

Title: ReadMe for CAVE 2019 PILS-IC data

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1.0. Data Set Description

Final data for the PILS-IC (Particle-into-Liquid Sampler-Ion Chromatography) measurements collected in Carlsbad Caverns National Park. PILS data status is final data. Data are collected every 30 min with a 13 min integration time. The data are reported at ambient conditions (i.e., not corrected for temperature and pressure). Measured species include:

- Glycolate
- Acetate
- Formate
- Chloride
- Nitrite
- Sulfate
- Oxalate
- Nitrate
- Sodium
- Ammonium
- Potassium
- Magnesium
- Calcium

Measurements were made at the Biology Office and Building 58 (32.18° N, 104.44° W) located within Carlsbad Caverns National Park. The field study took place from Jul. 25-Sept. 5, 2019.

Those interested in using these data are encouraged to contact the authors listed above for more information. In case of planned publication, we request that data users contact Jeff Collett (collett@colostate.edu) to discuss appropriate recognition of those that collected the data and the agencies that sponsored data collection.

2.0. Instrument Description

The composition of water-soluble inorganic cations, inorganic anions, and light organic acids in near real-time were measured using a PILS-IC system. The PILS collects ambient particles into purified water. After particles are grown inside the body of the PILS by mixing cool air with hot steam, the particles are collected by an impactor, and then washed off by a continuous flow of

liquid passed over the impactor, providing a liquid sample with the aerosol particles dissolved in it for analysis [Orsini *et al.*, 2003]. The PILS sampled ambient air at 15 LPM with a 2.5 μm size-cut cyclone. The PILS inlet was approximately 6 meters above ground level and co-located with the inlets for all other near real-time instruments involved in the study. Denuders coated with sodium carbonate and phosphorous acid were placed upstream of the PILS to remove inorganic gases.

3.0. Data Collection and Processing

For these measurements, the liquid sample from the PILS was split between two ICS-1500 ICs for analysis of anions/light organic acids and cations. Both systems utilized an isocratic pump, self-regenerating suppressor, and conductivity detector. Both ICs completed an analysis every 30 minutes with a sample loop fill time of 13 minutes. The cations were separated using a Dionex IonPac CS12A analytical (4×250 mm) column with eluent of 18 mM methanesulfonic acid at a flowrate of 1.0 mL/min. A Dionex IonPac AS15 analytical (4×250 mm) column using an eluent of 38 mM sodium hydroxide at a flowrate of 1.5 mL/min was used for the anion analysis. The ICs were calibrated using authentic standards before the study and a check standard was periodically injected during the study.

4.0. Data Format

Data can be found in the excel file named CAVE PILS-IC Data with LOD. The file contains the start time, end time, and concentrations for each of the species measured. All measurements are provided as ambient concentrations (i.e., are not corrected for temperature and pressure). The start and end times are provided in local time (LT), which is Mountain Daylight Time. All units are $\mu\text{g}/\text{m}^3$.

The limit of detection (LOD) for each measured species are:

Glycolate = $0.008 \mu\text{g}/\text{m}^3$

Acetate = $0.01 \mu\text{g}/\text{m}^3$

Formate = $0.01 \mu\text{g}/\text{m}^3$

Chloride = $0.01 \mu\text{g}/\text{m}^3$

Nitrite = $0.01 \mu\text{g}/\text{m}^3$

Sulfate = $0.01 \mu\text{g}/\text{m}^3$

Oxalate = $0.003 \mu\text{g}/\text{m}^3$

Nitrate = $0.01 \mu\text{g}/\text{m}^3$

Sodium = $0.01 \mu\text{g}/\text{m}^3$

Ammonium = $0.01 \mu\text{g}/\text{m}^3$

Potassium = $0.01 \mu\text{g}/\text{m}^3$

Magnesium = $0.008 \mu\text{g}/\text{m}^3$

Calcium = $0.01 \mu\text{g}/\text{m}^3$

A -8888 indicates data below the detection limit. A -9999 indicates missing data.

5.0. Data Remarks

Those interested in using these data are encouraged to contact the authors listed above for more information. In case of planned publication, we request that data users contact Jeff Collett

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6.0 Description of Variables

Variable Name	Units	Description	Time Resolution	Limit of Detection
ICStartDateTime (LT)	MM/DD/YYYY HH:MM	mountain time zone date time (24-hour)		
ICEndDateTime (LT)	MM/DD/YYYY HH:MM	mountain time zone date time (24-hour)		
Glycolate (ug/m3)	$\mu\text{g m}^{-3}$	Concentrations of 13 water-soluble PM _{2.5} species	13-minute integrated sample every 30 minutes	0.008 $\mu\text{g m}^{-3}$
Acetate (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Formate (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Chloride (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Nitrite (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Sulfate (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Oxalate (ug/m3)				0.003 $\mu\text{g m}^{-3}$
Nitrate (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Sodium (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Ammonium (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Potassium (ug/m3)				0.01 $\mu\text{g m}^{-3}$
Magnesium (ug/m3)				0.008 $\mu\text{g m}^{-3}$
Calcium (ug/m3)				0.01 $\mu\text{g m}^{-3}$

7.0. References

Orsini, D.A., Y. Ma, A. Sullivan, B. Sierau, K. Baumann, and R.J. Weber, Refinements to the particle-into-liquid sampler (PILS) for ground and airborne measurements of water-soluble aerosol composition, *Atmos. Environ.*, 37, 1243-1259, 2003.