

LBA-ECO CD06 Carbon Sources and Respiration Rates in Rivers in Amazonas and Acre: 2005-2006

Summary:

This data set provides measured and calculated variables describing the carbon pools in river waters, CO₂ respired from the water and total amount of CO₂ evaded, dissolved oxygen isotopes ($\delta^{18}\text{O}$ -O₂), and concentration of bacterial cells in river water.

Samples were collected from 10 white-water rivers, two clear-water streams (one each in Amazonas and Acre), and two black-water rivers in Amazonas from July to September 2005, which coincided with a severe drought in the western and southern regions of the Amazon Basin (Zeng et al. 2008). Eight of these sites were resampled during August through September 2006 of the following year (no drought).

There is one comma-delimited data file with this data set.

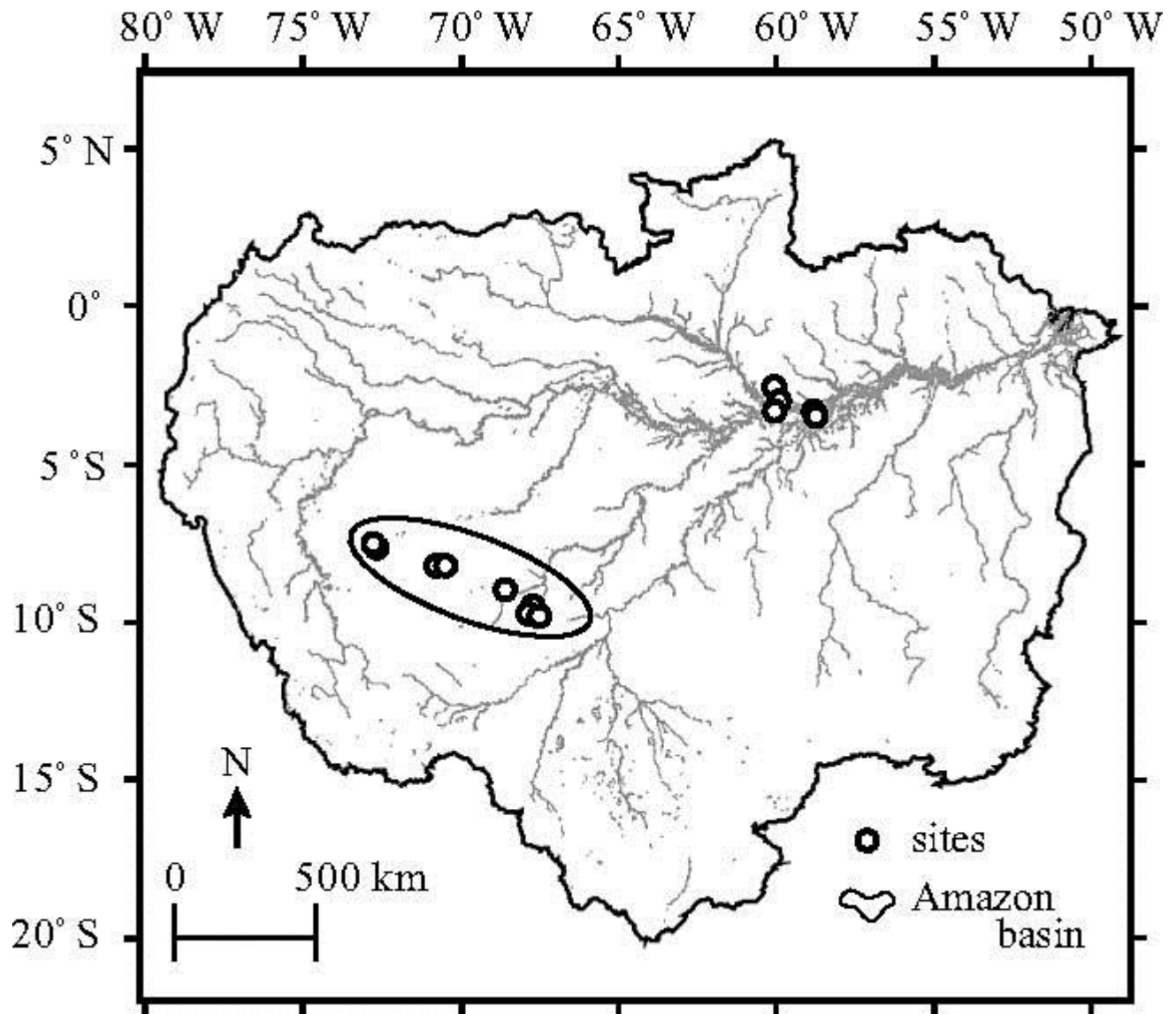


Figure 1. Map of study sites within the Amazon River Basin. Major tributaries are in grey. The circled sites are located in the state of Acre, whereas the others are in the state of Amazonas (Ellis et al., 2012).

Data Citation:

Cite this data set as follows:

Ellis, E.E, J.E. Richey, A.K. Aufdenkampe, A.V. Krusche, P.D. Quay, C. Salimon and H. Brandao da Cunha. 2012. LBA-ECO CD06 Carbon Sources and Respiration Rates in Rivers in Amazonas and Acre: 2005-2006. Data set. Available on-line [<http://daac.ornl.gov>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.
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Data users should use the Investigator contact information in this document to communicate with the data provider. Alternatively, the LBA website [<http://lba.inpa.gov.br/lba/>] in Brazil will have current contact information.

Data users should use the Data Set Citation and other applicable references provided in this document to acknowledge use of the data.

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1. Data Set Overview:

Project: LBA (Large-Scale Biosphere-Atmosphere Experiment in the Amazon)

Activity: LBA-ECO

LBA Science Component: Carbon Dynamics

Team ID: CD-06 (Richey / Victoria)

The investigators were Richey, Jeffrey E.; Victoria, Reynaldo Luiz; Souza, Reginaldo; Aalto, Rolf Erhart; Abdo, Mara Silvia Aguiar; Alin, Simone Rebecca; Aufdenkampe, Anthony K.; Ballester, Maria Victoria Ramos; Barbosa, Roosevelt Passos; Bernardes, Marcelo Correa; Bezerra de Barros Lima, Roberta ; Bolson, Marcos Alexandre; Bolson, Marcos Alexandre; Bonelle, Nilton; Brito, David Silva; Cabiianchi, Giovana; Cogo, Michelle Cristine; da Silva, Luis Vilmar Souza; Dalmagro, Higo Jose; de Oliveira, Carolina Barisson Marques; Deus, Fabiano Alves de ; Devol, Allan H.; do Nascimento, Clive Reis; Ellis, Erin Elizabeth; Ferro, Jaderson Coradi; Filho, Walter Jorge do Nascimento; Frickmann, Fernando Cruz ; Gamero Guandique, Manuel Enrique; Gomes, Beatriz M.; Gomes, Viviane; Gouveia Neto, Sergio Candido; Hanada, Lais de Carvalho; Holtgrieve, Gordon William; Kelly Batalha Silva, Roberta ; Krusche, Alex ; Kurzatkowski, Dariusz ; Lacerda, Francisco A. Siebra; Leite, Nei Logsdon, Miles Grant; Macedo, Gelson de; Marcondes, Renata; Marilheuz, Campos Paro; McGeoch, Lauren; Melo, Emanuele Gurgel

de Freitas; Mendes, Francisco de Assis; Moreira, Marcelo Zacharias; Munhoz, Kelli; Neu, Vania; Ometto, Jean Pierre; Pimentel, Tania Pena; Priante Filho, Nicolau Rabelo, Claudenir Silva; Rasesa, Maria de Fatima Fernandes Lamy; Remington, Sonya Marie; Rodda, Sarah; Ruiz Mateus, Neuza Maria; Salimon, Cleber; Santiago, Alailson Venceslau; Santos, Arnaldo Marcilio dos; Silva, Cleoni Virginio da; Silva, Jonismar; Silva, Simao Correa da; Sousa, Eliete; Souza-petro, Petronio Lopes de; Toledo, Andre Marcondes Andrade; Tumang, Cristiane Azevedo; Umetsu, Cristiane Akemi Victoria, Daniel de Castro and Xavier, Farley de Oliveira. You may contact Ellis, Erin Elizabeth (ellise@u.washington.edu).

LBA Data Set Inventory ID: CD06_Carbon_respiration

This data set provides measured and calculated variables describing the carbon pools in river waters, CO₂ respired from the water and total amount of CO₂ evaded, dissolved oxygen isotopes (delta 18O-O₂), and concentration of bacterial cells in river water.

Samples were collected from 10 white-water rivers, two clear-water streams (one each in Amazonas and Acre), and two black-water rivers in Amazonas from July to September 2005, which coincided with a severe drought in the western and southern regions of the Amazon Basin (Zeng et al. 2008). Eight of these sites were resampled during August through September 2006 of the following year (no drought).

2. Data Characteristics:

Data are presented in one ASCII comma separated file:

CD06_River_respiration_survey.csv

Column	Heading	Unit/format	Description
1	Site Name		Name of the river of stream sampled
2	Sampling Year	YYYY	Year in which samples were collected
3	Date	YYYYMMDD	Date on which samples were collected
4	Latitude	decimal degrees	Geographic coordinates for the sampling site reported in degrees latitude
5	Longitude	decimal degrees	Geographic coordinates for the sampling site reported in degrees longitude
6	Area_watershed	km ²	Area of the watershed for the river sampled reported in square kilometers
7	Hydrograph_stage		Hydrograph stage indicating if the river level was falling, at a minimum, rising or at a maximum
8	Water_type		Water type: clear, black or white
9	Depth	m	Sampling depth reported in meters
10	DO	umol/L	Dissolved oxygen concentration reported in micromoles of oxygen per liter of water (umol/L)
11	pCO ₂	Pa	Partial pressure of CO ₂ gas in water reported in pascals
12	DIC	umol/L	Dissolved inorganic carbon concentration reported in micromoles of C per liter of water (umol/L)
13	delta_13C_DIC	per mil	delta 13C of the dissolved inorganic carbon component reported in per mil relative to the PDB standard
14	ph		ph of the river water
15	Temp	degrees C	Temperature of the river water at the time of sampling

			reported in degrees Celcius
16	Respiration	umol CO2/m2/s	Depth integrated respiration rate. Flux of CO2 reported in micromoles of CO2 per square meter per second (umol CO2/m2/s)
17	SE_Respiration	umol CO2/m2/s	Standard error of the calculated respiration flux (N=3) reported in micromoles of CO2 per square meter per second (umol CO2/m2/s)
18	Evasion_CO2	umol CO2/m2/s	Evasion flux of CO2 reported in micromoles of CO2 per square meter per second (umol CO2/m2/s)
19	SE_Evasion	umol CO2/m2/s	Standard error of the calculated evasion flux of CO2. Error was propagated using Monte Carlo boot strapping procedures. Reported in micromoles of CO2 per square meter per second (umol CO2/m2/s)
20	Resp/Evas	percent	Percent of CO2 evasion flux attributed to respiration calculated as respiration/ evasion *100. Reported in percent
21	SE_R/E	percent	Standard error of the calculated fraction of evasion represented by respiration
22	WC_Respir_Rate	umol O2/L/h	Water-column respiration rate reported in micromoles of oxygen per liter per hour (umol O2/L/h)
23	O2_Sat		The concentration of oxygen measured in the river water relative to the concentration that would be expected if the water-column was 100% saturated with oxygen at that temperature. Data are reported as proportions with values ranging from 0 to 1, to convert the value to percent multiply the current value by 100
24	delta_18O_DO	per mil	delta 18O of the dissolved oxygen in the river water reported in per mil relative to the SMOW (standard mean ocean water) standard
25	TSS	mg/L	Concentration of total (CSS + FSS) suspended sediment reported in milligrams per liter (mg/L)
26	CSS	mg/L	Concentration of coarse suspended sediment (63 micrograms) reported in milligrams per liter (mg/L)
27	FSS	mg/L	Concentration of fine suspended sediment (between 0.7 micrograms and 63 micrograms) reported in milligrams per liter (mg/L)
28	TOC	mg C/L	Concentration of total organic carbon reported in milligrams C per liter (mg C/L)
29	CPOC	mg C/L	Concentration of coarse particulate organic carbon reported in milligrams C per liter (mg C/L)
30	FPOC	mg CL	Concentration of fine particulate organic carbon reported in milligrams C per liter (mg C/L)
31	DOC	mg C/L	Concentration of dissolved organic carbon reported in milligrams C per liter (mg C/L)
32	DOC_high_MW	mg C/L	Concentration of high molecular weight dissolved organic carbon defined as greater than 100 kDa in size and reported in milligrams C per liter (mg C/L)
33	DOC_med_MW	mg C/L	Concentration of medium molecular weight dissolved organic carbon defined as less than 100 kDa but greater than 5 kDa in size and reported in milligrams C per liter (mg C/L)

34	DOC_low_MW	mg C/L	Concentration of low molecular weight dissolved organic carbon defined as less than 5 kDa in size and reported in milligrams per liter (mg/L)
35	C:N_CPOC	per mil	The atomic carbon to nitrogen ratio of the coarse particulate organic carbon reported in milliliters
36	C:N_FPOC	per mil	The atomic carbon to nitrogen ratio of the fine particulate organic carbon reported in milliliters
37	delta_13C_CPOC	per mil	delta 13C of the dissolved coarse particulate organic carbon component reported in per mil relative to the PDB standard.
38	delta_13C_FPOC	per mil	delta 13C of the dissolved fine particulate organic carbon component reported in per mil relative to the PDB standard
39	delta_13C_DOC	per mil	delta 13C of the dissolved organic carbon component reported in per mil relative to the PDB standard
40	delta_13C_CO2resp	per mil	delta 13C of the carbon dioxide resulting from respiration reported in per mil relative to the PDB standard
41	Conc_bacteria	cells/ml	Concentration of bacterial cells reported in number of cells per milliliter of water (cells/ml)
missing data are represented by -9999			

Example data records

<p>Site Name,SamplingYear,Date,Latitude,Longitude,Area_watershed,Hydrograph_stage,Water_type,Depth,DO, pCO2,DIC,delta_13C_DIC,ph,Temp,Respiration,SE_Respiration,Evasion_CO2, SE_Evasion,Resp/Evas,SE_R/E, WC_Respir_Rate,DO_Sat,delta_18O_DO,TSS,CSS,FSS,TOC,CPOC,FPOC,DOC,DOC_high_MW,DOC_med_MW, DOC_low_MW, C:N_CPOC,C:N_FPOC,delta_13C_CPOC,delta_13C_FPOC,delta_13C_DOC,delta_13C_CO2resp,Conc_bacteria</p> <p>Campina,2006,20060817,-2.589,-60.033,10,falling,black,0.3,102.6, 1308,344.7,-26.6,4,25.1,-9999,-9999,-9999,-9999,-9999,-9999, -9999,-9999,-9999,4,3.1,0.9,32.8,1.3,0.18,31.3,3.6,21.1, 6.6,29.6,23.6,-29,-29.2,-9999,-9999,-9999</p> <p>Barro_Branco,2005,20050716,-2.93,-59.974,10,falling,clear,0.4,186.9, 970,327.4,-22.4,4.6,25.6,0.014,0.007,12.41,-9999,0.11,0.05, 0.13,0.76,25.7,0.5,0.5,-9999,3.4,0.17,0.08,3.2,-9999,-9999, 2.2,23.8,10.7,-29.9,-28.2,-9999,-9999,-9999</p> <p>Barro_Branco,2006,20060829,-2.93,-59.974,10,falling,clear,0.4,196.1, 731,279.9,-24.3,4.7,25.8,-9999,-9999,-9999,-9999,-9999,-9999, 0.03,0.83,25.2,0.3,0.1,0.2,2.4,0.03,0.07,2.2,0.1,1.3, 0.9,23.5,16,-29.7,-27,-29.8,-9999,164355</p> <p>...</p> <p>Negro,2005,20050802,-3.062,-60.285,716770,falling,black,34,101.3, 659,208.5,-25.2,5.1,29.2,1,0.4,12.7,0.8,8,3, 0.11,0.55,27,0.4,0,0.4,9.6,0,0.56,9,2.9,3, 3.1,11.6,11.7,-31.5,-29.6,-9999,-9999,-9999</p> <p>Negro,2006,20060811,-3.062,-60.285,716770,falling,black,34,93.7, 491,222.8,-25.6,4.8,29.1,0.8,0.4,4.3,0.5,20,10, 0.08,0.51,27.3,6.6,1.4,5.1,7.6,0.06,0.35,7.2,1.3,4.1, 1.9,18.9,11.1,-29.8,-28.9,-29.7,-30.1,2137375</p> <p>...</p>

Catuaba,2005,20050830,-10.073,-67.614,10,Low,clear,0.5,207.7,
 201,121,-16.9,6.2,23.5,0,0.008,2.87,-9999,1,0,
 0.17,0.88,24.7,4.2,0.2,4,2.1,0.01,0.5,1.6,0.8,0.2,
 0.5,18,11.4,-30,-28.6,-9999,-9999,-9999
 Catuaba,2006,20060925,-10.073,-67.614,10,Low,clear,0.5,217.9,
 163,108.5,-20.2,5.1,24,-9999,-9999,-9999,-9999,-9999,-9999,
 0.36,0.86,25.3,9.3,0.3,9,2.6,0.03,1.05,1.5,0.8,0,
 0.7,20.7,9.9,-29.5,-29.1,-28.7,-28.3,2208262
 Humaita,2005,20050826,-9.751,-67.672,10,Low,white,0.3,156.5,
 281,104.9,-17.1,5.6,27.9,0.1,0.03,1.13,-9999,6,2,
 0.76,0.62,27,4.6,0.6,4,4.2,0.05,0.48,3.7,1.1,-9999,
 -9999,18.4,8.5,-29.7,-27.4,-9999,-9999,-9999

Site boundaries: (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Amazon Basin (Amazon Basin)	-72.7	-58.746	-2.589	-10.073	World Geodetic System, 1984 (WGS-84)

Time period

- The data set covers the period 2005/07/16 - 2006/09/25
- Temporal Resolution: Data were collected in two campaigns: one July through September 2005 and the second August through September 2006

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / ANALYSIS / RESPIRATION
- LABORATORY / MASS SPECTROMETER / CARBON
- LABORATORY / MASS SPECTROMETER / NITROGEN
- FIELD INVESTIGATION / ANALYSIS / CARBON DIOXIDE
- LABORATORY / MASS SPECTROMETER / DISSOLVED SOLIDS
- LABORATORY / MASS SPECTROMETER / ISOTOPES
- FIELD INVESTIGATION / ANALYSIS / DISSOLVED GASES
- LABORATORY / FLUORESCENCE MICROSCOPY / BIOMASS

3. Data Application and Derivation:

The purpose of this work was to understand the factors that control the range of water-column respiration rates observed in rivers and streams across the Amazon Basin. Accordingly, the investigators sampled rivers with a range of water chemistry types and respiration rates to determine how in situ concentrations of various parameters affected respiration rates. They then performed a series of statistical analyses, including partial correlation, step-wise backward multiple linear regression, and standard linear regression. To be considered a candidate for the multiple linear regression, input variables were excluded if they were highly correlated with each other (i.e. had a value of r that exceeded 0.7), or if there was more than one missing datum per variable.

Much of the details on the derivitization of the data is reported in the methods section below and users are encouraged to view Ellis et al., (2012), for full details. Many parameters were processed minimally post field collection.

4. Quality Assessment:

We list the precision below for the following variables analyzed in this study:

- delta 13C: 0.3 per mil
- pH: 0.1 pH unit.
- DIC concentration: 1 percent of DIC value.
- Respiration rate: 0.01 umol O₂ L⁻¹ hr⁻¹
- delta 18O of dissolved O₂: 0.2 per mil

All measures of organic carbon concentration

- (DOC, DOC > 100 kDa, DOC between 5-100 kDa, DOC < 5 kDa) FPOC, CPOC)= 0.1 mg L⁻¹

All measures of suspended sediment concentration

- (TSS,FSS, CSS) = 0.1 mg L⁻¹

Bacterial concentration:

- x 10⁶ cells mL⁻¹

5. Data Acquisition Materials and Methods:

Study area:

Samples were collected during 2005 and 2006 in the Brazilian states of Acre and Amazonas, which are located in southwestern and central Amazonia. Locations were chosen to represent a range of water types and conditions found in these regions. Due to the predominance of white-water Rivers in both Amazonas and Acre and the logistical challenges of reaching a variety of river types in this large region, investigators sampled 10 white-water rivers of varying sizes. They also sampled two clear-water streams (one each in Amazonas and Acre), and two black-water rivers in Amazonas. Watershed areas ranged from less than 10 km² to 2,910,510 km², which were calculated as in Mayorga et al. (2005). Not all sites were in the same stage of the hydrograph at the time of sampling. All rivers in Acre were in the low water stage, whereas rivers draining Amazonas were in the falling-water stage. Investigators collected samples from 14 sites from July to September 2005, which coincided with a severe drought in the western and southern regions of the Amazon Basin (Zeng et al. 2008). Eight of these sites were resampled during August through September 2006 of the following year (no drought).

Sample collection:

- Water samples were collected from the thalweg of rivers using a submersible pump placed at six-tenths of the total river depth.
- Field probes (Thermo Orion 290 A+ pH meter, a Chek Mite CD-30 conductivity meter, and a 55 YSI dissolved oxygen probe) were immersed in a continuously overflowing graduated cylinder for pH, conductivity, and dissolved oxygen concentration determinations.

- Samples from small streams were collected directly below the water surface to minimize disturbance.

Analysis methods:

- PCO₂ was analyzed via headspace equilibration following the methods of Cole et al. (1994) and modified as in Alin et al. (2010).
 - PCO₂ samples were either measured immediately using infra-red gas analysis via a Li-Cor LI-820 (Alin et al. 2010) or stored in glass bottles until analysis with a Shimadzu gas chromatograph (GC-17A equipped with flame ionization and electron capture detectors and a methanizer).
- Bulk size fractions of coarse particulate organic carbon (CPOC [greater than 63 μm], FPOC [0.7 to 63 μm], and DOC [less than 0.7 μm]) were filtered in the field, whereas size fractionation of DOC was processed in the laboratory.
- Coarse suspended sediment (CSS) concentrations were measured by first passing a known volume of river water through a 63-μm sieve, and then later drying and weighing the sieved material. CSS concentrations were multiplied by percent by weight C to determine CPOC concentrations.
- The material collected from a plankton net was preserved with HgCl₂ for later analyses of weight percentages (percent by weight) of C, N, and δ¹³C of CPOC.
- Sieved river water was homogenized with a churn splitter (Wilde and Radtke 2003) and then filtered, providing the fine suspended sediment concentration (FSS) by mass difference (Aufdenkampe et al. 2001).
- Sieved water was also passed through precombusted glass fiber filters (GF/F), which were then analyzed for δ¹³C, percent by weight of C and N, and FPOC concentrations.
- The filtrate of the GF/F filter (defined as DOC) was stored in precombusted glass vial and immediately preserved with HgCl₂ pending no further analysis. Centrifuge ultrafiltration was used to size-fractionate DOC into the following categories:
 - high molecular weight (HMW; greater than 100 kDa)
 - medium molecular weight (MMW; between 5 and 100 kDa)
 - low molecular weight (LMW; less than 5 kDa) DOC, using a method modified from Burdige and Gardner (1998).
- Water was filtered through two GF/F filters in the field, placed on ice in the dark, transported back to the laboratory, and refrigerated until analyzed (within 48 h). Fifteen milliliters of sample were then centrifuged for 40 min.
- Filtrate was analyzed according to the following:
 - To calculate the percentage of DOC that was less than size X, we used the following equation (see Ellis et al., 2012).

$$\% \text{DOC} < x = \text{DOC}_F V_F / \text{DOC}_1 V_1 \times 100$$
 - To determine the concentration of DOC (less than 5 kDa or less than 100 kDa) the unfiltered DOC concentration was multiplied by the percentage of DOC in the given size category.
 - The concentration of the size fractions of DOC was obtained by subtracting the appropriate value(s) from the original DOC concentration.
 - DOC concentrations were measured after acidification and sparging with high-temperature combustion using a Shimadzu TOC500A carbon analyzer (2005 samples) and a Shimadzu TOC-V CPH carbon and nitrogen analyzer (2006 samples).
 - Those samples with high DIC concentrations were acidified and sparged for an additional 20 min to ensure DIC removal.

Carbon isotopic analyses and C:N ratios

Stable isotopes (^{13}C) of carbon were measured in both the inorganic and organic size fractions to aid in partitioning among end-member sources. Results are given in delta notation with units of per mil, and were normalized relative to Vienna Pee Dee Belemnite.

- After drying coarse and fine materials in a 60 degree C oven, the samples were analyzed for delta ^{13}C and C:N ratios using a Finnigan Delta Plus mass spectrometer coupled to a Fissions EA 1110 CHN analyzer with a precision of 0.3 per mil for the mass spectrometer.
- For 2005 samples, the C:N ratio was obtained directly from a model 440 CHN analyzer made by Exeter Analytical.
- The delta ^{13}C of DOC was analyzed using an automated method in which DIC was sparged from the sample after adding phosphoric acid, followed by sodium persulfate oxidation of DOC to CO_2 . The CO_2 gas was carried to an infra-red gas analyzer and then to a PDZ Europa-Hydra 20-20 isotope ratio mass spectrometer. Only the 2006 samples were analyzed.
- DIC field collections and isotopic measurements (delta ^{13}C of DIC) were conducted as in Quay et al. (1992), with a precision of 0.03 per mil for the 2006 samples. DIC concentrations were calculated from pH and PCO_2 for the 2005 samples. We used temperature-dependent equilibrium constant values (K_1 , K_2 , and K_H) as reported in Clark and Fritz (1997).
- To estimate the delta ^{13}C of phytoplankton, we used an isotopic fractionation factor of 12 to 17 per mil between the delta ^{13}C of H_2CO_3 (calculated from the delta ^{13}C of DIC [as in Mayorga 2004, using the equilibrium fractionation factors from Zhang et al., 1995]) and phytoplankton. This fractionation factor is derived from the relationship between H_2CO_3 and POM (predominantly phytoplankton) in the surface ocean (Goericke and Fry 1994).

Calculation of CO_2 gas evasion flux

Most of the gas evasion rates were also published in Alin et al. (2010) and were determined using a floating chamber equipped with a fan. However, not all sites were analyzed by Alin et al. (2010). Thus, for these sites, the gas evasion flux (in $\mu\text{mol}/(\text{m}^2\cdot\text{s})$) was determined by using the difference between the pCO_2 measurements of the atmosphere and the water (as described in detail in Ellis et al. (2012)) using the following equation:

$$F = k_{\text{CO}_2} * \gamma * (\text{PCO}_{2_atm} - \text{PCO}_{2_s})$$

where:

- F is the outgassing flux of CO_2 in ($\mu\text{mol m}^{-2} \text{s}^{-1}$)
- k_{CO_2} is the temperature-dependent gas exchange coefficient for CO_2 (m d^{-1})
- γ is CO_2 solubility ($\mu\text{mol m}^{-3} \text{uPa}^{-1}$; Weiss 1974)
- PCO_{2_atm} and PCO_{2_s} are the partial pressures of CO_2 in the atmosphere and solution, respectively.

k_{CO_2} was determined as a function of wind speed (Alin et al. 2010). A value of k_{600} , the gas transfer velocity for freshwater at 20°C , was selected for each wind speed based on the relationship between k_{600} and u_{10} values presented in Alin et al. (2010).

Monte Carlo error-propagation techniques were used to determine the error of our calculated gas evasion flux.

In situ respiration rates

Respiration rates were calculated at all sites by measuring the consumption of oxygen over a 24-h period.

- Five initial and final replicate samples were incubated in 60-mL acid-washed Biological Oxygen Demand bottles in the dark in river water held at ambient temperatures.
- Bottles were agitated twice daily by gently inverting them several times to reduce aggregate formation.
- Oxygen concentrations were measured by Winkler Titrations (Wetzel and Likens 1991) using a Hach titrator. Dissolved oxygen consumption was determined as the rate of change between the initial and final replicates over the incubation period.

Calculation of the depth-integrated respiration rate

The depth-integrated respiration rate for a given site was calculated from the respiration rate (i.e. measurements of oxygen consumption (in $\mu\text{mols L}^{-1} \text{ h}^{-1}$). This rate was converted to CO_2 production by using a respiratory coefficient of 1. It was then multiplied by the depth of the river to yield a depth-integrated respiration rate in terms of $\mu\text{mols CO}_2 \text{ m}^{-2} \text{ s}^{-1}$. The error was determined using Monte Carlo error propagation techniques.

Bacterial abundance measurements

Bacterial abundance measurements were made by epifluorescence microscopy using 4,6-diamidino-2-phenylindole (DAPI) optical filters in 2006.

- Forty-milliliter samples were collected, preserved with formaldehyde to a final concentration of 2%, and analyzed within 2 to 4 months of collection.
- A surfactant (0.5% solution of Triton X-100 in distilled water) was added drop-wise to particle-rich samples, which were then sonicated for 10 min.
- Next, the sample solution was stained with Acridine Orange for 3 min.
- Samples were then filtered using $0.22 \mu\text{m}$ black polycarbonate-membrane filters, and stained with DAPI for 10 min. Because these samples had high sediment concentrations, this dual-stain technique was necessary to illuminate the bacterial cells against the particle-rich background for counting purposes (Schmidt et al. 1998).
- Between 250 μL and 5 μL of sample were used, such that 200 cells were counted in 20 fields.

Measurements of delta 18O-O₂ and delta 18O-H₂O

Stable isotopes of oxygen dissolved in water (delta 18O-O₂) were measured to assess the origin of O₂ (Holtgrieve et al. 2010).

- Samples were analyzed within 3 months using a Finnigan Delta XL continuous-flow mass spectrometer (Thermo Electron Corp).
- Masses 32, 34, and 40 ($^{16}\text{O} : ^{16}\text{O}$, $^{18}\text{O} : ^{16}\text{O}$, and ^{40}Ar) were simultaneously measured (Barth et al., 2004; Holtgrieve et al., 2010).
- Water isotopes (delta 18O-H₂O), which came from a separate sample of river water, were analyzed on a Micromass Isoprime mass spectrometer.
- Results are given relative to Standard Mean Ocean Water in delta notation with units of per mil.

6. Data Access:

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

Data Archive Center:

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov

Telephone: +1 (865) 241-3952

7. References:

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