Step by Step method for valid comparison of calibration values

1. Convert $\overrightarrow{PCO}$ vector into matrix of calibration values which depend on satellite elevation (and azimuth) (Equation 3-4).
2. Combine matrix PCO and PCV to yield total antenna phase center (Equations 1-2).
3. Remove a constant bias from APC; by convention, we remove APC at zenith so that the final antenna phase center APC_{final} equals zero at zenith.

Detail

Phase Center Offset (PCO) is a 3-component vector which expresses the mean antenna phase center. PCO is traditionally expressed in North, East, and Up components.

Phase Center Variations (PCV) express deviations from the mean phase center PCO. PCVs are expressed as a function of potential satellite observation angles, elevation θ and azimuth α.

PCO and PCV are intimately tied; it is possible to move phase center behavior from PCO to PCV and vice versa. To eliminate the PCO versus PCV ambiguity, it is instructive to sum the two components into a total Antenna Phase Center (APC):

$$APC(\theta,\propto) = PCV(\theta,\propto) - PCO(\theta,\propto) \qquad (1)$$

Note that PCO is subtracted from PCV, which references the total APC to the ARP. This equation is simplified for the elevation-only dependent PCV (**NOAZIM** line in ANTEX):

$$APC(\theta) = NOAZIM(\theta) - PCO(\theta) \qquad (2)$$

In Equation (1), PCO depends on elevation θ and azimuth α, yet PCO is traditionally expressed as a 3-component vector in North, East, and Up components. To convert the 3-component vector $\overrightarrow{PCO}$ into (θ,α) space, we project $\overrightarrow{PCO}$ onto the unit vector for a range of line-of-sight vectors:

$$PCO(\theta,\propto) = \overrightarrow{PCO_{NEU}} \cdot \begin{bmatrix} \cos\theta\cos\alpha \\ \cos\theta\sin\alpha \\ \sin\theta \end{bmatrix} \qquad (3)$$

For the elevation-only dependent PCV (Equation 2), the PCO conversion depends only on elevation angle and the vertical component of PCV:

$$PCO(\theta) = PCO_U \cdot \sin\theta \qquad (4)$$

When comparing APC values, the convention established by Geo++ is to set APC to zero at zenith:

$$APC_{final}(\theta, \propto) = APC(\theta, \propto) - APC(\theta = 0) \quad (5)$$

This bias value $APC(\theta = 0)$ will differ between different calibration methods, frequencies, and antennas under test. Luckily for positioning applications, this bias will be soaked up by the clock estimate or differenced away in double-different applications, thus it is valid to remove a bias which is independent of the angles of observation.