(Final?) Correction for Eureka SKiYMET twisted antenna data.

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1 Introduction

Wayne Hocking had noticed a problem with the Eureka SKiYMET on Oct 23 2016: sudden increase in the number of ambiguities, and very height-smeared height vs. τ (decay time) plot . But a visit wasn't possible until the next July. Due to some sort of freak weather/accident/muskox/? one of the SKiYMET antennas had become twisted by about 40° (we **need** to know this for the correction process and will assume 40). The twist is expected to affect meteor zenith and azimuth (AOA), and therefore height for 9 months! of data, so it was worth looking for a fix. A paper was presented at the 2018 CANDAC workshop on this subject. The method was to invert the AOA, correct the phase at the affected antenna, and recalculate AOA (which basically involves choosing between different aliases) . [hereafter known as Method#1] But since the original AOA was calculated using all phases, the inversion can't be expected to give us correct phases for the other antennas, and so correcting just one antenna is expected to fail. [The source code for the analysis is not available to me.] And because we can't know what the no-twist results would have been, it's hard to say what effect the twist has.

The solution was to somehow twist the antenna on good data and process that with the SKiYMET program. I maintain a large but spare set of raw data I use for monitoring noise (important in the past). Through a lot of head scratching and effort (and luck) - I was able to create the 40° twist and process the result at Eureka while the SKiYMET data aquisition was temporarily halted. I chose raw data files that produced good meteor parameters, comprising ∼1000 meteor trails. And I now have the results which woild have bee obtained if the same antenna had been twisted.

Figure 1 shows the receiving antenna array. Note the two orthogonal lines of antennas, the NW line which was affected, and the NE line which was not. [At the time it was not known whether the analysis treated the two lines separately.]

All results (so far) depend on the Nov1-21 2017 data set I twisted and reprocessed. The longer write-up goes into detail, but briefy what I found was (I did not know any of this for the CANDAC workshop paper):

1. Figure 2: The twisted NE zenith angle component result (by inverting the original AOA) is virtually the same as if no twist, so it appears the two antenna lines are dealt with separately.

2. Figure 3: The twisted NW zenith component (Figure 3) has two possible values; one gives the same result as no twist; the other is a single valued function of the untwisted value. So given a twisted NW zenith, a correction can be applied - except the NW zenith value may have already been correct. So a way is needed to select which result to choose.

3. Figure 4: 65% of the accepted (e.g. non-ambiguous etc.) processed twisted data by the CANDAC-workshop method#1 (which tried to correct the NW zenith component, but did not modify the NE) give a correct AOA (and thus correct meteor parameters)

4. We know that τ is a function of height (but with a large amount of scatter), and since a different AOA will usually produce a different height (note, heights are also selected from aliases), this can be used to pick the more likely NW zenith option.

But we need a climatological calulation of τ vs. height (depends on temp and pressure). Originally Aura MLS was used, but it only goes up to ~90 Km (which is also the maximum height of occurrence for meteors). I extrapolated to 100 Km, but that is not a good fit in the summer near the mesopause (very sharp ~86 Km minimum in temperature, so I switched to MSISE-00 (global atmospheric model, no dependence on year) Applying this (and one or two other minor selection criteria, e.g. accepting twisted NW zenith between -40 and -25° uncorrected, because correction gives an unlikely value > 70 °, I get 78.8% good results (and 22.2% bad): Figure 5. Since I know everything in these tests (except the *black box* SKiYMET program) I can say which are good and which bad, but this is not the case for the real twisted data.

With this higher percentage of good, the two-pass wind fit program have a better chance of rejecting bad (I hope).

In prder to separate these re-processed data from the original "bad", I use mvYYYYMMDD.eureka.mpd names rather than mpYYYYYMMDD.eureka.mpd The other difference in these new ascii files is that there is only one header line

Figure 6 shows hourly means sequences for the CANDAC workshop Method#1 versus the new method. How well the artificially-created-twist-data methods apply to real twisted is a moot point, since we don't know the real original untwisted values, but the new correction certaily looks much better.

2 Conclusion

It might be argued that the incorrect ~22% of data (in off-axis clumps in Fig. 5) which should maybe not have been corrected or which were not corrected when when they should have beenin some other way, are somehow are related to particular AOA areas, maybe a different area for a different clumps. Histograms of # vs zenith and azimuth for each area (not shown) did not produce an answer, but with such a small number of data available it cannot be ruled out. The result of such "preferred areas" would be that correction worked better or worse depending on the actual meteor AOA, which we will not know in practice. If I had good statistics, a weighting could be given in the choice of NW zenith (to operate in addition to τ value) depending on corrected-AOA area.

The statistics are necessarily sparse, not because I am short of raw data files, but because of the time required to upload raw data files to Eureka and download the modified result.

The main conclusion is that a good percentage of the corrected date are the same as if there was no twist. The wind fit is a two pass process which helps get rid of spurious meteor data. So in my opinion the corrected data are usable

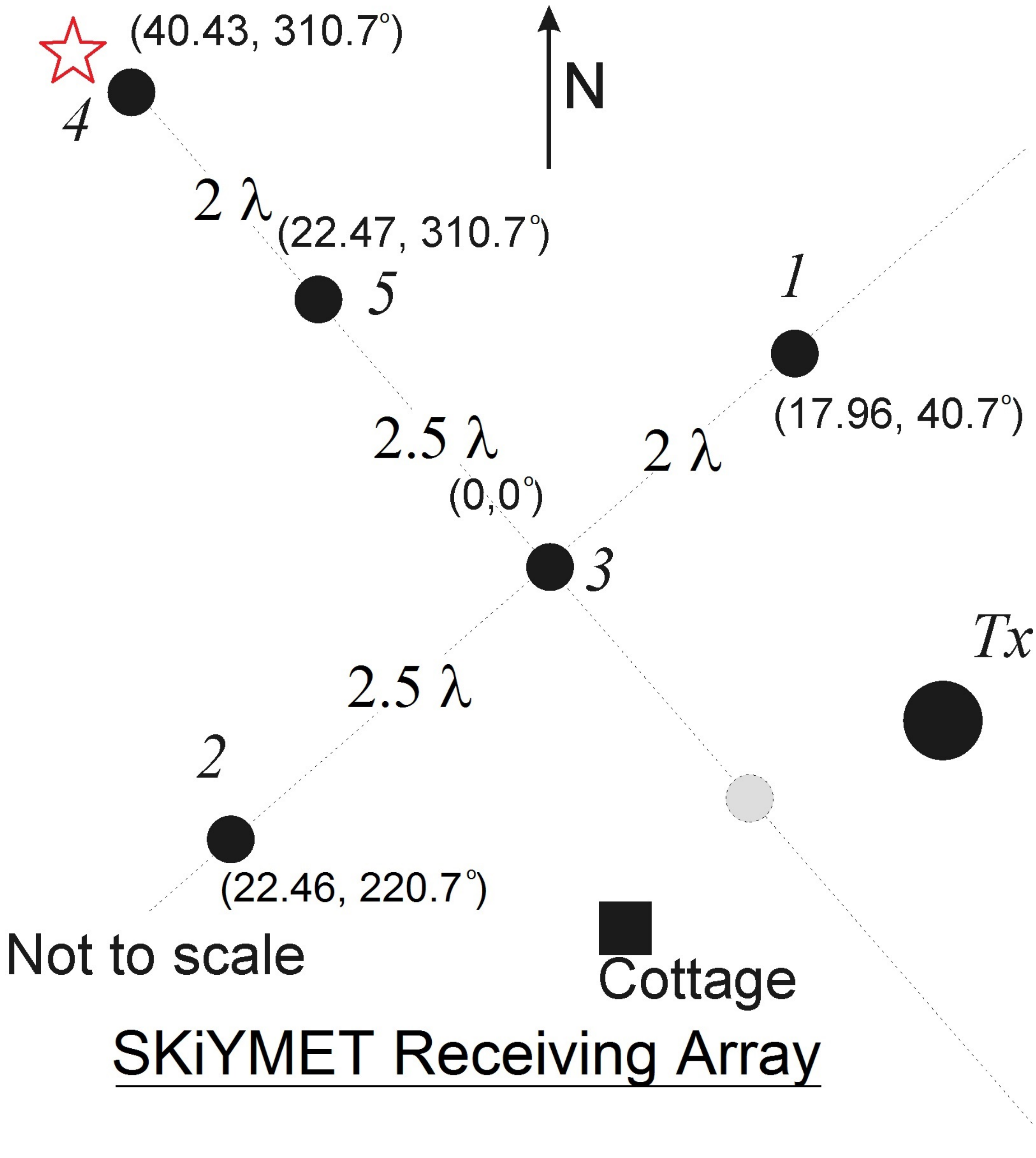

Figure 1: Eureka SKiYmet Receiving array.

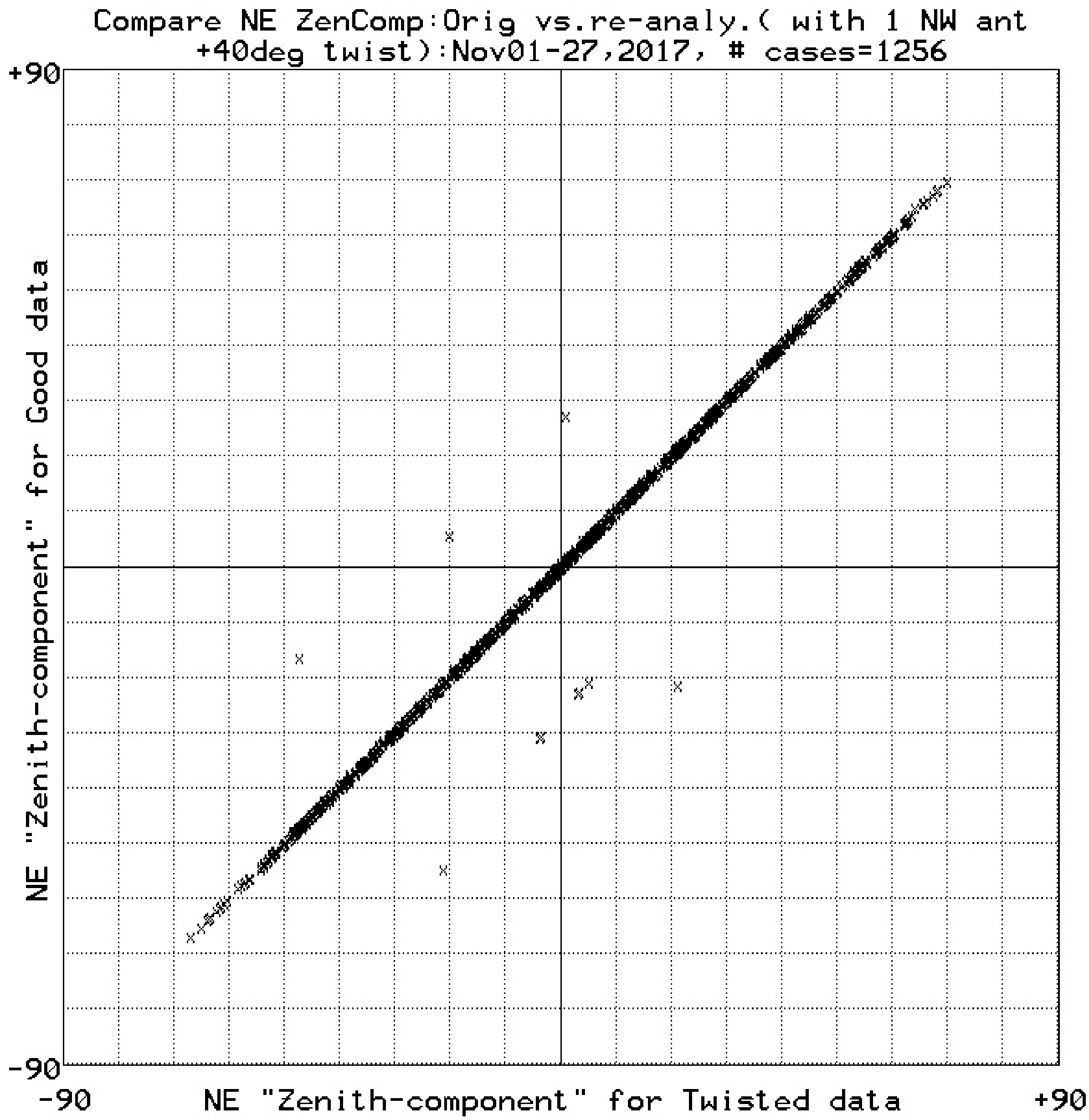

Figure 2: Compare original NE zenith component with that for artificially twisted then analysed data.

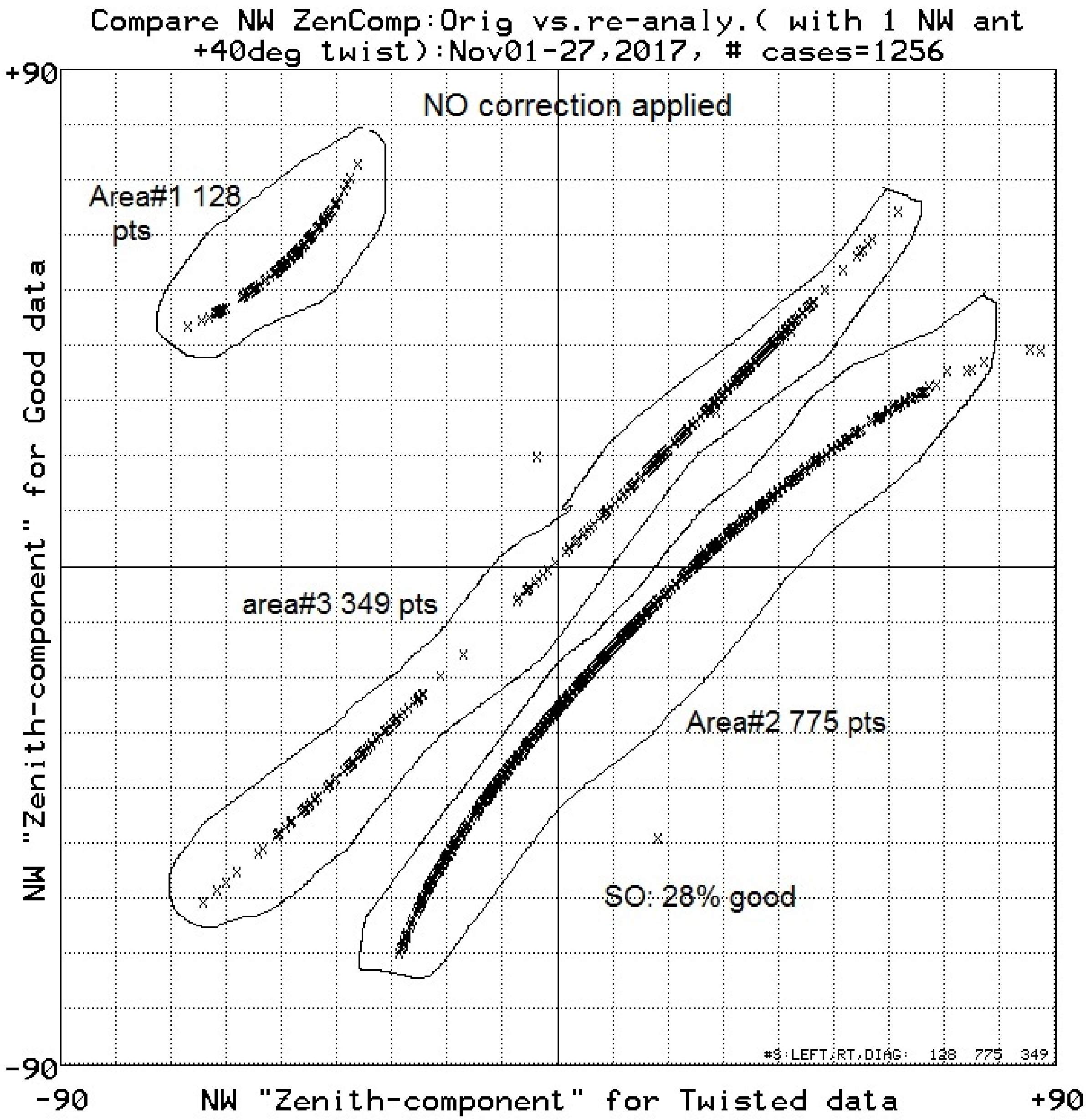

Figure 3: As in Fig 2 but for NW zenith component

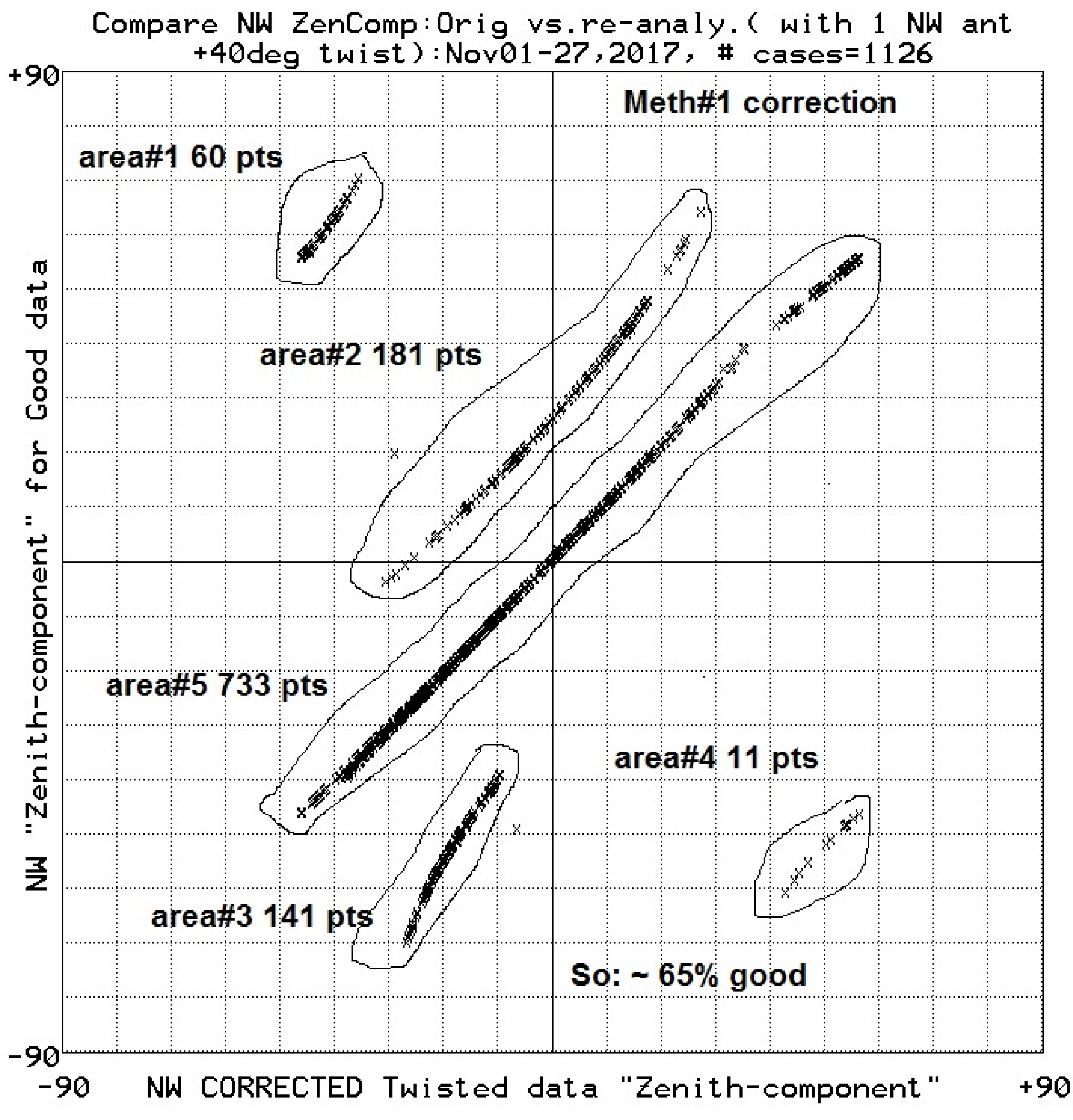

Figure 4: NW zenith component after Method#1 applied to the artifically twisted data. 65% of the corrected data give the same result as if the antenna had been no twist.

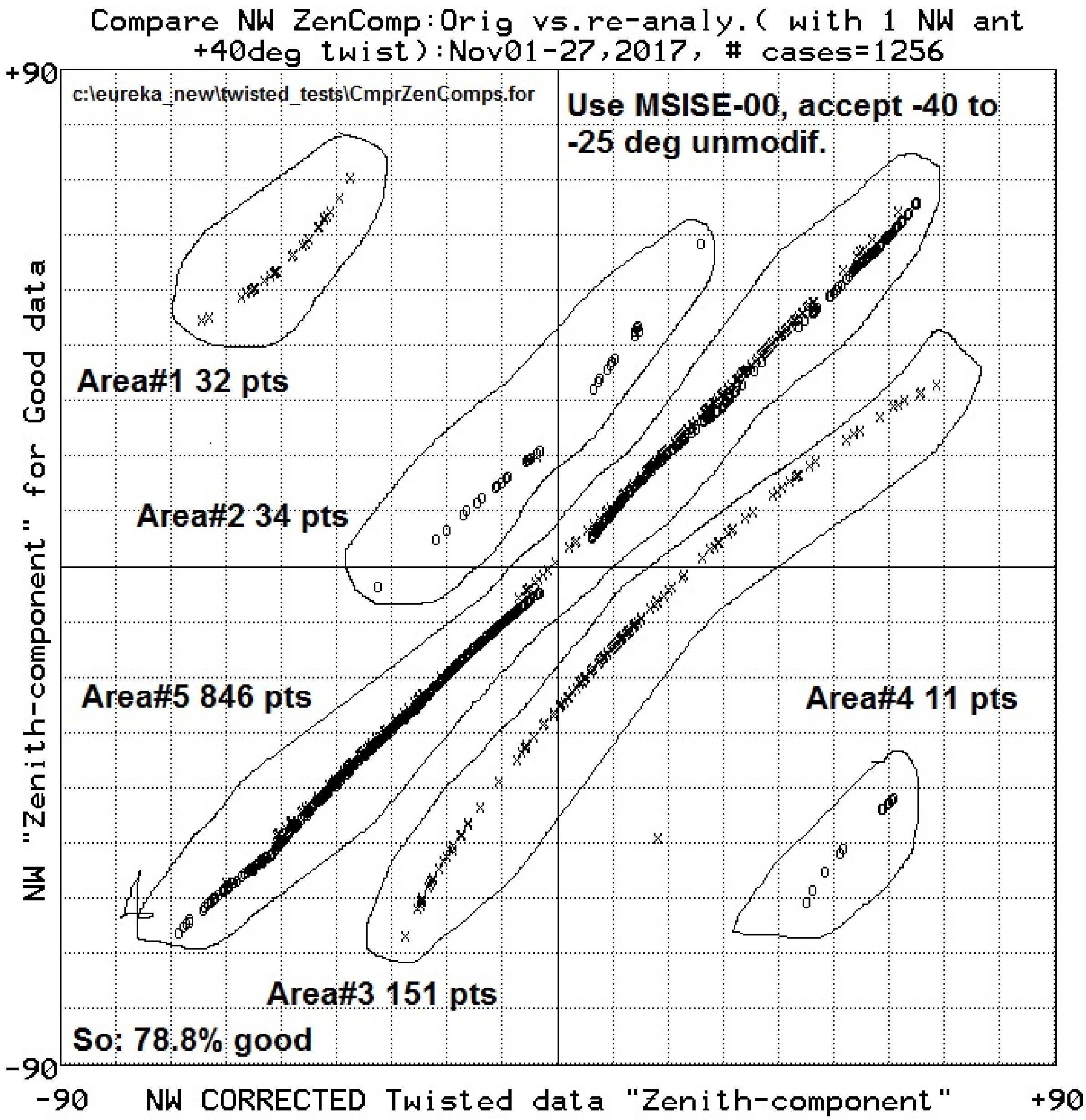

Figure 5: As in Figure 4 but with new correction method. 78% of the results are correct.

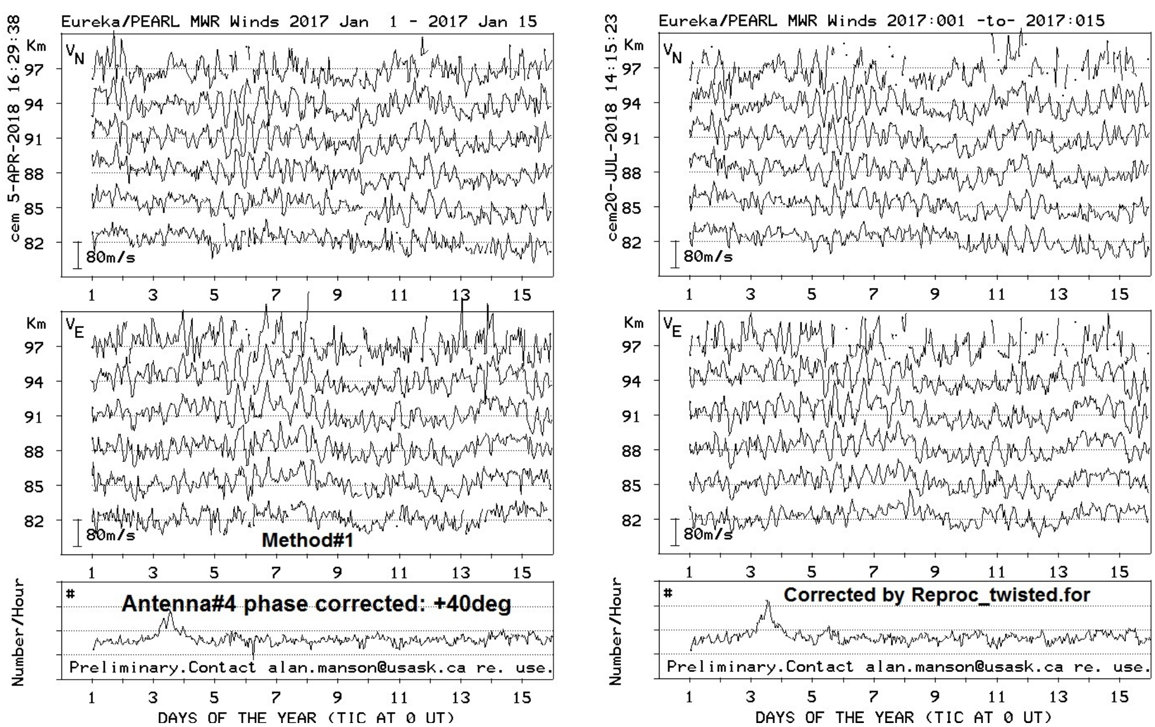

Figure 6: Compare Method#1 (Fig. 4) and Reproc_twisted (see Fig. 5) wind sequences on actual twisted, corrected, data.Reproc_twisted method is definitely superior.