Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-162-RC1, 2017

Atmospheric Measurement Techniques Discussions

Interactive comment on "Improved model for correcting the ionospheric impact on bending angle in radio occultation measurements" *by* Matthew J. Angling et al.

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Received and published: 7 August 2017

General comments: The manuscript deals with a very interesting approach to further reduce ionospheric correction errors in neutral atmosphere GPS radio occultation measurements. The manuscript should be of interest for readers of Atmos. Meas. Techniques. The manuscript is well structured shortly reviewing the classical method referred to as VK94 and the improved approach published by Healy and Culverwell (2015) before describing the new approach. The suggested approach is practically an extension of the formula suggested by Healy and Culverwell (2015) where the classical equation is extended by a quadratic term of the linear combination of the bending

angles at L1 and L2 frequencies. The contribution of this term is optimized by a fixed factor κ. To better mitigate the remaining biases the new approach considers this factor as being variable. The related model for κ depends on the solar activity level (F10.7), the solar zenith angle and altitude. The presented results based on simulations using the NeQuik model as background indicate a clear improvement. To further confirm the results another model like IRI should be used. The publication of the manuscript is recommended.

Specific comments: Nevertheless there remains a significant difference between daytime and nighttime corrections which indicates still some bias. As the authors point out the remaining biases at nighttime can be ignored in practical applications due to their smallness. From a pragmatic point of view this is certainly true but from a scientific point of view this is unsatisfactorily. So I recommend discussing the observed day-night difference in more detail trying to explain the difference and to give an outlook how to improve the approach. As a starting point for the discussion here is my view: Former studies on ionospheric refraction of transionospheric radio waves have shown that not only the ionization level but also the profile shape plays a significant role on refraction as shown e.g. by Jakowski et al. (1994) and Hoque and Jakowski (2008, 2010). So I guess that the current κ model considers the shape of daytime profiles very well because the daytime ionization is usually much higher than at nighttime. However it is well known that the vertical electron density profiles at night have a much broader shape as at daytime due to the relative higher contribution of the plasmasphere (e.g. Jakowski et al. 2017). So the resulting bending effects at night differ considerably from those at daytime due to the high non-linearity of ionospheric refraction. To overcome this problem I suggest adding a local time dependence of κ in equation 8. The argumentation that the solar zenith angle embodies the position, local time and season is not sufficient because the slab thickness depends strongly on LT but much less from the solar irradiance (cf. Jakowski et al., 2017). So a separation of these dependencies by adding a LT term in equation 8 should improve the results.

Technical corrections: P6, l19: there is only one subsection, therefore should be cancelled P6 equation 8: the term dh looks like an increment of h, perhaps the coefficient symbol could be changed P9, l4: GPS instead of Gps Figure 9: unit of κ missing Figures 8, 10-15: Axis font size too small

References Jakowski N., F. Porsch, and G. Mayer, Ionosphere - Induced -Ray-Path Bending Effects in Precision Satellite Positioning Systems, SPN 1/94, 6-13, 1994 Hoque M. M. and N. Jakowski (2008), Estimate of higher order ionospheric errors in GNSS positioning, Radio Sci., 43, RS5008, doi: 10.1029/2007RS003817. Hoque M. M., Jakowski N. (2010) Higher order ionospheric propagation effects on GPS radio occultation signals, Advances in Space Research, doi:10.1016/j.asr.2010.02.013 Jakowski, N. und Hoque, M. M. und Mielich, J. und Hall, C. (2017) Equivalent slab thickness of the ionosphere over Europe as an indicator of long-term temperature changes in the thermosphere. J. Atmos. Solar-Terr. Phys., DOI: 10.1016/j.jastp.2017.04.008 ISSN 1364-6826

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-162, 2017.