

E-SURFMAR recommended ship-to-shore dataformats

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Modifications brought to the different versions of the present document are described in Annex I.

1. Background

Noticing that satellite communications are more expensive than terrestrial communications and that BUFR messages for ships data are larger than FM13 SHIP reports, E-SURFMAR recommends the use of specific dataformats for ships (conventional VOS and S-AWS) to report their observations ashore. The main formats, called dataformat #100 and #101, contain no metadata but only raw observation data which are compressed as much as possible before being transmitted ashore. Received at dedicated processing centres these data are mixed with metadata locally available and converted into BUFR before GTS transmission.

2. Other dataformats

Dataformats for ships are part of a wider family of dataformats recommended by E-SURFMAR for other platforms. For instance, some are already used by data buoys. The following list shows the distribution of the identifiers (first byte of each message) within the categories of platforms.

Ident.	Platform type
000-099	Reserved for data buoys (see " buoy dataformats " document)
100-199	Reserved for ships. These include:
100	S-AWS ship observations (autonomous or integrated)
101	Conventional VOS
110	Most recent S-AWS sensor measurements
111	Most recent S-AWS operating information (from log)
200-255	Reserved for other platforms

The characteristics of these dataformats are similar:

- Each dataformat starts with its 8-bit identifier (#100, #101, #110 or #111);
- Observation time is given through the following timestamp (year, month, day, hour, minute);
- In case the presence of optional groups is considered (e.g. inside #100 and #101), the length of the format may vary.
- It is recommended to fill up the rooms of missing parameters with all bits to "1" ;
- The total length of the message must be a round number of bytes. The last one is completed if needed.

3. Dataformats for ships

The present document describes dataformats which should be used to report VOS observations to the shore (e.g. through Iridium). These dataformats are the results of experiences/discussions exchanged with different team including DBCP Iridium Pilot Project, E-SURFMAR Task Team on S-AWS and JCOMM ETMC experts. They are a compromise between user's requirements as well as technological and economic constraints. Most especially, dataformats #100 and #101 try to:

- meet conventional observation requirements (FM13-SHIP content),
- comply with BUFR coding and most especially future templates for surface marine data,

- preserve ship data for climate studies.

It must be noted that a special encoding of dataformat #101 is recommended for conventional VOS to report their data through Inmarsat-C in two 32-character blocks (see section 5). The technique, called "half compression" is an alternative to the SEAS communications used in the US to save communication costs. SEAS is using the data mode of Inmarsat-C instead of the text mode.

In order not to multiply dataformats, and to simplify their procesings, E-SURFMAR recommends to also use the #101 half compressed messages for observations sent ashore through emails.

In addition to the main dataformats (#100 and #101), two technical formats are proposed for the purpose of S-AWS in the present document.

4. Dataformat #100 (S-AWS observations)

The dataformat is made of five areas: green, yellow, blue-violet, pink-violet and orange. First (green) block put apart, the other blocks are optional. Dataformat #100 may be used either by:

- Shipborne Automated Weather Stations (S-AWS) with visual (manned) observations added: green block is used to report measured parameters; other blocks than orange are used to report visual observations; orange block is used to report other measured parameters if available;
- Shipborne Automated Weather Stations (S-AWS) with no visual observations added: green block may be used alone; orange block is used if other measured parameters are available.

Each optional group starts with a one-bit word (presence indicator) forced to "1". In the absence of the group, the word is forced to zero. One-bit words are mandatory. For instance, a message which only contains measured parameters (green part of the dataformat) must end with four bits with "0" as value.

BUFR Id.	Sensor abbreviation	Nb of bits	Notes	Slope (phys.)	Offset (phys.)	Max (phys.)	Units	Name of the element
001198		8	a	1	0	254		Format identifier (100 for the present version)
001199		1	a, e	1	0	1		Callsign encryption indicator
001012	COG10	7	w	5	0	360	Degree	Ship's Course Over Ground (past 10 minutes)
001013	SOG10	6	w	0.5	0	30	m/s	Ship's average Speed Over Ground (past 10 minutes)
011104	HDT10	7	w, m	5	0	360	Degree	Ship's average True Heading (past 10 minutes)
010039	S _{hh}	5	c	1	-10	20	m	Departure of summer loadline from actual sea level
004001	YYYY	7	t	1	2000	2126		Year
004002	MM	4	t	1	0	12		Month
004003	DD	6	t	1	0	31		Day
004004	Hour	5	t	1	0	23	UTC	Hour
004005	Minute	6	t	1	0	59		Minute
005002	Lat	15	p	0.01	-90	90	Degree	Latitude (coarse accuracy)
006002	Lon	16	p	0.01	-180	180	Degree	Longitude (coarse accuracy)

010004	Press	11	s	10	85000	105460	Pa	Pressure at barometer height
010051	MSLP	11	s	10	85000	105460	Pa	Pressure reduced to mean sea level
010061	ppp	10	s	10	-5000	5000	Pa	3-hour pressure change
010063	a	4	s	1	0	8	Code	Characteristic of pressure tendency
011001	dd	7	w	5	0	360	Degree	True wind direction clockwise from the north
011002	ff	10	w	0.1	0	102	m/s	True wind speed
011007	RWD	7	w	5	0	360	Degree	Relative wind direction clockwise from the bow
011008	RWS	8	w	0.5	0	127	m/s	Relative wind speed
011041	ff _{max}	8	w	0.5	0	127	m/s	Maximum wind gust speed
011043	dd(ff _{max})	7	w	5	0	360	Degree	Maximum wind gust direction
012101	Ta	10	s	0.1	223.2	325.4	K	Air temperature
013009	U	10	hr	0.1	0	100	%	Relative humidity
022043	SST	12	hr	0.01	268.15	309.05	K	Sea temperature
025026	Vbat	7	te	0.2	5.0	30.2	Volt	AWS Supply voltage
010201	T _μ	8	te	0.5	233.15	360.15	K	AWS μprocessor temperature
010200		8	te	1	-50	204	m	GPS height above sea level
110000		1		1	0	1		Visual obs. presence indicator
020001	VV	4	st	1	90	99	Code	Horizontal visibility
020003	ww	9	bt	1	0	510	Code	Present weather
020004	W ₁	5	bt	1	0	30	Code	Past weather 1
020005	W ₂	5	bt	1	0	30	Code	Past weather 2
020010	N	4	st	1	0	9	Code	Total cloud cover
020011	Nh	4	bt	1	0	14	Code	Cloud amount (low)
020012	Cl	6	bt	1	0	62	Code	Cloud type (low)
020012	Cm	6	bt	1	0	62	Code	Cloud type (middle)
020012	Ch	6	bt	1	0	62	Code	Cloud type (high)
020013	h	4	st	1	0	9	Code	Height of base of lowest clouds
108000		1		1	0	1		Wave obs. presence indicator
022012	P _w P _w	5	s	1	0	30	s	Period of wind waves
022022	H _w H _w	6	s	0.5	0	31	m	Height of wind waves
022003	d _{w1} d _{w1}	6	s	10	0	360	Degree	Direction of 1 st swell
022013	P _{w1} P _{w1}	5	s	1	0	30	s	Period of 1 st swell
022023	H _{w1} H _{w1}	6	s	0.5	0	31	m	Height of 1 st swell
022003	d _{w2} d _{w2}	6	s	10	0	360	Degree	Direction of 2 nd swell
022013	P _{w2} P _{w2}	5	s	1	0	30	s	Period of 2 nd swell
022023	H _{w2} H _{w2}	6	s	0.5	0	31	m	Height of 2 nd swell
108000		1		1	0	1		Ice obs. presence indicator
020031		7	s	0.01	0	1.26	m	Ice deposit (thickness)
020032		3	bt	1	0	6	Code	Rate of ice accretion
020033		4	bt	1	0	7	Code	Cause of ice accretion
020034	C _i	5	bt	1	0	30	Code	Sea ice concentration

020035	b _i	4	bt	1	0	14	Code	Amount and type of ice
020036	Z _i	5	bt	1	0	30	Code	Ice situation
020037	S _i	5	bt	1	0	30	Code	Ice development
020038	D _i	4	s	45	0	360	Degree	Bearing of ice edge
115000		1			0	1		Other obs. presence indicator
022062	SSS	12	o	0.01	5	45	psu	Sea surface salinity
022043		12	o	0.01	268.15	308.15	K	Sea temperature (2 nd sensor)
041001		11	o	0.5	100	1100	μatm	pCO ₂ (dissolved CO ₂)
041005		11	o, u	0.01	0	20	NTU	Turbidity
041002		11	o	0.025	0	50	μg/l	Fluorescence
013080		11	o	0.001	7	9	pH unit	pH
041003		11	o	0.05	0	100	μmol/kg g	Dissolved nitrates
022188		11	o, u	0.5	0	1000	μmol/kg g	Dissolved oxygen
		12	o	1	0	4096		Spare sensor data
		12	o	1	0	4096		Spare sensor data
		8	o, te	0.2	0	50.8	l/min	Pump speed
		7	o, te	0.2	5	30	V	Pump voltage
014004		11	o	3000	0	6.10 ⁶	J.m ⁻²	Short wave radiation (past hour)
014002		10	o	3000	0	3.10 ⁶	J.m ⁻²	Long wave radiation (past hour)
015028	CO ₂	10	o	0.1	350	450	ppm	Atmospheric CO ₂

Remarks:

1. The total length of dataformat #100 varies from 235 bits (30 bytes) for autonomous S-AWS to 530 bits (67 bytes) if all optional groups are reported.
2. Metadata (e.g. height or depth of sensors, sampling period...) are not directly reported by the station within the raw data but added at the processing centre prior to the transmission onto the GTS. Consequently, they are not present into the #100 dataformat.
3. First column gives the identifier of the corresponding BUFR element. It must be noticed that the resolution and the offset used in dataformat #100 may be different from the BUFR data.
4. It is proposed not reporting ship's course and average speed over the ground during the past three hours (requested for better use of pressure tendency) but over the 10-minute sampling of the wind (COG10 and SOG10).
5. Physical values are deduced from raw data (N), slope and offset as following:

$$\text{Physical value} = \text{slope} * N + \text{offset}$$
Units are those given in the table.
6. Maximum physical values are given for information only. For some parameters, it does not represent the maximum which may be coded but the maximum possible (e.g. +90 degrees for the latitude).

Notes:

- a** A few non-official identifiers, (e.g. 001198 for the format identifier) are locally used for dataprocessing. They appear **in blue** in the tables.
- c** VOSclim parameter. Only reported if known.
- bt** BUFR tables (different from SHIP tables).
- e** Callsign encryption indicator: “0” means “encrypted”; “1” means “not encrypted”.
- dl** Parameter 0-01-044 should refer to ship’s heading. Presently it refers to ship’s course in the most recent BUFR template. This is probably a mistake since it is already identified by 0-01-012.
- hr** Parameters with better resolution than for SHIP messages. Required by climate and satellite data users. It must be noticed that entry 0-13-009 - for relative humidity reported in 0.1 % - is not present in BUFR template for marine observation data.
- o** Other parameters (reported if available)
- p** Ship’s position at observation time
- s** Conform to FM13-SHIP message.
- st** SHIP tables. Related BUFR identifier refers to metres (visibility and height of base of clouds) or percent (cloud cover). Climate data users recommend to use FM13 codes for data preservation. New entries in BUFR are desirable. This given in the table (**in red**) may ne wrong.
- t** Observation timestamp
- te** Technological parameters
- u** Units present in BUFR tables for turbidity and dissolved oxygen are not those recommended to E-SURFMAR by oceanographic experts. Related BUFR Ids. are presented **in red**.
- w** According to WMO rules, wind measurements are sampled over the 10 minutes which preceed the observation time. Ship’s course, speed and heading are averaged on the same period. COG, SOG and HDT must be preceeded by a period indicator in the BUFR message. They are named COG10, SOG10 and HDT10 in the table here above. Maximum wind gust speed and direction are also computed over this 10 minutes period.

5. Dataformat #101 (conventional VOS observations)

The dataformat is based on format #100. The green block is slightly modified and the orange block is removed. Within the green block, differences with dataformat #100 are the following:

- AWS supply voltage, μ processor temperature and GPS height were removed;
- Wet bulb and dew point temperatures were added.

As for dataformat #100, each optional group starts with a one-bit word (presence indicator) forced to “1”. In the absence of the group, the word is forced to zero. One-bit words are mandatory.

BUFR Id.	Sensor abbreviation	Nb of bits	Notes	Slope (phys.)	Offset (phys.)	Max (phys.)	Units	Name of the element
001198		8	a	1	0	254		Format identifier (101 for the present version)

001199		1	a, e	1	0	1		Callsign encryption indicator
001012	COG10	7	w	5	0	360	Degree	Ship's Course Over Ground (past 10 minutes)
001013	SOG10	6	w	0.5	0	30	m/s	Ship's average Speed Over Ground (past 10 minutes)
011104	HDT10	7	w, m	5	0	360	Degree	Ship's average True Heading (past 10 minutes)
010039	S _{hh}	5	c	1	-10	20	m	Departure of summer loadline from actual sea level
004001	YYYY	7	t	1	2000	2126		Year
004002	MM	4	t	1	0	12		Month
004003	DD	6	t	1	0	31		Day
004004	Hour	5	t	1	0	23	UTC	Hour
004005	Minute	6	t	1	0	59		Minute
005002	Lat	15	p	0.01	-90	90	Degree	Latitude (coarse accuracy)
006002	Lon	16	p	0.01	-180	180	Degree	Longitude (coarse accuracy)
010004	Press	11	s	10	85000	105460	Pa	Pressure at barometer height
010051	MSLP	11	s	10	85000	105460	Pa	Pressure reduced to mean sea level
010061	ppp	10	s	10	-5000	5000	Pa	3-hour pressure change
010063	a	4	s	1	0	8	Code	Characteristic of pressure tendency
011001	dd	7	w	5	0	360	Degree	True wind direction clockwise from the north
011002	ff	10	w	0.1	0	102	m/s	True wind speed
011007	RWD	7	w	5	0	360	Degree	Relative wind direction clockwise from the bow
011008	RWS	8	w	0.5	0	127	m/s	Relative wind speed
011041	ff _{max}	8	w	0.5	0	127	m/s	Maximum wind gust speed
011043	dd(ff _{max})	7	w	5	0	360	Degree	Maximum wind gust direction
012101	T _a	10	s	0.1	223.2	325.4	K	Air temperature
012102	T _w	10	s	0.1	223.2	325.4	K	Wet bulb temperature
012103	T _d	10	s	0.1	223.2	325.4	K	Dew point temperature
013009	U	10	hr	0.1	0	100	%	Relative humidity
022043	SST	11	hr	0.02	268.15	309.05	K	Sea temperature
110000		1		1	0	1		Visual obs. presence indicator
020001	VV	4	st	1	90	99	Code	Horizontal visibility
020003	ww	9	bt	1	0	510	Code	Present weather
020004	W ₁	5	bt	1	0	30	Code	Past weather 1
020005	W ₂	5	bt	1	0	30	Code	Past weather 2
020010	N	4	st	1	0	9	Code	Total cloud cover
020011	Nh	4	bt	1	0	14	Code	Cloud amount (low)
020012	Cl	6	bt	1	0	62	Code	Cloud type (low)
020012	Cm	6	bt	1	0	62	Code	Cloud type (middle)
020012	Ch	6	bt	1	0	62	Code	Cloud type (high)
020013	h	4	st	1	0	9	Code	Height of base of lowest clouds
108000		1		1	0	1		Wave obs. presence indicator

022012	P _w P _w	5	s	1	0	30	s	Period of wind waves
022022	H _w H _w	6	s	0.5	0	31	m	Height of wind waves
022003	d _{w1} d _{w1}	6	s	10	0	360	Degree	Direction of 1 st swell
022013	P _{w1} P _{w1}	5	s	1	0	30	s	Period of 1 st swell
022023	H _{w1} H _{w1}	6	s	0.5	0	31	m	Height of 1 st swell
022003	d _{w2} d _{w2}	6	s	10	0	360	Degree	Direction of 2 nd swell
022013	P _{w2} P _{w2}	5	s	1	0	30	s	Period of 2 nd swell
022023	H _{w2} H _{w2}	6	s	0.5	0	31	m	Height of 2 nd swell
108000		1		1	0	1		Ice obs. presence indicator
020031		7	s	0.01	0	1.26	m	Ice deposit (thickness)
020032		3	bt	1	0	6	Code	Rate of ice accretion
020033		4	bt	1	0	7	Code	Cause of ice accretion
020034	c _i	5	bt	1	0	30	Code	Sea ice concentration
020035	b _i	4	bt	1	0	14	Code	Amount and type of ice
020036	Z _i	5	bt	1	0	30	Code	Ice situation
020037	S _i	5	bt	1	0	30	Code	Ice development
020038	D _i	4	s	45	0	360	Degree	Bearing of ice edge

Remarks:

7. The total length of dataformat #101 varies from 230 bits (29 bytes) to 365 bits (46 bytes) if all optional groups are reported; 328 bits if only ice observations are missing.
8. The other remarks and the notes given for dataformat #100 are valid for #101.

It is proposed to use dataformat #101 in a future version of TurboWin. After expansion to get alphanumeric characters, the length will be multiplied by 8/6. So, it will be shorter than 62 bytes. This part of the message will be then preceded by the ship's identifier (7 characters). So, the maximum length of the message should be 69 bytes.

However, in most of the cases, optional group "ice" should not be used. Consequently, the total length of the message will be 328 bits before expansion, 62 bytes after expansion and ship identifier added. This is less than two 32-byte blocks charged by Inmarsat communication providers, even if a LF and a CR are added at the end of the data string.

6. Dataformat #110 (most recent S-AWS sensor measurements)

This format serves to transmit the most recent measurements carried out by a S-AWS, consecutively to a request sent through a Land Base Monitoring Facility (LMF).

Message header

Sensor abbreviation	Nb of bits	Degree	Slope (phys.)	Offset (phys.)	Max (phys.)	Units	Name of the element
	8	1	1	0	254		Format identifier (110 for the

							present version)
	7	1	1	2000	2126		Year
	4	1	1	0	12		Month
	6	1	1	0	31		Day
	5	1	1	0	23	UTC	Hour
	6	1	1	0	59		Minute
	6	1	1	0	59	s	Second of first observation
	5	1	1	0	21		Number of observations

Next blocks (one observation per block)

COG	9	1	1	0	360	Degree	Ship's Course Over Ground
SOG	8	1	0.1	0	25.4	m/s	Ship's average Speed Over Ground
HDT	9	1	1	0	360	Degree	Ship's True Heading
Lat	18	1	0.001	-90	90	Degree	Latitude
Lon	19	1	0.001	-180	180	Degree	Longitude
Press	11	1	10	85000	105460	Pa	Pressure at barometer height
RWD	9	1	1	0	360	Degree	Relative wind direction clockwise from the bow
RWS	10	1	0.1	0	102	m/s	Relative wind speed
Ta	10	1	0.1	223.2	325.4	K	Air temperature
U	7	1	1	0	100	%	Relative humidity
SST	12	1	0.01	268.15	309.05	K	Sea temperature
	8	1	0.1	5.0	30.4	Volt	Supply voltage
	8	1	0.5	233.15	360.15	K	μprocessor temperature
	8	1	1	-50	204	m	GPS height above sea level

The length of the header is 47 bits. The length of following blocks is 146 bits. Considering a maximum length of 340 bytes for an Iridium SBD message, this allows to report up to 18 most recent observations through a single message.

7. Dataformat #111 (most recent S-AWS operating information)

This format serves to transmit the most recent S-AWS operating information from the log, consecutively to a request sent through a Land Base Monitoring Facility (LMF).

Message header

Sensor abbreviation	Nb of bits	Degree	Slope (phys.)	Offset (phys.)	Max (phys.)	Units	Name of the element
	8	1	1	0	254		Format identifier (111 for the present version)

	6	1	1	0	62		Number of records
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Next blocks (one record per block)

Sensor abbreviation	Nb of bits	Degree	Slope (phys.)	Offset (phys.)	Max (phys.)	Units	Name of the element
	7	1	1	2000	2126		Year
	4	1	1	0	12		Month
	6	1	1	0	31		Day
	5	1	1	0	23	UTC	Hour
	6	1	1	0	59		Minute
	6	1	1	0	59	s	Second
	8	1	1	0	254		Event Id. number

The length of the header is 14 bits. The length of following blocks is 42 bits. Considering a maximum length of 340 bytes for an Iridium SBD message, this allows to report up to about 60 most recent log records (events) through a single message.

ANNEX

Modifications brought to the present document

Version 1.9 :

- Modification of some parameters units to be in accordance with compression pilot files

Version 1.8 :

- Modification of several descriptors to match template 308014

Version 1.7 :

- SST is reported in dataformat #101 with a resolution of 0.02 K instead of 0.01 K in the previous versions. This allows to save one bit. Consequently, a message spreads over two 32-byte blocks when ice observations are not reported, even if a LF and a CR are added at the end of the data. The message length is optimized.
- BUFR element identifiers are completed for ship heading and for the hydrological and radiation data.

Version 1.6 :

- Value of the “callsign encryption indicator” specified in dataformats #100 and #101: “0” means “encrypted”; “1” means “not encrypted”.
- pH values are reported with 2 more bits in dataformat #100 (11 instead of 9). Resolution is brought to 0.001 instead of 0.01. Offset is now 7.000 (instead off 6.00). Since only one station is assumed to report its data according to this dataformat, it is decided to keep #100 as format identifier (1st byte of the message) and to inform the developer of this station about the change. The maximum length for dataformat #100 is now 530 bytes instead of 528.
- Reference to 3s removed for wind direction and wind speed in dataformat #110.

Version 1.5 :

- Three minor corrections applied to the previous version.
- Dataformat #101 added (for conventional VOS).

Version 1.4 :

- New parameters, most of them oceanographic, have been added in the last block (orange).

Version 1.3 :

- 4 bits are reserved for the cause of ice accretion (instead of 2 in the previous version).

Version 1.2 :

- Modifications implemented on dataformat #100 after discussions with JCOMM Experts on Marine Climatology. These modifications include:
 - o The use of a better resolution for SOG (0.5 m/s), true and relative wind speeds, (0.1 and 0.5 m/s, respectively), relative humidity (0.1%);

- o A come back to FM13 code values for horizontal visibility, total cloud cover and height of base of lowest clouds;
- o More explanations on the use of this dataformat and more information in column “sensor abbreviation”.
- o A change in the range and resolution of radiation data.

Version 1.1 :

- Resolution for SST is now 0.01°C instead of 0.1°C in previous versions.

Version 1.0 :

- Dataformat #150 (TurboWin) is withdrawn. Dataformat #100 may be actually used - before expansion - by VOS ships reporting “half compressed messages” (see § 6).
- A sentence explaining that one-bit words are mandatory, even if the optional blocks are missing.
- A sentence is added to explain the purpose of each dataformats #110 and #111.

Version 0.9 :

- Dataformats #100 (autonomous S-AWS) and #120 (integrated S-AWS) are replaced by a single one (new #100). Visual observations are reported through an extension of former dataformat #100.
- Optional groups of parameters (e.g. visual atmospheric observations, wave observations, additional measured parameters such as salinity) are introduced.
- Two new dataformats (#110 and #111) are introduced to report the most recent sensor measurements and the most recent operating information (log records) further to a request sent to the station.
- Dataformat #150 is introduced to report the IMO number of the ship in addition to the content of dataformat #100. Although not related to the Iridium SBD transmission, it is presented in the present document. It should be used to report manned VOS observations prepared by TurboWin and transmitted through the “half compression technique”.

Version 0.8 :

- Three parameters added to dataformats #100 and #120: callsign encryption indicator, departure of summer loadline from actual sea level (VOSclim parameter) and GPS height above sea level (technological parameter – not to be reported onto the GTS).