Can formaldehyde column densities be used to estimate near-surface ozone in urban areas?

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Understanding pollutant exposure for populations in urban areas requires air quality monitoring at a finer scale than can be reasonably provided by surface networks. Satellite measurements of short-lived trace gases could potentially help shape our understanding of the distribution of near-surface ozone throughout entire regions, thus aiding the development of more effective mitigation strategies. In this work, the extensive vertical profiling performed by aircraft in support of NASA's DISCOVER-AQ field campaign is used to examine the relationship between formaldehyde column measurements and near-surface ozone. At large spatial and temporal scales, a fairly strong relationship exists between column formaldehyde and near-surface ozone, but this relationship often weakens at smaller spatial and temporal scales. The cause of these small-scale discrepancies was determined to be an artifact of the difference in lifetimes between ozone and formaldehyde. While ozone has a long lifetime (multiple days) and tends to accumulate throughout the day, formaldehyde has a very short lifetime (a couple hours) and tends to reflect the local hydrocarbon oxidation environment. In Maryland, where biogenic emissions dominate the hydrocarbon mix, a stronger correlation between ozone and formaldehyde was seen than in Texas, where anthropogenic emissions dominated the hydrocarbon mix. This is because in Maryland, while ozone was accumulating throughout the day, formaldehyde was also increasing in conjunction with changes in biogenic emissions. When data are segregated spatially and averaged over the duration of each campaign, a clear trend can be seen between column formaldehyde and surface ozone measurements. While not useful for day-to-day monitoring, this could be useful for long-term exposure estimates and could help facilitate the re-distribution of surface monitoring sites.