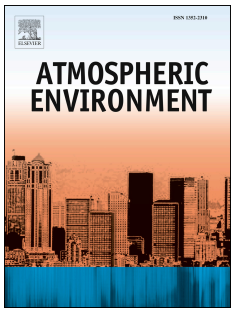
Accepted Manuscript



Smoke aerosol chemistry and aging of Siberian biomass burning emissions in a large aerosol chamber

A.-C. Kalogridis, O.B. Popovicheva, G. Engling, E. Diapouli, K. Kawamura, E. Tachibana, K. Ono, V.S. Kozlov, K. Eleftheriadis

PII: S1352-2310(18)30264-4

DOI: 10.1016/j.atmosenv.2018.04.033

Reference: AEA 15966

To appear in: *Atmospheric Environment*

Received Date: 1 December 2017

Revised Date: 6 April 2018

Accepted Date: 22 April 2018

Please cite this article as: Kalogridis, A.-C., Popovicheva, O.B., Engling, G., Diapouli, E., Kawamura, K., Tachibana, E., Ono, K., Kozlov, V.S., Eleftheriadis, K., Smoke aerosol chemistry and aging of Siberian biomass burning emissions in a large aerosol chamber, *Atmospheric Environment* (2018), doi: 10.1016/j.atmosenv.2018.04.033.

Smoke aerosol chemistry and aging of Siberian biomass burning emissions in a large aerosol chamber

Kalogridis A-C.[1], Popovicheva, O.B.[2], Engling, G.[3], Diapouli, E.[1], Kawamura, K.[4,5], Tachibana, E[5]., Ono, K.[5], Kozlov, V.S.[6], Eleftheriadis, K.[1]

[1]ERL, Institute of Nuclear and Radiological Science & Technology, Energy & Safety N.C.S.R. "Demokritos", 15310 Athens, Greece

[2]Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, Russian Federation

[3]Department of Biomedical Engineering & Environmental Sciences, National Tsing Hua University, Hsinchu, Taiwan

[4]Chubu Institute for Advanced Studies, Chubu University, Kasugai 487-8501, Japan

[5]Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan

[6]Zuev Institute of Atmospheric Optics, Siberian Branch Russian Academy of Sciences, Tomsk, Russian Federation

Keywords: biomass burning; chamber experiments; aerosol emission factors; aging in dark conditions; anhydrosugars; dicarboxylic acids

Abstract

Vegetation open fires constitute a significant source of particulate pollutants on a global scale and play an important role in both atmospheric chemistry and climate change. To better understand the emission and aging characteristics of smoke aerosols, we performed small-scale fire experiments using the Large Aerosol Chamber (LAC, 1800 m^3) with a focus on biomass burning from Siberian boreal coniferous forests. A series of burn experiments were conducted with typical Siberian biomass (pine and debris), simulating separately different combustion conditions, namely, flaming, smoldering and mixed phase.

Following smoke emission and dispersion in the combustion chamber, we investigated aging of aerosols under dark conditions. Here, we present experimental data on emission factors of total, elemental and organic carbon, water-soluble carbon as well as individual organic compounds, such as anhydrosugars, phenolic and dicarboxylic acids. We found that total carbon accounts for up to 80 % of the fine mode ($PM_{2.5}$) smoke aerosol. Higher $PM_{2.5}$ emission factors were observed in the smoldering compared to flaming phase and in pine compared to debris smoldering phase. For low-temperature combustion, organic carbon (OC) contributed to more than 90 % of total carbon, whereas elemental carbon (EC) dominated the aerosol composition in flaming burns with a 60-70 % contribution to the total carbon mass. For all smoldering burns, levoglucosan (LG), a cellulose decomposition product, was the most abundant organic species (average LG/OC=0.26 for pine smoldering), followed by its isomer mannosan or dehydroabietic acid (DA), an important constituent of conifer resin (DA/OC = 0.033). A levoglucosan-to-mannosan ratio of about 3 was observed, which is consistent with ratios reported for coniferous biomass and more generally softwood.

The rate of aerosol removal for OC and individual organic compounds were investigated during aging in the chamber in terms of mass concentration loss rates over time under dark conditions and