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Source apportionment of carbonaceous aerosol in Canada’s oil sand region

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Oil sands (also tar sands) are a type of unconventional petroleum deposit from which bitumen is mined by surface mining or in-situ extraction to produce heavy oil. A globally significant soil sand region (producing 3.3 M barrels per day in 2022), is located in the Athabasca River basin of Alberta, Canada. The environmental impacts of oil sand mining, specifically air pollution, are not well understood. This is in part because mining activities are taking place in the boreal forest region where rapid climate change is leading to changes in vegetation productivity and composition and increasing the risk of wildfires.

Here, we report the concentration and sources of total carbon (TC) and elemental carbon (EC) in fine airborne carbonaceous aerosol (PM2.5) in Canada’s oil sand region. A total of 36 24-hr quartz filter samples were collected with high-volume samplers at the Wood Buffalo Environmental Association’s Bertha Ganter –Fort Mckay station in Fort McMurray between February and October 2017. Ancillary continuous measurements at the station included meteorological conditions, PM2.5, SO2, NOx, and ozone. Air mass contributions to the station were analyzed using NOAA’s Hysplit backward trajectory model. Bulk filter samples were analyzed for their total carbon and nitrogen content and stable isotope composition and radiocarbon content with EA-IRMS and AMS. EC was isolated on a modified Sunset OC/EC analyzer with the Swiss_4S protocol, converted to graphite using a small-sample closed-tube zinc-reduction method, and analyzed with AMS.

Preliminary analyses show that bulk aerosol ranged in composition from pristine to 6 ug C m-3 (good AQI) and 0.5 ug N m-3, with C/N-ratio of 19 to 54. δ13C values were typical for emissions from C3-biomass (-23 to 27 ‰), with δ15N values ranging from 5 to 14 ‰. Analyses of radiocarbon in TC show significant contributions of fossil sources to the TC burden (10-80%) that are significantly greater than reported for other parts of the Arctic. Together, our data will enhance our understanding of the sources and seasonal dynamics of air pollution in Canada’s oil sands region.

Student Submission

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