Reactive and Non-reactive Quenching of O(1D) by the Potent Greenhouse Gases SO₂F₂, NF₃, and SF₆CF₃

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Abstract

We investigated the reactive and non-reactive quenching of O(1D) by SO₂F₂, SF₆CF₃, and NF₃, three of the most potent greenhouse gases. Experimental and atmospheric modeling were performed to determine their reactivity and potential impact on the stratospheric O(1D) concentration. We found that SO₂F₂ had the highest reactivity, followed by NF₃ and SF₆CF₃. Our results suggest that these gases could play a significant role in the stratospheric chemistry and climate system. Further study is needed to fully understand their impact.

Keywords: O(1D); reactive quenching; non-reactive quenching; greenhouse gases; modeling.

Introduction

Smaller atmospheric quenching rates for the long-lived greenhouse gases (greenhouse gases) have been reported in recent studies. Several studies have shown that the atmospheric lifetimes and GWP coefficients for these compounds are not accurately estimated by their relative reactivity and quenching efficiency. This is because their reactivity is dominated by quenching processes with large GWP values, whereas their absorption coefficients are small. In summary, the atmospheric lifetimes and GWP coefficients of these compounds are not accurately determined by their relative quenching efficiency and absorption coefficients. In this study, we investigated the reactive and non-reactive quenching of O(1D) by SO₂F₂, NF₃, and SF₆CF₃, three of the most potent greenhouse gases. Experimental and atmospheric modeling were performed to determine their reactivity and potential impact on the stratospheric O(1D) concentration.

Results

(112) The observed temporal profile of O(1D) in the presence of a range of [R] allows both the first-order rate coefficient and the yield from the O(1D) + R reaction to be determined. The temporal profiles of O(1D) fluorescence intensity (Figure 2) following the laser flash are described by the double exponential expression:

\[ \frac{dN}{dt} = \gamma R \left( 1 - e^{-kt} \right) \]

where \( k \) is the first-order rate constant and \( \gamma R \) is the fluorescence signal at time t after the laser flash. The observed temporal profiles of O(1D) fluorescence intensity are shown in Figure 2.

The rate coefficient for reactive quenching is found to be slower than the non-reactive quenching. A schematic diagram of the LIF apparatus is shown in Figure 1. A sample of O(1D) was exposed to SO₂F₂, SF₆CF₃, and NF₃, and the fluorescence intensity was measured. The rate coefficient for reactive quenching was found to be slower than the non-reactive quenching.

Discussion

The rate coefficient for reactive quenching was found to be slower than the non-reactive quenching. A schematic diagram of the LIF apparatus is shown in Figure 1. A sample of O(1D) was exposed to SO₂F₂, SF₆CF₃, and NF₃, and the fluorescence intensity was measured. The rate coefficient for reactive quenching was found to be slower than the non-reactive quenching.

In this study, we investigated the reactive and non-reactive quenching of O(1D) by SO₂F₂, SF₆CF₃, and NF₃ by monitoring the appearance of O(1D) atoms using atomic resonance fluorescence spectroscopy (RFS) and laser flash fluorescence spectroscopy (LFFS) techniques. A schematic diagram of the LFFS apparatus is shown in Figure 1. A sample of O(1D) was exposed to SO₂F₂, SF₆CF₃, and NF₃, and the fluorescence intensity was measured. The rate coefficient for reactive quenching was found to be slower than the non-reactive quenching.

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