

**Black Carbon (BC) Aerosol Processes in the Climate System**

**Sources of black carbon aerosol and co-emitted species**

- Agricultural burning
- Residential cooking and heating
- Brick kilns
- Coke-making
- Industrial emissions
- On-road cars and trucks
- Off-road vehicles
- Ship emissions

**Atmospheric Processes:**

- Co-emitted gases and aerosols
- Black carbon aerosol
- Scattering solar radiation
- BC absorption of incoming and outgoing solar radiation leading to atmospheric **warming** and dimming of the surface
- BC cloud effects: **warming** or **cooling** from BC nucleation effects
- Ice cloud effects: **warming** or **cooling** from BC nucleation effects
- Cloud droplet activation and aerosol lofting by convection
- Wet-phase cloud effects and wet removal from BC nucleation effects
- Vertical advection and mixing
- Surface deposition of BC by rain and snow
- BC scavenging and wet removal by precipitation
- Intercontinental and regional transport of internally and externally mixed BC-containing particles
- Surface **warming** by BC deposition to mid-latitude snow and ice
- Surface **cooling** by BC deposition to mid-latitude snow and ice
- to polar snow and sea ice
- Surface chemical processing: internal mixing with organics, sulfates, and nitrate
- Coagulation, nucleation, condensation

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## 2015

The screenshot displays the Pyrolysis Station software interface. The top section features a chromatogram with multiple data series: a green line representing the 'Transmittance Signal', a blue line for 'Back Oven C', a red line for 'FID', and a black line for 'Methanator Oven C'. The x-axis represents time, and the y-axis represents signal intensity. A prominent peak is visible in the green signal. The top right corner shows the date '2984' and time '1737'.

Below the chromatogram, a status bar indicates 'WAIT - Too hot (>75 C) for new sample.' The bottom section contains a data table with various parameters and their current values.

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
Status	Idle		Sample Temp C	182	°C	FID	100.000	uA
Cal Constant	-20.84		Back Oven C	858	°C	Transmittance Signal	3753	
			Methanator Oven C	581	°C	PSM	0.25	
			Max Time Remaining	0.00	s	Instrument Name	SL BV GC1C1	
32000	0	1	0	0	0	Accumulated Time	13.15	s
Wait over probe	19517					Dried hot oven	0	
Back oven probe	19551					Dried front oven temperature	0	°F
Chd oven probe	16609					Dried Chd oven temperature	0	°F
						Dried Chd oven temperature	500	°F

The bottom right corner of the interface includes a section for 'del' and 'Addition' with a 'Unit' column. The 'Unit' column shows 'g' for 'del' and 'g' for 'Addition'. The 'del' column shows '182.326' and the 'Addition' column shows '182.326'.

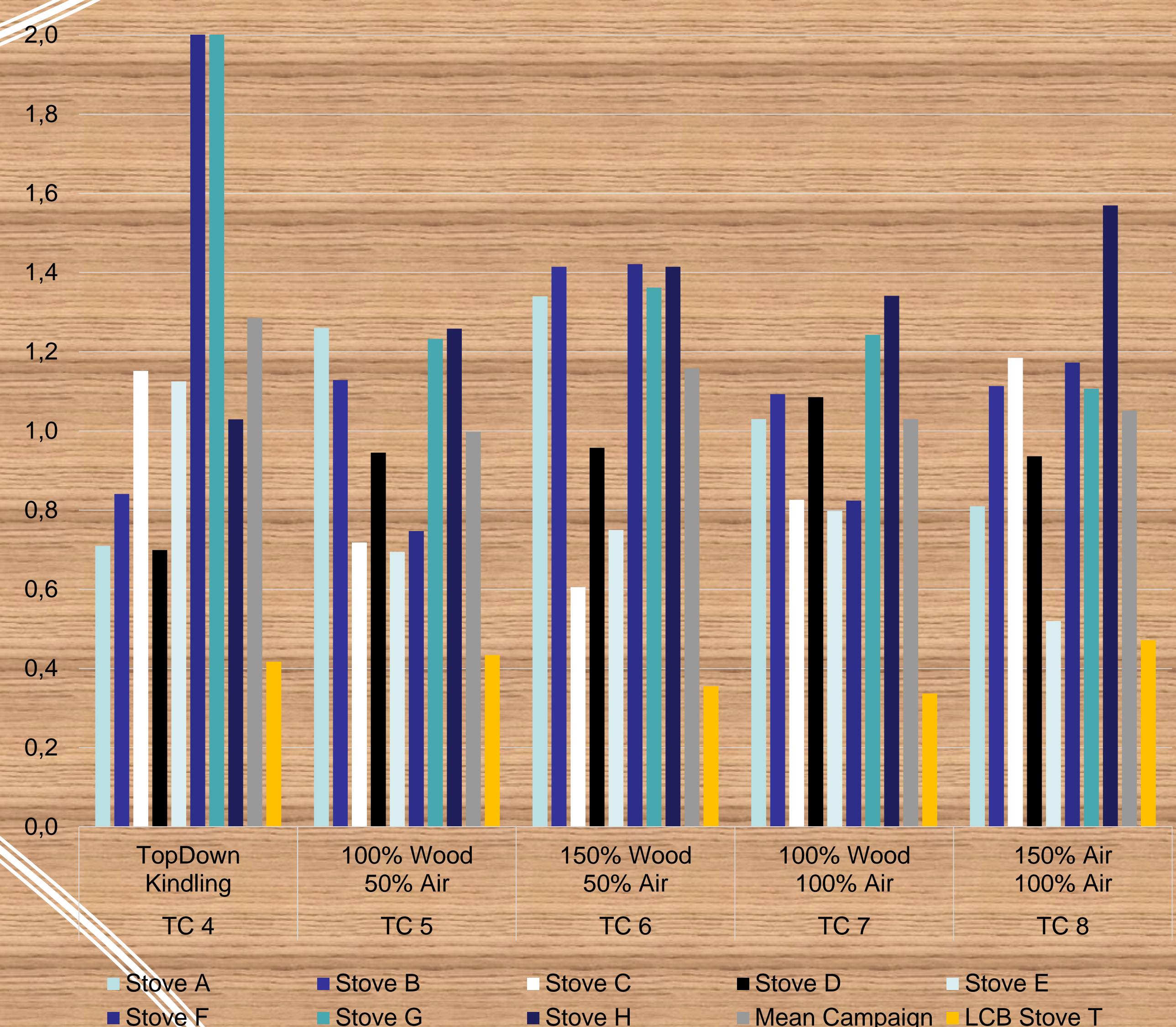


The EC-OC analysis revealed the possible main reasons regarding the formation of the black carbon containing particles. It suggested that the placement of the combustion air supply and construction of the firebox could be the main reasons more than the geometry of the firebox itself.

## 2016

***“ Results from the designed fire-box showed a 5% more efficient and a 63% less polluting firebox – for both black carbon containing particles and other present emission factors ”***

Eight modern wood burning stoves with different geometry and combustion air supply have been measured after the developed measurement protocol. The collected mass of the particulate emissions has been analysed with a Thermal-Optical analysis approach, which divides the particulate mass into an organic- and elemental carbon fraction. The results are furthermore compared with other valid emission parameters.



An overview of the collected and emitted elemental and organic carbon for the eight stoves, a combined mean from the campaign and the produced LCB Stove T for the different test cycles (TC) of wood quantities and air supply settings.

Parameter:	Efficiency	CO-emission	OGC-emission	EC-emission	OC-emission
[Unit]	[%]	[%]	[mgC/Nm³ dry gas at 13% O₂]	[g/kg (dry matter)]	[g/kg (dry matter)]
Mean Campaign Stove A-H	77	0,125	138	0,48	0,62
LCB stove T	81	0,046	41	0,20	0,20
%-wise Improvement	5%	61%	65%	58%	67%

The LCB Stove T compared to the stoves in the campaign. Out of a total of 225 parameters, the LCB Stove had a **success rate on 94%!**

## 2017

Experiences from the project ends up with a set of guidelines for future less black carbon emitting firebox designs. This knowledge is very useful for the partners in case of an implementation of black carbon containing particles as a future emission factor for intermittent stoking.