# ON THE NATURE AND CAUSES OF YEAR-TO-YEAR VARIABILITY IN THE CARBON CYCLE

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## ABSTRACT

Monthly time series of atmospheric carbon dioxide ($CO_2$), the relative amount of carbon-13 in $CO_2$ ($^{13}C$), hydrogen ($H_2$) carbon monoxide (CO), and methane ($CH_4$) are examined and related to each other and to an index of the status of ENSO. Making use of simple 12-month running mean and difference filters isolates the year-to-year variability in the concentrations and apparent sources of these constituents.

It is shown that from 1991 onward, the apparent sources of $CO_2$, $H_2$ and CO have tended to vary in synchrony and out of phase with variations in $^{13}C$. These relationships suggest that biomass burning is responsible for most of the year-to-year variability in the rate of increase of atmospheric $CO_2$. The largest rates of injection of $CO_2$ into the atmosphere coincided with major forest fire outbreaks. Fires in Indonesia and Amazonia in late 1997 and early 1998 injected ~4.2Pg C into the atmosphere. Though less important as a global source of $CO_2$, boreal forest fires perturb the carbon cycle by injecting carbon into the atmosphere, thereby reducing its oxidizing capacity and permitting the buildup of $H_2$ and $CH_4$. Boreal fires also appear to be a significant direct source of $CH_4$.

The relationship between the rate of increase of atmospheric $CO_2$ and the ENSO cycle is documented, making use of much longer $CO_2$ records at Mauna Loa and the South Pole. Years when sea surface temperatures in the equatorial Pacific are above normal tend to be drier than normal over most tropical continental regions, rendering the forests more susceptible to fires. This scenario plays out quite differently in different El Niño events.