Metadata

Dataset Title:

Cary_AQ_Chemistry_Data.csv

Cary Environmental Monitoring Program Air Quality Chemistry Data: 1984-2018

Abstract

The Cary Institute of Ecosystem Studies Environmental Monitoring Program is a long-term data collection program designed to understand how the environment changes over time. The program includes monitoring of climate including temperature and precipitation, as well as variables related to air pollution, such as acid deposition and ozone, water pollution and streamwater hydrology. The Cary Institute of Ecosystem Studies, Environmental Monitoring Program furnishes data under the following conditions: The data have received quality assurance scrutiny by our program, and, although we are confident of the accuracy of these data, the Cary Institute will not be held liable for errors in these data. Data are subject to change resulting from updates in data screening or models used. Data citation: The following is a standard citation for referencing data from the Cary Institute of Ecosystem Studies, Environmental Monitoring Program:

Cary Institute of Ecosystem Studies, Environmental Monitoring Program. 2019 (or current year). Cary Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545, www.caryinstitute.org.

Those wishing to publish data from the Cary Institute of Ecosystem Studies, Environmental Monitoring Program are encouraged to contact Data Manager Vicky Kelly, kellyv@caryinstitute.org.

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Keywords

Cary Institute, Cary Institute of Ecosystem Studies, data, climate, chemistry, dry deposition, air quality, sulfur dioxide, nitric acid vapor, aerosol, particulate matter, calcium, magnesium, potassium, sodium, chloride, sulfate, nitrate, ammonium, phosphate

Timeframe

The data in this file start January 1988 and end December 2018. Data collection is ongoing.

Geographic location

The air quality sampler is located in a flat, open field at an elevation of 128 m. GPS coordinates for the site are: N41.785823 W073.741447.

Methods

Aerosol concentrations, HNO3 and SO2 are sampled using Teflon filter packs. Three 47-mm diameter filters are placed in each filter pack: a Teflon filter (1988-February 2004 Zefluor, 2 micron, Gelman Sciences, Inc.; February 2004-present Whatman, 1 micron) for collection of aerosols, a Nylasorb 1 micron nylon filter (Gelman Sciences, Inc.) for collection of HNO3 vapor and a potassium carbonate-coated cellulose filter for collection of SO2. The cellulose filters are Whatman 41, >20-25 µm particle retention, coarse porosity,

ASTM, 12 sec, (Whatman number 1441-047). The cellulose filters are cleaned before coating by rinsing and soaking overnight in double-deionized water. The three filters are placed in line so that the Teflon filter is exposed to incoming ambient air first, the nylon filter second and the carbonate filter last. The filter packs are placed in an inverted stainless steel pot (from 1988 - July 1993 it was an inverted plastic funnel) on a tower approximately 10 m above a mowed grass surface. A continuous flow of air is drawn through the filter pack at 3.00 lpm using a Gast, Inc. oil-less vacuum pump (model 1031, upgraded to model 1531-107B-6288 in 1998), which is regulated by a mass flow controller (Tylan General Inc., model FC280V, upgraded to model FC2604S in 1998 and to Aalborg model GFC 17 in September 2002). When the mass flow controller is off line for any reason, either a needle valve or another mass flow controller regulates flow. During this time, flow is measured using a rotameter (Gilmont Instruments, Inc., or Scienceware®), and the flow measurements are corrected for instantaneous temperature and atmospheric pressure. Clean filter packs are exchanged for exposed ones every Tuesday.

The Teflon filters are extracted in 50 ml of double deionized water for 24 hours in the dark at 2 degrees C after sonication for 15 minutes. The solution is then decanted into sample bottles and analyzed at the Cary Institute for pH, nitrate, sulfate, ammonium, phosphate, Chloride, Sodium, Calcium, Magnesium and Potassium for determination of aerosol chemistry (see Table 1 for analytical methods). Nitric acid vapor is determined by extracting each nylon filter in 50 ml of a mixture of $NaHCO_3$ (0.28 M) and Na_2CO_3 (0.22 M) diluted 1:100 with double deionized water. The filters are sonicated for 15 minutes and then refrigerated for 24 hours before decanting the solutions and analyzing them for nitrate and sulfate. Sulfur dioxide is determined by extracting the carbonate-coated filters in 50 ml of double deionized water with 2 drops of hydrogen peroxide. The filters are sonicated and extracted as described above and the resulting solution is analyzed for sulfate. Concentrations of sulfate from the nylon and carbonate filters are added to determine total sulfur dioxide. From 1993-2015 all sample extractions were preserved with 2 drops of chloroform. No preservative was used from 2016 onward.

Using the total amount of time that each filter was exposed and the average flow rate for the week, weekly concentrations of each component are calculated. For samples that returned less than detection limit concentrations, one half the detection limit is used to calculate air concentrations. Monthly average deposition velocities were estimated for 1988-2013 using a multi-layer dry deposition model (Meyers, T.P., Finkelstein, P., Clarke, J., Ellestad, T.G., Sims, P.F. 1998. A multilayer model for inferring dry deposition using standard meteorological measurements. Journal of Geophysical Research 103: 22645-22661). Montly average deposition velocity values were used to estimate weekly average deposition velocities, which were combined with weekly concentrations to estimate weekly fluxes. Data sets include monthly mean air concentrations, monthly mean deposition velocities and monthly total deposition. For a descriptions of variables, see variable list with units below.

LOW-VOLUME FILTER PACK AIR CHEMISTRY DATA VARIABLE DESCRIPTIONS WITH UNITS

LOW-VOLUME FILTER PACK AIR CHEMISTRY INSTRUMENT MAKE, MODEL & DATES USED

Pump: Gast, Inc. oil-less vacuum pump model 1031 (1988-1998), model 1531-107B-6288 (1998- present)

Mass Flow Controller: Tylan-Millipore model FC280V (1988-1998) FC2604S (1998-2002) Aalborg GFC17 (2002-present)

LOW-VOLUME FILTER PACK AIR CHEMISTRY DATA QUALITY ASSURANCE & QUALITY CONTROL PARAMETERS & METHODS

All filter packs and bottles are cleaned by rinsing in deionized water 7 times, allowing to soak overnight in deionized water, rinsing again 4 times in deionized water and finally either dried in a drying oven at no more than 60 degrees C or allowed to sit with caps loosened (bottles) until dry. Every 12 months a filter

pack with a set of filters is exposed under a vacuum of 3.00 lpm for 3 minutes. The filter pack and filters are handled and analyzed as regularly exposed filters. This is to ensure that the sample handling procedures introduce no contamination.

When analytical results are received from the Cary Institute analytical lab, data are examined and checked using two methods. First, ion balances and ionic strength are calculated using the following equations:

Ion Balance = ((ANIONS - CATIONS)/((CATIONS+ANIONS)/2))*100;
Ion Strength = CATIONS + ANIONS;

Where:
Cations = CA/20 + MG/12 + NA/23 + K/39 + NH4/18 + HA;
Anions = NO3/62 + SO4/48 + CL/35.5;

And:
HA is teflon filter H+ conc (mg/l)
CA is teflon filter Ca concentration (mg/L)
MG is teflon filter Mg concentration (mg/L)
NA is teflon filter Na concentration (mg/L)
K is teflon filter K concentration (mg/L)
NO3 is teflon filter NO3 concentration (mg/L)
SO4 is teflon filter SO4 concentration (mg/L)
CL is teflon filter Cl concentration (mg/L)
NH4 is teflon filter NH4 concentration (mg/L)

HA is calculated as (10**PH)*1000, where PH = pH of teflon filter extractant.

Ion balances and ionic strength are examined and samples are considered for reanalysis if the following criteria are met:

  Ionic Strength (ueq) andIon Balance (%)
  Less than 50greater than 40
  Between 50 and 100greater than 20
  Greater than 100greater than 10

The second quality control step is to examine time series graphs of sample concentrations for each analyte. If any samples are obvious outliers, they are considered for reanalysis.

Analytical methods, instrument notes including calibration schedule, malfunctions and repairs, new instrumentation, anecdotal information etc. can be made available on request.

Data Table

Column name	Description	Unit or code explanation or date format	Empty value code
STARTDAY	day filter pack placed on tower	Datetime	empty cell
ENDDAY	day filter pack taken off tower	Datetime	empty cell
SO2	air concentration of gaseous SO2 (ug/m^3)	ug/m^3	empty cell
ACHNO3	air concentration of gaseous HNO3 (ug/m^3)	ug/m^3	empty cell

ACNO3	air concentration of particulate NO3 (ug/m^3)	ug/m^3	empty cell
ACNH4	air concentration of particulate NH4 (ug/m^3)	ug/m^3	empty cell
ACSO4	air concentration of particulate SO4 (ug/m^3)	ug/m^3	empty cell
ACCA	air concentration of particulate Ca (ug/m^3)	ug/m^3	empty cell
ACMG	air concentration of particulate Mg (ug/m^3)	ug/m^3	empty cell
ACNA	air concentration of particulate Na (ug/m^3)	ug/m^3	empty cell
ACK	air concentration of particulate K (ug/m^3)	ug/m^3	empty cell
ACCL	air concentration of particulate Cl (ug/m^3)	ug/m^3	empty cell
SO2FLUX	SO2 dry deposition for the week (mol/ha)	mol/ha	empty cell
HNH3FLUX	HNO3 vapor dry deposition for the week (mol/ha)	mol/ha	empty cell
NO3FLUX	NO3 particle dry deposition for the week (mol/ha)	mol/ha	empty cell
SO4FLUX	SO4 particle dry deposition for the week (mol/ha)	mol/ha	empty cell
NH4FLUX	NH4 particle dry deposition for the week (mol/ha)	mol/ha	empty cell
TOTAL_S	Total S dry deposition for the week (mol/ha)	mol/ha	empty cell
TOTAL_N	Total N dry deposition for the week (mol/ha)	mol/ha	empty cell
CAFLUX	Ca particle dry deposition for the week (mol/ha)	mol/ha	empty cell
MGFLUX	Mg particle dry deposition for the week (mol/ha)	mol/ha	empty cell
NAFLUX	Na particle dry deposition for the week (mol/ha)	mol/ha	empty cell
KFLUX	K particle dry deposition for the week (mol/ha)	mol/ha	empty cell
CLFLUX	Cl particle dry deposition for the week (mol/ha)	mol/ha	empty cell
VDSO2	deposition velocity for SO2 (cm/s)	cm/s	empty cell
VDHNO3	deposition velocity for HNO3 (cm/s)	cm/s	empty cell
VDTSP	deposition velocity for fine particles (cm/s)	cm/s	empty cell

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Methods of Analysis
Cary Institute of Ecosystem Studies Analytical
Laboratory

ION	INSTRUMENT	TECHNIQUE
$NH4^+$	Lachat QuikChem 8000	Phenate method[1] #10-107-06-1-J
$SO_4^=$, NO_3^- (PPT, AQ), Cl^-	Dionex ICS2000 Ion Chromatograph	Ion exchange chromatography, AS18 and AG18 columns, SRS (self-regenerating) suppressor[2] with CRD 200 (carbonate removal device)
K^+, Na^+	Perkin Elmer Aanalyst 300 Atomic Absorption Spectrometer	Flame atomization, direct air[3]
Ca^{++}, Mg^{++}	Leeman Labs Inductively Coupled Plasma/Profile	Emission spectroscopy
NO_3^- (WC)	Lachat QuikChem 8000	Cadmium diazotization[1] Method #10-107-04-1-C
PO_4	Lachat QuikChem 8000	Phosphomolybdate[1] Method #_10-115-01-1-M
pH	Fisher-Accumet AR20 pH meter with Fisher glass electrode, Fisher calomel reference probe	Standardization with Fisher 7.00 and 3.00 buffer solutions; samples and buffers at room temperature
Specific Conductance	Fisher-Accumet AR20 pH/conductivity meter	Conductivity probe w/ $1.0\ cm^{-1}$ cell constant
DOC (Dissolved Organic Carbon)	Shimadzu TOC 5050	High temperature combustion of sample; platinum catalyst C to CO2, NDIR detect.

[1] Standard Lachat methods, 2000, Lachat Instruments, Milwaukee, WI

[2] Small, H., Stevens, T.S., and Bauman, W.C. *Anal. Chem.* 1975, 47:1801-1809

[3] Slavin, W. *Atomic absorption spectroscopy.* Wiley-Interscience, New York. 1968. PPT=precipitation

samples, AQ=air samples, WC=Wappinger Creek samples

Updated 01/27/2006