SAFARI 2000 Fire Emission Data, Dry Season 2000

Companion document: Listed below are detailed photographs provided by the investigator that complement the experimental descriptions. File names are linked to the ORNL DAAC.

Categories	File name	Caption	Provided by
Smoke Plumes	1815b.jpg	This picture is taken just before flying directly into the vertical column of smoke above an actively burning fire (to measure the emissions) near Skukuza in Kruger National Park.	B. Yokelson
	1815c.jpg	A closer look at the same fire with flames just visible at the leading edge.	B. Yokelson
	1815d.jpg	Same fire again. Often various point sources will combine and drift horizontally together.	B. Yokelson
	aftiruw.jpg	Our airborne FTIR (AFTIR), before installing protective mesh rack, is anchored to the floor of the University of Washington Convair-580 research aircraft. The optical bench carries a spectrometer (white box), beam transfer optics (covered by plastic bag), 100m pathlength White cell (glass cylinder), and liquid-nitrogen cooled detector (red). The optical bench is isolated from the mounting brackets by shock mounts, 3 to a side. A small scuba cylinder (not shown) to operate pneumatic sampling valves fits between the instrument and the portside wall of the aircraft. A laptop computer that controls AFTIR is mounted on the protective rack.	B. Yokelson
	blowing sand.jpg	On the coast of Namibia between Walvis Bay and Swakopmund.	B. Yokelson
	bob.jpg	Bob Yokelson - On our only day off in ~3 months we drove 18 hours through South Africa to see as much as we could. This photo is near "God's Window" on the escarpment.	B. Yokelson
	BurnedDamboDegradedMiombo.jpg	A partially burned dambo. Dambos are often heavily used and sometimes the miombo is "degraded" adjacent to dambos.	B. Yokelson
Southern Africa (mostly Zambia) from the air	BurnedDamboDegradedMiombo2.jpg	The degree of degradation in the interface between the dambo and miombo varies. Villagers often harvest wood for cooking, heating, and/or charcoal making in these areas.	B. Yokelson
	BurnedDamboDegradedMiombo3.jpg	Another partially burned dambo. In this photo the understory of the miombo is also burned.	B. Yokelson

Southern Africa (mostly Zambia) from the air	charcoalBag.jpg	For this particular kiln, 4 people worked for 2 weeks to produce 5 charcoal bags, which sell for $2 each. One of the bags from our kiln is shown here.	B. Yokelson
	charcoalcook1.jpg	Charcoal provides more energy per unit mass and is more economical to transport than wood. It is normally burned in some type of simple stove.	B. Yokelson
	chitemene1.jpg	When Chitemene agriculture is extensive in a region (near roads or larger villages) a patchwork pattern forms on the landscape.	B. Yokelson
	chitemene2.jpg	A close up of an area where the miombo trees have been felled and burned to fertilize crops. Zambian slash/burn farming is known as Chitemene agriculture.	B. Yokelson
Aircraft and Instruments	cv580Inlet.jpg	Ram pressure forces outside air through the 1 inch diameter inlet tube (center of picture) and then through a Teflon bellows to the AFTIR White cell, where we measure it's infrared spectrum every 0.8 seconds. Metallic parts of the AFTIR system, including the inlet, are coated with halocarbon wax to minimize wall interactions with reactive compounds. In addition, the residence time in the exterior portion of the inlet is only ~2.5 milliseconds.	B. Yokelson
	cv580inside2.jpg	The CV-580 is "jammed full" with a world-class instrumentation package.	B. Yokelson
	cv580outside3.jpg	The CV-580, maintained and operated by the Cloud and Aerosol Research Group (CARG, University of Washington). AFTIR is mounted just behind the wing and just forward of the rear cargo hatch on the left side.	B. Yokelson
	damboandVillage.jpg	A village on the way to Milumbwa. Villages are often located on the margins of dambos where water availability and grazing are often better.	B. Yokelson
	ER2.jpg	The NASA ER2 aircraft is flown solo at 20 km and carries a suite of instruments similar to those on satellites. The CV-580 and ER2 were often operated simultaneously below the TERRA satellite and above instrumented ground sites for validation of satellite measurements.	B. Yokelson
	Fire Crew for woodland burn.jpg	This is a photo of the crew hired by Darold Ward to light and control the series of planned fires near Kaoma, Zambia. The fires were sampled by the CV-580 and monitored by the ER2 and TERRA. Jose Pereira's group (also pictured) measured the fuel consumption and other characteristics.	B. Yokelson

Aircraft and Instruments	FloodPlainFireScar.jpg	The Zambezi river flood plain is used primarily for grazing. The picture shows some of the difficulties encountered in estimating burned area.	B. Yokelson
Biomass used for cooking	isaac.jpg	Isaac Bertschi - In some cases local people wanted to be in our pictures. Here is Isaac behind a high school tour group.	B. Yokelson
	kaomaHutCook.jpg	Sidney Ilukena builds a wood cooking fire for emissions measurements by open-path FTIR in the backyard of our guest house back in Kaoma.	B. Yokelson
Charcoal Kiln	kilnCrew.jpg	A local crew of charcoal makers built this kiln and we measured the emissions from it. The kiln is constructed of clumps of sod piled over a stack of wood. A small opening is left for ignition. The wooden rack was intended to support the FTIR above the kiln, but the smoke drifted sideways and we didn't need the rack.	B. Yokelson
	KilnFTIRendview.jpg	Looking upwind at the smoke drifting sideways out of the kiln and through the optical path of our open-path FTIR trace gas measurement system. The rails of the instrument are wrapped with Teflon sheeting to avoid losing reactive gases.	B. Yokelson
	KilnFTIRsideview.jpg	Another view of smoke drifting between the mirrors of the open-path FTIR. The battery in the foreground powers the spectrometer, which draws 4A, for up to 8 hr. The system computer is powered by the battery of a running truck parked well downwind and through an extension cord and AC/DC converter.	B. Yokelson
	kilnLight.jpg	After a few minutes of vigorous flaming, the opening is closed with more sod and the fire smolders until the charge is carbonized; in this case 4.5 days.	B. Yokelson
Miscellaneous	kilnstartdarold.jpg	Darold Ward was the fearless leader of the Fire Chemistry group at the USFS Fire Sciences Lab for many years.	B. Yokelson
	LongDambo.jpg	Dambos occur in many shapes.	B. Yokelson
	madikwe.jpg	A capping cumulus cloud formed at the top of the vertical smoke column produced by this prescribed fire at Madikwe Game Reserve on 18 August, 2000. This allowed us to acquire spectra of smoke before and after cloud processing.	B. Yokelson
	metofficec130.jpg	The UK Met Office operated their C-130 research aircraft out of Windhoek, Namibia. Here on the tarmac in Walvis Bay, the huge plane makes its own weather.	B. Yokelson

Miscellaneous	milumbwaRoad.jpg	Some 20 km west of Kaoma this dirt road branches off and continues ~ 30 km to the village of Milumbwa. In remote rural locations like Milumbwa, wood is by far the main fuel for cooking and heating.	B. Yokelson
	milumbwaVillage.jpg	Driving into Milumbwa. The trees with deep green leaves even in the dry season are mango trees. The ones seen here provide shade for the school and the dwellings of the village chief.	B. Yokelson
	P0000586.JPG	Darold Ward took this picture from the ground just after ignition of the Miombo fire we sampled from the air on UW Flight 1826. The fire removed grass, litter, and small shrubs leaving the trees and a more open wooded savanna.	B. Yokelson
	s2k_haze.jpg	This photograph of the setting sun behind a hazy sky over Lusaka, the capital city of Zambia, is a typical example of sky conditions throughout the burning season in 2000. The color of the sky clearly indicates the presence of heavy smoke from agricultural and urban burning practices. During the SAFARI 2000 Field Campaign, researchers measuring ozone at the ground found astonishingly high levels of pollution over the Lusaka. The ozone pollution registered .95 parts per million (ppm) during the daytime, equivalent to a 'Red Alert Ozone Day' in U.S. cities.	A. Thompson
	s2k_launch.jpg	To properly measure ozone throughout the atmosphere, large balloons equipped with instruments are launched in the region of biomass burning activity. These "ozonesondes" pass through the troposphere, which ranges from the Earth's surface to approximately 40,000 feet high, before bursting in the middle of the stratosphere. Anne Thompson of NASA Goddard Space Flight Center and Agnes Phahlane, a South African SAFARI researcher, are seen here preparing an ozonesonde for launch over the city of Lusaka, during September 2000.	A. Thompson
	sandstone quarry.jpg	Sandstone blocks cut from the desert. Dune 7(?) is in the background. The blocks are shipped to Windhoek and beyond by rail. The train carrying the blocks was often delayed while workers shoveled sand from the tracks.	B. Yokelson

Miscellaneous	smolderingLogFTIR.jpg	Several days after the flame front has passed through a Miombo understory there is still smoke being produced by a process known as residual smoldering combustion. These emissions are perhaps 10% of the total emissions and cannot be sampled from the air so we are making ground-based measurements of the emissions here. The battery in the foreground powers the spectrometer, which draws 4A, for up to 8 hr. The system computer is powered by the battery of a running truck parked well downwind through an extension cord and an AC/DC converter. For a few trace gases the emissions from this type of combustion are quite different than during the plume-forming phase.	B. Yokelson
	theo.jpg	Ted Christian - Shown here with some new friends at the Pietersburg airport, home base for the S2K campaign.	B. Yokelson
	UnderstoryFireZambia.jpg	Another picture of a fire clearing out Miombo understory.	B. Yokelson
	VirginMiombo_UnburnedDambo.jpg	The miombo forests constitute an open wooded savanna that stretches from Angola in the west to Mozambique in the east and from Tanzania and southern Congo in the north to Zimbabwe in the south. They are distinguished by the presence of legume trees belonging to the genera Brachystegia, Julbernardia, and Isoberlinia. The Miombo covers 80% of Zambia occurring on sandy soils. Dambos cover some 20% of Zambia and occur on clay soils that flood during the wet season preventing tree growth. Dambos are grazed by cattle and burned annually. The miombo understory is burned ~ every two years and the trees are resistant to low intensity fire.	B. Yokelson