EIM Help - Atmospheric Deposition Data

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Before You Begin

Verify your data type

Atmospheric deposition data are always expressed as fluxes, concentration per area per unit of time (e.g., ng/m2/day). If your units don't contain time, your data are concentrations and not fluxes. Air concentration data include ambient indoor and outdoor air monitoring and soil gas monitoring. For concentration data, see the Air, Vapor, and Soil Gas Data help document.

Download EIM templates and help

Use the EIM Location and Results Help documents along with this document when you fill out the data templates. Download them here:

- Location Template
- Location Help
- Results Template
- Results Help

Atmospheric Deposition Basics

Definition and significance

Atmospheric deposition is the process by which gases or particles in the atmosphere deposit on soil, surface water, vegetation, and synthetic surfaces. These deposits can contain toxic chemicals and particles. They build up over time and become sources of environmental contamination. Land-deposited contamination can run off into waterways. Vegetation-deposited contamination can re-release into the air during wildfires, rendering the smoke more toxic. Atmospheric deposition is responsible for the worldwide distribution of certain contaminants.

Sources and types

Emissions from activities like farming, manufacturing, power generation, transportation, and burning emit contaminants into the atmosphere. Winds transport and deposit them near and far. Following are examples of atmospheric deposition.

Acid rain

Acid rain is the most familiar form of atmospheric deposition. The main source is fossil fuel burning for power generation and transportation, although agriculture contributes. The main components are nitrogen oxides (NOx), sulfur dioxide (SO2), and ammonia (NH3). When these particles fall from the atmosphere, they acidify the environment by lowering the pH. This harms certain plants and animals. It also leaches and concentrates metals like aluminum from soils, which can be toxic. Excess nitrogen (N) can cause rampant plant and algae growth, leading to oxygen starvation in lakes and streams.

Organic compounds and metals

Contaminants like volatile and semi-volatile organic compounds (e.g., pesticides, PCBs, and PAHs) and trace metals (e.g., arsenic, chromium, lead, and mercury) accumulate in sediment, soil, and water from atmospheric deposition. They can pose toxic threats to plants and animals, including humans. For example, some fish from lakes high in Olympic National Park contain levels of mercury unsafe for human consumption.

Emerging contaminants

Emerging contaminants are those recently recognized as threats to human health and the environment.

PFAS

Per- and polyfluoroalkyl substances (PFAS) include stain and water repellants and certain firefighting foams. Manufacturing and waste burning sends a significant quantity into the atmosphere. PFAS don’t easily break down. They bioaccumulate in the food chain. Levels build up in humans and animals over time. Examples of biological systems affected by PFAS include liver, reproductive, and thyroid.

Microplastics

Atmospheric deposition of microplastics (plastic particles smaller than 5 millimeters) is a growing area of study due to their ubiquity in the environment. Microfibers are the most common type. They are lightweight and easily picked up and distributed atmospherically. Aquatic and other organisms can mistake them for food. They can also often contain toxic chemicals like PFAS.

Modes of deposition

Atmospheric depositon occurs via three main modes: dry, wet, and bulk (Figure 1):

- **Dry:** Deposition of particles by dry-fall and gases by adsorption.
- **Wet:** Deposition of particles and gases by precipitation, including rain and snow.
- **Bulk:** Combined dry and wet deposition.

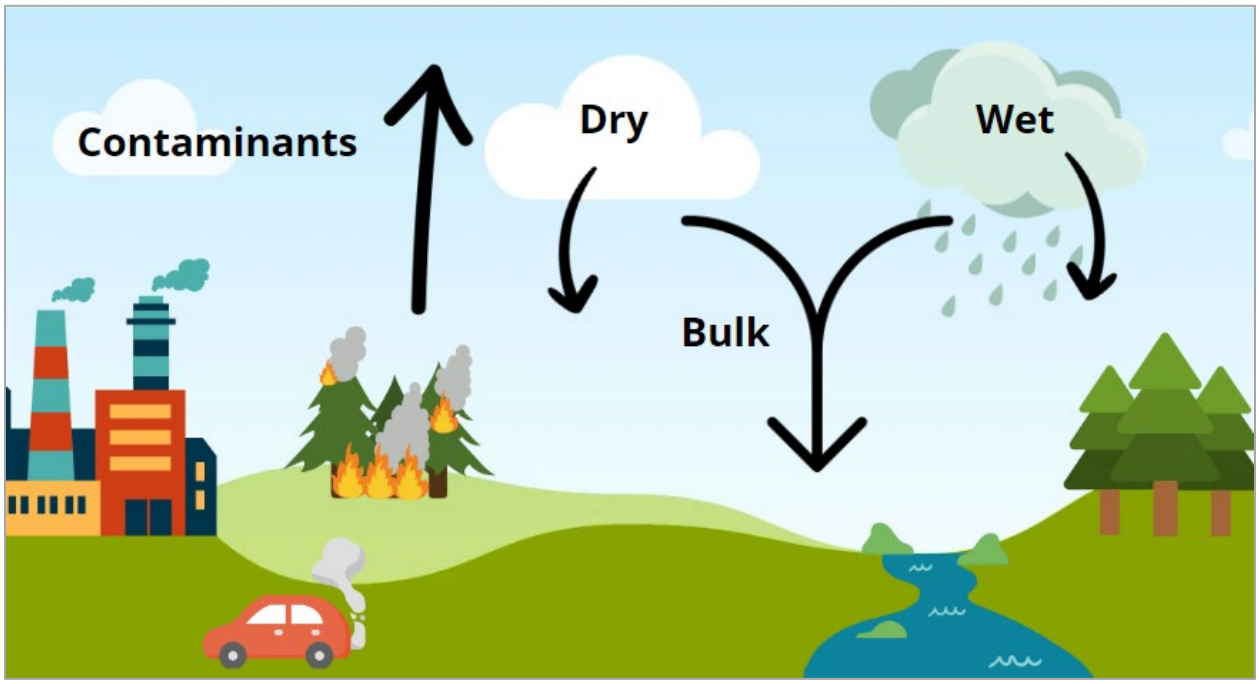

Figure 1: Atmospheric deposition cycle (Washington Department of Ecology, 2023)

Measurement

Determining atmospheric deposition involves measuring contaminant concentrations and calculating the amount transferred to a set surface area over time. This is called **flux**. Here's an example flux calculation showing concentration of a contaminant (nanograms per liter; ng/L) deposited in a square meter (m2) per day (day).

$$Concentration\ (ng/L) x\ Precipitation\ volume\ (L) + Sample\ rinse\ volume\ (L) / Funnel\ area\ (m2)\ /\ Deployment\ duration\ (days) = Flux\ (ng/m2\ day)$$

Collecting Atmospheric Deposition Data

Wet or dry deposition

Some samplers collect wet or dry samples. Others do both. A wet/dry deposition sampler has two collectors (Figure 2). Precipitation and dry particles fall into them. A retractable lid moves from side to side to cover the wet collector during dry periods or the dry collector during precipitation events. A moisture sensor controls the lid.

Figure 2: Wet/dry sampler with retractable lid, from the U.S. Department of Agriculture/National Atmospheric Deposition Program (NADP).

Bulk deposition

The funnel is the most common type of bulk deposition sampler. The funnel collects precipitation and dry particulates at the same time. Precipitation drains into a receptacle. Particulates get rinsed into the same receptacle with a known volume of water. The samplers are usually stainless steel or Teflon™. Funnel setups vary in level of sophistication. Figure 3 shows a more complex setup, with a secure, refrigerated receptacle. Figure 4 has several collectors optimized for several types of contaminants. Figure 5 shows a simple funnel and bucket collector.

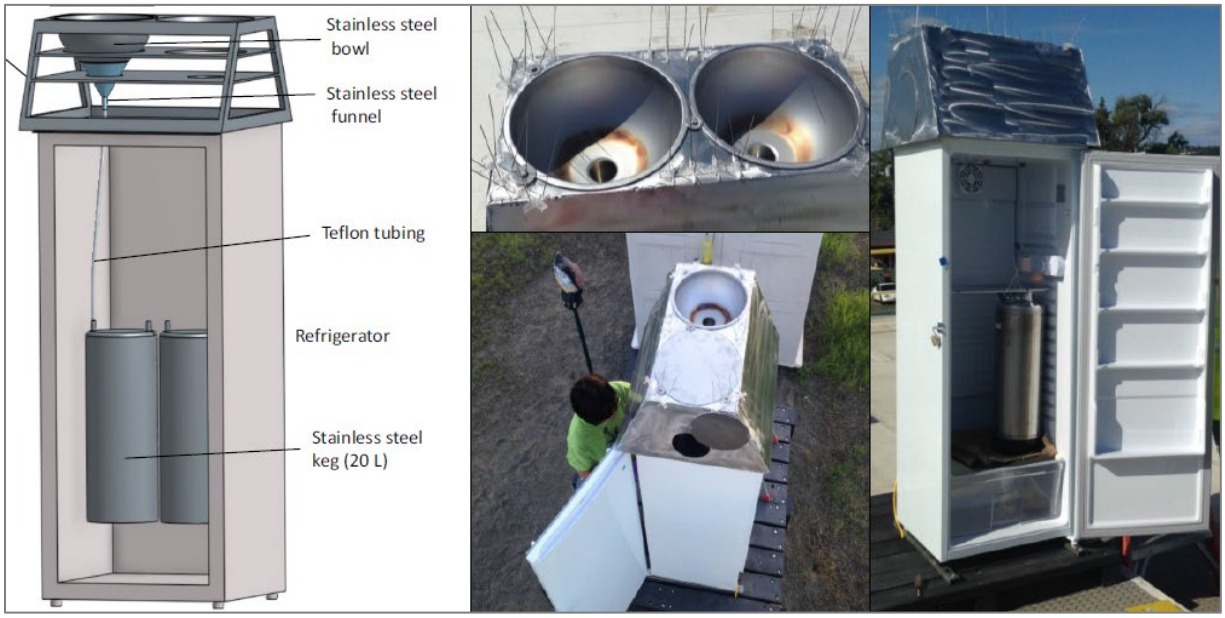

Figure 3: Dual-funnel bulk sampler with refrigerated collector keg, Department of Ecology, Era-Miller, et al., 2019.

Figure 4: Multi-funnel bulk sampler for organics, trace metals, and mercury, Department of Ecology, Brandenberger et al., 2010.

Figure 5: Single funnel and bucket bulk sampler, Department of Ecology, Bookter and Serdar, 2019.

How to Enter Your Data into EIM

Use the EIM Location and Results templates to fill out this information.

Locations

Use the Location Help document along with the following information.

- Location Setting (Column C) = “Air/Climate”

Results

Use the Results Help document along with the following information.

Type of data	Field Collection Type Valid values (Column D)	Sample Matrix Valid values (Column X)	Sample Source Valid values (Column Y)
Bulk Atmospheric Deposition	Sample	Air/Gas	Bulk Atmospheric Deposition
Dry Atmospheric Deposition	Sample	Air/Gas	Dry Atmospheric Deposition
Wet Atmospheric Deposition	Sample	Air/Gas	Wet Atmospheric Deposition

Note: Don’t enter “precipitation” for wet atmospheric deposition.

Common methods and units

Following are common examples of methods and units for atmospheric deposition data. If you don’t see the valid value you need, search for more methods or units online, or ask your EIM Data Coordinator.

Sample collection methods

Collection methods go in the Sample Collection Method field (Column AA) of the Results Template. See collection method examples below. Contact your EIM data coordinator if you need a method that better describes your sampling device. There are methods we don’t yet have in EIM.

Method category	Valid value example (Column AA, Results Template)	Description
Collection	AtmDepoFunnelSS	Stainless steel funnel and collector for wet, dry, and/or bulk atmospheric deposition.

Search for more Sample Collection Methods online.

Result (lab) methods

Laboratory analytical methods go in the Result Method field (Column AY) of the Results Template. The Result Method depends on the type of contaminants you targeted. See examples below.

Method category	Valid values (Column AY, Results Template)	Description
Sample	ASTM-D1946-90	Standard Practice for Analysis of Reformed Gas by Gas Chromatography.
Sample	MASSDEP-APH-01	Method for the Determination of Air-Phase Petroleum Hydrocarbons (APH) by GC/MS, Rev 1.

Search for more Result Methods online.

Result units

Result units go in the Result Value Units field (column AN) of the Results Template. For atmospheric deposition data, units are always expressed as flux - a concentration in an area per unit of time. See example below.

If your units don't contain time (e.g., day or year), they are considered concentrations and not fluxes. Enter your data following the Air, Vapor, and Soil Gas Data help document instead.

Valid value example (Column AN, Results Template)	Description
ng/m2/day	Nanograms per square meter per day

Search for more units online.

References

Bookter, A., and D. Serdar. 2019. Copper and Zinc in Urban Runoff: Phase 2 – Rainwater Washoff Monitoring. Washington State Department of Ecology, Olympia. Publication 19-03-008.

Brandenberger, J.M., P. Louchouarn, L.-J. Kuo, E.A. Crecelius, V. Cullinan, G.A. Gill, C. Garland, J. Williamson, and R. Dhammapala, 2010. Control of Toxic Chemicals in Puget Sound, Phase 3: Study of Atmospheric Deposition of Air Toxics to the Surface of Puget Sound. Prepared for the Washington State Department of Ecology, Air Quality Program, with Pacific Northwest National Laboratory and Naval Facilities Engineering Command. Washington State Department of Ecology, Olympia. Publication No. 10-02-012.

Era-Miller, B., S. Wong, and T. Ghidey, 2019. Atmospheric Deposition of PCBs in the Spokane River Watershed. Washington State Department of Ecology, Olympia. Publication 19-03-003.

Document Revision History

Revision date	Revision no.	Summary of changes	Reviser(s)
4/26/2023	1.0	Original draft	CN