Detection of phase offsets in SuperDARN interferometry: some practical recommendations

by Pasha Ponomarenko

The first thing to look at is the elevation value at the very first range (gates 0). From what we know, it should correspond to virtual heights of around 100 km. The virtual height at close ranges can be roughly estimated as $h = r / \sin\varepsilon$, where *r* is the group range and ε is elevation. At these distances it is also important to use an accurate value for the group range. For Canadian radars, the *prm.frang* parameter describing the distance to the closest range gate corresponds to the leading edge of the radar pulse (Note: this can be different at other sites!!!). In this case, in order to relate our measurements to the centre of the scatter volume, we need to correct this value by adding a half of the range gate size, *prm.rsep*. Therefore, the expression for the group range vs range gate number *n* should be $r = prm.frang + prm.rsep*(n+1/2)$, where $n = 0,1,2...$. So, for the default values of *prm.frang* and *prm.rsep* (180 and 45 km, respectively), the expected elevation at the closest range gate should be $\varepsilon = \sin^{-1} h/r = \sin^{-1} 100/(180+45/2) \approx 30^o$. If this is what you observe within ±2-3°, then the phase calibration should be reasonably accurate. However, if there is a significant difference between the measured and expected values, then the phase (not elevation!) should be corrected, and the elevation values have to be re-calculated. The magnitude of the phase offset at a given frequency can be roughly estimated from the observed difference between the expected and measured elevation as $\Delta\Psi \approx \Delta\varepsilon \sin\varepsilon / kd$, where *k* is the wavevector magnitude and *d* is the interferometer base. The sign of the phase correction is determined by the position of the interferometer antenna, i.e. either in front of or behind the main array.

If the observed phase shift can be attributed to a simple time delay, then it should be converted to microseconds and entered as *tdiff* paramter into the hardware file for the time interval for which this particular source of the phase offset has been identified.

One way of finding out if the phase offset is indeed caused by the time delay is provided by the two-frequency mode. In this case the closest range gate, where we don't expect too much refraction, should provide very close elevation values at both probing frequencies (within the measurement uncertainty, of course!). So, if there is a noticeable difference in elevation between the two frequencies, one should vary the phase correction until both of them produce the same elevation values at the closest range. If this value corresponds to the virtual height of ≈ 100 km, then there is a high probability that the offset is produced by the time delay, otherwise the problem is more complex and requires further investigation.

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