

On the relationship between acetone and carbon monoxide in different airmasses



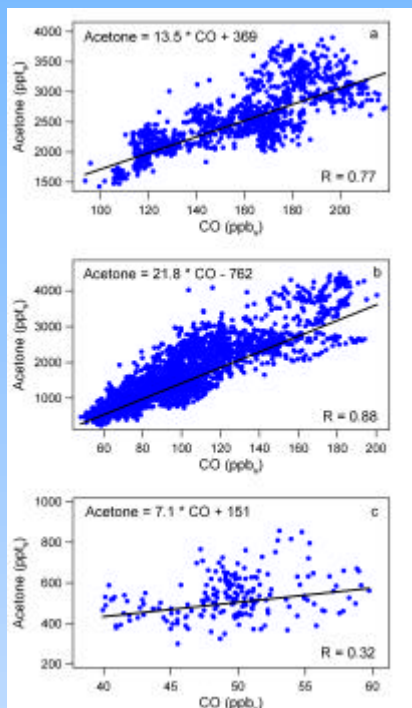
MAX-PLANCK-GESellschaft

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The correlation between CO and acetone has been investigated for five airborne measurement campaigns, at mid-latitudes, polar and tropical regions and show a common slope for different layers of the atmosphere.

Free tropospheric airmasses, which were influenced by anthropogenic emissions, showed a linear relation between CO and acetone, with a slope of 21 ppt_v acetone/ppb_v CO. Measurements in the, anthropogenically disturbed, marine boundary layer revealed a slope of 15 ppt_v acetone/ppb_v CO. The reduced slope in the marine boundary layer indicates the uptake of acetone by the ocean. In the lowermost stratosphere, a good correlation between CO and acetone was observed as well, however, with a much smaller slope (5 ppt_v acetone/ppb_v CO) as in the troposphere. This is caused by the longer lifetime of CO compared to acetone in the lower stratosphere, due to the photolysis of acetone. No significant correlation between CO and acetone was observed over the tropical rain forest due to the large biogenic emissions of acetone and acetone precursor gases.

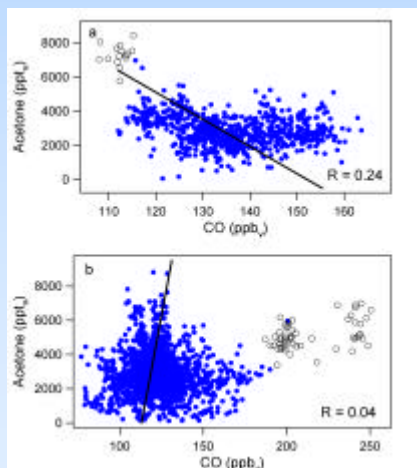


Linear correlation between the acetone and CO mixing ratio, observed during the MINOS campaign. Figure (a) shows data from the marine boundary layer, (b) the free troposphere and (c) the lower stratosphere.



The STREAM, LBA-CLAIRE and INDOEX measurements were performed onboard the Dutch Cessna Citation aircraft.

The correlation between acetone and CO has often been used in box model studies for the initialisation of acetone mixing ratios from measured CO mixing ratios [e.g. McKeen *et al.*, 1997; Frost *et al.*, 2002]. For this a CO-acetone ratio of 6.1 ppt_v acetone/ppb_v CO has been used, which has been observed in the lower stratosphere by McKeen *et al.*, [1997]. This study shows that different ratios have to be considered for marine boundary layer, free tropospheric and stratospheric airmasses. Moreover, the CO-acetone ratio can not be used in areas where biogenic emissions dominate.

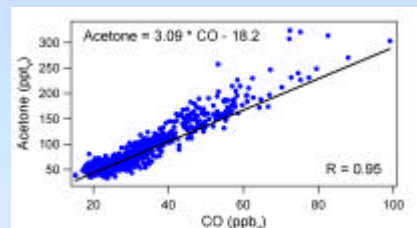


Linear correlation between the acetone and CO mixing ratio, observed during LBA-CLAIRE. No significant linear correlation was observed in the boundary layer (a) and free troposphere (b) over the Amazonian rain forest. The open circles represent measurements in the marine boundary layer and in an upper tropospheric biomass burning plume and are not included in the linear fit.

CO measurements were performed using a tunable diode laser spectrometer, acetone measurements using a proton-transfer reaction mass spectrometer or a chemical ionisation mass spectrometer. An orthogonal distance regression, taking into account errors in both coordinates, is used to determine the linear correlation between CO and acetone.



During MINOS, acetone and CO measurements were performed onboard the German research aircraft Falcon.



Linear correlation between the acetone and CO mixing ratio in the lower stratosphere during STREAM97.

References:

McKeen *et al.*, The photochemistry of acetone in the upper troposphere: A source of odd-hydrogen radicals, *Geophys. Res. Lett.*, 24, 3177-3180, 1997.
Frost *et al.*, Comparison of box model calculations and measurements of formaldehyde from the 1997 North Atlantic Regional Experiment, *J. Geophys. Res.*, in press, 2002.

Slope of the linear relation between CO and acetone for five airborne measurement campaigns.

| Campaign | Place | Time | Boundary layer | Free troposphere | Stratosphere |
|------------|---------------------|--------------|----------------|------------------|--------------|
| STREAM97 | Kiruna, Sweden | March 1997 | - | - | 3.1 ± 0.14 |
| LBA-CLAIRE | Paramaribo, Surinam | March 1998 | no correlation | no correlation | - |
| STREAM98 | Timmins, Canada | July 1998 | - | 20.2 ± 0.28 | 5.7 ± 0.35 |
| INDOEX | Male, Maldives | Feb/Mar 1999 | 16.2 ± 0.85 | 21.6 ± 0.41 | - |
| MINOS | Crete, Greece | July 2001 | 13.5 ± 0.70 | 21.8 ± 0.22 | 7.1 ± 2.5 |