Reconstructing Urban Fossil Fuel Carbon Dioxide emissions Utilizing the Radiocarbon Composition of Tree Rings from the Wellington Region, New Zealand

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This study demonstrates the utility of tree ring radiocarbon analysis to quantify a temporal record of recently-added fossil fuel-derived carbon dioxide (CO_{2ff}) in the urban atmosphere, to retrospectively measure emissions and potentially validate local emissions inventories. Measurements of the carbon-14 (^{14}C) content of cellulose from the annual tree rings of a Kauri tree (*Agathis australis*), located in the downtown area of the Wellington suburb of Lower Hutt, have been used to reconstruct a retrospective record of CO_{2ff}. We compare this record with tree rings from two Kauri located at a nearby coastal site and the long-term clear air $^{14}CO_2$ record from Baring Head, 11km from the test site.

This study showed increasing trends of CO_{2ff} over time at the urban location, which becomes apparent from the mid-1980s. The observations were compared qualitatively with meteorological data and socioeconomic variables (census tract, population and vehicle statistics) to assess mechanisms of variability of CO_{2ff}. With this study we aim to demonstrate how this technique can be used to assist municipalities to ensure accurate emissions quantification, allowing appropriate reduction and development strategies to be established.

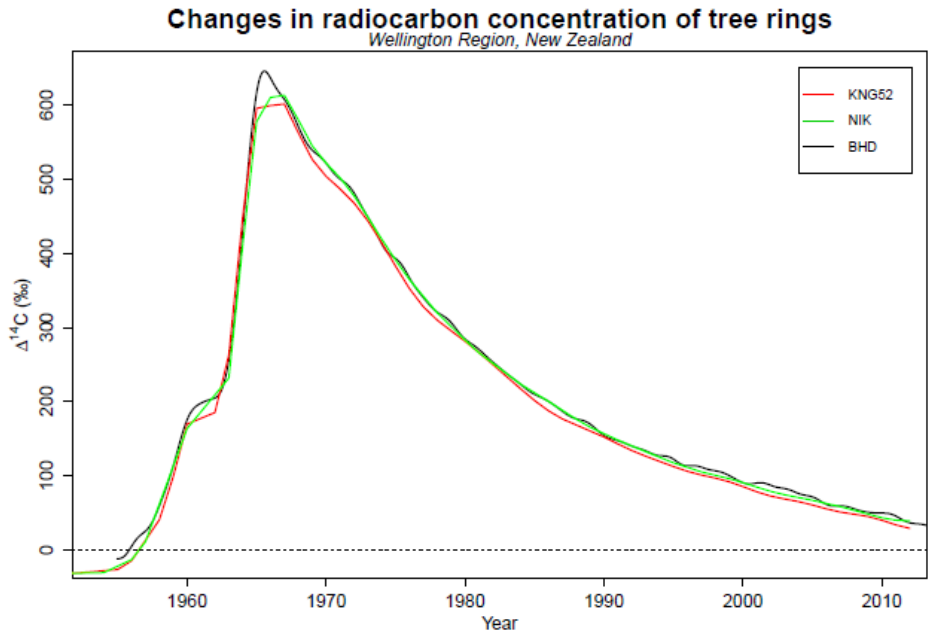

Figure 1. $\Delta^{14}CO_2$ of urban tree rings (KNG 52; red) compared with the Baring Head clean air record (BHD; black) and tree ring measurements representative of background atmosphere (NIK; green). The KNG52 record exhibits a decrease in $\Delta^{14}CO_2$ corresponding to an increase in ^{14}C-depleted fossil fuel emissions in the Wellington Region, New Zealand. Pre-1960, a natural level of ^{14}C existed – with cosmogenic production balancing radioactive decay. The "bomb spike" produced by atmospheric weapons testing occurs at 1965 due to the site location in the Southern Hemisphere. The post-bomb era sees uptake of bomb ^{14}C by oceans and terrestrial biosphere. Additions of ^{14}C-depleted CO_{2ff} becomes dominant in the KNG52 record from 1980 onwards.