9 July, 2001

ARGOS Emails

Profiling floats, once surfaced, continually transmit its profile data to satellites passing overhead until its next descent. A particular profile data set can contain 15 messages (the number depends on the number of temperature measurements per profile programmed into the float) with the first message containing information about the profile (see Data Format for message number 1). Messages 2 and higher contain the parameter measurements. For each satellite transmission, ARGOS captures the data, attaches a station header to the transmission data(see sample message) and then sends the messages to MEDS in 32 byte hex messages via ftp files.

Data Format:

Format for message number 1 only:
Byte #

- 01 **CRC**, described below.
- 02 **Message number**, assigned sequentially to each 32 byte message. Messages are transmitted in sequential order starting with 1 and incrementing by one for the data set.
- 03 **Message block number**, begins as 1 and increments by one for every ARGOS message data set. This, combined with the ARGOS repetition rate, allows the user to track surface drift. Byte 03 with roll-over at 256 and will reset to 1 on each new profile.
- 04 & 05 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
- 06 **Profile number**, begins with 1 and increases by one for every float ascent.
- 07 **Profile length**, is the number of six byte STD measurements in the profile. Total number of bytes of STD data from each profile depends on the sampling strategy chosen.
- 08 **Profile termination flag byte**, can have the following Values(hex):
  - 00 Pressure reached surface pressure.
  - 02 Pressure reached zero.
  - 04 Pressure unchanged for 25 minutes. (Does not terminate profile.)
  - 08 Piston fully extended before surface.
- 09 **Piston position**, recorded as the instrument reaches the surface.
- 10 & 11 **Pump motor time**, in two second intervals.
- 12 **Battery voltage**, at initial pump extension completion.
- 13 **Profile piston position**, in counts(Park and profile only)
- 14 **Surface piston position**, in counts
- 15 **Air bladder pressure**, in counts
- 16 & 17 **Bottom temperature**, sampled just before instrument begins ascent (see below).
- 18 & 19 **Bottom salinity**, sampled just before instrument begins ascent (see sample output).
- 20 & 21 **Bottom pressure**, sampled just before instrument begins ascent (see above).
- 22 **Battery voltage**, no load.
- 23 & 24 **Surface pressure**, as recorded just before last descent with an offset of +5db.
- 25 **Internal vacuum**, as recorded just before last descent.

26 **Piston position at bottom**, in counts.
27 to 32 6 bytes in sequence: (see sample output)
2 bytes **temperature**
2 bytes **salinity**
2 bytes **pressure**

From the above information MEDS uses the following:
CRC - (see below)
Message number - to know which message does not contain parameter measurements
Profile number – to help determine if a profile has not yet been received
Profile length – to help determine if a profile or TESAC is complete
Bottom temperature, salinity, pressure – to know deepest depth and measurements at that depth
Bytes 27 to 32 – gives the second measurements taken

Format for message number 2 and higher: (see sample message)
Byte #
01 **CRC**, described below.
02 **Message number**
03 to 32 6 bytes in sequence:
2 bytes **temperature**
2 bytes **salinity**
2 bytes **pressure**
All information is used to create a complete profile or TESAC.

Message Format and Sampling Depths

BYTE #	MSG 1
16 & 17	Tb*
18 & 19	Sb*
20 & 21	Pb*
23 & 24	Ps**
27 & 28	T1***
29 & 30	S1***
31 & 32	P1***

BYTE #	MSG 2	MSG 3	MSG 4	MSG 5	MSG 6	MSG 7	MSG 8
3 & 4	T2	T7	T12	T17	T22	T27	T32
5 & 6	S2	S7	S12	S17	S22	S27	S32
7 & 8	P2	P7	P12	P17	P22	P27	P32
9 & 10	T2	T8	T13	T18	T23	T28	T33
11 & 12	S3	S8	S13	S18	S23	S28	S33
13 & 14	P3	P8	P13	P18	P23	P28	P33
15 & 16	T4	T9	T14	T19	T24	T29	T34
17 & 18	S4	S9	S14	S19	S24	S29	S34

19 & 20	P4	P9	P14	P19	P24	P29	P34
21 & 22	T5	T10	T15	T20	T25	T30	T35
23 & 24	S5	S10	S15	S20	S25	S30	S35
25 & 26	P5	P10	P15	P20	P25	P30	P35
27 & 28	T6	T11	T16	T21	T26	T31	T36
29 & 30	S6	S11	S16	S21	S26	S31	S36
31 & 32	P6	P11	P16	P21	P26	P31	P36

BYTE #	**MSG 9**	**MSG 10**	**MSG 11**	**MSG 12**	**MSG 13**	**MSG 14**	**MSG 15**
3 & 4	T37	T42	T47	T52	T57	T62	T67
5 & 6	S37	S42	S47	S52	S57	S62	S67
7 & 8	P37	P42	P47	P52	P57	P62	P67
9 & 10	T38	T43	T48	T53	T58	T63	T68
11 & 12	S38	S43	S48	S53	S58	S63	S68
13 & 14	P38	P43	P48	P53	P58	P63	P68
15 & 16	T39	T44	T49	T54	T59	T64	T69
17 & 18	S39	S44	S49	S54	S59	S64	S69
19 & 20	P39	P44	P49	P54	P59	P64	P69
21 & 22	T40	T45	T50	T55	T60	T65	T70
23 & 24	S40	S45	S50	S55	S60	S65	S70
25 & 26	P40	P45	P50	P55	P60	P65	P70
27 & 28	T41	T46	T51	T56	T61	T66	FFFF
29 & 30	S41	S46	S51	S56	S61	S66	FFFF
31 & 32	P41	P46	P51	P56	P61	P66	FFFF

***** Tb, Sb, and Pb are bottom Temperature, Salinity, and Pressure values
** Ps is surface Pressure
*** T, S, and P are Temperature, Salinity, and Pressure values
**** FFFF: Invalid data points

Data format table above assumes that bottom pressure (maximum hydrostatic pressure at start of profile) is 2000dbar. Data format will change if bottom pressure varies.

APEX records a profile during ascent (i.e. upcast). Bottom pressure may change due to several causes, such as variation of insitu density, internal waves, float grounding in shallows, change of float mass, etc. APEX automatic depth adjustment will compensate in most, but not all, cases. Actual bottom pressure is transmitted as bytes 20 & 21 of message one.

Number of sample points is proportional to depth. The first (i.e. deepest) sample is taken at the first point in the depth table above bottom pressure, and is designated as T1, S1, P1 in the table above.

CRC

Because ARGOS data may contain transmission errors, the first byte of each message contains an error checking value. This value is a Cyclic Redundancy Check(CRC), and is calculated as a function of the message content (bytes 2 to 32).

MEDS also calculates a CRC value for each message received and compares it to the transmitted CRC (Byte # 01). If the calculated and transmitted CRC values are not equal, the message has been corrupted and is deleted before further processing.

Test Message Format:

The test message is sent whenever an I2 command is given, the six transmissions during the startup cycle, and during the six hour surface mode period prior to the first dive. Each test message, containing information about the instrument, also has 32 bytes in hex, with the following format:

Byte#

01 **CRC**, described above.
02 **Message block number**, begins as 1 and increments by one for every ARGOS message.
03 & 04 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
05 **Hour**, the following is the time from startup (in decimal).
06 **Minutes**.
07 **Seconds**.
08 **Flat (2) byte,** see below.
09 & 10 **Current pressure.**
11 **Battery voltage**, nominally at 15 volts.
12 **Current bladder pressure**, in counts.
13 **Flag (1) byte,** see below.
14 **Up** time, intervals.
15 & 16 **Down** time, intervals.
17 **Trip interval** time, hours.
18 & 19 **Profile pressure**, in centibars.
20 **Profile piston position**, in counts.
21 **Depth correction factor**, in counts.
22 **Ballast piston position**, in counts.
23 **Fully extended piston position**, in counts.
24 **OK vacuum count at launch**, nominally 2 inches Hg.
25 **Ascend time,** intervals
26 **Target bladder position.**
27 & 28 **Park pressure,** (for use in park and profile floats only).
29 **Park piston position**, (for use in park and profile floats only).
30 **Month**, software version number (in decimal).
31 **Day**, software version number (in decimal).
32 **Year**, software version number (in decimal).

Flag (2) Byte		**Flag (1) Byte**	
Bit		Bit	
1	Unused	1	Trip interval time
2	Pressure reached zero	2	Profile in progress
3	25 minute next Press time out	3	Timer done
4	Piston fully extended	4	UP/DOWN
5	Ascend time out	5	Data entry error
6	Test message at turn on	6	Unused
7	Six hour surface message	7	Piston motor running
8	Arithmetic round up	8	Negative SBE number

Sample Message:

Below is an example of an ARGOS email made up of three satellite transmissions. Each transmission has a "station" line and one or more message blocks containing the parameter measurements (as described by the Data Format for messages 2 and higher) and represents the data received from one satellite pass. There must be at least 4 message blocks in a pass in order for the location of the float to be determined. If there are fewer than four, the station line contains no date or location, although some data were received. The data are kept and given the date and time of the previous message but with a quality flag of '3' on the location to indicate this uncertainty.

Generally, there is more than one float reporting in any particular ARGOS email which are listed in numerical order. As shown in the example, message blocks are not always picked up by the satellite in a sequential order. The first satellite pass received messages 03, 05, 06, 07, 09 and missed 04 and 08. Message 04 was received in the second pass as well as duplicates 05 and 06. Therefore, the 15 messages containing data for one profile are usually contained in more than one ARGOS email.

Description of "station" line:

FIELD	CONTENTS
09704	Argos Program number
20919	Argos ptt identifier
41	The number of lines in this satellite transmission
32	The number of bytes in a single message block
K	The satellite that received the transmission (NOAA K)
1	The location class (can be 0, 1, 2, 3, / WMO code table 3302)

2000-02-02	Date (as YYYY-MM-DD: 2, Feb, 2000)
18:55:36	Time of the satellite location fix as HH:MM:SS
49.306	Latitude (decimal degrees, north of the equator)
227.725	Longitude (decimal degrees, east of Greenwich)
0.000	Altitude of the measurements (i.e. 0 = sea level)
401647116	Frequency of the satellite transmission
2000-02-02	Date that the message was sent
18:51:06	Time that the message was sent
1	Number of repeats of this message in the transmission

(Red hex byte refers to message number, see Sample Output message 03 for other color references)

09704 20919 41 32 K 1 2000-02-02 18:55:36 49.306 227.725 0.000 401647116

2000-02-02 18:51:06 1	9B	03	**0F**	**8F**
	A2	**D9**	**18**	**32**
	0F	**BA**	**A1**	**F4**
	17	**6B**	**0F**	**D3**
	A1	**7A**	**16**	**A4**
	10	**26**	**A1**	**1B**
	15	**D6**	**10**	**48**
	A0	**8D**	**15**	**11**
2000-02-02 18:54:06 1	A2	05	11	84
	9C	6F	10	64
	11	F1	9B	B7
	0F	99	12	37
	9B	25	0F	03
	12	81	9A	BA
	0E	6D	12	C1
	9A	83	4D	D3
2000-02-02 18:55:36 1	8D	06	13	2E
	9A	4D	0D	40
	13	84	94	13
	0C	AE	13	F5
	99	E0	0C	17
	14	78	99	B8
	0B	80	15	09
	99	A4	0A	EB
2000-02-02 18:57:06 1	75	07	15	B3
	99	B2	0A	54
	16	49	99	94
	09	BF	16	BF
	99	7C	09	27
	17	39	99	5C
	08	94	17	E7
	99	49	07	FD
2000-02-02 19:00:06 1	F6	09	1A	CB

				96	DD	05	CB
				1B	2B	93	5C
				05	42	1B	3B
				91	5B	04	DD
				1B	76	8E	06
				04	77	1B	75
				83	FB	04	16
09704	**20919**	**25**	**32**	**J**				
	2000-02-02	20:48:06	1	37	04	10	BE
				A0	56	14	4B
				10	EA	9F	01
				12	82	19	1A
				8E	71	13	B6
				11	0C	9D	83
				11	F0	11	62
				9D	2D	09	29
	2000-02-02	20:49:36	1	A2	05	11	84
				9C	6F	10	64
				11	F1	9B	B7
				0F	99	12	37
				9B	25	0F	03
				12	81	9A	BA
				0E	6D	12	C1
				9A	83	0D	D9
	2000-02-02	20:51:06	1	8D	06	93	2E
				9A	4D	0D	40
				13	84	9A	13
				0C	AE	13	F5
				99	E0	0C	17
				14	78	99	B8
				0B	80	15	09
				99	A9	0A	EB
09704	**20919**	**65**	**32**	**J**	**1**	**2000-02-02**	**22:29:20**	**49.294**	**227.734**	**0.000**	**401647115**
	2000-02-02	22:24:05	1	F4	02	0E	35
				A5	44	1C	4C
				0E	77	A4	D7

The pressure is measured every 6 seconds. Temperature, salinity and pressure are measured and stored at each point in the depth table. Depth table (in db) for this example:

Bottom, 800, 775, 750, 725, 700, 680, 660, 640, 620, 600, 580, 560, 540, 520, 500, 480, 460, 440, 420, 400, 385, 370, 355, 340, 325, 310, 295, 280, 265, 250, 235, 220, 205, 195, 185, 175, 165, 155, 145, 135, 125, 115, 105, 95, 85, 75, 65, 55, 45, 35, 25, 15, 5, or surface

Note: Surface measurement has an offset of 5 db as a stop profiling point so as to leave the Sea-Bird cell full of water while transmitting.

Two hex bytes are stored for each sensor. The decimal numbers from the STD sensors are converted to hex for compression in the ARGOS messages as follows:

Temperature: first 5 digits, 1 milli-degree resolution.
Salinity: 5 digits
Pressure: first 5 digits, 10 cm resolution.

To convert the hex ARGOS message back to decimal numbers:

	Hex →	dec	=	converted	units
Temperature:	3EA6 →	16038	=	16.038	C
Temperature*:	F58B	02677	=	-2.677	C
Salinity**:	8FDD →	36829	=	36.829	
Pressure:	1D4C →	7500	=	750.0	decibars

*Any minus temperatures are 2s complemented. –0.1808 rounds to –0.181 and converts to FF4B(181 is B5 hex and 0 – B5 = FF4B). Positive temperatures will take the range of 0 to 62.535C (0 to F447 hex) and negative temperatures will take the range of –0.001 to –3.000C (FFFF to F448 hex). In practice, the positive temperatures work from 0 hex up and the negative temperatures work from FFFF hex down.

**The 5 most significant salinity digits are telemetered. The 6 digit salinity number is rounded up and converted to hex. 36.8286 rounds to 36.829 and converts to 8FDD.

Some knowledge of the area of ocean being profiled is necessary to convert the compressed data. At MEDS, careful inspection is taken of the graph of the converted salinities with regard to depth and temperature in order to quality control the conversions of compressed hex to converted salinity.

Handling ARGOS emails at MEDS:

MEDS receives ftp files from ARGOS every six hours and each file has a time window that is 12 hours wide. For example, data in a file contain all data received within the last 12 hours. Each file contains many transmission messages from many different floats. The messages are reformatted from hex to decimal and added to a data file which contains all the messages ever received from ARGOS. Duplicates are flagged as a result of processing of the surface drift data.

The “station” line of each non-duplicate message is copied into a drifter archive. This information, without the parameter values, is called a drift message. The drift messages are grouped together according to ptt number and date and time. Duplicates are removed.

Quality checks are done on each group of messages to determine the best messages to use for creating a TESAC, a full resolution temperature and salinity profile. This is done by flagging those messages that do not have date/time/position values (as noted above) or have values that

are questionable. The first message that has a valid date/time/position information is used as the station header for the TESAC

Once there are enough good messages to make a complete TESAC, each drift message and its parameter values are used to build a complete station and profile records in ocean processing format. The number of depths given in message 01 is used to determine if all the profile data is there. Quality control is done on the temperature and salinity measurements. If measurements are found to be bad, they are flagged. A PI filter on the profiles is also done if necessary. For example, a PI might report to MEDS that the salinity sensor on one of its floats is not working correctly. MEDS will check the profiles for that float and flag all corresponding salinity measurements as bad.

Once these filters are complete, TESACs are created from the ocean processing file. All measurements with a flag of '4' (bad) are removed from the TESAC. The data are sent to PI's and Argo servers reformatted in its entirety (with all flags) in netCDF. The original data file is updated and flagged to show which messages have been used to create TESACs.

Sample output: (for one profile)

```
$  APEX-Seabird (110598) ARGOS Message Parser & Calibration Applicator
[SwiftWare]
$  $Revision: 1.6 $  $Date: 2000/01/02 21:29:17 $
$  Cmd Line: /net/freeland/bin/ApexSbe111398-parser
if=/net/freeland/219/219.023.msg of=/net/freeland/219/219.023.edf
fixes=/net/freeland/219/219.023.msg-all r=/net/freeland
$
$ E    lat     lon       date   time  zbot  zmax sh co          stnid      n
$ H  49.30  227.72 02/02/2000 17.289     *   797  *  *         219.023     53
$  VoltCount=134  BatteryVoltage=14.2V
$  VacuumCount=58 Vacuum=7.8"Hg
$  BottomPistonPosition=40
$  SurfacePistonPosition=192
$  SurfacePressure=6 dbar
$  ProfileTermination=0x0 (Pressure reached surface pressure)
$  NFix=8   //     lon     lat Julian-sec       date   hour quality
$  Fix(First): 227.723  49.301  949511841 02-02-2000 17.289       1
$  Fix:        227.725  49.306  949517736 02-02-2000 18.927       1
$  Fix:        227.734  49.294  949530560 02-02-2000 22.489       1
$  Fix:        227.718  49.287  949536500 02-03-2000  0.139       2
$  Fix:        227.698  49.293  949541045 02-03-2000  1.401       1
$  Fix:        227.698  49.292  949542620 02-03-2000  1.839       1
$  Fix:        227.686  49.303  949546940 02-03-2000  3.039       2
$  Fix(Last):  227.686  49.317  949552925 02-03-2000  4.701       1
$ F %6.1f %6.3f %7.4f
$ T    p       t        s
     5.6   7.240  32.6184 Message 11
    14.4   7.237  32.6192
    24.3   7.230  32.6203
    34.2   7.225  32.6204
    44.3   7.217  32.6216
    54.4   7.209  32.6238 Message 10
    64.2   7.206  32.6248
    74.3   7.205  32.6261
    84.6   7.207  32.6289
    94.6   7.219  32.7588
   104.6   7.029  33.3787 Message 09
   114.3   7.030  33.6358
   124.5   6.971  33.7211
```

```
134.6   6.955  33.7724
144.3   6.859  33.8621
154.6   6.694  33.9020 Message 08
164.4   6.620  33.9100
174.4   6.531  33.9156
184.6   6.410  33.9216
194.2   6.288  33.9238
204.5   6.119  33.9241 Message 07
219.6   5.945  33.9260
234.3   5.823  33.9292
249.5   5.705  33.9316
264.4   5.555  33.9346
279.5   5.385  33.9337 Message 06
294.4   5.240  33.9352
309.5   5.109  33.9392
324.6   4.996  33.9443
339.2   4.910  33.9501
354.5   4.801  33.9555 Message 05
369.3   4.737  33.9610
384.3   4.663  33.9717
399.3   4.593  33.9863
419.6   4.484  34.0047
439.3   4.450  34.0237 Message 04
459.2   4.365  34.0385
479.0   4.378  34.0561
499.4   4.330  34.0737
519.5   4.286  34.1046
539.3   4.168  34.1101 Message 03
559.0   4.134  34.1243
579.6   4.051  34.1338
599.5   4.026  34.1460
619.4   3.983  34.1689
639.1   3.955  34.1874 Message 02
659.0   3.876  34.1948
679.3   3.789  34.2110
699.5   3.703  34.2199
724.4   3.637  34.2308
749.4   3.534  34.2468 Message 01
774.0   3.483  34.2590 (bytes 27-32)
797.2   3.399  34.2803 (bottom measurements)
```

The colors represent the data from message block 03 (see sample message).
As mentioned before, each message block is 32 hex bytes and therefore contains at most 5 Pressure/Temperature/Salinity (PTS) measurements. The Argo floats drop down to the programmed maximum depth and then collect the profile data as it is returning to the surface. Therefore, the last message block (number 11) actually contains the first 5 PTS measurements and so the profile data sent to MEDS is in descending order. The output produced by MEDS lists the measurements in ascending order. Using message 03 as an example, the blue measurements are the last measurements reported in message block 03 of the ARGOS sample message.