An Update of the NOAA-University of Colorado Global Methane Isotope Record

John Miller[1,2], Mark Dreier[3], Valerie Claymore[3], James White[3], Sara Fletcher[1,4], Ed Dlugokencky[1], Pieter Tans[1]

1. NOAA/CMDL Boulder, CO 2. CIRES, U. of Colorado, Boulder 3. INSTAAR, U. of Colorado, Boulder, 4. IGPP, U. of California, Los Angeles

email: john.b.miller@noaa.gov

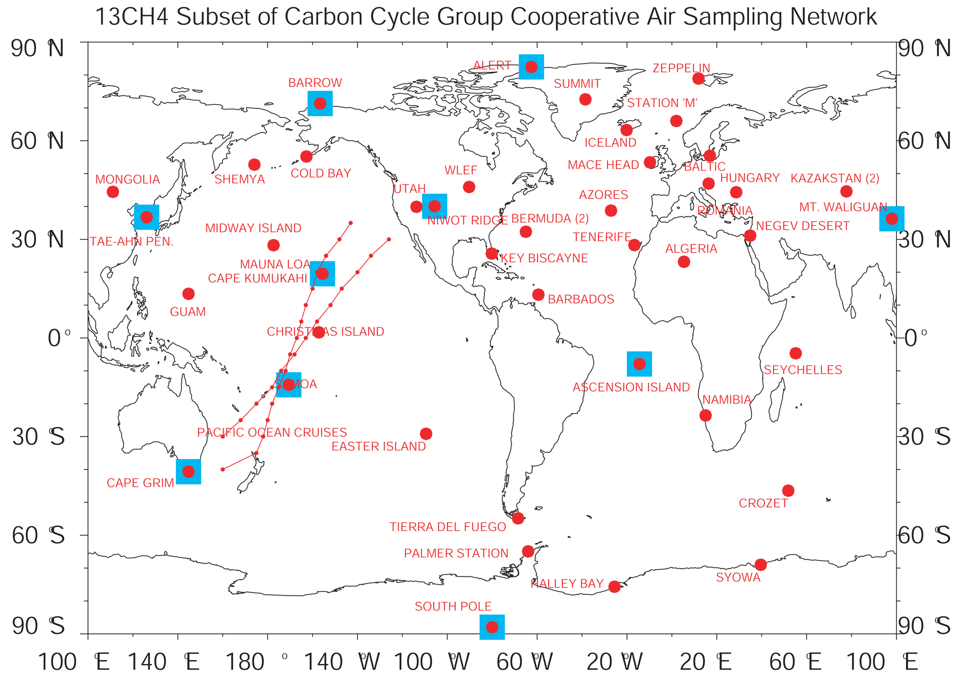
Introduction

The poster describes the current state of the NOAA/CMDL - University of Colorado 13CH4 measurement program.

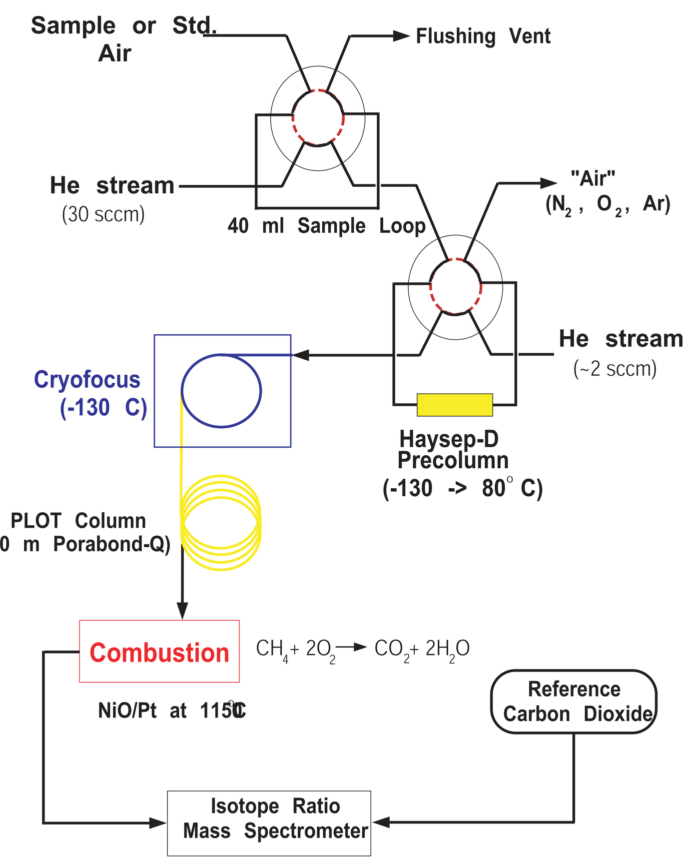
1. Since starting with 6 sites in 1998, we have added 7 more (11 total with > 1yr records are shown here).
2. We have modified our analysis system by changing our column to a 50m Porabond-Q, and removed chemical traps previously in place.
3. The precision/stability of measurements has improved over time as can be seen in the tightening of time series of samples and 'survielence' tanks.

Measurement Sites

13CH4 Subset of Carbon Cycle Group Cooperative Air Sampling Network

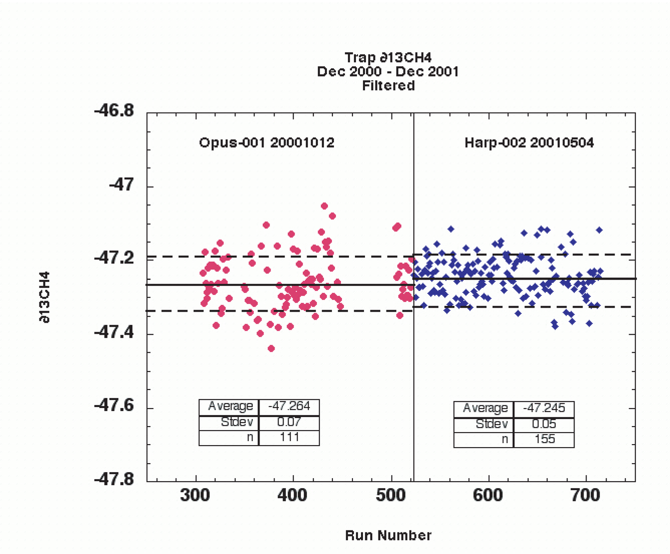


Method

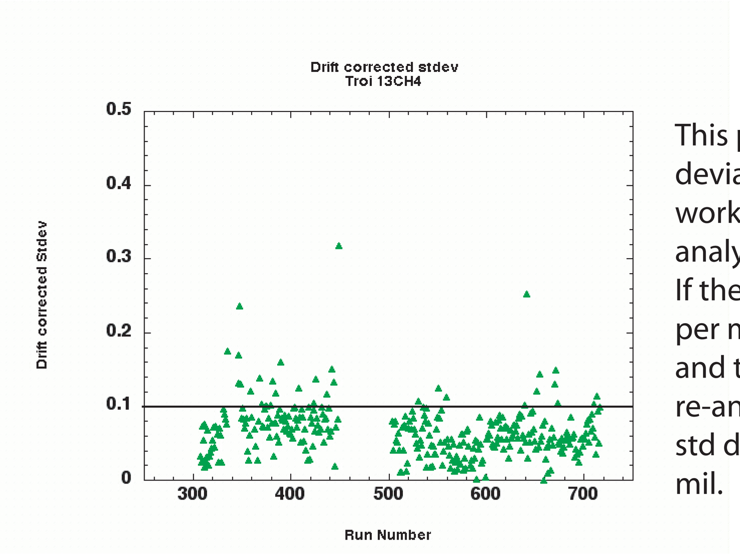


Samples are run in batches of 16 using an automated manifold. Along with the samples, 12 aliquots of a working reference are measured. 4 aliquots from a second reference tank are also measured every run and treated as unknowns, in order to assess the run-to-run stability of our system (results of these 'Trap' tank analyses are shown in the next panel).

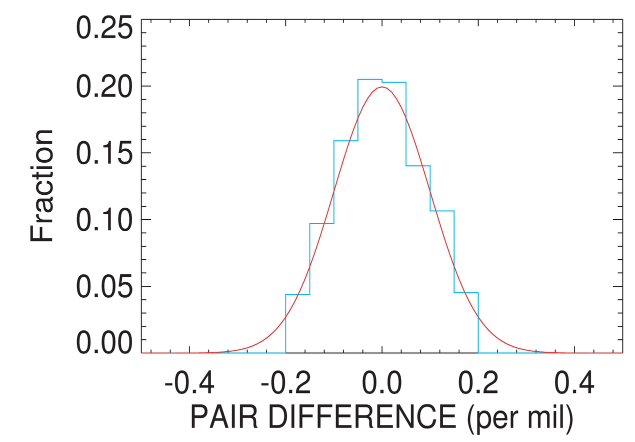
Measurement Diagnositics



Each datum is the mean of 4 aliquots of a reference tank treated as an unknown during a sample run. The absence of drift in the results show the internal consistency of our system. The spread of data also estimate the measurement precision.

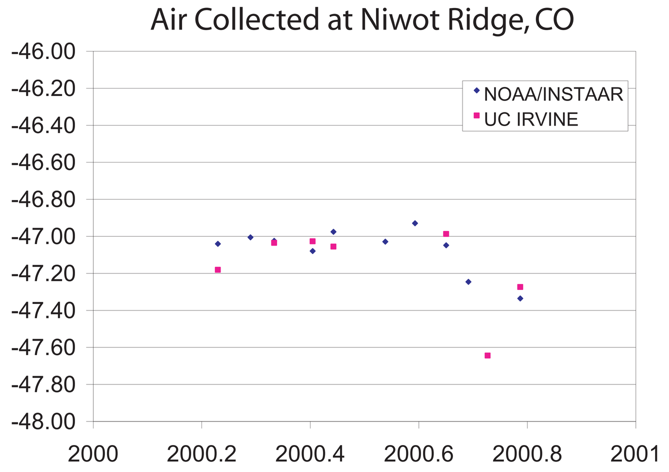


This plot shows the std. deviation 12 aliquots of our working reference analyzed during each run. If the std. deviation is > 0.1 per mil, the run is rejected, and the samples may be re-analyzed. The average std deviation is 0.06 per mil.



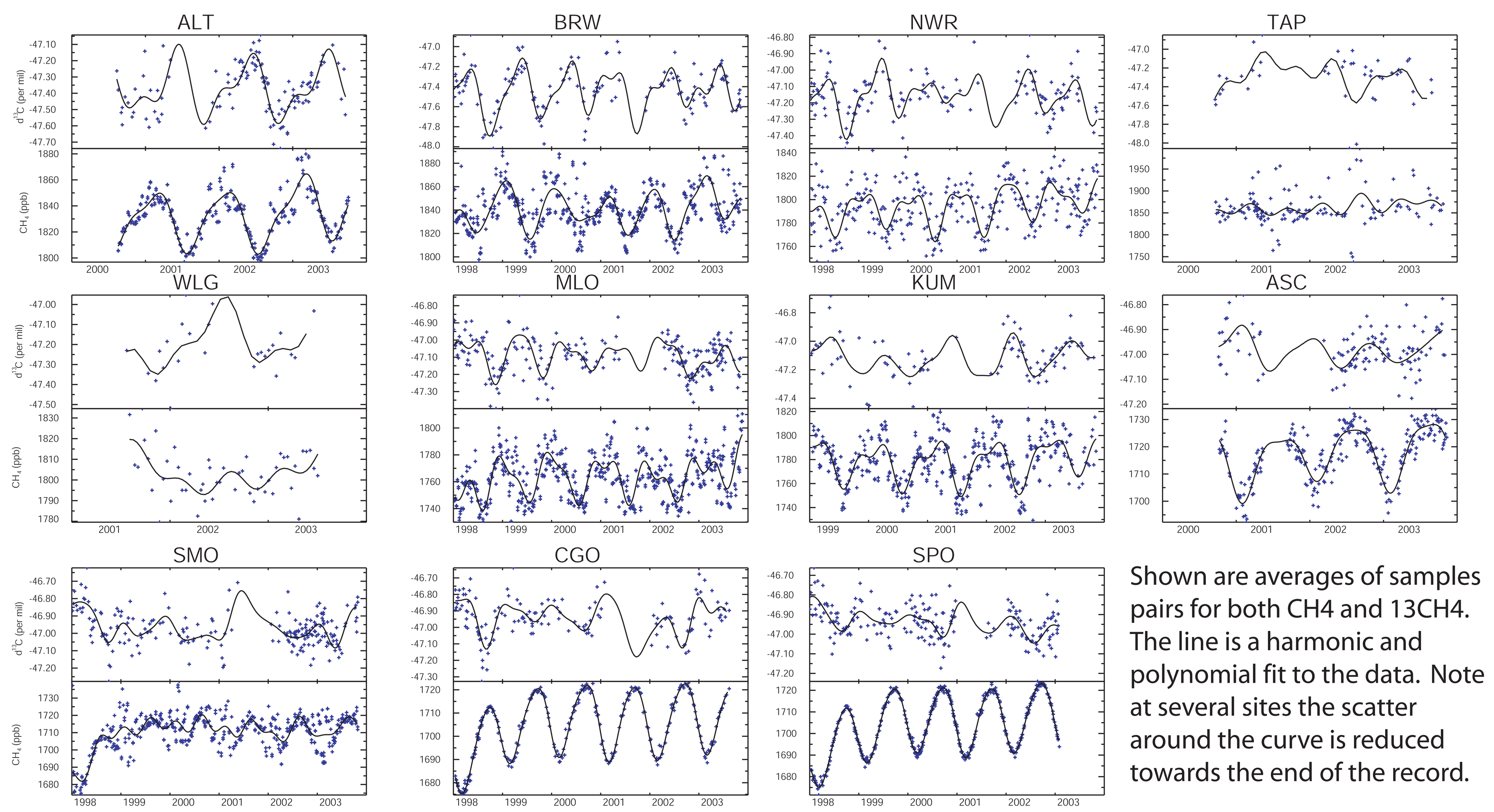
All air samples in the network are collected as pairs, and shown are the differences of 1390 pairs from all sites. The std. deviation is 0.09 per mil. A gaussian function with a 0.1 per mil std. deviation is shown for reference.

Air Collected at Niwot Ridge, CO



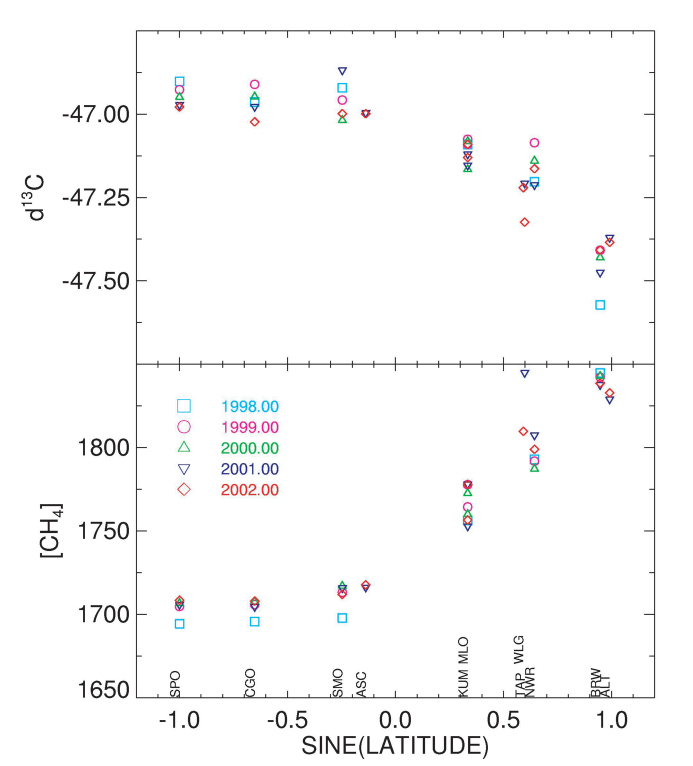
We analyze air from samples collected for Stan Tyler (UC Irvine) at Niwot Ridge, CO. This allows us to compare our scales. The mean offset is 0.01 +/- 0.08 per mil.

Data



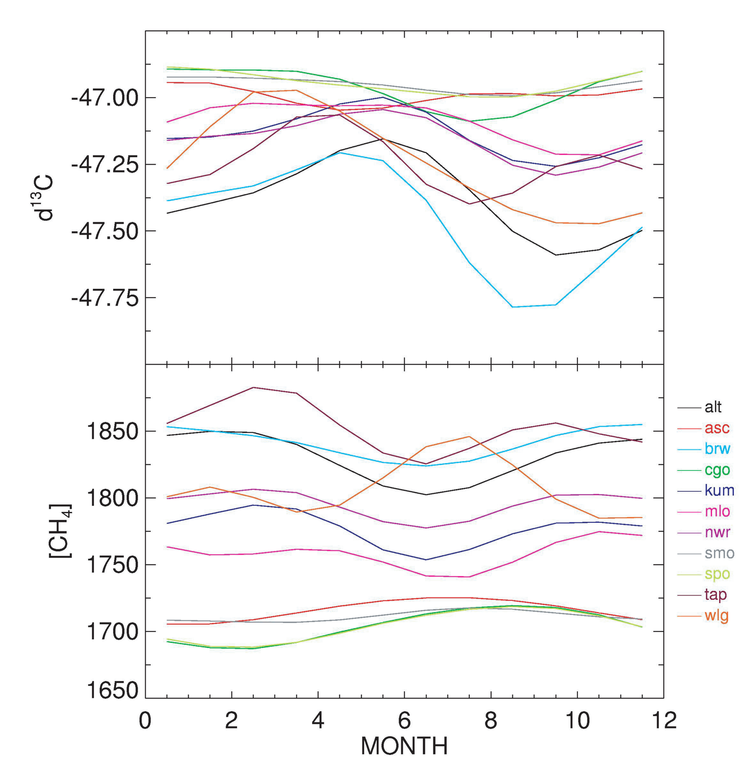
Shown are averages of samples pairs for both CH4 and 13CH4. The line is a harmonic and polynomial fit to the data. Note at several sites the scatter around the curve is reduced towards the end of the record.

Annual Mean Latitudinal Gradient



In contrast to the seasonal cycles of CH4 and d13CH4, the (annual mean) latitudinal gradients are strongly anti-correlated. Both gradients result from primarily Northern Hemisphere emission followed by transport to the Southern Hemisphere during which time, CH4 is consumed by reaction with OH. In the case of d13CH4, the OH reaction also enriches the remaining CH4 in 13C.

Average Seasonal Cycles

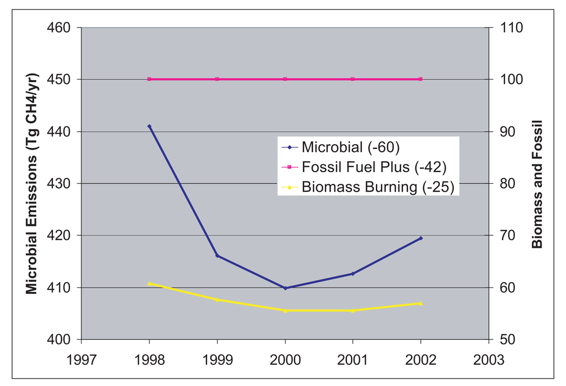


This plot shows the mean season cycles for both d13CH4 and CH4 calculated from fit to the data shown above. The two sets of measurments often appear out of phase, indicating a complex interplay of sources and sinks determining the CH4 seasonal cycle.

Analysis

1. One Box Model

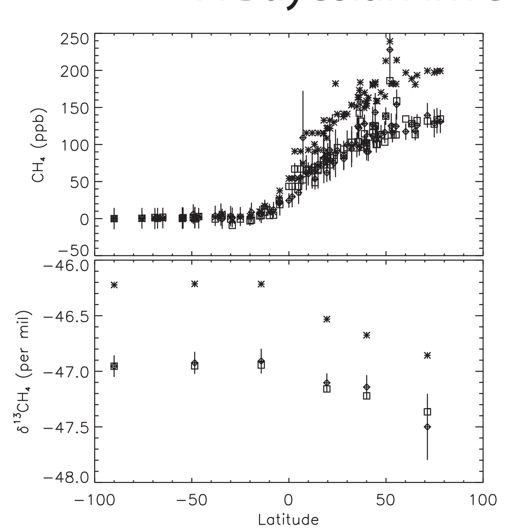
Source Deconvolution Using Global Average CH4 and d13CH4



If we estimate fossil fuel emissions (using 14CH4), we can use global mean CH4 and d13C to determine microbial and biomass burning emissions on an annual basis. This rough analysis indicates that the a large portion of the 1998 anomaly was due to microbial emissions, but in the years since then the budget has been close to balanced.

2. 3-Dimensional Model

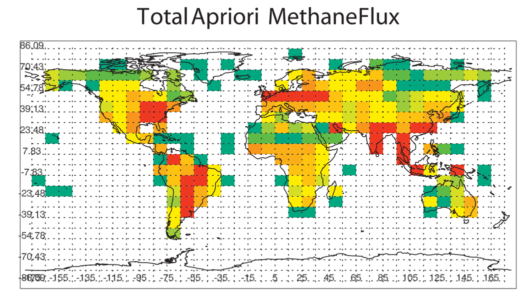
A Bayesian Inversion Using 1998-99 Data



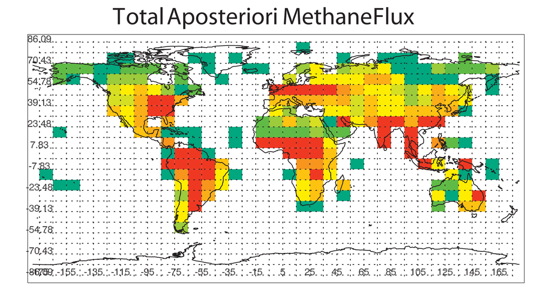
To determine source strengths using a 3D transport model, we attempt to find a source pattern, that when transported, closely matches observations of CH4 and d13CH4. Here we specify the lifetime of CH4 and its isotopic fractionation, as well as the isotopic composition of sources, which is a significant uncertainty.

To the left we see the observations (diamonds) and model (squares). The stars are the model output using a source pattern based on inventories, which fails to match the observations. Below is the annual mean spatial pattern of sources that fits the observations best, along with the inventory (prior) pattern and the difference between the two.

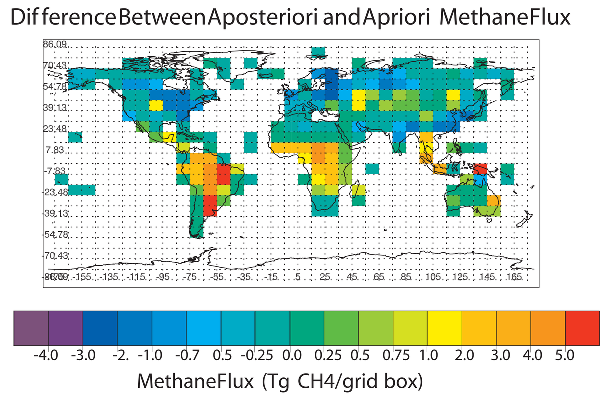
Total Apriori MethaneFlux



Total Aposteriori MethaneFlux



Difference Between Aposteriori and Apriori MethaneFlux



The optimized source strengths based on the data are shown below. One feature of sources derived from atmospheric d13C data, whether using a box model or a 3D model, is the large amount of biomass burning that is derived, relative to inventory approaches.

Category	Model Emission (Tg CH_4/yr)	Approx. Isotopic Ratio
Swamps	206+/- 44	-60
Bogs	21 +/- 14	-60
Tundra	4 +/- 4	-60
Rice Agriculture	54+/- 17	-60
Ruminant Animals	91+/-18	-60
Termites	29 +/- 19	-60
Biomass Burning	88+/- 18	-25
Coal	30+/- 11	-40
Natural Gas	65+/- 18	-40
Landfills	35+/- 14	-50
Total Source	**609**	