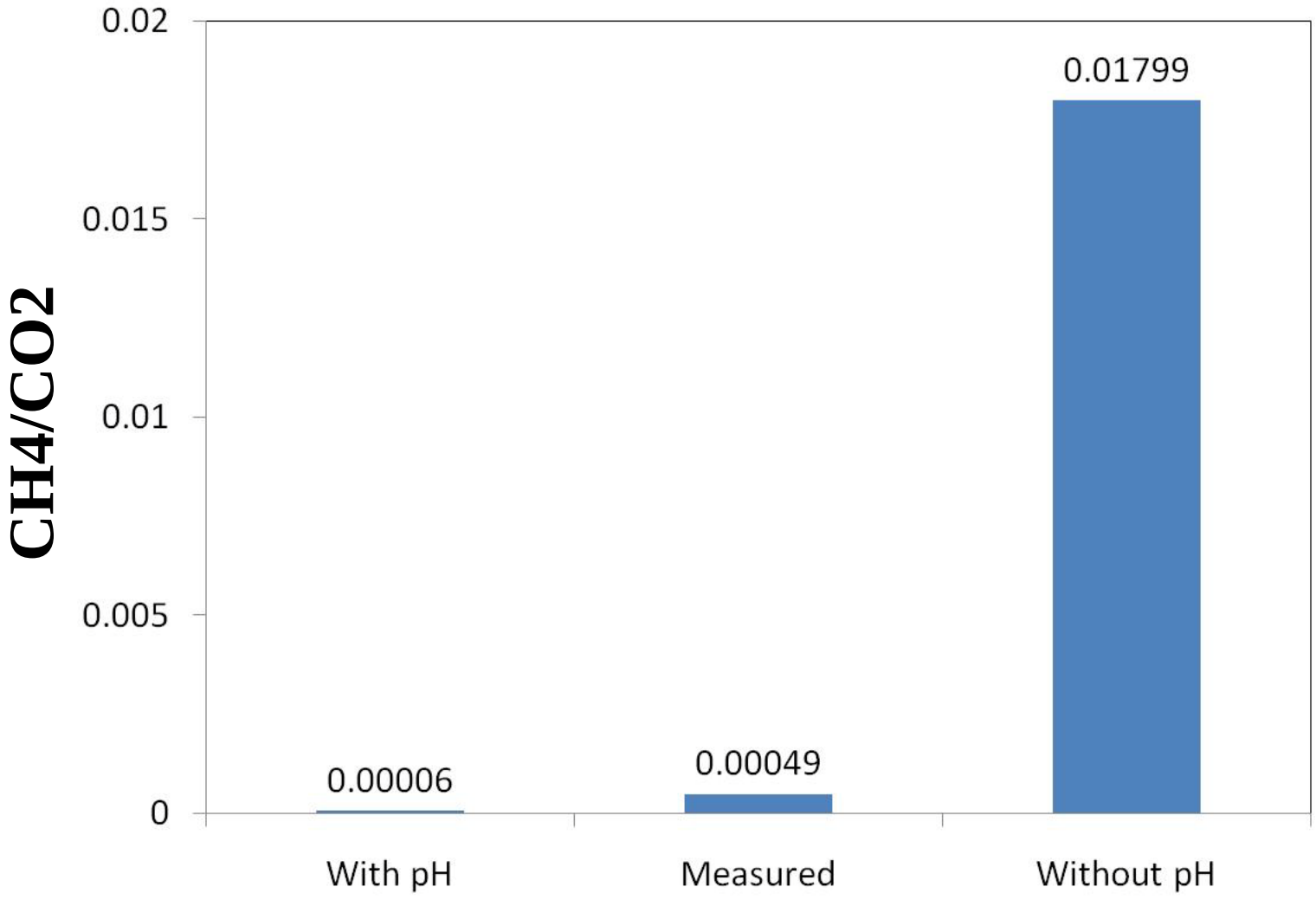
Single-point simulation



Single-point simulation



Indonesia CH4/CO ratio



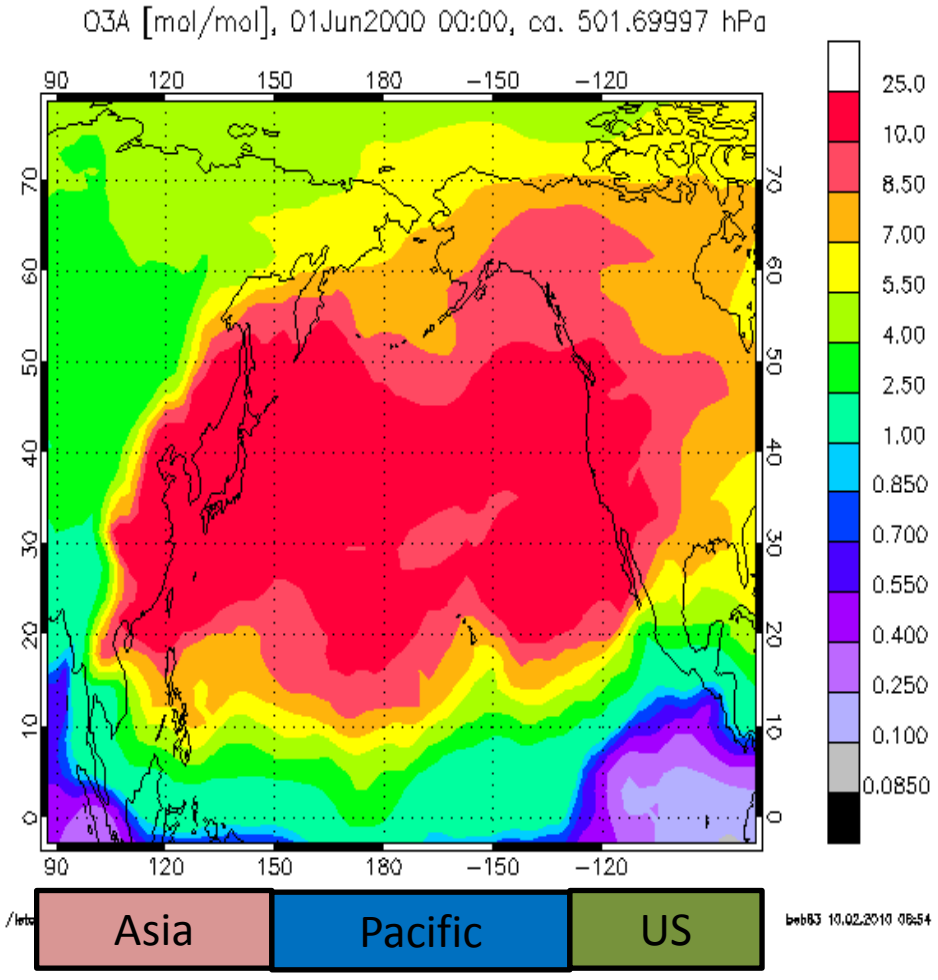
Data source: Jauhiainen et al. 2005

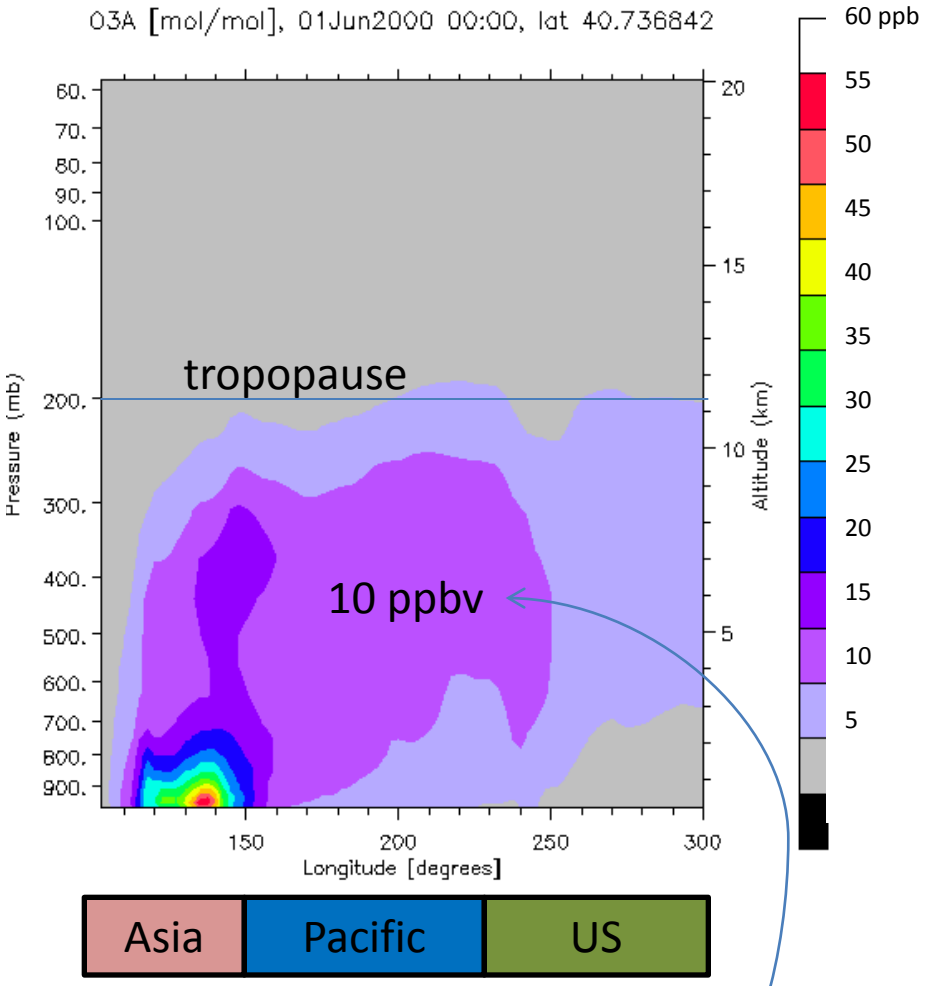
Asian Influence on US Surface O_3

Ben Brown-Steiner

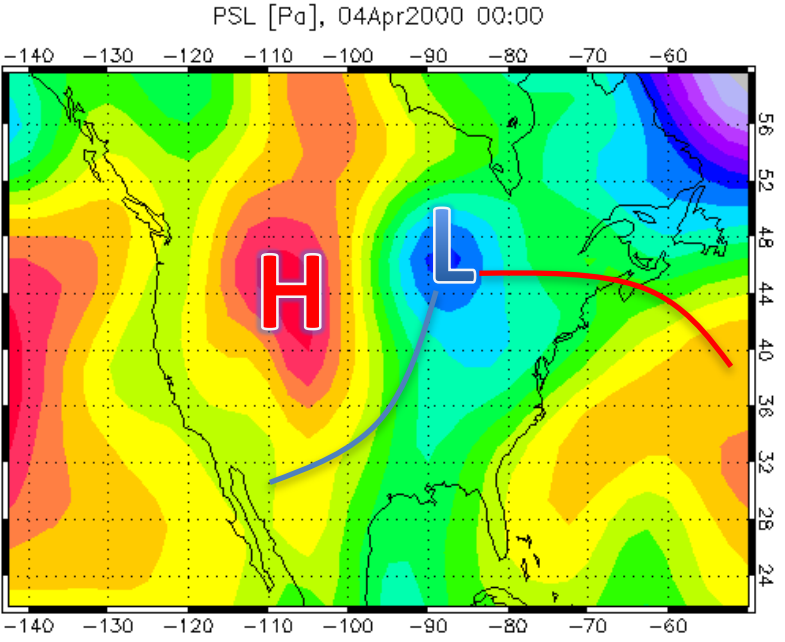
- Tagged NO_x emissions over Asia are modeled as they transport over the Pacific and into the US
- Ozone produced from Asian NO_x tagged as O3A
- Study is Looking at Mechanisms of Asian Ozone import to the U.S. including: Seasonality, Distribution, and Variability

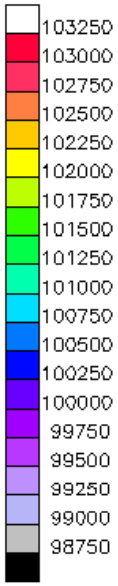
Effect of Specific Ozone Pollution Plumes on the US Atmosphere

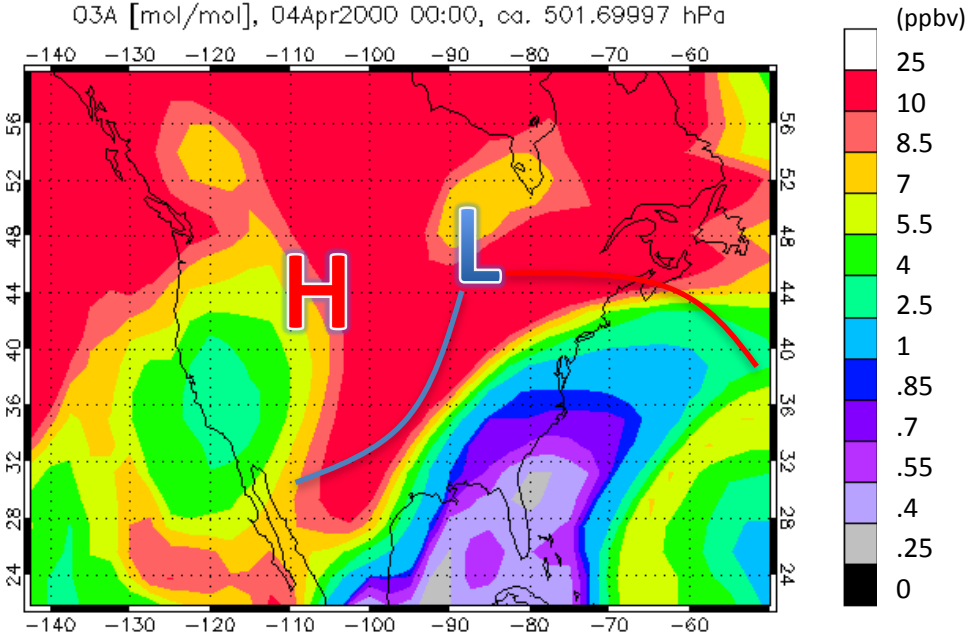


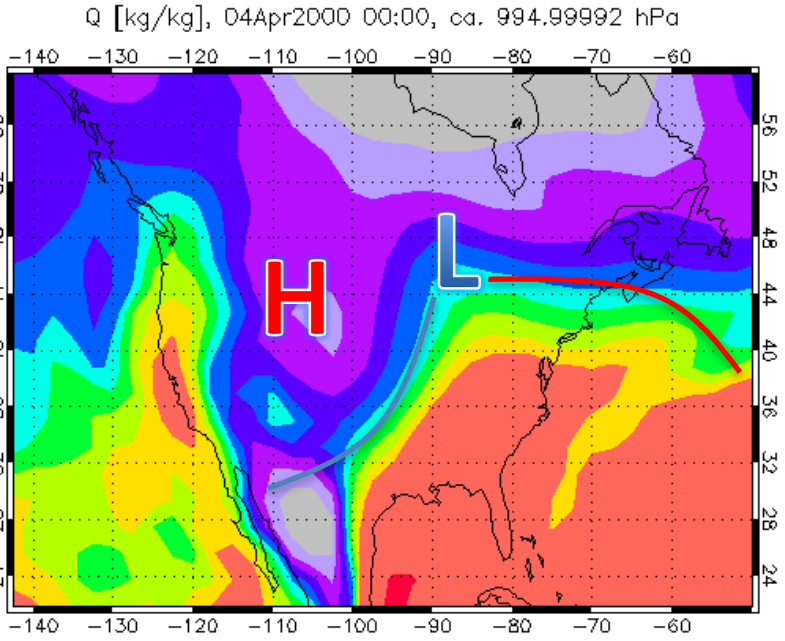


Individual Asian Plumes ~ 10 ppbv

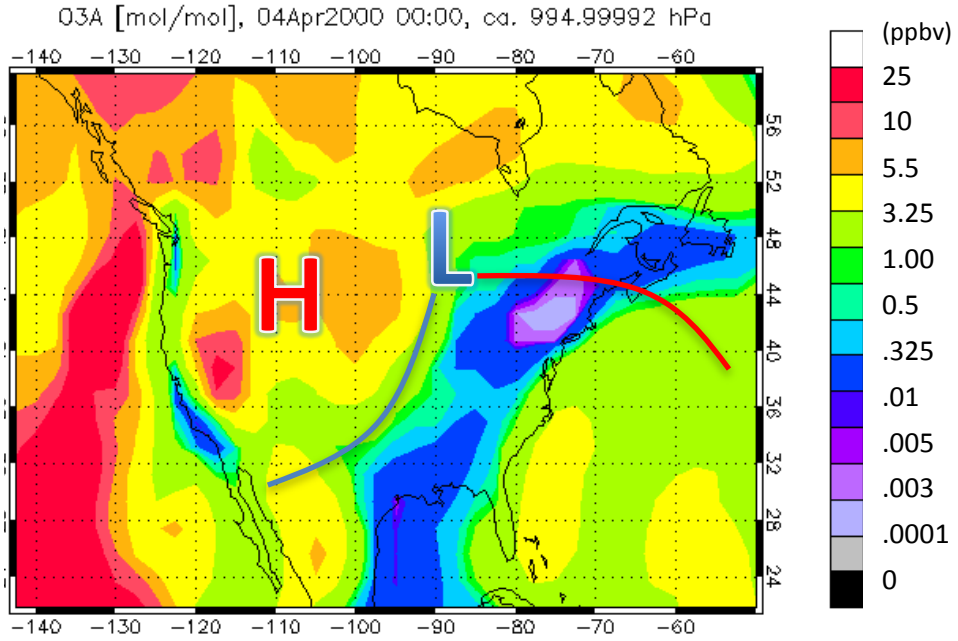

PSL [Pa], 04Apr2000 00:00
H
L

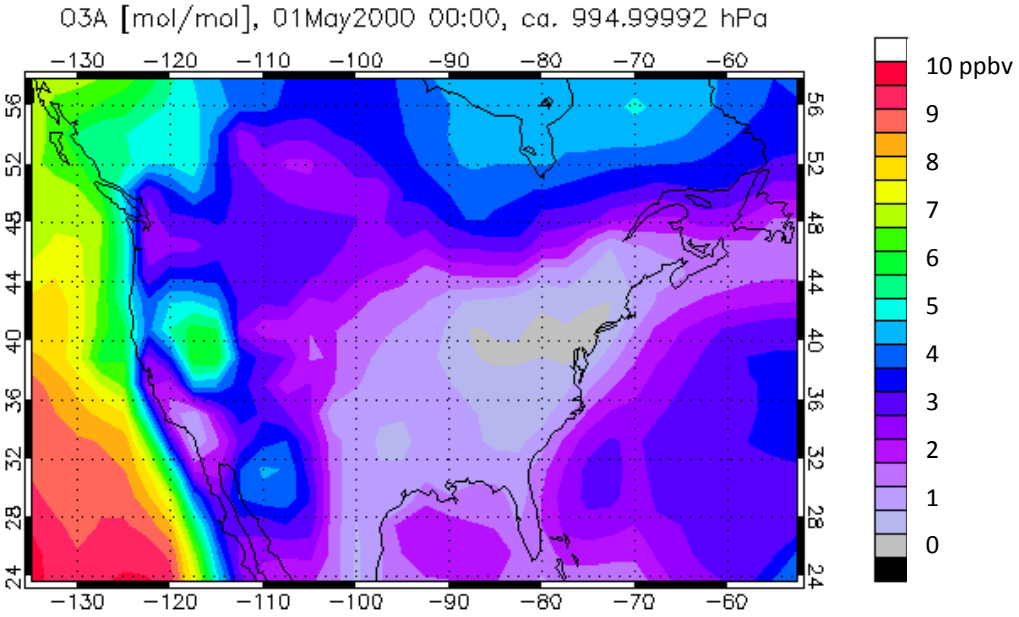

103250
103000
102750
102500
102250
102000
101750
101500
101250
101000
100750
100500
100250
100000
99750
99500
99250
99000
98750


O3A [mol/mol], 04Apr2000 00:00, ca. 501.69997 hPa
H
L
(ppbv)
25
10
8.5
7
5.5
4
2.5
1
.85
.7
.55
.4
.25
0


Q [kg/kg], 04Apr2000 00:00, ca. 994.99992 hPa
H
L


.03
.01
.008
.006
.004
.002
0

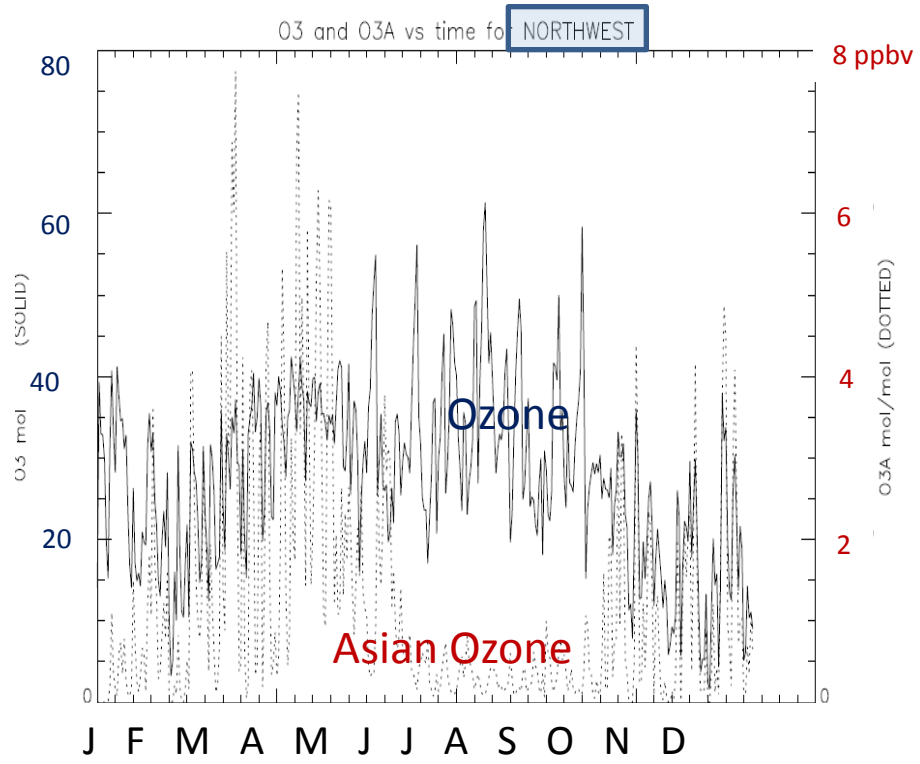

O3A [mol/mol], 04Apr2000 00:00, ca. 994.99992 hPa
H
L
(ppbv)
25
10
5.5
3.25
1.00
0.5
.325
.01
.005
.003
.0001
0

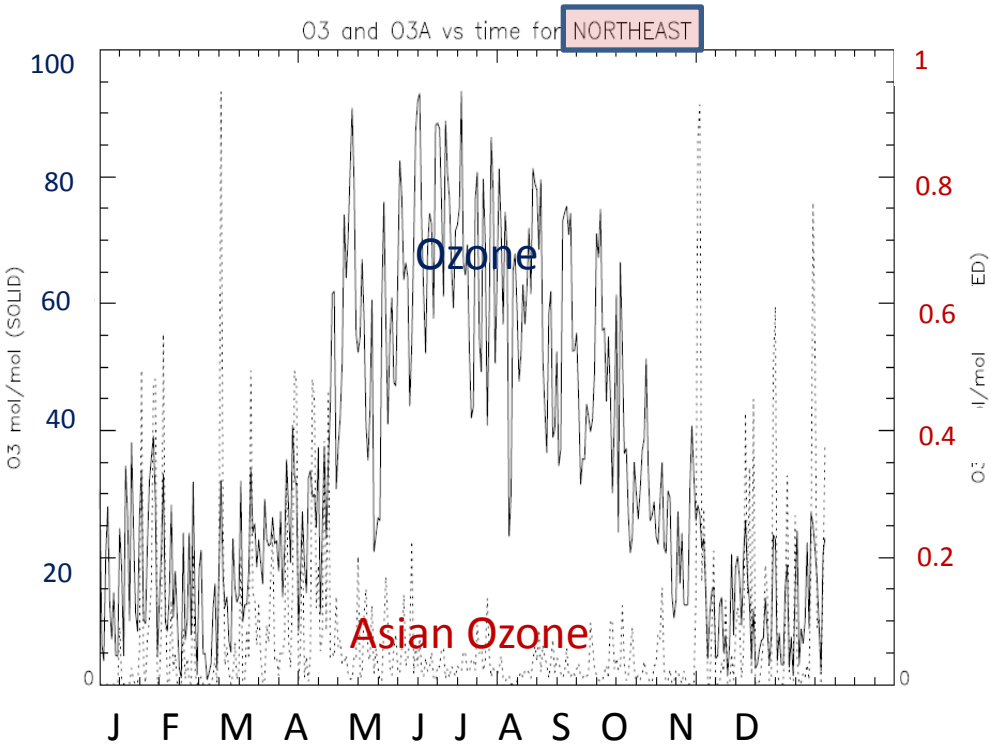


(Monthly Average)

Asian Ozone Background

- Increases O_3 levels around 5 ppbv in the west US, and 1 ppbv in the east US

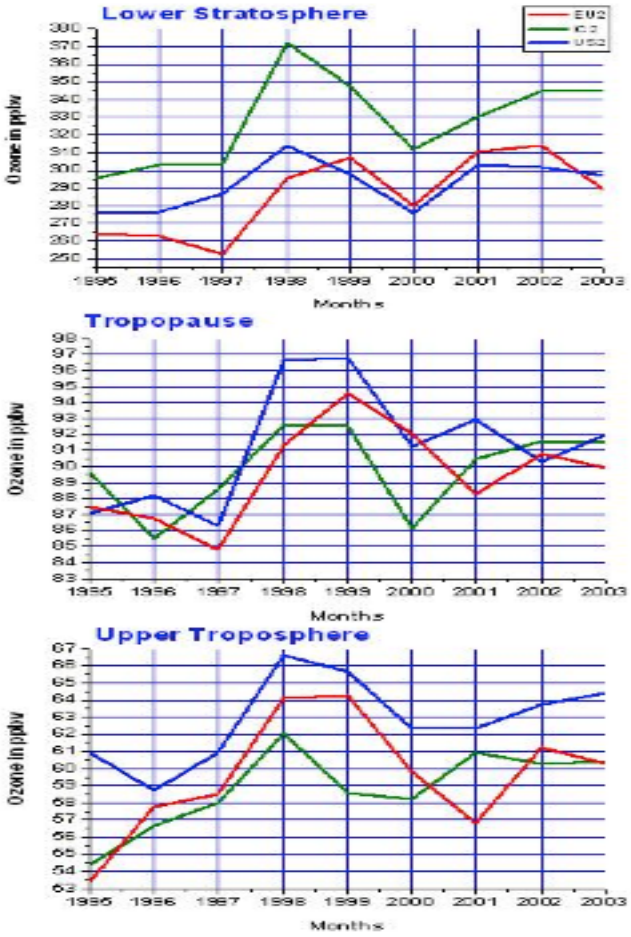




P. Hess

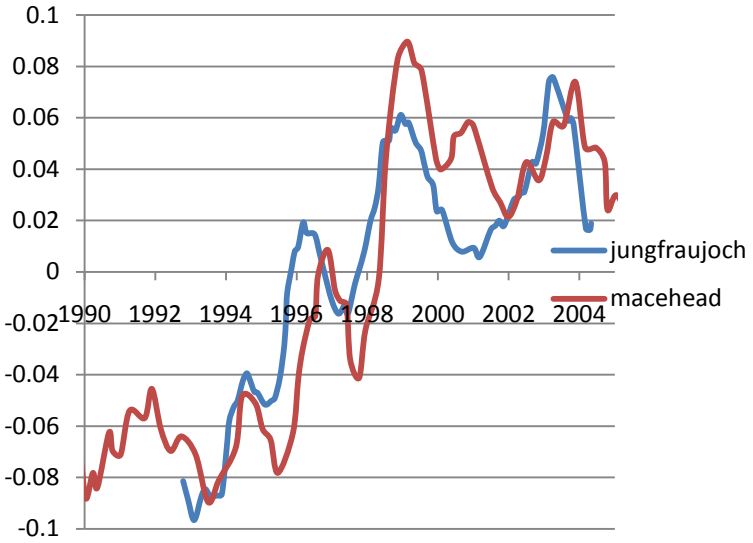
Ozone Trends and STE, Peter Hess

1998-1999 Ozone Anomaly
Europe, Eastern U.S. , Iceland



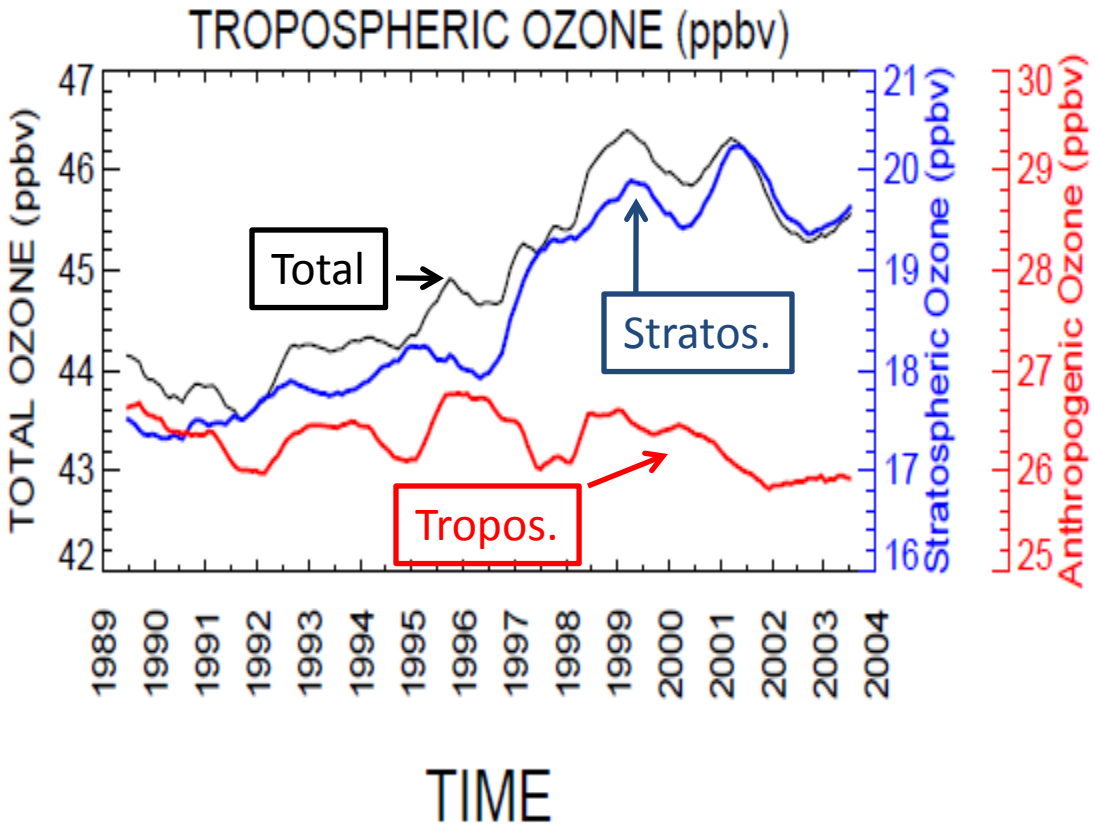
V. Thouret et al., 2006

Percent Ozone Anomaly, 1992-2004
Macehead, Jungfraujoch



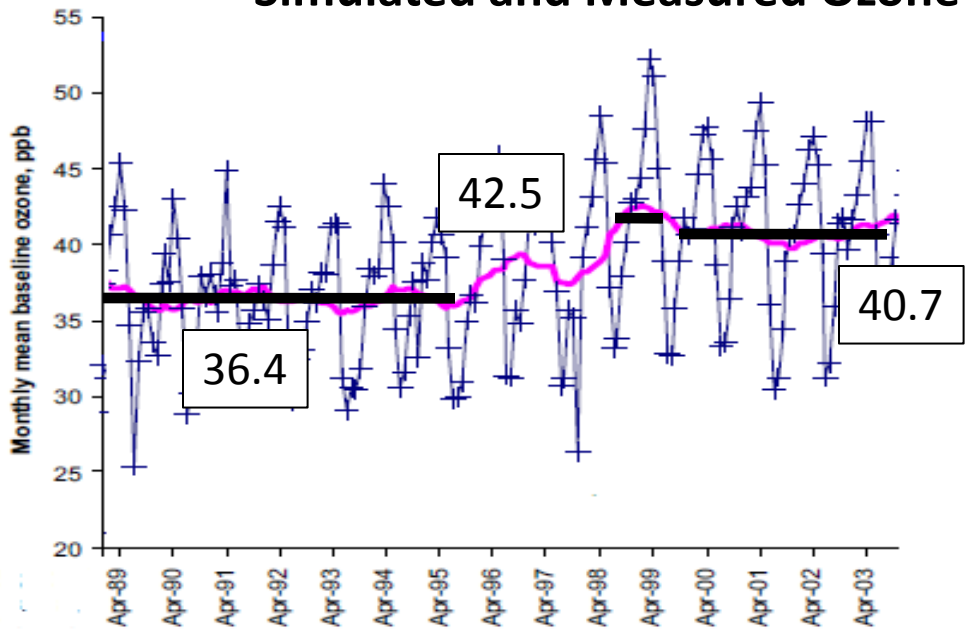
Increased stratospheric ozone drives large-scale long-term variability since 1990

(Increase ~.2 ppbv/year since 1990)

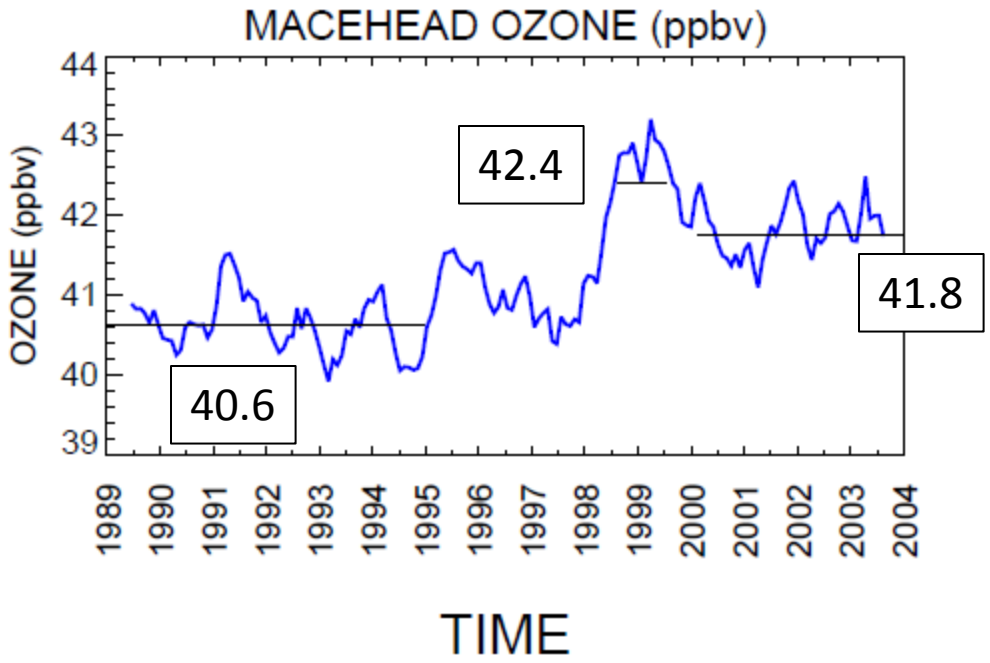


-CAM-CHEM Simulation
-NCEP Reanalysis
-Tagged NO_x to calculate ozone produced from NO_x reactions
- Stratospheric ozone calculated as a residual

Simulated and Measured Ozone at Macehead



Adapted from Derwent et al, 2007
Filtered for clean sector



CAM-chem simulation
12 month running mean
from monthly averages

Crudely Filtered for
Clean Sector
-5^{o} off coast
-Filtered for CO < 1σ