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

Dale R. Durran

February 5, 2015

Chapter 1

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

Chapter 2

• p. 38, text line 14: “t_n” should be “τ_n”

• p. 39, second line in first equation after (2.12) is missing an “(”; it should begin

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

• p. 39, last equality in (2.13) should be “≤”

• p. 40, line 10: Replace “Define the amplification” with “For homogenous ODE, define the amplification”

• p. 40, 1st line after (2.15), Replace “η = \lambda is just the coefficient of ψ in the forcing F(ψ, t).” with “η = |\lambda|.”

• p. 45, first equation after (2.24), both instances of (ωΔt) should be (ωΔt/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

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

---

*© Dale Durran
\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/2) \right].
\end{align*}

\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/2), \\
\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/2),
\end{align*}

(2.48)

(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 $O(\Delta t)$. 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: $A_{lfb}$ should be $A_{lft}$

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:

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

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

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

\[
Q_{j}^+ = (\phi_{j}^{\text{max}} - \phi_{j}^{\text{td}}) \Delta x \Delta y \Delta t \\
Q_{j}^- = (\phi_{j}^{\text{td}} - \phi_{j}^{\text{min}}) \Delta x \Delta y \Delta t
\]

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

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

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

Chapter 6

• p. 345, 4th displayed equation should read

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

• 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$^{-2}$”.

Numerical Methods for Fluid Dynamics
With Applications to Geophysics
Durran, D.R.
2010, XVI, 516 p., Hardcover