Variables and Units

VARIABLES AND UNITS USED IN THE EDMS

Data held in the EDMS are usually archived in the units specified by the International System of Units, commonly known by the French abbreviation "SI" (*Système International d'unités*). However, instruments frequently do not measure data in these same units, making conversion necessary. In addition, many variables have traditionally been recorded in non-SI units and their use remains common in the scientific community. For the sake of simplicity, these traditional units are archived (water column pressure in decibars is a good example).

Below we give information on the most common variables measured, the units they are reported in, and unit conversions (including some units that were formerly used but that are now obsolete). The list is not exhaustive; if additional information is needed, there are many on-line sites available that are dedicated to unit conversion (e.g., http://physics.nist.gov/cuu/index.html or http://www.digitaldutch.com/unitconverter/).

We also include methods for converting latitude and longitude to decimal degrees and local time to GMT.

TIME–SPACE INFORMATION

» Time (archived in UTC)
UTC (Universal Time Coordinate) or Z time (Z for zero meridian or Zulu time). Before 1972, universal time was known as Greenwich Mean Time (GMT), but this term is no longer in use. Convert local time to UTC by adding the offset in the western hemisphere and subtracting it in the eastern hemisphere. Don't forget that changing times around midnight might also result in a change of the date.

Note: the Uniform Time Act of 1966: daylight saving time to begin on the last Sunday of April until the last Sunday of October; in 1986, it changed to begin on the first Sunday in April. Starting in 2007, daylight time will begin on the second Sunday in March and end on the first Sunday in November.

Standard time:			
Eastern	EST	+5 h	= UTC
Atlantic	AST	+4 h	= UTC
Newfoundland	NST	+3.5 h	= UTC
Daylight time:			
Eastern	EDT	+4 h	= UTC
Atlantic	ADT	+3 h	= UTC
Newfoundland	NDT	+2.5 h	= UTC

examples: 08:00 EST + 5 hours => 13:00 UTC; 16-May-2000 20:00:00 EDT + 4 hours => 17-May-2000 00:00:00 UTC

To indicate local time, specify a positive offset west of 0° longitude and a negative offset east of 0° longitude. For example, to indicate Eastern Standard Time, one would specify –05:00.

» Position (archived in decimal degrees)

By convention, latitude north and longitude east are positive.

- degrees + (minutes.mm / 60) = decimal degrees
  example: 45°45.0' W = –45.750°
- degrees + (minutes + (seconds.ss/60))/60 = decimal degrees
  example: 45°30'30.0'' N = 45.50833°
- to convert decimal degrees to degrees minutes.mmm, multiply the decimal portion by 60 to get decimal minutes
  example: 45.2500°N = 45+(0.25*60) = 45°15.0'

ENVIRONMENTAL INFORMATION (weather and sea conditions)

» Air temperature (archived in °C)
°C = (°F-32)*(5/9)
example: (50°F-32)*(5/9) = 10°C

» Atmospheric pressure (archived in hectopascals, hPa)
millibars (mb) ≡ hPa
1 atm=101325 Pa = 760 mm Hg = 1013.25 hPa = 1013.25 mb = 29.921261 in Hg
in of mercury * 33.86388 = mb = hPa

» Cloud cover (World Meteorological Organization [WMO] code table 2700 for recording cloud amount)
To use this table, the sky is divided either into eighths ("okta") or tenths and the cloud cover is estimated.

Code		Cloud cover
0	Zero	Zero
1	1 okta or less, but not zero	1/10 or less, but not zero
2	2 oktas	2/10 to 3/10
3	3 oktas	4/10
4	4 oktas	5/10
5	5 oktas	6/10
6	6 oktas	7/10 to 8/10
7	7 oktas or more, but not 8 oktas	9/10 or more, but not 10/10
8	8 oktas	10/10
9	Sky obscured, or cloud amount cannot be estimated	

» Sea state (WMO code table 3700 for recording sea state)

Code	Description	Wave height (m)
0	Calm-glassy	0
1	Calm-rippled	0–0.1
2	Smooth-wavelet	0.1–0.5
3	Slight	0.5–1.25
4	Moderate	1.25–2.5
5	Rough	2.50–4
6	Very rough	4–6
7	High	6–9
8	Very high	9–14
9	Phenomenal	>14

» Secchi disk depth (archived in m)
A measure of water clarity

» Wind speed estimation: the Beaufort Wind Scale (marine)
The Beaufort Scale was originally developed in 1805 by Sir Francis Beaufort as a system for estimating wind strengths without the use of instruments. It is still in use for this same purpose as well as to tie together various components of weather (wind strength, sea state, observable effects) into a unified picture.

Even though the Beaufort Scale is not used in the EDMS archive, we include it here to dispel any confusion between it and the WMO code table 3700, which we use for describing sea state.

Force	Wind speed		Marine Conditions
	knots	mph	
0	<1	<1	Calm, sea like a mirror
1	1-3	1-3	Light air, ripples only
2	4-6	4-7	Light breeze, small wavelets (0.2m), crests have a glassy appearance
3	7-10	8-12	Gentle breeze, large wavelets (0.6m), crests begin to break
4	11-16	13-18	Moderate breeze, small waves (1m), some white caps
5	17-21	19-24	Fresh breeze, moderate waves (1.8m), many white caps
6	22-27	25-31	Strong breeze, large waves (3m), probably some spray
7	28-33	32-38	Near gale, mounting sea (4m) with foam blown in streaks downwind
8	34-40	39-46	Gale, moderately high waves (5.5m), crests break into spindrift
9	41-47	47-54	Strong gale, high waves (7m), dense foam, visibility affected
10	48-55	55-63	Storm, very high waves (9m), heavy sea roll, visibility impaired. Surface generally white
11	56-63	64-73	Violent storm, exceptionally high waves (11m), visibility poor
12	64+	74+	Hurricane, 14m waves, air filled with foam and spray, visibility bad

» Wind speed (archived in m s^{-1})
knots * 0.514 = m s^{-1}
knots*1.151=mph; mph*0.86=knots; mph*0.45=m/sec

» Wind direction (archived in degrees)
The wind direction is by convention the direction from which the wind blows and is measured as degrees from true north.
0: wind from the north; 90: from the east; 180: from the south; 270: from the west

PHYSICAL PROPERTIES

The most common physical variables held in the EDMS archive include:

» Altimeter (archived in m)
Distance of the instrument off-bottom

» Conductivity (archived in mho m^{-1}; ≡ S m^{-1})
Siemens (S) were formerly called “mho”; mho are still commonly used. Siemens are the reciprocal of ohms: 1 ohm = 1/S.

» Current components (archived in m s^{-1})
The north-south (V) component is positive toward the geographic north.
The east-west (U) component is positive toward the east.

» Current direction (archived in degrees)
By convention, current direction is the direction toward which the current flows, measured in degrees from true or magnetic north.
0: current flowing toward the north; 90: flowing toward the east; 180: flowing toward the south; 270: flowing toward the west

» Current direction; magnetic declination (archived in degrees)
The angle between the magnetic and geographical meridians at any place, expressed in degrees east or west to indicate the direction of magnetic north from true north.

» Density (archived in kg m^{-3})
Density of seawater

» Density, sigma-t (archived in kg m^{-3})
Sigma-t = the density of seawater – 1000 kg m^{-3}

» Depth (archived in m)
1 fathom=6 feet=1.8288 m

» Descent rate (archived in m s^{-1}) of the profiler (e.g., a ctd)

» Fluorescence (archived in mg m^{-3})
An index of the amount of chlorophyll in the water

» Oxygen (archived in mL L^{-1})
The amount of oxygen dissolved in the seawater. It can be expressed in many different units (e.g., mg L^{-1}, mL L^{-1}, µmol kg^{-1}, % saturation; see the section "substance concentrations" for unit conversions). The unit used most frequently is mL L^{-1}. The percent saturation corresponds to the measured value divided by the value for 100% saturation of oxygen in seawater (calculated from water temperature and salinity) multiplied by 100.

» Oxygen sensor current (archived in µA)
Older oxygen sensors used sensor current and sensor temperature to calculate dissolved oxygen.

» Oxygen sensor temperature (archived in °C)
Older oxygen sensors used sensor current and sensor temperature to calculate dissolved oxygen.

» PAR radiation (Photosynthetically Active Radiation; archived in µE s^{-1} m^{-2})
Units currently used include moles, einsteins (E), photons, and quanta:
1 µmol s^{-1} m^{-2} ≡ 1 µeinstein s^{-1} m^{-2} ≡ $6.02*10^{17}$ photons s^{-1} m^{-2} = $6.02*10^{17}$ quanta s^{-1} m^{-2}

» Pressure (archived in db, decibars) depth=pressure*1.019716 in freshwater; saltwater conversion is more complicated (it takes latitude into consideration)

» Salinity (unitless)
The calculation of salinity is a ratio so there are no units. One will frequently see salinity (incorrectly) recorded in units of "PSU" to indicate "practical salinity unit," making reference to the Practical Salinity Scale 1978 (PSS78).

» Temperature (archived in °C)
The calculation of temperature is based on the International Temperature Scale of 1990 (ITS-90) or the International Practical Temperature Scale of 1968 (ITPS-68).
°C (ITS-90) = °C (ITPS-68)/1.00024

» Transmissometer (archived in %)
Measurement of light transmission (index of the concentration of suspended matter)

SUBSTANCE CONCENTRATIONS

Data from bottle samples. The SI unit for the amount of a substance is mole, abbreviated as "mol."

» Dissolved oxygen (archived in mL L^{-1}; SI unit is mmol m^{-3})
mL L^{-1} * 44.66 = mmol m^{-3} = µM
mL L^{-1} = mg L^{-1} * (1 mL / 1.42903 mg) (≈same as mg/L *0.70)
mg L^{-1} = mL L^{-1} * 1.42903 mg mL^{-1}
mg L^{-1} ≈ mg kg^{-1}
mg L^{-1} ≈ ppm
mL O_2 L^{-1} = 11.2 * mg-atoms O_2 L^{-1}
mg O_2 L^{-1} = 16.0 * mg-atoms O_2 L^{-1}

» Nutrients (archived in mmol m^{-3})
The most common nutrients measured are nitrite, nitrate + nitrite, phosphate, and silicate.
µmol L^{-1} = mmol m^{-3}
M ≡ gram molecular weight per liter (or molar concentration)
µg-atoms L^{-1} ≡ mg-atoms m^{-3} ≡ µM≡ µmol L^{-1} ≡ mmol m^{-3}
µg L^{-1} = mg m^{-3}
ppm ≈ mg L^{-1}
ppb ≈ µg L^{-1}
µg L^{-1} / atomic mass = µg-atoms L^{-1}
µg L^{-1} / molecular mass = µM = µmol L^{-1}
1 mole = $6.023*10^{23}$ molecules

» Particulate matter
- unspecified or complex compounds (including chlorophyll) (precise molecular mass unknown):
  mg m^{-3} = µg L^{-1}
  mg L^{-1} = g m^{-3}
- POC (particulate organic carbon): (µg L^{-1})/12.01 = mmol m^{-3} (archived in mmol m^{-3})
- PON (particulate organic nitrogen): (µg L^{-1})/14.01 = mmol m^{-3} (archived in mmol m^{-3})

QUALITY FLAGS *(following the Global Temperature-Salinity Pilot Project [GTSPP] system)*

0: No quality control (QC) has been performed on the value
1: QC performed, value appears correct
2: QC performed, value appears inconsistent with other values
3: QC performed, value appears doubtful
4: QC performed, value appears erroneous
5: Value has been changed as a result of QC
6-8: Reserved for future use
9: Value of the parameter is missing

MISCELLANEOUS

1 degree of latitude = 60 nautical miles
1 minute of latitude = 1 nautical mile = 1852 m
1 nautical mile = 1.85 km = 1.15 statute miles
1 fathom = 6 feet = 1.83 m
1 knot = 1 nautical mile per hour