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Developing OC/EC Separation Equipment for Accurate Radiocarbon Source Attribution and Carbon Cycle Modelling

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The Rafter Radiocarbon Lab, through the CarbonWatch-Urban project, is developing detailed CO2 emissions information for all towns and cities in New Zealand. Tracking fossil fuel CO2 emissions traditionally involves radiocarbon measurements of atmospheric CO_2 to separate fossil fuel from natural CO2 fluxes. In contrast, this study aims to further separate CO2 and carbon monoxide (CO) from wood burning and fossil fuel combustion sources utilizing aethalometer and radiocarbon measurements of organic carbon (OC) and elemental carbon (EC) derived from aerosol samples. An aethalometer measures black carbon absorption at multiple wavelengths, allowing separation of black carbon derived from fossil fuel and biogenic (wood burning) combustion. Radiocarbon measurements are essential to calibrate the aethalometer separation of biogenic and fossil black carbon. These measurements will together be used in a tracer ratio approach to partition CO2 and CO from these sources. This is particularly important in New Zealand cities, where there is a substantial CO2 and CO source from wood burning used for home heating.

This study proposes the use of an advanced pre-treatment process based on the methodology developed by Dusek et al (2014), which involves the thermal separation of OC and EC at specific temperatures under oxygen gas flow. The samples will be heated in a controlled environment in oxygen atmosphere, with OC combusted at lower temperatures and EC at higher ones, ensuring precise separation. The resultant CO_2 from each fraction will then be subjected to radiocarbon analysis. Our OC/EC thermal separation system is built as an additional module of an existing vacuum system designed for ramped pyrolysis radiocarbon separation, taking advantage of the similar equipment needed.

This approach not only supports more effective environmental policies and interventions but also enhances our understanding of the complex dynamics of carbon in the atmosphere. This research underscores the importance of advanced analytical techniques in environmental science, particularly in the context of climate change mitigation and air quality management.

Student Submission

No

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