Infrared Spectra and Radiative Efficiencies of Atmospherically Persistent Perfluoroamines: N(CxF2x+1)3, x = 2-5

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1 INTRODUCTION

Perfluorinated amines (N(CxF2x+1)3, PFAm) are persistent greenhouse gases

- (C2F5)3N has a reported radiative efficiency of 0.86 W m⁻² ppb⁻¹ (Hong et al. 2013)
- (C3F7)3N mixing ratio of 0.18 ppt observed in urban Toronto, Canada (Hong et al. 2013)
- Other PFAms have not been observed to date

Atmospheric loss processes and lifetimes for PFAms are NOT well characterized

Atmospheric lifetimes are expected to be >250 years

Objectives of This Study

Laboratory measurements used to evaluate key atmospheric metrics for this class of compounds

Global Warming Potential (GWP)

Radiative efficiencies (RE)

Atmospheric lifetimes (τ)

Atmospheric loss processes: UV photolysis, O(1D) reaction

2 EXPERIMENTAL DETAILS

- Infrared Spectroscopy-
  Measure infrared absorption spectra
    - Spectral range: 600-4000 cm⁻¹
    - Detector: HgCdTe (MCT)
    - Resolution: 1 cm⁻¹
    - Pathlength: 15, 185 and 455 cm
    - Temperature: 294 K
    - Total pressure: 10-600 Torr (He bath gas)

- UV Photolysis -
  Measure UV absorption spectra
    - Light source: Deuterium lamp
    - T = 294 K
    - λ range of interest: 195-235 nm

- O(1D) Reaction -
  Measure O(1D) Rate Coefficient
    - Relative rate method
    - O(1D) source:
      O₃ + hν (248 nm) → O(1D) + O₂ (1/2)
    - T = 294 K, P = 300 Torr
    - Reference: CF₃H
      k(CF₃H+O(1D)) = 2.4×10⁻¹² cm³ molecule⁻¹ s⁻¹ (Burkholder et al., 2015)

3 RESULTS

3.1 Infrared absorption spectra

PFAms absorb strongly in the mid-IR region
- IR absorption falls within the atmospheric window
- IR band strength increases with increasing chain length (increase of C-F bonds)
- (CxF2x+1)3N spectrum is in good agreement with that reported by Hong et al. (2013), but not with Godin et al. (2016)
- No data available for other compounds

3.2 Radiative efficiencies (RE)

PFAms have very high RE values and are potent greenhouse gases (GHGs)

- RE calculated using the methodology reported in Hodnebrog et al. (2013)
- RE from PFAm are higher than those of HFCs and CFCs which have REs typically ≤ 0.3 W m⁻² ppb⁻¹ (WMO, 2014)

References

- Hodnebrog et al., Global warming potentials and radiative efficiencies of halocarbons and related compounds: A comprehensive review, Rev. Geophys., 51, 300-378, 2013

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