Measuring CO2 to fight global warming: Scientists develop way to enforce future greenhouse gas treaty

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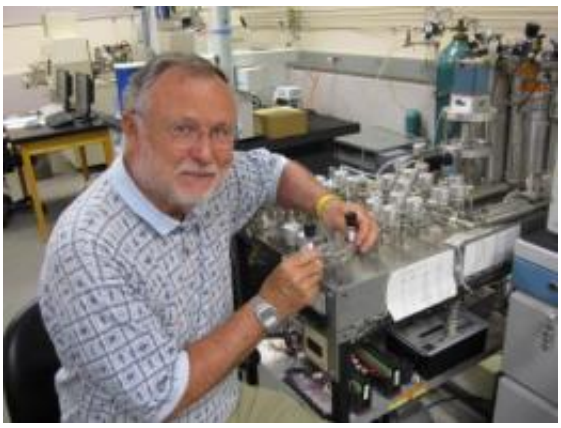

University of Utah biologist Jim Ehleringer and colleagues at Harvard developed a new method to estimate carbon dioxide emissions and thus verify compliance with a greenhouse gas treaty -- if the nations of the world ever agree to limit emissions of the climate-warming gas. Credit: Lee J. Siegel, University of Utah

If the world's nations ever sign a treaty to limit emissions of climate-warming carbon dioxide gas, there may be a way to help verify compliance: a new method developed by scientists from the University of Utah and Harvard.

Using measurements from only three carbon-dioxide (CO_2) monitoring stations in the Salt Lake Valley, the method could reliably detect changes in CO_2 emissions of 15 percent or more, the researchers report in the

online edition of the Proceedings of the National Academy of Sciences for the week of May 14, 2012.

The method is a proof-of-concept first step even though it is less precise than the 5 percent accuracy recommended by a National Academy of Sciences panel in 2010. The study's authors say satellite monitoring of carbon dioxide levels ultimately may be more accurate than the ground-based method developed in the new study.

"The primary motivation for the study was to take high-quality data of atmospheric CO_2 in an urban region and ask if you could predict the emissions patterns based on CO_2 concentrations in the air," says study coauthor Jim Ehleringer, a distinguished professor of biology at the University of Utah.

"The ultimate use is to verify CO_2 emissions in the event that the world's nations agree to a treaty to limit such emissions," he says. "The idea is can you combine concentration information – CO_2 in the air near the ground – and weather patterns, which is wind blowing, and mathematically determine emissions based on that information."

Ehleringer did the study with four Massachusetts atmospheric scientists: Kathryn McKain and Steven Wofsy of Harvard University, and Thomas Nehrkorn and Janusz Eluszkiewicz of Atmospheric and Environmental Research, Inc.

While the method can detect changes of 15 percent or more in CO_2 levels, determining absolute levels is tricky and depends on certain assumptions, but it can be done, Ehleringer says.

"The model [new method] predicts more CO_2 emissions than we see," based on a federal government survey that previously estimated carbon dioxide emissions based on interviews with gas- and coal-burning

utilities and sellers of fuel and natural gas, he says. "That shouldn't surprise you. People are underreporting."

Estimating CO_2 Emissions

Ehleringer began monitoring carbon dioxide levels in the Salt Lake Valley in 2002 as part of a National Science Foundation-funded study of the urban airshed. The monitoring network measures CO_2 from six sites across the Salt Lake Valley and a seventh well above the valley at Snowbird.

"It is the most extensive publicly available and online data set of CO_2 concentrations in an urban area in the world," he says (co2.utah.edu).

The new study created a computer simulation of CO_2 emissions in the Salt Lake Valley using three sources of information:

- CO_2 measurements from three sites – the University of Utah, downtown Salt Lake City and Murray, Utah, about halfway south down the valley's length.
- Data from weather stations in the valley, crunched through weather forecasting software used to predict wind and air circulation.
- Satellite data showing what parts of the valley are covered by homes, other buildings, trees, agriculture and so on.

The emissions estimates from the simulation were compared with the results of the government survey that estimates CO_2 emissions.

"You come up with estimates for emissions that are within 15 percent or better of the actual emissions for the region," Ehleringer says.

Even though that is not as precise as desired by the National Academy of Sciences, "it is a very powerful first step," he adds. "However we would like to be within 5 percent for treaty verification purposes."

Because urban regions are major sources of CO_2, "a large fraction of a country's emissions likely emanate from such regions, and results from several representative cities over time could provide strong tests of claimed emission reductions at national or regional scales," the researchers write.

The simulation showed how ground-level CO_2 concentrations increased overnight when air was calm, and then decreased in the morning as sunlight mixed the air and plants consumed CO_2 due to photosynthesis. Sometimes the simulation failed to catch the exact time this mixing occurred.

That is part of the reason the researchers argue satellite measurements through a mile-thick vertical column of air may better estimate CO_2 concentrations and thus emissions by being less sensitive to ground-level variations close and far from emissions sources like smokestacks or intersections with idling vehicles.

Several satellites around the world now make limited CO_2 measurements. But the researchers write that "no presently planned satellite has the necessary orbit or targeting capability" for the desired urban CO_2 measurements.

Several previous studies looked at CO_2 levels in various cities, but none at the full urban scale or with accuracy near what is required for treaty verification, the researchers say. The only study that accurately measured an urban area's CO_2 emissions over time – in Heidelberg, Germany – did so with a method too expensive for routine use.

Ehleringer's part of the research was funded by the U.S. Department of Energy. The study says his coauthors were funded by NASA, the National Science Foundation and – without specifics – "by the U.S. intelligence community," which would be involved in treaty verification.

Provided by University of Utah

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