

## ***Interactive comment on “A comparison between the GNSS tomography technique and the WRF model in retrieving 3D wet refractivity field in Hong Kong” by Zhaohui Xiong et al.***

### **Anonymous Referee #1**

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General comments: The article is interesting in combining the two ways of retrieving 3D wet refractivity field. But it could still become significant with major changes, revisions. Therefore, the paper has the following issues that need to be addressed before it can go through the next process. The problems include (but are not limited to) the following.

Specific comments: - lines 46-51: I agree that 1) the least squares scheme or the Kalman filter scheme with additional constraints or using a priori information and 2) the algebraic reconstruction algorithm or similar methods are the main ways to get the results of the tomographic inversion, but the GNSS WV tomography methods quite a bit more than the tomographic inversion. The methods to establish the tomographic

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region, and then to divide up this region by tomographic voxels or tomographic nodes are also very important for improving the tomographic model. For completeness, it would be of great benefit to the readers to say something about the other aspects of the tomographic method except the tomographic inversion.

- lines 85-96: I think that the process of the GNSS data does not need to be described in such detail. The parameter settings for Bernese 5.0 software can be presented by a table in the appendix. It may not be appropriate to devote much space in the main body of the paper.

- lines 103-104: Do I understand it correctly that the settings of the horizontal resolution and the number of the vertical layers are defined manually? If I understand it correctly then I am not clear the actual resolutions both in horizontal and vertical of the input data. I think it would be better to provide more information about the input data.

- line 122: Are you sure that the unit of specific humidity is kg/kg.

- section 3.2: Although a reference to GNSS tomography is useful, how to achieve this also an important content for readers in this paper. The detail information about the process of the GNSS tomography is needed to add.

- lines: 128-130: Priori information, as the initialization parameters, is the main part of the tomographic model. Line 144 shows that the background data (ECMWF ERA-Interim Data) has been used in WRF preprocessing system. Some background data as NWM fields or even standard atmosphere water vapor distribution can also be used in GNSS tomography. So I think it would be better to increase a set of experiments for the GNSS tomography with the priori information (GTPI). It would be interesting to compare the results from GTPI with other experiments which were conducted in the paper.

- lines: 139-140: You state that the reanalysis results and the radiosonde observation are interpolated to the centers of the associated tomography voxels. I am a little bit

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surprised by this statement. The radiosonde (RS) data are used to validate the WR derived from GNSS tomography and reanalysis in this paper. Therefore, you should avoid adjusting the original data of RS. The other reason is that the RS data also exists the potential error. Comparison of the tomographic results with corresponding interpolation results of the RS may increase the influence of RS error due to insufficient results of the comparison. To get more reliable and complete results, it would be nice to interpolate the results of GNSS tomography and reanalysis to the position of the RS. On the one hand, can you explain how did you unify the units of the layers between the reanalysis and the GNSS tomography? You don't provide any information about it. I mean that the atmosphere is vertically divided into 45 layers by different pressure for the reanalysis (in line 104). However, for the GNSS tomography, the troposphere is vertically divided into 13 layers with a constant thickness of 800 meters (in line 131). It should be followed by one paragraph description of the method to unify the units.

- line 222: "time points" is not suitable for this case. The inversion of the tomographic WR needs GNSS data during a specific period of time. It's more like epochs than time points.

- lines 229-230: The average DA-ZTD and DA-Tomo may not suit for this case. It would be better to use Mean Absolute Error (MAE) instead of the average. MAE can avoid the canceling effect of the positive and negative values.

- lines 238-241: I am not sure that the rainy period and the rainless period present a striking contrast. Even in the rainy period, the WR derived from GNSS tomography and reanalysis only at the specific period (i.e., 0:00 and 12:00 UTC daily), at which it may not rain.

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