



# **Stable Isotope ( $\delta^{18}\text{O}$ and $\delta^2\text{H}$ ) Data for Precipitation, Stream Water, and Groundwater in Puerto Rico**

By Martha A. Scholl, Angel Torres-Sanchez, and Manuel Rosario-Torres

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## Conversion Factors

### SI to Inch/Pound

| Multiply                            | By        | To obtain                      |
|-------------------------------------|-----------|--------------------------------|
| Length                              |           |                                |
| centimeter (cm)                     | 0.3937    | inch (in.)                     |
| millimeter (mm)                     | 0.03937   | inch (in.)                     |
| meter (m)                           | 3.281     | foot (ft)                      |
| kilometer (km)                      | 0.6214    | mile (mi)                      |
| meter (m)                           | 1.094     | yard (yd)                      |
| Area                                |           |                                |
| square meter (m <sup>2</sup> )      | 0.0002471 | acre                           |
| hectare (ha)                        | 2.471     | acre                           |
| square kilometer (km <sup>2</sup> ) | 247.1     | acre                           |
| square meter (m <sup>2</sup> )      | 10.76     | square foot (ft <sup>2</sup> ) |
| hectare (ha)                        | 0.003861  | square mile (mi <sup>2</sup> ) |
| square kilometer (km <sup>2</sup> ) | 0.3861    | square mile (mi <sup>2</sup> ) |
| Volume                              |           |                                |
| liter (L)                           | 0.2642    | gallon (gal)                   |
| cubic meter (m <sup>3</sup> )       | 35.31     | cubic foot (ft <sup>3</sup> )  |
| Flow rate                           |           |                                |
| meter per second (m/s)              | 3.281     | foot per second (ft/s)         |
| millimeter per year (mm/yr)         | 0.03937   | inch per year (in/yr)          |
| Mass                                |           |                                |
| gram (g)                            | 0.03527   | ounce, avoirdupois (oz)        |
| kilogram (kg)                       | 2.205     | pound avoirdupois (lb)         |
| Pressure                            |           |                                |
| hectopascal (hPa)                   | 1         | millibar (mb)                  |
| Hydraulic conductivity              |           |                                |
| meter per day (m/d)                 | 3.281     | foot per day (ft/d)            |

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as  $^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$ .

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as  $^{\circ}\text{C} = (^{\circ}\text{F} - 32) / 1.8$ .

## Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83)

Altitude, as used in this report, refers to distance above the vertical datum.

## Supplemental Information

Note to USGS users: Use of hectare (ha) as an alternative name for square hectometer ( $\text{hm}^2$ ) is restricted to the measurement of small land or water areas. Use of liter (L) as a special name for cubic decimeter ( $\text{dm}^3$ ) is restricted to the measurement of liquids and gases. No prefix other than milli should be used with liter. Metric ton (t) as a name for megagram (Mg) should be restricted to commercial usage, and no prefixes should be used with it.

# Stable Isotope ( $\delta^{18}\text{O}$ and $\delta^2\text{H}$ ) Data for Precipitation, Stream Water, and Groundwater in Puerto Rico

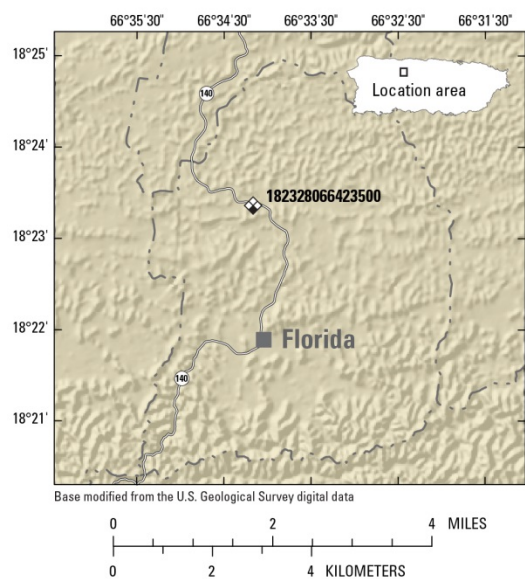
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## Introduction

### Description of Study Area

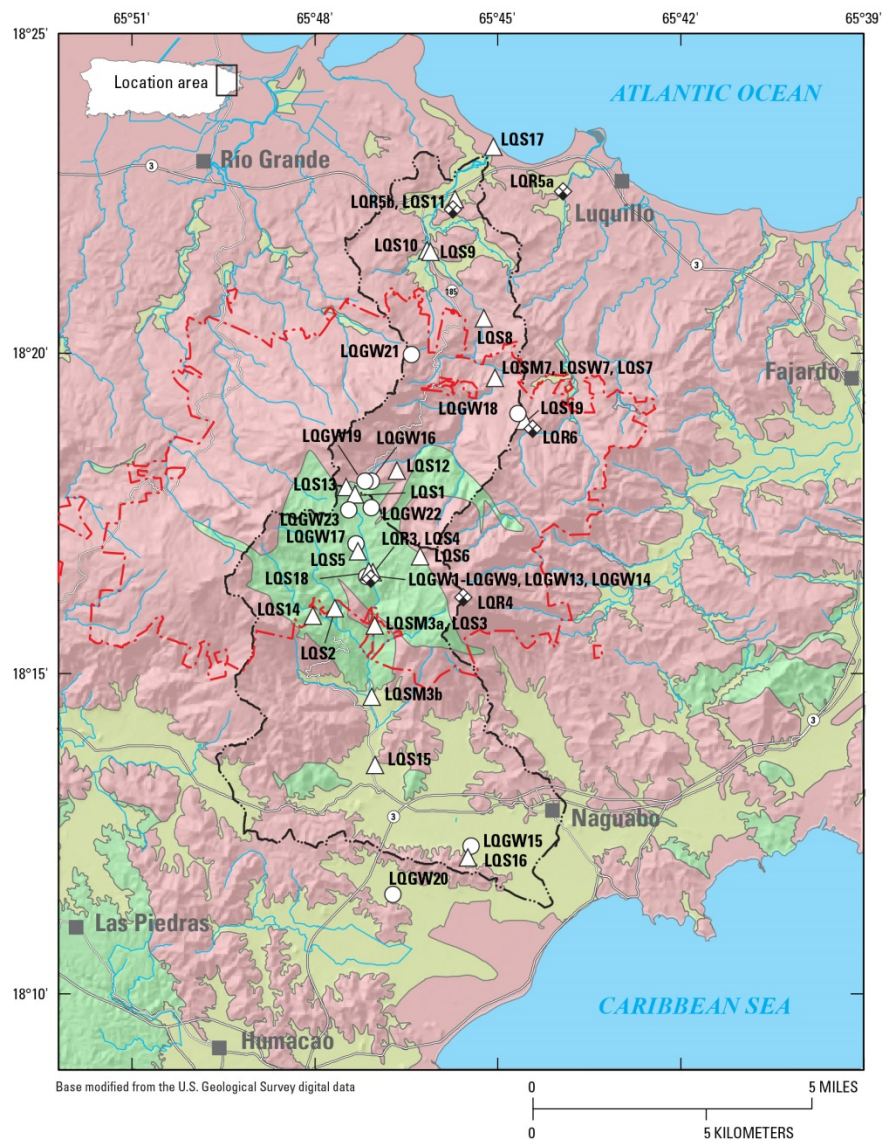
Puerto Rico is located in the northeastern Caribbean Sea (18.2 °N, 66.3 °W), with the Atlantic Ocean on its northern coast. The U.S. Geological Survey's Water, Energy, and Biogeochemical Budgets (WEBB) program study area in which most of these data were collected comprises the El Yunque National Forest and surrounding area of eastern Puerto Rico. Samples were collected in two forested watersheds, the Rio Mameyes and the Rio Icacos/Rio Blanco, on opposite sides of a ridge in the Luquillo Mountains on the eastern end of the island (fig. 1). Elevation in both watersheds ranges from sea level to approximately 1,000 meters (m). Near sea level, land use is mixed pasture, moist forest, and residential, grading to completely forested within the boundaries of El Yunque National Forest. Forest type changes with elevation from tabonuco to palo colorado to sierra palm to cloud forest above approximately 950 m (Murphy and others, 2012). The Rio Mameyes watershed is oriented north-northeast, and the basin is underlain by volcanoclastic bedrock (basaltic to andesitic volcanic sandstone/mudstone/conglomerate/breccia). The Rio Icacos/Rio Blanco watershed is oriented south-southeast. The Rio Icacos is one of the headwaters of the Rio Blanco and is underlain by quartz diorite. The lower Rio Blanco basin is underlain by andesitic volcanoclastic bedrock. This report also contains a long-term rain isotope dataset from the San Agustin site, in north-central Puerto Rico (fig. 1).

Puerto Rico has a tropical climate dominated by easterly trade winds, and seasonal climate patterns affect the hydrology of the study area. The summer wet season is characterized by convective precipitation from tropical easterly waves, troughs, and cyclonic low-pressure systems, including tropical storms and hurricanes; in contrast, the drier winter season is characterized by trade-wind showers and frontal systems. The highest single-event rainfall totals tend to be associated with tropical storms, hurricanes, and cold fronts, although frequent low-intensity orographic showers occur throughout the year in the mountains. The stable isotope signatures of rainfall ( $\delta^2\text{H}$  and  $\delta^{18}\text{O}$ ) are broadly correlated with the weather type that produced the rainfall (Scholl and others, 2009; Scholl and Murphy, 2014).



**EXPLANATION**

- Fissured aquifers (not intergranular) karst and nonkarst
- Quaternary alluvial deposits
- Quartz diorite plutonic rocks
- Volcaniclastic rocks
- River
- Secondary road
- Primary road
- El Yunque boundary
- Watershed boundary
- Town or city
- Surface-water sampling site
- Groundwater sampling site
- Precipitation sampling site



**Figure 1.** Map of the Luquillo Mountains and San Agustin study areas in Puerto Rico, showing geology, streams, and sample-collection sites.

## Purpose and Scope

Stable isotope data can be used to determine interactions between climate, streamflow, and groundwater resources, and to characterize watershed residence times and streamflow generation processes. This report contains stable isotope datasets for rain water, cloud water, stream water, and groundwater, and is intended to supplement interpretive research publications from the Luquillo WEBB program, as well as other research efforts within the study area.

## Methods

### Field Sample Collection

#### Monthly Rain-Water Isotope Samples

Cumulative monthly rain-water isotope samples ( $\delta^2\text{H}$  and  $\delta^{18}\text{O}$ ) were collected from nine sites across the Luquillo Mountains for 3 years beginning in April 2005, and sampling has continued at four of those sites to the present (2014). The 3-year dataset collected at the nine sites from April 2005 to April 2008 is published in Scholl and others, 2009, and is not repeated herein. Stable isotope data from the four long-term monthly rain-water collection sites from 2005–2013 are presented in this report. These sites are Pico del Este, Rio Mameyes gage, Rio Icacos gage, and Bisley tower; locations are shown in figure 1 and table 1, and the data are provided in table 2. Rain samples for isotopic analysis were collected in 20-liter high-density polyethylene (HDPE) rectangular carboys. An HDPE funnel was glued into the cap; funnel diameter varied depending on rainfall amount expected at each site. The funnel contained a small amount of polyester fiber to filter debris. Mineral oil was added to the carboy to make a 1-cm-thick layer over the water sample to prevent evaporation and subsequent isotopic fractionation (Scholl and others, 2009). Samples were collected by replacing the funnel cap with a spigot cap, positioning the carboy horizontally with the oil layer above the outlet, and dispensing the sample through a coarse, qualitative paper filter into a 60-mL glass bottle with a conical-insert cap. The filter paper served to remove residual oil from the sample. The volume of the entire monthly sample was then measured so that volume-weighted averages could be calculated, and to correlate with rainfall amounts measured in nearby tipping-bucket rain gages.

Monthly rain samples were collected for isotopic analysis from 1993 through 2013 at the San Agustin rain gage site (USGS 182328066423500) in the Florida municipality of north-central Puerto Rico (fig. 1; table 1). Rainfall samples were collected daily by using a cylindrical clear-plastic rain gage with a 10-cm-diameter funnel. The daily samples were accumulated in 1-liter plastic bottles during each month and combined at the end of the month to produce a composite sample. The composite rainfall samples were kept closed and protected from sunlight to avoid evaporation and contamination. Monthly composite samples were filtered through a nonreactive silicon-based 0.45-micron pore-size capsule filter to remove particles and debris, and the aliquot for isotope analysis was stored in a 60-mL glass bottle with a conical-insert cap.

The International Atomic Energy Agency–Global Network of Isotopes in Precipitation (IAEA–GNIP) published cumulative monthly  $\delta^{18}\text{O}$  values for rainfall at the San Juan, Puerto Rico airport for the period from 8/1/1968 to 4/30/1973 (IAEA–GNIP, 2014). The rainfall isotope data from San Agustin from May 1993 through December 1995 were published in Rodriguez-Martinez (1997). These data and subsequent analyses continuing to 2013 are provided in table 3 of this report. These represent the only stable isotope data for rain water that we are aware of from Puerto Rico during the 1994–2005 period,



and the full dataset has not previously been published. Volumes of the monthly samples were not available for the dataset from 1994–2003, so monthly rainfall totals from the nearby station at Arecibo Observatory (NCDC–NOAA, 2014), 20 km to the west-southwest and approximately 140 m higher in elevation, were calculated and are provided in table 3. In figure 2, the San Agustin data are compared with the average value of the Luquillo WEBB samples for the approximately 8-year period that the two datasets overlap.

### Cloud-Water Isotope Samples

Cloud-water samples for stable isotope analysis were collected with an active-strand cloud-water collector, similar to the design of those described in Daube and others, 1987. The fan-driven cloud-water collector draws air across a set of cartridges strung with Teflon monofilament, and the impacting cloud droplets coalesce and fall into a collection trough and then into sample bottles. Rain, if present, is excluded from the sample. Samples were collected on Pico del Este while the site was immersed in clouds in September 2007, May 2010, and March 2013.

### Stream-Water Isotope Samples

Stream-water isotope samples from the Rio Mameyes at USGS gage 50065500 (the site is also called Puente Roto) were collected monthly from 11/1/2007 until 3/9/2010, then weekly thereafter. Samples were also collected sporadically from the Rio Icacos upstream from USGS gage 50075550. Grab samples were collected from the bank of the flowing stream in 60-mL bottles with conical-insert caps. Site locations are provided in table 1, and stable isotope data are presented in table 4.

Five sets of contemporaneous (collected during a 2- to 3-day period) stream-water samples from multiple sites along the length of the Rio Mameyes and the Rio Blanco/Rio Icacos and their tributaries were taken during different seasons in February 2006, November 2006, September 2007, June 2008, and January 2010. The samples were collected at different elevations in the watershed from near sea level to the headwaters, and sampling times generally represented baseflow conditions. Site locations are provided in table 1, and stable isotope data are presented in table 5.

### Groundwater Isotope Samples

Groundwater samples were collected from available wells in eastern Puerto Rico, by using either a peristaltic pump or an installed pump. The larger wells were pumped until the specific conductance stabilized, then the sample was taken. The smaller, shallow wells were pumped until empty, then sampled between 12 and 24 hours later, after they refilled. Samples were taken in January 2010, May 2010, June 2011, and May 2012. Site locations are provided in table 1, and stable isotope data are presented in table 6.

**Table 1.** Rain-water, stream-water, and groundwater sampling sites for monitoring natural-water isotopic composition in eastern Puerto Rico.

[Sample type: R = Rain Water, CW = Cloud Water, S = Stream Water, G = Groundwater]

| Site name   | Site ID                             | Latitude, °N | Longitude, °W | Elevation<br>land surface<br>(m) | Sample type |
|---|-------------------------------------|--------------|---------------|----------------------------------|-------------|
| Rio Icacos, USGS stream gage 50075000   | LQR3                                | 18.277       | -65.786       | 625                              | R           |
| Pico del Este (East Peak)   | LQR4                                | 18.270       | -65.760       | 1011                             | R, CW       |
| <sup>1</sup> Mata de Platanos USGS QMP1, from<br>4/20/05–7/21/08                          | LQR5a                               | 18.376       | -65.733       | 2                                | R           |
| <sup>1</sup> Rio Mameyes at Mameyes, USGS<br>streamgage 50066000 from 7/21/08–<br>3/26/13 | LQR5b, LQS11                        | 18.37226     | -65.76311     | 5                                | R           |
| <sup>2</sup> Bisley upper tower, USGS Meteorological<br>Station 50065549                  | LQR6                                | 18.31582     | -65.74315     | 482                              | R           |
| San Agustin, Florida, PR  | 182328066414600,<br>182328066423500 | 18.38930     | -66.56934     | 178                              | R           |
| Arecibo Observatory, PR, rainfall amounts   | GHCND:RQC00660<br>426               | 18.3494      | -66.7525      | 323                              | R           |
| Rio Icacos, above Lago Icacos, from<br>11/1/07 to 5/3/12                                  | LQSM3a, LQS3                        | 18.2626      | -65.7844      | 453                              | S           |
| Rio Icacos at Hydroelectric Plant, from<br>5/3/12   | LQSM3b                              | 18.244       | -65.785       | 43                               | S           |
| Rio Mameyes near Sabana, USGS<br>streamgage 50065500, Puente Roto                         | LQSM7, LQSW7,<br>LQS7               | 18.327       | -65.751       | 84                               | S           |
| Rio Mameyes headwaters  | LQS1                                | 18.29592     | -65.78941     | 732                              | S           |
| Rio Sabana (Rio Blanco basin) at Hwy. No.<br>191 bridge                                   | LQS2                                | 18.2672      | -65.7952      | 483                              | S           |
| Rio Icacos, USGS streamgage 50075000  | LQS4                                | 18.277       | -65.786       | 616                              | S           |
| Quebrada Guaba, USGS streamgage<br>50074950   | LQS5                                | 18.28204     | -65.78907     | 640                              | S           |
| Rio Icacos headwaters   | LQS6                                | 18.28048     | -65.77202     | 813                              | S           |
| Rio Mameyes at Rte. 990 crossing  | LQS8                                | 18.34246     | -65.75427     | 47                               | S           |
| Rio Mameyes above Quebrada Tabonuco   | LQS9                                | 18.35966     | -65.76887     | 11                               | S           |
| Quebrada Tabonuco   | LQS10                               | 18.35973     | -65.76937     | 12                               | S           |
| Rio de la Mina above falls  | LQS12                               | 18.30295     | -65.77805     | 536                              | S           |
| Mt. Britton tributary to Rio de la Mina   | LQS13                               | 18.29845     | -65.79199     | 778                              | S           |
| Rio Cubuy at Hwy. No. 191 bridge  | LQS14                               | 18.26505     | -65.80112     | 479                              | S           |
| Rio Blanco near Florida USGS streamgage<br>50076000                                       | LQS15                               | 18.22601     | -65.78452     | 15                               | S           |
| Rio Blanco at Rt. 927   | LQS16                               | 18.20243     | -65.75903     | 8                                | S           |
| Rio Mameyes at mouth  | LQS17                               | 18.38713     | -65.75134     | 0.1                              | S           |
| Rio Icacos tributary, McDowell  | LQS18                               | 18.2772      | -65.7858      | 624                              | S           |
| Bisley tributary, McDowell  | LQS19                               | 18.31554     | -65.74530     | 285                              | S           |

**Table 1.** Rain-water, stream-water, and groundwater sampling sites for monitoring natural-water isotopic composition in eastern Puerto Rico.—Continued

[Sample type: R = Rain Water, CW = Cloud Water, S = Stream Water, G = Groundwater]

| Site name  | Site ID                     | Latitude, °N | Longitude, °W | Elevation land surface (m) | Sample type |
|--|-----------------------------|--------------|---------------|----------------------------|-------------|
| <sup>3</sup> McDowell well field, near Rio Icacos streamgage (McDowell and others, 1992) | LQGW1-LQGW9, LQGW13, LQGW14 | 18.2772      | -65.7858      | 625                        | G           |
| CA-1 well, Naguabo 181217065453000   | LQGW15                      | 18.2047      | -65.7583      | 5                          | G           |
| Caimitillo well, ElYunque NF   | LQGW16                      | 18.3008      | -65.7856      | 645                        | G           |
| LGW1 Icacos deep well  | LQGW17                      | 18.28245     | -65.78873     | 648                        | G           |
| BIW2 Bisley deep well  | LQGW18                      | 18.318       | -65.7458      | 239                        | G           |
| Palo Colorado well, El Yunque NF   | LQGW19                      | 18.3006      | -65.7875      | 694                        | G           |
| Pennock Gramas well 181134065464400  | LQGW20                      | 18.1928      | -65.7789      | 10                         | G           |
| Aviary well, El Yunque NF  | LQGW21                      | 18.3335      | -65.7742      | 461                        | G           |
| CD3 East Peak Well ( approximately 5-m depth)  | LQGW22                      | 18.2947      | -65.785       | 775                        | G           |
| LGW2B (bailed from drilled well top of Hwy. No. 191)                                     | LQGW23                      | 18.2941      | -65.7911      | 740                        | G           |

<sup>1</sup>Site changed to a safer location (Rio Mameyes gage) 3 km to the west in July 2008.

<sup>2</sup>Land surface is 482 m; elevation of rain collector at top of tower is 502 m.

<sup>3</sup>Wells all within an area about 15 by 20 meters; no individual latitude-longitude coordinates. See McDowell and others, 1992, for a detailed location map.

## Laboratory Analysis Methods

Hydrogen-isotope-ratio ( $\delta^2\text{H}$ ) analyses were performed by using a hydrogen equilibration technique (Coplen and others, 1991; Révész and Coplen, 2008a). Water samples were measured for delta O-18 ( $\delta^{18}\text{O}$ ) by using the  $\text{CO}_2$  equilibration technique of Epstein and Mayeda (1953), which has been automated (Révész and Coplen, 2008b). Oxygen and hydrogen isotopic results are reported in per mil (‰) relative to Vienna Standard Mean Ocean Water (VSMOW), and normalized (Coplen, 1994) on scales such that the oxygen and hydrogen isotopic values of Standard Light Antarctic Precipitation (SLAP) are -55.5 ‰ and -428 ‰, respectively.

# Stable Isotope Data

## Monthly Rain-Water Isotope Data

**Table 2.** Monthly rain-water isotope data for sites LQR3, LQR4, LQR5, and LQR6 in eastern Puerto Rico, 2005–2013.

[mm = millimeters, -- = no data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details]

| Collection date and time   | Sample volume (mm) <sup>1</sup> | δ <sup>2</sup> H (‰) | δ <sup>18</sup> O (‰) | Collection date and time   | Sample volume, (mm) <sup>1</sup> | δ <sup>2</sup> H (‰) | δ <sup>18</sup> O (‰) |
|----------------------------|---------------------------------|----------------------|-----------------------|----------------------------|----------------------------------|----------------------|-----------------------|
| LQR3, Rio Icacos           |                                 |                      |                       | LQR4, Pico del Este        |                                  |                      |                       |
| <sup>2</sup> 4/20/05 13:00 |                                 |                      |                       | <sup>2</sup> 4/20/05 14:00 |                                  |                      |                       |
| 5/16/05 11:00              | 247                             | 0.9                  | -1.80                 | 5/16/05 12:00              | 345                              | -7.2                 | -2.52                 |
| 6/13/05 11:50              | 691                             | -40.7                | -6.45                 | 6/13/05 10:20              | 592                              | -44.0                | -7.12                 |
| 7/12/05 11:50              | 284                             | -6.1                 | -2.46                 | 7/13/05 11:05              | 185                              | -9.3                 | -2.99                 |
| 8/10/05 12:30              | 247                             | -14.7                | -3.24                 | 8/10/05 11:10              | 197                              | -16.5                | -3.71                 |
| 9/7/05 11:30               | 308                             | -9.9                 | -2.94                 | 9/7/05 10:30               | 210                              | -13.4                | -3.41                 |
| 10/5/05 12:00              | 543                             | -13.6                | -3.28                 | 10/5/05 11:00              | 518                              | -16.0                | -3.92                 |
| 11/9/05 11:45              | 857                             | -39.9                | -6.80                 | 11/9/05 10:50              | 817                              | -42.4                | -7.25                 |
| 12/7/05 12:35              | 323                             | -8.6                 | -2.95                 | 12/7/05 11:10              | 299                              | -10.4                | -3.53                 |
| 1/11/06 10:40              | 290                             | 4.0                  | -1.47                 | 1/11/06 12:00              | 237                              | 1.7                  | -2.09                 |
| 2/13/06 14:15              | 565                             | 3.0                  | -1.57                 | 2/13/06 12:30              | 343                              | -0.6                 | -2.08                 |
| 3/15/06 10:50              | 175                             | 4.5                  | -1.52                 | 3/17/06 12:20              | 181                              | 2.1                  | -2.03                 |
| 4/26/06 12:25              | 385                             | 1.2                  | -1.62                 | 4/27/06 17:40              | 465                              | -1.4                 | -2.08                 |
| 5/25/06 11:20              | 200                             | 1.5                  | -1.84                 | 5/25/06 14:40              | 212                              | -4.2                 | -2.56                 |
| 6/26/06 14:25              | 433                             | -9.1                 | -2.80                 | 6/26/06 12:45              | 559                              | -10.1                | -3.08                 |
| 7/28/06 13:00              | 545                             | -10.1                | -2.75                 | 8/1/06 15:05               | 491                              | -15.7                | -3.48                 |
| 8/31/06 12:35              | 296                             | -18.6                | -3.56                 | 8/29/06 12:35              | 392                              | -20.6                | -3.92                 |
| 9/29/06 12:50              | 317                             | -5.6                 | -2.32                 | 9/27/06 12:05              | 294                              | -11.5                | -3.43                 |
| 11/2/06 11:45              | 298                             | -17.0                | -3.85                 | 10/27/06 13:50             | 368                              | -12.9                | -3.40                 |
| 11/29/06 16:10             | 392                             | -5.4                 | -2.66                 | 12/7/06 13:20              | 423                              | -7.2                 | -3.05                 |
| 1/4/07 14:45               | 405                             | 1.0                  | -1.75                 | 1/12/07 14:30              | 201                              | 0.1                  | -2.22                 |
| 2/7/07 11:00               | 263                             | 4.0                  | -1.48                 | 2/7/07 11:00               | 109                              | 1.6                  | -2.08                 |
| 3/8/07 12:10               | 139                             | 9.3                  | -0.95                 | 3/8/07 13:45               | 78                               | 5.4                  | -1.52                 |
| 4/4/07 12:20               | 339                             | -5.7                 | -2.26                 | 4/3/07 15:00               | 228                              | -13.5                | -3.35                 |
| 5/1/07 11:50               | 363                             | 1.1                  | -1.63                 | 5/1/07 14:40               | 268                              | -0.1                 | -2.11                 |
| 6/7/07 13:40               | 277                             | -12.9                | -2.96                 | 6/7/07 12:30               | 172                              | -9.0                 | -2.82                 |
| 7/2/07 12:30               | 234                             | -9.0                 | -2.28                 | 7/2/07 14:45               | 191                              | -10.2                | -2.94                 |
| 8/15/07 14:35              | 400                             | -4.8                 | -1.84                 | 8/16/07 14:20              | 306                              | -6.6                 | -2.64                 |
| 9/14/07 11:45              | 269                             | -7.5                 | -2.36                 | 9/14/07 10:05              | 238                              | -13.0                | -3.48                 |
| 9/30/07 14:45              | 198                             | -9.2                 | -2.73                 | 9/30/07 11:00              | 126                              | -12.7                | -3.50                 |
| 11/8/07 12:15              | 651                             | -38.9                | -6.55                 | 11/8/07 14:40              | 627                              | -42.7                | -7.25                 |
| 12/13/07 15:50             | 516                             | -14.3                | -3.71                 | 12/13/07 14:55             | 405                              | -20.4                | -4.70                 |
| 1/16/08 11:00              | 355                             | 0.0                  | -1.93                 | 1/17/08 14:00              | 368                              | -2.9                 | -2.48                 |
| 2/21/08 13:45              | 392                             | 5.5                  | -1.41                 | 2/21/08 14:15              | 189                              | 3.9                  | -1.96                 |
| 4/18/08 13:55              | 454                             | 5.7                  | -1.28                 | 4/16/08 12:40              | 380                              | 2.5                  | -1.95                 |
| 5/7/08 12:40               | 146                             | -4.0                 | -1.76                 | 5/7/08 14:50               | 232                              | -5.3                 | -2.11                 |
| 6/24/08 13:30              | 368                             | -0.7                 | -1.55                 | 6/24/08 10:45              | 349                              | -4.0                 | -2.13                 |

**Table 2.** Monthly rain-water isotope data for sites LQR3, LQR4, LQR5, and LQR6 in eastern Puerto Rico, 2005–2013.—Continued

[mm = millimeters, -- = no data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details]

| Collection date and time   | Sample volume (mm) <sup>1</sup> | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) | Collection date and time      | Sample volume, (mm) <sup>1</sup> | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|----------------------------|---------------------------------|------------------------|---------------------------|-------------------------------|----------------------------------|------------------------|---------------------------|
| LQR3, Rio Icacos—Continued |                                 |                        |                           | LQR4, Pico del Este—Continued |                                  |                        |                           |
| 7/21/08 13:00              | 176                             | 2.0                    | -1.12                     | 7/21/08 12:00                 | 146                              | 0.1                    | -1.72                     |
| 8/27/08 12:55              | 337                             | -17.6                  | -3.74                     | 8/28/08 14:30                 | 312                              | -22.3                  | -4.47                     |
| 9/25/08 9:40               | 1034                            | -35.8                  | -6.18                     | 9/26/08 12:20                 | 1009                             | -41.1                  | -6.99                     |
| 10/30/08 12:05             | 380                             | -36.3                  | -6.29                     | 10/30/08 11:20                | 491                              | -35.8                  | -6.58                     |
| 11/18/08 13:20             | 201                             | -7.8                   | -2.72                     | 11/18/08 12:30                | 386                              | -10.5                  | -3.30                     |
| 12/10/08 13:15             | 121                             | 5.6                    | -1.53                     | 12/10/08 12:35                | 158                              | 1.2                    | -2.26                     |
| 1/29/09 15:30              | 331                             | -1.8                   | -1.98                     | 1/29/09 14:45                 | 516                              | -5.1                   | -2.65                     |
| 2/19/09 15:15              | 146                             | 3.9                    | -1.37                     | 2/19/09 16:15                 | 146                              | 0.6                    | -2.08                     |
| 3/26/09 11:45              | 244                             | 6.6                    | -1.34                     | 3/26/09 12:45                 | 281                              | -0.2                   | -2.27                     |
| 4/28/09 13:35              | 220                             | 3.4                    | -1.32                     | 4/28/09 12:44                 | 257                              | 0.2                    | -2.00                     |
| 5/29/09 14:30              | 306                             | -1.0                   | -1.78                     | 5/29/09 15:25                 | 577                              | -4.1                   | -2.33                     |
| 6/10/09 12:00              | 102                             | -2.1                   | -1.99                     | 6/10/09 11:20                 | 270                              | -5.7                   | -2.54                     |
| 7/30/09 14:35              | 275                             | -3.4                   | -2.09                     | 7/30/09 15:50                 | 300                              | -6.2                   | -2.47                     |
| 8/25/09 15:45              | 220                             | -4.7                   | -2.06                     | 8/25/09 15:00                 | 244                              | -11.2                  | -3.02                     |
| 9/28/09 11:30              | 577                             | -16.9                  | -3.62                     | 9/24/09 15:40                 | 479                              | -18.7                  | -4.01                     |
| 10/27/09 16:25             | 269                             | -9.8                   | -2.98                     | 10/27/09 15:25                | 244                              | -11.0                  | -3.26                     |
| 11/17/09 16:05             | 368                             | -5.0                   | -2.58                     | 11/17/09 15:23                | 355                              | -6.4                   | -2.91                     |
| 12/17/09 13:00             | 146                             | 3.9                    | -1.43                     | 12/17/09 14:00                | 109                              | 1.8                    | -2.04                     |
| 1/21/10 11:00              | 664                             | 1.9                    | -2.01                     | 1/22/10 12:20                 | 602                              | -1.1                   | -2.33                     |
| 2/17/10 10:45              | 102                             | 6.4                    | -1.36                     | 2/17/10 11:20                 | 7                                | 2.9                    | -1.98                     |
| 3/10/10 11:45              | 220                             | 5.2                    | -1.48                     | 3/10/10 11:05                 | 207                              | 1.9                    | -1.90                     |
| 4/27/10 15:50              | 645                             | -1.5                   | -2.08                     | 4/27/10 15:05                 | 657                              | -4.8                   | -2.71                     |
| 5/18/10 10:50              | 577                             | -3.2                   | -1.94                     | 5/19/10 11:35                 | 553                              | -4.0                   | -2.26                     |
| 6/7/10 12:15               | 429                             | -31.4                  | -5.21                     | 6/7/10 14:45                  | 331                              | -34.5                  | -5.68                     |
| 7/13/10 14:20              | 639                             | -16.8                  | -3.58                     | 7/13/10 15:35                 | 503                              | -13.9                  | -3.52                     |
| 8/17/10 10:50              | 1058                            | -19.9                  | -4.03                     | 8/17/10 11:35                 | 331                              | -22.4                  | -4.42                     |
| 9/29/10 12:00              | 269                             | -8.3                   | -2.63                     | 9/29/10 13:30                 | 207                              | -13.1                  | -3.57                     |
| 10/28/10 15:00             | 331                             | -18.7                  | -3.98                     | 10/28/10 14:10                | 269                              | -25.2                  | -4.81                     |
| 11/18/10 11:25             | 257                             | -13.7                  | -3.56                     | 11/18/10 12:15                | 269                              | -17.1                  | -4.10                     |
| 12/15/10 10:50             | 294                             | -1.9                   | -2.42                     | 12/15/10 11:30                | 343                              | -4.9                   | -2.90                     |
| 1/28/11 11:15              | 417                             | 5.8                    | -1.89                     | 1/26/11 10:15                 | 286                              | 2.3                    | -2.16                     |
| 2/16/11 13:50              | 158                             | 4.9                    | -1.34                     | 2/16/11 14:30                 | 146                              | 1.4                    | -1.76                     |
| 3/17/11 12:35              | 170                             | 2.2                    | -1.77                     | 3/17/11 13:35                 | 146                              | 0.2                    | -2.28                     |
| 5/25/11 12:45              | 388                             | -24.0                  | -4.43                     | 5/25/11 15:20                 | 614                              | -21.3                  | -4.35                     |
| 6/8/11 15:30               | 225                             | -54.2                  | -8.18                     | 6/8/11 17:10                  | 281                              | -52.3                  | -8.32                     |
| 7/26/11 14:50              | 593                             | -9.6                   | -2.61                     | 7/26/11 13:55                 | 429                              | -9.5                   | -2.79                     |
| 9/2/11 14:00               | 1034                            | -40.5                  | -6.55                     | 8/30/11 12:20                 | 923                              | -37.6                  | -6.45                     |
| 9/30/11 13:55              | 368                             | -21.9                  | -4.29                     | 9/27/11 15:40                 | 392                              | -21.0                  | -4.37                     |
| 10/20/11 12:25             | 292                             | -4.6                   | -2.24                     | 10/20/11 13:10                | 222                              | -7.7                   | -2.83                     |
| 11/29/11 13:00             | 228                             | -17.6                  | -3.75                     | 11/29/11 13:45                | 555                              | -25.2                  | -5.00                     |
| 12/15/11 12:55             | 308                             | -20.3                  | -3.99                     | 12/15/11 13:35                | 185                              | -19.7                  | -4.32                     |
| 1/24/12 14:40              | 355                             | 3.8                    | -1.45                     | 1/26/12 15:45                 | 294                              | 0.5                    | -2.28                     |

**Table 2.** Monthly rain-water isotope data for sites LQR3, LQR4, LQR5, and LQR6 in eastern Puerto Rico, 2005–2013.—Continued

[mm = millimeters, -- = no data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details]

| Collection date and time                   | Sample volume (mm) <sup>1</sup> | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) | Collection date and time      | Sample volume, (mm) <sup>1</sup> | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|---------------------------------|------------------------|---------------------------|-------------------------------|----------------------------------|------------------------|---------------------------|
| LQR3, Rio Icacos—Continued                 |                                 |                        |                           | LQR4, Pico del Este—Continued |                                  |                        |                           |
| 3/1/12 12:30                               | 454                             | 3.7                    | -1.33                     | 3/1/12 14:20                  | 308                              | 2.2                    | -2.01                     |
| 3/28/12 11:35                              | 602                             | -0.4                   | -2.10                     | 3/28/12 13:00                 | 555                              | -5.1                   | -2.73                     |
| 4/16/12 12:10                              | 664                             | -0.6                   | -1.96                     | 4/16/12 15:30                 | 503                              | -3.5                   | -2.37                     |
| 5/8/12 13:50                               | 308                             | -10.1                  | -2.81                     | 5/8/12 17:20                  | 382                              | -14.4                  | -3.40                     |
| 7/9/12 14:20                               | 558                             | -7.0                   | -2.35                     | 7/9/12 16:10                  | 619                              | -13.0                  | -3.43                     |
| 8/8/12 11:00                               | 262                             | -8.7                   | -2.32                     | 8/8/12 12:15                  | 329                              | -19.2                  | -4.05                     |
| 9/20/12 17:30                              | 397                             | -17.7                  | -3.72                     | 9/21/12 14:30                 | 231                              | -18.5                  | -3.98                     |
| 10/23/12 11:30                             | 447                             | -8.4                   | -2.84                     | 10/25/12 14:35                | 527                              | -14.6                  | -3.67                     |
| 12/4/12 11:45                              | 595                             | -8.8                   | -2.65                     | 11/30/12 15:00                | 755                              | -9.7                   | -3.05                     |
| 12/14/12 15:30                             | 187                             | 0.2                    | -2.08                     | 12/13/12 12:35                | 224                              | -8.6                   | -3.24                     |
| 1/17/13 12:30                              | 274                             | 5.1                    | -1.35                     | 1/18/13 22:00                 | 286                              | 0.7                    | -2.10                     |
| 3/1/13 9:55                                | 317                             | 4.1                    | -1.22                     | 2/26/13 13:05                 | 224                              | 0.0                    | -2.00                     |
| 3/26/13 11:40                              | 138                             | 4.2                    | -1.46                     | 3/26/13 12:35                 | 138                              | 1.1                    | -2.09                     |
| LQR5a and b, Mata de Platanos/ Rio Mameyes |                                 |                        |                           | LQR6, Bisley tower            |                                  |                        |                           |
| <sup>2</sup> 4/20/05 10:00                 |                                 |                        |                           | <sup>2</sup> 4/21/05 11:00    |                                  |                        |                           |
| 5/16/05 14:30                              | 362                             | -13.1                  | -2.78                     | 5/17/05 12:25                 | 440                              | -17.1                  | -3.38                     |
| 6/13/05 14:05                              | 224                             | -36.7                  | -5.75                     | 6/14/05 12:20                 | 360                              | -38.7                  | -6.28                     |
| 7/12/05 15:05                              | 141                             | -10.0                  | -2.42                     | 7/12/05 12:20                 | 122                              | -3.9                   | -2.21                     |
| 8/10/05 14:00                              | 100                             | -4.8                   | -1.83                     | 8/9/05 11:00                  | 159                              | -12.5                  | -3.09                     |
| 9/7/05 13:00                               | 147                             | -6.6                   | -2.14                     | 9/6/05 12:30                  | 148                              | -9.0                   | -2.74                     |
| 10/5/05 14:20                              | 218                             | -10.6                  | -2.78                     | 10/4/05 12:00                 | 238                              | -13.2                  | -3.27                     |
| 11/9/05 13:30                              | 403                             | -31.3                  | -5.13                     | 11/8/05 12:00                 | 1103                             | -38.7                  | -6.46                     |
| 12/8/05 12:30                              | 315                             | -4.5                   | -2.46                     | 12/6/05 12:40                 | 258                              | -4.8                   | -2.69                     |
| 1/13/06 12:50                              | 129                             | 8.0                    | -0.84                     | 1/10/06 10:50                 | 258                              | 4.5                    | -1.48                     |
| 2/15/06 11:50                              | 100                             | 8.4                    | -0.52                     | 2/14/06 12:40                 | 290                              | 4.8                    | -1.41                     |
| <sup>3</sup> 3/17/06 0:00                  | --                              | --                     | --                        | 3/14/06 13:00                 | 78                               | 5.0                    | -1.35                     |
| 4/26/06 14:35                              | 238                             | 2.9                    | -1.26                     | 4/25/06 11:45                 | 502                              | 0.1                    | -1.72                     |
| 5/25/06 16:15                              | 131                             | 4.1                    | -1.42                     | 5/31/06 11:15                 | 245                              | 2.0                    | -1.60                     |
| 6/23/06 14:20                              | 101                             | -1.3                   | -1.23                     | 6/27/06 12:20                 | 269                              | -6.0                   | -2.07                     |
| 7/27/06 13:40                              | 147                             | -11.0                  | -2.48                     | 7/25/06 12:55                 | 738                              | -8.6                   | -2.48                     |
| 8/28/06 10:30                              | 106                             | -9.3                   | -2.24                     | 8/22/06 8:05                  | 245                              | -10.7                  | -2.67                     |
| 9/29/06 14:20                              | 187                             | -1.6                   | -1.63                     | 9/26/06 13:20                 | 275                              | -9.1                   | -2.75                     |
| 11/3/06 11:50                              | 29                              | -15.6                  | -3.50                     | 10/31/06 13:50                | 414                              | -11.2                  | -3.08                     |
| 12/5/06 15:20                              | 152                             | -2.6                   | -2.04                     | 12/6/06 15:35                 | 402                              | -3.4                   | -2.44                     |
| 1/8/07 12:00                               | 55                              | 4.9                    | -0.84                     | 1/11/07 13:25                 | 129                              | 4.0                    | -1.62                     |
| 2/2/07 13:10                               | 29                              | 6.8                    | -0.93                     | 2/5/07 14:20                  | 92                               | 4.8                    | -1.42                     |
| 3/8/07 16:00                               | 34                              | 10.6                   | -0.52                     | 3/7/07 12:55                  | 83                               | 8.4                    | -1.04                     |
| 4/2/07 14:00                               | 57                              | -5.9                   | -2.23                     | 4/3/07 12:25                  | 151                              | -9.3                   | -2.88                     |
| 5/4/07 13:30                               | 137                             | 4.9                    | -1.12                     | 5/9/07 12:55                  | 347                              | 2.2                    | -1.73                     |
| 6/6/07 14:05                               | 79                              | 2.8                    | -0.92                     | 6/12/07 15:00                 | 140                              | -10.3                  | -2.71                     |
| 7/2/07 16:15                               | 112                             | -7.4                   | -2.06                     | 7/3/07 13:30                  | 77                               | -0.1                   | -1.56                     |

**Table 2.** Monthly rain-water isotope data for sites LQR3, LQR4, LQR5, and LQR6 in eastern Puerto Rico, 2005–2013.—Continued

[mm = millimeters, -- = no data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details]

| Collection date and time                             | Sample volume (mm) <sup>1</sup> | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) | Collection date and time     | Sample volume, (mm) <sup>1</sup> | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|---------------------------------|------------------------|---------------------------|------------------------------|----------------------------------|------------------------|---------------------------|
| LQR5a and b, Mata de Platanos/ Rio Mameyes—Continued |                                 |                        |                           | LQR6, Bisley tower—Continued |                                  |                        |                           |
| 8/14/07 14:25  | 159                             | -2.2                   | -1.48                     | 8/14/07 12:45                | 320                              | -5.9                   | -2.30                     |
| 9/11/07 13:50  | 150                             | -5.4                   | -2.08                     | 9/12/07 14:00                | 158                              | -7.0                   | -2.43                     |
| 10/1/07 13:45  | 133                             | -8.8                   | -2.44                     | 10/2/07 10:30                | 214                              | -6.9                   | -2.48                     |
| 11/6/07 9:50   | 184                             | -42.0                  | -6.59                     | 11/9/07 10:20                | 301                              | -37.5                  | -6.37                     |
| 12/13/07 12:00                                       | 240                             | -10.2                  | -2.88                     | 12/12/07 12:25               | 312                              | -17.6                  | -4.10                     |
| 1/15/08 9:40   | 130                             | 2.9                    | -1.28                     | 1/17/08 10:00                | 259                              | 0.5                    | -1.94                     |
| 2/20/08 14:35  | 178                             | 1.1                    | -1.83                     | 2/20/08 12:55                | 89                               | 5.4                    | -1.65                     |
| 4/16/08 14:10  | 93                              | 7.9                    | -0.63                     | 4/18/08 11:50                | 264                              | 5.2                    | -1.50                     |
| 5/7/08 16:00   | 140                             | -1.6                   | -1.43                     | 5/6/08 12:30                 | <sup>4</sup>                     | -5.2                   | -2.12                     |
| 6/25/08 11:10  | 163                             | -3.0                   | -1.39                     | 6/25/08 14:45                | 244                              | -1.8                   | -1.49                     |
| <sup>5</sup> 7/21/08 14:05                           | 70                              | 5.2                    | -0.61                     | 7/22/08 12:40                | 121                              | 1.1                    | -1.45                     |
| 8/28/08 13:15  | 73                              | -24.6                  | -4.56                     | 8/27/08 11:10                | 229                              | -15.5                  | -3.30                     |
| 9/26/08 11:30  | 140                             | -60.3                  | -8.81                     | 9/24/08 11:14                | 614                              | -36.2                  | -6.11                     |
| 10/30/08 10:11                                       | 167                             | -30.0                  | -5.37                     | 10/28/08 13:25               | 337                              | -33.9                  | -6.04                     |
| 11/18/08 11:30                                       | 96                              | -6.7                   | -2.29                     | 11/21/08 12:35               | 269                              | -9.5                   | -3.11                     |
| 12/10/08 11:50                                       | 34                              | 6.9                    | -1.07                     | 12/17/08 13:50               | 126                              | 4.2                    | -1.46                     |
| 1/29/09 16:50  | 106                             | 1.6                    | -1.29                     | 1/29/09 12:35                | 169                              | 5.3                    | -0.66                     |
| 2/19/09 17:20  | 53                              | 5.9                    | -1.02                     | 2/19/09 12:55                | 76                               | 13.9                   | -0.25                     |
| 3/26/09 13:45  | 100                             | 4.7                    | -1.26                     | 3/25/09 11:15                | 229                              | 14.1                   | -0.05                     |
| 4/29/09 11:00  | 58                              | 6.3                    | -0.68                     | 4/29/09 14:20                | 105                              | 12.2                   | 0.02                      |
| 5/26/09 15:40  | 157                             | 1.8                    | -1.09                     | 5/26/09 12:15                | 497                              | 2.0                    | -1.36                     |
| 6/9/09 9:25  | 56                              | 3.3                    | -0.88                     | 6/9/09 12:05                 | 182                              | 4.3                    | -1.02                     |
| 7/28/09 15:10  | 227                             | -0.6                   | -1.42                     | 7/28/09 14:15                | 651                              | -3.5                   | -1.93                     |
| 8/25/09 17:30  | 93                              | -14.4                  | -2.99                     | 8/25/09 13:20                | 116                              | -16.3                  | -3.44                     |
| 9/24/09 16:30  | 106                             | -17.3                  | -3.25                     | 9/24/09 13:35                | 328                              | -13.9                  | -3.07                     |
| 10/27/09 14:15                                       | 80                              | -2.6                   | -1.82                     | 10/28/09 13:50               | 179                              | 4.4                    | -0.76                     |
| 11/17/09 17:23                                       | 110                             | -0.7                   | -1.96                     | 11/17/09 13:10               | 243                              | -2.7                   | -1.78                     |
| 12/17/09 15:25                                       | 56                              | 5.5                    | -0.92                     | 12/15/09 13:35               | 184                              | 0.0                    | -1.93                     |
| 1/21/10 15:45  | 177                             | 6.4                    | -1.25                     | 1/22/10 10:50                | 645                              | 4.7                    | -1.77                     |
| 2/17/10 12:20  | 31                              | 10.4                   | -0.59                     | 2/16/10 13:10                | 89                               | 6.8                    | -1.24                     |
| 3/9/10 13:05   | 106                             | 10.1                   | -1.04                     | 3/9/10 11:45                 | 328                              | 7.2                    | -1.55                     |
| 4/29/10 14:50  | 358                             | -2.1                   | -2.00                     | 4/13/10 13:10                | 349                              | -0.1                   | -2.11                     |
| 5/20/10 13:15  | 117                             | 0.8                    | -1.32                     | <sup>6</sup> no sample       | --                               | --                     | --                        |
| 6/8/10 16:15   | 106                             | -29.6                  | -4.60                     | <sup>6</sup> no sample       | --                               | --                     | --                        |
| 7/13/10 17:10  | 152                             | -12.0                  | -2.87                     | 7/21/10 13:05                | --                               | --                     | --                        |
| 8/17/10 12:35  | 398                             | -17.9                  | -3.21                     | 8/18/10 13:00                | 169                              | -9.2                   | -2.62                     |
| 9/28/10 14:50  | 100                             | -2.1                   | -1.67                     | 9/28/10 12:55                | 359                              | -10.7                  | -2.88                     |
| 10/27/10 11:50                                       | 75                              | -25.5                  | -4.34                     | 10/28/10 12:00               | 426                              | -21.4                  | -4.11                     |
| 11/18/10 10:25                                       | 177                             | -15.8                  | -3.54                     | 11/17/10 13:00               | 328                              | -8.6                   | -3.11                     |
| 12/15/10 13:00                                       | 86                              | -0.1                   | -2.22                     | 12/16/10 13:10               | 614                              | -0.9                   | -2.54                     |
| 1/25/11 16:00  | 163                             | 4.5                    | -1.68                     | 1/25/11 13:30                | 211                              | 6.8                    | -1.50                     |
| 2/15/11 13:30  | 29                              | 4.6                    | -0.92                     | 2/18/11 12:30                | 227                              | 3.7                    | -1.45                     |

**Table 2.** Monthly rain-water isotope data for sites LQR3, LQR4, LQR5, and LQR6 in eastern Puerto Rico, 2005–2013.—Continued

[mm = millimeters, -- = no data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details]

| Collection date and time                             | Sample volume (mm) <sup>1</sup> | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) | Collection date and time     | Sample volume, (mm) <sup>1</sup> | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|---------------------------------|------------------------|---------------------------|------------------------------|----------------------------------|------------------------|---------------------------|
| LQR5a and b, Mata de Platanos/ Rio Mameyes—Continued |                                 |                        |                           | LQR6, Bisley tower—Continued |                                  |                        |                           |
| 3/17/11 14:10  | 23                              | 7.2                    | -0.63                     | 3/15/11 12:45                | 31                               | 5.8                    | -1.34                     |
| 4/27/11 15:25  | 33                              | 7.7                    | -0.57                     | 4/12/11 12:30                | 222                              | 1.3                    | -1.72                     |
| 5/26/11 12:40  | 220                             | -14.6                  | -3.04                     | 5/24/11 12:00                | 524                              | -14.8                  | -3.39                     |
| 6/8/11 18:00   | 140                             | -16.7                  | -3.26                     | 6/8/11 11:00                 | 290                              | -34.0                  | -5.70                     |
| 7/27/11 14:10  | 334                             | -5.4                   | -1.97                     | 7/27/11 12:25                | 577                              | -3.0                   | -1.60                     |
| 8/30/11 15:15  | 383                             | -33.0                  | -5.25                     | 8/29/11 13:55                | 1133                             | -35.5                  | -5.81                     |
| 9/29/11 15:20  | 90                              | -15.6                  | -3.31                     | 9/28/11 13:00                | 672                              | -16.7                  | -3.52                     |
| 10/19/11 15:05                                       | 83                              | -15.1                  | -3.30                     | 10/19/11 13:25               | 151                              | 4.6                    | -0.96                     |
| 11/30/11 16:00                                       | 179                             | -15.1                  | -3.36                     | 11/30/11 13:50               | 620                              | -13.8                  | -3.16                     |
| 12/15/11 14:40                                       | 117                             | -8.0                   | -2.65                     | 12/14/11 13:45               | 249                              | -15.9                  | -3.61                     |
| 1/26/12 16:20  | 94                              | 9.7                    | -0.44                     | 1/26/12 13:25                | 243                              | 10.5                   | -0.45                     |
| 2/28/12 15:30  | 37                              | 16.7                   | 0.72                      | 2/28/12 13:10                | 195                              | 12.4                   | -0.29                     |
| 3/28/12 14:15  | 70                              | 7.6                    | -0.73                     | 3/27/12 10:50                | 380                              | 3.1                    | -1.54                     |
| 4/18/12 15:20  | 180                             | 2.9                    | -1.50                     | 4/18/12 13:00                | 474                              | 3.2                    | -1.46                     |
| 5/7/12 16:15   | 122                             | -8.5                   | -2.34                     | 5/7/12 13:25                 | 101                              | -9.2                   | -2.54                     |
| 7/3/12 13:35   | 171                             | -11.4                  | -2.61                     | 7/3/12 11:50                 | 261                              | -10.1                  | -2.68                     |
| 8/7/12 12:55   | 108                             | -2.6                   | -1.45                     | 8/7/12 11:50                 | 245                              | -1.0                   | -1.49                     |
| 9/21/12 16:30  | 128                             | -13.0                  | -2.84                     | 9/18/12 12:30                | 155                              | -7.8                   | -2.22                     |
| 10/25/12 16:40                                       | 125                             | -13.7                  | -2.92                     | --                           | --                               | --                     | --                        |
| 11/27/12 13:45                                       | 285                             | -7.6                   | -2.44                     | 11/27/12 11:45               | --                               | --                     | --                        |
| 12/13/12 13:40                                       | 78                              | -1.8                   | -2.13                     | 12/17/12 11:45 <sup>7</sup>  | 224                              | -2.8                   | -2.48                     |
| 1/18/13 11:55  | 71                              | 8.5                    | -0.66                     |                              |                                  |                        |                           |
| 2/26/13 14:40  | 48                              | 7.8                    | -0.70                     |                              |                                  |                        |                           |
| 3/26/13 10:45  | 44                              | 8.1                    | -0.96                     |                              |                                  |                        |                           |

<sup>1</sup>Sample volume in mL converted to mm by using funnel diameter, to facilitate correlation with rainfall.

<sup>2</sup>The initial placement date for the collector.

<sup>3</sup>Collector missing; no sample.

<sup>4</sup>Volume not recorded.

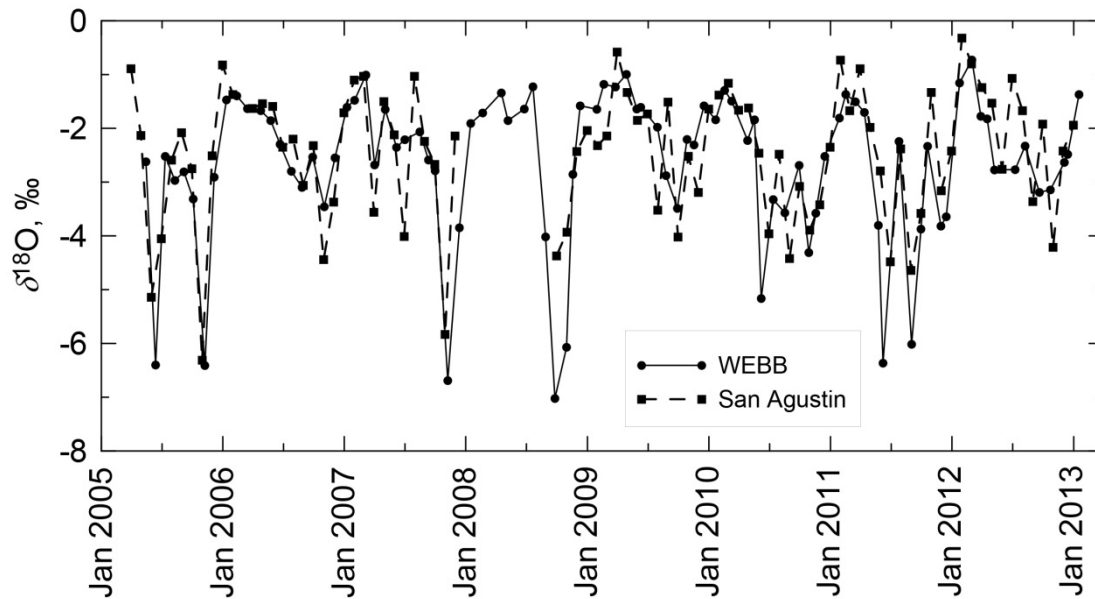
<sup>5</sup>All subsequent samples from location LQR5b.

<sup>6</sup>No samples taken; tower support cable damaged by landslide.

<sup>7</sup>Collection at LQR6 discontinued after this date.

To verify that the different collection methods in the WEBB and San Agustin studies produced similar results, monthly isotope values for San Agustin (north-central Puerto Rico, table 3) are compared with the average monthly isotope value of the four WEBB sites (eastern Puerto Rico, table 2) for corresponding dates (fig. 2). There was some variation in isotopic composition between the two records because the collection dates included different rain events, and a single site is being compared to the average of four sites from 2- to 1,011-m elevation. Overall, however, temporal variation in  $\delta^{18}\text{O}$  values in rainfall collected near San Agustin and in the WEBB study area in El Yunque were similar; the  $\delta^2\text{H}$  values (not shown) have a similar pattern.





**Figure 2.** Comparison of  $\delta^{18}\text{O}$  values (WEBB sites, averaged, and San Agustin) for monthly rain samples for the time period that the two datasets overlap.

**Table 3.** Monthly rain isotope and rainfall data for the San Agustin rain gage site, USGS 182328066423500, with monthly rainfall totals from the Arecibo Observatory, NOAA station GHCND:RQC00660426.

[mm, millimeters; --, no data; md, more than half the days in month have missing data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. San Agustin rainfall prior to 9/30/2008 was estimated from accumulated volume in the collector, by using the relation: (rainfall in mm) = (recovered volume in mL)/7.87276. See figure 1 and table 1 for location and site details]

| <sup>1</sup> Collection date           | Arecibo rainfall (mm) | San Agustin rainfall (mm) | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|-----------------------|---------------------------|------------------------|---------------------------|
| Monthly rain isotope data, San Agustin |                       |                           |                        |                           |
| 8/31/1994                              | 125.6                 | --                        | -5.7                   | -1.14                     |
| 10/31/1994                             | 269                   | --                        | -23.4                  | -4.08                     |
| 11/30/1994                             | 121.2                 | --                        | -10.9                  | -2.28                     |
| 12/31/1994                             | 206.3                 | --                        | 1.5                    | -0.88                     |
| 2/28/1995                              | --                    | --                        | 14.5                   | 0.80                      |
| 4/30/1995                              | 71.1                  | --                        | 9.7                    | -0.18                     |
| 5/31/1995                              | 653.8                 | --                        | 5.8                    | -0.10                     |
| 6/30/1995                              | --                    | --                        | 5.1                    | -0.47                     |
| 7/31/1995                              | 203.8                 | --                        | 0.9                    | -0.58                     |
| 8/31/1995                              | 321.3                 | --                        | 7.7                    | 0.61                      |
| 9/15/1995                              | 142.9                 | --                        | -37.1                  | -5.36                     |
| <sup>2</sup> 9/30/1995                 | 264.8                 | --                        | -31.0                  | -4.72                     |
| 10/31/1995                             | 195.2                 | --                        | *14.8                  | *2.70                     |
| 2/29/1996                              | 124.2                 | --                        | -1.9                   | -1.91                     |
| 3/31/1996                              | 98.2                  | --                        | -5.1                   | -1.91                     |
| 4/30/1996                              | md                    | --                        | -0.7                   | -1.41                     |

**Table 3.** Monthly rain isotope and rainfall data for the San Agustin rain gage site, USGS 182328066423500, with monthly rainfall totals from the Arecibo Observatory, NOAA station GHCND:RQC00660426.—Continued

[mm, millimeters; --, no data; md, more than half the days in month have missing data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. San Agustin rainfall prior to 9/30/2008 was estimated from accumulated volume in the collector, by using the relation: (rainfall in mm) = (recovered volume in mL)/7.87276. See figure 1 and table 1 for location and site details]

| <sup>1</sup> Collection date                     | Arecibo rainfall (mm) | San Agustin rainfall (mm) | δ <sup>2</sup> H (‰) | δ <sup>18</sup> O (‰) |
|--|-----------------------|---------------------------|----------------------|-----------------------|
| Monthly rain isotope data, San Agustin—Continued |                       |                           |                      |                       |
| 5/31/1996  | 206.8                 | --                        | 2.5                  | -1.26                 |
| 6/30/1996  | 126.8                 | --                        | 2.3                  | -0.52                 |
| 7/31/1996  | 144.6                 | --                        | -26.6                | -4.12                 |
| 8/31/1996  | 336.9                 | --                        | -4.3                 | -1.25                 |
| 9/30/1996  | 376                   | --                        | -26.7                | -4.31                 |
| 10/31/1996                                       | 174                   | --                        | -15.6                | -2.73                 |
| 11/30/1996                                       | 171.4                 | --                        | -9.6                 | -2.93                 |
| 12/31/1996                                       | 108.7                 | --                        | 6.0                  | -1.20                 |
| 1/31/1997  | 365.2                 | --                        | 2.7                  | -1.36                 |
| 2/28/1997  | 60.3                  | --                        | 24.7                 | 3.00                  |
| 3/31/1997  | 67.7                  | --                        | 9.0                  | -0.10                 |
| 4/30/1997  | 47                    | --                        | 9.9                  | -0.21                 |
| 5/31/1997  | 171.3                 | --                        | 1.5                  | -0.81                 |
| 7/31/1997  | 228.8                 | --                        | 6.3                  | 0.17                  |
| 8/31/1997  | 216.2                 | --                        | -0.8                 | -1.38                 |
| 9/30/1997  | 74.7                  | --                        | -20.0                | -4.43                 |
| 10/31/1997                                       | 159.6                 | --                        | -24.5                | -4.36                 |
| 1/31/1998  | 80.7                  | --                        | -1.6                 | -1.47                 |
| 2/28/1998  | 72.1                  | --                        | 1.8                  | -1.86                 |
| 3/31/1998  | 125.8                 | --                        | 8.1                  | -0.46                 |
| 4/30/1998  | 178.5                 | --                        | 3.6                  | -1.11                 |
| 5/31/1998  | 278.6                 | --                        | -5.7                 | -1.80                 |
| 6/30/1998  | 196.3                 | --                        | 6.8                  | 0.59                  |
| 7/31/1998  | 281.7                 | --                        | 2.6                  | -0.16                 |
| 8/31/1998  | 327.3                 | --                        | -20.1                | -3.21                 |
| 9/30/1998  | 254.9                 | --                        | -20.2                | -2.47                 |
| 10/31/1998                                       | 310.7                 | --                        | -24.6                | -4.50                 |
| 11/30/1998                                       | 142.4                 | --                        | -16.3                | -3.31                 |
| 12/31/1998                                       | 168.2                 | --                        | -11.8                | -3.05                 |
| 1/31/1999  | 68.9                  | --                        | 10.6                 | 0.82                  |
| 2/28/1999  | 136.7                 | --                        | 18.5                 | -0.30                 |
| 3/31/1999  | 125.3                 | --                        | 15.9                 | 0.49                  |
| 4/30/1999  | 135.3                 | --                        | -5.1                 | -1.93                 |
| 5/31/1999  | 152.8                 | --                        | -5.8                 | -2.18                 |
| 6/30/1999  | 330.6                 | --                        | -18.7                | -3.76                 |
| 7/31/1999  | 156.1                 | --                        | 1.5                  | -0.45                 |
| 8/31/1999  | 205.8                 | --                        | 3.0                  | 0.52                  |
| 9/30/1999  | 274.8                 | --                        | 4.5                  | -0.65                 |

**Table 3.** Monthly rain isotope and rainfall data for the San Agustin rain gage site, USGS 182328066423500, with monthly rainfall totals from the Arecibo Observatory, NOAA station GHCND:RQC00660426.—Continued

[mm, millimeters; --, no data; md, more than half the days in month have missing data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. San Agustin rainfall prior to 9/30/2008 was estimated from accumulated volume in the collector, by using the relation: (rainfall in mm) = (recovered volume in mL)/7.87276. See figure 1 and table 1 for location and site details]

| <sup>1</sup> Collection date                     | Arecibo rainfall (mm) | San Agustin rainfall (mm) | δ <sup>2</sup> H (‰) | δ <sup>18</sup> O (‰) |
|--|-----------------------|---------------------------|----------------------|-----------------------|
| Monthly rain isotope data, San Agustin—Continued |                       |                           |                      |                       |
| 10/31/1999                                       | 356.7                 | --                        | -21.7                | -2.75                 |
| 11/30/1999                                       | 310                   | --                        | -7.2                 | -0.42                 |
| 12/31/1999                                       | 267.2                 | --                        | 12.8                 | -0.07                 |
| 1/31/2000  | 140.5                 | --                        | -4.7                 | -2.30                 |
| 2/29/2000  | 60.9                  | --                        | -1.9                 | -1.85                 |
| 4/30/2000  | 87.6                  | --                        | -12.6                | -2.38                 |
| 5/31/2000  | 198.2                 | --                        | -16.4                | -2.38                 |
| 6/30/2000  | 24.4                  | --                        | -18.4                | -2.19                 |
| 7/31/2000  | 126                   | --                        | -4.5                 | -0.56                 |
| 8/31/2000  | 177.1                 | --                        | -11.1                | -1.62                 |
| 9/30/2000  | 220.2                 | --                        | -6.4                 | -2.27                 |
| 10/31/2000                                       | 310.9                 | --                        | -2.4                 | -1.39                 |
| 11/30/2000                                       | --                    | --                        | -7.9                 | -2.44                 |
| 12/31/2000                                       | 43.4                  | --                        | 10.0                 | 0.20                  |
| 1/31/2001  | 107.2                 | --                        | 9.2                  | -0.94                 |
| 2/28/2001  | 77.1                  | --                        | 12.2                 | 0.20                  |
| 3/30/2001  | 98.1                  | --                        | -10.7                | -2.80                 |
| 3/31/2001  | --                    | --                        | 13.1                 | 0.41                  |
| 4/30/2001  | 133.6                 | --                        | 10.0                 | 0.12                  |
| 5/31/2001  | 318.3                 | --                        | -2.4                 | -1.36                 |
| 6/30/2001  | 188                   | --                        | -22.2                | -3.39                 |
| 4/30/2002  | 409.6                 | --                        | -0.3                 | -1.27                 |
| 5/31/2002  | 188.7                 | --                        | 11.5                 | 0.40                  |
| 6/30/2002  | 66.4                  | --                        | -6.8                 | -1.54                 |
| 7/31/2002  | 157.1                 | --                        | 9.0                  | -0.33                 |
| 8/31/2002  | 301                   | --                        | -5.8                 | -1.19                 |
| 9/30/2002  | 164.2                 | --                        | -11.3                | -2.30                 |
| 10/31/2002                                       | 239.2                 | --                        | -9.1                 | -1.95                 |
| 11/30/2002                                       | 175.5                 | --                        | 2.2                  | -0.42                 |
| 1/31/2003  | 112.5                 | --                        | 7.3                  | -1.23                 |
| 2/28/2003  | 61                    | --                        | 1.6                  | -1.59                 |
| 3/31/2003  | 53.6                  | --                        | -9.8                 | -2.28                 |
| 4/30/2003  | 337.5                 | --                        | -9.6                 | -2.24                 |
| 5/30/2003  | 186.3                 | --                        | 2.0                  | -0.96                 |
| 6/30/2003  | 184.8                 | --                        | -1.1                 | -0.70                 |
| 7/31/2003  | 79.7                  | --                        | -0.8                 | -1.09                 |
| 8/31/2003  | 243.6                 | --                        | -2.9                 | -1.55                 |
| 9/30/2003  | 239.6                 | --                        | -7.4                 | -2.44                 |

**Table 3.** Monthly rain isotope and rainfall data for the San Agustin rain gage site, USGS 182328066423500, with monthly rainfall totals from the Arecibo Observatory, NOAA station GHCND:RQC00660426.—Continued

[mm, millimeters; --, no data; md, more than half the days in month have missing data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. San Agustin rainfall prior to 9/30/2008 was estimated from accumulated volume in the collector, by using the relation: (rainfall in mm) = (recovered volume in mL)/7.87276. See figure 1 and table 1 for location and site details]

| <sup>1</sup> Collection date                     | Arecibo rainfall (mm) | San Agustin rainfall (mm) | δ <sup>2</sup> H (‰) | δ <sup>18</sup> O (‰) |
|--|-----------------------|---------------------------|----------------------|-----------------------|
| Monthly rain isotope data, San Agustin—Continued |                       |                           |                      |                       |
| 10/23/2003                                       | 182.9                 | --                        | -14.7                | -3.53                 |
| 11/30/2003                                       | 263.6                 | --                        | -23.5                | -4.46                 |
| 12/31/2003                                       | 153.7                 | --                        | -4.6                 | -2.54                 |
| 1/31/2004  | 32.5                  | --                        | 8.6                  | -1.06                 |
| 2/29/2004  | 42.2                  | 106.0                     | 8.4                  | -1.09                 |
| 3/31/2004  | 150.2                 | 226.1                     | 1.1                  | -1.98                 |
| 4/30/2004  | 159                   | 63.9                      | 1.9                  | -1.56                 |
| 5/31/2004  | 325.1                 | 344.3                     | -5.6                 | -2.09                 |
| 6/30/2004  | 140.7                 | 93.9                      | -13.3                | -2.82                 |
| 7/31/2004  | 105.1                 | 69.0                      | -10.6                | -2.27                 |
| 8/31/2004  | 224.2                 | 43.4                      | 2.8                  | -1.02                 |
| 9/30/2004  | 312.3                 | 280.4                     | -36.0                | -5.92                 |
| 10/31/2004                                       | 110.7                 | 86.9                      | -7.1                 | -2.73                 |
| 11/30/2004                                       | 369.7                 | 356.4                     | -12.9                | -3.51                 |
| 12/31/2004                                       | 98.8                  | 265.1                     | -2.2                 | -2.38                 |
| 1/31/2005  | <sup>3</sup> 289.8    | 393.5                     | 4.8                  | -1.53                 |
| 2/28/2005  | 59.8                  | 46.0                      | 12.5                 | -0.68                 |
| 3/31/2005  | 11.2                  | 5.1                       | 8.3                  | -0.89                 |
| 4/30/2005  | 497.9                 | 490.6                     | -2.8                 | -2.13                 |
| 5/31/2005  | 383.3                 | 319.4                     | -30.4                | -5.14                 |
| 6/30/2005  | 188.5                 | 235.7                     | -22.2                | -4.05                 |
| 7/31/2005  | 165.7                 | 263.2                     | -10.4                | -2.59                 |
| 8/30/2005  | 316.9                 | 120.1                     | -5.4                 | -2.08                 |
| 9/30/2005  | 159.2                 | 239.4                     | -9.7                 | -2.75                 |
| 10/31/2005                                       | 196.4                 | 199.3                     | -40.9                | -6.31                 |
| 11/30/2005                                       | 172.6                 | 127.8                     | -6.7                 | -2.51                 |
| 12/31/2005                                       | 19.5                  | 46.6                      | 10.4                 | -0.82                 |
| 1/31/06  | 178.6                 | 173.7                     | 5.6                  | -1.37                 |
| 3/31/06  | 244.9                 | --                        | 1.8                  | -1.63                 |
| 4/30/06  | 138.8                 | --                        | 0.9                  | -1.54                 |
| 5/31/06  | 223.8                 | --                        | 2.2                  | -1.59                 |
| 6/30/06  | 283.2                 | --                        | -8.3                 | -2.35                 |
| 7/31/06  | 87.1                  | --                        | -10.1                | -2.20                 |
| 8/31/06  | 226                   | --                        | -16.3                | -3.06                 |
| 9/30/06  | 166.5                 | --                        | -8.9                 | -2.32                 |
| 10/31/06   | 171.1                 | --                        | -24.2                | -4.44                 |
| 11/30/06   | 202.4                 | --                        | -13.1                | -3.37                 |
| 12/31/06   | 49.1                  | --                        | 0.3                  | -1.71                 |

**Table 3.** Monthly rain isotope and rainfall data for the San Agustin rain gage site, USGS 182328066423500, with monthly rainfall totals from the Arecibo Observatory, NOAA station GHCND:RQC00660426.—Continued

[mm, millimeters; --, no data; md, more than half the days in month have missing data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. San Agustin rainfall prior to 9/30/2008 was estimated from accumulated volume in the collector, by using the relation: (rainfall in mm) = (recovered volume in mL)/7.87276. See figure 1 and table 1 for location and site details]

| <sup>1</sup> Collection date                     | Arecibo rainfall (mm) | San Agustin rainfall (mm) | δ <sup>2</sup> H (‰) | δ <sup>18</sup> O (‰) |
|--|-----------------------|---------------------------|----------------------|-----------------------|
| Monthly rain isotope data, San Agustin—Continued |                       |                           |                      |                       |
| 1/31/07  | 65.8                  | --                        | 4.0                  | -1.10                 |
| 2/28/07  | 175.8                 | --                        | 8.2                  | -1.03                 |
| 3/31/07  | 216.8                 | --                        | -15.6                | -3.56                 |
| 4/30/07  | 199.9                 | --                        | 2.7                  | -1.50                 |
| 5/31/07  | 276.6                 | --                        | -6.3                 | -2.12                 |
| 6/30/07  | 132.1                 | --                        | -24.4                | -4.01                 |
| 7/31/07  | 72.1                  | --                        | 0.1                  | -1.03                 |
| 8/30/07  | 258.8                 | 172.7                     | -7.8                 | -2.24                 |
| 9/30/07  | 165.8                 | 176.5                     | -10.0                | -2.67                 |
| 10/31/07   | 130.4                 | 172.7                     | -35.8                | -5.83                 |
| 11/30/07   | 158.2                 | --                        | -3.0                 | -2.14                 |
| 9/30/08  | 447.3                 | 324.8                     | -22.0                | -4.37                 |
| 10/31/08   | 152.2                 | 219.6                     | -19.3                | -3.93                 |
| 11/30/08   | 245.3                 | 234.4                     | -5.8                 | -2.43                 |
| 12/31/08   | 201.5                 | 195.4                     | -2.7                 | -2.04                 |
| 1/31/09  | 77.1                  | 128.2                     | -7.4                 | -2.32                 |
| 2/28/09  | 202.9                 | 171.0                     | -3.2                 | -2.14                 |
| 3/31/09  | 170.5                 | 112.8                     | 8.0                  | -0.58                 |
| 4/30/09  | 56.7                  | 72.4                      | -0.8                 | -1.33                 |
| 5/31/09  | 194.3                 | 252.0                     | -3.4                 | -1.85                 |
| 6/30/09  | 253.2                 | 232.8                     | -2.0                 | -1.73                 |
| 7/31/09  | 137.3                 | 55.2                      | -19.8                | -3.52                 |
| 8/31/09  | 227.9                 | 156.2                     | -0.9                 | -1.51                 |
| 9/30/09  | 281.2                 | 189.6                     | -23.8                | -4.02                 |
| 10/31/09   | 109.7                 | 157.0                     | -7.9                 | -2.52                 |
| 11/30/09   | 187.4                 | 120.8                     | -11.9                | -3.19                 |
| 12/31/09   | 45.1                  | 92.0                      | 0.5                  | -1.64                 |
| 1/31/10  | 264.2                 | 260.4                     | 7.4                  | -1.38                 |
| 2/28/10  | 64.6                  | 153                       | 7.2                  | -1.16                 |
| 3/31/10  | 89.7                  | 98.2                      | 6.5                  | -1.66                 |
| 4/30/10  | 277.5                 | 170.6                     | -0.4                 | -1.62                 |
| 5/31/10  | 448                   | 422.2                     | -9.7                 | -2.46                 |
| 6/30/10  | 214                   | 141.2                     | -25.7                | -3.96                 |
| 7/31/10  | 216.6                 | 187.6                     | -10.8                | -2.48                 |
| 8/31/10  | 265.6                 | 237.4                     | -23.0                | -4.42                 |
| 9/30/10  | 193.1                 | 204.2                     | -13.0                | -3.08                 |
| 10/31/10   | 244.9                 | 354.2                     | -18.2                | -3.89                 |
| 11/30/10   | 155.9                 | 154.2                     | -11.3                | -3.42                 |

**Table 3.** Monthly rain isotope and rainfall data for the San Agustin rain gage site, USGS 182328066423500, with monthly rainfall totals from the Arecibo Observatory, NOAA station GHCND:RQC00660426.—Continued

[mm, millimeters; --, no data; md, more than half the days in month have missing data. Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. San Agustin rainfall prior to 9/30/2008 was estimated from accumulated volume in the collector, by using the relation: (rainfall in mm) = (recovered volume in mL)/7.87276. See figure 1 and table 1 for location and site details]

| <sup>1</sup> Collection date                     | Arecibo rainfall (mm) | San Agustin rainfall (mm) | δ <sup>2</sup> H (‰) | δ <sup>18</sup> O (‰) |
|--|-----------------------|---------------------------|----------------------|-----------------------|
| Monthly rain isotope data, San Agustin—Continued |                       |                           |                      |                       |
| 12/31/10   | 252.1                 | 421.2                     | 1.3                  | -2.35                 |
| 1/31/11  | 39.9                  | 56.6                      | 10.5                 | -0.73                 |
| 2/28/11  | 56.5                  | 66.6                      | 3.5                  | -1.67                 |
| 3/31/11  | 183.9                 | 132.8                     | 7.2                  | -0.89                 |
| 4/30/11  | 114.5                 | 109.6                     | -2.4                 | -1.98                 |
| 5/31/11  | 243.4                 | 274.4                     | -10.9                | -2.79                 |
| 6/30/11  | 280.7                 | 223.4                     | -26.5                | -4.48                 |
| 7/31/11  | 298.4                 | 190.4                     | -10.3                | -2.38                 |
| 8/31/11  | 178.5                 | 310.0                     | -26.7                | -4.64                 |
| 9/30/11  | 285.2                 | 189.8                     | -17.3                | -3.58                 |
| 10/31/11   | 259.3                 | 124.4                     | 2.7                  | -1.33                 |
| 11/30/11   | 371.6                 | 395.2                     | -15.2                | -3.16                 |
| 12/31/11   | 145                   | 168.4                     | -8.9                 | -2.42                 |
| 1/31/12  | 130.9                 | 94.8                      | 8.8                  | -0.32                 |
| 2/29/12  | 143.1                 | 195.4                     | 6.0                  | -0.80                 |
| 3/31/12  | 416.3                 | 179.2                     | 2.5                  | -1.24                 |
| 4/30/12  | 299                   | 135.2                     | -0.7                 | -1.53                 |
| 5/31/12  | 218.5                 | 327                       | -10.8                | -2.76                 |
| 6/30/12  | 50.3                  | 32.2                      | 1.6                  | -1.07                 |
| 7/31/12  | 195.9                 | 165.6                     | -1.6                 | -1.67                 |
| 8/31/12  | 229.7                 | 180.8                     | -17.8                | -3.36                 |
| 9/30/12  | 160.8                 | 135                       | -1.7                 | -1.92                 |
| 10/31/12   | 305.3                 | 191.8                     | -21.3                | -4.21                 |
| 11/30/12   | 272.4                 | 297.4                     | -6.6                 | -2.42                 |
| 12/31/12   | 93.4                  | 111.6                     | 0.0                  | -1.94                 |
| 1/31/13  | 71.3                  | 71.0                      | 11.5*                | 0.82*                 |
| 2/28/13  | 52.6                  | 16.4                      | 9.5*                 | 0.75*                 |
| 3/31/13  | 210.9                 | 198.6                     | 11.6                 | -0.94                 |
| 4/30/13  | 131.1                 | 50.2                      | 9.4                  | -0.82                 |
| 5/31/13  | 446.8                 | 344.6                     | -10.8                | -2.92                 |
| 6/30/13  | 120.4                 | 108.0                     | 4.6                  | -0.94                 |
| 7/31/13  | 262.5                 | 264.4                     | -10.5                | -2.61                 |

<sup>1</sup>Beginning date of composite sample is the first day of the month, except where noted.

<sup>2</sup>Beginning date for this sample is 9/16/1995.

<sup>3</sup>Ten days of missing rainfall data in the month ending 1/31/2005.

\*Isotopic composition for these samples appears fractionated due to evaporation.

## Cloud-Water Isotope Data

**Table 4.** Cloud-water isotope data collected at Pico del Este in eastern Puerto Rico in September 2007, May 2010, and March 2013.

| Collection Date/Time (Start) | Collection Date/Time (end) | Field ID          | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|------------------------------|----------------------------|-------------------|------------------------|---------------------------|
| 9/28/07 11:25                | 9/28/07 12:25              | LQCW1             | -1.0                   | -2.12                     |
| 9/28/07 11:25                | 9/28/07 12:25              | LQCW2             | -0.9                   | -2.08                     |
| 9/30/07 8:15                 | 9/30/07 9:30               | LQCW3             | -1.7                   | -2.30                     |
| 9/30/07 8:15                 | 9/30/07 9:30               | LQCW4             | -3.1                   | -2.36                     |
| 9/30/07 9:52                 | 9/30/07 12:15              | LQCW5             | -1.5                   | -1.99                     |
| 9/30/07 9:52                 | 9/30/07 12:15              | LQCW6             | -1.8                   | -2.00                     |
| 5/18/10 12:14                | 5/18/10 14:30              | LQF4CASC-1        | 7.6                    | -0.77                     |
| 5/19/10 11:34                | 5/19/10 14:55              | LQF4CASC-2        | 12.2                   | -0.73                     |
| 3/23/13 16:30                | 3/24/13 9:30               | LQCW8-40, mean    | 4.7                    | -0.88                     |
| 3/24/13 18:00                | 3/25/13 9:30               | LQCW41-72, mean   | 6.7                    | -0.97                     |
| 3/25/13 16:41                | 3/26/13 10:11              | LQCW73-108, mean  | 5.9                    | -0.94                     |
| 3/26/13 17:41                | 3/27/13 4:41               | LQCW109-118, mean | 6.5                    | -1.09                     |

## Stream-Water Isotope Data

**Table 5.** Stream-water isotope data for Rio Mameyes near Sabana (Puente Roto) USGS 50065500 and Rio Icacos above Lago Icacos in eastern Puerto Rico, 2007–2013.

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Rio Mameyes samples were collected monthly until 3/9/10, then weekly thereafter. Rio Icacos samples were collected intermittently]

| Collection date and time             | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) | Collection date and time                | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--------------------------------------|------------------------|---------------------------|---|------------------------|---------------------------|
| Rio Mameyes near Sabana LQSM7, LQSW7 |                        |                           | Rio Icacos above Lago Icacos, LQSM3a, b |                        |                           |
| 11/1/07 16:10                        | -12.0                  | -3.17                     | 11/1/07 13:30                           | -12.3                  | -3.24                     |
| 11/27/07 11:30                       | -6.8                   | -2.65                     | 11/27/07 14:00                          | -6.3                   | -2.39                     |
| 12/28/07 14:45                       | -7.9                   | -2.63                     | 12/28/07 13:00                          | -7.0                   | -2.63                     |
| 1/10/08 13:30                        | -7.0                   | -2.61                     | 1/10/08 15:30                           | -6.6                   | -2.80                     |
| 1/30/08 14:35                        | -5.0                   | -2.54                     | 1/30/08 11:55                           | -7.4                   | -2.64                     |
| 3/6/08 14:00                         | -2.9                   | -2.30                     | 3/6/08 12:30                            | -4.5                   | -2.45                     |
| 4/17/08 15:25                        | -3.9                   | -2.34                     | 4/17/08 9:50                            | -6.1                   | -2.59                     |
| 5/15/08 15:20                        | -5.9                   | -2.48                     | 5/15/08 12:45                           | -6.9                   | -2.68                     |
| 6/25/08 16:30                        | -3.7                   | -2.28                     | 6/23/08 12:00                           | -6.7                   | -2.58                     |
| 7/30/08 14:25                        | -4.9                   | -2.39                     | 7/30/08 10:25                           | -5.3                   | -2.58                     |
| 8/29/08 15:00                        | -10.0                  | -2.92                     | 8/29/08 12:30                           | -6.8                   | -2.57                     |
| 10/24/08 10:00                       | -12.8                  | -3.38                     | 10/24/08 15:15                          | -10.2                  | -3.26                     |
| 11/25/08 7:10                        | -7.7                   | -2.84                     | 11/25/08 12:25                          | -7.9                   | -2.86                     |
| 12/30/08 8:45                        | -3.7                   | -2.50                     | 12/30/08 14:00                          | -8.4                   | -2.92                     |
| 1/22/09 8:10                         | -7.1                   | -2.71                     | 1/22/09 12:55                           | -8.2                   | -2.70                     |
| 2/25/09 10:55                        | -4.8                   | -2.53                     | 2/25/09 14:30                           | -6.7                   | -2.67                     |
| 3/25/09 9:30                         | -2.1                   | -2.39                     | 3/26/09 11:00                           | -3.1                   | -2.42                     |
| 4/30/09 12:00                        | 0.0                    | -1.91                     | 4/30/09 9:05                            | -6.8                   | -2.79                     |

**Table 5.** Stream-water isotope data for Rio Mameyes near Sabana (Puente Roto) USGS 50065500 and Rio Icacos above Lago Icacos in eastern Puerto Rico, 2007–2013.—Continued

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Rio Mameyes samples were collected monthly until 3/9/10, then weekly thereafter. Rio Icacos samples were collected intermittently]

| Collection date and time                       | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) | Collection date and time                          | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|------------------------|---------------------------|---|------------------------|---------------------------|
| Rio Mameyes near Sabana LQSM7, LQSW7—Continued |                        |                           | Rio Icacos above Lago Icacos, LQSM3a, b—Continued |                        |                           |
| 5/26/09 15:15                                  | -3.2                   | -2.02                     | 5/27/09 13:10                                     | -6.6                   | -2.75                     |
| 6/9/09 10:00                                   | -3.8                   | -2.15                     | 6/11/09 12:20                                     | -3.5                   | -2.41                     |
| 7/28/09 14:50                                  | -7.3                   | -2.66                     | 7/28/09 10:05                                     | -3.2                   | -2.34                     |
| 8/25/09 14:15                                  | -4.4                   | -2.31                     | 8/26/09 11:15                                     | -7.5                   | -2.76                     |
| 9/15/09 18:00                                  | -5.7                   | -2.46                     | 9/15/09 13:00                                     | -7.7                   | -2.80                     |
| 10/28/09 15:05                                 | -4.3                   | -2.64                     | 10/29/09 10:30                                    | -7.7                   | -2.48                     |
| 11/30/09 12:50                                 | -7.4                   | -2.58                     | 11/30/09 9:25                                     | -6.1                   | -2.67                     |
| 12/30/09 14:00                                 | -5.2                   | -2.51                     | 12/30/09 14:00                                    | -6.1                   | -2.63                     |
| 1/21/10 16:55                                  | -5.4                   | -2.50                     | 1/20/10 11:00                                     | -5.2                   | -2.61                     |
| 2/25/10 15:25                                  | -4.3                   | -2.51                     | 2/25/10 11:30                                     | -6.5                   | -2.67                     |
| 3/9/10 9:50                                    | -2.6                   | -2.28                     | 3/29/10 10:50                                     | -7.3                   | -2.74                     |
| 3/15/10 10:35                                  | -4.6                   | -2.44                     | 4/29/10 11:45                                     | -5.6                   | -2.69                     |
| 3/24/10 10:35                                  | -5.8                   | -2.50                     | 5/27/10 11:45                                     | -4.1                   | -2.33                     |
| 3/29/10 10:50                                  | -5.7                   | -2.55                     | 6/9/10 12:30                                      | -6.0                   | -2.62                     |
| 4/13/10 10:55                                  | -1.7                   | -2.20                     | 7/6/10 12:45                                      | -5.0                   | -2.45                     |
| 4/20/10 14:55                                  | -5.6                   | -2.48                     | 9/9/10 9:55                                       | -7.5                   | -2.80                     |
| 4/29/10 14:30                                  | -6.3                   | -2.55                     | 10/27/10 9:45                                     | -7.5                   | -2.76                     |
| 5/6/10 10:15                                   | -2.6                   | -2.16                     | 11/18/10 12:50                                    | -7.2                   | -2.78                     |
| 5/13/10 11:30                                  | -2.2                   | -2.14                     | 1/31/11 11:05                                     | -5.2                   | -2.57                     |
| 5/18/10 10:15                                  | -1.5                   | -1.89                     | 2/25/11 9:45                                      | -6.3                   | -2.58                     |
| 5/27/10 14:00                                  | -4.1                   | -2.30                     | 3/29/11 14:45                                     | -5.8                   | -2.64                     |
| 6/4/10 8:45                                    | -7.6                   | -2.62                     | 5/5/11 12:15                                      | -3.8                   | -2.46                     |
| 6/8/10 11:30                                   | -6.3                   | -2.59                     | 5/27/11 13:15                                     | -3.6                   | -2.45                     |
| 6/18/10 14:15                                  | -12.6                  | -3.13                     | 7/28/11 10:15                                     | -11.9                  | -3.30                     |
| 6/23/10 11:35                                  | -7.5                   | -2.64                     | 9/23/11 9:45                                      | -8.3                   | -2.79                     |
| 7/1/10 10:11                                   | -5.9                   | -2.47                     | 10/31/11 10:35                                    | -12.4                  | -3.34                     |
| 7/9/10 12:03                                   | -5.7                   | -2.58                     | 11/28/11 10:55                                    | -12.1                  | -3.40                     |
| 7/15/10 11:50                                  | -3.2                   | -2.36                     | 12/22/11 13:45                                    | -8.6                   | -2.98                     |
| 7/19/10 9:15                                   | -7.4                   | -2.55                     | 3/15/12 12:25                                     | -6.1                   | -2.56                     |
| 7/28/10 9:45                                   | -5.7                   | -2.50                     | 5/3/12 13:20                                      | -7.3                   | -2.59                     |
| 8/18/10 10:00                                  | -6.5                   | -2.62                     | <sup>1</sup> 5/3/12 14:45                         | -7.9                   | -2.60                     |
| 8/26/10 9:15                                   | -5.7                   | -2.50                     | 8/2/12 15:30                                      | -7.2                   | -2.76                     |
| 9/23/10 11:55                                  | -6.4                   | -2.57                     | 12/18/12 14:15                                    | -7.5                   | -2.77                     |
| 9/28/10 10:40                                  | -5.2                   | -2.46                     | 1/30/13 11:15                                     | -2.8                   | -2.38                     |
| 10/21/10 11:30                                 | -6.3                   | -2.66                     | 2/16/13 16:30                                     | -6.5                   | -2.66                     |
| 10/27/10 12:30                                 | -5.4                   | -2.54                     | 3/26/13 14:45                                     | -5.9                   | -2.72                     |
| 11/4/10 10:45                                  | -5.4                   | -2.65                     |   |                        |                           |
| 11/9/10 10:38                                  | -8.3                   | -2.89                     |   |                        |                           |
| 11/18/10 13:55                                 | -2.4                   | -2.31                     |   |                        |                           |
| 12/2/10 11:30                                  | -5.0                   | -2.63                     |   |                        |                           |



**Table 5.** Stream-water isotope data for Rio Mameyes near Sabana (Puente Roto) USGS 50065500 and Rio Icacos above Lago Icacos in eastern Puerto Rico, 2007–2013.—Continued

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Rio Mameyes samples were collected monthly until 3/9/10, then weekly thereafter. Rio Icacos samples were collected intermittently]

| Collection date and time                       | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|------------------------|---------------------------|
| Rio Mameyes near Sabana LQSM7, LQSW7—Continued |                        |                           |
| 12/15/10 12:20                                 | -1.6                   | -2.62                     |
| 12/27/10 12:50                                 | -4.4                   | -2.46                     |
| 1/19/11 9:45                                   | -3.7                   | -2.34                     |
| 1/25/11 15:10                                  | -3.8                   | -2.38                     |
| 1/31/11 8:00                                   | 0.1                    | -1.96                     |
| 2/9/11 12:05                                   | -2.7                   | -2.24                     |
| 2/15/11 12:40                                  | -0.8                   | -2.04                     |
| 2/25/11 12:05                                  | -5.1                   | -2.39                     |
| 3/2/11 12:05                                   | -5.9                   | -2.42                     |
| 3/9/11 13:45                                   | -4.5                   | -2.32                     |
| 3/15/11 13:45                                  | -5.3                   | -2.49                     |
| 3/23/11 10:05                                  | -4.6                   | -2.40                     |
| 3/29/11 10:12                                  | -4.8                   | -2.39                     |
| 4/6/11 10:45                                   | -5.3                   | -2.59                     |
| 4/13/11 14:45                                  | -3.6                   | -2.36                     |
| 4/27/11 11:20                                  | -2.4                   | -2.06                     |
| 5/4/11 11:35                                   | -3.4                   | -2.31                     |
| 5/10/11 11:15                                  | -5.1                   | -2.47                     |
| 5/24/11 13:55                                  | -6.0                   | -2.62                     |
| 5/27/11 21:10                                  | -5.3                   | -2.52                     |
| 6/2/11 9:00                                    | -4.5                   | -2.34                     |
| 6/8/11 13:25                                   | -17.5                  | -4.06                     |
| 6/30/11 13:47                                  | -6.2                   | -2.64                     |
| 7/7/11 14:37                                   | -4.5                   | -2.33                     |
| 7/13/11 12:25                                  | -7.3                   | -2.71                     |
| 7/20/11 13:55                                  | -5.6                   | -2.47                     |
| 7/27/11 13:20                                  | -4.1                   | -2.38                     |
| 8/9/11 16:15                                   | -6.5                   | -2.60                     |
| 8/29/11 15:35                                  | -9.8                   | -2.93                     |
| 9/7/11 14:30                                   | -8.2                   | -2.76                     |
| 9/14/11 16:15                                  | -14.3                  | -3.57                     |
| 9/23/11 12:25                                  | -3.0                   | -2.26                     |
| 9/28/11 13:55                                  | -10.9                  | -3.11                     |
| 10/6/11 14:10                                  | -8.0                   | -2.66                     |
| 10/12/11 11:00                                 | -3.3                   | -2.20                     |
| 10/19/11 12:05                                 | -7.1                   | -2.69                     |
| 10/31/11 14:25                                 | -5.6                   | -2.53                     |
| 11/10/11 15:45                                 | -16.5                  | -3.59                     |
| 11/17/11 15:50                                 | -9.3                   | -3.02                     |
| 11/22/11 16:15                                 | -11.5                  | -3.19                     |
| 11/30/11 15:20                                 | -11.8                  | -3.18                     |

**Table 5.** Stream-water isotope data for Rio Mameyes near Sabana (Puente Roto) USGS 50065500 and Rio Icacos above Lago Icacos in eastern Puerto Rico, 2007–2013.—Continued

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Rio Mameyes samples were collected monthly until 3/9/10, then weekly thereafter. Rio Icacos samples were collected intermittently]

| Collection date and time                       | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|------------------------|---------------------------|
| Rio Mameyes near Sabana LQSM7, LQSW7—Continued |                        |                           |
| 12/7/11 15:25                                  | -6.2                   | -2.60                     |
| 12/14/11 14:50                                 | -9.7                   | -2.95                     |
| 12/21/11 14:35                                 | -7.3                   | -2.72                     |
| 12/29/11 14:05                                 | -5.9                   | -2.60                     |
| 1/11/12 15:10                                  | -4.2                   | -2.46                     |
| 1/19/12 14:00                                  | -4.3                   | -2.51                     |
| 1/26/12 14:20                                  | -5.7                   | -2.62                     |
| 2/1/12 15:15                                   | -4.4                   | -2.49                     |
| 2/8/12 14:55                                   | -4.4                   | -2.36                     |
| 2/17/12 14:45                                  | -5.0                   | -2.61                     |
| 2/21/12 12:40                                  | -3.1                   | -2.34                     |
| 2/28/12 14:00                                  | -4.7                   | -2.56                     |
| 3/6/12 15:40                                   | -5.8                   | -2.54                     |
| 3/15/12 14:35                                  | -4.5                   | -2.41                     |
| 3/28/12 10:20                                  | -6.2                   | -2.56                     |
| 4/3/12 13:10                                   | -8.3                   | -2.72                     |
| 4/11/12 14:10                                  | -3.1                   | -2.34                     |
| 4/18/12 14:05                                  | -7.6                   | -2.64                     |
| 4/25/12 14:40                                  | -7.7                   | -2.58                     |
| 5/1/12 13:10                                   | -6.3                   | -2.56                     |
| 5/3/12 15:55                                   | -6.3                   | -2.51                     |
| 5/7/12 15:55                                   | -5.7                   | -2.67                     |
| 5/15/12 14:15                                  | -7.9                   | -2.80                     |
| 5/22/12 12:05                                  | -3.9                   | -2.26                     |
| 5/30/12 17:30                                  | -5.9                   | -2.57                     |
| 6/6/12 10:35                                   | -6.8                   | -2.70                     |
| 6/13/12 14:55                                  | -7.4                   | -2.68                     |
| 6/20/12 18:00                                  | -7.3                   | -2.45                     |
| 6/28/12 11:05                                  | -7.6                   | -2.55                     |
| 7/3/12 12:45                                   | -6.1                   | -2.49                     |
| 7/5/12 13:05                                   | -8.5                   | -2.74                     |
| 7/17/12 07:30                                  | -4.4                   | -2.36                     |
| 7/31/12 14:00                                  | -8.9                   | -2.68                     |
| 8/2/12 13:30                                   | -7.2                   | -2.65                     |
| 8/7/12 10:45                                   | -7.6                   | -2.66                     |
| 8/15/12 11:45                                  | -5.9                   | -2.48                     |
| 8/28/12 15:15                                  | -10.2                  | -3.09                     |
| 9/6/12 13:40                                   | -7.5                   | -2.67                     |
| 9/13/12 13:45                                  | -6.7                   | -2.61                     |
| 9/18/12 13:30                                  | -7.1                   | -2.66                     |
| 9/27/12 16:15                                  | -8.3                   | -2.85                     |

**Table 5.** Stream-water isotope data for Rio Mameyes near Sabana (Puente Roto) USGS 50065500 and Rio Icacos above Lago Icacos in eastern Puerto Rico, 2007–2013.—Continued

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Rio Mameyes samples were collected monthly until 3/9/10, then weekly thereafter. Rio Icacos samples were collected intermittently]

| Collection date and time                       | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|------------------------|---------------------------|
| Rio Mameyes near Sabana LQSM7, LQSW7—Continued |                        |                           |
| 10/5/12 13:50                                  | -4.2                   | -2.51                     |
| 10/18/12 12:45                                 | -7.7                   | -2.94                     |
| 10/25/12 15:25                                 | -6.6                   | -2.67                     |
| 11/1/12 14:15                                  | -7.2                   | -2.70                     |
| 11/16/12 10:00                                 | -7.1                   | -2.75                     |
| 11/27/12 13:25                                 | -6.8                   | -2.67                     |
| 12/13/12 11:45                                 | -5.8                   | -2.58                     |
| 12/18/12 12:35                                 | -5.8                   | -2.70                     |
| 12/27/12 15:05                                 | -6.8                   | -2.63                     |
| 1/11/13 12:45                                  | -3.0                   | -2.43                     |
| 1/17/13 19:00                                  | -3.2                   | -2.38                     |
| 1/22/13 12:45                                  | -5.4                   | -2.59                     |
| 1/26/13 14:15                                  | -5.7                   | -2.64                     |
| 1/30/13 12:35                                  | -2.8                   | -2.20                     |
| 2/6/13 17:30                                   | -5.1                   | -2.50                     |
| 2/14/13 9:45                                   | -4.6                   | -2.44                     |
| 2/20/13 13:15                                  | -4.9                   | -2.44                     |
| 2/26/13 14:20                                  | -6.5                   | -2.47                     |
| 3/7/13 14:45                                   | -2.0                   | -2.31                     |
| 3/14/13 17:15                                  | -5.5                   | -2.44                     |
| 3/20/13 14:00                                  | -0.8                   | -2.11                     |
| 3/26/13 13:20                                  | -4.9                   | -2.40                     |
| 4/3/13 13:20                                   | -4.4                   | -2.46                     |
| 4/10/13 17:35                                  | -1.7                   | -2.16                     |

<sup>1</sup>Duplicate sample at new site; see table 1 for location information. All subsequent samples were taken at LQSM3b.

**Table 6.** Contemporaneous stream stable isotope data collected from sites at different elevations in the Rio Mameyes and Rio Blanco/Rio Icacos watersheds in the Luquillo Mountains study area, eastern Puerto Rico.

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Table 6A, data sorted by site; table 6B, data sorted by collection date]

| Site ID  | Collection date | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|--|-----------------|------------------------|---------------------------|
| A. Contemporaneous stream isotope data by site |                 |                        |                           |
| LQS1   | 2/9/06 10:55    | -4.9                   | -2.69                     |
| LQS1   | 11/7/06         | -6.7                   | -2.68                     |
| LQS1   | 9/29/07 14:35   | -5.9                   | -2.58                     |
| LQS2   | 2/9/06 16:00    | -4.8                   | -2.53                     |
| LQS2   | 11/6/06         | -8.1                   | -2.81                     |
| LQS3   | 2/9/06 14:40    | -5.0                   | -2.65                     |
| LQS3   | 11/6/06         | -7.6                   | -2.75                     |
| LQS3   | 9/27/07 12:15   | -7.1                   | -2.70                     |
| LQS3   | 1/11/10 16:30   | -5.6                   | -2.60                     |
| LQS3   | 6/23/08 12:00   | -6.7                   | -2.58                     |
| LQS4   | 2/9/06 17:30    | -6.6                   | -2.78                     |
| LQS4   | 11/4/06         | -7.8                   | -2.72                     |
| LQS4   | 9/28/07 14:15   | -7.3                   | -2.66                     |
| LQS4   | 9/30/07         | -6.1                   | -2.63                     |
| LQS4   | 6/24/08 14:05   | -5.5                   | -2.22                     |
| LQS4   | 1/11/10 16:45   | -6.5                   | -2.66                     |
| LQS5   | 2/10/06         | -10.1                  | -3.27                     |
| LQS5   | 11/4/06         | -9.3                   | -2.95                     |
| LQS5   | 9/28/07 14:55   | -6.4                   | -2.64                     |
| LQS5   | 1/11/10 17:25   | -6.1                   | -2.78                     |
| LQS6   | 2/10/06         | -3.9                   | -2.64                     |
| LQS6   | 11/4/06         | -9.4                   | -2.90                     |
| LQS6   | 9/30/07         | -5.9                   | -2.78                     |
| LQS7   | 2/10/06 10:30   | -5.3                   | -2.58                     |
| LQS7   | 11/4/06         | -7.6                   | -2.62                     |
| LQS7   | 9/29/07 10:15   | -4.7                   | -2.43                     |
| LQS7   | 1/9/10 14:40    | -2.3                   | -2.44                     |
| LQS7   | 6/25/08 16:30   | -3.7                   | -2.28                     |
| LQS8   | 2/10/06 11:15   | -6.0                   | -2.47                     |
| LQS8   | 11/4/06         | -6.9                   | -2.54                     |
| LQS8   | 9/28/07 9:40    | -5.2                   | -2.58                     |
| LQS9   | 2/10/06 13:55   | -5.2                   | -2.49                     |
| LQS9   | 11/4/06         | -7.2                   | -2.54                     |
| LQS9   | 9/29/07 15:30   | -4.9                   | -2.40                     |
| LQS9   | 1/10/10 10:45   | -3.6                   | -2.37                     |
| LQS10  | 2/10/06 14:05   | -4.3                   | -2.15                     |
| LQS10  | 11/4/06         | -6.1                   | -2.32                     |
| LQS10  | 9/29/07 15:40   | -5.0                   | -2.14                     |
| LQS11  | 2/10/06 14:40   | -4.5                   | -2.35                     |

**Table 6.** Contemporaneous stream stable isotope data collected from sites at different elevations in the Rio Mameyes and Rio Blanco/Rio Icacos watersheds in the Luquillo Mountains study area, eastern Puerto Rico.—Continued

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Table 6A, data sorted by site; table 6B, data sorted by collection date]

| Site ID   | Collection date | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|---|-----------------|------------------------|---------------------------|
| A. Contemporaneous stream isotope data by site—Continued  |                 |                        |                           |
| LQS11   | 11/4/06         | -6.1                   | -2.50                     |
| LQS11   | 9/29/07 17:00   | -5.2                   | -2.37                     |
| LQS11   | 6/25/08 11:55   | -3.6                   | -2.02                     |
| LQS11   | 1/10/10 11:15   | -2.9                   | -2.24                     |
| LQS12   | 2/11/06 15:20   | -4.8                   | -2.52                     |
| LQS12   | 11/4/06         | -6.4                   | -2.71                     |
| LQS12   | 9/29/07 13:10   | -5.0                   | -2.52                     |
| LQS12   | 6/24/08 16:40   | -3.3                   | -1.94                     |
| LQS12   | 1/10/10 14:15   | -3.5                   | -2.46                     |
| LQS13   | 2/11/06 16:30   | -4.2                   | -2.58                     |
| LQS13   | 11/4/06         | -5.6                   | -2.66                     |
| LQS13   | 9/28/07 16:15   | -6.5                   | -2.61                     |
| LQS13   | 6/24/08 15:20   | -2.9                   | -2.00                     |
| LQS13   | 1/9/10 15:28    | -1.6                   | -2.29                     |
| LQS14   | 11/6/06         | -8.3                   | -2.86                     |
| LQS14   | 9/27/07 13:55   | -8.3                   | -2.99                     |
| LQS15   | 11/6/06         | -8.1                   | -2.74                     |
| LQS15   | 9/27/07 15:55   | -8.1                   | -2.77                     |
| LQS15   | 6/23/08 14:48   | -7.1                   | -2.40                     |
| LQS15   | 1/11/10 13:55   | -5.4                   | -2.52                     |
| LQS16   | 11/6/06         | -7.3                   | -2.60                     |
| LQS16   | 9/27/07 15:15   | -10.0                  | -2.97                     |
| LQS17   | 1/9/10 12:40    | 1.5                    | -1.82                     |
| LQS18   | 1/13/10 11:00   | -6.6                   | -2.78                     |
| LQS18   | 5/21/10 15:23   | -4.6                   | -2.58                     |
| LQS19   | 1/26/10 9:00    | -5.6                   | -2.49                     |
| LQS19   | 5/22/10         | -6.5                   | -2.60                     |
| B. Contemporaneous stream isotope data by collection date |                 |                        |                           |
| LQS1  | 2/9/06 10:55    | -4.9                   | -2.69                     |
| LQS3  | 2/9/06 14:40    | -5.0                   | -2.65                     |
| LQS2  | 2/9/06 16:00    | -4.8                   | -2.53                     |
| LQS4  | 2/9/06 17:30    | -6.6                   | -2.78                     |
| LQS5  | 2/10/06         | -10.1                  | -3.27                     |
| LQS6  | 2/10/06         | -3.9                   | -2.64                     |
| LQS7  | 2/10/06 10:30   | -5.3                   | -2.58                     |
| LQS8  | 2/10/06 11:15   | -6.0                   | -2.47                     |
| LQS9  | 2/10/06 13:55   | -5.2                   | -2.49                     |
| LQS10   | 2/10/06 14:05   | -4.3                   | -2.15                     |
| LQS11   | 2/10/06 14:40   | -4.5                   | -2.35                     |

**Table 6.** Contemporaneous stream stable isotope data collected from sites at different elevations in the Rio Mameyes and Rio Blanco/Rio Icacos watersheds in the Luquillo Mountains study area, eastern Puerto Rico.—Continued

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Table 6A, data sorted by site; table 6B, data sorted by collection date]

| Site ID   | Collection date | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|---|-----------------|------------------------|---------------------------|
| B. Contemporaneous stream isotope data by collection date |                 |                        |                           |
| LQS12   | 2/11/06 15:20   | -4.8                   | -2.52                     |
| LQS13   | 2/11/06 16:30   | -4.2                   | -2.58                     |
| LQS4  | 11/4/06         | -7.8                   | -2.72                     |
| LQS5  | 11/4/06         | -9.3                   | -2.95                     |
| LQS6  | 11/4/06         | -9.4                   | -2.90                     |
| LQS7  | 11/4/06         | -7.6                   | -2.62                     |
| LQS8  | 11/4/06         | -6.9                   | -2.54                     |
| LQS9  | 11/4/06         | -7.2                   | -2.54                     |
| LQS10   | 11/4/06         | -6.1                   | -2.32                     |
| LQS11   | 11/4/06         | -6.1                   | -2.50                     |
| LQS12   | 11/4/06         | -6.4                   | -2.71                     |
| LQS13   | 11/4/06         | -5.6                   | -2.66                     |
| LQS2  | 11/6/06         | -8.1                   | -2.81                     |
| LQS3  | 11/6/06         | -7.6                   | -2.75                     |
| LQS14   | 11/6/06         | -8.3                   | -2.86                     |
| LQS15   | 11/6/06         | -8.1                   | -2.74                     |
| LQS16   | 11/6/06         | -7.3                   | -2.60                     |
| LQS1  | 11/7/06         | -6.7                   | -2.68                     |
| LQS3  | 9/27/07 12:15   | -7.1                   | -2.70                     |
| LQS14   | 9/27/07 13:55   | -8.3                   | -2.99                     |
| LQS16   | 9/27/07 15:15   | -10.0                  | -2.97                     |
| LQS15   | 9/27/07 15:55   | -8.1                   | -2.77                     |
| LQS8  | 9/28/07 9:40    | -5.2                   | -2.58                     |
| LQS4  | 9/28/07 14:15   | -7.3                   | -2.66                     |
| LQS5  | 9/28/07 14:55   | -6.4                   | -2.64                     |
| LQS13   | 9/28/07 16:15   | -6.5                   | -2.61                     |
| LQS7  | 9/29/07 10:15   | -4.7                   | -2.43                     |
| LQS12   | 9/29/07 13:10   | -5.0                   | -2.52                     |
| LQS1  | 9/29/07 14:35   | -5.9                   | -2.58                     |
| LQS9  | 9/29/07 15:30   | -4.9                   | -2.40                     |
| LQS10   | 9/29/07 15:40   | -5.0                   | -2.14                     |
| LQS11   | 9/29/07 17:00   | -5.2                   | -2.37                     |
| LQS4  | 9/30/07         | -6.1                   | -2.63                     |
| LQS6  | 9/30/07         | -5.9                   | -2.78                     |
| LQS3  | 6/23/08 12:00   | -6.7                   | -2.58                     |
| LQS15   | 6/23/08 14:48   | -7.1                   | -2.40                     |
| LQS4  | 6/24/08 14:05   | -5.5                   | -2.22                     |
| LQS13   | 6/24/08 15:20   | -2.9                   | -2.00                     |
| LQS12   | 6/24/08 16:40   | -3.3                   | -1.94                     |

**Table 6.** Contemporaneous stream stable isotope data collected from sites at different elevations in the Rio Mameyes and Rio Blanco/Rio Icacos watersheds in the Luquillo Mountains study area, eastern Puerto Rico.—Continued

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details. Table 6A, data sorted by site; table 6B, data sorted by collection date]

| Site ID   | Collection date | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|---|-----------------|------------------------|---------------------------|
| B. Contemporaneous stream isotope data by collection date—Continued |                 |                        |                           |
| LQS11   | 6/25/08 11:55   | -3.6                   | -2.02                     |
| LQS7  | 6/25/08 16:30   | -3.7                   | -2.28                     |
| LQS17   | 1/9/10 12:40    | 1.5                    | -1.82                     |
| LQS7  | 1/9/10 14:40    | -2.3                   | -2.44                     |
| LQS13   | 1/9/10 15:28    | -1.6                   | -2.29                     |
| LQS9  | 1/10/10 10:45   | -3.6                   | -2.37                     |
| LQS11   | 1/10/10 11:15   | -2.9                   | -2.24                     |
| LQS12   | 1/10/10 14:15   | -3.5                   | -2.46                     |
| LQS15   | 1/11/10 13:55   | -5.4                   | -2.52                     |
| LQS3  | 1/11/10 16:30   | -5.6                   | -2.60                     |
| LQS4  | 1/11/10 16:45   | -6.5                   | -2.66                     |
| LQS5  | 1/11/10 17:25   | -6.1                   | -2.78                     |
| LQS18   | 1/13/10 11:00   | -6.6                   | -2.78                     |
| LQS19   | 1/26/10 9:00    | -5.6                   | -2.49                     |
| LQS18   | 5/21/10 15:23   | -4.6                   | -2.58                     |
| LQS19   | 5/22/10         | -6.5                   | -2.60                     |

## Groundwater Isotope Data

**Table 7.** Groundwater stable isotope data from sites in the Luquillo Mountains study area, eastern Puerto Rico.

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details]

| Well ID                         | Collection date and time | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|---------------------------------|--------------------------|------------------------|---------------------------|
| Groundwater stable isotope data |                          |                        |                           |
| LQGW1                           | 1/13/10 10:02            | -6.9                   | -2.82                     |
| LQGW1                           | 5/21/10 15:00            | -6.7                   | -2.74                     |
| LQGW1                           | 6/16/11 10:45            | -6.8                   | -2.57                     |
| LQGW1                           | 5/30/12 12:55            | -10.7                  | -3.08                     |
| LQGW2                           | 1/13/10 10:20            | -3.3                   | -2.32                     |
| LQGW3                           | 1/13/10 10:32            | -2.5                   | -2.05                     |
| LQGW4                           | 1/13/10 10:52            | -5.4                   | -2.59                     |
| LQGW5                           | 1/26/10 9:00             | -5.6                   | -2.58                     |
| LQGW6                           | 1/26/10 9:00             | -3.8                   | -2.29                     |
| LQGW6                           | 5/21/10 15:15            | -0.7                   | -2.04                     |
| LQGW7                           | 1/26/10 9:00             | -6.2                   | -2.52                     |

**Table 7.** Groundwater stable isotope data from sites in the Luquillo Mountains study area, eastern Puerto Rico.—Continued

[Delta values are expressed in per mil (‰) differences relative to Vienna Standard Mean Ocean Water. See figure 1 and table 1 for site locations and details]

| Well ID                                   | Collection date and time | $\delta^2\text{H}$ (‰) | $\delta^{18}\text{O}$ (‰) |
|---|--------------------------|------------------------|---------------------------|
| Groundwater stable isotope data—Continued |                          |                        |                           |
| LQGW7                                     | 5/21/10 14:45            | -4.5                   | -2.52                     |
| LQGW8                                     | 1/26/10 9:00             | -2.2                   | -2.06                     |
| LQGW8                                     | 5/21/10 14:55            | -1.5                   | -2.08                     |
| LQGW9                                     | 1/26/10 9:00             | -3.9                   | -2.46                     |
| LQGW9                                     | 5/21/10 15:40            | -3.4                   | -2.36                     |
| LQGW10                                    | 1/26/10                  | 2.0                    | -1.63                     |
| LQGW11                                    | 1/26/10                  | -6.0                   | -2.49                     |
| LQGW12                                    | 1/26/10                  | 5.7                    | -1.40                     |
| LQGW13                                    | 5/21/10 15:35            | -6.8                   | -2.63                     |
| LQGW14                                    | 5/22/10                  | 2.3                    | -1.52                     |
| LQGW15                                    | 6/15/11 10:45            | -6.9                   | -2.25                     |
| LQGW15                                    | 5/25/12 12:30            | -6.7                   | -2.27                     |
| LQGW16                                    | 6/21/11 14:35            | -10.1                  | -2.90                     |
| LQGW16                                    | 5/29/12 10:15            | -6.0                   | -2.70                     |
| LQGW17                                    | 6/16/11 10:00            | -5.5                   | -2.61                     |
| LQGW17                                    | 6/1/12 12:05             | -10.3                  | -2.97                     |
| LQGW17                                    | 6/11/12 10:30            | -8.8                   | -3.06                     |
| LQGW17                                    | 6/13/12 9:50             | -9.6                   | -2.88                     |
| LQGW17                                    | 6/17/12 14:00            | -9.6                   | -3.02                     |
| LQGW17                                    | 6/18/12 15:00            | -9.2                   | -2.97                     |
| LQGW17                                    | 6/20/12 10:25            | -8.8                   | -2.93                     |
| LQGW17                                    | 6/27/12 11:07            | -8.5                   | -2.98                     |
| LQGW17                                    | 7/2/12 13:41             | -9.0                   | -3.06                     |
| LQGW17                                    | 7/7/12 11:30             | -9.0                   | -2.61                     |
| LQGW17                                    | 7/9/12 16:50             | -9.2                   | -2.67                     |
| LQGW17                                    | 7/11/12 10:19            | -9.4                   | -3.03                     |
| LQGW17                                    | 7/15/12 13:00            | -8.4                   | -2.73                     |
| LQGW17                                    | 7/18/12 16:00            | -9.4                   | -3.10                     |
| LQGW17                                    | 8/16/12 12:30            | -10.0                  | -3.14                     |
| LQGW17                                    | 8/18/12 12:30            | -11.3                  | -3.11                     |
| LQGW17                                    | 8/22/12 15:00            | -11.4                  | -3.15                     |
| LQGW18                                    | 6/16/11 9:00             | -2.2                   | -1.96                     |
| LQGW19                                    | 6/21/11 14:59            | -6.5                   | -2.80                     |
| LQGW19                                    | 5/29/12 11:10            | -6.5                   | -2.72                     |
| LQGW20                                    | 6/21/11 11:04            | -9.3                   | -2.61                     |
| LQGW20                                    | 5/25/12 13:45            | -9.0                   | -2.63                     |
| LQGW21                                    | 5/29/12 12:00            | -4.5                   | -2.33                     |
| LQGW22                                    | 6/5/12 10:00             | -2.8                   | -1.75                     |
| LQGW23                                    | 7/15/12 11:30            | -5.2                   | -2.50                     |



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