Table S1. RMSE between modeled and measured vTEC values for the year 2008. The model with the best performance is bolded. Measurements from Swarm A were unavailable in 2008.

vTEC RMSE (TECU) - 2008						
Satellite	Dataset	IRI-NeQuick (g=0.125)	NeQuick-corr (g=0.125)	NeQuick-corr (g=1.5)	NeQuick-corr Lomidze (g=0.125)	NeQuick-corr Lomidze (g=1.4)
GRACE	Global	2.330	2.380	**1.869**	2.130	1.939
	High latitudes	1.000	1.083	**0.875**	0.979	0.878
	Middle latitudes	2.156	2.137	**1.465**	1.919	1.525
	Low latitudes	3.145	3.200	**2.680**	2.835	2.764
Swarm A	Global					
	High latitudes					
	Middle latitudes					
	Low latitudes					
TerraSAR-X	Global	2.107	2.136	**1.599**	1.925	1.681
	High latitudes	0.778	0.851	1.029	**0.849**	0.999
	Middle latitudes	1.824	1.729	**1.220**	1.557	1.264
	Low latitudes	2.911	2.998	**2.210**	2.669	2.343
COSMIC-1	Global	3.517	3.228	**2.644**	3.069	2.718
	High latitudes	2.140	1.912	2.111	**1.889**	2.039
	Middle latitudes	3.055	2.797	**2.472**	2.704	2.513
	Low latitudes	4.455	4.086	**3.037**	3.817	3.179
METOP	Global	2.838	2.863	**2.012**	2.715	2.192
	High latitudes	1.269	1.170	**0.794**	1.083	0.883
	Middle latitudes	2.377	2.313	**1.619**	2.202	1.777
	Low latitudes	3.974	3.992	**2.815**	3.753	3.037

Table S2. RMSE between modeled and measured vTEC values for the year 2011. The model with the best performance is bolded. Measurements from Swarm A were unavailable in 2011.

vTEC RMSE (TECU) - 2011						
Satellite	Dataset	IRI-NeQuick (g=0.125)	NeQuick-corr (g=0.125)	NeQuick-corr (g=1.5)	NeQuick-corr Lomidze (g=0.125)	NeQuick-corr Lomidze (g=1.4)
GRACE	Global	4.467	3.332	**2.281**	2.746	2.296
	High latitudes	2.586	2.907	2.117	2.534	**2.088**
	Middle latitudes	2.911	3.154	1.918	2.529	**1.866**
	Low latitudes	6.725	3.981	**2.916**	3.259	3.036
Swarm A	Global					
	High latitudes					
	Middle latitudes					
	Low latitudes					
TerraSAR-X	Global	2.578	2.481	**1.603**	2.130	1.703
	High latitudes	1.432	1.752	**1.257**	1.569	1.287
	Middle latitudes	1.895	2.186	**1.283**	1.865	1.353
	Low latitudes	3.741	3.324	**2.216**	2.837	2.386
COSMIC-1	Global	4.167	4.190	**2.815**	3.885	3.032
	High latitudes	3.294	3.476	**2.531**	3.281	2.691
	Middle latitudes	3.671	3.945	**2.631**	3.669	2.851
	Low latitudes	5.096	5.017	**3.294**	4.606	3.543
METOP	Global	2.591	2.742	**1.574**	2.430	1.700
	High latitudes	1.560	1.653	**1.068**	1.493	1.107
	Middle latitudes	2.196	2.421	**1.413**	2.180	1.542
	Low latitudes	3.509	3.879	**2.146**	3.387	2.322

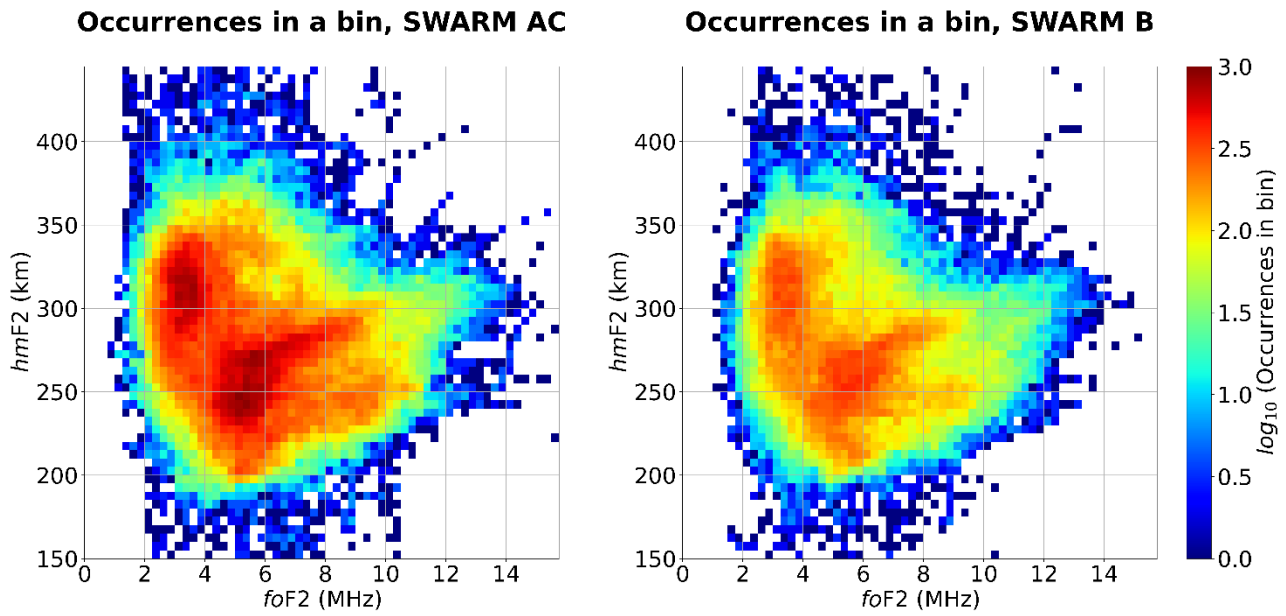

Figure S1. With reference to Figure 1 of the paper, these plots show the occurrences of values in each bin when considering the period from 5 December 2013 to 31 December 2018.

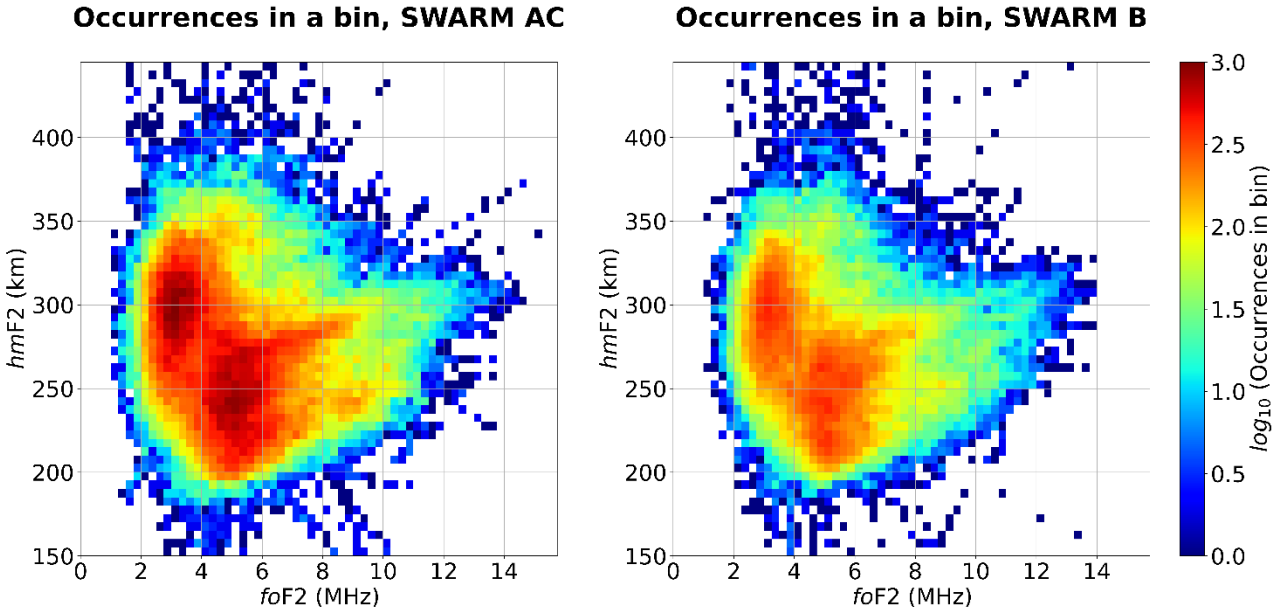

Figure S2. With reference to Figure 3 of the paper, these plots show the occurrences of values in each bin when considering the period from 5 December 2013 to 31 December 2021.

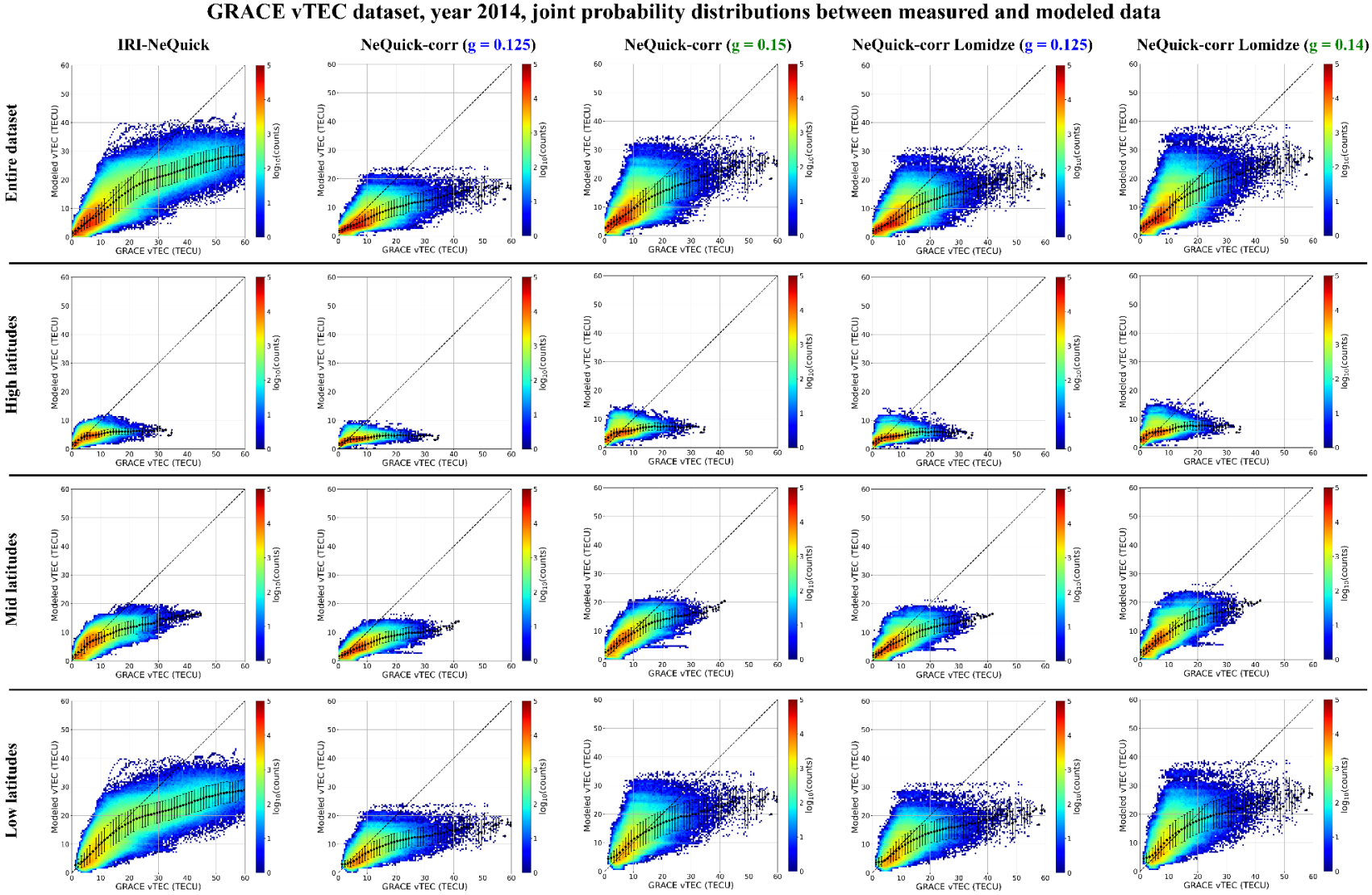

Figure S3. Joint probability distributions between measured and modeled vTEC values for 2014. Measured values are those from the GRACE mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by GRACE observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

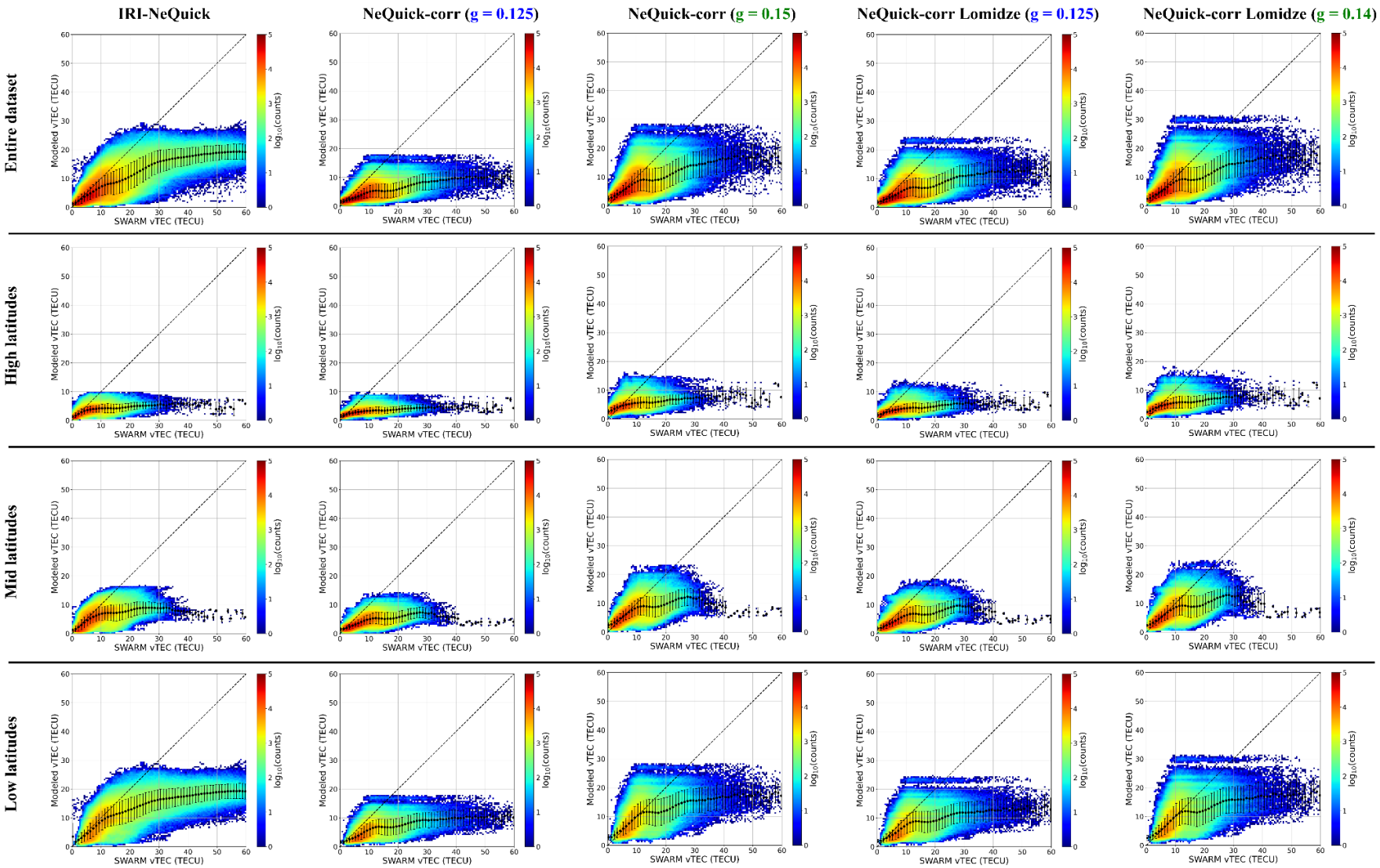

Figure S4. Joint probability distributions between measured and modeled vTEC values for 2014. Measured values are those from the Swarm A satellite. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by Swarm A observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

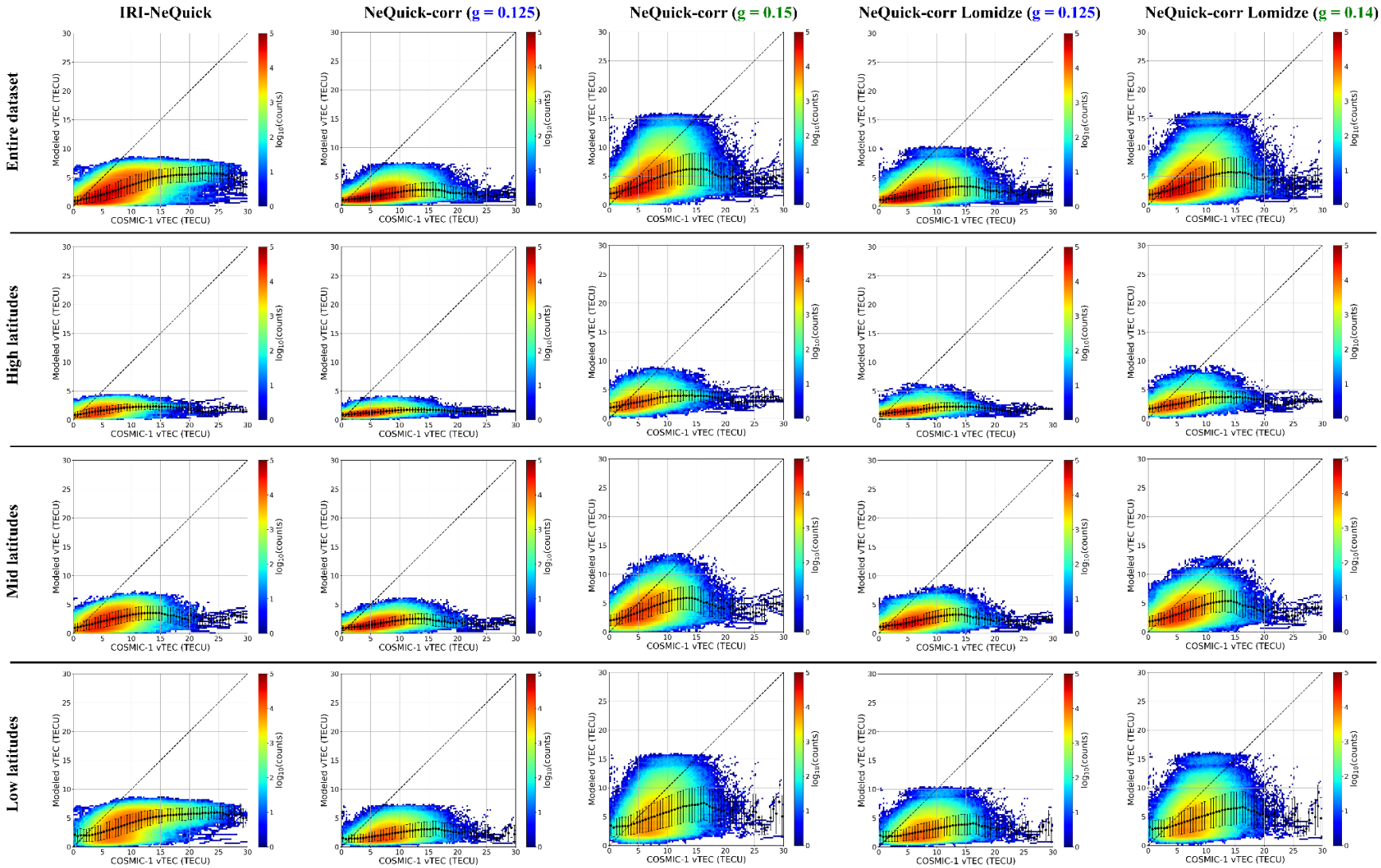

Figure S5. Joint probability distributions between measured and modeled vTEC values for 2014. Measured values are those from the COSMIC-1 mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by COSMIC-1 observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

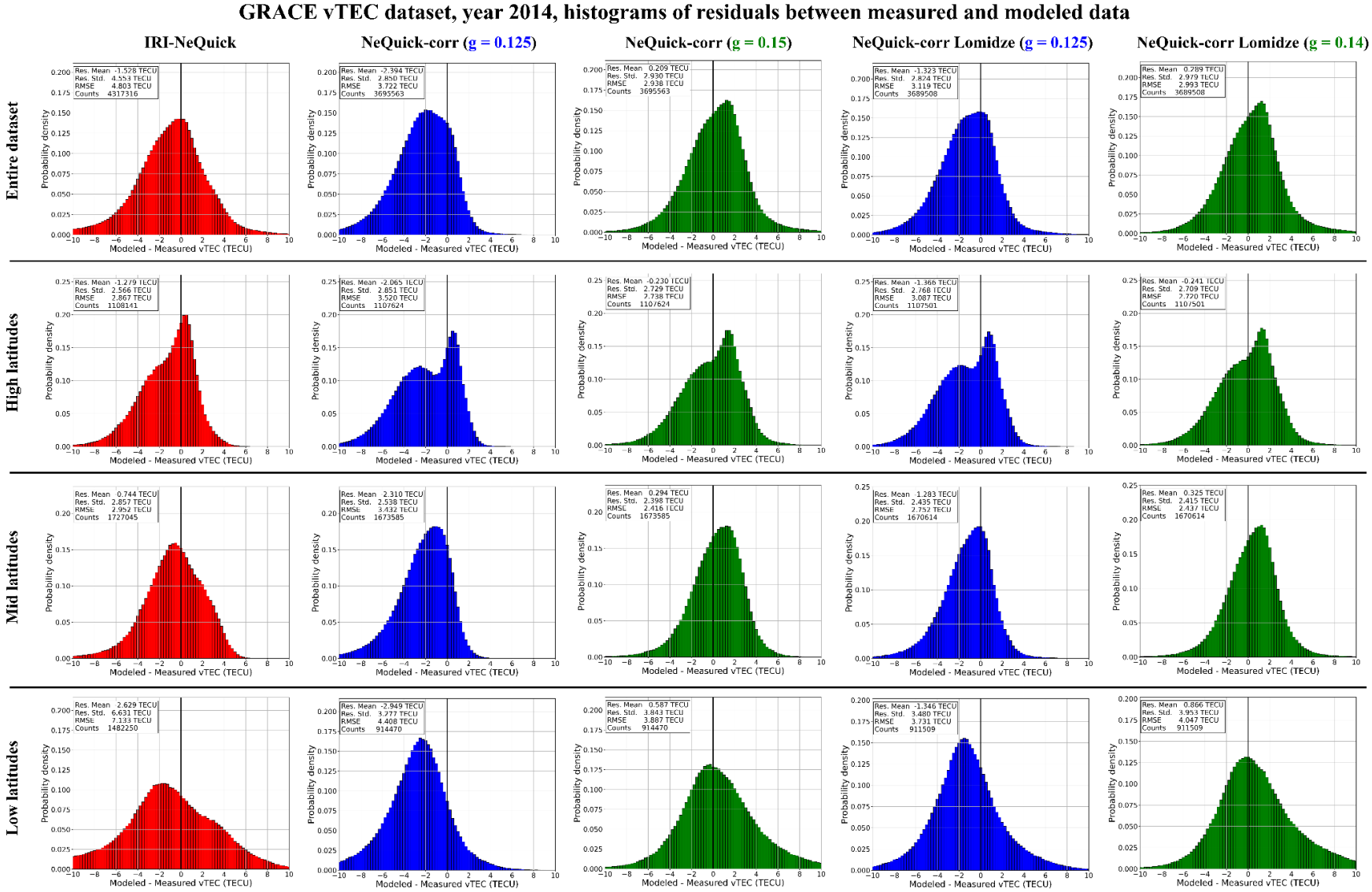

Figure S6. Distributions of residuals between measured and modeled vTEC values for 2014. Measured values are those from the GRACE mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

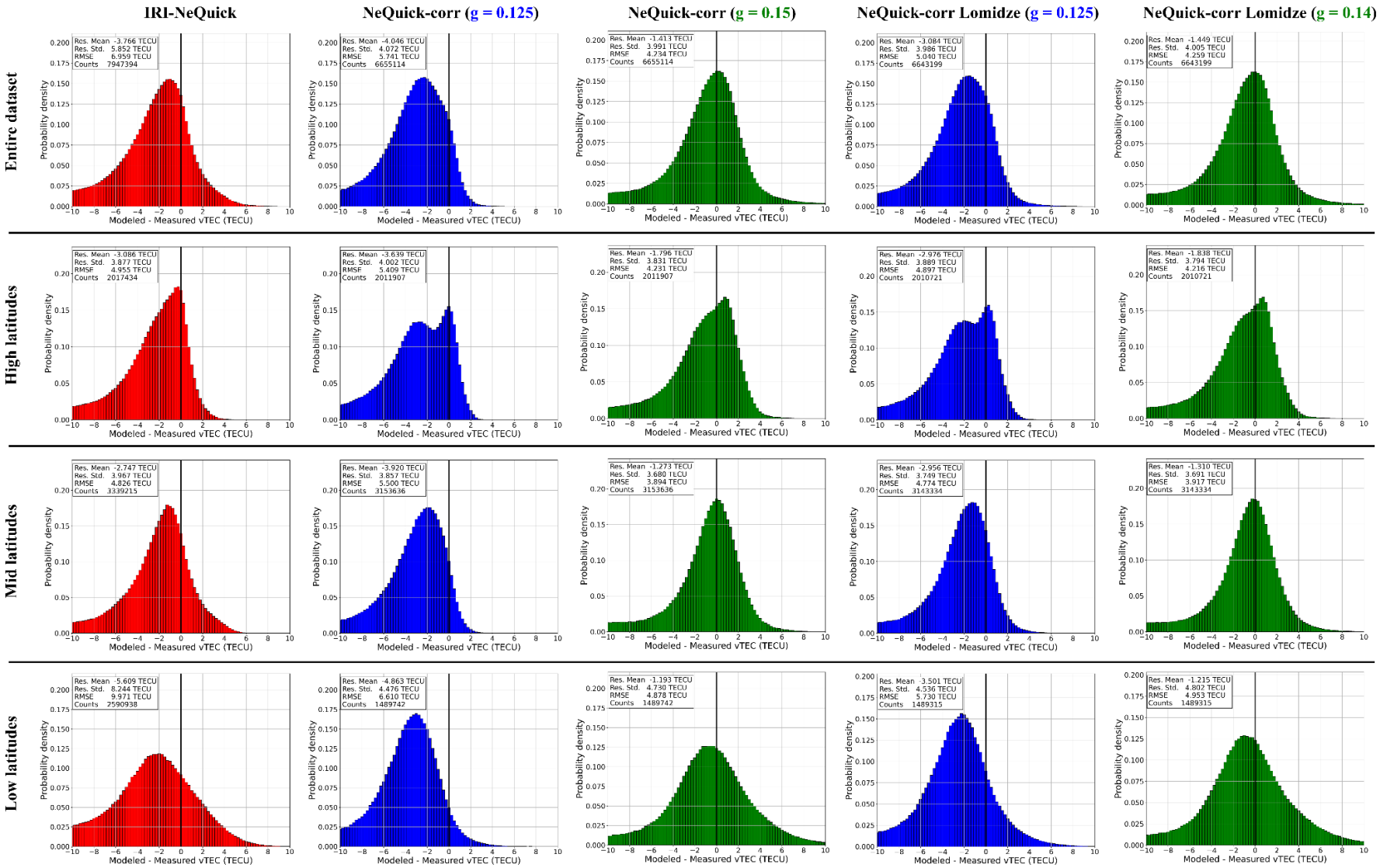

Figure S7. Distributions of residuals between measured and modeled vTEC values for 2014. Measured values are those from the Swarm A satellite. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

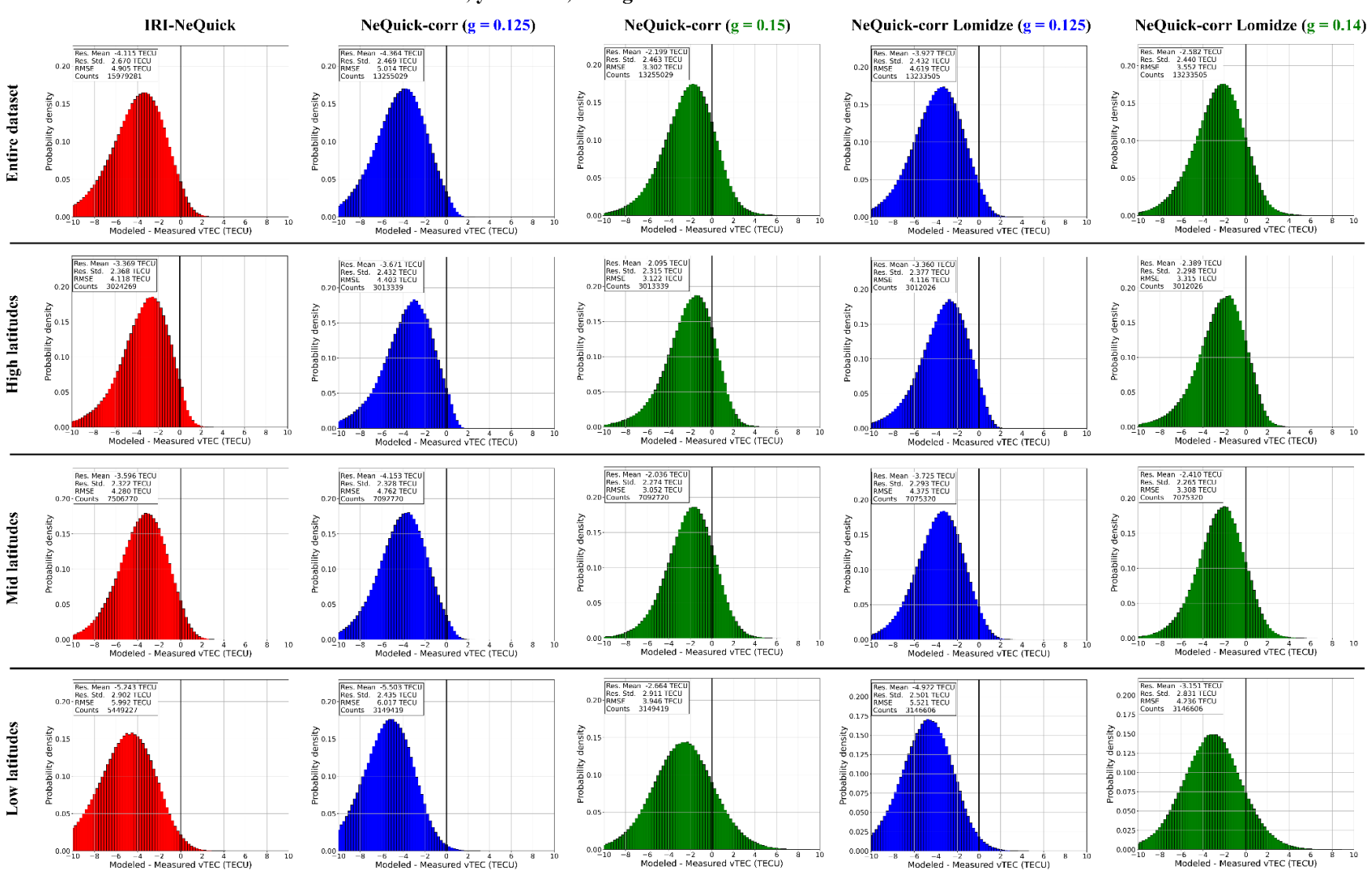

Figure S8. Distributions of residuals between measured and modeled vTEC values for 2014. Measured values are those from the COSMIC-1 mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

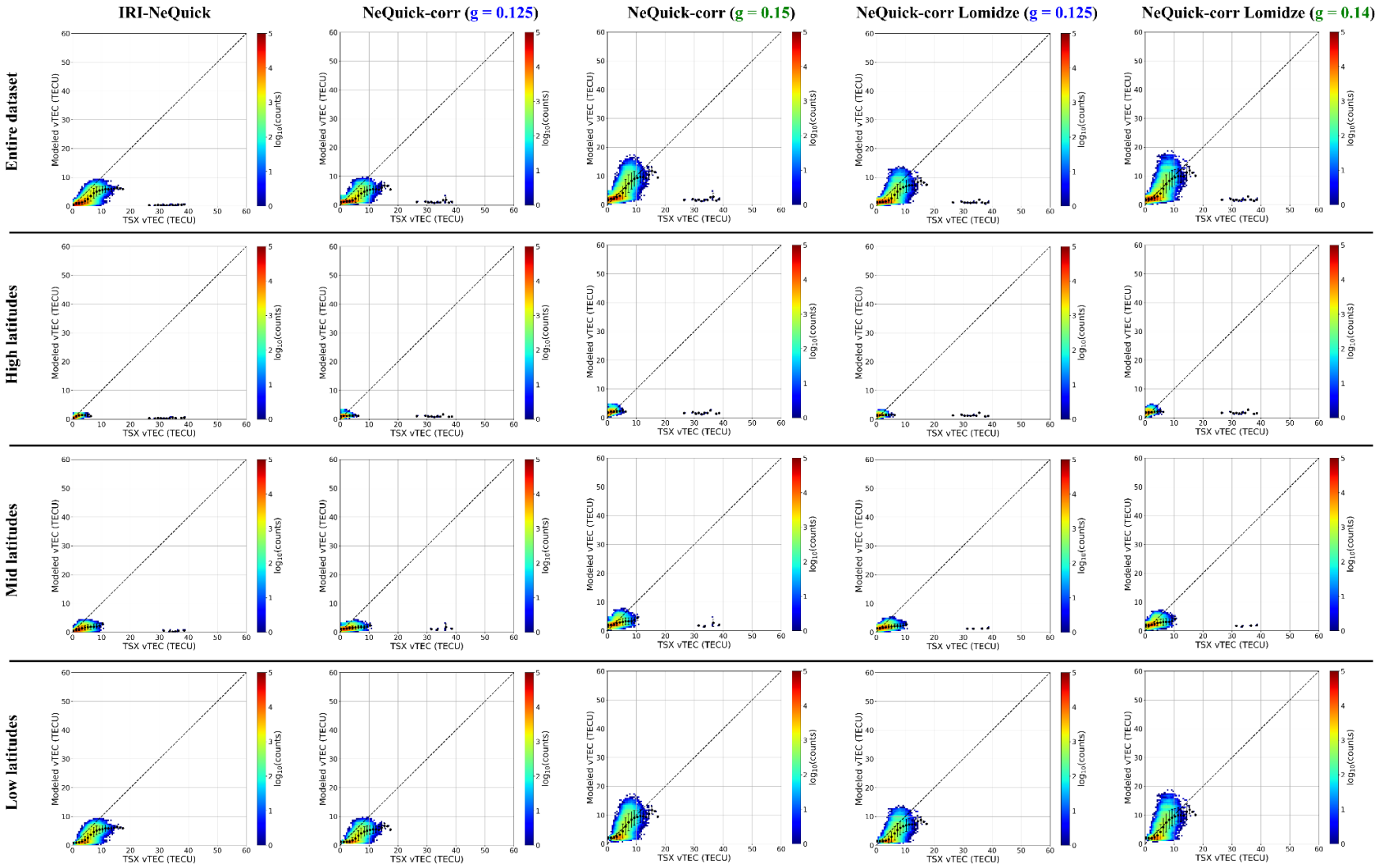

Figure S9. Joint probability distributions between measured and modeled vTEC values for 2008. Measured values are those from the TerraSAR-X mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by TerraSAR-X observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

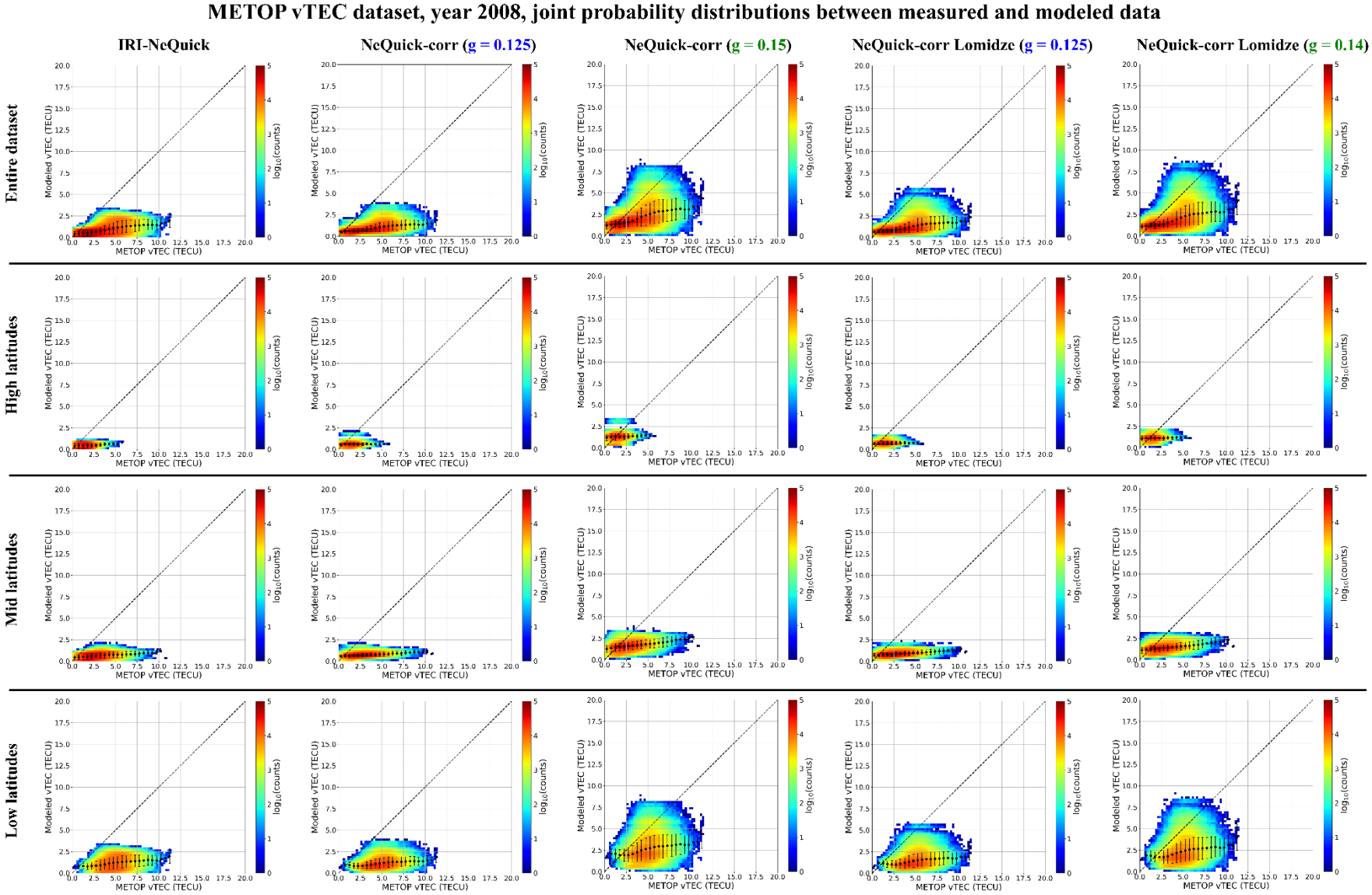

Figure S10. Joint probability distributions between measured and modeled vTEC values for 2008. Measured values are those from the METOP mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by METOP observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

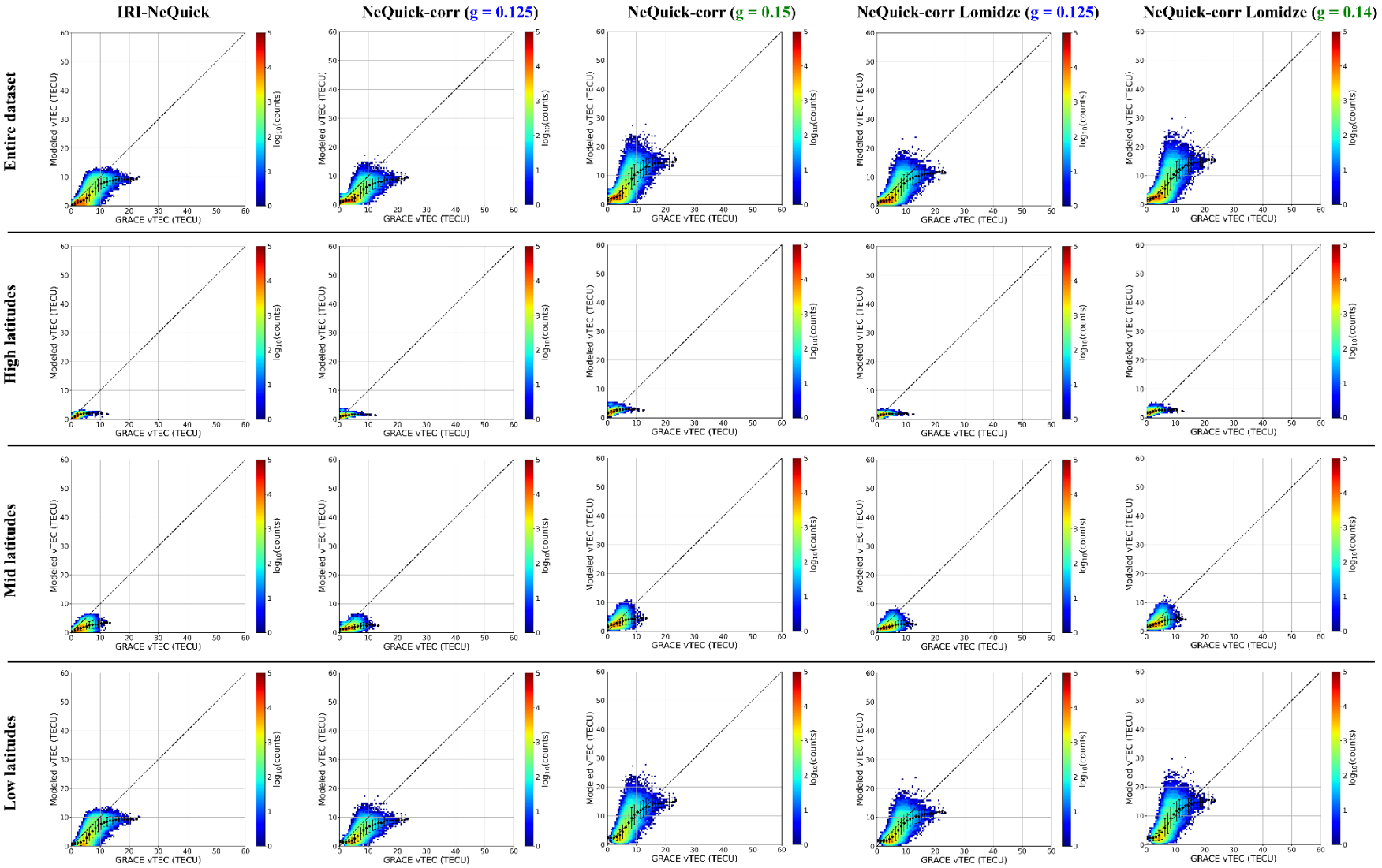

Figure S11. Joint probability distributions between measured and modeled vTEC values for 2008. Measured values are those from the GRACE mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by GRACE observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

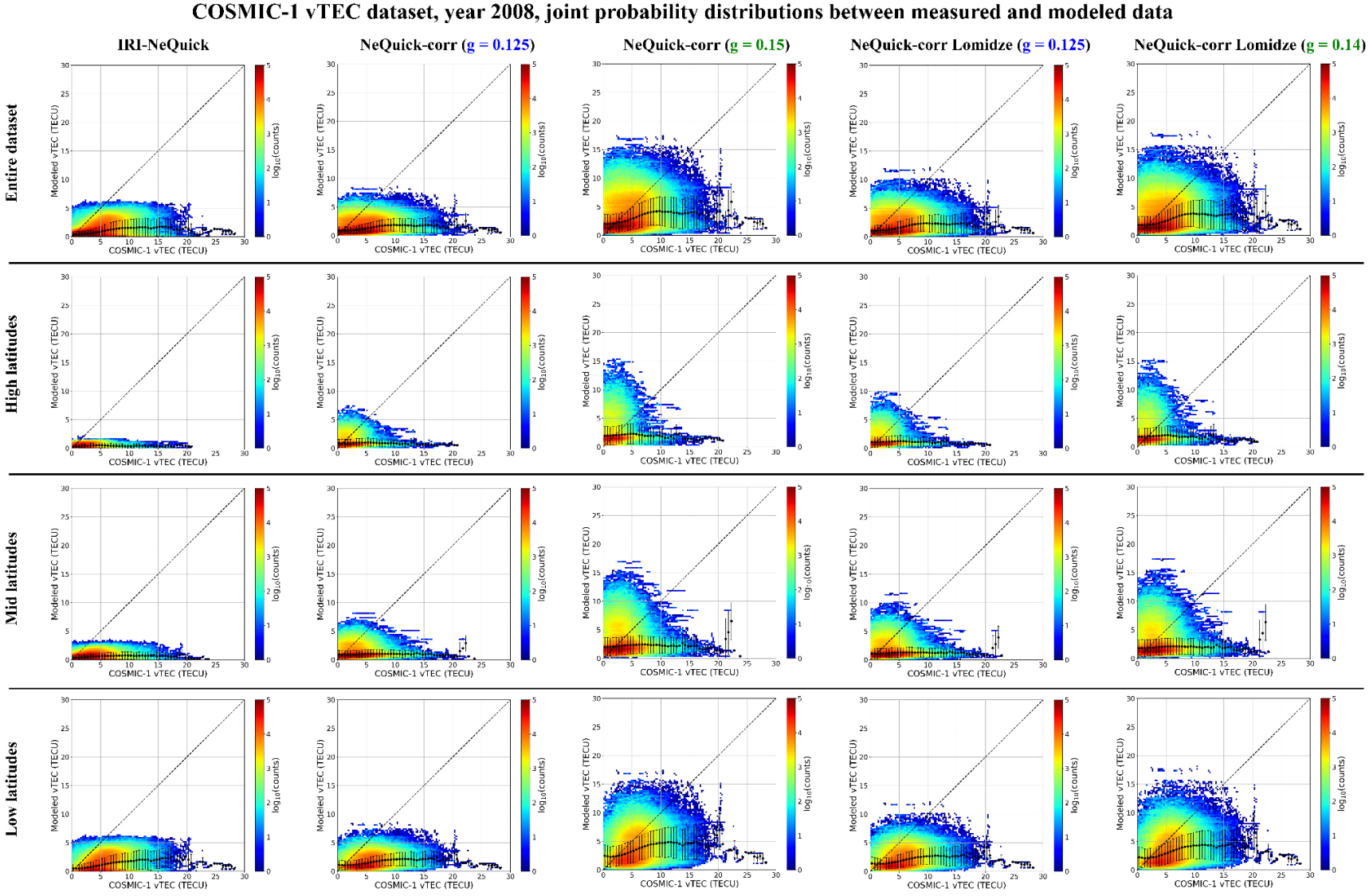

Figure S12. Joint probability distributions between measured and modeled vTEC values for 2008. Measured values are those from the COSMIC-1 mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by COSMIC-1 observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

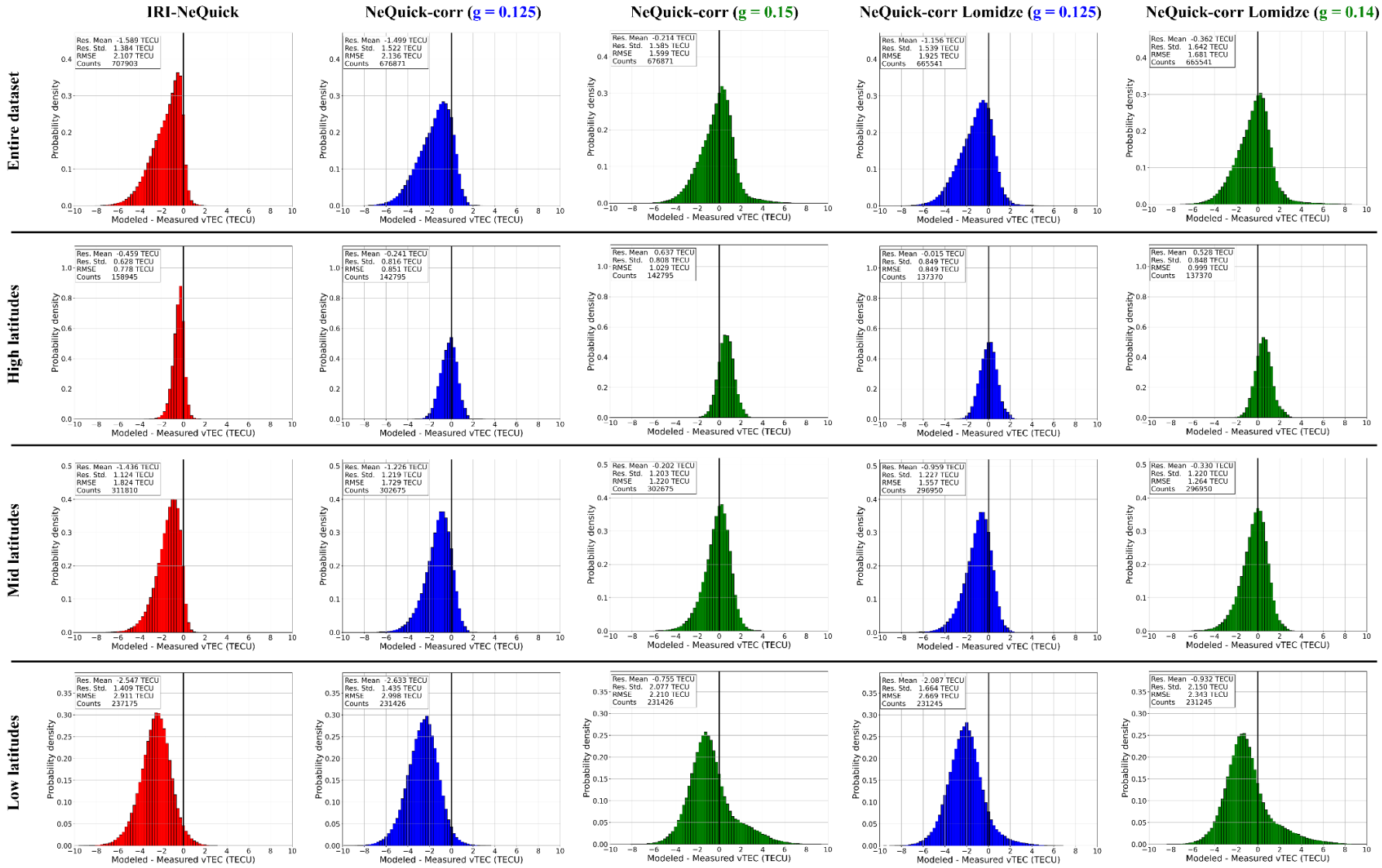

Figure S13. Distributions of residuals between measured and modeled vTEC values for 2008. Measured values are those from the TerraSAR-X mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

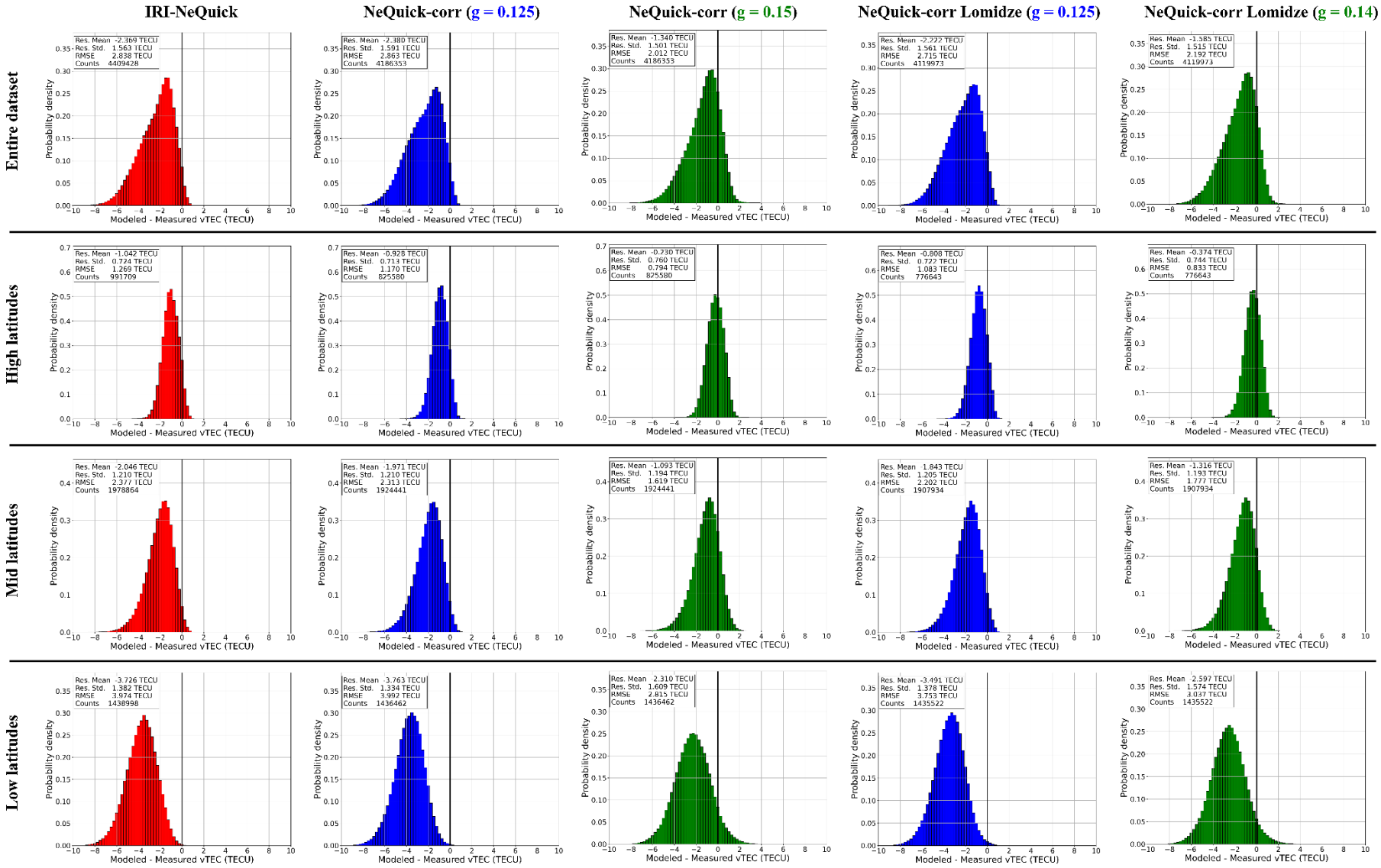

Figure S14. Distributions of residuals between measured and modeled vTEC values for 2008. Measured values are those from the METOP mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

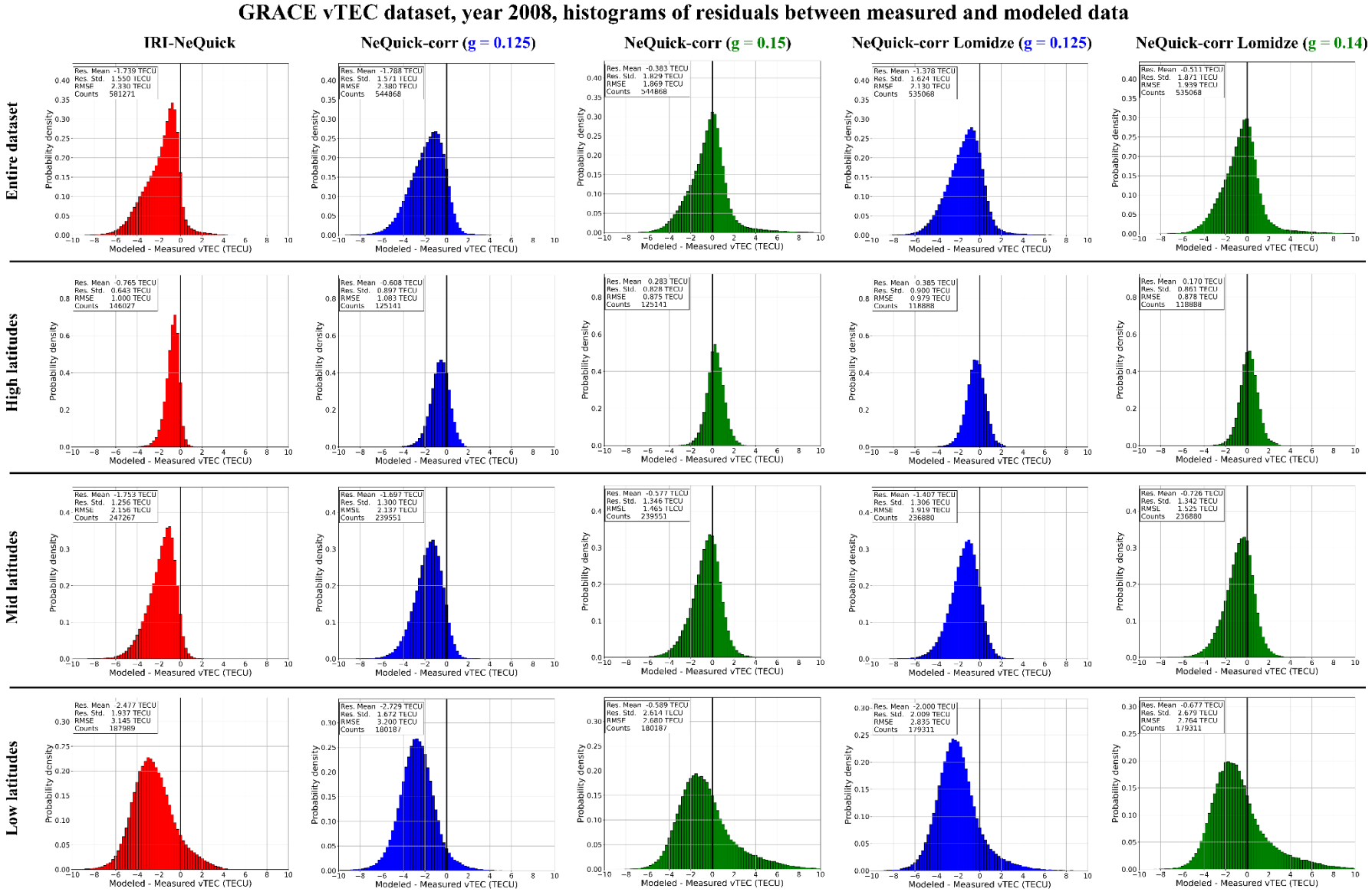

Figure S15. Distributions of residuals between measured and modeled vTEC values for 2008. Measured values are those from the GRACE mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

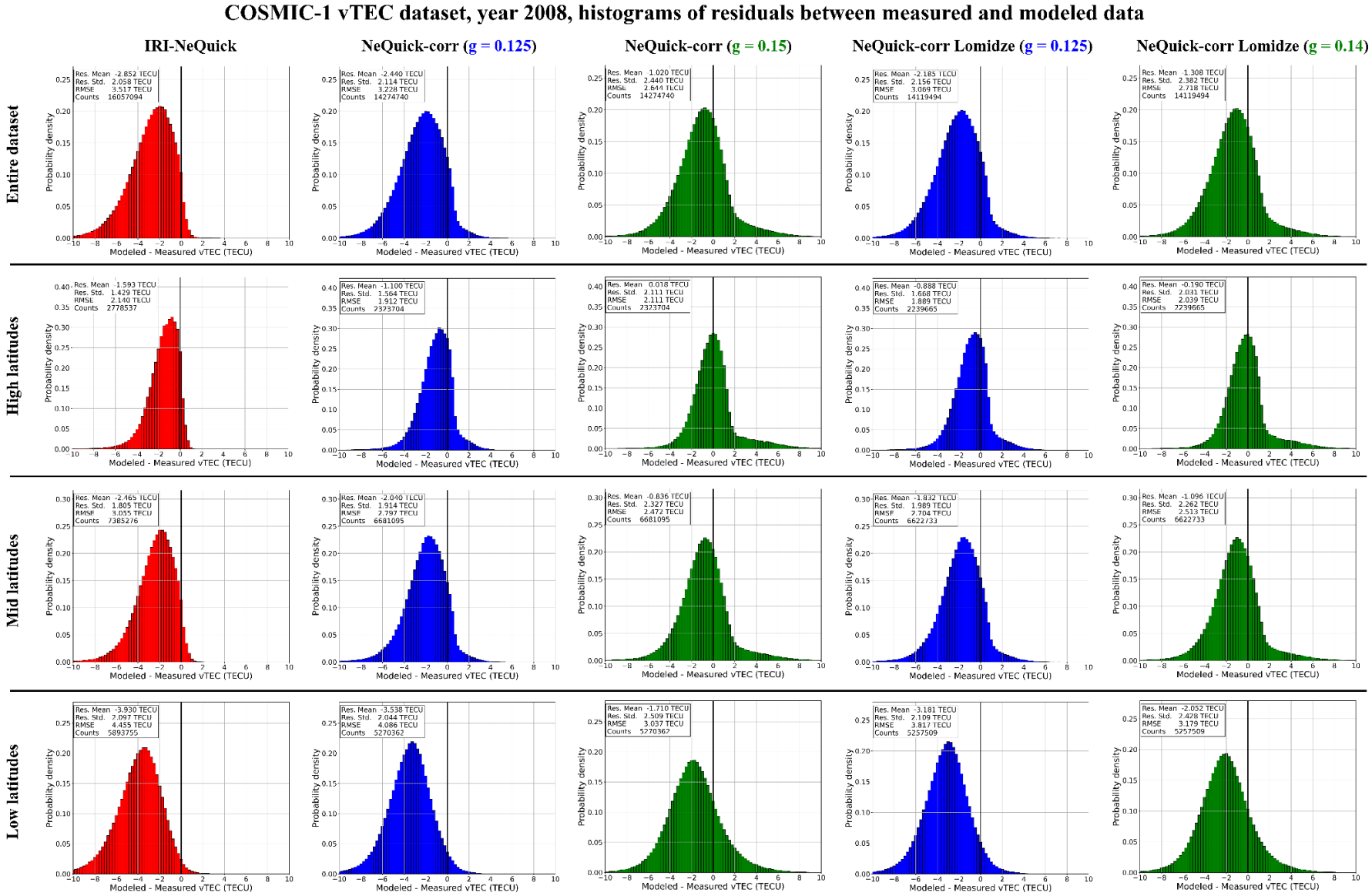

Figure S16. Distributions of residuals between measured and modeled vTEC values for 2008. Measured values are those from the COSMIC-1 mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

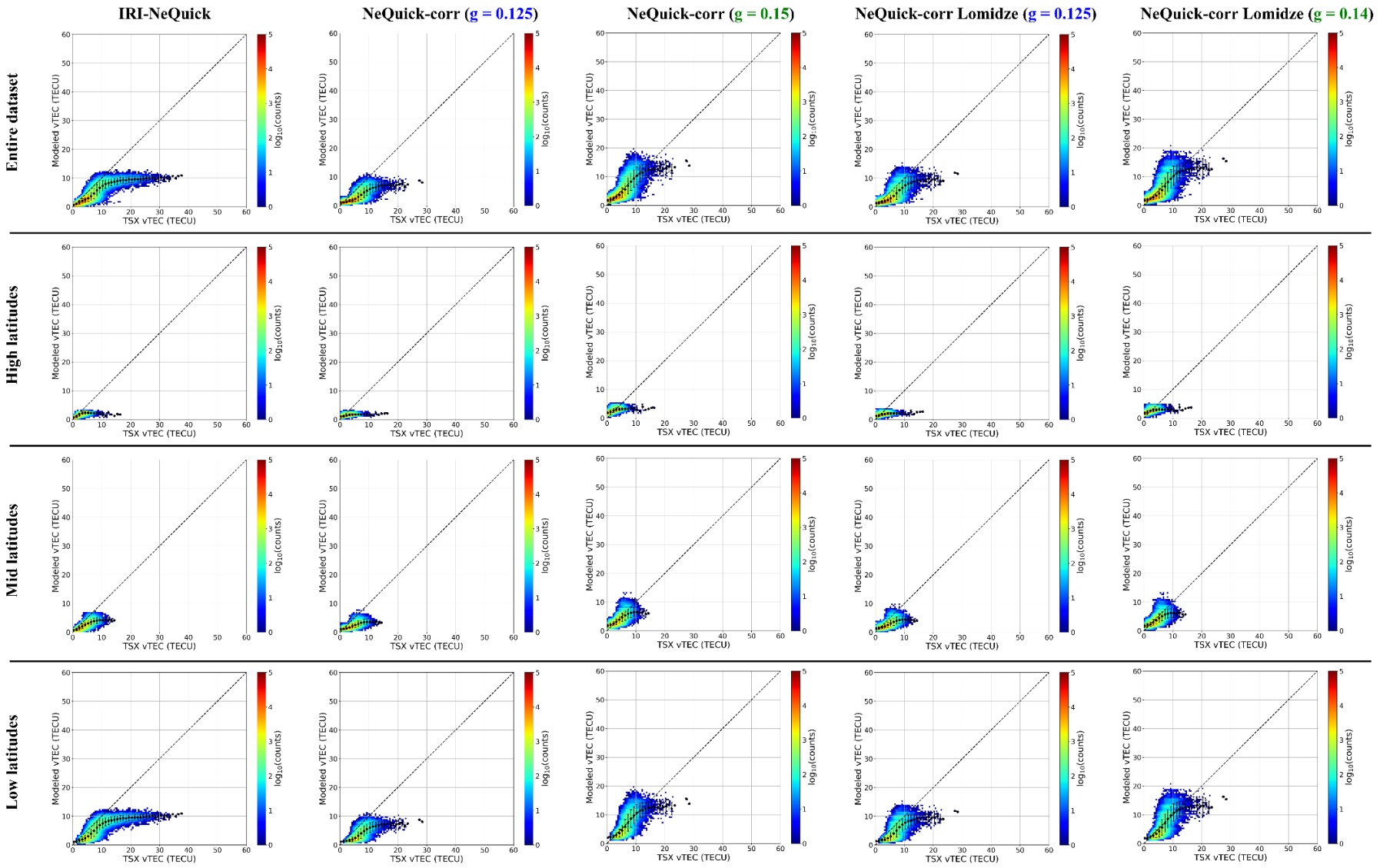

Figure S17. Joint probability distributions between measured and modeled vTEC values for 2011. Measured values are those from the TerraSAR-X mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by TerraSAR-X observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

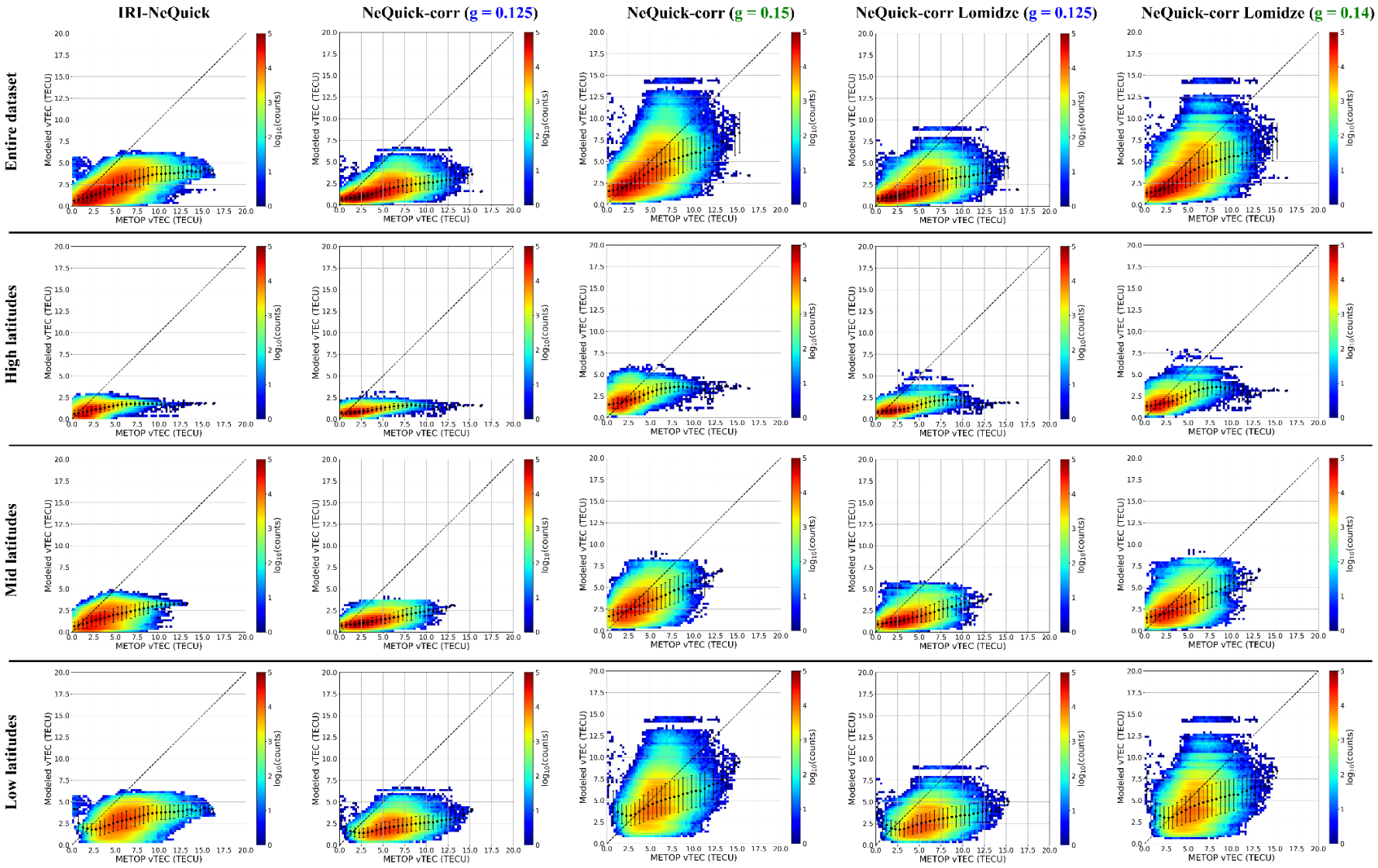

Figure S18. Joint probability distributions between measured and modeled vTEC values for 2011. Measured values are those from the METOP mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by METOP observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

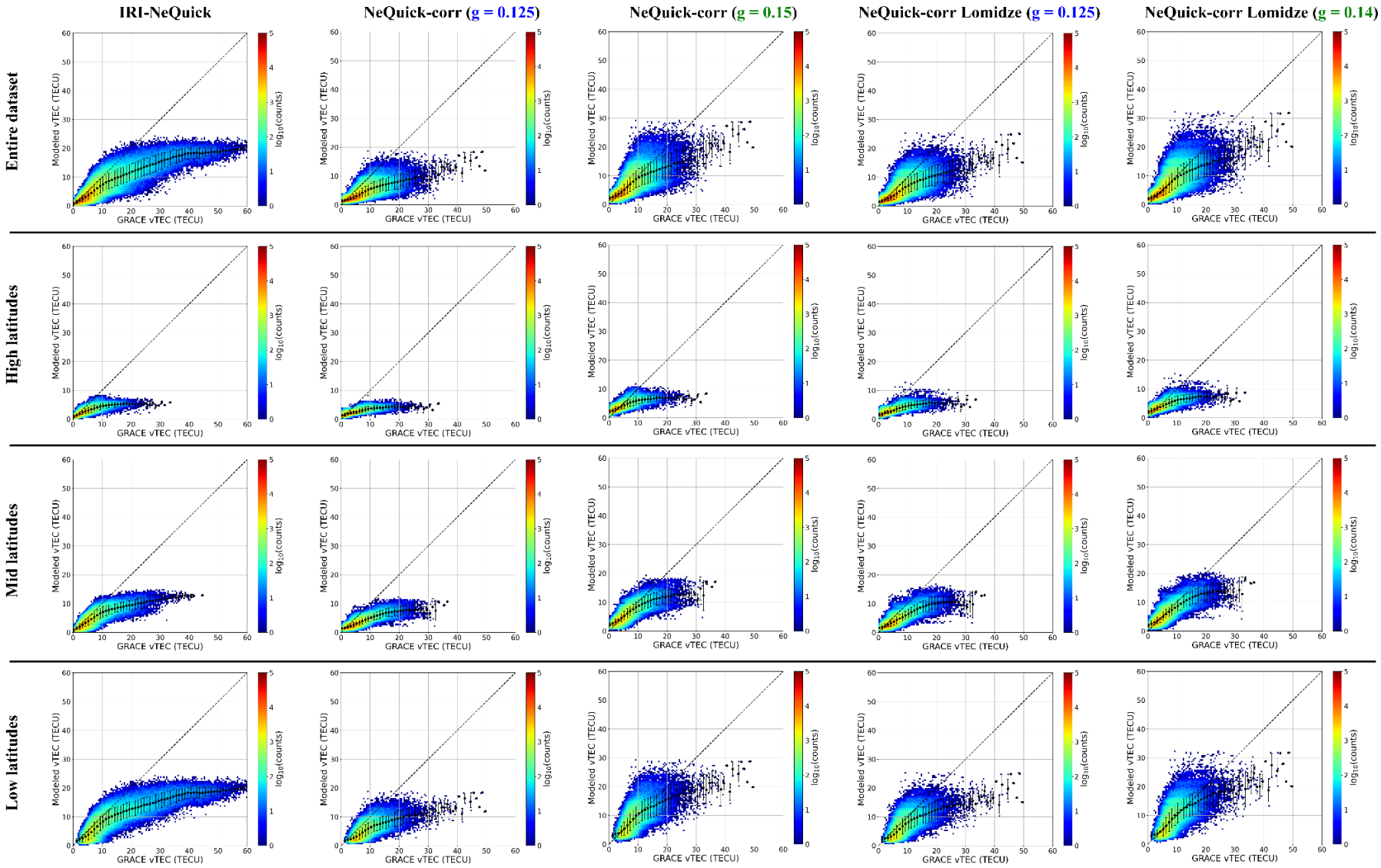

Figure S19. Joint probability distributions between measured and modeled vTEC values for 2011. Measured values are those from the GRACE mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by GRACE observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

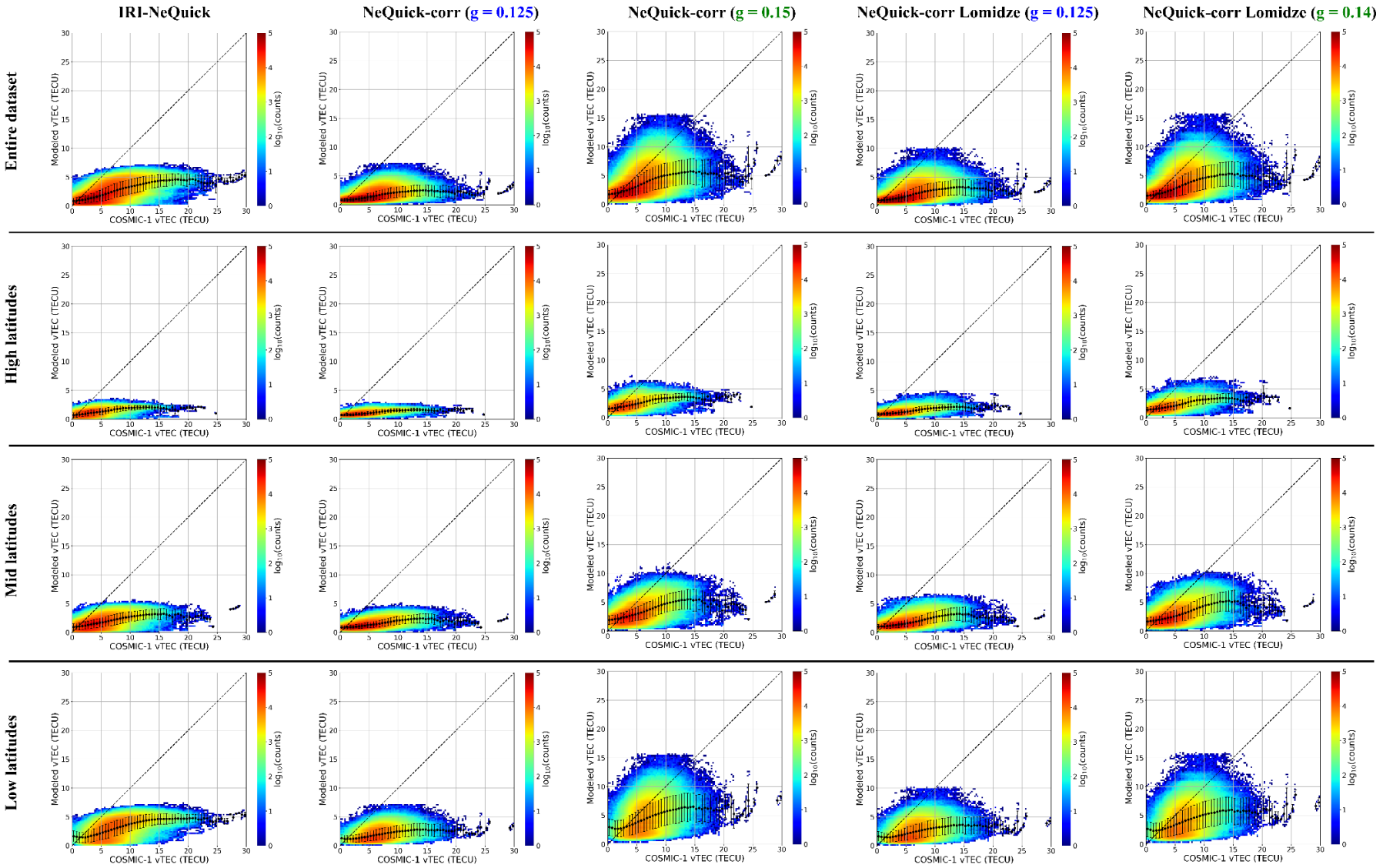

Figure S20. Joint probability distributions between measured and modeled vTEC values for 2011. Measured values are those from the COSMIC-1 mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. The black dots refer to the mean of modeled values conditioned by COSMIC-1 observations, with the corresponding standard deviation as error bars. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125.

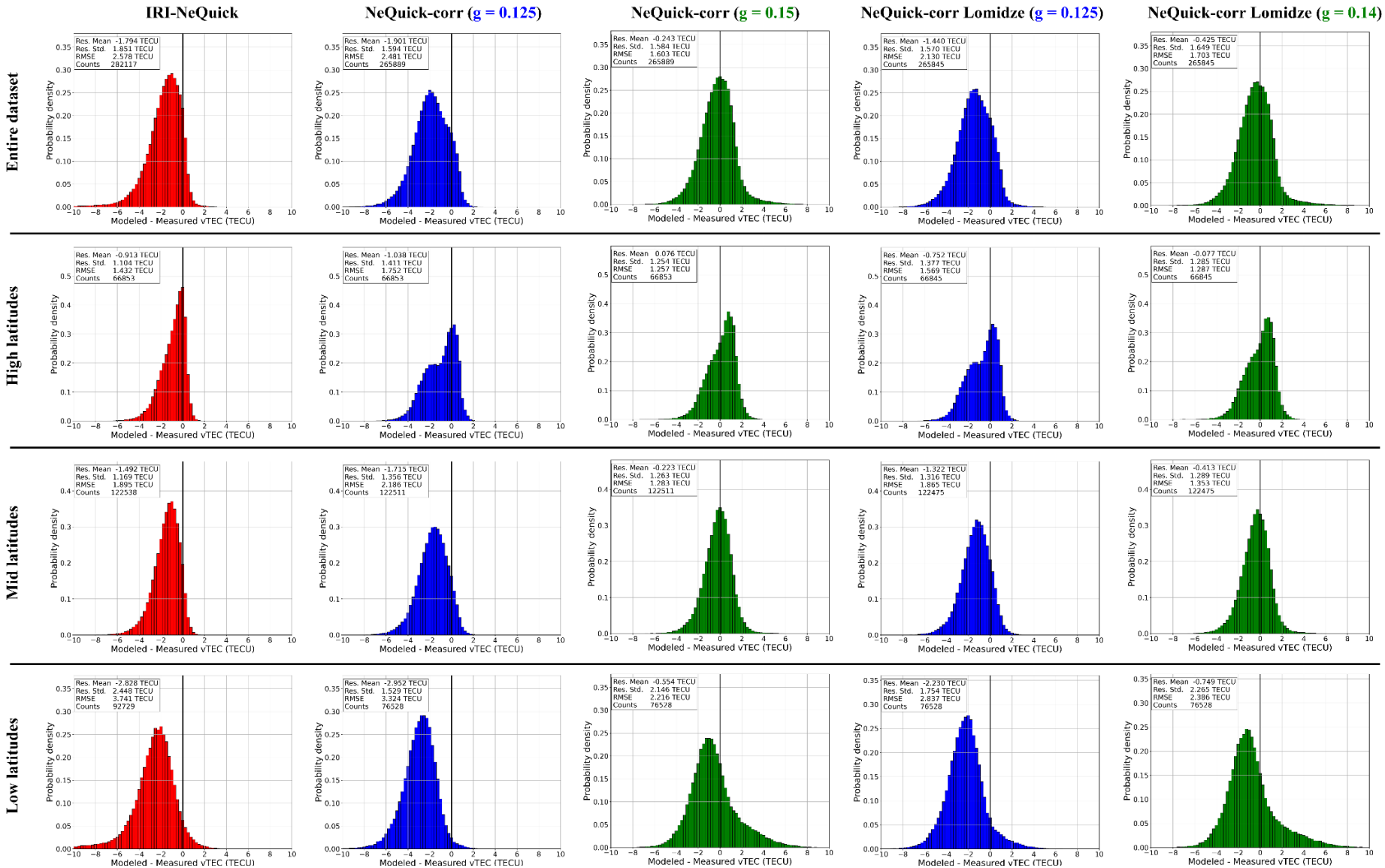

Figure S21. Distributions of residuals between measured and modeled vTEC values for 2011. Measured values are those from the TerraSAR-X mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

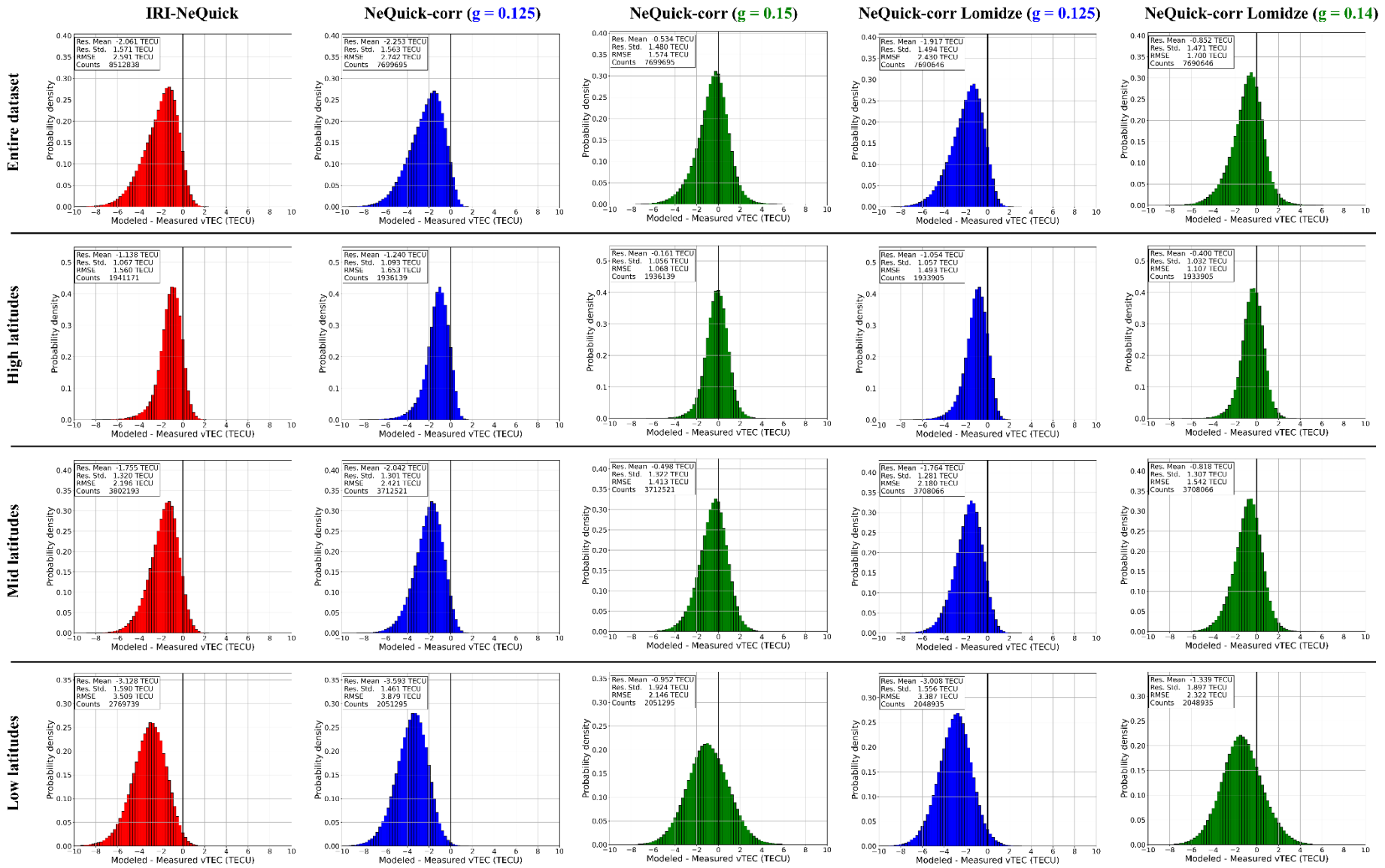

Figure S22. Distributions of residuals between measured and modeled vTEC values for 2011. Measured values are those from the METOP mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

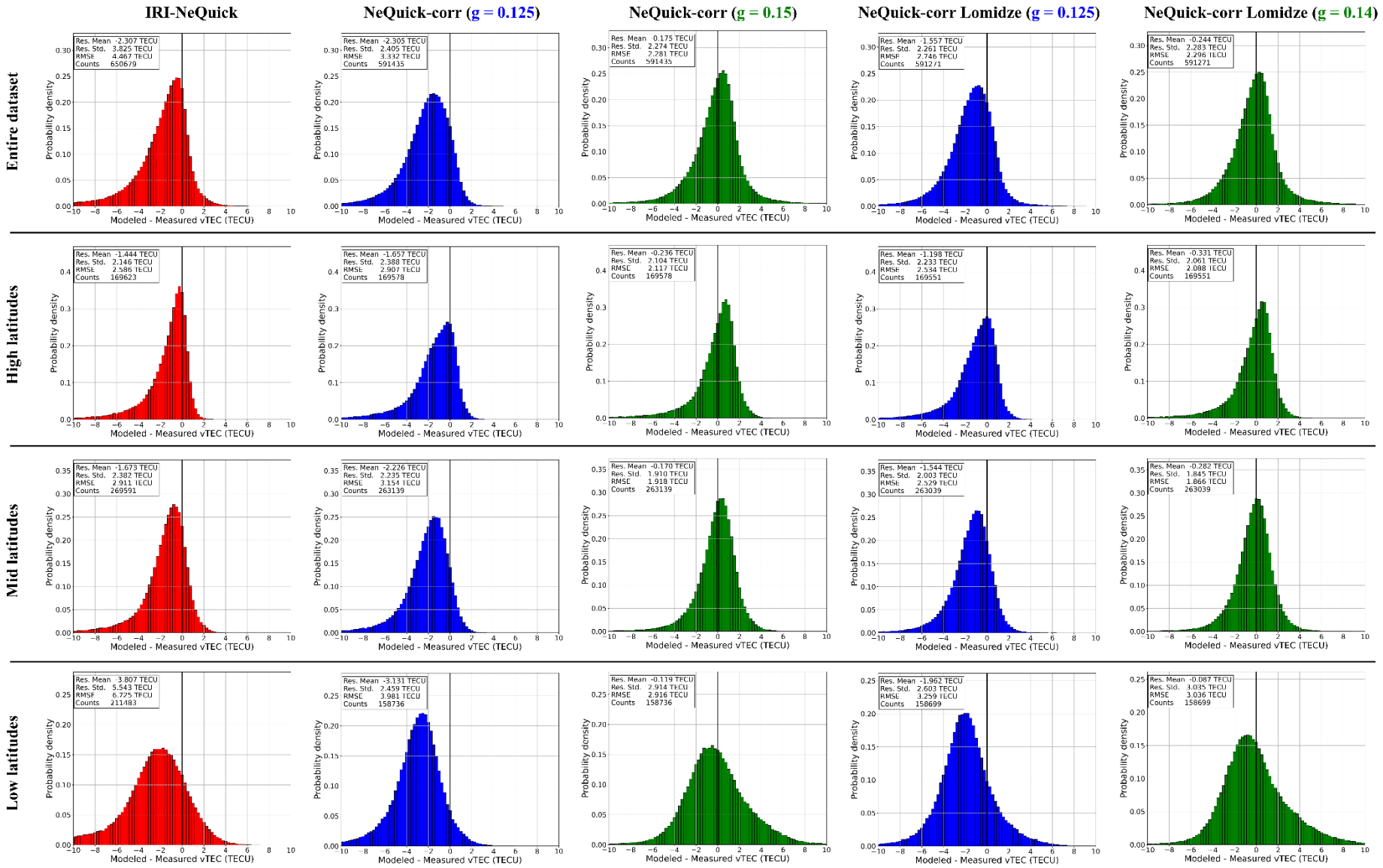

Figure S23. Distributions of residuals between measured and modeled vTEC values for 2011. Measured values are those from the GRACE mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

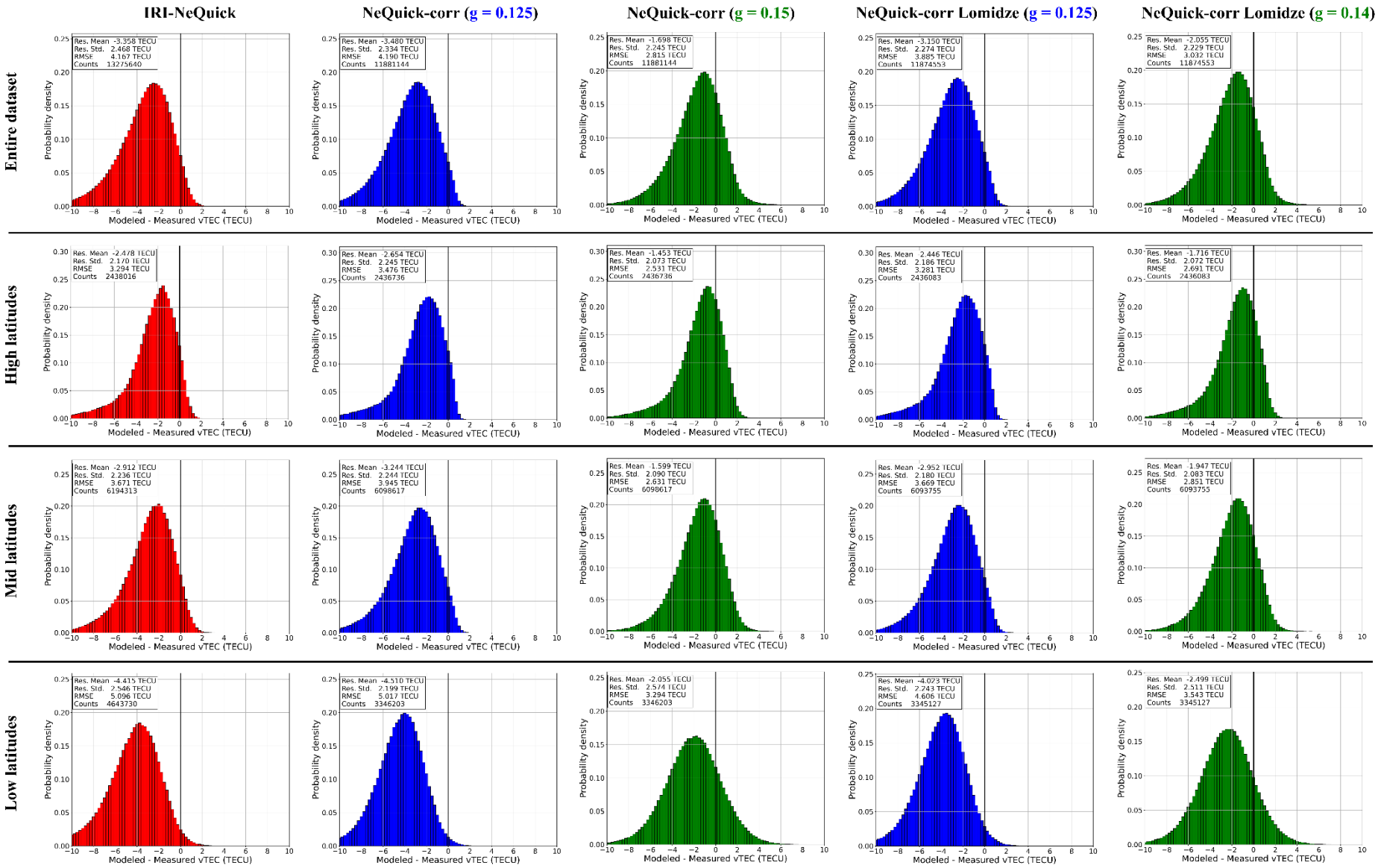

Figure S24. Distributions of residuals between measured and modeled vTEC values for 2011. Measured values are those from the COSMIC-1 mission. Modeled values are those from the five NeQuick topside descriptions considered in the study. In the upper left corner of each plot, the residuals mean, the residuals standard deviation, the RMSE and the counts are visible. The NeQuick-corr options (with g = 0.15 and 0.14) reduce the underestimation of VTEC compared to the options with g = 0.125 (green versus blue histograms).

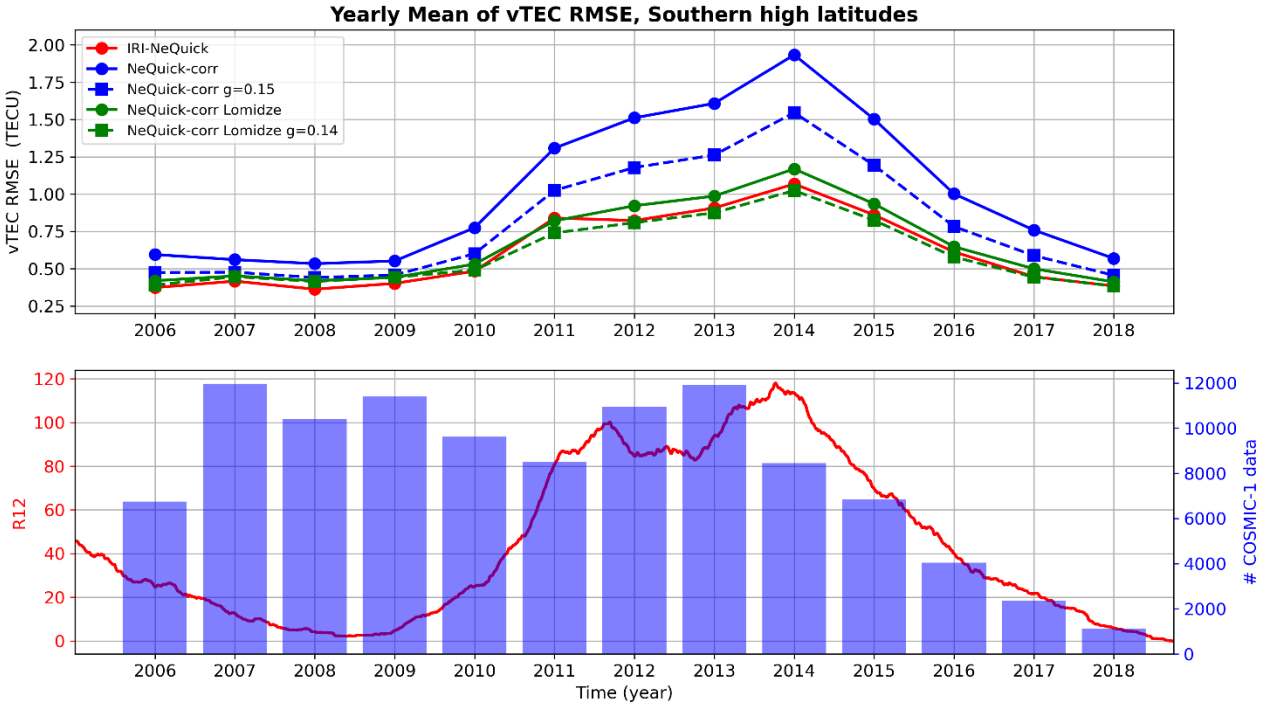

Figure S25. Yearly mean of RMSE for Southern high latitudes between (red dots) the IRI-NeQuick model and COSMIC-1 derived vTEC values, between (blue dots) the NeQuick-corr model and COSMIC-1 derived vTEC values, between (blue squares) the NeQuick-corr(g = 0.15) model and COSMIC-1 derived vTEC values, between (green dots) the NeQuick-corr Lomidze model and COSMIC-1 derived vTEC values, and between (green squares) the NeQuick-corr(g = 0.14) model and COSMIC-1 derived vTEC values. The R_{12} solar activity index as well as the number of COSMIC-1 RO data considered for each year are also reported.

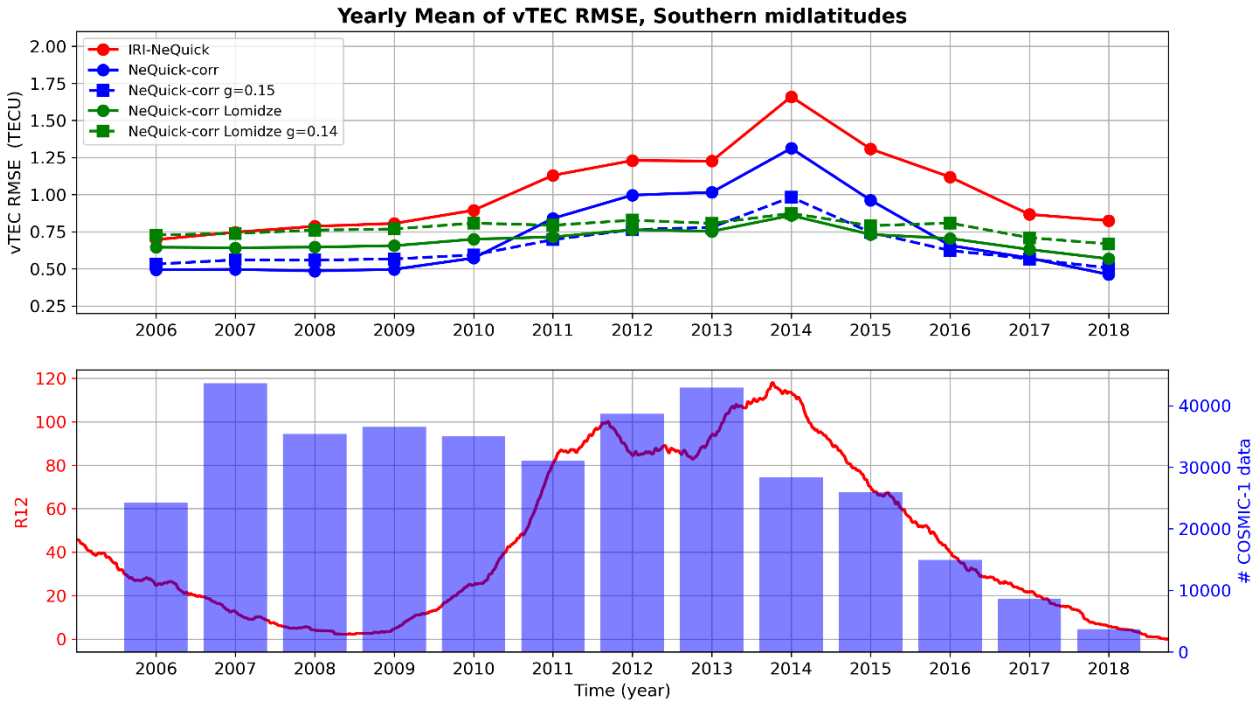

Figure S26. Yearly mean of RMSE for Southern middle latitudes between (red dots) the IRI-NeQuick model and COSMIC-1 derived vTEC values, between (blue dots) the NeQuick-corr model and COSMIC-1 derived vTEC values, between (blue squares) the NeQuick-corr(g = 0.15) model and COSMIC-1 derived vTEC values, between (green dots) the NeQuick-corr Lomidze model and COSMIC-1 derived vTEC values, and between (green squares) the NeQuick-corr(g = 0.14) model and COSMIC-1 derived vTEC values. The R_{12} solar activity index as well as the number of COSMIC-1 RO data considered for each year are also reported.