PARTITIONING TERRESTRIAL CARBON FLUXES INTO NET PRIMARY PRODUCTION, HETEROTROPHIC RESPIRATION, AND BIOMASS BURNING COMPONENTS FOR THE 1997-2003 PERIOD

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ABSTRACT

Interannual variations in the contemporary atmospheric CO_2 growth rate are large and are closely linked with El Nino/Southern Oscillation [*Bacastow*, 1976; *Keeling et al.*, 1989]. Inverse modeling studies using carbon isotopes indicate that much of the CO_2 variability originates within terrestrial ecosystems [*Battle et al.*, 2000]. Here we investigate controls over terrestrial ecosystem fluxes during the 7 year period from 1997 – 2003 using satellite data and the Carnegie-Ames-Stanford-Approach (CASA) biogeochemical model. In our analysis, we separate annual variations caused by Net Primary Production (NPP), heterotrophic respiration (R_h), and biomass burning. NPP was estimated using Advanced Very High Resolution Radiometer (AVHRR) Global Inventory Modeling and Mapping Studies (GIMMS), [*Tucker et al.*, 2005] data in combination with interannual varying solar radiation [*Kanamitsu et al.*, 2002; *Zhang et al.*, 2004], precipitation [*Adler et al.*, 2003], and temperature [*Hansen et al.*, 1999] data. The precipitation and temperature data were also used to estimate heterotrophic respiration rates. We estimated the amount of carbon released through biomass burning using satellite data from MODIS [*Justice et al.*, 2002], ATSR [*Arino et al.*, 1999], and VIRS [*Giglio et al.*, 2003] sensors in combination with moisture data. Major improvements over our earlier biomass burning estimates included the use of more extensive burned area data, the introduction of age classes in our biogeochemical model, and a new representation of organic soil layers. For the 1997 – 2003 period, we find that on average ~58 Pg C/yr is fixed by plants, and ~ 92% of this is returned back to the atmosphere via microbial respiration. Another ~ 5%, or 3.0 Pg C/yr is emitted by biomass burning. Interannual variability in R_h was low, with a 1 Pg C range for the 7 year period. Variations in NPP were larger with a ~2 Pg C range. Biomass burning also showed a range of ~2 Pg C between low and high years. NPP and R_h tend to vary in parallel, but because of the larger amplitude in NPP they influenced NEE in a way that productive years (i.e. first half of 1997, 2001) caused a net uptake while other years (i.e., 2000, 2003) caused a net release of carbon, see Fig.1. In addition, biomass burning rates were highest in drought years, amplifying the NEE signal from NPP and R_h alone. High fire years included the second half of 1997, 1998, and 2002. Combined, these three components of terrestrial exchange appear to account for much of the CO_2 growth rate variability as measured by NOAA/CMDL.

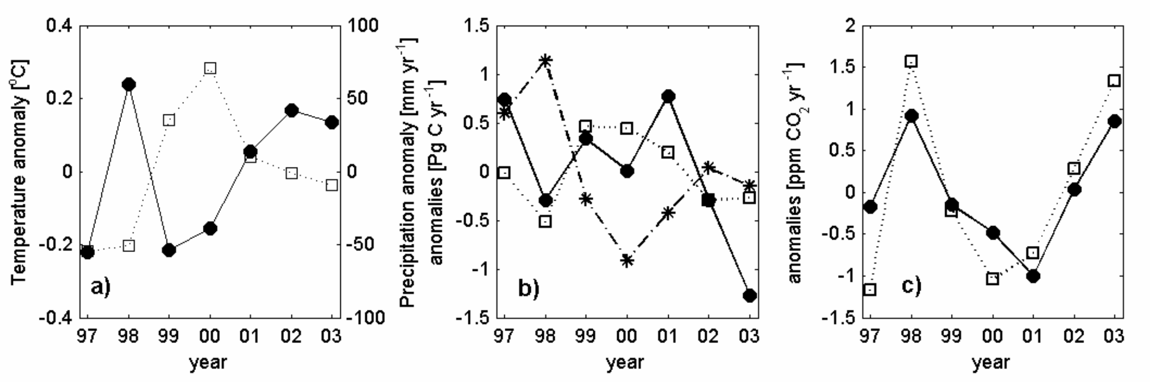

Fig. 1. a) NPP weighted temperature anomalies (solid line) and precipitation anomalies (dotted line). b) CASA calculated anomalies of NPP (solid line), Heterotrophic respiration (dotted line), and biomass burning (dash-dotted line). c) Inverted Net Biome Production anomalies (NPP – R_h – Biomass burning), solid line, and NOAA-CMDL measured global CO_2 growth rate anomalies (dashed line). Positive numbers indicate an anomalous source.

REFERENCES

Adler, R.F., G.J. Huffman, A. Chang, et al. (2003), The version-2 global precipitation climatology project (GPCP) monthly precipitation analysis (1979-present), *J. of Hydrometeorology, 4* (6), 1147-1167.

Arino, O., J.-M. Rosaz, and P. Goloub (1999), The ATSR World Fire Atlas. A synergy with 'Polder' aerosol products, *Earth Observation Quarterly* (64), 1-6.

Bacastow, R.B. (1976), Modulation of Atmospheric Carbon-Dioxide by Southern Oscillation, *Nature, 261* (5556), 116-118.

Battle, M., M.L. Bender, P.P. Tans, et al. (2000), Global carbon sinks and their variability inferred from atmospheric O-2 and delta C-13, *Science, 287* (5462), 2467-2470.

Giglio, L., J.D. Kendall, and R. Mack (2003), A multi-year active fire dataset for the tropics derived from the TRMM VIRS, *Int. Journal of Remote Sensing, 24* (22), 4505-4525.

Hansen, J., R. Ruedy, J. Glascoe, and M. Sato (1999), GISS analysis of surface temperature change, *Journal of Geophysical Research-Atmospheres, 104* (D24), 30997-31022.

Justice, C.O., L. Giglio, S. Korontzi, et al. (2002), The MODIS fire products, *Rem. Sensing of Env., 83* (1-2), 244-262.

Kanamitsu, M., W. Ebisuzaki, J. Woollen, et al. (2002), NCEP-DOE AMIP-II reanalysis (R-2), *Bull. of the American Meteorological Society, 83* (11), 1631-1643.

Keeling, C.D., R.B. Bacastow, A.F. Carter, et al, A three-dimensional model of atmospheric CO_2 transport based on observed winds: 1. Analysis of observational data, in *Aspects of Climate Variability in the Pacific and the Western Americas*, edited by D.H. Peterson, pp. 165-236, American Geophysical Union, Washington, DC, 1989.

Tucker, C.J., J.E. Pinzon, M.E. Brown, et al. (2005), An Extended AVHRR 8-km NDVI Data Set Compatible with MODIS and SPOT Vegetation NDVI Data, *Int. J. Remote Sensing*, *in press*.

Zhang, Y.C., W.B. Rossow, A.A. Lacis, et al. (2004), Calculation of radiative fluxes from the surface to top of atmosphere based on ISCCP and other global data sets: Refinements of the radiative transfer model and the input data, *J. of Geophysical Research-Atmospheres*, *109* (D19).