Stable isotopes of carbon in atmospheric methane suggest strong increases in microbial emissions between 2020-2022.

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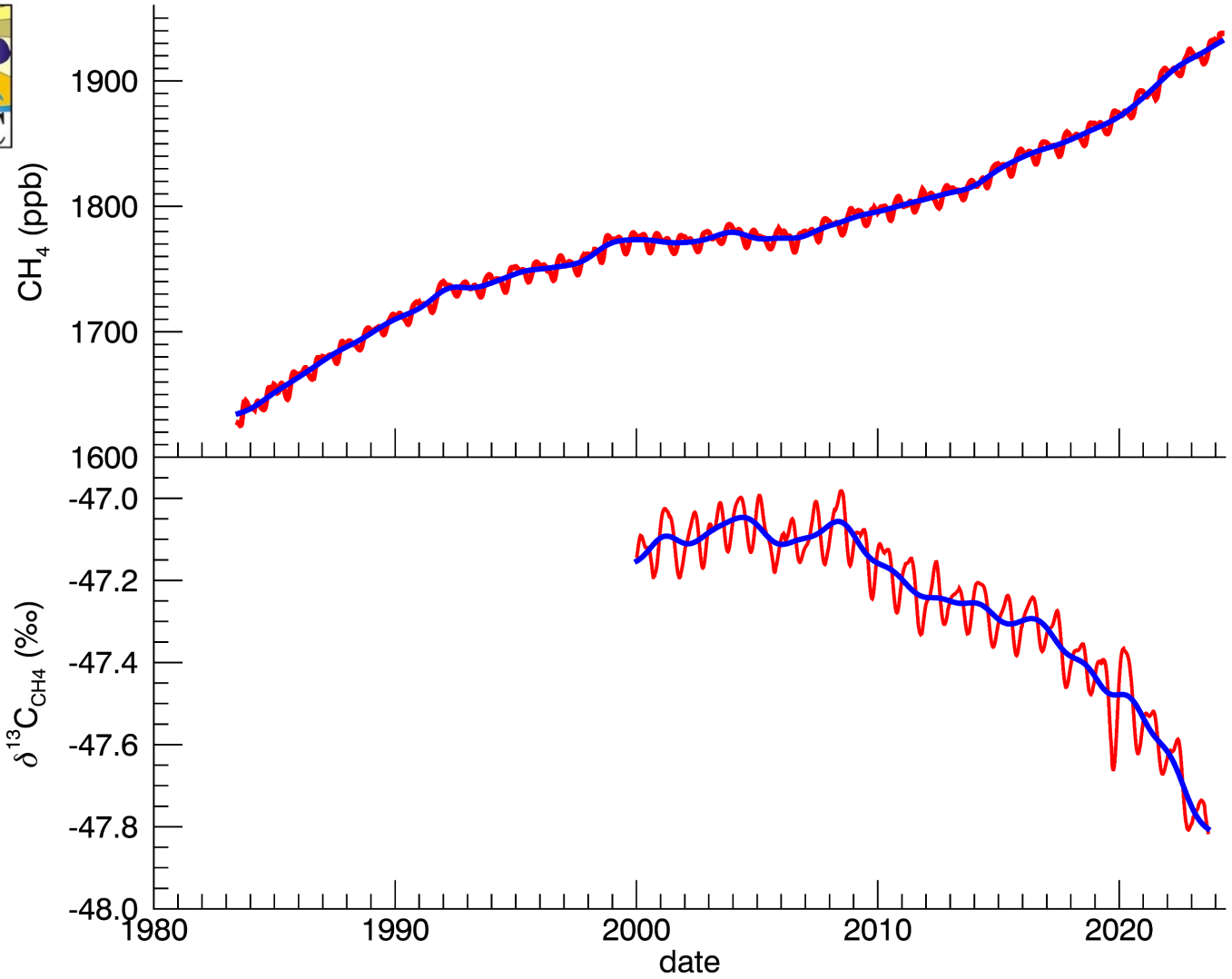
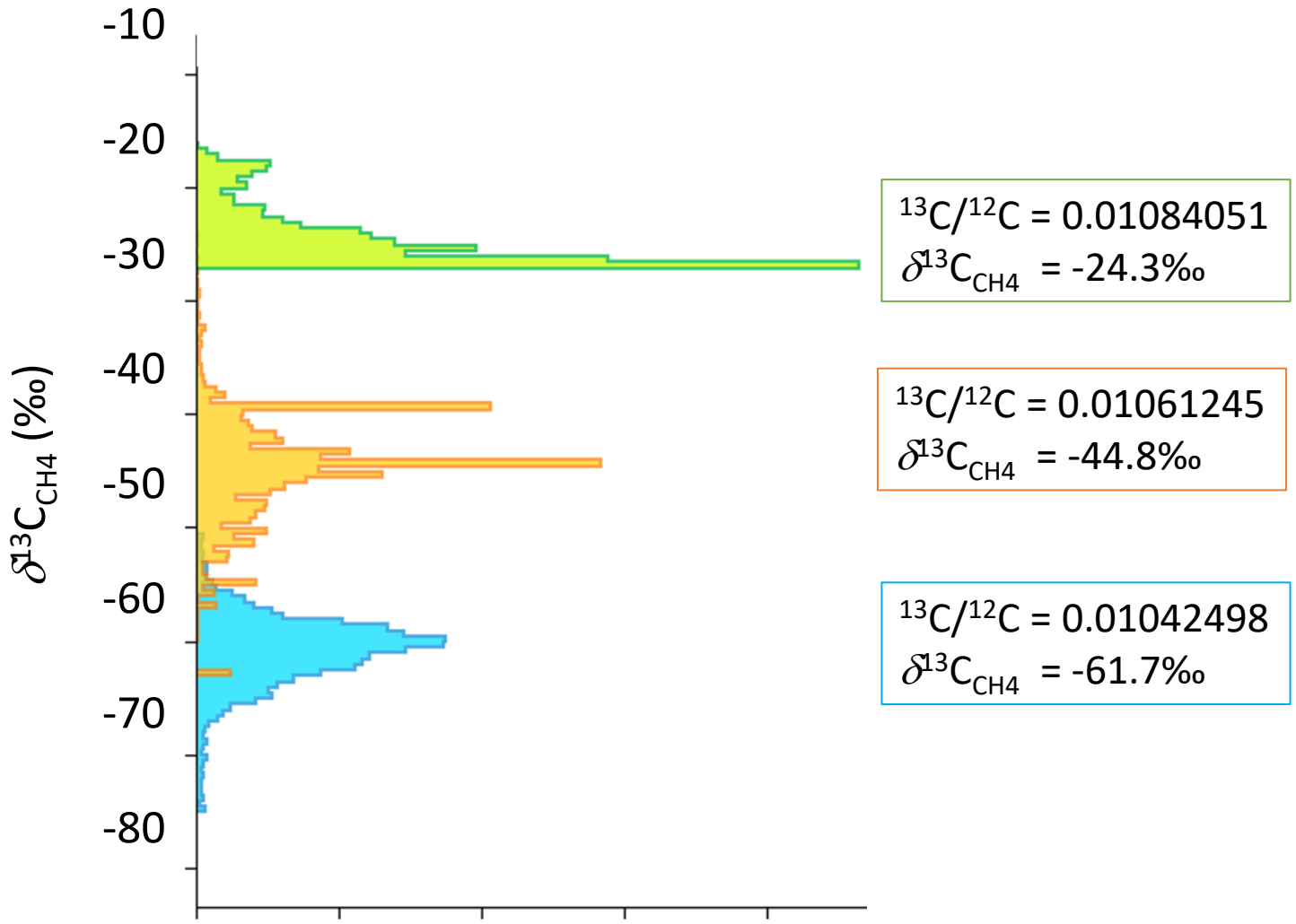


Different sources of methane have different $\delta^{13}C_{CH4}$ values.

Biomass burning sources:
incomplete combustion of biomass, soil carbon, and fuel

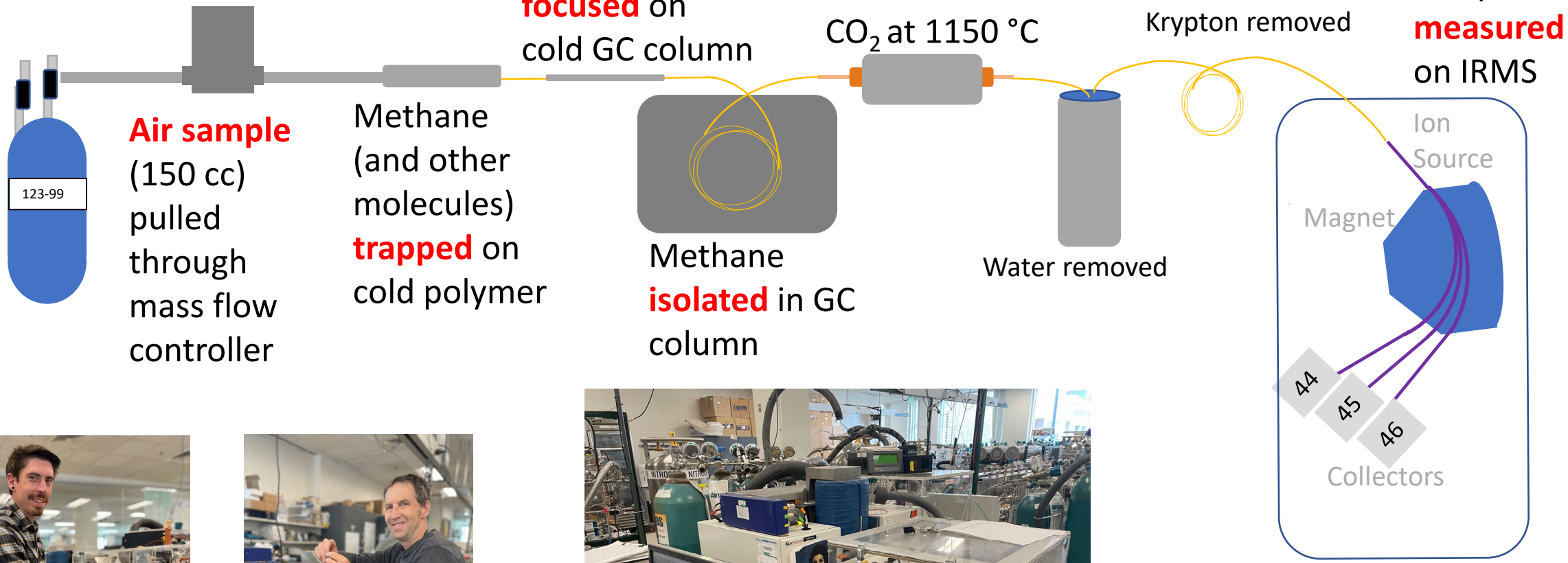
Fossil sources: natural seeps, mud volcanoes, and coal, oil, and natural gas

Microbial sources: methanogenic microbes from wetlands, rice paddies, ruminants, landfills, etc.



Flux weighted PDF of occurrence, from Basu et al., 2022

Analysis of $\delta^{13}C_{CH4}$ requires many steps.



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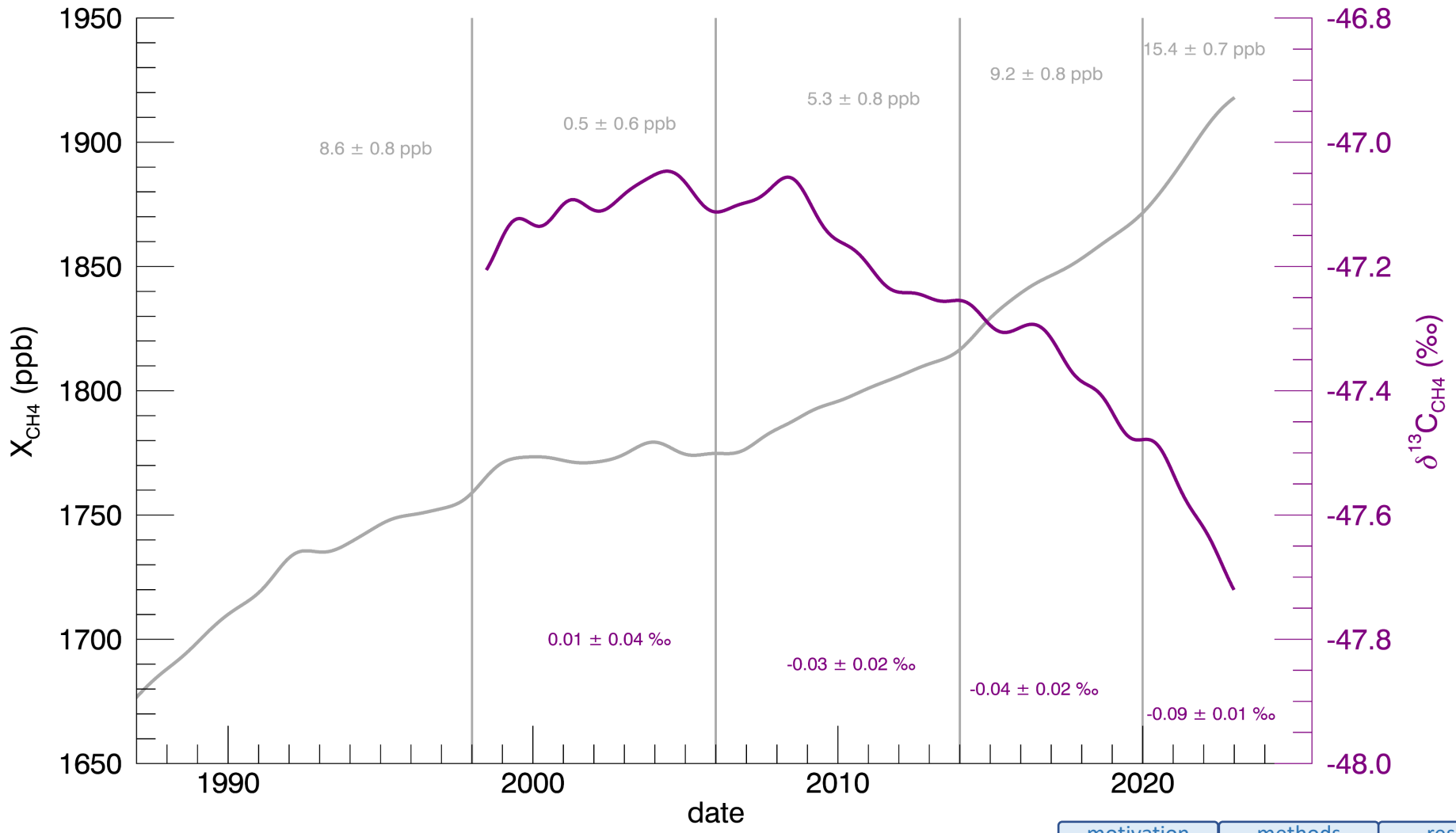
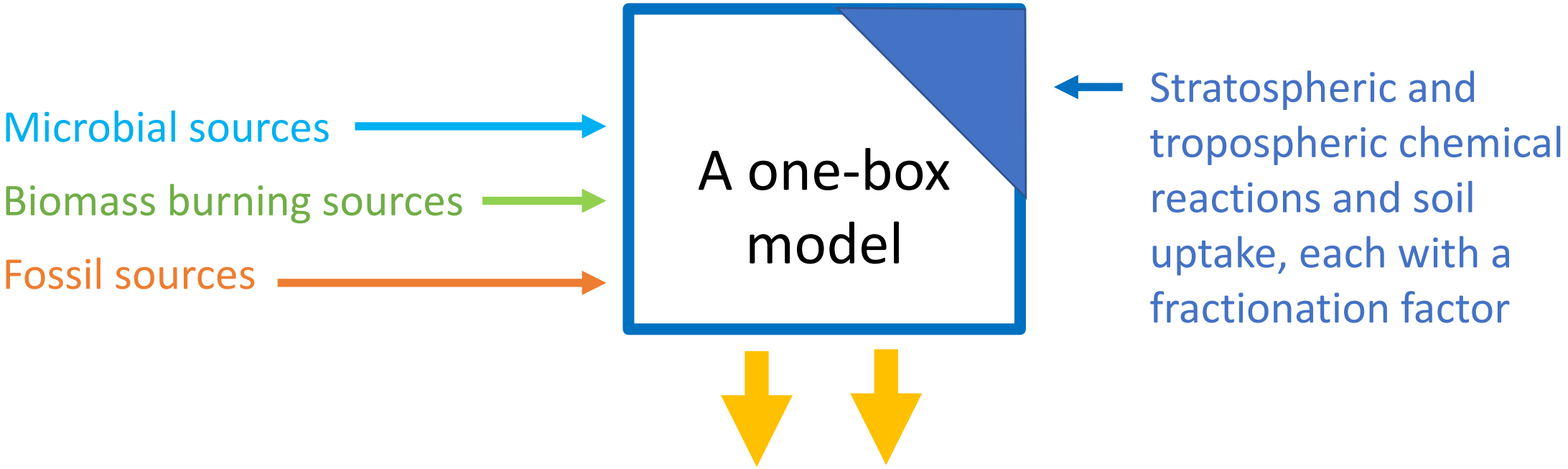
What can explain the changing growth rates of CH_4 and $\delta^{13}C_{CH4}$?



We can use a simple analytical framework to test quantify the changes in the methane budget.



$$\frac{d[CH_4]}{dt} = Q - \frac{[CH_4]}{\tau}$$

Change in methane mole fraction

Methane emissions

Lifetime of all sinks

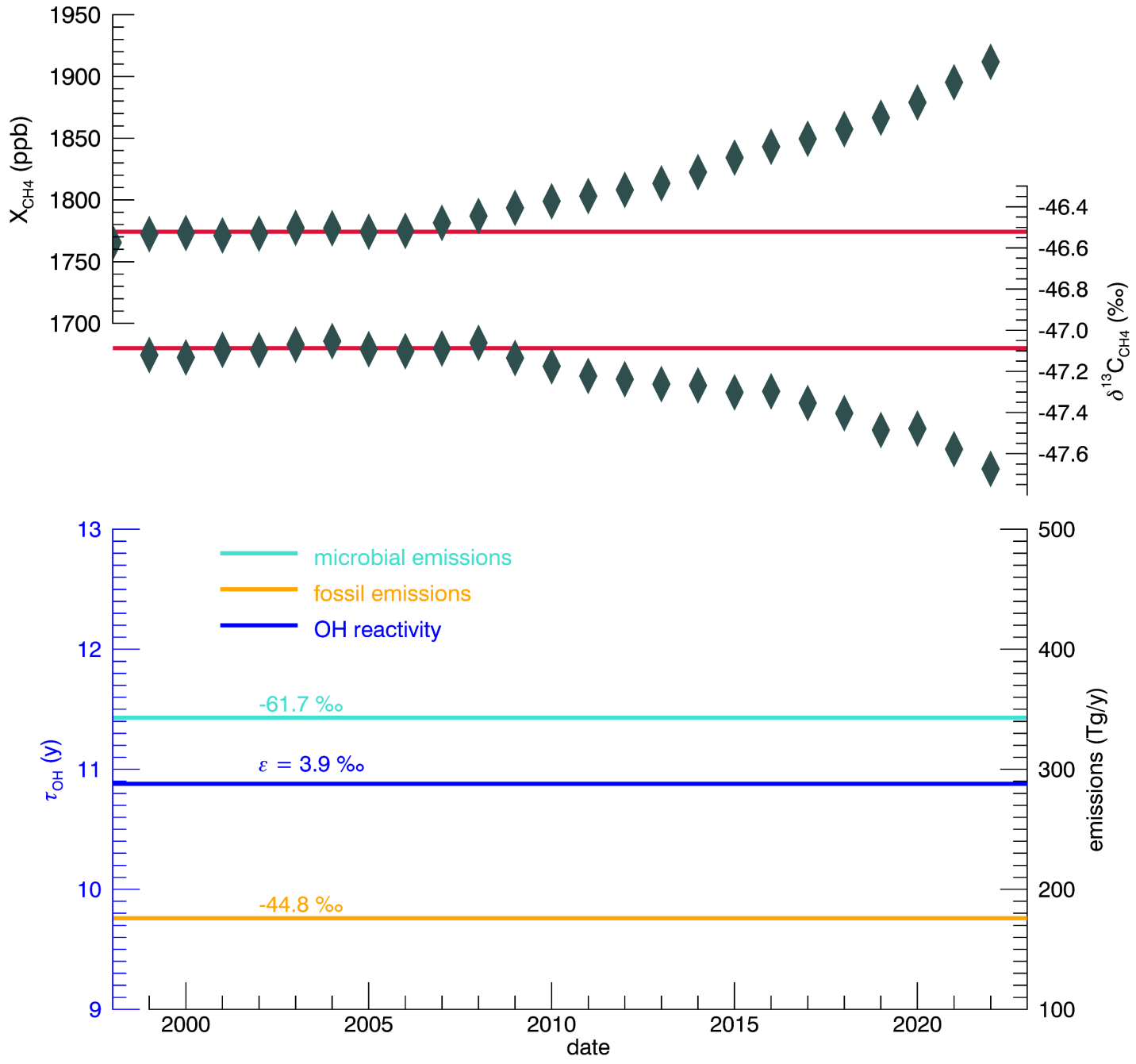
$$\delta^{13}C_Q = \alpha\delta^{13}C_A + \varepsilon$$

Isotopic value of combined sources

fractionation factors of combined sources

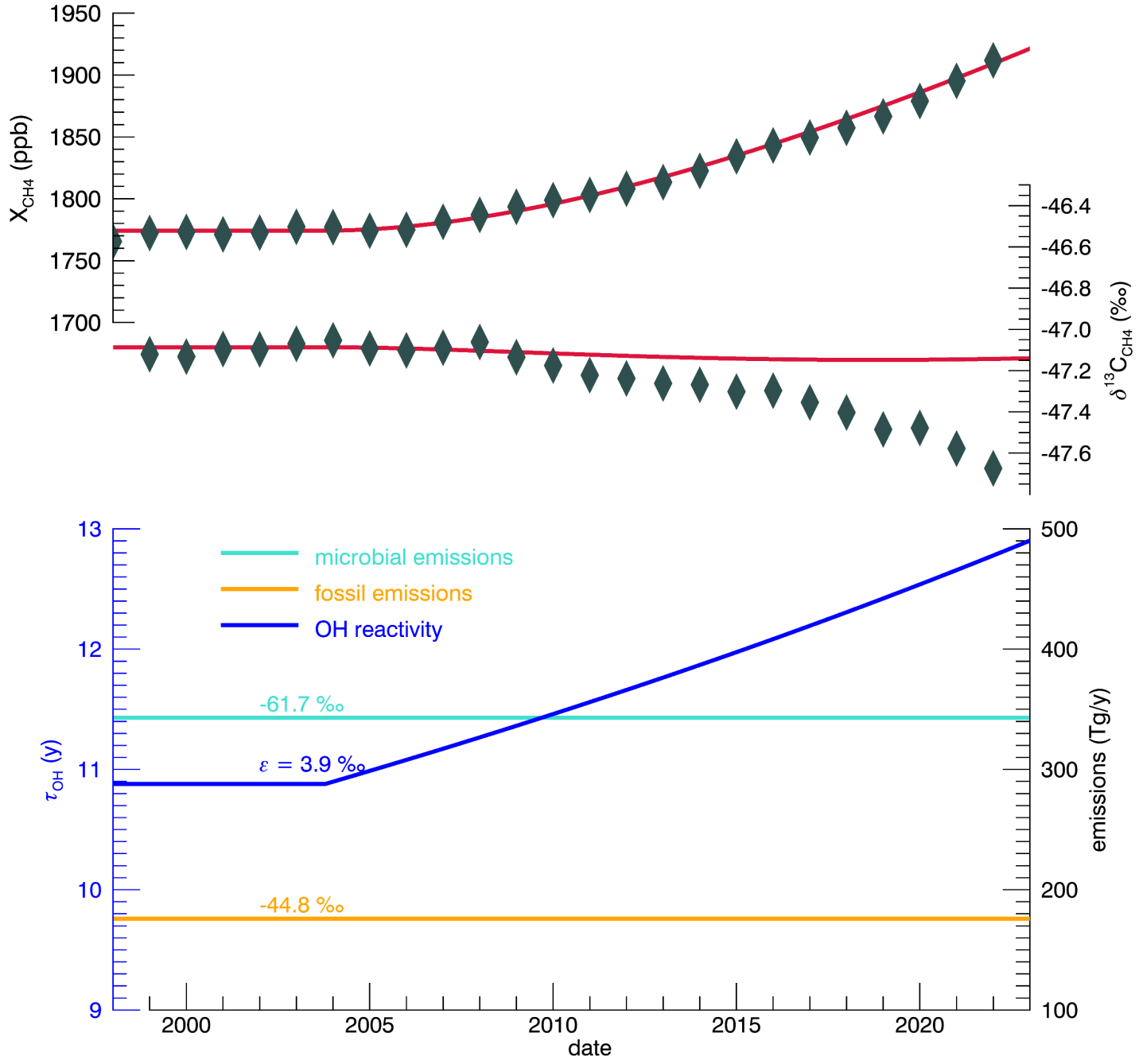
Isotopic offset due to fractionation during CH_4 destruction

We tune the model to match the observations, starting with the steady state period.



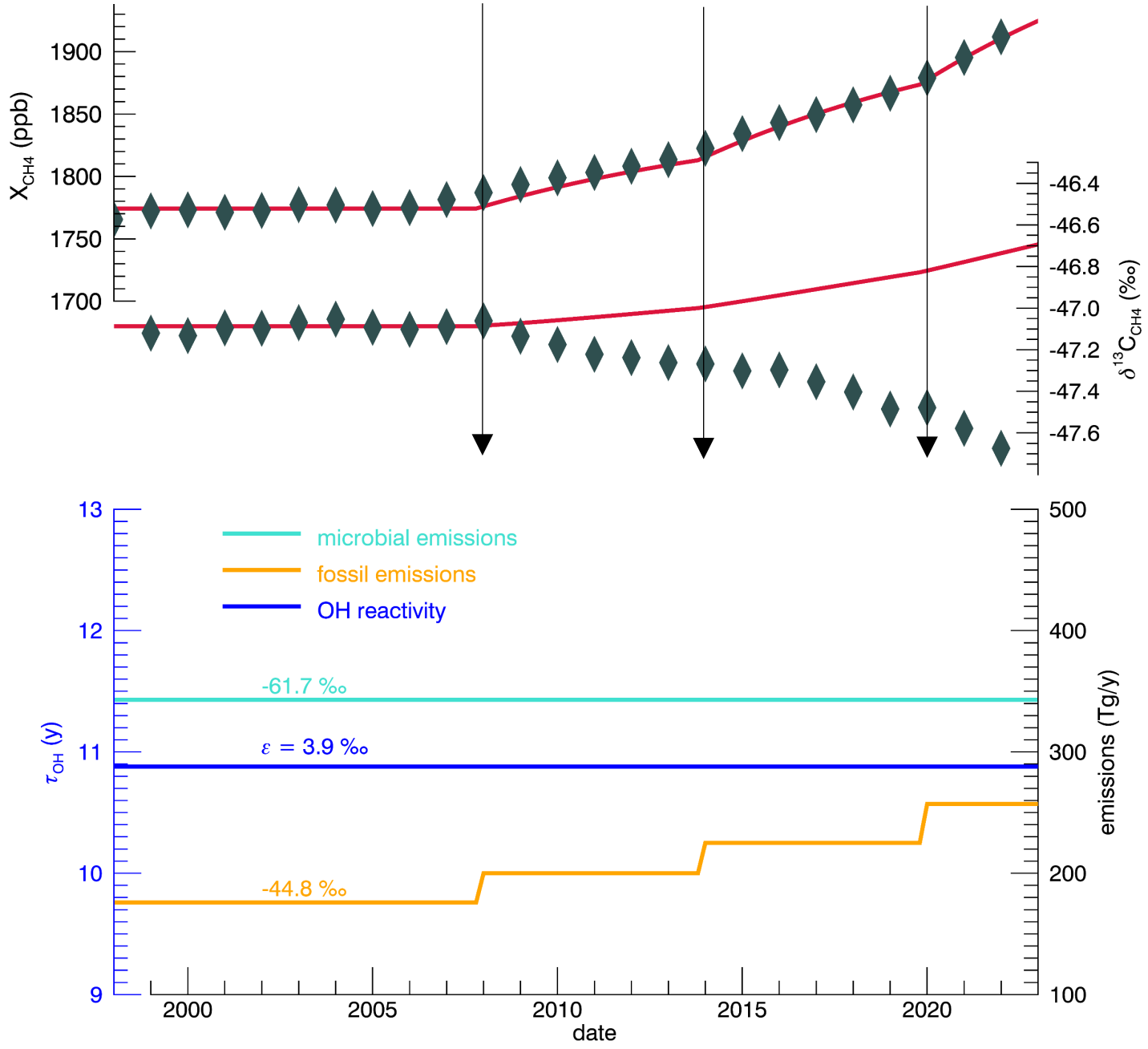
There are many ways to match the change in CH_4, such as changing the OH sink.

This does not match the trend in $\delta^{13}C_{CH4}$.



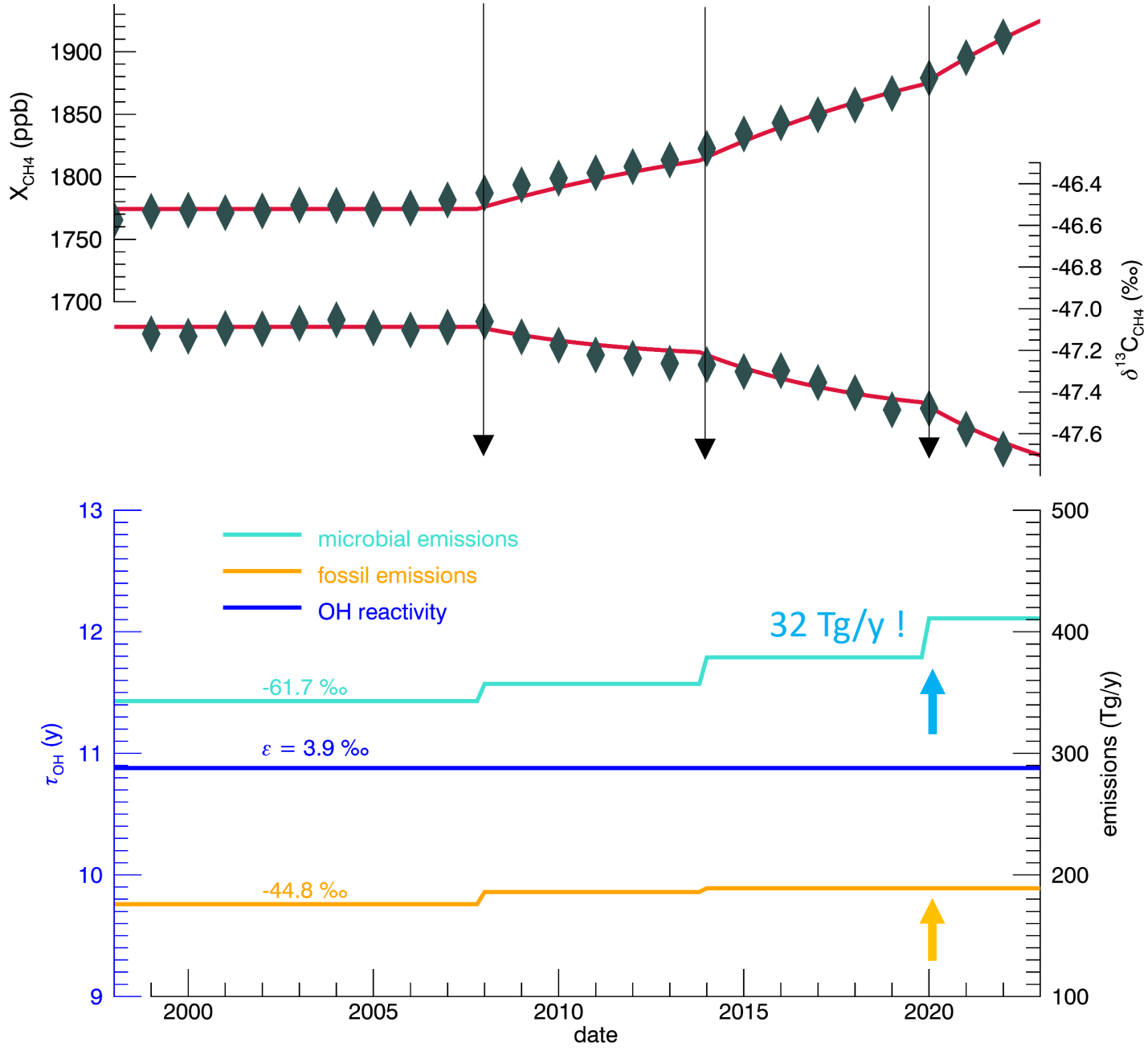
There are many ways to match the change in CH_4, such as increasing fossil fuel emissions.

This does not match the trend in $\delta^{13}C_{CH4}$.

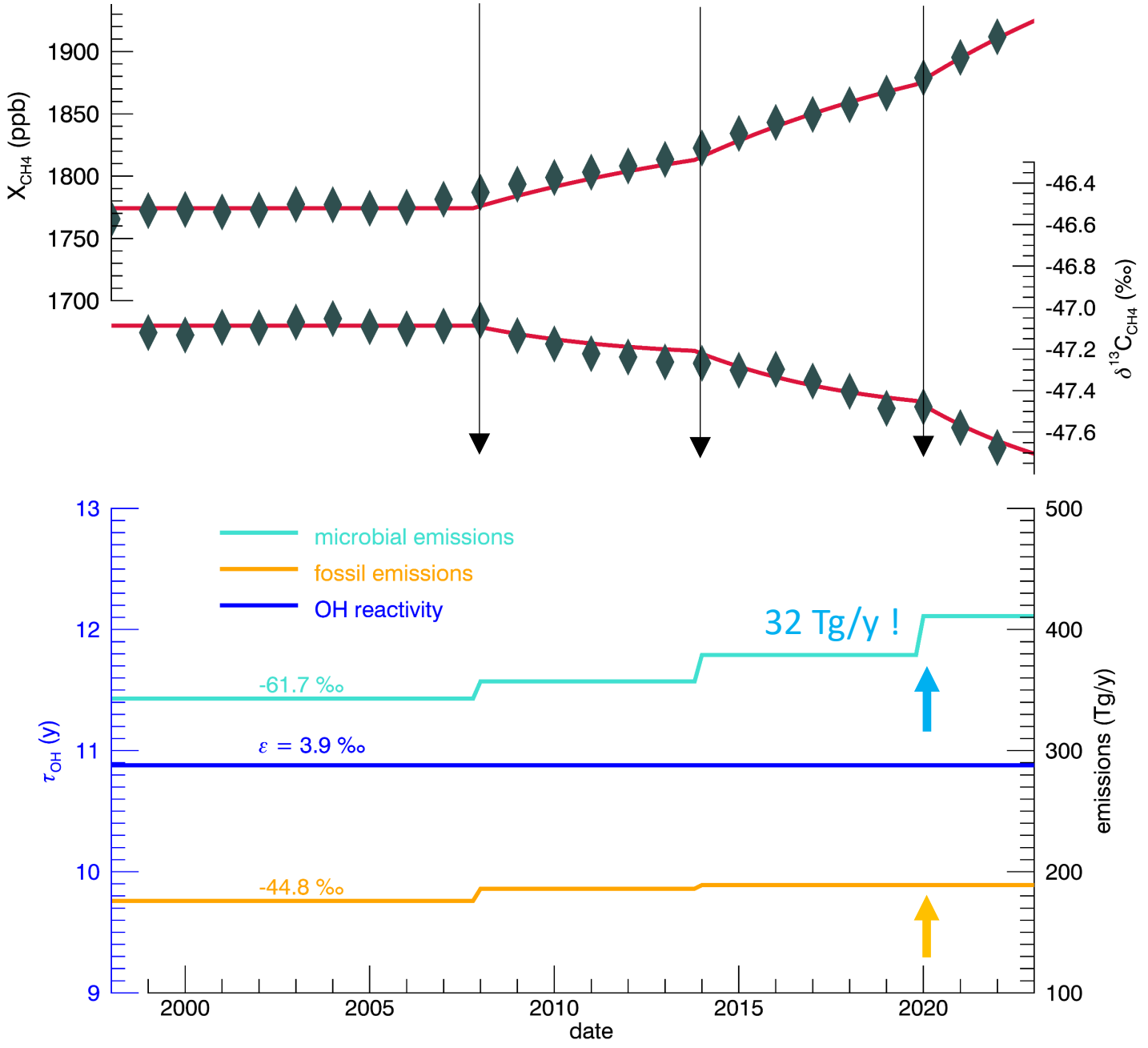


An increase in mostly microbial AND some fossil emissions is the best match to the CH_4 and $\delta^{13}C_{CH4}$ data.

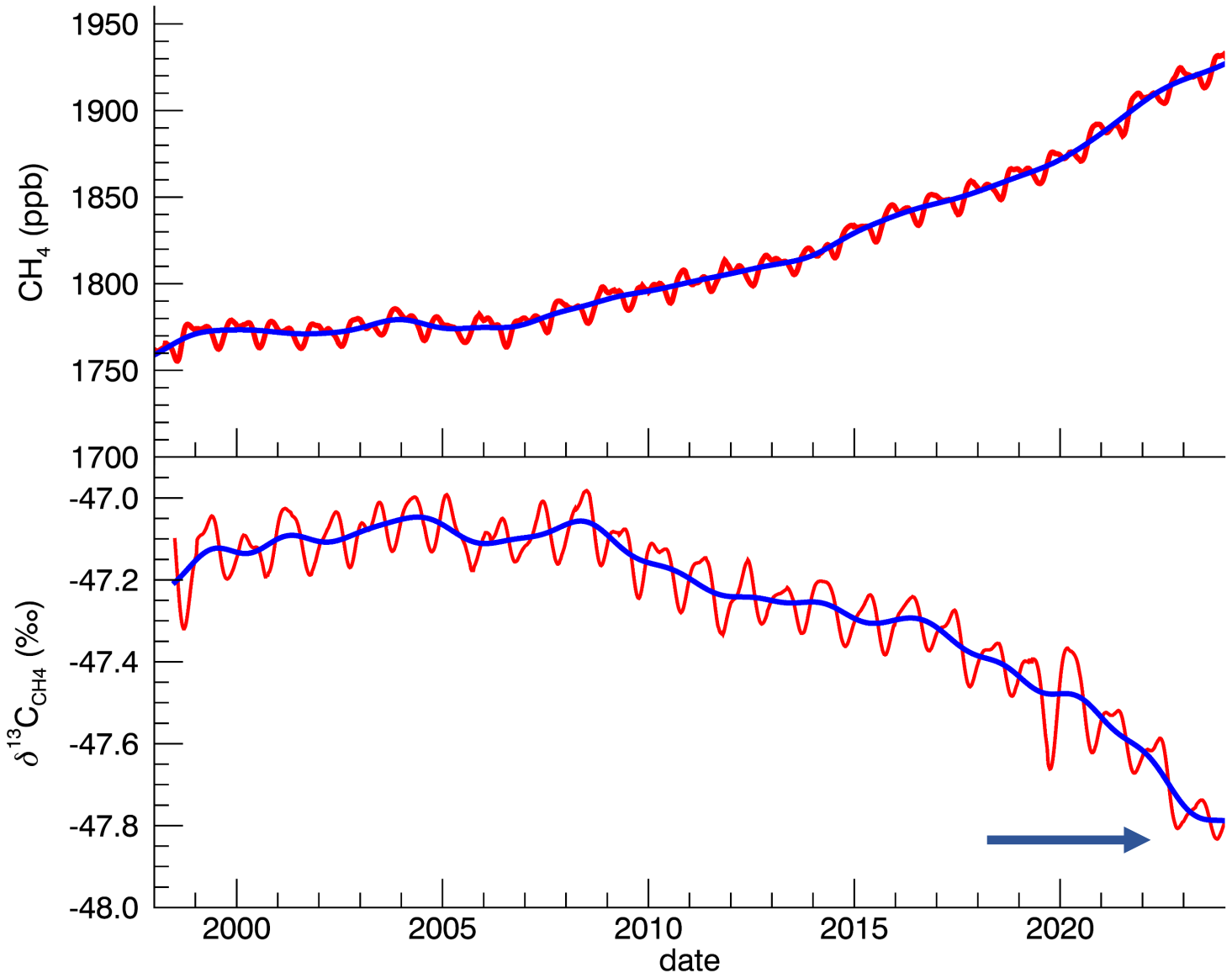
An increase in only microbial emissions is necessary to match the data between 2020-2022.



- The changes since 2007 are likely driven by increases in microbial emissions. In this simple model, 88 %.
- Emissions from microbial sources are even more significant since 2020.
- Are these anthropogenic sources (agriculture, landfills, etc) or natural systems (wetlands) responding to climate change?



Things look a bit different in 2023.



Read our paper here:

Thank you!