Methane and Ethane Observations for Boston, MA, 2012-2020

Get Data

Documentation Revision Date: 2022-03-08

Dataset Version: 1

Summary

This dataset provides the hourly average of continuous atmospheric measurements of methane (CH4) from two urban sites and three boundary sites in and around Boston, Massachusetts, U.S., from September 2012-May 2020, measured with Picarro cavity ring down spectrometers (CRDS). Five-minute average atmospheric measurements of ethane (C2H6) and methane at Copley Square in Boston, MA, are also provided, with ethane measured with a laser spectrometer and methane measured with a Picarro CRDS. Background CH4 concentrations for the urban sites were determined using Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories at the boundary of the study region based on measurements at three boundary sites and wind direction from the North American Mesoscale Forecast System (NAM) 12-kilometer meteorology.

There are 3 data files in comma-separated values (*.csv) format included in this dataset.

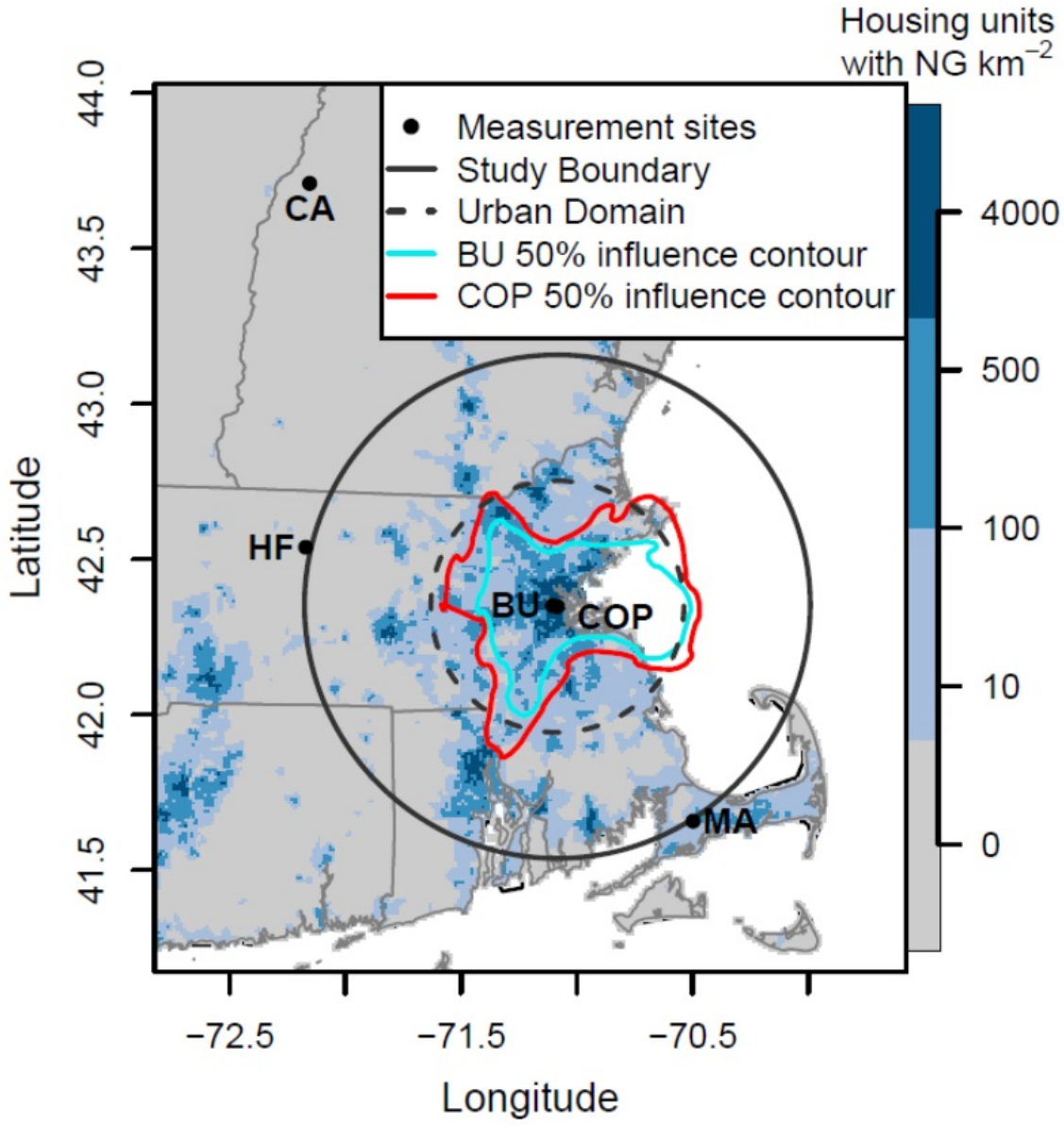

Figure 1. Map of measurement stations in the Boston network. The black line demarcates the 90 km radius circle in which emissions were optimized and the dashed line bounds the urban domain for study. The blue shading represents the number of housing units with natural gas (NG) per square kilometer. The red and blue contour encloses 50% of the average footprint (sensitivity area) initiated at the COP and BU sites, respectively. Source: Sargent et al. (2021)

Citation

Sargent, M., S.C. Wofsy, C. Floerchinger, J. Buddy, and E.W. Gottlieb. 2022. Methane and Ethane Observations for Boston, MA, 2012-2020. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1982

Table of Contents

1. Dataset Overview

This dataset provides the hourly average of continuous atmospheric measurements of methane (CH_4) from two urban sites and three boundary sites in and around Boston, Massachusetts, U.S., from September 2012—May 2020, measured with Picarro cavity ring down spectrometers (CRDS). Five-minute average atmospheric measurements of ethane (C_2H_6) and methane at Copley Square in Boston, MA, are also provided, with ethane measured with a laser spectrometer and methane measured with a Picarro CRDS. Background CH_4 concentrations for the urban sites were determined using Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories at the boundary of the study region based on measurements at three boundary sites and wind direction from the North American Mesoscale Forecast System (NAM) 12-kilometer meteorology.

Project: Carbon Monitoring System

The NASA Carbon Monitoring System (CMS) program is designed to make significant contributions in characterizing, quantifying, understanding, and predicting the evolution of global carbon sources and sinks through improved monitoring of carbon stocks and fluxes. The System uses NASA satellite

observations and modeling/analysis capabilities to establish the accuracy, quantitative uncertainties, and utility of products for supporting national and international policy, regulatory, and management activities. CMS data products are designed to inform near-term policy development and planning.

Related Publication

Sargent, M.R., C. Floerchinger, K. McKain, J. Budney, E. W. Gottlieb, L. R. Hutyra, J. Rudek and S. C. Wofsy. 2021. Majority of US urban natural gas emissions unaccounted for in inventories. PNAS 118:e2105804118. https://doi.org/10.1073/pnas.2105804118

Related Datasets

Sargent, M., S.C. Wofsy, and T. Nehrkorn. 2018. CO2 Observations, Modeled Emissions, and NAM-HYSPLIT Footprints, Boston MA, 2013-2014. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1586

- Contains continuous atmospheric measurements of CO_2 from the same five sites reported in this dataset.

Acknowledgments

Earth Networks, Inc. provided the Canaan, NH, and Mashpee, MA methane measurements. Funding for this study was provided by the National Oceanic and Atmospheric Administration Urban Awards NA20OAR4310303 and NA17OAR4310086; the Environmental Defense Fund; the National Aeronautics and Space Administration through OCO-2 Grant 1637874 and Carbon Monitoring System Award NNX16AP23G.

2. Data Characteristics

Spatial Coverage: Massachusetts and New Hampshire, U.S.

Spatial Resolution: Point measurements

Temporal Coverage: 2012-09-01 to 2020-05-30

Temporal Resolution: 5-minutes or 1 hour

Site Boundaries: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Massachusetts and New Hampshire, U.S.	-72.4	-69.8	43.71	41.5

Data File Information

There are 3 data files in comma-separated values (*.csv) format included in this dataset.

Table 1. File names and descriptions.

File Name	Description
MA_NH_CH4_obs_2012_2020.csv	Hourly average CH_4 observations from two urban sites (Boston University, MA and Copley Square, MA) and three boundary sites (Canaan, NH, Harvard Forest, MA, and Mashpee, MA).
copley_square_C2H6_CH4_obs_2019_2020.csv	Five-minute average atmospheric measurements of C_2H_6 and CH_4 at Copley Square during afternoon hours (16–21 h UTC; 11–16 h EST).
boundary_CH4_HYSPLIT_2012_2020.csv	Background CH_4 concentrations for the urban sites that were determined by HYSPLIT trajectories.

Data File Details

Missing data are represented by -9999.

Table 2. Variable names and descriptions for MA_NH_CH4_obs_2012_2020.csv.

Variable	Units	Description
Site		Site name
Date		Date in YYYY-MM-DD format
Hour		Hour of the day
Latitude	Decimal degrees	Latitude
Longitude	Decimal degrees	Longitude
Elevation	Meters	Elevation above sea level
Sampling_height	Meters	Height of sample observation
CH4_mean	ppb	Methane (CH4) concentration, hourly mean
CH4_median	ppb	Methane concentration, hourly median
CH4_variance	ppb	Methane concentration, hourly variance
CH4_n_obs		Methane concentration, hourly number of observations

Table 3. Variable names and descriptions for copley_square_C2H6_CH4_obs_2019_2020.csv.

Variable	Units	Description
Site		Site name

Date		Date in YYYY-MM-DD format
Time		Time of day
Latitude	Decimal degrees	Latitude
Longitude	Decimal degrees	Longitude
Elevation	Meters	Elevation above sea level
Sampling_height	Meters	Height of sample observation
CH4	ppb	Methane concentration, 5-minute average
C2H6	ppb	Ethane (C2H6) concentration, 5-minute average

Table 4. Variable names and descriptions for boundary_CH4_HYSPLIT_2012_2020.csv.

Variable	Units	Description
Date		Date in YYYY-MM-DD format
Hour		Hour of the day
cop_background	ppb	Estimated background CH4 at Copley Square site
bu_background	ppb	Estimated background CH4 at Boston University site

3. Application and Derivation

Methane and ethane observations from five sites in and around Boston and a high-resolution transport model were used to calculate methane and natural gas emissions for the urban region.

4. Quality Assessment

Uncertainty in hourly average CH_4 concentrations measured by a Picarro was estimated to be ~3 ppb from September 2012 to August 2013 and ~1 ppb from August 2013 to May 2020.

Total analytical uncertainty was approximated as the sum of measurement precision, uncertainty in calibration and surveillance tank values, and uncertainty in the H_2O correction.

5. Data Acquisition, Materials, and Methods

CH_4 concentrations were measured at 5 sites (Table 4; Fig. 1) using Picarro cavity ring down spectrometers. Sampling was conducted at two urban sites in Boston, Massachusetts, near the urban center, Boston University (BU) and Copley Square (COP), and three boundary locations 90–175 km outside of Boston at Harvard Forest in Petersham, Massachusetts (HF); Canaan, New Hampshire (CA); and Mashpee, Massachusetts (MA). BU, COP, and HF are operated by Harvard University, and CA and MA are operated by Earth Networks Inc. and the National Institute of Standards and Technology. Additionally, ethane was measured at COP with a laser spectrometer.

Table 5. Study site characteristics.

Site	Operator	Abbrev.	Latitude	Longitude	Elevation (m)	Sampling Height (m)
Copley Square	Harvard	COP	42.35	-70.08	6	215
Boston University	Harvard/BU	BU	42.35	-71.10	4	29
Harvard Forest	Harvard	HF	42.54	-72.17	340	29
Canaan, NH	ENI	CA	43.71	-72.15	559	100
Mashpee, MA	ENI	MA	41.66	-70.50	32	46

Background CH_4 concentrations for the urban sites were determined using Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories at the boundary of the study region. The HYSPLIT model released 500 particles that were tracked back in time based on wind direction from North American Mesoscale Forecast System (NAM) at 12 km resolution and the High-Resolution Rapid Refresh (HRRR) at 3 km resolution meteorology. Background concentrations are based on running 48 hr lower 20th percentile at each background site. Determining background CH_4 concentrations allows for estimation of CH_4 production within the boundary area

Detail can be found in Sargent et al. (2021).

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Methane and Ethane Observations for Boston, MA, 2012-2020

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

Sargent, M.R., C. Floerchinger, K. McKain, J. Budney, E.W. Gottlieb, L.R. Hutyra, J. Rudek and S.C. Wofsy. 2021. Majority of US urban natural gas emissions unaccounted for in inventories. PNAS 118:e2105804118. https://doi.org/10.1073/pnas.2105804118

Home

About Us
Mission
Data Use and Citation Policy
User Working Group
Partners

Get Data
Science Themes
NASA Projects
All Datasets

Submit Data
Submit Data Form
Data Scope and Acceptance
Data Authorship Policy
Data Publication Timeline
Detailed Submission Guidelines

Tools
MODIS
THREDDS
SDAT
Daymet
Airborne Data Visualizer
Soil Moisture Visualizer
Land - Water Checker

Resources
Learning
Data Management
News
Earthdata Forum

Contact Us