Land-use patterns and photo-oxidation of soot black carbon

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Soot black carbon (BC) is the product of incomplete combustion of fossil fuels and biomass. This poster highlights two datasets that investigate soot BC degradation rates:

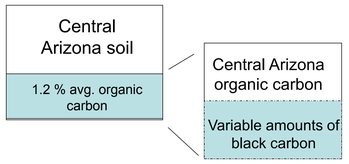
1) Trends between soot BC concentration at urban sites and current and historical land use data indicate the main input of soot BC to soil is the actual *changing* of land use from desert to urban.

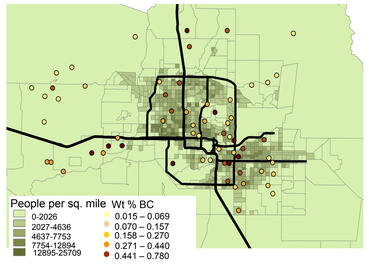
2) Organic and soot BC can be degraded by photo-oxidation on short time scales (monthly). Oxygenated functional groups are included in post photo-oxidized soot BC samples that are not found in the pre photo-oxidized samples suggesting that photo-oxidation not only decreases soot BC concentration but also changes its inherent chemical composition.

Background information

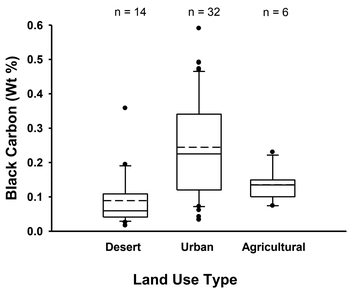
Summary of Survey 200 soils AVG (n = 63)

Wt % OC (g OC/g soil)	1.2 ± 0.9
Wt % BC (g BC/g soil)	0.2 ± 0.2
BC/OC (g BC/g OC * 100)	31 ± 24
Avg. Black Carbon $\delta^{13}C$ (‰)	-18 ± 3





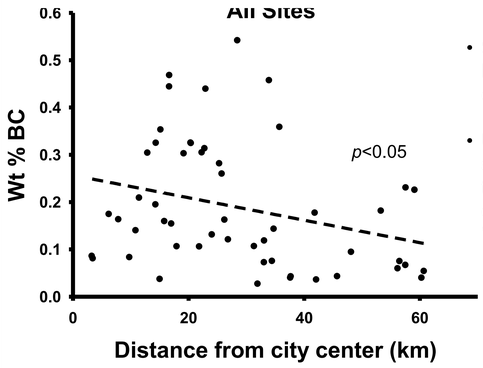
Soot BC is unevenly distributed across the city



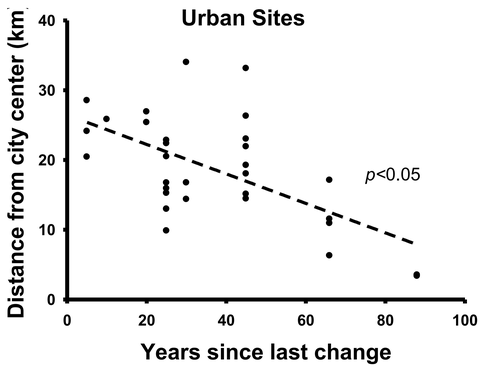
Soot BC varies by land use (p<0.05, ANOVA)

HOW CAN WE BETTER UNDERSTAND INPUTS AND REACTIVITY OF SOOT BC IN SOIL?

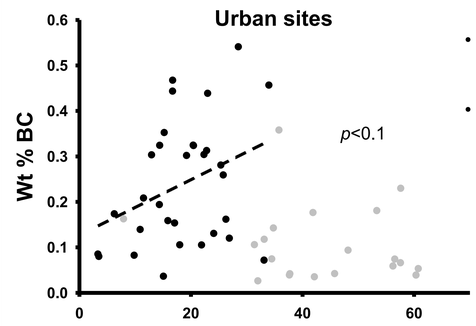
Soot BC concentration is high in the most recently urbanized areas



- Soot BC concentrations are higher at sites closer to city center.
- Urban sites have higher soot BC concentrations than desert sites because of human activities (see 'Background' section).



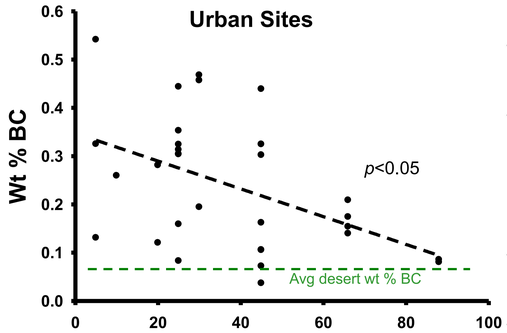
- Historical land use (LU) change data shows sites further away from city center have undergone more recent LU changes.
- Urban areas near city center have not experienced LU change in decades.
- Soot BC concentrations are higher at sites where LU change is recent.



- Opposite trend is seen for urban sites.
- Soot BC input mechanisms for urban sites are different than those for desert and agricultural sites.

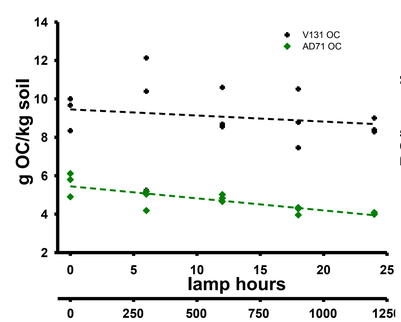
(desert and agricultural sites are grayed out.)

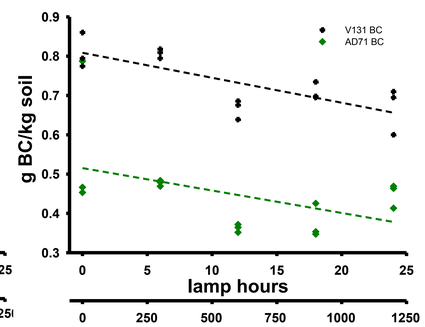
P-values calculated using linear regression



- Changing LU deposits soot BC in soil.
- Soot BC is lowest at sites urbanized 60-100y ago, indicating soot BC oxidation rates > deposition rates in soils
- Older Urban sites approach desert-level soot BC!
- BC degradation rate determined from slope = **29 ± 10 mg soot BC/kg soil/yr**

Soot BC is degraded by UV radiation



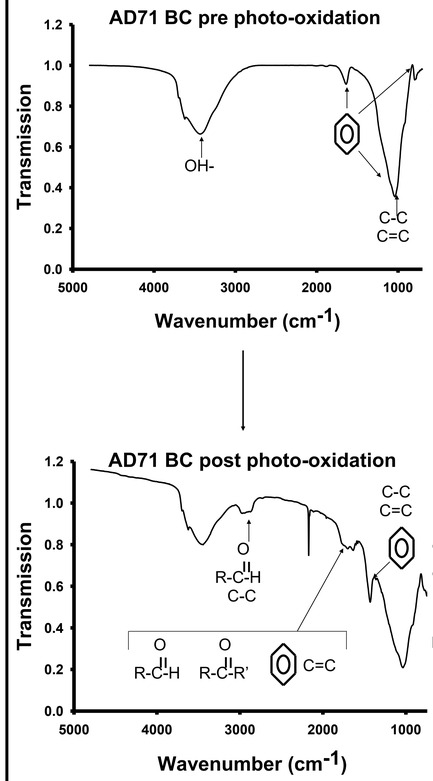


- Organic and soot BC can be removed via photo-oxidation over monthly timescales (note the y-axis scale difference).

		Degradation rate (mg C/kg soil/yr)
OC	V131	2773 ± 4000
	AD71	5498 ± 1000
BC	V131	**555 ± 100**
	AD71	**490 ± 300**

- Black carbon degradation rate is an order of magnitude lower than organic carbon degradation rate.
- Black carbon degradation rates from photo-oxidation are about an order of magnitude higher than those determined from historic land-use data

Photo-oxidation changes chemical composition



- Soot BC prior to photo-oxidation has a different chemical composition than soot BC after photo-oxidation.
- The differences appear in the form of oxygenated functional groups in the post photo-oxidation samples.
- Oxygenated functional groups increase the reactivity of molecules, allowing further reactions driven by biotic and abiotic processes.

Despite the differences in methodology, uncertainty, variability, etc., the order of magnitude difference in the calculated degradation rates for these two data sets is fairly small. As a result we have gained a better understanding of the contribution of photochemical oxidation to soot BC degradation in central AZ.

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