Total organic carbon, total nitrogen content, carbon, nitrate, ammonium and oxygen isotope composition of atmospheric particulates collected aboard R/V Dong Fang Hong-3 in the western North Pacific from October 31 to December 1, 2019

Website: https://www.bco-dmo.org/dataset/947080
Data Type: Cruise Results
Version: 1
Version Date: 2025-01-14

Project
» Collaborative Research: Characterization of Reactive Nitrogen in The North Pacific Atmosphere (North Pacific Atmos)

Contributors	Affiliation	Role
Hastings, Meredith	Brown University	Principal Investigator
Schiebel, Hayley N.	Suffolk University	Co-Principal Investigator
MacFarland, Alexandra	Brown University	Student, Contact
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
These data include the content of total organic carbon content, carbon isotope (13C and 14C), total nitrogen, nitrate isotope (15N), ammonium isotope (15N), and oxygen isotope (17O and 18O) composition of atmospheric particulates collected during western North Pacific Cruise. On-ship aerosol sampling was conducted on the R/V Dong Fang Hong-3 during a cruise to the western North Pacific from October 31 to December 1, 2019. Instruments used were two portable aerosol particle samplers (model 2030, Qingdao Laoying Environmental Technology Co.) with a filter size of 9 cm O.D. Recognizing the deposition of atmospheric particulates has the potential to understanding the important role of atmospheric deposition to the nitrogen cycle and biogeochemistry in the ocean. These data assess the contribution of atmospheric deposition to inorganic nitrogen and were collected by Chief Scientist Zaohui, Chen (chenzhaohui@ouc.edu.cn) at the Ocean University of China.

Table of Contents

Coverage

Location: Files History Datasets Processing Western Pacific Cruise Data Location North Pacific Ocean
Spatial Extent: **N**:37.00028 **E**:153.33306 **S**:14.00056 **W**:120.23222
Temporal Extent: 2019-10-31 - 2019-11-29

Methods & Sampling

On-ship aerosol sampling was conducted on the R/V Dong Fang Hong-3 during a cruise to the western NP

from October 31 to December 1, 2019. We used two portable aerosol particle samplers (model 2030, Qingdao Laoying Environmental Technology Co.) with a filter size of 9 cm O.D. The GF/F filters were precombusted (550 °C, 4 h) before used, and the sampling period was 18 to 72 h for each filter with an air flow rate of 100 L/min based on the cruise track. A total of 16 samples were collected during the cruise.

Data Processing Description

For the aerosol samples, we measured the concentrations of aerosol particulate OC (POC), total nitrogen (TN), and carbon isotope (13C and 14C) compositions of aerosol OC. All measurements were conducted at the Center for Isotope Geochemistry and Geochronology (CIGG) at the Qingdao National Laboratory for Marine Science and
Technology (QNLM) in Qingdao, China. For atmospheric POC measurements, a cut piece of filter containing particles was acidified first with 10% high-purity HCl to remove inorganic carbon and then dried at 50 °C. Concentrations of POC and TN were measured using an elemental analyzer (Elementar vario Isotope select) with analytical standard deviations of ±0.03% for OC, and ±0.04% for TN (n = 6). The δ13C values of POC were measured using a Thermo Delta V advantage isotope ratio mass spectrometer coupled with an Elemental Analyzer-IsoLink CN. Values of δ13C were reported in ‰ relative to 13C standards (IAEA-CH-3, cellulose, and IAEA-600 caffeine), and the analytic precision was ≤0.2‰ (n = 10). For POC 14C measurements, the pretreated flters were placed separately in double quartz tubes (precombusted at 850 °C for 2 h) with CuO and Ag wires added. The tubes were then evacuated on a vacuum line, flame sealed, and combusted at 850 °C for 2 h (Druffel et al., 1992). CO2 resulting from POC oxidation was collected cryogenically and quantifed monometrically on a vacuum line. The purified CO2 was converted to graphite using the closed tube iron reduction method (Xu et al., 2007; Walker et al., 2019) and 14C was measured by accelerator mass spectrometry (AMS, NEC 0.5MV XCAMS). Δ14C results were reported, and conventional radiocarbon ages [years before present (BP)] were calculated based on the study by Stuiver and Polach (1977).

Nitrogen (15N/14N) and oxygen (18O/16O) isotope analyses of nitrate were conducted at the Department of Earth, Environmental, and Planetary Sciences at Brown University in Providence, RI (USA). After the frozen samples were received at Brown University, a 5 × 5 cm square was cut from the center of the filter at room temperature and extracted in a pre-cleaned bottle with ~100 mL of MQ water (exact amounts were recorded via weight) and then sonicated for 1 h. After sonication, the filters were removed, and the samples were frozen at -20 ◦C until further analyses.

The denitrifier method (Casciotti et al., 2002; Sigman et al., 2001) was used to complete nitrate (15N/14N) and oxygen (18O/16O) isotope analyses via nitrous oxide on a continuous flow isotope ratio mass spectrometer. Values were reported in ‰ relative to standards.

Instruments:

Portable aerosol particle samplers: aerosol samples were collected with portable aerosol particle samplers (model 2030, Qingdao Laoying Environmental Technology Co.) with a filter size of 9 cm O.D.

Elemental analyzer: the concentrations of POC and TN were measured using an elemental analyzer (Elementar vario Isotope select).

Thermo Delta V mass spectrometer: the δ13C values of POC were measured using a Therm Delta V advantage isotope ratio mass spectrometer coupled with an Elemental Analyzer-IsoLink CN.

Thermo Delta V Plus Isotope Ratio Mass Spectrometer: used in continuous flow mode for ammonium, nitrate, and oxygen isotope analyses.

Accelerator mass spectrometry: the Δ14C values of POC were measured by accelerator mass spectrometry (AMS, NEC 0.5MV XCAMS).

BCO-DMO Processing Description

* Adjusted parameter names to comply with database requirements
* Converted sampling latitude and longitude notation from decimal, minute, seconds to decimal degrees.

Rounded these fields to 5 decimals
* Converted date to ISO notation (Y-m-d)
* Merged sampling date and time columns and created DateTime variable in ISO format

[table of contents | back to top]

Related Publications

Casciotti, K. L., Sigman, D. M., Hastings, M. G., Böhlke, J. K., & Hilkert, A. (2002). Measurement of the Oxygen Isotopic Composition of Nitrate in Seawater and Freshwater Using the Denitrifier Method. Analytical Chemistry, 74(19), 4905–4912. doi:10.1021/ac020113w
Methods

Druffel, E. R. M., Williams, P. M., Bauer, J. E., & Ertel, J. R. (1992). Cycling of dissolved and particulate organic matter in the open ocean. Journal of Geophysical Research: Oceans, 97(C10), 15639–15659. Portico. https://doi.org/10.1029/92jc01511 https://doi.org/10.1029/92JC01511
Methods

Joyce, Emily Elizabeth, "From the Atmosphere to the Sea: Atmospheric Nitrogen Deposition to Aquatic Ecosystems" (2022). Earth, Environmental and Planetary Sciences Theses and Dissertations. Brown Digital Repository. Brown University Library. https://repository.library.brown.edu/studio/item/bdr:ytp8w8gx/
Results

Ren, P., Luo, C., Zhang, H., Schiebel, H., Hastings, M. G., & Wang, X. (2022). Atmospheric Particles Are Major Sources of Aged Anthropogenic Organic Carbon in Marginal Seas. Environmental Science & Technology, 56(19), 14198–14207. https://doi.org/10.1021/acs.est.2c06321
Results

Sigman, D. M., Casciotti, K. L., Andreani, M., Barford, C., Galanter, M., & Böhlke, J. K. (2001). A Bacterial Method for the Nitrogen Isotopic Analysis of Nitrate in Seawater and Freshwater. Analytical Chemistry, 73(17), 4145–4153. doi:10.1021/ac010088e
Methods

Stuiver, M., & Polach, H. A. (1977). Discussion Reporting of 14C Data. Radiocarbon, 19(3), 355–363. doi:10.1017/s0033822200003672 https://doi.org/10.1017/S0033822200003672
Methods

Walker, B. D., & Xu, X. (2019). An improved method for the sealed-tube zinc graphitization of microgram carbon samples and 14C AMS measurement. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 438, 58–65. https://doi.org/10.1016/j.nimb.2018.08.004
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
Sample_Number	The atmospheric particulates samplers were labeled from 1 to 16	unitless
Date	The sampling date in ISO format (yyyy-mm-dd)	unitless
Start_time	Time when sampling started in format hh:mm:ss (Time Zone: UTC)	unitless

Start_DateTime_UTC	Start date and time of sampling in iso format (TimeZOne: UTC)	unitless
Sampling_period_h	Time sampling from start, in format hh (Time Zone: UTC)	hours (hrs)
latitude	Sampling latitude, south is negative	decimal degrees
longitude	Sampling longitude, west is negative	decimal degrees
Duplicate	Duplicate number: 1 or 2	unitless
Total_Air_Volume_L	Total air volume during the sampling in liters	liter (L)
TotalAirVolume_m3	Total air volume during the sampling in cubic meters	cubmic meters (m3)
ParticleWeight_mg	Atmospheric particulates weight of each samples	miligrams (mg)
TOC_percent	Total organic carbon (TOC)	percentage (%)
TN_percent	Total organic nitrogen (TON)	percentage (%)
C_N_Ratio	Carbon to nitrogen ratio	unitless
Carbon13_12_Ratio	Carbon isotope ratio (13C/12C)	parts per thousand (permil) (‰)
Delta15N_Nitrate	Nitrogen isotope ratio (15N/14N) of atmospheric nitrate (NO3-).	parts per thousand (permil) (‰)
Delta15N_NH4	Nitrogen isotope ratio (15N/14N) of atmospheric ammonium (NH4+).	parts per thousand (permil) (‰)
Delta18Oxygen_Nitrate	Oxygen isotopic ratio (18O/16O) of atmospheric nitrate (NO3-)	parts per thousand (permil) (‰)
Delta17N_Nitrate	Measured isotope value of atmospheric nitrate (NO3-)	parts per thousand (permil) (‰)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	NEC 0.5MV XCAMS
Generic Instrument Name	Accelerator Mass Spectrometer
Dataset-specific Description	Accelerator mass spectrometry: the Δ14C values of POC were measured by accelerator mass spectrometry (AMS, NEC 0.5MV XCAMS).
Generic Instrument Description	An AMS measures "long-lived radionuclides that occur naturally in our environment. AMS uses a particle accelerator in conjunction with ion sources, large magnets, and detectors to separate out interferences and count single atoms in the presence of 1x1015 (a thousand million million) stable atoms, measuring the mass-to-charge ratio of the products of sample molecule disassociation, atom ionization and ion acceleration." AMS permits ultra low-level measurement of compound concentrations and isotope ratios that traditional alpha-spectrometry cannot provide. More from Purdue University: http://www.physics.purdue.edu/primelab/introduction/ams.html

Dataset-specific Instrument Name	Portable aerosol particle samplers - model 2030, Qingdao Laoying Environmental Technology Co.
Generic Instrument Name	Aerosol Sampler
Dataset-specific Description	Portable aerosol particle samplers: aerosol samples were collected with portable aerosol particle samplers (model 2030, Qingdao Laoying Environmental Technology Co.) with a filter size of 9 cm O.D.
Generic Instrument Description	A device that collects a sample of aerosol (dry particles or liquid droplets) from the atmosphere.

Dataset-specific Instrument Name	Elementar vario Isotope select
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Elemental analyzer: the concentrations of POC and TN were measured using an elemental analyzer (Elementar vario Isotope select).
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	Thermo Delta V Plus Isotope Ratio Mass Spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Thermo Delta V Plus Isotope Ratio Mass Spectrometer: used in continuous flow mode for ammonium, nitrate, and oxygen isotope analyses.
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	Therm Delta V advantage isotope ratio mass spectrometer coupled with an Elemental Analyzer-IsoLink CN
Generic Instrument Name	Mass Spectrometer
Dataset-specific Description	Thermo Delta V mass spectrometer: the δ13C values of POC were measured using a Therm Delta V advantage isotope ratio mass spectrometer coupled with an Elemental Analyzer-IsoLink CN.
Generic Instrument Description	General term for instruments used to measure the mass-to-charge ratio of ions; generally used to find the composition of a sample by generating a mass spectrum representing the masses of sample components.

[table of contents | back to top]

Project Information

Collaborative Research: Characterization of Reactive Nitrogen in The North Pacific Atmosphere (North Pacific Atmos)

Coverage: coastal China atmosphere, Northwestern Pacific waters and atmos, Hawaii atmosphere

NSF Award Abstract:
Nitrogen is an essential element for life, and its availability can limit the growth of phytoplankton in the surface waters of the oceans. One source of nitrogen to surface waters is deposition from the atmosphere, which is the result of reactive nitrogen emissions from both human (anthropogenic) activities and natural processes. Anthropogenic nitrogen emissions to the atmosphere and nitrogen deposition to the oceans have increased exponentially since preindustrial times. In fact, global modeling studies have suggested that as much as 80% of total nitrogen deposition to the oceans is anthropogenic in origin, and that the magnitude of input to the global oceans rivals estimates of biological nitrogen fixation. The impacts associated with this increased nitrogen deposition are clear in both terrestrial and coastal systems, but the implications for open ocean biogeochemistry are less well studied. Recent work in the North Pacific Ocean (NPO) has suggested that increased nitrogen due to anthropogenic atmospheric deposition is detectable even in the open ocean, while other work can explain nutrient dynamics based upon natural biological and physical processes. The investigators propose to study the influence of both anthropogenic and natural sources on the deposition of nitrogen (as nitrate, ammonium, and organic nitrogen) in the NPO. This will be based on collection of aerosol and rainwater samples year-round at two sites: (1) Chang-Dao Island, China where they expect high anthropogenic nitrogen inputs; and (2) Oahu, Hawaii where they expect marine sources to dominate. They will also collect ship-based samples in the marine boundary layer via already planned short-term research cruises in each season. In addition to the scientific outcomes, this project will provide for human resources and professional development of the team members (faculty members, a graduate student, undergraduate

student, and technicians), advance international collaborations, and contribute to education and public outreach. Identifying the sources of nitrogen deposition to the open ocean is crucial for understanding anthropogenic impacts on biogeochemical cycles. A primary question is, is nitrogen deposition the result of external, anthropogenic processes or does it represent recycled nitrogen from the ocean's point of view? The specific objectives of this project are to: characterize the atmospheric composition and sources of inorganic (ammonium and nitrate) and organic nitrogen with an emphasis on seasonality; diagnose the influence of air-sea exchange versus anthropogenic sources of nitrogen on atmospheric deposition; and determine the isotopic composition of gaseous and particulate inorganic nitrogen in the marine boundary layer via ship-based sample collections in the NPO. Using concentration and isotopic measurements of reactive nitrogen species, in addition to transport and chemical box modeling, the study aims to characterize nitrogen deposition in two locations with very different source influences. This study will provide the first comprehensive, seasonal analysis of the isotopic values of reactive nitrogen species in the NPO atmosphere where nitrogen deposition is considered intense. Ultimately this project will lead to a better understanding of how anthropogenic changes in the atmospheric nitrogen cycle may influence the biogeochemistry of the surface ocean as well as the composition of the marine atmosphere.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.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851318
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851343

[table of contents | back to top]