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Nonlinear Processes in Geophysics
Discussions

Interactive comment on "An improved global zenith tropospheric delay model GZTD2 considering diurnal variations" *by* YiBin Yao et al.

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point-by-point response to the comment

Scientific questions

1. Reading becomes tedious by overuse of acronyms and references to other models are results. Please, use cm or mm, not both.

Response: Thanks for your comment. We have reduced the overuse of acronyms and references to other models. Particularly, we have shorten the introduction about other models. The new second paragraph of the Introduction is 'Some tropospheric delay models are developed to mitigate the tropospheric delay. The traditional models like the Hopfield model (Hopfield 1969), Saastamoinen model (Saastamoinen 1973) and

Black model (Black 1978) require real-time meteorological data to reach a correction accuracy better than 10 cm. Given the location and time information, the UNB series models (Collins and Langley 1997, 1998; Leandro et al. 2006, 2008) and EGNOS model (Dodson et al. 1999; Penna et al. 2001; Ueno et al. 2001) use the empirical meteorological parameters in the form of the latitude band table to estimate the ZTD with an accuracy of about 5 cm, while the IGGTrop model (Li et al. 2012) is based on the empirical three-dimensional parameters in the form of the grids to calculate the ZTD with an accuracy of about 4 cm. However the IGGTrop model needs a large number of parameters. Then Li Wei et al. (2015) developed the new versions of IGGtrop named IGGtrop_ri (i = 1, 2, 3) by simplifying the algorithm and lowering the resolution, which substantially reduce the required numbers with a similar accuracy. Krueger (2004;2005) and Schüler (2014) obtained the annual and diurnal coefficients for underlying parameters by fitting every grid point's meteorological parameters time series of the National Centers for Environmental Prediction (NCEP) atmospheric data, and established two global tropospheric delay models-TropGrid and TropGrid2 . The correction accuracy of TropGrid2 is 3.8 cm. Böhm et al. (2015) proposed Global pressure and temperature 2 wet (GPT2w) as an extension to GPT2 (Lagler et al. 2013) with an improved capability to determine zenith wet delays in blind model. The GPT2w model accounts for the annual and semiannual variations of meteorological parameters, and the validation with IGS data and an extended validation with ray-traced delays (Möller et al. 2014) show a high accuracy of about 3.6 cm for GPT2w. However, GPT2w has numerous parameters for storage like the above grid models such as IGGTrop series models and TropGrid series models.'

In this paper, we have changed the unit of mm to cm in some parts.

2. I think that it's necessary an atmospheric approximation to problem. An approximation as of the article 'Seasonal variability of GPS-derived zenith tropospheric delay (1994–2006) and climate implications' of Shuanggen Jin, Jong-Uk Park, Jung-Ho Cho, Pil-Ho Park in Climate and Dynamics Journal can be more appropriate for this journal.

A reference to this article can be included.

Response: Thanks for your comment. The reference of article 'Seasonal variability of GPS-derived zenith tropospheric delay (1994–2006) and climate implications' is in the reference list of our paper. We have added a reference as you suggested, which is 'Pramualsakdikul, S., Haas, R., Elgered, G., & Scherneck, H. G. (2007). Sensing of diurnal and semi-diurnal variability in the water vapour content in the tropics using GPS measurements. Meteorological Applications, 14(4), 403-412.'

3. An article very similar has been written for Li Wei with their IGGTrop model for Chinese Science Bulletin, and comparisons with results of IGGtrop model (or TopGrid2) can be of interest when you compare your results. Please, change in your references and include the entire name of first author (line 447, line 449).

Response: Thanks for your comment. We have no access to the codes or programs of the IGGTrop model and TropGrid2 model. Maybe these models are not available for public currently. Although we cannot directly compare our model with these models, we presented these two models's accuracy verified in their articles in our introduction section. We have changed the reference and completed the entire name of first author as you suggested.

4. The aspects related with validation (3.2), can be the most contentious. Why you use these 362 IGS sites?

Response: Thanks for your comment. In 2010, some IGS sites have the severe problem of ZTD data missing. For a convinced validation, only the IGS sites with at least 120 days (approximately a third of the year) of tropospheric delays are selected. We have added this explanation in section 3.2.

5. Aspects related with the ZTD changes are poorly traited. Convection effects are much more intense at the tropics daily. This would seem sufficient to explain the increased error near the equator. In line 327 you compare between GZTD and GZTD2

and you indicate that there are improvements of RMS in areas where you have limited IGS sites to compare.

Response: Thanks for your comment. We have rewritten the explanation as 'These areas are near the equator where the deep moist convection effects related to the change of ZTD are more intense , so the weather change in these areas are more complex compared with other areas, resulting in difficulty for modelling tropospheric delay.' The expression of line 327 is not very rigorous as you pointed out, which has been rephrased as ' The significant improvements of RMS are found at the low-latitude sites which are distributed in Pacific Ocean, South America coast and West Africa coast where the diurnal variations are notable (see Figure 3d)'

Technical corrections

Change Predication in line 56 for Prediction. Change girds for grids in line 79. Include'2. The new..' in line 98 and '4. Conclusions' in line 372. You forgot the dot.

Response: Thanks for your comment. We accepted all your suggestions and made the corrections.

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