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Source mechanisms and transport patterns of tropospheric bromine monoxide: findings from long-term multi-axis differential optical absorption spectroscopy measurements at two Antarctic stations

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This document contains supplemental material to the manuscript entitled 'Source Mechanisms and transport Patterns of tropospheric BrO: Findings from long-term MAX-DOAS Measurements at two Antarctic Stations' by Frieß et al. Section 1 shows histograms of the DOAS fit error and of the degrees of freedom for signal of the aerosol and BrO profiles at both sites. Section 2 presents correlation plots for each pair of parameters observed at both sites, separately for each season, as well as matrices of p-values of the regression analysis. Source-receptor maps of BrO and related parameters for all seasons can be found in Section 3. The multi-annual variability of BrO and aerosols at both sites is presented in Section 4.

1 DOAS Fit Errors and vertical Profile Information Content

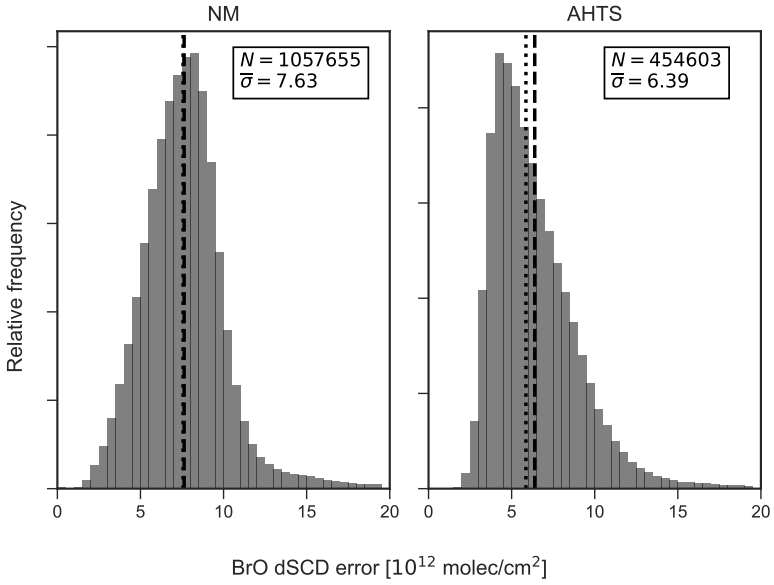

Figure S1: Histogram of the BrO fit errors for NM (left, 2003 - 2021 data) and AH (right, 2012 - 2021 data) as derived from the DOAS analysis. Mean and median are shown as dashed and dotted lines, respectively.

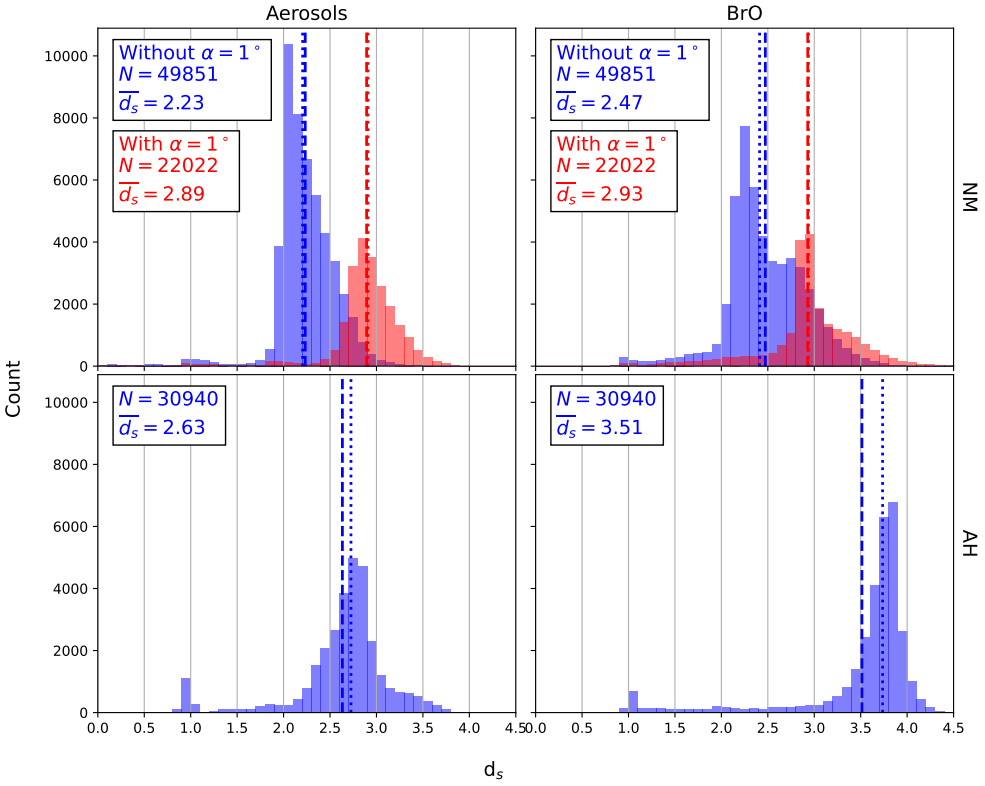

Figure S2: Histograms of the DOFS for aerosols (left) and BrO (right). Top panels show the DOFS distribution for NM, with blue and red bars for the periods without (before February 2016) and with (after February 2016) 1° elevation included in the MAX-DOAS sequence, respectively. Bottom panels show the respective histograms for AH. Mean and median DOFS are shown as dashed and dotted vertical lines, respectively, and the legends show the total number of observations as well as the mean value.

2 Correlation plots

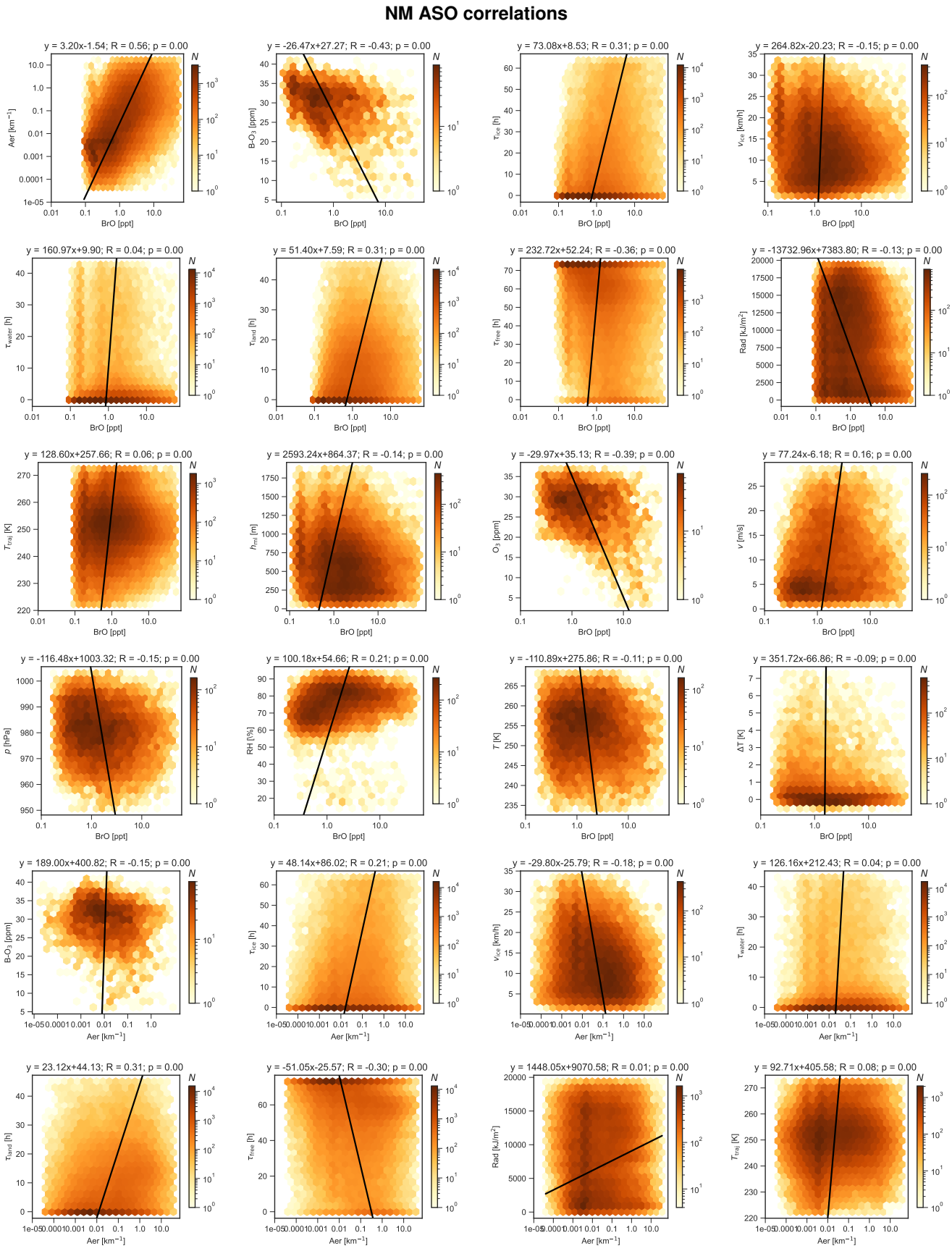

Figure S3: Correlations plots for parameters observed at NM during ASO. Each plot shows the correlation of a pair of parameters. The colour in each hexagon corresponds to the number of data points in this area (logarithmic colour scale). Note that BrO and aerosols are in logarithmic scale. Slope, intercept, PCC and p-value are listed in the subfigure titles.The linear fits are shown as black lines.For a description of the variables see Tables 4 and 5 in the main paper.

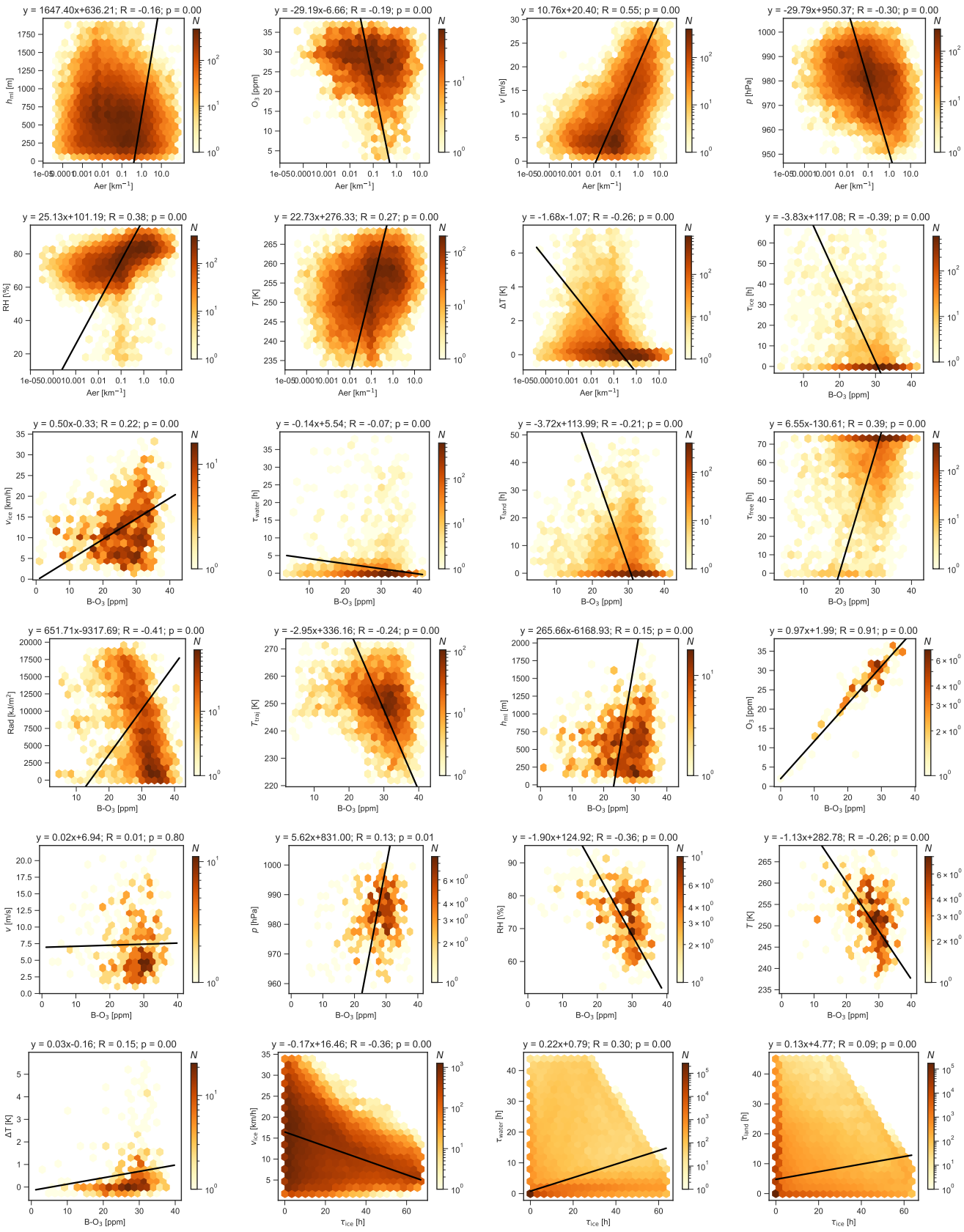

Figure S3: Correlations plots for parameters observed at NM during ASO (continued)

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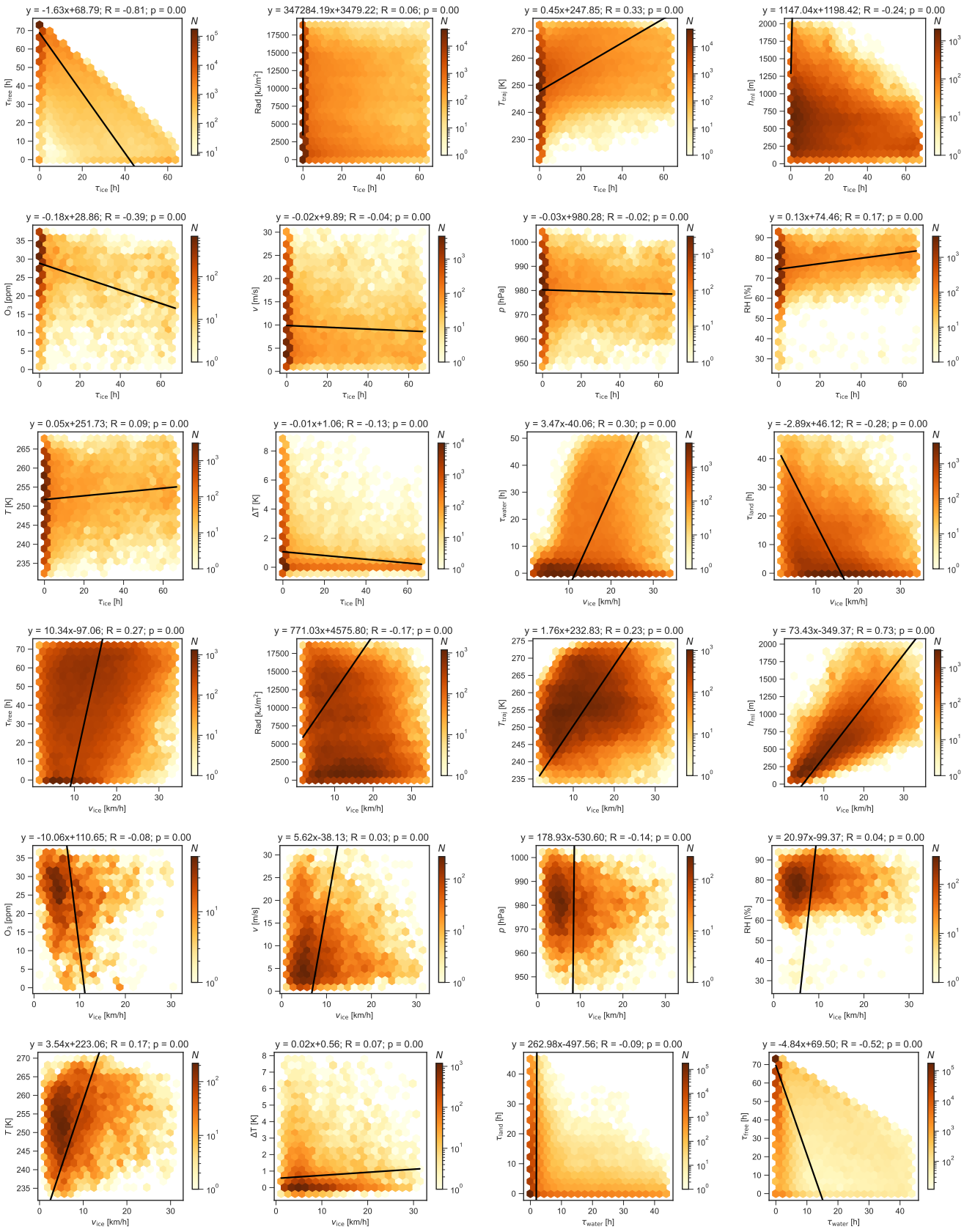

Figure S3: Correlations plots for parameters observed at NM during ASO (continued)

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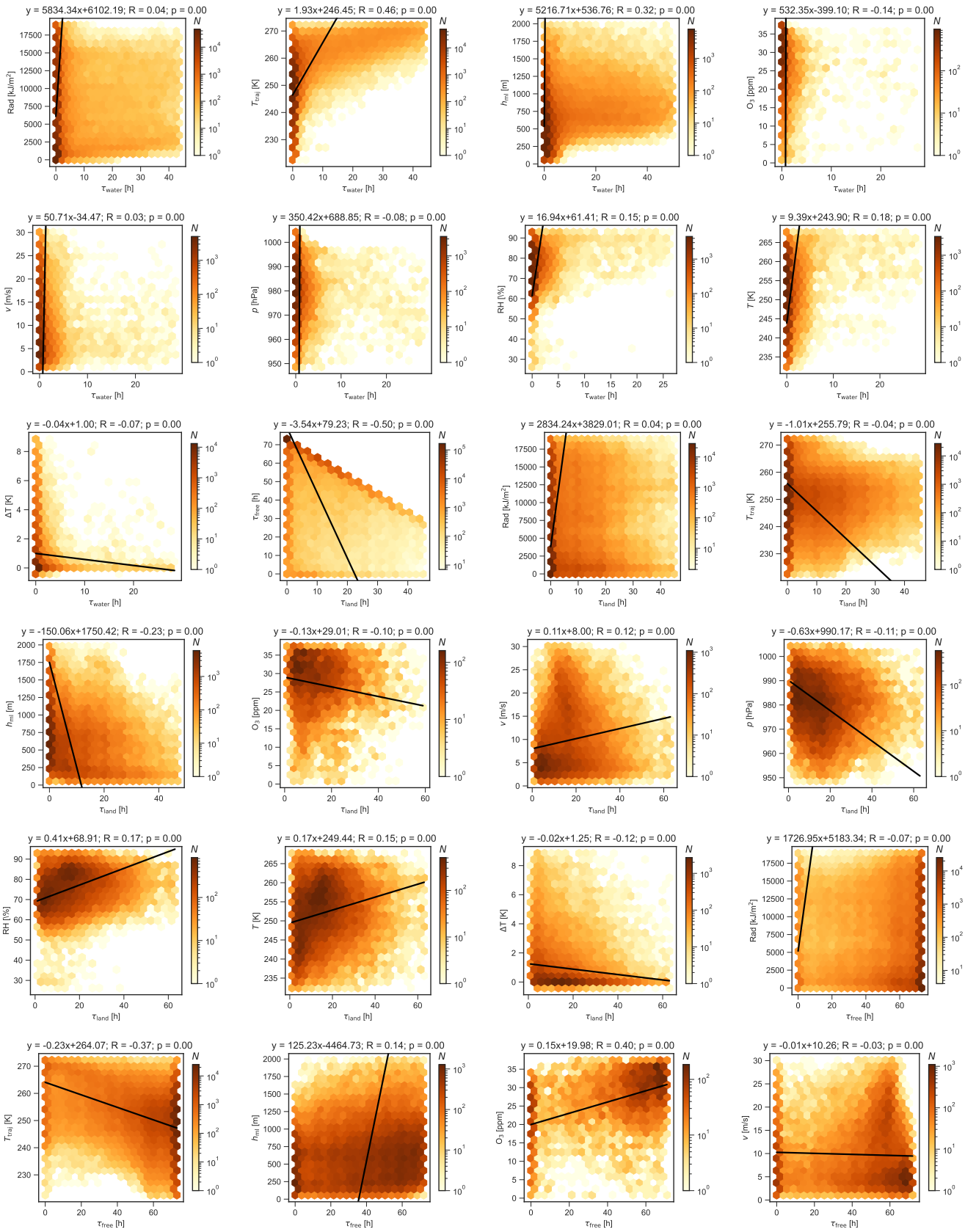

Figure S3: Correlations plots for parameters observed at NM during ASO (continued)

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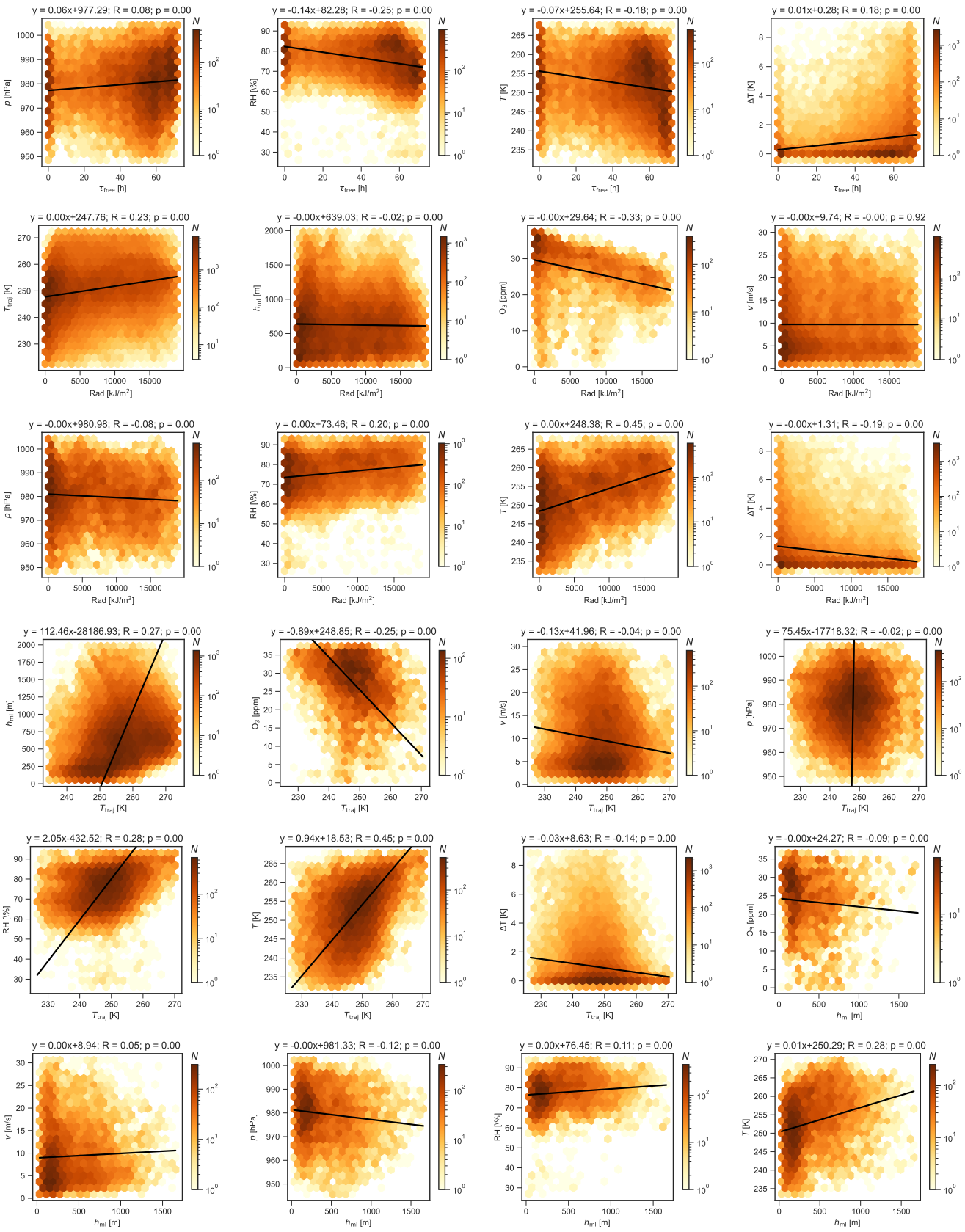

Figure S3: Correlations plots for parameters observed at NM during ASO (continued)

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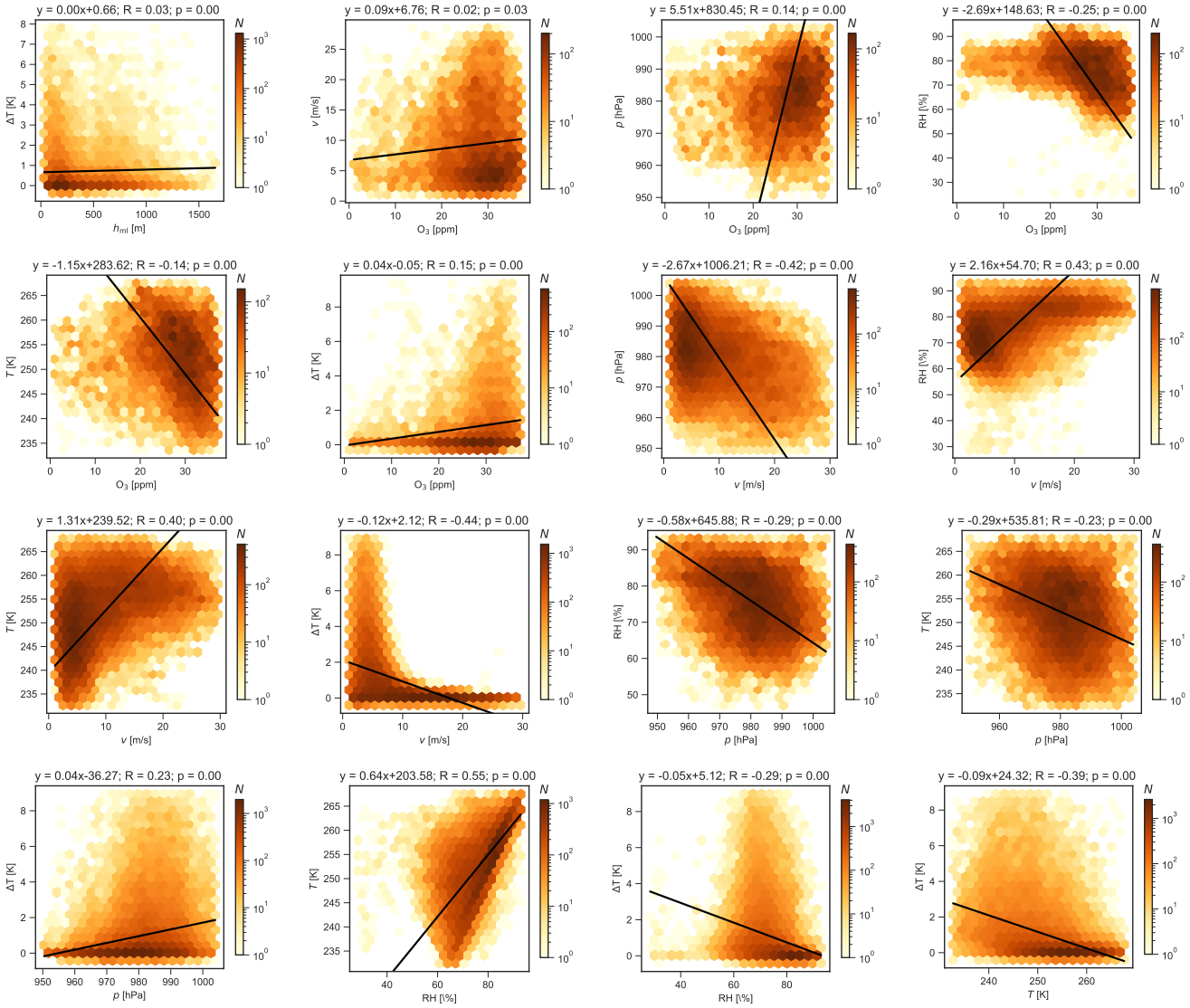

Figure S3: Correlations plots for parameters observed at NM during ASO (continued)

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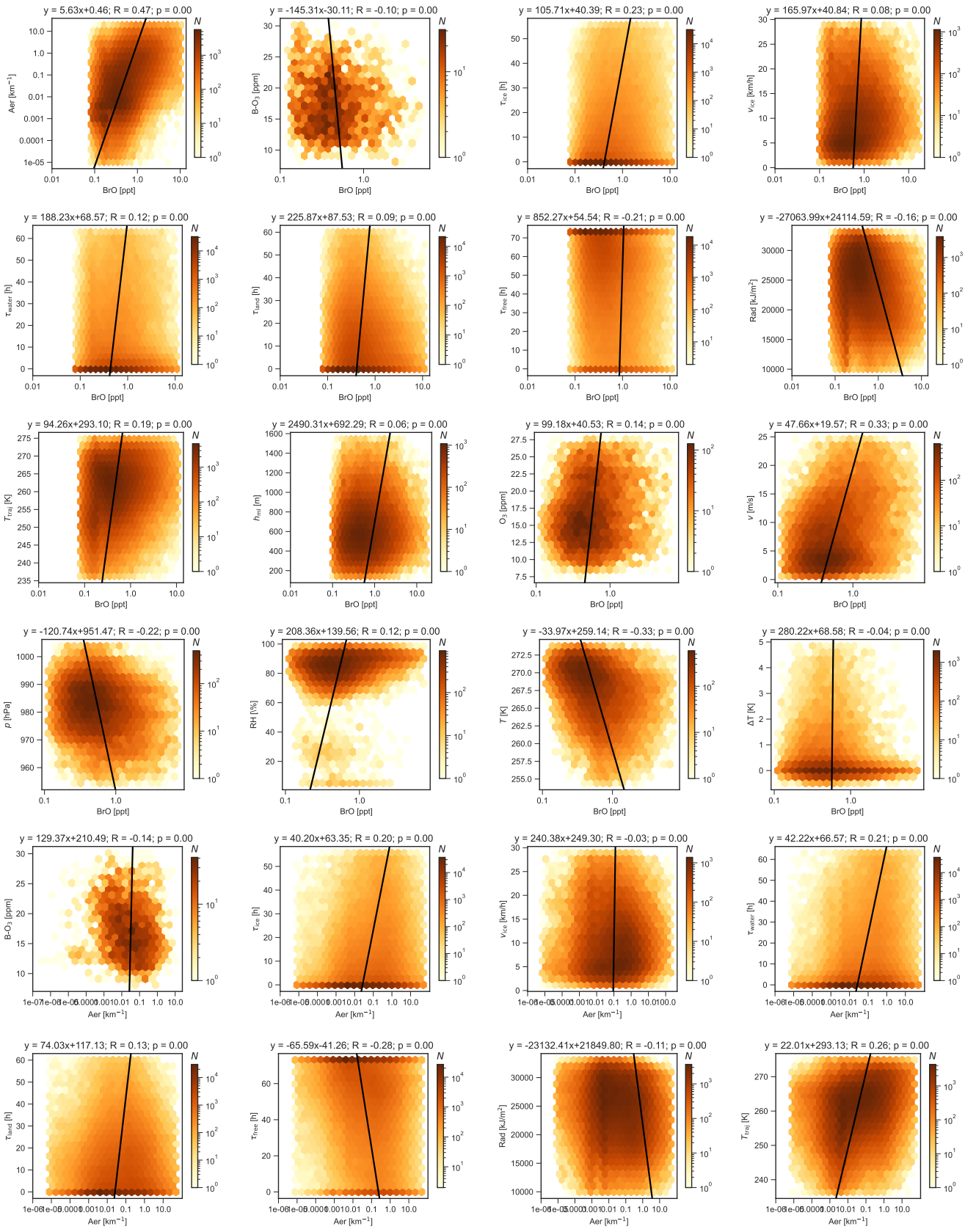

Figure S4: Correlations plots for parameters observed at NM during NDJ. Each plot shows the correlation of a pair of parameters. The colour in each hexagon corresponds to the number of data points in this area (logarithmic colour scale). Note that BrO and aerosols are in logarithmic scale. Slope, intercept, PCC and p-value are listed in the subfigure titles.The linear fits are shown as black lines.For a description of the variables see Tables 4 and 5 in the main paper.

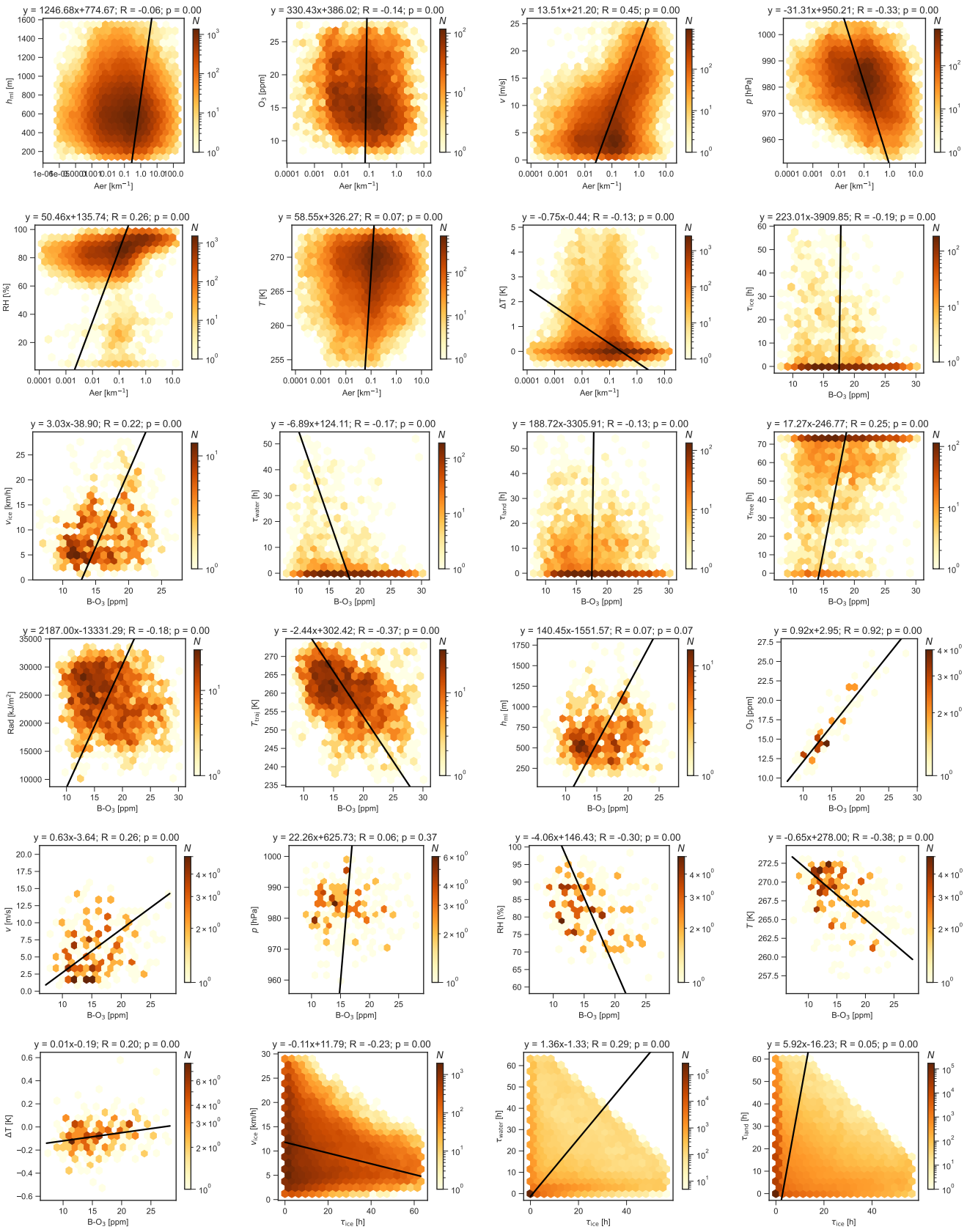

Figure S4: Correlations plots for parameters observed at NM during NDJ (continued)

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NM NDJ correlations

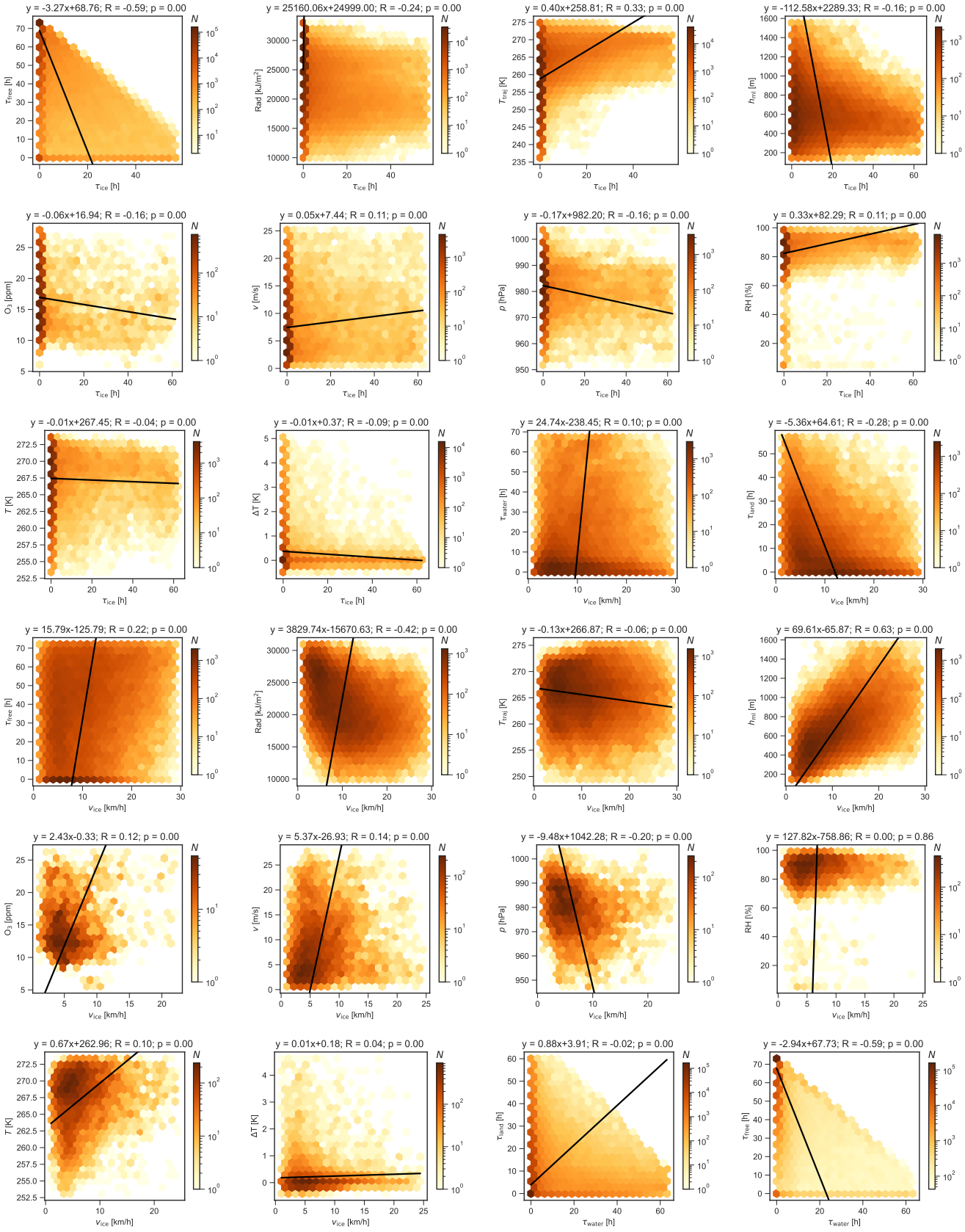

Figure S4: Correlations plots for parameters observed at NM during NDJ (continued)

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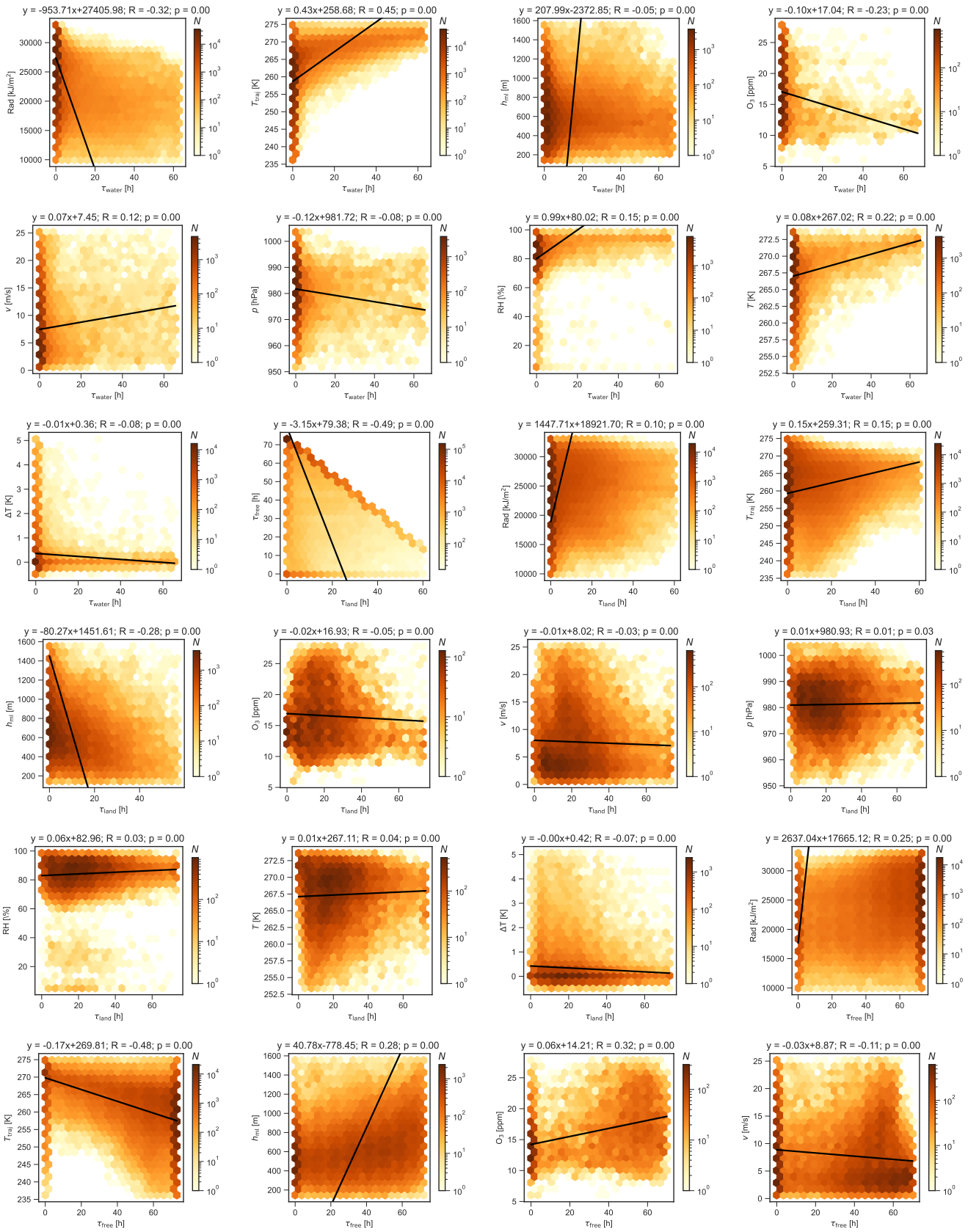

Figure S4: Correlations plots for parameters observed at NM during NDJ (continued)

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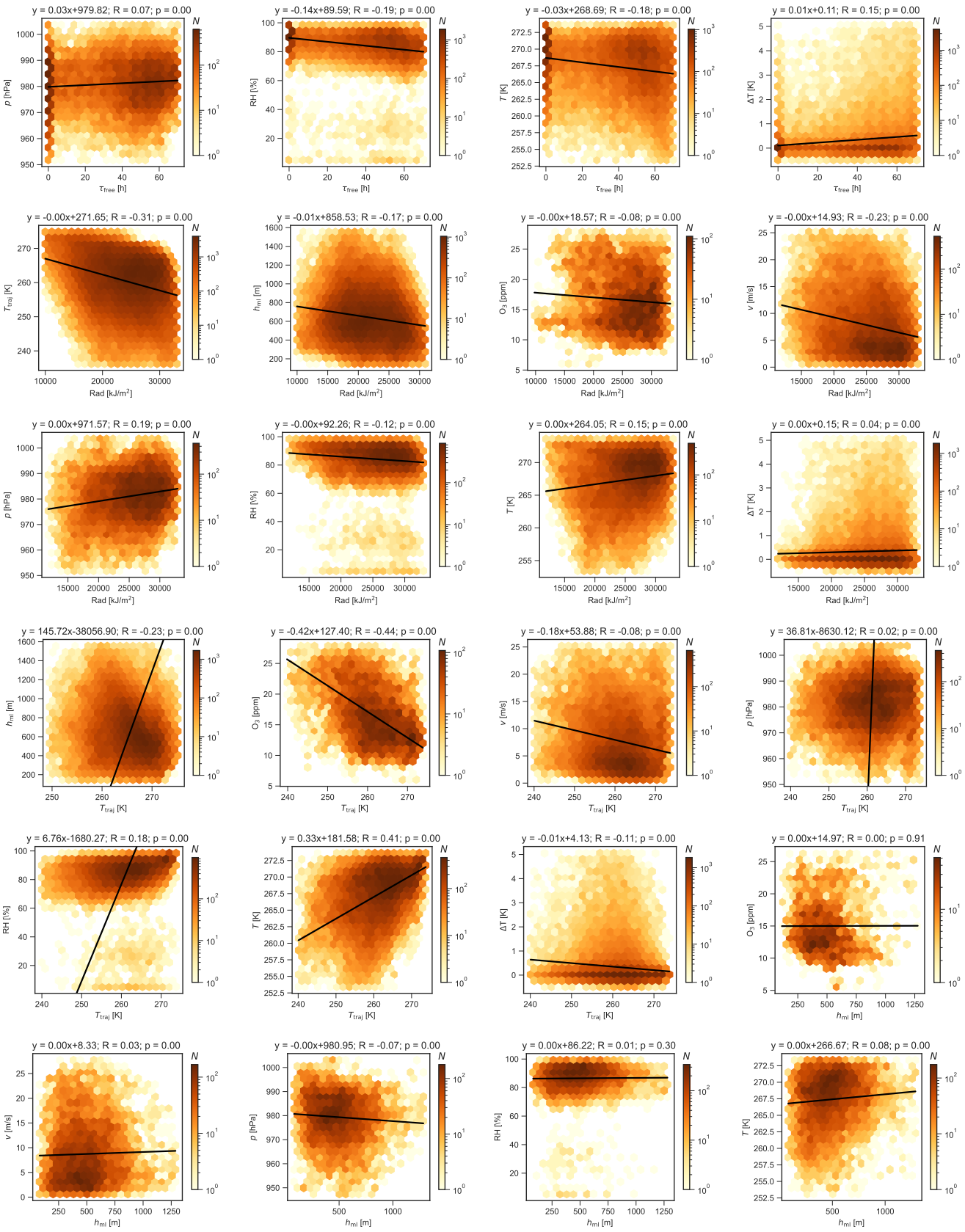

Figure S4: Correlations plots for parameters observed at NM during NDJ (continued)

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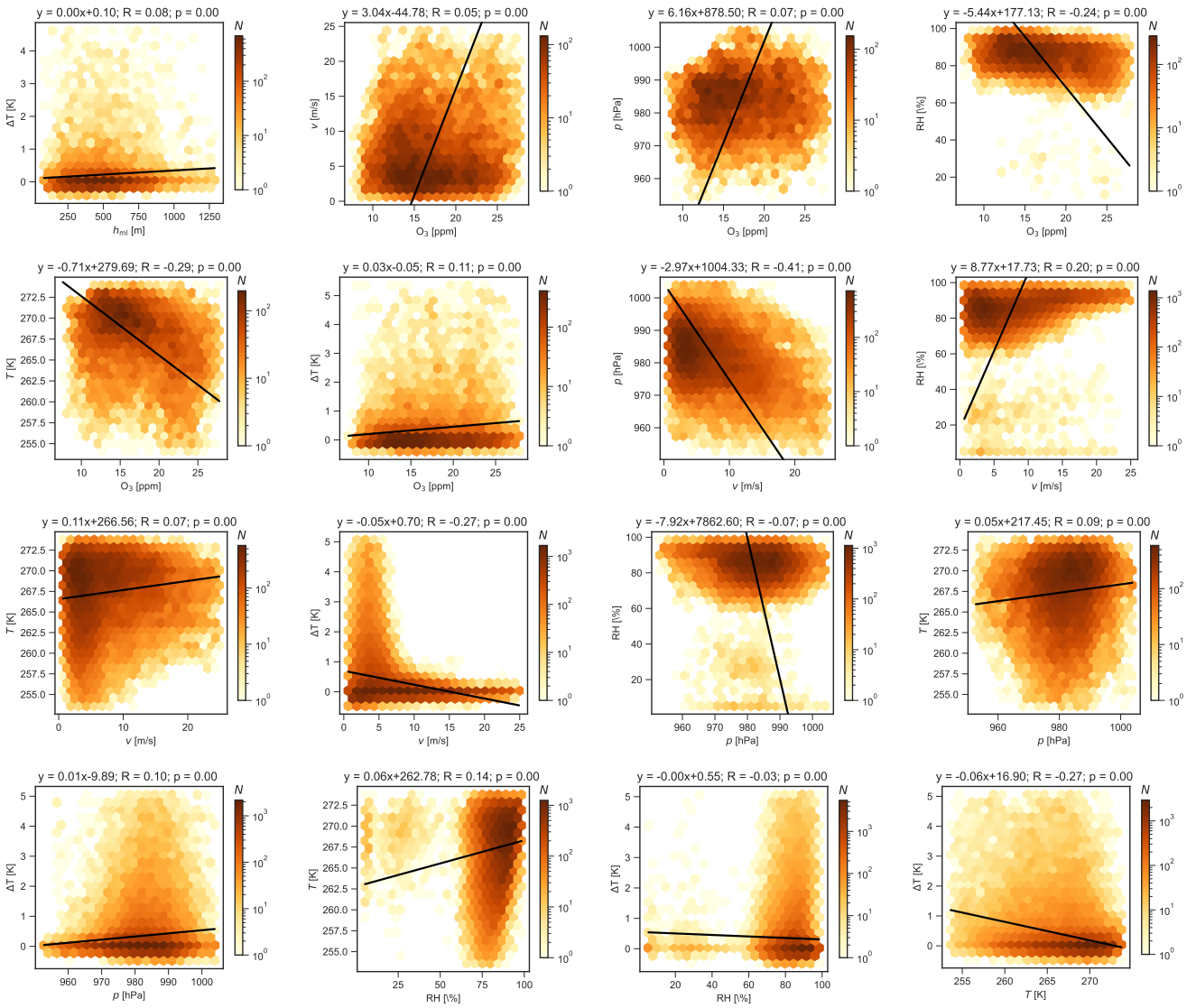

Figure S4: Correlations plots for parameters observed at NM during NDJ (continued)

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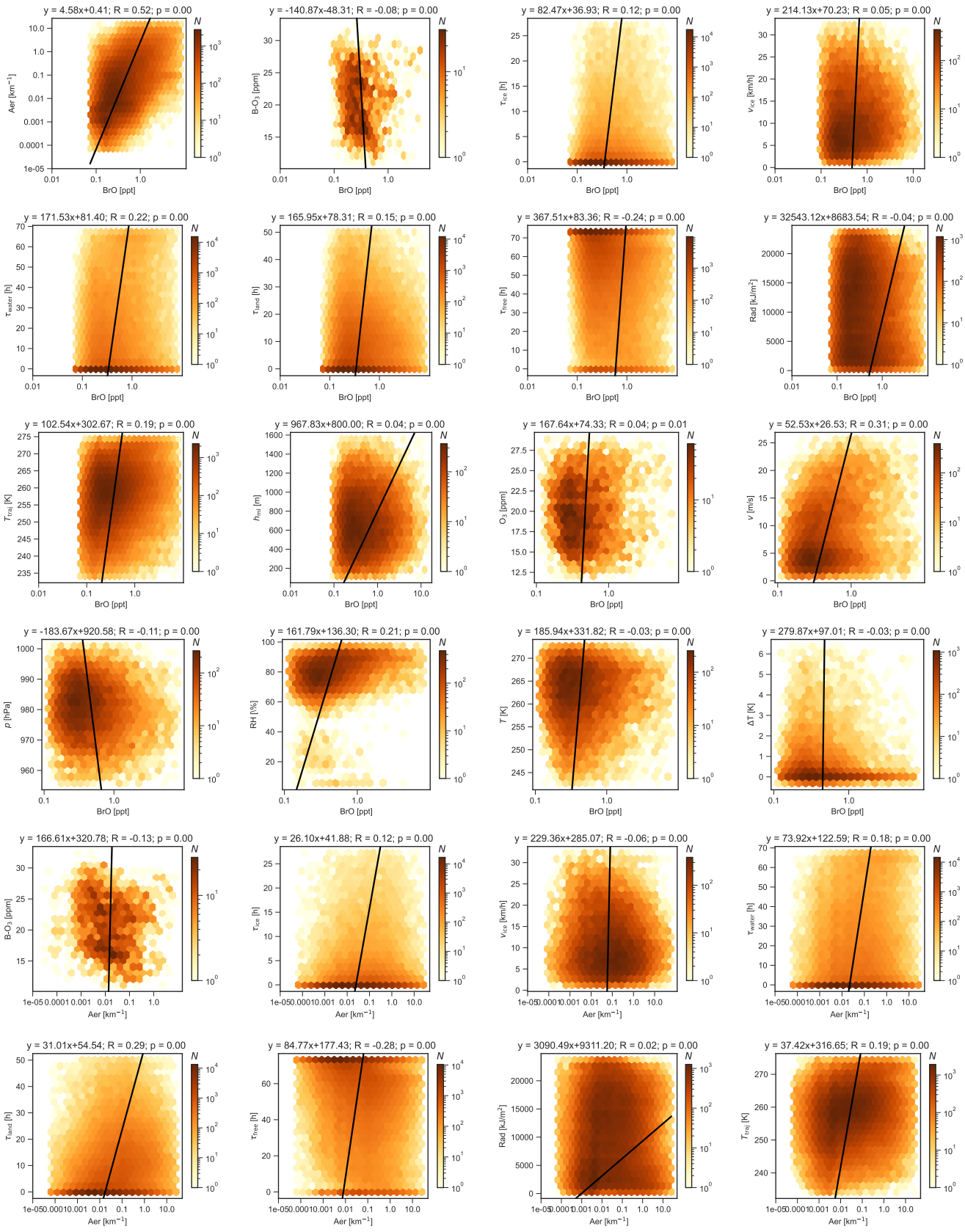

Figure S5: Correlations plots for parameters observed at NM during FMA. Each plot shows the correlation of a pair of parameters. The colour in each hexagon corresponds to the number of data points in this area (logarithmic colour scale). Note that BrO and aerosols are in logarithmic scale. Slope, intercept, PCC and p-value are listed in the subfigure titles.The linear fits are shown as black lines.For a description of the variables see Tables 4 and 5 in the main paper.

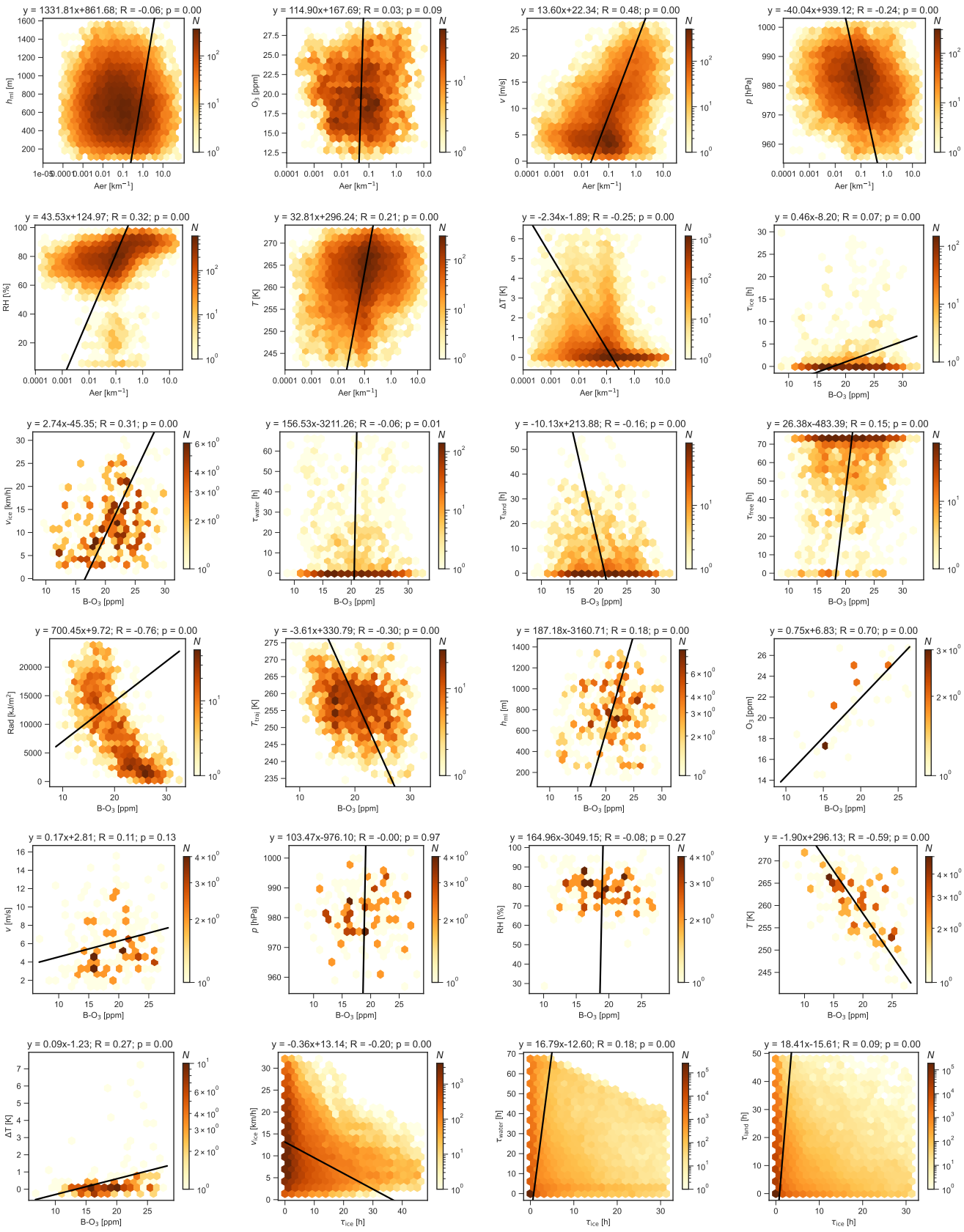

Figure S5: Correlations plots for parameters observed at NM during FMA (continued)

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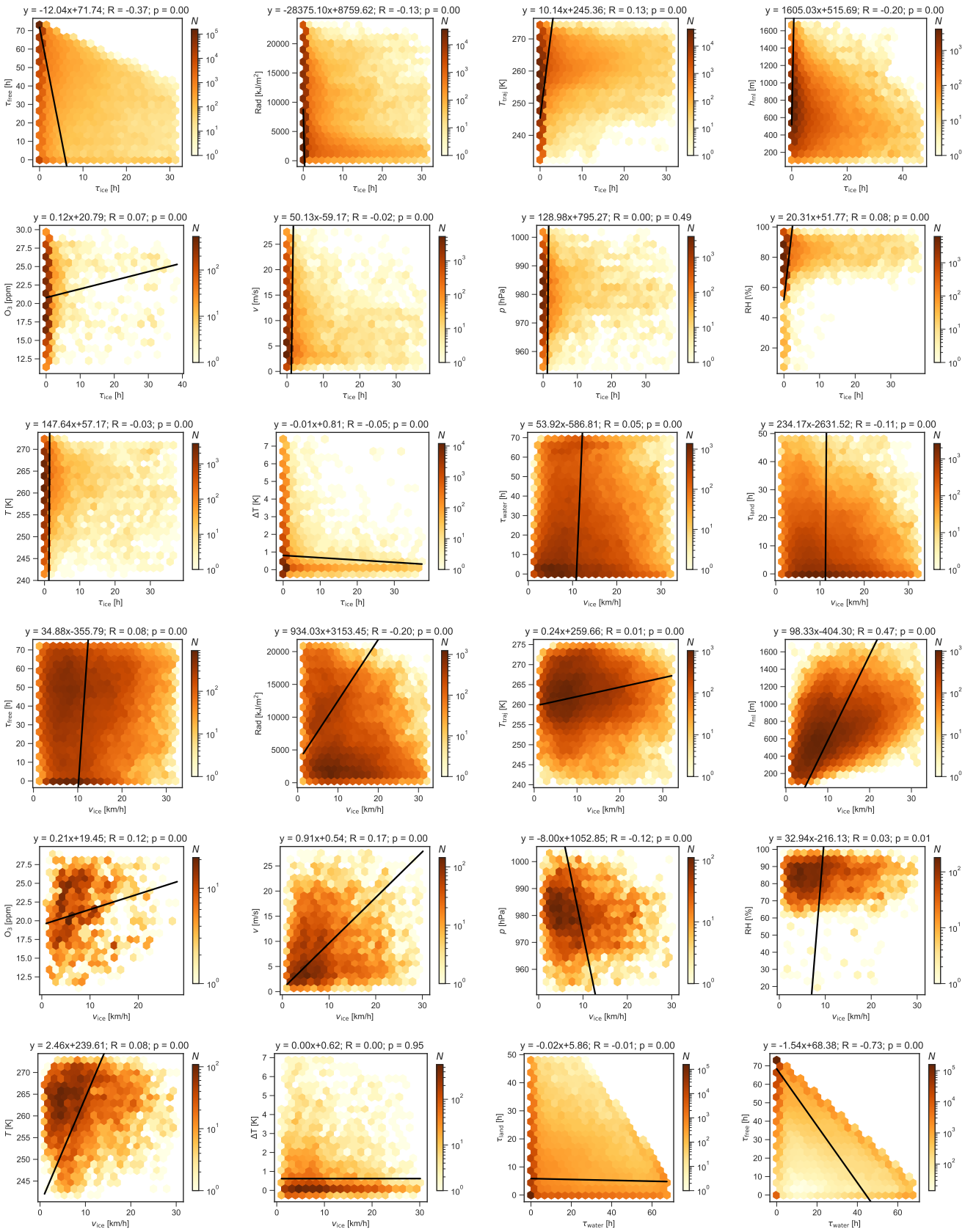

Figure S5: Correlations plots for parameters observed at NM during FMA (continued)

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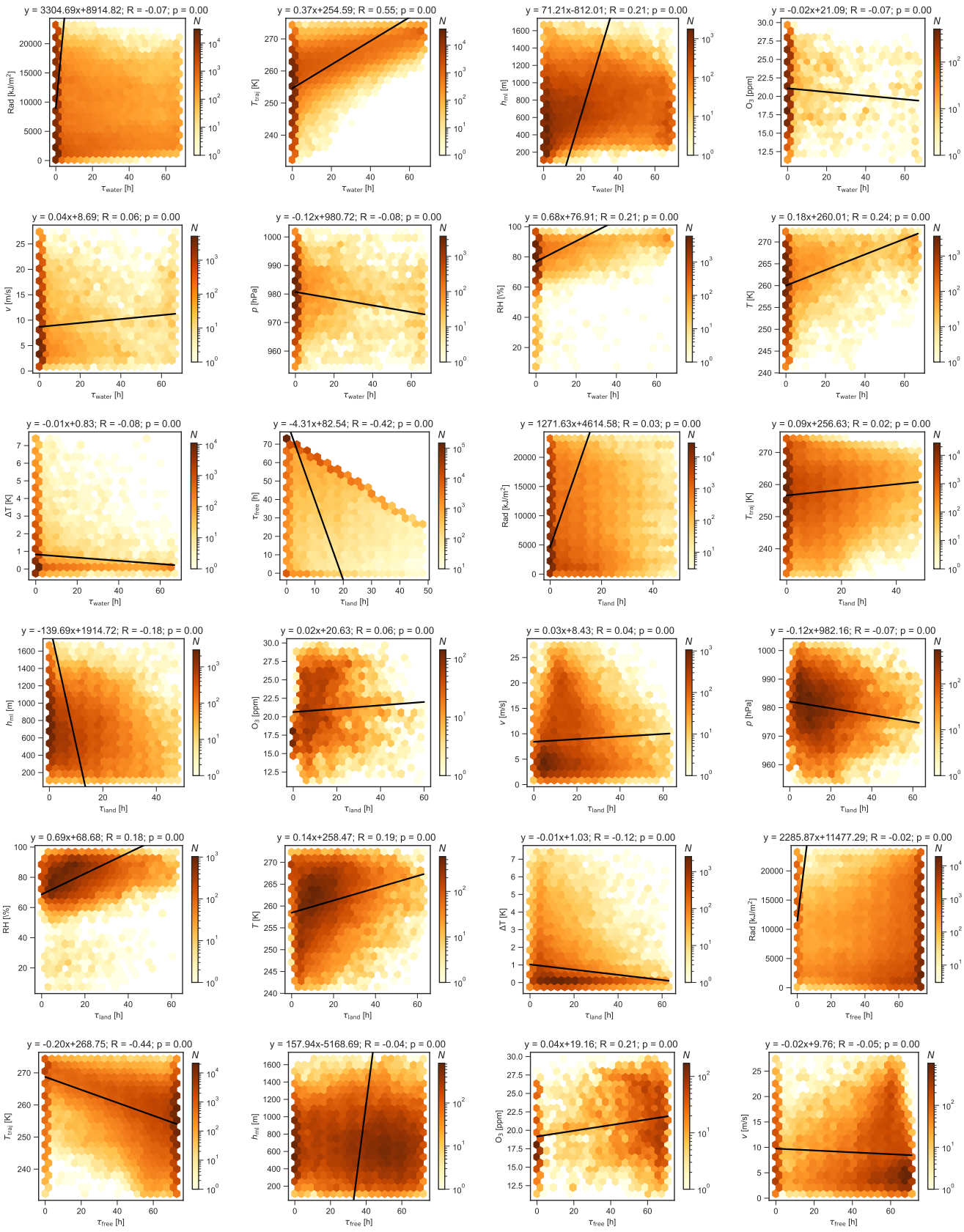

Figure S5: Correlations plots for parameters observed at NM during FMA (continued)

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NM FMA correlations

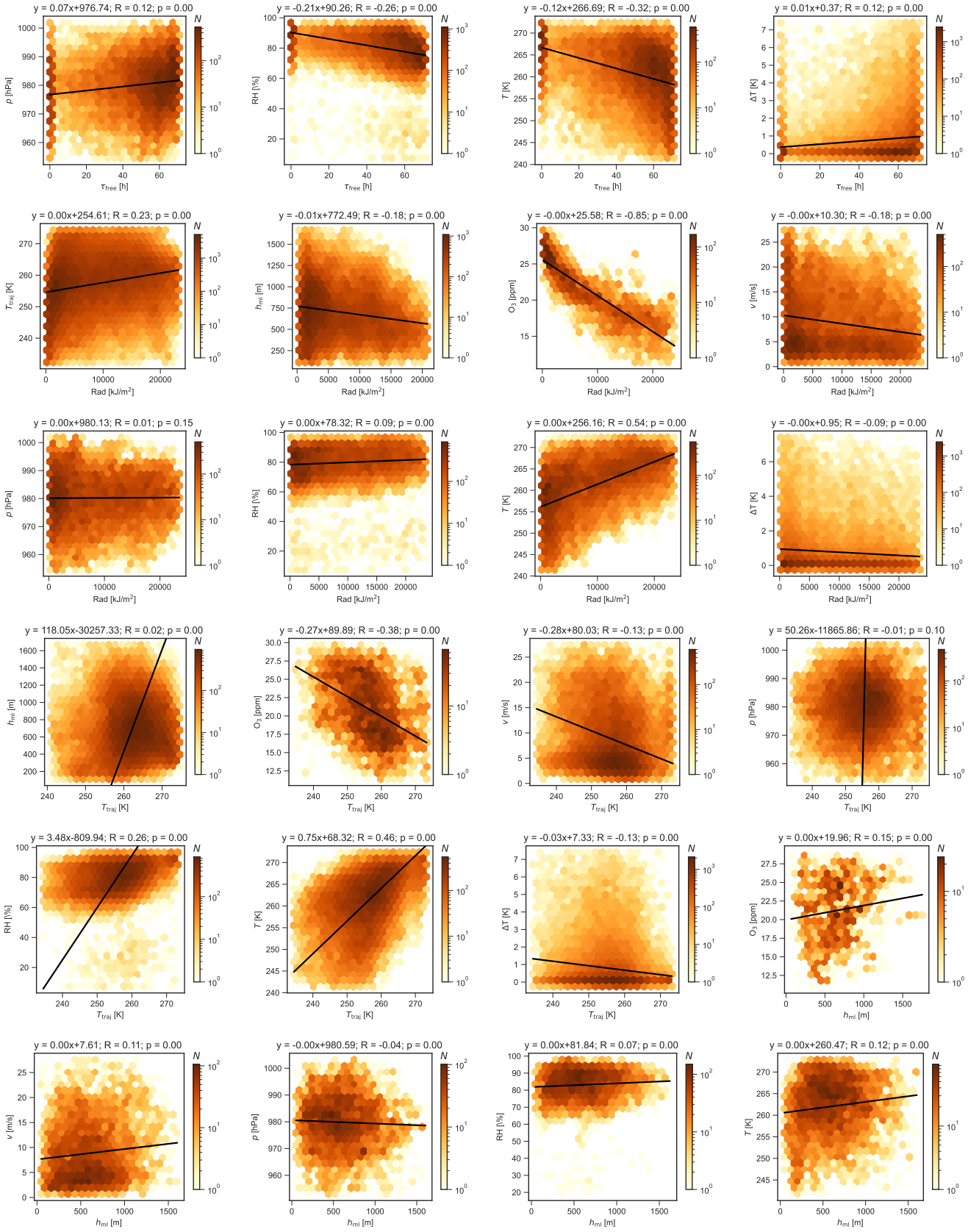

Figure S5: Correlations plots for parameters observed at NM during FMA (continued)

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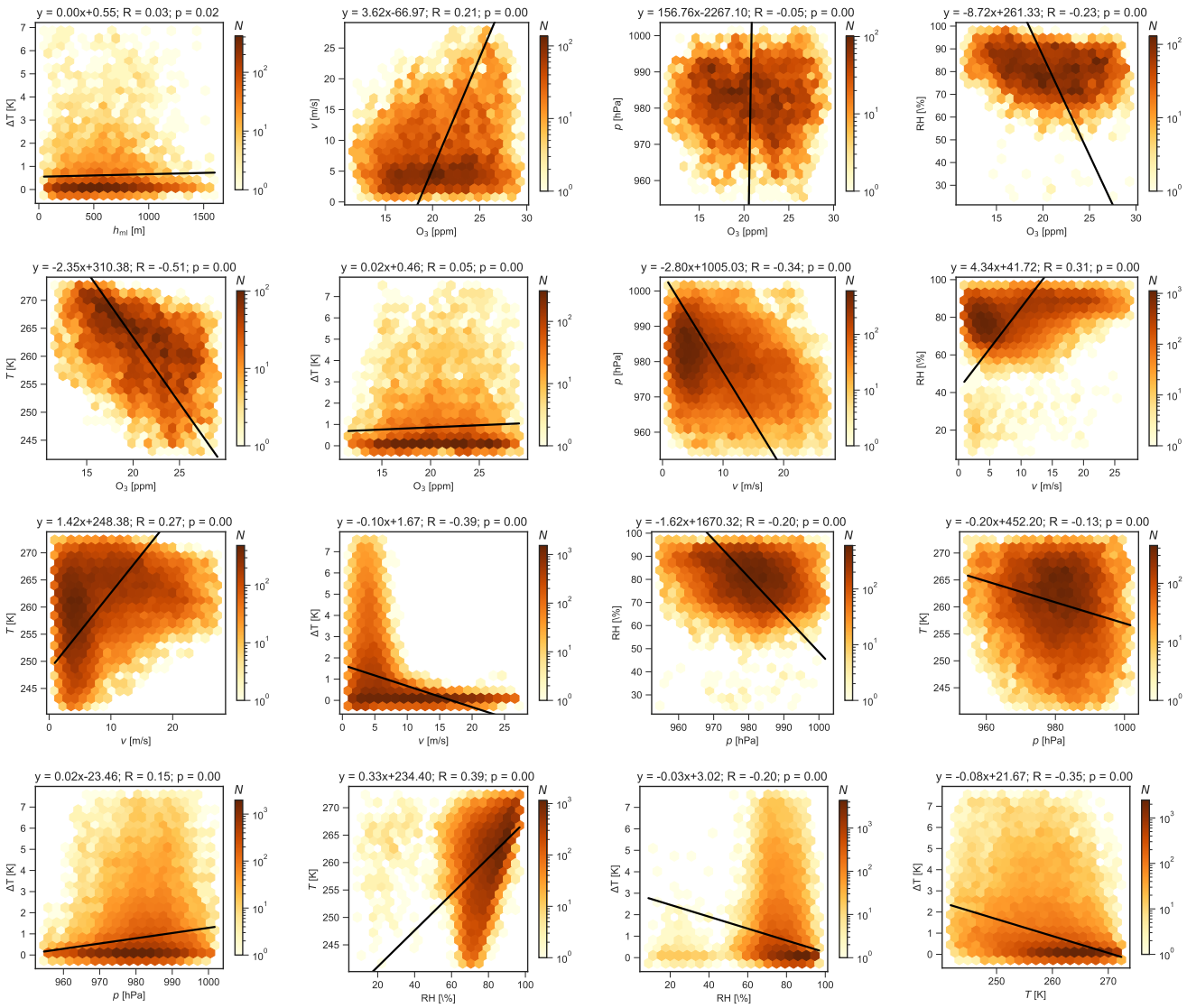

Figure S5: Correlations plots for parameters observed at NM during FMA (continued)

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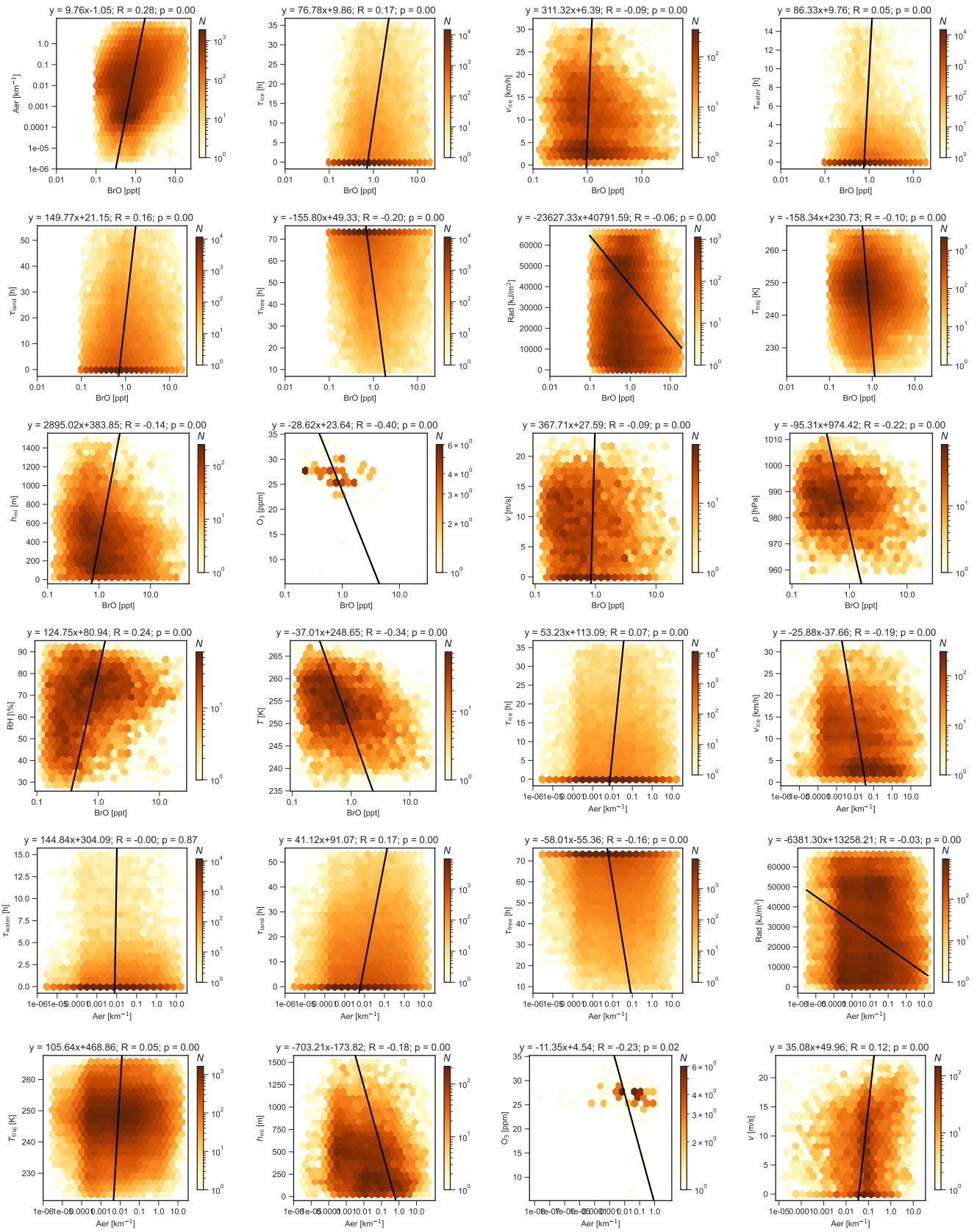

Figure S6: Correlations plots for parameters observed at AH during ASO. Each plot shows the correlation of a pair of parameters. The colour in each hexagon corresponds to the number of data points in this area (logarithmic colour scale). Note that BrO and aerosols are in logarithmic scale. Slope, intercept, PCC and p-value are listed in the subfigure titles.The linear fits based on orthogonal distance regression are shown as black lines.For a description of the variables see Tables 4 and 5 in the main paper.

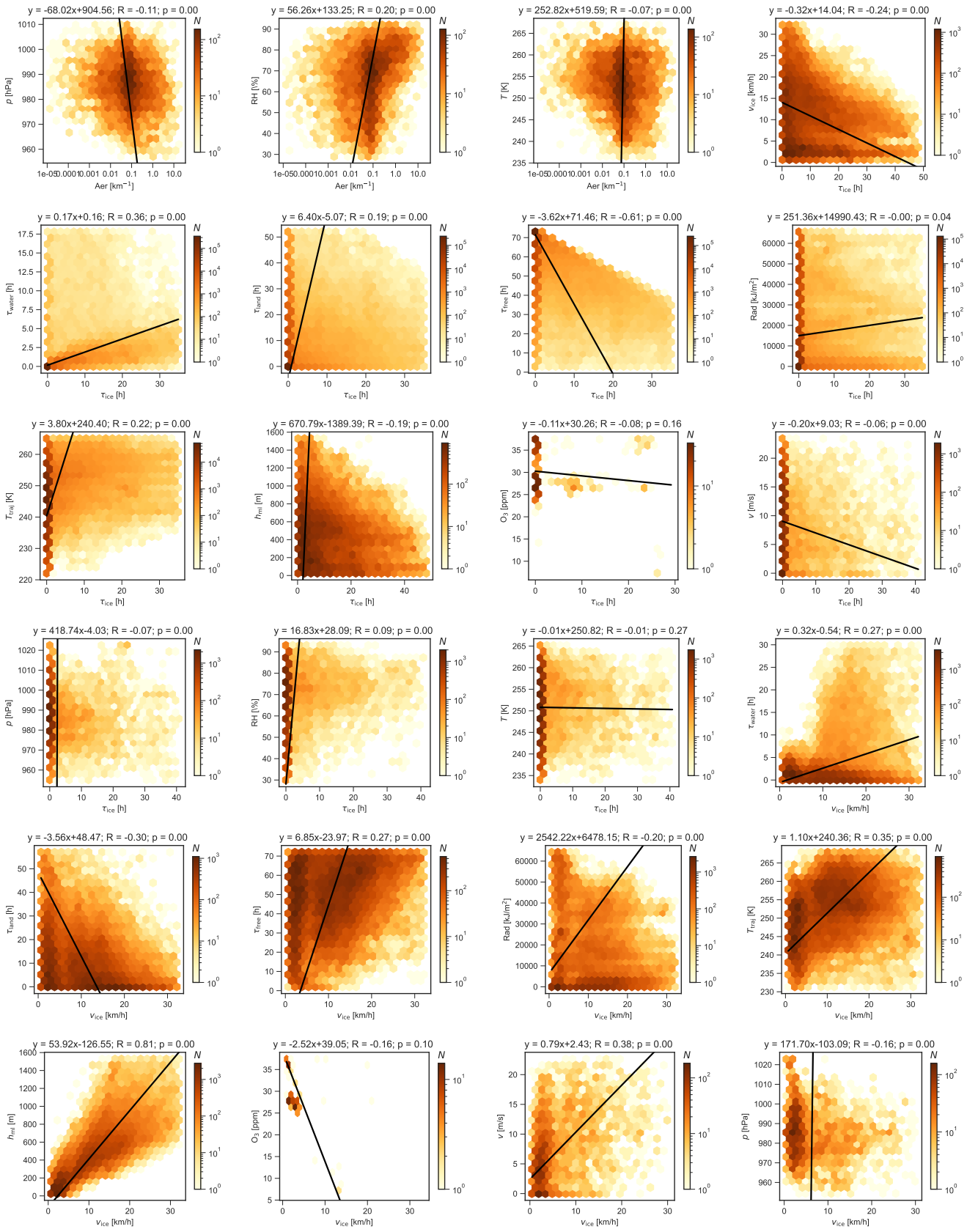

Figure S6: Correlations plots for parameters observed at AH during ASO (continued)

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AH ASO correlations

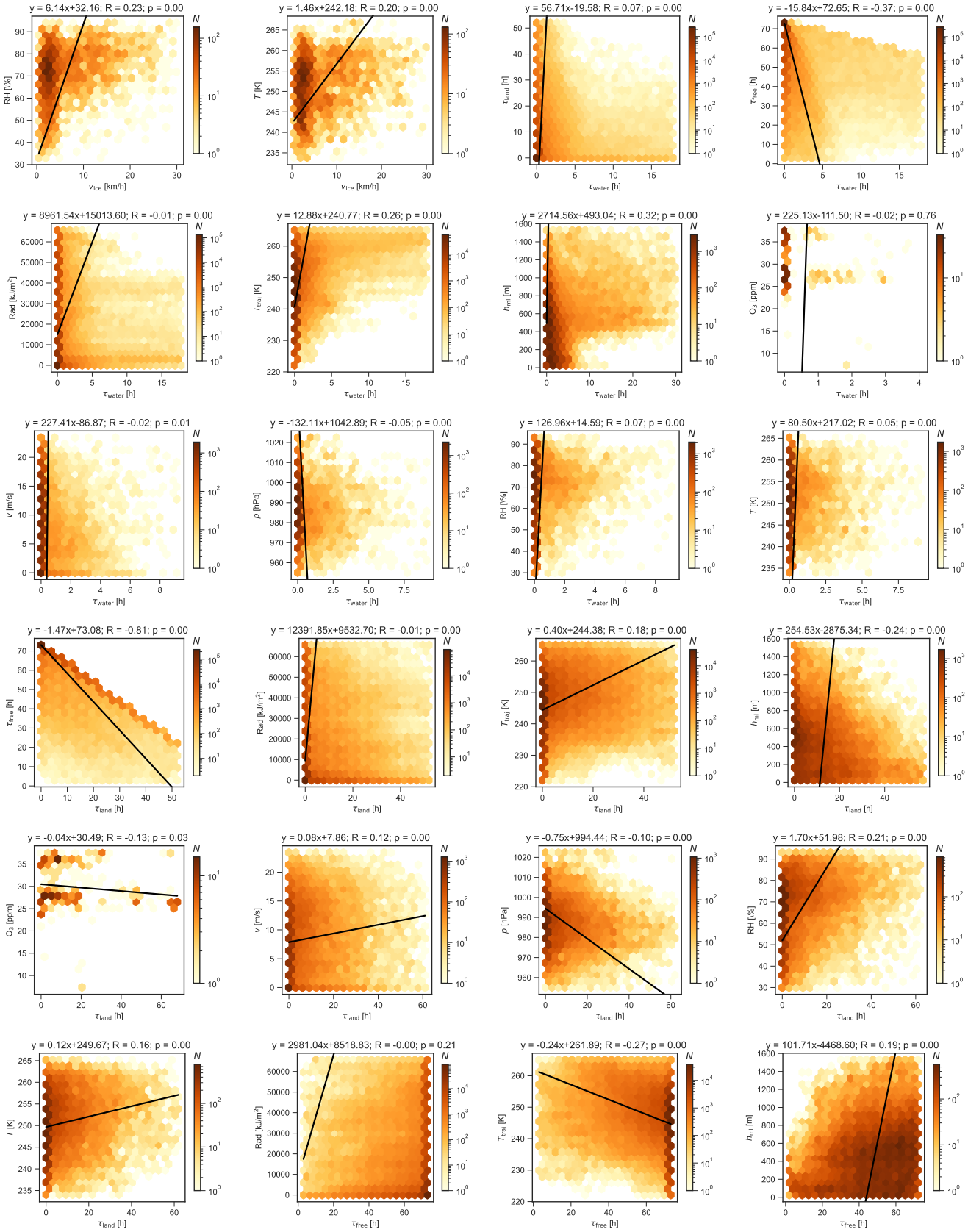

Figure S6: Correlations plots for parameters observed at AH during ASO (continued)

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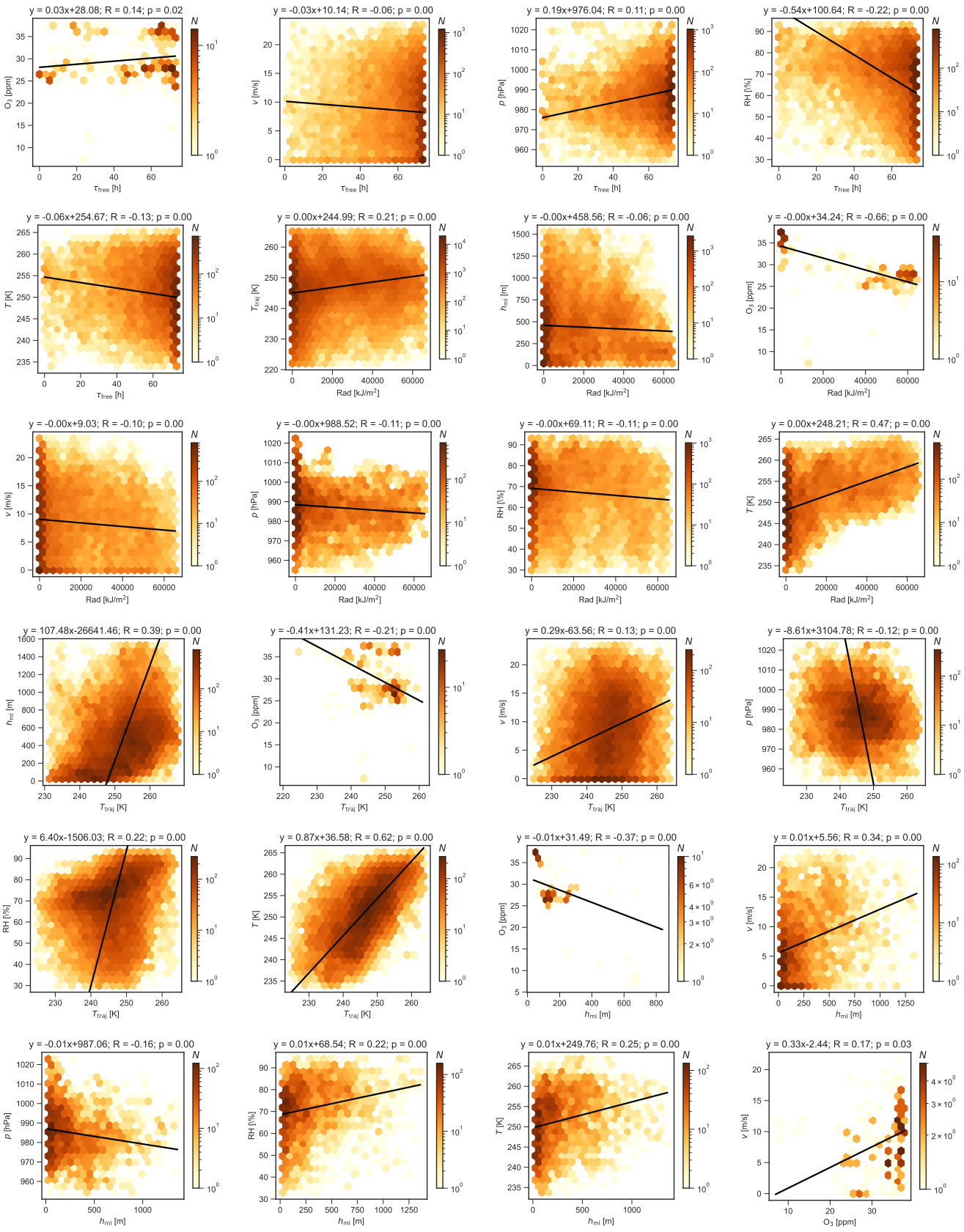

Figure S6: Correlations plots for parameters observed at AH during ASO (continued)

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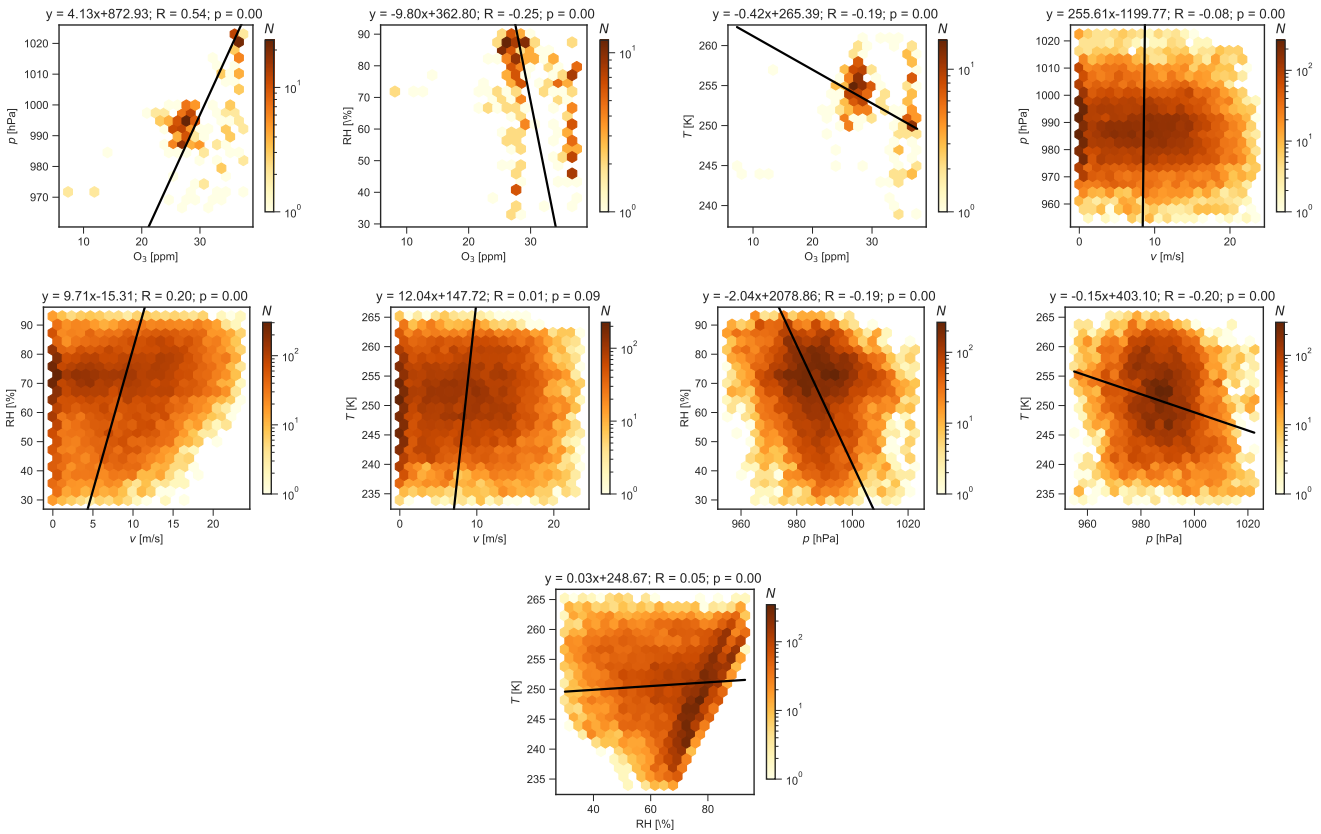

Figure S6: Correlations plots for parameters observed at AH during ASO (continued)

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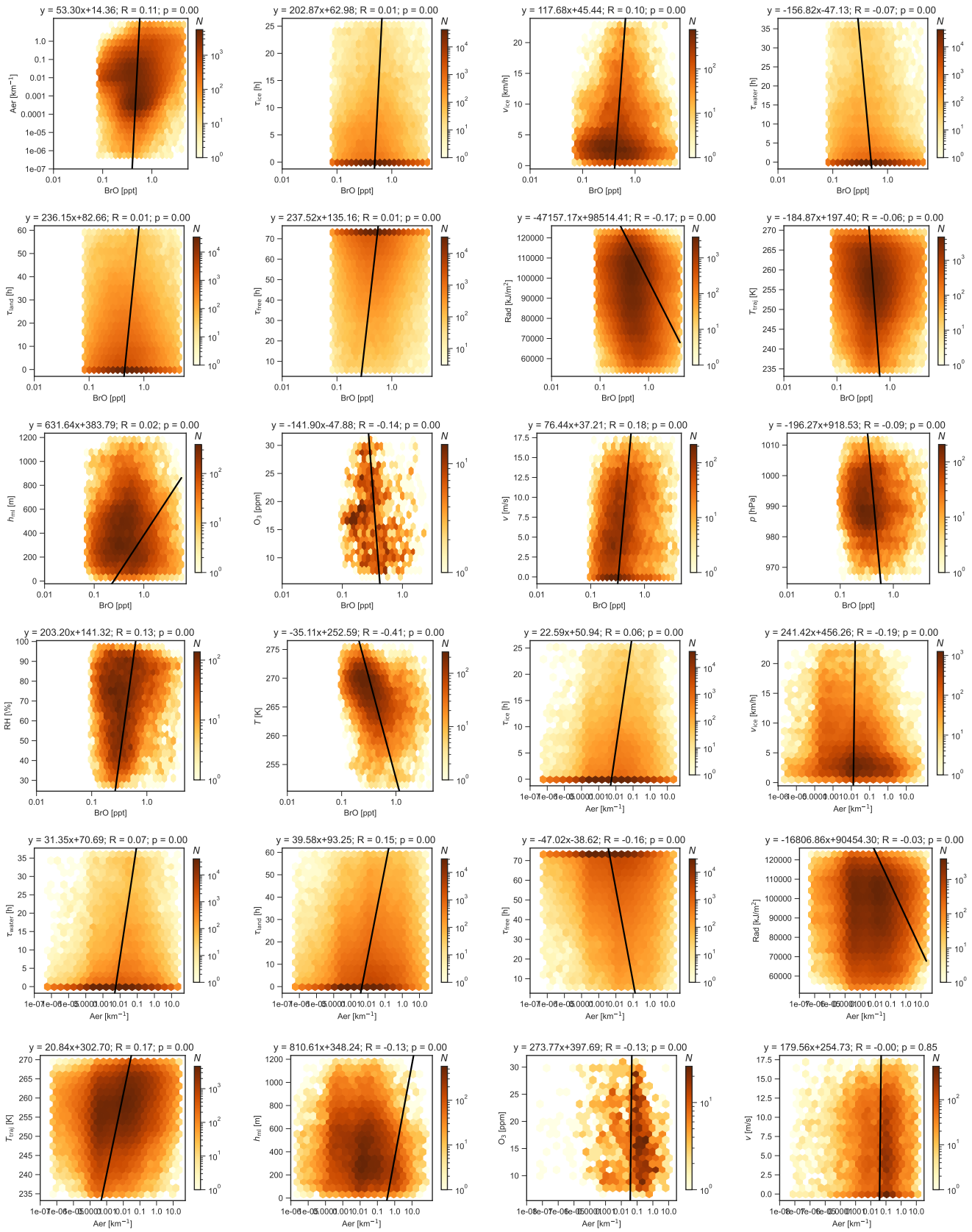

Figure S7: Correlations plots for parameters observed at AH during NDJ. Each plot shows the correlation of a pair of parameters. The colour in each hexagon corresponds to the number of data points in this area (logarithmic colour scale). Note that BrO and aerosols are in logarithmic scale. Slope, intercept, PCC and p-value are listed in the subfigure titles.The linear fits based on orthogonal distance regression are shown as black lines.For a description of the variables see Tables 4 and 5 in the main paper.

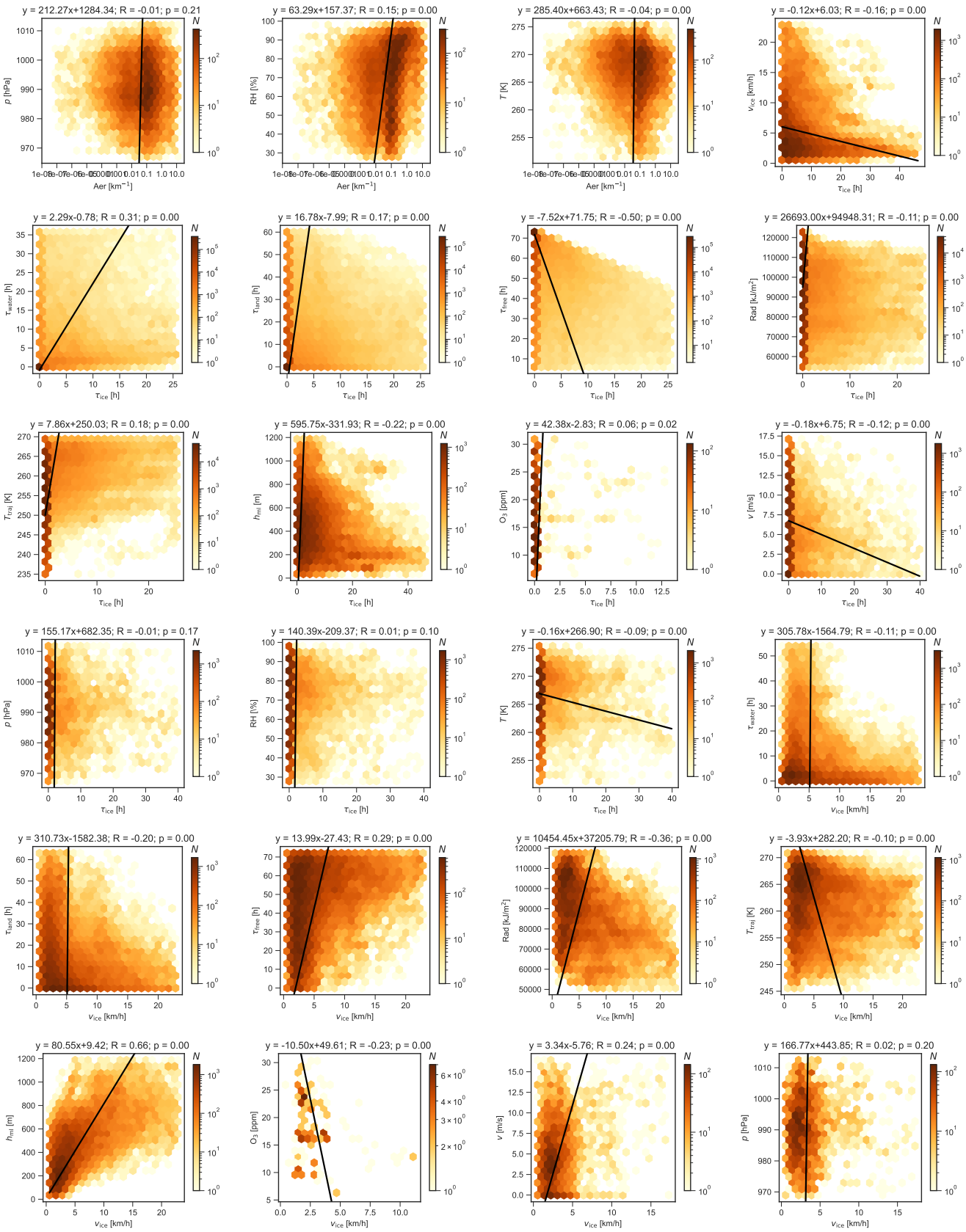

Figure S7: Correlations plots for parameters observed at AH during NDJ (continued)

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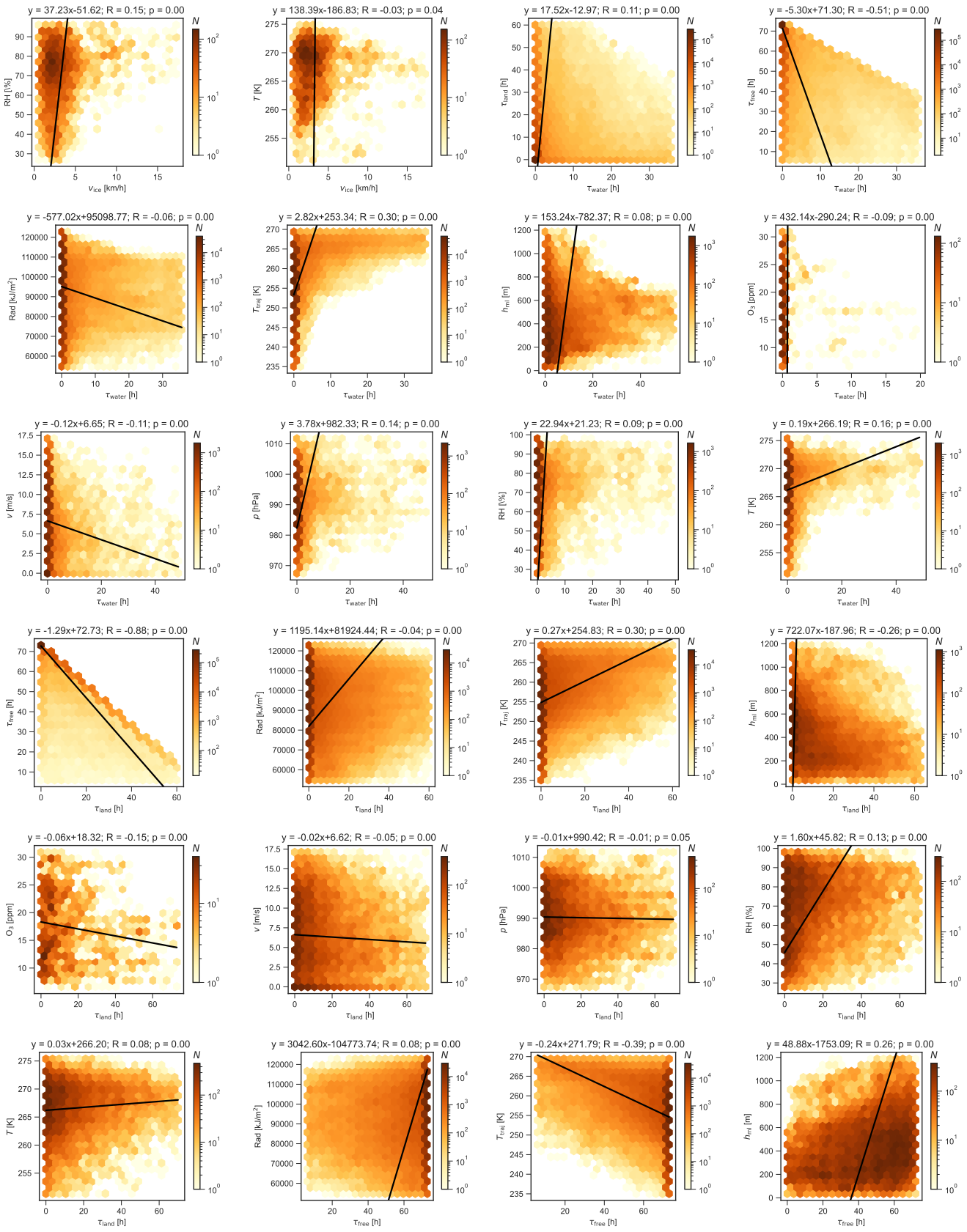

Figure S7: Correlations plots for parameters observed at AH during NDJ (continued)

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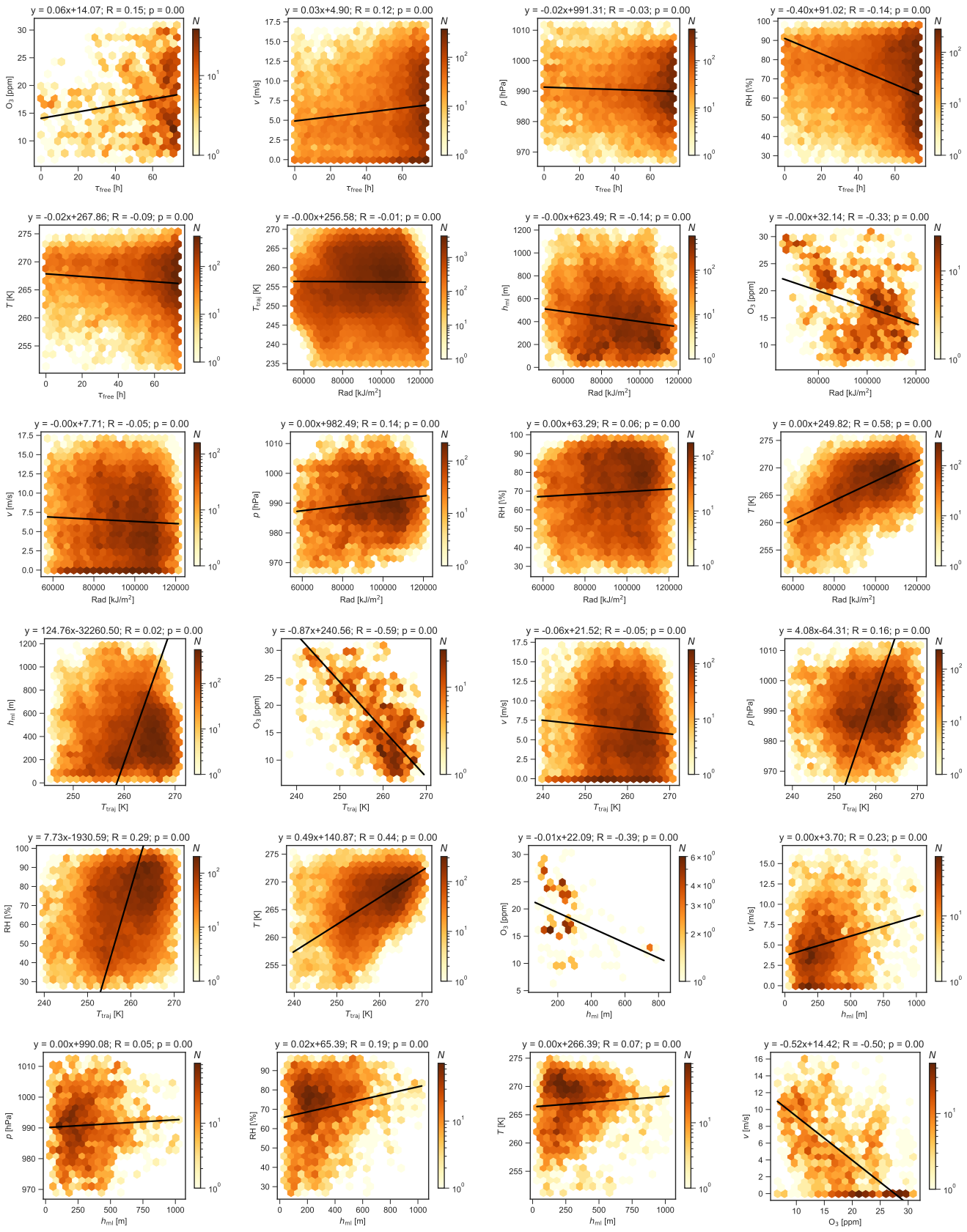

Figure S7: Correlations plots for parameters observed at AH during NDJ (continued)

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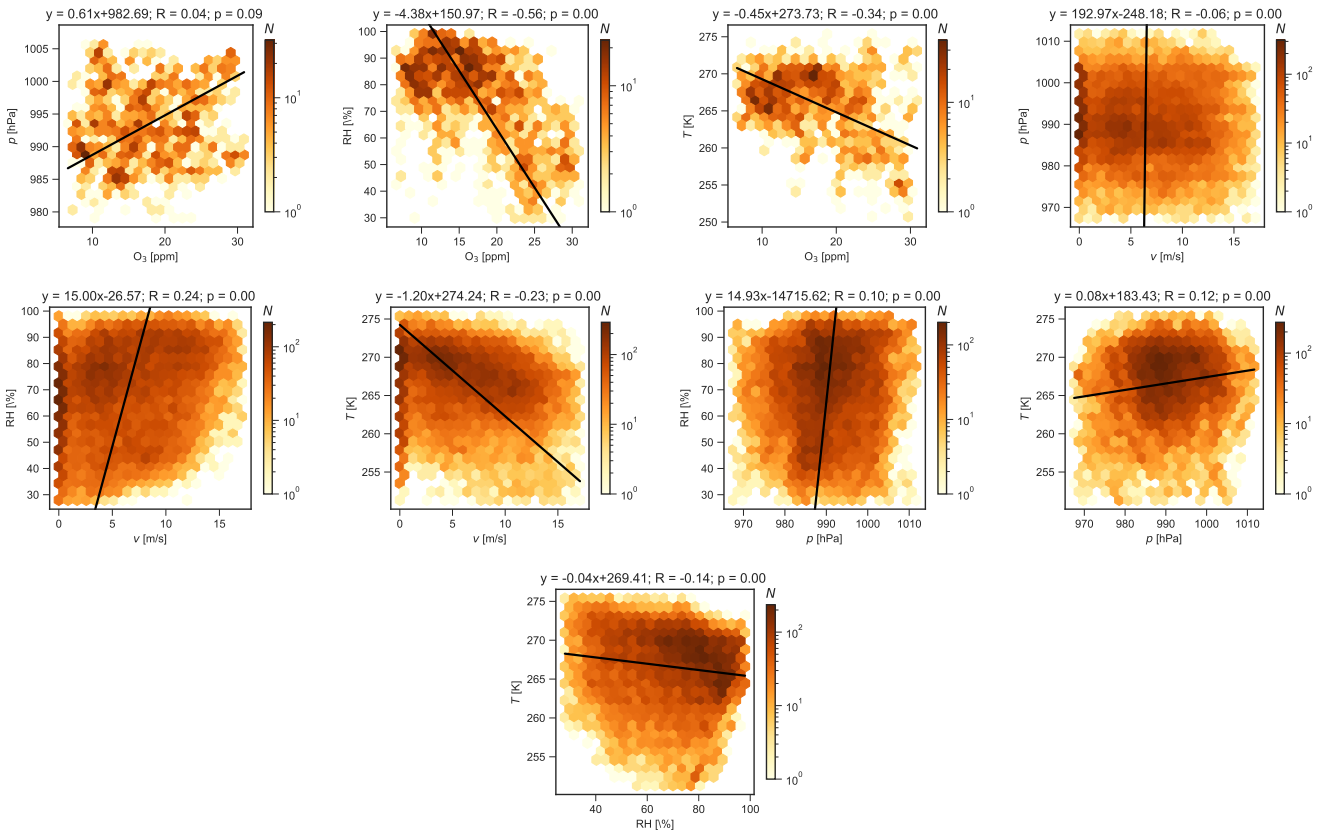

Figure S7: Correlations plots for parameters observed at AH during NDJ (continued)

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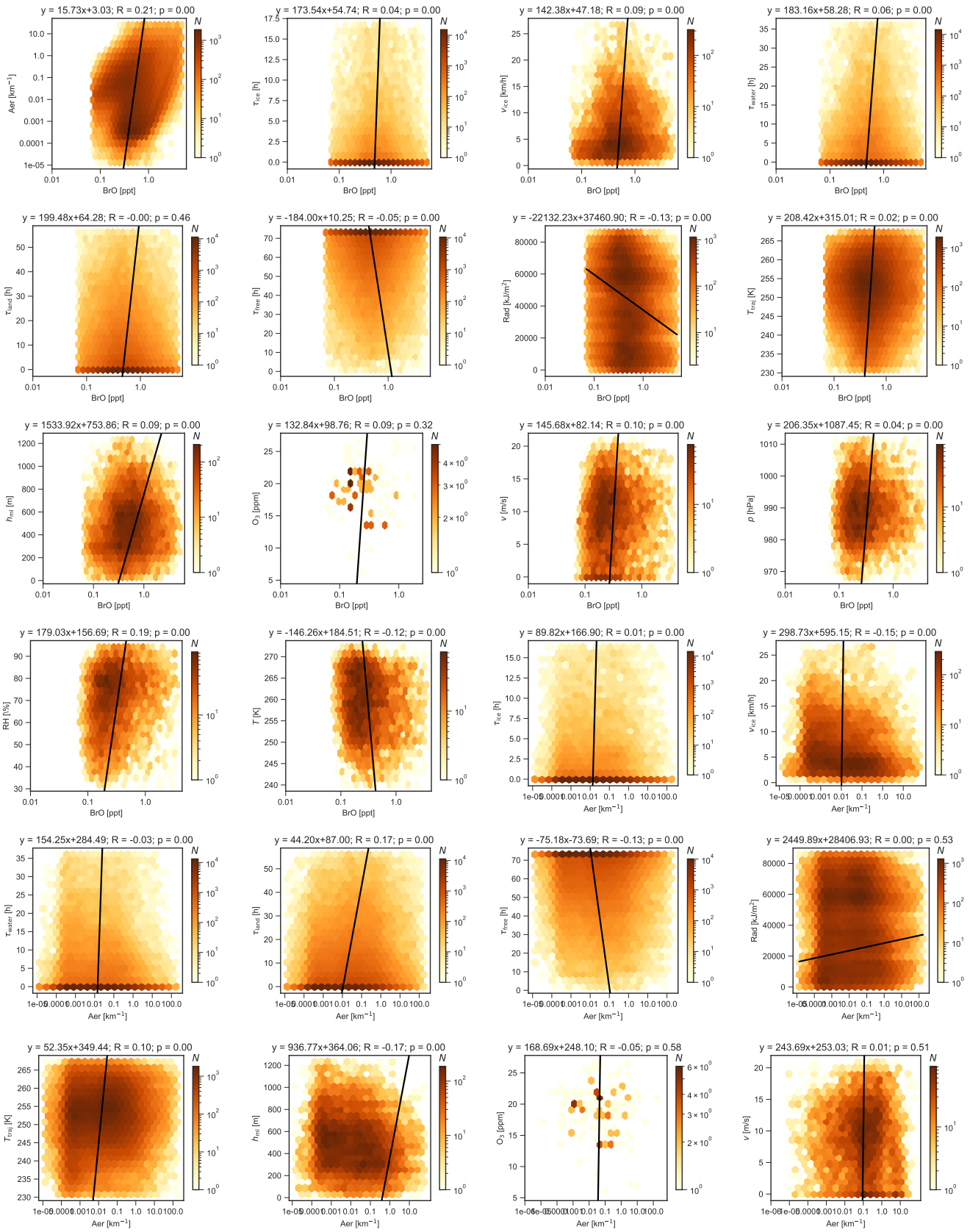

Figure S8: Correlations plots for parameters observed at AH during FMA. Each plot shows the correlation of a pair of parameters. The colour in each hexagon corresponds to the number of data points in this area (logarithmic colour scale). Note that BrO and aerosols are in logarithmic scale. Slope, intercept, PCC and p-value are listed in the subfigure titles.The linear fits based on orthogonal distance regression are shown as black lines.For a description of the variables see Tables 4 and 5 in the main paper.

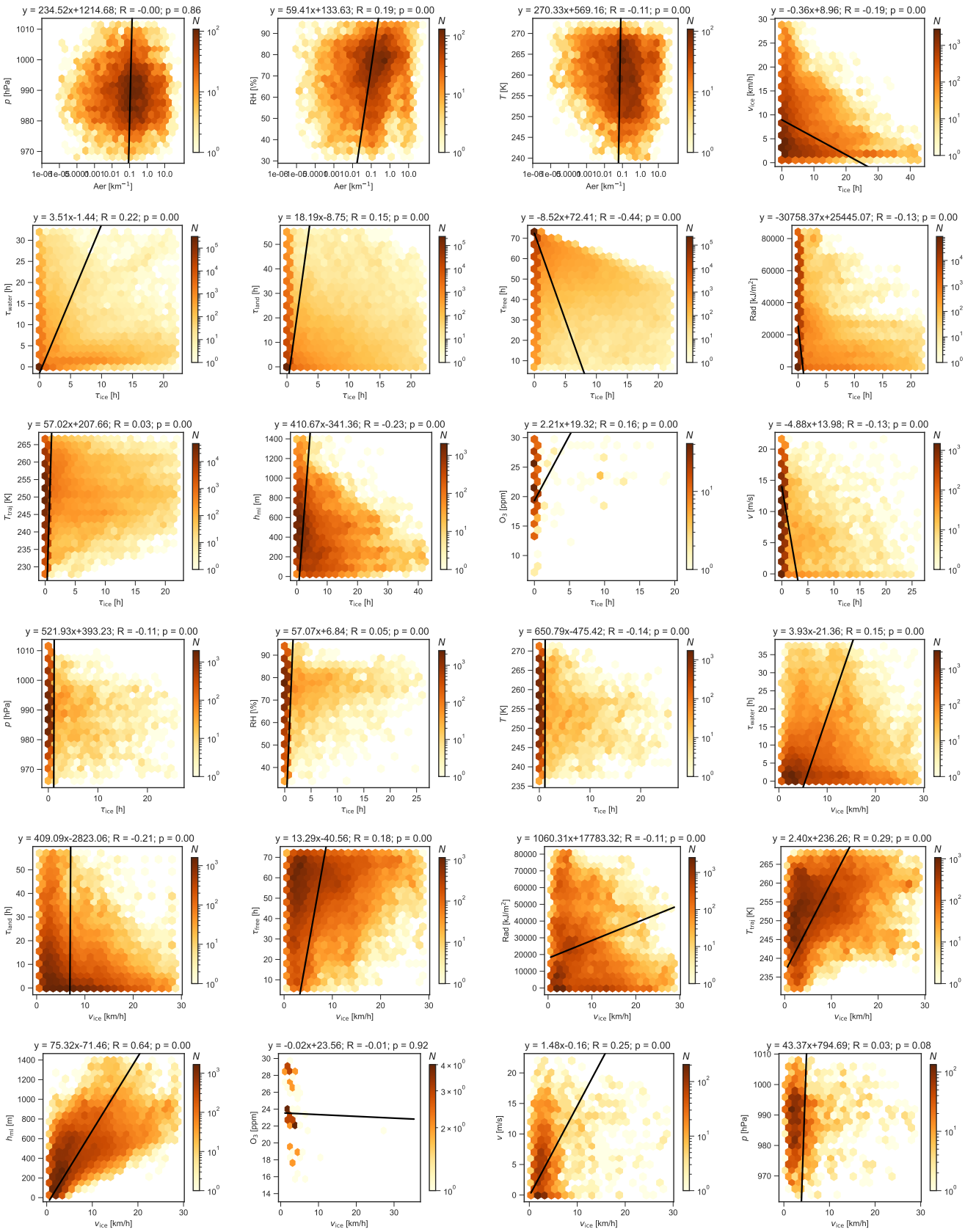

Figure S8: Correlations plots for parameters observed at AH during FMA (continued)

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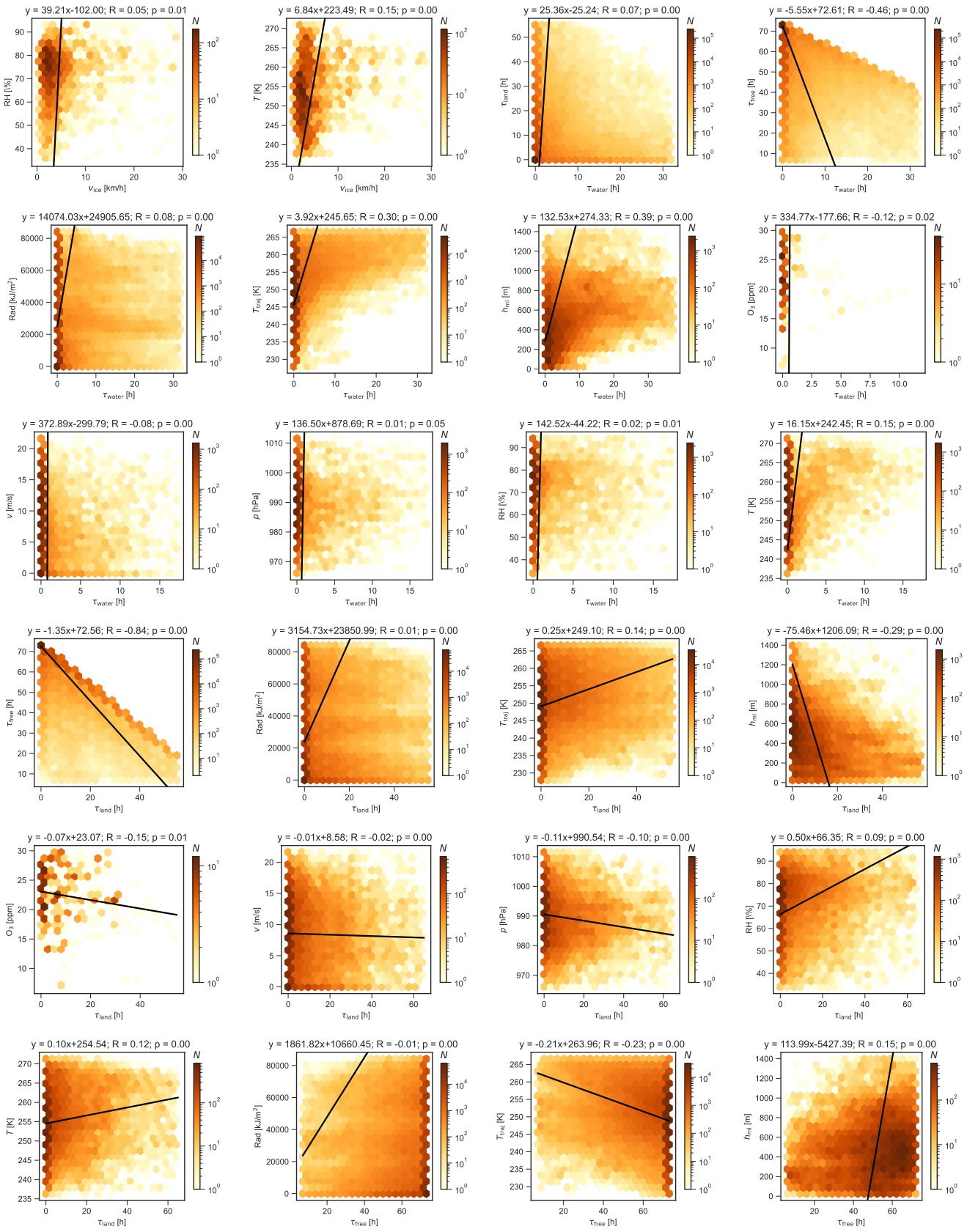

Figure S8: Correlations plots for parameters observed at AH during FMA (continued)

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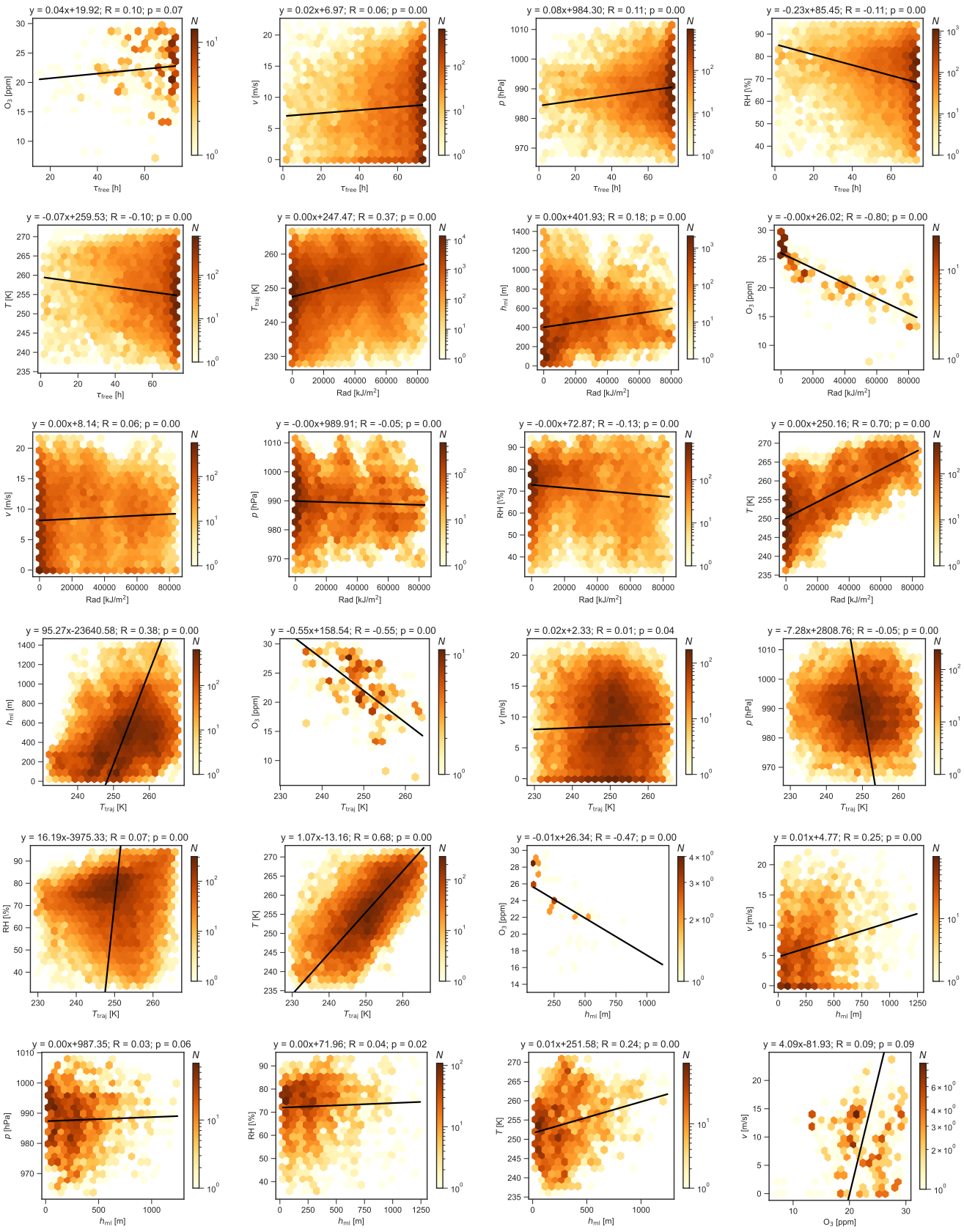

Figure S8: Correlations plots for parameters observed at AH during FMA (continued)

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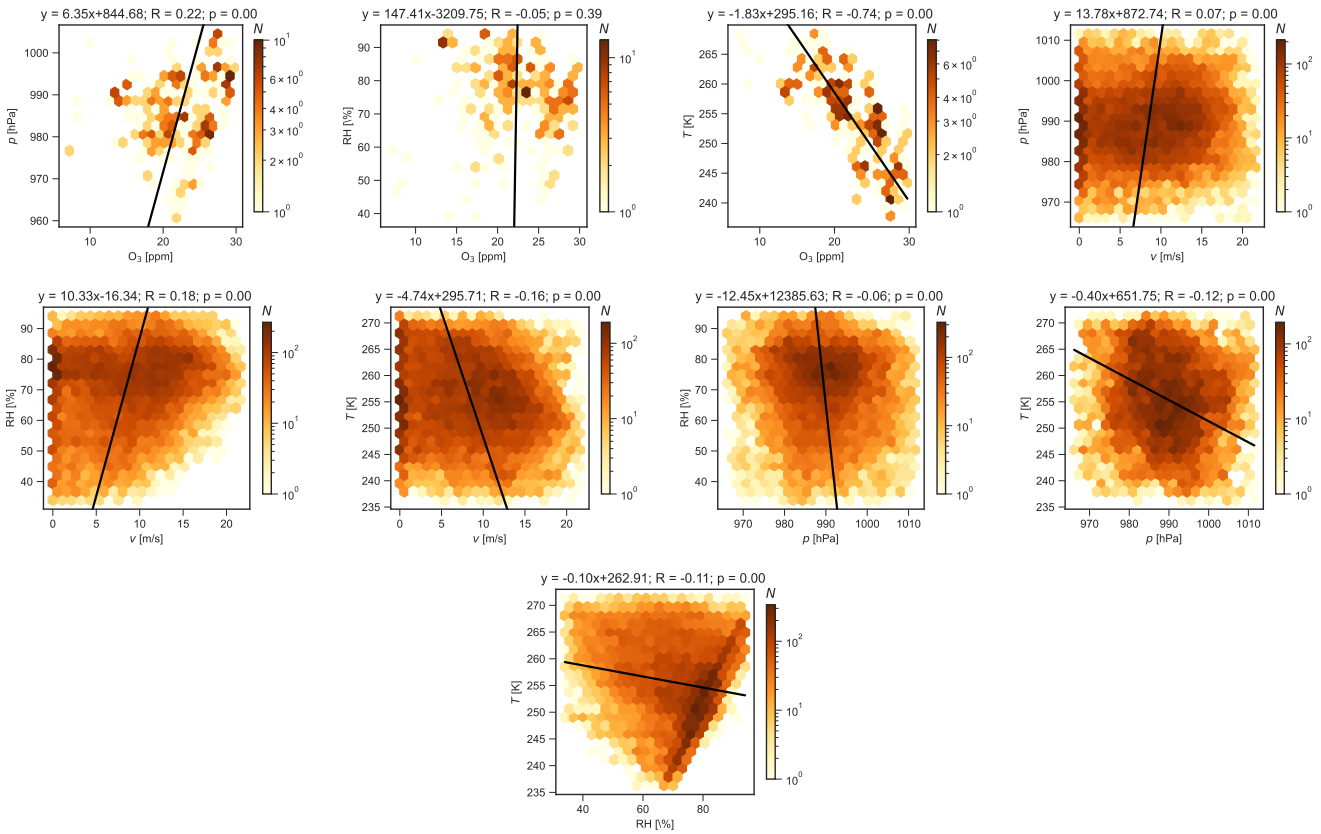

Figure S8: Correlations plots for parameters observed at AH during FMA (continued)

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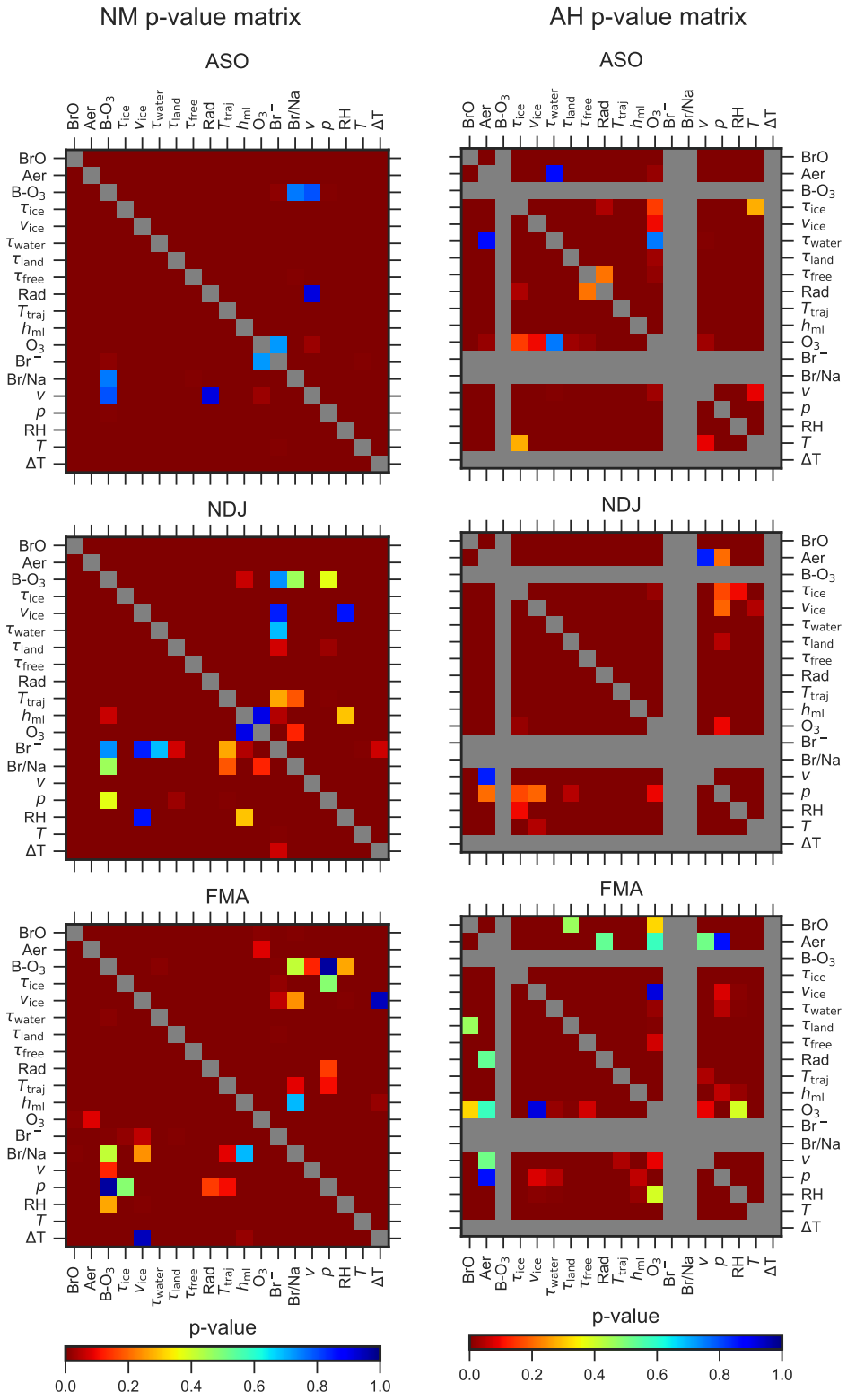

Figure S9: P-values of the regression analysis, corresponding to the correlation coefficients shown in Figure 10 of the main paper.

3 Source-Receptor Maps

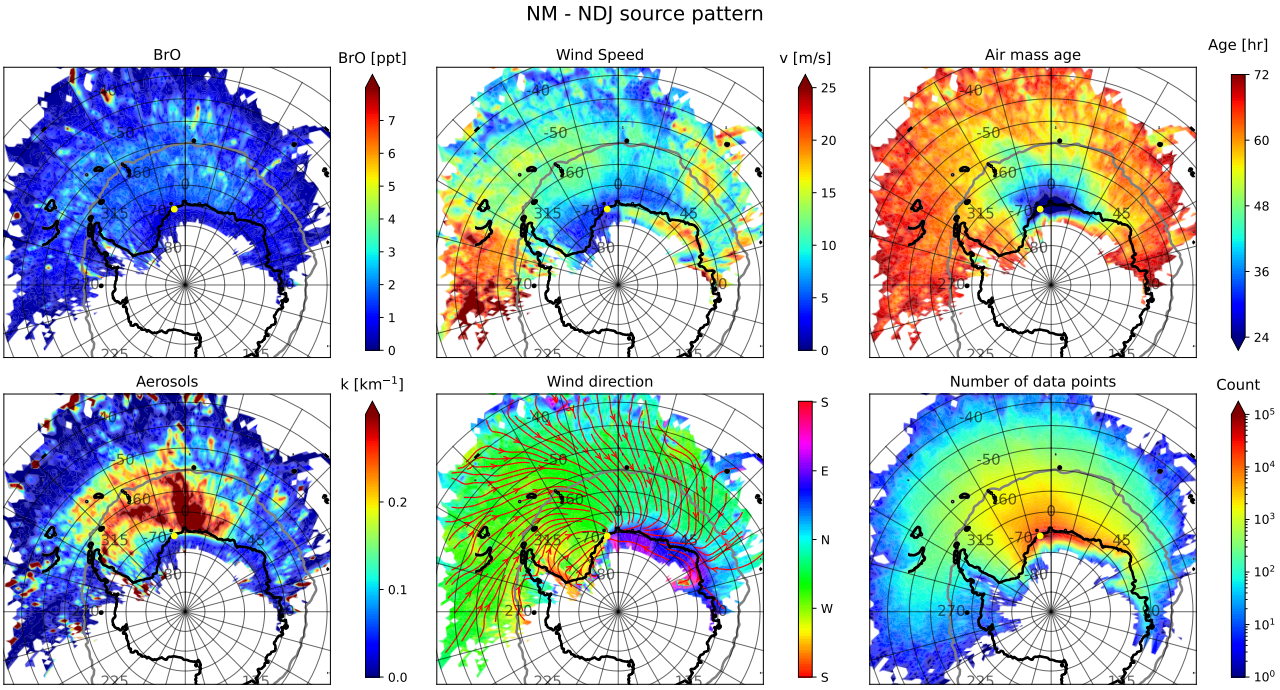

Figure S10: Source-receptor maps of BrO at NM during NDJ, together with source-receptor maps of mean aerosol extinction, wind speed, wind direction and air mass age, as well total number of air parcels, within each $1^\circ \times 1^\circ$ grid cell. The thick grey line indicates the mean location of the sea ice edge during NDJ. The wind direction plot also contains average stream lines of the air flow (red lines with arrows). The yellow dot indicates the location of the measurement site.

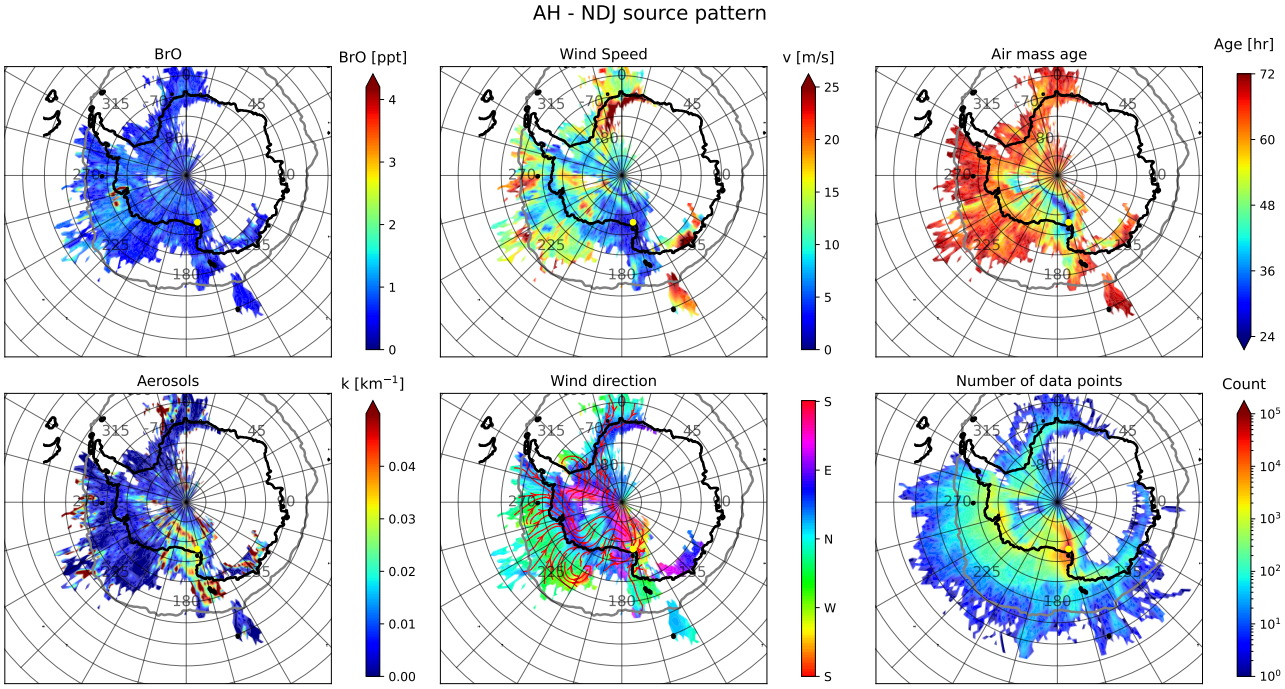

Figure S11: Same as Figure S9, but for AH during NDJ.

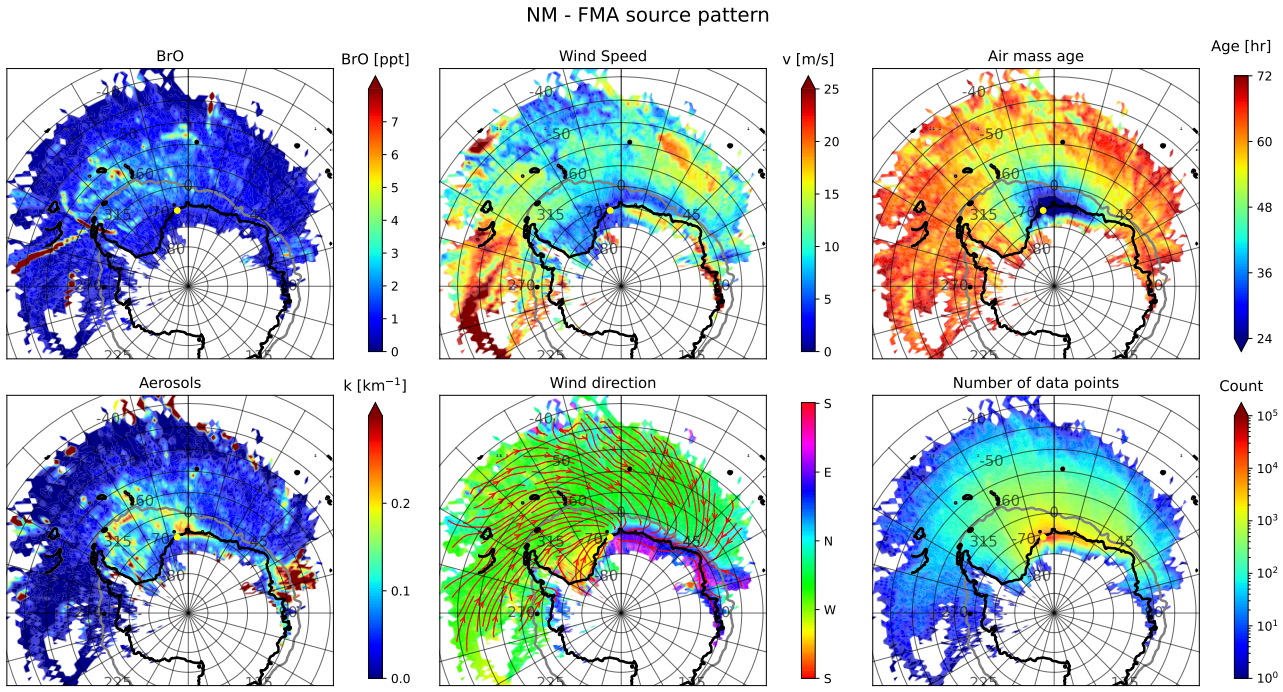

Figure S12: Same as Figure S9, but for NM during FMA.

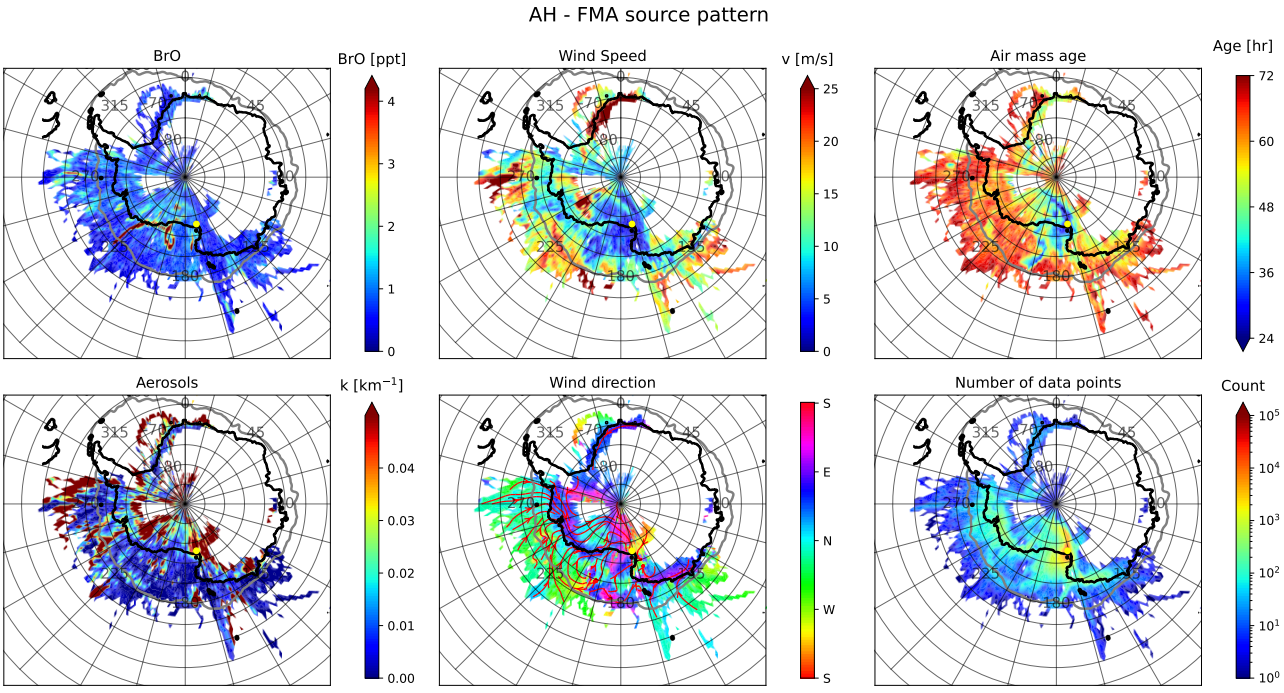

Figure S13: Same as Figure S9, but for AH during FMA.

4 Multi-annual variability of BrO and Aerosols

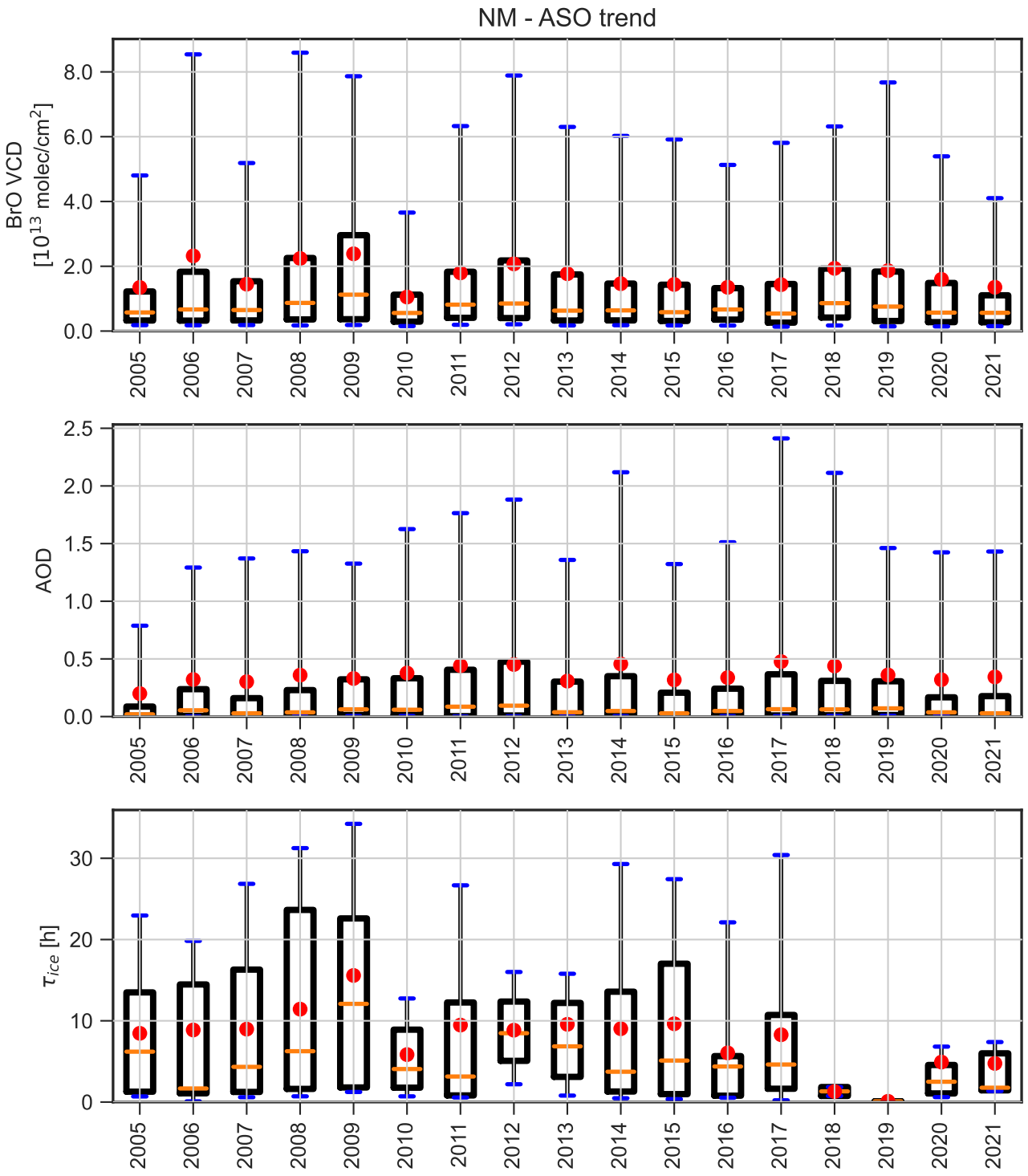

Figure S14: Multi-annual variation of the BrO VCD (top), AOD (centre) and sea ice contact time (bottom) at NM during ASO.

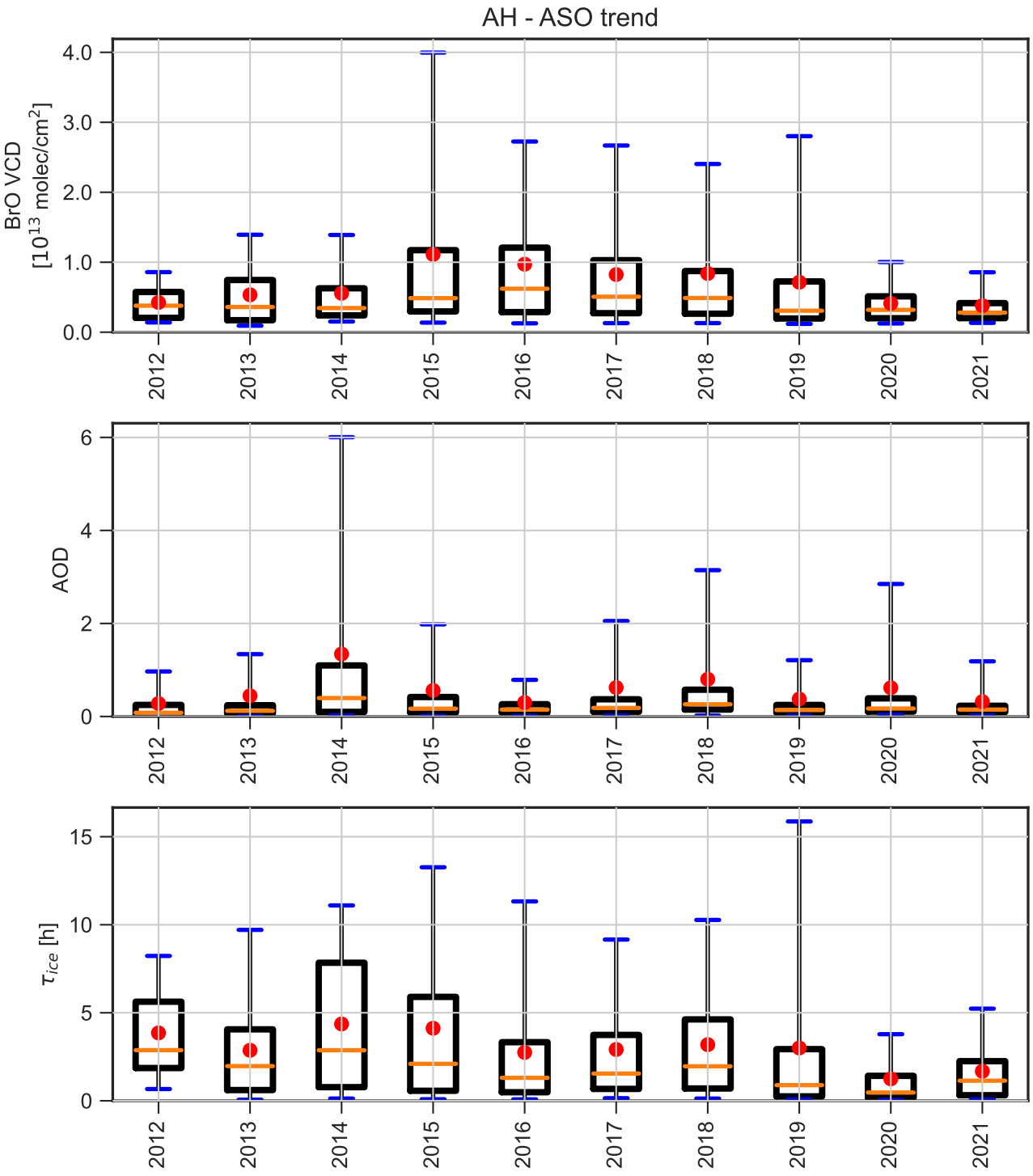

Figure S15: Same as Figure S15, but for AH.