

Comments to the Author,

This manuscript integrates TPW products from eight microwave satellites with those from the Himawari-8/9 (H8/9) geostationary satellite to generate an all-weather TPW dataset at the highest spatiotemporal resolution (0.02°). Methodologically, two correction strategies are developed. First, a bias correction approach is introduced, using H8/9 TPW data as a reference to calibrate multi-source microwave remote sensing TPW and thereby reduce inter-sensor discrepancies. Second, an adaptive correction method is designed to improve the accuracy and spatial continuity of the fused TPW data under cloudy conditions. Compared with ERA5, which has a spatial resolution of 0.25° , the fused product represents a 12.5-fold improvement in spatial resolution. Overall, this is an interesting topic and the methodology is appropriate. However, I find several issues that require further clarification, as outlined below. I recommend the manuscript needs revision before accepting for publication.

Major comments:

1. Lines 361–363: The correction model is trained using a random forest algorithm. Please clarify which year of data was used for training and how many samples were included. Furthermore, how is the model trained, updated, and applied on a monthly basis?
2. Similarly, for the downscaling of coarse-resolution TPW, from which time period are the datasets used to train the spatial downscaling model and the correction model, and how many samples are included?
3. Line 371: The authors state that “for the remaining missing areas, linear interpolation was used to fill the data pixel by pixel.” As shown in Fig. 4c, in some regions—for example, over the Tibetan Plateau—TPW data are available only in the central and eastern parts, while large areas in the west remain missing. In such cases, how is interpolation performed to generate the fused TPW data at 0.25° resolution?
4. The fused TPW data under all-weather conditions include clear-sky conditions derived from the H8/9 TPW dataset, which is retrieved using a neural network–based rapid retrieval algorithm (Jiang et al., 2022). Whereas the high-resolution TPW data under cloudy conditions, derived from eight microwave satellites, are used to fill the missing areas in the H8/9 TPW dataset. Therefore, it is recommended that the authors provide an evaluation of the fused TPW specifically under cloudy conditions to assess its accuracy and reliability.
5. The authors have constructed an all-weather TPW dataset with hourly temporal and 0.02° spatial resolution covering the Tibetan Plateau from 2016 to 2022. However, the accuracy evaluation is performed only for the TPW in 2017, and no assessment in the other years is given in the current manuscript. It is recommended that the authors evaluate the TPW data for all years from 2016 to 2022 to ensure the robustness and consistency of the dataset.
6. The fused high-resolution TPW product can be compared with radiosonde-derived TPW to further validate its accuracy, as radiosonde measurements are considered a reliable method for obtaining TPW with minimal uncertainty. As shown in line 230, the manuscript mentions a comparison with TPW data from radiosonde observations (IGRA). Here, it unclear how well the

fused high-resolution TPW product agrees with the IGRA data. A quantitative assessment or validation would help clarify this point.

Other minor comments:

1. Line 218: The hyphen in “3.5 - 5.2 mm” should be replaced with an en dash, i.e., “3.5–5.2 mm,” to conform to standard scientific notation.
2. The sub-subsection titles formats need to be standardized. For example, line 254 is titled “2.2.3.GNSS TPW data,” whereas line 276 is titled “2.2.5ERA5 TPW data.” It is recommended to include a consistent separator, such as a period or space, between the subsection number and the title to avoid potential confusion for readers.
3. Line 287, the term “spatiotemporal information” is used. Does this refer to the “time” mentioned in line 292?
4. In Figure 2, within the bias correction section, the coarse-resolution TPW panel for 2017-06-08 10:00 (UTC) appears to have an extra arrow in the lower-right corner (around 67°E–77°E). Please check this.
5. In Figure 3, the maximum difference in scanning times among the satellites is approximately 3 hours, while the minimum difference is about 1 hour. Does this imply that the temporal resolution of the fused TPW data in this study ranges from 1 to 3 hours?
6. Line 357: The authors mention using the random forest algorithm. A proper reference for the random forest method should be provided to support its use.
7. Lines 459–460: The manuscript states that “the fused TPW product generated for the same year was validated under all-weather conditions at three temporal scales: hourly, daily, and monthly.” Could the authors clarify how the fused TPW data are processed at different temporal scales? For example, do “daily” and “monthly” refer to daily and monthly mean TPW, respectively? Additionally, was the evaluation conducted using the entire year of 2017?
8. Line 483: “figure” should be “Figure 6”.
9. The citation style for figures should be kept consistent throughout the manuscript. For example, line 481 cites “...(Fig. 6a, c, e),” whereas line 513 cites “...(Fig. 8(c, f, i, l)).” Please adopt a uniform format for figure references.