Paper archives reveal pollution's history

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A new source of climate records is as close as the nearest university library: Back issues of magazines reveal the rise in atmospheric CO2 from burning fossil fuels.

Some of the history preserved in old tomes and newspapers may be hiding in between the lines of print. A Weizmann Institute scientist has found that the paper in such collections contains a record of atmospheric conditions at the time the trees that went into making it were growing. By analyzing the carbon isotopes in bits of paper clipped from old magazines, Prof. Dan Yakir of the Environmental Sciences and Energy Research Department in the Faculty of Chemistry has traced the rising effects of atmospheric pollution from burning fossil fuel going back to beginnings of the industrial revolution.

Scientists generally reconstruct the record of past climate change from such sources as ice cores or tree rings. But a reliable tree ring history, says Yakir, requires an analysis of quite a few trees. "Rather than going to forests all over the world to sample trees," says Yakir, "we went to the local library." In the Weizmann library's archives, Yakir found issues of the scientific journals Science, Nature and the Journal of the Royal Chemical Society going back over 100 years to the late 19th century. Removing small samples from the margins of successive volumes, he took them back to the lab for analysis.

The analysis was based on a finding that the proportion of a carbon isotope – carbon 13 (13C) – to its lighter counterpart – carbon 12 (12C) – could provide information on the CO2 added to the atmosphere from

burning fossil fuel. This is based on a cycle that begins with plants taking up CO2 in photosynthesis. All plants prefer to use CO2 made with the more common version of carbon, 12C, than the slightly heavier 13C. Plant biomass from millions of years ago was transformed into reservoirs of oil, gas and coal, and so these are naturally low in 13C, as well. When we started to burn those reservoirs following the industrial revolution, we began returning the 13C-poor CO2 to the atmosphere. Now the atmospheric 13C content has become increasingly diluted, and this is reflected in the carbon ratios in the trees milled for pulp and paper. Yakir's work shows that this continuing dilution is, indeed, clearly recorded in the archival paper and, plotted over time, it demonstrates the increasing intensity of our fossil fuel burning in the past 150 years.

This project has been ongoing for about 14 years, with figures from new issues added over time. In the process, says Yakir, he has had to learn something about the paper industry. Some early issues, for instance, had been printed on rag paper (made of cotton, flax, etc.) rather than wood pulp, while blips in the data around the time of WWII led Yakir to suspect that the paper was either recycled, or again supplemented with rag content to make up for wartime shortages.

Anomalies aside, 13C levels in the paper, especially for two of the journals, were a good match for existing atmospheric records, and even revealed some local phenomena, including differences between American and European records. In addition to alerting climate scientists to a very well organized, untapped, source of global change records, says Yakir, the technique could be used to authenticate antique paper samples.

Provided by Weizmann Institute of Science