IF THESE TREES COULD TALK

Reconstructing urban CO_2 emissions utilising the radiocarbon composition of tree rings from the Wellington Region, New Zealand

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INTRODUCTION

This study demonstrates the utility of tree ring radiocarbon analysis to quantify a temporal record of recently-added fossil fuel-derived CO_2 (CO_{2ff}) in the urban atmosphere, to retrospectively measure emissions and potentially validate local emissions inventories.

Measurements of the ^{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.

METHODS

1. Dendrochronology
Counting of annual growth rings to establish chronology

2. Sample Preparation
Wood samples prepared using a scalpel to cut into slivers

3. Chemical pre-treatment
Rafter organic solvent washes followed by the ANSTO cellulose extraction technique

4. Sample measurement
EA combustion, graphitisation and AMS analysis

5. Data analysis
Fossil fuel calculations with biosphere correction

RESULTS + DISCUSSION

1

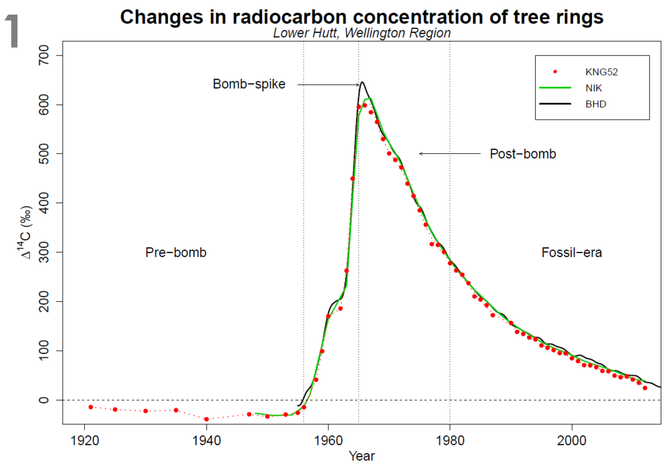

Figure 1:
$\Delta^{14}CO_2$ of urban tree rings (KNG52; red) compared with the Baring Head clean air record (BHD; black) and tree ring measurements representative of background atmosphere (NIK; green). The KNG52 record exhibits a decrease in $\Delta^{14}CO_2$ corresponding to an increase in ^{14}C-depleted fossil fuel emissions.

Pre-1960, a natural level of ^{14}C existed - with cosmogenic production balancing radioactive decay. The "bomb spike", occurs at 1965 due to Southern Hemispheric site location. Post-bomb era sees uptake of bomb ^{14}C by oceans and terrestrial biosphere. Additions of ^{14}C-depleted fossil fuel CO_2 becomes dominant in the KNG52 record from the 1980's.

2

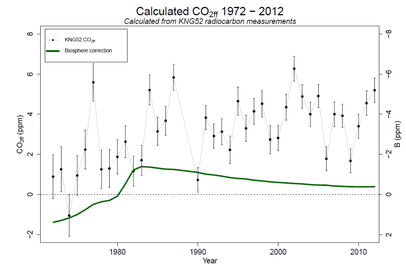

Figure 2:
The CO_{2ff} record was calculated using this equation:

$$CO_{2ff} = \frac{CO_{2bg}(\Delta_{obs} - \Delta_{bg})}{\Delta_{ff} - \Delta_{bg}} - \beta$$

β is the biospheric effect (green line), which became less prominent from the 1980s when CO_{2ff} dominates.

3

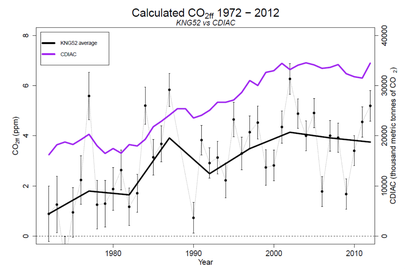

Figure 3:
The averaged KNG52 CO_{2ff} record was compared with New Zealand CO_2 data collated by CDIAC. Both sets of data appear to approximately double over time.

CONCLUSIONS

- NIK provides an accurate record of background $^{14}CO_2$,
- Calculations of CO_{2ff} (derived from the KNG52 $^{14}CO_2$ record) doubles in concentration over a 40-year period.

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