Gravitational Acceleration

The gravitational acceleration g in the ocean can be taken to be the following function of latitude ϕ and sea pressure p, or height z relative to the geoid,

$$
\begin{aligned}
g/(\mathrm{m\ s^{-2}}) &= 9.780\ 327\left(1 + 5.3024x10^{-3}\sin^2\phi - 5.8x10^{-6}\sin^2 2\phi\right)\left(1 - 2.26x10^{-7}\ z/(\mathrm{m})\right) \\
&= 9.780\ 327\left(1 + 5.2792x10^{-3}\sin^2\phi + 2.32x10^{-5}\sin^4\phi\right)\left(1 - 2.26x10^{-7}\ z/(\mathrm{m})\right) \qquad \text{(D.3)} \\
&\approx 9.780\ 327\left(1 + 5.2792x10^{-3}\sin^2\phi + 2.32x10^{-5}\sin^4\phi\right)\left(1 + 2.22x10^{-7}\ p/(\mathrm{dbar})\right).
\end{aligned}
$$

The dependence on latitude in Eqn. (D.3) is from Moritz (2000) and is the gravitational acceleration on the surface of an ellipsoid which approximates the geoid. The variation of g with z and p in the ocean in Eqn. (D.3) is derived in McDougall *et al*. (2010b). The height z above the geoid is negative in the ocean. Note that g increases with depth in the ocean at about 71.85% of the rate at which it decreases with height in the atmosphere.

At a latitude of $45°\mathrm{N}$ and at $p = 0$, $g = 9.8062\ \mathrm{m\ s^{-2}}$, which is a value commonly used in ocean models. The value of g averaged over the earth's surface is $g = 9.7976\ \mathrm{m\ s^{-2}}$, while the value averaged over the surface of the ocean is $g = 9.7963\ \mathrm{m\ s^{-2}}$ (Griffies (2004)).