

Review of the paper “Improved model for correcting the ionospheric impact on bending angle in radio occultation measurements” by M. Angling, S. Elvidge and S. Healy.

The authors consider residual error of the standard ionospheric correction, linear combination of L1 and L2 bending angles, related to ray separation at L1 and L2 GPS frequencies. In previous publications, this second order effect was approximated by squared L1-L2 bending angle with the coefficient. In the reviewed paper, the authors come up with the global model of the fitting coefficient and demonstrate that such model results in more effective reduction of the residual ionospheric error than constant coefficient. The results may be useful for climate applications of the GPS RO. I recommend publishing the paper after revision with account for comments below.

In this study, the authors: (i) assume local spherical symmetry of electron density; (ii) neglect higher order terms in the Appleton-Hartree equation. It may be useful to introduce these approximations at the beginning of the paper (currently (i) is mentioned in the last sentence of conclusions, while (ii) is not mentioned). Also, it may be useful to include reference to the paper by Hardy et al. (this paper may be available from different sources, see information at the end of the review). The paper by Hardy et al. also includes references to earlier publications on the second order ionospheric effects.

p.1, lines 13-14; p.5, lines 13-14: *"The main area of interest for k estimation is between 40 and 80 km. It is in this region where the residual error from the ionospheric correction is likely to be a major contributor to the overall error budget of neutral atmosphere retrievals."*

First, why 40-80 km is the region of interest? I believe that for weather and climate applications, GPS RO may be somewhat useful at 40 km but it is totally useless at 80 km. An explanation or reference is needed. Second, "likely" means the authors are not sure that large-scale ionospheric residual is the major error contributor. An explanation or reference would be helpful.

p.1, line 13: *"As expected, the residual bending angle is well correlated (negatively) with the vertical TEC. However, k is more strongly dependent on the solar zenith angle."*

In the context of the first sentence, the second sentence is not clear. In the approximation used by the authors, k depends only on electron density. The electron density, in turn, depends on the solar zenith angle. Thus k depends on the solar zenith angle through the electron density, and the expression "more strongly dependent" is not clear, unless it is explained "more strongly than what (?)". Also, see comment to p.5, line 24.

p.1, lines 16-17: *"The global mean error (i.e. bias) and the standard deviation of the residual errors are reduced to -2.2×10^{-10} rad and 2.0×10^{-9} rad respectively."*

First, the number to which something is reduced requires the number from which that something is reduced. Second, it is not clear from the context, whether the reduction is relative to k=0 or k=const? The abstract should be self-explanatory. Also, see comment to p.7, line 12.

p.2, line 17: "... *simple of implement* ..."
It should be "simple to implement".

p.2, line 22: "*Examples of now k varies with height* ..."
It should be "how" instead of "now".

p.3, line 1: " r_t " is introduced but never used. Is it needed?

p.3, lines 14-15: "... *bending angle error ... which increases as a function of the electron density squared, integrated over the vertical profile.*"

This sentence is not clear in several respects.

First, it is said "increases", but not said with what parameter? "Increases as a function" does not make sense (function may increase or decrease).

Second, "integration over" is commonly used with respect to domain (e.g., over height interval). Integration "over the profile" is not a common expression.

Third, if the authors mean equation (22) from VK94, it is more complicated than just integrated squared electron density; it includes derivative and kernel.

This sentence should be made clear and reference provided.

p.3, line 24: "... *as a function of ... time* ..."
Logically, it should be "local time".

p.4, line 2: "*A month median* ..."
It should be "A monthly median".

p.4, line 10: "PRIME" and "COST 238" should be explained.

p.4, line 12: "... *current version NeQuick* ..."
It should be "current version of NeQuick".

p.4, line 13: "... *Galileo GNSS system* ..."
In the "GNSS", the last "S" already stands for "system". The expression above should be corrected and "GNSS" explained.

p.5, line 16: "*Example height dependence*"
It should be "Example of height dependence"

p.5, line 19: "... *k is approximately linear* ..."
Linear with what parameter?

p.5, line 24: "... *k appears to be more strongly dependent* ..."
More strongly than what? Also, see comment to p.1, line 13.

p.5, lines 30-32: What is the physical sense of the statement that dynamic range of k is smaller than of F10.7? What are practical conclusions from this statement? This should be explained, otherwise I don't see why is this statement needed.

p.6, line 11: "*In order the build the models...*"
It should be "in order to build the models".

p.6, lines 20-25: It may be better to introduce "chi" here (rather than after equation 8) because "chi" is used in discussion of figures 11-13.

p.6, lines 11-13; p.7, line 7: What is the reason for using two different sets, generated with the same "random drivers", for building and testing the k-model? I assume that the sets are statistically representative and the results are statistically significant. Will the results be substantially different with the use of one set for building and testing?

p.7, line 12: "... *residual errors are reduced to 2.2×10^{-10} rad and 2.0×10^{-9} rad respectively.*"

The number to which something is reduced requires the number from which that something is reduced. Also, see comment to p.1, lines 16-17.

Figure 9: Axes labels on all figures, except Figure 9, have units in parentheses. Thus "k (impact parameter 60 km)" is confusing. It should be "k (1/rad)". The title above the figure can be changed to "k value at 60 km above London".

Figure 16: I think, "left" and "right" are mixed up in the caption. Left is full histogram, while right is zoomed to highlight tails.

Reference:

K.R. Hardy, G.A Hajj, E.R. Kursinski: Accuracies of Atmospheric profiles Obtained from GPS Occultations.

(i) Proceedings of the 6th International Technical Meeting of the Satellite Division of ION (ION GPS 1993), Salt Lake City, UT, September 22-24, 1993, pp. 1545-1556.

(ii) International Journal of Satellite Communications and Networking, Vol. 12, No. 5, 1994, pp. 463-473.