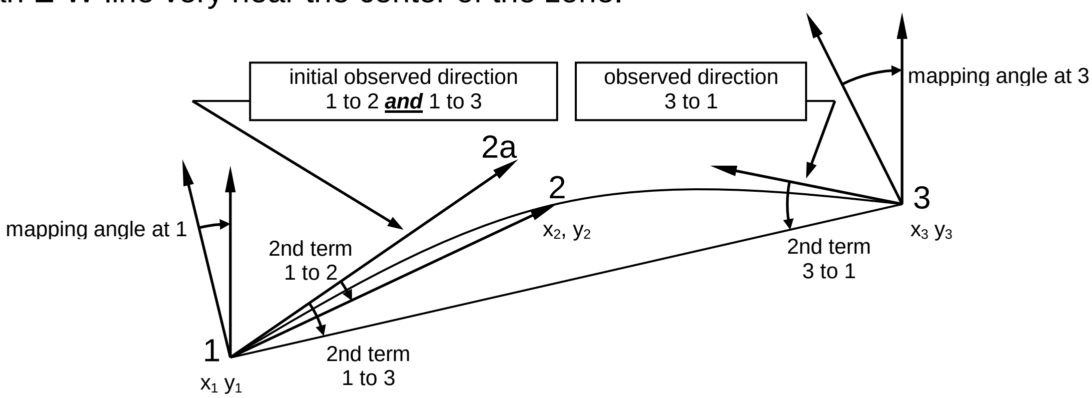
The so-called “second term” is a correction to compensate for the fact that a “long line” projects onto the developed cone as a curved line, unless it is a meridian. Note that “long” in this context means over five miles in length. These lines are concave to the latitudinal line designated y_o in the tables – a latitudinal line very near the center of the zone.

The second term is proportional to the change in x (Δx) and the average distance from y_o, an E-W line very near the center of the zone.



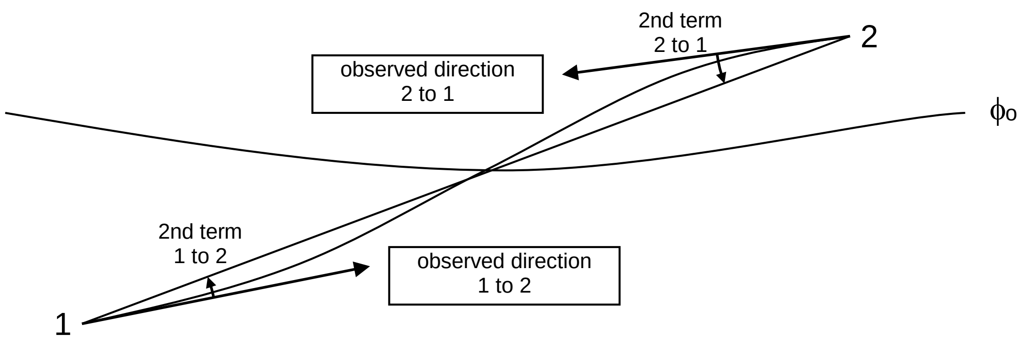
Assume line 1-2-3 is a “straight line” 20 miles long, and 1-2 is 10 miles. When plotted on the State Plane Grid it is curved concave toward y_o. This is because it really isn’t straight – it is a great circle arc (in the vertical plane) and this curvature shows up in the flat grid as a horizontal curve. Hence the coordinates at 2 are not the average of 1 and 3, and lines 1-2, 2-3, and 1-3 all have different grid bearings (as well as different geodetic bearings). If the second term were not used on the grid when calculating from 1 to 2, you would actually end up at 2a.

Conformality is maintained however, because the grid angles conform very well to the observed angles. For example, the observed horizontal angle at point 2 (backsighting 1 and foresighting 3) is 180° exactly. Remember that on the ellipsoid the great circle is in the vertical plane.

The second term, usually very small (on the order of only a few seconds at most), is slightly different at each end of a line. Though normally ignored on short line calculations, the effect of several second term corrections is cumulative. They should be considered on long traverses, especially if there are numerous angle points.

The forward and back grid bearings are the same (numerically) for each line on the grid. For short lines, the forward and back geodetic bearings differ essentially only by the same amount as the difference in the mapping angles at the two ends of the line. They differ more for long lines because of the curvature situation described above.

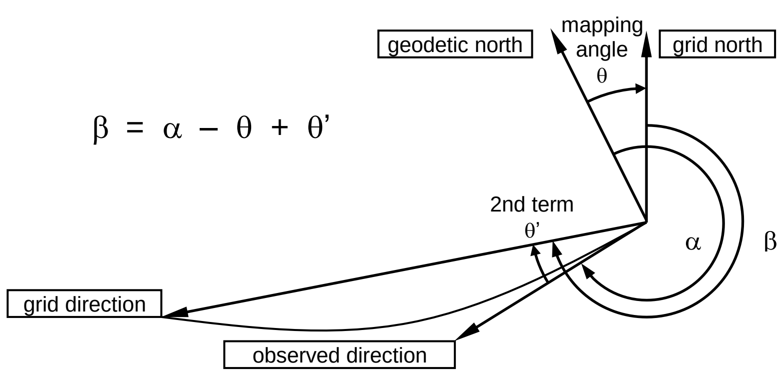
A long line which crosses the y_o latitude presents a special case and should be dealt with in two parts.



When the correction is applied to the observed geodetic azimuth, the proper azimuth value to use for calculating the coordinates of the forward point is obtained. Hence the equation for grid azimuth is…

Grid Azimuth = Geodetic Azimuth – Mapping Angle + Second Term

$$\beta = \alpha - \theta + \theta'$$



While the second term is shown with a "plus" sign, it must be remembered that it is added <u>algebraically</u>, and its actual sign depends upon the solution to the second term equation…

$$2^{nd}\text{ term} = \theta' = A\left(x_2 - x_1\right)\left(y_1 - y_0 + \frac{y_2 - y_1}{3}\right)$$

The second term will be slightly different at each end of a line. In this equation, the occupied station is $x_1\ y_1$ and the observed station is $x_2\ y_2$. Hence, in the example from page 1, when computing the second term angle at 3 looking back to 1, point 3 is $x_1\ y_1$ and point 1 is $x_2\ y_2$. To avoid an error in algebraic sign a sketch similar to the one above should be made.

The constant "A" is the same throughout a zone and is a function of the mean radius of the earth (ρ_o) at latitude ϕ_o …

$$A = \frac{1}{2\rho_0{}^2 \sin 1''}$$ (approximately $2.36 \cdot 10^{-10}$ for <u>all</u> NAD27 zones in the U.S.)

In computing the value of θ', the approximate coordinates of the occupied and observed points are adequate (<u>to the nearest 1000 feet</u>).