

CARS OR TREES:

Which Contribute More to Particulate Matter Air Pollution?

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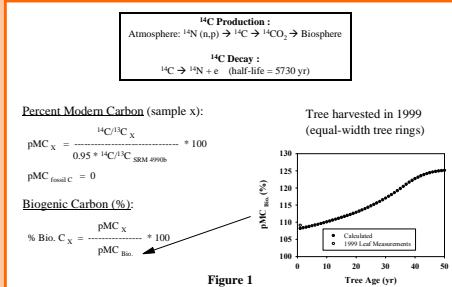
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WHAT DID WE MEASURE?

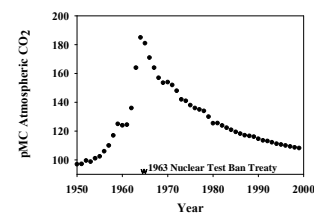
The Radiocarbon Method

- Naturally-occurring radioactive carbon (¹⁴C) is present at trace levels in all living material, resulting from the photosynthesis of atmospheric carbon dioxide that contains ¹⁴C.
- ¹⁴C is not present in fossil fuels (coal, petroleum, natural gas) due to its radioactive decay.
- percent Modern Carbon (pMC) = percentage of ¹⁴C in a sample of unknown origin relative to that in a sample of living material.
- pMC ~ percentage of carbon in a sample that originated from non-fossil (biogenic) sources.
- pMC has been increased above natural levels by nuclear weapons testing during the 1950's and 1960's (a correction can be applied).
(see details below)

¹⁴C Basics



pMC Atmospheric CO₂ vs. Year



WHERE DID WE MEASURE?

Field Sampling in Nashville TN and Houston TX

Samples of air particles were collected at a rural site (Figure 3) near Nashville TN under the following conditions:

- Cornelia Fort Airport, 8 km east of Nashville urban center
- June 21 – July 14, 1999
- 11.5-hr sample durations, starting 7 am & 7 pm
- PM_{2.5} sampling system: 300 L min⁻¹, 90-mm dia. quartz filter

During the following summer, August 9 – 30, 2000, similar sampling was performed at three suburban/rural sites – Aldine, Conroe, & Galveston – near Houston TX (Figure 4).

Cornelia Fort Airport site (Nashville)



Figure 3

Houston-Galveston-Conroe PM_{2.5} Sampling Sites



Figure 4

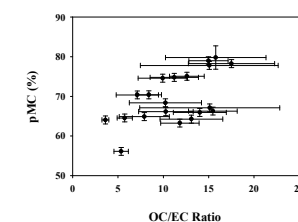
WHAT DID WE FIND?

pMC Results

The table below summarizes the pMC results from radiocarbon measurements performed on the samples from the two field studies. The values are surprisingly high, implying a correspondingly high biogenic contribution to the total carbon contained in the samples.

	Nashville	Houston
pMC range (%)	56 - 80	27 - 77
pMC mean (%)	69	55

pMC (Total Carbon) vs OC/EC (Nashville, 1999)



Definitions

Secondary Organic Aerosol (SOA): carbon-containing particles formed in the atmosphere from volatile organic compounds (VOC), rather than emitted from sources directly as particles (primary aerosol).

Elemental Carbon (EC): refractory, graphitic, light-absorbing component of total carbon (TC).

Organic Carbon (OC): all remaining carbon (OC = TC – EC).

Secondary Organic Aerosol (SOA) Interpretation

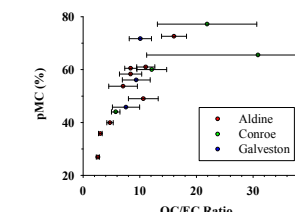
The "OC/EC ratio" is commonly regarded as being an SOA indicator.* A ratio greater than (OC/EC)₀ = 2 – 4 indicates the onset of SOA, and the larger the ratio, the larger the relative contribution of SOA:

$$SOA/OC = 1 - (OC/EC)_0 / (OC/EC)$$

In Figures 5 and 6 the individual Nashville and Houston pMC results are given, plotted against the OC/EC ratio for each sample. For both field studies most of the samples have an OC/EC ratio that is well above the onset of SOA. Furthermore, the greater the amount of inferred SOA, the greater the biogenic percentage (~ pMC) of the sample's carbon content.

* Atmospheric Environment 25A, 207 (1991)

pMC (Total Carbon) vs OC/EC (Houston, 2000)



J. Geophys. Res. 107(D22), 4613 (2002)

BOTTOM LINE

- Results from two regions show large biogenic contributions – in the form of Secondary Organic Aerosol – to the carbon component of PM_{2.5}
- Regulatory-based attempts to control PM_{2.5} only affect man-made sources and will not control biogenically-produced PM_{2.5}

