Oceans Melting Greenland MRV Alamo Ocean Water Properties Data User's Guide

Data Set

OMG Ocean Alamo Level 1 Data

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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 For the OMG mission, data from all floats through 31 Oct 2021 has been archived here.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 Alamo 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.

F9145

This float was deployed in a trough offshore of Ummunnaq in West Greenland in September 2017 during the annual OMG ocean survey. It did not report back after melting of the following winter sea ice and is now inactive.

Alamo F9145, IMEI 300234063555580, CTD S/N 40526
Launch Notes: Ship launched offshore, cardboard removed
Time: 02 Sep 2017, ~08:00 UTC
Latitude: 70.84
Lon: -55.888

F9146

This float was deployed near the offshore end of the Upernavik fjord in West Greenland in August 2017 during the annual OMG ocean survey. It did not report back after melting of the following winter sea ice and is now inactive.

Alamo F9146, IMEI 300234063554640, CTD S/N 40527
Launch Notes: Ship launched in narrow fjord, cardboard not removed
Time: 25 Aug 2017, ~01:00 UTC
Latitude: 73.00
Lon: -56.22

F9147

This float was deployed in Melville Bay in West Greenland in October 2017 during the annual OMG ocean survey. It did not report back after melting of the following winter sea ice and is now inactive.

Alamo F9147, IMEI 300234063559700, CTD S/N 40557
Launch Notes: air launched - C130 - through short launch tube
Time: 19 Oct 2017, 15:26 UTC
Latitude: 74.60078
Lon: -60.03438

F9202

This float was deployed in the trough offshore of Upernavik in West Greenland in August 2019 during the annual OMG ocean survey. It was swept offshore into Baffin Bay during the fall/winter of 2019. It has survived two winters in Baffin Bay but is no longer on the shelf and is not parking on the sea floor. This float remains active at mission end.

Alamo F9202, IMEI 300234065790990, CT S/N 40733
Launch Notes: Ship launched from M/V Sanna
Time: 07 Aug 2019, 12:25:00 UTC
Latitude: 73.288
Longitude: -57.887

F9250

This float was deployed in Disko Bay in West Greenland in April 2020 during field work by E. Rignot at University of California, Irvine. This float remains active at mission end.

Alamo F9250, IMEI 300234067435020, CTD S/N 200162
Launch Notes: Ship launch - E. Rignot, UCI field campaign
Time: 22 Apr 2021, 18:15:00 UTC
Latitude: 69.07
Longitude: -51.60

F9275

This float was deployed near Sermilik Fjord in East Greenland in August 2021 during the annual OMG ocean survey. This float remains active at mission end.

Alamo F9275, IMEI 300534061706900, CTD S/N 204792
Launch Notes: boat launch with all cardboard and chute removed
Time: 22 Aug 2021 18:44 UTC
Latitude: 65.5574
Longitude: -37.3636

F9312

This float was deployed in an offshore trough just north of Bernstorff Glacier in East Greenland in August 2021 during the annual OMG ocean survey. However, before activation and surfacing the float drifted far south along the shelf to the southern tip of Greenland. A few profiles were collected as it was traveling south, but before the float surfaced. The locations of these profiles are unknown. After surfacing, the float began a regular dive program but continued to drift south and rounded Cape Farewell along the shelf break before mission end. This float remains active at mission end.

Alamo F9312, IMEI 300534061883890, CTD S/N 206546
Launch Notes: air launched - 2000ft, speed 110 kts, DC-3 C-FBKB, Side Door launch - chute visible after launch.
Time: 18 Aug 2021 13:51:00 UTC
Latitude: 64.0000
Longitude: -40.2542

F9315

This float was deployed in a trough offshore of Zacharie glacier in East Greenland in August 2021 during the annual OMG ocean survey. This float encountered sea ice in late September before mission end, and it is unknown whether it remains active at mission end as ice avoidance should prevent it from attempting to surface in the presence of sea ice until summer.

Alamo F9315, IMEI 300534061883930, CTD S/N 206545
Launch Notes: air launched - 2000ft, 120 kts - Side door DC-3, C-FBKB
Time: 27 Aug 2021 12:19:03 UTC
Latitude: 78.23815
Longitude: -16.8807

F9316

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.

Alamo F9316, IMEI 300534061889900, CTD S/N 206544
Launch Notes: air launched - 1000 ft. 100 kts, KBA C-FBKB side door
Time: 09 Sep 2021 16:24:39 UTC
Latitude: 70.9140
Longitude: -53.42178

Files

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

<u>Float Info Files</u>: 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.

<u>Processed Data Files</u>: These files contain the decoded data reported by the float during each of its dives. Science dives begin with Dive 1 and are numbered sequentially. An initial diagnostic dive, called Dive 0, is carried out before science data acquisition begins. Although usually shallow, dive 0 data does include a small profile and so its data is included in this distribution. For each science dive there are two file types, both of which contain identical information. The first type is a human-readable text format and the second type is a machine-readable JavaScript Object Notation (JSON) format.

Both file types contain temperature and salinity profile data, temperature and salinity data collected during park, GPS positions, engineering information for the float, mission configuration and software state. These files have the following naming convention:

OMG_Alamo_F<NNNN>_Dive_<DDD>.<YYYYMMDD>T<HHMMSS>.<EXT>
- 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
- EXT – is the extension of the file where "txt" is for the text file type and "json" is for the JSON file type

Format

A brief description of the file formats is provided here. For more information on the meaning of acronyms used for float configuration and the meaning of the various engineering states reported in the data, users are referred to the *ALAMO_ALTO_Deployment_and_Piloting_Guide_v1.0.pdf* document provided by MRV and included in the documentation folder. The file format description below focuses primarily on the science data contained in the files.

Both the Text and JSON files have the same basic structure, which is outlined below. In the JSON file, the structure is illustrated in the tree shown in Figure 1 below. For the Text file, the sections are organized by text blocks, as illustrated in Figure 2.

Basic format structure:
- Header
  - Float Serial Number
  - Float type
  - Dive Number
  - Firmware version
- Trajectory
  - GPS – contains GPS fix data at beginning and end of dive

- o Fallrise – contains a time series of pressure and program code for the float, eg. "descent start", "descent", "ascent", etc.
- Science
  - o Descending
    - ▪ Binned – for floats that collect profile data while descending (not present on OMG floats)
    - ▪ Unbinned: - for floats that report all profile data with no bin-averaging (not present on OMG floats)
    - ▪ Discrete: - Empty for OMG floats
  - o Park/drift:
    - ▪ Discrete: time series of pressure, temperature and salinity measurements during the park phase. Separated in time by the "Park Sampling Interval, PSI", expressed in milliseconds
  - o Ascending:
    - ▪ Binned – Profile data expressed as rows of pressure, temperature, salinity and for some floats, Tcond, the temperature at the conductivity sensor
    - ▪ Unbinned: - for floats that report all profile data with no bin-averaging (not present on OMG floats)
    - ▪ Discrete: - Empty for OMG floats
  - o Surface:
    - ▪ Continuous – empty for OMG floats
    - ▪ Discrete – Pressure, temperature and salinity measurements at the surface, at a time interval specified by the "Surface Sampling Interval, SSI" in milliseconds.
- Status
  - o Mission parameters – User controllable mission parameters for the float, see user guide for additional information
  - o Argo – Engineering information
  - o Engineering – additional engineering information

Figure 1 – Example of file structure for the JSON format files.
Note that the profiles can be found under
array->0->dives->0->science->ascending->binned
and GPS locations can be found under:
array->0->dives->0->trajectory->gps

```
▼ array [1]
  ▼ 0  {3}
       sn    : 9250
       model : Alamo/Alto
     ▼ dives [1]
       ▼ 0  {5}
            dn   : 42
            sw_version : 8.0.5
          ▼ trajectory {2}
            ▼ gps  [2]
              ▼ 0  {10}
                   kind : DiveStart
                   datetime : 2021-08-12T01:46:00Z
                   lat  : 69.0515561
                   lon  : -51.9767242
                   ttf  : 0
                   nsat : 7
                   hdop : 1.6
                   snr_min : 27
                   snr_mean : 38
                   snr_max : 47
              ▼ 1  {10}
                   kind : DiveEnd
                   datetime : 2021-08-17T01:38:00Z
                   lat  : 69.05676
                   lon  : -51.9643922
                   ttf  : 100
                   nsat : 5
                   hdop : 2.2
                   snr_min : 33
                   snr_mean : 38
                   snr_max : 46
            ▶ fallrise {3}
          ▼ science {4}
            ▶ units {17}
            ▼ ascending {1}
              ▼ binned {4}
                ▶ pressure [360]
                ▶ temperature [360]
                ▶ salinity [360]
                ▶ tcond [360]
            ▶ park {1}
            ▶ surface {1}
          ▶ status {3}

        -
```

Figure 2 – Example of file structure for the Text format files.

```
==============
Float 9250 (Alamo/Alto)
-------------
Float 9250, Dive 42
Product ID STANDARD
Software Version 8.0.5
Trajectory
GPS fixes:
fix kind:  DiveStart
fix time:  2021-08-12 01:46:00 UTC
latitude:  69.0515561
longitude: -51.9767242
ttf:       0
nsat:      7
min snr:   27
mean snr:  38
max snr:   47
hdop:      1.6

fix kind:  DiveEnd
fix time:  2021-08-17 01:38:00 UTC
latitude:  69.05676
longitude: -51.9643922
ttf:       100
nsat:      5
min snr:   33
mean snr:  38
max snr:   46
hdop:      2.2

Fall/Rise series:
```

time	pressure (dBar)	code
1628732809	0.1200	descent start
1628733063	10.1200	descent
1628733156	20.1200	descent
1628733245	30.1600	descent
• • •		
1629164075	30.8400	ascent
1629164120	20.8800	ascent
1629164162	10.8800	ascent
1629164202	1.7200	ascent end

```
Science
science data
descending: binned:
<empty>

unbinned:
<empty>

discrete:
<empty>

park/drift: discrete
```

pressure (dBar)	temperature (degC)	salinity (psu)	time (seconds)
429.7200	2.6620	34.2080	1200
429.6800	2.6510	34.2100	3000
429.4400	2.6460	34.2070	4800
• • •			

Figure 2 (continued) – Example of file structure for the .txt format files.

● ● ●

430.0400	2.6150	34.1940	415200
430.2000	2.6250	34.1940	417000
430.2000	2.6220	34.1990	418800

ascending: binned:

pressure (dBar)	temperature (degC)	salinity (psu)	tcond (degC)
430.4800	2.6290	34.1970	2.6020
429.0400	2.6290	34.2000	2.6200
427.0000	2.6110	34.1950	2.6320
● ● ●			
3.4000	7.2990	32.3360	3.9580
2.4000	7.2850	32.2630	4.2460
1.5600	7.1810	32.1860	4.2240

unbinned:
<empty>

discrete:
<empty>

surface: continuous:
<empty>

discrete:

pressure (dBar)	temperature (degC)	salinity (psu)	time (seconds)
0.2000	7.0020	32.1940	1629164228
0.1200	7.0010	17.2550	1629164288

```
Status
Mission Parameters
sensor: 0          0 = RBR, 1 = SBE
MSN   : 42         dive cycle number
MPS   : 0          mission phase (0-2)
●     ●     ●
SAO   : 1080       surface air assist min duration (sec)
SPT   : 120        surface CTD data storage timeout (sec)
SSP   : 20         surface oil pump duration (sec)

Argo
0xF0 - Engineering: Argo
target profile pressure   : 800.0000 dBar
target parking pressure   : 500.0000 dBar
max ascend duration       : 40.0000 minutes

●     ●     ●
```

Figure 2 (continued) – Example of file structure for the .txt format files.

• • •

```
surface salinity gain       : 1000.0000
surface salinity offset     : 1.0000 psu
mission phase number        : 0

Engineering
pump:
```

state	pressure (dBar)	duration (seconds)	voltage (V)	current (A)	case_pressure (inHg)
descent pump	50.5200	40.0000	14.5600	0.2440	5.9800
ascent start	430.5600	90.0000	14.5400	0.4070	6.0200
ascent	401.0000	30.0000	14.5300	0.4040	6.0800
ascent	366.2400	30.0000	14.5200	0.3810	6.1300
ascent	325.7600	31.0000	14.5400	0.3760	6.1900
ascent	280.1600	30.0000	14.5300	0.3520	6.2500
ascent	231.0400	30.0000	14.5500	0.3180	6.3100
ascent	170.4400	30.0000	14.5300	0.2900	6.3800
ascent	30.1600	30.0000	14.5700	0.2550	6.3500
surface	0.0000	21.0000	14.5400	0.2370	6.6000

```
valve:
```

state	pressure (dBar)	duration (seconds)	case_vac (inHg)
descent start	0.1200	616.0000	5.9200

```
other:
0xE7 - Engineering: Descend
start time              : 2021-08-12 01:46:48 UTC
case vac start          : 7.5800 inHg
case vac end            : 5.9000 inHg
```
• • •
```
air valve surface middle pos: 0.7420 V
seek attempts           : 1
seek pump time adjust   : -3.0000 seconds

0xE8 - Engineering: Park
start time          : 2021-08-12 03:58:21 UTC
case vac start      : 5.9000 inHg
case vac end        : 5.9000 inHg
average pressure    : 429.6000 dBar
average temperature : 2.6170 degC
average salinity    : 34.1890 psu
seek attempts       : 0.0000
seek time adjust    : 0.0000 seconds

0xE9 - Engineering: Ascend
start time          : 2021-08-17 00:58:28 UTC
case vac start      : 5.9000 inHg
case vac end        : 6.2500 inHg
fall start time     : 2000-01-01 00:00:00 UTC
fall start pressure : 0.0000 dBar

0xEA - Engineering: Surface
start time                  : 2021-08-17 01:36:43 UTC
start packetize time        : 2021-08-17 01:36:44 UTC
end packetize time          : 2021-08-17 01:39:06 UTC
num packets                 : 12
previous transmission attempts: 13
```
• • •

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 Alamo 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.