Depth distribution and photo-reactivity of black carbon in Survey200 soils

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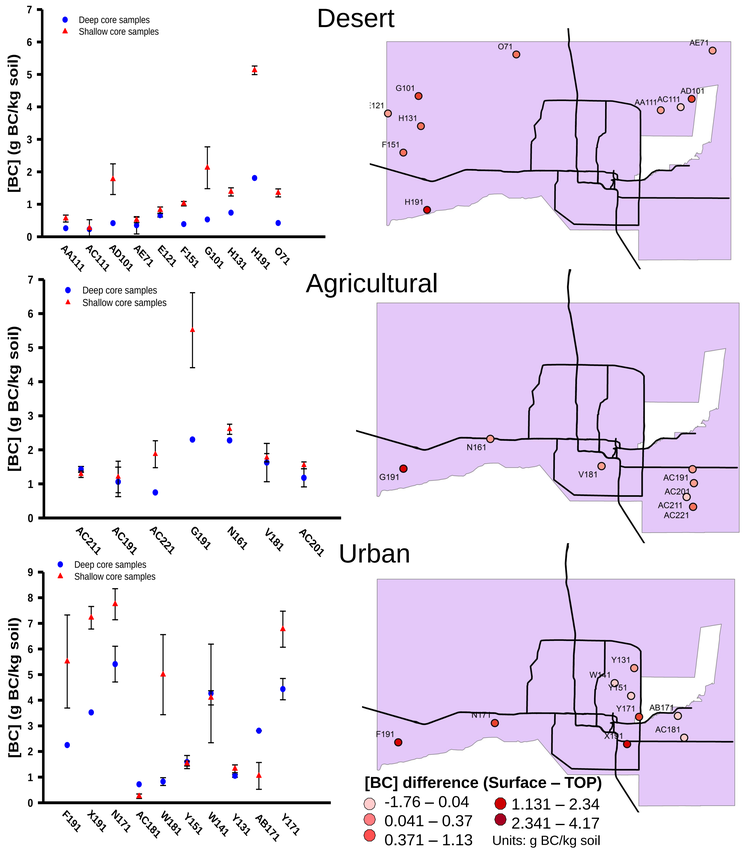
Black carbon (BC) is the product of incomplete combustion of fossil fuels and biomass. Little is known about BC in a terrestrial urban setting; however, BC is a significant portion of the organic carbon in central Arizona soils (31%). BC could, therefore, play a major role in organic biogeochemical processes in this area. We hypothesize that Surface soils (top 5 cm) contain a larger percentage of BC than TOP (top 15 cm) soils. Laboratory analyses show that, on average, Surface soil contains 1.2 g of BC/kg soil more than TOP soil.

Since the BC global budget is unbalanced with respect to sources and sinks, we hypothesize that BC is undergoing bio-, chemical-, or photo-degradation in soil. Photo-degradation of black and organic carbon in a desert and urban soil was monitored in a solar simulator and under a mercury (Hg) lamp. The solar simulator experiment showed no statistical change in BC or OC concentration. Hg lamp experiment showed a statistical decrease in organic and black carbon for both desert and urban soils. These results indicate that BC can be photo-oxidized and that BC in a desert/urban ecosystem might be more reactive than previously thought.

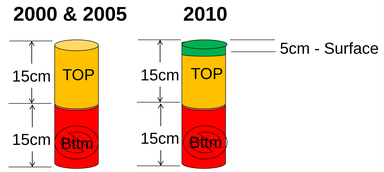
BC concentrations: Surface vs. TOP soil



Fifteen of 27 sites contained more BC in the Surface sample. A statistically significant difference in avg [BC] between Surface and TOP soils was only seen at desert sites (p>0.05).

Method

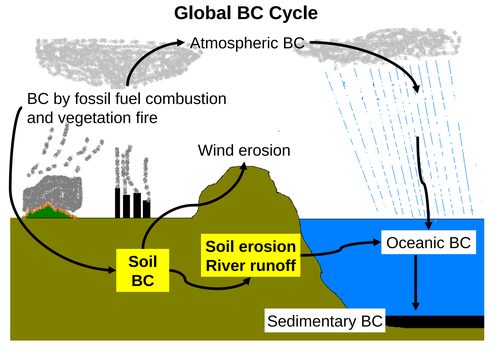
- 27 Survey200 samples
- TOP sample: top 15cm
- Surface soil is top 5 cm.



Conclusions: Surface vs. Deep soils.

- Black carbon concentrations are higher on average in surface soil than in deep core soil.
- Differences in average BC concentrations are only seen in desert sites. This is because desert soils are less well mixed than urban or agricultural sites.
- Physical and chemical processes that occur at atmosphere/lithosphere interface (weathering, **photo-oxidation**, microbial degradation) can play a role in BC reactivity.

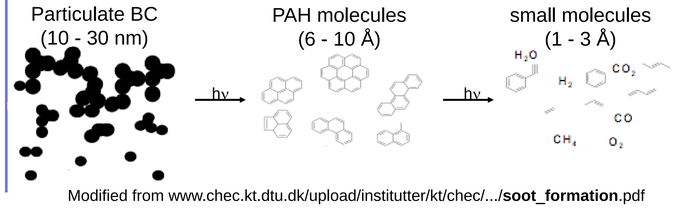
Background information



Sources (Biomass burning and Fossil Fuel) 62 to 284 Tg yr^{-1}	
Sinks (Sedimentary BC)	10 Tg yr^{-1}
Imbalance **:**	52 to 274 Tg yr^{-1}

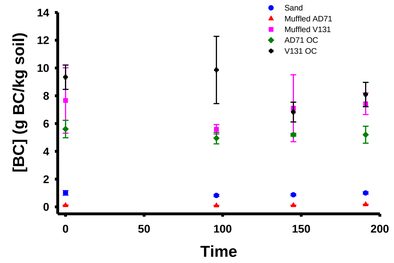
Inputs do not equal outputs!
Where do the 52 to 274 Tg of BC go? One possibility is that it is photo-oxidized in soil.

Proposed photo-oxidation of BC



Modified from www.chec.kt.dtu.dk/upload/institutter/kt/chec/.../**soot_formation**.pdf

Photo-oxidation of organic and black carbon

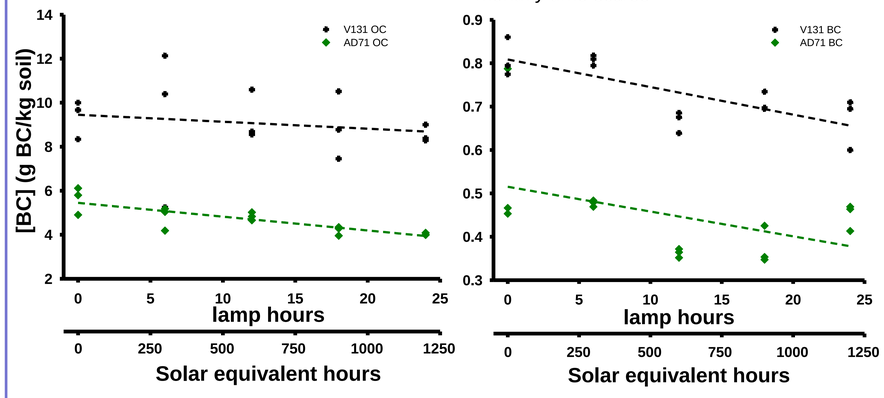


Solar simulator Experiment

- AD71 – Desert; V131 – Urban
- 200hrs
- Blank measurements are as expected.
- No statistical change in OC conc.

Hg Lamp oxidation Experiment

- 24 lamp hours
- Irradiance energy for Hg lamp is ~50 times stronger than solar simulator
- Decrease in both OC and BC seen over monthly time scales



Degradation rate constant

		%Δ	(g C/kg soil · h, k)
OC	**AD71**	29	6.3x10^{-2}
	V131	6	3.2x10^{-2}
BC	**AD71**	13	5.7x10^{-3}
	V131	25	6.4x10^{-3}

Conclusions: Photo-oxidation.

- Black and organic carbon can be removed via photo-oxidation over monthly timescales.
- Black carbon is degraded at a slower rate than organic carbon.
- Future work will include organic and black carbon microbial degradation experiments

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