

MMSIMI Errata as of April 3, 2009

- Page ix line 3 of second paragraph:** Replace “*Mathematical*” with “*Mathematics*.”
- Page 5, Last paragraph of Section 1.2:** Replace “optimization” with “optimization under some norm.”
- Page 17, Paragraphs 3 and 4:** These paragraphs are redundant.
- Page 35, Exercises 2.1 and 2.2:** Replace “(2.2.6)” by “(2.2.5)”.
- Page 35, Exercise 2.4:** Add the text “Assume $\mathcal{L} = \mathcal{L}^*$ here.”
- Page 39, Problem 28:** Replace “ u'_S ” and “ u_S ” with “ u ” and “ u ”, respectively.
- Page 43, Exercise 2.10:** “Section 2.1” should read “Section 2.2.”
- Page 48, line 1, first paragraph;** Replace “slow variations” with “smooth variations.”
- Page 49, line 8, first paragraph:** replace “corresponding” with “corresponds.”
- Page 49, footnote 11:** Replace “It is important note” to “it is important to note.”
- Page 58, line 7, second paragraph:** $h_2 < x < h_1$ should read $h_1 < x < h_2$.
- Page 61, end of first paragraph:** The reference to Bleistein [1984] ought to be replaced by Coddington and Levinson [1984].
- Page 64, line 1, second paragraph:** Replace “For $F(c(y)k)$ ” with “For $F(c(y)k/2)$.”
- Page 66, line 5, second paragraph:** Replace “In contrast, seismic data” with “In contrast, the seismic data.”
- Page 67, Exercise 2.13 c:** $A_0^2 = c(x)$ should read $A_0^2 \propto c(x) \dots$
- Page 68, Exercise 2.14:** Absorb the paragraph labeled as part a) of the problem into the problem introduction, and relabel “b), c), and d)” as “a), b), and c)” respectively.
- Page 70, equation (2.5.17):** The phases in the numerator and denominator are missing divisors of c_1 . The equation should read

$$u_S(0, \omega) = -F(\omega) \frac{c_0}{2i\omega} \frac{R_1 + R_2 e^{2i\omega[h_2-h_1]/c_1}}{1 + R_1 R_2 e^{2i\omega[h_2-h_1]/c_1}} e^{2i\omega h_1/c_0}. \quad (2.5.17)$$

Page 72, equation (2.5.20): In the first line, the substitution of $u_S(0, \omega)$ should have a multiplier of $c_0/2$ rather than c_0 , so that this line should read

$$\beta(y) = \frac{2}{\pi c_0^2 T_1^2} \int_{-\infty}^{\infty} F(\omega) \frac{c_0}{2} \left[R_1 e^{2i\omega h_1/c_0} + R_2 [1 - R_1^2] e^{2i\omega [h_2 - h_1]/c_1 + 2i\omega h_1/c_0} \right]$$

Page 72, just below the middle of the page: The sentence,

We reject this term, therefore, because we are concerned only with $y \leq h_1$, at this point in our discussion.

should read

We reject this term, therefore, because we are not concerned with $y \leq h_1$ at this point in our discussion.

Page 73, equation (2.5.24): The first line should have a multiplier of $c_0/2$ rather than c_0 . This line should read

$$\beta(y) = \frac{2}{\pi c_0^2 T_1^2 T_2^2} \int_{-\infty}^{\infty} F(\omega) \frac{c_0}{2} \left[\left(R_1 + R_2 [1 - R_1^2] e^{2i\omega [h_2 - h_1]/c_1} \right) e^{2i\omega h_1/c_0} \right]$$

Page 74, equation (2.5.26): The second phase in the first line is missing a factor of 2. The equation should read

$$\beta(y) = \frac{1}{\pi c_0 T_1^2 T_2^2} \int_{-\infty}^{\infty} \left[R_1 + R_2 e^{2i\omega [h_2 - h_1]/c_1} \right] \left[1 + R_1 R_2 e^{2i\omega [h_2 - h_1]/c_1} \right] \cdot F(\omega) e^{-2i\omega [(y - h_2)/c_2 + (h_2 - h_1)/c_1]} d\omega.$$

Page 78, third line from the bottom: Introduce the word, "to," as follows:

"...are not guaranteed to produce values"

Page 80, footnote: "...from the right, $c(h-)$." should read "...from the left, $c(h-)$."

Page 81, line 6: A t was omitted: "...one could certainly choose $c\Delta t/k$, where k is a tunable parameter"

Page 82, after equation (2.8.2): Insert the sentence "Here, $\delta\rho$ and δv represent small perturbations in density and wavespeed, respectively."

Page 83, last sentence: Replace "into (2.8.10)" with "into (2.8.9)."

Page 85, Problem 2.18: Replace “with $j = 1, k$ ” with “with $j = 0, k$.”

Page 93, Exercise 3.1: Parts a and b should be replaced by the following. Consider the general problem

$$\begin{aligned}\mathcal{L}u(\mathbf{x}) &= -f(\mathbf{x}) \\ \mathcal{L}^*g^*(\mathbf{x}, \mathbf{x}_g) &= -\delta(\mathbf{x} - \mathbf{x}_g).\end{aligned}$$

- a. Use Green’s theorem, (3.1.10) to derive the following representation for $u(\mathbf{x}_g)$ in terms of the source and the boundary values.

$$\begin{aligned}u(\mathbf{x}_g) &= \int_D f(\mathbf{x})g^*(\mathbf{x}, \mathbf{x}_g) dV \\ &\quad + \int_{\partial D} \left\{ g^*(\mathbf{x}, \mathbf{x}_g) \frac{\partial u(\mathbf{x})}{\partial n} - u(\mathbf{x}) \frac{\partial g^*(\mathbf{x}, \mathbf{x}_g)}{\partial n} \right\} dS.\end{aligned}$$

- b. Let ∂D be a large sphere whose radius will ultimately be allowed to approach infinity. Explain why the previous equation can be rewritten as

$$\begin{aligned}u(\mathbf{x}_g) &= \int_D f(\mathbf{x})g^*(\mathbf{x}, \mathbf{x}_g) dV \\ &\quad + \int_{\partial D} \left\{ g^*(\mathbf{x}, \mathbf{x}_g) \left[\frac{\partial u(\mathbf{x})}{\partial n} - u(\mathbf{x}) \right] - u(\mathbf{x}) \left[\frac{\partial g^*(\mathbf{x}, \mathbf{x}_g)}{\partial n} - g^*(\mathbf{x}, \mathbf{x}_g) \right] \right\} dS.\end{aligned}$$

Identify $\partial/\partial n$ with $\partial/\partial r$ on ∂D and use the Sommerfeld radiation conditions (3.1.2) to conclude that the integral over ∂D must approach zero as the radius approaches infinity.

Page 93, Exercise 3.1 c), second line: There should be no minus sign on the delta function. That is, $f = \delta(\mathbf{x} - \mathbf{x}_s)$.

p 94, Exercise 3.2 a): A u is missing in the first term of the expression on the right. That is,

$$\int_D [g^*\mathcal{L}u - u\mathcal{L}^*g^*] dV = \int_{\partial D} \left[g^* \frac{\partial u}{\partial n} - \frac{u}{\rho} \frac{\partial}{\partial n}(\rho g^*) \right] dS.$$

Page, 94, first sentence, last paragraph After the first sentence insert the sentence, “By the term *specular reflections* we mean that the scattered energy must obey the law of reflection.”

Page 95, 4 lines from bottom Replace “... preprocessing are not be ...” by “... preprocessing may not be ...”

Page 96, paragraph 3 Replace “abyssal plane” by “abyssal plain”.

Page 100, equations (3.2.2) and (3.2.3): replace “ c ” with “ $c(\mathbf{x})$.”

Page 101, second unnumbered equation check to see that the sign of the transport equation part is correct.

Page 111, Equation (3.3.13) should be formatted as follows

$$\equiv \begin{cases} \operatorname{sgn}(\omega) \left[\frac{\omega^2}{c_0^2} - \kappa^2 \right]^{1/2} & \text{for } |\omega| \geq c_0 \kappa , \\ i \left[\kappa^2 - \frac{\omega^2}{c_0^2} \right]^{1/2} & \text{for } |\omega| < c_0 \kappa , \end{cases} \quad (3.3.13)$$

Page 121, Exercise 3.5 d) Replace:

$$-i(\mathbf{k} \cdot \hat{\mathbf{n}})\tilde{g}(\mathbf{k}) = \tilde{f}(\mathbf{k})$$

with

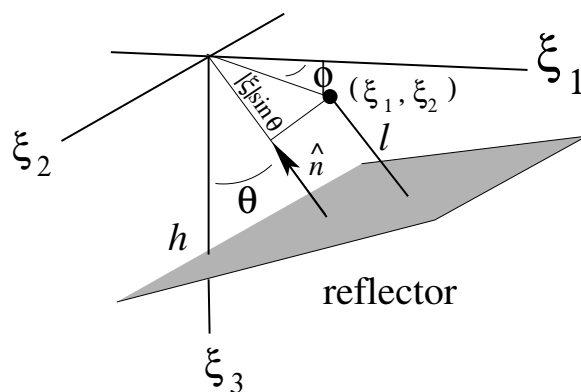
$$i(\mathbf{k} \cdot \hat{\mathbf{n}})\tilde{g}(\mathbf{k}) = \tilde{f}(\mathbf{k})$$

Page 121, Exercise 3.5 e) Replace:

$$-ik\operatorname{sgn}(k_2)\tilde{g}(\mathbf{k}) = \tilde{f}(\mathbf{k})$$

with

$$ik\operatorname{sgn}(k_2)\tilde{g}(\mathbf{k}) = \tilde{f}(\mathbf{k})$$



Page 117, Figure 3.2 Replace Figure 3.2 with:

Page 132, Unnumbered equation between (3.6.10) and (3.6.11): Replace ρ^2 by $(\boldsymbol{\rho} - \boldsymbol{\xi})^2$.

Page 135, Exercise 3.8 Replace:

$$\frac{\partial}{\partial \bar{z}} \quad \text{with} \quad \frac{\partial}{\partial z}$$

Page 136, Exercise 3.8, part c): should read: Verify (3.6.15).

Page 141, line 4: Replace “matterr” with “matter.”

Page 150: The sentence in the second paragraph reading, It is then easy to show that the matrix Φ_{ij} has two positive eigenvalues equal to $1/r_0$ and two negative eigenvalues equal to $-1/r_0$.

It is then easy to show that the matrix Φ_{ij} has two equal positive eigenvalues, given by $(1 + \sqrt{5})/2r_0$, and two equal negative eigenvalues, given by $(1 - \sqrt{5})/2r_0$.

Page 180-181: Replace the words “point scatter” with “point scatterer” in the captions of Figure 4.11 and in all other occurrences on these two pages.

Page 182: Replace the words “line scatter” with “line scatterer” in text and in the captions of Figure 4.13.

Page 183, caption of Figure 4.14 Replace “Figure 4.1a” with “Figure 4.12a.”

Page 235, equation(5.1.45): The last line, first equality should be $2/c^2(\mathbf{y}) \{ \dots$ That is

$$\begin{aligned} |\nabla_{\mathbf{y}}\phi(\mathbf{y}, \boldsymbol{\xi})|^2 &= |\nabla_{\mathbf{y}}\tau(\mathbf{y}, \mathbf{x}_s)|^2 + |\nabla_{\mathbf{y}}\tau(\mathbf{y}, \mathbf{x}_g)|^2 \\ &\quad + 2\nabla_{\mathbf{y}}\tau(\mathbf{y}, \mathbf{x}_s) \cdot \nabla_{\mathbf{y}}\tau(\mathbf{y}, \mathbf{x}_g) \\ &= \frac{2}{c^2(\mathbf{y})} \{1 + 2 \cos 2\theta\} = \frac{4 \cos^2 \theta}{c^2(\mathbf{y})}. \end{aligned} \tag{5.1.45}$$

Page 239, equation (5.1.52): Omit $\gamma(\mathbf{x})$. That is,

$$\begin{aligned} u_S(\mathbf{x}_g, \mathbf{x}_s, \omega) &\sim -i\omega F(\omega) \int_S dS R(\mathbf{x}, \mathbf{x}_s) \\ &\quad \cdot a(\mathbf{x}, \boldsymbol{\xi}) |\nabla_{\mathbf{x}}\phi(\mathbf{x}, \boldsymbol{\xi})| e^{i\omega\phi(\mathbf{x}, \boldsymbol{\xi})}. \end{aligned} \tag{5.1.52}$$

Page 241, equation (5.1.56): $\beta(\mathbf{x})$ on the left side of the equation should be $\beta(\mathbf{y})$.

Page 246, last line of (5.2.14): Omit μ_g . That is,

$$\begin{aligned} (\mathbf{p}_s + \mathbf{p}_g) \cdot (\mathbf{v}_g \times \mathbf{w}_g) &= \frac{\mu_g}{c(\mathbf{y})} (1 + \cos 2\theta) |\mathbf{v}_g \times \mathbf{w}_g| \\ &= \frac{2\mu_g \cos^2 \theta}{c(\mathbf{y})} |\mathbf{v}_g \times \mathbf{w}_g| \\ &= 2 \cos^2 \theta \mathbf{p}_g \cdot (\mathbf{v}_g \times \mathbf{w}_g). \end{aligned} \quad (5.2.14)$$

Page 247, Exercise 5.22: Eliminate “Hint:”

Page 252, middle of page: The sentence below the unnumbered equation should read
 “This just represents an interchange of orders of differentiation between the independent variables on the upper surface and the variables at depth.”

Page 254, second line of equation (5.3.10): In the first factor of the second line, there is an extra factor of

$$\frac{\partial x_{g3}}{\partial \xi_I}.$$

That second line should read

$$= \left[\frac{\partial}{\partial x_{gK}} \frac{\partial \tau}{\partial x_j} \right] \left[\frac{\partial x_{gK}}{\partial \xi_I} - \frac{q_K}{q_3} \frac{\partial x_{g3}}{\partial \xi_I} \right]. \quad (5.3.10)$$

In the third line below this equation, $J = 1, 2$ should read $j = 1, 2$.

Page 255: In the last two lines of equation (5.3.12) and two lines below, replace \mathbf{p} by \mathbf{q} .
 The interpretation below the equation remains correct.

Page 278, equation (5.6.11): Replace *tau* with τ in denominator. That is,

$$R^{vd}(\mathbf{x}, \mathbf{x}_s) = \frac{\frac{1}{\rho(\mathbf{x})} \left| \frac{\partial \tau}{\partial n} \right| - \frac{1}{\rho_+(\mathbf{x})} \left\{ 1/c_+^2(\mathbf{x}) - 1/c^2(\mathbf{x}) + \left[\frac{\partial \tau}{\partial n} \right]^2 \right\}^{1/2}}{\frac{1}{\rho(\mathbf{x})} \left| \frac{\partial \tau}{\partial n} \right| + \frac{1}{\rho_+(\mathbf{x})} \left\{ 1/c_+^2(\mathbf{x}) - 1/c^2(\mathbf{x}) + \left[\frac{\partial \tau}{\partial n} \right]^2 \right\}^{1/2}}, \quad (5.6.11)$$

Page 309: The phases in (6.3.25) and (6.3.26) should read: $[r_s + r_g]/c$. That is,

$$\beta(\mathbf{y}) = \frac{4y_3}{\sqrt{2\pi c^3}} \int d\xi \sqrt{r_s + r_g} \frac{r_s^2 + r_g^2}{(r_s r_g)^{3/2}} \cdot \cos \theta \int \sqrt{|\omega|} d\omega e^{-i\omega[r_s+r_g]/c+i\pi/4\text{sgn}(\omega)} u_S(\mathbf{x}_g, \mathbf{x}_s, \omega) \quad (6.3.25)$$

and

$$\beta_1(\mathbf{y}) = \frac{2y_3}{\sqrt{2\pi c}} \int d\xi \sqrt{r_s + r_g} \frac{r_s^2 + r_g^2}{(r_s r_g)^{3/2}} \cdot \int \sqrt{|\omega|} d\omega e^{-i\omega[r_s+r_g]/c+i\pi/4\text{sgn}(\omega)} u_S(\mathbf{x}_g, \mathbf{x}_s, \omega). \quad (6.3.26)$$

Page 341, below equation(7.4.32): The sentence,

In these equations, the repeated indices are, again, to be summed over 1 and 3. should be replaced by

In these equations, the repeated indices are to be summed over 1 and 2.

Page 348, equation (7.5.2): The factor, $[2\pi]^{3/2}$ should be $\sqrt{2\pi}$.

Page 404, beginning of first full paragraph: Replace “Of in the course” with “Often in the course.”

Page 440, (E.2.2): The second term in the first line should read: $F(\mathbf{x}, u, \mathbf{p})$. That is,

$$\begin{aligned} & F(\mathbf{x} + \delta\mathbf{x}, u + \delta u, \mathbf{p} + \delta\mathbf{p}) - F(\mathbf{x}, u, \mathbf{p}) \\ &= \sum_{i=1}^3 \frac{\partial F}{\partial x_i} \delta x_i + \frac{\partial F}{\partial u} \delta u + \sum_{j=1}^3 \frac{\partial F}{\partial p_j} \delta p_j = 0. \end{aligned} \quad (\text{E.2.2})$$

Page 453, unnumbered equation below equation (E.3.22): The second term needs to be changed. The equation should read

$$\sqrt{J(\sigma)} \frac{dA_j}{d\sigma} + \frac{A_j}{2\sqrt{J(\sigma)}} \frac{dJ(\sigma)}{d\sigma} = -\frac{\sqrt{J(\sigma)}}{2} \nabla^2 A_{j-1},$$

Page 453, last unnumbered equation: The left side of the equation is missing a subscript j . The equation should read

$$A_j(\sigma) = A_j(\sigma_0) \sqrt{\frac{J(\sigma_0)}{J(\sigma)}} - \frac{1}{2J(\sigma)} \int_{\sigma_0}^{\sigma} \sqrt{J(\sigma')} \nabla^2 A_{j-1}(\sigma') d\sigma'.$$

Page 454: The expression at the bottom of the page should have exponent: $i\omega|\mathbf{x}-\mathbf{x}_0|/c(\mathbf{x}_0)$. That is,

$$g(\mathbf{x}, \mathbf{x}_0, \omega) = \frac{1}{4\pi|\mathbf{x}-\mathbf{x}_0|} e^{i\omega|\mathbf{x}-\mathbf{x}_0|/c(\mathbf{x}_0)},$$

Page 455: The expression for K below “We see that” should read

$$K = \lim_{\sigma \rightarrow 0} A(\sigma) \sqrt{J_{3D}(\sigma)}$$

Page 456: The second equality in the second unnumbered equation should read:

$$\frac{p(\mathbf{x}_0) \sin \phi}{(4\pi)^2}.$$

That is,

$$\begin{aligned} A^2(\sigma) J_{3D}(\sigma) &= A^2(\sigma_0) J_{3D}(\sigma_0) \\ &= \left[\frac{1}{4\pi p(\mathbf{x}_0) \sigma_0} \right]^2 p^3(\mathbf{x}_0) \sigma_0^2 \sin \phi = \frac{p(\mathbf{x}_0) \sin \phi}{(4\pi)^2}. \end{aligned}$$

Page 457, Exercise E.1: Rewrite parts a) and b) as follows.

a. Show that for this choice and constant wavespeed,

$$J_{3D} = \frac{\sigma^2}{c^2 p_3}, \quad A(\mathbf{x}) = \frac{Kc}{\sigma \sqrt{p_3}}.$$

In this equation, $K = K(p_{10}, p_{20})$ is a constant in σ to be determined. This constant is different from the choice of $K = K(\theta, \phi)$ in the example of this section.

b. Use this result and the known amplitude for the constant-wavespeed Green’s function amplitude to conclude that even for variable wavespeed,

$$A(\mathbf{x}) = \frac{1}{4\pi \sqrt{p_3(\mathbf{x}_0) J_{3D}}}.$$

Page 461, Eq (E.4.16): The left side of the third equation should be $\frac{\partial \tau_{\mathbb{T}}}{\partial n}$.

Page 461, Eq (E.4.17): Replace $-\text{sgn}$ by sgn .

Page 466: Equation (E.5.6) is missing a “)” and should read

$$\nabla_{2D} \cdot (\sigma A^2(\mathbf{x}) \nabla_{2D} \tau(\mathbf{x})) = 0, \quad \mathbf{x} = (x_1, 0, x_3). \quad (\text{E.5.6})$$

Page 467: The second line of equation (E.5.8) an \mathbf{x} is in the wrong font and should read

$$= \frac{1}{4\pi} \sqrt{\frac{p(\mathbf{x}_0) \sin \phi}{\sigma J_{2D}(\sigma)}} \exp\left(i\omega \int_{\sigma_0}^{\sigma} 1/c^2(\mathbf{x}(\sigma')) d\sigma'\right). \quad (\text{E.5.8})$$

Page 468: The second line of equation (E.6.9), an \mathbf{x} is in the wrong font and should read

$$= \frac{1}{4\pi} \sqrt{\frac{\rho(\mathbf{x}) p(\mathbf{x}_0) \sin \phi}{\rho(\mathbf{x}_0) J_{3D}(\sigma)}} \exp\left(i\omega \int_{\sigma_0}^{\sigma} 1/c^2(\mathbf{x}(\sigma')) d\sigma'\right). \quad (\text{E.6.9})$$

Page 468: The second line of equation (E.6.10), an \mathbf{x} is in the wrong font and should read

$$= \frac{1}{4\pi} \sqrt{\frac{\rho(\mathbf{x}) p(\mathbf{x}_0) \sin \phi}{\rho(\mathbf{x}_0) \sigma J_{2D}(\sigma)}} \exp\left(i\omega \int_{\sigma_0}^{\sigma} 1/c^2(\mathbf{x}(\sigma')) d\sigma'\right). \quad (\text{E.6.10})$$

Page 487, equation (E.8.23): The factor, $\sqrt{|\omega|}$, should be replaced by $\sqrt{2\pi|\omega|}$. The equation should read

$$\begin{aligned} u_S(\mathbf{x}_g, \mathbf{x}_s, \omega) &= \sqrt{2\pi|\omega|} e^{3i\pi \text{sgn}(\omega)/4} \\ &\cdot \int_C R \sqrt{\frac{\rho(\mathbf{x}_g)}{\rho(\mathbf{x}_s)}} A(\mathbf{x}_g, \mathbf{x}) A(\mathbf{x}, \mathbf{x}_s) \sqrt{\frac{\sigma_s \sigma_g}{\sigma_s + \sigma_g}} \\ &\cdot (\hat{\mathbf{n}} \cdot \nabla [\tau(\mathbf{x}_g, \mathbf{x}) + \tau(\mathbf{x}, \mathbf{x}_s)]) e^{i\omega\{\tau(\mathbf{x}_g, \mathbf{x}) + \tau(\mathbf{x}, \mathbf{x}_s)\}} ds. \end{aligned} \quad (\text{E.8.23})$$

Page 489: The references, Bleistein 1986a and 1987b, are the same reference. 86 was the year of the meeting and the CWP report. 87 was the year of publication.

Page 489: Omitted reference: Bleistein, N., and S. H. Gray, 1985, An extension of the Born inversion method to a depth dependence reference profile: *Geophysical Prospecting*, 33, 999-1522.

Page 494: “Miller, N., and Beylkin, G., 1987” should read “Miller, N., Oristaglio, M., and Beylkin, G., 1987.”

Page 496: “Sullivan, J. K.,” should read, “Sullivan, M., and J. K. Cohen.”

Page 506: The section on inversion which reads as follows.

Inversion, 2.5D

- analytical example
- single tilted plane, 117
- common-offset, 247
- common-shot, 245
- zero-offset, 249

Inversion, 2.D

- common-offset, 305, 309
- common-shot, 299, 301
- zero-offset, 309

Inversion, 2D

- for β_1 , 238
- zero-offset, 125

should read as follows:

Inversion, 2.5D

- common-offset, 305, 309
- common-shot, 299, 301
- zero-offset, 309
- zero-offset, constant background, 125, 126

Inversion, 2D, 228
for β , 232
for β_1 , 238

The items listed under Inversion, 2.5D should be moved to

Inversion, 3D
analytical example
single tilted plane, 117
common-offset, 247
common-shot, 245
zero-offset, 249

Page 508: An additional item should be added under “N”:

Najmi’s relationship between h_g and j_g , 250