PCBs

Transformer Storage Yard – Ying-Kuang Hsu

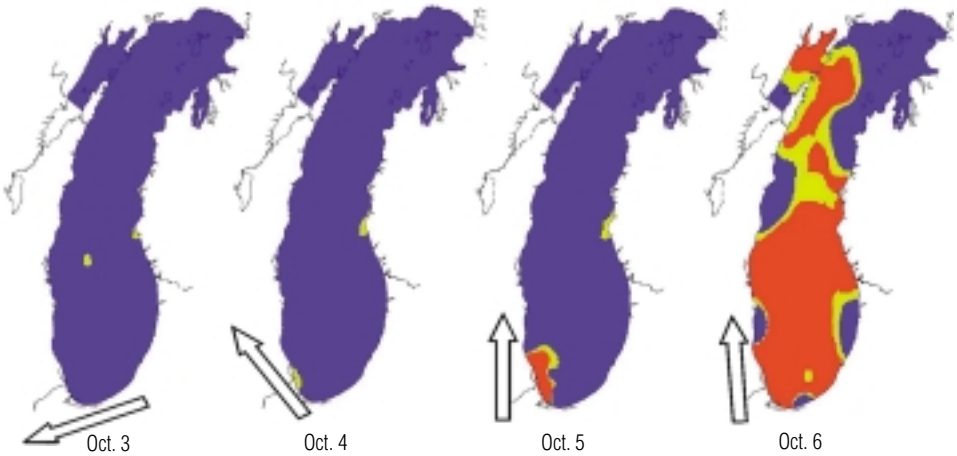
PCBs are a class of highly toxic, persistent and bioaccumulative compounds that were produced in the U.S. from 1927 to 1977 for insulating and cooling electrical equipment. New manufacturing and some uses were banned in 1979 but many of the PCBs originally produced remain in use[1]. The significant pathway for human exposure is through consumption of PCB contaminated fish. There are fish consumption advisories throughout Lake Michigan[2]. Atmospheric deposition accounts for over 80% of the PCBs that enter Lake Michigan[3]. The total annual deposition of PCBs to Lake Michigan is approximately 3,200 kg[4].

Urban industrial areas, such as the Chicago region, are considered to be a major source of PCBs to Lake Michigan. The Chicago region contributes an average of 10% of the gas phase deposition of PCBs[4]. Deposition of PCBs in the gas phase is dependent on temperature and wind direction. With winds from the south and higher temperatures, a plume of PCB deposition can extend from the Chicago region to cover the entire lake. Particle deposition of PCBs is also higher in urban areas but the deposition effects do not extend as far over the lake[2].

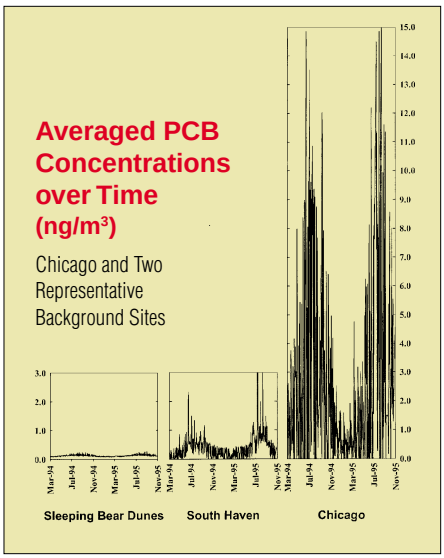
The maps (below left)[4] show the impact of PCB from the Chicago region on four consecutive days over Lake Michigan, beginning with October 3,1994. Red represents deposition into the lake. On October 5th and 6th the winds were predominately southerly and a PCB plume was observed entering the lake. The temperature rose on October 6th, from a three-day average of 13.6ºC to 17.9ºC (56º to 64º), causing the plume to extend over almost the entire lake[4].

The variability in concentrations for atmospheric PCBs from the Chicago region and other sites is a clear indication of volatilization from uncontrolled sources. The chart (below right) demonstrates PCB concentrations over time, comparing levels at a Chicago site with two examples of background sites: South Haven, a small city, and Sleeping Bear Dunes, a pristine site. A pattern of summer volatilization can be seen at each site but PCBs levels are typically elevated in the air of the Chicago region two to seven times higher than background levels[6,7,8]. Potential high emissions sources within urban areas include landfills, sludge drying beds, transformer storage yards, incinerators, and other highly contaminated sites[8].

Net Gas Exchange of Total PCBs



Red indicates deposition into the lake. Arrows indicate wind direction



PCBs continued

Recent monitoring and modeling efforts have been able to identify specific sources that are likely contributing to PCBs in the ambient atmosphere in the Chicago region. Upwind downwind air samples were used to confirm emissions from these sources. As demonstrated in the chart below, at Calumet East sludge drying beds of the Metropolitan Wastewater Reclamation District of Chicago, the CID Landfill, and a ComEd transformer storage yard in the Chicago region, downwind air samples show PCB levels to be elevated two to five times higher than in the upwind air, and up to 24 times higher than background levels[8]. Sources such as these may represent a significant fraction of the PCBs entering the air, which may then be deposited to the lake.

Upwind/Downwind PCB Concentrations (Hsu and Holsen 2000)

Date	Site	PCB concentration ng/m³ upwind	downwind	Level of Elevation
7/6/99	Calumet East Drying Beds	2.87	5.47	1.9
8/13/98	CID Landfill	NA	5.13	10X over background
7/4/99		1.93	3.99	2.1
8/16/99		1.23	2.47	2.0
8/14/98	ComEd Transformer Storage Yard	NA	11.89	24X over background
8/15/99am		1.41	2.11	1.5
8/15/99pm		1.33	2.73	2.1
8/17/99am		NA	3.29	6X over background
7/20/00am		1.21	6.49	5.4
7/20/00pm		1.53	8.07	5.3

Calumet East Drying Beds – Ying-Kuang Hsu

[1] BTS. 1999. *Polychlorinated Biphenyls (PCBs): Sources and Regulations.* Binational Toxics Strategy. (Draft) November.

[2] LaMP. 2000. *Lake Michigan Lakewide Management Plan (LaMP 2000).*

[3] EPA. 2000b. *Lake Michigan Mass Balance Results.*

[4] Hornbuckle, K.C. and Green, M.L. 2000. *The Impact of Chicago on Lake Michigan: Results of the Lake Michigan Mass Balance Study* (Unpublished). October.

[5] Green, M.L.; DePinto, J.V.; Sweet, C.; Hornbuckle, K.C. 2000. *Regional Spatial and Temporal Interpolation of Atmospheric PCBs: Interpretation of Lake Michigan Mass Balance Data.* Environmental Science and Technology. 34(9)1833-1841.

[6] Simcik, M.F. et al. 1997. *Urban Contamination of the Chicago/Coastal Lake Michigan Atmosphere by PCBs and PAHs During AEOLOS.* Environmental Science & Technology. 31(7)2141-2147.

[7] Keeler, G.L. 1994. *Project Summary: Lake Michigan Air Toxics Study.* U.S. EPA, Atmospheric Research and Exposure Assessment Laboratory. Research Triangle Park, North Carolina. EPA/SR-94/191. November.

[8] Hsu, Y.K. and Holsen, T.M. 2000. *The Use of Receptor Models to Locate Atmospheric Pollutant Sources: PCBs in Chicago* (Unpublished). Clarkson University, Department of Civil and Environmental Engineering.