Microturbulence profiler data series for cruise Dana D1198

Principal Investigator and Data Originator

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Content of data series

Parameter	Unit	Parameter code	Number of profiles	Comments
Parameters loaded in the PROVESS Database				
Depth	m	DEPHPR01	299	see BODC processing
Temperature T	deg.C	TEMPST01	299	none
Salinity	PSU	PSALST01	299	none
Sigma-T	kg m^{-3} –1000	SIGTEQST	299	none
$\log_{10}$ (dissipation rate)	$\log_{10}$(W m^{-3})	EPSIFY01	295	none
$\log_{10}$ (Cox number)	dimensionless	COXNFT01	295	none
$\log_{10}$(temperature dissipation rate)	$\log_{10}$(deg.C^2 s^{-1})	TDSSFT01	295	none
Parameters available in ASCII files on Disk 2 of CD-ROM				
Eddy viscosity	m^2 s^{-1}	n/a	295	*.edd ASCII files
Pseudo-dissipation rate	m^2 s^{-3}	n/a	295	*.xy2 ASCII files
Brunt-Vaisala frequency squared	s^{-2}	n/a	299	*.bvf ASCII files
Thorpe scale and displacement	m	n/a	299	*.tho ASCII files
Turbulent patch length	deg.C m^{-1}	n/a	300	*.akt ASCII files
Epsilon correction factor	Dimensionless	n/a	295	*.xyc ASCII files

Instrumentation and originator's data processing

The MST (Micro Structure - Turbulence) profiler is an instrument for simultaneous microstructure and precision measurements of physical parameters in marine water. The profiler used during this cruise was the SAI-Profiler MST001 of the Joint Research Centre, Marine Environment unit. The profiler was equipped with standard CTD sensors for precision measurements (P, T, C), a microstructure temperature sensor and two microstructure shear sensors: a PNS 93 shear probe (X) and a newly developed PNS 98 shear sensor (U) which served for testing a different isolation material. Internal vibrations of the profiler housing which can interfere with the shear measurements are recorded using an internal vibration sensor. The microstructure sensors are placed at the tip of a slim shaft, about 150 mm in front of the CTD sensors.

The profiler was used in the free falling mode. Its sinking velocity was adjusted to 0.8 m s^{-1}. The cable was deployed with high speed into the water in order to avoid cable tension. For that purpose, a special winch system specifically designed by the company ISW Wassermesstechnik of Dr. Hartmut Prandke was used. This new ship winch SWM98 is specially designed to allow measurements of quasi free-falling instruments, by maintaining a slack in the cable during profiling. It also enables measurements to be made from the moving ship (ca. 1 knot). This new winch was successfully applied for the measurements.

Specification of precision CTD sensors:

Parameter	Principle	Range	Accuracy	Resolution	Time constant
Pressure (P)	Piezo-resistive	0 – 200 dbar	+/- 0.1 % of full scale	0.002 % of full scale	40 ms
Temperature (T)	Resistor Pt 100	-2 – +30 deg C	+/- 0.01 deg C	0.001 deg C	160 ms
Conductivity (C)	7-Pole-cell	0 – 60 mS/cm	+/- 0.01 mS/cm	0.001 mS/cm	100 ms

Specification of microstructure (N and X) and control (A) sensors:

Parameter	Principle	Sensing element	Length of sensor tip	Time constant
Temperature (N)	Resistance measurement	Thermistor FP07	ca. 0.3 mm	ca. 10 ms
Shear SHE (X)	Lift force measurement at airfoil nose	Piezoceramic bending beam	3.5 mm	ca. 3 ms

Characteristics of the shear sensors used:

Shear Sensor Channel	Number	Sensitivity [Vms^2/kg]	Gain	Remarks
Shear SHE X	1007	2.64E-4	10.78	
Shear SHE U	5004	0.58E-4	53.90	
Shear SHE Y	3002	3.50E-4 (acc=1.7 mV^{-1} s^{-2})	10.78	Reference

Full details on instrumentation and data processing including algorithms used can be found in the following documents included on the CD-ROM:

'Report on microstructure data processing and presentation of the results from the PROVESS-1098 campaign' (Stips, Prandke and Tschesche 2000).
'Recommended Algorithm for Dissipation Rate calculation within PROVESS' (Stips and Prandke 2000).

In summary the procedure of data processing consisted of the following steps:

1. Conversion of the raw data into their physical value using manufacturer's calibration coefficients (temperature N and T in deg. C, pressure P in dbar and conductivity C in mS/cm) or an intermediate value (shear X, U and Y). These data were then stored in binary XDR format and information files were created for each casts.
2. A cut off procedure was then applied. This is an interactive procedure which eliminates falsified data at the upper and lower part of the profile. The algorithm searches for the first occurrence at the upper and lower part, where the difference of pressure between a selected difference of records is smaller than the selected threshold. After drawing the calculated cut line, an interactive adjustment is integrated and additional shear X and shear Y are drawn. The selected thresholds are a difference of pressure P of 0.01 dbar and a difference of records of 100. The channels for microstructure sensors and precision sensors are considered separately.
3. Checks for data consistency were carried out (transmission and time errors, absolute physical limits, maximal gradients, spikes and calibration). Identified wrong data were flagged in order to perform a correction using a linear interpolation. Due to technical problems with the grounding for the winch a high number of transmission errors occurred from casts 1 to 4. Casts with time errors were not found. Only a very few wrong sensor values were found. Meaningful gradients were checked, by comparing the difference of two neighbouring sensor values with a maximal possible gradient. If a sensor value was outside this range, the value was flagged. Shear X and shear U contained many such errors. The settings used for checking absolute physical limits and maximal gradients are detailed below.

Sensor	Channel	Unit	Lower limit	Upper limit	Max. difference for gradient
Pressure	P	[dbar]	1.0	120.0	0.009
Temperature	T	[degC]	1.0	20.0	0.005
Fast temperature	N	[degC]	1.0	20.0	0.004
Conductivity	C	[mS/cm]	20.0	50.0	0.007
Shear	X		1000	65000	2500
Shear	U		1000	65000	2500
Shear (reference)	Y		1000	65000	700

4. Averaging procedure: the averaging procedure was applied to the corrected data. For the microstructure sensors a mean value over 4 records was calculated. For the precision sensors a mean value over 10 records was calculated.
5. Computation of oceanographic standard parameters: temperature, salinity and density were all calculated in the depth region 5.0 to 120.0 m in a depth interval of 1.0 m and with a shift between two segments of 0.5 m (50% overlap). The minimum number of values per segment was 30. All parameters were standardized according to UNESCO/ICES recommendation. Pressure was converted into depth by the Saunders and Fofonoff method.
6. Computation of dissipation rate Epsilon: turbulent kinetic energy (TKE) dissipation rates were estimated from the variance of small scale shear using the isotropic formula based on the theory of Allen and Perkins (1952). Details of the procedure applied are described in eg. Prandke and Stips (1996). The dissipation rates were calculated in the depth region 5.0 to 120.0 m in a depth interval of 1.0 m and with a shift between two segments of 0.5 m (50% overlap). The computation of dissipation rates included four routines to correct for disturbances caused by components of the profiler, spikes, vibrations and changes in profiler velocity, and to carry out a spectral correction for lost variance.
7. Computation of Brunt-Vaisala frequency squared, eddy diffusivity, Cox number, Thorpe scale and Thorpe displacement and rate of diffusive temperature smoothing (Chi).

Sampling strategy

Data were collected during the cruise Dana D1198 between October 14 and 27 1998. The measurement location was close to 59° 20’ N and 1° E in the northern North Sea (NNS). The mean depth at that site was about 110 m.

The measurements cover the water column beginning in the near surface region (on average 8.06 m depth) down to the bottom (on average 104.35 m and maximal 120.00 m). Series of 5 successive casts were generally made every 3 hours during the cruise. Several breaks occurred because of rough weather conditions. Two periods of intense turbulence measurements (5 casts every two hours for about 24 hours) were made at the beginning (16-17 October) and at the end (22-23 October) of the cruise. These periods corresponded to neap and spring tides respectively.

BODC processing

Data files containing the different parameters from individual casts were merged into a single file for each cast based on a single depth channel. This involved resolving for occasional differences between the depth channel associated with parameters derived from CTD sensors and that associated with parameters derived from the microstructure sensors. These differences were attributed to the different averaging and cut off procedures used for CTD and microstructure data. As a general rule, if both sets of parameters were present, preference was given to the depth value associated with the microstructure parameters. The resulting imprecision on the depth of the measurements derived from the CTD sensors was small (<0.10 m) and at most, resulted in a maximum error of 0.6 m on the measurement depth of CTD parameters for isolated records at the beginning and end of each profile.

In order to standardise parameter units with those held in the BODC Parameter Dictionary the following modifications were carried out prior to loading the data into a database under the Oracle Relational Database Management System:

- dissipation rates were converted from $m^2 s^{-3}$ to $W m^{-3}$ by multiplying the value by an average density value of 1027.162 calculated for the whole campaign. The dissipation rates were then expressed on a $\log_{10}$ basis.
- temperature dissipation rate and Cox number were expressed on a $\log_{10}$ basis.

Derived parameters such as eddy viscosity, Brunt-Vaisala frequency squared etc. were not loaded in the database. These parameters are contained in the originator's ASCII files and may be found on Disk 2 of the PROVESS CD-ROM set in the directory: SAI_MSS/D1198.

Comments on data quality

None to report.

References

Allen HJ, Perkins EW (1952) A study of effects of flow over slender inclined bodies of revolution. Report N°1048, U.S. National Advisory Committee for Aeronautics.

Prandke H, Stips A (1996) Investigation of microstructure and turbulence in marine and limnic waters using the MST Profiler. Technical Note N° I.96.87, European Commission, Joint Research Centre, Space Applications Institute, Ispra/Italy.

Stips A, Prandke H, Tschesche U (1999) Report on microstructure data processing and presentation of the results from the PROVESS-1098 campaign. Technical Note N° I.00.128, European Commission, Joint Research Centre, Space Applications Institute, Ispra/Italy.

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