14C and 13C measurements of particulate and sedimentary organic carbon from the Santa Clara River, California, during the 2023–2024 El Niño event

Website: https://www.bco-dmo.org/dataset/1006750
Data Type: Other Field Results
Version: 1
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Project
» RAPID: The effect of El Nino on delivery of organic carbon in the Santa Clara River, CA (Santa Clara River POC)

Contributors	Affiliation	Role
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Abstract
Radiocarbon (Δ14C) and stable carbon isotope (δ13C) values were measured in particulate organic carbon (POC) from river water and sedimentary organic carbon (SOC) from river silt and beach sand collected by Niels Hauksson from the Santa Clara River (SCR), California, during the 2023–2024 El Niño event from December 2023 to April 2024. The SCR watershed has experienced significant change over the past decades due to both urban development and increased drought. The dataset contains measurements of POC samples from Santa Clara River water and sedimentary organic carbon (SOC) from river silt and beach sand, including sample collection information, Δ14C and δ13C measurements and associated analytical uncertainties, and sample collection coordinates. This analysis is helping to establish whether the observed change in the aged OC end member is the result of variation in precipitation or due to other alterations in the watershed. If precipitation is the main control of the aged end member, we can estimate how the expected changes in local climate will affect the OC exported by the SCR. Dr. Hauksson, undergrad student Taylor Hart and PI Ellen Druffel analyzed the samples and are writing the papers with these data.

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Coverage

Location: Santa Clara River at three locations: river water from Santa Clara River Bridge 34.230, -119.259, river silt at 34.230, -119.261, beach sand at 34.230, -119.262
Spatial Extent: **N**:34.23 **E**:-119.259 **S**:34.23 **W**:-119.262
Temporal Extent: 2023-12-21 - 2024-04-01

Methods & Sampling

Sample Site Description

The SCR (Santa Clara River) is a SMR (small mountainous river) with a watershed area of 4232 km^2, (Henry et al. 2024; Swain et al. 2018). The river is in Ventura and Los Angeles Counties and 37% of the basin is controlled by dams (Brownlie and Taylor, 1981). Rainfall occurs in the winter, resulting in high streamflow from December to March, and dry periods during the rest of the year, typical of a Mediterranean climate. Sediment and POC samples were collected from the SCR after high flow periods from four precipitation events.

Samples were collected from the mouth of the Santa Clara River at three locations: 1) river water (for particulate organic carbon POC) from Santa Clara River Bridge, Highway 101, Oxnard, CA at 34.230, -119.259; 2) river silt (for sedimentary organic carbon SOC) at 34.230, -119.261, and 3) beach sand (SOC) at 34.230, -119.262. Bottle casts were conducted by hand from the Santa Clara River Bridge, Highway 101, CA (1 m depth) and sediment collection from the estuary during December 2023-April 2024. All samplings took place during rain events.

Particulate Matter Collection and Sample Processing

All glass sampling equipment was soaked in 10% HCl for > 2 hours, rinsed with Milli-Q water, and baked at 540˚C for 2 hours. Metal sampling equipment was baked at 540˚C for 2 hours. Bottle and jar lids were lined with Teflon tape cleaned in Chromerge.

River water was collected by submerging a 2.5L glass bottle deployed by rope from the SCR Bridge. The samples were stored on ice for up to 24 hours until vacuum filtered in the lab using pre-combusted 2.2µm quartz fiber filters. The filters were frozen in glass petri dishes, wrapped in clean aluminum foil and plastic bags. For isotope analyses, filters were cut into sections using a razor blade cleaned with methanol, transferred into quartz combustion tubes, then acidified with 3% H_3PO_4 overnight and dried in vacuo.

Riverbank Sediment Collection and Processing

Sediment from the top 3 cm of the riverbank were collected in glass jars and stored on ice for up to 24 hours until transport to the lab, and frozen. Sub-samples were taken by thawing, and weighing approximately 200 mg of sediment in a petri dish before fumigation with concentrated HCl for 3 to 4 hours (Komada et al. 2008). Samples were transferred into quartz combustion tubes with quartz wool and dried in vacuo. Moisture content of sediment samples was determined by drying samples at 40˚C to a constant mass.

^{14}C Analysis

Cupric oxide and silver were added to the quartz tubes, then vacuum sealed and combusted to CO_2 at 850˚C for 2 hours. The CO_2 was cryogenically purified and reduced to graphite using zinc reductant and iron catalyst (Xu et al. 2007; Walker and Xu 2019). ^{14}C analyses were performed at the Keck Carbon Cycle AMS (KCCAMS) Laboratory at UCI by our group. Uncertainties for river POC and sediment OC samples was determined by pooled standard deviation of replicates (McNaught and Wilkinson, 1997). Uncertainty of river POC $\Delta^{14}C$ values was ±4‰ and that for estuary sediment OC $\Delta^{14}C$ values was ±45‰, and were high due to heterogeneity of the samples.

^{13}C Analysis

The CO_2 obtained from combusted samples for ^{14}C analysis were split after equilibration for at least 2 minutes to prevent fractionation. The split was analyzed for $\delta^{13}C$ using a Finnigan Delta Plus mass spectrometer at UCI. Uncertainty was determined using pooled standard deviation of replicates (McNaught and Wilkinson, 1997). River POC samples have an uncertainty of ± 0.1 ‰; estuary sediment OC samples have an uncertainty of ± 0.5 ‰ and were high due to heterogeneity of the samples.

Data Processing Description

We use custom programs that are available in our group to process the isotope measurements we make.

BCO-DMO Curation Notes

This section documents curation actions performed prior to publication review with the submitter, and

additional information relevant to understanding and reusing this dataset. It distinguishes changes made to the submitted (meta)data from unresolved issues and/or enhancements that improve future reuse and interoperability.

CURATION ACTIONS PERFORMED ON DATA

- Loaded RAPID BCO-DMO data Druffel.xlsx (sheet "Isotope Data"), assigning explicit column headers: UCID sample number, Sample Description and filter # and date collected, D14C, D14C_error, d13C, d13C_error, latitude, longitude; skipped rows 1-6 (multi-row header, grant note, PI note); set "" and "nd" as missing values
- Split column "Sample Description and filter # and date collected" via regex into sample_type (first 3 letters), site_name (next 3 letters), filter_number (middle text, e.g. "Filter 34", "Silt A"), and date_collected_raw (raw MM-DD-YY date string); deleted original input column
- Converted date_collected_raw (format %m-%d-%y) into new date column date_collected (output format %Y-%m-%d)
- Deleted column date_collected_raw
- Reordered columns to: UCID sample number, sample_type, site_name, filter_number, date_collected, D14C, D14C_error, d13C, d13C_error, latitude, longitude
- Renamed column "UCID sample number" to "UCID_sample_number"
- Output as 1006750_v1_santa_clara_river_isotopes.csv

CURATION ACTIONS PERFORMED ON METADATA

- BCO-DMO's standard metadata entry and text formatting steps were performed.
- Created definitions for newly created fields.
- Changed abstract from "June" to "April" to align with data and extent information.
- Adjusted title and abstract to clarify contents of dataset.

ISSUES POTENTIALLY IMPACTING REUSE

- N/A

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Data Files

File	
1006750_v1_santa_clara_river_isotopes.csv	(Comma Separated Values (.csv), 5.05 KB) MD5:d3f358a22a55a5f5f7ba815795901215
Primary data file for dataset ID 1006750, version 1	

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Related Publications

Brownlie, W. R., & Taylor, B. D. (1981). Sediment Management for Southern California Mountains, Coastal Plains and Shoreline. Part C: Coastal Sediment Delivery by Major Rivers in Southern California. *California Institute of Technology*. https://doi.org/10.7907/Z9VT1Q1R
Methods

Henry, D., Catalán, N., Obrador, B., & Marcé, R. (2024). Modeling carbon burial along the land to ocean aquatic continuum: Current status, challenges and perspectives. Earth-Science Reviews, 253, 104791. https://doi.org/10.1016/j.earscirev.2024.104791
Methods

Komada, T., Anderson, M. R., & Dorfmeier, C. L. (2008). Carbonate removal from coastal sediments for the determination of organic carbon and its isotopic signatures, $\delta^{13}C$ and $\Delta^{14}C$: comparison of fumigation and direct acidification by hydrochloric acid. Limnology and Oceanography: Methods, 6(6), 254–262. Portico. https://doi.org/10.4319/lom.2008.6.254
Methods

McNaught, A. D., & Wilkinson, A. (1997). IUPAC Compendium of Chemical Terminology. 2nd Edition, The “Gold

Book " (Vol. 1669). Oxford: Blackwell Science. ISBN 0865426848 Available from https://doi.org/10.1351/goldbook
Methods

Swain, D. L., Langenbrunner, B., Neelin, J. D., & Hall, A. (2018). Increasing precipitation volatility in twenty-first-century California. Nature Climate Change, 8(5), 427–433. https://doi.org/10.1038/s41558-018-0140-y
Methods

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

Xu, X., Trumbore, S. E., Zheng, S., Southon, J. R., McDuffee, K. E., Luttgen, M., & Liu, J. C. (2007). Modifying a sealed tube zinc reduction method for preparation of AMS graphite targets: Reducing background and attaining high precision. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 259(1), 320–329. https://doi.org/10.1016/j.nimb.2007.01.175
Methods

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Parameters

Parameter	Description	Units
UCID_sample_number	Unique laboratory sample identification number	unitless
sample_type	Sample type: Particulate organic carbon (POC) from river water or sedimentary organic carbon (SOC) from river silt or beach sand	unitless
site_name	Body of water name: SCR (Santa Clara River)	unitless
filter_number	Filter number: Filter 34, Filter 42, Filter 51, Filter 60, Filter 63, Filter 69, Sand A, Sand B, Silt A, Silt B	unitless
date_collected	Date sample was collected	unitless
D14C	Radiocarbon content expressed as Δ14C in per mil (‰), following the reporting conventions of Radiocarbon. Measurements were made at the Keck Carbon Cycle AMS Laboratory at the University of California, Irvine using accelerator mass spectrometry (AMS). Samples were graphitized from CO2 using the zinc reduction method.	‰
D14C_error	Analytical uncertainty of the Δ14C measurement, in per mil (‰), expressed as the standard error of replicate analyses.	‰
d13C	carbon-13/carbon-12 content expressed as δ13C in per mil (‰), following the reporting conventions using secondary standards corrected to Pee Dee Belemnite limestone standard. Measurements were made at the Keck Carbon Cycle AMS Laboratory at the University of California, Irvine using using a Gas Bench II and Thermo Electron Delta Plus isotope ratio mass spectrometer.	‰
d13C_error	Analytical uncertainty of the δ13C measurement, in per mil (‰), expressed as the standard error of replicate analyses.	‰
latitude	Latitude of sample collection, positive is North	decimal degrees
longitude	Longitude of samples collection, negative is West	decimal degrees

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Instruments

Dataset-specific Instrument Name	Keck Carbon Cycle AMS (KCCAMS)
Generic Instrument Name	Accelerator Mass Spectrometer
Dataset-specific Description	14C analyses were performed at the Keck Carbon Cycle AMS (KCCAMS) Laboratory at UCI by our group.
Generic Instrument Description	An AMS measures "long-lived radionuclides that occur naturally in our environment. AMS uses a particle accelerator in conjunction with ion sources, large magnets, and detectors to separate out interferences and count single atoms in the presence of 1x1015 (a thousand million million) stable atoms, measuring the mass-to-charge ratio of the products of sample molecule disassociation, atom ionization and ion acceleration." AMS permits ultra low-level measurement of compound concentrations and isotope ratios that traditional alpha-spectrometry cannot provide. More from Purdue University: http://www.physics.purdue.edu/primelab/introduction/ams.html

Dataset-specific Instrument Name	Finnigan Delta Plus mass spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	The CO2 obtained from combusted samples for 14C analysis were split and analyzed for δ13C using a Finnigan Delta Plus mass spectrometer at UCI.
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

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Project Information

RAPID: The effect of El Nino on delivery of organic carbon in the Santa Clara River, CA (Santa Clara River POC)

Coverage: Santa Clara River CA

NSF abstract:
El Niño–Southern Oscillation (ENSO) causes changes in winds and sea surface temperature over the tropical eastern Pacific Ocean. Typically, this results in above average rainfall in Southern California. This project aims to understand how high rainfall associated with ENSO influences the delivery of carbon from land to the ocean. Specifically, the scientists will evaluate whether a unique pool of aged carbon derived from eroded soils in the watershed is transported to the ocean during these events. Samples of particulate and sedimentary organic carbon will be collected from the Santa Clara River in California. The samples will be collected under different river flow conditions between December 2023 and April 2024. The chemical composition of these samples will be analyzed and compared to samples collected during previous ENSO and non-ENSO time periods. This unique set of samples will record whether there are differences in the amounts and sources of carbon delivered to the ocean under different river flow conditions. Results from this study will improve global and long-term estimates of carbon export from land to the ocean. This project will support an early career scientist and an undergraduate student at the University of California-Irvine, a Hispanic-serving institution.

This study will examine the sources of organic carbon (OC) delivered to the coastal zone of Southern California during the upcoming El Niño event of 2023-24. The project will test the hypothesis that extreme precipitation in the Santa Clara River watershed mobilizes a unique pool of mineral-associated OC that differs from the OC that is mobilized during normal or low precipitation years. Previous studies have shown that the mineral-associated OC mobilized during the strong El Niño of 1997-98 had higher Δ14C and d13C values than the OC exported during low flow periods. The science team will collect particulate OC (POC) and sedimentary OC (SOC) samples from the Santa Clara River under different flow conditions during the 2023-2024 El Niño event. Radiocarbon (Δ14C) and stable carbon isotope values (d13C) for bulk OC, and compound specific isotope analyses of n-alkanes will be measured. These data will be compared to data obtained during time periods when precipitation and river flow conditions varied (1997-98, 2002-03, 2021-22). This combination of isotope information will allow the scientists to estimate the relative contributions of organic matter derived from different sources as well as the contribution of eroded mineral associated OC to the sediments. The project will provide research and training opportunities for a postdoc and an undergraduate student at the University of California-Irvine (UCI), a Hispanic-serving institution. The postdoc will participate in the CLEAN Education Program (Climate, Literacy, Empowerment and iNquery) and design phenomenon–based science curricula for use in local high schools and undergraduate labs in the Earth System Science Department at UCI.

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

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2401563

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