

Monthly atmospheric nitrous oxide (N₂O) and carbon monoxide (CO) mixing ratio measurements from San Cristobal, Galápagos Islands collected using a cavity ring-down spectrometer

Website: <https://www.bco-dmo.org/dataset/917743>

Data Type: Other Field Results

Version: 1

Version Date: 2024-01-22

Project

» [EAGER: Testing the Galápagos as a long-term monitoring site for nitrous oxide emissions from the Pacific oxygen deficient zones](#) (ETP ODZ mapping)

Contributors	Affiliation	Role
Babbin, Andrew R.	Massachusetts Institute of Technology (MIT)	Principal Investigator
Cinay, Timur	Massachusetts Institute of Technology (MIT)	Student
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract

This dataset includes atmospheric nitrous oxide (N₂O) and carbon monoxide (CO) mixing ratio measurements from San Cristobal, Galápagos Islands between July 18, 2023 and December 31, 2023. The data are collected using a cavity ring-down spectrometer (Picarro Inc., G5310).

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Coverage

Spatial Extent: Lat:-0.8956 Lon:-89.6087

Temporal Extent: 2023-07-18 - 2023-12-31

Dataset Description

This version of the dataset includes 6 NetCDF files, accessible below under "Data Files":

- (1) GAL202307_N2O_CO.nc for the time period 2023-07-18 to 2023-07-31 (yyyy-mm-dd)
- (2) GAL202308_N2O_CO.nc for the time period 2023-08-01 to 2023-08-31
- (3) GAL202309_N2O_CO.nc for the time period 2023-09-01 to 2023-09-30
- (4) GAL202310_N2O_CO.nc for the time period 2023-10-01 to 2023-10-31
- (5) GAL202311_N2O_CO.nc for the time period 2023-11-01 to 2023-11-30
- (6) GAL202312_N2O_CO.nc for the time period 2023-12-01 to 2023-12-31

Methods & Sampling

Ambient air samples are collected with a flow rate of 100 cubic centimeters (cm³ per minute from 27 meters (m) above sea level. The air is first filtered through a 0.7 micrometer (µm) Swagelok filter. Then, the air is dried using a Nafion tubing to a constant water content of approximately 600 parts per million (ppm) H₂O in a temperature-controlled setup at 34 degrees Celsius (°C). The air sample is then filtered through a 0.2 µm Swagelok filter. Finally, the nitrous oxide and carbon monoxide mole fractions (parts per billion (ppb)) are measured using Picarro Inc., G5310 Cavity Ring-down Spectrometer. GCWerks software is used to monitor and control the sampling process as well as export the measurement data. The NetCDF files are created using the Xarray package for Python 3.10.

Data Processing Description

Data are processed using GCWerks software. Raw data are calibrated based on measurements from the calibration gas cylinders provided by the National Oceanic and Atmospheric Administration (NOAA).

Problem Description

The gaps in the data correspond to the daily and monthly sampling of calibration cylinders and instrument downtimes due to communication or hardware-related issues.

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Data Files

File

2023-07-18 to 2023-07-31

filename: GAL202307_N2O_CO.nc

(NetCDF, 1.80 MB)

MD5:02b9f40a21704cb6d9ce578091344a5e

```
netcdf GAL202307_N2O_CO {
dimensions:
  time = 15596 ;
variables:
  double n2o_mean(time) ;
  n2o_mean:_FillValue = NaN ;
  n2o_mean:long_name = "mean nitrous oxide mole fraction" ;
  n2o_mean:units = "ppb" ;
  double n2o_stdev(time) ;
  n2o_stdev:_FillValue = NaN ;
  n2o_stdev:long_name = "nitrous oxide mole fraction standard deviation" ;
  n2o_stdev:units = "ppb" ;
  double n2o_number(time) ;
  n2o_number:_FillValue = NaN ;
  n2o_number:long_name = "number of n2o measurements averaged in each time stamp" ;
  n2o_number:units = "unitless" ;
  double co_mean(time) ;
  co_mean:_FillValue = NaN ;
  co_mean:long_name = "mean carbon monoxide mole fraction" ;
  co_mean:units = "ppb" ;
  double co_stdev(time) ;
  co_stdev:_FillValue = NaN ;
  co_stdev:long_name = "carbon monoxide mole fraction standard deviation" ;
  co_stdev:units = "ppb" ;
  double co_number(time) ;
  co_number:_FillValue = NaN ;
  co_number:long_name = "number of co measurements averaged in each time stamp" ;
  co_number:units = "unitless" ;
  string time_string(time) ;
  time_string:long_name = "Time stamp corresponding to the samping time in string format" ;
  time_string:timezone = "UTC" ;
  int64 time(time) ;
  time:timezone = "UTC" ;
  time:long_name = "Time stamp corresponding to the samping time" ;
  time:units = "minutes since 2023-07-18 16:21:00" ;
  time:calendar = "proleptic_gregorian" ;

// global attributes:
:Site = "San Crisotbal, Galapagos Islands, Ecuador" ;
:string :Latitude = "0.8956 °S " ;
:string :Longitude = "89.6087 °W" ;
:Inlet\ Height = "27 m above sea level" ;
:Contact = "tcinay[at]mit[dot]edu or babbins[at]mit[dot]edu" ;
:Instrument = "Picarro Inc. G5310 Cavity Ringdown Spectrometer" ;
:Software = "GCWerks" ;
}
```

File

2023-08-01 to 2023-08-31

filename: GAL202308_N2O_CO.nc

(NetCDF, 4.77 MB)

MD5:b917fc9748df48a86b1ab6332afc0e72

```
netcdf GAL202308_N2O_CO {
dimensions:
  time = 41505 ;
variables:
  double n2o_mean(time) ;
  n2o_mean:_FillValue = NaN ;
  n2o_mean:long_name = "mean nitrous oxide mole fraction" ;
  n2o_mean:units = "ppb" ;
  double n2o_stdev(time) ;
  n2o_stdev:_FillValue = NaN ;
  n2o_stdev:long_name = "nitrous oxide mole fraction standard deviation" ;
  n2o_stdev:units = "ppb" ;
  double n2o_number(time) ;
  n2o_number:_FillValue = NaN ;
  n2o_number:long_name = "number of n2o measurements averaged in each time stamp" ;
  n2o_number:units = "unitless" ;
  double co_mean(time) ;
  co_mean:_FillValue = NaN ;
  co_mean:long_name = "mean carbon monoxide mole fraction" ;
  co_mean:units = "ppb" ;
  double co_stdev(time) ;
  co_stdev:_FillValue = NaN ;
  co_stdev:long_name = "carbon monoxide mole fraction standard deviation" ;
  co_stdev:units = "ppb" ;
  double co_number(time) ;
  co_number:_FillValue = NaN ;
  co_number:long_name = "number of co measurements averaged in each time stamp" ;
  co_number:units = "unitless" ;
  string time_string(time) ;
  time_string:long_name = "Time stamp corresponding to the samping time in string format" ;
  time_string:timezone = "UTC" ;
  int64 time(time) ;
  time:timezone = "UTC" ;
  time:long_name = "Time stamp corresponding to the samping time" ;
  time:units = "minutes since 2023-08-01 15:18:00" ;
  time:calendar = "proleptic_gregorian" ;

// global attributes:
:Site = "San Crisotbal, Galapagos Islands, Ecuador" ;
:string :Latitude = "0.8956 °S " ;
:string :Longitude = "89.6087 °W" ;
:Inlet\ Height = "27 m above sea level" ;
:Contact = "tcinay[at]mit[dot]edu or babbins[at]mit[dot]edu" ;
:Instrument = "Picarro Inc. G5310 Cavity Ringdown Spectrometer" ;
:Software = "GCWerks" ;
}
```

File

2023-09-01 to 2023-09-30

filename: GAL202309_N2O_CO.nc

(NetCDF, 4.22 MB)

MD5:0ab1641565ea79af759ca8706a2fd661

```
netcdf GAL202309_N2O_CO {
dimensions:
  time = 42245 ;
variables:
  double n2o_mean(time) ;
  n2o_mean:_FillValue = NaN ;
  n2o_mean:long_name = "mean nitrous oxide mole fraction" ;
  n2o_mean:units = "ppb" ;
  double n2o_stdev(time) ;
  n2o_stdev:_FillValue = NaN ;
  n2o_stdev:long_name = "nitrous oxide mole fraction standard deviation" ;
  n2o_stdev:units = "ppb" ;
  double n2o_number(time) ;
  n2o_number:_FillValue = NaN ;
  n2o_number:long_name = "number of n2o measurements averaged in each time stamp" ;
  n2o_number:units = "unitless" ;
  double co_mean(time) ;
  co_mean:_FillValue = NaN ;
  co_mean:long_name = "mean carbon monoxide mole fraction" ;
  co_mean:units = "ppb" ;
  double co_stdev(time) ;
  co_stdev:_FillValue = NaN ;
  co_stdev:long_name = "carbon monoxide mole fraction standard deviation" ;
  co_stdev:units = "ppb" ;
  double co_number(time) ;
  co_number:_FillValue = NaN ;
  co_number:long_name = "number of co measurements averaged in each time stamp" ;
  co_number:units = "unitless" ;
  string time_string(time) ;
  time_string:long_name = "Time stamp corresponding to the samping time in string format" ;
  time_string:timezone = "UTC" ;
  int64 time(time) ;
  time:timezone = "UTC" ;
  time:long_name = "Time stamp corresponding to the samping time" ;
  time:units = "minutes since 2023-09-01 00:00:00" ;
  time:calendar = "proleptic_gregorian" ;

// global attributes:
:Site = "San Crisotbal, Galapagos Islands, Ecuador" ;
:string :Latitude = "0.8956 °S " ;
:string :Longitude = "89.6087 °W" ;
:Inlet\ Height = "27 m above sea level" ;
:Contact = "tcinay[at]mit[dot]edu or babbin[at]mit[dot]edu" ;
:Instrument = "Picarro Inc. G5310 Cavity Ringdown Spectrometer" ;
:Software = "GCWerks" ;
}
```

File

2023-10-01 to 2023-10-31

filename: GAL202310_N2O_CO.nc

(NetCDF, 4.22 MB)

MD5:8396897d5ad6dedd8be0b09b0ca79e2c

```
netcdf GAL202310_N2O_CO {
dimensions:
  time = 42199 ;
variables:
  double n2o_mean(time) ;
  n2o_mean:_FillValue = NaN ;
  n2o_mean:long_name = "mean nitrous oxide mole fraction" ;
  n2o_mean:units = "ppb" ;
  double n2o_stdev(time) ;
  n2o_stdev:_FillValue = NaN ;
  n2o_stdev:long_name = "nitrous oxide mole fraction standard deviation" ;
  n2o_stdev:units = "ppb" ;
  double n2o_number(time) ;
  n2o_number:_FillValue = NaN ;
  n2o_number:long_name = "number of n2o measurements averaged in each time stamp" ;
  n2o_number:units = "unitless" ;
  double co_mean(time) ;
  co_mean:_FillValue = NaN ;
  co_mean:long_name = "mean carbon monoxide mole fraction" ;
  co_mean:units = "ppb" ;
  double co_stdev(time) ;
  co_stdev:_FillValue = NaN ;
  co_stdev:long_name = "carbon monoxide mole fraction standard deviation" ;
  co_stdev:units = "ppb" ;
  double co_number(time) ;
  co_number:_FillValue = NaN ;
  co_number:long_name = "number of co measurements averaged in each time stamp" ;
  co_number:units = "unitless" ;
  string time_string(time) ;
  time_string:long_name = "Time stamp corresponding to the samping time in string format" ;
  time_string:timezone = "UTC" ;
  int64 time(time) ;
  time:timezone = "UTC" ;
  time:long_name = "Time stamp corresponding to the samping time" ;
  time:units = "minutes since 2023-10-01 00:00:00" ;
  time:calendar = "proleptic_gregorian" ;

// global attributes:
:Site = "San Crisotbal, Galapagos Islands, Ecuador" ;
:string :Latitude = "0.8956 °S " ;
:string :Longitude = "89.6087 °W" ;
:Inlet\ Height = "27 m above sea level" ;
:Contact = "tcinay[at]mit[dot]edu or babbin[at]mit[dot]edu" ;
:Instrument = "Picarro Inc. G5310 Cavity Ringdown Spectrometer" ;
:Software = "GCWerks" ;
}
```

File

2023-11-01 to 2023-11-30

filename: GAL202311_N2O_CO.nc

(NetCDF, 3.90 MB)

MD5:f6a5196d21cf5542dd59fe4a0613f9cc

```
netcdf GAL202311_N2O_CO {
dimensions:
  time = 39249 ;
variables:
  double n2o_mean(time) ;
  n2o_mean:_FillValue = NaN ;
  n2o_mean:long_name = "mean nitrous oxide mole fraction" ;
  n2o_mean:units = "ppb" ;
  double n2o_stdev(time) ;
  n2o_stdev:_FillValue = NaN ;
  n2o_stdev:long_name = "nitrous oxide mole fraction standard deviation" ;
  n2o_stdev:units = "ppb" ;
  double n2o_number(time) ;
  n2o_number:_FillValue = NaN ;
  n2o_number:long_name = "number of n2o measurements averaged in each time stamp" ;
  n2o_number:units = "unitless" ;
  double co_mean(time) ;
  co_mean:_FillValue = NaN ;
  co_mean:long_name = "mean carbon monoxide mole fraction" ;
  co_mean:units = "ppb" ;
  double co_stdev(time) ;
  co_stdev:_FillValue = NaN ;
  co_stdev:long_name = "carbon monoxide mole fraction standard deviation" ;
  co_stdev:units = "ppb" ;
  double co_number(time) ;
  co_number:_FillValue = NaN ;
  co_number:long_name = "number of co measurements averaged in each time stamp" ;
  co_number:units = "unitless" ;
  string time_string(time) ;
  time_string:long_name = "Time stamp corresponding to the samping time in string format" ;
  time_string:timezone = "UTC" ;
  int64 time(time) ;
  time:timezone = "UTC" ;
  time:long_name = "Time stamp corresponding to the samping time" ;
  time:units = "minutes since 2023-11-01 00:00:00" ;
  time:calendar = "proleptic_gregorian" ;

// global attributes:
:Site = "San Crisotbal, Galapagos Islands, Ecuador" ;
:string :Latitude = "0.8956 °S " ;
:string :Longitude = "89.6087 °W" ;
:Inlet\ Height = "27 m above sea level" ;
:Contact = "tcinay[at]mit[dot]edu or babbin[at]mit[dot]edu" ;
:Instrument = "Picarro Inc. G5310 Cavity Ringdown Spectrometer" ;
:Software = "GCWerks" ;
}
```

File

2023-12-01 to 2023-12-31

filename: GAL202312_N2O_CO.nc

(NetCDF, 4.29 MB)

MD5:39d5b77cf9b9f7bc76184e4f17b989d6

```
netcdf GAL202312_N2O_CO {
dimensions:
  time = 43103 ;
variables:
  double n2o_mean(time) ;
  n2o_mean:_FillValue = NaN ;
  n2o_mean:long_name = "mean nitrous oxide mole fraction" ;
  n2o_mean:units = "ppb" ;
  double n2o_stdev(time) ;
  n2o_stdev:_FillValue = NaN ;
  n2o_stdev:long_name = "nitrous oxide mole fraction standard deviation" ;
  n2o_stdev:units = "ppb" ;
  double n2o_number(time) ;
  n2o_number:_FillValue = NaN ;
  n2o_number:long_name = "number of n2o measurements averaged in each time stamp" ;
  n2o_number:units = "unitless" ;
  double co_mean(time) ;
  co_mean:_FillValue = NaN ;
  co_mean:long_name = "mean carbon monoxide mole fraction" ;
  co_mean:units = "ppb" ;
  double co_stdev(time) ;
  co_stdev:_FillValue = NaN ;
  co_stdev:long_name = "carbon monoxide mole fraction standard deviation" ;
  co_stdev:units = "ppb" ;
  double co_number(time) ;
  co_number:_FillValue = NaN ;
  co_number:long_name = "number of co measurements averaged in each time stamp" ;
  co_number:units = "unitless" ;
  string time_string(time) ;
  time_string:long_name = "Time stamp corresponding to the samping time in string format" ;
  time_string:timezone = "UTC" ;
  int64 time(time) ;
  time:timezone = "UTC" ;
  time:long_name = "Time stamp corresponding to the samping time" ;
  time:units = "minutes since 2023-12-01 00:00:00" ;
  time:calendar = "proleptic_gregorian" ;

// global attributes:
:Site = "San Crisotbal, Galapagos Islands, Ecuador" ;
:string :Latitude = "0.8956 °S " ;
:string :Longitude = "89.6087 °W" ;
:Inlet\ Height = "27 m above sea level" ;
:Contact = "tcinay[at]mit[dot]edu or babbins[at]mit[dot]edu" ;
:Instrument = "Picarro Inc. G5310 Cavity Ringdown Spectrometer" ;
:Software = "GCWerks" ;
}
```

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Picarro Inc. G5310 Cavity Ring-down Spectrometer
Generic Instrument Name	Cavity enhanced absorption spectrometers
Generic Instrument Description	Instruments that illuminate a sample inside an optical cavity, typically using laser light, and measure the concentration or amount of a species in gas phase by absorption spectroscopy. Techniques include cavity ring-down spectroscopy (CRDS) and integrated cavity output spectroscopy (ICOS).

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Project Information

EAGER: Testing the Galápagos as a long-term monitoring site for nitrous oxide emissions from the Pacific oxygen deficient zones (ETP ODZ mapping)

Coverage: Eastern tropical and subtropical Pacific Ocean

NSF Award Abstract:

Nitrous oxide is a potent greenhouse gas and agent of ozone destruction. Atmospheric concentrations are rising, but the role of natural marine sources is poorly understood due to a lack of data. High rates of oceanic production are localized to remote areas, impeding direct data acquisition from oxygen minimum zones especially. Correct attribution of sources is key to interpreting observations, establishing mitigation policies, and predicting future climate feedbacks. The investigators aim to quantify marine nitrous oxide fluxes through a continuous monitoring site in the eastern Pacific that can identify hotspots and mechanisms of production. Such a station will permit the ocean's role in this greenhouse gas budget to be refined and its variability across space and time to be assessed. The data will be publicly accessible and maintained at a bilingual web portal in English and Spanish. The work will further educate and train a graduate student in oceanic and climate sciences and help establish an early career investigator.

The project will establish an atmospheric chemistry monitoring station at the Galapagos Science Center in Ecuador to continuously measure nitrous oxide and carbon monoxide. The measurements will be linked specifically to ocean outgassing via atmospheric inversion modeling. This new methodology complements sea-going research, permitting the assessment of emissions across the entire eastern tropical Pacific Ocean region from a single well-sited monitoring station. The investigators will specifically deploy a cavity ring-down laser spectrometer onsite, maintain the instrument, and analyze the continuous data. By the end of this initial 2-year study, a multi-year record of primary atmospheric concentrations of nitrous oxide will be established and tied to emissions from specific ocean sources. The researchers will map the data via inversion modeling, paying particular attention to cross-shelf variability and any roles of sub-mesoscale eddies in modifying the rate of nitrous oxide loss from the ocean. Carbon monoxide will be utilized as a diagnostic molecule for terrestrial influence on nitrous oxide. Overall, this project will elucidate the emissions from a critical yet under-sampled production region and reduce the level of uncertainty in data products and modeled syntheses. These measurements will aid in interpreting global observations, ground-truth current and future sampling campaigns, and improve forecasting of climate scenarios into the future.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

This award is funded in whole or in part under the American Rescue Plan Act of 2021 (Public Law 117-2).

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2138890

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