

# Supplementary Materials

## 5 **Direct-sun versus Sky-Scan Pandora Formaldehyde Retrievals: Implications for Satellite Validation and Sampling Representativeness in Tropical Southeast Asia**

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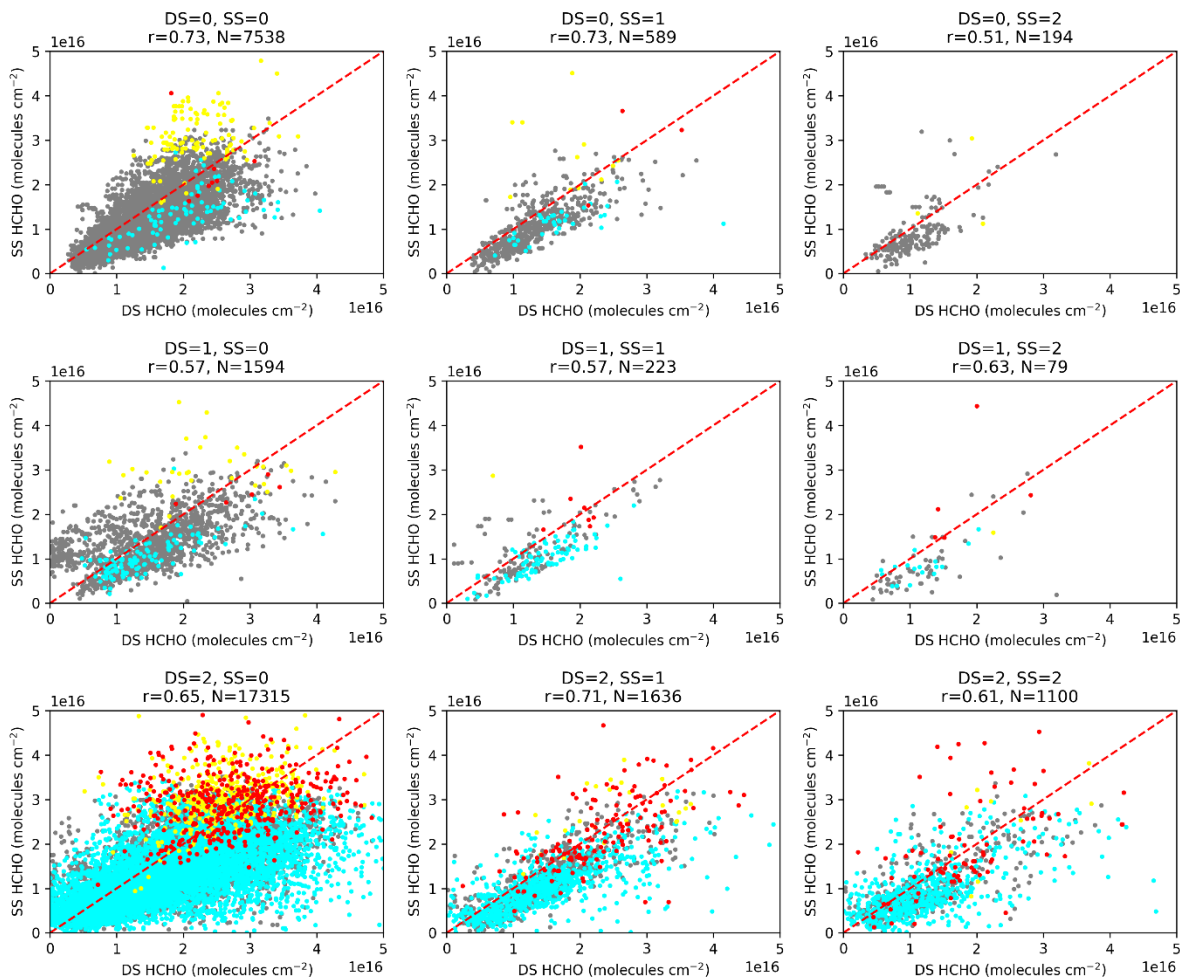
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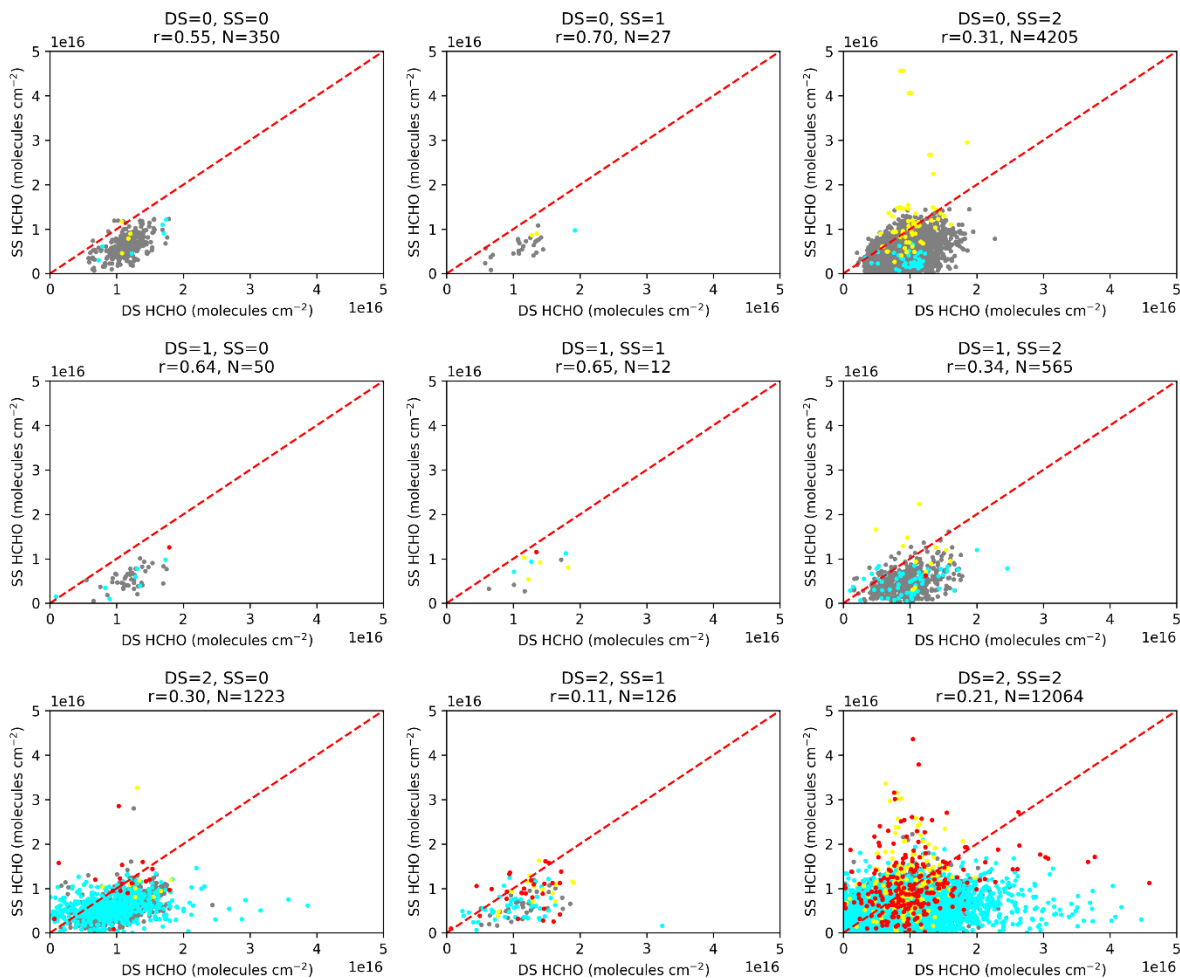
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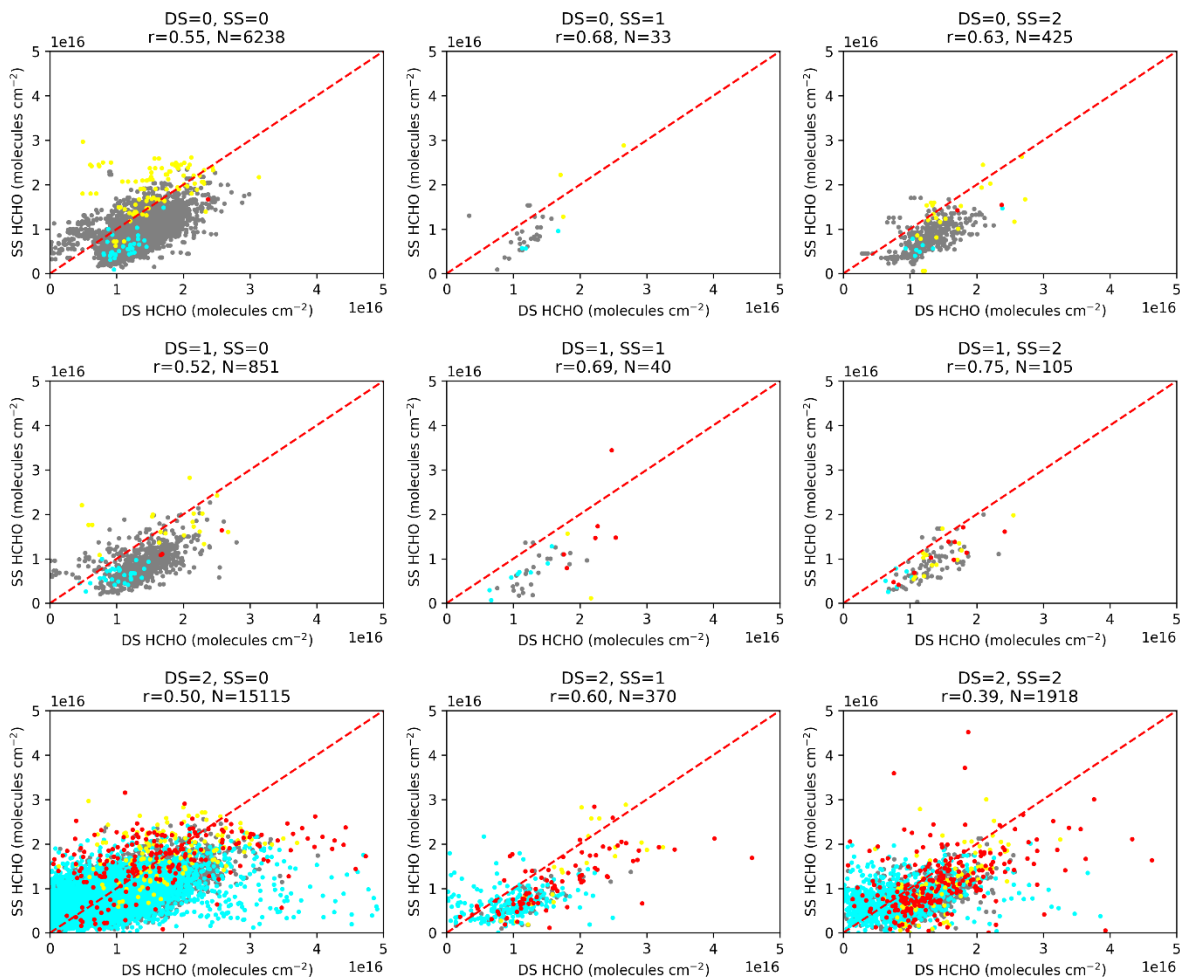
**Figure S1.** Nine-panel plot of correlation between contemporaneous Pandora HCHO column amounts: direct-sun (DS) vs sky-scan (SS) for each quality category, following the Rawat et al. (2025, AMT) QC method at Bandung station. Panels are organized by DS and SS quality categories (0 = high, 1 = medium, 2 = low). Each panel shows the scatter of DS vs SS HCHO (molecules cm<sup>-2</sup>), with points color-coded by uncertainty thresholds: gray = both below cutoff, cyan = DS above cutoff, yellow = SS above cutoff, red = both above cutoff. The red dashed line represents the 1:1 relationship, and the correlation coefficient ( $r$ ) and number of matched observations ( $N$ ) are indicated in each panel.

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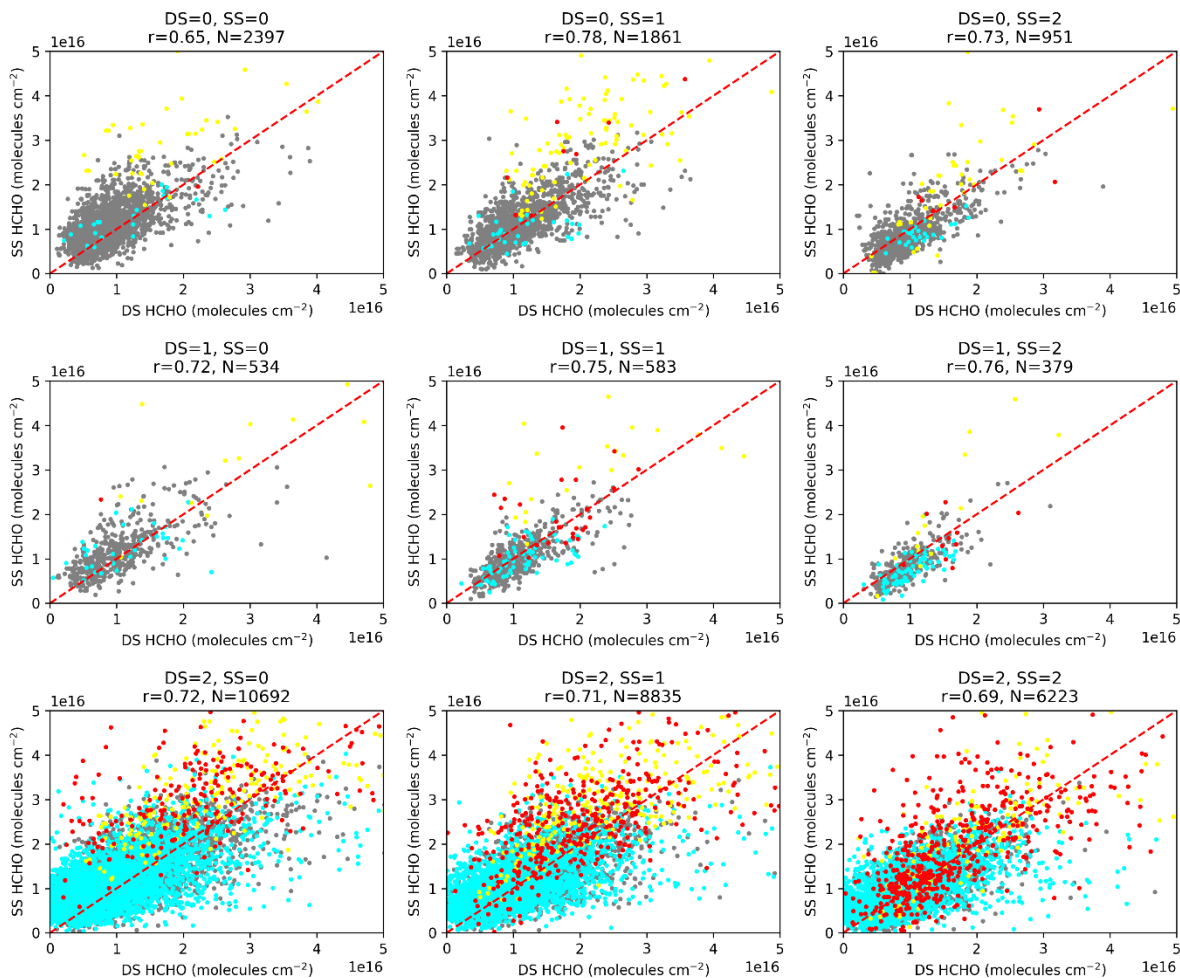
**Figure S2.** Nine-panel plot of correlation between contemporaneous Pandora HCHO column amounts: direct-sun (DS) vs sky-scan (SS) for each quality category, following the Rawat et al. (2025, AMT) QC method at Agam station. Panels are organized by DS and SS quality categories (0 = high, 1 = medium, 2 = low). Each panel shows the scatter of DS vs SS HCHO (molecules cm<sup>-2</sup>), with points color-coded by uncertainty thresholds: gray = both below cutoff, cyan = DS above cutoff, yellow = SS above cutoff, red = both above cutoff. The red dashed line represents the 1:1 relationship, and the correlation coefficient (r) and number of matched observations (N) are indicated in each panel.

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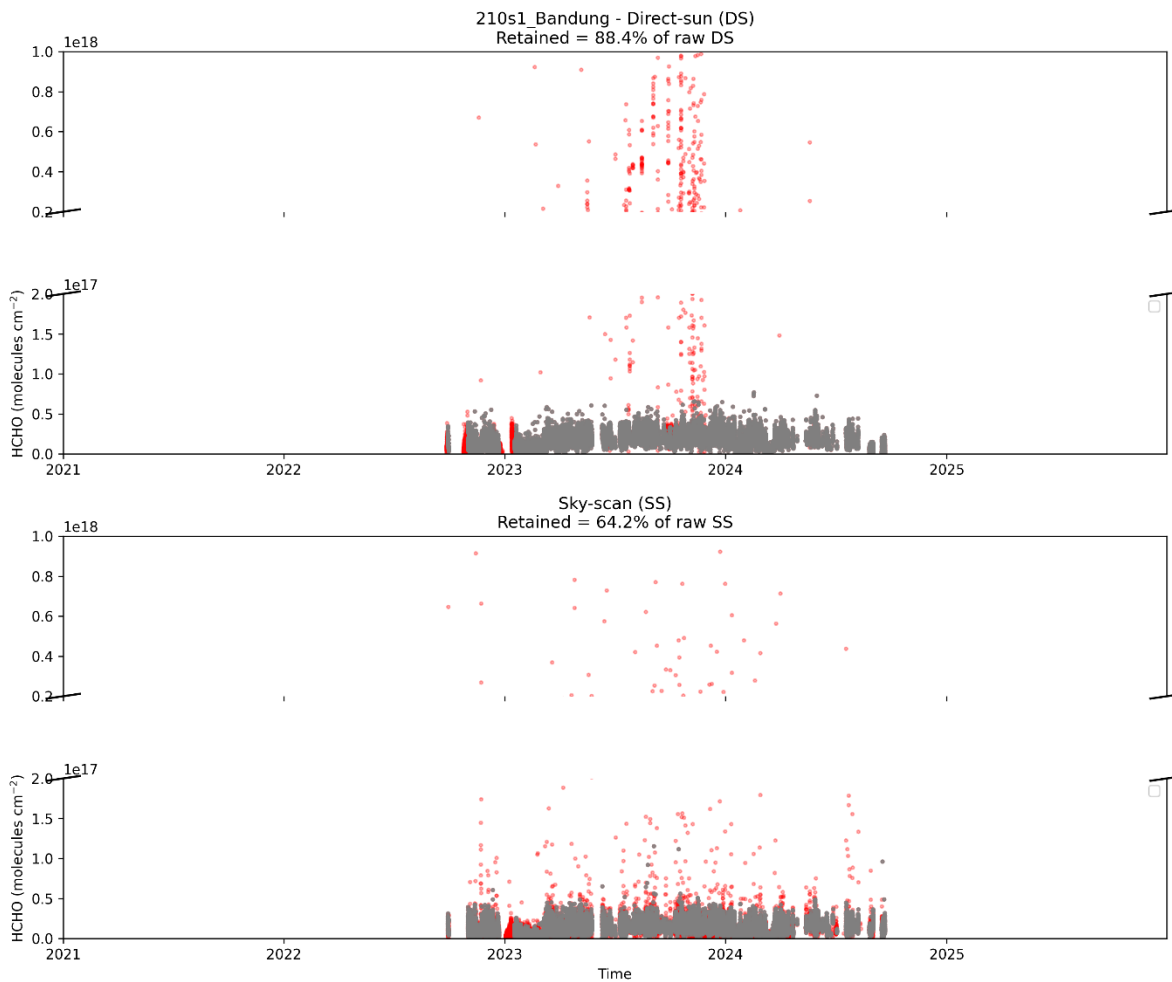
**Figure S3.** Nine-panel plot of correlation between contemporaneous Pandora HCHO column amounts: direct-sun (DS) vs sky-scan (SS) for each quality category, following the Rawat et al. (2025, AMT) QC method at Pontianak station. Panels are organized by DS and SS quality categories (0 = high, 1 = medium, 2 = low). Each panel shows the scatter of DS vs SS HCHO (molecules  $\text{cm}^{-2}$ ), with points color-coded by uncertainty thresholds: gray = both below cutoff, cyan = DS above cutoff, yellow = SS above cutoff, red = both above cutoff. The red dashed line represents the 1:1 relationship, and the correlation coefficient ( $r$ ) and number of matched observations ( $N$ ) are indicated in each panel.

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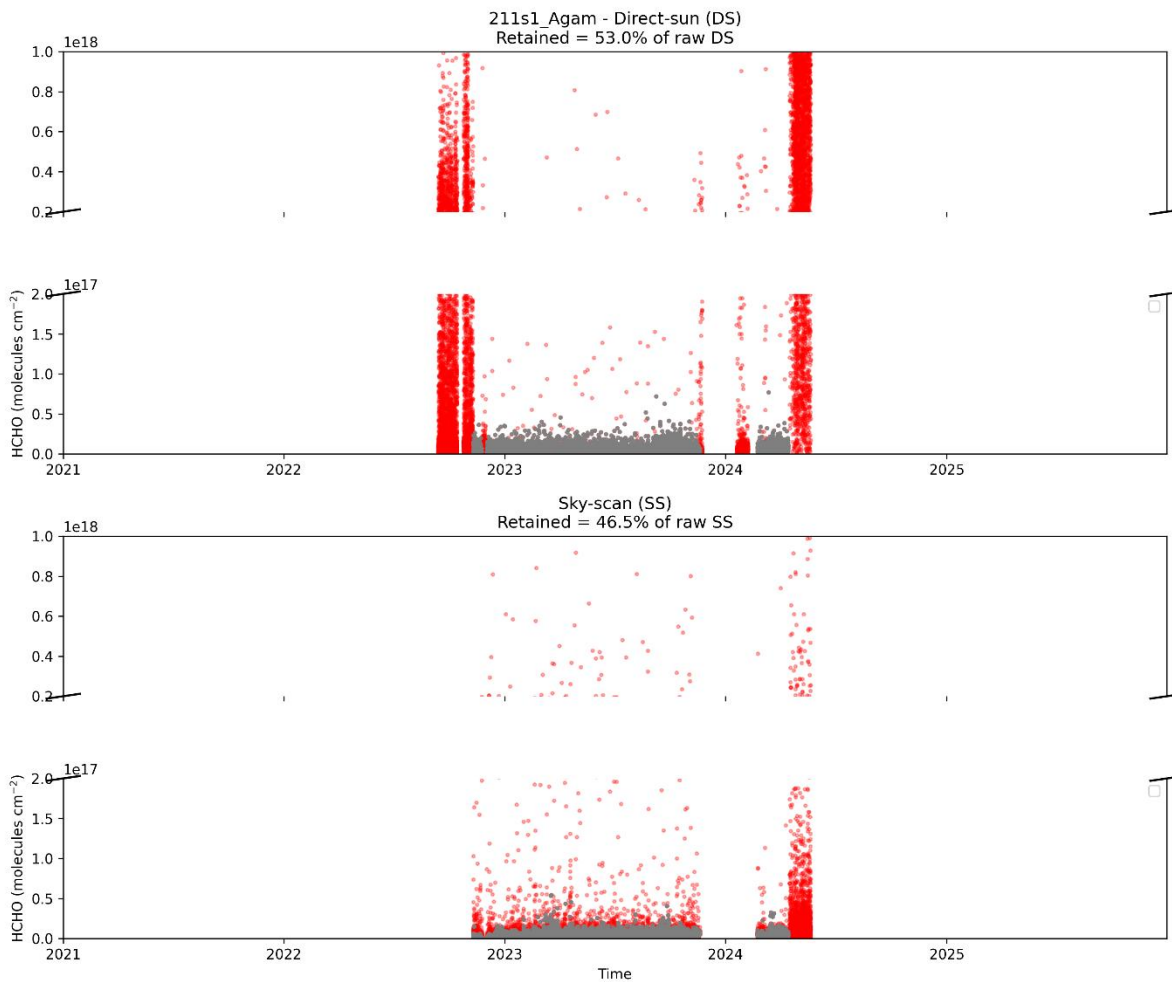


50 **Figure S4.** Nine-panel plot of correlation between contemporaneous Pandora HCHO column amounts: direct-sun (DS) vs sky-scan (SS) for each quality category, following the Rawat et al. (2025, AMT) QC method at Singapore-NUS station. Panels are organized by DS and SS quality categories (0 = high, 1 = medium, 2 = low). Each panel shows the scatter of DS vs SS HCHO (molecules cm<sup>-2</sup>), with points color-coded by uncertainty thresholds: gray = both below cutoff, cyan = DS above cutoff, yellow = SS above cutoff, red = both above cutoff. The red dashed line represents the 1:1 relationship, and the correlation coefficient (r) and number of matched observations (N) are indicated in each panel.

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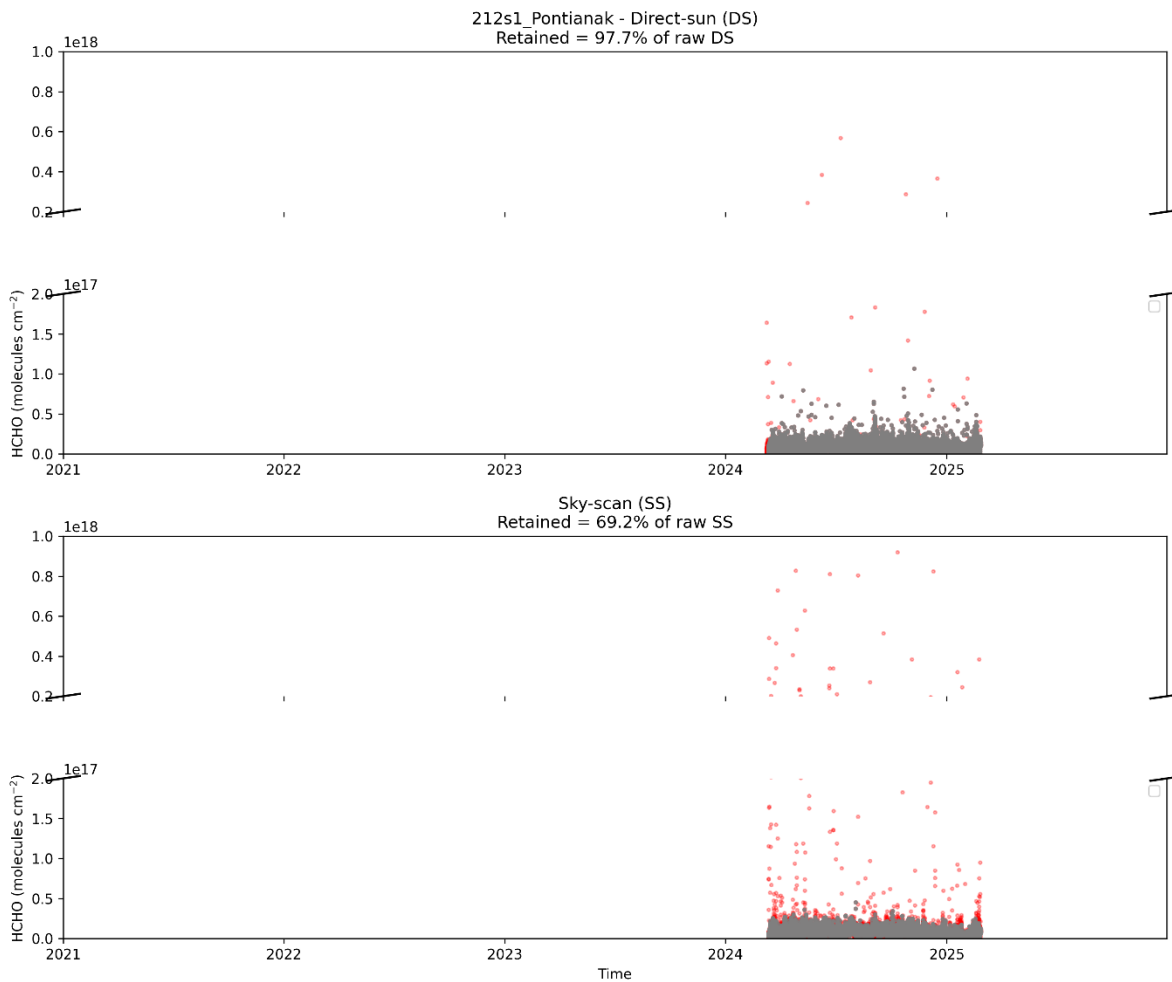
60 **Figure S5.** Time series of Pandora HCHO column amounts for direct-sun (DS) and sky-scan (SS) measurements following the Rawat et al. (2025, AMT) QC method at the Pandora Bandung station. The upper panels show DS HCHO, and the lower panels show SS HCHO. Removed data points failing quality control (QC) are highlighted in red, while retained measurements are shown in gray. Broken y-axes are used to display both low and high concentration ranges. The percentage of removed points due to QC is indicated in the DS panel titles. Corresponding time series for the other stations are provided in Figures S5–S8.



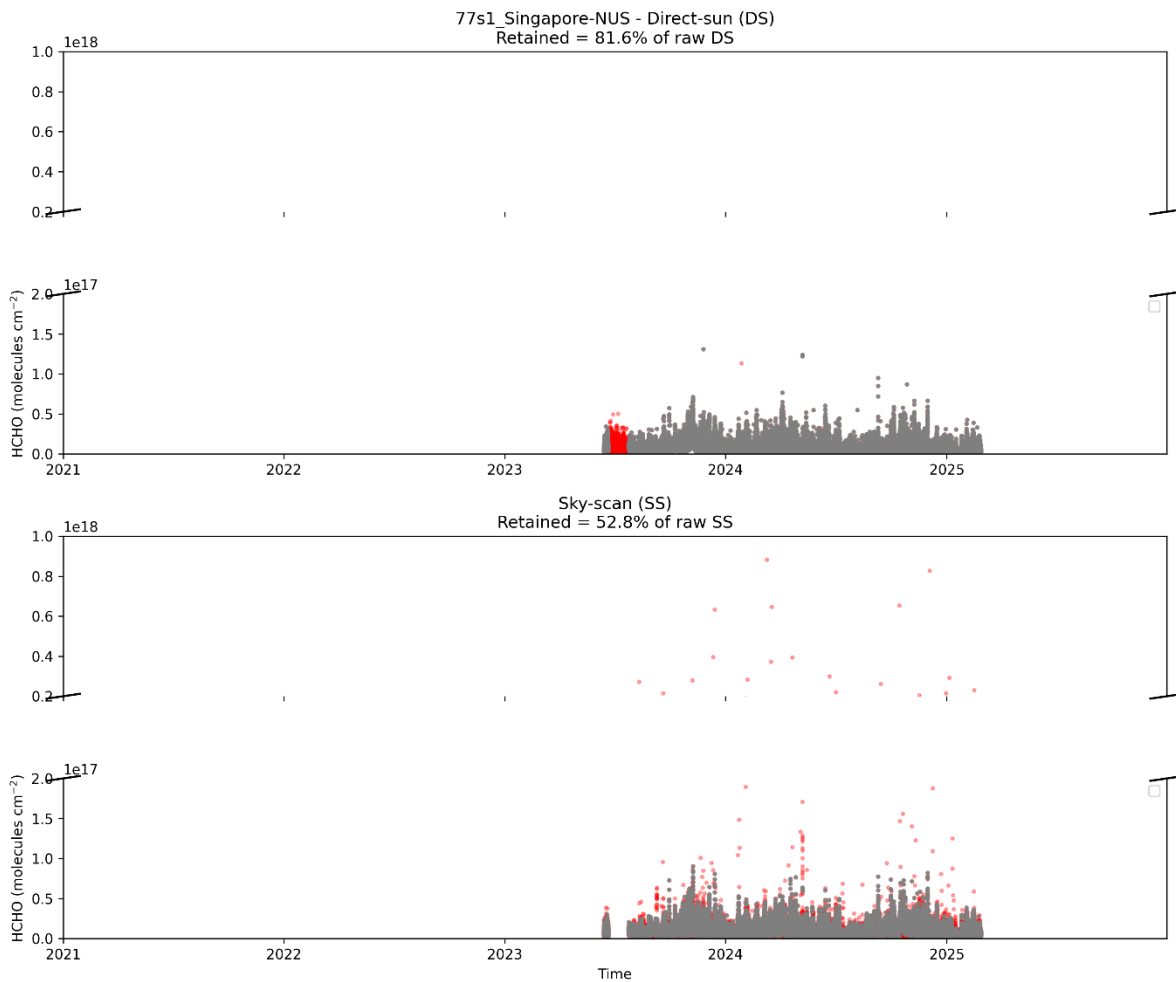
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**Figure S6.** Time series of Pandora HCHO column amounts for direct-sun (DS) and sky-scan (SS) measurements following the Rawat et al. (2025, AMT) QC method at the Pandora Agam station. The upper panels show DS HCHO, and the lower panels show SS HCHO. Removed data points failing quality control (QC) are highlighted in red, while retained measurements are shown in gray. Broken y-axes are used to display both low and high concentration ranges. The percentage of removed points due to QC is indicated in the DS panel titles. Corresponding time series for the other stations are provided in Figures S5–S8.

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75 **Figure S7.** Time series of Pandora HCHO column amounts for direct-sun (DS) and sky-scan (SS) measurements following the Rawat et al. (2025, AMT) QC method at the Pandora Pontianak station. The upper panels show DS HCHO, and the lower panels show SS HCHO. Removed data points failing quality control (QC) are highlighted in red, while retained measurements are shown in gray. Broken y-axes are used to display both low and high concentration ranges. The percentage of removed points due to QC is indicated in the DS panel titles. Corresponding time series for the other stations are provided  
 80 in Figures S5–S8.



85 **Figure S8.** Time series of Pandora HCHO column amounts for direct-sun (DS) and sky-scan (SS) measurements following the Rawat et al. (2025, AMT) QC method at the Pandora Singapore-NUS station. The upper panels show DS HCHO, and the lower panels show SS HCHO. Removed data points failing quality control (QC) are highlighted in red, while retained measurements are shown in gray. Broken y-axes are used to display both low and high concentration ranges. The percentage of removed points due to QC is indicated in the DS panel titles. Corresponding time series for the other stations are provided in Figures S5–S8.