

Translation Specification for World Ocean Database 2014 (WOD13) to ICOADS IMMA1 format

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Reference document: Johnson, D.R., T.P. Boyer, H.E. Garcia, R.A. Locarnini, O.K. Baranova, and M.M. Zweng, 2013. World Ocean Database 2013 User's Manual. Sydney Levitus, Ed.; Alexey Mishonov, Technical Ed.; NODC Internal Report 22, NOAA Printing Office, Silver Spring, MD, 172 pp. Available at <http://www.nodc.noaa.gov/OC5/WOD13/docwod13.html>. (hereafter called *NODC-rpt22_WOD13*).

The WOD13 with updates up to 2/24/2015 are stored in a packed ASCII format. Due to the large number of possible ancillary information at each station and varying numbers of parameters on each profile a variable length ASCII record format is used. All the details of the pack ASCII format are not repeated here. Two FORTRAN access programs developed by the NODC Ocean Climate Laboratory (*wodFOR.f* and *wodSUR.f*) are used to access each profile and surface data, as well as the primary and secondary headers. These programs are available at <ftp://ftp.nodc.noaa.gov/pub/WOD/PROGRAMS/>.

WOD13 has non-profile data in the SUR (Surface-only data) files. These files have a special format that is described in the *NODC-rpt22_WOD13*. Each observation along a cruise track is used to create an independent IMMA1 record.

The Global Ocean Surface Underway Data (GOSUD) data were provided by NCEI. The original format was converted to WOD format making it possible to process the data into IMMA using the *wodSUR.f* program.

1. Version 3 Real time data
2. Version 3 Near real time data
3. French research vessel Data
4. French sailing ship data
5. Version 2 data (included to capture early data not included in files 1 through 4, above)

Undulating Oceanographic Recorder (UOR) data are processed into up and down casts. Some special considerations have been given to the assignment of cast time and position. The average time and location are used. The approximations and averaging described in the *NODC-rpt22_WOD13* seem appropriate and are not in conflict with ICOADS principles.

The FORTRAN 90/77 code [rdimma1:01F \(21 Feb 2014\)](#) is used to place the unpacked WOD13 data into the ICOADS IMMA1 format. Fortran 77 code

[lmrlib.f:01G \(17 November 2004\)](#) is used to handle Beaufort wind force and special adjustments related to time and dates.

The WOD13 data are transformed into IMMA1 using a three-phase process.

Phase 1: Fill FTRUE, ITRUE and CTRUE – fill all available variables from values read in by wodFOR.f/wodSUR.f. Missing values are set to -999.99 in WOD13.

Phase 2: Inventory Check – count yearly total records, missing values, and error values for each of the 11 WOD13 data file types: Ocean Station Data (OSD), High-resolution Conductivity-Temperature-Depth (CTD) Data, Mechanical/Digital/Micro Bathythermograph (MBT) Data, Expendable Bathythermograph (XBT) Data, Surface (SUR) Only Data, Autonomous Pinniped Bathythermograph (APB) Data, Moored Buoy (MRB) Data, Profiling Float (PFL) Data, Undulating Oceanographic Recorder (UOR) Data, and Glider (GLD) Data. A value is counted as an error if it is out of the valid data ranges specified for the IMMA1 variable.

Phase 3: Output IMMA1 – convert error values to missing and output to IMMA1 format. To enable file tracking between the WOD13 input and IMMA1 output the file naming convention of the WOD13 is preserved and the suffix 'IMMA1' is added, e.g. OSD02000.IMMA1.

At least one observed field in the IMMA1 Core, Regular section (Table C0) or in C8 must exist. If not the input records is ignored.

IMMA1 Core, Location section, Table C0

- YR, 4-digit year, IYEAR of primary header in wodFOR.f or derived from Julian year-day (TEMP(N, 32)) in wodSUR.f.
- MO, 2-digit month, MONTH of primary header in wodFOR.f or derived from Julian year-day (TEMP(N, 32)) in wodSUR.f.
- DY, 2-digit day, IDAY of primary header in wodFOR.f or derived from Julian year-day (TEMP(N, 32)) in wodSUR.f.

A missing value for DY is not specified in the WOD13 documentation. The wodFOR.f code package does not test for legitimate DY values. DY = 0 may be found in WOD13. Action: treat DY=0 as an error.

- HR, decimal value hour, TIME of primary header in wodFOR.f or derived from Julian year-day (TEMP(N, 32)) in wodSUR.f.

The hour value is not in a fixed precision. A precision indicator is returned as IPREC(3) in wodFOR.f or MPREC(N, 32) in wodSUR.f.

Hour values of 24., 24.0, and 24.00 are set to 0.0, and the DY, MO, and YR are adjusted using standard library ([lmrplib.f:01G](#)) routines 'ixdtnd' and 'rxnddt'. Other illogical hour values, such as 100., 100.0, and 99.90, are treated as error.

- o Hour values are returned as real values with assigned precision, see item 12c in Table 10.1 of NODC-rpt22_WOD13.
 - if precision = 0 , set TI = 0
 - if precision = 1 , set TI = 1
 - if precision >= 2 , set TI = 3
- LAT, N and S latitude in decimal degrees, RLAT of primary header in wodFOR.f of the profile data or TEMP(N, 30) in wodSUR.f
 - o LAT = negative value for south latitude
 - o LAT = positive value for north latitude
 - o Skip record if it is missing for GOSUD data
- LON, E and W longitude, RLON of primary header in wodFOR.f of the profile data or TEMP(N, 31) in wodSUR.f, converted to ICOADS convention of E longitude
 - o LON = negative value for west longitude
 - o LON = positive value for east longitude
 - o Skip record if it is missing for GOSUD data

LAT and LON can occasionally have DIFFERENT precisions, IPREC(1) and IPREC(2) in wodFOR.f or MPREC(N, 30) and MPREC(N, 31) in wodSUR.f. Set LI based on the minimum precision of LAT and LON.

- if precision = 0, set LI = 1
 - if precision = 1, set LI = 0
 - if precision >= 2, set LI = 5
 - if either LAT or LON is missing, LI = missing
- IM, IMMA1 version, set = 1
 - ATTC, attm count, set = 2, including *Icoads* and *Nocn. Uida* and a modification to *Icoads* will occur in a later step of data processing when a UID is assigned to each record.

- TI, set as noted in HR description
- LI, assigned as noted in LON description
- DS, VS, and NID, are not set
- II, and ID

ID, is the WMO Identification Code, ARGOS ID number, or the NODC cruise number in the following ranked order.

- WMO Identification Code is second header field SECHEAD(94) in wodFOR.f and wodSUR.f
- ARGOS ID number is second header field SECHEAD(98) in wodFOR.f and wodSUR.f
- WOD Platform Code is second header field SECHEAD(3) in wodFOR.f and wodSUR.f.
- The NODC cruise number is the primary header field ICRUISE in wodFOR.f and wodSUR.f.

Only non-blank fields are packed and all characters are left justified in ID.

1. If WMO Identification Code is extant, set ID = WMO ID and II = 3.
2. If WMO Identification Code is not extant and ARGOS ID number is extant, set ID = ARGOS ID and II = 4.
3. If WMO Identification Code and ARGOS ID number are not extant, and WOD Platform Code is extant, set ID = WOD Platform Code and II = 6.
4. If WMO Identification Code and ARGOS ID number and WOD Platform Code are not extant, and NODC cruise number is extant, set ID = NODC cruise number and II = 7.
5. Set ID = missing and II = missing if 1, 2, 3 or 4 is not applied.

- C1
WOD13 country code is a two character alphanumeric value, CC in wodFOR.f. Set C1 = CC.

IMMA1 Core, Regular section, Table C0

- DI, set = 0, the direction is coded as a 36 point compass
- D, wind direction of 36 point compass code value, SECHEAD(21) of

secondary header in wodFOR.f, and not extant in wodSUR.f.

- o $D = 10 * \text{SECHEAD}(21)$, direction in whole degrees
- o $D = 361$ if $\text{SECHEAD}(21) = 0$
- o $D = 362$ if $\text{SECHEAD}(21) = 99$ or 49

See NODC-rpt22_WOD13: Table 2.9

- WI, see discussion for W below
- W, wind speed in knots and/or Beaufort Force (10 level scale) may be extant and are returned by wodFOR.f, and not extant in wodSUR.f. They are two different fields in the secondary header, SECHEAD(22) and SECHEAD(19), respectively.
 - o If wind speed in knots is extant, convert to m/s with standard library routine fxktms, and set $WI = 4$
 - o If wind speed in knots is NOT extant use Beaufort Force if extant.
 - Beaufort Force is converted to wind speed in m/sec using standardized library function fxbfms

The Beaufort Wind Force scale used at NODC is equivalent to the scale shown in Release 1. Table K5-5. NODC Beaufort numbers are converted to wind speed in m/sec using the values defined in the "Old" midpoint column of Table K5-5. NODC-rpt22_WOD13, Table 2.7. Set $WI = 5$.

If Beaufort Wind Force scale is in error (i.e. Force value is less than 0, greater than 12, or non-integer), W is not assigned and WI is not set.

- VI, do not set VI
- VV, visibility, the WMO 4300 code, secondary header SECHEAD(41) in wodFOR.f and is in agreement with the code used in the IMMA1 format, NODC-rpt22_WOD13 Table 2.19, $VV = 90 + \text{SECHEAD}(41)$; not extant in wodSUR.f.
- WW, weather condition, WMO 4501 or WMO 4677, SECHEAD(26) of secondary header in wodFOR.f; not extant in wodSUR.f. WMO 4677 matches the code used in the IMMA1 format – coded as values 0 through 99. When WMO 4501 is present it has values 1 through 9 that are converted to -1 through -9, respectively. WMO 4501 value 0 is equivalent to WMO 4677 value 0. NODC-rpt22_WOD13 Table 2.10.
 - o Map all WMO 4677 values directly into WW, i.e. values 0-99.
 - o Do not map negative values; WMO 4501 codes 1 through 9

- W1, are not set
- SLP, barometric pressure, SECHEAD(23) of secondary header in wodFOR.f or TEMP(N, 29) in wodSUR.f, in millibars that is equivalent to tenth of hPa.
- A, PPP – are not set
- IT – called T1 in LMR, the temperature indicator does not seem to be applicable for WOD13. There is likely to be some consistency in the precision of AT, and WBT, but it is not guaranteed or documented. SST will have a wide range of precision, whole degrees to 1000th of degrees. Do not set IT. DPT does not exist in WOD13.
- AT, dry bulb temperature, SECHEAD(24) of secondary header in wodFOR.f or TEMP(N, 26) in wodSUR.f. It is returned in degrees C.
- WBTI – indicator of WBT, are not set
- WBT, wet bulb temperature, SECHEAD(25) of secondary header in wodFOR.f; not extant in wodSUR.f. It is returned in degrees C.
- DPTI, are not set
- SI – see SST
- SST, WOD13 has a number of possibilities for IMMA1 SST. The sea temperature profile data, TEMP(N, 1) in wodFOR.f and wodSUR.f, is the desired first choice. The profile of each station is examined and used to select an SST estimate from a depth closest to 4.0 m and not greater than 10m.

If an SST is estimated from a profile the WOD flag rules are examined to determine the quality

- o the whole station profile temperature flag IERROR(1) = 0 (accepted temperature profile).
- o the WOD13 QC flag for the selected depth IDERROR(Nsst,0) = 0 (accepted depth level)
- o the WOD13 QC flag for the temperature at the selected depth IDERROR(Nsst,1) = 0 (accepted temperature value)

If the sea temperature profile cannot be used to estimate SST (primarily because there are no observations at depth less than or equal to 10 meters), then the "Reference/SST, secondary header", SECHEAD(46), is used if it is extant and the following condition is true:

- o The whole station profile flag for sea temperature IERROR(1) = 0.
- o For all data file types except SUR.

This may seem like an odd condition, but the OCL has done some QC on the profile data and not on the "Reference/SST". If the whole profile is flagged to be unacceptable it is unlikely that any sea temperature is valid. Through standard deviation comparisons and bulls eyes checks whole station profile flags often mark mislocated and/or very bad data.

- SI, if a sea temperature profile is used to determine a SST the following two setting are used.
 - 11 = reversing thermometer or mechanical sensor (OSD, MBT, note low resolution CTD is included in OSD)
 - 12 = electronic sensor (CTD, XBT, SUR, APB, MRB, PFL, DRB, UOR, GLD)

If a "Reference/SST" is used to estimate SST set SI according to the "Instrument for reference temperature, secondary header", SECHEAD(40), if it exists, as follows:

IMMA1 SI setting	NODC Code 0615	Description
0	1	Bucket
1	10	Engine intake
3	9	Hull contact sensor
11	3	Reversing thermometer

All "Reference/SSTs" with non-extant "instrument for reference temperature" or with "instruments for reference temperature" not on the above list have SI = missing.

- N, total cloud amount, SECHEAD(28) of secondary header in wodFOR.f, returns the same code as used in [LMR](#), i.e. WMO 2700 or equivalently NODC 0105; not extant in wodSUR.f.
- NH, HI, H, CM, CH – are not set
- CL, WOD13 has a single cloud type code (WMO 0500), this code is not uniquely translatable to the 3-level (low, middle, high) cloud type fields in IMMA1 so this value is not set.

- WD wave direction code matches IMMA1 format (WMO 0877) for values of 0 through 36, SECHEAD(18) of secondary header in wodFOR.f; not extant in wodSUR.f.
 - WD = 37, if SECHEAD(18) = 49
 - WD = 38, if SECHEAD(18) = 99
- WP, WOD13 is a combination of two codes that numerically overlap, but have very different meanings. The codes are NODC 0378 and WMO 3155. These codes are the same as shown in Tables 10 and 11 in the [LMR](#) description, but no indication of similar rules are available for the WOD13. It is likely, but not certain, that the same rules apply. Furthermore, WOD13 does not include SP (swell period) or any data specifically for swell waves. It may be the case that WP in the WOD13 is some convoluted mix of local wind wave period and swell period. No other documentation is available. Do NOT translate WP from the WOD13.
- WH, wave height in a 0.5-meter interval scale like IMMA1 requires, i.e. WMO (1555), SECHEAD(17) of secondary header in wodFOR.f; not extant in wodSUR.f. The WOD13 scale is truncated at code = 26.
 - WH = SECHEAD(17), if $1 \leq \text{SECHEAD}(17) \leq 26$
 - WH = FERR/FMISS, if $\text{SECHEAD}(17) \geq 27$
- SD, SP, SH – are not set

Icoads attachment, Table C1

- ATTI = 1
- ATTL = 65
- B10, B1 – leave to be filled in later
- DCK = 780 NODC/OCL World Ocean Database (WOD) (and formerly Atlas, WOA).
DCK = 782 for GOSUD.
- SID = 149 NODC/OCL 2013 World Ocean Database (WOD13) updated through 24-02-2015.
SIDs for GOSUD
 - 162 - GOSUD v3 real-time data from NCEI in WOD format received 30 April
 - 163 - GOSUD v3 near real-time data from NCEI in WOD format received 30 April 2015

- 164 - GOSUD delayed-mode French research vessels and sailing ship data from NCEI in WOD format received 30 April 2015
- 159 - Global Ocean Surface Underway Data (GOSUD v2) from NCEI in WOD format received 19 May 2015
- PT, (nnn) are the WOD13 data file type names, see Table 2
 NODC-rpt22_WOD13
 5 = ship (SUR)
 6 = moored buoy (MRB)
 7 = drifting buoy (DRB)
 10 = oceanographic station data (bottle and low-resolution CTD/XCTD data) (OSD)
 11 = mechanical/digital/micro bathythermograph (MBT)
 12 = expendable bathythermograph (XBT)
 17 = high-resolution Conductivity-Temp.-Depth (CTD)/Expendable CTD (XCTD) (CTD)
 18 = profiling float (PFL)
 19 = undulating oceanographic recorder (UOR)
 20 = autonomous pinniped bathythermograph (APB)
 21 = glider (GLD)

***Nocn* Attachment, Table C8**

- ATTI = 8
- ATTL = 104

OTV = Ocean Temperature Value, the profile value nearest to the surface. The maximum depth is 99.99m. This is the standard rule for all values in *Nocn*, except for the SUR dataset, which does not have an assigned depth.

Standard data quality checks for value/depth pairs

- o The whole station profile value flag IERROR(1) = 0 (accept value).
- o The QC flag for the selected depth IDERROR(Nval,0) = 0 (accept depth level)
- o The QC flag for the value at the selected depth IDERROR(Nval,1) = 0 (accept value)

An additional check of the number of significant digits in a field is necessary to assure a valid value exists. ERROR values can be found set equal to zero and the data field is empty, i.e. number of significant digits = 0. **Set to MISSING if value is out of valid data range.**

- OTZ = Ocean Temperature Value Depth, the sample depth, positive value in meters, of the OTV. For SUR data type the depth field is either set = 0 or missing - these data are carried forward as specified. **Set OTZ to missing if it's OTV value is missing.**

- OSV = Salinity Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
- OSZ = Salinity Value Depth
- OOV = Oxygen Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
 - In the WOD the calibration indicator is Code 16 of the variable-specific secondary header. If the variable-specific secondary header ID = 16 (uncalibrated) has value = 1, meaning uncalibrated data, set value to missing. The variable-specific second header ID information is not passed back in wodSUR.f; therefore it is not checked for SUR.

Note: From NODC we were warned about the possibility of negative values for uncalibrated nutrient measurements. In fact, we did not find any in WOD09 OSDO. Nevertheless, we will continue to check for WOD13 and discard them if found.

- OOO = Oxygen Value Depth
- OPV = Phosphate Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
 - If uncalibrated set value to missing, as for Oxygen Value.
- OPZ = Phosphate Value Depth
- OSIV = Silicate Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
 - If uncalibrated set value to missing, as for Oxygen Value.
- OSIZ = Silicate Value Depth
- ONV = Nitrate Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
 - If uncalibrated set value to missing, as for Oxygen Value.
 - Check Code 17 of the variable-specific secondary header, if it is set to 1 the value is actually nitrate + nitrite. In this case set ONV to missing.
- ONZ = Nitrate Value Depth
- OPHV = pH Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
 - If uncalibrated set value to missing, as for Oxygen Value.
- OPHZ = pH Value Depth
- OCV = Total Chlorophyll Value

- Apply same data quality checks for Value/Depth pairs as for OTV
 - If uncalibrated set value to missing, as for Oxygen Value.
- OCZ = Total Chlorophyll Value Depth
- OAV = Alkalinity Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
 - If uncalibrated set value to missing, as for Oxygen Value.
- OAZ = Alkalinity Value Depth
- OPCV = Partial Pressure of Carbon Dioxide Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
 - If uncalibrated set value to missing, as for Oxygen Value.
- OPCZ = Partial Pressure of Carbon Dioxide Value Depth
- ODV = Dissolved Inorganic Carbon Value
 - Apply same data quality checks for Value/Depth pairs as for OTV
 - If uncalibrated set value to missing, as for Oxygen Value.
- ODZ = Dissolved Inorganic Carbon Value
- PUID = Provider's Unique Record Identification, unique cast number, Primary Header (5), variable jj in wodFOR.f and wodSUR.f. The cast number is an integer and it is converted to character string and then it is left justified in the 10 character field. Note about 10% of the APB data type do not have an assigned unique cast number. PUID is missing in these cases.