SOHFEA
Sulfide-Oxygen-Heat-Flux Eddy Analysis
Software Package Version 2.0

DRAFT User Manual

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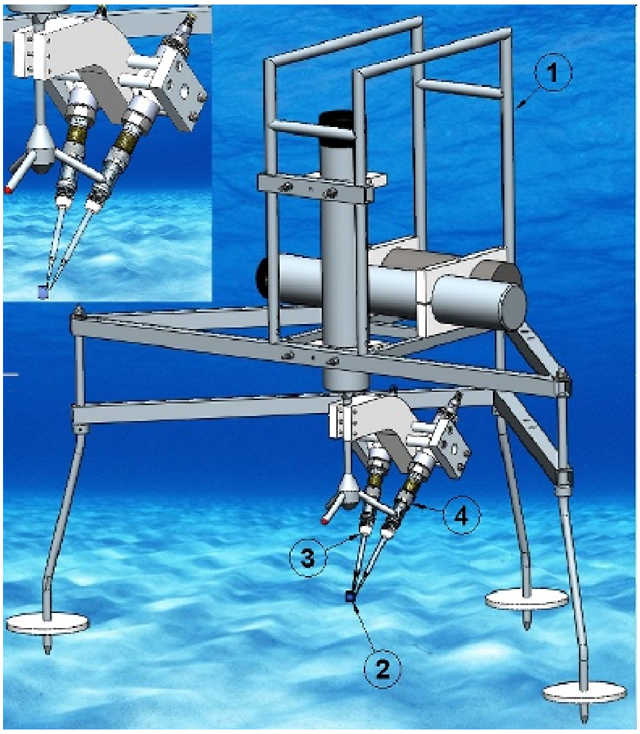


Figure from McGinnis et al. 2011 (R. Schwarz, GEOMAR)

Synopsis

The aquatic eddy correlation technique is an exciting new technology for measuring benthic fluxes that is rapidly gaining in popularity. This increasing popularity fortunately comes with advancing equipment specifications, especially battery and memory capacity.

With the birth of the aquatic eddy technique over a decade ago, deployments were typically limited to less than about 24 hours. However, with today's eddy instrumentation, deploy lengths can theoretically be in excess of 30 days with sampling rates of 64 Hz. This has lead to much longer and larger data sets; dramatically increasing data handling requirements.

The sheer volume of data produced by the eddy correlation can be intimidating, especially for newcomers to the field. While most deployments these days seem to be between 3-5 days long, this still produces over 16 million lines of data that must be processed for quality control and data analyses in an efficient and expedient manner.

The purpose of the SOHFEA software package is to provide the eddy correlation community with a fast and efficient means to both preprocessing, averaging and analyzing their eddy flux data. SOHFEA is designed for both rapid "field-processing" of data for a first look on data quality and fluxes as well as for final processing for publication-level results.

SOHFEA is written in Fortran 90 and uses a Fortran digital compiler to ensure fast program execution times (minutes for a 5-day long data set). SOHFEA is free to the academic and scientific community and can be downloaded at http://dfmcginnis.com/SOHFEA/.

This instruction manual assumes an introductory knowledge of the eddy correlation technique; however some key references are provided. The manual is geared towards (but not limited to) the GEOMAR eddy configuration (McGinnis et al. 2011) and the recommended eddy data collection settings: continuous mode (as opposed to burst) at 64 Hz. In my opinion, these settings provide optimum flexibility for extracting high quality data.

Please send any comments, feedback, suggestions or bug-reports to dfmcginnis@yahoo.com – I would be happy to hear from you.

Acknowledgements

I would like to express my thanks to Karl Attard and Kasper Hancke (University of Southern Denmark) and Andreas Lorke (Uni. Landau – Koblenz) for providing excellent feedback on SOHFEA and the manual and website.

Software Package Overview

SOHFEA Ver. 2.0 consists of three processing categories
- Preprocessing routings containing 3 programs
- Eddy flux program, SOHFEA
- Postprocessing and ancillary routines

1. Preprocessing

The preprocessing routine contains three programs to be run sequentially. These three programs are run separately so the user has the opportunity to inspect the output after each step to ensure the results are meeting expectations or to adjust filtering/output parameters. If the user wishes, these programs can be run sequentially by creating a BATCH program (downloadable on the website).

The programs consist of:
Step1_filter.exe – this program averages the data down, while flagging and removing low-quality (user-defined) data.
Step2_despike.exe – the next program replaces data flagged in Step1 and despikes the velocity and O_2 data.
Step3_rotate.exe – the final preprocessing program performs a simple double-rotation of the data to minimize the average vertical velocity and converts the ADV velocity data from instrument coordinates to earth coordinates.

To run the programs: Simply place your data in the same folder with the programs, fill out the configuration file, and then execute the programs sequentially.

2. SOHFEA

SOHFEA.exe (and SOHFEAHeat.exe) extracts and outputs the eddy fluxes. In addition, the program computes the average measured parameters and several other variables of interest. SOHFEA.exe is used for standard O_2 or H_2S fluxes (and in principle other constituents). SOHFEAHeat.exe extracts heat fluxes and is uses the same configuration file.

All software is programmed with Digital Fortran 90 and compiled with global optimizations. The software is designed for Windows XP, but should operate on any Windows based system. It has not been tested for other operating systems.

Getting Started:
Preprocessing & Extracting Fluxes

The SOHFEA preprocessing is designed to read the Nortek Vector ADV ASCII output file. The program can be modified to accommodate other input formats – please contact me. An input conversion program is available to convert UNISENSE Eddy data.

All routines use the same input file **ConfigSOHFEA.dat** (see below). The program relevant input blocks are separated by a row of numbers (`1234567890123456789x12345678901234567890`). The first 20 spaces are the line input description (up until the 'x'). The next 20 spaces are for the input parameters. The line comments begin after the '!'.

ConfigSOHFEA.dat - WordPad

File Edit View Insert Format Help

```
1  SOHFEA Software Package V2.0 - March 23,2013.   !This software is provided "as is" without express or implied warranty of any kind. Copyright (C) 2013 Daniel McGinnis
2  1234567890123456789x12345678901234567890  BLOCK1!Input field starts on space 21 (after 'x') and should not exceed 40 (after last '0'). NO TABS IN INPUT FIELDS!
3  Input File          Example64Hz.dat             !Begin input fields for Step1_filter.exe. Vector ascii data file
4  Output File DO      Out8Hz.Dat                  !Specify output file name (input file name for Step2_despike)
5  Output File BS      OutBS8Hz.Dat                !Backscatter output
6  Frequency           64                          !Frequency of measured data
7  Averaging points    8                           !Number of data points to average (1 = no average)
6  Calibration Ampl (DOuM = Counts x a + b)
9  a:                  0.01579449                  !Slope of calibration curve
10 b:                  -100.88932334               !Intercept
11 Calibration Amp2 (DOuM = Counts x a + b)
12 a:                  1
13 b:                  0
14 Start Time (Hours)  0                           !The program calculates deployment time starting from 0 in hours. You can specify a different starting value.
15 SNR Threshold       5                           !Threshold for removing bad data (default = 5)
16 Beam Correlation    70                          !Threshold for removing bad data (default = 70)
17 1234567890123456789x12345678901234567890  BLOCK2!Begin input for Step2
18 Despiking Routines                              !Step2_despike.exe field
19 Output Despike      Despike8Out.Dat             !Despike output file name (input file name = file name on line 3)
20 Despike Start time  1.                          !Timerange to despike (note - all data are saved)
21 Despike End time    20.                         !Endtime to despike (must be specified)
22 O2 detrend win.(s)  300                         !Length of running mean to be considered for O2 despiking
23 O2 StDev. Multi.    2                           !Factor of O2 standard devation to remove as spikes
24 Vel. Acceleration   0.3                         !Acceleration factor for despiking vertical velocity (default = 0.3 m/s2)
25 Despike Iterations  100                         !Number of iterations for velocity despiking
26 Interp. Warning(s)  1                           !Writes warning output when interpolation is greater than the time specified.
27 1234567890123456789x12345678901234567890  BLOCK3!Begin input for Step3
28 Coordinate Rotation                             !Step3_rotate.exe
29 Output Rotation     Rotation8Out.Dat            !Output for rotation program
30 Heading             0.                          !Heading to convert to earth coordinates (heading from *.sen Vector file)
31 1234567890123456789x12345678901234567890  BLOCK4!Begin input for SOHFEA
32 Output File         Out_60s.Dat
33 Frequency           8                           !Frequency after downsampling
34 Start Time(0=SOF)   0                           !Specify start time of anaysis. A 0 here implies start of file.
35 End Time (0=EOF)    0                           !Specify end time of anaysis. A 0 here implies the end of file
36 Window Size (sec)   60                          !Window or bin for flux extraction
37 Ampl or Amp2        1                           !Channel 1 or Channel 2
38 Use rotated Z       1                           !1 specifies to use the rotated velocity data, 0 is unrotated.
39 Running Mean (sec)  30                          !Running mean
40 1234567890123456789x12345678901234567890
```

Figure 1. Example input for SOHFEA

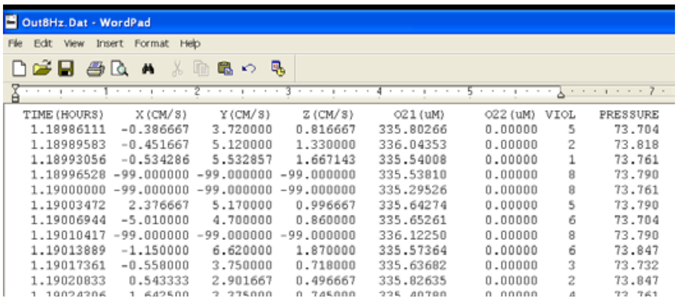
RULES: The program reads input from the 24th space until the 44th space (after the 'x' until the end of the numbering). Please do not include any 'TABS' in this field, only spaces. It is suggested that input be started on the line 1 after the 'x'. User comments may be added anywhere to the left of the numbered field (44th space). Each block between the number lines is for each consecutive processing program. The output file names from one block are the input file names for the next program block.

Step1_filter.exe – Block 1: Performs the following functions:

1. <u>Averages</u> the input data
2. <u>Applies calibration coefficients</u> (only linear function)
3. <u>Filters</u>: Removes data flagged as bad before average is performed. Data are flagged based on user specified signal-to-noise ratio (SNR; default = 5) and beam correlation (BC; default = 70) – Lines 15 & 16, respectively. If all points removed for a bin average, that bin is assigned a -99. The -99 will be replaced in the next step.

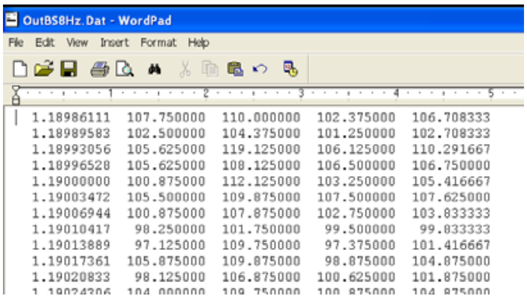
4. Outputs time in hours: Line 14 'Start Time (Hours)' allows the user to specify a start time other than 0. This is useful when synchronizing the output with more than 1 eddy or other instruments.

Input: ASCII data file from Vector
Output: Averaged data file (user specified name)
Averaged backscatter (BS) data file with individual beam and average BS.



Out8Hz.Dat - WordPad

TIME(HOURS)	X(CM/S)	Y(CM/S)	Z(CM/S)	O21(uM)	O22(uM)	VIOL	PRESSURE
1.18986111	-0.386667	3.720000	0.816667	335.80266	0.00000	5	73.704
1.18989583	-0.451667	5.120000	1.330000	336.04353	0.00000	2	73.818
1.18993056	-0.534286	5.532857	1.667143	335.54008	0.00000	1	73.761
1.18996528	-99.000000	-99.000000	-99.000000	335.53810	0.00000	8	73.790
1.19000000	-99.000000	-99.000000	-99.000000	335.29526	0.00000	8	73.761
1.19003472	2.376667	5.170000	0.996667	335.64274	0.00000	5	73.790
1.19006944	-5.010000	4.700000	0.860000	335.65261	0.00000	6	73.704
1.19010417	-99.000000	-99.000000	-99.000000	336.12250	0.00000	8	73.790
1.19013889	-1.150000	6.620000	1.870000	335.57364	0.00000	6	73.847
1.19017361	-0.558000	3.750000	0.718000	335.63682	0.00000	3	73.732
1.19020833	0.543333	2.901667	0.496667	335.82635	0.00000	2	73.847



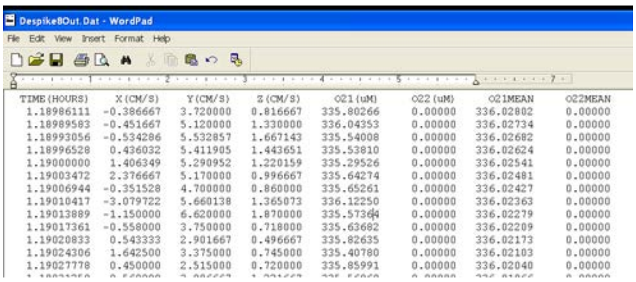
OutBS8Hz.Dat - WordPad

1.18986111	107.750000	110.000000	102.375000	106.708333
1.18989583	102.500000	104.375000	101.250000	102.708333
1.18993056	105.625000	119.125000	106.125000	110.291667
1.18996528	105.625000	108.125000	106.500000	106.750000
1.19000000	100.875000	112.125000	103.250000	105.416667
1.19003472	105.500000	109.875000	107.500000	107.625000
1.19006944	100.875000	107.875000	102.750000	103.833333
1.19010417	98.250000	101.750000	99.500000	99.833333
1.19013889	97.125000	109.750000	97.375000	101.416667
1.19017361	105.875000	109.875000	98.875000	104.875000
1.19020833	98.125000	106.875000	100.625000	101.875000

Figure 2. Example output files Step 1. Left – averaged output. VIOL represents the number of instances in an averaging bin that data exceed the threshold BC or SNR criteria. If all the points are discarded (e.g. VIOL = 8) then the velocity values are assigned a -99. The PRESSURE is pressure in dbar. Right – Time (hr), X, Y, Z, and average BS values (dB).

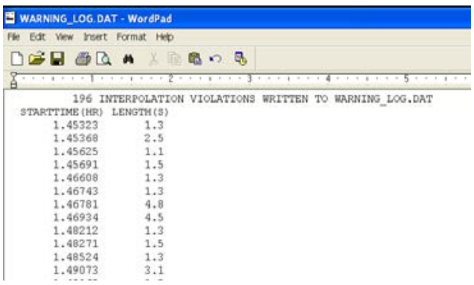
Step2_despike.exe – Block 2: Performs the following functions:

1. Replaces -99 assigned in Step 1 and outputs warning (WARNING_LOG.DAT) if -99's are greater than a consecutive time span indicated by 'Interp. Warning' (Line 26).
2. Despike time range: User specifies start and end time for despiking algorithms (both velocity and O2) – Lines 20 and 21. It is important that periods of very noisy data are excluded (e.g. when the instrument it being deployed or operated out of water). Extremely noisy data (above the levels commonly measured) may interfere with the despiking algorithms.
3. Despike O2: The user has option of depiking O2 data (use extreme caution) by specifying an O2 running mean length in seconds (Line 22 – O2 detrend win.) and a standard deviation multiple (Line 23 – O2 StDev. Multi). Any data point that falls outside the standard deviation times the multiple will be removed and replaced by the running mean at that point.
3. Despike velocity: Spike removal for X, Y, and Z velocity based on vertical acceleration threshold (default for Vz = 0.3 m s^{-2}, line 24). Removed spikes are replaced by linear interpolation of neighboring data, thus it is necessary to solve iteratively over data set. Default iterations are set to 100 (line 25). See Goring and Nikora, 2002 for more information.



Despike8Out.Dat - WordPad

TIME(HOURS)	X(CM/S)	Y(CM/S)	Z(CM/S)	O21(uM)	O22(uM)	O21MEAN	O22MEAN
1.18986111	-0.386667	3.720000	0.816667	335.80266	0.00000	336.02802	0.00000
1.18989583	-0.451667	5.120000	1.330000	336.04353	0.00000	336.02734	0.00000
1.18993056	-0.534286	5.532857	1.667143	335.54008	0.00000	336.02682	0.00000
1.18996528	0.436032	5.411905	1.443651	335.53810	0.00000	336.02624	0.00000
1.19000000	1.406349	5.290952	1.220159	335.29526	0.00000	336.02541	0.00000
1.19003472	2.376667	5.170000	0.996667	335.64274	0.00000	336.02481	0.00000
1.19006944	-0.351528	4.700000	0.860000	335.65261	0.00000	336.02427	0.00000
1.19010417	-3.079722	5.660138	1.365073	336.12250	0.00000	336.02363	0.00000
1.19013889	-1.150000	6.620000	1.870000	335.57364	0.00000	336.02279	0.00000
1.19017361	-0.558000	3.750000	0.718000	335.63682	0.00000	336.02209	0.00000
1.19020833	0.543333	2.901667	0.496667	335.82635	0.00000	336.02173	0.00000
1.19024306	1.642500	3.375000	0.745000	335.40780	0.00000	336.02103	0.00000
1.19027778	0.450000	2.515000	0.720000	335.85991	0.00000	336.02040	0.00000



WARNING_LOG.DAT - WordPad

196 INTERPOLATION VIOLATIONS WRITTEN TO WARNING_LOG.DAT

STARTTIME(HR)	LENGTH(S)
1.45323	1.3
1.45368	2.5
1.45625	1.1
1.45691	1.5
1.46608	1.3
1.46743	1.3
1.46781	4.8
1.46934	4.5
1.48212	1.3
1.48271	1.5
1.48524	1.3
1.49073	3.1

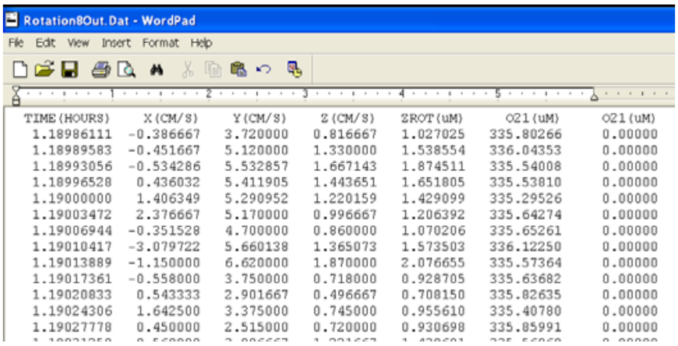
Figure 3. Example output files Step 2. Left – Output after spikes/-99 values replaced. Two right columns are the running mean for the O2 despiking. Right – warning if more than X consecutive seconds of data are replaced (X = 1 second in this example, see Line 26 in ConfigSOHFEA.dat example).

Input: Output file from Block 1 (input file name it taken from Line 4).
Output: Despiked file (user specified name Line 19)
WARNING_LOG.DAT – warning of more than X consecutive seconds of data are replaced (X is specified on line 26).

Step3_rotate.exe – Block 3: Performs the following functions:

1. Double Rotation: Simple double rotation to minimize the mean vertical velocity.
2. Earth Coordinates: User can enter the ADV compass heading from the *.sen file (Line 30) to rotate the data from instrument coordinates to earth coordinates.

Input: Output file from Block 2 (input file name it taken from Line 19).
Output: Rotated file (user specified name Line 29)



TIME (HOURS)	X (CM/S)	Y (CM/S)	Z (CM/S)	ZROT (uM)	O21 (uM)	O21 (uM)
1.18986111	-0.386667	3.720000	0.816667	1.027025	335.80266	0.00000
1.18989583	-0.451667	5.120000	1.330000	1.538554	336.04353	0.00000
1.18993056	-0.534286	5.532857	1.667143	1.874511	335.54008	0.00000
1.18996528	0.436032	5.411905	1.443651	1.651805	335.53810	0.00000
1.19000000	1.406349	5.290952	1.220159	1.429099	335.29526	0.00000
1.19003472	2.376667	5.170000	0.996667	1.206392	335.64274	0.00000
1.19006944	-0.351528	4.700000	0.860000	1.070206	335.65261	0.00000
1.19010417	-3.079722	5.660138	1.365073	1.573503	336.12250	0.00000
1.19013889	-1.150000	6.620000	1.870000	2.076655	335.57364	0.00000
1.19017361	-0.558000	3.750000	0.718000	0.928705	335.63682	0.00000
1.19020833	0.543333	2.901667	0.496667	0.708150	335.82635	0.00000
1.19024306	1.642500	3.375000	0.745000	0.955610	335.40780	0.00000
1.19027778	0.450000	2.515000	0.720000	0.930698	335.85991	0.00000

Figure 4. Example output files Step 3. ZROT is the vertical velocity after a simple double rotation.

Step4: SOHFEA.exe – Block 4: SOHFEA.exe is now executed to extract fluxes. SOHFEA.exe will work with both O2 and H2S data (and other constituents in the same range). The extracted fluxes in this case use the vertical velocity with the simple double rotation from Block 3. If other rotations are desired, the user must implement this as an independent step and produce a file with readable format (simply comma or space delimited with no more than 1 header at the top of the file – see Figure 4). See Lorke et al. 2012; Wilczak et al. 2001 for more information on coordinate rotation.

Configuration information:

1. Output file: The user specifies the output file name (Line 32)
2. Frequency of the data in the file (Line 33 – I left this option in so users can run SOHFEA without going through the first 3 steps).
3. The start and end times: (Lines 34 & 35) are specified for SOHFEA to solve (0 defaults at start/end of file, respectively).
4. Flux window size: (Line 36) is the time length of the flux window.
5. Channel: (line 37) is either analog output 1 or 2 from the Vector
6. Rotated vertical velocity, z: (Line 38) selecting 1 here will specify using the rotated z velocity, 0 will use the unrotated z velocity for solving the fluxes.
7. Running mean length: (line 39) Time window (seconds) for running mean, can not exceed the value from the flux window (Line 36).

Input: Output file from Block 3 (input file name it taken from Line 29).
Output: Flux output file (user specified name Line 32)

cumflux.out & cumfluxSHIFT.out – see example below
Cospectra.out – see example below

Out_60s.Dat - WordPad

File Edit View Insert Format Help

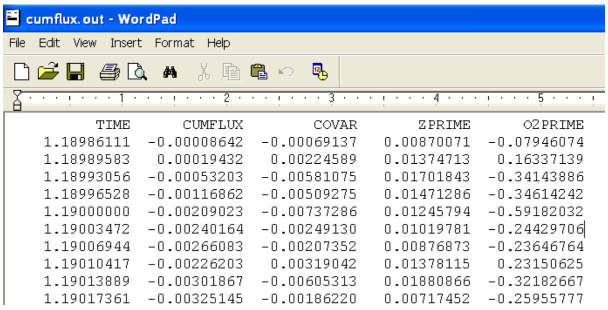
TIME	X-VEL	Y-VEL	Z-VEL	Z-STD	MAG	MAG-STD	DIR	O2	O2-STD	FLUX-L	FLUX-R	LINMIN	RUNMIN	LINMAX	RUNMAX	SLMIN	SRMIN	SLMAX	SRMAX
1.1917	-1.107	3.535	0.135	0.829	3.704	1.936	287.4	335.750	0.381	-39.66	-46.76	-50.25	-57.28	-25.79	-33.73	-0.25	-0.25	-1.75	-1.75
1.2084	-2.454	2.983	0.121	0.799	3.863	1.633	309.4	335.765	0.421	-49.79	-39.35	-78.64	-67.09	-49.79	-39.35	-0.88	-0.88	-1.75	0.00
1.2250	-2.653	2.778	-0.082	0.567	3.841	1.510	313.7	335.835	0.345	-9.66	-13.27	-33.29	-36.86	-1.21	-4.22	-0.75	-0.75	-1.63	-1.63
1.2417	-3.885	4.465	0.367	1.079	5.919	1.809	311.0	335.961	0.329	-37.91	-50.60	-62.37	-75.15	-6.02	-15.81	-0.75	-0.75	-2.00	-2.00
1.2584	-3.718	5.924	0.471	1.160	6.994	2.272	302.1	335.784	0.368	-61.46	-63.05	-115.73	-114.30	-61.46	-63.05	-1.00	-1.00	-2.00	0.00
1.2750	-2.300	3.497	-0.479	0.822	4.186	1.707	303.3	335.674	0.435	-82.20	-89.66	-86.30	-95.19	-73.74	-82.99	-0.88	-1.13	-2.00	-2.00
1.2917	-2.703	3.697	0.002	0.770	4.580	1.620	306.2	335.795	0.299	-29.33	-26.47	-35.49	-32.21	-9.36	-7.21	-0.25	-0.25	-1.88	-1.88
1.3084	-1.864	3.960	0.274	1.106	4.377	1.685	295.2	335.597	0.413	-77.26	-86.65	-159.23	-177.72	-77.26	-86.65	-1.63	-1.63	-1.88	0.00
1.3250	-0.669	2.087	-0.002	0.783	2.192	1.479	287.8	335.231	0.329	-36.37	-31.38	-56.74	-52.41	-30.97	-31.06	-0.63	-0.63	-2.00	-2.00
1.3417	-2.381	2.719	-0.047	0.719	3.614	1.583	311.2	335.483	0.433	-93.80	-112.84	-95.61	-113.91	-71.19	-85.18	-0.25	-0.25	-1.25	-1.25
1.3584	-2.410	3.490	0.234	0.924	4.241	1.725	304.6	335.598	0.440	-45.17	-30.01	-96.25	-82.42	-45.17	-30.01	-0.88	-0.88	-1.25	0.00
1.3750	-1.619	3.738	-0.106	0.689	4.074	1.325	293.4	335.804	0.366	-28.99	-34.09	-33.30	-38.43	12.82	7.38	-1.13	-1.13	-2.00	-2.00
1.3917	-2.641	3.582	-0.175	0.708	4.450	1.712	306.4	335.761	0.427	-65.34	-65.05	-65.34	-65.05	-20.87	-23.79	-1.13	0.00	-2.00	-2.00
1.4084	-2.709	3.475	-0.202	0.722	4.406	1.503	307.9	335.867	0.383	-56.47	-63.54	-72.65	-79.70	-50.77	-57.83	-0.38	-0.38	-1.88	-1.88
1.4250	-1.688	2.339	0.966	1.654	2.885	3.385	305.8	335.445	0.507	-65.20	-86.36	-76.56	-98.63	-10.24	-36.89	-0.25	-0.25	-1.75	-1.63

Figure 5. Example output SOHFEA.dat. See Table SOHFEA for description.

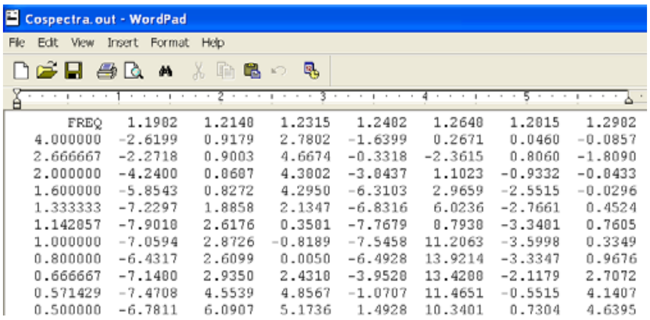
Table SOHFEA

Time	hours	
X-VEL	cm s^{-1}	X or East velocity
Y-VEL	cm s^{-1}	Y or North velocity
Z-VEL	cm s^{-1}	Vertical velocity
Z-STD	cm s^{-1}	Standard deviation of vertical velocity
MAG	cm s^{-1}	Velocity magnitude (only X and Y)
MAG-STD	cm s^{-1}	Standard deviation of velocity magnitude
DIR	degrees	Current direction
O2	umol L^{-1}	Mean oxygen concentration over eddy window (60 seconds in this case)
O2-STD	umol L^{-1}	Standard deviation of vertical velocity
FLUX-L	mmol m^{-2} d^{-1}	Flux with linear detrending+
FLUX-R	mmol m^{-2} d^{-1}	Flux with running mean detrending+
LINMIN	mmol m^{-2} d^{-1}	Linear detrending, time shift. The program shifts to O2 data back in time (maximum -2 seconds) and seeks the minimum flux (maximum respiration/uptake)*
RUNMIN	mmol m^{-2} d^{-1}	Same as LINMIN, but with running mean detrending
LINMAX	mmol m^{-2} d^{-1}	Same as LINMIN, but seeks maximum flux (in the case of O2 production)
RUNMAX	mmol m^{-2} d^{-1}	Same as LINMAX, but with running mean detrending
SLMIN	seconds	Time shift corresponding to LINMIN
SRMIN	seconds	Time shift corresponding to RUNMIN
SLMAX	seconds	Time shift corresponding to LINMAX
SRMAX	seconds	Time shift corresponding to RUNMAX

+ See Moncrieff et al. 2004 for details on detrending methods.
* See McGinnis et al. 2008 for more details regarding time shift.


cumflux.out - WordPad

TIME	CUMFLUX	COVAR	ZPRIME	O2PRIME
1.18986111	-0.00008642	-0.00069137	0.00870071	-0.07946074
1.18989583	0.00019432	0.00224589	0.01374713	0.16337139
1.18993056	-0.00053203	-0.00581075	0.01701843	-0.34143886
1.18996528	-0.00116862	-0.00509275	0.01471286	-0.34614242
1.19000000	-0.00209023	-0.00737286	0.01245794	-0.59182032
1.19003472	-0.00240164	-0.00249130	0.01019781	-0.24429706
1.19006944	-0.00266083	-0.00207352	0.00876873	-0.23646764
1.19010417	-0.00226203	0.00319042	0.01378115	0.23150625
1.19013889	-0.00301867	-0.00605313	0.01880866	-0.32182667
1.19017361	-0.00325145	-0.00186220	0.00717452	-0.25955777


Cospectra.out - WordPad

FREQ	1.1982	1.2140	1.2315	1.2402	1.2640	1.2815	1.2902
4.000000	-2.6199	0.9179	2.7802	-1.6399	0.2671	0.0460	-0.0857
2.666667	-2.2718	0.9003	4.6674	-0.3318	-2.3615	0.8060	-1.8090
2.000000	-4.2400	0.0687	4.3802	-3.0437	1.1023	-0.9332	-0.0433
1.600000	-5.8543	0.8272	4.2950	-6.3103	2.9659	-2.5515	-0.0296
1.333333	-7.2297	1.8858	2.1347	-6.8316	6.0236	-2.7661	0.4524
1.142857	-7.9018	2.6176	0.3581	-7.7679	0.7930	-3.3401	0.7605
1.000000	-7.0594	2.8726	-0.8189	-7.5458	11.2063	-3.5998	0.3349
0.800000	-6.4317	2.6099	0.0050	-6.4928	13.9214	-3.3347	0.9676
0.666667	-7.1400	2.9350	2.4310	-3.9520	13.4200	-2.1179	2.7072
0.571429	-7.4708	4.5539	4.8567	-1.0707	11.4651	-0.5515	4.1407
0.500000	-6.7811	6.0907	5.1736	1.4928	10.3401	0.7304	4.6395

Figure 6. Example output files SOHFEA.exe. Left **cumflux.out** – CUMFLUX is the cumulative flux over the entire data series in mmol m^{-2}, which is the time integrated flux. COVAR is the covariance z´C´, which is the product of the last two columns. **cumfluxSHIFT.out** is the same but with the data shifted seeking the most negative (minimum) value over a particular window. Right **Cospectra.out** – this file provides an estimate for the cumulative cospectra (unshifted data) after the method from McGinnis et al. 2008. The left most column FREQ is the frequency in Hz. The very top row is the mean time of the window (hours), and below that in column 2 – onward are the fluxes associated with a that time and integrated to that frequency (starting at high frequency and going lower – See McGinnis et al. 2008 for more detail).

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