NAME

mbabsorption – calculates the absorption of sound in sea water in dB/km as a function of frequency, temperature, salinity, sound speed, and depth.

VERSION

Version 5.0

SYNOPSIS

mbabsorption [**–C***soundspeed* **–D***depth* **–F***frequency* **–P***ph* **–S***salinity* **–T***temperature* **–V –H**]

DESCRIPTION

mbabsorption – calculates the absorption of sound in sea water in dB/km as a function of frequency (kHz), temperature (degrees C), salinity (per mil), depth (m), pH, and water sound speed (m/sec).

We use the Francois and Garrison equations from:

```
Francois, R.E., Garrison, G.R., "Sound absorption based
  on ocean measurements: Part I: Pure water and magnesium
  sulfate contributions", J. Acoust. Soc. Am., 72(3),
  896-907, 1982.
Francois, R.E., Garrison, G.R., "Sound absorption based
  on ocean measurements: Part II: Boric acid contribution
  and equation for total absorption", J. Acoust. Soc. Am.,
  72(6), 1879-1890, 1982.
```

Francois and Garrison [1982] model the sound absorption in sea water as resulting from contributions from pure water, magnesium sulfate, and boric acid. The boric acid contribution is significant below 10 kHz. The equations are:

```
absorption = Boric Acid Contribution
                + MbSO4 Contribution
                + Pure Water Contribution
```

Boric Acid Contribution:

```
AlphaB = Ab * Pb * Fb * f**2
        –------------------
          f**2 + Fb**2

Ab = 8.86 / c * 10**(0.78 * pH – 5) (dB/km/kHz)
Pb = 1
Fb = 2.8 * (S / 35)**0.5 * 10**(4 – 1245 / Tk) (kHz)
```

MgSO4 Contribution:

```
AlphaM = Am * Pm * Fm * f**2
        –------------------
          f**2 + Fm**2
Am = 21.44 * S * (1 + 0.025 * T) / c (dB/km/kHZ)
Pm = 1 – 0.000137 * D + 0.0000000062 * D**2
Fm = (8.17 * 10**(8 – 1990 / Tk)) / (1 + 0.0018 * (S – 35))  (kHz)
```

Pure Water Contribution:

```
AlphaW = Aw * Pw * f**2
```

For T <= 20 deg C
  Aw = 0.0004397 − 0.0000259 * T
        + 0.000000911 * T**2 − 0.000000015 * T**3 (dB/km/kHz)
For T > 20 deg C
  Aw = 0.0003964 − 0.00001146 * T
        + 0.000000145 * T**2 − 0.00000000049 * T**3 (dB/km/kHz)
Pw = 1 − 0.0000383 * D + 0.00000000049 * D**2

Parameters:
f = sound frequency (kHz)
c = speed of sound (m/s)
T = temperature (deg C)
Tk = temperature (deg K) = T + 273 (deg K)
S = salinity (per mil)
D = depth (m)

If the speed of sound is not specified by the user, it will be calculated from temperature, salinity, and depth using:
c =˜ 1412 + 3.21 * T + 1.19 * S + 0.0167 * D

Normally, **mbabsorption** simply prints the resulting absorption value to stdout. If the **−V** option is specified, the output will include a listing of the parameters used in calculating the absorption.

AUTHORSHIP

David W. Caress (caress@mbari.org)
  Monterey Bay Aquarium Research Institute
Dale N. Chayes (dale@ldeo.columbia.edu)
  Lamont-Doherty Earth Observatory

OPTIONS

−H This "help" flag cause the program to print out a description of its operation and then exit immediately.

−C *soundspeed*
Specifies the water sound speed in m/sec. If the option is not used, the water sound speed will be calculated from the temperature, salinity, and depth.

−D *depth*
Sets the depth in meters at which the sound absorption should be calculated. Default: *depth* = 0.0 m (i.e. the sea surface).

−F *frequency*
Sets the sound frequency in kHz at which the sound absorption should be calculated. Default: *frequency* = 200 kHz.

−P *ph*
Sets the pH value at which the sound absorption should be calculated. Default: *ph* = 8.

−S *salinity*
Sets the salinity in per mil at which the sound absorption should be calculated. Default: *salinity* = 35 per mil.

−T *temperature*
Sets the temperature in degrees C at which the sound absorption should be calculated. Default: *temperature* = 10.0 degrees C.

−V Normally, **mbabsorption** outputs only a single absorption value to the stdout stream. If the **−V** flag is given, then **mbabsorption** works in a "verbose" mode and also outputs the parameters used to calculate the absorption.

EXAMPLES

Suppose that one wishes to obtain the water sound absorption for a 200 kHz multibeam sonar operating at a depth of 1000 meters (on an AUV, for instance) in water with a salinity of 35 per mil, a pH of 8, and a temperature of 4 degrees C. The following will suffice:

```
mbabsorption –D1000 –F200 –P8 –S35 –T4
```

The output will be:

```
 37.692561
```

In order to obtain a more readable result, use the **–V** option:

```
mbabsorption –D1000 –F200 –P8 –S35 –T4 –V
```

The output will be:

```
 Program MBabsorption
 Version $Id: mbabsorption.ps 2191 2014-06-05 00:59:01Z caress $
 MB-system Version 5.1.1beta15

 Input Parameters:
     Frequency:        200.000000 kHz
     Temperature:      4.000000 deg C
     Salinity:         35.000000 per mil
     Depth:            1000.000000 m
     pH:               8.000000
 Result:
     Sound absorption: 37.692561 dB/km
```

SEE ALSO

mbsystem(1)

BUGS

None known.