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Dioxins and PCBs in rural areas

New measurements of dioxins and PCBs in ambient air over rural and remote regions of the U.S. show background levels and possible trends.

Several decades ago, industrial sites in the U.S., such as waste incinerators and paper pulp plants, spewed dioxins and related compounds into the atmosphere, polluting rural and urban areas alike. Years after regulations resulted in reduced emissions from those sources, cities have stepped in to become the latest suppliers of the toxic contaminants in rural air, according to new research published today on *ES&T*'s Research ASAP website (DOI: 10.1021/es0616736).

U.S. EPA

More than 30 sites across the U.S., including this one near Ozette Lake in Olympia National Park, track dioxins and PCBs in rural and urban air.

Following Clean Air Act requirements to control the releases of dioxins and PCBs from industrial sites, scientists predicted that levels of these contaminants would drop significantly. Indeed, after controls were installed, those levels decreased. But by 1998, the contaminants leveled out in the atmosphere, according to measurements taken by the National Dioxin Air Monitoring Network (NDAMN). In the following years, until 2002, NDAMN recorded minimal changes in those levels.

In the new *ES&T* research, David Cleverly of the U.S. EPA and his colleagues present 4.5 years of atmospheric measurements taken from 34 sites across the country, beginning in 1998. The team finds that the contaminants—polychlorinated dibenzo-*p*-dioxins (PCDDs), dioxin-like polychlorinated dibenzofurans (PCDFs), and coplanar PCBs—correlate with population density. Dioxins in particular, because of the similar distributions between cities and rural areas, appear to be spreading outward relatively quickly from urban centers. Cities, they conclude, seem to be creating plumes of the pollutants that can waft 160 kilometers (km) away, into rural and remote regions, to 1000 km and beyond.

"Higher amounts of PCBs observed in summer months are consistent with the theory that PCBs are volatilizing," particularly from soils and plants, says Cleverly. "Dioxins are not so easily explained by their chemical–physical properties, but a fair amount of work points to a primary removal process: hydroxyl interaction or photochemical interactions in the atmosphere."

Previous research suggests that during cooler weather, humans burn more fossil fuels and engage in other activities that increase ambient levels of potentially cancer-causing chemicals. These chemicals eventually get sequestered in animal fats. The team confirmed a slight increase in dioxins in winter and a decrease in summer, particularly in northern latitudes. Cleverly and co-workers, however, suggest that winter conditions dampen the atmospheric chemical reactions of hydroxyl radicals with dioxin and photolysis of the dioxins, leaving more of the compounds intact in winter air.

"It's interesting that they report pretty stable patterns in rural and urban areas—even over seasons," says Rainer Lohmann of the University of Rhode Island. The seasonal changes for dioxins are not significant, says Lohmann, who would like to see the data on the relative abundance of the different dioxins measured. "I doubt photolysis is as important as they think," he comments. Because of air travel times, measurements would have to be made much farther away from urban centers in order to catch the hydroxyl chemistry, which can take days, he says; therefore, vehicle traffic and other activities that change with the seasons cannot be ruled out yet as a source.

Still, "this study was a huge effort, producing the first data set of its kind," says Tom Harner, an Environment Canada research scientist who works on tracking persistent organic pollutants (POPs) at a global scale. "We now not only have a high-resolution picture of PCDD/F and co-PCB concentrations in ambient air across the U.S. but [also] how they vary with season and what the temporal trends are over several years."

The data can be used to test fate and transport models, particularly for the more volatile species that interact with hydroxyl radicals. And they eventually will be useful for assessing the success of regulations on the chemicals by establishing a baseline for future comparison, Harner says. They can also be used for future assessments under the Stockholm Convention of the UN Environment Programme, which lists PCBs and dioxins in the "dirty dozen" of global POPs.

Lohmann notes that the yearly stability of dioxin and PCB concentrations shows that the U.S. may have reached the limits of emissions controls on industrial plants and sites, particularly depending on what the current sources of dioxins turn out to be. "EPA has been very good at reducing emissions from big plants, and they are now much more diffuse: general traffic, household burning of waste and wood," and other "not very strong point sources," he says. Regulating those kinds of activities "is a political nightmare."
—NAOMI LUBICK
