Oceans Melting Greenland (OMG) Narwhals Mooring CTD Data, Ver. 1

User's Guide

Data Set

OMG Narwhals Mooring CTD Level 2 Data

Authors

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Abstract

NASA's Oceans Melting Greenland (OMG) campaign obtained oceanographic observations around Greenland at an unprecedented spatial scale and confirmed that the ocean plays a key role in Greenland glacier acceleration and retreat. Yet, ocean observations along Greenland's margins are biased toward summer months with relatively few year-round measurements. OMG Narwhals, a project coupled with NASA's OMG mission, seeks to understand the ecological importance of glacial habitats to narwhals. Narwhals return to glacial outlets and fjords each summer with high site fidelity but what attracts them to specific glacier fronts remains unclear. **Seafloor-mounted ocean moorings with marine mammal acoustic recorders and oceanographic instruments were deployed near three glacier fronts with known narwhal presence in Melville Bay, northwest Greenland. This OMG Narwhals dataset contains measurements from the moored CTDs that span two years: August 2018–August 2020.**

Citation

This research was conducted by the University of Washington, the Greenland Institute of Natural Resources, and the Jet Propulsion Laboratory, managed by the California Institute of Technology under a contract with the National Aeronautics and Space Administration. Use of these data should be cited as follows:

Zahn MJ, Laidre KL, Simon MJ, Fenty I. 2023. OMG Narwhals oceanographic data from moorings, 2018-2020. Ver. 1. PO.DAAC, CA, USA. Dataset accessed [YYYY-MM-DD] at https://doi.org/10.5067/OMGNW-MOOR1

Contact

For questions about access to the data product please email podaac@podaac.jpl.nasa.gov or visit the PO.DAAC forum. For questions about the data product itself please email Marie Zahn, mzahn@uw.edu, or Ian Fenty, Ian.Fenty@jpl.nasa.gov.

Introduction

Mass loss of the Greenland ice sheet has contributed substantially to global sea level rise with impacts to local ecosystems and the global climate. The Greenland ice sheet connects to the ocean via hundreds of glaciers that terminate in deep troughs and valleys. These marine-terminating glaciers are important sites of heat transfer from the ocean to the ice through complex mechanisms shaped by the interaction between Arctic and Atlantic waters, local bathymetry, and atmospheric forcing. Over six years (2015–2021), NASA's Oceans Melting Greenland (OMG) mission studied ice-ocean interactions around the entirety of Greenland by measuring ocean temperature and salinity, bathymetry, and ice elevations along the continental shelf. While OMG obtained observations at an unprecedented spatial scale, they were largely restricted to summer months and therefore could not adequately capture seasonal variability.

OMG Narwhals, a project coupled with NASA's OMG mission and funded by the Office of Naval Research, deployed ocean moorings near three glacier fronts with known narwhal presence in Melville Bay, northwest Greenland spanning two years. The primary goal of OMG Narwhals is to understand the ecological importance of glacial habitats to narwhals. Greenland's coastal margins are rich ecosystems that host a variety of marine organisms from fish to marine mammals. Narwhals return to glacial outlets and fjords each summer with high site fidelity but what attracts them to specific glacier fronts remains unclear. Between 2018 and 2020, five bottom-mounted moorings with a suite of instrumentation were deployed year-round near three glacier fronts: Sverdrup Glacier, Kong Oscar Glacier, and Rink Glacier. The moorings carried equipment with two primary objectives: 1) identify Arctic toothed whale (beluga and narwhal) presence using passive acoustic recorders to record their sounds, and 2) describe year-round hydrographic variability using oceanographic instruments. Moored hydrographic measurements provide foundational knowledge about how Melville Bay marine ecosystems evolve throughout the year.

Examination of water properties at these sites demonstrate the presence and seasonality of warm, salty Atlantic Water intrusion into Melville Bay tidewater glaciers. These data will be used to investigate what physical properties of glacier front marine ecosystems attract narwhals. Results from this work increase our understanding of narwhal habitat-use and Greenland ice-ocean interactions and enable improvements in observation methods to better monitor Arctic whales and Greenland's surrounding oceans.

This Level 2 dataset contains hydrographic observations from five moorings deployed in Melville Bay that were instrumented with Conductivity Temperature Depth (CTD) sensors and temperature loggers. These datasets include observations from the CTD sensors.

Campaigns

The OMG Narwhals field effort spanned three years (2018–2020) where moorings were deployed and/or recovered in August each year. All mooring operations were conducted aboard the R/V *Sanna*.

Level 2 Product Generation

Data files produced by the instruments (*.hex) were converted to *.cnv format using Seabird's SBE Data Processing software. Conversion of L0 (*.cnv) to L2 data was done in Python. Measurements that occurred during the deployment and recovery of the mooring (i.e., when the instrument was on the deck) were removed. The workflow used to generate these datasets is available on GitHub: https://github.com/mjzahn/OMG_Narwhals_hydrography-manuscript/.

Data Fields

Oceanographic Measurements

Conductivity

The conductivity variable contains sea water electrical conductivity measurements (S/m).

Salinity

The salinity variable contains sea water practical salinity (psu).

Temperature

The temperature variable contains sea water temperature measurements in °C.

Potential Temperature

The potential temperature variable contains sea water potential temperature measurements in °C.

Pressure

The pressure variable contains sea water pressure measurements in decibars.

Depth

The depth variable contains depth measurements in meters derived from pressure (positive=down).

Density

The density variable contains sea water density measurements in kg m^{-3}.

Coordinate Fields

Station

Station is a dimensional coordinate (length=1) that indicates which of the three ocean mooring sites in Melville Bay (Rink/Fisher, Kong Oscar, or Sverdrup) the data were collected from.

Time

Time is a dimensional coordinate that defines the UTC time at which each measurement was taken.

Latitude

The latitude of the mooring and station location.

Longitude

The longitude of the mooring and station location.

Additional Fields

Flag_depth

The flag_depth variable is a quality flag for depth measurements. The variable provides an index for outliers in depth observations (i.e., extreme values or spikes) where the mooring was likely depressed by moving icebergs (see example in Figure 1). Values of 0 correspond to valid observations and values of 1 indicate times when the instrument was substantially moved in the water column. Users of this dataset should consider masking variable data for flag_depth values equal to 1 for a more consistent timeseries of CTD observations.

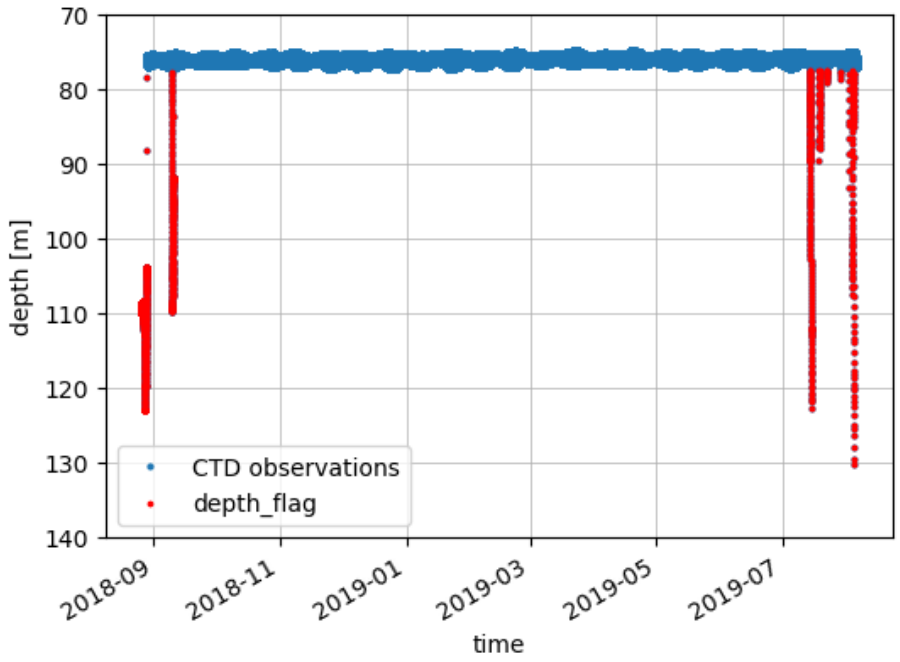

Figure 1. Example dataset showing depth measurements from the Rink Glacier mooring where flagged observations are shown in red, indicating occasions when the mooring (and instruments) was depressed in the water column.

NetCDF File Format

The file names for this dataset are of the form:

"OMG_Narwhals_Mooring_CTD_L2_<serial_number>_<time_coverage_start>.nc"

where <serial_number> is the serial number of the sensor, and <time_coverage_start> is formatted as "YYYYMMDD". The data files are in NetCDF format and are compliant with the Climate and Forecast (CF) Metadata Conventions.

Each data file contains the following **data variables** and **metadata**:

Note: variables and metadata denoted with an 'X' represent values that differ depending on the mooring and instrument.

Dimensions and data variables:

dimensions:
station = 1;
time = XXXXXX;

variables:
string **station**(station) ;
station:long_name = "station" ;

station:standard_name = "station" ;
station:coverage_content_type = "coordinate" ;
station:comments = "One of three ocean mooring sites in Melville Bay: Rink/Fisher, Kong Oscar, and Sverdrup." ;

double **latitude**(station);
latitude:_FillValue = 9.96920996838687e+36;
latitude:long_name = "station latitude";
latitude:standard_name = "latitude";
latitude:units = "degrees_north";
latitude:coverage_content_type = "coordinate";
latitude:comments = "Latitude of mooring location.";

double **longitude**(station);
longitude:_FillValue = 9.96920996838687e+36;
longitude:long_name = "station longitude";
longitude:standard_name = "longitude";
longitude:units = "degrees_east";
longitude:coverage_content_type = "coordinate";
longitude:comments = "Longitude of mooring location.";

int **time**(time);
time:long_name = "time";
time:standard_name = "time";
time:coverage_content_type = "coordinate";
time:axis = "T";
time:units = "minutes since XXXX-XX-XX XX:XX:XX";
time:calendar = "proleptic_gregorian";

double **conductivity**(station, time);
conductivity:_FillValue = 9.96920996838687e+36;
conductivity:long_name = "sea water electrical conductivity";
conductivity:standard_name = "sea_water_electrical_conductivity";
conductivity:units = "S/m";
conductivity:coverage_content_type = "physicalMeasurement";
conductivity:seabird_var_name = "cond0S/m";
conductivity:valid_min = 0.;
conductivity:valid_max = 6.;

double **density**(station, time);
density:_FillValue = 9.96920996838687e+36;
density:long_name = "sea water density";
density:standard_name = "sea_water_density";
density:units = "kg m-3";
density:coverage_content_type = "physicalMeasurement";
density:seabird_var_name = "density00";
density:valid_min = 999.;
density:valid_max = 1045.;

double **depth**(station, time);
depth:_FillValue = 9.96920996838687e+36;
depth:long_name = "depth";
depth:standard_name = "depth";
depth:units = "meters";
depth:positive = "down";
depth:axis = "Z";
depth:coverage_content_type = "coordinate";
depth:seabird_var_name = "depSM";
depth:valid_min = 0.;
depth:valid_max = 1000.;

double **potential_temperature**(station, time);
potential_temperature:_FillValue = 9.96920996838687e+36;
potential_temperature:long_name = "sea water potential temperature";
potential_temperature:standard_name = "sea_water_potential_temperature";
potential_temperature:units = "degrees_C";
potential_temperature:coverage_content_type = "physicalMeasurement";
potential_temperature:seabird_var_name = "potemp090C";
potential_temperature:comments = "ITS-90";
potential_temperature:valid_min = -2.2;
potential_temperature:valid_max = 35.;

double **pressure**(station, time);
pressure:_FillValue = 9.96920996838687e+36;
pressure:long_name = "sea water pressure";
pressure:standard_name = "sea_water_pressure";
pressure:units = "dBar";
pressure:coverage_content_type = "physicalMeasurement";
pressure:seabird_var_name = "prdM";
pressure:valid_min = 0.;
pressure:valid_max = 1000.;
pressure:comments = "strain gauge";

double **salinity**(station, time);
salinity:_FillValue = 9.96920996838687e+36;
salinity:long_name = "sea water practical salinity";
salinity:standard_name = "sea_water_practical_salinity";
salinity:units = "1";
salinity:coverage_content_type = "physicalMeasurement";
salinity:seabird_var_name = "sal00";
salinity:valid_min = 0.;
salinity:valid_max = 45.;

double **temperature**(station, time);
temperature:_FillValue = 9.96920996838687e+36;
temperature:long_name = "sea water temperature";

temperature:standard_name = "sea_water_temperature";
temperature:units = "degrees_C";
temperature:coverage_content_type = "physicalMeasurement";
temperature:seabird_var_name = "tv290C";
temperature:comments = "ITS-90";
temperature:valid_min = -2.2;
temperature:valid_max = 35.;

double **flag_depth**(station, time);
flag_depth:_FillValue = 9.96920996838687e+36;
flag_depth:long_name = "quality flag for depth measurements";
flag_depth:standard_name = "quality_flag";
flag_depth:units = "1";
flag_depth:flag_values = 0., 1.;
flag_depth:flag_meanings = "depth_consistent depth_spike";
flag_depth:coverage_content_type = "qualityInformation";
flag_depth:comments = "Recommended to use flag_depth=0 for consistent results.
flag_depth=1 marks any spikes in depth observations when
mooring instruments were pushed down (e.g., from icebergs).";

Metadata:

Global attributes:

:**title** = "OMG Narwhals Moored CTD Level 2 Data";

:**summary** = "This dataset contains conductivity, temperature, and pressure measurements from a CTD instrument attached to an ocean mooring. It also contains derived variables: depth, salinity, density, and potential temperature. This dataset was collected by the Oceans Melting Greenland (OMG) Narwhals program that provides two years of oceanographic measurements from Melville Bay, northwest Greenland. Between August 2018 to August 2020, three bottom-mounted moorings with a suite of instrumentation were deployed in front of three glaciers: Sverdrup Glacier, Kong Oscar Glacier, and Rink Glacier.";

:**keywords** = "Conductivity, Salinity, Water Depth, Water Temperature";

:**keywords_vocabulary** = "NASA Global Change Master Directory (GCMD) Science Keywords";

:**Conventions** = "CF-1.8, ACDD-1.3";

:**standard_name_vocabulary** = "NetCDF Climate and Forecast (CF) Metadata Convention";

:**id** = "OMG_Narwhals_Mooring_CTD_L2";

:**uuid** = "XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX";

:**featureType** = "timeSeries";

:**cdm_data_type** = "Station";

:**platform** = "mooring";

:**region** = "Melville Bay, northwest Greenland";

:**glacier_front** = "XXXX glacier";

:**bottom_depth** = "XXX meters";

:**filename** = "OMG_Narwhals_Mooring_CTD_L2_XXXXXXXX_XXXXXXXX.nc";

:**serial_number** = "XXXXXXXX";

:**instrument** = "SBE37SM-RS232";

:**target_sensor_depth** = "XXX meters";

:**actual_sensor_depth** = "XXX meters";

:**history** = "CTD dataset was created from processed *.cnv files that were converted from the instrument\'s output *.hex file.";

:**source** = "Temperature and salinity data were collected using Conductivity Temperature Depth (CTD) instruments purchased from Sea-Bird Electronics, Inc. that were attached to moorings.";

:**processing_level** = "L2";

:**acknowledgement** = "This research was carried out by the University of Washington's Applied Physics Laboratory and School of Aquatic and Fishery Sciences, the Greenland Climate Research Centre/Greenland Institute of Natural Resources, and the Jet Propulsion Laboratory, managed by the California Institute of Technology under a contract with the National Aeronautics and Space Administration. This research was funded by the US Office of Naval Research (award no. N00014-17-1-2774) and the NASA Oceans Melting Greenland EVS-2 mission.";

:**license** = "Public Domain";

:**product_version** = "1.0";

:**creator_name** = "Marie J. Zahn";

:**creator_email** = "mzahn@uw.edu";

:**creator_type** = "person";

:**creator_institution** = "University of Washington";

:**institution** = "University of Washington";

:**project** = "Oceans Melting Greenland (OMG) Narwhals";

:**contributor_name** = "Marie J. Zahn, Kristin L. Laidre, Malene J. Simon, Ian Fenty";

:**contributor_role** = "author, principal investigator, co-investigator, co-investigator";

:**contributor_email** = "mzahn@uw.edu; klaidre@uw.edu; masi@natur.gl; ian.fenty@jpl.nasa.gov";

:**naming_authority** = "gov.nasa.jpl";

:**program** = "NASA Earth Venture Suborbital-2 (EVS-2) and Office of Naval Research (ONR) Marine Mammals and Biology Program";

:**publisher_name** = "Physical Oceanography Distributed Active Archive Center (PO.DAAC)";

:**publisher_institution** = "NASA Jet Propulsion Laboratory (JPL)";

:**publisher_email** = "podaac@podaac.jpl.nasa.gov";

:**publisher_url** = "https://podaac.jpl.nasa.gov/";

:**publisher_type** = "group";

:**geospatial_lat_min** = XX.XXXXXX;

:**geospatial_lat_max** = XX.XXXXXX;

:**geospatial_lat_units** = "degrees_north";

:**geospatial_lon_min** = -XX.XXXXXX;

:**geospatial_lon_max** = -XX.XXXXXX;

:**geospatial_lon_units** = "degrees_east";

:**geospatial_vertical_min** = XXX.XXX;

:**geospatial_vertical_max** = XXX.XXX;

:**geospatial_vertical_units** = "meters";

:**geospatial_vertical_positive** = "down";

:**time_coverage_resolution** = "P180S";

:**time_coverage_start** = "XXXX-XX-XXTXX:XX:XX";

:**time_coverage_end** = "XXXX-XX-XXTXX:XX:XX";

:**time_coverage_duration** = "PXXXDTXXHXXMXS";

:**date_created** = "2023-XX-XXTXX:XX:XX";