

Corrections to 2006 Edition of Fundamentals of Geophysical Fluid Dynamics  
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Note: Some corrections were made in the 2008 printing, and more were made in the 2011 printing.

- Page 9, last line: replace the clause “and  $m\mathbf{x}a$  is momentum” with “the time derivative of velocity  $v$ , and  $mv$  is momentum”.
- Page 10, second line before (2.3): change “acceleration of a fluid parcel” to “time derivative”
- Page 20, Fig. 2.4: the sign symbol should be changed from “+” to “-” in the center of the right panel and “positive  $\chi$ ” should be changed to “negative  $\chi$ ” in the caption.
- Page 28, line 5: the pressure unit is equal to “ $10^5$  Pa” not “1 Pa”.
- Page 54, equation (3.17), last line, and equation (3.18): insert minus sign on right-hand side.

$$\begin{aligned}\frac{dC}{dt} &= - \int_C \frac{1}{\rho} \nabla p \cdot d\mathbf{s} + \dots \\ &= - \int \int_A \hat{\mathbf{n}} \cdot \nabla \times \left[ \frac{1}{\rho} \nabla p \right] dA + \dots \\ &= - \int \int_A \frac{1}{\rho^2} \hat{\mathbf{n}} \cdot \nabla p \times \nabla \rho dA + \dots .\end{aligned}\quad (3.17)$$

$$\frac{dC}{dt} = - \int \int_A \frac{\hat{\mathbf{z}}}{\rho_0^2} \cdot \nabla_h p \times \nabla_h \rho dx dy + \dots .\quad (3.18)$$

- Page 65, equation (3.60): the final right-hand parenthesis in the third line should be deleted to become:

$$\begin{aligned}\zeta(\mathbf{x}, t) &= \sum_{\alpha=1}^N C_\alpha \delta(\mathbf{x} - \mathbf{x}_\alpha) \\ \psi(\mathbf{x}, t) &= \frac{1}{2\pi} \sum_{\alpha=1}^N C_\alpha \ln |\mathbf{x} - \mathbf{x}_\alpha| \\ \mathbf{u}(\mathbf{x}, t) &= \frac{1}{2\pi} \sum_{\alpha=1}^N \frac{C_\alpha}{|\mathbf{x} - \mathbf{x}_\alpha|^2} [-(y - y_\alpha)\hat{\mathbf{x}} + (x - x_\alpha)\hat{\mathbf{y}}].\end{aligned}\quad (3.60)$$

*[This correction was made in the 2008 Edition.]*

- Page 66, equation (3.67): replace it with

$$p_\alpha = |C_\alpha|^{1/2} x_\alpha, \quad q_\alpha = |C_\alpha|^{-1/2} C_\alpha y_\alpha .\quad (3.67)$$

and make the prefactor for  $H$  be  $1/4\pi$  in (3.69), instead of  $1/2\pi$ .

- Page 73, first line after equation (3.72): the sentence should begin "Introducing (3.72) into (3.30) and ..."; i.e., the reference previously was (3.24), but should be (3.30).

- Page 74, equation after (3.77): delete one of the  $r$  factors in the right-side integral:

$$\int_0^\infty g^* \partial_r [r \partial_r g] dr = - \int_0^\infty r (\partial_r g^*) (\partial_r g) dr$$

- Page 74-75, bottom and top lines: replace parenthetical remark with "(since the point in  $x$  where  $\partial_x \bar{\zeta} = 0$  in a parallel flow is an inflection point for the velocity profile,  $\partial_{xx} \bar{v} = 0$ )"

**bullet** Page 76, equation (3.85), the factor of 2 in  $\gamma^2$  should be in the numerator not denominator:

$$\gamma^2 = \frac{2}{r^3} \bar{A} \frac{d\bar{A}}{dr} \Big|_{r=r_o} . \quad (3.85)$$

- Page 77, equation (3.91): there is a typographic error, and after its removal the formula is

$$s^2 = \left( \frac{kU}{2} \right)^2 \left( 2 \frac{1 + (1 - [kD]^{-1}) \tanh[kD]}{kD(1 + \tanh[kD])} - 1 \right) . \quad (3.91)$$

- Page 85, equation (3.106): a  $\nabla$  symbol needs to be inserted into the second left-side term to become:

$$\frac{\partial \bar{\tau}}{\partial t} + \bar{\mathbf{u}} \cdot \nabla \bar{\tau} = - \nabla \cdot (\bar{\mathbf{u}}' \bar{\tau}') .$$

*[This correction was made in the 2008 Edition.]*

- Page 85, equations (3.107)-(3.108): move last line in the former to start of latter and put a factor of  $1/2$  into the final line to become:

$$\begin{aligned} \overline{\mathbf{u}' \tau'} &\approx - \overline{\mathbf{u}' (\mathbf{r}' \cdot \nabla) \bar{\tau}} \\ &= - \frac{d\bar{\mathbf{r}}'}{dt} (\mathbf{r}' \cdot \nabla) \bar{\tau} . \end{aligned} \quad (3.107)$$

and

$$\frac{dr^{i'}}{dt} r^{j'} = \frac{1}{2} \frac{d}{dt} r^{i'} r^{j'} = \kappa_e \delta_{i,j} , \quad (3.108)$$

- Page 124, Fig. 4.11: The two dotted sloping lines connecting the middle equal-height points on the front and rear side of the wave form have the same propagation velocity  $V_+(\xi_+)$ , hence the same slope. The revised figure below depicts this feature more accurately.

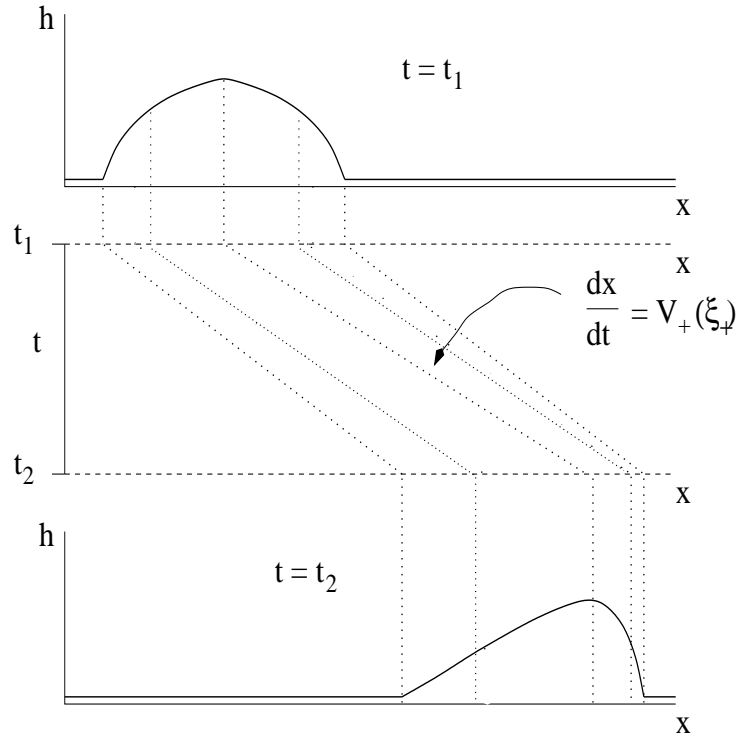


Fig. 4.11. Nonlinear evolution for an isolated, shallow-water, gravity wave of elevation. The wave shape at the earlier time ( $t = t_1$ ; top) evolves into the shape at a later time ( $t = t_2$ ; bottom) that has a shallower slope on its backward face and a steeper slope on its forward face. This example is for a rightward propagating wave. The characteristic coordinate,  $\xi_+$ , remains constant for each point on the wave, but its associated velocity,  $V_+$ , is larger where the elevation is higher (shown by the line slopes in the middle diagram).

- Page 125, top line of text (below Fig. 4.12): The coordinate relations are “ $x_1 < X < x_2$ ”, not the reverse.
- Page 126-127, equations (4.92) and (4.97): In the expressions for  $\mathbf{u}_h$  and  $\mathbf{r}'_h$ , cancel the  $g$  factors in numerator and denominator, and change the sign of the term  $\propto f$ .

$$\begin{aligned}
 \eta &= \eta_0 \cos[\Theta] \\
 \mathbf{u}_h &= \frac{\eta_0}{HK^2} (\omega \mathbf{k} \cos[\Theta] + f \hat{\mathbf{z}} \times \mathbf{k} \sin[\Theta]) \\
 w &= \frac{\omega \eta_0 z}{H} \sin[\Theta] , \qquad (4.92)
 \end{aligned}$$

and

$$\begin{aligned}
 \mathbf{r}'_h &= -\frac{\eta_0}{HK^2} \left( \mathbf{k} \sin[\Theta] - \frac{f}{\omega} \hat{\mathbf{z}} \times \mathbf{k} \cos[\Theta] \right) , \\
 r^{z'} &= \frac{\eta_0 z}{H} \cos[\Theta] . \qquad (4.97)
 \end{aligned}$$

- Page 128, first unnumbered equation: The expression to the right of the arrow has a factor of  $1/2$ , *i.e.*,

$$\mathbf{u}^{st} \rightarrow \sqrt{\frac{g}{H}} \frac{\eta_0^2}{2H} \left( \frac{\mathbf{k}}{K} \right) = \frac{u_{h0}^2}{2\sqrt{gH}} \left( \frac{\mathbf{k}}{K} \right),$$

- Page 129, first line of equation (4.103): There are two horizontal gradient operators, *i.e.*,

$$\begin{aligned} -\overline{\mathbf{u}'_h \cdot \nabla_h \tau'} &= \overline{(\mathbf{u}'_h \cdot \nabla_h) \left( \int^t \mathbf{u}'_h dt \right) \cdot \nabla_h \bar{\tau}} \\ &\approx -\overline{\left( \left( \int^t \mathbf{u}'_h dt \right) \cdot \nabla_h \right) \mathbf{u}'_h \cdot \nabla_h \bar{\tau}} \\ &= -\mathbf{u}^{st} \cdot \nabla_h \bar{\tau}. \end{aligned} \quad (4.103)$$

- Page 135, second line following equation (4.124): The symbol  $R$  should be formatted the same as the first symbol in (4.124) and as on the fifth line following equation (4.124), *i.e.*, approximately drawn as  $\mathcal{R}$ . [*This correction was made in the 2008 Edition.*]

- Page 151, equation (5.37): the prefactors for  $\tilde{\psi}_1$  should have square roots:

$$\begin{aligned} \psi_1 &= \tilde{\psi}_0 + \sqrt{\frac{H_2}{H_1}} \tilde{\psi}_1 \\ \psi_2 &= \tilde{\psi}_0 - \sqrt{\frac{H_1}{H_2}} \tilde{\psi}_1. \end{aligned} \quad (5.37)$$

- Page 156, first line in equation (5.52): The exponent should be  $n$ , not  $n + 1$ :

$$\bar{\psi}_n = (-1)^n U y$$

- Page 161, Fig. 5.6: remove the tilde symbols from the two layer streamfunctions in the third row of the figure, so they are  $\psi'_1$  and  $\psi'_2$ .

- Page 181, equation (5.103): The sign convention here for  $\mathbf{E}$  is the opposite of that used in Andrews, D.G., J.R. Holton, and C.B. Leovy, 1987: *Middle Atmosphere Dynamics*. Academic Press. [*This is a remark not a needed correction.*]

- Pages 198 (equation (6.30)), 199 (equation (6.33)), and 202 (equation (6.38), first line): the symbol  $f$  should be replaced by  $|f|$  in these specific formulas. Also, in equation (6.38), the equation for  $\bar{v}(z)$  should swap  $\cos[\lambda z]$  and  $\sin[\lambda z]$ .

$$h_{ek} = \lambda^{-1} = \sqrt{\frac{2\nu_e}{|f|}}. \quad (6.30)$$

$$\epsilon_{ek, bot} = \sqrt{\frac{|f|\nu_e}{2}} = \frac{|f|h_{ek}}{2} \quad (6.33)$$

$$\begin{aligned}
U(z) &= (1 - i\mathcal{S}_f) \frac{\tau_s^x + i\tau_s^y}{\rho_o \sqrt{2|f|\nu_e}} e^{\lambda(1+i\mathcal{S}_f)z} \\
\bar{u}(z) &= \frac{1}{\rho_o \sqrt{2|f|\nu_e}} e^{\lambda z} \left( (\tau_s^x + \mathcal{S}_f \tau_s^y) \cos[\lambda z] \right. \\
&\quad \left. + (\tau_s^x - \mathcal{S}_f \tau_s^y) \sin[\lambda z] \right) \\
\bar{v}(z) &= \frac{1}{\rho_o \sqrt{2|f|\nu_e}} e^{\lambda z} \left( (-\mathcal{S}_f \tau_s^x + \tau_s^y) \cos[\lambda z] \right. \\
&\quad \left. + (\mathcal{S}_f \tau_s^x + \tau_s^y) \sin[\lambda z] \right) , \tag{6.38}
\end{aligned}$$

- Page 238, Rotating shallow-water and wave dynamics, problem 7, fourth line: insert "zonal" before "velocity patch" so it becomes "; (c) a zonal velocity patch". [*This correction was made in the 2008 Edition.*]
- Page 239, Baroclinic and jet dynamics, problem 5, second line: insert "quasigeostrophic," before "baroclinic instability" so it becomes "quasigeostrophic, baroclinic instability of a mean flow." [*This correction was made in the 2008 Edition.*]
- Page 239-240, problem 8: We rotate the flow orientation to be consistent with the Answers. The equation in the third line should be changed from

$$\mathbf{u} = Sz\hat{\mathbf{y}}, \quad b = N^2z + fSx ,$$

to

$$\mathbf{u} = Sz\hat{\mathbf{x}}, \quad b = N^2z - fSy ,$$

The mean advection in the top two equations on p. 240 should be changed from  $V\partial_y$  to  $Sz\partial_x$ , and the factor in the last term in the vertical boundary condition should be changed from  $\partial_y\psi'$  to  $\partial_x\psi'$ . The new forms are

$$[\partial_t + Sz\partial_x]q' = 0 \quad \Rightarrow \quad q' = 0 ,$$

and

$$[\partial_t + Sz\partial_x]\partial_z\psi' - S\partial_x\psi' = 0$$

- Page 243, reference Holland, W.R. (1986), second line: The editor's name should be J.J. O'Brien. [*This correction was made in the 2008 Edition.*]