

Methane in CESM1

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Collaborators:

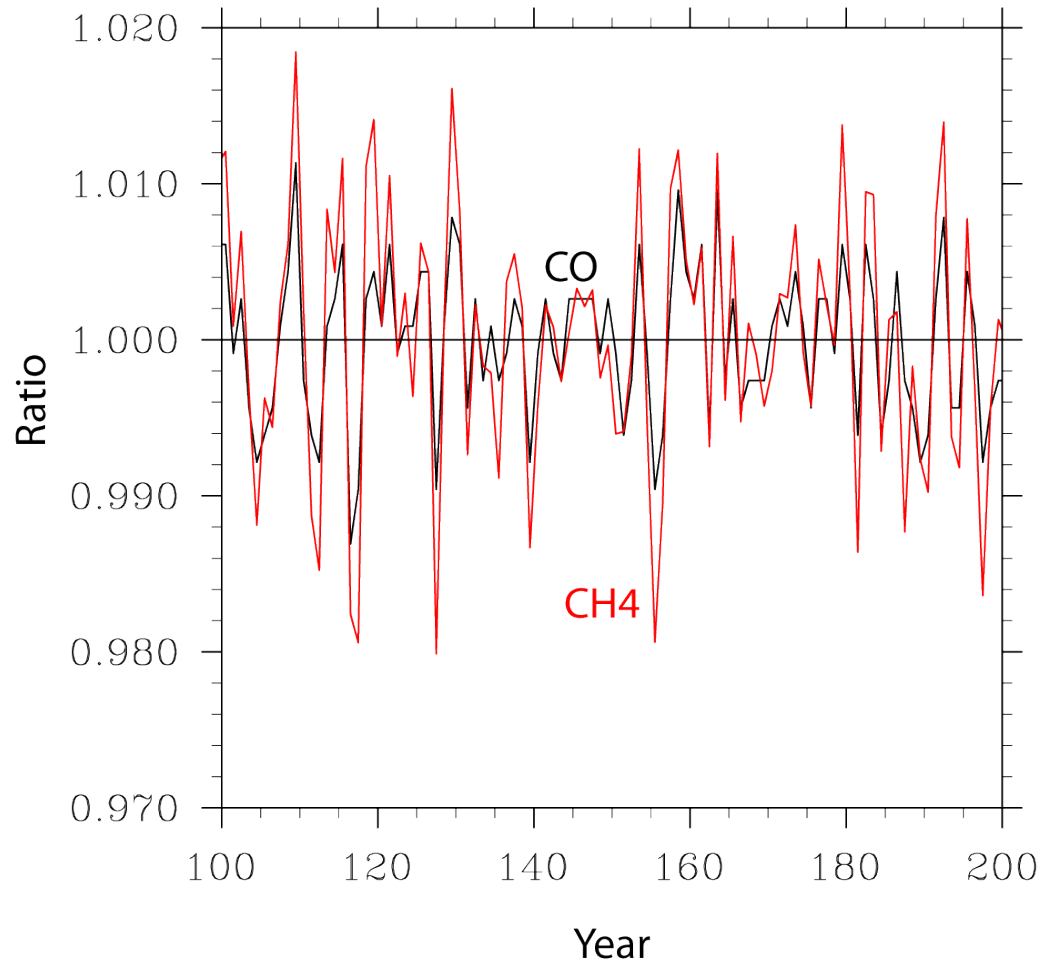
P. Cameron-Smith, P. Hess, D. Kinnison, M. Prather, S. Tilmes, and F. Vitt

SUPERFAST CHEMISTRY

Model version

- CCSM4 0.9x1.25
- Super-fast chemistry in troposphere
- LINOZ + Cariolle in stratosphere
- CH₄ prescribed everywhere from CAM3.5
- Fully coupled
- 1850 control (250 years)
- 3 20th century simulations

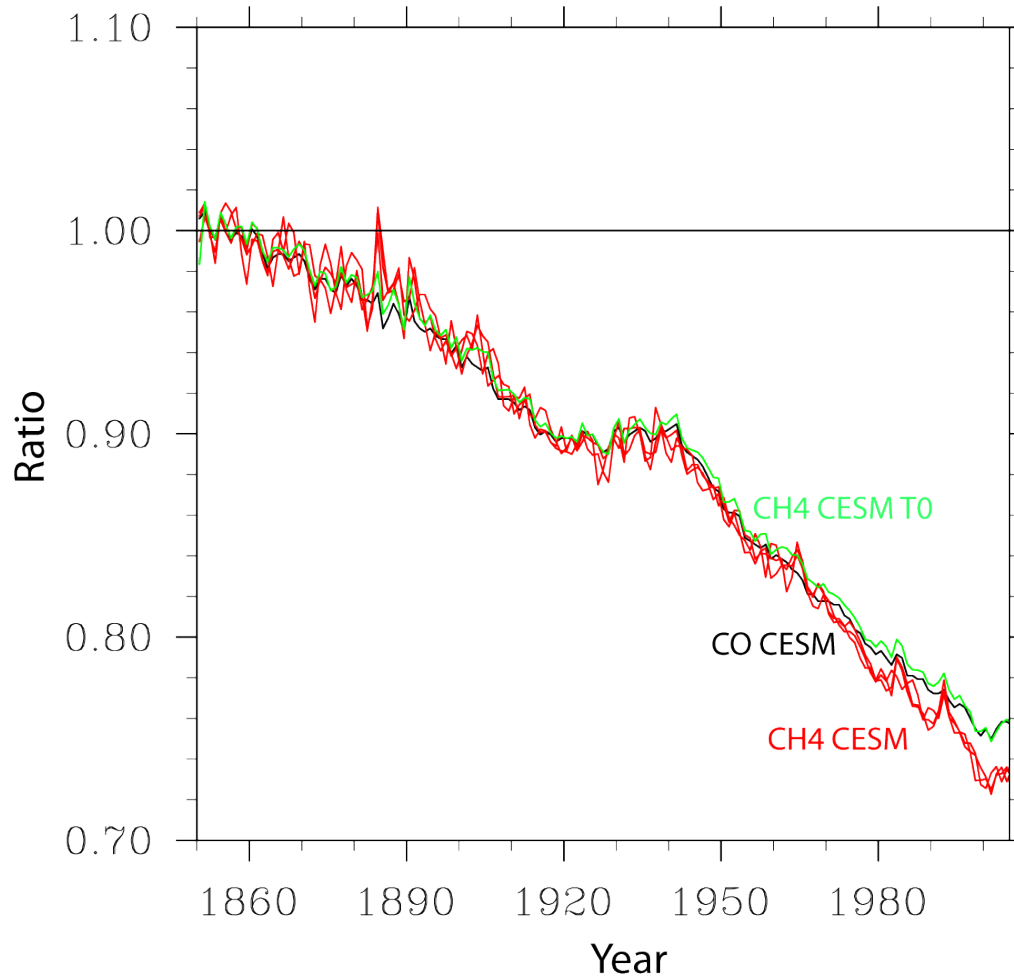
CH₄ & CO lifetimes: control



Lifetime with respect to OH loss only, integrated from surface to 200 hPa, normalized by year 100-109 average

$$\text{Ratio} = \frac{\text{Lifetime}(\text{year})}{\text{Lifetime}(100\text{s})}$$

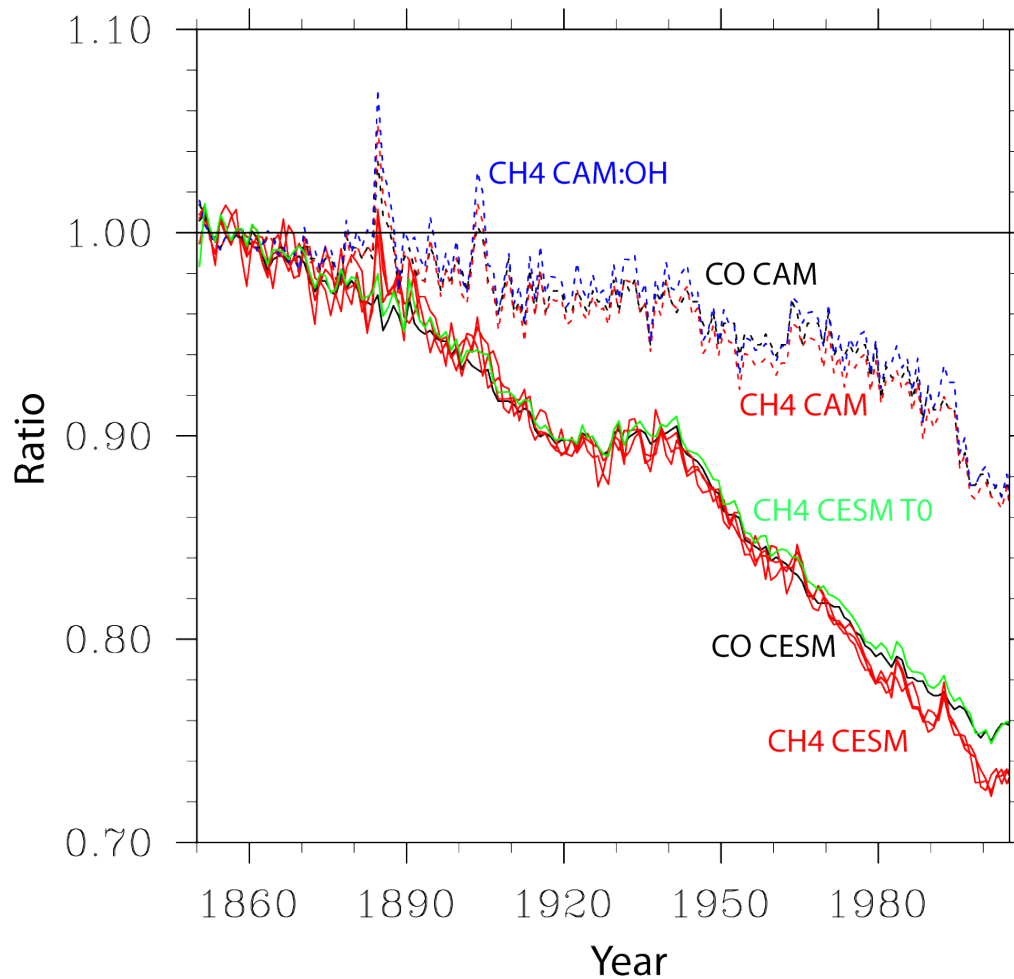
CH₄ & CO lifetimes: historical



Lifetime with respect to OH loss only, integrated from surface to 200 hPa, normalized by 1850-1859 average

$$\text{Ratio} = \frac{\text{Lifetime}(\text{year})}{\text{Lifetime}(1850\text{s})}$$

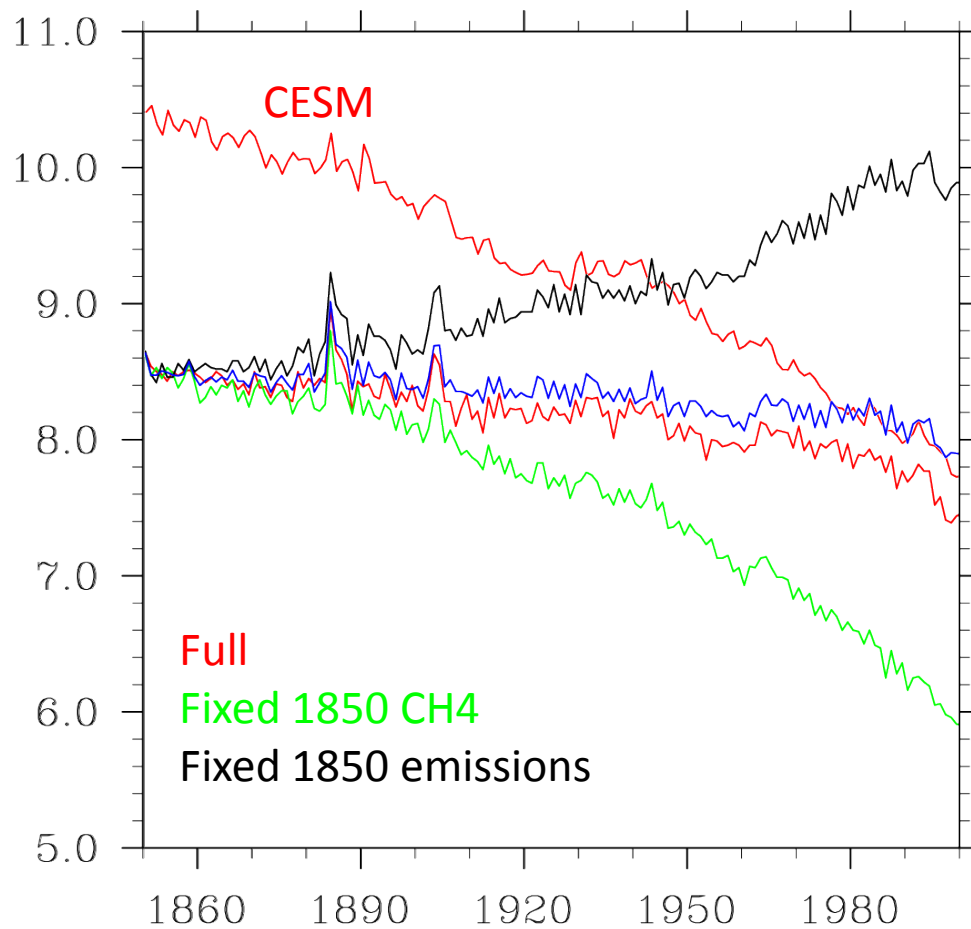
CH₄ & CO lifetimes: historical



Lifetime with respect to OH loss only, integrated from surface to 200 hPa, normalized by 1850-1859 average

$$\text{Ratio} = \frac{\text{Lifetime}(\text{year})}{\text{Lifetime}(1850\text{s})}$$

Methane lifetime (years)

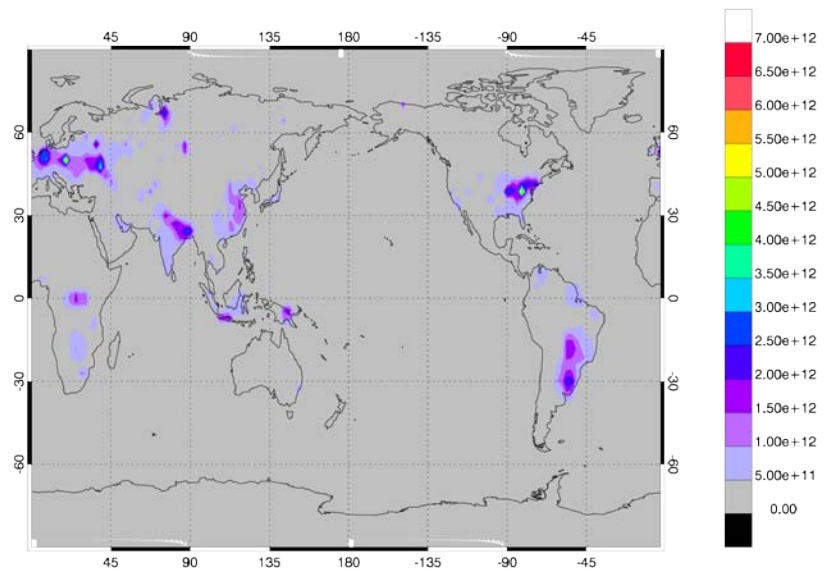


TROP-STRAT CHEMISTRY

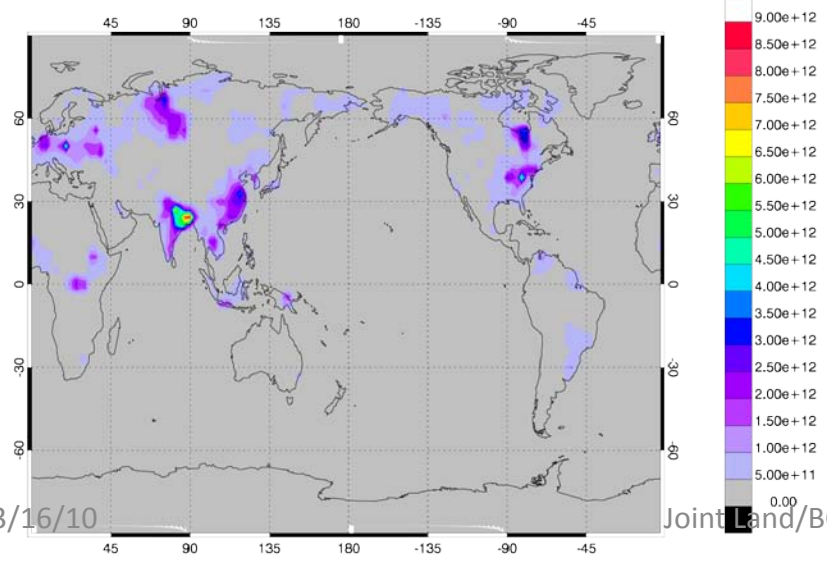
Model version

- CESM1 1.9x2.5
- Reduced NMHCs in troposphere
- Stratospheric chemistry from WACCM
- 2000 conditions, CH₄ driven by emissions (590 Tg/yr; Dlugokencky et al., 2009 \cong 550 Tg/yr)

Emissions

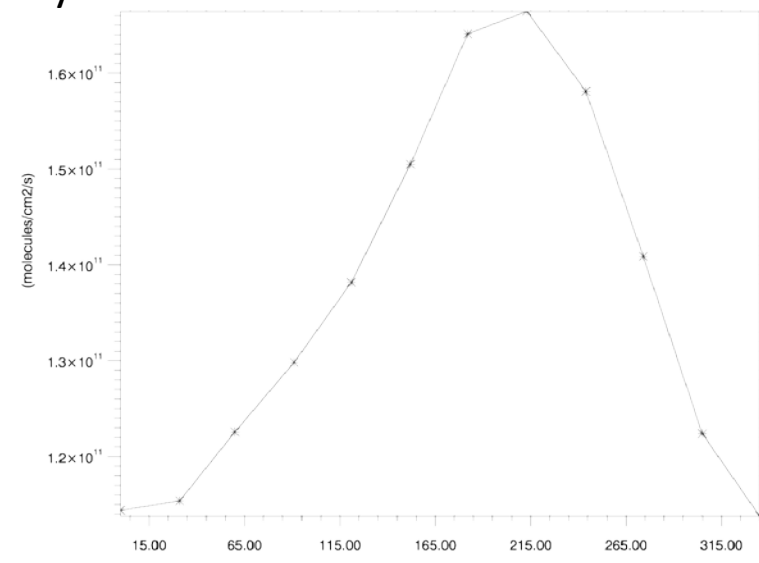


January

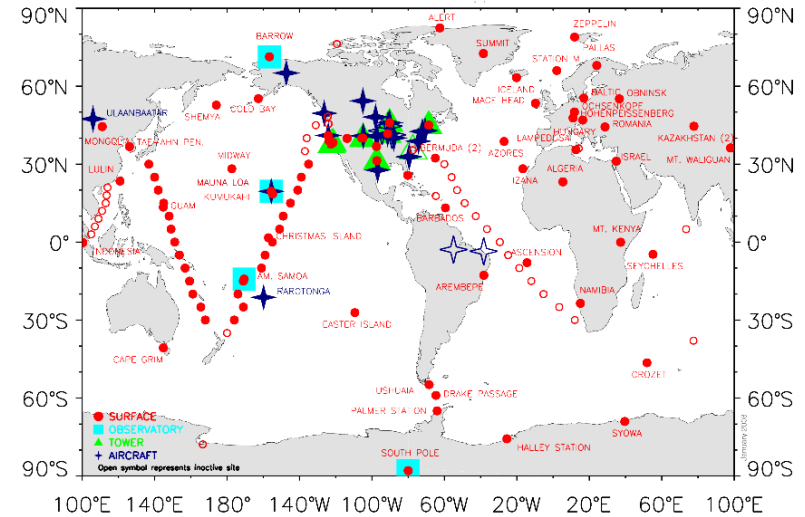
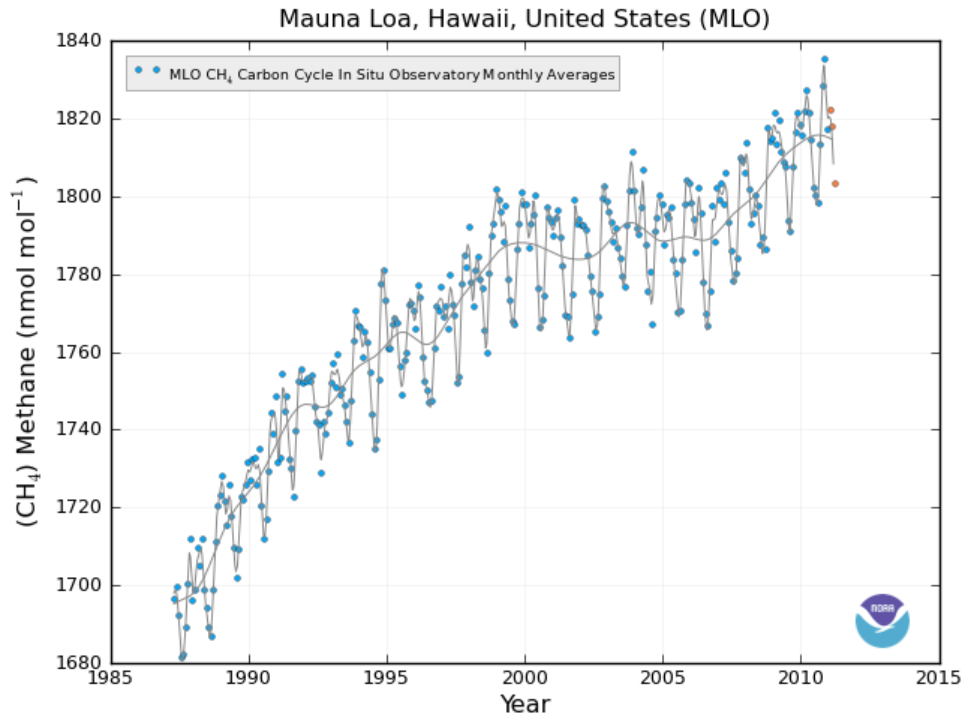


July

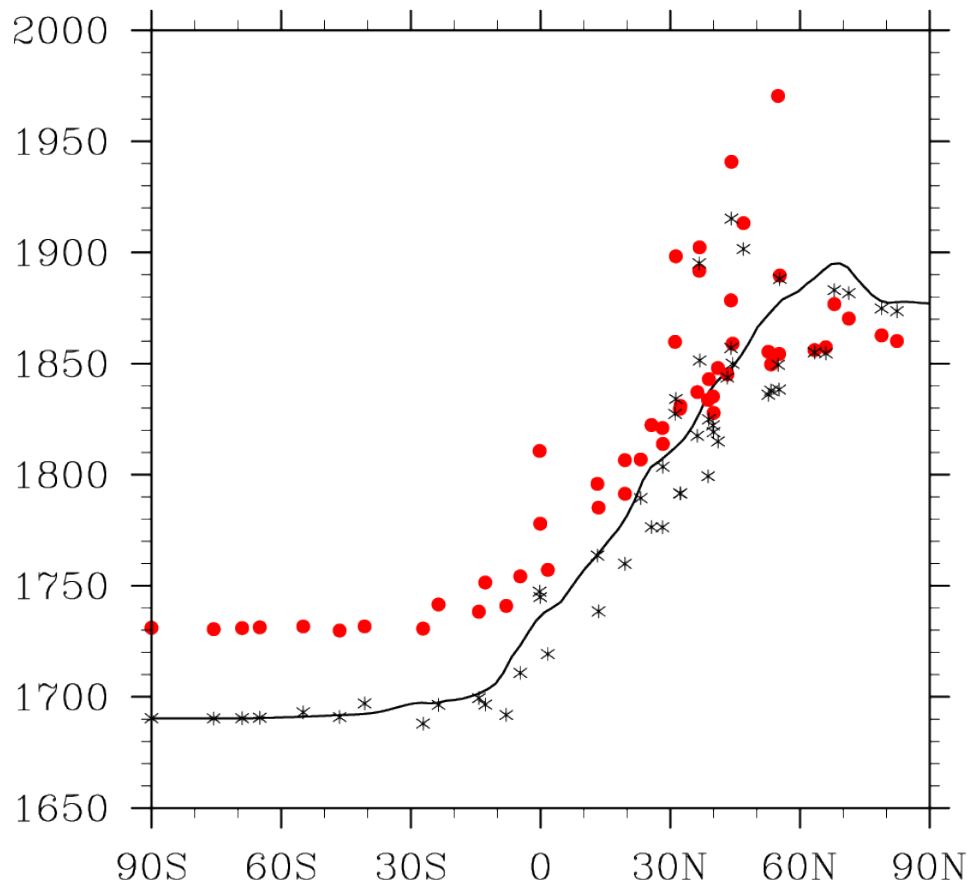
Annual cycle



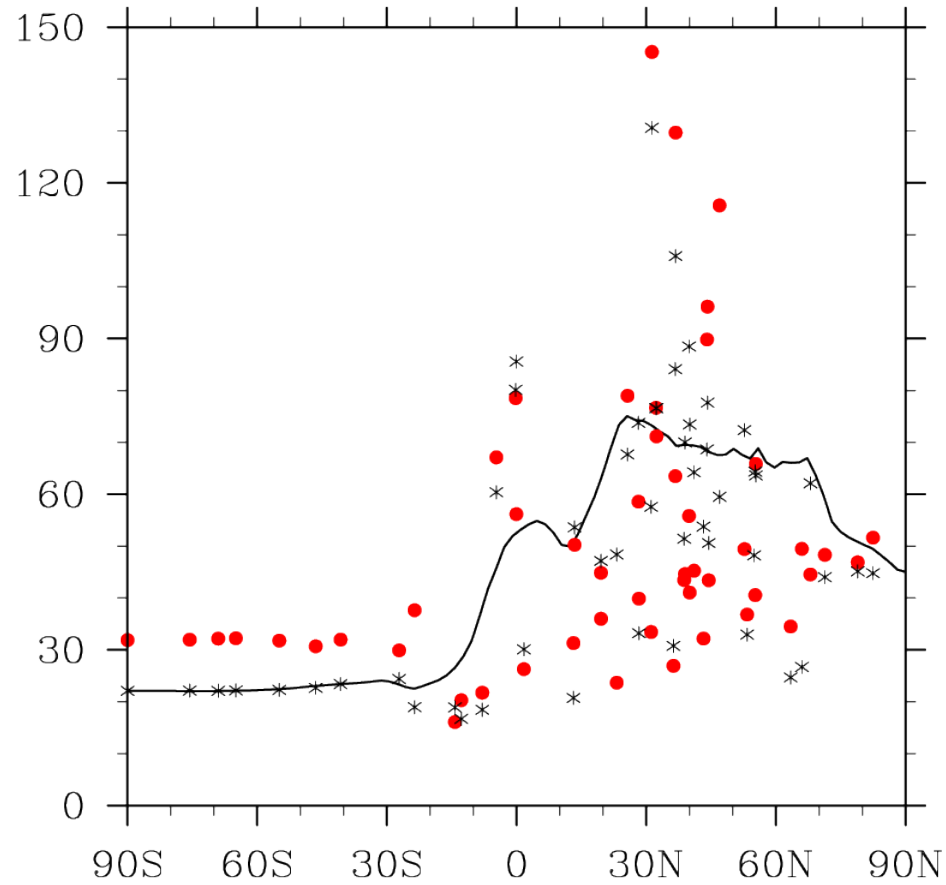
CMDL observations



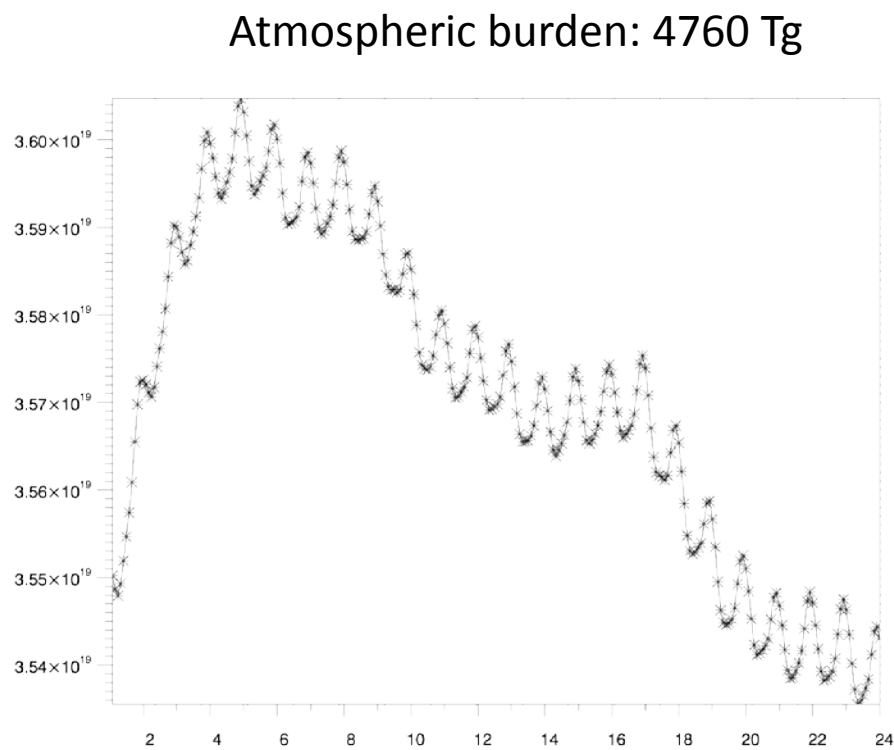
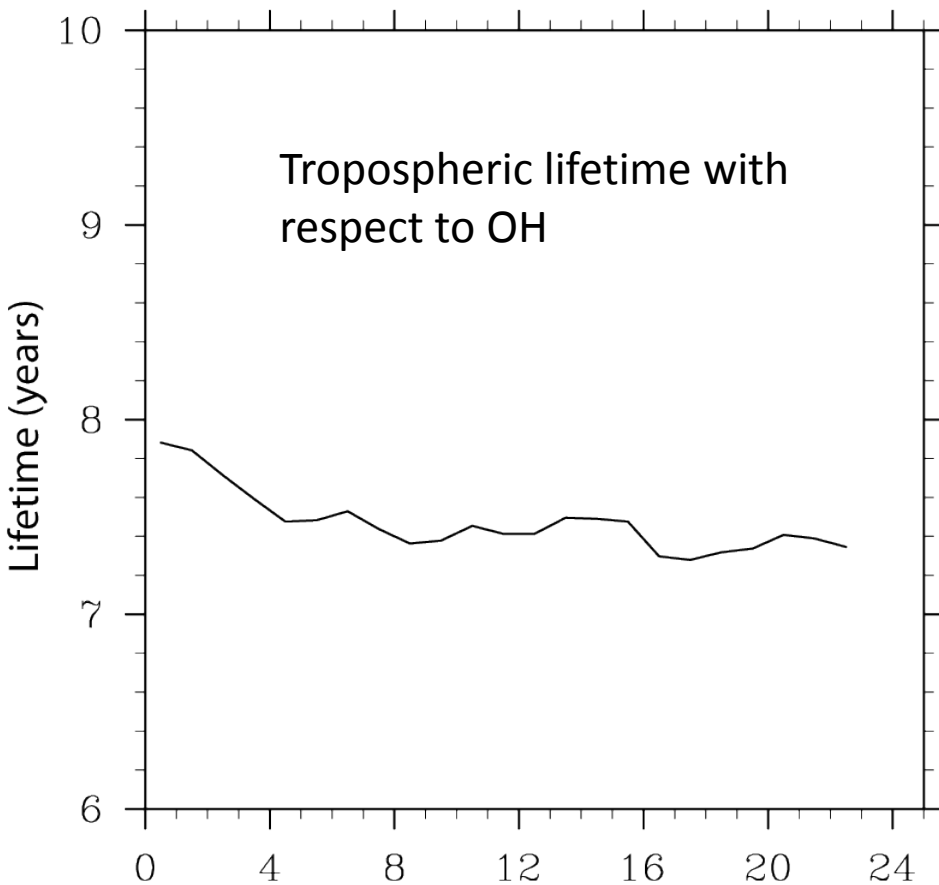
Surface concentration



Seasonal cycle (max-min)



Lifetime and burden



Main results

- Reasonable representation of methane lifetime (probably a little too short), surface concentration and seasonal cycle
- Too little methane in the Southern Hemisphere
- Seems to require enough tropospheric NMHC chemistry