Oceans Melting Greenland
Teledyne APEX Ocean Water Properties Data
User's Guide

Data Set
OMG Ocean APEX Level 1 Data

Author
Joshua K. Willis, Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA, USA.

Introduction
Global sea level rise will be one of the major environmental challenges of the 21st Century. Oceans Melting Greenland (OMG) will pave the way for improved estimates of sea level rise by addressing the question: To what extent are the oceans melting Greenland's ice from below? Over a six-year mission, OMG observed changing water temperatures on the continental shelf surrounding Greenland, and how marine glaciers reacted to the presence of warm, salty Atlantic Water. The complicated geometry of the sea floor steers currents on the shelf and often determines whether Atlantic Water can reach into the long narrow fjords and interact with the coastal glaciers. Because knowledge of these pathways is a critical component of modeling the interaction between the oceans and ice sheet, OMG also collected measurements of the shape and depth of the sea floor in key regions.

Beyond completing its baseline science mission of conducting yearly surveys of temperature and salinity with expendable profiles, OMG tested and deployed several autonomous, profiling floats. These floats change their buoyancy by inflating an external bladder with oil, allowing them to dive and surface regularly. Conductivity, Temperature and Depth sensors (CTDs) allow them to collect vertical profiles of temperature and salinity.

These floats also employ algorithms to avoid attempting to surface when sea ice is present. This has allowed several floats to survive through the winter sea ice cover and continue to profile. The winter data is stored and transmitted after the sea ice melts and the floats have access to the surface. This means, however, that the status of such floats will remain unknown until the sea ice retreats.

Several of the floats deployed during the OMG mission remained active beyond the mission's end. For the OMG mission, data from all floats through 31 Oct 2021 has been archived here.

Data beyond the 31 Oct 2021 end date will be added to the archive on a best effort basis.

These data are sent back using an Iridium Modem through Short Data Burst (SBD) messages. Data returned include GPS positions before and after a dive, temperature, salinity and pressure measurements collected during the float's ascent to the surface—which comprise the vertical profiles and primary science data return. They also return temperature, salinity and pressure measurements collected during the period where the float was parked at a pre-determined depth, typically on the sea floor of the continental shelf for OMG, as well as various engineering data about the float. These Iridium email messages contain binary attachments, which are the SBD messages. They also contain a message body with information about the message number, and an approximate position for the float when it transmitted the message. The SBD message attachment files and email message body files comprise the Level 0 data and are available from the archive upon request.

The decoded messages comprise the Level 1 data, which is described below.

Floats

This data set consists of data from multiple APEX floats deployed along Greenland's coastline. A brief description of each float is provided below, including its deployment information, its Iridium modem number (IMEI number), the serial number for its CTD instrument, and details of its launch.

F9184

This float was deployed in Disko Bay in West Greenland in September 2020 during the annual OMG ocean survey. It did not report back after melting of the following winter sea ice and is now inactive.

APEX F9184, IMEI 300534060836190
Sensor: RBR L3 - SN 203421
Launch Notes: 1000 ft. 110 kts, DC-3 KBA C-FBKB side door
Time: 2020/09/11 17:17:52
Latitude: 69.00195
Longitude: -53.11300

F9185

This float was deployed in Melville Bay in West Greenland in September 2020 during the annual OMG ocean survey. This float stayed in the bay through the following winter and remains active at mission end.

APEX F9185, IMEI 300534060832230
Sensor: RBR L3 - SN 203422
Launch Notes: 1000 ft. 110 kts, DC-3 KBA C-FBKB side door
Time: 2020/09/11 13:29:42

Latitude: 75.39575
Longitude: -61.5429

F9186

This float was deployed in the wide trough offshore of Upernavik in West Greenland in September of 2020 during the annual OMG ocean survey. This float stayed in the trough through the following winter and remains active at mission end.

APEX F9186, IMEI 300534060836350
Sensor: RBR L3 - SN 203598
Launch notes: 1000 ft. 110 kts, DC-3 KBA C-FBKB side door
Time: 2020/09/11 14:57:08
Latitude: 73.257333
Longitude: -57.89070

F9443

This float was deployed in the bay offshore of Ummunnaq in West Greenland in September 2021 during the annual OMG ocean survey. This float remains active at mission end.

APEX APEX F9443, IMEI 300534060831190
Sensor: RBR L3 - SN 205381
Launch Notes: 1000 ft. 110 kts, DC-3 KBA C-FBKB side door
Time: 2021/09/09 16:24:39 UTC
Latitude: 70.9140
Longitude: -53.42178

F9444

This float was deployed in Melville Bay in West Greenland in September 2021 during the annual OMG ocean survey. This float remains active at mission end.

APEX F9444, IMEI 300534061140530
Sensor: RBR L3 - SN 205380
Launch Notes: 1000 ft. 110 kts, DC-3 KBA C-FBKB side door
Time: 2021/09/02 13:45:00 UTC
Latitude: 73.3952
Longitude: -61.5348

Files

The processed data in this data set consists of the following types of files:

Float Info Files: These files contain information about float launch, sensor type and calibration and sometimes information about float ballasting, as well the launch information provided in this document as noted above.

Processed Data Files: These files contain the decoded data reported by the float during each of its dives. Science dives begin with Dive 1 and are number sequentially. An initial diagnostic dive, called Dive 0, is carried out before science data acquisition begins. Dive 0 data is archived and available upon request. For each science dive there are three file types as follows:

- Vitals Log – This is a comma separated value file containing engineering information about the health of the float and its instruments.
- System Log – This is a text file containing information about the configuration and software state of the float for each dive.
- Science Log – This is a comma separated value file containing the science data for each dive, including the temperature, salinity and pressure profiles, the data collected during park and descent, and GPS locations.

The above files have the following naming convention:

OMG_APEX_F<NNNN>_Dive_<DDD>.<YYYYMMDD>T<HHMMSS>.<TYPE>_log.csv

- NNNN – is the float number
- DDD – is the dive number
- YYYYMMDD – is the date represented as year-month-day
- HHMMSS – is the time represented as hours-minutes-seconds
- TYPE – is the type of the file. Valid values include “vitals”, “system” and “science”

Format

Format information for the Vitals & System Log files can be found in the Teledyne documentation titled “APEX Profiling Float User Manual Rev 11.pdf”, included in the documentation folder. The Science Log is also described there in greater detail. Below is a short description of the “*.science_log.csv” files reprinted from the manual by permission from Teledyne. This should allow most users to retrieve profile and location information from the Level 1 data provided here.

Science Log Files

An example printout of a Science log file with CTD data is shown in the Table below. In this example, only several rows of data are shown to illustrate the structure of the log file. Typically, there would be many rows of data.

The columns for the Message rows are from left to right:

- Time stamp in UTC (YYYYMMDDTHHMMSS)
- Firmware version or float id

Message	20161121T223335	Firmware: 07/18/16 20:08:07 DEEP_APEX-v2.3.18			
Message	20161121T223335	FloatId/Username: f0001			
GPS	20161121T223335	-58.6827	-56.0524	5	

CTD_P	20161121T223357	-0.29			
Message	20161121T223357	Park Descent Phase*********			
CTD_P	20161121T223412	-0.3			
CTD_P	20161121T223416	-0.4			
CTD_P	20161121T223515	-0.38			
		• • •			
CTD_P	20161122T135830	1484.48			
Message	20161122T135835	Park Phase******************			
CTD_P	20161122T140340	1483.73			
Message	20161122T140340	Deep Descent Phase***************			
CTD_P	20161122T140447	1483.62			
Message	20161122T140452	Profiling Phase************			
CTD_P	20161122T140455	1483.72			
Message	20161122T140502	Continuous Profile Started**********			
CTD_PTS	20161122T140526	1483.47	1.3397	34.707	
CTD_PTS	20161122T140741	1476.69	1.3475	34.7078	
CTD_PTS	20161122T141248	1448.63	1.3648	34.708	
		• • •			
CTD_PTS	20161122T174039	1.94	0.2297	33.6195	
Message	20161122T174047	Surface Phase**************			
CTD_bins	20161122T174441	12917	743	1483.59	
CTD_CP	20161122T174832	2.27	0.2294	33.6214	11
CTD_CP	20161122T174832	3.98	0.2295	33.6217	15
CTD_CP	20161122T174832	6	0.2377	33.6214	15
		• • •			
CTD_CP	20161122T174911	1483.36	1.3385	34.7081	41
CTD_P	20161122T180349	0.04			
GPS	20150214T033525	-58.7147	-55.9328	9	

The columns for the GPS rows are from left to right:

- Time stamp in UTC (YYYYMMDDTHHMMSS)
- Latitude in decimal degrees (±DD.DDDDD) of the surface position.

- Longitude in decimal degrees (±DDD.DDDDD) of the surface position
- Number of GPS satellites used

The columns for the CTD_P rows under Park Descent Phase, Deep Descent Phase, Profiling Phase, and Surface Phase contain CTD pressure data that were recorded when interval sampling and are from left to right:

- Time stamp in UTC (YYYYMMDDTHHMMSS)
- Pressure in decibars

The columns for the CTD_PTS rows under Profiling Phase contain sensor data that were recorded when interval sampling and are from left to right:

- Time stamp in UTC (YYYYMMDDTHHMMSS)
- Pressure in decibars
- Temperature in degrees Celsius
- Salinity in PSU

Although not shown in the example printout, columns under Profiling Phase that contain *only* pressure and temperature data that were recorded when interval sampling would be associated with CTD_PT rows and would be from left to right:

- Time stamp in UTC (YYYYMMDDTHHMMSS)
- Pressure in decibars
- Temperature in degrees Celsius

The columns for the CTD_bins row under Profiling Phase contain bin averaging statistics which apply *only* to a float with a pumped type CTD and are from left to right:

- Time stamp in UTC (YYYYMMDDTHHMMSS)
- Number of samples recorded during the mission
- Number of bins recorded during the mission
- Highest pressure in decibars recorded during the mission

The columns for the CTD_CP rows under Profiling Phase contain sensor data for a float with a pumped type CTD and were recorded when continuous profiling. Similarly, for a float with a non-pumped type CTD, the columns are associated instead with CTD_CP+ rows under Profiling Phase. For this float there is one additional data column which contains conductivity data.

For a float with a non-pumped type CTD, the columns are from left to right:

- Time stamp in UTC (YYYYMMDDTHHMMSS)
- Bin averaged pressure in decibars
- Bin averaged temperature in degrees Celsius
- Bin averaged salinity in PSU
- Conductivity in mS/cm
- Number of samples averaged per bin

Citation

This research was carried out by the Jet Propulsion Laboratory, managed by the California Institute of Technology under a contract with the National Aeronautics and Space Administration. Use of this data should be cited as follows:

> OMG Mission. 2021. Temperature and Depth data from APEX ocean floats. Ver. 1. PO.DAAC, CA, USA. Dataset accessed [YYYY-MM-DD] at https://dx.doi.org/10.5067/OMGEV-XXXXX.

Contact

For questions, please email podaac@podaac.jpl.nasa.gov or visit the PO.DAAC forum.