National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

UNIVERSITY OF CAMBRIDGE

Cambridge Centre *for* Climate Science

Cambridge perspective: Large scale modelling in the tropics.

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BUNIAACIC – Monday 2nd July 2012, Manchester

Outline of talk

- The model.
- Isoprene chemistry.
- Land use change.
- Halogens.

UM-UKCA a key component of HadGEM-3 ES.

- ***Dynamics:***

Non-hydrostatic model.

Horizontal res. 2.5°×3.75°

60 vertical levels extending to 84 km.

- ***Chemistry:***

55 Chemical tracers.

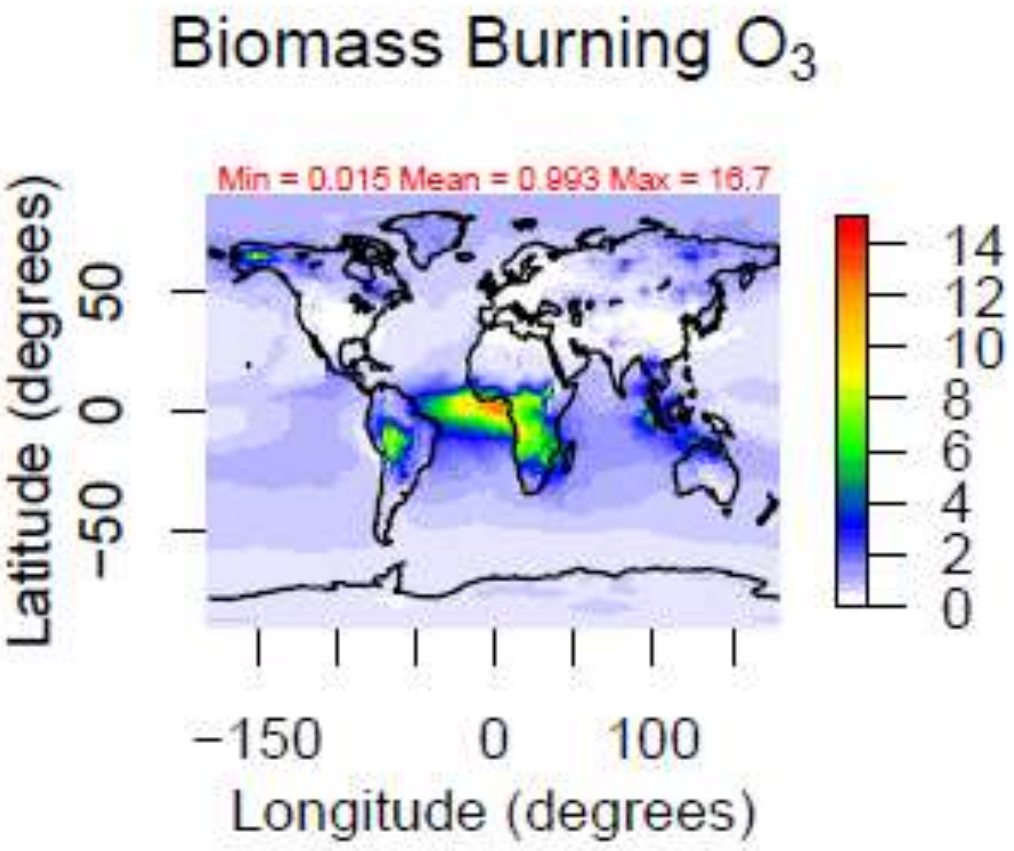
169 photochemical reactions.

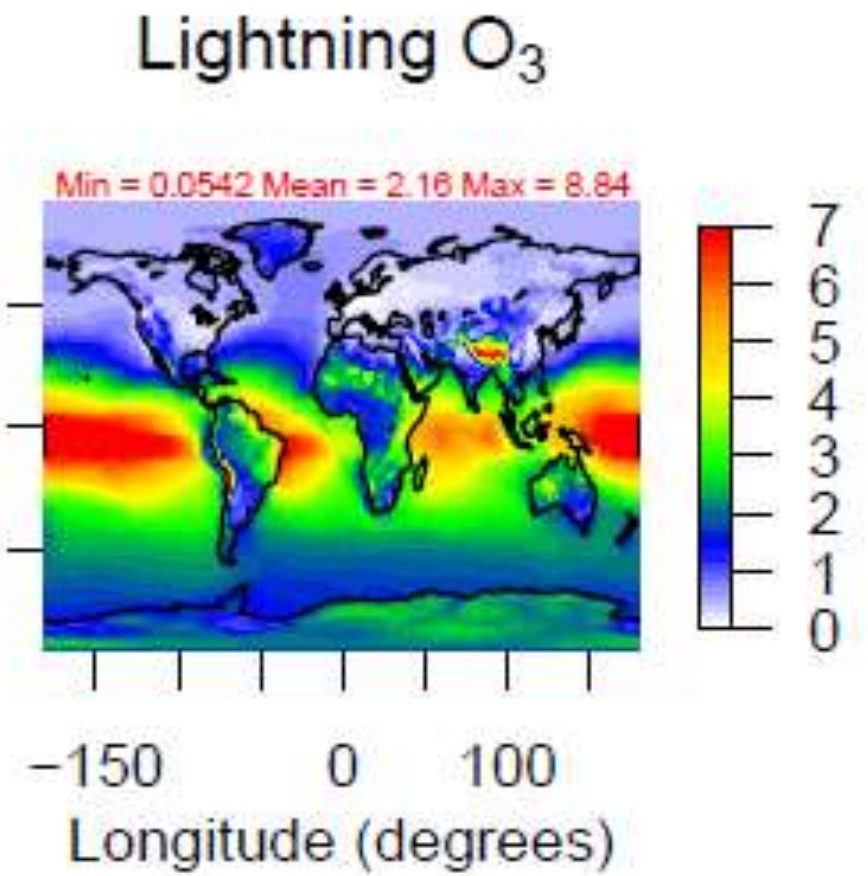
Photolysis calculated offline.

- ***Emissions:***

Eight chemical species are emitted in the model. Diurnal variation in emission is applied to isoprene.

Tagging of NOx sources.

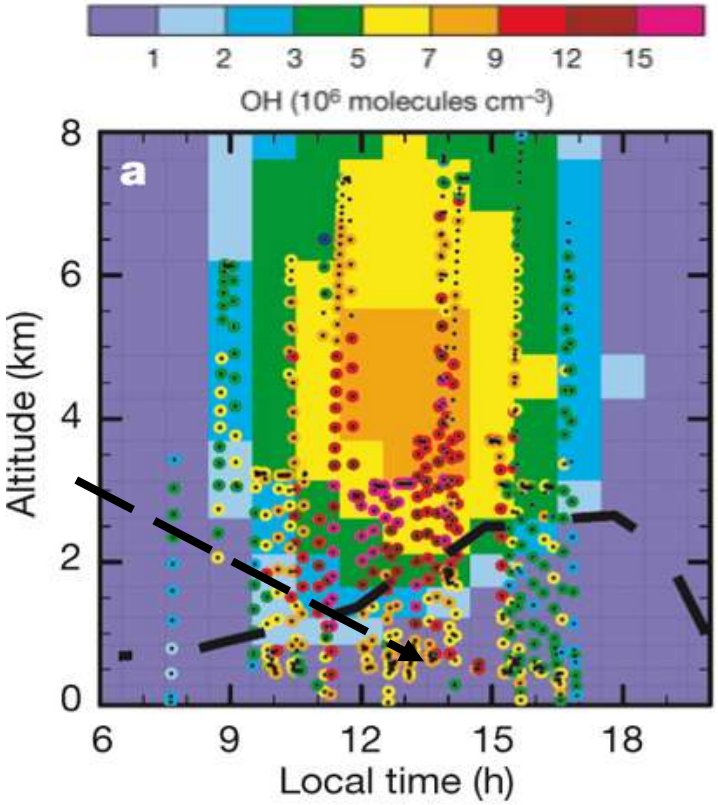


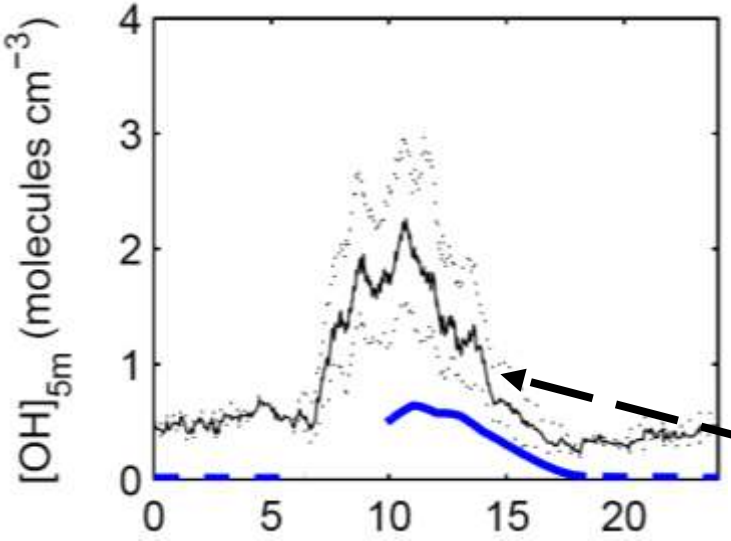


Models underestimate HO_x in low NO_x environments!

Lelieveld et al., (2008) in the Amazon

Factor of 10 difference!!

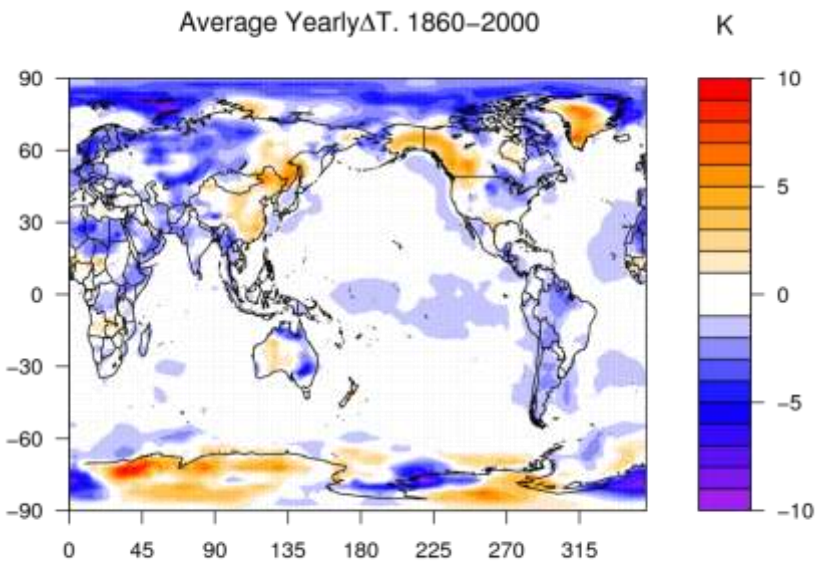


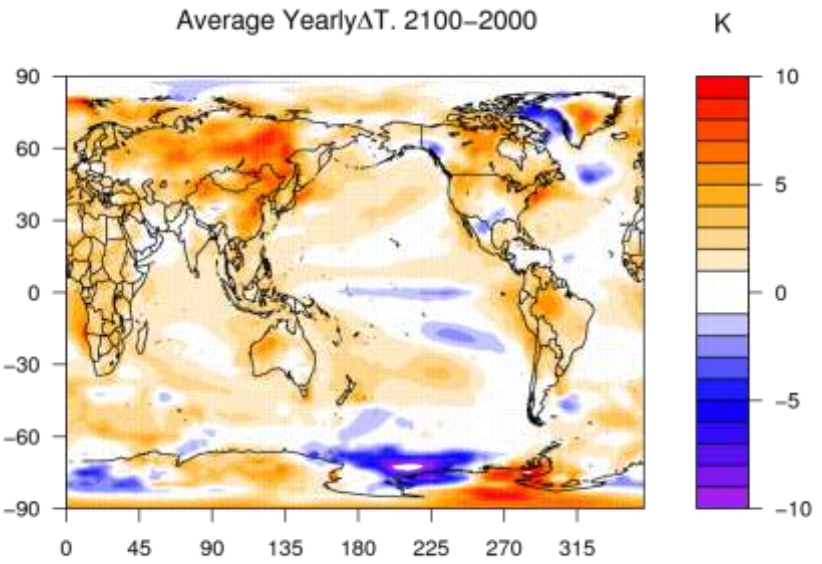


Pugh et al., (2010) in Borneo Rainforest

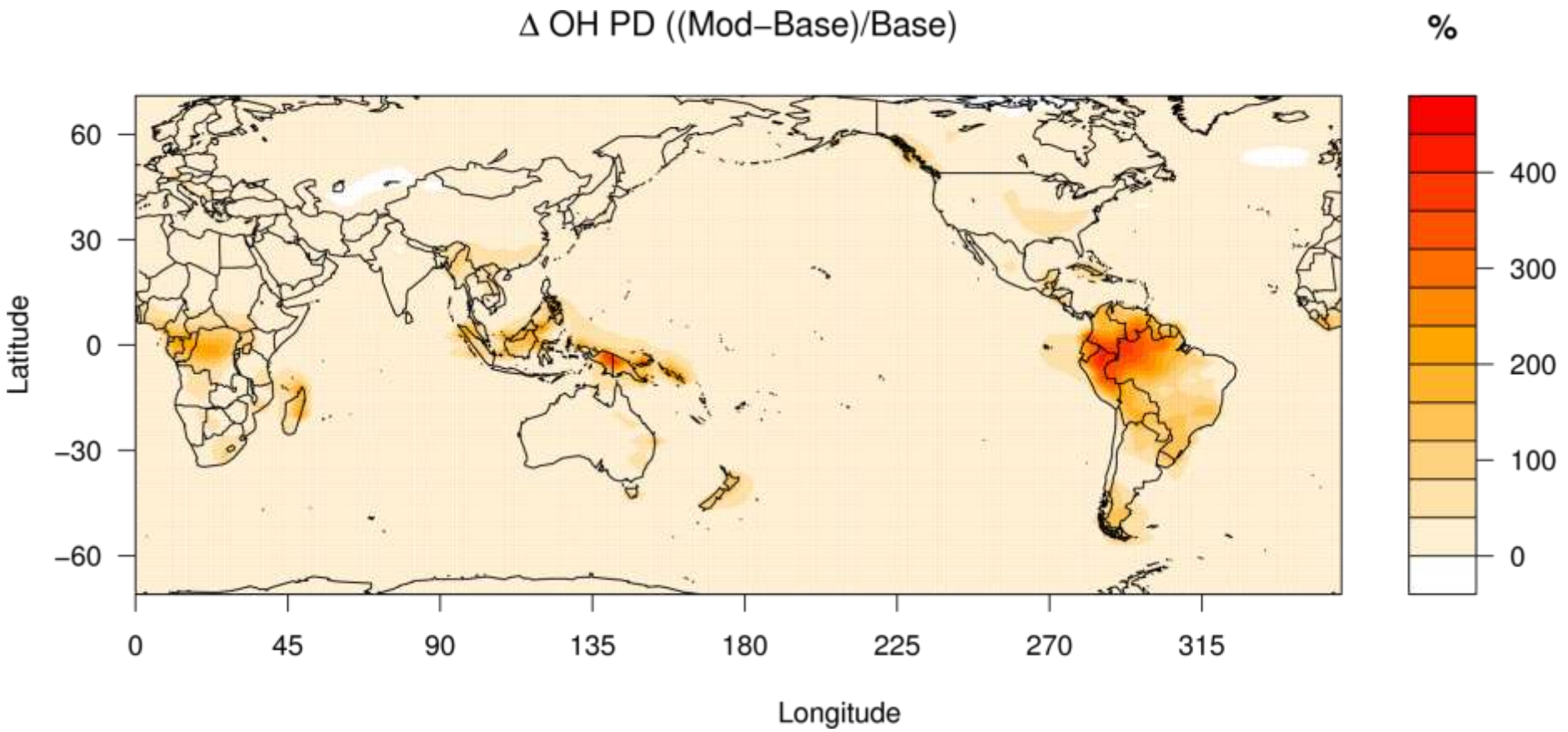
Factor of 4 difference!

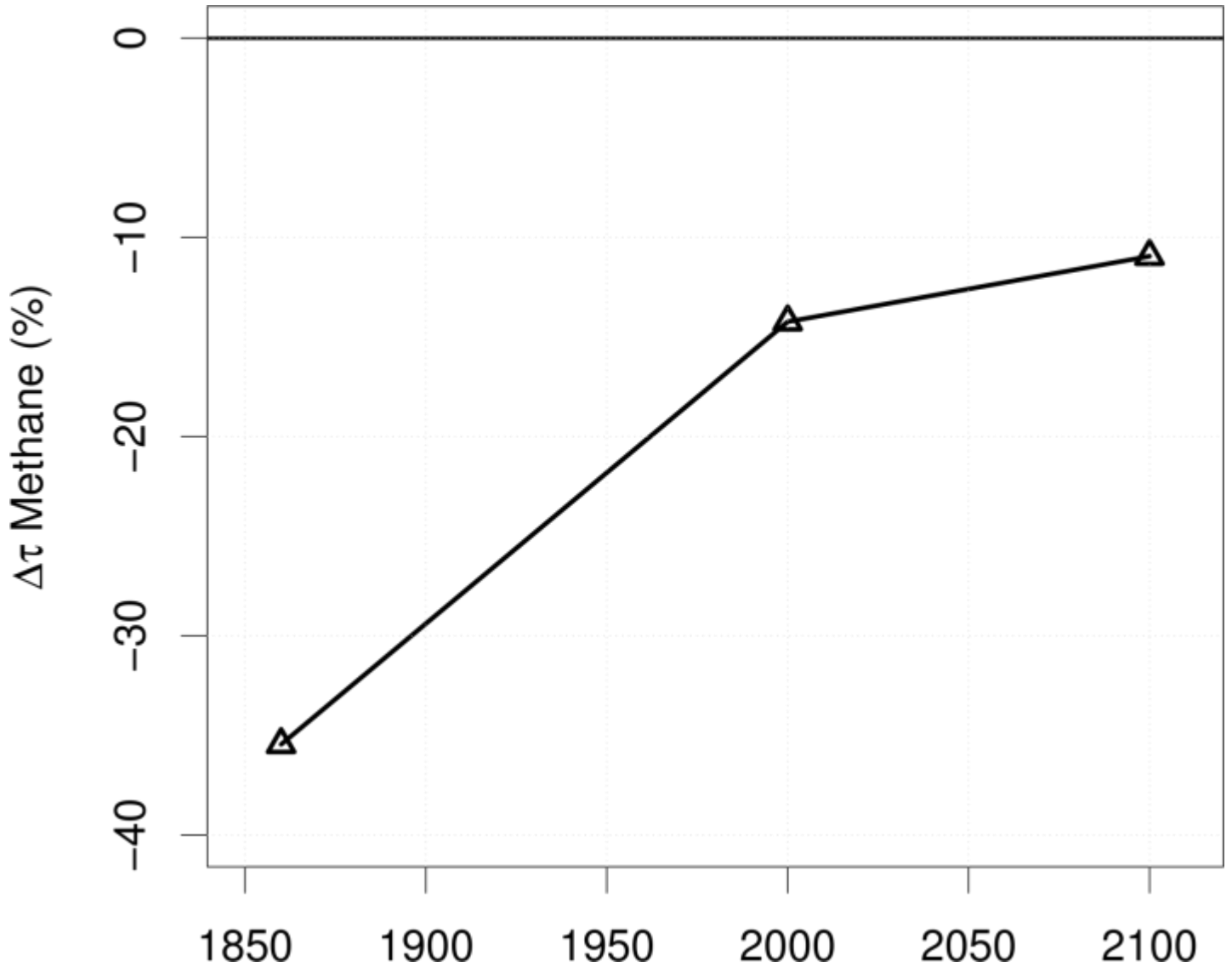
Past, present and future changes.





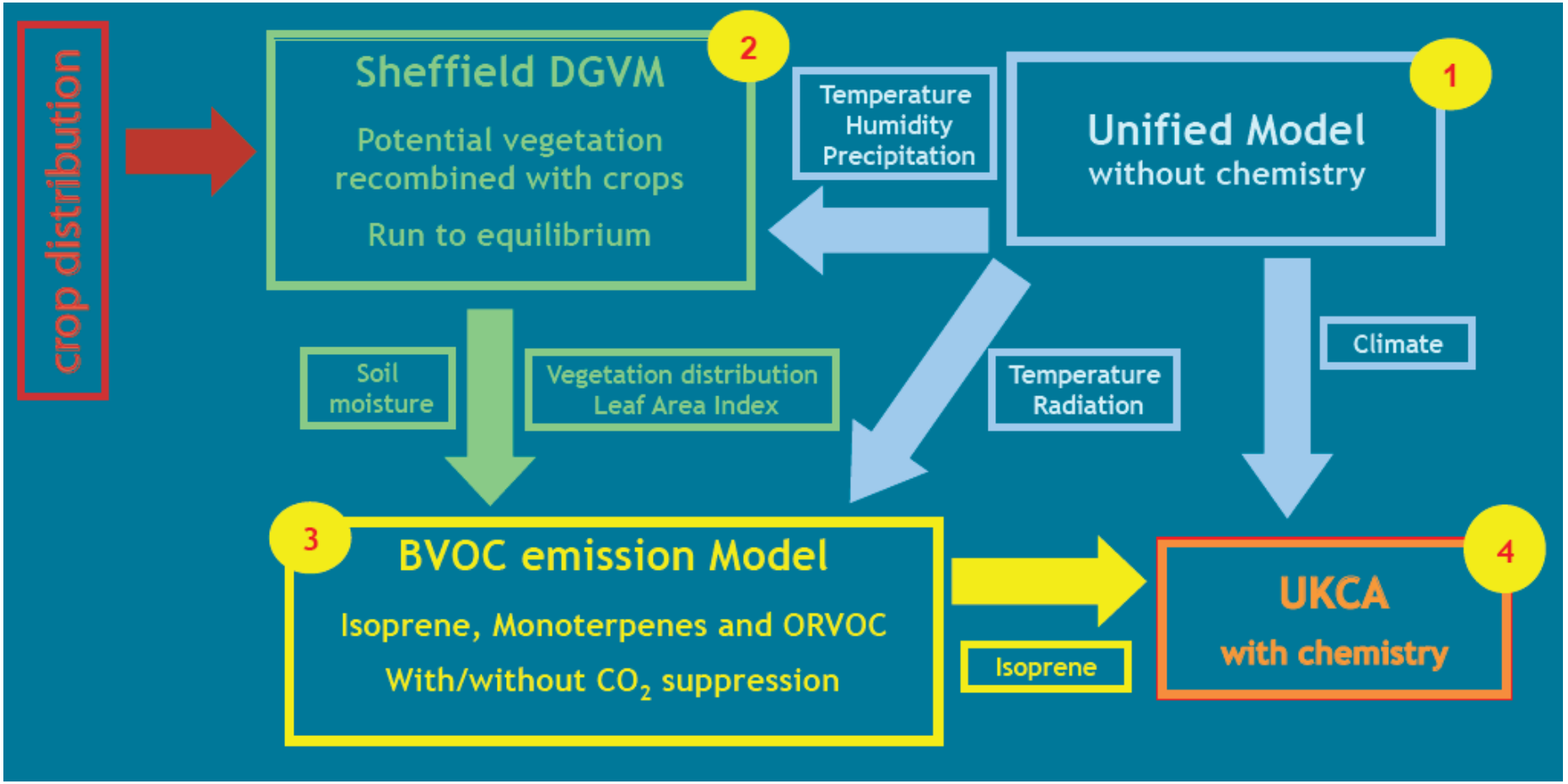
	NO_2 /Tg	CO /Tg	VOC /Tg	C_5H_8 /Tg	VOC/NO_x
1860	32.9	434.7	68.5	573.0	32.9
2000	147.0	1078.1	195.4	467.1	11.8
2100	122.9	1039.5	179.3	545.3	14.4


Δ OH PD ((Mod−Base)/Base)
%
400
300
200
100
0
60
30
0
−30
−60
Latitude
0
45
90
135
180
225
270
315
Longitude

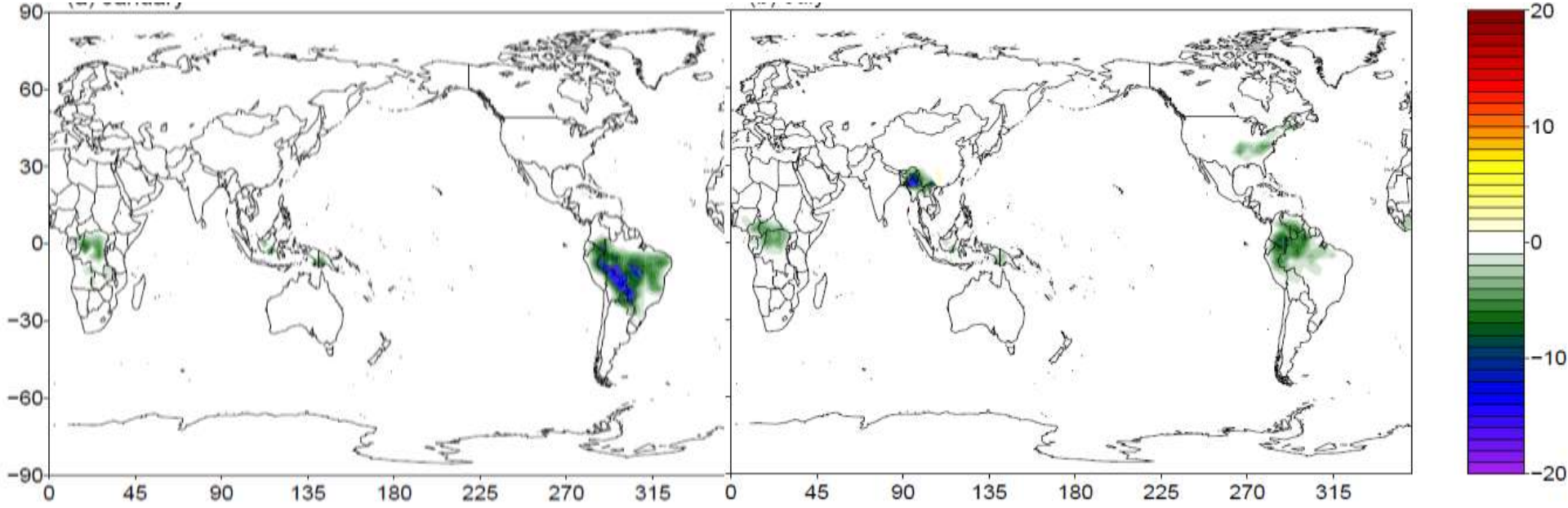

Δτ Methane (%)
0
−10
−20
−30
−40
1850
1900
1950
2000
2050
2100

Impacts of future land use change on atmospheric chemistry.

Impacts of future land use change on atmospheric chemistry.

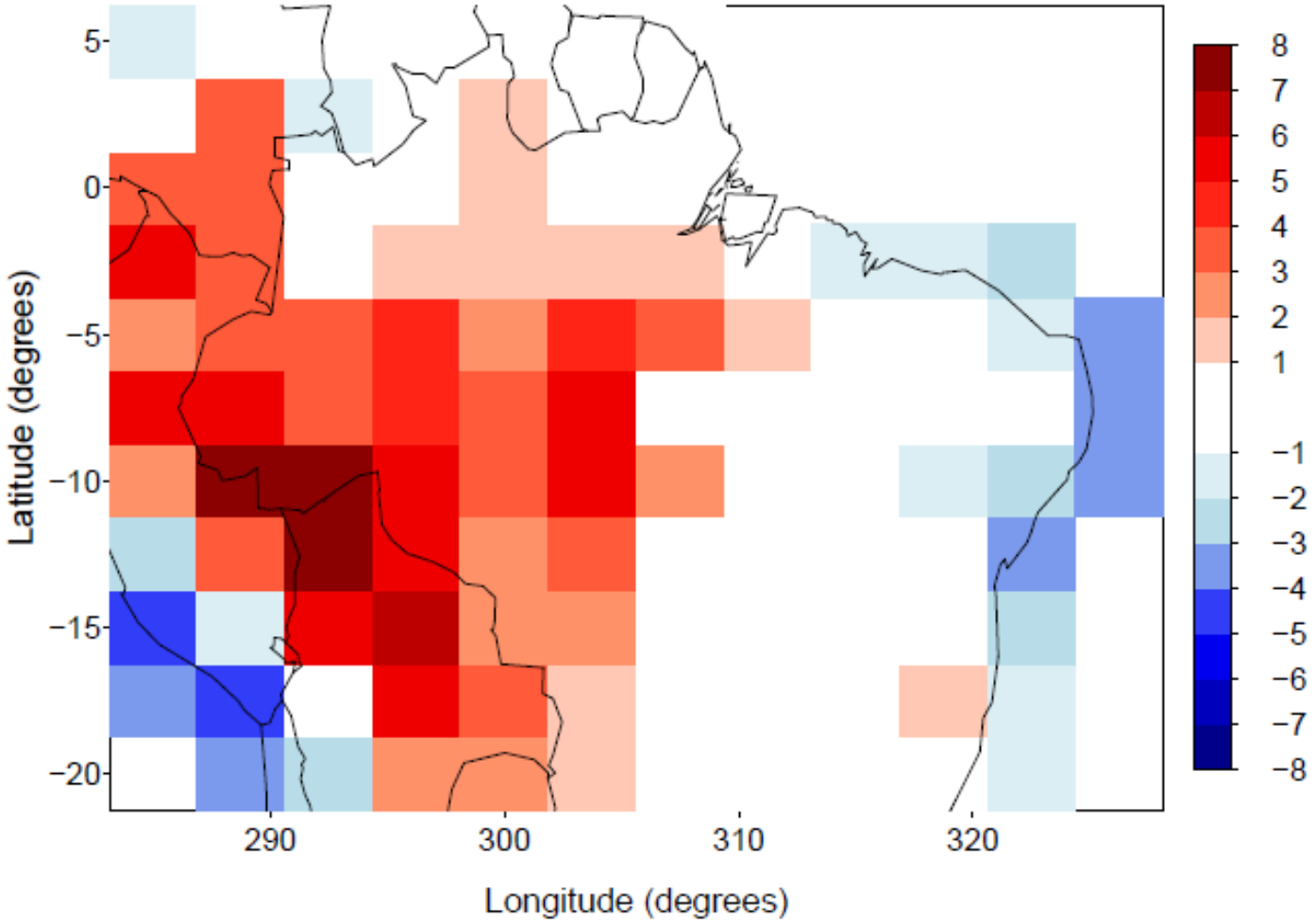


Changes in isoprene emissions and concentrations.



January **July**

Δ DM8H O_3 (ppb).

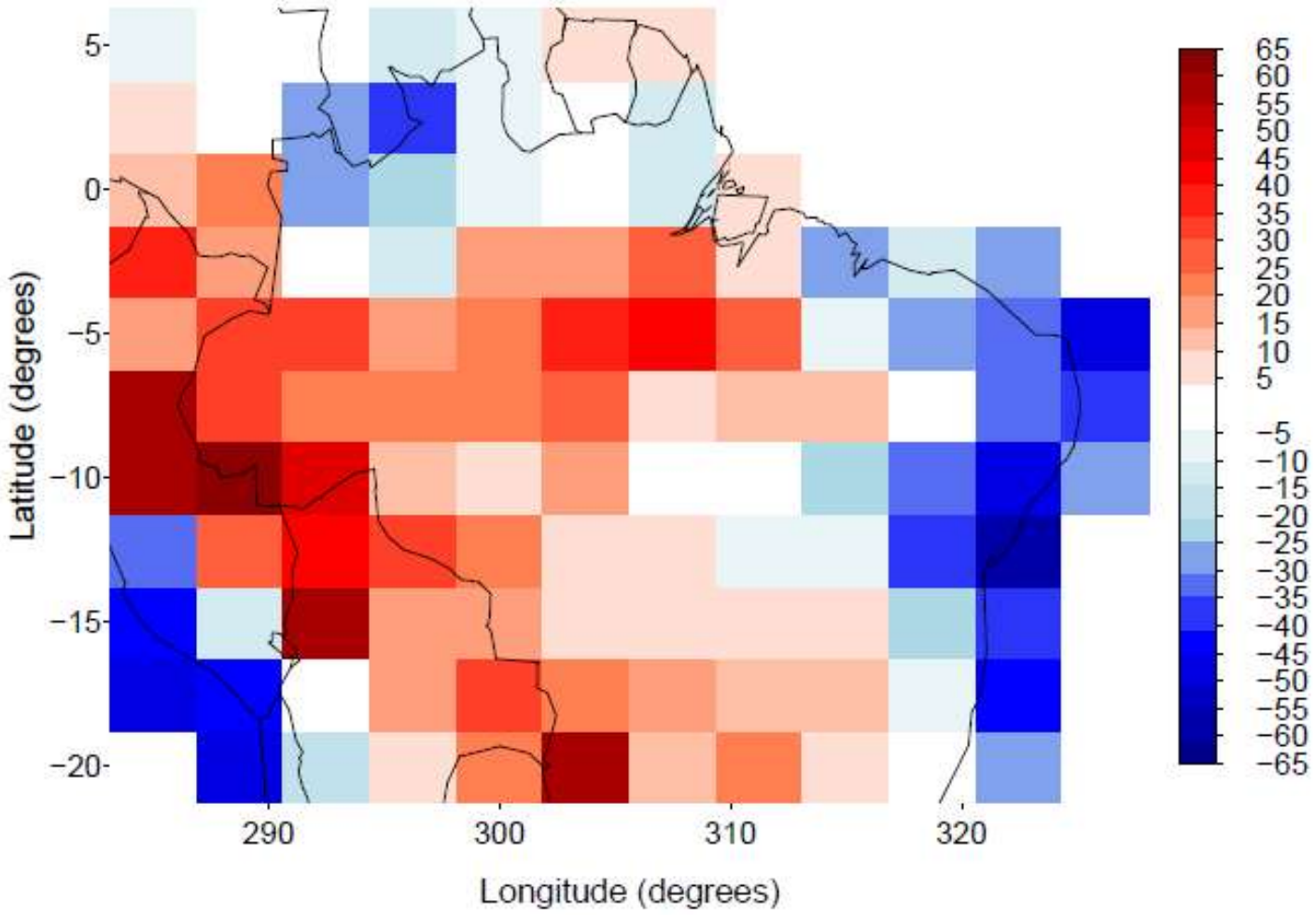


- Emis Isop ↓

- Deposition ↓
- ISON ↓
- O_3 + Alkene ↓

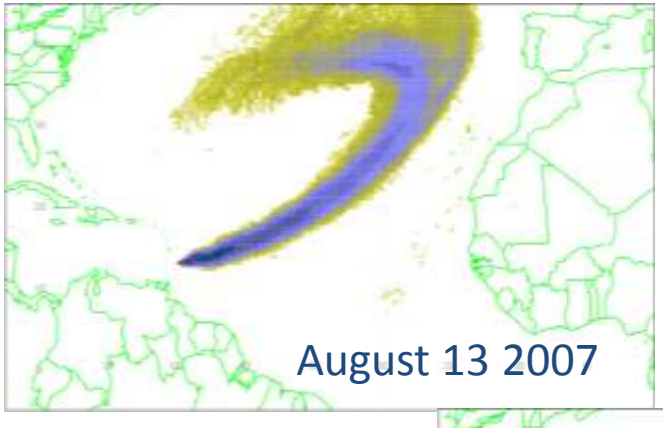
- $[O_3]$ ↑

Δ DM8H O_3 (days).



Long term measurements at RPB

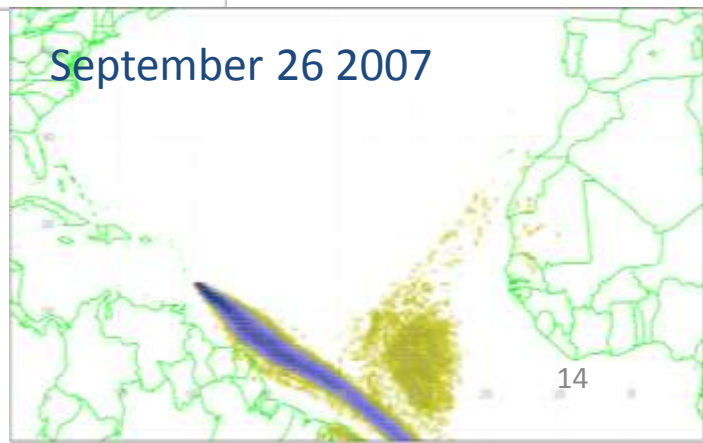
- Ragged Point, Barbados (13° N, 59° W, 42 m asl).
- Continuous measurements since 1978 (GC-MD).
- 2005 instillation of Medusa GC-MS (improved trace gas coverage inc. NMHC).



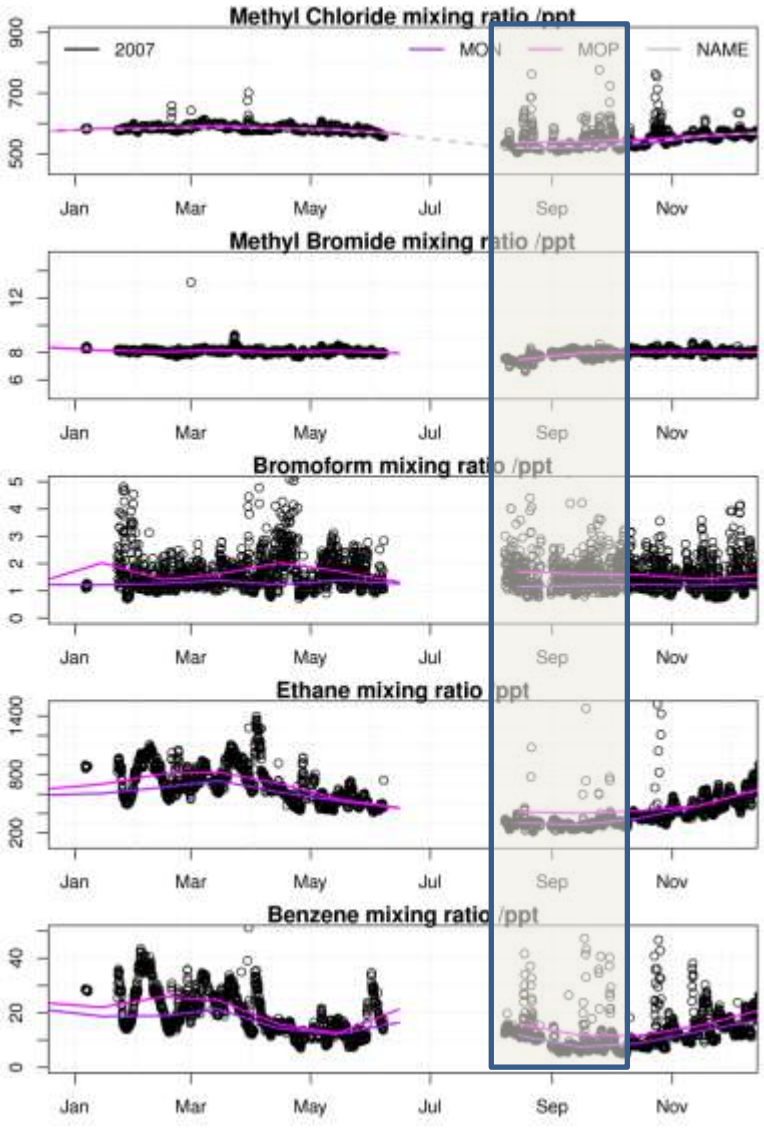
NH Baseline?!

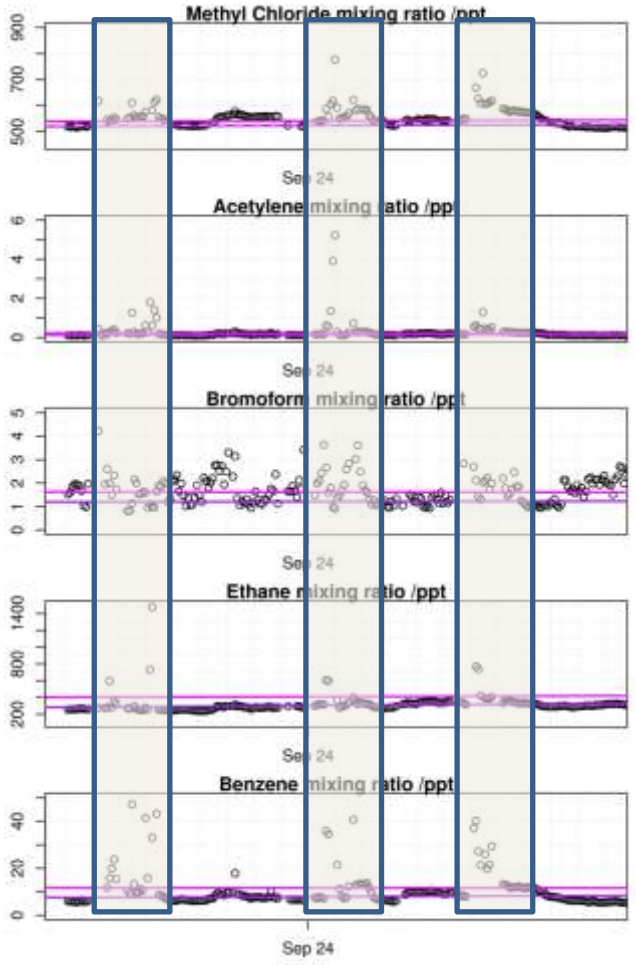
Example air history

SH Baseline?!



RPB NMHCs and ODSs: Trends and variability.

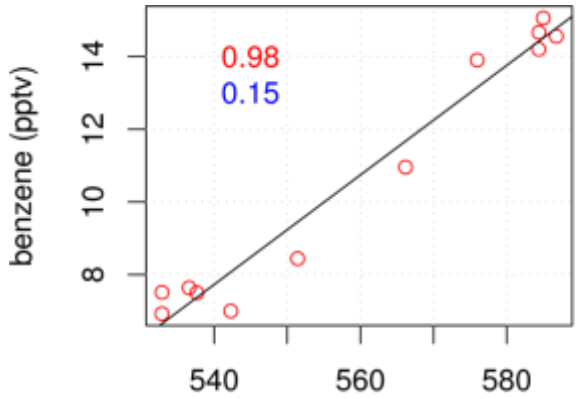


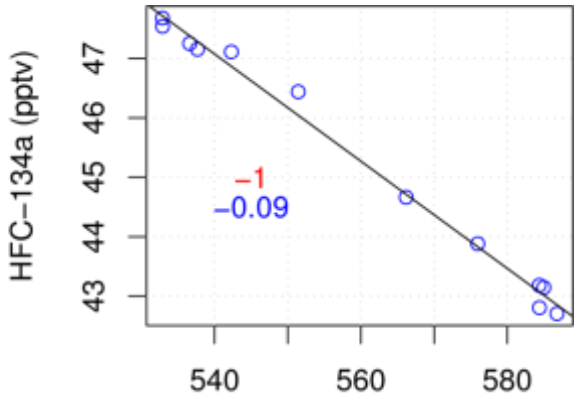


Focus on the autumn period (Sep-Oct)

Correlations of species during September "events".

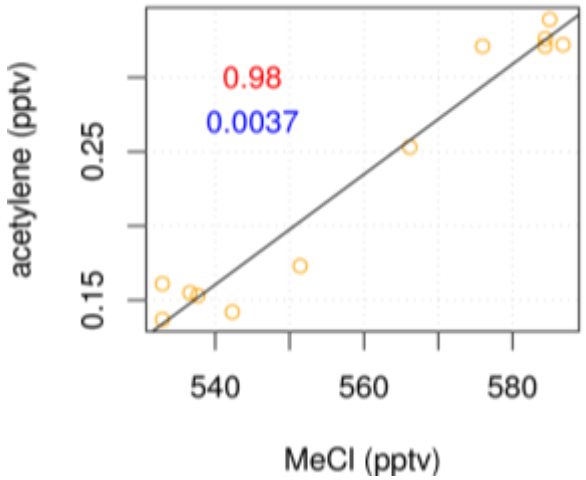
Burning/ Anthropogenic tracer?

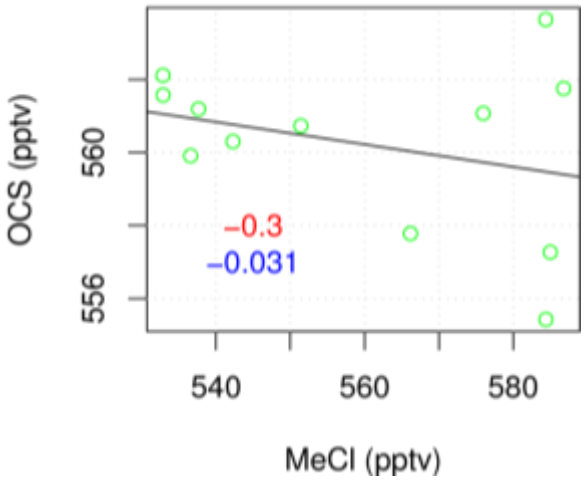




Anthropogenic tracer?

Burning/ Anthropogenic tracer?





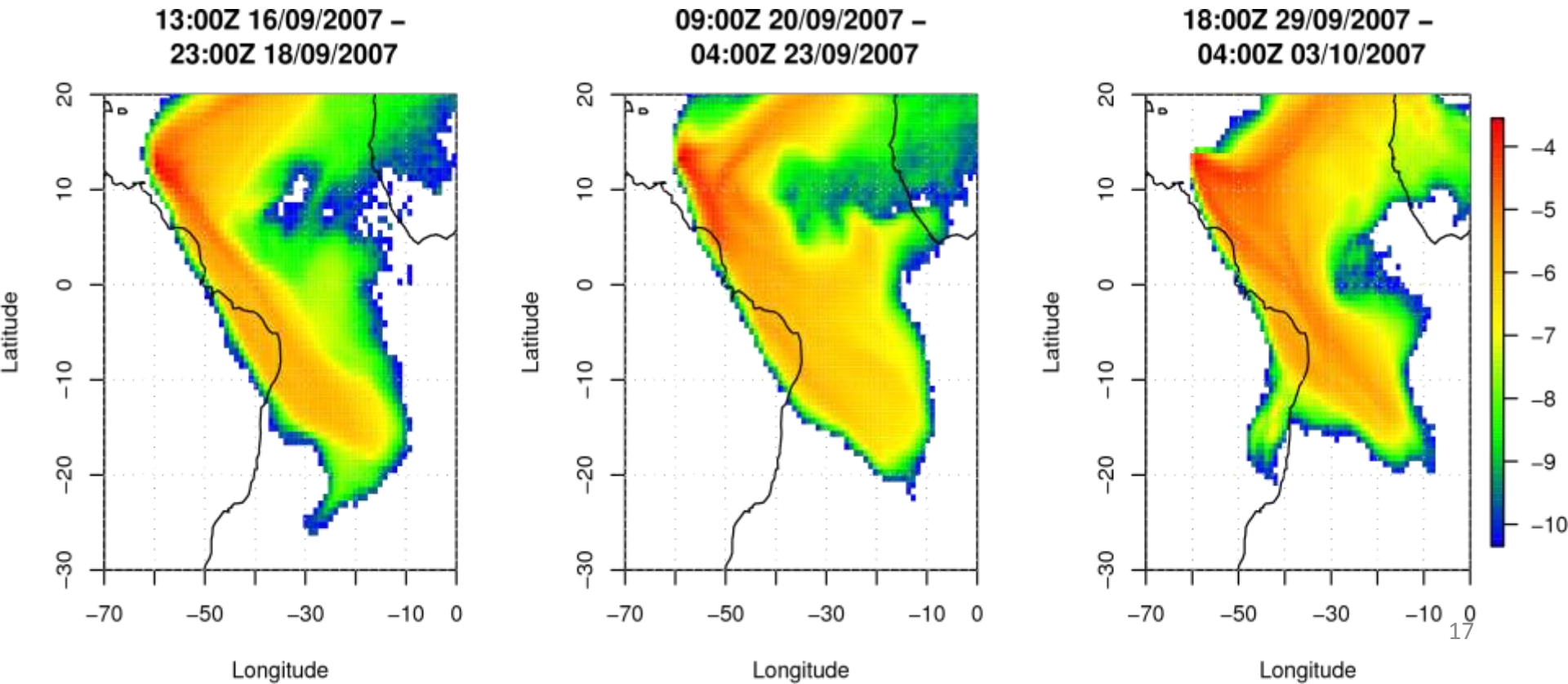
Oceanic tracer?

Understanding RPB data with NAME.

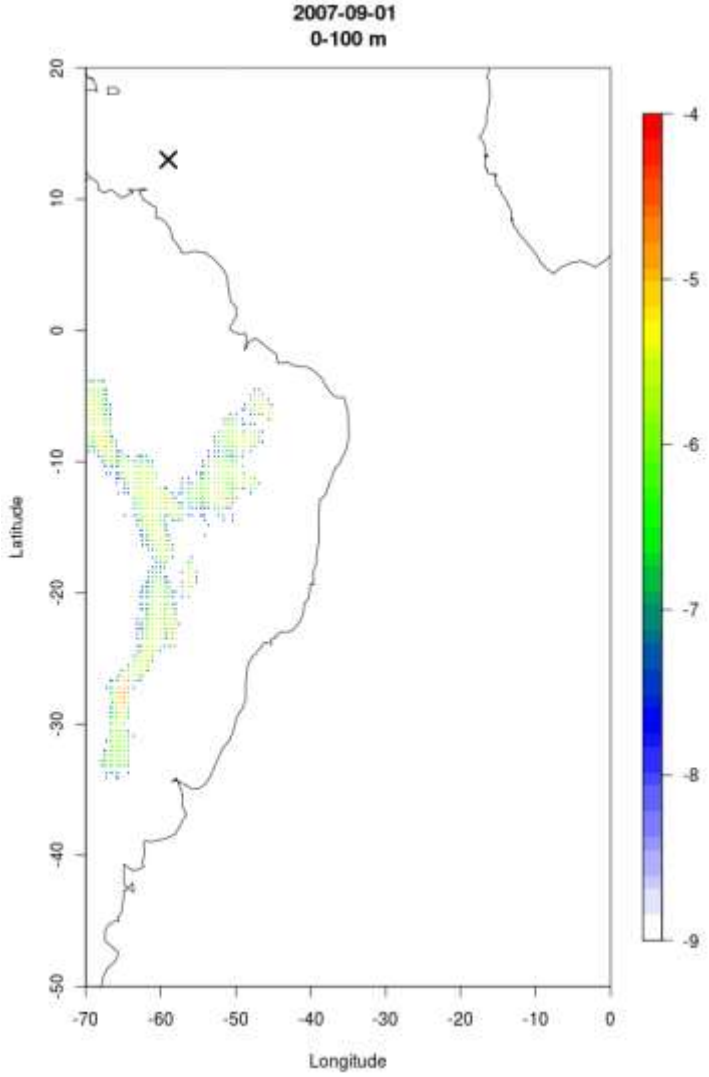
NAME model setup:

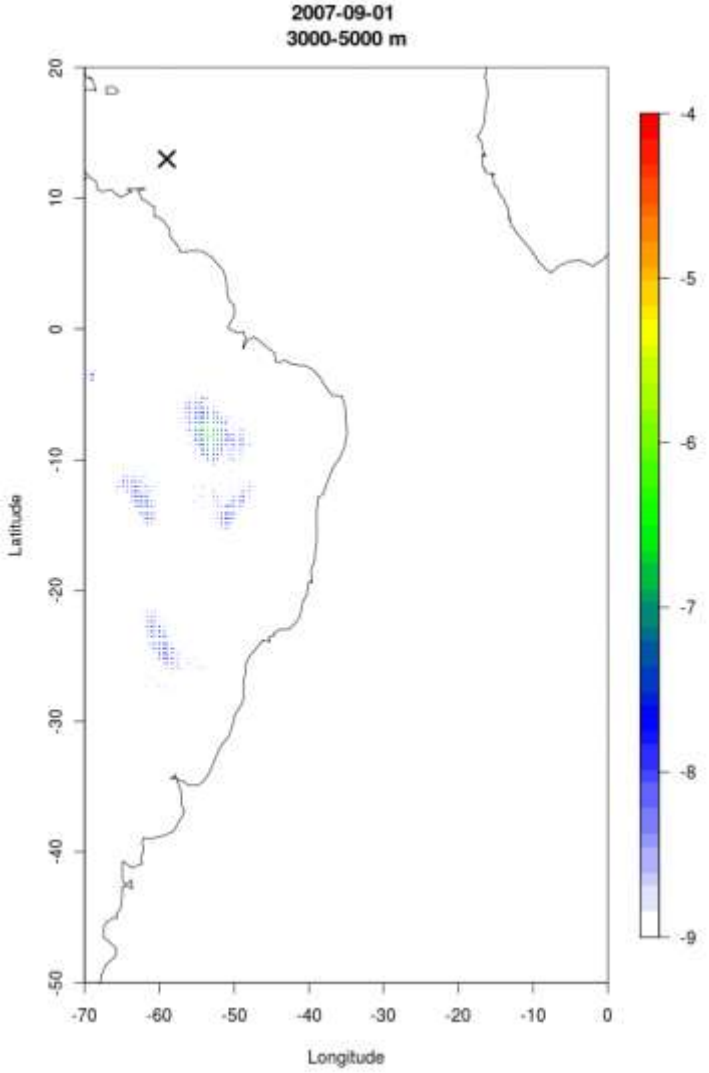
•NAME III v5.2.

•Global met resolution (at 2007) 0.5625°x0.375° (~60x60km).

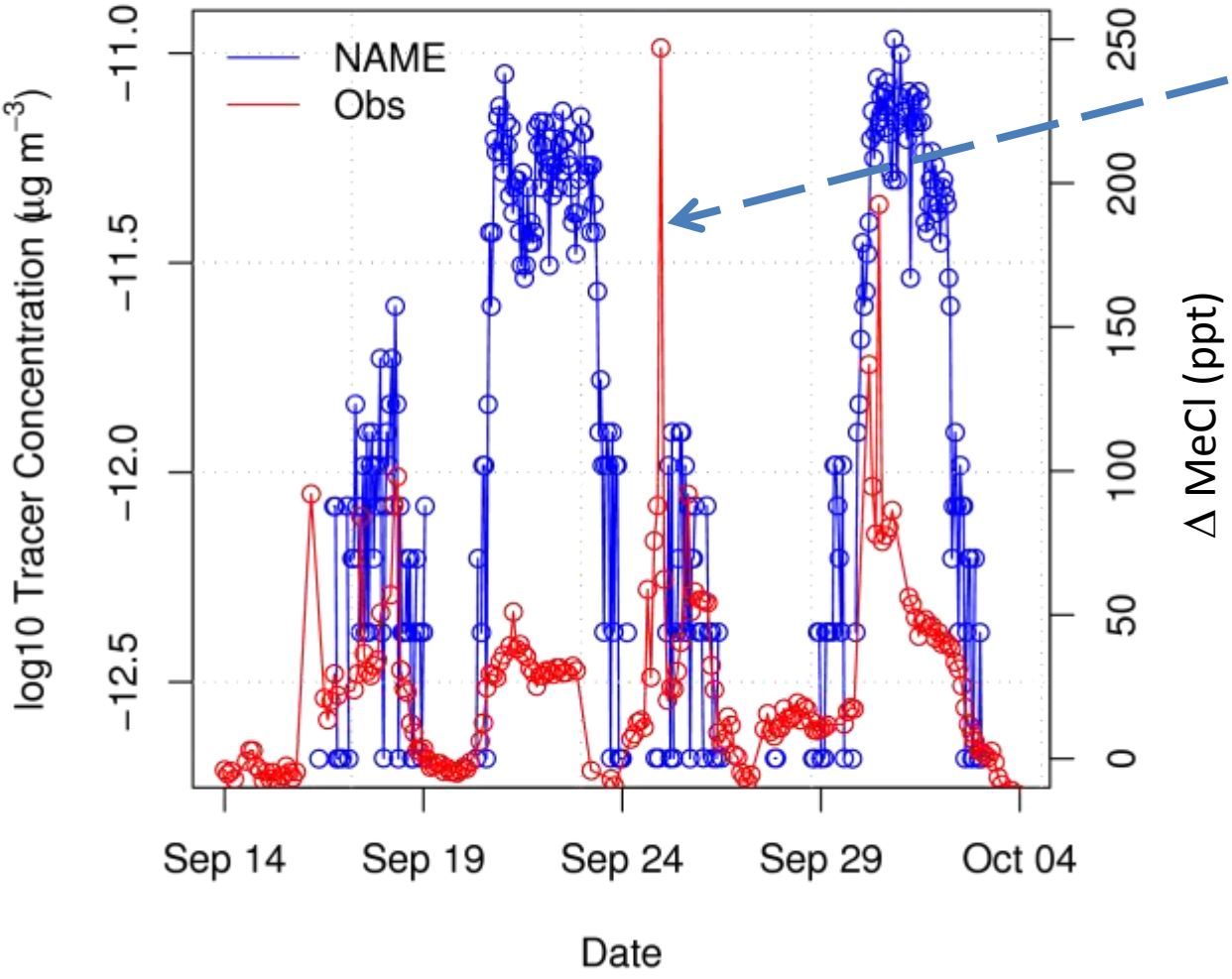


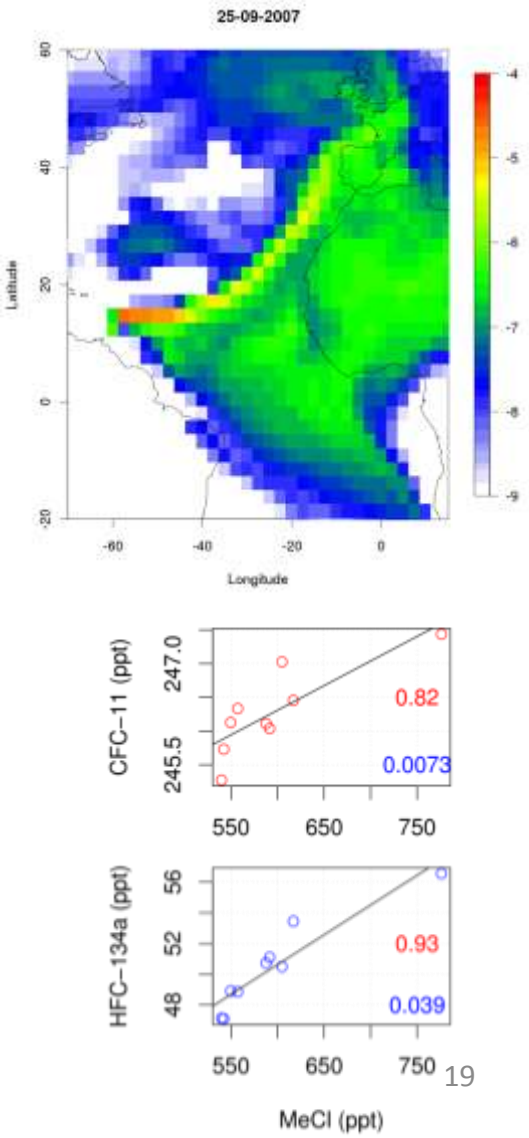
Simulating Biomass Burning emissions with NAME.





Correlation between Biomass Burning and CH_3Cl "events"?





Estimating emissions.

Date	Method	Species	Emission Strength (g)
Sep 2007	NAME	CH_3Cl	1.01×10^{10}
(Savannah) (Tropical Forest)	Remote Sensing*	CH_3Cl	4.04×10^{8} - 3.51×10^{9}
	NAME	Benzene	$1.33\times10^{11\dagger}$
	Remote Sensing*	Benzene	1.47×10^{9} - 2.58×10^{10}
	NAME	Ethane	5.83×10^{10}
	Remote Sensing*	Ethane	4.85×10^{9} - 4.70×10^{10}

*Use MODIS burned area (monthly) scaled by fire counts (daily) and Tb_{fire}

†Takes into account e-fold lifetime ca 3 days (OH=3e6)

Methyl Chloride: Sources and budget.

Miscanthus

Dipterocarp

Willow

Flux type	(1) In situ + NOAA & NIES flask[1]
Fungal	165 ± 117
Tropical	2197 ± 394
Bio. Burn.	917 ± 198
Oceans	430 ± 100
Salt marsh	170 ± 67
Soil sink	-259 ± 92
Total Emi.	4089 ± 471 (Gg /yr)

Methyl Chloride: Sources and budget.

Bioenergy

Willow

-10 to 50

Conventional

Wheat

-60 to 1

Other sources/sinks

Wetlands

-4,300 to 170,000

Miscanthus

0 to 130

Oilseed rape

35 to 430

Tropical rainforest

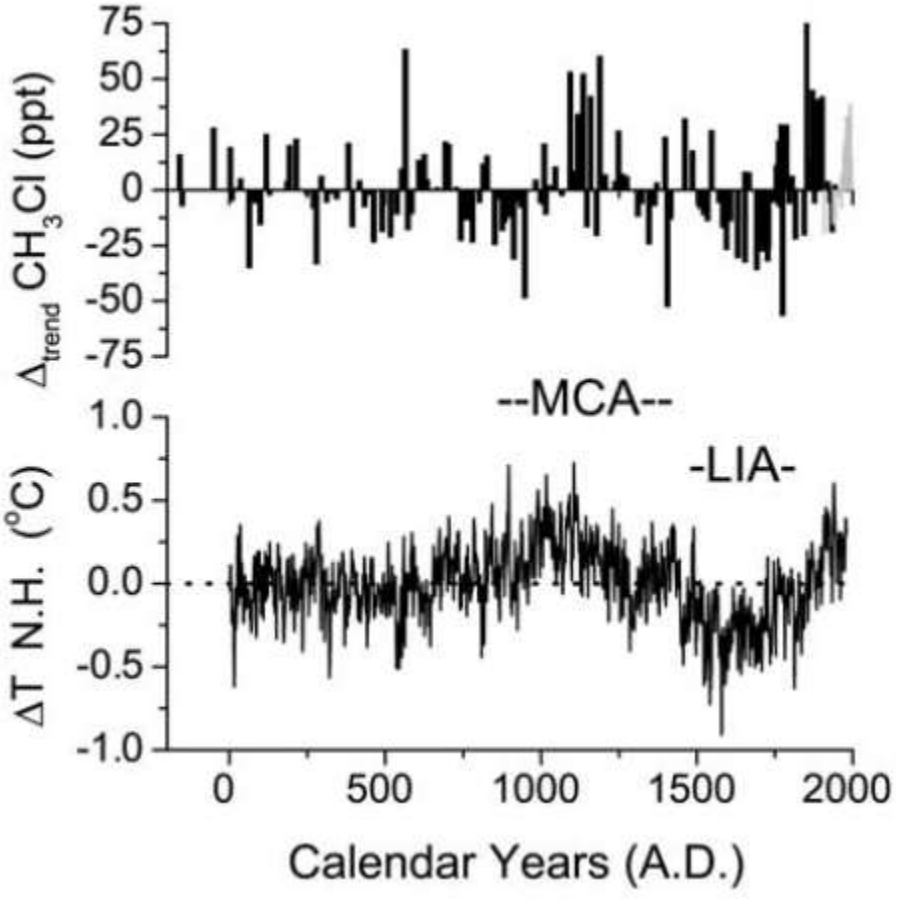
0 to 110

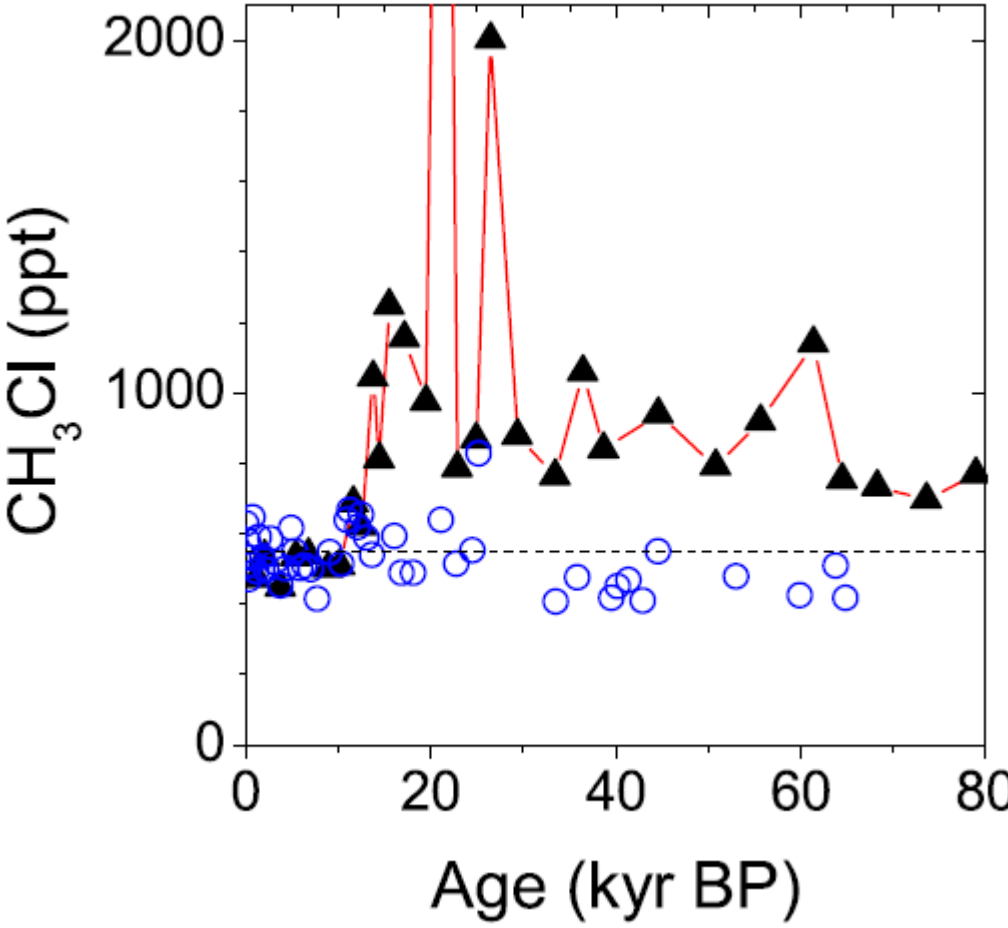
Salt marshes

0 to 4,000

(fluxes of MeCl ng g^{-1} h^{-1})

Methyl Chloride: Past variability.





Impacts of increased CH_3Cl levels in a future atmosphere.

- Simulate an increased surface boundary condition of 1,000 ppt CH_3Cl (cf. presently ~ 550 ppt).

- Simulate 18 years of model run (perpetual year 2100, prescribed GHG, ODS and emissions from CCMVal).

Impacts of increased CH_3Cl levels in a future atmosphere.