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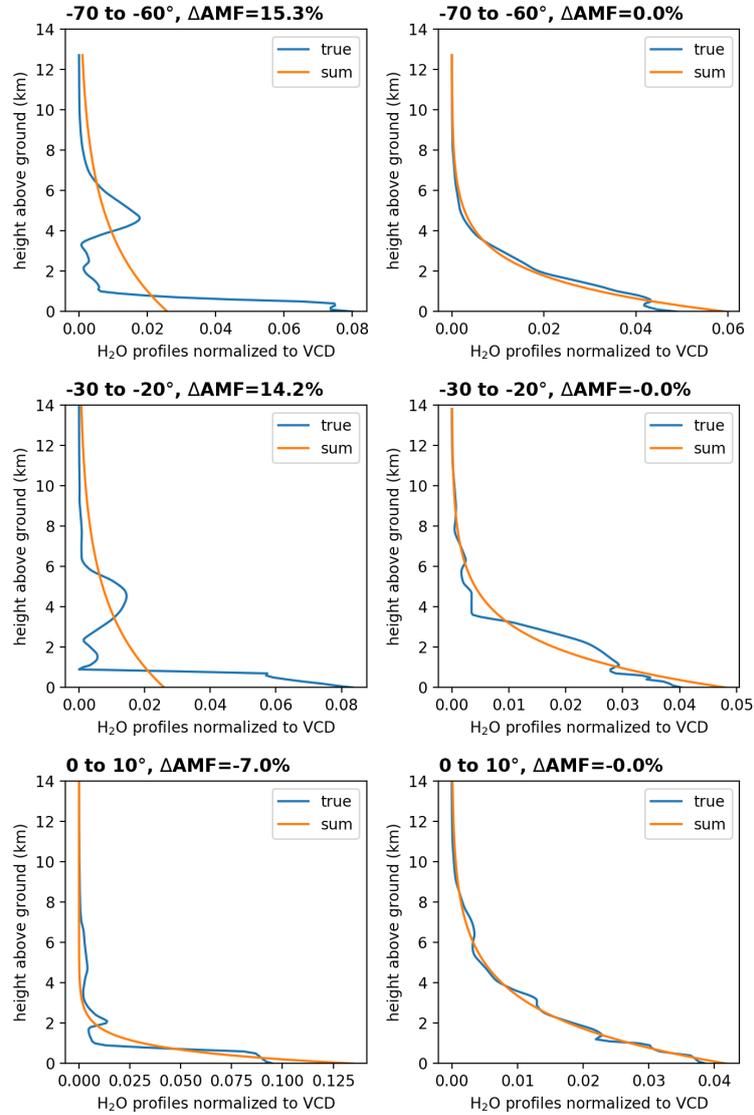
*Supplement of*

## **Total column water vapour retrieval from S-5P/TROPOMI in the visible blue spectral range**

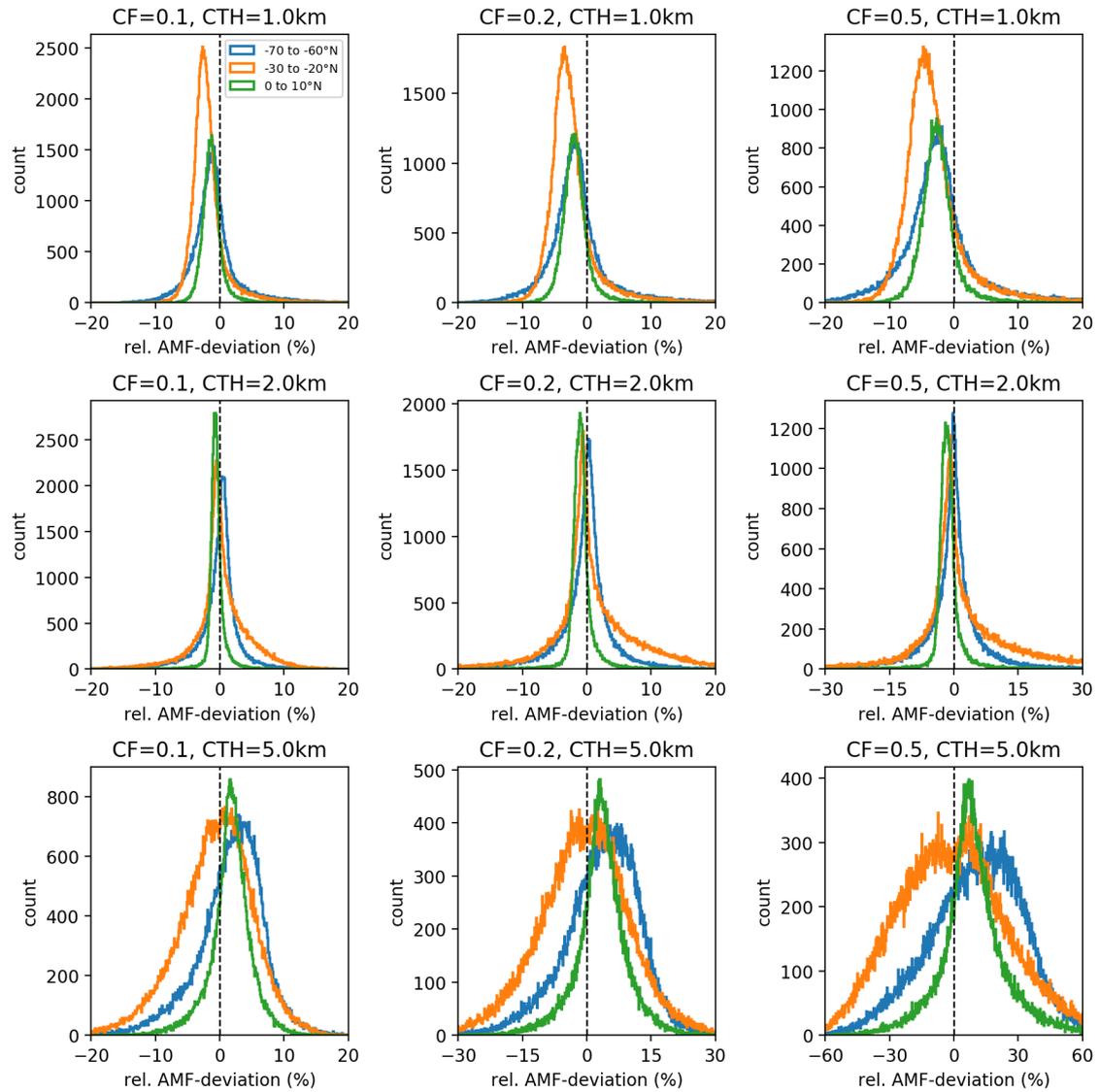
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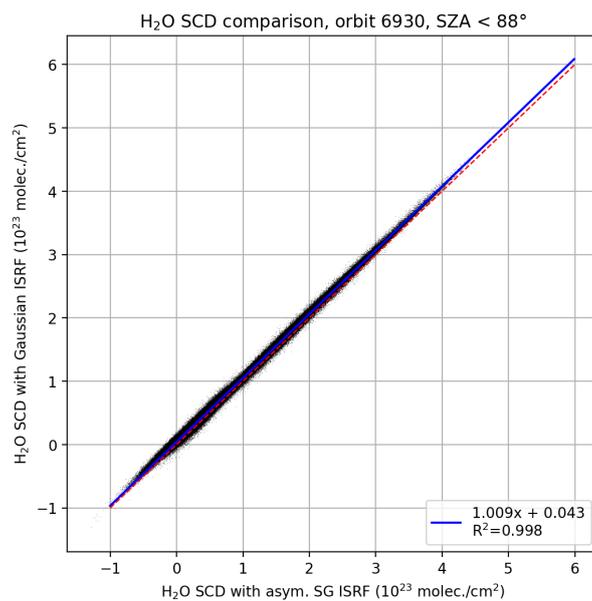
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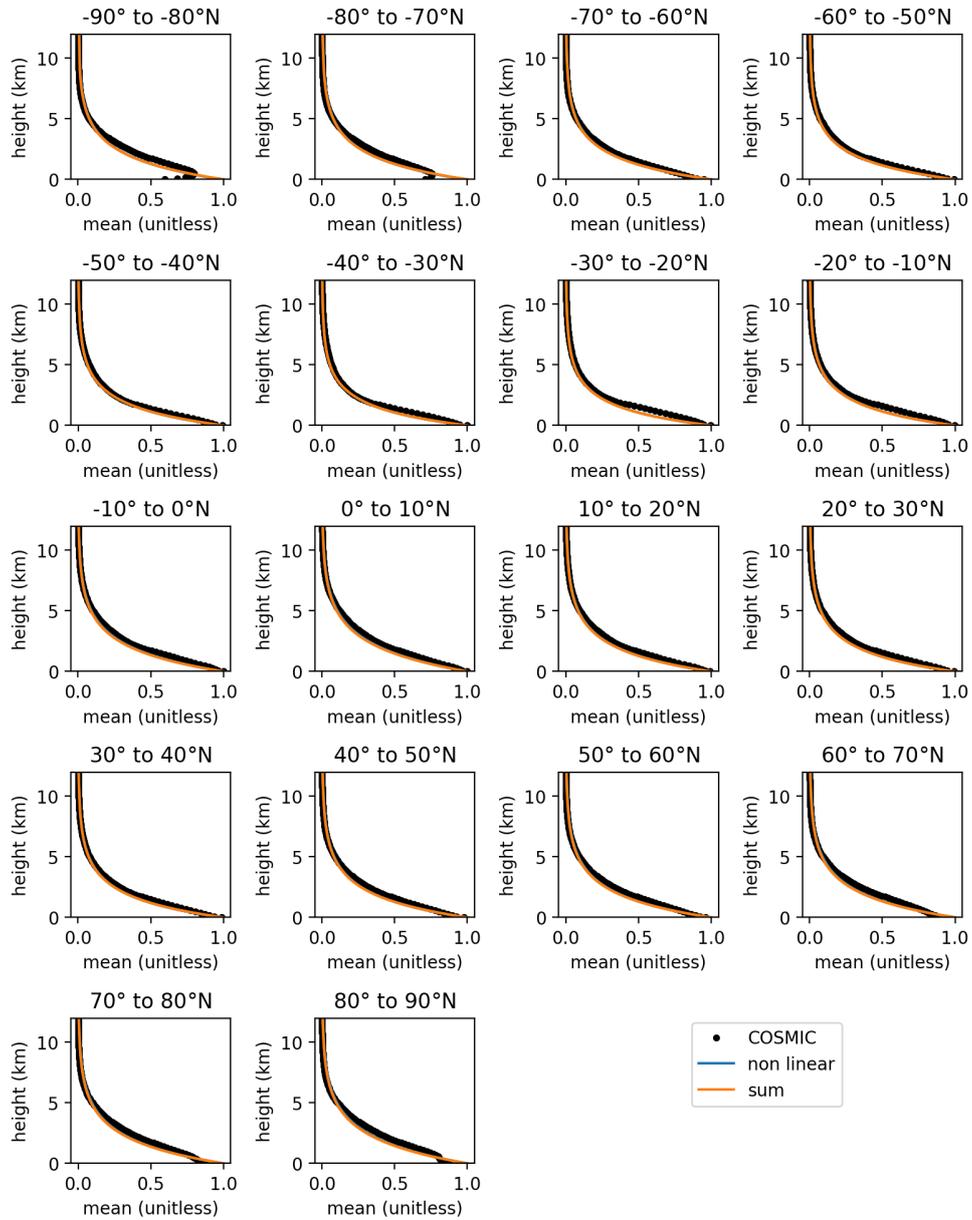
**Figure S1.** Comparison of profile shapes for selected latitude bins illustrating the maximal (left column) and minimal (right column) absolute relative AMF deviations. The blue line represents the “true” water vapour profile shape as measured from COSMIC and the orange line represents the exponential profile with a scale height  $H$  calculated from the sum method.



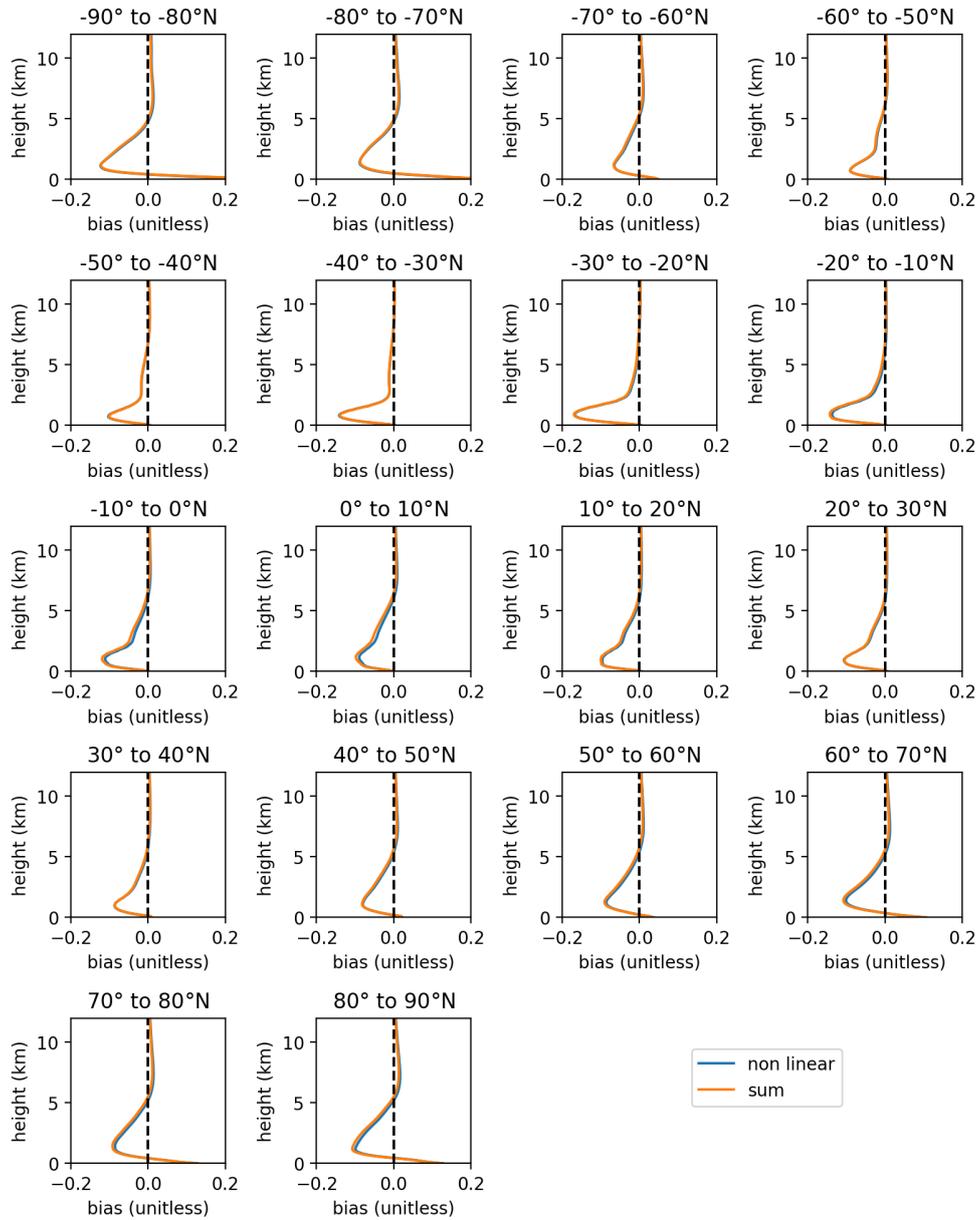
**Figure S2.** Histograms of the relative AMF deviations between exponential profile and COSMIC profile for the same latitude bins as in Fig. 5 for different cloud scenarios (cloud fraction 10, 20 and 50 % (left to right); cloud top height 1 km, 2 km and 5 km (top to bottom)) and a nadir viewing geometry.



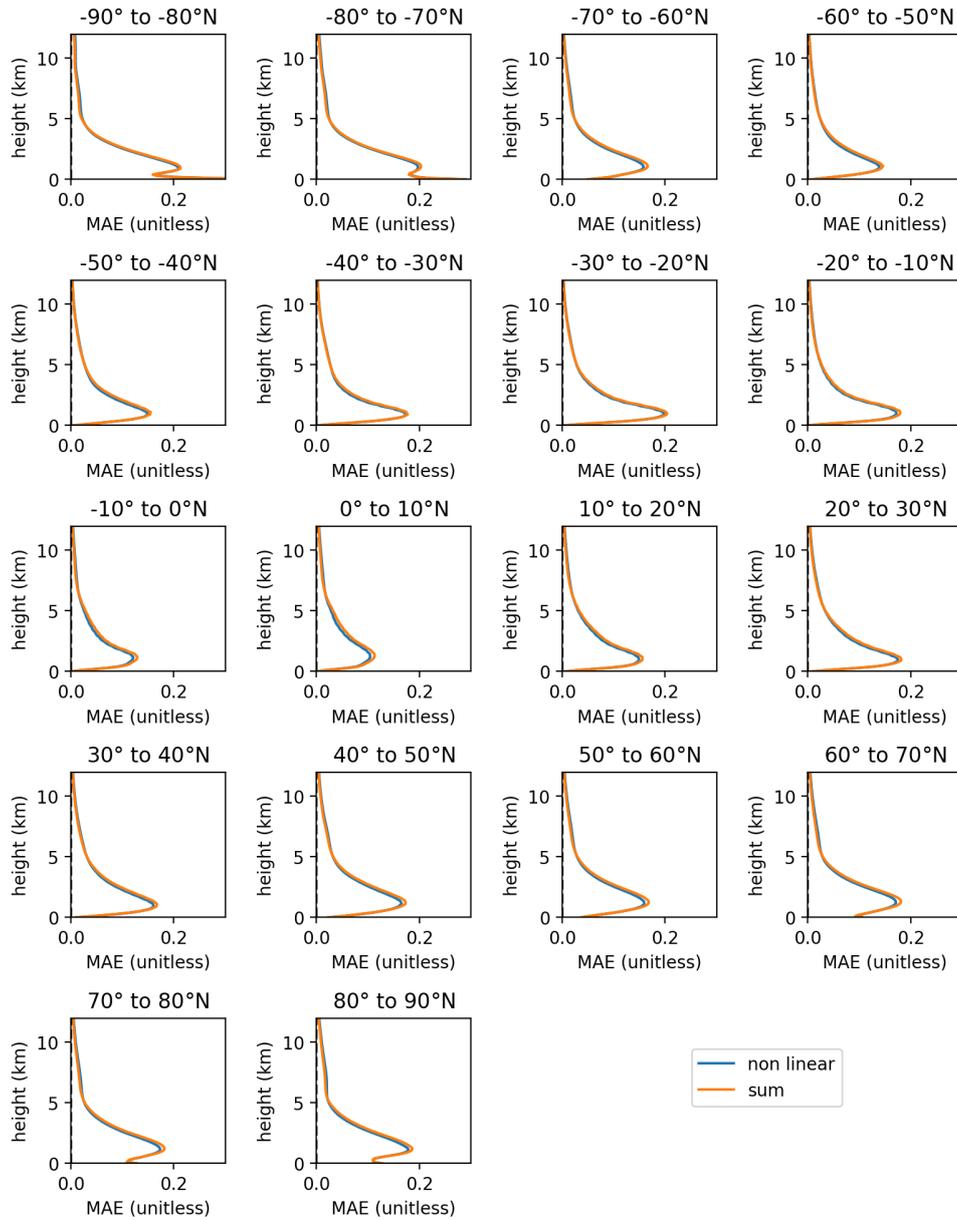
**Figure S3.** Comparison of H<sub>2</sub>O SCDs fitted assuming a Gaussian and an asymmetric Super-Gaussian ISRF. Values are taken from orbit 6930 for a solar zenith angle < 88°. The blue solid line indicates the results of the linear regression and the red dashed line the 1-to-1 diagonal.



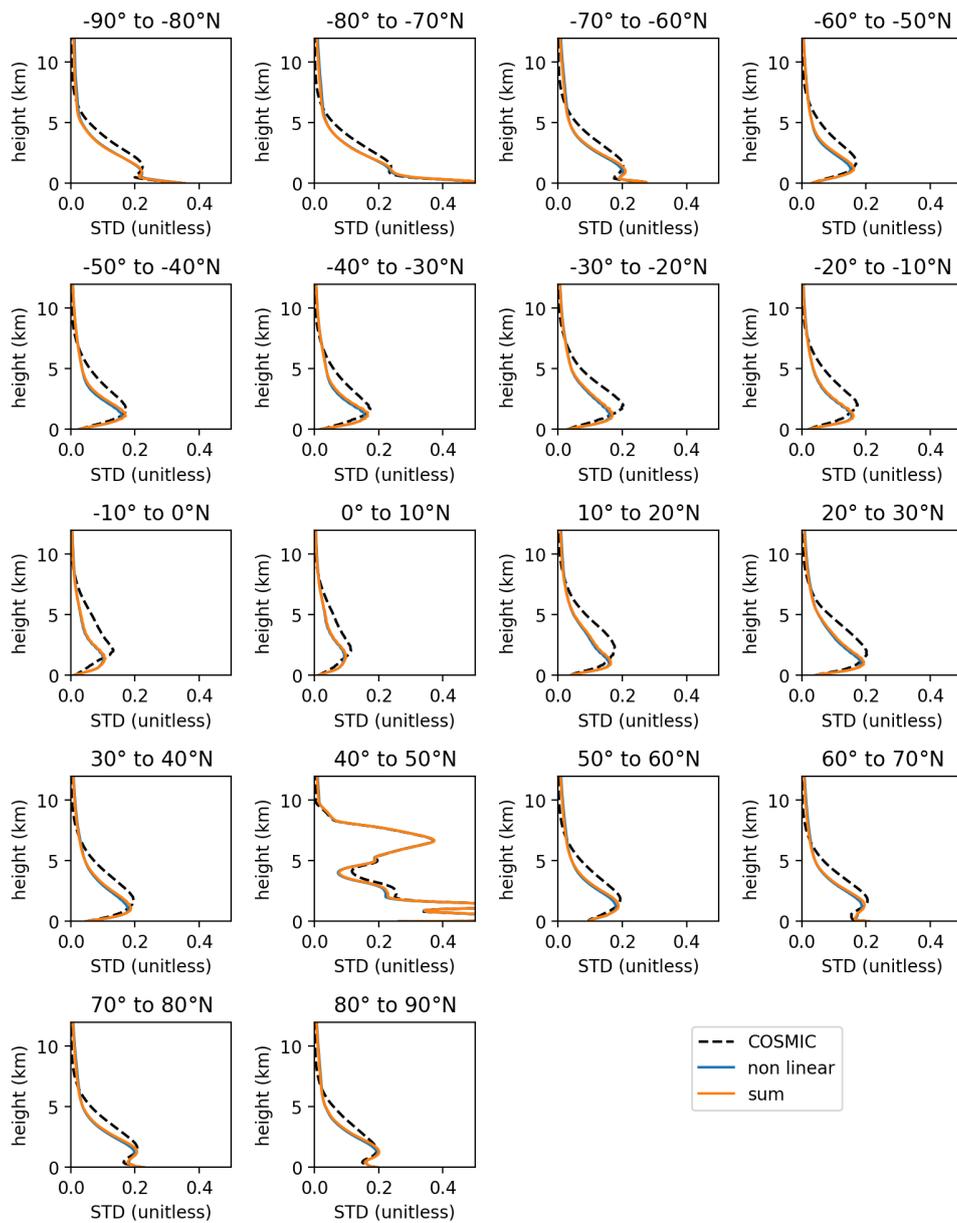
**Figure S4.** Mean water vapour profile shapes for data in 2013 for latitude bins of  $10^\circ$ . The solid lines represent the results from the exponential scale height approaches (blue: non-linear fit; orange: sum method) and the black dots represent the COSMIC measurements.



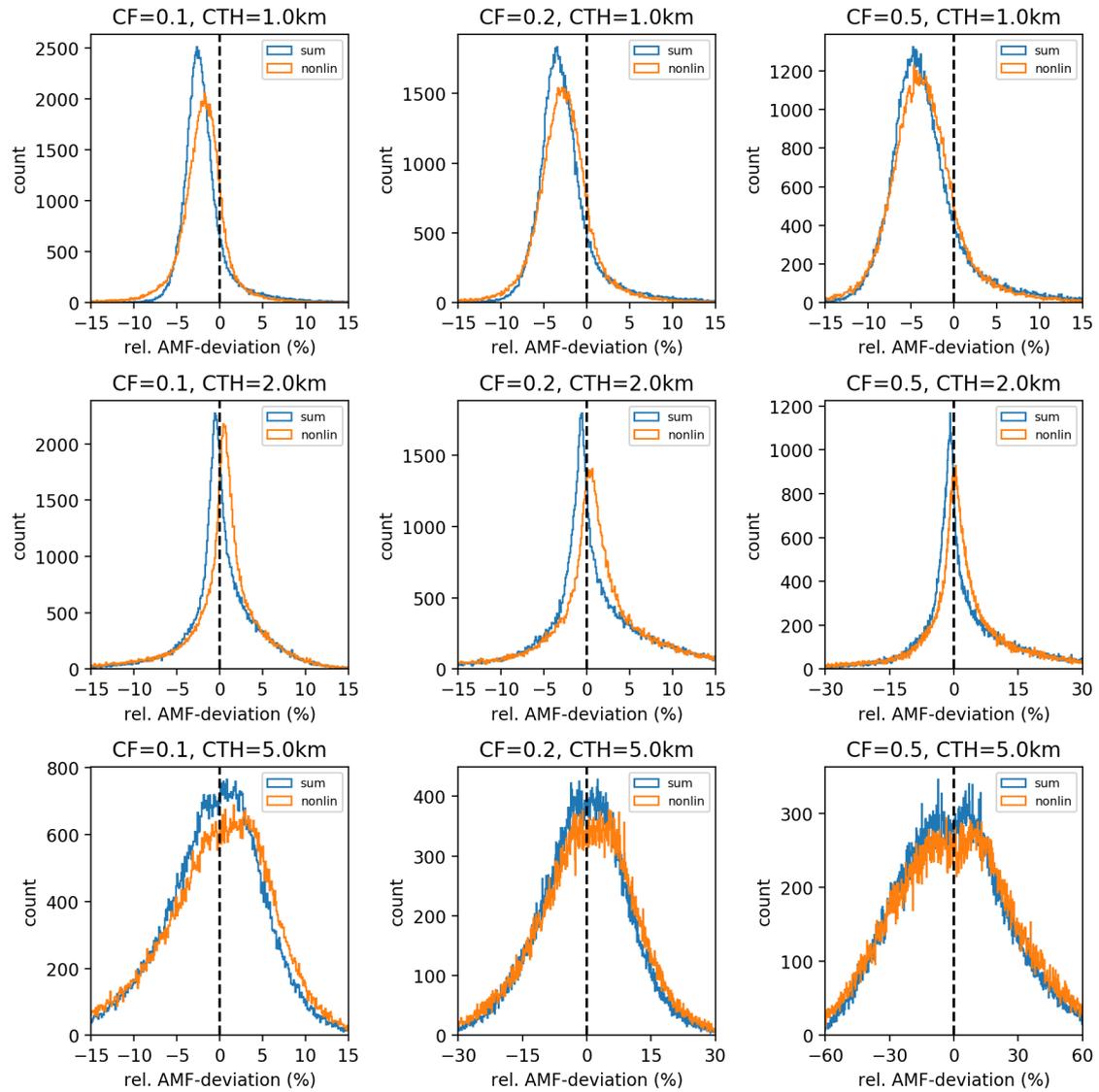
**Figure S5.** Bias of the profile shapes with respect to COSMIC profile shapes for the same data as in Fig. S4 (blue: non-linear fit; orange: sum method). The dashed black line represents the zero bias line.



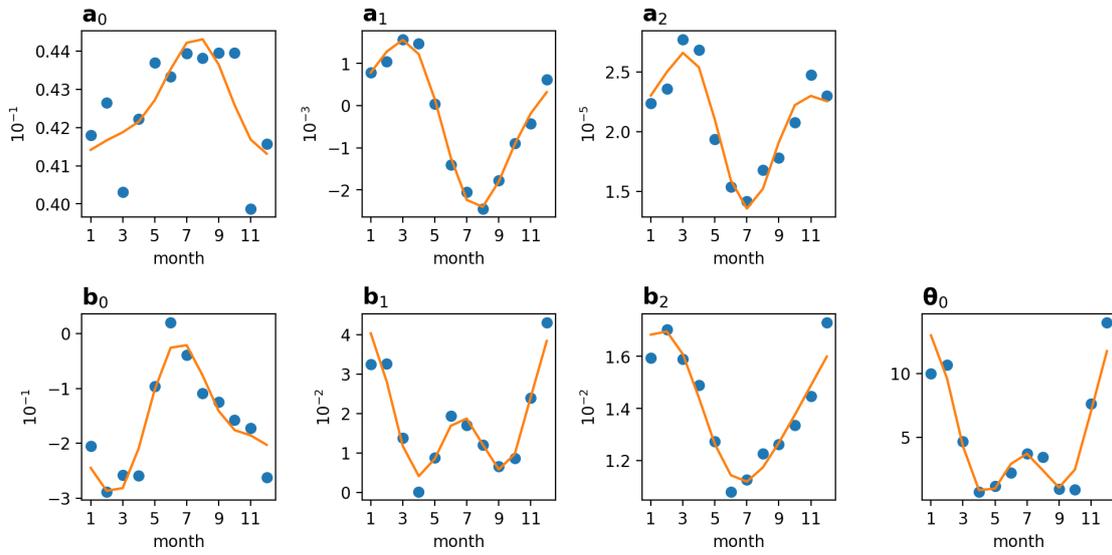
**Figure S6.** Mean absolute error of exponential profile shapes with respect to COSMIC profiles for the same data as in Fig. S4 (blue: non-linear fit; orange: sum method).



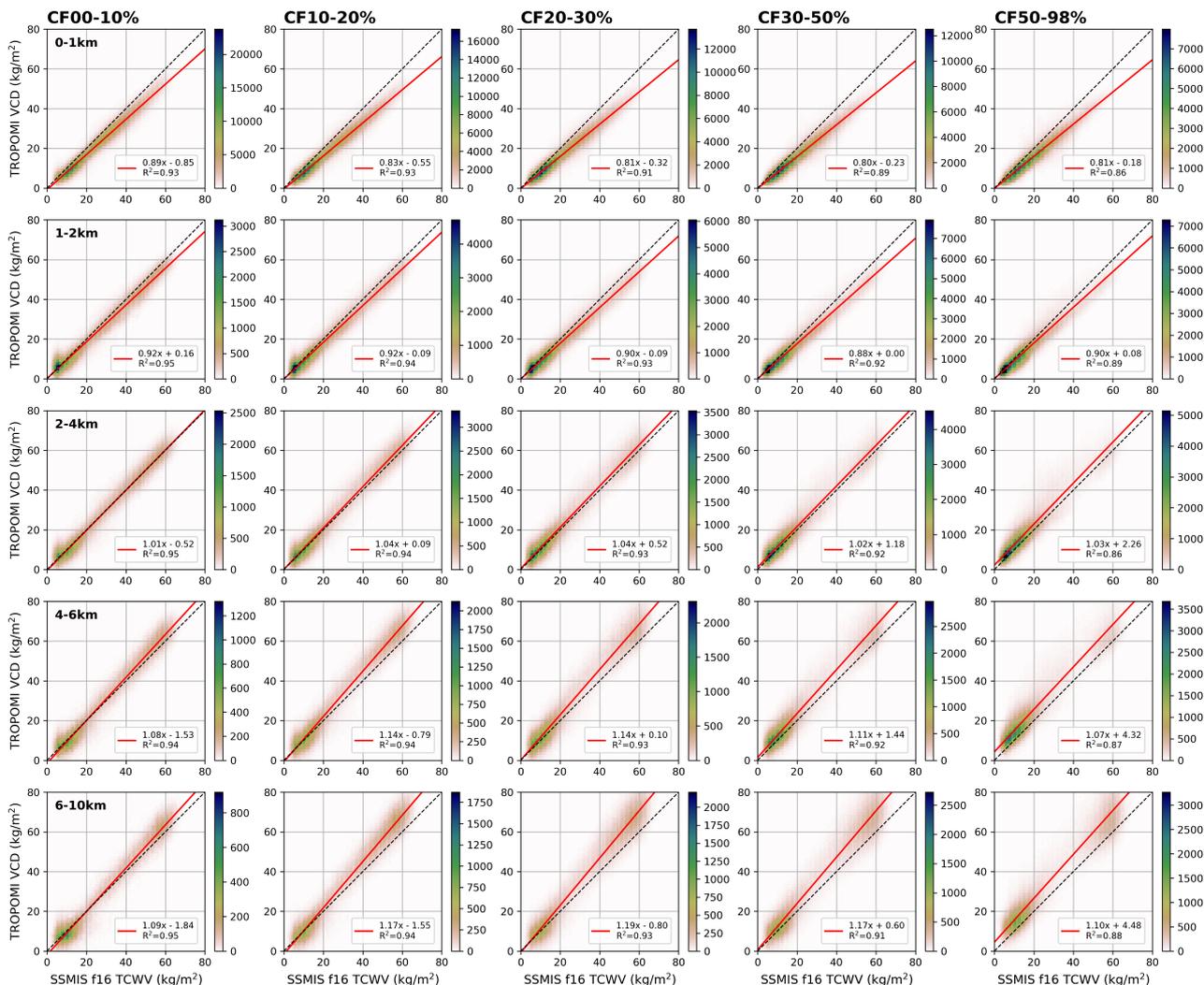
**Figure S7.** Standard deviations of the exponential and measured COSMIC profile shapes for the same data as in Figure S4. The blue solid line represents the results for the non-linear fit and the orange line for the sum method. The dashed black line represents the results for the COSMIC measurements.



**Figure S8.** Histogram of the relative deviation of the calculated synthetic AMFs between sum method (blue)/non-linear fit (orange) and COSMIC profile for latitude bin from  $-30^{\circ}\text{N}$  to  $-20^{\circ}\text{N}$  assuming different cloudy-sky conditions (cloud fraction 10, 20 and 50% (left to right); cloud top height 1 km, 2 km and 5 km (top to bottom)) and nadir viewing geometry.



**Figure S9.** Monthly/seasonal dependence of the fit parameters  $(a_0, a_1, a_2)$  and  $(b_0, b_1, b_2, \theta_0)$  for the functions  $\alpha(\theta, t)$  and  $\beta(\theta, t)$  in Eq. (11).



**Figure S10.** 2D histograms for the comparison between TROPOMI and SSMIS f16 for July 2018 for different cloud fraction bins (left to right column) and cloud top height bins (top to bottom row). The color indicates the amount of points within one bin of each panel. The black dotted line indicates the 1-to-1 diagonal and the red solid line represents the results of the linear regression. The parameters of the linear regression and the coefficient of determination are given in the box in each panel.

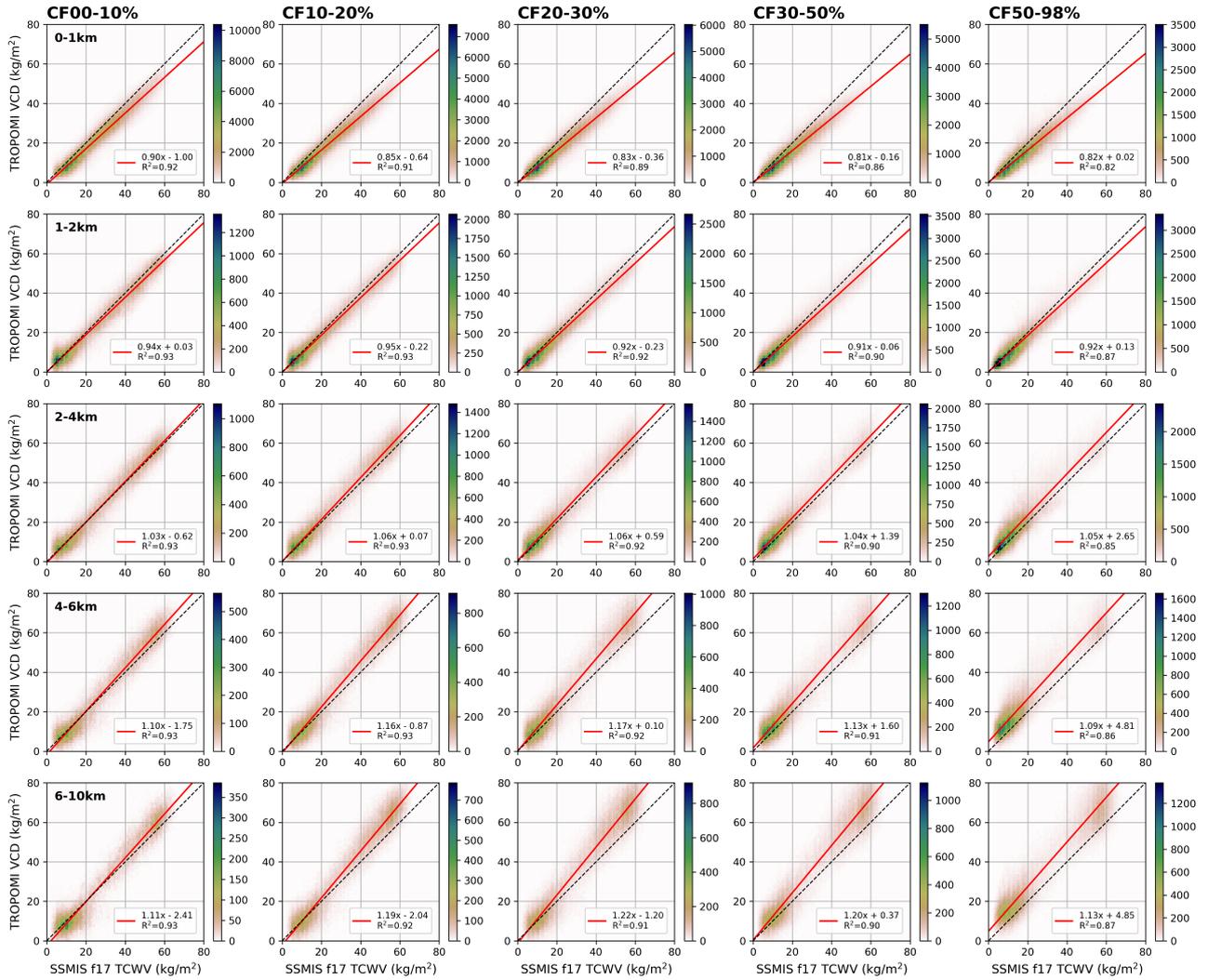


Figure S11. Same as Fig. S10, but for SSMIS f17.

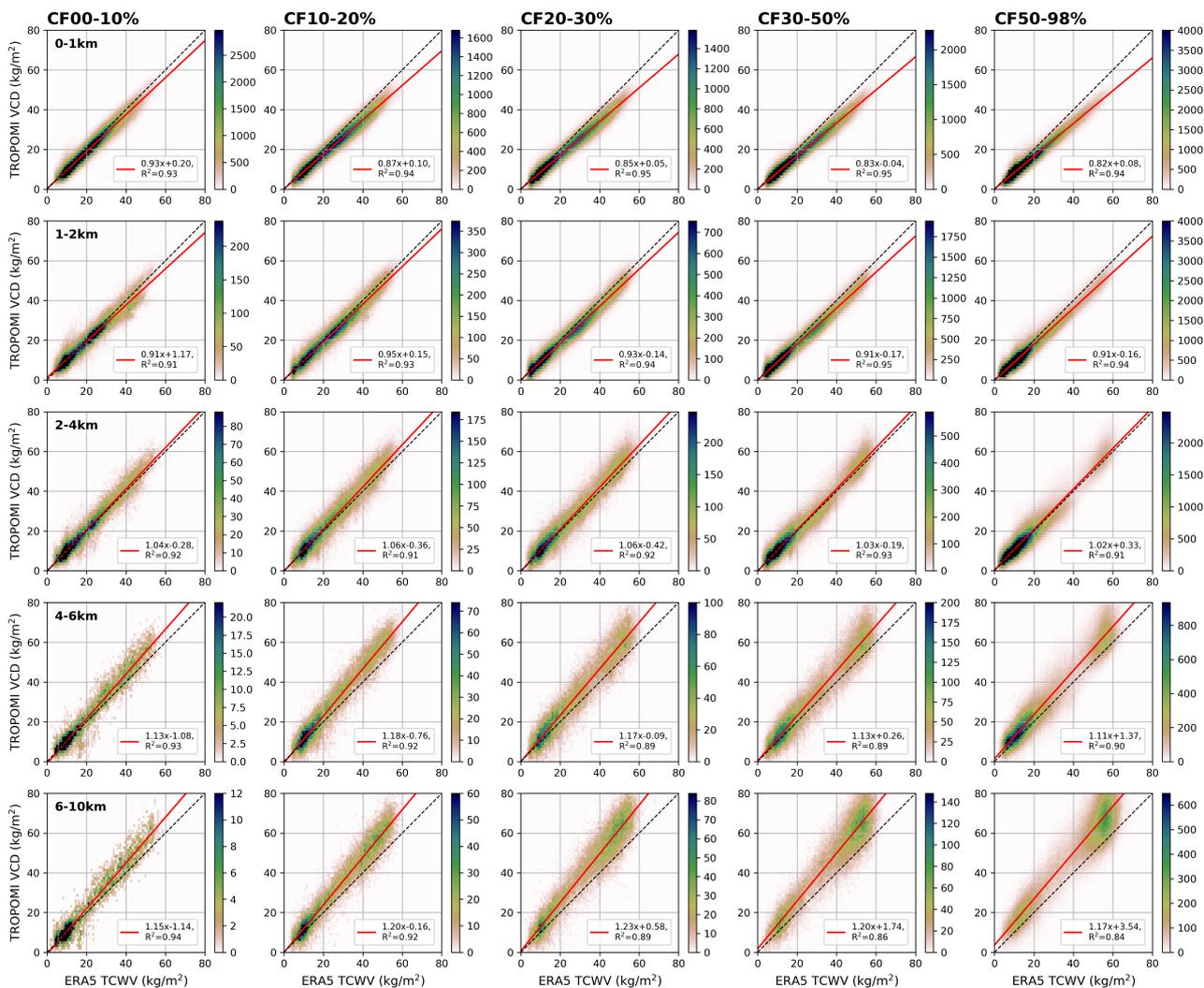


Figure S12. Same as Fig. S10, but for ERA-5 TCWV data over ocean.

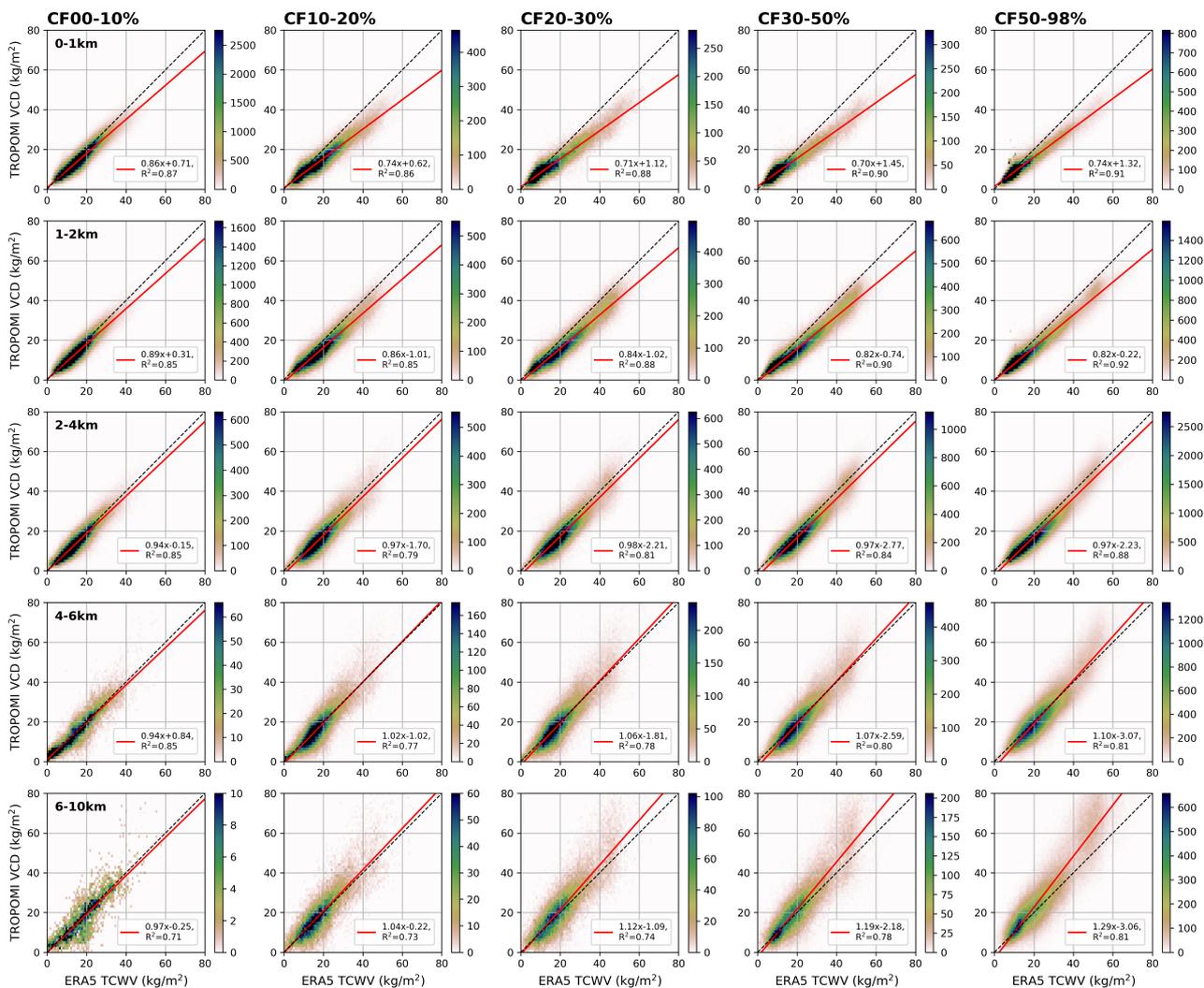
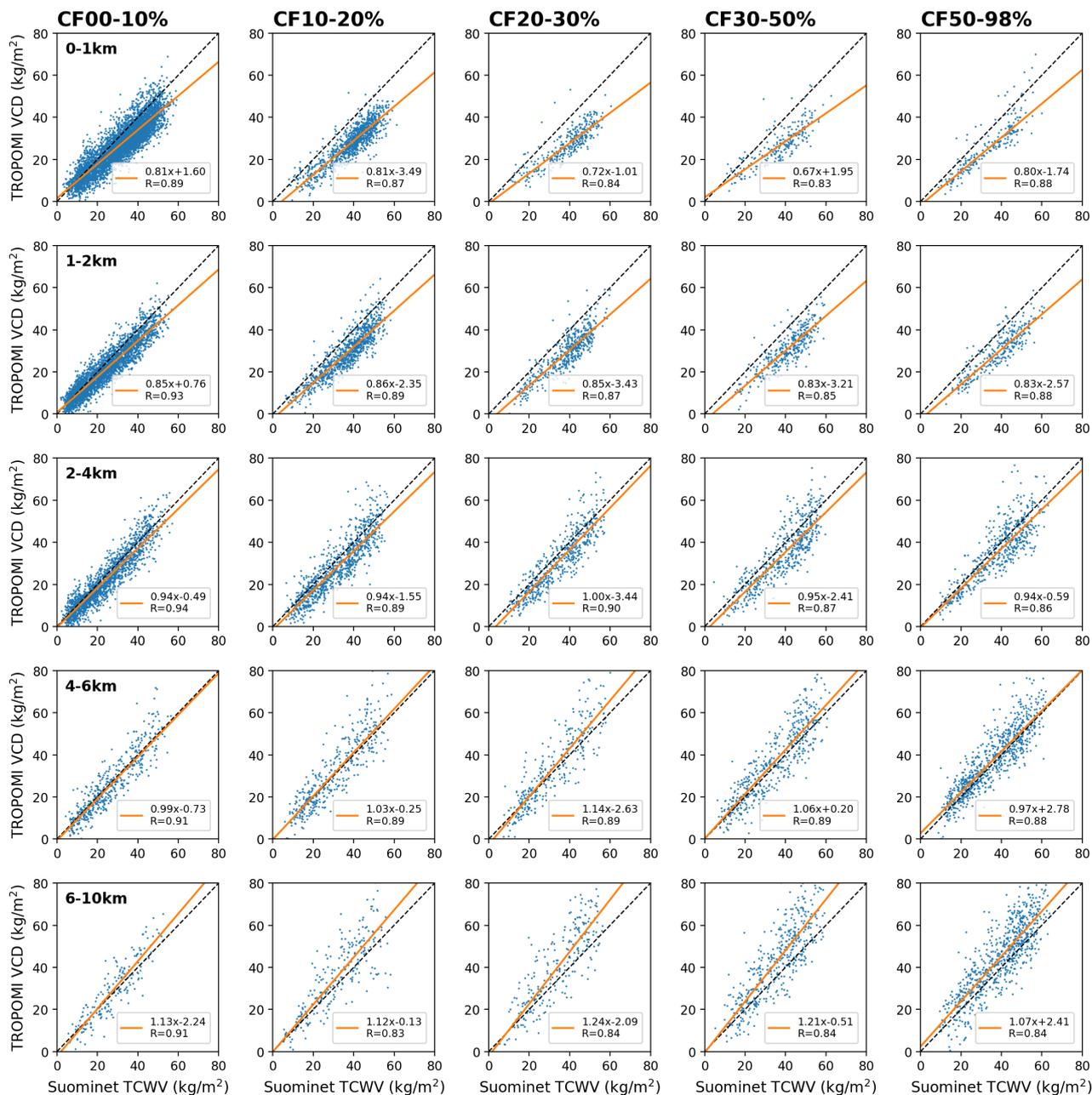


Figure S13. Same as Fig. S10, but for ERA-5 TCWV data over land.



**Figure S14.** Scatterplots for the comparison between TROPOMI and SuomiNet for boreal summer 2018 for different cloud fraction bins (left to right column) and cloud top height bins (top to bottom row). The black dashed line indicates the 1-to-1 diagonal and the orange solid line represents the results of the robust regression. The parameters of the regression and the correlation coefficient are given in the box in each panel.