THE NATIONAL DIOXIN AIR MONITORING NETWORK (NDAMN): RESULTS OF THE FIRST YEAR OF ATMOSPHERIC MEASUREMENTS OF CDDs, CDFs AND DIOXIN-LIKE PCBs IN RURAL AND AGRICULTURAL AREAS OF THE UNITED STATES: JUNE 1998 – JUNE 1999

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Introduction

The U.S. EPA has established a National Dioxin Air Monitoring Network (NDAMN) to determine the temporal and geographical variability of atmospheric CDDs, CDFs and dioxin-like PCBs at rural locations throughout the United States. Consisting of 29 sampling stations (Figure 1), NDAMN has three primary purposes: (1) to determine the atmospheric levels and occurrences of dioxin-like compounds in rural and agricultural areas where livestock, poultry and animal feed crops are grown; (2) to provide measurements of atmospheric levels of dioxin-like compounds in different geographic regions of the U.S.; and (3) to provide information regarding the long-range transport of dioxin-like compounds in air over the U.S. Designed in 1997, NDAMN has been implemented in phases, with the first phase consisting of 9 monitoring stations. The following is intended to report the air monitoring results of the first phase of NDAMN which operated from June 1998 to June 1999.

Methods

In 1997, a team of EPA and Versar scientists developed and designed NDAMN based on the following criteria: (1) NDAMN must provide reasonable geographical coverage of the continental U.S.; and (2) whenever possible, NDAMN sites are to be located in rural, wilderness and other non-impacted areas. To enhance cost savings, many of the sites were co-located at pre-existing air monitoring network stations located in rural areas. Twenty-nine stations were selected using these criteria (Figure 1). Due to the complexity in operation, and resource constraints, NDAMN is being implemented in phases. Phase 1 consists of an array of 10 monitors at 9 sites, which are identified as stations 1-10 on Figure 1. A duplicate sampler (station 2) is co-located at site 1. Each station consists of a PS-1 PUF sampler.[1] The sampling medium has two components: a quartz fiber filter (QFF) to collect and retain particulate matter (≥0.1 microns); and a polyurethane foam plug (PUF) to collect and retain gaseous phase compounds. In order to achieve a target 0.1 fg m^{-3} level of detection (LOD) necessary to avoid non-detects in air, the sampling moment was 24 days of sampling over a 28-day period, on a weekly schedule of 6 days of continuous operation followed by one day of inactivity. Each week, on the day the sampler was inactive, the QFF was harvested,

yielding 4 composite samples per sampling moment. The PUF was harvested once at the end of the sampling moment. Strict QA/QC procedures are described in the Quality Assurance Project Plan.[2] Sampling proceeded with a regime of sampling 24 days, every other month. This produced 6 sampling moments over the year: (1) 6/23/98 – 7/21/98; (2) 8/18/98 – 9/15/98; (3) 11/24/98 –12/22/98; (4) 1/26/99 – 2/23/99; (5) 3/23/99 – 4/20/99; and (6) 5/18/99 – 6/15/99. Although not perfectly aligned with seasons, such a scheme did encompass different climatic conditions. Samples were shipped to EPA's Environmental Chemistry Laboratory for extraction, clean-up and analysis with HRGC/HRMS in accordance with EPA Method 1613.[3] The analytes of interest in this monitoring program are the CDDs, CDFs substituted in the 2,3,7,8 positions on the molecule, and the coplanar PCBs (IUPAC PCB-77; PCB-105; PCB-118; PCB-126; PCB-156; PCB-157 and PCB-169).

Results

The following are the results of the first year of operation of NDAMN at 9 monitoring stations in the U.S. These are considered interim results; data interpretation may change in the future as data are collected over a longer time scale from all 29 sites in the network.

1. The overall annual average TEQ_{df}–WHO_{98} air concentration of CDDs, CDFs measured at nine rural stations is 12 fg m^{-3}. Other studies of rural areas of the U.S. found the following TEQ_{df}–WHO_{98} air concentrations: Ohio[4]: 22 fg m^{-3}; a mountain in Connecticut[5]: 10 fg m^3.
2. All congeners were detected in ambient air at a frequency >95% in rural locations.
3. There was a 6-fold range in TEQ_{df}–WHO_{98} annual average air concentrations from the lowest to the highest: 4.2 fg m^{-3} (station 8, Figure 1), and 25.4 fg m^{-3} (station 6). Figure 2 summarizes the annual average TEQ_{df}–WHO_{98} for all the 9 NDAMN stations.
4. Figures 3a and 3b show the variability of TEQ_{df}–WHO_{98} over 6 monitoring moments at the 9 stations. The data indicate a significant increase in TEQ_{df}–WHO_{98} across all stations during the November/December monitoring moment. The TEQ_{df}–WHO_{98} rises by up to 9-fold over the other moments of the year. The increase in TEQ is characterized by a large increase in actual measured concentrations of 1,2,3,7,8-PeCDD and 2,3,7,8-TCDD. Lohmann *et al.*[6] found a similar seasonal pattern in air monitoring in the U.K. and attributed it to seasonal changes in the predominant air mass movement carrying concentrated D/F from urban into rural areas. For the other sampling moments, TEQ_{df}–WHO_{98} varies from 2 to 17 fg m^{-3}, with the exception of station 6 (Monmouth, IL) and station 7 (McNay, IA), which remained elevated through March/April, 1999. The largest relative change (measured as the ratio of the winter concentrations to those of the prior sampling moment) occurs at station 8 (Lake Scott, KS.)
5. The PCB TEQ (WHO98) is small compared to D/F (range: 0.2 – 1.3 fg m^{-3}; mean: 0.7 fg m^{-3}). This comparison is displayed on Figure 2.

References

1. USEPA (1997). Compendium Method TO9a. EPA/625/R-96/010b.
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3. USEPA (1995). EPA 821-B-94-005.
4. State of Ohio EPA (1995). Dioxin Monitoring Study 1995. September 1995.
5. Hunt, G.T.; Maisel. B. (1995). Ambient monitoring for PCDDs/PCDFs in Connecticut – fall 1993 – summer 1994. State of Connecticut Dept. of Environmental Protection Doc. # 6350008500R1. Sept. 1995.
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FIGURE 1. Locations of NDAMN Stations

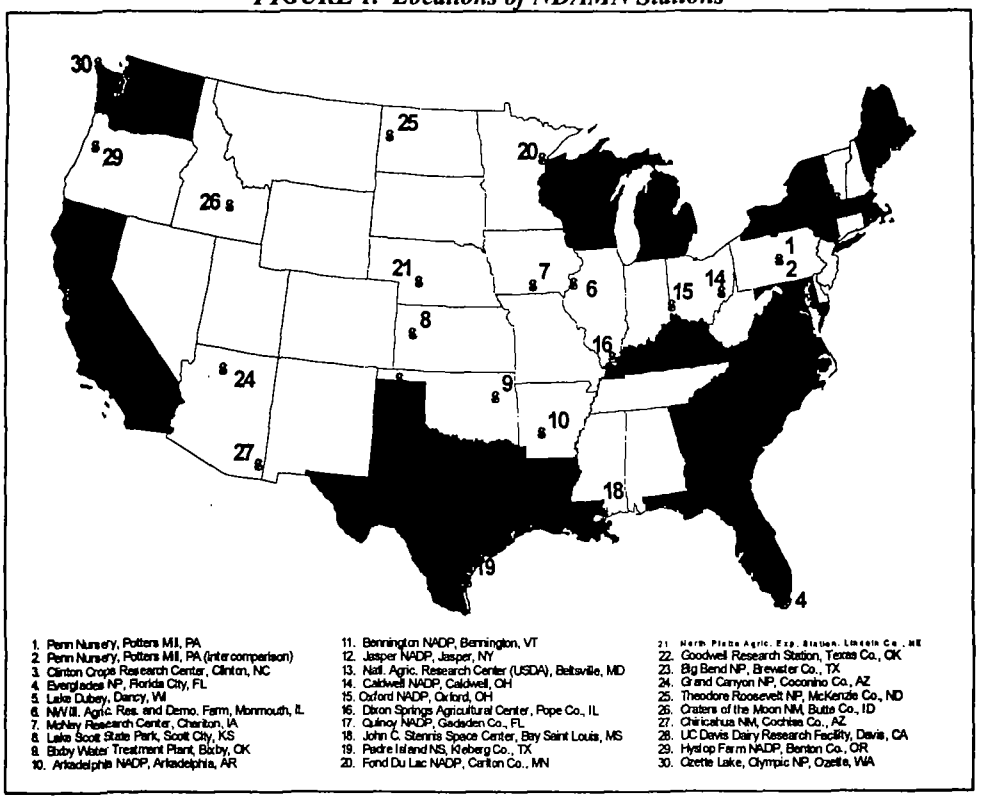

Figure 2. Annual Average Air Concentrations at 9 NDAMN Sites (femtogram per cu. m)

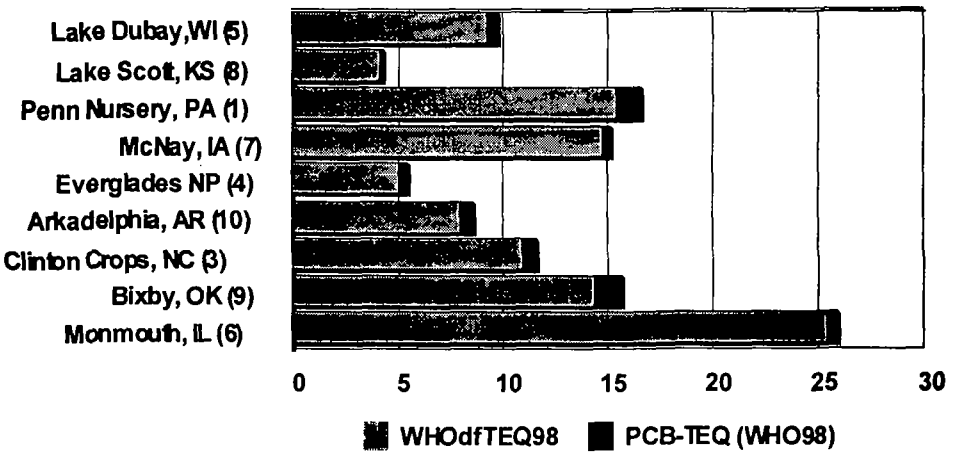

Figure 3. Seasonal WHOdf TEQ (fg/m3)