Calculating Distance and Azimuth

To make things easy, `JO43LD` is taken as an example to explain the conversion of a locator to longitude φ and latitude ϑ in radian which are given by:

$$\varphi = \frac{\pi}{180} \cdot \left[(C(\texttt{J}) - 74) \cdot 20 + (C(\texttt{4}) - 48) \cdot 2 + (C(\texttt{L}) - 65) \cdot \frac{2}{24} + 0.5 \cdot \frac{2}{24} \right] \tag{1}$$

$$\vartheta = \frac{\pi}{180} \cdot \left[(C(\texttt{O}) - 74) \cdot 10 + (C(\texttt{3}) - 48) \cdot 1 + (C(\texttt{D}) - 65) \cdot \frac{1}{24} + 0.5 \cdot \frac{1}{24} \right] \tag{2}$$

The function C converts an ASCII character to the corresponding number. The negative numbers in equations (1) and (2) represent the "zero locator" `JJ00AA` since $C(\texttt{J}) = 74$, $C(\texttt{0}) = 48$ and $C(\texttt{A}) = 65$. The quantity 0.5 makes sure that longitude and latitude are taken with respect to the center of a locator field. [1]

The distance in km is given by

$$d = 111.2 \cdot \frac{180}{\pi} \cdot \arccos\Big(\sin(\vartheta_0)\ \sin(\vartheta_1) + \cos(\vartheta_0)\ \cos(\vartheta_1)\ \cos(\varphi_1 - \varphi_0) \Big) \tag{3}$$

with ϑ_0 and ϑ_1 being the latitude of the reference and target locator (in radian), and φ_0 and φ_1 the longitude respectively. The quantity 111.2 is the length of an arch of 1 degree angular distance in km.

The azimuth (at the reference) with respect to north in degrees is given by

$$a = 180 - \frac{180}{\pi} \cdot \arctan\left(\frac{\sin(\varphi_1 - \varphi_0)}{\sin(\vartheta_0)\cos(\varphi_1 - \varphi_0) - \cos(\vartheta_0)\tan(\vartheta_1)} \right) \quad . \tag{4}$$

The division implied in equation (4) is actually not carried out. The signs of the numerator and the denominator determine the quadrant of the azimuth. This information would get lost by dividing the fraction, thus numerator and denominator are passed on to `atan2` which yields the proper angle in the range $-\pi$ and π. Subtracting this angle (converted to degrees) from 180 degrees, places the the azimuth into the range 0 to 359.99 degrees.

Finally, both distance and azimuth are rounded to integers.

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[1] The constants in both equations may be multiplied and added, yielding -1581.375 and -790.6875 respectively. By prepending rather than appending these numbers, cancellation of least significant digits is avoided, resulting in slightly higher accuracy.