R. J. Yokelson - Field Measurements in Africa (2000)

2000 Field Measurements in Southern Africa (SAFARI 2000) -
S2K Photo Gallery

* *Description* - Biomass burning injects an amount of trace gases into the troposphere that is almost as large as the contribution from fossil fuel burning. The two major types of biomass burning are savanna fires and domestic biofuel use. NSF funded our group to make the first comprehensive measurements of the emissions from both of these types of burning during the Southern Africa Regional Science Initiative (SAFARI 2000). We used ground based OP-FTIR to measure the trace gas emissions from the production and use of biofuels in remote villages in rural Zambia. We used AFTIR onboard the University of Washington CV-580 research aircraft to measure the initial emissions from 9 savanna fires.

We found that the emission factor for HCN was much larger than previously thought. HCN was shown to have high potential as a tracer for savanna fires (Figure 1). 60-70% of the non-methane organic compounds emitted by both types of fires were oxygenated organic compounds, which has significant implications for the atmospheric HOx budget. Even during the peak of the savanna fire season, most of the emissions of some compounds come from cooking fires (Figure 2). The production and use of charcoal (the fastest growing energy source in the third world) emits more pollutants per unit energy than simply burning wood (Figure 3).

We obtained the first precise measurements of the rate of photochemistry in nascent biomass burning plumes. $\Delta O3/\Delta CO$ and $\Delta CH3COOH/\Delta CO$ increased to as much as 9% ($> \Delta CH4/\Delta CO$) in <1h of photochemical processing downwind of fires (Figure 4). OH was shown to be very elevated in the nascent plumes; this will strongly impact the distribution of many of the emissions. We made the first measurements of chemical changes in smoke subjected to cloud processing, which greatly reduced CH3OH, NH3, CH3COOH, SO2, and NO2 levels, but significantly increased HCHO and NO (Figure 5).

Our measurement of the NOx emission factor for ocean-going ships supported the higher of two previous values and the proposal (by Lawrence and Crutzen) that ships are a major source of NOx (and thus O3) in the maritime atmosphere.

Major Trace Gases Emitted By Savanna Fires

Rank	Compound	ppb/ppmCO_2
1	CO_2	1000
2	CO	66.4
3	H_2	12.6
4	CH_4	3.53
5	NO_x	3.10
6	N_2	2.87
7	C_2H_4	1.14
8	CH_3COOH	1.06
9	HCHO	0.97
10	CH_3OH	0.96
11	SO_2	0.85
12	HCN	0.57
13	NH_3	0.47
14	HCOOH	0.39
15	C_2H_2	0.29

RED INDICATES TOO RX TO MIX GLOBALLY

OVOC/NMHC = ~2.4

Figure 1

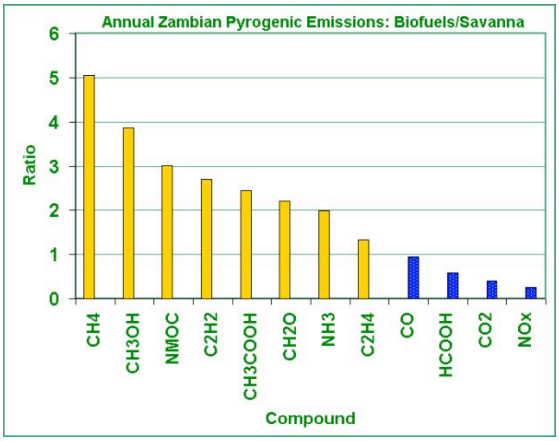

Figure 2

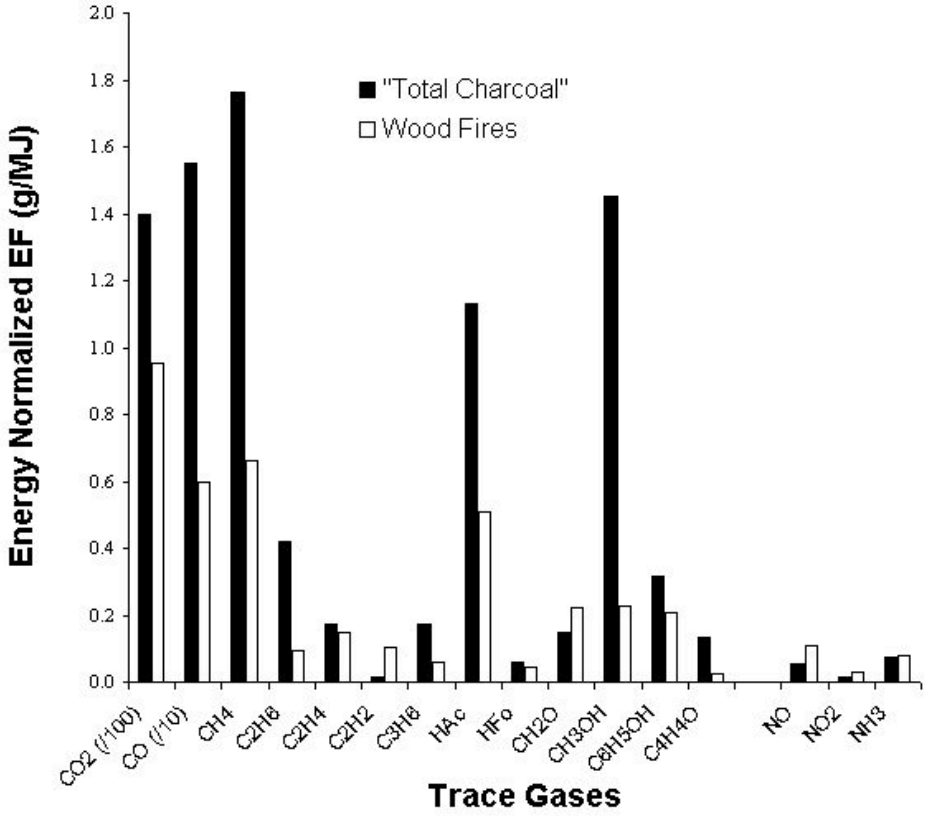

Figure 3

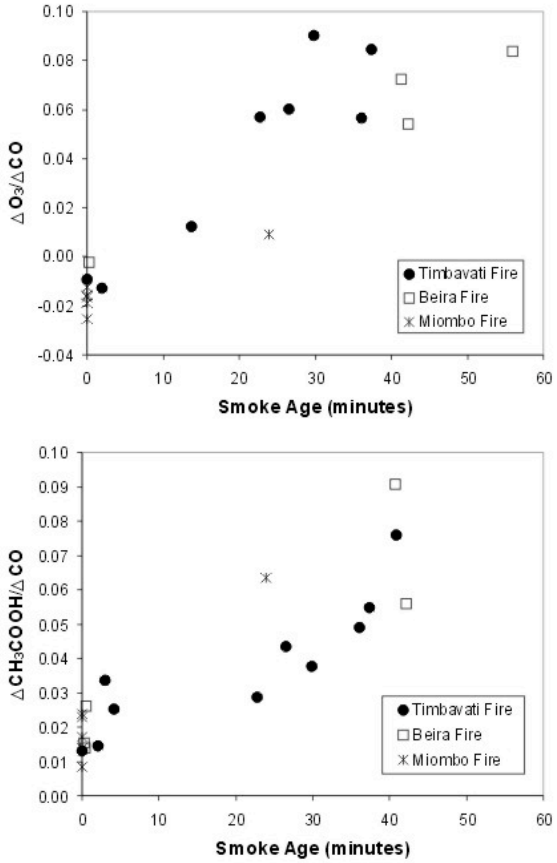

Figure 4

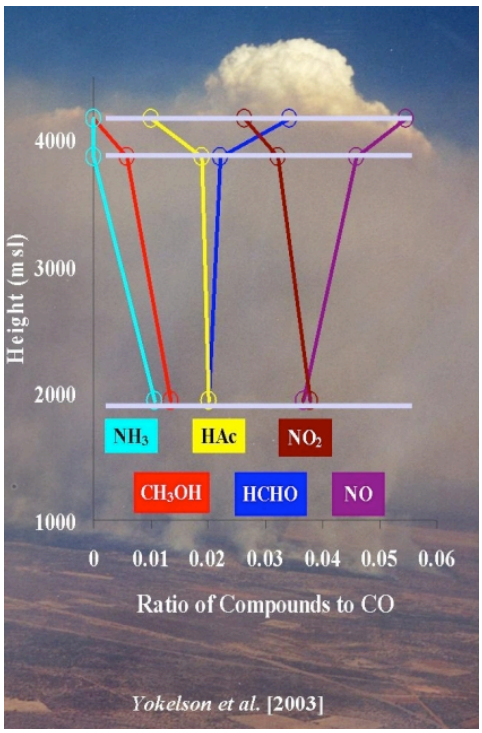

Figure 5