ABSTRACT

It is well known that VOCs are released into the atmosphere by both anthropogenic and natural sources (e.g., fossil fuel combustion, biomass burning and biogenic emissions). Nevertheless, the discrimination of these sources is difficult due to the small contribution of their emissions. In order to better characterize these sources, tracers of the oxidation of the VOCs such as HCHO and CHOCHO are used as proxies. Formaldehyde, the smallest aldehyde in the atmosphere is primarily formed through the oxidation of VOC by OH but is also directly emitted. Glyoxal, the smallest dicarbonyl, is a monospecies product formed mainly under the influence of solar radiation and is a good tracer of HCHO oxidation.

HCHO and CHOCHO were measured from 2003 to 2007, and an annual basis the vertical column (VC) values of CHOCHO ranged from 8.6x10^14 to 3.4x10^15 molecules cm^-2 while the respective glyoxal values ranged from 6.0x10^14 to 2.0x10^15 molecules cm^-2. The main known sinks of HCHO and CHOCHO are: a) the reaction with the OH radical and the b) photolysis leading to an estimated lifetime of 3.5 h and 1.0 h respectively.

INTRODUCTION

Formaldehyde

Current knowledge

- HCHO is mainly produced by the oxidation of methane (CH4) and Non-Methane hydrocarbons (NMHCs)
- It is also (to a lesser extend) primarily emitted by anthropogenic and biogenic sources.

HCHO is formed by the oxidation of NMHC.

Contrary to HCHO no direct sources are expected. This makes CHOCHO a better indicator of the VOC oxidation.

RESULTS - ANNUAL VARIATION

Glyoxal and formaldehyde were calculated on an annual basis for the period 1.8.2002 – 31.12.2006. The figures to the left depicts the global mean values for each country for the two species. Certain areas appear to have more enhanced vertical column values for both CHOCHO and HCHO pointing to the presence of photochemical hot spots. These areas are found in South America, Africa, East USA, the developing Asian cities, India and to a lesser extend Europe. At a first glance it was found that the highest glyoxal values were observed near the source regions (anthropogenic, biogenic and biomass burning). This could be associated with the short lifetime of the CHOCHO.

The graph to the right presents the annual variation of glyoxal above four indicative areas where glyoxal had increased during the last years (Tianjin). It maintained its levels (Kolkata), did not have a seasonal variation (Bangkok) and it had winter maxima (Southern Hemisphere, Johannesburg).

SEASONAL VARIATION

The retrieved SCIAMACHY data of CHOCHO and HCHO for the period 2003–2006 were also analyzed on a seasonal basis by calculating the average values of winter months (blue circles, left figure) and summer months (red color, left figure). It was found that in most of the cases both glyoxal and formaldehyde show similar seasonal behavior. For instance, during winter, the observed maxima are found in the tropics hemisphere, while during summer the northern hemisphere dominates. This enables us to draw the conclusion that both species have short- and well-comparable lifetimes.

For the areas chosen (see the analysis below), the mean monthly value of CHOCHO and HCHO was calculated (right graph). It can be seen that during winter conditions span maximun. This is mainly due to the enhanced OH that control the VOC oxidation and produces the HCHO and the CHOCHO.

CONCLUSIONS

Emission of CHOCHO and HCHO from megacities and industrial regions (e.g., South Korea, China, India and South Asia) have a significant global impact on the tropics.

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Instrumentation & Experiment

The vertical column (VC) of HCHO and glyoxal are calculated with the Differential Optical Absorption Spectrometer (DOAS) and subsequently converted to the vertical column (VC) in molecules cm^-2. The latter is then divided by the area of the observation site to get the average concentration over the observation area. The data have been analyzed in the original region of 2.5° in latitude and 1° in longitude and finally re-binned to 3° in latitude and 2° in longitude. The mean values in the vertical direction are then binned to global coverage in 8 days with a spatial resolution of 1° in latitude and 2° in longitude.