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On the relationship between acetone and carbon monoxide in different air masses

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Abstract. Carbon monoxide and acetone measurements are presented for five aircraft measurement campaigns at mid-latitudes, polar and tropical regions in the northern hemisphere. Throughout all campaigns, free tropospheric air masses, which were influenced by anthropogenic emissions, showed a similar linear relation between acetone and CO, with a slope of 21-25 ppt_v acetone/ppb_v CO. Measurements in the anthropogenically influenced marine boundary layer revealed a slope of 13-16 ppt_v acetone/ppb_v CO. The different slopes observed in the marine boundary layer and the free troposphere indicate that acetone is emitted by the ocean in relatively clean air masses and taken up by the ocean in polluted air masses. In the lowermost stratosphere, a good correlation between acetone and CO was observed as well, however, with a much smaller slope (~5 ppt_v acetone/ppb_v CO) compared to the troposphere. This is caused by the longer photochemical lifetime of CO compared to acetone in the lower stratosphere, due to the increasing photolytic loss of acetone and the decreasing OH concentration with altitude. No significant correlation between acetone and CO was observed over the tropical rain forest due to the large direct and indirect biogenic emissions of acetone.

The common slopes of the linear acetone-CO relation in various layers of the atmosphere, during five field experiments, makes them useful for model calculations. Often a single observation of the acetone-CO correlation, determined from stratospheric measurements, has been used in box model applications. This study shows that different slopes have to be considered for marine boundary layer, free tropospheric and stratospheric air masses, and that the acetone-CO relation cannot be used for air masses which are strongly influenced by biogenic emissions.

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