Developing the PAGES Seawater Database for Studying Past and Present Hydrology

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Abstract

The stable oxygen isotope ratio of seawater (delta-18O) is a useful tracer of the hydrologic cycle. Because of its lighter mass, oxygen-16 evaporates more easily than oxygen-18 and condenses more slowly. This partitioning allows scientists to track the flow of water in the ocean and the atmosphere. Studying seawater delta-18O provides insight into ocean-atmosphere interactions and processes such as ocean upwelling. Despite the significance of delta-18O, most seawater delta-18O data are not publicly available; many are either published in tables of scientific articles or dispersed in various public data repositories. To support current and future research, the PAGES (Past Global Changes) CoralHydro2k project is creating a publicly accessible database of observational seawater delta-18O data complete with essential metadata that scientists can use for a myriad of research applications. In addition to modern analyses, the database will be useful for creating paleoclimate reconstructions and for evaluating data from climate models. The data is pulled from scientific articles, other databases, and submissions from researchers. In total, the database currently boasts over 19,000 data points. The database is machine-readable and compliant with findability, accessibility, interoperability, and reusability standards and it is rich in metadata (including depth, salinity, temperature, analysis technique, and reference standard), which allows the database to be versatile and informative. After more than a year of development, we are now quality-controlling the database and comparing the observational data with model data.

Introduction

Why is delta-18O important?

The stable oxygen isotope ratio of seawater (delta-18O) can be used to trace water throughout different stages of the water cycle. The tracing can help scientists follow ocean-atmosphere processes and shed insight into lesser-understood processes such as El Niño Southern Oscillation (ENSO).

How is delta-18O related to this study?

Much of this study consisted of first understanding the meaning and applications of delta-18O and then organizing data on delta-18O into the CoralHydro2k Seawater Database. Delta-18O was also used to compare observational data and model data using plotting and analyses in Python.

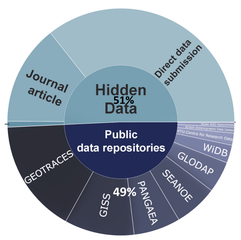
CoralHydro2k Database

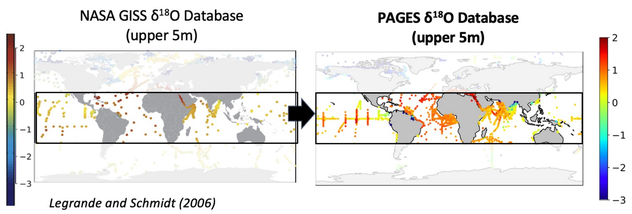
The PAGES CoralHydro2k project began in 2017. It is an effort to collect seawater isotope data from current researchers, past research, and data collection that may or may not be published. The project also seeks to collate data from other global seawater databases such as GISS. When complete, the database may function as an updated and complete source of seawater isotope information. This resource will be publicly available and will contain essential metadata for research and analysis.

Methods

Working on the CoralHydro2k Database

- Finding essential metadata related to each specific delta-18O measurement
  - Information such as delta-18O analysis technique, analysis location, cruise information, and notes on temperature, salinity, depth, collection, and analysis
  - Every entry in the database is required to have essential metadata
- Quality control of the database
  - Each data point and its related metadata had to be checked for technical errors





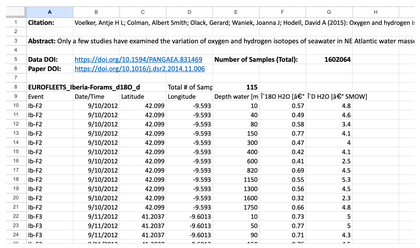
Legrande and Schmidt (2006)

Python

- Learning to perform analyses and create plots using Python
- Using the Hadley Centre Coupled Model 3 (HadCM3) to analyze average seawater delta-18O data
- Identifying areas where both seawater data and coral proxy data are abundant

Results

CoralHydro2k Seawater Delta-18O Seawater Database



	A	B	C	D	E	F	G	H
1	**Citation:**	Voelker, Antje H L; Colman, Albert Smith; Olack, Gerard; Waniek, Joanna J; Hodell, David A (2015): Oxygen and hydrogen i						
2								
3	**Abstract:**	Only a few studies have examined the variation of oxygen and hydrogen isotopes of seawater in NE Atlantic water mass						
4								
5	**Data DOI:**	https://doi.org/10.1594/PANGAEA.831469		**Number of Samples (Total):**		**1602064**		
6	**Paper DOI:**	https://doi.org/10.1016/j.dsr2.2014.11.006						
7								
8	**EUROFLEETS_Iberia-Forams_d18O_d**			**Total # of Samp**		**115**		
9	Event	Date/Time	Latitude	Longitude	Depth water [m	ˆ18O H2O [â€°	ˆD H2O [â€° SMOW]	
10	Ib-F2	9/10/2012	42.099	-9.593	10	0.57	4.8	
11	Ib-F2	9/10/2012	42.099	-9.593	40	0.49	4.6	
12	Ib-F2	9/10/2012	42.099	-9.593	80	0.58	3.4	
13	Ib-F2	9/10/2012	42.099	-9.593	150	0.77	4.1	
14	Ib-F2	9/10/2012	42.099	-9.593	300	0.47	4	
15	Ib-F2	9/10/2012	42.099	-9.593	400	0.42	4.1	
16	Ib-F2	9/10/2012	42.099	-9.593	600	0.41	2.5	
17	Ib-F2	9/10/2012	42.099	-9.593	820	0.69	4.5	
18	Ib-F2	9/10/2012	42.099	-9.593	1150	0.55	5.3	
19	Ib-F2	9/10/2012	42.099	-9.593	1300	0.56	4.5	
20	Ib-F2	9/10/2012	42.099	-9.593	1600	0.32	2.3	
21	Ib-F2	9/10/2012	42.099	-9.593	1750	0.66	4.8	
22	Ib-F3	9/11/2012	41.2037	-9.6013	10	0.73	5	
23	Ib-F3	9/11/2012	41.2037	-9.6013	50	0.77	5	
24	Ib-F3	9/11/2012	41.2037	-9.6013	90	0.71	4.3	

Figure 1. Example source in the Literature Review and Metadata workbook

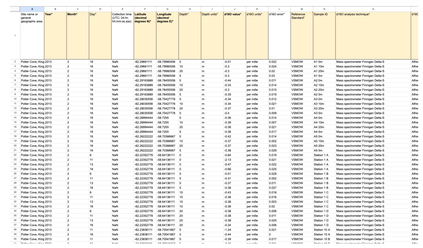
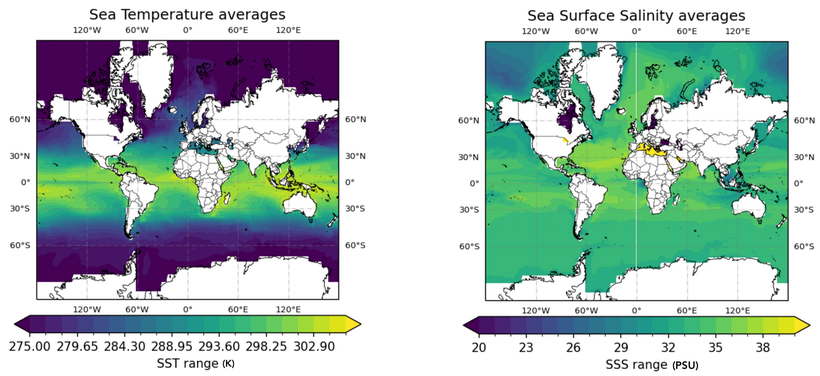


Figure 2. The Master d18Osw Workbook



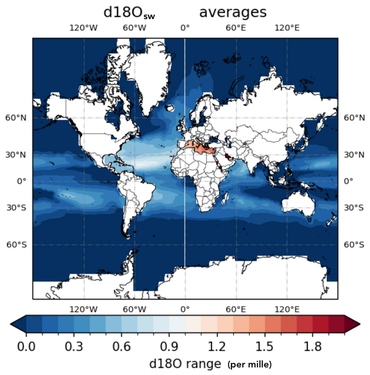


Figure 3. Plots of seawater data from 1810-1909 using global climate model HadCM3 (Python)

Discussion

The contributions of this undergraduate project will help the development of the seawater delta-18O database that the CoralHydro2k project has been working on for over 3 years. The database will allow for easier analyses because of the standardized metadata. Also, the project's emphasis on comparisons between model data and observations will help identify accuracy in models.

Future Directions

Future research would likely involve comparing plots of modern data to plots of historical proxy data from corals. As more data from corals and observations are gathered, we form a better idea of hydrologic processes and the ocean's role in global climate. Delta-18O is just one of many components of seawater that help scientists reveal the mechanisms and processes in earth's oceans. Salinity is another tracer of the hydrological cycle, but salinity values are not always parallel to delta-18O. Future studies may use the CoralHydro2k delta-18O seawater database to identify relationships between salinity and delta-18O.

This project may involve fieldwork in the future. One way to obtain delta-18O data is through drilling corals. The Atwood Lab has drilled at Kiritimati Island (Christmas Island) and is planning on returning to Kiritimati and the Galapagos for scientific diving. To prepare for this potential expedition, I am enrolled in a scientific diving course through the FSU Coastal and Marine Laboratory to become certified as an AAUS Scientific Diver.

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References

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