Supplement C. Record Types

The IMMA *Core* (Table C0) forms the common front-end for all record types. By itself, the *Core*, which is divided into location and regular sections, forms a useful abbreviated record type incorporating many of the most commonly used data elements in standardized form (drawn from the fields to be agreed internationally, listed in Supp. D). Concatenating one or more "attachments" (attm) after the *Core* creates additional record types. At the time of Release 3.0 of ICOADS, in addition to the *Core*, the following attms have been defined:

Table C0: Core (*Core*)	(108 characters)
Table C1: ICOADS (*Icoads*) attm	(65 characters)
Table C5: IMMT-5/FM 13 (*Immt*) attm	(94 characters)
Table C6: Model quality control (*Mod-qc*) attm	(68 characters)
Table C7: Ship metadata (*Meta-vos*) attm	(58 characters)
Table C8: Near-surface oceanographic (*Nocn*) attm	(102 characters)
Table C9: Edited cloud report (*Ecr*) attm (see Annex E)	(32 characters)
Table C95: Reanalyses QC/feedback (*Rean-qc*) attm	(61 characters)
Table C96: ICOADS Value-added Database (*Ivad*) attm	(53 characters)
Table C97: Error (*Error*) attm	(32 characters)
Table C98: Unique report ID (*Uida*) attm	(15 characters)
Table C99: Supplemental data (*Suppl*) attm	(source-dep. length)

including three deprecated attms:

Table C2: IMMT-2/FM 13 attm	(76 characters)
Table C3: Model quality control attm	(66 characters)
Table C4: Ship metadata attm	(57 characters)

whose documentation can be found in http://icoads.noaa.gov/e-doc/imma/R2.5-imma.pdf.

Additionally, the following attms have been proposed (CP):

Table CP1: Automated instrumentation (*Auto*) attm	(41 characters)
Table CP2: Near-surface oceanographic QC (*Nocq*) attm	(28 characters)
Table CP3. Alternative QC (*Alt-qc*) attm	(proposed)
Table CP4: Platform tracking (*Track*) attm	(proposed)
Table CP5: Historical (*Hist*) attm	(proposed)

The proposed attms are discussed in Supp. F, but have not been implemented at the time of R3.0. In addition, the following attms are envisioned as further possibilities, but without any suggested content in Supp. F:

Buoy metadata (*Meta-buoy*) attm	(proposed, no table)
Daily observational (*Daily*) attm	(proposed, no table)

Throughout Supp. C, each table contains these columns:

1 Field number (No.). Field numbering is attm-internal beginning with field number 1 and ending with the last field indicated in each table.

2 Length (Len.) in characters (i.e., 8-bit bytes[1]).

[1] "Character" fields in IMMA should be limited to the printable set of ASCII characters i.e., 32=space, 33="!", ..., 126="~" (ref. http://en.wikipedia.org/wiki/ASCII#ASCII_printable_code_chart).

3,4 Abbreviation (Abbr.) for each element (or field), and a brief Element Description.

5,6 For fields with a bounded numeric range (either decimal or base36), the minimum (Scaled Min.) and maximum (Scaled Max.) are indicated in decimal (and/or in base36 in [square brackets]). When values are provided for Scaled Min./Max., they represent the field value multiplied by the numeric part of the Units field (if applicable). In other cases, the range and configuration are listed as: "a" for alphabetic (A-Z), "b" for alphanumeric (strictly 0-Z with no leading blanks), "c" for alphanumeric plus other printable characters, or "u" for undecided form (only for fields that are currently unused). Base36 fields include "[b36]" in the Units column, and, as for decimal numeric fields, any leading missing positions are blank (vs. zero) filled (note: as a consequence, base36 is not always interpretable as alphanumeric). For Base36 encoded fields both the numeric range and Base36 range (in [ ]) are listed for the Scaled Min./Max.

Base36 encoding showing decimal numbers and base36 equivalent values (reproduced from Table 1 in main text above). The complete set of 1-character encodings (0-35) is listed on the left, and examples of 2-character encodings (0-1295) are given on the right. Note that the subset 0-F of base36 is the same as hexadecimal.

1-character encoding:								**E.g., 2-character encoding:**	
dec.	*base36*	*dec.*	*base36*	*dec.*	*base36*	*dec.*	*base36*	*dec.*	*base36*
0	0	10	A	20	K	30	U	0	0
1	1	11	B	21	L	31	V	1	1
2	2	12	C	22	M	32	W	2	2
3	3	13	D	23	N	33	X	.	.
4	4	14	E	24	O	34	Y	.	.
5	5	15	F	25	P	35	Z	.	.
6	6	16	G	26	Q			1293	ZX
7	7	17	H	27	R			1294	ZY
8	8	18	I	28	S			1295	ZZ
9	9	19	J	29	T				

7 Units of data and related WMO codes. Information in parentheses usually relates the IMMA field to a field from Supp. B, Table B2 (if applicable): WMO code symbolic letters are listed, or "•" followed by a field number from Table B2 in the absence of symbolic letters. This information is prefixed by "Δ" to highlight field configurations that are extended in range or modified in form from presently defined WMO representations.

Table C0. IMMA *Core*.

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
			Location section (45 characters):			
1	4	*YR*	year UTC	1600	2024	(AAAA)
2	2	*MO*	month UTC[1]	1	12	(MM)
3	2	*DY*	day UTC[1]	1	31	(YY)
4	4	*HR*	hour UTC[1]	0	23.99	0.01 hour (Δ GG)
5	5	*LAT*	latitude	–90.00	90.00	0.01°N (Δ $L_aL_aL_a$)
6	6	*LON*	longitude[1]	–179.99	359.99	0.01°E (Δ $L_oL_oL_oL_o$)
				0.00	359.99	(ICOADS convention)
				–179.99	180.00	(obsolete NCDC-variant)
7	2	*IM*	IMMA version	0	99	(Δ •65)
8	1	*ATTC*	attm count	0 [0]	35 [Z]	[b36]
9	1	*TI*	time indicator	0	3	
10	1	*LI*	latitude/long. indic.	0	6	
11	1	*DS*	ship course	0	9	(D_s)
12	1	*VS*	ship speed	0	9	(Δ v_s)
13	2	*NID*	national source indic.[1]	0	99	
14	2	*II*	*ID* indicator	0	10	
15	9	*ID*	identification/callsign	c	c	(Δ •42)
16	2	*C1*	country code	b	b	(Δ •43)
			Regular section (63 characters):			
17	1	*DI*	wind direction indic.	0	6	
18	3	*D*	wind direction (true)	1	362	°, 361-2 (Δ dd)
19	1	*WI*	wind speed indicator	0	8	(Δ i_W)
20	3	*W*	wind speed	0	99.9	0.1 m/s (Δ ff)
21	1	*VI*	*VV* indic.	0	2	(Δ •9)
22	2	*VV*	visibility	90	99	(VV)
23	2	*WW*	present weather	0	99	(ww)
24	1	*W1*	past weather	0	9	(W_1)
25	5	*SLP*	sea level pressure	870.0	1074.6	0.1 hPa (Δ PPPP)
26	1	*A*	characteristic of *PPP*	0	8	(a)
27	3	*PPP*	amt. pressure tend.	0	51.0	0.1 hPa (ppp)
28	1	*IT*	indic. for temperatures	0	9	(Δ i_T)
29	4	*AT*	air temperature	–99.9	99.9	0.1°C (Δ s_n, TTT)
30	1	*WBTI*	*WBT* indic.	0	3	(Δ s_w)
31	4	*WBT*	wet-bulb temperature	–99.9	99.9	0.1°C (Δ s_w, $T_bT_bT_b$)
32	1	*DPTI*	*DPT* indic.	0	3	(Δ s_t)
33	4	*DPT*	dew-point temperature	–99.9	99.9	0.1°C (Δ s_t, $T_dT_dT_d$)
34	2	*SI*	*SST* meas. method	0	12	(Δ •30)
35	4	*SST*	sea surface temp.	–99.9	99.9	0.1°C (Δ s_n, $T_wT_wT_w$)
36	1	*N*	total cloud amount	0	9	(N)
37	1	*NH*	lower cloud amount	0	9	(N_h)
38	1	*CL*	low cloud type	0 [0]	10 [A]	(Δ C_L) [b36]
39	1	*HI*	*H* indic.	0	1	(Δ •9)

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
40	1	*H*	cloud height	0 [0]	10 [A]	(Δ h) [b36]
41	1	*CM*	middle cloud type	0 [0]	10 [A]	(Δ C_M) [b36]
42	1	*CH*	high cloud type	0 [0]	10 [A]	(Δ C_H) [b36]
43	2	*WD*	wave direction	0	38	
44	2	*WP*	wave period	0	30, 99	seconds (P_WP_W)
45	2	*WH*	wave height	0	99	(H_WH_W)
46	2	*SD*	swell direction	0	38	($d_{W1}d_{W1}$)
47	2	*SP*	swell period	0	30, 99	seconds ($P_{W1}P_{W1}$)
48	2	*SH*	swell height	0	99	($H_{W1}H_{W1}$)

1. Fields differing from the ICOADS-standard representation in the obsolete NCDC-variant format (see Supps. D-E for further details). For *MO*, *DY*, and *HR*, the NCDC-variant format used leading zeros as an exception to the "blank left-fill" aspect of the ICOADS-standard representation for numeric data.

_____

Table C1. ICOADS (*Icoads*) attm.

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI*=1
2	2	*ATTL*	attm length			Note: set *ATTL*=65
			Box elements (6 characters):			
3	1	*BSI*	box system indicator	u	u	(currently set to missing)
4	3	*B10*	10° box number	1	648	(ICOADS BOX10 system)
5	2	*B1*	1° box number	0	99	
			Processing elements (17 characters):			
6	3	*DCK*	deck	0	999	
7	3	*SID*	source ID	0	999	
8	2	*PT*	platform type	0	21	[Note: Max.=15 in IMMA0 documentation was error]
9	2	*DUPS*	dup status	0	14	
10	1	*DUPC*	dup check	0	2	
11	1	*TC*	track check	0	1	
12	1	*PB*	pressure bias	0	2	
13	1	*WX*	wave period indicator	1	1	
14	1	*SX*	swell period indicator	1	1	
15	2	*C2*	2nd country code	0	40	
			QC elements (38 characters):			
16-27	1×12	*SQZ-DQA*[1]	adaptive QC flags	1 [1]	35 [Z]	(12 flags)^2 [b36]

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
28	1	*ND*	night/day flag	1	2	
29-34	1×6	*SF-RF*[1]	trimming flags	1 [1]	15 [F]	(6 flags)[2] [b36]
35-48	1×14	*ZNC-TNC*[1]	NCDC-QC flags	1 [1]	10 [E]	(14 flags)[2] [b36]
49	2	*QCE*[3]	external (e.g., OSD)	0	63	integer encoding (6 flags)
50	1	*LZ*	2°×2° landlocked flag	1	1	
51	2	*QCZ*[3]	source exclusion flags	0	31	integer encoding (5 flags)

1. A set of flags (elaborated briefly here and in Table C1a; see *R3.0-stat_trim* for detailed information: http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf) is stored in each of these element lengths. The first letter of each such QC flag indicates the applicable fields(s) (or if the QC applies to an entire report), according to the following general scheme (referring, except as noted, to field abbreviations from Table C0): *A*=*AT*, *B*=*VV*, *C*=clouds[4] (*N*, …, *CH*), *D*=*DPT*, *E*=wave, *F*=swell, *G*=*WBT*, *P*=*SLP*, *R*=humidity variables (relative humidity, *DPT*, and/or *WBT*, depending on QC scheme), *S*=*SST*, *T*=*A* and *PPP*, *U* or *V*=wind U- or V-component (monthly summary variables not in Table C0), *W*=wind, *X*=*WW*, *Y*=*W1*, Z=entire report. The lists of flag abbreviations are then:
   - Adaptive QC flags: *SQZ*, *SQA*, *AQZ*, *AQA*, *UQZ*, *UQA*, *VQZ*, *VQA*, *PQZ*, *PQA*, *DQZ*, *DQA* (two flags × 12 variables).
   - Trimming flags: *SF*, *AF*, *UF*, *VF*, *PF*, *RF* (one flag × six variables).
   - NCDC-QC flags: *ZNC*, *WNC*, *BNC*, *XNC*, *YNC*, *PNC*, *ANC*, *GNC*, *DNC*, *SNC*, *CNC*, *ENC*, *FNC*, *TNC* one flag × 14 variables).
2. *R3.0-stat_trim* (http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf) provides further information about how to convert the coded (base36) values stored in these flags into true (floating-point) values (handled automatically by {rwimma1}).
3. Handled as a single element by {rwimma1}, but actually holds a set of flags (elaborated as follows, and in Table C1a), which must be decoded separately. Using the 1st-letter naming scheme described in the first footnote, the abbreviations for the flags stored in *QCE* are: *ZE*, *SE*, *AE*, *WE*, *PE*, *RE*; and those stored in *QCZ* are: *SZ*, *AZ*, *WZ*, *PZ*, *RZ*. Flag *RE*, presently unused, has been set aside for possible future use. *R3.0-stat_trim* (http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf) provides further information about how to decode the information stored within *QCE* and *QCZ*.
4. Further details on the NCDC-QC (e.g., noting which parameters are considered in the cloud group) can be found in *Release 1*, supp. J (http://icoads.noaa.gov/Release_1/suppJ.html).

Table C1a lists the QC elements available (some presently obsolete or unused, as noted) as part of the *Icoads* attm.

Table C1a (note: Table 1 in *R3.0-stat_trim:* http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf). QC elements within the *Icoads* attm (fields 1-15 of that attm are described in Table C1). Grey shaded flags presently are unused.

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code)
			QC elements (38 characters): **Adaptive QC flags (12 characters; only *SQZ-SQA* in use):**			
16	1	*SQZ*	*SST*: z flag	1	35	base36 (obsolete)
17	1	*SQA*	*SST*: alpha flag	1	21	base36 (obsolete)
18	1	*AQZ*	*AT*: z flag			(unused)
19	1	*AQA*	*AT*: alpha flag			(unused)

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code)
20	1	*UQZ*	U-wind: z flag			(unused)
21	1	*UQA*	U-wind: alpha flag			(unused)
22	1	*VQZ*	V-wind: z flag			(unused)
23	1	*VQA*	V-wind: alpha flag			(unused)
24	1	*PQZ*	SLP: z flag			(unused)
25	1	*PQA*	SLP: alpha flag			(unused)
26	1	*DQZ*	Humidity: z flag			(unused)
27	1	*DQA*	Humidity: alpha flag			(unused)
			Night/day flag (1 character):			
28	1	*ND*	night/day flag	1	2	
			Trimming flags (6 characters):			
29	1	*SF*	*SST* flag	1	15 [F]	base36
30	1	*AF*	*AT* flag	1	15 [F]	base36
31	1	*UF*	U-wind flag	1	15 [F]	base36
32	1	*VF*	V-wind flag	1	15 [F]	base36
33	1	*PF*	*SLP* flag	1	15 [F]	base36
34	1	*RF*	*RH* (& *WBT*/*DPT*) flag	1	15 [F]	base36
			NCDC-QC flags (14 characters):			
35	1	*ZNC*	report-status flag (ship position)	1	10 [A]	base36
36	1	*WNC*	wind flag	1	10 [A]	base36
37	1	*BNC*	visibility (*VV*) flag	1	10 [A]	base36
38	1	*XNC*	present weather (*WW*) flag	1	10 [A]	base36
39	1	*YNC*	past weather (*W1*) flag	1	10 [A]	base36
40	1	*PNC*	*SLP* flag	1	10 [A]	base36
41	1	*ANC*	*AT* flag	1	10 [A]	base36
42	1	*GNC*	*WBT* flag	1	10 [A]	base36
43	1	*DNC*	*DPT* flag	1	10 [A]	base36
44	1	*SNC*	*SST* flag	1	10 [A]	base36
45	1	*CNC*	cloud flag	1	10 [A]	base36
46	1	*ENC*	wave flag	1	10 [A]	base36
47	1	*FNC*	swell flag	1	10 [A]	base36
48	1	*TNC*	pressure tendency (*A* and *PPP*) flag	1	10 [A]	base36
49	2	*QCE*	**External flags (i.e., 2-char. *QCE* when decoded into six flags[1]):**	0	63	integer encoding (6 flags)
		ZE	report-status flag	1	1	1 = erroneous (based on OSD quality control)

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code)
		SE	*SST* flag	1	1	"
		AE	*AT* flag	1	1	"
		WE	wind flag	1	1	"
		PE	*SLP* flag	1	1	"
		RE	*RH* (*WBT*/*DPT*) flag	1	1	(unused)
50	1	*LZ*	**Landlocked flag (1-character):** 2°×2° landlocked flag	1	1	
51	2	*QCZ*	**Source exclusion flags (i.e., 2-char. *QCZ* when decoded into five flags[1]):**	0	31	integer encoding (5 flags)
		SZ	*SST* flag	1	1	data excluded from enhanced or standard trimmed IMMA/MSG (in addition to other QC flag criteria, see Table 8)
		AZ	*AT* flag	1	1	"
		WZ	wind flag	1	1	"
		PZ	*SLP* flag	1	1	"
		RZ	*RH* (*WBT*/*DPT*) flag	1	1	"

1. The Appendix describes about how to convert the coded (base36) values stored in these flags into true (floating-point) values (handled automatically by {rwimma1}).

Note: Tables C2, C3, and C4 are assigned to deprecated attms (IMMT-2/FM 13, Model quality control, and Ship metadata, respectively) associated with R2.5. Documentation for these tables and deprecated attms can be found http://icoads.noaa.gov/e-doc/imma/R2.5-imma.pdf.

Table C5. IMMT-5/FM 13 (*Immt*) attm. This attm includes data fields that are widely applicable to Voluntary Observing Ship (VOS) data reported in formats other than IMMT and FM 13.

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI*=5
2	2	*ATTL*	attm length			Note: set *ATTL*=94
			Common for IMMT-2/3/4/5 (49 characters):			
3	1	*OS*	observation source	0	6	(•40)
4	1	*OP*	observation platform	0	9	(•41)
5	1	*FM*	FM code version	0 [0]	35 [Z]	(Δ •64) [b36]

No.	*Len.*	*Abbr.*	*Element description*	*Scaled Min.*	*Scaled Max.*	*Units (Code) [base36]*
6	1	*IMMV*	IMMT version	0 [0]	35 [Z]	[b36]
7	1	*IX*	station/weather indic.	1	7	(i_X)
8	1	*W2*	2nd past weather	0	9	(W_2)
9	1	*WMI*	indic. for wave meas.	0	9	(•31)
10	2	*SD2*	dir. of second. swell	0	38	($d_{W2}d_{W2}$)
11	2	*SP2*	per. of second. swell	0	30, 99	($P_{W2}P_{W2}$)
12	2	*SH2*	ht. of second. swell	0	99	($H_{W2}H_{W2}$)
13	1	*IS*	ice accretion on ship	1	5	(I_s)
14	2	*ES*	thickness of I_s	0	99	cm (E_sE_s)
15	1	*RS*	rate of I_s	0	4	(R_s)
16	1	*IC1*	concentration of sea ice	0 [0]	10 [A]	(Δ c_i) [b36]
17	1	*IC2*	stage of development	0 [0]	10 [A]	(Δ S_i) [b36]
18	1	*IC3*	ice of land origin	0 [0]	10 [A]	(Δ b_i) [b36]
19	1	*IC4*	true bearing ice edge	0 [0]	10 [A]	(Δ D_i) [b36]
20	1	*IC5*	ice situation/trend	0 [0]	10 [A]	(Δ z_i) [b36]
21	1	*IR*	indic. for precip. data	0	4	(i_R)
22	3	*RRR*	amount of precip.	0	999	(RRR)
23	1	*TR*	duration of per. *RRR*	1	9	(t_R)
24	1	*NU*	national use	c	c	(national practice)
25	1	*QCI*	quality control indic.	0	9	(•45)
26-45	1×20	*QI1-20*	QC indic. for fields	0	9	(Q_1-Q_{20})
			New for IMMT-2/3/4/5 (41 characters):			
46	1	*QI21*	MQCS version	0	9	(Q_{21})
47	3	*HDG*	ship's heading	0[1]	360	0, ° (HDG)
48	3	*COG*	course over ground	0	360	0, ° (COG)
49	2	*SOG*	speed over ground	0	99	kt (SOG)
50	2	*SLL*	max.ht.>Sum. load ln.	0	99	m (SLL)
51	3	*SLHH*	dep. load ln.: sea lev.	–99	99	m ($s_L$hh)
52	3	*RWD*	relative wind direction	1	362	°, 361-2[2] (ref. *D*)
53	3	*RWS*	relative wind speed	0	99.9	0.1 m/s (ref. *W*)
54-61	1×8	*QI22-29*	QC indic. for fields	0	9	(Q_{22}-Q_{29})[3]
62	4	*RH*	relative humidity	0.0	100.0	0.1%
63	1	*RHI*	relative humidity indic.	0	4	(RHi)
64	1	*AWSI*	AWS indicator	0	2	(AWSi)
65	7	*IMONO*	IMO number	0	9999999	(IMOno)

1. Zero is documented to mean "no movement," but has been suggested should not be used (see Supp. D).
2. Special code 362 for "variable, or all directions" is allocated in IMMA, but IMMT does not presently contain a corresponding configuration for *RWS* (see Supp. D).
3. As from IMMT-4 and IMMT-5, usage of Q_{26} is discontinued, see Table B3 and IMMT-5 documentation (https://www.wmo.int/pages/prog/amp/mmop/documents/IMMT-5-JCOMM-4.pdf): "now Q_{27} serves as the indicator for both S_L and HH."

Table C6. Model quality control (*Mod-qc*) attm. For reference, the Units column also includes (following any units information) the current UK Met Office BUFR element names.

No.	*Len.*	*Abbr.*	*Element description*	*Scaled Min.*	*Scaled Max.*	*Units (Code) [base36]*
1	2	*ATTI*	attm ID			Note: set *ATTI*=6
2	2	*ATTL*	attm length			Note: set *ATTL*=68
			GTS bull. header fields (10 characters):			
3	4	*CCCC*	collecting center	a	a	COLTN_CNTR
4	6	*BUID*	bulletin ID	b	b	BLTN_IDNY
			Model comp. elements (54 characters):			
5	1	*FBSRC*	Feedback source	0	0	(0=operational)
6	5	*BMP*	background (bckd.) *SLP*	870.0	1074.6	0.1 hPa; BCKD_MSL_PESR
7	4	*BSWU*	bckd. wind U-comp.	−99.9	99.9	0.1 m/s; BCKD_SRFC_WIND_U
8	4	*SWU*	derived wind U-comp.	−99.9	99.9	0.1 m/s; SRFC_WIND_U
9	4	*BSWV*	bckd. wind V-comp.	−99.9	99.9	0.1 m/s; BCKD_SRFC_WIND_V
10	4	*SWV*	derived wind V-comp.	−99.9	99.9	0.1 m/s; SRFC_WIND_V
11	4	*BSAT*	bckd. air temperature	−99.9	99.9	0.1°C; BCKD_SRFC_AIR_TMPR
12	3	*BSRH*	bckd. relative humidity	0	100	%; BCKD_SRFC_RLTV_HUMDY
13	3	*SRH*	(derived) relative humidity	0	100	%; SRFC_RLTV_HUMDY
14	5	*BSST*	bckd. *SST*	−99.99	99.99	0.01°C; BCKD_SEA_SRFC_TMPR
15	1	*MST*	model surface type	0	9	(UK 008204); MODL_SRFC_TYPE
16	4	*MSH*	model height of surface	-999	9999	m; MODL_SRFC_HGHT
17	4	*BY*	bckd. year	0	9999	year; BCKD_YEAR
18	2	*BM*	bckd. month	1	12	month; BCKD_MNTH
19	2	*BD*	bckd. day	1	31	day; BCKD_DAY
20	2	*BH*	bckd. hour	0	23	hour; BCKD_HOUR
21	2	*BFL*	bckd. forecast length (time period or displacement minute)	0	99	hours BCKD_FRCT_LNGH

Table C7. Ship metadata (*Meta-vos*) attm. For more information, including other fields available in WMO Pub. 47 but not selected for this attm, see Berry et al. (2009; http://icoads.noaa.gov/e-doc/imma/WMO47IMMA_1966_2007-R2.5.pdf).

No.	*Len.*	*Abbr.*	*Element description*	*Scaled Min.*	*Scaled Max.*	*Units (Code) [base36]*
1	2	*ATTI*	attm ID			Note: set *ATTI*=7
2	2	*ATTL*	attm length			Note: set *ATTL*=58
			Ship metadata elements (54 characters):			
3	1	*MDS*	metadata source	0	1	(0=WMO Pub. 47; 1=COAPS)
4	2	*C1M*	recruiting country	a	a	(Δ •43)
5	2	*OPM*	type of ship (program)	0	99	(code unlike *OP)*
6	2	*KOV*	kind of vessel	c	c	
7	2	*COR*	country of registry	a	a	(Δ •43)
8	3	*TOB*	type of barometer	c	c	
9	3	*TOT*	type of thermometer	c	c	
10	2	*EOT*	exposure of thermometer	c	c	
11	2	*LOT*	screen location	c	c	
12	1	*TOH*	type of hygrometer	c	c	
13	2	*EOH*	exposure of hygrometer	c	c	
14	3	*SIM*	*SST* meas. method	c	c	(code unlike *SI)*
15	3	*LOV*	length of vessel	0	999	M
16	2	*DOS*	depth of *SST* meas.	0	99	M
17	3	*HOP*	height of visual observation platform	0	999	M
18	3	*HOT*	height of *AT* sensor	0	999	M
19	3	*HOB*	height of barometer	0	999	M
20	3	*HOA*	height of anemometer	0	999	M
21	5	*SMF*	source metadata file	0	99999	e.g., “19991” 1st Q 1991
22	5	*SME*	source meta. element	0	99999	line number in file
23	2	*SMV*	source format version	0	99	(see Berry et al. 2009[1])

Table C8. Near-surface oceanographic data (*Nocn*) attm. Field contents are tailored to the specialized requirements of capturing data deemed most relevant to marine meteorology from the World Ocean Database (e.g., WOD13; http://www.nodc.noaa.gov/OC5/WOD13/).

No.	*Len.*	*Abbr.*	*Element description*	*Scaled Min.*	*Scaled Max.*	*Units (Code) [base36]*
1	2	*ATTI*	attm ID			Note: set *ATTI*=8
2	2	*ATTL*	attm length			Note: set *ATTL*=102 [2U] [b36]
			Near-surface oceanographic data and metadata (98 characters):			

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
3	5	*OTV*	temperature value	–3.000	38.999	0.001°C[1]
4	4	*OTZ*	temperature depth	0.00	99.99	0.01 m
5	5	*OSV*	salinity value	0.000	40.999	0.001 (unitless)
6	4	*OSZ*	salinity depth	0.00	99.99	0.01 m
7	4	*OOV*	dissolved oxygen	0.00	12.99	0.01 milliliter/liter
8	4	*OOZ*	dissolved oxygen depth	0.00	99.99	0.01 m
9	4	*OPV*	phosphate value	0.00	30.99	0.01 micromole/liter
10	4	*OPZ*	phosphate depth	0.00	99.99	0.01 m
11	5	*OSIV*	silicate value	0.00	250.99	0.01 micromole/liter
12	4	*OSIZ*	silicate depth	0.00	99.99	0.01 m
13	5	*ONV*	nitrate value	0.00	500.99	0.01 micromole/liter
14	4	*ONZ*	nitrate depth	0.00	99.99	0.01 m
15	3	*OPHV*	pH value	6.20	9.20	0.01 (unitless)
16	4	*OPHZ*	pH depth	0.00	99.99	0.01 m
17	4	*OCV*	total chlorophyll value	0.00	50.99	0.01 microgram/liter
18	4	*OCZ*	total chlorophyll depth	0.00	99.99	0.01 m
19	3	*OAV*	alkalinity value	0.00	3.10	0.01 milliequivalent/liter
20	4	*OAZ*	alkalinity depth	0.00	99.99	0.01 m
21	4	*OPCV*	partial pressure of carbon dioxide value	0.0	999.0	0.1 microatmosphere
22	4	*OPCZ*	partial pressure of carbon dioxide depth	0.00	99.99	0.01 m
23	2	*ODV*	dissolved inorganic carbon value	0.0	4.0	0.1 millimole/liter
24	4	*ODZ*	dissolved inorganic carbon depth	0.00	99.99	0.01 m
25	10	*PUID*	provider's unique record Identification	c	c	

1. The *SST* min. and max. limits in the *Core* (Table C0) are -99.0 to 99.0°C with a precision of 0.1°C, this attachment has greater precision as is appropriate for modern oceanographic profile data, with a max. value based roughly on QC limits from the GOSUD program.

Table C9. "Edited Cloud Report" (*Ecr*) attm. Elements as outlined originally in Hahn and Warren (1999). Cloud variables *Ne*, *NHe*, *He*, *CLe*, *CMe*, and *CHe* correspond (i.e., abbreviations without trailing "e") to variables in the IMMA *Core*, but may be "edited" as described in Supp. D.

No.	Len	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI*=9
2	2	*ATTL*	attm length			Note: set *ATT*L=32
			EECR Basic Cloud Elements (15 characters):			
3	1	*CCe*	change code	0 [0]	13 [D]	[b36]
4	2	*WWe*	present weather	0	99	(*WW*)

No.	Len	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
5	1	*Ne*	total cloud amount	0	8	(*N*; *N*=9 edited)
6	1	*NHe*	lower cloud amount	0	8	(*NH*; *NH*=9 edited)
7	1	He	lower cloud base height	0	9	(H)
8	2	*CLe*	low cloud type	0	11	(*CL* edited)
9	2	*CMe*	middle cloud type	0	12	(*CM* edited)
10	1	*CHe*	high cloud type	0	9	(*CH* edited)
			EECR Derived Cloud Elements (8 characters):			
11	3	*AM*	middle cloud amount	0	8.00	0.01 oktas
12	3	*AH*	high cloud amount	0	8.00	0.01 oktas
13	1	*UM*	NOL middle amount	0	8	oktas
14	1	*UH*	NOL high amount	0	8	oktas
			EECR Sky Brightness Elements (9 characters):			
15	1	*SBI*	sky-brightness indicator	0	1	
16	4	*SA*	solar altitude	−90.0	90.0	0.1 degrees
17	4	*RI*	relative lunar illuminance	−1.10	1.17	hundredths

Table C95. Reanalyses QC/feedback (*Rean-qc*) attm. Intended to store selected QC and feedback information on the ICOADS observations, as made available from reanalysis projects.

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI*=95
2	2	*ATTL*	attm length	b	b	Note: set *ATTL*=61
			Reanalysis QC*/* feedback data and metadata (57 characters):			
3	2	*ICNR*	input component number—*Rean-qc*	0	99	IMMA component number
4	2	*FNR*	field number—*Rean-qc*	1	99	IMMA field no. within *ICNR*
5	2	*DPRO*	data provider—reanalysis: lead organization	1	99	lead organization ID (e.g., 1=ECMWF, 2=NOAA-NCEP, 3=NASA, 4=JMA)
6	2	*DPRP*	data provider—reanalysis: project	1	99	project ID (e.g., 1=ERA-20C, 2=CFSRv2, 3=MERRA, 4=JRA-55)
7	1	*UFR*	usage flag—reanalysis	1	6	1=assimilated and used, 2=assimilated and rejected, 3=blacklisted[1], 4=whitelisted[2],

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
						5=available but unused, 6=none apply
8	7	*MFGR*	model-collocated first guess value or representative value in the case of ensemble methods	*(inh.[3])*	*(inh.[3])*	Inherited from *ICNR* & *FNR*, with numerical precision increased by one (additional) position right of the decimal to better accommodate numerical precision used in the assimilation process
9	7	*MFGSR*	model-collocated first guess spread[4]	–999999[5]	9999999[5]	" "
10	7	*MAR*	model-collocated analysis value or representative value in the case of ensemble methods	*(inh.[3])*	*(inh.[3])*	" "
11	7	*MASR*	model-collocated analysis spread[4]	–999999[5]	9999999[5]	" "
12	7	*BCR*	bias corrected value	*(inh.[3])*	*(inh.[3])*	" "
13	4	*ARCR*	author reference code—*Rean-qc*[6]	b	b	(alphanumeric)
14	8	*CDR*	creation date—*Rean-qc*[7]	20140101	2nnn1231	ISO-8601, YYYYMMDD
15	1	*ASIR*	access status indic.—*Rean-qc*	0	1	0=active, 1=inactive

1. Determined *a priori* to be erroneous and is not used.
2. Determined *a priori* to be used regardless of assimilation assessment.
3. The range, numeric precision, and units of measurement are all inherited from *ICNR* & *FNR*, e.g., *ICNR*=0 and *FNR*=29 refer to *AT*, which can range from –99.9 to 99.9, with precision and units of 0.1°C. Thus feedbacks on *AT* stored in this attm in *MFGR, MAR* and *BCR* have precision increased to 0.01°C, with range –99.99 to 99.99.
4. Optional field, used in the case of ensemble reanalyses.
5. Note: these ranges differ from those specified in other tables (e.g., –99.9 to 99.9 for *AT*) in that they represent scaled values (i.e., no decimal points are listed, if applicable).
6. *ARCR* as an optional field that is intended to point to a publication or technical report.
7. To be set by the external developer, as to when they produced the attm, ref.: http://en.wikipedia.org/wiki/ISO_8601.

_____

Table C96. ICOADS Value-Added Database (*Ivad*) attm. Intended to store adjusted fields associated with *INCI* and *FNI*, whereas the unadjusted data will continue to be stored in the *Core*/other attms.

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI=96*
2	2	*ATTL*	attm length			Note: set *ATTL*=53
			Value-added data and metadata (49 characters):			
3	2	*ICNI*	input component number—*Ivad*	0	99	IMMA component number

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
4	2	*FNI*	field number—*Ivad*	1	99	IMMA field no. within *ICNI*
5	1	*JVAD*	scaling factor for *VAD*	0 [0]	35 [Z]	10^{JVAD} ([b36])[1]
6	6	*VAD*	value-added data	*(inh.)*	*(inh.)*	10^{-JVAD} (units inherited)[2]
7	1	*IVAU1*	type indicator for *VAU1*	1 [1]	35 [Z]	([b36])
8	1	*JVAU1*	scaling factor for *VAU1*	0 [0]	35 [Z]	10^{JVAU1} ([b36])[1]
9	6	*VAU1*	uncertainty of type *IVAU1*	−99999	999999	10^{-JVAU1} (units inherited)[2]
10	1	*IVAU2*	type indicator for *VAU2*	1 [1]	35 [Z]	([b36])
11	1	*JVAU2*	scaling factor for *VAU2*	0 [0]	35 [Z]	10^{JVAU2} ([b36])[1]
12	6	*VAU2*	uncertainty of type *IVAU2*	−99999	999999	10^{-JVAU2} (units inherited)[2]
13	1	*IVAU3*	type indicator for *VAU3*	1 [1]	35 [Z]	([b36])
14	1	*JVAU3*	scaling factor for *VAU3*	0 [0]	35 [Z]	10^{JVAU3} ([b36])[1]
15	6	*VAU3*	uncertainty of type *IVAU3*	−99999	999999	10^{-JVAU3} (units inherited)[2]
16	1	*VQC*	value-added QC flag	1	4, 9	(see Supp D., Table C96a)
17	4	*ARCI*	author reference code–*Ivad*	b	b	(alphanumeric)
18	8	*CDI*	creation date—*Ivad*	20140101	2nnn1231	ISO-8601, YYYYMMDD (as for *CDR*, ref. Table C95)
19	1	*ASII*	access status indic.—*Ivad*	0	1	0=active, 1=inactive

1. Scaling factor applied to convert "*FVAD*," an input floating-point value, into *VAD* (i.e., representing also *VAU1*, *VAU2*, or *VAU3)* according to $VAD = FVAD \times 10^{JVAD}$. Then the original un-scaled value is reconstructed according to $FVAD = VAD \times 10^{-JVAD}$.
2. Only the units of measurement are inherited from *ICNI* & *FNI* (e.g., *ICNI*=0 and *FNI*=29 refer to *AT*, which has units of °C); the scaled range is as specified, and the numeric precision is determined (e.g., at run time by {rwimma1}) from the scaling factor (e.g., again taking the *AT* case: 0 = whole °C, 1 = 0.1°C, 2 = 0.01°C, etc.).

Table C97. Error (*Error*) attm. Designed to support correction of erroneous IMMA elements. Errors (e.g., callsign garbling) for a given *ICNE* and *FNE* will be stored by ICOADS in the *Core*/other attms, whereas uncorrected data will be stored in this *Error* attm—this is an inversion of the planned handling of data adjustments using the *Ivad* attm.

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI*=97
2	2	*ATTL*	attm length			Note: set *ATTL*=32
			Corrected erroneous data and metadata:			
3	2	*ICNE*	input component number—*Error*	0	99	IMMA component number
4	2	*FNE*	field number—*Error*	1	99	IMMA field no. within *ICNE*
5	1	*CEF*	corrected/erroneous field flag	0	1	0: *ERRD* is the corrected value; 1: *ERRD* is the erroneous value
6	10	*ERRD*	corrected/erroneous field value	c[1]	c[1]	(units & numeric precision inherited from *ICNE* & *FNE*)

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
7	4	*ARCE*	author reference code—*Error*	b	b	(alphanumeric)
8	8	*CDE*	creation date—*Error*	20140101	2nnn1231	ISO-8601, YYYYMMDD (as for *CDR*, ref. Table C95)
9	1	*ASIE*	access status indic.—*Track*	0	1	0=active, 1=inactive

1. {rwimma1} initializes *ERRD Min., Max.* to c c but these values are changed to *(inh.)* after *ICNE* and *FNE* are known; fields are right-justified, e.g., *ID* is left-justified in *ERRD* characters two through ten.

_____

Table C98. Unique report ID (*Uida*) attm.

No.	Len.	Abbr.	Element description	Scaled Min.	Scaled Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI*=98
2	2	*ATTL*	attm length			Note: set *ATTL*=15
			Processing elements (10 characters):			
3	6	*UID*	unique report ID	b	b	(alphanumeric[1])
4	1	*RN1*	Release no.: primary	0 [0]	35 [Z]	e.g., 3 [b36]
5	1	*RN2*	Release no.: secondary	0 [0]	35 [Z]	e.g., 0 [b36]
6	1	*RN3*	Release no.: tertiary	0 [0]	35 [Z]	e.g., 0 (thus 3.0.0 together) [b36]
7	1	*RSA*	Release status indicator	0	2	0=Prelim., 1=Aux., 2=Full
8	1	*IRF*	intermediate reject flag	0	2	0=Retain in Intermediate, Reject from Final dataset; 1=Retain in both Intermediate and Final datasets; 2=Reject from both Intermediate and Final datasets

1. While it represents a base36 number, this field is handled by {rwimma1} as strictly (i.e., without leading spaces, e.g., 35=00000Z) alphanumeric, and thus is not fully translated into an integer or floating-point (REAL) number (ref. {rwimma1} comments: "For character […] fields, note that ITRUE and FTRUE contain the ICHAR of the first character of the field…"). Separate from {rwimma1} however, this Fortran library is available to transform *UID* into an integer (and vice versa): http://icoads.noaa.gov/software/base36.f. Users interested in handling *UID* as a number should be aware of possible finite precision issues arising in the representation of large numbers on computers:

- In the integer case, the largest 6-character base36 number is ZZZZZZ (2,176,782,335); however, if one bit is reserved for sign, the largest positive integer representable in 32 bits is only 2^{31}–1 (2,147,483,647; ZIK0ZJ in base36). As noted below the current maximum of *UID* is $m_{R2.5i}$ (~295M) and thus well below this threshold.
- Whereas, in the floating-point case it is not even possible to accurately represent $m_{R2.5i}$ as a 32-bit single precision REAL number.

_____

Table C99. Supplemental data (*Suppl*) attm. This attm stores the original input data string, with recommended settings *ATTL*=0 (unspecified length) and *ATTE*=missing (ASCII). For processing via {rwimma1}, this attm must appear at the end of the record, and the record must terminate with a line feed.

No.	Len.	Abbr.	Element description	Min.	Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI*=99
2	2	*ATTL*	attm length			Note: set *ATTL*=0[1]
3	1	*ATTE*	attm encoding	0	1	Note: set *ATTE*=missing[2]
			Supplemental data (format determined by data source):			
4		*SUPD*[1]	supplemental data	c	c	

1. The length of the supplemental data is unspecified if *ATTL*=0, and may be variable. Thus far, *ATTL* in bytes has not been supported in the read/write IMMA programs (e.g., {rwimma1}).
2. Thus far, *ATTE*=1 (hexadecimal) has been used only for MORMET (deck 732) data (to represent binary input). This printable representation, which {rwimma1} treats identically to ASCII, was undocumented in previously available (i.e., IMMA0) Suppl. D information. In addition, while the *ATTE*=0 (base64 encoding; unprintable) representation is documented in Suppl. D, currently it is unused and not fully implemented in {rwimma1}.

Supplement D. Field Configurations

This supplement provides configuration details for the individual fields listed in Supp. C. References to external information include the WMO *Manual on Codes* (2009a) and its Codes and Regulations governing e.g., the SHIP (FM 13) GTS code. Background notes indented below field descriptions provide additional usage or technical information, e.g., comparing field configurations with other formats, such as IMMT (Supp. B), COADS *Release 1* (Slutz et al. 1985), or LMR (http://icoads.noaa.gov/e-doc/lmr). Further detailed technical notes related more specifically to ICOADS, and to its current Release 3.0 (R3.0; Freeman et al. 2016) appear enclosed in [square brackets].

The IMMA field abbreviations are simple alphabetic strings (plus in some cases numeric suffixes), based generally on GTS (or IMMT) symbolic letters (if defined) but without subscripts. These are listed in *UPPER-CASE*, for broad computer portability. As discussed in Supp. A, symbolic abbreviations already provide an important means of communication about the fields and data among Member countries and end-users. However, a transition away from subscripts is recommended to facilitate computerized implementation (e.g., headings for listings of the data).

The configurations of numeric fields were developed on the basis of representations readily input and output by computer software. Fields are right justified within the specified field-widths (Supp. C), and to reduce data-volume decimal points are implicit (e.g., –99.9 is represented as –999). For signed numeric data, the plus sign ("+") is omitted, and the minus sign ("–") immediately prefixes the numeric portion (i.e., blank left-fill[2]). These conventions have the advantage that numeric data can be readily input without separate steps to handle IMM sign positions (0=positive, 1=negative), and without parsing to ensure that a field does not contain non-numeric characters (e.g., "/").

In a delimited format, a universal missing value (e.g., –9999.99) could be selected outside the range of all data (except possibly for alphanumeric fields). In contrast, the fixed-field IMMA format contains different field-widths so a single numeric value is unworkable. A convention such as all nines filling each indicated field width also is impractical, e.g., because many of the 1-character fields have extant numeric values covering the range 0-9.

Therefore, blanks are used in IMMA as the universal representation for missing data. However, it is important to note that Fortran for example considers blanks (by default) to be equivalent to zero, thus to ensure correctness the processing must first parse a field as characters to ensure that it is not entirely blank. Machine-transportable Fortran software to help read (and optionally write) the IMMA data ("rwimma1") is available (http://icoads.noaa.gov/software/).

Field configurations for proposed IMMA attms (e.g., for the historical attm) are undecided, and will benefit from future feedback and discussion (including possible alternative implementation options noted as part of the background information for some fields). In other cases, existing (originally LMR-based) configurations have been utilized. These

[2] As an exception, the (obsolete) NCDC-variant record uses leading zeros in fields *MO*, *DY*, and *HR*. Additional differences between the NCDC-variant record and the ICOADS-standard record are described in Supp. E.

provisional configurations are outlined in Supp. F and may warrant modification or expansion after international consideration.

Core (C0)

Location section

1) *YR* year UTC (four digits)
2) *MO* month UTC (1=January, 2=February, …, 12=December)
3) *DY* day UTC (1-31)
4) HR hour UTC (0.00 to 23.99)[3]

Background: As for IMMT-5 except *HR*. In the NCDC-variant record, no longer produced (as well as in IMMT-5), MO, DY, and HR will include leading zero-fill, as applicable (e.g., 01=January). VOS data typically are reported to nearest whole hour, but the extended resolution is needed, e.g., for storage of drifting buoy data. For VOS data, WMO (2015) Reg. 12.1.6 states: "The actual time of observation shall be the time at which the barometer is read."

5) *LAT* latitude
6) *LON* longitude

Position to hundredths of a degree +N or –S (measured north or south of the equator) and +E or –W (measured east or west of the Greenwich Meridian). The longitude range (–179.99° to 359.99°) specified in Supp. C (Table C0) encompasses two distinct longitude conventions: 0° to 359.99° (i.e., 0°E, 0.01°E, …, 359.98°E, 359.99°E; ICOADS convention) and –179.99° to 180.00° (i.e., 179.99°W, 179.98°W, …, 179.99°E, 180.00°E; NCDC-variant convention, now obsolete).

Background: The two longitude conventions are desirable for different applications and archival requirements. However, 0° to 359.99° is generally recommended, because it is the simplest formulation and thus helps reduce the likelihood of location errors. Extended resolutions are needed in comparison to the IMMT-5 format, e.g., for drifting buoy data. Disallowing 360.00 and –180.00° ensures that meridians are uniquely represented within the convention range (i.e., avoiding: 0°/360.00°; 180.00°/–180.00°). However, even if IMMA records are stored in a mixture of these conventions, all longitude values can be accurately interpreted because the overall range for longitude reserves negative for the western hemisphere. Organizing *YR*, *MO*, *DY*, *HR*, *LAT*, and *LON* in sequence can facilitate synoptic sort operations. Characters (N, S, E, W) could alternatively have been used in place of sign for both *LAT* and *LON*, but this complicates computer processing and therefore was deemed not advisable, as was usage of conventions for quadrant (WMO Code 3333 as used in IMMT-5) or octant numbers (WMO 2015 notes under Code 3333 how the choice of quadrant is left to the observer under specific circumstances such as along the Equator).

7) *IM* IMMA version

0 – version 0 (2010, http://icoads.noaa.gov/e-doc/imma/R2.5-imma.pdf)
1 – version 1 (the current version, 2016, this document)
2 – version 2
etc.

[3] Throughout Supp. D, floating-point ranges, if applicable, are provided as values would appear after applying the units scaling from the appropriate table in Supp. C to the integer values stored in the IMMA format.

8) *ATTC* attm count

ATTC provides the attm count:

0 – abbreviated record (no attm)
1 – one attm
2 – two attms
etc.

Background: *IM* and *ATTC* are positioned near the front of the record to allow computerized input and interpretation (e.g., of different IMMA versions), but after *LON* so as not to interfere with sort operations. The configuration of *IM* is similar to the IMMT-5 field "IMMT version" with a valid range 0-99. For IMMA1, the range of *ATTC* is extended to 10 and the representation is now base36.

9) *TI* time indicator

10) *LI* latitude/longitude indicator

TI preserves the incoming precision of time fields:

0 – nearest whole hour
1 – hour to tenths
2 – hour plus minutes
3 – high resolution (e.g., hour to hundredths)

LI preserves the precision at which *LAT* and *LON* were recorded or translated from, or if they were derived later by interpolation between known positions:

0 – degrees and tenths
1 – whole degrees
2 – mixed precision
3 – interpolated
4 – degrees and minutes
5 – high resolution data (e.g., degrees to seconds)
6 – other

Background: *TI* and *LI* match original LMR configurations, except that *LI*=2 was described there as "nonrandom tenths" (a type of mixed precision; see *Release 1*, supp. F). [Note: No indication is available in *TI* for quasi-instantaneous vs. time-period averaged data (e.g., daily averages from PMEL deck 145).]

11) *DS* ship course

12) *VS* ship speed

WMO Code 0700 for true direction of resultant displacement of the ship during the three hours preceding the time of observation (i.e., ship's course (true) made good):

0 – stationary (ship hove to)	5 – SW
1 – NE	6 – W
2 – E	7 – NW
3 – SE	8 – N
4 – S	9 – unknown

WMO Code 4451 for ship's average speed made good during the three hours preceding the time of observation (beginning 1 January 1968):

0 – 0 knots	5 – 21-25 knots
1 – 1-5 knots	6 – 26-30 knots
2 – 6-10 knots	7 – 31-35 knots
3 – 11-15 knots	8 – 36-40 knots
4 – 16-20 knots	9 – over 40 knots

Prior to 1 January 1968 a different code for *VS*, also with range 0-9, applied (Met Office 1948):

0 – 0 knots	5 – 13-15 knots

1 – 1-3 knots
2 – 4-6 knots
3 – 7-9 knots
4 – 10-12 knots
6 – 16-18 knots
7 – 19-21 knots
8 – 22-24 knots
9 – over 24 knots

Background: As was originally the case in LMR, both the old and new *VS* codes are stored in the same field, to be differentiated by date (but *DS* and *VS* were named *SC* and *SS* in LMR). In IMMPC format documentation, Code 4451 may have been used to refer to both the old and new *VS* codes. Further research is needed to clarify the timing and details of that apparent code change.

13) *NID* national source indicator

A field available for national use in identifying data subsets.

Background: IMMT has a similar 1-character field for "national use" (see Supp. B, Table B2), which thus far has not been translated into this (or another) IMMA field. *NID* was set to "1" by the Data Assembly Center (DAC; at NOAA/NCEI) for identified VOSClim ships, or to missing otherwise. [Note: Presently in R3.0 not all VOSClim ships were identified in all data sources, such that this indicator was set only sporadically. R3.0 VOSClim data obtained in the ICOADS-standard format should be identifiable by *NID*=1.]

14) *II* *ID* indicator

15) *ID* identification/callsign

II indicates whether a callsign or some other sort of identification is contained in the *ID* field (and in R3.0 data, *II* should always be extant when *ID* information exists; whereas *II* should always be missing if *ID* is missing):

0 – ID present, but unknown type
1 – ship, Ocean Station Vessel (OSV), or ice station callsign
2 – generic ID (e.g., SHIP, BUOY, RIGG, PLAT)
3 – WMO 5-digit buoy number
4 – other buoy number (e.g., Argos or national buoy number)
5 – Coastal-Marine Automated Network (C-MAN) ID (assigned by US NDBC or other organizations)
6 – station name or number
7 – oceanographic platform/cruise number
8 – fishing vessel psuedo-ID
9 – national ship number
10 – composite information from early ship data
11 – 7-digit buoy ID (proposed)

Background: *ID* is extended to nine characters (versus e.g., seven in IMMT-5). In platform track checking, for example, consideration should be given to using a combination of *II* and *ID*, since identical *ID*s can sometimes have different *II* values and thus may represent different platforms. [Note: ICOADS processing normally left-justifies extant information stored within *ID* (with right blank-fill). GTS reports generally contain a radio callsign or WMO buoy identification number (http://www.wmo.int/pages/prog/amp/mmop/wmo-number-rules.html), but early IMM logbook reports sometimes contained IDs such as national ship numbers and "log" numbers (see Table B4). Documentation of the format of such numbers generally appears to be unavailable (but could potentially be sought from individual countries), thus *II*=9 has generally been assigned only for earlier (pre-IMM) card decks for which the format of the information was known.] *II*=11 is listed as proposed since new 7-digit buoy IDs exist, but are not presently marked as such in R3.0 of ICOADS. Future expansion of the list of *II* values is likely with the advent of new WMO identifiers (e.g., WIGOS).

16) *C1* country code

The country that recruited a ship, which may differ from the country of immediate receipt (*C2*, field 15) and may also differ from the ship's registry. WMO transitioned from the older numeric code values 0-40 (Table D1) to the current 2-character ISO 3166 (http://www.iso.org/iso/country_codes.htm) alphabetic codes effective 1 Jan. 1998.

Background: Both the older numeric codes for historical data, and the alphabetic codes for more recent data, are stored in this field (since e.g., the old numeric codes include the USSR and other former country names). [Note: The older numeric codes were "according to numbers assigned by WMO" (see IMMT-1 documentation in WMO 1993a). Some deficiencies in NCDC's processing many years ago of early IMM receipts, involving missing country codes and card "overpunch" handling, are discussed in the LMR documentation (http://icoads.noaa.gov/e-doc/lmr).]

Table D1. WMO numeric country codes (now obsolete).

C1	*Country*	*C1*	*Country*	*C1*	*Country*	*C1*	*Country*
0	Netherlands	10	Ireland	20	Sweden	30	Spain
1	Norway	11	Philippines	21	FRG	31	Thailand
2	US	12	Egypt	22	Iceland	32	Yugoslavia
3	UK	13	Canada	23	Israel	33	Poland
4	France	14	Belgium	24	Malaysia	34	Brazil
5	Denmark	15	South Africa	25	USSR	35	Singapore
6	Italy	16	Australia	26	Finland	36	Kenya
7	India	17	Japan	27	Rep. of Korea	37	Tanzania
8	Hong Kong	18	Pakistan	28	New Caledonia	38	Uganda
9	New Zealand	19	Argentina	29	Portugal	39	Mexico
						40	GDR

Regular section

17) *DI* wind direction indicator

18) *D* wind direction

DI gives the compass (and approximate precision) used for reporting the wind direction:

0 – 36-point compass
1 – 32-point compass
2 – 16 of 36-point compass
3 – 16 of 32-point compass
4 – 8-point compass
5 – 360-point compass
6 – high resolution data (e.g., tenths of degrees)

D is the direction (true) from which wind is blowing (or will blow), stored in whole degrees (i.e., 360-point compass; range: 1-360°), or special codes:

361 – calm
362 – variable, or all directions

Table D2 lists the standard mappings used in ICOADS of contemporary (WMO Code 0877) and historical ship wind direction codes into degrees.

Background: IMMT-5 follows WMO Code 0877 (including 00 for calm, and 99 for variable). In FM 13, stations within 1° of the North Pole instead use Code 0878 (WMO 2015). In designing D to store both high- and low-resolution directions, an unambiguous and numerically closed range (i.e., 1-362, rather than e.g., 0-360, 999=variable) was deemed advantageous for computational reasons (e.g., range checking).

Table D2. Translation of contemporary (*DI*=0; WMO Code 0877) and some historical (shaded) ship wind direction codes (*DI*=1-3 as represented in NCDC 1968) into degrees (blank indicates an undefined conversion) for storage of wind direction in *D*. *Release 1*, supp. F provides the original rationale for the degree values shown in this table and further background information (including uncertainties associated with past usage of *DI*=4 in ICOADS, see Table F2-1 in http://icoads.noaa.gov/Release_1/suppF.html).

WMO Code 0877		*DI*				
Code	*Range*	*0*	*1*	*2*	*3*	*4*
01	5-14	10	11			?
02	15-24	20	23	25	23	?
03	25-34	30	34			?
04	35-44	40	45		45	?
05	45-54	50	56	45		?
06	55-64	60	68		68	?
07	65-74	70	79	65		?
08	75-84	80	90		90	?
09	85-94	90	101	90		
10	95-104	100	113		113	
11	105-114	110	124	115		
12	115-124	120	135		135	
13	125-134	130	146			
14	135-144	140	158	135	158	
15	145-154	150	169			
16	155-164	160	180	155	180	
17	165-174	170	191			
18	175-184	180	203	180	203	
19	185-194	190	214			
20	195-204	200	225	205	225	
21	205-214	210	236			
22	215-224	220	248		248	
23	225-234	230	259	225		
24	235-244	240	270		270	
25	245-254	250	281	245		
26	255-264	260	293		293	
27	265-274	270	304	270		
28	275-284	280	315		315	
29	285-294	290	326	295		
30	295-304	300	338		338	
31	305-314	310	349			
32	315-324	320	360	315	360	
33	325-334	330				
34	335-344	340		335		
35	345-354	350				
36	355-4	360		360		
00 (calm)		361	361	361	361	
99 (variable)		362	362	362	362	

19) *WI* wind speed indicator

20) *W* wind speed

Wind speed is stored in tenths of a meter per second (to retain adequate precision for winds converted from knots, or high-resolution data). *WI* shows the units in which and/or the method by which *W* was originally recorded (0, 1, 3, 4 follow WMO Code 1855):

0 – meter per second, estimated

1 – meter per second, obtained from anemometer (measured)
2 – estimated (original units unknown)
3 – knot, estimated
4 – knot, obtained from anemometer (measured)
5 – Beaufort force (based on documentation)
6 – estimated (original units unknown)/unknown method
7 – measured (original units unknown)
8 – high-resolution measurement (e.g., hundredths of a meter per second)

Background: No indication is given as to the incoming units and precision of *W*, e.g., whole knots. For reports derived from e.g., TDF-11 format (NCDC 1968), the meaning of *WI*=6 either is "estimated (units unknown)," or "both method and units unknown" (i.e., the indicator was missing). This unfortunate ambiguity derives from the dual meaning present in some original archive formats, including IMMPC (ref. Supp. B). [Note: In earlier ICOADS processing, *WI*=2 and *WI*=7 were used for reconversion of deck 555 from the original "SPOT" format; however, no missing value was available in the SPOT format, thus both those *WI* settings should be interpreted with caution.]

21) *VI* visibility indicator
22) *VV* visibility

VV (horizontal visibility at the surface in kilometers) according to WMO Code 4377 from which, in reporting visibility at sea, WMO (2009a; Reg. 12.2.1.3.2) states that the decile 90-99 shall be used (moreover Reg. 12.2.1.3.1: when the horizontal visibility is not the same in different directions, the shortest distance shall be given for VV):

90 – less than 0.05 kilometer
91 – 0.05
92 – 0.2
93 – 0.5
94 – 1
95 – 2
96 – 4
97 – 10
98 – 20
99 – 50 or more

VI shows whether *VV* was:

0 – estimated (or unknown method of observation)
1 – measured
2 – fog present (obsolete)

Background: The "Cloud height and visibility measuring indicator" from IMMT-5 is separated into independent indicators in IMMA format, *HI* (see field 39) and *VI.* [Note: When *VI*=2, and *VV*=93, it meant that fog was present and visibility was not reported (NCDC 1968). This "fog present" combination of *VI*=2 with *VV*=93 appears to originate from "overpunch" procedures that took effect in the IMMPC format around 1966 (see Table B2) as translated into the TDF-11 format.]

23) *WW* present weather
24) *W1* past weather

WMO Codes 4677 (Table D3) for *WW*, and 4561 for *W1*:

0 – Cloud covering 1/2 or less of the sky throughout the appropriate period
1 – Cloud covering more than 1/2 of the sky during part of the appropriate period and covering 1/2 or less during part of the period
2 – Cloud covering more than 1/2 of the sky throughout the appropriate period

3 – Sandstorm, duststorm or blowing snow
4 – Fog or ice fog or thick haze
5 – Drizzle
6 – Rain
7 – Snow, or rain and snow mixed
8 – Shower(s)
9 – Thunderstorm(s) with or without precipitation

For use of weather data starting 1 Jan. 1982, also refer to *IX* (*C5*, field 7).

Background: WMO Code 4561 also applies to *W2* (*C5*, field 8). WMO Codes 4680 (W_aW_a) and 4531 (W_{a1}/W_{a2}) (not shown) are used instead for reporting present and past weather from an automatic weather station (see WMO 2015). Those alternative Codes have the same numerical ranges as *WW* (00-99) and *W1*/*W2* (0-9) but different meanings, and *IX* must be used to determine which codes are being utilized.

Table D3. WMO Code 4677 for present weather (*WW*) (after WMO 2015). Leading zero is omitted in IMMA. Large multi-line braces ("{" and "}") as appear in WMO (2009a) are reproduced in this table by denoting the code groups to which text characteristics given in the first column (e.g., "No meteors except photometeors") or last column apply by listing the codes in square [brackets] (e.g., "[00-03]").

	Code		
WW = 00-49		*No precipitation at the station at the time of observation*	
WW = 00-19		No precipitation, fog, ice fog (except for 11 and 12), duststorm, sandstorm, drifting or blowing snow at the station[1] at the time of observation or, except for 09 and 17, during the preceding hour	
	Code		
No meteors except photo-meteors [00-03]	00	Cloud development not observed or not observable	[00-03] Characteristic change of the state of sky during the past hour
	01	Clouds generally dissolving or becoming less developed	
	02	State of sky on the whole unchanged	
	03	Clouds generally forming or developing	
Haze, dust, sand or smoke [04-09]	04	Visibility reduced by smoke, e.g., veldt or forest fires, industrial smoke or volcanic ashes	
	05	Haze	
	06	Widespread dust in suspension in the air, not raised by wind at or near the station at the time of observation	
	07	Dust or sand raised by wind at or near the station at the time of observation, but no well-developed dust whirl(s) or sand whirl(s), and no duststorm or sandstorm seen; or, in the case of ships, blowing spray at the station	
	08	Well-developed dust whirl(s) or sand whirl(s) seen at or near the station during the preceding hour or at the time of observation, but no duststorm or sandstorm	
	09	Duststorm or sandstorm within sight at the time of observation, or at the station during the preceding hour	
	10	Mist	
	11	Patches	[11-12] shallow fog or ice fog at the station, whether on land or sea, not deeper than about 2 meters on land or 10 meters at sea
	12	More or less continuous	
	13	Lightning visible, no thunder heard	
	14	Precipitation within sight, not reaching the ground or the surface of the sea	

	Code		
	15	Precipitation within sight, reaching the ground or the surface of the sea, but distant, i.e., estimated to be more than 5 km from the station	
	16	Precipitation within sight, reaching the ground or the surface of the sea, near to, but not at the station	
	17	Thunderstorm, but no precipitation at the time of observation	
	18	Squalls	[18-19] at or within sight of the station during the preceding hour or at the time of observation
	19	Funnel cloud(s)[2]	
WW = 20-29		Precipitation, fog, ice fog or thunderstorm at the station during the preceding hour but not at the time of observation	
	20	Drizzle (not freezing) or snow grains	
	21	Rain (not freezing)	
	22	Snow	[20-24] not falling as shower(s)
	23	Rain and snow or ice pellets	
	24	Freezing drizzle or freezing rain	
	25	Shower(s) of rain	
	26	Shower(s) of snow, or of rain and snow	
	27	Shower(s) of hail[3], or of rain and hail[3]	
	28	Fog or ice fog	
	29	Thunderstorm (with or without precipitation)	
WW = 30-39		Duststorm, sandstorm, drifting or blowing snow	
	30	Slight or moderate duststorm or sandstorm – has decreased during the preceding hour	
	31	Slight or moderate duststorm or sandstorm – no appreciable change during the preceding hour	
	31	Slight or moderate duststorm or sandstorm – has begun or has increased during the preceding hour	
	33	Severe duststorm or sandstorm – has decreased during the preceding hour	
	34	Severe duststorm or sandstorm – no appreciable change during the preceding hour	
	35	Severe duststorm or sandstorm – has begun or has increased during the preceding hour	
	36	Slight or moderate drifting snow	[36-37] generally low (below eye level)
	37	Heavy drifting snow	
	38	Slight or moderate blowing snow	[38-39] generally high (above eye level)
	39	Heavy blowing snow	
WW = 40-49		Fog or ice fog at the time of observation	
	40	Fog or ice fog at a distance at the time of observation, but not at the station during the preceding hour, the fog or ice fog extending to a level above that of the observer	
	41	Fog or ice fog in patches	
	42	Fog or ice fog, sky visible	[42-43] has become thinner during the preceding hour
	43	Fog or ice fog, sky invisible	
	44	Fog or ice fog, sky visible	[44-45] no appreciable change during the preceding hour
	45	Fog or ice fog, sky invisible	
	46	Fog or ice fog, sky visible	[46-47] has begun or has become thicker during the preceding hour
	47	Fog or ice fog, sky invisible	
	48	Fog, depositing rime, sky visible	
	49	Fog, depositing rime, sky invisible	
WW = 50-99		*Precipitation at the station at the time of observation*	
WW = 50-59		Drizzle	
	50	Drizzle, not freezing, intermittent	[50-51] slight at time of observation
	51	Drizzle, not freezing, continuous	
	52	Drizzle, not freezing, intermittent	[52-53] moderate at time of observation
	53	Drizzle, not freezing, continuous	
	54	Drizzle, not freezing, intermittent	[54-55] heavy (dense) at time of observation
	55	Drizzle, not freezing, continuous	

	Code		
	56	Drizzle, freezing, slight	
	57	Drizzle, freezing, moderate or heavy (dense)	
	58	Drizzle and rain, slight	
	59	Drizzle and rain, moderate or heavy	
WW = 60-69		Rain	
	60	Rain, not freezing, intermittent	[60-61] slight at time of observation
	61	Rain, not freezing, continuous	
	62	Rain, not freezing, intermittent	[62-63] moderate at time of observation
	63	Rain, not freezing, continuous	
	64	Rain, not freezing, intermittent	[64-65] heavy (dense) at time of observation
	65	Rain, not freezing, continuous	
	66	Rain, freezing, slight	
	67	Rain, freezing, moderate or heavy	
	68	Rain or drizzle and snow, slight	
	69	Rain or drizzle and snow, moderate or heavy	
WW = 70-79		Solid precipitation not in showers	
	70	Intermittent fall of snowflakes	[70-71] slight at time of observation
	71	Continuous fall of snowflakes	
	72	Intermittent fall of snowflakes	[72-73] moderate at time of observation
	73	Continuous fall of snowflakes	
	74	Intermittent fall of snowflakes	[74-75] heavy (dense) at time of observation
	75	Continuous fall of snowflakes	
	76	Diamond dust (with or without fog)	
	77	Snow grains (with or without fog)	
	78	Isolated star-like snow crystals (with or without fog)	
	79	Ice pellets	
WW = 80-99		Showery precipitation, or precipitation with current or recent thunderstorm	
	80	Rain shower(s), slight	
	81	Rain shower(s), moderate or heavy	
	82	Rain shower(s), violent	
	83	Shower(s) of rain and snow mixed, slight	
	84	Shower(s) of rain and snow mixed, moderate or heavy	
	85	Snow shower(s), slight	
	86	Snow shower(s), slight	
	87	Shower(s) of snow pellets or small hail, with or – without rain or rain and snow mixed	Slight
	88	Shower(s) of snow pellets or small hail, with or – without rain or rain and snow mixed	Heavy
	89	Shower(s) of hail[4], with or without rain or rain and snow mixed, not associated with thunder	Slight
	90	Shower(s) of hail[4], with or without rain or rain and snow mixed, not associated with thunder	Heavy
	91	Slight rain at time of observation	[91-94] Thunderstorm during the preceding hour but not at time of observation
	92	Moderate or heavy rain at time of observation	
	93	Slight snow, or rain and snow mixed or hail[3] at time of observation	
	94	Moderate or heavy snow, or rain and snow mixed or hail[3] at time of observation	
	95	Thunderstorm, slight or moderate, without hail[3], but with rain and/or snow at time of observation	[95-99] Thunderstorm at time of observation
	96	Thunderstorm, slight or moderate, with hail[3] at time of observation	
	97	Thunderstorm, heavy, without hail[3], but with rain and/or snow at time of observation	
	98	Thunderstorm combined with duststorm or sandstorm at time of observation	
	99	Thunderstorm, heavy, with hail[3] at time of observation	

1. The expression “at the station” refers to a land station or a ship.
2. Tornado cloud or water-spout.

3. Hail, small hail, snow pellets. French: grêle, grésil ou neige roulée.
4. French: grêle.

_____

25) *SLP* sea level pressure
26) *A* barometric tendency
27) *PPP* amount of pressure tendency

SLP and *PPP* (amount of pressure tendency at station level during the three hours preceding the time of observation) in tenths of hPa (i.e., millibars), and *A* according to WMO Code 0200 (Table D4).

Background: IMMT-5 contains a 4-character (PPPP) representation of *SLP* in (dropping the leading digit). WMO (2009a) Reg. 12.1.3.7, Note (3) describes how for auxiliary ships *SLP* (similarly to *AT*, as discussed below) still may be reported to whole hPa (using the solidus "/" for the tenths position, which was probably generally set to zero in translated GTS data, with a resulting loss of precision information).

Table D4. WMO Code 0200 for characteristic of pressure tendency during the three hours preceding the time of observation (*A*) (after WMO 2015).

Code	Definition	Additional definition related to codes in brackets [ ].
0	Increasing, then decreasing; atmospheric pressure the same or higher than three hours ago	
1	Increasing, then steady; or increasing, then increasing more slowly	[1-3] Atmospheric pressure now higher than three hours ago
2	Increasing (steadily or unsteadily)[1]	
3	Decreasing or steady, then increasing; or increasing, then increasing more rapidly	
4	Steady; atmospheric pressure the same as three hours ago[1]	
5	Decreasing, then increasing; atmospheric pressure the same or lower than three hours ago	
6	Decreasing, then steady; or decreasing, then decreasing more slowly	[6-8] Atmospheric pressure now lower than three hours ago
7	Decreasing (steadily or unsteadily)[1]	
8	Steady or increasing, then decreasing; or decreasing, then decreasing more rapidly	

1. For reports from automatic stations, see Reg. 12.2.3.5.3.

_____

28) *IT* indicator for temperatures
29) *AT* air temperature (i.e., dry bulb)
30) *WBTI* *WBT* indicator
31) *WBT* wet-bulb temperature
32) *DPTI* *DPT* indicator
33) *DPT* dew-point temperature
34) *SI* *SST* method indicator
35) *SST* sea surface temperature

Temperatures are stored in tenths of a degree Celsius.

IT provides information about the precision and/or units that the *Core* temperature elements were translated from:

0 – tenths °C
1 – half °C
2 – whole °C

3 – whole or tenths °C (mixed precision among temperature fields)
4 – tenths °F
5 – half °F
6 – whole °F
7 – whole or tenths °F (mixed precision among temperature fields)
8 – high resolution data (e.g., hundredths °C)
9 – other

Background: For *IT*, 0-2 match i_T=3-5 in IMMT-5; the full configuration matches predecessor field *T1* in LMR. Early historical temperatures may have also been reported in degrees Réaumur, mixed units, etc.; additional fields may be desirable in the historical attm to record such details. WMO (2009a) Reg. 12.1.3.7, Note (3) describes how for auxiliary ships *AT* (similarly to *SLP*, as discussed above) still may be reported to whole degrees (using the solidus "/" for the tenths position, which was probably generally set to zero in translated GTS data, with a resulting loss of precision information). Only starting in 1982 could *DPT* be reported to tenths in the SHIP code, and only starting 2 Nov. 1994 did it become possible to report *WBT* (to tenths) in FM 13.

WBTI and *DPTI* indicate which of *WBT* or *DPT* was measured or computed, and ice bulb conditions:

0 – measured
1 – computed
2 – iced measured
3 – iced computed

Background: *WBTI* and *DPTI* are derived from sign positions s_w and s_t in IMMT-5. [Note: For data originally translated into LMR from IMMT formats, the predecessor LMR field *T2* preserved only a subset of information derived from s_w and s_t, coupled with whether *DPT* was computed during ICOADS processing. Future work should seek to recover more complete information for data that were translated to IMMA from LMR, and consider new configurations to separately document ICOADS processing. WMO (2009a) Reg. 12.2.3.3.1 specifies when (e.g., owing to instrument failure) relative humidity (RH) is available and may be reported in FM 13 instead of *DPT* in an alternative group 29UUU. For R3.0, we are now translating more *RH* data into the IMMA1 *Immt* attm, both from modern GTS and IMMT sources.]

SI shows the method by which *SST* was taken:

0 – bucket
1 – condenser inlet (intake)
2 – trailing thermistor
3 – hull contact sensor
4 – through hull sensor
5 – radiation thermometer
6 – bait tanks thermometer
7 – others
9 – unknown or non-bucket
10 – "implied" bucket [note: applicable to early ICOADS data]
11 – reversing thermometer or mechanical sensor
12 – electronic sensor

Background: 0-7 follow the IMMT-5 code. Except for omitting *SI*=8 ("unknown"), this is a direct mapping from the LMR configuration. *SI* values should be used with extreme caution in earlier data (see discussion of "bucket indicators" in sec. 4 of *Release 1*). [Note: In translation from LMR, *SI*=8 was made missing (*SI*=8 indicated that no information was available; it resulted from a conversion error applicable only to decks 705-707). For data translated from IMM formats effective

since 1982, *SI*=7 refers to "other than 0-6," because the only other extant values were 0-6. For FM 13 data reported since 2 Nov. 1994 (when *SI* information first became available on GTS), in contrast, *SI*=7 refers to "other than 0-1 or 3," because the only other extant values were equivalent to 0-1 or 3. *SI*=9 arose because a distinct missing value was not available in some earlier IMM and archive formats, e.g., in NCDC (1968) a blank in the SST indicator field for deck 128 meant "determined by other than bucket method," but blank also generally signified a missing field in that format.]

36) *N* total cloud amount (cover)
37) *NH* lower cloud amount

For *N*, codes 0 to 9 (WMO Code 2700) show the total fraction of the celestial dome covered by clouds (irrespective of their genus). For *NH* (also WMO Code 2700) they show the amount of all the low (*CL*) cloud present or, if no *CL* cloud is present, the amount of all the middle (*CM*) cloud present:

0 – clear
1 – 1 okta or less, but not zero
2-6 – 2-6 oktas
7 – 7 oktas or more, but not 8 oktas
8 – 8 oktas
9 – sky obscured by fog and/or other meteorological phenomena

Background: In WMO 2015 (WMO Code 2700), *N* is termed "total cloud cover." This description adopts the current WMO Code 2700 definition of code 9, which in LMR was defined as "sky obscured or cloud amount cannot be estimated" (as in Met Office 1948). The solidus ("/") is defined as a further possibility in WMO Code 2700 as "Cloud cover is indiscernible for reasons other than fog or other meteorological phenomena, or observation is not made," which should have been translated into missing data in IMMA. [Note: Historically "/" was omitted e.g., from Met Office 1948 and NCDC 1968, and thus also not included in *Release 1* or current LMR configurations for *N* and *NH*. In contrast *CL*, *H*, *CM*, and *CH* have always had an ICOADS configuration ("A" in IMMA) corresponding to "/" separate from missing data (see also background notes following *CH*, field 42).]

38) *CL* low cloud type

Codes 0 to 10 [A in base36 encoding] show characteristics observed of clouds of the genera Stratocumulus, Stratus, Cumulus, and Cumulonimbus (WMO Code 0513; see also background notes following *CH*, field 42).

39) *HI* cloud height indicator

HI shows if cloud height *H* was:

0 – estimated
1 – measured

Background: The "Cloud height and visibility measuring indicator" from IMMT-5 is separated into independent indicators in IMMA format, *HI* and *VI* (see field 21).

40) *H* cloud height

Codes 0 to 9 and "A" (following WMO Code 1600) show the height above surface of the base of the lowest cloud seen (such that a height exactly equal to one of the values at the ends of the ranges shall be coded in the higher range, e.g., a height of 600 m shall be reported by code 5):

0 – 0 to 50 m
1 – 50 to 100 m
2 – 100 to 200 m
3 – 200 to 300 m
4 – 300 to 600 m

5 – 600 to 1000 m
6 – 1000 to 1500 m
7 – 1500 to 2000 m
8 – 2000 to 2500 m
9 – 2500 m or more, or no clouds
10 [A in base36 encoding] – height of base of cloud not known or base of clouds at a level lower and tops at a level higher than that of the station

Background: Further notes regarding WMO Code 1600 (WMO 2015) concern *H* data reported from automatic stations.

41) *CM* middle cloud type

Codes 0 to 10 [A in base36 encoding] show characteristics observed of clouds of the genera Altocumulus, Altostratus, and Nimbostratus (WMO Code 0515).

42) *CH* high cloud type

Codes 0 to 10 [A in base36 encoding] show characteristics observed of clouds of the genera Cirrus, Cirrocumulus and Cirrostratus (WMO Code 0509).

Background: Configurations for *CL*, *H*, *CM*, and *CH* are as in IMMT-5, except for use of "A" (10 in base36) in place of "/" (LMR used 10 in place of "/"). Analyses of cloud types may be impacted by a 1 Jan. 1982 GTS code change: When *N*=0, the types *CM*, *CH*, and *CL* were reported as missing (i.e., the FM 13 $8NhC_LC_MC_H$ group was omitted), whereas previously these types may have been reported zero (see Hahn et al. 1992). However, to improve climatological data quality, starting 2 Nov. 1994 FM 13 was again modified so that all cloud observations at sea including no cloud observation shall be reported (see WMO 2015, Reg. 12.2.7.1). [Note: For historical reasons (see background under *NH*, field 37), an inconsistency exists in IMMA in how solidus ("/") is translated for *N* and *NH* (i.e., to missing data) versus for *CL*, *H*, *CM*, and *CH* (i.e., to "A"). A related complication (i.e., in terms of preserving information about whether data were explicitly reported as "/" versus omitted from transmission) is that group Nddff in FM 13 is mandatory, whereas $8NhC_LC_MC_H$ can be omitted (Reg. 12.2.7.1).]

43) *WD* wave direction

Starting in 1968, *WD* was no longer reported in the SHIP code. Codes 00 to 36 (note: leading zero is omitted in IMMA) show the direction (if any) from which (wind) waves come, in tens of degrees (following WMO Code 0877; ref. Code and Range columns in Table D2). Codes 37 and 38 show:

37 – waves confused, direction indeterminate (*WH* $\leq$ 4.75 m)
38 – waves confused, direction indeterminate (*WH* > 4.75 m; or irrespective of wave height, corresponding to 99 in WMO Code 0877)

44) *WP* wave period

Period of wind waves, in seconds. Starting in 1968, *WP* was reported in seconds; prior to 1968 the period was reported as a code, which was converted into whole seconds following Table D5a, with *WX* (*C1*, field 13) set accordingly.

45) *WH* wave height

Height of wind waves, in units of 0.5 m (i.e., 1=0.5 m, 2=1 m, etc.).

Background: Historically, the (wind) wave and swell codes have been subject to complex changes. Prior to 1949 both sets of fields were apparently reported descriptively in the SHIP code, and thus are expected to be missing (and the swell fields are expected to be missing prior to 1 July 1963, as discussed below). Codes 37-38 arise from earlier historical codes (see Met Office 1948). Starting in 1968, *WD* was no longer reported and *WP* was reported in seconds. [Note: *WP*=99, indicating a confused sea, is defined in IMMA, but not in use in R3.0. Future work should seek to recover confused sea information from original formats. Some NDBC wave data currently are transformed for storage in Table C5 fields

(potentially inappropriate). Specifically, ICOADS contains increasing amounts of measured wave data from NOAA National Data Buoy Center (NDBC) moored buoys in the vicinity of the US coastline. These variables, in the NCDC (2003) TD-1171 format (ftp://ftp.ncdc.noaa.gov/pub/data/documentlibrary/tddoc/td1171.pdf, Note: no longer produced, since NDBC and NCEI have adopted a netCDF format going forward from ~2012), have been translated into IMMA variables (with a loss of data resolution, at least in the case of *WD*, which is represented in degrees in TD-1171 (e.g., 0-360) as compared to coded units of ten degrees in IMMA, e.g., 0-36):

WD = principal wave direction (pos. 84-86 in TD-1171)
WH = significant wave height (pos. 75-77 in TD-1171)
WP = dominant wave period (pos. 78-80 in TD-1171)]

46) *SD* swell direction
47) *SP* swell period
48) *SH* swell height

Configurations similar to the corresponding wave fields *WD*, *WP*, and *WH*. Prior to 1968 (1968-1982), *SP* was reported as a code, which was converted into whole seconds per Table D5a (Table D5b), with *SX* (*C1*, field 14) set accordingly.

Background: Beginning 1 July 1963 both sea (i.e., wind wave) and swell were reported. Prior to that date only the higher of sea and swell was reported. Starting in 1982, *SP* was reported in seconds.

Table D5a. Conversion for *WP* always, and for *SP* prior to 1968.

Seconds	*Code*	*Interval*
5	2	5 seconds or less
7	3	6-7 seconds
9	4	8-9 seconds
11	5	10-11 seconds
13	6	12-13 seconds
15	7	14-15 seconds
17	8	16-17 seconds
19	9	18-19 seconds
21	0	20-21 seconds
22	1	over 21 seconds
0	–	calm or period not determined

Table D5b. Conversion for *SP* beginning 1 January 1968 and ending in 1982.

Seconds	*Code*	*Interval*
10	0	10 seconds
11	1	11 seconds
12	2	12 seconds
13	3	13 seconds
14	4	14 seconds or more
5	5	5 seconds or less
6	6	6 seconds
7	7	7 seconds
8	8	8 seconds
9	9	9 seconds
0	–	calm or period not determined

ICOADS (*Icoads*) attm (C1)

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=1 for *Icoads*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes.

Box elements

3) *BSI* box system indicator
4) *B10* 10° box number
5) *B1* 1° box number

10° and 1° box numbers (see *Release 1*, supp. G; http://icoads.noaa.gov/Release_1/suppG.html) are available e.g., for use in sorting operations. The box system indicator is currently unused.

Background: *BSI* provides flexibility in case other box requirements arise (i.e., future extant values of *BSI* could indicate different contents in *B10* and *B1*). *Release 1*, supp. G also describes the obsolete Marsden Square (MSQ) system.

Processing elements

6) *DCK* deck

Number of the deck from which the report came (Table D6a), with Tables D6b and D6c providing additional information about selected *DCK* ranges. "Deck" originally referred to a punched card deck, but is now used as the primary field to track ICOADS data collections. Each deck may contain a single Source ID (*SID*) or a mixture of *SIDs* (see C1, field 7 for additional information about the relationship between these two fields, and with the format of supplemental data).

Table D6a. Deck assignments (adapted regarding R2.5 from Table AII in Woodruff et al. 2011). For each deck number, the description, starting and ending years, and number of reports (in thousands) are listed for R2.5 and R3.0 output (blanks in these columns indicate that no data were input and/or output[1]). Decks replaced or augmented in R3.0, are listed in **bold**. ICOADS also offers preliminary data (now based on a blend of decks 792-797 and 992-995) extending beyond 2014, but not reflected in the last three columns.

		R2.5			*R3.0*		
Deck	*Description*	*Start*	*End*	*Rpts K*	*Start*	*End*	*Rpts K*
110	US Navy Marine	1945	1951	633	1945	1951	633
116	US Merchant Marine	1945	1963	6 866	1945	1963	6 860
117	**US Navy Hourlies**	**1952**	**1964**	**11**	**1950**	**1964**	**2 535**
118	Japanese Ships No. 1 (Kobe Collection Data keyed in 1961)	1930	1953	1 727	1930	1953	1 727
119	Japanese Ships No. 2 (Kobe Collection Data keyed in 1961)	1951	1961	904	1951	1961	904
128	International Marine (US- or foreign-keyed ship data)	1950	1978	14 537	1950	1978	14 440
143	Pacific Marine Environmental Laboratory (PMEL) Buoys	1976	1977	13	1976	1977	13

144	TAO/TRITON and PIRATA Buoys (from PMEL & JAMSTEC)[2]	1985	2004	7 192	1985	2004	496
145	PMEL (Daily) Equatorial Moorings and Island Stations[2]	1979	1991	17			
146	**Global Tropical Moored Buoy Array (GTMBA) from PMEL via NOC**				**1977**	**2014**	**13 852**
150	Pacific (US Responsibility) HSST Netherlands Receipts	1939	1961	85	1939	1961	85
151	Pacific (US Responsibility) HSST German Receipts	1862	1960	206	1862	1960	206
152	Pacific (US Responsibility) HSST UK Receipts	1855	1961	15	1855	1961	15
155	Indian (Netherlands Responsibility) HSST	1861	1960	1 068	1861	1960	1 068
156	Atlantic (German Responsibility) HSST	1852	1961	5 564	1852	1961	5 564
184	Great Britain Marine (194 extension)	1953	1961	344	1953	1961	344
185	USSR Marine IGY	1957	1958	111	1957	1958	111
186	USSR Ice Stations	1950	1970	20	1950	1970	20
187	Japanese Whaling Fleet	1946	1956	10	1946	1956	10
188	Norwegian Antarctic Whaling Factory Ships	1932	1939	2	1932	1939	2
189	Netherlands Marine	1939	1959	232	1939	1959	232
192	Deutsche Seewarte Marine	1855	1939	5 944	1855	1939	5 941
193	Netherlands Marine	1800	1938	6 276	1800	1938	6 276
194	Great Britain Marine	1856	1955	457	1856	1955	457
195	US Navy Ships Logs	1941	1946	598	1941	1946	598
196	Deutsche Seewarte Marine (192 extension)	1949	1954	143	1949	1954	143
197	Danish (and Other) Marine (Polar)	1871	1956	23	1871	1956	23
201-255[3]	UK Met. Office (MetO) Main Marine Data Bank (MDB)	1854	1994	15 212	1699	1944	18 003
281	US Navy Monthly Aerological Record (MAR)	1926	1945	187	1926	1945	187
500	Gulf Offshore Weather Observing Network (GOWON) (plat data)						
555	US Navy Fleet Num. Met. and Oceano. Center (FNMOC; Monterey) Telecom.	1966	1973	2 213	1926	1945	187
666	Tuna Boats	1970	1975	17	1970	1975	17
667	Inter-American Tropical Tuna Commission (IATTC)	1971	1997	1 148	1971	1997	1 148
700	**UK Met. Office GTS BUFR Data**	2003	2007	10	**2000**	**2012**	**13 402**
701	US Maury Collection	1784	1863	1 346	1784	1863	1 345
702	Norwegian Logbook Collection	1867	1889	201	1784	1863	1784
703	**US Lightship Collections**				**1931**	**1980**	**201**
704	US Marine Meteorological Journals Collection (1878-94)	1878	1894	1 761	1878	1894	1 761
705	US Merchant Marine Collection (1912-46) (500 series)	1910	1946	1 014	1910	1946	1 014

706	US Merchant Marine Collection (1912-46) (600 series)	1910	1944	2 062	1910	1944	2 062
707	US Merchant Marine Collection (1912-46) (700 series)	1913	1941	425	1913	1941	425
708	**US Navy Marine (US-keyed ship data; hourly METAR format)**				**2001**	**2012**	**387**
709	**US Navy Marine (IMMA formatted by US Navy)**				**2004**	**2006**	**8**
710	**US Arctic Logbooks (OldWeather)**				**1870**	**1946**	**165**
711	**Weather Detective Crowdsourcing**				**1889**	**1899**	**36**
714	**Canadian Oceanography and Scientific Data (OSD; formerly ISDM/MEDS) Buoys**	1978	2007	57 274	**1978**	**2014**	**132 741**
715	German Deep Drifter Data (via OSD; originally from IfM/Univ. Kiel)	1980	1996	1 031			
720	**Deutscher Wetterdienst (DWD) Marine Met. Archive**	1876	1914	976	**1868**	**1988**	**2 100**
721	**German Maury Collection**				**1845**	**1868**	**538**
730	Climatological Database for the World's Oceans (CLIWOC)	1662	1855	261	1662	1855	261
731	Russian S.O. Makarov Collection	1804	1891	3	1662	1855	261
732	Russian Marine Met. Data Set (MORMET) (rec'd at NCAR)	1888	1995	7 873	1888	1995	7 527
733	Russian AARI North Pole (NP) Stations	1937	1991	98	1937	1991	98
734	**Arctic Drift Stations**	1893	1924	12	**1893**	**1924**	**13**
735	Russian Research Vessel (R/V) Digitization	1936	2000	1 789	1936	2000	1 789
736	Byrd Antarctic Expedition (keyed by Hollings Scholars)	1929	1934	1	1929	1934	1
740	**Research Vessel (R/V) Data Quality-Evaluated by FSU/COAPS**	1990	1998	56	**1990**	**2014**	**771**
749	First GARP Global Experiment (FGGE) Level IIb	1978	1979	6	1978	1979	6
750	**Australian Navy Vessels: SST Data (1972-77)**				**1974**	**1977**	**4**
761	Japanese Whaling Ship Data (CDMP/MIT digitization)	1946	1984	20	1946	1984	20
762	Japanese Kobe Collection Data (keyed after decks 118-119)	1889	1940	3 135	1889	1940	3 135
780	**NOAA/NCEI World Ocean Database (WOD) (and formerly Atlas, WOA)**	1800	2015	15 200	**1770**	**2014**	**12 000**

781	**Chinese/Global Ocean Data Archeology and Rescue (GODAR) Ships**				**1968**	**1993**	**382**
782	**Global Ocean Surface Underway Data (GOSUD)**				**1980**	**2014**	**1 578**
792	**US Natl. Cntrs. for Environ. Pred. (NCEP) BUFR GTS: Ship Data**	1998	2007	5 889	**1998**	**2014**	**1 351**
793	**NCEP BUFR GTS: Buoy Data (transmitted in FM 13 "SHIP" code)**	1998	2007	10 545	**1998**	**2014**	**21 876**
794	**NCEP BUFR GTS: Buoy Data (transmitted in FM 18 "BUOY" code)**	1998	2007	1 950	**1998**	**2014**	**2 800**
795	**NCEP BUFR GTS: Coastal-Marine Automated Network (C-MAN code) Data**	2005	2007	4 056	**2008**	**2014**	**6 768**
796	NCEP BUFR GTS: Miscellaneous (OSV, plat, and rig) Data						
797	**NCEP BUFR GTS: CREX code**				**2008**	**2014**	**2 824**
849	First GARP Global Experiment (FGGE)	1978	1979	250	1978	1979	250
850	German FGGE	1978	1979	146	1978	1979	146
874	**Shipboard Environmental (Data) Acquisition System (SEAS)**	1991	2007	504	**1995**	**2014**	**67**
875	**US TurboWin (e-Logbook) Voluntary Observing Ship (VOS) Receipts**				**2012**	**2014**	**2**
876-882[4]	US National Data Buoy Center (NDBC) Data	1972	1979	315	1972	1979	315
883[4]	**US National Data Buoy Center (NDBC) Data**	1980	2004	20 538	**1980**	**2012**	**49 763**
888	US Air Force Global Weather Central (GWC)	1973	1997	5 993	1973	1997	5 987
889	Autodin (US Dept. of Defense Automated Digital Network)	1972	1995	1 039	1972	1995	1 038
890	US National Met. Center (NMC, now NCEP) Data (obsolete)						
891	US National Oceanographic Data Center (NODC) Surface Data						
892	US Natl. Centers for Environmental Pred. (NCEP) Ship Data	1980	1997	9 209	1980	1997	9 190
893	NCEP Moored Buoy Data	1986	1997	2 225	1986	1997	2 225
894	NCEP Drifting Buoy Data						
895	NCEP Coastal-Marine Automated Network (C-MAN) Data						
896	NCEP Miscellaneous (OSV, plat, and rig) Data	1980	1997	575	1980	1997	575
897	*Eltanin*	1962	1963	1	1962	1963	1
898	Japanese	1954	1974	121	1954	1974	121
899	South African Whaling	1900	1955	64	1900	1955	64
900	Australian	1931	1979	386	1931	1979	386

901	FOSDIC Reconstructions (card images from 16mm film)	1868	1963	7	1931	1979	386
902	Great Britain Marine (184 extension)	1957	1961	99	1957	1961	99
926	**International Maritime Meteorological (IMM) Data**	1954	2007	25 372	**1954**	**2014**	**30 612**
927	**International Marine (US- or foreign-keyed ship data)[5]**	1970	2007	11 138	**1970**	**2012**	**11 160**
928	Same as 927 including Ocean Station Vessels (OSV)	1970	1974	4	1970	1974	4
992	**NCEI GTS: Ship Data**				**1999**	**2014**	**14 231**
993	**NCEI GTS: Buoy Data (transmitted in FM 13 "SHIP" code)**				**1999**	**2014**	**8 019**
994	**NCEI GTS: Buoy Data (transmitted in FM 18 "BUOY" code)**				**1999**	**2014**	**1 428**
995	**NCEI GTS: Coastal-Marine Automated Network (C-MAN code) Data**				**1999**	**2014**	**16 054**
996	NCEI GTS: Miscellaneous (OSV, plat, and rig) Data						
997	NCEI GTS: CREX code						
999	US Air Force Environ. Technical Applications Center (ETAC)	1967	1969	37	1967	1969	37

1. Some of these decks (ref. http://icoads.noaa.gov/e-doc/lmr) were used in ICOADS prior to R3.0; others have not been used (e.g. deck 500 was input for Release 1a, but not output). LMR documentation also defined for real-time data processing unofficial deck numbers 001-009, which have not actually been used for ICOADS.
2. Deck 145 contains daily-averaged data, and up to the early 1990's TAO deck 144 contains average estimates for 2-8 hours depending on the buoy instrument package and power requirements.
3. See Table D6b.
4. See Table D6c.
5. A mixture of US- and foreign-keyed data exists in deck 927 prior to 1980; starting about 1980 deck 927 is believed to contain only US-keyed ships.

_____

Table D6b. UK Met. Office (MetO) Main Marine Data Bank (MDB) deck assignments (equivalent to MDB "series" numbers). For each deck number, the description, starting and ending years, and number of reports (in thousands) are listed for R2.5 and R3.0 output (blanks in the last three columns indicate that no data were input and/or output). Decks entirely new to (or replaced in) R3.0, are listed in **bold**. Assignments falling in the range 201-255 not listed below (217, 219-220, etc.) are not yet assigned. Approximate time periods are also given in the description column from earlier MDB or other external documentation.

		R2.5			*R3.0*		
Deck	*Description*	*Start*	*End*	*Rpts K*	*Start*	*End*	*Rpts K*
201	All Ships (1930 code) (1850-1920)	1854	1956	1 403	1854	1956	1 403
202	All Ships (1921 code) (1921-29)	1915	1938	1 170	1915	1938	1 170
203	Selected Ships (1930 code) (1920-39)	1929	1961	416	1929	1961	416
204	British Navy (HM) Ships (1930 code) (1930-48)	1929	1949	115	1929	1949	115
205	Scottish Fishery Cruisers MARIDS (1930 code) (1946-56)	1945	1956	17	1945	1956	17

206	Ocean Weather Stations (OWS) (1930 code) (1947-49)	1947	1948	2	1947	1948	2
207	Selected Ships (1930 code) (1945-48)	1945	1953	390	1945	1953	390
208	Light Vessels (1949-56)						
209	Selected Ships (including some foreign ships) (1951-56)	1951	1956	458	1951	1956	458
210	OWS (including Dutch "J") (1950-56)	1950	1956	4	1950	1956	4
211	Scottish Fishery Cruisers MARIDS (1956-61)	1956	1961	41	1956	1961	41
212	Light Vessels (1956-61)						
213	Selected Ships (1956-61)	1953	1962	1 133	1953	1962	1 133
214	OWS (1956-61)	1956	1961	8	1956	1961	8
215	German Marine (1860-1938)[1]	1860	1940	802	1860	1940	802
216	UK Merchant Ship Logbooks (METFORMS; keyed in 1996) (1935-39)	1935	1939	457	1935	1939	457
218	US OWS (1953-)	1953	1963	9	1953	1963	8
221	MARIDS and Trawlers (1961-)	1962	1988	60	1962	1988	60
222	Light Vessels (1961-)						
223	Selected Ships (1961-81)	1962	1982	416	1962	1982	416
224	OWS (1961-81)	1976	1981	2	1976	1981	2
225	Norwegian Format (1953-)						
226	OWS (1949 code) (1949-52)	1949	1952	3	1949	1952	3
227	Selected Ships (1949-53)	1947	1954	479	1947	1954	479
229	British Navy (HM) Ships (1961-)	1953	1981	50	1953	1981	50
230	Int. Maritime Met. Punched Card (IMMPC) Data (1960-81)	1962	1971	1 102	1962	1971	1 102
233	Selected Ships (1982-)	1982	1994	48	1982	1994	48
234	OWS (1982-)	1982	1994	1	1982	1994	1
235	RIGG, PLAT, Automatic Weather-Observing System (AWS; buoy) (1982-)						
239	British Navy (HM) Ships (1982-)	1953	1993	42	1953	1993	42
241	MetO GTS Receipts (primarily SHIP code; from MDB format)[2]						
242	MetO GTS Receipts (SHIP code; raw messages from MetDb)[3]						
245	Royal Navy Ship's Logs (keyed by 2007) (1938-47)	1936	1955	1 423	1936	1955	1 423
246	**Atmospheric Circ. Reconstructions over the Earth (ACRE) Digitized Data: Print./Published Expeditions (held at Met. Office)**				**1699**	**1940**	**128**
247	**ACRE Digitized Data: *Challenger* Expedition**				**1872**	**1876**	**16**
248	**English East India Co. (EEIC) Ship Logs**				**1789**	**1834**	**247**
249	**Extended WW1 UK Royal Navy Ship's Logs (OldWeather)**				**1912**	**1925**	**983**
254	Int. Maritime Met. (IMM) Data (foreign or unknown origin)	1860	1994	6 561	1860	1994	6 556
255	Undocumented TDF-11 Decks or MDB Series	1857	1994	23	1857	1994	23

1. Believed to be derived from the same original German punched cards as deck 192 (see Table D6a).
2. 1 Jan 1982-26 Jun 1998 (missing: Apr-Jun 82; Mar, Jun, Sep 85; Sep 88). Some non-SHIP (e.g., BUOY) data may also be included in earlier years.
3. 21 Dec 1996-23 Feb 1998.

Table D6c. Deck assignments for early US National Data Buoy Center (NDBC) data (decks 876-882), and the latest version from NCDC of NDBC data (deck 883). For each deck number, the description, starting and ending years, and number of reports (in thousands) are listed for R2.5 and R3.0 output (blanks in the last three columns indicate that no data were input and/or output[1]).Initially, separate deck numbers 876-880 were assigned to indicate hull design, etc.[1] At a later date, this convention was abandoned, such that decks 882 and 883 were used for all data.

		R2.5			*R3.0*		
Deck	*Description*	*Start*	*End*	*Rpts K*	*Start*	*End*	*Rpts K*
876	NDBC Data (High Capability Buoy; HCB)	1972	1977	36	1972	1977	36
877	NDBC Data (Limited Capability Buoy; LCB)	1973	1976	5	1973	1976	5
878	NDBC Data (Prototype Environmental Buoy; PEB)	1974	1978	43	1974	1978	43
879	NDBC Data (5-meter Continental Shelf Buoys)	1974	1978	46	1974	1978	46
880	NDBC Data (10-meter Continental Shelf Buoys)	1976	1978	8	1976	1978	8
881	NDBC Data (Offshore Platforms)	1976	1977	1	1976	1977	1
882	NDBC Data	1978	1979	175	1978	1979	175
883	**NDBC Data (latest version from NCDC)**	1980	2004	20 538	**1980**	**2012**	**49 763**

1. Hull design information is based on informal NCDC documentation (NCDC 1972a and 1972b) and D. Gilhousen (NDBC) personal correspondence (13 Dec. 1995).

---

7) *SID* source ID

Number of the source ID from which the report came (Table D7). Each *SID* may contain a single deck or a mixture of decks, but each *SID* is generally constrained to a single input format. This helps to identify the format of data stored in the supplemental attachment. However, exceptions include UK Marine Data Bank (MDB) data, for which both *DCK* (201-255) and *SID* (90-93) may be required to determine the supplemental format.

Table D7. Source ID (*SID*) assignments (adapted in part from Table AIII in Woodruff et al. 2011). For each *SID* number, the description, starting and ending years, and number of reports (in thousands, where "<1" signifies a report count falling in the range 1-499) are listed for R2.5 and R3.0 output (blanks in the last three columns indicate that no data were input and/or output[1]). *SID*s entirely new to (or replaced in) R3.0, are listed in **bold**. ICOADS also offers preliminary data (presently based on a blend of *SIDs* 103 and 114) extending beyond 2014, but not reflected in the last three columns.

		R2.5			*R3.0*		
SID	*Description*	*Start*	*End*	*Rpts K*	*Start*	*End*	*Rpts K*
0	*[reserved]*						
1	Atlas	1800	1969	32 713	1800	1969	32 651
2	HSST Pacific	1855	1961	405	1855	1961	404
3	HSST Indian	1861	1960	1 068	1861	1960	1 068
4	HSST Atlantic	1852	1961	5 564	1852	1961	5 564
5	Old TDF-11 Supplement B	1854	1975	2 694	1854	1975	2 652
6	Old TDF-11 Supplement C	1855	1978	2 625	1855	1978	2 625
7	Monterey Telecommunications	1966	1969	661	1966	1969	661
8	Ocean Station Vessels (OSV)	1945	1973	822	1945	1973	819
9	OSV Supplement	1947	1973	57	1947	1973	49
10	MSQ 486 and 105 Omissions	1854	1968	172	1854	1968	171

11	US National Oceanographic Data Center (NODC) Surface						
12	US NODC Surface Supplement						
13	*Eltanin*	1962	1963	1	1962	1963	1
14	Japanese	1954	1974	121	1954	1974	121
15	South African Whaling	1900	1955	64	1900	1955	64
16	Australian	1931	1970	192	1931	1970	192
17	International Maritime Meteorological (IMM) Data	1956	1979	224	1956	1979	224
18	'70s Decade	1970	1979	12 183	1970	1979	12 163
19	IMM '70s	1978	1979	<1	1978	1979	<1
20	OSV Z ('70s)	1970	1974	1	1970	1974	1
21	Australian ('70s)	1971	1979	194	1971	1979	194
22[2]	NCDC: 1980-84 Annual Receipts	1982	1987	135	1982	1987	135
23	'70s Mislocated Data	1973	1979	2	1973	1979	2
24	Buoy Data	1972	1979	192	1972	1979	192
25-28[3]	NCDC: 1980-85 Annual Receipts	1962	1985	1 534	1962	1985	1 534
29	NCDC: US Nat. Met. Center (NMC, now NCEP) Reconversion (1980-92)	1980	1992	8 201	1980	1992	8 189
30	NCDC: 1980-84 Period of Record	1965	1984	4 192	1965	1984	4 185
31	Corrected Canadian Data						
32-33[3]	NCDC: Annual Receipts (and duplicates; starting in 1986)	1974	1997	4 440	1974	1997	4 435
34-45[3]	NCDC: 1986-97 Receipts (delayed)	1969	1996	1 251	1969	1996	1 251
46-47[3]	International Maritime Met. (IMM) Tape Archive (1982-)	1969	1995	7 117	1969	1995	7 116
48	NODC/OCL 1994 World Ocean Atlas (WOA94; Mar. 93 NODC archive data)						
49	NODC/OCL 1994 World Ocean Atlas (WOA94; non-NODC archive)						
50	US National Data Buoy Center (NDBC) Data	1980	1997	12 770	1980	1997	12 770
51-52[3]	Russian AARI North Pole (NP) Stations	1937	1991	98	1937	1991	98
53	First GARP Global Experiment (FGGE) Level IIb: Surface Marine Data	1978	1979	6	1978	1979	6
54	FGGE Level IIb: Oceanographic Data						
55	FGGE Level IIb: Drifting Buoy Data						
56	Russian S.O. Makarov Collection	1804	1891	3	1804	1891	3
57	Russian Marine Meteorological Data Set (MORMET) (rec'd at NCAR)	1888	1993	7 873	1888	1993	7 527
58	French International Maritime Met. (IMM) Uncorrected (1954-88)						
59	UK IMM Corrections (1982-89)	1982	1989	1 552	1982	1989	1 552
60	French International Maritime Met. (IMM) Corrected	1954	1988	159	1954	1988	159
61	Canadian Oceanography and Scientific Data (OSD; formerly ISDM/MEDS) Buoys						
62	OSD (formerly ISDM/MEDS) World Ocean Circulation Experiment (WOCE) Buoys						
63	**Canadian OSD (formerly ISDM/MEDS) Buoys (July 2005 archive extended by Dec. 2008, & by May 2015 for 2008-14)**	1978	2007	57 274	**1978**	**2014**	**132 741**

64	Russian Research Vessel (R/V) Digitization: Marine Surface	1936	2000	1 153	1936	2000	1 153
65	Russian Research Vessel (R/V) Digitization: Marine Actinometric	1947	2000	637	1947	2000	637
66	Pacific Marine Environmental Lab. (PMEL) TOGA/TAO Buoys	1985	1992	236	1985	1992	188
67	PMEL (Daily) Equatorial Moorings and Island Stations	1979	1991	17			
68	Arctic Drift Stations	1893	1924	12	1893	1924	12
69	US Maury Collection	1784	1863	1 346	1784	1863	1 345
70	Inter-American Tropical Tuna Comm. (IATTC) Porpoise Obs. Logs	1979	1997	736	1979	1997	736
71	IATTC Fishing Logs	1971	1997	413	1971	1997	413
72	IMM Tape Archive from WMO Global Collecting Centre (GCC) (1994 format)	1982	1997	3 808	1982	1997	3 808
73	NCDC Marine Obs. Processing System (MOPS): Pre-MOPS (TD-9973)						
74	NCDC MOPS: Duplicate File (TD-9974)						
75	NCDC MOPS: Original Observations (TD-9980)						
76	NCDC MOPS: Supplementary or Correction Data						
77	NCDC: US National Cntrs. for Environ. Pred. (NCEP) Reconversion (1994-97)	1994	1997	2 609	1994	1997	2 605
78	NCDC: US-keyed Logbook Data Reconversion (TD-9972; keyed during 1996-97)	1987	1997	307	1987	1997	307
79	US Air Force Global Weather Central (GWC): DATSAV2 format	1980	1997	1 469	1980	1997	1 465
80	US Navy FNMOC Monterey Telecom: NCAR: Kunia (OPCON) format						
81	US Navy FNMOC Monterey Telecom: NCAR: NEDN format						
82	US Navy FNMOC Monterey Telecom: NCAR: Surface Ship (SPOT) format						
83	US Navy FNMOC Monterey Telecom: NCDC: Surface Ship (SPOT) format (TD-9769)						
84	US Merchant Marine Collection (1912-46): Full QC	1910	1944	1 927	1910	1944	1 927
85	US Merchant Marine Collection (1912-46): Partial QC	1910	1946	1 246	1910	1946	1 246
86	Pacific Marine Environ. Lab. (PMEL) TOGA/TAO Buoys: RAM Data						
87	Pacific Marine Environ. Lab. (PMEL) TOGA/TAO Buoys: SPOT Data						
88	NODC/OCL 1998 World Ocean Database (WOD98; Mar. 94 NODC archive data)						
89	NODC/OCL 1998 World Ocean Database (WOD98; non-NODC archive)						
90	UK Met. Ofc. (MetO) Main Marine Data Bank (MDB): Flatfile 1 (no cardimage)	1856	1994	9 272	1856	1994	9 267
91	MetO MDB: Flatfile 1A (Flatfile plus cardimage data)	1854	1979	5 413	1854	1979	5 413
92	MetO MDB: Flatfile 1B (no Flatfile match; data derived from cardimage)	1855	1978	69	1855	1978	68
93	MetO Historical Metforms (1935-39): Flatfile 1C (data from cardimage)	1935	1939	457	1935	1939	457
94	MetO GTS Receipts (primarily SHIP code; from MDB format)						

95	Japanese Kobe Collection Data (IMMT format; 2003 Edition)	1889	1940	3 135	1889	1940	3 135
96	Norwegian Logbook Collection	1867	1889	201	1867	1889	201
97	Japanese Kobe Collection Data (IMMT format; 1998 Edition)						
98	US Merchant Marine Collection (1912-46): Full QC (CLICOM system)	1914	1944	328	1914	1944	328
99	Japanese Kobe Collection Data (IMMT format; 2001 Edition)						
100	NCEP BUFR GTS: Operational Tanks: Converted from Original Message	1998	1999	2 198	1998	1999	1 706
101	NCEP BUFR GTS: Operational Tanks: Converted from BUFR						
102	NCEP BUFR GTS: Dumped Data: Converted from Original Message						
103	**NCEP BUFR GTS: Dumped Data: Converted from BUFR**	1999	2007	20 241	**1999**	**2014**	**33 912**
104-108	*[reserved]*						
109	**US Navy Marine (US-keyed ship data; hourly METAR format)**				**2001**	**2012**	**387**
110	**UK Met. Office VOSClim GTS BUFR Data**	2003	2007	10	**2000**	**2010**	**10 593**
111	Shipboard Environmental (Data) Acquisition System (SEAS)	1991	2007	438			
112	**IMM Tape Archive from WMO GCC (IMMT-2 or IMMT-3 format)**	1982	2007	7 990	**1982**	**2014**	**13 238**
113	**International Marine (US-keyed ship data)**	1992	2007	533	**1992**	**2012**	**575**
114	**NCEI GTS**				**1999**	**2014**	**39 823**
115	Japanese Whaling Ship Data (CDMP digitization)	1946	1984	20	1946	1984	20
116	Japanese Whaling Ship Data (MIT digitization)	1951	1976	<1	1951	1976	<1
117	PMEL TAO/TRITON and PIRATA Research Archive Hourly Average Data	1990	2001	3 394	1990	2001	3
118	PMEL TAO/TRITON and PIRATA Research Archive 10-Minute Average Data	1996	2004	2 746	1997	2004	5
119	JAMSTEC TRITON Hourly Average Data	1998	2004	595	1998	2004	299
120	PMEL TAO/TRITON and PIRATA Research Archive Hourly Average SLP Data	2000	2004	222	2001	2004	<1
121	**US National Data Buoy Center (NDBC) Data (obtained from NCDC 2005-2012)**	**1998**	**2004**	**7 768**	**1998**	**2012**	**13 085**
122	**US NDBC data (NODC f291 archive version translated by NCDC 2008)**				**1980**	**2008**	**23 908**
123	*[reserved]*						
124	Climatological Database for the World's Oceans (CLIWOC; Release 2.0)						
125	US Marine Meteorological Journals Collection	1878	1894	1 761	1878	1894	1 761
126	Royal Navy Ship's Logs (keyed by 2007)	1936	1955	1 423	1936	1955	1 423
127	Antarctic Expeditions: Print./Published (held at Met Office)	1898	1940	35	1898	1940	25
128	**North Polar Expedition of the Fram (digitized by Environment Canada**				**1898**	**1902**	**1**
129	Byrd Antarctic Expedition (keyed by Hollings Scholars)	1929	1934	1	1929	1934	1
130	Research Vessel (R/V) Data Quality-Evaluated by FSU/COAPS: WOCE ver.3.0	1990	1998	56	1990	1998	56

131	**Research Vessel (R/V) Data Quality-Evaluated by FSU/COAPS: SAMOS**				**2005**	**2014**	**714**
132	Research Vessel (R/V) Data Quality-Evaluated by FSU/COAPS: Other						
133	Climatological Database for the World's Oceans (CLIWOC; Release 2.1, limited edition)	1662	1855	261	1662	1855	261
134	Deutscher Wetterdienst (DWD) Marine Meteorological Archive: Compo Subset	1884	1914	580	1884	1914	580
135	DWD Marine Meteorological Archive: Newly Digitized Data	1876	1902	395	1876	1902	395
136	DWD Marine Meteorological Archive: HISTOR Data	1882	1899	<1	1882	1899	<1
137	NODC/OCL 2005 World Ocean Database (WOD05) updated through 13 Dec. 2007	1772	2005	7 738			
138	ACRE Data: *Challenger* Expedition	1872	1876	16	1872	1876	16
139	German Deep Drifter Data (via OSD; originally from IfM/Univ. Kiel)	1980	1996	1 031			
140	**US Navy Hourlies: Deck 117 in TD-1100 format**				**1950**	**1964**	**15**
141	**US Navy Hourlies: Original card deck 117 format (from FOSDIC)**				**1951**	**1964**	**3**
142	**US Navy Hourlies: Original card deck 117 format (from NCEI DSI-1117)**				**1951**	**1964**	**2 516**
143	**Chinese/Global Ocean Data Archeology and Rescue (GODAR) Ships**				**1968**	**1993**	**382**
144	**US Lightship Collection: Woods Hole Oceanographic Institution**				**1931**	**1980**	**201**
145[4]	US Lightship Collection: National Archives and Records Admin.						
146	**UK Met. Office & NOC: VOSClim-compliant GTS BUFR Data: Historical ship/buoy (FM 13)**				**2010**	**2012**	**1 938**
147	**UK Met. Office & NOC: VOSClim-compliant GTS BUFR Data: Historical buoy (FM 18)**				**2000**	**2012**	**871**
148	**English East India Co. (EEIC) Ship Logs (containing instrumental data)**				**1789**	**1834**	**247**
149	**NOAA/NCEI 2013 World Ocean Database (WOD13) updated through 24-02-2015**				**1770**	**2014**	**11 974**
150	**Shipboard Environmental (Data) Acquisition System (SEAS9.1): IMMT-5 format**				**2013**	**2014**	**<1**
151	**US TurboWin (TurboWin 5.0) (e-Logbook) VOS Receipts: IMMT-4 format**				**2012**	**2014**	**2**
152	**German Maury Collection**				**1845**	**1868**	**538**
156	**Australian Navy Vessels: SST Data (1972-77)**				**1974**	**1977**	**4**
157	**US Navy Marine (IMMA formatted by US Navy)**				**2004**	**2006**	**8**
158	**US TurboWin+ (e-logbook) VOS Receipts: IMMT-5**				**2014**	**2014**	**<1**
159	**Global Ocean Surface Underway Data (GOSUD v2) from NCEI in WOD format received 19 May 2015**				**1980**	**2013**	**539**
160	**DWD Marine Meteorological Archive: HISTOR Data (receipts in 2015)**				**1868**	**1907**	**167**
161	**DWD German Light Vessels (receipts in 2014)**				**1929**	**1988**	**925**
162	**GOSUD v3 real-time data from NCEI in WOD format received 30 April 2015**				**2014**	**2014**	**10**

163	**GOSUD v3 near real-time data from NCEI in WOD format received 30 April 2015**				**2000**	**2014**	**838**
164	**GOSUD delayed-mode French research vessels and sailing ship data from NCEI in WOD format received 30 April 2015**				**2001**	**2014**	**191**
165	**World War I (WW1) UK Royal Navy Logbooks (OldWeather) (1914-23) (Accessed 29 May 2015)**				**1912**	**1925**	**983**
166	**US Navy Arctic Logbooks (OldWeather) (Accessed 29 May 2015)**				**1870**	**1946**	**165**
167	**ACRE Historical Digitised (expeditionary and other spreadsheets) - Translated by UK Met Office**				**1699**	**1930**	**98**
168	**ACRE Historical Digitised (expeditionary and other spreadsheets) - Translated by NCEI**				**1816**	**1872**	**5**
169	**Global Tropical Moored Buoy Array (GTMBA) from PMEL via NOC RT**				**1998**	**2014**	**1 990**
170	**Global Tropical Moored Buoy Array (GTMBA) from PMEL via NOC DM**				**1977**	**2014**	**11 862**
171	**Australian Abstract Logs (Wragge Collection) from Weather Detective Crowdsourcing (Accessed 29 May 2015)**				**1889**	**1899**	**36**

1. Some of these SIDs (ref. http://icoads.noaa.gov/e-doc/lmr) were used in ICOADS prior to R2.5; others have not been used.
2. Originally SID 22 was assigned to *Islas Orcadas* (see *Release 1*, supp. F), but the data were never translated.
3. LMR documentation provides a breakdown of descriptions for *SID* range.
4. Tentative source ID assignment—data are not yet available.

———————

8) *PT* platform type

The type of observing platform:

0 – US Navy or “deck” log, or unknown
1 – merchant ship or foreign military
2 – ocean station vessel—off station or station proximity unknown
3 – ocean station vessel—on station
4 – lightship
5 – ship
6 – moored buoy
7 – drifting buoy
8 – ice buoy [note: currently unused]
9 – ice station (manned, including ships overwintering in ice)
10 – oceanographic station data (bottle and low-resolution CTD/XCTD data)
11 – mechanical/digital/micro bathythermograph (MBT)
12 – expendable bathythermograph (XBT)
13 – Coastal-Marine Automated Network (C-MAN) (NDBC operated)
14 – other coastal/island station
15 – fixed (or mobile) ocean platform (plat, rig)
16 – tide gauge
17 – high-resolution Conductivity-Temp.-Depth (CTD)/Expendable CTD (XCTD)
18 – profiling float
19 – undulating oceanographic recorder
20 – autonomous pinneped bathythermograph

21 – glider

Background: *PT* settings 0-4 are derived from the "OSV or Ship Indicator" in NCDC (1968); *PT* settings 0-1 are very poorly documented and probably should be regarded as equivalent to ship data (*PT*=5).

9) *DUPS* dup status

Indicates duplicate status (Table D8). For the final R3.0 product, reports with *DUPS*>2 were not output (and landlocked *LZ*=1 reports were eliminated; see *R3.0-stat_trim:* http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf). However, to allow for more detailed analysis of the processing results and possible adjustments, all those flagged reports were retained in R3.0 "total" datasets (see Supp. E).

Background: Matches predecessor field *DS* in LMR format.

Table D8. Duplicate status (*DUPS*) assignments. In previous Releases, "certain" (C) duplicates were eliminated from the LMR output, and then "uncertain" (U) duplicates were eliminated from LMRF. Prior to R3.0 processing, settings marked by footnotes apply only to pre-1980 data. For R3.0 processing, *DUPS*=3, 5, 6, and 7 were no longer used (indicated by grey shading).

DUPS	*U/C*	*Description*
0		unique
1		best duplicate
2		best duplicate with substitution
3	U	worse duplicate: uncertain weather element match with hour cross[1]
4	U	worse duplicate: uncertain weather element match with no cross
5	U	worse duplicate: uncertain weather element match with day cross[2]
6	U	worse duplicate: time/space match with *ID* mismatch (unused until 1950)
7	U	worse duplicate: certain weather element match with hour cross[1]
8	C	worse duplicate: certain weather element match with no cross
9	C	worse duplicate: combined *DUPS* 4 and 6
10	C	worse duplicate: combined *DUPS* 6 and 8
11	C	worse duplicate: time/space/ID match
12	C	worse duplicate: combined *DUPS* 4 and 11
13	C	worse duplicate: combined *DUPS* 8 and 11
14	C	automatic data rejection

1. For *Release 1*, applied to 1854-1979 data; for R2.0, applied to 1784-1979 data; for R2.5, applied to 1662-1979 data.
2. For *Release 1*, applied to 1854-1969 data; for R2.0, applied to 1784-1969 data; for R2.5, applied to 1662-1969 data.

_____

10) *DUPC* dup check

The presence of a duplicate match between a Global Telecommunication System (GTS) and logbook (or other delayed-mode) report may provide some location verification, with greater credibility if *SLP* and *SST* match under "allowances." *DUPC* indicates whether such matches were detected during duplicate elimination processing (either the GTS or delayed-mode report is retained in the output data mixture), in case users might wish to make use of this information for independent quality control purposes:

0 – GTS and logbook match with *SLP* and *SST* match
1 – GTS and logbook match without *SLP* and *SST* match
2 – no GTS and logbook match was encountered

Background: Matches predecessor field *DC* in LMR format.

11) *TC* track check

TC, if set, indicates if a report was:

0 – not track checked
1 – track checked

Background: This indicator, which refers exclusively to track-checking procedures performed by external data providers, was unused prior to Release 2.0, and remains missing in most data. Specifically, only these decks were set to have *TC*=1 (either for R2.0, or for deck 721 for R3.0):

701 US Maury Collection
702 Norwegian Logbook Collection
704 US Marine Meteorological Journals Collection (1878-94)
721 German Maury Collection (set for R3.0)
733 Russian AARI North Pole (NP) Stations

Consequently, records from these decks with *TC*=1 are also available in R3.0.

12) PB pressure bias

PB, if set, indicates questionable sea level pressure data:

0 – questionable *SLP*: level 0: individual platform (unused)
1 – questionable *SLP*: level 1: deck
2 – questionable *SLP*: level 2: deck

Background: All indicator settings unused prior to Release 2.0; still missing in most data (see LMR documentation, http://icoads.noaa.gov/e-doc/lmr, for additional information).

13) *WX* wave period indicator
14) *SX* swell period indicator

Unless missing, *WX* and *SX* indicate that the wave and swell periods were converted from code into whole seconds:

1 – period converted from code into whole seconds

15) *C2* 2nd country code

The country of immediate receipt (*C2*), which may differ from the recruiting country (*C1*) and may also differ from the ship's registry.

Background: *C2* was tracked for some earlier receipts of International Maritime Meteorological (IMM) logbook data, but IMM data are now generally received via Global Collecting Centres (GCCs; in Germany and UK). Thus this field is generally missing (see *C1*, field 16 for code tables and additional information).

QC elements

16-27) *SQZ-DQA* adaptive QC flags
28) *ND* night/day flag
29-34) *SF-RF* trimming flags
35-48) *ZNC-TNC* NCDC-QC flags
49) *QCE* external (e.g., OSD)
50) *LZ* landlocked flag
51) *QCZ* source exclusion flags

Quality control and related flags, described in detail in *R3.0-stat_trim (*http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf*)*.

IMMT-5/FM 13 (*Immt*) attm (C5)

The fields described below are as they appear in IMMT-5. Many reports in R3.0 however come from older IMMT (or IMMPC) versions (see Supp. B) and may not contain data for every field within the *Immt* attm.

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=5 for *Immt*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes.

3) *OS* observation source

For International Maritime Meteorological (IMM) logbook data, *OS* shows the observation source:

0 – unknown
1 –logbook (paper)
2 –national telecommunication channels
3 –national publications
4 – logbook (electronic)
5 – global telecommunication channels (GTS)
6 –international publications

Background: Because the modified IMMT-4 configuration (developed because of deficiencies in the existing configuration) is not backward compatible, the IMMT version (see Supp. B, Table B2) has been added to IMMA (see C5, field 6) to allow proper interpretation of the observation source. [Note: Formerly in IMMT versions 0-3 (usage now discontinued): codes 1-3 also referred to "National data exchange," and codes 4-6 also referred to "International data exchange"; distinction added between paper and electronic logbook].

4) *OP* observation platform

For International Maritime Meteorological (IMM) logbook data, *OP* shows the observation platform:

0 – unknown
1 – selected ship
2 – supplementary ship
3 – auxiliary ship
4 – registered VOSClim ship
5 – fixed sea station (e.g., rig or platform)
6 – coastal station
7 – *[reserved]*
8 – *[reserved]*
9 – others/data buoy

Background: Because the modified IMMT-4 configuration (developed because of deficiencies in the existing configuration) is not backward compatible, IMMT version (see Supp. B, Table B2) has been added to IMMA (see C5, field 6) to allow proper interpretation of the observation source. [Note: Formerly in IMMT versions 0-3 (usage now discontinued): code 4 referred to "Automated station/data buoy;" and codes 7-8 referred to "Aircraft" and "Satellite," respectively].

5) *FM* FM code version

GTS traditional alphanumeric SHIP code "FM" version (see WMO 2015).

0 – previous to FM 24-V
1 – FM 24-V

2 – FM 24-VI Ext.
3 – FM 13-VII
4 – FM 13-VIII
5 – FM 13-VIII Ext.
6 – FM 13-IX
7 – FM 13-IX Ext.
8 – FM 13-X
9 – FM 13-XI
A – FM 13-XII Ext.
B – FM 13-XIII
C – FM 13-XIV Ext.

Background: A 1-character field in IMMT (see Supp. B, Table B2), which is stored in IMMA1 as a 1-character base36 value (see Table 1) to allow for expansion (in IMMA0 *FM* was a 2-character field). Yoshida (2004) describes use at least back to 1949 of the "FM" notation (e.g., in FM 21 SHIP and FM 22 SHIP). [Note: While the IMMT-5 range of this input field is only 0-C, and the IMMA0 range of this field was tightly constrained to 0-8 (reflecting the legal range of the input data at IMMT-2), the IMMA0 range was not increased to account for expansions in the range of this field associated with the intermediate IMMT-3/4 updates. Thus increasing the *FM* max. for IMMA1 accommodates future IMMT field adjustments without requiring adjustment in the IMMA1 configuration (but conversely offers less stringent control on the legality of the *FM* data).]

6) *IMMV* IMMT version

Indicates the applicable IMMT version within the attm, which accommodates some format evolution problems, e.g., in that some IMMT fields changed meaning between IMMT-3 and IMMT-4.

0 – IMMT version just prior to version number being included
1 – IMMT-1 (in effect from 2 Nov. 1994)
2 – IMMT-2 (in effect from Jan. 2003)
3 – IMMT-3 (in effect from Jan. 2007)
4 – IMMT-4 (in effect from Jan. 2011)
5 – IMMT-5 (in effect from June 2012)

7) *IX* station/weather indicator
8) *W2* second past weather

IX (WMO Code 1860) indicates both whether the station is manned or automatic, and the status of present (*WW*, see C0, field 23) and past (*W1*, *W2*; WMO Code 4561, see C0, field 24) weather data:

1 – manned	included
2 – manned	omitted (no significant phenomenon to report)
3 – manned	omitted (no observation, data not available)
4 – automatic	included [using WMO Codes 4677 and 4561]
5 – automatic	omitted (no significant phenomenon to report)
6 – automatic	omitted (no observation, data not available)
7 – automatic	included using WMO Codes 4680 and 4531

Background: Starting 1 Jan. 1982, the procedure for reporting present (*WW*) and past (*W1*, *W2*) weather in FM 13 was altered significantly by adding *IX*, which allowed the "7 group" (7wwW$_1$W$_2$ for manual stations, and usually 7w$_a$w$_a$Wa$_1$Wa$_2$ for automatic stations) to be omitted when there was no significant present or past weather to report (see Hahn et al. 1992). However, to improve climatological data quality, starting 2 Nov. 1994 FM 13 was again modified so that any present and

past weather including phenomena without significance shall be reported (see WMO 2015, Reg. 12.2.6.2). [Note: Refer to the LMR documentation for more information regarding use of *IX* with present and past weather data, and unforeseen complications attending its introduction in 1982 (e.g., *IX* was not included in IMMT until 1 March 1985). *IX*=4 was initially defined (WMO 1981) without the Code references (hence brackets above), and *IX*=7 was introduced at a later date. The *IX*=7 value was not included in LMR; thus future work should seek to recover this information for data that were translated to IMMA from LMR.]

9) *WMI* indicator for wave measurement

WMI corresponds to the IMMT-5"indicator for wave measurement":

0 – wind sea and swell estimated	shipborne wave recorder
1 – wind sea and swell measured	shipborne wave recorder
2 – mixed wave measured, swell estimated	shipborne wave recorder
3 – other combinations measured and estimated	shipborne wave recorder
4 – wind sea and swell measured	buoy
5 – mixed wave measured, swell estimated	buoy
6 – other combinations measured and estimated	buoy
7 – wind sea and swell measured	other measurement system
8 – mixed wave measured, swell estimated	other measurement system
9 – other combinations measured and estimated	other measurement system

Background: Note: Field not included in the LMR regular section, thus future work should seek to recover this information for data that were translated into IMMA from LMR.]

10) *SD2* swell direction (2nd)
11) *SP2* swell period (2nd)
12) *SH2* swell height (2nd)

Configurations as for *SD*, *SP*, and *SH* (C0, fields 46-48).

Background: [Note: Fields not included in the LMR regular section, thus future work should seek to recover this information for data that were translated into IMMA from LMR.]

13) IS ice accretion

Accretion on the ship according to WMO Code 1751:

1 = icing from ocean spray
2 = icing from fog
3 = icing from spray and fog
4 = icing from rain
5 = icing from spray and rain

14) ES ice thickness

Ice accretion thickness on the ship in centimeters.

15) RS ice accretion rate

Accretion rate on the ship according to WMO Code 3551:

0 = ice not building up
1 = ice building up slowly
2 = ice building up rapidly
3 = ice melting or breaking up slowly
4 = ice melting or breaking up rapidly

16) *IC1* concentration of sea ice
17) *IC2* stage of development
18) *IC3* ice of land origin
19) *IC4* true bearing ice edge
20) *IC5* ice situation/trend

The fields changed dramatically in 1982 (field names reflect the 1982 Codes):

pre-1982	*starting 1 Jan. 1982*
description of ice type	concentration of ice (WMO Code 0639)
effect of ice on navigation	stage of ice development (WMO Code 3739)
bearing of principal ice edge	ice of land origin (WMO Code 0439)
distance to ice edge	true bearing principal ice edge (WMO Code 0739)
orientation of ice edge	ice situation/trend (WMO Code 5239)

IMMA stores the old/new information as listed above in the same field, thus making it critical that users be aware of the code change. Configurations are as in IMMT-5 except for use of "A" (10 in base36) in place of "/."

Background: Separate fields (or a Code indicator) could be considered in the future. Earlier historical ice codes might also need to be researched for possible consideration. Met Office (1948) lists an Ice Group (c_2KD_ire) that may be similar or identical to the above pre-1982 code (see also Table B4 of Supp. B). Ice codes used at least for early telecommunicated data from ~1947-82 can be found at http://icoads.noaa.gov/reclaim/pdf/Met_O_509.pdf. [Note: Fields not included in the LMR regular section, thus future work should seek to recover this information for data that were translated into IMMA from LMR.]

21) *IR* indicator for precipitation data
22) *RRR* amount of precipitation
23) *TR* duration of period of reference for amount of precipitation

WMO Codes 1819, 3590, and 4019, respectively. Configurations are as in IMMT-5.

Background: [Note: Fields not included in the LMR regular section, thus future work should seek to recover this information for data that were translated into IMMA from LMR.]

24) *NU* National use

A field available for national use in identifying data subsets copied from IMMT format.

25) *QCI* quality control (QC) indicator

Field *QCI* provides general information about the level of manual and/or automated quality control (QC) that has been applied to the data, including usage if indicated of time sequence checks and possible usage of the standardized Marine QC (MQC) software. Configuration as in IMMT-5 (https://www.wmo.int/pages/prog/amp/mmop/documents/IMMT-5-JCOMM-4.pdf):

0 – no QC has been performed on this element
1 – QC performed; element appears correct
2 – QC performed; element appears inconsistent with other elements
3 – QC performed; element appears doubtful
4 – QC performed; element appears erroneous
5 – QC performed; element changed (possibly to missing) as a result
6 – QC flag amended: element flagged by CMas correct (1), but according to MQCS still appears suspect (2-4) or missing (9)
7 – QC flag amended: element flagged by CM as changed (5), but according to MQCS still appears suspect (2-4)
8 – [reserved]

9 – element is missing

Background: For values from formats IMMT0-3, code meanings for values 6-8 have changed multiple times over the course of the IMMT format evolution. For IMMT1-3, values 6-8 were termed 'Reserved'. For IMMT-0, values 7-8 were instead termed "not used." [Note: Field not included in the LMR regular section, thus future work should seek to recover this information for data that were translated into IMMA from LMR.]

26) *QI1* QC indicator for height of clouds
27) *QI2* QC indicator for visibility
28) *QI3* QC indicator for clouds
29) *QI4* QC indicator for wind direction
30) *QI5* QC indicator for wind speed
31) *QI6* QC indicator for air temperature
32) *QI7* QC indicator for dew-point temperature
33) *QI8* QC indicator for air pressure
34) *QI9* QC indicator for weather
35) *QI10* QC indicator for sea surface temperature
36) *QI11* QC indicator for period of wind waves or of measured waves
37) *QI12* QC indicator for height of wind waves or of measured waves
38) *QI13* QC indicator for swell
39) *QI14* QC indicator for precipitation
40) *QI15* QC indicator for characteristic of pressure tendency
41) *QI16* QC indicator for amount of pressure tendency
42) *QI17* QC indicator for true direction of ship
43) *QI18* QC indicator for ship's average speed
44) *QI19* QC indicator for wet-bulb temperature
45) *QI20* QC indicator for ship's position

Twenty quality control (QC) indicators applicable to individual fields or field groups (further details are available in Supp. B, Table B3; which also lists additional QC indicators available in IMMT-3/4/5). Configuration as in IMMT-5 (https://www.wmo.int/pages/prog/amp/mmop/documents/MQCS-7-JCOMM-4.pdf), indicating QC as applied by the Contributing Member (CM) and/or by the Global Collecting Centres (GCCs). Indicator values include the following:

0 -- No quality control (QC) has been performed on this element
1 -- QC has been performed; element appears to be correct
2 -- QC has been performed; element appears to be inconsistent with other elements
3 -- QC has been performed; element appears to be doubtful
4 -- QC has been performed; element appears to be erroneous
5 -- The value has been changed as a result of QC
6 -- The original flag is set "1" (correct) and the value will be classified by MQCS as inconsistent, dubious, erroneous or missing
7 -- The original flag is set "5" (amended) and the value will be classified by MQCS as inconsistent, dubious, erroneous or missing
8 – [reserved]
9 -- The value of the element is missing

Values 6 and 7 are set when the original flag settings were amended by the GCCs using the Minimum Quality Control Standard (MQCS).

Background: [Note: Fields not included in the LMR regular section, thus future work should seek to recover this information for data that were translated into IMMA from LMR, plus additional QC indicators available in IMMT-3/-4.]

46) *QI21* MQCS version

Version identification for the Minimum QC Standard (MQCS), with this expanded configuration defined for IMMT-5:

1 – MQCS- I (Original version, Feb. 1989): CMM-X
2 – MQCS-II (Version 2, March 1997) CMM-XII
3 – MQCS-III (Version 3, April 2000) SGMC-VIII
4 – MQCS-IV (Version 4, June 2001): JCOMM-I
5 – MQCS-V (Version 5, July 2004): ETMC-I
6 – MQCS-VI (Version 6, January 2011): JCOMM-III)
7 – MQCS-VII (Version 7, June 2012): JCOMM-IV

Background: [Note: Field not included in the LMR regular section, thus future work should seek to recover this information for data that were translated into IMMA from LMR.]

47) *HDG* ship's heading

Direction to which the ship's bow is pointing, referenced to true North (001-360°; e.g., 360° = North, 90° = East).

Background: According to IMMT-2/-3/-4 documentation, 0 indicates no movement. However, KNMI has suggested that even if the ship is not moving it always has a heading, and therefore zero should not be reported for *HDG* (in contrast to *COG*). According to the IMMT-5 documentation (https://www.wmo.int/pages/prog/amp/mmop/documents/IMMT-5-JCOMM-4.pdf) valid range for heading is 001-360; the indicator for no movement has been removed.

48) *COG* course over ground

Direction the vessel actually moves over the fixed Earth, referenced to true North (0-360°; e.g., 360° = North, 0 = no movement, 90° = East).

49) *SOG* speed over ground

Speed the vessel actually moves over the fixed Earth, rounded to the nearest whole knot.

50) *SLL* maximum height > Summer load line

Maximum height of deck cargo above Summer maximum load line (reference level), rounded to the nearest whole meter.

51) *SLHH* departure of Summer max. load line from actual sea level

Departure of reference level (Summer maximum load line) from actual sea level. Difference to the nearest whole meter (0-99) between the Summer maximum load line and the sea level (water line); positive when the Summer maximum load line is above the level of the sea, and negative if below the water line.

52) *RWD* relative wind direction

Relative wind direction in degrees (1-360°) reported in a clockwise direction off the bow of the ship, using 360° when directly on the bow. *RWD*=0 when wind is calm relative to the deck (platform).

Background: It appears that no guidance currently exists for reporting *RWD* when *D* is reported as "variable, or all directions" (i.e., special code 362). Special code of 361 for calm no longer used in IMMT-5.

53) *RWS* relative wind speed

Reported in either whole knots or whole meters per second (e.g., 10 knots or 5 m/s), with units established by *WI* (C0, field 19). RWS is a 3-character field to store values of RWS larger than *W* (C0, field 20; if WI indicates knots), e.g., *W*=98 knots, RWS=101 knots.

Background: Fields added to IMMT-2 for VOSClim. [Note: Fields 147-153 were not included in the LMR regular section; thus future work should seek to recover this information for data that were translated into IMMA from LMR.]

54) *QI22* QC indicator for ship's heading
55) *QI23* QC indicator for course over ground
56) *QI24* QC indicator for speed over ground
57) *QI25* QC indicator for maximum height > Summer load line
58) *QI26* Blank for IMMT-4/5, QC indicator for S_L in earlier IMMT versions
59) *QI27* QC indicator for departure of Summer max. load line from actual sea level
60) *QI28* QC indicator for relative wind direction
61) *QI29* QC indicator for relative wind speed

Eight additional quality control indicators applicable to individual fields or field groups from IMMT-3/4/5 (further details are available in Supp. B, Table B3). Indicator values are the same as for C5, fields 26-45.

Background: As from IMMT-4, usage of Q_{26} is discontinued, ref. IMMT-4 documentation: "now Q_{27} serves as the indicator for both S_L and HH." [Note: Fields not included in the LMR regular section, thus future work should seek to recover this information for data that were translated into IMMA from LMR, plus additional QC indicators available in IMMT-3/-4/-5.]

62) *RH* relative humidity
63) *RHI* relative humidity indicator

Relative humidity is stored in tenths of a percent. *RHI* shows the reported data precision and whether the *RH* was directly measured or computed according to the following:

0 – Relative humidity in tenths of Percentage, measured and originally reported
1 – Relative humidity in whole Percentage, measured and originally reported
2 – [Reserved]
3 – Relative humidity in tenths of Percentage, computed
4 – Relative humidity in whole Percentage, computed

64) *AWSI* AWS indicator

An indicator of whether or not measurements are made using an automated weather station (AWS):

0 – No AWS
1 – AWS
2 – AWS plus manual observations

65) *IMONO* IMO number

Seven-digit unique ship identification number issued by the International Maritime Organization.

Model quality control (*Mod-qc*) attm (C6)

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=6 for *Mod-qc*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes.

GTS bulletin header fields

3) *CCCC* collecting center
4) *BUID* bulletin ID

These two fields are part of the "abbreviated heading" (WMO 2009), providing product identification for purposes of transmission and communication handling ref., http://www.nws.noaa.gov/oso/oso1/oso15/oso153/SECC123.htm). Specifically, *CCCC* is the "international four-letter location indicator of the station or center originating or compiling the bulletin, as agreed internationally, and published in WMO–No.9, Volume C1, *Catalogue of Meteorological Bulletins*;" and *BUID* provides "data designators" ($T_1T_2A_1A_2$ii; see Background, and WMO 2009 for a detailed description).

Background: Using traditional alphanumeric codes, individual (ship or buoy) reports are transmitted over GTS beginning with the identification group $M_iM_iM_jM_j$ (e.g., BBXX or ZZXX used to indicate the SHIP or BUOY code, respectively) and collected together to form the "text" (i.e., content) of a "bulletin" (which when enveloped with an initial line and end-of-message signal constitutes the "message"). The initial information includes an abbreviated heading of the form:

$T_1T_2A_1A_2$ii CCCC YYGGgg (BBB)

where in the context of marine data (see http://www.nws.noaa.gov/tg/head.html):

T_1T_2: Data type and/or form designators

A_1A_2: Geographical and/or data type and/or time designators

ii: Used to differentiate two or more bulletins which contain data in the same code, originate from the same geographical area, and have the same originating center.

CCCC: International 4-letter location indicator of the station originating or compiling the bulletin (e.g., KWBC = Washington, NOAA)

YYGGgg: International date-time group (YY: day of month; GGgg: hour and minute)

(BBB): (optional) for delayed (RR_x) reports, or corrections (CC_x) or amendments (AA_x) to previously relayed reports

The additional elements YYGGgg and BBB making up the abbreviated heading could potentially be important, but are not presently retained e.g., in the UK Met Office VOSClim data. For example, the BBB information could be important to correct information that was not properly relayed initially, and later in the event errors are made in the decoding of the data (e.g., BBB data are not properly handled) there may be no opportunity to reprocess the data properly if header information is not archived. *CCCC* information may be important to determine transmission details (e.g., origination from Local Users Terminals for drifting buoy reports), but the significance of any of this information has not been fully determined.

Model comparison elements

5) *FBSRC* Feedback source
An indicator of whether or not measurements are made using an automated weather station (AWS):

0 – operational

Background: [Note: Any additional values are to be determined, e.g., for use with reanalyses.

6) *BMP* background (bckd.) *SLP*
7) *BSWU* bckd. wind U-component
8) *SWU* derived wind U-component
9) *BSWV* bckd. wind V-component
10) *SWV* derived wind V-component
11) *BSAT* bckd. air temperature
12) *BSRH* bckd. relative humidity
13) *SRH* (derived) relative humidity
14) *BSST* bckd. *SST*
15) *MST* model surface type
16) *MSH* model height of surface
17) *BY* bckd. year
18) *BM* bckd. month
19) *BD* bckd. day
20) *BH* bckd. hour
21) *BFL* bckd. forecast length (hours)
Model quality control feedback information.

Background: Upon receipt of each GTS report from a VOS ship or moored/drifting buoy, the UK Real Time Monitoring Centre (RTMC – UK Met Office) appends co-located parameters (and related information) from the Met Office forecast model for six variables—*SLP*, wind U- and V-components, air temperature, relative humidity, and *SST*—to a selection (translated into BUFR) of the originally reported GTS data. These augmented ship reports are made available in BUFR format to the VOSClim Data Assembly Center (DAC; at NOAA/NCEI), which converts them into IMMA1 format, including this attachment. [Additional technical notes:
(1) In R2.5 data, *BFL* was discovered to be subject to a conversion error and should not be used. Additionally, the original BUFR field that provides *BFL* is in minutes. *BFL* values for R3.0 have been corrected and are being reported in hours, when available.
(2) For *BSRH* and *SRH*, values appeared in the input data at least as high as 107%. While actual *RH* can't be that high, this raises the question whether the ranges of these model-generated fields should be increased in the future e.g., to 107%. Currently, ICOADS format translation or QC procedures remove any such values outside of the range 0-100%. On the other hand, the width of *MSH* has been expanded in IMMA1 to a 4-character field, since negative values (such as –152.0 and less than –99) have been detected (plus larger positive values than previously allowed).
(3) *BSST* is translated to SI units at the Met Office using constant 273.15K, whereas a lower-precision 273.1K constant is used for *BSAT*, the only other temperature field presently being made available by the Met Office. To keep its resultant higher precision, *BSST* has been expanded to 5 characters. Explanation from Colin Parrett at the RTMC (28 September 2011):

"As far as I know, the conversions depend on the precision of the received data, using 273.0, 273.1 or 273.15 for 0, 1 or 2 (or more) decimal places. I've enquired with our MetDB Team for confirmation and I'll let you know if things have changed. The

background SST does come from a different source, so that might explain the greater precision."

(4) The referenced encoding constant 273.0 does not appear to apply to the temperature elements currently received from the Met Office, but in the event such data were received in the future a 4-character field configuration like that for *BSAT* would be sufficient (however, to accurately translate temperature data back from Kelvin to °C, it is crucial to know what constant has been used for encoding originally reported °C temperatures to Kelvin for storage in BUFR).]

Ship metadata (*Meta-vos*) attm (C7)

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=6 for *Mod-qc*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes.

Ship metadata elements

3) *MDS* Metadata source

An indicator of source/provider of the metadata:

0 – WMO Publication No. 47

1 – Center for Ocean-Atmospheric Prediction Studies, Tallahassee, USA

Background: Originally designed to store metadata from WMO publication 47, the attm is also used by other data providers to submit metadata for vessels within their respective datasets.

4) *C1M* recruiting country

AD – ANDORRA
AE – UNITED ARAB EMIRATES
AF – AFGHANISTAN
AG – ANTIGUA AND BARBUDA
AI – ANGUILLA
AL – ALBANIA
AM – ARMENIA
AN – NETHERLANDS ANTILLES
AO – ANGOLA
AQ – ANTARCTICA
AR – ARGENTINA
AS – AMERICAN SAMOA
AT – AUSTRIA
AU – AUSTRALIA
AW – ARUBA
AX – ÅLAND ISLANDS
AZ – AZERBAIJAN
BA – BOSNIA AND HERZEGOVINA
BB – BARBADOS
BD – BANGLADESH
BE – BELGIUM
BF – BURKINA FASO
BG – BULGARIA
BH – BAHRAIN
BI – BURUNDI
BJ – BENIN
BL – SAINT BARTHÉLEMY
BM – BERMUDA
BN – BRUNEI DARUSSALAM
BO – BOLIVIA
BR – BRAZIL
BS – BAHAMAS
BT – BHUTAN
BV – BOUVET ISLAND
BW – BOTSWANA
BY – BELARUS
BZ – BELIZE
CA – CANADA
CC – COCOS (KEELING) ISLANDS
CD – CONGO, THE DEMOCRATIC REPUBLIC OF THE
CF – CENTRAL AFRICAN REPUBLIC
CG – CONGO
CH – SWITZERLAND
CI – CÖTE D'IVOIRE
CK – COOK ISLANDS
CL – CHILE
CM – CAMEROON
CN – CHINA
CO – COLOMBIA
CR – COSTA RICA
CS – SERBIA AND MONTENEGRO
CU – CUBA
CV – CAPE VERDE
CX – CHRISTMAS ISLAND
CY – CYPRUS
CZ – CZECH REPUBLIC
DD – GERMAN DEOMCRATIC REPUBLIC
DE – GERMANY
DJ – DJIBOUTI

DK – DENMARK
DM – DOMINICA
DO – DOMINICAN REPUBLIC
DZ – ALGERIA
EA – KENYA, UGANDA, TANZANIA
EC – ECUADOR
EE – ESTONIA
EG – EGYPT
EH – WESTERN SAHARA
ER – ERITREA
ES – SPAIN
ET – ETHIOPIA
EU – EUMETNET
FI – FINLAND
FJ – FIJI
FK – FALKLAND ISLANDS (MALVINAS)
FM – MICRONESIA, FEDERATED STATES OF
FO – FAROE ISLANDS
FR – FRANCE
GA – GABON
GB – UNITED KINGDOM
GD – GRENADA
GE – GEORGIA
GF – FRENCH GUIANA
GG – GUERNSEY
GH – GHANA
GI – GIBRALTAR
GL – GREENLAND
GM – GAMBIA
GN – GUINEA
GP – GUADELOUPE
GQ – EQUATORIAL GUINEA
GR – GREECE
GS – SOUTH GEORGIA AND THE SOUTH SANDWICH ISLANDS
GT – GUATEMALA
GU – GUAM
GW – GUINEA-BISSAU
GY – GUYANA
HK – HONG KONG
HM – HEARD ISLAND AND MCDONALD ISLANDS
HN – HONDURAS
HR – CROATIA
HT – HAITI
HU – HUNGARY
ID – INDONESIA
IE – IRELAND
IL – ISRAEL
IM – ISLE OF MAN
IN – INDIA
IO – BRITISH INDIAN OCEAN TERRITORY
IQ – IRAQ
IR – IRAN, ISLAMIC REPUBLIC OF
IS – ICELAND
IT – ITALY
JE – JERSEY
JM – JAMAICA
JO – JORDAN
JP – JAPAN
KE – KENYA
KG – KYRGYZSTAN
KH – CAMBODIA
KI – KIRIBATI
KM – COMOROS
KN – SAINT KITTS AND NEVIS
KP – KOREA, DEMOCRATIC PEOPLE'S REPUBLIC OF
KR – KOREA, REPUBLIC OF
KW – KUWAIT
KY – CAYMAN ISLANDS
KZ – KAZAKHSTAN
LA – LAO PEOPLE'S DEMOCRATIC REPUBLIC
LB – LEBANON
LC – SAINT LUCIA
LI – LIECHTENSTEIN
LK – SRI LANKA
LR – LIBERIA
LS – LESOTHO
LT – LITHUANIA
LU – LUXEMBOURG
LV – LATVIA
LY – LIBYAN ARAB JAMAHIRIYA
MA – MOROCCO
MC – MONACO
MD – MOLDOVA, REPUBLIC OF
ME – MONTENEGRO
MF – SAINT MARTIN
MG – MADAGASCAR
MH – MARSHALL ISLANDS
MK – MACEDONIA, THE FORMER YUGOSLAV REPUBLIC OF
ML – MALI
MM – MYANMAR
MN – MONGOLIA
MO – MACAO
MP – NORTHERN MARIANA ISLANDS
MQ – MARTINIQUE
MR – MAURITANIA
MS – MONTSERRAT
MT – MALTA
MU – MAURITIUS
MV – MALDIVES
MW – MALAWI
MX – MEXICO
MY – MALAYSIA
MZ – MOZAMBIQUE
NA – NAMIBIA
NC – NEW CALEDONIA
NE – NIGER
NF – NORFOLK ISLAND
NG – NIGERIA
NI – NICARAGUA
NL – NETHERLANDS
NO – NORWAY
NP – NEPAL
NR – NAURU
NU – NIUE
NZ – NEW ZEALAND
OM – OMAN
OT – OTHER
PA – PANAMA

PE – PERU
PF – FRENCH POLYNESIA
PG – PAPUA NEW GUINEA
PH – PHILIPPINES
PK – PAKISTAN
PL – POLAND
PM – SAINT PIERRE AND MIQUELON
PN – PITCAIRN
PR – PUERTO RICO
PS – PALESTINIAN TERRITORY, OCCUPIED
PT – PORTUGAL
PW – PALAU
PY – PARAGUAY
QA – QATAR
RE – REUNION
RO – ROMANIA
RS – SERBIA
RU – RUSSIAN FEDERATION
RW – RWANDA
SA – SAUDI ARABIA
SB – SOLOMON ISLANDS
SC – SEYCHELLES
SD – SUDAN
SE – SWEDEN
SG – SINGAPORE
SH – SAINT HELENA
SI – SLOVENIA
SJ – SVALBARD AND JAN MAYEN
SK – SLOVAKIA
SL – SIERRA LEONE
SM – SAN MARINO
SN – SENEGAL
SO – SOMALIA
SR – SURINAME
ST – SAO TOME AND PRINCIPE
SV – EL SALVADOR
SY – SYRIAN ARAB REPUBLIC
SZ – SWAZILAND
TC – TURKS AND CAICOS ISLANDS
TD – CHAD
TF – FRENCH SOUTHERN TERRITORIES
TG – TOGO
TH – THAILAND
TJ – TAJIKISTAN
TK – TOKELAU
TL – TIMOR-LESTE
TM – TURKMENISTAN
TN – TUNISIA
TO – TONGA
TR – TURKEY
TT – TRINIDAD AND TOBAGO
TV – TUVALU
TW – TAIWAN, PROVINCE OF CHINA
TZ – TANZANIA, UNITED REPUBLIC OF
UA – UKRAINE
UG – UGANDA
UM – UNITED STATES MINOR OUTLYING ISLANDS
US – UNITED STATES
UY – URUGUAY
UZ – UZBEKISTAN
VA – HOLY SEE (VATICAN CITY STATE)
VC – SAINT VINCENT AND THE GRENADINES
VE – VENEZUELA
VG – VIRGIN ISLANDS, BRITISH
VI – VIRGIN ISLANDS, U.S.
VN – VIET NAM
VU – VANUATU
WF – WALLIS AND FUTUNA
WS – SAMOA
XX – AMBIGUOUS CODE
YE – YEMEN
YT – MAYOTTE
ZA – SOUTH AFRICA
ZM – ZAMBIA
ZW – ZIMBABWE
ZY – NONE / SELF RECRUITED
ZZ – THIRD PARTY SUPPORT SHIPS

5) *OPM* type of ship (program)

10 – Selected ships
15 – Selected ships (AWS)
30 – VOSClim
35 – VOSClim (AWS)
40 – Supplementary ships
45 – Supplementary ships (AWS)
70 – Auxiliary ships
75 – Auxiliary ships (AWS)
99 – Unknown

6) K*OV* kind of vessel

BA – Barge
BC – Bulk Carrier
CA – Cable ship
CG – Coast Guard Ship
CS – Container Ship

DR – Dredger
FE – Passenger ferries
FP – Floating production and storage units
FV – Other Fishing Vessel
GC – General Cargo
GT – Gas Tanker
IC – Icebreaking vessel
IF – Inshore Fishing Vessel
LC – Livestock carrier
LT – Liquid Tanker
LV – Light Vessel
MI – Mobile installation including mobile offshore drill ships, jack-up rigs and semi-submersibles
MS – Military Ship
OT – Other
OW – Ocean Weather Ship
PI – Pipe layer
PS – Passenger ships and cruise liners
RF – Ro/Ro Ferry
RR – Ro/Ro Cargo
RS – Refrigerated cargo ships including banana ships
RV – Research Vessel
SA – Large sailing vessels
SV – Support Vessel
TR – Trawler
TU – Tug
VC – Vehicle carriers
YA – Yacht / Pleasure Craft

7) *COR* country of registry

Encoding same as *C1M*.

8) *TOB* type of barometer

AN – Aneroid barometer (issued by Port Meteorological Officer or Meteorological Agency)
DA – Digital Aneroid Barometer
ELE – electronic digital barometer
MER – Mercury Barometer
SAN – Ship's Aneroid Barometer
OT – Other

9) *TOT* type of thermometer

ALC – Alcohol Thermometer
ELE – Electric (resistance) Thermometer
MER – Dry Bulb Mercury Thermometer

10) *EOT* exposure of thermometer

A – Aspirated (Assmann type)
S – Screen (not ventilated)
HH – Hand-held digital thermometer / humidity sensor
RS – Radiation shield (e.g. cylindrical / Gill multi-plate)

SG – Ship's Sling
SL – Sling
SN – Ship's screen
US – Unscreened
VS – Screen (ventilated)
W – Whirling

11) *LOT* screen location

1 – Bridge wing port
2 – Bridge wing starboard
3 – Bridge wing both sides
4 – Bridge wing windward side
5 – Wheelhouse top port
6 – Wheelhouse top starboard
7 – Wheelhouse top both
8 – Wheelhouse top center
9 – Wheelhouse top windward side
10 – Mainmast
11 – Foremast
12 – Mast on Wheelhouse top
13 – Main deck port side
14 – Main deck starboard side
15 – Main deck both sides
OT – Other (specify in footnote)

12) *TOH* type of hygrometer

1 – Hygristor
2 – Chilled Mirror
3 – Other
C – Capacitance
E – Electric
H – Hair hygrometer
P – Psychrometer
T – Torsion

13) *EOH* exposure of hygrometer

Encoding same as *EOT*.

14) *SIM* SST measurement method

BTT – Bait tanks thermometer
BU – Bucket thermometer
C – Thermometer in condenser intake on steam ships, or inlet engine cooling system on motor ships
HC – Hull contact sensor
HT – "Through hull" sensor
OT – Other
RAD – Radiation thermometer
TT – Trailing thermistor

15) *LOV* length of vessel
16) *DOS* depth of SST measurement

17) *HOP* height of visual observation platform
18) *HOT* height of air temperature sensor
19) *HOB* height of barometer
20 *HOA* height of anemometer

Height and depth elements 15 – 20 are stored to the nearest whole meter.

21) *SMF* source metadata file

WMO Pub. 47 source file for the metadata encoded as 4-digit year and 1-digit quarter (e.g., 19991 = 1st quarter of 1999).

22) *SME* source metadata element

Line number from source file.

23) *SMV* source format version

1 – Output from digitization project, semi-colon delimited format (1955)
2 – Output from digitization project, semi-colon delimited format (1956)
3 – Output from digitization project, semi-colon delimited format (1957 – 1967)
4 – Output from digitization project, semi-colon delimited format (1968–69)
5 – Fixed format (1970–94)
6 – Semicolon delimited format (1995–2001)
7 – Semicolon delimited format (2002–2007 q1)
8 – Semicolon delimited format (2007 - 2008)
9 – Semicolon delimited format (2009 - 2014)

Background: See Kent et. al (2007a) for details on version information.

Fields 4 – 23 contain metadata selected from WMO–No. 47 (1955–) by the UK National Oceanography Centre, Southampton (Kent et al. 2007a, Berry et al. 2009). Some deck 740 (Research Vessel Data Quality-Evaluated by FSU/COAPS) metadata have also been stored in this attachment. Tables defining select field have been reproduced from Berry et al. 2009 (http://icoads.noaa.gov/e-doc/imma/WMO47IMMA_1966_2007-R2.5.pdf).

Background: The codes defined in WMO–No. 47, and used in IMMA, for *OPM* and *SIM* differ from the codes used for the similar fields *OP* and *SI*. Prior to 1995 a 3-digit numeric code was defined in WMO–No. 47 for *C1M*; starting in 1995, WMO–No. 47 adopted the 2-character ISO alphabetic code, which was in 1998 also adopted for IMMT. For *C1M*, the earlier 3-digit numeric codes were transformed by NOCS into the 2-character alphabetic codes.

Near-surface oceanographic data (*Nocn*) attm (C8)

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=8 for *Nocn*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes (*ATTL=102* [2U in base36] for *Nocn*).

Near-surface oceanographic data and metadata elements

3) *OTV* temperature value
4) OTZ temperature depth

Temperature of water is stored in thousandths of a degree Celsius along with the associated depth of the measurement to the nearest hundredth of a meter.

Background: The *SST* min. and max. limits in the *Core* (Table C0) are -99.0 to 99.0°C with a precision of 0.1°C, this attachment has greater precision as is appropriate for modern oceanographic profile data, with a max. value based roughly on QC limits from the Global Ocean Surface Underway Data (GOSUD) program (http://www.gosud.org).

5) *OSV* salinity value

6) OSZ salinity depth
Salinity of water is stored as a unit-less value (commonly known as the practical salinity unit) to the nearest thousandths along with the associated depth of the measurement to the nearest hundredth of a meter.

7) *OOV* dissolved oxygen value
8) OOZ dissolved oxygen depth
Dissolved oxygen concentration is stored in hundredths of a milliliter per liter along with the associated depth of the measurement to the nearest hundredth of a meter.

9) *OPV* phosphate value
10) OPZ phosphate depth
Phosphate concentration is stored in hundredths of a micromole per liter along with the associated depth of the measurement to the nearest hundredth of a meter.

11) *OSIV* silicate value
12) OSIZ silicate depth
Silicate concentration is stored in hundredths of a micromole per liter along with the associated depth of the measurement to the nearest hundredth of a meter.

13) *ONV* nitrate value
14) ONZ nitrate depth
Nitrate concentration is stored in hundredths of a micromole per liter along with the associated depth of the measurement to the nearest hundredth of a meter.

15) *OPHV* salinity value
16) OPHZ salinity depth
pH of water is stored as a unit-less value to the nearest hundredth along with the associated depth of the measurement to the nearest hundredth of a meter.

17) *OCV* total chlorophyll value
18) OCZ total chlorophyll depth
Total chlorophyll concentration is stored in hundredths of a microgram per liter along with the associated depth of the measurement to the nearest hundredth of a meter.

19) *OAV* alkalinity value
20) OAZ alkalinity depth
Alkalinity concentration is stored in hundredths of a milliequivalent per liter along with the associated depth of the measurement to the nearest hundredth of a meter.

21) *OPCV* partial pressure of carbon dioxide value
22) OPCZ partial pressure of carbon dioxide depth
Partial pressure of carbon dioxide is stored in tenths of a microatmosphere along with the associated depth of the measurement to the nearest hundredth of a meter.

23) *ODV* dissolved inorganic carbon value
24) ODZ dissolved inorganic carbon depth
Dissolved inorganic carbon concentration is stored in tenths of a micromole per liter along with the associated depth of the measurement to the nearest hundredth of a meter.

25) *PUID* provider's unique record identification

A unique identifier associated with the record that was assigned by the data provider.

Edited Cloud Report (*Ecr*) attm (C9)

Background: This attm is based on previous work of Carole Hahn. Element descriptions are summarized below. Additional details are provided in Hahn et al. (1995) and Hahn and Warren (1999).

Hahn, C.J. and S.G. Warren, 1999: Extended Edited Synoptic Cloud Reports from Ships and Land Stations Over the Globe, 1952-1996. NDP-026C, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN, doi:10.3334/CDIAC/cli.ndp026c.

Hahn, C.J., S.G. Warren and J. London, 1995: The effect of moonlight on observation of cloud cover at night, and application to cloud climatology. *J. Climate*, **8**, 1429-1446, doi: 10.1175/1520-0442(1995)008<1429:TEOMOO>2.0.CO;2.

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=9 for *Ecr*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes (*ATTL=32* for *Ecr*).

Extended Edited Cloud Report (EECR) basic elements

3) *CCe* Change code

Indicator of whether the original report was changed (edited) during processing. Code values are defined in Table C9a (and previously in sec. 3.3 of Hahn and Warren [1999]). Table C9b gives definitions of cloud and weather conditions used in Table C9a, for example "fog" or "showers".

Table C9a. Change codes (*CCe*) and their associated descriptions, cases categorizations, and field changes made (from Table 3 of Hahn and Warren (1999)). The *CCe* ordering in this table (0-13) also reflects the order in which changes to the cloud fields must be made during processing.

CCe[1]	*Description*	*Case*	*Changes made*
0	No changes required		None
1	Cause of *N*=9 determined from *WW* Set *Ne*=8, *NHe*=8, and *He*=0 If *CL* missing, then set *CLe*=0 If foggy, then set *CLe*=11 If showers, then set *CLe*=10 If drizzle/rain/snow, then set *CMe*=10	*N*=9 with precipitation or fog	*Ne*=8 *NHe*=8 *He*=0 *CLe*=10,11 or *CMe*=10
2	*NH* is amount of sky covered by medium cloud if no low cloud is present. If *NH*=0 with *CM* present and *CL*=0; then if *CH* present, set *NHe* missing else, set *NHe*=N	*NH*=0 with *CM*>0 and *CL*=0 and *CH*≤0 *NH*=0 with *CM*>0 and *CL*=0 and *CH*>0	*NHe*=N *NHe*=missing
3	If *NH=N* or missing and only high cloud present, set *NHe*=0	*NH=N* with *CH*>0 and *CL=CM*=0	*NHe*=0

4	If *NH*<*N* and only low cloud is present, then set *NHe*=missing	*NH*<*N* where it should be *NH*=*N*	*NHe*=missing
	If *NH*<*N* and only mid cloud is present, then set *NHe*=missing	*NH*<*N* where it should be *NH*=*N*	*NHe*=missing
	If *NH*≠*N* and only high cloud present, set *NHe*=missing	*NH*≠*N* with *CH*>0 and *CL*=*CM*=0	*NHe*=missing
5	If low cloud information (*NH* or *CL*) is missing and *CM* or *CH* present, then set *CMe*=*CHe*=missing	*CL*="/" with *CM* or *CH* not "/"	*CMe*,*CHe*=missing
6	If (*N*=*NH*=*8* or *N*=*NH*=7) and *CM*=0, then set *CMe*=missing	*CM* or *CH* miscoded as 0	*CMe* or *CHe*=missing
	If (*N*=*NH*=*8* or *N*=*NH*=7) and *CH*=*0,* then set *CHe*=missing		
7	If *CM*=7 when drizzle/rain/snow, then set *CMe*=11	*CM*=7 or 2 identified as *Ns*	*CMe*=11 or 12
	If *CM*=2 when drizzle/rain/snow, then set *CMe*=12		
8	If drizzle/rain/snow and *CM* is missing and *CL* is present; and *CL*≠1,2,3 or 9; then if either *WW*≥60 or *CL*=7 or *CL*=0; set *CMe*=10	*CM*="/" for *Ns*	*CMe*=10
9	If *CM* is missing and both *CL* and *CH* present, then set *CMe*=0	*CM* or *CH* miscoded as "/"	*CMe* or *CHe*=0
	If *N*≤4, *N*=*NH*, *CL* is present, *CM*=missing, and *CCe*=0, then *CMe*=0		
	If *N*≤4, *N*=*NH, CL* is present, *CH*=missing, and *CCe*=0, then set *CHe*=0		
10	*N*=9 not explainable by *WW*		all parameters set missing
11	*NH*>*N*		all parameters set missing
12	*N*=0 accompanied by precipitation		all parameters set missing
13	N>0 and *CL*=*CM*=*CH*=0		all parameters set missing

1. Also order in which changes are made, but *CCe*=9 is recorded only if no previous change occurred (this conflict can occur only with *CCe*=7 or 8).

Table C9b. Cloud and Weather Type Definitions Used in ECRs (modified from Table 2 of Hahn and Warren (1999)). Note that "/" has been coded in IMMA format as "A", interpreted as "10".

Level	Shorthand notation	Meaning	Synoptic Codes	Extended Ecr Codes[1]
	TC	Total cloud cover	N = 0-9	*Ne*=0-8

	Cr	Completely clear sky	N = 0	*Ne*=N
	Ppt	Precipitation	WW= 50-75, 77, 79, 80-99	
	D	Drizzle	50-59	
	R	Rain	60-69	
	S	Snow	70-75, 77, 79	
	Ts	Thunderstorm or Shower	80-99	
Low			CL=	
	Fo	Sky obscured by fog	/ with N=9 and ww=10-12,40-49	*CLe*=11
	St	Stratus	6, 7	*CLe=CL*
	Sc	Stratocumulus	4, 5, 8	*CLe=CL*
	Cu	Cumulus	1, 2	*CLe=CL*
	Cb	Cumulonimbus	3, 9,	*CLe=CL*
			or N=9 with ww=Ts	*CLe=10*
Mid			CM =	
	Ns	Nimbostratus	2,7, or N=9 with ww=DRS	*CMe*=12,11,10
			/ with ww=DRS and CL=0,7	*CMe*=10
			/ with ww= RS and CL=4-8	*CMe*=10
	As	Altostratus	1; 2 if ww not DRS	*CMe=CM*
	Ac	Altocumulus	3,4,5,6,8,9;	*CMe=CM*
			7 if ww not DRS	*CMe=CM*
High			CH =	
	Hi	Cirriform clouds	1-9	*CHe=CH*

1. In the processing for the extended code both "/" ("A" in IMMA) and missing (blank in IMMA) are treated in the same way.

_____

4) *WWe* present weather
5) *Ne* total cloud amount
6) *NHe* lower cloud amount
7) *He* lower cloud base height
8) *CLe* low cloud type
9) *CMe* middle cloud type
10) *CHe* high cloud type

Weather and cloud variables coded as specified by WMO and as documented in the Core for elements WW, N, NH, H, CL, CM, and CH (C0, fields 23, 36, 37, 40, 38, 41, and 42, respectively) except that CLe and CMe have been "extended" as indicated in Tables C9c and C9d, respectively. Also, cases of N=9 with fog or precipitation have been converted to N=8 (defined in Table C9b). Any such conversion is recorded in the change code (CCe, Table C9a).

NOTE: An *Ecr* attachment is provided only if N is given in the original report.

Table C9c. Low cloud type (*CLe*) coding information.

Code	*WMO (or EECR) Code*	*Description*
0	Code 0513	no stratocumulus, stratus, cumulus or cumulonimbus
1	Code 0513	cumulus with little vertical extent and seemingly flattened, or ragged cumulus, other than of bad weather, or both
2	Code 0513	cumulus of moderate or strong vertical extent, generally with protuberances in the form of domes or towers, either accompanied or

		not by other cumulus or stratocumulus, all having bases at the same level
3	Code 0513	cumulonimbus, the summits of which, at least partially, lack sharp outlines but are neither clearly fibrous (cirriform) nor in the form of an anvil; cumulus, stratocumulus or stratus may also be present
4	Code 0513	stratocumulus formed by the spreading out of cumulus; cumulus may also be present
5	Code 0513	stratocumulus not resulting from the spreading out of cumulus
6	Code 0513	stratus in a more or less continuous later, or in ragged shreds, or both but no stratus fractus of bad weather
7	Code 0513	stratus fractus of bad weather or cumulus fractus of bad weather, or both (pannus), usually below altostratus or nimbostratus
8	Code 0513	cumulus and stratocumulus other than that formed from the spreading out of cumulus; the base of the cumulus is at a different level from that of the stratocumulus
9	Code 0513	cumulonimbus, the upper part of which is clearly fibrous (cirriform) often in the form of an anvil; either accompanied or not by cumulonimbus without anvil or fibrous upper part, by cumulus, stratocumulus, stratus or pannus
10	(EECR code)	cumulonimbus, identified from sky obscured (*N*=9) accompanied by showery precipitation or thunderstorm (WW≥80)
11	(EECR code)	fog, identified from sky obscured (*N*=9) accompanied by *WW* indicating fog (*WW*=10-12 or 40-49)

Table C9d. Medium cloud type (CMe) coding information.

Code	*WMO (or EECR) Code*	*Description*
0	Code 0515	no altocumulus, altostratus or nimbostratus
1	Code 0515	altostratus, the greater part of which is semi-transparent; through this part the sun or moon may be weakly visible, as through ground glass
2	(EECR code)	altostratus, the greater part of which is sufficiently dense to hide the sun or moon
3	Code 0515	altocumulus, the greater part of which is semi-transparent; the various elements of the cloud change only slowly and are all at a single level
4	Code 0515	patches (often in the form of almonds or fish) of altocumulus, the greater part of which is semi-transparent; the clouds occur at one or more levels and the elements are continually changing in appearance
5	Code 0515	semi-transparent altocumulus in bands, or altocumulus, in one or more continuous layer (semi-transparent or opaque), progressively invading the sky; these generally thicken as a whole
6	Code 0515	altocumulus resulting from the spreading out of cumulus or cumulonimbus
7	(EECR code)	altocumulus in two or more layers, usually opaque in places, and not progressively invading the sky; or opaque layer of altocumulus, not progressively invading the sky; or altocumulus together with altostratus
8	Code 0515	altocumulus with sproutings in the form of small towers or battlements, or altocumulus having the appearance of cumuliform tufts
9	Code 0515	altocumulus of a chaotic sky, generally at several levels

10	(EECR code)	nimbostratus, identified from sky obscured (*N*=9) accompanied by drizzle, or non-showery precipitation
11	(EECR code)	nimbostratus, identified from *CM*=7 accompanied by *WW* indicating rain
12	(EECR code)	nimbostratus, identified from *CM*=2 accompanied by *WW* indicating rain

EECR derived cloud elements

11) *AM* middle cloud amount

12) *AH* high cloud amount

These variables give the "actual" amounts of middle and high clouds, derived from *N* and *NH* with use of the random overlap equation, if necessary (see sec. 3.5 of Hahn and Warren [1999]).

13) *UM* *NOL* middle amount

14) *UH* *NOL* high amount

These variables, derived from *N* and *NH*, give the "non-overlapped" (NOL) amounts of middle and high clouds; i.e., the amounts visible from below (see sec. 3.5 of Hahn and Warren [1999]).

EECR sky brightness elements

15) *SBI* sky-brightness indicator

The sky-brightness indicator has a value of "1" (light) if the illuminance criterion described in Hahn et al. (1995) was satisfied at the time and place of the report, suggesting that there was adequate light for visual observation of cloud cover and cloud types (if not, then *SBI*=0; dark). This variable can be used in lieu of *SA* and *RI* if one accepts the criterion recommended in Hahn et al. (1995).

16) *SA* solar altitude

17) *RI* relative lunar illuminance

The solar and lunar parameters needed to determine the illuminance provided by the sun or moon for the date, time and location of the report (see sec. 3.6 of Hahn and Warren (1999)). *SA* is the altitude of the sun above the horizon. *RI* is the relative lunar illuminance, defined in Hahn et al. (1995), which depends on the lunar altitude and phase, and the earth-moon distance. The illuminance criterion of Hahn et al. (1995) is satisfied (*SBI*=1) when *SA*≥-9° or *RI*>0.11. A negative value of RI means the moon was below the horizon.

Reanalysis QC/feedback (*Rean-qc*) attm (C95)

1) *ATTI* attm ID

2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=95 for *Rean-qc*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes (*ATTL=61* for *Rean-qc*).

Reanalysis QC/feedback data and metadata elements

3) *ICNR* Input component number-*Rean-qc*

Component within the IMMA record for which the reanalysis QC/feedback applies (e.g., 0=*Core* or appropriate *ATTI* for other attm).

4) *FNR* Field number – *Rean-qc*

Field number from the referenced IMMA component (*ICNR*) for which the reanalysis QC/feedback applies (e.g., for sea temperature in the *Core*, *FNR* = 35 and for sea temperature from the *Nocn*, *FNR* = 3).

---

5) *DPRO* Data provider – reanalysis: lead organization

An indicator of lead organization providing the QC/feedback:

1 – ECMWF
2 – NOAA-NCEP
3 – NASA
4 – JMA

6) *DPRP* Data provider – reanalysis: project

An indicator of the project providing the QC/feedback:

1 – ERA-20C
2 – CFSRv2
3 – MERRA
4 – JRA-55

7) *UFR* Usage flag - reanalysis

An indicator of whether or not the record was used in the reanalysis:

1 – Assimilated and used
2 – Assimilated and rejected
3 – Blacklisted
4 – Whitelisted
5 – Available but not used
6 – None apply

Background: Blacklisted records (*UFR*=3) are determined *a priori* to be erroneous and are not used. Whitelisted records (*UFR*=4) are determined *a priori* to be used regardless of assimilation assessment.

8) *MFGR* Model-collocated first guess value/representative value in case of ensemble methods

Value of model-collocated first guess or a representative value in case ensemble methods are used.

Background: The range of minimum and maximum values, numeric precision, and units of measurement are all inherited from *ICNR* & *FNR*, with numerical precision increased by one (additional) position right of the decimal to better accommodate numerical precision used in the assimilation process. For example, *ICNR*=0 and *FNR*=29 refer to *AT*, which can range from –99.9 to 99.9, with precision and units of 0.1°C. Thus feedbacks on *AT* stored in this attm in *MFGR, MAR* and *BCR* have precision increased to 0.01°C, with range –99.99 to 99.99.

9) *MFGSR* Model-collocated first guess spread

Spread of model-collocated first guess. This is an optional field only used in the case of ensemble reanalyses.

10) *MAR* Model-collocated analysis value/representative value in case of ensemble methods

Model-collocated analysis value or a representative value in case ensemble methods are used.

Background: The range of minimum and maximum values, numeric precision, and units of measurement are all inherited from *ICNR* & *FNR*, with numerical precision increased by one (additional) position right of the decimal to better accommodate numerical precision used in the assimilation process. For example, *ICNR*=0 and *FNR*=29 refer to *AT*, which can range from –99.9 to 99.9, with precision and units

of 0.1°C. Thus feedbacks on *AT* stored in this attm in *MFGR, MAR* and *BCR* have precision increased to 0.01°C, with range –99.99 to 99.99.

11) *MASR* Model-collocated analysis spread

Spread of model-collocated analysis value. This is an optional field only used in the case of ensemble reanalyses.

12) *BCR* Bias corrected value

Bias corrected value from model.

Background: The range of minimum and maximum values, numeric precision, and units of measurement are all inherited from *ICNR* & *FNR*, with numerical precision increased by one (additional) position right of the decimal to better accommodate numerical precision used in the assimilation process. For example, *ICNR*=0 and *FNR*=29 refer to *AT*, which can range from –99.9 to 99.9, with precision and units of 0.1°C. Thus feedbacks on *AT* stored in this attm in *MFGR, MAR* and *BCR* have precision increased to 0.01°C, with range –99.99 to 99.99.

13) *ARCR* Author reference code – *Rean-qc*

The author reference code is an optional alphanumeric value that is intended to point to a publication or technical report describing the reanalysis QC/feedback provided in the *Rean-qc* attm. The following *ACRC* has been assigned:

PH13 – ERA-20C, 2013 (Poli, P., H. Hersbach, D. Tan, D. Dee, J.-N. Thépaut, A. Simmons, C. Peubey, P. Laloyaux, T. Komori, P. Berrisford, R. Dragani, Y. Trémolet, E. Holm, M. Bonavita, L. Isaksen and M. Fisher, 2013: The data assimilation system and initial performance evaluation of the ECMWF pilot reanalysis of the 20th-century assimilating surface observations only (ERA-20C). ERA Report Series no. 14, ECMWF, 59 pp.

14) *CDR* Creation date – *Rean-qc*

Date conforming to ISO 8601 (YYYYMMDD) that identifies when the reanalysis QC/feedback for the given record was created. Set by the external developer that produced the *Rean-qc* attm.

15) *ASIR* Access status indicator – *Rean-qc*

An indicator of the status of the access to the record within ICOADS, such that only active records are still available within ICOADS:

0 – Active
1 – Inactive

ICOADS Value-Added Database (*Ivad*) attm (C96)

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=96 for *Ivad*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes (*ATTL=53* for *Ivad*).

ICOADS value-added data and metadata elements

3) *ICNI* Input component number-*Ivad*

Component within the IMMA record for which the value-added data, uncertainties, and/or quality control applies (e.g., 0=*Core* or appropriate *ATTI* for other attm).

4) *FNI* Field number – *Ivad*

Field number from the referenced IMMA component (*ICNI*) for which the value-added data, uncertainties, and/or quality control applies (e.g., for sea temperature in the *Core*, *FNI* = 35 and for sea temperature from the *Nocn*, *FNI* = 3).

5) *JVAD* Scaling factor for *VAD*

Scaling factor applied to convert "*FVAD*," an input floating-point value, into *VAD* (i.e., representing also *VAU1*, *VAU2*, or *VAU3)* according to $VAD = FVAD \times 10^{JVAD}$. Then the original un-scaled value is reconstructed according to $FVAD = VAD \times 10^{-JVAD}$.

[Note: Future versions of IMMA may lower the max to a value more likely to be realistic considering current data characteristics, e.g., 5 (i.e., scaling factor max becomes 10^5, thus again taking the *AT* case numeric precision of *FVAD* becomes 0.00001°C).]

6) *VAD* Value-added data value

Adjusted data value (e.g., bias-corrected) associated with field defined by *ICNI* and *FNI*.

Background: The adjusted value will be stored in this *Ivad* attm, whereas the unadjusted data will be stored in the *Core*/other attms as noted by *ICNI* and *FNI*. *VAD* units are inherited from *ICNI* and *FNI* (e.g., *ICNI*=0 and *FNI*=29 refer to *AT*, which has units of °C); the scaled range and the numeric precision is determined (e.g., at run time by {rwimma1}) from the scaling factor (e.g., taking the *AT* case: *JVAD*=0 yields whole °C, *JVAD*=1 yields 0.1°C, *JVAD*=2 yields 0.01°C, etc.). [Note that the storage of the adjusted value in this attm is an inversion of the planned handling, after blending into ICOADS, of straightforward data corrections using the *Error* attm (see Table C97).]

7) *IVAU1* Type indicator for *VAU1*
8) *JVAU1* Scaling factor for *VAU1*
9) *VAU1* Uncertainty of type *IVAU1*
10) *IVAU2* Type indicator for *VAU2*
11) *JVAU2* Scaling factor for *VAU2*
12) *VAU2* Uncertainty of type *IVAU2*
13) *IVAU3* Type indicator for *VAU3*
14) *JVAU3* Scaling factor for *VAU3*
15) *VAU3* Uncertainty of type *IVAU3*

Indicators *IVAU1, IVAU2, IVAU3* defined the type of uncertainty provided:

0 – To be determined in prototype
1 – To be determined in prototype

Scale factor *JVAU1, JVAU2, JVAUE* for *VAU1, VAU2, VAU3*, respectively, and defined identically to *JVAD*.

Uncertainty, *VAU1, VAU2,* and *VAU3,* associated with field defined by *ICNI* and *FNI*.

Background: Uncertainty value units are inherited from *ICNI* and *FNI* (e.g., *ICNI*=0 and *FNI*=29 refer to *AT*, which has units of °C); the scaled range is as specified, and the numeric precision is determined (e.g., at run time by {rwimma1}) from the scaling factor (e.g., taking the *AT* case: *JVAU1*=0 yields whole °C, *JVAU1*=1 yields 0.1°C, *JVAU1*=2 yields 0.01°C, etc.).

16) *VQC* Value-added quality control flag

The *VQC* is designed to store externally derived and provided data QC information. The provider of QC information is required to map their flags to the *VQC* configuration (Table C96a) and describe their mapping method in external documentation as linked via *ARC* (also original QC flags, prior to mapping to *VQC*, can be stored in the *Suppl* attm together with original data).

Table C96a. Configuration of the value-added QC Flag (*VQC*), following primary-level quality flag (QF) codes and definitions from IOC (2013)[1], which also recommends that any QC tests must be well documented in metadata that accompany the data.

Code	*Primary level flag's short name*	*Definition*
1	Good	passed documented required QC tests
2[2]	Not evaluated, not available or unknown	used for data when no QC test performed or the information on quality is not available
3	Questionable/suspect	failed non-critical documented metric or subjective test(s)
4	Bad	failed critical documented QC test(s) or as assigned by the data producer
9	Missing data	used as placeholder when data are missing

1. IOC, 2013: Ocean Data Standards, Vol. 3: Recommendation for a Quality Flag Scheme for the Exchange of Oceanographic and Marine Meteorological Data. IOC Manuals and Guides 54, Vol. 3., 12 pp. (English.)(IOC/2013/MG/54-3). [http://www.iode.org/index.php?option=com_oe&task=viewDocumentRecord&docID=10762].

2. Explanation for the placement of flag value 2, from IOC (2013): 'The quality of verified "Good" (flag 1) is considered higher (smaller flag value) compared to "Not evaluated" (flag 2), as the latter could turn out to be of any quality from good to bad, once the quality checks have been performed. Consequently, the neutral "Not evaluated" (flag 2) is placed between verified "Good" and verified "Questionable/suspect".'

_____

17) *ARCI* Author reference code – *Ivad*

The author reference code is a required alphanumeric value that is intended to direct the user to a publication or technical report describing value-added data, uncertainties, and/or quality control provided in the *Ivad* attm. The *ARCI* values defined for the IVAD prototype are the following:

BKT – National Oceanography Center, Berry, Kent, and Taylor, created 2015
FS01 – Florida State University, Smith et al. 2015

18) *CDI* Creation date – *Ivad*

Date conforming to ISO 8601 (YYYYMMDD) that identifies when the value-added data, uncertainties, and/or quality control for the given record was created. Set by the external developer that produced the *Ivad* attm.

19) *ASII* Access status indicator – *Ivad*

An indicator of the status of the access to the *Ivad* record within ICOADS:

0 – Active
1 – Inactive

Error (*Error*) attm (C97)

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=97 for *Error*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes (*ATTL=32* for *Error*).

Corrected erroneous data and metadata elements

3) *ICNE* Input component number-*Error*

Component within the IMMA record for which corrected erroneous data or metadata applies (e.g., 0=*Core* or appropriate *ATTI* for other attm).

4) *FNE* Field number – *Error*

Field number from the referenced IMMA component (*ICNE*) for which the error correction applies (e.g., for sea temperature in the *Core*, *FNE* = 35 and for sea temperature from the *Nocn*, *FNE* = 3).

5) *CEF* Corrected or erroneous field flag

An indicator of whether or not the *ERRD* field contains the corrected or uncorrected value.

0 - *ERRD* is the corrected value
1 - *ERRD* is the uncorrected value

Background: It is envisioned that when external providers submit *Error* attm, they will provide the corrected value in the attm and set *CEF=0.* To simplify the user interface, corrections for straightforward errors (e.g., callsign garbling) will ultimately be stored by ICOADS in the *Core*/other attms, whereas uncorrected data will be stored in this *Error* attm—this is an inversion of the planned handling of bias adjustments using the *Ivad* attm. The swapping of the information from externally provided *Error* attms, to final inverted storage in IMMA1 (i.e., from *CEF*=0 to *CEF*=1, and interchanging the data fields), will likely be handled by the ICOADS data team at NCEI; however, the *CEF* flag settings should allow this inversion to be handled externally instead if desired (i.e., through the provision of both Main and Subsidiary records).

6) *ERRD* Corrected or uncorrected value

Adjusted data value (e.g., bias-corrected) associated with field defined by *ICNE* and *FNE*.

Background: The numeric precision and units of measurement are inherited from *ICNE* and *FNE.* [Note: In {rwimma1}, the *Min.* and *Max.* of *ERRD* are initialized to character (i.e., "c" and "c") but these values are changed to "*(inh.)*" after *ICNE* and *FNE* are known. Moreover, all fields are right-justified, e.g., *ID* is left-justified in *ERRD* characters two through ten.]

7) *ARCE* Author reference code – *Error*

The author reference code is a required alphanumeric value that is intended to direct the user to a publication or technical report describing error correction provided in the *Error* attm. At the time of R3.0, no *Error* attm had been created.

8) *CDE* Creation date – *Error*
Date conforming to ISO 8601 (YYYYMMDD) that identifies when the error correction for the given record was created. Set by the external developer that produced the *Error* attm.

9) *ASIE* Access status indicator – *Error*
An indicator of the status of the access to the *Error* record within ICOADS:

0 – Active
1 – Inactive

Unique report identifier (*Uida*) attm (C98)

1) *ATTI* attm ID
2) *ATTL* attm length
Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=98 for *Uida*), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes (*ATTL=15* for *Uida*).

Report elements
3) *UID* Unique report identifier (ID)
A unique ID for each record in ICOADS represented as a base36 number of length 6. Development considerations for *UID* are discussed in Annex B of Woodruff et al. (2015; http://icoads.noaa.gov/ivad/IMMA-Rev.pdf).

Background: The *intermediate* Release 2.5 product (R2.5*i*), containing available duplicates and other reports excluded from the normal user product (R2.5), was used as the starting point for assigning *UID.* R2.5*i* contains ~295M (specifically: 294,725,525) reports ($m_{R2.5i}$), so all those records (in predefined temporal archive sequence) had *UID* assigned from 1, …, $m_{R2.5i}$. During preparation of R3.0, new and historical records were numbered starting from $m_{R2.5i}$+1 to $m_{R3.0t}$ (specifically 1,233,945,192; where the "t" subscript refers to the *total* file output from R3.0). After blending the old and new records into R3.0, all the *UIDs* are no longer sequential (i.e., new *UIDs* have been interleaved into the old purely numeric sequence; see http://icoads.noaa.gov/ivad/IMMA-Rev.pdf for further discussion).

While *UID* is a base36 number, this field is handled by {rwimma1} as strictly (i.e., without leading spaces, e.g., 35=00000Z) alphanumeric, and thus is not fully translated into an integer or floating-point (REAL) number (ref. {rwimma1} comments: "For character […] fields, note that ITRUE and FTRUE contain the ICHAR of the first character of the field…"). Separate from {rwimma1} however, this Fortran library is available to transform *UID* into an integer (and vice versa): http://icoads.noaa.gov/software/base36.f. Users interested in handling *UID* as a number should be aware of possible finite precision issues arising in the representation of large numbers on computers:

- In the integer case, the largest 6-character base36 number is ZZZZZZ (2,176,782,335); however, if one bit is reserved for sign, the largest positive integer representable in 32 bits is only 2^{31}–1 (2,147,483,647; ZIK0ZJ in base36). However, the current maximum of *UID* is $m_{R3.0t}$ (~1.234B) and thus below this threshold.
- Whereas, in the floating-point case it is not even possible to accurately represent $m_{R3.0t}$ as a 32-bit single precision REAL number.

5) *RN1* Release number: primary
6) *RN2* Release number: secondary

7) *RN3* Release number: tertiary

Three elements that make up the full release number associated with the record. For example, Release 3.0.0 (1662-2014) is represented with *RN1*=3, *RN2*=0, and *RN3*=0, and R3.0.1 (the 2015-forward GTS blend product, providing a NRT preliminary extension to R3.0) with *RN1*=3, *RN2*=0, and *RN3*=1

Background: A uniform policy on the usage of these Release number digits has yet to be developed, but the primary number is envisioned to change only at major full-period Releases, the secondary number at noteworthy incremental Releases, and the tertiary number can describe subsequent Releases associated with a major or incremental Releases (e.g., R3.0.1, R3.1.1).

8) *RSA* Release status indicator

An indicator that specifies whether the record is

0 – Preliminary (Not yet included in an official ICOADS Release)

1 – Auxiliary (Records provided in separate data files in addition to ICOADS official Releases and Preliminary data. This also includes new data sources received, but awaiting blending into an official ICOADS Release)

2 – Full (A record included in an official ICOADS Release)

9) *IRF* Intermediate reject flag

A flag assigned during processing of a release to indicate whether each report is to be rejected or retained during construction, from the Total output dataset, of the Final user dataset, and also flagging the potential construction of an Intermediate dataset (note: not implemented presently for R3.0, only the Total and Final datasets are available). Values are:

0 – Intermediate (i.e. Retain in Intermediate data file, reject from Final dataset)

1 – Final (i.e. Retain in both Intermediate and Final datasets)

2 – Reject (i.e. Reject from both Intermediate and Final datasets)

Supplemental data (*Suppl*) attm (C99)

1) *ATTI* attm ID
2) *ATTL* attm length
3) *ATTE* attm data encoding
5) *SUPD* supplemental data

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents, and *ATTL* was allocated (but is presently unused, see below) to provide the total length of the attm (including *ATTI* and *ATTL*) in bytes, or zero for length unspecified (record terminated by the ASCII line feed character; line feed not counted as part of *ATTL*; note all IMMA data from R3.0 currently follow this form). The supplemental data attm (C99) also includes *ATTE*, which indicates whether the supplemental data that follow are in ASCII or encoded:

missing – ASCII

0 – base64 encoding

1 – hexadecimal

The {rwimma1} software tests to determine if each individual IMMA record is properly configured, without checking *ATTC* (ref. Table C0) against the number of attachments present. Also, {rwimma1} sets *ATTC* when an IMMA is written, and it allows duplicate attms (i.e., two attms with the same *ATTI*) to appear in a record, but the second overwrites the first (i.e., in memory) unless they are one of the two-dimensional (i.e., *Rean-qc*, *Ivad*, *Error*) attms. The software does not require that attachments appear in any particular order

by *ATTI*, with one exception: the supplemental data attm must be the final attm within the record with *ATTL*=0.

> Background: Thus far, *ATTL* in bytes has not been supported in the read/write IMMA programs (e.g., {rwimma1}). Also thus far, *ATTE*=1 (hexadecimal) has been used only for MORMET (deck 732) data (to represent binary input). This printable representation, which {rwimma1} treats identically to ASCII, was undocumented in previously available (i.e., IMMA0) Suppl. D information. In addition, while the *ATTE*=0 (base64 encoding; unprintable) representation is documented in Supp. D, currently it is unused and not fully implemented in {rwimma1}.

Supplement E: ICOADS Release 3.0 IMMA Status

This supplement provides additional technical information on the IMMA1 implementation presently used for Release 3.0 (R3.0.0; 1662-2014), plus for monthly "preliminary" data (based on a blend of NCEP and NCEI GTS receipts) extending ICOADS to near-current dates (R3.0.1; 2015-forward). Also discussed is an alternative "Total" output product derived during the creation of R3.0 that some users may wish to access.

New to R3.0 is the implementation of the IMMA1 linked report format, which includes Main and (optional) Subsidiary records, linked together by the unique record identifier (stored in the *Uida* attm). From this approach, the main records may include (see Table E1 for more information about the individual format components):

Main IMMA record: *Core* + *Icoads* + *Immt* + *Mod-qc* + *Meta-vos* + *Nocn* + *Ecr* + *Uida* + *Suppl*

which contains (if all attms are present) 542 characters prior to the variable-length *Suppl*. However, the attachment structure of IMMA (and {rwimma1} software) is designed with the capability to save space through omission of empty attachments (i.e., information not relevant, or not available, for a given dataset). Since we utilize this feature for the main ICOADS records, they may frequently be shorter than 510 characters (e.g. the *Meta-vos* and *Ecr* attms in general are only available for VOS data).

During development of R3.0, ICOADS developed a method to blend GTS data streams from NCEI and NCEP, which will support the near-real-time (NRT) extension of R3.0 from January 2015 to present (updated monthly, up to five days into the next month, and referred to as R3.0.1). In 2007 NCEP began masking all ship call signs, and this product recovers up to 70% of the actual ship radio call signs by blending the NCEI stream. Additionally, approximately 5% unique reports are gained from the merge. More information on this product can be found at http://icoads.noaa.gov/merge.html.

Also available to the user community will be the newly created "Total" output. This product includes available duplicates and landlocked reports, flagged so that they could be readily removed when creating the "Final" R3.0 user product. The Total product additionally contains reports that were rejected during the initial processing because of known and documented errors. R3.0 contains a number of known unresolved inhomogeneities and data mixture problems (Freeman et al. 2016; http://icoads.noaa.gov/r3.html). Particularly for some of the data mixture issues, the Total product is available for further study or potentially to develop improved solutions.

For example, WMO–No. 47 (1955–) metadata (Berry et al. 2009) were blended into the Total product, partly in recognition that in some cases only duplicates not selected for final output received the metadata (e.g., due to the lack of a ship callsign in duplicates selected for final output). Another incompletely resolved R3.0 issue for which the total file could be utilized concerns the VOSClim data and metadata, which have not yet been practical to provide in the form of a fully merged dataset (e.g., possibly bringing elements from the GTS and logbook reports, together with the Table C6 (*Mod-qc* attm) feedback information, into composited reports).

Following the release of R3.0 in June 2016, enhancements of R3.0 are planned as resources permit. Most immediately, we plan to add *Rean-qc* attms from at least one reanalysis project, and *Ivad* attms from the pilot IVAD project. Longer-term, quality control

improvements and other enhancements to ICOADS are needed as soon as practical (as discussed further in Freeman et al. 2016). These additional format elements are also reflected in Table E1.

Table E1. Sizes of IMMA1 format components: Core and attachments (attm). We plan to populate C95 and C96 in an incremental release soon following R3.0.0, and while C97 is fully implemented (e.g. in {rwimma1} it is not yet in use but proposed for use in a future release.

Abbrev.	*Name*	*Size (B)*	*Cumulative size (B)*	*Comments*
C0	Core (*Core*)	108	108	
C1	ICOADS (*Icoads*) attm	65	173	
C5	IMMT5/FM 13 (*Immt*) attm	94	267	
C6	Model quality control *(Mod-qc*) attm	68	335	
C7	Ship metadata (*Meta-vos*) attm	58	393	From WMO–No. 47 for 1966-2014; plus from COAPS (deck 740)[2]
C8	Near-surface oceanographic (*Nocn*) attm	102	495	
C9	Edited cloud report	32	527	
C98	Unique report ID (*Uida*) attm	15	542	
C99	Supplemental data (*Suppl*) attm[1]	variable		
C95	Reanalysis QC/feedback (*Rean-qc*) attm	61	603	To be populated soon after R3.0 in a subsequent release
C96	ICOADS Value-Added Database (*Ivad*) attm	53	656	To be populated soon after R3.0 in a subsequent release
C97	Error (*Err*) attm	32	688	Available for future use

1. For ICOADS Release 2.4, 1784-1997 IMMA were recreated using LMR to merge important supplemental data into the *Suppl* attm (previously "C6," now C99). As resources permit, and as the IMMA format evolves to include additional fields, those and more recently received supplemental data should be tapped for regular fields not previously defined in ICOADS but becoming available in IMMA (e.g. sea ice fields), or planned for availability in IMMA in historical attm (e.g. Beaufort wind force numbers).
2. The WMO–No. 47 metadata were blended into the "Total" R3.0 product (see Table E2) as was done for R2.5 (see Berry et al. 2009), whereas the COAPS metadata were retained from the R2.5.1 input for DCK 740, *SID*=130 (1990-1998) and added to R3.0 for DCK 740, *SID*=131 (2005-2014).

Table E2. Numbers of reports and data volumes for the "Total" and "Final" user products output from R3.0.0. The Total product is a superset of the Final product, in that it also contains flagged duplicates, landlocked reports, and some flagged erroneous "Reject" data. Total product sizes (10^9 bytes) are uncompressed.

Product	Period	Reports	Total product size
Final	1662-2014	455,528,938	149 GB
Total	1662-2014	1,009,511,934	390 GB

Supplement F: Proposed IMMA Attachments

This supplement contains IMMA attachments that are proposed or in development. None of these attachments have been implemented in IMMA1 or in {rwimma1}. Notes related to the proposed attm development are included below each table, with specific fields in the proposed *Hist* attachment fleshed out in additional detail below Table CP5.

Table CP1. Automated instrumentation (*Auto*) attm (proposed)

No.	*Len.*	*Abbr.*	*Element description*	*Min.*	*Max.*	*Units (Code) [base36]*
1	2	*ATTI*	attm ID			Note: set *ATTI=(tbd)*
2	2	*ATTL*	attm length			Note: set *ATTL*=41
			Automated instrumental metadata (37 characters):			
3	8	*ALAT*	latitude	–90.000	90.000	0.001°N
4	9	*ALON*	longitude	0.000	359.999	0.001°E (ICOADS conv.)
5	1	*INAV*	navigation system indicator	0	9	(controlled vocabulary *tbd*, e.g., 0=GPS, 1=POSMV, 2=INS)
6	6	*APRS*	atmospheric pressure	870.00	1074.60	at barometer height (*HOB*)
7	6	*ARSW*	shortwave radiation	0.00	1600.00	Wm^{-2}
8	1	*IARSW*	shortwave radiation indicator	0	9	(controlled vocabulary *tbd*, e.g., 0=down-, 1=upwelling)
9	5	*ARLW*	longwave radiation	200.00?	800.00?	Wm^{-2}
10	1	*IARLW*	longwave radiation indicator	0	9	(controlled vocabulary *tbd*, e.g., 0=down-, 1=upwelling)

***Auto* attm notes:**

This attm is designed to provide a location to capture meteorological and underway ocean data that are not routinely reported by VOS or in historical ship reports. These values would be derived from automated instrumentation.

This attm could be expanded to include all possible parameters that could be derived at high precision from automated instrumentation. Candidate fields that are included elsewhere in IMMA0 are: Ship's course and speed (*DS*/*VS*, in the *Core*; or *COG/SOG* for the over ground elements, in *Immt*), and ship's heading (*HDG* in *Immt*), wind direction and speed (true *D*/*W*, in the *Core*; or relative *RWD/RWS* in *Immt*), *AT*, *WBT*, *DPT* (*Core*), and *RH* and precipitation (*Immt*). Other possible fields for this table include visibility and cloud height derived from automated sensors, but they are currently very rare on ships or moorings, or possibly surface velocity data (not presently part of ICOADS).

For *ARSW*, it is still not determined if the field should allow for negative values. They are common due to sensor calibration issues (and flagged e.g., by SAMOS), but are not physical.

Storing *APRS* is proposed for two reasons (a) there is no place in IMMA to store atmospheric pressure values not converted to sea level and (b) precision automated barometers can easily record *SLP* (or *APRS*) to 2 or 3 decimal places. However, if the field serves two purposes, an associated indicator may be needed to flag the high-resolution pressure type (i.e., *SLP* or *APRS*)

Radiation could be handled in different ways. The idea above provides for separate shortwave/longwave total radiation variables. If we added a signed range, this could also allow for net radiation. Another other option would allow for multiple radiation values each with an indicator stating whether it is shortwave, longwave, PAR, UV, etc. This may result in a variable-length attachment or one of fixed-length with many empty fields. Also, some indicator of the time period over which the radiation was integrated may be needed. The draft E-SURFMAR Dataformat#100

(http://esurfmar.meteo.fr/doc/o/vos/E-SURFMAR_VOS_formats_v011.pdf) suggests "over the past hour."

Table CP2. Near-surface oceanographic QC (*Nocq*) attm (proposed).

No.	*Len.*	*Abbr.*	*Element description*	*Min.*	*Max.*	*Units (Code) [base36]*
1	2	*ATTI*	attm ID			Note: set *ATTI=(tbd)*
2	2	*ATTL*	attm length			Note: set *ATTL*=28
			Near-surface oceanographic QC and calibration information (24 characters):			
1	1	*OQCI*	quality control indic.[1]	0	9	(Same as *QCI* in Table C5)
2	1	*OQCFL*	QC flag list[2]	u	u	*(tbd)*
3	1	*OTQC*	*OTV* (temp.) QC flag	0	9	*(tbd)*
4	1	*OTCI*	*OTV* calibration indic.	0	9?	*(tbd)*[3]
5	1	*OSQC*	*OSV* (salinity) QC flag	0	9	*(tbd)*
6	1	*OSCI*	*OSV* calibration indic.	0	9?	*(tbd)*
7	1	*OOQC*	*OOV* (oxygen) QC flag	0	9	*(tbd)*
8	1	*OOCI*	*OOV* calibration indic.	0	9?	*(tbd)*
9	1	*OPQC*	*OPV* (phosphate) QC flag	0	9	*(tbd)*
10	1	*OPCI*	*OPV* calibration indic.	0	9?	*(tbd)*
11	1	*OSIQC*	*OSIV* (silicate) QC flag	0	9	*(tbd)*
12	1	*OSICI*	*OSIV* calibration indic.	0	9?	*(tbd)*
13	1	*ONQC*	*ONV* (nitrate) QC flag	0	9	*(tbd)*
14	1	*ONCI*	*ONV* calibration indic.	0	9?	*(tbd)*
15	1	*OPHQC*	*OPHV* (pH) QC flag	0	9	*(tbd)*
16	1	*OPHCI*	*OPHV* calibration indic.	0	9?	*(tbd)*
17	1	*OCQC*	*OCV* (total chlor.) QC flag	0	9	*(tbd)*
18	1	*OCCI*	*OCV* calibration indic.	0	9?	*(tbd)*
19	1	*OAQC*	*OAV* (alkalinity) QC flag	0	9	*(tbd)*
20	1	*OACI*	*OAV* calibration indic.	0	9?	*(tbd)*
21	1	*OPCQC*	*OPCV* (PaC02) QC flag	0	9	*(tbd)*
22	1	*OPCCI*	*OPCV* calibration indic.	0	9?	*(tbd)*
23	1	*ODQC*	*ODV* (DIC) QC flag	0	9	*(tbd)*
24	1	*ODCCI*	*ODV* indic.	0	9?	*(tbd)*

1. Proposed as an overall QC method flag, the same as *QCI* in the *Immt* attm, which has this configuration:
   0 - No quality control (QC)
   1 - Manual QC only
   2 - Automated QC only /MQC (no time-sequence checks)
   3 - Automated QC only (inc. time sequence checks)
   4 - Manual and automated QC (superficial; no automated time-sequence checks)
   5 - Manual and automated QC (superficial; including time-sequence checks)
   6 - Manual and automated QC (intensive, including automated time-sequence checks)
   7 & 8 - Not used
   9 - National system of QC (information to be furnished to WMO)
2. Proposed indicator that points to different QC flag schemes (e.g., the ODS-based scheme as listed in Table C96a).

3. As agreed at the April 2013 UK EarthTemp meetings, it appears we need at least 4 configurations: (0) not calibrated, (1) calibrated, (2) bottle calibrated, (3) others.

_____

***Nocq* attm notes:**

QC flags and calibration information paralleling the data value (and accompanying depth) fields in the *Nocn* attm (Table C8).

Table CP3. Alternative QC (*Alt-qc*) attm (proposed).

No.	*Len.*	*Abbr.*	*Element description*	*Min.*	*Max.*	*Units (Code) [base36]*
1	2	*ATTI*	attm ID			Note: set *ATTI=(tbd)*
2	2	*ATTL*	attm length			Note: set *ATTL*=18
			Alternative QC information (14 characters):			
3	2	*ICNQ*	input component number–*Alt-qc*	0	*(tbd)*	IMMA component number
4	6	*FNQ*	field number–*Alt-qc*	1	*(tbd)*	IMMA field no. within *ICNQ*
5	1	*AQCFL*[1]	QC flag list	u	u	(*tbd*; possibly [b36])
6	1	*QCFV*	QC flag value	0	9	(tbd; possibly [b36])
7	4	*ARCQ*	author reference code–*Alt-qc*	b	b	(alphanumeric)

1. See *OQCFL* in the *Nocq* attm (Table CP2).

_____

***Alt-qc* attm notes:**

Envisioned as a means by which data providers could provide QC flag information on a flexible basis, akin to the *Error* attm, but for additional quality control flags for any field number in any attm. The intent of the QC flag list is to allow users to submit data using a range of QC flagging schemes (e.g., 0-9, A-Z, etc). This could be supported by using base36 representation. May also want to consider need for length>1 for the *QCFV*.

Table CP4. Platform tracking (*Track*) attm (proposed).

No.	*Len.*	*Abbr.*	*Element description*	*Min.*	*Max.*	*Units (Code) [base36]*
1	2	*ATTI*	attm ID			Note: set *ATTI=(tbd)*
2	2	*ATTL*	attm length			Note: set *ATTL=(tbd)*
			Platform track information (~25 characters):			
3	1?	*UIDT*	UID type			(*tbd*; e.g., 1=ICOADS-standard, 2=collection/*SID*-specific,3=platform/voyage-specific)
4	6	*UID1*	UID of previous report	1	*(tbd)*	
5	6	*UID2*	UID of this report	1	*(tbd)*	
6	6	*UID3*	UID of next report	0	*(tbd)*	
7	4	*ARCT*	author reference code–*Track*	b	b	(alphanumeric)

No.	Len.	Abbr.	Element description	Min.	Max.	Units (Code) [base36]
8	8	*CDT*	creation date—*Track*	20140101	2nnn1231	ISO-8601, YYYYMMDD (as for *CDR*, ref. Table C95)
8	1	*ASIT*	access status indic.—*Track*	0	1	0=active, 1=inactive

***Track* attm notes:**

Sets aside space for "pointer" fields indicating the UID of the previous (*UID1*) and next (*UID3*) report, with respect to this report (*UID2*), in ship/buoy track sequence (i.e., both forward, and backward, in time and space). If indicated by *UIDT*, this attm could contain collection- (or source ID, *SID*) specific, or even platform/voyage-specific, rather than ICOADS-standard, *UID* information (which thus in a sense can be considered value-added information, if assembled externally).

This could be very useful e.g., for reanalyses to resolve the problem of connecting ship/buoy voyages within ICOADS. Due to effects of dupelim, tracks may consist of records interspersed from a variety of sources, with possibly varying *IDs* for records in track sequence. This proposed attm would provide the storage mechanism for this information, but populating the attm seems likely to be challenging; therefore, as with the *Ivad* attm, ICOADS might consider the *Track* to be metadata and possibly this info could be ingested if somebody else had the resources to implement the ship tracking.

Table CP5. Historical attm (*Hist*) (proposed).

No.	Len.	Abbr.	Element description	Min.	Max.	Units (Code) [base36]
1	2	*ATTI*	attm ID			Note: set *ATTI=(tbd)*
2	2	*ATTL*	attm length			Note: set *ATTL=(tbd)*
			Historical data fields (>19 characters):			
3	?	*SN*	ship's name	u	u	[Note: either the full name, or possibly abbreviated with reference to a separately maintained list, to same space?]
4	5	*LCR*	longitude by chronometer	0.00	359.99	0.01°E[1] (ICOADS conv.)
5	5	*LMG*	longitude made good[2]	0.00	359.99	0.01°E[1] (ICOADS conv.)
6	5	*LDR*	longitude by account[3]	0.00	359.99	0.01°E[1] (ICOADS conv.)
7	1	*WFI*	*WF* indic.	u	u	
8	2	*WF*	wind force	0	12	
9	1	*XWI*	*XW* indic.	u	u	
10	3	*XW*	wind speed (ext. *W*)	0	99.9	0.1 m/s
11	1	*XDI*	*XD* indic.	u	u	
12	2	*XD*	wind dir. (ext. *D*)	u	u	
13	1	*SLPI*	*SLP* indic.	u	u	[Note: This or another indicator needed to indicate the presence or absence of *SLP* adjustment (ref. *PB*)?]
14	1	*TAI*	*TA* indic.	u	u	
15	4	*TA*	*SLP* att. thermometer	–99.9	99.9	ref. *AT*
16	5	*SMPR*	sympiesometric pressure	25.000	32.000	0.001 inches of mercury[4]
17	1	*XNI*	*XN* indic.	u	u	
18	2	*XN*	cloud amt. (ext. *N*)	u	u	
19	1	*SGN*	significant cloud amount	0	9	(N_S; ref. Table B4)

No.	*Len.*	*Abbr.*	*Element description*	*Min.*	*Max.*	*Units (Code) [base36]*
20	1	*SGT*	significant cloud type	0	9, "A"	(C; ref. Table B4)
21	2	*SGH*	significant cloud height	0	99	(h_Sh_S; ref. Table B4)
(plus additional elements tbd)						

1. A possible alternative approach for storing these longitudes, such as from the EEIC collection, would be to keep the DDD.MM.SS original format, noting however that original data configurations should be preserved anyway in the *Suppl* attm. Also storing decimal points would violate the standard IMMA representation for numeric data (unless these fields were stored as character strings).
2. With reference to Greenwich Meridian.
3. As calculated by dead reckoning.
4. Due to the erratic nature of the sympiesometer measurements such as observed in the EIC Collection, these values might fall well out of the range specified here.

_____

Preliminary definitions of fields for within the proposed Hist attm (Table CP5):

1) *ATTI* attm ID
2) *ATTL* attm length

Each attm begins with *ATTI* and *ATTL*. *ATTI* identifies the attm contents with a numeric identifier (*ATTI*=tbd), and *ATTL* provides the total length of the attm (including *ATTI* and *ATTL*) in bytes (*ATTL=tbd*).

Historical data fields (field numbering preliminary)

3) *SN* ship's name
4) *LCR* longitude by chronometer
5) *LMG* longitude made good
6) *LDR* longitude by account

7) *WFI* wind force indicator
8) *WF* wind force
9) *XWI XW* indicator
10) *XW* wind speed (extension field for *W*)
11) *XDI* *XD* indicator
12) *XD* wind direction code (extension field for *D*)

WFI and *WF* are proposed primarily for 0-12 Beaufort wind force codes, but potentially could be extended to other 2- or 1-digit codes, with *WFI* indicating the type of information, e.g., 0-6 (half Beaufort code in 19th century Norwegian logbooks), Ben Nevis Observatory code. *XWI* and *XW* are proposed for equivalent wind speed, with *XWI* indicating the scale used to convert from *WF* (e.g., the existing WMO Code 1100 scale or newer alternatives). Similarly, fields *XDI* and *XD* are proposed for older 2- or 1-digit wind direction codes, with *XDI* indicating the type of information, e.g., 32-, 16-, or 8-point compasses.

13) *SLPI* *SLP* indicator
14) *TAI* *TA* indicator
15) *TA SLP* attached thermometer

SLPI is proposed for historical data to indicate the barometer type (e.g., mercurial, aneroid, or metal). *TAI* (configuration undecided, but probably similar to some of the other temperature indicators) and *TA* are proposed for older mercurial barometer data, in which the attached thermometer is critical for data adjustments.

16) *SMPR* *Sympiesometric pressure*

17) *XNI* *XN* indicator
18) *XN* cloud amount (extended field for *N*)
XN is proposed for historical cloud amount data (e.g., in tenths), with *XNI* indicating the units (e.g., tenths).

19) *SGN* significant cloud amount
20) *SGT* significant cloud type
21) *SGH* significant cloud height
Use of "A" (10 in base36) in place of "/."

Background: These significant cloud fields are listed in Met Office (1948), but appear to have been omitted from regular IMM fields (see Table B4) and the current FM 13 code; in presently available ICOADS data they should always be missing [Note: Since these appear to be strictly historical fields, deletion from this attachment and possible repositioning within Table C5 is suggested for future consideration).]

***Hist* attm notes:**

Fields *SGN*, *SGT*, and *SGH*, which are believed to be purely historical (1960s or earlier), are moved here from the *Immt* attm. Refer to the complete version of the IMMA0 documentation (http://icoads.noaa.gov/e-doc/imma/R2.5-imma.pdf) and Table B4. Among potential additional elements: dead reckoning positions (if preserved additionally to observed positions) and surface current movement (derivable from dead reckoning positions), Leeway, magnetic deviation and variation, etc.

Other examples from recent work on the C19th German Maury Collection:

Cloud form:

Cirrus	CI	Cirrocumulus	CC	Cirrostratus	CS
Altocumulus	AC	Altostratus	AS		
Stratocumulus	SC	Stratus	ST	Nimbostratus	NS
Cumulus	CU	Cumulonimbus	CB		

Present Weather indicated by combinations of the following Beaufort Codes:

b	blue sky	p	passing showers
c	cloudy sky	q	squally
d	drizzle	r	rain, rainy
f	fog	s	snow
g	gloomy	t	thunder
h	hail	u	ugly threatening sky
l	lightning	v	exceptional visibility
m	mist	w	dew
o	overcast, overcast skies	z	haze

Additional historical fields, such as sea state and sea ice
will have to be investigated further to determine the feasibility of incorporating them in IMMA. Historically, these are largely non-standardized recordings, recorded in comments possibly embedded in large amounts of text (e.g., greater than 1500 unique state of sea and weather comments in the EEIC collection).

Document Revision Information

First draft version: 20 May 2016. This report is a major update of http://icoads.noaa.gov/e-doc/imma/R2.5-imma.pdf and contains information regarding ICOADS Release 3.0 in IMMA1 format, with additional information and clarifications added since the initial draft version.

Second draft version: 16 June 2016. Updates to DCK/SID Tables 6a-c,7 and additional text edits.

Third draft version: 29 June 2016. Updates to DCK Table 6c.

Fourth draft version: 14 July 2016. Updated Freeman et al. (2016) reference to include DOI. Removed "[in preparation]" notes from references to *R3.0-stat_trim (*http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf*)*. For field 49) *QCE* and in Table C1, "MEDS" was changed to "OSD." In Table C1a, noted in the table heading that this is Table 1 in *R3.0-stat_trim (*http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf*)*, and corrected table footnotes to agree with *R3.0-stat_trim (*http://icoads.noaa.gov/e-doc/R3.0-stat_trim.pdf*)*. Changes were made in Table D8 to properly describe the handling of DUPS in R3.0 processing.

Fifth draft version: 15 September 2016: Correction in Table C1a in the Units wording associated with *ZE*, "NCDC" changed to "OSD." Minor updates in the Introduction, and minor updates/corrections in Tables B1 and D6a, and in the Background information for *UID*. A variety of additional minor editorial and format adjustments was also completed prior to final publication. Also updated Supplement E to include tables E1 and E2. Hyperlinks were added to *R3.0-stat-trim* documentation available on the ICOADS website.

Sixth draft version: 28 October 2016: Update to Table C98 to update RN numbers to current version: RN1=2, RN2=5, RN3=0 (i.e. R2.5.0) changed to RN1=3, RN2=0, RN3=0 (i.e. R3.0.0) in the '*Units*' column

Final version: 5 April 2017.