The Impact of CH₄ and N₂O Atmospheric Loss Process Uncertainties on Model Calculated Ozone and Global Lifetimes

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1. OVERVIEW and OBJECTIVES

- Accurate determination of the loss rates of Methane (CH₄) and Nitrous oxide (N₂O) is important in understanding how these key atmospheric trace gases impact ozone abundance and radiative forcing.
- Global loss of CH₄ is dominated by reaction with OH (96.5%, mainly in the troposphere); stratospheric reactions with excited state atomic oxygen (O(¹D)), 2%, and chlorine (Cl, 1.5%) are minor loss processes.
- Global loss of N₂O is due to photolysis at 185-230nm (90%) and reaction with O(¹D) in the stratosphere (10%).
- In this study, uncertainties in the loss rates of CH₄ and N₂O are estimated from available laboratory measurements, as updated the recent SPARC (2013) lifetime report.
- GSF2 2D model simulations are shown to quantify the uncertainty ranges in lifetimes, ozone abundances, and long term ozone trends due to uncertainty in the CH₄ and N₂O loss rates. Impacts in the ozone hole region are also quantified using the GMI 3D model.
- The uncertainty ranges are calculated by setting the model loss rates to the 2σ uncertainty low (slow) and high (fast) values and compared with the baseline.

2. CH₄ and N₂O loss rates: Kinetic and Photochemical Data Evaluation

3. Uncertainty Impacts on Model Ozone – Present Day

4. Time Dependent Uncertainty Ranges in Total Ozone

5. Model Lifetimes

6. Conclusions

Table 1. CH₄ and N₂O atmospheric lifetimes and uncertainties (years) calculated from the 2D model using rate parameters from SPARC (2013) and JPL-2010. Values are global/annual averages for 2000 steady-state conditions.

References: