The very short-lived ozone depleting substance, CHBr₃ (bromomethane): Revised UV absorption spectrum, atmospheric lifetime and ozone depletion potential

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I. Introduction

Reactive Bromine (Br₂) in the Stratosphere

Bromine has a significant impact on stratospheric ozone through its participation in various catalytic ozone destruction cycles. Bromine is ~40 times more efficient in depleting ozone than chlorine.

CHBr₃, a very short lived substance

CHBr₃, alternatively known as CH₂BrBr, CH₂Br₂, or CH₂Br₃, is a very short-lived ozone depleting substance. It is a potent ozone-depleting substance, and the improved UV cross section data provided in this work, combined with recent GH kinetic data enable an improved estimate of its impact on stratospheric ozone – particularly in a changing climate.

II. Experimental Details

Approach and Conditions

Measure the CHBr₃ weak absorption cross sections using the sensitive cavity ring-down spectroscopy (CRDS) technique.

Identify and account for possible systematic errors (Rayleigh scattering, impurities) using CRDS (532 nm) and Fourier Transform Infrared Spectroscopy (FT-IR).

Methods and Materials

- Online measurement of CHBr₃ with 254 nm absorption (cross section taken from JPL 10-6)
- CHBr₃ sample purity checks:
  - Several samples used
  - BR scavenger used (Cu turnings)
  - Impurity upper level measured with CRDS at 532 nm
- Upper limits for commonly used stabilizers and halocarbons was established with FTIR

- CHBr₃ Rayleigh scattering cross section measured at 532 nm. Scattering between 300 and 345 nm determined by fitting dependence
- Negligible loss of CHBr₃ through the flow system determined using different flow configurations

III. CHBr₃ UV Absorption Spectrum

Representative Data and Quality

Most of the data is at selected wavelengths and temperatures. Different symbols for each temperature represent variation of experimental conditions (different samples, Br source, various flow and pressure conditions).

Unreliability in CHBr₃ absorption cross section data impacts calculated atmospheric photolytic rate, lifetime, and transport to the stratosphere.

IV. CHBr₃ Photolysis Rates, Lifetimes, and ODPs

Atmospheric Photolysis Rate Calculation Details

CHBr₃ Photolysis Rates

Comparison with JPL 10-6

Relative Contribution of Atmospheric Loss Processes of CHBr₃

CHBr₃ Lifetimes and ODPs

Ozone Depletion Potentials (ODPs)

- Seasonal CHBr₃ lifetime and ODPs

V. Concluding Statement

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* Accurately quantify the CHBr₃ atmospheric photolysis rate - via improved absolute UV cross sections measurements of CHBr₃
* Identify and account for sources of systematic errors
* Estimate the total CHBr₃ gas-phase lifetime - photoysis + OH reactive loss
* Estimate the Ozone Depletion Potential (ODP) for CHBr₃ - using a semi-empirical method (Brodale et al.)

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