This manuscript introduces a globally empirical ZTD model using ERA5 atmospheric reanalysis data. It offers a well-structured analysis of temporal and spatial characteristics, presenting intriguing research within the domain of high-precision tropospheric modeling. However, I have identified several minor issues that warrant attention and correction. Therefore, in preparation for potential publication, I recommend implementing the following modifications:

Respone: According to the your comments, we have revised the manuscript. If there are any other modifications we could make, we would like very much to modify them and we really appreciate your help. The detailed revisions and responses are listed below:

1. In the introduction, the authors introduce only classic models. It is suggested to supplement the literature with recent global ZTD empirical models.

Thank you very much for your comments. we have substituted and added the following content **to L27 and L55**:

"Accurate Zenith Tropospheric Delay (ZTD) information can improve GNSS positioning precision (Nafisi et al., 2012; Zhang et al., 2022; Zhao et al., 2023a; Zhang et al., 2020; Zhou et al., 2021)."

"Furthermore, Yang et al. (2021) employed an Artificial Neural Network (ANN) to effectively mitigate the systematic deviation within the GPT3 model, leading to improved ZTD accuracy in Hong Kong, China. Zhao et al. (2023) took into account the residual term between the GPT3 model and GNSS observations ZTD to develop a novel model specific to China (CHZ). Additionally, Li et al. (2023) discover the disparities between ERA5 and GNSS-based ZTD, prompting the creation of a new global model (IGGZTD-S). This new model demonstrated exceptional performance in Precise Point Positioning (PPP), particularly in the vertical direction."

Zhao, Q., Liu, K., Sun, T., Yao, Y., and Li, Z.: A novel regional drought monitoring method using GNSS-derived ZTD and precipitation. Remote Sensing of Environment, 297, 113778. https://doi.org/10.1016/j.rse.2023.113778. 2023a.

Yang, F., Guo, J., Zhang, C., Li, Y., and Li, J.: A Regional Zenith Tropospheric Delay (ZTD) Model Based on GPT3 and ANN. Remote Sensing, 13, 838. https://doi.org/10.3390/rs13050838. 2021.

Zhao, Q., Su, J., Xu, C., Yao, Y., Zhang, J., and Wu, J.: High-precision ZTD model of altitude-related correction. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 16, 609-621. https://doi: 10.1109/JSTARS.2022.3228917. 2023b.

Li, H., Zhu, G., Kang, Q. and Wang, H.: A global zenith tropospheric delay model with ERA5 and GNSS-based ZTD difference correction. GPS Solutions, 27, 154. https://doi.org/10.1007/s10291-023-01503-8. 2023.

2. In 158, "This may be due to the complex climate variations in these areas causing more dramatic ZTD variations ", are the authors sure that semi-daily period amplitude is mainly due to complex climate variations? Is there any other explanation for this phenomenon?

Thank you for your suggestion. We realize that this statement may be too simplistic, We have modified it **in L169**:

"This may be due to the fact that these regions are located at the junction of the ocean and land and are in the same direction as the northeast (Northern Hemisphere) and southeast (Southern hemisphere) equatorial trade winds (Yao et al., 2013), indicating that the distribution of ZTD is not only related to meteorological variables and topography, but also influenced by thermodynamic circulation (Yao et al., 2013)."

Yao, Y., Zhu, S. and Yue, S.: A globally applicable, season-specific model for estimating the weighted mean temperature of the atmosphere. Journal of Geodesy, (86), 1125–1135. https://doi.org/10.1007/s00190-012-0568-1. 2012.

Yao, Y., He, C., Zhang, B., and Xv, C.: A new global zenith tropospheric delay model GZTD. Chinese Journal of Geophysics, 56(7), 2218-2227. https://doi:10.6038/cjg20130709. 2013.

3. In 162, please include specific references to substantiate the description and enhance its credibility.

Thank you for your suggestion. We have revised it in **L173**:

"According to relevant studies, ZTD values are primarily associated with latitude factors on a global scale, while showing a smaller correlation with longitude factors (Chen et al., 2020; Huang et al., 2022)."

Chen, P., Ma, Y., Liu, H., and Zheng, N.: A new global tropospheric delay model considering the spatiotemporal variation characteristics of ZTD with altitude coefficient. Earth and Space Science, 2020, 7(4), e2019EA000888. https://doi.org/10.1029/2019EA000888. 2020.

Huang, L., Zhu, G,, Peng, H., Liu, L., Ren, C., and Jiang, W.: An improved global grid model for calibrating zenith tropospheric delay for GNSS applications. GPS Solutions, 27(1), 17. https://doi.org/10.1007/s10291-022-01354-9. 2023.

4. In 183, consider providing a more comprehensive explanation of "Hs" to ensure clarity and understanding.

Thank you very much for your comments. We have modified it in **L197** as follow:

"In Eqs. (4) and (5), H_s stands for ZTD value at the average elevation, H_t stands for target elevation, H_r stands for reference elevation, and ZTD_t stands for ZTD value at target elevation. a_i stands for the constant, annual and semi-annual period correction factor. ZTD_{r1}, ZTD_{r2}, ZTD_{r3}, ZTD_{r4} stands for ZTD values at the reference elevations of different piecewise, respectively."

5. In 197, please correct the error in the expression of "ai".

We appreciate for your effort to review our manuscript. As you said, it was a mistake, We have revised it **in L215** as follow:

" a_i represents the constant, latitude, annual and semi-annual period correction factor, H_t stands for target elevation, φ represents latitude, DOY represents year day, HOD represents time."

6. The authors need to pay attention to the format of all the images in the full manuscript, some partitions have subtitles, some do not, need to be uniform.

Thank you very much for your comments. It was an oversight on our manuscript, and we modified and unified the images:

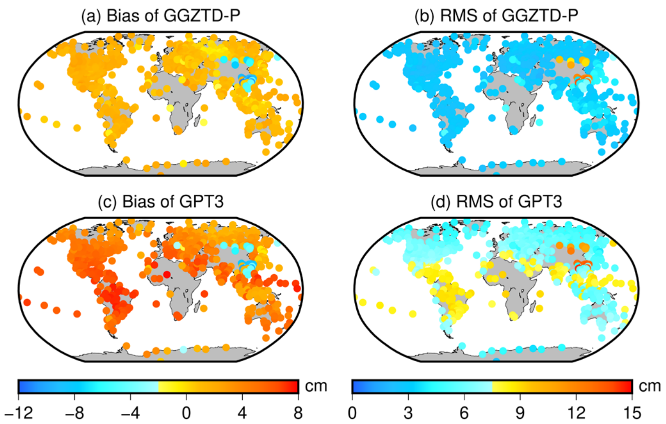

Figure 8. ZTD profiled accuracy distribution of GGZTD-P model and GPT3 model for global radiosonde stations in 2017 and 2018.

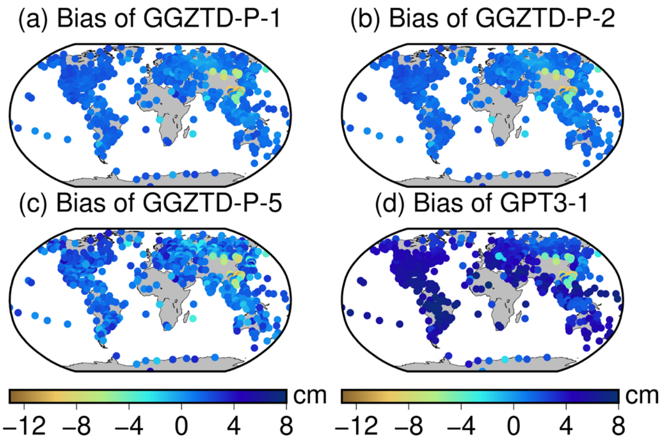

Figure 10. Bias distribution of the GPT3 model and the combined GGZTD-P model in the global radiosonde profiled ZTD accuracy.

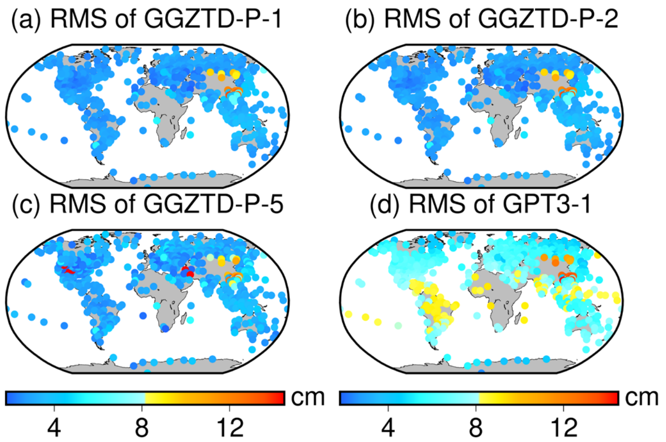

Figure 11. RMS distribution of the GPT3 model and the combined GGZTD-P model in the global radiosonde profiled ZTD accuracy.

7. In Figure 6, can the authors explain why they chose a height of 6km and not some other height?

   Thank you very much for your comments. We chose 6km because the highest global surface height provided by ERA5 is around 6km. Therefore, 6 km was chosen to analyze the variation of ZTD. In addition, Figure 6 proves that the global distribution of ZTD of ERA5 atmospheric reanalysis data is closely related to latitude factors.

8. In Figure 8, the author needs to pay attention to the border of each small bar chart.

   We are grateful for the suggestion. We have corrected it as follow:

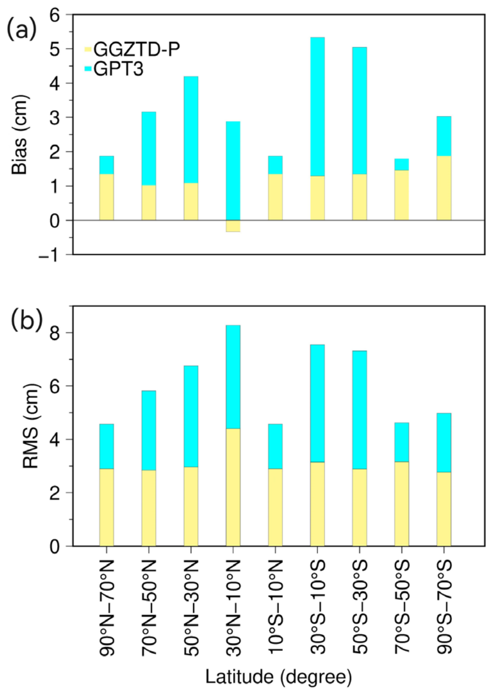

Figure 9. Accuracy distribution of GGZTD-P model and GPT3 model in different latitude regions of MERRA-2 profile ZTD.