Errata for Numerical Methods for Fluid Dynamics: With Applications to Geophysics*

Dale R. Durran

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Chapter 1

• p. 28, line 4: “Chap. 2” should be “Chap. 3”

Chapter 2

• p. 38, text line 14: “$t_n$” should be “$\tau_n$”
• p. 39, second line in first equation after (2.12) is missing an “(”; it should begin

\[ = (1 + \lambda \Delta t) \]

• p. 39, last equality in (2.13) should be “\( \leq \)”
• p. 40, line 10: Replace “Define the amplification” with “For homogenous ODE, define the amplification”
• p. 40, 1st line after (2.15), Replace “$\eta = \lambda$ is just the coefficient of $\psi$ in the forcing $F(\psi, t)$.” with “$\eta = |\lambda|$.”
• p. 45, first equation after (2.24), both instances of $(\omega \Delta t)$ should be $(\omega \Delta t/2)$
• p. 53, first half of 2nd displayed equation: should read

\[ b_2 c_2^2 + b_3 c_3^2 = \frac{1}{3} \]

• p. 56, while not actually errata, I have been asked for the non-autonomous versions of (2.47)–(2.49). Here they are

\[
\begin{align*}
\phi_{(1)} & = \phi_n + \Delta t B(\phi_n, t_n), \\
\phi_{(2)} & = \phi_{(1)} + \Delta t B(\phi_{(1)}, t_n + \Delta t), \\
\phi_{n+1} & = \frac{1}{2} \left( \phi_n + \phi_{(2)} \right) \quad (2.47)
\end{align*}
\]

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\[ \begin{align*}
\phi_{(1)} &= \phi_n + \Delta t B(\phi_n, t_n), \\
\phi_{(2)} &= \frac{3}{4} \phi_n + \frac{1}{4} \left[ \phi_{(1)} + \Delta t B(\phi_{(1)}, t_n + \Delta t) \right], \\
\phi_{n+1} &= \frac{1}{3} \phi_n + \frac{2}{3} \left[ \phi_{(2)} + \Delta t B(\phi_{(2)}, t_n + \Delta t) \right].
\end{align*} \]  
(2.48)

\[ \begin{align*}
\phi_{(1)} &= \phi_n + \frac{1}{2} \Delta t B(\phi_n, t_n), \\
\phi_{(2)} &= \phi_{(1)} + \frac{1}{2} \Delta t B(\phi_{(1)}, t_n + \Delta t), \\
\phi_{(3)} &= \frac{2}{3} \phi_n + \frac{1}{3} \left[ \phi_{(2)} + \frac{1}{2} \Delta t B(\phi_{(2)}, t_n + \Delta t) \right], \\
\phi_{n+1} &= \phi_{(3)} + \frac{1}{2} \Delta t B(\phi_{(3)}, t_n + \Delta t),
\end{align*} \]  
(2.49)

- p. 58, 4th line: To avoid ambiguity, the last equality is better written as \( \alpha = 1 \pm \sqrt{2}/2 \). (Thanks to Greg Hammett for noting this.)

- pp. 69-70: The forcing in (2.80)–(2.83) should include explicit time dependence; for example, \( F(\phi_n) \) should be replaced by \( F(\phi_n, t_n) \)

- p. 70: Replace \( h \) in (2.81)–(2.83) by \( \Delta t \)

- p. 80; top 5 lines: Three instances of \( 1/2\sqrt{2} \) are less ambiguously written as \( \sqrt{2}/2 \)

- p. 81, 1st line: \( 1/2\sqrt{2} \) is less ambiguously written as \( \sqrt{2}/2 \)

- p. 86, problem 5: Replace text after the displayed equation with:

  Being centered in time, this method should be second order in \( \Delta t \). Show that the truncation error is indeed zero through \( O(\Delta t) \). \( \textbf{Hint:} \) note that if \( \psi' = F(\psi, t) \),

  \[ \psi'' = \frac{\partial F}{\partial \psi} \psi' + \frac{\partial F}{\partial t}. \]

**Chapter 3**

- p. 128, eqn 3.84: \( \Delta x^2 \) should be \( (\Delta x)^2 \)

- p. 129, text line 15: “unconditional instability” should read “unconditional stability”

- p. 133, eqn after 3.92, and following text line: \( A_{1f} \) should be \( A_{1f} \)

**Chapter 4**

- p. 170, footnote: Sect. 2.2.3 should be Sect. 2.1.2
p. 198, Hint for problem 3b: Compare the direction of the paths along which energy propagates, determined by the ratio of the vertical to the horizontal group velocity, in the limit where the vertical wavelength approaches $2\Delta z$. The temporal and horizontal resolution should be assumed to be greater than $4\Delta t$ and $4\Delta x$, respectively.

Chapter 5

p. 231, 2nd line in caption: “MS” should be “MC”

p. 256, first set of displayed equations should read:

$$P_{i,j}^+ = \left[ \max \left( 0, A_{i-\frac{1}{2},j} \right) - \min \left( 0, A_{i+\frac{1}{2},j} \right) \right] \Delta y$$
$$+ \left[ \max \left( 0, A_{i,j-\frac{1}{2}} \right) - \min \left( 0, A_{i,j+\frac{1}{2}} \right) \right] \Delta x,$$

$$P_{i,j}^- = \left[ \max \left( 0, A_{i+\frac{1}{2},j} \right) - \min \left( 0, A_{i-\frac{1}{2},j} \right) \right] \Delta y$$
$$+ \left[ \max \left( 0, A_{i,j+\frac{1}{2}} \right) - \min \left( 0, A_{i,j-\frac{1}{2}} \right) \right] \Delta x.$$  

p. 256, after last set of displayed equations add:

$$Q_{j}^+ = (\phi_j^{\max} - \phi_j^{td}) \frac{\Delta x \Delta y}{\Delta t}$$
$$Q_{j}^- = (\phi_j^{td} - \phi_j^{\min}) \frac{\Delta x \Delta y}{\Delta t}$$

p. 279, 2nd line of Prob. 10: the zero is redundant, the line could read

$$\text{sgn}(a) \max \left( \min(|a|, |b|), \min(2|a|, |b|) \right)$$

p. 279, 7th line from bottom: “forward” should be “upstream”

Chapter 6

p. 345, 4th displayed equation should read

$$\frac{\Delta x_j}{2} \frac{d a_k}{d t} = \sum_{n=0}^{N} F[\tilde{\phi}_j(\xi_n)] D_{k,n} w_n - \hat{F}(\tilde{\phi}_j, \tilde{\phi}_{j+1}) \delta_k N + \hat{F}(\tilde{\phi}_{j-1}, \tilde{\phi}_j) \delta_{0k},$$

p. 349, line 1: “$N = 5$” should be “5 nodes” (which is $N = 4$)

p. 349: both instances of “0.67” should be “0.69”

Chapter 8

p. 419, (8.78): replace $du/dt$ by $\partial u/\partial t$
• p. 419, (8.79): replace $dw/dt$ by $\partial w/\partial t$

• p. 419, 4th line from bottom: “$\alpha = 0.2$” should be “$\alpha = 0.5 \, \text{m}^2 \, \text{s}^{-2}$”

• p. 420, Fig. 8.2: replace lower of the two contour labels reading “9.8” by “10.2”. (The perturbation $u$ is anti-symmetric about $z = 0$.) Also the units for $\Psi$ should read “m$^2$ s$^{-2}$”.

• p. 421, Fig. 8.3: The units for $\Psi$ should read “m$^2$ s$^{-2}$”.

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