Geophysical Research Abstracts
Vol. 16, EGU2014-2393, 2014
EGU General Assembly 2014

Pyrogenic carbon characteristics relate to wildfire behaviour

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Pyrogenic carbon (PyC) comprises the whole range of organic compounds produced both naturally during wildfires (by charring or incomplete combustion) and anthropogenically by pyrolysis processes (heating in absence of oxygen). Relationships between pyrolysis conditions and biochar properties (i.e. 'antropogenic PyC') are well established, but limitations affecting wildfire research make these relationships more difficult to be investigated for wildfire PyC. Here, we study relationships between wildfire behaviour and characteristics of PyC by taking advantage of the experimental FireSmart boreal forest fire (June 2012, NWT- Canada), which reproduced wildfire conditions, and, at the same time, allowed fire behaviour monitoring and immediate post-fire sampling.

Before the fire, three parallel transects of 18-m length were established in the direction of the prevailing wind in the central area of the burnt plot. These were instrumented at a spacing of 2 m with thermocouples connected to data loggers (Lascar, Easylog) to continuously (every second) record temperatures at the forest floor surface. Immediately after fire, samples of the PyC produced in the forest floor where collected adjacent to each thermocouple. PyC samples were characterized by elemental analysis and differential scanning calorimetry.

Our results show that transformation of the forest floor material by fire into PyC led to an enrichment of the carbon content, a higher carbon/nitrogen ratio and an increase of the thermal recalcitrance. Statistically significant relationships between some PyC characteristics and wildfire conditions were found such as an increase of carbon content of PyC with maximum temperature recorded during fire and an increase of thermal stability of PyC with fire duration.

Considering that in boreal forests the fuel component most affected by fire is the forest floor and that the enhanced recalcitrance of PyC is likely to increase its resistance to biological degradation compared to the unburned forest floor, PyC production for this fuel component may have important implications for carbon sequestration and fluxes in boreal forest. In addition, the relationships found here between PyC quality and wildfire conditions could provide the first insights into effects of wildfire behaviour, and its potential variations with climate change, on C sequestration in the boreal ecosystem via PyC production.