Purple: Additional errors discovered since the third printing

Blue: Corrections and additions (changes in black) corrected in the third printing

Red: Errors in the first printing corrected in the second printing

pXV (acknowledgments), four lines from the bottom, add Shu-Chih Yang and:
Shu-Chih Yang and Matteo…

Chapter 1

P15 , eq (1.4.3) R should not be to the minus 1 power

$\mathbf{W} = \mathbf{BH}^T(\mathbf{HBH}^T + \mathbf{R})^{-1}$

p29 last line 2nd para: Szunyogh

Chapter 2

P34 last line, add "dry" and onesentence:

…gas constant for dry air.For moist air this has to take into account the partial pressure of moist air,usually done by defining the virtual temperature $T_v \approx (1+0.6q)$, i.e., the dry air temperature having the same density asmoist air at the same pressure. This equation indicates…

p36

$$\frac{d\mathrm{k}}{dt} = \frac{u}{r\cos\varphi}\frac{\partial \mathrm{k}}{\partial\lambda} + \frac{v}{r}\frac{\partial \mathrm{k}}{\partial\varphi} = \frac{u\mathrm{i}}{r} + \frac{v\mathrm{j}}{r} \qquad \textbf{(2.2.1a)} \quad \textbf{ui/r}$$

Exercise 2.2.1: Use spherical geometry to show (2.2.1a).

Derive $d\mathbf{i}/dt = \dfrac{u}{r\cos\varphi}(\mathbf{j}\sin\varphi - \mathbf{k}\cos\varphi)$, and $d\mathbf{j}/dt = \dfrac{1}{r\cos\varphi}(-u\mathbf{i}\sin\varphi - v\mathbf{k}\cos\varphi)$ (2.2.2). (The second formula needsto be corrected, thanks to Kara Sedwick)

P39, Exercise 2.3.1, second line, replace p_0 by 1000hPa: $T\left(1000hPa/p\right)^{R/C_p}$

P41, lines 4 and 5, c_s should not be squared:

$v/k = \pm c_s$ line 4

$\partial v/\partial k = \pm c_s$ line 5

P42, line 4, replace $\partial p'/\partial z = -\gamma R T_0$ **with** $\partial p'/\partial z = -p' g / c_s^2$

p42 (2.3.13)

$-i\nu P = -c_s^{\,2} ikU$ **- sign**

p45: note that the – sign in the second term of eq (2.3.22) is incorrect

p46 Fig. 2.3.2 caption: Schematic of density weighted internal (vertically propagating) waves. Add "density weighted"

p49 before (2.4.3) change to

and letting $\beta = 0$**, (**with $\alpha = 1$**)**

p50 change the last line

letting $\alpha = 0$, (with $\beta = 1$)

In (2.4.4)

$$n^2 = \frac{-\left(\nu^2 - f^2 - c_s^{\,2}k^2\right)N^2}{c_s^{\,2}\left(\nu^2 - f^2\right)} - \frac{1}{4}\left(\frac{N^2}{g} - \frac{g}{c_s^{\,2}}\right)^2$$ **- sign on the first term of (2.4.4)**

p51 eq (2.4.6) last term in thedenominator should be $\frac{1}{4H^2}$ **, not** $\frac{1}{4}H^2$

p53 table (2.4.1)

add new line after f

Rossby (20hpa)	………………………	Constant f ($\beta = 0$)

p54 (2.5.2) add minus sign

$$\frac{\partial \phi}{\partial t} = -\nabla \cdot \left[\left(\phi - \phi_s\right)\mathrm{v}\right]$$

P55 last line: replace (2.3.26)with (2.4.6)

P56 second line …Lamb waves (2.4.5) if we define… (add (2.4.5))

p57 (2.5.17b) should be –fu**(not plus)**

p57 Sentence after (2.5.17d)should be

taking the x-derivative of (2.5.17b) minus the y-derivative of (2.5.17a). (x and y should be exchanged)

p58, Exercise (2.5.4), add: in(2.5.22). How will this change the FDR (2.5.21)?

p58, Exercise (2.5.5), change to: Estimate the initial time derivative for typical values of the horizontal wave number (L=2000km, 8000km), that Richardson would have observed, i.e., compare the frequency ν for the external (barotropic, H~10km) mode for inertia-gravity waves and for Rossby waves.

Chapter 3

P68 replace first equation with

$$\alpha\frac{\partial^2 u}{\partial x^2}+2\beta\frac{\partial^2 u}{\partial x\partial y}+\gamma\frac{\partial^2 u}{\partial y^2}+\delta\frac{\partial u}{\partial x}+\varepsilon\frac{\partial u}{\partial y}+\eta=0$$

P73, eq (3.2.5) replace $=0$ **with** ≈ 0

p76 two lines after (3.2.8):

the truncation error is first order in time and second order in space

less or equal

$$U^{n+1}\le\{|\mu|+|1-2\mu|+|\mu|\}U^n$$

p79 Figure 3.2.3: replace with the new Fig. 3.2.3 at the end of this list

Also, the last line of the Figure 3.2.3 legends should be

$\mu=0.1$; L is the wavelength in units of Δx; $\rho_{EB}=\left[1-\mu^2\sin^2 p+\mu^4\sin^4 p\right]^{1/2}$,

and $\rho_{Upstr}=\left[1-4\mu(1-\mu)\sin^2 p\right]^{1/2}$.

p80 Change the first line to

wavenumber p, using a Courant number $\mu=0.1$, a typical value for advection given the presence of fastgravity waves.

P80 two lines below (3.2.25). Replace “real” with“positive”

P83, NEW: Formula c': don't divide by 2 $\frac{U^{n+1}-U^{n}}{\Delta t}=F\left(\beta U^{n}+(1-\beta)U^{n+1}\right)$

P85, last sentence, at the point $U_{j+1/2}^{n+1/2}$ **(change– to + sign in the subindex)**

p89 (3.2.52) change 1/delta to2/delta t

$$\left(\delta_{2x}^{2}+\delta_{2y}^{2}-\frac{1}{\Phi\Delta t^{2}}\right)\phi^{n+1}=-\left(\delta_{2x}^{2}+\delta_{2y}^{2}+\frac{1}{\Phi\Delta t^{2}}\right)\phi^{n-1}$$
$$+2(\delta_{2x}R_{u}+\delta_{2y}R_{v})+\frac{2}{\Delta t}(\delta_{2x}u^{n-1}+\delta_{2y}v^{n-1})-\frac{2}{\Phi\Delta t}R_{\phi}=F_{i,j}^{n}$$

p90 (3.2.53) add squares to the lhs terms

$$\left(\delta_{2x}^{2}+\delta_{2y}^{2}-\frac{1}{\Phi\Delta t^{2}}\right)\phi=\frac{\phi_{i+2,j}+\phi_{i-2,j}+\phi_{i,j+2}+\phi_{i,j-2}-\left(4+\frac{1}{\mu^{2}}\right)\phi_{i,j}}{4\Delta^{2}}$$

p93, equation above (3.3.12): drop one of the imaginary "i" and drop the prime on c'

p94, second line change to

$$L=3\Delta x$$

p95, last equation (3.3.19), adda minus sign to the right hand side

p105 (3.3.35) add a comma on thefirst term and a 2 to the denominators

$$\frac{\partial h_{i,j}\alpha_{i,j}}{\partial t}+\frac{(hu)_{i+1/2,j}(\alpha_{i,j}+\alpha_{i+1,j})-(hu)_{i-1/2,j}(\alpha_{i,j}+\alpha_{i-1,j})}{2\Delta x}$$
$$+\frac{(hu)_{i,j+1/2}(\alpha_{i,j}+\alpha_{i,j+1})-(hu)_{i,j-1/2}(\alpha_{i,j}+\alpha_{i,j-1})}{2\Delta y}=0$$

p106: Eq (3.3.9) Omit the 2 inthe denominators

p108

After first paragraph, add

Exercise 3.3.8: derive the finite difference equivalent of J1, J2 and J3.

p118, equations (3.4.20) and(3.4.21)

Replace α **by** $(4+\alpha)$

Chapter 5

p145 line 5: *prior* **in italics**

p148 (5.3.21) change subindex bto a in two terms

$$\varepsilon_{b,i+1} = \left(T_b - T_t\right)_{i+1} = M(T_a)_i - M(T_t)_i + \varepsilon_M = M\varepsilon_{a,i} + \varepsilon_M$$

p153

In the last line of eq (5.4.9)the first term should have $y_j(t)$ **not** $y_i(t)$ **(thanks to**

Alberto P. Costa Neves)

drop minus sign in eq after(5.4.9)

$$\frac{\partial \varepsilon^T \varepsilon}{\partial w_{ij}} = 2\left\{\left[\mathrm{Wy}(t)\mathrm{y}^T(t)\right]_{ij} - \left[\mathrm{x}(t)\mathrm{y}^T(t)\right]_{ij}\right\}$$

p172 (5.5.13) replace + with =

$$\delta x_a = \left(\mathrm{BH}^T\right)(\mathrm{R} + \mathrm{HBH}^T)^{-1}\delta \mathrm{y}_o$$

P174, 3rd line: …are uncorrelated and have equal variance.

4th line: HBH should be $\mathbf{HBH^T}$

p184, last line at the end of section 5.6.3: add a sentence:

and Courtier, 1995, Cohn and Todling, 1996). 4D-Var has been successfully implemented at ECMWF and at Meteo France, and has resulted in improved forecast scores attributed principally to the fact that observations are assimilated at the time they were made, rather than at the analysis time.

P 217, eq (6.3.25): the terms in the first two sums should be squared

$$\sum_{i=1}^{n}\left(\frac{\left\langle \mathbf{y}(t), \mathbf{u}_i \right\rangle}{\sigma_i}\right)^2 = \sum_{i=1}^{n}\left\langle \mathbf{y}(t_0), \mathbf{v}_i \right\rangle^2 = \left\|\mathbf{y}(t_0)\right\|^2 = 1$$

P226, first formula, replace with

$$\mathbf{u}_1(t+2T) = \mathbf{L}\mathbf{u}_1(t+T) = \begin{bmatrix} 8.47 \\ 0.21 \end{bmatrix} \qquad \mathbf{u}_2(t+2T) = \mathbf{L}\mathbf{u}_2(t+T) = \begin{bmatrix} -0.76 \\ -0.14 \end{bmatrix}$$

p226 First line of the last paragraph change order of words

with two Lyapunov vectors growing with rates

p234 [Adapted from IPCC (2002)] should be on plate 4, not plate 3

Plate 3 …….. ~~[Adapted from IPCC (2002)]~~

Plate 4

(b) the blue ……… proxy data. [Adapted from IPCC (2002)]

p268 (B.1.24)

$$u_i^{j+1} = u_i^{j-1} - \frac{\Delta t}{\Delta x}\left[u_i^j(u_{i+1}^j - u_{i-1}^j)\right] + \frac{2\Delta t}{\Delta x^2}\left[u_{i+1}^j - (u_i^{j+1} + u_i^{j-1}) + u_i^j\right]$$

p268 (B.1.26) three corrections,a, b, c:

a) Move the last 3 paragraphs on **p268** and first paragraph of **p269** to the end of the program code on **p268**. The title of this new subsection is B.1, and make Example of FORTRAN code subsection B.2. It should look like:

ADZ=0.0

B.1 Verification

Finally, we discuss…

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$(\mathrm{L}\delta x_0)^T(\mathrm{L}\delta x_0) = (\delta x_0)^T \mathrm{L}^T(\mathrm{L}\delta x_0)$ **b) drop the * on the rhs**

.

$(AQ)^T(AQ) = Q^T[A^T(AQ)]$ **c) drop the * on the rhs**

B.2 Example of FORTRAN CODE

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p301 Houtekamer and Mitchell 2001reference: replace pages 796-911 with 123-137.

New figure 3.2.3: