Partitioning of flask sample carbon dioxide into fossil fuel, oceanic, and terrestrial biosphere components

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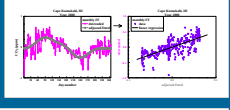
ABSTRACT A recently compiled monthly, fossil-fuel, carbon dioxide inventory (Andres et al, 2010) allows for a reexamination of the contribution of fossil fuels to the seasonal cycle observed in atmospheric carbon dioxide concentrations. Previous analysis (e.g., Heimann et al., 1989) revealed a site specific role for fossil fuel carbon dioxide based upon the seasonal cycle determined by Rotty (1987). This study begins with a much more detailed and rigorous analysis of the fossil fuel seasonal cycle than available to Rotty (1987).

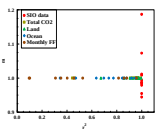
The monthly, fossil-fuel, carbon dioxide inventory serves as one input into an atmospheric general circulation model (AGCM) based chemistry-transport model (ACTM). The inquiry centers on if fossil fuel emissions significantly impact the seasonal cycle of measured atmospheric carbon dioxide concentrations. Model results will be compared to Scripps Institution of Oceanography (SIO) flask and continuous analyzer data. Primary metrics to be used in the comparison are slope and correlation analyses. Slope analysis will help assess the degree to which model and SIO data agree. Correlation analysis will help assess the degree to which the various model components (i.e., fossil fuels, terrestrial biosphere, oceans) contribute to the overall seasonal cycle.

1. Methodology All data, from the atmospheric chemistry transport model (ACTM) or Scripps samples (SIO), go through the same detrend and curve fitting procedures.

2. SIO and model data curve fits CO_2 concentration versus time plots are transformed into detrended versus adjusted fitted data plots. Linear regression analyses are then performed. Ideally, slope (m) and correlation coefficient (r^2) equal one. All correlations shown are statistically significant at the 0.05 level.



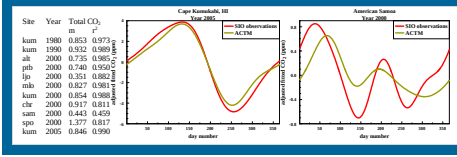
Site	Year	Latitude	SIO in situ Total CO_2 m	r^2	Model Output Total CO_2 m	r^2	Land m	r^2	Ocean m	r^2	Monthly FF m	r^2
kum	1980	19.5	1.008	1.000	1.000	0.955	1.000	0.967	1.000	0.844	1.000	0.351
kum	1990	19.5	0.954	1.000	1.000	0.943	1.000	0.958	1.000	0.877	1.000	0.402
alt	2000	82.3	0.979	1.000	1.000	0.972	1.000	0.976	1.000	0.344	1.000	0.881
ptb	2000	71.3	0.987	1.000	1.000	0.930	1.000	0.906	1.000	0.471	1.000	0.858
ljo	2000	32.9	0.993	1.000	1.000	0.444	1.000	0.861	1.000	0.735	1.000	0.301
mlo	2000	19.5	0.987	1.000	1.000	0.963	1.000	0.975	1.000	0.773	1.000	0.896
kum	2000	19.5	0.983	1.000	1.000	0.962	1.000	0.973	1.000	0.918	1.000	0.526
chr	2000	2.0	1.073	1.000	1.000	0.926	1.000	0.929	1.000	0.635	1.000	0.814
sam	2000	-14.2	1.187	1.000	1.000	0.462	1.000	0.673	1.000	0.695	1.000	0.307
spo	2000	-90.0	0.944	1.000	1.000	0.990	1.000	0.995	1.000	0.947	1.000	0.958
kum	2005	19.5	1.011	1.000	1.000	0.955	1.000	0.971	1.000	0.850	1.000	0.455



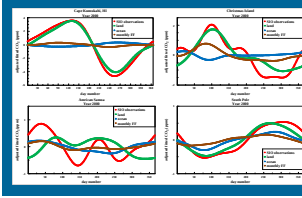
Overall, the SIO *in situ* data are fit very well. The model total CO2 and land data are fit well, with isolated outliers. The model ocean and monthly fossil fuel data are fit less well.

3. Total CO_2 comparison Data from the observations and the model agree quite well, except with one outlier. The best and worst curve fits (in terms of r^2) are shown in the graphs.

Site	Year	Total CO_2 m	r^2
kum	1980	0.853	0.973
kum	1990	0.932	0.989
alt	2000	0.735	0.985
ptb	2000	0.740	0.950
ljo	2000	0.351	0.882
mlo	2000	0.827	0.981
kum	2000	0.854	0.988
chr	2000	0.917	0.811
sam	2000	0.443	0.459
spo	2000	1.377	0.817
kum	2005	0.846	0.990



4. Component fluxes We are still very early in the data analysis stage. Following are four plots. Most of our data are exemplified by the first plot where the land component accounts for approximately 90% of the total CO_2, fossil fuels about 10%, and oceans are negatively correlated. Christmas Island, American Samoa, and South Pole stations all deviate from this pattern with the land component taking a more reduced role in determining total CO_2 and oceans and fossil fuels taking more important roles. Your comments are welcomed.



5. Conclusions/questions

a. What implications are there for the differing fossil fuel and total CO_2 peaks for interpreting biosphere processes?

b. This study preferentially excluded heavy fossil fuel contributions to the SIO sampling. Is a 10% fossil fuel contribution to total CO_2 concentrations surprising?