

# Errata in The Explanatory Supplement to the Astronomical Almanac (3rd edition, 1st printing)

Last update: 13 November 2015

**Pg. xxxiii, Contributing Authors:**

For “Barnard Guinot”, read “Bernard Guinot”.

**Pg. 12, Eq. 1.5:**

The equation should read:

$$\text{LAT} = \text{LST} - \text{RA Sun} + 12^{\text{h}} \quad (1.5)$$

**Pg. 12, Eq. 1.6:**

The equation should read:

$$\text{UT} = \text{GST} - \text{RA } U + 12^{\text{h}} \quad (1.6)$$

**Pg. 27, Chapter 1, 1st bullet:**

For “Stages 5, 6, and 7 would be...”, read “Stages 5 and 6 would be...”

**Pg. 27, Chapter 1, 2nd bullet:**

For “Stages 3 through 7 can be...”, read “Stages 3 through 6 can be...”

**Pg. 135, Figure 5.6:**

Two elements of the figure are in error:

1. The labels for  $x$  and  $y$  are incorrectly described. The  $x$  label should read “ $\mathbf{x}$  (east)” and the  $y$  label should read “ $\mathbf{y}$  (north)”.
2. Angle  $a$  beginning position is wrong. The beginning position for angle  $a$  should be on the line in the azimuth direction in the horizontal plane.

**Pg. 135, Figure 5.6:**

Angle  $a$  beginning position is wrong. The beginning position for angle  $a$  should be on the line in the azimuth direction in the horizontal plane.

**Pg. 142, State plane coordinates paragraph:**

The conversion between the International foot, meter, and U.S. survey feet has a typographical error. The sentence should read:

“... (1 International foot = 0.3048 m = 0.999 998 U.S. survey feet exactly).”

**Pg. 155, Eq. 5.83:**

The first factor in the numerator is in error. The equation should read:

$$N_{nm} = \left[ \frac{(n-m)! (2n+1) (2-\delta_{m0})}{(n+m)!} \right]^{1/2} \quad (5.83)$$

**Pg. 200, Eq. 6.2:**

The matrix  $\mathbf{R}_2(\theta)$  is incorrect. It should read:

$$\mathbf{R}_2(\theta) = \begin{bmatrix} \cos \theta & 0 & -\sin \theta \\ 0 & 1 & 0 \\ \sin \theta & 0 & \cos \theta \end{bmatrix} \quad (6.2)$$

**Pg. 200, Eq. 6.4:**

The first rotation matrix is in error. It should read:

$$\mathbf{W} = \mathbf{R}_3(-s') \mathbf{R}_2(x) \mathbf{R}_1(y) \quad (6.4)$$

**Pg. 207, §6.3, 1st paragraph:**

Strike the sentence, "It is also equivalent...", including Eq. 6.6.

**Pg. 207, Table 6.1:**

Multiply all of the values for  $C'_k$  by  $(-1)$ .

**Pg. 208, Eq. 6.8:**

The middle portion of the equation should be dropped. It should read:

$$E_o(T) = \theta - \text{GAST} \quad (6.8)$$

**Pg. 209, Eq. 6.13:**

The sign of element  $\mathbf{B}_{3,2}$  is in error. The matrix should read:

$$\mathbf{B} = \begin{bmatrix} 0.999\,999\,999\,999\,994\,25 & -7.1 \times 10^{-8} & 8.056 \times 10^{-8} \\ 7.1 \times 10^{-8} & 0.999\,999\,999\,999\,996\,95 & 3.306 \times 10^{-8} \\ -8.056 \times 10^{-8} & -3.306 \times 10^{-8} & 0.999\,999\,999\,999\,996\,208 \end{bmatrix} \quad (6.13)$$

**Pg. 210, Figure 6.2(d):**

One tickmark is mislabeled. For " $Y = -50^\circ$ ", read " $Y = -5^\circ$ ".

**Pg. 211, Eq. 6.14 and following line:**

The units of the coefficients are incorrect. It should read:

$$\begin{aligned} \Delta\psi - \Delta\psi_{2000A} &= (0.4697 \times 10^{-6} - 2.7774 \times 10^{-6} T) \Delta\psi_{2000A} \\ \Delta\varepsilon - \Delta\varepsilon_{2000A} &= -2.7774 \times 10^{-6} T \Delta\varepsilon_{2000A} \end{aligned} \quad (6.14)$$

where  $T$  is in centuries and  $-2.7774 \times 10^{-6}$  is in  $\text{cy}^{-1}$ .

**Pg. 214, Figure 6.4:**

Topmost angle label is in error. It should read, " $180^\circ - \Pi_A - \psi_A$ ".

**Pg. 216, Table 6.3**

Three individual elements of the table are in error:

1.  $\psi_A$  coefficient for units of (arcsec/cent.<sup>3</sup>) should read  $-0.001\,140\,45$ .
2.  $\omega_A$  coefficient for units of (arcsec/cent.) should read  $-0.025\,754$ .
3.  $\chi_A$  coefficient for units of (arcsec/cent.<sup>3</sup>) should read  $-0.001\,211\,97$ .

**Pg. 227, Table 6.6:**

The symbol  $D$  Argument should read, "The mean elongation of the Moon from the Sun".

**Pg. 228, Eq. 6.51:**

Individual matrix elements  $\mathcal{X}$ ,  $-\mathcal{X}$ ,  $\mathcal{Y}$ , and  $-\mathcal{Y}$  have the wrong signs. The equation should read:

$$\begin{aligned} \text{NPB}_{\text{CIO}} &= \mathbf{R}_3(-s)\mathbf{R} \\ &= \mathbf{R}_3(-s) \begin{bmatrix} 1 - a\mathcal{X}^2 & -a\mathcal{X}\mathcal{Y} & -\mathcal{X} \\ -a\mathcal{X}\mathcal{Y} & 1 - a\mathcal{Y}^2 & -\mathcal{Y} \\ \mathcal{X} & \mathcal{Y} & 1 - a(\mathcal{X}^2 + \mathcal{Y}^2) \end{bmatrix} \end{aligned} \quad (6.51)$$

**Pg. 229, Eq. 6.53:**

A factor in the last line of the equation is incorrect. It should read:

$$s = \dots - 0'072\,574\,11\,T^3 + 2''798 \times \dots \quad (6.53)$$

**Pg. 229, paragraph following Eq. 6.53:**

The paragraph should read: “Approximate formulae for the position of the CIP—accurate to 0.1 mas—and the CIO locator—accurate to 0.5  $\mu\text{as}$ —are found on pages B46 and B47 of *The Astronomical Almanac*.”

**Pg. 235 – 236, Eqs. 6.64, 6.69 – 6.72 :**

Equation 6.64 and Eqs. 6.69 – 7.72 were originally computed using a pre-release version of the Capitaine, Wallace and Chapront (2005) paper. Updated equations, consistent with the final Capitaine, Wallace and Chapront paper, are given below.

**Pg. 235, Eq. 6.64:**

Equation 6.64 should read:

$$\text{GMST}(D_U, T) = \dots - 1^{\text{s}}997\,07 \times 10^{-6} T^4 - \dots \quad (6.64)$$

**Pg. 235, Eq. 6.69:**

Equation 6.69 should read:

$$\begin{aligned} s_{JC} &= \frac{\partial \text{GMST}}{\partial T} + \frac{\partial \text{GMST}}{\partial T_U} \\ &= 8\,640\,184.794\,4783 + 0.185\,544\,22\,T - 8.8 \times 10^{-8} T^2 \\ &\quad - 0.000\,007\,9883\,T^3 - 1.23 \times 10^{-8} T^4 \text{ s} . \end{aligned} \quad (6.69)$$

**Pg. 236, Eq. 6.70:**

Equation 6.70 should read:

$$\begin{aligned} s_d &= 86\,636.555\,367\,405\,291 + 5.079\,9239 \times 10^{-6} T - 2.4 \times 10^{-12} T^2 \\ &\quad - 2.1871 \times 10^{-10} T^3 - 3.36 \times 10^{-13} T^4 \text{ s} \end{aligned} \quad (6.70)$$

**Pg. 236, Eq. 6.71:**

Equation 6.71 should read:

$$\begin{aligned} r' &= 1.002\,737\,909\,344\,968\,64 + 5.879\,5417 \times 10^{-11} T - 2.8 \times 10^{-17} T^2 \\ &\quad - 2.5313 \times 10^{-15} T^3 - 3.89 \times 10^{-18} T^4 \text{ d} . \end{aligned} \quad (6.71)$$

**Pg. 236, Eq. 6.72:**

Equation 6.72 should read:

$$\begin{aligned} \frac{1}{r'} &= 0.997\,269\,566\,334\,878\,91 - 5.847\,4783 \times 10^{-11} T + 2.8 \times 10^{-17} T^2 \\ &\quad + 2.5175 \times 10^{-15} T^3 + 3.87 \times 10^{-18} T^4 \text{ d}^{-1} . \end{aligned} \quad (6.72)$$

**Pg. 241, Eq. 6.92:**

Equation 6.92 should read:

$$\mathbf{r} = \mathbf{R}_1(-y) \mathbf{R}_2(-x) \mathbf{R}_3(\text{GAST})\mathbf{r}_0 \quad (6.92)$$

and strike the remainder of the sentence and the sentence immediately following.

**Pg. 275, Eq. 7.76:**

Equation 7.76, for  $\mathcal{Z}$ , should read:

$$\mathcal{Z} = \sin \epsilon \cos \psi \sin \bar{\phi} + \cos \epsilon \cos \bar{\phi} \tag{7.76}$$

**Pg. 292, Eq. 7.128:**

The parallax factor is not needed in this equation. Equation 7.128 should read:

$$\mathbf{U} = \mathbf{u}_B(t) - \mathbf{E}_B(t) \tag{7.128}$$

**Pg. 302, Chapter 7 References:**

A reference is missing. Add: “Mueller, I.I. (1969). *Spherical and Practical Astronomy as Applied to Geodesy*. New York, NY: Ungar.”

**Pg. 411, last paragraph, 3rd sentence:**

The sentence should read: “Those of the other planets and Pluto<sup>5</sup> are based on Harris (1961) for all but Jupiter, whose  $V(1,0)$  value is from Irvine et al. (1968).”

**Pg. 413, Table 10.6:**

Some values are inconsistent with the sources quoted on pg. 411. The modified table is given below. Bodies with changes are highlighted.

Body	$V(1,0)$ (mag)	$V_0$ (mag)	$\Delta m(i)^a$ (mag)
Mercury	-0.60	—	$0.0498 i - 0.000488 i^2 + 3.02 \times 10^{-6} i^3$
Venus <sup>b</sup>	-4.47	—	$0.0103 i + 0.000057 i^2 + 0.13 \times 10^{-6} i^3$
Venus <sup>c</sup>	0.98	—	$-0.0102 i$
Earth	-3.87	—	$0.0130 i + 0.000019 i^2 + 0.48 \times 10^{-6} i^3$
Mars	-1.52	-2.01	$0.016 i$
Jupiter	-9.40	-2.70	$0.005 i$
Saturn	-8.88	+0.67	$0.044 i$
Uranus	-7.19	+5.52	$0.002 i$
Neptune	-6.87	+7.84	—
Pluto	-1.01	+14.90	—
Io	-1.68	+5.02	$0.46 i - 0.0010 i^2$
Europa	-1.41	+5.29	$0.0312 i - 0.00125 i^2$
Ganymede	-2.09	+4.61	$0.323 i - 0.00066 i^2$
Callisto	-1.05	+5.65	$0.078 i - 0.00274 i^2$

<sup>a</sup>The coefficient  $i$  is the phase angle in degrees.

<sup>b</sup> $2^\circ 2' < i < 163^\circ 6'$

<sup>c</sup> $163^\circ 6' < i < 170^\circ 2'$

**Pg. 421, Eq. 10.32:**

Equation 10.32 should read:

$$\cos i = \mathbf{s} \cdot \mathbf{e} \tag{10.32}$$

**Pg. 427, Eq. 10.47:**

Equation 10.47 should read:

$$SD = 206\,264.8062 \frac{d_S}{|\mathbf{r}_e|} \tag{10.47}$$

**Pg. 428, Eq. 10.49:**

The matrix  $\mathbf{R}_2(\theta)$  is incorrect. It should read:

$$\mathbf{R}_2 = \begin{bmatrix} \cos \theta & 0 & -\sin \theta \\ 0 & 1 & 0 \\ \sin \theta & 0 & \cos \theta \end{bmatrix} \quad (10.49)$$

**Pg. 433, Eq. 10.67:**

The sign in the denominator is incorrect. It should read:

$$\tan \Omega_M = \frac{-\sin I \sin(\Omega + \Delta\psi)}{\cos I \sin \epsilon - \sin I \cos \epsilon \cos(\Omega + \Delta\psi)} \quad (10.67)$$

**Pg. 433, Eq. 10.70:**

Equation 10.70 should read:

$$\Omega_T = \phi_c + \psi_c - 180^\circ \quad (10.70)$$

**Pg. 448, Chapter 10 References:**

The de Vaucouleurs (1970) book title is in error. It should read, “*Surfaces and Interiors of Planets and Satellites*”.

**Pg. 523, first line:**

Delete the extra “a” at the end of the line.

**Pg. 564, Table 14.5:**

There are two errors in the plane triangle portion of the table, equations for  $s$  and  $r^2$ . They should read:

$$s = (a + b + c)/2$$

and

$$r^2 = (s - a)(s - b)(s - c)/s$$

**Pg. 568, 4th paragraph:**

A sentence is incorrect. It should read “Two great circles passing through  $E$  and  $Q$ , each being orthogonal to side  $EQ$ , intersect the equator and ecliptic planes at the vernal equinox.”

**Pg. 592, § 15.1.10:**

The sentence is incorrect. It should read “The Julian Day Number of Saturday 2000 January 1 is then 2 451 545 and of Monday  $-4712$  January 1 it is 0”.

**Pg. 601, Eq. 15.10:**

Equation 15.10 should read:

$$V = E/24 - E/25 + (G/12) * (E/25 - E/26) \quad (15.10)$$

**Pg. 620, Algorithm 8:**

Step 2 should be clearer. It should read “Calculate, using algorithm 5, the Julian Day Number, ...”.