DATASHEET: Ocean Warming Annual Variation (1992-2020) Dataset

INTRODUCTION

Dataset Name

OceanWarmingAnnualNOAA.xlsx (1957-2020)

Datasheet Author

NASA Office of STEM Engagement

Note: This datasheet follows the format of the <u>Educator-Facing Datasheet for Derivative</u> <u>Datasets</u>. (see also <u>Datasets for K-12 Data Science</u>, <u>Datasheets for Datasets</u>).

Date Datasheet Created

May 2023

Context

This dataset shows annual changes in Ocean Heat Content (OHC) from 1957 to 2020, relative to 1957, for depths 0-2000 meters. Data is expressed in zettajoules (ZJ). One ZJ is 10²¹ joules. As a reference, the total energy consumption around the world is around <u>half</u> a zettajoule annually.

OHC values are calculated using in-water instrument measurements, and ocean circulation computer models. In-water instruments measure temperature and salinity profiles from conductivity-temperature-depth instruments (CTDs), <u>Argo</u> profiling floats, eXpendable BathyThermographs (XBTs), instrumented mooring arrays, and ice-tethered profilers (ITPs). National Oceanic and Atmospheric Administration (NOAA) <u>National Centers for Environmental Information (NCEI)</u> provides the data.

OHC is an essential metric for understanding climate change and the Earth's energy budget. The oceans are the dominant reservoir for the storage of heat in the climate system. The effects of ocean warming include sea level rise due to thermal expansion, coral bleaching, accelerated melting of Earth's major ice sheets, intensified hurricanes, and changes in ocean health and biochemistry.

<u>Vital Signs of the Planet: Ocean Warming</u> Earth's Energy Balance

1. ORIGIN

Where can the original dataset be found?

Vital Signs of the Planet: Ocean Warming

Select "Get Data" under the heading OCEAN HEAT CONTENT CHANGES SINCE 1955 (NOAA) Direct Link

Credits: <u>NOAA Global Ocean Heat and Salt Content: Seasonal, Yearly, and Pentadal Fields</u> <u>NOAA/NCEI World Ocean Database</u>

Users are referred back to the original dataset for the most recent values. The original dataset for this datasheet is duplicated as a tab in "OceanWarmingAnnualNOAA.xls"

Column Name	Description					
Col A: Year	Year					
Col B: WO	Change in World Ocean Heat Content in zettajoules (ZJ) relative to 1957. Each data point represents a five-year (pentadal) running average where the pentadal estimate is provided for the midpoint of the 5-year period. For example, the 1957 value includes OHC estimates from 1955-1959 and the 2020 estimate includes OHC values from 2018-2022.					
Col C: WOse	Standard error (se) for the World Ocean data point in ZJ.					
	 "±se" is the "uncertainty margin," or the range from the average within which there is a high probability that the true number resides. For example, when we say the OHC for a particular year is 220 +/- 2 ZJ, the true value for that year has a high probability of being between 218 and 222 zettajoules. The uncertainty margin exists both because of: natural variability (some years, more heat goes into the ocean, other years, less so; some years, more energy goes increasingly deeper in the ocean, and other years, more of it stays closer to the surface) how accurately available instruments are able to measure ocean heat; this has substantially improved over time 					
Col D: NH	Annually averaged change in OHC for the Northern Hemisphere in ZJ relative to 1957. Each data point represents a 5-year (pentadal) running average.					
Col E: NHse	Standard error for the Northern Hemisphere OHC in ZJ					
Col F: SH	Annually averaged change in OHC for the Southern Hemisphere in ZJ relative to 1957. Each data point represents a 5-year (pentadal) running average.					
Col G: SHse	Standard error for the Southern Hemisphere OHC in ZJ.					

2. METADATA

3. MOTIVATION

For what purpose was the original dataset created?

To create a climate data record of how global OCH is changing over time.

For what purpose was the derived dataset created?

To simplify the dataset to serve as an entry point for data analysis of Earth system datasets for the K-12 classroom.

Who created the **original** dataset?

National Oceanic and Atmospheric Administration (NOAA) National Center for Environmental Information (NCEI)

Who created the **derived** dataset?

NASA Office of STEM Engagement

Who funded the creation of the original dataset?

National Oceanic and Atmospheric Administration (NOAA)

Who funded the creation of the **derived** dataset?

National Aeronautics and Space Administration (NASA)

4. COMPOSITION

What does a row in the dataset represent?

Each row represents the global ocean heat content (ZJ) for a 5-year running average +/- the standard error along with partitions for the Northern Hemisphere and Southern Hemisphere.

How many rows are in the dataset, in total?

336 rows covering Jan. 1992 to Dec. 2019.

Original dataset is updated as more recent data becomes available.

Does the dataset contain all possible rows or is it a sample of rows from a larger dataset?

All possible rows as of date of datasheet creation.

If it's a sample, describe your sampling process (random, weighted, etc). Is the sample representative of the larger set (e.g., geographic coverage)?

n/a

5. DERIVATION PROCESS

Who was involved in the data derivation process and how were they compensated?

NASA Office of STEM Engagement.

What processes (e.g. cleaning, filtering, labeling) did the derivation process perform?

- The original NOAA dataset shows data for the midpoint of each year to represent the global average. NASA truncates the "0.5" from each year for ease of interpretation.
- The original NOAA dataset uses units of 10²² joules. For example, the data point for 1957 in the <u>original dataset</u> is -9.303 x 10²² joules. The data shown on <u>NASA's Vital Signs of the</u> <u>Planet: Ocean Warming</u> graph is in zettajoules (10²¹ joules). All values for ocean heat content and the standard error (Cols B-G) were first multiplied by 10 to be shown in joules.
- OHC is always computed with a reference mean subtracted out from each temperature observation (<u>See World Ocean Heat Content and Thermosteric Sea Level change (0-2000</u> <u>m</u>), 1955-2010). This is why some OHC values appear negative and others positive.
- For ease of interpretation, <u>NASA's graph</u> of global OHC uses 1957 as a reference point set to 0. Each value in the WO column is therefore offset by 93 ZJ (or 9.3x10²² joules). This makes it much easier to visualize a 345 ZJ increase in OHC from 1957 to 2020.
- For example:

Original Dataset			Derived Dataset					
			Step 1	Step 2	Step 2	Step 3	Step 4	Step 5
YEAR	WO (10 ²² joules)	WOse (10 ²² joules)	Year	WO (ZJ)	Wose (ZJ)	WO (ZJ) + Vertical Offset (93.03 ZJ)	WO (ZJ)	Wose (ZJ)
1957.5	-9.303	2.025	1957	-93.03	20.25	0	0	20
1958.5	-8.059	2.017	1958	-80.59	20.17	12.44	12	20
1959.5	-8.713	2.036	1959	-87.13	20.36	5.9	6	20
1960.5	-5.479	1.893	1960	-54.79	18.93	38.24	38	19

Step 1: Truncate Year

Step 2: Multiple WO and WOse values by 10 to convert to ZJ

Step 3: Add the vertical offset of 93.03 ZJ to each year

Step 4: Round WO to the nearest whole number.

Step 5: Round WOse to nearest whole number.

• This same process is repeated for Northern Hemisphere and Southern Hemisphere values.

• See example in "DerivationExample" tab in OceanWarmingAnnualNOAA.xls

If software was used to perform the derivation, is it available? If so, please point to a link or other access point.

n/a

What information was removed or transformed during derivation that might influence the findings of an analysis (e.g., deleting rows due to missing data, a sampling mechanism that over-samples from a particular group, etc.)?

n/a

6. USES

Are there real-world applications of the dataset that an educator should be aware of?

- Scientific studies to monitor ocean heat content over time and create a climate data record.
- Ocean heat content is an essential metric for understanding climate change and the Earth's energy budget.
- Validate climate model simulations.
- Impacts to ocean currents and heat transport.
- Impacts to marine wildlife including ice-associated marine mammals.
- Impacts to commercial and local fisheries and world food production.

7. EDUCATOR'S GUIDE

Are there recommended subsets to be explored?

NASA studies long term trends. All data points are needed to compile a comprehensive time series to better understand these phenomena.

Are there outliers or unusual observations to be pointed out?

Dataset shows continuous and steady rise in global ocean heat content with a multiyear cooling period (1962-1967). The rise is accelerating beginning at the end of 2017.

Are there any correlations in the derivative dataset to be pointed out?

n/a

Does the data embody any computing or statistical learning goals (e.g., columns have a particular skew, correlations demonstrate Simpson's Paradox, etc.)?

n/a

What potential threats to validity would be worth discussing?

n/a

Suggestions for student activities

- Compute the decadal rate of change (WO, NH, SH) per decade and for the entire record.
- Sea Level Rise Classroom Activities
- My NASA Data: Hydrosphere Lesson Plans
- Calculate decadal rate of change.
- Compare to rates of sea level change.