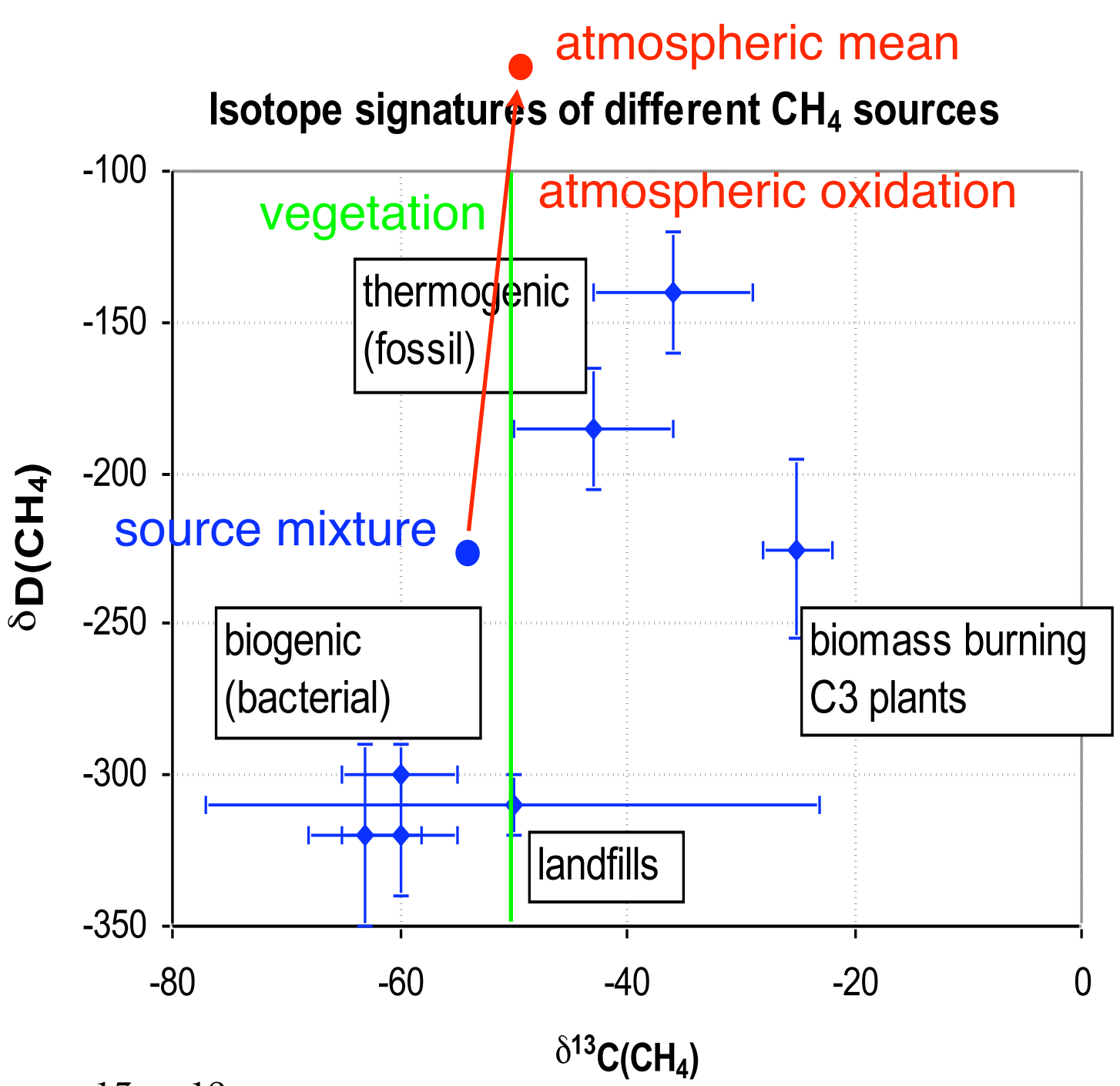
Simulation of CH_4 over the Amazon and ^{13}C analysis

S. Houweling, TM5 meeting 21-6-2007

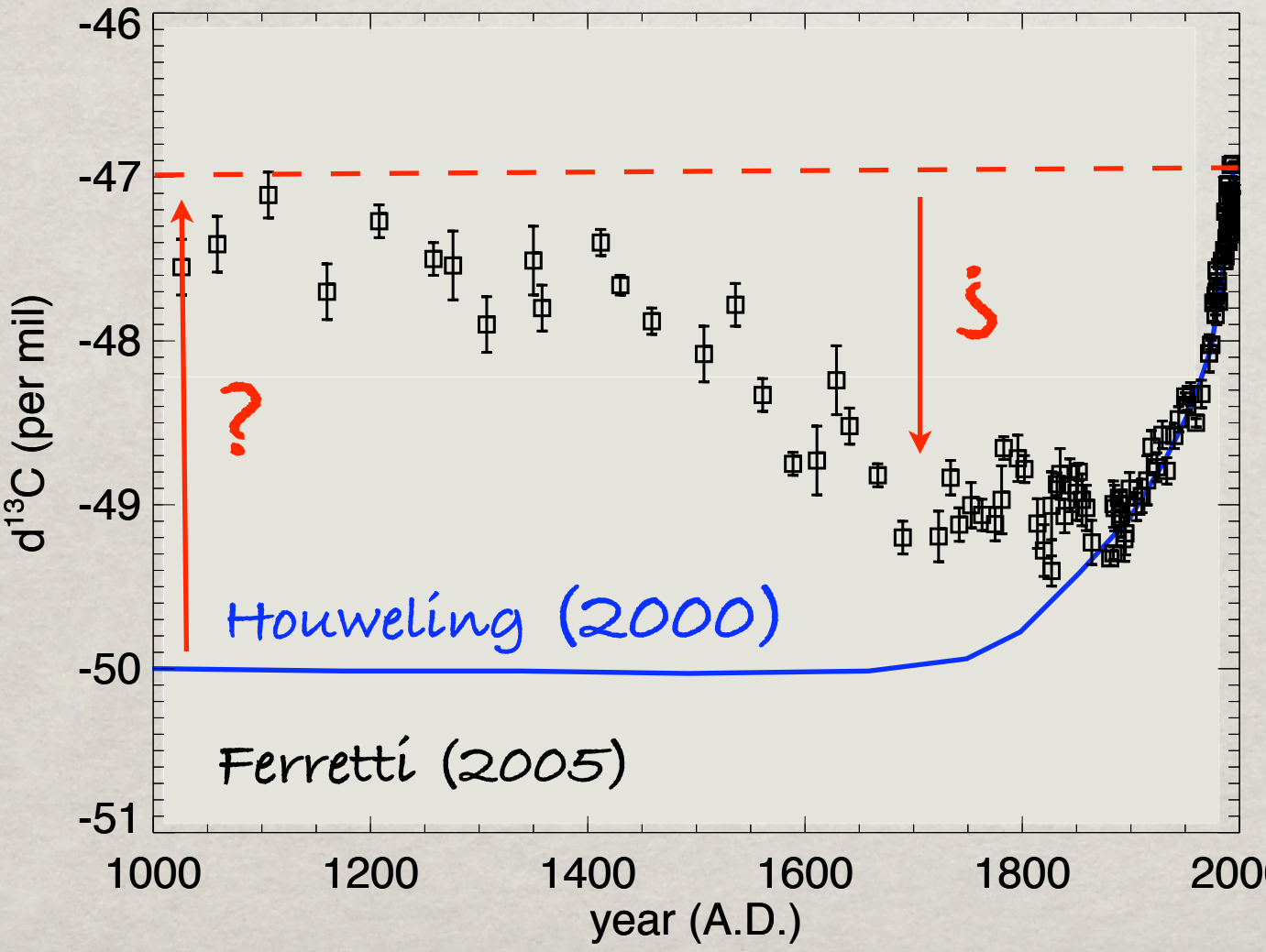
Motivation

- Methane emissions from plants
- Any atmospheric evidence? (CH_4, $^{13}CH_4$)
- How to further investigate this?



$$\delta^{13}C = \left[\frac{^{13}C/^{12}C}{(^{13}C/^{12}C)_{ref}} - 1 \right] x1000$$

What about natural $\delta^{13}CH_4$?



Hyp. 1:

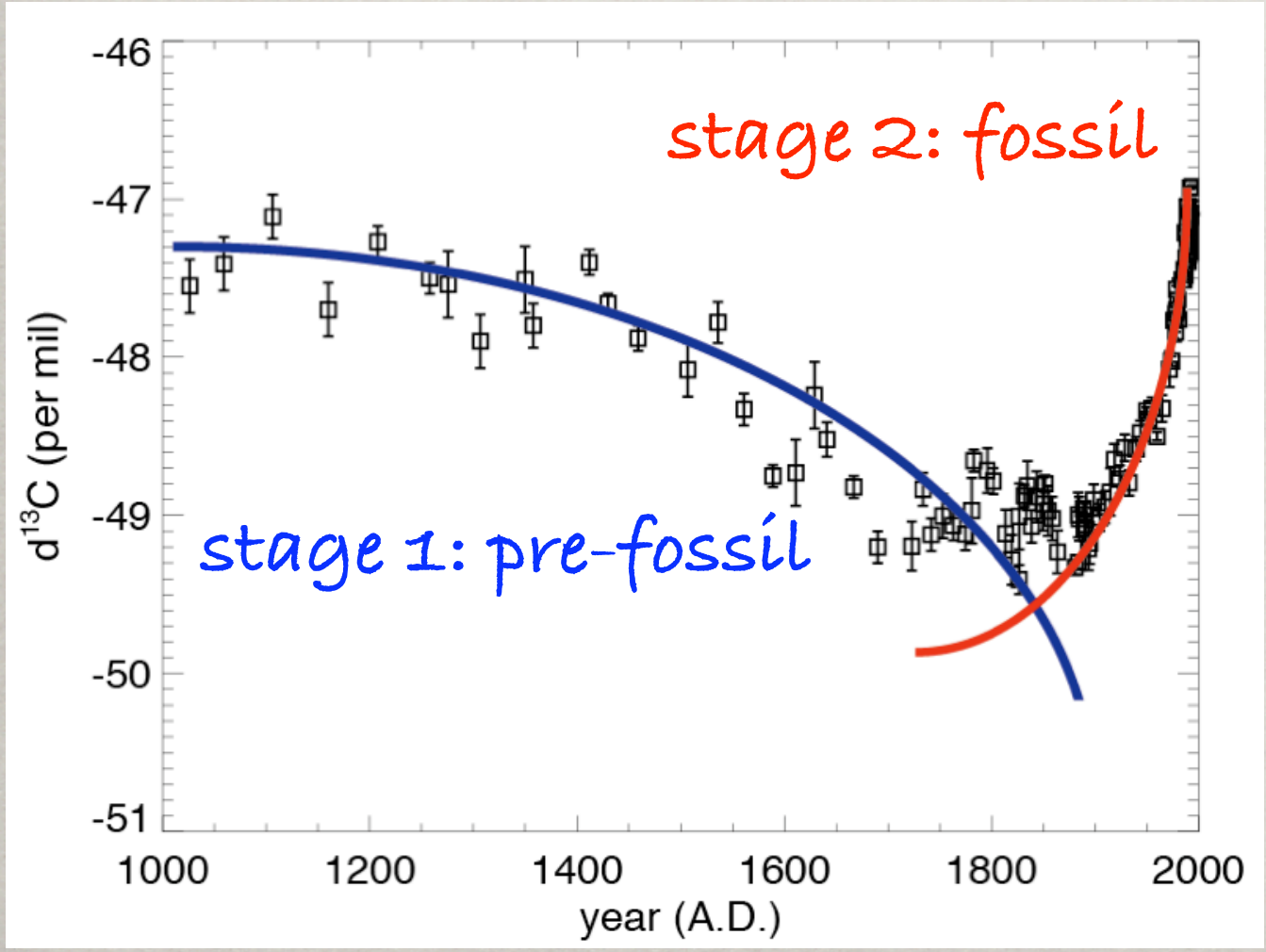
Biom. burning

Hyp. 2:

Plants

New Hypothesis

Exponential human development



But prior to 1750 AD: Natural sources should have decreased ...

Due to LIA?

Historic CH_4 modeling

$$\frac{\delta C_x(t)}{\delta t} = \frac{1}{m_{air}} \sum_i E_{x,i}(t) - \sum_j S_{x,j}(t) C_x(t),$$

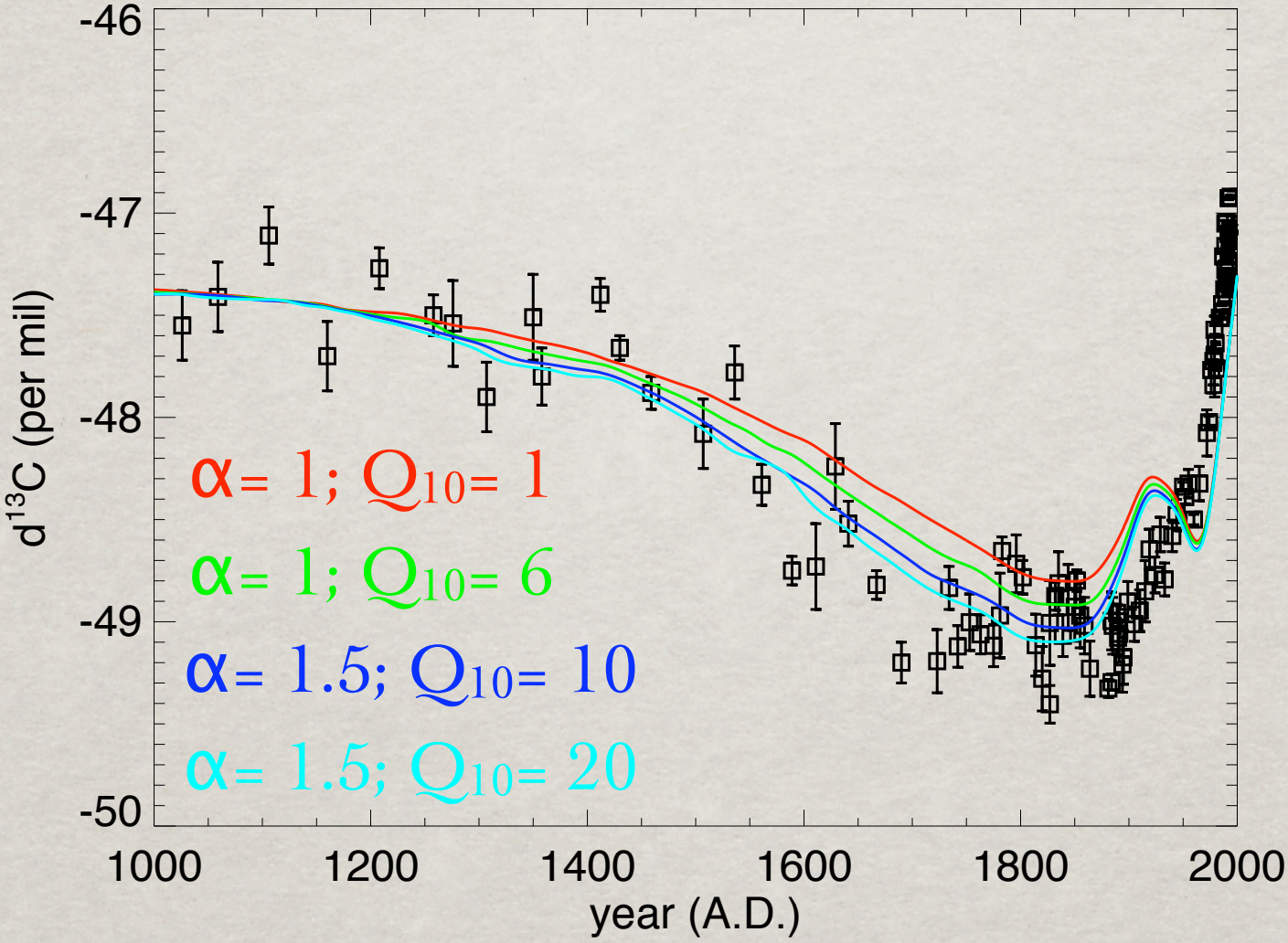
Natural sources:

$$E'_i(t) = E_i(t) Q_{10}^{\alpha (T_{NH}(t) - T_{NH}(1990))/10}.$$

α= 1, 1.5

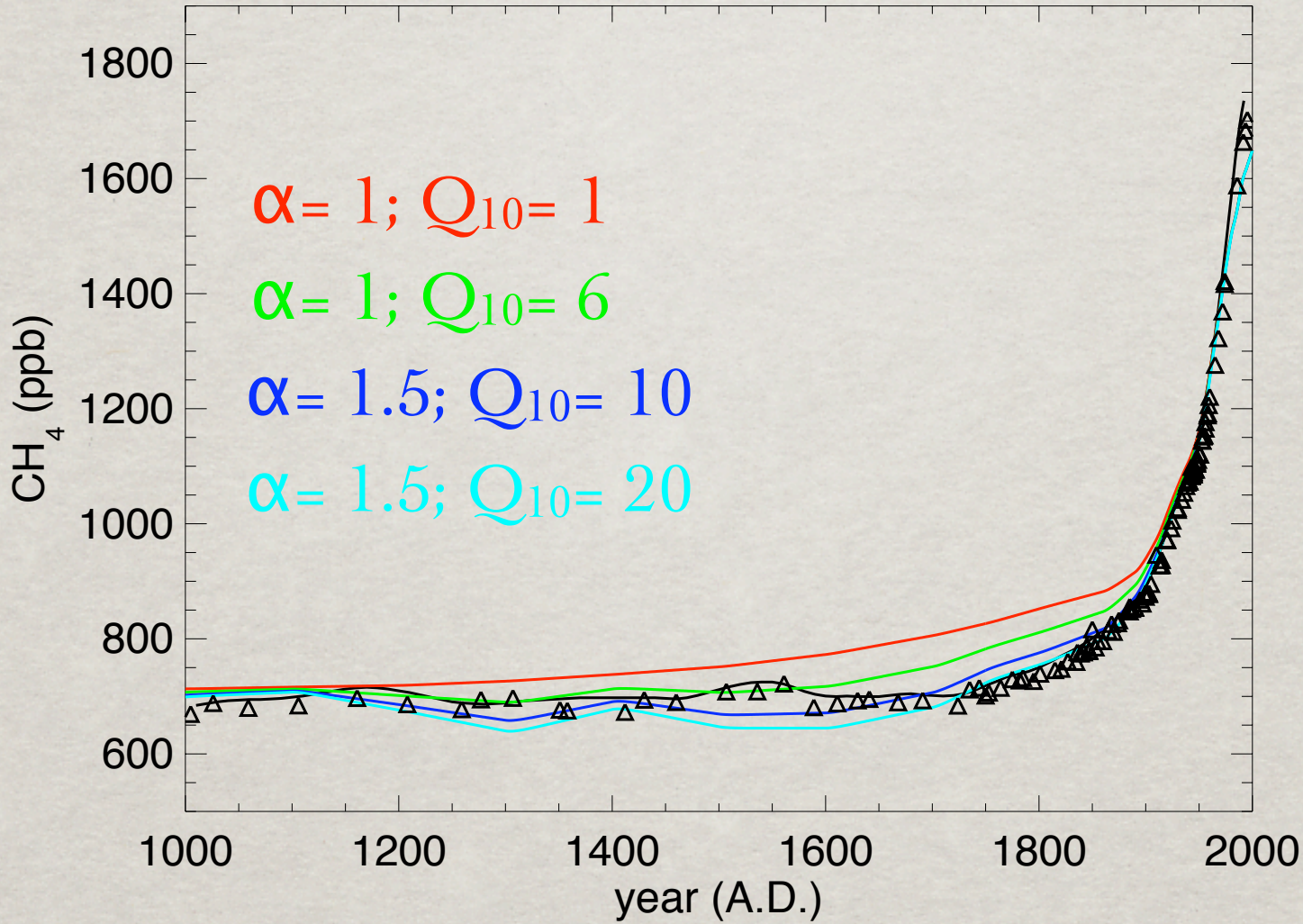
Q_{10}= 1, 6, 10, 20

Results: $^{13}CH_4$



Scenario includes 85 Tg CH_4 yr^{-1} from plants

Results: CH_4



Required reduction: ~100 ppb ➡ Glacial: 400 ppb (350 ppb)

This scenario works, provided that:

- Plant really emit a substantial amount of CH_4 (see Dueck et al., 2007)
- The tropospheric fractionation is not as high as suggested by Allan et al.

Sink fractionation

$KIE = k^{12}CH_4 / k^{13}CH_4$

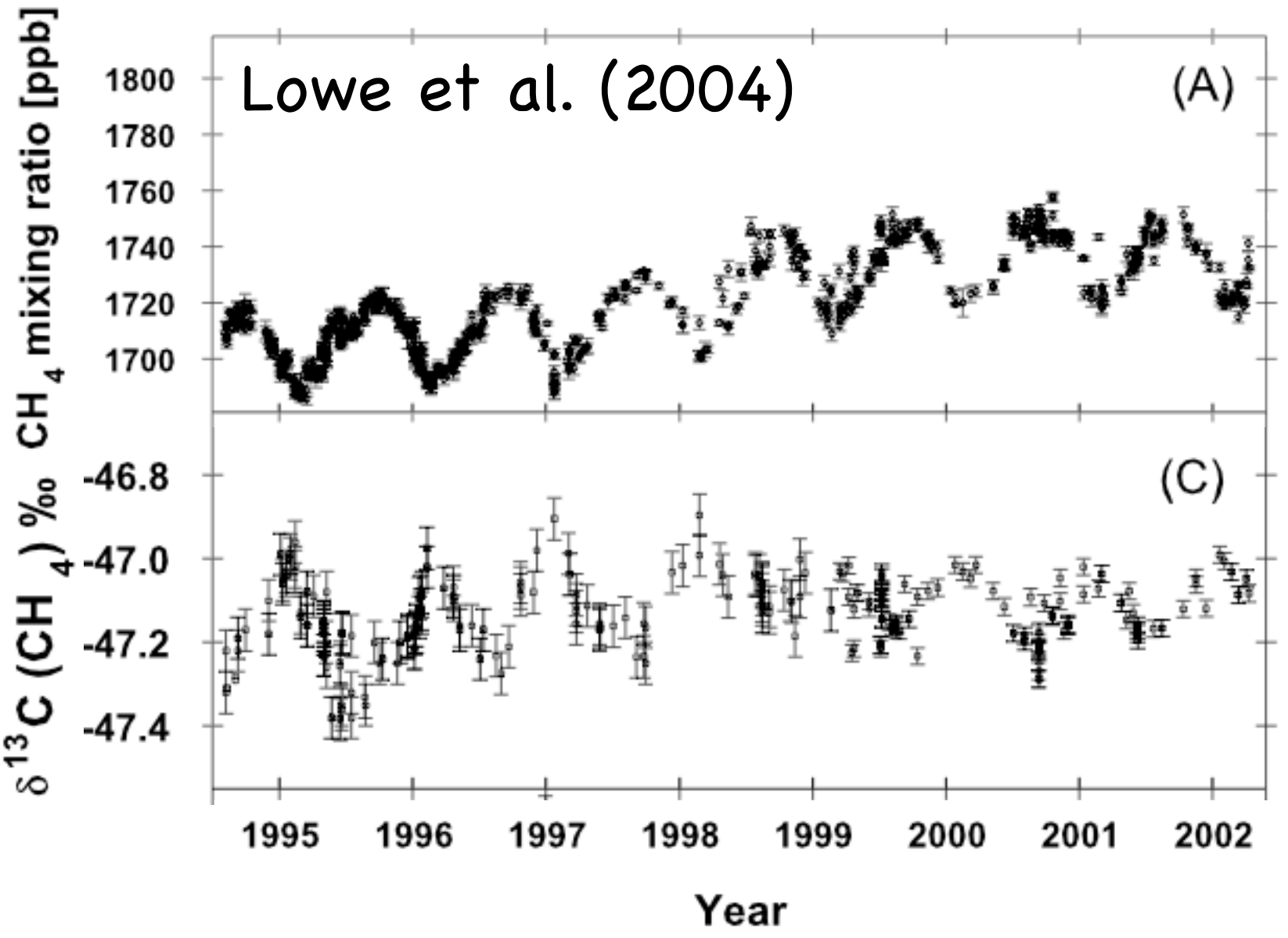
- CH4+OH -> ... KIE= 1.0039 or 1.0054
- CH4+O1D -> ... KIE= 1.013
- CH4+Cl -> ... KIE= 1.066

] mainly stratosphere

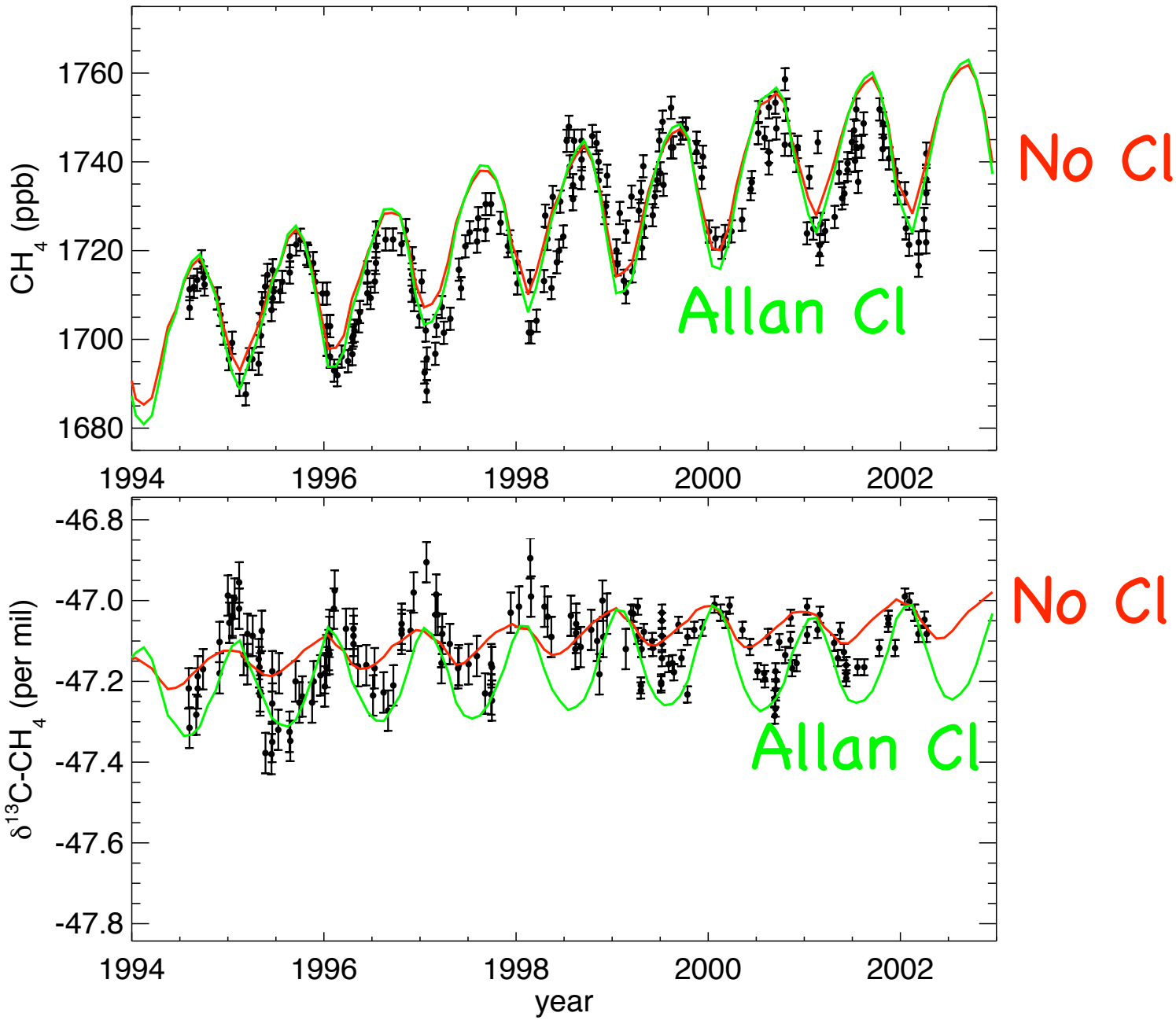
What is the mean fractionation in the troposphere?

Baring Head, NZ (BHD)

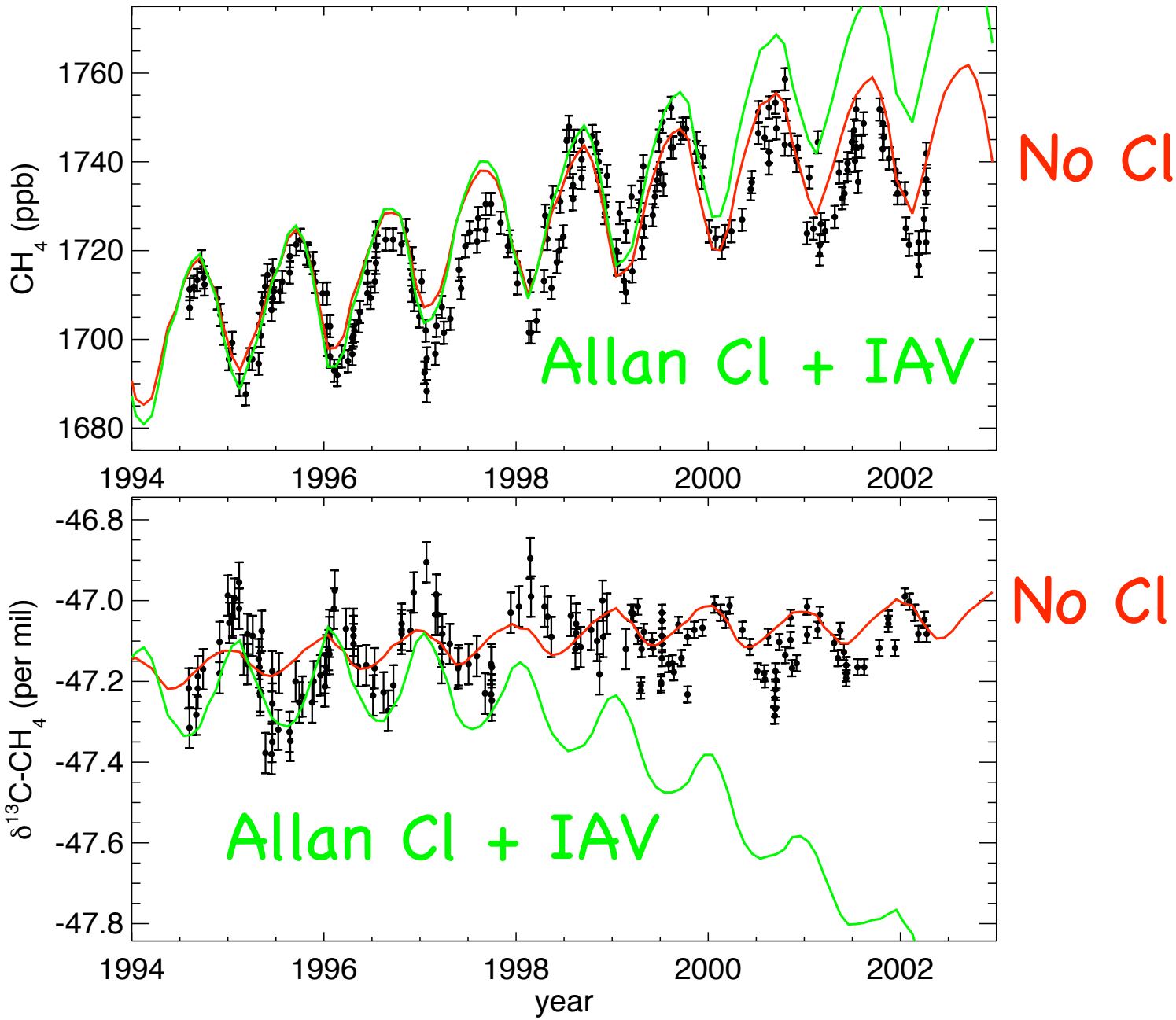
BHD measurements



TM3 v. measurements



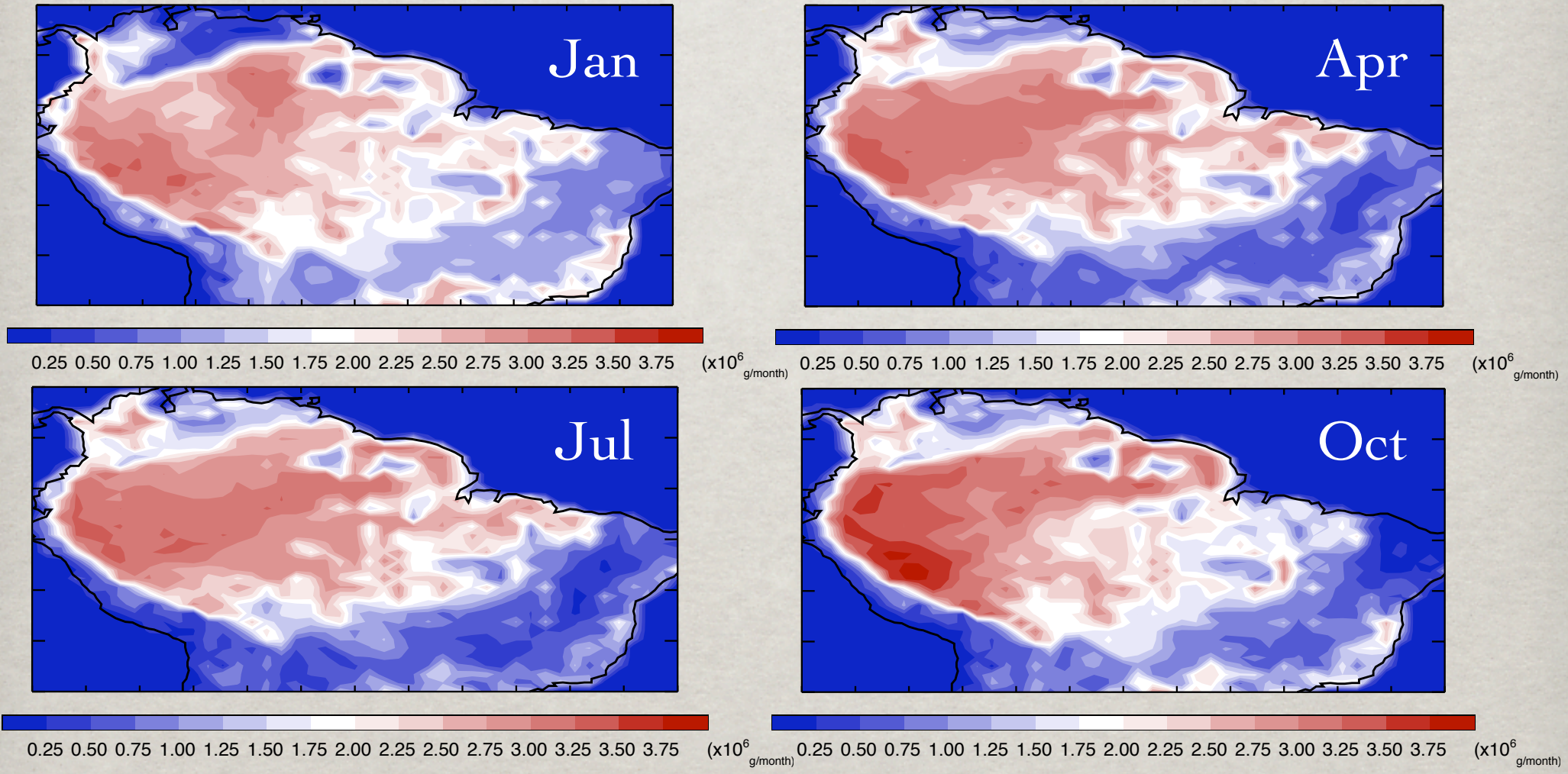
TM3 v. measurements



Further investigation of plant emissions

- In situ measurements of CH_4 and $^{13}CH_4$ in the Amazon (Vici project Thomas Roeckmann)
- Where to measure?

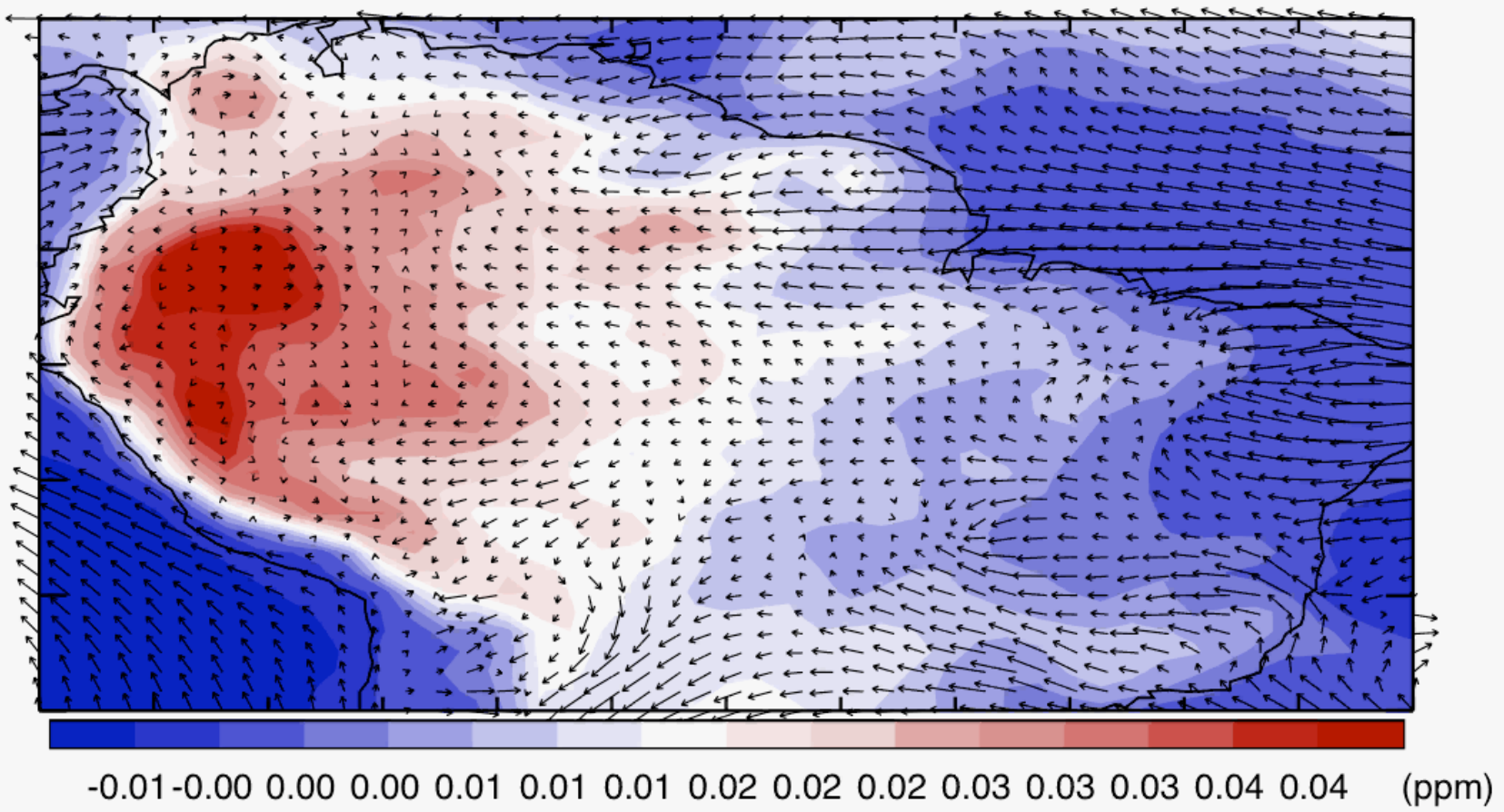
Estimated plant source



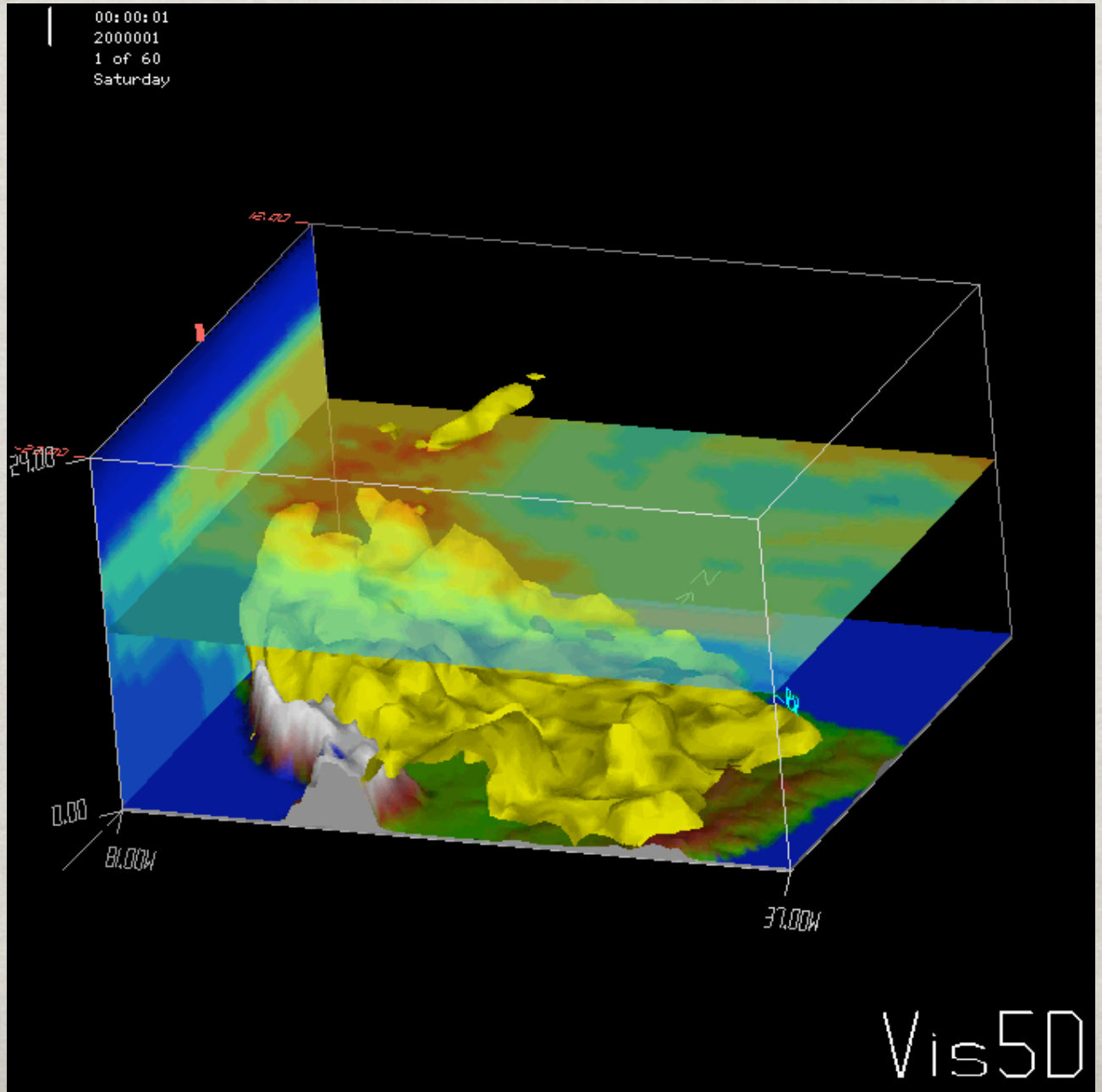
Integral over the Amazon: 30 $TgCH_4yr^{-1}$

TM5 simulation of plant emissions

Oct 2003, Surface layer (~1000-900hPa)



3D view of transport



Conclusions

- Simulations provide no evidence of plant emissions, but it could fit quite well
- East-West transect through Amazon seems an interesting option for new in-situ measurements (notably west of Manaus)