A new equation for the accurate calculation of sound speed in all oceans

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A new equation is proposed for the calculation of sound speed in seawater as a function of temperature, salinity, depth, and latitude in all oceans and open seas, including the Baltic and the Black Sea. The proposed equation agrees to better than 􏰆0.2 ms with two reference complex equations, each fitting the best available data corresponding to existing waters of different salinities. The only exceptions are isolated hot brine spots that may be found at the bottom of some seas. The equation is of polynomial form, with 14 terms and coefficients of between one and three significant figures. This is a substantial reduction in complexity compared to the more complex equations using pressure that need to be calculated according to depth and location. The equation uses the 1990 universal temperature scale (an elementary transformation is given for data based on the 1968 temperature scale). It is hoped that the equation will speed in applications of marine acoustics.

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*Expanded for C programming*

C = 1402.5 + (5\*T) – (5.44e-2 \* T\*T) + (2.1e-4 \* T\*T\*T) + 1.33\*S – (1.23e-2 \* S \* T) + (8.7e-5 \* S \* T\*T) // first order for small depths

+ (1.56e-2 \* Z) + (2.55e-7 \* Z\*Z) − (7.3e-12 \* Z\*Z\*Z) // first order depth correction, max +4.70 m/s @ 300 m

+ (1.2e-6 \* Z \* (Θ – 45) ) − (9.5e-13 \* T \* Z\*Z\*Z) // second order latitude/temperature/depth, max +/- .004 m/s @ 300m over latitude 0° to 90°

+ (3e-7 \* T\*T \* Z) + (1.43e-5 \* S \* Z) // third order temperature/salinity/depth, max + .29 m/s @ 40°C, 35ppt, 300m

*Using First Order Depth Correction (max error at 300m over entire temperature and salinity range < .32 m/s)*

C = 1402.5 + (5\*T) – (5.44e-2 \* T\*T) + (2.1e-4 \* T\*T\*T) + 1.33\*S – (1.23e-2 \* S \* T) + (8.7e-5 \* S \* T\*T) + (1.56e-2 \* Z)

*Where C = sound speed in m/s, T = temperature in °C, S = salinity in ppt, Z = depth in meters*

For T = 19°C, Z = 0m, S = 0ppt:

C = 1402.5 + (5\*19) – (5.44e-2 \* 361) + (2.1e-4 \* 6859), or C = 1402.5 + 95 – 19.64 + 1.44, or C = 1480.3 // compare to 1479 from Del Grosso, 1972