Marginal Ice Zone DRI – Seaglider Data Deployment Narrative

This summary was provided to NSIDC (Florence Fetterer) in April, 2022. It documents the Seaglider instrument data that are part of data set G10031.

Craig M. Lee and Luc Rainville
Applied Physics Laboratory, University of Washington
craiglee@uw.edu, lucrain@uw.edu

The Office of Naval Research Emerging Dynamics of the Marginal Ice Zone Departmental Research Initiative (MIZ-DRI; Lee et al., 2012; Lee et al., 2017) focused on understanding the processes that govern Beaufort Sea MIZ evolution from initial breakup though the course of the summertime sea ice retreat. A broad range of autonomous instruments were deployed on and under the ice prior to initial formation of the MIZ along the Alaska coast, sampling though the melt season as they drifted westward and the ice retreated northward.

The data assembled here were collected by long-endurance Seagliders - small, reusable, long-range autonomous underwater vehicles designed to glide from the ocean surface to as deep as 1000 m and back while collecting profiles of temperature, salinity, and other oceanic variables. Gliders steer through the water by controlling attitude (pitch and roll) and can thus navigate between waypoints to execute survey patterns. Typical horizontal speed is about 20 km per day. In ice-free conditions, Seagliders communicate using Iridium satellite telemetry and geolocate using GPS. When operating under ice, Seagliders estimate their positions by multilateration from an array of drifting broadband 900 Hz acoustic navigation sources. Position estimates were further refined in post-processing. MIZ-DRI sampling strategy employed Seagliders to repeatedly occupy sections that extended from open water, across the MIZ and deep into the pack ice, serving to bridge measurements collected by ice-based and drifting instruments. Four Seagliders (SG197, SG197, SG198 and SG199) were deployed at the shelf break near 72° 54’ N, offshore of Prudhoe Bay, Alaska, on 28 July 2014. Gliders transited north, collecting multiple sections into the pack ice along two roughly parallel meridional lines. Sampling extended to 75° 20’ N, with gliders working under the ice through most of September before retreating south for recovery on 2 October, 2014. In total the Seagliders completed 1726 dives (3452 profiles, as they sample both during the dive and the climb), including 259 completely under the ice (15% of the dives). Gliders sampled temperature, conductivity, dissolved oxygen, chlorophyll fluorescence, optical backscatter, spectral downwelling irradiance and temperature microstructure. Microstructure probes failed early in the deployment, likely due to interactions with small bits of floating ice.

A hydrodynamical flight model (Bennett et al., 2019) uses data from the glider’s attitude sensors and from the environment to estimate glider speed through the water, and thus location during the dive. The hydrodynamical model provides an estimate of the horizontal distance travelled through water in an ocean at rest, which, when compared to the actual positions at the beginning and end of the dive, provides a good estimate of the depth-averaged current (or, more accurately, ocean current averaged along the underwater trajectory of the

glider). Repeated GPS fixes obtained during the surface drift, before and after every call to the base station, provide an estimate of ocean surface velocity.

Data samples are gridded by profile and on regular depth bins (1-m) from 0 to 1000 m. The time and spatial intervals between two successive profiles are approximately 1.5 hours and 1.4 km, respectively. Profiles are available at Level 2 (basic gridding) and Level 3 (despiked and interpolated).

References

Bennett, J. S. Stahr, and C. Eriksen, 2019: Determining Seaglider Velocities Automatically. University of Washington, Department of Oceanography Technical Reports, available at https://digital.lib.washington.edu/researchworks/handle/1773/44948.

Lee, C. M., S. Cole, M. Doble, L. Freitag, B. Hwang, et al., 2012: Marginal Ice Zone (MIZ) program: Science and experiment plan, Tech. Rep. APL-UW 1201, 48, Appl. Phys. Lab., Univ. of Wash., Seattle Wash.

Lee, C.M., J. Thomson, and the Marginal Ice Zone and Arctic Sea State Teams. 2017. An autonomous approach to observing the seasonal ice zone in the western Arctic. *Oceanography* 30(2):56–68, https://doi.org/10.5670/oceanog.2017.222.

Data Description

Level 2 data

Gliders record samples on a non-uniform time (and depth) grid, on both the down (dive) and up (climb) portion of a complete dive. These time series (level 1, not included here) are gridded on a regular depth and separated by profile. Value is NaN if no observation is present in that depth bin. Variables included in this file are:

z : depth [m]
time : date in seconds for every sample point [seconds since 1970-1-1 00:00:00]
T : in-situ temperature [degree C]
S : salinity [psu]
speed : forward speed of the glider through the water from the flight model [m/s]
lat : latitude of every sample point, from the flight model when underwater
lon : longitude of every sample point, from the flight model when underwater
N_time : number of time observations in the bin
N_T : number of temperature observations in the bin
N_S : number of salinity observations in the bin
dive : dive number
u_dive : depth-average current in the east direction from the flight model [m/s]

v_dive : depth-average current in the north direction from the flight model [m/s]
surface_curr_east : surface drift in the east direction from the time at surface [m/s]
surface_curr_north : surface drift in the north direction from the time at surface [m/s]
lat_dive : averaged latitude of the dive
lon_dive : averaged longitude of the dive

Level 3 data

Interpolated version of Level 2 data, with the additional step of "despiked", where we remove data that are more than 2 standard deviations for a running mean.

z : depth [m]
time : date in seconds for every sample point [seconds since 1970-1-1 00:00:00]
T :corrected in-situ temperature with outliers removed, interpolated over gaps < 50 m [deg C]
S : corrected salinity with outliers removed, interpolated over gaps < 50 m [psu]
speed : forward speed of the glider through the water from the flight model [m/s]
lat : latitude of every sample point, from the flight model when underwater
lon : longitude of every sample point, from the flight model when underwater
N_time : number of time observations in the bin
N_T : number of temperature observations in the bin
N_S : number of salinity observations in the bin
S_ref : low-pass filtered salinity, 5 days and 10 m
S_rms_ref : rms of salinity within smoothing window (high-freq variance). Despiker removes data more than 3 deviations for mean
T_ref : low-pass filtered temperature, 5 days and 10 m
T_rms_ref : rms of temperature within smoothing window (high-freq variance). Despiker removes data more than 3 deviations for mean
S_L2 : level-2 salinity [psu]
T_L2: level-2 temperature [deg C]
T_flags : qc flag for temperature: 0 no data (interpolated), 1 is good
S_flags : qc flag for salinity: 0 no data (interpolated), 1 is good
P : pressure [dBar]
SA : Absolute Salinity [g/kg]
CT : Conservative Temperature (ITS-90) [deg C]
PD : Potential density [kg/m3]
dive : dive number
u_dive : depth-average current in the east direction from the flight model [m/s]
v_dive : depth-average current in the north direction from the flight model [m/s]
surface_curr_east : surface drift in the east direction from the time at surface [m/s]
surface_curr_north : surface drift in the north direction from the time at surface [m/s]
lat_dive : averaged latitude of the dive
lon_dive : averaged longitude of the dive