Recent Measurements of Biomass Burning Emissions and Plume Chemistry

R. Yokelson, T. Christian, I. Burling, U Montana; T. Karl, A. Guenther, A. Fried, T. Campos, A Weinheimer, NCAR; A. Tabazadeh, Stanford; D. Blake, UC Irvine; E. Atlas, U Miami; P. Wennberg, J. Crounse, Caltech; P. DeCarlo and J. Jimenez, CU; P.V. Hobbs, J. Trentmann, U Washington; P. Artaxo, U Sao Paulo; L. Molina, MIT; D. Toohey U Colorado; P. Buseck, K. Adachi, Arizona State; D.W.T. Griffith, U Wollongong; C. Warneke, J. de Gouw, etc, NOAA; T. Johnson, PNNL; D. Cocker, UC Riverside S. Urbanski, USFS.

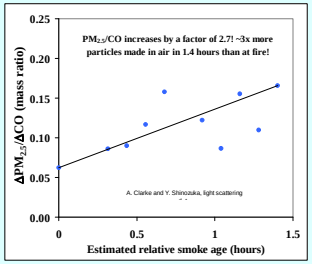
1. Global Emissions in Tg/y

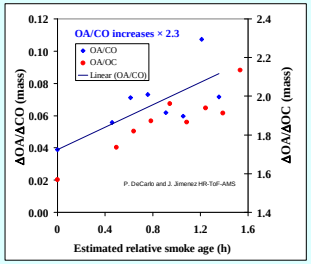
Source	OC primary	BC	gas-phase NMOC VOC	SVOC	Total C
FF (total)	2	3	200		7000
BB (total)	32	5	250	250	4600-6100
savanna					1600
cooking					1500
forest fires					1000
crop residue					500
peat (El-Niño)					1500
biogenic (total)			800	200	1000

Bond et al 2004, Andreae and Merlet 2001, Forster et al 2007, Yokelson et al 2008

1. Biomass burning is the main source of primary OC particles and gas-phase SVOC.
2. BB gas-phase SVOC source is much larger than primary OC potential for significant SOA!

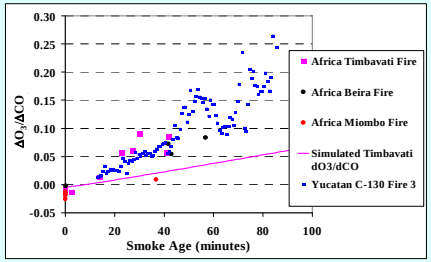
2.Secondary Aerosol Formation in BB Plumes

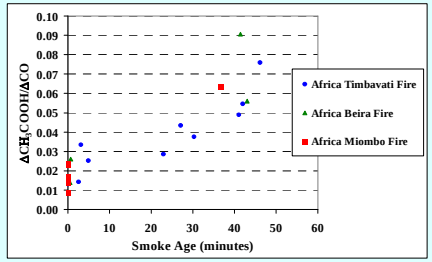




1. Factor of 2.3 increase in OA/CO in Yucatan in 1.4 hours (CU data in Yokelson et al., 2009)
2. Globally this would be another 42 Tg OC from just 17% of the gas-phase SVOC in < 2 hours!

3. Fast Post-Emission Production of Ozone and Organic Acids

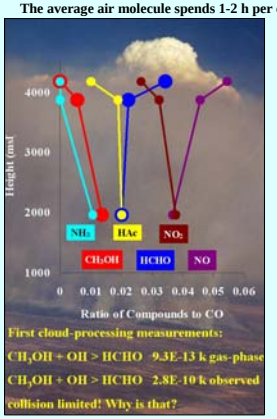


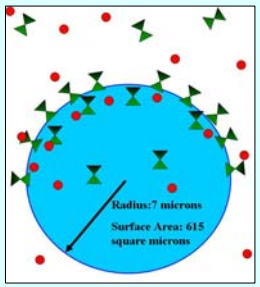


1. Measured ozone rise in Mexico similar to Africa and about 2-3 × faster than simulated in dedicated model.
2. Modeled ozone matches measured ozone if initial NMOC set to 2 × actual, measured NMOC as surrogate for unmeasured SVOC.
3. Virtually no acetic acid made in model even though it is 3rd largest C reservoir in the smoke aged about one hour!

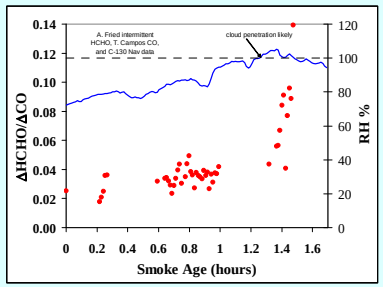
4. Smoke-Cloud Interactions

The average air molecule spends 1-2 h per day in a cloud (D. Jacob, 2000)





1. Methanol and other organics coat droplet reducing surface tension.
2. 300 ppb of "surface sites." Are droplet surfaces a major global loss process?



Second smoke-cloud interaction measurements? Apparent confirmation of rise in ΔHCHO/ΔCO. No significant change in NO/NO_2 (no data on ammonia, methanol, acetic acid).

Yokelson et al (2009)

5. Pyrocloud Effects Lava Effects (PELE)

Pyrocumulus From Burning Sugar Cane: Maui

Volcanic Vents Kilauea "Big Island"

Lava-Seawater Interaction Plume: "Big Island"

Proposed Addition to Future C-130 Mission

8-9 AM: sample pyrocumulus Maui.

Followed by sampling on Big Island of:

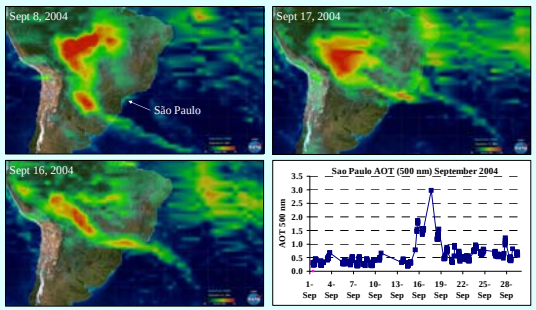
fresh > aged volcanic emissions Kilauea

lava-seawater interaction plume

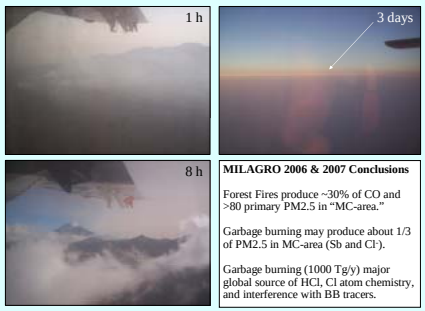
Other targets (e.g. aged Asian emissions, etc)

6-7. Regional Impacts of Biomass Burning

Brazil's "River of Smoke"



Mexico City Area Outflow (1 h, 8 h, 3 days)



MILAGRO 2006 & 2007 Conclusions

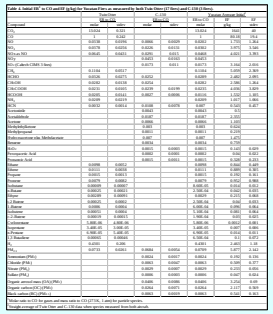
Forest Fires produce ~30% of CO and >80 primary PM2.5 in "MC-area."

Garbage burning may produce about 1/3 of PM2.5 in MC-area (Sb and Cl^-).

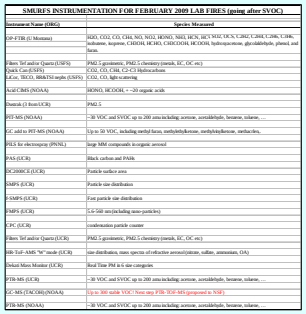
Garbage burning (1000 Tg/y) major global source of HCl, Cl atom chemistry, and interference with BB tracers.

8. Going After the SVOC (SMURFS-2009)

Typical Aircraft Capability



SMURFS Instrumentation



SMURFS Layout

Preliminary (Feb 2009) Findings: HCl high from garbage burning *and* coastal vegetation; tentative confirmation of large HONO initial emissions observed by Yokelson et al in Brazil; over 300 species quantified by NOAA GC/MS.