

Response Letter to Reviewer #1

Dear Reviewer,

We sincerely thank you for your careful re-evaluation of the revised version of our manuscript, entitled “*Evaluation of reanalysis precipitable water vapor under typhoon conditions using multi-source observations*” (Manuscript ID: EGUSPHERE-2025-4438), as well as of our previous response. We are truly grateful for your recognition and positive assessment of our work and revisions.

In your report, you mentioned that some minor technical corrections were still needed. The handling editor, Dr. Gabriele Stiller, uploaded the suggested technical corrections in the system, and we have carefully checked and corrected them accordingly.

Specifically, we have corrected the incorrect figure citation in line 264, the spelling error in line 247, and the repeated commas in line 206. We are very grateful for your careful reading of the revised manuscript. In addition, we have checked the manuscript throughout for similar issues.

Regarding your suggestion on the typhoon numbering format, we have adopted your recommendation by removing “No.” and consistently using the format “Typhoon In-fa (2106)” throughout the manuscript. Regarding the word “native” in line 136, we have removed it as suggested.

Regarding the issue raised for Table 2, we would like to provide the following clarification. We sincerely thank you for your careful examination of the Bias, RMSE, and dRMSE values. You are absolutely correct that, according to the mathematical derivation and the definitions of these statistics, the square of the Bias plus the square of the dRMSE should equal the square of the RMSE. However, the values reported in Table 2 are averages across all GNSS stations. In other words, this relationship holds for an individual GNSS station, but it does not necessarily hold after averaging these statistics over all GNSS stations. Therefore, this does not indicate a calculation error. This is also why the averaged results not only for ERA5, but also for MERRA-2 and JRA-3Q, do not strictly satisfy this relationship. To illustrate this point more clearly, we provide below several examples of Bias, RMSE, and dRMSE values for individual typhoon–GNSS station pairs, that is, the results for a single GNSS station during a specific typhoon event, as shown in the following figure.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	'202002'	'NURI'	'2020-06-0...	'2020-06-1...	'GDZH'	'TY----->'	0.5963	2.9718	2.9114	-1.5354	4.1962	3.9053	-0.5699	5.5491	5.5197
2	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'GDZH'	'TY----->'	0.0702	1.1864	1.1844	-2.9054	3.3859	1.7387	-0.7375	2.3946	2.2782
3	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'GDZJ'	'TY----->'	0.1596	2.4189	2.4137	0.0409	1.0910	1.0902	1.1198	2.0840	1.7576
4	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'GUAN'	'TY----->'	1.7485	1.9294	0.8157	-1.8795	1.9896	0.6525	1.8197	2.2109	1.2557
5	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'GXBH'	'TY----->'	0.4109	1.9703	1.9270	0.2112	1.2342	1.2160	0.8105	1.8750	1.6908
6	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'GXNN'	'TY----->'	-2.7003	2.9708	1.2387	-2.7067	2.8729	0.9631	-0.1123	2.1786	2.1757
7	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'HIHK'	'TY----->'	0.3504	2.3014	2.2745	0.9025	3.2346	3.1062	2.2331	3.5344	2.7396
8	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'HISY'	'TY----->'	2.6216	3.5047	2.3260	2.1929	4.0775	3.4377	5.4521	6.6663	3.8359
9	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'QION'	'TY----->'	-0.9953	2.7299	2.5420	-1.5083	2.6102	2.1302	4.4863	5.7484	3.5942
10	'202003'	'SINLAKE'	'2020-07-2...	'2020-08-0...	'YONG'	'TY----->'	2.5257	3.3350	2.1777	3.0114	3.6237	2.0156	3.9911	4.3227	1.6605
11	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'FJPT'	'TY----->'	-1.1720	2.8542	2.6025	-2.1607	2.9282	1.9762	0.3207	3.7604	3.7467
12	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'FJXP'	'TY----->'	-0.0944	3.2650	3.2636	-1.5464	3.4622	3.0977	2.8547	6.2302	5.5377
13	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'JSL5'	'TY----->'	0.1353	2.0537	2.0492	-2.2724	3.7139	2.9376	1.8308	4.2098	3.7909
14	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'JSNT'	'TY----->'	1.1302	2.4517	2.1756	-1.2731	3.3649	3.1148	2.3774	4.9604	4.3535
15	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'SHA2'	'TY----->'	0.5082	2.0850	2.0221	-1.6405	2.7284	2.1801	1.4077	4.9973	4.7949
16	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'ZJJD'	'TY----->'	0.3202	1.8652	1.8375	-1.2074	3.2801	3.0498	4.1419	5.9302	4.2441
17	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'ZJWZ'	'TY----->'	-1.4653	2.5747	2.1170	-3.1874	4.0911	2.5647	-0.3982	4.6313	4.6142
18	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'ZJZ5'	'TY----->'	0.8090	2.1919	2.0372	-1.7589	2.4229	1.6663	2.2233	4.6086	4.0368
19	'202006'	'MEKKHALA'	'2020-08-0...	'2020-08-1...	'GDS1'	'TY----->'	1.0221	2.6974	2.4963	-1.0127	2.8524	2.6666	-0.4069	6.0313	6.0176
20	'202006'	'MEKKHALA'	'2020-08-0...	'2020-08-1...	'XIAM'	'TY----->'	0.8784	1.9411	1.7310	-1.3079	2.6712	2.3290	0.1528	4.9293	4.9269
21	'202007'	'HIGOS'	'2020-08-1...	'2020-08-2...	'GDZH'	'TY----->'	0.0166	1.2717	1.2716	-2.8113	4.8053	3.8971	-0.3172	3.4990	3.4845
22	'202007'	'HIGOS'	'2020-08-1...	'2020-08-2...	'GUAN'	'TY----->'	0.5890	1.8209	1.7230	-3.1941	3.6183	1.6999	0.9333	3.6503	3.5289
23	'202007'	'HIGOS'	'2020-08-1...	'2020-08-2...	'GXWZ'	'TY----->'	-0.7677	1.7559	1.5792	-3.5460	4.0970	2.0520	-0.1123	2.5996	2.5972
24	'202009'	'MAYSAK'	'2020-08-2...	'2020-09-0...	'ZJZ5'	'TY----->'	1.7708	2.8158	2.1893	0.1464	2.9099	2.9063	1.8264	3.7749	3.3037
25	'202011'	'NOUL'	'2020-09-1...	'2020-09-1...	'HISY'	'TY----->'	1.9365	5.7593	5.4240	-1.6946	5.0781	4.7870	3.5463	6.0558	4.9088
26	'202011'	'NOUL'	'2020-09-1...	'2020-09-1...	'QION'	'TY----->'	-2.6653	3.8341	2.7562	-5.4926	5.8798	2.0986	-0.1558	6.4544	4.6427
27	'202011'	'NOUL'	'2020-09-1...	'2020-09-1...	'YONG'	'TY----->'	3.7678	5.5356	4.0555	1.1666	4.5487	4.3965	4.8153	7.2480	5.4172
28	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'GDZJ'	'TY----->'	0.5901	1.3340	1.1963	-0.3694	1.6631	1.6215	0.1354	3.0650	3.0620
29	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'GXBH'	'TY----->'	-0.0041	1.1102	1.1102	-1.2463	1.9554	1.5068	1.1792	3.4101	3.1997
30	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'GXNN'	'TY----->'	-3.5505	3.8685	1.5359	-5.1935	5.4413	1.6235	-0.2942	3.6419	3.6300
31	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'HIHK'	'TY----->'	1.1184	1.7197	1.3063	-1.0262	2.0736	1.8019	2.2512	3.8421	3.1134
32	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'HISY'	'TY----->'	1.3639	2.7963	2.4411	2.3003	4.5992	3.9826	5.0675	6.0895	3.3768
33	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'QION'	'TY----->'	-0.3656	2.3949	2.3668	-0.6792	3.9695	3.9110	4.8620	6.0611	3.6190
34	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'YONG'	'TY----->'	5.6148	6.2309	2.7015	2.8455	4.3134	3.2417	5.5218	6.1650	2.7416
35	'202017'	'SAUDEL'	'2020-10-1...	'2020-10-2...	'HIHK'	'TY----->'	-0.1205	1.7236	1.7194	-1.8372	3.1457	2.5535	1.2297	4.2052	4.0214
36	'202017'	'SAUDEL'	'2020-10-1...	'2020-10-2...	'HISY'	'TY----->'	0.2164	2.9442	2.9362	-0.4795	3.0322	2.9940	1.7086	4.0935	3.7198
37	'202017'	'SAUDEL'	'2020-10-1...	'2020-10-2...	'QION'	'TY----->'	-1.5139	2.4823	1.9672	-3.0353	4.0229	2.6402	0.6126	3.5261	3.4725

This figure is a screenshot of our calculation results in MATLAB. From left to right, the columns represent the following information: typhoon number, typhoon name, typhoon start time, typhoon end time, collocated GNSS station, typhoon marker (“TY----->”), ERA5-Bias, ERA5-RMSE, ERA5-dRMSE, MERRA2-Bias, MERRA2-RMSE, MERRA2-dRMSE, JRA3Q-Bias, JRA3Q-RMSE, and JRA3Q-dRMSE. Using the first data record as an example, the square of 0.5963 plus the square of 2.9114 equals the square of 2.9718. The same relationship holds for each of the subsequent rows.

Regarding your thoughtful comment on JRA-3Q, we believe it is highly valuable, and we will carefully consider it in our future work.

We sincerely thank you again for your valuable comments, which have greatly improved the quality of our manuscript. We are also deeply grateful for the time and effort you devoted throughout the review process.

Sincerely,

Jiaqi Shi

GNSS Research Center, Wuhan University

On behalf of all co-authors

March, 2026

Response Letter to Reviewer #2

Dear Reviewer,

We sincerely thank the reviewer for the careful evaluation and positive assessment of the revised version of our manuscript, entitled “*Evaluation of reanalysis precipitable water vapor under typhoon conditions using multi-source observations*” (Manuscript ID: EGUSPHERE-2025-4438), as well as of our response to the previous comments. Although Reviewer #2 indicated that no further evaluation of our manuscript would be necessary, we have nevertheless prepared this brief response letter to express our sincere appreciation for his/her considerable effort and valuable contribution throughout the review process.

Sincerely,

Jiaqi Shi

GNSS Research Center, Wuhan University

On behalf of all co-authors

March, 2026

Response Letter to Dr. Stiller and Editors

Dear Dr. Stiller and the Editors,

We sincerely thank you for uploading the suggested technical corrections in the system. With regard to these technical corrections, we would like to provide the following clarification.

Specifically, we have corrected the incorrect figure citation in line 264, the spelling error in line 247, and the repeated commas in line 206. We are grateful to the reviewer for the careful reading of the revised manuscript. In addition, we have checked the manuscript throughout for similar issues.

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Regarding the issue raised for Table 2, we would like to provide the following clarification. We sincerely thank the reviewer for the careful examination of the Bias, RMSE, and dRMSE values. The reviewer is absolutely correct that, according to the mathematical derivation and the definitions of these statistics, the square of the Bias plus the square of the dRMSE should equal the square of the RMSE. However, the values reported in Table 2 are averages across all GNSS stations. In other words, this relationship holds for an individual GNSS station, but it does not necessarily hold after averaging these statistics over all GNSS stations. Therefore, this does not indicate a calculation error. This is also why the averaged results not only for ERA5, but also for MERRA-2 and JRA-3Q, do not strictly satisfy this relationship. To illustrate this point more clearly, we provide below several examples of Bias, RMSE, and dRMSE values for individual typhoon–GNSS station pairs, that is, the results for a single GNSS station during a specific typhoon event, as shown in the following figure.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	'202002'	'NURI'	'2020-06-0...	'2020-06-1...	'GDZH'	'TY ---->'	0.5963	2.9718	2.9114	-1.5354	4.1962	3.9053	-0.5699	5.5491	5.5197
2	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'GDZH'	'TY ---->'	0.0702	1.1864	1.1844	-2.9054	3.3859	1.7387	-0.7375	2.3946	2.2782
3	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'GDZJ'	'TY ---->'	0.1596	2.4189	2.4137	0.0409	1.0910	1.0902	1.1198	2.0840	1.7576
4	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'GUAN'	'TY ---->'	1.7485	1.9294	0.8157	-1.8795	1.9896	0.6525	1.8197	2.2109	1.2557
5	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'GXBH'	'TY ---->'	0.4109	1.9703	1.9270	0.2112	1.2342	1.2160	0.8105	1.8750	1.6908
6	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'GXNN'	'TY ---->'	-2.7003	2.9708	1.2387	-2.7067	2.8729	0.9631	-0.1123	2.1786	2.1757
7	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'HIHK'	'TY ---->'	0.3504	2.3014	2.2745	0.9025	3.2346	3.1062	2.2331	3.5344	2.7396
8	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'HISY'	'TY ---->'	2.6216	3.5047	2.3260	2.1929	4.0775	3.4377	5.4521	6.6663	3.8359
9	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'QION'	'TY ---->'	-0.9953	2.7299	2.5420	-1.5083	2.6102	2.1302	4.4863	5.7484	3.5942
10	'202003'	'SINLAKU'	'2020-07-2...	'2020-08-0...	'YONG'	'TY ---->'	2.5257	3.3350	2.1777	3.0114	3.6237	2.0156	3.9911	4.3227	1.6605
11	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'FJPT'	'TY ---->'	-1.1720	2.8542	2.6025	-2.1607	2.9282	1.9762	0.3207	3.7604	3.7467
12	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'FJXP'	'TY ---->'	-0.0944	3.2650	3.2636	-1.5464	3.4622	3.0977	2.8547	6.2302	5.5377
13	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'JSLJ'	'TY ---->'	0.1353	2.0537	2.0492	-2.2724	3.7139	2.9376	1.8308	4.2098	3.7909
14	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'JSNT'	'TY ---->'	1.1302	2.4517	2.1756	-1.2731	3.3649	3.1148	2.3774	4.9604	4.3535
15	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'SHA2'	'TY ---->'	0.5082	2.0850	2.0221	-1.6405	2.7284	2.1801	1.4077	4.9973	4.7949
16	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'ZJJD'	'TY ---->'	0.3202	1.8652	1.8375	-1.2074	3.2801	3.0498	4.1419	5.9302	4.2441
17	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'ZJWZ'	'TY ---->'	-1.4653	2.5747	2.1170	-3.1874	4.0911	2.5647	-0.3982	4.6313	4.6142
18	'202004'	'HAGUPIT'	'2020-07-3...	'2020-08-1...	'ZJZJ'	'TY ---->'	0.8090	2.1919	2.0372	-1.7589	2.4229	1.6663	2.2233	4.6086	4.0368
19	'202006'	'MEKKHALA'	'2020-08-0...	'2020-08-1...	'GDSJ'	'TY ---->'	1.0221	2.6974	2.4963	-1.0127	2.8524	2.6666	-0.4069	6.0313	6.0176
20	'202006'	'MEKKHALA'	'2020-08-0...	'2020-08-1...	'XIAM'	'TY ---->'	0.8784	1.9411	1.7310	-1.3079	2.6712	2.3290	0.1528	4.9293	4.9269
21	'202007'	'HIGOS'	'2020-08-1...	'2020-08-2...	'GDZH'	'TY ---->'	0.0166	1.2717	1.2716	-2.8113	4.8053	3.8971	-0.3172	3.4990	3.4845
22	'202007'	'HIGOS'	'2020-08-1...	'2020-08-2...	'GUAN'	'TY ---->'	0.5890	1.8209	1.7230	-3.1941	3.6183	1.6999	0.9333	3.6503	3.5289
23	'202007'	'HIGOS'	'2020-08-1...	'2020-08-2...	'GXWZ'	'TY ---->'	-0.7677	1.7559	1.5792	-3.5460	4.0970	2.0520	-0.1123	2.5996	2.5972
24	'202009'	'MAYSAK'	'2020-08-2...	'2020-09-0...	'ZJZJ'	'TY ---->'	1.7708	2.8158	2.1893	0.1464	2.9099	2.9063	1.8264	3.7749	3.3037
25	'202011'	'NOUL'	'2020-09-1...	'2020-09-1...	'HISY'	'TY ---->'	1.9365	5.7593	5.4240	-1.6946	5.0781	4.7870	3.5463	6.0558	4.9088
26	'202011'	'NOUL'	'2020-09-1...	'2020-09-1...	'QION'	'TY ---->'	-2.6653	3.8341	2.7562	-5.4926	5.8798	2.0986	-0.1558	6.6454	4.6427
27	'202011'	'NOUL'	'2020-09-1...	'2020-09-1...	'YONG'	'TY ---->'	3.7678	5.5356	4.0555	1.1666	4.5487	4.3965	4.8153	7.2480	5.4172
28	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'GDZJ'	'TY ---->'	0.5901	1.3340	1.1963	-0.3694	1.6631	1.6215	0.1354	3.0650	3.0620
29	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'GXBH'	'TY ---->'	-0.0041	1.1102	1.1102	-1.2463	1.9554	1.5068	1.1792	3.4101	3.1997
30	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'GXNN'	'TY ---->'	-3.5505	3.8685	1.5359	-5.1935	5.4413	1.6235	-0.2942	3.6419	3.6300
31	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'HIHK'	'TY ---->'	1.1184	1.7197	1.3063	-1.0262	2.0736	1.8019	2.2512	3.8421	3.1134
32	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'HISY'	'TY ---->'	1.3639	2.7963	2.4411	2.3003	4.5992	3.9826	5.0675	6.0895	3.3768
33	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'QION'	'TY ---->'	-0.3656	2.3949	2.3668	-0.6792	3.9695	3.9110	4.8620	6.0611	3.6190
34	'202016'	'NANGKA'	'2020-10-1...	'2020-10-1...	'YONG'	'TY ---->'	5.6148	6.2309	2.7015	2.8455	4.3134	3.2417	5.5218	6.1650	2.7416
35	'202017'	'SAUDEL'	'2020-10-1...	'2020-10-2...	'HIHK'	'TY ---->'	-0.1205	1.7236	1.7194	-1.8372	3.1457	2.5535	1.2297	4.2052	4.0214
36	'202017'	'SAUDEL'	'2020-10-1...	'2020-10-2...	'HISY'	'TY ---->'	0.2164	2.9442	2.9362	-0.4795	3.0322	2.9940	1.7086	4.0935	3.7198
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This figure is a screenshot of our calculation results in MATLAB. From left to right, the columns represent the following information: typhoon number, typhoon name, typhoon start time, typhoon end time, collocated GNSS station, typhoon marker (“TY----->”), ERA5-Bias, ERA5-RMSE, ERA5-dRMSE, MERRA2-Bias, MERRA2-RMSE, MERRA2-dRMSE, JRA3Q-Bias, JRA3Q-RMSE, and JRA3Q-dRMSE. Using the first data record as an example, the square of 0.5963 plus the square of 2.9114 equals the square of 2.9718. The same relationship holds for each of the subsequent rows.

Regarding the reviewer’s thoughtful comment on JRA-3Q, we believe it is highly valuable, and we will carefully consider it in our future work.

Regarding the notification to the authors uploaded in the system by Polina Shvedko on 26 January 2026, we have added the full forms of the abbreviations that were previously not spelled out in full. We are not entirely sure whether we still have the opportunity to upload the revised short summary in the system, so we provide the rewritten version here: “This study evaluates how three reanalysis datasets represent precipitable water vapor (PWV) during more than 100 typhoons from 2020 to 2024 using multi-source observations. The fifth-generation European Centre for Medium-Range Weather Forecasts Reanalysis (ERA5) performs best, the Japanese Reanalysis for Three Quarters of a Century (JRA-3Q) improves during typhoons, and the Modern-Era Retrospective Analysis for Research and Applications Version 2

(MERRA-2) is less stable”. This version meets the requirement of being under 500 characters.

In addition, we made three further minor revisions elsewhere in the manuscript. First, in line 258, one period had been shown in red in the previous version, and we have changed it to black. Second, in the Data Availability section in line 531, we removed “the” before “IBTrACS”. Third, in the Acknowledgements, we added the institutional affiliation of a person we wished to thank, which had inadvertently been omitted in the previous version.

We would like to express our sincere gratitude once again for the time and effort you have devoted to handling this manuscript and for giving us the opportunity to revise it. We truly appreciate your careful consideration and support throughout the review process.

Sincerely,

Jiaqi Shi

GNSS Research Center, Wuhan University

On behalf of all co-authors

March, 2026