The Direct Geodetic Problem Using the Method by Bowring

Some useful angle functions:

$$dd(ang) := \left| \begin{array}{l} degree \leftarrow floor(ang + 0.0000000001) \\ mins \leftarrow (ang - degree)\cdot 100.0 \\ minutes \leftarrow floor(mins + 0.000000001) \\ seconds \leftarrow (mins - minutes)\cdot 100.0 \\ degree + \frac{minutes}{60.0} + \frac{seconds}{3600.0} \end{array} \right.$$

$$radians(ang) := \left| \begin{array}{l} d \leftarrow dd(ang) \\ d\cdot\frac{\pi}{180.0} \end{array} \right.$$

$$r2d := \frac{180.0}{\pi}$$

$$dms(ang) := \left| \begin{array}{l} degree \leftarrow floor(ang) \\ rem \leftarrow (ang - degree)\cdot 60 \\ mins \leftarrow floor(rem) \\ rem1 \leftarrow (rem - mins) \\ secs \leftarrow rem1\cdot 60.0 \\ degree + \frac{mins}{100} + \frac{secs}{10000} \end{array} \right.$$

The following data refer to a given reference system

$a := 6378160\cdot m$ $\quad f := \frac{1}{298.25000158005}$ $\quad b := a - a\cdot f$

$b = 6356774.71930860\ m$

second eccentricity squared: $e_{p2} := \frac{a^2 - b^2}{b^2}$ $\quad e_{p2} = 0.00673966076$

Given data:

$\phi := -37.39155571$ $\quad \lambda := 43.55306630$

$p := if(\phi < 0, -1, 1)$ $\quad l := if(\lambda < 0, -1, 1)$

$\phi_1 := p\cdot radians(|\phi|)$ $\quad \lambda_1 := l\cdot radians(|\lambda|)$

$s := 54972.161m$ $\quad az := 127.1027080$

$\alpha_{12} := radians(az)$

Common equations:

$A := \sqrt{1 + e_{p2}\cdot(\cos(\phi_1))^4}$ $\quad A = 1.001323083$

$B := \sqrt{1 + e_{p2}\cdot(\cos(\phi_1))^2}$ $\quad B = 1.002110004$

$C := \sqrt{1 + e_{p2}}$ $\quad C = 1.003364172$

Direct Problem:

$$\sigma := \frac{s \cdot B^2}{a \cdot C} \qquad \sigma = 0.008626201655$$

$$\sigma := 0.008626201652$$

$$\sigma \cdot r2d = 0.494244948$$

$$tmp_u := A \cdot \tan(\sigma) \cdot \sin(\alpha_{12})$$

$$tmp_d := B \cdot \cos(\phi_1) - \tan(\sigma) \cdot \sin(\phi_1) \cdot \cos(\alpha_{12})$$

$$\lambda_{2r} := \left(\lambda_1 + \frac{1}{A} \cdot \operatorname{atan}\left(\frac{tmp_u}{tmp_d}\right)\right)$$

$$l := \text{if}(\lambda_{2r} < 0, -1, 1)$$

$$\lambda_2 := l \cdot \text{dms}(|\lambda_{2r}| \cdot r2d)$$

The longitude of point 2 in DDD.MMSSssss format

$\lambda_2 = 44.252481666$

$$w := \frac{A \cdot (\text{radians}(\lambda_2) - \lambda_1)}{2}$$

$$D := \frac{1}{2} \cdot \operatorname{asin}\left[\sin(\sigma) \cdot \left(\cos(\alpha_{12}) - \frac{1}{A} \cdot \sin(\phi_1) \cdot \sin(\alpha_{12}) \cdot \tan(w)\right)\right]$$

$$D = -0.00259700$$

$$\phi_{2r} := \left[\phi_1 + 2 \cdot D \cdot \left(B - \frac{3}{2} \cdot e_{p2} \cdot D \cdot \sin\left(2 \cdot \phi_1 + \frac{4}{3} \cdot B \cdot D\right)\right)\right] \cdot r2d$$

$$p := \text{if}(\phi_{2r} < 0, -1, 1)$$

$$\phi_2 := p \cdot \text{dms}(|\phi_{2r}|)$$

The latitude of point 2 in DDD.MMSSssss format

$\phi_2 = -37.570912879$

$$tmp_u := -B \cdot \sin(\alpha_{12})$$

$$tmp_d := \cos(\sigma) \cdot (\tan(\sigma) \cdot \tan(\phi_1) - B \cdot \cos(\alpha_{12}))$$

$tmp_u = -0.79848346$

$tmp_d = 0.59883662$

$$\alpha_{21} := \begin{cases} \text{dms}[(\text{atan2}(tmp_d, tmp_u)) \cdot r2d] & \text{if } (tmp_u > 0 \wedge tmp_d > 0) \\ \text{dms}[(\text{atan2}(tmp_d, tmp_u)) \cdot r2d] & \text{if } (tmp_u > 0 \wedge tmp_d < 0) \\ \text{dms}[(\text{atan2}(tmp_d, tmp_u) + 2 \cdot \pi) \cdot r2d] & \text{if } (tmp_u < 0 \wedge tmp_d < 0) \\ \text{dms}[(\text{atan2}(tmp_d, tmp_u) + 2 \cdot \pi) \cdot r2d] & \text{if } (tmp_u < 0 \wedge tmp_d > 0) \end{cases}$$

The back azimuth from 2 to 1 in DDD.MMSSssss format

$\alpha_{21} = 306.52073376$