Citation:

Fer, Ilker (2024), Dissipation measurements from a Slocum glider in the Barents Sea Polar Front, October 2022. [Dataset] Norwegian Marine Data Centre, https://doi.org/10.21335/NMDC-247353299

Summary

1) Data files

Ocean microstructure measurements were obtained from a Rockland Scientific (RSI) MicroRider attached to an electric Slocum glider. The glider was operated across the Barents Sea Polar Front, during the Nansen Legacy cruise, KB2022625, in October 2022.

The glider mission started on 2 October 2022 and ended on 9 October 2022. In addition to the turbulence package, the glider was equipped with a pumped Seabird conductivity-temperature (CTD) sensor. Both the CTD and the MR were configured to sample during dives and climbs of the glider.

The dissipation rate was measured using two airfoil shear probes. Turbulence channels sampled at a rate of 512 per second, and the slow channels at 64 per second. The dataset has been processed and formatted in accordance with the SCOR Working Group ATOMIX guidelines and recommendations. One NetCDF (NC) file per instrument's native file is provided (typically one file between consecutive surfacings of the glider, 191 files in total). Each provided NC file is organized in four hierarchical groups including continuous time series of data converted into physical units, cleaned time series used for spectral analysis, wavenumber spectra, and dissipation rate estimates. The first group also includes time series, matched with the MR time, of longitude, latitude, temperature, salinity and flight parameters from the glider (so-called hotel).

The grouped NC files are large and may be impractical to download and merge. For users only interested in the dissipation estimates and other time-averaged profiles, we also provide two separate NC files with all dissipation rate (and other related parameters) profiles and 1-s averaged sensor data, including flight parameters, collated into one file each as long 1-D time series. For more detailed information, please refer to the comments within the data file.

2) Collated files

This set of two NetCDF (NC) files are constructed by concatenating time series from the individual NC files per instrument's native file.

MERGED_SLOW contains the data from selected sensors, along with flight parameters, averaged in 1-second windows, and then concatenated in a 1-D time series.

MERGED_EPSI contains dissipation rate estimates together with quality control parameters concatenated in a 1-D time series.

A section (a more general term for a profile) is a continuous part of the time series that has been selected for dissipation estimates. As the glider moves through the water while collecting data, its flight characteristics may change and at times may not meet the conditions necessary for good dissipation estimates. This can result in multiple separated sections of dissipation estimates per dive or climb. Each such section has a unique section identifier number. The two NetCDF files described here are constructed from the 382 sections.

When producing the merged files, in addition to the automated quality assurance, we performed manual quality screening and updated the flag values. The screening removed data (i.e., replaced with NaN) during times with malfunctioning probes and abrupt flight behavior changes. More details can be found in the description and attributes of the two merged NC files. In the MERGED_EPSI file, quality flags are applied to EPSI_FINAL time series.

The data in the concatenated files are not gridded in time or pressure. Each data point has its own time stamp and a pressure value, with time increasing monotonically from the start of the first section. Sections when the glider ascends (climbs) will therefore have pressure values decreasing with time.

3) Additional details

Ocean microstructure measurements were obtained from a Rockland Scientific (RSI) MicroRider attached to an electric Slocum glider. The glider was operated across the Barents Sea Polar Front, during the Nansen Legacy cruise, KB2022625, in October 2022.

The glider Odin is a Teledyne Webb Research 1000m electric glider (Slocum G3, SN775). The glider mission started on 2 October 2022 and ended on 9 October 2022. The glider was equipped with a pumped Seabird conductivity-temperature (CTD41CP, SN9545) and an integrated RSI MicroRider (MR-1000, SN324) with two shear probes (S1=M2033, S2=M2034) and two thermistors (T1=T2060, T2=T1107) for measuring turbulence microstructure. Both the CTD and the MR were configured to sample during dives and climbs of the glider.

The data from the MR include measurements from 2 shear probes, 2-axis piezo-accelerometers (vibration), an inclinometer (pitch and roll) and a pressure transducer. Turbulence channels sampled at a rate of 512 per second, and the slow channels at 64 per second. The glider was operated with fixed battery positions during dives and climbs to reduce vibrations from the servo mode. Shallower dives prior to fixing the battery position are excluded from the data set. In total 191 files are processed, out of a total of 207, excluding the short files when the glider was on deck or at the surface, and the files using the servo mode. The 191 files resulted in 382 sections. A section (a more general term for a profile) is a continuous part of the time series that has been selected for dissipation estimates. As the glider moves through the water while collecting data, its flight characteristics may change and at times may not meet the conditions necessary for good dissipation estimates. This can result in multiple separated sections of dissipation estimates per dive or climb. Each such section has a unique section identifier number.

The processing of the data and the format of this data set follows the recommendations and guidelines of the SCOR Working Group 160, ATOMIX (https://atomix.app.uib.no/), as decribed in Lueck et al. (2024). The processing was based on the standard Matlab routines provided by Rockland Scientific, which were adjusted for the ATOMIX recommendations.

One NetCDF (NC) file per instrument's native file (one file between consecutive surfacings of the glider) is provided. Each NC file includes four hierarchical groups:

L1_converted : time series from all sensors converted into physical units
L2_cleaned : selected signals that are filtered and/or despiked before spectral analysis. Time stamp and length of the signals are the same as in L1.
L3_spectra : wavenumber spectra from shear probes and vibration sensors
L4_dissipation: dissipation estimates together with quality control parameters

The glider (the so-called hotel), in addition to the temperature and salinity, also recorded roll and pitch. Together with the angle of attack and flow speed past sensors estimates using a hydrodynamic flight model, the hotel data are also included in L1_converted. The glider data are processed using the GEOMAR Matlab Slocum glider processing toolbox (Krahmann, 2023).

Spectral calculation and dissipation rate estimate details are given in the attributes and processing parameters. Initial processing using 4-s fft length resulted in low-wavenumber contamination of the shear spectra. To avoid this, spectra are obtained using 2-s fft length. The short fft length, however, is not ideal for resolving low dissipation rates. Dissipation estimates are obtained over 10 s segments, overlapping by 5 s (50% overlap). Detailed data processing parameters and choices can be found in the attributes. Shear and vibration spectra, their complex cross-spectra, and the cleaned shear spectra using the Goodman method are provided. L4 includes estimates from both shear probes, using the cleaned spectra, as well as their average (EPSI_FINAL), together with quality control parameters. The figure of merit (FOM) and mean absolute deviation (MAD) relative to the Lueck model spectrum are used.

During the automated processing of data records, together with the other quality assurance metrics described in the ATOMIX recommendations, a despike_shear_fraction_limit of 0.14 and a FOM threshold of 1.3 were used. For dissipation estimates less than 1e-10 W/kg, we relaxed the FOM threshold by a factor of two, as this parameter is not well-constrained for low dissipation rates. We observed systematically larger FOM values with decreasing dissipation rates, most with marginally acceptable estimates. This choice was made to retain noise-level dissipation estimates instead of introducing gaps in the data. Users may want to apply additional quality screening. Data quality flags for dissipation estimates are summarized in the attributes of the variable EPSI_FLAGS in the L4 group. A final dissipation estimate, EPSI_FINAL, failing the data quality control is reported as NaN; however, the individual dissipation estimates from each probe are accessible in the EPSI parameter.

Because each file includes data sampled at a rate of 512 per second at two levels and their spectra in the third group, the grouped NC files are large in size and may be unpractical to download and merge. For users only interested in the dissipation estimates and other time-averaged profiles, we also provide two separate NC files with all dissipation rate (and other related parameters) profiles and 1-s averaged sensor data, including flight parameters, collated into one file each. When producing the merged files, in addition to the automated quality assurance, we performed manual quality screening and updated the flag values. The screening removed data (i.e., replaced with NaN) during times with malfunctioning probes and abrupt flight behavior changes. Data quality flags for dissipation estimates are summarized in the attributes of the variable EPSI_FLAGS. In the MERGED_EPSI file, quality flags are applied to EPSI_FINAL time series. A final dissipation estimate, EPSI_FINAL, failing the data quality control is reported as NaN; however, the individual dissipation estimates from each probe are accessible in the EPSI parameter. The data in the concatenated files are not gridded in time or pressure. Each data point has its own time stamp and a pressure value, with time increasing monotonically from the start of the first section. Sections when the glider ascends (climbs) will therefore have pressure values decreasing with time. More details can be found in the description and attributes of the two merged NC files.

Notes related to the glider operation:

The fixed battery position was determined from test dives to 180 m, and implemented from 3 October 2022. The pump volume was set to fixed values and adjusted manually from 5 October to avoid adjustments during the flight. A minimum of auto ballast control was maintained for optimizing the flight.

Flight data did not indicate adjustments that should impact the measurements. To capture the complete water column, particularly the top few meters, the glider carried out one dive-climb profile per segment. The “climb to” depth was set to 0 m to avoid noise contamination from the air bladder and ballast bump that automatically switch on when the glider reaches surface. The glider dived to 30 m above ground until 6 October, and then to 22 m above ground. Inspection of the pressure records show the following details for the file numbers:

1 : a bench test
2-4 : some short files on deck or surface
5 : 20 m dive-climb
6 : 40 m dive-climb
7-14 : 80 m dive-climb
15-35 : full dive-climb
36-37 : 60 m dive-climb
38-207 : full dive-climb

Files 1 to 14 and 36-37 did not return dissipation estimates and are excluded from the data set.

References

https://atomix.app.uib.no/;

Lueck, R., I. Fer, C. E. Bluteau, M. Dengler, H. P., R. Inoue, A. LeBoyer, S.-A. Nicholson, K. Schulz, and C. Stevens (2024), Best practices recommendations for estimating dissipation rates from shear probes, Frontiers in Marine Science, 11, https://doi.org/10.3389/fmars.2024.1334327.

Krahmann, Gerd (2023) GEOMAR FB1-PO Matlab Slocum glider processing toolbox. https://doi.org/10.3289/SW_4_2023.

Acknowledgements

This work was supported by Research Council of Naorway, through the Nansen Legacy Project, project number 276730. The glider was operated by the Norwegian national facility for ocean gliders (Norgliders) at the Geophysical Institute, University of Bergen. We thank the scientists and crew of RV Kristine Bonnevie for help with deployment and recovery.