Ocean Carbon and Biogeochemistry: EDDIES Data System

EDDIES 2004 Survey 1 cruise: OCEANUS 404-1

CTD profile data processing notes

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01 November 2007: Prepared for OCB data system by Cyndy Chandler, BCO-DMO (WHOI).

Data were reprocessed in June 2007 by Olga Kosnyreva (WHOI) using the standard set of Seabird utilities, to generate final 1-decibar pressure sorted downtrace files for all CTD casts. All final processed *.cdn CTD files were downloaded by the OCB DMO on 31 November 2007 from the EDDIES web site:

http://science.whoi.edu/users/olga/eddies/data/2004_data/oc404-1/ctd/process_dim_olga/

A perl script was used by the DMO to extract data from the .cdn files. The event number, date, time, latitude and longitude position information were taken from the CTD header records in the .cdn data files. Data were reprocessed in March 2006 to extract secondary sensor data and add derived parameters. Data were reprocessed again in June 2007, to recalculate fluorometry data (chlorophyll) after comparison with data from Niskin bottle samples. Data from the ISUS Nitrate sensor (ISUS_NO3 and ISUS_ch2) were processed, but have been removed from the data set.

Final CTD station header record showing history of processing steps: oc404-1064.txt

* Sea-Bird SBE 9 Data File:
* FileName = C:\data\ctd\OC404064.dat
* Software Version Seasave Win32 V 5.28e
* Temperature SN = 4148
* Conductivity SN = 2147
* Number of Bytes Per Scan = 33
* Number of Voltage Words = 5
* Number of Scans Averaged by the Deck Unit = 1
* System UpLoad Time = Jul 02 2004 20:44:03
* NMEA Latitude = 30 29.69 N
* NMEA Longitude = 065 20.23 W
* NMEA UTC (Time) = 20:43:58
* Store Lat/Lon Data = Add to Header Only
** Ship: Oceanus
** Cruise: oc401
** Station:
** Latitude:
** Longitude:
# nquan = 18
# nvalues = 700
# units = metric
# name 0 = timeS: time [elapsed seconds]
# name 1 = pr: pressure [db]
# name 2 = t090: temperature, pri, ITS-90 [deg C]
# name 3 = t190: temperature, sec, ITS-90 [deg C]
# name 4 = c0S/m: conductivity, primary [S/m]
# name 5 = c1S/m: conductivity, secondary [S/m]
# name 6 = upoly0: userpoly 0
# name 7 = par: irradiance (PAR)
# name 8 = xmiss: transmissometer
# name 9 = upoly1: userpoly 1
# name 10 = upoly2: userpoly 2
# name 11 = sbeox0ML/L: Oxygen, SBE, primary [ml/l]
# name 12 = spar: surface irradiance (SPAR)
# name 13 = sal00: salinity, PSS-78 [PSU], T0, C0
# name 14 = sal11: salinity, PSS-78 [PSU], T1, C1
# name 15 = sigma-00: density, sigma-theta [kg/m^3], T0, C0
# name 16 = sigma-11: density, sigma-theta [kg/m^3], T1, C1
# name 17 = flag: 0.000e+00
# span 0 = -2.011, 828.894
# span 1 = 2.000, 701.000
# span 2 = 10.0357, 27.4485
# span 3 = 10.0361, 27.4289
# span 4 = 3.874357, 5.813657
# span 5 = 3.874476, 5.812706
# span 6 = -0.06516, 0.58357

span 7 = 2.4298e-05, 2.3963e+02
span 8 = 96.0186, 97.6244
span 9 = -0.21718, 0.75867
span 10 = 4.3368e-18, 4.3368e-18
span 11 = 3.29259, 5.50741
span 12 = 2.8190e+03, 2.9618e+03
span 13 = 35.3139, 36.7937
span 14 = 35.3149, 36.8041
span 15 = 23.9075, 27.2071
span 16 = 23.9186, 27.2081
span 17 = 0.0000e+00, 0.0000e+00
interval = decibars: 1
start_time = Jul 02 2004 20:44:03
bad_flag = -9.990e-29
sensor 0 = Frequency 0 temperature, primary, 4148, 10-Jan-2004
sensor 1 = Frequency 1 conductivity, primary, 2147, 01-Nov-03, cpcor = -9.5700e-08
sensor 2 = Frequency 2 pressure, 69685, 18 dec 2002
sensor 3 = Frequency 3 temperature, secondary, 2900, 10-Jan-2004
sensor 4 = Frequency 4 conductivity, secondary, 2707, 08-Jan-2004, cpcor = -9.5700e-08
sensor 5 = Extrnl Volt 1 userpoly 0, 013, 12/09/2002
sensor 6 = Extrnl Volt 2 irradiance (PAR), 4600, 21-Aug-2000
sensor 7 = Extrnl Volt 3 transmissometer, 537DR, 12/10/2002
sensor 8 = Extrnl Volt 4 userpoly 1, ISIS_NO3
sensor 9 = Extrnl Volt 5 userpoly 2, ISUS_ch2
sensor 10 = Extrnl Volt 6 Oxygen, SBE, primary, 0264, 04-Mar-2004
sensor 11 = Extrnl Volt 9 surface irradiance (SPAR), degrees = 0.0
datcnv_date = Jun 09 2007 00:02:10, 4.249
datcnv_in = OC404064.DAT OC404_1.CON
datcnv_skipover = 0
wildedit_date = Jun 09 2007 00:05:19, 4.249
wildedit_in = OC404064.CNV
wildedit_pass1_nstd = 2.0
wildedit_pass2_nstd = 20.0
wildedit_pass2_mindelta = 1.000e-003
wildedit_npoint = 100
wildedit_vars = timeS pr t090 t190 c0S/m c1S/m upoly0 par xmiss upoly1 upoly2 sbeox0ML/L spar
wildedit_excl_bad_scans = yes
filter_date = Jun 09 2007 00:07:10, 4.249
filter_in = OC404064.CNV
filter_low_pass_tc_A = 0.030
filter_low_pass_tc_B = 0.150
filter_low_pass_A_vars = c0S/m c1S/m
filter_low_pass_B_vars = pr
loopedit_date = Jun 09 2007 00:11:02, 4.249
loopedit_in = OC404064.CNV
loopedit_minVelocity = 0.100
loopedit_excl_bad_scans = yes
alignctd_date = Jun 09 2007 00:13:00, 4.249

alignctd_in = OC404064.CNV
alignctd_cond_advSecs = 0.000, 0.000
alignctd_temp_advSecs = 0.000, 0.000
alignctd_oxygen_current_advSecs = 0.000, 0.000
alignctd_oxygen_temp_advSecs = 0.000, 0.000
alignctd_wetstar_advSecs = 0.000
alignctd_varInd_advSecs = v11 6.000
binavg_date = Jun 09 2007 00:14:52, 4.249
binavg_in = OC404064.CNV
binavg_bintype = Pressure Bins
binavg_binsize = 1.00
binavg_excl_bad_scans = yes
binavg_downcast_only = no
binavg_skipover = 0
binavg_surface_bin = no, min = 0.000, max = 0.000, value = 0.000
derive_date = Jun 09 2007 00:16:51, 4.249
derive_in = OC404064.CNV OC404_1.CON
split_date = Jun 09 2007 00:16:56, 4.249
split_in = OC404064.CNV
split_excl_bad_scans = yes
file_type = ascii
END

Final CTD station configuration report files:

ConReport file station 1 and 2

```
Date: 06/11/2007

ASCII file: C:\olga\oc404\ctd\OC404_1_dim_olga_sts_1_2_final.con

Configuration report for SBE 911/917 plus CTD
---------------------------------------------

Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : Yes
NMEA position data added      : Yes
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 4148
   Calibrated on : 10-Jan-2004
   G             : 4.37334110e-003
   H             : 6.61218005e-004
   I             : 2.43690559e-005
   J             : 2.06100587e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity

   Serial number : 2147
   Calibrated on : 01-Nov-03
   G             : -1.03409814e+001
   H             : 1.44457231e+000
   I             : -2.76762621e-003
   J             : 2.55865529e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 69685
   Calibrated on : 18 dec 2002
   C1            : -4.680530e+004
   C2            : -8.320595e-001
   C3            : 1.450810e-002
   D1            : 3.903100e-002
   D2            : 0.000000e+000
   T1            : 3.038361e+001
   T2            : -5.411459e-004
   T3            : 4.085080e-006
```

T4 : 2.564540e-009
T5 : 0.000000e+000
Slope : 0.99995000
Offset : -0.54220
AD590M : 1.280820e-002
AD590B : -9.210198e+000

4) Frequency 3, Temperature, 2

Serial number : 2900
Calibrated on : 10-Jan-2004
G : 4.32911701e-003
H : 6.44107572e-004
I : 2.32868553e-005
J : 2.25293752e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 2707
Calibrated on : 08-Jan-2004
G : -1.07300026e+001
H : 1.56055977e+000
I : -1.61614292e-003
J : 2.14476060e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Free

7) A/D voltage 1, User Polynomial

Serial number : 013
Calibrated on : 12/09/2002
Sensor name : Fluorometer, Wetlab ECO-AFL/FL
A0 : -3.15810000
A1 : 16.31530000
A2 : 0.00000000
A3 : 0.00000000

8) A/D voltage 2, PAR/Irradiance, Biospherical/Licor

Serial number : 4600
Calibrated on : 21-Aug-2000
M : 1.00000000
B : 0.00000000
Calibration constant : 357142857.00000000
Multiplier : 1.00000000
Offset : -3.83600000

9) A/D voltage 3, Transmissometer, Chelsea/Seatech/Wetlab CStar

Serial number : 537DR

Calibrated on : 12/10/2002
M : 21.4097
B : -1.2203
Path length : 0.250

10) A/D voltage 4, User Polynomial, 2

Serial number : ISIS_NO3
Calibrated on :
Sensor name : ISUS_NO3
A0 : -3.24600000
A1 : 25.80400000
A2 : 0.00000000
A3 : 0.00000000

11) A/D voltage 5, User Polynomial, 3

Serial number : ISUS_ch2
Calibrated on :
Sensor name : ISUS_channel 2
A0 : 0.00000000
A1 : 1.00000000
A2 : 0.00000000
A3 : 0.00000000

12) A/D voltage 6, Oxygen, SBE 43

Serial number : 0264
Calibrated on : 04-Mar-2004
Soc : 4.0150e-001
Boc : 0.0000
Offset : -0.5824
Tcor : 0.0005
Pcor : 1.35e-004
Tau : 0.0

13) A/D voltage 7, Free

14) SPAR voltage, Unavailable

15) SPAR voltage, SPAR/Surface Irradiance

Serial number : 6294
Calibrated on : 04/21/97
Conversion factor : 1671.77000000
Ratio multiplier : 1.00000000

ConReport file station 9

```
Date: 06/11/2007

ASCII file: C:\olga\oc404\ctd\OC404_1_deep_dim_olga_final.con

Configuration report for SBE 911/917 plus CTD
---------------------------------------------

Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : Yes
NMEA position data added      : Yes
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 4148
   Calibrated on : 10-Jan-2004
   G             : 4.37334110e-003
   H             : 6.61218005e-004
   I             : 2.43690559e-005
   J             : 2.06100587e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity

   Serial number : 2147
   Calibrated on : 01-Nov-03
   G             : -1.03409814e+001
   H             : 1.44457231e+000
   I             : -2.76762621e-003
   J             : 2.55865529e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 69685
   Calibrated on : 18 dec 2002
   C1            : -4.680530e+004
   C2            : -8.320595e-001
   C3            : 1.450810e-002
   D1            : 3.903100e-002
   D2            : 0.000000e+000
   T1            : 3.038361e+001
   T2            : -5.411459e-004
   T3            : 4.085080e-006
   T4            : 2.564540e-009
   T5            : 0.000000e+000
```

```
   Slope         : 0.99995000
   Offset        : -0.54220
   AD590M        : 1.280820e-002
   AD590B        : -9.210198e+000

4) Frequency 3, Temperature, 2

   Serial number : 2900
   Calibrated on : 10-Jan-2004
   G             : 4.32911701e-003
   H             : 6.44107572e-004
   I             : 2.32868553e-005
   J             : 2.25293752e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

5) Frequency 4, Conductivity, 2

   Serial number : 2707
   Calibrated on : 08-Jan-2004
   G             : -1.07300026e+001
   H             : 1.56055977e+000
   I             : -1.61614292e-003
   J             : 2.14476060e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

6) A/D voltage 0, Free

7) A/D voltage 1, User Polynomial

   Serial number : 013
   Calibrated on : 12/09/2002
   Sensor name   : Fluorometer, Wetlab ECO-AFL/FL
   A0            : -3.15810000
   A1            : 16.31530000
   A2            : 0.00000000
   A3            : 0.00000000

8) A/D voltage 2, Free

9) A/D voltage 3, Transmissometer, Chelsea/Seatech/Wetlab CStar

   Serial number : 537DR
   Calibrated on : 12/10/2002
   M             : 21.4097
   B             : -1.2203
   Path length   : 0.250

10) A/D voltage 4, Free

11) A/D voltage 5, Free

12) A/D voltage 6, Oxygen, SBE 43
```

Serial number : 0264
Calibrated on : 04-Mar-2004
Soc : 4.0150e-001
Boc : 0.0000
Offset : -0.5824
Tcor : 0.0005
Pcor : 1.35e-004
Tau : 0.0

13) A/D voltage 7, Free

14) SPAR voltage, Unavailable

15) SPAR voltage, SPAR/Surface Irradiance

Serial number : 6294
Calibrated on : 04/21/97
Conversion factor : 1671.77000000
Ratio multiplier : 1.00000000

ConReport file station 3-65 (except 9)

```
Date: 06/11/2007

ASCII file: C:\olga\oc404\ctd\OC404_1_dim_olga_sts_3_65_final.con

Configuration report for SBE 911/917 plus CTD
---------------------------------------------

Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : Yes
NMEA position data added      : Yes
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 4148
   Calibrated on : 10-Jan-2004
   G             : 4.37334110e-003
   H             : 6.61218005e-004
   I             : 2.43690559e-005
   J             : 2.06100587e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity

   Serial number : 2147
   Calibrated on : 01-Nov-03
   G             : -1.03409814e+001
   H             : 1.44457231e+000
   I             : -2.76762621e-003
   J             : 2.55865529e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 69685
   Calibrated on : 18 dec 2002
   C1            : -4.680530e+004
   C2            : -8.320595e-001
   C3            : 1.450810e-002
   D1            : 3.903100e-002
   D2            : 0.000000e+000
   T1            : 3.038361e+001
   T2            : -5.411459e-004
   T3            : 4.085080e-006
   T4            : 2.564540e-009
   T5            : 0.000000e+000
```

Slope : 0.99995000
Offset : -0.54220
AD590M : 1.280820e-002
AD590B : -9.210198e+000

4) Frequency 3, Temperature, 2

Serial number : 2900
Calibrated on : 10-Jan-2004
G : 4.32911701e-003
H : 6.44107572e-004
I : 2.32868553e-005
J : 2.25293752e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 2707
Calibrated on : 08-Jan-2004
G : -1.07300026e+001
H : 1.56055977e+000
I : -1.61614292e-003
J : 2.14476060e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Free

7) A/D voltage 1, User Polynomial

Serial number : 013
Calibrated on : 12/09/2002
Sensor name : Fluorometer, Wetlab ECO-AFL/FL
A0 : -3.15810000
A1 : 16.31530000
A2 : 0.00000000
A3 : 0.00000000

8) A/D voltage 2, PAR/Irradiance, Biospherical/Licor

Serial number : 4600
Calibrated on : 21-Aug-2000
M : 1.00000000
B : 0.00000000
Calibration constant : 357142857.00000000
Multiplier : 1.00000000
Offset : -3.83600000

9) A/D voltage 3, Transmissometer, Chelsea/Seatech/Wetlab CStar

Serial number : 537DR
Calibrated on : 12/10/2002
M : 21.4097

```
   B             : -1.2203
   Path length   : 0.250

10) A/D voltage 4, User Polynomial, 2

    Serial number : ISIS_NO3
    Calibrated on :
    Sensor name   : ISUS_NO3
    A0            : -0.32100000
    A1            : 2.57950000
    A2            : 0.00000000
    A3            : 0.00000000

11) A/D voltage 5, User Polynomial, 3

    Serial number : ISUS_ch2
    Calibrated on :
    Sensor name   : ISUS_channel 2
    A0            : 0.00000000
    A1            : 1.00000000
    A2            : 0.00000000
    A3            : 0.00000000

12) A/D voltage 6, Oxygen, SBE 43

    Serial number : 0264
    Calibrated on : 04-Mar-2004
    Soc           : 4.0150e-001
    Boc           : 0.0000
    Offset        : -0.5824
    Tcor          : 0.0005
    Pcor          : 1.35e-004
    Tau           : 0.0

13) A/D voltage 7, Free

14) SPAR voltage, Unavailable

15) SPAR voltage, SPAR/Surface Irradiance

    Serial number     : 6294
    Calibrated on     : 04/21/97
    Conversion factor : 1671.77000000
    Ratio multiplier  : 1.00000000
```

Two README files were also contributed by Olga Kosnyreva:

processing notes README (dimensional processing)

```
OC404-1 CTD Dimensional processing by Olga



CON files used for processing:
------------------------------

1. CON file used for Stations #1 and #2 processing:

Filename: OC404_1_dim_olga_sts_1_2_final.con
Source:   OC404-1_ISUS_0_100_right.con


2. CON file used for Stations #9 processing:

Filename: OC404_1_deep_dim_olga_st_9_final.con
Source:   OC404-1_deep.con
NOTE: Voltages 2, 4 and 5 are free (sensors have been removed)


3. CON file used for Stations ## 3:65 (excluding stations #9) processing:

Filename: OC404_1_dim_olga_sts_3_65_final.con
Source:  OC404-1_ISUS_0_10_right.con
NOTE from Dennis' email 5/5/2007:


NOTES from the cruise:

ISUS sensitivity changed from 0-100 to 0-10 micromolar.Configuration files:
    OC404-1_ISUS_0_100_wrong.con (originally used for casts 1 and 2)
    OC404-1_ISUS_0_100_right.con (casts 1+2 need to be reprocessed with this)
    OC404-1_ISUS_0_10.con (starting with cast 3)


CHANGES in the FINAL processing CON files in comparison with the source CON
files:
--------------------------------------------------------------------------
-----
1. The name of sensor connected with Voltage 1 changed from "Fluorometer" to
"UserPoly0". Automatically Voltages 4 and 5 sensors become "UserPoly1" and
"UserPoly2" (originaly "UserPoly0" "UserPoly1").

Fluorometer calibration coefficients have been corrected:
    to fit the difference between the formulas used by Seabird Seasoft for
"UserPoly0" and "Fluorometer";
    to fit Bottles Chlorophyll a plus Phaeopigments data.

2. Oxygen calibration coefficients Soc and Voffset have been corrected -
calculated at minimum(chi), where

chi=sum((OxyCTD-OxyWinkler)^2/OxyWinkler).
```

NEW Module added to Processing - Align CTD to advance Oxygen relative to Pressure with delay time mean_DT=6sec:
---
mean_DT is the average of DT calculated for each of 10 stations from the OC404-1 cruise with DT=1:10 seconds at minimum of sum((OxyDown-OxyUp)^2).

CTD Fluorescence README

EDDIES 2004, 2005 cruises
CTD Fluorescence Notes

1) OC415-1 two fluorometers.

There were two CTD fluorometers during the OC415-1 cruise time.
Fluorometer #1, Voltage 1 - did not work properly;
Starting from station #24 new Fluorometer #2, Voltage 3 has been installed on CTD replacing the Seapoint turbidity meter.

So, correct Fluorescens data in CTD data files is:
name 7 = upoly1: userpoly 1 Extrnl Volt 3 userpoly 1, flrtd-297, 6/27/05
and is available only starting from the station #24. Please see CTD data heders:

Stations ## 1-23:
name 6 = upoly0: userpoly 0 Extrnl Volt 1 userpoly 0, afl013, 12/09/2002
name 7 = seaTurbMtr0: seapoint turbidity meter [FTU] Extrnl Volt 3 seapoint turbidity meter, 1660

Stations ## 24-81:
name 6 = upoly0: userpoly 0 Extrnl Volt 1 userpoly 0, afl013, 12/09/2002
name 7 = upoly1: userpoly 1 Extrnl Volt 3 userpoly 1, flrtd-297, 6/27/05

Note that 'bad' Fluorometer #1 has not been removed from CTD as well as the related data from CTD data files.

2) CTD Fluorescence data correction versus Bottles Chlorophyll plus Phaeopigments.

OC404-1 and OC404-4 Fluorescence has been corrected opposite Bottles Chlorophyll plus Phaeopigments.

OC415-1 and OC415-3 Fluorescence has not been corrected in processed data files and can be corrected by computing using Bottles Chlorophyll plus Phaeopigments data.

Note that OC404-1 and OC404-4 Fluorescence profiles are kind of noisy and there are some surface outliers (~3-10 times of Bottle measurement, e.g. OC404-1 stations ## 2, 5, 12, 22, 23)

Several parameters were calculated using MATLAB Physical Properties of Seawater Toolbox and then added to the CTD cast data by the OCB DMO:

Depth [sw_dpth.m]

Z=sw_dpth(P,LAT); % avg LAT = 31 North

```
function DEPTHM = sw_dpth(P,LAT)

% SW_DPTH    Depth from pressure
%==========================================================================
% SW_DPTH   $Id: sw_dpth.m,v 1.1 2003/12/12 04:23:22 pen078 Exp $
%           Copyright (C) CSIRO, Phil Morgan 1992.
%
% USAGE:  dpth = sw_dpth(P,LAT)
%
% DESCRIPTION:
%    Calculates depth in metres from pressure in dbars.
%
% INPUT:  (all must have same dimensions)
%   P   = Pressure    [db]
%   LAT = Latitude in decimal degress north [-90..+90]
%         (lat may have dimensions 1x1 or 1xn where P(mxn).
%
% OUTPUT:
%  dpth = depth [metres]
%
% AUTHOR:  Phil Morgan 92-04-06  (morgan@ml.csiro.au)
%
% DISCLAIMER:
%   This software is provided "as is" without warranty of any kind.
%   See the file sw_copy.m for conditions of use and licence.
%
% REFERENCES:
%    Unesco 1983. Algorithms for computation of fundamental properties of
%    seawater, 1983. _Unesco Tech. Pap. in Mar. Sci._, No. 44, 53 pp.
%==========================================================================

% Modifications
% 99-06-25. Lindsay Pender, Fixed transpose of row vectors.

% CALLER:  general purpose
% CALLEE:  none
```

```
%-------------
% CHECK INPUTS
%-------------
[mP,nP] = size(P);
[mL,nL] = size(LAT);
if mL==1 & nL==1                    % LAT scalar - fill to size of P
  LAT = LAT*ones(size(P));

elseif nP == nL & mL == 1           % LAT is row vector
  LAT = LAT(ones(1, mP), :);        % Coppy down each column

elseif mP == mL & nL == 1           % LAT is column vector
  LAT = LAT(:, ones(1, nP));        % Copy across each row

elseif mP == mL & nP == nL
  % Ok

else
   error('sw_depth.m:  Inputs arguments have wrong dimensions')
end %if

%-------------
% BEGIN
%-------------
% Eqn 25, p26.  Unesco 1983.

DEG2RAD = pi/180;
c1 = +9.72659;
c2 = -2.2512E-5;
c3 = +2.279E-10;
c4 = -1.82E-15;
gam_dash = 2.184e-6;

LAT = abs(LAT);
X   = sin(LAT*DEG2RAD);  % convert to radians
X   = X.*X;
bot_line = 9.780318*(1.0+(5.2788E-3+2.36E-5*X).*X) + gam_dash*0.5*P;
top_line = (((c4*P+c3).*P+c2).*P+c1).*P;
DEPTHM   = top_line./bot_line;
return
%=========================================================================
%
```

Potential Temperature [sw_ptmp.m]

potemp=sw_ptmp(S,T90,P,0);

```
function PT = sw_ptmp(S,T,P,PR)
```

```
% SW_PTMP    Potential temperature
%==========================================================================
% SW_PTMP  $Id: sw_ptmp.m,v 1.1 2003/12/12 04:23:22 pen078 Exp $
%          Copyright (C) CSIRO, Phil Morgan 1992.
%
% USAGE:  ptmp = sw_ptmp(S,T,P,PR)
%
% DESCRIPTION:
%    Calculates potential temperature as per UNESCO 1983 report.
%
% INPUT:  (all must have same dimensions)
%   S  = salinity    [psu      (PSS-78) ]
%   T  = temperature [degree C (ITS-90)]
%   P  = pressure    [db]
%   PR = Reference pressure  [db]
%        (P & PR may have dims 1x1, mx1, 1xn or mxn for S(mxn) )
%
% OUTPUT:
%   ptmp = Potential temperature relative to PR [degree C (ITS-90)]
%
% AUTHOR:  Phil Morgan 92-04-06, Lindsay Pender (Lindsay.Pender@csiro.au)
%
% DISCLAIMER:
%   This software is provided "as is" without warranty of any kind.
%   See the file sw_copy.m for conditions of use and licence.
%
% REFERENCES:
%    Fofonoff, P. and Millard, R.C. Jr
%    Unesco 1983. Algorithms for computation of fundamental properties of
%    seawater, 1983. _Unesco Tech. Pap. in Mar. Sci._, No. 44, 53 pp.
%    Eqn.(31) p.39
%
%    Bryden, H. 1973.
%    "New Polynomials for thermal expansion, adiabatic temperature gradient
%    and potential temperature of sea water."
%    DEEP-SEA RES., 1973, Vol20,401-408.
%==========================================================================

% Modifications
% 99-06-25. Lindsay Pender, Fixed transpose of row vectors.
% 03-12-12. Lindsay Pender, Converted to ITS-90.

% CALLER:  general purpose
% CALLEE:  sw_adtg.m

%-------------
% CHECK INPUTS
%-------------
if nargin ~= 4
   error('sw_ptmp.m: Must pass 4 parameters ')
end %if

% CHECK S,T,P dimensions and verify consistent
[ms,ns] = size(S);
[mt,nt] = size(T);
[mp,np] = size(P);
```

```
[mpr,npr] = size(PR);


% CHECK THAT S & T HAVE SAME SHAPE
if (ms~=mt) | (ns~=nt)
   error('check_stp: S & T must have same dimensions')
end %if

% CHECK OPTIONAL SHAPES FOR P
if     mp==1  & np==1      % P is a scalar.  Fill to size of S
   P = P(1)*ones(ms,ns);
elseif np==ns & mp==1      % P is row vector with same cols as S
   P = P( ones(1,ms), : ); %   Copy down each column.
elseif mp==ms & np==1      % P is column vector
   P = P( :, ones(1,ns) ); %   Copy across each row
elseif mp==ms & np==ns     % PR is a matrix size(S)
   % shape ok
else
   error('check_stp: P has wrong dimensions')
end %if
[mp,np] = size(P);


% CHECK OPTIONAL SHAPES FOR PR
if     mpr==1  & npr==1      % PR is a scalar.  Fill to size of S
   PR = PR(1)*ones(ms,ns);
elseif npr==ns & mpr==1      % PR is row vector with same cols as S
   PR = PR( ones(1,ms), : ); %   Copy down each column.
elseif mpr==ms & npr==1      % P is column vector
   PR = PR( :, ones(1,ns) ); %   Copy across each row
elseif mpr==ms & npr==ns     % PR is a matrix size(S)
   % shape ok
else
  error('check_stp: PR has wrong dimensions')
end %if

%***check_stp

%------
% BEGIN
%------

% theta1
del_P  = PR - P;
del_th = del_P.*sw_adtg(S,T,P);
th     = T * 1.00024 + 0.5*del_th;
q      = del_th;

% theta2
del_th = del_P.*sw_adtg(S,th/1.00024,P+0.5*del_P);
th     = th + (1 - 1/sqrt(2))*(del_th - q);
q      = (2-sqrt(2))*del_th + (-2+3/sqrt(2))*q;

% theta3
del_th = del_P.*sw_adtg(S,th/1.00024,P+0.5*del_P);
th     = th + (1 + 1/sqrt(2))*(del_th - q);
q      = (2 + sqrt(2))*del_th + (-2-3/sqrt(2))*q;
```

```
% theta4
del_th = del_P.*sw_adtg(S,th/1.00024,P+del_P);
PT     = (th + (del_th - 2*q)/6)/1.00024;
return
%==========================================================================
```